Teaching Timber Across the Curriculum: A Two-Studio Sequence on Mass Timber

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Contemporary discourse around mass timber tends to focus on the material's ecological, formal, or technical significance and not on the unique role the material might play within an academic design studio. As mass timber continues to gain prominence within the built environment and within academic design studios, educators must develop a critical understanding of mass timber that extends beyond its sustainability and that considers the material's role within design pedagogy and architectural education. This paper outlines a two-semester sequence of undergraduate design studios that attempts to do just that by introducing students to broader considerations of mass timber's extraction, production, transportation, installation, and cultural reception within the built environment. Over the course of two successive design studios, students were given the opportunity to explore the technical as well as the formal and aesthetic possibilities of mass timber elements. With each semester providing unique geographic and programmatic contexts for student investigation, the two-studio sequence allowed students to gain a diverse understanding of the constraints and subsequent design possibilities for mass timber design. Throughout both semesters, students collaborated directly with structural engineers and mass timber fabricators and installers to gain a detailed understanding of the technical constraints and structural limitations of various mass timber systems, including one-way post and beam systems, two-way post and plate systems, and full CLT bearing wall systems.

Ultimately, by participating in an extended studio sequence focused on the design and implementation of mass timber within the built environment, students developed the knowledge and skills necessary to operate with creativity and critical agency as they prepare to transition from an academic setting into professional practice. Exposing students to the regulatory, fabrication, transportation, and structural constraints of mass timber within a recursive learning environment empowered students to engage with these common constraints in informed and creative ways, extending their thinking beyond the passive reception of normative practices and toward broader, more critical interpretations of mass timber.

INTRODUCTION

In his review of Jennifer Bonner and Hanif Kara's *Blank: Speculations on CLT*, Edwin Heathcote describes a scenario that is likely all too familiar to many architecture faculty:

> When I began studying architecture in the 1980s, students would often get asked at crits what, exactly, those blank white or beige walls indicated on their drawings or models were intended to be made of. The answer, almost inevitably, was 'concrete.' Concrete was the wonder material, the realizer of dreams. The reliable, universal one-word answer. The staff would, inevitably, roll their eyes.[1]

Heathcote notes that this tendency to rely on concrete as the primary means to materialize abstract form has become not only uninspired in recent decades but also ethically problematic as the world has become more aware of the impending climate crisis. Yet, with the emergence of this broader ecological awareness and the desire to find alternatives to concrete construction within the design and building industries, another material has recently experienced a meteoric rise in popularity: mass timber. Heathcote describes mass timber as "the architect's dream material," noting that mass timber is "(relatively) sustainable, a renewable resource, prefabricated, digital in its milled manufacture, precise, warm, and able to elude the requirements for… endless layers of finish and insulation."[2] When combined with recent updates to the International Building Code (IBC) that permit mass timber to be utilized in the construction of taller and taller buildings, mass timber's warmth and sustainability has made it "the new wonder material of our eco-aware, guilt-burdened age; the world-saving, carbon-soaking, multifunctional stuff sent to salve our consciences in the creating of new buildings we know to be wrong, in attempting to make architecture at all."[3]

With so much potential, mass timber is becoming increasingly common in buildings throughout the United States, and it is also finding its way into the core of more and more academic design studios. Yet, despite this proliferation within professional and academic realms, few have theorized the significance of mass timber relative to architectural education and design studio pedagogy. Instead, much of contemporary discourse around the material tends to focus on mass timber's ecological, formal,

or technical significance and not on the unique role the material might play within an academic design studio. To return to Heathcote's earlier narrative, how does the emergence of mass timber within the design studio challenge how we teach and how we think about, analyze, and discuss the work of our students?

To create an environment in which mass timber can be "conceptualized beyond its sustainability"[4] and, instead, be considered for its unique pedagogical possibilities, we have developed a two-semester sequence of undergraduate design studios using mass timber as a central framework for student design investigations. The studio sequence occurs during the last two semesters of the undergraduate program and serves as a culmination of students' undergraduate education ahead of their entrance into professional practice or a graduate degree program in architecture. The studios allow students to engage with mass timber at multiple scales and across different project types, creating a recursive learning environment in which students conceptualize mass timber not as a static material to be applied to predetermined geometries, but as a dynamic material system that can be critically examined and carefully designed.

