Building Information Modeling and Architectural Practice

On the Verge of a New Culture

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Abstract

The introduction of machine-readable tools for architectural design, which do not just focus on mere geometry or presentation, but on the richness of information embedded computationally in the design, has impacted the way architects approach and manipulate their designs. With the rapid acceleration in building information modeling (BIM) as a process which fosters machine-readable applications, architects and other participants in the design and construction industry are using BIM tools in full collaboration. As a trend which is already invading architectural practice, BIM is gradually transforming the culture of the profession in many ways. This culture is developing new properties for its participants, knowledge construction mechanisms, resources, and production machineries. This paper puts forward the assumption that BIM has caused a state of transformation in the epistemic culture of architectural practice. It appears that practice in the architecture, engineering and construction (AEC) industry is still in this phase of transformation; on the edge of developing a new culture. The paper attempts to address properties of such an emerging culture, and the new role architects are faced with to overcome its challenges.

1. Transformations in architectural practice: How is BIM different?

Conventional methods of manual drafting through sketching and digital drafting through computer-aided design (CAD) representation techniques have been used by architects extensively in the design process. In such methods, these types of representations are typically "logical pictures"[1] of things; analogies rather than copies of reality, used to intentionally and explicitly inform about specific key aspects of the design in hand. They can be considered as 'abstractions' of reality, but which hold within a plethora of interpretations with varying degrees of ambiguity. The architect or designer in this case has control over 'what to show' or 'what to highlight' in his design, as the drawback of these drafting methods as non machine-readable representations helps conceal specific points of interest.

With the introduction of BIM in the architectural profession, the notion of the 'logical picture' in this sense became slightly different in meaning. The accuracy and degree of detail that BIM tools claim to maintain takes the machine-readable representations to the 'copy' end of the spectrum more than the 'analogy' end; to a virtual mimic of the elements, processes and mechanisms in a building rather than just a mere depiction.

BIM was introduced as the latest generation of object oriented CAD systems. It built on strategic limitations in previous systems. These limitations revolved around two key issues. Previous systems produced representations interpretable only by humans and not computers, and they required endless effort to comprehend the full geometrical detail of those representations in order to adequately provide construction information, thus making them highly open to errors.

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[1] see Langer S. "The study of forms", in *An Introduction to Symbolic Logic*, New York, Dover, 1967, p. 24

BIM built on the main concept of the 'virtual building'[1] which describes a single consistent source that captures all the information about the 'intelligent objects' in the represented building. BIM tools allow for extracting different views from a building model. These views are consistent, as each object instance is defined only once. Because BIM relies on machine readable representations, data from virtual models can be used in many ways. Benefits such as spatial conflict checking, consistency within drawings, automatic generation of bills of material, energy analysis, cost estimation, ordering and tracking, can be achieved. Other benefits include the integration of these analyses to provide feedback for architects and engineers from other disciplines to inform them of effects of alterations of designs, while designing, rather than post facto checking[2].

2. Properties of a new culture

The mechanisms of interaction among participants in the BIM process; how they "sit together at one table" early in the process to develop a project design, and how they "construct together" the project electronically as a "virtual building"; have led to a revolution in project delivery. The culture of architectural practice is thus changing. Mechanisms of practice, participant roles and communication, knowledge construction mechanisms, are all being re-shaped in a way that is challenging for both practice and participants. BIM has created a paradigm shift that has caused a state of transformation in the epistemic culture[3] of architectural practice.

2.1. Problem solving contexts

Different mindsets, machineries and mechanisms are being produced to cope with the rapidly developing territory of BIM. For example, the idea of variations in design problem solving contexts has been influenced by BIM. Traditionally, resources to finding clues for design "solutions" were usually embedded in freehand design sketches and prescriptive execution drawings[4], in the experience and design expertise of talented architects[5], and the intuition of multidisciplinary teams working on projects. All these factors tended to vary elements of the design strategy in order to come up with "satisficing" solutions[6]. All these resources usually constituted "communal stocks of knowledge" and "experiential registers" where the "narrative culture" of the architectural community contributes to the problem solving process through "blind variations" [7].

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[1] see Seletsky, P. "Questioning the Role of BIM in Architectural Education: A Counter-Viewpoint", AECbytes Viewpoint #27, 2006.

[2] see Eastman, C., Teicholz, P., Sacks, R. and Liston, K. BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors, Wiley, 2008.

[3,7] see Knorr Cetina, K. *Epistemic Cultures: How the Sciences Make Knowledge*, Cambridge, MA: Harvard University Press, 1999.

[4] see Schön, D. *The Reflective Practitioner. How professionals think in action*, London, Temple Smith, 1983.

[5] see Cross, N. "The Expertise of Exceptional Designers", in N Cross and E Edmonds (eds), Sydney, Australia, 2003, pp. 23-35.

[6] see Simon, H. and March, J. *Organizations*, New York, Wiley, 1958.

With BIM, whether or not resources for problem solving contexts have remained unchanged is a controversial issue. Viewed as a tool which automates various stages of the design process, BIM is seen as enclosing the process into a closed universe, where systematic variations are operationalized within the detailed technical specifics of the mechanism of the digital tool alone. Viewed as a process by itself, however, which emphasizes the underlying logic of design, BIM is seen as fostering creative thinking, enhancing paths of self discovery, and enabling the synthesis of knowledge through the digital tool. But knowledge resources have shifted to "registers" within the intelligent tool rather than "experiential registers"[1].

2.2. Knowledge construction

Participants in the architecture, engineering and construction industry are moving from being active "epistemic agents"[2] who produce the knowledge of that culture throughout the process into passive agents. The produced knowledge is embedded within the "single model", where all participants contribute to a pool of knowledge, thus melting down individual identities within the knowledge construction process. Copyright, data management and database transaction issues become highly critical. Contributions to a specific project or to knowledge databases that inform future projects become identity-anonymous in a way that may require a redefinition of roles and responsibilities.

