Agent Provocateur – BIM In The Academic Design Studio

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Abstract

Building Information Modeling challenges academia to question the fundamental roles of abstraction and simulation in design education. Architectural education and practice assume a traditional set of visual conventions at varied scales and levels of detail, that when taken in concert signifies a whole, complete idea of a building, a correspondence between design intent and interpretation, between the representation of ideas and the design of buildings. BIM viewed as provocateur to these assumptions provides potential critical analysis of how architectural design is taught. Academia must seek out new design methodologies for exploring architecture that reflect the representational shift of BIM by developing teaching methods that reprioritize ways of seeing, thinking and making. This paper describes a studio model that seeks out new active methods for exploring architecture that embrace this shift by developing processes that provoke novel ways to reconcile the traditions of abstraction and the opportunities of synthetic simulation.

1. BEYOND TOOLS – APPROACHING WAYS OF THINKING

> "A Tool directs your attention. Its function becomes your focus: as the saying goes, when you hold a hammer, all the world looks like nails." - Malcom McCullough, Abstracting Craft (1996) [1]

The challenge is to understand the opportunities presented when digitally driven design, process and production technologies are envisaged more comprehensively than as mere tools [2] to fully embrace them as ways of thinking in and of themselves. One of the dilemmas of *tool* thinking is that it undermines the additive value of skills and intentions working together when conceptualized as a working methodology with its own rules and boundaries to be played against. A tool, like a chisel, is one way to remove material. As a *tool of removal,* a chisel is limiting. BIM is not a tool, but *a way of thinking*, a conceptual position. BIM is not the chisel, but, more precisely, it is the *concept of removal* that the chisel represents. Positioning BIM as method for *design thinking* is far more powerful than limiting it as a tool. As a methodology it can be developed and dissected into and throughout a curricular structure. It is a *way of thinking* that seeks to simulate the construction of a building. The method by which the model is constructed must be considered as a design decision. The challenge is to understand not only the model geometry but the implications of the ways the process of modeling the building simulation is constructed [3] to develop a rigorous process of critical evaluation to understand the elements not only through building convention but also design intent.

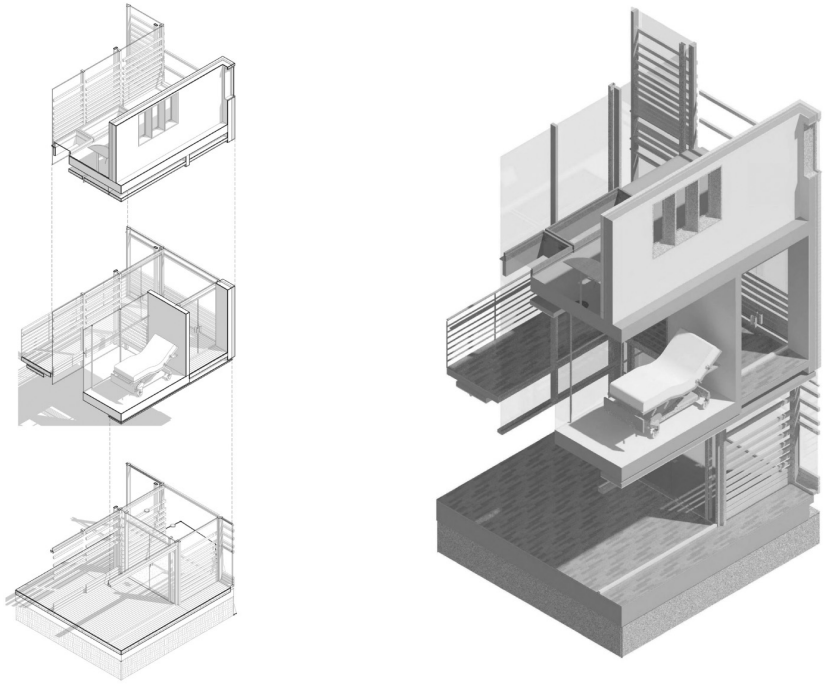
The primary question is; with BIM, does architectural education still require representational abstraction? What are the issues and what is the knowledge that academia should now address to enable the BIM methods? What current issues and knowledge gets displaced? Many academics and scholars favor a reductionist approach that seeks to mediate the complexities and simultaneities that BIM brings to bear. What might happen if, as Daniel Friedman posits,