A PEDAGOGY OF AGENCY AND CONSTRAINT

Influenced by Stan Allen's conceptualization of architecture as a material practice, the pedagogical framework of the two-studio sequence encourages students to operate from a position of disciplinary poise, balanced between the technical and logistical considerations involved in the construction of a built artifact on the one hand and the aesthetic, cultural, and political performances of such artifacts on the other. Collaborations with industry experts and outside design professionals allows students to obtain an understanding of the constraints, common practices, and contingent realities of professional practice. Yet, when working within an iterative and collaborative studio environment, students are encouraged to leverage this knowledge of the "real" to extend their thinking beyond a passive reflection of the status quo and develop their own agency within the design discipline. Ultimately, this means equipping students with the knowledge and skills necessary to "engage the complexity of the real" while still fostering a critical curiosity that encourages students " to go beyond the simple reflection of the real as a given."[5]

Central to this ability to go beyond the real as a given is a specific conceptualization of creativity employed within the studio sequence. Adopting Bruner's definition of creativity as a form of "effective surprise," the studio encourages students to conceptualize the creative process as a fundamentally "combinatorial activity" that generates novel experience or new understanding through a reframing of existing conditions–"a placing of things in new perspectives."[6] This definition of creativity emphasizes the importance of close attention and privileges processes of reconsideration and reexamination. Instead of celebrating tired notions of the singular creative genius producing novel proposals through sheer imaginative projection, the studio pedagogy asks students to work in collaboration with others to develop alternate ways of thinking and building that are informed by but never fully dictated through existing realities. Processes of editing, of working critically in response to constraint become foregrounded. In short, the studio encourages a form of disciplinary curiosity that is perhaps best summarized by Michel Foucault's description of curiosity as "the care one takes for what exists and could exist; a readiness to find strange and singular what surrounds us; a certain relentlessness to break up our familiarities and to regard otherwise the same things."[7]

This curiosity is a valuable skill not only for those within the academic studio environment, but it is also an increasingly important skill for those entering professional practice. Through its engagement with mass timber, the two-studio sequence focuses student attention toward many of these challenging or contingent aspects of everyday practice and attempts to "mature a methodological foundation in our discipline that embraces the conditions of everyday practice and that enables us to act strongly within in."[8] In other words, the studio sequence uses mass timber as a means to expose students to a particular form of creative agency–i.e. one that necessitates intentional engagement with existing conditions, constraints, and contingencies encountered as part of any design process. By focusing studio investigations on the contingencies of mass timber design, fabrication, and construction; and by returning to these issues across a range of scales and multiple project types, the course sequence provides recursive learning opportunities that further reinforce the idea of operating with nimbleness and disciplinary agency. As part of this development, the studio sequence integrates students into a collaborative design process involving mass timber manufacturers, structural engineers, professional architects, and mass timber installers. This provides students the opportunity to refine their technical and creative capacities within an interdisciplinary design environment reminiscent of contemporary architectural practice and exposes them to the layered material and labor ecologies of mass timber production, fabrication, and installation.

FLAT-PACK FOLLIES

The mass timber studio sequence began in the fall semester with a collaborative design studio in which students from the school's architecture, landscape architecture, and interior design programs worked in interdisciplinary teams to design small pavilion and visitor center structures for a rural state park site. The first phase of the studio asked students to design an open-air pavilion using only cross-laminated timber (CLT) panels, or blanks. This initial project explored the specific formal and aesthetic qualities that might emerge through an intentional engagement with CLT and the constraints associated with the material's fabrication, detailing, and transportation. Most importantly, however, the project provided the opportunity to examine how the direct engagement with CLT as the sole building material might inform or even modify students' typical design processes and conceptualizations of creativity.

