Design-Build as Collaboration: Hands-on Construction to Facilitate Communication and Dedication

Design-Build has become so ubiquitous in NAAB accredited architecture programs that over 80% have some form of Design-Build program.[1] This is necessitated by the interest of both faculty and students to provide an alternative to lectures as the only form of information transfer, primarily through interactive learning experiences such as Design-Build. [2] [3]

ALEXIS GREGORY
Mississippi State University

INTRODUCTION

However, collaboration is an important, and necessary, component to Design-Build that can teach students the skills needed to communicate with colleagues and to aid in the investment in the project by all involved parties. This paper examines three various Design-Build projects in three different courses. The scale of the projects vary as well and include small constructed details focused on specific connections, storage sheds for Habitat for Humanity houses, and partial full construction mock-ups for a Habitat for Humanity prototype. The range of scales, courses, project types, and pedagogies created a wealth of information on how collaboration can work, or not work, in Design-Build projects. The paper will discuss the specific collaboration methods for each project and critique each as to its efficacy and duplicability.

HAPTIC LEARNING

The use of hands-on, haptic learning techniques in architecture education, such as Design-Build, has been around for some time, most notably in the Rural Studio at Auburn University. This idea began in 1993 as the brainchild of D.K. Ruth and Samuel Mockbee, and has been emulated by many architecture programs ever since. However, the connection between haptic learning and the interactive skills of the current generation has not been made. This is an important consideration highlighting the relevance and potential value of Design-Build in architecture education. Despite the agreement of the majority of faculty and administrators in architecture programs of the importance of Design-Build programs as an educational tool, Design-Build is not considered a necessary component of architecture education. This is regardless of the fact that this type of learning is part of many architecture programs. [4] Also, not every architecture program will have the opportunity, or ability, to incorporate Design-Build into their curriculum, which is why using haptic techniques in lecture classes is so important.

Educators have known intuitively that the traditional lecture is no longer the best way to educate. [5] This is why we have seen not only the Design-Build approach enter

the curriculum, but also growth in the use of haptic learning in lecture courses. Kevin Dong, P.E. and Thomas Leslie, AIA explored haptic learning in their article "Breaking Stuff: A No-Frills Approach to Haptic Learning in Structures Classes." Dong and Leslie acknowledge a growing awareness in the academic community of the importance of using haptic learning techniques, yet their implementation of such techniques was not in response to these developments. Their "common sense" guided them to employ more hands-on learning methods because they understood, intuitively, that millennial students require more interactive teaching strategies in order to grasp technical concepts. The relationship of real-world issues to structural principles, iterative development of structural designs, and the exploration of materials to test the ideas in a haptic setting are all based on the authors' ideas of common sense in architecture education. The lecture is not completely abandoned in this model, but seen as one of many important components to learning. Therefore, the lecture moves from passive memorization to a more active role in the process of learning. This process allows the authors to reiterate important concepts in various contexts to enhance the connection between the "aural, visual, and haptic." [6]

DESIGN-BUILD

Design-Build uses this haptic learning idea to teach architecture students through designing and building projects for real-world clients. The promising and potential benefits of Design-Build in architecture education was discussed as early as 1996 by Boyer and Mitgang in their seminal book *Building Community: A New Future for Architecture Education and Practice.* The authors note the integrative approach and the use of authentic projects with real clients. Bruce Meyer, a former faculty member at Ball State University teaching a Design-Build studio, is quoted as stating that Design-Build studios give students the opportunity to be "total architects." The students learn collaboration because they must "work with others in teams, communicate with clients, reach compromises, and shepherd a project through the complete building process, from conception and design, to negotiation, to construction." [7]

Despite the praise of Design-Build projects by Boyer, Mitgang, and Meyer they still are facing resistance nearly twenty years later. Geoff Gjertson conducted research on why most of the Design-Build projects are only electives and not integrated into the curriculum of architecture programs. He found a lack of support from both faculty and administrators not actively involved in the Design-Build activities. Additionally, the stress on the faculty conducting the Design-Build projects included the increased work load of coordinating the Design-Build project, which included fund raising, being the architect of record, and the constant increase in student enrollment and project scale. This does not even include the required research, teaching, and service that the faculty must also satisfy. These barriers and burdens tended to marginalize the Design-Build projects and the faculty conducting them. Based on this information gathered by Gjertson are Design-Build programs sustainable? [8]

Due to the growing interest by both students and faculty in haptic learning and service-learning in architecture the value of Design-Build is important. The value of Design-Build programs outweighs the burden, but architecture programs must still address the issues raised. Research shows that architecture students prefer haptic, hands-on learning that serves their community. [9] [10] Gjertson notes:

> "Few question the importance of experiential, project-based, service-learning. Collaborative team skills, communication, leadership skills, and interdisciplinary practice, the benefits of service-learning, are also accrued through Design-Build teaching and experience."

