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Constructing Relationships: Examining Project Structures to Align Design Conception and Realization

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Constructing Relationships: Exploring the Correlation between Project Structures and Design Outcomes

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Abstract

As the profession develops ever more collaborative project structures and delivery models, it is necessary to consider how the ultimate value of these models will be transmitted to current and emerging practitioners. This paper documents pedagogical research that employs an experiential model for integrating these professional practice issues into design curricula. Original objectives of the *Voices from the Field* course focused on introducing students to the relationship between concept design and technical execution. Testing the format across varied project types, delivery methods, scales of operation, and practice models with a range of practitioners, however, addressed a much larger realm of concerns than initially hypothesized. The focus of the course has thus expanded, with an increasing emphasis on examining the connection between the quality of collaborative working relationships and the successful manifestation of design intent. The paper posits that, among professional practice topics, contracts and delivery methods may seem abstract and difficult to grasp for students who have little practice experience. It explores whether experiencing the realization of spaces, details, and materials that are a direct result of the project structures would make these relationships more understandable to students. By sensitizing students to the value of collaborative behaviors as an essential ingredient to creating advanced architecture, the course supports the shift in the culture of the building industry toward greater and more productive collaborative practices.

Introduction

For the multiple agents involved in contemporary design and construction projects, the task of transforming a design concept into a constructed reality remains an ongoing challenge. Design activities rarely end at 100% completion of the contracted design phase of a project; often they continue throughout its construction and even occupation. In this context, the building process may be reconceived as a series of information operations in which "the initial building representation is progressively enriched and completed through a process of accretion by bits and pieces that takes place during and by means of the interaction of project participants."[1]

Traditional tactics for bridging poetic conception and pragmatic realization emphasize clarity and rigor in the production of documentation that communicates design intent to fabricators and constructors. This is followed up with an uncompromising attitude toward construction administration, which is frequently learned on the jobsite through modeling and mentoring. At a more detailed level, the design team may employ mechanisms such as construction mockups early in the design process, as well as punchlists at its conclusion, to further align concept and realization. A tactic less visible and yet highly effective in ultimately assuring the successful execution of design decisions is the careful structuring of relationships among the project's various agents.

This paper documents pedagogical research that makes a clear connection between successful collaborative working relationships and the manifestation of design intent. The research examines the *Voices from the Field* course, an experiential model for integrating professional practice issues into the design curriculum. Original course objectives focused on introducing students to the relationship between conceptual and technical execution by reviewing project documentation and then visiting construction sites to discuss issues of design, materials, methods and constructability. However, while testing the course format through

several semesters and across varied project types and delivery methods, and by interacting with a range of project agents, the focus of the course notably shifted, with an increasing emphasis on project structure and relationships.

This paper will focus on two of the projects examined in the course, which feature different project types and contract structures. The first project involves a higher educational residential building executed by a nationally recognized design firm working collaboratively with a local associate architect. The second project examines a complex hospital project executed through an IPD contract. By analyzing student assignments, both quantitatively and qualitatively, for evidence correlating relationships among project agents to successful design realization, the paper establishes a pedagogical method for connecting these professional practice issues to design concerns.

Practice Context

On the search for technological workflows and delivery modes that facilitate a move toward greater integration of design and building, Marty Doscher, Vice President at Dassault Systemes, writes,

> "The act of design is a complex network of interactions across teams. The architect is becoming an integrator of increasingly complex design information generated by ever larger and more diverse teams. This role seems to have arisen not by choice but as a pragmatic response to the growing complexity of executing built work, and the desire to get through the construction process with the design as intact as possible."[2]

Whereas architects aim to preserve their design agendas, owners seek more predictable results from construction projects, such as higher performance and lower project risk. To achieve their goals, owners look to project structures that ensure greater integration between team members. Methods that provide for the early integration of all disciplines, combined with better communication and collaboration among all parties, provide some of the most effective mitigation of overall project risks.[3]

