Integrated Practice and Architecture Education: The Evolution of a Pedagogy

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ABSTRACT: Integrated Practice and Integrated Project Delivery are becoming the norm in architectural practice and therefore must be addressed in architecture education. Architecture programs are also continuously facing pressure from the profession and the collaborative architectural organizations to integrate the profession into education. This has been encouraged through programs such as the various NCARB awards. However, if architecture programs do not take the lead and begin to create programs that address professional education issues, such as integrated practice, the decisions will start to be made for them.

This paper is about nascent research on integrated practice being conducted in an architecture program through the design studio. A three-week charette consisting of teams of architecture, interior design, and building construction students has been conducted for the past two years as an experiment in integrated practice and its impact on learning in architecture education.

Data was collected through surveys completed by the students through five surveys conducted throughout the three week time period. The first survey was a combination of quantitative data collection in the form of demographic information and qualitative data collection in the form of open-ended questions. The next three surveys were spaced out at certain intervals along the length of the charette and were specifically open-ended questions. The final survey was a reiteration of the qualitative questions from the original survey to gauge any changes in perceptions and knowledge since the administration of the first survey.

This paper will discuss the final results of the data and how that will affect the formation of the integrated practice charette for the next three years of the project. The paper will also propose best practices for using this type of project for a full semester studio, as well as for use by other architecture programs.

KEYWORDS: building information modeling, collaboration, interdisciplinary, integrated project delivery, millennial

INTRODUCTION

Ove N. Arup may have written that “Integration and collaboration have been preached ad nauseum…” but never before has integration and collaboration had a better opportunity of reaching its full potential than now. Architects are taking the lead on Integrated Project Delivery (IPD) and are the most experienced and informed of all AEC professionals in the definition and use of this important project delivery method (Kent and Bercerik-Gerber 2010). However, the majority of architects who are using IPD, and are the most experienced with IPD, are AIA members that have been in practice for fifteen years or more. Principals are also the most frequently reported as having experience on an IPD project (*2010-11 BIM/IPD SURVEY RESULTS-SUMMARY* 2011). Architecture education has a unique opportunity to increase the number or architects experienced in IPD by educating the younger generation of architects, starting with our students. This paper will discuss a recently formed integrated practice studio that teams students from architecture, building construction science, and interior design in a three-week charette. The discussion will focus on the implementation of IPD in design studios, the benefits of working with Millennial students, and the structure of the project. Quantitative and qualitative data was collected during the execution of the charette to gauge student knowledge and perceptions on IPD and the allied professions involved in this project. The information gathered from the students will be discussed in terms of methodology and the data results. Additionally, a comparative analysis of the professional structure of IPD and its applications to an integrated practice studio will be discussed.

1.0 THE IMPLEMENTATION OF INTEGRATED PROJECT DELIVERY IN DESIGN STUDIOS

1.1. Architecture Education

Boyer and Mitgang challenged the architecture education and professional community in 1997 with their report *Building Community: A New Future for Architecture Education and Practice: A Special Report*. Many issues were raised in this seminal report, but integration has come to the forefront not just due to this challenge, but also based on changes in the AEC (Architecture Engineering Construction) industry over the

past fifteen years. Integrated Project Delivery (IPD) may have become to the fastest growing form of project delivery since the American Institute of Architects (AIA) issued the first contracts referring to Building Information Modeling (BIM) in 2008 (Sabongi 2009). There is no mention of IPD in the NCARB 2007 Practice Analysis of Architecture, and "Collaboration/Cooperation" is the 7th most important change wanted in the field of architecture at only 4.97%. However, the upcoming NCARB 2012 Practice Analysis of Architecture should show a significant increase in the importance of IPD and BIM for the field of architecture (*NCARB 2007 Practice Analysis of Architecture* 2007). This increase in significance has already been shown in architecture education through the recent 2010-2011 BIM/IPD Survey Results conducted by the Association of Collegiate Schools of Architecture (ACSA). Autodesk and the ACSA partnered to gather information on the integration of BIM and IPD in architecture curricula. Administrators at 37% of ACSA accredited or candidate programs responded with the following results:

General Use of BIM

- 75% of respondents use BIM in studio courses
- 60% of programs use BIM in non-studio, required courses
- 63% use BIM in elective courses

Integrated Project Delivery

To assess this area of the curriculum the survey asked respondents how they are using collaborative design strategies in studios.

