Automated Comprehensiveness: Sectional Practices and the Misuse of Revit

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Abstract

All architectural drawings leave gaps in information. Drawing sets leave the impression that a combination of drawing types is comprehensive, that more information is better, but gaps always exist. In generating architecture, these gaps serve as opportunities for ambiguity, speculation, and exploration. The introduction of BIM in the late twentieth century and its more ubiquitous application in Autodesk's 2004 release of Revit, challenged these previous notions of orthographic comprehensiveness as many images could be output from a single digital model. As representational types, plans, sections, elevations, and details did not disappear. Yet, the historic and conceptual practice for generating architecture through them started to. In Revit, the particular disappearance of sectional practices has been impacted by the automation of the section cut. What is lost when section cuts are automated through a digital tool like Revit and how can the tool be used to support sectional practices once again? The studio work presented in this paper focuses on the ontological transition from orthography to BIM, the impacts of automated processes, and the role of implementing sectional practices in a post-orthographic setting by critically examining specific tools and commands used in Revit. Ultimately, the work exemplifies a pedagogical approach that stems from the "misuse" of Revit as an archaeological and generative sectional tool for exploring gaps in information.

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Orthography and BIM

Orthography is dead in architecture. Perhaps, this is too strong of a statement (and too soon) for those of us educated and practiced in orthography. It may be better to say orthography now belongs to the historical realm of mechanical processes that shaped the discipline and profession for hundreds of years. While Building Information Modeling (BIM) attempts to mimic familiar representational types in the forms of plans, sections, and elevations, as a tool it is fundamentally different in shaping space. This difference underlines the conceptual backing of the pedagogical approaches implemented in this work. In his essay, *Everything is Already an Image,* John May states "the notion that ideas exist apart from their technical formation (in the brain or "the mind") is one of the most pervasive fallacies of modern life".[1] May further positions architecture in a post-orthographic world by describing the ontological shifts from orthographic thinking to BIM thinking. Ultimately, May says, BIM makes us understand architecture and the world differently than orthography.

At the core of orthography lies mechanical gestures for arranging marks into geometrically based lines and texts.[2] For the orthographer, geometry is the organizational scheme for seeing, understanding, and structuring the world through conventions that have now been standardized through the discipline and profession. To practice architecture, one had to be able to make and read through these conventions. Additionally, the speed for recording gestures occurred at a rate in which decisions unfolded with the speed of making marks. Once complete, the drawing worked as a solidified

representation of the orthographer's thought. The emergence of BIM disrupted this method of working as well as the decision-making rate for making space through commands. In BIM platforms, the rate of transformation is much quicker than orthographic methods leading to the processing of multiple options within the same timeframe.

Although the concept of BIM emerged in the late twentieth century, its ubiquitous implementation in architecture did not arrive until the early twenty-first century. Before its emergence, Nicholas Negroponte posited that "digital technologies first mimic the processes that they are designed to replace, then extend them, and eventually disrupt them completely".[3] This prediction from 1970 prophesized the emergence of Computer Aided Design (CAD) tools that provided a digital platform for orthographic projection. This initial technological wave then extended to digital platforms outside of architecture in the form of NURBS-based modeling tools used primarily in the manufacturing realm. From this second wave, a third wave of digital technologies were made possible in the form of BIM tools. They have completely disrupted the methods for making architecture through parametric processing.

The focus here lies primarily in one BIM platform, Revit, since the platform provides the specific tools under examination in this studio work. Revit's emergence in 1997 and its subsequent acquisition by Autodesk in 2004 coincides with the rise of BIM software in the architectural profession. The platform introduced an unfamiliar process for making architecture by presenting multiple possible outcomes through a single revisable digital model. The output of images through plan, section, and elevation views, however, remained familiar. As a representational type, plans, sections, and elevations did not disappear. Yet, the historic and conceptual practice for generating architecture through them started to.

Because BIM platforms are based in telegraphy, the processes for making and outputting images are largely unseen. Behind the simple rotation of a model or the multiple commands used to alter it are a series of calculations processed through electrical signalization. The differences between these quick electrical signals and the slower mechanical gestures that accommodate drawing lie in the speed and reflection built into both processes. In orthography, the slower speed for constructing a drawn line allowed for the point of decision-making to be made before the line was drawn, then to be reflected upon before the next line was placed on paper. Electrical signalization, on the other hand, lends itself to automation meaning questions pertaining to points of intentional decision-making as well as reflection remain open.

