BIM’s Complexity and Ambiguity

BIM v. Paper Architecture

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Architects rely on the graphic language of words and art to bridge intention and design, just as it has always been. Yet, passing an idea or concept from mental imagery to design practice through 2D, 3D, and 4D design filters is especially challenging in BIM technology. Severe limitations hinder or even preclude BIMs use in certain complex design tasks, as identified in the Anti-Box, “The anti-box celebrates the death of the ninety-degree angle- in fact, every angle.” (de Graaf 2017). Compatibility and constraints determine the most appropriate uses of BIM software, from designing mundane shopping mall developments to complex architectural engineering feats that stagger the imagination. BIM’s main benefit is in the middle when it is creatively employed by professional architects in multi-discipline collaborations, well versed in symbolic representation, of designs conceived of multivalent design factors: narrative, form, function, multi-sensory access, materiality, space, and environment.

Keywords: BIM, analog, HIC, Constructivist, Chernikov, photomatch

Introduction

“BIM (Building Information Modeling) is an intelligent 3D model-based process that gives architecture, engineering, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure.” (Autodesk, 2018) While Autodesk addresses project optimization and cost efficiencies, it is silent on design methodologies and processes - except for acknowledgment of 3-dimensional visualization capabilities. Visualization, however, is not a design strategy. This paper investigates Revit’s documented and undocumented processes to directly incorporate analog media to improve the fidelity between the designer’s intent and BIM processes. Individually, the case studies examined adapt mapping functions typically reserved for tiled materials applications: brick, tile, and marble. In this study, un-tiled paintings, drawings, and text are applied to entire building surfaces as abstract symbolic representations by the designer. Consequently, conceptual design models employ massing, graphic imagery, and site placement within Google Earth imagery; then the BIM model is engaged.

BIM and the analog interface

“The analog and digital are co-dependent; they could not exist without each other. However, to see how the digital and analog are inseparable, we must first see how they are unique.” (Mall 2003) BIM’s com-
prehensive approach to materiality, constructability, documentation, and cost control are the primary drivers contributing to BIM’s dominance in architectural practices in the US. Economic exigencies of practice have subsumed the significance of traditional design graphic media approaches, sketches, drawings, and text. Consequently, without an industry consensus on the design process, BIM accommodates conceptual design in an ad-hoc manner. While the design interface between conceptual design and schematic design development is evolving with BIM, the mechanics are hindered by a dated media interface - the mouse, keyboard, and computer monitor. These mechanical constraints are further hampered by the need to develop BIM models chronologically. Depending on its complexity this can be time-consuming and labor-intensive, and design revisions at this stage are cumbersome. The objective here is to evaluate the efficacy of incorporating analog media first so that it is integral to the BIM process, entirely self-contained within Revit. The intention is to streamline and codify a flexible and efficient conceptual design strategy where design proposals are evaluated, leading to the schematic development of a comprehensive BIM model.

**Revit, a theoretical perspective**

The inspiration for this case study is Iakov Chernikov’s Architectural Fantasies: 101 Compositions, “[His] sixth and final volume on design theory, [where] he defended the significance of visionary paper architecture: ‘Not without reason, however, have great thinkers of all times accorded vast importance to fantasy, as being the forerunner of any progress. To look one-sidedly at the idea of fantasy and not to consider its positive role in all fields of culture and art-this is to make a great mistake.’” (MoMA 2018).

Student work is developed in the seminar, “Building Information Modeling: Principals and Practices.” The assignment, Structuring Art as Architectural Space, “Proposes to break out of Revit’s requirement for actual building materials and construction techniques before the satisfactory realization of the design concept. Its objective is to visualize complex design forms using only Constructivist paintings and avoiding the complexity of constructing a BIM model. Simple planar projections, floors, walls, and roofs, are superimposed on simple planar surfaces. Its location is the Denver Art Museum plaza. “In this conceptual design proposal, planar geometry is the substrate for transparent and opaque projections to create a temporary walk-through structure, an exhibit of the foundations of Constructivist art.” (Flanagan 2018)

**Revit’s analog image capabilities**

Revit 2019 imports scanned digital imagery into planar projections, site and building plans, elevations, and print sheet compositions. Revit’s project filer supports images that may be scaled and used as underlays for backgrounds for composite imagery. Revit’s 3D View supports a graphics display option using background imagery to photo-match a three-dimensional environmental model. Photomatch capabilities are demonstrated in Figure 1’s site model. This capability is compatible with three-dimensional site orientation and Google Earth. Site models are additionally, geographically aware of orientation, north, and true north.

Revit 2019 also imports scanned digital imagery into planar projection within its mass modeler, plans, and elevations. It does not transfer these images to the project file. It also does not support three-dimensional background projections, although the mass model is transferable to the project modeler for this capability. Materials map to the massing surface, but when masses convert to walls and roofs, it displaces the map.

