

Agent Provocateur — BIM and the Design Studio: Questioning Roles of Abstraction and Simulation in Design Education

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INTRODUCTION

“How can teaching proceed within a framework that demands its own subversion?”

—Marc Angelil, *Inchoate*, 28

Persistent questions exist within the academy, profession and discipline at-large about the transient nature and increasingly expansive means of design and design education in the digital age. These questions challenge us to confront and reconcile the often conflicting and subversive effects of new digital concepts, methodologies, theories and technologies have on the production and education of architectural design in our contemporary culture. 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 transition in our means of production has since the renaissance.

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 *how* of *how we do* is changing, and the *what* of *what we do* is changing. The *way we make architecture* is being transformed through the very digital tools, 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. How architectural education and the design studio model of education evolves to reflect, interpret, translate, or challenge the multiplicitous modes of contemporary practice presents opportu-

nity and risk to this generation of digital scholars and digital practitioners. Might we re-conceive the design studio as a venue in which a critical dialogue about how the many facets of architectural design practice are engaged? The possibilities afforded by digital design media and digital design technologies are increasingly affecting *what we make* and simultaneously *how we make* as architects. Increasingly digital modeling is replacing (or displacing) digital drawing. 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; plan, section, elevation, are all based on the predisposition for abstract, two-dimensional communication that has been a part of architectural education, understanding and practice for generations. How will architectural education and practice best evolve and develop to address these challenges? What will the academic design studio of the future look like? What will we have to become in order to produce the architectural practitioners of tomorrow? These are the questions that persist for architecture, these are the questions that challenge academia for the future.

Building Information Modeling (BIM) and the emerging vision for *Integrated Practice*¹ provide potential to fundamentally transform the way in which architectural education engages issues of design and representation and suggest 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 analy-

sis of architectural design and design process and how they are fundamentally conceived and taught. Focused on the virtual building model simulation as the primary means of communication and representation in the emerging concept of *Integrated Practice*, architectural educators must take pause to critically engage and conceive outcome driven educational models. Pedagogical positions must be evaluated relative to the conceptual shift away from abstraction as the *modus operandi* embedded in current models of education revealed in the primacy of the traditional projected conventions of plan, section, and elevation. The foundation issues, conventions and fundamental pedagogies of architectural education all need to be reconceived.

The consequences of digitally driven processes and thinking on architectural education will be profound. The underlying premise for design processes, fabrication and construction will increasingly challenge the historic relationships between architecture and its means of production² leading to new demands of the profession on education to adapt and prepare students for digitally enabled *Integrated Practice*. Academia must completely revisit the curricula 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 segments³ of contemporary architectural education into question.

Educators must explore and develop new methods to develop three-dimensional and four-dimensional, data driven, thinking and skills. These methods will contribute to, and expand upon, the learning objectives of modern curricula. 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 role⁴ in architectural education. Integrating BIM into the way students are educated will necessitate innovative thinking about the generation and definition of new forms of representational conventions. New conventions will develop, not based on the abstract biases of the past, but instead on emergent ones based in simulation and information management. As the conventions of communication and representation of the past were determinant factors in the architecture the new conventions will propose new architectures. The design studio that embraces these new conventions in the age of BIM will transform

the architectural design product as much as the architectural design process.

PLAN IS DEAD... OR SO THEY SAY.

Building Information Modeling (BIM) has the potential to radically transform the way in which architectural education engages issues of design and representation and 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 century⁵ 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 digitally⁶ in order to replicate drawing in the form of plan, section and elevation.

To the extent that architecture and its graphic representation is understood in terms of its communicative potential as a language⁷ of sorts, it can be seen as a purely 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, ideas and meanings of their designs. This is the fundamental position that leads to the traditional conventions as means of communication that abstract form and space through a process of fragmentation and isolation of discreet representations of the whole through descriptions of its parts.

Building Information Modeling presents an object oriented, information driven, intelligent component/database synergistic promise of virtual assemblage through simulation. BIM has the potential to remarkably alter the conception and production of architectural design and representation for the first time since the fifteenth century. Building Information Modeling obfuscates the role of composition, scale and abstraction by displacing the primacy of abstract representation with literal re-presentation while simultaneously clarifying the holistic relation-

ships in the architectural design of form and space. Plans (and sections and elevations, etc.) are merely representations of ideas composed in distorted two-dimensional abstractions of three-dimensional 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. Orthographic, axonometric and perspective projections are each profoundly distorted, abstract ways to communicate architectural ideas and intentions. Yet, this is how architects imagine buildings, through abstraction. Architects have been educated to represent their ideas through a series of representational processes that lead to increasingly abstract and distorted forms of communication.

