An Industry-Sponsored Competition to Explore Integrated Project Delivery in an Educational Setting

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As integrated project delivery continues to gain prominence, educators need to adjust their traditional teaching approaches to prepare students for the interdisciplinary collaboration they will encounter in their professions. This paper explains the process and outcome of the second year of a sponsored, annual, two-week long interdisciplinary design competition among architecture, building construction science and interior design students at Mississippi State University. The competition is intended to explore the roles of each discipline in an integrated project delivery situation. Students were placed in interdisciplinary teams of four to five students, with at least one student from each discipline per team. Teams were asked to develop proposals for converting existing housing on Mississippi State University's campus into an eco-village. In order to measure the students' knowledge and perception of integrated project delivery, and how it may have changed throughout the competition, qualitative and quantitative data was collected in the form of student surveys taken at the outset, twice during, and at the conclusion of the competition.

Key Words: Building Information Modeling, Collaboration, Integrated Project Delivery, Interdisciplinary

Introduction

Inefficiency in the delivery of construction projects is one of the driving forces behind the shift toward integrated project delivery (IPD) (Kent et al 2010). IPD seeks to foster collaboration among the project participants throughout all phases of a project, from the early design phase to occupancy. It is defined by the American Institute of Architects California Council (AIACC) as "a project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively harnesses the talents and insights of all project particpants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication and construction" (AIACC, 2007, p.1). Because each discipline has early representation in the project outcome, the project evolves in a way that meets the needs of all project participants (Ghassemi et al 2011). By aligning the team goals and collaborating throughout the course of the project, efficiency is improved, errors are reduced, and adversarial relationships are reduced and / or eliminated (Kent et al 2010). In a 2010 survey of 415 owners, architects, engineers, general contractors, and construction managers, 24.7% of survey respondents reported being both inexperienced and uninformed about IPD, yet approximately two-thirds of all respondents believe IPD will become the project delivery system of choice in the United States (Kent et al 2010). The challenge for educators is to prepare students for a project delivery method that is relatively new, constantly being redefined, and varies greatly based on the project and parties involved.

Although not necessarily required, a key component of IPD is the utilization of Building Information Modeling (BIM). BIM is a parametric modeling system that relies on informational databases to create multi-dimensional models that can be used to "generate space calculations, energy efficiency analyses, structural details and traditional design documents" (Sabongi 2009). In comparison to a typical set of two-dimensional architectural drawings, a BIM model can show both construction and design details while also allowing multiple groups of people, from architects to general contractors to subcontractors, in various locations to work on the same model. A 2009 survey of 424 respondents who primarily consisted of architects, engineers, contractors, construction managers, BIM consultants, and owners, indicated that nearly two-thirds of the respondents utilized BIM on more than 60% of their projects. Furthermore, nearly 23% of the respondents indicated that they use BIM on all of their projects (Becerik-Gerber et al 2010).

While it is widely recognized that IPD and BIM typically go hand in hand (Kent et al 2010), a separate study of 45 colleges and universities which are members of the Associated Schools of Construction (ASC) shows that 62% of survey participants found that BIM education was inadequate at the undergraduate level and is only being addressed in approximately 10% of undergraduate programs (Sabongi 2009). In his article, "Notes on the Synthesis of BIM," Randy Deutsch takes the position that Integrated Design, also known as IPD, is more than a delivery method. Deutsch quotes the GSA's Charles Hardy, who is famous for saying "BIM is about 10% technology and 90% sociology," when he states that we should focus our attention on the sociology of IPD while the 10% technology works itself out. Deutsch describes the "ideal synthesis" - the synthesis of "design and construction, BIM and IPD" - as allowing for: "BIM's inherent complexity, the complexity of the construction process, the design profession's discomfort with addressing means and methods, the constructor's discomfort with addressing intent, and technology to work hand-in-hand with sociology" (Deutsch 2010). Solutions to overcoming the sociological / cultural barriers include collaboration, communication, and confidence in the capabilities of the parties involved (Ghassemi et al 2011).

In an effort to facilitate the ideal synthesis Deutsch describes, and so students will be better prepared to enter the job market with interdisciplinary experience, faculty members in architecture (ARC), building construction science (BCS) and interior design (ID), with the support of the Brasfield & Gorrie General Contractors and the College of Architecture, Art and Design at Mississippi State University, conducted the second annual student design-build competition at the beginning of the Fall 2012 semester. Interdisciplinary groups of students teamed up to design an eco-village on the edge of the campus of Mississippi State University. Student surveys were conducted at the beginning, throughout, and at the conclusion of the competition to determine the students' initial understanding of IPD and any preconceived beliefs they had about the roles, strengths and weaknesses of the other disciplines, as well as how that understanding changed during and at the conclusion of the competition.

