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CLOSED-LOOP DESIGN DIALECTS

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"Amid the clamor of modernity's ceaseless march, there exists a lamentable loss, one not often heard but profoundly felt - the gradual fading of the architectural narratives that once wove the tapestry of humanity's existence."

– Dionysopoulou 2017

This essay focuses on such narratives- looking at the cycle of buildings and the environment as a closed loop system- and the integration of closed-loop design pedagogies in the architecture curriculum at a Historically Black College University (HBCU). We hypothesize that this shift in concept development introduces the students to architecture thinking as "A System" and material banks and plays a role in implementing this concept in students' projects.

As digital design tools are becoming more prevalent, the question is whether environmental tools could shape conceptual conversations (dialects) and lost narratives across the curriculum. This qualitative research explored student project outcomes in ARC Design 4, Design 5, and Design 7, applying observation and analysis methods. We then investigated the impacts of discussions on circularity in beginning design and energy resourcing in the upper-level as concept tools on student narratives.

Critical Pedagogy by Pelsmakers on designing for climate emergency discusses methods to incorporate environmental features through implementing circularity in architecture education. In this work, beginning design is seen as the foundation to introduce the students to the rationale of environmental tools. For instance, the students learn and research subjects of circularity, healthy materials, and energy in buildings as conceptual tools. As part of this curricular shift, the upper-level students get introduced to adaptive reuse and energy modeling to assess their early design decisions. One of the innovations in this pedagogical approach is implementing design at different mass and enclosure scales concerning climate requirements.

Student learning outcomes represented climate-conscious discussions and designs based on shifts in architectural concepts. This contribution illustrated the significance of a climate-based curriculum through shifting concepts inspired by environmental remediation in an era of energy crisis.

Keywords: *Closed-loop Systems. Circularity. Pedagogy. Environmental dialects. Tools.*

INTRODUCTION

Closed-loop design and pedagogies could imply a systems thinking, where environmental measures are valued in terms of the life cycle of a building.

Historical observations trace climate change and architectural discourse through vernacular and passive design. A design that provides shading in a hot climate versus a compact building in a cold environment illustrates such examples. However, rapid industrialization enhances the need for the profession to adapt to new climate change disruptors. One of the climate-conscious solutions in architecture is achieved through Circularity by focusing on buildings as material banks. Other methods strategize material resourcing and assembly techniques. Similarly, Pelsmakers enumerates transformability and design for disassembly as strategies for climate emergencies (Pelsmakers et al. 2022).

This study reviews practical climate solutions to address the emergence of circularity and their pedagogical integration into the architecture design curriculum. Passive design and circularity are examples of climate change disruptors, which open up conversations on material resourcing, Resource scarcities inspire designers to implement materiality as the deriving concept. Within this context, this paper focuses on inspirations in materiality and assembly methods as examples of a closed-loop system.

Heisel, in the book Circularity, discusses Adaptive Reuse and Design for Disassembly as climate change solutions (Heisel et al. 2020). Adaptive reuse introduces adaptability in building designs that exceed existing infrastructure capacity. The existing literature on circularity addresses the concept of buildings as material banks to mitigate the impacts of climate change through the lens of materiality. On the other hand, studies on inspiration from nature mainly focus on biomimicry as form-finding or bio-based materials. The interconnections to address climate urgencies through nature as a closed-loop (circular) system are worth exploring.