Showing the importance of collaboration and service-learning in Design-Build projects may be able to demonstrate the value to colleagues not currently supportive of these activities. The increase in interest in public interest design and collaboration professionally as well can be an important aspect that can integrate Design-Build into architecture curricula.

COLLABORATION

Collaboration has become more important in the field of architecture over the past few years. The NCARB 2007 Practice Analysis of Architecture noted "Collaboration/ Cooperation" as only the 7th most important change wanted in the field of architecture. However, the NCARB 2012 Practice Analysis of Architecture released in June 2013 gives more in-depth information on the importance of collaboration. Educators, interns, and licensed architects were surveyed to gauge the level of agreement on the knowledge and skills that students were achieving during their education.

The Education section of the 2012 NCARB Practice Analysis of Architecture delves into the knowledge and skills that educators and practitioners think architecture students should achieve. Select data from this report shows that over 50% of architects and educators agree on the importance of the understanding of certain knowledge and skills such as different project delivery methods, the roles, responsibilities and authorities of project team members during construction, and building information modeling (BIM) and its impact on planning, financial management and construction documentation. Additional results of the 2012 NCARB Practice Analysis of Architecture are that more than 80% of practitioners that completed the survey feel that "collaboration with stakeholders is important, very important, or critically important." Educators note that collaboration is included in their program, with a response of over 50%, and 70% of educator respondents noted that students worked collaboratively with either guidance or feedback from faculty, or collaborated independently. [11]

Starting with the challenge from Boyer and Mitgang to the architecture community in their report Building Community: A New Future for Architecture Education and Practice: A Special Report, and continuing through the NCARB 2007 Practice Analysis of Architecture to the more recent 2010-2011 BIM/IPD Survey Results collaboration, BIM, and IPD are becoming more important and more relevant to architecture education. General use of BIM, Integrated Project Delivery, and Collaborative Design Strategies are being used more and more. [12] Data shows an expected increase of the use of BIM in the AEC marketplace over the next five years, which in turn, shows the importance of keeping the momentum going on collaboration in architecture education. [13]

BIM is an integral part of IPD and allows Design-Build teams to foster other important parts of IPD such as:

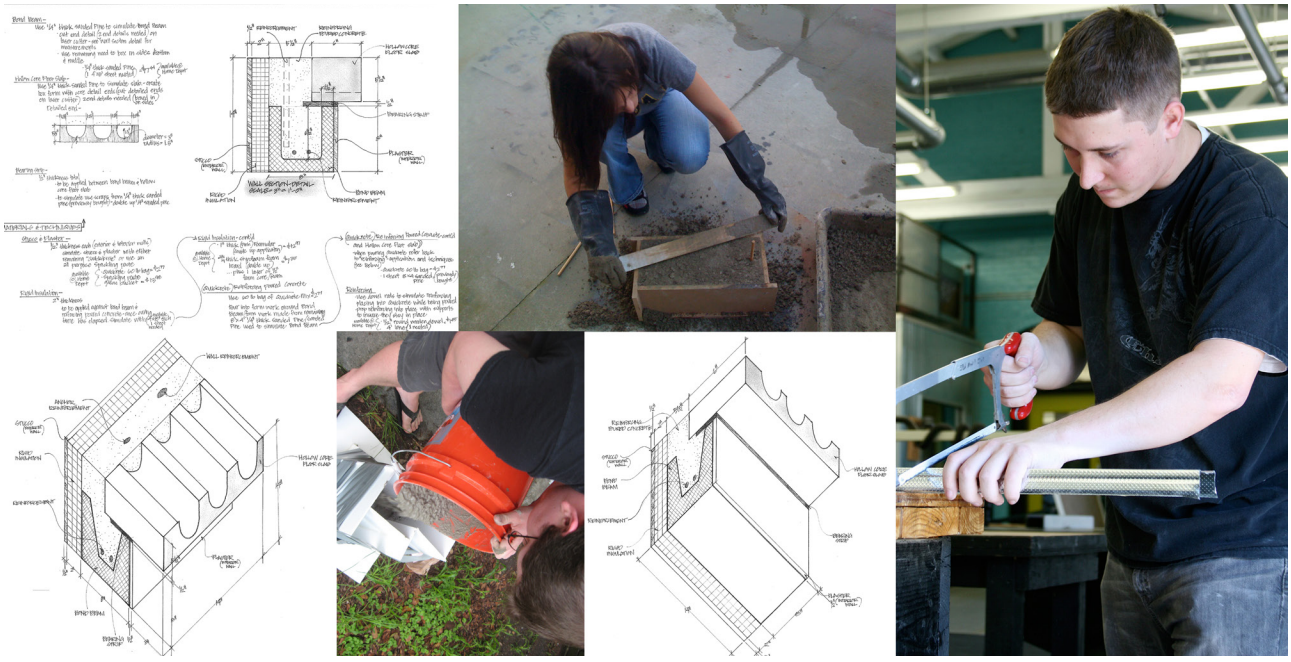
- Early involvement of all parties
- Shared risk and reward
- Multi-party agreements
- Collaborative decision-making and control
- Liability
- Jointly developed and validated performance goals [14]

