Design for Change - Climate Centered Pedagogy in the Architecture Studio

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ABSTRACT: Climate change is truly the existential threat of our time. With buildings generating nearly 40% of annual global CO2 emissions, architects have an ethical and professional responsibility to consider the implications of their design on the environment, while architecture students need to be educated in effective adaptation and mitigation strategies. Organizations such as Architecture 2030 offer important framing of this topic, while also providing educational tools. However, there is still a dearth of information about how pedagogy in the architecture classroom can be developed to address the climate crisis. This paper describes how climate change has been foreground in the architecture studio at two collaborating universities. Each studio offers an important case study in developing climate smart architectural pedagogy to train the next generation of practitioners. While there were differences in scope of work and site location, shared investigative methods engaged with a multi-scalar perspective, expanding the role of architecture beyond the boundary of a building footprint to explore an interconnected network of the urban fabric and ecological systems. A mutual premise of the studios was to reframe climate change problems confronting our cities instead as opportunities for design innovation. This approach challenges students as future architects to rethink the current toolbox of the discipline and develop new methods of inquiry, analysis, and design of the built environment. Research outcomes discuss how pedagogical approaches in the studio led students to develop innovative methods of climate mitigation through research and application of sustainable building materials and construction methods reducing embodied carbon, net zero energy and closed-loop systems improving efficiency in building operations, in addition to climate adaptation addressing sea-level rise, urban heat island, and migration. The conclusion reflects on lessons learned from the studios to better train future architects to consider climate change as a primary component of their design.

KEYWORDS: Climate Change, Resilience, Pedagogy, Collaborative, Interdisciplinary
PAPER SESSION TRACK: Climate - Coastal Cities: Design Frameworks for Interconnectivity

INTRODUCTION

In the most recent report by the Intergovernmental Panel on Climate Change (IPCC), scientists paint a dire portrait of the planet, where climate change is intensifying and global warming is increasing more rapidly than previously predicted (IPCC, 2021). This means that mitigation efforts to reduce greenhouse gas emissions have not been substantial enough, and adaptation strategies will need to be increasingly employed. With sustained reduction in emission of greenhouse gases, it could still take 20-30 years for global temperatures to stabilize and sea level rise will be irreversible over hundreds to thousands of years (IPCC, 2021).

Now, more than ever, there is a pressing need for sustainable and resilient solutions in design and planning of the building environment that directly address the mounting issues of climate change facing our cities. The Fourth U.S. National Climate Assessment report states that while many impacts of climate change are unavoidable, much is still largely determined by our collective actions (Hayhoe, 2018). With embodied carbon in building materials and construction contributing 10% of global CO2 emissions and building operations generating 28%, architects have a professional and moral responsibility to do better to mitigate climate change (United Nations, 2020). Strategies to make buildings net-zero energy and zero-carbon will be essential for global decarbonization and according to the Global Alliance for Building and Construction, this “should become the primary form of building construction across all economies to achieve net zero emissions by 2050” (United Nations, 2020). Furthermore, architects will need to consider new and innovative strategies to adapt to a changing climate that respond to more intense rainfall and flooding, continued sea level rise, extended droughts, and amplified heat waves.

It is clear that climate change mitigation and adaptation should be an essential part of architecture in professional practice and in the education of future architects. In turn, curriculum in architecture schools must be able to train students to understand the challenges and impart solutions for addressing climate change in the built environment. The American Institute of Architects has developed a Climate Action plan that declares an “urgent climate imperative for carbon reduction,” pressing architectural practice to “achieve a zero carbon, equitable, resilient, and healthy built environment” (AIA, 2020). In their climate action goals they call for: (1) “*Mitigating the sources*” to “achieve zero CO2

emissions in the building sector by 2040;" (2) "*Adapting to the impacts*" to "design buildings and communities that can anticipate and adapt:" (3) "*Catalyzing architects to act*" through leadership in "partnership with our global community" (AIA, 2020). How do these goals take action, rather than just serving as appealing aspirations and formal platitudes? How do we train the next generation of architects to have the knowledge and skillsets to address the complex and wicked problems related to climate change?