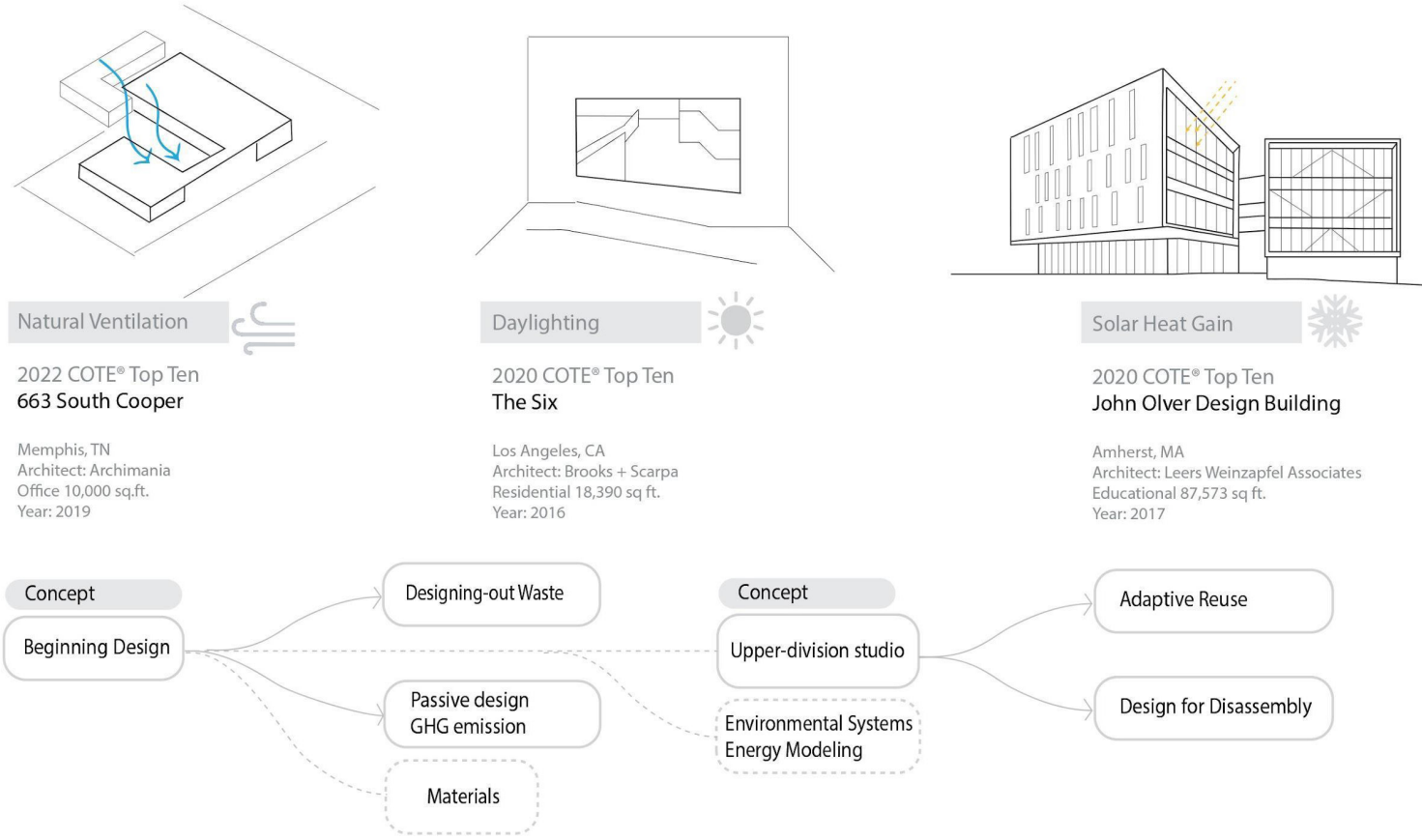
CLOSED-LOOP PEDAGOGIES AND FINDINGS

Literature on closed-loop pedagogies addresses the integration of climate-aware and circular design pedagogies. Cornell University has a distinguished lab, called the Circular Construction Lab, which focuses on introducing the students to the circular economy, Building for ReUse, and Cycles of materials (Cornell University). General challenges in integrating climate-based design thinking into a curriculum include finding a sequence and step-by-step approach to build on different skills. Achieving this cohesive educational goal could be challenging depending on the size of the school and the diversity of faculty's expertise.

From passive design strategies to student design guides for climate emergencies, they all account for different ways of defining a curriculum that responds to climate change. Hausladen, in ClimateSkin (Hausladenand Kaufmann 2008) and Barber (Barber 2020) enumerate building skin concepts such as solar screening and facade typologies and technologies. In addition to passive design strategies, Pelsmakers' guide (2022) addresses contemporary challenges by introducing, developing, and communicating climate design strategies. These strategies include global responsibility, infrastructure, environment, passive resilience, energy and carbon, materials, health, people, and performance (Pelsmaker et al. 2022, 107). This architecture student guide sheds light on integrating principles of circularity in the context of design studios.