The Competition

The Programmatic Challenge

On the edge of Mississippi State University campus lies abandoned housing for students with families in a combination of one and two-bedroom apartments. Developed in the early 1960's, the site contains 266 unfurnished apartments spread among 16 buildings: 207 two-bedroom units of approximately 570 square feet, and 59 one-bedroom units of approximately 405 square feet. The site is adjacent to a university-run childcare facility, is within walking distance of the rest of the campus, and is serviced by the university shuttle service. The university recently closed the development, citing the lack of a fire suppression system and unpopularity of the units, and has since been studying options for repurposing the site, with demolition of the buildings on the top of the list of options. The programmatic challenge for the competition was for each team of students to develop a proposal for turning the existing site into an eco-village. It was left up to each team to determine exactly what the definition of an eco-village was to that team, and what amenities and characteristics should be contained within that eco-village.

Competition Format and Schedule

The competition began on the first day of class for the Fall 2012 semester. The students, numbering nearly seventy, were placed in fourteen teams of four to five students, with each team containing two to three ARC students, one BCS student, and one to two ID student(s). For the two and a half week duration of the project the students shared a single studio space in the architecture building. One of the reasons this competition is able to occur is that each of the disciplines involved has a studio-based curriculum. Although slight changes needed to be made to the typical schedule of the ID studio for the duration of the competition, ARC and BCS studios routinely meet on the same days and at the same times for a total of twelve hours per week. This parallelism allows for the synthesis of design and construction education to occur. Another aspect that facilitated the interdisciplinary collaboration is that each discipline already incorporates BIM into its curriculum. ID offers a stand alone class for Revit and other 3-D modeling software, while all three disciplines integrate Revit into the content of the studios. In additional to the integration of BIM in each curriculum, the ARC and BCS curricula are structured such that students in both majors take six core curriculum classes, such as structures and passive building systems, together.

The students began the project on the first day of class. Over the course of the following two weeks students had the opportunity to attend presentations by representatives from the competition sponsor, Brasfield & Gorrie General Contractors, conduct group pin-ups with faculty and outside guests, and meet daily with faculty from each discipline to discuss their ideas. On the final day of the competition, students presented their work to representatives from Brasfield & Gorrie General Contractors, faculty from the three disciplines involved, and other guests. All fourteen teams had the opportunity to participate in a science fair-style review where each team stands near its work while faculty and guests are free to mingle and ask questions in a more informal setting. That process was followed by a more formal review where the top three teams, selected by the faculty the day prior, presented their projects to the sponsors and invited guests, who then ranked the three teams at the conclusion of the reviews and announced a winner. The top three teams were awarded a monetary prize based on their ranking at the conclusion of the presentations.

Method

Pre-Competition Survey

At the outset of the competition students were asked to complete a pre-competition survey intended to measure their understanding of IPD. In addition to demographic questions, the survey asked questions about prior experiences on group projects, prior interdisciplinary collaboration, perceived strengths and weaknesses of each of the disciplines, what the students knew about IPD, and whether they anticipated being required to collaborate with other disciplines upon graduation. The survey was taken after the project was introduced, but prior to the beginning of the collaboration. For this survey and the others, the students received an e-mail with a hyperlink, inviting them to complete the Qualtrics survey online.

Progress Surveys

The first periodic survey was given at the end of the first week of the project. The purpose of this survey was to measure how the collaboration was progressing, what the students had learned about the other disciplines, and what any perceived weaknesses of the other disciplines may be. A second periodic survey was given at the end of the second week of the project and was the same in content as Progress Survey I. The purpose of this survey was to see if the students' responses changed after an additional week of collaboration and, if so, how?

Post-Competition Survey

A post-competition survey was given at the conclusion of the collaborative period, after the students submitted their printed drawings and digital files, but before the final presentations. The purpose of this survey was to compare how their responses regarding collaboration and IPD changed from the pre-competition survey, as well as to gather data regarding how the effect of the level and quality of collaboration among the group members on the outcome of the project.

Results

Demographic Information

Sixty-seven students took part in the competition: 37 third-year ARC students enrolled in a 5-year B.Arch program, 14 fourth-year (senior) BCS students, and 16 fourth-year (senior) ID students. The discipline-specific gender distribution for the 40 males and 27 females taking part in the competition is shown in Figure 1, below.