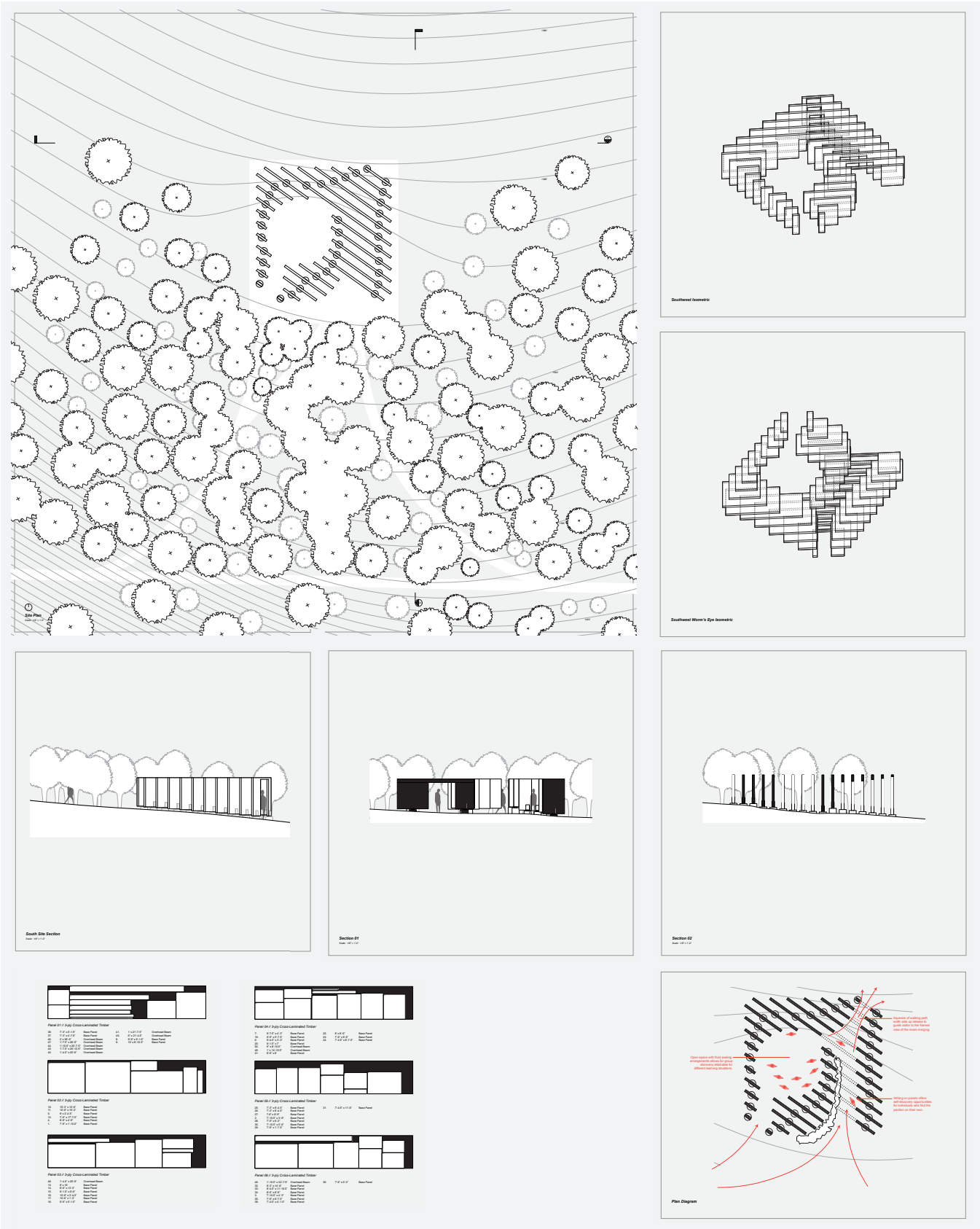

Figure 1. Pavilion concept consisting of a series of carefully cut and composed CLT blanks. When viewed from the exterior, the precise arrangement of the CLT blanks creates the appearance of an orthogonal mass, with a gathering place and a circulation route hidden within. Work by Philip Boyd and Michael Leiting.

Unlike other studios within the undergraduate curriculum in which students progress from abstract formal proposals to more specific tectonic and material proposals, the pavilion project began with the specific–i.e. with the material and dimensional characteristics of the CLT blank. Students began their design explorations by studying the features and characteristics of CLT blanks and then immediately transitioned into physical model making processes. Rather than developing an initial design proposal through digital modeling or two-dimensional orthographic drawing, students develop initial design proposals through the construction of quarter-inch-scale foam-core models, using their understanding of the structural and fabrication constraints of CLT to inform their design thinking.

This process began with each group being given four panels of foam-core and tasked with constructing their initial design proposals through basic processes of cutting and stacking. Because the site for the pavilions was located in a geographically remote area, the project brief dictated that no more than a single truckload of CLT material could be used in the design of each pavilion as a means to reduce the costs and emissions associated with transport. For the purpose of the studio, the maximum quantity of CLT was defined as four, five-ply CLT blanks measuring eleven feet in width, fifty-three feet in length, and approximately seven inches in thickness. The four panels of foam-core initially provided were a direct scaled representation of this initial material allotment of CLT, and it offered a tangible, consistent constraint from which students could then begin to explore more individualized design responses. Starting with a physical model forced students to confront the physical realities of the material and encouraged thoughtful consideration of CLT's dimensional characteristics, methods of production, and standard fabrication techniques. With each group challenged to create compelling spatial enclosures using the fewest amount of "cuts" possible, considerations of programmatic fit, spatial experience, and formal expression had to be balanced with considerations of material economy and fabrication efficiency.