> "...schools acknowledged design as an epistemology more than a skill; reoriented the development of individual expertise to the ethos of team; expanded studio as the laboratory for all academic activity in architecture..." [4]

Perhaps academia might hybridize existing educational models with the goals of *Integrated Practice* and reformulate the underlying value of technology and process and the comprehensive nature of architectural design. Abstraction is the ethos of architectural design. Abstraction is at the heart of most design studios in schools of architecture. The traditional conventions of communication; plan, section, elevation, are based on radical abstractions of orthographic projections. Drawing itself as a means of representation is inherently abstract. Architectural model making whether it be physical or digital is also an abstract device. Abstraction is so imbued throughout

architectural curricula it is difficult to see where the concept ends and where architecture begins.

Simulation is the promise and potential of BIM. The ability to virtually simulate the building construction and architectural assemblage is perhaps the most important transformation and architectural production in the last several hundred years. Every other discipline that has adapted simulation as its primary model of design and fabrication has benefited from increased efficiency and economy. Simulation is the destination of contemporary digital design. The ability to understand a building from an environmental, structural, systems, and energy perspective simultaneously in the design and development of an architecture is so profoundly important that all applications for the digital production of architecture are headed that way.



◀ Figure 1: Abstract fragments and the simulated assembly – Student work – Emma Crenshaw.

It is the synthesis of these two conceptual operations for the design of architecture that reveals BIM as a process and methodology beyond the mere concept of a tool. The extracted building fragment exhibited in Figure 1 demonstrates the working method of BIM applied to a novel simulation of the assembly of construction elements. The ability to integrate the culture of abstraction existing in architectural education and the culture of simulation embedded in the digital design applications is fundamental to developing new curricula and a new education for the architect of tomorrow.

Architecture finds itself at unique moment in time where the means of production for the profession, and indeed the entire discipline, are transforming and threaten to fundamentally undermine the existing models of education, production and understanding in a way no previous technological transition in the means of production has since the renaissance. Fundamentally tools and methods of simulation and computation are displacing tools and methods based on abstraction and representation. The application of digital technologies beyond CAD, such as, BIM, and parametric (or generative) design, and digital fabrication are fundamentally altering the *how* and *what* of architectural design. The *way we make architecture* is being transformed through the very digital tools, methods, processes and applications we use that allow the designs of our minds eyes to be transformed into the conceptual, tangible, and ever-buildable world of today. Increasingly intelligent (or semi-intelligent) digital modeling is replacing (or displacing) digital drawing or representational (un-intelligent) modeling. We see diminishing returns of the value of transforming three-dimensional spatial/formal ideas into two-dimensional conventional abstractions of those complex ideas. The basic conventions of architectural visual communication are all based on the predisposition for abstract, two-dimensional communication that has long been a part of architectural education, understanding and practice.

Building Information Modeling (BIM) and the emerging vision for *Integrated Practice* [4] provide potential to fundamentally transform the way in which architectural education engages issues of design and representation and suggests opportunities to question the roles and rules of traditional architectural conventions of visual communication. The conceptual and practical advantages and consequences of BIM provide a unique catalyst for a critical analysis of architectural design and design process and how they are fundamentally conceived and taught. Provoked by the virtual building model simulation as the primary means of communication and representation architectural educators must take pause to critically engage and conceive outcome driven educational models. BIM defined as a *design methodology* and not simply a *design tool* acts as provocateur to design education and the *how* and *what* of the academic design studio. Newly focused on the virtual building model simulation as the primary means of communication the design studio must take pause to critically engage and reconceive this fundamental shift away from abstraction as the *modus operandi* embedded in traditional educational models tracing back to the Bauhaus and École des Beaux-Arts. The associated pedagogies are transforming the way in which architectural education engages issues of design and representation and creates opportunities to question the roles and rules of the traditional conventions of communication.