Many architects, owners, and contractors achieve high levels of collaboration regardless of contract or delivery method. However, research shows that collaborative team behaviors can be fostered by IPD contracts when these are aligned with practices that support a team culture wherein members are willing and able to engage in collaborative problem solving to address project challenges.[4] Projects delivered by IPD currently account for only a small share of the construction market: in 2015 only three percent of projects by dollar volume used this method.[5] This approach is expected to increase in the coming years, however, particularly as its concurrent use with BIM becomes more widespread.[6] Moreover, the collaborative strategies of IPD are impacting the industry: many project teams are adopting similar structures and employing similar strategies in order to build mutual trust and respect, foster communication, and increase knowledge sharing.[7]

Voices from the Field

The *Voices from the Field* course was originally developed as a response to the *2012 NCARB Practice Analysis Education Report*. The *Practice Analysis* findings identified eight areas requiring additional focus and reinforcement in academic curricula: collaboration, as well as communication, professional conduct, practice and project management, site design, constructability, sustainability, and technology.

The initial objective of the course, which was piloted in the Spring semester of 2014, was to bridge education and practice by increasing students' understanding of the relationship between concept design and technical execution. Whereas constructability was certainly a primary focus, the intention was to expose students to the complex web of factors that go into taking design decisions to realization. The structure of the course combines classroom time with fieldwork. First, students review project documentation to understand its role in communicating design detailing for construction. Then, they attend site visits with project agents such as architects, construction managers, owner's project managers, and engineers. This enables students to gain direct experience of the construction process and to become familiar with roles of various agents during construction.

Students are evaluated on several individual and group efforts: general participation and contribution to the discourse; team facilitation of a pre-site visit seminar to present context for the project; submission of individual field reports following each site visit; and a final project comprising a short, reflective paper or an instructor-administered survey, designed to synthesize their experiences. The final two deliverables provide an opportunity to measure student learning outcomes with respect to established and emerging course objectives.

Research Questions

After its initial offering in Spring 2014, *Voices from the Field* was tested again in Fall 2014 and further developed in Fall 2015. Early stages of the research inquired as to whether sampling available projects from a mostly rural region would enable the course to cover a sufficiently broad spectrum of project types, issues, and professional roles to address the *Practice Analysis* Recurring Themes.[8] Ongoing research investigates whether the situated learning that occurs through personal observation and interaction with practitioners on the construction site yields a deeper integration of concepts typically covered in a comprehensive but compartmentalized manner.[9] In this paper, the author looks more closely at two course deliverables in order to evaluate how this method of teaching can contribute to student understanding of the relationship between project structures and design outcomes.

Exploring the Correlation between Project Relationships and Design Outcomes

As suggested above, the student-created Field Reports provide one important method for assessing students' increasing understanding of the correlation between project structures and relationships to design outcomes. In their reports, students juxtaposed photographs with annotated excerpts from construction documents and added written descriptions of the transformations that occur from drawing to construction. In their reports, they also illuminated aspects of the design and construction process that were not readily apparent from the documentation alone: in particular, issues of project management and delivery, construction scheduling, collaboration, the role of technology, and professional conduct.

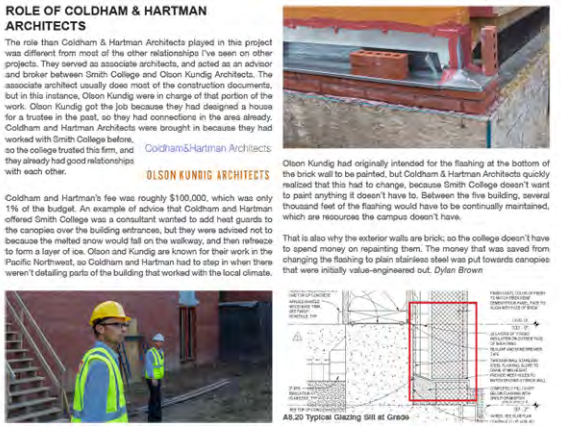

Fig. 1. Field Report: "Observation" documenting the role of the Associate Architects (Dylan Brown, 2015).

