Moving Toward Synergistic Building Delivery and Integration

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Abstract

Building Information Modeling is a method for digitally representing the intelligent physical and functional characteristics, directly or related, of buildings. Current BIM usage is primarily patchwork and fragmented. The literature strongly concurs that industry direction for complete utilization of BIM technologies is imperative. Integrated Project Delivery is another effort to enhance project delivery and building implementation. There is no dispute that IPD depends upon BIM to be most effective. Still much is to be done for IPD & BIM to unite and be used to the fullest potential, however; the possibilities are encouraging. Synergistic possibilities require raising this unification another notch to include high-performance building delivery ideals, addressing not only sustainability, but economic, environmental, and social impact considerations, from the cradle to cradle of buildings (this is critical). The pressure and need for change is becoming too great to ignore. To satisfy the current critical needs of the building industry and transform the way buildings are delivered and integrated, educators must breathe new life into what is now a stalled educational process. Current managers and especially future managers must be trained to understand the implications of the synergistic value for true collaboration including BIM, IPD and the sustainable integration of high performance buildings. The purpose of this paper is to define research necessary to develop new curriculum integrating BIM, IPD-(like) and sustainable high performance building delivery methods into higher education programs, preparing today's managers to be successful in tomorrow's world.

Keywords: *Building Information Modeling (BIM), Integrated Project Delivery (IPD), Sustainable Design, High-performance Buildings*

1. INTRODUCTION

For centuries the master builder was the keystone of every large construction project. The master builder throughout history has been responsible for both the design and the construction of a building. In fact, the term architect was derived from Ancient Greece where *Arkhi* meant head chief or master and *tekton* meant worker or builder (Berman, 2003). The profession of the architect is in a new infancy, trying to find its place in a continuously evolving construction process. Although there have been attempts that have resolved some concerns, there are also new problems such as confusion of definitions and conflicts of roles.

The construction industry was formally organized in the United States in 1724 by the Carpenters Company in Philadelphia. Shortly, other organizations followed in Boston and New York. These organizations were considered to be "master builders." Master builders were responsible for the design, survey, engineering, and management of the construction. In other words, (the head builder) would be the architect, engineer, and superintendent for each project (Yates, 2003).

The early 1800's saw changes. Steel beams for multi-story buildings, elevators, plumbing, ventilation systems, central heating, and electric lighting all began to be incorporated into construction. The apprentice-trained craftsmen struggled to maintain their expertise in all aspects of the process (Landau, 1996). Culturally, legally, functionally, and economically, the design of buildings first began to separate from the construction. The architect worked out the design and construction details and then attempted to communicate the entire construction process to the builder through drawings.

Soon after the initial separation of the builder and the designer, the architect began to go through the same process as the builder in creating new relationships with *sub-contractors*. Consultants
to the architect began to assume the responsibility of various areas of design specialization such as electrical design, mechanical and plumbing design, and structural integrity. Today, the architect engages additional architects as specialized consultants, such as landscape, interior, acoustical, and laboratory designers (Woods, 1999). Fragmentation has eliminated a single source of responsibility and hindered collaboration due to the growing number of professionals involved in the process. The role of the master builder has not only changed, but it has all but disappeared. Today it becomes a challenge to know where exactly the responsibility and the expertise reside.

It is for this reason that a research study was accomplished using the Delphi method approach. Qualified panel members were randomly selected from a list of pre-qualified candidates who were chosen based on their level of expertise in their given field as it may relate to architecture and the construction process. The panel members were selected from the following disciplines: two architects, two general contractors, two engineers, two construction managers, a specialty contractor, an attorney, an owner – private sector, an owner – public sector, a banker, and a developer (Burr, 2011).

Several factors revealed from the study are meaningful to this paper. With so many individuals involved on a construction project, it is not always clear who may be the responsible party. Errors and omissions on construction documents have long been a source of contention in the construction process. Prior to the establishment of the architect as a professional, the client had a legal right to expect a defect-free building. In the 20th century, however, the professionals and the clients accepted the "*standard-of-care principle*."

One of the questions asked addressed the standard-of-care principle. The question asked whether the principle is too lenient, fair and just or too strict. Eighty-five percent of the panel members felt that indeed it is fair and just indicating a sort of complacency in the building industry with the current mode of practice. The chart below shows a graphic of the breakout: Considering all of the complexities of the building process, Delphi panel members were asked to identify professionals that will most likely experience conflicts of role. A large majority again, eighty-five percent, agreed that role conflicts will be most likely to occur between the architect and the general contractor. The remaining small percentages believed that there would be significant conflict with the owner. The main catalyst for contention between the architect and the general contractor according to the panel is poor communication. Fifty-four percent agreed on that point. Other points of contention are as follows: Poor communication – 54%, Different backgrounds and cultures – 14%, Project budget – 8%, Poor quality of performance from either party – 8%, Different goals and a misunderstanding of the concept of collaboration – 8% and Deficiencies and incompleteness of the plans – 8%.