Pedagogical methods of embedding climate emergencies are broad. However, the goal is to design a step-by-step approach to build on different climate design skills. This article applies the following two strategies as a design system in an academic setting:

- Material dialects: Beginning Design
- Assembly dialects: Upper Level



The sophomore students learn about materiality and build on it by being introduced to carbon emissions and ways to reduce them in the beginning design. Understanding energy and carbon emission sources such as building operations, material production, and demolition clarifies and connects design decisions for students. For instance, discussions on design for durability and learning about a project's supply chain of materials significantly shape students' priorities at the early stages of design. Shifts to embed concepts tied to material resourcing and manufacturing profoundly influence architecture pedagogy. Figure 1 summarizes the pedagogical map of the progression of the closed-loop pedagogy addressing climate urgencies in the architecture curriculum hypothesized in this study. This curricular shift suggests implementing discussions on materiality as a conceptualization tool in Beginning Design, followed by building assessment and disassembly techniques in the upper-level studios. This curricular shift is not specific to our HBCU, but it is a progression of embedding environmental tactics through a systems thinking in the architecture studio setting.

Figure 1. Climate Urgencies and Pedagogical Implementations Map. Illustration by Author

This section inquires about the curriculum toward climate emergencies, the shift in conceptualizations, and the thinking from form-based to assembly-based approaches. In this observation, a beginning design studio integrates materiality with the design discourse, whereas an upper-level studio introduces students to concepts of reuse and disassembly. The students at an HBCU respond with awareness toward finding solutions and concepts for climate emergencies, carbon emissions, and the building's life cycle.

MATERIAL DIALECTS

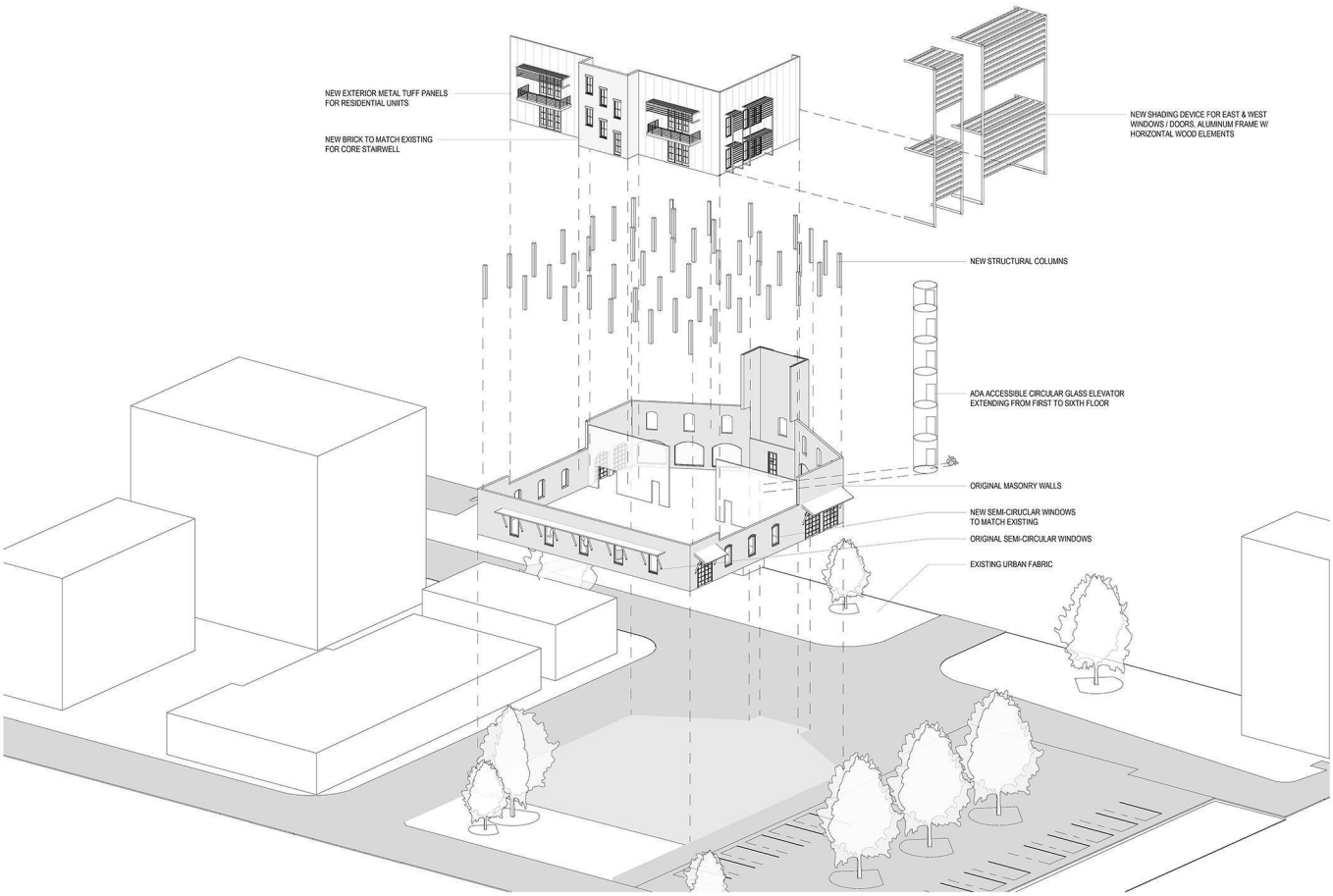
"In nature, materials are expensive and shape is cheap." Professor Julian Vincent (Pawlyn 2016)

