Constructing Experience: Exploring Design-Build Strategies Within a Technology Course

"Most designers - such as glass artists or furniture designers, not to mention architects - rarely make the objects they design themselves. Consequently, they need to understand the possibilities and limits of the materials and crafts, and communicate their ideas and intentions to the specialist craftsman, whose hands become the designer's surrogate hands in the execution of the work."[1]

CHAD SCHWARTZ

Southern Illinois University

INTRODUCTION

The pedagogy of Design-Build creates opportunities to diversify learning experiences through embodied processes of investigation. Engaging students in a dialogue between representation and built artifacts creates the opportunity to gain insight into the process of making, but also, as Pallasmaa suggests, into the successful communication of design ideas. Design-Build can be deployed in multiple ways in an architectural curriculum. The pedagogy has common goals: breaking free of the classroom, exploring through experiential learning, and imparting a well-rounded understanding of the practice of architecture. Yet the particular construct of Design-Build utilized can significantly impact course learning objectives and student outcomes. As with most curricular constructs, a primary challenge is configuring projects to optimize experiences with objectives.

For the past three years, Design-Build has been an integral part of the second year introductory building technology course at Southern Illinois University [SIU]. This course has experimented with two different styles of Design-Build. The first involved the building of residential wall sections in the courtyard of the School of Architecture [SOA]; the second was the Design-Build of an amphitheater for a university-based outdoor learning and event space. Both Design-Build strategies presented opportunities for student learning and engagement. However, a reflective analysis of the semesters' work reveals some inconsistencies between prescribed objectives and actual experiences . This paper constitutes an initial reflection on three years of building, focused specifically on the course objectives and outcomes. Initial findings suggest that, despite its popularity, community-based Design-Build may, in some situations, not be the best choice for delivering experiential building content in architectural coursework.

BUILDING TECHNOLOGY I

Building Technology I is a core course in the architecture and interior design programs at SIU. Taken in the spring semester, the course has (2) one-hour lectures and (2) two-hour lab sessions each week. The primary course content and exams are delivered in lecture. The lab provides construction document and Building Information Modeling [BIM] training; it is also the forum for the coordination of the course's projects. A faculty lead teaches both lecture and lab components, typically supported by one graduate teaching assistant [GA] (three were used during the 2014 Design-Build). The enrollment in Building Technology I varies with a high of 69 students in 2012 and a low of 43 students in 2014.

This paper will focus on the iterations of Building Technology I taught in 2012 and 2014; both classes took on the same set of three projects, allowing for better comparison. The first project involved the exploration of wood joints. The joints designed were inspired by connections found in everyday life (doorknob, necktie, bra strap, etc.). The second project was the Design-Build component and the subject of this paper. Finally, the third project centered on the generation of construction documents for a single family residence. These BIM manufactured drawing sets varied between (2) and (4) 24x36 sheets.

DESIGN-BUILD: WALL SECTION

In 2012, Design-Build pedagogy was introduced to Building Technology I. In this initial iteration, students (in groups of 6 or 7) were given a wall section drawing of a single-story residence built using wood light frame construction. The foundation system was replaced with a single course of concrete masonry units [cmu]. The section included a single window. The students were required to study this drawing and develop a strategy for building a 4'-0" long mock-up of this wall; the details, finishes, and unspecified components were the groups' responsibility to develop.

The working process for the project emphasized translation. Each group detailed the design of the wall, generated a parts list from their design, created a cost estimate from the parts list, and, finally, developed a storyboard detailing the construction sequencing and scheduling. After all submittals were approved by the faculty, the student groups built their wall sections at full scale in the courtyard of the architecture building. The build was accomplished in a single day, with demolition coming the following week. One of the nine constructions was built in the school's main gallery space for a longer display period that included the school's accreditation visit. After completion, each group was required to submit a photo narrative of the construction process. This same project was repeated in the spring of 2013.

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Figure 1: Courtyard build during construction, *photographs by R. Swenson*

DESIGN-BUILD: AMPHITHEATER

In 2014, a grant was awarded by SIU to do a Design-Build project at Touch of Nature [TON]. TON is a 3100 acre campus preserve. It serves a wide variety of campus and non-campus programs. Among its many events are summer camps, corporate retreats, and weddings. After a survey of the property, class efforts focused on the rebuilding of a hillside amphitheater. In addition to reaching TON's primary users, the project required no electrical, mechanical, or plumbing work; simplified engineering meant limited interaction with the campus unions. Also, since the amphitheater was not listed on SIU's building register (just an outdoor structure), the class was not required to formally submit for a lengthy campus building review.

