Design the "Building in Construction" for the Progress-Users: a 4D Perspective

Steve Rowlinson and Yunyan Jia
Department of Real Estate and Construction, the University of Hong Kong, Pokfulam, Hong Kong

[Abstracts] The implementation of Building Information Modeling (BIM) is driving and enabling a paradigm shift in building design methods. Traditional architectural design process focuses on the design of "form, space and order" of the built environment, responding to the need and demand of the clients, the "end-users". Under this professional paradigm, construction workers, the builders, are part of the construction machine to turn the design into reality. However, the "building in construction" is the working environment of builders, in which they spend most of their time in their everyday lives. They are "progress-users" of the building environment, a changing environment composed of building components, scaffolds, moving equipment and temporary facilities. They are performing various activities, which has a great impact on their physical and psychological health, and more importantly, their safety. If we add the time dimension into the building process, the concept of "user" needs to be extended and the dynamic environment needs to be taken into account at the stage of architectural design. This paper argues for an alternative perspective on the built environment and proposes a methodology for sustainable architectural design through the implementation of BIM.

[Key Words] building-in-construction, progress users, building life cycle, Building Information Modeling, architectural design

1. Introduction

The traditional architectural design process focuses on the design of "form, space and order" of the built environment, but ignores the social economics context of the design product. This was criticized as the "moral deficiency of architects" by Herbert Simon, the 1978 Nobel Economic Laureates, who argued for the rights of clients and users of the built environment against architects(Simon, 1991). However, neither of these two mutually exclusive paradigms goes beyond concentration on the "end-users" of the built environment. What is ignored in both paradigms is the rights of the "progress user" of buildings, the builders, who spend most of their time in the "building-in-construction", a changing environment composed of building components, scaffolds, moving equipment and temporary facilities. They are performing various activities – building, wielding, casting, or resting – in the dynamic environment, which has a great impact on their physical and psychological health, and more importantly, their safety. Many fatal accidents on construction sites have their genesis in the design process, especially an ignorance of buildability. If we add the time dimension into the building process, the concept of "user" needs to be extended and the dynamic environment needs to be taken into account at the stage of architectural design. The implementation of in Building Information Modeling (BIM) has offered the opportunity of a holistic design of the progressive building environment for both the end users and the progress users. In this paper we will argue for an alternative perspective on the built environment and proposes a new methodology for architectural design.

2. Beauty vs. Efficiency: the core values underpinned two major paradigms among the built environment professionals

The construction industry is the results of struggling paradigms of architects, engineers, developers, contractors and users. The core values of each paradigm generate a different path of power relationship. Classical architectural design is about "form, space and order" (Ching, 1979), while the classical worries of developers and contractors are "time, cost and quality". The clash of two distinct

paradigms are apparent when a strong economist encountered a strong architect in the late 1940s, when Mies van der Rohe, in his 50s, chaired the architecture school of IIT, meanwhile Herbert Simon, in his 20s, started his academic career in the same institute, teaching economics to architecture students (Simon, 1991). In Mies's statement, "beauty is the radiation of truth", the truth he found from St. Augustine's work and identified as the meaning of architectural design (Mies van der Rohe, 1938). The core value of Mies' paradigm of architectural design is "beauty". However, in the irony of Herbert Simon, a young economist under the pressure of a great architect and his disciples, the architecture paradigm is "to preserve their profession for the expression of the noble artistic impulses from the baneful influence of money-grubbing speculators……the architect was an artist, whose task is to build beautiful buildings (or cities) either in collaboration with or in spite of the client" (Simon, 1991: 98). He pointed out that the core value of beauty is associated with a moral judgment of developers and an ignorance of the right of users:

"Any rights of the client to determine the amount of resources to be applied to the task, or the functionality of the final structure, were not included in Mies's view. On the contrary, the client was to be educated, persuaded—I won't say *duped*—to contribute the resources necessary to produce a great work of art, as defined by the architect. The client was an instrument, a means." (Simon, 1991: 98)

Mies's own comments on client-architect relationship illustrate the same picture in the architects' angle:

"Never talk to a client about architecture. Talk to him about his children. That is simply good politics. He will not understand what you have to say about architecture most of the time. An architect of ability should be able to tell a client what he wants. Most of the time a client never knows what he wants. He may, of course, have some very curious ideas and I do not mean to say that they

are silly ideas. But being untrained in architecture they just cannot know what is possible and what is not possible."(Mies van der Rohe, 1959: 10)

When being asked what if a client does not like the finished building, Mies responded with overconfidence, which unfortunately comply with Simon's criticism of his ignorance of user's right:

"That would not matter at all, although I have never had this experience. I may have had many wrangles with clients while a building was being designed, and often while it is being built, but always, in the end, they have been satisfied with the way I did it." (Mies van der Rohe, 1959: 10)

Simon made clear his own paradigm in his criticism of architects, which concentrates on the optimization of resources, the paradigm of an economist and a developer:

"A society as affluent as ours can afford to provide painters with just about all the canvas and paint they can use, and let them paint what they want. But no society is affluent enough to provide its architects with all the steel and glass and concrete they need to save their artistic souls. " (Simon, 1991: 98)

Moreover he argues for the right of users to make decisions in their living area:
"Nor should the members of a democratic society be obliged to delegate to the architectural profession the decisions that determine the comfort and pleasantness of their daily surroundings."(Simon, 1991: 98)

3. The Gap of the two paradigms: the progress-user and the building-in-construction

The argument between the above mentioned paradigms is the power struggle among investor, user and designer of the building as a product. In both paradigms above, the construction workers are machines to turn the resources

from developers, ideas from architects and expectations from clients into the product of building. The process of construction and the environment during construction are minimized in the consideration of designers. The gap in these arguments is the ignorance of the users of the building-in-construction, the builders in a changing environment composed of building components, scaffolds, moving equipment and temporary facilities. This dynamic building environment accommodates site workers and engineers who perform certain tasks as building, wielding, casting, or supervising. The building-in-construction thus has a great impact on the physical and psychological health, and more importantly, their safety. Many fatal accidents on construction sites have their genesis in the design process, especially an ignorance of buildability (Lingard and Rowlinson, 2005). Taking a 4D perspective of the building life cycle, the concept of "user" needs to be extended to include the builders working in the rapidly changing built environment. The dynamic environment of building-in-construction needs to be taken into account at the stage of architectural design(Weinstein *et al.*, 2005).