Each Field Report comprised eight to ten distinct "Observations," and students were required to submit five reports per semester; some students made multiple points per "Observation." (Fig. 1) In 2014, there were fourteen students in the spring course and twelve students in the fall course; each project's Field Reports yielded 120-40 observations, a total of 1492 data points. With eight students in the Fall 2015 course, each project's Field Report yielded 50-60 observations, yielding a total of 350 data points. At the end of each semester, these data points continue to be analyzed with respect to how often the eight areas identified by the 2012 Practice Analysis requiring additional focus and reinforcement in academic curricula are discussed. Additional recurring thematic issues emerge each semester and these are added to the coding process.

The emergent themes that are brought forth through the data in Field Reports has led to new final deliverables that can best address the course cohort and respond to refinements in the instructor's research paradigm. During the initial offering, students were required to submit an essay reflecting on their overall experience. Many students wrote about how their perspective on practice had changed and how the course affected their thinking about their future plans. In an effort to analyze more precisely the relationship between student learning and the topics identified in the *Practice Analysis*, the

culminating assignment of the Fall 2014 course offering was changed from an essay to a survey. Questions employed specific language adopted from the *2012 Practice Analysis*.

In the course's third iteration, Fall 2015, the final deliverable comprised a short paper and accompanying diagram that considered one or more of the studied projects in the larger context of architectural design and realization. Students were asked to analyze their collected evidence regarding the project team, their roles, how the projects were structured, and their collaborative processes. They were also instructed to reflect on the specific ways that they understood these relationships to have impacted the project outcomes. In these papers, students were able to draw connections across multiple projects and had considerably more freedom than in the prescriptive Field Reports to choose practice topics that broadly interested them.

Students visit five projects per semester; the course has revisited projects in a subsequent semester to observe a different phase of construction such that twelve projects have been analyzed over three semesters. As a result of valuable data from the Fall 2014 semester studying an IPD project, this project was revisited and a new deliverable was introduced in Fall 2015. Two of the projects from this most recent semester are particularly worthy of closer analysis. These feature different project types and contracts, which help in considering whether this method of experiential learning—through interaction with practitioners and personal observation on construction sites—yields insights into the essential role played by relationships among project agents to successful design realization. By first analyzing deliverables from each project and then discussing them in aggregate, certain learning outcomes become apparent.

Residential Housing Complex

In Fall 2015 students visited a residential building complex at a higher educational institution comprising twenty apartment units in five buildings. Prior to visiting this $11.3 million, 34,000-square-foot project, most students had only limited experience on construction sites and no knowledge of the architect's role during construction. This proved an auspicious start to the course, as students were able to witness every phase of construction, from wood framing, MEP work and brick cladding to window installation, insulation and interior finishing. In one largely completed building, students experienced the near-final realization of the design.

Filled with details of materials and methods they encountered on site, the students' Field Reports bear evidence of their learning. Out of the sixty reports submitted, more than half concerned constructability, with brickwork, insulation, window details, flashing, and roof details claiming the most interest. Interestingly, most students also wrote in detail about the nuances of the relationships they observed between the project agents. These agents included a nationally-recognized architecture firm working collaboratively with a local associate architect. The project departs from standard practice, in which a client hires a Design Architect to create a design which is then handed off to a local Architect-of-Record for construction documentation and supervision. Instead, on this project the Design Architect produced the construction documentation and the local Associate Architect worked with the Design Architect continuously from the Schematic Design phase through Construction Administration.

After touring the project with members of the Associate Architect's firm, students commented in their Field Notes on the productive and valuable nature of the team structure they witnessed: the Design Architects contributed their exacting design sensibility, their attention to details, and their broad vision, while the Associate Architects contributed their commitment to advanced building performance standards, knowledge of local building culture, and a longstanding and trusting relationship with the client.