In order to assist students with navigating the constraints and contingencies associated with CLT as a material, staff from a local mass timber fabrication and erection company were invited into the studio to discuss CLT's standard methods of production, current and emerging fabrication processes, and challenges faced during transportation and erection. This detailed presentation included software simulations of standard cutting or milling processes, as well as videos of CLT panel detailing that ultimately served as a sort of visual catalog of the tools and techniques available to each group as they began to develop their physical model proposals. This direct engagement with outside professionals clarified the means and methods available to modify the CLT blanks, and it allowed students to engage with the CLT in an informed yet critical manner.

Ultimately, in utilizing the CLT blank as the starting point, students' design processes became heavily focused on processes of subtraction or removal. The sheer scale of the original CLT blanks in this particular project necessitated the cutting, subdivision, and removal of material in order to create habitable space. This emphasis on subtraction shifted the student design process away from the more familiar territory of tectonics–e.g. stacking, joining, etc.–toward processes more typically associated with stereotomic materials. Defined as materials often involving "the act of removal, of creating through voids,"[9] it should be immediately evident how CLT can be understood as a stereotomic material. The removal of material and the creation of voids through standard processes of routing, profiling, and cutting represent the primary methods of engaging with CLT. In contrast to more additive approaches, the design process of the pavilion project can ultimately be understood as a process of editing–of careful reconsideration or recombination. By emphasizing a design process based on the careful editing of an initial set of CLT blanks, the project reinforced a conceptualization of creativity in line with Bruner's notion of creativity as a contingent, combinatorial activity. The project required close attention to the contingent characteristics of CLT and privileged processes of subtraction and creative recombination in order to realize novelty or "effective surprise."

Constrained to exploring the spatial and aesthetic potentials of a single material, students came to understand the CLT blank's simultaneous performance as "structural support, enclosure, and architecture."[10] Similar to Anne Beim's description of a tectonics of the ordinary, the project combined students' technical knowledge of a particular material with a rigorous design curiosity "to develop playful and inventive relations between aesthetics, material consciousness, and (construction) technique."[11] Considerations of ornamentation, shape, figure, or texture became intimately tied to questions of manufacturing and fabrication, with the orientation or "grain" of the CLT panels, the processes of CNC profiling or routing of edges or surfaces, and the expression of the CLT "plies" all playing a fundamental role in the development of specific design proposals within the studio.

Two of the resulting student designs can be seen in Figures 1 and 2. The first project employs the subdivision of the CLT blank as a driving factor of the design, utilizing simple orthogonal cuts as a way to create unique panels whose dimensions respond to the sloping topography of the site. By keeping the top edge of each cantilevered panel aligned, the overall form of the pavilion operates as an index, making the specific topographic features of the site more legible while simultaneously defining a series of programmatic voids within the interior of the pavilion's implied mass. Once again, the proposal exemplifies a sort of creative editing, with the basic processes of cutting and repetition forming the foundation of its proposal. Similarly, the second project focuses attention on a clear, repetitive subdivision of the original CLT blanks, methodically cutting each blank to produce a series of smaller wall panels that are subsequently arranged in a circular form. Through a systematic analysis of the CLT blank geometry, the student team explored how an otherwise orthogonal

