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Culture of Collaboration

The 21st century architect is being introduced to a shift in the way buildings are designed, built, and maintained that differs from the 20th century model and the early master builder model. Building is becoming increasingly complex at an exponential rate. However, emergent material and digital technologies are suggesting a much more integrated collaborative model that builds upon the individual expertise of key players. Branko Kolarevic in Architecture in the Digital Age suggests that by integrating the process of building design, delivery, and management, the AEC industry has the opportunity to redefine the relationships between conception and production.[i] Therefore, in an integrated practice model, the architect's potential role is one of an intense key collaborator or master facilitator of a building process that oscillates between the key players in a design and building project.

Outside of material and digital technology itself, the environmental and organizational barriers to collaboration and consequently innovation include but are not limited to: a falsely premised *architectural culture*, an outmoded *construction culture*, and *risk* barriers. It is all too often communicated that a genius architect is a social hero, a savior, making ubiquitous decisions that the design and building team support, follow and obey. This understanding of the role of the architect could be called the Howard Roark syndrome, which does a disservice to young architects as it can lead to a lack of fostering a collaborative ethic and hence a lack of innovation potential of involving other critical disciplines. In addition, the professional culture likewise teaches young graduates that they can get more innovative work, if only they are good enough, stay up late enough and prove themselves through isolated master minding. Amidst new models of integrated practice and collaboration being touted, many young designers remain unchanged in their heroic aspirations and schools of architecture continue to be overcrowded. This scenario is in sharp contrast to the reality of the majority of architectural practices, in which firms are exploiting young architects and their staff to survive and in many cases faced with a catastrophic economical position. In this model of practice, there is no trace of a social ethic or glamour.[ii] Muir and Rance in Collaborative Practice in the Built Environment state that

> "collaboration has been seen by many architects as the greatest single threat to their long established position as the natural 'leader' of the team. The view is often expressed that designers must provide leadership and that if they do not the quality of the building, in both functional and aesthetic terms, will suffer. The weaknesses in this argument were provided by a plethora of studies which suggested that the traditional method of independent practice was equally susceptible to considerable criticism for inadequate performance of buildings, not only in functional and aesthetic terms but also in technical, management and cost control aspects."[iii]

Construction culture depends on skilled craft method of assembly for buildings. This handicraft identity made of building is not consistent with its automated adjacent industry counterparts such as aerospace and automobile. Standardization is defined as a set of accepted standards and specifications that determine industry guidelines. Dana Buntrock in Japanese Architecture as a Collaborative Process indicates that in the case of building, architects and others on the building team need to look above the Fordist mass production mentality of set lengths, widths and material specifications; they need to look beyond economy of means (larger quantities lead to greater economy), beyond the assumption that unskilled laborers need to produce affordable building components, and beyond the idea that assembly line production is needed to facilitate speedy and efficient production methods. Today's post-Fordist technology suggests not the standardization of building components but customization, utilizing digital information to automate machines, such as CNC, to produce infinitely diverse outputs.[iv] This information technology revolution that has affected so many other industries is now being harnessed for its ability to flatten the design to delivery of building, and provide visions for new materials and methods of production for architecture.

3Form Vice President of Architectural Division, Ruben Suare, has indicated that in the experience of working with architects, collaboration if negotiated and used for positive sum gains leads to innovation. This relationship between collaboration and innovation is potentially interdependent, each relying on the other for success. Suare indicated that while their collaboration and innovation have increased in their model, so has *risk*. Issues of risk have been the point of discussion and debate among architects for many years. "The liability crisis of the 1980s pushed architects further from job site responsibilities and pressed new risks on contractors."[v] Today, projects are built quicker, involve many more stakeholders, and entail more risk than those over 150 years or even 20 years ago. The concern among architects regarding risk involves maintaining too much responsibility or cost control of budgeting during a project life-cycle.

The design/bid/build contract structure in the U.S. puts architects and engineers at an adversarial relationship with builders. A reworking of contract structures is necessary to ensure a more collaborative, less conflict inducing process for construction that will lead to reduced change orders and thereby reduce inefficiencies, cost, and risk. Although contracts are being reworked by the AIA currently, risk can be mitigated through the quality of integration of collaboration. However, this requires architects understanding the various roles on the design and production team in order to effectively integrate, collaborate, and thereby innovate.