Several students, for example, pointed in their Field Report to the Associate Architect's success in brokering a new detail for flashing included at the bottom of a brick wall. The original plan was to paint the flashing, but anticipating the client's objection to ongoing maintenance costs associated with paint, the Associate Architect advocated substituting a lower-maintenance material. The Associate Architect was then able to redirect the money saved by this change to reintroduce canopies important to the

Design Architect but value-engineered out of the project at an earlier stage.

Several students pointed out other examples of the Associate Architect acting as an "advocate" for the Design Architect during the decision-making process. For example, each of the buildings features small bedrooms and a large living room. To emphasize the importance of the communal space, the Design Architect provided a double-height space with a large bank of windows. Achieving this composition required some additional drywall framing, leading the contractors to question the time, money, and effort required to achieve it. The Associate Architects argued successfully for this work in order to meet the designers' spatial and daylighting objectives. Walking through the finished space, students appreciated how this extra effort contributed to the quality of the space; many described the Associate Architect's intervention in their Field Reports.

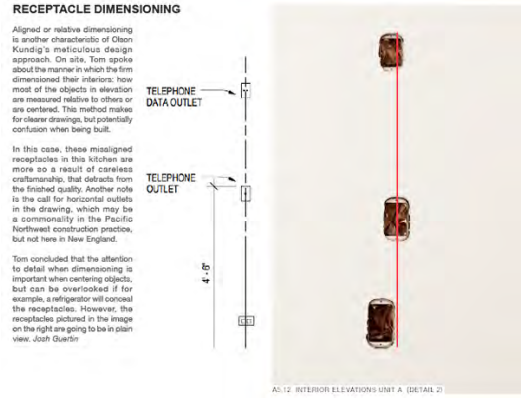

Fig. 2. Design tolerances (Josh Guertin, 2015)

Students also perceived instances where the Associate Architect acted as a "translator" for the Design Architect, communicating their particular approach to other agents. For example, the Design Architect employs tight tolerances and alignments to achieve their clean minimalist detailing. The contractors were less familiar with this meticulous method of detailing. This required the Associate Architect to act as a translator to insure that the contractors successfully complied. Students recorded observations of these interventions in areas ranging from brick coursing and window buck detailing to the alignment of receptacles, light fixtures, and other interior features. (Fig. 2)

Students also recorded in their Field Notes other occasions in which the Associate Architect advocated on behalf of the contractor. This ability of one party to operate on behalf of another selectively (students frequently made reference to "both sides," meaning both client and Design Architect, or both contractor and Design Architect) demonstrated the complexity of relationships on the jobsite and the critical value of navigating them skillfully. These real world examples made clear to students that the successful navigation of project relationships leads to better overall design outcomes

Healthcare Fit-Out

In Fall 2014 and Fall 2015, students visited a 90,000-square-foot addition to a healthcare facility, which included a new inpatient pharmacy. This $40 million project is unique in that approximately forty-five percent of the building area was designed as shell space for future growth. During the 2014 visit, students saw many different stages of construction including framing, drywall, insulation, flooring, and utility rough-ins. They also observed a mock-up patient room, which was used for collaborative problem solving as well as to gain consensus among project stakeholders regarding design options and material choices. During the Fall 2015 visit, students were able to observe more of the design realization and compare it with the shell space. While this was the most complex project visited throughout the course, it was also the last: armed with additional site experience, students were able to identify many of the typical construction details they had observed elsewhere and focus on those that were particular to the project at hand or healthcare facilities generally.

The project was delivered through a tri-party Integrated Project Delivery (IPD) contract. IPD partners included the Owner, the Architect, the Construction Manager, the Mechanical Contractor, the Electrical Contractor, and the MEP Engineers. Both semesters, students met with the Project Manager and several of the architects to learn about the principles of IPD and its implementation on this project. Greater design quality, client satisfaction, and cost savings, as well as an accelerated

schedule emerged in these discussions as benefits of the project's use of IPD.