The goal for the community based TON Design-Build was to adapt it to the rigorous working process established two years earlier. Based on the class construct, each lab section worked on one facet of the project: the stage, the primary seating area, or the threshold and path bench. The path bench was installed halfway up the hillside, serving as a rest point for visitors. The project had a total footprint of 1400 gsf.

After a site visit, students in each lab (in pairs) generated schematic designs for their facet of the project, working with the other labs to create cohesive design ideas. The class voted on the top schemes and presented them to our client, the TON staff, for review. After receiving a decision from TON, each lab was divided into four task groups for project development (3 to 4 students per group). The timeframe and project scope necessitated each group to focus on specific tasks: material list and cost analysis, storyboard and construction sequence, site analysis and construction documentation, and mockups and models. This process required significant coordination between groups and between lab sections. At the conclusion of design and documentation, the project moved to the site. Students were required to attend three build days and were rewarded with extra credit for attending additional days. At the conclusion of the project, each group was required to contribute to a summary document of the project's process.

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LEARNING OBJECTIVES

Building Technology I has a series of objectives, derived from multiple sources, that need to be met for it to succeed as a learning environment. The faculty of the SOA has developed a series of learning objectives for its building technology courses. As part of an accredited program in both architecture and interior design, the course has been assigned objectives from the National Architectural Accrediting Board [NAAB] and the Council for Interior Design Accreditation [CIDA]. And finally, the course faculty has integrated core learning objectives into Building Technology I which served as a foundation for its restructuring in 2012. Figure 3 displays these objectives. The figure indicates which objectives have been assigned to each course component and describes how well they are met for the Design-Build project. The remaining sections of this paper examine the relationship between these objectives and the Design-Build project.

PRIMARY COURSE OBJECTIVES

The primary course objectives are part of the course master syllabus and were created by the faculty as an outline of critical goals. There are three primary course objectives assigned to the Design-Build project. The first objective (#2 in Figure 3) is:

Figure 2: TON Design-Build during construction, *photographs by S. Jariwala*

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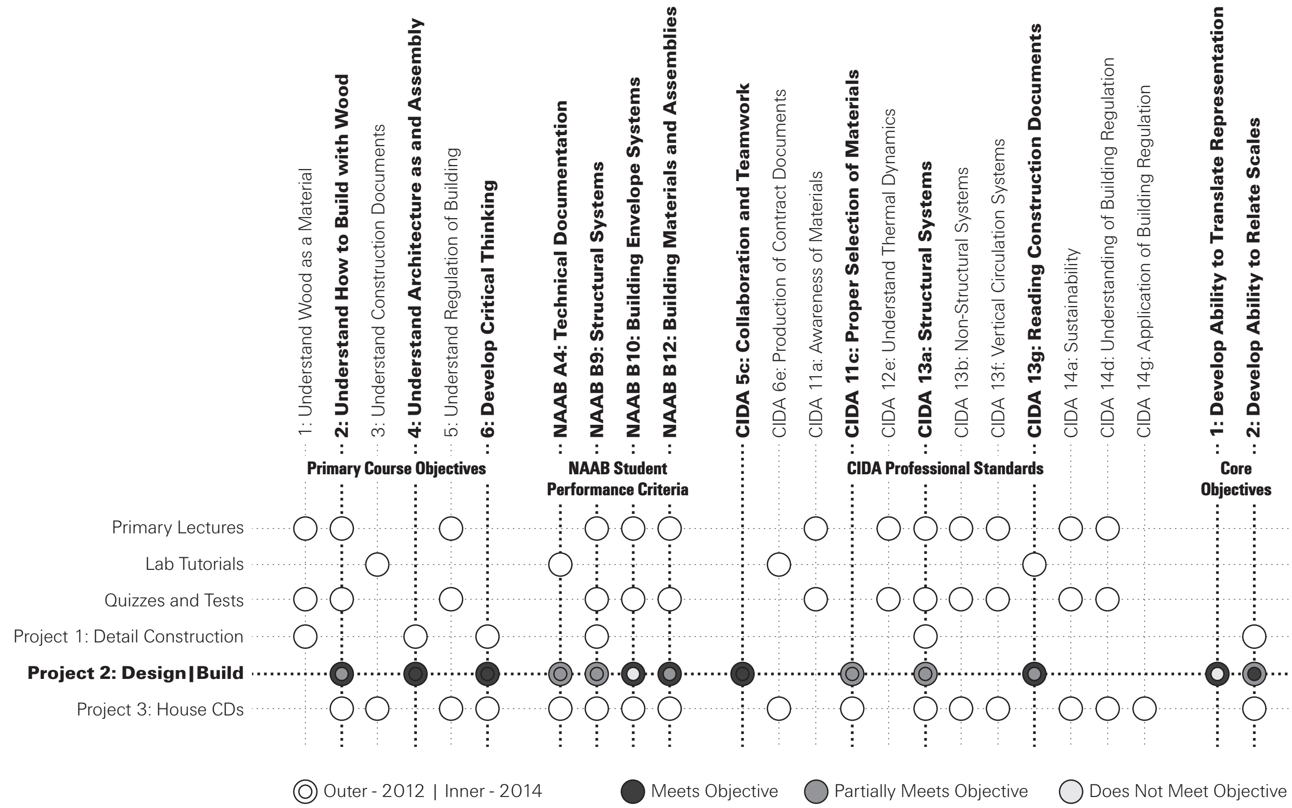