Knowledge-Share

"Without knowledge, there is not technology."[vi]

Today's most technologically advanced societies are knowledge-based. The UK Department of Industry and Trade states that "the knowledge economy is not only about new creative industries and high-tech businesses, it is relevant to traditional manufacturing and to businesses ranging from construction and engineering to retailing and banking."[vii] Computer science has adopted *architecture* as a term to describe the conceptual design and operational structure of a computer system. With regard to knowledge, Henderson and Clark in *Architectural Innovation* indicate that computer engineers should have both component knowledge (knowledge about each of the core design concepts) and architectural knowledge (knowledge about the ways in which the components are integrated and linked together into a coherent whole).[viii] Although critical to collaborating effectively, architects should have more than just macro level knowledge concerning how the different components are linked together in a building. Architects need to also develop component knowledge, or an understanding of the role that each player contributes to the team, utilizing a joining effort to innovate on a project.

There is a player in the process of building that holds the key to innovation -- the subcontractor, including fabricators and manufacturers. The subcontractor fabricates, manufactures and does all the buying and selling. Subcontractors are generally small businesses and in many cases, because of their being affected by market fluxes and economic changes, cannot invest in high technology. Conversely, a few successful manufacturers are emerging as key innovators, by collaborating with architects in order to deliver innovative products. Architects should avoid isolating themselves in design by teaming with fabricators and manufacturers to deliver more innovative architectural products.

Michael Mulhern, Vice President of TriPyramid Structures, a subcontracting component manufacturer, has indicated that on a building project during design, fabrication and erection, the discussion of what is the right material or system involves not only technical considerations but also financial and aesthetic. Each member of the design team offers a voice that demands a great deal of trust from the other key players on a design and building project.[ix] Relying on manufacturers and others during design is difficult for many architects as already discussed because of the embedded cultural necessity to maintain absolute control. However, many models are turning toward reliance of architects on manufacturers to provide design services because of the subcontractor's expertise with a specific material or system that is being implemented. Mark Dodgson in the <u>Management of</u>

Technological Innovation suggests that this kind of collaboration demands a horizontal structure rather than a traditional vertical organization; where collaborators on a building project are trusted and given enough freedom in the process in order to ensure a successful and innovative end.[x]

One such subcontractor is 3Form. By focusing on high level of collaboration, 3Form has set a precedent for working with and through architects to achieve an increased level of innovation. 3Form's method follows Stefan Thomke's explanation of a characteristic practice of innovative manufacturers in Experimentation Matters: where the iterative design to production process is front loaded, placing material and digital innovation at the beginning of a project to avoid late stage developments that are problematic because they hinder innovation in favor of the quick fix. They rely on experimenting frequently through utilizing new and traditional modes of technology to unlock performance goals. Finally, 3Form organizes for rapid experimentation and manages projects as experiments. This combination allows the company to fail early and often to avoid risk and costly changes on site.[xi]

Lead Users

Eric von Hipel, a professor at MIT's Sloan School of Management, coined the term "lead users" to describe forward thinking and innovative individuals that anticipate market forces before competitors. Dana Buntrock calls architects who similarly exploit construction industry materials and processes in order to innovate "lead users." "Lead users do not, and perhaps cannot, work alone in a market as technologically diverse as the construction industry. Manufacturers also benefit from working closely with these designers, as their input can encourage innovation and help industry to project future demand more accurately."[xii]

This paradigm shift in architecture toward an integrated collaborative provides the opportunity for architects to be a lead user, the player that can exploit industry resources, working with subcontractors, fabricators and manufacturers in order to innovate. In justification for this role, architects are the individuals in the building industry that are most well equipped with a general knowledge of the different roles on a project, and an ethic concerning society and the environment, to be a lead user of innovative technology, bringing meaning to the building process. It is clear that if architects do not integrate stakeholders in the industry building, the industry will continue without them.

In order to prepare young architects to fill this role as leads of collaborative efforts, we need to break down the barriers of cultural stifling, involving the construction industry, work toward the development of updated contractual/legal structures, and assume more risk in the process. Though difficult, this is necessary to innovate, much less to stay relevant. As John Fernandez indicates, "architects are the primary actors in determining the material composition of our buildings and therefore assume the role of primary drivers in the extraction, recycling and processing of specific materials, the manufacture and assembly of components and the construction of our buildings."[xiii] A new type of architect is therefore necessarily emerging, one that can be a master facilitator of industry parties. An architect that will not be merely a consultant, but a key contributor in the collaborative building process.

