HAPPINESS

THE BUILT ENVIRONMENT

SHAPING THE QUALITY OF LIFE

ARCC-EAAE
INTERNATIONAL
CONFERENCE

PHILADELPHIA
MAY 16-19 2018

Volume 1

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Architectural Research for a Global Community

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Volume 1

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Architectural Research for a Global Community

Happiness: The Built Environment Shaping the Quality of Life

The two volumes of proceedings transcribe the papers presented at the 2018 conference in Philadelphia, jointly organized by ARCC and EAAE. The conference was a forum to bring together architectural scholars and practitioners from around the world. The conference gave us an opportunity to reflect on what and why we research. The idea of Gross National Happiness speaks to a measure of the collective well-being of a nation. Introduced by the King of Bhutan in early 1970s as an alternative to the prevalent notion of Gross National Product and with a focus on the human, the revised concept identifies four pillars of happiness, outlined in Bhutan's constitution: good governance, sustainable socioeconomic development, preservation and promotion of culture, and environmental conservation.

Recognizing the inherent relationship of the built environment to the tenets outlined in Bhutan's constitution, the conference used the framework of Gross National Happiness to provoke thought and dialog about how the things we research, design, and make contribute to our collective well-being and the places in which we live. The theme served us well – the proceedings present an examination of the architectural dimensions of community at scales between intimately local settings and the broader global commons.

The timing of the conference aligns with major shifts in social and political agendas both globally and locally that impact our physical and social environment. The location, Philadelphia – sometimes referred to as the cradle of modern democracy – provides an opportunity to extend the conversation to consider the humanistic and environmental forward-looking gaze that is part of the spirit of the place.

The papers and projects selected for presentation at the conference and inclusion in the proceedings are organized according to the following categories:

Architectural research and advocacy: the consideration of urgent social and political issues that face the built environment. Topics considered notions such as leadership and citizenry in a changing world, the role and impact of public engagement architecture in a social setting, architectural research and design connecting space, property, and value, and the transformative nature of data driven planning and design.

Architectural research and application: the consideration of the value of relationships between design and research. Topics focused on techniques and tools that enable us to think about the reciprocity between research and application at multiple scales and by a range of means. Issues included the impact of global design and planning research on local environments and social conditions, the change in global priorities due to local innovation, and the ethics of development.

Architectural research and culture: the consideration of the role of built environment as an active participant in the local and global production of culture. We posed questions about the shifting methods of research that yield a broader knowledge base and emerging digital tools that drive the course of humanities-oriented research. Topics included architecture's role in cultural change, historical research as design strategy, public history and cultural heritage, and the culture of architectural practice and research.

Architectural research and the environment: the consideration of the vital symbiosis between the natural and the built world. We sought participation that would address research questions and design solutions, reframing the dichotomy to find transformative relationships between humanity and its environment. Topics included environmental humanities, local sustainable practices facing global issues, greening of the built environment, and resilience as tracked through the interior to the exterior and from the object to the infrastructural scale.

As is often the case, the papers belonged, more often than not, in multiple categories. But the topical areas – advocacy, application, culture, and environment - provided us with threads and overlaps for dialog during the four days of the conference. The level of participation and engagement, by presenters, moderators, audience members, organizers, students, and staff was wonderful to observe. Many thanks to all who participated. The high quality of thought put into the research is reflected in the two volumes of proceedings presented here and gives us food for thought for the long term.

The three conference keynotes by Nigel Dancey, Billie Faircloth, and Sean Griffiths punctuated the discussion in the first three days of the conference. The opening and closing plenary sessions served as bookends for dialog and discussion. As moderator for the opening plenary, "The Built Environment Shaping the Quality of Life," I had the pleasure of engaging in dialog with Oya Atalay Franck, Brian Sinclair, and Frederick Steiner, all of whom are well versed through professional and academic experience in the topic. The closing plenary, "Urban Acupuncture: Identifying 'Must-Do' Projects and Why They Matter to the Quality of Urban Life," was moderated by David Riz, with back-and-forth dialog between Alan Greenberger, Madlen Simon, and Jeremy Voorhees. The session used the backdrop of projects in the local context – Philadelphia - for discussion about universal topics that impact our work. Ending with current projects in Philadelphia in a time of substantial growth gave us an opportunity to reflect on the applied nature of our research and creative work.

From all of us here at Temple University I offer thanks to our partner schools, Drexel and Jefferson University. The use of the three Philadelphia campuses, Temple in North Philadelphia, Jefferson in Center City, and Drexel in West Philadelphia, provided a wonderful way to engage the city in between the keynote, panel and paper sessions. And finally, many thanks to Hazem Rashed-Ali and the board of ARCC and Oya Atalay Franck and the board of EAAE for providing us with guidance and a clear framework for the 2018 conference.

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Introduction

Over the past few years, there has been an increasing appreciation of the important role that architectural research can play in expanding knowledge boundaries in both the discipline and the profession of architecture. Through architectural research activities, scholars, educators, and practitioners continuously improve our understanding of the built environment and related issues as well as explore innovative means of mitigating and overcoming the variety of challenges currently faced by our communities.

One of the most important requirements for enhancing the impact of architectural research is developing effective and high-quality venues for disseminating the outcomes of this research including conferences, journals, books among others. Since their start almost 20 years ago, conferences of the Architectural Research Centers Consortium (ARCC) have aimed to be an inclusive venue that offers a place to all architectural researchers, regardless of their areas of interest, while at the same time maintaining a very high standard of rigor and quality in the work presented. The biannual conferences, organized jointly with the European Association for Architectural Education (EAAE), have consistently maintained this high standard of rigor and quality while at the same time bringing together architectural scholars, educators and practitioners from North America, Europe and many other places, thus providing a much larger platform for the dissemination of architectural research ideas across many countries and several continents. The relationship between ARCC and EAAE represents an example of the type of collaboration needed to further enhance the effectiveness of architectural activities in addressing the range of global challenges that are fast increasing in type, size, and complexity.

This year's conference focused on the role of architectural research within the global community through exploring the inherent relationship between the built environment and the basic tenants of happiness: good governance, sustainable socioeconomic development, preservation and promotion of culture, and environmental conservation. The conference included four sub-themes that aimed to advance the discourse on the explicit connections between design decisions, qualities of life, and the promotion of community. These themes included: Architectural research and advocacy, which considered the social and political issues linked to the built environment; architectural research and application, which considered the value of relationships between design and research, and the techniques and tools that enable this reciprocity; architectural research and culture, which considered the role of the built environment as an active participant in the local and global production of culture; and architectural research and the environment, which aimed to explore the vital symbiosis between the natural and the built world. Given these themes, it was fitting to host the conference in the city of Philadelphia, one of the largest cities in the US, a city that faces many of the challenges the conference aims to explore, and one that offers numerous successful examples of how architecture and architectural research can serve to mitigate these challenges.

The conference included 23 paper sessions featuring 90 peer-reviewed paper presentations, selected from 236 submissions. These papers represented a wide range of research areas of interest including history and theory of architecture, architectural design, architecture and health, architectural education, sustainability and high performance, architectural technology, architectural practice, urban design, among others. The papers also covered the full scope of architectural research approaches and methods including qualitative, quantitative, and mixed methods. In addition to the paper sessions, the conference featured three poster sessions with 28 poster presentations, as well as two panel discussions and four workshops. The three keynote presentations reinforced the diversity of approach to research in architecture and underlined the global nature of the conference: They were held by Nigel Dancey, Senior Executive Partner at Foster and Partners of London, UK; Billie Faircloth, Partner and Research Head at Kieran Timberlake Architects of Philadelphia, USA; and Sean Griffiths, of the British office FAT fame and Professor at the University of Westminster, UK. The conference was attended by 135 participants, representing 61 institutions and organization from 11 countries, thus forming a truly global audience befitting both the conference's theme and the collaborative relationship between ARCC and EAAE.

Finally, on behalf of our two organizations, we would like to express our appreciation and gratitude to our hosts, Temple University, Jefferson University, and Drexel University. In particular, we would like to thank Professor Kate Wingert-Playdon, the conference chair from Temple University, who's effort made this conference possible. We highly appreciated the hospitality and generosity that she, her team of volunteers, and all other organizers showed to all of us during our time in Philadelphia. We would also like to express our thanks and gratitude to everyone who participated in making this conference a success including our authors, organizing committees, paper reviewers, volunteers, and attendees. Without their generous efforts and contributions, this conference would not have been possible.

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The Discipline of Architecture and the Rights of Nature

The Discipline of Architecture and the Rights of Nature

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ABSTRACT: The *Universal Declaration of Human Rights*, proclaimed by the United Nations General Assembly in Paris in 1948, stands unmatched as a common standard for global human rights. As the impacts of industrialization reinforce the dependence of humans on functioning ecosystems, it is fitting for the United Nations to take the lead in advancing dialogue on shared principles for the rights of nature. In 2016, the United Nations General Assembly initiated a dialogue on “harmony with nature,” a phrase chosen to describe ecological holism and described sometimes by “earth jurisprudence,” to describe legal frameworks for the rights of nature. The *Expert’s Summary Report* on that dialogue was presented to the General Assembly at its seventy-first session in September 2016 (United Nations, 2016). The *Expert’s Summary Report* includes perspectives from earth-centered law, ecological economics, education, holistic science, humanities, philosophy/ethics, theology, and the arts, media, design and architecture. Representatives from each of these disciplines were asked: What would the practice of the selected discipline look like from an earth jurisprudence perspective? What are approaches, obstacles, recommendations, and priorities for achieving earth jurisprudence?

While harmony with nature is an ancient principle and while earth jurisprudence as a legal philosophy is gaining global traction, the inclusion of the discipline of architecture in such discussions is both new and significant. In this paper, I report on existing dialogues in the discipline of architecture that have bearing on this topic and then ask: What are ways that frameworks for the rights of nature or earth jurisprudence have the potential to shape the practice of architecture? In responding to this initial question, this paper offers a brief view on considering design processes that integrate fundamental rights of nature and offers speculation on the shape of a built environment that is rooted in these principles.

KEYWORDS: Architecture, Sustainability, Nature, Rights

INTRODUCTION

1.0 BACKGROUND

The idea of humans as one interdependent part of an ecological whole, the idea that the health and wellbeing of such a whole is dependent on relationships between its components, and the idea that natural systems have intrinsic value, are each fundamental to ancient and contemporary indigenous ontologies (Westra, 2014). In contrast, the ontologies that shape modern global capitalism are rooted in the idea that humans are separate from the living and nonliving world (nature) and in the idea of nature as a resource for human gain (Merchant, 1990).

At the same time, climate change and other effects of industrialization are bringing global attention to the consequences—including for humankind—of environmental degradation. While it is not clear that economic liberalism is compatible with an eco-centric world view or that there is a place for the intrinsic value of natural systems in market capitalism or in democratic judicial systems, a movement for the “rights of nature” is gaining some notable ground.

Some of the most significant gains are rooted in the Global South. In 2008, the government of Ecuador included the rights of nature in its constitution, explicitly stating that nature has the right to exist, the right to be cared for, and the right to restoration (Lake, 2017). In 2010, Bolivia hosted The *World People’s Conference on Climate Change and the Rights of Mother Earth*. That conference concluded with the presentation of a *Universal Declaration of the Rights of Mother Earth* to the United Nations. That declaration describes the earth as an “indivisible community of diverse and interdependent beings with whom we share a common destiny and to whom we must relate in ways to benefit Mother Earth” (Burdon, 2011). This is parallel to work in North Amercia. In 2006, Tamaqua Borough, Pennsylvania passed an ordinance recognizing nature as a rights-bearing entity. Since then, at least twenty-four communities in the US have done the same. In 2010, New Zealand and Maori people resolved a treaty with the Waikato Settlement Act that includes the description of the Waikato River is a “single, indivisible whole” (Lake, Westra).

The diversity of language used to describe ecological holism reflects fundamental differences in global cultures. In some indigenous languages, specific phrases embody the idea of integration with nature, such as *sumak kawsay* in Quichua. In South America, this is most often described in Spanish as *buen vivir*, a phrase that implies a kind of ecologically-connected wellbeing and is a phrase that has been adopted by proponents of ecologically-minded development in the Global South (Kauffman, 2017).

The intersection of eco-centric worldviews and western thought, mostly in the Global North, has yielded frameworks for talking about relationships with ecosystems in legal terms—in terms of the *rights of nature* or *earth jurisprudence*. But, the idea of natural rights or legal rights is a modern and western concept. In launching a knowledge network on the rights of nature in 2016, the United Nations General Assembly chose to refer to the project with the more globally-inclusive phrase *harmony with nature*.

The United Nations knowledge network’s virtual dialogue Harmony with Nature generated an *Expert’s Summary Report* that was presented to the General Assembly at its seventy-first session in September 2016 as part of assembly discussions on sustainable development (United Nations, 2016). That summary report included perspectives from earth-centered law, ecological economics, education, holistic science, humanities, philosophy/ethics, theology, and the arts, media, design and architecture. Representatives from each of these disciplines were asked: What would the practice of the selected discipline look like from an earth jurisprudence perspective? What are approaches, obstacles, recommendations, and priorities for achieving earth jurisprudence?

In this paper, I review the limitations and then the opportunities of a harmony with nature or earth jurisprudence perspective in existing dialogues in the practice of architecture. My comments are rooted in my own contributions to the United Nations knowledge network that generated the 2016 Expert’s Summary Report.

2.0 EXPANDING ARCHITECTURAL FRAMEWORKS FOR HARMONY WITH NATURE

2.1 Frameworks

The design of the built environment within the context of market capitalism demonstrates extreme disharmony with nature. The most grave environmental crises of the era: climate change—melting ice sheets, sea level rise, ocean acidification, climate disruption and global warming—along with widespread species extinction, are direct consequences of the construction and operation of the built environment through unchecked combustion of fossil fuels and unchecked conversion of carbon-rich habitats to polluting landscapes. The practice of architecture and the nature of the built environment are physical manifestations of the legal, economic, and ideological frameworks that separate humans from the living and nonliving world (nature) and that position nature as a resource for human gain.

Despite architecture’s complicity in these most serious environmental crises and despite the near inseparability of contemporary architectural practice from the legal, economic, and ideological frameworks that are at the root of these crises, contemporary architectural theory includes at least three anchoring points for beginning to explore architectural practices that are in harmony with nature.

2.2 Design with Nature

The discipline of architecture includes a body of 20th-century literature and case studies that guide the design of buildings that are integrated with nature at the scale of the architectural site. Site-responsive design in architecture, as described in a canon of North American guidebooks such as *Design With Nature* (McHarg, 1969), *Sun Wind and Light* (Brown, 1985), and *Design with Climate* (Olgyay, 1963) and as demonstrated by architects globally such as Glenn Murcutt and Behnisch Architekten, demands careful response to regional climate and natural phenomena. Like Sim van der Ryn’s foundational book *Ecological Design* (van der Ryn, 20007), these and other texts acknowledge the connection between architecture and water, energy, and nutrient systems and propone design strategies that optimize gain from the environment (rain water catchment and solar energy) and that minimize harm (consumption of fossil fuels, on-site pollution). Each of these texts centers on the idea of knowing and responding to the architectural site.

These texts gained popularity concurrently with the discipline of ecology in science, the concept of permaculture in agricultural development, and with late 20th-century awareness of the finitude of fossil fuels. They are at the root of concepts of sustainable architecture and are related to voluntary metrics for greener building such as LEED (Leadership in Energy & Environmental Design) in North America. These texts and metrics represent enormous efforts to make new buildings less environmentally impactful. These same texts and metrics have helped building designers follow the path of car producers—who have made more fuel efficient cars—in making buildings that are proportionally less “gas guzzling.”

While the focus on connecting to regional climates did redirect some attention to local ecosystems, the center of this movement for green architecture was its focus on slowing down resource consumption by making buildings that were “less bad.” In the case of the original LEED metric, the explicit goal was to make buildings that used fractionally less operations energy. This design paradigm is in keeping with a view of nature as a finite resource and perhaps with idea of the wellbeing of nature as inseparable from that of other components in the ecosystem, but not necessarily in keeping with the idea of the intrinsic value of intact ecosystems.

The limitations of the term “sustainability” as a way of talking about green architecture is parallel to the limitations of this way of practicing architecture. While the term has come to represent the leading edge of green design practice, it is also defined in the often repeated but never cited anecdotal conversation about sustainability as “the ability to keep on taking from the earth without giving back” (Lockwood, 2017).

In order to achieve harmony with nature, the discipline of architecture will need to figure out how to make buildings that have value that is measured by their participation in functioning ecosystems rather than by limitations on their destruction of such. The original texts that anchor this way of thinking—design with nature—include important ideas about interconnection that may not be fully manifested in metrics and green building practices that focus on quantities of resource consumption.

2.3 Materialism

Architecture can be understood as a material practice. Buildings are arrangements of physical material that reacts to other physical material in dynamic, infinitely complicated ways. Architecture is a practice that is dependent on the nature of material, living and non-living, and on the way that those materials interrelate. As Aldo Rossi wrote in *A Scientific Autobiography*, architecture is “made possible by the confrontation of a precise form with time and the elements, a confrontation which lasted until the form is destroyed in the process of this combat” (Rossi 1981). Aldo Rossi’s *tempo* (time and the elements) anticipates Diana Coole and Samantha Frost’s foundational anthology *New Materialism: Ontology, Agency, and Politics.* They write: “Our existence depends from one moment to the next on myriad micro-organisms and diverse higher species, on our own hazily understood bodily and cellular reactions and on pitiless cosmic motions, on the material artifacts and natural stuff that populate our environment . . . .” (Coole, 2013).

In new materialist philosophy, the physical material of the world exists outside of imposed hierarchies and independent of perception-based ontologies. In this view, physical materials are not inert but are, in the words of Jane Bennett, “key actants” (Bennett, 2010). In this view of material as vibrant, vital, and primary, there can be no separation between humans and nature. Understanding and practicing architecture as a materialist practice is a step toward undermining the humans versus nature dualism.

New Materialism describes a world that is true to the reality of architectural practice. Steel rusts, sunlight warms, water creeps, concrete cracks, spiders weave. Architecture is, in fact, an inseparable part of nature. New Materialism may offer a framework for embracing and expanding this way of thinking about architectural practice. In an expanded materialism, design processes could include a full accounting of the physical context of its material actants. The design process could include an understanding of energy and material sources, an understanding of how energy and material transforms over time. New Materialism offers a way of thinking about design processes as the choreography of material and energy over time.

Compared to ecological holism or *buen vivir*, materialism in architectural practice depends on the idea of absolute interrelation, including between humans and nature. But, unlike ecological holism or *buen vivir*, it does not necessarily include a vision of wellbeing. To anchor a practice of architecture in harmony with nature, architectural materialism would need to be paired with an eco-centric environmental ethic.

2.4 Expanded Site

Architectural site documentation is part of the canon of architectural education and practice. The practice of making site drawings is based on the idea that, fundamentally, good design should improve a site. Even without defining improvement, it is important to consider the site boundaries in this kind of drawing. How do you define the boundaries of the site that is being judged? Is it just the building site itself? Or, does a good design need to be a net gain for an entire city, region, or watershed? Can the benefit be temporary or does it need to be lasting to be considered good design or at least an overall improvement?

Ecosystem thinking and global climate change break down the usual temporal and physical boundaries of site design. For example, emissions from converting forests to fuel in South America have global climate impacts. Even though global climate change will affect some parts of the world more acutely, it is impossible for just part of the atmosphere to be impacted. It is also impossible to separate present from future generations. Everything on the planet is connected and what we do now will impact the future. In these terms, buildings should be judged for their holistic, global, and permanent good.

The idea of interpreting and judging buildings in terms of an expanded site is described well by David Leatherbarrow in what he calls the building's "orientation." In *Architecture Oriented Otherwise* he explains the word in terms of a building's topographical, performative, and experiential context. In his way of thinking, the building is not an object but rather a place where things happen in relation to other things. A building's orientation is the influence it has on light, on an individual person or on a neighboring street (Leatherbarrow, 2009).

Leatherbarrow's perspective could be understood as an extension of Karsten Harries' or even David Harvey's perspective on the ethical functions or political ramifications of architecture in which buildings and cities operate in very broad spheres of influence. For Harries and Harvey, the built environment is inseparable from the social, economic, and politic realities that it embodies and reinforces (Harries, 1997; Harvey, 1990). For Leatherbarrow, this perspective may be more directed at the physical nature or experience of a place than at political, social, or economic realities.

Leatherbarrow writes that contemporary ecological theory may offer a parallel to his idea of orientation, to his idea of "thinking widely and acting locally." While he does not expand on his comparison to contemporary ecological theory, his descriptions of the orientations of buildings do seem to echo the fundamental principle of ecosystem thinking—the idea that everything is connected.

This expanded site of architectural impact challenges the media and methods of architectural site analysis. The next challenge is to find ways to draw the full site—because in architecture, to draw something is to account for it—that account for the extreme local and global natures of environmental impacts.

3. Conclusion: Architecture and Nature

These three frameworks from drawn from current architectural discourse—the idea of responding to nature in architecture, the idea of materialism in architectural practice, and the idea of the site in architectural design—each anchor a way of beginning to think about how architecture might fit into a practice that is in harmony with nature. At the same time, each of these frameworks are limited in their current practice, much because of the way that architecture necessarily manifests the legal systems, economic systems, and ideologies of global capitalism.

It is important to note that while these three frameworks are each in some way relatable to the idea of harmony with nature, or ecological holism, it is more difficult connect these frameworks with earth jurisprudence, or with the idea of rights of nature. This disconnect when it comes to legal philosophy is a result of the limitations of architecture as a practice that is framed by outside hierarchies. Within those structures, architecture does have agency to make connections with ecosystems (connect with nature), to choreograph physical relationships (materialism), and to account for a global site of impact (expanded site).

Meanwhile, while humans and the built environment remain separated from nature, and while the idea of nature itself is a human construction, it is worthwhile to note that every building reflects some cultural construction of the idea of nature in the way that it positions people in relation to the bigger environment. The most important contribution to be made by architects to dialogues about harmony with nature will be in buildings themselves that explore and reflect changing views on the idea of nature in the human world.

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Rashida Ng, Andrew Wit, Tonia Hsieh

Cloud Magnet: The Ethical Imperative for Environmental Health and Restoration

Cloud Magnet: the ethical imperative for environmental health and restoration

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ABSTRACT: This paper presents data from Cloud Magnet, a research and design project conducted in the summer 2017 within the cloud forest of the Monteverde Biological Reserve in Costa Rica. Cloud Magnet explores the co-dependencies between material, form, energy, and environment. Cloud forests have been rapidly disappearing due to climate change and deforestation. Rising global temperatures and deforestation cause a cloud-lifting effect, raising the cloud cover above the tree canopy and forest ecosystem that depend on constant moisture and humidity to support its life. The impetus for this project is to explore how design can contribute to the stabilization of the atmosphere and the restoration of the forest. In recognition of the mutual and inseparable presence of built and natural contexts, Cloud Magnet suggests that architects bear an ethical responsibility for the health of the environment. As such, priorities of environmental performance might be extended beyond energy efficiency to include aspirations of environmental remediation and ecological healing to reverse the harmful effects of human habitation on the world.

KEYWORDS: ethics, environmental restoration, material performance, phase change material, carbon fiber reinforced polymers

INTRODUCTION

As society contends with rising concerns over the viability of our ecosystems, the convergence of human and ecological priorities is increasingly evident. Architecture bears a long history of prioritizing the needs and desires of human experience, including the provision of shelter, creation of community, and design of conditions for physical comfort and human health. Over the past several decades, architecture has responded to challenges of sustainability, seeking to minimize the overall environmental impact of buildings and establish new metrics of energy performance. These measures increasingly acknowledge the impact of buildings on the biosphere. However, these standards and principles do not yet fully embrace the fundamental alignment of human and natural contexts. We assert that architects bear an ethical responsibility for the health of the atmosphere.

1.0 ETHICS OF ENVIRONMENTAL RESPONSIBILITY

Environmental philosophers began to shift their thinking in the 1960s, placing greater emphasis on “humans-in-the-world” as compared to “humans-apart-from-the-world.” They began to explore the history and evolution of our societies to understand the ways in which our cultures connect us or separate us from nature and its diverse resources through these questions:

> What can I know about the environment in which humanity exists?
> What should I do to both sustain and contribute to this environment?
> What may I hope for regarding the future of this environment?
> What is “humanity” in relationship to this ecosystem?
> What role does nature play in developing our sense of beauty?
> What are the most logical ways of addressing the role of humans in the environment? (Delaney 2014, 8)

For philosophers, these queries expound on the fragility of human existence and its connections to the various ecospheres that sustain our lives – and all life. They serve as a reminder of the similarities that exist between human life and other biota, while also underscoring the distinction of the ethical vantage point that only humans can assume. Unlike other forms of life, humans possess the moral responsibility to preserve and safeguard the environment, while also harnessing the power and ability to harm it.

In consideration of the relationship between the professional ethics of architects and the collective responsibility of society to defend the current and future health of the environment, a number of challenges arise. Tom Russ suggests, “There is a design philosophy at the heart of every design effort” (Russ 2010, 117). The act of design consistently requires the subjective prioritization of certain criteria over others, as well as the resolution of competing and conflicting agendas at the same time. The ethics of professional judgment is an essential aspect of the practice of architecture. Current standards of sustainability focus on energy and resource efficiency and human health, but fall short of identifying the health of the environment as a benchmark criterion. Human acts of making, i.e. objects, buildings, infrastructure, do not simply create a built environment that is separate and apart from the natural. To the contrary, these acts of making can be conceived of as a new natural state. As human health is fundamentally aligned with environmental health, architects bear an ethical responsibility to preserve and improve the condition of the environment. In order to act with ethical responsibility towards this goal, we must expand our understanding of the micro-climatic and macro-climatic effects of constructed objects within the ecosystems of the earth.

1.1. A threatened ecosystem

As scientific evidence continues to intensify confirming the significant and indisputable rise in the temperature of the Earth's atmosphere, some of the most bio-diverse ecosystems such as grasslands, coral reefs, and rainforests are threatened. Among these is the Monteverde Cloud Forest Reserve, a tropical montane cloud forest in Costa Rica that has been subject to well-documented effects of climate change since the early 1990s (Holmes 2000). Moisture levels in the cloud forests depend on the trade winds that carry humid air into the mountains, where it condenses covering large areas of forest in fog. Tropical montane cloud forests have been found to be particularly susceptible to the effects of climate change. Encompassing six Holdridge life zones within its diverse topography, Monteverde is a highly useful place to study climate change as it characteristically experiences wide seasonal variations in temperature, precipitation, and other climatic variables (Holmes 2000). Furthermore, recent simulations of climate change through the year 2100 suggest continued pressures on the ecosystem, projecting an increase of 3.8 °C (6.8 °F) in the mean dry surface air temperature along Costa Rica's Pacific slope, while dry season precipitation is expected to fall by approximately 14% during the same period (Nadkarni 2014). If this comes to pass, the current ecology of the forest would be undoubtedly imperiled.

The cloud forest in Monteverde is located within the Guanacaste-Tilarán Mountains, along the continental divide, a topographic ridge between the Pacific and Atlantic oceans that extends from Canada to Argentina. The highest peak of the forest rises 1,800 meters (5,900 feet) above sea level, with hiking trails located up to 1,250 meters (4,100 feet). The cloud forest plays a vital role in the hydrologic cycle in Monteverde as it captures water as wind-driven mist and fog, protects watersheds from erosion, and reduces runoff. Although reforestation measures within the protected, high-altitude zones of the forest have been initiated over recent decades, research on the broader context of this interconnected landscape has identified two primary causes for the persistent reduction of cloud-covered forest. Firstly, the rising global temperature has caused a rise in the altitude of cloud bases by 25 to 75 meters (Deepak 2006). Secondly, deforestation at lower altitudes for farming and more urbanized land uses have been linked to an estimated 5 to 13% decrease in cloud cover in the forest (Deepak 2006). This fragmented landscape further increases the local temperature of the atmosphere due to the reduction of dense flora that retains moisture and distributes it from the cloud to the ground. Furthermore, fauna depend on the connectivity of the tree canopy between altitudinal gradients for movement and migration.

The removal of forestland continues to jeopardize the native biota at the higher altitudes of the cloud forest by lowering the relative humidity and increasing the temperature of the air that rises over the mountains. Forest clearing also causes soil compaction, reducing the infiltration of rainfall into the ground, decreasing the moisture levels in soils, increasing the runoff within streams and rivers, and decreasing the presence of atmospheric mist (Lawton 2001). These changes have been linked to the disappearance of high altitude flora and fauna, including birds, reptiles, amphibians, and other forms of life that are less closely monitored. The changing climate has also made way for outbreaks of pathogens that thrive within the warming atmosphere, and further threaten native species. The interdependency of forest ecosystems foreshadows ongoing ripple effects in the years to come (Nadkarni 2014).

1.2. A history of conservation of nature

The Monteverde Cloud Forest Reserve was founded on principles of conservation that reflect the ethical obligation of humans to protect the environment. American Quakers who were disillusioned with the war efforts in the United States settled in Monteverde in 1950 drawn to the climate, farming industry, and antiviolence position of the country, which had just abolished its army. Well before the effects of climate change became evident, the tropical montane cloud forest was rapidly disappearing due to deforestation. The Quakers purchased about 1400 hectares (3500 acres) of land in Monteverde for dairy farming, parceling some of the land into lots for their homes, farmland, a school, and a meetinghouse for worship. However, they also protected about a third of their land, entitled the Watershed Property, and agreed to leave this area of forest intact to protect the streams needed to supply water for their community (History of Monteverde).

This Quaker community spurred additional interest from English-speaking visitors, as scientists began to visit the area to study the rare species of fauna, namely the golden toad, now extinct from the forest, and the Resplendent Quetzal that remains an attraction for today's eco-tourists. Twenty years after the first Quakers arrived, biologists George and Harriett Powell visited the area and foresaw the impending threat to this unique ecosystem. Alarmed at the rate of forest removal for farmland, the Powells raised money and purchased as many parcels of primary forest as they could to save the forest. The Powells arranged for the Tropical Science Center, a non-governmental scientific and environmental organization in San José, to care for the newly protected land. With assistance from the World Wildlife Foundation, more properties were purchased and added to the privately owned protected land. In 1974, the Quaker community also leased its land to the Tropical Science Center, increasing the total area of secured property to 2,000 hectares (4,940 acres). With the help of Wolf Guindon, one of the original Quaker settlers, and Eladio Cruz, a native Costa Rican from San Luis, the Reserve continued to expand, including higher altitude forest and land in the Peñas Blancas River valley on the eastern side of the Continental Divide. Today, the Monteverde Cloud Forest Reserve encompasses over 10,500 hectares (26,000 acres) of primarily virgin forestland. Much of this land remains inaccessible to the public, as less than 3% of the reserve is open to visitors through a trail network maintained by the reserve (History of Monteverde).

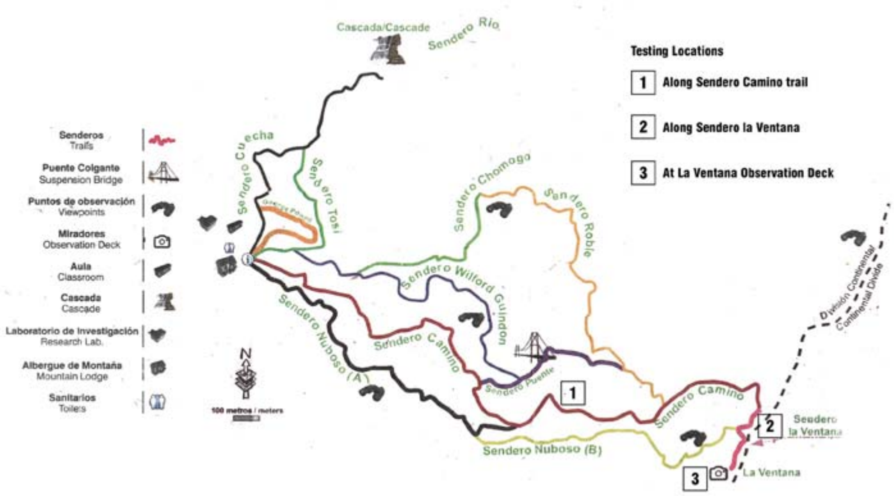


Figure 1: Monteverde Cloud Forest Reserve Trail network (modified) with testing locations (distributed by the Monteverde Cloud Forest Reserve, June 2017)

2.0 A SPECULATIVE PROPOSAL

Cloud Magnet is a research proposal that explores how design might contribute to the restoration of the cloud forest in Monteverde. The initial ideas for the project emerged from a speculative proposal in response to the 2013 d3 Natural Systems Competition, an ideas contest that encouraged the investigation of natural processes that proposed innovative, sustainable, and ecological design solutions to the impending threats associated with climate change. The team's entry, "Cloud Magnet: Restitching the Costa Rican Forest Canopy" proposed a systems strategy to conserve and restore the cloud forest and received a Special Mention for Ecological Systems Enhancement in the competition.

2.1. A systems strategy for forest restoration

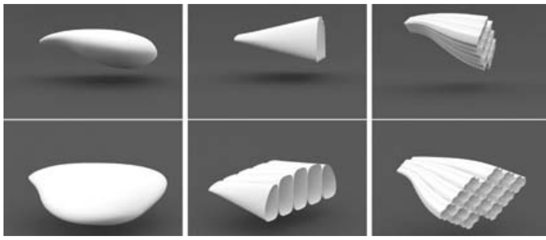
In response to the issue of deforestation, the competition proposed a networked system of structures intended to act as a catalyst by which fragmented patches of forest would begin to be reconnected. The design considered five different site zones from the higher altitude forest through the lower altitude farmland, including the Elfin Forest, the Highland Tree Fall Gap, the Midland Valley, the Lowland along Route 702, and the Lowland Pastureland. Central to this proposal were a series of forest stitching (FS) structures that provide a habitat where native epiphytes, such as mosses and bromeliads, would propagate and grow through the collection of moisture and nutrients from the air. The FS structures were also designed to serve as windbreaks at the vulnerable edges of the forest, providing a continuous biological corridor through a network of flexible epiphyte-covered ropes that span over roadways for the migration of fauna. Capturing and directing water, synthetic dew ponds were proposed along cable zip lines between the structures to provide micro-ecosystems for the habitation of small insects, plants, and amphibians, to aid in the restoration of the forest. The network of structures was designed to provide a transitional zone between the reforming forest and areas of human habitation. In time, the structures are intended to be overgrown by the local flora to reconnect the diverse life zones of the Costa Rican cloud forest. The re-densification of plant life within farmland would also help reduce surface air temperatures within the lowlands, capturing the moisture from the humid air and directing it towards the re-colonization of the forest, with the hope of reversing some of the adverse effects of deforestation that plague the tropical montane cloud forest above.

Figure 2: (Left) Cloud attracting (CA), cloud forming (CF), and forest stitching (FS) structures; (Right, top) Site strategy for the elfin forest using CA kites; (Right, bottom) Site strategy for the Highland tree fall gap using FS structures and CF kites.

In addition to the forest stitching structures, the speculative proposal also proposed the distribution of a series of kites along various elevations within the Guanacaste-Tilarán mountain range. The Cloud Magnet kites were designed to modify airflows in order to stimulate the formation of clouds. Two types of kites were proposed: cloud-forming and cloud-attracting types, which would work through the creation of low pressure zones and the reduction of air temperature, essential environmental conditions for the formation of clouds. The skin of the kites would be fabricated with phase change material (PCM) coated fabric to reduce the temperature of the surrounding air by storing high quantities of latent heat in the change of state from solid to liquid. The forms of the kites were based on scientific principles of airflow and designed to reduce the pressure of the air. Based on Bernoulli's Principle of Pressure, the cloud-forming (CF) kites channeled air through a cluster of venturi tubes, cylindrical forms with a narrow throat that increases the velocity of the air thereby decreasing its pressure. The CF kites were sited in varying densities within the lower to mid altitude site zones. The shape of the cloud-attracting (CA) kite was informed by the sectional profile of an airfoil used within the wing of an airplane. As air circulates around the airfoil shaped kite, a low-pressure zone is created on the top surface due to the increased velocity that occurs on the upper surface of an airfoil. Located in clusters at the highest altitudes of the forest, the cloud-attracting kites were envisioned to mitigate the lifting effect of the clouds off the mountain. Dust particles and pollen within the wind would be funneled through and around the diminutive microclimates of the Cloud Magnet assemblies thereby stimulating the formation of clouds and mist.

3.0 DESIGN AND PROTOTYPING

Following the completion of the ideas competition, we received funding to test ¼ full-scale "proof-of-concept" prototypes of the Cloud Magnet kites in the cloud forest in Costa Rica. The team refined the designs of the cloud-forming kites through digital modeling, computational fluid dynamic (CFD) simulations, material studies, and physical prototyping. The final prototypes were fabricated in Philadelphia, shipped by airfreight to Costa Rica, and then assembled at the Monteverde Cloud Forest Reserve prior to testing along the trails of the forest. One of the primary design considerations was to utilize a form that reduced the pressure of the air flowing through and/or around the kites. We evaluated both the speculative designs of the CF and CA kites for their potential for further refinement and future prototyping. Based on our initial CFD studies, the venturi tube form of the CF kite seemed to have a greater potential to modify the pressure differential of the air and was therefore selected for further development. We explored several iterations of the designs, including a series of bundled venturi tubes similar to that of the initial proposal and a hybrid design that combines the form of the venturi tube of the CF kite with the sectional profile of an airfoil utilized in the CA kite design (See Figure 3).



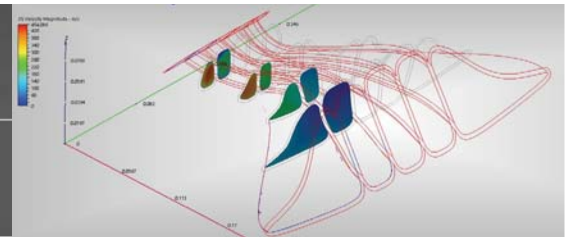


Figure 3: (Left) Formal studies of kites **Figure 4**: (Right) CFD simulation of airflow and velocity showing increased velocity (reduced pressure) in the narrow throat.

As we refined the forms, further CFD simulations were used to analyze flows, pressure change, air velocity, and the overall aerodynamics of the model. As shown in Figure 4, the smaller the circumference of the tube, the greater the velocity of the air, which results in a corresponding decrease in air pressure. These design studies were useful in establishing basic criteria for the movement of air through the kites including ratios of air inlets to air outlets, and served to inform the physical prototyping of the kite frame and skin that followed. Concurrent to the digital studies of form, we also evaluated the movement of air through the forms utilizing 3d printed studies of the forms placed within a smoke tunnel for flow visualization.

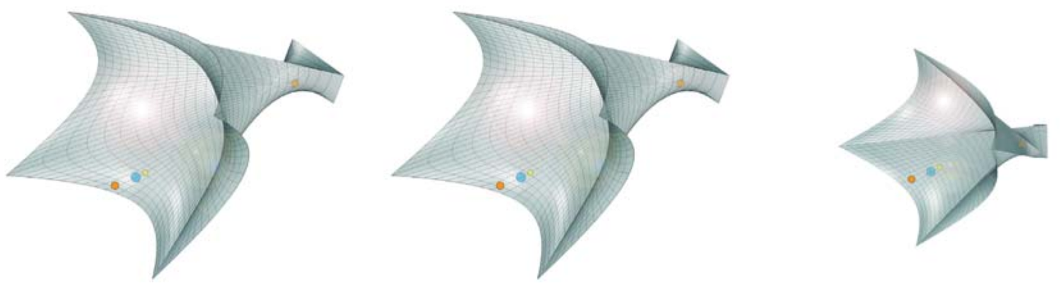
Given the expertise of the project team and the lightweight characteristics of the materials, we prototyped the skin of the kites with Dyneema CT5K.18, a laminated nonwoven ultra-high molecular weight polyethylene (UHMWPE) fabric skin, which was stretched over a flexible pre-impregnated carbon fiber reinforced polymer (CFRP) frame. The Dyneema fabric was coated with a pattern of high performance transfer adhesive tape dusted with Rubitherm PX27, a microencapsulated phase change material (microPCM). Data from the CFD analysis was utilized to create an iterative dialogue between the digital modeling and formal studies and the iterative prototyping of the frames.

Throughout the design process, nearly twenty CFRP frame prototypes were fabricated; each wound in a malleable state then cured in large gas fired kilns. The curing process took approximately four hours of firing at a temperature of 127°C (260°F), with an additional eight hours dedicated to temperature ramp up and down time to achieve its desired structural characteristics. The early frame prototypes attempted to replicate the complex and fluid curvatures of the digital studies. To achieve this, we created a removable core of laser cut cardboard that could withstand the heat of the kiln during firing, and be removed from the cured frame by soaking it in water. Although successful at a small-scale, creating high strength frames and low-cost rapid prototyping, the cored system produced excess waste in the cardboard core, and the rigid form posed problems for shipping. Therefore, this approach was abandoned in favor of a more material-efficient coreless winding process that produced a high level of structural strength while retaining a spring-like elasticity in the frame when compressed. The coreless winding process introduced a logic in which the fabrication process closely informed the final geometry of the frame, rather than attempting to replicate a digitally derived predetermined form. 24k (24,000 strand) CFRP tow, bundled into rovings of carbon fiber that resemble cable or rope, were wound between stainless steel hooks that were bolted to a reconfigurable steel frame which allowed for variation on both ends of the kite as well as in its length. The pattern of hooks on one side created a wide opening as the air inlet; the hooks on the other side were arranged to produce the narrow throat of the kite outlet. Non-stretch, high-temperature cable was wound around the hooks before the CFRP tow was added, creating a predefined formwork of the structure that minimized the chance of CFRP tow slippage during the winding and baking process. The CFRP was wound in a pattern of alternating clockwise and counter clockwise passes. With each successive winding, the CFRP cables were pulled into increased tension creating the desired double curvature in the form.

The reusable cable formwork not only minimized error in during the winding and baking processes, but also minimized the amount of CFRP necessary, providing a more material-efficient, lightweight, and flexible frame. The flexible CFRP wound frames were compressed for shipping efficiency, and then attached to pre-fabricated CFRP perimeter arches and compressive rectangular rings to provide a rigid frame. The final geometry of the kite prototype that was tested in Costa Rica included a 45-degree rotated axis, provided to maximize the efficacy of the microPCM by allowing the kite to rotate its sun facing surface allowing for even heat distribution on all sides of the fabric skin. The Dyneema skin was sculpted to fit the rotated frame through the use of the MPanel tensile fabric modeling software and fabricated from (16) flat panels that achieved a double curvature when fully assembled. The fabric was trimmed and rolled onto a cardboard spool, and each of the (16) panels was printed onto the textile using a wide format ink-jet plotter. The individual patterns for each panel included 1” wide tab extensions that were affixed with Dyneema fabric welding tape to join all the patterns into a fabric sock with openings at both ends. The fabric sock was stretched inside the CFRP framework and pulled into tension. The microPCM was affixed to the interior of the kite, to provide for maximum temperature reduction along the airflow path.

4.0 TESTING AND RESULTS

The team fabricated and tested (2) ¼ full-scale kites and one smaller prototype as indicated in Figure 7. The kites were equipped with programmed microcontrollers with (2) temperature, pressure, and humidity sensors, one located at the air inlet, the other positioned at the air outlet. Kite 01_Yellow was a ¼ full-scale prototype with a CFRP frame and Dyneema fabric skin without microPCM. Kite 02_Blue was the same as Kite 01_Yellow with the addition of microPCM. Kite 03_Red included a 90 degree rotated frame and Dyneema fabric skin with microPCM.



	KITE 1	KITE 2	KITE 3
Size:	Large (30" x 30" x 48")	Large (30" x 30" x 48")	Small (24" x 24" x 36")
Design:	180° Rotation	180° Rotation	90° Rotation
Fabric:	Dyneema CT5K.18 welded w/ CTPSA tape	Dyneema CT5K.18 welded w/ CTPSA tape	Dyneema CT5K.18 welded w/ CTPSA tape
PCM:	None	Rubitherm Microencapsulated PX 27 50% surface area w/ 3M transfer tape	Rubitherm Microencapsulated PX 27 50% surface area w/ 3M transfer tape
Data:	(1) Feather M0 Micro-controller (2) BME280 Temp/Humidity/Pressure (1) RTC_DS3231 Real-time	(1) Feather M0 Micro-controller (2) BME280 Temp/Humidity/Pressure (1) RTC_DS3231 Real-time	(1) Feather M0 Micro-controller (2) BME280 Temp/Humidity/Pressure (1) RTC_DS3231 Real-time

Figure 7: Kites fabricated in Monteverde for testing.

Testing was conducted at several locations with perceptible wind flow along the hiking trails. Many of the trails are located with the forest canopy, beneath the shelter of mature trees with little to no access to the trade winds. Also, some of the trail paths were narrow and steep, and therefore difficult to traverse with the kites and computing equipment in hand. The team identified three locations with steady airflow for the kite testing as indicated in Figure 1; one along the Sendero Camino, another in a clearing along the Sendero la Ventana, and the third situated along the continental divide at the La Ventana lookout. The exposed mountain peak at La Ventana proved to be the best location for testing as it offered the greatest access to the trade winds from the North East. The vegetation in this area consisted of shorter elfinwood trees characteristic of exposed mountain ridges at this altitude, and several viewpoints openings are cleared along the mountain peak that provided adequate space for testing.

When exposed to the open area, Kite 2 performed as expected, increasing the relative humidity of the air at the outlet, and decreasing the temperature of the air. The Figure 8 graph diagrams the performance of Kite 2 for approximately ten minutes of testing at location 3, La Ventana (Data Set 013). The plot charts the change in relative humidity (%) and dry bulb air temperature (°C) between sensor 1 (located at the air inlet) and sensor 2 (located at the air outlet). Plotted values indicate the difference calculated as the variable measured at sensor 2 – sensor 1. The kite was lifted into the air at 10:49:46, just after testing was initiated at 10:59:37.

The initial weather conditions from the outset of testing to approximately 11:02 (+/-) were windy and overcast with high clouds about the mountain peaks. During this time, the airflow stabilized with about a -3 °C temperature change, and an 11% increase in humidity. Then, the sun began to peek through the clouds and the performance of the kite improved, reaching a maximum increase in relative humidity of 18.12%, with a concurrent decrease in temperature of 4.41°C (7.87°F) and decrease in air pressure of 70.67 hPa. When the peak change was observed, the temperature and pressure at sensor 1 (inlet air) was 26.35°C (62.94°F) and 84,732.72 hPa, with the temperature and pressure at sensor 2 (outlet air) of 22.10°C (71.78°F) and

84,662.05 hPa. At approximately 11:04, the wind speeds began to decrease during which time the change in relative humidity steadily declined as indicated in Figure 8. In addition, the data reveal an increase in the performance of the kite when clouds and mist were not observed in the air as compared to conditions when intermittent mist was present in the winds moving upward along the mountain slope. The kite was dismounted at 11:09:11, marked by the distinct shift in the graph where the temperature change and relative humidity change lines cross for the second time.

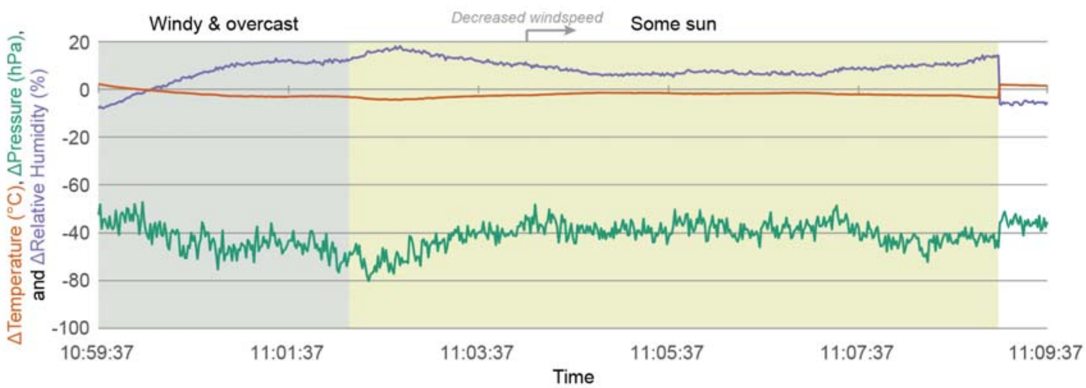


Figure 8: Testing of Kite 2 at Location 3: La Ventana, Data Set 013, June 28, 2017.

For the ten second interval surrounding the peak in humidity change, the mean change in humidity (sensor 2 minus sensor 1) was 16.98% +/- 0.62%; the mean change in temperature was -4.28 +/- 0.10 °C; and the mean pressure change was -72.11 +/- 2.61 hPa. Refer to Figure 9 for absolute values during this interval.

Change: Sensor 2 - Sensor 1	
Δ Humidity	16.98 +/- 0.62 %
Δ Temperature	-4.28 +/- 0.10 C
Δ Pressure	-72.11 +/- 2.61 hPa

Absolute Values: Sensor 1	
Humidity	63.48 +/- 0.49 %
Temperature	26.34 +/- 0.12 °C
Pressure	84730.64 +/- 3.22 hPa

Absolute Values: Sensor 2	
Humidity	80.46 +/- 0.42 %
Temperature	22.06 +/- 0.0272 °C
Pressure	84658.53 +/- 2.17 hPa

Figure 9: Mean and Standard Deviation, 10-second interval at peak humidity change; Kite 2 at Location 3: La Ventana, Data Set 013, June 28, 2017.

Kites 1 and 2 were simultaneously tested on June 27, 2017 at testing location 1 along the Sendero Camino trail during light rain and misty conditions. These kites were identical in form, but Kite 1 did not contain microencapsulated PCM, thereby allowing for comparative results that isolate the performance of the PCM. Unfortunately, some data was lost seemingly due to moisture contact with the microcontrollers. Valid data from Kite 1 was collected for 11 minutes 19 seconds (Data Set 004) producing a mean change in temperature of -0.09 °C, a mean change in pressure of 9.23 hPa, and a mean change in relative humidity of -1.85%. It is notable that the relative humidity decreased from sensor 1 at the inlet air to sensor 2 at the outlet, which is the opposite of the anticipated result. However, the specific relative humidity was high at both sensor locations, with consistent values near 99.5% at sensor 1, which may be attributable to the weather at the time of testing. Perhaps even more significant is the extremely small reduction in temperature of 0.09 °C. At the same location and in similar weather conditions, Kite 2 produced a mean reduction in air temperature of 0.86 °C and a mean change in pressure of 12,235.26 hPa (Data Set 005). The relative humidity at both sensors was 100% during this test. Although further testing is required, these results are positive indicators of the use of PCM in reducing air temperature, as compared to kite forms without PCM.

Testing at location 2 did not perform as expected. After confirming the sensor locations and wiring, we realized that location 2 was located within a “natural” venturi tube within the forest. This testing site was positioned under a dense tree canopy, and along a compressed section of path connecting a viewpoint (with an opening in the forest vegetation) to a wider picnic area along the Sendero la Ventana. Trade winds traveling through the opening on the side of the mountain increased velocity as it traveled through the compressed opening, and air that flowed through the kite produced a decrease in humidity and an increase in temperature between sensors 1 and 2, the opposite of the anticipated results.

Data was not collected from Kite 3 due to the malfunctioning of the sensors after exposure to moisture.

5.0 CONCLUSION

Cloud Magnet seeks to contribute to contemporary design discourse through a research and design project that evaluates the restorative capabilities of performative materials within a localized ecosystem. Specifically, it aims to produce a proof-of-concept prototype of a cloud-producing kite in the cloud forest of Monteverde, Costa Rica. The data supports the design aims as the kites produced a reduction in air temperature and air pressure that corresponded to a maximum increase in relative humidity of 18.12%, a maximum decrease in dry bulb air temperature of 4.41°C (7.87°F), and a maximum decrease in air pressure of 80.2 hPa. We recorded an average increase in relative humidity of 9.42%, an average decrease in temperature of 2.40°C (4.32°F), and an average decrease in air pressure of 61.85 hPa. Furthermore, the results indicated improved performance of the kites in sunny weather conditions, where the natural occurrence of clouds is diminished. These data provide supportive evidence for the potential to modify the microclimate of the Montverde Cloud Forest to stimulate the formation of clouds. However, further research is needed in the following areas: 1) adjustment and evaluation of the melt temperature of the microPCM to maximize its effectiveness in the climate of the cloud forest; 2) improved waterproofing of microPCM coated Dyneema fabric; 3) improved waterproofing of the sensors and micro-controllers; and 4) stabilization of the aerodynamic properties of the kites. Future testing should also be located in open-air locations to avoid natural Venturi tubes and conducted during sunny or partly sunny weather conditions to maximize performance.

Beyond the localized performance of the Cloud Magnet kites within the cloud forest in Monteverde, this project reinforces the notion that the constructed objects produce changes in weather in time that lead to measurable and interdependent micro-climatic and macro-climatic changes over longer periods. Scientists have produced definitive evidence that the current era of rapidly intensifying global climate change is the result of human factors. Current metrics of energy and material efficiency do not go far enough to assess the full impact that buildings have on the environment. Furthermore, if we are to fully embrace the ethical obligation that humans have to all other life forms, we must raise our aspirations beyond the notion of do no harm, and take measured steps to reverse the destructive consequences of our previous (and current) practices.

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Designing Happiness: Capitalizing on Nature Restorative Qualities

Designing Happiness: Capitalizing on Nature's Restorative Qualities

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ABSTRACT: Scientific studies exploring the environmental and experiential elements that help boost human happiness have become a significant body of expanding work. A wide variety of studies from both neuroscience and environmental psychology have recorded the restorative quality of the natural environment, noting both positive impacts on overall mental health, and strong correlations with self-reported happiness. This paper extracts insights on the impacts of social interaction, access, surprise, light, and beauty on happiness then extrapolates design principles and strategies to use in creating built environments that promote greater well-being. A virtual test case, drawn from a Master of Architecture thesis, is used to demonstrate possible ways these selected principles and design strategies can connect people to nature, with the intent to inform a science-backed approach to creating truly happy places. It is anticipated that these tactics will be useful to architects, planners, and urban designers as they endeavor to design positive user experience into form and place. To the best of our knowledge, many of these principles have not yet been tested and measured in real-world conditions. Potential future development would be collaboration with neuroscientists and environmental psychologists for examining post-occupancy testing of user experience in built environments.

KEYWORDS: Nature, Access, Happiness, Design

INTRODUCTION

This research leaps from the science of happiness found in a literature review to design strategies for universal application in architectural, planning, and urban design practice. It then applies those strategies to a virtual test case set in Baltimore City. Although there is still much to learn about how built environments impact people's emotional lives, much can be extrapolated now by combining ideas from different research disciplines. The work can continue to be enhanced and refined by collaborating with neuroscientists and environmental psychologists to test and study the impact of these principles and strategies as they are applied in real-world projects.

1.0 OUR LIVES ARE SHAPED BY THE SHAPES IN WHICH WE LIVE OUR LIVES

1.1. Need for Intervention

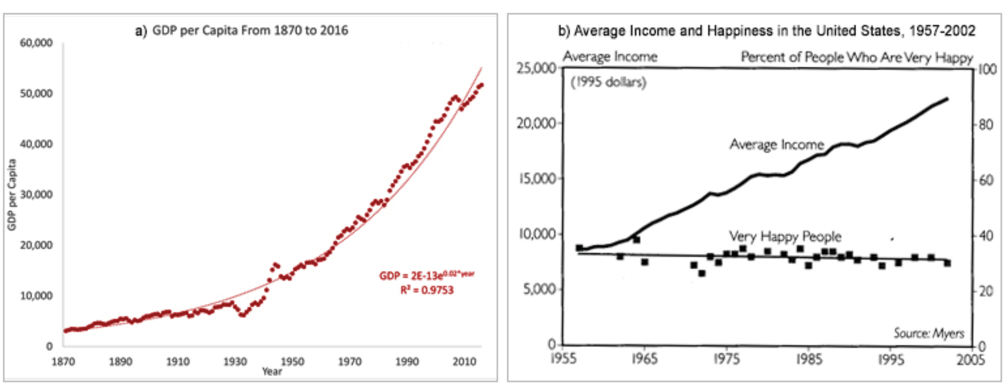

Figure 1: Growth in income over the last century has not led to equivalent growth in happiness; a) US GDP per Capita 1870 to 2016. Data Source: (Johnston 2018); b) Average Income and Happiness in the US. Source: (Speth 2005)

The United States (US) has experienced exponential growth in our gross domestic product (GDP) over the last century, but that growth in wealth has not resulted in the equivalent growth in happiness that economists predict. Current industrial and technological progress is no longer dramatically boosting well-being the way it has in the past (Gordon 2017). We consume more, live in bigger houses, drive and fly faster than ever before, but we trust our neighbors less, work and commute longer hours, are less healthy, and remain on the hedonic treadmill. The US traditionally uses GDP to track progress, this measure does not capture the emotional well-being of the nation, and it does not concern itself with equity issues, nor is it a sustainable model for the long-term health of our people and planet.

Happiness has come to be considered a better measure of national progress. Prompted by the United Nations (UN), World Happiness Reports have been published annually since 2012 examining factors that influence happiness, both social and personal. In June 2016 the Organization for Economic Cooperation and Development (OECD) committed “to redefine the growth narrative to put people’s well-being at the center of governments’ efforts.”(World Happiness Report 2017, 3) Widely comprehensible, place-based, and politically popular, happiness has been also been recognized as a potentially powerful goal for community planning that may help bring together competing desires community development practitioners face working to implement the three pillars of sustainability—environment, economy, and social equity (Cloutier 2017).

Neuroscientists, psychologists, environmental psychologists, economists, planners, architects, and others seek to define, measure and trigger happiness. Research demonstrates the significance of environmental factors, on a par in some studies with the impacts of socio-economic and demographic factors. (Nettle 2005, Brereton 2008) By making happiness a design priority, a substantial difference can be made in people’s lives, particularly as good architectural, urban design, and planning decisions coalesce and multiply positive effects in the growth of communities and cities designed for happiness.

1.2. What is the Science Telling Us?

Nature’s impact on improving happiness through its restorative effects have been supported by research on just about every scale: a plant in the office (Evensen 2015), a view out the window (Kaplan 2001), a walk through a green campus (Hipp 2015), a visit to a pocket park (Nordh 2013), a day in a garden (Chen 2009), the greening of a playground (Kelz 2015), and living daily in a natural setting. (Liltsi 2014) Exposure to nature has also been linked to reductions in crime, reduced levels of aggression, and higher levels of altruism (Montgomery 2013, Korpela 2001). Nature relatedness is a significant distinct predictor of many happiness indicators, even after controlling for other subjective connections, e.g. with friends or country. (Zelenski 2014) People report happiness more in nature than in urban environments (MacKerron 2013).

Within environmental psychology, restorative theory proposes that natural settings promote recovery from stress and fatigue via attention restoration mechanisms. This state of emotional recovery from stress is seen as a key element in improving happiness. Soft fascination (intriguing environmental stimuli) typical in nature, promotes involuntary attention, enabling cognitive recovery. By contrast, hard fascination (demanding stimulation) present in lively settings, grabs attention, increasing cognitive load. Neuroscientific studies also support this theory. In one test, subjects walking outside wearing EEG devices demonstrated evidence of lower frustration, engagement and arousal and higher meditation when in a green park; and higher engagement and frustration when in active hardscaped urban zones (Aspinall 2013). Being relaxed, being away from everyday life, forgetting worries, and reflecting on personal matters link people’s favorite places to *restorative* experiences. Natural settings, compared to urban settings, lead to a reduction in physiological indicators of autonomic arousal, as well as to an improvement in mood (Herzog 2008).

Within the broad category of nature and people’s ability to engage with nature, the authors identified seven sub-factors that are particularly relevant to the work of architects and urban designers: biodiversity, water, social interaction in nature, surprise in nature, sunlight as a source of well-being, community connection to nature, and universal access to nature. We will examine these factors one by one within the context of a case study project.

1.3. Test Case Location: Baltimore City, Maryland, USA

Research performed by Vemuri et al. in Baltimore City discovered that *access to a clean natural environment always contributed to higher satisfaction*, regardless of the scale of analysis (Vemuri 2011). This shows the great potential for really impactful environmental interventions. Baltimore has suffered from egression, disinvestment and destructive urban renewal strategies. Many city residents struggle with blight, crime and limited opportunity, even as opportunistic investors reinvest in downtowns in the form of wealthy enclaves, often subsidized by the government. Butting up against this wealth, city poverty grows stark by contrast, exasperating discord. Existing vacancy and blight in Baltimore City provides opportunities to rethink and redesign the city’s future growth and recovery, aiming for a happier future.

2.0 INTEGRATING NATURE THROUGH DESIGN

2.1 Design Strategy: Amplify Biodiversity

Test subjects reported feeling healthier, more connected, and more grounded after spending time in parks with many different kinds of trees and birds than in parks that distilled nature down to lawns and a few trees.

(Montgomery 2013) Other studies reinforce the idea that design complexity enhances preference for certain landscapes (Kelz 2015), specifically perception of species richness (birds, butterflies, plants), and riparian tree cover shows notable increases in reported well-being (Leyden 2011, Dallimer 2012).

Figure 2: The Palm House Natatorium, shown here in section, brings a much needed interactive experience with biodiversity to the public in a blighted urban grey-scape. Source: (Habtour)

Test Case: Architectural Acupuncture Brings Biodiversity. A Palm House Natatorium brings together a tropical palm house, a public pool, and community gathering spaces. Carefully placed to maximize positive impact, it acts as a community anchor and a place of respite from the stresses of Baltimore City life. As a publicly accessible institution, it is egalitarian and restorative.

2.2 Design Strategy: Integrate Water

A focal point within a landscape, along with vegetation and water are identified as meaningful elements for a restorative experience. (Herzog 2008) Waterfront is frequently mentioned in surveys when asking people to describe a happy place. (Habtour 2016) Exposure to Amsterdam's Eastern Docklands, whose main feature is water with very little green, proved to have equivalent restorative effects on test subjects, to lush green rural Dutch Amstelland (Karmonov 2008). A bold water feature can cancel stress-inducing noise from a busy urban street, drawing in users as exemplified in New York City's popular Greenacre Park (Whyte 1980).

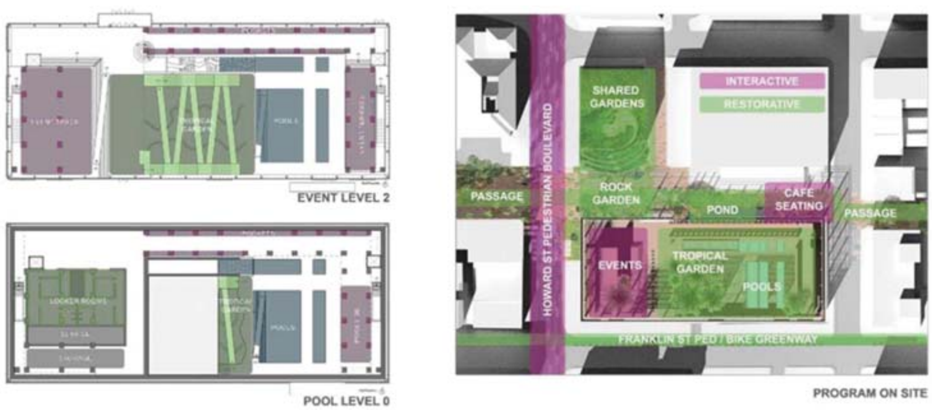

Figure 3: The program shown in plan of the Palm House Natatorium building and site highlights approaches to bring the public both restorative and interactive opportunities by co-locating water, nature, and social spaces; including accessible swimming pools, a tropical garden, and public event spaces on the inside; and a pond, gardens, and cafe seating outside. Source: (Habtour)

Test Case: Pools Inside and Ponds Outside. A large pool accessible by an ADA compliant ramp, a separate lap pool, a smaller warm relaxing pool, and a waterslide make up the water elements on the inside, surrounded by tropical foliage and trees. In a city where many do not get the opportunity to vacation someplace tropical, this offers an opportunity to get away. Outside is a rock garden and pond, offering places to explore, sit, and dip one's toes as local plant species sprout along the water's edge.

2.3 Design Strategy: Encourage Positive Social Interaction

A study on pocket parks identified popular activities like relaxing, philosophizing, reading, social play, physical activities, eating/drinking and that short informal contacts are highly important to well-being (Nordh 2013). Friendly interactions with neighborhood people can give a positive oxytocin boost without the added stressors that come with serious relationships (Montgomery 2013).

One key to creating a framework for positive social interaction is to provide several options so people may exert control their preferred social experience (Halpern 2008). Using nature to slow traffic or to buffer pedestrian areas, bicycles, and cars, allows people to feel safe, reduces noise, encouraging walking and conversation (Montgomery 2013). Providing comfortable seating in a nature enhanced spot creates casual social opportunity. Integrating nature on the way to, or in relation to a benefit, like food, work, recreation, or a cultural venue builds on the meaningful relationship between sociability, happiness, and access to amenities, such as movie theaters, museums, recreation, concert halls, and libraries (Leyden 2011).

Figure 4: Interior of the Palm House Natatorium providing people the opportunity to build relationships with each other and identify with a local landmark, through sharing the experience of a unique biodiverse setting. Source: (Habtour)

Test Case: A Variety of Options for Lingering Among the Plants. The Palm House interior provides multiple visible egress options, and a variety of places to linger, wander through the plants, lounge by the pools, walk on the balcony, or sit beneath the palms. The mid-block exterior of the community tropical retreat brings biodiversity to human level with birch trees and wildflowers interspersed on a wide path for people to meander between on their way to and fro. Cafe style chairs and tables adjacent to a neighboring coffee shop overlook a rock garden and small pond with more places to sit, climb, wander through, and play. Native plants peek out between the rocks and frame the water. Linking transit, housing, businesses, schools, and community assets as well as providing places to dwell, the site offers opportunities for incidental or intentional nature experience within a daily commute.

2.4 Design Strategy: Strive for Beautiful Surprises

The pleasure centers of the brain light up when surprised with something pleasant, even more so than when a pleasant thing is expected (Berns 2001). Self-reported overall satisfaction with life is substantially higher when subjects are asked after a pleasant surprise, on a sunny day, in a beautiful room, or on a day going better than expected (Nettle 2005). A study of the relationships between happiness and city design found that the perception of living in a beautiful city had the strongest correlation with happiness (Leyden 2011). Case studies conducted in Kristianstad, Sweden, and Copenhagen Denmark focused attention on the ability of incidental nature experience to use surprise and engage soft fascination. One example studied was a heavily used pedestrian bridge over a wetland area linking different parts of Kristianstad, Sweden, with transportation nodes and a variety of uses. Visitors engaged in their daily commute would be surprised by otters and other marsh wildlife near and under the bridge, and would often linger, and share their experience on social media, making it a popular place to visit and hang out. Bridge users enjoyed the regular opportunity for surprise, fascination, and attention redirection from their daily tasks (Beery 2017). Designers can utilize the changes inherent in nature to create surprising, interactive experiences.

Figure 5: Mid-block exterior of the Palm House Natatorium incorporating art, nature, and active programming to keep a city throughway feeling safe and welcoming into the night. Source: (Habtour)

Test Case: Activating Pleasure and Wonder with Art and Nature. At night on the mid-block exterior of the Palm House, an artist's LED light installation mimics the movement of fireflies flickering up through flowers and grasses, seeking both to draw a sense of fascination from the human visitors and attract real fireflies. Among grasses and pebble paths people discover animal sculptures by local artists to sit and play on. Flowering bushes host families of birds. A water feature edged by a rock garden ripples reflections of the light and activity spilling out of the adjacent glass building, all of which help keep the outdoor space active, safe, and enjoyable late into the evenings.

2.5 Design Strategy: Use Sunlight as a source of Well-Being

Natural light cycles support internal circadian rhythms, boost serotonin levels, and are a necessity for good health and happiness. Going with too little daylight for too long can lead to depression, sleep disorders, and other maladies (Senne 2005). However, sunnier climates do not necessarily mean greater happiness. Iceland is considered one of the happiest places in the world. Mark Easton at the BBC in his article about sunshine and happiness quipped "Perhaps it is not the sunshine that matters so much as the pleasure we get when our weather changes?" (Easton 2012, 1). One of the important psychological aspects from daylighting is meeting a need for contact with the outside living environment. (Edwards 2002). Extrapolating this human need for sunlight into design recommends a sunny wall to warm by in winter, a leafy canopy to cool under on a hot day, a framed shaft of light revealing the shifting shadows of time gliding forward, or a surprise of magical refraction, scattering the colors in dazzling ways.

Figure 6: Palm House Natatorium in sections shows the utilization colored glass and exterior climbing plants as shading mechanisms that respond to changes in season and time of day. Opportunities for users to choose places to linger with nearly full, sun, filtered light, or full shade are present. Source: (Habtour)

Test Case: Using Nature & Color to Filter Sunlight. To minimize solar gain and capture the beauty of light filtration, the Palm House celebrates a variety of natural light experiences using a combination of climbing plants, and translucent colored angled fins all along the exterior south & west facades and in the roof, creating a cathedral-like atmosphere, intertwined with the dappled texture of a forest floor. There are spaces in full shade, and the lower floor spaces allowing slots of natural light into their quiet solitude, providing visitors a variety of natural light experiences to explore and enjoy.

2.6 Design Strategy: Capitalize on Community Priorities

Every community has priorities and initiatives already in motion to address identified needs. Those may be headed by governments, community groups, or non-profit organizations. Bringing happiness through nature overlaps in a surprising amount of ways with other objectives, and a synergy of purpose can multiply the positive impact of everyone's work. Does the community need stormwater improvements? Create rain gardens to beautify a bland urban street. Need to reduce city maintenance costs? Well planned native polyculture can eliminate the need for mowing, reduce or eliminate watering, while enhancing biodiversity, supporting local pollinators and wildlife. There are many opportunities for win-win solutions when seeking to build happy communities.

A great example of this is the green cycle lane network in Copenhagen Denmark. Dedicated to cycling along vegetation and water it allows for shortcuts and provides calm and pleasant cycling environments. Cyclists asked to map positive and negative experiences highlighted the importance of nature in forming positive experiences. While building the network, Copenhagen planned for incidental nature experiences while building on efforts to ensure that human environments are resilient to environmental, social, and economic challenges. Continued planned and connected green infrastructure offered intentional and incidental experience along with many corridors which support daily movement while addressing conservation efforts (Beery 2017).

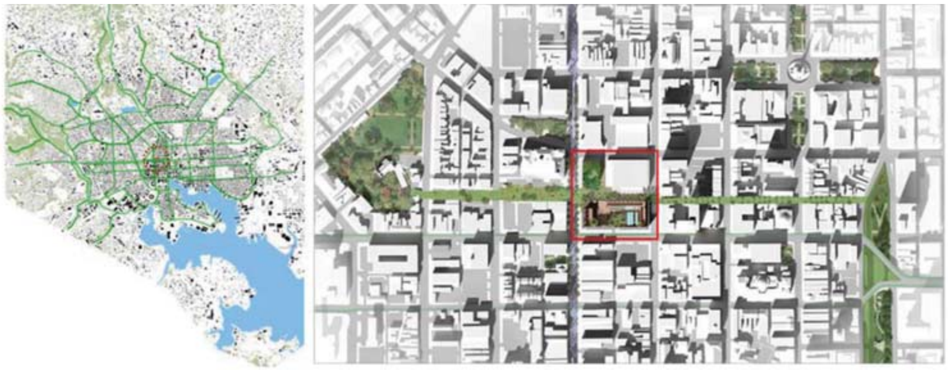

Figure 7: Proposed Baltimore Greenways infrastructure to encourage walking and biking by providing safe and pleasant routes, gives people multiple opportunities for intentional or incidental daily interactions with nature. Site-specific linkages between small urban parks promote possible local interventions for pedestrian and cycle prioritized passage. Source: (Habtour)

Test Case: Creating a City Wide Greenway Network. To increase the frequency and quality of city resident's interaction with nature, a network of nature enhanced pedestrian and cycle routes is built throughout the city connecting to the architectural site. The city is checkered with several large impervious asphalt lots, crumbling vacant buildings and a few parks of varying quality and upkeep. The opportunity for improving the experience of walking and biking through downtown is significant. With thoughtful design, this network dovetails beautifully with city strategies to improve stormwater management, to reduce flooding and polluted runoff poisoning the bay and to build bicycle infrastructure. As a large civic project, it provides opportunities for youth-works, and second-chancer programs for employment, skill building, and community connections. Public nature-oriented architectural interventions become connectors, icons, and visual landmarks in the greater greenway system.

2.7 Design Strategy: Ensure Access to All

Injustice is a historic and chronic cause of unhappiness. As wealth inequality continues to rise in America, the haves and have-nots are increasingly segregated. Opportunities for people to experience natural interactions of quality and other amenities that support happiness vary enormously. Striking inequality leads to stigmatization and negative comparisons, which on the individual and community level are extremely harmful to happiness (Nettle 2005). Equality, empowerment, and inclusion are vital, (Soul of the Community 2010) as are geographical and socio-economic context, because of the impact social and spatial inequalities and social justice (Ballas 2013) have on happiness. One can create the most uplifting nature integrated experiences in the world, but if those are only regularly accessible to the privileged, the happiness project fails. The design challenge is finding ways of weaving the positive environmental impacts into everybody's every day, to be experienced with frequency and in close proximity.

Figure 8: The Palm House Natatorium demonstrates design strategies for happiness by providing public access, incorporating nature, including surprises and play, engaging people socially and contributing to a place-based sense of identity by offering a unique new connection to a rich local history. Source: (Habtour)

Test Case: Serving Equality by Proximity and Affordable Public Access. As a publicly accessible, entry donation optional, institution centrally located at a transition between struggling and more stable areas, it serves the wide range of local demographic groups already present, which include people with low, middle, and upper incomes, school children, college students, professionals, senior citizens, blacks, whites, a variety of other races and ethnicities, diverse sexual orientations, and people with disabilities. The site immediately connects transit stops to local schools and residents, and businesses. Complimentary planning around the site retaining and incorporating affordable and assisted housing and amenities with the newer mixed-use market-rate development can improve the area with ongoing inclusivity.

CONCLUSION

Design strategies extrapolated from a broad array of research on factors for human happiness have potentially universal application to the work of architects, planners, and urban designers. When designers incorporate aspects of nature into the human environment, they shape spaces with the potential to increase the happiness of the inhabitants. While the virtual test case explored here is one specific example focused on an immersive nature experience in an urban area, these principles can be applied at different scales, and in different contexts.

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Courtney Erin Crosson

Creating Our Own Ladder to Climb: Architects Setting Policy Using the Climate Stabilization Triangle Method

Creating Our Own Ladder to Climb: Architects Setting Policy Using the Climate Stabilization Triangle Method

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ABSTRACT: This paper addresses the pedagogical process of teaching architects to operate within a system of limited resources – by having them design the regulatory game to manage those resources. In 2015, the president of the University of Arizona (UA) signed a commitment to reach carbon neutrality by 2050. In 2016, an upper-level architecture studio was planned in partnership with university administration to create a roadmap for the campus to achieve this neutrality commitment. The studio pedagogy was structured using the climate stabilization triangle method, originally pioneered by scientists Stephen Pacala and Robert Socolow, co-directors of the Princeton's Climate Mitigation Initiative. Pacala and Socolow assert that rather than advancements from the lab bench or computational model, forthcoming answers to global warming will be provided by those that coordinate the implementation of a portfolio of existing solutions (Pacala 2004). Students created a climate stabilization triangle for the 2050 campus by projecting the future escalation of campus scope 1-3 carbon production and then coordinated existing mitigation strategies to reach a zero target. Each implementation given by the students had a stated funding strategy, policy outcome, and corresponding physical outcome for the campus. The UA is currently integrating the work as a chapter in the campus master plan for 2018. The paper argues that by designing their own ladder of regulations, students learn to dissect why policy exists, connect physical outcomes with policy mandates, and understand their work as an architect within the complexity of actors and objectives impacting global warming. Architects can play a central role in the growing imperative of climate planning if methodologically trained with the current research methods and analytical tools to address this challenge.

KEYWORDS: net zero, climate stabilization triangle, wedge diagram, carbon neutrality, campus master plan

INTRODUCTION

> Humanity already possesses the fundamental scientific, technical, and industrial know-how to solve the carbon and climate problem for the next half-century. Every element in this portfolio has passed beyond the laboratory bench and demonstration project; many are already implemented somewhere at full industrial scale. Although no element is a credible candidate for doing the entire job (or even half the job) by itself, the portfolio as a whole is large enough that not every element has to be used.
>
> : evolutionary biologist S. Pacala and physicist R. Socolow, in Science in 2004

In 2004, scientists Stephen Pacala and Robert Socolow delivered a hopeful message: society is in a position to solve the problem of climate change for the next half century, now. Rather than new research and development, the problem can be addressed for a 2050 target through the coordination of a portfolio of existing solutions. Pacala and Socolow devised the stabilization triangle method to view projected carbon increases alongside the stepped mitigation strategies to achieve a desired level of future mitigation (Pacala 2004). This tool is used to sequence and understand the impact of a portfolio of solutions for a given carbon emitter.

In 2015, the president of the University of Arizona (UA) signed a commitment to reach carbon neutral by 2050 under the American College and University Presidents' Climate Commitment (ACUPCC). Upon taking this pledge, the UA had created a climate stabilization triangle projecting future campus scope 1, 2, and 3 carbon emissions and a 2050 zero target. However, the most important piece of the stabilization triangle was missing: the coordinated portfolio of existing solutions. In 2016, university administration and a professor at the UA School of Architecture partnered to form an upper-level architecture studio course to create a roadmap for the campus to achieve its neutrality commitment and an additional, unique target of water neutrality. Fundamentally, architecture pedagogy trains students to coordinate a distinct set of resources to achieve a maximum effect. Pacala and Socolow outlined a solution to climate change where these type of coordination and optimization skills are required, rather than the skills of climate scientist or policy analysist.

This paper outlines how future architects can use their unique, fundamental skills to address a warming climate. This paper focuses on the stabilization triangle method to solve for carbon and water neutrality for the UA campus by 2050. The paper starts with a discussion of the ACUPCC and its implementation challenges. Then, carbon and water neutrality are defined. Next, the stabilization triangle method is outlined using the case study of a UA architecture studio course. The paper concludes with a discussion of the opportunities, challenges, and potential impact of the stabilization triangle method on architecture pedagogy and ACUPCC signatory campuses. The paper argues that architecture students learn to orchestrate physical change through policy mandates and incentives and ACUPCC campuses are given actionable plans to bridge from goals to tangible implementation.

1.0 CAMPUS MASTER PLANNING AND ACUPCC SIGNATORIES

Campus master plans, traditionally led by teams of architects, have increasingly changed from an exercise in land planning and vision rendering to a focus on strategic resource allocation and management. For example, Rice University's recent 2014 Integrated Campus Plan is undertook this shift. The recent Kieran Timberlake plan aimed to minimize energy use, efficiently deliver resources, and ameliorate flooding risk (Harris 2017). These goals bear stark contrast to Michael Grave's 1990 Rice University master plan that choreographs building placement and warmly renders visions of stylistic unity (Coulson 2015).
In 2006, in line with this shift in campus planning and growing concerns over climate change, the ACUPCC was launched as a collective effort by higher education institutions to pursue carbon neutrality in campus operations and master plans. To date, the commitment has been signed by over 700 colleges and universities within all 50 states (ACUPCC 2017, Dyer 2017). Signatories develop an implementation plan with carbon emission targets and timetables, integrate sustainability and climate change into the curriculum, and make their plans and greenhouse gas inventories publicly available. Between 2007 and 2012, ACUPCC institutions reduced GHG emissions 25% on average across the network (ACUPCC 2012). Although, the commitment has had a significant impact on many campuses, still over a third of signatories struggle to move from goal setting to implementation of policies and initiatives to meet targets (Dyer 2017). Currently, only 61% of the signatories that have submitted two or more greenhouse gas (GHG) inventories have reported a decrease in carbon emissions (ACUPCC 2017). This paper outlines how architectural pedagogy can support ACUPCC campus signatories, like the UA, by creating a pathway to successful reduction and goal attainment with the stabilization triangle method for carbon and water neutrality.

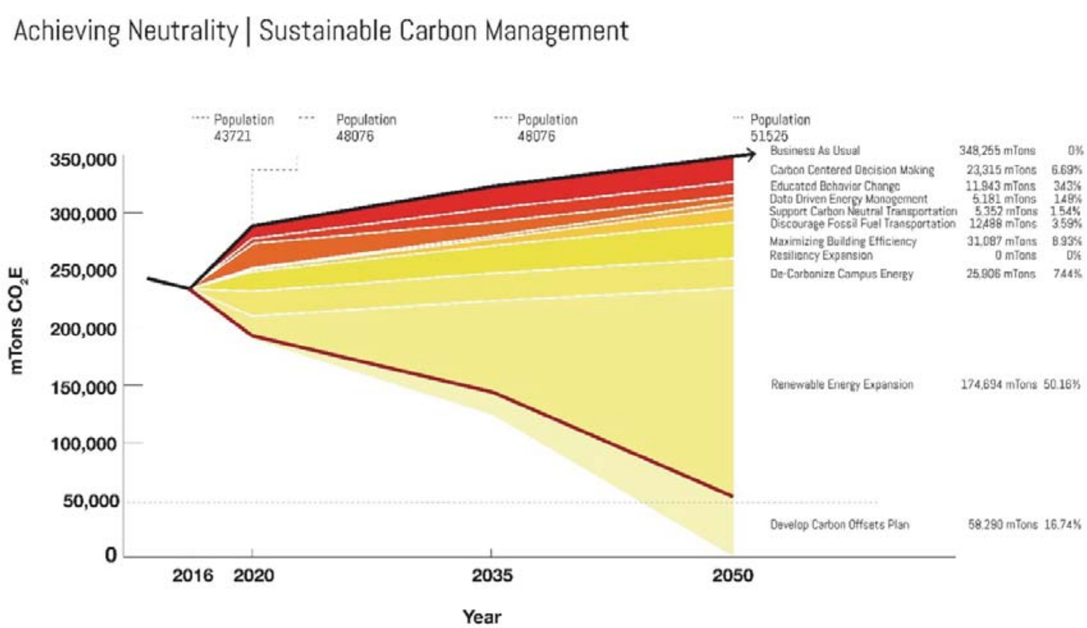

Figure 1: The stabilization triangle created for UA 2050 carbon neutrality. Source: (Author and UA ARC451b 2016)

2.0 DEFINING NEUTRALITY AND UNDERSTADNING LOCAL SPECIFICITY

There are a range of definitions of carbon neutrality based on the inclusion of indirect and transportation emissions. The definition for water neutrality is even murkier as a nascent concept. The functioning definition for neutrality used by this paper are stated below.

2.1. Carbon Neutrality and the Local Campus Reality

Carbon neutrality is defined in this paper as eliminating or offsetting the amount of carbon produced within a given site such that there is a zero or neutral annual effect (US Department of Energy 2015). Carbon emission sources are broken into Scope 1 (direct sources), Scope 2 (indirect sources), and Scope 3 (transportation related sources). Each ACUPCC campus working toward neutrality faces unique challenges based on current energy demand profile (e.g. heating and cooling loads), current energy generation infrastructure (e.g. direct or indirect sources, gas or electric generation and distribution), and transportation needs (e.g. commuter campus or required onsite living). To achieve the ACUPCC goal of carbon neutrality the decarbonization of a campus's energy infrastructure is largely required. Current central plant infrastructure must change to electrical energy supply rather than one that is fossil fuels based.

The UA has three central plants and operates on a cogeneration system (COGEN) and steam supplied heating. The efficient COGEN system of capturing and repurposing waste heat to further provide energy to the campus unfortunately involves carbon emitting fuel sources. Additionally, the steam system is powered by natural gas generators linked to an extensive pipe distribution system. The UA also hosts a large solar array on its property on the outskirts of Tucson through a power-purchasing agreement (PPA). The 2015 carbon inventory for UA was 80,268 metric tons of CO_2e for scope 1 (34.5%), 92,837 metric tons of CO_2e for scope 2 (39.9%), and 59,392 metric tons of CO_2e for scope 3 (25.6%) (STARS 2017).

2.2. Water Neutrality and Local the Campus Reality

Water neutrality is defined in this paper as maintaining an annual sustainable water supply such that no imported water is needed. On a water neutral campus, the amount of water that is used is locally recharged and one hundred percent of historic storm water flow is mitigated within the site boundary for ecological benefit (International Living Futures Institute 2018). The particular challenges of achieving campus water neutrality vary greatly based on the local precipitation profile (e.g. frequency and intensity of rain), the probability of extreme events (e.g. floods and drought), local hydrogeology (e.g. ground water availability), and local permeability (e.g. available permeable land cover and soil absorption capacities).

Currently, the UA receives over half of its potable water from on campus wells (STARS 2017). Although in a desert location, the UA is at the convergence of water sheds from the surrounding four mountain ranges: Rincon Mountains, Santa Catalina Mountains, Tucson Mountains, and Santa Rita Mountains. Additionally, the Sonoran Desert climate is characterized by two significant annual rain events. The winter rains come off the Pacific and reach Tucson during the months of December and January. The summer monsoon rains come off the Sea of Cortez and arrive during the months of July, August, and September. The monsoon rains provide a deluge that fertilizes desert plants and creates significant storm water flooding issues throughout the city, while the dry desert conditions the remainder of the year raise drought concerns. The 2010 water sources for the UA were 75 million gallons reclaimed water (12.8%), 250 million gallons municipal water of which roughly a third is imported (42.7%), and 260 million gallons campus wells (44.4%) (STARS 2017).

3.0 METHODS

To achieve campus carbon and water neutrality by 2050, the stabilization triangle was used as a structuring method. This section outlines the case study of an upper level, vertically integrated architecture studio at UA comprised of six fifth-year Bachelor of Architecture students, four second-year Master of Architecture students, and one professor. Four stages comprised the semester-long formulation of a neutrality pathway with the stabilization triangle: (1) Baseline Calculation (top line), (2) Goal Setting (bottom line), (3) Sequencing (vertical line), and (4) Achievement (Figure 1 & 2).

Over the course of the semester, students were charged to deliver four components to illustrate the achievement of the 2020, 2035, and, ultimate, 2050 goals: (1) carbon and water wedge diagrams illustrating the sequenced reductions based on their prescribed implementations (see Figures 1 and 2), (2) a detailed timeline of implementation (see Figure 4), (3) a "play book" sequenced from short term to long term implementations (see Figures 5, 6,and 7), and (4) an exploded axonometric drawings of resulting carbon and water neutral system designs. The resulting product was the design of a system of interrelated policies sequenced temporally and spatially delivered as thirty carbon and thirty water operations presented to UA administrators in the form of a 240 page electronic and physical book.[i]

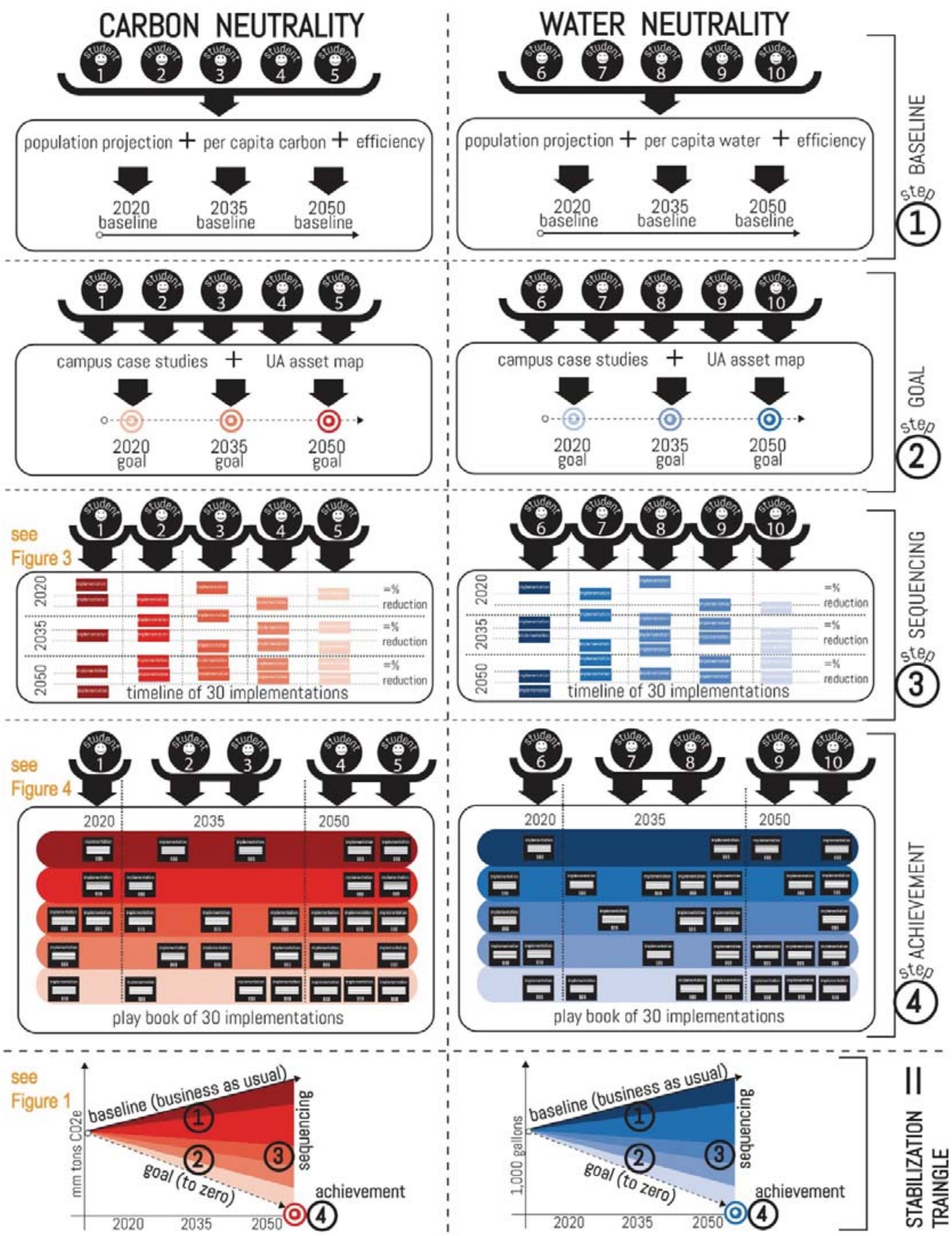

Figure 2: The stabilization triangle method used in an upper level architecture studio course. Source: (Author 2018)

3.1. Baseline Calculation: Setting the Business as Usual Short, Mid, and Long Term Case

First, a baseline for 2015 and a set of baseline projections for the short (2020), mid (2035), and long term (2050) carbon emissions and water use were constructed. The baseline formed the top line of the stabilization triangle (Figure 1 & 2).

1. Current Carbon and Water Data Analysis: The first step in this process was to establish a baseline for 2015. *S*tudents worked with campus administrators and facilities managers to analyze current campus carbon and water data and establish a current status of annual emissions and use. Data was provided through the self-reporting score card interface from the Association for the Advancement of Sustainability in Higher Education (AASHE) Sustainability Tracking, Assessment, and Rating System (STARS) (STARS 2017).
2. Creation of Per Capita Carbon and Water Annual Demand: This analyzed data was then divided by the total 2015 population of the UA to derive a per capita annual consumption for carbon and water. Population data was provided by the Arizona Board of Regents (ABOR) Annual Report (Arizona Board of Regents 2015).
3. Population Projections: UA campus population projections for 2020, 2035, and 2050 were extracted from the ABOR Strategic Plan for state university campuses (Arizona Board of Regents 2015).
4. Carbon and Water Projections for Short, Mid, and Long Term: The future carbon emissions and water use were calculated by multiplying the per capita carbon emission and per capita water use by the projected population for 2020, 2035, and 2050.
5. Discount for Future Efficiency: A discount number for future efficiency was created by comparing 2015 and 2010 per capita data and national projections for future energy and water efficiency. This constructed discount number was then applied to create the final 2020, 2035, and 2050 baseline numbers.

3.2. Goal Setting: Identifying Opportunities

Next, case studies of high performing sustainable campuses and an asset map of existing UA sustainability features were completed. From this research, a portfolio of thirty carbon and thirty water existing solutions were identified to meet neutrality goals. These short, mid, and long term goals formed the bottom line of the stabilization triangle, culminating in the final zero target on the x and y axis in 2050 (Figure 1 & 2).

6. Case Study of High Performing Sustainable Campuses: Students researched ten campuses that had been nationally identified through AASHE as achieving ambitious carbon and water goals. Student inspected the incremental, phased milestones each of these campuses had set.
7. UA Campus Sustainability Asset Map: Students broken into groups and identified current UA campus assets in four categories: Infrastructure and Resilience (renewables, active systems, indoor water management), Connections and Logistics (public transportation, bicycle and pedestrian, and waste management), Nature and Health (green spaces, outdoor water management, health and wellbeing), and Culture and Place (green buildings and education). These four categories comprised the possible areas that could be expanded for increased success at UA.
8. Identify Portfolio of Solutions: From the best practice case studies and identified campus assets, students identified a portfolio of thirty carbon and thirty water existing solutions to be employed to reach the carbon and water neutrality goals at UA. Students codified five overarching principles to guide the selection of the portfolio of solutions: (1) Spirited Optimism, (2) Principled and Practical Action, (3) Transformative Thinking, (4) Responsible Risk Taking, and (5) Organizational Effectiveness.
9. Set Milestone Goals: Based on the research of other campuses' incremental goals and the selected portfolio of solutions for UA, students set 2020, 2035, and 2050 goals. These targets formed the bottom line of the stabilization triangle (Figure 1 & 2).

3.3. Sequencing: Spatial and Temporal Dependencies

The thirty carbon and thirty water implementations were then temporally sequenced across the short (2020), mid (2035), and long term (2050) targets. The stabilization triangle was used to choreograph how each of these implementations contributed to the set milestone targets toward the final neutrality end. The carbon and water implementations were also spatially coordinated. This portfolio of sequenced solutions formed the final, vertical line of the stabilization triangle, along the y axis (Figure 1 & 2).

10. Assign Implementation Groups: Students were each assigned a set from the thirty carbon and thirty water implementations in the portfolio and asked to identify steps toward action.
11. Coordination of Temporal Sequence of Implementations within Carbon and Water: Students then were broken into pairs and tasked with either short, mid, or long term period within either carbon or

water, for a total of six groups. The identified implementation steps from step 10 were then organized by each of these six groups into a timeline (see Figure 3).

12. Coordination of Spatial Sequence of Implementations between Carbon and Water: Students in carbon and water short, mid, and long term groups met to coordinate across campus, as practical considerations for implementations overlapped between carbon and water (e.g. retrofitting, carbon and water tax)and reductions has co-effects (i.e. the energy-water nexus).

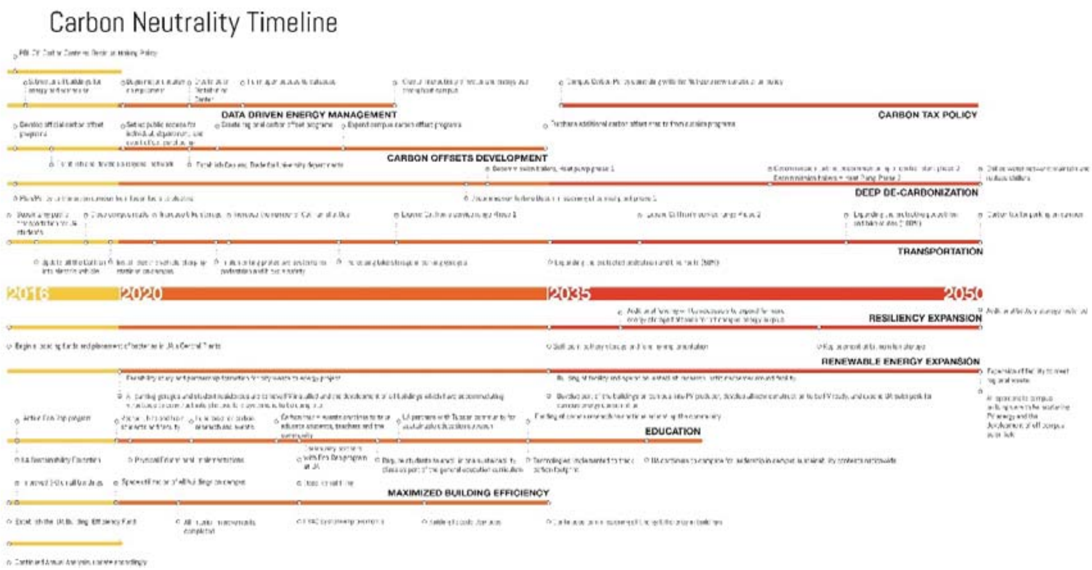

Figure 3: The coordinated implementation timeline for UA 2050 carbon neutrality. Source: (Author and UA ARC451b 2016)

3.4. Achievement: Dissemination of the Playbook and Stabilization Triangle

Finally, students put their work together into a book and disseminated it through presentations to the UA administration and broader public. The achievement was proven by meeting the target on the stabilization triangle (see Figure 2).

13. Details of the Existing Solutions Portfolio: Students created a series of pages for each of the thirty carbon and thirty water implementations into a playbook. Each implementation had a policy and physical outcome, a suggested funding source, a list of necessary stakeholders from the campus and community, and a set of linked implementations (see Figure 4).
14. Stabilization Triangle Finalization: These final implementations were then tagged with a projected decrease in either carbon or water from the baseline numbers. These numbers were then coordinated in a net effect represented in a final stabilization triangle diagram (see Figure 2).
15. Dissemination: Students edited their work into a final 240 page book distributed in electronic form (through Issuu online publishing) and a physical, self-published copy (through Lulu online publishing). The Issuu electronic book has been read 59 times since the Fall of 2016 from IP addresses around the world. Students made presentations to the UA Vice Presidents of Planning, Design and Construction and Facilities, the UA Office of Sustainability, and the 2018 UA Master Plan professional team.

4.0 DISCUSSION: APPLICATION AND RELEVANCE

The stabilization triangle method can be employed to prepare emerging architects to be the coordinators of climate action solutions within their future communities. Additionally, this pedagogical method can help address the existing gap between ACUPCC signatory goal setting and an implementation plan with sequenced and specific financial, policy, and physical actions. Within these two outcomes, the UA case study presents several opportunities and challenges.

4.1. Student Learning Outcome: Pedagogical Challenges and Opportunities

The stabilization triangle method provided a clear structure, translatable to science, policy, and practice, by which emerging architects learned about climate planning. The students gained the new skillset of master planning with resource-based models that incorporated financial strategies and infrastructure realities. One challenge in classroom management was the differing levels of mathematical and computational acumen by design students. Some students quickly understood resource modeling and budgeting, while other struggled. Through partnered assignments and a diverse portfolio of solutions, students participated in areas where they had strengths and weaknesses. In the future, a more careful and conscious matching of students existing skills, desired learning growth areas, and necessary talents for deliverables could be completed. Positively, after the course, two students attributed securing jobs from the hiring employers' specific interest in the studio work and students' exposure to resource modeling and financial thinking.

Students were challenged to integrate various scales of design (i.e. building to district plan to infrastructural network) and various disciplines (i.e. science, policy, financial thinking). Students rose to the challenge of integrating these scales and modes of thinking with the assistance of the professor and visiting professionals who specialize in this line of work. It was a challenge to have students jump from one scale to another or one mode of analysis to another. The integration of professionals and campus administrators was key to supporting students to be open to the challenge and nimble yet clear in their ways of thinking.

Finally, students learned to better link experiential ways of knowing (i.e. their life on campus) with analytical ways of knowing (i.e. carbon and water modeling and projections) with design solutions (i.e. the future physical form of proposed implementations). The UA campus sustainability asset map assignment was helpful in priming students to identify links between the three. In future courses, this assignment could be improved by better integrating current data and future projections into the asset mapping process to more strongly reinforce links between the three.

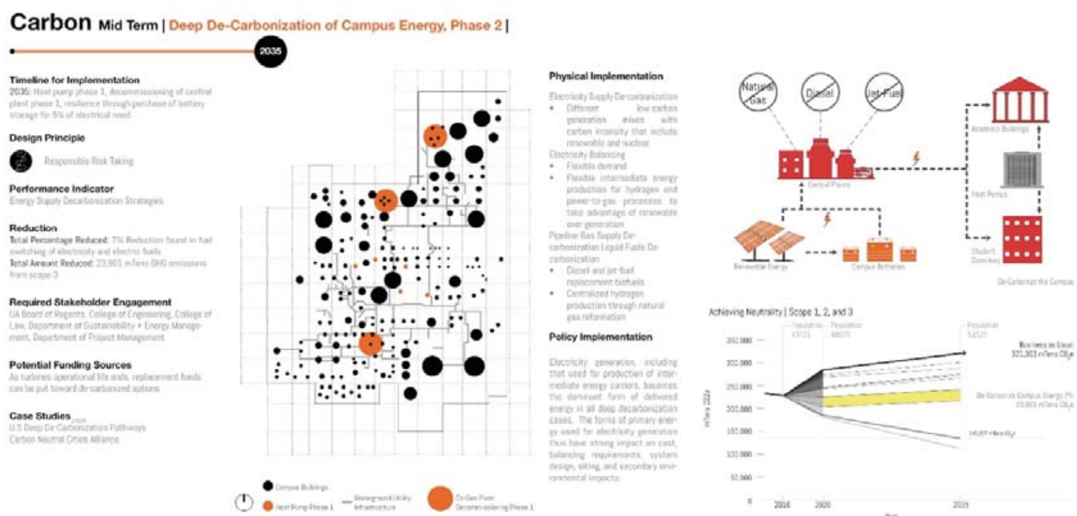

Figure 4: Example from play book for De-Carbonization mid-term(2035) implementation. Source: (Author and UA ARC451b 2016)

4.2. ACUPCC Implementation Outcome: Campus Administration Challenges and Opportunities

The stabilization triangle method is the most widely adopted means by which to project and plan for carbon emissions reduction. This method was successful at communicating the implementations laid out by the students to the campus administration and master planning project team, as evidenced by adoption of the work into the 2018 UA master plan.

Despite clarity of communication of implementations, challenges existed in unifying different staffs across campus in cross cutting implementations, particularly the campus capital projects staff with the facilities staff. Cooperation between campus facilities and capital project teams is a vital partnership for any campus climate action plan to efficaciously implement a portfolio of solutions. A unified commitment to the climate action targets is necessary for success and can be created through an outspoken and clear executive university administrator who persists to focus attention on achieving campus targets. Policy research has found that commitment from the top is one of the key determinants for success of higher education institutions in becoming sustainability leaders (Dyer 2017). From the case study research, campuses that had already achieved carbon neutrality had three unifying factors: (1) small population size, (2) centralized leadership invested in being at the forefront of sustainable campuses, and (3) use of biomass (in a cold climate with adjacent forests) to deliver full 'renewable' energy supply. These three characteristics were poles apart from UA.

Finally, financial barriers were the largest road block to the carbon and water implementations. Students researched and suggested funding mechanisms to campus administration for each implementation in the portfolio of solutions to reduce this real and psychological road block. By sequencing the low hanging fruit first in the timeline of implementations, momentum can be gained and a revolving funding strategy can be initiated. The students also gave campus administration five guiding principles that recognized the difficulty and worth of the task ahead of 2050: (1) Spirited Optimism, (2) Principled and Practical Action, (3) Transformative Thinking, (4) Responsible Risk Taking, and (5) Organizational Effectiveness.

5.0 CONCLUSION

Since the creation of the ACUPCC carbon neutrality 2050 goal in 2006, over 700 colleges and universities have taken the pledge. Over the last ten years of actualization, a common struggle exists within ACUPCC institutions to convert the promise to actionable policy and physical implementations on their campuses. University and college architecture faculty and students have the unique skillset to bridge between target goals and realized change. Using the Pacala and Socolow stabilization triangle method, a portfolio of existing solutions can be coordinated for tangible campus carbon and water action successes. This paper outlines a case study of an upper level UA architecture studio that used an adaptation of this method and created a road map to carbon and water neutrality. Ultimately, such an application can train emerging architects to be the coordinators of climate solutions and support ACUPCC signatories to take the bold steps from intension to short, mid, and long term organized action. This application leverages the unique, fundamental skills of architects as resource coordinators and optimizers to achieve climate action success.

6.0 NEXT STEPS

The UA campus master plan is currently in process. The work by the students will be represented in the plan as a final chapter on sustainability. Focus groups will be held to further integrate the playbook of implementations outlined in the work into the overall professional master plan team's recommendations.

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[i] The book can be found at: https://issuu.com/universityofarizonaschoolofarchitec/docs/chapter_1_2_3_4_5_6_7_8]

Dario Vanegas, Mallika Bose

Sustainable Urban Design with People In Mind: A Framework Revisited

Sustainable urban design with people in mind: A framework revisited

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ABSTRACT: This paper provides a critical view of the Sustainable Urban Design Framework proposed by Nico Larco in 2015. It problematizes its embedded top-down/expert approach and argues for the use of the alternative understanding of sustainability as a social phenomenon proposed by the Circles of Sustainability as a theoretical reference. The paper proposes adjusting the framework in two ways: explicitly including social aspects of sustainability and including the temporal dimension of sustainability. The first one will help to overcome issues of index standardization on the one hand and to more closely connect with local contexts on the other. The second one will directly address issues of place-making and identity by embedding history, current conditions and future expectations of specific communities as fundamental elements for any urban intervention that strives for sustainability.

KEYWORDS: Social sustainability, Urban Design, Framework

INTRODUCTION

The physical manifestation of cities results from a combination of a variety of phenomena, some of which are under the control of specialists in the design and organization of procedures within the realm of urban design. A broad definition of urban design entails the participation of numerous contributors from different disciplines in a complex operation aimed at producing the backdrop of life for the increasing number of people living in urban areas (Carmona, 2010). By transforming physical aspects of cities, urban design should contribute to achieving sustainable urban environments that provide equitable opportunities for all groups in society.

In 2015 Nico Larco proposed a framework for the design and evaluation of urban design practice. The framework provides a roadmap to help urban designers/researchers understand the elements and issues to be considered when addressing sustainability through urban design. Larco states that although theoretical, historical and methodological issues related to urban sustainability, urban design, and sustainable development have been tackled by researchers, a holistic framework that explicitly guides urban design practitioners to achieve sustainable design was still missing. According to Larco, the well-established link between urban design and sustainability manifests primarily through the effect of urban form on the following focus areas (discussed in greater detail in the next section):

1. Energy use and GHG emissions (based on transport related issues)
2. Water quality and recharge
3. Habitat and ecological quality
4. Energy use and production (based on non-transport related issues)
5. Equity and health

Larco's Sustainable Urban Design framework matrix include primary and related metrics for each of the five focus areas and provides a breakdown of metrics at different scales of intervention. Most of these metrics are objective measures of physical conditions, like *percentage of pedestrian and bike friendly streets* or *urban land consumption/compactness,* which corresponds to the claim of urban design as the discipline that deals with the physical manifestation of urban areas. This framework represents primarily a top-down/expert approach to incorporating sustainability issues in urban design practice. Assuming that enhancing people's quality of life is an important goal of urban design (Jenks, M. and Dempsey, N., 2016), it seems pertinent to include user-centered measures of the impact of urban design on sustainability. We assert that Larco's framework is missing an explicit space to account for people's desires, expectations and needs to have a better life in urban areas.

It is our contention that a holistic framework for sustainable urban design should include measures of social sustainability, especially as urban design deals with issues of everyday life and provides options/solutions that could enhance people's quality of life. Failing to do so would only increase the gap and disconnection that is claimed to exist between designer's intentions and people's actual needs and expectations (Smith et al., 1997).

This paper highlights the importance of weaving in the social dimension of sustainability into Larco's framework (2015) to balance out its top-down/experts approach. The argument uses the Circles of Sustainability as the supporting theory (James, 2015) emphasizing the understanding of sustainability as a social phenomenon. The paper concludes with suggestions for incorporating social dimensions of sustainability in Larco's framework.

1.0 Larco's framework

1.1. The proposed framework for Sustainable Urban Design

Larco's framework is based on a review of literature produced by researchers and practitioners who have proposed a number of concepts, issues, and elements that constitute sustainable development and its subset urban design from 1984 to 2010. It draws from the work of Hough (1984), Calthorpe (1993), Frey (1999), Wheeler (2000), Wheeler and Beatley (2004), Jabareen (2006), Kenworthy (2006), Farr (2008), Ritchie and Thomas (2009), and Condon (2010). Larco identifies that this body of literature investigates theoretical, historical and methodological underpinnings of sustainable development that need to be decanted into a framework that can be useful for urban design practitioners and researchers. The framework Larco proposes also draws from rating systems at urban scale such as LEED-ND (2018), BREEAM Communities (2012), STARS (2012) and SITES (2014), the best-known rating systems to guide and/or assess the design of urban design projects in developed countries.

Focus areas	Primary metrics	Related metrics
Energy use/GHG (transp. related)	GHG production	Vehicle miles/km traveled
	Transp. energy consumption	Mode split Density Land use mix Percentage of ped/bike friendly streets Urban land consumption/compactness
Water quality and recharge	Recharge rate	Percent piped (vs. direct recharge) Percent permeable surface
	Water quality (pollutants, particulates, temperature, and speed)	Drainage concentration time Water velocity urban land consumption/compactness
Ecology/habitat	Species diversity/strength	Amount of habitat Grade of habitat Health of indicator species Urban land consumption/compactness
Energy use/production (non-transp.)	Non-transp. energy production/ Consumption	Street lighting energy use Heat island effect Building typology split Urban land consumption/compactness
Equity and health	Accessibility Affordability Safety Physical activity	(related metrics of energy use/ghg) Housing/unit type, transport access Crime rates, accident rates Access to open space, connectivity

Figure 1: Sustainability primary and related metrics. Source: (Nico Larco 2015)

The five focus areas of the framework are briefly described next:

Energy use and greenhouse gas (GHG) emissions (transport related): urban transportation remain the most energy consuming and GHG emitting activity (Schafer and Victor, 1999) in urban areas, particularly in the United States. Urban design can influence travel modes by providing favorable conditions for less energy intensive modes such as walking, biking and transit.

Water quality and recharge: according to Larco, not all water systems are of direct concern for urban design practice. Potable water, wastewater, greywater and rainwater are systems that other disciplines deal with. The main focus of urban design is the management of stormwater by first reducing run-off and second by mitigating the run-off that is created. It also addresses the typical challenge of urban areas that have a high proportion of impervious surfaces that reduce the rate of direct recharge of stormwater into the earth.

Habitat and ecological quality and extent: urban areas by definition are a disruption of natural ecosystems. Urban design is challenged to manage and limit the negative effects of urban development creating areas that preserve, protect and incorporate healthy ecologies and habitat.

Energy use and production (based on non-transport related sources): this focus area deals with three non-transport related sources of energy use in urban areas: building energy use (heating, cooling, lighting and ventilation), energy use through street lighting (also parking, parks and public space lighting in general) and embodied energy of infrastructure (the total energy required to produce, transport and install any material or product).

Equity and Health: urban design impacts accessibility, affordability, safety and degree of physical activity. Accessibility refers to how easily individuals can reach goods, activities and services in urban environments. Affordability includes housing, transport, and utilities costs based on their distribution and availability. Safety covers three primary areas related to urban design: safety from crime, safety from accidents and safety from pollution and toxins. Finally, physical activity is directly impacted by urban design through increased access, size and attractiveness of places for recreation and the design of systems for utilitarian physical activity mainly related to transportation modes.

Larco presents the framework as a tool to help address design related issues by organizing critical elements of sustainable urban design by scale and resource goals while attempting to be clear about the relationships between elements and specific sustainability goals. Four out of five focus areas deal primarily with environmental issues with the fifth focusing on equity and health.

All the metrics included in the framework are informed by objective measures. Larco conceptualizes metrics as primary or related. Primary metrics are those that can be directly measured, while related metrics are used as proxies for more than one primary metric and come from well established studies on the matter usually serving purposes beyond the realm of urban design. For example, *density* is a measure that is used in urban planning, urban economics, architectural design and social science research in urban environments. Similarly, *water velocity* is a measure that informs landscape architecture design, a variety of civil engineering projects such as aqueducts, roads design, etc., and the work of ecologists, plant scientists and earth scientists to name a few.

The framework addresses the spatial dimension of urban design through a matrix that establishes relationships between the focus areas of sustainability and the traditional geographical scales of UD (regional, district/neighborhood, block/street, project/parcel). The corresponding elements of sustainable urban design at different scales intend to help practitioners and researchers to account for the complexity involved in designing and/or assessing urban design interventions while keeping track of the relationships between them at different geographic scales.

1.2. The shortcomings of the framework

The framework proposed by Larco does an excellent job of culling from a wide and dispersed literature on different facets of sustainable development pertinent to the urban design process. However, in the process of distilling the five focus areas of the framework from the literature, it does not pay attention to the conceptual tenets of the sources, leaving an open question as to what extent there might be fundamental contradictions between them, or whether that would matter whatsoever. To begin with, a framework for sustainable urban design should clearly declare the underlying sustainability understanding it adheres to. Sustainability is a widely debated and often abused concept due to its vagueness (Daly, 1996) that requires a contextual definition to avoid loose interpretations.

For example, the best known definition of sustainability was tightly connected to development which was understood as economic growth (Mebratu, 1998). This iconic definition “development which meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, Our Common Future, 1987) sees development (economic growth) as the way out of poverty and the environment as something to be managed. Another definition emphasizes people’s accountability by stating that sustainability is about “transforming our ways of living to maximize the chances that environmental and social conditions will indefinitely support human security, well-being and health." (McMichael et al., 2003). Yet another definition of sustainability conceptualizes it in terms of an expected outcome: "I define sustainability as the possibility that all forms of life will flourish forever." (Ehrenfeld, 2005). In the case of the proposed framework for sustainable urban design, such a definition is missing leaving an open door to freely assess the success of an intervention according to the lens it is looked through.

Since the framework also draws from the best-known rating systems for sustainable urban design, it embodies an understanding of sustainability underlying their conception. These rating systems are, in varying degrees, industry lead, market-driven efforts to convey sustainability thinking within the established status quo of the profession of urban design and more broadly sustainable development practice. Many of the guiding tools offered by the rating systems encourage technologically driven solutions to issues greatly bound within environmental concerns. Some of these rating systems are taking important steps towards assessing performance instead of only assessing design but these efforts do not permeate the proposed framework. To illustrate this point, SITES only awards the certification after performance data is collected in areas such as *Site Design - Human Health & Well Bein*g or *Education & Performance Monitoring*, shifting the emphasis from prescriptive guidelines to design decision making aware of every day people-environment interaction.

The framework is conceived within a top-down/expert approach that relies on hard measures of objective matters. As a result, it does not account for people's beliefs, attitudes and expectations regarding sustainability goals. This has the unintended consequence of augmenting the chances of increasing the gap that is claimed to exist between designer's intentions and people's actual needs and expectations (Smith et al., 1997).

Even though Larco's framework acknowledges the limitation of insufficient research linking different aspects of urban design to sustainability, the overall approach fails to explore the reasons behind the weak links between aspects of sustainable urban design as well as their link with overall sustainability. We think that in part the disconnect between aspects of urban design and sustainability come from the understanding of sustainability as a combined "capital" that operates in a trade-off system. In this system, environmental, economic and social capitals participate in often unbalanced operations that emphasize one dimension over the others resulting in biased assessments and interpretations that reveal the interests at stake.

Simply put, this trade-off system works as arithmetic operations between metrics of environmental, economic and social aspects of sustainability. For example, if an urban design intervention in a given neighborhood of a city increases green surface area (environmental aspect) and provides more areas for new businesses (economic aspect) but overlooks the need of the community for a safer place for kids (social aspect), it still can be considered as sustainable urban design because two out of three facets of sustainability yielded positive numbers. As far as the cumulative result shows improvement, the given operation is considered a success. The proposed framework for sustainable urban design is heavily invested in environmental issues (four out of five focus areas) informed by objective primary and related metrics.

The social aspects of sustainability in the framework are comprised largely in the focus area called Equity and Health. Although the author acknowledges the importance of place making and identity, there is no explicit place for measures that contribute to this aspects in the framework. For example, in assessing levels of *accessibility* the framework could incorporate measures of continuity, walkability, proximity, etc for different groups especially disadvantaged/vulnerable groups; in assessing levels of *engagement in activities* it could use measures of vitality and usefulness; in assessing levels of *comfort* the framework could incorporate measures of safety, cleanliness, attractiveness, etc. from stakeholders of the project. All these and other metrics can come from both qualitative and quantitative data.

The economic dimension of sustainability does not have a place in the framework either, arguably because of the framework's declared focus on the physical manifestation and design of urbanized areas. We assume that this omission also derives from the combined capital understanding of sustainability where economic aspects are regarded as an abstraction and not as one aspect of social life. The economic dimension influences and is influenced by the physical reality of urban environments. For example, the design of mixed-use urban areas not only contributes to decrease commuting time but also incentivizes economic transactions, which in turn can provide livelihoods to residents of a neighborhood. In a similar manner, housing typology is also tightly connected to economic aspects not only in terms of affordability but also expressed as projected property value in urban areas as a result of strategic operations of mixed use (which allows small scale income generating activity) or keeping single housing typology.

The fact that Larco's framework does not declare its affiliation with a specific understanding of sustainability is problematic. It leaves the door open to interpretations as to what sustainability means to urban design practice. It doesn't seem to have a critical stance over the mainstream understanding of sustainability known as the Triple Bottom Line. The framework seems to accept that sustainability can be broken down into dimensions that are ultimately given variable weights according to the interests at hand regardless of the potential unbalance between them.

2.0 Sustainability as a social phenomenon

Sustainability is by definition a holistic concept only compartmentalized for epistemological and practical reasons. Epistemologically, the concept of sustainability is broken down into dimensions that allow in-depth investigation of the aspects that influence such dimensions. It also serves the purpose of contextualizing each dimension and its corresponding aspects and measures in specific times and places. The practical reasons behind the compartmentalization of the concept of sustainability have to do with providing an organized break down of its complex and interrelated aspects to prevent confusion and unnecessary reiterations when defining tools or during field research. The break down of the concept of sustainability into dimensions also serves the purpose of giving different emphasis to particular aspects in specific moments and places as long as not a single dimension of sustainability is discarded and there is always a recomposition of the whole.

While Larco's framework offers urban design practitioners a useful checklist of metrics to aim for, its approach fails to guarantee a truly holistic understanding of the problem at hand due to the unbalanced presence of aspects from the different dimensions of sustainability; privileging environmental aspects over economic and social ones. Such an unbalanced framework is likely to do little to advance the sustainability of communities targeted by urban design interventions, especially disadvantaged communities with limited control over processes that impact their quality of life.

One alternative to get closer to the recomposition of the whole while giving emphasis to one dimension of sustainability is to re-think the way we understand sustainability. So far the three dimensions of sustainability have been considered as separate domains. We don't question whether there should be these three dimensions or the way they actually address the issues of living in this planet now and in the future. Researchers from the Institute for Culture and Society at Western Sydney University, Sydney, and the Senate Department for the Environment, Transport and Climate Protection, Berlin, in association with Metropolis, the World Association of Major Metropolises (Barcelona and Montreal), reformulated the understanding of sustainability to counteract the ease and manipulative accommodation of the three domains to almost every aspect of life. They proposed an understanding of sustainability that positions the social as an integral part of every domain: sustainability as a social phenomenon (James et. al., 2015).

Moreover, this alternative understanding of sustainability presents it as a component of the bigger construct of *social life* where it intersects with other social conditions such as resilience, liveability, adaptation, innovation and reconciliation. Thus, understanding the social as the reference and ultimate goal, sustainability reformulates its domains as four quadrants in what the authors call The Circles of Sustainability (ibid). The four domains are *ecology, economics, politics and culture*.

> *Economy* is defined as "a social domain that emphasizes the practices, discourses and material expressions associated with the production, use and management of resources." (ibid. pg. 53) It is one more aspect of social life and not the one that rules them all.
>
> *Ecology* is defined as "a social domain that emphasizes the practices, discourses and material expressions that occur across the intersection between the social and natural realms." (ibid. pg. 53) It goes beyond a series of metrics that describe the state of nature and establishes the availability of resources; it understands that humans are part of nature and should live within its limits.
>
> *Politics* is defined as "a social domain that emphasizes practices and meanings associated with basic issues of social power as they pertain to the organization, authorization, legitimation and regulation of social life held in common." (ibid. pg. 54) It deals with social relations in general going beyond the conventional understanding of politics as activities associated with the governance of a country.
>
> *Culture* is defined as "a social domain that emphasizes the practices, discourses and material expressions, wich, over time, express the continuities and discontinuities of social life held in common." (ibid. pg. 54) It is aimed to understand how and why people do what they do at this moment and place making specific both the spatial and temporal dimensions of sustainability.

Urban design interventions have the ultimate goal of contributing to enhancing the quality of life for inhabitants of urban environments. Quality of life is a composite index that includes material living conditions (income, consumption, and material conditions), productive or human activity, health, education, leisure and social interactions, economic and physical safety, governance and basic rights, natural and living environment, and overall experience of life (Eurostat, 2015). The metrics of all these dimensions are often oversimplified and/or isolated for comparison purposes through the lens of standardized global indexes like the GDP. As a consequence, comparison for example of absolute GDP numbers do not convey much about quality of life of specific communities. Neither does comparing material living conditions of two communities with different cultural background or from very different climatic areas.

The urgency to compare realities often uncomparable tend to deviate attention from the actual reason to come up with indexes and metrics: we want to know how people are doing in their lives as urban residents of particular cities. In that regard it is important to underline that urban design practice has the ability to impact many of the measures of quality of life by transforming the built environment where human activities occur. It also has the obligation to find out what people think, want and need as well as the values they hold before making any decision regarding the transformation of urban places. A comprehensive framework for urban design practice and research must include explicit consideration of subjective perceptions from local people to inform project design and sustainability assessment.

3.0 Adjusting the framework

3.1. Incorporating the social

A sustainable urban design framework should incorporate social aspects of sustainability by using metrics that directly reflect human perception, attitudes and beliefs. Each one of the focus areas proposed in the framework of sustainable design has embedded human activity to some extent. For example, in the focus area of water quality and recharge, it would be important to find out the perception regarding water quality, affordability, and accessibility of different residents and user groups. At a minimum, everyone holds a position regarding water quality, energy use, and ecological issues in their locality. Urban design practitioners would be taking important steps towards engaging the community by acknowledging the various points of view about particular issues in specific places and times. This would also provide the opportunity to find out reasons behind certain attitudes and behaviors that might interfere with the sustainability objectives of a given intervention.

Moreover, qualitative data captured directly from the users of the urban area under study helps to better understand hard measures of GHG production, water quality and recharge rates or the health and level of conservation of natural habitats. Urban design practitioners should investigate and interpret people's perceptions, beliefs and expectations about urban environments when striving for sustainability to increase the levels of community engagement in the process of transforming urban places. Community engagement is a measure of sustainability associated with bottom-up approaches that contributes to strengthening identity, ownership and capacity building to project urban interventions into the future.

A framework for urban design practice should be guided by a balance between top-down and bottom-up approaches as a strategy to reconnect goals and processes towards sustainable urban environments. The apparent irresolvable quandary between the two approaches can be solved by shifting the focus from the *what* and the result to the *how* and the process. Processes aimed to enhance the sustainability of urban places can engage experts and communities merging global concerns on one hand with local realities, values and interests on the other through urban design interventions. The resulting indexes to assess the success of the intervention should be selected by a group the that includes both experts and community members to keep comparability with global indicators as well as remaining locally relevant for the communities being impacted.

3.2. Incorporating the temporal dimension

Urban design interventions happen at specific points in time and place. At the same time, they are part of the continuous process of urban transformation, the physical manifestation of that process. Larco's framework matrix addresses issues of urban design concerned with the spatial dimension (different scales from the region to the parcel) but fails to address issues concerned with the temporal dimension (present, near-future, far-future).

The different spatial scales involved in urban transformation processes interlink and interact with each other yielding different indices of sustainability at local and global scales. The accuracy of the process of assessing the success of a given intervention benefits from evaluating it throughout the different scales traditionally used in urban design practice. For example, a project to design a pedestrian path along a river as it crosses an urban area has local impact in the immediate micro habitat of the river shore, helps the citizens understand the benefits of having a healthy river and contributes to the conservation of the water system it belongs to at regional scale while connecting with global concerns about water quality and availability.

However, the success of such interventions must also include the temporal dimension of sustainability. It is often overlooked that time is essential to sustainability as a concept. For urban design practice and research it is fundamental to understand the history of a place, its culture (past). It is also important to operate within the current set of conditions, resources and possibilities. But perhaps more importantly, urban design interventions must address people's future expectations; understanding the values, attitudes and beliefs residents/user groups hold to avoid neglected urban areas and guaranteeing the sustainability of places. Following up with the pedestrian path along the river example, a successful design can only be fully accomplished when it is contextualized, when careful investigation of the meanings, beliefs and feelings about water is carried through, and the hopes and expectations of the target and expanded communities are interpreted through the design. When discussing sustainable urban design, the long-term viability of any intervention is crucial. Maintenance and upkeep are aspects of a project that are intrinsically linked to buy-in from local partners and organizations. This is possible when local partners are an integral part of the process from conception, planning, implementation, use and maintenance.

Places are socially constructed, and time is at the core of the spirit of societies. Investigating and understanding people in their temporal context, from cultural background, current conditions and future expectations become a key part of any urban design process intended to be sustainable.

4.0 Conclusion

Any framework is grounded on theories and conceptual understandings of the matters it intends to provide a reference for. A framework for urban design practice and research is an important tool that helps to organize strategies and processes of grand complexity. Larco's framework presents a good starting point to begin incorporating sustainability issues into urban design practice. However, by failing to declare the conceptual tenets upon which this framework for sustainable urban design rests, it can result in misled interventions and skewed and/or incomplete assessments.

Given the role of urban design as an important contributor to enhancing quality of life for urban residents, a sustainable urban design framework must include metrics that account for the user's perspective to assess and propose urban design interventions. The Circles of Sustainability provides a starting point to include issues pertaining to social sustainability into all aspects of sustainable urban design practice.

Any framework to assess sustainable urban design practice and research should incorporate the temporal dimension to account for the history, current conditions and future expectations of residents of a given locale. This can come from incorporating bottom-up approaches to the process that help increasing the sense of belonging by engaging and participating in the definition of the future of their own urban environment.

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Fahad Alotaibi

Touching the Ground: The Urbanity of the Tall Building in the Gulf Region

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Touching the ground:
The urbanity of the tall building in the Gulf Region

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ABSTRACT: Tall buildings, by definition, are vertical objects. Historically, architects are more concerned about the tops of towers and less about their bases. Understandably, this is to make a statement through which more attention to the building can be drawn. However, the building base—the podium—is the place that is important to ground the building within its context. This neglected part of tall buildings is responsible for not only welcoming people to this gigantic structure, but also mediating the scale of the tower with the surrounding buildings and creating a good public realm for the city. This paper aims to address the issue of urban integration between tall buildings and the urban fabric. To achieve this goal, a desk study and field work were undertaken. The former involved a literature and professional documents review, whereas the latter involved interviewing 23 experts from the Gulf Region (including architects, planners, and academics) and observing six tall buildings in the Gulf Region's main cities, including Riyadh and Dubai. This study draws some lessons from comparing tall buildings in the Gulf Region with those in Canadian cities, including Toronto and Calgary. This paper concludes with proposing some design recommendations to improve urban integration, enhance the quality of ground spaces in tall buildings, and refine our experience with the podium.

KEYWORDS: urban integration, public realm, tall buildings, vibrant places, tower podium

INTRODUCTION

The tall building, as a building typology, has been considered by many scholars as harsh and unfriendly, lacking the proper human scale, and destroying any kind of urban realm. Tall buildings play a huge role in the "living" fabric of the city. The real issue today is not about how tall buildings shape the skyline, but rather how tall buildings meet the ground and integrate with the urban realm. Tall buildings have increased dramatically around the world from the beginning of the 21st century. For a long time, planners and academics considered the tall building as an urban enemy of the city fabric and livability (Alexander 1977; Gehl 1987; Jacobs 1961). Christopher Alexander (1977) also points out that the ultimate height for a building that satisfies our psychological and environmental needs is four floors. He believes that buildings that go beyond that limit create an unpleasant and chaotic environment for both the inhabitants and the city. Having said that, many cities around the world try to enhance the relation between tall buildings and the city fabric. The detailed attention that focuses on the relation between the base and the tall building, the effects of the microclimate on the surrounding areas, and the contribution to the public realm are among the factors that help to better integrate the tall building with the urban fabric. But this typology evolved over time, and the tall building changed from an insulated building that was freestanding in the middle of the dark park (e.g., Pruitt-Igoe) to the vertical cities (Yeang 2002) that have many amenities that make life for the inhabitants inside the tower easier and happier. The urgent need is to apply good urban design principles for tall buildings, and to have these buildings integrate within the urban realm, which would add to the city's diversity and vitality.

1.0 METHODOLOGY

To achieve the objectives of the study the following methods were used. First, a desk study and field work were undertaken, including study of the history of urban development of the Gulf cities and the tall buildings that emerged in those cities. The desk study involved a literature and professional documents review. The field work included interviews with the main stakeholders for the tall building industry; 24 interviews with architects and planners, officials and policy makers, and academics were conducted. Third, six tall buildings in Dubai and Riyadh were used as case studies for observing and testing urban integration. This study draws some lessons from comparing tall buildings in the Gulf Region with those in Canadian cities including Toronto and Calgary.

2.0 URBAN INTEGRATION OF THE TALL BUILDING

The tall building has a huge burden on the site (context) and could work as a positive or negative contribution for the urban fabric. Many examples exist in the world of the great integration of the tall building with the urban environment and the way that the tall building meets the ground. The way the tall building embraces the street is a vital factor in the way the public realm is shaped. The tall building should be in harmony with the other components of the city's fabric, and should complement them, not dominate them. Historically, we can trace the role of the tall building in the urban fabric on both positivity and negativity to the beginning of the 20th century. We can cite two examples of the effect of the tall building on the urban public realm. The first example, which is one of negativity, is the Equitable Building (New York) in 1916, designed as a huge bulky building that negatively dominates the fabric around it. The negative aspects include overshadowing, blocking natural light, and creating narrow sidewalks. These negative effects were the main reasons for the new building law in New York (1916) that required tall buildings to be set back in order to let the natural light penetrate to the street and surrounding area (Short 2012; Chappell 1990). However, the set-back that dominated the subsequent tall buildings will not solve all the problems, as Alexander et al. (1977) state that "building setbacks from the street, originally invented to protect the public welfare by giving every building light and air, have actually helped to greatly destroy the street as social space." (Cited from Ewing and Clemente 2013). These set-back spaces need to be carefully designed to welcome the street and the passersby, and the proportion of width to height should be addressed in a way that will create vivid places. In contrast to the Equitable Building, the Rockefeller Center that comprises 14 buildings and the GE building by Raymond Hood are centerpieces. The Rockefeller Centre adds elegance to the urban fabric by offering a public plaza and walkable area, and works as a social and gathering area for the people. The prominent architecture critic Ada Louise Huxtable (2008) described it as such:

> If you look at Rockefeller Center in detail, it's a very elegant plan: higher and lower levels that lead you from one to the other, streets cut through to keep the human scale. You always feel you're going around a corner, not around a wind-swept plaza, into some other area that has an inviting activity.

This kind of urban realm, in the way in which the tall building must integrate with the urban fabric, leading to more vivid spaces, has been the major issue with tall buildings in the Gulf cities. The case studies in this paper will show us some obstacles that affect this kind of integration.

3.0 CASE STUDIES: THE GULF REGION CONTEXT

3.1. Riyadh

Riyadh is the capital of Saudi Arabia. It evolved from a traditional settlement in the central area of the Arabian Peninsula to one of the largest modern metropolises in the world (the city expanded from 9 km^2 in 1917 to 1,798 km^2 now). The urban development of the city occurred in different historical phases, but the city gained its most important role when King Abdul-Aziz established it as the capital of the new Kingdom in 1932. The city had the same character as the old Arab cities in that it was constructed from local materials and built in a way that was sensitive to the harsh desert climate. These urban elements include narrow alleys that are shaded by the adjacent buildings and work as passive ventilation corridors for the city. The buildings were low-rise modest buildings built usually from mud material. The urban development of the city can be summarized in four main phases: 1) the pre-oil phase, which was the traditional settlement that covered the area inside the walled city between 1824 until 1950; 2) the modern planning phase that dates back to the early 1970s when the Greek planner Constantinos Apostolou Doxiadis was hired to conceive the first master plan for the city that was based on a modern grid iron planning system; 3) the second phase of the master plan that aimed to revise the Doxiadis plan and was designed by SIT International; and 4) the last phase which began in the late 1980s and continues to the present and mainly focuses on the work of the Arriyadh Development Authority (ADA) that controls the planning and management of the growth of the city.
The city has been considered low-rise; it has resisted the vertical urbanism surge that happened in other Arab cities such as Dubai. However, two examples stand out as exceptions to the horizontal development of the city. The first tall building was AlFaislaih Tower by Norman Foster completed in 2000. Then came the Kingdome Tower in 2001. The building height limit in the city was kept at 30 floors until the new law in 2008 that changed the face of the city and created a signature skyline for the city.

3.1.1. AlFaisliah Tower

AlFaisliah Tower, designed by Norman Foster, was an iconic addition to the city skyline. The minaret was the main inspiration behind the building and the building was considered climatically sensitive in that the architect neglected the fully glazed box and instead designed the tower with less transparent facades that were covered with louvers. The site was organized to create pleasant places. The complex components (The Hotel, The

Mall, the Tower) were distributed on the site in such a way as to frame the whole site. However, the green area that occupied the main area on the west side of the tower is rarely used because the vast area is out of scale, the difficult permeability of the site, and the landscape design (Fig. 1). On the east side of the building—the Mall entrance—the area is dominated by the vehicular area for drop-off and features some seating but is improperly designed. On the north and south sides, the sidewalks are a reasonable walkable area, the width of the street is reasonable, and the trees enclose the sidewalks. The placement of the tower in the middle of the site helps to promote imageability of the tower and respects the scale of surrounding buildings, and the urban organization of the site to create in-between spaces that encourage the urban realm, but unfortunately with no proper landscape design.

Figure 1: The main plaza of AlFaisliah Tower. Source: (Alotaibi 2017)

3.1.2. Olaya Towers

The Olaya Towers are twin towers that rise 203.4m and 166.3m for towers A and B, respectively. The towers were designed by BDPL Gulf Architects and are located in the commercial spine of Riyadh. The location of the towers in the Olaya, on one of the city's walkable streets (Al-tahlia street), inspired the architect to elegantly design the site in a way that contributes to the city's fabric. This was achieved through the exceptional design of the site, which features a triangular plaza that is sandwiched by the tower podium and two outdoor retail shops. The provision of the outdoor retail shops keeps the area usable and alive even after the work day is over. The parking was placed on the four-floor basement and vehicle movement has been designed to not cross with the pedestrian area. The size of the plaza and the way the retail shops frame the entrance that faces the intersection adds greatly to the city's public realm. The continuity and permeability of the site is another great contribution; the sidewalks that surround the site work in coherence with the urban fabric of the area. However, the plaza lacks proper public seating, a green area, water space, and a playing area; these would enhance and increase the use of the place.

Figure 2: The plaza of the Olaya Towers. Source: (Alotaibi 2017)

3.1.3. Rafal Tower

Rafal Tower, the 70-storey, 308m building, is the second tallest building in Riyadh behind the Capital Authority Tower in KAFD. It is located on King Fahad Road north of Riyadh city. The fully glazed facade with the elliptical shape of the tower makes it an elegant contribution to the city skyline. Urban-wise, the tower complex consists of the Tower, which includes the hotel, residential apartments and offices, and the base, which consists of retail shops. The base of the building was designed to reflect the sense of the place through imitating the vernacular language of the traditional architecture of the city—Najdi architecture—which has triangular openings and uses local materials such as Riyadh limestone. The buildings occupy the whole site with lack of public spaces and plazas. The only public space that promotes urban quality is the plaza in front of the hotel entrance, which is a roundabout for vehicle drop-off and features water spaces. The continuity between the site and surrounding areas is achieved through proper sidewalks. The site is elevated above street level and pedestrians access the site through a ramp that evokes a sense of revelation that makes the experience more energic and exciting.

3.2. Dubai

Dubai's model has attracted many cities in the region to follow, imitate and, to some extent, compete with it, (for example, in the case of Doha). The city in less than 20 years has surpassed Beirut, which was the finance and business capital of the region in the 1970s and 1980s.[i] Thus, the effect of Dubai on the cities of the region and beyond led the urbanist Elsheshtawy (2009) to coin the term 'Dubaization.' The city emerged beside the creek with a population of approximately 800 (Elsheshtawy 2009). The built environment of Dubai at the time did not have a distinct status and was identified by a small land area containing small mud huts (Elsheshtawy 2009). The city was like the other Gulf villages at that time; they shared the same characteristics of the Arabian Peninsula urbanism, including traditional elements such as narrow alleys, local materials, and privacy and climate preferences such as windcatchers and courtyards. The city gained its significant role in the region as a commercial pivot in 1870 when Britain declared Dubai as the new port for its Empire's merchants in the Trucial States (i.e., the group of Sheikdoms they were under British control from 1820 until 1971; Ramos and Rowe 2013). The influence of oil on the city's urban shape was substantial, as for other Gulf cities. In 1960, the ruler of Dubai, Shiekh Rashed Ibn Maktoum, invited the British architect John Harris to develop the first master plan for the growing city. The aims of this plan were the provision of roads and infrastructure for the city, general land use zoning for residential, industrial, and commercial uses, and the control of the future growth of the city (Ramos 2010). In 1971, following the discovery of oil in 1966, Harris executed the second phase of the master plan, extending his vision for the new Dubai by establishing a ring road system and two bridges across Dubai Creek, and connecting the outer housing area with the inner city (Ramos and Rowe 2013; Elsheshtawy 2004).

3.2.1. The Index Tower

The Index Tower is a 328m (1076ft), 80-storey mixed-use building located in the Dubai International Financial Centre (DIFC). In contrast to the norm of tall buildings located in the Sheikh Zayed area, where the long side of the building faces the road to maximize its visual appearance from the road, this tower stands striking with its short side to the road and positioned in the best climatic orientation. The tower touches the ground gently, with the ground floor, except the core services and the entrances have been elevated to create a shaded atrium (Wood 2011). This atrium features a public gathering area and large pools (Fig. 3) that help create a sensual experience and pleasant micro-climate for the inhabitants. However, the whole site of the building is designed to satisfy vehicular movement and is hard to access by pedestrians; the only access is through stairs that are placed on the main road and there is no signage for pedestrians except for the atrium. Also, the continuity with context is diminished through the huge walls that prevent permeability through the whole fabric. This discontinuity with the context is the shortcoming of the urban configuration of this tower. Conversely, the building enhances the public realm by creating the shaded atrium that lifts the building gently and evokes a sense of vividness.

Figure 3: The large pools that engulf the main atrium of the Index Tower. Source: (Alotaibi 2017)

3.2.2. Al Mas Tower

Al Mas Tower, soaring at 360m with 68 storeys, is the tallest building in the Jumeirah Lake development in Dubai. It is located in the middle of the development as a centerpiece for the whole development and is engulfed by two man-made lakes and surrounded by abundant green spaces and plazas. The tower is based on a huge podium, which is inspired by “Al Mas,” the Arabic meaning for diamond shape. The urban configuration of the project is thoughtfully addressed through the good podium design that creates a transition place between the vertical and the horizontal. The podium is elevated from the street by approximately three meters, giving the project a kind of monumentality. On the other side this difference in height between the street and the project creates an impossible scale for passersby; they must access the site through ramps and stairs. The positive aspect about this elevation from the street level is “monumental tectonics and the desire for revelation”; this kind of spatial configuration, according to renowned Canadian architect Arthur Erikson, is a fundamental aspect for architecture to evoke and enhance the experience of place (Sabatino 2016). This experience will be achieved by pedestrians when they access the site through these intriguing routes that reveal the tower’s sensuality. On the east side of the tower, the building podium features some terraces and cafés that have a good view of the public space that is engulfed by East Al Mas Lake.

3.2.3. The Khalifa Tower

The Khalifa tower is an icon for the region, era, and the people in the Gulf. Rising to 828m and comprising 163 floors, it is the tallest structure in the world and a true mirror for the human aspiration and achievement in technological advancement and symbolical power. The design originated from the desert flowers and an Islamic pattern, inspiring the architect, Adrian Smith, to develop the Y-shape that consists of buttressed wing step-backs while rising. This morphology helps to achieve structural stability by reducing the impact of the wind forces on the building sides (Alotaibi and Sinclair 2015). The tower is the centerpiece for the new development of the Downtown Dubai. The access by walking to the tower base is restricted because there is no continuity with the context. The tower is an inclusive place for the residents of the apartment section or for hotel visitors. The integration is not addressed well and the tower works as a gated community that welcomes only a small segment of the society. This raises an important question: Is the tall building a type of building that is designed to satisfy only the wealthiest people of society? How can we change this idea to make tall buildings more open to all? This is not the norm in other parts of the world (e.g., tall buildings in Chicago) where tall buildings can enhance the urban realm of the city. However, the new downtown in general stands as a perfect example of urban integration, with an abundance of walkable areas, a lot of public spaces and a well-designed landscape. The tower, the mall, and the other surrounding buildings provide great access for the Dubai Fountain which is placed on one of the largest man-made lakes in the city. The Dubai Fountain is the focal point of the city and provides a place for memorable photos (AL-Kodmany 2017).

Figure 4: The main entrance area of the Khalifa Tower. Source: (Alotaibi 2017)

4.0 CANADA CONTEXT

4.1. The Bow Tower in Calgary

The Bow Tower is the tallest building in Calgary, rising to 237m. It was designed by Norman Foster and partners as a new skyline icon for the city. The tower’s form takes a curve shape that enhances the structural performance of the building and creates an enclosed plaza that improves the urban quality. The building features different climatic principles, such as being oriented in the optimal environmental direction, providing a sky garden on three levels of the tower, and not casting the tower’s shadow on the Bow River, as restricted by city bylaws (Barnes and Hendricks 2013). The plaza, located on the south-east corner of the site, adds to the city's urban realm and is well-designed from the landscape point of view. The plaza features "Wonderland," a sculpture created by Spanish artist Jaume Plensa. The sculpture is a giant face made of white steel and is in visual harmony with the tower. This blend of architecturally elegant building and unique art work helps to create a pleasant, energetic public space. The plaza has different types of public seating and green areas. The building is not well connected on the ground but is through the elevated famous +15 walking system that links most of the downtown public buildings through +15 ft bridges.

4.2. ICE Tower in Toronto
The ICE Tower is a complex of mix-use development in the heart of Toronto. It consists of two residential towers and one office building. It was designed by Toronto-based architectural firm Architects Alliance. According to the design concept the shape of each tower reflects its function, the office tower designed as a modern, rational shape while the residential towers are a slender, sculptured shape that maximize the view for inhabitants to Lake Ontario. The most striking element of this complex design is the way the tall buildings meet the ground. The site is covered by a huge canopy that works as a seven-meter-high umbrella. This base integrates the site with its context very well by providing high permeability through the site, and a lot of public facilities that encourage people to stay in the site and not just walk through it.

5.0 THE INTERVIEW RESULTS

> However, when we take the Gulf cities for instance as encounter or another case, you will find that no we don't have this kind of integration. Usually tall buildings started to take over in certain district as isolated object. because of its image making they are been concentrated in one zone and yet transit, mobility and infrastructure to come. (Interviewee 5)

Urban integration is the missing element for tall buildings in the Gulf Region. The majority of tall buildings in the Gulf cities as we explored in the case studies lack the proper integration with the urban fabric: there is a poor relation between the tall building and the base; they are giant structures that look far from the human scale; and they are exclusive spaces that dominate huge lot in an important area without any aspect of a public realm. The lack of vivid places at the ground level and the inappropriate integration with the urban context are the main factors for people calling these places ghost areas, especially at night. Based on the interviews that we conducted with the main players for tall building design in the region, the main factors for poor integration between the tall buildings and the urban fabric can be summarized as: Lack of a designated area with proper infrastructure, human scale, the lack of social activities in the building base, the lack of climatically sensitive consideration for the podium, and the lack of specific tall building regulations (Fig. 5).

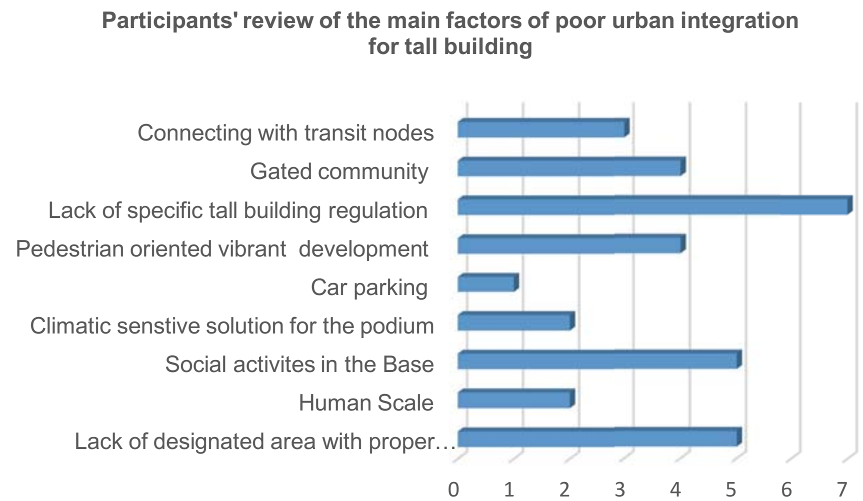

Figure 5: Participants' review of the main factors for poor urban integration. Source: (Alotaibi 2017)

6.0 THE DESIGN RECOMMENDATIONS FOR BETTER URBAN INTEGRATION OF THE TALL BUILDINGS IN GULF CITIES

Based on the gap that arises from the case studies and the interview results, these design recommendations work as a mechanism to achieve better integration between tall buildings and their urban context. It's worth emphasizing here that these design recommendations are not covering all the issues that related to the urbanity of tall building but the one that emerged from the observation of the author of the case studies and the results of the interviews with the experts. The following design recommendation could set the foundation for more design guidelines and expand on more details in future research.

6.1. Coherence

Tall buildings should meet the ground in a way that will contribute to the urban realm. This union should complement the existing urban fabric and encourage permeability and continuity of the context. This could be achieved through respecting the adjacent building, creating a base that acknowledges the human scale, and relating to the identity and character of the whole area (Ewing and Clemente 2013). However, the need for more complexity is one of the main aspects for tall buildings that aim to add more vitality and energic atmosphere for the whole area. Based on our observations in the Gulf cities, many of these elements for coherence are ignored or addressed poorly. The results are huge buildings that fragment the urban realm of the city and are usually enclosed, creating a kind of gated community. Solving the problem of lack of coherence in the area requires specific tall building regulations that address these issues and participation from the local community regarding the design proposal, such as in the Canadian context.

6.2. Connecting with transit nodes

Tall buildings that are well-integrated with the public transportation nodes are crucial for achieving the optimal urban integration. Tall buildings that do not address the increase in people and vehicles associated with the building will create chaos that will affect the city. The transit-oriented development is a model that satisfies the needs of the people and vehicles; it is applied in many cities in Asia (e.g. the ICC Tower in Hong Kong). Tall buildings with connectivity to the public transportation hub add value to the city from several perspectives; it has been shown that the more people relying on public transportation, the more sustainable the city is; also, the lives of people are improved in a way that enhances the interaction with the built environment. The ICC Tower project stands as a clear example for the integration with the transit system; the building stands above Kowloon Station, where 30,000 workers are served directly by public transportation (Malott 2010). Advanced transit systems were recently embraced by two Gulf cities: The Metro in Dubai in 2009, and the Riyadh Metro scheduled to open in late 2018. These systems will help to create more integration between the tall buildings and the urban fabric and reduce the negative aspects of this building typology on the city.

6.3. People-oriented cities and walkability

Walkability is not related to the height of the building, whether the building is tall or a low-rise, but rather to how the designer treated what the urbanists call "soft-edge." Alexander (1977) draws on the importance of this aspect of the building and he asserts that "if the edge fails, then the space never becomes lively" (as cited in Gehl 2011 p. 88). Many cities around the world have great integration between the tall buildings and the urban fabric, including JBR in Dubai. Its master plan focuses on the tall buildings, and the way the bases on these tall buildings touch the ground creating an elegant and inviting environment for people, great safe spaces for walking, and different facilities available across the area that invite people to walk, talk, and enjoy the urban space. Designs like these are needed to encourage more districts in Dubai to integrate tall buildings with the urban fabric in a way that gives the people the spaces that encourage them to integrate with the urban realm. Still, some areas need more revision of their planning, such as the cluster of tall buildings in Sheikh Zayed Road in Dubai and in other Gulf cities.

7. CONCLUSION:

As conclusion this paper raised questions rather than providing answers, and shed light on the most important issues of the urbanity of tall building in the Gulf cities. Further emphasis is required to investigate in this area in particular the direct ramifications of the tall building on the context, such as microclimate effects, continuity with the context, and the role of this buildings in enhancing the public realm of the city in general.

The issue of urban integration for the tall building plays a vital way in that these buildings fit within the context, enhance the public realm, and create human spaces. The examples from a Canadian context, show us that integration can be achieved between the street life and tall buildings in different ways; by opening the site for more social gathering spaces, encouraging continuity with the surrounding areas, and incorporating art work. Cities like Calgary and Toronto are clear examples of this phenomenon. The tall buildings in their architecture are not a direct cause of the poor livability of the cities; often these tall buildings, if placed in harmony with the urban context, can frame and create livable urban spaces. The interview results show us the main factors that affect the better integration between the tall buildings and the cities in the Gulf. The experts emphasized that the lack of specific building regulations is the main reason for this poor integration. A second major factor is locating an area that is designed for low-rise buildings that lacks the proper infrastructure for tall buildings. To summarize, the design recommendations could help this kind of integration, and could be evolved into specific design guidelines that will lead to locate the tall buildings in harmony with the urban fabric.

8. Acknowledgment:
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ENDNOTES

[i] Beirut in early 1970 was the capital for high-rise buildings in the region which accounted for around 22% of all the buildings in the city (Costello 1977).

Sérgio Barreiros Proença

Reading and Interpreting Portuguese Atlantic Seashore Streets in Sea Level Rise Context

Reading and interpreting Portuguese Atlantic seashore streets in sea level rise context.

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ABSTRACT: The lead role and the morphological diversity of streets, avenues and seashore drives that conform the articulation line between city and water on Portuguese coastal settlements is acknowledged. The dynamic inherent to the urban object underlines the fact that the present state is just a transitory moment in the evolution of these elements. In this context, several studies on climate change acknowledge the gradual but inevitable sea level rising, and warn on its effects on urban and humanized areas.
The convergence of research units of the University of Lisbon on urban morphology and on climate change allow stemming from the morphological knowledge on the origin, evolution and current state of the diversity of Portuguese Atlantic Seashore Streets, for the design of innovative solutions of adaptation measures and pathways to an expected and urgent scenario of sea-level rising. The research main goal is building a reference framework for interventions in each case, therefore site specific, with attention to the cultural and patrimonial values that make up each context, but with potential to define a methodology of approach and to typify operations or actions adaptable to similar contexts.
The present state of these elements is understood as the result of a sedimentary evolution process in time. Therefore, the ongoing first phase of the research project on *Portuguese Atlantic Seashore Streets* deals with the interpretative reading through systemic decomposition of layers underlining Form, Function and Role of the state of evolution of each element and its relation to the urban settlement and to the sea.
Departing from a generic characterization of the origin and evolution of these elements, the present paper uses the current pilot case studies of Sesimbra and Cascais to demonstrate the instrumental role of drawing for reading and interpreting the selected seashore streets.

KEYWORDS: seashore streets, climate change adaptation, sea level rise, urban morphology, systemic decomposition.

1.0 FRAMING AND STRUCTURE OF THE RESEARCH

The lead role and the wide morphological diversity of linear urban elements that conform the articulation between city and water on Portuguese coastal settlements was acknowledged by Forma Urbis Lab during the elaboration of the *Morphological Atlas of the Portuguese City*. The genetic relation with the site, the formation and transformation periods and the dynamic of the occupation and use of the place may explain this contemporary morphological diversity.

In the current context in which climate change promotes a gradual but inevitable sea-level rise, it is essential to know the diversity of this type of urban element - the seashore street or *rua marginal* - as well as to develop extreme flood models in order to define adaptation measures to climate change. The design of these measures must be coordinated both with the cultural heritage of the urban spaces and the needs and aspirations of the populations, who understand them as irreplaceable references both in their daily lives and as representation stages of the exceptional events of society.

Therefore, the underlying main idea of the research project is the construction of an essential reference framework for the design of waterfronts based on their memory and adapted to an inevitable becoming, namely to climate change effects from sea-level rise, addressing an urban space typology that plays a lead role in the mediation between city and sea: Portuguese Atlantic Seashore Streets.

1.1 Structure of the research project

The convergence of research units of the University of Lisbon on urban morphology, led by Forma Urbis lab (CIAUD/Faculty of Architecture), and on climate change, led by CCIAM and IDL (Faculty of Sciences), allow stemming from the morphological knowledge on the origin, evolution and current state of the diversity of Portuguese Atlantic Seashore Streets, for the design of innovative solutions of adaptation measures and pathways to an expected and urgent scenario of sea-level rising.

It is considered that only the knowledge of the past allows conceiving the future, therefore the research unfolds into 5 phases: starting with 1) The interpretative reading of Portuguese Seashore Streets through the elaboration of a Morphological Inventory of the diversity of cases; followed by 2) The development of models of extreme flooding based on projections for Sea Level Rise for 2050 and 2100; and 3) The compilation and selection of a set of adaptation measures for specific case studies to respond to projected sea level rise impacts, creating alternative adaptation pathways with the engagement of key stakeholders using Scenario Workshop and Adaptation Pathways methodology;[1] finally, it will take place 4) A research by design approach of urban and architectural answers on future scenarios materializing sea-level rise adaptation measures in academic projects. This phase will frame a Final Master's Project theme for students who will devise divergent, alternative, design solutions from common adaptation pathways previously defined. 5) The research also contemplates its dissemination through an itinerant exhibition, a synthesis book and a closing seminar.

Given the research current initial state of development, the paper focuses on the role of interpretative and characterization drawing and uses the pilot case studies of Sesimbra and Cascais to exemplify the usefulness of systemic decomposition methodology used in the first phase of the research, as well as tests a scenario of sea level rise for a tipping point of +5m.

2.0 THE LIMIT THAT MEDIATES

The Portuguese coast has about 943 km in mainland Portugal, 667 km in the Azores and 250 km in Madeira, totalling an Atlantic margin with more than 1800 km. Numerous coastal towns and villages dot this line of mediation between land and water, which defines and limits one side of the coastal belt where 80% of the Portuguese population lives.