> Students should understand the principles, materials, means and methods, and sustainable design issues for wood light frame construction. Students should learn the basic tenants of the construction of a wood light frame building and learn the steps necessary to design and assemble it.

The courtyard build directly engages materials, means, and methods of construction. In this iteration, students studied accepted building practices for this typology and applied those lessons through full-scale construction. This build, in coordination with the lectures and project 3, satisfactorily addressed this objective for every student in the class.

Although the TON Design-Build engaged students with the study of construction systems, the construction typology was not traditional wood light frame; resultantly, the links to the lectures and project 3 were less substantial than in prior semesters. Due to the necessary division of labor, this objective was unequally met by the student participants. The amphitheater stage utilized wood light frame techniques and satisfied the objective well. The threshold and path bench used light wood frame materials, but in a decidedly a-typical way, partially fulfilling this objective. The amphitheater seating did not include any traditional wood light frame construction techniques, although wood was used significantly in other ways (seating, retaining conditions, etc.).

The second objective (#4) is:

> Students should understand the realities of architecture being an assembly of parts that are joined together. Students should understand the fundamentals of tectonic assembly, joining, and making.

Both Design-Build projects integrate this objective substantially. Through virtual

Figure 3: Building Technology I course objectives

studies and the direct manipulation of material, students learned what it means to assemble a small component of the built environment. In both iterations, the students sought out ways to transform materials from a raw state into an assembled, occupiable structure. Throughout the process, the students had to think through the attachment of each discrete element to the next. Both projects placed this objective at the forefront of this learning process.

The third objective attributed to Building Technology I (#6) states:

> Students should develop an ability to think critically about how and why we construct architecture in the ways we do.

Again, both projects fulfilled this objective. In both iterations the student groups thoroughly worked their way through the given problem. The translation to full-scale construction alleviated the ability to partially solve or ignore difficult components. Although information was provided in lecture and months were spent developing the skills and techniques necessary to design and build the structures, the students were required to engage the project beyond what was given and critically think through a solution that was not handed to them.

The TON Design-Build was significantly more complex than the courtyard build. This complexity pushed the investigation further from a direct translation of lecture and course material. It was necessary for the students to interpret the information provided and translate it into a new construction typology. Despite the potential for increasing critical thinking opportunities, many decisions were too complex for the students to make within the timeframe of the project. Many key decisions required significant input from the faculty or GAs and often were made too late to provide the opportunity for more than a few students to gain any insight from the process. In addition, the course's compartmentalization made sharing critical thinking opportunities between groups and lab sections difficult, creating unequal learning opportunities.

NAAB STUDENT PERFORMANCE CRITERIA

Four NAAB student performance criteria [SPC] have been assigned to Building Technology I. All four should be present in the Design-Build problem. SPC A4 states:

> [Students need the] ability to make technically clear drawings, write outline specifications, and prepare models illustrating and identifying the assembly of materials, systems, and components appropriate for a building design.[2]

The courtyard build did not involve technical drawings, but did include a detailed storyboard. The storyboard outlined the assembly, systems, and components of the construction in a step-by-step format. These documents were considered semi-technical and were presented in axonometric form. All group members helped create the storyboard drawing sets for their respective constructions. The storyboards were reviewed twice and redlined for resubmittal by the faculty to encourage iterative process development.

The TON Design-Build did include technical drawings. Approximately one quarter of the class participated in the creation of these documents. These students created working documents for the build as well as as-built drawings after the completion of 75% of the project. These drawings were substandard (compared to those generated in project 3) and were not iteratively reviewed and reworked due to the project's timeframe. The working drawings were used while building, but needed refinement on-site to remedy numerous errors and inaccuracies. Additionally, the critical layout drawings were generated by a small number of students with heavy faculty intervention, isolating key learning experiences from the class. Another quarter of the class produced a storyboard similar to that of the courtyard build. Again, though, the desired iterative process was absent due to timeframe issues. The remaining half of the class did not do technical documentation for the project.

