The Rewards of Collaboration: Lessons Learned from Innovative Practices

Throughout the history of the professions, architects and engineers have depended on one another for expertise, but in recent decades, as the practices grow undeniably more complex, that dependency has increased dramatically, generating new approaches to collaborative work. These collaborations pose challenges in their own right, but when done well, they can make design and construction processes more efficient and robust.

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In order to gain insights about collaboration and the processes that accompany them, the authors interviewed over 40 prominent architecture and engineering professionals across the world about their collaborative strategies and the influence of those collaborations on their design practices. A number of themes emerged from the primary research, highlighting the rewards of new models of engagement and the potential inherent in integrated production methods for the building industry. Through broad strokes across this research, this paper describes the consistencies and inspiring moments found amongst the working methods of successful interdisciplinary collaborations. These emerging methods include new integrated and shared design models, contract types and social structures. Profoundly, use of some or all of these collaborative methods early in the design process often lead to innovative architecture and engineering projects, generating remarkable monetary and professional rewards.

BACKGROUND

Concerns about stratification of design roles and the challenges of collaboration between architects and engineers is not new to the professions. Recalling the great gothic cathedrals, the design, structure, envelope, lighting, and interiors all came under the rubric of one profession. But as the discipline expanded, particularly after the industrial revolution, and we came to have ever-higher expectations of both the complexity of our buildings and the speed and volume of construction, specialists abounded. Over time, as the professions of the architect and engineer have diverged, they have each also become more reliant on one the other for their disciplinary expertise while working towards common goals in the form of safe, habitable, beautiful buildings.

Among the most well-known civil engineers of the 20th century, Ove Arup, was concerned that the members of both disciplines be well trained with regard to collaboration: "The Author believes firmly that the civil engineers should learn...[an] appreciation of architecture,"[1] and further noted, "The engineer receives the best architectural education from the architects he is working with—or some of them—and the architect, through the same collaboration, gets to know what a structure can or cannot do."[2] Arup's legacy of collaboration

in his practice and teachings resonates even more strongly in design practice today, which is imbued with the complexities of hyper-specialization and customization of the technical aspects of building at all scales. The process of designing those complex systems requires a multitude of disparate experts.

RESEARCH METHODOLOGY

With the goal of researching 10 case studies in depth, the authors interviewed the practitioners about a specific project and also more generally about the firm's working methods. In order to uncover themes amongst practices, the same core set of questions was asked of the interviewees, although the language was modified depending on whether the questions were being asked of an architect or engineer. The hypothesis was simple: we anticipated that collaboration facilitates innovation, and this held true, although we uncovered a much deeper understanding of the nature of collaborative practice today. Specifically, we tailored our interviews to examine the working methods that best supported positive collaboration, to ascertain how (or even if) collaboration is manifest in the final built object, and to query how practitioners recruit and train able collaborators among their junior colleagues. As educators ourselves, a secondary goal was to gain insight into how faculty can design courses, coursework, and curricula to best prepare both architecture and engineering students for productive and innovative design collaborations in both their academic work and their future careers. It is clear that the components of a successful practice entail not only concern for the ultimate realized product, but striving for innovation in the processes through which that work is manifest.

On the whole, the projects that practitioners discussed with us were highly complex in a variety of ways: if not in scale, then in the new materials or technologies that the building employed. The projects included, for example, 41 Cooper Square, an intricate lab-filled school on a tight site in Manhattan, and the Glass Pavilion at the Toledo Art Museum, which although much smaller in scale, had significant, ambitious and intricate mechanical and structural system challenges. Other projects discussed with practitioners included five highly complex transportation-related projects and three large housing projects. In sum, all but one of the case studies were large-scale, multifarious undertakings that each required a sizeable and diverse team of architectural and engineering collaborators for their realization.

Contrary to public perceptions of the Howard Roark-type master architect, architectural practitioners today, at least those we talked to, recognize the value of collaborating with engineering partners and other technical experts both early and often throughout the design process. With shrinking design budgets, it makes smart sense to develop an integrated approach to design from the early stages so that redesign, or worse, change orders, can be avoided when structural and mechanical systems conflict with the architecture. But "early and often" hasn't been the norm since the American Institute of Architects design-bid-build contracts have dominated the building industry in the U.S. In fact, it can easily be argued that this contract structure above all other cultural differences inherent between the disciplines has done the most to create (perhaps unwittingly) a culture of animosity.[3] Practitioners today, however, are seeking new approaches to working relationships.