Materials have instituted architectural movements and forms throughout history, from historical sites to modern concrete, steel, and glass buildings. The viewpoint toward materials in this article centers on how materials, as systems and tools, shape the design. Is there a relationship between the growth cycle of materials and a climate-responsive design? Natural organisms are one of the most resilient resources that withstand climate change impacts. For instance, Daisugi is a Japanese regenerative technique that provides wood by pruning trees instead of cutting, which implies a sustainable solution for using timber in construction (Wall 2022). This example illustrates how regenerative harvesting of resources could disrupt the negative impacts of climate change. This suggests a shift in our design pedagogies by observing how nature, as a closed-loop system, employs materials and regenerates them.

One of the objectives of this pedagogical experiment is to rethink the concept development process in architecture. For instance, in teaching climate-responsive design, the beginning design class is introduced to nature as a source of response to climate change. This introduction connects the students to the sense of materiality in buildings and re-wilding as a responsible method of disassembly. This work experiments with embedding designing-out waste as a driving concept in the sophomore studio, where students work on a climate-responsive project. Figure 2 represents student work on an urban infill model in Savannah, GA, using timber as the structure and enclosure design. Students explored local timber and healthy material resources, where materiality was used as the leading tool in this beginning design studio.

The observation of discussions and student work points out that teaching architecture concepts based on climate urgencies plays a crucial role in decisions made at the early stages of design.

Figure 2. Climate-Responsive Project Beginning Design Studio 2023-2024. Photos by Students: Lauren Stewart and Darien Lawrence

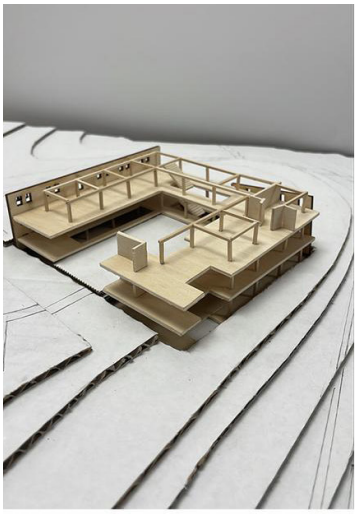


ASSEMBLY DIALECTS

This work experiments with redefining architectural concepts as adaptive reuse in the third year and disassembly in fourth-year studios in 2022-23. Students research adaptive reuse and assembly techniques to design structures near a retrofitted building. Students then review Urban Mining case studies (Rosen and Matzken 2022) and reflect on the value of integrating buildings as closed-loop systems. This third-year studio aims to build on students' research on materiality and consider regenerative resourcing of building materials. To investigate this initiative further, students designed their project to expand an existing structure (Figure 3). This studio provides them with the opportunity to create an urban space in addition to learning about adaptive reuse and the use of structural timber.