Assembling Architecture Studio

An example of providing students with opportunities to learn collaborative skills, share knowledge with subcontractors, become lead users and thereby innovate has been captured in a graduate studio at the University of Utah called Assembling Architecture. The author developed the studio as a research based design course in which students collaborated with manufacturers and fabricators in the Salt Lake region. The studio was organized as the final capstone experience in the six-year masters sequence. The studio was broken into 3 phases.

Phase 1 Research: Each student was teamed with a manufacturer or fabricator in the Salt Lake Valley. The assignment was to perform research that evaluated the process that leads to the development of products. This exercise was meant to help students see outside of physical objects we specify for buildings into the social and organizational structure that fosters product development. The list of collaborating companies included (names of students and companies removed for anonymity):

-Architectural Resin Panel Manufacturing

-Architectural Stone Cladding Fabrication

-Lumber Panelization and Truss Fabrication

-Architectural Interior Panels

-Aluminum Extrusion Manufacturing

-Sheet Metal Fabrication

-Concrete Precast

-Brick Manufacturing

-Structural Steel Fabrication

-Composites Carbon Fiber

Students were encouraged to work collaboratively with specific individuals assigned to the studio from the company. Students visited the fabricators repeatedly to develop an understanding of the following process topics for their respective companies:

-market target

-collaboration and integration

-economies of scale

-economies of scope

-flexibility and adaptability

-standardization and customization

-labor

-transportation and delivery restrictions

-tolerance and precision

-waste and sustainable practice

-life cycle or material flow analysis

The intention of the research was to focus on discovering information that could lead to innovative products that the companies may produce in the future. Students were to discover a place in the production flow that could be interrupted to manipulate the output to serve an architectural end. In addition, students evaluated potential uses for the process to develop an entirely new product for architecture. Figure 1 illustrates excerpts from a student research assignment. This student evaluated a composites production process that has been broken into raw material evaluation and three methods of manufacturing including lay-up, filament winding, and compression molding. These methods were evaluated in the second phase for possible applications in architecture.

Phase 2 Application: In this assignment, students applied the research toward the development of an architectural product. The discussion began by defining the purpose of prefabrication technology as being social before it is technical. Students therefore began evaluating the development of prefabricated components based on a social need or desire. Students were encouraged to think of systems that had variable life cycles, were designed for assembly, were able to be reused or were able to be deconstructed and recycled. This allowed the design project to take on much more of a meaningful role in the final phase of design and aided students in being motivated by a strong social and environmental ethic.

Figure 2 illustrates analysis that revealed composites' ability to take on various shapes and maintain a high strength to weight ratio. The project then began to take these characteristics and apply them to design a disaster relief shelter.

Phase 3 Design: The studio was concerned with understanding how collaboration with fabricators can lead to unanticipated results in an architectural design process. Students therefore selected programs and sites that would maximize the opportunity to realize the research and development of the potential product(s). Figure 3 illustrates the solution to the same student's final proposal for a disaster relief shelter system from carbon fiber translucent composite for both a hot dry and hot humid climate. The student later indicated that the idea of doing a disaster relief shelter and using composite would not have crossed his mind as a final studio experience had he not collaborated with a manufacturer of the material and understood the possibility and properties of the material and process of production. The final design suggests a shelter that is used as packaging for food and clothing in transit and is then deployed on site to be used for temporary shelter as well as centering during reconstruction. It is suggested that the composite structure would be slipped out and transported to a new location in need of shelter.

Conclusion

The authors in Technological Innovation in Education and Industry illustrate that educational models should integrate more with industry and practice in order to provide for collaborative learning and feed technological innovation.[xiv] In architectural education, this could take the form of more service learning methods and cooperatives with manufacturers and firms in the school's region. However, in order to integrate effectively with industry, young architects must have skills and abilities to bring to the collaboration table. Students therefore must have a deep understanding and develop ability in their own area in order to effectively play a critical role on a building team. In addition, as inventive materials and digital tools for architectural production continue to emerge, it is paramount that young architects develop ideas concerning the making of material and exploitation of digital technology in order to innovate collaboratively in practice. In speculation for a future of architectural education in the 21st century, the 20th century technologist Jean Prouvé stated, "When the architect has made his choice, he must build immediately at the college, which will have been transformed into a factory or a practice. No more endless years of drawing to no purpose…use advanced techniques and bring architects, engineers, economists, and sociologists together in the same colleges."[xv]


LAY - UP FABRICATION
PROCESS
MATERIALS
SUSTAINABILITY
PRODUCTS
PRO / CON

Fig. 1.