RELATIONSHIPS, THE CORE OF COLLABORATION

People, and their expertise they bring to the table, provide the transformational power to take a project from the seed of an idea to successful fruition. Conversations with almost all of the architects and engineers interviewed described the importance of developing communication strategies and nurturing relationships that foster in innovation, learning and growth. Out of the numerous skills required in practice today, it is communication that proves most crucial. In fact, good communication skills can not only enhance a project, but also have the potential to further a professional's career. Ken Sanders, on the Board of Directors at Gensler

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Figure 1: Morphosis Architects, *41 Cooper Square*, New York, New York, 2009. Photo by Sinéad Mac Namara

described that technical skills can be taught on the job, but the ability to collaborate is "the most important criteria for new hires…The human piece is the harder piece."[4] When communication is clear and comfortable, the project and the collaborators benefit.

Despite that communication would seem to be a fundamental skill of working professionals, communicating with experts outside one's discipline can be challenging and sometimes frustrating. The large gulf between the training and disposition of disciplinary experts poses challenges for communication and the ability to find common ground in working methodology. Longstanding relationships between architects and engineers are the hallmark of some of the most successful design practices. Famously, Louis Kahn and engineer August Komendant designed innovative reinforced concrete structures together from the 1950's until Khan's death in the late 1970's. The fruitful collaboration of SOM's architect Bruce Graham and engineer Fazlur Kahn produced many skyscrapers of the Second Chicago School. Their jointly designed works are markedly structurally expressive.[5] Although the Pompidou Center in Paris is the most well-known example of their collaborative work, Renzo Piano and Peter Rice designed numerous projects together.

These prominent historical examples also rang true with our interviewees. Bruce Gibbons, of Thornton Tomasetti Los Angeles argues for early collaboration, but recognizes, "It's always easier to collaborate with someone you know. When working with people for the first time, communication can be a major challenge."[6] Similarly, Mutsuro Sasaki, one of the most innovative structural engineers in contemporary practice, describes the personal and professional rewards of collaboration. Sasaki is a strong proponent of an equitable division in design between architects and their engineering collaborators stating, "The structural engineer's role is…defined as being more like an architect than an engineer…They must undertake their collaborations from an equivalent standing."[7] He describes the importance of his long term collaborative relationships with a number of acclaimed architects:

> I have maintained long term collaborations with some of the most influential architects [to me], and especially Arata Isozaki, Toyo Ito, and SANAA/Sejima and Nishizawa have had strong influence on my carrier. My relationship with each of them are different, my responsibility for them and with them are different. For the case with SANAA, when we started our collaboration, I was in my 40s while they were at their 30s and 20s. Therefore, my role with SANAA has been more as a mentor to lead our collaboration. This is how we pass down the values, knowledge, and wisdom from one generation to the next.[8]

Describing the rewards of another long-standing collaboration, engineer Hans Schober of SBP, speaking about the Berlin Hauptbahnof design, claimed that years of experience working with the architects, Gerkan, Marg and Partners (gmp), prompted them to invite SBP to the design team. Schober also asserted that his firm agreed to be involved because they knew gmp were open to the kind of structurally honest designs that SBP favors.[9] Similarly, Chandler Ahrens, lead designer for Morphosis on the 41 Cooper Square project notes that when designing high profile, demanding projects, the mutual trust inherent in a long term partnership is all the more vital. "It takes time to educate your engineers about how a company like Morphosis works. It is not a typical company--it takes a few projects, so it is hard to switch and work with someone you don't know."[10]

As all of these examples demonstrate, mutual respect is a key component to successful collaboration and provides a platform for the creation of new knowledge and professional development. One of the ways we found that respect is fostered is through face-to-face meetings. Interviewees described that bonds became stronger when collaborators could meet in person, on a regular basis. In all ten of the projects researched, the collaborators met regularly, usually weekly. Even though an AIA survey described co-location "was not

significant factor in the perception of open and effective communication"[11], the authors found the opposite to be the case. Rather, working in proximity to develop personal relationships and mutual understanding proves an absolutely vital practice for project success.[12]

Perhaps for this reason, prominent architecture firms have been steadily hiring engineers to work in-house. Although this model has proven successful for SOM for nearly 80 years, it is only in recent years that firms such as Foster + Partners are spearheading a movement towards a similar practice. Xavier De Kestelier, a Partner at Foster + Partners and joint head of the Specialist Modeling Group describes:

> The engineers sit with the architects—they really integrate by proximity—there isn't a separate department. There isn't a different review to look at the engineering and the architecture—they are reviewed at the same time…the integration within our office at all levels has worked quite beautifully.[13]

Mutual respect might seem an obvious and straightforward expectation for optimal collaborations, but since engineers and architects are educated in almost opposite ways, communication can be a struggle between the professions. Peter Simmonds, a mechanical engineer with IBE, who was described by his collaborator on 41 Cooper Square, Chandler Ahrens as "[an] engineer who really knows how to work with architects,"[14] sums up the importance of appreciating the point of view of the "other" discipline:

> I think the one thing I have learned, not from my education, but in my experience, is that you have to know how to discuss the project with the architects. There is no point in coming with a lot of math to an architect. That is just not effective. They are looking for the big picture, or the artistic solution; you have to learn how to communicate with them.[15]

When communication and respect are lacking, the collaboration can be intense and occasionally dysfunctional. Only one set of collaborators interviewed (who shall not be named) had marked disrespect for the talents and contributions of the other. The engineers on this project (which it should be noted was of a particularly complex nature) took on software development and design roles that are normally the purview of the architects. Since highly sophisticated coding was required and the engineers had that expertise, it was logical and extremely beneficial for the project that responsibilities shifted during the design process. Despite the obvious time savings and design achievements that resulted, it was clear in our communication with the project architect that his ego had been badly bruised. It's probably safe to say that those architects and engineers will not work together again. Egos aside, however, there is no doubt that the contributions of the architects and engineers were all essential to the success of the widely acclaimed project.

EMERGING COLLABORATIVE METHODS

In addition to the critical importance of communicative and present collaborators along with long standing working relationships, the practitioners interviewed described the crucial role that drawings play in coordination. This includes hand drawings early in the design discussions to communicate ideas, and of course, shared digital tools that facilitate the construction documentation and coordination processes. Shared software, especially Building Information Modelling (BIM), proves transformative in project production by enabling a fluid exchange of information within 3-dimensional space. The time required to coordinate a digital model, although consuming, is less costly than discovering conflicts in the field, alleviates jobsite waste and the stress of finding a quick solution while contractors' clocks tick.

Another of the great advantages of BIM software is that costs can be estimated throughout the design process rather than after the project has gone out to bid. Costs were the basis of frequent discussions for the SHoP-Arup team working on a mixed use prefabricated housing

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Figure 2: SHoP Architects, Arup, *B2 BKLYN*, Brooklyn, New York, 2014. Image by SHoP Architects via archdaily.com

project in Brooklyn, B2 BKLYN. According to David Farnsworth, Arup structural engineer, "Contractors, architects and engineers were continually working on cost feedback; design decisions were often driven by production considerations (for example, whether something would take 10 hours to install or 16 hours). These goals helped to refine the design work."[16] The production and construction innovations for the BKLYN tower serve as a model for prefab projects, which will undoubtedly boom in practice in the future.

For many firms, BIM tools go hand-in-hand with employment contracts that demand them. Although still the "underdog" of the contract world, the American Institute of Architects' Integrated Project Delivery contracts encourage the use of BIM through a supplemental BIM agreement that helps collaborators to insure a collective approach. Contemporary federal government contracts all require BIM. For many architects, a team-based approach provides a welcomed sense of shared responsibility and if contracted as such, a shared liability, which can inform "healthier" modes of interaction amongst partners. In the traditional design-bid-build contract type and working model, architects carry the burden of responsibility for the content of the construction documents and for paying the engineers and other consultants on the project. In a highly traditional interpretation of this mode, the architect makes design decisions then brings the consultants on to the project when necessary, and often after the project has been through schematic design. However, in an increasingly litigious climate, alternative contract types such as integrated project delivery provide a welcome respite from the responsibilities of architect-as-master-decision-maker, document checker and budget coordinator.