For instance, students in this studio explore the meaning of material banks, case studies, and expansion projects. Additionally, building upon this research, students search for local timber resources to promote resiliency and health. Discussions on physical model-making techniques to represent assembly

Figure 3. Adaptive Reuse Project Upper-level studio. Illustration by Donna Kronenberger

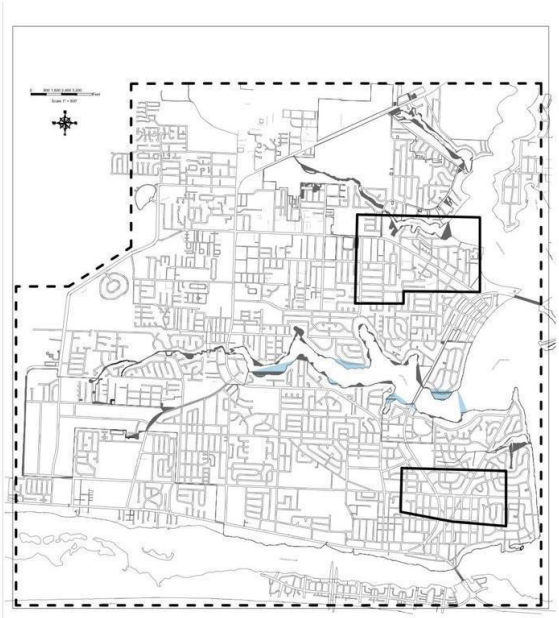


methods as a tool result in profound learning outcomes. The outcomes indicate that diversifying concepts based on climate urgencies and environmental responsibilities defines the paradigm shift needed throughout the curriculum. Figure 4 illustrates student work in ARC Design 5 in Fall 2024, where they were introduced to exploring timber assembly through prototyping as a means of ideation skills. Student learning outcomes indicate an enhancement in the perception of applying methods of assembly towards a closed-loop design dialect. In the proposed sequence of studios, the dialects revolve around the intersection of "soft" prototyping methods in the beginning design studios and the "hard" production tools.

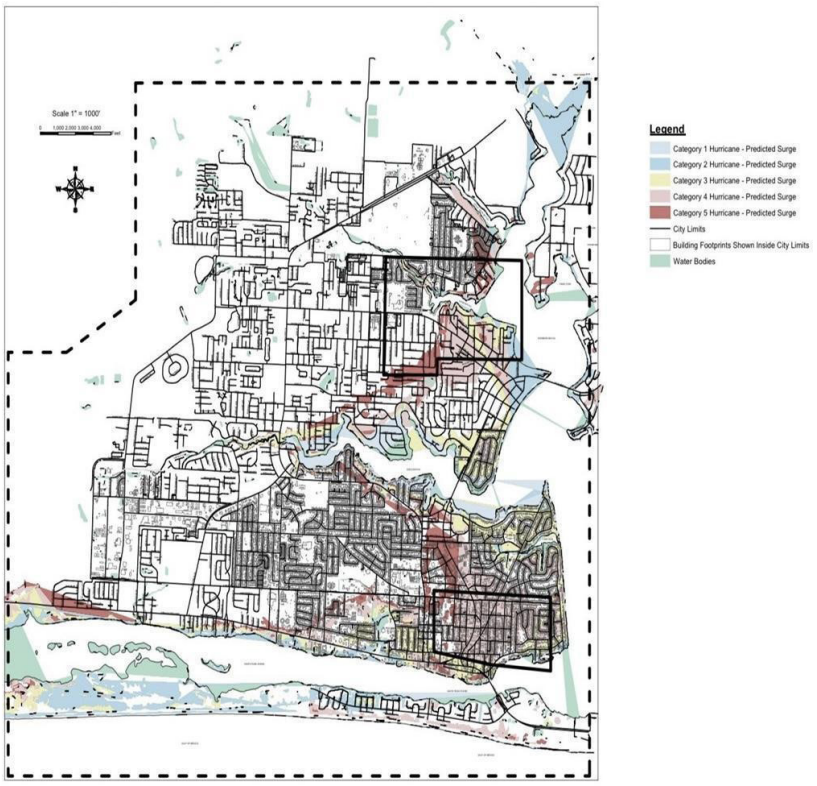
Tools of the trade shape architectural making and pedagogies. Modular thinking and prefabrication drive the means of moving towards a circular economy, signifying that assembly tools and algorithmic thinking should be interwoven within the architecture curriculum.