- 77% teamed architecture students at the same level
- 33% teamed architecture students at the different levels
- ~50% teamed architecture and non-architecture students
- 63% teamed architecture faculty in the same studio
- ~33% teamed architecture and non-architecture faculty
- ~50% used non-architect critics or instructors during the term (outside of reviews), with engineers being the most mentioned discipline of these students, faculty, or critics

Use of BIM in Studio Courses

- 40 (70%) of all respondents use BIM in an undergraduate design studio.
- In which levels is BIM used?
    - Undergraduate Studio (figures comprise all respondents, regardless of degrees offered)
        - 1st Year Studio (4%)
        - 2nd Year Studio (21%)
        - 3rd Year Studio (35%)
        - 4th Year Studio (51%)
        - 5th Year Studio (26%)

Collaborative Design Strategies

Please indicate how you are using collaborative design strategies in design studios? Check all that apply

a. Teaming architecture students at the same year level – (77%)
b. Teaming architecture students at different levels – (33%)
c. Teaming architecture students with non-architecture students – (47%)
d. Teaming architecture faculty in the same studio – (63%)
e. Teaming at last one architecture faculty member with a non-architecture faculty member – (32%)
f. Using non-architect critics or instructors during the term (not just during reviews) – (51%)

Disciplines of non-architecture students, faculty, critics or instructors included in the IPD studio (35 comments)

- Engineering (any discipline): 23 mentions
- Other Discipline: 21 mentions
- Landscape Architecture: 13 mentions
- Interior Design: 11 mentions
- Graphic or Industrial Design: 9 mentions
- Urban Design or Planning: 8 mentions
- Structural Engineering: 7 mentions
- Mechanical Engineering: 5 mentions
- Business: 5 mentions
- Other Engineering Discipline: 5 mentions (*2010-11 BIM/IPD SURVEY RESULTS-SUMMARY* 2011)

These numbers show that not only are architecture programs utilizing BIM and IPD in design studios, but that it has become an integral part of studios in many cases. What these numbers do not show is how BIM and IPD are being used in design studios. When 75% of respondents use BIM in studio courses, is it a required technology, or do students choose this tool? Also, is BIM taught as part of the studio, or is full immersion and knowledge required by the time students need to use it in studio? These types of questions

will help to further the research and conversation on how best to implement IPD and BIM in design studios, and they will be addressed in this paper on our integrated practice studio.

1.2. Building Construction Education

Building construction education programs have not been as successful as architecture programs in implementing IPD and BIM into that curriculum. A survey by Farid Sabongi found that 62% of respondents feel that BIM education in undergraduate construction curriculum is inadequate. This is despite the data that shows that 75% of respondents to the survey think that BIM will increase in the marketplace over the next five years. Additionally, only 10% of building construction programs are addressing BIM in any way (Sabongi 2009). The project discussed in this paper will posit suggestions on how best to use IPD and BIM in a design studio to prepare students in the allied disciplines of architecture, building construction science, and interior design for their future as professionals.

2.0. THE BENEFITS OF WORKING WITH MILLENNIAL STUDENTS

Understanding the traits of Millennial students is another important part of implementing an integrated practice studio. The article "Generation NeXt Comes to College: 2006 Updates and Emerging Issues" by Mark Taylor notes important traits and issues inherent to teaching Millennials. There are both positive and negative traits on how these students view their college education and knowing both allows a proactive pedagogy that can engage the students without capitulating to their consumerist mentality. The traits Taylor discusses include:

- The change from the conforming Millennial, similar to the college students of the past, to the entitled consumer.
- Delayed adolescence that is becoming the norm and is leaving students unprepared to enter the workforce.
- The digital dependence of students in college life.
- Pressure on higher education due to the increasing international competition of the "flat" world.
- Increasing calls for reform outside of higher education due to critical evaluation by the public.

Faculty and staff have also added to the information Taylor has collected on Millennial traits. Given that faculty and staff see students in a more detailed fashion, this information differs somewhat from the initial traits Taylor identifies. William C. Durden, President of Dickenson College sees students having traits that are considered an "emerging stereotype." Durden notes that Millennial students:

> …expect high grades without significant effort and often just for showing up; demand comfort and luxury more than a rigorous education; see themselves as consumers and expect services, and extended and direct personal attention on demand; have little respect for authority and show distain for collegial and social rules of conduct, instead asserting personal privilege; fail to differentiate between civil exchange of reasoned ideas and shouting personal beliefs, yet grow defensive when faced with constructive criticism; and have a naïve sense of the future (Taylor 2006, 2:48).