The underlying premise of BIM methodology for design processes, fabrication and construction will increasingly challenge the historic

relationships between architecture and its means of production [2] leading to new demands of the profession on education to adapt and prepare students for digitally enabled *Integrated Practice*. Academia must revisit current curricular approaches and imagine a system that acknowledges the obsolescence of the *how* and *what* of that which is taught in today's schools of architecture. BIM represents a shift in thinking that calls large segments [5] of contemporary architectural education into question.

Educators must explore and develop new methods to develop three-dimensional and four-dimensional, information driven, thinking and skills. Simply applying new tools and processes to old pedagogical and educational paradigms will not be sufficient. The careless introduction of BIM could be detrimental to design thinking and its central role [3] in architectural education. There are three primary opportunities and threats to the academic integration of digital tools reliant on simulation and computation over abstraction and representation. The first of these is *form follows software*, wherein the digital application and the interface with intelligent information actively impacts the architectural design in form and development. The second of these effects relates to the economic value of these new digital technologies presented by BIM, *more is less expensive*. It relates to the economic reduction in the cost of production, the collateral effect of the integrated practice that intelligent modeling cuts costs in the new digital design process. The last of these is perhaps greatest fallacy of BIM, which is; build a model, and the *drawings magically appear*. In the academic design studio drawings *are* the media of communication, the media for design learning, the primary convention of communication for students and faculty to connect intent with interpretation.

In the existing tradition of architecture the conventional adage is that form follows function. This has become a common axiom in schools of architecture. However, in today's digital world increasingly it is the means of production, not the internal functional motivations of the building, that leads to a formal bias. Form, is now as likely to follow the software application toward its ultimate formal expression as it is any programmatic or functional derivation of the architectural design motivations. This is increasingly true within BIM applications, revealing their influence as a *design method* more than as a *design tool*. The move from representational modeling systems to information systems bound to simulate or virtually construct architecture has shifted the conceptual motivations away from representational issues. When architects such as Thom Mayne, of Morphosis, proclaim that BIM has killed the *plan* [6] he refers to the conceptual breakdown of the inherent value of representational conventions such as plan and section in the production of intelligent building model simulation.

2. THE NEW BIM STUDIO

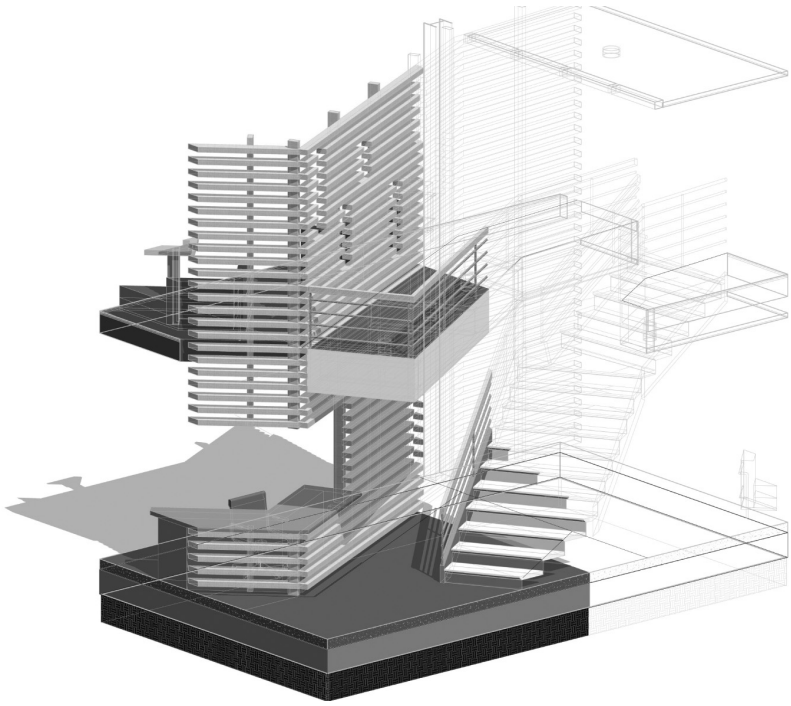
> "How can teaching proceed within a framework that demands its own subversion?"
>
> - Marc Angélil, Inchoate (2004) [7]