1.0 CLIMATE CHANGE AS ARCHITECTURAL PEDAGOGY

1.1 Architecture education leading the profession

Architecture envisions speculative futures and makes tangible spatial imaginaries into physical form. By its very nature, architecture is an optimistic pursuit that believes in creating a better world. The pressing challenges posed by climate change, present opportunities for design innovation. Architecture students today, may very well be the leaders tomorrow in developing and applying climate change mitigation and adaptation efforts in professional practice. This, of course, will very much depend on how students are taught and if there is a focus on these topics in the classroom and throughout the curriculum. Much like how the introduction and application of digital tool for drafting, modeling, and rendering radically changed architectural education and practice in the early 2000's, there can be a new shift related to a focus on climate change. If addressing the climate crisis is a major part of architectural pedagogy, recent graduates may take on important roles and responsibilities early on in their careers, similar to how graduates with strong digital skills have influenced firm dynamics.

1.2. Program criteria goals for climate curriculum

There is often no formal program criteria in architecture schools for educational goals related to climate change. The recent NAAB guidelines may present an opportunity for schools to further define how issues of environmental sustainability are integrated into the Program Criteria. Schools are asked to "demonstrate how its curriculum, structure, and other experiences" address the (8) Program Criteria (NAAB, 2020). The NAAB criteria include "PC.3 *Ecological Knowledge and Responsibility*," which is expected to show how architecture students are learning to "mitigate climate change responsibly by leveraging ecological, advanced building performance, adaptation, and resilience principles in their work and advocacy activities" (NAAB, 2020). In faculty meetings at Temple University, it has become clear that PC.3 could be incorporated into nearly every class. However, questions remain about what materials should be taught, how can they be incorporated, and what resources are out there to guide this?

1.3. Platforms for academic resources

Organizations such as Architecture 2030 offer a platform to share knowledge and direct architectural development of "sustainable, resilient, equitable, and zero-carbon buildings, communities, and cities" (Architecture 2030). Their contributions include the 2030 Palette, an online resource for climate change responsive strategies from the building to regional scale (Architecture 2030). Architects Climate Action Network (ACAN) offers online resources for architecture instructors with their Education Toolkit and Educators Workshops. Resilience by Design University (RBD_U), an offshoot of the Rebuild by Design Competition brings together students, practitioners, and community in workshops and symposium on issues of resilience, in addition with current efforts to coordinate and share climate change related curriculum in architecture schools. US Architect's Declare has a similar committee underway that seeks to create climate change related educational tools and resources for both practitioners and students of architecture.

1.4. Intercollegiate studio coordination

It is within this context that Professor Gabriel Kaprielian of Temple University and Professor Alex Hirsig of Cal Poly developed climate change pedagogy for their architecture studios. However, it was a matter of chance invitation to serve as a mid-review guest critic that the content of each studio was shared. It just so happened that both studios at were developing projects for a Climate Change Institute in Philadelphia and Center for Climate Change in New York. This shed light on the lack of present coordination and collaboration between architecture schools to address climate change. Seeing an opportunity to share resources and amplify the educational experience of the students, coordination of the studios took place from mid-semester onward. This included combining the students on opposite sides of the country for shared group presentations using *Miro* virtual whiteboard and *Zoom*, sitting in on each other's reviews, and sharing of syllabus and course material. The result of the collaboration was beneficial to both instructors and students alike. It resulted in planned further alignment of climate change related studios and the writing of this paper with the intended goal to bring climate change related architectural pedagogy into the foreground as a vital element of contemporary architecture education. By sharing examples of each studio methodology, outcomes, and reflection the intended purpose is to serve as precedent and establish discourse on how best to incorporate these pressing challenges in the architectural classroom.