Student Field Reports from both semesters as well as final papers from the Fall 2015 semester provide evidence of student learning. Reports remarked on the intensive MEP coordination necessary for a project of this complexity. Students were also impressed with the care given to design for occupant comfort. (Fig. 3) They paid particular attention to the hospitality-like indirect lighting strategies that they experienced. They were also impressed by the unique hospital features such as the narcotics vault, the network of pneumatic tubes for prescription delivery, the detailing of bariatric rooms, and the pre-fabricated headwall panels.

Because the project progressed from one phase of construction to the next, student observations differed. Fall 2014 reports focused heavily on construction, with a great many students noting the difficulties associated with managing an active construction project in the midst of an operational hospital. Over sixty percent of data points concerned constructability while twenty-seven percent focused on project management, collaboration, and project delivery; only eight percent focused on design. By Fall 2015 many areas of the project were complete; more students focused on design realization, with a greater interest in finishes. These reports also demonstrated an understanding of unique concerns for healthcare projects, such as maintenance, security, and sanitary requirements. Thirty-seven percent of data points focused on design, while twenty-three percent concerned constructability and seventeen percent focused on project management, collaboration, and project delivery.

The Fall 2014 Observations clearly document student understanding of the collaboration required to reach the client's goals and realize the designers' intent. Almost all students wrote about the full-scale patient room mockup: the mockup sequence started out rough, in cardboard, and was gradually refined as materials were applied and tested. Students recognized that this iterative process was used to both solicit end-user feedback as well as refine details in order to achieve a forty-six percent cost savings compared to earlier project phases. Nearly all students recognized that the high level of early trade engagement provided input to achieve very integrated solutions. For example, most Field Reports documented the prefabricated headwall panel that supplies utilities at each bed; students noted that this solution integrated early MEP and millwork trade expertise to save time on future field coordination issues while maintaining finish quality.

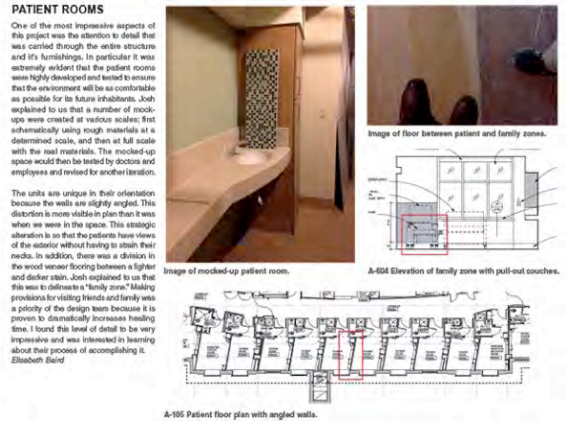

Fig. 3. Patient Room development (Elisabeth Baird, 2014).

Field Reports from the Fall 2015 semester which documented the impact of the IPD method focused on project efficiencies, including increased communication, easier coordination of trades, and reductions in cost and schedule. Student observations indicate they understood the value to design afforded by cost estimating in real time rather than after design is complete, which the team had identified as central to the project's success.

Along with the Field Reports, in the Fall 2015 final paper and accompanying diagram, students reflected on specific ways they understood the structuring of project relationships to have impacted the project outcomes. Half of the students focused on the healthcare project and its delivery method, whereas a few compared the outcomes of IPD with the delivery methods used on other projects they had studied during the semester.