Figure 4 (Top). ARC Design 5 Fall 2024. Photos by Joel Cuba, Gustavo Estala, & Sidnie Kikta

Figure 5 (Part a) (Bottom). Energy Modeling Comparison of Design Iterations Upper-level studio Fall 2023. Illustration by Kanako Ishikawa



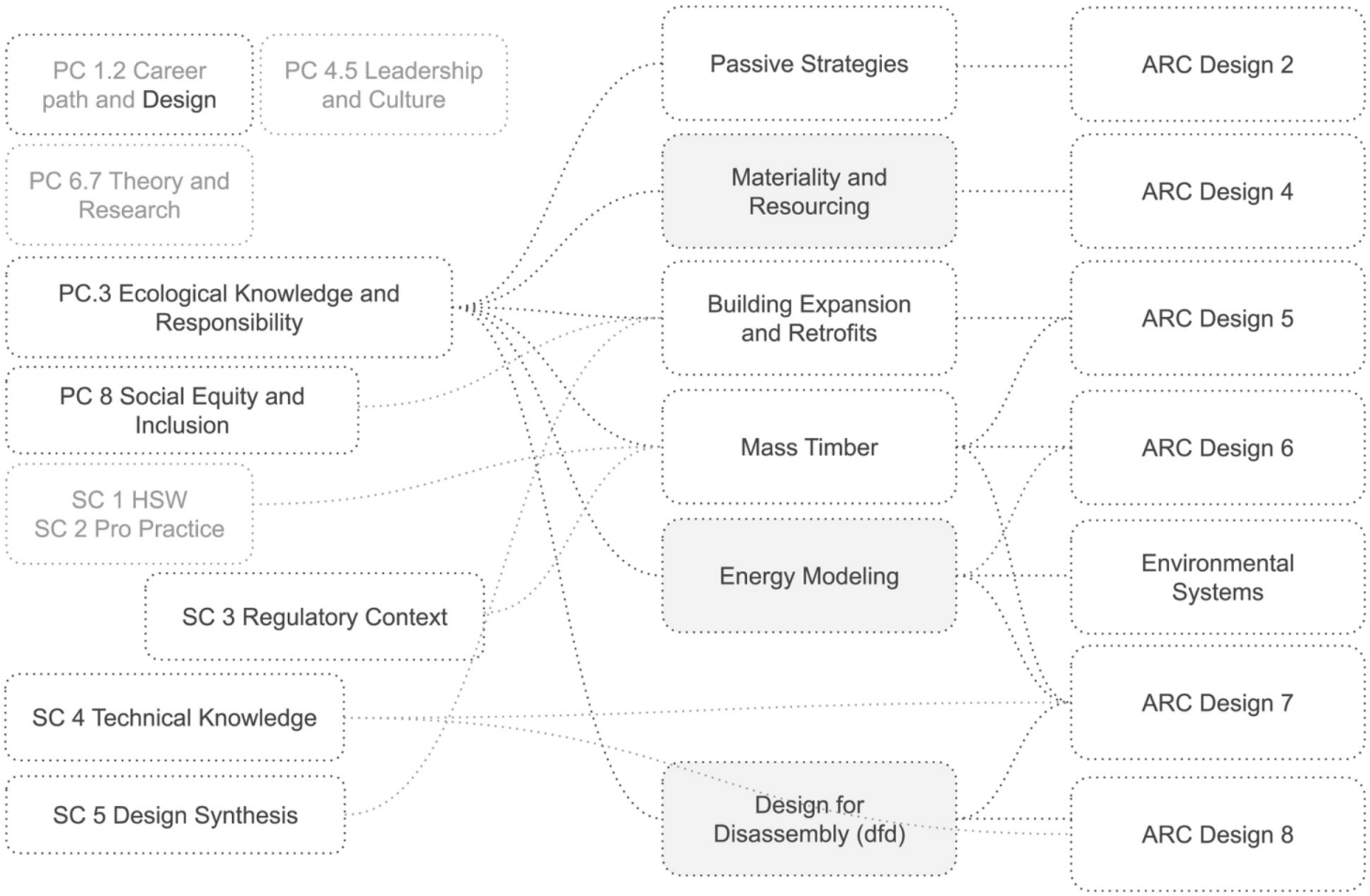
Fort Walton beach storm surge and demographics