Automated Sections

Automation refers to the replacement of a human task with mechanical or telemetric labor. Though it is widely discussed alongside autonomous processes, those processes which have agency to act independently beyond the control of the individual operating the process, it is important to establish a difference between the two and to stress a focus on automation here.[4] In Revit (and BIM software), two levels of automation are at work in the production of a digital model. The first refers to the previously discussed telemetric processes that calculate the various possible outcomes of the digital model. Unlike mechanical processes, which are made visible through the movement of working parts like gears or hand-scaled gestures, telemetric processes conceal these calculations at a physical scale made non-visible to humans.[5] This is something inherent in BIM as well as other digital tools. The second level of automation relates to the specific commands or the default interface given in a platform. Sequencing commands within a digital space take place under radically different conditions than constructing lines on paper. In orthography, to draw a series of repetitive objects, for example, meant the lines

for each object had to be drawn and the exact operations had to repeated again and again for each subsequent object. To digitally model a series of repetitive objects, on the other hand, means the initial object must be modeled and a copy or array command applied to quickly multiply the object. The outcomes may be the same, however, the operations for making the repetition are different. While certain efficiencies develop from commands that automate, it is questionable when this activity begins to automate thought and mental labor. It is this second level of automation that the studio work addresses by attempting to develop a more conscious approach through the misuse of sectional tools.

In Revit, sections are cut by placing a view in a model that is initially constructed from a plan view or they are revealed in three-dimensions through a section box. The accumulation of views cut from a model compose the final output of a project while carrying the notion that a combination of drawing types builds a complete and comprehensive drawing set. Unlike orthographic drawings, these cuts are not constructed through a collection of lines that represent the elements and spaces composing them. Instead, cuts are modeled in plan and automated in section, which points to a form of automation that replaces the mental labor of slowly constructing a section through lines. The work here, does not stem from a nostalgic call for a return to orthographic hand drawings. Instead, it examines how sectional practices can unfold through tools that no longer promote orthography.

Sectional Practices

Throughout history, the changing role of the section cut reveals sectional practices that have affected the way form and space were made during any given era. In architecture, a section is "a representational technique as well as a series of architectural practices pertaining to the vertical organization of buildings and related architectural and urbanistic conditions".[6] Though it has become a standard drawing type in any set, a section

was not one of the original drawing types that established the profession. In *the Ten Books on Architecture*, Vitruvius states that an architectural arrangement's forms for expression are, "the ground plan (orthographia), elevation (ichnographia), and perspective (scaenographia)."[7] Each of these drawing types refer to the program of the building, the façade or main face of the building, as well as the experience of the building, respectively. The vertical organization of a building visualized through a section cut(s) is not mentioned. In fact, sectional drawings did not emerge through the architectural discipline, but instead as an archaeological act for discovering what already exists.

Archaeology of Sectional Practices

"Archaeology, as a discipline is devoted to silent monuments, inert traces, objects without context, and things left by the past, aspired to the condition of history, and attained meaning only through the restitution of historical discourse".[8] Foucault's definition of archaeology moves beyond the simple observance of objects by upholding discourse as a descriptive effort in identifying transformational ruptures in history. Here, archaeology extends to the rules and standards that emerged from the transformation of sectional practices during various eras. Alone, the origin of section does not entirely describe the shifts in architectural thinking that resulted from sectional practices. Rather, the transformational ruptures in sectional practices that stemmed from the cultural, social, and political conditions that defined these shifts led to codified architectural thinking that now impacts approaches to making section cuts in BIM.

As previously mentioned, the origin of section did not emerge through the architectural discipline, but as a reflective act in describing anatomy and architectural ruins. The description of the human body as well as the practice of recording the surviving decayed monuments

from antiquity gave birth to the section as a conscious projection of architectural intentionality.[9] The crumbled remains of an architectural ruin already exhibited sectional features in the exposed material thickness of the remaining roofs or walls that served as mediators between exterior and interior spaces. The origin of the section cut, therefore, was a way to reveal what might otherwise be hidden.

The fifteenth-century, marks a transformational rupture in the standardization of the section cut in the architectural profession. Observers of the Pantheon documented the classical structure similar to other ruins, however, the Pantheon was not a ruined structure. In its completeness, observers sketched sections that speculated the relationships between interior and exterior spaces. In these early Renaissance drawings, dimensional accuracy was traded for the illusion of a perspectival scene. Section perspectives, therefore emerged as a tool for understanding space conceived and experienced volumetrically. In the sixteenth century, section further developed into a measurable drawing that combined the section cut with interior elevations in order to allow for geometric and dimensional accuracy. Additionally, the cut was made parallel to the picture plane. These Orthographic sections led to initial standards for making sectional drawings by further aligning the section with plans and elevations as a primary architectural drawing and tool.