While the Field Reports examined specific design and construction elements, the paper and diagram permitted students to reflect on the larger project context. First and foremost, students noted how in the IPD project the shared risk and reward structure seemed to them to mean that everyone was working toward a single goal. They also focused on the

significant difference in project timelines, pointing out that the IPD structure "leveraged early contributions of knowledge and expertise." (Fig. 4) One student noted, "Designers fully understand the ramifications of their decisions at the time the decisions are made and the contractors know how to organize construction based on the architectural design." Students perceived a clear benefit to the architect: "IPD allows for more extensive pre-construction efforts related to resolving potential design conflicts that traditionally may not be discovered until construction." This eliminates the need for "hacking off design elements deemed too expensive" or "sacrificing design intentions" during value engineering. Students found evidence that IPD reduced conflicts, especially over design goals.

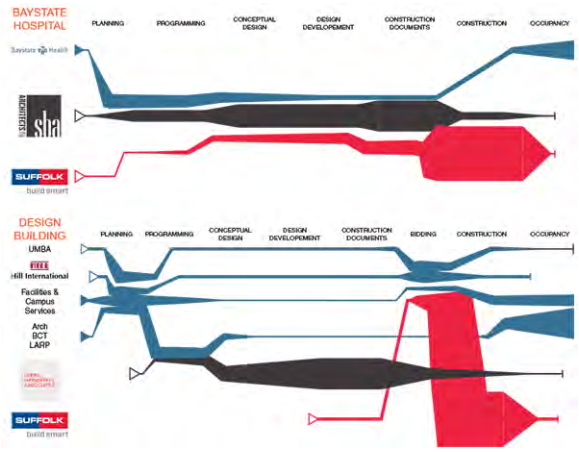

Fig. 4. Comparative timeline for the integration of team members. (Dylan Brown, 2015)

Comparing this project to the *Residential Housing Complex*, another student wrote, "[At the Hospital Fit-Out] I picked up on the support and flexibility of problem solving. The constant conversation that occurs before and during construction amongst all parties enables a more fluid operation. In comparing the tone, coordination and problem solving experienced on both sites, IPD proves…superior… This flexibility sets the tone of the project. There was a willingness to adapt the design to the wants and need of the occupants of [the hospital project]. There was a more rigid tone within the Housing Project...I sensed a more practical tone in the suggested changes of the design." Students found evidence that project structures directly influenced collaborative behavior, which they increasingly valued.

Discussion

Architectural educators employ experiential projects to increase student understanding of a variety of subjects, from site, culture and sustainability to structures, materials, and detailing.[10] By comparison, professional practice topics have been less typically explored through these means. Abstract and intangible in nature, subjects such as contracting, scheduling, project structuring and delivery may be among the most difficult for students with limited exposure to practice to "experience." However, as the profession looks for ways to shorten the licensure process, eliminating months or even years of internship in a practice setting, it is necessary to examine how these issues may be addressed in a situated learning environment within the academy. By locating professional practice learning within active construction projects, and by allowing students to experience the spaces, details, and materials that result directly from varied project structures, students are better able to visualize the impact of project relationships on design outcomes.

Analysis of the data extracted from the course deliverables demonstrates an increased understanding of this relationship among *Voices from the Field* participants. Although the course will continue to explore materials and methods as its baseline, in order to more fully investigate issues such as interaction among project agents, some experimentation is still needed. The Fall 2015 deliverables enabled students to engage the topic more deeply when students grappled with constructing the web of project relationships graphically to produce the assigned diagram. The most successful papers and diagrams were those created by students who chose to compare multiple projects, as they needed to identify project and team variables, and connect those variables to project outcomes. These successes suggest that future assignments might, at minimum, require comparisons between projects to enable students to assess evidence of each teams' achievement of project goals across several dimensions—for example, time, budget, building performance metrics, user satisfaction, and quality of design.