Architectural education currently is a process of acculturation that privileges the abstract, privileges representation rather than re-representation. 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 ideas⁸ 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 space is the space, and the forms are the forms. The plans, sections, and elevations, the traditional conventions of representation are an illusion. Plan is dead.

BEYOND TOOLS — APPROACHING WAYS OF THINKING

"A tool directs your attention. It's function becomes your focus; as the saying goes, when you hold a hammer, all the world looks like nails."⁹

—Malcom McCullough, *Abstracting Craft*, 59

The challenge is to understand the opportunities presented when digitally driven design, process and production technologies are envisaged more comprehensively than as mere tools¹⁰ 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. Understanding and positioning BIM as a way of 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. Students must understand not only the model geometry but the implications of the ways the model is constructed¹¹ 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; does architectural education still require representational abstraction in the age of BIM? What are the issues and what is the knowledge that academia should now address to enable the digital design process? What current issues and knowledge gets displaced? Many academics and scholars favor a reductionist approach¹² 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..." 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.

Perhaps a design studio in this new era might not end with the design of a building but might begin with a model of one already designed. The lessons might have to do with 4D logistical planning for construc-

tion and staged building processes. Perhaps detailed investigations or analyses of structural, electrical or mechanical systems in consultation with allied disciplines or consultants would set the agenda for a design studio. Fabrication of steel frame and composite wall systems at 1:1 scale from CNC processes would be the conceptual vehicle for the pedagogical lessons instead of drawing or modeling design ideas. The promise of BIM applications is that simulated and actual construction might be the products derived from the design studio. The possibility of starting with *building* rather than ending with *building* might radically reposition curricular goals, concepts and knowledge in the design studio.

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 and skills. Architecture is a way of seeing and thinking that requires understanding of BIM beyond the idea of tool to one of process, even methodology. It is in this spirit that BIM is discussed here. This presumes a convergence of best-of-class technologies that leverage data management and knowledge production as the value of the architect and the true goal of the design process. The greatest potential BIM promises is the opportunity to re-invigorate and re-center contemporary practice and education simultaneously on ways of exploring architecture by developing and exposing design processes and methodologies that reprioritize ways of seeing, thinking and making.

Abstraction and its role in architectural representation has traditionally been about fragmentation and isolation of the parts from the whole. Contemporary educational models presume this relationship of the *parts to the whole*. BIM as a concept or process is much more of a context driven anti-fragmentation, anti-isolation design process that is dependant on contextual relationships in the modeling environment and data to fundamentally reconceive the relationship of the *whole through the parts*. Speculation about this shift should at least provoke a critical debate about the possibilities and pitfalls of the new trajectory suggested by BIM and Integrated Practice.

BEYOND TOOLS — APPROACHING WAYS OF MAKING

"Anything you can imagine is possible."

—Thom Mayne, *Change or Perish*, 1-11

Contemporary architectural education assumes a traditional set of communicative visual conventions, orthographic projections, at varied scales and levels of detail, that when taken in concert signifies a whole, complete idea of a building. Contemporary architectural practice assumes a simple one-to-one correspondence between design intent and interpretation, between the representation of ideas and the interpretation of the design of buildings.

Contemporary construction documents reveal this assumption, these abstract, fragmented representations of the building and its components rely on reductive syntactic connections¹³ where by each abstraction is part of a dissected whole and when taken as a summation these fragments exceed their individual abstraction and constitute a literal description of the complete building. BIM conversely begins with the virtual construction (simulation) of the whole, which is then viewed as a series of synthetic assemblies of constituent components. BIM represents a design process that does not prioritize abstract representation or fragmented conventions of communication but instead privileges the contextual construction of a formal/spatial systemic *intelligent* simulation.

When avant-guard practioners such as Thom Mayne proclaim¹⁴ "I haven't drawn a plan in five years." 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? When anything is possible how can academia educate students to know good from bad, right from wrong? To find a way forward academics might be well served to expose debate or hybridized transition in the projects themselves. The pedagogical discourse around a design projects conception might very well accelerate design thinking and embracing simulation and its emergent conventions over the conventions of the past.

The academy must seek out new methodologies for exploring architecture that reflect the pedagogical shift represented in BIM by developing teaching methods that reprioritize ways of seeing, thinking and making in the design process. This technology is outpacing the discipline's ability to respond. It is this 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 projection¹⁵ in the fifteenth and sixteenth centuries. Focused on the virtual building model simulation as the primary means of communication and representation in the emerging concept of *Integrated Practice*, architectural educators must take pause to critically engage and conceive outcome driven educational models.