2. THE TOOLS AND ETHICS

The issues determined by the Delphi study were not surprising. The building industry is on the

cusp of entering unfamiliar waters. Many long time and "my way or the highway" practitioners are becoming fewer and less influential. The needs for buildings have changed; the culture has changed and technology has evolved. There must be new insights into what is now a seemingly stale conversion. Managers today, and certainly of the future, must be prepared to undertake a return to collaboration using the strategic melding of synergistic values, including BIM, IPD, and the sustainable integrated high performance building delivery system.

2.1 (BIM) Building Information Modeling

Current BIM implementation with few exceptions is primarily patchwork and fragmented. Tardif (2009), contributing editor for AIArchitect maintains that "With building information modeling (BIM) becoming more and more common as the preferred platform ... Owners are increasingly specifying BIM deliverables in their RFPs, but the scope of work, or „level of detail" of the model is rarely indicated with any specificity. This creates an environment that could, at best, lead to misunderstandings and, at worse, lead to contractual disputes."

As a technical society, the potential of BIM has merely begun to be tapped. And, the industry"s understanding of what BIM is today, or what it is capable of becoming, is also limited and uncertain. As an example, some of the more accepted yet divergent definitions of BIM from the building industry are as follows: 1) The BIM is used for simulation of the building and its construction – AIA, 2) An object-oriented building development tool that utilizes 5-D modeling concepts, information technology and software interoperability to design, construct and operate a building project, as well as communicate its details. – AGC, 3) BIM is a tool to assist the owner best. Everything we do is aimed at the owner to save them money and build a better building." - Ben May of May Construction, 4) BIM is digital, spatial, accessible, comprehensive, measurable, [and] durable information. - Mortensen Construction and 5) The Building Information Model is a set of information generated and maintained throughout the life cycle of a building. – Anon.

2.2 Sustainability and Buildings

Buildings are responsible for forty percent of the primary energy use in the U.S., seventy-two percent of the electricity consumption and thirty-nine percent of CO2 emissions. The U.S. generated 143.5 million tons of building-related construction and demolition debris in 2008, but only 28% (40.2 million tons) was reused, recycled or sent to waste-to-energy facilities. Consider that one year's debris is enough to build a wall about 30 feet high and 30 feet thick around the entire coast of the continental United States or 4,993 miles (AR, 2011). Two and a half percent of the earth"s water is freshwater, 0.3% of water is surface water and 1 person in 6 is without safe drinking water. In the United States, water use in buildings and their surrounding landscapes accounts for about 47 billion gallons per day (AIA/CC, 2011). These statistics are areas of great concern for the building industry and our society at large. Therefore, a great priority for the industry is to manage construction so that excess, gluttony and waste are equalized. "Determining how building materials will affect the environment is the central unresolved problem of the green building movement" (Kibert, 240).

As is standard practice and believable outcomes of the building industry sustainable building practices are erecting with energy, economic, and environmental performance that is substantially better than standard practice. Kibert further addresses it as "Sustainable Construction most comprehensively addresses the ecological, social, and economic issues of a building in the context of its community (Kibert, 2008)."

If design and construction could once again be molded into the "master builder" concept by being one in scope and jointly utilize new technologies, it could make the building process stronger. Kibert (2008) stated "The high performance green building movement is said

to be the most successful environmental movement in the United States, certainly the fastest-growing and highly successful at creating partnerships with a broad cross section of manufactures, builders, and others who are not often allies with (the) environment." The building industry cannot afford to ignore these important progressive elements that require the collaboration of design and construction into one whole.

2.2 A Different way of Thinking or Mode of Delivery

The industry recognizes that to proceed ahead with any level of efficiency, changes to the process of project delivery is eminent. The needed change in how a project is delivered has metamorphed its way to the fragmented state of today for the past seventy years.

One of the roles that the architect played, in the traditional delivery method, is to be the owner's representative during the construction phase. In this role, the architect holds the responsibility of inspecting the work of the builder down to the smallest details and ultimately being the one who accepts or rejects the work. This role creates an *adversarial relationship* between the architect and the contractor. Furthermore, in the traditional delivery method, the contractor bases the project estimate and budget on the construction documents provided by the architect. Any omissions or inaccurate details will take away from the accuracy of the budget, drive the project cost up with change orders, and delay the schedule while changes are made. All of which can chip away at the profit of the builder.

