Teaching Integrated Practice: An Integrated Project Delivery Theater

The ability to work effectively in teams has become increasingly important because of the complexity of projects requiring expertise from a variety of specialties and demands from clients for better building performance. Collaboration is a meaningful response to the ongoing marketplace mandate for buildings that are faster to design and construct and at lower cost than those built in the past.

—Andrew Pressmann, Designing Relationships:
The Art of Collaboration in Architecture

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INTRODUCTION

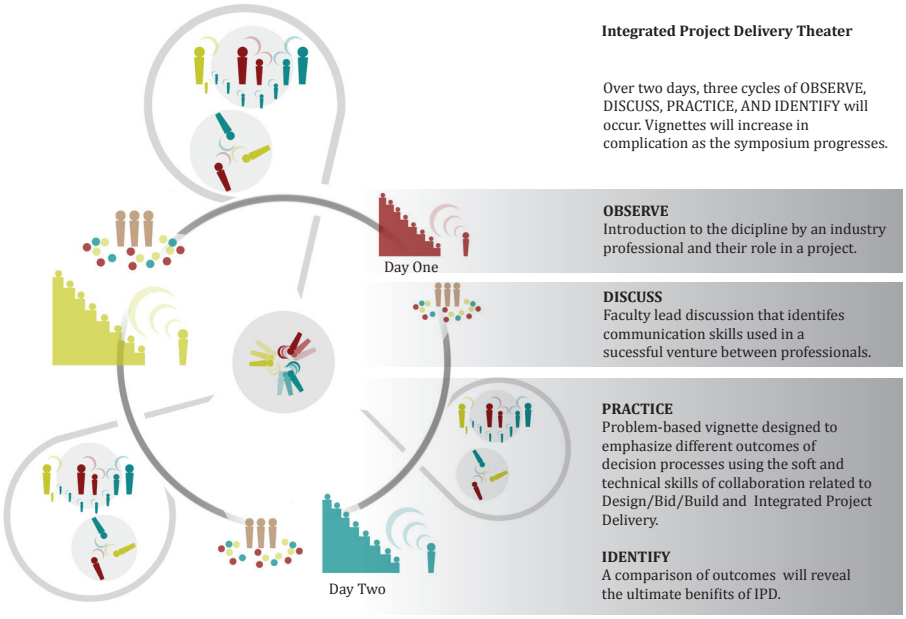
As projects become more complex and performance based, industry professionals must work together to provide functional, cost effective, and well-designed buildings. The allied disciplines of architecture, construction, and engineering are becoming interdependent, and more pressure is being applied to the relationships between owners, designers, and builders. Before they enter professional practice it is important to teach collaborative models of work to students.

As Noreen M. Webb explains in *The International Handbook of Collaborative Learning,* collaboration is a learned skill, and "simply asking students to collaborate will not ensure that they will engage in productive dialogue."[2] Project delivery methods such as design-build (DB) and integrated project delivery (IPD), generally termed "integrated practice" (IP), should be taught and demonstrated to students before they are expected to be full professional participants.

There are difficulties associated with teaching IP in the academy. According to survey data collected by the authors, few architecture and construction faculty have a background in IP because they are relatively new project delivery methods. Personal experience enriches a professor's teaching abilities, but without firsthand knowledge, explaining the processes and benefits of IP can be challenging. The results of a 2014 survey of architecture and construction faculty, conducted by the authors, found that 71% of faculty have never practiced under an IP contract, such as IPD and/or DB. In the same survey, 79% of respondents plan to incorporate IP principles in their coursework. Architecture and construction faculty are teaching IP without first hand experience.

Practitioners offer real world examples of successful collaboration within IP. This paper documents an academic experiment that brings a professional collaborative team to students learning about IP. In a two-day symposium, developed by the authors, the six principles of integrated project delivery are creatively exemplified and then explained by the practitioners. In a true collaboration between teachers and practicing professionals, the strengths of both combine to bring IP into light for architecture and construction students.

Figure 1: Students collaborating to build a sandwich based on the communication principles of IPD.



2

Figure 2: The interactions between students, faculty, and industry professionals which bring the principles of IP from industry to academia.

MAKING A CASE FOR COLLABORATION FROM PRACTICE

In the *2012 NCARB Practice Analysis of Architecture*, collaboration is identified as one of eight areas in which recent graduates need reinforcement "The practice of architecture is a highly collaborative, team-driven effort; therefore, the ability to successfully interact with other professionals is essential."[4]

The same report determined that "over 80 percent of architects rated 'collaboration with stakeholders' as important/critical …"[5] Clearly, NCARB and practicing architects understand that collaborative relationships are important to the success of architecture, but recent graduates report they are not receiving the necessary education while they are in school.

