Defeat in Victory: Reflecting on the Value of Design/Build

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Working Out: Thinking While Building III | Learning from Failure

Course Outline and Background Philosophy

In the Fall of 2011, when I joined the faculty in the School of Architecture at Southern Illinois University, I was given the reins of the introductory building technology course and tasked with creating an effective learning environment. Taken in the spring semester, the course is a core offering in the architecture and interior design programs and centers on developing an understanding of wood construction. The student enrollment has varied significantly in the course, with anywhere from 35 to 70 students participating in a given year between 2012 and 2017. The primary course content is delivered through (2) one-hour lectures each week while (2) two-hour labs provide a forum for the application of lessons learned. To actualize the lessons, I created a set of three lab projects: a brief introductory exercise that varied from year to year, a primary individual project centered on the generation of a minimal set of construction documents, and a full-scale build exercise undertaken in groups.

Project Outline and Objectives

This paper focuses on the build project, the first full-scale making exercise ever undertaken in this course. One catalyst that prompted me to explore using this type of making in a building technology class came from a growing belief that traditional design/build courses do not engage enough of the student body. In a 2011 study of design/build programs, published just prior to the development of this course and certainly serving as an influence, Professor Geoff Gjertson found that less than 15% of responding programs required students to engage with the practice of design/build. These numbers, for me, identified a significant barrier to the development of design/build as a core architectural pedagogy. Gjertson's findings were not surprising given that 93% of the respondents utilize design/build pedagogy in a studio-based model.[1] A design/build studio is, typically, one of several offered in a semester and it ideally operates with a limited enrollment, giving only a percentage of the student population the opportunity to engage through this educational construct.

One technical course, however, has the ability to affect a much broader audience than a single studio. Construction activities in technology courses are certainly not new. Most, however, are more likely to be categorized as material or assembly studies than they are to be called design/build work. These activities are far less documented and celebrated than their community-based counterparts, but are in many ways just as effective as learning experiences for the students. It is here where my efforts to integrate full-scale making into my technology course began.

Courtyard Build

In the initial iteration of the project, groups of six to seven students were presented with a sectional drawing of a single-story residence to be built using wood light frame construction. The students were required to develop a strategy for building a 4'-0" wide mock-up of the wall; the details, finishes, and unspecified components were the groups' responsibility to develop.

The working process for the project emphasized translation. Fundamental to the practice of architecture is the translation of information into a physical product. Full-scale making provides a forum for students to explore the relationship between drawing and constructing and to begin to build a constructional consciousness that they can call on later in their careers when they must comprehensively understand a project during the design process. Within this type of exercise, lines and other virtual signifiers become real; they are hammered, screwed, sawn, and anchored in place; they are carried, lifted, and braced; they cause slivers and cuts and they tire out the participants. Through this process, students learn firsthand how to translate conceptual knowledge into a final built work.

In 2012, each group completed 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.

Hillside Build

While this project, utilized in 2012 and 2013, proved to be an excellent tool for conveying core concepts about wood construction and for helping the students to make connections between their drawings and built reality, it also had some concerns. Each semester concluded with the demolition of the structures, generating a significant amount of waste product. The demolition also brought up issues of permanence and discussions of how the student's efforts might become more productive long-term.

The result was a shift in the Spring of 2014 to design/build, financed by a grant from the University. After exploring several options, we partnered with a regional environmental education center, agreeing to re-design and build a frequently used, but dilapidated hillside amphitheater. In this shift from full-scale build to design/build, the rigorous working process established with the wall sections was adapted to the complexity of this community-based project.

In 2014, the course had approximately 50 students housed in three lab sections. Each lab was assigned to work on one facet of the project: the stage, the primary seating area, or the threshold, which totaled to about 1400 square feet. Initially, the students worked in pairs to generate schematic designs for their facet of the project, coordinating with students in the other labs to create cohesive design strategies. The class voted on the top schemes and presented them to the client for review. After receiving a decision, development began and each lab was divided into four task groups of three to four students: materials and cost analysis, storyboard and construction sequence, site analysis and construction documentation, and mockups and detailing. At the end of the development phase, the project moved to the site. Students were required to attend three build days followed by optional construction time spread out over the final month of the semester.