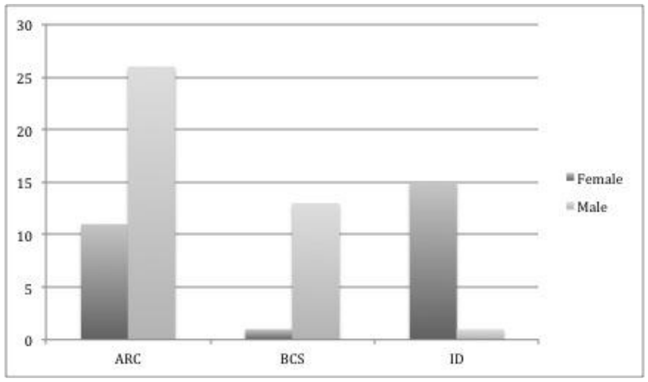

Figure 1: Discipline-Specific Gender Distribution

Pre-Competition Survey Results

Prior to the competition, all of the students had participated in a group project of some sort while only 57% (38 out of 67) had worked on an interdisciplinary group project. Of those who had worked on an interdisciplinary project prior to the competition, on a scale of one to five with one being the least positive and five being the most positive experience, the average rating was 3.2. While the students unanimously responded that it was important to work on interdisciplinary projects while in school, 93% (62 out of 67) expect to work in a collaborative setting upon graduation. Those who did not anticipate working in on an interdisciplinary team indicated the reason for their response was that they anticipate working for a small company, plan to start their own business, or are unsure of their post-graduation plans.

The students were asked which discplines they anticipated collaborating with after graduation. The results, grouped by discpline / major, are shown in Figure 2, below.

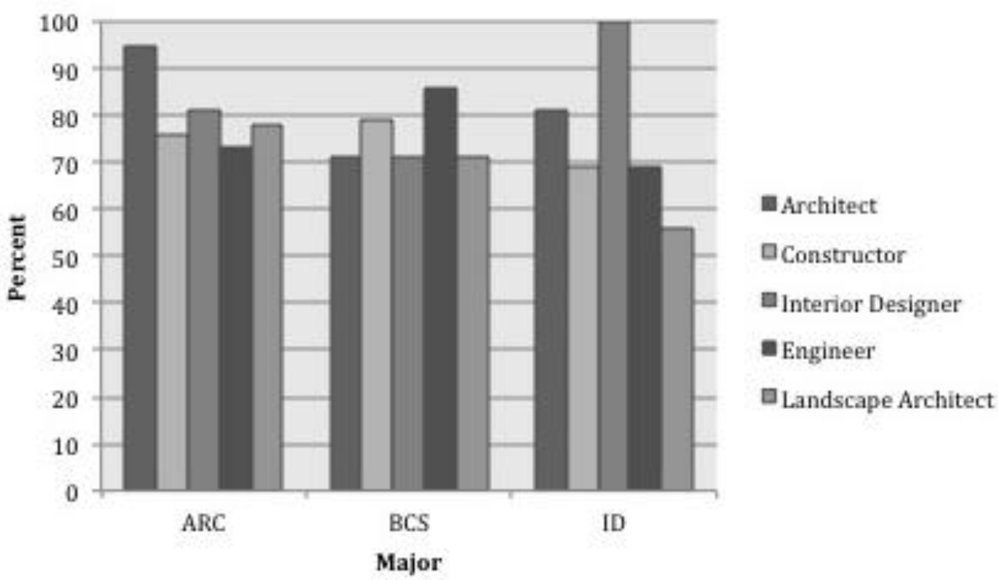

Figure 2: Anticipated Post-Graduation Collaboration By Discipline

When asked to define IPD, many of the responses contained elements of the definition provided by the American Institute of Architects California Council (AIACC), which defines IPD as "a project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively harnesses the talents and insights of all project particpants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication and construction" (AIACC, 2007, p.1). The responses largely referenced collaboration, shared knowledge bases, and an improved project delivery / outcome as the defining characteristics of IPD and interdisciplinary collaboration.

Of the 49% (33 out of 67, with 41 responding) of the students who anticipated the work load being equally shared throughout the competition, their responses indicated that each discpline had its own area of expertise to contribute and that they would need to rely on each other to be successful in the competition. 97 % (65 out of 67) of the students anticipated learning something about the other disciplines involved in the project, with the responses largely indicating that each discpline has specific knowledge the others do not that would be shared during the competition.

Progress Surveys

The most significant outcome of the first periodic survey was that within their groups, the students were learning a great deal about how the other disciplines think and work, although some saw those difference as a weakness – "The one weakness I have noticed is that each field's design process is very different." Yet many of the students recognized that "…everyone is good at what they are responsible, and whatever a person does not know, other disciplines are there to aid each other." The results of the second progress survey showed responses that shifted away from the skills of the disciplines and focused more on communication issues related to challenging group dynamics, indicating that Deutsch's position of focusing on the social aspects of IPD is valid.

Post-Competition Survey

In the post-competition survey, when asked to rank their competition experience on a scale of one to five with one being the least positive and five being the most positive experience, the average rating was 3.2. More than half of the students (57% - 35 out of 61) indicated that collaboration among the disciplines benefited the competition outcome yet, when asked whether they would be interested in participating in another collaborative experience, on a scale of one to five with one being unlikely and five likely, the average rating was a neutral 3.0. The more detailed responses of those students who responded with a result of less than three tended to indicate difficult group dynamics as a reason for not wanting to particpate in a similar exercise again, i.e. one or more team members dominated the discussion, group members were not able to or did not particpate equally, or that each team should have had equal discipline representation. Those students who gave a response of 3 or higher indicated by far in their detailed responses that the project was realistic to what they will face upon graduation and was an opportunity to learn about the other disciplines.