Additionally, Durden describes Millennial students as having the idea that

> facts don't really matter; what matters is the uninhibited, unedited, and immediate assertion of your egotistical options and thereby, the preservation of your self-esteem at all costs. It truly is all about you (Taylor 2006, 2:49).

Postmodernism is also very influential to Millennial students because they were born in this era and are very influenced by its ideals. Research by scholars such as Lyotard, McAllister, Sacks, and the former president of the Czech Republic, Vaclav Havel, show the relationship between Millennials and Postmodernism. This research states that Postmodernism tends to be pessimistic because there is more possibility, but less certainty. Higher education, on the other hand, is based on the Enlightenment, and the idea that science, reason and optimism would lead the way. These contrasts create friction between higher education and our current students, and also formulate these additional Millennial characteristics discussed by Taylor.

- Consumer orientation – *The "customer" is always right*
- Entertainment orientation – *Education should be fun!*
- Entitlement – *You get what you pay for…or at least show up for*
- Instant gratification – *A reflection of the fast food culture of the United States*
- Short event horizon – *Lack of long-term planning, critical thinking, and problem solving skills (which happen to be a requirement for architects and architecture education)*
- Adaptability and pragmatism – *Flexibility and open-mindedness*
- Excellence – *Grade inflation and little effort for much reward*
- Skepticism – *Postmodern trait that puts personal experience over information*
- Cynicism – *Right and wrong does not matter as much as someone's agenda*
- Safety issues – *Overprotected, Millennials do not take responsibility for their own safety*
- Stressed – *Not currently able to handle the stress of higher education*
- Civility issues – *Emotionally repressed and difficult to engage, "Are you talkin' to me?"*
- Intellectually disengaged – *Bored, constantly tardy, and only concerned with what they will be graded on* (Taylor 2006) [i]

Solutions suggested by Taylor to utilize these traits and teach Millennials include moving from the teaching model to the learning model, prolonged student engagement, the creation of significant learning experiences, developing meaning through real life application, requiring students to engage by having them bring needed information to class, multiple learning options, and facilitation of high level learning instead of rote memorization. The incorporation of integrated practice in a design studio can harness the ideas of Taylor, and the traits of Millennials to create a successful course that educates and connects our students to the architecture profession. The structure of the studio allowed the use of some Millennial traits such as:

Useful in a General Collaborative Studio

- Preparing students to enter the workforce
- Harnessing their digital dependence by using BIM
- Using a design competition to foster significant effort
- Introducing IPD to encourage respect for the knowledge and authority of others
- Project presentations to allow for the civil exchange of reasoned ideas
- Exposure to IPD and the allied professions to give students a better understanding of their future
- Collaborative teams to allow students to be adaptable and pragmatic

Specific to this Integrated Practice Studio

- Site, precedent, market, and LEED research to show that facts do matter and are important to synthesizing information needed in IPD
- A project of a campus facility to further engage the students and address their possible consumer and entertainment orientation by being able to better their surroundings
- A project duration of only three weeks to challenge instant gratification and short event horizon by having the students see the positive and negative of short project periods

Not all Millennial traits were able to be fully engaged, but future research and more in-depth analysis of this studio project will allow development to see if other traits can be included.

3.0 PROJECT STRUCTURE

3.1 Organization

The project was a three-week charette where fourteen interdisciplinary teams of students from architecture, building construction science, and interior design proposed ideas to redevelop a recently abandoned student-housing complex on campus into eco-housing. The project was a design competition with a monetary reward sponsored by a large local construction company to promote IPD in design studios. The studio was conducted by three architecture faculty, one building construction science faculty, and one interior design faculty. Students were organized into teams of four to five students, depending on the amount of students in each allied discipline. All teams had at least two architecture students, one building construction science student, and at least one interior design student. The student teams began with site verification and research on the site, precedent studies, market research on housing, and LEED requirements. These initial verification and research assignments helped to build team spirit and allowed the students to learn about the skills and knowledge of their teammates while they got to know one another. In addition to their research, the students learned about IPD, BIM, and Lean Construction from representatives of the large construction company that sponsored the studio. This allowed the students to see the professional application of IPD and BIM and then learn how they can relate it back to their collaborative studio. Once the students had built some camaraderie on the first assignment, they began their design using the information collected during the site verification and research. The students worked face-to-face in a typical studio environment that was located in the School of Architecture Building. The face-to-face format of the studio structure and the short time frame of the charette forced communication because the students had little time to make and implement decisions. This forced the students to spend minimal time apart, and decreased the use of email and other distance-based communication.