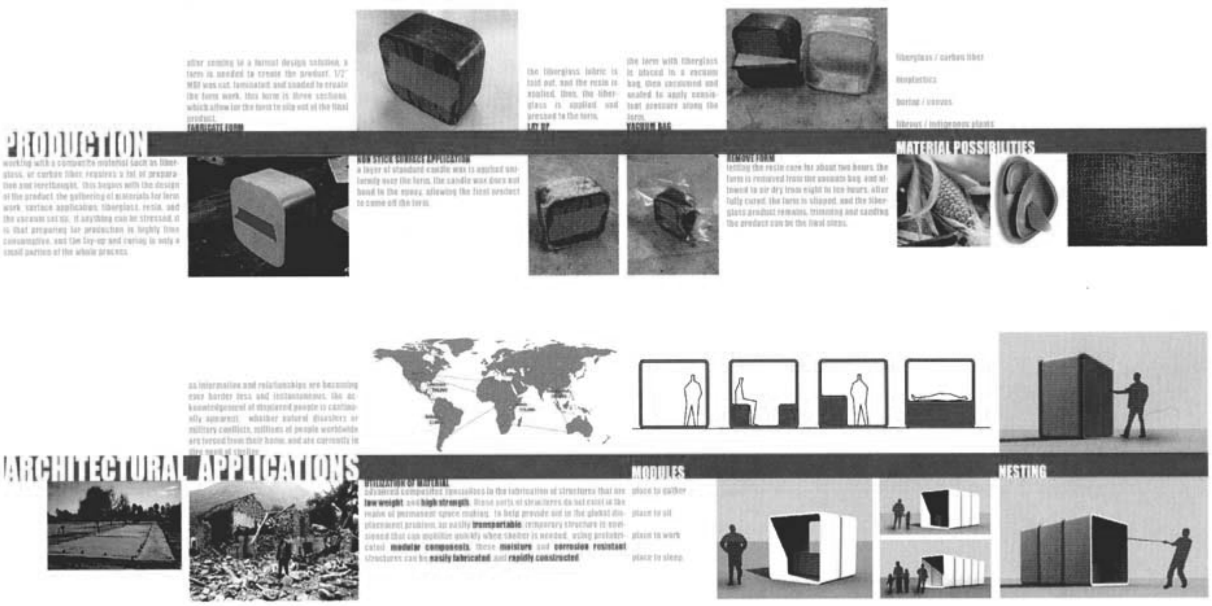
PRODUCTION
MATERIAL POSSIBILITIES
ARCHITECTURAL APPLICATIONS
MODULES
NESTING

Fig. 2.