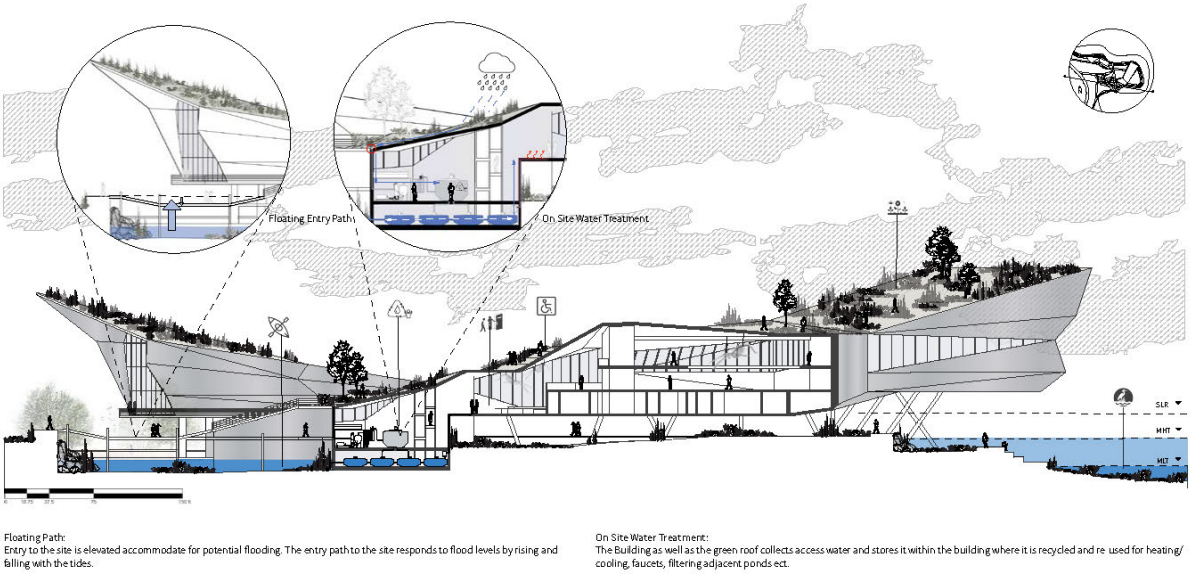

Figure 1: Climate Change Institute Section Drawing. Source: (Isaiah Graham – Temple University, 2021)

2.0 STUDIO PROJECT: CLIMATE CHANGE INSTITUTE, PHILADELPHIA

2.1. Studio Introduction

The 4th year Capstone Architecture Studio project at Temple University was titled, "Climate Change Institute - Adaptation in the Anthropocene: Resilience, Ecology, and Poetics." The goal of the studio was to explore the role architects can have in adaptation and mitigation efforts related to a changing climate. The semester-long studio project was located on Philadelphia's Delaware River waterfront. The course was structured into three phases: (1) *Site Analysis + Research*, focusing on precedents from Rebuild by Design and Resilience by Design competitions and interdisciplinary research, such as the Urban Waterfront Adaptation Strategies handbook developed by NYC Planning and other international studies; (2) *Neighborhood Master Planning*, exploring a multi-scalar urban design and planning strategy for the year 2121 to accommodate sea-level rise and increasingly severe storm events, resilient infrastructure, and the reintroduction of tidal wetlands; (3) *Architectural Design for a Climate Change Institute* sited on the water's edge at Pier 55 that is adaptive and resilient to continually changing site conditions.

2.2. Instructional Methodology

Through extensive fieldwork and research of the past, present, and future transformations, the site became a significant factor in the studio project. A major premise of the studio brief was considering how to design architecture that is adaptable to ever changing site conditions within the contested landscape of a tidal waterfront. In "Why Site Matters," Carol Burns and Andrea Kahn describe site thinking as "continually oscillating between material and conceptual, abstract and physical, discursive and experiential, and general and specific points of view" (Burns and Kahn, 2005). This varied and contradictory interpretation reconfigures site as a dynamic process and places it in a broader architectural discourse. Like many urban waterfronts in tidal cities, the post-industrial area in the studio site is no longer used as an active port and includes mostly underutilized and vacant land. Much of the site was built with landfill on the historic tidal wetlands, also making it highly prone to inundation from sea level rise and increasingly severe storm events. These challenges presented students with an opportunity to redefine the waterfront in Philadelphia, developing a resilient urban form that blurs the edge between water and land. The students were asked to develop a Master Plan where they choose what development to protect, where to have a managed retreat, and how to accommodate of sea level rise, while reintroducing tidal wetland ecologies that coexist with resilient new forms of built environment.

The incorporation of multi-scalar design was a fundamental part of the studio project. Through designing a Masterplan for the neighborhood, architecture students were able to contextualize the subsequent building design of the Climate Change Institute within a larger system of built and natural environments. Expanding beyond the building footprint, students explored the interconnected networks of social, infrastructural, and ecological systems that later influenced decisions at the architectural scale. A *21st century toolkit* of adaptation and mitigation strategies was developed by

Figure 2: Climate Change Institute Perspective Renderings. Source: (Tanzina Islam – Temple University, 2021)

each student team from case study research to be applied in phased planning and architectural design from 2021 to 2121. *Scenario planning* and the introduction of *chance events cards* established design thinking to include the multiplicity of unknown and external factors that could contribute to success or failure of the strategies. Students were asked to further interrogate their plans by creating *stakeholders profiles* to develop design empathy to understand who they might be designing for and to consider multiple personal perspectives and motivations.