In these urban fabrics, the relation with the sea is structuring from the primordial choice of the founding site of each settlement. Initially, the sea was used as a productive space or communication infrastructure, the sea supplied fish and seafood and, in the early periods, long distance travels were faster and safer by sea than by land. The mediation between urban space and water was at this early stage played by the beach sand, which supports boats and fishing gear. (Fig. 1)

Figure 1: View of Sesimbra village in the mid XIXth century. The beach mediates the settlement and the sea. Source: (Sesimbra Municipal Archive ref: EFHAMS/D/B/05)

Figure 2: View of Sesimbra seashore street and beach in the mid XXth century. Source: (António Passaporte)

In a second stage of occupation, protection structures such as walls, in some cases fortifications, and mediation structures such as ramps and piers are identified both in iconography and cartography and later in photographs, in the beginning more precarious but progressively these became more permanent and solid. The conformation of the seashore proto-urban spaces often stemmed from the functions that occupied the marginal buildings and the individual use given to the adjacent beach areas.

This lasting reality suffered transformations in most cases during the decades of 1930 / 1940. In that period, in several coastal settlements the construction of a continuous wall supported a horizontal plan in the coastal edge of the urban nucleus, associated to the consolidation of ramps and staircases that fulfilled the role of articulation with the beach and the sea. This surface was the embryo of the “rua marginal”, the ground that the seashore street would occupy.

In the Portuguese context, with the exception of few coastal villages, such as Cascais and Estoril, and restricted to a fringe of society that already had leisure activities connected to the use of the beach and the sea, in the end of the XIXth century, it was essentially from end of the first half of the XXth century, that the fishing related occupations of the urban sea margins began to coexist and overlap with another phenomena associated to a cultural transformation of the society in which leisure periods and, later on, summer tourism gain widespread prominence. These social changes had a physical impact on the waterfront spaces of coastal Portuguese settlements, which suffered more or less deep transformations: shading elements were placed on the beach, wide sidewalks for strolling and seashore drives were opened, paved and sometimes planted with tree lines, accompanying and redesigning the coastal urban edges aiming at the fruition of the ocean margin. From that moment on, the seashore street or avenue became an evidence. (Fig. 2)

Linear spaces limited by buildings on one side and with the other side opened to the Atlantic Ocean, supporting leisure uses and functions associated to exceptional urban representation spaces, such as squares, replacing the former fishing related buildings. On several of these settlements, seashore streets started to play the multiple roles of public buildings representation space, leisure space, framing space of the ocean view and mediation space between the city and the sea.

These characteristics are common to the wide diversity of cases of seashore streets and the leisure and tourism vocation is nowadays underlined on urban seashores over the early infrastructural and productive roles. Nevertheless, the essential identity representation role of the society on these mediation spaces between land and sea carries on. Seashore streets and avenues remain the main stages for social, political and religious demonstrations, and the specificity of each case seems to lie on how in each context the pre-existence was embraced and preserved, namely the site and the heritage elements.

3.0 TO DRAW IS TO LEARN

The city may be studied from its shape, therefore from the shape of the elements that compose it. With this statement it is not intended to remove the importance of the other essential components of the city's existence, but to acknowledge the importance of the shape of the city, as the cultural product that most persists in time,[2] for the understanding of the most complex human creation.

Furthermore,

> the development of a typo-morphology offers a rich data base on forms and form-making processes. And more importantly, to morphogenetic research grounds this design work in the history of city building. (Moudon 1994)

Framed by this idea, in order to better understand the diversity of cases present in this specific type of space, the aim of the first phase of the research is to build the base for a typo-morphology of Portuguese Atlantic Seashore Streets, the Morphological Inventory.

3.1. Making a morphological inventory

The first question an elaboration of an inventory places is which elements to include and which to exclude. Therefore, it requires the survey of the universe of study, along the Portuguese coastline, from which a representative corpus might be selected. This representativeness of the cases is based on diversity criteria regarding geographic coverage; origin; formal features; and vulnerability to sea-level rise of the urban elements in question - the seashore streets. Seeking representativeness by examples, on the other hand, does not exclude the arbitrariness that is part of any choice, even if a thorough knowledge of the study universe exists. (Fig. 3)

The second question that concerns the built up of an inventory is how to represent or characterize the elements that compose it in a way that is useful for its interpretation. The interpretation of a complex urban object requires its simplification. In this sense, a segmented and decomposed approach of its shape allows to reduce its complexity and reveal qualities and patterns otherwise hidden. As Gandelsonas states, drawing is a process that allows us to see formal configurations that are not perceived in reality and therefore affects how we see the city (Gandelsonas 1991) and in Jacobs work on Great Streets (Jacobs 1993) it is particularly evident the emphasis given to the representation of the limits of the street, the elements that compose the space, the relation between buildings and street or revealing the uses and atmospheres.
The coding of the graphic representation of the seashore street is therefore essential for its morphological analysis, and according to Anne Vernez Moudon, morphological analysis must consider the shape, resolution and time. (Moudon 1997, 3-10)

Regarding *shape*, we are interested in the shape of the seashore street, its limits and the relation between the built fabric and the sea. For this task we choose classical rigorous architectural representation pieces, i.e., plans and cross-sections, grounded on the previous work of the research team in the Morphological Inventory of the Portuguese City.[3]

Regarding *resolution* levels, the question is which are relevant for studying the seashore street. Seashore streets are urban elements, therefore it is possible to elementary decompose them from the surrounding urban fabric. However, the importance of its context requires a wider resolution covering the whole urban area. These two resolution levels allow to study the seashore street on its context in two different framings: one that relates the seashore street with the surrounding private space (plot structure and built fabric) and adjoining public spaces using 1:500 to 1:2000 scale; and another one that relates with the settlement (urban layout) and its support territory (topography) on a wider 1:5000 scale that allows us to read the street on the context of the public space of the city and on the territory it is inscribed.

Figure 3: Samples of urban fabrics of pre-selected seashore streets: Sesimbra; Nazaré; Cascais; Póvoa de Varzim; Ponta Delgada; Quarteira. Source: (Author edition of Google earth satellite images)

Regarding *time*, although the observation of reality is made in the present moment, this moment is understood as the result of successive sedimentation processes. The necessary interpretative reading of the moments that conformed these elements is made through a theoretical recomposition. In order to enable it, a collection of cartography, iconography and historical photographs must be composed for the reconstitution of the past moments that allow its description at the present time since the origin, using three essential two-dimensional strata drawings for its reading: the site (represented by the topography); the urban layout (public space); and the built fabric.

In synthesis, the morphological characterization is made through a set of drawings representing the current state of the selected corpus, particularly regarding form, function and role that it plays in relation to site, urban fabric and the sea. Thus, the selected cases will be treated in the same way and with the same criteria of representation and scale: aerial photography, topography and urban layout [1:5000]; seashore street plan and functional occupation diagram [1:2000]; seashore street detail plan [1:1000]; cross-sections [1:500]; uses and occupation photographs; and a synthesis text on the origin, evolution, current state and significant features.

In order to test and adjust the graphical coding and scales of representation, pilot study cases are being drawn up, such as the cases of Sesimbra and Cascais, chosen by their proximity to Lisbon and the availability of historical and cartographical material that renders more easy the restitution of the elements that compose the inventory. From these preliminary tests it is already possible to demonstrate their usefulness.

3.2. Using the morphological inventory

The uniformity in scale and criteria for the representation drawings renders possible to compare the elements that compose the corpus. The comparison between cases shows common properties, revealing the essence of the type of urban element, and distinctive ones, allowing identifying variations to the type, being particularly useful for the interpretation and transmission of ordered knowledge.

When looking at the drawn elements of the pilot study cases of the seashores of Sesimbra and Cascais, namely the urban layout and the topography strata or layers at 1:5000 scale, their comparison allow us to acknowledge the coincidence between valley lines and structuring linear elements of the public space, as well as the coincidence between the coast line and the linear seashore street in each case is evident. (Fig. 4 and Fig. 5)

The intersection of these linear elements in both cases corresponds to an important public space that at the same time is also a sensitive area to sea level rise. Therefore, these areas were considered relevant as first choices for the detail characterization and also for the Sea Level Rise scenario tests.

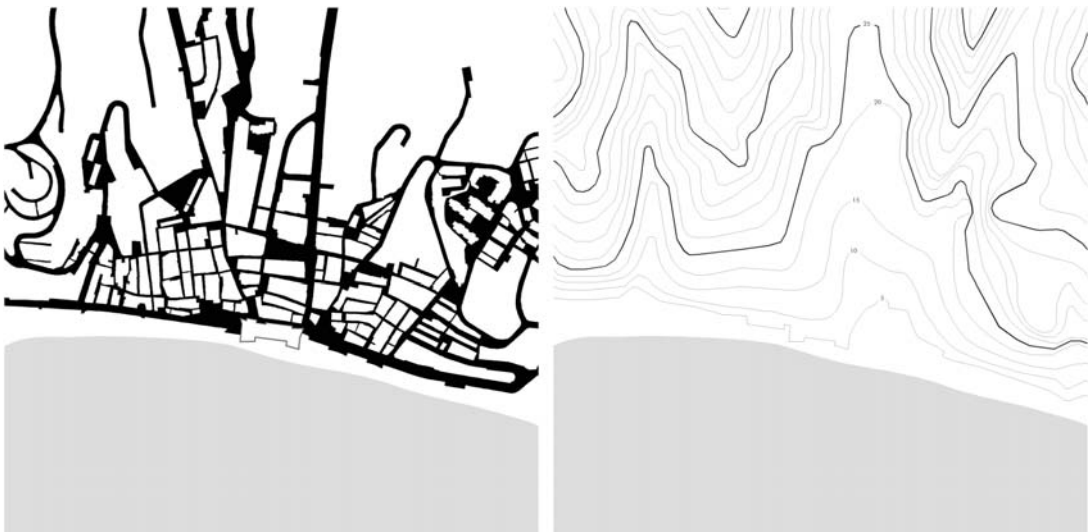

Figure 4: Sesimbra. Urban layout and Topography. Source: (Forma Urbis Lab and Author)

Figure 5: Cascais. Urban layout and Topography. Source: (Forma Urbis Lab and Author)

Several studies on climate change acknowledge the effects of climate change, namely the gradual but inevitable sea level rising, and warn on its effects on urban and humanized areas, such as the research project *Urbanized Estuaries and Deltas. In search for a comprehensive planning and governance. The Lisbon case* or the work developed in the scope of the *FP7 BASE project*,[4] which defines participated adaptation measures to be implemented in medium and long term in 23 European study cases.

The methodology to project Sea Level Rise under climate change that will be used in the research is based on the approach developed by the IDL research team for Portuguese coast studies in the scope of the application of the European Directive 2007/60/CE related to the risk and vulnerability of flooding. The definition of specific scenarios for each case study that can frame the uncertainty inherent to the evolution of climatic conditions and their impacts proves to be doubly relevant to assess their impacts and to plausibly program and design these spaces in a context of adaptation to the inevitable sea level rise. With the definition of these scenarios and based on the topographic information, it is possible to elaborate cartography of the impacts of the floods and extreme sea waves forcing considering two temporal horizons: in the medium and long term, i.e. for 2050 and 2100.

The definition of tipping points allows establishing objective impact levels of sea level rise on the seashore regardless of the combination of factors or events (such as sea level rise projection, storm surges, flash floods, tidal cycle effects, and undulation) defining a critical mark that is not dependent of a date. (Costa, J.P. 2013, 107) In other words, the irreversibility of the process implies that a critical level is reached, regardless the uncertainty of the future moment when it occurs.

In the pilot study cases of the seashores of Sesimbra and Cascais, the rigorous sea level rise models haven't been developed yet. Therefore provisional scenarios for a tipping point of +5m (TP +5m) were tested in both cases. This level is conditioned by available topographical information and informed by one of the scenarios tested by the research team of the project *Urbanized Estuaries and Deltas. In search for a comprehensive planning and governance. The Lisbon case*. The proximity of Lisbon to the present study cases renders this projected sea level rise as a fairly plausible one to be used in this preliminary test.

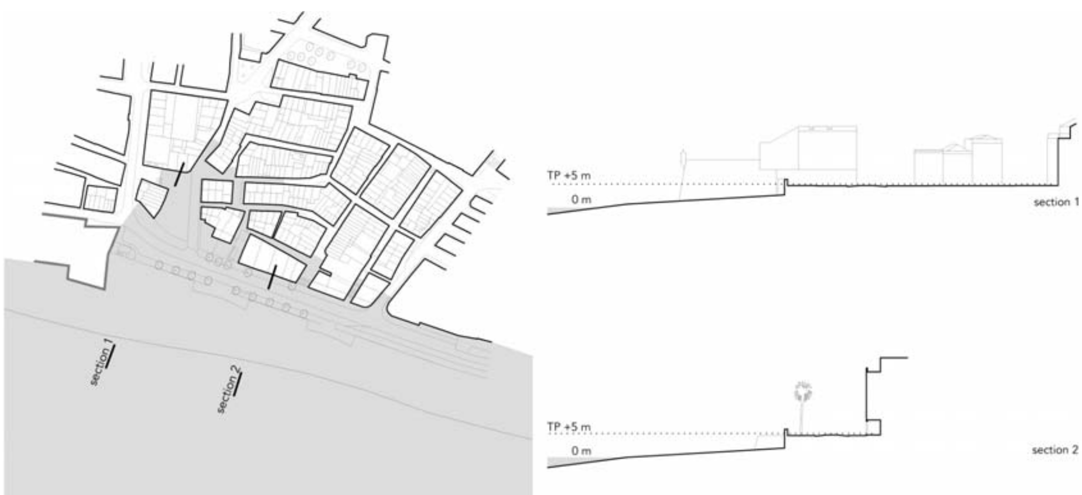

Figure 6: Sesimbra seashore street. Detail plan and cross sections considering a +5m sea level rise. Source: (Forma Urbis Lab and Author)

Representations in plan and cross section are particularly useful when building the sea level rise scenarios. In the case of Sesimbra, the impacts with this tipping point of +5m are clear along the entire seashore avenue but are particularly evident on *Largo de Bombaldes*, east of the Santiago fortress, submerging public space under 1m to 1,5m of water and affecting the surrounding ground floors of the built fabric. (Fig. 6) In the case of Cascais, similar effects occur in public spaces of *Passeio Dom Luís I* and inland along *Alameda dos Combatentes da Grande Guerra*, where the valley bottom configuration promotes a deep inland penetration of water that affects commercial ground floors and important public buildings. (Fig.7)

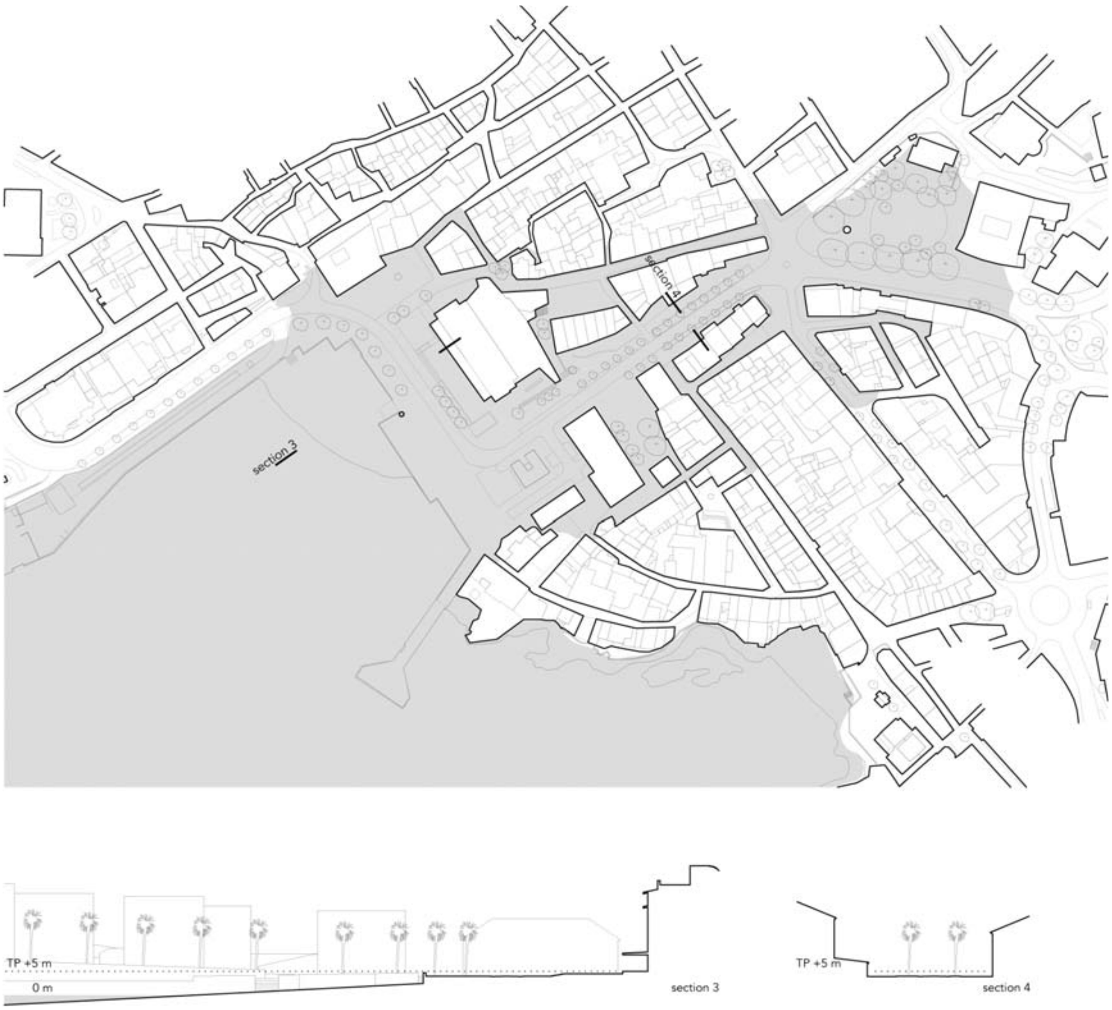

Figure 7: Cascais seashore street. Detail plan (rotated 90ª clockwise) and cross sections considering a +5m sea level rise. Source: (Forma Urbis Lab and Author)

Both scenarios, when first presented, comprehensibly emerge as a shock. Nevertheless, if we recall that these spaces lie in the valley bottoms and confront the scenarios with historical cartography, iconography and even photographs from the first half of the XXth century, we find that in the same areas existed river streams, docks and beaches. Eventually we can even find similarities with the coastal contour, previous to the land filling and construction of the topography that supports the seashore streets and waterfront spaces. Using poetic freedom we could say that water has memory.

4. UNDERSTAND THE PAST TO DRAW THE FUTURE

The dynamic inherent to the urban object underlines the fact that the present state is just a transitory moment in the evolution of these elements. Understandably an urban organism by the very dynamic nature of itself must not crystallize; therefore its harmony must be in constant mutation and reshaping.

Seashore streets are not an exception and often we find answers to future challenges in the past that built our present. Therefore the methodological approach for the characterization of seashore streets that is proposed considers both the knowledge of the site and its evolution. This phase of the research on the significant spaces that mediate land and sea enables a drawn understanding of seashores and the future integration of their own memory in the design of adaptation measures to an inevitable sea level rise.

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ENDNOTES

[1] The adaptation pathways and tipping-points tool (Haasnoot, M., et al. 2013) is one of the available approaches for participatory action research in planning for climate change and was recently integrated with scenario workshop, generating the *Scenario Workshop and Adaptation Pathways* methodology (SWAP) (Campos, I., Vizinho, A., Coelho, C., Alves, F., Truninger, M., Pereira, C., Santos, F.D. & Penha-Lopes, G. 2016). This approach was developed and applied in the FP7 BASE project (in which CCIAM collaborated). It is proposed to apply this methodology in this project, which will require the projection and mapping of sea level rise for the Portuguese coast and subsequent identification of possible adaptation measures for each pilot case that afterwards will be filtered and ordered through participatory workshops with local key stakeholders.

[2] Carlos Dias Coelho considers three distinct times regarding the city longevity: the shorter time of the individual, the intermediate time of the urban uses and behaviors, and the longer time of the built spaces: “The time of spaces and buildings is the third time and this is the one that deciphers the importance of the built city as a physical object, always changing but nonetheless stands out by its resistance and ability to be reinterpreted.” (Dias Coelho 2014)

[3] Forma Urbis Lab team, part of CIAUD/FA/UL, began working on the topic of urban morphology roughly sixteen years ago and since then has conducted different pieces of research, both individually and as a group, interlinking the different morphological elements that compose the urban fabric and disseminated the results. Nevertheless, prominence should be given to the *morphological atlas of the Portuguese city*, which was designed to be laid out in two parts, the first regarding public space and for which the phases on *urban layout and squares* have been concluded and published (Dias Coelho, Lamas 2005) (Dias Coelho, Lamas 2007), and for which the phase on *streets* is concluded. The second part, on the private space, approached first from the *urban block* is also concluded and the phase on *building typology* is ongoing.

[4] Ng, K., Campos, I., & Penha-Lopes, G. (Eds.), 2016. *BASE adaptation inspiration book: 23 European cases of climate change adaptation to inspire European decision-makers, practitioners and citizens.* Lisbon: Faculty of Sciences, University of Lisbon, available at http://base-adaptation.eu/base-adaptation-inspiration-book-23-european-cases-climate-change-adaptation

Stephen Michael Anderson

Ex-urban Urbanity: Prolegomena to an Understanding of the Architectural Provision of Urbanity

Ex-urban urbanity: prolegomena to an understanding of the architectural provision of urbanity

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ABSTRACT: If happiness is associated with concepts of full-living, and if full-living is associated with city life, the tasks of architecture relative to the city assume an ethical cast. A better understanding of that nexus –full living, urbanity, city, architecture—will help inform those tasks, but the interrelation of those ideas is not obvious, and conventional presumptions regarding those relationships are inadequate. Despite conventional conflation of the two terms, *cities* do not guarantee *urban living*: even a dense, expansive city might lack or only weakly exhibit qualities associated with urbanity. A partial explanation for this non-synonymy between city and urbanity is that inasmuch as cities are physically composed of architectural works, neither does architecture guarantee urbanity: as with the city of which it is a part, a building, even if successful in other ways, might neglect or eschew provision of conditions conducive to urbanity. Much like a dining table's essentiality to certain social structures of the meal, architecture is essential to the structure, character, and perpetuation of urbanity.

Of the many sets of architectural questions that emerge from those premises, two are primary. If detachable from concepts of *city*, how should we understand the term *urbanity*? And, what kinds of architectural attentions effectively engage urbanity and render it more available, more probable? In short, what is urbanity and what is its architecture?

As a preliminary move toward exploring those questions, this paper turns to Sverre Fehn's *Hamar Museum* (1972). An unlikely building to bring to consideration of the architecture of urban life, a strong and purposeful concern for urbanity is nevertheless evident in its architect's thinking and design. Fehn's project helps inform an understanding of the nature of urbanity, and shows how an architectural concern for urban situations manifests at the scale of a building, from conceptual approach to the finest of constructed details.

KEYWORDS: city, Fehn, culture, history, theory, ethics

INTRODUCTION

In contemporary architectural parlance, the Greek word πόλις, or *polis*, is typically translated as *city-state*, the two being commonly regarded as interchangeable. But the word's translation disguises a host of subtle distinctions that have rendered that simple formulation problematic. For example, the Greeks did not refer to every city as polis, and the determination seems not to have been based on quantitative thresholds like, say, geographical area or population. Most scholars interested in the distinction have sensibly argued that the qualities of city that warranted the status of polis were juridical ones, with many modern translations, in a particularly obfuscating instance of era-bias, simply substituting the word "state." Aristotle, however, though deeply interested in governance and its relation to the polis, was convinced that the essence of the polis was to be found elsewhere, that a political account of the city was subordinate to an account of what the city *is*. In attempting to delineate what made a polis a polis, he mused that you might have a diverse population living harmoniously in light of a system of laws, that all of those people's needs might be met with a functioning economy, with provisions made for their defense, and that the size of that population might be vast, their proximities dense, and, yet, you might still not have a polis. That is, Aristotle intuited that the polis in its essence is not to be found at a particular scale, nor in systems of laws, nor economies, nor even in the peaceful coexistence of large numbers of people. It suggests, paradoxically, that the essence of city-ness –whatever that may be-- can be decoupled from definitions of city: you might have one without the other, or both but to varying degrees. [In part to avoid confusion of terms going forward, I will use the term city in keeping with its common contemporary usage, but in place of city-ness I will use the term urbanity.] Contemporary theorists of urban life from diverse disciplines have continued consideration of this paradox of the mutual independence of urbanity and city. Ethicist and theologian Max Stackhouse, for example, has elaborated on problems arising from the spread of urbanity beyond the city, and, concurrently, the exsaguination of urbanity within cities; and political and social theorist Murray Bookchin has argued that modern "urbanization" is actually antithetical to the urbanity of the city. A less esoteric, well-known example from the last century, Gertrude Stein's now infamous critique of Oakland ("There's no *there* there.") rehearses Aristotle's thinking: no one could reasonably argue that Oakland was not a city, but the idea that it (or some part of it) might be lacking some ineffable and essential quality associated with urbanity, even if debatable, was within the realm of plausibility. Especially for those charged with the design and construction of urban configurations, a critical question emerges from these observations: what, exactly, might that ineffable quality, essential to urbanity, be? As readers will have anticipated, answers like "philos," "tolerance," "compassion," and "love" arise – and, yes, in keeping with the formative idea of this conference, also the term *happiness*. Aristotle, too, arrived in that conceptual territory, making appeals to concepts of both love and happiness as foundational to city. Among those ideas, to cite a more contemporary example, James Hillman has argued that the city is not just soulful, nor the place where the soul flourishes, but that the city *is the soul* of humanity – a formulation that, subscribed to, rather increases the stakes of urban policy and design. But no matter how compelling or truthful we may find them, such ideas do not offer much of immediate use to us as architects – "make your buildings more loving, more soulful," might make a fine credo, but it is not at all clear what that might mean for design, for materialization. If density and efficiency and infrastructure and busy-ness and publicity do not on their own or together add up to urbanity, how, exactly, might an architect otherwise conceive, engage, and sustain configurations conducive to urbanity? What design habits might inadvertently render urbanity *less* probable? What, even, is the vocabulary for such a conversation? How might it be taught? Such is the conceptual topography I have in my sights, but I do not pretend that I might satisfactorily map those broad questions in this short paper. My aim, rather, is to offer an entrance, a landing of sorts, from which deeper explorations might be launched. Generally, my method involves bringing one simple question to architectural works: "In what ways and through what design decisions might one understand this project as *urban architecture*?" In what follows, more narrowly still, I bring that question to one unlikely work. It is its unlikeliness, I hope to show, that makes it especially illustrative: if we can isolate and consider those qualities of place that are at their fullest in cities but which can exist outside of cities, and which some cities, in their misconfiguration, might actually diminish or preclude, then those designers who deem it important may be afforded a better understanding of how they might materially engage and facilitate an architecture of urbanity.

1.0 Sverre Fehn's Unlikely Urban Project

As an entrance to foundational questions of urbanity, Sverre Fehn's Hedmark Museum in Hamar, Norway, makes an unlikely beginning. For starters, Fehn was not an urbanist in the mold of peers like De Carlo, Bakema, and Van Eyck, and even less so in comparison to urbanism's Post-Modern devotees. He knew those sets of ideas well, even participating at times in their dissemination, but he made no attempt to emulate that work nor ever presented himself as "an urbanist." In fact, he explicitly distanced himself from the term, a position that likely factored in his reluctance to align with his colleagues (like Geir Grung) under the aegis of Team X, even though important pieces of his design thinking exhibited sympathy with their ideals. Second, modern Hamar is relatively small, and, while the town holds several urban lessons, the Hedmark project itself is peripheral to the town. It is a topographical setting more accurately described as rural than urban, and at the threshold of wilderness: the Hedmark Museum is an isolated project on the outskirts of an isolated town on the edge of a lake in sparsely populated territory. Third, the project is a museum, a building type regarded as a symbol and agent of urbanity but almost always contrived, paradoxically, as a citadel apart from that context. Furthermore, the two-centuries' rise of the museum as a centerpiece of both city and high-style architecture is indicative of forces which can be understood as at odds with urbanity – a line of criticism to which Fehn himself subscribed. Yet for all that, Fehn understood the Hedmark project to be essentially urban. He wrote, "Someone without an urban sensibility in his or her subconscious could not have solved Hamar. One must understand the building as an urban reality. The exhibition became culture born again, new." An understanding of Fehn's link between the conditions of this project and, as he says, "urban reality," will inform more general understandings, first, of urbanity as the impetus, not merely the descriptor, of city; and, second, of at least one set of architectural considerations with which a designer might approach the founding, perpetuation, and structure of urban settings.

The site's history is critical to understanding the present-day museum, so, while too complex to expound here, a summary is necessary. In the 11th century, the site became the new center of an important farming network that had been operative in eastern Norway for several hundred years. The new site was linked to the landholding interests and personal history of Harald Hardråda, the cosmopolitan warrior traditionally regarded as the last of the Viking kings. A medieval village arose around the extensive farm and emerged as a center of trade and of Christianity as conversion from Germanic paganism falteringly advanced. Hamar was made the seat of a new bishopric, and the construction of the Romanesque Domkirke there was underway by the middle of the 12th century. The medieval town thrived as a center of commerce, production, and political and religious power into the 14th century, but was then decimated by bubonic plague and began a long process of decline. The remnants of Hamar and its defining buildings were further diminished in the aftermath of the Reformation, during which the vacated cathedral and bishop's house were converted to a sheriff's residence and fortification. War with Sweden in the late medieval period provided the final blows, and the area fell into complete disuse and ruin as the region's dwindling cultural and mercantile interests shifted south to Hanseatic Oslo. For all practical purposes Hamar ceased to exist. The site, rural once again, was eventually converted to private property, and a farm known as Storhammer, comprising a few agrarian buildings built into the medieval ruins, was operated there from the mid-18th century. It was not until the middle of the 19th century, amid a zeitgeist of Romantic nationalism and economic expansion that modern Hamar was founded from scratch just to the south of the medieval site, rising as a rail-connected tourist destination and minor lake port by the new millenia. Though almost all of medieval Hamar had vanished into the landscape, the remaining ruins of the cathedral and of Storhammer became objects of curiosity, eventually attracting archaeologists to its 1500 years of layered history, and so it gained recognition as a site of significant regional, national, and European heritage. So it was that in 1963 a project was initiated that would make a museum of the ruins, one that would allow for archaeological work there to continue while making the findings of that work and other regional historical traces legible and available to the public. Fehn was charged with the project, dubbed the Hedmark Museum, through a bit of happenstance in 1967, and was periodically occupied with the design and realization of this first phase of the museum until 1979.

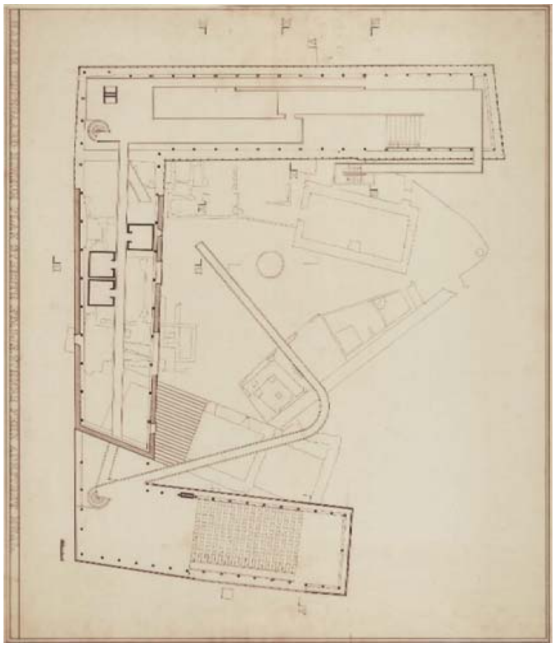


Figure 2: Detail, west facade, primary entrance.

To reiterate, at the time of Fehn's initial design work, the site was an active archeological excavation – fieldwork that was to remain, and does remain, ongoing. The project is situated so as to reoccupy, stabilize, and largely enclose the existing ruins of the bishop's estate, later fortress, and barn. The Hedmark museum (Fig. 1) is loosely comprised of 4 areas -- three sides of a "C" and the courtyard space they collectively bound. Starting with the northern-most section at the top of the "C" and proceeding counter-clockwise, those 4 parts house, respectively, a series of exhibits featuring historical objects of daily farm-life aptly arranged in the ruins of a barn that had been appended to the remnants of the medieval defensive walls; a series of exhibits focusing on the site's earlier medieval history; an area given mostly to administration and assembly; and the roughly three-sided courtyard that stages the majority of the contemporary archeological work. Fehn's design solution might be described as riparian in its approach, a streaming path of rough-shuttered concrete that in places narrows and accelerates, and, at other points, opens and slows, staging an array of proximities and perspectives of ruin and artifact as it winds, rises, and falls through epochs. On an archeological site, the "layered-ness" of history is not only a metaphor, but also a physical condition, and Fehn's design wanders vertically between those layers as much as it wanders laterally above them.

I want to open an analysis of the project by emphasizing two themes, recurrent in many essays on the work, in order to set up a more narrow exploration of how such an isolated project might help us better understand the relation of architectural design to, as Fehn puts it, "urban reality."

First, observers have thought it important to characterize the project's relation between old and new as embodied in the structural-architectural conjoining of old and new components. That relationship is introduced upon approach to the project's primary point of entry (Fig. 2), where tempered glass enclosure meets medieval rubble wall. Using meticulously cut glass in a mullion-less design, Fehn preserves and presents the jagged jambs of the existing opening in a sharp contrast of wall-building techniques from different ages, accentuated by their contrasting haptic and optic qualities –smooth/rough, shiny/stony, precise/coarse, contemporary/ancient. This treatment, a technique in opposition to restoration, and which is preservatory only in the sense that it preserves ruin as ruin, is deployed throughout the project wherever windows, doors, or partially collapsed wall had created existing apertures.

Figure 3: Laminated lumber post bearing on existing rubble wall.

In several places the structural system supporting the new enclosure is consonant with that reading of the openings. For example, the glued laminated wood posts that support the new roof at the ruins of the barn slip past the existing walls to bear on new concrete footings poured alongside, and the concrete bond beam, necessary for stabilizing the rubble wall and simplifying its enclosure, is used only for lateral bracing. Such a detail suggests a "light touch," a somewhat curatorial regard of the existing condition.

Second, and in keeping with the first theme, the project's curious relationship to horizon and grade has widely been recognized as essential to its character. Foremost in those considerations is the arcing ramp that presides over the courtyard and then continues, variously defined, into the project's interior. At the courtyard, the ramp's monolithic section requires only four thin concrete piers to support its spans, minimizing the disturbance of the archeological site below while its circuitous route provides visitors good vantage of the partially excavated court's zones and layers (Fig. 4). Upon passing into the project's interior, the ramp's configuration becomes more complex, but largely continues in this function, conducting visitors through the museum while establishing measured separation from the ruins.

Both of these – a delicate adjacency, a floating promenade—show Fehn's care for the artefactual ruin. But this "touch the past lightly" thematizing requires turning a blind eye to those aspects of Fehn's designs that are rather intrusive and forceful in regard to their engagement of the ruin. The cordoning of details inconvenient to a reading of deference props up a clear and morally satisfying narrative, but neglects the greater complexity of the project's orientation to past and ground. For examples, Fehn's three elevated tomb-like vaults (Fig. 5) –"treasuries," Kenneth Frampton calls them—cannot rightly be understood as receding or deferential, and they compete with the medieval ruin for dominance in the spatial configuration. Also, the ramping walkway that winds through the museum (Figs. 4, 5, and 6) is not delicate (as, say, in the designs of related projects by Scarpa and Zumthor), but massive, opaque, even clunky, and detailed with an intentional coarseness. And, yes, in many places the new structural elements are arranged to minimize contact with the ruin, but in other places that contact is surprisingly direct, making structural use of the ancient walls (Fig. 3) even where such incorporation could have been at least as easily avoided. The causes of restoration of ruin and preservation of ruin differ in approach, but both belong to a conservative, romanticizing regard of the past that Fehn's direct engagements defy. In this light, those instances where Fehn exhibits "a light touch" can be understood not as the fetishization of the ruin, but as one move in a more varied effort to bring the past into active dialog with what is unfolding *presently*. Like any good dialog, it is facilitated by establishing equal footing for the participants, or at least balanced footing – it is the disproportionate force of the present that Fehn's moves check, not as apologia, but as preparatory to reciprocal dialog, an opening.

Figure 4: Cast concrete ramp curving above excavations at court.

Figure 5: Pod-like concrete exhibit rooms and walkway

This way of thinking can also be brought back to the exterior ramp to make sense of its circuitous route through the courtyard.

The ramp's indirect arc opens it to the landscape. Or, being a little more careful, the ramp's arc presents the landscape to the walker, and opens the possibility of the walker bringing the landscape into consideration of the experience of the museum. The ramp structures (makes provision for) an open-to-ness of walker, ruin, and land. In contrast to museum designs that foreclose circumstance in order to accentuate the artifacts, Fehn's design enlists circumstance. On the one hand, it is nothing more than a concrete ramp connecting courtyard to the museum's upper level. But its eccentric configuration and detailing and orientation toward what is distant establish the possibility that the lake-cove, the peripheral town, the air, the topography itself, might be brought into dialog with the ruin and its historical artifacts. In some ways architecturally aggressive, in other ways recessive, the ramp helps negotiate a temporal balance conducive to that dialog, or its possibility.

Fehn makes great effort not to diminish the site as given, then, but neither is he timid about its appropriation. As if in opposition to the science fiction trope in which time travelers mustn't engage the past lest they distort their future, Fehn meticulously establishes conditions for imaginative tampering. One such detail appears in the elevated concrete walkway that passes above the medieval section of the museum and which serves the three "vaults" like a causeway. In a move wildly difficult to effect in cast concrete, that walkway very slightly undulates. Why? What could justify expending so much design and construction effort on so subtle an effect? The related and more pronounced undulation of the massive laminated hip-beams at the roof (Fig. 6) brings structure into relationship with, and subordinates it to, the room it helps define. But that explanation does not suffice at the concrete walkway, as its concavity does not describe volume. The wave of the viaduct, barely perceptible visually, is unignorable viscerally. It is a detail that appeals not through formal or volumetric coherence, but through bodily movement, an architectural idea given to the gut and the inner-ear. The undermining of the expectation of a level, stable walking surface fleetingly renders it *conspicuous*. In a strategy reminiscent of Surrealism, the ordinary is subverted so that the ordinary, typically opaque, might be made available to imaginative consideration. Maurice Merleau-Ponty understood the problem this way:

Figure 6: Curving laminated beam above farming exhibit

> We live in the midst of man-made objects, among tools, in houses, streets, cities, and most of the time we see them only through the human actions which put them to use. We become used to thinking that all of this exists necessarily and unshakably.

Fehn's design stages a productive instability, gently shaking museum goers from expectations regarding distance and separation in an effort to effect conditions conducive to more engaged and imaginative consideration of the museum's artifacts.

2.0 Urbanity Exhibited

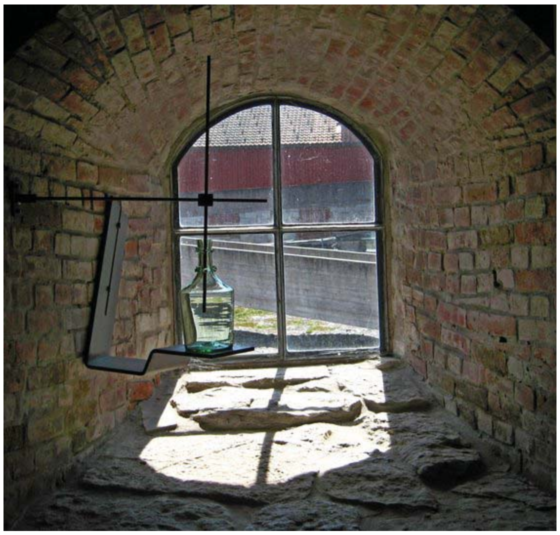
These ideas take on a finer scale where Fehn applied them to the presentation of the object-artifacts that the museum was intended to display. Just as Fehn deployed frame, structure, and bodily position to help bring landscape and ruin into active dialog, so too does he approach the display of the museum's artifacts. Fehn insisted on having access to the objects to be displayed as he worked on the design of their exhibition. Rather than develop a universal system of display adequate to the artifacts as a set, each presentation device is tailored to the unique artifact it displays. Some of those devices are simple and quiet, others more complex and forceful, but in total. Whereas museum-goers are generally accustomed to devices of display that tend toward passivity (and typically minimalism), Fehn's devices are often active participants in the dialog between viewer and artifact. Two examples will illustrate this characteristic, and will help describe the kind of participation those devices structure.

Figure 7: Unified display of crucifix and sepulchre fragment.

The first of these is Fehn's design for the dual display of a medieval fragment of an ornately carved soapstone tablet –possibly a piece of a sepulchre--and a relatively small crucifix, barely visible here in a small glass case fixed to the top left edge of the white stone (Fig. 7). Both objects are set within that field of two symmetrical polished slabs of sandstone joined by a set of carefully designed metal insertions that ornament the stones' surfaces. There are several striking features of this ensemble. By bringing the two artifacts into relation with such a device, manifold scalar relationships are created. The crucifix is diminutive and fragile compared to the mass and size of the soapstone fragment positioned to its right. The first belongs to the scale of the hand and invites very close inspection of its fine detail – perhaps inches of distance between the face of a curious viewer, leaning, and the cross, with its canted glass enclosure beautifully anticipating both that proximity and that bodily posture. The positioning of the stone fragment, itself weighty, suggests its relatively larger and unwieldy whole. Yet the crucifix is mounted upright in a drilled hole along the top edge of the sandstone slab, suggesting-- in a curious scalar inversion --horizon. If there were any doubt about that reading, it is cleared by two additional details. The stone surface into which the crucifix is mounted is slightly canted and rotated relative to the axes of the slab, and that portion of the slab's top edge is also slightly raised: the sandstone slab edge becomes landscape, the crucifix, topographically set, stands on a hill, and what is small relative to the stone fragment now dwarfs it. Or if this imagined landscape is expanded rightward to include the soapstone fragment, the soapstone's position between mass and air, spanning horizon and breaching the bounds of the sandstone's geometries, then the faint figure carved in its surface assumes a spirit-like cast, augmented by the word etched into the medieval slab's edge, made visible through its precise positioning within its sandstone setting: "GOD." [Norwegian: "good"]. Once that particular scale is apprehended, a third scale opens, as the polished sandstone can in that context be read as a section cut deep into the earth, inviting imaginative inquiry about the relationship between the crucifix, the events it is meant to commemorate, and the subterraneous fissures and joints in the depths of the rock. Geological relationships are evoked: the sandstone *is* a section of deep earth, excavated, now finished and exposed to view, spurring speculation about the circumstances that had surrounded the quarrying, movement, and inscribing of the contrasting soapstone. Scales of time layer up: the event of the Crucifixion, its rehearsal in totems and carved imagery centuries thereafter, the distance to Golgotha, the aeonic timescales of the sedimentary and metamorphic rocks, the labors of the cast of craftspeople involved in the various components of the ensemble, the lives of which the artifacts had been a part, the present appeal to the observer invited to bend closer, the silence of the vault in which you stand.

Figure 8: Plough exhibit installed on cast-concrete wall

In a second example, excavated from the archeological site's farming history, a plough is mounted to a display device that is in turn mounted to a rough-shuttered concrete wall (Fig. 8). That device is primarily composed of two metal plates welded along a diagonal edge like a fold. The topmost plane supports the artifact, and it is canted to restate the angle of the plough when ploughing, the lateral force of the ox's movement driving the wedge into the earth. This upheaving is mimicked in the mounting apparatus, where the metal plate is torch-cut in a T-pattern, the resultant triangles folded upward like lapels. Those steel tabs hold and support the artifact, but it is as if the mounting surface is sheared by the plough. That trope is furthered by the deep rust finish of the metal plates, recalling rich, wet loam, and also by the second plate that folds behind and beneath the plough, suggesting earthen depth. The long slot-cuts in that second plate receive the two bolts that connect the ensemble to the wall beyond, but which clearly double as figures of some sort. Are these signature decorative flourishes, in the spirit of Scarpa's corbelled leitmotifs? I doubt it: conceptually rotated and in a scalar shift similar to what was effected in the previous example of the soapstone, the lower plate of the plough's mounting device can be read as a plan --a long, straight row cutting into the surface of a dark expansive plane.



There are many others like these two. A small boat, for example, hung unexpectedly high and adjacent to a partial wall, setting up a fish's-eye view from below and, then, having continued up the ramp to the mezzanine, the boat is encountered anew at a more familiar angle and set of distances – as if moored along a dock. Judging from the abundance of images uploaded to the web, an inventive device for displaying glass urns and backlighting them with daylight may be the most popular of Fehn's exhibition designs at Hamar. It is a two-armed fixture– one holding, one stirring.

Conspicuously absent from most of these installations are the otherwise ubiquitous informational placards that we are so accustomed to finding next to artifacts and artworks in museums. At Fehn's Hedmark Museum, the artifacts are not "solved" for the visitor through textual explication. The overall effect can be understood as direct, provocative, and communicative: the exhibits aren't read so much as encountered, each with its predisposition, but open to the visitor's imaginative rejoinder. The museum's widening and narrowing, accelerating and decelerating conveyances hold and disclose these encounters, presenting artifact as entity – not quite the same kind of entity as the other visitors wandering past or gathered in the rooms and room-like spaces, but among them. One way to describe this quality of the exhibits is the difference between someone showing you an item and handing it to you, diminishing the effects of distanciation – whereas the former maintains separation, the latter more directly implicates you --your body, your imagination, and your intentions—in the characteristics and narrative of the object.

It is precisely that quality that Fehn's design decisions build up to, an endeavor that sheds light not only on the exhibit designs, but also on the larger architectural moves discussed above, and in which the several scales of design cohere. In the case of the soapstone ensemble, if the crucifix were, for example, just laying on a pad of felt in a glass case, such connections and avenues of consideration would not thereby be rendered unachievable, only far less likely, less communicative. Similarly, at the larger scale, the up and down, the undulation, the circuitous ramp and stair, the constriction and release of route, the comingling of past and present, the odd positioning of landscape and horizon, sets up conditions for imaginitive connections not obvious at the most surficial levels. Establishing an ambiance of a kind of bodily and imaginative drift, it is like one of those visits to the attic where you don't rush in, grab what you need and leave, but when you find yourself pausing, unplanned, and get caught up in what is in front of you -- you do not merely make an account of what you see there, object and setting comingles with memory and imagination, you are not apart from it, but conversant with it.

The attic analogy is helpful, but as a descriptor of the museum it overly emphasizes personal reverie and private introspection. If reverie is even the right term here, it is not an exclusively personal reverie that Fehn sets up, but also a public and communicative one. In this sense, *attic* is less apt than another archetypal configuration where historical depth, personal memory, imaginative enticements, everyday life, and alterity all layer-up: *street*. Fehn himself advanced such an understanding of the Hedmark museum:

> The path is no longer a ramp, but a street…a marketplace for exhibition and display, a reflection of different personalities and ambitions. Here we can feel the dimension of the old barn and the sled gallery, a dimension mediated by the resistance of stone. The image is of people striving together to overcome privation and to fulfill their hopes and dreams.

There is nothing particularly novel in observing that the street is a place of exhibition and display, nor that it is a place that puts diverse people and their aspirations into relation and makes them available for imaginative speculation. In this case, however, we are apart from any conventional definition of city, and many of the people with whom we are mingling, the ambitions of whom we're mulling and connecting to our own, the objects and strategies of whom we are now taking up, are not present except through the tokens and ruins that once structured their lives. Those lives find expression again through our ability to construct from those remains narratives that bring them usefully, meaningfully into our active consideration. In this sense, Fehn's opening assertion about the Hedmark Museum and "urban sensibility" is not the non sequitur that it first seemed. His designs suggest that the essence of urbanity is to be found in an orientation toward, and concern with others, some where – even when those others are not present except by proxy through physical traces. Fehn's thinking, then, echoes Aristotle's but ventures further into the physical characteristics of settings, showing how such orientation can be facilitated and provoked through architectural configurations. At Hamar, Fehn's designs engage and apportion temporal depth, circumstance, self, and other. In creating conditions conducive to bringing those four factors into active relationship, the presumed limits of each are exceeded and an urban architecture is realized.

Returning with Fehn's example to the broader questions outlined at the outset, the work suggests that temporal continuity and attention to environment and circumstance do not belong to a conservative allegiance to a status quo, but, on the contrary, to the potentially liberating and expanding connection to others that creative engagement with the past and with circumstance renders more available. It also suggests that those conditions, while embodied in the archetype of street and closely associated with concepts of urbanity, can exist apart from cities. And if evidence that cities can exist apart from those conditions is all around us, Fehn shows how architecture can yet make urbanity primary to design, inscribe its possibility in physical configurations. And might such architectural attentions yield greater happiness? When Fehn's fellow Pritzker Prize laureate Glenn Murcutt – the great pioneer of ecologically concerned architecture—was once lecturing in Oslo, he was escorted on a three hour drive to the Hamar project, with which he was utterly unfamiliar at the time, not even knowing of its existence nor its designer. It was an experience that would lead him to seek out Fehn, and to become a devotee of his architecture. Murcutt has since described the Hamar project as "the most significant architectural experience of my life," and has returned to it many times. Happiness may not be the most apt term for the overall effect of Fehn's designs at Hamar, especially if our definition of happiness cleaves close to the "don't worry" variety. But if our consideration of happiness is extended to include concepts of fuller living through expanded and creative interconnectedness with others, in place, then perhaps the term obtains. Like Murcutt, many have found in the Hamar project something undeniably potent, alive. It is that understanding of happiness –a potent, expanded, engaged, fuller living-- that Fehn connects to urbanity at Hamar.

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Reconstructing Antiquity: Interpreting Ancient Architecture with Computational Simulation Tools

Reconstructing Antiquity: Interpreting Ancient Architecture with Computational Simulation Tools

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ABSTRACT: This paper presents a new approach to archeological reconstruction, utilizing state-based building performance simulation (BPS) tools to compare regressed climate data and architectural features unearthed during field excavation. In the archaeological discipline, where reconstructions of architectural systems are routine, no applied methodologies have been established that highlight the use of state-based BPS tools as a complimentary track to culture-based forms of interpretation. To address this shortfall, this paper offers an overview of a BPS enhanced workflow that prioritizes trial and error experimentation, enriched by the systematic observation of building-environment relationships that are fundamental to early dwelling patterns. The workflow consists of four primary phases: (1) the integration of archaeological datasets within an interoperable modeling domain; (2) the introduction of input states into the domain with subsequent state-change observation; (3) the corroboration of simulation output across multiple analysis types; and (4) the reiteration of various building configurations. The interaction of the base modeling platform and the simulation plug-in components within a common interface eases the swift instantiation of reconstruction alternatives from output acquired using state-based lighting, radiation and fluid dynamics domain branches. The observed behavior of light, heat and airflow patterns within the simulation domain invite incremental revisions to virtual models that test their probability with respect to the maintenance of human health described in ancient treatises. The paper provides an in-depth description of each workflow phase and demonstrates their functionality using case studies from classical sites in ancient Asia Minor including Miletus, Priene and Pergamon where structures currently exist in an incomplete state. While much can be understood about these building systems from even meager archaeological records including building location, ground integration, structural configuration and spatial disposition; new knowledge about how early populations organized space around the dictates of climate can be elicited using BPS tools.

KEYWORDS: ancient architecture, computational simulation, experimental archaeology, environmental design, virtual reconstruction

INTRODUCTION

Architectural anastylosis is a reconstruction method used in archaeology to restore a ruined building from its fragmented remains, in its original location, to the most comprehensive degree attainable. In a broader sense, architectural reconstruction in the field of archaeology is a preservation practice used to return a building in ruin to an earlier and more complete state (ICOMOS, 2013). This restoration practice includes graphic forms of illustration and visualization that traces back to the fifteenth century and the likes of Alberti who included recommendations and instructions for the study and the visual restoration of ancient buildings (Salmon, 2003). The purpose of these efforts, as they progressed into the sixteenth century, by architects including Palladio and Raphael was to methodically document ancient buildings that were being steadily destroyed during this period (Brothers, 2001). However, in the nineteenth century, architects including Ruskin were critical of this approach due to the stylistic embellishments introduced by interpreters that tended to diminish the weathered character the building had attained over its lifetime (Stanley-Price, 2009). Even today, there is ample criticism of this approach due to the lack of concrete evidence surrounding the configuration of ancient buildings in their complete state that would be required to finalize preservation. Additionally, physical preservation presents risks related to further damage of architectural antiquities with attempts toward on-site anastylosis (UNESCO, 1976). However, with the emergence of digital technology within the archaeological reconstruction process, virtual reconstructions are now possible to offset the risk of further damage to ancient sites.

Developments in archaeological digital survey methods and remote sensing in recent decades have aided the advancement of three-dimensional reconstruction modeling, resulting in an acceleration of archeological interpretation and an increased understanding of archeological datasets (Forte, 2016). The ability to conjoin datasets pertaining to building and environment in a shared modeling domain is especially pertinent in ancient building reconstruction where building models can be born directly from correlations made between climatic states and boundary configurations. This approach is particularly useful in situations where architectural evidence is meager and additional data is required to underpin working interpretations of past building configurations. Furthermore, drawing comparisons between building and climatic datasets approximates that act of sheltering in place, which is one of the founding principles of architecture, to protect inhabitants from extreme elements, especially the weather (Rapoport, 1979). Furthermore, if early dwelling patterns are understood as an orderly network of relationships between people and place, a reliable architectural reconstruction methodology necessitates a synergistic approach that permits the observation and measurement of these fundamental relationships.

When prioritizing a synergistic approach to architectural reconstruction, BPS tools are well suited to support the process through their hypothesis testing potential on one hand and through a domain that is capable of emulating early dwelling environments on the other. In recent decades, experimental archaeology has emerged as a testing procedure used to replicate ancient processes in order to learn more about how early societies coped with the world around them (Outram, 2008). The method is particularly useful when there are large gaps in data pertaining to how people built in antiquity as it adds a valuable layer of evidence that can help strengthen interpretations generated by more conventional modes of analysis (Hostetter, 1994). This approach also incorporates hypothetico-deductive routines as well, which permits the team to develop a hypothesis stemming from reliable datasets, test it through modes of reconstruction, and evaluate the outcomes against the original assumption (Barton, 2014). While this process is used to physically reconstruct buildings on projects of archaeology, digital modeling and simulation platforms enable researchers to conduct similar investigations virtually. The usefulness of digital technology in reconstruction is further reinforced through its support of 'optioneering', where numerous building configurations can be digitally modeled and tested to better understand boundary-state interactions while using iterative testing protocols to strengthen working interpretations (Marsh and Khan, 2011). This trial and error form of experimentation is enhanced through the mathematical replication of physical real world phenomena by simulation tools in applying physical conservation laws to approximate the behavior of light, heat and airflow within constructed environments (Augenbroe, 2003).

1.0 BACKGROUND

The core of state-based BPS analysis is the technical domain comprised of digitally modeled building boundary configurations, input states taken from regressed climate data and mathematical equations used to calculate the behavior of environmental factors within the built environment. Building boundary and environmental state interactions tested and observed within the modeling domain disclose the relative effectiveness of proposed building reconstructions in moderating climatic extremes for the well-being of inhabitants. Literary sources translated from antiquity serve as the basis for performance benchmarking that outline the impact on human health by development decisions at both urban and building scales. Therefore, the acquisition of three major data sources prior to the commencement of the simulation supported architectural reconstruction process appropriately situates the study in relation to reliable building, climate and cultural data.

A central part of the archaeological record, acquired through field survey and excavation, includes building data. Archeological survey entails the examination of areas in the field through observation of surface level features and the use of remote sensing equipment to determine the nature of subsurface building signatures. While survey methods make no disturbance and leave no physical traces in the field, excavation is a more invasive approach, where archaeologists systematically remove horizontal layers in a given area to collect the maximum amount of information. These highly scrutinized activities require permits by the host country's ministry of culture and require meticulous care by experts trained in the area. Thorough drawings, photographs and notes are kept during excavation that describe the three dimensional nature of features uncovered and constitute the architectural record reported on in detail at the conclusion of each field season. Outcomes from these activities can be viewed on-site if the site is well preserved and managed by the local ministry, in museums dedicated to the archeological site in addition to the yearly publication of results by the archaeological field team. For the sake of accuracy, carefully vetted building element representations generated by permitted field teams maintain precision as many inaccurate representations of ancient structures are in circulation today. In the example provided below, portions of three Classical and Hellenistic sites in ancient Asia Minor are depicted: Miletus, Priene and Pergamon, all of which were surveyed and excavated under the auspices of the German Archaeological Institute that serve as the basis for all reconstructions cited and presented below (FIG. 1).

Climate data, a relatively new dataset on projects of archaeology, is acquired from local monitoring stations and is logged over many years to determine the microclimatic patterns present on excavation sites. Since weather patterns shift in a span of centuries, the science of paleoclimatology has emerged to examine climate change across millennia. Reconstructions of earlier climatic states occur through the study of natural elements like ice, tree rings and fossils that serve as proxies and extend our knowledge of climate patterns across thousand-year periods when compared against weather data logged today.

Figure 1: Foundation reconstructions above and site photos below. Source: (Frank 2015)

The case studies highlighted in this paper all reside in western Anatolia, also known as ancient Asia Minor, and share a similar temperate macroclimatic profile with hot, dry summers partnered with cool, wet winters. Variability has been noted in the region over the course of three millennia with shifts in temperature levels and precipitation rates (Bryson et al., 1974). However, wind patterns are considered stable in these climate reconstructions across this three thousand-year period. These findings are consistent with correlations between ancient sources and climate data logged in the same province today that describe strong northerly winds, named Boreas, bringing cold temperatures and moderate winds out of the west, named Zephyros, supplying warmer temperatures (*Theogony 870; Iliad 9.5; Odyssey 5.295*). Meanwhile, mild variations in the earth's orbital tracking around the sun in one-hundred-thousand-year phases, lead to negligible shifts in solar path across the span of three millennia. Asia Minor is located along the western coastline of modern-day Turkey and resides 38 degrees north of the equator and 27 degrees east of the prime meridian. From the winter to the summer solstice, the sun's altitude angle in Asia Minor changes from 27–74° when measured at noon.

While the modern practice of architectural design defines standards for occupant comfort and well-being using quantitative benchmarks, acutely measured with portable instrumentation and simulation tools; they were depicted in a qualitative manner in antiquity. Recommendations regarding the built environment's impact on human health emerged in the 5th century BCE in Asia Minor through the writings of Hippocrates, a physician practicing during the Classical period. His treatise on the subject titled, "Air, Waters, and Places" describes the impact of climate on human society and makes recommendations for how urban microclimates influence the health of inhabitants (Hippocrates and Adams, 1881). Solar exposure is factored relative to cardinal orientation, rising from the east, setting to the west and most influential at midday where exposure is recommended to combat disease in moderation for structures that orient to its southerly orientation. The configuration of structures should account for prevailing wind directions; where irregular southerly hot winds blow should be tempered, strong northerly cold winds should be prohibited, a westerly humid wind from the Aegean should be moderated, and healthy easterly winds should be admitted. Houses in the period are described as largely enclosed to protect inhabitants from the wind, rain and snow while rainwater is depicted as being light, sweet and clear for consumption. Together, these recommendations play an important role in the analysis, as fitness criteria for simulation outcomes, used to evaluate the effectiveness of structures to moderate environmental factors in accordance with occupant well-being.

2.0. METHODOLOGY

The initial stage of the workflow consists of importing drawings from the archeological record into the interoperable modeling domain where they are scaled and traced over using vector contours. These traces serve as the regulating armature for NURBS surface construction and eventual translation into closed watertight poly-surfaces. It is crucial at this stage to trace the record plans accurately as they likely serve as the only remaining physical vestiges of the building. The first reconstruction model should reflect what remains on-site, which in the case of buildings from the Classical and Hellenistic periods in Asia Minor, would consist of foundation systems, floors and entry thresholds since stone was the predominately-used building material. Once modeling concludes of building remains and surrounding areas, the systematic tracking of additions or subtractions to the model commences as this practice enters into the realm of speculation whose outcomes cannot be known with absolute certainty. It is also important at this stage of modeling to use simplified representations of the structure as superfluous information can lead to unnecessary demands on computational resources.

After the initial building configuration is digitally reconstructed, the workflow shifts to the second stage where plugin simulation programs migrate to the modeling domain and input states are assigned. Again, input states stem directly from the writings on climate and health in addition to regressed weather data. Once simulations are run, researchers observe the change in environmental states that result from interaction with building boundary configurations within the shared domain. The digital process emulates the way ancients would have moderated climatic factors in order to maintain well-being, according to text from those like Hippocrates writing at the same time. Therefore, the evaluation of output states within a simulation domain is framed relative to these ancient recommendations in order to partner interpreted building outcomes with presumed intent during the same period. Using multiple simulation branches enables the synergistic study of buildings where boundaries can be evaluated relative to numerous environmental factors within the same domain.

The third stage of the process examines possible synergies in the reconstruction model, which in this example, is the interaction of multiple physical substances whose outcome provides greater impact than the summation of individual parts. While simplified simulation tests reduce analysis time, they also allow researchers to narrow the scope of analysis, focusing on relationships between individual building parts and their effect on environmental states. However, comparing and contrasting results from within the more extensive domain facilitates a systematic understanding of how individual building elements satisfy a number of environmental factors, bringing the polyvalent or synergistic aspects of the building to light. Moreover, reiterating simulation routines within one branch brings result corroboration to the fold, where non-expert users can gain confidence in simulation outcomes, especially when results from one test verifies the results from another.

However, there are limitations to this approach, knowledge that the research methodology just cannot elicit. Because evidence of buildings and cultural heritage in antiquity is so sparse and poorly preserved, we cannot draw absolute conclusions about the reconstructions produced nor the environmental states represented in these virtual domain models. While this caveat may prove prohibitive for many researchers, the process does shed valuable light on how early societies organized space in relation to their environment. Instead of focusing on singular solutions that would be impossible to validate, the workflow prioritizes alternative reconstructions to strengthen working interpretations generated by more established protocols in the field. This leads to the fourth stage of the process where the building geometry is transformed within the modeling domain to examine how these alterations result in state change within the surrounding area of influence. The pluralism enabled by digital technology in partnership with a stable domain configuration can support this form of analysis, incremental change resulting in an incremental understanding of state-boundary relationships. It is at this stage that an improved understanding of these first-principles relationships are compared to datasets outside the domain either on the same archaeological field project or on others developed during a similar period in the same region.

3.0. CASE STUDIES

This paper demonstrates the functionality of the presented workflow using case studies from portions of three Classical and Hellenistic settlements located in ancient Asia Minor including, Miletus, Priene and Pergamon whose building remains are incomplete. A family of peristyle building types have been selected to test the response of this building type to its climate profile, to ascertain why the building configurations proposed in regional reconstructions to-date share such similar characteristics, and how building simulation tools can offer new layers of information to this well-established discourse. The courtyard house was the prominent dwelling type in urban communities with a peristyle or colonnade surrounding a central courtyard that supplied access to enclosed perimeter rooms. The court in Classical and Hellenistic schemes was an indispensable feature that supplied natural light and air to all rooms of the house while doubling as a collection point for rainwater (Schoenauer and Seeman, 1962).

3.1. Miletus

Once a harbor city, Miletus was one of the most prominent Greek settlements prior to the 5th century BCE whose plan was designed by city native Hippodamus consisting of a grid plan that was inspired by geometrically designed settlements (Bayhan, 1998). The urban plan contains houses on individual blocks created by rectilinear street networks occupied by late period peristyle courtyard houses, each approximately 100 feet by 120 feet in size. A Hellenistic peristyle house adjacent to the North Agora is digitally reconstructed after Schleif to include a central court, surrounding peristyle and enclosed rooms on the northern edges of the compound to buffer cold winds indicated in ancient descriptions. Analysis indicates ample light and air access through the courtyard with moderate to low light and air velocity levels in the surrounding spaces (FIG. 2). Openings introduced along the outer and the inner walls of the compound along with additional ventilation chases through the roof promote increased air velocities in surrounding rooms along with higher light levels in enclosed spaces. Simulation analysis reveals little change in openings along the outer wall, demonstrating the value of the central court when securing compound perimeters while ventilation chambers provide the most impact drawing fresh air from the central court through the surrounding spaces (FIG. 3). Reconstruction alternatives of the roof structure over the enclosed rooms could examine how light and air sourced from the central courtyard could be drawn at higher velocities through enclosed areas while exhausting smoke from internal heating sources during the winter.

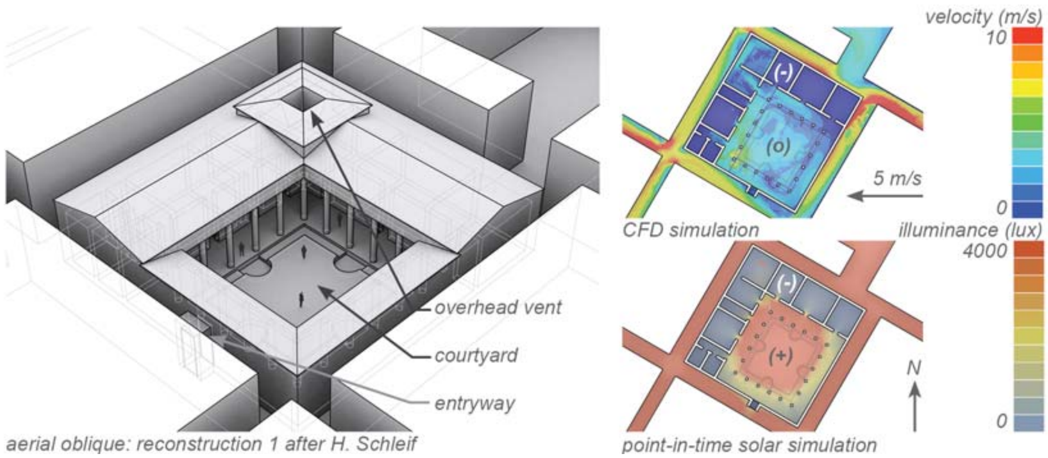

Figure 2: Miletus reconstruction #1 after H. Schleif. Source: (Frank 2017)

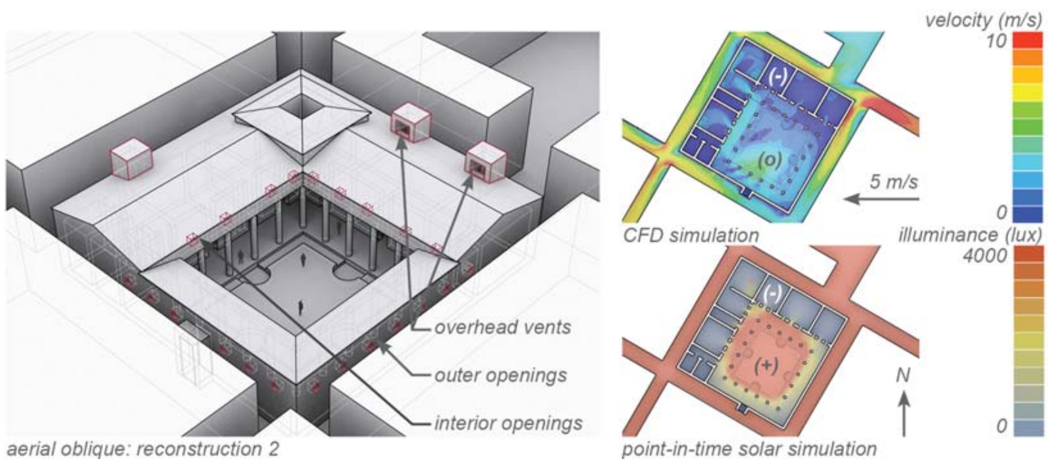

Figure 3: Miletus reconstruction #2. Source: (Frank 2017)

3.2. Priene

Priene was also once a harbor city and organized using the Hippodamian grid system, experiencing its most prosperous period during the sixth century BCE. In this application of the ancient planning system, the planning grid orients in the cardinal directions enabling the buildings situated within each block, also known as insulae, to orient directly south to benefit from solar access (Dontas and Ferla, 2006). A structure of 60 feet by 100 feet within a typical block of 114 feet by 154 feet, Phase B of House 33 in the Western Residential Area is reconstructed after Krischen. The house includes a central court with prostas, or vestibule, opening to the south that together harvests abundant solar gains with moderate access to fresh air (FIG. 4). Openings are introduced in the northernmost enclosed rooms overhead to draw air sourced from the central court while increasing illuminance rates for spaces separated from the prostas and court. Simulation analysis indicates little light and airflow increases from small sidewall apertures but moderate upsurges in both light and air velocities for southward oriented clerestory openings (FIG. 5). Additional reconstructions would explore how shifts in roof height partnered with multiple levels could accommodate clerestory openings oriented to the south that would illuminate the northernmost spaces in the complex while promoting natural ventilation throughout.

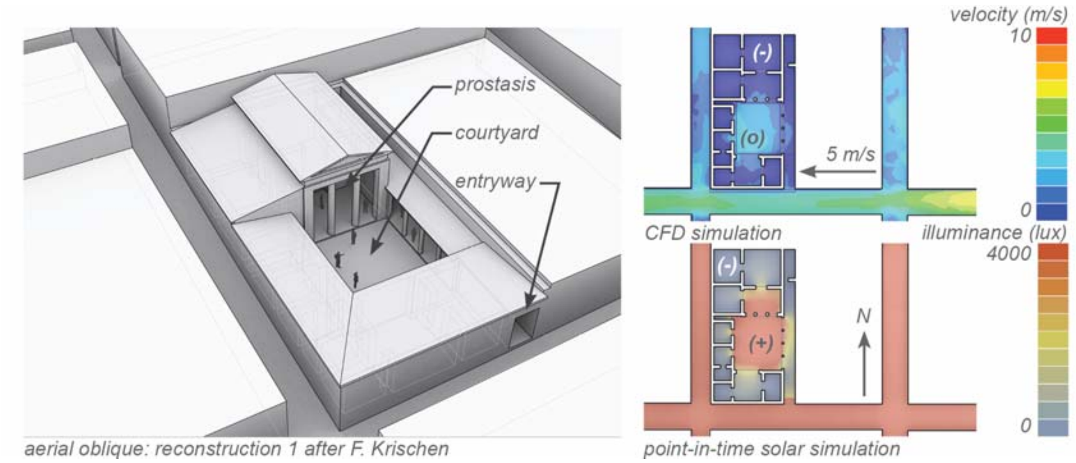

Figure 4: Priene reconstruction #1 after F. Krischen. Source: (Frank 2017)

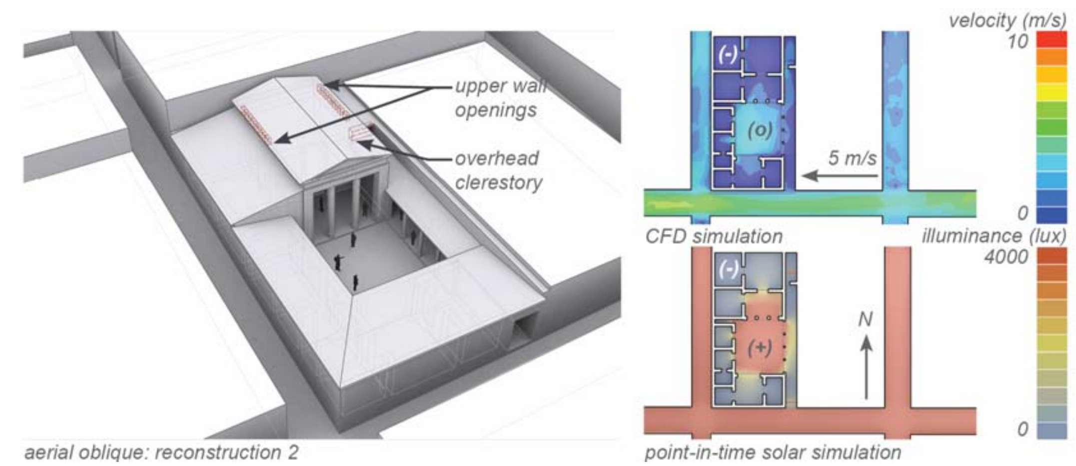

Figure 5: Priene reconstruction #2. Source: (Frank 2017)

3.3. Pergamon

Pergamon, situated inland, a few kilometers from the coast was a city whose acropolis was perched atop the southern face of a naturally protected promontory serving as a capital city beginning in the third century BCE. (Pirson and Scholl, 2014). While planning in this city was more organically derived, the palace complexes, which were organized in the peristyle form, lined the northern edge of the upper acropolis and began the cascading of terraced plinths down the slope, each supporting civic structures including the library, stoa and upper agora. The Palace to Attalus I (IV) is reconstructed after Schleif to include a central court equipped with rainwater cistern, a largely enclosed passageway surrounding the court serving enclosed perimeter rooms. While ample light and air access is indicated in the open court, the surrounding spaces show limited access to natural resources likely due to the multi-level structure and the high degree of enclosure around the courtyard suggested by the reconstruction (FIG. 6). In the second reconstruction, the area defining the central court loosens with the introduction of a slender colonnade while the easternmost block of rooms are outfit with new openings overhead. These alterations produce increased light levels in the passageway and the rooms that encircle the central court while the easternmost openings promote additional ventilation rates in the eastern half of the palace complex (FIG. 7). With the height of the easternmost area in the initial reconstruction geometry partnered with its fortified plinth, added levels of permeability for this section of the complex could be explored to source higher amounts of fresh air and natural daylight to some of the deeper rooms in the palace.

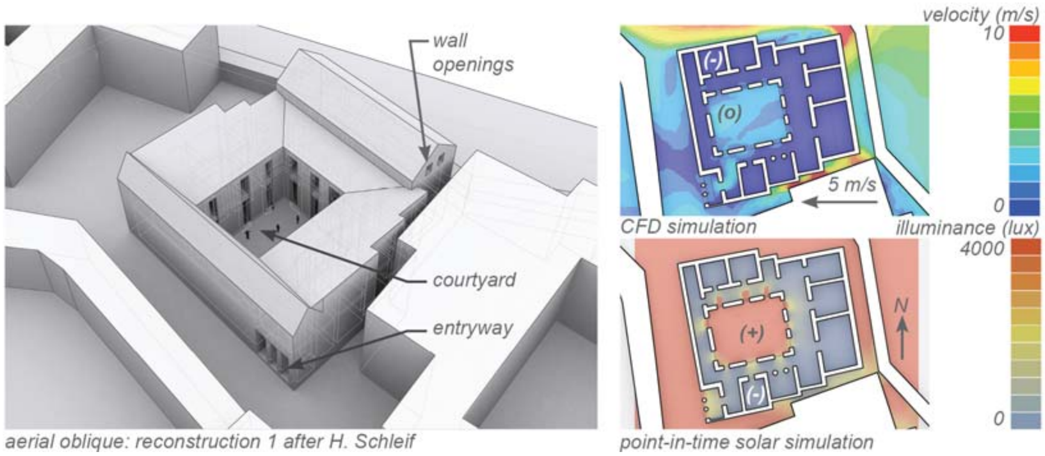

Figure 6: Pergamon reconstruction #1 after H. Schleif. Source: (Frank 2017)

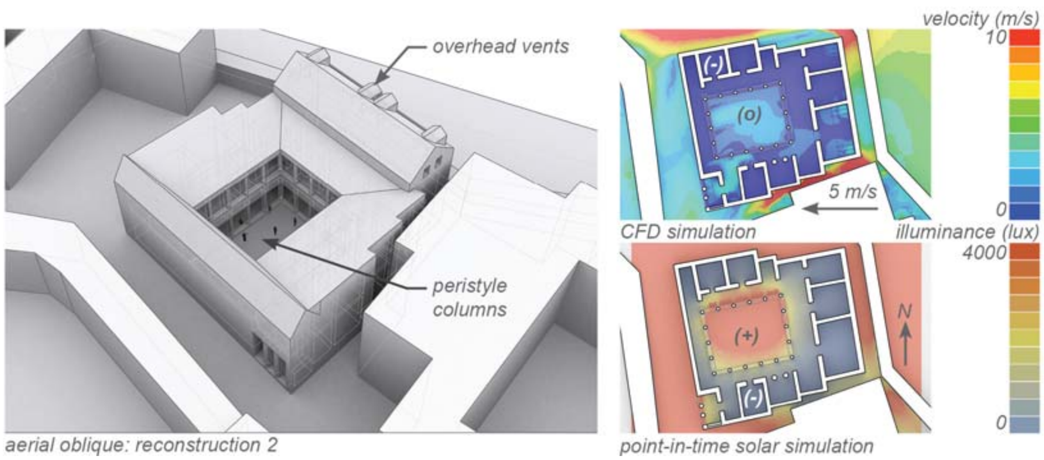

Figure 7: Pergamon reconstruction #2. Source: (Frank 2017)

CONCLUSION

The results from this workflow contribute to our understanding of how humans could have persisted through climatic extremes using constructed systems in the first millennium BCE. The workflow also offers emerging technology-enriched methods to engage the large repository of building knowledge that remains latent at classical archaeological sites. The process compliments deductions drawn from cultural sources and offers fresh insight to archaeological analysis by introducing climate data to the ongoing discourse, comparing this new dataset to existing material finds using well-established scientific methods that emulate physical states from laws of conservation. However, simulation tools and the outcomes they produce are not panaceas. The method does not aim to bring value judgments to the process of reconstruction, evaluating outcomes in absolute terms, the basic process aims to diversify our understanding of ancient building systems through new forms of data and methods of comparative analysis. While this process is still in the nascent stages of development, the need for improvements have been noted including the need for a central platform that would host and gather all digitized archaeological datasets collected in order for interpretative trajectories to be better informed through comparison and corroboration. To set the stage for these improvements, next steps in this research include further engagement of the presented case study areas, expanding upon work in the result corroboration phase by introducing additional state branches to the process for comparison. Furthermore, next steps also include extending the geometric reiteration stage of the process, continuing to propose reconstruction alternatives in critical areas to understand incrementally how ancient building typologies, like the peristyle court, had likely moderated the extensive environment.

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Vaisali Krishna Kumar

A Conceptual Framework to Approach Conservation of Indian Modernist Heritage

A conceptual framework to approach conservation of Indian modernist heritage

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ABSTRACT: Preservation community over the last fifty years have developed philosophical and technical competence in managing various cultural heritage. However, it is yet to come in terms with the challenges pertaining to Modernist architecture, the latest to come under the umbrella of 'heritage'. Conserving Modernist Heritage involves many technical and philosophical challenges. Lack of recognition and protection, absence of a shared methodological approach, dearth of public appreciation, obsolescence in term of functionality, sustainability and adaptability are some of the challenges that needs to be tackled while dealing with built heritage of the Modernist era. The transplantation and development of modernist architectural principles in every country was deeply influenced by the socio-political and economic agenda of the country. Therefore, concepts of heritage conservation require to be flexible in interpretation and region specific with respect to Modernist heritage. A conceptual framework needs to be developed with full understanding of the socio-economic, cultural and historical contexts of the region/country under study. This paper aims to develop a conceptual framework to determine appropriate conservation approach for Modernist Heritage in India. Modernist Heritage in India does not qualify the 'age' criteria defined by heritage legislations of the country and hence is not protected by the government. With the loss of one of its most significant and iconic modernist landmark, the need for an immediate framework becomes indispensable in India to recognize and protect the remaining significant Modernist heritage resources. The paper is based on a systematic literature review of pertinent sources on concepts such as heritage value assessment, community engagement, authenticity and its association with Indian Modernist heritage. The paper deduces that in order to develop an approach to recognize and protect Modernist Heritage of India, a collective understanding is critical, which involves three key dimensions: established/ existing frameworks, experts and local community.

KEYWORDS: Modernist Architecture, Cultural Heritage, India. Historic Preservation, Document Analysis

INTRODUCTION

The clandestine razing of the Hall of Nations in Delhi on April 24th, 2017, a mere three days before a hearing in Delhi High Court to preserve it, shocked both local and international architecture communities. The structure was inaugurated in 1972 to commemorate twenty-five years of India's independence. The demolition of this historically significant and iconic modernist structure testifies to the threat faced by all other modernist buildings and sites in India. The Hall of Nations located on the grounds of Pragati Maidan was designed by the architect Raj Rewal and the structural engineer Mahendra Raj and was the largest concrete space-frame structure in the world.

The architectural heritage of the modernist era in India is a significant part of its cultural landscape, but it does not meet the one-hundred-years 'age' criteria defined by India's heritage legislation and hence is not protected by the government. The sites on which many of the significant modernist structures are located have also grown in value and now attract new functions and development opportunities, increasing the pressure to demolish these structures. The question is, how can we effectively preserve the architectural heritage of the modernist era given the lukewarm public acceptance of the style and the lack of a comprehensive philosophical approach to it? Heritage preservation communities over the last fifty years have developed philosophical and technical competence in managing various cultural heritage sites around the world. However, they have yet to achieve similar standards when considering modernist architecture. Conserving modernist heritage involves many technical and philosophical challenges such as the lack of explicit recognition and protection standards, the absence of a shared methodological approach, the dearth of public appreciation, and their obsolescence in terms of functionality, sustainability, and adaptability. The transplantation and development of modernist architectural principles in every country are deeply influenced by the socio-political and economic agenda of the people in power. Therefore, 'established' or 'accepted' concepts of heritage conservation and preservation need to be flexible to allow for local and regional interpretations.

This paper attempts to develop a conceptual framework for this purpose by looking at some central concepts vis-à-vis heritage and how it impacts conservation of Modernist heritage in India. The main concepts that would be discussed below are heritage value assessment, authenticity and local community. The first section of the paper discusses some concerns and issues regarding preservation of modernist heritage in general and in India, underpinning the problem the paper attempts to address. The paper concludes with a proposed conceptual framework that could be used to evaluate modernist heritage and aids its sustainable management.

1.0 PRESERVATION OF MODERNIST ARCHITECTURE- ISSUES AND CONCERNS

The concept of Modernity is understood in various ways by different practitioners, historians and other experts. Hilda Hayden (1999) in *Architecture and Modernity*, defines Modernity as " a condition of living imposed upon individuals by socioeconomic process of modernization. She postulates that the experience of modernity involves a rupture with tradition and has a profound impact on the ways of life and habit." Modernity is that quality that makes the present different from the past and paves new direction to the future, usually by rejecting the inheritance of the past. In *All that is Solid Melts into Air* (1988), Marshall Berman's studies the dialectics of modernization and modernism. He claims that the turbulence of modern life has been fed from many sources. These are, the discoveries in physical sciences that changed our image of the universe and our place in it; the industrialization of production- which converted scientific knowledge into technology that helped create new human environments and destroyed old ones; human migration with several millions of people moving from their ancestral lands to build new lives; rapid urban growth; development in systems of mass communications; changing political dynamics with increasingly powerful national states striving to expand their powers; mass social movements of people challenging their political rulers and eventually developing an ever-expanding and fluctuating capitalist world market. Berman asserts that in twentieth century, the social process mentioned above brought in a turbulence into being and kept it in a state of perpetual becoming and termed it as "modernization". These world processes have nourished a variety of visions and ideas that aim to make men and women both objects and subjects of modernization, to give power to change the world that is changing them, to make sense of the turbulence and own it. Berman states that these visions and values over the past century have grouped together under the name of "modernism".

Modernism as a rupture from the traditional way of living emerged as an art and architectural movement during the late-nineteenth and early-twentieth centuries, gaining momentum in the inter-World War period (1919-1939). The origins and evolution of modernist architecture are complex and have been widely discussed in architectural scholarship (Collins, 1965; Curtis, 2010; Frampton, 2007; Prudon, 2008). Post-WWII, changes in the power dynamics around the world, increased housing demands, and limited availability of resources catalyzed the opportunity for modernism to thrive. Society perceived the benefits of technology to create healthy working and living environments through experimenting with new materials and streamlining production processes. For war-ravaged Europe, the concept of moving towards a future without explicit references to historical precedents was compelling. Modernist architecture emphasized the functional, technical, and spatial properties of design rather than ornamentation or decoration. European modernists saw architecture as a means to improve the lives of people. In India, modernist architecture evolved from a British imperialist propaganda into a political tool used by the government to re-invent the newly independent country starting in 1947(Chatterjee, 1985; Lang, 2002; Scriver, Srivastava, 2015). Indian modernist architecture, therefore, represented the technological innovation of a new-nation re-branded as an economical, educational, and industrial powerhouse, equipped to compete internationally. Modernist architectural principles were used to design and build structures catering to the growing housing and institutional needs of India as an independent country. Over the years (1930s-1980s) modernist architecture in India had evolved from the international modernist principles to adapt to the local cultural and climatic requirements as well as the design philosophy of the local Indian architects. This adaptation and evolution has resulted in modernist architecture that is unique to India.

A characteristic that distinguishes modernist heritage is the shortened time period between its creation and its need for conservation (Macdonald, 2011). The conservation needs of modernist heritage range from individual buildings (e.g. Sydney Opera House), to an entire city (e.g. Brasilia, Brazil) or a collection of works by a single architect spread across different regions (e.g. Louis Kahn, Le Corbusier). It is imperative to keep in mind that the commercial possibilities, public empathy, and technical skill set needed to conserve modernist heritage differ from region to region as do the philosophical attitudes towards building conservation(). Apart from the challenges mentioned above, other practical and philosophical challenges to conserving modernist works include the quality of materials used for the construction, such as concrete, plastics, synthetic paints, which have not necessarily aged well, complicate the determination of authenticity and integrity. Many modernist buildings also perform poorly against current environmental and sustainability standards. Both the general public and a significant portion of professionals and policy makers do not consider this heritage worthy of protection. Studies have shown that the established concepts and principles of conservation are ill-equipped (Orbasli, 2017) and need to be more flexible in terms of modernist heritage. A general framework such as *The Madrid Document* proposed by the International Council on Monuments and Sites (ICOMOS)[i] cannot be used directly in any cultural context without adaptation. This reiterates the fact that a framework needs to be developed on a country-by-country basis with full understanding of the socio-economic, ecological, cultural, and historical contexts of the heritage in question.

3.0. HERITAGE CONCEPTS AND MODERNIST HERITAGE – AN EVALUATION

3.1. Heritage and value assessment of modernist architecture

The term 'heritage' has been associated with a numbers of items from buildings to culinary, from personal belongings to ethnicity etc., making it a 'conveniently ambiguous' and problematic concept (Lowenthal, 1985). Heritage is also seen as a set of relationships characterized by attachment to select objects, places and practices that is connected to the past in some way (Harrison, 2013). UNESCO has identified categories of heritage: Cultural heritage (Tangible and intangible), Natural heritage and heritage in the event of armed conflicts. Considering that a heritage becomes culturally significant to its custodian(s) based on the 'values' that is attached to it (Australia ICOMOS, 2013), the dimension of values and its various forms becomes important in the narrative of heritage. Early definitions of cultural heritage were merely individual monuments and buildings, often regarded as standalone with no relation with the surrounding elements. In contemporary conservation practice, cultural heritage is regarded to be a product of interactions between built environment and natural environment based on cultural interpretations by humanity (Nezhad & ed.al.,2015). With this expanded definition of cultural heritage, it becomes more significant to assess significance and determine the worthiness for conservation. Modernist heritage can range from individual buildings to entire city (Brasilia, Brazil) to collection of buildings and sites spread across many countries unified by its designer/architect. Recent understandings on heritage endorse that it has to undergo processes of adaptations to meet social needs instead of remaining 'frozen' or 'petrified' in time (Assi, 2000). With the ever increasing social and economic development needs of contemporary society, especially in developing countries like India, heritage must be conceived within the framework of development. This becomes even more relevant in terms of modernist heritage, which would be more beneficial to the society through adaptive reuse or continued use rather than 'monumentalization'.

Heritage is multivalent as it has different values ascribed at different levels, making this its most essential quality(Mason, 2002). To make the process of understanding and assessing the different values associated with heritage easier to comprehend, it was compartmentalized and categorized. Also, such a clear-cut classification and definition was assumed to benefit historic preservationists/conservationist, community and other important stakeholders in having a common dialect in which a conversation between them to express values they ascribe can be possible. However, such as approach can be problematic especially when community and other stakeholders are involved. Firstly, the various articulations of heritage values by different people are at some level different expression of the same qualities, for example the yardsticks used by an art historian, economist, sociologist and architect to describe the value of an object cannot be compared or translated to one another. Secondly, there can be differences in assessment of a particular value by different stake holders, for example, the economic value assessed by a corporate organization operating or owning a heritage site compared to a typical resident of the community will be completely different. A third challenge in categorizing and characterizing values lies in the fact that value is never constant, it changes from time to time and hence this should be considered to be an essential nature of heritage (Silva, 2015; Mehrotra, 2016). It is this subjectivity and contingency of heritage values that makes it challenging to assess and create a clear framework to evaluate them. Heritage value assessment is an ongoing process, where time, space, social and cultural experiences play a vital role in the potential diversity of the methods of valuation, making it site specific (Mydland & Grahn, 2012).

Comparing the various heritage value typologies devised by various scholars and organizations (Reigl (1982); Lipe(1984) ; BURRA Charter(1999); Frey(1997); English Heritage(1997)) , The Getty Conservation Institute(Mason, 2002) came up with a provisional typology of heritage values that comprises of all the values one could ascribe to a cultural heritage. However, a recent study re-examining heritage value typologies (Fredheim & Khalaf, 2016) concludes that the value-based theory is based on the incomplete understanding of values, and recommends a critical review and reframing of the value-based heritage discourse as necessary.

The applicability of using the aforementioned value categories to assess Modern Architecture need to be further investigated. Perhaps the incompatibility of the previous approached formalized to assess buildings and places of the Modern Movement probably resulted in the *The Madrid Document: Approaches for the Conservation OF Twentieth-Century Architectural Heritage.* The Document of Madrid (Burke & ed.al, 2011) was prepared by the International Scientific Committee on 20th Century Heritage(ISC20C) and currently limited to criteria for identification, conservation and intervention of architectural heritage. To Identify and assess cultural significance, the document suggests using 'accepted' heritage identification and assessment criteria, and the assessment must include interiors, fittings, associated furniture and art work, setting and landscapes.

Other suggestion in this respect include development of inventories of the architectural heritage of the twentieth century and comparative analysis to establish cultural significance. The document further details recommendations for managing change to conserve cultural significance, promote environmental sustainability, interpretation and communication.

Do.Co.Mo.Mo or the International Committee for documentation and conservation of buildings, sites and neighbourhoods of the Modern Movement, a is non-profit organization was initiated in 1988(DoCoMoMo website). The Mission of this organization are to be on a look out for important modern movement buildings under threat, knowledge exchange related to conservation technology, history and education, fostering interest in the ideas and heritage of the modern movement and to elicit responsibility towards this recent architectural inheritance. The organization claims to its success through its interdisciplinary approach and include 69 worldwide chapters. The Do.Co.Mo.Mo. US chapter register provides a criterion to evaluate significance of the Modern Movement buildings which is on the basis of six categories:(DoCoMoMo website): Technological merit; Social merit; Artistic and Aesthetic merit; Canonic merit; Referential Value; Integrity

The feasibility of the same six criteria for Indian examples need to be investigated and the possibility of building a national-wide online register with the assistance of the community needs to be assessed. Do.Co.Mo.Mo India chapter is currently underdeveloped and does not have any presence on the internet or social media scene at the moment. Involving the community and making them a valuable stakeholder in this mission could benefit the cause. The importance of community participation in the conservation movement on whole and preserving Indian Modernist Heritage in particular therefore needs further exploration.

3.2. Authenticity

Authenticity is one of the most fluid concept in the scholarship of heritage conservation. It has been the official qualifying criterion for the inclusion of sites in the UNESCO World heritage list. One of the fundamental objectives of heritage conservation is to safeguard monuments and heritage places for the present and future generations by preserving them in the most possible *authentic* form (Jones & Yarrow, 2013). Authenticity has been given multiple interpretations such as, it is the quality of cultural heritage that convinces us about its heritage value (Assi, 2000); or ability of an object or property to convey its significance over time (Labadi,2010). The *Madrid Document: Approaches for the Conservation of Twentieth-Century Architectural Heritag*e (Burke & ed.al, 2011) defines Authenticity as “the quality of a heritage site to express its cultural significance through its material attributes and intangible values in a truthful and credible manner. It depends on the type of cultural heritage site and its cultural context”. This definition leaves enough room for case specific interpretation and adaptability when it comes to modernist heritage. Authenticity does not give any value to an object or property per se, nor can it be added to the subject. It can be revealed only as long as it exists, unlike values which is subject to cultural processes and changes over time. The Nara Conference in 1994 and the subsequent drafting of the *Nara Document on Authenticity* (henceforth referred to as the Nara Document) organized by Japanese government with the aim to better define the concept of authenticity and make the World Heritage Convention relevant to the diversity of world cultures.. The *Nara Document* states in detail that the assessment of the authenticity of cultural heritage is based on multiple attributes, including: Form and Design, Materials and Substance, Use and Function, Traditions and Techniques, Location and Settings Language, and Other Forms of Intangible Heritage,Spirit and Feeling, and Other Internal and External Factors.

Authenticity in terms of materialistic and constructivist approach is an intriguing debate. Over centuries, philosophers have discussed concepts of continuity, change and truth value, both of which are relevant in the notion of authenticity. The case of the ship of Theseus by Plutarch is often taken as an example to demonstrate the debate (Jokilehto, 2006, Labadi, 2010). In a study conducted to examine intersection between material transformation, scientific intervention and cultural value (Douglas-Jones, Jones, Hughes, Yarrow, 2016), it was understood that attention needs to be given to interdisciplinary approaches to comprehend the evolving role of materiality in heritage conservation. An interdisciplinary approach would be beneficial to understand the cultural implications associated with material transformation in heritage structures. For instance, in some cases material weathering and decay and accure ‘age value’ marking the passage of time and hence contribute to authenticity. In other cases, loss of materiality can be associated with loss of value or authenticity through loss of material or because of larger consequences of deterioration. In the context of modernist heritage or modernist architectural examples, the short-life span of their construction materials complicates determining the role of materiality in defining its authenticity. Recent, conservation practices have taken into account the social and cultural processes of heritage and turned away from viewing conservation as a material practice- which is particularly predominant in understanding modern architecture along with its complexities (Tait & While, 2009).

Even though, authenticity as a concept is important in itself, an equal emphasis should be placed on the importance of the procedures used to define what is authentic (Labadi, 2010). The practical applications of the guidelines on authenticity has presented various challenges. Authenticity is often crafted in the process of conservation by the different players on the basis of their expert practice (Jones & Yarrow, 2013). In their ethnographic study of conservation of Glasgow Cathedral Jones and Yarrow (2013) interacted with the different 'players' like architects, masons, curators. It was observed that each player interpreted authenticity in a different form. Curators advocated for the Cathedral's historic fabric, Masons in the cutting of the material stone and Architects on the design of the building. In practice therefore, the maintenance of authenticity is a result of co-existence of various techniques deployed by each expert player. Jones and Yarrow suggests that locating the conservation project 'inside' or 'outside' the history, could also facilitate in resolving the material authenticity versus fabric authenticity dilemma. To discuss further on the practical implications of preserving and determining authenticity in preservation of modernist heritage, the case study of Frank Lloyd Wright's Solomon R.Guggenheim Museum, New York would be apt. During its preservation process four major design challenges namely structural repairs, rain protection, fenestration upgrade and exterior colour issues, were tackled (Ayon, 2009). While design intent of the architect was given importance in some instances, historic fabric or *original* material was given in others and sometimes neither of the factors were considered, proving that a sole guiding principle cannot be used for preserving modernist heritage. In the research paper (Ayon, 2009) discussing the above case-study extensively, the author establishes that a new paradigm is not necessarily required to intervene in Modernist Architecture, but acknowledging the historic fabric vs. design intent dichotomy is required for analyzing them. The design intent become as important as historic fabric in of Modernist Architecture as it resonates with technical innovation and functional efficiency that characterizes them. As per *Madrid Document*, Modernist Architecture conservation standards need to compliment environmental efficiency, while intervening with these examples a sustainable preservation approach should be adopted. Such an approach would be able to replace authentic but poor-performing historic fabric with improved systems that retain the buildings historic character.

3.3. Local community and heritage

Heritage and community share a symbiotic relationship with each other. However, when it comes to assessing heritage values it is the experts that take the lead with limited or no involvement of the public for whom it is conserved for. Assuming that the value that community inscribes to its heritage is different and often influenced by tradition, memories and place attachment; when compared to the experts' values, the need for a combined understanding and approach becomes evident.

In living heritage sites (heritage sites that are continually inhabited and used by local community) across rural and urban Asia, there is a continuing relationship between the community and its built and natural environment, hence decoding this relationship is crucial to discover how they have survived over the centuries(Sharma, 2013). However, this connection is overlooked and ignored in conventional conservation approaches until the 2005 UNESCO Convention, post which the concept of 'Living Heritage' has gained momentum (Wijesuriya, n.d.). *Living Heritage Approach* aims at empowering the community to make decisions for their heritage and focusing on a long term sustainability in heritage management.

Traditionally in India, views of experts which includes historian, historic preservationists, archaeologists etc. are considered to be the guiding directions towards formulating policies and guidelines. The local community is kept away from the scene and are often neglected in the whole process. This has led to the lack of awareness and motivation to protect their heritage among the people, which in turn harms the unprotected heritage. Understanding what communities consider their heritage is and what values are attributed to those heritage is essential l(Silva, 2010) and cannot be emphasized enough. Community based heritage management has been extensively experimented by experts all around the world (Norway, Australia, UK for example) but not all have been a success story. Studies have shown (Hodges & Watson, 2000; Aas, Ladkin, & Fletcher, 2005) that involving the community in the decision making and implementation of the heritage management does not define their capacity to participate. though there is willingness among the people in the community to participate, there is also lack of faith in the ability of the community to do so among experts. But in a few cases, traditions rooted in community stewardship ensured that heritage sites valued by the community have been repaired and renewed for over thousands of years. Each cycle of repair, renewal and creation has served to strengthen community associations with the site and has enhanced its value for contemporary communities for example in Ladakh, India (Sharma, 2013). Appropriate skills need to be developed among the people which also includes awareness and training on the principles of heritage conservation and planning. This is where the capacity of experts and researchers become vital. Potential of the participants needs to be understood in order to determine how each member can positively contribute towards the initiative. High level of public awareness regarding the significance of heritage areas need to be carried out as the authenticity and integrity of such locales will be safer in the hands of those who holds pride as custodians of unique heritage (A Engelhardt & Rogers, 2009). Although, very often there could be conflict of interest between the community and the professionals in terms of what they consider valuable to maintain and preserve.

In India, the community participation in heritage management is limited with the Eurocentric top-down approach being followed till date. Though in many instances, the community has conglomerated against officials protesting the mismanagement of heritage properties, it has also been countered with vandalism and theft of cultural heritage (Thapar, 1984). The public's true and collective attitude towards their cultural heritage therefore remains ambiguous. First step towards tis would be to define the ‘local community’ and identify important stakeholders. Gauging this public attitude and willingness to engage in conservation activities become all the more valuable in the case on ‘unofficial’ or ‘unprotected’ heritage as Indian Modernist Heritage, especially due to the unpopularity Modernist heritage has drawn in other parts of the world.

4.0. CONCEPTUAL FRAMEWORK

A holistic or collective understanding of heritage must include three key dimensions: the existing heritage framework, the experts in the field, and local communities. Therefore, when dealing with the conservation of any particular cultural heritage, we could investigate these dimensions. Knowledge from the existing framework could be acquired through published research on the heritage as well as international laws and charters. Knowledge from experts could be gained through published accounts and interviews with architectural and heritage experts with theoretical and practical knowledge in dealing with the concerned heritage. Knowledge from local communities could be garnered through questionnaire survey with local residents and groups to assess their general awareness about heritage, the values they ascribe to it and their willingness to engage in conservation activities. The key to this dimension is to define the ‘local community’.
‘Heritage agnosticism,’ a concept developed by anthropologist Christoph Brumann (2014), could be used as a theoretical lens for this purpose. Heritage agnosticism was developed as a middle path between the referential path of ‘heritage belief’ and the overly critical path of ‘heritage atheism’ and avoids their disadvantages. Brumann derives this analogy from ethnographers studying religion who use this path to steer away from biases when interacting with informants with extreme religious views. Since a clear dichotomy exists in India in terms of empathy towards preservation of modernist heritage, this approach would be useful to determine the most significant and valuable modernist examples in a more rational and objective manner and to promote sustainable conservation management. An agnostic study of heritage takes into account some qualities of heritage that can be considered verifiable facts, such as age and rarity, from subjective qualities such as aesthetics. It also rejects the idea of heritage value as being intrinsic to the object or practices so labelled.

The three knowledge dimensions mentioned here: Knowledge from existing frameworks, experts and local community; are interdependent and should not be excluded in the process of heritage evaluation. The deficiencies of excluding one of these dimensions in the framework is discussed below:

- When *Knowledge from Local Community* is excluded

This situation is relatable to the current heritage management framework followed in India. The local community is alienated from the process of conservation and hence affects their attitude towards heritage places negatively, leading to theft and vandalism of cultural property (Thapar, 1984, p. 70). Also, the change is the social value ascribed by the community towards heritage environment as a result of contemporary living practices is left unexplored (Jones, 2016)

- When *Knowledge from Experts* is excluded

In the situation where the community is given complete power over their heritage places with the help of established frameworks, the meaning of heritage values and authenticity could be misinterpreted, miscommunicated or lost in translation. Also, initiatives such as improving public awareness on heritage and empowering the community to manage them sustainably could be severely affected.

- When *Knowledge from Existing Heritage Frameworks* is excluded

In a situation when local community and experts are given the control over the heritage management without the foundation of any existing frameworks and prior knowledge to guide, it could lead to a potential chaos. Philosophical conflicts, errors on the adopted approach, and delay in implementation are some of the potentials bottlenecks that could arise.

The paper argues that in order to implement a holistic and sustainable approach towards heritage management, a *Universal Knowledge on Heritage* needs to be obtained. The *Universal Knowledge on Heritage* is a combination of the three dimensions of knowledge screened through the lens of Heritage Agnosticism in order to avoid potential biases. This conceptual framework is suited for Indian Modernist heritage because: 1) currently they are not recognized as heritage by the legal framework, 2) public awareness on the issue of conserving Modernist heritage is unknown, 3) there is a lack of common methodological and theoretical understanding on conserving them among experts, 4) shorter life span and other technical issues that are characteristic to Modernist Heritage – which demands a case-specific conservation approach.

CONCLUSION

The conceptual framework discussed above is an attempt to decipher and make the existing 'accepted' heritage frameworks flexible and adaptable on a case-to-case basis. Heritage preservation community has lately accepted the value of multi-disciplinary approach towards conservation of modernist heritage and acknowledged it as one of their key points in the *Madrid- New Delhi document*. This echoes the need to view and evaluate heritage through multi-lenses and dimensions. Involving different stakeholders in heritage management and engaging them in preservation activities could not only improve the public awareness about heritage issues, but also encourage public-private partnership in heritage preservation. India has a mammoth task at hand in the recognition and protection of its modernist heritage, however, recent efforts by local and national agencies such as INTACH Delhi and ICOMOS India National Committee on Twentieth Century Heritage are in the promising direction. Future research needs to be carried out to test the *Universal Knowledge on Heritage* framework with suitable modernist heritage case-studies to fully understand its virtues and shortcomings.

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ENDNOTES

[i] *The Madrid Document: Approaches for the Conservation of Twentieth-Century Architectural Heritage* (Burke & ed.al, 2011) was prepared by the International Scientific Committee on 20th Century Heritage (ISC20C) and revised in December 2017 as The Madrid-Delhi Document during the ICOMOS General Assembly, New Delhi.

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Rewriting Architecture: Methodological Principles for Architectural Heritage Reconstruction

Rewriting Architecture: Methodological Principles for Architectural Heritage Reconstruction

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ABSTRACT: The study here displayed deals with the relationship between project and landscape through the technique of rewriting in contexts and conditions of emergency where war events compromise and mutilate the architectural heritage. In particular, the rewriting process is here identified as a generative technique capable to convert a mutilated structure, not efficiently recoverable with conservation and restoration techniques, into a general syntagmatic element or into a group of syntagmatic elements ascribable to the original one through a transformation process of the landscape and natural environment. The architecture of the collapsed cities damaged by the war represents a preferential experimental field. That situation leads to reflect not only on the generative conditions of the urban structure's elements, but it is also fundamental to understand the idea beneath them, working in continuity with the transformation of its physical structure. In the production of the city's forms, the element that intervenes in the philosophical and aesthetic field in the creation process is action that balances the creative gesture between what was and gives it back coherently to what will be, in its physical substance and in its inclination to transform itself in something else, through the fundamental recognition of an existing structure, formally composed even if compromised. In other words, this rewriting process entails the recognition of the current architectural heritage in order to assume it critically, trying to give back the invariant elements that characterized the permanence as an incorruptible factor of continuity in time. A tangible example of application concerns some areas subjected to war conflicts, which have caused a huge damage to the architectural heritage of cities. The developing of a critic reconstruction methodology in these contexts represents a fundamental need for the safeguard of the architectural heritage and cultural identity of populations involved in war conflicts.

KEYWORDS: Cultural heritage, architectural reconstruction, critical urban transformation

1. INTRODUCTION TO THE REWRITING PRINCIPLES

The aim of this paper is to analyze some reconstruction techniques starting from several procedures experimentally assumed in the literary field when, for example, the rewriting work:

> consists to find an operative solution to the never-ending problem of the relationship between the historical and universal significance of literary texts, their functional belongings to a precise communication system and, at the same time, to a more generic system of esthetic values (translated by the author, Ceserani 1990, 109-110).

This investigation attempts to transfer in the architectural field not the literary techniques, but the experimental procedures engaged in the rewriting modalities which release the microcosm of linguistic discard otherwise neglected and abandoned. These procedures strongly attribute the sense of an ideological choice in each physical detail, for an historical transformation of an esthetic and literary image. In architecture, rather than in literary field, the rewriting process means not to recombine but to recompose the semantic structures recognizable as invariants of the general structure of the city.

The rewriting is process is not the possibility to deconstruct and recombine the language's elements of the literature, but to recombine already established sequences of elements, provided with a strong identity, which are extracted from the original context and inserted in new narrative mechanisms. These sequences have to be mixed with the original elements to create new semantics structures. The procedure that links architecture to literature gets some elements of a defined order from an hypotext, through a dialectic progression with a critic reworked version of the invariants, both from literature and architecture, from which extracts nourishment its will of semantic transformation related more to reinvention than to the creation of something new. The Encyclopedia Treccani gives a more generic interpretation of the rewriting process. It is described as a

> fundamental process of generative grammar that converts a general syntagmatic element in to another element or group of syntagmatic elements ascribable to the previous one, according to specific formulas, called rewriting processes (translated by the author, Treccani 2018).

In the following paragraphs, we will try to determinate which are these passages in the literary field.

The concept of *transtextuality,* related to rewriting process, belongs to a more extended relation set as a codex's image with a script overlapped onto another one previously grasped (palimpsest), in other words, the "literary transcendence of a text" defined as "everything that connects the text in a manifest o hidden way, to other texts" (Genette 1997, 5). These definitions are theoretically valid also for architecture when the image of a structure with an essential and inherent character of inclination to be reproduced elsewhere, undermines a strong authority in the literary field and overcomes the romantic idea of work's originality in the architectural one: it is not related to "bricolage" or "writing quotations", rather than the necessity included in some situations where "making the new with the old should have the advantage to create more complex and engaging objects, reintroducing also the ancient work into a new network of sense" (Genette 1997).
It is easy to grasp that in this parallelism the object othis analysis is not a single text (or the single architectural episode) taken in its uniqueness and autonomy, but is the architext, the literary of literature (the architectural of architecture) that is its transcendence. This last term is conceived in its etymological meaning, where "transcending" means to overstep a limit, overcome an enclosure and thus inserting itself in a new network of relations. On the other hand the nature of intertextual relationships was already anticipated by Julia Kristeva (*Théorie d'ensemble, Problèmes de la structuration du texte*) who suggests that, starting from a single text, could be normal that a second text takes some characteristics of the first one creating an allusion, a parody or a true redraft of other authors' works, intended as a creative process (Kristeva, 1968). It is indeed impossible that a text is drafted without considering all the previous works. A system of visible connections links all the texts written the same network.
That goes beyond the simple similarities and habits that combine the texts belonging to the same literary category. The transtextualiy techniques assume different forms: intertextuality, actual presence of a text inside another one (citation, plagiarism or allusion); metatextuality, a reflexive critic relation that a text has with another one; architextuality the relation between two texts that have the same common character (literary category, subjects, etc.); paratext, the relation between a text with others belonging to the same textual periphery (titles, other author's opinions, etc.); , the relation that inserts a text into another one but not as a comment or note. The most interesting relation that helps us to define the rewriting process' operative methods is the hypertextuality, that defines the relationship between text B and text A, where B represents "the second level text" that derives directly from A through analytical-interpretative processes. The hipertextual practices that determine the realization of a text B starting from A can be divided into two categories: transformation and imitation (Genette 1997). This study does not take in consideration the imitation techniques (parody, ludic transformations, etc.), focusing its attention on the transformation process, also called transportation, mainly related to an interpretative approach of the rewriting process. The interpretation takes place through a formal typological transposition of the text, such as the literary translation, or a thematic one, that adulterates the structure of the text. The formal transposition modifies the meaning of the text only as an indirect consequence, rather than the thematic transportation, which interprets the text following the author's ideological intentions (Genette 1997).
The linguist and critic Roland Barthes developed a furthermore reflection on the rewriting processes' application techniques in his essay entitled *L'activité structuraliste*, in which analyzes the operative methods of the intertextual practices through the main characters of the structuralism with the aim to define an analytical structure that can describe all the existing texts. The structuralist method consists in a deconstruction and reconstruction of the elements that compose a specific object to determine a new comprehension of its generative principles. The introduction of this activity inside the literary text consists in a segmentation process of the original one into units endowed with meaning called *lessie* (Barthes 1981), capable to create relations with other texts. In a second phase, their syntactic reconfiguration generates new texts and significations, different from the original one. These principles lead us to understand how the intertextual practice acts within the rewriting processes, starting from the decomposition of the text into units of meaning and concluding with a creation of a second text that reorganizes those units in a new way.

2. CRITICAL READING IN ARCHITECTURE

At this point is important to introduce an important distinction between a "writable" and a "readable" text. The first term describes a category of literary texts capable to stimulate the reader towards an interpretation process of the intertextual relationships hosted by the text itself. A readable text is characterized by an absence of these relationships and for this reason is not able to create other significances different from the original one, making the interpretation process impossible for the reader (Barthes 1981). Starting from these considerations is possible to suppose an existence of a relationship between an interpretative lecture of a literary work and its rewriting methodology. We can assume that reading a text involves intertextual relations. Therefore, it can be related to a rewriting process, as it recreates the original text through its interpretation by the reader (Rebei 2004). Following an analogical process, the first phase of the rewriting techniques in the reconstruction of an architectural object characterized by a critical reading of its own constituent elements.

The analysis of the "Casa del Fascio" conducted by Peter Eisenman in his essay *Giuseppe Terragni: transformations, decompositions, critiques* gives an emblematic example of critical reading in the architectural field. The cognitive survey developed by the American architect is deeply different from the conventional analytical approach that sees the architecture in its historical context. Instead, the analytical framework used by Eisenman distances the architectural object from this methodological approach in order to question the principles that characterize its formal construction through an interpretation process (Eisenman 2003). The Eisenman's critical analysis can be reassumed as an architectural transposition because it went through specific ideological principles represented by the desire to eradicate the architectural project from an anthropocentric vision, typically of the Renascence, where the buildings are conceived as "extensions of the creative subject and mirrors of self-conception" (Eisenman 2003, 23). This analytical approach questions the traditional relation between the creating subject and the architectural work through the introduction of an alternative methodology of transformational narrative that adulterates the comprehension of the building, moving the attention to the principles that regulate the formal transformations' processes. Moreover, these processes must be conceived as critical in the sense that the traces of the process are seen as elements that undermine the traditional formal interpretation of these processes and their derivation from functional concerns (Eisenman 2003).
The application of this analytical procedure is mainly based on decomposition and reconfiguration processes of the primary geometries that describe the constitutive elements of the architecture. The relation between these geometries and the architectural elements constituted the primary configuration of the formal system of architecture, which is converted in a final configuration through a transformation process based on the fundamental operation of geometry such as subtraction, addition, symmetry, rotation, and translation.
Overlapping of the different phases of this formal transformation leaves recognizable residuals in the architectural body; these residuals must be interpreted as the evidence of the transformation processes. Retracing these residuals Eisenman created a critic narration of the architectural formal elements that constitute form, space and typological structure of the "Casa del Fascio".

> In this sense, the architect is no longer a composer of given codes, an independent agent manipulating conventional tactics, but rather someone engaged in an intertextual material such as these residues (Eisenman 2003, 29).

Eisenman attributes this ability to create intertextual relationships to the residues of the formal transformation processes. The narration of these traces shows "a range of textual possibilities conventionally obscured by the observer's precepts" (Eisenman 2003). In other words, the critical narration of these transformation procedures inspires infinite interpretations of the formal construction process of Terragni's building.
We have seen how the critical textual reading of the "Casa del Fascio" developed by Eisenman provides an interpretation of architectural object through a critical lecture of the traces left by the transformation process. Due to these observations, the trace can be identified as the essential element that has to be considered during an analytical reading of the formal characters of architecture. We have to recognize that this type of reading does not represent an example of architectural rewriting but illustrates a cognitive approach for a formal pre-comprehension of architecture. For this reason, the next paragraphs will deeply analyze the role of the trace inside the project, trying to investigate specifically the relationship between trace and architecture, conceived as the result of a stratification of historical memory.

3. TRACE AND MEMORY

This analysis does not refer to the phenomenological dimension of the trace in architecture, identifiable with a building's fragment or ruin, but analyzes the trace starting from its meaning of sign. The idea of trace adopted by this paper expresses the way in which the passing of events leaves a mark in the environment in which they operate. It is, therefore, something that speaks in place of an absence. This definition of the trace as an expression of an absence leads us back to the theoretical work of Peter Eisenman:

> One of Jacques Derrida's most incisive thesis in *Of Grammatology* is that it is possible another form of memory, a memory that no longer concerns fragments or representations or abstractions, but something that he defines as a trace. The trace is the presence of an absence (Eisenman 2005, 40).

According to Jacques Derrida, "there cannot be a representational object, neither representable reality" (Eisenman 2014, 269), in other words, reality cannot be conceived as a set of images or isolated presences, but as a system of *differences*. With *difference* Derrida describes the impossibility to isolate a single object as *presence* without taking into consideration its boundary conditions, especially without considering the aspects linked to its memory. According to Eisenman when architecture is conceived itself as a system of differences, the trace becomes its visual expression, which records a movement that leads us to read the present object as a system of relations with other previous or subsequent movements (Eisenman 2014). Consequently, whether we refer to the landscape or to a single architectural object, the trace, understood as the presence of an absence, takes on the role of representative element of memory. What is then the generative process that binds trace with memory?

> As you know I'm working on an hypothesis concerning the fact that our psychic mechanism was formed by a stratification process; the material present in the form of mnemonic traces is from time to time subjected to a new arrangement in accordance with recent events, as well as rewriting a work. What is essentially new in my theory is that memory is not present in a unique form but in multiple forms and that it is codified in different types of signs (translated by the author).

This letter by Freud to his friend Wilhelm Fliess clearly expresses how the concept of memory changes over time through a rewriting process of its traces according to recent experiences. In other words, memory constitutes that device like the idea of a written text reconfigurable by the action of the present, in which the metaphor of writing takes possession of the problem of the psychic apparatus in its structure and of the psychic text in its plot (Derrida 1967). In this reconfiguration process, the traces symbolize the intertextual material that allows the creation of a link between the perceived reality and the baggage of past experiences. Starting from an article by Freud about the removal process of traces within the memory, Derrida describes the rewriting procedures as a replacement action.

> There is no translation, or system of translations when a permanent code does not allow to replace or transform the meanings. Retaining the same meaning always present despite the absence of some definite signifier. (…) The radical possibility of substitution would, therefore, be implied by the pair of significance/signifier concepts, hence by the concept of sign itself (translated. by the author, Derrida 1967, 271).

Rewriting the trace as a sign of an absence is possible only through a substitution of the absence with another element or sign that modifies its signifier without changing its significance. The rewriting operation involves the creation of a second text starting from a previous one through a process of replacing the traces, changing the set of signs that characterize the main text (hypotext) without altering its structure. We should say that the trace is the element that allows the reconfiguration of the past within the palimpsest of the present. When we refer to the trace in the architectural field we won't talk about processes of reconstruction or reconfiguration but about architectural rewriting.

4. THE ROLE OF TRACES IN ARCHITECTURAL RECONSTRUCTION

The acceleration of socio-political and technological changes in our society, together with the precarious condition in which the architecture of the city is concerned, offers the necessary resources to reflect on the design actions that can be adopted to revitalize the architectural heritage (Canella 1998). In the architectural reconstruction, when prevails a conservative approach, the design intervention is limited only to those minimum precautions to prevent degradation. However, when the criterion of revitalization prevails, it is legitimate to ask whether the restoration intervention can be reconducted to a prescribed set of rules that have to be followed during the drafting and the evaluation phase of the project. These rules have the task to define the ways in which the project of the new dialogue with the persistence because the dialogue between the new and the old is to be considered indispensable since very often to conserve it is necessary to invent, transform and reallocate enough to prevent degradation (Canella 2004). Therefore, in order to develop a reconstruction process it is necessary to reflect on the relationship between invention and memory, especially during the process of formal construction of the new architecture's elements. The architectural project, when conceived as an invention coming from the catalogue of tradition, proves its validity when

> it seeks out its own form of contextual awareness, stepping back from that sort of linguistic atopia pursued by so much of international architecture in the race for globalization of economy and of information (Canella 1998, 11).

Reconstructing architecture means thus to experiment, through a creative process, a more significant valorization that aims to complete the architectural heritage and to transpose the formal characters into the esthetic and functional standards that the society evolution requires. According to Ernesto Nathan Rogers, the creative process which describe the construction of form in architecture comes from an history interpretation, made by the artist, which is the result of his own view on the historical context.

> The creative operation is influenced by two actions of memory, or rather by the dialectic relationship of two opposite tensions: the first action addresses the past, draws conscious or subconscious food from the experiences already consummated to create new ones (translated by the author, Rogers 2006, 73).

The second action mentioned by Rogers refers to the role of the monument, which reminds us that it is essential to create, through our works, a synthesis of the era in which we live just like those that preceded us (Rogers 1961). These statements by Rogers underline how the invention of the new is the result of a dialogue between the memory of past actions and the necessity to represent our reality through architectural forms.

> The present work serves as the intermediary between the past and the future; it is not a moment of pause but the obligatory point of passage in history from yesterday to tomorrow (translated by the author, Rogers 1961, 74).

Therefore, memory plays a fundamental role in defining the architectural form, as a necessary but not sufficient condition for artistic invention. In fact, the invention, like any creative process, causes other phenomena related to the individual action of the artist and to his way of interpreting reality.

For these reasons the principles that regulate the construction processes of architectural memory can be compared, even if with due caution, to those identified by Freud for the construction of psychic memory. Previously we have seen how the trace, sign of previous experience, represents the primary element that characterizes the structure of the psychic apparatus. Similarly, architecture as a material expression of the historical memory of a community is composed by a process of stratification of the traces, where "trace" no longer refers to the sign left by experience but to that left from the processes of physical transformation of the landscape.

The architectural traces are subjected to a rewriting process of the constitutive characters of the form in accordance with socio-economic changes, as happens in the psychic mechanism. This process, analogous to the writing of the psychic text, takes place by substitution, where the absence is filled by the architectural project. Furthermore, the fundamental operations during the procedure of traces substitution should not be limited in recognizing the existing formal relationship within the pre-existence environment. Developing new architectural elements should be directed towards the creation of different relational systems, due to the urgent rise of new conditions based on economic-social changes that imply the evolution of forms (Rogers 1958).

Following this reasoning, the trace can be described as the indispensable intertextual material that can be used to develop a project that can combine invention and tradition through an interpretative procedure of architectural settlements.

5. A POSSIBLE METHODOLOGICAL APPROACH

The analytical procedures that characterize the architectural rewriting techniques of a mutilated or damaged architecture should not be limited to an analysis of formal transformation processes, but they have to provide a methodology to interpret the traces that compose the architectural memory into the reconstruction project. When the city's architecture is in a precarious condition due to the destruction brought by war, it becomes necessary to reflect not only on the formal reasons of architecture but also on the generative conditions of its structure, such as history, context, culture, etc.

Because of these observations, the application procedures of the architectural rewriting will be divided into three phases: the first will focus on the study of the signification process between the cultural context of the architecture and its formal characteristics. The second phase will be characterized by the application of a critical reading to identify the traces left by the transformation process. In the last one we will try to develop an interpretation of the traces according to the architectural signs left by the process of signification previously analyzed.

An in-depth study of the architectural and cultural context that encloses the object of rewriting techniques creates the first phase of the architectural rewriting, in which there will be studied the generative conditions of architectural and urban structure starting from an analysis of the historical, social and cultural stratification processes. This analysis considers the final structure of the architectural object as the result of a signs' stratification that constitutes the general syntagmatic element of architecture. These signs are meant as a consequence of signification processes where the signifier is the formal element of architecture, while the significance represents the conceptual reasons of the form influenced by the cultural context (Barthes 1975). The analysis of these signs aims to produce a comprehension of the relations between form and its ideological principles and the way in which these relationships are translated into architecture. The analytical process of the syntagma takes place only through a decomposition of its components:

> The syntagma is a combination of signs that has as support the extension; in the articulated language this extension is linear and irreversible (…) each term here is indebted for its value to its opposition to what precedes and to what follows it; in the chains of words the terms are literary grouped in *presentia*; the analytical activity applicable to the syntagma is the decomposition (translated by the author, Barthes 1975, 53).

The statement expressed by Barthes suggests a decomposition process of the general syntagma in different groups of signs in order to analyze each single signification process between the formal elements of architecture and their ideological reasons. This process can be articulated in three different linear phases linked to each other. The first group of signs identifies the relationships between the pattern of the city's settlements, imposed by social, political and religious needs and the urban structure. The second group of signs gathers the relationships between the group of signs previously analyzed and the architectural

structure. Finally, the third group will include the signs deriving from the relationship between the concatenations of the signification processes analyzed in the first two phases and the formal characters of architecture.
Through a study of these groups of traces, is possible to define the invariant elements within the formal transformation, concerning both the urban structure and the architectural one. Therefore, these architectural invariants are the consequences of the influence employed by the social, political and cultural context on the formal character of architecture.
The second phase of the architectural rewriting identifies the typological and figurative character of architecture that comes from a stratification of traces left by the formal transformation processes. This stratification constitutes a syntagmatic element, not more general but specifically related to the analyzed architecture, where the signification processes are composed by the relations between primary geometric figures and their spatial characteristics such as symmetry and asymmetry, rotation and stasis, full and empty, line and plane, addition and subtraction (Eisenman 2003).
Also, in this case, the analytical procedure takes place through a decomposition of the specific syntagmatic element in subgroups of signs in which the processes of formal transformation of the constitutive elements of architecture are analyzed through plans, sections, elevations and in its volumetric conformation. In each subgroup, the transformation processes of the primary geometric elements are linked together in a linear manner as it happens for the analysis of the general syntagma. The stratification of these signs in the final shape of the architecture will constitute the traces of the formal transformation processes. Through an in-depth study of this material it is possible to identify the elements that can be defined as formal variables of architecture.
The rewriting principles previously analyzed in the literary field (metatextuality, architextuality, transtextuality, intertextuality, etc.), assemble an interpretative system that can be adopted to describes how the variables and invariants should be interpreted to build the constitutive elements of architecture. Following this interpretative system, the shape of the new architecture will be the result of a transposition procedure of the architectural and urban settlements into the new architectural object, which substitutes the traces that compose both invariant and variable elements. As happen in the literary field, the architectural transposition creates a second structure that is strictly linked to the original one, with the same common characters (typology, urban settlement, etc.), but with different figurative ones according to the evolution of forms that the changes of our society require. In other words, the architectural reconstruction project will be conceived as a palimpsest, where the collapsed or compromised section of the building is substituted with a new set of elements, which belongs to the same formal and structural reasons that characterized the previous architecture (Figg. 1-3). This interpretative procedure can be summarized as a reconfiguration process of a classical set of elements. Even if they do not adulterate the main structure of the text, they propose an architectural translation that is still significant today (Canella 2003).

6. CONCLUSIONS: A CRITICAL TEXTUAL RECONSTRUCTION

Placing the architectural project in continuity with the signs left by historical stratifications we want to demonstrate that a process of urban reconstruction can be conducted without losing the fundamental characteristics of the architectural heritage. This design methodological approach, due to its interpretative nature, does not preclude the possibility of a renewal of both the language and the architectural system. Instead, it can help to develop a reconstruction process in which the preservation and renovation of the building heritage coexist in a two-way relationship.
Obviously, this paper does not pretend to provide a method capable to solve all the problems related to the formal and structural construction processes of architecture in post-war reconstruction contexts. The paper deals with this issue by a critical point of view: it questions the methodologies of reconstruction up to now adopted, as in the case of Beirut where a policy of liberalization of the real estate market during reconstruction has favored a process of westernization of the city, distorting its architectural and urban characteristics. As for Beirut, we can take in consideration many other cities, such as Berlin, Warsaw, Dresden, etc. where the post-war reconstruction has caused an adulteration of the typical characters of the city with the consequent loss of its historic and social identity.
The methodology described attempts to open a debate on architectural reconstruction starting from the generative aspects of the architecture, underlining how they play a central role in the reconstruction of a social system in which cultural identity has been deliberately destroyed. We can conclude that the architectural rewriting technique in post-war contexts induces to a critical textual reconstruction process, where the terms textual and critical are used to underline how the constituent elements of the new architecture are the result of an interpretation of the signs' stratification left by the formal transformation processes that characterize both architecture and context.

Figure 1: The reconstruction of Kolding Castle by Inger and Johannes Exner.

Figure 2: Museum Thyssen-Bornemisza by Rafael Moneo.

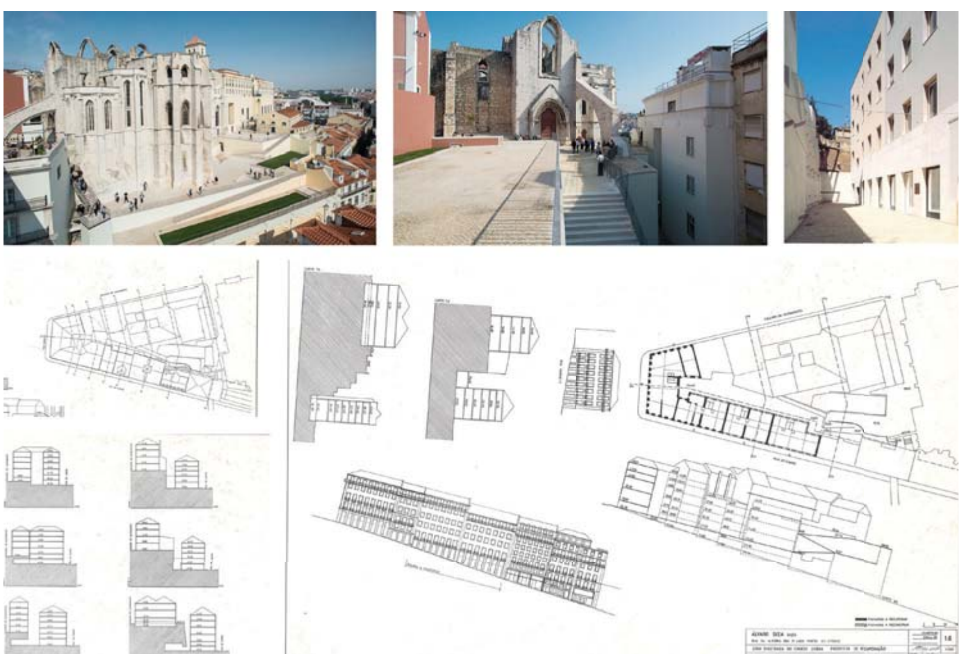

Figure 3: The reconstruction of Chiado district by Alvaro Siza.

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Dealing with Remnants of Politics, Power and History in Germany

Dealing with Remnants of Politics, Power and History in Germany

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ABSTRACT: The link between place and identity is not stagnant or fixed. It changes over time, influenced by social and political changes and ethical developments, from one generation to another. What was important to remember (or commemorate) yesterday may not have the same significance tomorrow. What we see as right and just now may be viewed as wrong or obsolete in a decade or two. So, what do we do when the storyline changes? In our current political climate, the question about the validity of certain historic monuments, their context, their meaning for various groups and our handling of these at times uncomfortable monuments gained unexpected relevance. Suddenly the question becomes important what to do with these memories, with monuments and buildings that clearly reference a certain time or nationalistic expression and that today leave us with an uncomfortable aftertaste.

This abbreviated version of the paper explores the questions posed above by looking at Germany as one example of where the people had to grapple with the role and impact of collective memory, of public monuments and architecture that are freighted with heavy past. German history since 1871 is filled with fractures of political, cultural and social orders that forced the definition and re-definition of what to remember and how to remember appropriately by its politicians and citizens. The paper will retrace the changes in significance and how authorities and the public dealt with buildings of historic significance in two locations of Berlin as examples from a larger range of buildings and monuments the author is investigating in context of the topic. They give an overview how uncomfortable monuments were treated in a country with turbulent past.

KEYWORDS: Berlin, architecture, symbolism, perception, monument, politics, history

> *Who controls the past controls the future. Who controls the present controls the past.*
> George Orwell[1]

INTRODUCTION

Our cities and landscapes are filled with remnants of the past; with authentic traces of lives that passed and histories that happened. These remnants – intentional memorials as much as unintentional monuments[2] – tell their story and give form to the collective identity of place. Space, memory and history are often intrinsically linked. However, memory and history cannot be considered synonymous. Memory is rooted in the concrete, in spaces and places, images and objects. Memory evolves, is “open to the dialectic of remembering and forgetting, unconscious of its successive deformations, vulnerable to manipulation and appropriation, susceptible to being long dormant and periodically revived.” (Nora 1989, 8) History, on the other hand, is a representation of the past – its reconstruction of what is no longer, always problematic and incomplete. It “belongs to everyone and to no one, whence its claim to universal authority.”(Ibid. 9) The links between place and identity, memory and history are not stagnant or fixed. What do we do with monuments and buildings that clearly embody a certain time or nationalistic expression that today leave us with an uncomfortable aftertaste?

Orwell’s quote points to two aspects related to this question: history is not a monolithic narrative, that cannot or should not be questioned. The shaping of history can range from omission of important facts to recounting different versions of the same events to outright fabrications, which today are also called “alternative facts”. Orwell’s quote also implies that the “power to shape the historical narrative is elemental to the ability to influence future development” (Dellenbaugh-Losse 2014). Who holds the key to “the truth” at any given time? Who writes the story? Who decides which memories or memorials to keep and which ones to abandon? This paper attempts to review the handling of memory and historic architecture by reviewing the story of artefacts and places in Berlin. We will observe how their importance and appreciation changed over time and become witness to stories of construction, reinterpretation, destruction, revival and renewal.

1.0 BERLIN

Berlin has surpassing importance and symbolic meaning in the nation’s more recent history. Its fate during and after World War II highlights how its urban landscape was exploited more than any other German city to further political agendas in various ways. A complex set of historical and political issues has influenced the urban form and symbolism of Berlin. Before serving as the capital of the Kingdom of Prussia, Berlin had existed for five hundred years. Berlin became the residence of the Prussian kings and later the center of Wilhelmine Germany. After 1871, it was successively the capital of the first unified German republic, the Second Reich and of the Weimar Republic. It was the epicenter of the National Socialist governments during Adolf Hitler's Third Reich, and after World War II, the capital of the socialist German Democratic Republic (GDR). At each stage of Berlin's development, the ruling regime has imprinted signs of its power on the architecture and urban fabric of the city. Had the most megalomaniacal dreams of Hitler and his architect Albert Speer for the "World Capital Germania," a monumental Berlin been constructed, it would have changed the face of the city drastically. However, World War II scarred the metropolis deeply. In a city divided between the Soviet forces and the western allies after the war, any symbolism appeared to have been amplified on both sides of the wall with various measures. Berlin Mitte, the central district, was of crucial importance and a focal point of eastern propaganda. Here the east German socialists demolished badly damaged buildings to create a monumental central axis spanning from the Palace of the Republic and to the Television Tower at Alexanderplatz with the extensive use prefabricated construction, the so called *Plattenbauten*. Along with renaming of streets and erecting monuments to Lenin, Marks, Engels and other socialist and communist heroes, the governing Social Unity Party of Germany SED created the modern socialist city (Dellenbaugh-Losse 2014). The fall of the Berlin Wall and the collapse of the Soviet Union triggered yet another shift of Berlin's status by the 1990s and put the city into the political and social epicenter of its time and marked its renewal as the capital of a reunited Germany. "The choice of the monumental city of Berlin as capital raised fears about the emergence of a powerful and assertive Germany willing to exercise its newfound strength" (Asher Barnstone 2005). The decision to abandon Bonn as the capital in favor of Berlin, a city in the heart of the former East Germany, also marked an openness to form a new state identity and allow noticeable change rather than merely absorbing East Germany into the social-capitalist West Germany. Establishing Berlin as the capital of the reunified Germany brought with it discussions and assessments to use or repurpose historic buildings – some of them with significance from the Nazi era. More than a decade ago, Huyssen wrote about the city:

> "As Berlin has left behind its heroic and propagandistic role as flash point of the Cold War and struggles to imagine itself as the new capital of a reunited nation, the city has become something like a prism through which we can focus issues of contemporary urbanism and architecture nation identity and statehood, historical memory and forgetting. Architecture has always been deeply invested in the shaping of political and national identities, and the rebuilding of Berlin as capital of Germany gives us significant clues to the state of the German nation after the fall of the Wall and about the ways it projects its future."[3]

In a country so sensitive to symbols and to references to its past, the decisions concerning relocation were bound to cause controversy. While the city today is filled with many examples of buildings or locations that experienced significant symbolic changes, we will be able to discuss only two locations in Berlin in this paper. Both are, in their unique ways, "uncomfortable monuments," that address remnants of power and architecture. Each building/location was at times cherished and important, then lost significance and purpose and was threatened with demolition that has or has not been executed. Each of these locations, at every symbolic fracture, stood at the center of public discussions and debate about its future. At every instance, political decisions were weighted against public resistance or support and prompted action.

2.0 STADTSCHLOSS BERLIN – THE CITY PALACE

2.1. The royal palace

On the Cölln-side of the river Spree the royal palace once stood. It served as the winter residence of the Electors of Brandenburg and the Hohenzollern Kings of Prussia since 1701. For this purpose, a medieval fortress that was first turned into a renaissance palace. It was later transformed and expanded by one of Germany's most significant baroque artists, Andreas Schlüter. This palace for Friedrich I was to show off the young Prussian monarchy and strike out its significance among other sovereigns of the Holy Roman Empire within the Germanic ethnic sphere. The magnificent Berlin Palace, the Stadtschloss, was praised as *the* masterwork of northern baroque architecture. Located on the Museum Island at Schlossplatz, across the Lustgarten (pleasure garden) park and adjacent to the river, "its long and ornate facades, four stories and 30 meters high, established the final scale of the palace and – it has been argued – of all Berlin architecture" (Ladd, 1997; p. 52). A second addition by Johann Eosander von Göthe doubled the palace in size. Focal point of this extension was the Eosander portal that was later crowned by a 100 m tall cupola designed by August Stüler. When King Willhelm I was elevated to the status of Emperor (Kaiser) of the new united Germany in 1871, the Stadtschloss became the symbolic center of the German Empire as the central royal residence.

The German Empire, however, was a constitutional state, and from 1894 the newly constructed Reichstag building, served as seat of the German parliament.[4] The new parliament building quickly came to overshadow the Stadtschloss as the center of power. This contributed to the loss of significance of the imperial palace in parallel to the loss of political power of the monarchy. Following Germany's defeat in World War I, the emperor was forced to abdicate on Nov. 9, 1918. The Spartacist leader and founder of the communist party, Karl Liebknecht, declared the German Socialist Republic that same day, first from Tiergarten and then two hours later from a balcony of the Stadtschloss. The political acts of that day ended more than 400 years of royal occupation of the building.[5] Following the fall of the German Empire, the Stadtschloss, no longer needed as a royal residence, became a museum and housed one of the most significant collections of artwork in Berlin. During the summer time, concerts were hosted in the Schlüter courtyard and interior spaces were rented out to a number of different organizations with widely different backgrounds. During the Third Reich, the Hitler's National Socialist (Nazi) Party largely avoided the use of the imperial palace for their events and the building was mostly ignored. However, the former Lustgarten was remodeled in 1935. A statue of King Willhelm III and the garden's fountains were moved to the side so the space would serve better as parade ground.

During World War II, the Stadtschloss was twice struck by Allied bombs. On the latter occasion, the building lost its roof and largely burnt out. And while the Stadtschloss was a burned-out shell of its former glory, it could have been restored, as many of the other bombed-out buildings in central Berlin later were. The building remained structurally sound, much of its interior decoration was still salvageable and it had been documented well prior to the war. However, the palace's location was within the Soviet zone, which became the German Democratic Republic. "The East German governing party SED and state institutions failed to create a coherent, national preservation policy. Without formal ideological or state guidance on preservation, the Stadtschloss was bound to become a site of extraordinary conflict" (Campbell, 2005). The new Communist regime installed in East Berlin soon declared the palace a symbol of Prussian militarism, although at first there appeared to be no plans to destroy the building. Some parts of it were in fact repaired and some interior rooms used from 1945 to 1950 as exhibition space while others served as office space. However, during the late 1940s there was a steady increase in the subtle attacks by the SED politicians, who increasingly demanded the removal of the palace. In October 1949, Soviet authorities filmed the war movie "The Battle of Berlin," in which the ruin of the Stadtschloss served as backdrop (Maether 2000). For realistic cinematic impact Soviet soldiers acting as extras for the film fired with live artillery shells. This vandalized and further damaged the palace. Campbell notes that the notion of neglect or failure to act to preserve the Stadtschloss was not unique:

> In terms of nation building, preservation often played a negative role. The East German government and SED neglected and demolished older buildings on the one hand while promoting future oriented, utopian architecture on the other. Under Walter Ulbricht, historical buildings were symbols of the decay of capitalism, the destruction of Nazism and the Second World War and emblems of organized religion and past feudal aspirations. This changed under Honecker as the SED appropriated historical monuments to create a narrative of East German history which extended beyond Soviet liberation and the GDR's establishment. At the same time, Honecker sealed off the GDR from the rest of Germany in an attempt to create a national identity based upon a socialist state rather than German ethnicity.[6]

In his research on the Berlin Stadtschloss, Maether concludes that Walter Ulbricht, the First Secretary of the Central Committee of the Socialist Unity Party (SED) of Germany and thus effectively the most powerful man in the state, finally decided alone to destroy the Stadtschloss in June 1950 (Maether 2000; Campbell 2005). Despite public objections and criticism from east and west, the demolition of the palace commenced only a few months later, in September, 1950. The task took four months, consuming 19 tons of dynamite. So solid was its construction that the dome and its entire base remained intact even after it fell to the ground. In place of the Stadtschloss there arose a parade ground with a huge grandstand in the east, the Marx-Engels-Platz. Here, enormous parades to celebrate the German Democratic Republic with as many as 750,000 people filed past the top leadership of the East German state for hours. Interestingly enough, it must be noted that not all of the old palace was lost: One particular section of the Stadtschloss was preserved: the Eosander Portal with the balcony on which Karl Liebknecht declared the German Socialist Republic in 1918. And thus, the Eosander Portal was included in the new Council of State Building (Staatsratsgebäude) in 1964, an otherwise plain structure that exemplifies the reduced GDR modern style, which was erected to the south of the vacated site (Ladd, 1998). With an altered cartouche, the baroque portal forms the main entrance of the building designed by the architecture collective lead by Roland Korn and Karl Erich Bogatzky (Ströver 2010).

2.2 Palast der Republik

While the government of the GDR used the vacant plaza for parking when it was not needed for propaganda purposes, only following diplomatic recognition of East Germany plans for a new structure in the same location became concrete. From 1973 to 1976, during the reign of Erich Honecker, who succeeded Ulbricht as Secretary of the Central Committee of the SED, a large modernist building was built designed by lead architect Heinz Graffunder and his design collective (Holfelder 2008). The so-called "Palace of the Republic" was erected on one side of the giant square occupying most of the site of the former Stadtschloss. By virtue of its location more than by its architectural presence, it became the old city center's most prominent structure (Ladd 1998). The Palast der Republik was the seat of the parliament of the German Democratic Republic, the Volkskammer (People's Chamber). The building further housed two large auditoria, art galleries, a theatre, 13 restaurants, a bowling alley, a post office and a discothèque. Thus, the Palast der Republik was the central venue of the German Democratic Republic for major political and cultural events while the remaining area in front of the Palast der Republic continued to be used as a parade ground.

The building was promoted as the “House of the People” to millions who experienced all sorts of functions and events there. Constructed with a steel skeleton, its exposed structure was sprayed with about 5,000 tons of asbestos for fire protection. Shortly before the German reunification in October 1990, the Palast der Republik was found to be so badly contaminated with asbestos that it had to be closed to the public. After reunification, the Berlin city government ordered the removal of the asbestos, a process which was completed by 2003. At the same time, a 20-year-long debate started as to whether the former Stadtschloss, the royal palace, should be reconstructed in its former location to replace the Palast der Republic, and whether this should be done in part or completely. By the mid-1990s, somehow, the earlier demolition of the Stadtschloss appeared to have given legitimacy to the liquidation of the Palast der Republic and seemed to justify erasing the GDR showpiece from the urban memory of Berlin (Holfelder 2008, Ladd 1998). In 1991, the Marx-Engels-Platz was once again renamed to Schlossplatz. In 1993 a scaffold was erected and shrouded in fabric depicting the former baroque palace that used to hold its place (Holfelder, 2008). Despite the fact that the majority of East Germans opposed the demolition and various protests by people who felt the GDR building was an integral part of Berlin's culture and the historic process of the German reunification, in November, 2003 the German parliament decided to demolish the Palast der Republik and leave the area as parkland until further use of the site was decided. This decision was especially controversial with former East Germans for whom the Palace of the Republic had been a place of fond memories, or who felt a sense a dislocation in a post-communist world. For others, who had suffered during socialist times, it was a blessing that this testament of their oppression would disappear at last.

2.3 The Humboldt Forum – Reconstruction of the Stadtschloss with new function

While the future of the Palast der Republic was uncertain, the debate about reconstruction of the Stadtschloss, however, amplified. Some groups argued that the rebuilding of the Stadtschloss would restore the unity and integrity of the historical center of Berlin. Opponents of the project included those who advocated the retention of the Palast der Republik on the grounds that it was itself a building of historical significance. Then there were those voices who argued that the area should become a public park that would allow the opportunity for the creation of a new history. Then again there were those who believed that a reconstructed palace would be an unwelcome symbol of Germany's imperial past and others voiced that it would be unacceptably expensive for no definite economic benefit. The public debate was varied and heated. The reconstruction scheme was not without precedent: Completed in 2005, the rebuilding of Dresden’s Frauenkirche was an encouraging example for those who wanted the palace back. There, the new building incorporates the remaining original stones, stained black by bombing and fire. Some had been piled up to a huge mound in the middle of the city, others were neatly stored on gigantic shelves close by (Buchard 2016). However, in Dresden no new building had occupied the site of the destroyed church and remains of it had been archived and saved for future use. The situation in Berlin was more complicated. Eventually, it was decided to rebuild the palace but with a new function. The design of Italian architect Franco Stella was the winning entry in an architectural competition in 2008. The new building will have the massing of the former palace and include authentically reconstructed facades on three of the four exterior sides. While the interior will be modern, the facades of one of the courts will be in the original style (Schlüterhof). The floorplan, however, has been designed to allow potential future reconstruction of notable historical rooms. The building will house the Humboldt Forum museum, a museum that has been described as the German equivalent of the British Museum, and congress center. The corner stone was set in June 2013. Completion is scheduled for 2019. And while construction is ongoing, discussions about details of the new “old” building have been ongoing as well.

3.0 THE REICHSTAG

3.1 The Reichstag as Diet of the German Empire

The Reichstag may take the most prominent place in Berlin’s contested historical landscape (Ladd, 1998, p.84). Ascher Barnstone points out that “any interpretation of the meaning of the Reichstag is wholly dependent on the reading of its history” (Ascher Barnstone 2005, 180). Germany’s parliaments had to endure “many vicissitudes in modern German history–in Bismarck’s Second Reich, the Weimar Republic, Hitler’s Third Reich, divided Germany, and now the unified Federal Republic. The Reichstag’s prominent role in each period makes it a monument to Germany’s troubled national dignity” (Ladd 1998, 84). “The word *Reichstag* initially referred to the politically weak pan-Germanic parliament that began meeting in the seventeenth century” (Ascher Barnstone 2005, 180). Best understood as semi-parliamentarian, the empire’s 1871 constitution of the Second Reich created an awkward balance of power between the emperor and a modern representative government with the imperial chancellor at the center. Otto von Bismarck, who was the first who fill that role, was in the unique position to manipulate both – the political parties and Emperor Wilhelm I. Initially Bismarck was able to keep democratic impulses in Germany under control, much to the pleasure of autocrats and the Emperor himself. However, the Reichstag became increasingly more independent with the strengthening of liberal, conservative and religious parties and increasingly social democrats represented in parliament. Already the decision on the location for a new building appeared complicated. It was “inseparable from the unsettled question of the Reichstag’s role in governing the new German state” (Ladd 1998, 85). A first international architectural competition was held in1872 but led nowhere as parliament was initially unable to purchase the proposed site on Königsplatz. Only after another decade of uncertainty, construction of the building designed to house the *Diet of the German Empire* began. In 1882, the Neo-Baroque design of architect Paul Wallot, that was modeled after Memorial Hall, the main building of the 1876 Centennial Exhibition in Philadelphia, was chosen as winner of a second design competition.[7] The architect was charged "to create a symbol of Germany and of German parliamentarism" (Ladd 1998, 86) but there was no model for him on which to fall back. In fact, there was not even a national style he could use to help his design. Nevertheless, in 1884, the foundation stone was laid. Construction was completed in 1894. The building was acclaimed for the construction of an original cupola of steel and glass, considered an engineering feat at the time and interpreted as a symbol of modernity. But its mixture of architectural styles drew widespread criticism and "has often [been] labeled the epitome of bombastic " Wilhelmine" architecture, a usually pejorative term to the bluster and bombast of the autocratic Emperor William II (Ladd 1998, 87).[8] It was not until 1916, in the middle of World War I, that the iconic words *Dem Deutschen Volke* ("[To] the German people") were placed above the main façade of the building – much to the displeasure of emperor Wilhelm II, who had tried to block the adding of the inscription for its democratic significance.(Cullen 2014, 61). Kaiser Wilhelm II, who undoubtedly took the construction of a dome five meters higher than the one towering over his Stadtschloss as a personal insult, publicly referred to it as "the epitome of bad taste" and "the ape house" (Cullen 1995; Turner 2000, 83.). After losing World War I, the monarchy collapsed. William II was forced into exile and to abdicate.[9] Philipp Scheidemann proclaimed the institution of a republic from one of the balconies of the Reichstag building on Nov. 9, 1918. It was "an attempt to preempt the radical Karl Liebknecht's proclamation of a socialist republic from the royal palace on the same day" (Ladd 1998, 88). Following a brief occupation by the Workers' and Soldier's Councils, parliamentarian order was reestablished. The building, which was still called the Reichstag, continued to be the seat of the parliament of the Weimar Republic (1919–1933) and transformed into the real center of power.

3.3 Reichstag Brand – Reichstag Fire and Nazi rule

The National Socialist Party rose rapidly in popularity during the 1920s. The nation had never fully recovered from the disgrace of a lost war and suffered from additional hardship due to payments of reparation to the victory powers. Widespread unemployment and economic hardship helped to promote the Nazi message. During the Reichstag elections in 1930, the National Socialist Party managed to win 18.3% of the votes and became the second-largest party in the Reichstag after the Social Democrats. Political instability and weak minority governments deepened Germany's political crisis during 1931 and into 1932. The votes that the Nazis received in the 1932 elections established the Nazi Party as the largest parliamentary faction of the Weimar Republic government. Then on Jan. 30, 1933, Hitler was appointed as German Chancellor. The tragic consequences of those events are well known. The Nazi era is the darkest chapter of German history. On Feb. 27,1933, the Reichstag building caught fire, under still uncertain circumstances (Cullen 2014, 121). The Nazi propaganda machine quickly put blame on the communists. Only about a month into taking political office, the event gave Hitler a pretext to suspend most democratic rights provided for by the 1919 Weimar Constitution. The *Reichstag Fire Decree*, allowed Nazis to arrest communists and other political opponents without specific charge, curb the freedom of speech and press and increase police action throughout Germany. The burning of the Reichstag had also created fear in other capitalist states of the rise of communism in Germany. This furthered their *Policy of Appeasement* towards Hitler, a self-proclaimed anti-Communist. During the 12 years of Nazi rule, the Reichstag building was not used for parliamentary sessions. If the Reichstag convened at all, it did so in the Kroll Opera House, across from the Reichstag building. On March 23, 1933, the Reichstag parliament surrendered its powers to Adolf Hitler in the *Enabling Act*, another step in the so-called Gleichschaltung ("coordination"). The Reichstag, never fully repaired after the fire, was further damaged by war-time air raids. During the *Battle of Berlin* in the spring of 1945 it became one of the central targets for the Red Army to capture due to its perceived representational significance. On May 2, 1945, the photo of a Soviet soldier raising a flag over the Reichstag was taken, which celebrated the victory of the USSR over Nazi Germany. "For the Russians, then, the taking of the Reichstag was synonymous with vanquishing Fascism; the Reichstag was seen as the symbol of the National Socialist state no matter how it was understood by the Germans and the other Allied Power" (Ascher Barnstone 2005, 182).

3.4 An empty shell during the Cold War

When the Cold War emerged, the Reichstag was physically within West Berlin, but only a few meters from the border of East Berlin, which ran around the back of the building. In 1961 the Berlin Wall, a heavily guarded concrete barrier that physically and ideologically enclosed the western sectors of the divided city and sealed them off toward the east. The Wall highlighted the dissection of the city and the country as it passed the building freighted with history and symbolism only a few steps from the Reichstag's rear entrance (Ladd 1998, 91). After the war, the structure was essentially a ruin. In addition, there was no real use for it, since the seat of government of West Germany had been established in Bonn in 1949. Still, in 1956, after some debate, the West German government decided that the Reichstag should not be torn down but restored instead. It's historic and political significance was too important to lose what was left. However, the cupola of the original building, which had also been heavily damaged in the war, was demolished. Paul Baumgarten oversaw the reconstruction of the building from 1961 to 1964. He removed all monuments and decorations referring to German mythology. In effect, he created a plain building inside the historic Reichstag, retaining only the outer walls stripped of most of their ornamentation. Starting in 1971, a permanent, widely lauded exhibition on German history was displayed and tours of the building were given. However, until 1990, the building was otherwise used only for occasional representative meetings.

3.5 From Reichstag to Bundestag

After weeks of peaceful civic resistance against the dictatorial GDR regime, public and political pressure built up. On the evening of Nov. 9, 1989, the East German government announced that GDR citizens would be permitted to visit West Germany and West Berlin. East Germans rushed to borders, crossed and climbed onto the Wall, joined by West German citizens from the other side in a celebratory atmosphere. With the fall of the Berlin Wall and reunification within reach, things began changing rapidly and the hope that the Reichstag would one day return to prominence grew stronger (Ladd 1998, 82). On Oct. 3 1990, the official German reunification ceremony was held here, and one day later, the parliament of the united Germany would assemble in an act of symbolism in the Reichstag building. At that time, the role of Berlin had not yet been decided. On June 20, 1991, after fierce debates the parliament, the Bundestag, decided, with a slim majority of 17 votes, in favor of relocating the newly reunified government's seat from Bonn back to the German pre-war capital, Berlin (Walker 2009). In 1992, Sir Norman Foster won the architectural contest for the reconstruction of the building. His winning concept looked very different from what was later executed and did not include a cupola and the construction process was accompanied by much public debate. The decision to rebuild the dome was probably the most controversial aspect of all.

> "Many found the dome the part of the Reichstag most representative of the authoritarian German past, associating domed capital buildings with expressions of power. Ironically, in its day, critics considered the Reichstag dome the one modern element, the one architectonic component representative of the New Order and a democratic future on an otherwise reactionary piece of architecture" (Ascher Barnstone 2005, 207).

During the reconstruction in the early 1990, the Reichstag building again was gutted, taking out everything except the outer walls, including all changes made by Baumgarten in the 1960s. However, traces of historical events were retained in a visible state; among them the graffiti by Soviet soldiers from the final battle for Berlin.

But before reconstruction began, the Reichstag was wrapped by the Bulgarian-American artist Christo and his wife Jeanne-Claude in 1995, attracting millions of visitors. The project was financed by the artists through the sale of preparatory drawings and collages. In June 1995, for two weeks, the building was shrouded with silvery fabric, shaped by blue ropes, highlighting the features and proportions of the imposing structure. The slogan accompanying the wrapping of the Reichstag was "What is veiled can be perceived more clearly." Christo chose the Reichstag for its symbolic meaning: for years it stood up in an open, strangely metaphysical area, with a complex past and an uncertain future. While the building has experienced its own continuous changes and perturbations, the Reichstag always remained the symbol of democracy and a signifier of German identity. Ascher Barnstone interprets the event as follows (2005, 168):

> Although the perception of the building underwent a change in the eyes of some commentators in the popular press, the fact that the Reichstag's transformation was intended as purely symbolic meant that the event had virtually no effect on public opinion about the building, as numerous contemporary articles demonstrate. The wrapping and unwrapping did signal another potential reading of Foster's coming project and its relationship to history; the way interpretations of architecture are profoundly related to how people think and see the world, and the irrational force of associations. Christo and Jeanne-Claude referred to the project as a "memorial to democracy." In which sense they intended this memorial is unclear, however, to the death of democracy or the rebirth, or the commemoration?

The reconstruction based on Norman Foster's design was completed in 1999, with the Bundestag convening there officially for the first time on April 19th of that year. The Reichstag is now the second most visited attraction in Germany, not least because of the huge glass dome that was erected on the roof as a gesture to the original 1894 cupola, giving an impressive view over the city, especially at night. "The new dome has assumed as many layers of meaning as the building on which it stands. Moreover, it has rapidly become a symbol, if not the symbol, of the new Berlin" (Ascher Barnstone 2005, 205).