The students presented their developing work at a mid-review a week and a half into the charette. The reviewers were the university campus planner, the university sustainability coordinator, and the facilities director of the housing complex. This presentation provided the students with valuable feedback from the client, while also getting the opportunity to work on preliminary board layout and presentation techniques. The last week of the charette included desk critiques by the various faculty in the studio with each team to help refine and finalize the ideas for the competition. The final presentations began with gallery-style presentations where faculty and students from the three departments, as well as invited guests, and representatives from the large construction company came and reviewed all of the student projects in an informal manner by walking around the School of Architecture gallery presentation space. The top three teams were chosen earlier by the faculty in the studio to narrow down the number of formal presentations and decisions on who the winner was by the sponsor of the student design competition. After the gallery-style presentations the top three student teams presented their designs to the university sustainability coordinator, the two representatives from the large construction company, and various faculty from the three departments. The top three teams were then ranked in order of first place, second place, and third place by

the university sustainability coordinator and the two representatives from the large construction company acting as the client and sponsor of the competition. The combination of a more relaxed gallery-style presentations and formal presentations was intended to give every student team the opportunity to present, and defend, their ideas while giving the winners of the competition more emphasis by focusing on their work in a formal presentation. This increased the student engagement by showing the importance of trying to be one of the top three teams, in addition to the monetary reward.

3.2 BIM and IPD

The studio required that BIM be used to develop and create the project design. The researchers agree with Randy Deutsch that BIM and IPD must be synthesized together for IPD to be successful. Therefore BIM was an integral part of this integrated practice studio. The synthesis of BIM and IPD also reflects the synthesis of information that students in AEC education must learn to do so it is seen as an important element of this studio development. Students had varied experience with BIM, which influenced the team dynamic, and resultant project development and quality. Various student comments note the discrepancy of technological skills between the different students on the team. This is a result of the combination of third year architecture students with fourth year (senior) building construction science and fourth year (senior) interior design students. The Integrated Practice studio facilitates most of the points of ideal synthesis proposed by Deutsch in his article “Notes on the Synthesis of BIM” by creating teams composed of architecture, building construction science, and interior design students who work together from the beginning to the end of the project to create a solution to a design problem (Deutsch 2010).

The students used Autodesk Revit 2013 as the tool to facilitate the BIM in the charette. Revit allowed the students to share files to increase the ability of the students to work on the same project while working on separate parts on the project. These files were brought together similarly to the way that Autodesk AutoCAD used external references to allow collaboration amongst various design disciplines. This allowed the students to also see where there were conflicts in the building information that was created by each discipline. The architecture students used Revit to create the exterior building shell renovations and modifications, while the interior design students used it to create the interior renovations and additions. The building construction science students were then able to access the Revit files as they were being created to critique in regards to construction methods and budget. The building construction science students were also able to use this information to create their project phasing plans to facilitate the overall construction planning of the proposal, which, in turn, helped to finalize the project budget proposal for each group. This was the general method of BIM implementation in the studio but not every group was as skilled or as experienced as others who were more successful in fully using this method.

4.0 METHOD

4.1 Survey Instrument

Five surveys were conducted throughout the three-week charette and all were intended to gauge the student perceptions of IPD and the allied professions are various points throughout the project. The first survey was conducted during the first day of class, but after the project was introduced to the students. This survey consisted of quantitative questions to collect demographic and curricular data, and open-ended qualitative questions to allow students to give feedback on questions about IPD and the allied professions. The three primary faculty that organized the studio charette worked with a faculty member in the Department of Psychology to construct the surveys and to analyze the data. Qualtrics was used to conduct all five surveys through an online link that was sent via e-mail to all of the students in the integrated practice studio. A new email was sent to students for each survey. The second survey was conducted five days later at the end of the first week of the charette. This survey, and the next two surveys were follow up questions to gauge the students’ opinions and what they were learning in the various stages of the studio. The third and fourth surveys were also conducted one week after the previous survey at the end of each week. The final survey asked the students the same basic questions as the qualitative questions on the initial survey. This survey was conducted on the day of the final presentations, but before the students presented. (Fig. 1)