In addition to collaborating Cal Poly architecture studio, there was planned coordination with a graduate landscape architecture studio at Temple University focused on the same site and scope to incorporate a cross-disciplinary perspective. Since the studios met on different days, a co-taught interdisciplinary team studio was not possible. However, each instructor coordinated meetings between the landscape and architecture students to consult each other's projects as the "disciplinary expert." By foregrounding the issue of climate change, students from both studios were able to consider how integration of site and building design can create more robust adaptation and mitigation efforts.

Students utilized resources from the Architecture 2030 Palette to explore strategies for the "design of zero-carbon, adaptable and resilient built environments" from the scale of region and city, district and site, building and material (Architecture 2030). These examples offer a good starting point for students to consider incorporating climate change adaptation and mitigation strategies at different scales of design. Furthermore, the AIA COTE student competition focused on solutions to climate change as a framework that the studio was built upon. This competition offered criteria with which to judge the meaningful impacts to imagine "healthy, sustainable, and equitable future in the categories of: Design for Integration, Equitable Communities, Ecosystems, Water, Economy, Energy, Well-Being, Resources, Change, and Discovery" (Architecture 2030). The studio guide further illustrated supplemental resources for instruction to consider the site, project, and analysis.

2.3. Student Projects

The students responded to the complex challenge of the studio with brilliance and ingenuity. At the urban scale, student projects envisioned a changing waterfront that became a mosaic of spongy tidal wetlands, boardwalks, parks, and programmed spaces that embraced the wet and constantly changing landscape including consideration of a more-than-human-world. Masterplans sought to stitch together the current residential neighborhood with future resilient development built into tidal wetlands, connected through blue/green infrastructure and multi-modal transportation in a post-combustion engine world. Architectural designs of the Climate Change Institute were integrated into new adaptive urban fabric such as Student Isaiah Graham's project "Restore the Store," [fig. 1] which allows for the managed retreat of the shoreline as sea levels rise, while embracing the reintroduction of the tidal wetlands with a network of pathways. "Inhabiting Nature," [fig. 2] by Tanzina Islam utilized a raised foundation along with pier and submerged architecture, while cohabitating with rising water and tidal ecologies. In the Urban Design proposal by Joe LaPorta and Marcos Diaz-Sanchez [fig. 3], they transform the city grid into a new system of buildings raised on piers along a ring road and tidal wetlands, while utilizing existing infrastructure of the highway as a tidal barrier and lock to protect dense new raised development connected both to the historic city fabric and water transportation along the Delaware River.

2.4. Studio Reflections

The final projects in the studio were consistently strong at the application of design responses to address climate change. It was evident that the collaboration with Cal Poly and the graduate Landscape Architecture studio at Temple University made a considerable impact through sharing of ideas and motivation in pushing students to explore new modes of architectural design. However, it was also a challenging semester for all students, asking them to consider so many factors in their project from design at both urban and architectural scales, interdisciplinary design integrating building and site, and design that responded to climate change adaptation and mitigation. Student projects were far more developed in adaptation rather than mitigation. This was perhaps due to having already developed an adaptation framework in the masterplan that was then applied at the architectural scale to respond to sea-level rise. While some student projects applied sustainable strategies in their building design, it was not a primary design driver as it was with the comprehensive studio at Cal Poly. If students would have had more exposure to courses in the curriculum that foreground climate change adaptation and mitigation, a better integration of the two may have been more successful.