CONCLUSION

The urban environment with its public and private building represents the material remanence of our historical past in the present. As Huyssen states, "we have come to read cities and buildings as palimpsests of spaces, monuments as transformable and transitory, and sculpture as subject to the vicissitudes of time." (Huyssen, 2003. 7) There would be many other buildings, structures and monuments in Berlin alone that are suitable to discuss how we define and re-define national identity. This paper can only discus a minimal sampling to illustrate how perception of these places change over time along with our attitude and treatment of these monuments: The site of the former Stadtschloss is an example where in a number of decidedly political moves, the historic imperial palace, a monument to aristocratic power and social oppression, was destroyed to superimpose a building that would represent a new, radically different, modern state and symbolize socialist ideals. Within decades of its erection, the GDR's Palast der Republic was torn down and had to make way for a reconstructed Hohenzollern palace. While each step was highly controversial, the decisions must be understood as the humiliation and final Cold War victory of capitalist politics over socialist ideas at the expense "an East German population that felt increasingly deprived of its life history and of its memories of four decades of separate development." (Ibid. 45) The Reichtag building that housed the first German parliament played an important part in the rise and the fall of the Weimar Republic. Gutted by the Reichstag Fire and mostly ignored during the Nazi era, it's conquest still became the symbol of ultimate victory during the 1945 Battle of Berlin. As a reminder to the failed republic, it stood mostly in ruin after the war until it resumed its symbolic power and political value in the 1990s through the German reunification. The 1995 veiling as part of an art installation allowed the Reichstag to become a monument of democratic culture and opened space for reflection. With its new cupola, the building today symbolizes the new Berlin and "it successfully embodies the tensions between the unloved imperial past (the building's outside shell), a bureaucratic functional present of the German republic (the plenary hall for the Bundestag), and the desire to have a flashy image of democratic transparency marking Berlin's reclaimed status as capital." (Ibid, 76-77)

The examples illustrate how those in power took the opportunity to steer public debate, to interpret or re-interpret history to conform with their opportune narrative. They should also be a reminder to all of us that we must grapple with the meaning of national identity and the shifts, fractures and re-interpretations that happen as they relate to the built environment. What parts of our history, which monuments and buildings do we retain, which ones do we leave behind? Why are some spaces "cleansed" of unwanted or uncomfortable histories and their symbols, while others become subject to historiographies and yet other spaces are not? The traces and remnants of our history we find in our city form the collective identity of the place. The link between place and identity is not stagnant or fixed. It changes over time, influenced by social and political changes and ethical developments, from one generation to another… what was important to remember (or commemorate) yesterday may not have the same significance tomorrow. What we see as right and just now, may be wrong or obsolete a decade or two from now. So, what do we do, when the storyline changes? And why is it important to argue especially about those spaces, places and buildings, that seem uncomfortable or contested. We must question what makes us uneasy and we also must question their representation. We should carefully observe changes and ask, why some spaces will be or have been cleansed of unwanted memories and their attendant symbols while others remain intact. What are the underlying motivations? Dellenbaugh-Losse describes a fourfold process for normalizing a selected past in the landscape or urban fabric (Dellenbaugh-Losse 2014). It is a process of selection, representation, presentation, and normalization. She further points out that "contested spaces, spaces with multiple narratives, or spaces of parallel histories serve as good examples for such issues" (Ibid. 2). Looking back at the examples from Berlin, the city that stood at the center of the German state that collapsed four times within a single century, we understand that the historical narrative found there reflect the impression of historiographic links that connect our time with the past. The symbolic values have served and still serve to reinforce the political narratives, even if it may mean that at times we begin editing the past.

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ENDNOTES

1. Orwell, G. 1984. *1984*. New York: Harcourt Brace Jovanovich.P. 35.
2. A monument in the context of this paper is a type of structure that was explicitly created to commemorate a person or event, or which has become important to a social group as a part of their remembrance of historic times or cultural heritage, or as an example of historic architecture. The term is often applied to buildings or structures that are considered examples of important architectural or cultural heritage.
3. Huyssen, Andreas. 2003. *Presents Past: Urban Palimpsests and the Politics of Memory.* Stanford: Standford University Press. P. 49.
4. The first imperial Chancellor Otto von Bismarck, established a welfare state to gain working class support in an industrializing country and to undercut a strengthening of socialist powers. Distrusting democracy, Bismarck controlled domestic and foreign affairs under Wilhelm I, until Kaiser Wilhelm II forced his resignation in 1890.
5. Socialist Party leader Philipp Scheidemann however was the first who had proclaimed the founding of the German Republic based on democratic parliamentarian principles at the Reichstag just prior to Liebknecht.
6. Campbell, Brian William. 2005. "Resurrected from the Ruins, Turning to the Past: Historic Preservation in the SBZ/GDR 1945–1990."ProQuest Dissertations Publishing. Rochester, NY: University of Rochester.
7. The *Centennial International Exhibition* of 1876 was the first official World's Fair in the United States. The location was chosen to be Philadelphia, PA, to celebrate the 100th anniversary of the signing of the Declaration of Independence in Philadelphia. Designed by Herman J. Schwarzmann in Beaux-Arts style as the Art Gallery building, Memorial Hall was the largest art venue in the USA when it opened. Its 150-foot dome sitting atop a 59-foot-high structure was highly applauded as a symbol of modern engineering at the time.
8. Emperor William II ruled from 1888 to 1918. He judged the Reichstags building as the “height of tastelessness.” His judgement of the architecture likely reflected his attitude towards the parliamentarian system in general. (Quoted Michael S. Cullen. 1982. *Der Reichstag: Die Geschichte eines Monuments*. Berlin: Fröhlich & Kaufmann. As referenced in Ladd, 1998.)
9. While he had fled German earlier and in Belgium, William II did not abdicate as German Emperor and King of Prussia until November 28 in his Doorn exile. Philipp Scheidemann proclaimed the republic based on rumors that the emperor had already abdicated.

Silvina Lopez Barrera

Exploring Spatial Justice Challenges in Rural Mississippi

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Exploring spatial justice challenges in rural Mississippi

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ABSTRACT: The poverty and food insecurity rates in Mississippi are the highest in the nation, 20.8% of people in Mississippi are living in poverty and 18.7% of Mississippi households were food insecure for the years 2014-2016. This study identifies and explores spatial justice challenges in small towns in rural Mississippi, by examining the social-spatial implications of unequal access to resources and affordable housing through the lenses of spatial justice theory. It reviews existing literature exploring issues of food insecurity, housing inequality, and inequitable development in vulnerable rural communities and it highlights the need for a spatial justice approach in this state. This article critically examines literature on food deserts and geographical discrimination practice of redlining as an important barrier for minority populations in Mississippi to access to affordable housing and adequate housing quality. The goal of this literature review is to inform policymakers to consider innovative and inclusive ways for community development and development of infrastructure in vulnerable communities in the context of limited resources in rural Mississippi.

KEYWORDS: spatial justice, small towns, food insecurity, housing inequality

INTRODUCTION

The State of Mississippi located in the Southern United States, is characterized by its rural landscape with small towns and few large cities. According to the U.S. Census Bureau, Mississippi has a population of 2,984,100 people: 59.3% white, 37.7% Black or African-American, 3.1% Hispanic or Latino, 1.1% Asian, and 0.6% Native American. Being one of the poorest states in the country, Mississippi ranks very low in health, education, and median household income, among others. The median household income is $40,528 and 20.8% of its population lives in poverty; this poverty rate is 7.1 % higher than the national average (13.7%) (U.S. Census Bureau 2017)

This article reviews existing literature to reveal spatial injustices in vulnerable communities in Mississippi, highlighting the everyday struggles of systematically oppressed groups to access to community resources and adequate housing, and healthy well-being. Through the lens of spatial justice theory, it critically examines literature on food deserts, geographical discrimination practice of redlining, and exclusionary zoning as important barriers for minority populations in Mississippi to access to food and to affordable and adequate housing.

In rural areas in the Southern United States, high poverty rates and the presence of minority population are predictors of the possibility of the existence or formation of food deserts (Dutko , Ver Ploeg and Farrigan 2012). This is particularly relevant in the state of Mississippi where the rate of food insecurity is the highest of the U.S (Coleman-Jensen , Rabbitt , et al.). Thus, rural areas in Mississippi are particularly vulnerable to the lack of access to food and other resources.

In general, low-income households experience financial barriers to access to adequate and affordable housing, spending more than 50 percent of their income in poor quality housing solutions (Lee, Parrott and Ahn 2012). The access to fair housing is even more challenging for low-income minorities in Mississippi, who often face higher denial rates, predatory style loans, and geographical discriminatory practices of redlining.

In addition, zoning ordinances in the form of exclusionary zoning supported by local privileged groups can exacerbate unequal and an unjust development; intensifying environmental injustices and resulting in the displacement of vulnerable minority groups.

The goal of this multidisciplinary literature review is to inform future research and policy, and encourage policymakers to consider innovative and inclusive ways for community development in vulnerable communities in rural Mississippi. Moreover, recommendations center on the following questions: Is it possible to facilitate the right to space in Mississippi? How can communities be empowered to transform the spaces they live in and to access to resources and infrastructure? What are the possible ways to promote and strengthen inclusive community development?

1.0 SPATIAL JUSTICE

1.1. Urbanization of inequality

To explore spatial justice and injustice in Mississippi, it is critical to understand contemporary urban and rural development processes and their social, economic, and environmental impacts and implications. In this section, I discuss the significance of spatial justice as a way to challenge the current production of unequal geographies and a way to claim the right to the city.

The term spatial justice implies a response to conflict and asymmetric geographies; it is also a response to the struggle of access to resources, and injustice. The notion of the spatial dimension of injustice was introduced by Henry Lefebvre (1996). This author argues that urbanization and development create inequality and these unjust realities can be challenged when those who are negatively affected fight for their right to the city.

David Harvey (2008, 23) emphasizes the idea of the right to the city as a fundamental human right, which according to this author, it has been disregarded for a long time. Harvey arguments that the right to the city is a common right, not an individual, which can be pursued by grassroots movements at community level to exercise community power and to challenge the process of urbanization itself and the inequalities produced by the urbanization process.

Spatial justice underlines the fundamental relationship between social structure and the organization of the space. The organization of the space embodies a relationship of power between those who are advantaged and those who are disadvantaged from space. In the words of Lefebvre, “The space of a (social) order is hidden in the order of space” (Lefebvre 1991, 289). In “The Production of Space,” Lefebvre (1991) brought to urban discourse the role of the state and politics in determining people’s relation to the built environment. Thus, space is understood not just as a built environment, but also as a force of production and an object of consumption. The space consequently produced is an instrument of thinking and action; and it is both a mechanism and a consequence of control, domination, and power relations. Space expresses the material and political priorities of societies; each society produces its own space (Lefebvre 1991).

1.2. The right to space

Lefebvre’s right to the city highlights the right of local residents to access to urban resources, to occupy urban space and to transform it. The right to the city is not associated to the term “citizenship” that implies membership in specific nationality or ethnicity. In contrast, it empowers inhabitants of space, it is earned by experiencing everyday life in the urban space (Purcell 2002, 102). This highlights the inclusive characteristic of the right of the city, as a right that also belongs to marginalized and disenfranchised communities.

According to Soja (Seeking Spatial Justice 2010, 7), demanding the right to the city becomes a synonymous of seeking spatial justice. In addition, the spatial approach to social justice implies the spatial redistribution of resources and ensures the access to resources and urban infrastructure by the entire society (Harvey, Social justice and the city 1973, 14-15).

Soja’s theory of spatial justice is a response to social and spatial inequalities created by unjust urbanizations and geographical uneven development. The conceptualization of spatial justice argues that all geographies that humans produce are embedded with spatial inequalities, giving relative advantage or disadvantage to different spatial locations. When these relative advantages and disadvantages are based on specific social statuses such as race, gender, and class, they produce and reproduce oppressive and exploitative practices and consequences. In other words, spatial injustice occurs when segments of the population are systematically oppressed reducing their well-being, their participation in social life, and their access to societal resources (Soja 2010, 71-79).

2.0 SPATIAL JUSTICE CHALLENGES IN MISSISSIPPI

2.1. Food insecurity

According to the U.S. Department of Agriculture, food security means access by all people at all times to enough food for an active, healthy life. In 2016, 13 % of U.S. households were food insecure throughout the year (Coleman-Jensen, Rabbitt, et al. 2017). There is a direct relation between poverty and food insecurity. The Economic Research Service’ report found that food insecurity rates were higher than the national average in households with incomes close to the Federal poverty line. The rate of prevalence of food insecurity in Mississippi is the highest of the nation, 18.7% of Mississippi households were food insecure for the years

2014-2016. Mississippi's prevalence of food insecurity is 5.7 % higher than the national average (13 %) (Coleman-Jensen , Rabbitt , et al. 2017).

Food deserts are defined as lack of access to healthy food sources. Based on 2000 Census and 2006 data on locations of supermarkets, supercenters, and large grocery store, USDA identified approximately 6,500 food desert census tracts in the U.S. (Dutko , Ver Ploeg and Farrigan 2012).

According to Dutko et. al, the food desert status in rural and urban areas is correlated with high poverty rates and the presence of minority population. In addition, the region within the U.S is also a predictor of food desert status, rural census tracts located in the South, the West, and the Midwest are more likely to be identified as food deserts than rural census tracts in the Northeast (Dutko , Ver Ploeg and Farrigan 2012, 23-26).

A study by Walker et. al., identifies different theories about the formation of food deserts and their implications in the built environment. One cause of formation of food deserts is associated with the closure of stores because of the development and growth of large chain supermarkets in the outskirts of inner-cities, this is also associated to use of vehicular transportation to access to food sources (Walker , Keane and Burke 2010, 876).

The status of vacant housing and lack of access to transportation are also associated with food deserts. Particularly in rural areas, the presence of vacant housing and high poverty rates are strong indicators of the likelihood of food deserts (Dutko , Ver Ploeg and Farrigan 2012, 23-26). In addition, food insecurity is intrinsically linked to lack of access to transportation, especially for low-income households in rural food deserts. (Canto, Brown and Deller 2014, 2).

2.2. Housing inequality

Declining small rural towns, boarded-up downtown buildings, shacks and vacant residential and commercial buildings, are images of complex and unjust geographies in rural Mississippi.

According to the State of the Nation's Housing report 2017, the gap between high and low-income households has increase because of unequal rates of household growth. The increase of household income inequality has affected the growth of economically segregated neighborhoods. In 2015, 54 % of population below the poverty line in the U.S. was living in high-poverty neighborhoods. High-poverty neighborhoods have increased by 59 % in the period 2000-2015 for the entire U.S.(Joint Center for Housing Studies of Harvard University 2017, 16-17).

Furthermore, because of affordability challenges, low-income households are associated with inadequate and poor housing quality. In 2009 the Joint Center for Housing Studies reported that around 50 percent of low-income households in the U.S. that were living in low quality housing conditions, were paying more than 50 percent of their income in housing (Lee, Parrott and Ahn 2012, 94). Thus, low-income households have financial barriers to access to adequate housing quality.

The socio-economic and demographic causes of vacant housing are diverse, but the patterns of vacant housing can represent a barrier to access to affordable and adequate housing. According to the 2014 "Analysis of Impediments to Fair Housing Choice" Report, in the last decade, the growth of the number of housing units was higher than the population growth in Mississippi. This affected the growth of vacant housing units where rental housing units accounted for a substantial portion of the overall vacant housing units (State of Mississippi Development Authority 2014 , 4).

Adequate housing quality is even more challenging for low income minority populations in the Southern United States. Low-income minority populations experience additional challenges to access to adequate housing due to different factors such as income, education, and living in rural areas. Additionally, low-income minority homeowners struggle to maintain their homes and this usually establishes conditions of poor and inadequate housing quality (Lee, Parrott and Ahn 2012, 93-96).

Although Mississippi residents are protected from discrimination by the Federal Housing Act, there are studies that show the presence of discriminatory practices in the housing market (State of Mississippi Development Authority 2014 , 4). In this regard, minority populations experience constraints to access home loans. In general, these constraints are based on higher denial rates, predatory style loans, and geographical discrimination practices.

A study in the state of Mississippi revealed relevant information about high denial rates for minorities that were not explained by economic issues (Ezeala-Harrison and Glover 2008, 94). Minority population including Black, Hispanic and women borrowers experienced higher rates of denial for home loans than the average denial rate. Additionally, there is evidence of predatory style home loans towards minority populations in Mississippi (State of Mississippi Development Authority 2014 , 5).

The study done by Ezeala-Harrison and Glover presented evidence of "redlining" geographical discriminatory practices towards minority home loan borrowers in Mississippi. This form of discrimination occurs when lenders deny loans to minorities to acquire property in transitional neighborhoods and it reinforces determined racial composition of neighborhoods. Thus, the practice of redlining tends to aggravate the residential patterns of segregation between different races (Ezeala-Harrison and Glover 2008, 77-78). According to Wyly et al., these residential patterns of neighborhood segregation are deeply shaped by historical and contemporary contexts of race and ethnicity. In the case of Mississippi, some of the residential patterns of neighborhood segregation still reflect the antebellum fabric of small towns that emerged from the old plantation network (Wyly, et al. 2012, 587).

2.3. Inequitable development

Zoning ordinance defines the different land uses for residential, commercial, and industrial purposes. It specifies land-use restrictions related to lot size, square footage and height of buildings, number of building units per acre, and density. In the U.S., zoning ordinances and other restrictive mechanisms have been widely used as exclusionary planning practices. According to Bullard (2001), exclusionary zoning has been used against certain developments. This practice makes more vulnerable communities and groups that are not able to protect their environmental interests, specially affecting minority communities (Bullard 2001, 159).

Exclusionary zoning can intensify environmental injustices. For example, exclusionary zoning practices tend to produce discriminatory siting of landfills, incinerators, and unwanted facilities in marginalized communities. The placement of hazard waste landfills in predominantly African-American communities was a common practice in the region of Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee (Bullard 2001, 160).

In some cases, exclusionary zoning practices also represent an important barrier to access to affordable and adequate housing by minority groups. According to Evans-Cowley and Canter, exclusionary zoning practices usually occur when communities try to protect their property values. An example of this, is the case of the Mississippi cottage which aimed to alleviate the housing demand for low-income and minority population after Katrina natural disaster in the gulf coast. This emergency housing solution was intended to be a transition into a more permanent solution but it encountered numerous zoning barriers supported at the local level, resulting in the displacement of low-income and minority population in different communities in the gulf coast area (Evans-Cowley and Canter 2010, 47-78).

CONCLUSION

The studies cited in this article highlights the importance to address the social-spatial implications of unequal access to resources, food, and housing in disenfranchised communities with high concentration of poverty. It highlights the need for a spatial justice approach in the state of Mississippi, to facilitate access to community resources and infrastructure, and to empower communities through inclusive community development strategies enabling their right to space.

A research conducted by Mississippi State University studied the poverty spatial distribution in rural Mississippi. Its results highlight the vulnerability of rural places, small towns and villages of less than 2,500 people with a concentration of low-income population; and it emphasizes on the importance of "building places" by improving the built environment in impoverished rural communities and by focusing on the development of infrastructure, such as transportation and child care to facilitate access to more thriving labor markets (Parisi , et al. 2005, 481-482). This and other studies from the South encourage us to critically think about traditional community development strategies in the context of limited resources.

This multidisciplinary literature review attempts to inform future research and policy as well as to propose innovative and inclusive ways for community development focusing on generating social, economic, and spatial conditions necessary to improve the well-being of vulnerable and disenfranchised communities in rural Mississippi.

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Ming-Chun Lee

Towards a Scenario-Based Approach to Participatory Design

Towards a scenario-based approach to participatory design

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ABSTRACT: Scenario-based community design enables designers and community members to work together to address uncertainty in future community growth and develop a range of alternative design solutions to envision and plan for possible future conditions. This essay traces the history of scenario-based design practice and attempts to understand its application to community design from a socio-technical perspective, which sees community design as both spatial inquiry and communicative action. The essay discusses the three fundamental components that enable the implementation of scenario-based design. These three components can be best understood from the three common perspectives of design: 1) evaluation: design as an iterative feedback loop; 2) visualization: design as spatial thinking; 3) collaboration: design as a participatory process. This essay then discusses two projects and demonstrates the key steps to implement these scenario analysis methods, including visioning, compiling data, and conducting community design workshops.

KEYWORDS: scenario planning, participatory design, citizen participation, community design, geographic information system

1.0. INTRODUCTION

Physical places matter. Mollenkopf and his colleagues, in their book *Place Matters* argue that where we live makes a big difference in the quality of our lives, and how the places in which we live function has a big impact on the quality of our society. People's view of a place is dominated by its physical features: its roads, houses, business buildings, green spaces, railroad tracks, bridges, vacant land, etc. (Mollenkopf et al., 2001). Architects and design professionals have long been tasked to (re)shape the physical qualities of a place. They are often asked by their clients (or the public) to help envision the futures of a place (or a community) as some sort of master plans. Their missions, however, cannot be fulfilled without a clear understanding of a place's unique characteristics. This requires architects and professionals in other associated design fields to take a bottom-up approach to reach out to the people in the place. They ought to understand the collective wills of the people in (re)shaping their place and to hear the collective stories and memories about the place from the people. Any change to the physical settings of a place requires collective vision. Architects and design professionals must work to see that collective vision together with the public.

Throughout his career, Samuel Mockbee had stressed the importance of a deeper democratic inclusion in the practice of architecture, which, from his view, requires not only individual participation from practitioners, but also requires active civic engagement from one's community. Many methods for conducting community engagement have been developed and introduced in architecture and its allied fields such as community planning and urban design. Scenario planning is one of such methods allowing architects and urban designers to interact with community members in a design project. It enables community members to envision a range of alternative future conditions for their community by creating a series of design scenarios. By evaluating the strengths and weaknesses of these different scenarios against a set of measures, a preferred design scenario may emerge to become the selected solution.

Scenario planning typically relies on mapping software, such as Geographic Information System (GIS), to manage and process data and provide contextual information about a community. It then utilizes a unique user interface to enable painting on the map generated by the software to develop and test ideas for possible improvements in the community. This type of community-based practices has its root in the field of participatory design, which is a response to the demand to have voices heard and ideas taken from those who are involved in the design process. It sees community members as citizen designers who play an active role in shaping the formulation of both the design process and its results.

This essay discusses two community design projects conducted between 2014 and 2017 for two small neighborhoods, one in Georgia and the other in North Carolina. These projects employed scenario analysis to connect regional planning frameworks to local community design processes. This essay revisits scenario planning's theoretical background, which has three fundamental components tying closely to the three common conceptions of design: 1) evaluation: design as an iterative feedback loop of concept generation, performance evaluation, and design refinement; 2) visualization: design as spatial thinking relying on seeing in our mind's eye what the intended outcome could be; 3) collaboration: design as a participatory process requiring an inclusive, communicative, and interdisciplinary approach to information sharing and public deliberation. The essay then details the empirical framework for these projects including key steps taken to implement the scenario planning exercises, including visioning, compiling data, conducting community workshops, and drafting of community design plans.

2.0. TECHNICAL PERSPECTIVE: COMMUNITY DESIGN AS SPATIAL PLANNING

Spatial planning shapes the physical settings of a place where people live. It integrates a variety of techniques to influence the distribution of people, resources, and activities in spaces of various scales. Community design is inherently a spatially oriented profession. As spatial planning, it gives geographical expression to the economic, social, cultural, and environmental policies of society. It is both a scientific discipline and an administrative technique that is developed as a comprehensive approach towards a balanced land development and physical organization of space according to a wide-ranging strategy supported by rigorous technical knowledge and investigations. Community designers are routinely confronted with a myriad of ad hoc decisions requiring accurate spatial data. Their tasks rely on a set of procedures that enable them to convert a diverse amount of spatial data into the type of information needed to support decision-making. Community design provides structured processes in which decision-making and problem-solving occur (Kliskey, 1995). Within these structured processes, information becomes a key ingredient to successful decision-making. Community design therefore is considered to be an information processing activity. All relevant information must be stored, managed, made available, and presented in a suitable and organized form for use at different stages in community design (Scholten et al., 1990).

3.0. SOCIO-POLITICAL PERSPECTIVE: COMMUNITY DESIGN AS COMMUNICATIVE PLANNING

Counter to its rational and technical aspect, community design is regarded as not only the activity of spatial analysis performed by isolated individuals but also as an ongoing process of social design, interactive dialogue and debate in which designers, public officials, and the general public seek to decide together how to best manage the collective concerns of society (Healey 1992, 1997). Moving away from its analytical nature requiring data and information processing, community design has increasingly become a process of structured negotiation and deliberation that requires broader participation from those who involved in its processes. It needs soft data to reveal the social values and cultural meanings embedded in different sectors of society, which are usually based on personal views from differences in culture, religion, education, politics, or age. Communicative planning has been called upon in planning and design domains where there are a range of competing stakeholders and where the distribution of decision-making power is highly dispersed across different sectors of society. Community design that incorporates communicative approaches allows for uncertainty and conflict in its processes. It encourages outreach and engagement, and attempts to foster socio-political will among the stakeholders by promoting structured dialogue.

4.0. FACING UNCERTAINTY IN COMMUNITY DESIGN WITH SCENARIO PLANNING

Architects and planners, tasked to help envision the future, have recognized the need to prepare for future community needs and challenges through structured planning and design activities with a hope that the future can somehow be created following planned investments and fall within reasonable expectations. However, a community's future remains uncertain. The number of factors that influence whether development occurs and to what extent it takes place is enormous. Moreover, past trends are not necessarily the direction communities wish to head. Consequently, scenario planning has grown in use recently, particularly that which is referred to as visioning (Bartholomew 2005). Over the course of the past two decades, planners, designers, and citizens increasingly articulated priorities and values to help shape the futures of their communities. Through scenario planning, the question of what the future might bring can be narrowed down to a more manageable set of possibilities.

5.0. SCENARIO PLANNING IN COMMUNITY DESIGN

According to Porter, a scenario is “an internally consistent view of what the future might turn out to be; not a forecast, but one possible future outcome” (Porter, 1985, p. 446). Essentially, scenarios are stories about the future (Ogilvy, 2002). They cannot predict the future precisely. Instead, each should present a vision of the future plausible in light of known information (Ringland, 2002). Following Bartholomew (2007) and Smith (2007), most scholars trace the origin of scenario planning to the RAND Corporation (Kahn, 1962) and its application to business to the Royal Dutch Shell (Wack, 1985). In its earliest stages, scenario planning was used as a way to consider multiple facets of a problem simultaneously; considered as a tool to help decision makers with limited backgrounds and resources address the uncertain future. It has been used in disciplines from business to conflict resolution to military (Andrews, 1992; van der Heijden, 1996). The scenario planning practices emerged in the 1990s essentially grafted the military and business approaches onto to the more customary planning structures of the continuing, cooperative, and comprehensive (3C) process required by the Federal Aid Highway Act of 1962 and the environmental impact reporting requirements of the National Environmental Policy Act (NEPA) (Bartholomew, 2005). The typical scenario planning process compares one or more alternative future community design scenarios to a trend scenario. In the trend scenario, urban development and infrastructure investment patterns of the recent past are assumed to continue to the planning horizon 20 to 50 years in the future and the impacts of this on the study area are assessed. This is followed by the formulation of one or more alternative futures that differ from the trend with respect to community design and growth (Lee, 2016). Essentially, scenario planning assumes that if planners and designers consider multiple futures, they are more likely to make better decisions.

6.0. GIS-ENABLED SCENARIO PLANNING TOOLS

The advancement in digital visualization and analytical capabilities of geospatial technologies has supported scenario planning substantially over the past two decades (Ewing, 2007). Many agencies and private firms were involved in this growth; among them, Peter Calthorpe and John Fregonese was particularly instrumental in popularizing the tools and their associated applications (Goodspeed, 2013). The adoption of GIS by professionals and the emergence of a dominant GIS software package in the 1990s enabled the development of this new class of computer tools, which relied on GIS for data management, visualization, and other functions. Especially, the ArcGIS software suite produced by ESRI has become a monopoly provider of GIS software, enabling them to effectively define file formats and analytical workflows. The analytical and mapping functions offered by GIS-enabled scenario analysis tools estimate and illustrate likely effects and potential costs of various community growth and development patterns portrayed by multiple scenarios. This expansion of software development included the creation of a new class of scenario planning tools in the 1990s such as CommunityViz, INDEX, I-PLACE3S, What-if, and Envision Tomorrow. These tools present a variety of technical and functional approaches that are necessary to support community designers in their daily tasks (Lee, 2017).

7.0. SOCIO-TECHNICAL PERSPECTIVE

These GIS-enabled scenario planning tools are designed to make full use of modern geospatial technologies to support a design process that is characterized by communicative and participatory actions. In general, this type of scenario planning practices and techniques shares the following characteristics: 1) a focus on spatial development patterns typically in the form of physical design; 2) extensive use of spatial data, geographic analysis, and visualization; 3) the involvement of multiple stakeholders through public participation activities. This type of community design is fundamentally a way of thinking and implementing the design of community spaces. Any discussion about it therefore has to be based on the ways in which community design is conceptualized. In this regard, scenario-based community design, as a method of design, has three major components that tie closely to the three common conceptions of design.

Component 1: Evaluation: Design as an iterative feedback loop of concept generation, performance evaluation, and design refinement

Scenario-based design tightly couples the creation of design ideas with performance evaluation and impact assessment informed by geographic analysis (Flaxman, 2009). It is expected to produce databased design options and in turn lead to informed decisions (Dangermond & Artz, 2012). Scenario-based design enables designers to sketch alternative design scenarios and quickly get feedback on performance and suitability by comparing design proposals to geospatial data behind GIS.

Component 2: Visualization: Design as spatial thinking relying on seeing in our mind's eye what the intended outcome could be

Design at the geographic scale implies an effort to create something that is functionally efficient and environmentally sound. It requires an ability to generate a macro-level, or bird’s-eye, view of the designed thing embedded within landscape in the mind’s eye of a designer. This type of broad-scale image reveals both the process and the product in a conscious way before it eventually becomes realized. Scenario-based design, using the cartographic and graphical capabilities built into GIS, allows designers to visualize spatial relationships within and to map potential impacts of their design (Ervin, 2016).

Component 3: Collaboration: Design as a participatory process requiring an inclusive, communicative, and interdisciplinary approach to information sharing and deliberation

Scenario-based design emphasizes collaboration and relies on a joined effort that draws upon inputs from different fields, including landscape architecture, environmental science, engineering, urban planning, and community development (Slotterback et al., 2016). In order to increase public engagement and collaborative learning, it offers different tools for individuals to communicate, share data, and design collectively.

Scenario-based community design takes on a unique approach that seeks to integrate social and technical dimensions of design. This socio-technical perspective is essential to examine this particular genre of design. It emphasizes the importance of investigating technology and social contexts together in order to both develop methodology and improve problem-driven technology. Therefore, this essay sees this class of GIS-enable scenario planning tools not as a freestanding technology in a laboratory setting, but as they are applied in real-world projects with specific socio-political settings.

8.0. CASE STUDIES

This section presents two scenario planning projects. Each case starts with a brief description of the case contexts, including its geographic area, physical conditions, and a project overview. This background information is followed by detailed descriptions of two key aspects of the project: 1) the development of technical components supporting the scenario-based design process; 2) the design and implementation of public outreach activities enabling communication and collaboration among key participants in the project.

8.1. Case 1: Davidson, North Carolina

The town

Town of Davidson is a vibrant community located 20 miles north of Charlotte. It has a lively main street with local shops, a post office, library, farmer's market, and pedestrian friendly atmosphere. Located just north of the main downtown of Davidson, the North Gateway area covers 134 acres and spans both Mecklenburg County and Iredell County. It is mostly a green field site, bordered on the west by Lake Norman and Ingersoll Rand, and Highway 115 to the east. With the surrounding residential neighborhoods and an industrial park, the site is situated to be an extension of Downtown Davidson creating a new destination for residents to live, work and play in the area. It has a mixture of multifamily, townhomes, single family lots, industrial and civic spaces, blended with lake shore overlay buffers, vast tree canopy, and open grass fields.

The project

This project, funded by a Faculty Research Grant, launched a Scenario Planning Assistance Team, aimed to function as a research platform for collaborative projects to advance the practice of scenario planning. The team partnered with Town of Davidson to conduct a community design project. This project utilized GIS and scenario planning methods to articulate community growth alternatives that inform the adaption of land use policies aimed to create sustainable built environment.

Figure 1: A scenario planning workshop was successfully held at Town Hall in April 2015. Each table had about eight participants with one moderator who used ET+ to track participants' actions and record all mapping and scenario-building activities. Source: (Lee, 2015)

The technical framework: software tools and processes

This project used Envision Tomorrow Plus (ET+) to create and test land use scenarios at the site scale. ET+ is an enhanced scenario planning software plug-in for the ArcGIS platform. The components of ET+ include Microsoft Excel and an extension to ArcGIS, a popular GIS software package by ESRI.

The actual scenario planning process consisted of following four steps:

1. Create Prototype Buildings: Develop a range of prototype buildings at the parcel level that are financially feasible based on local conditions in Davidson.
2. Create Development Types: Create a series of development types by combining a mix of prototype buildings with streets, open spaces, public amenities and other urban attributes.
3. Build Scenarios: Conduct a workshop with a mapping exercise to allow participants to create scenarios. ET+ was used alongside the mapping exercise to digitize these workshop scenarios on the fly into computer.
4. Evaluate the Scenarios: Evaluate the scenarios using ET+ template maps, charts, and graphics.

A total of 27 prototype buildings were identified and included in ET+. 9 different development types then were developed by combining a mix of these 27 prototype buildings with various public infrastructure and amenities to create a range of different places that are suitable for the context in Davidson.

The socio-political framework: workshops

Another important component of the project is the establishment of a citizen engagement program. Two rounds of public events at the site were conducted. At the first, a scenario planning workshop was successfully held at Town Hall in April 2015 with 27 participants. Four alternative growth scenarios were created by the participants (Fig. 1). Three complete scenarios were further digitized and analyzed using ET+. Each complete scenario had similarities and differences that allow them to pose different choices for how Town of Davidson might develop in the future. In addition to these community growth scenarios that were created in the workshop, a baseline scenario was later prepared by a joined effort between Davidson planning office and the Team. This baseline scenario was mainly based on current planning ordinances and was meant to be used as a reference for policy comparisons (Fig. 2). Four weeks after the first workshop, an open house event was held at Town Hall to present the four scenarios to the community based upon the results from the workshop. Through in-person discussions with participants at the meeting, residents stated preferences and offered further suggestions for the refinement of the community design concepts.

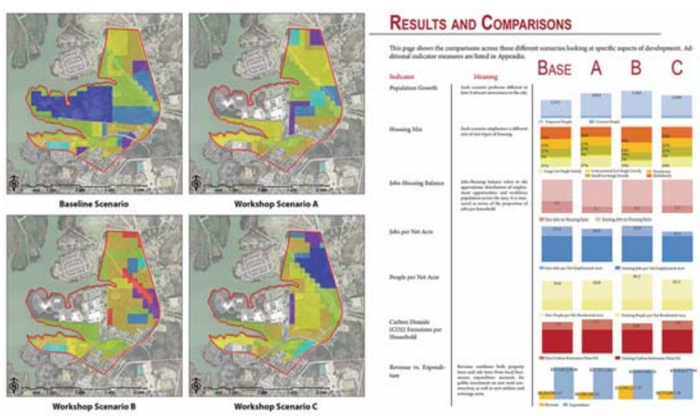

Figure 2: Three complete scenarios were further digitized and analyzed using ET+. A baseline scenario was also prepared for comparison purposes. Source: (Lee, 2015)

The outcomes

This scenario planning project was mainly conducted as a pilot study to demonstrate our research and project managing capacity. Despite its experimental nature, this pilot project thoroughly followed steps for a typical scenario planning process to calibrate all analytical components based on local development conditions and market trends to ensure that the GIS model reflects closely what is on the ground in Town of Davidson. In addition, with enthusiasm, rich awareness of local issues, and constructive dialogues during the workshop, participants together created four different community growth scenarios. A survey was conducted at the end of the workshop. 21 of 27 workshop participants completed the survey form. The results generally revealed participants' positive experience with this type of planning exercise involving the use of information technology.

8.2. Case 2: Buttermilk Bottom, Atlanta, Georgia

The site

Buttermilk Bottom was originally an African-American neighborhood in the City of Atlanta, Georgia. It is currently centered on the area where the Atlanta Civic Center now stands in the Old Fourth Ward side of the SoNo area in Atlanta, just south of Midtown. The area was once considered a slum area with unpaved streets and no electricity. Some suggest that the name may also refer to the sour stench of stagnant water, which tended to pool in low-lying areas with poor surface drainage and inadequate basic infrastructure.

The project

The main idea for this academic project for a graduate-level urban design studio, conducted in spring 2017, was to learn from the historic City of Savannah in Georgia about how we might use those lessons to redo what was badly done three decades ago in this site in Buttermilk Bottom. The students studied the original African American neighborhood, learned about the badly imagined plans and urban renewal developments that followed, and then explored ways to apply lessons from Savannah. The site was complex with a lot of topography, stormwater issues, real estate markets that are currently pushing for higher densities. The class assignment was to re-design the Buttermilk Bottom site according to the design principles observed in the plan for Savannah Georgia's Historic District and their quantifiable traits. Many GIS applications were incorporated in this urban design project, including 2D mapping, remote sensing, scenario planning, 3D procedural modeling, and cloud-based tools.

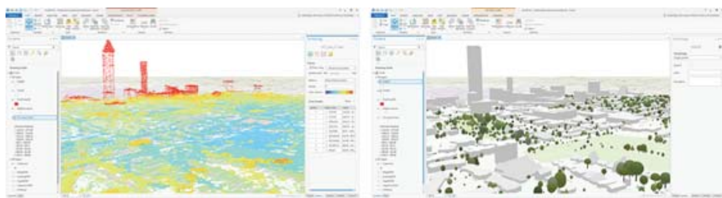

Figure 3: The class used ArcGIS to reclassify LiDAR remote sensing data (left) and extract 3D features from the LiDAR (right) for the study site in City of Atlanta. Source: (Lee, 2017)

The technical framework: software tools and processes

The class was divided into three teams with each developing a design scenario for the site based on one of the three principles of sustainable development respectively: 1) environmental preservation; 2) economic development; 3) social equality. The three teams, initially only representing one narrow view, then went through a negotiation process to modify their design scenarios in order to incorporate all three aspects of the sustainability ideals. Envision Tomorrow, an ArcGIS plug-in for conducting scenario planning, was used throughout these processes to assist in design, scenario development, and discussions. In addition to the use of scenario planning tools similar to the Davidson case, this case utilized more advanced imagery processing techniques and virtual reality for 3D visualization.

Figure 4: ESRI CityEngine allowed the class to create a large-scale model with details to render future urban design solutions. Source: (Lee, 2017)

The class created city-scale 3D models to further visualize and analyze these different community design scenarios. These 3D models were created by extracting features from LiDAR data, an optical remote-sensing technique that uses laser light to densely sample the surface of the earth. This step built a simple 3D representation of the existing urban structure for the site and its surrounding area (Fig. 3). ESRI CityEngine was then used to build a series of 3D models according to the scenarios proposed by the class. These 3D models were built with details including architectural structures and textures, landscape features, roadway signs and pavements, transportation features, vehicles and human figures. The students imported

GIS scenario maps into CityEngine, which then generated 3D scenes of these design scenarios using the procedural rules available in the program (Fig. 4). Overall, the class was able to use these 3D models to examine the physical qualities of the areas, such as overall land use distributions by color-coding building footprints; potential ways of urban transformations by urban design; streetscape configurations with fully rendered details. The class also tested the potential of using virtual reality (VR) as a way to explore community design scenarios. Their 3D CityEngine models were imported into Unity, a game development platform, and converted into virtual reality scenes. Unity allows additional lighting effects and environment rendering options to enhance the appearance of the models. It also enables virtual reality settings that allow a user to experience these community designs in an immersive way through a VR-enabled headset, such as Oculus Rift. The user can use a typical game controller, such as Xbox controller, to walk around 3D scenes generated by the CityEngine models (Fig. 5).

Figure 5: Virtual reality scenes, converted from CityEngine models, allowed reviewers to experience students' urban design solutions in an immersive way. Source: (Lee, 2017)

Participatory processes

While public input was not integrated into the overall experience of this project, the class built upon an interdisciplinary knowledge base with students coming from different design programs, encouraged collaboration among students themselves and between faculty members and local activists with deep local knowledge about the site. The combination of virtual and in-person collaborations with community activists provided students with insights into the participatory access that this scenario-based design practice can afford designers. In this sense, the studio utilized local community activists as surrogate public participants in order to provide both expert opinion as well as overall qualitative feedback.

9.0. DISCUSSIONS AND FINAL THOUGHTS

One of the many characteristics shared by these two projects is that both incorporated GIS-based methods into their community design processes for 1) collecting and analyzing data; 2) promoting and sustaining public participation; 3) developing and evaluating alternative design choices for the future of their communities. As demonstrated in this essay, GIS-enabled scenario planning seeks to increase the technical effectiveness of spatial analysis in community design as well as to offer transparent channels for communications and open platforms for participation. This socio-technical perspective is important to understand the significance of this particular type of community design, which seeks to integrate social practices of participatory design with information technologies. It is again through this particular viewpoint that four key observations about the interplays between the two aspects are drawn as the follow:

Technology enables scientific inquiry and increases understandings of the complexity in design processes

The ability of these geospatial technologies to conduct analyses and to illustrate the results of such analyses substantially increased designers' ability to engage and educate the public about the scientific aspect of various key factors involved in the design process.

Technology allows collaborative design and enables exploration on design alternatives

Scenario planning tools allow users to generate and compare various community design scenarios that represent different design alternatives.

Technology helps identify community values and promotes social learning

The awareness created through public engagement efforts about the potential benefits of alternative growth strategies help build durable, inclusive consensus within the community over time.

Technology helps shape community coalitions and build organizational capacity

The success of this type of scenario-based practices is highly dependent on the delicate organizational sensibility of the early leadership of a local community. The initial involvement of key players prior to the beginning of the process is a formula for reducing resistance in the long run. This process of building coalitions can also be assisted by some of the technical procedures in the scenario planning process.

In summary, scenario-based community design helps transform ad hoc community development into better design by clearly revealing the true impact of incremental changes in the built environment of a place over time with the use of simple diagrams and clear charts generated by innovative GIS-enabled digital tools. Furthermore, through public participation, collaboration, creativity, and careful consideration of the long-term impact of design choices, communities can design better, more livable futures. The two projects described in the essay show that, with proper tools and methods and an open mind to listen, architects and designers can learn about the collective wills and vision from the people in a community and together reshape the built environment of the community as the foundation for future prosperity.

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Margaret McManus

An In-depth Look at Design Students as they Embark on Teaching Architecture to Children

An in-depth look at design students as they embark on teaching architecture to children

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ABSTRACT: Affording higher education design students the opportunity to teach their skills in the community has proven to be a positive and meaningful experience that often benefits both their personal and professional lives. By instating a program at the University, titled *Architecture In Schools* (AIS), students who step up to the challenge of teaching others begin to take on leadership roles beyond any that are offered within the confines of a campus, and responsibilities that push them well outside their design discipline. This program is different from a typical volunteer service program; here students are incentivized by college credit all the while understanding that the particular position necessitates considerable time outside of contact-service hours and professional conduct as representatives of their schools and communities. This paper takes an in-depth look at the learning objectives that an outreach program can satisfy for university students who take part, and in-turn touches on why such engagement is essential to the community at-large.

Evidence shows that the impacts are consistently positive from the recipients of such a program: the primary and secondary students (and indirectly—the community); but it is the study of the higher education students in which primary qualitative measures are being considered. It can be difficult to measure--as discrepancies are hard to come by when evaluating the happiness (or can we call it rewards?) of the college participants, therefore Bloom's Taxonomy has been used as a standard means of assessing learning objectives and justifying the course's viability. This particular endeavor aims to better understand the effects that this type of service (for credit) might have in the midst of a college setting—particular to architecture students—when considering their expectations against actual outcomes related to their experiences with *Architecture In Schools*.

KEYWORDS: Teaching, Architecture, Children, Outreach, Independent Study

INTRODUCTION

Kurt Vonnegut has written in Cat's Cradle "… any scientist who couldn't explain to an eight-year-old what he was doing was a charlatan."

This paper delves into a university program—a combination of an Independent Study with *Architecture in Schools* (AIS)--that challenges the aforementioned quote by affording upper-level architecture students the opportunities to shift their typical duties as students into those of a teacher. The Independent Study program is a modification of the AIS model--an already-established outreach program (as will be discussed)—that provides upper-level undergraduate design students an opportunity to receive credit for the participation and leadership roles it necessitates while benefitting the surrounding community. In addition to describing the background and efforts of this Independent Study program, this paper will look at the course's structure, objectives, and evaluation. Please note that from this point forward "university student" is referring to upper-level (4th and 5th year) undergraduate students enrolled in a NAAB-accredited School of Architecture; and unless noted otherwise, "program" is referring to the university's combined AIS-Independent Study program.

Referring back to Vonnegut's quote, we cannot rightfully, substitute the word *architect* for *scientist* because the university students themselves have not yet become professionals in their field, and are still in a learning environment throughout this Independent Study program. However, the program does share the quotes' sentiments as its primary goal is to emphasize the importance of communication (both verbal and visual) within a professional discipline to those unfamiliar to the subject: in this instance to children—on the subject of architecture.

Allowing university students to shift from student to teacher in a supported and organized manner is what makes this program unique and challenging to those interested in taking on the appointment. These students are not volunteering as teachers' helpers but are taking on the role of course instructor: initiating their own lesson plans and taking on significant responsibilities that move beyond the university campus. This paper hopes to provide substantial reasoning and positive evidence related to this program so that this type of outreach can gain momentum through Independent Studies in other design schools.

1.0 PROGRAM BACKGROUND

1.1. An Architecture in Schools (AIS) program

Before looking at details of the Independent Study, it is necessary to understand some background of the Architecture in Schools (AIS) program and how it evolved into its current state at a small, liberal-arts University.

The basis of AIS is to provide an outreach program with nearby elementary and secondary schools to enrich the learning experience of children. It promotes the idea of "Bring an Architect into the Classroom," advocating that architects can help to make connections between primary subjects such as art, mathematics, science and social studies with the realities of design and the built environment. The AIS model of community service has previously existed throughout AIA Chapters (American Institute of Architects) across the country, and they have had great success in cities like Washington DC, and Philadelphia where they can leverage the vast number of local architectural firms to partner with local elementary schools. Thus, there exists confirmed rationale for implementing the program at the primary and secondary grade levels. In smaller towns, however, with fewer architecture firms, finding professional volunteers to commit to an eight-week AIS schedule (typically, 1-2 hours of class time each week for eight weeks) proves to be more challenging—a predicament of this particular study. Thus, the AIS program was reconsidered as a possible component of the University's Architecture School; leveraging the undergraduate students to participate in what might otherwise be volunteer roles. By monitoring such a program in its infancy, this paper looks at whether or not there is substantiated reasoning for continuing such a program as a three-credit Independent Study within the University.

2.0 UNIVERISITY IMPLEMENTATION OF AIS: AN INDEPENDENT STUDY

Independent studies are often the most viable basis for students seeking information on topics they are curious about and that are not available to them. This particular Independent Study, however, was not born in this traditional course of action. This Independent Study was organized, promoted and advertised by a pro-active faculty member who has professional, teaching, and even prior AIS experience. University students were presented with the challenge of this three-credit course, and those that were intrigued stepped up to be a part of the fledgling program. Such independent studies, depending on their nature and ambition, will require varying degrees of supervision; this AIS Independent Study required that students take charge of lesson plans and instruction without the direct presence of a university faculty supervisor in the classroom.

This type of education and learning is not foreign to most universities. It is, in fact, typical to many University Education programs—requiring students to spend a number of hours in the classroom—after years of study based on approach, strategies, and behavior when entering primary and secondary schools. Not only are architecture students not equipped with this preparation, but supervisors within the department (although higher education teachers) are not likely versed in this preparation either (of which is typically attested by a degree in education). In light of this, the AIS Independent Study program proposes and encourages cross-discipline interaction in the form of interviews with current teaching professionals and with other university students embarking on education degrees.

It should also be noted that while there are creative degree programs that exist to bridge the gap between the education of *education* and the education of *educating subject matter* (such as a Degree in Arts Education), there remain few channels that aim to connect children with such topics as the design of the built environment. STEM, arguably, is the nation's foremost, pro-active attempt at forging this connection with primary and secondary students (Honey, Pearson, 2014). And it is STEM's crucial transition to STEAM, which gives Architecture + Art (Design + Invention) its rightful and integrated place among Science, Technology, Engineering, and Mathematics, that is likely a defining reason why many participating K-12 schools welcome the AIS program (Sousa, Pilecki, 2013). It should be noted that while STEM and STEAM are relevant and related topics, they are too expansive to be dealt with in this particular study.

2.1. A syllabus excerpt

To further understand the nature of the fledgling program, it is necessary to take a brief look at an excerpt from the AIS-Independent Study course syllabus:

Course Description & Introduction:

> An Independent Study, this course serves as outreach to and collaboration with the larger community while providing a platform for growth and experience for the [university] students involved. This course brings upper-level architecture students into select classrooms ranging from grades 4-8 and allows them to challenge their abilities of interpreting, communicating and teaching architectural ideas. When in the position of teaching there is inevitably a process of RE-learning and gaining a more substantial grasp on the subject matter; all the while being open to the unexpected lessons that teachers will, no doubt, learn from their students. This class will involve a pro-active research and planning process; real-world experience in front of a classroom; a parallel documentation and reflection requirement in the form of a blog; and a professional, graphic, and photographic record in the form of a book of their entire experience. A requirement is to be met that will involve engagement (through documentation of your choice: transcript interview, video, etc.) with a professional educator and a student in the Department of Education to assist in cross-disciplinary studies, mentorship needs, and applicable assistance relating to primary and secondary education.

2.2. A Lesson plan excerpt by university students

The university students are required to create lesson plans that apply to their target audience and that have set goals or learning objectives related to architecture. These objectives range from communicating through drawing; through hands-on building, and to role-playing as client, architect, or builder. The following is an excerpt from an exercise that demonstrates all three of these goals: *The Tower Challenge* (Figure 1).

> Goal: The Tower Challenge provided the opportunity for the students to explore and discover a number of different concepts present in architecture. We hoped they would learn the effects of equilibrium, balance, center of gravity, aesthetics, and scale.
>
> The students were split up into small groups and each given the same set of 6 cardboard boxes. Each box in the set varied in shape, size, and weight. We used the blocks as a teaching tool for two different exercises. In exercise one, the students explored equilibrium, balance, and center of gravity. Given a range of requirements to follow, they were challenged to build block towers as tall as possible. In Exercise two of the Tower Challenge, each group selected one student as the designer. Unable to touch the blocks, they needed to communicate their design Idea to their fellow "builders." Each group was given a large sheet of plotter paper and a set of markers. They were instructed to draw the tower at real scale with no measuring devices. They used their hands to measure lengths and angles of blocks, then draw the tower's elevation on their papers.

Figure 1: Elementary Students build towers out of pre-made, odd-shaped blocks that encourage learning lessons related to equilibrium, balance, center of gravity, and scale. Source: (McManus 2017)

3.0 PROGRAM REFLECTION AND EVALUATION

While further study can be had on narrowing down elementary age groups for this type of interaction, this program and evaluation—being in its initial years—is referring to university students who have been teaching children in grades 4th-8th in both elementary classrooms and after-school programs. This broader evaluation is necessary for the incipient stages to prioritize specific criteria as the program moves forward.

3.1 Relating Assessment and Evaluation to Bloom's Taxonomy

Solely considering the benefits of the university students, it is necessary to seek out why this program might be relevant to architectural discourse and education. The paper will reveal evidence of what the students gain relative to educational objectives as defined by Bloom's Taxonomy: a classification and measuring tool for the assessment of cognitive learning (Bloom, 1956). Evidence in parts 3.2 and 3.3 indicate that through the AIS-Independent Study the students experience an opportunity to recognize (re-know) and to re-communicate ideas and thoughts that they have on architecture, and that they have taken the initiative (an Independent Study) to do so. These indicators and the varying degrees in which the students demonstrate them are part of--not one--but of all three of Bloom's Taxonomy of Educational Goals: *Knowledge-Based Goals, Skills-Based Goals, and Affective Goals* (Armstrong, 2018). Meeting qualifying measurements related to these three goals verifies that there is a definite and viable trajectory for the program to meet the needs of a three-credit architectural course.

In addition to first-person student survey responses that can be found in 3.3, brief definitions of Bloom's Taxonomy of Educational Goals and subsequent scenario examples are provided as follows in order to confirm the meeting of such objectives. Each of Bloom's three goals dives into five varying levels of expertise. Pairing examples for each of these (combined: fifteen) levels will necessitate further comprehensive scrutiny, therefore, for the purposes of this study, only overall learning objectives from the three educational goals will be paired with student examples.

Knowledge-Based Goals can be met through recalling facts and recognizing terms; translating or transferring ideas to other situations; and applying abstractions to general principles. University students in the program demonstrate these principles by recalling, translating, and abstracting architectural knowledge. For example, Figure 1 shows a class exercise where architectural principles related to observation, technical drawing, and building sections were communicated to young kids using relatable, manipulate-able objects such as fruit.

Figure 2: An elementary student practices lessons as instructed by university design students. The lesson indicates knowledge-based learning by relating and translating principles of a building to fruit. Source: (McManus 2017)

Skills-Based Goals can be met through knowing and showing required steps needed to perform a task, and modifying such tasks or creating new ones relative to a situation. In Figure 2 the university student exhibits these descriptions by safely demonstrating the assembly of a stud wall, and by allowing the young kids to take a hands-on approach to learning.

Figure 3: A university student displays *skills-based learning* by demonstrating and teaching methods of constructing a stud wall. Source: (McManus 2017)

Affective Goals are described such that a student demonstrates a willingness to participate; seeks out an opportunity to engage a subject, and adopts a long-term value system related to the subject. These indicators are expressed by each university student through the willingness and initiative that is necessary to take part in the Independent Study. It is not a required course, and therefore it is necessary to seek out enrollment and be an active contributor. Student responses in part 3.3 can more directly attest to a long-term appreciation of the experience.

3.2 Recurring Challenges and Benefits

It is difficult to separate the challenges from the benefits for reasons that align with the *rewards of hard work!* Hence, they are combined in this section. Introducing architecture to primary or even secondary students is not easy. Elementary and high school teachers are not trained for it, and that is part of the reason why the initiative behind the program can be successful and beneficial on a variety of levels.

Significant challenges with the program start with what is arguably the most obvious: the introduction to and connection with a wholly new audience of fourth-through-eighth graders. Being in the presence of twenty or so children is intimidating for most who are not used to it; and having to keep their attention, relate to them and converse with them bring about many challenges on top of that.

Time also poses a challenge for the students who have only a semester to plan, reflect and carry-out their objectives. The course syllabus does allow for prep-time built into the early weeks of the semester, but the primary challenges for the university students are in the execution weeks as they get a taste of proposal, failure, iteration, and perseverance as they face their students week after week. This particular lesson-through-experience results in frequent assessment survey comments conveying that *this was much more difficult than I had imagined* or even *everyone should need to take this course before graduating.*

While this program exposes the university student to the profession of teaching, its aim is quite broader and more significantly relevant to the professional degree in which they are seeking. Architecture, as a profession, is about communication—both verbal and visual. In their NAAB accredited educations, students are aiming high, focusing on their portfolios, and targeting employers; but they are rarely if ever, obliged in their education, to "express" their architectural understanding and abilities to the general public. This program provides that opportunity, and in turn, helps to build confidence.

Confidence-building, in this case, is a natural result of the university students practicing and reinforcing fundamental attributes of architecture along with their ideas on communicating such knowledge. While in college, every architecture student must eventually present his/her work to an already-knowledgeable jury of professionals and professors in the discipline, the task of holding the attention of eight-to-twelve-year-old critics presents entirely new challenges. It is this task, precisely, that provides apparent benefit to the university student. As soon-to-be licensed, professional upholders of health, safety, and welfare, it is important that students begin to understand that public speaking—often engaging communities and individuals unfamiliar with any part of the undertaking or practices of the Architecture industry—is a large part of their future career.

Teaching is the vehicle in which the AIS-Independent Study program permits students the opportunity to stretch, flex, and strengthen their communication skills. They become comfortable with garnering attention in a public realm [in front of a classroom]; reacting to public situations; responding to and fielding direct questions, and assessing and addressing their effectiveness over a period of a semester.

3.3 Evaluating the program – University Student Survey and Outcomes

While there is the opportunity to assess and evaluate the learning outcomes of the primary and secondary students, that is not the objective of this paper. To determine if it is to be valuable in the realm of Higher Education, it is necessary to evaluate the fledgling AIS-Independent Study program: its registered students and its viability to continue as a three-credit course.

Evaluating the university students who take part is difficult in the quantitative sense because this program is under that of an independent study, at the pace of a fifteen-week semester, where direct supervision at all times is unlikely--and in fact contrary to the nature of autonomous learning that is encouraged in the program. Therefore survey questions were used as a means of evaluation and assessment. Below is a look at student responses to relevant questions that reveal evidence of educational learning as attested by Bloom's Taxonomy.

Reflecting Bloom's Taxonomy of Educational Objectives related to the *Affective Goals* of *valuing the objectives* and *internalizing an appreciation for the course,* the following question was posed: *Would you recommend this program to other Students? (If so, under what restrictions, i.e., only 5th years, perhaps with a GPA cut-off, interview screening process, etc.)*

Student #1 answer:

> I think it is one of the best things an architecture student can do. The obvious reason is that by explaining any concept to an elementary school kid, it helps us understand better. The less obvious is that this program builds passion. When you see a class of kids getting excited about architecture and telling you they want to be an architect someday, it makes you really appreciate what you do.

Student #2 answer:

> I would definitely recommend this program to other students. I think it holds you accountable to meet real-life deadlines in which all of the work has to be done and there are no shortcuts. With that being said, I believe that the course should only be allowed to 4th and 5th year architecture students with a GPA requirement. For example, [the participating school] is putting their faith in the [university] student(s) to have a well detailed lesson plan and time allotted to correspond to that plan. Every lesson was important because you had to balance the amount of lecturing versus activities to keep the students attention. Going [to the participating school] unprepared would not only reflect poorly on the student(s), but also on the [university] as a whole.

Student #3 answer:

> *I would definitely recommend this program to other students, I think it really challenges us as designers to be able to understand the content and then simplify it and teach younger students about it. I think it is best suited for upper level students because it requires efficient time management and a comprehensive understanding of architecture content.*

Student #4 answer:

> YES! I would definitely recommend the program! For sure there should be restrictions: underclassman would be okay to volunteer; 5th year students only to lead; possibly a 12 credit max including AIS (I took 15 and felt overloaded).

The latter comment from Student #4 attests to the deceptive amount of work required by the Independent Study when considering the real-world consequences of deadlines and accountability. It also demonstrates the fact that the students' values, attitudes, or interests have been affected by the course (an indicator of Bloom's most complex level of expertise under the Educational Objectives for Affected Goals).

Another question was also posed to uncover which of the three of Bloom's Taxonomy of Educational Goals remained more present from the students' perspective. The results indicate a variety of descriptions that lie within the range of measurable objectives that are, not surprising, quite personal for each participant. The question posed: *With regard to your own architecture education, what are some of the greatest benefits to this course?*

Student #1 answer:

> I think a huge benefit of the course is that it gets us off campus and out of studio. It's a major change of pace, and one that is honestly very much needed. It also starts to get us involved in the community. I know from experience how important this is going into the profession.

Student #2 answer:

> One of the greatest benefits of this course was understanding how to take an architectural concept and simplify it so that a middle school student can understand it. Another benefit was seeing students get excited about design and wanting to delve deeper into the subject.

Student #3 answer:

> I learned how to simplify certain ideas and knowledge about architecture and comprehend and teach it to younger students. It forced me to really understand the vital and important aspects of certain lessons. I also learned a lot from the students and how they comprehended and understand what we taught them. It is interesting to see their own view and perspective of architecture and design and then have a hand in shaping them. I believe I learned just as much from them as they did from me.

Student #4 answer:

> The kids' joy about architecture was inspiring. Developing lessons was a self-educating process. Simplifying concepts helped me to understand and relearn aspects of architecture again.

CONCLUSION AND FUTURE RESEARCH

In response to the conference theme, *Architectural Research for a Global Community* and the idea of Gross National Happiness (GNH), it appears that engaging university students in the practice of outreach and teaching can have significant side-effects that reflect feelings of well-being, reward, compassion, and perhaps one could surmise: happiness. It proves to be a viable, substantiated avenue in which to further educate the profession's emerging, young architecture students. In addition to meeting learning objectives set forth by Bloom's Taxonomy, the AIS-Independent Study program further reinforces one (if not all!) of this conference's core messages set forth by the King of Bhutan's four pillars of happiness: *the preservation and promotion of culture,* wherein preservation and promotion can be equated with the cyclical notion of teaching and learning.

The AIS-Independent Study program fuses empowerment and reward with leadership and hard work as the participating university students move beyond their comfort zones and initiate new opportunities for learning outside of campus walls. The young program looks to introduce increasingly comprehensive connections to maximize educational objectives at both ends of teaching and learning. Further research is to continue to relate and apply Bloom's Taxonomy objectives (and subsequent revisions) with those of the University Student and elementary and secondary students. The early success of such a program can vie for more participants that may lead to research on team-teaching and the compilation of a database of objectives, lessons, and outcomes.

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Ray Kinoshita Mann

Nipmuc Design for Empowerment

Nipmuc Empowerment by Design

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ABSTRACT:

Public-interest design pioneers Lisa Abendroth and Bryan Bell have articulated the need for "creatively using and devising strategies to solve problems that often push the boundaries of conventional practice." (Abenroth/Bell, 2016) One of these problems is the persistent "black box" moment between community information-gathering and design production. The focus of this study is about empowering individuals and communities through a design-integrated planning process, so that they become full participants throughout the procedure in their own cultural production. Effective techniques need to be explicitly described and shared at a granular level, with detailed descriptions of and analysis about the multiple roles of design thinking and making in the empowerment process.

I have been working with the Nimpuc Native Americans of central Massachusetts to develop such a process as we work towards the dream of establishing a Nipmuc cultural center. We seek not only to create a building/site that embodies their cultural and environmental values in both old and new ways, but to do in a process that will both help bring together the divided Nipmuc community and enabling it to move forward on shared goals.

I will argue that design can take on a myriad of manifestations as “instruments” to play an integral role in eliciting hidden information and exciting response, as well as serving to enact narratives and become an engine of collective memory. I will also demonstrate the benefits of tapping into knowledge opportunities outside the design milieu. Methods described are entirely qualitative, relying on non-scientific "experiments" derived through design thinking, and using natural observation, subjective analysis and interpretation to assess their impact. The outcomes include greater confidence to participate and take on ideation and leadership roles, and various workshops getting turned into recurrent annual events.

KEY WORDS: empowerment, design instruments, culture, Nipmuc, body language

INTRODUCTION

I have been working with the Nimpuc Native American community of central Massachusetts towards the goal of creating a Culture and Education Center. We are about four years into what is likely to be a ten-year process, as we have worked to help build up the empowerment individually and collectively required to take on such an endeavor. After an initial period of working in a more conventional engaged process with students in the architecture studio, it became clear that a deeper, more gradual "building up" process would be needed for this significantly disempowered community. I obtained a public service endowment grant from my institution in 2016, which gave me both the support and flexibility required for such an undertaking. Rather than review the full undertaking to date, I will discuss four of about a dozen different steps we have taken, in order to focus on several questions: 1) what authentic empowerment means in the context of a group like the Nipmuc; 2) how design and design thinking integrated from the get-go can enhance empowerment; 3) and the merits of using purely qualitative observational methods to gauge the effectiveness of the work.

1.0 BACKGROUND

1.1. A Brief Nipmuc History

One of the first groups to encounter the "Great Migration" of English colonizers in the 1620s and 1630s, the Nipmuc ("People of the Fresh Waters") were a substantial confederation of small kinship groups which migrated seasonally between settlements, extensively managing land, forest, and water for food and resources in what would become known as central Massachusetts, northern Connecticut, and Rhode Island. Overwhelming colonial pressure to take possession of these fertile lands soured relationships that had started on a relatively equal footing, and the backlash against the Nipmuc's near-victory in King Philip's War (1675-76) resulted in their almost complete genocide by the end of the 17th century. Despite the destruction, small numbers survived and regrouped, leaving descendants who fought in the Civil War and worked in the factories of the Blackstone River Valley (originally the Nipmuc River), where the American Industrial Revolution is said to have begun. (Connole, 2007) Reservations hadn't yet been invented during early colonialization, but their precursors—"Praying Towns" that corralled and Christianized the Nipmuc population—were successively shrunk until only a 2.5-acre homestead of the Hassanamesit band Nipmucs "never owned by the white man" persists to this day. While largely urbanized and dispersed, family groups kept memories and traditions alive for centuries under the radar, and began pressing for formal recognition starting in the 1920's. Other than the Hassanamesit Homestead, almost no other Nipmuc "buildings" per se remain, but extensive traces of constructions and ceremonial markers in the landscape and waterways throughout the region have been increasingly identified through ongoing formal and informal research.

In the 20th century, the Nipmuc sought state and federal recognition, a legal step which would have put them in a much stronger legal position and guaranteed them access to desperately needed resources. The state of Massachusetts recognized them in 1976, but the very means by which they had survived through the centuries—intermarriage and assimilation—worked against federal recognition, which was denied in 2001. The campaign for federal recognition was long, costly, and divisive, because it required determining who belonged on the tribal rolls. The wounds from the recognition process were still felt even a dozen years out: people still speak of the pain of being forced off the rolls at the time, and others speak of the pain of feeling forced to make those determinations. As Nipmuc author Larry Spotted Crow Mann wryly comments about the Native American experience, "No other people have to prove who they are." Today the Nipmuc number about 3000 in the region and beyond. Most belong to two predominant bands, and they practice their culture through powwows and other seasonal celebrations, language and history teaching, and organizational activities. For the Nipmuc to move forward with new initiatives without federal recognition was difficult, because they do not have access to funding instruments such as casinos—nonetheless, they are determined to do so.

1.2. Nipmuk Cultural Preservation, Inc.

Nipmuk Cultural Preservation, Inc. (NCP), the non-profit with which I work, was formed in 2013 to counteract this bitter legacy and to reach out to the broadest possible community of Nipmuc. Its leadership has always given highest priority to the idea of constructing a cultural and education center. An unusual outcome of the failed recognition campaign, is that the NPC leadership has developed a clear preference for locating any center on "neutral" ground, away from rather than near or within the historic locales of either of the two predominant bands, even though it would put a project at some distance from the daily lives of most members. An added advantage would be the likelihood of being in a less thickly settled area. Most engaged processes, however, rely on a community embedded in a locale, where people have layers of memories and pride of place, as well as local government agencies and other sources of support. The NPC could assume none of these for all the reasons outlined above. Furthermore, most Nipmuc are from the working class—nurses, construction workers, teachers, social workers—and are already stretched thin for money and time. Even young Nipmuc often hold down multiple jobs on top of other responsibilities to the tribe. Although they are a lively, intelligent, and creative crowd—it was also clear that the idea of having an actual site and a building of their own seemed as remote to most tribal members as the stars. As a Narraganset preservation officer said to me, "When you've only had nothing for so long, that's all you know how to get."

The task before us was to use the design process as a tool to empower the Nipmuc community to the state in which it would be possible for them to envision truly having a center of their own. Even more to the point, the project would be an act of invention to enable the Nipmuc to imagine who they are and what they want to be, as keepers of an ancient culture in the modern world—but emphatically on their own terms as contemporary people. Native American groups are at an interesting historical moment as the depth of indigenous culture and knowledge is becoming better understood and recognized as relevant to all of us moving forward, putting such acts of recovery and invention well beyond the nostalgic and into the necessary.

1.3. Gifted Land

The awarding of the public service grant coincided with a long-contemplated land gift to the tribe of a 2.5-acre parcel in Petersham, Massachusetts, which is within historic Nipmuc territory but otherwise relatively far from where most tribal members live. The donor wanted the Nipmuc to be part of a consortium of sustainably-oriented communities in that locale, and subsequently offered the NCP an additional 35 acres of land adjacent to the original parcel which could be purchased if funds become available. A key feature of this land is its proximity to a fine example of an archaic (non-colonial) stone chamber, possibly by Nipmuc ancestors (Fig. 1). In addition, much of the area's land is within the watershed of the Quabbin reservoir, which supplies Boston and will likely be in conservation in perpetuity.

Although all of this was good news, the Nipmuk Cultural Preservation Chair and I knew that we'd have to make sure that the top-down process driven by the donor and his priorities would not overrun the delicate process of developing within the Nipmuc community its own attachment to this remote piece of land, and the individual and collective will to move towards inhabiting it. Keeping this in mind, we were able over the course of the year to work through a multi-stage process with students and the Nipmuc community, including an informed study of the nearly 40-acre area of the two parcels, and development of a building and landscape design that can move the project towards fund-raising.

Figure 1: NCP Chair, donor, author, collaborators & students at indigenous formation on the land. Source: (Author, 2017)

1.4. Empowerment Processes

The SEED evaluation system offers comprehensive guidelines for creating a successful public-interest design process. While the general procedure relatively straightforward—articulating your mission, setting milestones, evaluating as you go—the SEED system notes that one must expect the unexpected, and that "not all strategies are transferable—evaluation of each context is important" (Abendroth/Bell 2016, 123). Techniques and mechanisms need to be searched out or invented, tried and discarded as needed—the usual approaches may not work at all. One of the key goals of public-interest design is community empowerment, but this seemingly self-evident notion is anything but straightforward, especially when architecture is involved. The process of engaging with and eliciting information from a community to incorporate into a design project which reflects their values may be assumed to be empowering, but it could merely fall into the category of using design for an empowering *outcome* as opposed to an empowering *process*—a nicely designed building reflecting community input may still fall short of co-developing the political and economic empowerment needed for the long-term success of such a project. In other words, the architect has to be willing not only to design buildings, but to build capacity.

> "The notions of enabling design and empowerment have been fused in community design and many of its failures have resulted from not understanding the difference between the two activities" (Comerio 1987, 27).

According to Julian Rappaport's *Terms of Empowerment*, empowerment is a "process by which people, organizations, and communities gain mastery over issues of concern to them" (Rappaport 1987, 122). Here "mastery" is the key word. In other words, to have a successful empowering process the community should develop from being simple "participants" into co-equal partners, "develop[ing] skills as to not have to be dependent on professionals" (Rappaport 1987,122). On an individual basis this would mean "perceptions of personal control, a proactive approach to life…critical understanding of the sociopolitical environment" (Zimmerman 1995, 581). The individuals' sense of how to operate in the broader context becomes critical not only for knowing how to help move a project forward, but also for maintaining its long-run vitality. While most community members would not want the burden of actually being the architect, they needed to begin to see themselves as high-level project participants and "owners".

Working with the NCP, I have tried as the professional architect to lead from behind or beside—providing ideas and materials for work sessions but letting others own the process (except when they wanted me out front). As per Awan, Till and Schneider's *Spatial Agency*:

> "There are many examples of how the architect can operate modestly and invisibly, but to great effect, through an intelligent and imaginative engagement with the economic, social and political contexts of spatial production." (Awan, Till, Schneider, 45)

We tried to make it seem like events were just unfolding by themselves, and that what was needed just happened to be at hand—something that requires considerable action behind the scenes coupled with a willingness to be both flexible and creative when faced with contingencies. Serving from the outside as an agent for their vision required an added attentiveness. Oddly enough, my interest and scholarship into Alvar Aalto and, separately, Japanese culture had convinced me of the legitimate potentials of designers to interpret and generate ideas anew, as active participants in cultural production. Resonance for the community, and an ability to withstand the test of time and use would ultimately be the judge of the results.

1.5. Design Instruments for Empowerment

The advent of sustainable-design approaches has been a boon for the empowerment process. Hands-on involvement in gardening, sustainable landscape infrastructures, design/build community structures, and so on are win-wins for attracting people of all ages and building skills that in turn build leadership. But most engaged processes that I had studied or been part of did their initial work of engagement through "get to know you" paper-based activities that range from questionnaires to artful hands-on exercises that physically involve people in drawing, images, word-play, cutting, pinning, posting. They tap memories and information—subjective and objective--and snapshots of everyday lives as well as other cyclic events. Although a successful process gets people involved and can bring leaders to the fore, it does not necessarily prepare them individually or as a group for the spatialized work ahead. As the NPC leadership and I brainstormed, we wondered if there could be ways to bring Nipmuc people deeper into the realm of the architect, or more specifically into a spatialized mind- and skillset. Those of us who undergo architectural training rarely have the opportunity, in the crush, to reflect on the remarkable design instruments that we have been required so quickly to master. Even the most basic aspects of design, such as working in and between scales—from the vast to the tiny—to represent a world in miniature, or drawing sections as if at will the world can be dissected in slices, startle and delight non-designers. With the Nipmuc, I hypothesized that these instruments or tools of design could be shared more explicitly to let the community start to feel bodily located within the site and the imagined project. "Some of the most inventive examples of spatial agency focus on the design of these tools, seeing them as primary means to unlock the potential of a given situation." (Awan, Till, Schneider, 45)

1.6. Evaluating Impact

From the outset of our working relationship, I realized that trying to obtain evaluative feedback through standard means such as surveys or feedback sessions would be awkward, and should be reserved for moments when the community itself particularly wanted to do it. Tribal members are constantly asked by others how they feel about this or that "as a Nipmuc", yet for obvious historical (and possibly cultural) reasons, they are quite guarded about expressing strong opinions openly to any outsiders. Listening with deliberateness is also valued over immediately voicing an opinion. For all of these reasons it was important to ensure that the group never felt that they were part of an "experiment," and that I was going to collect the data and run. John Quale from the University of Virginia ecoMOD projects also refers the sensitive handling of such issues (Kraus, 138). I needed alternative ways to gauge whether or not our engagements were having any impact.

Working with clients over years of professional practice, I've noticed that body language is often more telling than the spoken word. If something is way off the mark, clients will usually tell you directly, but their body language will let you know if something is just "OK" or if they really love it. If people really like something—a drawing or model, for instance—they don't just look at it, they take them into their hands and even cradle it slightly. They begin to grin and even giggle spontaneously. Verbally, they might start spinning tales about what they could see themselves doing there (Fig. 2). This is an extremely subjective or qualitative observational technique, but which in my experience can be useful in situations such as this, where overt measurement techniques would be inappropriate. In consequence, I kept informal notes and images to capture such moments throughout the process.

Figure 2: Joyful body language? Source: (Author, 2017)

2.0 CASE STUDIES OF DESIGN INSTRUMENTS USED FOR EMPOWERMENT

2.1. Case Study 1: Scale Figure Conversations

The first example is a simple variation on a get-to-know-you exercise. After a year of work with the founding Chair of the NCP, it was time to widen the pool of those involved, and introduce the new Chair's tenure. Armed with a big bag of art supplies, we asked participants to make self-portraits of themselves or each other at 3/8"=1'-0" scale for a hands-on modular model "kit" that was partially put together and set to the side. This could be construed as a modestly more ambitious version of a typical step in a guided workshop where students create a scale figure that represents the client, which "more easily allows clients into the dialogue because they can imagine themselves in the design." (Kraus, 41) The elaboration here, was that the community itself was doing the making alongside some student helpers, as much to elicit unselfconscious conversation as to supply figures. Sitting around a big table, we had people chat about what they could see themselves doing at a culture and education center as we twisted pipe cleaners, felt and modeling foam. Responses ranged from the intricate portrait of a daughter dancing in her full regalia, to gardeners cultivating traditional herbs and foods, to the Chair in tan khaki's expounding about Nipmuc history. We took short breaks to informally chat using some information-packed user-friendly posters that "road-mapped" different courses of action (these were designed to be left with them for their own explaining purposes to the rest of the community).

Soon we had about 20 figures, and lots of useful information. A couple participants really got going and leaped into assembling the model's modules and to churn out scale garden plantings (Fig. 3). The activity focused people on making, so that information flowed unselfconsciously. Building to scale (we had tiny paper rulers) helped people imagine themselves in the scene while feeling like real participants in preparing a representation of their future project right at the get-go. The model itself was essentially a throw-away—a more attuned design would be developed with them later, and the scale figures and plants would populate the new model—nonetheless having scale model components there to 'play with' was key. In this case, the positive body language consisted of the enthusiastic making and handling of the scale figures and model parts, reinforced by lots of smiles and laughter. The chair heard afterwards that the participants loved the experience and wanted to do it again.

Figure 3: Scale Figure Workshop & Figures populating eventual design, Source: (Mighty, 2016)(Author, 2017)

2.2. Case Study 2: Mapping

The distance and unfamiliarity of the gifted land to much of the community was concerning, compounded by my not yet knowing much about the area myself. Luckily, based on a lead from the donor/stakeholder, I heard that another regional Native American-oriented non-profit had received a small grant to help train native youths in geo-mapping, in particular around indigenous ceremonial stone landscapes. For centuries people have noticed unusual stone configurations throughout New England, but only recently have they become fully recognized as systematic and symbolic constructions that are clearly not colonial. After some delicate negotiations we got agreement from the tribal elders that a mapping training could take place on the new land, in partnership with the other non-profit. I arranged for equipment, software licenses, and supplemental honorariums, understanding that as an outsider I should not be present nor disclose any findings. The session exceeded expectations, and subsequent workshops are already being planned by the NCP.

In a related vein, I had reached out to several scholars of Native American history in the area and learned that one scholar in particular had developed significant new research on the Nipmuc that included the geo-mapping strategic routes and landmarks throughout the region as derived from descriptions in primary 17th c. Nipmuc documents (many were educated and literate within a few decades of colonial arrivals). Among other things, the mappings showed the positioning of Petersham (previously known as Nichewaug) as a waystation for the Nipmuc in particular, between their primary area of inhabitation in the Blackstone River Valley and the mountainous "safe zones" of southern Vermont where colonials were at considerable navigational disadvantage (Brooks, 2017)(Fig.4). In other words, new information previously unknown to most of the Nipmuc community was unfolding in real time just as they were getting to know this new land. In our collective perception, the sense of the region had suddenly shifted, and the worry of far away-ness began to evaporate as we began to read the land from a truly native perspective. While all this was a lucky and specific circumstance, the use of Geo-mapping to train youth in a highly useful technology while gaining personally relevant spatialized historic knowledge about a place and its relationship to a wider region, further reinforced the notion of using an instrument of design—i.e. of scale and positioning—for empowerment.

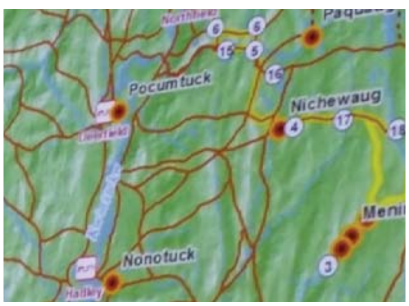

Figure 4: GIS Map by Prof. Lisa Brooks, showing routes in and around Petersham/Nichewaug, Source: (Author, 2017)

2.3. Case Study 3: A Lecture

For some time I had wanted to invite a Native American architect to come lecture and converse with the Nipmuc, who were very interested in how architecture could address both their modern and ancient selves (as was I). Such an invitation would also fulfill a desire an obligation to provide a learning opportunity for architecture students and faculty less familiar with the kind of work I was doing, not to mention the broader community. I happened on an intriguing article about a young and innovative Oneida architect, Chris Cornelius, and rang him up with an invitation. Architectural lectures can be quite intimidating for those outside our field, so I went to some trouble to prepare friendly flyers and personalized emails to send to the Nipmuc as well as to Native American Studies students and faculty in the Five Colleges.

Chris Cornelius was nothing short of brilliant. Having extracted himself from difficult childhood circumstances to attend architecture school at University of Wisconsin, Milwaukee, he made his way ultimately to graduate school at the University of Virginia, where he had clearly soaked up its fine tradition of deep thinking and exquisite drawing and design. In turn, he had also tapped a deep sense of Oneida culture, particularly in its story-telling traditions and narratives which he metaphorically embedded into his projects. He moved fluidly between remarkable, meditative hand drawings to soulful digital and analog models. His work was extremely sophisticated but also clear and easy to grasp because the ideas and narratives had been enacted with such delicacy and deliberation. Cornelius had clearly spent years working the question of how indigeneity could manifest itself in contemporary life such that he was able to share his journey and findings to immense effect on a large crowd of strangers.

A couple drawings that Cornelius had generated for a Native America school struck me as particularly strong examples of instruments of design that provide avenues to empowerment, concretely furthering my thoughts on this topic. In the first, he took the convention of a section and showed that to make it truly meaningful in a native context it would have to begin at the height of the moon and descend well below the surface of the earth, since the moon as well as the trajectory of birds and other animal migrations and the earth-connected badgers are fundamental to indigenous cosmology. In the second, a corresponding floor plan inflected towards bird migration paths, and program elements were deliberate differently-named— “feasting” instead of “cafeteria”, “gathering” instead of “auditorium”, reminding us all how conventional programming takes the life and spirit out of our daily actions (Fig. 5). These are simple examples amongst a remarkable body of work, but it was as if shafts of new light had pierced the audience’s consciousness, and the Nipmuc and other Native Americans present were practically jumping out of their seats by the end of his talk (again, the body language was clear). We would like to have him back for further discussions and work, but at the same time, he gave us a sense of how one could move forward meaningfully with or without him—a true gift.

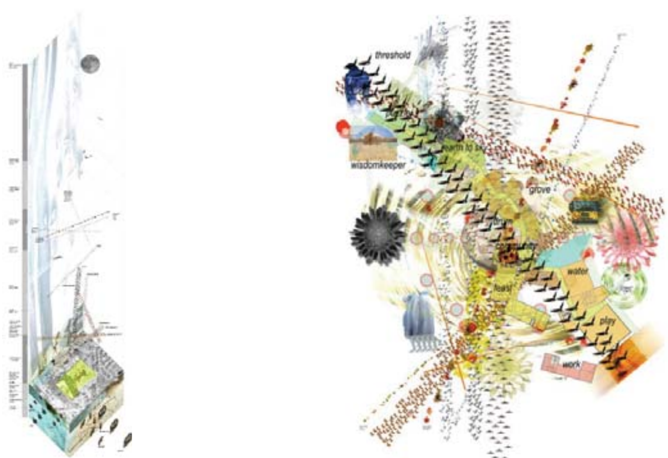

Figure 5: Studio Indigenous conceptual section and plan, Indian Community School. Source: (Cornelius 2005)

2.4. Case Study 4 Starplate Dome

While the land donor’s intentions about the eventual transfer had put us on a slightly uncertain trajectory of planning the cultural center for the larger parcel, the NCP board and I felt strongly that we wanted to establish a toe-hold on the initial land as soon as possible. Parenthetically, well-meaning outsiders inquired repeatedly why the Nipmuc didn’t just want to build an ancestral dwelling or *wetu*, so we had to explain that, while the typologies of the *wetu* and settlements of grouped *wetus* were very much on our minds, the Nipmuc were a modern people not museum pieces, who wanted a comfortable, accessible and relatively bug-free contemporary evocation of their traditions to encourage their community to be there on a regular basis—once established, *wetu*-buildng as a teaching activity could be considered. Amusingly the NCP Chair suggested a “starplate dome” system as a kind of modern *wetu*—an inexpensive set of pre-engineered pentagonal plates and bolts designed to quickly put up geodesic-type chicken coops, sheds and gazebos. I immediately shelved some more grandiose, labor-intensive design/build thoughts, realizing that the Chair was mindful of the fact that there wouldn’t be hundreds of free hands or hours available—speed in terms of total hours and effort on site would be of the essence—without compromising quality—for this busy and distantly-located community.

Eight-foot 2x4 struts would let us build a “shed” just under 120 square feet, which would not trigger a permit requirement and would let us nestle it into the forest with minimal disturbance. The chicken coop brochure renditions were homely, but inspired by Chris Cornelius we could all now see the simple structure’s potential. A few extended struts gave us a moon-gazing oculus and the first structure would become the elegant “crow” with planning for a second that would be the earth-bound “badger,” host to solar composting toilets and captured rainwater. The somewhat triangulated deck frame we called a “travois”, recalling the formation of lashed saplings that indigenous peoples used to move heavy loads—these could also be lifted and moved later by a couple dozen volunteers if re-siting to the larger parcel was desired. While clearly bearing no literal resemblance to a traditional (wetu or longhouse) structure, which are sophisticated frames of bent saplings overlaid with large, adjustable sheets of tree bark—we tried to embody their cleverness and versatility, as well as their constructional elegance. Off-site, with a couple students on hand, I took charge of pre-cutting, pre-drilling—and pre-thinking—various items such that the on-site work would proceed seemingly effortlessly. In one day-long session with about eight community members, we were able to build the deck and erect the core structure—and three half-day sessions later it was more or less done. We were able to strike a balance between real effort invested by the community, with a payoff that was satisfyingly achievable and reasonably attractive to boot (Fig. 6). In this case, the behind-the-scenes preparation to create an empowering illusion of ease, acted as a "design instrument"—though perhaps the analogy is at this point getting stretched. Developing the narrative of the "crow" could also be seen as a means for generating an attachment narrative to the site and overall undertaking as well. Planning for the second structure is about to begin, and a Nipmuc theater grad is planning a summer workshop/performance for on site. Both of these reflect a growing feeling for the site and a confidence in moving forwards.

Figure 6: Starplate domes, Source: (Author 2017)

CONCLUSION

Mechanisms for generating genuine empowerment are worthy of being studied at the granular level, even though each example may seem rather basic under scrutiny. The moments that spark engagement and change in individuals and groups are subtle and emotional as they are rational. Design and the "instruments of design"—a clumsy term that needs refinement—should be explored as simple mechanisms with great power because they can build bridges of understanding and whole-body engagement for non-professionals. Architects should be less fearful of being at times simplistic, understanding that we wield powers that often feel like magic to others—and too often leave them too far behind. And as instruments or tools, each mechanism can be tossed away as easily as it is created, so that they continually provide the means if not necessarily the ends to a process. Similarly, the designer that is at ease moving between foreground and background as needed, while all the while paying attention to and adjusting with the bodily actions and reactions of those whom they serve, is likely to achieve great trust and a greater likelihood of project success.

ACKNOWLEDGEMENTS

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Sadiqa Al Awadh, Ihab Elzeyadi

Daylighting Beyond Instrumentality and Dynamic Metrics

Daylighting beyond Instrumentality and Dynamic Metrics

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ABSTRACT: The relationship between sustainable architecture and daylighting design has suffered from a limited approach where architects reduce daylighting to an instrumental quality and objective metrics related to daylighting quantities - devoid of its relationship to aesthetics, daylighting quality, and subjective impacts on space perception and indoor environmental quality. In design practice, architects and engineers place most emphasis on the visible transmittance of glazing and the quantity of daylight rather than spectral properties and the wavelengths that affect physiological response to light. This trend prioritizes daylight's dynamic metrics as the basis for green building rating systems' credits criteria. Seldom are other qualities of daylight, such as the biological effective wavelengths from different spectral power distributions or the impacts of daylighting on occupant's mood and behavior considered.

Non-visual benefits of daylight that affect well-being include: regulating the circadian biological clock, hormones (melatonin, cortisol, etc.), body temperature, heart rate, mood, stress, and depression. These are impacted by different characteristics of daylight such as luminance, spectral power distribution, color rendering index, correlated color temperature, duration of exposure, directionality, dynamics, and timing. Though architects often overlook the energy in the non-visible portions of the light spectrum, it must be considered in the overall appraisal of daylighting systems.

In this paper, we examine a meta-analysis of previous assessments on the relationship between occupant's health and well-being in relation to metrics, certification systems, and the attributes that guide their interactions. We explore the importance and influence of interdisciplinary research in addressing issues of daylighting design for sustainable architecture, which affect people on an individual, community, and global scale. The paper concludes with frameworks relating health effective light to appropriate metrics which will guide future daylighting design processes for sustainable architecture.

KEYWORDS: Daylight, Health, Rating Systems, Metrics, Circadian System

INTRODUCTION

As a stand-alone term, daylighting is difficult to define. This may as well be the reason behind its appeal and justify stakeholders' desire and fascination with a concept which cannot be easily constrained. Attempts have been made in defining daylighting in relation to sustainable design. Results of an online survey on the role of daylighting in sustainable design indicate some of many different viewpoints and approaches to this topic which have a significant body of work published in the field (Reinhart and Galasiu 2006).

- *Architectural definition:* the interplay of natural light and building form to provide a visually stimulating, healthful, and productive interior environment
- *Lighting Energy Savings definition:* the replacement of indoor electric illumination needs by daylight, resulting in reduced annual energy consumption for lighting
- *Building Energy Consumption definition:* the use of fenestration systems and responsive electric lighting controls to reduce overall building energy requirements (heating, cooling, lighting)
- *Load Management definition*: dynamic control of fenestration and lighting to manage and control building peak electric demand and load shape
- *Cost definition:* the use of daylighting strategies to minimize operating costs and maximize output, sales, or productivity

Light inspires us and can enliven space; it adds a higher level meaning to the experience and identity of a space (Ozorhon and Uraz 2014). However, there are common misconceptions that daylight has only an architectural and aesthetical value, and all other daylight functions can be replaced by electrical lighting solutions. Hence, with technological advancements, occupants tend to resort to electric lighting for its instrumental benefits as it offers a controlled electric lighting system with uniform illumination to meet visual task needs. It is constant and predictable, whereas daylight is dynamic and can be unpredictable (Haans 2014).

Emphasis within the field gravitates depending on current trends. The energy crisis of the 1970s shifted the practice back to the integration of daylight in building design - towards a focus on sustainability as a response to the energy-related concerns of the time. Design solutions proposed included increasing glazing on façades to incorporate daylighting that could minimize the demand for electric lighting. This resulted in the development of metrics which focused on task-based illumination levels as well as limited visual discomfort metrics based on illumination levels as a proxy to problematic glare in daylit spaces (Reinhart, Mardaljevic, and Rogers 2006).

These metrics reduce daylighting to an instrumental and objective qualities with emphasis on performance measures and standards - devoid of its relationship to aesthetics and subjective impacts on space perception and indoor well-being. In this paper, we make an argument about these aspects of the daylit environment that are ignored through current standards and ratings systems. We more specifically look at the impact of daylight's biological effective wavelengths on occupant health and well-being, and the role architecture can play in achieving a balance to daylighting design that combines both objective and subjective measures in the design of well-daylit spaces.

1.0 EVALUATING DAYLIGHT

1.1. Instrumental and Dynamic Daylight Metrics

The following luminous quantities outlined are some of many that have been extensively used in the literature for the assessment of daylight and the luminous environment (Mardaljevic, Heschong, and Lee 2009, Reinhart, Mardaljevic, and Rogers 2006).

- *Daylight Factor:* the ratio of internal illuminance to unobstructed horizontal illuminance under standard CIE overcast sky conditions, expressed as a percentage.
- *Daylight Autonomy:* the percentage of the year when a minimum illuminance threshold is met by daylight alone. It uses work plane illuminance as an indicator of whether there is sufficient daylight in a space so that an occupant can work by daylight alone.
- *Useful Daylight Illuminances:* determines when daylight levels are 'useful' for the occupant, that is, neither too dark (<100 lux) nor too bright (>2000 lux).
- *Annual Light Exposure:* defined as the cumulative amount of visible light incident on a point of interest over the course of a year, measured in lux hours per year.
- *Realized Savings Ratio:* the ratio of predicted to realized energy savings.
- *CIE Glare Index:* an index used for luminaire sources of glare, it requires both direct and diffuse illuminances - above 28 is intolerable, below 13 is barely perceptible.
- *Daylight Glare Index:* an index that considers glare from the sky viewed through a window - above 31 is intolerable, below 18 is barely perceptible.
- *Daylight Glare Probability:* glare sources are detected by contrast ratios - above 0.45 is intolerable, below 0.3 is barely perceptible.
- *Visual Comfort Probability:* the percentage of people predicted to feel comfortable with the luminous environment.

These commonly used metrics clearly reflect the academic research, lighting design, and manufacturing communities' priorities in relation to defining daylighting. This is seen in their abundant use of illuminance measurements, which are relatively simple to measure, for meeting visual task needs and energy savings. Though determining the impacts of illuminance levels in the luminous environment is essential, what about the other dimensions of daylight? Do these illuminance-based metrics unjustly overshadow the other components of daylight?

1.2. Daylight in its Third Dimension

To retort to the postulations by those who do not appreciate lighting's many facets, a wide body of research has investigated the non-instrumental benefits of light. Daylight embodies information about the weather, the time of day, and satisfies other deeply rooted psychological and biological needs. As opposed to electric lighting, there are both visual and non-visual health benefits received from daylight that cannot be replicated (Jennifer A. Veitch 2000). These are impacted by different characteristics of daylight such as luminance spectral power distributions (SPD), color rendering indices (CRI), and correlated color temperature (CCT), duration of exposure, directionality, dynamics, and timing (van Bommel 2006). Though there is a dominance of the eye and vision, and suppression of other senses and biological functions, the non-visual aspects of light and health are critical (Pallasmaa 2012). These non-visual benefits of daylight that affect well-being include: regulating the circadian biological clock, hormones, body temperature, heart rate, mood, stress, and depression (Lucas et al. 2014).

The biological effects of light on humans are usually translated from SPD and measured in ‘equivalent melanopic lux’, a proposed alternate flux density metric that is weighted to the intrinsically photosensitive retinal ganglion cells (ipRGCs) luminous efficiency function, which peaks at 480 nanometers and is based on the action spectrum of melanopsin - instead of the cones’ photopic luminous efficiency function V(λ), which peaks at 555 nanometers and is based on the response of foveal, long and middle-wavelength sensitive cones, which is the case with traditional lux. This translation is used to understand how much the spectrum of a light source stimulates ipRGCs and affects the circadian system. However, using this metric by quantifying light in terms of melanopic lux has been deemed to be inaccurate (Mariana Figueiro 2017). This is because photometric units have not been established for the circadian luminous efficiency function, the impact on the suprachiasmatic nucleus by different levels of melanopic lux is still unknown, and the fact that basing the metric on melanopsin alone disregards other combined neural channel responses.

Though designers often overlook the energy in the non-visible portions of the light spectrum, it must be considered in the overall appraisal of daylighting design. Daylight contains 4.6% ultraviolet radiation, 46.4% visible light and 49% infrared radiation. Vitamin D is best produced by exposure to UVB with wavelengths of 290-300 nm. The glass industry has emphasized its concern for human health. Thus, it has stressed the importance of photoprotection against UV detrimental effects including cancer, sunburn, skin aging, damaging the immune system and eyes (Holick and Jenkins 2003). This, however, is somewhat contradictory because they are disregarding health effective radiation as humans require UVB for the synthesis of vitamin D. This is especially important since statistics indicate that people spend more than 90% of their time indoors (Frontczak 2011).

2.0 METRIC APPROPRIATENESS

Upon reviewing the dynamic daylight metrics that are predominantly in use, it is important to investigate the appropriateness of their use in the current context of designing the luminous environment to enhance occupant health and well-being. Some of the leading green building assessment tools include: Leadership in Energy and Environmental Design (LEED™), Building Research Establishment (BRE) Environmental Assessment Method (BREEAM, United Kingdom), Green Building Council of Australia Green Star (GBCA, Australia), Deutsche Gesellschaft für Nachhaltiges Bauen e.V (DGNB, Germany), Comprehensive Assessment System for Built Environment Efficiency (CASBEE, Japan), and Korea Green Building Certification (KGBC) as examples These rating and certification systems provide frameworks for assessing a building’s performance, though they are also generally used as design guides by professionals. This brings into question how effectively these comparable green building rating systems can help a design team to implement critical components of human health benefits associated with indoor environmental quality, and how reliable are the metrics they use?

2.1. LEED

The Indoor Environmental Quality section of LEED v4 BD+C (Council 2018) covers the light and well-being aspects of the luminous environment which are within the scope of this paper.

The *interior lighting* credits aim “to promote occupants’ productivity, comfort, and well-being by providing high-quality lighting” by means of specifying individual lighting controls, using light sources with a CRI of at least 80 and minimizing ‘direct only’ overhead lighting to 25% or less of total connected lighting for all regularly occupied spaces, or use light sources that have a rated life of at least 24,000 hours for 75% of total connected lighting load. The *daylight* credits aim “to connect building occupants with the outdoors, reinforce circadian rhythms, and reduce the use of electrical lighting by introducing daylight into the space.” These are achieved by the project teams’ demonstration through computer-aided simulation and illuminance calculations that designs achieve appropriate sunlight exposure. Teams are also encouraged to provide manual or automatic glare-control devices for all regularly occupied spaces. The *quality views* credits aim “to give building occupants a connection to the natural outdoor environment by providing quality views.” The requirements for these credits is to achieve a direct line of sight to the outdoors via vision glazing of 75% of all regularly occupied floor area. 75% of all regularly occupied floor area must have at least two of the four kinds of views: (1) Multiple lines of sight to vision glazing in different directions at least 90 degrees apart. (2) Views that include at least two of the following: (a) flora, fauna, or sky; (b) movement; and (c) objects at least 25 feet from the exterior of the glazing. (3) Unobstructed views located within a distance of three times the head height of the vision glazing. (4) Views into the interior atria may be used to meet up to 30% of the required area.

Upon reviewing this section, it is noted that the LEED standards reference reinforcing circadian rhythms only once in the daylight credits, but they provide no guidance as to how this is expected to be achieved. The illumination-based metrics are not addressing health effective light; emphasis is still clearly placed on photopic vision and its visual architectural applications.

2.2. WELL

The Green Business Certification Inc not only administers the LEED certification program, but also a lesser-known WELL Building Standard (Institute 2017) which was launched in October 2014 by The International WELL Building Institute. This standard aims to implement, validate and measure features that support and advance human health and wellness through seven categories: air, water, nourishment, light, fitness, comfort, mind and innovation. It references existing standards, practice guidelines set by governmental and professional organizations and integrates scientific and medical research and literature on environmental health, behavioral factors, health outcomes and demographic risk factors that affect health with leading practices in building design and management. This standard is commendable as it not only assesses the design and operations of buildings much like the predominant rating systems, but it, more importantly, looks at how they impact and influence human behaviors related to health and well-being.

The light category in the WELL standard aims to “minimize disruption to the body’s circadian system, enhance productivity, support good sleep quality and provide appropriate visual acuity.” The credits cover aspects of visual lighting design, circadian lighting design, electric light glare control, low-glare workstation design, color quality, surface design, automated shading and dimming controls, right to light, daylight modeling, daylighting fenestration, light at night, and circadian emulation. The standard details circadian lighting design in terms of melanopic intensity for work areas, living environments, breakrooms and learning areas. Here, we notice the use of melanopic lux as a metric to establish the standard’s benchmarks.

For *work areas*, they should meet at least one of two requirements: (1) At 75% or more of workstations, at least 200 equivalent melanopic lux is present. (2) For all workstations, electric lights provide maintained illuminance on the vertical plane of 150 equivalent melanopic lux or greater. In *living environments* such as bedrooms, bathrooms, and rooms with windows, one or more fixtures should provide 200 or more equivalent melanopic lux. Lights in workplace *breakrooms* are required to maintain an average of at least 250 equivalent melanopic lux. They may be dimmed in the presence of daylight but should be able to independently achieve these levels. *Learning environments* need to meet at least one of two requirements: (1) At least 125 equivalent melanopic lux is present at 75% or more of desks, for at least 4 hours per day for every day of the year. (2) Ambient lights provide maintained illuminance on the vertical plane of equivalent melanopic lux greater than or equal to the lux recommendations in the Vertical (Ev) Targets of the American National Standards Institute and Illuminating Engineering Society IES-ANSI RP-3-13.

The circadian emulation category aims to “provide light which has intensity and spectrum similar to that of the daily changes of sunlight.” It details how light systems should follow users’ set "bed time" and "wake time" by gradually increasing light levels and providing a maintained average of at least 50 to 250 equivalent melanopic lux as prescribed. Though it has already been established that the equivalent melanopic lux metric is not a reliable measure, it is noteworthy that the WELL standard has taken a step further and addressed health effective light in a more rigorous manner.

2.3. The National Fenestration Rating Council

Window and glazing choices should be considered holistically. The Lawrence Berkeley National Laboratory has developed many widely available computer programs and repositories including WINDOW, THERM, COMFEN, RESFEN, Optics, IGDB, CGDB, Radiance, and AERCalc. These have been mostly used by the glass industry manufacturers for calculating total window performance indices (U-values, solar heat gain coefficients, shading coefficients, and visible transmittances). These are useful for assessing glazing in terms of thermal comfort, heat gains and losses, condensation control, acoustic control, energy requirements and visual requirements (privacy, glare, view), daylighting, shading and sun control, ultraviolet control and color effects.

Similarly, The National Fenestration Rating Council provides an NFRC label to certify whole product performance. Its fenestration energy rating system rates the performance of window and skylight products in terms of U-factor, Solar Heat Gain Coefficient (SHGC), Visible Light Transmittance (VT), and optionally Air Leakage (AL) and Condensation Resistance (CR). Building energy codes, tax credits and utility incentives, ENERGY STAR and other major standards for window energy efficiency base their criteria on these ratings.

There is a lot of hidden value in this data but most designers often do not look past these figures to see how they can be translated and reflected in their designs. Glazing is usually prescribed in accordance with performance and aesthetics. However, there should be more awareness of how these design decisions not only affect occupants’ perception of the space due to the filtered and transmitted light properties through the glazing; but also, how this modifies biologically effective wavelengths. This modification may or may not be perceived by occupants. Regardless, designers should get ahead and anticipate outcomes and repercussions from glazing property variables. Thus, designers would benefit if NFRC labels included biological impact criteria.

Studies should attempt to elaborate on the glass industry's research on the transmittance of light through different glazing types to look at the effects of glazing on the transmission of the electromagnetic spectrum within a space's interior. More specifically, on how the light that is being transmitted affects occupant health, wellbeing, and perception of the space. Occupants' preferences of internal space and lighting conditions due to different glazing properties should be taken into consideration to assess how the subjective aspect of lighting preferences conditions correlates with the objective results of biologically effective spectral light transmittance. This would give helpful insight into the overall effectiveness of design interventions, the relative impact of independent variables, the strength of the relationship between variables, and how this could affect the design practice.

3.0. TOWARDS A UNIFIED FRAMEWORK

It is becoming increasingly apparent that there is a conflict within the research, design and manufacturing communities in defining the metrics and standards for daylighting design. This is due to the development of inconsistent light quantities and units by various disciplines though they are all ultimately driven to describe a similar phenomenon dealing only with the objective qualities of daylighting. There is a need for a common, integrated metrics that would help transfer this knowledge and effectively evaluate and report the potential non-visual responses of daylight. The following section of the paper brings forward two approaches that have worked towards integrating frameworks through interdisciplinary research.

3.1. Circadian Stimulus

The Lighting Research Center at Rensselaer Polytechnic Institute has proposed a metric, known as "the circadian stimulus" for applying circadian light in the built environment (Mariana Figueiro 2017). It uses irradiance weighted by the spectral sensitivity of every retinal phototransduction mechanism that stimulates the biological clock, as measured by nocturnal melatonin suppression. The metric is derived from a transformation of circadian light into relative units, from 0 to the response saturation of 0.7, and is directly proportional to nocturnal melatonin suppression after one hour of light exposure (0 to 70%). The recommended levels aim for a circadian stimulus greater than 0.3 during the day and less than 0.1 in the evening.

This circadian stimulus metric was developed from several lines of biophysical and retinal neurophysiology interdisciplinary research. It has been validated in several controlled experiments and has been used successfully in a number of real-world applications including nuclear submarines, senior facilities for persons with Alzheimer's disease and offices. A circadian stimulus calculator is also made available online for lighting professionals to enable them to convert the photopic illuminance at the eye provided by any light source and level, into the effectiveness of that light for stimulating the human circadian system (Rea and Figueiro 2016, Rea et al. 2010). Though the science behind the circadian stimulus metric may be difficult in understanding for designers who have not specialized in lighting, it should not be a reason to adopt the simpler, alternate approaches that either disregard health effective light or are knowingly inaccurate, unreliable and without validation.

3.2. Relative Spectral Effectiveness

The Interdisciplinary Laboratory of Performance-Integrated Design at the École Polytechnique Fédérale de Lausanne has developed a new visualization tool, the "SpeKtro" dashboard - available online at spektro.epfl.ch, where it is possible to upload and analyze the SPD of any light source. It is based on two unit-less quantities: the energy-related and the vision-related relative spectral effectiveness (RSE) factors (Ámundadóttir, Lockley, and Andersen 2015). The energy-related RSE enables the evaluation of a SPD for a light source in terms of its comparative 'energy' relationship to an equal-energy spectrum for any system of photoreception. Similarly, the vision-related relative RSE factor enables the evaluation of a SPD for a light source in terms of its comparative 'brightness' relationship to an equal-energy spectrum.

The relative SPDs are shown for the visible part of the electromagnetic spectrum, between 390 nm and 700 nm. These spectral weighting functions show the relative spectral sensitivity of the five human photoreceptors and the photopic luminous efficiency. The interactive dashboard outputs light quantity dose-response curves that display the biological impact of melatonin phase shifts, melatonin suppression percentages and KSS rating of subjective alertness.

This unifying effort builds on existing literature and aims to help communicate information on non-visual spectral effectiveness in a universal way (Ámundadóttir, Lockley, and Andersen 2016). The dashboard can be adopted as an option to investigate the biological impacts of light sources. As it is fairly new tool, it could benefit from its use in many studies for exposure and validation.

4.0. STRAUB HALL PILOT STUDY

To further investigate the impacts of daylighting beyond its instrumental quality, a pilot study was conducted as a proof of concept for a larger study. This domain of work aims to elaborate on the glass industry's research by investigating the effects of window design decisions (location, orientation, type) on the transmission of the electromagnetic spectrum within a space's interior and how the light transmitted affects occupant perception of the space, health and wellbeing.

4.1. Background, Methods and Procedures

A pilot study was conducted on the 26th of January in Straub Hall at the University of Oregon campus in Eugene during the morning (8-10am) hours of the day. The aim of this study is to investigate the extent of change in spectral power distributions (SPD), color rendering indices (CRI), and correlated color temperature (CCT) in relation to distance from a clear window in the hallway and how this correlates to the decrease in illuminance levels. This is because using instrumental, dynamic metrics that simply measure illuminance levels neglect components of daylight that are responsible for human response to visual interest, psychological and biological impacts which are affected by SPD, CRI, and CCT.

With the use of an Asensetek Lighting Passport Pro spectrometer, SPD, CRI, CCT, and illuminance levels measurements were taken. This data was collected at different distances from the window, at 5ft marks. It was then converted in circadian stimulus using the circadian stimulus calculator developed by The Lighting Research Center.

4.2. Findings and Future Implications

The results indicate that differences in SPD, CRI, and CCT are subtler than the perceivable changes in illuminance levels (Table 1, Fig 1-3). However, these marginal differences still needed to be translated into biological impact for circadian entrainment in order to make this data transferable and fully comprehend the necessity of taking it into consideration for the sake of non-instrumental benefits of daylight.

When the SPD was converted to biological impact using the circadian stimulus calculator, the findings proved to identify false assumptions that illuminance levels and circadian entrainment necessarily go hand in hand. The readings at 10ft indicate that illuminance levels marginally reach 300 lux which is recommended for such a space. However, at that same 10ft mark, the 0.256 circadian stimulus fails to meet the recommended 0.3 benchmark as seen in Fig 2. This indicates that relying on illuminance-based metrics for health effective light might be insufficient in quantifying its applicability and impacts on occupant's well-being. This also gives insights into added considerations of changes in SPD as occupants step away from the window and rely on electric lighting. This influence could be used to maintain or increase illuminance levels, but it may still fail to meet the benchmarks for health effective light.

Table 1: Straub Hall Hallway Daylight Analysis. Source: (Author 2018)

Distance (ft)	Illuminance (Lux)	CCT(K)	CRI (Ra)	Circadian Stimulus (CS)
0	2154	5931	97	0.6442802
5	681	5143	97	0.498229045
10	297	4062	92	0.255852422
15	137	3964	92	0.127484796

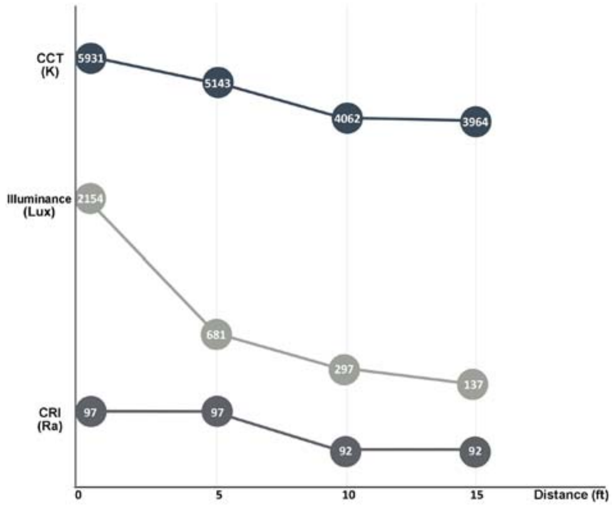

Figure 1: Straub Hall Hallway Illuminance, CCT, CRI. Source: (Author 2018)

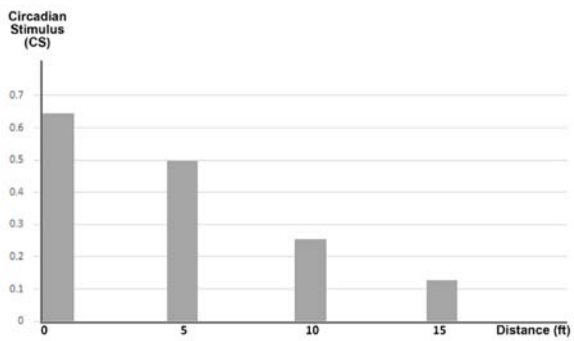

Figure 2: Straub Hall Hallway Circadian Stimulus. Source: (Author 2018)

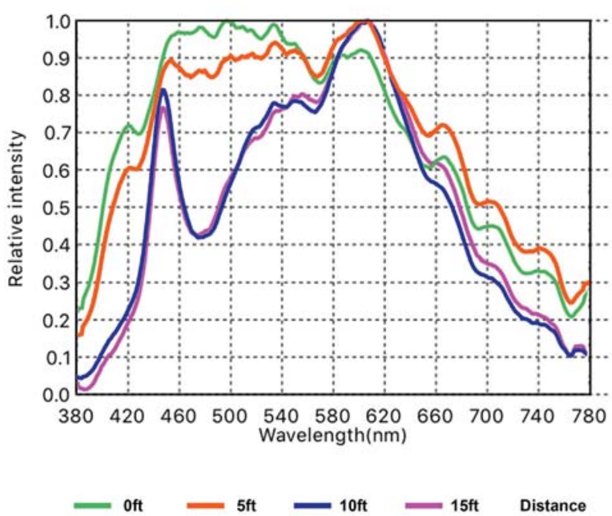

Figure 3: Straub Hall Hallway Spectral Power Distribution Analysis - Normalized. Source: (Author 2018)

CONCLUSION

In this paper, we have aimed to shed light on the shortcomings of the design community in regards to designing some aspects of the daylit environment. This is in the hope that this knowledge entices professionals to prepare and respond to the rising expectations of designing the luminous environment - not only to meet visual needs and related concerns such as reduction of glare but also to support human health and well-being. In order to integrate circadian lighting strategies, designers need to understand the behavior of occupants in the space, the sources of light and glazing types that transmit daylight so that the guidelines ensure the design intent is met. This can only be achieved if they have familiarized themselves with the appropriate metrics for health effective light. If lighting professionals do not have a proper grasp of how to measure light as an enabler for health and well-being, then their designs cannot be effectively delivered. Further studies need to acknowledge this limitation and develop applicable metrics for the proper quantification of instrumental and health impacts of daylighting in approachable terms for lighting designers and architects.

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Anupam Dutt Satumane, Jae Yong Suk

Impacts of Vertical Greening System (VGS) on Daylight Quantity and Quality in Buildings

Impacts of Vertical Greening System (VGS) on daylight quantity and quality in buildings

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ABSTRACT: With the efforts to reduce building energy consumptions and to improve occupant comfort, use of natural light in buildings has become inevitable. Buildings of today have large glazing on their facades to allow sunlight into building interiors. When adequately introduced, natural light provides numerous benefits ranging from energy saving to occupant comfort. However, natural light can also cause thermal and visual discomfort to occupants by uneven distributions of illuminations or extremely high luminance in occupant's field of view. Vertical greening system (VGS) on exterior building facades can be utilized to control the amount of sunlight in building interiors. Multi-angled reflective and translucent surfaces of plants reflect and diffuse direct sunlight so that appropriate amount of daylight can be introduced in buildings.

In order to verify potential daylighting benefits of VGS, physical experimentation was performed. Three different vines that are widely used in VGS were chosen and their influences on the quality and quantity of natural light were investigated. A wooden cube box was built to simulate building interior space and fitted with an acrylic panel to simulate a south-facing window. The vines are mounted on a metal trellis with a square grid of 6-inches to mimic the natural growth of the vine and installed 6inches away from the window. The model was then mounted on a Heliodon and tested for different times in the year using the Sun as a light source. Lighting characteristics such as illuminance, luminance, discomfort glare and light color temperature were measured and analyzed. The findings show that discomfort glare levels were greatly decreased with the help of the vines as vertical illuminance levels were lowered and luminance distributions became more even by reflecting and diffusing direct sun penetrations. It was also observed that illuminance level and discomfort glare reduction are not only affected by the physical characteristics of plants. They are also affected by sun positions such as altitude and azimuth angles in different times and dates of the year.

KEYWORDS: Vertical greening system, Daylighting, Vines, Discomfort glare, HDR Photography.

1.0 LITERATURE REVIEW

In a typical urban environment, buildings have a large amount of glazing on their facades. These fully or partially glazed facades allow natural light and direct views to outdoor environments. However, the transparency of the large glazed facades can cause serious visual and thermal discomfort to occupants. When discomfort is experienced, building occupants often choose to close interior blinds to block strong sunlight penetrations. This, can increase architectural lighting energy consumptions. Many exterior shading strategies have been adopted to avoid occupant discomfort and to maintain energy-saving benefit from daylight harvesting in buildings. VGS are considered as one of the potential strategies to condition sunlight for improved visual and thermal comfort while maintaining a direct view of outdoor environments. However, the impact of green screens on natural light in buildings have not been thoroughly investigated yet.

1.1. Benefits of daylighting

The largest end use of electricity by commercial buildings in the United States which constitutes to 17%, is used for lighting (CBECS 2018). This large consumption of electricity in buildings for architectural lighting can be reduced by employing a suitably designed daylighting system, which in turn can reduce the utility cost of buildings. Prior studies have found that the use of daylight in buildings also provides non-energy related benefits such as psychological and physiological impacts on occupants. Daylighting offers a better quality indoor space to building occupants as the full spectrum natural light provides the best color rendering and depth perception. These benefits are as important as savings in building energy consumption. Natural light

provides a homogeneous spectral distribution of light which is critical to regulating biological functions in humans. The majority of architectural lighting used in today's buildings lacks this spectral distribution, although full-spectrum fluorescent lighting does come close (Hathaway and Others 1992). Natural light provides a balanced spectrum of color, peaking in the blue-green area of the visible spectrum which makes it highly desirable (Liberman, J. 1991). The psychological and physiological effects of the different spectrums are not easily quantifiable and hence often overlooked.
A naturally daylit space has been known to improve mood, lower workplace fatigue, reduce eye strain and enhance morale. The dynamic nature of natural light with its change in intensity, subtle changes in color provides the occupants with a sense of connection to nature and enhance their experience. Occupants in daylight and full-spectrum office buildings reported an increase in general well-being. Specific benefits in these types of office environments include better health, reduced absenteeism, increased productivity, financial savings, and preference of workers. Benefits to the office worker are so great that many countries in Europe require that workers be within 27 feet of a window (Franta and Anstead 1994).

1.2. Visual discomfort

Visual discomfort is the phenomenon where there is irritation or pain in or around the eyes, usually accompanied by headache, nausea, redness or watering of eyes. Visual discomfort is caused due to lighting condition such as insufficient light for the task at hand, dramatic differences in illuminance around the task, shadows, reflections, glare and flicker (Boyce and Wilkins 2018).
Visual discomfort from natural light can be caused by direct sunlight penetrations or reflected sunlight from reflective and specular building materials. Discomfort glare can also be caused due to reflections from materials and surfaces such as glazed façade of building, water bodies and the sky. Precedent studies have proved that unsuitable levels of illumination cause strain to the eyes and reduce the productivity of occupants. Over-illumination causes fatigue, medically defined stress, anxiety and decreased sexual function in building occupants (Baum 1997, Burks 1994, Pijnenburg et al. 1991 and Knez 2001). Uneven distribution of light can make the extreme contrast in interior surfaces which cause visual discomfort.

1.3. Vertical Greening System

The vertical greening system is a structure that facilitates the growth of vegetation to spread over a building facade or interior wall. They can be installed as freestanding structures, or they can be attached to existing building facades. There are two supporting systems that are commonly used to support climbers and keep them away from facades; Cable and Wire-Rope Net and Modular Trellis Panel systems. Climbers are rooted in the ground at the bottom of these structures and it takes 3-5 years to achieve the full façade coverage (Greenscreen 2018). Vines on vertical greening system have been used for summer cooling by covering the building surfaces and pergola structure to produce shade (Stav, Y. 2008).
The metal trellis system is widely used in buildings with VGS. The trellis is made from either stainless steel or galvanized steel and coated with zinc at 380 g/m². Because of the system rigidity, it can be used for green walls that are freestanding. The thermal benefits of VGS on buildings have been extensively studied in precedent studies. However, the impacts of VGS on the quality of interior daylighting has not been quantified. Some of the notable buildings that employ VGS on their facades are, National wildlife headquarters in Virginia, The Kyocera Tanagura plant in Fukushima, Japan, The center for interactive research on sustainability in Vancouver, Canada, The Pritzker children’s zoo at Lincoln Park Zoo and the Rush University Medical Centre in Chicago Illinois (Figure 1).

Figure 1: Examples of VGS on building facades (Left: Pritzker children’s zoo at Lincoln Park Zoo in Chicago Illinois, Right: Rush Medical Centre in Chicago Illinois) (“Vines72.Jpg (324×432)” n.d.) (“TL_Mar-2008_Rush.Jpg (1200×900)” n.d.).

2.0 RESEARCH METHODOLOGY

To simulate and document daylighting quantity and quality influenced by VGS, physical experiments were performed in San Antonio, Texas on November 6th, 2017 under clear sky conditions. A physical model was made out of Baltic Birch wood measuring 3ft in height, width and depth (Figure 2). On one of the vertical faces, a 2ft by the 2ft window was cut out and fitted with an acrylic panel with 98% transparency to represent a window with high transmittance. The warm and light color wood material was sanded for uniform seamless grains. The vines were mounted on a metal trellis with a grid of 6-inch x 6-inch to mimic the natural growth of the vine. The 6-inch x 6-inch grid was selected as it is most widely used and provides adequate spacing between the leaves of the vines. The trellis was then installed 6 inches away from the window. The trellis is composed of a heavy duty 4 gauge (1/4") galvanized rods that were welded into a grid and are heavily galvanized with a thick zinc coating.

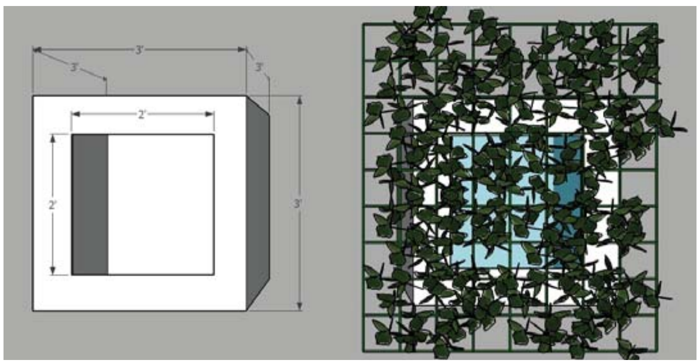


Figure 2: 3D model of the physical model and vine mounted on a metal trellis

Three different types of vines were selected for physical experiments: Carolina Jasmine, Rangoon Creeper, and Confederate Jasmine. These Vines were selected for the following three reasons: 1) they are available locally in San Antonio, 2) they are climbers that climb a metal trellis as they grow, and 3) they have different leaf sizes, shapes, leaf distribution pattern and leaf colors. The physical characteristics of each vine are listed in Figure 3. And key characteristics of the three vines such as density of foliage and leaf size are listed below.

- Vine 1(Carolina Jasmine) has the least dense foliage with small leaves of the length of 1 inch and width of 1/2 inch.
- Vine 2 (Confederate Jasmine) has medium dense foliage with medium leaves of the length of $3\frac{7}{8}$ inches and width of $1\frac{3}{4}$ inch.
- Vine 3 (Rangoon Creeper) has the highest dense foliage with large leaves of the length of 6 inches and width of 2 inches.

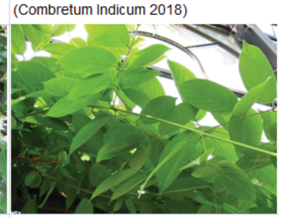
	Description of Vines	
Carolina Jasmine: source: (Gelsemium Sempervirens 2018)	Confederate Jasmine: source: (Trachelospermum Jasminoides 2018)	Rangoon Creeper: source: (Combretum Indicum 2018)
		
Leaf Retention: Evergreen	Leaf Retention: Evergreen	Leaf Retention: Evergreen
Leaf Shape: Lanceolate	Leaf Shape: oval to lanceolate	Leaf Shape: elliptical
Leaf Venation: Pinnate	Leaf Venation: Opposite	Leaf Venation: Opposite
Leaf Texture: Waxy	Leaf Texture: Waxy	Leaf Texture: Waxy
Leaf Size: 1/2 inch to 1 inch long and 1/2 inch wide.	Leaf Size: ($\frac{3}{4}$–$3\frac{7}{8}$ in) long and ($\frac{3}{8}$–$1\frac{3}{4}$ in) wide.	Leaf Size: 3-7 inch long and 1-2 inch wide.

Figure 3: Physical characteristics of the three selected vines.

The physical model with each type of the vines was mounted on a Heliodon to simulate various sun positions on the summer solstice, winter solstice, and equinox. The source of light used in the experiment is the Sun. No artificial light source was utilized or introduced in this study. Various incident sun angles at 9:00 am, 12:00 pm and 3:00 pm were simulated for each of the selected days. Each vine type was tested on a total of nine different test conditions (3 days x 3 times) as shown in Figure 4. And, measured daylighting quantity and quality data were compared to a baseline case without VGS.

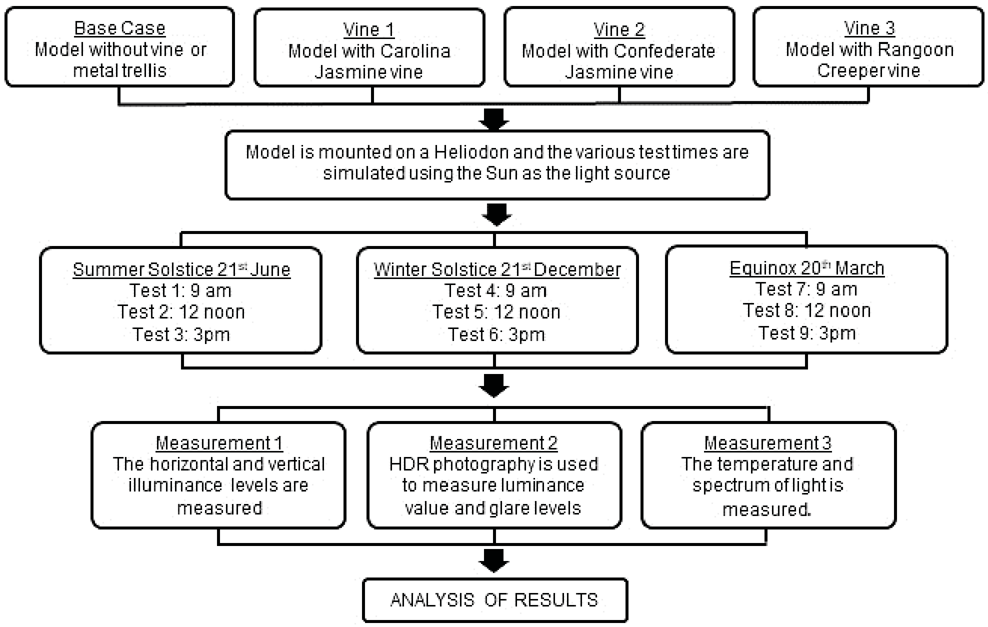


Figure 4: Physical experimentation sequence

Lighting characteristics such as illuminance, luminance, and light color temperature were measured using an illuminance meter, High Dynamic Range (HDR) photography technique and a spectrometer. Table 1 lists the different parameters and their units.

Table 1: Description and sequence of tests conducted

Sequence	Instrument	Parameter Analyzed	Metric Used
1	Illuminance Sensor	Quantity of Light	Lux
2	HDR Photography + HDR scope program	Glare	Daylight Glare Probability
3	Spectrometer	Correlated color Temperature	Kelvin
4	Spectrometer	Spectral composition of Light	Wavelengths

Li-Cor photometric sensors (Illuminance sensors) were used to simultaneously measure the quantity of natural light inside and outside the box for every case. The sensor inside the box was placed at the center of the floor of the box at the distance of 1 ft. from all the vertical faces. The sensor outside the box was placed at the center of the outward facing horizontal surface, representing the roof of the box at a distance of 1 ft. from all the edges. The indoor illuminance levels (Lux) with the three vines were compared to the illuminance levels of the base case to analyze the impacts of the vines on daylight quantity.

A spectrometer (Sekonik C-700-c) was used to analyze the light composition and color temperature of natural light inside the model after sunlight passes through the selected vines. Measured spectral composition of light and correlated color temperature values of each individual vine were compared to the base case to analyze the impacts of the vines on the quality of the light.

HDR photography was used to capture various daylit scenes with and without the selected vines. HDR images were taken inside the model with the camera fitted with a fisheye lens and facing towards the window. The camera was placed at the center of the vertical surface directly opposite to the surface with the window at a distance of 1 ft. from all its edges. Every pixel in the HDR image stores accurate luminance information that can be used to perform quantitative and qualitative light analysis. The camera was calibrated to match the luminance data from the HDR photographs to measured luminance values prior to the tests. These captured HDR images were analyzed using HDRscope to calculate the daylight glare probability (DGP) values. A DGP value below 0.35 is considered as imperceptible glare, 0.35 - 0.40 is perceptible glare, 0.40 - 0.45 is disturbing glare, and above 0.45 is intolerable glare (Wienold 2018).

3. ANALYSIS

The physical characteristics of vines such as density of foliage and leaf size play an important role in their impacts on the quantity and quality of light. Therefore, it is important to relatively compare these key characteristics amongst the three vines before analyzing the impacts of each individual vine.

3.1 Discomfort Glare Analysis

Glare analysis was first conducted with the captured HDR images. Daylight glare probability (DGP) values for each scenario were calculated and compared to the base case model (Table 2).
In the nine scenarios tested for a base case scenario without vines, five scenarios (bolded values in Table 2) show either disturbing glare or intolerable glare with DGP values ranging from 0.41 to 0.79. The calculated DGP values show that vines decrease the chances of visual discomfort, particularly in summer and winter solstices. The vines do not make any impact on DGP scores on the equinoxes as the DGP values in the base case were imperceptible to begin with.
In the five scenarios, it was noticed that:

- Vine1 (Carolina Jasmine) reduced perceptible glare to imperceptible values ranging from 0.26 to 0.35 in 3 scenarios on winter solstice.
- Vine 2 (Confederate Jasmine) reduced perceptible glare to imperceptible values ranging from 0.31 to 0.35 in 4 scenarios on winter solstice and at 3:00 pm on summer solstice.
- Vine 3 (Rangoon Creeper) reduced perceptible glare to imperceptible values ranging from 0.26 to 0.35 in all 5 scenarios on winter solstice and summer solstice.

Table 2: Daylight glare probability (DGP) values for glare analysis.

Glare Analysis - Daylight Glare Probability (DGP)					
Day and Time	Altitude	Base case	Vine 1	Vine 2	Vine 3
Summer Solstice-9:00 am	42°	0.29	0.25	0.25	0.23
Summer Solstice-12:00 pm	80°	***0.79***	0.47	0.54	***0.37***
Summer Solstice-3:00 pm	57°	***0.41***	0.41	***0.33***	***0.28***
Winter Solstice-9:00 am	16.5°	***0.47***	***0.26***	***0.32***	***0.27***
Winter Solstice-12:00 pm	36°	***0.55***	***0.35***	***0.31***	***0.24***
Winter Solstice-3:00 pm	26°	***0.53***	***0.32***	***0.33***	***0.26***
Equinox-9:00 am	30°	0.29	0.25	0.25	0.23
Equinox-12:00 pm	60°	0.26	0.23	0.23	0.22
Equinox-3:00 pm	46°	0.23	0.22	0.22	0.21

It is observed that the reduction in discomfort glare (the calculated DGP values) is directly proportional to the density and leaf size as the higher density of leaves provided more shading. Additionally, the larger glare reduction was seen in vines during test scenarios where the altitude of the sun was low, ranging from 16.5 degrees (9:00 am on the Winter solstice) to 57 degrees (3:00 pm on the summer solstice). However, in the case of the Equinox, the low sun altitude of 30°, 60° and 46° at 9:00 am, 12:00 pm and 3:00 pm showed imperceptible glare for the base case as well as the three vines. This imperceptible glare at low sun altitudes was caused due to the low levels of illuminance in comparison to the other cases. The luminance level inside the box for 9:00 am was 2596 Lux, 12:00 pm was 1678 Lux and 3:00 pm was 974 Lux which are significantly less when compared to the cases that show perceptible glare in the base case. This illustrates that in addition to the altitude of the sun, the DGP value is directly proportional to the intensity of the light.

At 9:00 am on Winter Solstice (16.5-degree sun altitude), the calculated DGP values for the base case was 0.47, Vine 1 was 0.26, Vine 2 was 0.32 and Vine 3 was 0.27. All three vines showed a significant reduction in

discomfort glare where the intolerable glare in base case was brought to imperceptible glare with the help of the vines.
At 3:00 pm on the summer solstice, the DGP values for the base case was 0.41, Vine 1 was 0.41, Vine 2 was 0.33 and Vine 3 was 0.28. Vine 1 showed no reduction in DGP score. However, Vine 2 and Vine 3 significantly reduced the DGP scores to imperceptible glare.
The test case with the highest altitude of the sun, at 80 degrees was observed at 12:00 pm on the summer solstice. In this case, the DGP value in the base case was 0.79 which is the highest DGP value observed in the tests. The DGP value of the Vine 1 was 0.47, Vine 2 was 0.54 and Vine 3 was 0.37. Despite a significant reduction of DGP values was observed in all three venues, only Vine 3 brought the DGP value low enough to be classified as perceptible glare. From the above data, it is inferred that the glare reduction potential of all three vines is inversely proportional to the angle of altitude of the sun in the sky.

In addition to the calculated DGP scores, examples of the captured HDR images for the base case, Vine1, Vine 2 and Vine 3 shown in Figure 5. At 12:00 pm on the winter solstice, all the vines were able to bring down the DGP values to imperceptible glare levels (0.33-0.38) from intolerable levels (0.53). A very large sunlight patch was projected on the floor of the room through the window. It is possible to assume that intolerable glare in the base case is caused by the reflected sunlight on the floor rather than the sky through the window. All three vines cast shadows on the floor as they block and filter direct sunlight. Compared to Vine 1 and 2, Vine 3 shows the densest shadows on the floor, which lowers discomfort glare levels to imperceptible glare sensation. At 12:00 pm on the summer solstice, all four scenarios have a small direct sunlight penetration right in front of the window. It is understood that the bright sky outside the windows causes an intolerable glare sensation and the three different types of the vines help to reduce the luminance of the sky as they filter direct sunlight. The luminance outside the box was observed to be 129500Lux, the luminance inside the box for vine 1 was 4407 Lux, Vine 2 was4193 Lux and vine 3 was 3088 lux. This demonstrates that Vine 3 showed a reduction of about 25% when compared to vine 1 and 2. However, the luminance of the windows is still in the range of causing an intolerable glare sensation in the Vines 1 and 2. Vine 3 with the large leaf size greatly reduced discomfort glare levels of intolerable glare to perceptible glare. From this it is evident that reduction of luminance values inside the box also reduces the DGP values.

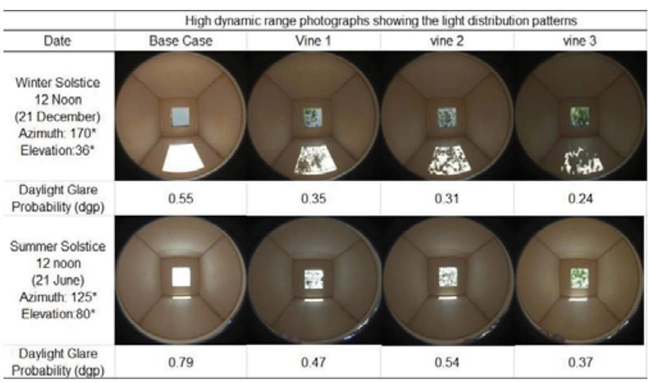


Figure 5: HDR images showing the light distribution patterns and daylight glare probability values

3.2 Correlated Color temperature

The impact of the vines on light color temperature was analyzed. Out of 24 measurements of light color temperature, 62% (15 cases) showed a significant decrease in light color temperature value in comparison to the base case. Corresponding to the color spectrum, making the light "cooler/whiter" or increase the value in Kelvin. For the cases where the vines made the light "warmer/redder" or decreased the value in Kelvin, a relation to the sun altitude angle was explored. However, no relation between the angle of altitude of the sun and the temperature of the light could be established.
Careful observation of the measured color temperature data revealed a relationship between the horizontal angles of the sun from the true North orientation, also known as the Azimuth angle. The three cases in which the Azimuth angle ranging from 130 degrees to 180 degrees, the vines decreased the Kelvin value compared to the base case making the light "warmer/ redder". This phenomenon can be attributed to the fact that the sunlight was not directly incident on the face of the model containing the window, the light that was entering the window was reflected from the immediate environment. The higher amounts of red in the reflected light can be explained by the Rayleigh scattering phenomenon where the short wavelength blue light gets scattered easily compared to the red light of longer wavelengths. The typical light distribution graph of both the cases, where the vines condition the light to appear "cooler/whiter" and "warmer/ redder can be observed in Figure

6. The data from the test, simulating the equinox at 3:00 pm was omitted as the light nearing sunset would be warmer in nature and provide misleading results.

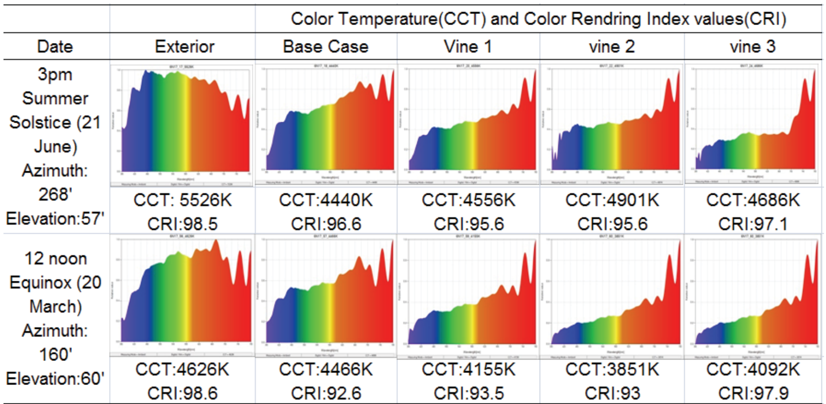


Figure 6: Color temperature, color rendering index values, and light composition spectrum

3.3 Illuminance level analysis:

Illuminance levels inside and outside the box were simultaneously measured for each scenario as shown in Table 3. The illuminance levels inside the physical model for the base case were compared to the three vines. In comparison with the light levels outside the box, the average reduction in light levels inside the model for the base case was 93.6%. In comparison to the light levels inside the model at the base case, the average reduction in Vine 1 was 34%, Vine 2 was 44% and Vine 3 was 55%. As expected, the percentage of reduction in illuminance levels was proportional to the density of the foliage and leaf size in the vines. In addition to the physical characteristics of the vines, the altitude of the sun also influenced the percentage of reduction in the individual cases.

The maximum reduction of illuminance levels was observed at 9:00 am on winter solstice, when the altitude angle is lowest among the cases. The reduction percentage in Vine 1 was 63%, Vine 2 was 60% and Vine 3 was 70 %. In the case of highest sun angle of 80 degrees at 12:00 pm on the summer solstice, the reduction percentage in illuminance levels were 37% in Vine 1, 40% in Vine 2 and 55% in Vine 3. This result also relates to the reduction in daylight glare probability of the individual vines.

Table 3: Light level reduction of the three vines compared to the base case

Test Conditions				Illuminance-Interior (Lux) and Percentage of reduction			
Date and Time	Azimuth (Degree)	Elevation (Degree)	Illuminance-Exterior	Base Case	Vine 1	Vine 2	Vine 3
21 June 9:00 am	84°	42°	90,980 lux	1564 lux	1116 lux 28%	1221 lux 22%	1022 lux 34%
21 June 12:00 pm	125°	80°	12,9500 lux	6934 lux	4407 lux 37%	4193 lux 40%	3088 lux 55%
21 June 3:00 pm	268°	57°	84,170 lux	2482 lux	1705 lux 31%	1092 lux 56%	1131 lux 54%
21 December 9:00 am	130°	16.5°	44,980 lux	6480 lux	2366 lux 63%	2586 lux 60%	1917 lux 70%
21 December 12:00 pm	170°	36°	66,720 lux	4810 lux	3382 lux 30%	2400 lux 50%	2555 lux 47%
21 December 3:00 pm	217°	26°	32,140 lux	3895 lux	1462 lux 62%	1783 lux 54%	1399 lux 64%
20 March 9:00 am	109°	30°	55,670 lux	2596 lux	1745 lux 33%	1706 lux 34%	982 lux 61%
20 March 12:00 pm	160°	60°	43,740 lux	1678 lux	1116 lux 33%	919 lux 45%	651 lux 61%
20 March 3:00 pm	235°	46°	20,310 lux	974 lux	722 lux 25%	622 lux 36%	451 lux 54%

4.0. CONCLUSION

The objective was to gain a better understanding of the potential influence of vertical greening system on daylight quantity and quality inside buildings. The findings show that physical characteristics of plants such as density of foliage, leaf size, and distribution have a significant impact on the quality and quantity of daylight into the building. The captured HDR images also show that the leaf size and density blocks outdoor view but casts more shadows, especially at low sun angles. Discomfort glare levels were greatly decreased with the help of the vines as both illuminance and luminance levels were lowered by blocking and diffusing direct sun penetrations. The study also reveals that illuminance level and discomfort glare reduction is not only affected by the physical characteristics of plants, but also affected by the intensity of sunlight, sun positions such as altitude and azimuth angles in different times and dates of the year. Consideration of both plants and sun position is required to make a successful integration of vertical greening system in buildings. No strong correlation was found between light color temperature changes in relation to the types of vines. However, vertical greening system can ensure the benefits of daylighting by significantly reducing glare and reducing the excessive amount of light levels.

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Mary Guzowski

An Ecology of Daylighting: Form Follows Light and Performance Follows Form

An ecology of daylighting: Form follows light and performance follows form

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ABSTRACT
This paper explores how an ecological approach to daylighting can give form to architecture while simultaneously defining the building performance and human experience. A case study profile of Mario Cucinella Architects' recently completed ARPAE (Regional Agency for the Prevention, Environment and Energy) Headquarters in Ferrara, Italy considers the balance between the practical and the poetic, as well as the aesthetic dimensions of ecological daylighting design. Over the past decade, the "science of daylighting," has matured as practitioners and building science researchers have continued to demonstrate measurable benefits of daylighting in the areas of energy savings, carbon and greenhouse gas reductions, increased human comfort, and improved productivity and health. These developments have benefited architects and designers to more effectively integrate daylight with other design and performance issues. Yet, with the promise of scientific and analytical advances, there also lies a risk of too narrowly focusing on daylight parameters that are measurable and empirically defined. An analytic perspective on daylighting design needs to be balanced with the qualitative and experiential dimensions of natural light. The ARPAE project was developed using design methods and tools for thoughtfully integrating daylighting performance with human experience in relation to place, seasons, and time. The paper investigates an ecological approach to daylighting design using interviews and evaluation of qualitative and quantitative assessments provided by the architect to consider the potential of daylighting to simultaneously shape the building and subsequent human experience and design performance.

KEYWORDS: Daylighting, Energy, Sustainable Design

INTRODUCTION

Over the past decade, the "science of daylighting," has matured as practitioners and building science researchers have continued to demonstrate measurable benefits of daylighting in the areas of energy savings, carbon and greenhouse gas reductions, increased human comfort, and improved productivity and health. Great improvements have been made in digital rendering, analysis tools, and an ever-increasing number of daylight metrics, guidelines, and assessment methods. These developments have benefited architects and designers in more effectively integrating daylight with other design and performance issues. Yet, with the promise of scientific and analytical advances, there also lies a risk of too narrowly focusing on daylight parameters that are measurable and empirically defined. An analytic perspective on daylighting design needs to be balanced with the qualitative and experiential dimensions of natural light.

This paper explores an ecological approach to daylighting design in which form, performance, and human experience are inseparable. It considers how daylight is foremost a design issue, and secondarily a question of technology. A case study investigation of the ARPAE (Regional Agency for the Prevention, Environment and Energy) Headquarters in Ferrara, Italy by Mario Cucinella Architects (MCA) reveals how daylight shapes

Figure 1: South and east facades (left); roof under construction (right). Source: (Moreno Maggi Photograher, MCA, 2017)

architectural form and form shapes the resulting experiential and performance qualities and characteristics of architecture (Figure 1). The study included interviews and evaluation of qualitative and quantitative assessments provided by the architect to consider the potential of daylighting to simultaneously shape the building and subsequent human experience and design performance. The building was studied through drawings, diagrams, schematic models, and findings from the technical report. Acknowledging the limitation of studying a single building, the research provides initial insight into the potential of daylighting as a poetic and performance design driver. Cucinella's approach to design seeks to integrate both the poetic and the pragmatic dimensions of daylight by considering natural light as an environmental phenomenon and a dynamic "building material". Daylight has evocative form-giving potential that is intimately related to site, programmatic, performance, material, and experiential dimensions of design. It is an environmental phenomenon and an ephemeral architectural material. Daylight and the changing environmental forces of sun, wind, and weather help us to know "where we are" and "who we are" by rooting us in the ecological phenomena of a particular place, in that climate, and on that site. When coupled with passive solar and bioclimatic design strategies, daylight can reduce energy consumption and provide environmental benefits while enhancing human comfort, health, and well-being. ARPAE demonstrates the intersection of form and performance as the essential design goal, as Mario Cucinella explains: "Form and performance is a relationship. Expressing well the idea of architectural form [as] fundamental to the performance of building and [considered] before technology (Cucinella, 2015)".

1.0 FORM FOLLOWS LIGHT

Early modern architect Louis Sullivan is renowned for his 1896 essay on the "tall office building," in which he penned the famous phrase "form [ever] follows function": "It is the pervading law of all things organic and inorganic, of all things physical and metaphysical, of all things human, and all things super-human, of all true manifestations of the head, of the heart, of the soul, that the life is recognizable in its expression, that form ever follows function. This is the law (Sullivan, 1896, 403-409)". Inspired by the Roman architect Marcus Vitruvius Pollio, who wrote in *De Architectura (Ten Books on Architecture)* about the architectural qualities of *firmitas, utilitas, venustas* or "firmness, commodity, and delight," Sullivan inspired architects to explore the richness, value, inherent beauty, and form-giving potential of fundamental elements of architecture such as structure, materials, construction methods, technology, and program (Sullivan, 1924, 108). In a similar spirit, Alvar Aalto, the renowned Finnish modern architect, cautioned against the exploration of form independent of context: "Only where form arises at the same time as content or in faithful combination with it, as it were, can we speak of a step forward, but then form as a separate element no longer interests us (Ruusuvuori, 1978, 155)". Similarly, Louis Kahn, a contemporary of Aalto, characterized the inseparable relationship between form, design, and program: "Form is 'what.' Design is 'how.' Form is impersonal; Design belongs to the designer. Design gives the elements their shape, taking them from their existence in the mind to their tangible presence. Design is a circumstantial act. In architecture, it characterizes a harmony of spaces good for a certain activity (Lobell, 1985, 28)".

An ecological variation on this theme can be found early in the development of regenerative design theory when landscape architect John Tillman Lyle included the concept "Shape Form to Guide Flow," as one of eleven regenerative design strategies, as Lyle explained: "This principle could also be stated 'flow follows form follows flow.' Energy and material flows occur within the physical medium of the environment, and the medium largely determines the pace and direction of flow. By shaping the medium (the environment), we can guide the flow (Tillman Lyle, 1994, 43)". This principle extends to daylighting design in the ways that form influences the flow of light in its movement, quantity, and quality. The flow of light also shapes form; while the luminous characteristics of natural light inform our perceptions of architectural form and space. The building massing, section, size and placement of windows, detailing of the windows inside and out, and other form-related factors determine how deeply light can penetrate into a space, how light is distributed, and the amount and atmosphere of light.

More recently, Swiss architect Peter Zumthor reflected on the notion that "form follows anything," as Zumthor explained: "In a way I think it's true, form can follow content, it can follow profit, it can follow the truth, it can be used to create presence. . . . Architecture is not about form, it is about many other things. . . . The light and the use, and the structure, and the shadow, the smell and so on. I think form is the easiest to control, it can be done at the end (Zumthor, 2013)". His variation on Sullivan's famous quote suggests that form can arise out of diverse factors such as place, climate, culture, users, activities, and construction. While form may not always be the starting point, it is nonetheless of fundamental importance, as Zumthor clarifies: "But if, at the end of the day, the thing does not look beautiful – and I'm deliberately just saying beautiful here . . . if the form doesn't move me, then I'll go back to the beginning and start again. So you could say . . . my final aim, probably is: The Beautiful Form (Zumthor, 2012, 71-73)". Form and light are inseparable from the activities and purposes of architecture. Whether poetic or pragmatic in nature, an inherent beauty and aesthetic comes from finding the appropriate form for the architectural context and aspirations.

2.0 LIGHT AND THE QUALITY OF PLACE

2.1. Ferrara and the Po River Delta

Located in the Emilia-Romagna region of northeastern Italy, the new headquarters for the ARPAE headquarters is a model of ecological innovation. The office building is designed to demonstrate the ways in which architectural form can integrate with climate-responsive passive strategies, innovative systems, and new construction methods to create beautiful architecture while meeting the highest sustainable design standards for performance.

2.2. Bioclimate and Italian Light

Located on the outskirts of Ferrara, the open suburban site affords excellent access to sunlight, wind, and views. As a humid temperate climate, precipitation and high humidity are common, with relative humidity averaging 60 to 70 percent in the summer months and 80 to 90 percent in the winter. Precipitation varies throughout the year, with light to moderate rainfall greatest in May and least likely in October. The location experiences only occasional winter snow. The average precipitation ranges from a minimum of 11.6 millimeters (0.45 inches) in March to a maximum of 39 millimeters (1.58 inches) in October (World Weather Online, 2017). Temperatures are cool in the winter and hot in the summer, with an average low of 2.5° C (36.5° F) in January and an average high of 31° C (87.8° F) in July (WeatherSpark.com, 2017). Skies are clearest during the summer months and most overcast in the winter. Wind direction is variable throughout the year.

3.0 LIGHT AND THE DESIGN INTENTIONS

3.1 Defining the Ecological Office Program

Designed to meet the expanding office and laboratory needs of ARPAE, an environmental protection agency, the program brief emphasized sustainable design, technological innovation, ecological performance, and health and well-being. Cucinella designed the headquarters as a "model ecological office building" to celebrate dynamic luminous and thermal conditions and to challenge the status quo uniform approach to human comfort: ARPAE is about change. . . . [In the past,] the future of technology and innovation was a closed building with air conditioning and always the same temperature and the same light. In another office building we surveyed 160 people with a questionnaire. The results were impressive. They cared most about daylighting and the natural variation of [light] intensity. Artificial light has no variation. Daylight is part of the psychology, an emotional part of the story, a bright light and a cloud, it can change completely in intensity (Cucinella, 2015).
Rather than viewing changing light and thermal conditions as problems, Cucinella designed an office building that fosters varied conditions to improve occupant satisfaction and performance.

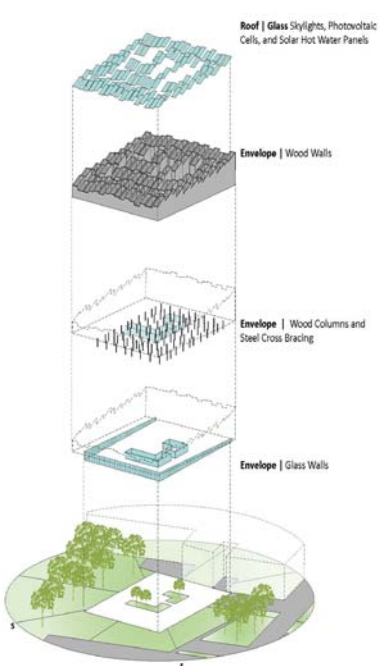

Figure 2: Massing and structure diagram. Source: (Fiona Wholey and Author, 2017)

Cucinella describes "form and performance" as an interrelationship that is the driving design concept at ARPAE: "Architectural form creates natural performance. . . . Combining the idea of daylight and natural ventilation gives extraordinary performance. The only way to improve comfort in summer is with cooling to increase air change and to move air and transport humidity (Cucinella, 2015)". The summer goal was to mediate the high relative humidity and temperatures with natural ventilation and to provide daylighting without solar gains. The winter goal was to harvest solar gains for passive heating, while providing luminous and thermal control in office and laboratory spaces (Figure 2).

3.2 Fostering a Site Relationship

To respond to today's ecological challenges, Cucinella argues that architects need a more empathetic understanding of the site and other living things:

> To be empathic is to have a relationship with someone else or a site . . . I call it 'creative empathy.' Showing empathy is an attitude. Using your mind and body to try to understand what is outside [of you]. Empathy is the capacity to listen, to create a relation. The first idea of the climate condition is to make an interpretation of the shape and angles of the building. I try to find in this information clarity . . . to influence and make the building from empathy with the site (Cucinella, 2015).

While always looking towards the future, Cucinella also seeks inspiration from bioclimatic design innovations that have been honed over thousands of years in vernacular architecture, which are often inherently empathic to place, culture, and nature. ARPAE provides a fresh interpretation of the traditional courtyard building by combining iterative wind chimneys with exterior and interior sidelighting to improve luminous and thermal performance and provide views to the site and gardens (Figures 2 and 3).

Figure 3: Interior courtyard (left); view to courtyard under construction (right). Source: (Moreno Maggi Photograher, MCA, 2017)

3.3 Enhancing Aesthetic and Sense Experiences

The design of ARPAE balances the practical dimension of daylight and the aesthetic and experiential opportunities. While mindful of addressing daylight requirements for visual comfort, glare, and illuminance targets (discussed in section 5.2), MCA also consider the role of beauty, aesthetics, health, and well-being in office design. Cucinella explains: “In the last 20 years architects have tried to make office space more efficient. They are so efficient that people are unhappy. If you look at the history of architecture, it was about quality. People are at work 8 to 10 hours [per day]. We need to take into account that they pass more time in the office than at home. We need to improve the office quality (Cucinella, 2015)”. Daylight, natural ventilation, and passive strategies invite occupants to experience the changing moods of the day and seasons. Interior and exterior views provide visual relief and connections to the landscape, while operable windows and adjustable shading enable occupants to individually tune their environment. The exposed wood structure and the healthy materials, finishes, and furnishings create a friendly and relaxed atmosphere that invites occupants to touch and interact with the envelope, space, and gardens (Figure 4 and 5). Human aesthetic and sense experiences of architecture have been design priorities throughout history, as Cucinella explains:

> I think of the Gothic architects, we see how much these people made an effort to make the wall so thin, to make colored glass to bring light inside, to create this emotion. . . . ARPAE’s new idea of beauty and sustainable design is not an illusion. It’s something very real. A connection, a relation to daylight and ventilation and shape. My concept of beauty is something invisible; but there is a part that is visible, that is aesthetic, like the character of a person (Cucinella, 2015).

Figure 4: Views into the courtyards and site while under construction: (Moreno Maggi Photograher, MCA, 2017)

4.0 LUMINOUS DESIGN STRATEGIES

Sited south of the existing office building, the rectilinear mass of the new headquarters is oriented to the southeast. A new garden entry creates a transparent connection between the old and new buildings to house the lobby and reception area. The single-story plan comprises a series of offices and labs organized around two L-shaped and interconnected garden courtyards at the heart of the building. In contrast to an open-office plan, Cucinella organized the building as a series of autonomous rooms linked by circulation routes and gardens. Each office and laboratory space has visual connections to either the outside landscape or the interior gardens and contains one or more roof monitors or “chimneys” to provide stack ventilation and daylighting. A seemingly “thick” building plan is transformed by the courtyards into a series of thinner spaces with both toplighting and sidelighting in each space. Borrowed light, views, and air are provided through interior and exterior operable glazing (Figure 5).

The building envelope uses two nested-façade systems, with recessed glazing at the ground level and an overhanging wood-clad envelope on the upper portion of the façades and roof monitors. The upper façade acts as a “solar visor” to shade the recessed glass during the warm seasons and to create a sheltered circulation space on the exterior of the building. Less shading is provided on the south to capture low winter sunlight for passive heating and daylight. Roof monitors extend beyond the glass envelope to admit light and air to the exterior circulation paths (Figure 6). Cucinella calls the roof “a climatic moderator,” and explains the essential ecological role of the chimney monitors: “The roof of the building, the so-called fifth façade, is the strongest design feature of the project. A series of chimneys give to the building a strong architectural identity while satisfying the technological requirements of the brief. The chimneys are skylights that filter natural light, promote natural ventilation and reduce the need for mechanical cooling (Mario Cucinella Architects, 2015, 1)”. The undulating rooftop monitors vary in height to avoid shading adjacent monitors and to respond to the east to west solar movement.

