Cross Disciplinary Design-Build: The Design of Collaborative Education

"The ability to work effectively in teams has become increasingly important because of the complexity of projects requiring expertise from a variety of specialities and demands from clients for better building performance. Collaboration is a meaningful response to the on going marketplace mandate for buildings that are faster to design and construct and at a lower cost than those built in the past. And, perhaps most important, it could be argued that the final outcome - the design work - is actually better."[1]

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INTRODUCTION

The School of Architecture and the Building Construction Science Program at Mississippi State University are developing a replicable, cross-discipline pedagogy for teaching appreciation of disciplinary expertise and effective communication between architects and constructors. This paper describes these efforts for a cross-disciplinary Design-Build studio that was completed in the fall of 2013. The goal of this paper is to first, document the learning objectives and teaching/instructional methods that were planned and second, to provide feedback on student response to the curriculum so that the outcomes may be used to help advance the program and similar efforts at other institutions.

WHY COLLABORATE?

Effective collaborations in architecture, engineering, and construction are more important than ever due to the increasing complexity of projects and to the building performance demands of clients.[2] Of course, collaboration between architects, constructors, engineers, and other industry professionals is not a new concept. The professionals within these fields have long relied on each other to accomplish their shared goal of designing and constructing buildings.

One of the most prominent arrangements for collaboration is based on a Design-Bid-Build contract. Architects and engineers design a building, the drawings are bid, and a contractor builds what has been drawn. In this process, methods of communication are at risk of being restricted, lengthy, and unclear. Although this method works, is it the best collaborative method for architecture and construction today?

As buildings increase in complexity and performance criteria become more specific, other collaboration methods where designers, builders, engineers, and consultants come together much earlier in the process to design and construct a building have gained popularity.[3] Andrew Pressman recognizes the reasons for this

rise in collaboration in his book *Designing Relationships: The Art of Collaboration in Architecture*: "the requirement for environmentally sensitive and sustainable architecture, unstable and recessionary economic trends, innovations in technology, globalization of architecture, contractual and liability issues, and competitive advantage can be achieved through strategic collaborations."[4] For these many reasons, Integrated Project Delivery and Design-Build contracts are more numerous and the methods of collaboration associated with these contract types are beginning to change how building professionals communicate to accomplish their goals. Early collaboration improves efficiency, reduces cost, and saves time in the design and construction of a building.[5]

The Mississippi State University (MSU) School of Architecture and Building Construction Science Program (BCS) recognize this important shift. As a result, a series of cross-disciplinary studios have been developed, and are being taught with the goal of teaching MSU students ways of working collaboratively. This paper outlines the pedagogical development of this program with a focus towards the process of developing and evolving the curriculum, a critique of the collaborative process itself, and lessons learned for the first joint studio in the series, fall 2013 *Collaborative Studio I*.

BACKGROUND ON *COLLABORATIVE STUDIOS I AND II*

Collaborative Studio I is a cross-disciplinary, six-credit hour studio between faculty and second year students in the School of Architecture and the BCS Program at MSU. The goal of this studio is to create awareness of the relationships between architecture and construction professionals through knowledge development of materials, methods, and processes associated with the built environment and how they impact design and construction outcomes.

The classroom relationship between disciplines is possible due to the BCS Program's unique studio based curriculum. Rather than the typical three-hour lecture course, the BCS Program uses an architecture framework of a six-credit hour studio. At its conception, the program's intent was structured to accommodate interaction between the architecture and construction disciplines. Sharing the same classroom space and schedule facilitates interaction. Furthermore, the holistic pedagogical design recognizes the necessity of practice and latency of learning. To address this, two collaborative studios take place throughout the students' academic career. *Collaborative Studio I* occurs in the fall semester of the students' second year. *Collaborative Studio II* takes place in the spring of the students' third year. This studio serves every second year student in architecture and BCS. Class sizes range from 40 to 50 students.