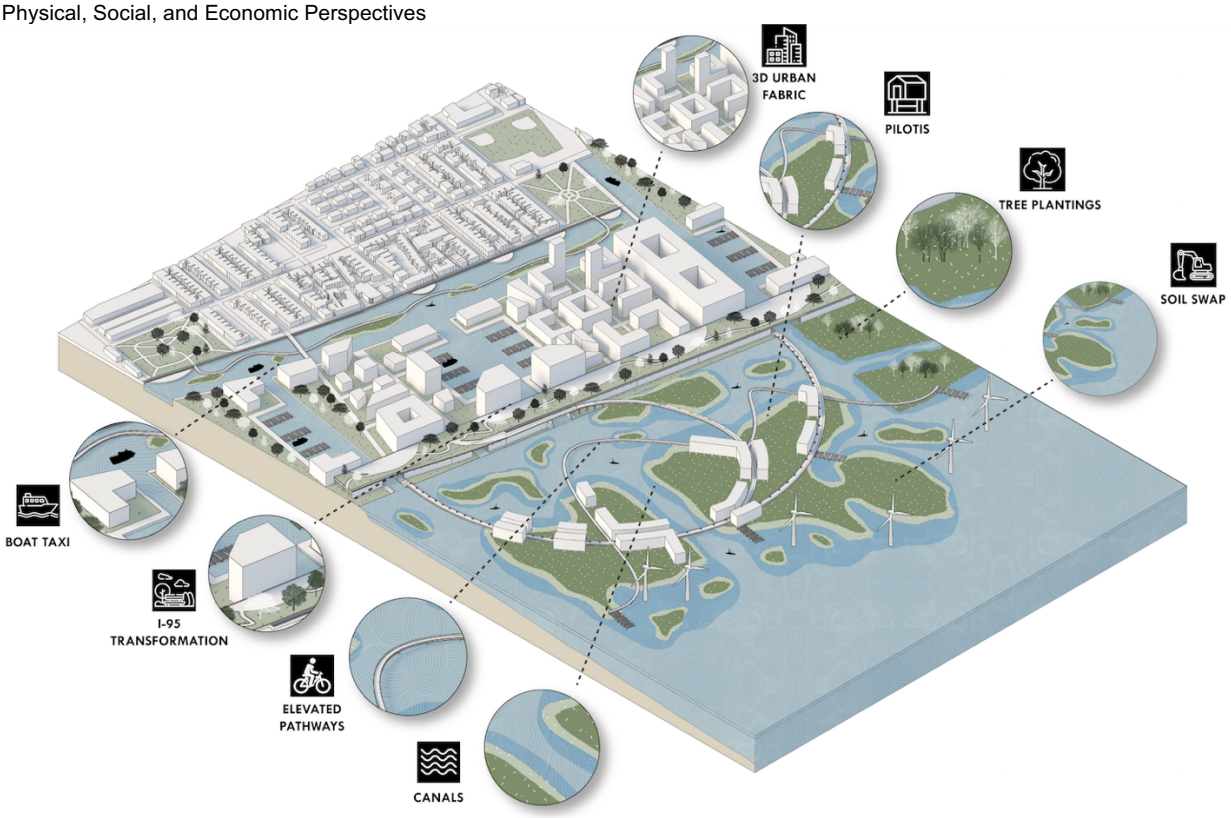

Figure 3: Climate Change Institute Site Design Isometric Drawing. Source: (Joe LaPorta + Marcos Diaz-Sanchez – Temple University, 2021)

3.0 STUDIO PROJECT: CENTER FOR CLIMATE CHANGE, NEW YORK +

3.1. Studio Introduction

For the past four years, a 3rd year architectural design studio taught by Professor Alex Hirsig at Cal Poly has designed a Center for Climate Change, leveraging the museum typology to explore the social and performative challenges surrounding architecture and climate change. For many, museums remain trusted sources of knowledge, a civic space akin to the library. Science and art museums are particularly adept weaving a tapestry of complex social, cultural, and technological phenomena into a tangible place for provocation. The studio brief asks how civic museums can curate the discussion on climate change and become a catalyst for change, and what role the architect can have in shaping the culture of climate change through this place-making. A deviation in the project brief has been a unique coastal context, which offers an opportunity for interpretations in its influence. The first project site was a small coastal town of Morro Bay, CA, the second in the urban SOMA neighborhood of San Francisco similar in climate. Most recently students have researched and agreed upon a NYC site evaluated by its perceived potential.

3.2. Instructional Methodology

Cal Poly operates on a quarter schedule, allowing students ten weeks to generate a conceptual design proposal. This studio began with a two-week warm-up project asking students to generate an expressive sculptural response to a topic of their interest that is generated by climate change events. The objective of this site-less assignment is to tap into a student's self-interest and personal history and reveal a studio fabric of individual perceptions about climate change through a shared creative medium. The students spend the following eight weeks developing a Center for Climate Change, with two weeks in site, typology, and climate change discourse, three weeks generating conceptual leads, and five weeks developing the Schematic Design.