SPC B9 covers structural systems; it states:

> [Students must gain an] understanding of the basic principles of structural behavior in withstanding gravity and lateral forces and the evolution, range, and appropriate application of contemporary structural systems.

The courtyard build did not explore the principles of structural behavior as the constructions were incomplete systems which could not stand without temporary supports. However, the students did learn about appropriate fabrication techniques for a wood light frame structural system; they studied and built all four primary structural elements: roof framing, exterior bearing walls, floor framing, and foundation walls. The proper connection of elements was stressed, including emphasis on creating structural stability. This hands-on experience paralleled the lessons learned in lecture.

The permanency of the TON Design-Build necessitated structural design of the amphitheater's primary systems: the gravity load on the stage, the lateral resistance of the earthwork, and the vertical cantilevers of the entry threshold and the path bench. This work was the result of collaboration between the faculty and several students and was absorbed by about 10% of the class. Again, the TON Design-Build provided the opportunity for positive learning experiences, but only for a limited number of students who were assigned this task or who were ambitious enough to engage the entire project.

SPC B10 states:

> [Students must develop an] understanding of the basic principles involved in the appropriate application of building envelope systems and associated assemblies relative to fundamental performance, aesthetics, moisture, transfer, durability, and energy and material resources.

The courtyard build covered this requirement well, engaging students in a careful study of the exterior wall, the roof, and the window. Each component of these systems was studied to determine the proper means of assembly. These lessons were evident in the build and the storyboard components of the project. The TON Design-Build, by its very nature, did not address building envelopes. Opportunity existed for this project to involve a traditional building instead of the amphitheater. However, as noted earlier, the approvals required to work on a campus building would have been unmanageable in a single semester of this course.

SPC B12 encompasses building materials and assemblies. It parallels objective #2 from the primary course objectives and the reflective analysis is nearly identical. Additional comments stem from B12's focus on material and system selection. In the courtyard build, the major systems were assigned, while the students primarily selected finishes. The TON Design-Build required the class to design and select all materials for the project based on environmental conditions, use, maintenance, build-ability, and cost. Once again, approximately one quarter of the class had the primary role of material selection and cost analysis. This group was informed by the other 75% of the class while working on their tasks.

CIDA PROFESSIONAL STANDARDS

Five of the professional standards assigned to this class for CIDA accreditation are covered by the Design-Build project. Standard 5c states:

> The interior design program [must include] learning experiences that engage students in collaboration, consensus building, leadership, and teamwork.

In both project iterations, it was the only component of the class that fulfilled this professional standard. Both projects provided opportunity for individuals to develop and exercise leadership skills. The courtyard build required an extensive amount of collaboration between the members of each group. The entire project was a team effort, with few exceptions.

The TON Design-Build required more complex collaboration. Each person was part of a collaborative task group. These task groups were responsible for communicating effectively with the other three groups in their lab to properly coordinate the project. Each lab section was also required to communicate with the others to ensure a resultant cohesive project. Although the potential for growth as communicators and collaborators in this iteration was greater, it was also easier for students to get lost in the chaos (or hide) and not collaborate at all.

Standard 11c involves materials and parallels NAAB SPC B12 quite closely; the reflective comments are similar with one exception. Both iterations of the Design-Build were decidedly architectural in nature. Traditional interior design decisions were minimal, but included the selecting of interior finishes in the courtyard build and the ergonomic design of seating for the TON Design-Build. In both cases, this standard was partially fulfilled.

Standard 13a covers structural systems and is nearly identical in requirements and in reflective analysis to NAAB SPC B9. Standard 13g states:

> Students [should be] able to read and interpret construction drawings and documents.

The courtyard Design-Build began with interpreting a construction document provided by an architect. This iteration focused on this standard, but with limited scope. The project did not have formal technical documentation to interpret during the build, relying on instruction-based storyboards instead. The TON Design-Build did involve technical documents in the build process. Many of these documents, however, proved difficult to interpret. This situation did prove useful as the drawings were marked up on the jobsite for errors and omissions. Regardless, the TON project only partially satisfied this CIDA standard.

CORE PEDAGOGY

In 2012, there were two issues that played a significant role in the redevelopment of this course's structure, projects, and projected learning outcomes. The first issue was translation - from virtual to real. Each student needs to realize that the lines they generate have meaning, inform their "surrogate hands," and, therefore, must be carefully considered. The courtyard build was designed to respond to this objective. It was the sole means of conveying this objective in Building Technology I through its rigorous series of translations.