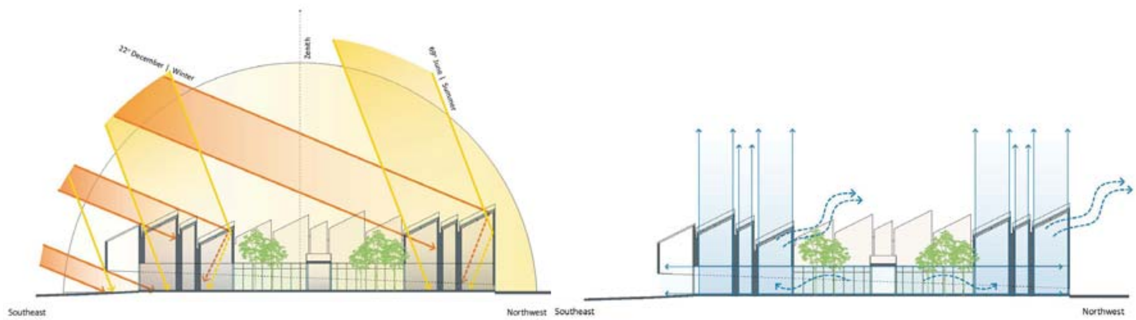

Figure 5: Sections illustrating façade overhangs and roof monitors. Source: (Fiona Wholey and Author, 2017)

Figure 6: View of layered façade (left); roof under construction (right). Source: (Moreno Maggi Photograher, MCA, 2017)

5.0 QUALITATIVE AND QUANTITIVE DESIGN PROCESSES

5.1 Qualitative Design Methods

MCA employ a variety of in-house methods and tools to support the early design decisions regarding the building siting, massing and section. The early design process includes diagramming, rendering, physical models, daylight models, and seasonal solar massing studies to assess daylight access and shading to explore massing, section, and varied roof forms and configurations. Cucinella emphasizes the importance integrating qualitative and quantitative intentions and methods into the early design process: “The way we design makes the aesthetic of the building…Using early design tools we bring that information from the beginning. I’m not an engineer, but I can simulate something at an early stage to work with daylight and suggest to the engineer how to integrate natural and artificial light (Cucinella, 2015).”

Cucinella encourages architects to reclaim more authority over the early integration of design and performance. He argues that the design process and performance testing are interrelated, and set the early trajectory of the project. Daylight models are an essential design tool used to study the building siting, exterior building massing, as well as the interior quantity and quality of light under varied sky conditions. Cucinella explains: "Daylighting is something you can learn using models. Start with a room and play with materials, shiny, matte, different intensities of color. Use a sensor to see how much daylight influences the quality and quantity of light inside the room (Cucinella, 2015)".

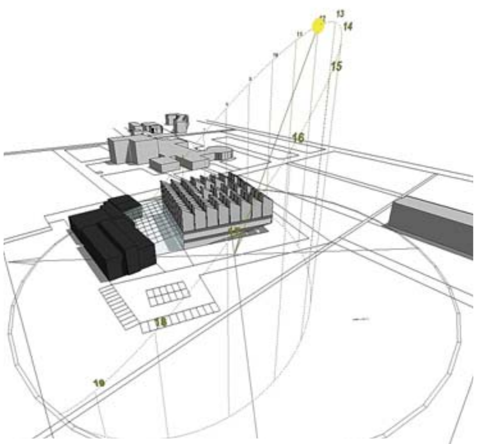

Figure 7: Example site massing solar diagram. Source: (MCA, 2016)

Despite sophisticated digital design tools, Cucinella stresses the critical role of simple physical models in understanding the design of daylighting. Given accurate geometry, room surface reflectance, and material properties, designers can accurately experience the quality of light while evaluating the illuminance levels and distributions. Cucinella emphasizes that the physical models are unique in allowing designers to have a tangible experience of light while and obtaining an accurate measure of illuminance levels in the space (Figure 8):

> We always start working with real models to understand and learn by experiencing the quality of light. You can learn so much from a box with a hole. You can see and transform the quality of light inside by changing color, changing surface, changing reflection. You can see the light and 3-D architectural elements. We always make physical models, especially daylight models (Cucinella, 2015).

Early design proposals for ARPAE were later refined using iterative quantitative analyses to assess the effectiveness of the daylighting and ventilation strategies.

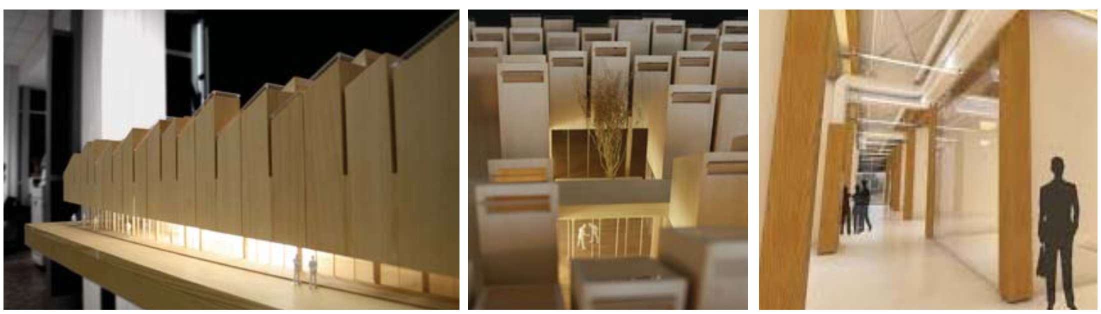

Figure 8: Example early daylight massing models and interior daylight studies. Source: (MCA, 2016)

5.2 Quantitative Design Methods

In later stages of the design, MCA worked with Roberto Zecchin, Adileno Boeche, and Andrea Fornasiero and colleagues at Manens-Tifs S.p.A, a leading engineering firm in Italy, to conduct bioclimatic studies and to further assess and refine the daylight, ventilation, and thermal design performance. Manens-Tifs developed a sequence of rigorous quantitative analyses to complement the qualitative in-house studies. Quantitative assessments provided essential insights into the architectural form and response to bioclimatic forces, while supporting an informed discussion to refine the daylighting design quality and performance.

Daylighting analyses were developed using RADIANCE software to assess the daylight factor (DF%) and illuminance levels (in lux) on the workplane at .75 meter (2.46 feet). Ten room locations were evaluated to compare the daylight performance in the four cardinal directions (north, east, south, and west) as well as interior locations along the courtyard. The studies evaluated the minimum, maximum, and average daylight factors in the select rooms to assess the room form and glazing transmission characteristics. An example illustration from the daylighting study is shown in Figure 9, which verifies that adequate daylight is provided on the workplane with an average daylight factor of 1.75-3.25% and illuminance levels of 350-550 lux. Additional daylight studies systematically evaluated the various combination of perimeter sidelighting, interior sidelighting from the courtyard, and toplighting to refine the building form and glazing specifications. Findings from Manens-Tifs were essential in design refinements: "The analyzes were carried out for several cases, in order to highlight the importance of the contribution of perimetrical windows and zenith glazing of the chimneys of light, taking into account some possible scenarios for the latter. Particular attention was paid to the importance of skylights, whose correct overall light transmission factor, taking into account shielding, is decisive for the success of the maximum natural lighting of the rooms" (Manens-Tifs S.p.A. 2009, 83-89).

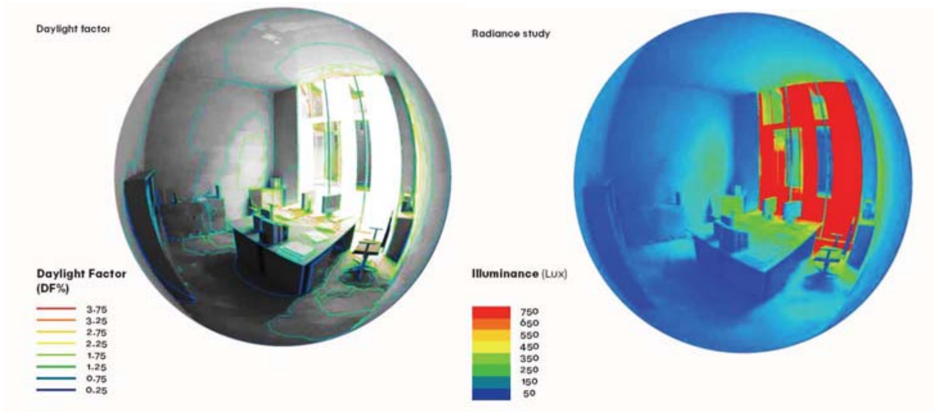

Figure 9: Radiance illuminance studies to assess daylight performance. Source: (MCA: Manens-Tifs S.p.A., 2009)

Natural ventilation was analyzed using Fluent 5.5 computation fluid dynamic software to evaluate the sectional contours of temperature in kelvin (k). Studies evaluated the direct average solar radiation in the solar chimneys (room monitors). Assessment of the vertical distribution and sectional contours of the room and chimney temperatures were conducted during the winter period (9;00-17:00 from December 1-February 28) as well as the summer period (8:00-19:00 on June 1-August 31). An example of the vertical distribution of temperature is illustrated in Figure 10. Findings from Manens-Tifs confirmed the effectiveness of the solar chimneys:

> "Stratification of temperatures does not take on too much marked characteristics, the action of a fan in conjunction with the presence of the solar chimney is useful in the de-stratification of the air inside the rooms and contributes to the heating of the occupied area…The flow of air coming from the lower part and coming out of the opening at the top avoids the accumulation of heat in the upper part of the structure" (Manens-Tifs S.p.A. 2009, 66).

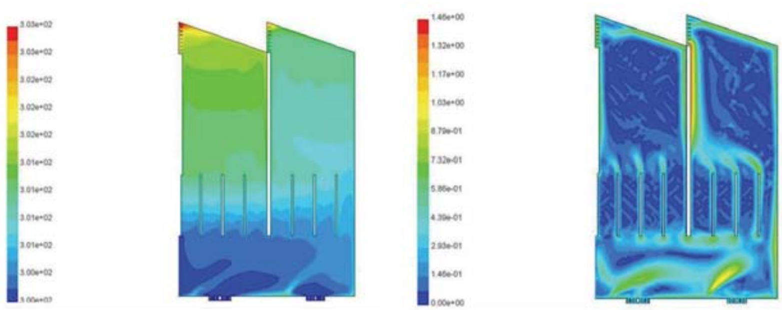

Figure 10: Computational fluid dynamics study of ventilation performance. Source: (MCA: Manens-Tifs S.p.A., 2009)

5.3 Light Shaping Form and Performance

Mario Cucinella set out to define a new model of ecological office building that responds to the particular conditions of site and climate; supports health and well-being of the occupants, and meets the highest standards of sustainable performance. The ARPAE building form and section are unique in combining three daylight strategies: 1. Exterior sidelighting, 2. Interior courtyard, and 3. Rooftop chimneys with skylight monitors to seasonally integrate natural light and ventilation. This hybrid configuration of exterior and interior sidelighting coupled with toplighting provides daylight and natural ventilation to every space in the office building. The shape of the plan, massing, and section are integral to the thermal and luminous comfort and energy performance of the building, as Cucinella clarifies: "Shape is part of performance; that's why I like ARPAE. We are really building a bridge with our past when buildings dealt with nature with no energy. That was the job in the past and now (Cucinella, 2015)". During the summer months, the combined wind chimney and daylight monitor, sidelighting, and self-shading building form are architectural strategies to reduce cooling loads. Winter strategies include direct solar gains, daylighting to reduce electric lighting loads, and high-performance envelope and glazing systems. A geothermal heat pump is connected to a radiant distribution and heat recovery system to optimize thermal comfort throughout the year. Additional water savings are realized through a rainwater system that collects runoff from the roof to reuse for heating, irrigation, and greywater. Renewable energy include solar hot water heating and a 201 sq.m (2,164 sq.ft) photovoltaic system. MCA estimates that bioclimatic, passive design, and renewable energy strategies, along with high performance systems, reduce summer and winter energy consumption by 30 percent and 40 percent respectively as compared to a similar-sized conventional building (Mario Cucinella Architects, 2015,1). The estimated energy profile for winter is 35 KWht/sq.m (11.1 kBtu/sq.ft), while summer is 50 kWhf/sq.m (15.9 kBtu/sq.ft). High performance mechanical systems are estimated to provide a carbon reduction of 85 percent at 3 kg CO2/year (compared to a standard building) (Mario Cucinella Architects, 2015, 1).

CONCLUSIONS

Architectural form, performance, and aesthetic experience are at the heart of an ecological approach to daylighting design. Architecture is not a static object, but rather a dynamic relationship with site, climate, and users. Cucinella uses architectural form, rooftop chimneys, courtyards, and a layered envelope to celebrate seasonal changes in luminous and thermal conditions and to invite visual and physical interactions between the users, architecture, and nature. The ARPAE headquarters elevates the promise of the ecological office, inspires a new definition of sustainable design excellence, and raises the bar for all building types, as Cucinella suggests: "Each building has the potential to redesign the surrounding natural, cultural, and socio-economic systems. Buildings can recreate an intimate relationship – a 'creative empathy' – to link places and their inhabitants . . . that are enriching and enabling environments for life and work (Cucinella, 2012)". While this research is limited in scope to one project, it suggests the potential of an ecological approach to daylighting in which "form follows light and performance follows form". As a new ecological model for office buildings, five daylighting design strategies emerge from the case study:

1. <u>Expand Performance Programming</u>: All scales of design were considered through the lens of performance, including measurable issues such as illuminance levels, air flow, annual energy consumption, and carbon emissions along with intangible qualities of health and well-being, beauty, and aesthetics.
2. <u>Rediscover Site and Climate as Design Drivers</u>: The first level of daylight and architectural response is to site and climate, with the integrated design strategies arising from context. Vernacular approaches to integrating daylight, passive heating, and natural ventilation are reconsidered from a contemporary perspective.
3. <u>Allow Form to Follow Daylight</u>: Cucinella ask designers to consider three key issues: How is natural light architectural? How might light shape form? And how might form shape light?
4. <u>Claim Authority over Early Testing and Analysis</u>: Early iterative testing and assessment are key to the integration of form and performance, with a variety of design methods and qualitative and quantitative metrics employed, from simple daylight models to sophisticated computational analyses and large-scale mock-ups.
5. <u>Verify that Performance Follows Form</u>: Architectural form is found through the meeting of design aspirations, site and programmatic forces, desired qualities, and performance goals. Just as a sculptor shapes a piece of marble to express a desired intention, so too an architect sculpts the building massing, plan, section, envelope, windows, and interior forms to create a desired luminous environment.

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The Relationship between Sunlight Pattern Geometry and Visual Comfort in Daylit Offices

The Relationship between Sunlight Pattern Geometry and Visual Comfort in Daylit Offices

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ABSTRACT: Sunlight in buildings is a multisensory phenomenon that can enhance occupants' comfort, health, and connection with the outside environment through its dynamic luminous and thermal attributes. Current daylighting design guidelines limit sunlight penetration in work environments, reducing both its negative and positive effects on visual comfort and occupants' satisfaction with their indoor environment. One gap in existing literature on sunlight exposure is the lack of addressing the effect of visual interest for both sunlight pattern geometry and its play of brilliants on visual comfort. This paper aims to examine differences in visual comfort and interest assessments under three different sunlight pattern geometries.

This paper reports on the results of a quasi-experiment conducted in an office building in Portland, OR. Three experimental settings (hereafter test stations) were created at the office using different window treatments to create three sunlight geometries –Fractal Pattern, Striped Pattern, and 'No-Pattern'– which were tested and compared for their impact on visual interest, visual comfort, and view quality. The study followed a within-subjects design (same group experienced three different sunlight conditions) where 22 office employees completed a brief questionnaire at each test station, while quantitative environmental data were collected.

Results showed that visual comfort and visual interest ratings for the Fractal Pattern were higher than those for the Striped Pattern, though the difference was not statistically significant. View ratings for the two patterns were significantly lower than those for No-Pattern ($p<0.001$). Interestingly, the relationship between the glare metric DGP and visual comfort ratings varied across the three stations. Further, the difference in visual interest between the Striped Pattern and No-Pattern stations was statistically significant ($p<0.05$). Overall, findings suggest that the visual interest of sunlight patterns and views influenced subjective visual comfort assessments. Implication of this study can inform the design of future facade systems to enhance occupants' visual comfort, interest, and satisfaction with their indoor environment.

KEYWORDS: Sunlight in buildings, visual interest, fractal patterns, glare, view.

1.0 INTRODUCTION

In addition to influencing occupant's visual and thermal comfort, previous studies found that sunlight exposure can expedite recovery for depression patients (Benedetti et al. 2001; Beauchemin and Hays 1996), boost the body's vitamin D supply, and regulate melatonin production (Mead 2008). Therefore, it is essential to effectively manage occupant's sunlight exposure in buildings. In this paper, visual comfort can be defined as the state of mind that expresses satisfaction with the visual environment, including perceptual, e.g. glare perception, and psychological satisfaction.

Sunlight penetration in buildings has been investigated by several researchers to examine occupant's ranges of acceptance and comfort in different space types. Previous studies showed that the main sources of visual discomfort is discomfort glare, which depends on glare source luminance, size, location, and adaptation of the observer (Clear 2012). Previous studies found that sunlight can influence visual discomfort by increasing the luminance of work surfaces and/or by increasing the contrast between task and surroundings within occupant's field of vision (Suk, Schiler, and Kensek 2016). When occupants reported their long term evaluations of visual comfort, they tended to be most sensitive to direct sunlight (Jakubiec and Reinhart 2013). Particularly, sunlight is likely to cause visual discomfort if it falls directly on the work plane or the eye, (Jakubiec, Reinhart, and Wymelenberg 2014). Yet, in several studies, participants preferred to allow sunlight on their desks when asked to adjust blinds to their preferred height (Kent et al. 2017; Van Den Wymelenberg and Inanici 2014). In another study, Ne'Eman (1974) found that 73% of occupants considered sunlight a pleasure while 61% preferred a good view over indoor sunlight. In a controlled experiment following a repeated measures approach, Wymelenberg, Inanici, and Johnson (2010) found that 11 out of 12 participants preferred to allow sunlight patterns into the space when it was available. It was argued that adequate luminance variations create a stimulating and interesting environment that improved occupants' preference ratings.

When sunlight enters a space, occupants react to its various aspects including its thermal, visual, aesthetic, and psychological attributes. Systemically, each one of these aspects influences overall comfort towards sunlight (Elzeyadi 2002). Therefore, to enhance the usability of current glare and sunlight exposure metrics, it is necessary to investigate not only direct but also the interactional effect of sunlight pattern geometry, glare perception, and their impact on occupant's visual comfort. Boubekri, Hull, and Boyer (1991) found that optimal sunlight penetration levels that create maximum degrees of relaxation are from 15%-25% of floor area, when positioned sideways to the window. They concluded that sunlight "sparkles" are preferred over large areas of sunlight patches. It was also found that sunlight as manipulated by size, season, and time of the day has significant impacts on the affective state of occupants, which influences occupant's satisfaction. In another study, the presence of sunlight was thought to have created cheering and pleasant effects that could have increased glare tolerance (Boubekri and Boyer 1992).

1.1. Sunlight pattern geometry

Previous studies on sunlight exposure did not investigate whether sunlight pattern geometry influences visual comfort as sunlight pattern geometry is largely determined by shading systems and exterior obstructions. Some of the commonly used shading systems in office buildings include roller shades and venetian blinds which would result in rectangular and striped sunlight patterns, respectively. On the other hand, in buildings with trees nearby, sunlight patterns can be dappled through the leaves, creating fractal-shaped patterns.

People's fascination with nature has been investigated by many researchers who proposed several hypotheses and theories to explain this phenomenon such as Edward Wilson's hypothesis of Biophilia (Wilson 1984), Kaplan's Attention Restoration Theory (Kaplan, 1995), and Ulrich's work on scene type (Ulrich 1981). Most of these hypotheses and theories implied that there are certain characteristics in natural scenes that trigger positive aesthetic and psychophysiological responses (Browning et al. 2012). One approach suggested that these effects can be explained by fractal patterns, which are prevalent in nature (Purcell, Peron, and Berto, 2001; Joye and van den Berg, 2011; Hagerhall et al., 2015).

Fractal patterns can be defined as shapes that display a cascade of never-ending, self-similar, meandering detail as observed at various levels of scales (Bovill 1996; Harris 2012). The prevalence of fractals in nature has caused the human visual system to adapt to efficiently process them. This adaptation is known as the fractal fluency theory (Taylor and Spehar 2016). Overall, previous studies suggested that fractal patterns induce relaxing and restorative effects (Hagerhall et al. 2008), visual preference (Aks & Sprott, 1996; Taylor, 1998; Spehar, Clifford, Newell, & Taylor, 2003), as well as stress recovery benefits (Taylor, 2006). Fractals are typically characterized by a variable called the fractal dimension (D). This parameter quantifies the fractal scaling relationship between the patterns at different magnifications. Based on the D value, fractals can be categorized into low (D=1.1-1.3), medium (D=1.3-1.5), and high complexity (D=1.5-1.9). Two previous studies by the authors (Abboushi et. al., under review) suggested that projected fractal light patterns of mid to mid-high complexity were more visually interesting than those in Euclidean shapes such as striped and rectangular patterns. Further, unlike Euclidean shaped light patterns, projected fractal light patterns maintained a better balance between relaxation and excitement. These findings formed the basis of this study.

Regarding Striped patterns, studies suggested that striped patterns are less visually comfortable (Wilkins 2016). Even checkerboard patterns (which have contrast energy in several orientations) are less uncomfortable than stripes in which the energy varies only in one orientation (Wilkins et al. 1984). Another study stated that striped sunlight patterns produced by venetian blinds can have a spatial frequency within the range appropriate for the induction of visual stress (Winterbottom and Wilkins 2009). The contrasting potential effects of striped and fractal patterns on visual comfort and preference makes these patterns ideal for investigating whether visually interesting sunlight patterns, e.g. fractals, influence perceived glare, compared to striped or rectangular sunlight patterns? This study addresses this question by investigating visual comfort and visual interest under three sunlight conditions: Fractal pattern, Striped pattern, and clear (No-Pattern).

1.2. Views

Access to views and view content have been incorporated into LEED v4 to enhance occupant's connection to their outdoor environment, however, the extent to which these variables influence visual comfort has not been comprehensively investigated. Significant differences in subjective evaluations of visual discomfort were found for different views at the same luminance (Shin, Yun, and Kim 2012). The same study also found that distant views received lower visual discomfort ratings than close views, which could be due to the sense of extent provided by distant views. These results are in line with results of another study (Tuaycharoen and Tregenza 2007) which found that glare discomfort decreased as interest in view increased at the same mean luminance value. Tuaycharoen and Tregenza concluded that the four factors typically used in glare formulae – source luminance, source size, surround luminance, and a position index – are not enough to predict visual comfort. Other factors including view type, nature scenes, and aesthetic preferences seemed to influence visual comfort.

1.3. Glare from Daylight

Sunlight is defined as the light of the sun; whereas daylight is defined as the light of the sun and sky during the day (Webster 2016). Generally, different glare metrics have slightly different approaches for estimating glare from daylight. For instance, Daylight Glare Index (DGI), Unified Glare Rating (UGR), and CIE Glare Index (CGI) are all based on the contrast between the luminance of the source and the luminance of the scene. In addition to contrast, the Daylight Glare probability (DGP) metric is influenced by another variable, that is, the amount of light falling on occupant's eye, hereafter vertical illuminance (Wienold and Christoffersen 2006). Vertical illuminance may explain discomfort for occupants seated close to windows (Hirning, Isoardi, and Garcia-Hansen 2017). Jakubiec and Reinhart (2012) found that DGP performs better when direct sunlight is present in the scene and the visible sky from the windows is very bright. To assess glare, a technique that uses high dynamic range images (HDRIs) has been widely utilized in previous studies to analyze the brightness of different surfaces in a scene (Inanici and Galvin 2004).

1.4. Hypotheses

We hypothesized that: 1) Mean view quality rating for the No-Pattern station would be higher than that for the Fractal and Striped patterns. 2) The visual interest of sunlight patterns and view quality might influence visual comfort ratings, therefore, the relationship between the objectively-measured glare level and visual comfort ratings is expected to differ across the three stations. In other words, at the same glare level, occupants might rate their visual comfort differently based on window condition. 3) The Fractal pattern is expected to improve visual comfort and receive higher visual interest ratings, compared to the striped pattern.

2.0 METHODS

2.1. The study setting

This study employed a 3x1 experimental within-subject research design where the same group of subjects experienced three sunlight conditions. Three experimental stations were created in an open-plan office space on the 8th floor of a multi-story LEED Platinum office building in Portland, OR. The three stations were next to each other at the North-east facade, which controlled for view direction and solar orientation across the three stations. The stations exhibited different sunlight pattern geometries which included a fractal pattern (Fractal), a striped pattern (Stripes), and a clear window with no pattern (No-Pattern). The Fractal and the Striped patterns were selected in this study because previous studies suggested that they were associated with positive and negative effects on visual preference and interest, respectively, as outlined in section 1. The No-Pattern condition was included as a base-case for comparison. Main parameters of the study setting are shown in Table 1.

Table 1: Parameters of the study setting.

Setting Parameters	Value
Visible transmittance of glazing (T_{vis})	0.28
Solar heat gain coefficient (SHGC)	0.19
Visible transmittance of pattern	0.04 for black regions and 0.89 for clear regions.
Overall visible transmittance	0.01 through black regions, and 0.25 through clear regions.
Distance between subjects and window	213.3 cm (7 feet)

The different sunlight patterns were produced by panels of clear Mylar with black ink that represented either a fractal or a striped pattern. Each panel was 0.91x1.98 m (3x6.5 feet) mounted on the upper half of a 1.8x1.98 m (6x6.5 feet) window. The roller shades were lowered to create this window size to avoid sunlight patterns on participant's body, particularly at the beginning of the study. For the No-Pattern station, the roller shade was adjusted to a height of 1.37m (54 inches) to ensure that clear areas across the stations are consistent. The three stations had a view of a river in the background and paved roads in the foreground. The space had floor-to-ceiling windows and roller shades, which allowed for controlling view areas within each one of the three windows, and for blocking light from other windows (Fig.1).

2.2. Data collection

A total of 22 office workers (13 male and 9 female) volunteered to participate in this study. Participants were given specific instructions and description of the study procedures and asked to sign a consent form prior to starting participation. Subjective and objective indicators of comfort were collected. Subjective comfort data was collected using an offline questionnaire on digital tablets. Table 2 shows the questions and scales used in the questionnaire. Participants interacted with the tablet by pressing on their answer to each question. These questions were selected based on previous studies that examined visual comfort and view quality (HMG 2012; Van den Wymelenberg 2012).

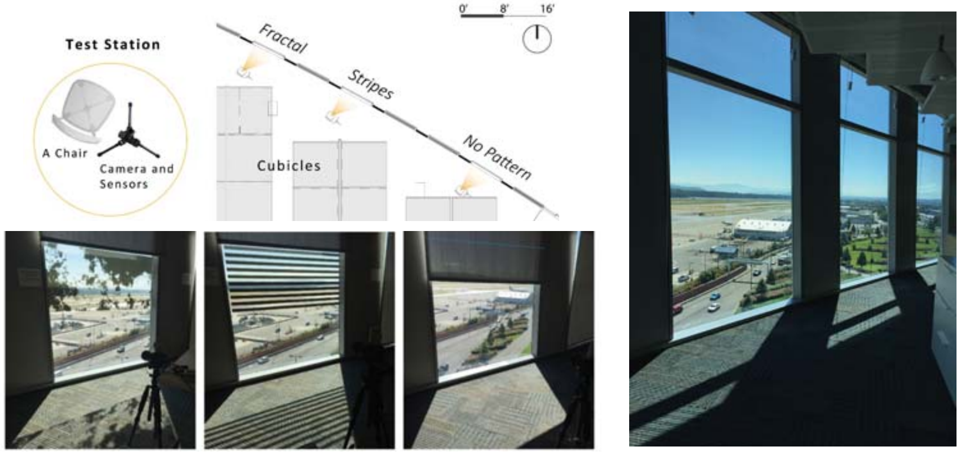

Figure 1: A floor plan of the research setting and test station (top left); pictures of the three stations (bottom left); and an overall picture of the perimeter zone where the study was conducted, prior to adjusting shades (right).

Table 2: The questionnaire and scale used for each question.

	Question	Scale
Q1	This is a visually comfortable environment for office work	7-point Likert scale (Strongly Agree (7)-Agree-Somewhat agree-Neither agree nor disagree-Somewhat Disagree-Disagree-Strongly disagree (1)).
Q2	Sunlight patterns look visually interesting	
Q3	I like the view I have from the window	
Q4	Air temperature feels:	7-point semantic differential (Too Warm- Too Cold).

Objective environmental data included vertical illuminance, High Dynamic Range Images (HDRIs), air temperature, relative humidity, and globe temperature. The HDR images were manually captured using Canon G11 cameras equipped with a fisheye lens (Opteka 52mm 0.2x HD Professional Super AF Fisheye) mounted on a tripod and positioned at a height of 142.2 cm (56 inches) to match eye-level position for participants. All other measurements were logged at 5-minute intervals using a series of sensors connected to U-12 Onset HOBO data-loggers. These sensors included; a Licor-210 photometric sensor with a custom voltage amplifier to measure vertical illuminance, and a calibrated NTC Thermistor (10k ohm ±0.1°C) suspended at the center of a black painted ping pong ball to measure globe temperature. The U-12 Onset data logger provided measurements of air temperature and relative humidity. All sensors, cameras, and amplifiers were calibrated prior to start of the study.

After signing the consent form, each participant was asked to sit at a chair located in each station for approximately two minutes and then answer the questionnaire using the tablet. The order by which participants completed questionnaires at the three stations was randomized. HDRIs were captured immediately after a participant completed the questionnaire to prevent interference with their perception of the environment. The study took place from 8 to 11 am on summer solstice. Regarding HDRIs, each HDRI comprised of six images combined using 'hdrgen' Radiance command-line (Anyhere Software) using a predetermined response function for each camera. Each HDRI was then analyzed using the 'evalglare' command. Lastly, questionnaire responses were paired with measurements –vertical illuminance, air temperature, globe temperature, relative humidity, and HDRIs using data timestamps.

3.0 RESULTS

The boxplots in Fig.2 show the distribution of responses for visual comfort (Q1), visual interest (Q2), and view quality (Q3) by sunlight condition. Means of visual comfort (Q1), visual interest (Q2), and view (Q3) for the No-Pattern station (5.8, 5, and 6.6 respectively) were higher than those for the Striped (4, 3.9, 3.5) and Fractal (4.6, 4, 3.6) stations. Further, means for the Fractal pattern were slightly higher than those for the Striped pattern. There was more variability in visual interest responses for the fractal (SD=2.2) compared to the Striped Station (SD=1.7). Regarding view, both patterns received low view quality ratings compared to the No-Pattern condition. As for thermal comfort (Q4), there were no significant differences in subjective responses to Q4. This question was included as a control variable to ensure that no thermal discomfort perceptions arise from sunlight patterns, which may influence overall comfort at any of the three workstations. Mean responses were 4.59, 4.82, and 4.77 for fractal, No Pattern, and Stripes, respectively. Questionnaire responses and the average predictive mean vote (PMV) of -0.2 indicated that no severe thermal discomfort was experienced.

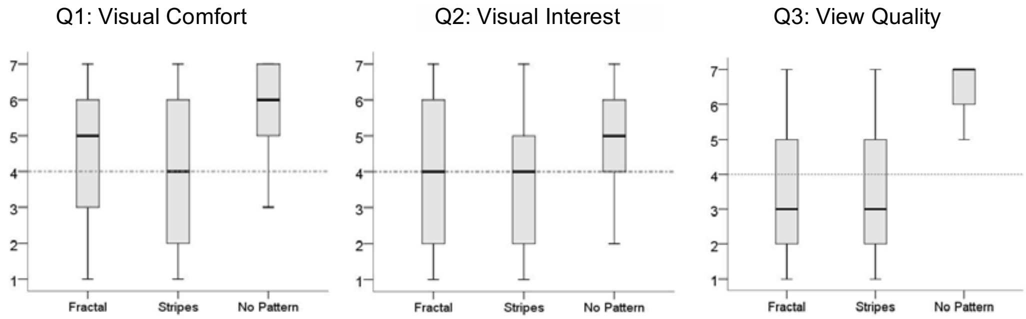

Figure 2: Boxplots of questionnaire responses. Number 7 represents "Strongly Agree", number 1 represents "Strongly Disagree", and number 4 is "Neutral".

Questionnaire responses were analyzed to examine differences among the three stations. Wilcoxon signed ranks test was used. This test was used because Shapiro-Wilk test confirmed that variables violate the normality assumption for the paired T-test. Results showed that visual comfort ratings for the No-Pattern station were significantly higher than those for the fractal ($Z= -2.48$, $p<0.05$) and the striped patterns ($Z= -3.281$, $p<0.05$). The difference between visual comfort ratings for the fractal and the striped patterns was not statistically significant. Regarding the visual interest of sunlight patterns, visual interest ratings for the No-pattern were only significantly higher ($Z=-2.188$, $p<0.05$) than those for the striped pattern ($Z= -2.188$, $p<0.05$). While view area size was consistent across the three stations, the distribution of these areas differed. For instance, in the No-Pattern station, the view area was not interrupted, unlike the Striped and Fractal patterns which included viewing areas within the pattern itself. Participant responses showed that view quality ratings for 'No Pattern' were significantly higher than those for Fractal ($Z= -3.753$, $p<0.001$) and Striped patterns ($Z= -3.742$, $p<0.001$).

4.0 DISCUSSION

Visual comfort and view quality ratings for the Fractal and Striped stations were significantly lower than those of the No-pattern station. This suggests that view quality might have influenced visual comfort, particularly because of the combination of imperceptible glare levels indicated by DGP and the panoramic views. The combination of these factors suggests that participants might be willing to tolerate these low-glare levels in favor of having uninterrupted views, thus neither pattern was deemed important for glare mitigation (Boubekri and Boyer 1992). The importance of shades might be further reduced because participants were not performing a visually critical office task such as typing or reading from a computer screen. Indeed, the preference for unobstructed views was indicated by some participants who mentioned that they preferred to see through the patterns. These findings support our hypothesis regarding a higher view quality rating for the No-pattern station.

Although visual comfort ratings for the Fractal pattern were higher than those for the Striped pattern, the difference was not statistically significant; therefore, our hypothesis regarding a difference between these two was not supported in the current setting with low glare levels. The difference in visual interest between Fractal station and the Striped station was not statistically significant. However, compared to the No-pattern station, only the Striped station significantly reduced visual interest. The expectation to observe a significant difference in visual interest between the two patterns was based on results of previous studies by the authors (Abboushi et al., under review), which suggested that projected fractal light patterns were significantly more visually interesting than rectangular or striped patterns. This study, though, introduced new variables such as glare and views, whose interactive effects with each pattern might have influenced their visual interest.

The relationship between visual comfort ratings and glare levels seemed to differ across the three stations, particularly between the Fractal and Striped stations. Fig.3 shows boxplots of visual comfort ratings and DGP for the three stations. For the Striped and No-Pattern stations, the relationship between visual comfort ratings and DGP followed a linear trend, where higher visual comfort was at lower DGP. In contrast, the plot for the Fractal station showed a quadratic "U" shaped relationship between these two variables. This suggests that the influence of glare on visual comfort was mediated by pattern geometry. This includes effects caused by sunlight pattern geometry and the visual interest thereof, which aligns with results of a previous study (Tuaycharoen and Tregenza 2007) that suggested that discomfort glare cannot be predicted from physical variables alone.

Investigating the visual interest of sunlight patterns should consider the location, geometry, and interactions with room surfaces. The amount of fine-scale detail in fractal sunlight patterns, for instance, varies based on the distance between the window surface and projection surfaces. Another important topic that warrants further studies are the qualitative aspects of sunlight pattern geometry. These aspects include feelings evoked by the sunlight pattern such as relaxation and excitement (Boubekri, Hull, and Boyer 1991) as well as resemblances associated. To rule out the effects of view quality, future studies would benefit from excluding views in a research setting where participants can sit parallel to the window with limited view of window and outdoor views. This approach would help focus on sunlight patterns to examine the extent to which they influence visual interest and visual comfort ratings.

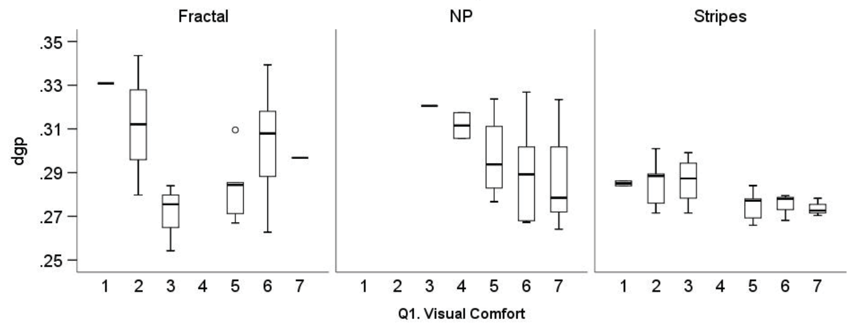

Figure 3: Visual comfort ratings and DGP for the three stations: Fractal (left), No-pattern (middle), and Stripes (right).

Assuming that view quality and the visual interest of sunlight patterns have both contributed to visual comfort ratings, the questions to be asked are: 1) what are the relative importance of these two factors for visual comfort; 2) how would the relationships observed in this study differ under higher glare levels. These questions warrant further studies that expand the levels of glare experienced to include perceptible, disturbing, and intolerable levels. This step is important to delineate whether visual interest and view quality can offset and reduce perceived glare, and if proved, to what extent. These questions are explored in another forthcoming paper by the authors that examined the same three sunlight conditions at an office building for an extended period and at participants' workstations while performing typical office tasks.

5.0 CONCLUSIONS

We summarize the conclusions of this study using the following points:

1. Occupants might be able to tolerate low levels of glare in an office setting when an interesting outdoor view of nature is present. The No-Pattern station received the highest mean ratings for visual comfort and view quality and the differences were statistically significant.
2. The No-Pattern station received the highest mean of visual interest ratings, and the difference was only significant compared to the Striped station.
3. If given a choice between Fractal and Stripped patterned window coverings, occupants might prefer the Fractal coverings and the projected sunlight patterns. The difference in visual interest between the Fractal station and the No-Pattern station was insignificant, whereas the difference in visual interest between the Striped station and No-Pattern station was significant.
4. The predictability of the DGP metric varied across the three stations. This could be due to aspects not addressed by glare metrics such as visual interest and view quality.
5. Visual interest to sunlight patterns in space was well perceived by the occupants and merit further discussion, metrics, and studies. Results showed that ratings of visual interest of sunlight patterns were associated with significant increases in visual comfort ratings.

6.0 LIMITATIONS AND FUTURE WORK

There were several limitations that should be considered when interpreting the results of this study: first, this study took place at an office space where volunteers were recruited for participation; thus, self-selection bias might be present. Second, the north-east facing zone was selected to include a range of sunlight conditions and sunlight profile angles. This, however, limited the timing of the study to when sunlight could be present in the space, hence, the study took place in the morning. Third, window tint and low visible transmittance might have contributed to the low DGP levels, which indicated imperceptible glare levels during the study. This suggests that the results might only be applicable to low glare levels. Beyond the need to refine existing glare metrics for scenes when sunlight is present in space, future studies would benefit from including a wider range of daylighting conditions, corresponding to perceptible to intolerable ranges of glare. It is possible that as glare level increases, the less important the visual interest becomes, hence lessening the difference in visual comfort responses among the three sunlight pattern geometries. This hypothesis warrants further studies to verify or refute it.

The time each participant spent at each station might have lessened annoyance and visual discomfort from potential glare or sunlight exposure. Future studies would benefit from examining visual comfort towards sunlight at participants' desks where a longer monitoring period, different orientations, different view qualities, higher DGP and glare levels, and typical office tasks are considered. Lastly, this study was conducted in a predominantly overcast geographic region which might have influenced occupant's preferences towards sunlight. More studies are needed to delineate regional and seasonal effects on visual comfort and tolerance towards glare from sunlight.

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João Silva Leite

Start-Up Buildings: The Built Space as Connector Between Public Space and Infrastructural Axes

Start-Up Buildings: The built space as connector between public space and infrastructural axes[i].

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ABSTRACT: The urban mobility infrastructure axes have an important potential in the structuring and aggregation of the urban fabric. Throughout the last century this fact takes on special relevance due to the increasing fragmentation of the fabric and its processes of composition. It is through the main infrastructural axes that the relations of continuity, physical and spatial, are often preserved occurring in certain cases a distortion of the notions of space and time. Thus, the strategic (and spatial) value of these urban elements causes, in the contemporary city, the definition of new linear centralities that attract buildings and singular uses. Marginal occupation often occurs in a fragmented and individual way. Infrastructure and urban fabric are thought out, and constructed, separately, creating often weak morphological relationships or indirect systems. Despite this, it is evident the creation of symbiotic mechanisms of interrelation between the infrastructural axis and the surrounding built fabric. Its formal caracteristics are influenciated by the visibility allowed by the infrasctrutural axis. A more or less constant continuum is built, but the vision as a whole appears relatively inconsistent, not stabilized and poorly articulated with the adjacent urban context.

The formal composition of the building itself has contradictory characteristics, on one hand it establishes strong visual and functional bonds with the infrastructural axis, but on other hand, its form as an architectural object, does not always contribute to a qualification of the space as a whole. The article seeks to look in a particular way for the case of the *Start-Up Buildings*, singular buildings that by their morphological and functional characteristics are promoters of particular dynamics capable of reinventing the urban space around them. There is particular interest in its ability to generate ambiguous urban spaces, developers of crossings and connections between distinct parts of the city, as well as links between the built fabric and the mobility infrastructure that supports it. In this way, through the study of these *Start-Up Buildings* is intended to collect contributions that can inform the exercise of the project, using them as didactic objects and not as models. It seeks to systematize principles of composition that allow a better articulation between certain infrastructural axes and the singular buildings that surround them, such as for example shopping centres or megastores. The qualification of the public space and the relation that it constructs with the collective space is seen as a factor that would potentiate the capacity to connect the two elements: infrastructure and building.

KEYWORDS: Start-Up Buildings, Mobility Infrastructures, In-Between, collective space.

INTRODUCTION

This article is based on a postdoc research recently initiated. The research seeks to understand certain relationships of interdependence that are created between the main axes of mobility and certain singular buildings. The street classic concept, mainly its type configuration, has undergone some important morphological changes over the last decades, so tries to understand new formal relations that are established between the singular building and the infrastructure that supports it. The reading of the formal composition of the architectural object and the links that it constructs with the axis of mobility becomes determinant to realize the dynamics that are established. The research therefore addresses the singular building through a morphological and functional study, identifying formal constitutive elements and which relation are made by them in the urban fabric.

In certain situations, the link between the building and the infrastructure is so intense that the architectural object itself generates new urban dynamics, ranging from the territorial scale to the architectural scale itself. This building typology, capable of creating new dynamics in the city, reconfiguring its urban space and its form of appropriation, is understood as *Start-Up Buildings.* This architectural typology redefines the contemporary urban space, breaking with classic processes of architectural, functional and urban composition. Its architecture acts as a connector between different parts of the urban space, creating ambiguous relations between the private and public space. Its formal composition contributes to the dissipation of boundaries, creating new forms of collective appropriation of the urban space. New urban flows are generated by the architectural form of the building, making it a dynamic pole capable of aggregating and simultaneously articulating the surrounding space.

The research seeks to identify new tendencies of living, of urban appropriation and spatial design stimulated by the Start-up Buildings, understanding phenomena that contribute to the qualification of the urban space. The article seeks to systematize and consolidate a thought that will be used as the basis for the debate of this issue and thus make way for the development of broader research. It looks for indications that can support future decisions of urban and architectural interventions.

1.0 THE MOBILITY INFRASTRUCTURE AS STRUCTURAL ELEMENT IN THE CONTEMPORARY CITY.

1.1. The emergence of linear centralities

With the beginning of the twentieth century, the city based in the western cultural matrix stops to grow, following a logic of continuity of its fabric, starting to develop various processes that have potentiated the fragmentation of its urban fabric.

> *"We no longer understand urban agglomeration as a continuous structure with its own recognizable form and we see it as a system of relations between autonomous pieces, an individual city..."* (Portas, 2011:167)

This phenomenon, especially accelerated after the second half of the century, is intrinsically linked to the consolidation of new ways of urban mobility, namely the rising of the automobile as the main transport vehicle. With this process of transformation of the cities, the metropolitan territory is confronted with the addition of new urban configurations and different processes of urban fabric constitution. This seeks to respond to the needs and impulses of society, even if this happens in a disjointed way from theoretical thinking or management tools. Within the diversity of phenomena that occur in urban space, it is important to highlight a set of systems with linear character, urban formations which having the mobility infrastructure as a referenciador axis assume a particular importance in the dynamisms and daily flows of this complex organism that is the contemporary city. These urban formations play a vital role in the articulation between urban frabrics, being used systematically as connecting elements, linking the various fragments dispersed throughout the territory.

Mobility of people and goods, gains a new dimension and territorial expression. The mobility infrastructure be came vital element in the urban paradigms of the present time. The speed of movement and the easy access to different points of the territory provides the raise through its channel space the appearing of new places of opportunities. Along its borders accumulate progressively buildings at a very constant rhythm and frequency, constituting linear sequences that built continuity (Boeri et al., 1993). The infrastructure axis (motorway, road or just a simple itinerary) is colonized by an urbanization that gives the element a new identity and innovative urban forms. Nevertheless, some of its formal and functional attributes end up referring to characteristics that we recognize as intrinsic to the urban element - Street.

One of these functions is undoubtedly the role that these elements play in the structuring and hierarchization of the territory. Its extension and scope allow connection to different points in the territory and when the urban compactness is consolidated around the axis gain the sense of a primordial structure of the city. These characteristics promote the creation of mental and sensorial mechanisms of reference among populations and allow these infrastructures to be able to establish a spatial hierarchy. In parallel, when stressing themselves as vertebral axes of the plot structure, which support the building, they allow the fixing of different fragments and also their aggregation around the same axis. This fact creates conditions for the urban fabric to disperse across the territory, prevailing its relations of continuity only through the road. These linear formations, when inserted in a specific urban context, with a specific territorial logic, starts to concentrate activities with singular uses, such as commercial spaces. Nevertheless, other uses and functions can be anchored to these elements, forming what Stefano Boeri (1993) refers to as places of flows, in a clear allusion to the intensity (traffic and operations) and dynamism that these elements incorporate. These various activities are strongly driven by the accessibility and affluence of users that the infrastructure potenciates and, as such, establishes a relationship of interdependence that transforms these urban formations into what Lorena Vecslir (2007) defined as "new spaces of centrality", placing new tensions in the stabilized concept of centrality.

Mobility infrastructures are today more than mere circulation elements; they are also living spaces, places and axial structures of mediation. They often call to themselves, without an awareness of government entities, the function of intermediating quite distinct formal and typological fragments and realities. The path, the road, the expressway, the mortorway, regardless of its capillary expression, affirm themselves as links between spaces, uses and forms. The metropolitan dynamisms, but not only, use these linear elements as tools in the construction of more continuous urban corridors, with greater spatial coherence.

In turn, these linear centralities also play a relevant scenographic role in the construction of a landscape (Lynch, 1964). Certain objects or architectural elements are distinguished as spatial references, interpreting equally situations observed in the consolidated city. The symbolic character assumes special power along these linear formations, being often saturated with stimuli that announce us, spaces, uses, functions, objects, etc. (Venturi et al., 1977). Mobility axes, of greater or lesser importance, and of a larger or smaller size, together with the whole urban system that surrounds them, brings together a set of characteristics that go well beyond the simple infrastructural function. The operated metamorphosis constructed a new reality on these mobility axes that endowed them with functions and an urban character. The morphological changes resulting shaped by this new character, and the progressive compactness increase in the territories around, gives the the infrastructure some elementary characteristics of the traditional street, leading us to question if we are not facing new formal trends of streets.

> *"... when I speak of the street, I mean what the rationalists denominated in a derogatory way" rue-corridor ", that is, the urban itinerary delimited by the continuity of an architectural line or by the limits of another element that defines compactness. The street is, at the same time, a place, an itinerary, an unpredictable supply of events, that is, the backbone of the two essential functions of the city: information and accessibility; but it is also the recognizable image of the community and the passage of services remains. "* (Bohigas, 2004:128-129)

1.2. The emergence of new street types [in the contemporary city]

The contemporary urban fabric presents a set of elements that by their morphological, functional and social characteristics could be interpreted as new types of streets.

The street [of the contemporary city] is not restricted to the urban element that is constituted by a simple section and which connects different points in the city, always accompanied by a regular urbanization (Panerai, 1999). Its shape presents multiple configurations that result from dynamics and urban processes developed during the XX century, as already mentioned previously.

> *"The urban street had traditionally united three physical roles: that of circulation route, that of public space, and that of built frontage."* (Marshall, 2005:6)

One of the most frequently observed situations in contemporaneity is the progressive transformation of the road, incorporating over time a regular and increasingly dense urbanization. Cases such as *Strada Valassina*, Milan, or the *Strip* of Las Vegas are paradigmatic examples of these situations, and remind us of historical transformation processes that have always accompanied the history of the city. However, the transformation process takes place at such a rapid rate of time and intensity that it generates urban forms quite distinct from those previously observed. Another phenomena regularly observed is the addition of new infrastructures and elements of circulation, overloading the channel space of the street. The transversal section is reconfigured, expressing innumerable formal and functional variations, of more or less complexity. The overlay of new platforms, levels and spaces of use and hybrid appropriation elevate this urban element to a new formal dimension. This multiplier of the levels of the street offers alternatives of movement, pedestrian, automobile, public transport, as it is observed in cities like Hong Kong, New York, Tokyo, São Paulo and among many others. To be noted also, the phenomenon of the underground pedestrian street. This constitutes a duplication of archetypal models of the traditional street, but at the underground level, used as a connector between different areas or conventional building fabric. The constant merging of atriums of buildings with access points to the network, and the vast system of corridors, arcades and blocks prove to be a collective space, which in itself can mean an innovation of the own perception by the user of public space.

1.3. The singular building as a preponderant element

The formal composition of the street is questioned normally when we are in presence of an axis that is presented as a centrality by itself. The pressure placed on this element causes it to react and to initiate a process of morphological and functional assessment. The street becomes a spatial reference, reinforcing its role as a structuring element of urban fabric.

Consequently it is natural to observe the concentration of a built fabric with specific characteristics that takes advantage of the greater exposure and centrality of the street, but also the emergence of some singular buildings (Dias Coelho, 2013) [ii]. The singular building is distinguished in the urban landscape by its exceptional function and often by its architecture of greater visual impact. In this way, the architectural object itself becomes an important piece in the construction of spatial reference maps (Lynch, 1960). They become landmarks in the city's urban space, interacting with people (Cullen, 1961).

This fact alone does not represent an inovation in the formal and sensorial dialogue between the city and its community. Throughout the history of the city for several moments we can observe this logic, just remember plane of Sixtus V to Rome, among other examples. However, it is interesting to observe that in the present city, in urban fabrics still to be consolidated or in strong sedimentation processes, this phenomenon occurs. On the other hand, it often occurs disconnected from an academic and formal thought, as happened on the plane of Sixtus V. At present, when we observe a mobility infrastructure to be colonized by urbanization along its axis, we quickly see the emergence of some singularly designed architectural pieces with a very exuberant architecture (Venturi et al., 1977). The architecture is used as a way to build a symbol in the landscape. The symbolic character and its ability to stand out from others turns out to be decisive in the construction of the space of these urban elements. Often these facts are directly linked to a commercial activities or services that set their success in an intense publicity communication with the observer.

The commercial or functional importance of some of these singular buildings located around these mobility infrastructures registers such preponderance that they potentiate in a decisive way the intensity of transformation that these elements begin to incorporate. They are creators of new urbanization, transformations of the section type of the infrastructure and often determine the degree of centrality of these elements within the wider system of the city. The singular building assumes itself as a pole of attractiveness, present in an axis that by itself is structuring of part of the urban fabric. It is affirmed in the territory by its functional singularity and in the own element by its architecture or formal/visual composition. It should also be mentioned that the singular building contributes to moments of greater consolidation of the urban fabric. It is on the space around it that more initiatives of consolidation and interconnection of the various urban fragments appear, helping to define a section type of the street. On the other hand, in realities more consolidated, where the section type is already more defined, these buildings stand out for their ability to connect different spaces, or levels, along the infrastructural channel.

1.4. The potential of the in-between space

The space where the influence of the singular building is most felt is the in-between. That is, in the intermediate space between the infrastructure and the constructed limit of the building itself. This space is often characterized by its ambiguity, corresponding to a place where it is not always clear whether it belongs to the private or public component of the city. Sometimes it corresponds to areas of the plot (of the singular building) that are given to public use by the private sector, in order to attract more users to their stores. But in other situations, these are empty, vacant spaces that result from the minimum distances that the mobility infrastructures require to be protected.

These spaces become areas with high potential and desirable for intervention. These spaces may prove decisive in the formal consolidation process of these emerging urban axis, but also in their spatial and functional qualification. To dwell this intermediate space allows to work in the moment of transition between the public and private component, dissipating limits. Knowing how to handle and work with this moment of transition allows us to operate on the ambiguity that some of these areas acquire, enhancing their ambivalence and developing social and collective activities and appropriations regardless of whether they take place in the public or private space of the city.

Given this, it is important to recover the thinking developed by Aldo Van Eyck and other members of the Team X group, such as Peter and Alison Smithson who starting from the reinterpretation of the concept of threshold understands it as a three-dimensional space as opposed to an approach which centers the idea of limit as surface. Aldo Van Eyck recognizes the importance of the existence of an intermediate space that articulates two distinct universes and that leads to the harmony of the characteristics of each one. In this way, one points to the need to know how to create a third universe, dependent on the two that supports it, connecting them but simultaneously capable to creat an identity of its own. Limits should leave their natural and well-defined rigidity and incorporate smoother transitions that build relationships between people and the most pleasant and balanced spaces[iii]. The design of the building can incorporate spatial notions that formalize mutually contradictory concepts, such as: *individual-collective, unity-diversity, interior-exterior.*

The intervention in the intermediate space must facilitate manifestations that dissipate limits, composing spaces that develop morphological relationships and acts of socialization. The in-between space should contribute to the clarification of urban and architectural elements, for the explanation of hierarchies and urban spaces. The constituted transition spaces can also act as permeability elements and interaction facilitators.

In this sense, it is important to reinforce the expansion of the ground floor space making it more permeable, continuous and open to the public space. The building conection to the ground level is vital to establishment it link with the street. The dissipation of the limit, physically or psychologically, allows the insertion of the street in the inner space and vice versa, which makes the relationship between the building and the public space more porous and capable of developing greater vitality.

The street acquires more activity, more personality, and the buildings become more dynamic and alive, according to their use, type of function and form of appropriation. The link between urban elements is stronger and interdependent. Xavier Monteys (2010), draws attention to this, stating that the ambiguity of the limits causes the living room to reappear on the street with its chairs, and that in turn the street noisily appears in the living room. This permeability between two inhabited sides creates an intermediate space that assumes a space of its own, managing to contaminate the adjacent spaces and requiring complementary spaces. The dialogue between the building and the street is favored at this more diffuse threshold, in its understanding as a limit but simultaneously clear in the identification of its identity.

2.0. START-UP BUILDINGS

2.1. An essay of a concept

As mentioned previously, the centrality offered by some of these emergent linear elements, understood as new street types, allows the appearance of singular buildings, transforming them into small poles that dynamize the territory. Its development as an architectonic object of exceptional character promotes the growth of new forms of occupation and appropriation of the territory. When this happens, we could say that the building resembles a *start-up*, an element that creates a new paradigm of urban appropriation or interrelationship [between elements, spaces, forms, uses or persons]. Thus, the idea of *Start-Up Building* seeks to classify a set of architectural objects that by their functional and morphological characteristics are capable of emerging new concepts of living in the urban space, developing new forms of social and urban interaction, questioning classic relationship processes of people with their own public or private space. This typology is not intended to be a reinterpretation of the *Hybrid Building* concept. This is fundamentally based on the capacity of a building to incorporate different types of uses, articulating different internal environments and building a specific dialectic with the urban space around (Fernandez Per, 2014). The *Start-Up Building* concept focuses more on the identification of unique buildings that are capable of reconfiguring the urban space around them, in an innovative way, becoming a dynamic center and giving rise to new processes of urban living. The urban transformation generated by a *Start-Up Building* should occur relatively quickly and in parallel configure a new spatial or functional model in the city. The architectural form, its articulation with the use(s) and the dialogue that establishes with the public space play an important role in the way that the *Start-Up Buildings* transform the surrounding territory.

2.2. A building type generator of transition spaces between built space and public space

One of the situations, in preliminary analysis, that the *Start-Up Buildings* generates is the construction of spaces of ambiguous character, where it is not clear to which universe belong, public or private. This ambiguity is revealed, for example, through two types of space: living spaces and circulation spaces.

The first situation refers to the existence of staying areas, with a collective character, in the interior space of the building. This fact brings back to the interior of the architectural space of this typology, areas that in the classical city normally are located in the public space. This phenomenon is not unconnected with the fact that, in several situations, there is a certain disqualification of the surrounding public space. Thus the building taking advantage of this handicap to creates a space of collective use that promotes actions of socialization. They mix activities usually associated to the public universe of the city with activities and behaviors proper to the private space. The common areas of certain buildings become "public spaces" (even though maintaining their own control of the private universe) by extending their area into the architectural object. A paradigmatic example of this phenomenon is the living and eating spaces that exist in certain commercial megastores. These spaces are thoughtfully designed to be very attractive to users and whenever possible seek to establish visual contacts with the outside. Another example is the architectural composition itself that promotes this dissipation of the limit and builds a strong interaction between the interior space of the building and outside space. The idea of a clear and well-defined limit is diluted with the aim of extending the public space. Crossing spaces are generated, but there are also living spaces where various activities, such as fairs, exhibitions, concerts, among others, take place inside the architectural object, although suggesting that it is an activity that takes place in the public space. This idea of extension of the public space into the interior of the buildings, of singular use, was also present in the century XVIII in the map of Rome of Giambattista Nolli. The representation of this map in the 1748 of the interior space of the churches, patios and atriums of palaces can be understood as a metaphor that expresses the idea that the interior of these spaces belong to the public universe of the city. The limit between the building and the square or street that supports it is eliminated and the pavement of the city penetrates the space, inviting to enter. The building and the collective activities that take place in it open to the city.

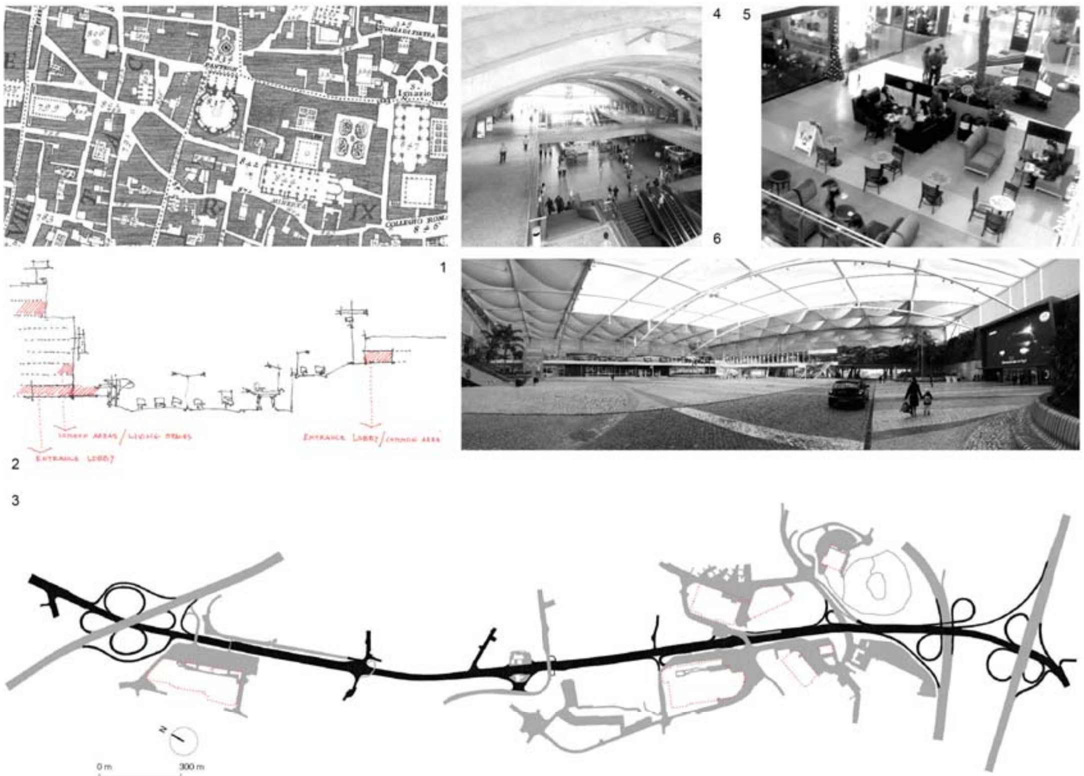

Figure 1: 1. Map of Rome of Giambattista Nolli, 1748; 2. Section Type (Author 2018); 3.Urban layout and collective spaces of N117 road, Lisbon; 4. Train Station of Oriente, Lisbon; 5. Collective areas inside of Alegro Shopping Mall, Lisbon; 6. "Public square in Dolce Vita Teja Shopping Mall, Lisbon. Source: (Author 2016)

The second situation refers to the construction of spaces of passage, of connection. In these cases the building itself, or part of it, becomes a passage, joining different parts of the urban fabric and solving some urban conflicts. This capacity that the building assumes of connector allows to make the urban space more effective, but adapted to the needs of the people and of the city. The spaces of passage extend to the user the perception of the public universe, built in a new layout of the city. The idea of limit disappears and the city uses these passages as public space if it were. The building itself gains a greater prominence. It becomes reference in the mental maps of the population like a pole that allows acceding to certain space or areas of the city of a faster and intuitive way. Its architecture seeks to respond to this function, while at the same time molding and transforming itself for greater efficiency. The channels spaces are formally qualified; being verified the implementation of various commercial activities or small services, such as living spaces, small gardens and/or cafes. The building assumes itself as a center and redefines logics of circulation and experience of the city. Some of the most emblematic examples of this situation are the train station in Tokyo. The station beyond its base function accumulates a set of valencies that elevates it to a new dimension. Its common areas are frequently transformed into passages between distinct points of the city of Tokyo. This connection does not only serve distances in extension. They are also used to join different levels, different buildings or infrastructures. The station is an authentic connector, which unites and merges everything into one system. Its interior spaces, turn into streets and squares. Stores or access to different lobbies of nearby buildings colonizes the corridors. The ambiguity of these zones is great, but they are also spaces of great ambivalence and interesting in urban terms. Some dialogues are constructed between the inner and outer space; some extend to the other and vice versa.

For the city, it does not matter who owns the property. Relevant is rather the efficiency and service that the space of this architectural typology offers. The idea of the in-between is somehow present. The physical and built limits between the building and the traditional street are present; however, the limit becomes porous there is a spatial and functional appropriation that goes beyond this boundary. Space becomes rich, diverse, multi-use and functional.

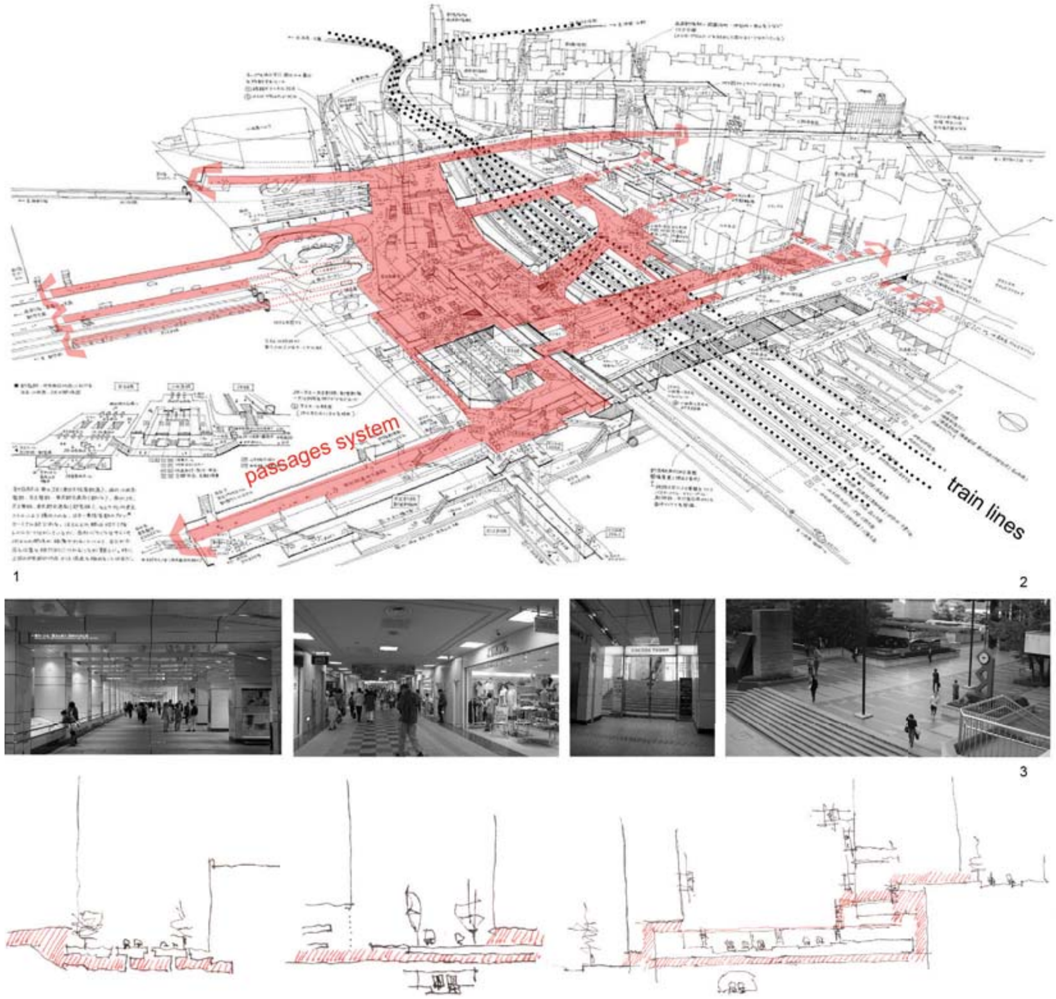

Figure 2: 1. Passages System through buildings in Shinjuku Station Area, Tokyo. Sourse: (base drawing: Tomoyuki Tanaka, 2016; overlap scheme: Author 2018); 2. Photographs of Shinjuku passages network, Tokyo. Sourse: (Author 2015); 3. Sections type. Sourse: (Author 2018).

FINAL REMARKS

The city as an organic system lives in a constant mutation and evolution. Its frabic grows, shrinks, sediments and transforms. Faced with the challenges of contemporary times, the city tends to adapt and reinvent development processes and forms of space appropriation. The phenomenon of the *Start-Up Buildings*, and fundamentally their influence in the redefinition of the intermediate space between them and the street or infrastructure that supports it, is one of the themes of greater opportunity at the present time. It is important to understand how the architecture of a building, together with its exceptional use, can redefine the nearest urban space or even a wider territory. The architectural conception of these objects cannot ignore the role and the added value that this can represent for the city.

In this sense, the investigation, now initiated, intends to decode, decompose and systematize its aggregation processes (between singular building and street/infrastructure); compositional and spatial logics; interactions and generated urban tensions and processes of spatial and functional reconfiguration.

Through a morphological study, formal and typological characteristics are systematized, which contribute to the simplification of the object, but also a better perception of the urban relations that it establishes and provides. In this way, it becomes possible to construct a referential framework that can be interpreted as a didactic instrument in support of the academic essays, but also in support of new creative, innovative processes of contemporary urban and architectural intervention. So the morphological readings developed by the research do not pretend to have an anachronistic meaning but to contribute to urban and architectural production more conscious and appropriate to the urban context where it is inserted.

The research is based on the need to deepen the study of new types of buildings that are emerging in the city and what dynamics they offer, stabilizing concepts and allowing a better decoding of certain urban phenomena unchained. It is sought to place the focus of attention on intervention processes and urban management that explore the architectural potential evidenced by the *Start-Up Buildings* but also by the adjacent urban spaces. In this way, the aim is to take full advantage of the urban dynamics generated, enhancing the polarizing capacity and contributing to the structuring and qualification of a wider territory.

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[ii] Through an elementary decomposition we could say that the urban fabric contains common buildings and singular buildings. These are characterized by their exceptional function and their singular typological role, contrasting with the residential use that constitutes the most common and predominant building of the city.

[iii] What is a door? A flat surface with hinges and a lock, constituting a hard terrifying borderline? When you pass through a door like that are you not divided? Split into two - perhaps you no longer notice! Just think of it: a rectangle two inches thick and six feet high! What hair-raising poverty - a guillotine is kinder! Is that the reality of a door? - Well, perhaps the greater reality of a door is the localized setting for a wonderful human gesture: conscious entry and departure. That's what a door is, something that frames your coming and going, for it's a vital experience not only for those that do so, but also for those encountered or left behind. A door is a place made for an occasion that is repeated millions of times in a lifetime between the first entry and the last exit, I think that's very symbolical. And what is the grater reality of a window? I leave that to you! in Van Eyck, A. 2008:62

Forrest Masterman Paige

A Phenomenological Study of the Alternative Appropriation of Urban Space by Parkour Practitioners

A phenomenological study of the alternative appropriation of urban space by parkour practitioners

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ABSTRACT: Parkour is an urban sport where practitioners utilize natural body movements such as running, jumping, and climbing to overcome obstacles in the urban environment efficiently and creatively. This phenomenological study investigates parkour practitioners and their alternative appropriations of urban space, defining the essence of their lived experiences. Utilizing the interview as the primary data collection method, parkour practitioners throughout the Midwest were questioned to define the essence of their collective lived experiences. The purpose of this study is to understand the contemporary perspective through which parkour practitioners view and experience the urban environment to contribute to the conversation between architecture, parkour, and urban space. The significance of this study is to understand this emerging usage of the city, identifying which urban conditions facilitate these movements, informing designers of which qualities and conditions in the city make these appropriations possible so that they may effectively incorporate this type of expression into urban spaces. Employing a qualitative phenomenological research methodology that is built upon the writings of Lefebvre, Borden, Merleau-Ponty, Pallasmaa, Serres, Latour, Angel, Csikszentmihalyi, and Lamb, this investigation addresses the main research question: What defines the essence of the lived experience that parkour practitioners have when they alternatively appropriate urban space? An important outcome of this study was the identification of certain urban conditions and elements which make urban spaces more ideal for parkour movements. Designers can utilize these examples to successfully incorporate the movements of parkour practitioners into urban spaces, giving them a multiplicity of different uses which go beyond their normative functions, expanding provided social functionality. Understanding this alternative perspective that parkour practitioners have on the function of urban space has the potential to redefine how these spaces are fundamentally considered, understood, and conceived by designers and how these spaces are perceived, utilized, and experienced by urban communities.

KEYWORDS: Alternative, Appropriation, Parkour, Phenomenology, Urban Space

INTRODUCTION

Parkour is a sport practiced in urban space. It is a movement art that emphasizes self-improvement and progression of abilities, teaching practitioners how to overcome obstacles, both physical and mental, efficiently and creatively. Utilizing natural movements such as running, jumping, and climbing, parkour practitioners explore their cities and their potential, using creativity and their training to move themselves through space. Parkour also deals with the processes of the mind to overcome the boundaries and obstacles in one's own thoughts, constantly questioning, changing, and reestablishing the perceived limitations and capabilities of one's own body. Parkour was initially established in Lisses, France in 1988 by David Belle, who learned a similar military discipline of movement from his father, which was utilized by the French Special Forces called *le parcours du combattant* (Lawrence 2006). Parcours du combattant is a military training discipline that teaches soldiers how to quickly navigate obstacle courses. The intention of requiring soldiers to practice navigating these obstacle courses was to prepare them for the physical requirements of active duty, preparing them for maneuvering in live combat situations, for navigating burning buildings, and for navigating submarines that have become disoriented underwater (WFPF). Belle established the present day sport of Parkour by adapting his father's training techniques to the urban landscape of the city. David Belle defines parkour as:

> A way of adapting to the environment around you, performed on all types of architecture. It's working on techniques through physical training to get over obstacles (Belle 2011).

A practitioner of parkour came to be referred to as a *Traceur,* a French term meaning 'one who traces a path'. Parkour, from its founding in Lisses, was always about overcoming challenges. The challenges that traceurs struggle, both physically and mentally, to overcome are created by urban spaces and objects in the city and are discovered through the traceur's unique alternative perspective of the urban environment.

Parkour originated as a non-competitive practice, focusing on the progression of one's own abilities. It is not about competition with other practitioners or about winning, but about one's own external, physical struggle for the advancement of their bodily movement abilities, and one's own internal, mental battle against their perceived limitations in movement. When practicing, parkour practitioners will typically repeat the same movement many times in succession to increase both their mental comfort with the action and the familiarity of the movement to the body, honing their precision and control of both body and mind. The practice usually occurs in short, episodic moments of appropriation in an urban landscape, which are typically repeated several times until the satisfaction of smooth, precise, and controlled movement is achieved. Parkour has a roughly established set of movements that have been categorized by practitioners of the sport over time. This index of movements includes types of actions such as jumps, vaults, leaps, flips, rolls, grabs, hangs, and steps. The movements in parkour were established based upon the interaction of the body with different spatial conditions found in the city, resulting in the roughly established global terminology for these movements. These movements are often executed in succession, which is referred to as a *line*, where the traceur performs several movements, one after another, in an urban space in one continuous action. While the established list of movements has been generally accepted by all practitioners of the sport, the list is fluid and open to interpretation by the traceur. Traceurs may add their own unique twist to certain movements or even discover a new bodily movement that has not been conceived of yet, adding another move to the index of the discipline. This fluidity and individuality of style in the practice of parkour leaves ample room for creativity to flourish. The ways in which parkour practitioners perceive and interact with the city creates a new perspective from which we can understand urban spaces, and uncovers new potential in the utilization of urban environments. Parkour, architecture, and urban space are inextricably connected, so it is important to understand how these practices interrelate and how they can influence each other.

1.0 PERCEIVING URBAN SPACE FROM AN ALTERNATIVE PERSPECTIVE

In order to identify movement opportunities and challenges in urban spaces, traceurs must develop what they call *parkour vision*. Parkour vision refers to the perspective that traceurs have when they observe urban spaces, identifying opportunities for alternative appropriations of those spaces for parkour movements.

> With parkour vision, you don't have to follow the prescribed route, you have options, you can kick off a wall and grab another wall and climb up...It gives us options and ways for us to see space differently (Lamb 2014).

A traceur learns to see the city from this perspective by regularly practicing parkour in urban spaces, helping them get an idea of which movements they are capable of executing and which urban conditions provide the opportunities for those movements. Traceurs who participated in this study expressed that they not only developed parkour vision through their training, but also developed better spatial awareness, a greater appreciation for architecture, a sense of value for all of the spaces of the city, a better relationship with physical objects, and a better understanding of heights, distances, materials, and textures. Through their tactile interactions with space, traceurs augment their visual understanding of space by extension. Pallasmaa explains that:

> All the senses, including vision, are extensions of the tactile sense; the sense organs are specializations of skin tissue, and all sensory experiences are modes of touching, both literally and metaphorically, and thus related to tactility. Our contact with the world takes place at the boundary line of the experiential self through specialized parts of our enveloping membrane (Pallasmaa 2014).

It is through this movement that traceurs gain a fuller understanding, experience, and appreciation for the city, because "for a perception to take place, continuous movements and adjustments are necessary" (Latour 2005, 169). The most fundamental level required is the movement of the eye, scanning, observing the world, collecting data. From this initial stage, the perceptions of the eye are reinforced, strengthened, and further investigated through the movement of the body;

> We have to commit to a new movement of exploration in order to verify the overall quality of all the links (Latour 2013, 460).
>
> We cannot express [space's] relation to ourselves in any other way than by imagining that we are in motion, measuring the length, width, and depth, or by attributing to the static lines, surfaces, and volumes the movement that our eyes and our kinesthetic sensations suggest to us, even though we survey the dimensions while standing still. The spatial construct is a human creation and cannot confront the creative or appreciative subject as if it were a cold, crystalized form (Borden 2001, 106, referencing Schmarsow 1893).

The collective experience and perception established by the combined movement of the eyes, body, and physical interaction with space through the skin verifies and reinforces one's observations and perceptions of the city.

> The less we just stare at the hammer-thing, and the more we seize hold of it and use it, the more primordial does our relationship to it become, and the more unveiledly is it encountered as that which it is – as tool (Heidegger, 1962).

By physically interacting with materials and objects through touch, as well as moving their bodies through space, traceurs learn about their environment in greater detail, developing a deeper relationship with the city, which translates to additional degrees of information that are recognized during visual observations of urban space. Through their physical and mental interactions with space in these alternative ways, traceurs learn to experience the city in a fuller way, transforming their experience from passively moving through the city to an active engagement with it.

For traceurs, they do not envision a city in the same way that a typical person would imagine it, concerned with street names, shopping locations, parking, public transportation services, and food vendors. Traceurs do not envision urban space as a totality on a macro scale; they are instead transfixed on the micro-conditions created by the architecture of the urban environment as a series of spaces and opportunities to physically engage with through alternative appropriations. They are concerned with very specific, localized elements within the urban fabric. Traceurs will often exclaim that the city is their playground, because they see the city as a uniformly endless series of unlimited possibilities for movement and play. They are concerned with the holistic sensorial experience of space through physical interaction, play, and exploration. Traceurs experience urban space in a more complete way, utilizing a variety of senses to develop intimate relationships with the objects, materials, and textures of the city. They experience the city in episodic moments of appropriation, employing sensory and cognitive mapping through their physical interactions with space.

2.0 THE PHENOMENOLOGY OF FLOW STATE

A flow state is a state of being where one is completely focused on, and absorbed in, the work they are currently engaged with. Flow states can be achieved in almost any type of work or activity. In parkour, flow state is often achieved during the execution of parkour movements or lines. Theorist Mihaly Csikszentmihalyi explains that flow happens:

> When a person's body or mind is stretched to its limits in a voluntary effort to accomplish something difficult and worthwhile (Csikszentmihalyi 2009).

It is likely that one will enter almost automatically into a flow state effortlessly and spontaneously while performing a task (Csikszentmihalyi 2009). This is precisely the situation which traceurs are often engaged in, faced with great physical and mental challenges that require tremendous mental focus to execute successfully. It is more likely that a person will enter into flow when a high amount of skill is needed to complete a task and when there are high levels of challenge present (Csikszentmihalyi 2009). The interviewees were asked to describe their experience of alternative appropriations of urban space in situations where they were training movements at the edge of, or even slightly beyond, their perceived skill level. It is during these training sessions requiring extreme focus and concentration when traceurs described that they most commonly entered into a flow state (Fig. 1, Fig. 2).

When asked to describe their experience of being in a flow state while executing parkour movements in urban spaces, traceurs described their sense of self stepping away as they metaphorically fell into their movements, letting their bodies and training take over.

> When you get to that zone, your body and your mind has to enter a state that's less and less thought or analytically oriented, and you kind of have to get out of that intellectualization of what you're doing and kind of let your body take over. I think that is one of the things that triggers Flow State…I think parkour, more than a lot of other sports activities, can induce that, and I think that's one of the reasons why it's so attractive (Graves, Group Interview 1).
>
> You're so focused on the actual movement that there is no process of thinking about it. The training takes over…That's when that sense of self steps back…For that moment while you are doing the jump, there wasn't an I…The body is kind of leading because it happens so fast that it has to be training, it has to be reflexive (Joe Torchia, Paired Interview 1).

During their experience, the interviewees described that this sense of self steps back while the body takes over, and upon completion of the movements, the self steps back into place, changed slightly through the process. Providing further insight into this retraction and reintroduction of the sense of self, Angel explains that:

> Parkour is an activity that allows participants to experience the 'flow' state, one that involves a letting go of the sense of self, then experiencing a re-enforced sense of self after an activity that involves entering the flow state has occurred (Angel 2011).

Through their experience of alternative appropriations of urban space, traceurs lose their sense of self temporarily, only to have it return in a more solidified form, reinforcing their identity through movement and overcoming challenges. This change that traceurs experience through their movements:

> Is tied up not just with the re-perception and subsequent alternative use of space, but [also with] the nature of the challenge experienced in parkour and developing the skills to exercise control in difficult situations (Angel 2011).

Because traceurs must break jumps by overcoming fear and hesitation in order to commit to certain movements and complete challenges, they become transformed through the crucibles of their experiences. These experiences alter their identities, however slightly, and gradually prepare traceurs for other similar situations they may encounter apart from the practice of parkour, teaching them how to face fear, overcome hesitation, and commit to movement, physically, mentally, and situationally throughout life.

During this experience of alternative appropriation of urban space, traceurs expressed that they felt a sense of weightlessness, power, euphoria, and freedom. Csikszentmihalyi refers to these feelings during flow state as 'ecstasy', which he describes as a mental state which can be identified by the sense that one is no longer taking part in everyday routines, but stepping out of them into an alternate reality (Csikszentmihalyi 2009). This experience of ecstasy can be an intense experience where one may feel almost as if they themselves do not exist while in this flow state (Csikszentmihalyi 2009). This phenomenon of the feeling of the non-existence of the self is exactly what the traceurs described during their experiences when they alternatively appropriate urban space. Because of their intense focus on their movements, there is no room left for conscious thoughts relating to the self or the body. When a person is involved in a task that is fully engaging, they have little attention left to dedicate to the awareness of bodily feelings or notions of the self; their identity disappears from conscious thought (Csikszentmihalyi 2009). Because the task requires extreme concentration and focus, the mind cannot simultaneously feel and be aware of one's own existence, and therefore those feelings of the self and of existence temporarily cease (Csikszentmihalyi 2009). For traceurs, the intense focus and concentration required to overcome difficult physical challenges when alternatively appropriating urban space causes them to lose their feelings of the self in their efforts, entering a flow state where they experience this ecstasy and euphoria.

This experience of being in flow is described by Csikszentmihalyi as having several common feelings associated with that mode of being. When in flow state, one is completely enveloped in what they are doing, focusing and concentrating on the task at hand, experiencing ecstasy in the process (Csikszentmihalyi 2009). In this mode of being, one knows exactly which actions must be taken to complete the work, and this knowledge comes from the high level of skill that one possesses, which provides confidence in knowing that the task is possible (Csikszentmihalyi 2009). Also present in this experience is, again, this notion of the self dropping away, a feeling of becoming part of something larger (Csikszentmihalyi 2009). Additionally, through this intense focus on the task at hand and on the present moment, the experience of timelessness is another commonly reported feeling during flow (Csikszentmihalyi 2009). This idea of timelessness and intense focus on the present moment was reciprocated by the interviewees when describing their experience of alternative appropriation of urban space. During this experience, the traceur is fully engaged in the present moment, focused on every movement and obstacle as they come to them; they are focusing on the present moment and not on the next move or on the end result.

> "Take each step as it comes. Execute each step perfectly, but only the one you're doing now. Don't try and think ahead to doing the next one perfectly, do the one right now." And that's literally each step after step. That is why I think, part of why there's this feeling of calmness and flow, because even though you've accepted the end result, you're not looking at it. Each step comes and you take it and you do each step perfectly (Foster quoting Daniel Ilabaca, Individual Interview 1).

In this flow state, their thoughts are entirely focused on the present moment when the mind steps back and the body and the training take over. Lastly, this state of flow offers intrinsic motivation, and becomes rewarding in itself (Csikszentmihalyi 2009). As the traceurs described, this state of flow during their experience of urban space provides them with feelings of euphoria and is intrinsically rewarding. Through engaging with, and overcoming, challenges and experiencing this flow state, traceurs feel a great sense of happiness and satisfaction through their alternative appropriations of urban space.

Figure 1: Paige executing precision jump, Kent State University Campus, Kent, OH (Author 2016)

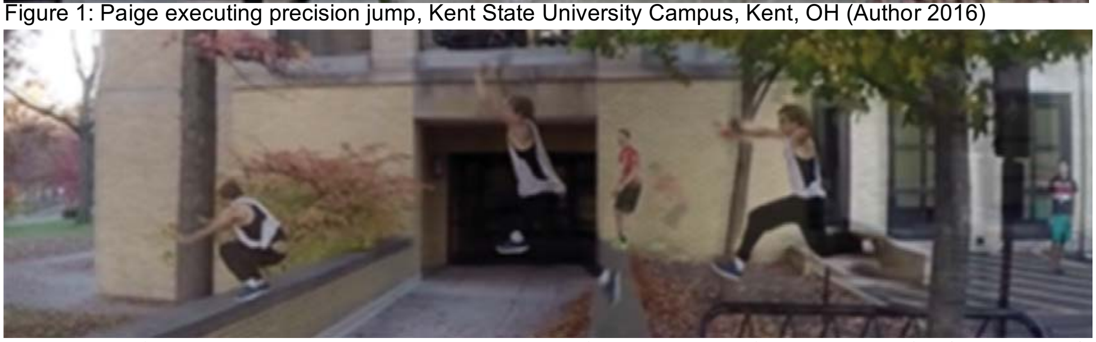

Figure 2: Wolfe executing strides to precision jump, Kent State University Campus, Kent, OH (Author 2016)

3.0 DESIGNING FOR ALTERNATIVE APPROPRIATION

In order to find locations that are suitable for practicing parkour movements, the traceurs interviewed for this study identified certain ideal physical conditions within urban spaces that they seek out. Ideal physical conditions for a suitable training area include elements such as thin low walls, suspended metal bars, multilevel sturdy platforming, railings, small square or circular objects, high walls made of a hard material, accessibility ramping structures, stairs and stairwells, tables, benches, trees, terrain variations, corners, and ledges (Fig. 3). Several of these conditions were identified prior to the interviews through a collective visual analysis of many parkour locations taken from online parkour forums, reaffirming these specified ideal conditions. In addition to these physical obstacles, the traceurs also identified other conditions of urban spaces which make them ideal for parkour movements including having many obstacles in close proximity, a less crowded area, good texture and grip on surfaces, sturdily built objects, older and dirtier appearance to the space, and a spot that is considered public space.

To makes spaces more suitable for parkour movements, these elements can be included in public urban space designs. An ideal parkour location should have several of these objects concentrated in an area where they are in close proximity with varying distances between objects, ranging from one to fifteen feet. These objects within the space should be constructed out of durable, textured material that has good grip for hands and shoes and is not easily damaged or marked up, such as stone, cement, rock, concrete, wood, or brick, all with rough rather than smooth textures to improve grip. The objects should be securely constructed, ensuring they do not shift or fall apart so that traceurs are less likely to injure themselves or damage the space. The objects in the space should also be specified to handle certain loads that would be applied to them through parkour movements, including impact load forces, pulling forces, and pushing forces. Most importantly, ideal parkour spaces should be public spaces that are designed and intended for pedestrian use.

The type of alternative appropriation of urban space that traceurs engage in is rarely understood or acknowledged by designers of urban spaces in the United States. Because this type of space usage has only recently begun to occur in the United States, urban spaces have not been designed in a way that is mindful of this type of space usage. As parkour grows and becomes increasingly popular, the phenomenon of this type of alternative appropriation will become increasingly common as well, and designers will need to start taking this type of space usage into consideration when designing urban public space. In order to effectively and mindfully accommodate for this type of alternative appropriation of urban space by traceurs, designers can incorporate some of the elements, objects, layouts, materialities, and conditions which the interviewees identified into urban spaces that allow for these appropriations.

Designer and theorist Juhani Pallasmaa emphasizes the importance of creating a sensory experience of architecture for the user, denouncing the surfacial nature of ocularcentrism (Pallasmaa 2014). Ocularcentrism can be described as a solely ocular focus when designing space, prioritizing the design of visual stimuli while, as a result, depriving the other senses of experiences or perceptions (Pallasmaa 2014). Pallasmaa argues that through this focus on visual stimuli in design, architecture is not experienced in a way that is as complete because of the sensory deprivation that ocularcentrism creates (Pallasmaa 2014). Lefebvre maintains similar thoughts, concluding that:

> Modern architectural space tends to concentrate on the visual, on objects and surfaces, ignoring the space of the body (Lefebvre 1992, 200).

By designing urban spaces that welcome physical interaction, touch, movement, and play, communities in cities can once again utilize all of their senses when experiencing space rather than just prioritizing visual stimuli.

> Space-production cannot...be reduced to theories of it, but must be seen as a process involving not only theories but also practices, objects, ideas, imagination, and experience (Borden 2001, 11, referencing Lefebvre).

All of these elements are important components in conceiving and designing successful, functional urban environments. This space for expression, movement, and difference is what gives people a sense of freedom, community, and relief from the stresses of the city, providing space in which they can further define their identity.

> The architecture of the city can be the means by which social relations are constructed. Practices such as skateboarding therefore suggest not only the redistribution of urban space according to the maxim 'to each according to his needs', but also the reformulation of the self according to the physical potential of the built environment (Borden 2001, 243, referencing Lefebvre).

Through designing urban public spaces that can be utilized for parkour movements, the creation of spaces that encourage physical intimacy and interaction which provide room for freedom of physical expression can be accomplished.

Pallasmaa argues that because of this trend towards a heavy focus on design for visual stimulation, our visual sense is becoming detached from our other senses, depriving us of a complete, fuller experience of architecture and allowing for no emotional dialogue with space (Pallasmaa 2014). To provide the conditions which generate this fuller experience of space, architects can choose to create spaces that encourage both visual and physical interaction through their design choices, because:

> The way that...spaces are set up will inform, or give us an expectation of, how we're supposed to interact with them (Lamb 2014).

Through their designs, architects typically have premeditated intentions about how they envision a space to function, where people are supposed to walk, look, and sit.

> These spaces are designed intentionally to give us experiences, or designed to elicit certain experiences from us (Lamb 2014).

These planned choices about space are expressed and communicated through the physical manifestations of their intentions in the built environment. People are aware of, and often follow, these designed architectural cues that guide them through space, directing them and informing them what to do and how to behave.

> Architecture communicates to us just as it communicates to the traceur, it will communicate expected behaviors (Lamb 2014).

In an identical process, architecture communicates to the traceur which movements the space is providing for, encouraging them to alternatively appropriate it in certain ways.

> Traceurs have a very intimate relationship with space and architecture, the reason being is that they are connected to it, corporeally they are connected to it, they feel it, they're in it, and they work with it. Architecture communicates to them the types of moves and types of behaviors that it will require for them to move through that environment (Lamb 2014).

Certain obstacles, materials, layouts, and spacings when filtered through the ability of the traceur can signify through parkour vision which types of movement challenges the space affords.

By choosing to design space with this type of physical engagement in mind, architects can provide for and encourage people to experience space on a more intimate level. Through designing space in ways that intentionally incorporate physical interactions involving the totality of the senses, the alternative ways in which traceurs appropriate space will become increasingly known, and:

> The more we experience these interactions, the more it develops a value or an expectation of behavior (Lamb 2014).

When the designs of the spaces begin to conceptually support physical interaction with the urban environment similar to the ways which traceurs engage it, their alternative appropriations become more acceptable and understandable in public perception.

Currently in the United States, because there are very few, if any, public spaces designed for the alternative appropriations of traceurs, public spaces that are suitable for this type of movement already exist and are utilized by traceurs. This means that the requirements of a decent parkour spot are nothing drastically different from existing spaces. But by mindfully incorporating these slight changes when designing urban spaces, the ways that traceurs use the city can be brought into the intended scope of usage for these spaces. Following these guidelines, parkour can be successfully incorporated into any new or existing public space.

> "Fifty percent of our population currently lives in an urban environment, and in thirty-five years, that is going to jump to seventy-five percent" so clearly we need to reevaluate or think differently or change our points of view about how we can use urban space and what sorts of things we can do differently with space" (Lamb 2014, referencing Gumpert).

By designing spaces and objects with multiplicity of use as opposed to singular usages, urban spaces become dynamic, interactive, inclusive, multipurpose environments, providing room for a plethora of different activities and forms of self-expression, increasing the potential social services they can provide for local urban communities.

Architects and city planners have only very recently begun to consider and discuss the implications of a conversation about the intersections and interactions of parkour, architecture, and urban design. Bjarke Ingels, a Danish architect from Copenhagen, engaged in conversation with members of Team JiYo, a widely known parkour group also from Copenhagen, in a documentary created by Team JiYo titled *My Playground*. In the dialogue, Ingels expressed that "there is an overlap of what we are doing and what you are doing" (*My Playground*, Ingels 2009). He explains how "architecture is the art of creating the setting for human life" and that "architecture in the means and the goal is the maximum evolvement of human life" (*My Playground*, Ingels 2009). Through architectural design, Ingels is "trying to bureaucratically plan it, whereas Team JiYo is just doing it guerilla style" (*My Playground*, Ingels 2009). Many of the buildings designed by Bjarke Ingels Group challenge or defy the traditional conventions of architecture similar to the ways that parkour challenges the traditional functions of urban spaces and saturates them with new potential. Klaus Bondam, the Mayor of Technical and Environmental Administration in Copenhagen, explains that he likes:

> To see that the spaces in the city are being used, because that is what they are there for. There is no doubt that if there is a lot of positive behavior in our city's space, then that behavior will take the positive power within that city space and get many more people in that city space with positive behavior, which is certainly something that parkour can contribute to, because it gives us something to look at (*My Playground*, Bondam 2009).

The positive energy and spectacle of parkour has the potential to reinvigorate city spaces by creating an invitation for others in the local community to either watch or take part in the spectacle and event that parkour creates. Signe Hojbjerre, a member of the Team JiYo parkour team, explains how:

> When you show that you look at the urban space and value it in a certain way, and when other people see that and also value it, it then becomes even bigger, and becomes a way of creating your own identity (*My Playground,* Hojbjerre 2009).

Defining and understanding the essence of this perspective through which traceurs view and utilize urban space, and incorporating this new perspective in the designed spectrum of usage for these spaces, could create more evocative, engaging, community spaces.

Lastly, the underutilization of certain areas of urban spaces can be ameliorated by taking into consideration this new perspective when designing *left over* space within cities. Often times there are areas of the city which are underutilized that can result from certain urban planning design implementations or from the necessary elements of a city which are not perceived as suitable for public space, such as alleyways, backsides of buildings, and service areas. It is often in these underutilized, unattractive, left over spaces of the city where traceurs find opportunities for movement, creativity, and play. Through the perspective of the traceur, all spaces of the city contain value and potential, providing these underutilized areas with usage possibilities. In Copenhagen, the Danish architectural design firm Kragh and Berglund created a project called Plug N Play which uses parkour as a means to give value and usage to planned building sites prior to the start of construction. They designed and implemented temporary sport parks in these cleared building sites, placing designed parkour equipment in this area for practitioners to use while the lots were sitting vacant, unused, waiting for construction to begin. Upon the start of construction, the sporting parks are removed and placed in new locations, temporarily imbuing these would-be useless areas of vacant city property with value and usage through parkour and other sports. Through the practice of parkour, all of these underutilized spaces of the city are once again given value through the perspective that traceurs have on urban space and the ways in which they alternatively appropriate them for their use.

Figure 3: Multilevel Sturdy Platforming, High Walls made of Hard Material, Stairs, Dirtier Appearance, Many Obstacles in a Close Proximity, Grand Fountain, Flint, MI (Author 2016)

CONCLUSION

Architects, designers, and urban planners currently design for the normative usage of urban spaces. But the innovative, contemporary ways through which parkour practitioners alternatively appropriate and interact with urban space to encourage creativity and play have yet to be introduced into the range of perspectives through which urban spaces are designed and understood by these professions. Traceurs, through their unique appropriations of space, do not simply observe and walk through urban spaces. They physically engage their environment, transforming these normative, bland social spaces into engaging, dynamic, repurposed, and interesting spaces where interaction, exploration, play, and creativity thrive.

In order to generate a meaningful, effective, substantive conversation between parkour and architecture, it is necessary to first establish parkour, and the experience that traceurs have when they appropriate urban space, in a framework of research. This inquiry aims to uncover and define the essence of the lived experience of what it is to perform parkour movements in urban spaces, the essence of the experienced relationship between parkour practitioners and urban spaces when they are performing movements. The purpose and intention of this phenomenological study is to define the phenomenon of alternative appropriation of urban space by parkour practitioners with the larger objective of contributing to the framework through which a conversation between parkour and architecture can continue to develop.

Conceiving of urban spaces through this new perspective that parkour practitioners have experienced is a completely different viewpoint for designers to consider when envisioning the functions of urban spaces within the city. It is important to define how this new perspective relates to architecture and to understand what impacts this new perspective could have on the design and function of current and future urban space. The normative urban public spaces, typically parks of grass, trees, and benches used primarily for walking and sitting, are transformed into immersive, sensuous, interactive, phenomenologically engaging social spaces when traceurs alternatively appropriate them through their movements.

Through the perspective of the traceur, one is able to visualize both the possibilities for use and the value in all spaces of the city. Designing with this perspective in mind, that of the traceur and their appropriation of space through alternative use, could result in spaces that generate greater community engagement and positive social activity. Exploring and defining the essence of this new perspective and experience that traceurs have concerning both urban space and the city is essential to understanding the possible future developments and evolutions of the functions of urban spaces. As Bjarke Ingels explains, as architects:

> Our intention is to open up for more possibilities, and then it's great if the city and buildings meet what wasn't expected, the unforeseen, the spontaneous, what's coming. Life in the city is always evolving and it is our job as architects to make sure that our opportunities for expression aren't limited, but that our cities match the life we want to live (*My Playground*, Ingels 2009).

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The Spanglish Turn: The Production of Architectural Hybridities in Los Angeles

The Spanglish Turn: The Production of Architectural Hybridities in Los Angeles

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ABSTRACT: The relevance of contemporary architectural design is intrinsically dependent upon it's being in-step with the aesthetic and spatial sensibilities of its time. Within Southern California, one of the most dramatic contemporary influences on aesthetic and spatial sensibilities is that of Latinization, in particular, Mexican/Chicano cultural practices. This research speculates on the emergence of an architectural hybridity autochthonous to Los Angeles informed by a theoretical framework termed the Spanglish Turn. The development of this framework begins with an analysis of visual arts, and material and popular culture in Los Angeles. Drawing upon a theory of language called systemic functional linguistic theory (or functional grammar), we adapt this system of analysis to work as a translating system to an architectural context. This strategy aims to 'stretch' the relationship between architecture and specific forms of popular and material culture by speculating on the behavior informing them. Then guided by a formulation of this emergent spatial logic, it looks for tangential inroads and alternative patterns to begin to articulate a new 'grammar of translation' for LA's popular and visual culture into the realm of architecture.

Keywords: Los Angeles, Hybridity, Immigration, Chicano/Popular Culture, Linguistics, Visual Art

INTRODUCTION

This research is about the production of Hybrid Architectures in contemporary Los Angeles as analyzed by the Spanglish Turn theoretical framework. It looks at the production of Architecture through the lens of cultural hybridity as manifested in visual arts, and popular and material culture. This theoretical framework uses a linguistic theory named systemic functional linguistic theory or 'functional grammar' as a translating system of culture and proposes a new architectural lexicon for the production of alternative architectures within the context of contemporary Los Angeles.

Today, in Los Angeles new emergent cultural hybridities are being created. These hybridities find innovative expressions in the visual arts, popular and material culture, contemporary urban practices, and architecture. The theoretical framework to situate and analyze these spatial and formal transformations is defined as the Spanglish Turn. The Spanglish Turn in Los Angeles is made up of parallel traditions, materials, scales, and visions, which coexist and co-mingle to create new urban and architectural forms. The Spanglish Turn is informed by the cultural connection between Los Angeles and Mexico City, a connection that has been intensified in the last few decades. This historical connection between people, beliefs, customs, and objects has facilitated the strong cultural flow between the two cities, joining the Latinization process occurring in Los Angeles and other major US cities. As such, the relationship between these two major cities has matured, establishing the high speed and dynamic cultural corridor where interchange and hybridity are second nature to a continually transitioning and emergent urban population.

1.0. Cultural Hybridity

In broad terms, this research centers on the study of culture, specifically it focusses its attention on cultural hybridity and its insertion into contemporary architectural discourse. Cultural hybridity has existed for very long time, and it is now seen as the main cultural symptom of our current globalized world. In Los Angeles, this cultural mixing is the result of particular and unique dynamics that has at its center Latino/Mexican culture. In Los Angeles, new sensibilities and mental cartographies are the reprogrammed "code," establishing the unique and emergent hybrid culture influencing the creative practices in LA, including current and future architecture in the city. Hybridity can happen and alter all different dimensions of culture: High and Low, Mainstream and Marginal, and Universal and Particular.

As the Latinization of the U.S. population continues, cultural hybridization will play an increasingly central role in the creation of space, architecture, aesthetics, and identity. In addition, the nuances of cultural context and the particularities of physical circumstances inform cultural mixing processes. Within the Spanglish Turn framework, hybridity is autochthonous to Los Angeles, closely tying recent Mexican immigration to this process of cultural mixing. As broader cultural processes in contemporary Los Angeles rapidly intertwine with other

Latino, Asian and other immigrant cultural dynamics, hybridity is rapidly becoming the force forging the future of the city.

In Los Angeles, cultural mixing occurs at different scales and intensities. The large scale of demographics and the landscape itself influences these dynamics. For instance, there is deep mixing that results in the creation of new and more enduring forms, and superficial and transitional mixing also occurs in the city, as well the various degrees of mixing between these two poles. Today mixing, from “light” mixing to the creation of enduring, more Creole-like cultural forms exist side-by-side and in various configurations across the city. Among these are also those forms that resist any mixing at all.

1.1. Three major cultural flows

Los Angeles is the place where an emergent hybrid culture is being forged. This cultural and spatial transformation is what I define as the Spanglish Turn. There are three major cultural flows that inform the Spanglish Turn: The Historical Progressive California ethos, the existing Mexican-American or Chicano culture, and Mexican/Latino Immigrant diaspora. These three dimensions work in a trialectical fashion and offer the capacity to produce new and innovative cultural hybrids that are essential for understanding and defining the spatial and formal expressions of contemporary Los Angeles. This set of three cultural flows aim to form the basis of a theoretical coordinates for the Spanglish Turn.

1.1.1. Historic California Progressive Culture

The historic progressive culture of California and Los Angeles and the variations of its geography, promoted acceptance of newness, difference, and innovation. This ethos of accepting newness and difference, and actually defining itself by these vary characteristics, is a big part of why the creation of so many hybridities has occurred on the scale that it has, and why this city is, at heart hybrid and more adaptive than many other metropolises.

In much of the twentieth-century in California, there was a non-rigidity in the cultural norms and practices that allowed for greater artistic and political experimentation. In California, artists, architects, and other creative practitioners participated in the ‘place making’ process; in their work, they were forming identity out of the surrounding spaces. In short, they were creating place out of space.

This was made possible also because of the fact that California is a frontier-type location and also contains the large metropolises of San Francisco and Los Angeles. These types of locations are particularly susceptible to change due to the fact that as frontiers, there exists within them a type of intersection between cultures, an ‘interculture’, so to speak.

As a major metropolis, Los Angeles has been home to large numbers of immigrants who push forward the development of cultural creolization, the development of new cultures that contain elements of existing cultures, together making one culture that is richer and more complex than the originals. In these situations, it is also frequently easier for people to accept newness, because they can easily take bits and pieces of what they like from other cultures without having to have any agreement about the meaning of what has been exchanged. Working misunderstandings then become a main ingredient in the creation of new, hybrid cultural forms.

1.1.2. Mexican-American or Chicana/o Culture

Another major influential cultural flow of the Spanglish Turn is the Mexican-American or Chicano culture in California. Chicano culture is a hybrid culture, a mix of Mexican and American traditions, customs and sensibilities. Chicano culture is based in an open cultural system that allows for absorption and incorporation of other cultural practices that it finds necessary for its own benefit. Since its beginning of its founding, Los Angeles has been influenced by Chicano or Mexican-American culture, this is evident in the name of streets, and neighborhoods, in popular music, food, lowrider culture, as well as in local politics, as demonstrated in 2005 when Antonio Villaraigosa became the first Mexican American mayor of the city of Los Angeles since its founding.

1.1.3. Latina/o and Mexican Immigrant Cultures

The third cultural flow is the current Mexican and Latino immigrant culture. Mexican immigrant cultures bring with them fresh formal and aesthetic sensibilities that tend to mix with existing ones creating new sensibilities that result in novel hybrid forms and aesthetics. They bring with them traditions and customs that are transforming the urban spaces of Los Angeles, affecting the dynamics of private and public space usage. One distinct tradition that has slipped into the Los Angeles urban dynamics is the use of public space. In Mexico City the distinction between private and public space is consistently blurred. It is in the public spaces that one can see an expression of a contemporary sensibility based on temporality, informality, adaptability, and performativity. This state of continuous unpredictability includes a strategic disregard for potential disaster on the one hand, and a disinvestment in the notion of permanence on the other. This has led to a perspective that has greater investment in acts and aesthetic forms that are short lived, spectacular, exuberant, and fantastic. This hybrid sensibility has slipped into Los Angeles and is rapidly transforming its spatial dynamics, as is evidenced in today's urban physiognomy. These three separate cultural flows converge at different degrees of intensity to form the conceptual triad that form the core of the Spanglish Turn theory.

2.1. Visual Art and The Spanglish Turn

This research also looked at how the Spanglish Turn principles are manifested at the scale of individual perceptions and at the scale of cultural community. The individual perceptions were analyzed through the work of three visual artists: Ruben Ortiz-Torres, Salomon Huerta y Refugio Posadas. Their works shows the effects of cultural hybridity in the development of new forms and aesthetic principles. Collectively, the work of these three visual artists provide a formal analysis through examples of "paring down" or "stripping away" to get at the essentials of line, color, form, and movement, as well as the opposite, the display of the ornate, decorative and baroque. These trends exist separately and in juxtaposed proximity, creating tension, excitement and unease. The two trends are conflicting and complementary, relating to the different charged forces within the Spanglish Turn.

2.1.1. Case Study # 1: Ruben Ortiz Torres

In the work of Ortiz-Torres cultural and physical context are essential. Hybridity and customization are two concepts that are central to his artistic practice. In his work, hybridity is characterized as a 'trickled up' cultural phenomena. Based on multiple factions that come in constant (and intense) contact by their proximity, they have produced cultural forms that tend to be radical, malleable, wild, and bold. Another concept significant in his work is that of playfulness. For Ortiz Torres the qualities of playfulness, style and delight are paramount to his artistic practice and aesthetic approach. Playfulness in Ortiz-Torres's work serves a dual purpose: to disarm the viewer by making him or her laugh or experience humor, and then provoke a subtle form of critique on the conventions and relationships between "high culture," cultural identity, Chicano culture, and cultural representations.

2.2. Material and Popular Culture and The Spanglish Turn

The analysis of the effect of cultural hybridity at the cultural scale of the group community is discerned through a close analysis of popular culture (Day of the Death) and material culture (Lowriders and Taco Trucks). These community expressions show us how hybrid forms are configured as a result of collective actions, also they demonstrate how cultural hybridity is a process that works well in the interstices of the public and the private spheres and challenges traditional notions of what constitute private and public space. The rhythms of these popular cultural processes have similar qualities in the careful slowness of their preparation and the culmination of their efforts in a spectacular short-lived performance. In this sense, ritual, aesthetics, and meaning become interwoven. Through this mechanism, rituals provide an emotional groundedness for both individuals and social groups, complicating the relationship between culture/creativity and the forces of commodification, providing a necessary antidote to the forces of depersonalization.

2.2.1. Case Study # 4: Lowriders

Lowriders hold tremendous potential for the field of architecture in terms of both aesthetics and design principles. Lowriders are unique objects that express cultural value, but at the center of its value system is the aesthetic dimension. Form and performance are the two most important values in lowriders. Form is essential to the signification of the object; form rules the object, and it is through the sophistication of the formal aesthetic qualities that a lowrider obtains its value. Line, color, and painting special effects all combine to form a distinct object charged with aesthetic ingenuity an affective exuberance. It is in the surface of the object that lowriders most directly express their distinct sense of aesthetics and style. This hybrid neo-baroque aesthetics, that combine high and low notions of art, craft and art per se, decoration and ornamentation and design, are the product of long elaborated process of meticulous customization that has developed over many decades. Other important characteristics of lowriders are those of humor and pleasure. In the Chicano community, humor plays a major part in the community's character and culture. Chicano material culture, such in the case of lowriders, is charged with emotive and affective qualities that reveal a sense of belonging and pleasure.

3.0. Functional Linguistics of the Spanglish Turn in Architecture

In addition to conducting the case studies (visual arts, and popular and material culture), the Spanglish Turn is uncovered through conducting a spatial analysis. This spatial analysis has two parts:
1) consideration of the city's *Metafunctions* of space, and 2) the city's *Charged Fields*.

Drawing upon a theory of language called systemic functional linguistic theory (or functional grammar), we adapt this system of analysis to work within an architectural context.[1] This theory asserts that form and meaning are interwoven, or in this case, form and spatial affect. In other words, there is no affect without the structure to create it. We use this system to provide the system of analysis for Spanglish spaces and to measure degrees of Chicano and Latino/Mexican immigrant aesthetic influence upon architectural structures and spaces of the city. Functional grammar posits that all language is realized in a social context. The success of any lexical or organizational choice relates to its appropriateness for that given context—formal or informal, written or spoken. Within this framework, spoken language is viewed as a distinct mode of language that utilizes three components: one, the shared experience of participants—the manner in which gesture, prosody, and tone reference aspects of a shared environment; two, social interactiveness—the frequent back and forth exchange and the switching of roles between speaker and listener; and three, the complex "chaining" of specific ideas and linking between parts of a larger discourse. Analyzing architecture as a type of verbal exchange opens up many possibilities for the study of architecture and urbanism. From this perspective, we may view Los Angeles as a type of informal and dialogical verbal exchange, operating as a highly performative, dramatic, and ever changing temporal network, a type of free-style gossip so to speak. Architectural theorist, Robert Somol notes that the structure of gossip is the best format for guiding speculative architectural design.[2]

The application of this theory is like a lens where one can view the particularities of material culture, urban space and architecture. It is aimed at moving fast through the myriad of spoken words and spaces that make up the city. It focuses on explicit characterizations of space and form, inseparable from affect and architectural characteristics. More specifically, it sorts forms and processes by function, design, and affect, giving special attention to context to determine the significance of architectural characteristics.

This is a process-oriented approach based on studying fluid and informal interactions within specific conditions. It is intended to respond to constantly changing dynamics. This research utilizes an expanded definition of the term, *text*. Originating from Hypertext or Stretchtext, *text* is defined as an image, symbol, sound or movement. The flexibility of the term engenders complex plots or stories to be read from spatial or formal narratives. A text can be anything that has a "readable" organizational structure and is internally linked.[3]

3.1. Metafunctions of Space: Situatedness, Organization, and Elements

As mentioned above, this theory uses three Metafunctions, which are attributes of performance, object, and structure. They are referred to respectively as Situatedness, Organization, and Elements. Situatedness relates to the theatricality of space or object, sensibilities, and the relationship between intention, the experience of space/object, and behavior within that space. It is also attuned to the tone or level of formality in urban contexts such as the ambiance of a building, space, object or process. The concept of Organization refers to the nature of the placement, proximity, and size of various spatial elements within a given environment. It is also concerned with the manner in which elements are linked, such as the organization of space and an architectural program. The Metafunction of Elements refers to the basic concepts of line, color, movement and form. It also defines the architectural elements of space, from surface, volume, and boundaries, to openings, passageways, and interruptions over time.

3.2. Charged Fields of Place: Adulteration-Densification, Acceleration-Deceleration, and Aggression-Sedation.

In addition to the three categories listed above which are attributes of form, this analytical framework also contains sets of actions which define the nature of creative oppositional forces as they enact upon physical forms. These oppositional forces can be seen as 'Charged Fields', that is, spatial manifestations of the imagination arisen out of collective systems formed at the local level. These are the result of emergent systems that have come to dominate the look and feel of the landscape. They are "charged" in that they act as manifesting actions that express aesthetic and spatial sensibilities in customized ways and influence the manifestations of spatial Situatedness, Elements, and Organization.

The connected oppositional forces that constitute the Charged Fields are: 1) Adulteration – Densification, 2) Acceleration – Deceleration, and 3) Aggression – Sedation. Specific ways in which these processes affect form are numerous. For example, Adulteration can multiply, recycle, and stretch. Its opposite Densification can saturate, detail, and intensify. Acceleration may connect and blur while Deceleration may scatter and delineate. Aggression has the power to heat, make graphic, and embolden while Sedation can restrain, soften,

[1] Schleppegrell, Mary J., *The Language of Schooling: A Functional Linguistic Perspective*. New Jersey: Lawrence Erlbaum Associates, Inc. 2004
[2] Somol, Robert. "Pass it on…," in *Log 3*: *Observations on Architecture and the Contemporary City*, New York, Anyone Corporation, Fall 2004
[3] Bernstein, Mark. "On Hypertext Narrative." ACM Hypertext Conference 2009, Torino, Italy, 2009

become delicate, and disappear. The charged fields are tactical processes that resemble Bernard Tschumi's notion of the Space-Event in Architecture. Tschumi posits that the relationship between concept and context determines the process and production of new architectural forms. He sees form as a by-product of the complex interaction between an original idea (concept) and the specific conditions where the idea is projected (context). Tschumi defines this interaction the 'in-between zone,' which works as a negation of pure form or style. Together these processes result in a dynamic, local network of 'interstitial spaces.' Form becomes a derivative product of a critical idea in a particular context of place and time. Form is not universal; it is contingent to local conditions. In a similar manner to the Spanglish Turn, Tschumi advocates for strong context specificity and concrete locality for the projection of new architectural ideas that respond to the rhythms of today's complex cities.[4]

While these factors are specifically manifested in any object, environment or structure, the emphasis of one attribute or process over another, or the existence of simultaneous, contradictory influences, mark the hybrid logic of everyday Spanglish Turn aesthetics. By focusing on the formal and aesthetic properties of the material city, this spatial analysis attempts to delineate new cultural vectors that can inform future architectural practices and forms.

Under the influence of the Spanglish turn, an aesthetic spatial portrait emerges, seeping out into greater LA, from today's Chicano/Mexican immigrant Los Angeles. These are, for example, of baroque style, dense surfaces, and adulterated space. In addition, aesthetic sensibilities have come to inform everyday interactiveness, non-permanence, moods juxtaposing aggression with sedation, and the speed of spatial production from "fast and furious" to "low and slow."

These examples all demonstrate extreme uses of adaptability and continuous rapid and transient translations of space into altered functions, visual impressions, social interaction, and viewers' experiences. In other words, the architectural forms become hybrid in their daily visual and functional transformations and in their regular recycling of repurposed spatial elements.

4.0. Re-inscribing Cultural Studies into Architecture

One way of revealing cultural hybridity dynamics within contemporary architecture is through experimentation of architectural forms derived from cultural and spatial concepts.

Current preoccupations within theoretical discourse include considering contemporary architectural form as a repository of new technologically-based design sensibilities rather than a manifestation or response to the current conditions of our contemporary global/local cultural dynamics.
Often times overemphasis on technology neglects or even dismisses other approaches to architectural design that might lead us towards alternative forms of architectural experimentation. Past cultural approaches towards architectural ideas and forms, such a postmodernism, or critical regionalism are now seen as ideologically suspect or even disconnected from our current emphasis on pragmatism.

As a culture, we are obsessed with technology. The intent here is not to dismiss the significance and relevance of technology in architecture but to aim focus back into the realm of *critical cultural* analysis. This approach is based on the conviction that architecture serves us best when it is directly engaged with the dynamics of contemporary cultural production, in Los Angeles, such dynamics are heavily influenced by the Latinization process of the region.
One of the most dynamic, intriguing cultural and social trademarks today is the incessant contact and mixing of diverse cultures. Cultural mixing today is tied to (im)migrant communities. The recent conflation of time and space at a global scale has accelerated processes of cultural mixing in the last several decades. It is not doubt, that we are becoming more and more a hybrid culture society, a condition that will continue and become stronger in the next few decades.

5.0 Applicability of the Spanglish Turn method to other contexts/cities

The Spanglish Turn is the first iteration of a method of analysis that posits cultural hybridity at the center of the production of new architecture. This mode of analysis is context specific, it intimately engages the dynamics of cultural and spatial production of a specific place and time. As mentioned earlier, cultural hybridity is the sign of our times of our global (im)migrant cultures, and the more societies and cities evolve the dynamics of cultural hybridity will become more intensified and complex. Although the Spanglish Turn method is specific to Los Angeles, it could be applied to other cities that are going, or will go, through similar dynamics of cultural and social change. The first logical next step will be to test the Spanglish Turn framework in other cities with a large number of Latino immigrants, for example Chicago, San Francisco, San Antonio, New York,

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[4] Tschumi, Bernard. *Event-Cities 3: Concept vs. Context vs. Content*. Cambridge, MA: MIT Press, 2004

Miami, to mention just a few. Also, the Spanglish Turn could be expanded and applied to another cultural context. US society is becoming more diverse as we speak, this cultural diversity is often dramatically manifested in the cities appearance and tenor. It is not doubt, the contact and mixing of different cultural groups has been intensifies and will continue to intensify in the next decades. Architecture and urban design will tremendously benefit by engaging with the dynamics of cultural hybridities in its practices and theories. In a larger framework, it would be interesting to see the applicability of the Spanglish Turn at the global scale, there are many large cities around the globe that are experiencing dramatic changes in their social and cultural make up due to recent immigration. In Europe, cities such as Paris, Berlin, London, Amsterdam are being transformed by their own dynamics of immigrant cultures creating their own new social and cultural patterns. In this way, the Spanglish Turn can be utilized as a theoretical “blueprint” that can guide future research in other places experiencing significant cultural, social and urban change. Each of these cities, whereas in the US or around the globe will have their own particular set of analytical systems and strategies, their own Metafunctions of Space, including Situatedness, Organization and Elements, and their own localized Charged Fields, including their own set of opposites such as Adulteration - Densification, Acceleration – Deceleration, and Aggression - Sedation. The Spanglish Turn can provide us with a new and different system of analysis for architecture that is intimately engaged with its own cultural and social context. An architectural design system that counter-balances the current dominant emphasis on mathematics and presents an alternative process that favor other forms of thinking, feeling and knowing for architectural design, a process that produces novel and fresh architectural forms.

CONCLUSION: Inscribing Latino culture into Architecture

While this process of analysis remains in its beginning stages, it is clear that the discipline of architecture has benefited, and will continue to benefit, from broadening its processes to include Mexican/Chicano aesthetic sensibilities and emergent behavioral systems within its ever-present goal to achieve contemporary relevance. As the process of Latinization will only continue to get stronger in the years to come, the aesthetic and spatial ramifications of this transformation of the contemporary city are enormous and exciting. And as the sensibilities of the Spanglish Turn become more fully elaborated, it seems certain that they will provide a picture of elaborate, malleable, and performative aesthetics that can provide a fresh take on old design approaches. Additionally, the conceptualization of forms as having both specific spatial attributes (situatedness, organization, and elements) and charged fields (adulteration - densification, etc.) can provide architects with the tools to utilize these translatable sensibilities for architectural design and to become agents of change within the city’s contemporary landscape.

Ultimately, this analysis demonstrates that various dynamic cultural streams have come together to create a vibrant cultural and artistic milieu in the Southern California region today. This can be seen in the popular culture, visual art, and architecture produced here. It is also exciting to think about future directions this may take as people respond to more and more of global communications opportunities and gain exposure to alternate sensibilities. Needless to say, it seems inevitable that a tipping point is coming in terms of the incorporation of the aesthetics and spatial sensibilities of Chicano and Mexican immigrants into the design principles and aesthetics of the region. This in turn expresses the new political reality that Latinos are redefining what it means to be American, and through the sheer force of numbers and the resulting emergent patterns, are turning this nation’s course towards a new, alternate direction – a direction whose specific end is still unknown – but one which will clearly be vibrant and dynamic.

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Rui Justo

Lisbon's Urban Block. The Transformation as a Design Process

The transformation of a Lisbon urban block Reading and designing with time

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ABSTRACT: The city is a dynamic object in permanent evolution, which makes its physical changes a fatality, justified by the constant need for man to reinvent his urban environment. It means that the city urban form is made from an adaptation effort between the need for change and the preservation of the existing and legible urban matrix.

The urban block is the physical object that best represents this extraordinary dynamic based on the constant and asynchronous movement of the elements that conform it. However, it is due to this dynamic, aligned with an absence of time perception, that the urban block has lost space as a defining element of the urban form. The loss of influence in the city design process, discernible in many of the urban conceptions of the twentieth century, matches with periods of greater formal uncertainty and urban solutions that deny one of the most important design tools available: time.

To refuse the urban block is refusing the time, the safest place where we can read the intentions that guided the evolution of the city, where the urban block has repeatedly proven its ability to adapt to several types of buildings and the changing urban and architectural models.

Thus, this study uses the city of Lisbon and one of its most representative urban blocks – the old Monumental Cinema Theater – to reveal the importance and usefulness of reading and designing the city with time.

Methodologically, the work offers a morphological and diachronic reading of the urban block, exploring over time its different evolution processes and formal oscillations. Complementary, it intents to reveal in a more operative approach how time could be an essential adviser in the city design process.

Designing city with time is searching for new compositional solutions that are not only compatible with the actual needs of urban living but, also, solutions capable of evolving and responding to future needs.

KEYWORDS: urban block, time, transformation, urban form, Lisbon

TIME AND URBAN FORM

It is widely apparent that the richest city environments are also the oldest. However, the quality of the built fabric does not necessarily focuses in its longevity, but mainly the capacity to incorporate successive information over time.

The city we are talking about is nothing more than the condensation of its history, of the different and successive evolution stages of the urban fabric in a process that is slow but permanent. It is enough to think that the initial formation of the city stems from the evolution of a rural structure to an urban configuration and its growth follows a gradual tendency for the addition and overlapping of new elements.

The urban fabric's formal changeability is therefore entirely linked to the asynchronous movement in time of the elements that give it shape and build their own history in different velocities. Different evolutionary processes trigger these movements as a result of a declared intention to change by different urban agents or unforeseen events.

It is, above all, in the sedimented city[1] that we recognize the physical expressions of time, that is, the phenomenon of sedimentary evolution. The overlapping of new urban strata with the pre-established ones is

[1] "Sedimented city" refers to, in a geological analogy to the progressive deposit of sediments, all urban spaces that result in its evolution from the overlap of different morphological strata.

complex and can be more, or less, obvious. It may result from less radical evolution phenomena that in some way does not significantly alter the preexisting morphological order or from structural changes that presupposes an overlapping of a new order in substitution of the preexisting one.

The sedimented city is, in fact, the safest place where we can read the actions that led the city evolution to what we know today. Therefore, its explanation would be less reflected without the decoding of those evolutionary phenomena that offer us synchronous and diachronic essential readings of the built fabric. Moreover, it allows us to recognize the evolutionary rhythm of each element that is part of it, the street, the square, the plot, the building or even the urban block. Even so, the elements of the city private component, which in aggregation constitute the urban blocks, are the ones that clearly represent this urban activity. Each plot has an autonomous and distinct time from those that are close to it and is its asynchronous movement in time, densification, building renovation, plot aggregation or segmentation, as well as the change between the public and private domain, which is its clearest expression.

1.0 THE URBAN BLOCK OF MONUMENTAL

This chapter proposes a diachronic reading of a singular urban block in Avenidas Novas[2] - the old Monumental Cinema Theater. This type of approximation understands that any physical object, taken at a given moment, can only be explained as a result of a sequence of actions and events in time.

The reason is simple, this urban block is representative of the site's urban and architectural evolution, condensing a set of unique characteristics that stems from its position within the Avenidas urban structure - next to the Duque do Saldanha square. This is precisely the point where two of the plan's settlement orders merge, producing urban blocks with tendentially irregular shapes within an assumedly orthogonal urban system. It is simultaneously a site marked by the existence of an old way out of the city - Estrada das Picoas - that would assume a major role in the formal oscillations of this object, especially in the relation between the public and the private space.

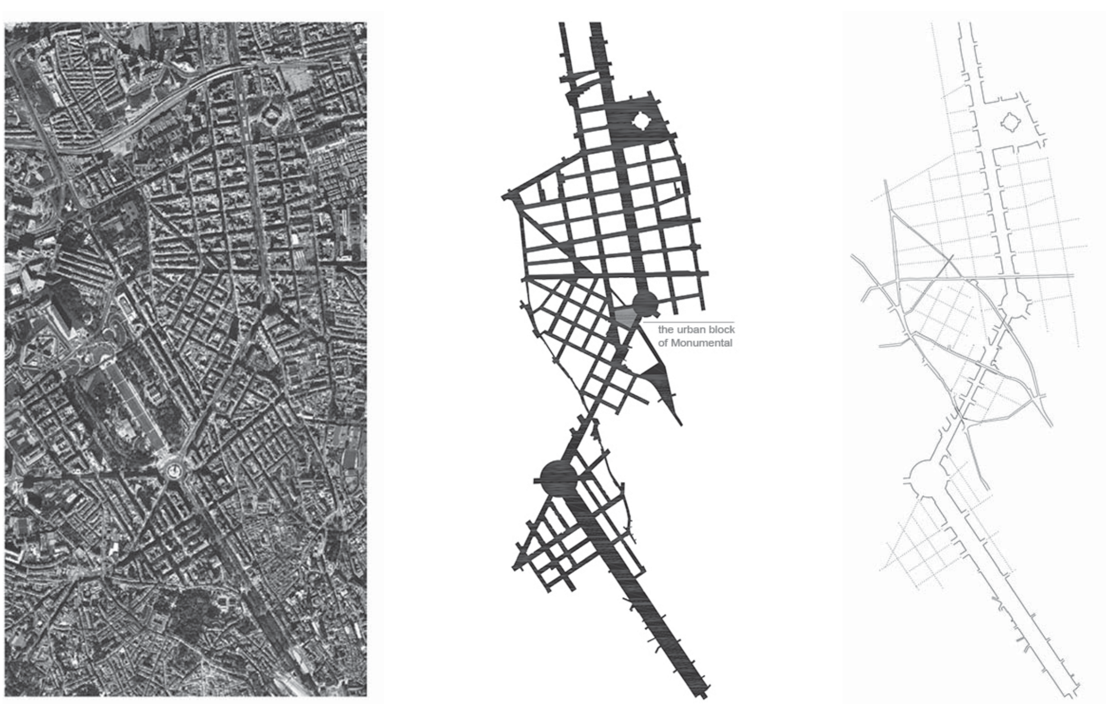

Figure 1: Avenidas urban structure (google earth and author)

[2] "Avenidas Novas" is a nineteenth-century expansion area of Lisbon.

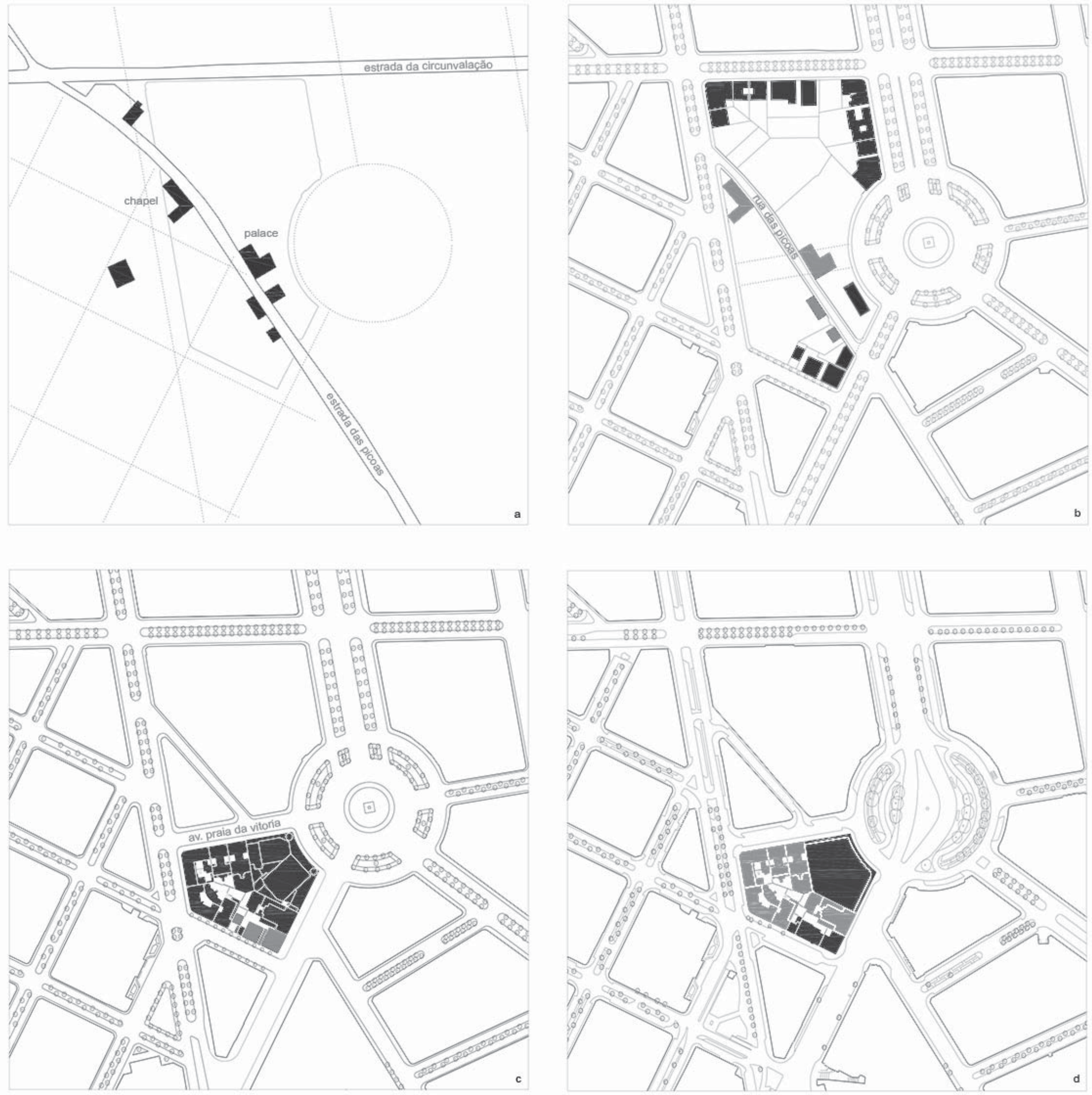

Figure 2: The evolution of the Monumental urban block (author)

We begin this reading by identifying the urban block most representative evolution moments: (**a**) the stage that precedes the execution of the Avenidas plan reproduced in the topographic map of Lisbon surveyed by Filipe Folque (1856); (**b**) the end of the nineteenth century with the implantation of the new urban structure, reproduced in the cartography of Silva Pinto (1908); (**c**) the mid-twentieth century represented in the Lisbon plan of 1950; (**d**) and the present situation (2014).

1.1 Urban transformation

Two roads – Estrada das Picoas and Estrada da Circunvalação - compose the primary structure that is at the origin of the urban block formation and constitutes the first moment of the site image. These roads established the connection between the city and the small rural nucleus developed beyond the Lisbon term. It is precisely in the meeting of these two roads that the first known occupation is developed. It is organized along Estrada das Picoas road by buildings and agricultural farms, in a plot structure marked by irregular configurations and extensive areas. From the set of buildings that were originally concentrated on the site, it's relevant to highlight two of them for the importance they assumed in the urban block evolution. The chapel located in the north of this occupation (the West of the road) and the palace located more to the south of this nucleus (the East of the road).

The permanence of these singular buildings and the corridor that ties them assumes an important role on the second evolution stage and perhaps the most significant of all. Between the end of the nineteenth century and the beginning of the twentieth century occurred the most drastic transformation ever known in this site. This stage marks the transition from a rural to an urban nature, supported by the Avenidas plan. The plan clearly appears as a response to the emergence of a new bourgeois class claiming for habitable, qualified, spacious, airy and green spaces.

The urban block formation results, in this new form of the city, from the overlapping of two morphological units to which is added the preservation of the old Estrada das Picoas road, now with a street attribute. The tension created by these two orders and by the implantation of the Duque do Saldanha square gave origin to a set of urban blocks with singular dimensions and forms. It is precisely in two of these urban blocks that the chapel and the nineteenth-century palace are integrated. These two singular elements contributed, at an early stage, to the resistance of the preexisting urban layout.

These two urban blocks gradually gained a set of buildings structured through a new logic of land subdivision that brought changes in the building shape and organization. We no longer speak only of houses surrounded by gardens and inserted in large properties, which despite the persistent renovation they continue to survive, but also of income buildings that were built around the urban blocks perimeter with more regular dimensions and new limits of height. However, the changes in the built structure are not limited to the addition of new built forms but also to the change of existing ones: the nineteenth-century palace became a school. This change led to the introduction within the plot of a new built body that points to a more direct relationship with the Duque do Saldanha square, gaining a dual relationship with the public space. The urban block that we know today began to take shape at this stage.

This new relationship with the square would become one of the most striking features of this urban block, reinforced a few decades later with the construction of the Monumental Cinema Theater over the nineteenth century palace. It is certainly one of the main transformations that characterize the third phase of this evolution that also points to the stabilization of the boundary in the urban block that we know today.

A progressive process of renewal and consolidation of the Avenidas urban fabric sign the temporal space between the next stage and the previous one. The Monumental urban block is no exception revealing considerable changes in their public and private form.

Starting with the urban layout, we verified that there was a simultaneous process of suppression and tearing of streets, with immediate reflexes in the private space shape. It corresponds into a coexisting process of fragmentation and aggregation of the urban blocks. On the one hand, there was an interruption of Picoas street, having been partially suppressed and oriented to the private domain and, on the other, the Praia da Vitória Avenue was opened over the space of the nineteenth century palace demolished in 1939. This process allowed the appearance of three new urban blocks.

Figure 3: (Left) Palace view from Picoas Street, early 20th century. (Right) Monumental building view from Engenheiro Vieira da Silva Street, old Picoas Street, 2014 (Municipal Archive of Lisbon and author)

In the same way, we confirmed that there were deep changes in the urban blocks built structure, which now have high densities and their useful space is mostly occupied by construction, contrasting what happened in the previous phase. From the beginning of the century remained only three buildings, with the others being part of a new generation of larger buildings. With the demolition of the palace and the chapel emerged a set of housing buildings and the most emblematic equipment built on the site since the 1920s - the Monumental Cinema Theater (1944-51) – making the urban block a reference in the Duque do Saldanha square and in the city of Lisbon itself.

Finally, we note the fourth phase of the urban block evolution, marked by important transformations in the architectural form. We are concretely referring to the demolition of the paradigmatic Monumental Cinema Theater in 1984, in a controversial process of great social impact. In the same space emerged the Monumental building with a commercial vocation and completely demarcated from the surrounding urban environment, as we can attest by its materiality and architecture. However, this was not the only change that occurred, in which new constructions replaced the last three buildings of the early twentieth century that survived in the prior period to the renovation process. These last transformations defined the image and shape of the urban block at the present moment.

The Monumental urban block constitutes the physical result of a progressive and evolutionary process that in just over 100 years underwent successive and different urban transformations.

1.2 Architectural transformation

The urban language of the Avenidas marked significantly the Lisbon architecture of this century part of a great and persistent typological, volumetric and aesthetic variation. The built fabric has in its origin the Avenidas plan that from the first moment admitted the existence of different building typologies. This can not be dissociated from the absence of architectural regulations that allowed the appearance in the same space of erudite, eclectic, new art, revivalist and modernist architecture, that still today coexist side by side.

We began the architectural transformation process in the urban block of Monumental from the first phase of building implementation. It coincides with the period of greater morphological, functional and even stylistic opening. Nevertheless, we recognize a tendency for a certain historicism, absorbing qualities of the nineteenth century traditional architecture and the influences of the French production of the beginning of the century.

However, this period is ruled by some lack of quality in the applied materials and in the buildings design. There was a clear intention of the owners to hide it with a strong use of decorative arts and elaborated details.

One of the architectural typologies that characterize this period is the luxury house or the palace, which is part of a bourgeois program that combines historical conservatism with urban and decorative details, in a posture of greater boldness, in line with the image projected for the new city. Taking into account the old maps we believe that one or another example of this typology had been built in the space of the Monumental urban block, but the truth is that we only know the nineteenth century palace, transformed at this point in a school.

We can affirm with more certainty the establishment of several tenement buildings, the architectonic typology more used in Avenidas. This typology is characterized by a more defined street front, organized by the building implementation on the urban block perimeter. If, on the one hand, a greater urbanity was projected onto the street, due to the size and the treatment given to the main façade, on the other hand, we recognize a certain rurality on the back façade turned to the urban block interior.

In the 1930s the built fabric began to be renewed initiating the consolidation process of Avenidas built structure. It corresponds with a phase of typological and constructive changes carried out during the Estado Novo[3] regime. The architectural form acquired at this moment a political expression through a more monumental and depurated language.

It is during this transition period that most of the urban block buildings are produced. Buildings representative of Avenidas typology and buildings of Estado Novo are built inside the same limit. Deep building occupations inside the plot with inner side light wells and large corridors, developed until the 1930s,

[3] "Estado Novo" is the name of the authoritarian and corporatist political regime that was in effect for 41 years in Portugal, from 1933 to 1974.

characterize the first typology of buildings. Deep building occupations inside the plot with the inner side light wells cropped, and thus opened to the plot, known as the “rabo de bacalhau” (codfish tail), characterize the second typology.

The demolition of the nineteenth century palace, due to the opening of the Praia da Vitória Avenue, gives way to the construction of the Monumental Cinema Theater, inaugurated in 1951. Designed by the architect Raul Rodrigues Lima, this great and emblematic equipment, takes a prominent position in the Duque de Saldanha Square, a place of reference in the city of Lisbon. About the building architecture, the author highlights the monumental image based on classic elements. With the construction of this building, the urban block gained a great volumetric and aesthetic balance. The three surviving buildings of the early twentieth century would be replaced in different decades (1950, 1970 and 1980) by other buildings, two of them with modernist conceptions. They are also part of the renovation process that lasted until the 1960s and a new trend of services and commerce buildings that would mark this area from the 1970s onward.

We finish this architectural transformation process in a tone of controversy, with the demolition of the Monumental Cinema Theater in 1984. Not only was the building demolished but also the harmony it offered to the space and the urban block in which it was implanted. It remains to be seen if the new commercial building that it replaced was able to give back some of the quality to this space.

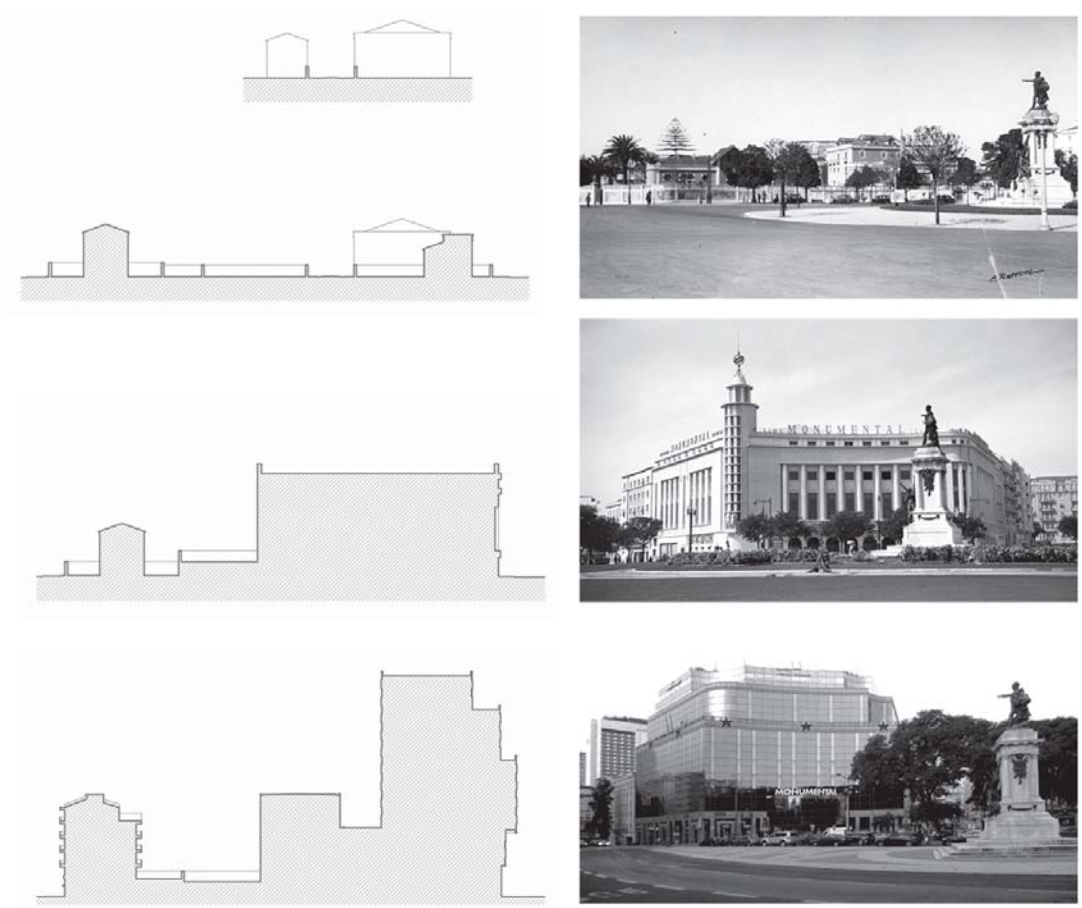

Figure 4: The architectural evolution of the Monumental urban block. (Author and Municipal Archive of Lisbon)

Figure 5: The typological variation of Monumental urban block. (Author)

TIME AND DESIGN

In our cities, particularly if the focus is on the urban block, we realize that the urban space heterogeneous specificity is the result of formal characteristics representative of different times. This quality reveals its great and continuous capacity for reinvention, sometimes questionable, but only understandable through the history and time that each element encloses.

It means that the explanation of the city form starts from the confrontation between the need to accommodate new spaces and built up and, at the same time, the preservation of the existing urban and architectural tradition, readable and understandable by the society that makes use of it. This is unequivocally a cyclical phenomenon, when we incorporate new elements or new urban orders in the city these will also be part of the new urban stratum preexistence. Therefore, we never produce finished objects, but rather objects that sooner or later will be reinterpreted or even transformed.

Designing an urban block with time is taking into account not only the moment of its conception but also the question of its sedimentary evolution. How time predictably will transform the object. If it is predictably the action of time on the object, the moment and the way it is going to happen is full of unpredictability. Nevertheless, it is essential to those who take over the production of these objects to contribute to its evolution.

Regarding this idea, and taking as an example not only the Monumental urban block but also the urban fabric structure of Avenidas, we realize how decisive it is to think the city in its evolution. We can easily see in this urban composition that we are facing two opposing approaches, given the great detail attributed to the public space design - hierarchical urban layout, infrastructure, urban equipment - and some lack of definition regarding the private space. We might think that the absence of building regulation constituted a disregard of the plan, but it is difficult this hypothesis taking into account its nature and importance. And it is precisely for this reason that we believed that this is indeed a "design option" with the aim of making the building process more embracing, with space to evolve, and not only to serve the needs of the moment. The truth is that this "rule" has avenged itself to the present day, setting up an eclectic unity that carries the identity and memories of the place.

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Mark Blizard

Understanding Place: A Reassessment of the Built Work of Giancarlo De Carlo in Urbino, Italy

Understanding Place: A Reassessment of the Built Work of Giancarlo De Carlo in Urbino, Italy

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ABSTRACT
While regionalism and placed-based strategies have returned to the forefront of the design discourse in the United States––gaining acceptance as a part of sustainable practice and shaping academic curricula––the work of Giancarlo De Carlo has remained curiously in the margins. Although much has been written about the Milanese architect over the years, little is available in English. In history books, his accomplishments are limited to a few references: along with Alison and Peter Smithson, De Carlo was an important member of Team X following the general disillusionment with the CIAM and its Athens Charter. De Carlo's initial study of Urbino (1964) is held up as a model for its consideration of place, social discourse and the role of the architect. Later, he emerged as an advocate of participatory design. Although both a writer and an educator, he left no singular treatise and was seemingly uninterested in theoretical pursuit as an end in itself. His built work, however, remains vital today––not just as a historical milestone, but for the lessons and insight that it offers. It is the purpose of this paper to gather and propose a codification of De Carlo's understanding of *place* and its import to shaping architectural design. For De Carlo, design was a complex practice of back and forth negotiations between landscape (city–region–culture) and provisional design responses, each tested through the analytical process of "reading the territory". Using a modern architectural language, he sought continuity of cultural forms through a placed-based design response that structured continued change while reinforcing the identity of its place. In support, this paper draws from the few writings that analyze his approach to design, his sources and influences, as well as from the author's direct analysis of De Carlo's built work in Urbino, Italy. Discussions with architects Antonio Troisi and Monica Mazzolani––both of whom collaborated with De Carlo and continue his practice––provide additional insight and clarity.

KEYWORDS: Architecture, Social Space, Reading the Territory, Giancarlo De Carlo, Design Practice

1.0 INTRODUCTION

Spontaneous Architecture, an exhibition of rural Italian building curated by Giancarlo De Carlo, Enzo Cerutti, and Guiseppe Samona at the 1951 Milan Triennale, was a condensation of a number of ideas that De Carlo was considering at that time including approaches to design that emerged from a direct confrontation with post-war economic and social realities. On one hand like the more well-known exhibition *Architecture Without Architects* (Rudofsky 1965) it was a celebration of vernacular traditions and the unknown craftsman. However, beyond its surface of photographic images and written descriptions it posed "a viable model for contemporary urbanism" that stood as an alternative to the CIAM's Athens Charter (Sabatino 2010, 172).

Spontaneous Architecture served as a starting point. It outlined the ideas, elements and forms that were to occupy De Carlo throughout his career. Perhaps equally formative of his architectural practice, was the analytical study and discourse that centered around Matera in Basilicata, Italy, at the same time. Matera also marked a point of departure in Italian architecture, prompting a broad reassessment of the tenants of European Modernism. In the wake of Carlo Levi's seminal book, *Christ Stopped at Eboli* (1945), Matera became a contested terrain and the central figure in a morality play––a controversial reassessment of the balance between tradition and modernization.[1] A thorough analysis of the social, economic and physical structures was conducted by a team of sociologists, urban planners, and architects. The results of the study then informed the design of a number of new neighborhoods where the population of Matera was relocated. By most measures La Martella and the other planned communities that formed a web surrounding the traditional city, were failures. Throughout the process, however, De Carlo and the other designers made a close examination of the traditional city, its fundamental elements, and its spaces for social interaction. What emerged was a sense that spontaneous architectural expression was closely calibrated to its environment and inextricable from its dense cultural fabric. It was in Matera that De Carlo began his systematic "search for an architectural expression matching the local environment, and at the same time, tuned with the spirit and ideas of contemporary civilization" (Toxey 2011, 137). This concept evolved over his career through the iterative nature of his built work and design proposals into an analytical methodology that he termed, *reading the territory*.

Under the direction of Alison and Peter Smithson, Team X's agenda and position was informed by a critical discourse among many voices in a fluid and loose affiliation including Aldo Van Eyck, Jaap Bakema, Shadrack Woods, George Candilis, and Giancarlo De Carlo. In debt to Le Corbusier and CIAM and no doubt influenced by the Matera studies, Team X forged a new humanist approach that incorporated many of the ideas prevalent in the post-war Italian polemic (Tafuri 1976). Their approach, echoing De Carlo's position, was founded on a growing awareness of the importance of social space in combination with a reevaluation of the traditional city as a relevant social and spatial construct. De Carlo advocated that the traditional city continued to be germane in the face of technological change and the economic, social and political realities that constituted post-war Europe. For De Carlo, the city—specifically Matera—would serve as a model. The Italian hill town of Urbino in the Marche region, became a laboratory to explore his findings at Matera. De Carlo was not advocating a return to a traditional architecture or merely rebuilding the city—depopulated by war and its aftermath—but rather a critical discourse with history and place (Pedret 2013, 204). This discourse would center around an examination of the structure, terrain, land-form, scale, physical condition, and identity of the city-region. The city itself, rooted in its particular relationship to place and region, provided the critical framework for the integration of new programs and construction. The city would be adapted, as it always had, to the ongoing changes in human needs while providing the fundamental structure and identity for human inhabitation of the environment.

At this juncture the reconsideration of De Carlo's built work will provide insight that is not apparent or fully formed within his writings—especially those that have appeared in English. This will enable us to better grasp his architectural language and continued value of his contributions. It is the purpose of this paper to draw from De Carlo's built works in Urbino in order to further understand his search for a place-based architecture. For De Carlo, design was a complex practice of back and forth negotiations between the situation (city-region) and provisional design responses, each tested through a continued analytical process. Using a modern architectural language he sought continuity between *place* and built form—form that was adaptable and yet provided a clear structure for continued change while maintaining and reinforcing the identity of a place. Architecture for De Carlo needed to be both logically rooted in its place and thoroughly modern—committed to addressing current social conditions and needs (McKean 2004, 10).

2.0 MODEL

In addition to the Matera "experiment,"[2] BBPR's Torre Velasca in Milan[3], Florentine "repristination" along the Arno (Mayernik 2009, 278), and Ignazio Gardella's Casa Cicogna alle Zattere in Venice (Gregotti 1968), stand out for their contribution to the post-war debate. De Carlo's text*, Urbino: The History of a City and Plans for its Development* (1964), was his measured contribution to the polemic.[4] The prolonged focus on Matera—from the initial Study Group to the final construction of new settlements and the social, economic, political and ethical questions that accompanied each step—attracted international attention and provided an important focus to the debate. For De Carlo, the intangible outcomes were perhaps more critical than the physical construction.[5] Matera's complex spatial and social organization rested on a limited number of architectural elements whose patterns of organization suggested an underlying place-based logic. These elements—cell, cluster, *vicinato* (neighborhood courtyard), path, piazza, and public buildings—and their underlying order as well as their connectivity to the land, had continued ramifications throughout De Carlo's career. The lessons from Matera were developed further in the *Urbino Report* and the subsequent projects in Urbino. The report outlined a practical approach for maintaining the city form and its buildings while addressing the changing economy and social conditions. The report's analytical investigation of a particular place drew from many of the principles and elemental discoveries that were first uncovered in Matera. Later these were shaped further through his involvement in the Team X circle. Unlike the aforementioned projects, De Carlo's approach to Urbino directly addressed the deterioration and depopulation of the traditional city. The study concluded that the *centro storico* and the city–region itself possessed a viable structure and authentic sources or lessons that were "regional and specifically functional rather than universal and canonical" and that could guide its continued development (McKean 2004,11).[6] The historical city was considered neither a collection of artifacts nor a museum. Instead, the history and fabric of the traditional city was understood as an important aspect of the present condition that had to be considered and incorporated into the continued evolution of its physical form. De Carlo proposed that the city of Urbino be reanimated with new programs that addressed contemporary needs.

The importance of the *Urbino Report* was multifold. It cast design as a discursive process that proceeded from a thorough analysis that simultaneously considered the physical, economic, and social structures of a place. This approach incrementally evolved into *reading the territory* and became the foundation for his continued practice. As with Lorenzetti's emblematic painting of the effects of good and bad government, urban fabric and its surrounding landscape were tied together and needed to be approached in unison.[7] A city could not be understood without taking its surroundings into account. For De Carlo, it was obvious that to sustain the city-region, new programs needed to be introduced into what was already a persistent and viable structure of streets, piazzas, neighborhoods and significant buildings. De Carlo's fifty-year relationship with Urbino provided a critical laboratory where he could refine his practice and continue his search for an appropriate language for architectural and urban spaces (Troisi 2017).[8]

3.0 WRITTEN WORKS

In all of his writing—as editor of *Space and Society*, and the ILA&UD publications are especially worth noting––De Carlo never codified his design process nor provided more than an outline of its principles.[9] However, the publications that document the practices of the ILA&UD most clearly articulate his discursive structure and approach. These intensive and targeted teaching–research–design laboratories brought students, practitioners, teachers, and other collaborators together to "deduce the rhythms, cadences, recurrent features, coincidences, divergences, correspondences, connections, fractures" of a particular place and to put forward design proposals (De Carlo 1996, 8). *Reading the territory* was the premise and structure for both the practice and products of the laboratory.

Printed in one of the earliest ILA&UD publications, *Participation and Reuse* (1978) Marc Angéhl stated that the discursive nature of *reading* is centered around a participatory process that brings together separate inquiry and insight from a wide range of perspectives in order "to have the possibility of identification and the possibility of interaction into a given culture in a given place. This implies a pattern of interaction between daily life and physical form" (Angéhl 1978, 108).[10] In the same issue, Thomas Chastain wrote about the link between urban rules and architectural variations. In his description of his team's examination of the "alphabet and language of the territory" as well as its coherences and dissonance, he continues, "for us this code consists of the patterns, orders, and uses which generated—and continues to generate—the form of the territory" (Chastain 1978, 98). Perhaps in the clearest description of his approach, De Carlo states that inquiry begins by

> "*looking for clues to the genetic codes and their effects directly in the features of the spatial patterns. These clues and effects are: the ways the buildings are arranged on the terrain in relation to its contours, to the sun, to light, to prevailing winds, to waterways, to roads and footpaths, to cultivated fields, to areas planted with trees, to woods, and to other buildings; the kinds of relationships that exist between built-up spaces and open spaces, spaces for activities and spaces for quiet, between homes and public facilities, between places of work and places of leisure; the ways built-up systems, component parts of buildings, techniques used and choice of building materials are reciprocally in harmony or dissonance; etc…* (De Carlo 1996, 8)."

Even taken together, his writings offer only a fragmented outline of his inquiry into place and practice.

4.0 ELEMENTS AND PRINCIPLES: TOWARDS A CODIFICATION

His built works are certainly not equivalent to a written discourse. Nonetheless, they offer definite insights into his evolving architectural language, its fundamental elements and guiding principles. His built work in Urbino presents a more extensive and consistent outline of his practice that his works elsewhere.[11] While a more detailed examination of each work and their sequential development is necessary, it is beyond the scope of this paper. Likewise, a more focused connection between my examination of De Carlo's built works and these design principles warrants much greater detail than this paper permits.

De Carlo wanted his buildings to meld into the environment and appear "as if they were always there".[12] He sought an architecture that would fit into the existing texture and patterns of its place.[13] Whether enmeshed within the historic center or located outside of its walls, the city informs his work. Urbino became a laboratory for considering the nature of "city", also as an "authentic source" from which to draw lessons and imagery.[14] The duration of his study as well as the range and scale of his architectural commissions—from street lamps to an entirely new university campus—provided him with a wide variety of opportunities. From his built works in Urbino, we can extrapolate a partial taxonomy of recurring elements and the principles that have evolved:

Elements / Vocabulary

Cell + Cluster; Social Condensers; Streets + Paths; Stairs + Ramps; Frames; Walls + Openings; Roof Garden or Terrace

Principles / Grammar

Dialog Between Building + Site: Reading the Territory; Dialog Between Past + Present; Persistence of Typical Forms and Gestures; Fundamental Spatial Types: Cell, Condenser, Path, Vicinato; Mobility as a Conceptual Framework

4.1 The Dialog Between Building + Site: Reading the Territory

De Carlo understood place as a dynamic field of active forces—natural and cultural. His deep analytical reading of the site was a hermeneutical process through which he attempted to decipher the forces and their traces and marks within the landscape. It involved not only analytical inquiry but also the formulation of tentative propositions. Each proposal was provisional—formed by questions and then challenged by the situation. Each in turn furthered the investigation. *Reading the territory* was a research methodology that was also an engine for forming and testing provisional design solutions. The territory in question was a hybrid—an integration of both natural forms and cultural forms. Perceived as an *active field*, place was non-objective and could not be abstracted from its fabric nor separated into definitive parts. Place was understood as an integrated whole or system. De Carlo proposed that every territory or place had a unique *genetic code* or inherent logic (De Carlo 1996). In a way, the patterns deciphered in the reading were seen as a "fingerprint" that was inextricable from the identity of the place. Beneath the surface was a logic that if followed would enable new buildings and interventions to fit into and reinforce the local identity. Each new work would be organized by a clearly defined spatial structure, that was in *dialog* with the existing city-region. Individual spaces, however, would have to be flexible enough to be re-appropriated by successive users with differing needs. In this way, the built form would stand a greater chance of remaining a vital contribution to a place and its people over time.