The American Institute of Architects (AIA) recognizes IPD as a way to provide quality buildings, on -time and on-budget to increasingly involved and demanding clients. Collaboration is at the heart of IPD where "teams are guided by principles of trust, transparent processes, effective collaboration, open information sharing, team success tied to project success, shared risk and reward, value-based decision making, and utilization of full technological capabilities and support."[6] Although logical, these team attributes are not always easy to practice—even for professionals.

The AIA's publication, *Integrated Project Delivery: A Guide* was specifically developed to provide understanding of IPD and its principles to professionals. Highly collaborative, alternative project delivery methods such as this require training before they can be fully utilized.

AND FROM THE ACADEMY…

The results of a 2014 survey of architecture and construction faculty, by the authors, show that a majority of faculty believe teaching collaborative practice is important, and that almost 80% of the respondents plan to incorporate IP principles into their coursework. The *2012 NCARB Practice Analysis of Architecture* reinforces this:

Data from NCARB's Practice Analysis further indicates that over half of the educators surveyed identified collaboration as included in their program, and over 70 percent of those same respondents reported that students performed collaboratively (with guidance and feedback or independently) by completion of their program.[7]

Contradictory to this belief, interns and recently graduated architects report much less collaborative activity. NCARB reports that ". . . only 31.5 percent of interns and recently licensed architects indicated that they had performed collaboratively prior to completion of their education program."[8] A gap in perceptions between teachers and students is apparent. To insure students receive the collaborative experiences that bolster their participation in IP, the academy must look for alternative teaching methods.

LITERATURE REVIEW

In a review of courses and other efforts to teach IP with industry professionals across schools of architecture, construction, and engineering, a variety of programs emerged. Typically, they fell into two categories, design studio or seminar coursework. The most significant and well documented effort is Pennsylvania State University's IPD and BIM Focused Capstone Course in the Department of Architectural Engineering. This four year pilot program crossed disciplines to provide students with a studio example of integrated working relationships. Although different in format, this example relied heavily on industry professionals for their expertise. The authors note this in the following quote:

> Actual project practitioner involvement in educating the students about the building and building process through guest lectures, seminars, training sessions, and tours was a great advantage as students gained valuable insight as to how and why decisions were made with respect to select systems, especially those systems and building assemblies that are not covered extensively in the current curriculum. The authors conclude that industry support in the classroom will be essential in the successful implementation of a program of this type for any institution considering a multidisciplinary capstone of this nature.[9]

At the University of Southern California a technology studio/seminar combination developed "for the integration of the design curricula with a building technology course by emphasizing teamwork and the use of three-dimensional software"10 utilized industry professionals as well. Although this course was not cross-diciplinary, it covered issues of teamwork and the reality of a more collaborative professional environment. Outside guests were invited to discuss the technology they use for their work.

Other teaching examples were similar like Texas A&M University Design-Build Project Delivery Method studio undertaken in 1999 and Iowa State University's 2009 Integrated Solar Decathlon Student Team. These studios combine disciplines to accomplish a design task while learning about the advantages of teamwork. At Mississippi State University, a cross-diciplinary studio sequence is currently being taught between the School of Architecture and the Building Construction Science Program. These examples extended throughout a semester or longer but do not use industry professionals as key participants in the experience.

Many examples of cross-diciplinary curriculum in architecture programs can be found. Although beneficial, it is less common to find partnerships between industry professionals and academia. Strengthening this link is one goal of the Integrated Project Delivery Theater. Its short length of time and low commitment level for professionals makes it an ideal solution.

INTEGRATED PROJECT DELIVERY THEATER

The development and performance of a two-day symposium, entitled *Integrated Project Delivery Theater*, which uses problem-based vignettes and an industry partnership to demonstrate the importance of collaboration to architecture and construction students is the subject of this paper. As a framework, the American Institute of Architects (AIA) IPD guide was used to create six interactive vignettes that demonstrate collaborative characteristics of IPD: teams, process, risk, compensation/reward, communication/technology, and

agreements.[11] Although the symposium's basis is IPD, the principles of collaboration are transferable to other project delivery methods.