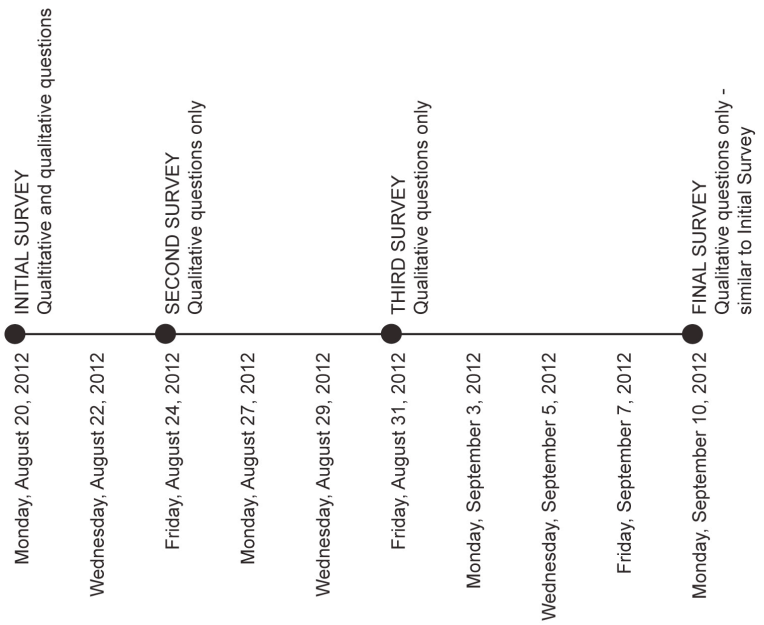

Figure 1: Timeline of Survey Distribution. Source: (Author 2013)

4.2 Data Results

The demographic data showed that sixty-seven students participated in the studio and survey with a make-up of 37 architecture students, 14 building construction students, and 16 interior design students. (Fig. 2) The average age of the students was 21 and the ages of the students ranged from 19-29. The majority of the students were in-state (67%) and the gender distribution of the class was 40 males to 27 females.

Figure 2: Student Demographic Data. Source: (Author 2013)

The data in experience with collaborative projects and interdisciplinary work showed that 100% of students had at least participated in a group project, with only 57% having worked on an interdisciplinary project. When asked about their experience on the interdisciplinary project those students rated their experience as a 3.2 on a scale of one to five with one being the least positive and five being the most positive experience. Despite this neutral response to interdisciplinary work 100% of students felt that it was important to work on interdisciplinary projects while in school. Most students (93%) expect to work in a collaborative setting once they graduate. Working in a small company, plans to start their own business, and uncertainty of their post-graduation plans were reasons given as to why the remaining students did not feel that they would be working in a collaborative setting. The students anticipated working with architects, constructors, interior designers, engineers, and landscape architects. (Fig. 3)

Figure 3: Integrated Project Delivery Pre-Project Question Data. Source: (Author 2013)

When asked to define Integrated Project Delivery the students tended to use the same basic ideas noted in the AIA definition. "Integrated Project Delivery (IPD) is a project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to reduce waste and optimize efficiency through all phases of design, fabrication and construction (*Integrated Project Delivery – A Working Definition* 2007)." Students in their definitions stated ideas such as collaboration, shared knowledge bases, and an improved project delivery and outcome.

Nearly half of the students (49%) expected to share the project workload, but when the students who disagreed were asked to explain the reasons behind their response none of the students chose to do so. However, the students who did expect the workload to be shared explained their answer by indicating that they felt that each discipline would contribute according to their area of expertise and level of knowledge and that they needed to collaborate to be successful. The majority of students (97%) believed that they would learn more about the allied disciplines that they were working with on the project and explanations of this response indicated that the students understood that each discipline had knowledge specific to their major that they would be able to contribute and share as part of the collaboration. The progress surveys garnered responses that showed that students were learning a lot about their partner disciplines. A variety of comments demonstrated the range of experiences from positive – "…everyone is good at what they are responsible, and whatever a person does not know, other disciplines are there to aid each other" – to negative – "the one weakness I have noticed is that each field's design process is very different…" On the other hand, the students were beginning to see the limitations of IPD and understanding the issues to be addressed to achieve a successful project.