The goals of *Collaborative Studio I*, through a small Design-Build project, are to help students develop a working knowledge of the principle construction material families and their related construction methodologies while learning fundamental concepts of formal and spatial manipulation. Model making and drawing are a means of testing and developing design concepts and construction conventions. Learning and working with BCS students' less obvious design issues, such as cost, time, embodied energy, and quality are factors that measure project outcomes. The end results of this intensive semester-long collaboration are practiced verbal and representative communications skills between the two sets of budding professionals. An understanding of the allied discipline's value structure and disciplinary interests is developed while also realizing a well-built, full-scale artifact that demonstrates these learned attributes.

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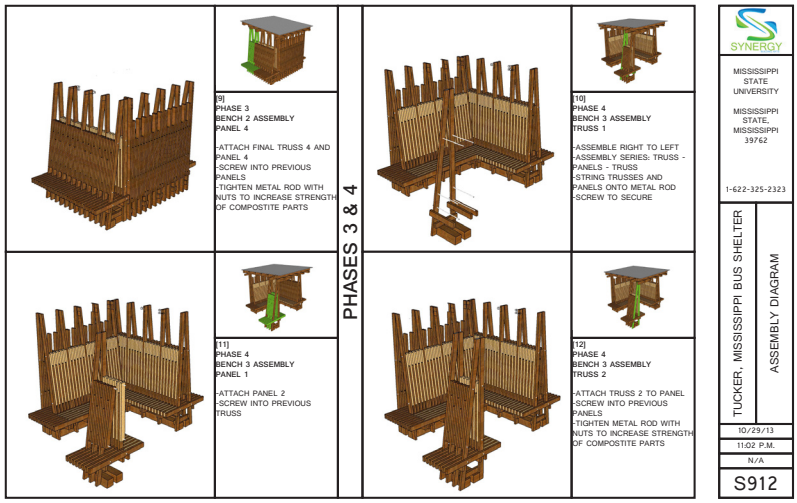
Figure 1: Framing model of the Tucker Bus Stop Shelter.

The Design-Build approach is an important aspect of the collaboration because it gives the students a common goal for the semester. They are required to use their individual expertise to design, plan for, and construct a shared project. The faculty select projects complex enough to challenge the students but small enough to be completed in one semester, if managed carefully. The focus of the studio is collaboration and tectonics so interaction with the client is limited for the students. The faculty members normally act as the client's representative, and it is necessary to find a client that is comfortable with this arrangement. Typically, funding for the projects comes from outside sources and is secured by faculty members with help from the department administration.

The scale and degree of project complexity is critical to a successful collaboration. Of



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fundamental importance is the issue of project planning. The pedagogy is intended to teach students how to abstract the design task. Through diagramming the phases and critical aspects of the work, the second year students do more than learn to build, they learn how design informs building and visa-versa.

RESEARCH AND DEVELOPMENT

To prepare for this large and fast Design-Build studio, architecture faculty members Hans Herrmann and Emily McGlohn, and BCS faculty member Tom Leathem collaborated during the summer of 2013 to design the cross-disciplinary pedagogy and curriculum. In addition to the summer R&D team, architecture faculty member, Alexis Gregory and BCS faculty member, Lee Carson joined the teaching team during the fall studio.

A grant awarded to the College of Architecture, Art, and Design has funded summer research for the *Collaborative Studios* for several years. The tasks for the summer of 2013 included a review of past research development (post-mortem reports), the establishment of common ground between the disciplines, the development of a collaborative pedagogy, and the creation of joint assignments that would insure learning outcomes related to the pedagogy.

POST-MORTEM REPORTS

Critical reflection of prior *Collaborative Studios* was an important aspect to the continued development. Each member of the development team created a written post-mortem report of his or her prior efforts. The intention of the post-mortem report was to document which efforts were most successful from past tests in the

Figure 2: Phasing diagrams for the Tucker Bus Stop Shelter.

pilot studios. These reports served as a way to generate new ideas for upcoming assignments and set the stage for initiating effective collaboration and communication among the faculty.