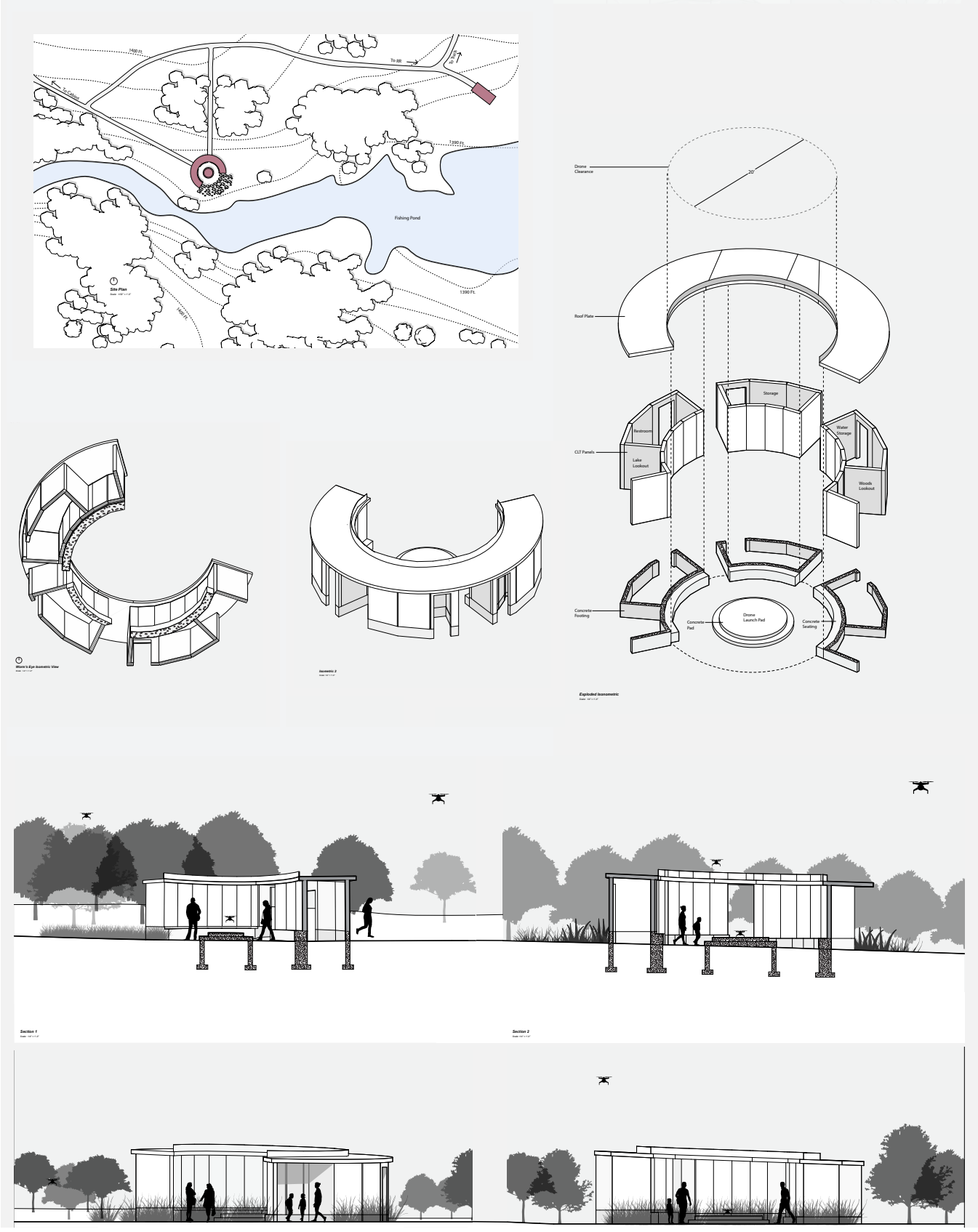

Figure 2. Pavilion concept consisting of a series of precisely subdivided CLT blanks that, when fully erected, create a strong circular form within the landscape. The design considers the relationship between the CLT blanks' orthogonal form and the curvalinear form of the overall mass. Work by Caleb Dreibelbis and Rachel Fuelberth.

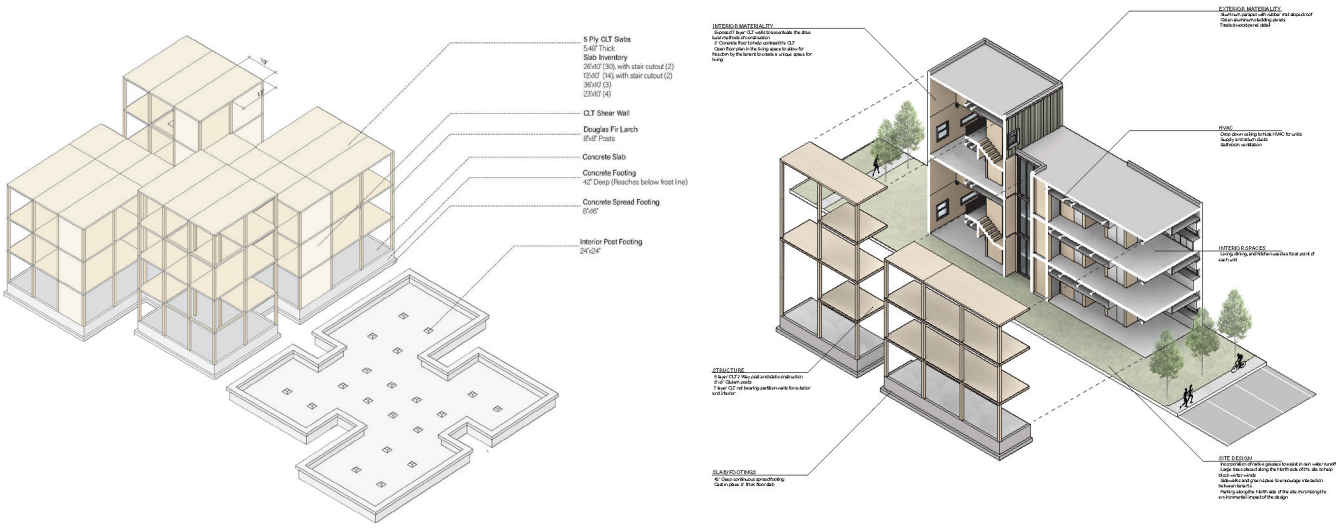

Figure 3. This design utilizes a two-way post-and-plate structural system (left) to create a unique iteration of a three-story walkup apartment building. The modularity of the structural system allows for subtle variation in unit configuration that creates a distinct building massing (right). Work by Kade Jensen and Dylan Lambe.

material could be used to generate non-orthogonal or curvilinear form that can still be erected on site with relative ease.