Design studio learning might not have to end with the design of a building. Instead it might begin with a complete model of a building already designed. Lessons might have to do with 5D logistical planning for construction, staged building processes, cost models, and post-occupancy modeling and management. Perhaps detailed investigations or analyses of the performance of structural, mechanical or technical systems in consultation with allied disciplines and consultants would set an agenda for a design studio. As stated by Clayton, et. al.;

> "Adoption of Building Information Modeling (BIM) disrupts the patterns of education that have been used throughout the past century. When understood as not merely a technology but also a rigorous process of design, BIM enables the emergence of new premises and patterns for design education that can address the critical technical and social problems of the 21st century." [8]

The promise of BIM applications is that simulated and actual construction might be intelligent products derived from a close collaboration of architects, engineers and consultants all working in their respective design studios, yet simultaneously and continuously sharing information within the BIM construct. If design studio began with the complete model of the building the design exercises could be focused on coordination, collaboration and redesigning individual components and entire systems. Starting with a building rather than ending with a building radically repositions curricular goals, concepts and knowledge in the design studio. This idea of reverse developing, or episodic development of an existing model allows objective evaluation of the building and challenges students to develop critical thinking skills to re-conceptualize how a building is understood as a comprehensive act of interdependent design decisions that can be best tested and explored in the BIM environment.

The comprehensive design studio experience begins with the distribution of a fully realized BIM model. The first two weeks of the term, students participate in a series of workshops with the architects, engineers, and specialty consultants that developed this model. Each discipline presents the design process and design resolution of their components within the model. The students work in small teams with the professional consultants to understand how the systems have been integrated, how each discipline frames and understands the model and how their discipline contributes to the whole. In these first weeks, the students are getting to know their way around the model but also learning a tremendous amount about how an actual architectural project exists as the convergence of different design solutions to various specific disciplinary perspectives on the building project.



◀ Figure 2. Stair component and integration of stair, walls and floors – Student work – Justin Obringer

The second phase of this design studio involves the students re-presenting what they have learned about the constituent parts of the building. The students have been learning about the building, about the building technologies, and the design processes that have led to design a building in its current state. They have gained familiarity with the model as seen in Figure 2. At this point the design studio focuses on radically changing one of the fundamental systems, structure. The original building was designed for steel frame construction. In the first weeks students came to understand how the dimensional requirements of the system led to a series of subsequent decisions made by the architects in the development of the program, the primary spaces of the building, and the external building skin. At this point the students will spend the next few weeks reintegrating and collaborating with the structural engineering consultants to redesign the building with concrete frame. One group of students within the studio will imagine the building has precast concrete considering the logistics of delivery and erection. Another group of students will imagine the building as site formed cast concrete. They will re-develop the building model in consultation with architects and engineers to adjust for new dimensions, new construction restrictions, and collateral design affects.

In the third phase of the studio, each student will now work individually to re-imagine the curtain wall system of one façade of the building. Each student has a particular environmental response, technological application

and performative requirement that will guide the design of this new wall system. Wall systems will have to work within the redesigned structural system and connect to the existing building envelope conditions on the adjacent exterior walls. The performative requirements of the façade design will require adjustments on the internal spaces adjacent to the vertical surface. Each student will have to test several iterations of design solutions to fully imagine a range of possibilities to solve the environmental response. Part of this exercise results in physically produced digitally fabricated models that will probe and test the constructability of one component of this curtain wall system. The ability to develop physical models while simultaneously testing and simulating the environmental systems in the BIM model will allow the students unique vantage point to explore the reiterative nature of architectural design.

With each subsequent phase of the studio a new design parameter is introduced that requires significant modifications to the original model while focusing the students on collaborative experiences with professional consultants and the classmates in the studio to develop a range of design possibilities. The projects are designed and scaled in such a way that the students are encouraged to explore as many design possibilities as possible. The goal is to not develop a single way to solve any design problem but instead to develop a *range of ways* to explore the problem. Privileging dynamic explorations of modeling, animation, and design diagramming each project challenges the studio to work collaboratively within the BIM environment. With each subsequent design change the building oscillates between completion and dismantlement. With each wave of development the design evolves, and the process progresses. With each progression the studio has a new opportunity to reiterate previous lessons, collateral effects of each discipline and develop a design process that embraces the reiterative learning developed through the continued exploration of the building model.