To complete this paradigm shift across the curriculum, ARC Design 7 explored using an energy modeling technique as a design tool in Fall 2023. Figure 5 illustrates senior students' concept development using building performance assessment (Cove tool) at the early massing stage in ARC Design 7. Students in this studio examined disassembly and building performance assessment as driving factors to shape their concepts. Students employed their energy comparison at the macro scale of massing, then used disassembled detailing to approach their project at the micro-scale. The example shown in Figure 5 part a provides Cove energy modeling and a modular proposal for vertical agriculture towards a circular architecture. The observation of students' presentations indicates a shift in their design approach based on the understanding of buildings as closed-loop systems.

Additionally, elective courses play a significant role in leading the supporting materials for design thinking. For instance, we offered a Sea-level Rise elective in 2022 to embed designs for vulnerable coastal areas. This elective explored different methods and scales of mitigation, from urban planning for bioswales to elevated structures. The student work in Figure 4 part b represents an analysis of flooding and potential mitigation possibilities in Fort Walton Beach, FL. This article is an attempt to bridge the gap between climate-aware conceptualization in the studios and electives by having dialects on the design assembly and energy modeling.

Figure 5 (Part b). Sea-level rise speculations Upper-level 2022. Illustration by Bani Nazirova



CONCLUDING REMARKS

This paper demonstrated how the view toward materiality and circularity assists in forming a holistic framework for climate change solutions. This work reviewed closed-loop design inspirations and applied them in a pedagogical setting at an HBCU. This study introduced nature beyond form, exploring it as a circular system based on materiality and disassembly as pedagogical tools. We provided an overview of pedagogies involved in climate urgencies and redefined concepts about materiality and disassembly in beginning design and upper-level studios, respectively. The literature review and the pedagogical observations in this article demonstrated trajectories in addressing concepts based on materiality, reuse, and disassembly. Pedagogical observations indicated student success and awareness in implementing a circular design at different levels, from beginning to upper-level studios. The student work emphasized the significance of integrating design dialects as a closed-loop systems thinking in the architecture curriculum. To respond to the emergence of enhanced climate issues, it is necessary to shift our concept tools, particularly in the beginning design, to adjust for the integration of climate solutions as our design dialects.

Figure 6. Integration of the ecological knowledge curriculum map. Illustration by Author

This work unraveled examples of the emergence of climatic methods as an integral part of the design studios at an HBCU. The significance of this work was in transitioning to environment-focused concept developments, resulting in an enhanced awareness of climate resiliency in our minority communities. The result of student narratives demonstrated a shift toward more contextual and resilient design thinking, with an enhanced awareness of the applications of different tools. Figure 6 illustrates a summary of proposed methods to embed ecological knowledge through the architecture core design curriculum. Ecological Knowledge is one of the interconnected Program Criteria (PC) of the National Architectural Accrediting Board (NAAB), in addition to the Student Criteria (SC). This diagram proposes how to meet different aspects of circularity through a connected curriculum, as discussed in this article. The next question is how emerging technologies could respond to optimized methods of design assembly and how our pedagogical dialects could implement them.

LIMITATIONS OF THE APPROACH

This work was limited in testing this curricular shift in the studios based on a faculty's approach in a small-size school of architecture; however, a cross-communication between different faculty could result in more collaborative work. The curricular map described in Figure 6 could be used as a proposed step-by-step method to integrate ecological knowledge within the context of our design studios.

CONFLICT OF INTEREST

The author(s) declare no conflict of interest and all the students were informed with consent.

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