THE PROFESSION AND BIM

"I have often conceived of projects in the mind that seem quite commendable at the time; but when I translated them into drawings, I found several errors in the very parts that delighted me most."

—Leon Battista Alberti

The conventional practice of architecture today assumes a traditional set of orthographic projections, at varied scales and levels of detail, that when taken in concert signifies a whole, complete idea of a building. Contemporary architectural practice assumes a simple one-to-one correspondence between design intent and interpretation, between the representation of ideas¹⁶ and the interpretation of the design of buildings. Contemporary construction documents reveal this assumption, these abstract, fragmented representations of the building and its components rely on reductive syntactic connections¹⁷ where by each abstraction is part of a dissected whole and when taken as a summation these fragments exceed their individual abstraction and constitute a literal description of the complete building. BIM conversely begins with the virtual construction (simulation) of the whole, which is then viewed as a series of isolated assemblies of constituent components. Is there an inherent value in the translation of ideas into abstract representation or is there a greater value a transcription of ideas in to a simulated construction?

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 Seletsky¹⁸ has said, "Properly ignored, the results [of BIM] may very well promote Construction Managers into a lead decision-making role..." 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 management¹⁹ 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. At the current time too much attention is being paid to the 'quick' extraction of relatively simple two-dimensional drawing/representational information. 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. It is this 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 in the fifteenth and sixteenth centuries.²⁰

ACADEMIA AND BIM

The academy must seek out new methodologies for exploring architecture that reflect the pedagogical shift represented in BIM by developing teaching methods that reprioritize ways of seeing, thinking and making in the design process. What are the skills and ideas that contemporary architectural education must employ to prepare students for this new digital practice that is based on a mod-

eled construction of architectural assemblages that transcends previous definitions of convention in design and construction representation?

The expanded use of digital design represented by BIM technology exposes the relationship between the scale of design (or lack thereof) and the scale of representation (or lack thereof) and how this relationship undermines the primacy of abstract representation in architectural design. When and if 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 scale²¹ usually addressed in the production of drawn representation? Does the continued prolonged use of the 'scroll wheel' scale-less place of the BIM environment present any advantage or disadvantage to the designer (especially the young) or is the ability to continually scale and scroll a drawing simply a new 'convention' of the new traditions yet to emerge from BIM?

Digital architectural education has great opportunity and risk in how it comes to terms with reconceptualizing design education as the profession struggles to redefine the media and methods of architectural deliverables in the age of BIM. Building Information Modeling has the potential to radically transform the way in which architectural education engages issues of design and representation and creates opportunities to question the roles and rules of the traditional architectural conventions of visual communication. BIM so fundamentally shifts the priority away from abstraction to simulation and is at its foundation based on a component/assemblage mindset that the academy will have to subvert its own canons²² to find new direction in its fundamental suppositions and foundations.

How the academy might prepare students of architecture for a digital practice in this period of transformation is the focus of this paper. The promise of BIM to the professional practice of architecture is profound. 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 where the 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 the design of a building they will instead construct a virtual replica of that building that is increasingly less an abstract representation and increasingly a literal re-presentation of constructed components.

Newly focused on the virtual building model simulation as the primary means of communication and representation the academy must take pause to critically engage and reconceive educational models²³ and pedagogical positions relative to this fundamental shift away from abstraction as the *modus operandi* embedded in the traditional projected conventions of plan, section, and elevation. The foundation issues of composition, depth and flatness, space, scale and size, shape, line, movement, light, color, intent and interpretation all need to be reconceived. BIM represents a design process that does not prioritize abstract representation or fragmented conventions of communication but instead privileges the contextual construction of a formal/spatial systemic '*intelligent*' simulation.

The conceptual and practical advantages and consequences of BIM provides both the profession and academy a unique moment filled with great potential for the critical analysis of the professional architectural design process and how architectural design is fundamentally conceived and taught. 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.

CONCLUSION

What will we have to become in order to produce the architectural practitioners of tomorrow? This is the question that persists for architecture, this is the open question that challenges academia for the future. The *how* of *how we do* is changing, and the *what* of *what we do* is changing. The *way we make architecture* is being transformed through the very digital tools, processes and applications we use.

Academia 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 relationships between design, data and communication. Academia should focus on new ways of teaching and addressing emergent digital design methods and processes, and critically evaluate their effects and possibilities in architectural production.

ENDNOTES

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