Statement of Failure

The Hillside Build was ultimately deemed a success by many of the parties involved. It was completed within budget and on time (if only barely in both cases); it was well-received by the client, who believes it is a substantial addition to both their physical property and their marketability as a venue; a large number of student participants have gone back to take pictures on the stage, demonstrating pride in the completed work; and the facility is used extensively and has been reviewed well by the guests who have used it for their events.

There are a number of reasons, however, why the project did not live up to expectations. The most critical, and the focus of this discussion, is the uneven quality of the learning experience for the student participants of this project, which contributes significantly to my classification of the project as a failure.

Factor for Failure | Communication[2]

There are four primary factors that contributed to the uneven learning experience in the Hillside Build. The first of those factors is communication. In 2012, the students building in the courtyard worked in small groups in which every member could reasonably communicate with the rest of his or her team. Students who were not performing well or not contributing to the overall success of the group could be quickly identified and group dynamic issues addressed swiftly. At two points during the semester, the students evaluated their teammates. The average grade at the project midpoint was an 86% with 55% of the students receiving above a 90% (Table 1). The average grade at the end of the project was a 93% with 77% in the 90s. Students receiving below a 70% dropped from 10% in the first evaluation to only 4% at the end of the semester. These statistics demonstrate two important points. First, the students were able to work out issues and, over time, were able to become more effective teammates. Second, they, in theory, became more engaged during the second half of the process when building.

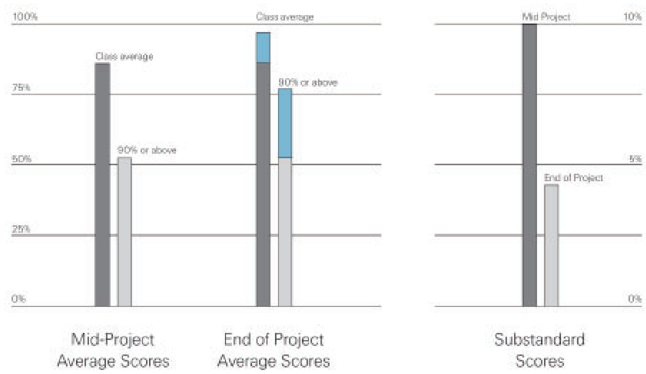

Table 1 | Student Evaluations from the Courtyard Build in Spring 2012

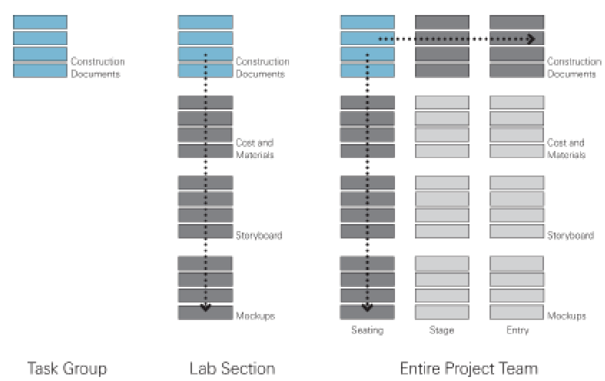

Table 2 | Student Evaluation Strategy from the Hillside Build in Spring 2014

In 2014, this evaluation process became more complex and less reliable. The students worked in small task groups, but had to coordinate with other groups in the lab and their counterparts in the other two labs to ensure continuity of the whole project. The amount of effort it took to properly communicate with the design/build team was significant and relatively ineffective. There were a number of coordination issues that had to be resolved by the faculty and graduate assistants involving communication breakdown between groups. The student evaluation process was more complicated this semester as well (Table 2). Because of the diversity of team structures, the students were asked to evaluate each student that they worked with during the process. In an ideal world, each student would have had contact with the fifteen members of their lab along with a handful of students from each of the other two labs. Achieving that level of engagement was certainly untenable, but what was revealing was the number of students who were evaluated by few of their colleagues. Almost half the class received less than seven reviews per evaluation. This discrepancy illuminates the communication problems in the project. Some students were lost in the shuffle while others effectively hid and allowed the more engaged students to struggle through the complexities for them.

The issue was also evident at the start of the construction process when the graduate assistants had to continually sit down with students and explain their own drawings to them. Many students had to be walked through the basic premises of what was to be constructed because they had not been properly introduced to their own group's documentation. The majority of these students were likely unable to make the critical connections between the work done in the classroom and the work done on the jobsite, which provided the predominant learning experience in the Courtyard Build.