3. PLAN IS DEAD?

Building Information Modeling (BIM) creates opportunities to question the roles and rules of the traditional architectural conventions of visual communication. The ubiquitous two-dimensional, orthogonal projections that today constitute the traditions and conventions of visual communication that contemporary architects take for granted took root in the fifteenth century [9] as architects found geometry and geometric projections increasingly useful to convey architectural intent and meaning in spite of the inherent abstraction in the two-dimensional portrayal of three-dimensional form and space. This foundation in geometry was acutely revealed in the development of most CAD applications as programmers solved the problems of describing and drawing geometry digitally [10] in order to replicate drawing. When architecture and its graphic

representation is understood in terms of its communicative potential as a language [11] of sorts, it can be seen as an abstract system. Architects, at their essence, construct abstract representations of ideas and those ideas constitute buildings. Architects deal in abstract representational means of communication, drawings, to convey the intentions and directions of their designs. This is the fundamental position that leads to the traditional conventions that abstract form and space through a process of fragmentation and isolation of discreet representations of the whole through discreet descriptions of the parts.

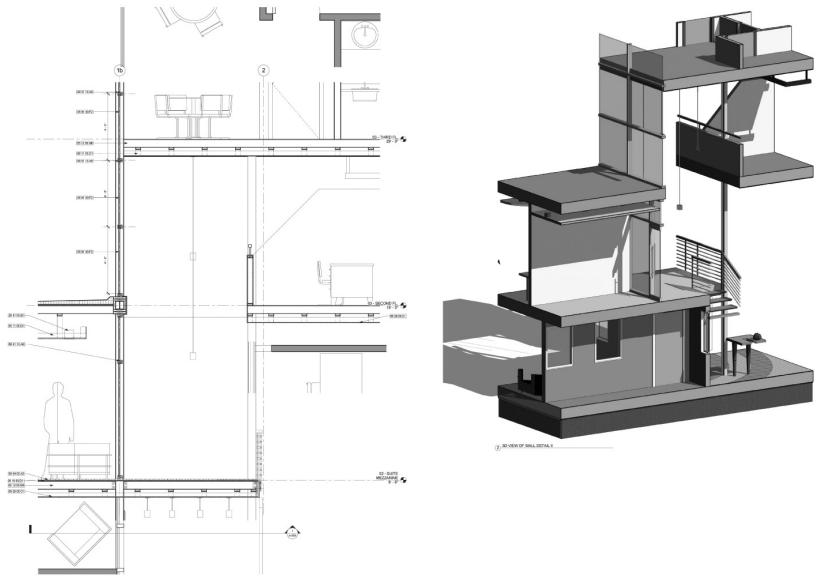
BIM presents an object oriented, intelligent component/database synergistic promise of virtual assemblage through simulation. BIM obfuscates the role of composition, scale and abstraction by displacing the primacy of abstract representation with literal re-presentation while simultaneously clarifying the holistic relationships in the architectural design of form and space. Plans and sections, the traditional conventions of architectural communication, are not literally the space, or a literal assembly of forms, they are simply the representation of such. They are a linguistic system, a visual, graphic language, and as such they are inherently an abstract system of symbolic representation. Lines drawn in a particular configuration *mean* 'wall' in another configuration they *mean* 'window' the context sets the definition. Architectural education currently is a process of acculturation that privileges the abstract, privileges representation rather than re-presentation. This culture is maintained by the profession at the expense of creativity, creativity that is now encouraged by the promise of BIM. Creativity that can emerge now from an imagination stirred by a confrontation and convergence between, and of, abstraction and the literal, representation and simulation. BIM offers the double-edged promise of displacing abstraction with simulation. There are profound conceptual differences between the translation of ideas and the transcription of ideas [9] and how architecture exists between the common forms of representation and to that to which they refer. The virtual building model is the thing as well as the representation of the thing. There is no abstraction. The building is literally *(virtually)* constructed. The plans, sections, and elevations, the traditional conventions of representation are an illusion. Plan is dead...