Future course experimentation might also include helping students develop a more rigorous interview methodology in order to extract richer material from their interactions with practitioners. Prior to site visits, students currently generate a collective list of questions for the practitioners with whom they will meet. In the future, students might be encouraged to standardize the list of questions; more in-depth, project-specific questions might be added subsequently. The setting for the interview may also be reconsidered. Interaction with practitioners typically occurs on the construction site, when students are excited and overwhelmed by construction activity. Practitioners have occasionally met with the class in advance in a seminar setting. One variable that has not yet been tested involves interviewing practitioners after the site visit, when students have had time to reflect on the experience; this might produce a different set of understandings. A final modification might relate to documentation. Some site visits were videotaped with recordings available afterwards to students. Field reports from recorded and non-recorded site visits might be compared to see if recording yielded greater integration of knowledge.

Conclusion

The experiential format of the *Voices from the Field* course provides an opportunity for students to gain an understanding of the dynamics of design decision-making as projects progress from inception to realization. The course has continued to shift and refine its focus on project relationships by altering the final deliverables, recalibrating and deepening student learning in an area that often remains opaque to students. By applying what we know to be an effective pedagogical method of experiential learning to professional practice topics, and especially to issues surrounding project agent interaction and relationships, we can heighten student awareness of the collaborative aspects of contemporary practice. One emerging goal of the *Voices* course is to advance this shift in the culture of the industry by imbuing students about to enter the workforce with not only an understanding of collaborative processes that will increasingly typify twenty-first century building but also an appreciation for the value of collaborative behaviors as essential ingredients from which to create better designed, more advanced, and highly innovative architecture.

Notes:

[1]Pietroforte, Roberto, Paulo Tombesi, and Daniel D. Lebiedz. “Are Physical Mock-Ups Still Necessary to Complement Visual Models for the Realization of Design Intents?” Journal of Architectural Engineering 18, no. 1 (March 2012): 34–41.

[2]Doscher was previously Technology Director of Morphosis Architects for eight years. Marty Doscher, “Disposable Code; Persistent Design,” in Digital Workflows in Architecture: Designing Design -- Designing Assembly -- Designing Industry, ed. Scott Marble (Basel: Birkhäuser, 2012), 211.

[3]A 2017 study of construction industry risk found that 91% of respondents agreed that the most effective risk mitigation strategies are those that enhance collaboration. “Managing Risk in the Construction Industry,” SmartMarket Report (Bedford, MA: Dodge Data & Analytics, 2017), p.1-5, 37. http://www.bim.construction.com/research/.

[4]See Renee Cheng, “Motivation and Means: How and Why IPD and Lean Lead to Success” (University of Minnesota, 2016), http://arch.design.umn.edu/directory/chengr/documents/motivation_means2016.pdf.

[5]American Institute of Architects, “The Business of Architecture 2016: AIA Firm Report” (Washington, DC, 2016), 74.

[6]“Project Delivery Systems: How They Impact Efficiency and Profitability in the Building Sector,” SmartMarket Report (Bedford, MA: McGraw Hill Construction, 2014), http://construction.com/about-us/press/construction-project-delivery-systems-vary-widely-in-benefits.asp.

[7]See Renee Cheng and Katy Dale, “IPD Case Studies” (AIA Center for Integrated Practice, AIA Minnesota, and University of Minnesota School of Architecture, 2012), http://www.aia.org/about/initiatives/AIAB087494.

[8]Brause, C., “Intern Architects in the Academy: Preparing for Future Practice,” *Future of Architectural Research: Proceedings of the 2015 ARCC Conference*, Chicago, IL 2015, 627-634.

[9]Brause, C., “Foraging for the Curriculum: Sourcing Local Projects for an Integrated Understanding of Issues Central to Practice,” *Intersections and Adjacencies: Proceedings of the 2015 Building Technology Educators’ Society Conference*, Salt Lake City, UT, 2015, 167-174.

[10]On architectural education’s emphasis on learning by doing, see Simon, Madlen, “Design Pedagogy,” in *Architecture School: Three Centuries of Educating Architects in North America*, ed. Ockman, Joan and Williamson, Rebecca (Cambridge, MA: MIT Press, 2012), 276–85.