As an example the residential cells of the Collegio del Colle (1962–66) are grouped in clusters and linked together (and to the residential nucleus above) with adjoining exterior "streets" and an array of paths that follow the topography (Fig. 1). Also conforming to the topography each cell extends out of the hillside providing a nearly unobstructed view of the landscape beyond. The "street's" steps and canopy negotiate the changing relationship between built-form and land-form. Walking along this "street," the adjacent hill is framed by the canopy's overhang. Likewise, the distant landscape is framed between each grouping of residential cells. The frame for De Carlo is not an abstraction but is understood only in tandem with the movement of the body from one place to another. Another example is the Renaissance wall that surrounds Urbino's historic center and provides a clear boundary between city and its *contado* or countryside. Its edge becomes a visual datum which defines and joins the spatial extension of the landscape outside with the interiority of city. This sort of datum is repeated throughout the campus.

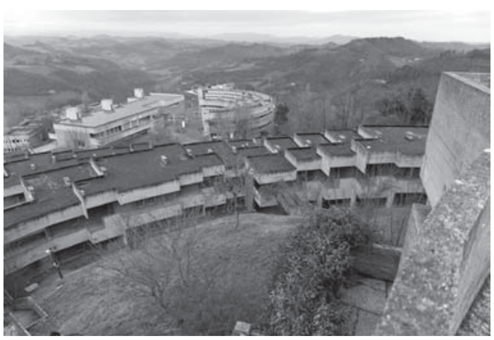

Figure 1: The cells of the Collegio del Colle spilling down the hill towards Piazza Tridente. Source: (Author 2017)

4.2 Dialog Between Past + Present

"On the one hand it has to root itself in the soils of its past […] But in order to take part in modern civilization, it is necessary at the same time to take part in scientific, technical, and political rationality. There is the paradox: how to become modern and return to sources" (Ricoeur 1965, 277). In considering the present a single frame within a temporal continuity, De Carlo "saw the slow and ongoing process of things always changing" (McKean, 2017). There is no definitive line that distinguishes past and present rather there is a single complex fabric. To walk through a traditional city is to encounter a dense, temporal simultaneity. De Carlo argued that the traditional city-region was the greatest source of cultural identity. It was therefor important for contemporary solutions to be found that maintain the vitality and significance of the extant urban fabric.[15] The nuances of his position are embedded in his Urbino works. There is a coherent web that weaves building and place. His architectural language of material, elements and forms is inseparable from its spatial, historical and social context. One example may serve as an illustration: the ocular window in Il Magistero (1986–1999). An otherwise blank wall with this one insertion respectfully faces the adjacent church of San Girolamo. This decision is a rich gesture that acknowledges the presence and importance of the church. The small parvis before San Girolamo draws these disparate buildings, separated by hundreds of years, into a unifying and meaningful dialog (Figs. 2.1 + 2.2).

4.3 Persistence of Typical Forms and Gestures

Gestures such as the ocular window are subtle references or mnemonics. They serve as points of connection and communication like a hand-gesture or a vocal inflection that signify a more complex thought and acknowledge a common inheritance. These do not form a pastiche nor are they "quotations" that have been lifted out of some original context. They are understood through inhabiting the buildings rather than as a signifier or purely visual form. A few examples might serve to illuminate: the roof of the Colle (meaning *hill* in Italian) which is essentially an inverse-dome and whose copper cladding references the Duomo that rises above the town of Urbino. Also: at the entry to one of the courtyards in Il Magistero, a bracket extends the surface of a wall above, framing the entry, which otherwise might go unnoticed (Fig. 4). It reads as a fragment of some a portal or gateway. Its reference is in part to the medieval brackets that permitted buildings to extend out over the narrow streets or the remains of an arch embedded in the layered construction of a wall.


Figure 2.1: Exterior view of Il Magistero facing San Girolamo. Source: (Author 2017)
Figure 2.2: View towards San Girolamo from ocular window in Il Magistero. Source: (Author 2017)

4.4 Fundamental Spatial Types: Cell, Condenser, Path, *Vicinato*

The cell as the fundamental and irreducible unit of architecture was apparent to De Carlo from his study of the Materan Sassi (Toxey 2011). From a single basic unit or cell more complex structures are generated based on their form of connection.[16] "The cell was the source of the overall composition and the collective spaces. Very simple parts are connected systematically, to bring about a complex of experiences and places" (Troisi 2017). De Carlo utilized typical spatial organizations—the linear "street," the compound and the courtyard for example—that incorporate the grouping of cells into the fabric. The spatial qualities and the ramifications of various groupings are explored throughout the University of Urbino campus. In each housing complex a single cell is repeated and placed in geometric groupings that are joined by the spaces in between.[17]



Figure 3: Entry into a courtyard in Il Magistero. Source: (Author 2016)
Figure 4.1: social condenser—L'Aquilone. Source: (Author 2016)
Figure 4.2: Paths through the landscape Collegio del Colle. Source: (Author 2017)

De Carlo referred to nodes of social activity as *social condensers* that unify and give a collective identity to a city (McKean 2004). His model was the traditional Italian piazza as well as the *vicinati* in Matera. The interior space of L'Aquilone (1973–1983)—one of the residential nuclei for the University of Urbino campus—is designed as a "territorial unifier," that joins the residential cells to larger social spaces and the campus beyond (Tafuri 1989) (Fig. 4.1). The Roman *cardo* and *decumanos* are readily identifiable—organizing the space as it opens vertically and extends horizontally from an interior "piazza." Residential "streets" join at different levels. A spiral stair burrows down to a library that breaks with the orthogonal geometry of the building and extends diagonally outward into the landscape. Originally commercial shops were planned for the upper floors where only a laundry and a few offices exist today.[18] A monumental stair is set at the piazza level and transforms the space into a theater. Above: a skylight extends the space vertically and meets a roof garden, also with a theater. The typology is borrowed from the historic Capuchin Monastery that sits above the campus, and is also a reference to the courtyard in Urbino's Palazzo Ducale.

The central gathering space for the entire college is Piazza Tridente: set on the roof of the campus dining hall and adjacent to a small indoor theater and bounded by a curved bank of lecture rooms. At other scales, the condenser is used within the interior of buildings in much the same way that the *vicinato* (semi-public courtyard) worked in Matera—as a necessary spatial nucleus joining a cluster of cells into a larger unit (Toxey 2011). At any scale, much like their precedents, these spaces are adaptable for many forms of social improvisation (Fig. 4.3). It must be remembered that one of the important findings from Matera was the significance and role of the *vicinato*.[19] The Sassi—literally carved out of the soft limestone—were joined by a system of voids: streets, paths, stairways, courtyards and piazzas. These formed a dense tissue of "rooms" whose spatial structure was coincident with the social organization and the terrain. The organic complexity of Matera was the result of the organization and configuration of these spaces between elements, wedding them to the site (Toxey 2011). This key principle shaped De Carlo's understanding of design as the negotiation between a family of elements in an active field.

Figure 4.3: Social condenser—Colle. Source: (Author 2017)
Figure 5: The hearth as spatial hinge, Ca'Romanino. Source: (Author 2017)

Along with the *vicinati streets* or paths connect residential cell groupings, social condensers and places of work and leisure. On the Urbino campus De Carlo did not organize them using a modernist or rationalist grid. Instead he was consistent with the Materan model: cells groupings are orchestrated by the land-form (Fig. 4.2). They form a body of redundancies that provide multiple possible connections. Movement is never restricted to a single path, even within buildings. Where paths cross the steep topography, they are composed of steps. Between one path and another, there is always a place to pause. Occasionally they take the form of a ramp or *scala* (a stepped ramp or ladder). In each case they mirror Urbino.

4.5 Mobility as a Conceptual Framework for Design
"In order to fully appreciate the construction, one's reading of the architecture must be linked to this notion of procession, of physical apprehension of the building" (Pauly 2008, 29). Although describing Le Corbusier's *promenade architecturale*, these words apply to De Carlo's design process as well. Apprehension of the city cannot be separated from the direct experience of movement through its streets. This conceptual framework for design was initially embraced by Team X (McKean, 2004) and adopted by Gordon Cullen—as evident in the Townscape movement.[20] Our movement across the Urbino campus is a series of open processions that weaves building and landscape together. Like the turns of a medieval street there is always something unexpected. "The mystery is important. There is always something to discover and our curiosity to go deeper into the life of the building increases (Mazzolani 2017)." The voids and frames of an urban fabric are integral to the city's identity. They form a unique pattern much like a "fingerprint" that reflects the social and spatial encounters within a particular place. The identity of a place is largely understood not from a list of monumental features but in how those artifacts and places are spatially organized and perceived.

Nowhere is the importance of mobility as a framework as evident as in Ca' Romanino (1966–1967).[21] This small house is deeply rooted in the land. Entering: passing through a cut in the earth then emerging into an enclosed garden that follows the original topography of the hillside, we find a narrow blue entry door. We step inside. Scanning the open space we perceive three distinct elements—a deep two-story window-wall, a monumental cylindrical hearth, and an enclosed study which is also a cylinder (Fig. 5). The central anchor to the open space is the massive red cylinder of the hearth around which the interior space seems to hinge—

connecting study, dining table and fire to the vineyard in the landscape beyond the window-wall. On the other side of the dining area is the brick cylindrical study set one step into the earth. A curved blue sliding door opens the study to the interior space or to the landscape or both simultaneously. The sequence of entering, moving through and inhabiting the house reveals its connection to the surrounding countryside.[22]

IN SUMMATION

While his practice of design can be readily understood as a process of negotiation—a back-and-forth dialog with the territory—the principles that guide this dialogic process are less clear. By examining his built-work we can discern definite elements and patterns. I believe that these are indicative of design principles—which, taken together, establish a dialog between building and place, the present and the past, inside and outside. *Reading the territory* is not only a strategic practice, in generating the proposed solutions it also embodies them. This dialog is an on-going discourse that draws together the roots of the past, the particulars of each situation and city-region, the universal typologies of spatial patterns, form and materials, while it proposes new solutions framed in a modern language. His is an architecture of *in-between*, an approach that evolved continually throughout his practice.[23] Essentially, De Carlo's discursive non-objective practice enabled the complexities of the city-region to enter the design process and become concretized within the built work. This process, tainted by the particular situation and the evolving body of knowledge that grew with each discovery, was both analytical and productive. It was pragmatic and idealist and formed an elemental poetics of realism.

So, what do we take-away from all of this? I am not sure that the discursive process of *reading the territory* and the architectural language of the buildings themselves, can be described or codified easily. While the fundamental elements—including spatial elements that form the in-between as taken from the *vicinati* of Matera—seem clear, the principles are less so. The principles, as put forward in this paper remain provisional and require an even closer examination. De Carlo's practice was after all, evolutionary and to a large extent site-specific. His material palette changed in accordance with each situation. Certainly over the length of career we find his work in continuous evolution. However there are definite consistencies many of which can be traced back to his formative period in Matera or his early work in Urbino. The Materian model became operative—tested and refined through an iterative process—in the laboratory of Urbino.

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ENDNOTES

[1] See: Anne Parmly Toxey's examination and clarification of the history, architecture and politics surrounding Matera in her book, *Materan Contradictions* (2011).
[2] La Martella, a new model-town for the population of Matera to be relocated, "was one of the first postwar experiments in which vernacular models […] were employed to create an autonomous village" (Lejeune and Sabatini 2010, 61).

[3] BBPR was Gianluigi Banfi, Lodovico Barbiano di Beliojoso, Enrico Peressutti, and Ernesto Rogers. BBPR's Torre Velasca in Milan (1956–58)—replete with its regional and vernacular references—was a loud reaction against the tenants of the International Style and its insistence on a universal language.) Rogers proclaimed the necessity of a dialog with the preexisting context (l'ambiente) (McKean 2004). De Carlo had already turned towards the vernacular in order to gain a foothold for a post-war architecture place: Spontaneous Architecture exhibit, 1951 (Lejeune and Sabatini 2010).

[4] De Carlo's 1958–64 "Piano Regulatore Generale di Urbino" (echoing the title of the Materan report) was published in book form in English (1964) as *Urbino: The History of a City and Plans for its Development.*

[5] "The truth of the Sassi is distilled in the ideal and perative model that was wondrously discovered here and that continues to function according to spontaneous orientation, which resulted from the life, the human environment, and the history of generations that gradually wove the structure" (Tafuri, as quoted in Toxey 2011, 116).

[6] The Gubbio Charter, signed in 1960, was the first official document to use term *centro storico* (Toxey 2011, 124). *Historic center* is a phrase that had just come into use in the late 1950s and was immediately adopted as a political and economic unit. Its boundaries were frequently, but not always, the historic walls that surrounded the Renaissance or medieval walls. (Greco, Elena. 2016. "Preserving and Promoting the Urban Landscape. The French and Italian Debates of the Post-World War II Decades." plaNext, anext.2016.5vol.02" http://dx.medra.org/10.17418/planex t.2016.5vol.02, 8.

[7] Ambrogio Lorenzetti's painting, *The Allegory of Good and Bad Government*—on the walls of the Sala di Nove in Siena—presents the city as an economic, social and cultural fabric of city-and-contado (countryside), is evidence that this concept was once widespread. Certainly, is was the critical backbone to the emergence and evolution of the Italian city-state.

[8] Michelangelo Sabatino writes, "Giancarlo De Carlo took the lead in the revival of the hill-town model with his extensive design work for Urbino. […] The student housing villages simultaneously embrace and facilitate communal student life by using the Italian hill town as urban model" (Lejeune 2009, 62).

[9] Le Corbusier—perhaps the best known modern example of such codification—provided us with his five points, and later, under the guise of poetics, offered us the enigmatic, *Le Poeme del L'Angle Droit* (*The Poem of the Right Angle).*

[10] This position, initially espoused in the Matera projects and, later by Team X, was examined contemporaneously by Pierre Bourdieu, Henri Lefebvre and Michel de Certeau. These social philosophers argued that the body, its movement and its occupation of social space was the means and frame-work for comprehending urban space and architectural form.

[11] De Carlo's major projects in Urbino include: Co-operative housing for university employees, 1955; Collegio del Colle, 1962–66; Ca' Romanino, 1966–67; Faculty of Law at Urbino University, 1968; La Pineta housing ("la Navarone"), 1967–69, 1984–86; Il Magistero, Urbino University, 1968–76; Mercantale projects, starting 1969; Restoration of the ramp by Franciesco di Giorgio and the Teatro Sanzio, 1970–77; Art School in Urbino, 1972–88; Collegio del Tridente, Urbino University, 1973–83; Collegio dell'Aquilone, Urbino University, 1973–83; Collegio della Vela, Urbino University, 1973–83; Faculty of Economics at Urbino University, 1986–99; City Interpretative Center in the Ducal Stables, 1990–2004; Renovation of Palazzo Passionei, 1995–2001. In all: fifteen realized, or partially realized, major projects.

[12] Antonio Troisi—from a conversation, April 18, 2017.

[13] One example would be the exterior of Il Magistero where he selected a brick whose tone approximated the historic context. Here, the evidence of a modern architecture language or the presence of a radically new set of interior spaces is minimal. His intervention into the urban fabric, in this case, is unobtrusive. The large skylight above the auditorium is, likewise, invisible except at a great distance.

[14] It must be noted that the word *image* is not understood by De Carlo in the same way as it is by either Kevin Lynch or Aldo Rossi. For De Carlo, image was something that was grasped primarily through experience—that is, through movement and inhabiting place. It is both spatial and visual simultaneously and its continued use to address the collective identity of a place is predicated on it being an appropriate response to its situation and one its following the logic of the *genetic code*.

[15] In speaking of De Carlo's built work in Catana, Sicily: Mazzolani states: "The question of old buildings is what should be done with them. If the historic artifact is still contributing to the cultural narrative, still usable, then he accepted them as they were, otherwise they needed to be adapted, that is, renovated or changed in some manner, to support to the present needs while contributing to the evolution of the narrative. The deepest question for De Carlo, was respect. Respect must be given to history." And again: as in Il Magistero, De Carlo seeks "to intertwine a dialog to with history… to establish a living, open, dialog with history. History is experienced as a presence, not something distant" (Mazzolani 2017).

[16] The cell: a concept and term extrapolated from biology, was explored by Shadrach Woods and Team X.

[17] One remarkable example outside of his Urbino work is De Carlo's 1993–1995 project for the restoration and reconstruction of Colletta di Castelbianco. As part of his analysis of the town, he examined the three-dimensional spatial organization of residential cells and their local adaptations to placement and position. His proposal for restoration and new interventions was founded on maintaining the logic of this traditional spatial organization. See: Mc Kean 2004, 178–183.

[18] From a conversation with Antonio Troisi, March 2017. Many of the members of Team X explored the ramifications of adapting urban spatial types to the scale of the building. Clearly, this idea has its origin with Le Corbusier's fascination with "streets in the sky" as incorporated into his Unité d'Habitation and other projects.

[19] The importance of paths and nodes were well understood by De Carlo—who lauded the publication of Kevin Lynch's book, *The Image of the City* in 1960—but the Materan *vicinato* was immediately recognized as the formative link and organizing principle which activated social dynamics and facilitated communication.

[20] See: Gordon Cullen's *The Concise Townscape* (1961) and Ivor de Wolfe's *The Italian Townscape* (1963).

[21] It may be argued that this diminutive building comes the closest of all of his built works to presenting an architectural manifesto. Following Alberti's analogy, it may be read as a diminutive city and a condensation of De Carlo's design process.

[22] The author was fortunate enough to spend over twenty-four hours in Ca' Romanino in the spring of 2017. Although he visited it on one other occasion, it was not until he experienced the day unfolding—moving through the building, inhabiting its interior, cooking and eating meals, watching the sunset from its roof, overlooking its garden, being awakened to the morning sun seen through a skylight—that he perceived its narrative structure. John McKean also spoke with the author of the sequential spaces that linked the "dark, dampness of the earth to the openness and brightness of the landscape".

[23] The importance of the in-between was evident in Giedion's perception of "the greater reality of the doorstep" (Giedion, 1955, as quoted in Pedret 2013, 148). This condition was presented earlier by Alison and Peter Smithson in their critique of the CIAM grid at CIAM 9 in 1953, and also Aldo van Eyck's use of the term *threshold*.

Jorge Cruz Pinto

Geometries of the Gaze and the Invisiability

Geometries of the gaze and the invisibility

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ABSTRACT:

This research lies between the visible and the latent structures of invisibility, and is supported by my theory of the Space-Limit. It integrates a set of original geometric analysis carried out on a well-known work of a Italian Renaissance painting and several historical buildings, in Portugal and in Spain. The matrix identification of sacred geometry, and the systems of forces and vector fields between the visible and the invisible recognized by the Gestalt theory become fundamental for our research. These latent structures define the DNA of the works that crosses different architectural cultures. The specific theme of the *Geometry of the Gaze* is based on my geometric analysis of the famous Renaissance fresco "La Trinità" by Masaccio (1428), where "perspective as a symbolic form" (Panovsky, 1991) constitutes the device for representing the interior architectural space. Underlying the representation is a vector tracing based on the matrix principles *ad triangulum* and *ad quadratum* that unites the eyes of the various characters represented through the geometries of the gaze. Vector lines of forces construct the "frame of the visible". Geometry constructs the plot that deepens the gaze beyond the imagery of Christian iconology, allowing access to the symbolism of the Tree of Life of Jewish Kabbalah that reveals itself as the structure from the latent plane. The same matrix geometric principles are present in the successive phases of the construction of the Mosque-Cathedral in Cordoba. The "*ad triangulum*", "*ad quadratum*" and "*ad circulum*" principles are also recognized in other buildings of other religious cultures, which will illustrate the discourse. Similar principles of the geometries of the gaze and the invisibility are applied in my contemporary architectural and pictorial production, such as portraits and para-architectural works, between painting, architecture and installation, developed under the theme of *in praise of emptiness*.

KEYWORDS:
Space-Limit Theory, Sacred Geometry and *Gestalt,* Trinity by Masaccio, Mosque-Cathedral of Cordoba, Jeronimos's Monastery.

1. Limit, Space and Geometry

The present research on the "geometries of the gaze and the invisibility" is based on the theoretical model about the "Space-Limit" of production and reception in the architecture and of its categories - "Appearance", "Emergence" and "Latency", which puts in evidence the transition between the visible and the invisible, (Author, 2007). Architecture can be defined as the art of delimiting and shaping space, adapting it to the purposes of habitability and aesthetic intentions. Therefore, every architecture is a "Space-Limit". All the action of delimiting implies the geometric operation, which simultaneously separates topologically one spatial territory from another, configures them and gives them form, which qualifies space. The geometries of architectural and urban forms define tracings, fields of force, that subtly magnetize the geometries of the user's gaze and are inscribed in the perception and reception of the subject, affecting and manipulating, to a certain extent, his behavior, beyond the functional and aesthetic intentions. Thus, architecture and urbanism have been, throughout history, the preferred symbolic forms of religious, political and economic powers.

The case of studies of this article are analysed based on a philosophical interpretation of the concept of boundary between the visible, the whole of the apparent and physical dimension, the phenomenological, and the invisible, the metaphysical, imaginary and latent dimension. It is from the concept of "Space-Limit" that we propose to accede to the various phases in which the architectonic artefacts are formed, at the production level, and to the successive strata in which they appear to reception, implying a joint interaction between work, perception and interpretation of the subject. The ontology of E. Trías (*Logic of Limit*, 1995), in Merleau-Ponty's phenomenology (*The Visible and the Invisible, 1964*) and in the metaphenomenology of J. Gil (*The Naked Image and the small perceptions*, 1996), are part of the supporting concepts that I transpose into the Space-Limit theory. Trías thinks the limit as: "being and habitable frontier space… from which opens the possibility of meaning and sense" (the sensible world); the "border fence" (hermeneutic and symbolic space); and the "hermetic encirclement" (the enigma, the secret and the sacred attainable through the secret dimension of symbol). Merleau-Ponty also establish a stratification between a sensible and visible dimension, and a deep ant latent dimension:

> The carnal being, as being from the depths has several leaves or has several faces, the being of latency and the presence of a certain absence, is the prototype of the Being" (*The Visible and the Invisible,* 1964, 179).

The phenomenology of Merleau-Ponty, supports the legitimation of Space-Limit categories. The Philosopher refers to a "first visibility", which corresponds to an apparent presence of things, and to a "second visibility", concerning the dimensions of "massive flesh" and "lines of force" corresponding to the known and phenomenological or "outer horizon", confronting is vaguely identified with an ontological and intelligible dimension. However, the "Metaphenomenology" proposed by José Gil tries to go beyond the phenomenological indetermination, exploring the borders of aesthetic perception that confer an ontological autonomous status to an invisible non-subsidiary of the retinal. Metaphenomenology is oriented to the phenomena of the phenomenon acting from the "boundary phenomena" that occur in the irreversible territory that separates and superimposes the conscious and unconscious, identifying the latter with the invisible. This invisible is total, unmanifested, but has an effect on the visible in terms of "bundles of forces", "forms of forces" and intensities revealed by the "naked image" devoid of concept that opens to the aesthetic perception through "small perceptions" (Gil, 1996). In interpreting the three philosophical theories, in a transposition to the field of architecture, I recognize three layers of phenomena that can be identified with the boundary categories: "Appearance", "Emergence", and "Latency". In architectural terms, "Appearance" is understood as the epidermal layer that corresponds to the figurative and the superficial decorative and stylistic aspect that so much fulfill the role of environmental background gradients influencing the totality of the architectural framework, as they can act as "transfiguration operators". "Emergence" corresponds to the external and three-dimensional, "flesh and bone" of architectural form; it is the perceptual truth, allied to the sense of constructive thickness, stereotomic materiality and tectonic structure, related to the way of making. In this sense "Emergency" is related to the technique which, in the context of production, allows the passage from the latent, the inner and pre-formal state, when it appears and emerges in the established form. "Latency" at the level of production constitutes the "black box" of the architectural conception, through the production of sketches that are graphic-configurational schemes of mental schemes, of approach to design and construction under the various architectural senses. "Latency", at the level of reception or interpretation, is related to the invisibility and indicia of the deeper contents, through the decoding of the inscribed symbols and hidden geometries and "forms of force" that serve as a framework for the emergent form during the conception of the works. It seeks to decode its deeper meanings.

2. Latent Structures

The Geometry of the Gaze and the Invisibility refer to the perceptual, heuristic and symbolic processes, in the production and reception of the works of architecture and other works of art. Geometry, in some of its meanings, constitutes a mediation that unfolds in different ways of gazing, of matrix, of structure and morphology, of proportion, of construction, of measurement, of irradiation, of rhythm, of intention and meaning ... The first of these geometries is the visual ray. The geometry of the gaze is the founding geometry of the visual perception of the subject as producer and receiver. The visual radius corresponds simultaneously to the radius or beam of light emitted, which in the opposite direction projects in the retina, and to the line from the interior projecting in to the exterior, as projection of the interior "point-body" that reaches and moves jumping from object in object, measuring distances close to distances, limits, goals and infinite indeterminations, tracing contours and fixing precise planes and points, in a shuttle between observer and observed. The radius projecting like a laser joining an inner point with an outer point is the first element of what we call geometries of the gaze and this is the first of the geometries that we can recognize, just as the pragmatic origin of geometry is associated with the practical reason for measuring earth and the instrumental and transcendent reasons for measuring the space of the firmament. The "Geometry of the Gaze", is the first instrument of measurement of visual perception, corresponds to the most primitive geometry that examines the world, which measures distances in an instinctive and intuitive way that projects, knows and recognizes reality, being one of the main cognitive instruments. Therefore, meaning translates the intention and sense of force, whatever it may be, in the field of ballistics of the eye, and the hermeneutic interpretation. It is the same geometry of the gaze that, observing the firmament "as a system of knowledge", that topologically grouped the stars by joining them with lines, in order to identify and name constellations, giving rise to astronomy and projecting from the mythical imaginary symbolic schemes, to try to know oneself through astrology. It is this gaze that, when moving from the scheme of the linear vector between the observer and the observed, to the transcendent triangulation based on the divine and the myth, that introduces the symbolic mediation between physics and metaphysics. Therefore, as Michel Serres states:

> Geometric thought penetrates the myth; reciprocally the discourse of myth invades geometry (...) are mixed astronomy and optics, metric, architecture and stone cuts, solar devotion, to liberate the objects from their black obstacles" (*The Origins of Geometry*, 1997, 114 and 182)

And referring to the Platonic cosmogony and triangulation systems that structure the creation of the world, he says:

> The aurora of the first Greek geometry considers the triangle as the simplest figure of space, after point, segment and angle ... so the Timae triangles the elements of the Earth - this is a new sense of the term geometry, when Earth passes from the piece to the world, (*Ibid*., 179).

Among latent structures, the regulating tracings of the so-called Sacred Geometry and, more recently, the “Fractal Geometry” (Mandelbrot, 1982) constitute geometric-mathematical forms of interpretation and matrices considered universal because they are believed to correspond to schemas of understanding and recognition in the formation and structure of the Cosmos, at its various macroscopic and microscopic scales (N. Pennick, 1980). The harmonic tracings of sacred geometry can be understood as ordering cosmograms that seek to have a symbolic, aesthetic and magical reach in the sense of "exorcizing" space and inscribing a harmonization of rhythms directed subliminally to human empathy. Hence, these canonical principles considered universal arise as symbolic forms intentionally applied by diverse cultures throughout history, not only applied to the religious architectural constructions (of the pyramids, temples and cathedrals), but also in other architectural constructions of profane character widening, urban planning, art works... As if Divine Creation were ruled by Divine Proportion, a latent transcendent and numerical geometric reason, such as the *Golden Section*, which structures and harmonizes visible forms of nature and architectural compositions. For this reason, we also call them geometries "Geometries of Invisibility”, because they are not directly visible but they structure the visible, hiding in the phenomenological and metaphenomenological condition, through symbols, "forms of force", "outlines of absence", balance or tensions of *Gestaltheorie's*, which give dynamism to architectural forms and have similar reflexes in the human mind (R. Arnheim, 1988, 163). Some of these *Gestalt* principles corresponding to the simple and pregnant configurations like the equilateral triangle, the square and the circle, and their homothetic repetitions, can be identified with the classical canonical geometric principles – “ad triangulum”, “ad quadratum” and “ad circulum”, and all the complex hidden structures that organize the visible, at the constitutive and perceptive levels. These structures exist between latency and emergency and in the perception of architectural appearance, where they act with the context looking for a principle of internal organization. The *Gestaltheorie* forms are schemes between formal emergence and latent invisibility. In the phenomenal reality we see neither fields nor forces in things, but we recognize structures and figurative schemes of constancy according to the laws of internal construction that convey them. The gestalt is a structural invisibility that is seen, in a state of particular attention, or perceptive transfiguration of the gaze. The gestalt is therefore in the hinge, or "pivot" between the visible and invisible, manifests itself in the configuration of the visible and reaches the interior, corresponding to a latent structure of forces directed in interaction, that support the visible, by the recognition of schematic configurations. As Merleau-Ponty says:

> Gestalt is already transcendence: it makes one understand that a line is a vector, a point a centre of forces - there are no lines, no points or absolute colours in things (Op. Cit., 1964, 248)

And José Gil adds:

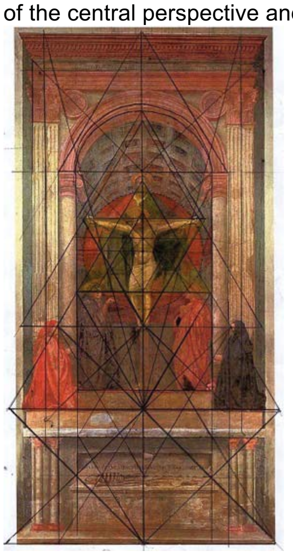
> A Gestalt is a configuration of absence, which closes the arc of the incomplete view of the visible (Op. Cit., 1996, 43)

In interpreting the three philosophical theories in a transposition to the field of architecture we recognize three layers of phenomena that we identify with what we designate as boundary categories: “Appearance”, “Emergence”, and “Latency”. In an anthropomorphic analogy, "Appearance" corresponds to skin of the architecture, the figurative and the superficial decorative and stylistic aspects, and other wall props, colors, textures… The environmental background gradients that influence the totality of the architectural framework, as they can act as “transfiguration operators”. "Emergence" corresponds to “flesh and the bone”, the three-dimensional architectural form, the constructive, the materiality and the tectonic structure; and "Latency" to inner and invisible space of the body (vital breath, soul, Being...) - the synergies that regulate the cohesion of the physical, metabolic, mental and spiritual systems of the Human Being. In an architectural transposition, these synergies surpass the idea of the classical composition, since they imply complex articulations of dynamic interaction, with intentions of perceptive attainment at the level of the related visual and haptic senses with the *Geometry of the Gaze* and the cognitive and aesthetical implication of the receiver. It is through the *Geometry of the Gaze* that we recognize the latent structures, by combining the canonical matrices of sacred geometry with the *Gestaltheorie* vector schemes, allowing us to access the deep meaning of pictorial and architectural works, as we shall see below.

3. Geometries of the gaze in “The Trinity” by Masaccio

The specific theme of the geometry of the gaze and the invisibility, started from my geometric analysis and hermeneutic interpretation of the Renaissance fresco "the Trinity" by Masaccio (1428), where "perspective as a symbolic form" (Panofsky, 1991) constitute the device for representing the interior architectural space and the religious iconography. The construction of perspective starts from the known vanishing point on the horizon line that divides the terrestrial plane from the celestial plane where the iconography of Christ's crucifixion takes place under the presence of God Father of the Holy Spirit (represented by the apparent visual ambiguity in the collar of God Father, as a white dove shape), the Virgin Mary, St. John and the couple of maecenas. Masaccio's pictorial-architectural composition propitiates the reading of different overlapping layers that go beyond visible appearance to the invisible field, through approaches to the latent

structure by the gestalt interpretation of vectors of force, coincident with the canonical forms of the sacred geometry, reaching the hidden part of symbolic forms.
In visual reading, figures and architectural elements define the symmetrical composition in the perspective and in the pyramidal hierarchical arrangement of figures. In latent reading, a network of bundles of vector forces, based on the *"ad triangulum"* matrix (1:√3) - symbol of the Trinity, main subject of this masterpiece - unites the eyes of the characters, starting from the central point between God's eyes; Christ is inscribed in the Star of David (union of the spirit triangle with the matter triangle), defining at the same time the structure of the central perspective and the interaction between the visible and the invisible.



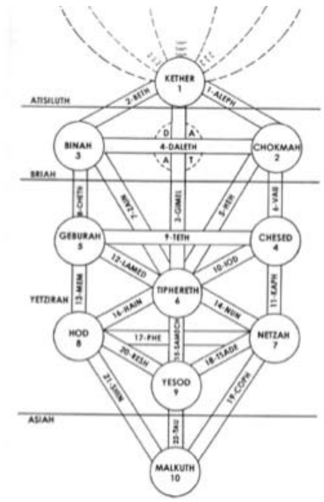


Fig. 1 – "The Trinity" by Masaccio (1428), "Geometry of the Gaze", geometric and iconological interpretation with the Kabbalah - Tree of Life (Author, 2009)

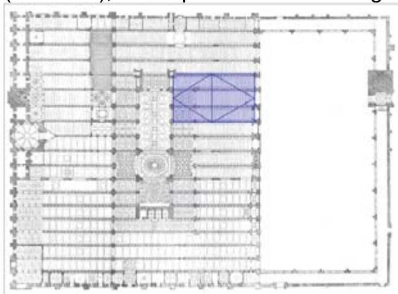
The geometrical complexity of the latent triangulations, formed by the vector forces of the gaze, constructs the "frame of the visible" where we found a correspondence to the iconology and the Kabbalah symbolism, in which transcending emptiness, *AYIN SOF OR*, identifies with God (Zev Ben Shimon Halevi, 1995). In our geometric-symbolic interpretation, the deepest matrix structure corresponds to the *Tree of Life* with its divine attributes represented by the *Sephiroths*. The architectural columns depicted, together with the axis corresponding to the cross, define the three pillars of the Kabbalah vertical structure. In an iconological reading from top to bottom, the *Sephiroths* are adapted to the Christian mysticism practiced in Florentine intellectual circles: the highest *Sephirot, Kether*, the crown, coincides with the head of God at the top of the pyramid; the *Sephiroths Binah* and *Hochmah* coincide with the two arms of the cross*; Daath*, the invisible *Sephirot*, corresponds to the heart of Christ; *the Sephiroths Geburah* and *Hesed* correspond respectively to St. John and the Virgin Mary; the *Sephirot Tiphereth* to the feet of Christ; *the Sephirots Hod* and *Neztzah* correspond to the maecenas; the *Sephirot Yesod* coincides with the vanishing point of the perspective, the aesthetic view of the sensible world, the point of view from the Ego; and finally *Malkhut,* the most material *Sephirot*, coincides with the place of absent sex of the skeleton of the *Adamic Man*, buried in the tomb inscribed in the double *"ad quadratum",* which corresponds to the physical world, the earth. The fresco resorts at the same time to the hermetic universe of symbolism and to the ambiguity of gestalt in the figure-background relationship and the vector lines of forces, which shape the composition between the visible and the invisible, and in parallel with iconography and symbolism. The field formed by the grid of the vanishing point and the vector of forces of the geometric triangulation linking the characters' eyes, envelopes and directly magnetizes the observer's gaze, producing an aesthetic osmosis. Concerning the appearance of the inner interfacial sphere, through the gaze in Renaissance painting, Peter Sloterdijk says:

> In the footsteps of Plato, Ficino presents the space between faces as a field of forces filled with turbulent rays. In this field, the facial surfaces turned towards each other work together in such a way that each time, they open to the human and historical visagity only by their being-for-the-other-face (*Bulles*, 2010, 22)

The geometry of and gaze and the latent Kabbalah structure, I found inside "The Trinity" by Masaccio (1428), precedes in the Fiorentine Renaissance context the principles of the Platonic gaze of the humanism of Marsilo Ficino (1433-1499) and the studies of the kabbalistic mysticism by Pico della Mirandola (1433-1499).

4. The DNA of the Mosque-Cathedral of Cordoba

Built during eight centuries through successive extensions, the Mosque-Cathedral of Cordoba is a paradigm of "openwork" (A. Monaco, 2004), linked to a process of architectural transformation of temporal overlaps that defined the building: through distinct, visible stylistic forms, and latent canonical structures that constitute its DNA. This is what we intend to prove from our geometric analysis based on Félix Ruiz's archaeological survey (R. Moneo, 1985), which highlighted the different phases of construction and enlargement of the building. Its foundation plan, originated from the Christian Basilica of San Vicente Martyr (6th cent.), corresponded to a rectangle that inscribe a double *"ad triangulum"* (√3).



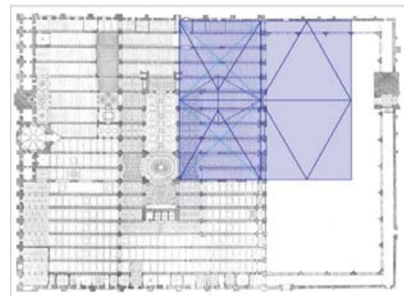
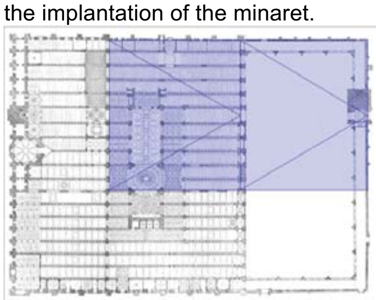


Fig. 2 – Basilica of San Vicente Martyr (6th century), geometric interpretation (Author with A. Monaco, 2007)
Fig. 3 – Mosque of Cordoba Foundation, Abderramán 1st, geometric interpretation (Author with A. Monaco, 2007)

With Moslem occupation, caliph Abderramán 1st founded the Mosque in 786, built the prayer room in the proportion of double "*ad quadratum"* and the ablution patio in the proportion of double "ad triangulum" (√3). Caliph Abderramán 2nd extended the prayer room of the Mosque in the direction of the *qiblah* wall, in the proportion *"ad triangulum"* (1: √3) and enlarged the patio in the proportion 1: √3, whose vertex determined the implantation of the minaret.



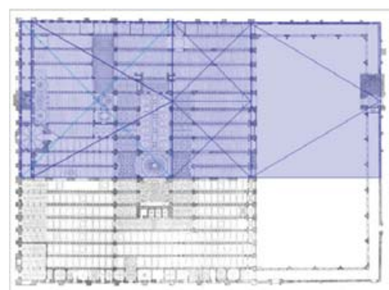
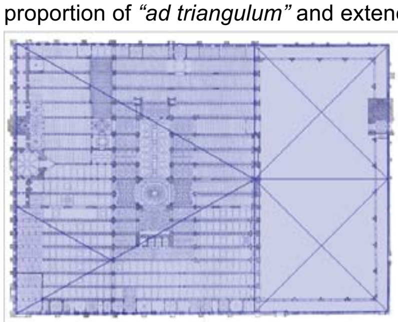


Fig. 4 – Mosque plan, 1st enlargement, Abderramán 2nd, geometric interpretation (Author with A. Monaco, 2007).
Fig. 5 – Mosque plan, 2nd enlargement, Alhaken 2nd geometric interpretation (Author with A. Monaco, 2007)

Caliph Alhaken 2nd extended the prayer room towards the qiblah wall, creating at the bottom a new qiblah of niches, in the proportions of *"ad triangulum"* by the interior and *"ad quadratum"* by the exterior. The last great enlargement of the Mosque promoted by caliph Almanzor, extended the prayer room in the total proportion of *"ad triangulum"* and extended the patio in the proportion of doble square (√4).



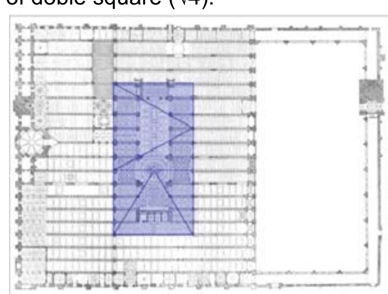


Fig. 6 – Mosque of Cordoba 3rd enlargement, Almansor 2nd, geometric interpretation (Author with A. Monaco, 2007).
Fig. 7 – Cathedral, inclusion plan, Hernán Ruiz I, II, III's works, geometric interpretation

Finally, with the Christian reconquest in 1236, and the reconversion to the Christian cult, led to the volumetric of the Renaissance cathedral in 1523 by Hernán Ruiz I, II and III, who introduced a new orientation in the temple, but also governed by the principles *"ad triangulum"* and *"ad quadratum".* Likewise, the entire cross section of the Cathedral is inscribed on the *"ad quadratum"* principle from the base of the building to the top of the dome and the vertical partitions of the building; while the matrix *“ad triangulum”* rule the addition of the work from the upper Muslim arches, to the apex of the outer covering of the dome. The articulation of *“ad triangulum”* and *“ad quadratum”* geometric principles with the *“ad circulum”* principle generates the various centres for the construction of arches and vaults.

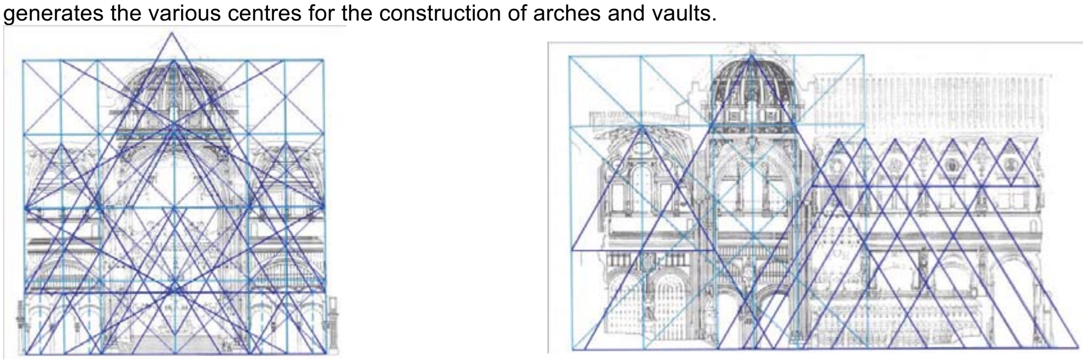


Fig. 8 – Cathedral sections, Hernán Ruiz I, II, III’s works, geometric interpretation (Author with A. Monaco, 2007)

The canonical structure determined the limits of the architectural form in the course of the compositional additions of the successive stages of growth, where each of the phases completed the unity of the tectonic and formal structure. Beyond religious differences and their apparent and emerging architectural stylistic differences, the "invisible structure" allowed geometric growth, founded on the matrices *“ad triagulum”, “ad quadratum”* and *“ad-circulum”,* constitutes the meta-religious and meta-historical DNA of this "open work". Beyond the geometries of invisibility, the architectural forms indicate geometries of the gaze: within the mosque the hypostyle space formed by 850 columns, analogous to palm tree oasis, generates rhythms of perspective *enfilade* and unusual visual crosses, reinforcing the vectors of horizontal vision, producing sensations of infinity, accentuated by the dark atmosphere that masks the walls boundaries. By contrast, in the Cathedral, the “geometries of the gaze” are driven by the “forces of shape” and “force of forms” of pointed vaults, pilasters and lantern tower that accentuate the ascetic verticality of space and light.

5. The Latent Mandorlas of the Jeronimos Monastery in Lisbon

Another case study of latent geometry is the Jerónimos Monastery in Lisbon, a building from the beginning of the 16th c., built by Boytaca and Juan de Castillo. Our analysis reveals that the southern portal façade of the Church of Santa Maria is structured in a system based on the geometric principles *“ad triangulum”, “ad quadratum”* and *“ad circulum”.* The equilateral triangle is the matrix associated with the construction of successive “*Mandorlas”* or “*Vesica Piscis”* - a mystical figure resulting from the intersection of the Circle of Matter with the circle of the Spirit (L. Freitas, 1977) - that frame the main sculptural iconographic elements of the portal axis: The head of Santa Maria is the center of the circle of canonical layout that governs the iconographic, architectural and structural composition of the façade. The same geometric matrix forms are inscribed as latent structures in the emergent form of the church plan and the Jerónimos Monastery complex. The matrices of the triangle are repeated in successive dilatations in the plan of the church, in the compound of the Jerónimos Monastery, and are intersected defining the peculiar octagonal form of the cloister, also emerged by the circle squareness, as its “frame of the visible”, according to my interpretation.

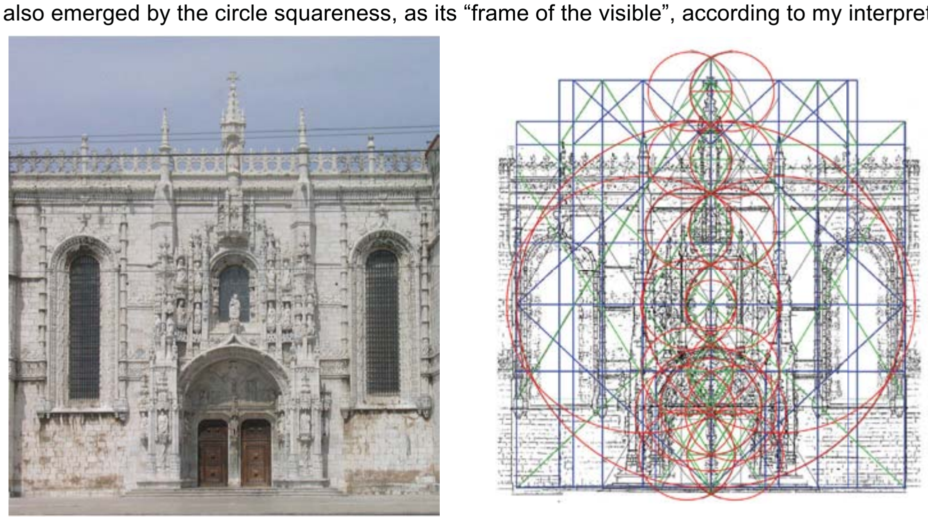


Fig. 9 Jerónimos's Monastery, Church of Santa Maria of Belen, Lisbon, geometric interpretation (Author 2007)

6. The compass and the rope

The compass is the prior and analogous instrument of the rope. Both compass and rope inscribe the infinite number "π"=3,1415..., and in drawing the circle from a fixed point, they plot on the symbolic plan the incommensurable nature of the cosmos. Rotations and translations define the fundamental movements of cosmological mechanics and simultaneously the compass and the rope associated with the square, are a basis of the geometry of the tracings where measure, form and proportion are integrated in the same syntactic and semantic operations. The conceptual traces of the schemes (using the compass), anticipates the execution site plan (using the rope), by the masons during the building construction. Starting from the basic geometric principles *"ad triangulum", "ad quadratum"* and *"ad circulum"*, the constructors developed geometric formulas and complex progressions, giving rise to constellations of forms (Ruiz de la Rosa, p.266, 1987). The geometric constructions of the various golden sections Φ = 1.6180 .., $\sqrt{2}$, $\sqrt{3}$, $\sqrt{4}$, $\sqrt{5}$ constitute derivations of the successive diagonal rotations of the square and rectangles (M. Gyka, 1968). In the same way that the construction of the *Mandorla* results from the intersection of two circles by its centres, it inscribes the double equilateral triangle, which is inscribed in the $\sqrt{3}$ rectangle. Besides the explanations of symbolic character that are associated with this geometric figure, as referred above, there is also a pragmatic explanation of the use of "*fabrorum* geometry". The *Mandorla*, also named "The Mystic Vagina", pointed arches is also a basis for the construction of the equilateral triangle, a canonical matrix, also related to the Pythagorean *"Tetractys".* It is the first of the regular polygons and a harmonic and structurally stable form. Therefore, 1: $\sqrt{3}$, underlies the emergence of the architectural form for the plan and section of the Milan Cathedral. Similarly, the known "12 or 13 knot rope" was one of the most used to draw an equilateral triangle of 4-4-4 sides or the known right triangle 3-4-5, and its multiples, and the base to draw the right angle and the construction of the Pythagorean Theorem (N. Pennick, 1980).

7. Pictorial and Para-Architectural Production

This analytical research favors the direct and conscious application of theoretical and geometrical principles in the artistic praxis of painting and in the territory I call *"para-architecture": an almost and imaginatively habitable space between painting, sculpture, installation and metaphysics under "the praise of the emptiness"* (J. Cruz Pinto, 2010). In the *para-architectual* context –- I created the "Matrix" piece, *Circumvolution of the Triangle* which constitutes a physical and metaphysical abstraction, from the three geometric principles "*ad-triangulum, "ad-quadratum"* and "*ad-circulum"*, of intentional praise of the emptiness and the principles of gestalt, where the empty background becomes the dematerialized figure. The empty triangle is formed by three burned wooden panels in the proportion of double square ($\sqrt{4}$) and is inscribed in a circle in stainless steel. Among the various possible readings: the burned wood alludes to the first phase of the alchemical process – *Nigredo*; the latent structure also corresponds to the old wooden structures that framed and supported the stone masonry during the construction of architectural works, which after being dismantled were certainly burnt and reduced to ashes ... they are reborn as the Phoenix in the present time, in the form of my *para-architectural* works.

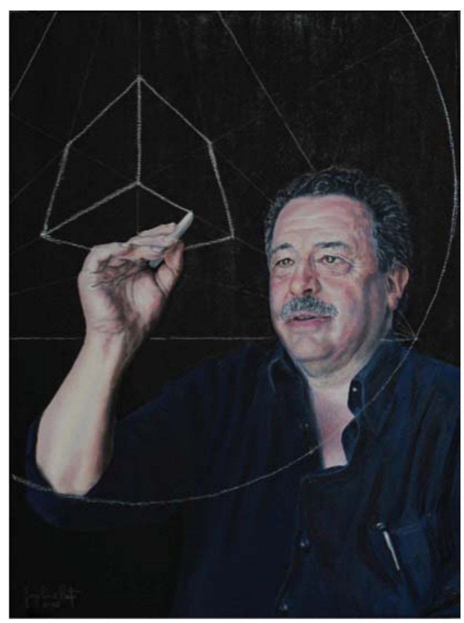


Fig. 10 – *"The Matrix",* mix technic on wood (Author, 2016) **Fig. 11** – "*The Geometer"*, oil on canvas (Author, 2013)**.**

*"The Geometer's Gaze"***:** The portrait of Manuel Couceiro, professor of descriptive geometry, which I painted for the chairmen's gallery of the Scholl of Architecture of the Lisbon University, seeks to translate the question of *geometry of the gaze*, as I interpret it in the construction of "The Trinity" fresco by Masaccio, and from the three geometric principles "*ad triangulum", "ad quadratum" e "ad circulum"* - pointed out on the slate represented on the famous portrait of Luca Pacioli. With his right hand raised, the professor draws, literally in the void of dark space, the layout of the construction of a cube in perspective, based on three vanishing points. The construction of the perspective cube, solid derived from the principle *"ad quadratum",* is based on the *"ad circulum"* matrix, where it is inscribed the *principle "ad triangulum".* Only one of the vanishing points is visible within the canvas, ambiguously placed in the foreground and behind the geometer's nape. To this vanishing point converge part of the vector lines that construct four of the cube edges in perspective, where two of them cross the geometer's eyes, like the luminous rays that define the geometry of the suspended gaze in the incomplete line of the cube he is drawing. Descriptive geometry, perceptual gestalt and sacred geometry overlap, converging literally in the demonstration of the cube construction and in the construction of the painting, from the *geometry of the gaze* of the represented geometer, who simultaneously observes it, draws it, and by my gaze that crosses it and paints him on canvas, making emergent invisible aspects.

CONCLUSION

The theoretical "Space-Limit" model of categories of production and reception – "Appearance", "Emergence" and "Latency" - through the transposition of philosophical concepts, for the domain of architecture, allowed to identify and to fund conceptually, the different layers of approach, and the internal structures between the visible and the invisible, made evident through experimental geometric analyzes in concrete artistic and architectural works. The experimental analysis of the "The Trinity" by Masaccio allowed to decode the latent contents, both at the level of the internal formative structures of the "Geometry of the Gaze" of the characters, combined with the Sacred Geometry, in convergence of the Renaissance conception of Ficino's Gaze, and the contemporary reinterpretation in the light of the "*Gestaltheorie"* through the identification of the centers and vectors of force that supported the apparent figuration, as at the level of the symbolic inscription of the Kabbalah in the latent invisible depth. The analysis of the Church façade of Santa Maria de Belém highlighted the invisible canonical structure through the discovery of the inscription of the Mandorlas, ordering of the integrated composition of the sculptural iconography and the tectonic structure having as focal point the Virgin and the Child Jesus under the matrices "ad triangulum", "ad quadratum" and "ad circulum". It was found that the same matrices are at the origin of the latent construction rules and the homothetic successive phases of expansion of the Mosque-Cathedral of Cordoba, behind the apparent forms of different cultures and religions. The classical principles "ad triangulum", "ad quadratum" and "ad circulum" constitute the invariant geometric matrices common to the analyzed works, reinforced by the "Geometry of the Gaze", which deepens the vision with the experimental help of the compass and the square. Finally, we have tried to demonstrate that the intentional application of these universal matrices continues to be valid in the production of contemporary works, while simultaneously highlighting the "Geometries of the gaze and the invisibility".

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Brian Robert Sinclair, Yuki Sinclair

Japan-ness + Gaijin-ness: Critical Explorations in Culturally-Sensitive Holistic Design in Urban Tokyo

Japan-ness + Gaijin-ness: Critical Explorations in Culturally-Sensitive Holistic Design in Urban Tokyo

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Tokyo is the world's largest, utmost complex and arguably most livable city. With a metropolitan region housing more people than Canada, Tokyo proves enigmatic – despite overwhelming size it's walkable, attractive, resilient, safe + dynamic. As a living laboratory for study of Architecture, Planning and Urban Design, Tokyo is second to none. The present research, critically considering & imaginatively exploring pedagogy, culture and competency, focused on an annually-offered Japan-based innovative/immersive study abroad initiative for environmental design graduate students. Urban design is at the core of the three-month study abroad venture. Lying at the nexus of Architecture & Planning, Urban Design in this amazing city is rich, diverse, creative and highly successful. In a city with daunting complexity quality of life is astounding, richness of milieu is remarkable, and design boldness unparalleled. The term abroad is structured with two intertwined course offerings – design studio and urban theory class. Both studio and theory class engage in intense critical analysis of city and components. The three month period is organized into three related phases: Characterizing Tokyo; Urban Ideation, and Urban Design Intervention. Threading through of these aspects is overarching interest in urban typologies. Key to learning is development of self/world views, including sensitivities around Japan-ness (local) versus Gaijin-ness (foreign) perspectives on design. From a learning perspective few vehicles are as potent as study abroad. The research, focused on development/analysis of a Tokyo graduate studio, proffers an innovative model for studio-based education and offers lessons surrounding potent ways to prepare design students for the realities of more complex, demanding and internationally intertwined futures. The present paper is exploratory in intent and extent – it examines a unique study abroad venture and novel teaching approach that is in many ways speculative, preliminary, unconventional and provocative. The paper reveals key dimensions of pedagogy, encounter and education that open fascinating doors and call for richer and more rigorous study.

Keywords: Japan, architecture, planning, pedagogy, holism

INTRODUCTION

"Major cities around the world today are caught up in intense and complex competition. The stakes in these processes of global inter-city interaction are extremely high."
Global Power City Index, Institute for Urban Strategies - Mori Memorial Foundation (2015)

Education is a powerful vehicle across a spectrum of realms, subjects and possibilities. Professional education, and design education, assume unique spaces within the greater ethos of higher education. Certainly a chief role of higher education is to instill knowledge, while concurrently developing skills to translate said knowledge into action. However, a higher mission of higher education involves the cultivation of wisdom – that is, the coupling of head and heart – that empowers students to embrace a world in need with greater compassion, with heightened empathy, and with an ability to connect the pieces in potent + meaningful ways. Simply to educate around facts and figures is insufficient. Facts are commonly equated with truths. That said, facts shift based on the power of technology, the strength of instrumentation (e.g., seeing closer, reaching father) and the efficacy of prevailing theories. In other words, it is inappropriate to rely solely on conventional tools and accepted mindsets as the basis for educating a next generation of professionals, designers, leaders and citizens. Rather, given the turbulent times we live in, it seems essential to equip our students with unprecedented, unbridled and unlimited ways of seeing, thinking and acting. Without question design education stands apart in the landscape of higher education, in large measure through its adoption and adaptation of compelling studio methods. Also of note in higher education is the undeniable value of taking teaching and learning 'on the road' via study abroad initiatives. Removing students from the safe and at-times sanitized milieu of campuses and classrooms, and moving them into the in-situ unvarnished environments of foreign countries, cultures and contexts, proves transformative and profound. The present paper highlights research and practice aimed at aggressively colliding these two rich teaching and learning approaches – that is, studio education and study abroad. The theories, strategies, pedagogy and practices deployed in the present project have been developed in partnership of the two authors – a lead instructor (Canadian-born, English mother-tongue), who is an experienced educator, architect, administrator and researcher together with a support instructor (Japan-born, Japanese mother-tongue), who is a seasoned artist, teacher and study abroad professional.

TERM ABROAD OVERVIEW

"Appropriate solutions to some of our most daunting problems will arise through the concerted efforts, open dialogue, and collective wisdom of the wide array of stakeholders, professionals, politicians, decision makers, and citizens (both engaged and disenfranchised) who have the will and wherewithal to make a difference and to make the world safer, healthier, and better. It seems vital for us to critically examine, and question, our belief systems and their connections to the ways we define, refine, and realize progress". Sinclair, 2015, Cybernetics + Systems

Study abroad, as a pedagogical approach, is exciting, engaging and intensely educational. To extract a student from the often conservative confines of the campus, and to relocate the curriculum from the predictability of classrooms to the uncertainty of the field (often a world away) is often riveting and usually life-changing. In the eyes of the present researchers the more foreign the field (culture, landscapes, language, cuisine, costumes, etc.) the more effective the learning encounters, experiences and outcomes. For example, educating North American students within English speaking nations abroad, while unquestionably worthwhile, does not tend to have the same impacts (personal and professional) as immersing these same students in places where there is little that is familiar. While it is disconcerting for newcomers to struggle with new languages, customs and conditions, this struggle is fundamental to greater growth. Such growth is not merely about academic issues and book knowledge, but rather is enlarged to envelope qualities of tolerance, understanding, empathy and respect.

Research in the present Tokyo Study Abroad involves precedent examination of Western/Eastern exemplars, detailed case studies of Japanese projects, literature investigation on spectrum of topics, and ongoing design development, iteration, critique and refinement. A fundamental pedagogical objective was to cultivate/ensure an integrated, holistic (*sogoteki*) & balanced learning experience. Set within the context of professional graduate programs (Environmental Design), the Japan semester acknowledges outstanding opportunities presented for cultural exposure, local living and rich learning. While professional competencies are vital from a teaching vantage point, equally weighted are cultural qualities/nuances that define Japan through both historical & contemporary lenses. On the cultural side students encounter local festivals, food, communities and context. They partake in sumo, kabuki, zazen and other activities that inform daily life, influence values and inspire design. Structurally the interdisciplinary studio centered on an urban design project within greater Tokyo. Students, working in pairs, are given wide latitude concerning site, size and scale of design. Pedagogically this strategy is important – through a non-prescriptive approach students build upon their interests and are fueled by their passions. Projects range in scale from modest residential developments on small sites to kilometer-long infrastructure-heavy urban passageways. Housed in dramatic space in the Toranomon district of Tokyo, the studio is organized similar to a design practice, with regular office hours interspersed with field study, cultural activities, guest lectures, factory tours, government meetings and project visits. Critical reflection through the term permits real time adjustments/refinements to pedagogy. Sustainability, broadly defined, proves an underlying responsibility to all interventions.

Study abroad is not simply moving curriculum from one place to another, as is often mistakenly assumed by educators not familiar with the pedagogical potential and practices. Instead it is a deep reinterpretation of the curriculum with a novel society and fresh situation front-of-mind. It is not about imposing home values onto the new destination, but rather involves listening to and learning from the host nation. Study abroad, from an administrative perspective, involves a remarkable level of pre-trip preparation and yet demands a tremendous amount of improvisation, give & take and accommodation in the field. There are inevitable uncertainties at hand and unknowns at play – if the initiative is well-planned and the educators well-prepared, then levels of nimbleness, agility and resiliency will contribute to positive and profound outcomes despite any adjustments necessitated and shifts realized.

TEACHING + LEARNING IN NIPPON

"Emptiness does not merely imply simplicity of form, logical sophistication, and the like. Rather emptiness provides a space within which our imaginations can run free, vastly enriching our powers of perception and mutual comprehension." Kenya Hara, 2008, Shiro

The present study abroad venture, based in Tokyo, is offered annually to graduate students from Architecture + Planning, with a maximum cohort size of twenty. The program has been developed and is led by a professor of Architecture (former chair + former dean), working in concert with an accomplished study abroad professional with experience in many countries globally. The term in Tokyo includes two mandatory courses – an Urban Design Studio and an Urban Systems class. These two core offerings are tightly interlaced to ensure leveraged learning and optimization of effort, resources, time, etc. In addition to these required courses students typically pursue one or more directed study (independent explorations led by a supervising faculty member), most often topically connected to the host country & culture. For example, a directed study course in Tokyo might examine uniquely Japanese approaches to space, design + meaning.

TOKYO

Tokyo was set at the main destination for the Asian study abroad trip due to a number of positive features of the municipality. Tokyo is the world's largest urban settlement. It is complex, rich, diverse from a design perspective and, from an institutional perspective, politically stable, well managed + personally safe.

The following quote (Sinclair, 2017) paints a colorful & convincing picture of the city:

> "Tokyo is a remarkable urban conurbation, with intense population, compact development, extraordinary character and an exceptionally high quality of life. With an urban population exceeding that of Canada, the Tokyo Metropolitan Region embraces a rich array of features key to a well-crafted, well-designed and highly-functioning city. Tokyo is regularly acknowledged as a leading global city, with metrics underscoring rich amenities, walkable streets, diverse neighborhoods and extraordinary attention to design + planning. From a world-class multi-modal transportation system and vibrant mixed-use communities to pedestrian-oriented fabric and design innovations, Tokyo demonstrates how an urban centre can be colossal and complex while proving demonstrably dynamic, accessible and livable. For those looking from outside the city Tokyo proves a paradox – it is massive in size, and incomprehensible in scope while functioning at high levels, running smoothly and relatively free from serious problems. Amenity is high, crime is low, efficiency is unprecedented, design is pervasive and a sense of community is ubiquitous. Tokyo's success is in many regards without parallel. As an urban phenomenon it is worth critical examination, not only to cull out reasons for such achievement but also to better grasp the features and facets of the city than contribute to its Gestalt. In many regards Tokyo affords environmental design theoreticians and practitioners an outstanding exemplar for study, for experimentation, for inspiration and for best practices."

The following is a brief description of the present study abroad venture, provided by the lead instructor to potential students in the recruitment phase. "Japan is a nation rich in history, steeped in tradition, complex in character and innovative in design. For a full semester, three months of immersion, will be exploring architecture, planning and urban design, both historical and contemporary, across all corners of the dynamic & robust greater Tokyo Metropolitan area. Our travels will take us from monumental sacred sites such as Meiji Shrine + Asakusa to the dominant grounds and structures of the Imperial Palace. We will be visiting iconic buildings of seminal Modern architects such as Tange, Maki, Isozaki, Ando and Kurokawa as well as touring works of leading cutting-edge contemporary designers such as Kuma, Ito, Ban, Yamanashi, Watanabe, Aoki and others. From fish & food markets to Buddhist temples & Shinto shrines we will be connecting to the essence of Japan. From the reclaimed lands of Tokyo Bay to the soaring towers of Roppongi Hills we will witness bold urban experiments that challenge the status quo. We will be connecting with leading Tokyo designers & planners with a goal to grasp the complexity, challenges, approaches and outcomes of the urban ethos. In addition to environmental design aspects, we will be encountering first hand Japan's extraordinary culture, sub-subcultures, spirituality, traditions, values, shopping, nightlife and, of course, cuisine. From sunrise to sunset, and well beyond, utilizing the region's unprecedented and dazzling multi-model public transit system, our activities will introduce new experiences and novel encounters, serving to open eyes and minds to a very magical, mysterious, design-oriented + highly-functional society. From the centering of Zen and the discipline of the Art of Tea to the creativity of the Metabolists and the pulse of Harajuku our itinerary will be intensive & extensive. Kampai!"

PRIMARY PEDAGOGY

The approach to the Tokyo Study Abroad initiative was, first and foremost, directed at an intense immersive interdisciplinary collaborative enterprise. In Japan there is a term, '*sogoteki*', which captures the nature of the pedagogy deployed in this scheme. *Sogoteki* is a full and comprehensive way of tackling a problem or looking at a subject. It aims to collect all aspects into the equation, such as in this case teaching and learning. The present curriculum was fully contextualized within the unique environment of the city, considering such matters as historical, regulatory, geographical and cultural nuance. From a teaching and learning vantage point, the overseas term followed closely the philosophic posturing and practices of the lead instructor (i.e., first author). This original approach has been developed over many years of administrating and teaching in design schools in many jurisdictions, including the USA and Canada.

Teaching is a tremendous privilege that encompasses both opportunity and obligation. With regard to opportunity, an educator is afforded the chance to shape minds, incite passion, and build knowledge. With respect to obligation, and especially in light of today's perplexing problems, an educator has a deep responsibility to foster citizenship, encourage volunteerism, and aid in the development of values that can change our world for the better. Post-secondary education is complex, diverse and demanding. Shifting expectations, shrinking resources and a sense of urgency tend to move the academy in new directions. In such a milieu the importance of teaching effectiveness, innovation and creativity is underscored. Design education is somewhat unique in that it finds itself at the nexus of science, technologies, art and humanities. Designers speak of 'wicked' problems – those daunting challenges that are complicated and perplexing. Design, as both mindset and method, affords modern society with a very potent means of tackling such 'wicked' problems. In recent times universities, and the world beyond, have placed increasing emphasis on the power of design, including paying closer attention to studio teaching as a model for education well beyond the borders of Architecture & Planning. The lead instructor's philosophy on teaching, and his pedagogical approach, while centered on design education in the primary instance, is relevant and applicable to many disciplines. His background is quite novel in that it spans from science (brain research) to arts (architectural design) -- building a strong knowledge base across disciplines as well as a deep appreciation for more inclusive & integrative ways of seeing, thinking and acting. His perspective is systems oriented, driven by an understanding of the need for more interdisciplinary means of coping with complexity and addressing contemporary challenges. Rather than building walls and containing fields the teaching approach pushes students to transcend conventional borders and to imagine in unknown directions.

Teaching Philosophy Components

To best convey the aforesaid philosophy of teaching four inter-related components are presented that together fuel and drive the pedagogical efforts: 1. Holism, 2. Balance, 3. Respect, 4. Community. The following sections delineate and elaborate on these notions.

1. Holism:

Having operated on both ends of the science-art spectrum, the lead instructor has come to realize that many modern problems have arisen through fragmentation, separation and isolation. The momentum for heightened specialization, in the academy and beyond, while understandable on some levels is also problematic on others. With regard to design education and studio teaching, a much more integrated, interdisciplinary and holistic approach is vital. This teaching approach strives to build in students a strong appreciation for the wide array of means and methods required to solve modern problems. This emphasis on systems thinking and holism is captured effectively in the lead instructor's "Holistic Framework for Design & Planning" (see Sinclair, 2009) which has been developed over many years of teaching, research, consulting and service. This model, which informs and inspires teaching efforts, comprises the inter-connected aspects of Agility, Fitness, Diversity and Delight. This approach stresses the need for designers (and students of design) to carefully attend to a series of key issues when problem solving. These issues reach from very technical and scientific features to more artistic and intuitive qualities. In the model all of the issues need to be addressed in the interests of arriving at optimal solutions. As part of the teaching philosophy this model fosters a much more complete consideration of the many variables acting upon a given situation and, in the end, leads to better considered and hopefully more appropriate solutions.

2. Balance

Related to the previously noted holistic framework, but in many ways residing above it, lies an intense belief in seeking and realizing balance and harmony in teaching. It is imperative to encourage broad engagement and inclusive learning within the classroom and studio. Balance is essential. Balance of the poetic with the pragmatic. Balance of telos and techno. Balance of research and design. Balance of analysis and synthesis. Balance of reason and intuition. Balance of thinking and feeling. As teachers we must not only impart knowledge but more critically must instill wisdom. Wisdom is the coupling of head and heart. Again a crucial balance, or harmony, must be sought and attained. In our modern world it is easy to be pulled into a level of specialization and segmentation that can be counter-productive to the needs at hand – for example, addressing endemic problems such as poverty, climate change and pollution. In order to cope with complexity, and especially within the ethos of design, many dots must be connected. CP Snow, in his 1957 essay entitled 'The Two Cultures', cautioned of the risks and perils of an increasing gap between the sciences and the humanities. In many ways Snow's forecasts have manifest, with many incomprehensible modern problems ushered in and amplified by such disjunction. A part of our role, as teachers, is to illuminate such issues and facilitate better understanding. With more comprehensive awareness of problems come greater possibilities for more enlightened, effective and appropriate paths forward. Balance and harmony are valuable pursuits to such ends.

3. Respect

A cornerstone of the lead instructor's teaching philosophy is the affording of respect. Respect is a very precious quality in our modern world – often lacking but always essential as pertains the rich relationships present in classrooms and studios. While the authority of the educator is an undeniable aspect of the teaching milieu, this in no way lessens the need for deep respect to be extended in both directions – teacher to students and students to teacher. In the study abroad venture the value of and need for respect is paramount. If students fail then the instructors too fail. If students succeed then that is indeed also the instructors' success. When respect is extended to students there are a wealth of benefits that follow, including greater motivation, more attention to outcomes, a more fulsome engagement in learning, and heighted esteem. Respect does not lessen the expectations and demands around performance – rather it builds a very strong bond between teacher and student that propels performance in critical directions. Related to respect are concepts of tolerance, mindfulness, charity and grace – which, while arguably seen as 'old-fashioned' in some circles, serve to motivate, guide and reward teaching activities. Also connected to this ingredient of respect is empathy – that is, the ability to see through the eyes of another. As a psychologist the lead instructor endeavors to truly understand the individual journeys each student pursues. Such journeys have high and low points, opportunities and obstacles, nuance and spin that are individualistic and special. As teachers it is our job to endeavor to understand the unique needs and capabilities of students, and to adjust/temper efforts in ways that realize + optimize the potential of students.

4. Community

A final and essential aspect of the lead instructor's teaching philosophy is a commitment to engage community. While such engagement is beneficial for all disciplines in a university, it is essential for professional programs. Architecture and Environmental Design are fundamentally concerned with people and environments – as such it is vital to position design education within the realities of the marketplace. In attempting to understand design problems, and to find appropriate design solutions, students must truly grasp the many forces at play. Designers speak about zeitgeist, or the spirit of the times. Sustainability concerns dictate a solid knowledge of both local and global parameters, coupled with a profound commitment to place. In order to educate students in the most effective manner possible, it is valuable to take them into the city and bring the city to them. Such efforts manifest in an array of teaching/learning possibilities. To ensure balance in the teaching approach, an engagement with community ensures that book-learning is blended with street-smarts, that theory is countered with practice, and that academic perspectives are juxtaposed with business concerns. In pursuing Architecture & Design education, including through the vehicle of studio, grounding students in culture + context is rewarding, wise and responsible.

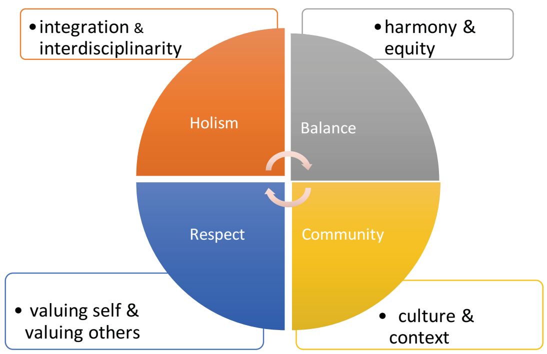

Figure 1: Sinclair Holistic + Tactical Pedagogy

It is very important to stress that the aforesaid dimensions of this teaching philosophy are highly inter-related and inter-dependent. In day-to-day work in classrooms and studios these dimensions need to be invoked both implicitly and explicitly. Effective and innovative teaching demands great vigilance, constant refinement, critical self-examination, and ongoing testing and verification of potency of methods. In keeping with a strong commitment to holism, balance, respect and community, teachers must constantly assume the role of the student. Teachers need to always be learning – this demands an open mind, abundance of energy, presence of humility, and an unswerving devotion to the well-being, progress & success of students.

STUDIO

DESIGN:
To create, fashion, execute, or construct according to a plan.
To conceive and plan out in the mind; to have as a purpose; to devise for a specific function or end.
To indicate with a distinctive mark, sign or name.
To make a drawing, pattern or sketch.
Merriam-Webster's Collegiate Dictionary (10th Edition)

Architecture, Planning and Urban Design are powerful and limitless vehicles for realizing positive change in our world. The disciplines of Environmental Design (e.g., Architecture, Planning, Landscape Architecture, Urban Design, Interior Design, Industrial Design, etc.) are increasingly focusing attention on the capacity and capability afforded through interdisciplinary practice and integrated design processes. Without question architecture, planning and urban design are potent forces that need to be understood, developed and deployed in our efforts to heighten the quality of life in our communities.

The world is now more urban than rural, with significant implications for the design disciplines. Coupled to growing urban realms is our increasing awareness of climate change and its many implications. Cities and buildings stand as major contributors to such phenomenon. However, they also loom as tremendous instruments to change directions. Architecture, Planning and Urban Design hold fundamental places in our society. Architects, Planners and Urbanists have real obligations and opportunities at the present juncture. "Urban Tokyo | Urban Typologies | Urban Design" (Tokyo Studio) presented us with a lens through which pressing dilemmas could be critically considered and meaningfully explored. Political dialogue, social change, intercultural sharing and 'seeing through the eyes of the other' all presented rich possibilities for contemporary development, professional advancement and international harmony. A major objective of the present studio was to explore urban conditions, analyze urban dimensions and synthesize urban responses that, while proving professionally competent and viable, also pushed our understanding concerning the potential of architecture, urban design & planning to make a difference to a world in need. The studio project presented a unique opportunity to explore how planning, urban design and architecture serve as potent vehicles to acknowledge, reflect and celebrate the identity and culture of place while concurrently providing opportunities for understanding more universal concepts and constructs.

The interdisciplinary studio, based in Tokyo, intertwined cultural, spiritual, social and design experiences in the field with more time-honored studio-type learning. Each week the class was walking around the Tokyo metropolitan region, visiting projects, participating in events, working with local environmental design professionals, and critically considering the city, its districts and its buildings. A key goal was to take advantage of the 'city as laboratory' and to critically consider many aspects of architecture, urban design and planning that contribute to Tokyo's premier position as one of the planet's most intriguing, dynamic, pioneering, walk-able and livable urban centers.

Studio projects were conducted in small interdisciplinary teams. The studio focused on a single project over our time in Tokyo – namely "Urban Tokyo | Urban Typologies | Urban Design". In our time in Japan we moved from an open exploration of city and region, to a critical analysis of space delineation & utilization, through to the conceptual development and delineation of urban responses (that encompass the street, the landscape, the site, and the building).

TYPOLOGY:
*noun: typology; plural noun: typologies: * a classification according to general type, especially in archaeology, psychology, or the social sciences. * study or analysis using typology. * the study and interpretation of types and symbols* <u>*Merriam-Webster's Collegiate Dictionary*</u> *(10th Edition)*

The Japan-based Senior Interdisciplinary Studio considered the rich, complex and multifarious urban realm of Tokyo – the planet's largest urban settlement. Students, working in teams of two were engaged in observation and study of the city's fabric, with an initial goal of gaining some familiarity and comfort with space and place. Following from this base overview, teams conducted more detailed analyses of selected areas of the metropolitan region, with a particular emphasis on districts and sites in proximity to major waterways and bodies (river, canal, lake, sea, etc.). Critical analyses, coupled with study of international precedents, revealed some common features and design dimensions that characterize 'typologies'. Some typologies reflected commonly accepted space/place types (e.g., streets, squares, parks, etc.) while others charted new ground. The objective of this analytical component of the studio was to gain, as a broader cohort comprising all teams, a deeper understanding of approaches to urban design and development in the greater Tokyo area. Building from this shared understanding, individual teams considered one or more interventions into the urban fabric, with a goal to synthesize, propose and delineate a conceptual urban design response. The intervention was not a detailed design of a building nor the shaping of a finite plan, but rather demanded a more holistic, creative, comprehensive and integrated urban design proposal that considered figure and ground, solid & void, streets, landscapes + buildings, and space & place at an preliminary conceptual levels. The urban design responses found a healthy balance of people/place, process/product, creativity/innovation, context/culture, integration/provocation and viability/ sustainability.

The emphasis of the Tokyo Studio was especially on the cultural, social and environmental (i.e. sustainability) potential of explorations and interventions of and in the urban fabric. The studio explored the relationships between the public realm, architectural form, compelling landscapes, cultural identity and sense of place. The basic curricular objectives incorporated a deep and meaningful exploration and analysis of the complex fabric of Tokyo as well as taking steps to develop one or more interventions that prove challenging, effectual, meaningful and appropriate. Consideration was given to user needs and human dimensions, including environmental perception, symbolism and meaning, ergonomics and adaptability, cultural sensitivity and place-making.

URBAN SYSTEMS

THEORY:
Analysis of a set of facts in their relation to one another.Abstract thought. Speculation.The general or abstract principles of a body of fact, a science or an art. Belief, policy or procedure proposed or followed as the basis of action. An ideal or hypothetical set of facts, principles or circumstances. A plausible or scientifically acceptable general principle or body of principles offered to explain phenomena. A hypothesis assumed for the sake of argument or investigation. An unproven assumption. A body of theorems presenting a precise systematic view of a subject.
<u>*Merriam-Webster's Collegiate Dictionary*</u> *(10th Edition)*

Cities are complex phenomena that present remarkable opportunities, and daunting challenges, for an increasing percentage of our planet's population. Our world is now more urban than rural, a fact that warrants the attention of Environmental Designers and calls for sound and effective decision making in order to heighten our quality of life. Cities prove rich in amenity, diversity, composition and character. They concurrently pose unique obstacles concerning infrastructure, order, management and harmony.

The urban design theory course was intended to present an overview to theories, principles and practices in both an historical and contemporary sense. Being closely connected to and interwoven with the Tokyo Studio, the course aimed to support and reinforce encounters, explorations and experiences in Tokyo. Structurally the course included lectures, video-taped talks, office visits, project tours and field studies which illustrates and reinforced the interplay of theories and practices. Several assignments, coordinated with studio, examined, delineated and demonstrated urban design theory in play in the city.

The Asia study abroad initiative brought together Architecture and Planning students in a rich interdisciplinary milieu. Urban Design, residing at the nexus of Architecture and Planning, affords an extraordinary vehicle through which to investigate and understand the city. Through its dynamic and three-dimensional quality, urban design approaches vital questions concerning how we inhabit and utilize the spaces and places of urban settlement. It addresses the significant realm between buildings and considers how landscapes, built and natural, operate and contribute to the mix. The course bridged between the specific and the general – accepting that Environmental Designers need to focus on the competent execution of the particular while respecting broader systems. Consideration of scale and scope proved essential (e.g., the project), while simultaneously responding to the larger ethos (e.g., the neighborhood, the district, etc.). Subscription to holism and the pursuit of synergies were paramount.

SYSTEM:
A regularly interacting or interdependent group of items forming a unified whole. An organized set of doctrines, ideas or principles intended to explain the arrangement or working of a systematic whole. Organized or established procedure. Harmonious arrangement or pattern. Merriam-Webster's Collegiate Dictionary (10th Edition)

The Urban Design Theory course considered most notably the rich, complex and multifarious urban realm this remarkable city. Tokyo is an amazing city that needs to be understood on its own as well as in comparison to other urban centers. While on one hand there are common qualities that often shape, define and determine city form and function, on the other hand the unique dimensions of place, including geography, history, context and culture, serve to make indelible differences. We examined and explored Tokyo while critically considering analyses and understanding other cities (including selected examples from North America, Europe and elsewhere). Our studies of the city were manifold, looking into broader systems & assemblies while digging deeper into more tightly demarcated and nuanced precincts, projects & parameters. Aspects that were covered included urban evolution, urban culture, urban space, urban politics, urban planning, urban innovation and, crucially, urban place-making.

Urban Design Theory surveyed a fundamental base through which to approach analysis and synthesis, from an Environmental Design perspective, in the city. Our understanding of the principles and practices of Urban Design afforded us a potent lens through which we approached both problem-seeking and problem-solving. In the instance of Tokyo, especially considering its complexity and density, it was essential that we operated with sound strategy as we planned, designed, intervened, altered and inserted. The objectives of the course included:

- Develop the means, methods and mindset to critically consider, compare and evaluate cities.
- Develop knowledge and skills concerning the planning, design and development of urban space and form.
- Develop understanding of the historical evolution of cities, their present circumstances and their emerging trends.
- Develop the ability to be able to research, assess, interpret and advance dimensions of urban design of cities.
- Develop more interdisciplinary, imaginative + team-based approaches to research, planning, design & communication.
- Develop world & self-views concerning urban design and its potential impact on planning, design, people & place.

PEDAGOGICAL PUZZLE: ON THE GROUND ACTIVITIES

"Cities are made of scenes. Those scenes have a syntax." Urban Code, Mikoleit & Purckhauer (2011)

The approach to three months in Tokyo was divided logistically into three phases, roughly each a month in duration. The first month was dedicated to exploring the city, becoming familiarized with getting around, and coming to terms with being comfortable in a dauntingly and incomprehensibly complex metropolitan center. The second month was aimed at critically analyzing aspects of the city that proved of great interest and relevance to the design challenge of studio. The third, and final, month was focused on refinement and resolution of an urban intervention, including critical examination and rationalization of the project's 'Japan-ness'. While a fresh perspective (Gaijin-ness) was welcomed and appreciated by the hosts and reviewers, a need to connect meaningfully to place (i.e., Tokyo and Japan) was judged as non-negotiable. Over the three months in Tokyo the students met with government officials, sang karaoke, grasped Western influences, conversed with architects and planners, studied Zen meditation, attended Sumo matches, enjoyed university talks, watched Kabuki theatre, danced in street festivals, downed sake with locals, went on factory tours, heard from real estate experts, visited shrines & temples, struggled with Japanese language, explored iconic buildings, journeyed to distance towns, consumed novel cuisine, and generally worked, lived and played as residents. Formal school time was carefully managed, with the studio operating as a firm – with access provided only during proper business hours. Students typically had evenings and weekends free. Reviews were all scheduled away from our home studio, typically in dramatic spaces found in unique areas around Tokyo. In many ways the three months abroad provided students with a special opportunity to complete a jigsaw puzzle – to slowly but surely put the pieces in place that would make sense of their new home, that would give meaning the their design efforts, and that would add immeasurably to their development as professionals and as people.

LESSONS LEARNED

"The Japanese society approaches much of life with a similar respect for space and a critical eye to efficiency. Take clothing, for example: kimonos are designed to be folded then stored flatly, tightly, and efficiently. The bento box for food is another example where the focus is on space: attention to delivery, designed presentation, concern for aesthetics, and no waste. Cemeteries are another example of high efficiency, effective use of room, and the appreciation for scale, mass, surface, and space. As regards design and space, Japanese culture so often places tremendous value on beautiful functionality, on quality, on keeping, on maintaining, on preserving, on innovating, and on appreciating."
Sinclair, 2015, Cybernetics + Systems

While the present paper conveys many rich and inter-related aspects of an environmental design study abroad venture located Asia, it is the pedagogy and the outcomes that warrant the most attention. In the eyes of the researchers, study abroad is tremendously valuable regardless of individual, major or destination. That said, the particular tactics for the venture described in the present paper stands unique in their aggressive reconsideration and imaginative re-conceptualization of study abroad in light of the peculiarities of Tokyo and the distinctive character of architecture and planning. Attending with resolve to the pursuit and attainment of Japan-ness, in both personal and professional ethos, is vital to the equation. Also foundational is the unswerving subscription to the Japanese notion of *'sogoteki'*, the inclusive, broad and comprehensive approach to teaching and learning. Many of the strategies and much of the posturing presented in the current paper, including the embrace of holism, balance, respect & community, prove relevant and applicable to study abroad more generally, and especially as pertains environmental design education.

CONCLUSIONS | IMPLICATIONS

"Nothing is harder, yet nothing is more necessary, than to speak of certain things whose existence is neither demonstrable nor probable. The very fact that serious and conscientious men treat them as existing things brings them a step closer to existence and to the possibility of being born." Hesse, Glass Bead Game (1972)

Study abroad proves a powerful and dramatic manifestation of teaching and learning within higher education. Taking students out of their zone of comfort, and immersing them in a totally unfamiliar realm, provides unparalleled chances for academic and personal development. With regard to Environmental Design education, few places on earth offer the design and construction potential of Tokyo. A city with a long-standing record of architectural innovation, design creativity and urban courage, Tokyo affords an extraordinary living laboratory for students to hone their skills, sharpen their minds and open their hearts. Deploying pedagogy developed by the first author, and reinforced through the cultural prowess of the second author, this collaborative study abroad initiative proved effective, efficient and meaningful across a spectrum of learning objectives. The deep embrace of '*sogoteki*', or comprehensive problem-solving, was fundamental to the enterprise. A relentless commitment to seek understanding and demonstration of 'Japan-ness', coupled with an appreciation of Gaijin-ness, proved a hallmark of the study abroad venture. From the authors' perspectives minds were expanded, tolerance was fostered, respect was established and education was attained. Clearly and admittedly the work covered in the present paper is exploratory in character, initial in development and provocative in nature. Further research is needed, including methods that measure efficacy and assess impact, in order to advance the place, power and potential of such study abroad, and associated pedagogies, within the landscape of environmental design education.

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Dr. Saba George Shiber: An Early Practice of Critical Regionalism Through the Lens of Arabian Modernity

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ABSTRACT
The discussion of Arabian modernity during the post-war period arose within the process of decolonization, and the reconfiguration of the new Arab metropolis. In the mid-20th century, as the Arab states developed, the Arab region did not only showcase international imported models of modernity; it also exported its own unique concepts of architectural regionalism. Dr. Saba George Shiber's studies of the "Contemporary Arab Metropolis" played a key role in the evolution of architectural regionalism. This paper will review the discourse of architectural regionalism as an ideological and technical implication of the Arab metropolis. To trace the urban and architectural models developed for the Arab region, I will review some of Shiber's written work, discuss his built and proposed projects, and highlight planning tools, including the urban renewal, architectural control, and the study of "Faces of the City."

INTRODUCTION

Following intensive training in the US from 1947 to 1956, Dr. Saba Shiber returned to the Arab region during the peak of Arab nationalism. He left Washington, D.C., his work on housing, rehabilitation slum clearance, and urban renewal to return to his native region and lead Arab professionals in the fields of architecture, planning, engineering, and design (Middle East Business Digest 1963). As a result, he was actively involved in evaluating, critiquing, theorizing, and proposing intellectual methods and technical systems to surmount the technical and cultural challenges facing the contemporary Arab metropolis. The term "Arab metropolis" refers to the citizens, cities, and towns throughout the Arab world that are similar in a practice of urban architecture as a regional and scientific tradition relating to the different environmental, cultural, ecological, economic, and political contexts (Shiber 1970). This approach to urban architecture stemmed from Shiber's personal background, Western training, affection for the ancient Arab civilization stemming from his readings of Ibn Khaldoun (14th century AD), and his exposure to and involvement in post-war architectural theories invested in urban architecture and regional approaches. The notion of displacement deeply influenced his critique of the Arab metropolis; unlike Edward Said (Said 2003), Shiber blamed not only Orientalism, but also local Arab planners' lack of professional training and experience in the fields of design, sociology, and architecture (Shiber 1960). He was actively involved in the remaking of the Arabian[1] urban scene, including present-day Kuwait, Lebanon, Syria, Saudi Arabia, Jordan, and Bahrain. Shiber was also a public intellectual who broadcasted his regional visions and critiques of the urban Arabian scene through regional and international periodicals, conferences, and radio and television appearances. At the International Seminar on City Planning and Urban Social Problems in 1960, he outlined the benefits and drawbacks of the urban plans of each of the Arab states, including Jordan, Kuwait, Saudi Arabia, Lebanon, Cairo, and Syria. He emphasized the urgent need for an industrial revolution in the Arab world to maintain organized urban expansion in contemporary Arab cities (Shiber 1961).

In addition, Shiber encouraged Arab professionals to learn from the earlier achievements of Arab civilizations and the technological advancements of international experts. He intended to prepare professional Arab engineers, planners, architects, and municipal councils for the next boom across the Arab metropolis. Shiber (1960) claimed that, when critically studied, the varieties and resemblances among Arab states would help to advance the future expansion of Arab cities across the Arab metropolis. His work emphasized the significant role of the physical buildup[2] of Arab cities and the development of desert architecture as a critical component of regional architecture. Several decades later after Shiber's life, in 2007, the Danish architect Rem Koolhaas argued that "the Gulf is not just reconfiguring itself; it is reconfiguring the world" (Koolhaas 2010).

The present paper argues that, as the Arab states developed in the mid-20th century, the Gulf region did not only showcase imported international models of modernity; it also exported its own unique ideas of architectural regionalism. Shiber's studies of the "contemporary Arab metropolis" played a key role in the evolution of architectural regionalism. For this reason, I will discuss the concepts of Arabian modernity in the form of the architectural and urban transformation. The socio-political, economic, and natural characteristics of the Arab city generate exceptional urban criteria specific to the Arab region through cycles of urgent and sudden construction booms. Shiber's critiques and recommendations highlight the significance of urban planning, design tools, and professional training in architecture, engineering, sociology, construction, and management. Thus, through the discussion of desert architecture, I will deliver an overview of the Arab metropolis as an early practice of critical regionalism.

WHO IS SABA SHIBER?

In 1924, Saba George Shiber was born in Palestine to a family of engineers, including his father, uncle, and younger brother. Like other Arab professionals of his time, he was trained at the American University in Beirut and at Cairo University as a civil engineer and an architect. During the English colonization of Palestine and the Second World War, the Shiber family was concerned about the lack of Arab training in architecture, especially in Jerusalem, where the training gap was highlighted by the arrival of well-educated Jewish émigrés fleeing Europe (Nasr 2005). Driven by a strong desire for Arab rebirth, the younger Shiber moved to the United States in 1947 to pursue a Master's in Architecture and City Planning at Massachusetts Institute of Technology (MIT). His academic goals exceeded simple personal ambitions. He dreamt of returning to Jerusalem and opening a university to provide young Arabs, particularly Palestinians, an opportunity to pursue an American education and training in architecture and city planning without having to migrate (Nasr 2005). Shiber's MIT master's thesis comprised two design projects: a campus design for Jerusalem University and a detailed architectural design for what he called the Shiber Institute for Training Young Palestinians (Shiber 1962).

Following the loss of Jerusalem in the Arab-Israeli War in March of 1949, Shiber was granted asylum in the US as a Palestinian refugee. He became an American citizen in 1954 (MEBD 1963). While in the US, Shiber's ambitions for the contemporary Arab metropolis continued to evolve. He pursued training in architecture and city planning to better understand the growth of contemporary cities around the world. Between 1948 and 1957, and after earning two master's degrees, Shiber held a wide variety of jobs in the US. He worked as a civil engineer, an architect, and a municipal planner in Kansas City, Missouri; an economic consultant for the New York State Planning Board in Albany; a director of architecture and city-regional planning at Rensselaer Polytechnic Institute in Troy, New York (1949 to 1951); and a research fellow at Cornell University (1951 to 1956). In 1956, he moved to Beirut, where he was appointed the chief of the Technical Bureau of the National Reconstruction Authority, Lebanon. In 1959, he launched a consultancy for urban, architecture, and engineering issues called the Associated Consulting Engineers (ACE). The practice, which mirrored the structure of Dar al-Handasa Consulting Engineers, was the first of its kind in Lebanon and one of the first in the entirety of the Middle East. Both practices were organized according to an Anglo-American model of engineers including architects and town planners (Nasr 2005). In May 1960, upon invitation from the government of the State of Kuwait, Shiber moved to Kuwait to become an assistant chief engineer in charge of the Department of Surveying, Town-Planning, Architecture Design, Agriculture, and Research at the Public Works Department. In 1964, he was also appointed as an expert consultant member of the Technical Committee at the Municipal Council and Development Board at the municipality of Kuwait (Dr. Saba George Shiber Vita, April 1961). Simultaneously, as a planning expert, Shiber was assigned several regional planning missions, such as the planning of Aqaba in Jordan, the planning of al-Karama in Palestine, the planning of Dhahran in Saudi Arabia, and the development of the capital city of the Republic of Rwanda, which he conducted upon invitation from the United Nations.

In December 1963, Shiber was nominated Arab of the Year and featured on the cover of *Middle East Business Digest* because of his active role in not only the fields of architecture, city planning, regional development, and public administration in the Arab world, but also economics, administration, politics, and various Arab affairs. Shiber was the only Arab to have worked in top positions for five Arab governments—Lebanon, the U.A.R. (Syrian province at the time), Saudi Arabia, Jordan, and Kuwait—a feat that he accomplished over a very short period of time and at a young age (MEBD 1963). He also published more than 1000 articles in about 16 English and Arabic newspapers and magazines as well two articles in Japanese newspapers in 1963. His work demonstrated a bold, critical, and constructive character that reflects his design ideology. (MEBD 1963, 46)

1.0 ARABIAN MODERNITY

The American historian Joan Ockman (2014) argued during the early 20th century, modernization was based on the idea of a "culture of experts." This approach originated from the technocratic drive to perfect life, labor, and leisure to optimize the organization of the social environment in the decolonized world. As Avermaete (2014) noted, "modernization was assumed to accompany change and progress, and above all to solve the existing problems of Third World cities and rural areas" (35–36). The "myth of development" and its socio-cultural implications were, thus, associated with the urban transformation models, and the concept of modernization became associated with the notion of "progress" as a cultural means of degrading human values in pursuit of the linear path of development motivated by man-made progress to create a Western utopia (Bianca 2000). Arabian modernity developed along similar notions, with a greater emphasis on the socio-cultural, ethnic, political, and regional characteristics that distinguish the Arab states from the rest of the world as cultural, political, and economic entities. Because of the abundance of financial recourses resulting from oil production and the ensuing development pressures in the Arab region, urban interventions were expressed through the superimposition of new cities against an old urban fabric.

Networks of highway roads, infrastructural services, nation buildings, and capitol cities replaced historical sites and traditional towns (Bianca 2000). Arabian modernity was depicted in the form of social science, including architecture as the process of the industrialization, rationalization, urbanization, and social change of the rising societies.

In the International Seminar on City Planning and Urban Social Problems, Shiber discussed the nature of the urban growth and development of Arab cities through a series of normal industrial drives and other abnormal urbanization shifts resulting from the lack of scientific and rational urbanization responding to local habitats and climates. He described Arabian urbanization as follows:

> The Arab World was subjected to sudden urbanizing forces, and that the Arab World was subject to unique conditions; sociologic, economic, and political. The uniqueness of the situation, and the magnitude of the pressures, have caused many understandable irrationalities to pervade and dominate the Arab urban scene, as it abruptly began to give way from the agrarian craftsman era to the industrial-commercial era of the 20th century. (Shiber 1960, 21)

Moreover, the political tension between the Arab states themselves and their political regimes, the instability of Arabs as individuals and as nations, and the unpredictable external political and economic pressures impacting the Arab world reduced the prospects of rational planning (Shiber 21). Shiber, therefore, outlined his vision for the "contemporary Arab metropolis" by calling for greater socio-cultural, economic, and scientific collaboration among the Arab states to achieve technological independence from Western domination:

> If Kuwait can build the largest sea-water distillation plant in the world, and Saudi Arabia the largest air-conditioned power plant in the world, and Lebanon the most glamorous casino in the world, the Arab World must, and can, master the best brains in the world to study the regional and economic future of the Arab World on a scientific basis. (Shiber 1960, 31)

Shiber's vision seemed exceedingly ambitious at a time when the Arab world was racing toward national identity and the rise of the metropolis as the center of the state. However, he believed that the economic, cultural, social, and industrial capacities of the Arab states, especially the oil-rich Gulf States, could revolutionize and maximize the regional capacities of the contemporary Arab metropolis. This vision stemmed from his readings of Ibn Khaldoun and his emphasis on the Arab ideology and the power of strong cohesion in nomadic societies, or *asabiyya. Asabiyya* fostered strong leadership and group solidarity as essential qualities for building cities and empires (Ibn Khaldoun, 2015). Nomadic tribes bred these strengths to thrive in the harsh environmental conditions of the desert (Shiber 1964). For a metropolis to sustain and grow over time, new social and cultural institutions demand new technical and rational Western administrational and planning methods. The active process of urban transformation and reinvention has been the root of Arabian modernity since the early 20th century, beginning in Cairo, Lebanon, and Bagdad, Iraq. The second wave centered particularly on the Gulf region, stemmed from abundant energy resources and a continuous increase in national income resulting from the Arab oil embargo. This income growth generated increased cultural, economical, and technical interest and investment in the Arab metropolis. Finally, the first decade of the 21st century saw another construction boom and urban reinvention wave, particularly in Dubai and Doha. Thus, Rem Koolhaas (2010) claimed:

> The Gulf is the current frontline of rampant modernization: a feverish production of urban substance, on sites where nomads roamed unmolested only half a century ago... Eventually, the Gulf will reinvent the public and the private: ... the coexistence of many cultures in a new authenticity rather than a Western Modernist default; experiences instead of Experience. (195–195)

Therefore, studying Shiber's mid-20th century urban and architectural designs and proposals is fundamental for comparing and comprehending the development of Arabian architecture and cities, especially now. Shiber's discussion of the Arab metropolis is closely related to the universal concept of temporary spaces or cities, as both focus on environmental aspects like the desert climate, a construction culture, scientific technologies, and design innovations. All of these concepts will be investigated in my Ph.D. dissertation. The remainder of the present paper, however, will focus on the urban design and planning tools developed for the Arab metropolis, beginning with the theoretical discourse of Arabian regionalism, continuing with the concept of physical buildup, and concluding with the development of Architectural control for the urban expansion.

2.0 ARABIAN REGIONALISM

Shiber's design ideology—the contemporary Arab metropolis—and sensitivity to regional architecture evolved from his nostalgia for the loss of Jerusalem, which influenced his Ph.D. project, *Urban Formation and Reformation*, at Cornell from 1953 to 1956. Shiber's research included an urban and architectural survey of several contemporary cities throughout the world, including the Arab cities of Beirut, Sinai, Cairo, and Casablanca and the global metropolises of Boston, Tokyo, Manhattan, Chicago, and Prague. It featured visual and spatial analyses of city environments, vernacular buildings and temples, post-war housing projects, and urban plazas and included more than 650 hand-drawn sketches of different city scenes and 24 aerial photographs of the urban fabric as a whole. Shiber simply gazed at different scenes of urban architecture, trying to understand what constituted a city's character. His intensive visual journey traced what he called "Faces of the City" to stress the criticality of positioning urban relations as a planning tool (Shiber 1962). He referenced the unique designs of houses, mosques, bazaars, and souqs to identify the individual character or "faces" of the traditional Arab city. Because of the critical role of gazing and comprehending a city's urban forms, Shiber continuously published his sketches and descriptions of the urban qualities and forms of cities in local and regional periodicals to emphasize the impact of a built environment on the well-being of its inhabitants (Shiber 1962). Shiber (1961, 5) argued that the city is a physical record of human achievements and a manifestation of the intellectual, technological, and physical power of its inhabitants. However, the boom circumstances of urgent development needs and massive construction processes require unique urban design tools:

> It is in the very nature of urban formation to evolve in time, except in boom circumstances. This time factor presents difficulties in conceptualization not otherwise encountered in short-term pieces of plastic work. Since urban conceptualisation must always stay in dynamic changes necessitated by time, active and multi-dimensional vision is required to attune the changes to a gradual unfolding work of art. (Shiber 1961, 5)

Shiber's urban design ideology was distinguished from those of contemporary architects/urbanists, including Team X, Aldo Rossi, Hassan Fathy, and Mohamed Makiya. Shiber combined the modern design notions of Le Corbusier and Walter Gropius with the ancient works of Ibn Khaldon, forerunners to the principles of city planning. His collective background combined the best of the Occident and the Orient, and this transcendence buttressed his authority and lent credibility to his influence in the Arab region. Drawing from local cultural heritage, Shiber was able to adjust the Western development process to uniquely fit the Arab world. He worked to substitute Western terminologies and ideas with Arabic ones based on Ibn Khaldoun's treatise *The Introduction—al-Muqadema* (Ibn Khaldoun, 2015). Ibn Khaldoun's writings focused on the significant role of the desert climate in advancing Arab culture and civilization. He argued that regional planning is not possible as a universal urban tool for all Arab states, or even for neighboring states, due to differences in their socio-political structure and geo-economic nature (Shiber 1960).

> From the burning sands of Kuwait to the beautiful hills of Jerusalem, to the nonchalant grace of Rabat, the Arab World is one of infinite variety, a social, historic, political, mosaic, avidly searching for a place in the sun. It is a world where nothing is stereotyped, nothing routine, nothing predictable. (Shiber 1960, 25)

Despite the diverse socio-political characters and economic and technical capacities of each Arab state, all share similar climatic and ideological factors shaping their urban formation. Yet, in 1962, the uniquely hot climate of the Arabian Peninsula was not properly considered in determining the architecture and the urban formation of the contemporary Arab city. The dramatic buildup of the desert urban form at the time, particularly in Kuwait and the Eastern provinces of Saudi Arabia, allowed for a "full-scale laboratory in city planning and architectural experimentation" (Shiber 1966, 58). Shiber, thus, emphasized the importance of learning from each urban experiment in the Arab metropolis to develop and sustain a long-tem development plan. There are no clear-cut answers: what applies for an Arab emirate may not apply for Arab republic, and what is applied today may not be applied tomorrow. However, Arabs must develop professional training, technical knowledge, and design skills benefitting from Western experience and design competitions to create planning boards that encourage collaborations between local and international experts (Shiber 1960).

Shiber's regional ideology shares roots with Kenneth Frampton's (1998) definition of "critical regionalism." Instead of resisting universalism, which reduces cultural differences to a single universal civilization, Shiber demanded that Arabs to look closely at contemporary metropolises around the world and develop rational models and systems to overcome the short outcomes of their rooted ideologies. He stressed the importance of importing rational and technological expertise to support the development of the contemporary Arab metropolis as a transcultural practice that integrates rational scientific achievement to develop urban and architectural design solutions suitable for the desert climate. Unlike Frampton (1998), Shiber believed that town planners, whom he saw as the "orchestration of the city," should manage urban planning and architectural projects simultaneously. He described the role and mission of the planner as follows:

> He must lobby, write in papers, talk to groups', caucus with members of parliament, spend time with mayors and "mukhtars,'' design subdivisions for free so that new ideas will be accepted by subdivisions and so on.... All engineers, architects, surveyors, and draftsmen he directs, he must look upon as potential students, and so he must not lose his patience when the politicians press ruthlessly for the production of plans and drawings. (Shiber 1960, 35)

CONCLUSION

Shiber's complex persona, which combined Western expertise, regional compassion, and, most importantly, his identify as an "Arab in Exile" led Shiber to be known as "Mr. Arab Planner." When the *Middle East Business Digest* featured Shiber as Arab of the Year in 1963, it described him as:

> An engineer, architect and town planner by profession but who is, by avocation, an artist, a writer, a rebel and one of the best travelled and informed men of the Arab World who has worked, relentlessly, to make the Arab World a better place. (MEBD 1963, 45)

Shiber's critique of Arabian modernity was delivered from his perspective on Arab nationalism. He was greatly influenced by both Western education and his nostalgia for the Arab Renaissance. His theoretical approach counteracted the vision of his colleague Hassan Fathy, who, a few years later Shiber's discussion of the Arab metropolis, would lead the charge to resist Western technology and methodology and replace them with local and indigenous design methods. Shiber, on the other hand, developed an Arab architectural language that challenged Western models by incorporating their principles to form Arab tectonics inspired by the local environment. His vision for the contemporary Arab metropolis was a response to the rampant demolition of urban historic centers in the name of redevelopment. Hence, he promoted an extreme approach to city evolution by encouraging a fresh start—an "urban reinvention" or "urban renewal"—that he argued would avoid disturbance and discomfort by applying optimized solutions made possible by the use of advanced technology and updated design solutions. This approach was specific to the planning and urban development of the Arab region because of the economic and socio-political configuration of Arab states (Shiber 1961). To create a sense of identity surrounding the new status of the modern, independent Arab city and to overcome the "superficial understanding and application of concepts behind so-called 'modern' architecture," (Shiber 1964) Shiber called for only first-rate architects and planners to be commissioned. To stimulate innovative design solutions, establish well-founded scientific methods for construction, and discover new materials, he called for the creation of professional challenges and competitions. Finally, he developed guidelines for zoning, architectural control, and regional planning to avoid rational two-dimensional planning and to neutralize the power of climate through design and technology (Shiber 1964). In conclusion, Shiber was a planner and visionary. His models and methods of regionalism were anchored in a desire to improve the bureaucratic system and train professional designers, architects, and engineers to organize the progress of Arabian regionalism across the Arab world, based on the notion that planning is the "orchestration of the city."

FOOTNOTES AND REFERENCES

[1] Arabian references the states in the Arabian Peninsula and Levant whose urbanization directly resulted from the revenues from oil productions. Some of these states are the largest oil producers of the world, while others have benefited from financial programs funded by oil income, such as the Kuwait Fund for Arab Economic Development.

[2] Urban Buildup is a term introduced by the planner Saba George Shiber to describe the process of transforming the old Arab medieval towns to a modern metropolis.

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The Health Design Research Innovation Project

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ABSTRACT: The Health Design Research Innovation Project (HDI) is a program of interdisciplinary research and coursework exploring urban health and environments through the processes of human-centered design leading to innovation. Supported by a local foundation, HDI is entering its third year of a four-year pilot and involves collaboration between design research and public health faculty. This work integrates social determinants of health into the consideration of design solutions for housing insecurity and urban living environments. Scale, economics, and resources are factors in the built environment that influence the health of a space, especially in urban settings. The faculty here have developed a research program, including an interdisciplinary course piloted spring 2016, which examines how Health and Design research inform innovative thinking for behavioral health in underserved communities, especially around topics such as eviction, shelter and wraparound services. This program is predicated on the struggle of a society with multifaceted health challenges. These challenges now require knowledge contributions from multiple disciplines (O'Campo 2012). The HDI Program seeks to challenge and train students to meet these new challenges.

KEYWORDS: Health Research, Social Justice Design, Advocacy, Housing Insecurity, Design Research, Culture of Health

INTRODUCTION

The Health Design Innovation Project (HDI) integrates social determinants of health into the consideration of design solutions for housing insecurity and safe-space environments. Scale, economics, and resources are factors in the built environment that influence the health of a space, especially in urban settings. The standing faculty have developed this program to inform new ways of creating actionable research and innovative thinking with regards to housing insecurity. Focused on the effects of housing insecurity on behavioral health in underserved communities, the team works to co-design solutions and tools pertaining to topics such as eviction and wraparound services, with community providers in this area. Complex challenges in the urban environment now rely on inter-professional collaboration for change (O'Campo 2012) and inter-sectoral healthcare approaches (Lindau et al. 2016). To take on the massive challenge of reforming healthcare strategy to address complex health needs, thus creating a Culture of Health, the Robert Wood Johnson Foundation's Culture of Health program calls for an expansion of responsibility uptake, or intersectoral health accountability and subsequent interdisciplinary collaboration to develop and implement comprehensive healthcare strategies (Lavizzo-Mourey 2015). As a group dedicated to this secular, robust vision of health realized through healthcare, the HDI team seeks to co-design with stakeholders in the many social and environmental spaces tangential to physiological and mental health. Accordingly, new players are inaugurated as healthcare professionals mobilized to care for systemic forces which contribute to health.

The HDI endeavor has become a year-round research project with housing insecurity at its center, beginning with the Health and Design Research course. The course guides students through an examination of the relation between the built environment, health, and behavioral health issues, linking these issues to the over-arching theme of housing insecurity. Students gain insight into the complex, multi-directional relationships between health and housing insecurity, and are compelled to form novel conceptualizations of health which contribute to the research and roles of health professionals. HDI faculty have developed a process of design research and thinking paired with a public health perspective which aids students in developing such novel conceptualizations. Social determinants of health and the "Knowledge Transfer" needed for meaningful impact on health were the main frameworks that the course examined as a way to create empathy-based research and solutions around housing insecurity.

The HDI project is marked by four cycles, the iterative phases in each cycle include the Health and Design Research course, funded research continuation, implementation, and examination of idea sustainability. Three student driven research projects have emerged from this cycle. To motivate the development of student ideas to take forward into the funded phase, and eventually implement, is a major course direction. Three groups emerged in the second-year course phase of this design challenge: Map the Gap, Therapeutic Expressions, and Data Linxors. Map the Gap examines the relationship between renters, those that own the properties rented, and community-based organizations as a way of reducing evictions and decreasing the burden of home disrepair. Therapeutic Expressions examined community building in shelters, and different artifacts that could be designed within a shelter to build such community. Data Linxors worked through a solution to link the different types of information that care providers, within the space of housing, need. Each team worked closely with community partners operating in the housing and/or health space. This paper will document and discuss the current outcomes and future directions of these three projects. Additionally, it will examine current thinking on such interdisciplinary nonprofit built environment work and speculate on the ultimate outcomes for those in underserved communities.

1.0 THE BUILT ENVIRONMENT SHAPING CAPACITY, SHAPING QUALITY OF LIFE

> *The motivation to create and sustain real change is a function of three factors. The first of these is dissatisfaction with the current state. This is followed by the articulation of a clear vision that includes a statement of what is possible. Finally, an organization must take the first concrete steps toward achieving the stated vision. (Beckhard 1969) All three factors must be present in order for an organization to overcome its natural resistance to change.* (Chaney Jones 2014)

In our urban built environment, services and care are provided in part through nonprofit organizations that supplement government services and shape the lives and spaces of many underserved residents. Design and the consideration of how to provide these services for those with a lack of housing or housing security often takes a back seat given nonprofits' capacity and resource challenges. Many nonprofits in this space are overwhelmed with demand, and struggle to create change. Their survival is often predicated on their ability to continue to build capacity through raising funds and serving the often overwhelming demand for their services. In part due to the fact that they operate as partners in the social service space (Kapucu 2012), the lack of capacity can be understood in the literature on nonprofit capacity. The projects touch on issues of infrastructure and question how the decisions made in terms of the infrastructure of care can make such care more efficient and more comprehensive. Projects elucidate gaps in these networks of care, and the stakeholders who inhabit those gaps. In addition, the projects seek to strengthen and support the already positive culture evidenced within the community providers' efforts. One example of such reinforcement is the identification of opportunities within the shelter system to create community, and the co-design of tools which leverage that potentiality for community connections.

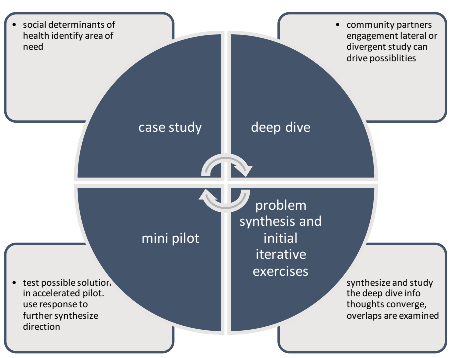
Many of the decisions that can shape the built environment for the better emanate from the research done by public health practitioners. As a practice, public health is "dedicated to fulfilling society's interest in assuring conditions in which people can be healthy" (Abrams et al. 2012). This mission is accomplished by assessing health, developing programs and policies to improve health and reduce disease, and working to assure access to equitable systems of care (Handler, Issel, and Turnock 2001). Historically, public health practitioners and researchers [epidemiologists] understood health to be a function of the places in which people lived and worked. This is illustrated through the well-known example of Dr. John Snow, father of Epidemiology, who mapped cholera deaths in 1854 London and identified a specific water source as the cause of the clustered cases, establishing that contaminated water, not air, was responsible for the deadly outbreak (Snow 1991). Many early public health interventions addressed aspects of the built environment that resulted in disease, for example mandating street cleaning, trash collection and water and sewer systems in cities to prevent cholera and other diarrheal diseases. As a result of these public health measures, these infectious conditions, which were among the most common causes of deaths prior to 1900, were no longer among the top contributors by 1950, replaced by chronic conditions such as heart disease and cancer (Armstrong, Conn, and Pinner 1999). Today mental illness is one of the largest contributors to the global burden of disease through stress (Vigo, Thornicroft, and Atun 2016). In developed nations, chronic diseases and mental illness are most prevalent among the poor (Wilkinson and Marmot 2003); and, the poor's access to sustainable and suitable housing options can drive the population's health in unexplored ways.

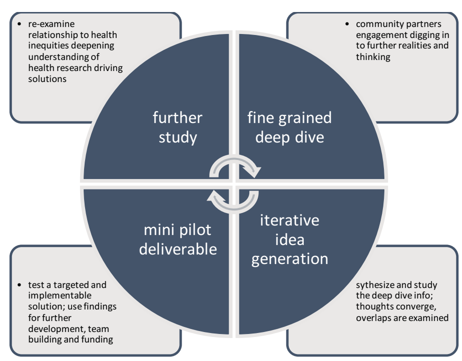
2.0 PUBLIC HEALTH, DESIGN AND INNOVATION

In the 2016/17 HDI project cycle students used both a combination of social determinants of health, and cultural and socio-economic research to understand the problems they were addressing. As stated above, three groups emerged in the second-year process of this design challenge: Map the Gap, Therapeutic Innovations, and Data Linxors. Map the Gap, worked with community providers to examine solutions to the historical tensions between renters and rental owners, as a way of decreasing evictions. This group has received a seed grant from the university's center for neighborhood partnerships and is exploring entrepreneurial support for the tool the team is developing based on its human centered findings. The faculty continues to advise and work with the group as it launches this endeavor. Therapeutic Innovations seeks to work on community building in shelters through design. Working primarily with one community provider, the students connected to one particular shelter in West Philadelphia. This shelter is for single mothers and their children, with a mission to nurture families, strengthen neighborhoods and drive change, and will become a course focus in the next cycle. Data Linxors examined how to link the different types of information that care providers within the space of housing need. The Data Linxors project focused in part on a group of non-profits convened to coordinate multiple services and deliver quality repairs in a more cost-effective manner. Data Linxors is currently under consideration with a larger group of partners. The 2017/18 course and projects are being planned with a focus on shelter projects, and a new community partner, a city organization focusing on those returning from incarceration.

The projects followed a research-driven, human centered process that began with an examination of how social determinants of health influence the lifelong health of urban dwellers. This section will describe a two-phase process each team followed. The goal for the projects was to gain traction, create change and launch a third independently-driven phase. Essentially the two phases described here follow a design research methodology that builds on human centered design methods with public health knowledge and secondary research. Design research methods produce projects that can range from the extremely speculative, to outcomes that have a specific environment, object or service orientation. A 2012 article on this subject defined Design Research as: "a subset of research activity…a kind of empirically-oriented and "applied" approach to knowledge discovery and creation." Ultimately, what defines this novel process is a consistently evolving relationship between processes of design, and processes of research, a type of informed and studied iteration

In the professional realms of design practice, design research can create new understandings of the market or the client. From a manual called the Designer's Guide to Research, "Research frames the problem. It provides context. It helps us get to know the people we're designing for, and the issues we're designing around…." (O'Grady & O'Grady 2017). As it is defined here, the research process allows teams to engage with community providers and community members and truly hear and act on their needs and situations. A variety of techniques are deployed to create overt opportunities in which the teams learn how to integrate and innovate around the needs of these underserved groups. The below listing and chart gives a sense of the paths followed in service to these projects, and expresses the frameworks that the teams used to create their innovative solutions.





Tables 1& 2: Phase 1, course driven development**;**   Phase 2, Research driven development

2.1 Phase one: Course Driven Projects

The projects commenced with a course driven design process as follows:

- Case Study: The course is convened with a case study and multiple formal meetings with community groups to understand their needs. The Social Determinants of Health framework is explored and used to identify an area of need within the boundaries of what each community member has shared.
- Deep dive: Community partners' and students engage, students then commence a study of possibilities that can drive new solutions.
- Problem synthesis: Utilizing their community engagement and initial findings, student teams synthesize a human informed problem statement and initial directions for solutions. They continue to study research data to examine how ideas converge and overlap.

- Mini pilot: The students produce and test possible solutions in an accelerated pilot, using the responses to further synthesize directions for their projects.

2.2 Phase Two: Research Driven Projects:

In the second phase of work, further study is commenced with a series of "anchors' or student leads selected to continue work over the summer. These anchors re-examine the relationships to health inequities and work to deepen their health research driving solutions through the following processes:

- Fine grained deep dive: The teams engage with community partners and cultivate more meaningful relationships with these community partners to gain a more fine-grained level of understanding. In addition, they continue a review of scientific literature. Teams also engage in many more iterative idea generation sessions in a targeted way around their challenges.
- Synthesize and study the deep dive information, thoughts converge, overlaps are examined
- Mini pilot deliverable: The teams then test a novel, targeted, and implementable solution; use findings for further development, team building and funding.

3.0 PROJECTS FOR CHANGE IN THE HOUSING INSECURITY LANDSCAPE

The projects described below were developed in these two phases, over six months and have yielded a variety of outcomes. Project work and research on each is ongoing, and as students rotate out due to graduation or life circumstances, new team members are identified. The hope is to sustain the community relationships, student teams, and design research process in order to maintain continuity and continue to create value and solutions in collaboration with the community partners.

3.1 Data Linxors

Data Linxors was conceived as a tool to mitigate limitations to communication and organization between agencies in the health and housing space. The team's process revealed that each community partner was using their own assessment tool. This had created a complex set of issues around the partnership needed to coordinate the data gathered from assessments to mobilize action. The community groups rely on this data to provide their services; however, sharing data was resource intensive. In seeking to demonstrate the benefit of the partnership anticipated to help scale up the reach of these organizations' individual services and combined capacity, Data Linxors found that streamlining data collection and using the combined information to allocate resources appropriately could possibly improve efficiency and efficacy. Long run outcomes the group hopes to accomplish include: Reduced resource waste; improved organization of resources; less overlap of services, better distribution; better communication; reduced wait times; and, better health outcomes.

The project developed by a three-person student team was designed to creatively resolve the informational conflicts and blind spots between several community providers/partners. The premise of this general research area is to develop a project with a "beginner's mindset," in other words keep an open mind. The student team conducted thorough background research work. The team found examples of other projects designed to link data, explored the needs of the users through informal focus groups and in-depth interviews, and engaged with the community providers in a professional manner. The practice of informed design requires that data or research is used to, in part, decide the direction of a project (Chong, Brandt, and Martin 2010). This is an important part of both design research, and human centered design. In this work, it is important to allow the research and in-person user centered interactions to drive the formulation of the problem, as well as possible solutions (IDEO 2011). The group used informal focus groups, expert interviews, and on-site observations of care providers to create a set of recommendations to better coordinate data collection and use. As the team continued to work towards possible solutions, it identified two main challenges to this work: first, overcoming differing cultures including those between students, faculty, and the community groups; second, all nonprofits are challenged to create any change in the face of their overwhelming need to serve immediately.

> *The continuation of Data Linxors extended the learning experience and developed a possible solution to inter-agency communication. The collaboration between students and community stakeholders made the development of the idea possible. Without interdisciplinary thinking and collaboration, and the cooperation and participation of the community stakeholders, none of the projects developed in this class would have happened. This collaboration, interdisciplinary practice, and introduction of design thinking to students not familiar (to it) make this course a valuable learning experience and give this course the potential to be a valuable asset to the Philadelphia community. Elise Krespan 2017 HDI Student and Project Lead for Data Linxors*

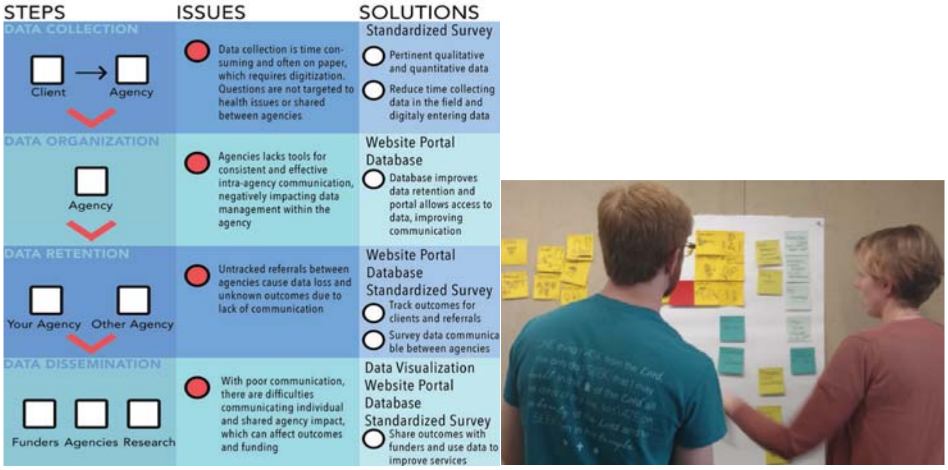


Figure 1 & 2: Initial Research Map Data Linxors & Student team at work (Authors 2018)

3.2 Therapeutic Expressions

The students in this group focused on the multiple definitions of privacy and their unique and practical applications. The team identified what privacy, and a lack thereof, mean to a West Philadelphia shelter and its residents, and elicited the parties' respective perceptions of the space. The group came to this area of study after visiting with local shelters and entering discussions with care providers who served as community partners to the class. They also examined the mental health risks and service needs of minors and young adults (ages 0-18 years) living with one or no parents, and recommended strategies to prevent the developmental delays and major behavioral problems that are associated with overcrowded shelters in Philadelphia, PA. The team wondered, can a sufficient level of privacy for mental health be obtained in crowded conditions? Privacy is a perception ultimately, the team concluded, so many design features may improve privacy without reducing the number of people in a room. The perception may be changed visually with the use of curtains or mirrors or it may be changed on an emotional level by allowing customization and a sense of control within the given space. Thus, many approaches can be used to improve the perception of privacy through the use of design resulting in better aesthetic and public health. The team also identified rules and constraints such as codes, safety and funding regulations which restrict such privacy tools in shelter spaces. Students studied enforcement and perception of the constraints and realized that the perception of what was required differed slightly from the reality. Furthermore, the team worked to understand the social dynamics of the shelter between residents and between residents and staff. The team also worked with the shelter to understand other constraints such as budget and capacity.

The community partner, identified a lack of privacy in its emergency housing for women and children. The conditions of the housing, mediated by perception, may modify the effect of the trauma these women and children have already experienced, and may help to mitigate poor potential mental, physical, and emotional health outcomes. Privacy directly impacts the women's health, resilience to trauma, and their pursuit of future housing with the provider. Also, employees and volunteers are directly affected as they are the implementers, and as such these changes may affect elements of their day-to-day activities. Finally, the surrounding community as a whole may be affected as the provider could better serve more families, and these families could each have a better quality of life and thus build the capacity to positively contribute to their communities. The goals for the project evolved to include an improved perception of the environment among residents. The team developed and presented to the agency leadership several concrete workable solutions for the shared sleeping areas and continues to develop ideas and solutions. The hope is that an improved sense of privacy will directly reduce the frequency and/or duration of anxiety and depression episodes, prevent incidents of aggression (arguments and fights), indirectly improve academic performance in children, and allow for faster transitions to permanent housing.

3.3 Map The Gap

> *As a researcher who pursues human-centered design as a lifestyle, I am constantly trying to live more ethically. This class has afforded me new ethical perspectives (such as my realization of the complexity of stakeholders as comprehensive beings) and has given me the tools through which to bridge theoretical ethics with pragmatism (understanding that it is okay to implement ideas so long as it is understood that they should be iterative and thus constantly reformed to address consequences). Samantha Stein 2017 HDI Student and Project Lead for Map the Gap*

Map the Gap is a decision-guidance tool intended to facilitate inter-sectoral collaboration between tenants, landlords, Community Based Organizations (CBOs), and other resources in order to address a novel, robust picture of health. As a way to map and bridge the gap between individuals and CBOs (which result in chasms in care) while influencing social norms for improved community health outcomes, the student group created an initial decision tree. Although the group has only created a PDF prototype thus far, they plan to produce a digital prototype for use and testing in the university's center for neighborhood partnerships. It is hoped that this prototype will eventually contribute to a smart, multi-level-data-informed digital user interface to provide housing system navigation guidance to residents of an underserved neighborhood nearby. As an endeavor in human-centered design, this decision tree will attend to the community's unique population of stakeholders. An effort in re-envisioned public health promotion, Map the Gap deploys user-centered design to address housing inequity as a constituent of poor health.

The common problem identified by each group member at the beginning of the course was stress related to home disrepair and subsequent health de-prioritization. The phenomenon primarily affects low income families. Due to low socioeconomic status, these families are considered vulnerable. The project is aimed at increasing empathy and thus decreasing tension between renters and rental owners, improving self-efficacy, increasing capacity to repair homes and influence housing policy, and increasing efficiency of interactions with CBOs. This project seeks to examine and engage with questions such as: "How can disadvantaged families prevent home disrepair?"; "What resources are available to promote home maintenance skills among low-income households?"; "What are feasible coping strategies for living in a home with risks to mental and physical health?"; and, "how can a community lacking financial resources leverage local resources to collectively address the implied warranty of habitability to realize safe, healthy homes?" A rental owner has an obligation to maintain habitable (safe, sanitary, and fit) premises. If such an obligation is broken, the tenant may be relieved of his or her obligation to pay part or all of his rent until the necessary repairs are made. The rental owner must be given notice of needed repairs and a reasonable opportunity to make repairs. Rental owners must repair any material defects to a rental property which affect health or safety of the occupants prior to renting and promptly upon notice during the lease. However, in a deprived community with many accidental landlords, such a responsibility is often overly burdensome on rental owners leaving all parties strained; the system itself is sick. Acknowledging this, the team sought creative solutions to inaugurate a healthier system which leverages existing infrastructure.

An initial problem statement for this group was: "Why do tenants deprioritize health in the face of unsafe housing?" Students discovered a concept called the *Bee Sting Theory. Bee Sting Theory* posits that low-income individuals deprioritize housing repair because any one fix is deemed trivial, and all fixes simultaneously are unaffordable. Accordingly, no fixes end up being executed. As a result, individuals stay sick and cannot direct funds to get better (Bennett 2008). The team recognized larger systemic factors that play into de-prioritization, such as a gentrification, housing discrimination, low financial literacy, and social norms ("Understanding Poverty; Is Economic Theory Wrong? - Opposing Viewpoints in Context" 2007). A user centered deep dive was then conducted to understand the perceived responsibilities of community based organizations (CBO) operating in the Mantua area. It was discovered that CBOs perceive one another's responsibilities differently than each CBO perceives its own responsibility, and that gaps in continuity of care exist within the system as a result. The project currently questions the origins of differences in responsibility perception amongst CBO's and ideates on ways to find shared value and align incentives to create a comprehensive, navigable, efficient, and effective care network.

> *At the end of this course, I saw a lot more of the "human" part of the human-centered design [HCD] process. I have been working mostly by myself or with experts on my thesis, so it was refreshing to collaborate with other group partners and multiple stakeholders. It showed me that the "human" part of HCD isn't limited to populations of interest. I found myself being more open to ideas and learning to adapt to others' work styles…we would constantly bounce ideas off of each other. Most importantly, working in a group put a slight pressure to work 110% harder, since others depended on my efforts. I was able to sympathize [with] and understand others' points of view. In all, even though I'm more than familiar with design research, reliving it through the lens of group interaction surprised me…Thanh M. Nguyen HDI Student and Project Lead for Map the Gap*

During the three-month period following the end of the class, the group initially aspired to develop a workshop outline and plan for implementation (a mini-pilot in the following term) to improve renter/rental provider dynamics. The group sought a series of expert interviews and attended a focus group intended to grant insight into the experiences of people living in the Mantua region. Ultimately, however, the group's deep-dive led to further questions and an extensive research process. Although the team ultimately opted to pursue a digital decision-guidance tool rather than a workshop given the need to respect autonomy, cultivate capacity, and attend to limited time-affordances. The digital interface will be continually user-informed and will thus be conscientious and accommodating of what is typically perceived as nuance. The students' work demonstrates an appreciation of the criticality of redesigning healthcare strategy to address the complex, sometimes obscured, underlying social issues which determine the experience of health and the built environment. By leveraging the need for housing system navigation guidance, the project seeks to promote equity, and thus to address health as an experience as a culture which exists beyond individual clinical healthcare. The group seeks to frame housing, and more substantially, equity as key components of a reformed healthcare strategy and constituents of reimagined health.

Initial ideas for expansion of the decision tree developed by the group included the development of a digital interface, potentially a mobile phone application, entitled Map the Gap, which will expand on the idea of collectively addressing cultural tensions, connecting people to resources, and providing highly personalized housing system guidance to Mantua-area residents through an interactive data synthesizer. Although specializing in addressing the local community's needs and navigating city resources, the group would like the resource to be open-source so that the software may be adapted and maintained for use in other cities. It is also imperative to be transparent with users so that they can feel secure knowing how all data inputted will be used, and so that they may assist in the design process beyond the initial deep diving/early development phase. As reducing inequity falls under the category of health promotion, it is applicable to apply the core tenets of healthcare to the project's social health goals, namely continuity of care, autonomy, and sustainability. By applying these core tenets to its healthcare strategy design, the group aims to promote a culture of health, as defined by the Robert Wood Johnson Foundation: "…that everyone has a fair and just opportunity to be healthier. This requires removing obstacles to health such as poverty, discrimination, and their consequences…" ("What Is Health Equity?", 2017). This tool-based solution, as identified by the group through their research, is intended to be accessible to community members at any time. The team has received seed funding through the university's center for neighborhood partnerships and will convene focus groups facilitated in the community center, to gain a better understanding of community digital usage habits and the granularity which informs such habits. During this next community engagement funded cycle, the team will arrange to provide participants with resources and advice from local experts to help address repairs, building trust between the project team and the community. These focus groups will invite community members to co-design an initial prototype which will serve as a proof of concept. While the final digital outcome of the project is yet to be determined, Map the Gap aims to help inaugurate a sustainable, equitable dynamic which constitutes housing as part of a culture of health. Additionally, Map the Gap will continue to seek funding to continue development and piloting of the proposed solution. The team's current seed funding will provide crucial information to inform the next grant application. Today, the team works to promote continuity of care through the cultivation of the digital interface, Map the Gap, which bridges renters, rental owners, and CBOs.

> *Upon doing a stakeholder map in class, I was instantly overwhelmed. People, I realized, are far too complex to be simplified to the labels we so commonly slap on. We are all intertwined, multifaceted stakeholders. And we must be treated as such if we are to thrive as comprehensive, holistic beings. We must be treated as such and treat others as such if we seek universal understanding. Samantha Stein, 2017 HDI Student, Map the Gap Co-lead*

CONCLUSION

The Health Design Innovation Project (HDI) is entering its third year, and the goal to launch these team driven, and human centered projects is coalescing. Developed and supported through such emerging community partnerships, these relationships continue to build in strength as they also grow in efficacy. As aforementioned, scale, economics, and resources are all factors in the built environment that influence the health of a space, and the experiences of the space's inhabitants. Team-driven capacity building is also emerging as a salient topic for exploration. The yearly course and team research is an endeavor that will continue to build on the relationships, and findings to implement these new solutions. This next year the group will focus on two of the community partners with clearly articulated problem statements. The team will also continue to identify partners with a base level of capacity in order to assure they have the resources to work with the students through the initial cycle of the course. Community partners must have sufficient resources to move the proposed solution forward as appropriate, and the group is currently engaged in discussing these possibilities with several community partners. As an advocate for new solutions through human centered design, HDI will continue to explore the themes of capacity building with partners through the projects.

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Advanced Design and Facility Management: Virtual Reality for Healthcare Project

Building Information Modeling and Virtual Reality: Workflows for Design and Facility Management

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ABSTRACT: Building information modeling (BIM) is used throughout a building's lifecycle from design to operations and maintenance (O&M). Virtual reality (VR) can be used for real-time simulation of a user's presence in a 3D interactive environment. Three workflows of BIM based VR were developed and applied towards design review and facility management (FM) for a patient room: (1) cinematic VR; (2) Revit + Unity; and (3) Revit + Fuzor. In the first workflow, a VR film was made with Revit, Maya, Mettle Skybox, Handbrake, Redshift, and After Effects to present the project through an Oculus Rift HMD for a semi-interactive immersive VR experience. In the second workflow, parameter data including the equipment's manufacturer, cost, and website was added to a project file in Revit. The geometry was exported to Unity using Maya as a go-between. The data was extracted from the Revit schedule to a text file. In Unity, the data was parsed based on a unique identifier and linked back to the equipment through C# scripting based on a panel based user interface of Unity. Through customized programming, the outcome was a room in VR where equipment information appeared on canvas panels. The third workflow used Revit, a database of the equipment in Excel, Fuzor, and a customized link written in Python using the Fuzor Application Program Interface (API). Fuzor was chosen as it is a game engine based solution specifically tailored for the building industry. An XML tool was developed to link an Excel sheet to the Revit and Fuzor models. This tool has immediate application potential because the Excel file can be any kind of database in a real project like a maintenance or repair logging schedule.

KEYWORDS: Building Information Modeling (BIM), Virtual Reality (VR), 3D Game Engine, Integrated Facility Management (IFM), Design Review of Healthcare Facility

INTRODUCTION

Virtual Reality (VR). Virtual reality (VR) is a virtual environment generated as a 3d digital model and accessed through multiple hardware platforms including stereoscopic goggles. A viewer's actions in the real world are tracked and reflected into that simulated 3D environment (Brouchoud, 2016). VR offers a visualization method to help people intuitively understand the environment in a fully immersive way (Donalek et al., 2014), with little effort (Arch Virtual, 2014). Although VR's characteristics are usually based on a single user's experiences, recently there has been environments created for collaboration and cooperative tasks (Peters et al., 2016). VR can be used to facilitate users to be more aware of a situation (Endsley, 1995), add interactivity for simulating real world, and enrich media content (Klein and Militello, 2001). Immersive collaboration in VR applications can help achieve a high degree of communication and collaboration among multiple players via text chat, voice communication, and interaction with shared components. There is a match between these VR characteristics and the nature of the architecture, engineering, construction (AEC) industry. Nevertheless, cumbersome headset and isolation from the real world are the two big hurdles in VR to be tackled in the future (Virtual Xperience Inc., 2017).

3D Game Engine. A game engine is a computer game application that includes elements such as 3D rendering, physics, collision, graphical user interface, artificial intelligence, sound, and event management (Eberly, 2007; Fritsch and Kada, 2004). A game engine enables the user to manipulate the virtual environment to achieve real-time control with more advanced software allowing multi-user collaboration. Unity is a commonly used 3D game engine. Its asset store, containing a library of high quality assets (pre-made objects, materials, animation, special effects), reduces development time and cost (Gaudiosi, 2016). Designed for the AEC industry specifically, Fuzor is a game engine allowing VR functionality and bi-directional synchronization with Revit. It provides a Revit add-on to convert the Revit model into a Fuzor model directly. Any change made in the Revit model can be automatically updated to Fuzor model and vice versa. Apart from the model, there is no need to export and import the BIM data of parameter information between the Revit and Fuzor (Kalloc Studios, 2018). The Fuzor API is the internal protocol that can be used for websites and applications to launch, query, and send commands to the Fuzor; this can also be regarded as an expanded user interface for Fuzor (Kalloc Studios, 2018). The REST (Representational State Transfer) API is the API using HTTP requests to get, put, post, and delete data (TechTarget, 2018). Fuzor REST API is one part of the Fuzor API. Although there are limitations in the Fuzor API and difficulty in use of Unity, the use of an existing software program like Unity or Fuzor makes the development of a workflow relatively easier (Du et al., 2018).

Integrated Facility Management (IFM). According to the International Facility Management Association (IFMA), facility management is a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process and technology (Professional Constructor Central, 2012). Integrated facility management (IFM) is essential in the lifespan of a building project because operations and maintenance (O&M) in IFM occupies the longest period. More than 85% of the total cost can be attributed to maintaining the normal working condition of a building (Teicholz, 2004). When as-built drawings are not available, data re-entry may be necessary for facilities managers; fieldwork inefficiency can be improved up to 20% by offering suitable information support (Lee and Akin, 2009). Around 50% of the total task time is accounted by activities related to documentation including finding the appropriate paper work and then reading it (Teicholz, 2004). Both the processes are time consuming because the building operating data is often not digitally associated with the building model; static information including annotated drawings, manuals, and photos have normally been stored in the form of paper documents (Hou and Wang, 2011).

Design Review of Healthcare Facility. Healthcare facilities are specialized spaces with critical consideration for patient safety and comfort. The design needs feedback from clients, architects, engineers, technicians, facility managers, healthcare staff, and even future patients. This can be difficult to accomplish as some of the stakeholders mentioned previously have different skills in interpreting architecture drawings. Yet, still, design review is important (Fu and East, 1999; Shiratuddin, 2009). Healthcare quality including the staff fatigue and effectiveness in delivering care, patient safety, and stress and recovery is strongly related to the physical environment (Ulrich et al., 2004). Creating a better physical environment can be enhanced through experience based design (EBD) for the initial and detailed design reviews in providing better solutions for visualization, information management, and collaboration. EBD improves feedback quality in design reviews. It can help reveal architectural errors, find incompatibilities between an equipment location and other physical constraints, and establish better design solutions in the early project stage. Done digitally (for example in a VR environment), it might be able to reduce costs versus building a full-size mockup of a room, which is a standard practice for expensive and complex rooms. For example, there are certain tasks that can be benefited from EBD: assessing the mobility of equipment and activity limitations of occupants, configuring indoor facilities like patient beds to different forms, and inspecting indoor dimensions. Through simulation, one can also evaluate architectural characteristics for infection control and compare different light sources (Kumar et al., 2011; Dunston et al, 2007).

Integration. BIM enabled FM has been utilized to enhance the communication in a more intuitive presentation by combining the model and data together after supplementing the FM related information in addition to the original BIM database. The addition of a multi-user environment via the game engine has solved the shortcoming of the BIM based VR solution which is lack of the communication (Shi et al., 2016). Another researcher has developed BIM to VR data synchronization with custom programming (Du et al., 2018). Training and design review for healthcare facilities can also be benefited from game engine based VR environment (Kumar et al., 2011). In addition, simulation and training purposes can both be satisfied by a special framework integrating BIM and the game engine (Wu and Kaushik, 2015). Based on the integration of all these elements in the literature review, three workflows using BIM and VR were developed for the main work of this paper, which were cinematic VR, Unity based interactive VR, and Fuzor based interactive VR.

1. WORKFLOW 1: CINEMATIC VR

Autodesk Maya was used as the main platform for integrating all the video ingredients, starting with basic models exported from Revit and ending with a cinematic VR file (Fig. 1).

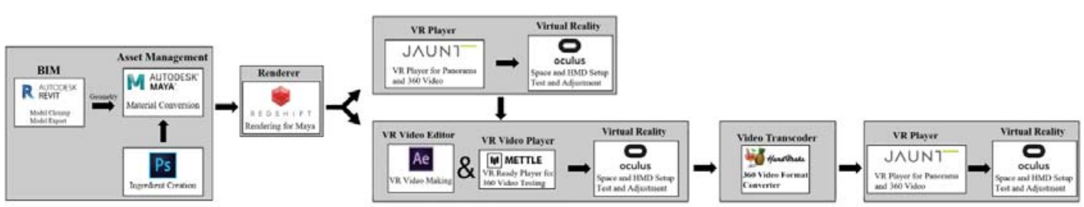
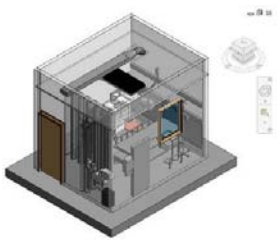
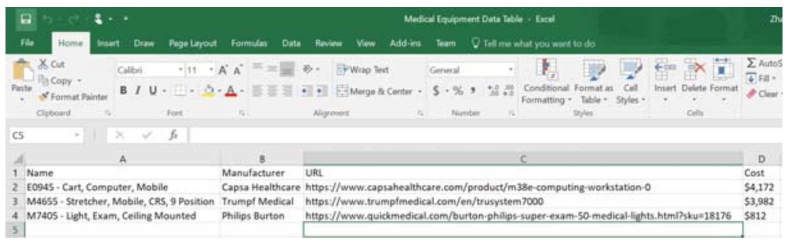


Figure 1: Workflow 1 of cinematic VR

All the information panels were made from Adobe Photoshop (PS). Redshift within Maya was responsible for rendering all the frames, followed by making a linear video from Adobe Effects (AE). AE was used to combine all the frames into a video with another round of rendering. AE was also for creating effects for better transitions between frames. The frame output from Maya could be rendered in either mono or stereo mode, the stereo mode being especially time-consuming for rendering. A single frame was rendered first. The test procedure was conducted via Jaunt Player (shown at the top right corner of the workflow diagram). Mettle, an AE plugin, was used to play the VR video after connecting to the Oculus Rift. It was also used to preview the video from AE before the final AE rendering. Jaunt Player is a standalone VR player and can also be used to play and present the final VR video either through Oculus Rift terminal or computer screen.

A generic model of the patient room from MILSTD1691 was used (Fig. 2). The data in the Excel database was gathered from the Internet for simulating a real application scenario of IFM. Later, this Excel data could be replaced with real IFM related data like a maintenance schedule, replacement list, warranties, O&M manuals, training videos, and change orders that are not standardly within a Revit model. Test data was applied to three pieces of equipment in the research model: Name, Manufacturer, URL, and Cost of the cart, stretcher, and light (Fig. 3).





Name	Manufacturer	URL	Cost
E0945 - Cart, Computer, Mobile	Capsa Healthcare	https://www.capsahealthcare.com/product/m38e-computing-workstation-0	$4,172
M4655 - Stretcher, Mobile, CRS, 9 Position	Trumpf Medical	https://www.trumpfmedical.com/en/trusystem7000	$3,982
M7405 - Light, Exam, Ceiling Mounted	Philips Burton	https://www.quickmedical.com/burton-philips-super-exam-50-medical-lights.html?sku=18176	$812

Figure 2: The modified Revit model of a patient room based on the EPS OOHR Template (Military Standard 1691, 2017)
Figure 3: The Excel database of the three pieces of equipment within the research model

After adding materials, establishing lighting, adding pan and render cameras for key frames, creating additional frames for scene changes, and setting up surrounding environment for viewing, the final footage was rendered. The frames were automatically linearly interpolated within Maya. There was a total of 1400 frames rendered via Redshift, with a resolution of 3840 × 1920 dpi. Adobe After Effects, using Mettle SkyBox VR, was used to composite the whole image sequence and produce the final rendering (Fig. 5). Mettle was also used to preview the VR video before the final rendering process was initiated. After transcoding the final raw video file through HandBrake, the final video was played via Jaunt Player. The information panels for the three pieces of data associated with the objects and the space limitation detected appeared in the final video (Fig. 4). Currently, this type of VR in the form of the linear film cannot achieve real-time interaction.

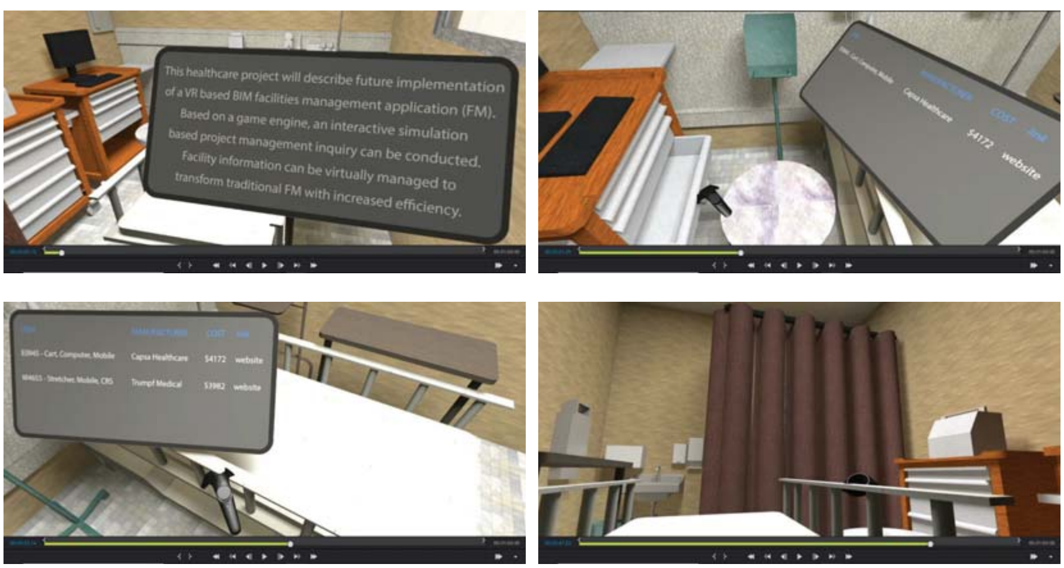


Figure 4: Four example frames of the final VR video played by the Jaunt Player

2. Workflow 2: Unity Based Interactive VR

The Unity based interactive VR environment was created for design review of an architectural space and for data visualization in an environment suitable for IFM (Fig. 5). Both the geometry and data attributes in BIM were exported from Revit to Unity with Maya as the transition tool. VRTK (Virtual Reality Toolkit) and Steam VR were both necessary for this workflow. VRTK was a free tool used to facilitate the VR game development through Unity, allowing the players to play the developed game through a mouse and keyboard without needing the head mounted display (HMD); this can save time and effort in development. Steam VR was used to support the HTC Vive (a type of HMD) connecting to a PC.

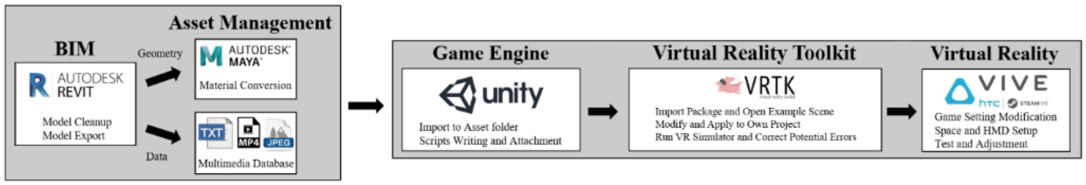
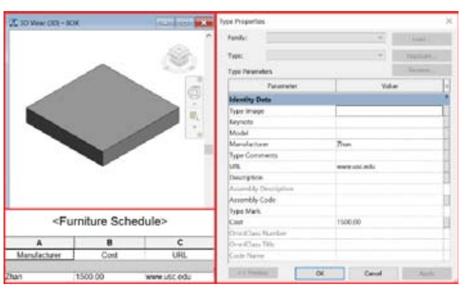


Figure 5: Workflow 2 of Unity based interactive VR

In addition to the geometry, Revit was also used to create a equipment schedule based on the family parameters. The schedule was then assembled into a database stored in the Unity Asset folder. A text file format was selected as the database format with a specific data structure including the semicolon as field delimiter and the quotation mark as text qualifier. A simple box furniture was created first for testing with the three family parameters of Manufacturer, Cost, and URL (Fig.6). Since the entire schedule contained the facility information of more than one piece of equipment and the display for any piece of the equipment should only extract its own specifically related information, the solution was to parse and extract the data from that schedule (Fig. 7). Since the name of each equipment in Revit was repeated twice in the name of the Unity model within the FBX group, the first five numbers were utilized as the unique marker instead of the whole name in the data parsing (Fig. 8).



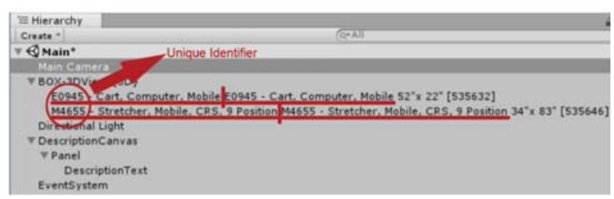


Figure 6: The Autodesk Revit interface showing the sample box furniture model with its type properties (left)
Figure 7: The exported specialty equipment schedule (upper right)
Figure 8: The names of FBX imported model pieces in Unity hierarchy window (lower right)

The VRTK class of C# code was used to convert the mouse input to the VR controller input, which could be “laser pointing” to use object or directly touching the object. Initially, the VR simulator was used to show the final VR environment, which could achieve almost the same effect as that of full VR except for the perception and the presence of the controller model in the scene.

This type of VR model could be used for both design review and O&M. In a complex project like a medical room, problems could be easily detected through VR simulation regarding space layout and utilization. The piece of equipment could be programmed to only perform as it would in a real-world environment with respect to gravity, collision, and movement (e.g. a door or a cabinet might only be able to open in a certain amount in accordance to the technical specifications). This part of the workflow was accomplished for a drawer in a cabinet showing it clashing with a chair when open. This was programmed in Unity, via VRTK SDK. However, the transfer from new Revit parameters (for example, the depth the drawer is physically possible to open) to VR object behaviors could not be easily automated and did not become part of this workflow.

The interactive data visualization for IFM was achieved using a C# script developed to place the data attributes from Revit into the VR environment (Fig. 9). In this script, the inheritance was essential to shift the mouse click control to VR control using VRTK. To be specific, the class of Information_Visualization was inherited from the class of VRTK_InteractableObject so that the behavior of VRTK_InteractableObject class could be reused, extended and modified by the new class of Information_Visualization (Microsoft, 2015).

Figure 9: The C# script for data visualization in VR

In the result, the related data was overlaid on top of the VR screen per laser point or controller touch (Fig. 10).

Figure 10: Sample data visualization in the Unity based interactive VR through HTC Vive

3. Workflow 3: Fuzor Based Interactive VR

In the third workflow, the inherent capability of Fuzor in displaying the Revit parametric information in VR was demonstrated and enhanced (Fig. 11). A tool was developed to automate the integration between the Excel sheet and the Fuzor model instead of using the internal Revit parameters as in the second workflow. This tool has potentially many applications in FM because the Excel file can be changed to an IFM database like a maintenance schedule or repair logging document. The tool is a customized Python script to parse the external data from Excel and execute the Fuzor API to add new parameters to Fuzor.

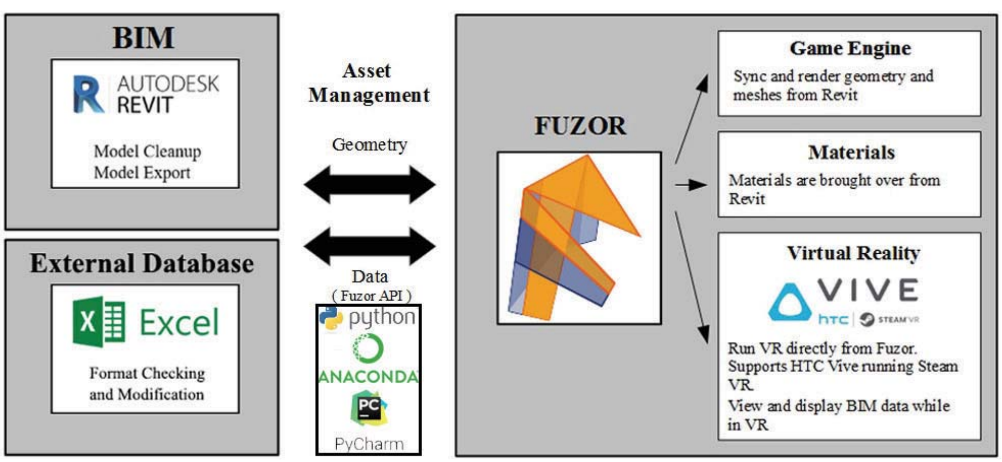


Figure 11: Workflow 3 of Fuzor based interactive VR

In the first test of workflow 3, materials were not yet assigned. Inherent in Fuzor and used with Revit were the following applicable features: any Revit family can be added, deleted, moved, and rotated; property data from the Revit family parameters can be visualized; dimensions can be measured in VR; and any issue can be marked up in VR and saved so that later it can be seen by the other reviewers and modified accordingly (Figs. 12 and 13)

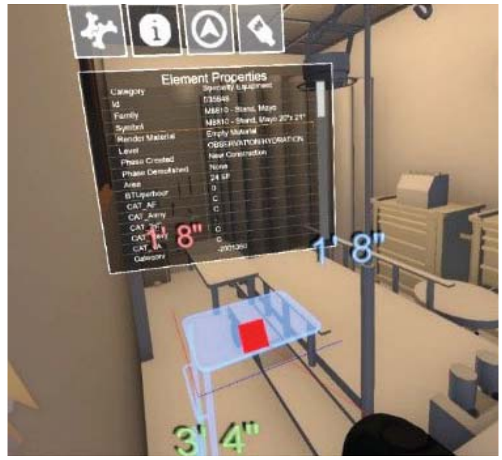


Figure 12: Fuzor VR inherent functionality examples
Figure 13: Close up of the object properties

Expanding the Fuzor's database through connecting to an external data warehouse for IFM involved creating a custom script. The database was the same as the original Excel datasheet with one difference - a new column for the object ID number was added for Fuzor API identification. The structure of the data was critical for parsing via the new script. The parameter label was at the top of each column: Name, Manufacturer, URL, and Cost. The parameter value was the cell value of the Excel whose value was determined by both the value of the first column of ID and the parameter label. Only one pair of the data could be added to Fuzor at a time. One pair of data consisted of a parameter label and its corresponding parameter value for each object identified by its unique identifier which was ID number for this case.

The Fuzor API is XML and Web based. It uses the uniform format of http://localhost:45190/query?parameter_list. One can query data from the Fuzor model using a "query" command (e.g. http://localhost:45190/selected). Another typical action performed is an "execute" where the API will be used to add parameters.