Through discussion, the success of an assignment was measured by the students' individual and group performance, their understanding of the assignment's intention, and the ability to replicate of the assignment.

COMMON GROUND

The first step in creating a cross-disciplinary pedagogy was to identify the shared objective and goals. As a team, it was determined that the following objective would serve the studio:

To create awareness of the relationships between architecture and construction professionals through knowledge development of materials, methods, and the processes associated with the built environment and how they impact design and construction outcomes.

The shared goals were intended to be a guide for interaction. With the goals in mind, assignments were created that met each discipline's needs. The shared goals are as follows:

- *Develop a working knowledge of the principle construction material families and their related construction methodologies.*
- *Learn fundamental concepts of formal and spatial manipulation.*
- *Develop an understanding of the relationship between design and construction professionals and their respective values.*
- *Use drawing (analogue and digital) as a means of testing and developing design concepts and construction means and methods.*
- *Understand how design is an informed process, which gathers information and parameters from many sources of input.*
- *Build verbal and non-verbal communication skills.*
- *Develop awareness of cost, time, and quality as a factor affecting project outcomes.*

COLLABORATIVE PEDAGOGY

The post-mortem analysis revealed a number of concerns that needed attention. In the past, architecture and BCS students had separate assignments both visually and contextually, which did not emphasize how the students were to work together. This further exacerbated an already challenging issue because the students were in separate classrooms, in separate buildings. Student work was not evaluated on how well they worked together as a group. Lastly, content of the assignments focused on students performing work specific to their discipline. Several changes were made for the fall 2013.

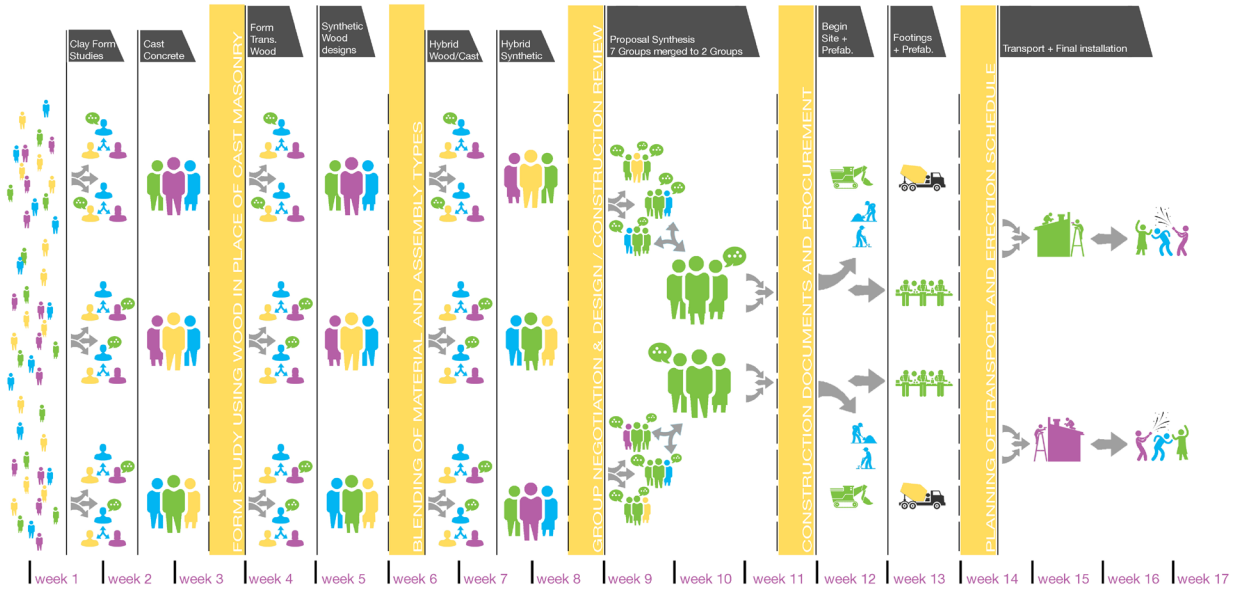
First and foremost, the students would have a common classroom. The faculty worked to develop an ethos of one. The most significant teaching decision made for the fall 2013 was to give all students the same assignments. In the pilot studios, begun in the fall of 2010, students interacted in a number of assignments at specific times throughout the semester. After discussing past outcomes of this method, the team concluded that an alternative pedagogical approach would be undertaken. Architecture and BCS students participated equally in conceptual design, design