Yet alternative contract types have been slow to catch on. This is understandable from the recognition that habits help to bring about efficiencies, so changes to working modes can be difficult to warm up to. An AIA Firm Survey on the four main contract types found that in 2011, 60% of firms were still using design-bid-build contracts. In the Architect's Handbook, the 2008 edition, Phil Bernstein warned, "All in all, projects today are faster, riskier, and involve far more participants than those of even twenty years ago. Choosing the appropriate delivery model is often the key to success—or the source of failure."[17] In fact, contractual relationships are a critical factor in project failure. An interviewee, Barbara Jackson, author of Construction Management Jumpstart, described the problematic aspects of the traditional, design-bid-build contract system, asserting, "Our industry (architecture, engineering, and construction) is so familiar with a reactive model of engaging with one another versus a pro-active model…We're missing fundamental trust."[18]

Given the complexity and multiplicity of the practices of architecture, engineering and construction, new contract types, especially integrated project delivery and its associated methods, hold extraordinary potential and should not be undervalued, especially in their capacity to facilitate collaboration through more productive, less adversarial, more cost effective ways of designing and delivering projects.[19]

REWARDS OF INTEGRATED DESIGN

In undertaking this research, we hypothesized that early synergistic collaborations lead to more innovative design, but we were surprised to find that an additional major benefit of productive collaborations in building design is the benefit of cost savings. Since earnings for architects have been particularly dismal in the past decade, it is hopeful and exciting to recognize that collaboration and integrated design methods are proving beneficial to the purse strings. A 2012 AIA Firm Survey found that a decline in architecture firms' revenue far exceeded the average decline in construction projects between 2009 and 2011, and "between 2007 and 2011, more than 28 percent of positions at architecture firms disappeared."[20] Financial woes have provided some with the impetus to look for new approaches to practice, both in terms of the structuring of professional relationships and the methods

of production. Early collaboration with experts in a range of fields may create some additional front-end costs, but interviewees indicated that construction savings made design costs—investment in people and their expertise—well worth it.

Numerous interviewees in our research cited the role of project finances in shaping the nature of collaboration. Richard Garlock, of structural engineering firm LERA, described that the contract structure, and the number of engineering hours the client is willing to pay for, can dictate whether an engineer is brought on board for the early discussions where they might have more design influence.[21] Garlock recognized that he had been hired earlier in the process after architects learned through experience on previous projects that he designed efficient structures that garnered significant cost savings. In the same vein, Steven Holl notes that waiting until later in the design process to consult with technical experts can be a false economy since design services are a small part of the overall budget in comparison to materials and construction.[22] Some architects may feel that since the engineer's fee often comes out of the architect's compensation then it makes financial sense to establish early collaboration only on the more technically complex projects. But, in large projects especially, collaborations resulting in minor savings in materials costs could more than compensate for higher engineering fees at the start of the project.

As previously discussed, using shared software amongst offices, especially BIM tools that enable an integrated digital model, has reduced the number of systems conflicts that can be costly to resolve during construction. An AIA survey from 2006 found that change orders averaged about 4% of total construction costs, and in 23% of projects, change orders amounted to 5% or more of total construction costs.[23] Saving just half of those change orders could easily double the designers' profits on a project. Advances in structural analyses software have led to similarly remarkable monetary rewards. In a particularly shocking example, Ken Sanders, principle of Gensler remarked that Thornton Tomasetti's digital analysis of the Shanghai Tower allowed the team to save about $50 million in steel costs[24], a lavish financial reward of relatively straightforward collaboration.

CONCLUSION: A MISSION FOR ACADEMIA

Despite clear evidence that early and robust collaborations are crucial for productive practices today, the skills required are not often a focus of architecture or engineering curricula. In fact, the two disciplines educate their students in remarkably opposing ways,

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Figure 3: Gensler, Shanghai Tower, Shanghai, China, 2016. *Image by Gensler via archdaily.com*