4. MOVING FORWARD – APPROACHING WAYS OF MAKING

This newly envisaged architectural design studio is based on continued operations on and within building model. Working on a live dynamic model in an interdisciplinary collaborative environment challenges the student to operate beyond the drawing centric view of most design studios. The traditional means of visual communication are supplanted by a continual development of the shared model. Sometimes a placeholder from one discipline, structures perhaps, requires that architectural decisions remain

tentative until the Allied disciplines provide appropriate information. In other instances architectural design decisions ripple through the project requiring responses from several systems. [12]

When avant-guard architects such as Thom Mayne proclaim they haven't drawn a plan in years [6] they expose a significant issue of BIM's effect on education. BIM fundamentally subverts plan thinking by prioritizing a three-dimensional view of the world. While seasoned practioniers my not need to work in plan does their education in that form of abstract thinking still serve them well? And if so does it bear continuing its prolific dissemination even at the chagrin of today's avant-guard? To find a way forward the academic design studio might be well served to expose debate or hybridized transition in the projects themselves.



► Figure 3. Simultaneity of drawing and modeling in design thinking – Student work – Michael Taylor

It is the gap between design theory and digital practice that exposes a possible path for engaging digital design media in education that explores how fundamentally BIM might reshape the design process and conceptually shift to production of architectural ideas and objects like nothing has since orthographic and perspective projection [13] in the fifteenth and sixteenth centuries. Acutely aware of the impending cultural shift that BIM represents to the profession some leading practitioners, such as Paul Seletsky of Skidmore Owings and Merrill, have mused about the opportunities and consequences for the transition from traditional practice to digital practice with BIM. As Seletsky has said,

> "Properly ignored, the results [of BIM] may very well promote Construction Managers into a lead decision-making role…" [14]

presumably out pacing architects ability to leverage the profession's knowledge base to regain lost ground. Architects can perhaps re-gain lost territory taken by the contractors, construction managers, interior designers, facilities managers, and others. BIM affords architects the opportunity to 'deal themselves back in' to the knowledge management [7] of a project from beginning to end and beyond. BIM shifts the focus away from representational development (drawings) and towards formal and spatial development (ideas) through the development of the three-dimensional model as seen in Figure 3. The profession has been leading the BIM charge and in the initial enthusiasm of the movement has not reflected on the potential changes in deliverables and continues to dumb down the building information model to the lowest common denominator, the drawn sheet set. The reasons for this are vast. From legal contractual and liability issues, to procedural and cultural issues this technology is outpacing the discipline's ability to respond [15].

5. CONCLUSION

The academic design studio must seek out new methodologies that reflect the pedagogical shift represented in BIM. When BIM supplants the need for drawn representation in two-dimensions how might/should the education of an architect be affected with regard to issues of scale usually addressed in the production of drawn representation? The cultural shift just emerging in digital practice has been grossly underexposed in the contemporary discourse. As firms move from a CAD-centric view of practice where architects and consultants compose ideas through drawings to communicate design intent to the new BIM-centric view of practice. BIM-centric practice will exist around a virtual simulation of assembled building components and systems. A critical tipping point will be reached where architects will no longer compose abstract drawings that represent a building they will instead construct a virtual simulation of that building as a literal re-presentation of constructed components.

Educators must seek out new educational models that expose creative new methodologies for exploring architecture that embrace a pedagogical shift through BIM as process by developing teaching methods that reprioritize ways to reconcile the traditions of abstraction and the opportunities of synthetic simulation. The design studio must now reflect new reiterative relationships between design, data and communication. Design studios should focus on new ways of teaching and addressing emergent digital design methods and processes that critically engage and leverage their immediate effects and possibilities in architectural production. As architects move beyond drawing-centric practice into a dynamic process/component oriented integrated practice, a new conceptual foundation for architectural thought and production that focuses on a fluid relationship between design, construction and maintenance in which

information, not drawing, as the medium will emerge. Students must be taught that architecture is more than simply applied knowledge, techniques and skills. Architecture is a way of seeing and thinking that requires understanding of BIM beyond the idea of tool to one where it is conceived of as a means to conceptualize the systemic development of multiple design processes from different disciplinary perspectives and critically evaluate their effects and possibilities in architectural production.

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