The post-competition survey asked the students to rank their experience on the project, and similarly to the average response about collaborative and interdisciplinary work on the pre-competition survey the average response was a 3.2 on a scale of one to five, with one being the least positive and five being the most positive experience. When the students were asked whether they would be interested in participating in another collaborative experience the average response was a similar 3.0 on a scale of one to five, with one being unlikely and five likely. Difficult group dynamics was indicated as a reason for students' reluctance to participate in a collaborative studio in the future. Yet, students with a more positive response stated that they felt the project was realistic to what they will encounter in their professional careers. The students also agreed, at a rate of 93%, that the incorporation of interdisciplinary projects into educational settings is important. When collaboration in education was seen by some students as a concern, students did not feel that the educational setting could mimic the real world conditions of IPD in the profession. The majority of students did, however, note that collaboration improved the overall project outcome. (Fig. 4)

5.0 COMPARATIVE ANALYSIS

5.1 Similarities Between IPD in Practice and Education

The most important thing that the professional and educational aspects of IPD share and must address is the importance of relationships and the barriers created by the social constraints of the allied professions. Deutsch reminds us of that fact when he quotes the GSA's Charles Hardy in his article "Notes on the Synthesis of BIM". Hardy is famous for stating "BIM is about 10% technology and 90% sociology," and Deutsch reiterates that we must focus on the social aspects of integrated design (Deutsch 2010). Understanding the evolution of the world-views of the stakeholders in building design and construction is also important and Ryan Smith analyzes this in his article "Socio-Technical Practices." Smith posits that the various parties involved in construction have diverged since the Renaissance, with disastrous consequences. This is further exacerbated by traditional construction contracts, which focus on winning the project instead of creating the best product possible. Defining the knowledge and resultant boundaries for each profession is important to overcoming this long-established barrier to an efficient and well-constructed project (Smith 2011). This is also important to a successful integrated practice studio to help the students understand not only their abilities and limitations, but also those of their partners. IPD in professional practice also has basic themes that run throughout most projects and research on the subject that can correlate to integrated practice in the design studio. These include:

- Early involvement of all parties
- Shared risk and reward
- Multi-party agreements
- Collaborative decision-making and control
- Liability
- Jointly developed and validated performance goals (Smith et al 2010)

The studio is organized to have the students working together from the first day of class to make sure that there is early involvement of key participants. Risk and reward is shared through the grading process and design competition reward stipend. The assignments were written so that all team members receive the same grade, no matter who does what parts of the project. Additionally, there were monetary rewards for the top three teams that supported the reward aspect. The assignments also acted as the multi-party agreements, or "Integrated Form of Agreement," to make sure all students knew what the expectations were for the project and how they would be graded. The teams were a balance of all three allied disciplines, however the teams contained more architecture students purely due to enrollment. The interdisciplinary teams were organized based on individual student strengths and traits to enhance the collaborative decision-making necessary in IPD.

Even though the hypothetical project in the integrated practice did not involve any real risk or liability to the students they were still reviewed by their faculty in relation to risk and real-world issues in the design and possible implementation of their project. The one element of IPD not initiated by the students was development of the performance goals. The faculty developed these as the studio charette was developed prior to the beginning of the course. The lack of student experience in the professional realm of design and construction necessitated the faculty control that aspect. However, future studios could be organized to help the students develop the performance goals as a first assignment to begin the studio.

While the professional aspects of IPD that result from socio-technical variables that Smith notes are important, and the research into the more contentious components of IPD such as liability insurance and contracts that Kent and Becerik-Gerber outline are also important , just as important are the aspects of AEC education that foster the continued disparate views of the stakeholders (Smith 2011, Kent and Becerik-Gerber 2010). Educators have a particular opportunity to not only utilize design scholarship to address the transformations in the building industry on a professional level, but with their students as well.