With the shift to the Design-Build at TON, the intention was to deliver this same pedagogical stance to the students. This desire proved to be difficult to achieve. It became obvious that time was going to have a dramatic impact on many learning objectives. The necessary division of labor left the class without the primary experience of translation. Instead of working sequentially, groups worked on tasks concurrently. In theory, this construct should have provided a rich learning environment, but it was heavily reliant on constant and thorough communication. That level of connectedness occurred only sporadically, limiting the opportunity for realization through translation.

The other core pedagogical issue was that of scale. The course was designed to explore wood light frame construction at a variety of scales. The original project layout moved from the exploration of a single detail, to a sectional construction, to a complete building. Each project had its own complexity and linked to the others. The TON Design-Build had little connection to the single family residence of problem 3, but was more versed in relating to the joints designed in problem 1. The second iteration, however, was an exercise in scale itself, including the investigation of primary joints, sectional profiles, and complete project design. Unfortunately, once again, many students did not experience all of these; while the overall project conveyed the idea of scale well, the learning experience did not always do so for each individual student.

CONCLUSION

Community-based Design-Build is seductive. We are seduced by the idea of making with a purpose; we are excited by the imagery of well-established Design-Build programs. And we should be. The work is phenomenal; the result of strong leadership and vision, positive relationships, and hard-working students. However, students and faculty alike can be drawn in to believing that this work is the ONLY viable strategy for Design-Build. It is easy to pursue the image of Design-Build without considering the relationship to the established learning objectives. Although there are countless examples of perfectly situated community-based Design-Build work, it is pertinent to reflect on how rich and rigorous the process is for the entire body of student participants. The seduction of Design-Build is the finished work, but learning outcomes are based on process, not on product.

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This paper is not intended as a critique of the pedagogy of Design-Build. Instead, it is a reflection on the relationship between a course project and its assigned learning objectives.

The discussion outlined here constitutes a small sample of the reflective analysis on these two Design-Build opportunities offered to the second year students in the School of Architecture at SIU. In addition to this critique, there are a series of

Figure 4: 2012 Completed courtyard build, *photograph by author*

interrelated issues which must be illuminated to properly understand these endeavors. Thirteen of the twenty-four objectives assigned to the class are associated with this Design-Build problem. These objectives were allotted at the beginning of 2012, when this reconstructed version of Building Technology I was first offered. In some ways, this entire analysis is skewed because the change in the construct of the Design-Build project was not concurrent with a re-analysis of the learning objectives. In addition to a complete review of these objectives, many other influences need to be considered such as: the relationship to the other two projects and lecture materials, the statistical performance of the students, the time available to complete projects, the project scope in relationship to the number of students, the configuration and regulation of project sites, the overall workload of the course, the available funding sources for the work, the graduate assistants required, the lifespan of the constructions, the recyclability of the materials, and the ability of the project to activate the School of Architecture.

In Some Notes on the Phenomenology of Making, Robert Morris discusses George Kubler's examination of the Incan city of Machu Picchu:

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Figure 5: Completed TON Design-Build, *photographs by author*

> [Kubler] is startlingly alone among art historians in his claim that the significant meanings of this monument are to be sought in reconstructing the particular building activity - and not in a formal analysis of the architecture. I believe there are 'forms' to be found within the activity of making as much as within the end products. These are forms of behavior, aimed at testing the limits and possibilities involved in that particular interaction between one's actions and the materials of the environment.[3]

Both Design-Build projects in Building Technology I had very positive reviews from the student body, the faculty of the School of Architecture, and from other observers about the results of the students' efforts. The real critique, however, needs to focus on Morris' "forms" of working, thinking, and making that the students are developing throughout the journey. As they move on in their academic and professional careers, Design-Build has the potential to have a critical impact on the student's outlook on the profession of architecture and, in turn, on the future built environment. This impact will be felt due to the process they have endured, however, and not the seductive image of the built work.

ENDNOTES

1. Pallasmaa, Juhani. *The Thinking Hand: Existential and Embodied Wisdom in Architecture.* West Sussex, United Kingdom: John Wiley & Sons Ltd, 2009. 63.

2. All accrediting board criteria descriptions have been pulled from either the National Architectural Accrediting Board 2009 Conditions for Accreditation or the Council for Interior Design Accreditation Professional Standards 2014 documents.

3. Morris, Robert. "Some Notes on the Phenomenology of Making: The Search for the Motivated." In *The Craft Reader*, edited by Glenn Adamson, 540-47. New York, New York: Berg Publishers, 2010.