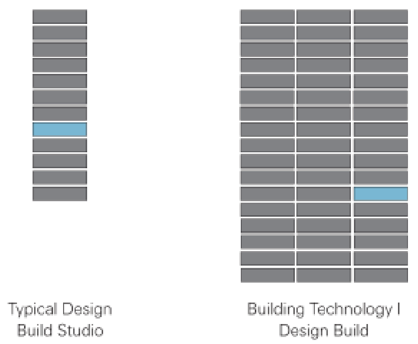

Table 3 | Enrollment Comparison between Architecture Course Types

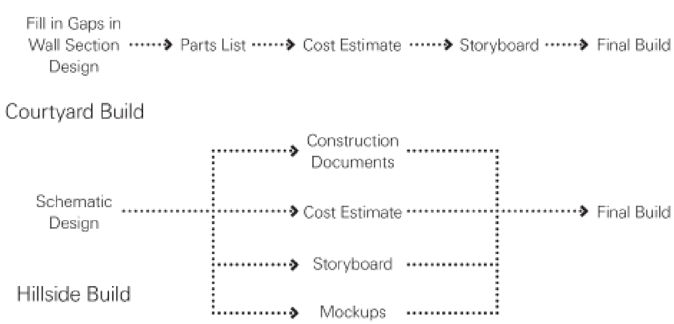

Table 4 | Working Processes of the Two Design/Build Project Types

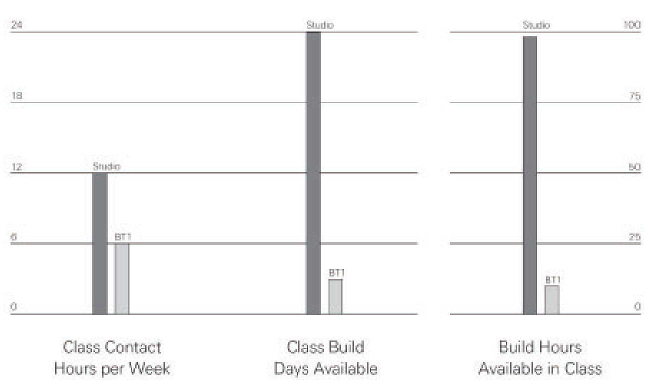

Table 5 | Timeframe of a Studio versus a Building Technology Course

Factor for Failure | Division of Labor

The second factor contributing to a deficient learning experience is directly related to the issue of communication: the division of labor. Technology courses are frequently data or information driven. As opposed to a design studio, these "support courses" tend to have less flexibility in their outcomes and are responsible for delivering information to each student in the class with relative equality. The most prominent factor limiting equal learning opportunity in a design/build project is a division of labor. In most design/build projects a division of labor is a necessary curricular construct in order to accomplish all of the required tasks in the project timeframe. The large number of contact hours and relatively small number of students in a design studio allows for information to be passed readily, ensuring that all participants understand the whole project relatively well (Table 3). With a higher student enrollment and more limited contact hours, disseminating information to all students in a technology course is a significantly greater challenge, a process requiring students to actively seek information rather than passively receiving it.

In 2012, the students in the courtyard build were separated into small groups. All tasks were completed in succession, with no tasks worked on concurrently (Table 4). Iteration was also utilized throughout the process to refine the work and provide more student contact with the lessons. With minimal effort, each student had the opportunity to receive a similar learning experience from the project. Based on observation, student performance, and evaluation results, most of the students working on the wall section project did appear to have a similar experience.

In 2014, the project experience was significantly different. Again, the students were divided into smaller groups, but as previously mentioned, due to the complexity of the build and the timeframe, significant portions of the work had to be done concurrently. As most of the students were absorbed in their assigned tasks, they did not have the time or ability to fully understand the work done by other task groups. As a result, the learning experiences varied distinctly from student to student. Only a handful of ambitious students took the time to fully investigate all four primary areas of development, while the majority scrambled to fully understand the project even as the construction was wrapping up.

Factor for Failure | Timeframe and Scope

The third, and most straightforward, factor involves the relationship between timeframe and scope. A semester-based design/build studio typically has around twelve hours of dedicated classroom time each week and stands as the centerpiece of a student's semester (Table 5). The students may spend the first half of their time designing a project and the second half building the final product. Twelve hours per week for eight weeks would result in 96 hours focused on construction, just within the dedicated class time. Many design/build courses extend the construction time outside of class as well. In contrast, each student in this lecture/lab course spends six hours in class each week and is concurrently enrolled in studio. Taking into account the rest of their semester schedule, I determined that the assigned build timeframe for the construction in this class could not exceed three scheduled class days. As a result, the students had a maximum of nine hours of dedicated class time assigned to construction. These three days could be extended to full days of work running from approximately 6:00 am to 6:00 pm.

