Questioning the Primacy of Visual Simulation in an Epistemology of Digital Models

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Abstract. *This paper questions the degree to which visual simulations are conventionally assumed to be a primary means of entering digital models into productive architectural discourse. The paper considers established means by which digital models are made known, specifically those which place epistemological value on multiple representational modes, particularly building information modeling software. The paper outlines a proposal to displace the use of visual simulation as a primary means of making digital models known.*
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Introduction

Architectural education has traditionally assumed the importance of multiple representational modes to the construction of architectural knowledge: drawings, models, photographs, and text constitute necessary, unique and irreducible ways of knowing architecture. The advent of digital technology within architectural education seemed for a time to cast this long-held assumption into doubt, or at least to temper it, as new technology held out the promise of an architecture conceivable with little or no dependence on old ways of knowing (Andia, 2002). In this way of thinking, traditional means, confronted with new technology, would be improved, replaced, or rendered irrelevant; not only would it become possible to know already-existing architecture in a completely new way, but a completely new way of making architecture would come about. After a long period of uncertainty, during which digital technology found applications within all aspects of architectural education, it became increasingly clear that this promise was exaggerated. Contemporary discourse recognizes that digital technology does not displace traditional ways of knowing but rather stands alongside them, offering its own unique contributions to architectural epistemology. Consequently, contemporary architectural educators generally acknowledge the importance – even the necessity – of multiple representational modes to the construction of architectural knowledge (Bermudez & King, 2000).

All of this is clear enough when the object of inquiry is 'a work of architecture'. However, when the object of inquiry is a digital model of a work of architecture, conventionally accepted practices undergo a shift, the reasons for which are not obvious. Digital models become known primarily through simulated visibility – that is, perspective rendering;

that models should become known through multiple representational modes is not widely accepted. This so-termed primacy of visual simulation means that other less obvious though still architecturally significant attributes latent within digital models may be overlooked. There is a risk that the practices, biases, exclusions, priorities, and emphases built into a given software application will become, in the face of increasingly sophisticated algorithms for visual simulation, negated with regard to the construction of architecturally specific knowledge.

This paper, then, questions the degree to which visual simulations (i.e., perspective renderings) are conventionally assumed to be a primary means of entering digital models into productive architectural discourse. The paper considers established means by which digital models are made known, specifically those which place epistemological value on multiple representational modes, particularly building information modeling software. The paper outlines a proposal to displace the use of visual simulation as a primary means of making digital models known.

Primacy of visual simulations

Using software to produce perspective renderings of architecture assumes that 'visual simulation' is relevant to the construction of architectural knowledge (Christenson, 2007). That this assumption is widely accepted is supported by the market demand for sophisticated digital modeling software. Simply put, how well a software application can produce photorealistic perspective renderings is widely understood as a mark of its utility both to architects and to amateur designers. Wang (2003) offers a framework for understanding this situation as evidence of an expanding 'cultural footprint' – that is, the extension of a building's territory of influence beyond a perceptible and measurable physical extent into the realm of media. To remain competitive, architects and publishers must disseminate their ideas through globally accessible media; consequently, they have come to rely increasingly on those types of mediating artifacts which most easily enable the reader to "identify with attributes of a particular visual fashion or trendy ideology" (Piotrowski, 2001). That visual simulation should in any case be sufficiently important as to minimize or silence other modes of architectural representation ignores Leatherbarrow's (1998) assertion that "the purpose of architectural drawings is to discover and disclose aspects of the world that are not immediately apparent and never will be."

Established means for making digital models known

Because of the inherent ambiguity involved in visualizing a three-dimensional digital model on a two-dimensional computer screen, most modeling software is provided with an optional multiple-window interface enabling simultaneous viewing of a single model through distinct projections, not necessarily perspectives. The paradigm of simultaneous-but-distinct-projections reaches a greater potential with building information modeling (BIM) software, which makes use of digital models by transcending solely geometrical definitions and becoming a fully integrated system, viewable and usable by multiple constituents for different reasons. These constituents (e. g., architects, engineers, contractors, agencies, owners) are able to exchange information during design and construction of a work of architecture by means of digital models accessible through multiple, distinctly-structured views supporting diverse lines of inquiry. The value of such a system to the construction industry is obvious. Because BIM must register those attributes of a work of architecture which are of real or potential significance to constituents, such as formal and material attributes, sensory-simulation attributes, and environmental performance attributes, it clearly must make digital models accessible in ways other than photorealism. (Christenson, 2008.) At the same time, BIM models are fully compatible with software providing photorealistic rendering capabilities.