Materials image mapping is the more significant analog design contribution. Images can map on materials surfaces full-size without tiling. A materials library and browser allows the importation and configuration of material maps. Materials may have physical characteristic although this is not mandatory. Materials may be assigned reflectivity, transparency, cutouts (alpha channel), self-illumination, bump maps, and tinting. Revit building models ren-
Jesse Young, sketches, image projections, and BIM model of Lakov Chernikhov's painting, “Fantasy #67.”

Figure 1, imagery, text and BIM image maps and 3-D models, were composed in Revit 2018.

**Table 1**

<table>
<thead>
<tr>
<th>Media interface characteristics</th>
<th>BIM – Revit computer model (mouse/keyboard/monitor)</th>
<th>Legacy Analog Design Process (sketches/graphic/text)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supports figurative/narrative development.</td>
<td>Indirect, must be imported as surfaces or views.</td>
<td>Yes, readily consolidates various graphic media.</td>
</tr>
<tr>
<td>Design process interface.</td>
<td>Chronological building design development.</td>
<td>Achronological conceptual design development.</td>
</tr>
<tr>
<td>Media interface.</td>
<td>BIM 3-D computer models.</td>
<td>Analog, planar graphics, and text.</td>
</tr>
<tr>
<td>Work-flow requirements</td>
<td>Potential additional software</td>
<td>Graphic design integration and interpretation.</td>
</tr>
<tr>
<td>Work-flow compatibility</td>
<td>BIM employs linear progression for model building.</td>
<td>Analogue media accommodates non-linear, figurative concepts.</td>
</tr>
<tr>
<td>Environmental awareness</td>
<td>Environmental factors i.e. HVAC climate, lighting, and structure.</td>
<td>none</td>
</tr>
<tr>
<td>Fiscal accountability</td>
<td>Real time cost controls.</td>
<td>none</td>
</tr>
<tr>
<td>Collaborative input</td>
<td>Simultaneous team input.</td>
<td>Limited accessibility.</td>
</tr>
</tbody>
</table>

**Revit’s digital-analog conundrum**

Translation between software applications, even within the Autodesk family, increase licensing fees, and labor costs, while it sacrifices model intelli-
gence. For instance, when combined with Trimble’s SketchUp, while it is technically compatible with Revit, it is only capable of a one-way model transfer. While less restrictive, Revit (BIM) and 3DStudio MAX (design visualization and virtual reality software) employ separate databases, separate renderers, and independent model intelligence capabilities with partial data compatible. Regardless of perceived advantages, the efficiencies of operating solely within Revit typically outweigh limitations when compared to employing two or more software programs to accomplish the same task.

The fidelity of the BIM model with the designer’s intention is dependent on communication between the designer and BIM modeler, and it requires teams working separately and without the benefit of simultaneous development. In this study, Revit is the sole 3D software; it employs updatable analog imagery to inform the BIM model from the start and throughout its conceptual design phase. BIM’s impact on design needs to be examined and addressed to compensate for capabilities lost.

**Reconfiguring design methodologies in BIM**

BIM partially automates the three-dimensional construction process and in doing so replaces symbolic representation as the consolidating design medium of the architect. In the pre-BIM era, the architect designed in the language of the plane. However, BIM negates the centuries-old processes of planar composition since BIM begins with a fully articulated three-dimensional model. This change primarily benefits production efficiencies, but it is at the cost and loss of critical design processes - the architects planar-symbolic design composition.

Before BIM, including up and through the CAD era, scaled line-drawings of plans, sections, and elevations were the default language of the designer. Architects used symbolic-graphic notation and semi-transparent media to record their design intentions. These scaled, paper and mylar drawings specified the location, repetition, order, and relationships of structure, walls, floors, roofs, and spaces to the site and each other. From these drawings, the architect constructed the representational model perspective.

BIM reverses standard architectural design practice, and three-dimensional model-making becomes the default process, bypassing the intermediate step of planar-symbolic composition. Revit begins by constructing walls, columns, windows, doors, and roofs three-dimensionally. Revit concurrently creates the derivative floor and ceiling plans, elevations, sections, and schedules. In summary, BIM reverses the privileged position of symbolic representation, eliminating it as a required design process, jumping directly to model creation.

**Compensating design strategies**

Transposing the order of planar composition with three-dimensional modeling diminishes the range of the architect’s design oversight. In the extreme, it negates any need for traditional planar development since Revit is capable of populating building models with doors, windows, materials, and details without the need to create sketches, draw plans, or project elevations.

Sketches, montages, collages, photographs and other inspirational imagery and text are no longer options on the desktop design palate; they are techniques now outside of the BIM designer’s focus. Further complicating matters, the BIM architect is managing building codes, making material choices, and establishing three-dimensional functional relationships, distractions from a design process that require immediate accountability.