In 2012, the students were able to build the wall section projects in a single, twelve-hour day without significant issues. A second build day was utilized for demolition of the structures, which took only a few hours, and for salvaging and storing recyclable materials for future use. This project optimized the limited timeframe of the build portion of the course, even returning some of the allocated time back to the students to complete other required coursework.

In 2014, the students utilized the required build days relatively well, but the three-day period was not sufficient for completing the amphitheater. Seventeen additional build days were required. Upwards of twenty students participated on any given day, but on some days there were only one or two students working. In all, about 70% of the students participated in some capacity during the extra days, but only about 20% were there for the majority. As such, the time required to build the amphitheater project was detrimental to student learning outcomes as many of the valuable learning experiences design/build has to offer came after the mandatory days – which were primarily focused on earthwork, foundations, retaining walls, and prefabrication of certain elements.

Factor for Failure | Complexity and Workload

The final factor impacting the students' learning experience was complexity and its impact on student workload. It was impossible to compare the performance of the students on the two build projects themselves because of the differing requirements. The work was also done in a group setting, which can create irregularities due to students being carried or hindered by the rest of the group. What can be compared, however, is student performance on the other course project, the creation of a minimal construction document set.

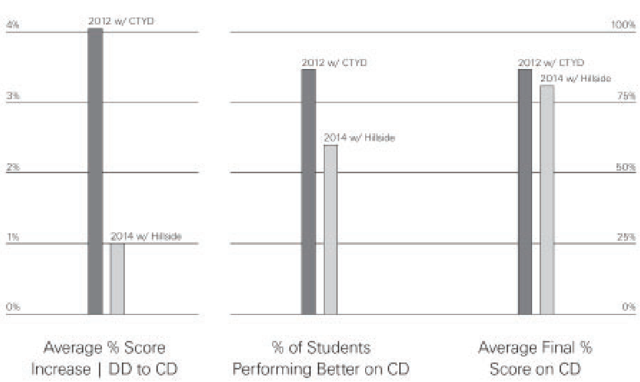

Table 6 | Construction Document Set Performance | 2012 vs. 2014

The students, working individually, had two separate drawing submittals for the project: a preliminary design development [DD] set and final construction document [CD] set. The latter was simply an improved and more detailed version of the former. To help balance out the additional work to be required in the Hillside design/build, the drawing set dropped from four sheets in 2012 to just two in 2014. In both semesters, the DD set was due in week 11 of the semester, the build started in week 12, and the CD set was due in week 15. In 2012, the class average went up 4.1% from the DD submittal to the CD submittal (Table 6). In that same year, 85% of the students who submitted both drawing sets performed better on the second submittal than the first. In 2014, however, despite the reduction in the scope of the set, the average score between the DD and CD submittals was only +1%. More significantly, only 58% of the class earned a higher score on the CD set than the DD set, a monumental decrease in overall performance. In 2012, the average score on the CD submittal was 85.4%, but in 2014 that average dropped 5.2% to 80.2%. For comparison, the average final score in the class in 2012 was an 84.1%, while the same average in 2014 was an 82.7 –a loss of only 1.4%. Although the class performed slightly worse overall in 2014, the radically different scores on the CD set indicate that something was negatively impacting their performance. There could be many factors responsible for this decrease, but it is likely that the performance drop can at least be partially (if not completely) attributed to the complexity and added workload of the amphitheater project, which was occurring while the students were also preparing their CD documents. As such, the complexity of the Hillside Build also had a negative effect on the students absorbing critical lessons in other components of the course.

What Did We Learn?[3]

After completing the Hillside Build in 2014, I reflected on the process of both build typologies and their relative successes and failures within the context of this course. The subsequent builds undertaken in 2015 and 2016 were a direct result of this examination. I will talk briefly about the 2016 project, the development of a series of educational stops along a hiking trail near the amphitheater, focusing on lessons learned from the earlier project iterations.