Proposal

This section of the paper outlines a proposal, manifest through strategies specifically designed to highlight biases inherent in digital models, to displace the use of visual simulation as a primary means of making digital models known. Examples are selected to illustrate the possibility of disclosing attributes of architecture which "are not immediately apparent and never will be" (Leatherbarrow, 1998).

Occlusion maps

Perspective rendering software relies in part on algorithms for resolving masking, or 'occlusion', the visual covering of one or more objects by another. This is not simply a concern of programmers. It is significant that every work of architecture functions from within as a visual occluder of its own site, operating at a degree of permeability specific to the work. As a means of accessing that part of architecture which is concerned with its permeability to vision, this section of the paper describes the construction of 'occlusion maps' with specific reference to two subject buildings: first, Le Corbusier's City Museum or Sanskar Kendra in Ahmedabad, India, and second, Mies van der Rohe's Crown Hall on the IIT campus in Chicago, Illinois, USA (Figure 1).

For the present study, both buildings were modeled in AutoCAD to a high degree of accuracy. Orthographic drawings – plans and sections – were produced from the models using AutoCAD's SLICE and SECTION commands. For each of several positions within the resulting orthographic drawings, rays representing lines of sight, originating from a station point, were extended outward from the station point until the rays encountered either another line, representing either a wall or a perimeter circle, representing an unobstructed view to the horizon. The resulting set of rays formed a line-of-sight diagram or a spatial boundary centered at the station point (Porter, 1979). Examples of such line-of-sight diagrams are reproduced in Figure 2, left, and in Figure 3, left. The closer a line-of-sight diagram is to a solidly filled circle, the more opportunities there are to view to the outside of the building without occlusion. The full set of line-of-sight diagrams for each floor of each building is therefore called an 'occlusion map'. Occlusion maps register the effect which an observer's position in space has on their perception of architecture's visual permeability.

Comparing Figure 2 with Figure 3 clearly demonstrates the City Museum's restriction of exterior

Figure 1
Crown Hall (left); City Museum (right)

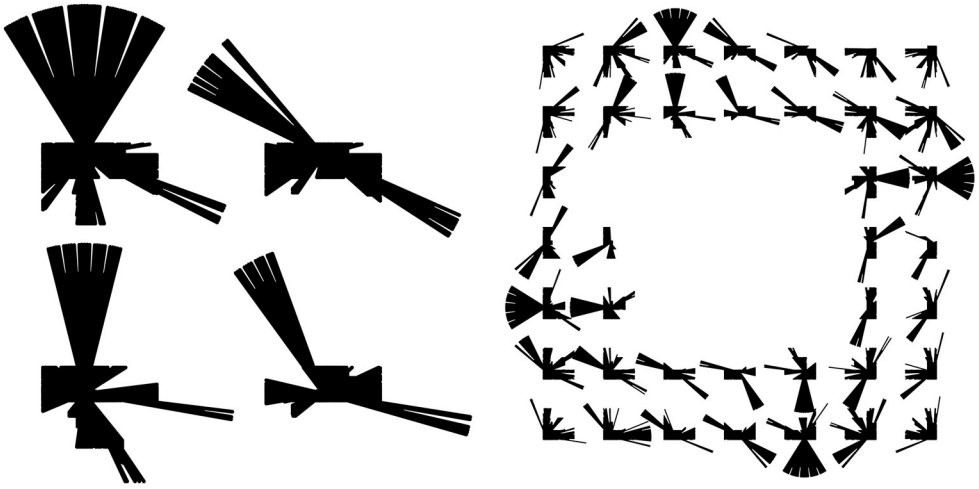

Figure 2
Occlusion map of the City Museum, for four station points (left), and for the entire main floor (right)

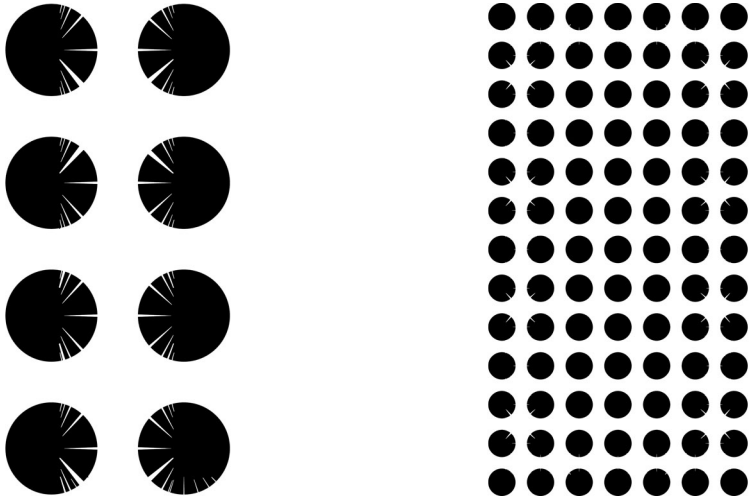

Figure 3
Occlusion map of Crown Hall, for eight station points (left), and for entire main floor (right)