There are four parts to the organization of the symposium: observe, discuss, practice, and identify. First, participants observe an introduction to the subject of the vignette. A discussion follows the observation phase, which is led by faculty. Participants then practice by completing the problem-based activity designed for each of the six principles. Participants share results of the vignette, and discussion follows, which is led by the industry professionals to identify real-life application of each principle. Above, in Figure 2, a diagram depicts the interactions between students, faculty and industry professionals. This cycle of activities occurs for each IPD principle.

Industry professionals from the AIA Firm of the Year, Eskew+Dumez+Ripple, Turner Construction Company, and ADAMS, a program management consultant participated in the 2015 symposium and made these concepts accessible to the students through shared personal experience. This team of practitioners worked together to design and construct the New Orleans BioInnovation Center (NOBIC), which was completed in 2011 and named by the AIA Committee on the Environment (COTE) as one of the top ten green projects of 2015.

The symposium was funded through a grant awarded by the Architecture + Construction Alliance (A+CA) and with funds provided by the authors' institution. The grant was awarded in November of 2013. Planning for the symposium took place during 2014, and the event was held in January of 2015. The methodology is described in the following sections.

PRE-TEST/POST-TEST

To assess the participants' level of knowledge of IP before the symposium, a pre-test was approved for distribution. An approved post-test was also administered on the last day. Both tests contained identical questions, because the intention of the tests was to assess what participants knew about IP prior to and after the symposium. Sample questions and pertinent results of both are described in a later section.

RESPONSE RATE

All fourth year and third year students in the School of Architecture and the Building Construction Science Program (BCS) were required to participate in the entire two day event. At the time of the symposium there were 27 third year architecture students and 13 BCS students. In fourth year there were 25 architecture students and 17 BCS students. A total of 82 students were expected to attend the symposium. Faculty members from other A+CA schools were invited as well as faculty members from Mississippi State University.

Seventy-two participants who identified themselves as either a third year or fourth year student took a pre-test giving a response rate of 88%. Seventy-three students took the post-test giving a response rate of 89%. The additional student can be attributed to varying schedules throughout the day. An exit survey was also administered. Its response rate is 82% with 66 students submitting a survey.

VIGNETTES

The vignettes are designed to demonstrate the six principles of IPD as defined by the AIA: teams, process, risk, compensation/reward, communication/technology, and agreements.[12] Each vignette requires student participation in varying degrees. Two of the vignettes, teams and process, require participants to break into small groups, while the other four vignettes are demonstrated publicly. Following the completion of each vignette, the practitioner team participates in a panel discussion that associates the participants' immediate experience to the practitioners' personal accounts of working together on the NOBIC. A summary of each vignette follows:

3

TEAMS

A pre-established scenario was developed by the authors prior to the break-out session. Participants are asked to make tough decisions about who will join them on a life raft based on the survivors' occupancies, race, beliefs, physical characteristics, and age. A limited number of survivors are allowed on the life raft; all other must be thrown overboard! There were six break-out groups and the results of each groups' survivor team are shared in the large group.

A discussion, led by a faculty member, about the teams' decisions followed the vignette. The decisions each team made proved to be controversial and difficult. After the results were shared and discussed, the practitioner team lead a follow-up discussion focused on the importance and difficultly of selecting a project team. The summary by the practitioners helped participants to see that selecting the right team for a project is key to a successful collaboration but not always easy to do. Preconceptions and allegiances sometimes block leaders from making the right decision.

PROCESS

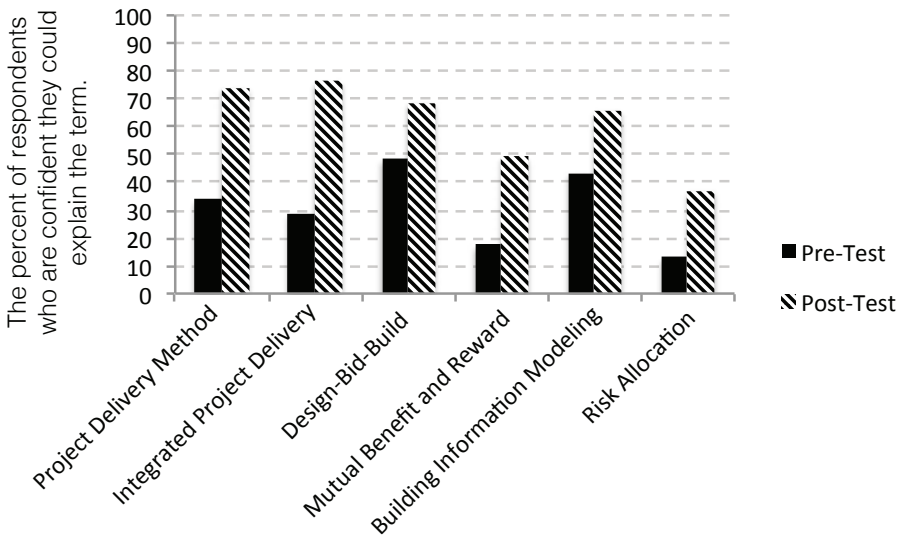
The process of ordering and having a sandwich made is similar to designing and constructing a building. An abstract idea of a what would make a good sandwich is conceived of, like the design process of a building. The person who thinks up the sandwich is not always the one who makes the sandwich. Clear instructions must be given to a cook by the chef or customer in order to insure the correct order is filled. Simplified, this is similar to set of drawings that a builder must follow to construct a building. Most students have not participated on a professional design team. The construction of a sandwich is something they are familiar with, and can be used to highlight various project delivery processes.