Reflecting the project's interest in operating creatively within and through constraint, the final deliverables for the initial pavilion project consisted of a range of drawing types that illustrated the shared origins, yet subsequently diverse results of each project. Final drawings included fabrication "cut sheets" illustrating the size and shape of final CLT components relative to the initial extents of the CLT blanks, scaled orthographic drawings illustrating the spatial characteristics of the final proposals, and high-resolution renderings that attempted to capture the experiential qualities of each pavilion. Whether through an emphasis on the processes of editing and recombination or the illustration of shared constraints within the final representation, the project ultimately allowed students to conceptualize the CLT blank as more than a neutral structural element and to demonstrate ways of leveraging the material's contingencies to create unique, creative solutions.

LOW-RISE TIMBER

Functioning as a capstone studio for the college's architecture program, the second studio course of the mass timber sequence required students to demonstrate a comprehensive understanding of building design and systems integration, with the goal of synthesizing multiple project constraints into a cohesive design proposal. For this specific studio, students were tasked with designing three- to four-story low-rise housing projects on a two-acre infill site. Rather than the typical exploration of mass timber utilization within a vertical tower typology, students explored how the repetition of mass timber elements might be deployed horizontally across an urban site as a means to decrease construction time and reduce the overall project costs of missing middle housing typologies.

In contrast to the subtractive or stereotomic processes of the first semester, the second studio's exploration of mass timber emphasized processes of integration and synthesis. The original emphasis on subtraction and processes of editing through removal were replaced by a stronger focus on combinatorial processes described in Bruner's notion of creativity and "effective surprise." In contrast to the monolithic material character of the pavilion project, the second semester focused more intently on ideas of material hybridity and processes of learning or creating through close attention and juxtaposition.

At the heart of this approach was again a desire to focus student attention toward the specific within architecture, to "slow down, to study, to compare…to take apart architecture and look for specificities, to construct narratives, to perform analysis, to be attentive in our attention."[12] Echoing the sentiments of Michael Meredith, the second studio in the sequence emphasized the importance of everything being placed "in comparison…in everything being in conversation. You put things next to each other, then you look at them and try to find similarities and differences."[13] This approach allowed students to conceptualize multiple responses to a single issue and to avoid a sort of reductive positivism in which the studio might focus on developing a singular, optimized answer to a particular problem. Instead, students developed a range of responses and, through the collective act of looking or close reading, developed a sense for the nimbleness required to operate effectively within the highly-constrained or highly-contingent design environment so often found within professional practice.

Initially focused on the examination of low-rise housing typologies and the analysis of alternative housing models such as co-housing, micro-units, or supportive transition housing, student groups developed strategies for synthesizing the programmatic and spatial goals of their projects with the dimensional and material constraints of a mass timber structural system. Working in collaboration with outside professional architects with substantial experience in mass timber design and implementation, students examined the benefits and constraints of a variety of mass timber structural framing systems, including one-way beam systems, two-way post-and-plate systems, and full CLT bearing wall systems. In addition, students were tasked with developing clear strategies for the distribution and integration of all building systems, including mechanical ductwork, fire suppression piping, electrical conduit runs, plumbing supply and waste piping, and internal roof drain systems. With all of the groups taking a slightly different approach to their basic housing units and subsequent structural systems, the studio explored a range of different mass timber structural applications, allowing students to continually analyze and discuss the benefits and disadvantages of each.

One such response came from a student group who examined the unique potential of the post-and-plate structural system within a low-rise housing typology. Offering fast erection times, simplified systems coordination due to the elimination of horizontal beams, and reduced floor-to-floor heights, the two-way post-and-plate offers many advantages for the construction of a low-rise, walk-up housing typology. While limited by maximum span distances and material widths, the post-and-plate system nevertheless offers a clear framework within which formal variation and unique expression can still occur. Despite the seemingly constrained and monotonous character of this system, the students realized a well-integrated building proposal exhibiting compelling spatial, material, and formal characteristics (see Figures 3 and 4). Another student group examined the potential of a full-CLT structural system, using a platform framing approach to construct a building shell composed entirely of CLT panels. The proposal utilized a series of modularized panels to construct varying unit types across the project site. By synthesizing room sizing with the structural span limitations of five-ply CLT panels, the team developed a series of repeated CLT panel types that were configured to create townhouse, apartment, and co-living residential building forms (see Figure 5).