views relative to Crown Hall's open, glass-walled enclosure. The comparison is between the inward-focused 'promenade architecturale' of the City Museum against Crown Hall's ideal grid. At the City Museum, the four outward-spiraling cross-arms interposed atop the plan provide "on one side, [a view] to the garden, and on the opposite side, the way to the central hall" (Le Corbusier et al, 1960), while Mies's building is visually permeable inside and out, with a perceptible heightening of visual occlusion the closer one reaches the translucent-glass facade (this occlusion is visible in the eight station points

reproduced in Figure 3, left).

The occlusion maps relate specific moments within a work of architecture to a structured conception of the work as a whole, setting out the possibility of experience without attempting to simulate it. Unlike simulated photographs, the occlusion maps do not 'simulate' vision but instead map that quality of the architecture which is about the structure of vision. Although the examples shown here consider floor plans from two similarly-sized, orthogonally-planned buildings, the method can apply to any orthogonal drawing (e. g., plans, sections) projected from a digital model of a work of architecture.

Gapmaking

Any attempt to 'enrich' a digital model with layers of information – as BIM software allows – as well as any attempt to generate increasingly sophisticated visual simulations from models tends to minimize the architectural-representational significance of gaps, fragments, and fissures (Allen, 2000; Leatherbarrow, 1998). This is especially true with BIM because if the software's maximum commercial potential is to be achieved, incompleteness and ambiguity within the model must be minimized or eliminated.

To deliberately introduce gaps into the representation of a digital model as a means of heightening its ability to productively stimulate architectural discourse is not an obvious strategy. However, introducing gaps follows easily from the characteristics of solid modeling software precisely because the software makes it easy to selectively hide multiple segments of the model in a single view. If a digital model is displayed in this way, and the visible segments are appropriately projected (e. g., in elevation oblique axonometric), they provide a means of spatially relating section, plan, and volume throughout the entire building (Figure 4).

The capabilities of BIM ensure that as components within the model are changed, the visible segments will correctly and consistently update to reflect those changes. However, because changes can be made to the model which are not visible in the segmented view, it follows that the BIM model need not uniformly encode all measurable attributes of the work in order for it to enter into constructive architectural discourse. The segmented view is therefore a productive though deliberately incomplete means of initiating such discourse.

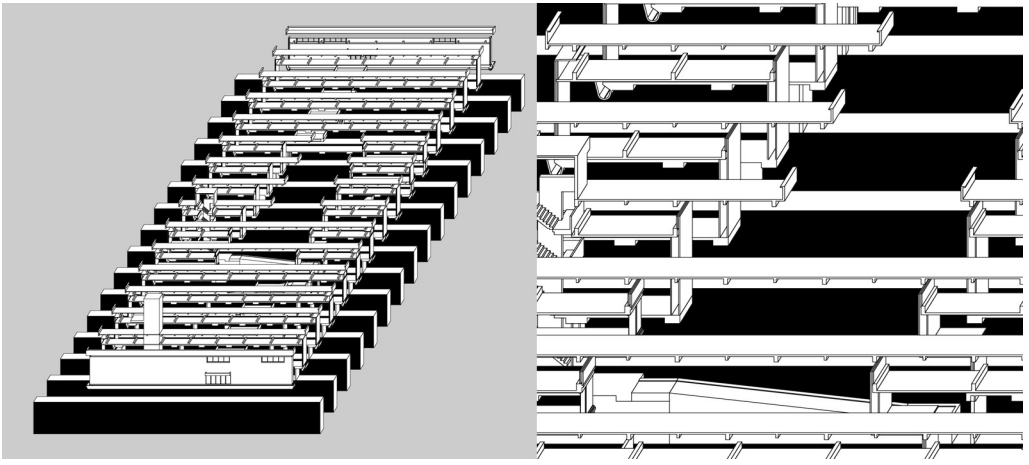

Figure 4
Alternate-segment model of City Museum (overall, left; detail, right).