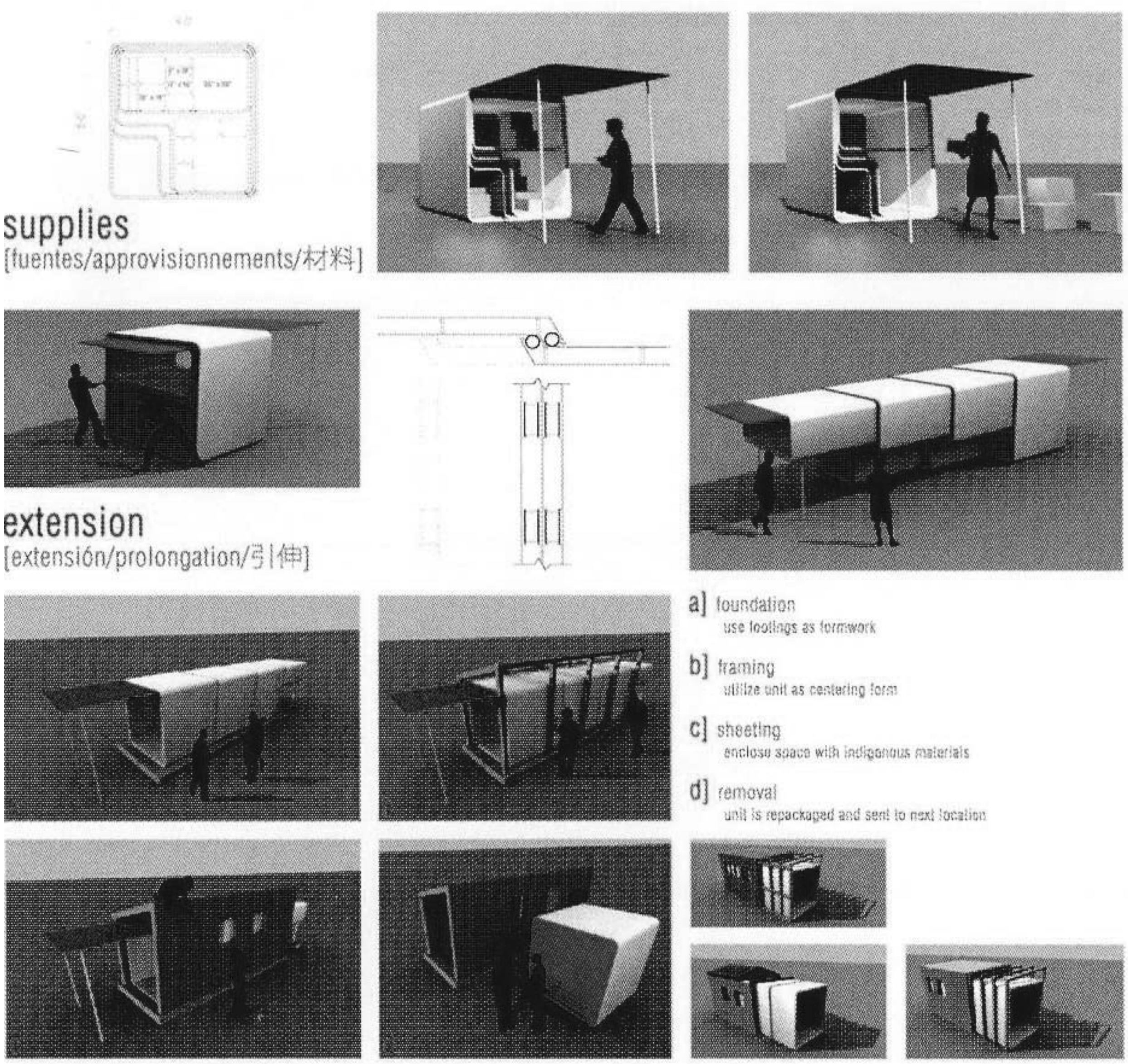
supplies
[fuentes/approvisionnements/材料]
extension
[extensión/prolongation/引伸]
a] foundation
use footings as formwork
b] framing
utilize unit as centering form
c] sheeting
enclose space with indigenous materials
d] removal
unit is repackaged and sent to next location

Fig. 3.

Notes

[i] Architecture in the Digital Age – Design and Manufacturing. Branko Kolarevic (Ed.) Spon Press 2003.

[ii] Workflow: Architecture – Engineering. Peter Cachola Schmal (Ed.) Birkhauser – Publishers for Architecture 2004. p. 4.

[iii] Collaborative Practice in the Built Environment. Tom Muir and Brian Rance (Eds.) Spon Press 1995. p. 15.

[iv] Buntrock, Dana. Japanese Architecture as a Collaborative Process: Opportunities in a Flexible Construction Culture. Spon Press 2001. pp. 105-106.

[v] The Architect's Handbook of Professional Practice. Student Edition. American Institute of Architects. Wiley Publishers 2001. p. 170.

[vi] Tornatzky, Louis and Mitchell Fleischer. The Process of Technological Innovation. Lexington Books 1990. p.13.

[vii] UK Department of Trade and Industry 1998.

[viii] Henderson, Rebecca and Kim Clark. *Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms*. Administrative Science Quarterly March 1990. Cornell University Graduate School of Management 1990. p. 4.

[ix] Architecture Boston. Volume 8. March – April 2005. *So Many Materials, So Little Time*. p. 21.

[x] Dodgson, Mark. The Management of Technological Innovation. p. 166.

[xi] Thomke, Stephan. Experimentation Matters: Unlocking the Potential of New Technologies for Innovation. Harvard Business School Press 2003. pp. 10-14.

[xii] Buntrock. p. 40.

[xiii] Fernandez, John. Material Architecture: Emergent Materials for Innovative Buildings and Ecological Construction. Architectural Press 2006 p. 59.

[xiv] Li, Yao Tzu; Jansson, David and Ernest Cravalho. Technological Innovation in Education and Industry. Van Nostrand Reinhold Company 1980. pp. 292-293.

[xv] Jean Prouvé: Industrial Architecture. Benedikt Huber and Jean-Claude Steinegger (Eds.), Alexander Lieven (Trans.). Artemis Zurich 1971. p. 173.