The introduction of sustainability into building design has changed the priority of both the developer and designer's concern. The core value of sustainability is a balance between the present and the future, and between environment, society and economics. Taken into account of society and environment, efficiency is never the ultimate measure of project success (Stokols, 1992). To pay resources and attentions to the working environment of builders is one of the main concerns of corporate social responsibility (Campbell, 2007).

4. The current paradigm of BIM

The core value behind the current paradigm of BIM implementation is efficiency. Take for example Autodesk's white paper, the main advantages of BIM are claimed to be: (1) time saved, (2) fewer errors, (3) money saved, (4) greater productivity, (5) higher-quality work, and (6) new revenue and business opportunities (Autodesk White Paper, 2003). In academic literature the advantages of BIM are supposed to be "to reduce industry's fragmentation,

improve its efficiency/effectiveness and lower the high costs of inadequate interoperability"(Succar, 2009). In this framework, BIM is merely a management tool to detect clashes among design drawings before the construction stage of the building, and a simulation tool for planning the construction process. The current literature has noticed that BIM provide a platform for screening the power relationship among stakeholders in the construction industry (Linderoth, 2010). The transparency will then cause the redefining of the roles and responsibilities of different professionals in the construction industry.

5. The new perspective of a BIM-integrated construction industry

Currently there are two ways in operation for BIM to be involved in the construction projects. One is that the BIM consultant as an independent party taking part of the job of architects and engineers, building 3D models from 2D drawings and checking clashes between drawings of building design, structural design and MEP. They involved in the project at the stage between detail design and construction. Their main task is to make sure the consistency among design drawings and minimize changes during construction. The key of the success for this operation is that the BIM professionals must be empowered by the client. Going beyond a management tool, BIM is driving the integration of the construction industry (Owen, 2010).

Another way of operation is the involvement of BIM at early stage of design. The BIM consultants do not work as an independent party, but rather they are working as facilitators of architects and engineers. They build BIM model for visualization at the preliminary design stage. As design being developed, the models are enriched with more parametric information. The professionals will be doing collaborative design in a transparent platform. The key of success for this operation is a paradigm shift in design. The use of BIM by all professions in the design stage demands a common language for communication among professionals. Convenience of communication makes it difficult for architects,

structural engineers and mechanical engineers to ignore each other. The process of developing design ideas is no more a linear process but rather a more complex process with more challenges and opportunities.

The BIM-driven integration in design is bringing new opportunity for creativity. The simulation of BIM for construction process has enabled the architects to have better control of the built product, better realization of their design ideas. Taking a 4D perspective in design, the simulation of construction process enables a more careful consideration of the working environment of building-in-construction. The new challenge and opportunities for architectural design now comes from the designing of building as a lifecycle and as a changing environment, an integrated solution for both end-users and progress-users.

6. Conclusion

This paper analyzed different paradigms among the stakeholders in the construction industry, and made implicit the paradigm of the current implementation of BIM in design and construction process. The gap between the main paradigms is the ignored construction workers' safety and health given the fact that the building-in-construction is the daily working environment of this population. A more integrated BIM application taken into account of the time dimension in design, especially take into architectural design the building-in-construction, which is a paradigm shift from 2D and 3D design to 4D, building lifecycle and the people and their activities at the specific stage of a living building envirnment.

7. References

Autodesk White Paper (2003) Building Informaiton Modeling in Practice. *http://resources.autodesk.com/Architecture/Revit_Architecture/White_Papers (accessed on 7 May 2010)*

Campbell, J. L. (2007) Why would corporations behave in social responsible ways? an institutional theory of corporate social responsibility. *Academy of Management Review*, **32**(3)**,** 946-967.

Ching, F. D. K. (1979) *Architecture: Form, Space and Order,* New York, Van Nostrand Reinhold.

Linderoth, H. C. J. (2010) Understanding adoption and use of BIM as the creation of actor networks. *Automation in Construction,* **19,** 66-72.

Lingard, H. & Rowlinson, S. M. (2005) *Occupational Health and Safety in Construction Project Management,* London ; New York, N.Y., Spon Press.

Mies van der Rohe, L. (1938) Banquet Speech. in http://www.iit.edu/giving/mies/ Accessed at 8 Aug., 2009

Mies van der Rohe, L. (1959) Interview. *Interbuild,* **6**(6)**,** 9-11.

Owen, R. (Ed.) (2010) *CIB White Paper on IDDS: Integrated Design & Delivery Solutions,* CIB Publication 328.

Simon, H. A. (1991) *Models of My Life,* New York, Basic Books.

Stokols, D. (1992) Establishing and maintaining healthy environments: toward a social ecology of health promotion. *American Psychologist,* **47**(1)**,** 6-22.

Succar, B. (2009) Building informational modelling framework: a research and delivery foundation for industry stakeholders. *Automation in Construction,* **18,** 357-375.

Weinstein, M., Gambatese, J. & Hecker, S. (2005) Can design improve construction safety? assessing the impact of collaborative safety-in-design process. *ASCE Journal of Construction Engineering and Management,* **131**(10)**,** 1125-1134.