documentation, scheduling, cost estimating, material acquisition, and site logistics in the fall of 2013. This approach was expected to demonstrate that more could be accomplished when individuals work together and insured exposure to the processes of the opposite discipline in hopes of fostering understanding and respect.

Students worked as individuals for a portion of each assignment so that they had time to develop questions about and solutions to problems on their own. Their individual efforts, theoretically, prepared them to work in a small group to which they were assigned. In total there were 12 groups of 4 students (one group of 5) and each team had at least 1 BCS student. Groups were encouraged to resolve internal issues on their own. When a group issue became too large for the students to solve, the professors intervened as facilitators.

Faculty members monitored each group's progress and rotated between the groups in traditional methods of feedback such as desk critiques and pin-ups. This insured that knowledge from both architecture and BCS faculty members was shared equally with all students. Architecture faculty interacted with BCS students and visa-versa. Review sessions were joint events where all students were expected to be able to present their team's work. Presentation and evaluation of project work would be consistent for all students. All students were required to represent clear understanding of both the design and construction elements.

To implement the approach from above, careful thought and consideration went into planning assignments because each discipline required separate learning



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outcomes to meet their accreditation needs. This section describes the assignments developed for design and the process used for construction.

JOINT ASSIGNMENTS

The methods used for design ideation were rooted in materials and methods and tectonic consideration. For example, in the first assignment every student was asked to create a clay form that possessed the qualities of a bus stop shelter. Second, as a group they combined their ideas into a single, clay form. Third, they were asked as individuals to interpret the group's clay form as cast plaster, then again as a group, cast plaster was considered. Finally, the entire group designed formwork and poured

Figure 3: Collaborative work plan for the design of the shelters. This chart show the actual process for group design and interaction.

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a large-scale concrete model based on the group's cast model. Presentation and evaluation of these models was done on a group basis as well.

There are several reasons this shared, iterative process was selected. First, it was assumed that by asking every student to perform the same task, they would learn about the opposite discipline's functional concerns. Second, it was expected that each discipline would bring knowledge to the process early to advance the work. Third, it was expected that the iterations would suit both disciplines. As an example, it was assumed the architecture students would feel comfortable designing a form with clay, but it would be new territory for BCS students. It was also assumed that BCS students would be more comfortable interpreting the clay form as a cast, formwork-based concrete construction, whereas architecture students had little to no experience with such an interpretive task.

Three iterations of scale and tectonic consideration were planned as assignments. Each student and group was to consider concrete, wood, and a synthesis of the two materials. The end product was planned to be a full proposal from each group for a shelter from which the studio would select two to build.

The planning for the construction of the shelters was not reserved for the BCS students as may be expected. The sequencing of construction, prefabricated parts, delivery, and assembly became a design exercise amongst disciplines.

In the fall of 2013, the plans were implemented for a cross-disciplinary studio. The next sections explain the project program, the client, and the shelters.

FALL 2013

After several pilot studios, the first official *Collaborative Studio I* was successfully undertaken in the fall of 2013. The Mississippi Band of Choctaw Indians (MBCI) asked for two new bus stop shelters for their improved transit system within the MBCI, Pearl River Reservation. This section describes the location, program, budget, schedule, and final constructions.

Figure 4: The completed Tucker shelter.

BUS STOP SHELTERS FOR THE MISSISSIPPI BAND OF CHOCTAW INDIANS.

One shelter was needed in Pearl River, MS, the most populous of the eight Choctaw communities, and the other at the Tucker Community Center in Tucker, MS. Both locations are important hubs in community members' commute to school, the doctor, and for running day-to-day errands.