The process included two parts: extracting Excel data and exporting the data to Fuzor using REST calls. First, the object whose parameter was to be updated from the external Excel file was selected, followed by running the first Fuzor REST API. After running, all the information was shown in a new webpage in XML. The object ID was under the line of <name>__fuzor_objectid</name> that was also the first value in that structure. The next step was to run the second API in the format of http://localhost:45190/execute?createcustomparameter=<ObjectID>:<Parameter_Label>:<Parameter_Value>. For instance, if the cost information of that stretcher was the data to be added, the command was http://localhost:45190/execute?createcustomparameter=13931801347516435145:Cost:3982. After execution, the new BIM parameter was added automatically. All the steps were included in a Python script to automate the entire process of parsing key information out of the Excel document, handling the REST calls, and sending the information back to Fuzor in real time (Fig. 14).

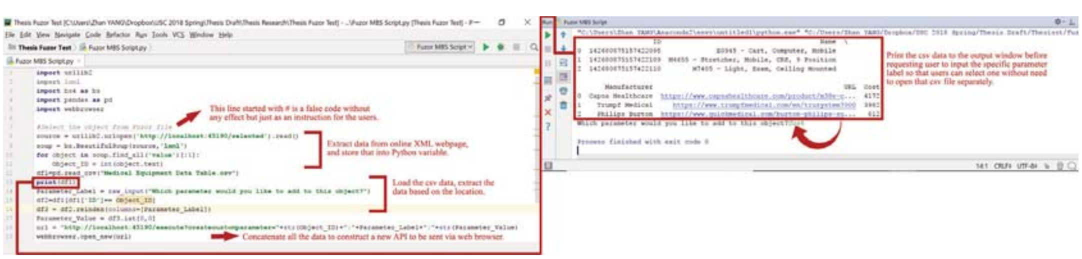


Figure 14: The Python script for automating extracting the Excel data and exporting the extracted data to Fuzor using REST Calls (shown in PyCharm)

The result of adding new parameters is shown in the red block, from which it can be found that the customized BIM parameters can also be added and deleted through the UI manually (Fig. 15). A new window within the yellow boundary is shown after clicking the Annotation button inside the window within the blue block. All the IFM related information can then be typed in (Fig. 16). This includes typical IFM data like the work order category, work description, and deadline. A markup image can be added as a separate attachment. With this information and the essential BIM data added previously, the basic IFM goal can be achieved.

Figure 15: The final result of the workflow 3. The yellow window can contain additional user added data.
Figure 16: Ability to add O&M data

The corresponding O&M scenario can be illustrated as follows. From all the markup images collected inside the Fuzor database folder, problems are identified for the specific equipment or its component. Customized parameters are used to supplement the necessary information for the life cycle of the project, important information for repair or maintenance can be retrieved (e.g. serial numbers, warranty information, and the O&M history of all the components inside the building). Then the work order can be established in the Annotation window, and the status of that work order can be constantly tracked within the Fuzor system until the issue is fixed. This scenario can be realized under the workflow described. If the level of development of the BIM is high enough, Fuzor can be also used as an advanced IFM tool with VR capability, and its model can be served as a living file which owns a precise snapshot of the full space.

DISCUSSION AND CONCLUSION

Three workflows are described for using VR for design review and facilities management: cinematic VR, Unity based interactive VR, and Fuzor based interactive VR. The first workflow creates an immersive experience for the user to comprehensively understand the environment. This workflow requires knowledge and access to many software programs including Autodesk Maya and Jaunt Player. Although no programming is needed, its development is time consuming and work intensive. While the final project provides only an animation path pre-determined for the user, it does allow for some interaction in the form of panoramic views. The lack of full interactivity in the VR environment is a weakness of this workflow.

The second and third workflows can both be used for both design review and facility management. Both workflows utilize a game engine based platform to achieve real-time control and accomplish interactive data visualization of the IFM data based on the existing BIM data. They can be used to transfer the needed information from the Revit model, in this example a patient room in a healthcare facility, to the VR model. Their main differences are the base software used. The Unity-based workflow allows for a high degree of customization and interactivity within the VR environment. However, this involves C# programming and the ability to use VRTK SDK. The third workflow with Fuzor, due to its bi-directional synchronization with Revit and easy access to a VR environment, has many features built-in that makes it easier for implementing a FM solution. However, the Fuzor API currently is relatively limited for developing customized applications.

Virtual reality provides an immersive environment. With additional data, it can also be used for better informed design and facilities management. Building information modeling is widely used in the building industry, and its files can provide both geometry and data. With some scripting, a game engine can be used to bring and link these together. Additional external data can augment original BIM data. Eventually, a complete database can be managed in the VR scene, which can benefit integrated facilities management. The proposed workflows can connect the 3d model and data more closely so that the virtual space can be transformed from a replica of a real project to a living project document suitable for both design and facility management.

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A Model for Public-Private-Academic Partnership: Supporting Climate Planning Imperatives in Cities

A Model for Public-Private-Academic Partnership: Supporting Climate Planning Imperatives in Cities

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ABSTRACT: As cities are pushed to the forefront of global climate leadership, long-range urban design and planning are increasingly urgent, yet municipalities face resource constraints. This paper provides a replicable model for academia to join with practice and local governments to fill this resource gap. This paper examines the case of a public-private-academic partnership (PPAP) formed between GLHN Architects & Engineers; the staff of the City of Tucson, Arizona; and the University of Arizona (UA). Led through an UA upper-level interdisciplinary design studio, the partnership used spatial mapping, quantitative analysis, and design inquiry to create a plan to achieve year 2050 carbon and water neutrality targets without sacrificing either livability or projected growth in downtown Tucson, Arizona. The case study demonstrates that the PPAP model can (1) marshal the necessary resources and expertise toward climate planning when small and medium size cities face resource constraints and (2) prepare the next generation of urban planners and designers with the analytical and design skills to leverage local expertise for climate planning, action, and monitoring. The Tucson model has secured multiyear investment from private and public partners as a result of the phase one work and has won awards for education (Arizona Forward's State Educator Award), design (Arizona AIA State Design Award for Regional and Urban Planning), and leadership (ACSA/AIA National Practice and Leadership Award).

KEYWORDS: Public-Private Partnership, EcoDistrict, Future Cities, Net Zero Energy, Net Zero Water

INTRODUCTION

> We see the withdrawal from the Paris Climate Accord as an abdication of American Leadership and America's mayors will certainly fill that void... This is a local issue that mayors must come together on and we will not shirk our responsibility. : Gregory Stanton, Mayor of Phoenix, Arizona and Chair of the US Conference of Mayors' Environmental Committee, in 2017 upon the announcement that the US pulls out of its commitment to the Paris Climate Accord

In 2017, when the US announced it would pull out of the Paris Climate Accord, over 1,040 US mayors had signed the United States Conference of Mayors' Climate Protection Agreement to reduce greenhouse gas emissions below 1990 levels, in line with the Kyoto Protocol (Rosenzweig 2010, Mayors Climate Protection Center 2017). Urban leadership is critical to advancing the global effort to mitigate climate change. According to the International Energy Agency (IEA), urban areas are responsible for 71% of global energy related carbon emissions and this percentage will grow as urbanization trends continue (Rosenzweig 2010). However, despite the importance of cities in climate change amelioration and the stated commitments by US mayors, studies of urban climate action have found a consistent lack of "financial resources, technical capacity, and staff to develop and implement local climate change policies (Betsill 2010, Bulkeley 2005)." Large cities like Charlotte, Philadelphia, or San Diego have employees and budgets to focus on long term goals for decreased global warming impact. Small and medium size cities, like Tucson and Tulsa, face limited resources to match their aspirational pledge. Small and medium sized cities comprise over 95% of the signatories of the US Conference of Mayors' Climate Protection Agreement. How can expanding, small and medium size city signatories marshal the resources to create, enact, and monitor climate action plans that are uniquely tailored to their physical, social, and economic growth realities? How can academia help fill the resource gap to support climate action within small and medium cities?

In 2017, a public-private-academic partnership (PPAP) was formed to support climate planning, action, and monitoring in Tucson, Arizona, a fast-growing, medium sized desert city near the US border with Mexico. The partnership aimed to address the city's climate commitment to the Kyoto Protocol and Paris Accord by achieving year 2050 carbon and water neutrality targets without sacrificing either livability or projected growth in the downtown. The year-long collaborative project was led by one professor and ten students, sponsored by a local engineering firm, and supported by city and county staffs. Case study research, spatial mapping, quantitative analysis, and design inquiry were used to create three components to address Tucson's climate commitment: (1) district energy, water, and living infrastructure, (2) district land use plan with sustainable building prototypes, and (3) three sub-district master plans with rendered visions.

The broad-based 2050 plan was disseminated through an electronic and printed 240 page book. This partnership produced a pathway and vision incorporated into Tucson's recently ratified Pima County Board of Supervisors' Climate Change Resolution 2017-39 & 2017-51. The Tucson 2050 Plan has secured multiyear investment from private and public partners as a result of the work and has won awards for education (Arizona Forward's State Educator Award), design (Arizona AIA State Design Award for Regional and Urban Planning), and leadership (ACSA/AIA National Practice and Leadership Award).

This paper addresses the question of how academia can help solve the resource gap for climate action planning in small and medium size cities through the case study of the Tucson 2050 Plan and the public-private-academic partnership (PPAP) model. The paper starts with a review of research on the challenges faced by small and medium cities during implementation of climate commitments. Then, the PPAP model is defined within the case study of the Tucson 2050 Plan. Next, the opportunities, challenges, and impact of the PPAP model on (1) municipalities, (2) architectural pedagogy, and (3) architectural practice is discussed. The paper argues that the PPAP model can be successfully used to teach students the tools of climate planning and provide small and medium sized cities with actionable plans to bridge from pledges to tangible implementation.

1.0 CLIMATE LEADERSHIP IN CITIES: EMPOWERED YET RESOURCE LIMITED

> That's what everyone wants to know: Cities have limited resources, so how do you do this?
> :Sandra Ruckstuhl, Sustainable development Solutions Network upon announcement of the United Nations Sustainable Development Goals in 2016

Since the signing of the Kyoto Protocol in 1997, a diverse and deep literature within academia and practice has investigated how climate action can be successfully planned and governed (Betsill 2010). Over the last twenty years, two structures of multi-level governance for climate action have been the focus of these literatures: (1) tiers of multi-level governance, typically differentiating between administrative units (e.g. cities, states, and nations) and (2) networks of multi-level governance formed between actors (e.g. city governments, non-governmental organizations, and private companies) (Liesbet 2003, Meadowcroft 2007). This paper focuses on the later dynamic within the context of small and medium cities.

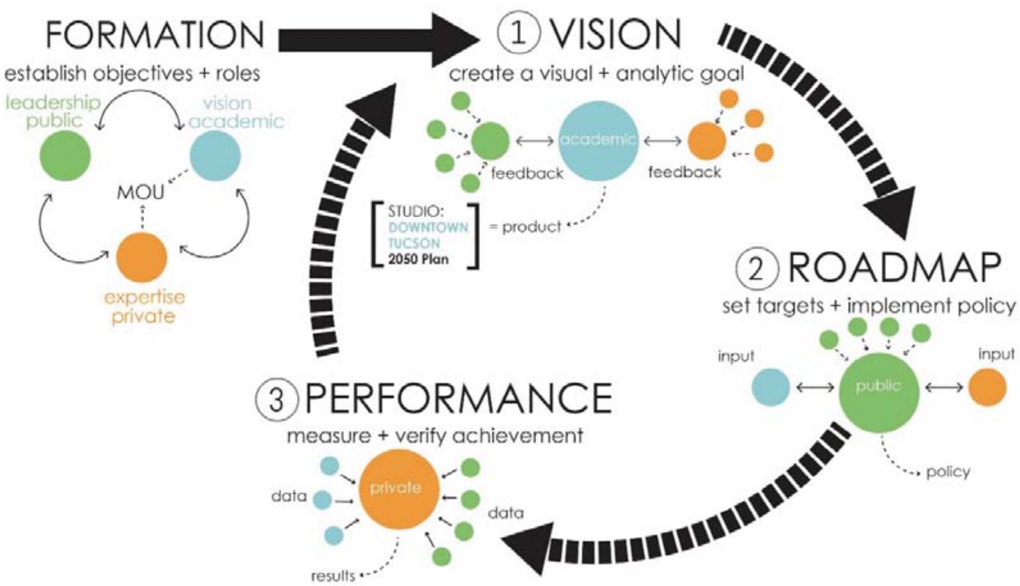


Figure 1: Public-Private-Academic Partnership (PPAP) model. Source: (Author 2017)

A reoccurring finding in the literature on climate action governance is the crucial need to link scientific research and policy practice, particularly in facilitating local climate action (Bulkeley 2013, Betsill 2007, Bulkeley 2005). A lack of resources, particularly in medium and small cities that have ambitions to contribute to climate change mitigation, has been consistently found (Bulkeley 2013). Michele Betsill and Harriett Bulkeley posit that an opportunity exists for academia to help solve the persistent local resource gaps in technical capacity for the development, implementation, and monitoring of local climate action (Betsill 2007). There is a need for private and academic actors to participate in climate policy formulation, implementation, and monitoring if meaningful, long term change is to occur (Bulkeley 2005). This paper presents a model and case study to fill this need, particularly in an architectural pedagogical context.

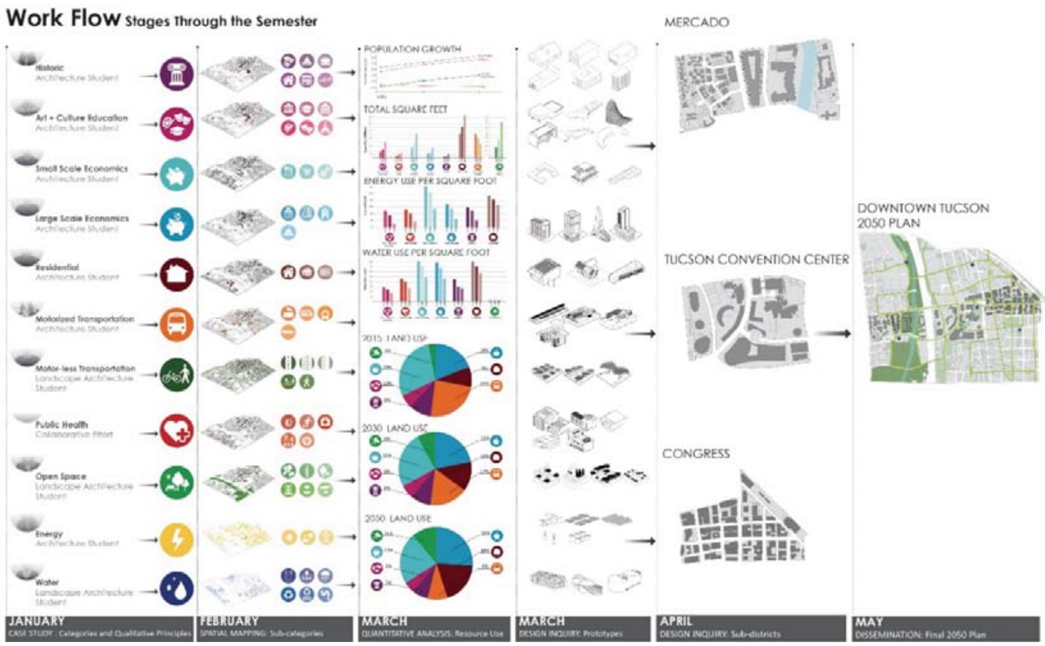


Figure 2: Work stages through the Spring 2017 semester. Source: (Author and Jennifer Braun 2017)

2.0 PUBLIC-PRIVATE-ACADEMIC PARTNERSHIP (PPAP MODEL: LEVERAGING RESOURCES TOWARD A SHARED FUTURE

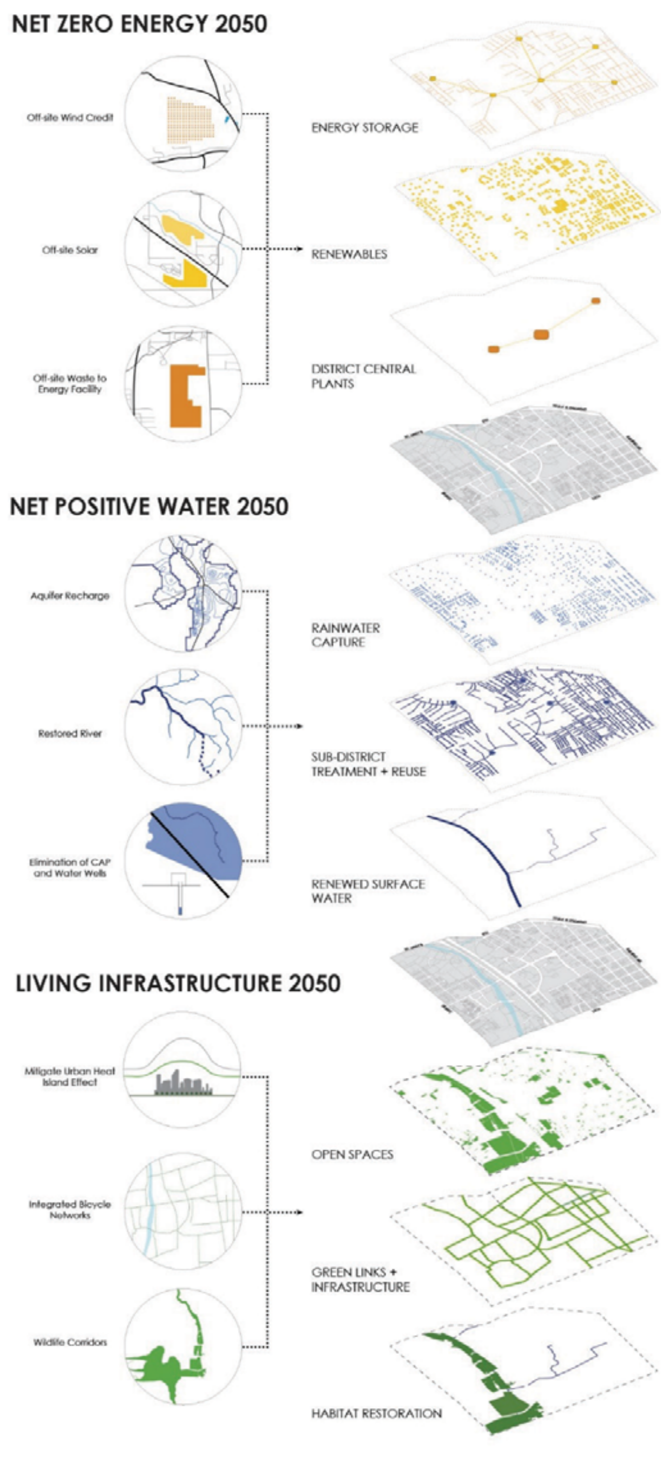
> Academic research potentially plays an important role in facilitating local climate action given the findings that local governments often lack the financial resources, technical capacity, and staff to develop and implement local climate change policies. :Betsill, Michele, and Harriet Bulkeley. "Looking back and thinking ahead: a decade of cities and climate change research." Local environment 12.5 (2007): 447-456.

Public-Private-Academic Partnerships (PPAP) has been broadly proven as a model to support climate planning within several collaboration-based organizations throughout the world. In Europe, the Urban Living Lab (ULL) is a framework for collective urban governance and experimentation to address the sustainability challenges created by urbanization (Voytenko 2016). Similar in purpose and title, the Urban Transition Labs (UTL) currently operates in two European cities as co-creative collaborations between actors and researchers to address sustainable development in cities (Nevens 2013). Within the United States, Metro Lab is a framework under which over two dozen city governments have joining with university partners to focus on the research, development, and deployment of new technologies and approaches to urban challenges (MetroLab 2017). This paper outlines the PPAP model used in the case study of the Tucson 2050 Plan between a state university, architecture and engineering practice, and local government.

To leverage the resources and responsibilities of public, private, and academic entities, the Tucson 2050 Plan codified a model for the long term collaboration (see Figure 1). The replicable PPAP model consists of three phases, each led by the expertise of a different primary partner: (1) vision creation / academic partner, (2) policy roadmap / public partner, and (3) performance verification / private partner. This paper focuses on the case study execution of phase one, vision creation (see Figure 1).

3.0 METHOD: THE CASE OF THE TUCSON 2050 PLAN

The Tucson 2050 Plan was led by one architecture professor at the University of Arizona, sponsored by the local engineering firm of GLHN Architects and Engineers, and supported by City of Tucson and Pima County staff. Phase one occurred over the course of a year, roughly divided into thirds. The project's goals were two-fold: (1) support local City of Tucson and Pima County commitments to climate planning, action, and



monitoring through the PPAP model and (2) equip the next generation of urban designers with a skillset able to address the pressing challenges of their urban environment. To achieve these goals, a framework for the partnership was established through a memorandum of understanding (MOU) with the three entities in the first third of the year. Then, students were taught the methodologies and tools of spatial mapping, quantitative analysis, and design inquiry during a spring semester design studio in the second third. And finally, in the final third of the year, the work was further developed by a paid student intern and disseminated by all three entities to gain wider community buy-in.

3.1 Partnership Planning and Codification: the first third

The first third of the yearlong project planned the course and deliverables and clarified of the roles between the private, public, and academic entities.

1. MOU Formalization: A MOU was signed between partners and established a project budget, roles and responsibilities, and timeline for deliverables. The private partner, GLHN, contributed funding to support the dissemination of the work and the hiring of a research assistant during the summer after the studio offering to support these efforts. City and county staffs, though not officially involved in the MOU, contributed time in all stages for planning meetings, work with students, leading student field trips, formal reviews of student work, arranging and participating in forums for dissemination of work, and letters of support.

3.2. Research and Work Production: the second third

The second third encompassed the majority of the research and work production undertaken by the Tucson 2050 Plan. The effort was orchestrated through an upper level UA multidiscipline studio comprised of ten students (seven Bachelor of Architecture (B. Arch) students and three Master of Landscape Architecture (MLA) students) during the Spring 2017 semester.

Figure 3: Energy, Water and Living Infrastructure overlay for the Downtown Tucson 2050 Plan. Source: (Author

3.2.1. Case Study Research and Qualitative Goal Setting: January

2. Case Study of High Performing Sustainable Cities: Students researched ten cities that had been nationally or internationally identified through public sector awards as a set of best practices for planning for carbon and water neutrality.

3. Case Study Interview and Site Investigation: Austin, Texas was identified as the case study city most closely aligned with Tucson. Students traveled to Austin and interviewed public and private officials on their sustainability plans for the fast-growing city. Students then returned to Tucson and similarly interviewed public and private actors to understand the current attitudes and previous plans. Interviews included the following actors: County Sustainability and Conservation Department, City Planning and Development Services, City Transportation Department, City Energy Manager, City Waste Recovery Manager, Tucson Water, City Historic Preservation Department, and City Archaeologist.
4. Qualitative Goal Setting: Based on the research of case studies and Tucson, students set six livability principles for their future designs: (1) Self-sustaining, (2) Adaptability, (3) Health + Prosperity, (4) Density + Walkability, (5) Community Cohesion, and (6) Connection to Place.

3.2.2. Spatial Mapping: February

5. Category and Sub-Category Codification: Students divided downtown land use into eleven categories and forty-eight subcategories (see Figure 2). Using Geographical Information System (GIS), students created a database of all square footage in downtown and then categorized this current square footage into all forty-eight subcategories.
6. Mapping: Students mapped this divided square footage over the entire downtown. Students researched historic land use and change in land use in the eleven categories from 1775 to 2015.

3.2.3. Quantitative Analysis and Quantitative Goal Setting: March

7. Growth Projection: University planning faculty expert, Arthur Christopher Nelson, was engaged to devise appropriate land use growth projections – determined at 2% (2015-2030) and 3% (2030-2050). With these growth projections, students then allocated appropriate subcategory land use growth for 2030 and 2050, with added growth in categories, such as housing, that currently had a deficit.
8. Resource Demand Projections: Students employed national projected energy (kWh/sf), water (gal/sf), and waste (lb/sf) use intensities for 2030 and 2050 by subcategory to calculate downtown resource demands in the future.
9. Resource Supply Projections: Students used data from local weather stations and climate change projections to calculate potential energy supply through photovoltaics and water supply from rainwater in 2030 and 2050 for the purposes of achieving net zero energy and water by 2050.
10. Quantitative Goal Setting: Based on their quantitative analysis of current and future resources, students set three resource goals for their designs: net zero energy, water, and waste by 2050 with interim 2030 targets.

3.2.4. Design Inquiry: March and April

11. Prototype Design: Students designed building and landscape prototypes as the building blocks of the future 2050 downtown. Each prototype was tagged with the energy, water, and waste projections and cross-cutting design strategies that addressed the set qualitative and quantitative goals.
12. Infrastructure Design: Students envisioned a new set of energy, water, and living infrastructure to achieve net zero, quantitative goals while supporting the six livability, qualitative goals. Ultimately, this infrastructure used an increasingly decentralized network model.
13. Subdistrict Design: Students deployed the prototype designs and integrating infrastructure to further develop details and renderings of three subdistricts within downtown Tucson as test cases for the plan. Large rendering visualizations were one of the products emphasized as a key deliverable by the public and private partners.

3.3. Development and Dissemination: the final third

The last third was completed in the summer of 2017 with a student intern hired through the private partner's sponsorship.

14. Book Finalization and Dissemination: The book, 2050 Downtown Tucson EcoDistrict, was finalized at the end of the course. Students were required to use a uniform InDesign template throughout the semester to submit their work. Two student editors put the book together. The 240 page book was disseminated in physical copy (over 20 copies) and electronic form (since May 2017 the book has been read online over 335 times on Issuu)[1] to wider public, practice, and academic communities.
15. Community Engagement and Presentation for Next Steps: A student intern was hired jointly by GLHN and UA CAPLA to check the calculations and prepare presentation materials. Presentations were made by the PPAP team at local venues (two city and county staff brown bags) and annual international conferences (the Association for Environmental Studies and Sciences (AESS) and the International District Energy Association (IDEA)). Presentation of the material was also made at state and national awards ceremonies (Arizona Forward's Awards Gala, American Institute of Architects (AIA) Arizona Design Awards, and Association for Collegiate Schools of Architecture (ACSA) Conference).

Additionally, the Tucson 2050 Plan work was presented at the 2017 hearings of the Pima County Board of Supervisors' for the ratification of the Climate Change Resolution 2017-39 & 2017-51. Partners in private practice have secured funding for a multi-year investment to offer this studio each year. The next iteration of the PPAP studio is currently being offered during the Spring 2018 semester.

4.0 DISCUSSION: APPLICATION AND RELEVANCE

The goals of the Tucson 2050 Plan were two-fold: (1) support local City of Tucson and Pima County commitments to climate planning, action, and monitoring through the PPAP model and (2) equip the next generation of urban designers with the analytical and design skills to address the pressing challenges of climate change in their future public and private professional roles. This section discusses the success to which these goals were achieved for each partner and where opportunities exist for future improvements. Additionally, contributions to the literature on climate planning and multi-governance structures are outlined.

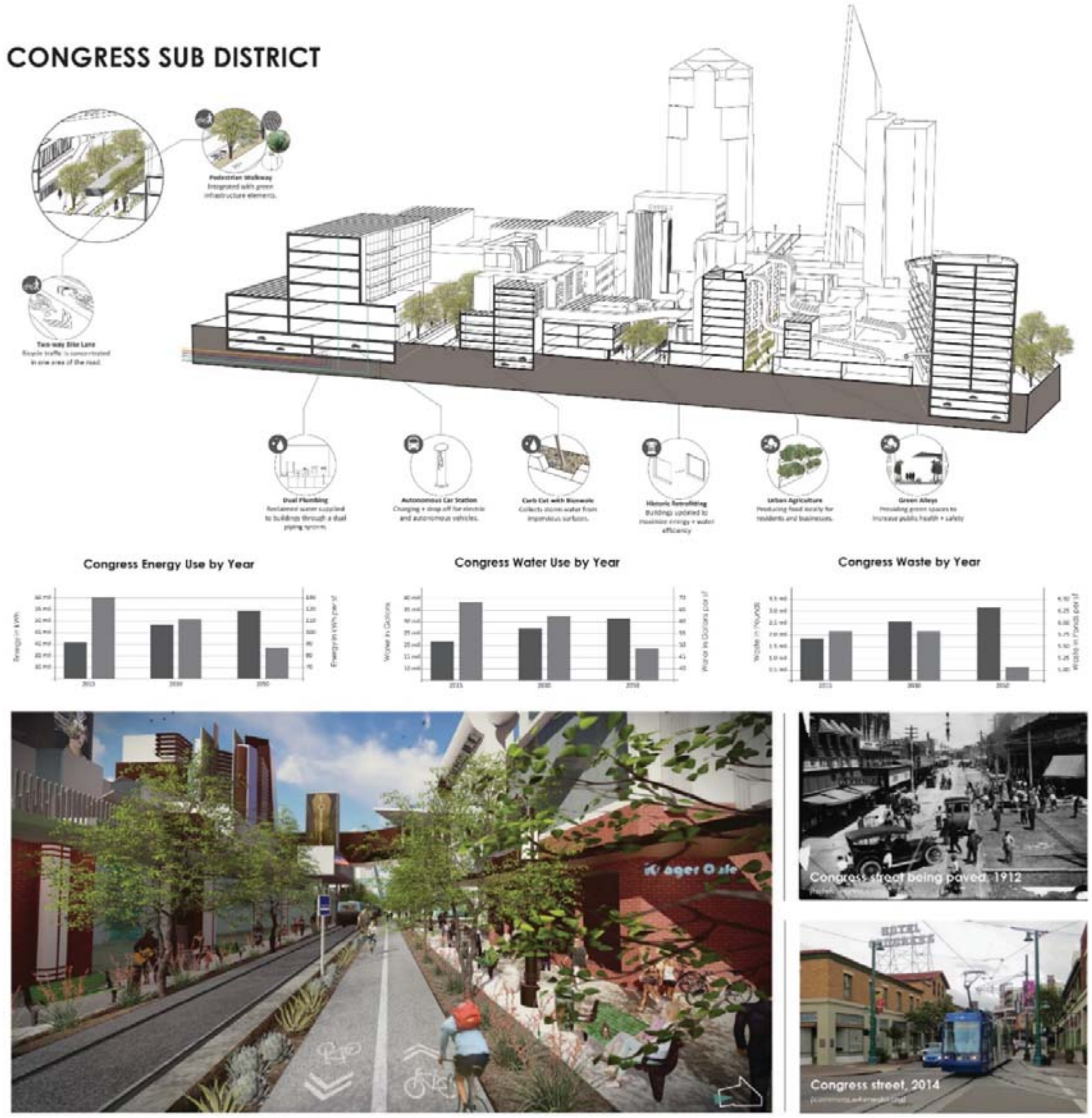


Figure 4: Section and rendering of Congress Sub-District. Source: (Author and Mikayla Krager and Brady Stanton 2017)

4.1 Public Partner: Assessing the PPAP Model for Climate Action Planning

> This collaborative project partnered with academia, private practice, and public government to create a quality product that addressed a critical gap within the city: a long-term, actionable vision for downtown Tucson. In its innovative and ambitious proposition, significant contributions were made… to reach higher sustainability standards and answer the city's call to climate action. : Jason Laros, Energy Manager, City of Tucson, June 2017

The PPAP model successfully leveraged the skills and resources from academia and practice to begin to fill the long term climate planning gap in the Tucson case. Sustainable solutions to climate change require deep buy-in and a broad-base of support throughout a community (Meadowcroft 2007). The PPAP model was able to engage three different sectors of the community to help to lay a broader, foundational support needed by the public sector when enacting climate planning policy. The work was used to support the passage of the County Climate Accord Resolution #20017-39 and 51 the summer following the studio course (Pima County Board of Supervisors 2017). Through partnership of architecture and engineering practice with academic researchers and students, the city and county staffs gained a wider base of support and 'community capital' for climate action policy to be enacted. The challenge of gaining this support continues and is one of the major foci of the next two years of the continued PPAP for the Downtown Tucson 2050 Plan. The planning and visioning undertaken by students helped provoke discussion and in several public discussions students were able to ask difficult questions, often perceived as taboo for professional people representing organizations. As development projects continue to be proposed downtown, the plan's aspirational vision is challenged by the immediate economic desires of today.

The measured impact on the actual carbon emissions of Tucson by the project is yet to be seen. Municipal climate planning projects in other cities have demonstrated significant reduction and public-private co-benefit on multi-year scales. Yet, there remain challenges in accurately assessing the impact of projects and policy against the ever moving baseline and measurement tools of climate change (Bulkeley 2015). The Tucson 2050 Plan will need to better articulate the methods and metrics of evaluation to make a future case for proven success.

Finally, the emerging areas of 'smart' and resilient' cities call for new approaches to the governance of infrastructure and the urban built environment (Nevens 2013). The project's multi-year PPAP will ask more direct questions in the areas of governance of infrastructure to support this emerging dialogue.

4.2 Academic Partner: Assessing the PPAP Model for Training Future Professionals

> The project introduced a new studio typology to develop student's abilities to conduct research and synthesize analysis with architectural design so that the next generation of designers are informed and capable of addressing these environmental issues. : University of Arizona Architecture Undergraduate (B.Arch '18), May 2017
>
> Through the hardest, or most challenging moments, we produced our best work. This multi-disciplinary studio course has given me a glimpse of my future, by preparing me for work in a real firm, where collaboration is key to a successful project. : University of Arizona Architecture Undergraduate (B.Arch '18) , May 2017

The PPAP model introduced students to multiple perspectives and methods of analysis through the diversity of public and private professional contributors. Through modeling the future resource use of Tucson and then formulate solutions, students were taught research skills in case study, spatial mapping, and quantitative analysis in addition to the design inquiry they had previously learned in their architectural education. By engaging a real context and real challenges, students learned to use an array of analytical tools in concert with design tools to devise reality-based solutions that were then critiqued by the actual development partners.

Students gained confidence in their ability to look at current and future resource use within cities and then envision a carbon and water neutral future. In their emerging careers, this skillset will be valuable. By working with city, county, and professional architects and engineers, students understanding of career options with expanded. Students also learned how practice and government can work together toward positive solutions. In the next iteration of the Downtown Tucson 2050 Plan studio this aspect is improved and strengthened. Students are paired directly with city and county staff members for a direct and consistent mentorship through the semester. An internship opportunity the summer following the course will continue to be sponsored.

4.3 Private Partner: Assessing the PPAP Model for Integrating Research and Advocacy

> I am very impressed with [the professor's] ability to lead such a diverse group of students through this process. The ideas, energy, and enthusiasm was everything we had hoped for.
> : Henry Johnstone, President, GLHN Architects and Engineers, Tucson 2050 Plan Sponsor, May 2017

The PPAP model connected architects and engineers in practice with the next generation of professionals to create mentorship opportunities. Students were exposed to multiple streams of current and emerging professional opportunities, beyond the traditional architect in practice model. Conversely, the PPAP allowed professional architects and engineers in practice to step outside of their focused projects and use their expertise toward the benefit of the planning of their future community. The expertise in practice was exploited for a better product and academics were able to share the latest research. Both were able to use their expertise for grounded advocacy to the public. The PPAP model provides a bridge between architectural academia and practice for meaningful dialogue and impact. The future iterations of the project will expand the joint speaking engagements to strengthen this model and widen dissemination.

5.0 CONCLUSION

Cities around the world have increasingly taken on the charge of climate action. Of the 1,040 signatories to the United States Conference of Mayors' Climate Protection Agreement, over 95% are small and medium sized cities. Despite ambitions to contribute to the amelioration of climate change, resource limitation for climate planning and long term planning have been consistently documents for municipalities of this size (Bulkeley 2013, Betsill 2007, Bulkeley 2005). Academia can help fill this resource gap through a Public-Private-Academic Partnership (PPAP) model. The Tucson 2050 Plan is a case study in how one medium sized city created a vision document for 2050 carbon and water neutrality for its downtown with local public, private, and academic partners. This PPAP resulted in unique benefits to each entity. Architecture students gained the analytical and design skills to take on this change through local cooperation in their future careers.

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ENDNOTES

[1] The book can be found through this link: https://issuu.com/home/statistics/publications/451a_fixed_book_final__spreads

Michael OBrien

Parklets, Social Media and Public Health

Parklets, Social Media and Public Health

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ABSTRACT:
The state of public health in America is being significantly eroded by rising rates of Hypertension, Type 2 diabetes, Stroke, Coronary heart disease, and mental illness related consequences of obesity. (CDC Adult Obesity 2017) The small postwar American city is reviewed with emphasis on walkability, food deserts, public health and sedentary lifestyles. Food, both prepared and unprepared as well as social and health screening services, delivered in close proximity (the five minute walk) to ones residence is proposed as an incentive for walking, thus eroding the sedentary lifestyle and mitigating some associated long term health effects. A combination of social movements (parklets), mobile prepared food outlets (food trucks) and social media (Twitter, Facebook) are proposed as enabling elements notifying residents of food or services available, when the food or services will be nearby, and allow for pre-purchasing to insure successful resident's shopping. A network of these parklets is proposed as a public health infrastructure element, much like a municipal water or sewage system. The network insures proximity for residents (five minute walks) and assures vendors of a larger market for their goods and services.

This paper presents a proposal to bring together small public spaces, neighborhood centers, with a social media enabled micro-economy to offer an incentive to sedentary city residents to make a small walk to their neighborhood "parklet" to obtain goods and services. This proposes remodeling the American Suburb. The paper investigates the relationship between the post-war shift from walkable neighborhood designs to auto-oriented neighborhood designs and proposes the pre-WWII approach to walkability, the "Neighborhood Unit" as a part of the solution to the health crisis arising out of sedentary life. This paper focuses on the potential for developing the network of "Parklets" as part of a community's public health infrastructure. The paper will further introduce the role of a social media enabled micro-economy, the state of city codes and regulations impacting "parklets" across the U.S. and prototype designs of temporary and more permanent "parklets".

KEYWORDS: Obesity, Environment, Community, Parklet, Social media

INTRODUCTION

This is the third paper authored on the topic of remodeling the American suburb to encourage walking through the deployment of a mesh network of small public spaces built in a few existing parking spaces. The first paper established the historical recognition of the essential nature of the walkable community by landscape architects and planners such as the Olmstead Brothers, John Nolen, and Arthur Comey who developed prototypes for the suburban landscape featuring centralized "Neighborhood Units" which placed, food, dry goods, and essential community services within a 5-minute walk of the residential areas in the suburb. (OBrien, 2017) The second paper argues for the network of parklets as a public health infrastructure element citing costs, metrics for evaluation, and payback projections. (OBrien 2017)

This third paper will include introductory elements of these two papers and focus upon the site selection and social media interaction with the network of parklets.

1.0 Small Urban Spaces, Parklets, Streatery's and the Popup Plaza

1.1 Parklets Defined

The Oxford English Dictionary defines a "parklet" as "A small seating area or green space created as a public amenity on or alongside a pavement, especially in a former roadside parking space." The curbside park, the "parklet" could become a small-scale neighborhood public place made a few parking spaces along a street. "Parklet's" have been built in cities around the world (Birdsall 2013) as both permanent or temporary public spaces as often happens in annual PARK(ING) Day events around the world. (Greco 2012) As such, "parklets" are a fairly recent phenomena, seen more in major urban areas, but are a "capital-investment-lite" approach to retasking a bit of streetside parking for use by pedestrians. (See Figure 1) The "parklet" is frequently one to two parking spaces that have been flagged off from the street to protect the pedestrians, and decked over to bring the surface elevation to curb elevation, then populated with chairs, tables, planters, sometimes even overhead shade and arbors. The temporary construction of "parklets" have been championed by San Francisco's Rebar Associates "PARK(ing)" day, held world over on the third Friday of September since 2005. Documentation of PARK(ing) day shows the great variation in the design of the 850 "parklets" around the world. (Coombs 2012)

1.2 Streateries

Streateries are the most common version of the parklet, appearing in cities of the pacific northwest. A streatery is effectively a parklet developed for the express purpose of outdoor dining by a coffee shop or restaurant. Spokane, Washington defines a streatery as “up to two parking stalls or a loading zone, as applicable, used either as an extension of, or a stand-alone sidewalk café, connected visually to, and for the use by patrons of, a nearby restaurant or bar and service at which is subject to all the terms and conditions of the nearby restaurant or bar food service permits and alcohol licenses.” (Spokane 2017) Because of the functional and revenue generating nature of a streatery, there seems to be many more streateries than parklets enduring in urban landscapes. Seattle is actively promoting steateries as a means to enhance the vibrancy of its streets. (Seattle 2015)

1.3 Popup Plazas

The popup plaza by comparison is much larger and usually more temporary than the streatery or the parklet. Popup plaza’s may be installed on public rights of way or public property for durations lasting as little as three hours (Boston Globe 2016) to six weeks (Yelp, 2014) in Louisville, KY as a beer garden for a festival. A few popup plaza’s become permanent, Larkin Square in Buffalo, NY is one such example sited on a former gas station, it is now home to food trucks, music, trees and popup shops. (Greco 2012)

Taken as a whole, Parklets, Streateries, and Popup Plazas are all examples of what planners call tactical urbanism, low-capital investment strategies that activate the public realm. But could they do more? Could these “urbanism-light” installations help us be healthier?

2.0 Environment and Public Health

2.1 The Charter for New Urbanism

As early as 1999 The Charter for New Urbanism posited a connection between neighborhood design and sedentary lifestyles. (Leccesse 2000) This was one of the early connections between environment and health, supported by the 1996 Report of the Surgeon General of the United States that found 60% of Americans were not physically active. (Health and Human Services (HHS) 1996)The Surgeon General’s report goes on to list the following as disease and injuries for individuals that could be reduced with modest increases in daily physical activity. (HHS) 1996)

- Cardiovascular Disease,
- Colon Cancer,
- Diabetes,
- Osteoarthritis,
- Osteoporosis,
- Falling,
- Obesity,

The report went on to say “*efforts must be made to encourage physical activity within the course of the day and to create environments in communities, schools, and workplaces that afford maximum opportunity to be active*.” (HHS 1996) At the time of this writing, 2017, the Surgeon General’s call to make the environment a supportive force in the prevention of sedentary related diseases remains largely unheeded.

Without Clarence Perry’s Neighborhood Unit, we have become tied to our automobiles to undertake even the simplest shopping tasks. Perhaps the time has come to re-envision the Neighborhood Unit in a contemporary way.

Recently, temporary pedestrian spaces have been installed in many cities by using streetside parking spaces – already publicly accessible within the street right of way. This eliminates the need to purchase land for the parklet networks allowing its development without purchasing land or making substantial capital improvements. These “micro parks” or ““parklets” offer the potential to reclaim a bit of automobile territory in service of the neighborhood. Part IV of this paper will examine ““parklets” in more detail and consider their role in the delivery of goods and services within an easy walk of most residents.

3.0 Case study: The Candy Hill Neighborhood

3.1 Candy Hill Overview

The Candy Hill Neighborhood is located North of downtown Bryan, Texas. It is chosen as a case study because of its being underserved with food and retail establishments and a history of mobile vendors.(Nash 1996) Candy Hill is bounded by Waco Street on the North, Military Drive on the South, The Bryan City

Cemetery on the West, and the Federal Prison Camp on the East. The neighborhood is approximately 62 acres in area, and while much of its housing was developed in the mid 1970's, it was an established neighborhood in the late 1940's and early 1950's as a segregated housing district for the nearby Army Air base. It is generally flat with scattered street and neighborhood yard trees. The center of this neighborhood is only one mile from the "downtown" area of Bryan, but like many older downtowns, one cannot purchase groceries, or visit a doctor as those functions have long since relocated away from the downtown area. (See Figure 1.)

Figure 1. Candy Hill Neighborhood between the cemetery and prison camp. (Google earth V. 7.1.8.3036, (1/17/2017). Bryan, Texas, USA, 30° 40' 55"N, 96° 21' 96"W, Eye alt 7587 feet)

Median income in the Candy Hill neighborhood is $27,743.00 and 10% of the residents self identify as college educated. Over 70% of the housing in the neighborhood is owner-occupied and 63% of the residents are married. One-quarter of the residents make a commute to work of less than 25 minutes, and 60% of the unmarried population is Male. (Trulia, 2017) While the greater Bryan city area has a higher crime rate than the U.S. average, the Candy Hill Neighborhood reports few instances of criminal activity.

The closest full-service grocery store is approximately 1.5 miles away, and the nearest medical facility is approximately 2.0 miles away.

3.2 Candy Hill in memories.

In the book "Bigmama Didn't Shop at Woolworth's" author Sunny Nash collects memories and anecdotes that document the hopelessness, violence, and insecurity that characterized the culture growing up in the Candy Hill neighborhood in Bryan, Texas in the 1950's and 60's.In her book, Ms. Nash recalls her mother buying ice, vegetables and fish off of trucks that came through the neighborhood; she noted that "Farmers drove their trucks through the neighborhood every week selling seasonal produce" (Nash, 1996)

3.3 Candy Hill; Walkability and Climate

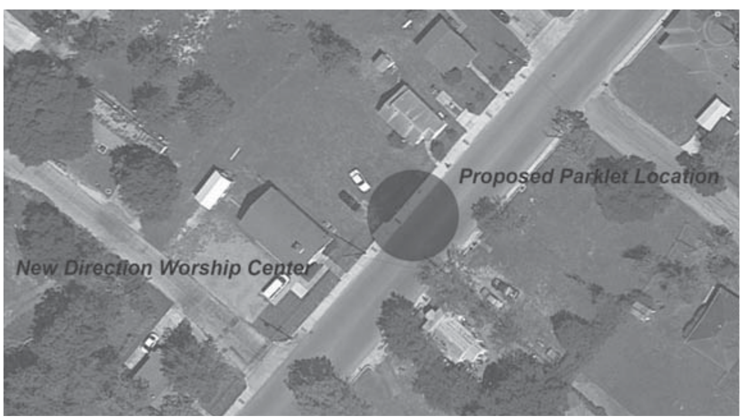
How far will people walk in the Candy Hill neighborhood? In 1929, Clarence Perry proposed 5-minute (quarter mile/.4K) was as far as most people would want to walk for goods and services, and this seems to hold true today as a general rule for planners. (Harris 1998) Recent scholarship (Mehaffy 2015) has been critical of the idea of a neighborhood based on Perry's model because it assumes a school as the center of a ¼ mile service radius, which in turn was based on the average size of the American family, which has changed from Perry's 1929 frame of reference. However, climate may play a larger role in establishing the service radius for the parklet. While Perry formulated that principle in the context of the cities of the Northeast where the weather was mostly walkable, in Bryan, Texas, the 5-minute walk in summer is likely to take place in 80 to 105 degree Fahrenheit (26 to 40 C) and in humidity that might range from 50 to 85% RH.

The United States Environmental Protection Agency lists this combination of temperatures and humidity as "caution" to "danger" of heat-related disorders "with prolonged exposure or strenuous activity." The effect of heat and humidity varies with age, gender and an individual's acclimatization to the exposure. (Coco 2016) In urban plazas, and in walking to and from plazas, we are more concerned with the perception of comfort in people than simple temperature and humidity charts. Mayer and Hoppe (1987) developed a model to measure human comfort that accounted for metabolic, radiative, conductive modes of heat transfer experienced by people. Their model, the Munich Energy-balance Model for Individuals, (MEMI) is the basis for arriving at the Physiological Equivalent Temperature (PET). While studies by show that Japanese residents preferred shaded areas of parks and plazas when temperatures rose above 68 degrees Fahrenheit (20C) (Thorsson 2007) research establishing “comfortable” walking distances at high temperatures, high humidity and low wind-speeds are difficult to find. (Brown 2017) Personal experience (mine) tells me that a home-to-destination distance of 5-minutes, yielding a 10 minute round trip, at typical summer temperatures/humidities/windspeeds will usually result in extreme perspiration, significant enough to become a strong disincentive to walk. (See Figure 2).

Figure 2. The 5-minute walk radius overlaid upon the Candy Hill neighborhood. (Google Earth V 7.3.1.4507. (February 5, 2018). Bryan, Texas, USA. 30° 40’ 53.44”N, 96° 21’ 38.28”W, Eye alt 2915 feet)

Figure 2 shows that a 5-minute walking radius easily encompasses the neighborhood. The next step might be finding a location for our proposed “parklet”. The center of the radius falls on the “New Direction Worship Center” on Martin Luther King Jr. Street. Two parking spaces near the Worship Center would be an ideal site for the “parklet” as there are no businesses nearby that might be concerned about competition and the Worship Center is already a community service type of organization. This possible “parklet” location is also on a low-speed street, 30 mph (48 KpH), and has a public sidewalk adjacent to the street. (See Figure 3)

Figure 3. Possible Candy Hill Parklet location. (Google Earth V 7.3.1.4507. (February 5, 2018). Bryan, Texas, USA. 30° 40’ 55.58”N, 96° 21’ 40.53”W, Eye alt 850 feet)



Drawbacks to the location are the shortage of shade, requiring some shading device or more substantial portable planters, and a nearby driveway that would have to remain unobstructed, but a two-parking space “parklet” would be physically possible on the site and is located near the heart of the neighborhood.

3.4 Siting regulations

At this time, Bryan, Texas has no regulations governing the process, sitting, setbacks, construction or management of "parklets." Many cities across the United States have developed design guidelines and helpful manuals to assist residents in the safely locating, constructing and operating a "parklet." San Francisco, Philadelphia, and Minneapolis are among the major cities with such manuals and regulations but even smaller cities like Bethlehem, Pennsylvania are providing residents support for "parklet" development.

San Francisco has an especially well assembled guide to parklet siting. The criteria for location of the parklet is simple: it must be at least one parking space from the corner, it may be a single or multiple parking space(s) that can be parallel, diagonal, or perpendicular to the curb, parklets should be located on streets having a 5% or less running grade, parklets may not infringe upon accessible (blue) parking spaces or in fire access (red) zones, parklets may not obstruct bus stops or transit stops, must be 48 inches set back from adjacent parking spaces and 12 inches from traffic or bicycle lanes. (San Francisco 2015)

Given restrictions such as these a parklet in the Candy Hill neighborhood, and in the Worship Center area should not cause many problems.

3.5 Parklet Management

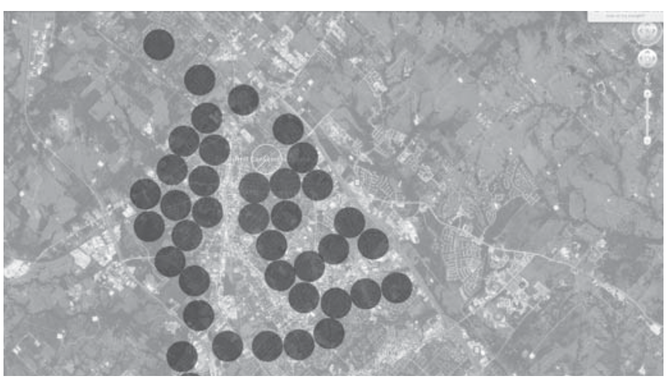
Who owns, operates and looks after a parklet? The city of Los Angeles has very clear guidance on this matter. Any parklet needs to be developed with a "Community Partner" who holds the following responsibilities:

- Seek appropriate licensed professional guidance to finalize plans for submission to the city for approval (may be pro-bono)
- Qualify as a grant recipient for design, construction and maintenance support as available
- Purchase materials and components for the parklet
- Contract with a local licensed and insured contractor for the construction of the parklet
- Maintenance and upkeep of the parklet, plant materials, emptying trash, replacing dead plant materials, keeping the parklet in good repair (free of pests and vermin)
- Secure moveable furniture (if any) between 7 A.M. and 10 P.M.
- Provide and maintain a $1 million dollar General Liability Insurance plan for the parklet
- Maintain ADA accessibility to the parklet
- May not restrict access to the parklet

3.6 The Parklet Network

To be successful in reaching the majority of residents in Bryan, Texas, the "parklet"/popup plazas must be conveniently located within a 5-minute walk of a citizen's domicile. For a city such as Bryan, with its population spread over the approximately 5,000 acres of residential development a series of approximately 39 parklets would service most of the population.

Figure 11. Series of 39 parklets within a 5-minute walking distance service radii, overlaid on the residential districts of the city of Bryan, Texas. (Google Earth V 7.3.1.4507. (February 5, 2018). Bryan, Texas, USA. 30° 39' 52.60"N, 96° 21' 28.05"W, Eye alt 44215 feet)



This network of parklets must have an identity in the neighborhood and in the network of neighborhoods, and must be actively scheduled, with vetted, dependable vendors. (See Figure 11)Parkle

In the case of both “parklet”s and popup plazas, ongoing costs to suburban government might only be the cost of a citywide micro-economic developer, and vendor coordinator, but could also become a “parklet”/popup plaza sponsor itself. First and operating costs should be weighed against the potential economic development impact of creating a mobile vendor industry to service these parklets for year-round dependable availability of goods and services to residents. Assuring this dependability would become the role of an economic developer, not one focused on the next mega development or massive chicken processing plant but one who is charged with devloping the small and micro business community, a “micro-eocnomic-developer.”

The role of the city’s micro-economic developer would be to educate and assist vendors interfacing with health departments and other city/state agencies to obtain the necessary training, permits and inspections to operate their small business. The micro-economic developer, as a vendor advocate, also help vendors interface with financial institutions and the Small Business Administration to find financing, mentorships, and develop business management skills beginning in the local high schools entrepreneurship programs. Local governments could even go farther than mentorship, establishing their own loan/equipment pool program to help bootstrap a new vendor into a tricycle, a pickup truck or food truck or trailer. Local service organizations might be recruited into this effort through their missions or projects for economic development, public health, or community well-being.

Given the number of small businesses, particularly those selling fresh or prepared foods that fail each year, this micro-business approach might allow motivated people who don’t have access to the capital necessary to lease/purchase, equip, train, and then open a small food related business. It may be possible to use some of the “failed” food preparation capacity in the city to make a food business incubator of sorts, similar to a multi-chef performance kitchen seen so often in the media. Such capacity lays idle in many towns like Bryan, equipment in place waiting for the next renter, or in the case of the massive mobile kitchens maintained by relief agencies, the next disaster. These could become the production centers for micro-entreprenuers servicing the parklet network and paying for equipment used on a time or transaction basis.

4.0 Proposed Evaluation tools

4.1 Evaluation overview:

As the proposed mesh networks of parklets would be incrementally developed across the suburban landscape of Bryan, Texas, the case study location for this paper, so too the evaluation process would be implemented to provide an understanding of the preconditions of each site to the planning and transportation departments of Bryan and the people of the neighborhoods.

Since the primary motivation in developing this mesh network of parklets is the health of the people in the suburban landscape of Bryan, evaluation would ideally occur in the following three domains: Public Health, Public Life Quality, and Economic Impact.

The public health evaluation would be developed in a partnership with the The Center for Community Health Development in the School of Public Health at the Texas A&M Health Science Center as this organization regularly conducts the Brazos Valley Health Status Assessment. The Public Life Quality evaluation would be developed from the LA DOT “ People Street” methodology as adapted by the City of Bryan and ideally would be led by personnel from the Departments of Planning and Transportation and the Economic impact would be led by the Research Valley Partnership’s, small business development center; the economic development team allied with Texas A&M, Brazos County, and the cities of Bryan and College Station Texas.

4.2 Case Study in Health Assessment: The Brazos Valley Health Assessment

In the Brazos Valley, home to the case study location of the proposed mesh network of parklets, Bryan Texas the The Center for Community Health Development in the School of Public Health at the Texas A&M Health Science Center conducts a series of community conversations involving over 5,000 residents around the issues of public health on a triennial basis. These conversations form the qualitative dataset for the health assessment while data collected from secondary sources (Census data, Centers for Disease control data, State public health data) to establish the information basis for the health assessment (Center for Community Health).

4.3 Case Study in Parklet Assessment: Los Angeles Department of Transportation (LADOT) “People Street”

In Los Angeles, Parklets, Streateries, and Popup Plazas are promoted and regulated under the "People Streets" program which began in 2013 (LADOT 2013). The "People Street" evaluation process begins upon city and neighborhood approval of a potential parklet site and consists of a:

1. Pre-Installation public life survey, which uses a combination of site observations of types of traffic flows (pedestrian, bicycle, automobile, public transit) broken down by age and gender at multiple times of the day and publicly available data such as number and severity of traffic offenses, criminal offenses, accidents and their severity on the site (pedestrian/vehicle, bicycle/vehicle, pedestrian/bicycle) and sales tax receipts of businesses within the study area.
2. A Pre-Installation Existing conditions report containing an analysis of the above data combined with descriptions of both the proposed parklet site and the boundaries of the study area.
3. A Post-Installation public life survey undertaken using the same combination of observational methods, and publicly available data.
4. A Post-Installation project evaluation report containing the analysis of pre and post installation data as well as description of the parklet site, parklet construction, maintenance records and assessment, and the study area boundary.

5.0 Conclusions

This proposed networks of parklets, distributed across the suburban landscape of Bryan, Texas could impact the public health through increased walking/reduced driving to procure daily food needs. If implemented this parklet network, serviced by a micro economy made up of social media enabled vendors, should result in the reduction of the food desert phenomena as well.

The primary goal is to provide a place to walk to (parklets) and a purpose (food/services) in order to reduce the negative impacts of a sedentary lifestyle on the residents.

Secondary goals include: (1) increased neighborhood cohesion, and (2) developing pathways to business for under-capitalized individuals not able to start up a brick and mortar storefront

It has been over 20 years since the Surgeon General of the United States issued this call for changing the built environment "*efforts must be made to encourage physical activity within the course of the day and to create environments in communities, schools, and workplaces that afford maximum opportunity to be active*." (HHS 1996). Beyond a few upscale New Urbanist communities, the design disciplines have not addressed the issue while voracious developments continue to consume the landscape, placing more and more people farther and farther from the essentials of life, and thus maintaining a dependence on the car, and often eliminating pedestrian paths and walks from developments under the guise of "efficiency".

This proposal, admittedly ambitious, is an effort to show that there are low-capital investment tactics that can be used by design professionals, in partnership with neighborhoods, local governments, and service organizations to begin to turn the tide against sedentary lifestyles that are associated with chronic, expensive, and life debilitating disease.

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Cyber-Innovation in the STEM Classroom

Cyber-innovation in the STEM classroom

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ABSTRACT: This paper presents the formative evaluation of an ongoing NSF-sponsored research project in classroom innovation using augmented reality (AR) to enhance STEM education. It will also discuss the relevance of AR in engineering and architecture research in understanding complex data sets in sustainability. Exposing students to advances in digital modeling, data visualization and performative software is preparing them for new pathways for decision-making in the AEC professions. Recent research shows that Technology Mediated Learning Environments (interacting with computer-based tools) can enhance learning. Augmented Reality (AR) or the ability to augment the real world environment with computer-generated information is bringing a new dimension to learning and designing using multiple data streams. The project objectives were to 1) explore opportunities and obstacles presented by AR in the classroom, 2) look at the impact of various strategies to integrate AR, and 3) contribute to research on how people learn using technology-mediated environments by developing a better understanding of the various attributes of these technologies.

KEYWORDS: cyberlearning, STEM education, virtual and augmented reality, sustainability

INTRODUCTION

Introducing new tools into a familiar environment is always a challenge. Introducing new teaching tools involves working with two distinct groups, instructors and students. Students lack familiarity with any previous models of the teaching environment as the course and the course material are assumed new. General learning theory assumes the critical issue for learners is they actively seek to integrate new knowledge with knowledge already in their cognitive structure (Novak: YEAR). However, introducing cyberlearning tools including augmented reality, mixed reality or any digital device creating an immersive virtual experience is a challenge for both teachers and learners. Recent research shows that Technology Mediated Learning Environments (interacting with computer-based tools) can enhance learning. Augmented Reality (AR) –the ability to augment the real-world environment with computer-generated information, experienced by multiple users in real time– is bringing a new dimension to learning (Kamarainen 2013) Integrating AR with other simulation technologies has the promise of leading the next generation of computer-based learning environments.

Our initial research questions were (1) how would engaging with digital tools impact students' problem-solving skills and collaborative learning interactions, (2) how would interaction with the project change students' understanding of building science principles in their respective disciplines, (3) would using AR enhance the ability of students to successfully transfer the principles they have learned to new situations and (4) what impact could the project approach have on student motivation for further collaborative learning, remain relevant and continue to inform our next steps.

Over the past two years, the University of Arkansas collaborated with Florida International University and Missouri State University on an NSF-Improving Undergraduate STEM Education (IUSE) grant "Collaborative Research: Strategies for Learning: Augmented Reality and Collaborative Problem-Solving for Building Sciences" (NSF #1504898). This project developed a new teaching and learning environment using integrated Building Information Modeling (BIM) with augmented reality (AR) in order to provide three-dimensional, interactive, annotated models of buildings for visual learning. In order to quantify and qualify the influence of AR on student learning, interdisciplinary courses were leveraged between architecture, mechanical, and civil engineering. The faculty collaborated to teach a joint course offered as an elective in all three disciplines on advanced topics in sustainability. The teaching staff believed this was an area with adequate duplication in all three disciplines for meaningful content to be created for a shared course.

This collaboration not only provided a platform for investigating AR in the classroom, but also exposed students to known professional domain affiliations in industry between architecture and engineering. In general, the strength of the architecture discipline is design and performance visualization while engineering focuses on design and performance analysis. Often professional students do not encounter real-world situations in the Architecture, Engineering and Construction (AEC) disciplines until they are in the professional world. Introducing the opportunity for collaboration in a shared setting to them in academia better prepares them to be leaders in their respective fields and advances student success by promoting innovation in teaching and learning in a multi-disciplinary classroom environment (Messadi 2017).

1.0 METHODOLOGY

The multidisciplinary collaboration at the University of Arkansas (UA) was pursued through three coordinated courses and group projects. The other participating schools, Florida International University (FIU) and Missouri State (MS), followed a similar structure. During the spring of 2016, the UA "Control Group" classes participated in the project. These included undergraduate level courses with students from: 1) Architecture (ARCH 303V Advanced Topics in Sustainability taught by Dr. Tahar Messadi, 2) Civil Engineering (CVEG 4863 Sustainability in Civil Engineering, taught by Dr. Andrew Braham) and 3) Mechanical Engineering (MEEG4473 Indoor Environmental Design, taught by Dr. Darin Nutter). The content of courses, testing and implementation process in the "Control Group" at UA, followed a similar path to FIU's Control Group. These courses ran autonomously but included interdisciplinary lectures by the participating faculty, combined with in-class presentations of student research. In addition, guest speakers provided additional insights into the topics examined in class. The courses comprised from 45 students working in teams of 5-6 students with each discipline represented on the team.

In the Fall 2016 semester the three groups of students tested traditional learning tools to understand sustainable concepts in building envelopes, heating and ventilation systems, and structural elements of the an addition to Vol Walker Hall on the UA campus. In Fall 2017 three instructors, one from each respective department continued the grant study by co-teaching a combined course introducing augmented or mixed reality into the student learning process. This was the "Experimental Group."

The UA team used the HoloLens™ a head-mounted display (HMD) with a holographic computer that creates a blended environment where the user can view reality while also "seeing" overlaid holographic data. This allows the user to interact with digital content as part of the real world. Fig. 1 is an example of the way we employed AR (technically also refereed to as 'mixed reality')[1] using the HoloLens to identify heating and ventilation (bright yellow), fire suppression (red), and support elements (dark yellow) in Vol Walker Hall. By overlaying these images on reality, students were able to "see" the different components of the building while standing in the building space. Based on our experimental data our formative evaluation informed

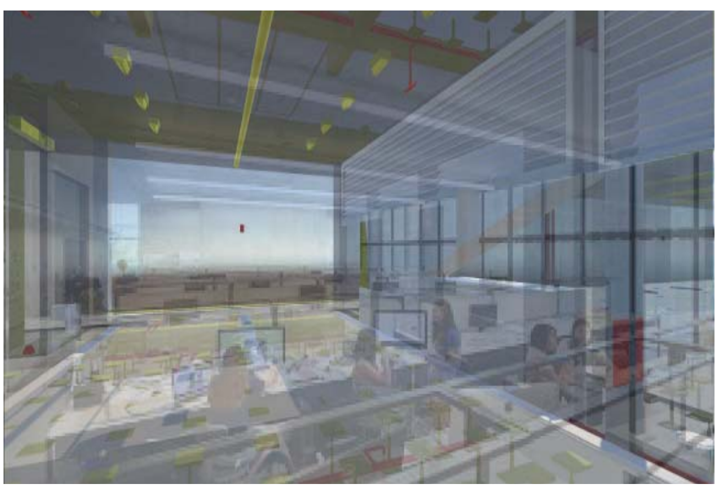

Figure 1: Simulated view using HoloLens showing projection of digital information on top of actual physical space. Source: (Author 2017)

refinements in the approach to the development of content for the HoloLens. Students indicated they became overwhelmed trying to work through too large an area in a building while managing quantitative analysis for three systems; we therefore focused on a single classroom area, a large studio, on the thread flow of the building.

For the content development of the digital information in the HoloLens the team collaborated with the UA TESSERACT Lab using previously generated BIM information from Vol Walker Hall. We anticipate continuing this affiliation moving forward. The summative evaluation of the IUSE-project uses pre- and post-surveys, video of collaborative student interaction and testing to compare control and experimental groups from the 2016 to 2017 semesters to measure the influence of AR on learning.

The FIU team using a similar protocol managed the cyberlearning components employing a different approach to augmented reality, AR-Skope and VR-Skope. The device used was a mobile tablet with software designed to give students just-in-time data and knowledge for building systems related to a specific campus building. Students were expected to go to the building and use the handheld device in situ while they discussing solutions to the problem sets given throughout the semester. Preliminary results of from the control and experimental group for the FIU team are given in this paper. A brief overview of their AR approach is given here and further steps are discussed in the conclusion.

The FIU team included Shahin Vassigh (FIU PI), Ali Mostafavi, Deborah Davis and Albert Elias. Three courses were identified in architecture, construction management and mechanical engineering. Rather than teach a unified course with students registered for the same class, students registered for unique courses, but worked together on three projects. The semester work was divided into three-five week units organized around the 3 units of: 1) Building Siting and Foundation, 2) Building Envelope and Mechanical Systems, and 3) Construction and Post-Occupancy Evaluation (Vassigh 2015). In cases that the content was not a part of the traditional course, it was added with an additional guest lecture, video recordings, or posted materials online. The course structure for the Experimental Group courses was almost identical to the Control Group course work, with the expectation that the Experimental Group of students had access to the project instruments. The Fall 2016 semester did not include AR and was designated the Control Group. The Spring 2017 semester included the AR-Skope software used on a mobile tablet device and was designated the Experimental Group.

2.0 RESULTS

As with our prior work, a formative evaluation and assessment continued centered around observing and understanding the interaction, collaboration and group approaches used when completing the Technical Reports, with a particular focus on improvements across our two experimental groups from Fall 2016 and Spring 2017. A key component of our formative evaluation was on providing just-in-time, constructive and informative feedback to the groups regarding their collaborative efforts, comments on their questions with respect to the Technical Report, as well as timely process-based evaluations. An important aspect involved communicating and enabling subsequent process changes to help improve group interactions and collaborative learning. The following preliminary results are based on responses from the Control and Experimental groups given on a pre- and post- Attitude Survey Questionnaire, Table 1.

Table 1: Survey given to students during the first week of classes and again in the last week of the semester. Source: (Lee 2017)

		Pre-Attitude		Post-Attitude	
Question	N	Mean	SD	Mean	SD
When I work together with others, I achieve more than when I work alone.	264	3.67	1.04	3.12	1.44
I willingly participate in cooperative learning activities.	264	4.09	0.91	3.54	1.44
When I work with other students I achieve more than when I work alone.	264	3.60	1.07	3.06	1.45
Cooperative learning can improve my attitude towards work.	264	3.95	0.91	3.42	1.41
Cooperative learning helps me to socialize more.	264	4.14	0.94	3.62	1.43
Cooperative learning enhances good working relationships among students.	264	4.11	0.88	3.52	1.40
Cooperative learning enhances class participation.	264	4.00	0.93	3.38	1.44
Creativity is facilitated in the group setting.	264	3.89	0.89	3.36	1.44
Group activities make the learning experience easier.	264	3.77	1.03	3.14	1.43
I learn to work with students who are different from me.	264	3.95	0.90	3.59	1.36
I enjoy the material more when I work with other students.	264	3.43	1.01	2.89	1.32
My work is better organized when I am in a group.	264	3.11	1.12	2.77	1.41
I prefer that my teachers use more group activities / assignments.	264	3.34	1.13	2.77	1.48

2.1 Pre-/Post-Attitude Survey on Collaborative Learning

A mixed model repeated measures ANOVA was conducted to compare the effect of Group (*Control Group, Experimental Group 1* and *Experimental Group 2*) and Major (*Architecture, Construction Management and Mechanical Engineering*) (IVs) on Test (Pre-/Posttest course learning and content knowledge) (DV). A main effect of Group was found, $F(2,256) = 7.24$ $p < .01$, $\eta^2_{partial} = .054$ as well as s significant interaction between Group and Test, $F(2,256) = 10.33$ $p < .01$, $\eta^2_{partial} = .075$. Follow up ANOVAs found a significant difference between Groups for the Posttest, $F(2,262) = 3.35$ $p = .04$, $\eta^2_{partial} = .025$, but not the Pretest. Post hoc tests using the Bonferroni correction revealed a significant difference between the *Control Group* (*M* = 4.29, *SD* = .23) and *Experimental Group 2* (*M* = 5.15, *SD* = .18) Posttests (p = .03) (See Figure 2). There was no significant difference between the Posttest of *Experimental Group 2* and the other two groups.

Pretest scores for all three groups were statistically the same, students in *Experimental Group 2* who employed the use of AR performed significantly better on the Posttests than students in the *Control Group,* who did not use any digital tools. This indicates that the use of our digital tools, AR positively impacts and increases on student learning and content knowledge of building science principles. This is important for two reasons. First, it provides evidence that interactive digital VR technologies can improve learning across domains that often need to work together on the same projects, such as Architecture, Construction Management and Mechanical Engineering. Second, the successful implementation of our AR application demonstrates that these technologies can further provide additional content that otherwise might be more difficult and time consuming to provide without this type of tool.

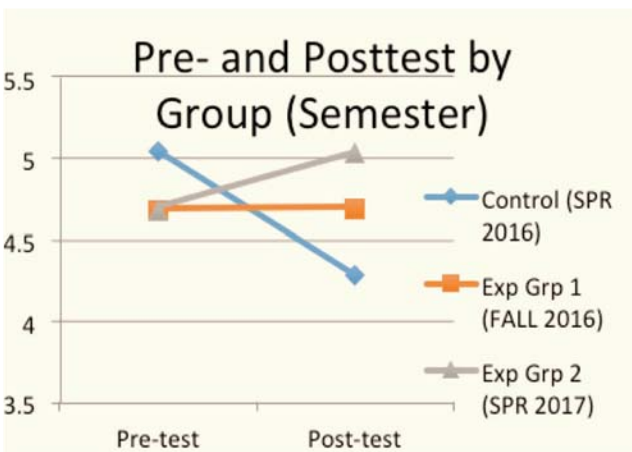

Figure 2: Content Knowledge Pre- and Posttest Scores by Group (Control Group, Experimental Group 1, Experimental Group 2) over actual physical space. Source: (Lee 2017)

Students in all three groups were also administered Pre- and Post-Attitude Surveys on their views of collaborative learning. Although engagement in collaborative learning was a focus of the formative assessment process, we were also interested in investigating whether use of the technologies in combination with formative collaborative learning approaches would impact student attitudes towards and motivation for engaging in further collaborative learning. This is of particular interest in this project as it involved students from three different domains where, some would argue, collaboration would be more difficult as a result of the need for collaboration across these divergent domains.

For all three groups, Pre-Attitude surveys were administered at the beginning of the semester, prior to the commencement of any group work. Post-Attitude surveys were administered at the end of the semester, once all group projects were completed. The survey consisted of 13 questions using a 5-point Likert scale, where responses ranged from Strongly Disagree to Strongly Agree. An overall score was calculated for each participant by converting the response for each question to an integer ranging from 1-5, and adding together the individual scores from each question. [2]

Overall, results indicate that students in all three groups indicated a decrease in their attitude towards collaborative learning from the Pre-Attitude (*M* = 48.57, *SD* =0.66) to Post-Attitude (*M* = 40.24, *SD* = 1.08) surveys. As can be seen in Table 1, this pattern is consistent across each of the questions of the survey. This finding is not surprising given the cross-domain nature of our study, but it also does not tell the whole story.

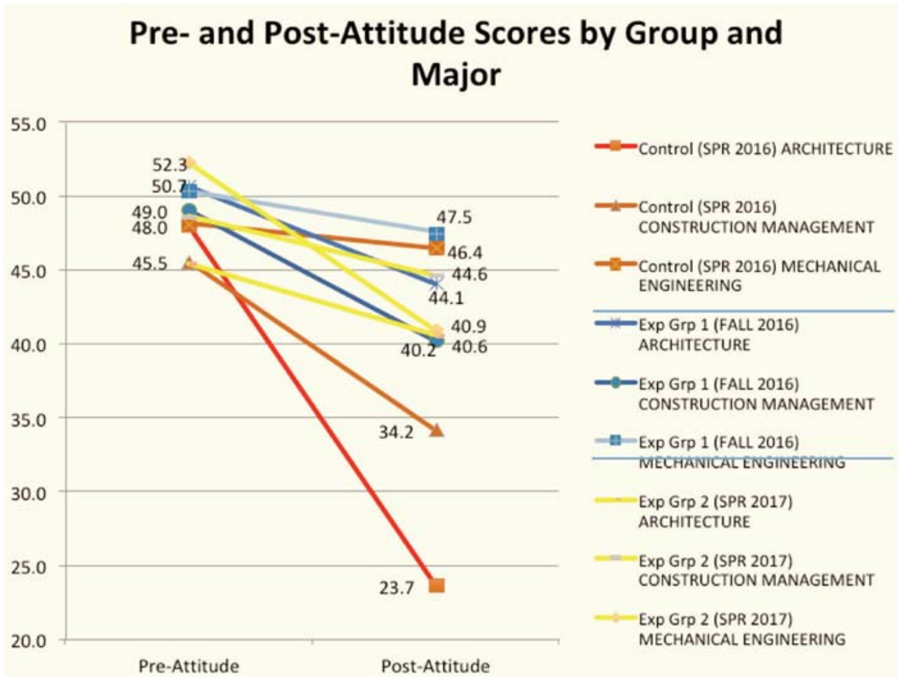

Figure 3: Collaborative Learning Attitude Pre- and Posttest Scores by Group (Control Group, Experimental Group 1, Experimental Group 2) and Major (Architecture, Construction Management and Mechanical Engineering). Source: (Davis 2017)

To better understand the formative influences on participants' attitudes, the significant interactions discussed above found should be explored more closely. Follow up ANOVAs found significant differences for the Posttest between Groups, F (2,255) = 5.71 p = .004, η2partial = .043, and Major, F (2,255) = 6.05 p = .003, η2partial = .045, and a significant interaction between Group and Major, F (4,255) = 5.02 p = .001, η2partial = .073. There were no significant differences found for the Pretest. Post hoc tests using the Least Significant Difference revealed difference between the Control Group (M = 34.77, SD = 2.21) and both Experimental Group 1 (M =43.91, SD = 1.66) Posttests (p = .01) and Experimental Group 2 (M = 42.03, SD = 1.70) Posttests (p = .011). A significant difference for Posttests was found between the Mechanical Engineering Majors (M = 44.95, SD = 1.60) and both Architecture Majors (M =36.10, SD = 2.10) (p = .001) and Construction Management Majors (M = 39.66, SD = 1.89) (p = .03) (See Figure 3). No significant difference was found between Architecture and Construction Management Majors. As can be seen in Figure 3, Architecture and Construction Management Majors in our Control Group had the steepest decreases in their attitudes toward collaborative learning (Lee 2015). As this was our first semester implementing collaborative learning, our formative assessments and improvements in subsequent semesters does appear to have had a mitigating impact on attitudes towards collaborative learning in subsequent semesters. Thus, although in *Experimental Group 1* and *Experimental Group 2* a decrease from Pre- to Post-Collaborative Learning Attitudes is present, the decrease is not nearly as marked as with the *Control Group*.

CONCLUSIONS

Based on our statistical analysis of preliminary results we are hopeful, but cautious about the value of cyberlearning in the STEM classroom. Results are not consistent and may reflect cultural differences across the majors participating in the study or other factors including the impact of the initial learning process with the technology, the ease of use of the AR technology offered in the FIU experimental group, or the overall organization of the course requiring students meet additional time outside of class to complete the collaborative assignments. There are various factors potentially impacting the attitudes of students in the project. The UA faculty completed the Experimental Group course in Fall 2017 and will be able to compare their results to the FIU study. We anticipate some variation in outcomes due to the differences in technology.

Designing learning models is a dynamic interaction between instructors, subject matter, and students. Adding cyberlearning tools, in our case a digital tablet giving students just-in-time access to critical data or knowledge, complicates the evaluation of results twofold. However, based on a faculty de-brief and indicators of productivity for the university such as publications and reports, there are several collateral benefits worth mentioning. First, faculty developed curriculum across departmental boundaries. This was significant for developing new courses, especially elective courses as second; giving students in the AEC disciplines the opportunity to work together during their university experience prior to their professional life is an important strategy for educating professionals able to navigate complex real-world problems. Third, differences in discipline approaches to similar problems helped faculty in the respective disciplines identify areas of improvement for courses specific to their disciplinary curriculum. For example, engineering students had more difficulty reading plans, elevations and sections whereas architecture students were not familiar with useful software for building performance analysis. And finally, faculty productivity was affected as the study supported numerous publications, proceedings, and grant applications disseminating findings over a wider array of journals and publications. Faculty published in journals typically outside of their sphere of influence as results pertained to students and classes in multiple disciplines.

It is our intention to continue to pursue this line of questioning regarding the value of cyberlearning in the STEM classroom. Our initial research questions collaborative learning and technology integration in the classroom remain relevant and continue to inform our next steps.

ACKNOWLEDGEMENTS

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ENDNOTES

[1] Mixed reality is a general term used to indicate the use of a (typically) digital device creating a virtual or simulated representation of either 2-d or 3-d information. Augmented reality indicated the user is aware of both a real-world condition and a virtual one at the same time. For example, a museum visitor using headphones while viewing an exhibit is augmenting their experience, hence it is an augmented reality.

[2] A mixed model repeated measures ANOVA was conducted to compare the effect of Group (*Control Group*, *Experimental Group 1* and *Experimental Group 2*) and Major (Architecture, Construction Management and Mechanical Engineering) (IVs) on Test (Pre-/Post-Collaborative Learning Attitude Score) (DV). Main effects of Test, $F(1,255) = 61.24$ $p < .01$, $\eta^2_{partial} = .194$, Group, $F(2,255) = 5.43$ $p = .005$, $\eta^2_{partial} = .041$, and Major, $F(2,255) = 5.79$ $p = .003$, $\eta^2_{partial} = .043$, were found. Significant interactions were found between Test and Major, $F(2,255) = 3.24$ $p = .04$, $\eta^2_{partial} = .023$, and Test, Major and Semester, $F(4,255) = 6.43$ $p < .001$, $\eta^2_{partial} = .092$, along with Semester and Major, $F(4,255) = 2.53$ $p = .04$, $\eta^2_{partial} = .038$.

Tom Collins

EQuALS – Environmental Quality in Active Learning Spaces

EQuALS – Environmental quality in active learning spaces

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ABSTRACT: The past 25 years has seen the emergence of active learning classrooms on higher education campuses. The goals of these spaces are to: improve student learning outcomes; change the way instructors engage with students; and offer increased flexibility and access to technology. In short, active learning classrooms aim to provide new, innovative, and state-of-the-art learning environments. Research on active learning classrooms tends to focus on the virtual learning environment independent from the physical classroom conditions. However, there is limited evidence that physical environmental factors in classrooms can influence (help and/or hinder) student performance outcomes, perceptions, and behavior. The study addresses a gap in the literature by examining indoor environmental quality (IEQ) parameters (e.g. air quality, comfort, lighting, and acoustics) in five refurbished active learning classrooms.

This mixed methods study relies on two frameworks for field studies of existing indoor environments: post-occupancy evaluation and the ASHRAE Performance Measurement Protocol (PMP). Data collection involved: interviews with stakeholders and observations in the classrooms; occupant surveys to gauge satisfaction levels with the physical environment; and spot measurements in the classrooms as a way of comparing existing conditions to industry metrics and benchmarks.

Findings suggest that the classrooms meet or exceed industry benchmarks for IEQ. Several surprising outcomes also emerged from the study. Classroom users do not appear to take advantage of opportunities to adjust IEQ conditions in the classrooms. Furthermore, retrofitted classrooms present spatial and environmental constraints for active learning environments. The five active learning classrooms examined provide satisfactory IEQ conditions, but these spaces may not be achieving their full potential. Additional research is needed to optimize these spaces and inform future classroom design and classroom research.

KEYWORDS: active learning, indoor environmental quality

INTRODUCTION

Over the past 25 years, active learning classrooms have emerged on campuses as a way of rethinking and challenging dominant pedagogical paradigms in higher education. Active learning classrooms encourage students to engage with peers and faculty, to collaborate, to move around, to use multi-media in the learning process, etc. This differs dramatically from the traditional college classroom predicated on passively listening to lecture presentations. In some ways, these classrooms look quite different from traditional classrooms primarily because of their flexible/movable furnishings and the prevalence of technology including projectors, LCD screens, etc. However, in other ways these classrooms have many of the same architectural features, layouts, and controls as typical college classrooms.

Research in active learning classrooms tends to focus on the virtual learning environment rather than on physical classroom environment. Indeed, the extent to which physical environmental factors impact occupant use of the spaces or student learning outcomes is not well understood. One barrier to a better understanding of these relationships is a lack of empirical data related to how active learning classrooms perform in terms of indoor environmental quality (IEQ) parameters (comfort, lighting, acoustics, and air quality) and how these parameters compare with industry benchmarks. This study sought to establish baseline IEQ performance in five active learning classrooms at Ball State University as a first step toward informing classroom operations, design, and future inquiry.

1.0 BACKGROUND

1.1. Active Learning Classrooms

Active learning classrooms emerged in the early 1990s when NC State University implemented their SCALE-UP program to reconfigure classrooms to change large lecture class instruction. Since then, other institutions have followed-suit including: MIT's TEAL Project, University of Minnesota's ALCs, University of Iowa's TILE initiative, and Stanford's Wallenberg Hall (Sun and Chiang 2015). Recently, Ball State University reconfigured five existing classrooms as part of their ILS Initiative (Straumsheim 2014).

Research in active learning classrooms has primarily focused on the virtual learning environment conditions (e.g. student motivation/space attractiveness (Strange and Banning, 2001) and space suitability for activities (Whiteside, Brooks, and Walker 2010). However, the prevailing attitude that learning takes place independently of physical space (Temple 2008) appears to be changing (Oblinger, 2006; Chang, 2010; Woolner and Hall, 2010). Nevertheless, Sun and Chiang (2015) still note "a paucity of systematic research examining the effects of these environments on teaching practices and student learning."

Research examining the physical environmental and spatial conditions in classrooms is limited and predominantly occurs in K-12 schools (Leung and Fung, 2005; Woolner and Hall, 2010). However, there is emerging evidence that specific physical environmental parameters in classrooms can influence learning outcomes (Jensen, 2005; Higgens et al., 2005). The literature suggests a need for research that provides a better understanding of physical environmental conditions in higher education classrooms.

1.2. Ball State University's active learning classrooms

Ball State University currently has five active learning classrooms. These spaces were retrofitted existing classrooms deployed in two stages and are referred to internally as "Interactive Learning Spaces" (ILS). The design of these spaces were a collaboration between the university's facilities group, the Office of Educational Excellence (OEE), and Steelcase Corporation (a primary furnishings vendor for the campus). OEE manages these spaces and oversees an ILS cohort or learning community of faculty from many colleges and departments who apply to teach in the classrooms each academic year.

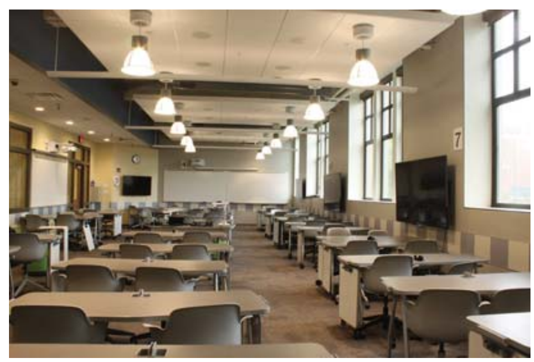

Figure 1: Before (left) and after (right) images of BB109.

The five ILS classrooms are located in three preexisting campus buildings: Teacher's College (TC), Burkhardt Building (BB), and Robert Bell (RB). These buildings are typical academic classroom buildings with spaces located off of double-loaded corridors and unilateral side lighting (one window wall). All of the retrofitted ILS classrooms have carpeted floors, gypsum board walls, and acoustical tile ceilings. The classrooms differ in size, arrangement, layout, and other architectural features. TC 411 is the smallest and the most eclectic/colorful in terms of furnishings including lounge-type chairs and movable tables and chairs. TC 412 has 24 node chairs (movable chairs with tablets), a raised floor, and has a breakout space attached to the main classroom. TC 414 is a "Mediascape" classroom with 4 fixed multimedia tables and movable chairs and the finishes are very similar to TC 412. RB 109 is a larger occupancy room with a long, narrow layout with node chairs/work tables. This classroom was previously two separate spaces. BB 109 is the largest ILS classroom and is long, narrow with high ceilings and large windows. This classroom went through, perhaps, the most dramatic alteration having previously been a lecture-style set-up with tiered seating and no daylighting. In the retrofitted space, the tiered seating was removed and the large windows uncovered. The room now has an open ceiling with acoustical clouds and soffit. See Figure 1 and Table 1.

Table 1: Ball State University's ILS active learning classrooms.

	TC411	TC412	TC414	RB109	BB109
Occupancy	18	24	24	36	76
Floor Area	451 SF	1,069 SF	883 SF	1,042 SF	1,368 SF
Glazing Area	52 SF	87 SF	87 SF	82 SF	176 SF
Ceiling Height	8'-9"	8'-4"	8'-5"	8'11"	10'-8"
Glazing to Floor Area	11.5%	8.1%	9.9%	7.9%	12.9%
Completed	2015	2012	2012	2015	2015

2.0 RESEARCH QUESTIONS

This research asked three primary questions of the Ball State University ILS active learning classrooms:

(1) Do the measured IEQ parameters meet established industry standards for IEQ performance?

(2) Do the measured IEQ parameters satisfy the criteria used as the basis of design for the spaces?

(3) Are the occupants satisfied with the existing IEQ conditions?

3.0 RESEARCH METHODS

The proposed mixed methods study can be characterized as a post-occupancy evaluation (POE) in which an existing building is systematically examined after occupancy (Preiser et al. 1988). However, this study is at the scale of specific spaces within a building rather than at the scale of the whole building. POE procedures emphasize collecting a variety of data (e.g. observations, surveys, etc.) to assess performance outcomes holistically (Preiser 2001). The ASHRAE Performance Measurement Protocol (PMP) (ASHRAE 2012) provides additional guidance on procedures for measuring physical environmental parameters (Hunn et al. 2012; Hunn and Bochat 2015). Basic-level evaluation procedures were used to: observe the space characteristics and occupant behavior; survey occupants on their satisfaction; and to take spot measurements of IEQ parameters (Ibid; Kim 2012). The procedure was duplicated in each classroom.

3.1. IEQ Survey Methods

This study used a standardized IEQ survey developed and administered by the UC Berkeley Center for the Built Environment (CBE). The ASHRAE PMP suggests the CBE IEQ survey instrument because the data can be compared with IEQ benchmarks in their extensive database of buildings. The survey questions were edited for their applicability to this study (e.g. whole-building related questions were removed since the study focused on specific classrooms) and the questions focused on IEQ and user satisfaction. A question was added for respondents to choose their classroom so that the data could be analyzed separately for each space. A new consent page was added for respondents and the survey received IRB approval. Faculty in each of the classes using the five ILS classrooms shared the link to the online survey with students.

3.2. Physical Measurement Methods

Physical spot measurements were taken in each of the five classrooms related to the four IEQ parameters: thermal comfort, indoor air quality, lighting/daylighting, and acoustics.

Thermal Comfort: Dry-bulb (air) temperature and relative humidity (RH) measurements were taken in each classroom. For the purposes of this study, MRT is considered to be the same as the dry-bulb temperature, and the air movement is 20 FPM. Metabolic activity in the classrooms is low at 1.1 MET and the clothing insulation for occupants is set at 1 CLO for winter dress. Temperature and relative humidity were measured using an Onset HOBO U12 logger with an accuracy of 0.63°F between 32°F and 122°F and +/- 5% RH typical. Measurements were logged over a 7-day period in each ILS classroom at 30" above the floor and mounted to the teaching wall. Measurements were taken in degrees Fahrenheit and % RH at 10-minute intervals. The data were plotted on the ASHRAE comfort zone using the online CBE Comfort Tool, which verifies compliance with ASHRAE Standard-55 (thermal comfort standard).

Indoor Air Quality: The ASHRAE PMP provided limited guidance on the IAQ assessment as the study was at the scale of the individual classroom and did not include mechanical spaces or systems. Air quality in indoor spaces can be difficult to measure due to the complex mixture of gases and particles in the air. Carbon dioxide (CO_2) concentrations are relatively easy to measure and can be used as a means of evaluating indoor air quality (IAQ) and ventilation rates in spaces because occupants breath and release CO_2 into the air. When this CO_2 accumulates in a space, it is an indication of insufficient air change from the building ventilation system. CO_2 was measured using an Onset HOBO MX-1102 logger with an accuracy of +/- 5-PPM at 77°F. Measurements were logged over a 7-day period in each ILS classroom at 30” above the floor and mounted to the wall. Measurements were taken in parts per million (PPM) at 10-minute intervals.

Lighting: Illuminance (or light level) on a horizontal work plane is the most common type of lighting measurement. Illuminance was measured using a handheld Konica Minolta T-10A illuminance meter with a relative spectral responsivity of within 6% and a cosine of within 3%. Measurements were taken on a 2 foot by 2 foot grid at 30” above the floor at three different lighting levels: Full electric lighting plus daylight from windows, dimmed electric lighting plus daylight from windows, and daylight from windows only. All lighting measurements were taken in diffuse overcast sky conditions common for about half the days each year.

Acoustics: Ambient background noise was measured using a Cirrus CR162A Class 2 integrating sound level meter with an omnidirectional condenser microphone and a tolerance of +/-1.4 dB at middle range. Measurements were taken in 5 locations in each space at 30” above the floor. Measurements were equivalent continuous sound level (Leq) over a 30 second measurement period that resulted in one A-weighted dB measurement per ASHRAE PMP. A-weighted dB measurements exclude frequencies above and below the human hearing range.

3.3. Physical Observations & Interview Methods

Physical observations of a sample of the occupied ILS spaces occurred during class time. Observations focused on how students and faculty used technology within the spaces, moved around the classroom during the class period, and other physical conditions present in the learning environment. These observations were documented using annotated floor plans and written notes.

Interviews were conducted with individuals associated with the planning, design, and operations of the ILS classrooms. They included a classroom design consultant, an architect, and a day-to-day manager of the spaces. Interviews were conducted in person, were audio recorded for analysis, and lasted approximately 30-45 minutes. Interviews were transcribed and analyzed using qualitative data analysis procedures to reveal recurring ideas and themes in the narratives.

4.0 RESULTS

4.1. IEQ Survey Results

The survey ran for 2 weeks in November 2016. 171 participants completed the survey. The sample was 65.5% female, 33.3% male, and 1.2% transgender. The average time to complete the survey was 5.5 minutes. 94% of the sample was 30 years old or younger. Most respondents spent less then 10 hours per week in their classroom and only for the previous several months.

Compared with the CBE benchmark, the ILS classrooms received high scores from occupants related to general satisfaction and indoor environmental quality parameters. Respondents rank thermal comfort and acoustics quite high on a scale of 1-7 (1 is very dissatisfied and 7 is very satisfied) compared to benchmark buildings at an average of 5.7 out of 7 and 5.8 out of 7 respectively. Lighting and general satisfaction are still higher than benchmarks, but receive the lowest scores among the IEQ parameters. In terms of general satisfaction, occupants seem less satisfied in TC 411 and most satisfied in TC 412 and TC 414. Thermal comfort scores seem consistent across the classrooms except for in TC 411, where it is slightly higher than the benchmark. Air quality scores are consistent for the TC classrooms, which use the same HVAC system on the same floor of the building. BB109 also scores high. RB109 scores lower on this parameter. Occupants appear quite satisfied with the lighting in all classrooms with TC 411 scoring slightly lower than the others. Occupants appear satisfied with the acoustics in the spaces with TC 411 scoring slightly lower than the others. Overall, occupants rank TC 412 highest for IEQ and TC 411 lowest. The other three classrooms score very similarly somewhere in between. See Table 2 below.

Several open-ended questions generated useful feedback about the ILS classrooms. Occupants complain about glare from the windows. Evidence of this issue can be seen in the classrooms where window blinds are often closed during the day. However, four of the five classrooms face east or west, problematic orientations for glare. In addition, the lack of a defined teaching wall and the mobile nature of the furniture makes glare mitigation challenging. Occupants like having white boards for working during class, but they wish there was more storage space. Also, the technology in the classrooms can be challenging to operate. Perhaps most interestingly, when asked which features of the classroom occupants adjust, 35% said the window shades/blinds, 30% said the door, and 49% said none. Very few respondents said they adjust the thermostat. 5% of occupants said that they make other adjustments to technology and furnishings. The ILS classrooms offer greater opportunities for user adjustment, but the occupants do not appear to take full advantage of these spatial affordances to improve their conditions for learning or comfort.

Table 2: Survey Results and benchmark comparisons.

	Benchmark Mean	Ball State Mean	TC411	TC412	TC414	RB109	BB 109
General Satisfaction	5.08	6.13	5.33	6.36	6.33	6.00	6.10
Thermal Comfort	4.09	5.70	4.33	5.85	5.80	5.70	5.71
Air Quality	4.60	5.84	5.67	6.04	5.93	5.43	6.00
Lighting	5.23	6.17	5.67	6.20	6.07	6.25	6.16
Acoustic Quality	4.04	5.80	5.33	6.00	5.80	5.70	5.85

*Scores on a scale of 1-7: 1 = very dissatisfied, 4 = neutral, and 7 = very satisfied

4.2. Physical Measurement Results

Thermal Comfort:

In BB 109, the average dry-bulb temperature and relative humidity fall slightly below the ASHRAE Standard 55 comfort zone. However, the average temperature and relative humidity during class times fall within the comfort zone. Conditions tend to fall to the cool side of the comfort zone during unoccupied times and are never too hot. In RB 109, the average dry-bulb temperature and relative humidity fall within ASHRAE comfort zone. The average temperature and relative humidity during class times also fall within the comfort zone. Conditions tend to fall to the cool side of the comfort zone for about 9% of the measurements and to the hot side of the zone only several times. In TC 411, the average dry-bulb temperature and relative humidity fall within ASHRAE comfort zone. The average temperature and relative humidity during class times also fall within the comfort zone. Conditions tend to fall to the cool side of the comfort zone for about 30% of the measurements and never to the hot side of the comfort zone. These measurements align with the lower survey scores for thermal comfort in this space. In TC 412, the average dry-bulb temperature and relative humidity fall within ASHRAE comfort zone. The average temperature and relative humidity during class times also fall within the comfort zone. Conditions do not fall outside the comfort zone for this space. These measurements align with the high survey scores for thermal comfort in this space. In TC 414, the average dry-bulb temperature and relative humidity fall within ASHRAE comfort zone. The average temperature and relative humidity during class times also fall within the comfort zone. Conditions do not fall outside the comfort zone for this space. However, the relative humidity measurements are somewhat higher than usual for a classroom space. These measurements align with the overall high survey scores for thermal comfort in this space. See Table.

Table 3: Thermal comfort measurements.

	TC411	TC412	TC414	RB109	BB109
Ave Temp (°F)	69.4	70.2	72.3	71.2	68.4
Ave RH (%)	51.3	45.3	61.2	33.0	31.2
Ave Temp (During Class Time) (°F)	70.3	70.4	72.9	71.6	70.4
Complies with ASHRAE-55	Yes	Yes	Yes	Yes	Yes

Indoor Air Quality:

ASHRAE Standard-62.1 recommends that maintaining a differential at or below 700 PPM of CO_2 above outdoor ambient conditions (e.g. 400 PPM) results in at least 15 CFM of ventilation air per person, which is the benchmark ventilation rate for classrooms. This study sets a benchmark of 1,100 PPM of CO_2 or below for compliance with the standard.

The average CO_2 concentration in the ILS classrooms ranged from 557.1-724.0 PPM and from 638.0-1038.2 during class times (8am to 8pm Monday through Friday). The averages during occupied times did not exceed the ASHRAE 62.1 recommendation of 1,100 PPM. However, 3 of the 5 classrooms had measurements that exceeded this threshold for 2.9-16.3% of the measurements. BB109 had the highest concentrations. The data suggests that overall the ILS classrooms are providing adequate fresh air to occupants and, in some cases, are likely over ventilated compared with the benchmarks. However, at peak occupancy times, concentrations in some rooms exceed the recommendations. Varying occupant numbers in the classrooms may explain some of this difference. These findings align with the high scores on air quality from occupants compared with CBE benchmark data in other buildings. Interestingly, TC 412 and TC 414 received he highest scores from occupants, which align with the CO_2 measurements. However, BB109 received favorable occupant scores while CO_2 measurements indicate potentially under ventilated conditions. The qualitative analysis suggests that air quality, while a consideration in terms of optimizing student engagement, was not a parameter that the design team could easily alter given that the classrooms were retrofitted spaces with existing HVAC systems and no operable windows. See Table 4 below.

Table 4: Indoor air quality measurements.

	TC411	TC412	TC414	RB109	BB109
Average CO_2 (PPM)	611.5	583.1	557.1	724.0	714.0
Ave Class Time CO_2 (PPM)	762.9	682.9	638.0	718.4	1038.2
CFM/Person	>15	>15	>15	>15	>15
Maximum CO_2 (PPM)	1506.0	1080.0	965.0	2397.0	2303.0
% above threshold	2.9	0	0	8.4	16.3

Lighting:
The ASHRAE PMP references the Illuminating Engineering Society (IES) benchmarks for classroom lighting: 40 maintained foot-candles and a range of 30-50 foot-candles. Daylight factor is the ratio of indoor illuminance to outdoor illuminance expressed as a percentage. Recommendations vary, but the industry standard for classroom daylight factor would be no less than an average of 2% with 5% as well daylit.

The average illuminance in classrooms with full electric lighting and daylighting ranged from 42.8-72.4 fc. BB109 and TC 411, at the low end of these measurements, meet the IES criteria for classroom illuminance while the other 3 classrooms appear to be overlit in the full electric lighting condition. All five ILS classrooms have adjustable electric lighting (switching and/or dimming). In the half electric light plus daylight condition, the average illuminance ranged from 13.5-47.6 fc. In this scenario, RB 109, BB 109, and TC 411 were underlit compared with the benchmarks. In the daylight only condition, all five classrooms performed poorly in terms of sufficient illuminance levels. However, in terms of daylight factor, BB109, TC 412, and TC 411 all appear inadequate as daylit only spaces. TC 414 and RB 109 had average daylight factors above 5% under diffuse sky conditions suggesting that they are usable without the electric lighting. See Table 5.

Table 5: Lighting illuminance measurements and daylight factors.

	TC411	TC412	TC414	RB109	BB109
Full Light (average fc)	45.0	72.4	70.8	59.0	42.8
Half Light (average fc)	26.7	47.6	37.0	13.5	21.5
Daylight (average fc)	4.77	12.3	9.2	8.38	7.93
Daylight Factor (% DF)	2.71	2.06	5.50	5.06	1.92

Acoustics:
The ASHRAE PMP provided benchmarks for ambient background noise in classroom spaces as 35 dB-A for ideal conditions and 45 dB-A as a high condition. The average ambient background noise in the ILS classrooms ranged from 34.6 to 38.9 dB-A. No single measurement in any classroom reached the 45 dB-A "high" threshold. TC 411 was the only classroom with an average background noise below the 35 dB-A "ideal" benchmark with all others slightly above ideal. TC 411 and BB109 also had the smallest range of measurements throughout the rooms. The other 3 classrooms had larger ranges, particularly at measurement locations near an HVAC diffuser. Overall, acoustics in the 5 classrooms varied, but appear in-line with ambient noise benchmarks. This finding is, perhaps, unsurprising given the prevalence of acoustically absorptive materials like carpet and ceiling tile in the spaces. This finding also aligns with the high scores on acoustics from occupants compared with benchmark data in other buildings. And, finally, the qualitative analysis suggests that acoustics were a priority for the teams that designed the classroom retrofits. However, several spaces, such as RB109 and BB109 are long, narrow spaces where some students and faculty may be located a long distance from others, which may result in speech intelligibility issues when the dB drop across the room falls below ambient background noise. See Table 6.

4.3. Physical Observations & Interview Results
Three interviews were conducted with individuals associated with the design and/or operations of the Ball State ILS classrooms. These individuals included an architect with the campus facilities group, a classroom administrator from OEE, and a classroom design consultant from outside the university. Results indicate that

Table 6: Acoustical measurements.

	TC411	TC412	TC414	RB109	BB109
Average Sound Level (dB-A)	34.6	38.9	34.4	38.6	37.8
Range Sound Level (dB-A)	1.7	3.8	5.4	4.5	1.6
Benchmark Exceeded	No	No	No	No	No

students and faculty are using the classrooms in different ways than a typical college classroom would be used. Learning is more active, students/faculty move around, collaboration is occurring, and occupants appear satisfied and comfortable in these settings. However, there is limited interaction with controls or other opportunities to change or adapt physical conditions within the spaces. For example, few occupants adjust the window blinds; few turn lighting on, off, up, or down. This aligns with the occupant survey responses.

Analysis of the interview data revealed seven salient themes that emerged from interviews:

(1) The importance of getting students and faculty to feel that they have some ownership of the classroom, which impacts space use
(2) Active learning classrooms should be student-centered or focused on student learning
(3) It is important to empower faculty to make the learning experience more engaging for the students
(4) Satisfactory or even good indoor environmental quality (IEQ) is a basic prerequisite for active learning in classrooms—students need it to thrive
(5) Some IEQ parameters rise to the top in the design goals such as acoustics and lighting
(6) Improvements to ILS spaces are ongoing—it's a learning process
(7) Spatial constraints such as existing buildings, structure, etc. impact the realization of the design vision and goals—there are certain things that can't be done or done easily

The interview data suggests that stakeholders involved in the design and operations of the ILS classrooms recognized the importance of optimal IEQ conditions for active learning settings. However, it is also clear that IEQ was not a primary consideration during design nor is it a focus of ongoing enhancements to the spaces. The fact that the classrooms were retrofitted and not designed from the ground-up may explain why IEQ conditions were not emphasized during design. Renovating spaces using standard industry practices for college classrooms appears to provide better IEQ than un-renovated spaces elsewhere on campus.

CONCLUSION

Physical measurements in the five ILS classrooms meet or exceed most established industry standards for IEQ performance. Thermal comfort appears excellent for four of the five spaces, with TC 411 running slightly cool. Average conditions meet the ASHRAE-55 Standards. Indoor air quality as measured by CO_2 concentrations meet ASHRAE 62.1 recommendations for providing sufficient fresh air and ventilation to classrooms. If anything, the classrooms may be over ventilated for the number of occupants, which vary by class. Lighting levels are high for full electric and low for full daylight, but the adjustability of the electric lighting coupled with the glare control from shades/blinds suggests that optimal light levels on work surfaces are possible. Finally, acoustically none of the classrooms meets or exceeds the ASHRAE PMP "high" threshold for background noise and all fall at or slightly above the "ideal" benchmark. Overall, ILS classrooms are performing well with respect to measured IEQ parameters.

Interviews suggest that there were no specific, verifiable design criteria related to IEQ parameters for the ILS classroom retrofits, although good IEQ conditions were important to the design team as a way of supporting active learning. Physical measurements suggest that the classrooms meet or exceed industry standards for IEQ performance in most cases, which would seem to satisfy the initial design intent.

Survey data suggest that occupants are quite satisfied with the IEQ conditions in the classrooms, and respondents score IEQ parameters high compared with the benchmarks from the CBE database. In some cases, as noted above, survey scores and/or open-ended comments align with less optimal physical measurements in the spaces. It was somewhat surprising that TC 411 emerged as a problematic space in both the survey and measured data, but the sample for this space was smaller.

The objectives established for this project were achieved. A performance baseline for the five BSU ILS classrooms now exists. This baseline data can be verified or reconfirmed in the future or compared with other classrooms, and should be useful validation of spatial performance for the university. There were no major deviations from the plans outlined in the original proposal other than the fact that some data collection/analysis procedures outlined in the ASHRAE PMP were deemed unnecessary for a classroom scale evaluation or where no indication of problems were evident from the field observations.

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Kihong Ku

Developing Bioinspired Approaches in Undergraduate Architecture Curricula: Incorporating Computational Methods

Developing bioinspired approaches in undergraduate architecture curricula: Incorporating computational methods

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ABSTRACT: Bioinspiration, biomimicry, biomimetics, are some of the terms being increasingly referenced in the fields of architecture and building engineering in the search for innovation towards sustainability, energy and resource efficiency. Some scholars define biomimetics as an interdisciplinary scientific field and emphasize the complexity of translating an inspiration from nature to a final technological product. The focus is to gain a deeper understanding of functional analogies, processes and mechanisms that aim to abstract fundamental principles beyond morphological analogies which are primarily focusing on the formal aspects.

In this paper, the author examines pedagogical research in bioinspired approaches incorporating computational design methods. This research acknowledges the lack of formalized bioinspired design methods and explains pedagogical case studies to expand the literature. The method is particularly applied in design courses that apply computational methods. The findings suggest that the pedagogical explorations are compatible with methods found in literature and demonstrate that computational tools and methods are important support tools for biomorphic form translations and generations, functional analysis, and prototyping.

KEYWORDS: Bioinspired design, generative design, fiber composites, curricular innovation, sustainability

INTRODUCTION

Biomimicry, bioinspired design, biomimetics are terms often used interchangeably to broadly reference the abstraction of good design from nature (Vincent et al., 2006). Some scholars more specifically differentiate biomimetics, technical biology, bionics as a scientific discipline which concentrates on functional analogies, processes and mechanisms beyond morphological analogies, and define it as interdisciplinary research and development involving biologists, scientists, engineers (Knippers et al., 2016; Pohl and Nachtigall, 2015; Gruber, 2011; Pawlyn, 2011). Biomimetic approaches have been adopted by biologists, engineers, and scientists, to abstract inspirations from nature and develop products and systems that are efficient from an energy and material perspective. Such biomimetic approaches oscillate between biology and technology domains. On the one end, the biologist initiates the research to gain new insights and knowledge of living organisms with the anticipation of potentially translating the findings into downstream technical applications and products. From the other end, an engineer/architect, or technical specialist starts examining an existing successful technical product to improve this product through the transfer of knowledge of natural solutions. While there is a general consensus regarding what these terminologies mean, it has been acknowledged that there is a lack of understanding of design methodologies of biologically based innovation processes (Pohl, 2010; Helms and Vattam, 2009; El Ahmar et al., 2013).

1.0 RESEARCH AIMS AND METHODOLOGY

1.1. Research aims

In this paper, the author adopts the broader notion of bioinspired design to encompass endeavors from biomorphic design to functional translations from biology that may have potential for innovations in architecture. As biomimetics is gaining attention in architectural and engineering research and product development, a number of questions arise about how these approaches apply to the architectural design process and what the role of the architect is in this process. What knowledge and skills can the architect contribute to this process? What tools can assist the architect in biomimetic architectural design? How can biomimetic approaches be taught to enhance architectural education? And can computational tools facilitate this process? To answer these questions, pedagogical research of biomimetic strategies in architectural courses is examined. Computational design and biomimetics were chosen as two compatible domains as it has been demonstrated that computational tools and methods can support modeling and representation of natural growth patterns, swarm behavior, structural analysis, other performance analyses, and physical prototyping capabilities through digital fabrication (El Ahmar, 2013; Menges and Ahlquist, 2011).

1.2. Research methodology

In this paper, literature review establishes a baseline of biomimetic research models and methods in practice and architectural research ranging from lightweight structures pioneered by Frei Otto and his collaborators, to more recent projects that explore the role of innovative materials in biomimetic solutions such as textiles and fiber composites, the design of bioinspired performative building envelope solutions, and the integration of computational design and fabrication processes with bioinspired structures. This review classifies previous approaches by research processes, architectural applications, and support tools. Research processes include a review of bottom-up vs. top-down research approaches and research approaches adopted by design teams to identify, collect, and analyze applicable biomimetic references. Literature provides insights into how biological precedents are filtered from the vast variety of candidates. Architectural applications illustrate the target solutions defined by designers such as structural applications (Pohl, 2010) or building envelopes (López et al., 2017) as evidenced in experimental research prototypes to commercialized applications in buildings. The findings help to support and establish research to design and implementation process frameworks. It is also being discussed what role and to what extent the architect can contribute and lead this research process. Support tools focus primarily on computational design tools that can be adopted by the design team to generate alternative solutions, to map and simulate material properties, to conduct performance analyses and evaluate, and to control and extend fabrication capacities. Based on the findings, a conceptual framework is developed to facilitate biomimetic design teaching within the architectural studio and seminar courses. The framework involves background research on bioinspirations and precedents, including evaluation and translations of morphologies and functional characters, and examines how the research outputs can be applied to an architectural problem of site and program and building systems.

2.0 BIOINSPIRED METHODOLOGIES IN ARCHITECTURE

Literature review classifies previous approaches by research processes, architectural applications, and support tools. Research processes include a review of bottom-up vs. top-down research approaches and research approaches adopted by design teams to identify, collect, and analyze applicable biomimetic references. The pedagogical method explained in this paper is based on the review to facilitate biomimetic design teaching within the architectural studio and seminar courses.

2.1. Knowledge transfer from nature

In this paper, the author includes endeavours from morphological to functional translation from nature to architecture as part of bioinspired design. Gruber (2011) mentions biomimetics involve the transfer of form, morphological characteristics, constructs, and more broadly *natural phenomena which can include surfaces, materials, structures, functions, constructions, mechanisms, principles, processes, etc*. Such properties have to be abstracted and applied to architectural scenarios. Biomimetics are applicable from nanoscale to buildings and to urban conditions. Successful examples include the self-cleaning surface coating product Lotosan which was developed based on the hydrophobic surface microstructure of a lotus leaf, or on the large-scale lightweight construction and material optimizations pioneered by Frei Otto and his successors.

2.2. Biomimetic methods

Pohl (2010) explains that biomimetic research can be either bottom-up or top-down methods. The bottom-up process is initiated by the biologist and can lead to undefined technical possibilities whereas the top-down approach starts from examining an already existing technical product in the market with the goal to improve it. Helms et al. (2009) term the former approach 'solution based' vs. the latter 'problem based'. In both approaches the knowledge transfer from nature to an architectural application occurs through abstraction which has to accommodate the translation at different scales, material, and timescales. Gruber (2011) recommends that the reduction of information, identification of relevant parameters and boundary conditions should be guided through personal interest and intuition rather than strict categorizations in the early stages.

2.3. Architectural applications and design methods

In recent years, a number of architects and architectural researchers have explored the potential of bioinspired approaches for architecture either adopting a bottom-up or top-down approach. Table 1 categorizes selected examples from literature and simplifies and categorizes them by biomimetic research methods, application area in architecture, abstraction methods, and support tools. Examples which purely are concerned with visual and formal interpretations of nature, or urban scale planning examples are not included in the table. The table indicates that most of the current research efforts that involve new materials for building construction remain experimental and are not yet implemented at the full building scale. Biomorphic translations as in the example of a hierarchical structural abstraction of diatom structures (Pohl, 2010) have also been proposed as a strategy to be applied for large scale load bearing structures. This particular example applies the geometric hierarchical pattern into the design of a railway station roof structure with the use of welded steel tubes. The efforts towards developing biomimetic strategies for adaptive façade systems that enhance energy efficiency and human comfort are still in very early stages at this point. López et al. (2017) explain a formalized biomimetic research and design approach for adaptive building façades. Their research discusses the complexity of addressing human comfort and also the complications of developing the abstracted biomimetic idea and finding or developing new potential building materials to implement such concepts.

Table 1: Categorization of biomimetic architectural research applications

Research team	Research method	Application area	Abstraction method	Support tools
Hensel et al. (2010)	Bottom-up	Material systems	Emergence	Computational, prototyping
Dörstelmann et al. (2014)	Bottom-up	Material systems	Structural optimization	Computational, prototyping
Knippers et al. (2016)	Mixed	Material systems	Structural optimization	Computational, prototyping
Pohl (2010)	Bottom-up	Material systems	Structural optimization	Computational, prototyping
López et al. (2017)	Top-down	Façade systems	Analysis of plant's adaptive behavior	Diagrammatic methods
Hertzsch (2010)	Top-down	Façade systems	Analysis of adaptive behavior	Diagrammatic methods

El Ahmar et al. (2013) highlight the need for biomimetic design methodologies and propose a computational architectural design method. The team explains biological principles of adaptation, material systems, evolution, form and behaviour, and emergence, and the importance of the interrelationships and hierarchies of form, structure, material within the organisms. Their model is based on a top-down approach starting with an architectural project brief subsequently followed with biological research for precedents/inspirations which define a genotype that is further refined through the use of computational algorithms, analyses and simulations to translate into a phenotype that goes through iterations for the final output.

3.0 PEDAGOGICAL CASE STUDIES

This chapter explains the author's teaching approach to bioinspired design from two courses, a fifth year undergraduate architecture studio and a fourth year level seminar course which involve computational methods. Both courses did not involve collaborators from the non-architectural disciplines of biology or engineering, but the studio involved two external architect practitioners.

3.1. Courses organization

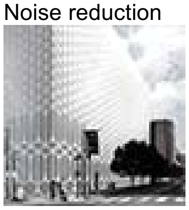
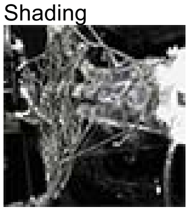
Both courses took a top-down approach for two reasons. First, there was no interdisciplinary partner who could provide access to open ended biological research, and second, from a curricular and personal familiarity standpoint, starting with an architectural target application facilitated the organization of bioinspired design activities into the courses. The studio project focused for seven weeks on retrofitting and designing a bioinspired façade of an existing building and involved 12 fifth year undergraduate students and two external architect practitioners who were partnering with the instructor. The students were grouped into two member teams. The final deliverable for this project included a fabricating a mock-up of a full scale prototype.

The seminar course tasked six fourth and fifth year students to identify and develop biomorphic concepts for architectural column structures through the application of various nature inspired algorithms utilizing Rhino3D and Grasshopper software.

3.2. Studio projects

The studio projects were conducted for the first half of the semester for seven weeks to redesign an existing façade based on bioinspired research which was located in Center City Philadelphia on the Thomas Jefferson University Campus. The façade was a typical masonry clad curtain wall with continuous bands of horizontal windows of a six-story building. For the project, the first task was broad based research of biological precedents that would offer opportunities for improvements of specific performance criteria that the students identified. The students were specifically tasked to focus on functional aspects that could improve the existing performance of the façade including daylighting, thermal comfort, acoustic comfort, etc., rather than simply designing a bioinspired image or aesthetic. Building on research of their selected biological precedents, the students then began designing and developing façade designs and systems concepts. During this process the six student teams were tasked to incorporate various computational approaches including form finding, performance analysis, and digital fabrication. Table 2 demonstrates the various biological characteristics, the architectural performance goals, abstraction methods and computational approaches employed by each team. The final stage led to developing construction details and producing a full scale mock-up.

Table 2: Summary of student projects

Architectural performance goals	Biological performance benchmarks/sources	Abstraction method	Support tools
 Noise reduction	Fennex fox ear	Morphological diagramming	Computational, prototyping
 Shading	Chromatophone cell	Morphological diagramming	Computational, prototyping
 Dynamic shading	Photochromatic cell & spider web	Structural optimization	Computational, prototyping
 Shading	Cactus morphology	Structural optimization	Computational, prototyping
 Daylight transmission and control	Oriental hornet exoskeleton	Analysis of plant's adaptive behavior	Diagrammatic methods
 Water harvesting & shading	Pineapple plant leaves	Functional abstraction	Circle packing algorithms, solar radiation simulation

The specific strategies adopted by each team varied, most teams prioritizing functional abstraction over formal analogies. As outlined in Table 2 the performance goals included noise control, shading, daylight transmission, and water harvesting. In comparison to López et al. (2017), students did not limit their bioinspirations solely to plants which arguably have similarities to buildings which are fixed to specific location and static. Students in contrast referenced chromatophore observed in cephalopods focusing on physiological color change, oriental hornet solar cells which generate electricity from sunlight, and fennex fox ear morphologies which facilitate acoustic amplification, besides various plant references. It is interesting to note that after identifying and abstracting an applicable function from a biological precedent, the teams translated and integrated the mechanisms and processes into a compatible abstracted patterns that could be related to the function. For example, in the case of the project that applied a cactus morphology, a deformed hexagonal pattern was developed in Rhino3D/Grasshopper to incorporate self-shading properties of the cactus skin into a building skin. Fiber composite materials were considered as the material to fabricate the system. In case of the dynamic shading control system, the team combined the characteristics of shape memory alloy and a delauney mesh pattern, creating a biomorphic shape of a spider web which acts as an exoframe for the kinetic shading elements that translate characteristics of photochromatic cells found in octopus. Each team established performance criteria for their façade design and conducted applicable building simulations to verify the performance of their system. However, the complexity of addressing human comfort and energy efficiency simultaneously proved to be challenging. The duration of the project, the knowledge and skill level of the teams, and limited resources including available computational tools and fabrication tools impacted the development process.

3.3. Seminar course projects

The primary goal of this course was to teach algorithmic modeling using Rhino3D and Grasshopper scripting. Students started with learning the basics of parametric modeling, surface operations such as tiling and mesh operations, and scripting of recursive patterns, branching and L-systems, flocking algorithms and cellular automata. In order to teach the analogies of natural patterns, the students were tasked to identify interesting patterns in nature and apply those patterns to a vertical column structure. Figure 1 is an example of a student's selected 3D printed models that applied L-systems and cellular automata algorithms to a vertical column structure which were based on inspirations from bones and the regeneration of cells within a connective network. The results show similarities to a bone structure and are generated based on a limited number of simple rules. Bioinspirations selected by students included specific characteristics, components, and aspects of plants and animals (e.g., snake, armadillo, etc.), which were analyzed in depth to understand morphological aspects and the relationship to specific functions. The students iterated multiple versions of bioinspired algorithms on vertical column structures and 3D printed the resulting geometry.

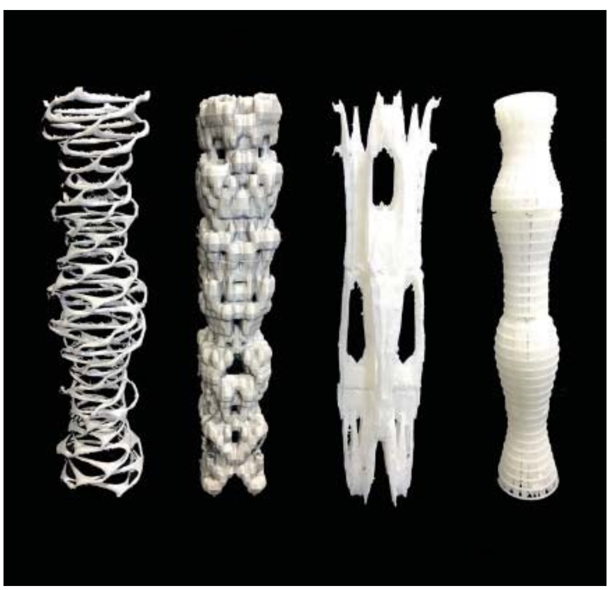


Figure 1: 3D printed structures generated using cellular automata algorithms based on studies of growth of cellular structures (Project credits: Jennifer McElroy).

4.0 DISCUSSIONS

The two different courses discussed above illustrate examples of bioinspired design taught in architectural courses that incorporate computational methods, the former focusing on designing a complex architectural system, the façade, and the latter focusing on generating nature based patterns through algorithmic processes.

4.1. Results

The pedagogical explorations presented here highlight the characteristics of bioinspired architectural design processes by students. While the absence of biologists eliminates the collaborative aspect of working with interdisciplinary partners, students were still able to conduct systematic research on biological precedents through literature and precedents to identify relevant sources of inspiration and evaluate the potential fit for the façade design project. Students approached research from two ends. Initially some students found interesting examples that they tried to justify for the façade design which eventually turned out to be difficult to transfer, and the team accordingly replaced their inspiration with different biological references. For example, one team investigated the armor of boxfish whose hexagon shaped scales and joints provide exceptional strength with potential applications for body armor and flexible electronics. But the application deemed less applicable to the building façade project and thus this team switched their focus towards a dynamic shading function that led to photochromatic cells and spider web examples. In most cases the students established specific functions they desired for the façade design to identify applicable biology precedents. In many cases students changed some of their original assumptions and found more applicable precedents. In terms of form finding, most teams found an applicable pattern geometry (i.e., circle packing, voronoi, etc.) which they manipulated to achieve some level of formal analogy to their biological reference while translating the abstracted functions into the façade scale. The students were given the constraint of using fiber reinforced composites as a material to implement their design into a construction material. Utilizing fiber composite material did not necessarily directly translate the biological characteristics of their selected precedents but it offered an option to develop a light weight composite structure to implement the design concepts.

In comparison, the seminar course allowed students to adopt more simplified strategies of abstracting biological inspirations because they were only concerned with identifying applicable morphological patterns or systems that could be replicated through computational algorithms which resulted in more algorithmic iterations. While this approach has potential to quickly study multiple examples, the abstraction into more complex downstream architectural and technological innovations may also be limited.

4.2. Future Considerations

Comparing the student projects from teaching with approaches from literature exemplify that the author's pedagogical processes were simplified and more flexible in comparison to professional team approaches. The teams did not involve interdisciplinary counterparts and biomimetic abstraction processes allowed somewhat flexible approaches. The ultimate goal of biomimetic approaches is to expand technological innovations that can enhance sustainability and energy efficiency. The historic examples of lightweight construction pursued material efficiency. Complex systems such as façade and building envelopes require more intricate system based approaches to address complicated issues of human comfort in addition to material and energy efficiency to be integrated through biomimetic approaches. The pedagogical explorations highlight a few future areas for improvement to better support bioinspired design processes and teaching: (1) interdisciplinary team building would offer the advantage of expanding rational boundaries between disciplines; (2) computational tools that support analysis of biological examples are typically beyond the scope of tools and knowledge that architect have access to. Interdisciplinary collaborations can help to facilitate cross pollination discipline specific tools, processes and methods; (3) architects and architectural students are well positioned to identify needs for improvement of existing systems and to abstract functional analogies between natural and man-made systems at different scales. Formalizing design methods of such abstraction processes will be helpful; and (4) architectural computational tools that can more efficiently support key capabilities including form finding, simulation of growth patterns, performance analyses, optimization, and digital fabrication will be helpful. Applying these tools in bioinspired design processes requires combining multiple tools iteratively throughout the design and development process. Enhancing computational literacy and skills beyond current levels will help architects and students lead and contribute to bioinspired design processes.

CONCLUSION

The results of the comparison suggest that practice/research and pedagogical approaches are compatible but highlight the challenges of creating interdisciplinary environments in the architectural curriculum. The pedagogical explorations presented were limited in scope of technical development and multidisciplinary team involvement, but the examples show that the biomimetic approaches can be applied at different scopes and scales to encourage innovative thinking in form finding, functional system development, and incorporation of computational design tools and processes. Shortcomings included the lack of interdisciplinary counterparts, lack of understanding of biological material processes which are difficult to translate into abstract architectural design concepts. This put a greater responsibility on the instructors' role. The studio instructors' team supplemented real-world perspectives to offer balanced feedback on the challenges of the architect, changing architectural knowledge and skillsets, and design processes.

Future research will continue to compile biomimetic approaches to define material and computational design strategies in teaching bioinspired experimental structures and performative building envelopes projects. Future plans include engaging with biologists/students to facilitate interdisciplinary experiences and to gain new understanding of the opportunities and challenges of this framework. The long term outcome of this pedagogical research will demonstrate that computational design and biomimetic approaches offer a viable framework to enhance creative and technical design skills of architects.

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Infusing Technology Driven Design Thinking in Architectural Education: Two Case Studies

Infusing Technology Driven Design Thinking in Architectural Education: Two Case Studies

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ABSTRACT: This paper narrates two case studies on technology driven design thinking-based education methodologies in an architecture program. The first case study course focuses on a design/build studio course in which the client, the campus performing arts center, incubated the studio in their production facility to mentor the students as they created a new cafe for the facility. Students engaged with the full spectrum of the design-thinking process, interviewing theatre-goers in the *empathize* mode, seeking the right problem in the *define* mode, generating alternative concepts in the *ideate* mode, rapidly *prototyping* with computer-aided design and manufacturing technology, *testing* resulting prototypes on users on site, learning from feedback, and cycling back through the design-thinking process, evolving the prototypes to higher and higher levels of resolution in each iteration. The second case study course integrates BIM (building information technology) into a traditional large technical lecture course, using the technology to overcome challenges caused by the size and mixed levels of students, meanwhile provide hands-on experience which is typically very difficult to implement in a large lecture course. These two pedagogical approaches intended to integrate fast-changing technologies into architectural education while simultaneously creating a novel learning environment for students. The authors reflect upon the results of the two case study courses, proposing recommendations which could be useful for educators and institutions contemplating the potential for technology to change student experience.

KEYWORDS: building information modeling, rapid prototyping, architectural education, design thinking

INTRODUCTION

Educators and practitioners have come to the consensus that technology has radically transformed how the architecture, engineering, and construction (AEC) industry practices and operates. Creativity and innovation has already been critical in educating future designers, architects and engineers. Teaching design thinking has been a key part in architectural curriculum. In the past several years, the emergence of a new wave of technologies such as 3D fabrication, BIM have been observed in industry as well as school. The rapid development and take up of technology, especially among young students has a significant impact on curriculum design, challenging educators and institutions to address the changed learning patterns and needs of the students. Consequently, we have seen a number of new teaching methods and trends have emerged in architectural schools recently, for instance, Design Thinking, Game-based learning, Flipped Classroom, Project-based learning in the school, etc. And a number of new technologies have been introduced to the students as teaching tools. In this paper, we will explore the impact of technology on learning through two case studies examining different pedagogical methods, course types, student audiences, and technologies.

BIM is a set of technologies and processes that can be adapted to different practice models. The learning curve for BIM programs is long and steep and they require a complete change of mindset from educators to set aside their conventional way of teaching and mentoring and relearn an instructional method. For these reasons, the obstacles to adopting the BIM approach are major, and the pedagogical shift has been spotty and unsystematic.

The introduction of prototyping into an architectural design studio in the context of the five-step design thinking process offers students vivid feedback on their response to human needs as well as technical performance and aesthetic aspects of their design proposals. Full-scale prototyping directly addresses learning outcomes of understanding materials, assemblies, and structures. The need for digital fabrication equipment and physical materials pose challenges for schools lacking resources. The time required to complete multiple cycles of prototyping and testing makes it difficult to undertake projects of large scale. And, this student-led learning approach requires a change in mindset on the part of the the instructor, who must shift roles from the critic who explains why the student’s approach will or will not work to the guide who takes students on a journey of discovery.

1.0 First Case – Design / Build Studio

1.1. Overview of design thinking and rapid prototyping

The key workflow concept underpinning the five-step design thinking process taught at Stanford University's d.school is that designers begin by discovering user's needs and complete the cycle by by testing prototypes with those users in order to validate their design solutions. While it is generally too costly and time-consuming to build a full-scale testable model of a building design, mock-ups of innovative building components are created and tested, but typically for evaluation of technical performance or visual qualities. For example, building facades are typically mocked up and tested in laboratories to test for water penetration and resistance to wind forces. Facade mockups are also frequently assembled on-site to test visual properties of materials. These prototypes are created late in the design process and used to validate fairly thoroughly developed concepts. A key concept in the design thinking process is to begin with low-resolution prototypes in order to quickly gain feedback on early-stage concepts. As early concepts are validated, subsequent prototype iterations can gain higher resolution to elicit more detailed feedback. While prototyping and testing for conformance to user needs is not the norm in architecture, it is more common in interior design, where users interface directly with components of interior spaces, and in product design, where usability and desirability are critical.

The introduction of prototyping into an architectural design studio in the context of the five-step design thinking process offers students vivid feedback on their response to human needs as well as technical performance and aesthetic aspects of their design proposals. Rapid prototyping shortens the time between concept and realization. Krista Ninivaggi of SHoP Architects calls this aspect "direct to fabrication," saying, "we can be in the studio riffing on ideas, and then those same design ideas can go from my desktop right into production with my design files." (Szenasy 2014) It also gives students direct experience of actual materiality, unusual in the studio environment, where design technologies of drawing and digital modeling tend to explore and represent materiality poorly, if at all. Physical modeling typically substitutes materials such as chipboard and basswood for actual building materials. And 3-D printing renders models in a uniform plastic material. As Alvise Simondetti notes, "Computer Aided Design has brought designers away from material properties including surface roughness, strength, thermal properties, elasticity etc. and the physical world characteristics including gravity. The CAD office generally looks more like a managerial suite than a builder's workshop. Rapid Prototyping has the potential to bring the material back into the architect's studio and give the designer that "feel" of the artifact that had disappeared." (Simondetti 1997,7)

1.2. Course design

The course was envisioned as a design-build studio that would serve the campus performing arts center's need to replace their aging on-site cafe. There was great potential for a productive exchange in this project. The performing arts center wanted to gain student buy-in by involving a group of students from another academic unit in their activities. They sought a creative new vision to replace a conventional university food service outlet located in a prominent position in their venue.

This faculty member saw an opportunity to meet the learning objectives of the architectural design studio whose brief was:

> Investigations into the relationship between the man-made and the natural world including introductory issues of assembly and material value. Design of the site and the building are combined into an integral process delimiting and probing the boundaries of each and exploring their reciprocal relationship. The architect's obligations to the natural and urban contexts are explored in many dimensions including historical, typological, environmental, and physical (UMD).

A design-build project offered direct opportunities to engage issues of assembly and material value. And we could investigate the reciprocal relationship between an interior space and its context. And, we could explore the architect's obligations to the context of the building interior in many dimensions. During the second half of the semester we would design a cafe for a natural landscape setting, allowing us to engage with the full spectrum of issues detailed in the brief.

Another compelling value to be gained from this relationship with the performing arts center was the opportunity to work in their well-staffed and well-equipped Scene and Prop Shops and to be incubated within the theater's vibrant culture of making. We would gain access to the performing arts center's Computer Numerically Controlled (CNC) machine, lacking in our own School's shop. And, the client would fund all necessary supplies and hire a digital fabrication consultant for our studio.

The design studio was composed of ten graduate students in their second year of a three and a half-year master of architecture degree program. The diverse group included students from a range of undergraduate majors and prior careers including architecture, art, history, accounting, and the military. The students brought varied levels of experience with digital modeling and woodworking to the studio. None had experience with digital fabrication.

1.3. Methodology

We began the studio with case study research focused on two topics, the cafe typology and environments created with Computer Numerically Controlled (CNC) machine technology. The cafe typology studies introduced the student team to the basic elements of design for small restaurant spaces. They also offered understandings of the relationship of built form to context and environmental factors. And, they demonstrated how a wide variety of program and design concepts could animate cafe design. The explorations focused on environments fabricated with CNC machines exposed students to the types of form-making enabled by the unfamiliar technology that they would be implementing later in the course. At this point, we brought in a consultant experienced in design for digital fabrication to begin working with the students to understand the potential, limits, and processes of the CNC fabrication technology.

The team launched into the design thinking process, beginning with *empathy*. In this mode, students engaged in the activities of immersing in the users' context, interacting with users, and interviewing users. We considered the cafe's context both narrowly, as a particular space situated at the head of a grand stair, along a primary building circulation route, and at a key building node - and broadly, as the performing arts center, a venue for a wide variety of performance types. Students interviewed client representatives along with a variety of users at different times and engaging in various activities.

Students began the *define* mode by mining their observations and interviews for insights into client and users' experiences, needs, desires, and aspirations. They arrived at several key insights: 1) the director views food and drink as a type of performance, hence fitting into the mission of the performing arts center, rather than existing merely as a support function, 2) the space comes alive during the NextNow Fest, when scenery, lights, and action spill out of the theaters and invade the lobby, 3) people do not perceive the two disconnected parts of the cafe, food service and seating areas as part of a unified whole, 4) the seating area, located at the building's hub, is an important community meeting space, and 5) students enjoy sitting on the deep window sills that connect the main corridor with the courtyard and verdant landscape beyond. They translated the resulting insights into "how might we?" statements to find a set of actionable challenges that would define the design problem.

Moving into the *ideate* mode, students worked individually, utilizing technologies of hand sketching and physical modeling, to explore potential solutions to these challenges in schematic design proposals. In this iteration, the sketches and models served as both investigative tools and *prototypes* for testing with the *clients*. Based upon client feedback, the team moved into the next iteration of the ideation, prototyping, and testing modes, narrowing the design options from ten to two. Option 1 was named the Garden Cafe, responding to the perceived desire for connection to nature. Option 2 was named Morph, highlighting the concept of a single architectural element that transformed as it undulated through and connected the disparate spaces of the cafe. Once again, sketching and physical modeling served as both ideation and prototyping technologies. In the third iteration, the team realized that the biomorphic form of Morph was an abstract representation of nature. This insight allowed the team to coalesce around a single schematic design proposal.

Subsequent ideation, prototyping, and testing iterations focused on developing this design concept at increasing scale and specificity. The team shifted technologies to work primarily with digital modeling. Our goal was to create construction documents that the Food Services crew would use to build the food service area and to create digital files that we would use to construct the elements of the dining spaces. Students modeled in Revit, then exported their files to Autocad. In Autocad, they separated the layers into individual pieces to be cut on the CNC machine.

Once we had the first iteration of the digital model complete, we started the rapid prototyping process. We began working in a new environment, the performing arts center's Prop Shop and Scene Shop, with their extensive facilities for both manual and digital fabrication, including a three-axis CNC machine with a 4' x 8' bed. We also gained the teaching support provided by the performing arts center's technical and instructional staff, including Director of Production and Instruction, Technical Director and Assistant Technical Director and Scene Shop Coordinator, members of the Set Construction Crew, Properties Shop Master, and Assistant Technology Manager specializing in lighting. These experienced makers and teachers advised us to revise our ultimate goal of constructing the cafe down to a still ambitious, but manageable, goal of producing final prototypes and fabrication files for construction by a commercial millwork shop. This shift in objectives relieved the pressure and, importantly, switched our focus from design-build to process and pedagogy of rapid prototyping.

1.4. Findings and discussion

Changing the orientation of the studio from design-build to rapid-prototyping transformed our concerns from product to process. Students were able to take the time to learn from testing each iteration of the prototype. The Prop Shop Master taught me to avoid critiquing the students' digital models, but instead to let them build their ideas out of inexpensive material, oriented strand board (OSB), and learn from user feedback and observation. The rapid prototyping process afforded multiple iterations during the limited project duration, giving us the ability to test prototypes multiple times, gaining new knowledge each time and revising based on this direct learning. Our prototyping process was semi-indirect computer-aided design (CAD), direct computer-aided manufacturing (CAM), and manual assembly (Simondetti . Drawing was done remotely, in the architectural design studio. The cutting, assembly, and finishing process, however, was hands-on in the shop. giving students a tactile experience of material and assembly, addressing the studio learning objective in a highly experiential manner.

Figure 1: Prototyping: Direct CAM with student operating CNC machine. Source: (Author 2016)

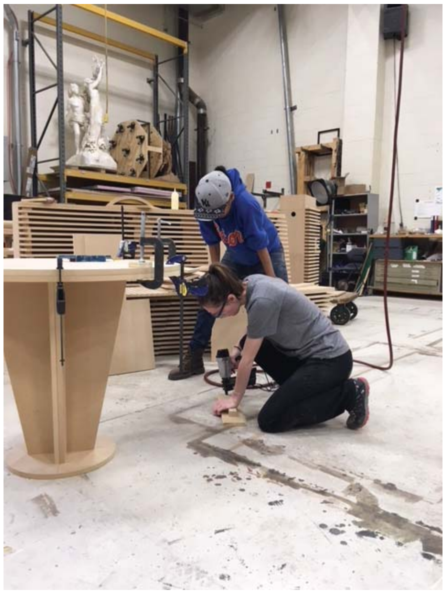

Figure 2: Prototyping: manual assembly. Source: (Author 2016)

Figure 3: Testing chair and table prototypes. Source: (Author 2016)

Lessons we learned from the prototypes that we would not have learned from creating scale models: 1) ergonomics lessons in human dimensions, comfort, and function, 2) physical properties of designed products, such as weight, texture, strength and appearance of joints, 3) lessons in user response to designs, 4) differences between different materials in terms of strength, durability, and appearance, 5) the relationship between design decisions and construction processes, 6) relationship between the drawing and the full-scale realization, 6) how the element fit into the context, 7) how the designed product would function under simulated use conditions. Reflecting upon the studio experience, one student observed,, “We’re so used to building things that are scaled to fit in our hands. I was actually able to sit in something I designed instead of just photoshopping people into it. The best part was seeing our designs come to life and being able to interact with it as it was meant to be used.” (Haley 2018)

2.0. SECOND CASE STUDY – BIM INTEGRATION IN LECTURE SETTING

2.1. The role of and challenge for BIM education in architectural curriculum

Educators and practitioners have already built a consensus regarding how BIM has radically transformed the way the AEC industry practices and operates. The activity of parametric modeling is fundamentally different from drawing and drafting because the product is a database of information and relationships instead of a set of 2D or 3D representations to be interpreted by different team members. Therefore, the move from traditional CAD to BIM constitutes a new methodology rather than the simple introduction of a new tool (Denzer et al., 2008). BIM has already disrupted the traditional building industry practice methods and threatens to disrupt the methodology in and pedagogy of AEC education, but this has only showed in isolated courses, programs, and schools. In comparison to the industry transformation, the incursion of BIM seems to have encountered more obstacles. BIM is “parameter-defined” and “inherently answer-driven,” while traditional design thinking is “question-driven” (Denzer et al., 2008). The new BIM approach could be seen by traditional studio teachers as a threat to critical (design thinking). The promotion of the BIM pedagogical shift needs to respect traditional design thinking to be successful. Based on previous study and program experiments, the obstacles to using BIM as a pedagogical tool include the following: 1) a higher requirement for students’ knowledge base and skill sets, 2) the disconnection and discontinuity among different courses, and 3) the fast pace of program/software development. The biggest challenge is to understand the opportunities presented when digitally driven learning and process technologies are envisaged more comprehensively and profoundly than as mere tools. Considering BIM only as a set of tools could undermine the additive value of skills and intentions working together to improve learning outcomes. BIM is not a tool, but a way of learning and thinking (Ambrose 2012).

Livingston thinks the placement of BIM-based investigation in technical courses addresses larger issues of architectural representation (Livingston 2008). The course taught at Montana State University was a 400-level construction documentation course. Students are required to create a schematic design information model and then develop details illustrating materials and connections based on the initial model. The way in which BIM played an important role is through the formulation and construction of details that integrate into the larger information model, forming a critical relationship between the role of 2D and 3D information.

2.2. Course Design

The course developed by author is derived from a traditional “Building Materials and Construction Methods” (BMCM) lecture course that is a required course for the Bachelor of Art in Architecture, Bachelor of Science in Architecture, and Master of Architecture degrees. It is offered as a mixed graduate/undergraduate technical prerequisite course in an Architecture curriculum (refer to Figure 4). The course is designed for a large student body, around 108 to 120, with a clear goal of not only teaching students fundamental knowledge about building materials and methods but also exposing students to BIM technologies and using BIM as a teaching tool to enhance and deepen their understanding. One important outcome for the students completing the course is to able to understand the complicated and multi-disciplinary construction activity and the integrated process in the building industry. This outcome requires students not only to understand materials properties and construction methods, but also to establish a framework to understand the different players in the building industry. This has been a challenge for a large lecture course taught in a single-discipline school in a traditional education curriculum. In this course BIM is used as simulator to aid students' active learning and design thinking. The ability to simulate building construction and assembly methods is a great way for students to bring design thinking (define, ideate and prototype) into a traditional lecture class.

A total of 118 students in Fall 2016 and 106 students in Fall 2017 enrolled in the class, including 4.6% freshmen, 59.4% sophomores, 14.2% juniors, 15.1% seniors, and 6.4% graduates. Of these, 51.9% were female students and 48.1% male students. Of these, 58.5% knew nothing about BIM at the beginning of the class, 16% had never used a 3D program, and 33% had learned Revit to certain degree as a drafting tool in community college or high school but never realized that Revit is one type of BIM software.

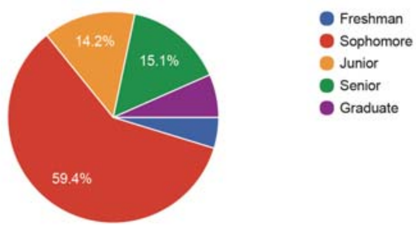

Figure 4: Level of students in Fall 2017. Source: (Author 2017)

The course contents are divided into three integrated categories: 1) three major building materials: wood, concrete, and steel; 2) major building assemblies: wall, roof, and other enclosure systems; and 3) integrated construction methods and modern technology. BIM is used as a platform to help students understand and interweave the three categories. Gaining an understanding of the relationship between design, construction, and energy consumption is especially important if students are to think critically about how a building's design and construction impacts the building's sustainability (Shen et. al 2012) (refer to Figure 5).

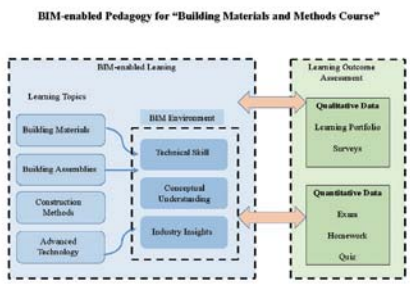

Figure 5: BIM-enabled pedagogy for BMCM course. Source: (Author)

2.3. BIM contents

The BIM content was divided into three major parts: 1) what BIM is and what BIM can do in design and construction; 2) what building component/assembly is and how to use the "Revit family" to represent and simulate the materials and constructions; and 3) how to represent/build the different wall assemblies, particularly brick and stone (refer to Figure 5). The technical details of how to use the software were taught using in-class tutorials, exercises, assignments, and multiple outside-class workshops conducted by the instructor and three teaching assistants. Altogether, 24 hours (roughly 16 hours of course time) of workshop and in-class hours are offered to teach software. Beyond the workshops, students are required to enroll in the online comprehensive Revit tutorial offered by Linda.com in the first week of the semester. Altogether, 72 hours of online training are available to students on Linda at any time without charge.

2.4. Methodology and Sample Assignments

Assignments, graded homework, and exams were used to provide frequent assessments of students' learning outcomes. To answer the question of whether BIM is an effective teaching method/tool in a topic-based lecture course, the author designed an assessment framework to measure the learning results and students' progress through the entire semester. Since this is large class with 108 students, the conclusion of this paper could provide a meaningful and helpful reference. The data generated by this research was a mix of qualitative and quantitative information. Quantitative data were from four surveys conducted after each major exam to collect students' self-assessments and feedback on the effectiveness of the BIM teaching method.

The following shows two homework assignments. The second and third homework assignments have portions about modeling/prototyping concrete floor systems and masonry walls. As shown in figures 6 and 7, almost half of the students felt strongly about the knowledge gained in learning brick walls.

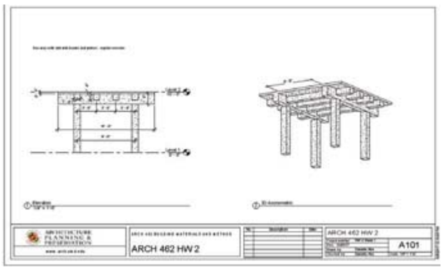

Figure 6: Homework two student's submission – concrete system. Source: (Author)

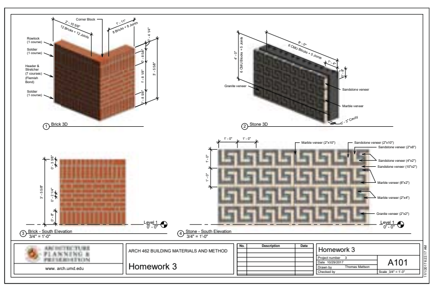

Figure 7: Homework three student's submission – masonry wall. Source: (Author)

2.4. Findings and discussion

At the conceptual level, BIM is not an easy concept to grasp. It's been proven that grasping the BIM concept demands a more in-depth understanding of the building industry than typically provided in overall curriculums. The lack of preparedness of students was compensated for by self-guided research into this topic. Through several research assignments, a much larger portion of students started to grasp the BIM concept. Establishing the understanding of BIM in a qualitative way is the foundation of the BIM pedagogy.

As for BIM technical skills, Revit is difficult program for beginners. Through the entire semester, students' perceptions about the difficulty of Revit did show meaningful change. From the survey taken at the beginning of the semester, the majority students had a neutral position before learning Revit. Two months into the semester, after several Revit assignments and exercises (10/17), 42% of students thought Revit was difficult and 35% of students were neutral regarding the difficulty of learning Revit. At the end of the semester, 87.9% of students agreed that "learning Revit is the most challenging part in this course" (refer to Figure 8). However, the complexity and challenge of learning this data-rich program forced students to spend time practicing and learning on their own. The additional effort was proportionally directly related to the deeper understanding of the lecture contents. Also, because of the hands-on exercise, which is very similar to their design/studio work process, students had a much easier time translating the knowledge into design. Providing a challenging environment and encouraging students' active learning is the first effective impact of using BIM in a traditional large lecture course.

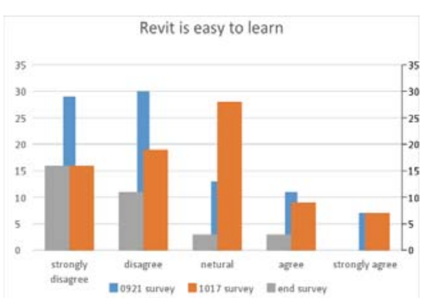

Figure 8: Difficulty of learning Revit. Source: (Author)

Regardless of the steep learning curve for Revit, students understood the importance of BIM integration in this course and agreed that learning Revit was helpful and that “BIM helps me to think about architecture and learn about architecture from different perspectives.” To the latter statement, 39.7% of student agreed and 33.3% strongly agreed (refer to Figure 9). The ability to understand a building assemblage from a structural, environmental and system perspective simultaneously in all courses is so profoundly important and is the way BIM could facilitate design thinking in a lecture course.

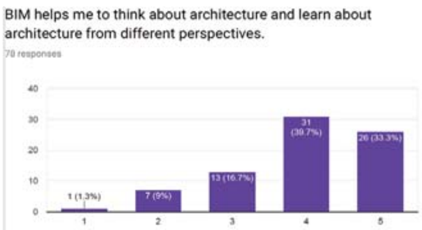

Figure 9: Students’ attitude towards BIM’s effectiveness. Source: (Author)

CONCLUSION

In the past decade, different experimental digital technology (DT) pedagogies have been implemented in AEC programs. Some programs developed new standalone digital fabrication courses to cover the techniques of variety programs. Some programs modified existing core courses to integrate particular digital contents. A third approach is to allow students to produce a digital technology-enabled capstone or thesis project. Previous studies suggest that offering standalone DT courses without any follow-ups in other courses does not support student long-term learning because students rarely find an opportunity to re-use DT skills in different courses. Updating existing course modules has had limited effect since DT was used as a secondary technical tool, and the combination of the steep learning curve and limited course time hinders the effectiveness of the DT pedagogy. The preliminary results from two courses indicated that DT, when integrated as an instruction tool, provided a novel pedagogical and technical platform for teaching critical thinking and design thinking.

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Pravin Bhiwapurkar

Determinants of Urban Health: Walkability and Urban Form

Space Syntax and Walkability Analysis in Support of Urban Design Decisions

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ABSTRACT: This research presents an application of the space syntax method to examine physical behavior in three urban neighborhoods – a compact downtown and two variations of sprawl development – in order to explore the link between environmental factors and physical activity. The environmental factors analyzed here include improved street connectivity, density, and mixed-use development. As a novel addition, this work also considered access to open spaces, parks, and trailheads, aspects unique to the study area. The first part of this research examined how compact urban areas, as compared to urban sprawl, influenced healthy behavior. The space syntax method was applied to explicate the morphological logic of the urban grid and quantify the built environment in relation to physical activity, including the street network characteristics of connectivity, integration, and depth. Second, this study addressed the comparative health and socio-cultural benefits of urban forms through measures of neighborhood completeness. This quantitative methodology was used to measure the level of density and amount of mixed-use in terms of walkability. As space syntax argues that more integrated streets are more likely to attract movement and visitors, the third part of this work evaluated the roles of various open spaces, parks, and trailheads within the mixed-use, dense development of a downtown, and how their respective locations might promote healthy behavior. Finally, this research concludes that increased residential density and retention of public open spaces of an existing single-use commercial downtown core, as well as easy access to parks and trailheads, could complement a walkable community design and suggest a healthy urban form. This work is relevant to existing urban neighborhoods and small urban communities looking to identify new development paradigms with regards to improved walkability and health promotive urban form.

KEYWORDS: Community Health, Connectivity, Mixed-use Development, Urban Density, Urban Form

1.0 INTRODUCTION

The Center for Disease Control (CDC) has reported that during the past 20 years, there has been a dramatic increase in obesity in the United States, with 35.7% of adults and 17% of children and adolescents reported as obese. Obesity, as well as diabetes, heart disease, and some cancers, often develops from the sedentary lifestyle and poor dietary choices frequently seen today. According to the CDC, these chronic diseases are the leading cause of death and disability in the United States. They cannot be cured, but they can be controlled; moreover, they are largely preventable through measures such as access to healthy food and exercise. After decades of designing spaces that discourage physical activity and promote chronic disease (primarily through increased auto-oriented development), the time has come to reevaluate community design and integrate new opportunities for healthier habits. Providing environments that make walking, biking, and using public transit more convenient and desirable will not only improve resident health, but might also lead to other positive outcomes such as reduced vehicular traffic congestion, environmental pollution, and social isolation.

As the rate of chronic disease has increased, architects and city planners throughout the United States have begun addressing the need for built environments that promote a healthy and active lifestyle, neighborhoods that are conducive to walking and other physical activities. In 2010, New York City officials produced the *Active Design Guidelines* as a reference for urban planners, designers, and architects, which address health concerns such as obesity and diabetes through intelligent design (New York City, 2010). Their compilation of research demonstrated that "a diverse mix of land uses, a well-connected street system and a good public transit system all tend to increase physical activity among city residents." Seattle is also embracing the future through a health-promoting EcoDistrict that offers healthier buildings, better mobility, improved access to fresh foods, and more social equity (Rainwater, 2012). Overall, the neighborhood form has a powerful influence on how people inhabit and traverse their environment during their daily activities. Urban design and planning strategies are known to motivate users to choose healthier options and strengthening a sense of community.

Walking is one of the most common types of aerobic physical activity. The National Household Travel Survey found that at the distance of one mile, 60% of people walked for social or recreational reasons, 46% walked to school or church, 40% walked to shops, and 35% walked to work (USDOT, 2017). However, such frequency, according to recent studies, may depend on the environmental dimensions present. With a focus on making walking an attractive and more viable option, researchers have identified five "d" variables that are necessary for analyzing the relationship between the urban environment and travel patterns: *density, diversity, design, destination accessibility,* and *distance to transit* (Cervero & Kockelman, 1997). *Density* includes the concentration of people and jobs within a given zone, and *diversity* involves gauging the number, variety, and balance of land uses (i.e., residential, commercial, institutional, etc.) within that zone. *Design* refers to the street system and its connectivity and integration. *Destination accessibility* considers the ease of travel for pedestrians, and *distance to transit* measures the average distance from a destination to transit stops.

Providing an environment in which residents are encouraged to walk at least 1.24 miles per day will help them to reach the public health goal of at least 30 minutes of moderate activity daily, and lower their chance of obesity and other chronic diseases (Frank et al., 2004). Researchers have demonstrated that people walk and bike more often when they live in neighborhoods with higher street connectivity, greater population density, and more mixed-use development (Frank et al., 2005). Studies have also suggested that the workplace is the main base for walking trips in urban settings, and that people will walk more often if they have local destinations such as their homes, dining, shopping, or transit within 0.25 to 0.5 miles of their workplace (Zimring et al., 2005). Having a substantial mix of destinations or land uses within the 0.25 to 0.5-mile radius has been proven to be a significant and meaningful variable for walkability. One study on the relationships among obesity, community design, and physical activity found that each quartile increase in land use mix was associated with a 12.2% reduction in the odds of being obese (Frank et al., 2004).

Having a wide variety of well-connected destinations in close proximity provides an environment conducive to walking and biking. However, public open spaces such as parks and trailheads have also been shown to offer health benefits to city residents, and should be integrated into urban neighborhoods in order to increase the possibility of physical activity (Koohsari et al., 2014). These open spaces provide more than just an environment conducive to various forms of recreation; they also add ecological, social, and aesthetic value to a community (Pikora et al., 2003). As urban environments can often deprive people of access to nature, open green spaces would provide attractive neighborhoods that would contribute to a positive attitude and increase social activity. Strong street connectivity to such recreational spaces would, in turn, increase the likelihood of people accessing these locations as part of their daily or weekly routines (Thompson, 2013). Out of necessity, cities were previously planned with dense, walkable, mixed-use neighborhoods, but with the advent of the automobile, a sprawling auto-oriented infrastructure led to the way cities have been built for the past 100 years (Rainwater, 2013). Departing from the car-centric way many towns and neighborhoods are planned today, promoting livable development patterns in closer proximity to a variety of desirable and necessary destinations would provide a comprehensive solution to the obesity epidemic and result in healthier cities. This research focuses on existing urban neighborhoods in Bozeman, Montana, as a means of exploring design strategies that could promote a higher level of health and wellness despite urban sprawl.

1.1 The study area

Over the past twenty years, the city of Bozeman has worked to maintain a healthy and vibrant downtown, establishing ten city blocks along Main Street that benefit from a wide array of local shops, services, and restaurants. The city anticipates a large population boom in the next 20 years, with a growth rate of 3.8% per year. Concerned by this growth and its possible ramifications, the city has adopted a community plan that addresses issues of development and change while protecting public health, safety, and welfare. Sprawl is defined as a pattern of development that includes low population density, underutilized areas, and forced reliance on individual automobile transportation to satisfy basic needs. To retain and enhance the qualities that make Bozeman a desirable place to live, work, and play, the city has taken note of an emerging urban planning and development paradigm that signals a return to the development pattern that promoted walking, cycling, and public transport. Thus, this downtown site provides an excellent example of a prosperous, lively, and appealing community. In terms of traveling to work, 9% of the working population walk, 6% bike, and 1% use public transportation. This is remarkable compared to the other dense, pedestrian-friendly cities such as New York City and Seattle have comparable numbers, with 10% from New York City and 9% from Seattle walking to work, and 3% and 4% biking, respectively (FindtheBest, 2014). The CDC reported that from 2009 to 2010, Bozeman had a diabetes rate of 3.9% and an obesity rate of 17.4%; this compares favorably to the national diabetes rate of 11.9% and obesity rate of 35.9%. Despite having these relatively low rates, the city of Bozeman is focused on further improving community health. Consequently, this research maps out the existing urban form to both illustrate its effectiveness and provide areas where it might continue to improve.