Students arrive in the studio with different attitudes toward climate change issues. In a contextual learning approach the studio aims to recognize the third space, where the students bring their own experiences and imagination to bear in the interpretation of the artwork (Stevenson, 2005). The studio environment is an opportunity to leverage their individual histories and find places where collaborative discussion can reveal alternative concerns and perceptions. In *The Third Space Why Learning Matters* a student explains,

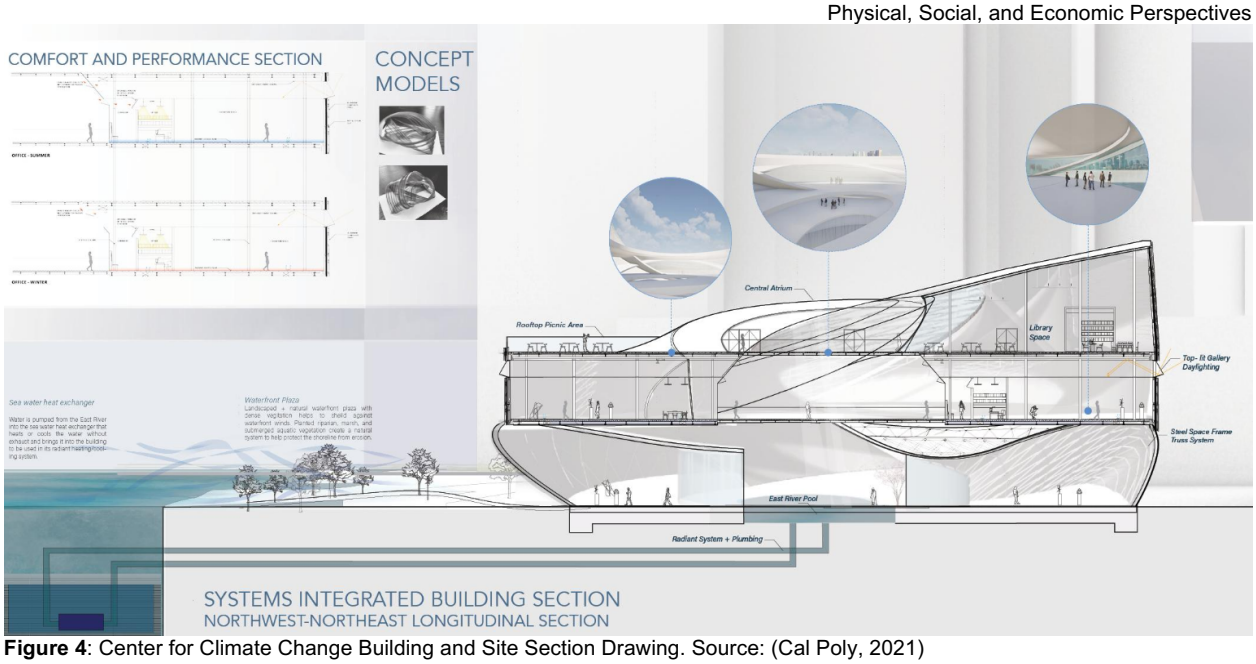

Figure 4: Center for Climate Change Building and Site Section Drawing. Source: (Cal Poly, 2021)

> "If you don't see things from different points of view it will be boring, just that's right and that's wrong. With art you can go around the subject. You can curve, make shapes; find new ways to enter it" (Stevenson, 2005).

The studio objective is to continually find new ways to "enter" the problems creating climate change.

Designing a "Center for Climate Change" places a tremendous responsibility on the architectural solution to be a forward-thinking model for sustainable design, and the project site has had a strong influence on the potency of the student's response. The studio takes a whole systems approach to the site, which asks students to consider their site not within a property line, but where water, energy, and probable materials are sourced. The AIA Framework for Design Excellence is unpacked to discuss how the project might serve two communities, local and global.

Given the museum typology, the studio discussions are tailored toward impactful building performance solutions and visitor provocation more than adaptation. Allowing the students to start design by story and aesthetics invites performance problems to emerge but also signals an imagination safe-zone in the project. An important pedagogic interference occurs in dedicating time to discussing how initial gestural interests for the project might affect social and performance values related to climate change. These challenges can prompt brainstorming of imaginative solutions for climate change mitigation where precedents offer only partial views. A pedagogical goal is to help students assign a currency to their ideas which can better inform decision making.