PROGRAM, BUDGET, AND SCHEDULE.

Programmatically, the client asked for the shelters to keep travelers dry and provide a place to sit while waiting on the bus. Ease of maintenance was another requirement. Both sites were approximately 59 miles from campus, increasing logistical complexity. Additionally, the two sites were 12 miles apart making on-site logistics important.

The total budget for two shelters was $9,000 including materials, travel, and tools. The MBCI funded the project by awarding a grant to the School of Architecture. To maintain a reasonable level of new-knowledge and anticipated learning, students were granted only limited interaction with the client. The faculty acted as the client's representative during the design process.

Thirty-five architecture students and 14 BCS students worked together to design and build the bus stop shelters. All students, including BCS, began the semester in mid-August with conceptual design – as individuals and then in groups. The final two shelters were selected for construction at the beginning of October, and on-site construction began the first week in November. During October, many components of the shelters were prefabricated on campus. The projects were finished and presented to the client on December 2nd. Both bus stop shelters were completed on-time and on-budget, while maintaining the design intent of the project – accomplishments that are sometimes difficult to achieve in Design-Build projects. This was due in part to the pedagogy of the studio. The importance of planning as a design activity was emphasized to students and expressed as equally as valuable as the design of aesthetics.

OUTCOMES

In summary, the following were expectations of the curriculum, students, and the project set forth by the faculty during the summer research and development. Each bullet point is followed by an explanation of the actual outcomes based on discussions and conclusions made by the faculty during the most recent research and development session in the summer of 2014.

•*By mixing the disciplines in groups and asking the students to participate in traditional roles of the opposite discipline, they would learn from each other. Students would become teachers for their cross-disciplinary counterparts.*

It was too much to expect of second year students to learn their discipline and teach it simultaneously. The students were not sufficiently prepared for their shared moments. In some cases this approach did work, but it was difficult for the students to appreciate what was happening because it was so frustrating. After many arguments due to work habits mostly, several groups seemed to gain a mutual respect for their counterparts and protested when the faculty made the decision to separate the disciplines for the last iteration of design.

Although it was not a mistake to require students to work in teams, expecting them to collaborate naturally was. Noreen M. Webb, in her essay Information Processing Approaches to Collaborative Learning, says that "simply asking students to collaborate will not ensure that they will engage in productive dialogue."[6] This was found to be true. She further explains several techniques teachers can use to increase the

chances of productive collaboration. A few relevant examples are: teaching students appropriate communication skills to use in their groups, crafting the group assignment to require the expertise from each student for successful completion, and assigning students to specific roles.[7] The faculty team is currently testing these techniques.

The major flaw in this plan was that the students were not experienced enough to teach their counterparts. This made group work frustrating and uncomfortable.

•The students would enjoy experiencing the responsibilities and functions of the opposite discipline.

During introductory lectures about integrated practice and the advantages of collaboration, discussions centered on why a builder or an architect would want to understand the other's functions within a team. However, the BCS students became frustrated when they were asked to complete the opposite discipline's tasks. In general, they did not believe they should be asked to do the same assignments as the architecture students. Architecture students did not express the same frustration. This teaching approach assumed that by exposing the BCS students to design, they would gain an appreciation naturally or become interested. This was presumptuous of the faculty. BCS students needed separate assignments for their discipline specific tasks and changes were made midway through the semester to accommodate this.

•The two shelters would be "designed through consensus."[8]

Originally, this cross-disciplinary process of moving through scales and tectonic consideration of different materials was going to include, concrete, wood, and a combination of the two. The end result was to be a synthesized proposal from each group for a complete shelter. The students were only able to complete the full process of mold/cast/pour and the last iterations of design were adjusted.

There were several factors that contributed a change in course. First, there was not enough time to complete the process in wood, as the students ultimately needed more time than originally thought to fully grasp the free-form to cast-form process.