Utilizing the points of ideal synthesis from "Notes on the Synthesis of BIM" by Deutsch the Design-Build teams will be able to work together from beginning to end to create a solution to a design problem. [15] Not only will the synthesis of BIM be important for Design-Build projects, but also the synthesis of information. This is extremely important to IPD and reflects the similarities between a Design-Build

project and the use of IPD in the profession. Without the correct synthesis of information students and professionals will not be properly educated to work together to create appropriate design solutions.

SMALL, MEDIUM, LARGE: TRIPARTITE EDUCATION

Based on the concerns discussed above on the integration of Design-Build in architecture education I worked to integrate Design-Build into my lecture and design studio courses as much as I could. The Design-Build was integrated into these courses to educate students through hands-on haptic techniques due to their impact on student learning, and to teach students both how to collaborate and the importance of collaboration. The three projects discussed here were selected based on their size. The size includes the actual size of the project constructed, as well as the "size", or quantity of collaboration.



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SMALL

This Design-Build project was considered small because the students were required to design and build a connection for a small infill project they were creating for my lecture course "Construction Technology II." (Figure 1) The students used a connection that came from the wall sections and floor plan details that they developed through the design of the infill project. The size of the final construction ranged from as small as 12"x12"x12" to 24"x24"x24". Typically I limited them to 14"x14"x14" to push them to consider material size and ability to fit within this atypical module. The connection was to be full scale if possible, but no smaller than half scale to show a full building connection at the structure and envelope. The small size of the collaboration was designed as an "architect"/"constructor" relationship. The students were to create a small set of 11"x17" construction drawings as well as a materials list to give to their fellow student, or "constructor." This placed the student in the role of "architect" to understand the importance of communicating their ideas through construction drawings and material lists. It also showed students the importance of collaboration as they worked with their "constructor" to answer questions while they built the project based soley on the drawings and materials list. All students acted as both an "architect" and "constructor" to see both sides of

Figure 1: Construction documents, material lists, and students acting as a "constructor"

this collaboration. They were able to understand why collaboration and communication were important as a “constructor” because they may not be given all necessary information by their “architect” and may not be able to live up to the expectations of their “architect” when building the connection.

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Figure 2:Students collaborating on the shed construction

MEDIUM

The medium Design-Build project was considered as such also due to the size of the built object, in this case small storage sheds for existing Habitat for Humanity houses, and due to the scale of the collaboration. (Figure 2) This project was for my lecture course “Construction Technology I.” The students began independently designing by drawing plans and elevations, as well as building a model of a design for the shed. They all presented their sheds and began the collaboration by voting for the shed designs that they felt were the most easy to build, most materially efficient, and most durable. The students then became one team where they refined the shed design chosen and made construction drawings, another model, and a materials list. This facilitated collaboration by allowing all students input into the refined design so that they all now had ownership of the project. The project continued the collaboration through the students working together to pre-fabricate the floor, walls, and roof structure of the shed to be taken out to the project site. Once on site, the students worked as a team to dig for the foundation, set the floor, and then raise the walls, install the roof, and sheathing over several weekends.