1.2 Research questions

While environmental factors are associated with improved physical activity levels in urban neighborhoods, their suitability for existing urban environments is not assured, and stakeholders continue to struggle with balancing economic, environmental, and social cohesion concerns. This paper investigates the suitability of Bozeman's existing urban form for furthering health benefits. Answers to the following questions are pursued: As compared to urban sprawl, how do existing compact urban forms influence walkability? What role mixed-use, dense developments play as compared to single-use, sprawl developments, particularly with regards to walkability? How can the locations of open spaces, parks, and trailheads within a mixed-use, dense development impact physical health?

(a) **(b)**

Figure 1: **(a)** Bozeman area map with outlying neighborhoods circled (source: Downtown Bozeman Improvement Plan, 2009). **(b)** Downtown plan area with 10 blocks highlighted (source: Downtown Bozeman Improvement Plan, 2009).

2.0 METHODS

This study employed measures of space syntax and neighborhood completeness and objectively analyzed several of the city's environmental characteristics. The first step involved comparing the compact urban forms and urban sprawl with regards to physical activity, using space syntax to measure the street network connectivity, depth, and integration of three locations. Secondly, to define and measure the health benefits of density and mixed land use, neighborhood completeness was calculated and walkable destinations and opportunities for densification were identified. As space syntax theory argues that more integrated streets are more likely to attract movement and visitors, the third part of this study evaluated the positioning of various open spaces, parks, and trailheads within the mixed-use, dense development. Although it was predicted that the urban form was already quite dense, diverse, and accessible as compared to the nearby sprawling residential neighborhoods, the ten blocks along Main Street that made up the downtown core lacked one vital component: housing. Therefore, the discussion below supplies suggestions for integrating more housing into the existing downtown fabric.

2.1 Compact urban form vs. urban sprawl

Introduced in 1984 by Hillier and Hanson, space syntax is "a set of techniques for the representation, quantification, and interpretation of spatial configuration in buildings and settlements." By developing an "axial map" comprised of the longest and fewest lines that can cover all of the spaces in a given layout and connect them with one another, the spatial layout of a street network can be quantified. The axial lines that make up the map represent sight lines for people moving within the spatial network, including streets, roads, and pedestrian paths (e.g., lines of movement or physical routes). These lines are then transformed into vertices on a graph in which each line has a value of *connectivity* that relates to the number of intersections along its length. Space syntax also involves the concept of *depth*, which measures the network distance or steps of adjacency between network components. For example, to travel to a space that has a depth of 3, one has to make three turns from a root space (e.g., Main Street). A third quantitative measure that can be derived using space syntax is *integration*. This is "a function of the mean depth (number of connections that must be traversed) if one were to move from every space (node) to every other space (node). The higher the integration value of the node, the less its depth." Thus, a shallow graph is highly integrated, whereas a deep graph includes segregated spaces (e.g., a cul-de-sac).

The configuration of a network is considered to be the "primary generator of pedestrian movement." The more a space is integrated, the more likely it is to be densely occupied by moving people (Hillier et al., 1993). Because space syntax can be used to link street network connectivity and integration with pedestrian movement, this research used space syntax measures to determine the extent to which the downtown area of Bozeman, MT, was highly integrated and pedestrian-friendly as compared to the totality of its residential neighborhoods. A street network is a connected web of thoroughfares that forms blocks (a system of logical sites for private development) and provides multiple routes for walking, biking, and driving (Marshall, 2006). Small blocks and frequent intersections are necessary to encourage walking and biking, as people then have a variety of routes from which to choose. In terms of scale, the "maximum average block perimeter to achieve an integrated network is 1,500 feet with a maximum uninterrupted block face of ideally 450 feet, with streets at intervals no greater than 600 feet apart along any one single stretch" (Farr, 2007, p. 129). In order to illustrate how a compact urban form (as compared to an area of sprawl) provides a more pedestrian-friendly environment based on street connectivity, the ten blocks of downtown along Main Street were compared to two nearby residential neighborhoods representing areas of urban sprawl (see Figure 2). In all three cases, the main route networks in each area were been made bold, for clarity.

(a) **(b)** **(c)**

Figure 2: The three environments assessed using space syntax, all shown on the same scale. **(a)** Map of the main study area, the 10 blocks of downtown Bozeman (17 lines). **(b)** Map of an adjacent residential neighborhood (13 lines). **(c)** Map of a second residential neighborhood located in the city's primary area of sprawl (17 lines) (source: Google Maps).

2.2 Mixed-use and dense development

Research has revealed a strong relationship between neighborhood design and the length and share of trips people will willingly make on foot. The essential element in encouraging such behavior is having more walk-to destinations clustered as closely together as possible (Farr, 2007). In other words, a strong mixed-use, dense development is key to promoting a healthy, walkable community. Questions raised by this concept include how many destinations are needed, and how close together they need to be to encourage consistent pedestrian behavior. Neighborhood completeness, a quantitative methodology presented by Criterion Partners and Farr Associates (Farr, 2007, p. 133), was used to evaluate the existing downtown community of Bozeman, and measure its levels of density and mixed-use in terms of walkability. It was then further employed to "identify opportunities for densification and economic development." The first step in calculating a neighborhood's completeness is listing all of the possible pedestrian destinations, such as banks, hardware stores, supermarkets, and places of worship (see Figure 3). The resulting number of destinations is then multiplied by the proportional area balance of all pedestrian destinations in the pedestrian shed, in order to determine the level of neighborhood completeness. Neighborhood completeness, then, equals the number of pedestrian destinations within a quarter-mile pedestrian shed multiplied by the proportional area balance of all pedestrian destinations in the pedestrian shed (use balance).

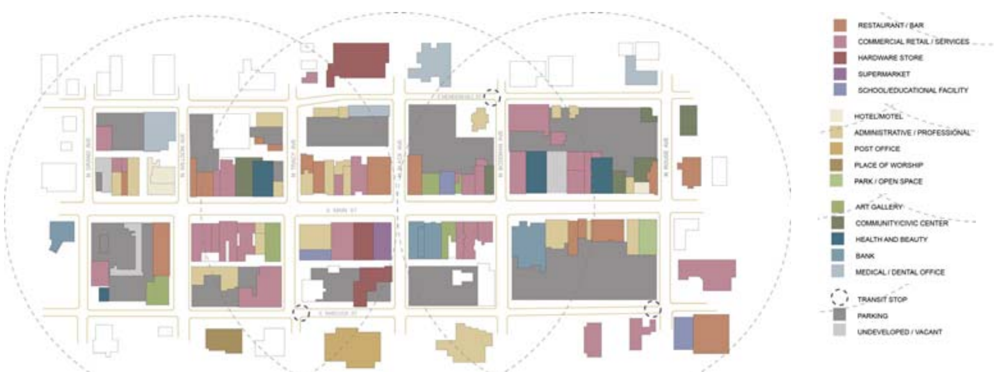

Figure 3: Downtown Bozeman land-use map showing 16 different pedestrian destinations in the neighborhood.

Neighborhoods should be suitable for walking, with all of the necessary amenities within a one-quarter to one-half mile radius. Most people will walk this distance before turning back. Longer distances will result in them opting to drive or ride a bicycle rather than walk. Therefore, the first value for finding the neighborhood completeness of these 10 urban blocks (see Figure 3) was calculated by finding the number of pedestrian destinations within a quarter-mile vicinity (critical mass); this made up the walking catchment area. Since the 10 blocks consisted of several quarter-mile radii, as seen in Figure 3, the overall neighborhood completeness was an average of these three radii calculations. The second value in the neighborhood completeness equation, the proportional area balance or use balance score, was found by multiplying the number of destinations in each land-use area; that number was then divided by the overall pedestrian catchment area. Next, the resulting value was compared to the neighborhood completeness indicator, which rates values as poor, minimal, satisfactory, or excellent.

2.3 Parks, open spaces, and trailheads

Public open spaces, parks, and trailheads are key locations within neighborhoods that can be both destinations for walking trips and settings for recreational physical activities; moreover, they can be enjoyed by people from a range of sociodemographic backgrounds. Although many studies have focused on proximity to determine its influence on physical activity, such as by measuring the shortest distance from home to the nearest park or open space, Hillier and Lida (2005) argued that people perceive and navigate urban spatial layouts in topographical rather than metric terms (Koohsari et al., 2014). In other words, the perceived distance to a destination such as a park or trailhead may be influenced more by the number of changes in direction that a person must make to arrive there. The more intersections, turns, and barriers that the journey to the location includes, the less comfortable people feel making that journey. Accordingly, space syntax was used to determine the ease of accessing public open spaces within the street network of downtown Bozeman. Figure 4a shows, the open space in the downtown area was rather lacking, despite the surrounding area having several large outdoor recreation destinations. In the 2009 Downtown Improvement Plan (Figure 4b), city planners and officials made courtyards and plazas a priority for new development, and improved Bozeman Creek to be a "centerpiece of a downtown open space system." Their goal was to provide more functional open spaces that could be used and enjoyed, day and night, by nearby residents, visitors, and workers.

Figure 4: (a) Map of downtown Bozeman showing existing open spaces. Although the surrounding area includes several parks and open areas, the downtown itself has very few. **(b)** Proposed network of open spaces for the ten-block downtown neighborhood (Downtown Improvement Plan, 2009).

3.0 RESULTS AND ANALYSIS

3.1 Neighborhood connectivity and integration

In order to illustrate how the compact downtown urban form provided a more pedestrian-friendly environment than the two nearby residential neighborhoods (see Figure 2), measures of street network connectivity, depth, and integration were calculated. The street network connectivity, which consisted of the number of intersections along a chosen path, helped to identify how many routes a pedestrian in Bozeman might travel. In each of the three axial maps (see Figure 5), which include **(a)** Downtown Bozeman, **(c)** Sprawling Neighborhood 1, and **(e)** Sprawling Neighborhood 2, the layouts demonstrate a comparable amount of axial lines (i.e., movement paths).

With Node 1 in each resulting graph **(b, d, and f)** representing the primary route (e.g., Main St.), the results were as follows: Node 1b had 12 intersections, Node 1d had two intersections, and Node 1f had three intersections. From these results, it was concluded that Downtown Bozeman had a much higher level of connectivity than the other residential neighborhoods, at least in terms of access to the major road in each area. The importance of strong connectivity is that these main roads are occupied by important destinations, such as food, work, and retail services, and the likelihood of traveling to these destinations by foot decreases as the connectivity level decreases.

In terms of depth, which is a measure of the steps of adjacency between network components (i.e., the number of turns), Graph b shows an overall depth of 2, Graph d a depth of 3, and Graph f a depth of 6. What this means is that anywhere a pedestrian might be within the downtown core environment, they would only have to turn twice to reach Main Street (see Line 1). A pedestrian would have to turn three times in the case of Sprawl Neighborhood 1 (see Figure 5c) to reach the main road, and six times in Neighborhood 2 (see figure 5e). As previously mentioned, people perceive and navigate urban spatial layouts more in terms of changes in direction than overall distance (Hillier, 2005). Thus, even if the route taken is longer in terms of distance, a pedestrian will likely be more comfortable walking it if the route has fewer turns.

The third quantitative measure, integration, shows the mean depth if one were to move from every space in the area to every other space. The downtown core had an integration level of 3.18, meaning that the average number of connections that must be traversed throughout the whole area was around three. Comparatively, Neighborhood 1 had an integration value of 4.08 and Neighborhood 2 had 5.06.

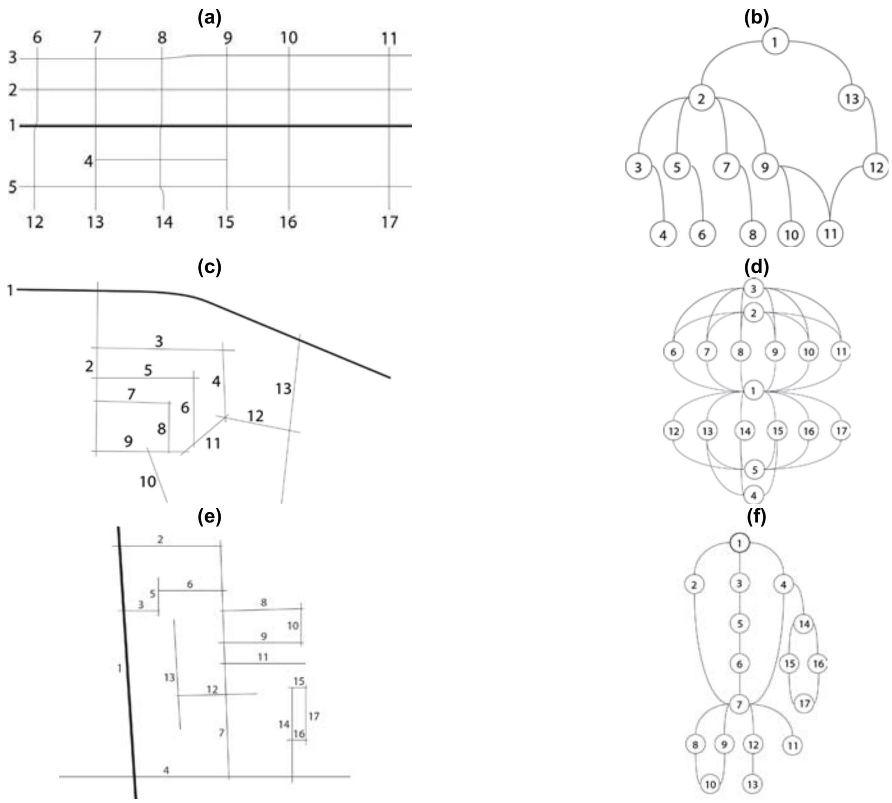

Figure 5: Using space syntax to assess the three environments. **(a)** Axial map of the downtown core (17 lines). **(b)** Downtown core graph. **(c)** Axial map of sprawl Neighborhood 1 (13 lines). **(d)** Graph of sprawl Neighborhood 1. **(e)** Axial map of sprawl Neighborhood 2 (17 lines). **(f)** Graph of sprawl Neighborhood 2.

As a recent study has pointed out, people living in neighborhoods that are better connected to the rest of the city tend to report higher levels of physical activity than those whose neighborhoods have lower connectivity. As shown in Table 1, the space syntax results indicate that the downtown core had a consistently stronger spatial configuration that the other two sprawling neighborhoods, and therefore provided an environment that supported a higher level of physical activity.

	Number of Axial Lines	Connectivity (node 1 intersections)	Depth (# of turns)	Integration (mean depth)
Downtown Core	17	12	2	3.18
Sprawl Neighborhood 1	13	2	3	4.08
Sprawl Neighborhood 2	17	3	6	5.06

Table 1: Comparison of the compact urban form of the downtown and two outlying neighborhoods in terms of connectivity, depth, and level of integration.

3.2 Density and mixed-use development

Since the 10 blocks consisted of several quarter-mile radii, the overall neighborhood completeness was calculated by averaging the three radii calculations. From the list of 16 amenities in the neighborhood (see Figure 3), it was determined that Area 1 had a critical mass of 11 pedestrian destinations within a quarter mile from one another; this made up the walking catchment area. Likewise, Area 2 had 10 destinations and Area 3 had nine destinations. The use balance, the second value in the neighborhood completeness equation, was calculated by multiplying the number of destinations per land-use area and dividing that number by the overall pedestrian catchment area. For Area 1, the proportional area balance equaled 0.73, for Area 2 it was 0.60, and for Area 3 it was 0.43.

By multiplying these values together (i.e., critical mass and use balance), the resulting neighborhood completeness values were determined to be as follows: Area 1 was 8.03, Area 2 was 6.00, and Area 3 was 3.87. In order to capture the overall neighborhood completeness, these three area calculations were averaged, with the result equaling 5.97 (see Table 2). According to the “Neighborhood Completeness Indicator,” the resulting neighborhood completeness for Downtown Bozeman was categorized as “satisfactory.” In order to improve this rating to “excellent,” the city should enhance the density and mixed use of the downtown core by increasing the number of unique pedestrian destinations by seven. The other two residential neighborhoods were determined to have “poor” levels of completeness. Improving this score is outside the scope of this research, as it would require significant changes in zoning and a substantial financial investment.

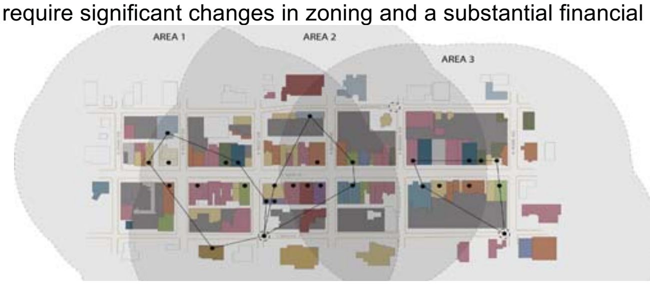

Figure 6: Downtown Bozeman land-use map showing three critical masses clustered no more than a quarter mile apart.

As the city of Bozeman anticipates population increase, the need for more housing is imminent. Furthermore, the potential threat of urban sprawl is rising, a situation the community desires to minimize. Previous space syntax data identified the downtown area as better connected, shallower, and more integrated than the more sprawling residential neighborhoods, which are positive factors in promoting physical activity. However, the downtown does not have the housing area that the sprawl neighborhoods possess. Table 2 categorizes the downtown neighborhood completeness as merely average, but there is room to improve this by providing a larger variety of pedestrian destinations in close proximity to one another.

	Critical Mass (# of Ped. Destinations)	x	Use Balance	=	Neighborhood Completeness	Neighborhood Completeness Indicator	
Area 1	11	x	0.73	=	8.03	Excellent	10 to 20
Area 2	10	x	0.60	=	6.00	Satisfactory	5 to 10
Area 3	9	x	0.43	=	3.87	Minimal	3 to 5
Averaged Neighborhood Completeness				=	5.97	Poor	Less than 3

Table 2: Neighborhood completeness calculations, with the indicator chart from Criterion Partners (Farr, 2007, p. 133).

In order to provide a truly walkable, livable environment, the downtown housing ratio and building density can be increased; this would be possible by building upon the existing infrastructure. In a proposal by Bhiwapurkar (2013), it was argued that the development density could be increased by adding mixed-use development above the existing two-story structures and employing a solar envelope design approach. Two options provided for growth are the addition of three residential floors or two commercial/retail structures, each with three residential floors above. The overlaying functions of multistory buildings will require further investigation using space syntax, as argued by Ratti (2004), in order to fully understand physical activities it will generate.

3.3 Parks, open spaces, and trailheads

Visiting a park, trail, or open space is usually voluntary unless the park is between the traveler and another go-to destination such as shops. This condition exists in Bozeman’s downtown. Space syntax argues that well-integrated streets are more likely to attract visitors, even nonregular ones (Koohsari et al., 2014). Figure 4(b) shows locations of six public spaces within the downtown street network. Location A, a large public space, located on a well-integrated Main Street is expected to have higher utilization, which may cause it to attract even more visitation. Conversely, Location F is on a street that is less integrated, and therefore less likely to be utilized. However, user behavior contradicts such prediction as spaces like Location F are being used by downtown visitors who park their cars nearby, as well as residents south of the downtown walk through these areas to get to Main Street. Also, this space connects with a trail frequently used by the majority of residents located on the east side of downtown, behind the new library. In addition to walkability, there are a number of physical and mental health benefits from urban greenery that have been reported in the literature; however, discussing them is beyond the scope of the present research. As the city moves forward with their downtown improvement plan, considering how these public spaces intersect with the overall street network will provide more convenient access. This point warrants further testing, as no study has yet examined whether public spaces located on more integrated streets are, in fact, frequented more often (Koohsari et al., 2014).

CONCLUSION

By exploring street connectivity, urban density, and mixed-use development, as well as easy access to public open space, parks, and trailheads, this research provides new insights into improving physical activity within the urban community of Bozeman, MT, as well as a development framework for other urban communities. Access to parks and trailheads from the downtown core is a newly added feature to improve physical activity and it is unique to the study area. The existing downtown core in Bozeman has strong street network connectivity, density, and integration as compared to the outlying sprawling residential neighborhoods. The density and mixed-use development of the single use downtown could be improved by adding to the existing infrastructure. Downtown residential housing could also be added to provide a truly walkable, livable environment. By doing so, the neighborhood completeness would be increased, allowing residents to meet their daily needs on foot, once more walk-to destinations begin to cluster together. By explaining how urban form impacts pedestrian activity, this study shows how to mitigate the increasing rate of obesity and associated chronic diseases, and positively impact the way communities grow. Future behavioral research, however, is suggested to test the walkability predictions made by the space syntax method in a mixed-use dense environment.

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Milad Fereshtehnezhad

Quantified Comparison of Landscape Urbanism and New Urbanism: Applying Mean Depth and Connectivity Measures in Space Syntax to Two Toronto Case Studies

Quantified Comparison of Landscape Urbanism and New Urbanism: Applying Mean Depth and Connectivity Measures in Space Syntax to Two Toronto Case Studies

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ABSTRACT: Landscape Urbanism and New Urbanism are two of the most recent and most relevant paradigms in contemporary urbanism. The two offer some major differences (such as density and approach towards urban sprawl, transportation mode choice, urban block size and arrangement, etc.) as well as some similarities (such as ecological sensibility, natural resource preservation, and connectivity of the urban fabric), causing them to become interested in similar urban contexts (such as post-industrial and brownfield sites), and making them comparable. Recently, there has been a lot of discussion around the conceived ideological, theoretical, and physical differences of these two paradigms, where proponents of each have brought forth arguments aimed at proving the superiority of their side and refuting the other. Despite the extent of these arguments, no quantitative comparison has been offered. To this date, the majority of these discussions have remained quite superficial. This paper proposes the use of Space Syntax as a methodology that can help fill this literature gap for meaningful quantitative comparison between the two paradigms. For the purpose of this study, a comparable Landscape Urbanist and a New Urbanist project were selected. The Lower Don Lands (Landscape Urbanist) and the West Don Lands (New Urbanist) projects are both located in downtown Toronto, Canada. They are both very recent projects and are of comparable sizes.

A common claim between Landscape Urbanism and New Urbanism, and a relevant issue in contemporary urbanism, is the connectivity of the urban fabric. This characteristic was selected to be quantitatively compared between the two case studies through measures of the Space Syntax methodology. As such, the two case studies were compared using "connectivity" and "mean depth" measures. Results were then assessed to determine which project performed more successfully in making a connection between its site and the surrounding urban fabric.

KEYWORDS: Landscape Urbanism, New Urbanism, Space Syntax, Integration, Mean Depth

INTRODUCTION

This study seeks to provide a quantitative method through Landscape Urbanist and New Urbanist projects can be compared and contrasted. To achieve this goal, first a methodological study of the two paradigms was performed where key claims of each were highlighted and further demonstrated and strengthened through case studies. Then, two urban cases were selected, one from each of the two paradigms. Then, according to the physical and quantifiable characteristics representing certain claims studied previously, Space Syntax was selected as the method through which those claims would quantifiably be put to the test and compared. Bafna offers holistic description of Space Syntax in his 2003 article:

> Space syntax is best described as a research program that investigates the relationship between human societies and space from the perspective of a general theory of the structure of inhabited space in all its diverse forms: buildings, settlements, cities, or even landscapes. (Bafna 2003)

As such, the cases were compared using "connectivity" and "mean depth" measures from the Space Syntax methodology. The intent of this study is to fill the gap in the existing literature, where comparison between Landscape Urbanism and New Urbanism lacked quantifiable evidence.

1.0 BACKGROUND

Landscape Urbanism and New Urbanism remain two of the most relevant urbanism paradigms in contemporary urbanism. Without a detailed study and to the untrained ear, most of what each of these two opposing sides in the world of urbanism claim to be after sounds logical and beneficial solutions to the maladies and issues of contemporary cities. Looking more closely, one can detect both stark differences, and obvious similarities as there are aspects where both paradigms correctly, albeit through different approaches, detect urban issues.

Extensively discussed throughout existing literature, from one perspective, Landscape Urbanism and New Urbanism's fundamentally different approach to the medium responsible for ordering of urban spaces appears to be primarily responsible for ensuing differences between the two. The subject of much heated debate is that Landscape Urbanism takes "landscape" as its medium, whereas New Urbanism takes the "building". One of the most famous quotes upon which Landscape Urbanism bases this choice is that of Stan Allen:

> landscape has traditionally been defined as the art of organizing horizontal surfaces… by paying close attention to these surface conditions – not only configuration, but also materiality and performance – designers can activate space and produce urban effects without the weighty apparatus of traditional space making. (Allen 2001)

This also boils down to the classic question of whether architects or landscape architects should be the dominating profession in urban design. On this issue, Waldheim calls for "architecture as a tool of instrumentality, not autonomy." (Waldheim 2016) For Landscape Urbanists, as Waldheim discusses, their pick of landscape as the major medium of urbanism sees its roots built on the canon of regional environmental planning such as Patrick Geddes, Benton McKay, Lewis Mumford, and even Ian McHarg. Waldheim also strengthens his stance on picking landscape as the Landscape Urbanist`s medium of urbanism by stating that,

> landscape is a medium uniquely capable of… temporal change… adaptation… [and] contemporary processes of urbanization… [It] is suited to open-endedness, indeterminacy, [and] change. (Waldheim 2016)

These are some of the major keywords appearing in any Landscape Urbanist discussion. This divergence between Landscape Urbanism and New Urbanism also extends into the discussion of the importance of streets and space definition through edge conditions, both of which are essential to New Urbanists as components of good urbanism. Douglas Kelbaugh explains this distinction between Landscape Urbanism and New Urbanism and the importance of the treatment of the street and space definition through buildings best:

> What [Landscape Urbanism] doesn`t agree about is the "street," especially the "room-like plaza," or street wall of buildings, which is bed rock to New Urbanism. (Duany and Talen 2013)

This leads us to one of the more widely known differences between Landscape Urbanism and New Urbanism, namely the former`s not only tolerance, but in some sense, encouragement of pseudo-suburban and low density urban conditions, and the latter`s despise for such setups. Landscape Urbanism is an admirer of horizontality, and of surfaces, whereas New Urbanism advocates verticality and higher density. In the Charter of the New Urbanism, New Urbanists decry sprawl and the suburbia by stating that New Urbanism is disinterested in "[the] spread of placeless sprawl… [we] stand for… [the] reconfiguration of sprawling suburb." (Talen 2013) They even go as far as to declare New Urbanism`s mission as "the reform of suburban sprawl." (Talen 2013) However, Waldheim believes that urban conditions such as low-density suburbia are part of the urban reality that we must deal with. On this subject, he asserts that,

> New Urbanism is unable to deal with the automobile-based horizontal character of contemporary urbanism. (Waldheim 2016)

Landscape Urbanism takes the "systems approach" rather than a "design guided by intention" approach as its method. Landscape Urbanists base many of their design concepts on ideas such as dynamic processes, temporal change, adaptation, indeterminacy, and flux, and deploy processes and systems through which constant change and morphogenesis is directed towards achieving such goals as ecological performance and wildlife habitat improvement. One of the projects where we can see such process design is the Lower Don Lands project in Toronto, Canada, which, as seen later, is one of the subjects of study in this paper. Waldheim describes the project as one that is after

> opening of the site to… the vicissitudes of tide and time… [and] activating dormant or redundant ecologies. (Waldheim 2016)

He declares that,

> Stoss`s proposal begins with… opening of hydraulic processes… [in this proposal], emergent, submergent, and submerged habitat are multiplied. Stoss`s project proposes a five-fold increase in surface area and watercourses devoted to open-ended and self-regulating fluvial processes. (Waldheim 2016)

On New Urbanism`s side of the story, probably the following quote from the Charter of New Urbanism suffices to explain their take on the issue: "We are not relativists." For New Urbanists, it is all about a determined end product. Duany and Talen clarify and elaborate the idea professing that,

> New Urbanism is limited and pre-occupied. It is about certainty and a determined state versus Landscape Urbanismwhich is about indeterminacy, flux, and open-endedness. (Duany and Talen 2013)

All that being said, Landscape Urbanism and New Urbanism showcase some remarkable similarities as well as stark differences discussed above. One such commonality is both theories' claim on aiming for providing urbanism with optimal ecological performance and environmental friendliness. However, each of the two employ different methods and techniques to achieve this goal. Landscape urbanism, largely concerns itself with the issues of natural and ecological processes, watersheds, storm water and flood management, and wildlife habitats. New Urbanism, approaches the issue by building compact, which preserves as much land and natural resources as possible, as well as parks that provide fresh and clean air.

Another major common issue of concern claimed by both Landscape Urbanism and New Urbanism is the connectivity of the urban fabric. We can see numerous examples in the form of urban infill projects all over the world such the Hellinikon airport redevelopment project in Athens, Greece on the Landscape Urbanism side. On the importance of what this project, as a means to stitch back the urban fabric, sets out to achieve, Waldheim states that the winning scheme for the project "…[reconnects] the higher elevation neighborhoods above with the coast below." (Waldheim 2016) Another example, this time on the New Urbanists` side is the Georgetown Safeway in Washington, D.C, a project which is described by Daniel Solomon as one which "…[mends] the hole in the neighborhood`s urban fabric" (Charter 2013) Although the common theme in reaching the goal of connectivity seems to be the street network, it must be noted that Landscape Urbanism and New Urbanism, because of their inherent formal characteristics, have vastly different looks to streets. Andres Duany and Emily Talen explain that,

> New Urbanism focuses on importance of streets defined by disciplined frontages… believing them to be an essential component of walkability… Landscape Urbanism is more concerned with maintaining a high profile of green space, irrelevant of its effect on street life. (Duany and Talen 2013)

Therefore, as Both Landscape Urbanism and New Urbanism claim to preserve and enhance urban networks, developing an approach to analyzing these claims is a central concern of this paper. This characteristic, as explained in more detail in the "Method" section of this paper is the urbanism theme explored quantitatively in this study.

Despite no lack of comparative literature considering the relatively young debate, there is an obvious absence of considerable literature regarding quantified studies. As such, and considering the quantitative analysis capabilities provided by Space Syntax, this study deals with quantifying Landscape Urbanism and New Urbanism in two case studies in downtown Toronto, Canada to assess how each of these projects perform regarding their success in creating connectivity and the stitching of the urban fabric.

2.0 METHOD

The Landscape Urbanist "Lower Don Lands", located in Toronto, and the New Urbanist "West Don Lands", located also in Toronto, just north of the Lower Don Lands project, were selected for the purposes of this study. These projects were studied and analyzed within an urban context three times as large as their cumulative sizes on each planar dimension.

Figure 1: Lower Don Lands. Source: (Google Earth)

Figure 2: West Don Lands. Source: (Google Earth)

Figure 3: Lower and West Don Lands within context (Axial map)

The Lower Don Lands is an infrastructure waterfront project designed by the Landscape Urbanist firm, Stoss LU in 2007. The site consists of 121 hectares of land on the Toronto waterfront, formerly and majorly consisting of, as per Stoss LU`s statement,

> a tangle of transportation infrastructure, a channelized and deadened river, and large territories of underutilized brownfields and former industrial port lands.

Stoss LU`s proposal seeks to revive the Don river by paying special attention to both flood protection as well as the river`s ecology and hydrology through its restoration as a wildlife habitat. Stoss LU describes another major goal of the project as

> [establishing] a comprehensive urban design framework that integrates new development, bold and image-able transportation infrastructures, dynamic new open spaces, and robust, multi-modal circulation networks (Stoss LU website).

Just north of the Lower Don Lands project and few years earlier in 2004, Urban Design Associates in collaboration with DTAH designed the West Don Lands project, a 32-hectare piece of formerly brownfield lands east of downtown Toronto, now reimagined as “6000 residential units and a wide range of live/work, commercial, retail, and employment space”. This project includes the design of a major park with flood control devices which also, like the Lower Don Lands project, considers itself to be a “critical component of the restoration of the Don River”.

As stated above, the question tackled in this study is, how can one make meaningful and analytical comparison of Landscape Urbanism and New Urbanism using a quantitative method? To answer this question, one must first look for a proven systematic method that equips researchers with measures that can successfully relate to variables that describes issues of study in a case. In this case, Space Syntax provides us with measures such as “mean depth” and “connectivity” that, in a quantified manner, provide a description of integration and connectivity of the urban fabric. There are numerous publications verifying Space Syntax and its capability for assessing integration of the urban fabric. As with the relationship between the street network and block structure being integral, Lim et al. (2015) that the question of how block patterns and street patterns relate is one often asked in the context of Space Syntax. Also, from a morphological standpoint, their assessment that,

> enriching the interface between classic Space Syntax measures and other morphological descriptors of urban form is a research aim which is being pursued with renewed intensity by many scholars in different centers of Space Syntax research (Lim et al. 2015)

seems right on cue and relevant to the question at hand in this study. The use of this method is further verified by Bafna, where he describes the aim of Space Syntax to be

> to develop strategies of description for configured, inhabited spaces (of buildings, settlements, or built complexes) in such a way that their underlying social logic can be enunciated. (Bafna 2003)

Bafna also offers definitions and descriptions of different measures of Space Syntax such as connectivity and mean depth, the two measures used for the purpose of this study.

> One local property that is often used is called connectivity. It is also defined for each spatial unit and is the number of spatial units directly connected to it. (Bafna 2003)

Bafna`s description of depth and its relationship with integration and therefore connectivity of the urban fabric is also of note:

> integration represents the average depth of the spatial unit from all other spatial units within a given system, and hence its value is affected by the entire spatial configuration. (Bafna 2003)

These descriptions help justify their use in the current study. As such, a comparison of the two aforementioned Space Syntax measures in each of the two projects mentioned above should provide us with a means to compare how each project performs regarding this characteristic which is one claimed by both Landscape Urbanism and New Urbanism.

3.0 RESULTS AND DISCUSSION

Apart from "mean depth" and "connectivity" measures in Space Syntax, there are several more measures and tools that might help describe and better understand the two Don Lands projects, especially regarding their perceived characteristics that are associated with the specific urbanism paradigm each of them are born from. What with the nature of this study having to do with street networks, all aspects of urbanism pertaining to street networks may prove relevant. For example, total street length per area represents the street density, a simple measure showing whether New Urbanism, with its much stronger emphasis on the importance of streets, holds true to its promise. This measure is 138.14 meters per hectare for the Lower Don Lands project and 308.57 meters per hectare for the West Don Lands project. With the New Urbanist measure turning out to be over twice as much as its Landscape Urbanist counterpart, we can conclude that the preliminary assertion regarding higher street density for New Urbanism holds true.

Table 1: Quantified Measures

	Lower Don Lands	West Don Lands	Urban Context
Total Street Length/Area	138.14 m/ha	308.57 m/ha	-
Average Block Area	2.52 ha	1.22 ha	-
Number of Blocks/Area	0.4 /ha	0.82 /ha	-
Average Connectivity	3.18	3.99	2.55
Average Depth	8.12	7.47	7.06
Average Integration	1.05	1.17	1.1

Another couple of measures identify with blocks, their number per area, and their average area. Here, it is imperative to provide a valid definition of blocks, as the Lower Don Lands project being a waterfront project, thus proving to be somewhat of an anomaly for the regular block definition. Jennifer Dill offers a fitting definition.

> [Census] blocks are typically defined as the smallest fully enclosed polygon bounded by features such as roads or streams on all sides. (Dill 2004)

Based on this definition, Lower Don Lands has 48 blocks and West Don Lands has 27 blocks, which, according to their respective areas, yields 2.52 and 1.22 hectares as their average block area measures. This could be looked at as another fortifying point for the New Urbanist project as its value of less than half as much as that of the Landscape Urbanist one can be interpreted as more easily handled blocks that have more street frontages. It is also worth noting that nearly all West Don Lands blocks were reasonably close to the average block size of their corresponding project, whereas this number for the Landscape Urbanist project varied significantly more. This can be read as a proof of New Urbanism`s tendency towards more regulated block network system and its conservative nature versus Landscape Urbanism`s more free and rebellious approach in this regard.

Another measured compared regarding blocks was the number of blocks per area. For the Lower Don Lands project, this measure turned out to be 0.4 per hectare and for the West Don Lands project, it was 0.82. Again, the significance difference bears meaningful interpretation. Number of blocks per area can represent number of street segments and subsequently be an account of intersection density which increases choice and speed of access to destinations.

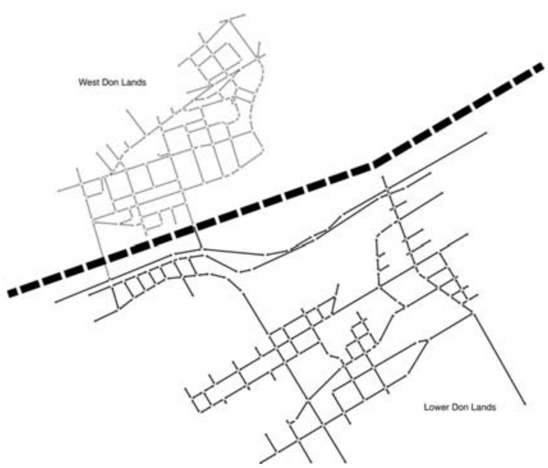

Figure 4: Line Segments

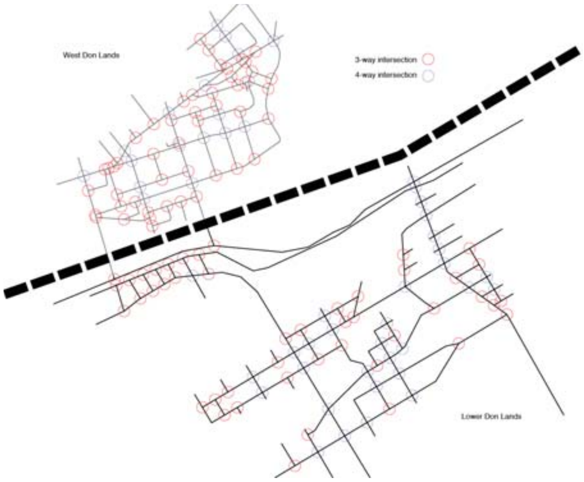

Figure 5: Intersections

To extract the “connectivity” and “mean depth” measures for Space Syntax analysis, the axial map of the context was used to input into the software “DepthmapX-0.50”. Each measure was extracted for the Landscape Urbanist project, the New Urbanist project, and the whole context, and then compared.
It is first appropriate to describe the meaning and significance of each of the two measures in question. Bafna (2003) accurately provides all definitions and applications needed in this study. According to him,

> Depth of one space from another can be directly measured by counting the intervening number of spaces between two spaces. (Bafna 2003)

Based on this definition and considering the purpose of studying our two syntactic measures, the lower the depth, the more an urban condition is successful stitching itself to the surrounding context and achieving connectivity of the urban fabric. That is to say that the lower the depth, there will be less intervening spaces between two spaces, which leads to depth providing a measure that interprets into indirect visibility. According to Table 1, the average depth for the axial line segments representing streets in the Lower Don Lands project is 8.12 and for the West Don Lands project, this number is 7.47, which is a little smaller than the Landscape Urbanist Project, but not so much to meaningfully make a difference. Compared to the whole urban context (7.06), both the Landscape Urbanist and the New Urbanist project offer a higher average depth, which, if taken to mean anything, it means that they possess less connectivity. However, one must consider other parameters such as the fact that a large portion of that urban context on the west side is comprised of downtown Toronto, where there is higher density of intersections and street density. However, if that can directly be translated into intelligibility in terms of way finding is quite a different story.

Figure 6: Mean Depth (Axial Map)

Bafna describes the local property of “connectivity” thus:

> [connectivity is] defined for each spatial unit and is the number of spatial units directly connected to it (which

This means that, contrary to the case with the connectivity measure, the depth value translates to direct visibility, and as such, makes an urban condition more connected to its context, the higher its average depth value. According to Table 1, the average connectivity of the Lower Don Lands project is 3.18 and that of the West Don Lands is 3.99. Again, this is not a large margin of difference, but judging solely on the numbers, one can say that also in this regard, the New Urbanist project is more successful at connecting the urban fabric.

Figure 7: Connectivity (Axial Map)

On the relationship between connectivity, integration, and intelligibility, Bafna asserts that,

> The degree of correlation between connectivity and integration values can be used as a measure of the predictability built into the entire environment and therefore of its intelligibility. (Bafna 2003)

He states that,

> [intelligibility] predicts that a small town whose street network is arranged such that streets that have a high degree of integration connect to more streets on an average, and those streets that are globally segregated connect to fewer streets directly, will be an intelligible town on the whole. (Bafna 2003)

According to Bafna, intelligibility is defined as

> the property of the space that allows a situated or immersed observer to understand it in such a way as to be able to find his or her way around in it, (Bafna 2003)

therefore making it directly related to wayfinding, which is an important cognitive factor of the connectivity of urban fabrics. By looking at the correlation between integration and connectivity in our area of study, one can deduce that overall, this is an intelligible urban condition:

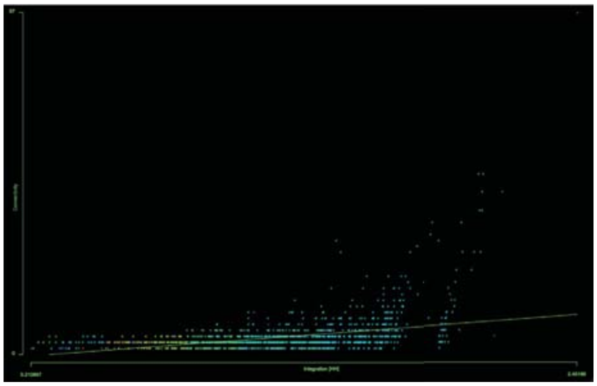

Figure 8: Correlation between Integration and Connectivity

Also, based on Table 1 and considering the integration values of Lower Don Lands and West Don Lands (1.05 and 1.17 respectively) individually in correlation with their corresponding connectivity values yield s almost similar results in terms of intelligibility, with not much of a meaningful difference for the purpose of comparison.

4.0 CONCLUSION

There is still a long way to go to successfully and meaningfully compare Landscape Urbanism and New Urbanism quantitatively. This study aims to try only one of many ways this gap in existing literature can be started to fill and as such, is simply here presented to be an experimentation of the application of one available method – with a quantitative definition of connectivity and integration as one of the many urban themes inherent to the two paradigms- to a comparative analysis of Landscape Urbanism and New Urbanism. Admittedly, there are several shortcomings and limitations to the Space Syntax Method as well as the conditions under which this study has been performed. One such limitation is the individual context under which each of the two projects in this study fall under. When considering connectivity of street networks, it is crucial to have as much of a similar street network context for both projects as possible. The Lower Don Lands project falls under an entirely different urban network context, what with the project sharing boundaries with water on the south and west, a major highway on the north, and not much urbanism on the east. The described condition makes this project an extremely isolated site and therefore more difficult than its New Urbanist counterpart to establish reviving connections with its surrounding context. Further, it should be noted that comparing two broad urbanism agendas like Landscape Urbanism and New Urbanism could never be called comprehensive and definitive by simply comparing two projects representing principles of each, as none of these projects fully represent their respective paradigms.

Another issue that limits the viability and validity of such studies is the lack of available built Landscape Urbanist projects, as this is still a young urbanism paradigm. Also, Landscape Urbanism's nature and purpose significantly differs from that of New Urbanist projects that are more geared towards the built environment and higher density.

As the current literature also suggests, there are serious limitations to the Space Syntax method as well. For example, Vinicius Netto (2016) points to limits of this method regarding the relationship between society and space, which is an inherent and underlying theme to everything that has to do with urbanism. Space Syntax, as with many other methods, also falls prey to heavy reductionism on many fronts, thus making it not comprehensive, and not reliable as a singular method, when drawing conclusions regarding multi-layered, far-reaching themes such as integration and connectivity. Mihai Racu (2016) also points out several inconsistencies within the Space Syntax Methodology that prevent it from being an effective and reliable means for meaningful assessment of urban issues. One issue that has to do with the actual application of the method has to do with the representation of the axial map, which was also used in this study. According to Racu,

> [the representation] process is based on drawing the map using the longest lines and the smallest number of lines, [and] this possibly [leads] to arbitrary results." (Racu 2016)

Therefore, although numbers might suggest that overall, the New Urbanist project is more successful at connecting the urban fabric, the fact that there is not much of a meaningful margin of difference between the numbers that yielded such a conclusion means that the said conclusion must be taken with a grain of salt. The above limitations are all elements that need to be carefully considered when drawing conclusions based on numbers that normally do not have the ability to take these adverse conditions into account.

However, none of this is to say that these types of studies are failed attempts. Quite to the contrary, it is to say that more studies and analyses are to be performed to find the right conditions, measures, and methods to make meaningful comparisons between Landscape Urbanism and New Urbanism and draw valid conclusions.

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Azza Kamal, Jae Yong Suk

Can Environmental Design and Street Lights' Retrofit Affect Crime Trends in San Antonio?

Can Environmental Design and Street Lights' Retrofit Affect Crime Incidents in San Antonio?

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ABSTRACT: The neighborhood planning and street design are two major contributors to the physical environment's implications on safety measures. Natural surveillance, including glazing, lighting, and positioning of non-private areas and access paths inside and outside of buildings, has been studied ever since Oscar Newman and Jane Jacobs writings on successful design of streets with community spaces and observer's control of outside spaces. Various methods and data processing tools are used in the literatures to examine the location's capacity for natural surveillance as a major player in Crime Prevention Through Environmental Design [CPTED] and criteria such as space formation, nighttime lighting and its intensity, and visibility are used to identify crime hotspots. This paper is part of a broader project that examines environmental variables acting as crime generators at the public realm in the City of San Antonio [CoSA], and it focuses on drug, property, and violent [DPV] crimes reported for the period from 2012 to 2016. The study area is comprised of ten-neighborhood alongside the historic corridor of Fredericksburg Rd. Using geoprocessing tools of Geographic Information Systems, the method included univariate analysis of five environmental design variables: land use, street network, major transportation corridors, public spaces (parks and bus stops buffers), and street lights. Variables were triangulated with crime hotspots and the results showed that two neighborhoods (Gardendale and Five Points) have endured perseverance of crime hotspots from 2012 to 2016 in areas where multiple variables non-grid street network, parks, highway underpass, and a mix of commercial, industrial and multifamily land use were detected. When these variables exist in one location, they acted as crime-generators and created situational crime areas with intensity of crimes in public open space. The study provides a pathway for further examining -through qualitative data and micro scale analysis- to intervene in policy and design of public space in order to mitigate the likelihood of crime occurrence and endurance.

KEYWORDS: Crime, Environmental Design, Land Use, Street Network, and Street lights

INTRODUCTION

The neighborhood planning and street design are two major contributors to the physical environment's implications on safety measures. The modern interpretation of crime prevention through environmental design [CPTED] has been discussed in published scholarly work in the fields of urban and environmental design, criminology, and social theory (Ekblom, 2011; Cozens and Love, 2015; Sakip et al., 2012; Minnery and Lim, 2005; Marzbali et al., 2012; Lee et al., 2016). In most literature, elements defining CPTED stemmed from the Jane Jacobs' narrative on what made a city safe including high pedestrianism and clear public private distinction, and from Oscar Newman's defensible space which suggests different urban design tools for leveraging crime prevention. Some studies (Lee et al., 2016 and Marzbali et al., 2012) defined several elements of the CPTED that would significantly reduce perception of fear of crime including: access control, surveillance, maintenance, parks and community centers, and territoriality. According to the National Guidelines for CPTED of New Zealand's Ministry of Justice (2005), there are seven qualities that characterize well designed and safe places. These qualities are: 1) access through safe movement and connections; 2) surveillance and sightlines; 3) layout: clear and logical orientation; 4) activity mix; 5) sense of ownership through caring for the place; 6) well-designed environments; and 7) physical protection using active security measure.

In urban planning and design, territoriality has been applied by Jacobs, and then by Newman to places with close social networks can develop voluntary community guardianship. According to Newman, residents' developing territoriality through increased visibility of public spaces. His concept is that spaces controlled by its own residents with the sense of community are more effective in maintaining safe neighborhood than police enforcement. Natural surveillance, including glazing, lighting, and positioning of non-private areas and access paths inside and outside of buildings, has been thoroughly studied ever since Newman and Jacobs writings.

The literature also discussed another, equally important, contributor to crime prevention attributes, which is land use. Researchers have also warned that the unplanned growth without studying the implications of land use may increase crime rates. The works of Hirschfield (2008), Ludin et al. (2013), Sypion-Dutkowska (2017), and Loukaitou-Sideris et al. (2001) have also discussed land use as a factor that could influence crime opportunity, and some studies suggested that policy-makers should examine potential areas of growth using GIS technology to strategically plan for future growth. Hirschfield (2008) also discussed the need to study the areas with ease of accessibility as they increase crime opportunities, and thus act as crime generators. These areas encompass the following elements: bus stations, road junctions, and the edges of urban areas according to crime pattern theory (Hirschfield, 2008). Changes in these elements are referred to as situational crime prevention approach, which is defined by Clarke (1997) as a strategy that focuses on crime settings, rather than those committing the crimes. It is therefore an approach that seeks to anticipate the occurrence of crime based on the analysis of environmental design elements, and thus can make the environment less appealing to offenders.

Beside CPTED physical components, sociologists have discussed social development theory, which support the role of urban lighting in providing a milieu for human interaction and feelings of safety at night time. During night time, street lights has a greater weight in natural surveillance measures and therefore it could impact the sense of safety and contribute to crime prevention endeavors. Kyttä et al. (2013) studied the impact of both the social qualities and design characteristics of the neighborhood on perceived safety of residents as well as perceived levels of crime. The study concluded that, because of their density and design qualities, and access to smaller open spaces, urban infills could help change distressed development by increasing the level of perceived safety.

Improvement of street lighting has been a popular strategy for improving community safety and reducing the fear of crime. This reflects a shift towards situational crime prevention using environmental improvements to reduce the fear and eliminate opportunities for crime. Nonetheless, studies by Gilling (1997), Koskela and Pain (2000), and Walklate (1989) criticized this approach by indicating that it evades the deeper implications of socio-economic causes of crime, yet it can reduce crime and fear in certain areas (Clarke, 1992; Oc and Tiesdell, 1997). Other studies argued that improvements of street lights is resulted in both day-time and night-time crime reductions, which might not be due to deterrence, but because of an increased sense of ownership and community pride (Pease, 1999). This argument is supported by other findings as Farrington and Welsh (2002) explained that street lights normally work best in stable and well-maintained communities.

Improvement of street lights was incorporated in the UK as a nationwide initiative that involved six cities, where the effect of retrofitting lighting sources was examined for its potential effect on crime and sense of safety. Herbert and Davidson’s (1994) research focused on two of these six cities, Hull and Cardiff, where in both the type of light sources and location of the street lighting poles increased the sense of safety in the two areas of study. In the same study, the authors divided the types of social problems into four categories: incivilities, crimes, insecurities, and services, where the effect of street lights changes was measured.

In San Antonio, a crime rate of 56 per one thousand residents (82,784 total crimes) made the city one of the highest crime rates in America compared to all communities of all sizes - from the smallest towns to the very largest cities (Neighborhood Scout, 2017). One's chance of becoming a victim of either violent or property crime in San Antonio is one in 18, which is higher than 96% of communities across Texas.

This paper is part of a broader project that looks into the changes in reported crime incidents in the inner city and urban corridors of the (City of San Antonio CoSA, Texas. Nonetheless, it focuses on crimes reported between 2012 and 2016. The paper focuses on a geographic area along one of the historic corridors, named Fredericksburg Road. To determine the study variables, a thorough review of the literature discussing crime prevention through/and association with environmental design variables was conducted. 20 papers were reviewed in this process, which resulted in two approaches of analyzing nighttime street lights. While in one approach adopted by several authors (i.e. Katyal, 2002 and Loukaitou-Sideris et al., 2001), street light was a component of environmental design variables, other authors (i.e. Shaw, 2014 and Steinbach et al., 2015) separated street light from other environmental design variables. It is worth mentioning that this disparity is due to the complexity of nighttime street lights impacts on crime.

In the first approach, street lights were considered with regard to the physical domain of light poles and their characteristics (i.e. location, height, source type, wattage, etc.), all of which are physically-measurable attributes through the utility companies or the municipalities and, thus, were part of the environmental design variables. In the second approach, street lights were considered a factor contributing to the sense of safety and reduced fear of crime, and therefore they were separated from environmental design variables. In this paper, physical attributes of street lights (i.e. location and wattage) are integral part of environmental design variables. With this decision, the approach of Ostrom (1976), Lee et al. (2016), Marzbali et al. (2012), Kim and Park (2017), Herbert and Davidson (1994), and Kyttä et al. (2013) was adopted.

1.0 METHOD

There are various methods and tools to examine the location's capacity for natural surveillance as a major player in crime prevention through environmental design. Both quantitative and qualitative methods including surveys and interviews were used to assess environmental design of the context of crime locations, and various criteria pertaining to space configuration, nighttime lighting intensity and light source type, and building and street configurations comprise primary features contributing to the creation of crime hotspots in specific locales. The geographic scope of the inner city of San Antonio, where most of older developments and variations of transit corridors exist, was selected to examine the impact of retrofitting street lighting and other environmental design facets on crime incidents. The new LED for street lights were installed in San Antonio throughout 2013, and thus for examining the impact of street light transitions, 2013 data was excluded from the analysis. Crime data CoSA was obtained from the year of 2012 through 2016 and were split into two categories: 1) crimes occurred before installation date of LED source, and 2) crimes occurred after installation.

1.1. Study Area

This paper focuses on the selected neighborhoods representing the geographic scope of 16 neighborhoods along the Fredericksburg Road. Selection criteria for the pilot neighborhoods were based on built environment attributes deemed associated with situational crime theory discussed in the literature. These attributes include: 1) availability of data on street lights by installation dates; 2) balance between mix of non-residential uses within the residential-only areas; 3) proximity to major transportation corridor (i.e. Interstate-10 or Interstate-410); and 4) proximity to areas with concentration of night life activities.

1.2. Study Variables

In their studies of the association of built environment variables including land use, Canter (1999), Ludin et al. (2013), and Sypion-Dutkowska and Leitner (2017) have praised the importance of using reliable data sources and tools that can identify patterns and spatial distributions of crimes. These three studies utilized Geographic Information Systems (GIS). Canter (1999) also discussed how the careful analysis of crime pattern, situation, and trend can be utilized to support policy decision making and allocate resources to determine the effectiveness of crime deterring strategies. Several spatial analysis models were also used in crime analysis.

Five themes comprising all variables discussed in more than 20 studies were concluded. The five themes are: 1) land use and zoning, 2) transportation and transit routes, 3) urban form and territoriality, 4) surveillance and crime generators, 5) socio-economic status, and 6) nighttime lighting. With the exception of the socio-economic status, selected variables in each of these themes, as shown in figure 2, were selected for this paper and were mapped using GIS. Socio-economic status was considered controlled variables for this paper, leaving only selected CPTED variables to be examined. In future, the authors will be integrating socio-economic variables as dependent variables. Variables used in this study encompassed the following:

Independent Variables

1) Land use: residential, commercial, industrials, etc.;
2) Street network: grid vs. non-grid/diagonal
3) Territoriality and major transportation corridors: interstates/highways;
4) Public open spaces: community parks, and bus stops buffers;
5) Natural surveillance: street lights (type of source and pole location)

Dependent Variable

Crime incidents that are likely to take place in the public view. Thus, only reported drug, property, and violent crimes [DPV were selected for this analysis. Areas with low -and no- counts of DPV crimes were omitted from the geographic scope of the 16 neighborhoods, which yielded only ten neighborhoods identified as the pilot study area (see Figure 1).

Figure1: Fredericksburg corridor and the ten selected neighborhoods for the study area in San Antonio, TX.

1.3. GIS for mapping variables and crime hotspots

All selected variables were mapped individually using ArcGIS 10.5.1 (ESRI, 2017) and a univariate analysis was conducted for each variable: land use, street network, bus stops buffers, parks buffers, highways buffers, street lights, and DPV crime incidents for 2012, 2014, 2015, and 2016. The analysis encompassed the following tools and measures, which are also illustrated in the workflow shown in Figure 2:

- A vector polygon layer of land use was analyzed by using ordinal measures of the standard Land-Based Classification Standards (LBCS) developed by the American Planning Association.
- A vector line layer of street network was classified using ordinal scale- into three categories: 1) grid, grid-edge, 2) non-grid intersection, 3) non-grid edges.
- Vector point layer of bus stops and polygon layer of parks were analyzed using geoprocessing tools of GIS. A 250 m (820 ft) buffer for parks and a 100 m (328 ft) buffer for bus stops were created to examine likelihood of crime occurrence in the vicinity of these features as public open spaces.
- Highways (transportation corridors with high traffic volume) were analyzed using a 250 m (820 ft) buffer around the two major highways adjacent to the study area: Interstate 10 (IH-10) Interstate 410 (Loop 410).
- Street lights' vector point layer was analyzed to create a heat map using kernel-density spatial analyst tool, and a seven-class categorical raster output was created. Kernel analyst was chosen for this analysis because its use of algorithm that allows for better weighting of highly dense points and its associated smoother outputs.
- Vector point layers of the DPV crime incidents reported in 2012, 2014, 2015, and 2016 were analyzed to create a heat map using kernel-density spatial analyst tool. Only crimes occurred during nighttime, between 6:00 pm to 6:00 am, were included, and crimes reported outside of this time were excluded. Seven-class categorical raster output was created. 2013 data was removed from the analysis due to the major LED lights retrofit that took place during 2013.

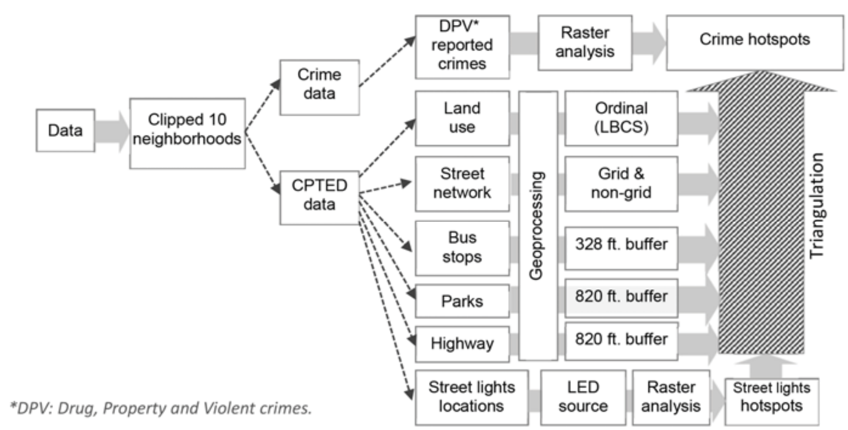

Figure 2: Workflow of the analysis and processing models of environmental design and DPV crime incident variables.

Following the univariate analysis using vector and raster data processing tools, cross examinations of the environmental design variables (land use, street network, highways, parks and bus stops/buffers) with the heat map of crime incidents was conducted. To assess the relationship between LED street lights and the location of crime hotspots, we cross-examined compared the crime heat maps of 2012 (pre-LED retrofit) with crime heat maps of 2014, 2015, and 2016. With this triangulation, it was possible to observe patterns, including perseverance and shifts, of some locations of crime hotspots as well as their relationships with different environmental design variables including nighttime street lights as discussed in the following section.

2.0 RESULTS AND DISCUSSIONS

2.1. Univariate Analysis

The univariate analysis of the selected environmental design variables revealed the following characteristics of the study area (see Figure 3). Univariate analyses were cross-examined with the raster outputs of DPV crime hotspots:

Land use: A concentration of commercial land uses is evident on both sides of Fredericksburg Road. along Maverick, Los Angeles Heights, Montecillo Park, Keystone, and Gefferson neighborhoods. Other areas where commercial activities are concentrated are: 1) south side of Alta Vita neighborhood, 2) North-west portion of Five Points neighborhood, where commercial and mixed land-use dominates land uses, 3) around Interstate 10 in Gardendale neighborhood, 4) intersection of Gefferson, Woodland Lake, and Monticello Park neighborhoods, and 5) west side of Gardendale neighborhood, and 5) north and east edges of Beacon Hill and Alta Vista neighborhoods respectively.

Street network and Highways: Most of residential blocks of the study area are stemmed from a grid network, however, in Five Points and Maverick neighborhoods, non-grid system represented the majority of street network. These two neighborhoods are located in the north and south sides of the study area. At Gardendale's east side as well as the intersection of Keystone, Monticello Park, and Woodlawn Park neighborhoods, street network was also based on non-grid system. The latter had a big box structure of the local grocery store, known as HEB.

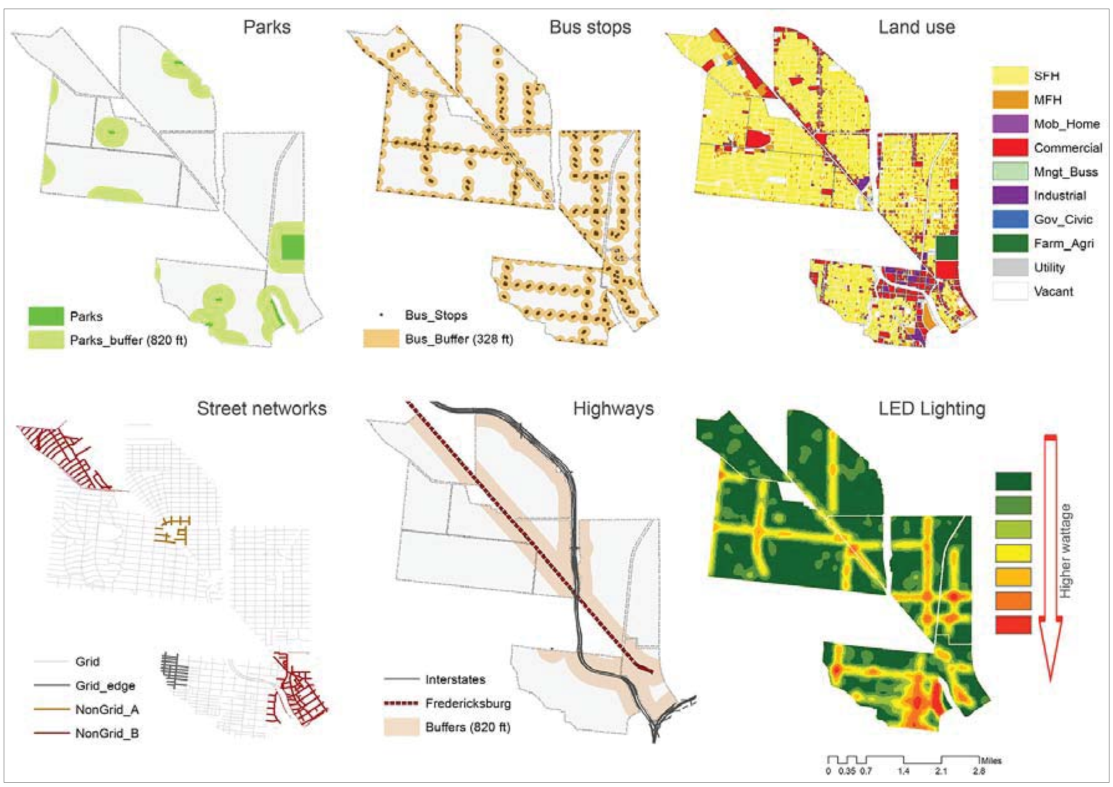

Figure 3: Univariate spatial analysis results for CPTED and street lights around Fredericksburg Corridor

Public open spaces: There are three parks inside the study area, and six parks on its edge. A 250 m (820 ft.) buffer around parks and a 100 m (328 ft.) buffer around bus stops was also created using ArcGIS geoprocessing tools (see Figure 3). Based on Anderson et al. (2013), these buffers normally act as crime generators, and thus create a situational crime opportunity as discussed in the introduction section of this paper. Therefore, the buffers were cross-examined with DPV crime hotspots and the results are discussed in the data triangulation section.

Interstates: There are two interstates, IH-10 and IH-410, pass-by and intersect with the study area. A 250 m (820 ft.) buffer around each was created using ArcGIS geoprocessing tools.

Street lights: Focusing on the watt-value of each LED street light source, a raster dot kernel-density analysis was performed on street lights layer. Figure 3 shows the aster output of this analysis including an overview of the concentration of LED lamps along main commercial and mixed-use streets, with higher wattage detected in the commercial areas, west of IH 10 in Gardendale as well as along the commercial corridor in Beacon Hill neighbourhood. It's worth mentioning that LED lamps was ranging from 100 to 400 watts. LED raster output was cross-examined with crime heat maps as discussed in the triangulation section.

2.2. Crime Hotspots

Using GIS spatial analyst tools, kernel-density analysis was performed on the point data of the DPV crimes (for 2012, 2014, 2015, and 2016) to create crime heat maps using seven-class scale to show areas with least crime concentration to areas with maximum concentration of crimes. In Figure 4, crime heat maps show a scale ranges from green to red, where red indicates the highest crime concentration in a cell size of 50 ft, and dark green is designated for the least concentration of crime incidents for the same cell size. The maps present a location-based profiling for areas with tenacious DPV crimes, which are indicated in red and orange- within the study area.

By comparing the location and intensity of crime hotspots across the study area from 2012 to 2016, an overall decline in the magnitude of DPV crimes reported at the intersection of Montecillo, Los Angeles Heights, and Keystone was evident. It is also noticed that both south portion of Five Points and south-east sides of Gardendale are obstinate with relatively high crime magnitude despite the drop in severity of crime concentration (from red to orange according to the crime concentration scale). Area located on the northwest portion of Gardendale showed a persistence of crime concentration, despite a slight drop in 2015. Along different segments of Fredericksburg Road, it was clear that a low to moderate crime magnitude was evident, and a drop in severe hotspots was detected particularly in 2014 and 2015.

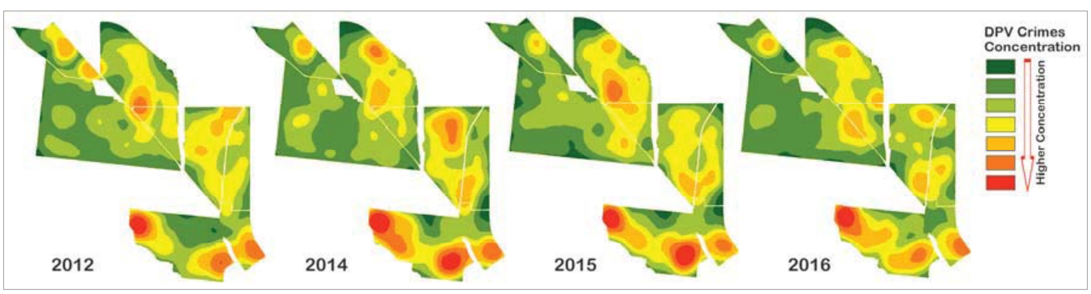

Figure 4: Heat maps of DPV crimes in the study area around Fredericksburg Corridor.

2.3. Data Triangulation

The univariate analysis maps were cross-examined with the raster output of DPV crimes hotspots. Each univariate map was separately examined for association with severe to moderate hotspots (shown in Figure 4 in red, orange and yellow respectively). Areas of the univariate map that proved a strong association with crime magnitude were designated as crime generators. Applying this triangulation process on the six univariate maps (land use, street network, bus stop buffer, park and park buffer, highway buffer, and LED street lights) showed that when a single variable coincide with the crime analysis, not clear evidence of association between both was detected. Only when commercial and/or mixed-use areas were examined, a partial association between commercial/mixed-use area and moderate crime hotspots was evident mostly in southeast and northwest portions of Gardendale. Additionally, LED wattage concentration had an inverse-association with moderate to severe DPV crime hotspots. Primary areas where high and moderate crimes from 2012 to 2016 were identified encompass:

- Northwest and east portions of Gardendale
- South portion of Five Points

Gardendale and Five Points neighborhoods are located north of the intersection of I-10 and I-410. Areas within the two neighborhoods where multiple variables overlapped resulted in severe to moderate crime hotspots. These hotspots are associated with the interstate I-10 buffer, non-grid street network, park and bus stops buffers, and mixed-use area. However, in the two neighborohoods, there is no evidence of the association of these hotspots with LED wattage. In Five Points, LED higher wattage concentration was associated with moderate to low crimes, however, in this part of the neighbourhood (Five Points), there were other variables exist including interstate buffer, bus stops buffers, and non-grid. In the south portion of Gardendale, LED wattage concentration was associated with high to moderate crime hotspots, however, in this area there was also mixed-use and bus stops buffers.

It is worth mentioning that even though the utility company has retrofitted the light sources across the study area from High Pressure Sodium Vapor to LED during 2013, changes in crime severity were not detected in 2014, rather in 2016 with one persistently high crime area located in the northwest portion of Gardendale. This portion of the neighborhood encompassed a concentration of commercial and mixed-use areas, park buffer, bus stops buffers, yet, it is a grid street network with lower wattage LED sources. From this analysis, it is clear that a significant association of environmental design variables and DPV crime is detected when multiple variables overlap, and thus act as crime generators.

CONCLUSION

The study provides evidence that when multiple environmental design variables exist in an area, they validate the crime generators theory of Katyal, N. K. (2002) and Hirschfield, A. (2008), and thus act to incite drug, property, and violent crimes. LED street lights, particularly with higher wattage showed less association with severe to high crimes across the study timeline. Only in southeast portion of Gardendale neighbourhood, LED street lights were associated with the magnitude of crime that continued to decrease (from high in 2014 and 2015 to moderate in 2016). When combined, the following variables showed significant associations with high to moderate crime incidents: commercial and mixed-land use, open spaces around parks and bus stops, non-grid street network, highway buffers, and sparse LED street lights. A further analysis is needed through allocated a different weight for each variable to identify variables with higher association with crime.

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Jae Yong Suk, Rebecca Walter

Street Lighting and Public Safety: New Nighttime Lighting Documentation Method

Street Lighting and Public Safety: New Nighttime Lighting Documentation Method

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ABSTRACT: While the rapid transition of street lighting technologies is occurring across the country for its promising benefits of high energy efficiency, higher intensity, long lamp life, and low maintenance, there is a lack of understanding on the impacts from street lighting's physical characteristics on public safety. Nighttime lighting and its impact on the incidence of crime and roadway accidents has been investigated since the 1960s in the United States and the United Kingdom. However, prior research has not presented any scientific evidence such as quantified lighting characteristic data and its impacts on public safety because they relied on subjective survey inputs or over-simplified quantification of nighttime lighting conditions. To overcome the limitation of previous studies, extensive documentation of street lighting characteristics was conducted in downtown San Antonio, Texas, which adopts both conventional and new street lighting technologies. Two different sets of light level data were collected on roadways in order to measure the amount of light falling on the ground and on drivers' eyes inside a car. Correlated color temperature and a color rendering index of nighttime lighting were recorded. The collected lighting data was mapped in a Geographic Information Systems database in order to spatially analyze lighting characteristics. The paper first highlights the potential issues with lighting analysis in previous studies. Next, the proposed research methodology to address these issues for both data collection and spatial analyses is explained. Finally, the preliminary documentation and analysis of street lighting characteristics are presented.

KEYWORDS: street lighting, public safety, nighttime environment, LED, High Pressure Sodium

INTRODUCTION

Currently, 10% of existing street lighting in the United States has been converted to Light Emitting Diode (LED) lighting technology with promising benefits for energy efficiency, higher intensity, long lamp life, and low maintenance (Kraus, 2016). While the rapid transition of street lighting technologies from conventional high pressure sodium (HPS) or metal halide (MH) to LED occurs across the country, there is lack of understanding on the impacts from street lighting's physical characteristics on public safety and security. Nighttime lighting and its impact on the incidence of crime and roadway accidents has been investigated since the 1960s in the United States and the United Kingdom. Previous research claims that brighter nighttime lighting environments do not simply guarantee positive impacts on public safety at night. On the contrary, excessive and uncontrolled street lighting can even cause negative impacts to communities. Discomfort or disability glare from unshielded or poorly designed street lighting can reduce human eye visibility at night that eventually decreases levels of safety and creates roadway hazards (Gibbons and Edwards, 2007; Lin et. al., 2014; Tyukhova, 2015). In 2016, the American Medical Association (AMA) Council on Science and Public Health concluded that pervasive use of nighttime lighting creates potentially harmful effects related to discomfort and disability glare and addressed the urgent need for more extensive research on lighting's impact on human health and safety, particularly in the rapid transitions and installations of new lighting technology (Kraus, 2016).

After reviewing a number of previous research studies on the topic, two potential issues were identified. First, the studies misinterpreted increased light levels or increased number of street lighting as improved nighttime lighting conditions. This oversimplified interpretation of improved nighttime lighting conditions caused other important lighting characteristics to be overlooked. Improvement of the nighttime lighting environment should be determined by a level of nighttime visibility and visual comfort instead of the number of streetlight poles. Secondly, subjective survey inputs from community residents were relied on without collecting and analyzing quantifiable lighting characteristics such as illuminance, luminance, uniformity, color temperature, and the color rendering index. For instance, a Chicago Alley Lighting Project study considered how many new lighting fixtures were added to an experimental area compared to a controlled area. No fixture location, illuminance levels, uniformity, color temperature, and beam optic data were documented or analyzed (Morrow and Hutton, 2000). Also, the AMA report was generated by literature reviews and lab tests without collecting or measuring physical characteristics of street lighting such as light spectrum, amount of light, duration of exposure, spatial distribution, and timing (Rea and Figueiro, 2016). These examples clearly show that more in-depth analysis on physical characteristics of lighting is required to truly understand street lighting's role on public safety.

Across the United States, there is on-going efforts to improve nighttime lighting environments and energy efficiency. Recently developed communities already have advanced lighting systems such as LED lighting technology to provide a higher energy efficiency and longer life while conventional lighting technologies, such as HPS or normal MH, are common in existing communities. However, existing communities have been rapidly replacing conventional lighting to new lighting technology. It is imperative to fully understand the impacts and consequences from this lighting transition. To overcome the limitation of previous studies, extensive documentation of street lighting characteristics was conducted in downtown San Antonio, Texas, which adopts both conventional and new street lighting technologies. Two different sets of light level data were collected on roadways in order to measure the amount of light falling on the ground and on a drivers' eyes inside a car. Correlated color temperature and a color rendering index of nighttime lighting were recorded. The collected lighting data was mapped in a Geographic Information Systems database in order to spatially analyze lighting characteristics.

The City of San Antonio has a city-wide street lighting redevelopment plan which will eventually introduce new LED lighting technology throughout the entire city. This redevelopment project provides an opportunity to use San Antonio as a case study. While the redevelopment plan is being implemented, the City of San Antonio has also created a working group to evaluate and develop a new dark sky policy in San Antonio. Dark sky is a worldwide effort to minimize the negative influence of street and architectural lighting on nighttime environments. The policy has been incorporated into the building codes and standards of major cities. It is crucial to measure the current status of nighttime lighting conditions in San Antonio and to evaluate the need for new guidelines to limit the amount of man-made light pollution into the nighttime sky. The findings from the study will also help validate and improve existing lighting guidelines of roadways, sidewalks, and public spaces.

EXISTING STREETLIGHT GUILDELINES

Currently, street lighting design and installations are determined by the pre-determined horizontal illuminance levels and uniformity ratios on roadways and sidewalks, which were developed by the Illuminating Engineering Society of North America (IESNA) and approved by the American National Standards Institute (ANSI). ANSI/IESNA RP-8-00 Roadway Lighting Guidance recommends to provide a range of 3.0 to 17.0 lux of average maintained horizontal illuminance level on local, collector, and major roadways (Table 1). It also recommends the roadways to maintain 3:1, 4:1, or 6:1 uniformity ratio between average and minimum illuminance levels depending on roadway types. This recommendation varies depending on the roadway type, pedestrian conflict potential, and road pavement classifications (Table 1).

Table 1: American National Standard Practice for Roadway Lighting ANSI/IESNA RP-8-00

Road	*Pedestrian conflict area*	*Average maintained illuminance*			*Illuminance uniformity ratio E_{avg}/E_{min}*
		R1	R2/R3	*R4*	
	High	12.0 lux	17.0 lux	15.0 lux	
Major	Medium	9.0 lux	13.0 lux	11.0 lux	3:1
	Low	6.0 lux	9.0 lux	8.0 lux	
	High	8.0 lux	12.0 lux	10.0 lux	
Collector	Medium	6.0 lux	9.0 lux	8.0 lux	4:1
	Low	4.0 lux	6.0 lux	5.0 lux	
	High	6.0 lux	9.0 lux	8.0 lux	
Local	Medium	5.0 lux	7.0 lux	6.0 lux	6:1
	Low	3.0 lux	4.0 lux	4.0 lux	

Besides ANSI/IESNA RP-8-00 Roadway Lighting Guidance, American Association of State Highway and Transportation Officials (AASHTO) Roadway Lighting Design Guide is referenced when streetlights are designed and installed on roadways. It shows similar recommendations as ANSI/IESNA guidelines but there are slight differences in required illuminance levels and uniformity ratios. Based on the roadway classifications, including secondary arterial, collectors, and local roads, AASHTO recommends average maintained horizontal illuminance levels ranging from 3.0 lux to 14.0 lux (Table 2). Also, a 4:1 or 6:1 uniformity ratio between average and minimum illuminance levels is recommended.

Table 2: AASHTO Roadway Lighting Design Guide

Roadway classification	*General land use*	*Average maintained illuminance*			*Minimum illuminance*	*Illuminance uniformity ratio avg./min.(max)*
		R1	R2/R3	*R4*		
Minor Arterials	Commercial Intermediate Residential	9.0 lux 8.0 lux 5.0 lux	14.0 lux 10.0 lux 7.0 lux	10.0 lux 9.0 lux 7.0 lux	As uniformity ratio allows	4:1
Collectors	Commercial Intermediate Residential	8.0 lux 6.0 lux 4.0 lux	11.0 lux 8.0 lux 6.0 lux	9.0 lux 8.0 lux 5.0 lux	As uniformity ratio allows	4:1
Local	Commercial Intermediate Residential	6.0 lux 5.0 lux 3.0 lux	8.0 lux 7.0 lux 4.0 lux	8.0 lux 6.0 lux 4.0 lux	As uniformity ratio allows	6:1

These existing guidelines are effective to determine the efficiency and evenness of street lighting design and installations. However, the guidelines do not consider the human biological response such as the level of visibility, potential discomfort or disability glare, light color perception, etc. In other words, public safety of nighttime environments cannot be guaranteed or ensured by simply meeting the guidelines. Other critical factors such as light color temperature, the color rendering index, and vertical illuminance levels on people's face should be considered to increase and enhance safety at night.

METHODOLOGY

The objective of this project is to determine if a correlation between quantifiable street lighting characteristics and public safety exists. In order to achieve this objective, extensive documentation of street lighting characteristics is presented in this paper to understand the existing street lighting characteristics in downtown San Antonio neighborhoods (Figure 1). Neighborhoods in downtown San Antonio were selected based on the types and locations of existing street lighting. Surrounded by major express ways, the selected neighborhoods include various zoning districts such as downtown, commercial, industrial, infill development, and residential districts. Based on existing street lighting data provided by CPS Energy, the project has a mixture of conventional and new lighting technologies and various lighting characteristics. The existing nighttime lighting environments in the selected area are documented and evaluated in a GIS.

Based on the roadway classification of the City of San Antonio, the project scope includes the roadways classified as major (or arterials), collectors, and local roads. Santa Rosa Avenue, South Alamo Street, and Cesar Chavez Boulevard are examples of major roadways (arterials). The remaining roadways in the project scope are either collector or local roadways. Express ways are not included within the project boundary.

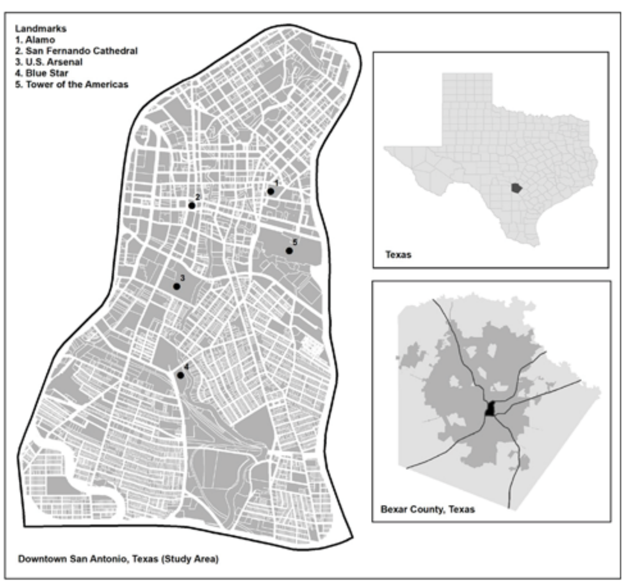

Figure 1: Selected project scope in downtown San Antonio

The following lighting documentation methodologies were utilized. Two different sets of light level data were collected on the roadways: horizontal illuminance levels at the ground level and vertical illuminance levels at the human eye height. These two illuminance data sets measure the amount of light falling on the ground and on the eyes of a driver inside a car. Correlated color temperature and a color rendering index of nighttime lighting is recorded at different locations within the project scope. The collected data was entered into the GIS database in order to analyze spatially the lighting characteristics which will be used in a future study to examine the relation to the incident rates and locations of both crime and roadway accidents.

For illuminance level measurements, one Li-Cor photometric sensor was mounted on a car to measure horizontal illuminance levels arriving on the roadway at 1 second intervals. Another Li-Cor photometric sensor was mounted inside a car simultaneously to measure vertical illuminance levels arriving at a driver's eye position. Both photometric sensors were connected to a Li-Cor LI-1500 data logger with a Global Positioning System (GPS) tracking function for data storage. Illuminance level measurements were made in multiple site visits during the nighttime. Driving routes were carefully planned by using Google Drive in order to avoid measuring the same roads multiple times and also to ensure driving directions and road closures in advance. The entire project scope was divided into seven different sections and a total of seven site measurements were made between November 1st, 2017 and December 14th, 2017. Each field measurement began after sunset (after 8:00PM) and took at least three hours to cover every single roads and alleyways in each section of the project scope.

Correlated color temperature and a color rendering index were measured by using Sekonic Spectromaster C-700. Different from the photometric sensors and datalogger utilized for illuminance measurements, the spectrometer is a hand-held device without data logging capability and GPS tracking function. Measurement locations were determined based on the streetlight types so that typical light color temperature and CRI values from each type of the streetlights can be recorded. Multiple measurements were made for each type of HPS, LED, MH, and Sodium Vapor streetlights. The ranges of measured color temperature and CRI values were then organized for analysis.

RESULTS AND ANALYSIS

Streetlight data obtained from CPS Energy was analyzed in order to understand the types of streetlight luminaires and their performance specifications. As of November 17th, 2017, a total of 119,714 streetlights exist in the City of San Antonio. Within the selected project scope of downtown San Antonio, a total of 3,061 streetlights have been installed. Table 3 shows the quantity and percent share of each installed streetlight lamp type including HPS, LED, MH, and Sodium Vapor. HPS streetlight is still a dominant type in the project scope. Currently, 32% of the total streetlights include various LED sources. The number of LEDs is expected to increase in the coming years due to the city-wide street lighting redevelopment plan.

Table 3: Streetlight lamp types in downtown San Antonio (CPS Energy 2017)

Lamp Type	*Count*	*Percent*
High Pressure Sodium	1,666	54.43%
LED	981	32.05%
Metal Halide	381	12.45%
Sodium Vapor	25	0.82%
Missing Data	8	0.26%

Different lamp wattages ranging from 100 Watts to 1,000 Watts are being used in the existing streetlights. HPS streetlight lamps are in 100W, 150W, 175W, 250W, 400W, and 1000W. MH streetlights are in 100W, 175W, 250W, and 400W. 40W, 96W, and 160W. LEDs were installed to replace the conventional HPS and MH streetlights. In prior studies, it was believed that a higher lamp wattage would improve nighttime lighting environments as it helps to make streets brighter. While lamp wattage determines lumen outputs from streetlights, it cannot be the only factor to determine whether nighttime lighting conditions are improved or not. Other lighting characteristics such as beam optic, color temperature, and CRI should also be considered to determine improved visual acuity and visual comfort at night.

Streetlight pole heights vary depending on the roadway types. Streetlights are mounted at 9.7 meters (32 ft) above ground at major and collector roadways while they are at 7.9 meters (26 ft) from the ground level on local roadways. Major roadways have 400W, collectors have 250W, and local roadways have 100W streetlights. The streetlight lamp specifications were also obtained from CPS Energy. HPS and LED streetlight specifications are described in Table 4. MH and Sodium Vapor streetlight specifications were not available.

Both HPS and LED streetlights are very efficient and generate around 100 lumens per watt. However, it is important to understand that initial lumens of HPS streetlights are lamp lumens, which are different from fixture lumens of LED streetlights. As light generated from HPS lamps passes through system enclosures, the amount of light decreases. It makes fixture lumens of HPS streetlights lower than fixture lumens of LED streetlights. HPS lamp color temperatures vary depending on manufacturers but it is known that HPS lamps typically produce very low (warm) light color temperatures around 2,500K and 2,700K with low color rendering index values. LED streetlights in the project scope have 4,100K correlated color temperature. Based on the specification comparisons, it is possible to conclude that LED streetlights are more energy efficient than HPS streetlights and also provide higher (cooler) color temperature and higher CRI values which help improve visual acuity in nighttime environments.

Table 4: Streetlight specifications of HPS and LED pole luminaires (CPS Energy 2017)

Lamp Type	*Watt*	*Lumens*	*Correlated color temperature*
High Pressure Sodium	100	9,500 (lamp)	N/A
	150	16,000 (lamp)	
	250	25,000 (lamp)	
	400	47,000 (lamp)	
LED	40	3,600 (fixture)	4,100K
	96	7,500 (fixture)	4,100K
	160	14,619 (fixture)	4,100K

Figure 2 shows streetlight types and locations within the project boundary. Red dots represent HPS streetlight locations and blue dots represent LED streetlights. Yellow dots are MH streetlights and purple dots are Sodium Vapor. All four types of streetlights are mixed in the downtown district (top half of the map). HPS and LED streetlights are randomly mixed in residential, commercial, and industrial districts (bottom half of the map). It is obvious that the downtown district has very dense streetlight installations on roadways compared to residential, commercial, and industrial districts. Based on the density of streetlight locations, it is possible to assume that there is a higher chance for over-illumination in the downtown district compared to the rest of areas. However, it is difficult to quantify actual illuminance levels or visual discomfort chances solely based on the map in Figure 2. In order to avoid overly simplified definitions of lighting conditions and to fully understand existing nighttime environment, accurate lighting data was measured on different roadways.

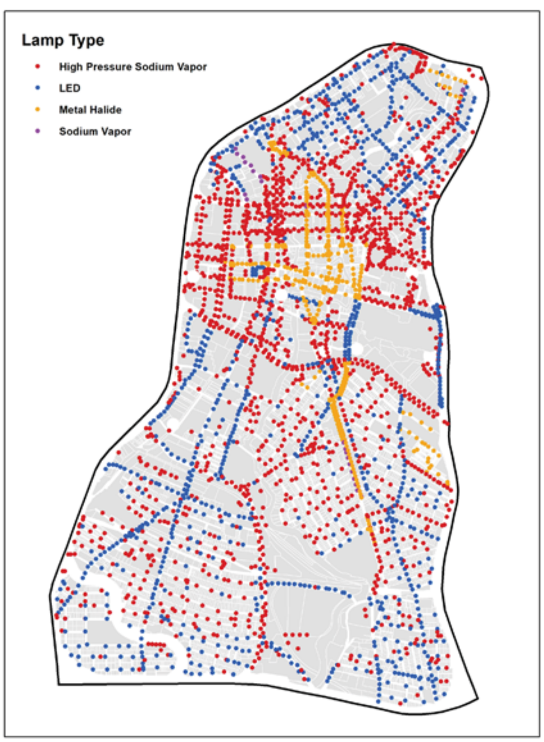

Figure 2: San Antonio Streetlight locations and types in the selected project scope

Collected illuminance data on roadways and driver's eyes were organized and the data were incorporated into ArcGIS software for analysis. Table 5 shows descriptive statistics of the collected illuminance data from the field measurements. Illuminance levels on roadways are not uniform as the range of illuminance levels on roadways is from 0.00 lux to 293.78 lux. Mean illuminance level on roadways is 13.43 lux, which is slightly brighter than what is required for local and collector roadways, but it is still an acceptable range for major roadways. Further statistical analysis is required to understand existing light levels in different land uses such as downtown, commercial, industrial, and residential districts. Different from the horizontal illuminance levels on roadways, collected vertical illuminance levels on driver's eyes show much lower light levels and less drastic contrast between minimum and maximum values. The mean vertical illuminance value of 2.35 lux shows that light level inside a car is much darker than what is available on roadways. The minimum value is still 0.00 lux while vertical illuminance level is up to 73.03 lux when incoming car headlight directly shines light towards driver's eyes. It is possible to assume that drastic changes of vertical illuminance levels on driver's eyes would negatively impact driver's night-time visibility and visual comfort while driving.

Table 5: Statistics of the collected illuminance levels within the entire project boundary

Value	*On roadways*	*On driver's eyes*
Mean illuminance	13.43 lux	2.35 lux
Median illuminance	6.43 lux	1.56 lux
Min. illuminance	0.00 lux	0.00 lux
Max. illuminance	293.78 lux	73.03 lux

The existing streetlight guidelines were referenced to check whether or not existing light levels in the project scope are sufficient and balanced. ANSI/IESNA RP-8-00 Roadway Lighting Guidance recommends local roadways to have a range of 4.0 to 9.0 lux of horizontal illuminance level on roadway, 6.0 to 12.0 lux for collectors, and 7.0 lux to 17.0 lux for major roadways. Based on these recommended illuminance levels and required uniformity ratios between average and minimum illuminance levels, it was possible to determine illuminance ranges for insufficient, acceptable (moderate), and excessive lighting conditions on various roadways. Based on the uniformity ratio 6 to 1, we can determine that illuminance levels below 0.66 lux is not sufficient for all roadway types. An illuminance range between 0.66 lux and 3.99 lux is lower than what is required but it is still acceptable for local and collector roadways. An illuminance range from 4.00 lux to 8.99 lux is appropriate for local and collector roadways. Also, it is an acceptable illuminance range for major roadways. An illuminance range between 9.00 lux and 17.00 lux is appropriate for major roadways but it is considered to be higher than what is required for local roadways. Illuminance levels above 17.00 lux may still be acceptable but it is unnecessary to provide this level of illumination for all three types of roadways.

Figure 3 illustrates existing illuminance levels on roadways. Different illuminance levels on roadways were color coded by the calculated illuminance ranges from the existing streetlight guidelines: 0.00-0.66 lux in blue (very low illuminance), 0.67-3.99 lux in green (low illuminance), 4.00-8.99 lux in yellow (moderate illuminance-local), 9.00-17.00 lux in orange (high illuminance-major), and above 17.00 lux in red (very high illuminance). As expected, a clear distinction between the downtown district and the rest of the neighborhoods can be made based on the nighttime lighting condition in Figure 3. The downtown district (the area inside the dashed white line) has much brighter nighttime lighting conditions than the rest of the areas in the project scope. Most of the roadways in the downtown district are either green, yellow, orange, or red in color, which represents acceptable or excessive lighting conditions. The roadways in either residential, commercial, or industrial districts have, in general, insufficient illuminance levels. Local roadways in residential and industrial districts are mostly in blue color, which shows that illuminance levels do not meet the required minimum light levels. Higher light levels are observed in intersections and also along the major and collector roadways. Further investigation is required to understand uniformity issues of different types of roadways and how this impacts public safety.

Figure 3: Collected street light level data mapped in ArcGIS

Besides the illuminance levels, correlated color temperature levels were collected from different locations of the project scope. Multiple measurements were made to record correlated color temperature ranges of each streetlight lamp type such as HPS, LED, MH, or Sodium Vapor. Locations of the measurements were determined based on the streetlight map. As expected, light color temperatures on roadways with HPS and Sodium Vapor streetlights are much lower than the ones with LED or MH (Table 6). Roadways with HPS and Sodium Vapor streetlights provide very warm (orange) light color that ranges from 1,800K to 2,600K. On the contrary, LED and MH streetlights provide cold (blue) light color that ranges from 3,900K to 9,300K. It is quite surprising that roadways with MH streetlights have light color temperatures up to 9,300K, which is an extremely cold light color. Color rendering index ranges are also shown in Table 6. LED streetlight shows the highest CRI values in a range of 74 to 78. MH streetlight also provides similar but a slightly lower color rendering index. HPS and SV streetlights show very low CRI values. As CRI values represent how different object and surface colors can be seen by our eyes, it determines human visibility at night. Human visibility is one of the most important factors that affect public safety. Therefore, the importance of good CRI light on roadways does not need to be highlighted again. The existing HPS and Sodium Vapor streetlights should be replaced by streetlights with a higher CRI value.

Table 6: Collected light color temperature and color rendering index (CRI)

Value	*Color temperature*	*Color rendering index*
High Pressure Sodium	1,963K-2,594K	14.9-41.9
LED	3,899K-4,370K	74.1-77.9
Metal Halide	4,190K-9,303K	62.6-76.9
Sodium Vapor	1,807K	-3.0

CONCLUSION

With the help of advanced lighting measurement technologies and a Geographic Information Systems (GIS) database, this study overcame the limitations of the previous studies by creating a database to analyze quantifiable data of nighttime lighting conditions. The new lighting data collection methodology allows for very detailed and accurate horizontal and vertical illuminance level measurements from all roadways within the project scope. The collected illuminance levels on roadways show that local roadways in residential and industrial districts do not have sufficient light levels to maintain visual acuity at night. On the contrary, the central downtown district currently has sufficient light levels on roadways but many of the roadways are overly illuminated by streetlights. Correlated color temperature and the color rendering index data helps to accurately describe the quality of existing nighttime lighting in downtown San Antonio. As stated earlier, this paper addresses the documentation of nighttime lighting environments. The next step is to investigate the collected roadway light levels in relation to crime data and roadway accident data. This investigation will help clarify the role of streetlight characteristics on public safety.

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Linfan Liu

Translating the Past: Suzhou Garden as a Generator in Architecture

Translating the past: Suzhou garden as a generator in architecture

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ABSTRACT: Until today, extensive studies on the traditional Suzhou gardens have primarily considered it a cultural artifact. The academic subject of garden history and garden art has crafted a rich narrative to define and refine the material culture of China's past. This essay, however, investigates the use of the ancient gardens as a generative means in contemporary architectural practice in China.

The study mainly analyzes and compares two specific projects and their garden "prototypes" to explore the topic in detail. The first project is I. M. Pei's Suzhou Museum (2002-06) and his childhood garden Lion Grove Garden; the second one is Wang Shu's Library of Wenzheng College (1999-2000) and The Garden of Cultivation. Although both architects acknowledged traditional gardens as the major inspiration of their modern designs, the two architects revealed distinct focuses and approaches in the process of translation, which are explained in the thematic and comparative discussions, including the symbolic image and the spatial type, cultural narrative and bodily experience. The initial interpretive analyses of the two projects anchor on the articulated aspects of the individual architect's interpretation respectively. The subsequent comparative study further demonstrates the complexity and parallels in the process of translation, thus realizing the comprehensive associations between the garden prototypes and architects' own design philosophies.

Through this comparative study, the essay aims to shift the interpretative paradigm of architecture through the lens of Suzhou garden. In contrast to the narrative constructed through ideological frameworks, the essay reasons how this spatial art is re-defined within a design discipline, and how the extracted concepts and techniques further shape contemporary architectural practice. Continuing the narrative of traditional gardens. the essay proposes the same metaphor of generative role of architectural design.

KEYWORDS: symbolic image, spatial type, cultural narrative, life experience

INTRODUCTION

The scholar's gardens in Suzhou represents one of the highest achievements of the classic gardens in China. The name, garden, which highlights the most celebrated feature in the design, however, cannot summarize the building type. Suzhou gardens were private residences of scholars and elites from the northern Song to the late Qing dynasties (11^{th}-19^{th} centuries). As a result, this building type has become an epitome of historical China. Extensive modern scholarship on garden history and garden art has crafted a rich narrative to define and refine the material culture of China's past. Meanwhile, Suzhou gardens are also considered an architectural treasure, particularly through recognized spatial complexity.[1] Recognized as an architectural category since the early 1950s, Suzhou gardens have been widely referenced by critics, reasoning the relevancy of this historical object in today's design discipline. Certainly, many architects have also looked into this building type for inspirations, yet, it was not until the beginning of the 21^{st} century we began to witness a collective yet diverse effort in architectural practice that specifically dwelled on this spatial prototype. This short essay will mainly discuss two projects built around the turn of the century to examine the complexity within the emerging phenomenon. While exhibiting multiplicity in the interpretations, this comparative study aims to argue for a collective understanding in the use of garden in contemporary design, addressing an undertheorized concern in current architectural discipline.

1.0 A typical image of a garden in a museum

I. M. Pei projects in China are often more difficult to theorize for they are drastically shifted away from the architect's w ell-established language – rigorous geometry and sculptural form. On top of that, they seem to be covered with an "opaque" layer of iconic imagery of Suzhou garden, a personal sentiment only visible in his projects in Mainland China. The direct reference of Suzhou garden, Lion Grove Garden (*Shizi Lin*) (Fig. 1) in particular,[2] was evident in Pei's designs, exemplified in two major projects – the Fragrant Hill Hotel (1979-82) (Fig. 2) and Suzhou Museum (2002-06) (Fig. 3). With the general idea of creating a garden, Pei searched for an expression of cultural continuity in his modern buildings in China.

  

Figure 1: (left) A typical image of Suzhou Gardens, corridor in Lion Grove Garden, Suzhou. Source: (Author 2016)
Figure 2: (Middle) View of the main building from the east garden, Fragrant Hill Hotel, Beijing. Source: (Pei Cobb Freed & Partners, 1982)
Figure 3: (Right) View of building complex from the north garden, Suzhou Museum, Suzhou. Source: (Author 2016)

Reflected in these projects, Pei's garden references contained a level of consistency, particularly demonstrated in the persistent use of the key materials/elements in the designs. In this regard, while more than three decades apart, Fragrant Hill Hotel and Suzhou Museum bear many similarities. Despite the differences in physical settings, functions, and building scales, both projects realized a composed landscape of rocks, "pictorial" plantations, and water, which were further complimented and enclosed by a typical black-and-white traditional residence of Suzhou. Pei's inspiration of garden, thus, has manifested through resembling these key elements in his designs.

However, Pei's "formally resemblance" of a Suzhou garden often led to puzzling criticisms. From the stylistic manipulation of historical reference (Cannell 1995, 322-23) to the symbolic interpretation of cultural continuity (Dong 2007, 63), the remarks not only suggested the historicism in this modernist's approach, but also questioned the partiality in Pei's interpretation of cultural continuity. In these criticisms, garden was transformed into several typical images, highlighting the aesthetically and culturally appreciated features in Pei's design. Can this type of argument justify the role of garden in Pei's design? Or can the categorical claim of symbolism be the most appropriate understanding of Pei's garden interpretation? Scrutinizing on several recurring elements in the design of Suzhou Museum, in comparison with Pei's previous design solutions, I will demonstrate the nuances in the translating process, suggesting a careful refinement underwent within establishing this typical image of Suzhou garden.

1.1 Painting the rocks in the garden

Undoubtedly, rock is a key element of a garden in China. This unique feature was endowed with great aesthetic and philosophical significance in traditional culture. The rockery landscape realized in Suzhou gardens is a compelling example of the rock art, inhabiting the cosmic rhythms of yin and yang and the philosophical thinking of human and nature in construction. Generational practices of rockery landscape in gardens certainly cannot be considered an immutable endeavor; nonetheless, it had formulated an iconic look exemplified in the type of Great Lake rock (*Taihu Shi*), which the Lion Grove Garden is most famous for. (Fig. 4) Pei's fascination with rock was fostered in this family garden, and it has become a profound influence on his design development, frequently acknowledged in discussions. (Cannell 1995, 57)

  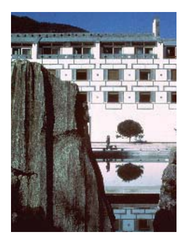

Fig. 4: (left) Rockery landscape in Lion Grove Garden. Source: (Author 2016)
Fig. 5: (middle) Conceptual collage using a 17th century landscape painting as background, Fragrant Hill Hotel. Source: (Pei Cobb Freed & Partners, 1979)
Fig. 6: (right) Rockery landscape in the east garden, Fragrant Hill Hotel. Source: (Pei Cobb Freed & Partners, 1982)

In his "home-coming" project, Fragrant Hill Hotel, Pei already had the rock feature in mind in his design. Conceived as a part of the comprehensive scheme, rocks were first identified as a continuation of the natural mountains encircling the building site through the conceptual collage of the project. (Fig. 5) In execution, the limestones from Yunnan Stone Forest was chosen both in the outdoor garden as a grouped landscape feature and in the indoor atrium as independent sculptures, following the typical rockery constructions in traditional gardens. In expression, there was a visual alliance between the limestone and the "dramatic" Great Lake rocks used in traditional gardens. Standing against the modern building, the articulated formal tension was pronounced in the design, alluding to the same idea realized in the Lion Grove Garden. (Fig. 6) In a sense, except for enlarging the sizes, the rockery landscape at Fragrant Hill Hotel still anchored on the established aesthetic criteria of the wonderful rocks and its cultural implications through *a specific look*.[3]

However, this *look* with associated formal characteristics seemed to have disappeared in the rockery landscape of Suzhou Museum. In this design, Pei used a handscroll painting of Mi Youren as the primary reference.[4] (Fig. 7) In construction, the granites from Shandong Province were sliced into thin pieces and then shipped on to the site. They were arranged in parallel on three tiers of platforms, which were raised consecutively in elevation to simulate a vertical, planar organization in Chinese landscape painting. The stone was carefully treated to configure a simple triangular shape iconic of Mi's painting, and a blow torch was used to re-texturize the "peaks," in order to imitate the famous brush stroke "Mi dot." Hence, framed by the boundaries of walkway and the black tile eave, the rockery landscape was transformed as "painted mountains" viewed from the central hall of the museum. (Fig. 8)

Fig. 7: (left) Mi Youren (1074-1153), *Cloudy Mountains*, section of a handscroll. Source: (Cleveland Museum of Art)
Fig. 8: (right) Rockery landscape in Suzhou Museum. Source: (Author 2016)

In Suzhou Museum, Pei detached the design from the classic aesthetics as well as the iconic image of the wonderful rocks. In a later interview, the architect acknowledged that the change of rockery landscape was to intentionally distant the feature from its symbolic expression of Chinese tradition while still maintaining a sense of connection to the past. (Pei and Lin 2003, 183-85) Pei's preference of this painting related to his interpretation of "literati painting" style, which did not focus on the formal imitation of a natural landscape, but aimed to realize the accordance through an integration between human's creation and models provided by nature. (Xu and Ni 2007, 66-68)

If the look, or the typical image, was significant for Pei, what was the purpose of altering it? Pei's own explanation on modifying the rockery landscape in Suzhou Museum begins to suggest the architect's self-revision of expressing cultural continuity. While still retaining the material nature of rocks, Pei was certainly aware of the confinement rooted in the visual resemblance of a typical image. While it ensures the notion of continuity, it can also be reduced to the symbol of rigid or even opaque meanings. The "un-changefulness" of this image also rejects possibility for further association in design development. In Suzhou Museum, by painting the "mountains" on the wall, Pei further anchored on the conceptual significance of rocks as the intermediary between natural object and human creation, a profound principle imbedded in the rock art.

1.2 The black-and-white image

The shift recognized in designing the rockery landscapes can be projected onto Pei's architectural solutions, particularly, in realizing a black-and-white image of the traditional gardens.

In the Fragrant Hill Hotel, the architect specified a vernacular tile along with the white stucco wall as the primary exterior wall finish materials. The chosen materials and the application of local constructional technique visualized another iconic image of traditional dwelling in Suzhou, namely, "white wall and black tile (*fen qiang dai wa*)." However, the application of the grey tile was critically challenged in most reviews of the project, interpreted as the formal manipulation of post-modernism. (Cannell 1995, 322-23) Even Pei admitted a decorative motif of the grey tile beyond its function of concealing the control joints on the facades. (Pei 1980, 20) The criticisms have a reasonable assumption, for the uneven layout of tile pattern on the façade does not correspond with the technical concern of distributing control joints. (Fig. 2) Another evidence is the different treatment of exposing control joints on the facades of the corridors. Similar to the rockery landscape employed in this project, the visual articulation of the grey tile, along with the expression of white stucco wall, aimed to create a typical black-and-white image of dwelling. Why did Pei insist on this building type? As the architect reasoned, the political upheaval did not change people's daily life and the meanings manifested by their living environment. "Architecture has to come out of people's homes," Pei claimed, therefore, the white wall and black tile of an ordinary residence rather than palaces of red pillars and golden roofs would be a more propriate reference. (Cannell 1995, 305-06) This explanation, though partial and subjective in judgement, presented a clear intention within the grand notion of cultural continuity, that is, to revive the specific meanings of continuity through the visual language construed from architecture.

Pei certainly understood the danger of this decorative use of material as a type of stylistic manipulation of historical reference. He directly responded to the criticism of post-modernism when he returned to Suzhou with a modification in mind. The Suzhou museum was finished with two similar materials – white stucco wall and black granite. (Fig. 3) In this project, even though the granite performed the same protective function as the grey tile of the Fragrant Hill Hotel, the material demonstrated a much clear construction logic in mind. Besides tiling the roof, which was also a typical building tradition in China, the black granite was the material for all type of edge trims of the building, including trim stones of all openings, edge trims at the corners of the surface, and trim divisions at the transition of floor levels and walls of different heights. Without decorative patterning, the design expressed a clearer construction logic of concealing the joints and panel transitions on the facades. In the end, the building remained the same black-and-white look. This appearance, while still an anticipated image of the design, could only be considered as the outcome following the continuous building tradition. Essentially, Pei's revision was a self-criticism of the symbolic expression of the "black edge" at Fragrant Hill Hotel. Similar to the revision that the architect made in the rockery landscape, this careful refinement of the "black edge" further bounded the visual image with the underlying conceptual significations, through which a modern building could sustain a sense of continuity of tradition.

Certainly, other key elements (i.e. plantations, water, window frames) in Pei's garden reference also deserve further scrutinizing. Nonetheless, this brief analysis begins to suggest not a *typical* but a *refined* image of Suzhou garden in Pei's design. Pei's interpretation of a garden certainly goes beyond this strategy of visualizing typical images, to which I will return later for further comparison. This strategy, visually pronounced yet problematic in interpretations, can be understood as one of the commonly applied methods in the translations of garden into architecture, precisely for its articulation of cultural continuity. Yet, learning from Pei, we need to be aware the power and the limitation of the narratives imbedded in these images. They can be quickly recognized as well as easily misread.

2.0 Garden as a type in a library

Compared to Pei's design approach of visualizing a typical image of a garden, Wang Shu's garden reference seems to intentionally avoid any figurative expression. Instead, the architect considered Suzhou gardens as the spatial types for contemporary architectural design.

2.1 The idea of type

Wang has long been interested in the concept of architectural type even before his doctoral study on Typology.[5] However, Wang's interpretation of architectural type went beyond the notion of form searching. When summarizing in writing, Wang intentionally avoided any formal analysis. Instead, by referring to an example of the mountain type described in painting theory, the architect wrote:

> Type is one of my favorite words. It embodies the life experience of people, though without external forms. (…) The type of mountain (in painting) contains many shapes but not concrete forms. The key (to construct a type) is the flexible organization (of shapes) in practice. It is not simply copying similar shapes, nor through arbitrary 'transformations.' Rather, it is to demonstrate an inner structure in complementary relationships, such as opposite scales within the same setting, contrary juxtaposition, unstable oblique views, reversed overlapping, and disrupted layering. These actions (through which a type is realized) are definitely not overpowering and arrogant, but seemingly trivial and joyful. (Wang 2008, 60)

If summarizing Wang's account, establishing a type contains two key aspects: first is to configure the type through inner structure rather than external form; secondly, type is realized through constructing complementary relationships, or rather, subtle plays of contradictions.

Fig. 9: (left) Plan of the southern portion of The Surge Waves Pavilion with the Elegant Bamboo House highlighted in yellow, modified by author. Source: (Tong, Jun, *Records of Jiangnan Garden*, 2nd ed., 2013)

Fig. 10: (right) View inside the Elegant Bamboo House. Source: (Gu, Kai, 2010)

This general statement found correspondences in specific applications, particularly in Wang's analysis of Suzhou gardens. During his repeated visits, the architect noticed a small building cluster named The Elegant

Bamboo House [*Cui Ling Long*] in The Surge Waves Pavilion [*Cang Lang Ting*]. This single-floor structure was encircled by a bamboo forest, revealing only a small entry way from the main corridor. Familiar with the spatial organization, the architect recalled a clear spatial layout of this building cluster in the plan – two transitional pavilions leading toward the main studio through a diagonal connection. (Wang 2009, 69) (Fig. 9) Yet, traveling inside the space, Wang realized a more complex experience. First, there was a constant change in direction as one passing through. Blocking as well as leading by the furniture layout, the visitors followed a zig-zag path, often ended up with a frontal view of one side of the building. While the winding route and the frontal views portraited the visit as a series of segments with sudden transitions, there was a visual continuity in the diagonal view. The patterned paneling construction wrapped along the enclosure walls, therefore, a visual continuity was formed when looking at the diagonal connection. (Fig. 10) This oblique view, as the architect pointed out, collapsed the spatial structure into a continuous surface; meanwhile, the uninterrupted traveling of the eyes also dissolved the established segmented movement on foot. (Wang 2009, 69)

Essentially, the Elegant Bamboo House was transformed into an architectural type in Wang's analysis. Reading this description closely, we begin to see how the two key aspects in the concept of type are realized in a specific application. The comparison between the spatial layout on the plan and the traveling experience inside the structure reflects directly to the distinction between the external form and the inner structure in Wang's summary of type. On the other hand, the demonstrated inconsistency in the visit, that is, the contradiction between segmented bodily movement and the visual continuity, becomes one of the subtle and joyful plays that the architect suggested. In the same article, Wang further referred the spatial type of The Elegant Bamboo House as a transfigured Great Lake rock, and demonstrated its continuously applications in his architectural practice. (Wang 2009, 74) Nonetheless, this typological interpretation of Suzhou gardens was not a singular case for Wang. Furthering the notion of experience, Wang claimed the fundamental intention of building an architectural type: Assimilating to garden making, for Wang, architectural design was another spatial construction to foster a *specific type of life experience*. (Wang and Fang 2012, 69)

2.2 The type of internal Viewing in Wenzheng Library

Wang's earlier work of the Library of Wenzheng Collage (1999-2000) can be considered an almost exclusive experiment on translating a garden type into architecture. The type was developed from another Suzhou garden, The Garden of Cultivation (*Yi Pu*).

This small garden, originally built in Ming dynasty (the 16th century), exhibits a relatively clear layout with the typical landscape composition of rocks, plantations, and water, enclosed by building structures. Looking beyond these representative features, Wang found a surprising relationship established by the spatial elements. The major building, the Longevity Hall (*Yanguang Ge*), dominates the entire garden. The structure spans across the garden in the east-west direction, cutting through the central pond. On the southeast corner of the water pond stands a small structure, The Fry Pavilion (*Ruyu Ting*). (Fig. 11) Wang's own experience of this place was described as follows:

> The large scale the Longevity Hall was disproportional compared to the scale of the garden. The simple rectangular box cut a water pond in a straight line, it was almost too rigid (compared to the typical garden construction). Yet, people seemed not even notice its existence. (…) I final realized that the hall disappeared through its emptiness. The space was experienced through occupancy; it was not to be looked at. The enclosure was a panel construction that can be completely removed, (in other words), the building had no façade. Contrarily, there was a pavilion at the other side of the water pond. This space had no function, yet it was to be looked at. (…) This garden made me realize how to make a large-scale functional building disappear within a confined site; it essentially required an internal experience. (Wang 2002, 170)



Fig. 11: (left) Overview of the Garden of Cultivation. Source: (Zhou, Yi 2016)
Fig. 12: (middle) Overview of the Library of Wenzheng College, Suzhou. Source: (Wang, Shu, 2002)
Fig. 13: (right) The "incomplete" view of the main building from the meditation room. Source: (Author 2016)

This garden became the spatial prototype of the Wenzheng Library. With the first floor largely buried underground, the visible building structure was realized as a large rectangular box extended into the water pond, with a small meditation room (a room with no function) standing separately from the main building. The mediation room, like the pavilion in the garden, situates at the oblique angle of the main building, floating on the water, facing towards the south curtainwall façade. In this project, Wang simply "copied" the spatial layout of the garden. Furthermore, the building was stripped down to the modern architectural language of concrete construction, highlighting the "formal" integrity of the structure. (Fig. 12) This formal interpretation, however, cannot be further contrary to the architect's own intention of the design. Tracing the architect's description of this garden, not only did Wang emphasize the internal experience, he also identified another complementary relationship established in this spatial type, that is, the exchange between using and look through the interaction of the two spatial structures. In fact, this typological construction should be the key to understand his architectural translation.

Pavilion in Suzhou gardens, as the architect summarized, is a structure to be looked at. More precisely, it has been understood as the structure of identifying the scenery [*dian jing*], that is to say, pavilion leads the eye to the extended landscape that it is encircled by. (Zhang 1991, 246-75) The formally articulated meditation room performs exactly as a pavilion. Not only does this independent room establish a visual focus from the main building – a structure to be looked at – more importantly, through this identified structure, the eyes are then led towards the open landscape to the south of the building. Meanwhile, the pedestrian bridge connecting the meditation room and the main building physically enhances the viewing orientation with its well-defined form and a clear orientation. The bridge also functions as the passage that people can walk on in order to reach the meditation room. Yet, the 6-meter-span of the bridge is extremely short to be able to develop a walking experience assimilating to the winding paths in the gardens. Rather, being cul-de-sac, it seems to encourage people to turn around after being "lured" to the dead end. However, when people turn around, they immediately face several "incomplete" views of the main building. (Fig. 13) Regardless of viewing directions, the visitors only see into a section of the main building, primarily into the curtain wall. These views realize an "incomprehensible" scale of the building, or rather, the viewing experience has made the large volume "disappeared." Therefore, the real intention of the bridge is not to be walked on, but to create an "appropriate" viewing experience of the main building, forming a similar interaction that Wang observed in the garden. This subtle play reveals Wang's major intention of the project. Assimilating the garden experience, the main library cannot be seen but to be occupied, whereas the mediation room is to be looked at. Moreover, the connecting bridge provides a proper way to experience the whole spatial structure from within.

This garden type has been continuously employed and refined in Wang's subsequent projects. The enriched materiality as well as the more confined site construction in the later designs collectively reinforced the type of internal experience articulated through this type. Relevant design strategies are too complex to expand in this essay; in sum, they all contribute to Wang's persistent pursuit of foster life experience through the means of architecture. From Suzhou garden, Wang found a method to concretize his concept of architectural type, as the architect claimed, "I find the method in garden, that is, not to treat architecture as an analyzable artifact, but rather as an embodiment of consciousness and experience that invites people to engage the built world." (Wang 2002, 169)

3. The exchange in analysis

Through these two projects, I have demonstrated two distinct methods of translating traditional gardens into contemporary architectural design. The analyses focused on the more pronounced aspects in the processes of translation in order to highlight the differences in Pei and Wang's approaches respectively. Yet, the emphasized aspects cannot be considered as the only gains that the two architects obtained from Suzhou gardens. This brief parallel in the final section aims to suggest a more comprehensive reading of these translation.

3.1 Garden as a spatial type in Pei's design

When insisting on building a water pond that covering over 1/5 of the total site area in Suzhou Museum, Pei did not only stress on the cultural significance of water in China. The architect further looked at water as a crucial element in spatial experience. In discussion, Pei related water to a particular experience – meandering – contrasting the lawn feature in western garden designs. (Jodidio and Strong 2008, 317) Situated at the center of the garden, the central pond ties different landscape elements altogether. Along the irregular outline, we find a tea pavilion at southwest corner, a bamboo grove at west, a small terrace facing towards the main hall, and a rockery landscape against the north wall. All the features are loosely connected by a zig-zag passage way across the pond in an east-west direction. (Fig. 14) Indeed, the formation of the passage way already begins to induce a type meandering movement; moreover, the sense of meandering is further enhanced by the viewing experience of the landscape. There are specific viewing directions and designated views designed contradict to the moving direction along the path, such as pictorial rockery landscape at north, the pavilion, and the extended terrace at south. Furthermore, this open and immense landscape enhances an expanded vision in experience that allows the flexibility in movement. Therefore, the meandering experience, largely defined by individual visitors, invites halting and lingering following one's own pace during the visit.



Fig. 14: (left) Overview of the garden of Suzhou Museum. Source: (Pei Partnership Architects 2006)
Fig. 15: (middle) View of the Atrium of the East Building of National Gallery. Source (Wikipedia: https://en.wikipedia.org/wiki/National_Gallery_of_Art)
Fig. 16: (right) Fuyang Cultural Complex, (2012-16), Fuyang. Source: (Iwan Baan: http://iwan.com/portfolio/fuyang-cultual-complex-fuyang-china-wang-shu/)

In fact, the emphasis of moving experience is an often-overlooked aspect in in Pei's design concept. Pei's description of space has reflected this particular concern from early on in his career.[6] The spatial organization, summarized by the architect as an "intriguing moving experience," was a recurring theme throughout his career, particularly exemplified in the design of the East Building of National Gallery. (Jodidio and Strong 2008, 183) More interestingly, the central pond in a garden found a parallel in the design of the atrium. (Fig. 15) In configuration, the open space, situated at the center, loosely bounded the surrounding individual galleries. Assimilating the experience of a Suzhou garden, Pei wrote,

> I was intrigued by movement as important part of the experience. We tried very hard to develop the possibilities (of the movements) fully (in the East Building), but [were careful] to ensure there was no loss of clarity. This [was] important because without discipline spatial richness would simply lead to confusion. Instead, through control we created interest. (Jodidio and Strong 2008, 136)

The large space, as a result, remains open while displaying a limited number of large sculptures. In this atrium, visitors can still be connected to different galleries via visual clues of crossing passages on different floor levels. Yet, there is a change of rhythm in movement. The expanded vision with "open views" seems to foster a similar "meandering experience" through the atrium, allowing the visitors to flexibly arrange their visit without the "loss of clarity." In this sense, the atrium becomes the "central pond" inside the building, not only for its open spatial configuration, but for the opportunities it provides to halt and redirect visitors, through their own meandering experience. While not explicit in description, the type of meandering was translated in Pei's atrium.

3.2 The garden element in Wang's design

Wang Shu's later projects exhibited richness in materiality, compared to the Wenzheng Library. There is also a sense of persistence in his material applications (i.e. layered tiles, bamboo-molded concrete, ramped earth), which has visualized the typical "images" of Wang's designs, alluding to the consistent narrative that the architect has been developing. In fact, among many of the recurring materials/elements in Wang's design, some are inspired by Suzhou gardens. The most evident one, not surprising, is water.

Pei's interpretation of water, while originated as a typical landscape image of a garden, became a means to induce a specific spatial experience. Wang, on the other hand, continued with his emphasis of "life experience" through the element of water. In his recent lecture at Cornell University, Wang described a variety of forms of water realized in a scholar's garden of Qing dynasty. (Wang, 2017) Interestingly, I n many constructions, water was only represented rather than directly used in the designs. As Wang summarized, this garden realized the "architectural responses to water" rather than the literal application of it. (Wang, 2017)

In the lecture, Wang demonstrated how these responses were translated into his architectural practice. In the case of the Wenzheng Library, the building formed a direct and intimate contact with water. This architectural response used water to expand the landscape view, at the same time, to restrict the bodily movement. In a sense, Wang considered a similar contradictory visual/body experience through the water element. Furthermore, Wang also discussed one of his most "symbolic" forms – the curved roof – and its specific response to water. The formal integrity exhibited in the curved roof often resulted in interpretations of symbolic expression of the flying roof, an iconic image of Chinese traditional building. (Lai, 2013) Regardless of the simplified or even misinterpretation, this form has been continuously employed in Wang's practice. (Fig. 16) Similar to the design of Wenzheng Library, there was a profound concern beyond formal articulation of the curved roof. Through this complex form, Wang developed a system of directing and collecting rain so that the water can be seen, heard, and eventually "sensed" through this particular architectural response. (Wang, 2017) Reminded by the architect own claim, "architecture is not to be looked at but experienced," we may be able to discern a more profound intention behind this formal invention.

CONCLUSION: Architectural discipline through the lens of Suzhou garden

Connecting traditional garden with modern space is not a novel topic in the 20th century architectural studies. However, most previous discussions have constructed through the ideological frameworks of modernity, Chinese-ness, and more recently, regionalism. As Andong Lu suggested, "Chinese garden was established as both an historical prototype and a national epitome of modern space." (Lu, 2011, 499) Garden, situated in the intersection of regionalism in architecture and cultural continuity in modern design, inevitably, is ingrained with complexity in interpretation. Certainly, these narratives were and still are important in its architectural translations, including the discussed projects of I. M. Pei and Wang Shu. However, I have downplayed these implications in the analyses of these two architects' works in order to emphasize another significant aspect of garden in architectural discipline. My study examines how this spatial art has been re-defined within a design discipline, and how the extracted concepts and techniques further shape contemporary design.

Since the beginning of this century, we have witnessed many more Chinese architects whose designs anchor on the art of garden making. These collective and diverse effort deserves further scrutinizing beyond the ideological framework of regionalism. Suggested in my essay, garden as a generative means in architectural design proposes another possibility of interpretation, that is, architecture continues the mission of garden to foster diverse experiences, thus inspiring more meaningful comprehensions of culture and human life. This profound yet undertheorized notion, learned from traditional gardens, invites further investigations to inform and guide the development of architecture.

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ENDNOTES

[1] The summary of the scholarship on garden study within architectural discipline refer to Andong Lu's article in the reference.

[2] The Lion Grove garden (*Shizi Lin*), originally built in the 14th century as a part of monastery and since then transformed into a private residence, became Pei's family garden during his teenage years in Shanghai. Pei lived in the garden for a few summers during his upbringing.

[3] A detailed analysis of the rockery landscape design in Fragrant Hill Hotel see Liu, Linfan. "Rethinking Pei: A Pictorial Vision of Space," Speech at *Rethinking Pei: A Centenary Symposium*, Hong Kong University, December 14, 2017.

[4] Pei misrecognized Mi Fu, the father of the Mi Youren, as the painter and used him as the reference in his own description. Therefore, all the writings about this project also used the father and some other related painting examples to suggest the connection. This painting was discovered in the project's archive at Pei Partnership Architects. Beside the formal resemblance between the painting and the rockery, it was the only painting example in the project's folder. Therefore, I think it is safe to assume this is the correct reference.

[5] In an article published in 1987, Wang discussed several key ideas without articulating the summarizing term of type. See Wang Shu, "Analysis of the inner structure of the valleys in Wannan Villages, (*Wanan cunzhen xiangdao de neijiegou jiexi*)," *The Architect*, No. 28, (October 1987): 62-66.

[6] Conversation with Janet Adam Strong, *Interview*, March 03, 2016.

Philip Plowright

Extending Skin: Architecture Theory and Conceptual Metaphors

Extending Skin: Architecture theory and conceptual metaphors

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ABSTRACT: Architects use metaphor constantly in their writing, speech and project development. It is engaged for its ability to transfer meaning and as an aid in orientating design positions (Collins 1971; Seligmann and Seligmann 1977; Alberti 1988; Forty 2000; Hearn 2003; Muller 2009; Libeskind 2012). While architects have acknowledged the general presence of metaphor as part of design theory, there is little understanding of metaphor's deeper role in architectural cognition and its effect on architectural values (Lakoff and Johnson 1980; Caballero 2006). This paper examines a small aspect of metaphor use in architecture in order to follow a thread from historically grounded applications of metaphorical terms to contemporary and highly conventionalized conceptualization of spatial design. The focus is on the HUMAN BODY as a source domain and, in particular, the concept of *skin*. Through the discussion, skin (and thus the human body) is shown to be present in architectural discussions not only knowingly used metaphorical expressions but also in highly conventionalized and normalized occurrences. These unrecognized examples of conceptual metaphors allow skin move well beyond simply being an analogue for a building enclosure. Rather, concepts related to skin are extended into interpretations of actions as a projection of human capacity into deep disciplinary examples of architectural concepts and abstractions.

KEYWORDS: conceptual metaphor theory, architectural theory, cognitive linguistics, building as body, conventionalization, cognitive semantics

INTRODUCTION

Architects use metaphor constantly in their writing, speech and project development. It is engaged for its ability to transfer meaning and as an aid in orientating design positions through the recognized, and historical, source domains of the HUMAN BODY, LINGUISTICS, GEOLOGY, ORGANISMS, BIOLOGY, and MECHANICS (Collins 1971; Seligmann and Seligmann 1977; Alberti 1988; Forty 2000; Hearn 2003; Muller 2009; Libeskind 2012). While architects have acknowledged the general presence of metaphor as part of design theory, there is little understanding of metaphor's deeper role in architectural cognition and its effect on architectural values (Lakoff and Johnson 1980; Caballero 2006).

Architecture, as a member of a larger group of design disciplines, stresses a value on tacit information transfer and outcomes over clear process, suppressing cause and effect relationships of design outcomes as communication vectors (Logan 2007). In the application of explicit non-disciplinary information based in either visual or textual form, metaphor is valued as a generator or an orientation tool for a design starting point which will 'inspire' a reaction (Goldschmidt and Sever 2011). Some theorists have made the claim that it "is a none-too-commonly-known fact that in Western culture the understanding of architecture is metaphoric in that it is rarely known for itself" (Johnson 1994, 429), raising the importance of understanding metaphorical operations in architecture. Yet, this is combined with ambiguity to how metaphorical statements and expressions are considered in architecture, with the possibility of metaphorical concepts interpreted as literal by the designer but analogical by the audience; or symbolic rather than metaphorical. What is clear, however, is that metaphor has been connected with issues of method and meaning in architecture for many centuries, whether acknowledged or latent in the texts of architectural theory. Clearly, metaphor matters to architecture.

This paper examines a small aspect of metaphor use in architecture in order to follow a thread from historically grounded applications of metaphorical terms to contemporary and highly conventionalized conceptualization of spatial design. The topic considers the application of the metaphor BUILDING IS A BODY (Forty 2000). This major metaphor involves highly conventionalized terms in architectural jargon such as *ribs* as an expression of structure, *bowels* to refer to deeply situated interior spaces, or *spine* to address a linear type of circulation that connects many spaces (Caballero 2006). While some of these topics are covered, the more detailed discussion is focused on *skin* to mean the surface of a building.

1.0 THE NORMALIZATION OF THE HUMAN BODY AS AN ARCHITECTURAL METAPHOR

The mapping between the human body and buildings is a metaphor found in historical texts of architecture as well as current discussions. The metaphor has been present in architectural theory since the earliest recorded text, Vitruvius' *de Architectura* (first century, AD), and codified by the Renaissance writing of Alberti's *On the Art of Building in Ten Books* ([1452] 1988). The body terms used in these metaphorical expressions have been normalized and become polysemic within the discipline, causing no incongruence to the reader, speaker or listener.

Vitruvius established symmetry as a principle of good architecture as part of a mapping that transferred the quality from the human body onto buildings (Vitruvius 1914). He also considered the building *to be literally* a body, addressing the same issues of health and protection (from heat, sun, wind, temperature) as any biological entity would need (1914, 19). The body metaphor applied a value system to buildings it that included wholeness and coherence, which made architecture analogous with closed system based on homogeneity, centrality and symmetry (Till 2007).

Alberti extended aspects of the human body as a source of meaning, directly connecting body references to building elements. He considered features of roofs to be "bones, muscles, infill panelling, skin, and crust" (Alberti 1988, 79) and used the same biological terms for vaults, stating that "with every type of vault, we should imitate Nature throughout, that is, bind together the bones and interweave flesh with nerves running along every possible section" (1988, 86). Beyond the human body, there are other organic references including those to shells, flesh, carcass, spine, bowels and so on (Caballero 2006, 18). In fact, the body and its containing category, the organic, is considered to the most prevalent metaphors in the history of architecture, connecting building design to nature and, thus, giving buildings both meaning and authority (Hvattum 2006).

The body was a dominant reference into the Enlightenment combining with the concept of BIOLOGY by the Industrial Revolution (Moloney 2011). The use of anatomical terminology before the Industrial Revolution tended towards equating buildings to body elements and body schemas (*arms, legs, head, heart, feet on ground, heart as central* etc.) and this included a parallel view of CITY AS BODY. The metaphor could go so far, as McClung (1981, 283) illustrates through a literary reference, that a building's "medieval arrangement of apartments (hall with kitchens to one end and private quarters to the other) is imposed upon a point-by-point correspondence of the castle to the human body." However, once the pursuit of scientific knowledge became rooted in Western society through the Enlightenment, understanding of the body shifted from "a sole description of bodily organs in terms of their physical appearance and position in the body, to focus on the functions performed by those organs within the whole." (Caballero 2006: 18).

The growth in biological knowledge, especially knowledge of evolution and cellular growth, also changed the type of information expressed through the metaphor. The dominant understanding shifted from the body as an anthropomorphic mapping between the environment and human physicality to instead focus on the body as a biological organism which stressed systems and natural laws (De Palma 2006). The organic metaphor was used in this way as part of early architectural Modernism, which projected completeness and solidity through biological principles in order to present a building as a final expression of natural, dynamic forces with a form that emerges from its context, and therefore cannot be questioned for its meaning (McClung 2981: 281; Hvattum 2006: 497). It also stressed issues of health and illness found in formal representation that ranged from early Modernist concepts of purity, hygiene, cleanliness (Till 2007; Muller 2009) to late 20th-century fixations on scars, scabs and parasites (Caballero 2006; Kanekar 2010), using these to associate redemptive qualities with design when applied to the environment.

2.0 RESEARCH METHODS AND KNOWLEDGE BOUNDARIES

This paper reports from a research project based in Cognitive Linguistics (CL) using Conceptual Metaphor Theory (CMT) but studying architecture as a discourse community and a discipline of knowledge. The purpose of the overall project was to examine central texts representing deep disciplinary discussions in architecture to address what patterns of metaphors are present and how they support the construction of meaning in the built environment. Understanding metaphorical language as an expression of ways of thinking and, therefore, systematic to human cognition rather than simply as a stylistic flourish positions CMT as an important tool in understanding the world. CMT is a contribution to Cognitive Linguistics that understands the organization of language as a direct reflection of how thoughts are organized. As such, it and allows access to thinking structures of the human mind by understanding conceptual metaphor as a central operation in human thinking rather than simply a linguistic embellishment.

A conceptual metaphor is the “understanding one conceptual domain in terms of another conceptual domain” (Kövecses 2010: 4). While some scholars might take issue with the term “understanding”, it is an important concept that places the conceptual metaphor as a major operation in meaning and human value structures. Lakoff and Johnson (1980) theorize that there is a pattern of concrete-to-abstract mapping that is fundamental to conceptual metaphor, considering that we use metaphors to map physical knowledge as a way of understanding abstract concepts. The generation of a conceptual metaphor is considered to operate through similarity (whether real or created by the metaphor itself), which creates a dependence between source and target domains (Lakoff and Johnson 1980, 147), is a systematic correspondence (Kövecses 2010, 7) and includes inferential structure (Grady 1997, 7). The similarity theory of metaphor comes from an Aristotelian position that metaphor connects two dissimilar concepts by some key shared feature and has been challenged recently as not being empirically consistent. If we follow the theory of embodied cognition, then it is more probable that the association between domains and concepts is predicated on physical human experience structured through the engagement of the body in the world (Grady 1997, 5).

Conceptual metaphors are recognized in this study through the presence of a term in a sentence or sentence fragment which produces incongruence between the literal meaning of that term and the context in which it is used. The overall focus remains on the expression rather than breaking a sentence into lexical units and testing each unit for its basic meaning as isolated elements (Pragglejaz Group 2007). As such, it is the intention of the sentence or sentence fragment in a discourse context which drives the identification of metaphor through the presence of incongruence. (Cameron and Maslen 2010). as the identified metaphors are understood to be discourse examples of metaphorical expressions which are the basis of analysing the presence of conceptual metaphors through decomposition.

3.0 DISCUSSION

The metaphors using the human body can be coherently organized under the megametaphor OBJECTS/BUILDINGS ARE HUMAN BODIES. The underlying correlation between objects in the environment and humans supports the coherence of several conceptual metaphors as well as the extension of basic mappings into associated concepts. Metaphors referencing the human body are common when discussing the physical understanding of architecture (i.e. as building) but the corpus also contains examples of when the same body concepts using the same salient features are used in abstract discussions as well. For example, *spines* and *backbones* refer to the physical space of a linear, organizing corridor, an abstract concept about the organization of circulation and also an idea that gives structure and is built upon by other ideas.

Not all aspects of the human body are used as part of metaphors even though the body is an important source reference for understanding parts of our world and experience. The most common metaphorical source terms and concepts are *skin*, *face*, *heart*, *spine* (*backbone*), *ribs* and *arms*. Common references use relational information - *arms* are physical extensions of a main building, the *body* of a building is the central massing of that structure, and a *face* is a reference to the front of an object. Less common in architecture is attribute or shape references using the human body. One that does occur is *ribs*, a concept used to refer to visible and repeated structural elements which usually involves a curved form.

3.1. Building enclosure as skin or clothing

The most common mapping between the human body and architecture is *skin* as a term used to understand the outer surface of an enclosure (physical) or container (conceptual). In this regard, historical instances of metaphor in architecture as architectural terminology, such as Alberti's reference to *bones*, *muscles*, and *skin* to refer to structure and cladding in *De re aedificatoria* (1443-52), is consistent with terms found in a corpus dedicated to late 20th and early 21st century architectural theory. The mapping of *skin* uses relational information as the outer surface of a building is considered to operate through similarity as the outer surface of a human body. As a normalized term in architecture, *skin* as a source domain does not include any operational complexity such as mappings between pores, temperature and pressure sensing, nor notions of elasticity. The conventionalized use of the metaphor enclosure is skin can be found in example below:

(1) “The *skin* is defined in places by concrete, and in places by glass” (Allen 2000, 1)

In (1), the mapping between skin and building enclosure is an analogy that uses knowledge of the skin as a thin outer layer acting as an interface coherence with the image schema CONTAINER or as boundary between interior complexity and the exterior environment. There is the inherent understanding that buildings are human bodies as internal systematicity suggests that *skin* is part of a coherent system that also links the building to *organs*, *limbs*, *faces* and *backbones*. The larger mapping relates buildings to being human and having a human body as the outer surface does not generally have *fur*, *scales* or *chitin* in the normalized version. While (1) is an example of the basic use of the conceptual metaphor, other concepts can be involved in the mapping. The next example (2) uses the same conceptual metaphor of enclosure is skin but the context involves more complex social engagement.

> (2) "we witnessed during the 1990s an attempt to use the *skin* of the residential building to represent diversity and multiculturalism" (Zaera Polo 2008, 93)

In this example, the metaphor involves the outer surface of the buildings as presenting socio-cultural information rather than skin as the physical outer surface of a container and aligned with the normalized understanding of BUILDINGS ARE (HUMAN) BODIES. The skin is representing a set of values and beliefs as part of cultural expression and does this because it is the surface which is visible to the public. The visible surface maintains social interactions and is connected to primary metaphors such as visibility is attention and perceptible is out but also, and more importantly, surface is identity. In (2), skin is a vehicle for a much more complex social situation than is considered in the previous example while using the same conceptual metaphor ENCLOSURE IS SKIN.

The outer enclosure of the building could be considered as clothing at the same time it is normalized as skin because cognition through domain association allows for multiple inferences without invalidation. The mapping of ENCLOSURE IS SKIN and ENCLOSURE IS CLOTHING co-exist in the same way that MORE IS UP does not contradict GOOD IS UP in discussions of cultural coherence (Lakoff and Johnson 1980: 23). While UP can be both MORE and GOOD, the building surface can be both skin and clothing without conflict but depending on context. One of the differences between skin and clothing is how knowledge of them is acquired and how they are classified. Skin is a biological term which is highly embodied as part of human body schema while clothing is a cultural reference that infers social content such as fashion, social norms (nudity) and social standing.

In the corpus, metaphoric expressions portraying building surfaces as clothing differ from those of skin. While both refer to the terminal surface between an object/organism and the environment, skin is understood as integral to the human body while clothes are an additional element to be overlaid on that body. As seen in the examples above, metaphors mapping skin to buildings and abstractions consider that outer layer as an integral surface. As a metaphor in architecture, the source domain of clothes is used when the enclosure of the building and the rest of the building to be considered as conceptually separate from each other. This attitude can be exemplified by the following example:

> (3) "The '*clothes*' have become so removed from the *body* that they require structural support independent of it." (Colomina 1992, 93)

In this example, there are two metaphorical expressions. The first uses the metaphor is ENCLOSURE IS CLOTHING ("'*clothes*' have become so removed") and the second uses CORE IS TORSO ("from the *body* [of the building]"). Both metaphors are coherent with the underlying megametaphor BUILDINGS ARE HUMAN BODIES. The source domain is clothing because the purpose of the sentence is a conceptual separation between the enclosure of the building and what is considered the essence of the building (often equated to structure and enclosed program). Referring to the enclosure as skin would not easily allow for understanding the enclosure and building as separate and independent elements as one is part of the other. However, the source domain of clothing replaces the source domain of skin if the speaker wishes to stress a conceptual isolation between the outer surface of the building and the idea of the building itself. As such, a building can be considered finished and functional in terms of its physical construction yet "undressed" (Cadwell 2007: 23) or even "nude" (Lavin 2011: 72). Clothes are a modification on the conceptualization of building enclosure as skin, coherent with understanding it as a terminal layer between a body and the environment.

As noted above, skin is used in a second way as well – as a representational surface that manages social interactions and expressions of identity. When ENCLOSURE IS CLOTHING replaces ENCLOSURE IS SKIN as a metaphor for the outer surface of an object, the purpose of the metaphor shifts from conceptual separation of object and surface to the role of clothing in socio-cultural systems, especially as part of a system of fashion. In the next example, the Disney Concert Hall in Los Angeles designed by Frank Gehry is considered as a body with clothing rather than simply a body.

(4) “The Concert Hall project is *fashionably dressed* up to designate a volumetric mass that denies any coherent and hierarchical order” (Hartoonian 2006, 123)

The concert hall in the example above expresses a clear separation between the façade and the building. The architect is known for curving building enclosures that are physically and conceptually isolated from the environmental and programmatic aspects of the project (i.e. the core of the building). However, the metaphor ENCLOSURE IS CLOTHING activates cultural values of being fashionable which requires social structures that pertain to status, rank, and timeliness. The discourse context of the expression discusses the building in how it is viewed from the surrounding streets, stressing its elegance and appropriateness to the urban context. The enclosure is operating as a surface that projects cultural identity as part of human social interpretation. This use of clothing is coherent with the second way that enclosure is skin is interpreted – as the visible surface that engages in relationships with other people. The difference between metaphors based on skin and clothing is that clothing can be changed, used to mask identity or be a disguise as the object and the surface is considered as non-integrated.

3.2. Extending body metaphors through external systematicity

As an underlying source domain for discussions of architectural concepts, the mapping to the human body allows for more innovative expressions which are still coherent through external systematicity. In these examples, the metaphor is BUILDINGS ARE HUMAN BODIES rather than BUILDINGS HAVE HUMAN BODIES. The latter expression involves considering ideas and objects as using the body in situations that extend human capacities to non-human, non-animate and non-physical constructs.

Once a building is understood as being a human body, the metaphor can be extended into many different expressions. The extension of metaphorical mappings in architectural discourse can be illustrated using the discussion of skin as a metaphor for both enclosure and social engagement above. The conventionalization and normalization of a metaphor allows for the possibility of elaborating on the basic metaphor to create richer and more subtle inferences. For example, once the surface of an object (or objectified abstraction) is normalized as skin, that surface can then be acted upon or modified in the same way as skin with the assumption that the underlying mapping is just accepted. This includes ornamentation such as piercings and tattoos, physical disfigurement such as when the discipline of architecture “has gained a *scar*” (Lavin 2011: 75) or when the conceptualization of urban and natural ecologies “are *sutured* together,” (Lerup 2001: 52). Biological and physical actions can also extend from the understanding of enclosure as skin. One author states it through considering the air above a city as being “*like our skin*, an immense enveloping organ, to be constantly attended to, chilled, channeled, and cleaned.” (Larup 2001: 58). Other actions present in the corpus make actions using skin including *flaying*, *piecing*, *cutting*, *slicing* and *exfoliation.* The next examples expand on these points.

The ENCLOSURE IS SKIN metaphor can be extended into novel expressions using non-normalized concepts while still being coherent with the BUILDINGS ARE HUMAN BODIES metaphor. In the example below, (5), the skin is considered to be marked through the cultural practice of tattooing, what seems to be a metaphor using similarity based on image.

(5) “It is a *tattooed surface* which does not refer to the interior, it neither conceals nor reveals it” (Colomina 1992, 98)

The “tattooed surface” in the example above refers to a physical interpretation of a building enclosure, a façade of alternating black and white horizontal stripes with very few windows. While the outer surface of a building is normalized as skin in architecture, this expression maps the human cultural artefact of tattooing ink into flesh to create images to that surface. Tattoos are used as part of social identity in human societies and change the role of human skin from biological enclosure to a surface on which other actions occur. In the expression, the stress on the surface of the enclosure changes the relationship between the enclosure of the building and the spaces it contains. While this novel expression builds on the underlying conceptual metaphor of ENCLOSURE IS SKIN and the megametaphor is BUILDINGS ARE HUMAN BODIES, there is no direct reference to either of these concepts.

The tattoo metaphor is being used to bring attention to the outer surface of the building but not as a way to explain an image or shape. When skin is tattooed, it fulfils a double role on the human body – it is the surface that mediates with the environment but it is also a drawing surface that changes the hierarchy and content of that interaction. Rather than being sensory surface of an organism, a tattooed surface uses the metaphor SKIN IS CANVAS to turn the body into a background for artwork or graphics. As a canvas, the skin’s primary role is not to contain the complexity of the body as a surface of a container but to mask the presence and operation of the body through focusing attention solely on the surface. In this example, the building enclosure is being claimed to work in the same way through the metaphor. The architectural critic is using the metaphor to claim that this particular enclosure exists in and for itself rather than its traditional role of protection from the elements, creation of privacy and allowing views from inside to outside and verse versa. As such, the novel expression both uses and modifies the underlying metaphors as the intention is that the building is all skin and no body as while the house has a *physical* interior, it does not have a *conceptual* interior. This is obviously not literal as the house has rooms, a roof, doors and windows but the conceptual understanding of space is overlying and overpowering the physical experience of space.

Metaphors building in novel ways on SKIN IS ENCLOSURE are more conceptually focused, addressing abstract concepts that are theoretically subtle and use deep disciplinary knowledge. While the tattooed surface in (5) could be understood as a basic attribute mapping creating an image metaphor, the purpose of the metaphor is to consider the conceptual understanding of the building rather than its physical presence. The next example also uses ENCLOSURE IS SKIN as part of BUILDINGS ARE HUMAN BODIES.

> (6) "This *flayed* modulation of interior and exterior produces the effect of loose and sometimes surprising correlations between program and space or room." (Somol 1999, 69)

In this example, enclosure is skin is being used not as an object but as the basis of an action performed on the surface. The action is *flaying,* referring to the stripping away the outer layer of skin to expose the flesh below. As a physical action mapped to a building, one might expect to find the metaphor present to describe how layers of a building façade are removed to allow views of interior space. The example (6) above, the "*flayed* modulation" is not directly addressing physical aspects of the building but instead brings attention to the conceptual relationship between building typology, conceptual occupation through the use of spaces (program), and the physical space of the building. These are complex ideas that are understood implicitly by members of the architecture discipline. In the expression, the metaphorical expression "flayed" is used to bring to the attention that the building under discussion (a community centre) purposefully reverses the traditional understanding of inside and outside as well as public and private as a critical aspect of the design proposal. The resulting physical building is conceived to deny the traditional edge/centre hierarchy (public is edge, private is centre) and presents the building as a body without skin . . . or more exactly, a building with skin on the inside and exposed flesh on the outside. There are, however, no physical clues to this interpretation in the building enclosure. In the extension of ENCLOSURE IS SKIN and BUILDINGS ARE HUMAN BODIES, skin is being equated to publicness and flesh (interior tissue) to privateness. The mapping includes correlational mapping of visible aspects of the environment as public elements, supported by the second normalized interpretation of skin as a social element. In this case, the ability to understand skin as a public expression is possible through the metaphors visibility is attention and visible is accessible. To consider flayed to be simply a condition of peeling back outer layers of the wall would be to completely misinterpret the expression as no physical comparison is possible.

The next example, (7), does not involve a physical object such as a building but is still uses the metaphor ENCLOSURE IS SKIN. In the same way as shown in the last example, architects consistently map their conceptual understanding of disciplinary knowledge into physical situations. The human body is often used as the basis of these mappings.

> (7) "Was the *exfoliation* of the private/public threshold to the inside of the unit a politically advanced decision," (Zaera Polo 2008, 94)

In the example, "exfoliation" is applied to the abstract idea of "the private/public threshold" rather than the outer surface of a building. The threshold found in (7) is where the space between the conceptual ideas of public and private is considered a threshold. For this to be possible, the qualities of publicness and privateness need to be understood as physical analogues through the metaphor (bounded) abstractions are containers, a corollary of (bounded) abstractions are objects. The surface of the container is then considered to be skin through understanding the surface of a container as an enclosure and enclosure is skin. The final association is conceiving of the skin as a type of threshold rather than just a surface between outside and inside.

The surfaces in the expression considered to be part of a threshold are the conceptual relationship between the abstract ideas of publicness and privateness. In this example, the normative public-to-private relationship expected by architectural and urban designers is the domestic residence relationship to urban context. However, the author is discussing a second more innovative public-to-private relationship which is found within the domestic residence through the use of screened rooms. The normative understanding of urban public-to-private relationships is considered be transferred to explain the non-normative understanding of domestic residence public-to-private relationships. Exfoliation then refers to the action of transferring an urban idea to an architectural situation even though they exist at very different scales. As a conceptual and experiential idea, the flaking of part of the conceptual urban environment to embed itself within the domestic interior then affects the physical organization of the building and the former is used through similarity to understand the latter. The metaphor is needed because the way that space is being conceived is non-normative and does not match a standardized typological pattern. The importance of the public-to-private relationship is not immediately understandable through the form of the building and the metaphor brings attention and focus to this abstract content.

CONCLUSION

The human body has a clear importance for the discourse of architecture. Conventionalized terms are used for their resemblance values to aspects of buildings mapping relational aspects of the human body to their counterparts in the built environment. The stress is on structure, enclosure, thresholds, circulation and centrality (i.e. importance). The body is also activated through correlational mapping of perceived actions into nonhuman things.

The application of actions to the object of the human body can be seen to be structurally and conceptually more complex than expressions than using the body as an object, like *spine*, *heart* or *face*. The other aspect to note about the examples above is that for while the immediate subject is a physical building, the sense of action places the focus not on the building itself but the content found in conceptual act of design that formed the physical building. These actions cannot be interpreted from the immediate physical context without knowledge of the architectural intentions. The actions are not interpretations of the environment through spatial motion or force dynamic image schema found in FORM IS MOTION. The other point to consider is that while many of the expressions exploring the use of skin to architectural discourse build on complex content such as social identity and deep disciplinary abstract concepts. This creates a complex structure that spans embodied concepts and disciplinary conceptual constructions (i.e. how architects understand space, occupation and use) while implicitly maintaining, or building upon, the conceptual metaphors BUILDING IS A BODY and ENCLOSURE IS SKIN.

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The Good Governance of Mexico City's Zócalo: A Recent History of Spatial Use and Morphological Transformations

The Good Governance of Mexico City's Zócalo: A Recent History of Spatial Use and Morphological Transformations

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Abstract:
The change in elected government of the Federal District (*Distrito Federal*), from the Institutional Revolutionary Party (*PRI*) to that of the center-left *PRD* party, was of utmost importance for the evolution of the Zócalo's *representative space.* Using Lefebvre's semiotic tools for the analyses of spatial production[1] through the prism of Cultural Geography and Social History, this article studies one of Mexico's most important *symbolic* spaces: The *Plaza de la Constitución,* colloquially known as the *Zócalo.* With the ascension of new local and federal governments, the plaza began a process of transformation from a space controlled by the State for the State's demonstrations of power, to an open, inclusive space for all users. As of 1997 diverse cultural, recreational, and mass movement events began to be promoted and experienced on the Plaza.[2] This article explains the process by which the Zócalo began to change through *spatial appropriation* of the *absolute space* by varied groups with diverse interests and organizational purposes. In the first part, the essay discusses the so-called "March of Dignity", which attracted the participation of people from all sectors: student and youth associations, peasant farmer and laborer communities, blue collar and low-income industrial workers, populist groups, civic organizations, to name a few. The article then describes the impact of Spencer Tunick's project titled "May 6, 2007: naked Zócalo." Tunick's spatial intervention was a massive scale human participation art/happening project. Finally, the article then turns its attention to the recent Ayotzinapa protests and the symbolic significance of the damage done to the Mariana Door of the National Palace which occurred because of the civil unrest of this period.

Introduction:
This article uses Habermas' "public sphere" theory, Althusser's State apparatus relationships and Lefebvre's "plan of the present work" *spatial practice* toolkit in order to analyze contemporary spatial use of the Zócalo, Mexico City's symbolic center. The article defines the key terms as follows: *spatial production*, exhibited socio-political and economic value systems used to produce spatial relationships*; representative space*: the projection of semiotic meaning to users through symbolism, and; *absolute space* as the physical manifestation of space, which includes all past and present morphological transformations[3]. The goal is to demonstrate how "good governance" is achieved by providing public realms for cultural production and a political structure that not only tolerate *spatial* socio-political mobilization but *encourage spatial production* as a venting mechanism for social discontent. This article was written utilizing a Cultural Geography (Sauer) and Social History prism. Research was undertaken via primary sources: first-hand observation, museum and university websites, newspaper reports, participant interviews, and government statements; secondary sources include: newspaper editorials and essays by social commentators.

At the end of the 1990's, Federal District (D.F.) residents gained the right to elect their local government for the first time since 1928. The elections resulted from the amendment of Article 73 of the Constitution, which originally stipulated that the Head of Government of the Federal District would be federally appointed. Once the Constitution was modified, elections took place on July 6, 1997, and the Democratic Revolution Party's (*PRD*) candidate, Cuauhtémoc Cárdenas Solórzano, was elected with 48.1% of the vote (vs. the then President's ruling *PRI* party's 25.6%[4]).

Since 1997 the stated purpose of local government (continuously controlled by the PRD to date)[5] is to "guarantee the rights of the citizens and serve their needs (which are) the main and unwavering duties of a democratically elected government, while placing special emphasis on the most vulnerable."[6] [*Translator's Note: All translations into English by the author*] As a clear example of good governance through civic participation, the new government of the D.F. would seek to "address the fragmentation of the social fabric"[7] through diverse social programs; among them the use of the capital's Zócalo (formally the *Plaza de la Constitución*) as a place for civic interaction and social integration. By examining how Mexico's Zócalo is used for civic socio-political purposes, we can help construct an argument for a cogent urban policy of "good governance" throughout the world by promoting and maintaining spaces for civic discourse in the public sphere.

The Zócalo's *spatial production* changed at the end of the 20th Century, through use of its *absolute space.* This *absolute* space had been since its inception in México-Tenochtitlan period controlled by political and ecclesiastical powers and rarely occupied by social groups in demonstrating for and against State power[8]. Morphological changes dating back to 1958 (fig.1), such as the removal of the French styled gardens allowed the Zócalo to be a simple but flexible gathering space. Starting with the 1997 election, the space became a tolerant *absolute space*, open to all groups, uses, and social trends. As of 1997 the Zócalo became a place for effective *spatial production* for individuals and groups of Mexican society, becoming a multi-purpose or multi-functional locus. Angélica Herrera argued that starting in the 21st Century, there are five forms of spatial appropriation of Mexico City´s Zócalo: pre-Hispanic events; protests; national values; commerce, and cultural recreation. These are represented by the different activities that take place, on a daily basis, in the Zócalo. Since 1997, events staged that follow Herrera's categories include: Day of the Dead, Three Kings Day, Easter Holy Week, Mexican and international artists' concerts, dance performances, film screenings, book distributions, opera, exhibitions, museum and circus productions, gastronomical fairs, chess tournaments, ice rinks, and pre-Hispanic ceremonies.

Simultaneously, federal and city official ceremonies including civic parades have continued, as have planned and ad hoc protests by the citizenry, occurring almost weekly and encompassing all population sectors. Against the backdrop of these activities, this article examines *spatial practices* through three events in chronological order: The arrival of the Zapatista Army to the Zócalo "March of Dignity", a mass photographic installation by Spencer Tunick, and the Ayotzinapa Protests.

1.0 The March of Dignity

On March 11, 2001, the Zapatista National Liberation Army (*EZNL*) arrived in Mexico City as part of its "Color of the Earth March" which had marched throughout Mexico. The 37day tour and covered 6,000 kilometers, culminating at the Zócalo. Nearly one million people watched a caravan headed by 23 EZLN "commanders" and the *Subcomandante* Marcos. By making the Zócalo the destination, the EZNL appropriated historic triumphant entrances while transforming the Zócalo by occupying its *absolute space.* Carlos Monsiváis described the symbolism of the Zócalo EZNL entrance: "We continue to acknowledge the Zócalo as the heart of the Republic. Systole, diastole, devil bastard."[9]

The marchers were joined by individuals from various social groups: student and youth associations, peasants, laborers, citizen organizations, as well as civil associations."[10] Monsiváis noted that marginalized groups such as the unemployed, homosexuals, punks and anarchists flocked to the Zócalo.[11] The indigenous leaders of the *EZLN* climbed onto the dais, their backs turned to the National Palace as a symbolic act. An interview published by *Reforma* the following day, noted that the dais' location was symbolic: "the pavilion where we're standing is where it is. It is no accident; …. since the beginning, the government has been harassing us."[12] The significance of the pavilion location is important in a political context. On December 1st, 2000, for the first time in 71 years, a new political party, the center-right National Action Party (*PAN*), and its candidate Vicente Fox, achieved the office of the Presidency.