Second, the BCS students became overwhelmed with the process. They were not conditioned to the structure of making iterative design models and consequently did not recognize the benefits. A different course of action was improvised for the BCS students at the midpoint of the semester. They were given a separate assignment until the shelters were selected for construction. BCS students focused on estimating, scheduling, and constructability by developing computer-generated models rather than actual scale models. It was the feeling of the BCS faculty that the BCS students would gain more from developing computer models rather than actual scale models.

Third, after the mold/cast/pour sequence and the BSC students separated, architecture students went directly into a hybrid wood and concrete model as individuals. This short circuit helped to maintain the schedule, however possibly compromising the design process along the way. The entire school then voted on these proposals. The final designs were selected based on the results of the vote and the opinions of the professors.

This process excluded some students in the design work and put too much pressure on the students whose projects were ultimately selected.

•When given a choice of tasks, students would naturally accept the roles their disciplines traditionally take.

It was assumed that when given the choice of tasks, the students would gravitate toward the tasks in which their discipline is normally associated. For example, when a member from each group was asked to estimate a budget and create a schedule, it was assumed the BCS students would volunteer for this job. This did not happen as expected. Overall, more architecture students took these roles. This became a problem because certain learning outcomes were required for each discipline, and they were not gaining the experience they needed. Adjustments to the assignments were made midway through the semester to accommodate this issue. One observation of why this happened was because the architecture students were more invested in the project due to the design generation. Whereas when the BCS students were pulled away from the design process they became less interested in even common tasks they would typically perform.

•*The shelters would be built on-time and on-budget.*

The shelters were planned to be built-on time and on-budget – like all projects. This was accomplished. One reason for this is that the process of construction was part of design activities. Students had ample time to plan for the completion of the project and ease of construction was a design criteria.

CONTINUING DEVELOPMENT

During the summer of 2014, a second round of research and development was undertaken. The outcomes from the fall 2013 *Collaborative Studio I* were considered, and adjustments have been made to the curriculum. Summaries of the considerations are below:

•*Design and construction assignments are separate.*

While the architecture students are working on conceptual design, the BCS students are preparing to meet the architecture students at an "integration node."[9]

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Figure 5: The completed Pearl River shelter.

This will insure that constructability can influence design throughout the design process without expecting the students to perform tasks in which they are unprepared to do. The BCS students' assignments are complementary to the architecture students' design phase. When they meet, each student will have knowledge to offer to the group. This more closely imitates how the two professions would interact as professionals. Most would not work on the same elements of the project but rather different parts and then come together at strategic moments to collaborate.

•*Nodes of integration"*[10]

Based on Andrew Pressman's process for "managed collaboration" from his book *Designing Relationships: The Art of Collaboration in Architecture*, the students are being taught how to collaborate instead of hoping for a positive outcome through spontaneous teamwork.[11] The work that students do separately prepare them for scheduled meetings where collaborative progress is made.

•*"Design by consensus."*[12]

There will be no vote on which projects to build. The entire class will discuss the positive attributes of each individual proposal. These recognized attributes are the deciding factors for which ideas move forward. Small groups will to integrate good ideas into two stronger, complete, group proposals.

•*Defined, separate learning outcomes.*

Where learning outcomes are necessary for one discipline, the students are asked to complete tasks as an individual for a grade. This insures that the students leave this studio prepared for the next studio level. BCS students are no longer given the choice to prepare a budget, schedule, and materials list.

CONCLUSION

This paper was written to record the learning objectives and teaching/instructional methods that were used for a collaborative studio between architecture and BCS at MSU. The second goal of this paper was to provide feedback on student response to the curriculum so that the outcomes may be used to help advance the program and similar efforts at other institutions. Overall, the deign/build projects were a success. The pedagogy and curriculum presented issues that stemmed mostly from the students not being prepared to effectively collaborate with each other. Second year architecture students are learning how to be professionals and cannot be expected to act or perform as such without training. With an understanding of which outcomes of *Collaborative Studio I* are positive and which ones need attention, the architecture and BCS faculty at MSU will continue to improve this important effort of teaching effective collaboration methods to future design and construction professionals.

ENDNOTES

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