The first lesson learned was that constructing a single built work was ineffective as a learning tool in this class (Table 7). As such, we returned to the decentralized model used in the courtyard, constructing six small structures. The benefits of the small group structure, including ease of communication and the involvement of all group members in all phases of the development, were present again this semester. The reduction in scale allowed the project to be completed with only five additional build days, some groups finishing in as few as one additional day (Table 8). Additionally, every team member participated in the entire build process in 2016, ensuring the opportunity for equal learning experiences.

The group evaluations, becoming manageable again with small groups, mirrored the results of 2012 (Table 9). The percentage of students receiving a 90% or higher shifted from 40% in the first evaluation to 68% in the final and the average jumped from 83% to 91%. The performance on the drawing set also returned to the quality seen in 2012 (Table 10). The students had an average increase of 3% from the DD to the CD set and an average final CD score of 86%. 72% of the class had a higher score on the CD set than the DD set. In all, the educational experience of the two projects returned to a more balanced state, with evidence found in the student performance.

The most compelling evidence for understanding the relative educational value of the various build projects comes through a study of the course objectives, completed after the Hillside Build and revised after the conclusion of the Trail Build in 2016 (Table 11). There are 26 total objectives for the course, coming from four diverse sources. Fifteen of those objectives are assigned to be at least partially satisfied by this project, shown in bold, while the other eleven are primarily delivered through other course components. The percentage score attributed to each iteration of the design/build project is determined by averaging the scores received for each objective based on a three-point scale of meets, partially meets, and does not meet.

The level of fulfillment of each objective was derived from an analysis of the project process (Table 12). A chart was developed that listed primary traits of a given project, which either created a case for or against it meeting each objective. Taken in to consideration were the lessons and the experiences available as well as the ability for the majority of the class to attain those experiences, stitching the concept of division of labor into the analysis process.