LARGE

The large Design-Build project is large in relation to a typical Design-Build project such as a Habitat for Humanity house or home designed and built by the Rural Studio. The collaboration was also large as it was conducted over two quarters of ten weeks each for a total of twenty weeks of work. The studio included fifteen students divided into three teams. The three teams were responsible for the design and

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construction of three important sections of the [fab]ricating Habitat house design. (Figure 3) The students were unable to construct the entire house because the local Habitat for Humanity for which we were working did not have any available property on which to build at that time. Therefore, we had the students construct three wall sections in the Habitat ReStore resale store as a learning tool for the students and advertising and fund raising piece for Habitat. The three sections were chosen because the faculty felt that they had the most elements to be constructed that would give a variety of examples and important aspects of residential construction.

Each team consisted of a Fabrication Coordinator, a Graphics Coordinator, a Construction Coordinator, a Project Architect, and a Project Manager. Students were given a description of their job title and responsibilities and were required to collaborate with their team, and their fellow students with the same job title. The idea behind this type of collaboration was to manage the large size of the class, encourage collaboration and bonding through the three smaller teams, while also maintaining a coherence throughout the entire construction project. For example, the Construction Coordinators worked together to make sure that the same materials and construction techniques were used for all three sections being built. The Graphics Coordinators worked together to make sure that the construction documentation for all three sections worked together with the same graphic standards, fonts, etc. The Project Architects worked together to make sure that the same detailing and architectural language were consistent throughout the three constructions the students were designing. The Fabrication Coordinators worked together to create the Rhinoceros files and the digitally fabricated elements of all three constructed sections. Finally, the Project Managers all worked together to make sure that all team members were completing their work, collaborating successfully, and that everything was being done.

DISCUSSION

All three of the Design-Build projects discussed previously benefit the students in both haptic learning by hands-on work and collaboration at various scales. However, they are all different in scale of the projects constructed and the scale of the collaboration. Each project was conducted at various levels in the education of the

Figure 3: Student design, student collaboration, student construction, student presentation on [fab] ricating Habitat

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Figure 4: Students taking a break from constructing a shed

students and all within the same educational institution. The small project was conducted with third-year students, the medium project was conducted with second-year students, and the large project was conducted with fourth-year students. The year-level of the students was not a determining factor of the appropriateness of the projects, with the exception of the large project. It was deemed as being appropriate only for upper-level students based on the knowledge and experience needed to complete the project. The small and medium projects were designed for nascent students with little to no knowledge of the construction means and methods they would be using for the projects. These projects were seen as a way to teach those means and methods through Design-Build and collaboration.

"INDEPENDENT" COLLABORATION

The small connection Design-Build project was considered an "independent" collaboration because of the limited nature of the collaboration. The students created their design and materials list and then handed it over to their "constructor." They had limited contact outside of the initial "meeting" where the "constructor" was allowed to ask questions of the "architect." Unless the "constructor" sought out their "architect" on their own outside of class that was all of the communication and collaboration in this project. This most closely emulates the traditional "design-bid-build" project delivery method. The facilitation of "collaborative knowledge" was conducted through class discussions of the importance of communication and collaboration. However, this was done after the Design-Build project was completed to allow students to see the full breadth and impact of communication and collaboration using construction documents, materials lists, and limited meetings. Student feedback showed the impact of even this limited collaboration:

> "The actual hands on building of the structuctural (sic) systems that we had to act as architect or contractor, it help to see where construction can go wrong and how the slightest impurfaction (sic) can cause the building to fall."
>
> "I believe that the only way to improve the learning experience would be with a different approach to group projects. Some students just can't be reliable that allows (sic) flexibility to learn the material."
>
> "Although the course work is balanced between individual and group work, this still proves to be an issue when attempting to organize time with others."
>
> "I would advise to possibly have more small scale built assignments that relate to different construction methods throughout the course so one can physically see the challenges they might face after designing something and then building it with a contractor."

These comments show that even in a "small" collaboration conflicts arose with scheduling meetings to collaborate on information, and that collaborators are not always dependable. Nevertheless, other comments show the impact of the learning experience and how some students even ask for more opportunities to participate in the collaboration to learn more about "…building it with a contractor."