Although architects would argue against this idea from a "master architect ego" point of view, no single individual or group of individuals can be identified as producing the resulting knowledge, and the only epistemic agent becomes the extended building information model. The architect's role in this sense can alternate between the "master builder" and the "team participant". It is up to the architect then to define the main emphasis of his role in the process of knowledge construction.

2.3. Knowledge representation

An important shift has also occurred in the design and construction industry, where the focus has deviated from skilled artistic techniques, catchy perspective drawings, and individual talents into representations of information and unified methods of presentation, exchange formats, and model attributes for the sake of collaboration and coordination between different participants. Personal "master architect" talents and techniques have blurred due to the global response to the concepts of the "virtual model" and the "single building model repository". The architect would have to rethink how to define his identity as a designer in this global and anonymous repository, and representation techniques are definitely no longer the proper way to express identity.

This would also imply consequently cutting down the amount of artistic strokes, the intentionally drawn ambiguous sketches and approximate drawings that are open to interpretation. The architect has to predefine a lot of elements and attributes before attempting to sketch a 3D volume. Ideally, the virtual output is quickly and accurately executed, associated with a whole set of information rich by-products. On the other hand, from a cognitive standpoint, understanding the modeling tool parameters, mechanisms and attributes introduces a burden to the creative process of design. The architect has to model something of which he has no clue of its final output or shape, but with a relatively high degree of precision beforehand.

[1,2] see Knorr Cetina, K. *Epistemic Cultures: How the Sciences Make Knowledge*, Cambridge, MA: Harvard University Press, 1999.

2.4. Mechanisms and data exchange

Emphasis has inverted within the discipline from *care of the object* to *care of the self*, where BIM systems work on designs of architects, consultants and various collaborators, only to absorb them into a *closed universe*[1]. Within this "single universe", the focus has become more involved in controlling, improving, monitoring and understanding the internal processes and components within the system. The culture becomes concerned with self-analyzing the 'design', and reconstructing it internally 'within the BIM tool' to produce negative images of registers through sign-oriented systems.

The design elements, represented in walls, spaces, doors, windows,…etc., enter the BIM system as these objects, but get transformed internally into signs that are absorbed and reconstructed via purely internal interpretations in terms of other 'meaningless' variables, neutral file formats and extensions, rather than relations close to the registered design elements. This is done for the purpose of satisfying the internal tool mechanisms which demand exchangeable formats in order to build up the single building model. Thus the internal tool mechanisms have more control over the design element in hand in this case.

2.5. Scope of Expertise

Along the many transformations that have influenced the architectural profession, the role of the architect as "master builder" has been fluctuating between having full control over design, construction methods and roles, and having a more narrowed focus on design aspects thus being isolated from the decision making process in other disciplines. BIM has presented a new challenge for the architect's scope of expertise. Architects are not only dealing with design complexities, but are facing the steep learning curve of computational tools which have become essential for engaging in BIM projects. The process of learning new tools is different from conventional CAD tools. It is now more a process of learning how to integrate BIM-authoring tools with concept design tools, analysis and simulation tools, facility management tools and others in a seamless fashion that serves the purpose of the design strategies at the same time. The question then becomes: where does the expertise required of the architect lie? In this sense, expertise does not reside in design expertise[2] only or computational tool expertise[3] only, but in the strategic management[4] of both design and tool strategies along all design phases.

3. The expanded role of the architect

The role of the architect is therefore now expanding and being redefined. The architect himself is going through a stage of transformation, where he has to extend the scope of his expertise, regulate the mechanisms of knowledge construction and representation, define

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[1] see Knorr Cetina, K. *Epistemic Cultures: How the Sciences Make Knowledge*, Cambridge, MA: Harvard University Press, 1999.
[2] see Cross, N. "The Expertise of Exceptional Designers", in N Cross and E Edmonds (eds), Sydney, Australia, 2003, pp. 23-35.
[3] see Bhavnani, S. and John, B. "The Strategic Use of Complex Computer Systems", in *Human-Computer Interaction*, Volume 15, 2000, pp. 107-137.
[4] see Sanguinetti, P. and Abdelmohsen, S. "On the Strategic Integration of Sketching and Parametric Modeling in Conceptual Design", in proceedings of *ACADIA 2007*, Halifax, Nova Scotia, Canada, 2007, pp. 242-249.

resources for problem solving contexts, and manage methods of data exchange in this new "BIM-enabled culture", while maintaining the role of the "master orchestrator" or "key team participant". Although this places more load on the architect, but it is perhaps ironically significant at the same time, where the architect needs to be deeply involved in the development and research of BIM technology, as well as being in continuous communication with BIM-authoring software vendors. The architect needs to ensure that while meeting the requirements of clients and specialists, *what matters* is not only efficiency, but the larger goal of design as primary importance, where creativity and extended horizons of design imagination are not sacrificed due to mere business requirements. In this sense, this new "BIM-enabled culture" may allow architects to maintain the balance through regaining control and management of the architecture, engineering and construction process.

At the same time, BIM should not divert architects from the fact that they are both technologists and artists. Architects' designs should meet objective performance criteria and solve problems, but on the other hand, architects still have the privilege of 'making meaning'[1]. Through their creative work, they tend to understand culture, society, history and time, and reflect through buildings that represent signs of people's social values, beliefs and feelings. It is not all about clients' needs, and architects should have that in mind in order to know what "gives things meaning" in their designs. So BIM may have influenced the culture of the architectural profession profoundly, but if tackled by architects properly, it could allow the master architect with the universal view to establish the agenda yet again for the AEC process.

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