5.2 Barriers to IPD

The social aspects of the AEC industry are one very large barrier to the success of IPD, but there are other barriers categorized by Ghassemi and Becerik-Gerber. These include legal, cultural, financial, and technological (Ghassemi and Becerik-Gerber 2011). The limitations of a collaborative studio including students from architecture, building construction science, and interior design allow only the exploration of two of these barriers: culture and technology. Culture ties directly into the social aspects discussed above and are evident in the fact that some in the construction industry still believe that the IPD contract type is needed. Nevertheless, the same respondents to the survey by Kent and Becerik-Gerber also noted that relationships were more important than contracts. Another positive development in the evolution of the culture of the AEC industry is that the majority of the AEC industry company owners who are experienced with, or at least informed about, IPD believe that it is the future of project delivery methods (Kent and Becerik-Gerber 2010). IPD training is also considered a part of culture, and students must be trained in IPD at the beginning of the project because it is not guaranteed that all students, even within one discipline, will be equally educated in IPD (Ghassemi and Becerik-Gerber 2011). However, students must come to the

studio already trained in BIM. Sabongi shows in his research that most AEC education programs feel that fitting BIM into an already tight curriculum is a challenge, and an IPD studio also has other ideas to focus on and implement. Therefore, a prior working knowledge of BIM by the students, and the AEC educators is imperative. Trust-building activities and tools are also needed to change the culture of the AEC to embrace IPD. The activities suggested include collaboration, coordination, openness, honesty, and transparency (Sabongi 2009). The faculty in the studios worked to promote these trust-building tools by meeting with the interdisciplinary teams and helping the teams overcome any individual issues and conflicts. Design studios also have these traits inherent through the development of studio culture and student bonding by working together. This integrated practice studio fosters collaboration and the students worked face-to-face in their interdisciplinary teams. All student teams worked in one large studio space in the School of Architecture building because it happened to have a space large enough to hold all of the students in the studio. The students spent a lot of time together as this was a quick, high-intensity charette of three weeks.

The integrated practice studio did not face all of the same challenges to integration of technology as those of professional AEC firms, such as collaborating with subcontractors, or translation and liability issues. However, the studio did benefit from the positive aspects of integrating BIM into the project process. The use of BIM built the student relationships, increased collaborations, and enhanced communication. This was due, in part, to the fact that not all students were educated in BIM. Even some of those who were educated in BIM were not knowledgeable enough to fully participate in the creation and development of the BIM model. These students instead participated through the development of project phasing and pricing, as well as project presentation. Other technological barriers not mentioned as being an issue for AEC professionals by Ghassemi and Becerik-Gerber ended up being barriers for the integrated practice studio. Many students were not versed in graphic design and development tools, such as Adobe Photoshop, Adobe Illustrator, and Adobe InDesign. These technological barriers seem to be unique to AEC collaborative studios and, just as with BIM, should be addressed prior to the start of a collaborative studio.

CONCLUSION

This integrated practice studio charette will be conducted for the next three years so various ideas and issues will continue to be investigated during each new iteration of the project. Barriers that educators can address through integrated practice studios are fear of change, lack of IPD awareness, limitations of technology, cultural barriers within the industry, falling back on tradition, and an unwillingness to try something new. Despite these barriers the majority of AEC industry company owners were willing to work on IPD projects, showing a bright future for our students to enter the workforce being prepared to work on IPD projects.

Integrated practice studio projects can address these barriers by giving students the opportunity to begin working together to create trust, respect, and good working relationships before they enter the profession. Educators must provide the leadership that is required to get this type of education off the ground and help move our students into the world of IPD. Considering the lack of certainty on the part of AEC professionals on how environments will be created to encourage and support IPD, educators also have the opportunity to educate their students to facilitate the creation of these environments when they transition into the profession and utilize what they have learned about collaboration.

Faculty need to define the scope of work, specific project goals, clearly define roles, relationships, and responsibilities between the project participants because the students are unable to do that due to their inexperience with design, construction and integrated practice. This will help create a team spirit of win-win for every team member and foster an environment of trust and mutual support. The AEC faculty should also act as the owner in an integrated practice studio to frame the scope and expectations of the collaboration and the project. Additionally, students have trouble synthesizing information, so we must foster that process as educators since synthesis between IPD and BIM is so important to collaboration.