The students overwhelmingly agreed, 93% (57 out of 61) it is important to incorporate interdisciplinary projects into educational settings, while indicating that interdisciplinary collaboration is a reality they will face throughout their careers. The four students who did not feel collaborative work was important in school provided explanations indicating that education cannot mimic real world conditions and in their careers they will have the opportunity to choose who they work with.

When polled in the pre-competition survey, 93% (62 out of 67) expected to work in a collaborative setting upon graduation. When asked the same question at the conclusion of the competition, 90% (55 out of 61) of the students responded yes. The responses of the students who indicated yes expressed a range of responses indicating that collaboration would be required on large projects, that IPD was the direction in which the respective industries are moving, and that shared knowledge results in a better project for all parties involved. The students who did not anticipate collaborating with other disciplines upon graduation seemed to indicate a reluctance and/or misunderstanding of the collaborative process. Their responses ranged from viewing collaboration and IPD as an internal company approach - as in the company they work for will be small and not include all of the different disciplines in house, to the fact that IPD is not yet the norm, and perhaps they would consider interdisciplinary collaboration when it becomes the accepted standard.

89% (54 out of 61) of the students polled indicated they learned something about the other discplines through the collaborative process. When asked to rank the level of communication among the team members, on a scale of one to five, the average ranking was 3.5, with 87% (53 out of 61) of the students indicating that the quality of the communication was directly related to the outcome of the competition, i.e. the better the communiation the stronger the outcome, and vice versa. 77% (47 out of 61) of the students reported having a better understanding of IPD at the conclusion of the competition.

Discussion

Many of the obstacles to IPD that are experienced in the industry are also present in an educational setting. While industry professionals show a reluctance to implementing IPD because it is relatively new and untested (Kent et al 2010), students also show a reluctance to fully accepting the future role of IPD in their careers – yet both groups acknowledge that IPD will likely become the project delivery method of choice in the near future. Both groups show a preference for sitting back and waiting for IPD to withstand the test of time, rather than embracing the benefits IPD offers and taking a proactive role in its adoption.

Typical barriers to IPD, such as legal, financial, and techonological concerns, can be overcome if all parties are willing to work together to solve those issues. Although the technological barrier is partially related to the legal barrier, i.e. concerns about ownership of the model, other concerns such as interoperability (Ghassemi et al 2011) can begin to be solved when users have a thorogh understanding of the technology. By integrating BIM into the curriculum of each discipline, understanding can be improved which, in turn, can help to overcome the technological barrier.

The more difficult barrier to overcome is the cultural barrier, the 90% that Deutsch suggests we focus on - the reluctance to stray from traditional project delivery methods and accept IPD, a relatively untested project delivery method. By facilitating opportunities for interdisciplinary collaboration, communication and confidence in the capabilities of professionals in other disciplines can be improved and we can move closer to the "ideal synthesis" described by Deutsch. Because students lack significant industry experience in any of the given project delivery methods, we as educators have the opportunity to reduce or elimiate the cultural barrier from the vocabulary of the next generation of professionals. In the post-competition survey nearly all of the students reported having learned more about the other discplines – how they think and work, as well as what knowledge they have to share. By having a better understanding of the various disciplines involved, there is an opportunity to increase the confidence in the capabilities of other disciplines, which in turn can lead to improved communication, which the students almost unanimously agreed was directly related to project outcome. If students have the opportunity to collaborate, improve their communication skills, and learn to respect and value the input of other disciplines, they will be more confident in their own skills and abilities when they enter the job market, and therefore more likely to take a proactive role in paving the way for IPD to become the project delivery method of the future. In turn, IPD has the opportunity to be the "traditional" project delivery method for the new generation. As educators, if we can impress upon our students that they have the opportunity to become leaders in BIM and IPD, the students will have the opportunity to shape the future of both.

Conclusion

Industry professionals and students agree IPD is likely to become the project delivery method of choice in the future. While many industry professionals express reluctance to particpate in IPD because it is largely untested, students are all too reluctant to take the lead and seize the opportunity to become the leading experts on IPD. As educators, we have an obligation to do what we can to facilitate interdiscipinary collaboration that will better prepare our students to become the leaders in the shift toward IPD as the preferred project delivery method. Each construction program should evaluate its curriculum to search for possible areas of overlap with other disciplines in order to spot opportunities for interdisciplinary collaboration. When the disciplines have a better understanding of each other, the cultural barriers to IPD will be reduced and/or eliminated.

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