The many advantages of BIM are well-documented by firms that specialize in its applications and the economic argument in favor of its productivity is overwhelming. However, the problem that has emerged is the blandness in the buildings that reflect standardization of building methods, building components, and building techniques, regulated within the BIM software.

**The suspension of disbelief**

In the subjective realm of the design process, BIM functionally restricts the inclusion and functionality
of the legacy design concepts, ‘the suspension of disbelief.’ In the essay, “Diller Scofido + Renfro: The Suspension of Disbelief,” “[T]he American architectural practice of Diller Scofido + Renfro (DS+R) defines itself as ‘an interdisciplinary design studio that integrates architecture, the visual arts and the performing arts.’” “To borrow a term from theater, DS+R create a ‘suspension of disbelief’ through their use of staircases not merely as circulatory aspect - taking building-users from one level to another - but as a form of communication - enabling and activating space either as an attractor or as a visual platform.” (Holt and Looby 2017)

While these concepts can be developed external to BIM, they must at some point be input - likely by a BIM expert, not the designer. The gap between intentionality and actuality is now dependent on a BIM operator, not the architect. Design decisions are fixed in the media and evolve only through the intervention of the designer. The learning curve in BIM is very steep and rarely do master architects master its intricacies.

**BIM: The designer’s learning curve**

Architects using Revit’s BIM face a steep learning curve, the complexity of the Revit software tends to reflect a design path of least resistance, where software predisposes designer's approach. Therefore comprehensive training is necessary to implement a creative design strategy successfully. However, even with expert knowledge of BIM software, there is no internal mechanism to replace the unencumbered nature of the designer's sketch; therefore, it must be imported. Sketches, pictures, drawings, and images imported into BIM [Fig. 1] improve the designer's access to analogic design concepts, especially the symbolic language of the abstract narrative.

**Architecture's symbolic language of narrative and memory**

Psychologist Theodore Sarbin's, “Narrative Psychology, The Storied Nature of Human Conduct,” identifies “Narratives [as] solutions to problems-in-living in that they have the potential for creating order in human affairs,” and “… a way of organizing episodes, actions, and accounts of actions; it is an achievement that brings together mundane facts and fantastic creations.” (Sarbin 1986) Mastery of the symbolic narrative coordinates the imagination and intention of the designer.

By adding a third, visualization dimension, extraneous data burden the design interface. The additional dimension must also share limited screen space with planar symbolic media, while the traditional architect's language of symbolic representation, plans, sections, and elevations, is now the combined result of the three-dimensional model interface. BIM's three-dimensional visualization is advantageous, but the added complexity of fully realized building models requires increased construction detail, as well as increased attention to materiality, structure, and building specifications - thereby further burdening conceptual design development and design flexibility.

The illustrated applied research tests the limits of incorporating traditional analog media and its compact symbolic design language into Revit-2018 processes: lines, planar projection, graphic abstractions, and layering (vellum and trace). It acknowledges the designer's exchange of realism for symbolic development and engaging the artist's concept of suspension of disbelief - rational accountability is not required to for design development as it is in BIM. Finally, while the language of symbolic representation coordinates design development, and the addition of a design narrative provides coherency to the evolving design concept. These may be incorporated into the model or be developed coincident with the design effort, including: include written manifestos, traditional montage and collage, and video memory diagrams (Flanagan 2001).

**The BIM decade, 2010s**

It is BIM’s third generation software and its ability to integrate three-dimensional modeling, visualization, and collaboration that continues to erode the architect's reliance on second-generation CAD vector-
based modeling software. Even as BIM continues its evolutionary advance over CAD, limitations in its computer interface are increasingly apparent. This study identifies the mouse and the keyboard, 1970's technology, as excessively restrictive in HCI, Human Computer Interaction. “A significant number of major corporations and academic institutions now study HCI.” (Ghaoui 2006) After a decade, these advances in HCI have infiltrated cell phone technology where voice communication is being privileged over the keyboard and the mouse.

Fourth-generation technology, HCI enhanced, is currently in concept development. Voice communication, Virtual and Augmented Reality interfaces (VR and AR) plus haptic awareness will extend the designer's perception beyond the desktop computer screen. As Human-Computer Intelligence integrates the spectrum of multisensory communication capabilities, the computer-design interface will continue evolving. Building components now constructed with the assistance of robots will give way to intelligent site automation and assembly. As augmented reality expands beyond proof of concept demonstrations it will progressively infiltrate the professional and tradesman's toolset.

Legacy applications perfected over decades or centuries will continue to perform a vital role in designing man's environment. The paper sketch, the drawing, hand graphs and narratives will maintain their role as notational devices to impart meaning to the box. The keyboard, the mouse, CAD's symbolic management, and BIM's collaborative approach to building modeling demonstration concepts will persevere for decades, and it is essential to document these capabilities. Nevertheless, it is inevitable that generational changes, especially related to Human Computer Intelligence, while not replacing the analog interface, will substantially alter the architect-designer's perception of architecture and reliance on BIM.

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