"DEPENDENT" COLLABORATION

The design and construction of the medium project was considered a "dependent" collaboration because the students were much more dependent on each other than in the small project. They worked as one large team to create one shed and had to balance schedules, personalities, and abilities to complete the design and construction. (Figure 4 and 5) Most of the students had never worked as a team before in their architecture education since they were only in their second year of the program. They were forced to separate duties and assess their strengths and weaknesses, as well as those of their classmates. This created some friction as

students were not only learning construction technology, but also how to work with others. Collaboration had not been stressed, or implemented, in their previous architecture courses so this was one of the largest struggles for many of the students. However, positive comments from the students show the benefits of collaboration on a Design-Build project in a lecture course.

> "The opportunity to have the hands on experience of actually building the shed the class designed as a group. This really helped clear the gaps of what a book can not (sic) necessarily cover, and allowed me to visually see what was being taught and truly understand how and why it came together."

> "Working with Habitat for Humanity contributed the most in my learning in this class. This gave us the opportunity to get hands-on experience in light wood framing construction and really made me realize how much actually goes into building something as simple as a shed. I definitely think that this class should continue to keep a project like this as part of its curriculum. Taking part in a Design-Build project is a tremendous advantage to any architecture student."

Collaboration was taught through the team work necessary to build the shed, but it was brought specifically to the student's attention through class discussions on how to coordinate a Design-Build project using collaboration. The faculty used every meeting and discussion where drawings were critiqued, material lists were made, and structures were pre-fabricated to talk with the students about how collaboration was facilitating all that was being accomplished. This project is similar to the "Design-Build" project delivery method where both design and construction are completed by the same entity.

[FAB]RICATING COLLABORATION

The final, large, Design-Build project "[fab]ricated" collaboration through the structure of the design studio. Since the fourth-year students had worked on team projects before they were very familiar with collaboration, but not for a Design-Build project. The standard concerns about hierarchy in a team project in design studio were addressed through the creation of the five job titles and job descriptions. These allowed students a clear idea of what their responsibilities were and eliminated the typical issues of some students doing all of the work while others sat around. The job titles did not hinder collaboration by setting expected responsibilities; it instead freed students to see how their responsibilities fed into the responsibilities of others. This model more closely resembles that of Integrated Project Delivery (IPD) as discussed earlier in that all parties know what they are responsible for, yet work together as one large team.

> "Learning in this class was mainly due to the availability of the professor and her 'no doubt' instructions. Prof. Gregory was available for questions at any time and responded in a timely manner. She made the class a fun learning environment and helped the studio bond student to student as well as student to professor. The Design-Build studio also provided alot (sic) of insight on building methods that architects should know going into a design-construction profession. This was the best way to put our design in perspective...sometimes those weird forms look cool, but just aren't feasibile. GREAT EXPERIENCE and I would recommend this teaching/learning strategy above lecturing. You can talk about all day, but to do it is another thing!!"

Added benefits of this collaborative model were that students learned more about their classmates and developed a newfound respect for those that they typically did not associate with. The faculty did choose which students got which job title and based it on their knowledge of each student's pre-existing skills and

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Figure 5: Students working on a shed

abilities. This fostered a confidence in each student as they tended to excel in the job with which they were placed, which in turn led to the increased respect of their team members and classmates.

CONCLUSION

The benefit of the hands-on haptic learning of Design-Build projects in architecture education has been supported by various studies on this topic. Nonetheless, the collaborative and service-learning aspects still need adequate research and exploration. Design-Build is still facing the challenge of full acceptance in architecture programs despite these important benefits and educational opportunities. Therefore, collaboration in Design-Build projects should be stressed and developed to prove the significance of Design-Build to architecture education. Collaboration is vital to the education of architects based on the collaborative nature of the developing, and soon to be dominant, project delivery methods in the profession. While conducting teamwork in every class is not feasible or beneficial to architecture education, the use of collaboration in Design-Build projects is paramount. The advantages include students learning how to work with others, ability to compromise on design ideas, dependence on others to critique and create work, respect for the abilities of others, improved communication skills, and increased confidence in personal abilities. Drawbacks include the hiding of underperforming students behind students who excel, the inability of students to integrate into a teamwork mindset and model, and increased faculty workload and stress. Regardless of the fact that the inclusion of collaborative Design-Build collaborative projects means added work for both faculty and students, the advantages outweigh the challenges. Hopefully with continued development and recognition of these benefits collaborative Design-Build projects will be recognized as the important and impactful opportunities that they are.

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