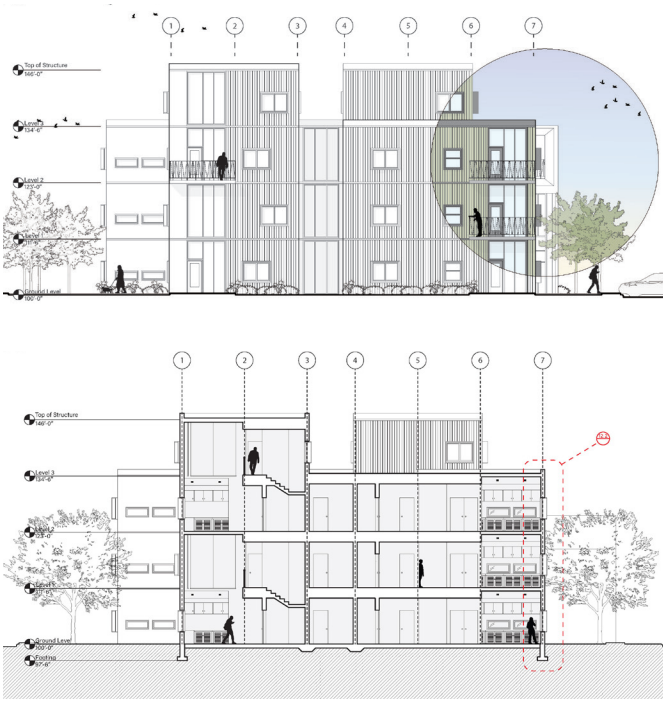

Figure 4. An exterior elevation (above, top) and section (above, bottom) of the post-and-plate apartment building concept. The project achieves formal variation utilizing a highly constrained and repetitive structural system. Work by Kade Jensen and Dylan Lambe.

In each case, the student groups again began with the analysis of the specific constraints associated with their respective mass timber elements and structural assemblies, including material thicknesses, span distances, and dimensional transportation or erection constraints. Unlike the first semester, however, students were required to synthesize these initial constraints with the programmatic requirements (room sizes), floor-to-floor heights, egress requirements, and fenestration patterns of a multi-family housing project. Shifting away from a pure stereotomic approach, this larger project relies on a mixture of both subtractive and additive processes and ultimately encourages a pursuit of novelty or creativity through combinatorial actions. The first project proposal combines an understanding of the post-and-plate structural system with insight regarding the internal egress requirements of walk-up apartments to create a final proposal that exhibits both formal and programmatic variation. The second project combines a careful analysis of programmatic room size requirements with an understanding of the dimensional limitations of CLT panels to create a modular system for creating unit variation across a single housing project.

While neither project presents a substantial, novel breakthrough, both projects articulate a position within the discipline that resonates with what Timothy Love describes as "a conscious decision to trade the radical but typically unrealizable position of the new avant-garde for the ability to effect real if incremental innovation within conventional culture."[14] Through a direct engagement with the contingencies of mass timber, building code, and building mechanical systems, the projects exhibit a creative exploration of the potentials of mass timber within the built environment that conceptualizes mass timber not as a static building material to simply be applied to a design, but a material that can serve as the primary site for design within a larger project.

CONCLUSION

Ultimately, the studio sequence's focus on mass timber proposes a conceptualization of the creative process not as a process consisting solely of abstract thought and intuition, but as one that