The qualities and characteristics that building owners look for in IPD teams relate to the same qualities and characteristics that AEC employers will begin to look for in the graduates of our programs. Integrated practice studio projects give our students the education and the advantage by placing them in a collaborative environment before they graduate. IPD in education not only addresses the barriers noted above, but also addresses the ideas generated by Boyer and Mitgang on the scholarship of integration, the integration of knowledge, and a more integrated curriculum. We can engage the university campus, other allied disciplines, and create a climate of integration that benefits both architecture education and the profession (Boyer and Mitgang 1997).

REFERENCES

Kent, David C., and Burcin Becerik-Gerber. "Understanding Construction Industry Experience and Attitudes toward Integrated Project Delivery." *Journal of Construction Engineering and Management* 136.8 (2010): 815-25. *Understanding Construction Industry Experience and Attitudes toward Integrated Project Delivery.* Journal of Construction Engineering and Management, (January 16, 2010),

http://ascelibrary.org/action/showAbstract?page=815&volume=136&issue=8&journalCode=jcemd4, (accessed October, 23 2012), 4.
"2010-11 BIM/IPD SURVEY RESULTS—SUMMARY." 2010-11 BIM/IPD SURVEY RESULTS—SUMMARY. Association of Collegiate Schools of Architecture (ACSA), (May 2011), https://www.acsa-arch.org/docs/resources/bimipdsurvey2010.pdf?sfvrsn=1, 11-12. (accessed September 13, 2011).
Sabongi, Farid J. "The Integration of BIM in the Undergraduate Curriculum: An Analysis of Undergraduate Courses." *International Proceedings of the 45th Annual Conference*. Associated Schools of Construction, (April 2009), http://ascpro0.ascweb.org/archives/2009/CEUE90002009.pdf, (accessed October 23, 2012), 1.
"NCARB 2007 Practice Analysis of Architecture." *NCARB 2007 Practice Analysis of Architecture*. National Council of Architectural Registration Boards (NCARB), (Nov. 2007), http://www.ncarb.org/~/media/Files/PDF/Special-Paper/2007NCARBpracticeanalysis.pdf, (accessed September 13, 2011), 16.
Taylor, Mark L. "Generation NeXt Comes to College: 2006 Updates and Emerging Issues." *A Collection of Papers on Self-Study and Institutional Improvement*, 2, (2006) 2:48.
Deutsch, Randy. "Notes on the Synthesis of BIM." *AECbytes Viewpoint #51.* Dr. Lachmi Khemlani, 7 (Apr. 2010) <http://www.aecbytes.com/viewpoint/2010/issue_51.html>, (accessed October 23, 2012).
"Integrated Project Delivery - A Working Definition." *Integrated Project Delivery - A Working Definition.* AIA California Council, (June 13 2007) <http://ipd-ca.net/images/Integrated%20Project%20Delivery%20Definition.pdf>, (accessed October 23, 2012).
Smith, Ryan E. "Socio-Technical Practices." – *Center for Integrated Practice*. American Institute of Architects, (August 18 2011), http://network.aia.org/CenterforIntegratedPractice/Resources/ViewDocument/?DocumentKey=ee286a4c-45ae-4560-a2c7-9aecbd0b98c0, (accessed October 23, 2012). 3.
Kent, David C., and Burcin Becerik-Gerber. "Understanding Construction Industry Experience and Attitudes toward Integrated Project Delivery." *Journal of Construction Engineering and Management* 136.8 (2010): 815-25. *Understanding Construction Industry Experience and Attitudes toward Integrated Project Delivery.* Journal of Construction Engineering and Management, (January 16, 2010) http://ascelibrary.org/action/ showAbstract?page=815&volume=136&issue=8&journalCode=jcemd4, (accessed October 23, 2012), 2.
Ghassemi, Reza, and Becerik-Gerber, Burcin. Transitioning to Integrated Project Delivery: Potential Barriers and Lessons Learned. *Lean Construction Journal* (2011): 32-52. Lean Construction Journal. Lean Construction Institute, (2011) http://www.leanconstruction.org/lcj/2011/LCJ_11_sp3.pdf, (accessed October 23, 2012), 4.
Boyer, Ernest L., and Lee D. Mitgang. *Building Community: A New Future for Architecture Education and Practice : A Special Report.* Princeton, NJ: Carnegie Foundation for the Advancement of Teaching, 1996.

ENDNOTES

[i] Millennial character notes in italics are those of the first author.