The basic principles of collaborative and traditional project delivery methods are exemplified by this vignette. The customer (client) orders a sandwich from the chef (architect), and the cook (general contractor) is asked to make this sandwich in a certain amount of time for a set cost. First, using oversized foam sandwich supplies (as seen in Figure 1), participants fulfill the chef's sandwich order using a linear process based on design-bid-build. The order is placed and the cook organizes the baker, cheese monger, vegetable provider, butcher, and condiment specialist (subcontractors) one by one to provide what is needed for the order. The time and cost of mistakes are recorded.

Figure 3: The results of unlimited (right) and restricted (left) communication.

Directly after this entertaining demonstration, another sandwich is ordered but made using a process based on IPD. The customer orders another sandwich, but this time the customer, chef, cook, and subcontractors are able to discuss the sandwich in advance. Their discussions result in an accurately priced and much faster assembly of the IPD sandwich.

The guest professionals related this experience to a real examples at the NOBIC where early involvement of the general contractor (GC) improved the final product. Early design specified the main entry stair as cast-in-place concrete. With advice from the GC and agreement from the architect, the stair was replaced with a precast concrete stair. The GC alternative was less expensive, logistically simplified, and of higher quality. The client and the architect were both satisfied with this substitution, and it was possible because of early GC input.



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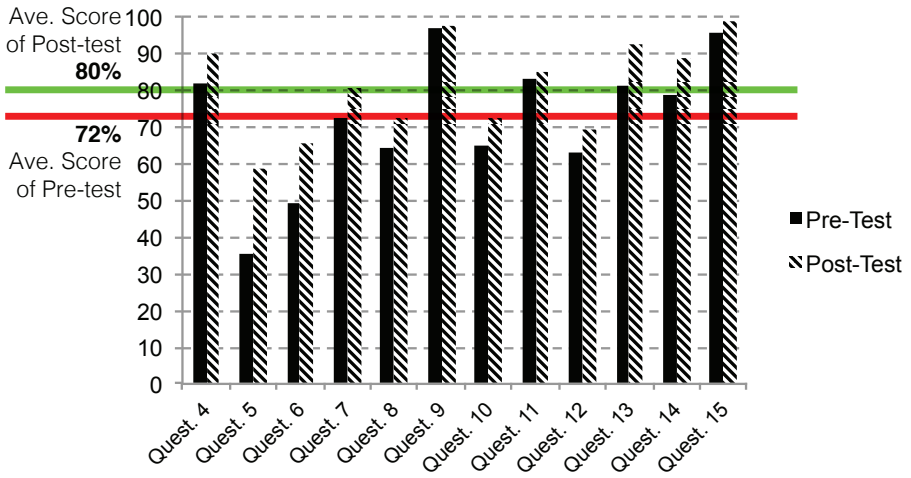
COMMUNICATION/TECHNOLOGY

To demonstrate the importance of early communication between members of a design team, the process vignette asks participants to attempt a joint painting with varying amounts of communication. Participants divide into their break-out groups and are asked to complete a painting with the instructions they are given. Six degrees of communication are pre-arranged and each group receives a different set of instructions. To exemplify what happens when communication is completely restricted, one group is given a portion of an image (in black and white), a limited selection of paints, and a brush. Their individual work is hidden from their teammates, and they are not allowed to speak during the time they paint. The result of this team's painting is a mismatched, incomplete copy of the original image, which vividly demonstrates the results of poor communication (or none at all). The left side of Figure 3 shows the results of their work.