ENDNOTES

1. Arup, Ove. "The Architect and the Engineer." *ICE Proceedings* 13, no. 4 (1959)
2. Ibid.
3. See for example, http://www.brandconstructors.com/diversification-of-aec-firms-services/
4. Sanders, Ken. "Collaboration & Performance/ Materials & Building Practices." Lecture, *New Constellations, New Ecologies* for Association of Collegiate Schools of Architecture, San Francisco, March 20, 2013.
5. Mac Namara, Sinead, and Clare Olsen. "Collaborations in Practice." In *Collaborations in Architecture and Engineering.* New York, NY: Routledge, 2014.6. Gibbons, Bruce. Interview by authors. Phone interview. Los Angeles, July 8, 2013.
7. Sasaki et al, *Morphogenesis of flux structure.* 11.
8. Sasaki, Mutsuro, Interview by the authors. Email Interview. Tokyo, Japan, September 5, 2013.
9. Schober, Hans. Interview by authors. Phone interview. Stuttgart, June 19, 2013.
10. Ahrens, Chandler. Interview by authors. Phone interview. St. Louis, MO, May 2, 2013. 11. AIA, AIA Minnesota, School of Architecture –University of Minnesota. "IPD Case Studies." www.aia.org/aiaucmp/groups/aia/documents/pdf/aiab093703.pdf
12. Mac Namara, Sinead, and Clare Olsen. "Collaborations in Practice." In Collaborations in Architecture and Engineering. New York, NY: Routledge, 2014.
13. De Kestelier, Xavier. Interview by the authors. Phone interview. London, England, June 18, 2013.
14. Ahrens, Chandler. Interview by authors. Phone interview. St. Louis, MO, May 2, 2013.
15. Simmonds, Peter. Interview by authors. Phone interview. Los Angeles, CA, May 30, 2013.
16. Farnsworth, David. Interview by authors. Phone interview. New York City, June 4, 2013.

and disciplinary vocabulary can be a barrier to communication for recent graduates. In an Architectural Record article dating from 2007, Andrew Pressman reacts to the declining popularity of design-bid-build contracts and warns, "The art of collaborating and negotiating must be integrated into courses across the curriculum, including design studio, architectural technology, and professional practice."[25]

Echoing similar sentiments, in discussing integrated project delivery, Ryan Smith, Director of the Integrated Technology in Architecture Center at the University of Utah says, "I'm really excited about…the paradigm shift towards the integration movement and I think this is affecting all aspects of practice, and academia as well, although we are not recognizing it as much…I think education is far behind and I hope that we can change that."[26] Given the challenges posed by collaborative practice and the rewards of great collaborations, it is imperative that curricula evolve to teach students how to communicate with colleagues "outside" the disciplines, teaching both verbal and representational tools.

It was once believed that digital tools would be best learned on the job after graduation, yet few today would disagree about the importance of teaching digital tools, workflows and design processes to students. Similarly, interdisciplinary collaboration requires skills that are not necessarily quick to learn on the job. Schools should bring together students from the architecture and engineering disciplines, hold discussions about communication, teach shared software and foster mutual respect. Talking about the need to share credit and give credit where it's due may be transformative for some students, impacting their working lives and the culture of offices in the future. Schools must teach collaboration skills to empower graduates to make positive contributions to diverse teams. Teaching collaboration will greatly impact the working life of professionals, and help to cultivate the rewards of interdisciplinary partners working together in the pursuit of innovation and progress.

17. Bernstein, Philip. "11.4 Project Delivery Methods." *The Architect's Handbook of Professional Practice.* Ed. Joseph Demkin. 14th ed. Hoboken: Wiley, 2008. 491-506, p 492

18. Jackson, Barbara. Interview by authors. Phone interview. Denver, August 21, 2013.

19. Originally printed in Olsen, Clare, and Sinéad Mac Namara. *Collaborations in Architecture and Engineering.* New York, NY: Routledge, 2014.

20. American Institute of Architects. "2012 AIA Firm Survey: The Business of Architecture Report." *AIA Business Report*. www.aia.org/aiaucmp/groups/aia/documents/pdf/aiab095792.pdf

21. Garlock, Richard. Interview by authors. Phone Interview, Princeton, NJ, June 25, 2013.

22. Holl, Steven. Interview by authors. Email interview. New York, NY, August 6, 2013. 23. Baker, Kermit, PhD, and Hon. AIA. "AIArchitect This Week | Economics: WORK-ON-THE-BOARDS SURVEY: Firms Enjoy a Late Summer Surge." http://info.aia.org/aiarchitect/thisweek06/0922/0922b_otb.htm

24. Sanders, Ken. "Collaboration & Performance/Materials & Building Practices." Lecture, *New Constellations, New Ecologies* for Association of Collegiate Schools of Architecture, San Francisco, March 20, 2013.

25. Pressman, Andrew, FAIA. "New AIA Firm Survey Indicates That While Business Is Good, the Profession Itself Changes Slowly." *Architectural Record* Mar. 2007: 1-3. , Page 3. Mar. 2007. Web. 19 Aug.2015.

26. Smith, Ryan. "Center for Integrated Practice: Education." Interview. Audio blog post. *AIA Podnet*. American Institute of Architects, 12 Aug. 2011.