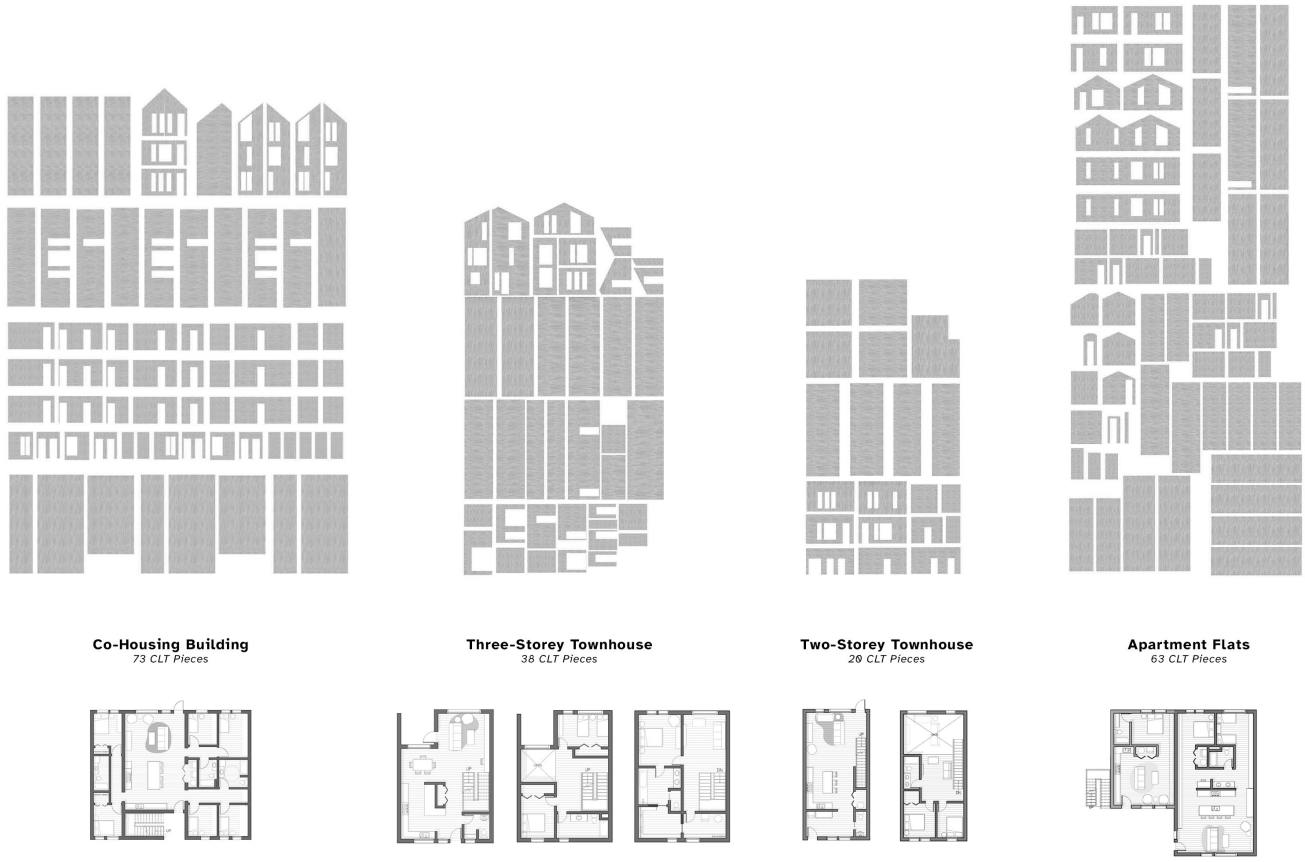

Figure 5. Relying on a consistent set of CLT panel dimensions, this design proposal produces a kit of parts that can be reconfigured to create four different housing unit typologies on a single site. Work by Luryn Hendrickson and Haley Herman.

also frequently requires direct engagement with constraints and the specific contingencies of material, fabrication, and transportation. Focusing on specific mass timber products and their respective material and dimensional constraints establishes a design process that begins with the specific and identifies the material as the primary site for design exploration and invention. Ultimately, this type of academic studio environment approximates many of the more highly-constrained aspects of professional practice, allowing students the opportunity to develop the skills necessary to operate with agency and creativity within these types of professional environments.

Yet, despite the success of some of the projects included here, a number of students within the studio sequence struggled to effectively engage with the specific material characteristics of mass timber in the ways we had hoped or anticipated. With much of the undergraduate curriculum structured around the development of design intention relative to abstract form and broader analysis of site and ecological context, the ability to respond creatively to the specific, detailed realities of CLT or other mass timber elements remained elusive for some students. In some cases, only through the final fabrication and assembly of a physical model for final presentation did students realize the gaps in their own understanding in regard to material thickness or the cutting and fitting of joints. In other instances, students developed abstract geometries separate from their material analysis and subsequently struggled to make mass timber "fit" into these predetermined forms. Moving forward, future iterations of the studio sequence will attempt to reinforce a conceptualization of creativity based on constraint but will also attempt to scaffold student learning more intentionally.

In the end, the studio sequence's focus on mass timber not only provides students the opportunity to engage in an extended, recursive examination of an increasingly familiar building material, but it also demonstrates how close analysis of a material can serve as a means to operate creatively within a constrained environment. The continuity provided across two semesters of learning allows students to slow down and pay attention to the specific characteristics of mass timber elements and, through direct collaboration with a variety of outside partners and professional collaborators, reconsider and test creative ways of implementing mass timber into their respective design proposals. The hope is that this experience will not only contribute to student success within their future careers but also ensure that students' conceptualizations of mass timber remain fluid, always open to further analysis, reconsideration, and exploration.

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