On the opposite end of the communication spectrum, a team is given a portion of the same painting (in color), access to any paint color and brush, and a copy of the original painting for reference. This group is allowed to communicate and plan from the beginning. Participants are encouraged to help one another. The results are clear in the end. More information and the ability to work together produce a more accurate and complete picture. Above, in Figure 3, the difference in accuracy and completeness depict how communication improves the outcome of working together.

Figure 4: The percent of respondents who are confident they could explain the term before and after the symposium. The average increase of all the terms was 30.97%.

To summarize the experience, the practitioners shared their process for designing and building the NOBIC. The paintings help the participants to understand that early and ample



communication at the beginning of a design project helps to produce buildings that meet design intent, schedule, cost, and sustainability goals. Industry professionals shared their communication strategies which included project management share-files, pre construction meetings, AOC (architect, owner, contractor) weekly meetings, weekly newletters/score cards, and field reports. Since the owner's representative, the architect, and the contractor were all participating, students were able to hear from each side about the advantages of clear communication.

COMPENSATION/REWARD

Using the two extremes from the collaborative painting exercise, compensation/reward is explained by this vignette. Each square from the original painting is assigned a dollar value for its worth based on how complicated it is. Next, each painting square by the participants is given an amount it is worth based on correctness, completeness, and craft. The total earned worth of the whole painting is then compared to the total value of the original painting.

As the left side of Figure 3 illustrates, the IPD team's quality and completeness far exceeds that of the less collaborative team. The worth of the painting squares that belong to the team who was not allowed any communication is less than the team who worked together based on the final paintings quality. This demonstrates that teams, as well as buildings, benefit from ample communication. When compensation is tied to building performance and schedule, working together pays off.

RISK

This activity uses the weight of sandbags to demonstrate the burden of risk. Several student volunteers are asked to hold five-pound sandbags that represent typical risks an individual owner, architect, or constructor may take when working in traditional project delivery methods. This scenario suggests the owner, architect, and contractor are carrying their risks on journey. Along their path the burdens begin to encumber their progress. It becomes clear that many risks are duplicates and that sharing the risks, as in IP, can reduce the burden. In the IPD version of this journey, the team shares the risk burden allowing them to complete the journey more quickly.

This vignette proved to be difficult to relate to the NOBIC project. Although it was built by an integrated team, an actual IPD contract was not used. General ideas of risk and teamwork were discussed by the industry professionals to emphasize that trust plays a major role on integrated teams.

Figure 5: The percent of respondents who correctly answered a series of questions related to IPD before and after the symposium. An 8% increase in correctness suggests a positive outcome of the symposium.

AGREEMENTS

The web of agreements formed by traditional project delivery methods is the focus of this vignette. Firstly, a number of participants are assigned typical design team roles and asked to link up using large rubber bands in the order of a traditional contract. A verbal directive is given by the architect and passed down through the ranks, in "telephone game" fashion. The resulting statement is announced, and it is predictably grossly inaccurate. This demonstrates the trouble with linear agreements and the resulting lines of communication.

Secondly, another group of participants is selected to play the same roles and asked to complete several tasks as a group. A very large rubber band (12' in diameter) "contracts" them together as they have to work together to achieve the best outcome. They all stand inside the rubber band together and are told not to let it touch the ground. Tension on the band is necessary at all times even as they are asked to complete their collaborative tasks.

When participants worked together to accomplish the task, the best outcome was possible. Again, this vignette was followed up with a general discussion of agreement types and the advantages of integrated processes.

TEST RESULTS AND DISCUSSION

As described earlier, a pre-test and a post-test were administered to symposium participants. The questions in each test were identical. An exit survey was also given in order to identify which aspects of the symposium were most successful. Questions one and two ask participants to identify their position at their university and if they are a student, which year level.

QUESTION 3—VOCABULARY

The test begins with vocabulary words associated with project delivery. Participants were asked to select one of the following categories for several words:

A. I have never heard the term,

B. I have heard the term but do not know what it means,

C. I have a general idea what the term means but I am not confident I could explain to someone the term and its significance, or

D. I am confident I could explain both the term and its significance.

Most significantly, the percentage of participants reporting "I am confident I could explain both the term and its significance" grew from the pre-test to the post-test. The largest increase in understanding was of the term "Integrated Project Delivery" at 47.7%. Below, Figure 4 compares the percent of students from before and after the symposium who report they are confident in explaining the given terms.