Because design had become separated from construction, the players had little opportunity to positively influence one another. It eliminated any motivation for cooperation between the two. This influenced participants to focus on the short-term costs, and largely ignored the long-term consequences, and costs, of design and construction decisions.

As a sort of answer to communication problems associated with DBB, Design/Build (D/B) was introduced in the 1960s. The D/B method allows one entity to handle all aspects of design and construction, recognizing that projects endure time, and that long-term cost-effectiveness, rather than the lowest competitive cost alone, creates the best value for an owner and leads to lower costs overall. Design/Build draws upon the strengths of all the participants to insure the highest value for the project. The Design-Bid-Build (DBB) or traditional project delivery method has been the standard for the longest period of time since the separation of design and construction. It is a result of economic specialization.

Then, realizing that D/B held some of the answers needed for modern project delivery but still lacked important aspects for idealism, the evolution of Integrated Project Delivery (IPD) emerged. Over the last decade IPD introduced a legal framework that the owner, the architect, and the builder can use to collaborate on a design and construction project. Owners enjoy improved cost control and budget management, as well as the potential for less litigation and enhanced business outcomes. Contractors are provided with the opportunity for stronger project pre-planning, more timely and informed understanding of design, the ability to anticipate and resolve design- related issues through direct participation in the design process, construction sequencing visualization to improve methods prior to the start of construction, and improved cost control and budget management. For architects and designers, IPD provides more time for design, reduces documentation, allocates more appropriate sharing of risk and reward and improves cost control and budget management (IPD, 2011). IPD is another step toward the change needed for the building industry to catch up with current project delivery expectations. Yet, incorporating the demands and possibilities of sustainable building and BIM require further enhancement to project delivery.

To learn where IPD stood among professionals today, a survey was generated asking members of the Associated Schools of Construction about their take on IPD. It was based upon a

five part Lykert scale going from "Strongly Agree" to Strongly Disagree." The survey revealed some interesting perceptions regarding sustainability and IPD. (November, 2009).
The first of five responses was from the statement; "IPD is a trend and will never find its way fully into the building industry." 51.7% disagreed and 18.3% strongly disagreed implying that IPD is, or might become the predominant future method of project delivery as DBB is today. The second statement said; "Even if owners change their philosophy on delivery, IPD will only be applicable for select projects and will never be effective for all." The responses to this statement were split (45% agree and 33.3% disagree), possibly meaning a split interpretation of IPD as a delivery method. This could mean that not enough understanding, knowledge and experience with IPD are had among professionals to discern its potential for all categories of projects. The third statement said; "IPD will have little effect upon common problems associated with project delivery like communication, litigation, responsibility, and control." 48.3% of respondents disagreed with 26.7% strongly disagreeing suggesting that IPD addresses some critical problems related to project delivery and quite possibly be a better option. Statement four said; "Green building philosophies will have no effect upon the way a project is delivered." 55% agreed while 20% strongly agreed indicating that regardless, sustainable building requires a different process of delivery to be most effective. The last statement said; "IPD is very well suited for sustainable (green) projects." 38.3% agreed, 23.3% strongly agreed while 36.7% had no opinion suggesting that there is a little uncertainty still around the affiliation between IPD and sustainable buildings. However, a good majority agreed that IPD would be a good fit.

Kibert (2008) analyzed the issue at hand and stated that, "Measures to cope with problems of constructability, cost, coordination of (documents), and attention to (owner) requirements have been woven into the high-performance green building delivery system. Three powerful approaches coexist to ensure the creation of a truly high-performance building; performance based fees, the charrette, and building commissioning. Although none of these concepts are new, each has rapidly gained acceptance …" The key to creating a high-performance building is an integrated approach that brings together, early in the process, all the professionals who have a hand in designing, constructing, operating and maintaining the building. The integrated process requires the design team and all affected stakeholders to work together throughout the project phases, and to evaluate the design for cost, quality-of-life, future flexibility, energy efficiency; overall environmental impact; productivity, and the well-being of the occupants. This approach is different from the typical planning and design process of relying on the expertise of specialists who work somewhat isolated from each other (wiki.aia, retrieved
3/10/2010).