Digital models have come to dominate the design process, offering a gateway for integrated building performance simulation. We use simulation tools in our studio to estimate EUI and daylight distribution at first formal concept, however the effective application of the studies are limited by student's concurrent first-time introduction to active building systems and course time constraints. Simulation software has been slow to adopt in professional practice due to intermittent use, workflow shifts, and interdisciplinary training (Hirsig, 2010). These challenges are overcome in practice through collaborative architecture and engineering teams, and a model adaptable to the college studio is of future interest to this studio.

3.3. Student Projects

Students are eager to adopt strategies to mitigate climate change. Given the studio prompt it is not surprising to see projects including technical features like photovoltaics and geothermal aimed at net zero energy, or rainwater retention for re-use. The students recognize reducing embodied carbon through declaration of the structural system and building envelope materials, but typically in absence of quantitative study. Student ideas which reach beyond the engineering applications and explore sensory influences are encouraged as promising examples of deeper thinking about climate change and our place between buildings and the natural environment. The following projects exemplify a synergy between performance and experience to provoke sensory awareness of environmental conditions and comfort among visitors. In a 2017 project the student accelerated the experience of sea level rise by locating a portion of the project entry in the tidal zone, providing previously unavailable "shoreline" to a bay fill bluff. In a 2018 project the piezoelectric hairs adopt an anthropomorphic presence. In a 2020 project [fig. 5] the student wrestles with the requirement for a civic institution to provide energy consuming conditioned space by programming mid-doors spaces. In a 2021 project [fig. 4] the turbid water of the East River mixes with harvested stormwater to reimagine the community-centered water play space that couples for building thermal exchange.