Before the Zapatistas arrived, President Fox, as the embodiment of the federal government, noted the government's *spatial occupation* tolerance, "Our democracy is showing great flexibility by allowing in its very breast, discussion of ideas, fostering debate and reaching consensus [sic]".[13] President Fox explained a larger concern:

> We hope Congress takes the first big step forward in reestablishing an open dialogue with *Zapatismo*; ….
> We will do everything that is in our power, oh! and we are not doing this for *Zapatismo*, but for the 10 million indigenous people in our country who cannot continue to be forgotten or discriminated against![14]

Demonstrating a political will for dialogue, Fox invited *Subcomandante* Marcos to "talk about indigenous communities and the country's situation".[15] For the first time in the history of the Zócalo, a president invited an armed group to discuss peace. Dissidents used the *absolute and symbolic space* of the Zócalo to debate the country's situation. The Zócalo occupation by the EZLN symbolized the arrival of a socio-political force, in conflict with prevailing Ideological State apparatuses. The occupation of the Zócalo's *absolute space*, was a first order symbolic statement that can be understood at three levels (Tamayo, Cruz, pg.126).[16] First as geographic, as it "weaved symbolic and material network of cities connected by the path of the march and, at the same time, built a bridge between the jungle and the city".[17] The second level was urban. Once the EZLN reached the Zócalo, it took symbolic control of the representative places: "public universities, civic plazas, archeological areas, towns and communities surrounded by the great city, and the legislative palace".[18] The third level was local, the EZLN and followers took over the city's plazas. As a *symbolic* heart of the country, the *Zócalo* was simultaneously a local and a national *representational space*.

An EZLN leader implored: "Don't allow for new day to dawn where that flag does not have a dignified place for those of us who are the color of the earth".[19] He referred to the flag located in the center of the Zócalo. It was historic irony that he spoke this sentiment precisely where Tenochtitlan once stood, conquered by the Spanish at its peak of power. The EZLN had traveled to the political center of the country to symbolically reclaim their historic spatial legacy. The Zócalo acted as a *representative space* to reestablish the social pact between government and Mexico's indigenous people.

In Marcos' speech (fig.2) he emphasized the importance of including not only Mexico's original inhabitants but all those alienated by the State. The Zócalo´s *symbolic, representative and absolute space* acted as an integrational space. Beyond official State symbols, the Zócalo became the Mexican diversity space:

> Native American, worker, farmer, teacher, student, neighbor, housewife, chauffeur, fisherman, taxi-driver, longshoreman, office worker, employee, street vendor, gang, the unemployed, communications worker,

> professional, religious, homosexual, lesbian, transsexual, artist, intellectual, militant, activist, marine, soldier, athlete, legislator, bureaucrat, man, woman, child, youth, elder,[20]

seek to reestablish the social contract not only with the country's government but amongst all those citizens who call themselves Mexicans. Ever since the Spanish Viceroyalty, sociocultural integration between indigenous groups with Mestizo and *Criollo* populations has not been achieved.[21] While Mexico's indigenous past is represented in the country's national symbols and form part of the foundational and morphological narrative of the Mexican national identity, the indigenous population has been marginalized since the Spanish period. The March 11th, 2001 march is one of the most transformative symbolic events of the Zócalo's *absolute space* history; the gathered masses witnessed and supported a march that demanded the recognition and integration of those who had been marginalized by Mexican society.

2.0 May 6, 2007: Naked Zócalo

Another major symbolic Zócalo event was the collective human nudity photography project organized by American photographer Spencer Tunick. Tunick had photographed naked people in streets starting in 1992 in New York. Tunick stated that the purpose of these urban installation photographs was to "expose the tension between the concepts of the public and the private, the moral and the immoral, the accepted and the forbidden."[22] In 1999, he began an international tour called "Nude Adrift", during which he photographed naked people in cities including London, Montreal, Vienna, Melbourne, Sao Paolo, Barcelona, and finally Mexico City.

The installation in the Zócalo was part of a global narrative and artistic exploration; while the *absolute space and representative space* was physically in Mexico City, photographic documentation of the installation formed part of an international narrative. José Gaspar and Begoña Sendino stated that for Tunick:

> The results are poly-significant works that speak of the metamorphosis of the city's landscape, all of it with a twofold consequence: on the one hand, the account of his fantasy extends to place our knowledge about reality in doubt, shattering the limited and finite idea we have about the city with the purpose of *re-creating* it through the intervention of the naked body; and on the other hand, it shows us a new vision of the nude.[23]

On April 30, 2007, Tunick announced that the Zócalo would be the stage for his massive nude photographic installation in Mexico.[24] The installation's objective was to transform the Zócalo into a stage set for the disconcerting presence of thousands of naked bodies. Tunick noted that permission was achieved because of the Mexican people and the freedom of expression in Mexico. The announcement and recruitment for the event was made on the web portal of the National Autonomous University of Mexico (UNAM) designed for the event.[25] In return for participating in the photographic project, each participant received an artist signed print of the installation.[26] Participants would experience posing nude in the fourth largest plaza in the world, but also receive an example of *spatial representation* of the Zócalo.

While the artist obtained permission to use the Zocalo's *absolute space*, the Federal government stipulated that the national flag would not be raised during the installation: The Plaza itself would be without its iconic national and international symbol. By removing the Mexican flag, the Zócalo as urban-scale backdrop was now integrated into the larger narrative of *spatial globalization*: only experienced eyes could determine where it was taking place.

Semiotic-based spatial analysis reveals poly-significant narratives. Meanings varied by groups: participants, the left-wing local government, conservative groups, and the Catholic Church. Controversy surrounded the installation from the beginning: the government argued that it was a cultural and artistic event that would give the Zócalo an international character and profile. The Catholic Archdiocese of Mexico spokesperson Hugo Valdemar opined on the project expressing that:

> Spencer Tunick's naked projects are not immoral, they are artistic, thus there is no objection whatsoever from the Curia. Furthermore, Mexican society shows great openness and tolerance for this type of artistic activity […].[27]

In another sign of tolerance, The Archdiocese postponed the traditional 7am Cathedral Mass so the artist would be able to work without interruption.

The Archdiocese's statements and actions are relevant because the Catholic Church, from the Viceroyalty onward, had periodically occupied the Plaza's *absolute space* as a sacred space, carrying out processions, and religious ceremonies -including two *auto-da-fés*. Now, the Archdiocese signaled tolerance if not outright support for the different Zócalo activities. The Church's statement may be interpreted as support for the local government's cultural position. If briefly, Tunick's installation united Church, the DF government and the subject-participants through *spatial* relationships.

Conversely prominent business leaders, conservative *PAN* politicians condemned the event as indecent. Congressman Jacobo Bonilla (PAN) expressed disapproval and suggested that the event was a distraction by the then local head of government, Marcelo Ebrard: "there are more pressing issues the local administration should focus on, not an event that will be uncomfortable for all the *capitalinos*".[28] Conservative *PAN* officials voiced their disagreement and rejection, claiming that permission for the "pseudo-artistic" installation was an excuse by the *PRD* to justify populist acts and self-serving promotion".[29] These statements, many of which were made before the event, were part of a torrent of opinions unleashed in favor and against the event; reinforcing the significance of the Zocalo's *absolute space* as central to civic discourse.

On May 6, 2007, at 04:30 am, enrolled participants began arriving at the Plaza. According to one participant's account in the *El Universal* newspaper, the entrance was via 16 *de Septiembre* Street. Even at that early hour, the access lines were already endless. Those that had already entered the Plaza waited seated, standing up, or lying down, cheering and singing "*Cielito Lindo.*"[30] As the Plaza reached capacity, would-be participants were turned away. Many of those who were turned away began heckling. Chants included "there are no limits to art and culture", "picture by picture, nude by nude" [31], "all of us or none at all", and the crude jeers "*puto*" and "*ulero*", traditionally reserved for political demonstrations. were heard across the Plaza. The installation had become a politicized event, engendering in those who were left out animosity shown at political events. Many excluded said they had been robbed of the opportunity to be "a part of the country's history".[32]

After thanking the participants, Tunick noted that Barcelona's record of 7,000 participants had been surpassed by Mexico City by 11,000. Next, Tunick instructed participants to take off their clothes. Once disrobed, they stood in pre-determined spots on the plaza, standing three or four people per module. The installation revealed Mexico's multi-culturalism and ethnic diversity enabled by the Zócalo's *absolute space*. There were men and women of all ages (over 18), skin colors, heights, with partners, friends and alone.

After the fourth photograph (fig.3), Tunick asked the men to leave, as he would photograph the women facing the National Palace. Now alone, many women began to chant "Abortion, yes! Abortion, yes! Abortion, yes!" politicizing the installation.[33] Fear spread among women when dressed men approached with their cell phones taking pictures. The women yelled: "Men Out!", "Men Out!", "Leave!" According to testimony from Ericka Montaño, it is then when "real nakedness and fear was felt."[34] The unity felt during the four poses required by the artist was broken when the men were asked to move away and get dressed. At that moment the women felt vulnerable and attacked, breaking the sense of gender equality that minutes before they had embraced in the Zócalo. After the men were removed, order was restored.

In a massive nude experience such as Tunick's installation, individual involvement becomes collective participation, sharing a common experience. Elías Canetti argued that people can shed the fear of touching another person when sharing experiences and situations, because the moment that the individual lets go into the mass, the fear of contact disappears, "the feeling of equality appears, and all are the same as one self".[35] Because of citizen participation, the artistic nature of the event, and *absolute space* morphology, the Zócalo became the "…meeting point in the city, but above all a place that reinforces the identity and social unity of the citizens".[36] One participant expressed: "being without clothes and seeing that we are all one community, defeats the fear of being naked in front of others. From the moment you start to take off your clothes, you defeat all".[37]

Media coverage included 256 certified reporters from 101 world news organizations. International media coverage thrust Mexico City into the logic of globalization as the Zócalo became an international center of attention. During the post-shoot press conference Tunick positioned Mexico City as an open, plural and cosmopolitan city challenging the stereotype of Mexico as a conservative nation. The 18,000 people that participated in the event were able to experience *spatial production* firsthand occurring in the most *symbolic, representative and absolute space* in the country.

Participants said posing for Tunick had been an "ode to the body", a way to free themselves from prejudices and accept the body as is, "beautiful by nature".[38] Many participants expressed that it had been an act of freedom staged in opposition to the conservatism of the ruling PAN party and their cadre of newcomers".[39] Younger people said that the mass nude was an "excellent way to present Mexico as a liberal country".[40]

Denise Gutiérrez, interviewed for this article, expressed her motivation to attend the event and described her experience of standing naked on the Zócalo:

> I got very excited....I just wanted to go and break free from all my limitations....I felt afraid, I felt shame when I got there, but it went away little by little […] What really got me excited being there was taking part or forming part of an event that made history in Mexico, for me it was about participating in something that would mark the history of the country.[41]

Staging the work of art in the Zócalo's *representative* and *absolute space* triggered a multitude of significations. For some, it was an act of rebellion against the Church and conservative politicians. Although the Catholic Church had been supportive, many of those present recall when participants started shouting: "Norberto Rivera your people are getting naked!" a statement of protests against the Church[42]. Others politicized the event as an opportunity to manifest activism, shouting: "Abortion yes! Abortion yes!", or by invoking electoral fraud with, "vote by vote, poll by poll". Participants were motivated by freeing themselves of prejudices, and to transcend as part of a work of art as protagonists in the country's history. These personal motivations are closely related to the buildings that bound the Zócalo and give the Plaza de la Constitución its character; for those opposing the Church, their participation occurred directly in front of the Cathedral; for those who opposed the government, their participation occurred in front of the National Palace, symbolic seat of power of the executive branch of the Federal Government; still, for others, it was a moment of multi-cultural union amongst the entire population. The way each person *experienced* the space was a way of *identifying* and *appropriating* what it meant to them to be Mexican.

The event reaffirmed the *symbolic* power of the Plaza, and its *representational* nature for a national and international audience. The Zócalo's *symbolic* power to convene, exactly because it is the *symbolic* center of the nation, drew 18,000 participants. The installation would not have been the same to disrobe in any other plaza; the *Plaza de la Constitución* hosts the nation's political, cultural and religious *symbols.* Filling the plaza with people, in the words of Herrera (pg.88), meant:

> […] having the power to summon the public opinion in a space that imposes and demands that society take a stance before social issues. 'In other words: the symbol and, therefore, the culture, is not only a meaning to be deciphered as a "text", it is also an instrument to intervene in the world and a device for power'.

By being naked in this environment, those who participated or witnessed others in the *absolute space* itself were forced to reconsider their *spatial practice*. The Zócalo acted as a venue in which to observe and be observed, and in the process modifying the perception of the *Plaza's* morphology, from a passive *spatial production* into an active meaning generator.

3.0 The Ayotzinapa Demonstrations

In last five years, the Zócalo has been characterized by large-scale mobilizations arising from organized groups and from civil society. The story of the missing 43 students of Ayotzinapa stands out as a noteworthy event in contemporary Mexican history. Students of the Raúl Isidro Burgos Rural Teachers' College in Ayotzinapa, went missing in Iguala, Guerrero. The sudden and violent disappearance caused a visceral reaction from Mexican society including mass protests in the Zócalo. Communities from all socio-economic groups demanded that the State clarify and resolve the case. The tragedy caught the attention of national and international media, bringing to the forefront what had been a latent anger with the State: corruption, lack of legitimacy of the government, calls for justice, use of legitimate and illegitimate violence at the federal and state levels. Since the incident, the Zócalo has functioned as a central space for the government, the Mexican citizenry and the world to hear the grievances and demands of the students' parents and of society at large.

On September 26, 2014, students from Ayotzinapa's Rural Teachers' College headed for Iguala, Guerrero, intending to commandeer buses in order to first complete their required practicums, and then transport themselves to Mexico City where they would join protest marches planned on October 2nd.[43] They managed to highjack two buses, travelled a few kilometers, passed through the *Plaza de las Tres Garantías* toll booth, and were stopped by police gunfire. Eyewitness accounts stated that at least six students were killed at the site by local police, while another 43 students were taken away into custody, and never heard from again.

On September 30th, 22 police officers were detained for their participation in the alleged murder of 6 people in Iguala. The Attorney General of Guerrero, Iñaky Blanco stated that "the violent incident that took place in Iguala was due to an excess in the use of deadly force by 22 police officers".[44] News media from across the world covered the incident and questioned the role of the Mexican government, demanding that the 43 students be returned alive. The Inter-American Human Rights Commission (*CIDH*), The Organization of American States (*OEA*) and the UN's office in Mexico requested that the Mexican government perform an investigation and search for the missing students. Five days after the 43 students had gone missing, the U.N. condemned the Iguala events, calling the incident "one of the most terrible in recent times".[45]

Intermittent small protests began in the Zócalo, while solidarity protests spread across Mexico and the world. Protests took place in public spaces outside of Mexican embassies, and in emblematic sites such as the Trocadero Plaza "Human Rights Esplanade" in Paris. The Zócalo became the *spatial representation* that connected the Mexican public sphere with global *representative spaces*.

Once again, the Zócalo was confirmed as the symbolic center of the Mexican public sphere. On October 8, a first mass protest took place in Mexico City, denominated the Day of National Action for Ayotzinapa. Protesters marched under the banner of "Not one more death!".[46] Concurrent to Mexico City's march, protests were carried out in New York, Río de Janeiro, Bogotá, Madrid, Buenos Aires, London and other cities in support of the parents of the missing students. In Mexico City, the protest began at the site of the Independence Angel monument and marched to the Zócalo. The parents led the march "to demand that the federal and state government bring back our children alive".[47] Families carried portraits of the children with their names while shouting, "they were taken alive, we want them back alive". Civil society organizations, university students, actors, singers, politicians, scholars and citizens in general joined in this first demonstration. The protesters joined together chanting: "You are not alone!".

On October 22, a second global protest called Day of Global Action for Ayotzinapa was convened. Once again, mass protests took place in Mexico and around the world. In Mexico City, the demonstration began at the Independence Angel at 18:00 with 50,000 people carrying lit candles and torches to the Zócalo. The march, dubbed the "Light for Ayotzinapa" saw parents, poets and actors speaking publicly. Actor Daniel Giménez read a text called "The strongest cry" at the Zócalo referring not only to the "missing 43" but also to Mexico's "Dirty War"[48] mass graves. The events in Iguala brought back into public discourse alleged 20th Century State murders and kidnappings. The Zócalo's *absolute space* became the public sphere from which justice was demanded for State violence. As the protest ended, lit candles and 43 desks with portraits of the students were installed throughout the Zocalo, creating a morphology of memory.[49]

On October 25, the newly formed Inter-University Assembly with over 80 Mexican schools called for a third day of National and international action, to take place on November 5, 2014. That day 115 schools held a national strike to protest the Ayotzinapa incident; thousands marched from the presidential residence of *Los Pinos* to the *Zócalo*. Once there, the chanted: "Out with Peña!" "Justice, Justice!" while banners were seen with the statements "State Crime!" and "We want them alive!"[50] Concurrent international protests: In New York, 80 people occupied the street in front of the Mexican consulate and lifted painted red hands and banners while chanting "teacher, brother, New York gives you a hand". [51]

On November 7, the parents of the 43 missing students met with Attorney General Jesús Murillo, who informed them that human remains of what could be the missing students were found in the town of Cocula, Guerrero.[52] *La Jornada* reported that the following day there was another peaceful demonstration in the Zócalo called "Ayotzinapa lives! The State is dead".[53] This time, protestors began their march from the Attorney General's Office and headed for the Zocalo. At 21:55, a group of hooded individuals, jumped the metal fences that surround the National Palace and began to spray paint the main or Mariana door of the building. Subsequently, they tried to break down the door with sections of the steel fencing. Reporters on site noted that demonstrators started yelling "no violence", while the group at the Palace doors replied, "This is not violence, violence is murdering students". León Ramírez, a protestor at the scene reported to the newspaper that at 22:20 the rioters tried to set fire to the National Palace main door. Ten minutes later they launched a large firecracker through a Palace window shouting "What pacifism? What non-violence? Direct action and resistance". The mass of protestors then began shouting "Out with the infiltrator!" and upon the explosion of a second rocket, began to withdraw via Madero Street. According to the *Excelsior*, there were an estimated 15 vandals at the Palace doors, however, their actions managed to eclipse the peaceful mass demonstration: ".... it became an act of vandalism that lasted around an hour, during which three attempts were made to set fire to the main door of the National Palace.[54]

The hooded individuals launched rocks and firework rockets at the large wooden door (fig.3), managing to make a hole through which they then hurled "Molotov cocktails". This attack lasted until presidential guards arrived, causing rioters to flee. Met by Federal riot police, the fleeing rioters threw rocks at the police, engaging in a violent clash that lasted several minutes. In the end, 10 rioters were placed under custody while five local police officers were wounded along with four presidential guard officers and three civilians.[55] The rioters understood their symbolic actions against the State by vandalizing the National Palace's *representational space.* Following the attack, photographs spread on-line depicting tolerant State apparatuses: Police and soldiers stood by passively without engaging rioters. One photograph seems to show the authorities protecting the rioter responsible for setting the door on fire. The images generated varied reactions: Protest leaders denied any responsibility for the violence, arguing their protests were peaceful. Other outlets interpreted the incident at the National Palace's main door as an alleged State conspiracy: infiltrators, hired by the government to discredit the mass movement through violence. As if prompted, President Enrique Peña declared that "the Ayotzinapa case is a call for justice, for peace, and for unity, not for violence or confrontation. Justice cannot be sought while acting with violence".[56]

The Ayotzinapa case triggered Mexican society mobilization and activism, making apparent a broken political system with little credibility. The Zócalo served as the *public spatial sphere* where dissatisfaction and citizen demands could be publicly voiced. The Zócalo became a *spatial nexus* that connected discontent in Mexico with the world at large.

Conclusion

This article demonstrates how various representative events of the first decades of the 21st Century transformed the Zócalo into a *public sphere* space of "good governance". Following Herrera's categories, examples were chosen that illustrate the Zócalo's socio-cultural *spatial production.* Earlier morphological transformations, such as the removal of Plaza gardens, along with the scale and flexibility of the *absolute* space, in combination with a new political tolerance, enabled a renewed positive use by the public sphere. The "March for Dignity" symbolized State aperture to engagement with belligerent groups such as the EZLN. The March's entry to the Zócalo, demonstrated a welcoming Mexican State to political counterweights into the symbolic heart of the nation. The Zócalo, as an *absolute, representative and symbolic space* acted as a space where Mexicans openly acknowledged and discussed their differences. The Zócalo became a space where diverse Mexicans sought to reestablish a social pact both with the country's government as well as with those who call themselves Mexican. Tunick's art project used the Zócalo to unify, if briefly, participants, Church, State and the world. Naked civic participation changed *spatial* perception of a flagless Zócalo and its *spatial public sphere* by allowing participants to feel vulnerable, but together, while engaging in something larger than themselves. Finally, the Ayotzinapa protests can be read as transforming the Zócalo into a *symbolic space* for the demands and aspirations not only of the missing students' parents but of Mexican society, and once again, much of the world: discourse focused on State democracy, justice for victims, and the debate over the legitimate use of State sanctioned violence. While the attack on the Mariana Door of the National Palace symbolized a potential break in the social contract, State inaction signified tolerance. The Zócalo's spatial lesson is that governments everywhere can foster "good governance" environments by promoting and building spaces where *public sphere* users can engage in large-scale community strengthening activities through *spatial production* and the opportunity to peacefully vent socio-political discontent.

Fig.1: Zócalo circa 1948 (Miguel Aguirre Botello)

Fig.2: Subcomandante Marcos in the Zócalo (Enclavesur)

Fig.3 : Spencer Tunick, "Mexico City 4" (MUCA/UNAM).

Fig.4: National Palace's Mariana Door, (Mediobson).

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Pedro Vasco Martins

The Fragmentation of Monumental Buildings. From a Single Building to an Urban Fabric

The Fragmentation of Monumental Buildings. From a Single Building to an Urban Fabric.

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ABSTRACT: The city is a living entity, dynamic, and in permanent construction. In the constantly changing human landscape dominated by the common fabric, prone to quick transformations, monumental buildings, given their high cultural value as well as robust construction, tend to show a greater resistance, remaining relatively stable trough out hundreds or even thousands of years. Yet, in periods of crisis or quick cultural change, even the resilient monumental buildings can suddenly lose their function or collective cultural value, undergoing a complete transformation of their unique nature as they appropriated and transformed by the common urban fabric, in a process identified as fragmentation.

From the ancient monumental roman structures occupied in the middle ages to the transformation of the Kowloon fort in Hong Kong in the second half of the 20th century, the communication proposes, through an analysis of several case studies, a reflection of how the subversive, ad-hoc and informal nature of fragmentation makes it one of the richest processes of urban fabric formation. In this sense, the knowledge of this process can be an important architectural design tool, contributing for the enrichment of the erudite architectural discourse, as well as, helping to understand the shape of the contemporary city as a result of sequence of events that can be identified, interpreted, classified and explained.

KEYWORDS: Fragmentation, Monumental Buildings, Urban Fabric, Plot Structure, Transformation.

INTRODUCTION

The urban fabric is composed by a great diversity of spaces, as well as built structures. These, in turn, are characterized by a great diversity of forms and functions. This heterogenous built landscape is mostly populated by two fundamental groups of buildings: the common buildings and the singular or monumental buildings. The common buildings, usually of residential nature, constitute the great majority of the urban fabric. Generally anonymous, built on more fragile materials and following vernacular designs, these buildings in the "long time" of urban evolution are constantly altered, augmented, destroyed and rebuilt, sometimes in short time and most often without leaving memory or traces. Monumental or singular buildings, on the other hand, are those whose form or function makes them stand out of the common urban fabric. These buildings tend to leave a lasting presence in the urban fabric, sometimes remaining virtually unaltered trough hundreds of years. We can associate this concept with buildings of a public nature and collective value, however for the purposes of our argument, we should consider as monumental buildings architectural objects with an erudite form, critically thought and projected. Buildings whose genesis originated from the formalization of a concept or an idea, and which materialize in its form the paradigms or utopias of the cultures responsible for their construction, such as palaces, temples, convents, theaters, parliamentary halls, municipal chambers, hospitals, etc. These buildings are the result of richer and more complex construction programs, both their design and in the quality of their constructive structure, as well as in their symbolic and cultural value.

1.0 THE FRAGMENTATION OF MONUMENTAL BUILDINGS

1.1. The process of "fragmentation"

The constructive and spatial quality as well as the symbolic value given to monumental buildings usually leads to them being preserved, successively reinterpreted and reused by different cultures over time, in deep contrast to the anonymous common buildings whose continuous construction and destruction is a part of the daily urban rhythm. However monumental buildings can also undergo a rapid process of erosion and transformation, particularly when they lose their main function or cultural meaning resulting in an abandonment and ruin of the building, that is subsequently appropriated and transformed by the common urban fabric trough the overlapping of new structures and the adaptation to different forms and new uses. This type of transformations, and their relevance in the production of urban fabric were particularly explored by Italian authors such as Caniggia (Pozo 1997, 49) or Gian Luigi Maffei and Mattia Maffei (Mattei Maffei Luigi Maffei 2011, 51) as they sought to understand the formation of medieval fabric over pre-existing roman structures. One of the fundamental consequences of this transformation is the fragmentation of the monumental building, dividing what was once a single, cohesive unit into several smaller entities that from then on will follow their own independent evolutions and transformations. The design of these new smaller entities is not only conditioned by the spatial traces left by the monumental buildings they now occupy, but often takes advantage of these features to construct new compositions created essentially from the surviving architectural remains. One of the most important component of these initial occupations is the plot structure as, once settled, plot structures are particularly resistant to transformation, and being defined at first directly by the remains of the monumental building the plots will tend to preserve in their morphology traces from the layout of the primitive building. In contrast, architectural fragments or structural remains, that although initially preserved and reused by the first occupations, as these are successively replaced by newer buildings, these traces will be gradually erased. In this process, the old monumental building tends to gradually dissolve into the various small occupations of its space, becoming an integral part of the common fabric. Thus, the original shape of the monumental building is in part preserved by the buildings initially built over its structures, even through the successive changes that characterize the urban evolution. All types of remains persist from small disperse architectural pieces to large spaces, complete or retransmitted by the street alignments and by the plots boundaries. Often the old interior circulation corridors turn into streets, the courtyards or cloisters in squares, and the interior divisions in separate buildings with an autonomous nature.

2.0 CASE STUDIES

2.1. The fragmentation of ancient roman monumental buildings

Known as the eternal city, Rome is the paradigmatic historic city. In it we can find some of the most notable examples of monumental architecture, both past and present, forming an eclectic mixture of current and past buildings. Underneath all this diversity we can also find significative traces of the ancient city past, as the city medieval core was initially set over the remains of several ancient roman monumental buildings. The well documented evolution of the city of Rome (with cartography as old as the roman Forma Urbis), and the available knowledge of roman architectural typologies makes these examples of fragmentation particularly relevant for their good documentation and formal clarity. Rome was probably formed in the beginning of the iron age after several villages existing in the surrounding hills coalesced in to a single civil entity. This merger was later materialized through the construction of the Servian wall in the IV century BC, securing the ancient city core roughly centered on the Colosseum valley. The city avoided the lower plains around the Tiber that were at the time occupied by marshes and frequently subjected to flooding. The construction of drainage infrastructures in the largest of these lower plains (similar the construction of the Cloaca Maxima in the roman forum) significantly improved its usability, allowing it to be more consistently occupied, at first as the main staging field for the roman army, thus giving it the name of *Campus Martialis* (Field of Mars) after the god of war.

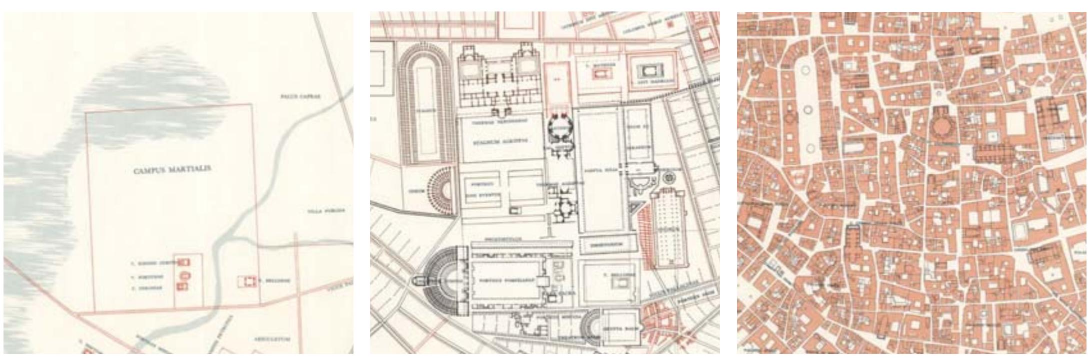

Figure 1: The Campus Martialis. From left to right: 1^{th} century B.C., 4^{th} century A.D., 16^{th} century A.D. (Muratori, 1963)

In the period between the end of the roman republic and the beginning of the roman empire as the city became the economic and military center of the Mediterranean world, rulers or even wealthy private citizens sought change Rome and transform it a cultural and architectonic reference that would rival cities like Athens or Alexandria. However, the high density of occupation made any large-scale interventions particularly difficult even for the first absolute rulers such as Caesar or Augustus, making the relatively free and open space of the *Campus Martialis* an ideal place to materialize monumental architectural visions. Thus, the area was soon occupied with large public buildings, such as the Theater and Porticus of Pompey, the Pantheon and the Baths of Agrippa, the Baths of Nero, the Stadium and Odeon of Domitian, the Theater of Balbus, and the Temple of the Divine Hadrian among many others. With the collapse of the empire in the early 5^{th} century the city contracted from more than one million inhabitants to only a few thousand. From the biggest city in the western world Rome became during the late antiquity a collection of rural buildings dispersed in the once monumental landscape. The urban decay led to the abandonment and ruin of the numerous aqueducts, with only the Aqua

Virgo subsiding, probably as its path was mostly underground. This aqueduct, built during the reign of Augustus by Agrippa to supply his baths in the *Campus Martialis*, became one of the only secure sources of potable water for the population of Rome, conditioning new growth of the city during the late middle ages and renaissance to the area around the *Campus Martialis* Thus, the inhabitants of the city concentrated themselves on an area that was fully occupied by the remains of the abandoned monumental buildings. (Fig 1).

Given the lack of resources to adequately clear the area, the new constructions used the ruins as much as possible for support. New houses occupied the spaces between the standing columns of ancient temples, under ruined arches, over the seating areas of theaters or even inside the vaults and domes of bathhouses (Fig. 2). These initial occupations contributed to the preservation of the roman structures, and only at much later dates were many of these completely demolished, mostly from the 16th century on. Some examples of this can be found in the Arch of Portogallo, demolished in the 1662 by Pope Alexander VII, the Septizodium demolished in late 16th century, the remains of temple of Nerva demolished in early 17th century, the remains of the Temple of Serapis on the Quirinal hill also demolished in the 17th century, among many others.

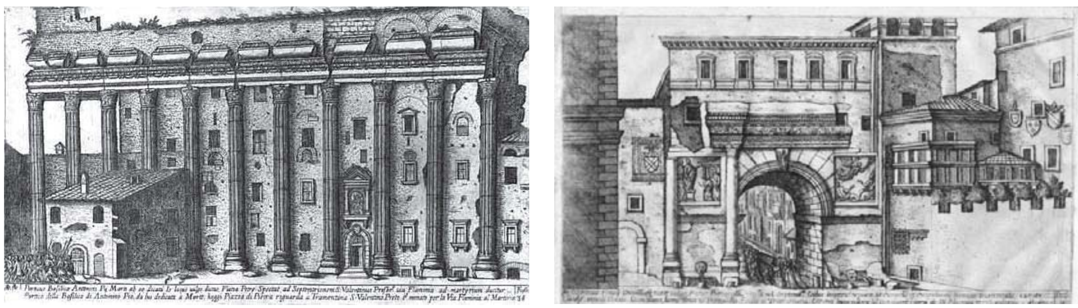

Figure 2: Remains of the Temple of the Divine Hadrian, the Arch of Portogallo (Aloisio Giovannoli, 1615).

Although most of the visible roman remains in the area of the *Campus Martialis* have been all but erased, the plot structure and the urban fabric have preserved to a significand degree traces of the original roman buildings, transmitted over the walls of countless iterations of common buildings. Rome thus stands out as perfect example of not only how this process has the potential to influence large areas of the city, but also how traces of ancient buildings can sometimes survive through hundreds or thousands of years. This is particularly clear in the cases of roman theaters and amphitheaters as these buildings, with large support structures for the seating areas, are more resilient the destruction of time as well as the circular nature of their designs making them more evident in the urban layout, while in contrast ancient monumental buildings with an orthogonal configuration tend to be more easily hidden by the common urban fabric. In this sense the remains of the theater of Pompey and the stadium Domitiani (now the Piazza Navona) prove a some of the most compelling examples on the resilience of the monumental buildings traces after the process of fragmentation, as the design of the ancient buildings is preserved in an exceptional manner in the contemporary urban fabric (Fig. 3).

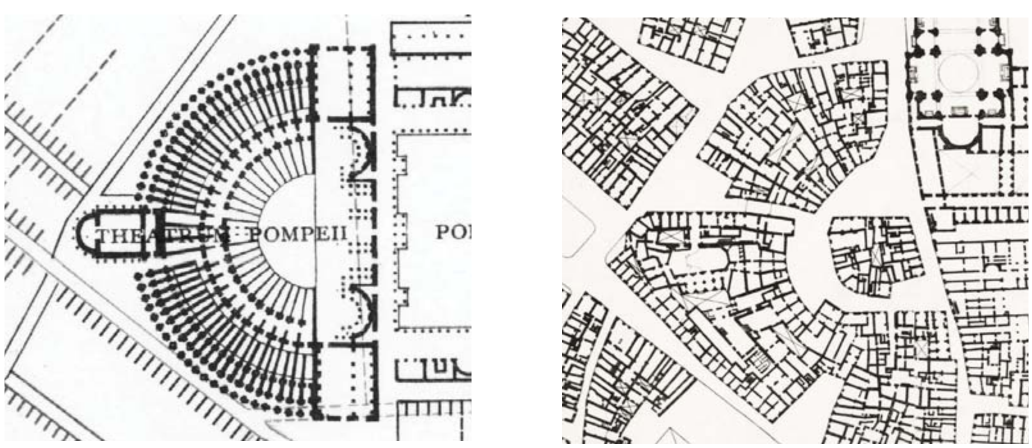

Figure 3: Comparison between the Theater of Pompey and contemporary urban fabric. (Muratori, 1963)

2.2. The fragmentation of Lisbon’s palaces and convents

Often associated with roman buildings, the fragmentation of monumental buildings can occur in any city or any period in history. A good example of the frequency with which this process can happen can be found in the city of Lisbon and the transformation suffered by some of the city’s palaces and monasteries. After the constant territorial expansion of the Reconquista during the middle ages, Portugal, with its mainland territory landlocked by the kingdom of Castile and Leon turned its attention to the creation of an overseas empire. Thus, the Lisbon became one of the largest world cities, head of an empire that stretched from north Africa to Brazil, Angola, Mozambique, Ormuz, India, Indonesia, and Japan. With the pretension of making a “new Rome” an an ambitious construction program was initiated to reflect this new position of power. This process, focused mainly in the construction of monasteries, churches and palaces, was carried out inconsistently in the following centuries by different kings, with moments of stagnation or of fast construction, giving it an haphazard and uncoordinated nature.

The process would however abruptly stop after the long period of instability that started with the earthquake of 1755, followed by the French invasions of 1807 and 1811 and the civil war from 1828 to 1834. The colonial world that had supplied the wealth behind the construction program suddenly collapsed and the city dramatically shifted from the past colonial world to the new industrial paradigm. Instead of receiving expensive commodities like spices and gold from the overseas, exporting them to Europe, Lisbon became an industrial powerhouse that supplied the country and the colonies with manufactured goods. As the aristocracy and clergy lost their traditional revenue sources, some palaces and monasteries built and maintained in the previous centuries were either adapted to other functions by the emerging republican state, sold to the increasingly powerful bourgeoisie factory owners or simply abandoned to ruin and taken by influx of working class squatters that flooded the city in search of work. While some buildings are transformed in hospitals, military barracks or factories, others, like the Val dos Reis palace or the Bernardas convent (Fig. 4) are converted in to lower working-class residences.

Figure 4: Courtyard of the Bernardas Convent transformed into lower class residences (Almeida, 2000)

These working-class residences adapt the old buildings by dividing the built areas in to autonomous units while at the same time preserving the open areas virtually unchanged, namely courtyards in palaces and cloisters in convents or monasteries. These will function as the main circulation and socialization spaces, generating a small enclave, a semi-private collective courtyard accessible only through a single passage almost always the original main entrance of the monumental building, giving these adaptations the common toponymical designation of "patios" (courtyards). As for the built areas, the once spacious halls are separated from each other and transformed in to individual residential spaces, adding smaller rooms that subdivide the space. These will, with time, have autonomous evolutions, eventually demolishing the original walls and replacing them with fully autonomous buildings.

Figure 5: Remains of the Coculim palace in the early XX century (Unknown Author)

One of the most significant cases of fragmentation in Lisbon can be found in the various palaces built along the old Islamic Wall. Of these the ancient Counts of Coculim palace, destroyed by the 1755 earthquake and tsunami, stands out, for its size and for the fragments that still survive, such as the large stone masonry corner bearing the coat of arms of the Mascarenhas family, as well as the large 17th century portal. The lack of detailed building plans prevents us from understanding impacted the interior spaces, however a 16th century painting as well as a photography from the 20th century allow us to reconstruct the impact of the fragmentation process on the building façade. Sometimes overlooked, the façade is a fundamental part of any building, and in the case of urban palaces this element is used as a statement of power, with a rigorous geometric composition frequently more elaborate than the building plan, that is usually conditioned by irregular pre-existing plots. In these cases, the process of building fragmentation is particularly evident in the study of the façade, where the former geometric order is contrasted by the irregularity of the newer constructions.

The Coculim palace facade presents a rigorous geometric composition characteristic of the period, with 15 large identical balconies in the first two floors, this composition was only interrupted in the centre by the large and portal in rusticated stonework. In the beginning of the 20th century, as a result of the earthquake, the top floor has disappeared as well as large part of the central façade area, replaced by small buildings (Fig. 5). The palace fragmentation assumes a more expressive character in its facade; being particularly evident the contrast between the erudite geometric order that existed before the earthquake and the irregularity caused by its fragmentation (Fig. 6). This building not only clearly illustrates how the original building is divided and slowly transformed piece by piece, but also how the most iconic elements tend to survive longer (In this case the entrance portal and the stone masonry corner bearing the coat of arms). This example also demonstrates how this process in should not be considered only in the context of roman or medieval buildings, occurring in much more diverse, and sometimes unexpected settings.

Figure 6: Evolution of the Coculim palace from the 16th century to the 20th century (Pedro Vasco Martins)

2.3 The fragmentation of Kowloon fort

Although this process is often associated with ancient buildings, transforming gradually over long periods of time we can find examples where this process occurs in a short span of time, of which the Kowloon walled city in Hong Kong is one of the most emblematic. Kowloon began as a small military outpost built in the early Sung Dynasty (960 – 1297) to house imperial soldiers controlling the surrounding area. After losing the First Opium War (1839-1842), the Qing government ceded Hong Kong Island to Britain. With the British occupation of Hong Kong, the once small military outpost became a strategic military station. Therefore, the Qing Dynasty decided to fortify the outpost adding a granite stone wall (Fig. 7) that formed an irregular rectangle with 130x230m. The wall enclosed an area of approximately 14.125 m2 (6 1/2 acres), with 4 gateways, 6 watchtowers and several interior support buildings, from offices to housings and warehouses. Construction was completed in 1847, serving both as an administrative hub to govern the surrounding areas, and as a centre for coastal defence. By 1898 the garrison numbered 500 soldiers and officials, as well as 200 civilians, generating a bustling market town along the road that connected the fort to the waterfront.

Figure 7: The norther corner of the Kowloon Fort, and surrounding landscape in 1856 (Girard, Lambot, 1993)

In 1898 the British begun negotiations to secure more territory in the mainland north of Hong Kong. Chinese Qing Dynasty authorities however were particularly reluctant in abandoning the Kowloon fort. Thus, to overcome this stalemate, British and Chinese officials agreed on the lease of all the territory in the Kowloon peninsula to British jurisdiction except for the Fort, that remained under the sovereignty of the Qing Dynasty. The unusual agreement would not last long as British troops took the fort in 1899, finding it had been hastily abandoned by the local garrison. Seeking to avoid provocations to the Chinese officials, the British refrained from enforcing their control, the Chinese on the other hand also didn't make any attempts to reinstate their control, leaving the Fort in an ambiguous apparent state of anarchy, out of British jurisdiction, and out of reach of Chinese authorities. Over time most of the buildings inside the fort fell in to a state of ruin while the surrounding fields were gradually occupied by squatters. In the 1933 plans were drawn to demolish the houses and turn the area in a tourist attraction under protests from Chinese authorities. By 1940 almost every building inside the fort had been demolished with the exception of the *yamen*. The planed tourist attraction would however never materialize as the Japanese occupation of Hong Kong interrupted the process, demolishing the remains of the granite wall and using the stone to extend the Kai Tak airport. By 1947 the area was flooded with 2000 refuges, while at the same time China flexed its authority announcing the intention to reclaim its rights and establish civil courts in the fort area. After the British tried to evict the squatters riots broke spreading as far as Canton and Shanghai, leaving the local Government with no options but to adopt a "hands-off" approach in an effort to prevent the further deterioration of Anglo-Chinese relations. The fort thus quickly fell again during the 1950's and 1950's in to a state of general lawlessness filled with brothels, gambling parlours and drug dens dominated by Triad societies. During the second half of the 20th century the initial improvised houses were gradually replaced by multi-storied buildings creating the most densely populated place ever to exist on earth. According to the 1971 census there were 10.004 inhabitants in 2185 dwellings, although the unofficial number was probably much higher, as in the late 1980's there were about 35.000 residents. Finally, in 1987 British and Chinese authorities agreed in the need to demolish the site in the interest of the local population. Demolition began in 1993 after a hard eviction process, and in 1995 the Kowloon Walled City Park opened its gates.

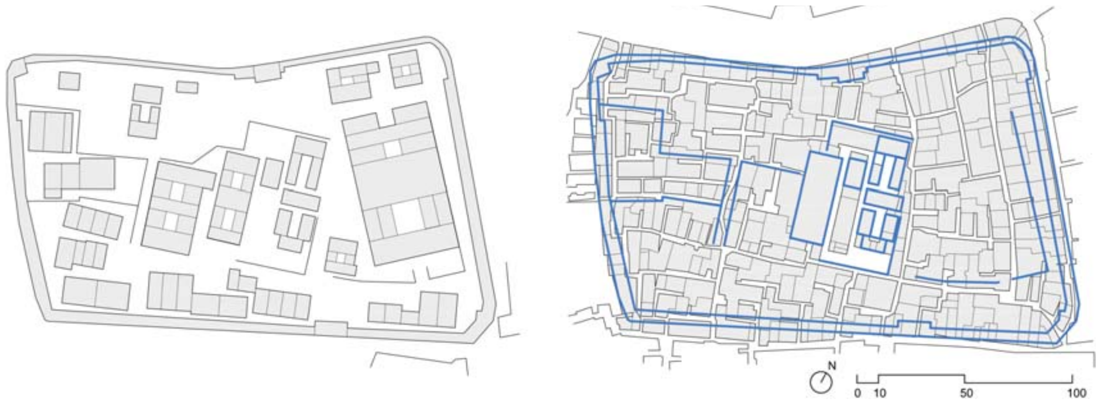

Figure 8: Comparison between the plan of the fort at the end of the 19th century and at the end of the 20th century, highlighting the common persisting traces (adapted from Lai, 2016 and Girard, Lambot, 1993)

The comparison between the plan of the fort at the end of the 18th century with the site plan in the late 1980s shows that rather than a complete destruction of the site, the urban fabric inside Kowloon not only respected the original walled precinct but also flowed the general orientations set by the ancient buildings. The inner retaining walls also continued to serve their purpose and were thus preserved helping to define the new urban fabric. These structures helped to initially condition the construction of the first improvised squatter houses, that would latter give way to multi-storied concrete buildings. Similarly, the *Yamen* building originally saved from destruction in the 1940s acquired a particular cultural or symbolic value as it was the last remain of the original construction, being continuously preserved even under the high demographic pressure to use every available space for the construction of new houses (Fig. 8). The example of Kowloon is also particularly relevant as it clearly shows the contrast between the resistance of the plot structure and the relative volatility of the individual buildings. The initial shanty town plot structure was constituted by small plots and small wooden buildings, that with the gradual densification of the area were quickly replaced by high rise concrete buildings. The plot structure however remained the same, creating an unusual group of needle like buildings, some as high as 14 floors in very small areas (Fig 9), that in virtue of their height and small base leaned heavily on each other, to such a degree that in one were to crumble the whole complex could collapse.

Figure 9: Aerial view of Kowloon highlighting the almost monolithic nature that urban fabric had. (Girard, Lambot, 1993)

CONCLUSION

The city is a living entity, dynamic, and in permanent construction. In the constantly changing human landscape dominated by the common fabric, prone to quick transformations, monumental buildings, given their high cultural value as well as robust construction, tend to show a greater resistance, remaining relatively stable trough out hundreds or even thousands of years. Yet, in the process of fragmentation, that tends to occur in periods of crisis or quick cultural change, even the resilient monumental buildings can suddenly lose their function or their collective and cultural value, undergoing a complete transformation of their unique nature, losing unity and breaking up into a sum of units that, from that moment will have their own independent evolutions. What was once a monumental building will transform in to a part of the common urban fabric. This new urban fabric will respect some aspects of the previous monumental buildings, namely structural elements such as exterior walls or functional and symbolic elements, such as entrances or temples. These fragments of the monumental buildings, absorbed by the common fabric, will be constantly recycled and reused, and in this way preserved, retransmitted trough countless iterations of buildings. Thus, rather than consisting in the apparent complete destruction of the monumental buildings, this process implies to a significant degree their preservation, the resulting new urban fabric shows a great richness, as it encapsulates both the new and the old, the past and the present, serving as a window in to the memory and the identity of the city. The fragmentation of monumental buildings is thus one of the richest and most complex processes of urban fabric formation, although it appears to occur almost naturally in particular circumstances of neglect or ruin, being often associated with the transformation of roman monumental buildings, the process of fragmentation is more widespread and common, occurring in some instances in the 20th century. In its genesis the process of fragmentation has a subversive, ad-hoc and informal nature of deconstructing the established order and reinterpreting it, however the knowledge of this type of processes can be an important architectural design tool, contributing for the enrichment of the contemporary erudite architectural discourse, as well as, assuming a role in the preservation of an urban memory and identity. Finally, the comprehension of these processes can also prove useful in helping to understand the shape of the contemporary city as a result of sequence of events that can be identified, interpreted, classified and explained.

ACKNOWLEDGEMENTS

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Software Development Within Architecture: A Graphical Evaluation and Discussion of Its Trends

Software Development Within Architecture: A Graphical Evaluation and Discussion of Its Trends

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ABSTRACT: Developmental leaps within digital technology has impacted architectural form and advanced how architects communicate, analyze, and incorporate advanced building technologies into their designs. Occurring over a period of decades, software's impact on the practice of architecture has escalated through an increase in its accessibility and adoption by the profession's leading architects. This has resulted in digital technology becoming one the largest contributors to innovation within the architecture, engineering and construction (AEC) industry, fundamentally changing the architectural process, and to some extent the contemporary design language. To better understand the relationship between digital technology and architecture, this study looks at a sampling of software utilized by the industry and evaluates it over a spectrum of time based on functional and developmental characteristics. Through the creation of a graphical representation of the collected data, patterns between taxonomies, software development, and its usage within architecture have been observed. It is proposed these trends can aid in the understanding of the landscape of software development, how it has transitioned over time, what programs are available for usage within architecture, and how they are interrelated with the architectural process. These trends -- aided by the understanding gained from their analysis -- can then be utilized to facilitate a discussion regarding how the trends relate to larger developmental tendencies within the AEC industry and be used as measures for the changing landscape of the architectural process.

KEYWORDS: Architecture; software; innovation; software development; digital technology

INTRODUCTION

The impact of digital technology on the practice of architecture over the past 35 years has been significant, contributing equally to the evolution of the built form and the design and construction process. Arguably as revolutionary to the design process as the introduction of paper or the discovery of perspective drawings (As and Schodek 2008; Kvan 2009), the era of the computer has fundamentally altered the way architecture is practiced through the introduction of advanced computational-based design methods, digital fabrication, simulation and analysis, digital representation, and advanced delivery and construction methods such as building information modeling (BIM). This redirection of the process has set a new mandate for the discipline, changing the design process from a representational and paper-based system to a digitally-managed and influenced system of analysis and simulation. As a result, digital technology has displaced more traditional design methods, requiring the architect to develop more digitally oriented ways of thinking and extend a design concept through interaction with a digital system. (Galofaro 1999)

Digital technology's ever-increasing bearing on practice is a result of a surge in access to software that was once almost entirely exclusive to researchers, advisers, and engineers. Related to both technological advances and economic factors, this access has resulted in a proliferation of possibilities as architects can now directly connect to and integrate simulation, optimization, building information systems, manufacturing process, visualization, and complex forms into their designs. (Grobman 2012) As a result, some relate this digital shift to an evolutionary movement that will establish a new era within architecture. (Aksamija 2016) In consideration to these factors, this study is interested in the potential relationship between the development of digital technology and the practice of architecture. As such, it is considered that patterns within the development of digital technologies can be used to draw conclusions that relate to trends within architecture, and the interconnectivity of software, software development, and the architectural process.

To aid in understanding the relationship between digital technology and architecture, a sampling of software within the architectural community was evaluated based on significant developmental information and function. The collected information has been graphically represented along a timeline illustrating the selected software's development and mapping their primary and secondary functions. Utilizing this software development graphical representation (SDGR), patterns were observed between the study-defined taxonomies, software development, and usage within architecture. These trends can aid in the understanding of the landscape of software development: how it has transitioned over time, what types of programs are available for usage within architecture, and how they are interrelated with the architectural process. Through this understanding, the patterns observed in the SDGR can be utilized to facilitate a discussion regarding how these trends can relate to larger developmental movements within the industry and be used as measures to understand the changing landscape of the architectural process.

1.0 Methods

Through literature review and discussion with practitioners, the study generated a sample of 57 software programs associated with architecture design. This research did not intend to include all software commercially available and therefore inclusion was based upon reference or discussion of the software within the AEC industry, known use in practice and academics, historical importance with respect to architectural developments, trends, or other software, and the availability of historical data. It is acknowledged that software or functions of the included software may have been omitted due to a lack of available information regarding the software or other related factors. Any omission is not considered significant for this study as the focus is on developmental patterns and not on the specific software.

For the utilized software packages, data regarding development dates, manufacturer, current version number, primary and secondary functions, associative software, and industry of origination was collected, when available. This data was retrieved from various sources including manufacturer-provided documents, academic publications, archived websites, and journals. In cases where an exact release date was not available, the developer's date of establishment as an entity was substituted when appropriate. When there were conflicting dates of release between sources, the sources were considered with developer-generated material taking priority, then peer-reviewed material, and finally publicly-generated sources such as blogs or website articles.

1.1. Software Data Graphical Representation (SDGR)

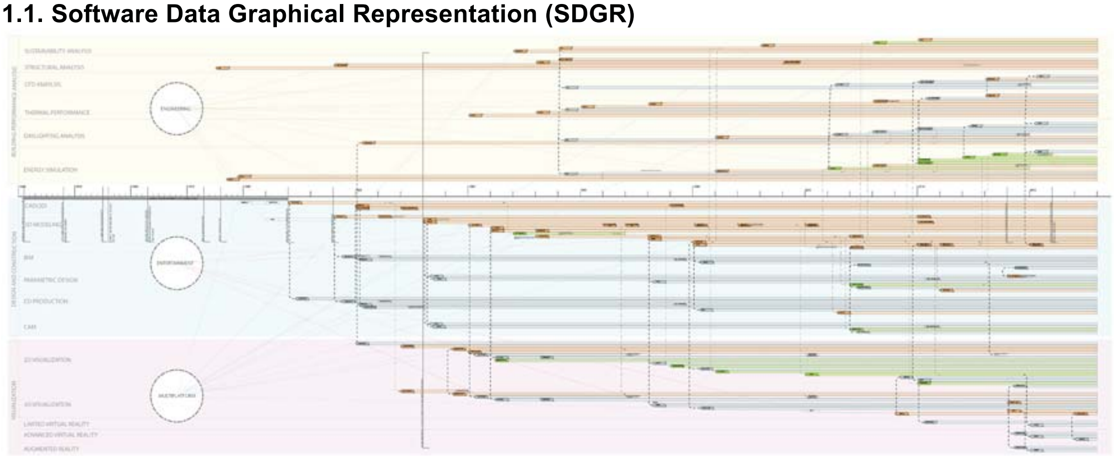

Figure 1: Software Development Graphical Representation (SDGR) (download: go.ncsu.edu/sdgr)

In the SDGR, Figure 1 and downloadable at go.ncsu.edu/sdgr, software programs are graphically represented along a timeline using initial development or release dates, field of origination, first use by architecture (when available), associated software, and key developmental occurrences, such as acquisitions, discontinuation, or significant name changes. The software is organized by three primary taxonomies and their subsequent categories. This structure was generated considering similar classification structures and discussion of the software found in literature. Represented horizontally along the SDGR, the taxonomies frame the larger usage of the software within the industry.

- ***Building Performance Analysis*** *(Yellow)*: related to analysis of building performance and structure
- ***Design and Construction*** *(Blue)*: related to CAD, modelling, and construction
- ***Visualization*** *(Purple)*: related to non-construction document representation

Each taxonomy is futher divided into function categories, specifically identifying the functions of the software.

Building Performance Analysis

- ***Sustainability Analysis*** – provides life cycle analysis and embodied energy of materials
- ***Structural Analysis*** – related to the analysis of structure and structural loads
- ***Computational Fluid Dynamics (CFD) Analysis*** – associated with the evaluation of fluid flow within structures and equipment
- ***Thermal Performance*** – performance of the evaluation of heat transfer through assemblies in 2D and 3D perspectives
- ***Daylighting Analysis*** – related to the evaluation of glare and daylighting in a structure
- ***Energy Simulation*** – associated with the evaluation and simulation of energy usage in a structure

Design and Construction

- ***CAD(2D)*** – entity or vector-based CAD programs that while can represent in 3D objects are created primarily in a 2D plane.
- ***3D Modeling*** – software used in the creation of 3D digital objects through object-based, NURB, volume-based, surface-based, or similar systems that create and represent objects primarily in 3D.
- ***BIM*** – related to building information modeling systems
- ***Parametric Design*** – provides algorithmic functions that aid in the design or manipulation of 3D objects
- ***Construction Documents (CD) Production*** – used in the creation of construction documents
- ***Computer Aided Manufacturing (CAM)*** – utilized for the creation of documents or coding used in Computer Numerical Control (CNC) systems.

Visualization

- ***2D Visualization*** – software used in the creation of static images of architectural representations.
- ***3D Visualization*** – related to interactive or dynamic representation of architecture
- ***Limited Virtual Reality (VR)*** – creation of VR systems that are primarily static and related to lower end headsets such as Google Cardboard.
- ***Advanced VR*** – associated with advanced VR systems that allow for observer movement and interaction often utilizing higher end headsets such as VIVE or Oculus Rift
- ***Augmented Reality (AR)*** – creation of mixed reality experiences that uses either smart phones or dedicated headsets for the blending of real and digital world objects using cameras.

Within the SDGR, software is represented by horizontal bars in the associated function categories, Figure 2. The functions of the software were identified through its discussion in literature and available manufacture information. Software that operates in multiple categories is listed in all applicable categories with the functions ranked into primary and secondary functions. Primary functions, represented as orange, are considered the main function that the program was created to perform or is currently used for in the AEC industry; for example, AutoCAD is primarily used as a *CAD(2D)* program, while Rhino3D is primarily used for *3D Modeling*. Secondary functions, represented as blue, are functions that the software can perform but are ancillary to its designated primary function. Such as, Revit's primary function is *3D Modeling,* but it is also used for *BIM* and *2D Visualization*. The SDGR includes a single primary function for each software, except when the manufacturer or industry's use demonstrates an equal weight to multiple functions. Such as, in the case of SimScale there is little evidence of a hierarchy between its functions related to *CFD Analysis* and *Thermal Performance*.

The SDGR also includes a special designation for software plug-ins, represented as green. Plug-ins are software that function with limited or no capacity without the assistance of another program. For example, Grasshopper requires Rhino3D for full functionality. In cases where plug-ins have multiple functions, the functions are also ranked, with secondary functions represented in blue.

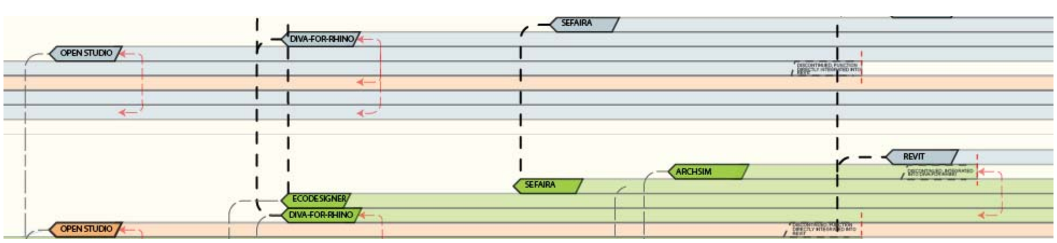

Figure 2: Software Representation and Functional Color Hierarchy

Each software bar is preceded by a header listing the software's name at the time of development. Additional headers are located along the bar, indicating significant name changes. The headers are located within the associated year of occurrence along the timeline. If there is an identified difference between the software's introduction date and its adoption within architecture, the difference in time between the introduction and adoption of the software is represented by a dashed bar proceeding the solid bar of the primary function. The dashed header and bar indicates the introduction date of the software and time prior before adoption, with the solid header and bar indicating its adoption and use within architecture.

Connections between a software's functions, along with any relationships between a software and a plug-in or other program, is illustrated using dashed lines. Black dashed lines connect the functions associated with a single software. For example, in Figure 2, the connections between the primary function of Sefaria, located in the *Energy Simulation* category and represented as a plug-in, is connected to its secondary function located in the *Daylighting Analysis* category directly above it through the black dashed line originating from its header. Lighter, dashed gray lines show connections between a primary program function and a plug-in or other related software package. These lines originate from the header of the plug-in or in some cases along the horizontal bar of the plug-in at the time in which they were first associated with the connecting software. In Figure 2, an example of the gray lines originates from the header of EcoDesigner and bar of Sefaria connecting them to ArchiCAD and Revit respectively, which are located elsewhere in the SDGR and not shown in Figure 2. A double-arrowed red line is used to connect the header of a software package acting as an interface (a program that transfers information directly between the user and another program without evidence of the transfer) to its related program. For example, in Figure 2, Diva-for-Rhino interfaces with Energy Plus (not identified in Figure 2).

The software's field of origination is also represented in the SDGR. Defined as the discipline or area of use in which the software was initially developed for or primarily associated with, four categories have been designated with three of them actively represented in the SDGR as a circle. Software corresponding to these areas are connected via a line drawn from the primary function header to the appropriate circle, Figure 3. If a connection is not made to one of the three represented categories, then the software is considered significantly connected to architecture since its development.

- ***Architecture***– software primarily associated with the architecture discipline
- ***Engineering*** – software primarily associated with engineering analysis or the engineering discipline
- ***Entertainment*** – software primarily used for movies, gaming, or other entertainment related function.
- ***Multiplatform*** – software that has been developed or strongly utilized since its release with multiple disciplines and cannot be related solely to one of the other origination categories.

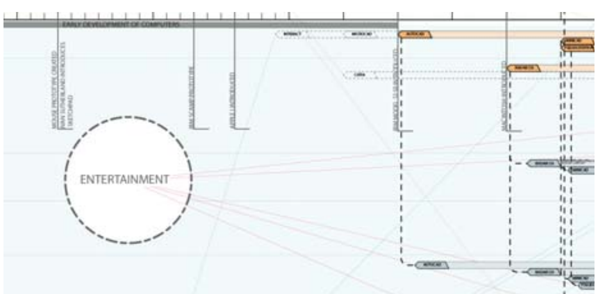

Figure 3: Representation of Field of Origination and Connections. All software not associated with a circle (e.g. Entertainment, Engineering, or Multiplatform) has originated from Architecture

2.0. Validation through Historical Trends

The evaluation of the SDGR initially concentrated on confirmation of the presence of early developmental trends documented by Aouad et al.(2012), Galofaro (1999), and Kalay (2004) in the SDGR. This consisted of three primary tends: 1) pre-1980 software development, 2) the impact of the introduction of the PC, and 3) the influence of hardware advancements with respect to processing and graphic rendering power. These trends were used to validate the patterns associated with the SDGR.

These trends are outside of the discussion of this paper but are included in summary. First, prior to 1980, software development was primarily related to engineering and governmental funded projects. This trend is present in the SDGR, with the three listed programs originating before 1982, DOE-2, Blast, and SAP, associated with *Engineering* and two of the three developed through government support, DOE-2 and Blast. Secondly, after the introduction of the personal computer (PC), there is an increase in the development of software in the SDGR, following known patterns. The software increases across the timeline with the number of sampled software almost doubling between the time frames of the 1980's, '90's, and beyond 2000. Finally, as the PC continued to evolve, hardware advancements influenced how software developed. This is specifically seen in the SDGR through development in categories such as *CAD(2D)* and *3D Modeling*. The entity-based systems associated with *CAD(2D)* were more quickly developed due to the ability of early PCs to accommodate their graphic requirements. The *3D Modeling* category lagged in development until PCs were able to accommodate more complex graphics.(Aouad et al. 2012) Outside of these categories the more graphically demanding software (e.g. Unity, Unreal, and Maya) developed at an even later period once graphic hardware was able to support their functions.

3.0. Analysis

The SDGR was evaluated in phases for trends associated with: 1) the taxonomy and their associated categories, 2) interactions between taxonomies, and 3) plug-ins. This analysis frames the discussion and its consideration of trends in software development within architectural practice.

3.1. Trends within Taxonomies

The study initially evaluated the SDGR for trends within the taxonomies (e.g. Building Performance Analysis, Design and Construction, and Visualization). This evaluation revealed patterns associated with the software's area of origination, function within industry, and the predominant category within the taxonomy.

Trends within the *Building Performance Analysis* taxonomy demonstrate the relationship between a software's field of origination, use within practice, and its development of functions. This taxonomy is closely associated with engineering with 14 programs associated with the *Engineering* category, more than the other two taxonomies. Additionally,19 of the 25 (76%) programs in the taxonomy retain a singular function, with the 6 remaining (24%) having multiple functions. Of these six multifunction programs, five have their primary or secondary functions in *Energy Simulation*, *Daylighting Analysis*, *Thermal Performance* or *CFD Analysis*. The sole software (e.g. IES) outside of this pattern has its primary function located in *Sustainability Analysis* with its secondary functions located in all the above listed categories. These patterns indicate that there is a relationship between function categories, the presence of multiple functions, and the associated software's use within the industry. Such as, it is more likely that a user requiring a software package that performs *Energy Simulation* will also require *Daylighting Analysis,* but it is unlikely they will require *Structural Analysis*. This is associated with the fact that these categories relate to different engineering specialties, such as *Energy Simulation* and *Daylighting Analysis* with mechanical engineering and *Structural Analysis* with civil engineering. This understanding provides insight into the patterns of segregation between categories and the presence of multifunction software. In this case, it can be observed that the specialized nature of the disciplines associated with *Engineering* and the software's use within the AEC industry results in the software of this taxonomy typically not requiring additional functions. As such, this trend indicates that the field of origination and the software's use will directly influence how primary and secondary functions within software will develop.

This pattern continues as the *Building Performance Analysis* taxonomy contrasts with the *Design and Construction* and *Visualization* taxonomies with regards to the presence of multifunctional software, again relating to the software's use and origination. Software in these two taxonomies frequently have both primary and secondary functions. In *Design and Construction* 11 out of the 19 (58%) programs have multiple functions with this number rising to 14 out of 19 (74%) when considering plug-ins. Visualization has less with 6 of the 13 (46%) having multiple functions, with 5 out of the 7 (71%) remaining programs being plug-ins that primarily support programs located in another taxonomy. This inclusion of multiple functions within the software in these taxonomies is an indication that there is a need or demand for multiple functions within these taxonomies and directly relates to their usage and area of origination.

In the case of *Design and Construction* 10 of the 19 (52%) programs are associated with *Architecture*, this increases to 12 out of 19 (63%) when *Engineering* related software is included by assuming these two categories have similar demands for software within this taxonomy. These demands will drive software in this taxonomy to provide multiple functions that allow for both the creation and documentation of designs. For disciplines outside of *Engineering* and *Architecture,* the requirements for documentation may differ and therefore there a reduction in the need for multiple functions in software associated with those disciplines in this taxonomy. Such is the case of 3DS Max, in which it originated outside of architecture and therefore there is no need for functions related to *CD Production* or *CAM*. For this reason, 3DS Max has a singular function in *Design and Construction* while other software in this taxonomy has developed multiple functions to satisfy the needs of their field of origin. This pattern of multifunction inclusion directly relates to the taxonomy and the areas of origination and relates to the trends found in *Building Performance Analysis*.

Finally, *Design and Construction* and *Visualization* contain dominant categories. A dominant category is defined as a category that is comprised of mostly primary functions and indicates its importance in the industry. In *Design and Construction*, *CAD(2D)* and *3D Modeling* are dominant categories as they contain the primary function for 15 of the 19 (79%) programs in the taxonomy. This dominance is strengthened when it is considered that of the four remaining software, two are plug-ins (e.g. Grasshopper and RhinoCAM) that provide access to *Parametric Design* and *CAM* respectively for software in *CAD(2D)* and *3D Modeling*; while the other two (e.g. Layout and Dynamo) are standalone programs that provide similar services. For instance, Layout is a standalone software, but its primary function is to allow Sketchup to generate construction documents. This dominance of *CAD(2D)* and *3D Modeling* indicates their importance to the industry and that they act as the core function in this taxonomy, allowing for the use of secondary functions. For example, production of construction drawings in AutoCAD would not be possible without first creating an object with the *CAD(2D)* function. In this case, the presence of two dominate categories also provides insight into how the development of dominant categories can relate to development trends within the industry. The development of two dominant categories in this taxonomy is a result of the software's handling of object creation and is tied to several factors. This has resulted in the industry using two different methods of object creation and can be tied to preferences and trends in practice.

This association with practice and a dominant category's development is also found in the patterns associated with *Visualization's* dominant category, *2D Visualization*. While noticeable as a dominate category, containing the primary function of 8 of the 13 (61%) programs in the taxonomy, unlike *CAD(2D)* and *3D Modeling, 2D Visualization* is not as pure as it contains secondary functions. Still indicating a primary demand of the industry, this weakened dominance can also indicate a change in industry preferences, along with the influence of other external factors such as PC development. This is similar to the presence of two dominate categories in *Design and Construction*. These links to practice will be discussed more in depth in the discussion as patterns associated with these occurrences can be used to indicate shifts in practice.

3.2. Trends between Taxonomies

Excluding the use of plug-ins, there is little to no connection between taxonomies. Software in a taxonomy, with minor exceptions, does not typically have secondary functions outside of their associated taxonomy. Meaning if a software resides in *Design and Construction*, it does not have secondary functions outside of *Design and Construction*.

3.3. Plug-in Trends

Generally, plug-ins serve as a bridge between taxonomies. This bridge acts as a conduit for software to incorporate additional functions from outside their primary category and often their taxonomy. An example of this is Sefaria providing Revit and Sketchup access to *Energy Analysis.* This development allows for software to evolve with the industry and provide access to functions that may not have been included in the software but is needed within the industry of use.

4.0. Discussion

The understanding of the trends in the SDGR allows for the measurement of current digital trends and the projection of how digital technology may develop in the future within architecture. Additionally, these trends may be used to reflect on how architecture is developing as a practice. This discussion will look at the analyzed trends, expand upon them, and briefly look at how they relate to these two concepts.

Starting with the segregation of taxonomies within the SDGR, considering the influence the software's area of origin has on the segregation and development of functions within a taxonomy, it can be concluded that there is a similar relationship with the segregation between taxonomies and their subsequent connection through plug-ins or functions that cross taxonomies. For example, while software in *Building Performance Analysis* is used within architecture, the software typically originates from *Engineering* and is primarily used by engineers or related disciplines. This results in the segregation of taxonomies as *Building Performance Analysis* is more associated with services that are specialized and outside of those that may be associated with *Design and Construction* or *Visualization*. However, this segregation is reduced through the use of plug-ins and cross-over functions. This is due to the need for the analysis of the models created using software residing in *Design and Construction*. As a result, the connection between *Design and Construction* and *Building Performance Analysis* is greater than that between *Building Performance Analysis* and *Visualization*. This difference is because the goals of software in *Building Performance Analysis* is the quantitative analysis of designs created through software in *Design and Construction*. This does not require the high-level visualization provided by software in the *Visualization* taxonomy. This relationship between the software's use and the field of origination, therefore, both informs the segregation of the taxonomies and how they relate through plug-ins.

This influence continues when evaluating functions that cross taxonomies. In *Design and Construction,* these functions are limited to Cinema4D, 3DS Max, and Revit. This is the result of either the adoption of software from other disciplines or a trend in which plug-ins are developed into secondary functions. The latter of which is associated with Revit and can be related to a change in practice. This will be discussed later along with trends associated with plug-in development. For 3DS Max and Cinema4D, the presence of functions crossing taxonomies is attributed the software's origin. In both cases the software was adopted from outside of architecture and as a result the software has limited functionality within its primary taxonomy, *Design and Construction*. In the case of 3DS Max, it is associated with multiplatform disciplines with its users having differing requirements depending on their area of practice. A common factor is its users will typically require high level visualizations, but not all require the other functions in *Design and Construction*. For example, video game designers use 3DS Max to design game environments, but they have no need to generate construction documents. Driven heavily by their origin, these programs are not capable of providing some of the more industry specific functions associated with the *Design and Construction* taxonomy. This results in the presence of functions that cross taxonomies, but the software may have limited functionality within its primary taxonomy resulting in segregation. This typically results in specialized use within the AEC industry.

Trends associated with a software's origin, as mentioned, can be adjusted through the use of plug-ins. Plug-ins add functions to existing software, both within and between taxonomies, and as a result reduce segregation. As such, their development is linked to the relationship between taxonomies and functions. They can also indicate a taxonomy's importance and adjust for quickly rising trends in the industry. The importance of a taxonomy is indicated through the connections created by plug-ins between taxonomies. For instance, *Design and Construction* is the only taxonomy connected to the other two, as *Visualization* and *Building Performance Analysis* do not have any connections aside from Radiance which stems from its method of creating shadows, which is used in both daylighting analysis and visualization. This pattern of connection indicates *Design and Construction* is more important in architecture, with regards to software use. Furthermore, this indicates the software in *Design and Construction* acts as a hub for the interaction between the taxonomies. Additionally, the rate and sequence in which plug-ins develop between taxonomies can be an indicator of their relationship. Such as, plug-ins between the *Visualization* and *Design and Construction* taxonomies developed earlier than those between *Building Performance Analysis* and *Design and Construction*. This suggests a longer and potentially stronger relationship between *Visualization* and *Design and Construction,* which is indicative of the importance of visualization to the design process.

The ability of plug-ins to adjust for a change in the industry is demonstrated through the more recent development of plug-ins between *Building Performance Analysis* and *Design and Construction*. This growth occurs later than that between *Design and Construction* and *Visualization*. This parallels the increased emphasis on sustainability and energy cost within architecture. This shift in practice has resulted in a need for the integration of sustainable and energy related functions into existing programs in *Design and Construction.* Therefore, plug-ins have developed to provide the needed functions. For example, EcoTect was developed to perform energy analysis within Revit. As demand for these functions has increased, Revit has progressed to the point of incorporating the functions provided by plug-ins as secondary functions that cross taxonomies. This scenario demonstrates how plug-ins may be an interim solution if demand is large enough for a function, but additional study is needed. From this study, the trends indicate this progression can be a result of industry demand, a strengthen of a relationship between disciplines, and a strong indicator of a change in practice.

This use of plug-ins to adjust for growth is not exclusive to functions outside of a software's taxonomy, such as those discussed. Plug-ins can develop within a taxonomy, linking categories. While this occurrence does not necessarily relate to an increased relationship between disciplines, it is a strong indicator of a shift in practice. For example, in P*arametric Design* there is growth over time of secondary functions and plug-ins included in the category. The use of parametrics is a concept that has been associated with architecture since Ivan Sutherland's development of Sketchpad in 1963 (Frazer 2016), however, the advancement of construction techniques in the past 20 years has allowed architects to more easily adopt its use. This has resulted in a wider adoption of parametric design in practice and the growth of secondary functions and plug-ins in *Parametric Design* that link to software with primary functions in other categories. This demonstrates how plug-ins can quickly adapt for an increased demand for functions within a taxonomy.

The final discussion of this study is that changes within or to a primary category in a taxonomy, when prevalent, may also be a predictive measure. This may occur in two ways, through an increase in the development of software within an existing dominant category, thereby furthering its dominance, or through the transition of dominance between categories within a taxonomy. Growth within a dominant category can indicate new or strengthening trends within the practice. For example, there is an increase in development within the *3D Modeling* category, with a decrease in *CAD(2D)*. This change reflects the shift in the architecture industry from 2D to 3D design but does not indicate a total abandonment of 2D design at this point.

The changing of the dominate category within a taxonomy must also be considered. While this has not explicitly occurred within the SDGR, this trend can be discussed using conditions observed between *CAD(2D) and 3D Modeling* and *2D Visualization and 3D Visualization*. The decline in *CAD(2D)* development with the increase in *3D Modeling* establishes that a once prominent category declines while development in another category increases and eventually overtakes the original category. This also occurs in *3D Visualization* in which there is an increase in development of software with a primary function associated with *3D Visualization* and a secondary function with *2D Visualization,* reversing early trends. If this trend continues, then *3D Visualization* may usurp *2D Visualization,* perhaps leaving *2D Visualization* as a secondary function. While currently theoretical in nature, as neither scenario has fully occurred, this potential trend is worth mentioning as this would indicate a significant change in direction within the industry.

CONCLUSION

The SDGR displays developmental trends of software used in architecture. Several patterns emerged from its analysis. These patterns may be able to indicate trends within software development that relate to larger trends and the software's use within architecture. Of these the following patterns are considered significant.

- The segregation of the taxonomies and development within them is related to the software's industry of origination, primary functions, and its associated use. This impacts how software interacts with the taxonomies and how it is used within architecture.
- Plug-ins can be used to indicate the importance or strength of the relationship between taxonomies.
- Development of plug-ins or secondary functions can be used as a predictive pattern to indicate the importance of the associated function to architectural practice.
- Primary categories, when prevalent in a taxonomy, can be viewed as measures for the taxonomy and industry.
- The changeover of a primary category within a taxonomy may be indicative of changes in practice or direction within the industry.

The encoding of software in the SDGR has aided in the understanding of software development in the AEC industry, its relationship to AEC disciplines, and how this information may be used to relate the observed trends to developmental trends within the industry. The SDGR format and the discussed patterns, when overlaid with larger trends in the AEC industry, may be able to provide additional insight into the development of the architecture discipline. Future studies will evaluate how this information may be used in conjunction with information such as a timeline of major projects, delivery methods, and software adoption to understand the relationship between software and larger trends within the AEC industry.

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Critical WikiHouse: Connecting GIS Data to Site and Tiny Home Design

Critical WikiHouse:
Connecting GIS data to site and tiny home design.

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ABSTRACT: The construction industry is one of the largest consumers of natural resources in the world, being responsible for 50% of the carbon emissions recorded since the 1950's (Adriaanse et al.,1997). While the information age has brought us tremendous amounts of environmental data and design computational ability that can be leveraged to create advanced sustainable design solutions in architecture, the dissemination and implementation of the tools and techniques of sustainable design are limited to a small fraction of the construction industry with architects designing only 2% of the total building construction worldwide (Parvin 2013). With the world population projected to rise by billion in the next 15 years, mass sustainable housing systems are going to play a crucial role in achieving sustainable development (Gerald 2014). This research suggests that the increasing availability of environmental data, combined with the ease of access to powerful computational capabilities and low costs of customized digital fabrication are the modern resources that can direct architecture in a way that is environmentally stable, resource conscious and ultimately sustainable. The research examines open source and easily accessible methods of employing these resources, connecting GIS data to BIM systems to create customizable design solutions optimized for sustainable development. [1]

This paper focuses on the application of environmental data and the adaptation and expansion of an existing open source WikiHouse platform. Currently it is a global, open-source, digitally de-centralized small home system, which is fairly autonomous; i.e., it has few connections to its specific environment and site. It can be customized for size, but lacks the ability to leverage environmental data for optimized form modifications. The research adapts this system to various natural forces and conditions, creating a new wiki design methodology, which incorporates various open-source inputs to create a more sustainable, adaptive design solution that responds to natural environmental conditions.

KEYWORDS: Digital fabrication, Grasshopper, Geographic Information Systems, WikiHouse, Sustainability

INTRODUCTION

The existence of humans is a short blimp on the chronology of the planet, but in our short time here the we have had a tremendous impact on the ecosystem of the planet, comparable to massive geological events, prompting some scientists to declare that we have entered the Anthropocene, a new unique geological epoch marked by the striking acceleration since the mid-20th century of carbon dioxide emissions and sea level rise, the global mass extinction of species, and the transformation of land by deforestation. We are currently at the highest carbon content in the last 800,000 years (World Metrological Organization, 2017) with a rate of species extinction that is comparable to mass extinction events (Ceballos et al. 2015) Recognition of impending problems has existed since the time of the great acceleration of the 1950s, marked as the beginning of accelerated resource consumption by humankind that has led to global climate concerns, but this is the first time in our existence that we have that ability to address the issues pragmatically with a collective intelligence as a species without borders. There is for the first time enough empowerment of information, open source knowledge sharing and data computational capability to propose a framework for a resilient, sustainable development that encompasses human, wildlife and ecosystem preservation and restoration with adaptive evolutionary technologies at a widespread scale.

While upcoming large scale commercial projects, with access to research and development in sustainable design and incentivized by green building initiatives, are beginning to make a headway towards sustainability, majority of the residential sector, being largely either self-built or developer driven construction i.e. without a direct connection to the academic or professional sustainable design and architecture community, has yet to adopt the more progressive tools and techniques of environmentally sensitive design available today. This issue escalates when we consider the need for housing to accommodate our growing population and the limited reach of progressive architects.

The changing landscape of ownership of data in recent years has fostered a new collaborative and openly shared outlook to information, with models of aggregated data collection such as WIkipedia and Google Maps being prime examples. The information age has also brought us a tremendous collection of environmental data, a lot of which is freely accessible or 'open source'. We are constantly recording and logging information from satellites, sensors and aggregators; the scope of data collection is growing rapidly and will continue to grow as technologies become more efficient, affordable and prevalent (Moore's Law). This data, combined with the ease of access to powerful computational capabilities and increasing low costs of customized digital fabrication has made sustainable design a lot easier to achieve than it has been in the past. This will at some point, push the residential construction industry into the age of sustainable development, whether by a bottom up or top down process. At this point we are limited by the sphere of influence that environmental design has in the construction industry. Hopefully soon with the help of technology we will be at a tipping point in architecture where design starts to break barriers of reach, coupled with a general rise in awareness and demand for sustainable, resilient and environmentally sensitive design.

1. ARCHITECTURE OF THE ANTHROPOCENE

Human beings are the predominant force affecting change at a planetary scale, the evidence for this is ample and undeniable. The graphs of change in virtually any parameter that matters for human wellbeing; carbon dioxide, nitrous oxide, methane, deforestation, land degradation, loss of species, have all entered a period of accelerated change post the Second World War (Rockstrom 2010). The rampant use of resources has rendered an unprecedented pressure on earth systems at a scale that climate scientists warn is causing irreparable harm to the stability of earth systems (Filperin 2006). The good news is that we are perhaps the first generation of humans to have the scientific data to be informed that we are undermining the resilience and stability of human life on this planet, and also the first to possess the computational and manufacturing capability to design to mitigate these risks. We are now perhaps in the most critical and exciting phase of human existence-a time when the choices we make will decide the longevity of mankind on this planet.

We should all be aware of the challenge that stand before us, and it's only prudent that one of the largest consumers of natural resources, the construction industry, takes united and drastic measures to combat the environmental challenges we face, and do so in a collective and accelerated pace. This research explores the modern technologies available to architecture and design in an effort to create an openly shared framework for sustainable residential housing that leverages digital design and fabrication to respond to available environmental data.

1.1 Collective Design

Collaborative knowledge aggregating projects have begun to change the way data is accumulated and compiled.

Projects such as Wikipedia exemplify this system with a large number of users contributing to write a modern encyclopedia of articles in a method that is largely peer reviewed and self-rectifying, with over 44 million articles in 287 languages, the English language Wikipedia with over 5 million articles is over 60 times larger than the next largest English language encyclopedia (Giles, 2018). While the architecture discipline has been relatively slow to adopt collective creation projects, the profession is now starting to change the way practice is organized networked and exchanged and we see colleges like AA, Columbia, Cornell, RMIT, MIT and SCI-Arc starting to adopt this modern methodology in their teaching (Hight 2006). Wikipedia, as defined by its goals of creating an encyclopedia of the sum of all human knowledge that is freely accessible by all, prompts this researcher to examine what is the architectural equivalent of the same and can it help accelerate the spread of sustainable design.

Aniket Kittur, a Carnegie Mellon university researcher found in a study related to collective intelligence that adding participants to a problem does not always make for a better solution, but it is rather the design of the framework that governs participation that ensures a growth of quality solutions (Kittur et al. 2009). This is best typified in architecture in the WikiHouse project, a collective, collaborative tiny house design project. The WikiHouse is perhaps the largest modern collaborative self-build design process in recent times. The project has over 500 members on Slack, an online collaborative forum, a portion of whom are contributors working on the Wikihouse roadmap of parametric design solutions. While there are many design programs written by the contributors, WikiHouse foundation only releases them after extensive testing of actual applications. Inclusion of environmental data and site information is one of the planned features on the WikiHouse future roadmap of parametrically adjusting features of the design, along with lighting, water, envelope design etc.

1.2. Big Data

Terrain data of most regions of the world is easily accessible at 30 or 10 meter resolution, while most of the United States is already, or will be in by 2018 available at a 1M resolution (NED 2018). The U.S. Climate Reference Network (USCRN) has over 140 climate stations spread across the United States that log accurate temperature information and the NEXRAD has 159 Doppler radars measuring precipitating and atmospheric data. The EPA's DRASTIC water vulnerability survey maps out at-risk locations across the United States that may be susceptible to ground-water pollution and contamination. Increasing amounts of LIDAR data across the world render highly accurate 3D point cloud models of tree canopies, land cover etc. Change analysis on these layers of data reveal patterns of growth and decay of many observable attributes. All this data is crucial to planned sustainable development, the key lies in the management, dissemination and reading of the data in systems so interdisciplinary functions of development can cohesively utilize the information and have the design fluently respond to said data. Computer coding is becoming more mainstream in the BIM industry allowing more ease with the digital connection between GIS packages, used by planners and landscape architects with those CAD and BIM packages.

1.3. Parametric Modeling and Digital Fabrication

Modern CAD and BIM software used by architects and engineers, such as Grasshopper a parametric design plugin to Rhinoceros, have made data processing tools affordable and accessible to a large market. Evolutionary design computation algorithms can take data such as solar exposure and optimize the form of a roof to output a structure that reduces solar gain in hot climates or increase exposure in cold climates. Similar computation can be applied to conduct surface analysis of land topography to very precisely predict water flow directions etc.

Digital fabrication is the most disruptive advancement in the manufacturing world since the industrial revolution, Computer numeric controlled systems of additive and subtractive fabrication are now becoming smaller, cheaper, faster and therefore more accessible. The ability to mass-produce irregular building components with the same facility as standardized parts introduced the notion of mass customization into building design and production. It is just as easy and cost-effective for a CNC milling machine to produce 1000 unique objects as to produce 1000 identical ones. As Catherine Slessor observed, “The notion that uniqueness is now as economic and easy to achieve as repetition, challenges the simplifying assumptions of Modernism and suggests the potential of a new, post-industrial paradigm based on the enhanced, creative capabilities of electronics rather than mechanics.” (Slessor 1997, 118-125). This means that for the first time we can now make the shift from mass production to mass customization to achieve site and environment specific optimized forms in architecture, which are built affordably with factory production quality specifications.

Architect Rachel Armstrong talks of Black Sky Thinking, an approach to design taking a speculative leap into the
future by observing current trends in technologies as a method to create frameworks of design that begin immediate engagement with innovative interdisciplinary technologies for design and development for the coming years (Armstrong 2017). Collective design, Big Data, Parametric modeling and digital fabrication are the resources of our times. Can we begin to forge connections between these new resources to help redefine the design approach to include optimized pragmatic solutions to environmental data? What this means to architecture is profound, we potentially have the ability to have our built environment develop in symbiosis with the natural world rather than against it. The editing and ethics of this data is paramount; what we want our architecture to respond to, and how the data is processed defines the form and function of our architecture and ultimately the longevity of sustained human life on this planet.

2.1. METHODOLOGY

Depending on the location of a site, there are various sources available online for many different kinds of geographical and environmental data. For most of the United States, United States Geological Survey is the primary resource for aerial imagery, digital elevation maps radar & land use land cover maps.[2] The process explored ways to translate the data available from various sources into drawings or forms that were readable by CAD softwares in order to run the custom written scripts or programs. In most cases the data is available in TIFF image format i.e. an image which contains metadata with geographical information contained in the pixels of the image pertaining to the location displayed on the image. These images can be read by GIS software that can further translate the images in DXF or similar drawing formats that can be read by design and architecture software. In the case of this research QGIS[3] was used as the GIS software and Rhinoceros was the design software, selected for its ability to run Grasshopper[4] a python based scripting software. Various custom scripts were developed that responded to the data to explore the possibilities of optimizing design for sustainability. The scripts developed are for site level intervention and for build level intervention[5](Fig. 1). As a demonstration of this framework of design, the paper will apply techniques learnt in this exploration to the design of an assisted living community of tiny homes on a 6 acre site in McMinnville, Oregon, a live project scheduled to be built in 2018. The site is currently predominantly untampered from its natural topography and eco systems, with only one permanent structure built, which gives this research the opportunity to examine best practices in approaching a natural site with minimal environmental impact.

The parametric nature of the programs developed in this project are versatile and customizable enough to be applied to any site or project by changing the input parameters of the program such as geographic location, site topography etc. and therefore can be applied as system of urban growth as cities expand to accommodate the demand for housing. The research will show that there is great potential in this system of data driven computational architectural design to achieve optimized sustainable design that is affordable, accessible and easy to fabricate. Since a lot of the tools used are open source and do not require special skills to run, the programs can potentially be adopted at the consumer level thus widening the influence of sustainable design solutions. While the most essential and basic elements of this thesis are achievable within technologies that are accessible today, the format of the thesis leaves room for modifications to the tools in lieu of future innovations in design and fabrication and the ever growing collection of data.

In approaching the project, the first goal was to develop a deep understanding of the watershed of the area and develop the site in response to it, so a site hydrology analysis script was developed. Since the client also wants to grow food on the land to support the homes on the site, the next consideration was to determine the areas on the land that are most suited for cultivation based on the solar exposure available in the dense forest site via a solar radiation analysis script. The build optimization is designed for structures that are based on the open source project WikiHouse that is a fully CNC manufacturable structure; new data driven design modifications were applied to the existing model that optimized the structure to respond to climate and environmental conditions. A surface optimization script modified the form based on solar gain requirements, and a foundation design script was written to design the footing of the structure to best suit the topography of the structure location. Further details of these four examples from the research follow.

Figure 1: Overview of researcher’s adaptations to existing WikiHouse.

2.2. Site Hydrology Analysis

One of the first elements of the ecosystem that gets altered when construction begins on a site is the watershed of the area. This is of significant importance when considering the ecological footprint of construction on the site and to attain or maintain the water quality standards in order to protect the flora and fauna that make up the carefully balanced ecosystem.

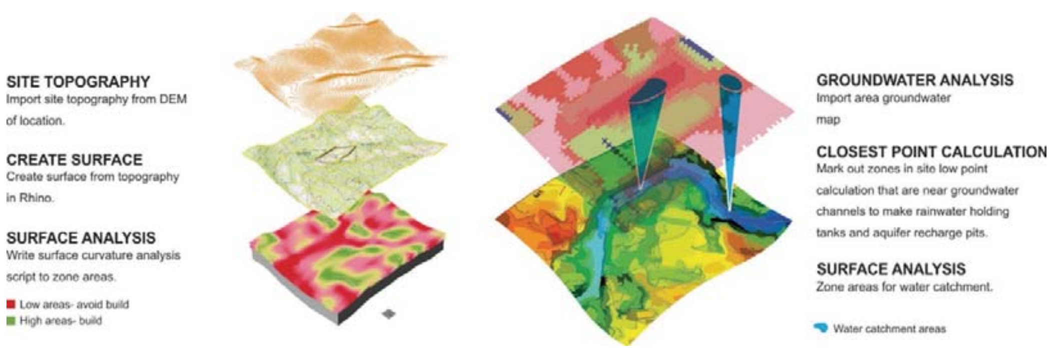

Figure 2: Layers of site hydrology and groundwater analysis.

A carefully managed watershed can maintain the physical, biological and chemical components that the local ecosystem has come to depend on (EPA 2018). In the absence of this understanding of the watershed, increased runoff from the site due to the addition of impervious surfaces can drastically alter the hydrology of the area. A micro-watershed analysis program was created as a part of this research to run a flow analysis in order to zone the site in such a way that the development does not interrupt the natural watershed of the area. This program workflow goes through two distinct software platforms, one is a GIS software that converts a

DEM image of the site location to a vector contour file, that contour data is then imported into a 3D modeling software and a triangulated surface is created from the contour data. Finally that surface is read by a grasshopper code that performs a surface curvature analysis and renders vector directions of the curvature from a grid of points on the surface. The vectors are assigned a color based on the vector attribute this renders a surface composed of green points to mark the high points of the site and red points that mark the low points.

The first step was to do a context water shed analysis to determine the position of the site in the watershed. A visualization strategy was applied to the program to render blue lines along the vector directions to simulate channels on the site that would form streams of water. This program was run first on the surrounding area of the site over a 1sq Km area. A second analysis was run on just the site, a 6 acre area. The site analysis provided zoning for where to build on the site and also areas that were most low lying on the site. This data, along with a groundwater map can be used to find areas to create rainwater catchment ponds, aquifer recharge wells, etc. (Fig. 2).

2.3. Site Radiation Analysis

The areas on the site that receive maximum sunlight exposure needed to be earmarked for cultivation, these areas will not be built upon in an effort to optimize the crop yield area of the site. LIDAR data was pulled for this analysis to create a triangulated 3D model of the site that was then imported to grasshopper to run solar exposure analysis. LIDAR or Light Detection and Ranging is a technique of remote sensing that uses pulses of lasers pointed at the surface of land usually from an airplane, the system measures the returning reflections of the laser to access the form of the land and generate a 3D point cloud of information.

LIDAR data for the site in Oregon was pulled from USGS data portal and triangulated into a 3d mesh using QGIS-an open source GIS software. The resulting 3D model contained highly detailed information about the site including the tree canopy heights-a crucial factor for establishing the amount of solar radiation available on the ground for cultivation purposes. Initial assessments made on the site using manual methods were time consuming and tedious, and provided little accuracy. Using the 3D model of the site, a program to run solar radiation analysis was written using Ladybug[6] that is a Grasshopper plugin. This analysis is usually run on building models to assess areas of heat gain based on geometry, orientation, and location of a structure. In this case a similar analysis was run on the entire site to render a heat map image of solar exposure on the site. The areas of maximum exposure were earmarked for cultivation and the remaining land was considered as sites for building structures (Fig. 3).

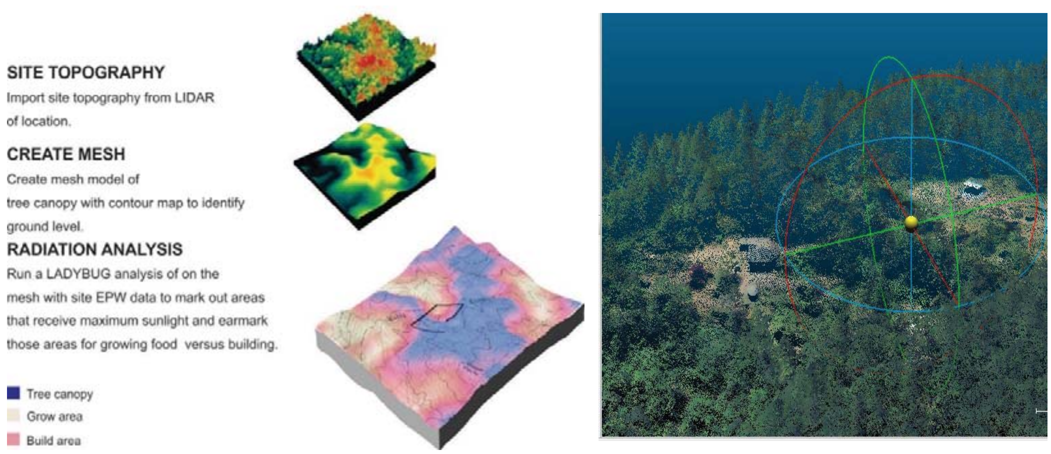

Figure 3: Solar radiation analysis process and visualization of heat map display and LIDAR point cloud image.

2.4. Structure Surface Optimization

As it stands the WikiHouse project has launched a Structure module; a parametric code that can be used to generate a custom sized skeleton structure framework and a Fit Out module, currently only a door design that can be CNC manufactured, but contributors are also working on programs for interior furnishings such as cabinets , etc. While these are the only two modules currently launched after intensive testing, the Wikihouse design framework also plans for various other levels of intervention: Envelope, Lighting, Water, Power, Data , etc. This portion of the research will be contributing to the Data modules, by creating programs for the structure to be optimized for climatic conditions to provide efficient passive human thermal comfort.

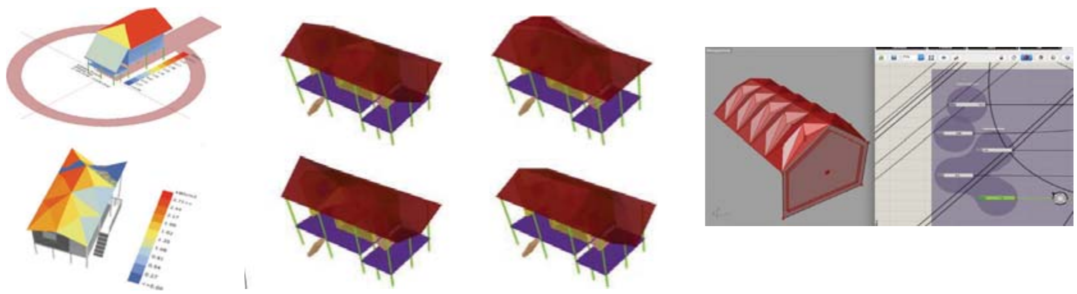

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Figure 4: Models showing roof solar radiation analysis and final optimized output

A program was written in Galapagos[7], an evolutionary computation module of Grasshopper, coupled with Ladybug, an environmental data reader in Grasshopper that inputs location weather data in the form of an EPW file that is a collection of about 30 years of temperature, humidity and rainfall data collected by weather stations. The program is given a set of parameters in the design of the structure that are decided to be flexible in their dimensions and the program runs through every possible permutation and combination of those parameters measuring the solar exposure in each and outputs the most optimal form based on the criteria specified, either to maximize or minimize solar gain. A script was written by the author for an academic project examining vernacular housing in Manaus, Brazil, where excessive solar heat gain via the roof was discovered in the analysis. The script was executed to produce a form that received minimum solar gain while maintaining the basic form and orientation of the structure. In the case on this project the requirement was to maximize solar gain by increasing the exposed surface on the roof. This exposed surface can also be used to achieve maximum area for roof top collectors for heating water, photovoltaic panels for power or glazed roof systems to introduce sunlight into the structure.

A similar program can be produced for the exterior walls with the flexible parameter being the fenestration sizes, measuring the solar gain inside the structure

2.3. Structure Foundation Design

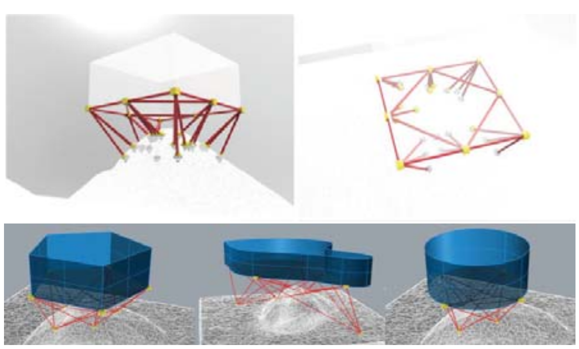

Figure 5: Renderings of conceptual foundation solutions working on a variety of topographies.

The Wikihouse model is a standard pier and beam floor that can be installed onto most foundation systems, for the purposes of this site we are recommending a raised floor system on stilts that connect to a diamond pier foundation block. By raising the floor of the house, we are further ensuring that the built structures have the minimum possible impact on the land and watershed. The stilts are parametrically calculated according to the input terrain data. A Grasshopper code written analyses the terrain mesh according to the location of the structure on the site and calculates the support design to use minimal material (Fig 5). The house base footprint is input into the algorithm and a code is written to place the base curve at a certain factor of height above the highest point of the terrain, cuboid support blocks are added to the base and then supports are rendered by discovering the closest points on the terrain from the support blocks. A foundation cone is added to the support pillars that depicts a diamond pier foundation block. Further refinement of the solution is warranted to generate a system that is structurally sound but this program serves as a demonstration of the concept and as a method of quickly visualizing terrain responsive systems.

3.0 FINDINGS

The entire framework of this research has created endless possibilities of nodes within architectural design for inputs of environmental data for the pursuit of sustainable development. Some of the scripts and programs written can function very well as stand-alone components of any project design and have implications to industries beyond architecture such as agriculture, urban planning and land use and water management projects. While the scripts worked for this project for the most part, the user interface is still too complex and intimidating to become a widely accepted norm in a design practice, the learning curve is steep but since the scripts are designed to be universally applicable, they may be worth the extra upfront time. The programs explored in this research may work for the specific outcomes defined for the research and may not be relevant for others, but the important takeaway is ease of interpolating GIS data with BIM softwares. Armed with this tool, the solutions as well as the problems themselves can be better defined and explored. While most of the data and software used in this research are open-source, there are other software programs with more advanced user interface design that are easier to navigate, but the prohibitive cost of those makes the scope of use limited and ultimately compromises the notion of widespread sustainable solutions. Additionally not all continents in the world have as comprehensive a collection and/or access to geographic information systems data.

Specific findings in the research pertaining to the site demand further investigations and testing, the hydrology analysis needs to be corroborated with experts in watershed survey fields to become an actionable solution; the roof optimization in the cold climate of Oregon may benefit from introduction of glazed roof sections to increase solar gain, additionally the form optimization may be more effective on the entire envelope of the structure and not just the roof; the footing design needs further refinement to make it structurally stable.

CONCLUSION

The impact of GIS data especially with its ease of access is an essential tool for intelligent sustainable development to address the climate challenges of today and the future; having our built environment develop in symbiosis with the natural world rather than against it is an attainable and essential program of development in the coming years. What can we achieve as goals towards sustainable development if we connect the vast amounts of environmental data we have-to urban design, city planning and down to the scale of individual project site interventions. Systems such as these have more impact when adopted by an entire neighborhood or community, the implementation of such knowledge on individual projects is only a stepping stone in this process.

As innovations in manufacturing technologies catch up to adaptive and changing forms in architecture, we may soon be able to build structures that are constantly reading geographic data, measuring climate health and adapting to best suit the ecosystems. While that technology may be in the future, we should begin to create a framework for GIS and other data inputs in architectural decisions.

While the backend processing of these systems, employed in this research are highly complex for the average home builder to invest in understanding, the hope is that with time and better user interface design- these programs will become highly intuitive and plug-and-play i.e. users can simply plug in their location data and output site specific solutions that are ready to implement. This would require a lot more research and development in the years to come, but until then these systems serve as a tool to support human design intuition and knowledge and vastly increase reach by offering faster actionable environmental data to work with. What this means for the profession of architecture is daunting in that we will see rapid shifts in roles and methodologies in the coming years, but like most modern vocations, the discipline of architecture will also respond and adapt to this brave new world and form what we will call the architecture of the Anthropocene.

ACKNOWLEDGEMENTS

This research would not have been possible without the help of the faculty and facilities at The University of Arizona Architecture and Geology departments, the open source community of design and architecture forums online and Grasshopper the free and open source parametric design user interface and it’s supporting forums.

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ENDNOTES

[1] Sustainable Development: Defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987), sustainable development has emerged as the guiding principle for long-term global development.

[2] USGS website source for GIS data sets, http://www.earthexplorer.usgs.gov

[3] QGIS is a free and open-source, cross platform, Geographic Information System (GIS) application that supports viewing, editing and analysis of geospatial data, https://qgis.org/

[4] Grasshopper 3D is a visual programming language developed by David Rutten that runs within Rhinoceros, by Robert McNeel & Associates, www.grasshopper3d.com

[5] All programs and scripts described in this paper have been developed for this research unless otherwise mentioned, with the help and guidance of University of Arizona faculty and the community of software users worldwide

[6] Ladybug is a Grasshopper plug-in that allows you to import and analyze standard weather data, http://www.ladybug.tools

[7] Galapagos is an evolutionary solver component of Grasshopper, http://grasshopper3d.com/group/Galapagos

Salah Ibrahim Imam, Brian Robert Sinclair

Dysfunctional Design + Construction: A Cohesive Frame To Advance Agility + Sustainability

Dysfunctional design + construction: a cohesive frame to advance agility in the 21st century

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ABSTRACT: Architecture is routinely recognized as being a valuable vehicle to improve our living spaces and enhance the quality of life. The notion of quality of life covers domains such as the interpersonal, psychological, spiritual and financial. In many ways, and in many jurisdictions, the connection between contemporary design & delivery systems for buildings, qualities of life and promotion of our community are broken. Quality of life is dynamic; people and the environment change over time. Hence, the role that agile architecture plays in this process, and in particular, what place it occupies in the unique social, political, environmental and economic setting is vital to promote the concept of quality living. Agility in buildings establishes the capacity to respond to evolving demands with regard to function, space, parameters and performance. However, for a plethora of reasons, robust solutions able to adapt to future changes are infrequent in present design practices and products. Additionally, worldwide population growth, scarcity of resources, and climate change warrant a dramatic shift in architectural practices to embrace concepts of agility – thereby realizing more dynamic and adaptive design solutions that can respond to an increasingly fluid, volatile and uncertain milieu. The present research critically assesses the status quo and in response synthesizes a conceptual framework for agility in architecture. Methods incorporated include meta-analysis, logical argumentation and case studies. Key deficiencies in the marketplace and contextual barriers against formulating/implementing such a framework are delineated. The seminal historic precedents of agile projects are drawn from numerous global cities, illustrating agility concepts in design, construction, legislative, and financial ethos. Case studies, in tandem with a strategic literature review, highlights leading themes, ideas and practices of agile architecture worldwide. This paper advocates the concept of agility as an indicator of the quality of life amongst architects, by adopting a more familiar language to them and by moving towards the development of a cohesive framework aimed at integrating interlocking distinct processes, better interlacing design phases to construction, operation, occupancy, disassembly and reuse. The forthcoming frame is viewed as a medium to aid developers, designers, builders and policymakers in applying and realizing greater project agility. Agility in this context must be the result of meaningful and productive relations between all layers, agents, facets and forces affecting the project – in essence migrating away from the static architectural practices and staid architectural outcomes that define modern building design. In the view of the researchers, "*change*" must be the new constant.

KEYWORDS: Quality of life, agility, holism, integration, design, innovation, open building, sustainability

INTRODUCTION

One of the most discussed issues in the design community is the capacity of the built environment to adapt over time to cope with ever-changing uses and preferences (Kendall, 1999). The physical form of our cities is radically changing and as Richard Rogers highlighted in his book: Cities For a Small Planet, "it is a commonplace to anticipate that a building will outlive the purpose for which it is built in a matter of a few years. Buildings no longer symbolize a static hierarchical order: instead, they have become flexible containers for use by a dynamic society" (Rogers, 1998). The challenge is to design buildings that can incessantly accommodate new technologies, allow for changes in the living patterns of occupants, and in the shape of households those occupants form. Only when buildings are designed to cope with both present and future challenges, will real estate decisions indeed characterize the holistic approach of worthwhile investments and transcend as sustainable architecture.

This agile perspective of the built environment is fully aligned with the persistent issues of environmental ethics, recycling and cradle-to-cradle concepts, the use of sustainable building materials and other vital concerns in the sustainability agenda worldwide (Kendall, 1999; Anupa Manewa et al., 2013). Hence, implementing sustainability and agile concepts will immensely depend on adjusting investment and regulatory rules as well as incentives related to the design, construction, and management of such buildings with built-in capacity for change. Challenges in the built fabric are present in areas of environmental considerations (Kincaid, 2000; Geraedts, 2008), technological novelties (Nutt, 2000), planning and policy, social necessities, political constraints (David M. Gann & James Barlow, 1996) and economic situations (Arge, 2005; Douglas, 2006). To cope with these macro-level challenges, the industry must shift from traditional static architecture that lacks the requisite flexibility to accommodate potential changes in users' needs and functional demands (Slaughter, 2001). Additionally, worldwide population growth, scarcity of resources and climate change warrant a dramatic shift in architectural practices to embrace concepts of agility (Kendall, 1999) – thereby realizing more dynamic and adaptive design solutions that can respond to an increasingly fluid, volatile and uncertain milieu. However, for a plethora of reasons, there is a disconnect between the current state of design practices and the market's need for agile architecture. This is fueled, in part, by a lack of advanced research in the field of agility. Currently, uninformed design approaches, conservative legislation and entrenched policies operate in concert to neglect social necessities and discount future environmental, spatial and functional mutability, while concurrently dismissing affordability concerns (Kendall, 1999; Kronenburg, 2007).

1.0 BACKGROUND

1.1. Flexible, adaptable and agile

It can be argued that flexibility and adaptability have overlapping meanings and includes different approaches. According to Rabenek, Sheppard and Town (1974), "flexibility is proposed against tight-fit functionalism." They argue that the inefficient design attempts at flexibility might lead to "fallacy of freedom through control," while adaptability relates to units and spaces "that can be easily altered adjusting to changing circumstances." In 1991, Herman Herzberger claimed that "in flexible design, no single solution is preferable to all others." He continues to criticize the flexibility approach uttering that the belief that neutral designs could make the building adapt to changing situations created a lack of identity. Consequently, he introduced a new concept, "polyvalence," which supports minimal flexibility so that the design could adapt to different uses without undergoing any changes. Steven Groak (1992) – in his book The idea of Building – referred to buildings as "unstable systems in the dynamic environments." He defined a fine line between flexibility and adaptability, where flexible design is "capable of different physical arrangements," while the adaptable design is "capable of different social uses." Gerard Maccreanor (1998) viewed flexibility as a "design idea that leads to the collapse of traditional layout," while adaptability – in his words – is a "different way of interpreting flexibility and it refers to multifunctionality." Maccreanor further noted that "most adaptable buildings were those not originally planned for flexibility." Schneider and Till (2007) characterized flexibility – in the context of housing – to be attained by "altering the physical fabric of the building," while adaptability is achieved "through designing units or spaces so that they can be used for various purposes."

While there are many ways one might define flexibility and adaptability with respect to building design, the authors are after a measure which is more independent, responsive and holistic; a measure that unifies the scattered facets of contemporary sustainable designs; that introduces all layers of physical, social, environmental and financial factors in the form of continuously evolving and dynamic framework; a measure better interlacing design phases to construction, operation, occupancy, disassembly and reuse; a measure that we call "agile".

1.2. Societies' challenges and potentials towards agility

Our societies are in fact agile, dynamic and resilient. They possess the ability to pass on knowledge from one generation to the other, to embrace and resolve different levels of challenges; they have the curiosity to explore and desire to succeed. However, societies are usually organized into certain living patterns and framed by a set of laws and rules. Also, habits and traditions can be another rival to a more dynamic milieu. They can control a person's beliefs, and regulate the way s/he thinks and acts in a particular social and cultural paradigm (e.g. moveable walls can oppose with the strict privacy concerns of some Islamic cultures). Such bounded societies might struggle to accept any kind of innovation or progress. But today, it could be argued that the fast lifestyle and technologies lead people to cope with the speed and scale of an ever-changing environment. Consequently, modern architecture must better match and serve these contemporary societies, it must respond to the qualities manifest by such movement.

Many buildings that were constructed since the 1920s – relying on the 'functionalist' design approach – are now obsolete (Kendall, 1999). These buildings were 'statically' designed to meet the standards and functions at that time and hence are not destined for occupants' evolving uses and require costly refurbishment due to their tight value-engineered specifications and incapability of being adjusted to meet shifting needs. This problem of static misguided attitude within the design community led us to falsely believe that our cities are rigid artifacts comprised of finished and single-use buildings and infrastructure. This argument posits that when scientific research is aligned with professional know-how early in the design stage, buildings would not require many alterations over the years, except perhaps cosmetically (Kendall, 1999). In the last few decades, technology has ushered in immense transformations in our living patterns and arguably increased consciousness of our world – An effect that we refer to as 'globalization' (Hubert-Jan Henket & Hilde Heynen, 2002). Although global mobility and consumerism secured freedom and allowed a much higher level of innovation, the consequences of climate change and global warming prove to be dramatic (Kendall, 1999;

Hubert-Jan Henket & Hilde Heynen, 2002). The reality seems complicated and worrying and urges immediate action. As our communities continue to expand, relocate, merge and eventually vanish, the need for agility is growing. The globalized living and working patterns of our cities necessitate novel architectural concepts that can sustain such contemporary societies (Hubert-Jan Henket & Hilde Heynen, 2002; Kronenburg, 2007). Perhaps a holistic design approach that is transformable, movable, adaptable and agile could efficiently allows for multiple uses in one space, better sustains the economic factor and adequately manages the over-use of energy resources.

2.0 EARLY APPLICATIONS OF AGILE ARCHITECTURE

It is insightful to consider several seminal historical design projects in order to better grasp concepts of mutability and the need for adaptation and change. The following precedents illustrate early approaches to environments that provide 'give & take' around shifting users and usage.

2.1. The traditional Japanese house

In Europe over the last three centuries spaces and places have increasingly been designed for fixed functions. However, in Japan, a multi-functional design approach continues to the present day (Kronenburg, 2002, p. 22). Japan is a country that has successfully approached extreme demands on space in unique and innovative ways (Sinclair, 2015). Traditional Japanese houses have unique interior and architectural features that reflect Japan's history and culture. Family homes were lifestyle-based and functional adaptability was the core of design concepts (Jeremy Till & Tatjana Schneider, 2007). The layout was designed according to the involvement of the inhabitants; where the sitting or dining room can be transformed into a bedroom by pulling out futons from a storage cupboard. Moveable partitions, a Japanese design feature known as 'shoji' (a sliding panel made of translucent paper in a timber frame), perhaps interiors to readily transform. When used for exterior skin, such walls give Japanese homes many possibilities as spaces between building and landscape can be dynamically reconfigured (Figure 1). Additionally, the traditional Japanese house used flexible construction techniques where wooden joints were tied with ropes known as 'Wagoya.' Overall, the flexible construction materials, interior and exterior architectural features, the modular approach to design and the indeterminacy of function of the traditional Japanese house established its uniqueness and efficiency, vital innovations and design approaches that are still included in modern homes.

Figure 1. Interior 'Shoji' panels and 'Tatami' floors which are made of rice straw, featuring the multifunctional use of space by integrating sliding walls. Exterior 'Shoji' panels perfectly integrate indoors and outdoors. The tatami-mat layout and the use of plain wood express sensitivity to natural materials. (photograph: Brian Sinclair)

2.2. Rietveld Schroeder House, Utrecht, the Netherlands. (1924)

The De Stijl architectural movement was the first to introduce and encourage the utopian vision of simplicity and functionalism of the design forms (e.g. all the unreasonable decorative features were abandoned) (Paul Overy et al., 1988). Flexibility was introduced by designing interiors that visually blur the boundaries between the space and furniture, having movable walls and designing furniture elements to slide from the walls so that space can be transformable. Such design approaches provided an instant response to individuals by creating spaces that can accommodate different functions. The Rietveld Schröeder House (Figure 2), is perhaps one of the most effective examples of De Stijl movement where open space plan liberated the interior and created a flexible domestic environment (Weston, 1996; Paul Overy et al., 1988). This two-storey house has an open plan space which is grouped around a central core. The large living space is transformable for the ability to respond to the individual needs and privacy by introducing partition walls. Each panel is independent, and thus, users can accommodate any desired configuration of the space by leaving the partitions open or closed or half closed. The built-in furniture also complements the transformable upper floor (Paul Overy et al., 1988, p. 29). Nearly 60 years of living in the house, Mrs Schroeder expressed that:

> For me, this house exudes a strong sense of real joy. That is absolutely a question of proportions, but here in this house, it's stimulated. I find it very important that a house has an invigorating atmosphere; that it inspires and supports the joy of living (Paul Overy et al., 1988).

Figure 2. The Schroder house elevation accentuates the relationship between vertical and horizontal planar forms (left). The upper floor interior with open partitions showing the full extent of the space (right). Source: *(Moritz, digitalized in 2010)*

2.3. Fun Palace, UK. (1964)

The late British architect, Cedric Price believed that designers must recognize the potential needs of a building structure to allow for uncertainties throughout the lifespan of a building. He also stressed that in any case if a building has outlived its anticipated purposes, it should be dismantled and not retrofitted (Mathews, 2005). It all started in October 1961, when the renowned theatre director Joan Littlewood told her friend Cedric Price about her lifelong dream:

> "She envisioned an alternative kind of social space, an experimental space where the public can freely interact in new ways, endlessly stimulating their creativity and broadening their knowledge. she wonders whether architecture might play a role" (Joan Littlewood & Peter Rankin, 2003, p. 702; Mathews, 2005).

Fun Palace is a proposition for an alternative educational leisure centre that is designed to facilitate various programmatic and spatial reconfigurations initiated by its users (Figure 4). Price reasoned that by accurately using the new technology, the public could have control over their environment thereby making the building responsive to the individual's needs (Anstey, 2007). The idea was to facilitate social experience and awareness through fun. Hence the Fun Palace program would need to be carefully designed to stimulate activity among individuals, leading them to recognize their potential and thus providing a more positive self-motivation (Joan Littlewood & Peter Rankin, 2003, p. 640). Consequently, Price eventually acknowledged that "Littlewood's idea would require a radically new kind of interactive architecture, highly adaptable to the rapidly shifting cultural landscape of England now – the 1960s – and in the future" (Mathews, 2005). Hence, the idea of a continuously self-reconfiguring program inspired Price to devise an anticipatory architecture, which harmoniously reconfigured itself to respond to users' shifting demands.

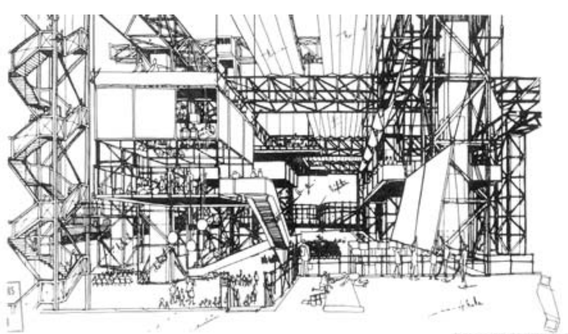

Figure 3. Cedric Price's Fun Palace, section. The concept was to make the design constantly under construction: Users can rearrange wall panels to create new spaces as the program change and evolve, creating endless variation forms and flexibility **Source:** (Price, C. Archives, Canadian Centre for Architecture [CCA])

2.4. The Nakagin Capsule Tower, Tokyo, Japan. (1972)

Among many, the Japanese Metabolism movement – established by Noboru Kawazoe and others – was rendered as one of the most influential in the emerging open building approach. This great architectural movement envisioned a whole new path for architecture in the 20^{th} century and beyond. The vision was to synthesise a harmony between technology, tradition, nature and humans. The concept expanded to manifest the idea that the built environment should develop organically in parallel with the dynamic needs of the inhabitants (Lin, 2010). Such an original vision – in the 1960s – resulted in various iconic architectural and planning developments in Japan, setting a trajectory for the future of flexible structures. One of the unique and distinguishing designs that became an architectural icon of that era is The Nakagin Capsule Tower by architect Kisho Kurokawa. The Capsule Tower design precisely signifies the Metabolism theory:

> The philosophy of metabolic design is based on modular buildings, exchangeability, prefabricated parts and capsules. The units move, change or expand according to the needs of the individual, thereby creating organic growth (Echavarria, 2005, p. 24).

3.0 AGILITY AND SUSTAINABILITY

The current state of worldwide population growth, scarcity of resources and climate change challenges explains the popularity and profile of the low carbon agenda in developed countries. This led to a surge in research and development, making the technical and operational facets of low carbon buildings well understood (Loms, 2010). Sustainable built environment to be one in which our use of resources is minimized while the utility of our buildings is maximized, as defined by Murakami (2011): “the achievement of high quality within a target-built environment while emitting low environmental load beyond the target-built environment.” It is tempting to outline agility concepts as an agenda solely in the frame of the energy/carbon reduction. However, this approach results in an overly-narrow focus of the agile agenda and prevents consideration of the broader benefits agile design could present (e.g. economic sustainability of continuously adaptable developments). Evidently, the agile agenda has interfaces with other pursuits beyond low carbon. Therefore, in our contemporary context, the pursuit of synergies between agility and sustainability concepts demands us to look intensely at the big picture – looking from above through an integrative lens is a necessary precursor to more detailed evidence-based intervention (Sinclair, 2009). In 1972, Sir Alex Gordon – former president of the Royal Institute of British Architects (RIBA) – argued that ‘good architecture’ should be designed for long life, loose fit and low energy (Gordon, 1972). The idea of integrating flexibility to accommodate future needs as well as minimizing energy footprint throughout the physical life of the building is undoubtedly the ultimate holistic objective for architecture in our modern society (Langston, 2014). Today, Gordon’s objectives can be interpreted as ‘durable, flexible and sustainable.’

- **DURABILITY**

Obsolescence can be defined as “the inability to satisfy increasing requirements or expectations” (Donald Iselin & Andrew Lemer, 1993; James Pinder & Sara Wilkinson, 2001). This is an area that posses considerable stress due to varying social demands (Kintrea, 2007). Obsolescence does not mean poor performance. Most available resources on building durability are more applicable to building components and systems rather than entire buildings. Factors affecting components durability can be: (a) quality of components, (b) Execution level, (c) indoor and outdoor environment, (d) usage settings and (e) maintenance level (Kincaid, 2000; Langston, 2014). While a building is a sum of parts, such parts can be replaced and hence renewed, leaving the primary structure to determine overall life expectancy. Other literature on service life discusses the effect of external and internal actions on building durability and identifies location, usage and design as the main parameters. Few researchers have included regulatory changes to zoning as a form of obsolescence (e.g. Austin, 1988; Campbell, 1996; Kincaid, 2000).

- **FLEXIBILITY**

For an array of reasons, buildings can become functionally obsolete long before their physical life has come to an end. Developing long-standing structures may be inefficient if their useful-life ends prior to their physical-life. Future designs need to be flexible enough to support alternative functional uses. The development of an integrative holistic framework for agility enables building designers to understand the long-term impacts of their decisions early in the design stage. As flexibility approach already embodies financial, social and environmental criteria, the framework would extend traditional operational considerations such as energy performance to include refurbishment, disassembly and reuse.

- **SUSTAINABILITY**

There are many comprehensive environmental rating systems for buildings worldwide (e.g. LEED, BREAM, Green Star, etc.), all of which are established for evaluating the environmental design and green attributes of projects. Most rating schemes are organized into a set of impact categories which usually cover issues of indoor environmental quality (IEQ), energy, transport, water, materials, land use and emissions. Fundamentally carbon reduction can be framed as a problem of energy reduction, which is further decomposable into separate issues of operational and embodied (or process) energy reduction. The low carbon agenda indeed provides powerful leverage through the provision of ancillary benefits (beyond emissions reduction) such as reductions in energy bills and a reduced dependency on external energy sources. The resonance flexibility has with ideas on the minimization of embodied energy (through a reduction in material wastage resulting from demolition and rebuilding) is also apparent (Gorgolewski, 2005). The present researchers highlight the importance of, yet insufficiency in, considering energy as part of any equation for sustainability.

In the view of the researchers, durability, flexibility and sustainability are interesting concepts for exploring agility's collision with sustainability. It is helpful to use such constructs in assessing key contemporary case studies, with an end goal of determining the overall ‘agility’ of each project. The authors argue that such assessment but be multifaceted and robust, moving beyond simply a consideration of energy use and low carbon. The sustainable design movement emerged more than a decade after Gordon’s 3L Principle, leading to a somewhat aggressive push towards low carbon targets at municipal and national levels in the developed world. Although progress on the delivery of such objectives has been gaining momentum, the focus has been on green building, with less consideration being given to durability and flexibility. Sinclair (2009) has previously delineated a Holistic Integrated Framework for Design + Planning. This theory considers the symbiotic interplay of Agility, Fitness, Diversity and Delight, understanding all hold equal value and significance. It considers energy and low carbon as components of a much greater system. The diverse action areas underlying the four core qualities are seen as having high flexibility, and subject to change and modification as conditions suggest and context dictates (Figure 4). Furthermore, Sinclair (2012) explored the matter of agility in depth and proposed a synergistic model for amplified agility in architecture to encompass four main areas, namely: Psychological (individual), sociological (group), legal (regulatory) and physical (constructional). This approach complements Gordon’s 3L principle in our present context. Looking at the suggested quadrant of agility, we can easily link into long life (recycling, design for disassembly and reassembly), loose fit (open building, user-controlled design, skeleton infill) and low energy (reduced embodied energy, lowered life-cycle cost). The present research aims to craft a new model that creatively and potently links agility and sustainability through exploring a spectrum of modern developments and emergent concepts.

Figure 4. Sinclair’s Holistic Integrated Framework for Design + Planning (Sinclair, 2009)

4.0 CASE STUDIES

The researchers are investigating the unifying principles of agile architecture throughout both early (historical) and contemporary applications in an attempt to understand the unique factors required to develop much more sustainable environments. Case studies introduced in the present paper can be seen as pragmatic and strategic examples with which to investigate modern agile concepts. We draw attention to six contemporary designs drawn from the flexible/adaptable building movement. Blundell-Jones – in his book Modern Architecture Through Case Studies – views the case studies approach as a unique dialogue and considers investigating the cultural and physical context of each case to be “a better way to disclose general set of principles and laws rather than bending the work to fit the rules” (Blundell-Jones, 2002, p. 5).

The selected case studies, which are vital components to this ongoing research, are drawn from six global cities -- they represent different building types while showcasing different responses to various contexts and conditions: Sendai Mediatheque (Japan), Loftcube (Germany), Sliding House (UK), Sharifi-ha House (Iran), Galaxy Soho (China) and Shotgun Chameleon (USA). All cases were constructed during the 21st century and had been recognized for national, state or regional recognition for architectural distinction. The present paper introduces these intriguing projects as subjects for the next phase of study – namely and in-depth field-based analysis with agility and sustainability front-of-mind. Our theoretic posturing avoids any set position or assumptions and instead innovatively evaluates and interoperates each project objectively in the context of durability, flexibility and sustainability. Case studies data, in tandem with the strategic literature review, aim to highlight leading themes, ideas and practices of agile architecture. The ongoing research will connect the analysis of these contemporary projects with historical precedents and an understanding of the literature. The next stage of the research, beyond conducting the case studies, will synthesize a framework that connects agility and sustainability – equipping architects and builders with the theory, tools and techniques needed to develop and realize more mutable, adaptable, responsive and responsible buildings.

CONCLUSION

The architecture of the 21st Century should possess the fundamentals of durability, flexibility and sustainability. Such principles are not mutually exclusive, nor incompatible with values of delight and performance, but rather hold equal significance. A zero-carbon structure with no robust functional flexibility will still become obsolete long before its physical life has come to an end. While such design demonstrates technological advancement, it is merely a prototype for concepts that need integration into a balanced and broader framework that should be more commonly practised. However, a standard theoretical framework for setting such agile concepts is not yet established, rather only generalized methods and guidelines are found in the literature. Hence, the long-term objectives of the present research are to: • Identify all layers, agents, facets and forces affecting the integrative design process, • Understand the failure and success of past attempts (technological, social, political, environmental and economic) and • Develop a novel framework and associated methods of analysis to provide the requisite levels of agility. The authors understand that whether our designs are partially or entirely adaptable – or even somewhere in between – there can be no 'one-size-fits-all' approach to pursuing agility in our modern society. Appreciating that, – listening and truly responding to users' needs – is the optimal way to achieve strategic, successful and necessary outcomes.

The present paper critically presented historical precedents, explored prevailing thinking, observed emerging trends, and pointed to contemporary building designs in an effort to bring agility into the spotlight. The ongoing research intends to synthesize a conceptual framework for heightened agility and sustainability, thereby realizing more responsible, responsive and appropriate architecture for the 21st Century. Advancing from the established foundation of Gordon's 3L principle, Open Building (OB) practices and drawing upon Sinclair's recent Holistic Framework for Design + Planning, the aspired integrative model aims to introduce continuously evolving and dynamic solutions – in essence migrating away from the static architectural practices and staid architectural outcomes that define modern architecture. The authors are presently pursuing better clarity and applicability of facets and concepts of agility in contemporary building design – using case study methods to illuminate best practices and identify future potential. Given the growth of population, scarcity of resources and the emerging society expectations due to the modern world technological advancements, our research pursuit into Agile Architecture seems significant, timely and necessary. In our proposition for reconsidered and more appropriate Architecture, people must reside centrally, and the dynamic, responsive and meaningful must eclipse the static, staid and stale. Ingenuity, creativity, imagination + open-mindedness prove valuable and vital.

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Karlla Dreser, Tim Frank

Compact or Dispersed? Examining the Effectiveness of Low Surface-to-Volume Ratios in Southern Structures

Compact or Dispersed? Examining the Effectiveness of Low Surface-to-Volume Ratios

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ABSTRACT: In a United Nations 2013 survey tracking World Sustainable Development Challenges, a global 'one size fits all' approach to sustainable development was distinguished and precluded from policy frameworks as regional priorities, objectives and paths toward sustainable development were notably diverse. Regional specificity is particularly evident in the formal and spatial disposition of vernacular buildings that respond directly to climate zone characteristics in that area. Today, despite the proven effectiveness of these past approaches, sustainable building guidelines have embraced the belief that buildings are more efficient through the widespread adoption of system building technologies, compact building forms and the subsequent reduction of surface to volume (S/V) ratios. This trajectory relies heavily upon interior building systems and exterior envelope technology, endowing much of a building's performance to the integrity of these components to ensure thermal comfort. However, in some climates, like temperate profiles with hot and humid summers, this approach may not produce the most energy efficient solutions.

To test the validity of this direction, this paper systematically explores two structures in the Southern U.S., a distinctly temperate climate with hot and humid summers, to ascertain whether designing compact structures is an appropriate strategy for energy savings, especially when this approach contradicts lessons offered by vernacular structures built in the same region centuries prior. This comparative analysis examines the Sadler House, a 19th century modified dogtrot located in McCalla, Alabama with a S/V ratio of 0.41 and the LEED Platinum RainShine House, a 21st century house located in Decatur, Georgia with a S/V ratio of 0.24. The results indicate the spatial disposition of the 19th century house outperforms that of its 21st century successor when inheriting the same interior and exterior system characteristics. The outcomes of this analysis reexamine vernacular strategies and stimulate the conversation pertaining to widely accepted sustainable design principles.

KEYWORDS: southern building performance, surface to volume (S/V) ratio, mixed mode systems, spatial disposition

INTRODUCTION

Sustainable architecture seeks to design buildings that are less harmful to the environment during construction and life span operations. The building industry's patterns of energy consumption and greenhouse gas emissions make its impact on today's environmental crisis clear, requiring reconsideration regarding how buildings are designed, constructed and managed (Berardi, 2015). Today's sustainable design practice incentivizes the use of compact building forms, reducing the building surface area relative to the spatial volume enclosed in order to facilitate thermal control over indoor environments. The surface to volume (S/V) ratio measures the area of a building envelope defining the conditioned spatial volume. The lower the ratio, the more compact the form and the less exterior envelope used to enclose a given unit of interior space. This strategy focuses on the continuity of hermetically sealed thermal envelopes and mechanical systems that provide steady-state interior environments, many times overlooking how passive building strategies can exploit rapidly renewable energy sources (Lechner, 2014). Approaches toward building permeability such as dispersed volumes and mixed mode spatial dispositions are frequent in vernacular structures in the Southeast but are often abandoned in contemporary construction. Therefore, this paper aims to examine these seemingly oblique approaches in search of the best way forward for sustainable development in the Southern U.S..

In recent decades, the pursuit of sustainable design outcomes has generated new interest in vernacular structures because of their performance characteristics. These buildings are able to address their environmental context and climatic needs without advanced technologies and materials (Fathy, 1973). The use of building performance simulation (BPS) tools has allowed researchers to learn from their pre-industrial predecessors by extracting valuable information from vernacular structures through the systematic observation of boundary-state observations in a shared domain. These tools allow building scientists to measure a building's reliance on high-tech systems and to assess low-tech opportunities when offsetting the use of high-grade energy sources in providing occupant comfort. Therefore, the desire to realize the full potential of these emerging toolsets motivates the work and is best situated through the following questions.

Primarily, can we utilize a universal one-size-fits-all approach in contemporary development even when the basic premise runs oblique to vernacular practices? In addition, are the advancements in the post-industrial world being used to their fullest capacity while acknowledging valuable lessons offered by our pre-industrial predecessors? A few rebuttals to the questions, examined through the lens of the sustainable development in the Southern U.S., are taken up in this paper.

The overarching goal of the research is to enhance the discussion of sustainable strategies by examining whether compact building forms and sealed envelopes can work in the context of ever-advanced systems in the spectrum of building technology. The long-term objective of the work is to offer BPS enhanced methodologies that can be used by researchers to extract engrained knowledge from vernacular structures and to test those lessons with state-of-the-art analysis tools to enhance thermal comfort without using high-grade energy sources. This paper examines the reduction of S/V ratio in Southern U.S. structures, testing its impact on building performance through simulation tools. It does this through the comparison of two southern residential structures, the pre-industrial Sadler House and the contemporary RainShine House. Implanted within both structures are aspects of the southern dogtrot typology that is tailored to passively moderate the temperate southern climate with hot-humid summers. The Sadler House is recognized in the National Register of Historic Places, while the RainShine House is one of the first LEED-platinum certified single-family residences in the southeast.

1.0 BACKGROUND

Through the study of vernacular architecture, it is possible to recognize generalizable characteristics about how builders used first-principles building strategies to moderate climatic conditions around the world (Fitch 1990). Lacking technological resources, climate-specific passive building techniques were developed over time by early societies, dictated by constraints of climate, these approaches lead to innovated low tech building models in order to achieve thermal comfort (Zhai and Previtali, 2010). In the Southern U.S., the humid temperate climate presents unique comfort challenges including enhanced cooling and dehumidification due to intense summer heat, heavy rains and humid air. Responsive design strategies are present in examples of vernacular architecture of the South. Pre-industrial southern building typologies such as the dogtrot and the bungalow provide comfort to inhabitants through basic architectural solutions like maximized protection from intense radiation through shading and ventilation to dissipate heat and humidity from indoor spaces (Kemp, 1990). Characteristics such as spatial dispersion and permeability of the building envelope are also commonplace in vernacular southern building systems to enhance the comfort of interior spaces (Coch, 1998). Together, these strategies aim to make buildings thin and permeable, thus increasing envelope area to enhance thermal comfort without the use of mechanical or technological means such as air conditioning and dehumidification systems.

Currently, the use of mechanical cooling systems has become ever more commonplace in the building industry (Addington, 2003). With the technological advancements of industrial building systems like heating, ventilation and air conditioning (HVAC) equipment, a noticeable shift has occurred in the design of buildings. Strategies for promoting interior comfort now emphasize hermetically sealed and tightly controlled indoor environments, forgetting the lessons offered by vernacular structures (Singh et al., 2009). Today, in the “Sustainability Era”, even though approaches may vary, many recommendations tend to prioritize innovative mechanical systems, super insulation of the envelope and reduction of S/V ratios (Ionescu et al., 2015; Ching and Shapiro, 2014). Envelope technology and building systems have become attractive solutions for building performance due to the possibility of increasing control over thermal characteristics of indoor environments. Furthermore, high performance “green building” rating systems like LEED typify and support those approaches as the most sustainable in order to create measurable results that can be compared through a systematic metric-based structure (Altomonte et al., 2015). Returning to an earlier postulation, can universal sustainable design solutions be the best fit for all climate profiles? Buildings located in the Southern U.S. stand to challenge the narrow benchmarks assigned by metrics-based rating systems and BPS tools are well equipped to examine the plausibility of universal approaches in the context of contradictory historical patterns of passive climatization.

2.0. METHODOLOGY

Simulation tools offer researchers the capability to replicate building configurations and observe their modulation of environmental states in specific time and climate contexts. Central to the simulation workflow is the domain comprised of a digital model representing building boundaries, input states culled from climate datasets and mathematical equations used to approximate state behavior relative to architectural contexts. While these tools are often used to predict how new buildings will perform in the future they can also be used to extract valuable knowledge from pre-industrial structures to inform how those geometries were attuned to local climates. This research leverages BPS tools to comprehend gaps in development patterns, from pre to post industrial, and proposes new trajectories that aim to close these gaps. The work does not intend to focus on simulation tools themselves but instead seeks to generate further comprehension between vernacular and contemporary building systems to identify forward trajectories, advancing sustainable building design by integrating vernacular strategies that exhibit mastery in response to environmental imperatives.

In order to analyze the performance of building systems, both new and old, measurable and quantifiable results are required for assessment against established comfort criteria. SketchUp, developed by @last Software with Brad Schell and Rhinoceros 3D, by Robert McNeel and Associates are the interoperable modeling domains used in the analysis. Simulation plugins used in tandem with these modeling platforms include Sefaira Architecture, DIVA-for Rhino and Autodesk® CFD that examine energy consumption, solar radiation and fluid dynamics respectively, all critical elements to ascertain building behavior. Sefaira, an energy analysis program developed by the Trimble Company uses analysis engines in compliance with EnergyPlus. This software analyzes passive and active strategies of a building to optimize performance and design. While Sefaira's functionality is limited in terms of its range of input factors and HVAC configurations, this study focuses on the program's ability to exchange assembly parameters to highlight the relative proximity of outcomes in lieu of obtaining absolute values. DIVA-for-Rhino is a solar raytracing tool developed at the Graduate School of Design at Harvard University used to understand daylighting and radiant heat gain in buildings with reliable engines including Radiance and Daysim. Lastly, Autodesk® CFD is a computational fluid dynamics program developed by the Autodesk® CFD Engineers used to replicate the fluid flow behavior of air in buildings using Navier-Stokes equations validated through test models with known results. Together, these simulation tools are used in concert to circumscribe the performance characteristics of each case study to disclose how the boundary configurations of each contribute to the modulation of environmental forces.

3.0. CASE STUDIES

In the Southern U.S., buildings moderate a humid temperate climate challenged by intense radiation and high humidity levels. Vernacular southern structures, developed incrementally over the course of centuries, exhibit hallmark characteristics including large overhangs to provide maximum solar shading, dispersed spatial volumes and intermediary space types that together enhance ventilation in order to minimize the effects of humidity (Banham, 1966). Alabama and Georgia in the Southern U.S. are home to some of the finest examples of southern vernacular architecture including residential typologies such as the dogtrot, the bungalow, and the antebellum mansion. The two houses analyzed in this paper, the Sadler House and the RainShine House, exhibit continuities and shifts in the building tradition across the two centuries that separate them. While they both implement characteristics of the southern dogtrot, they are built with very different envelope characteristics, materials and construction processes. They are each true reflections of their time and available building technologies. The extent of time between them provides an interesting basis for comparison pertaining to energy efficiency and strategies for passive climatization due to the advances in building technologies. Analysis of each structure using the aforementioned method follows to highlight how vernacular traditions progress from the 19th to the 21st centuries while understanding the value emerging building technologies offer regional development.

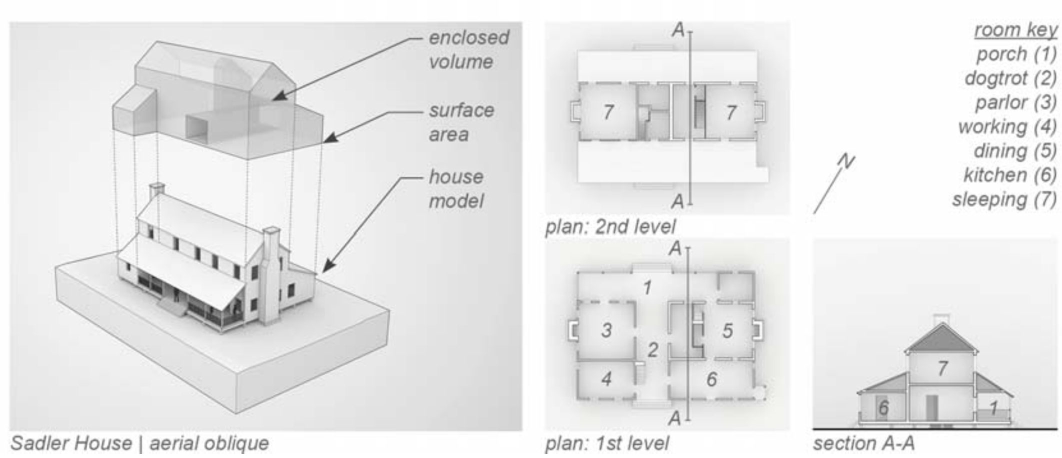

Figure 1: Sadler House reconstruction after Ford. Source: (Dreser and Frank 2017)

3.1. Sadler House

The Sadler House, built in the early 19th century, served as a plantation home in McCalla, Alabama. During the period, settlers to the Southern U.S. began to develop a building type called the dogtrot, or “single-pen” log house. These structures are built using load bearing wood logs and cedar shake roofs (Ford, 2014). While there are variations to this style as it propagates the Southern U.S., they all adapt to the hot and humid southern climate through strategies such as elevated floor plates, shaded intermediary spaces including porches and, perhaps the most identifiable characteristic, the presence of a dogtrot or open breezeway that bifurcates the structure’s mass. The S/V ratio of the Sadler House structure is calculated at .41, reflecting its thin floor plate on the second level and its intermediary space types central to its composition (FIG. 1). These construction strategies modulate the climate by allowing the house to breath and dissipate humidity through its floor, enhance ventilation in the interior rooms and protect the house from incident solar gains through shaded porches. Together, intermediary spaces like the breezeway and the porch, not only provide thermal comfort to the interior of the house, but also extend the enclosed living areas to the exterior that are often used as places to sit, interact with others and even sleep during the summer months. Given that the comfort standards in the early 19th century were likely less severe than we find today, they were attained by passive strategies to dissipate heat and humidity, and also through the migration of activities across the interior and exterior areas of the house.

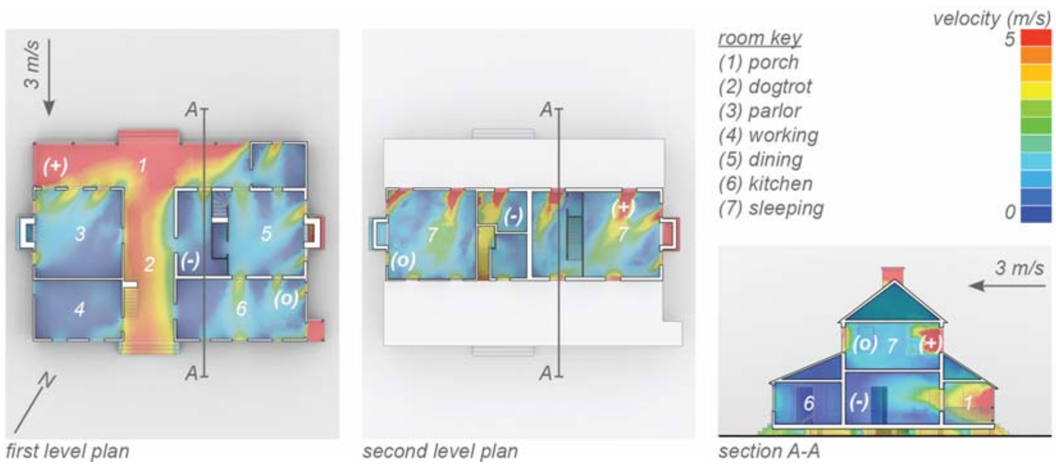

Figure 2: Sadler House CFD Analysis. Source: (Dreser and Frank 2017)

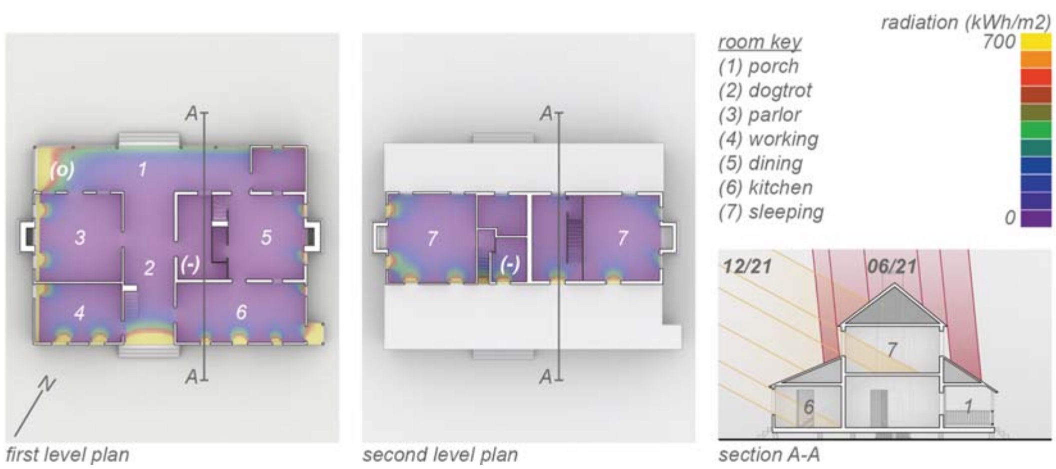

Figure 3: Sadler House Solar Raytracing Analysis. Source: (Dreser and Frank 2017)

CFD tests are run on the house, using the prevailing north-northwesterly 3 m/s summer wind as the velocity input to better understand the flow behavior within the structure. These results highlight the effectiveness of the breezeway in enhancing even moderate prevailing wind rates. Aligned apertures on the first level promote cross ventilation in the dining and kitchen spaces while corner openings in the parlor increase air changes within the space. The thin footprint combined with the aligned openings on the second level generate amble ventilation rates for warm summer nights (FIG. 2).

Solar ray tracing simulations are also conducted to ascertain the levels of direct incident gains that are present within the house annually. The radiation maps reveal that most areas of the house are protected from direct solar gain due to the overhanging roof planes and intermediary space types. Areas where over 700 kWh/m2 gains are noted annually include the northern porch and the southern edge of the central breezeway, two spaces with moderate degrees of enclosure and therefore ample ventilation rates to offset the potential for overheating. (FIG. 3).

The structure's energy use is also modeled, assigning pre-industrial building properties to building elements such as walls, roofs and floors without insulation and uninsulated single pane glass windows. The resulting EUI from the analysis resides at 64 KBtu/sq.ft./yr (FIG. 7). This outcome highlights the loose envelope construction and the low-tech systems employed in the early 19th century. Because these structures lack insulation and continuous thermal barriers, their quantitative performance outcomes sit below contemporary benchmarks that average 42 KBtu/sq.ft./yr for single-family detached houses in the same region (Architecture 2030, 2017). However, it should be noted that the resulting EUI should not be considered an absolute outcome since the properties assigned to the building's structure have not been validated. This is due to the prioritization of relative values between the two case studies in lieu of pursing the unconditional results of a singular building.

3.2. RainShine House

Robert M. Cain's RainShine House was built in 2008 for a couple living in Decatur, a small suburb located just outside Atlanta, Georgia. The home is comprised of quadrants with the western-most units conjoined to form the public areas of the main house, the northeast unit used privately as the main bedroom suite and the southeastern unit used as an exterior southern porch. The S/V ratio of the structure is calculated at .24, much lower than the former example. This low S/V ratio echoes the compact composition of the home with most of its volume contained within the western block of the structure. The house was the first modernist residence to receive platinum certification by LEED Homes in the Southeastern U.S. (Jetson Green, 2009). A few of the more celebrated characteristics of the home include its high-efficiency envelope characteristics and on-site renewable energy systems with roof-mounted photovoltaic panels and geothermal heat pump system (Flannery and Smith, 2011). The RainShine House highlights a shift in climatization in the south, indicated by a smaller envelope area while creating a tight boundary that can be sealed and conditioned through its state-of-the-art mechanical system. While the RainShine House implements several modern technologies, it also explores traditional strategies through an operable edge condition that includes passive ventilation providing further evidence of its exemplary design (FIG. 4).

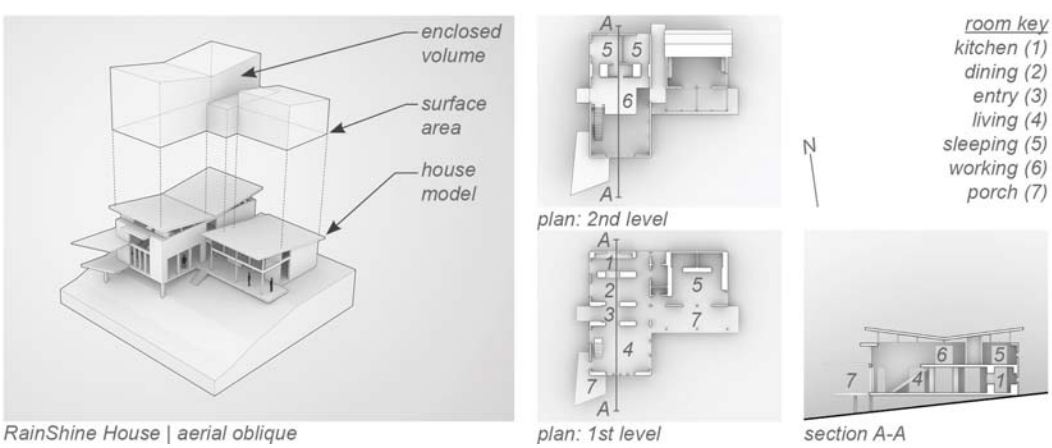

Figure 4: RainShine House reconstruction after Cain. Source: (Dreser and Frank 2017)

As indicated during the CFD analysis of the structure, the deep floor plates present within the compact building form reduces the rate of cross ventilation even with aligned apertures across its large mass. While stack ventilation rates are present from the ground floor to the upper volume of the house, low level velocities are noted with the limited operability of the upper level glazing that holds the potential to exhaust buoyant hot air. Furthermore, air stagnation is present in areas of the plan where clear ventilation are paths are obstructed by internal partitions or inoperable windows that are likely designed to minimize the level of heat transfer occurring through the exterior building envelope (FIG. 5).

Results from the solar ray tracing analysis indicate ample shading for many areas of the building plan, especially on the second level where inhabitable spaces are situated to the north of the building mass and in close proximity to the butterfly roof plane. However, areas of the first level show evidence of overexposure to solar gains, especially in the open living area encased in southward oriented glazing. While solar screens protect some areas of glazing, the orientation of the roof slope exposes areas of the southern envelope to direct solar gains. Other areas of the plan receiving over 700 kWh/m2 gains over the year are located in open-air spaces including the southern porches and the entryway (FIG. 6).

When modeling the energy use of the structure, modern-day properties are assigned to building entities that include high insulation for walls, floor and roof in addition to high-performance glazing systems. These assignments result in an EUI of 28 KBtu/sq.ft./yr for the building, much improved relative to its pre-industrial predecessor and modern contemporaries as evidenced by its LEED Platinum certification (FIG. 7). These results highlight the value of advances in envelope and system technology that together allow a compact building form to perform well in a region where dispersed spatial volumes were historically adopted. Also worth noting is the fact that vegetal and on-site renewable energy systems were not factored into the calculations to facilitate comparison of S/V differences between its 19th century predecessor.

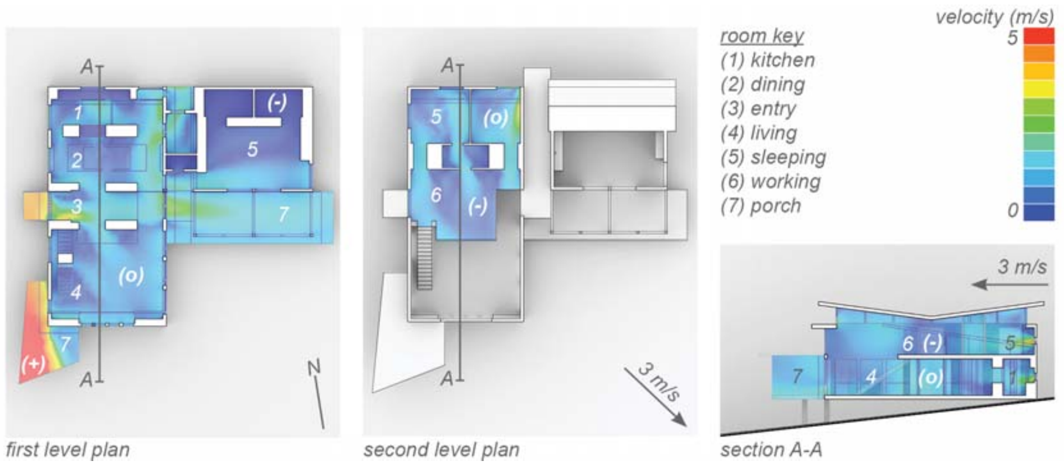

Figure 5: RainShine House CFD Analysis. Source: (Dreser and Frank 2017)

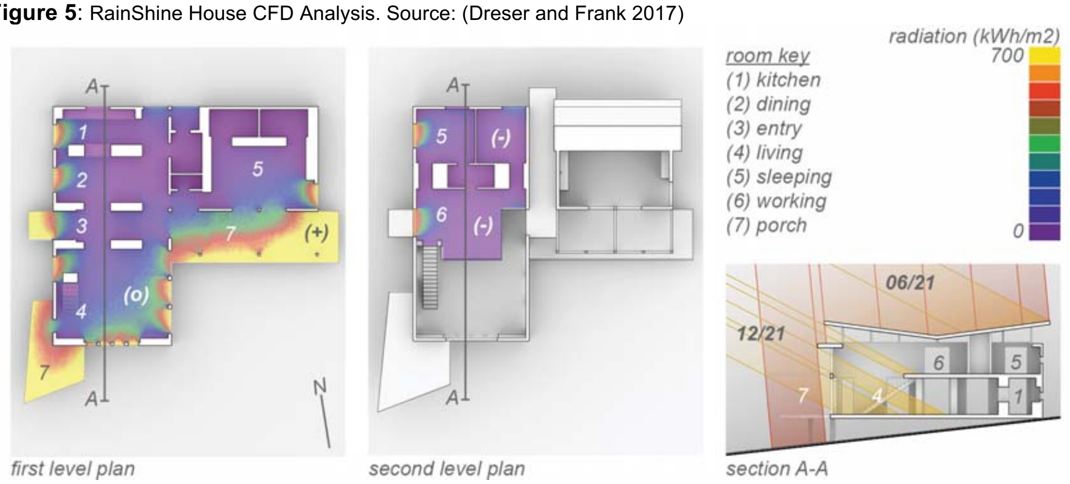

Figure 6: RainShine House Solar Raytracing Analysis. Source: (Dreser and Frank 2017)

4.0. SYNTHESIS

To gauge the relative effectiveness of massing strategies and corresponding S/V ratios for each structure, the energy models are reiterated to exchange building properties between case studies. When the Sadler House is assigned the properties of the modern RainShine House, its EUI shifts to 23 KBtu/sq.ft./yr. Likewise, when the vernacular properties of the Sadler House are applied to the RainShine House, its EUI increases to 69 KBtu/sq.ft./yr. (FIG. 7). The results from this exchange support the working hypothesis of the study highlighting the superior performance of dispersed building forms in temperate climates with hot-humid summers even when inheriting state-of-the-art building system specifications. To help rationalize the outcomes from this energy comparison, the CFD and solar ray tracing observations are further corroborated. The CFD results from the two projects indicate that thin building forms and intermediary space types break up the building mass and provide better opportunities for cross ventilation within inhabitable areas. Furthermore, aligning apertures throughout the structure strengthens ventilation paths but obstructions internal to the building composition interrupts flow networks along with wide floor plates that place significant distances between air inlets and outlets. Outcomes from solar raytracing show that thick building plans aid in shading interior spaces but access to natural daylight is inhibited without permeating interior partitions. However, thin footprints demonstrate adequate access to illuminance when shading devices such as overhangs protect the glazing. Without shading elements, spaces become susceptible to overheating and contrast glare. Results from CFD and raytracing studies both highlight the impact of intermediary space types like porches and breezeways. These spaces add to the room inventory, extending occupiable areas to the exterior where additional exposure to wind or sunlight may add direct benefit to the user group depending upon their desired activity type.

Figure 7: Energy Analysis. Source: (Dreser and Frank 2017)

CONCLUSION

While the outcomes from this study do not produce extraordinarily dissimilar results, they do demonstrate that despite 'one size fits all' recommendations made by some sustainable design guides today, decreasing S/V ratios in southern structures do not necessarily produce the most energy efficient results. These results underpin our research objective that aims to advance the conversation about the universal legitimacy of compact building forms, the espousal of lower envelope areas and highly insulated boundaries in all climate regimes. The work also serves to recall the sagacity of vernacular systems, tested with trial and error methods over centuries of development. The case study analysis presented here offers an initial glimpse into an alternative way forward that propagates important lessons from vernacular architecture, implements those lessons in contemporary development and uses post-industrial technologies to optimize building performance characteristics. We can elicit a number of lessons from this study for use in future research. While highly insulated enclosure systems minimize heat transfer in mechanically conditioned areas of a building, actively acclimatizing all interior spaces should be carefully considered to give occupants greater control over connections between inside and out. Furthermore, introducing a range of thermal zones should be prioritized in order to give occupants a variety of spatial alternatives while offsetting HVAC cost through the use of rapidly renewable sources for comfort. Finally, anticipating the migratory patterns of the building user group through the introduction of intermediary space types, extending activities to the outside of the building where moderate occupant protection can be provided. Based upon these lessons, the next steps in the research include the parametric flexing of domain models to increase the case study sample size for an improved boundary-state understanding. The examination of additional factors including outer envelope operability, building orientation and interior disposition to build upon the S/V ratio findings herein. Finally, next steps also include expanding the selection set of case studies in the Southern U.S.; incorporating additional vernacular structures and their post-industrial successors for further analysis using state-based simulation platforms.

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