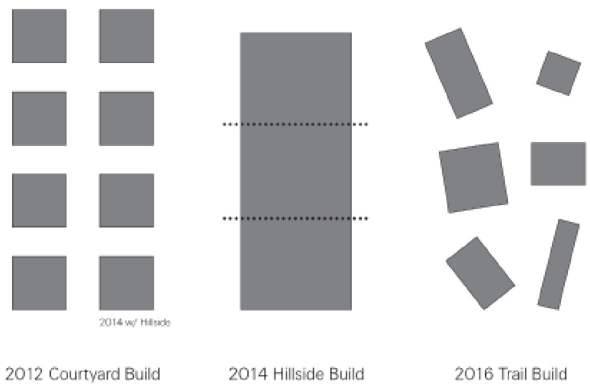

Table 7 | Comparison of Three Types of Build Compositions

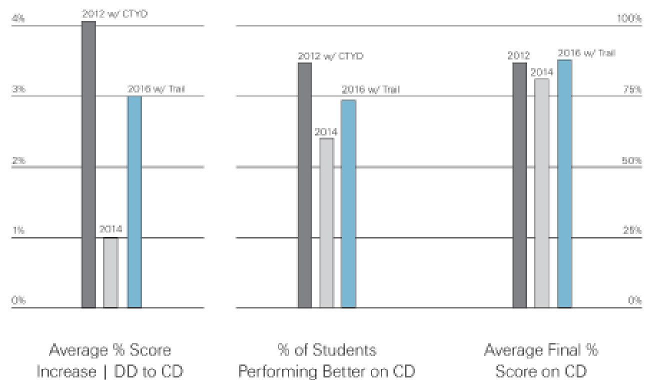

Table 10 | Constuction Document Set Performance | 2012 vs. 2016

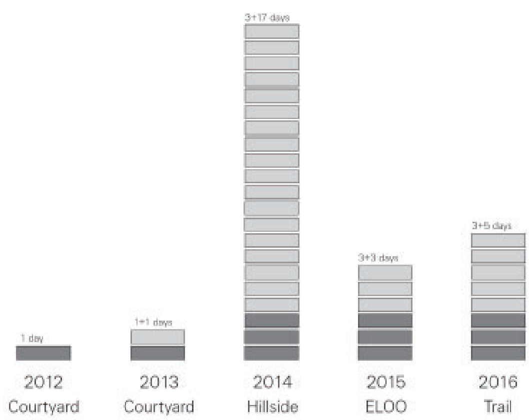

Table 8 | Construction Timeframe Comparison between all Five Years

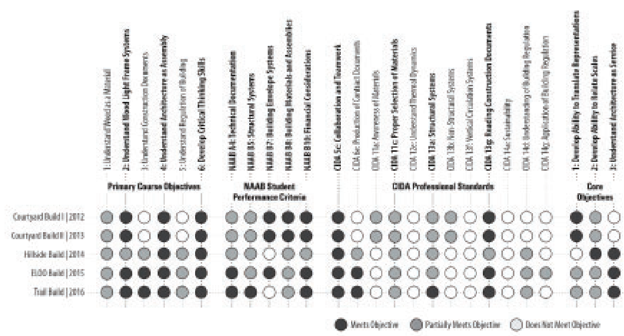

Table 11 | Learning Objective Comparison Table for all Five Years

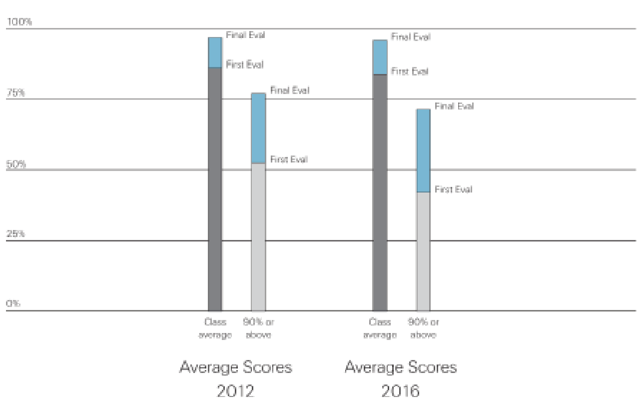

Table 9 | Student Evaluation Scores | 2012 vs. 2016


NAAB B5: Structural Systems

[S]tudents 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.

Courtyard Build | 2012 + 2013
Partially Meets Objective
- students learned about the construction and application of light wood frame structural systems through the project's process
- the constructions themselves, as sectional works, were not of themselves structurally sound without additional support
- the support systems were incomplete at the foundations as the built work was temporary

Hillside Build | 2014
Partially Meets Objective
- as a permanent structure, structural design was included in the process including looking at gravity loads and the lateral loading of vertical cantilevers
- about 10% of the students were highly involved in the structural analysis done on the project
- most students actively participated in the build and assembly of structural components of the project

ELOO Build | 2015
Partially Meets Objective
- as a permanent structure, structural design was included in the process including looking at gravity loads and the lateral loading of vertical cantilevers; the structures were not completed , however, leaving the experience for the students incomplete
- in their smaller groups, most of the students were involved in the structural analysis done on the project
- all students actively participated in the build and assembly of structural components of the project

Trail Build | 2016
Meets Objective
- as a permanent structure, structural design was included in the process including looking at gravity loads and the lateral loading of vertical cantilevers
- in their smaller groups, most of the students were involved in the structural analysis done on the project
- all students actively participated in the build and assembly of structural components of the project

Table 12 | Example of Learning Objective Study | Structural Systems

Although the Hillside Build is the course's single most impressive undertaking, its configuration as a single, large-scale build worked on by three large groups created a situation in which many students in the class experienced only a portion of the learning objectives. The division of labor was too great and the transfer of knowledge too difficult given the timespan of the project and the complexity of the process needed to complete it. As a result, this project has the lowest score amongst the five. Although it is visually the most impressive, success cannot be measured by product alone in an educational environment. Instead it must be measured by the students' educational gains, the truly permanent component of academic design/build.

Endnotes

1 Geoff Gjertson, "House Divided: Challenges to Design/Build from Within," in 2011 ACSA Fall Conference (Houston, Texas, October 6, 2011).

2 For a more significant analysis of the Courtyard and Hillside Builds, please see Chad Schwartz, "Constructing Experience: Exploring Design|Build Strategies within a Technology Course" (paper presented at the Working Out | Thinking While Building: 2014 ACSA Fall Conference, Dalhousie University, Halifax, Nova Scotia, Canada, 2014). and "Debating the Merits of Design/Build: Assessing Pedagogical Strategies in an Architectural Technology Course," Journal of Applied Sciences and Arts 1, no. 1 (2015).

3 For a more significant analysis of the post-Hillside Build work, please see "Examining Strategies for Delivering Design/Build Content in High-Enrollment Architecture Courses" (paper presented at the Poetics and Pragmatism: The 2017 Building Technology Educators' Society Conference, Des Moines, Iowa, 2017).