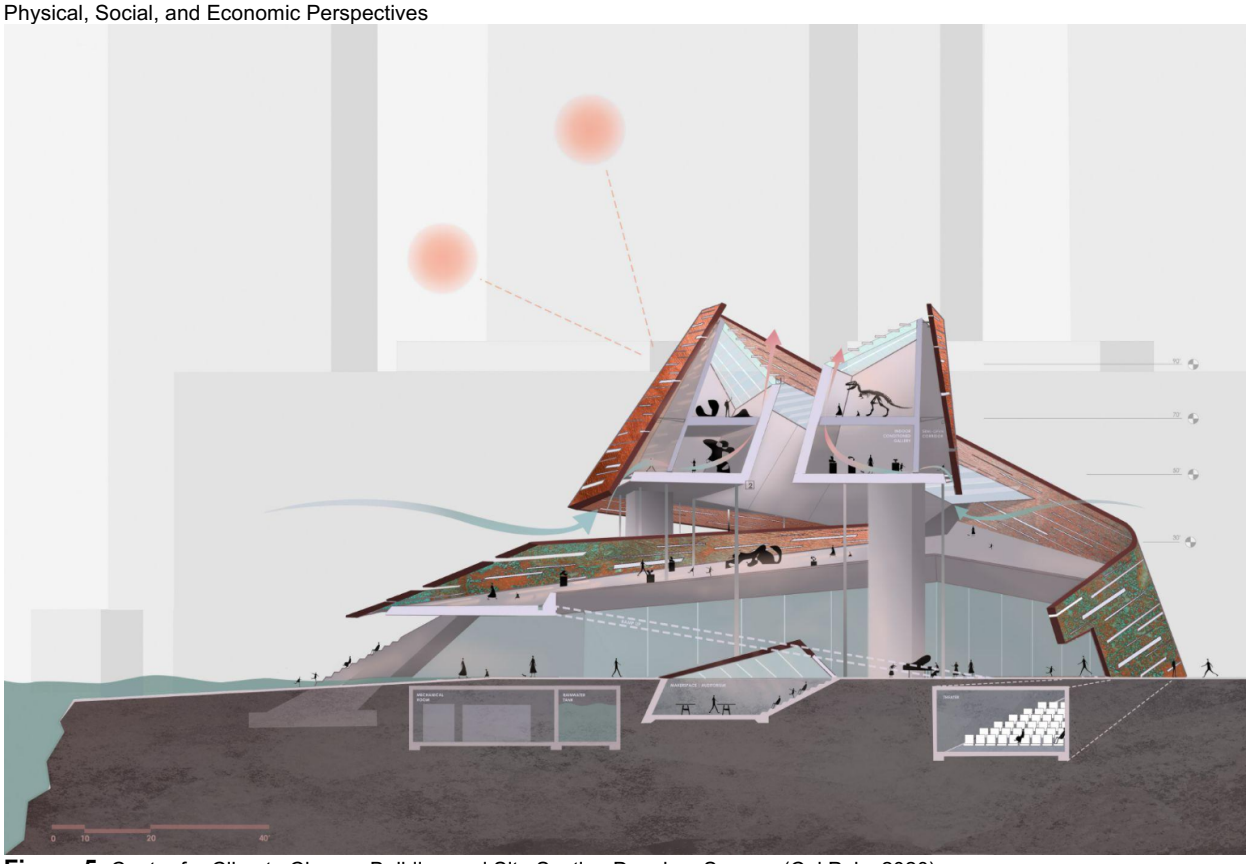

Figure 5: Center for Climate Change Building and Site Section Drawing. Source: (Cal Poly, 2020)

3.4. Studio Reflection

While student interest in mitigating climate change is personal, resolving climate change is a community concern. The college design studio environment provides the platform of community, reinforcing a collective interest and benefit. The intercollegiate studio discussions actively broaden the definition of community to the scale of climate change. Climate change conscious decisions may appear at different magnitudes for different individuals and recognizing and celebrating these moments is important encouragement. Drawing upon student's personal experiences has proven successful to igniting interest in design for climate change, while allowing agency has produced the most memorable concepts.

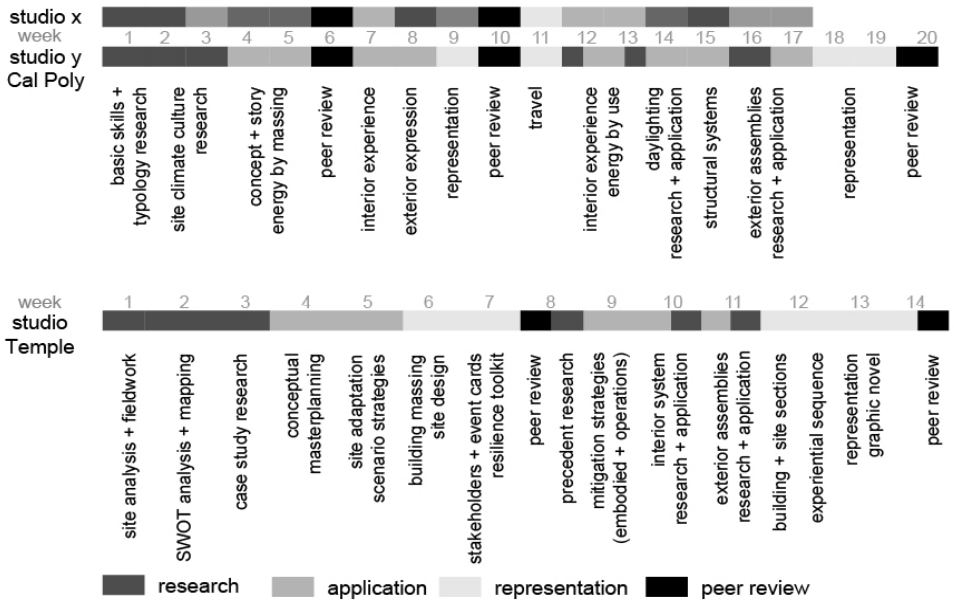

Figure 6: Studio Sequence Graph. Source: (Gabriel Kaprielian + Alex Hirsig, 2021)

CONCLUSION

The increasing urgency of the climate crisis is a call to architects to strive for further innovation and application of climate change mitigation and adaptation strategies. It is essential that curriculum foreground climate change in architectural pedagogy to prepare students to be the future leaders in the profession. The new NAAB Program Criteria requirements offer an opportunity for schools to define new sustainability and resilience focused curricular goals. While organizations such as Architecture 2030 and Architects Climate Action Network currently provide tools and resources for administrators and instructors. The climate change studios by Temple University and Cal Poly offer precedents for successful course structure and instructional methodology, while also offering insight on the benefits of leveraging intercollegiate studio coordination to share resources, amplify student engagement, and grow an academic community. To address the pressing challenges in the built environment, our best hope is for architecture schools to further develop platforms for collaboration, knowledge sharing, and interdisciplinary thinking that respond to the climate crisis.

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