GENERAL KNOWLEDGE OF IPD

The remaining questions tested participant knowledge about specific areas and nuances of IPD. As an example, text question 6 asked participants a true/false question: "When using a traditional project delivery method, an engineer and the general contractor can communicate with each other when a problem arises." The answer to this question is false. The contractor does not typically have direct communication access to the engineers of a design-bid-build project. Communication must filter through the architect. During the symposium the advantages of integrated meetings to discuss project development was emphasized. Although communication is not "free" in IP, increased access to team members improves understanding, therefore improving outcomes. The post-test reveals that 16% more students answered this question correctly after the symposium.

Other questions related to the six principles of IPD revealed an 8% increase in correctness after the symposium. This seemingly low increase is in part due to the students' prior exposure to IP in other classes and studio coursework. Two separate six-hour design studios concentrate on IP in the students' second and third years of school. Both architecture and BCS students participate in these mandatory studios, and as a result, 72% of students answered the questions correctly in the pre-test. A comparison of pre and post test results is depicted in Figure 5.

EXIT SURVEY

In addition to the pre and post-tests an exit survey was given to participants to determine if this alternative approach to teaching IP was effective. Questions asked students which vignettes they thought were most and least effective, and if they thought the industry professionals enriched their experience.

An overwhelming 98% of participants strongly agreed or agreed the industry professionals enriched their experience at the symposium. It seems two-days may have been too long for some with only 85% of students agreeing that two days was the right amount of time. This is being taken into account for future symposiums. A one-day session is under development for several reasons. First, one day is less disruptive to students' schedules, and second, industry partners may not be able to dedicate two days to the event in the future. Less time in the symposium may diminish leaning outcomes but the authors believe an abbreviated version is possible and also beneficial.

When asked which vignette they believed to be the most successful, 43% of respondents selected the process (sandwich) exercise. In a close second place, 40% of respondents preferred the communication (painting) exercise. Twenty-nine percent of participants reported the teams vignette was the least successful. Risk and agreements were also reportedly less successful with 24% and 22% of respondents, respectively, selecting these vignettes. True to the initial survey of architecture and construction faculty conducted before the development of the symposium, risk and agreements proved to be the most difficult subjects to teach. These vignettes are under review and will be reconsidered for the future.

CONCLUSIONS

It is clear there is a need for new methods of teaching IP, and that introducing the principles of collaboration to students is beneficial to the professions of architecture and construction. University faculty do not always have direct experience with collaborative project delivery methods and sometimes struggle to teach them effectively. Partnerships with industry professionals, who have worked together in collaborative models, provide faculty with the examples necessary to enrich a student's understanding of why collaboration is important after graduation.

Interactive vignettes prove to be a successful method for teaching collaborative principles. Of the six vignettes employed, three are worthy of repeating and two need adjustments to make them more effective. The two-day symposium provided valuable information about IP to participants, and an overall increase in understanding was documented. The percent of increase was small, but this can be explained by the college's mandated collaborative curriculum. The students who participated in this symposium have been exposed to IP repeatedly throughout their academic career and a large increase in understanding could not expected.

The two-day time frame does not lend itself to a regular teaching schedule but it is appropriate for a partnership with outside professionals. The success of the vignettes relies heavily on follow-up conversations that relate the abstract experience to one based in real practice. Although a partnership with industry professionals is ideal, it may not always be possible.

Adjustments to the vignettes could develop assignments for a seminar or in-studio activities for a collaboration focused projects.

INCORPORATION INTO TEACHING PEDAGOGY

The vignettes are easily replicable as part of a professional practice course or design studio with students as learner and the faculty managing the parts of the industry experts based upon their independent research. Vignettes could intentionally end with particular questions about IP practice, and students could undertake a research project intent on revealing answers to the problems raised by the vignettes.

The more simplified the vignette, the less students were able to engage and comprehend the issue. The issues are dense and they require the break-out vignettes as an "inquiry catalyst" upon which students may find their precedent studies on the particular facets of IP. There is no silver bullet just a better way to activate students interests and foreground the principles and issues associated with employing IP.

NEXT STEPS

The *Integrated Project Delivery Theater* successfully increased the students knowledge of IP, and the students' response was pleasing. Development for version two (possibly a one-day event) is underway, and opportunities to host another symposium are being sought. This repeatable event is designed to travel to other universities interested in bolstering their student and faculty understanding of collaborative methods of project delivery. Introducing students and faculty to the principles of IP will not only ready them for what lies ahead but will position them to shape the future of practice.

ACKNOWLEDGMENTS

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ENDNOTES

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