3. IMPLICATIONS OF RHETORIC

Stitching the arguments presented together reveals a congruent theme. **First**, BIM is the process of generating and managing building data during its complete *life cycle* (Lee, Sacks and Eastman, 2006). **Second**, as Mergenschroer (August, 2009) put it, "In my thirteen years of being in the Engineering and Construction industry, I have seen many changes that have benefited the Owners, Architects, Engineers and Contractors. However not all of these changes benefited the entire group. I see BIM as the total package. BIM has the power to change the way we do business. How we implement the BIM process into our daily work schedules is the challenge." The building industry is not yet prepared to fully integrate the complete capacity of BIM. The need for a definite process to facilitate integration, a method for bridging the gaps between old methods and new technology, is evident. The evolution of BIM to this point is

silo-ed. However, the potential of the technology to enhance the building process is immense. Jonassen (2009) emphasizes this, "A BIM-enabled integrated delivery business model holds the maximum potential for positively addressing the silo and communication ills of the design construction industry … In any BIM scenarios the management of sharing, integration, tracking, and maintaining the integrity of a set of models that make up the overall project model is a new and awesome endeavor." Building Information Model creates the potential to digitally represent the entire physical and functional characteristics of a building.

BIM facilitates collaboration by different stakeholders at different phases of the life cycle of a facility to insert, extract, update or modify information. There is a need to integrate all of the diverse facets that are involved in a building, bridging the gaps between old methods and new technology. Future managers need to be equipped with the tools to modernize the building industry through an intense knowledge of BIM capabilities and implementation.

Third, the literature is clear showing that the industry direction for *complete* utilization of sustainability and BIM technology is needed. Mergenschroer (2009) emphasized that, "With the demand for Building Information Modeling (BIM) escalating, it is paramount that design and construction professionals become accustomed to doing things differently … The total team concept that BIM brings to the table, will not only compel us to change the way we approach a project, it will also transform the way that we design a project."

Fourth, building owners who build multiple buildings generally are interested in looking at ways to save on time and money in their construction projects. In a question asked of the Delphi study, panel members said the most effective ways for the owner to save time and money (62%) was to create standards or guidelines for all of their buildings. One member elaborated by saying that, "If saving time and money is the objective, it would be using the same … standards or guidelines for all of projects (Burr, 2011). Navigant Consulting (2010) stresses, "The time has arrived for companies currently utilizing BIM tools to look beyond their individual BIM successes and begin to take advantage of the synergistic value of incorporating BIM-enabled IPD." BIM and IPD can then be used to more fully satisfy current sustainability issues becoming what might be deemed as a *high-performance green building delivery system.* Davis Langdon, a most respected construction consultancy firm headquartered in London, UK concluded that it is as fundamentally and entirely possible to produce sustainable buildings within budgetary guidelines as it is for traditional methods for building (Davis Langdon, 2007).

4. CONCLUSIONS

Traditionally, the building industry has been behind the norm when adapting to new technology or changing management strategies. Much of this can be attributed to the massive undertaking at hand in completing a building project. It is a fast paced and hard driving industry. The construction process with its many separate entities, by nature, is *contentious* and has been so for many years. The traditional method for many years has been limited to Design-Bid-Build (DBB). Even if BIM were implemented and sustainable principles were to be considered in a DBB project, this could not eliminate the barriers that are traditionally in place to most effectively and efficiently deliver the project. Therefore, a whole new way of project delivery, IDP, that embraces rather than just attaches BIM and sustainability is the future of the building industry.

The changes that need to occur for the building industry to move progressively forward are; 1) the further definition and exploration of the potential of BIM to become a complete building technical tool that begins with design through construction and then passed on to the owner for facilities management functions from cradle to cradle; 2) the development and

integration of BIM tools beyond their current individual realizations to implement a BIM-enabled IPD; 3) the use of greater synergistic possibilities in the process including a high-performance green building delivery system, addressing not only sustainability, but economic, environmental, and social impact considerations, from cradle to cradle of building existence. Practice must create structures using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort; 4) the creation of standards as key to the incorporation BIM, IPD and high-performance building values.

Additionally, expertise in this new way of looking at the process must be part of current educational practices. Otherwise, universities will continue to add to the problem and impede the implementation of new technology by producing new managers with only a limited understanding of new possibilities. Education must take the lead in embracing new technology and prepare students with the skills to not only implement technology but also to become the catalyst that will bridge the gap between the old and new ways of project delivery.

The concept of master builder could come full circle, with design and build arriving back together. Better technology, more effective communications and a concern for more than just buildings will make the building industry better prepared for the future. The data revealed in this paper is an important resource for the industry to reflect upon in order to evolve, striving to perform a service in a better way and to do business better in general.

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