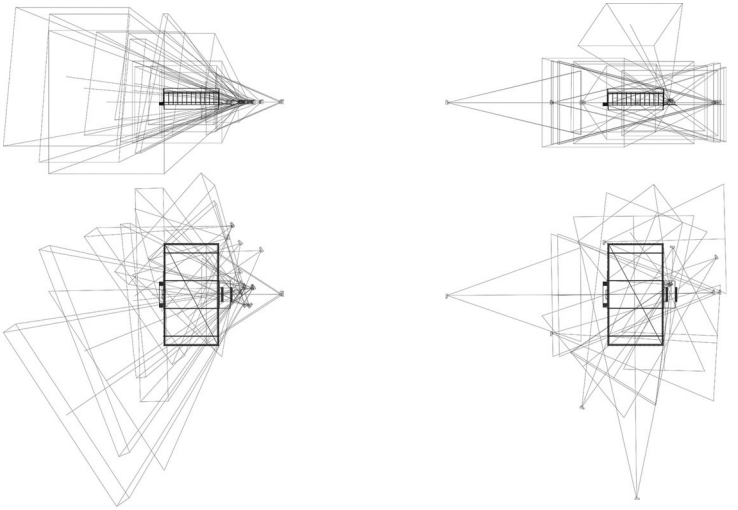

Figure 5
Space-of-photography maps of Crown Hall (Flickr.com, left; W. Blaser, right).

Spaces of photography

For this research, two sets of architectural photographs – the first set a scholarly book on Crown Hall (Blaser, 2001), and the second set resulting from an image search on Flickr.com – were documented in an AutoCAD model of Crown Hall. Viewing the AutoCAD model in plan and elevation reveals the distinct 'spaces of photography' present in the two sets of photographs (Figure 5).

The space-of-photography maps do not in any obvious way simulate the experience of visiting the building. Instead, each map registers the visits of one or more people by registering the superimposition of multiple fields of vision. Comparing the Flickr space of photography to Blaser's is to contrast visitors' tendency to photograph the building from one side against the purposeful visit of an individual photographer engaged in the production of a scholarly work, attempting to document the building in an academically useful manner – and also by inference a process of editorial selection from which several candidate images were certainly removed. (Christenson, 2008.)

Copying each set of cameras from the model of Crown Hall to the model of the City Museum translates each of the spaces of photography from the first building to the second. Two sets of simulated photographs of the City Museum result, corresponding

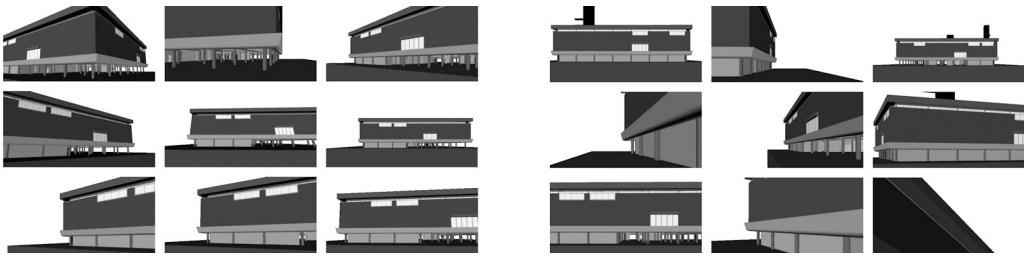

Figure 6
Simulated photographs of City Museum (after Flickr.com, left; after W. Blaser, right).

with the respective spaces of photography present at Crown Hall (Figure 6):

Each of these sets translates a way of seeing from Crown Hall to the City Museum, as if the photographers were themselves transported from Chicago to Ahmedabad, maintaining their cameras in the initial orientation set at Crown Hall. In other words, the simulated photographs in Figure 6 are a viewing of the Ahmedabad building through the cameras of visitors to Crown Hall. The exercise reflects on the translatability of ways of seeing from one work of architecture to another, but more importantly, it questions the degree to which simulated visibility should be treated noncritically as a means of constructing architectural knowledge. Could a specific set of cameras – or a specific space of photography – be defined such that it was equally appropriate to any digital model? Might there be a specific space of photography best suited for academic purposes?

Conclusion

The paper recognizes that visual simulation is a primary means of entering digital models of works of architecture into discourse. The paper offers a proposal for several strategies to expand the modes through which models are made visible beyond visual simulation. These modes include the production and application of 'occlusion maps', 'deliberate gaps', and 'space-of-photography maps', each of which results from a different kind of action taken on existing digital models of works of architecture. Because the work discussed in this paper is limited to study of architectural precedent (i. e., existing works of architecture), it will now be necessary to test the strategies with regard to proposed works.

In all cases the strategies described here are designed to address that about architecture which is specifically architectural, not simply visual; in this sense the proposal attempts to use software to recover within representation those aspects of architecture which are traditionally specific to the discipline.

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