What chronologically ensued were transitions that layered rules and standards onto the section cut and drawings. During the eighteenth-century Enlightenment era, sectional practices proliferated in architecture as interior volumes were drawn in relation to the exterior context of the site. In the nineteenth century Modernist era, sectional drawings delineated the interdependency of space and form through emerging industrial material relationships. Organization of these materials through a vertical cut demonstrated how building assemblies resisted and carried loads. In contemporary practice, the

section cut has been subjected to a unique set of conditions that have ruptured traditional standards. Digital technologies like CAD and BIM have polarized the section as efficiencies have pushed toward volumetric repetition and sectional practices are automated rather than constructed. The pedagogical approach in this studio work anchors these historical layers as chronicled sectional practices that contribute to archaeological acts in generating new sections. The additional study of an existing building mimics the origin of section as a method for observing and recording ruins. In this way, established building assemblies are made present in the Revit interface.

The studio is a first-year, pre-comprehensive, graduate studio. Though most students enter the course with some exposure to Revit, they have less exposure to building assemblies. To model the existing building, students must learn the tool, identify the existing volumetric relationships inherent in the building through section, and develop a basic understanding of the present material connections and relationships. In the most recent version of the studio, students studied a former 1918 Stock Judging Pavilion, a pavilion for judging cattle, pigs, and sheep. The building was added to in 1926 to include the University's Meat Lab, where previous generations of students learned how to slaughter and prepare meat. Today, the building serves as the University's Agricultural Heritage Museum, a building program in desperate need of more space. The building assembly ties brick bearing wall construction to steel framed trusses (Fig. 1). The riveted gusset plates that hold the trusses together are remnants of the massive bridge building practices performed in the area during the early twentieth century. The building, in addition to early drawing sets, which include modernist section drawings, served as a basis for generating sectional practices through the misuse of Revit.
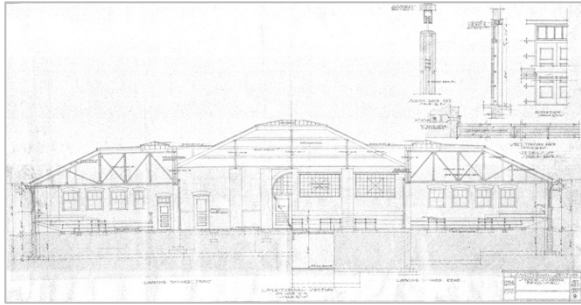
Fig. 1. Section Cut through the existing building.

Generation of Sectional Practices

The methodology established in the studio addresses the automation of sectional practices by identifying and misusing the commands or "tools" that cut sections in Revit. It is the second level of automation, the use of a specific command or a default interface, that this work seeks to confront. By layering the outcomes of two sectional tools and processes, the section work plane and the section box, section cuts are not only constructed, but examined through gaps in information.
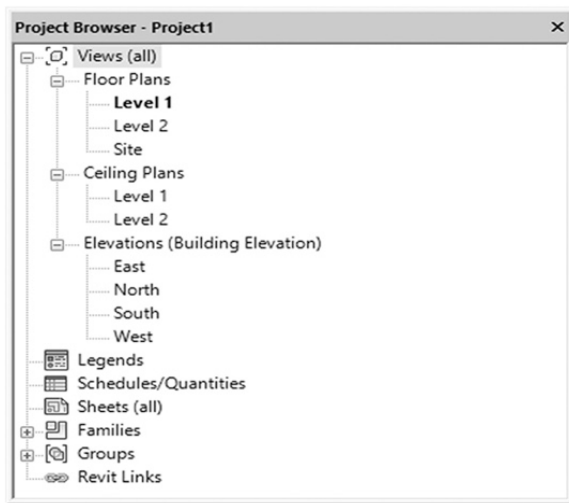

Fig. 2. No section view appears in the default project browser.

In Revit, a work plane is a virtual two-dimensional surface used primarily for the origin of a view.[10] Work planes are used for the attachment of sketched elements such as model lines and detail lines, for enabling other tools in particular views, and for placing work-plane based components. Automation of work planes lie in platform's default state. Upon opening Revit, a single work plane exists in the plan view or level one (Fig. 2). This points to the initial generation of digital models in plan, since elements must attach to an established work plane. The subsequent generation of a section cut or view is made by placing a section header in a plan or elevation view. Therefore, the first misuse of the tool, is the establishment of a default work plane in the vertical orientation for sectional elements to attach to.

The second misuse of the tool addresses the methods for constructing a section cut upon the newly established work plane. Rather than attaching system, loadable, or in-place families to the work plane, section cuts are "drawn" upon the work plane using model lines and details lines. Technically, these lines are modeled not "drawn" since they exist in three dimensions. By modeling each line, the process for constructing the cut is slowed in order to build an understanding of the tool as well as the elements and spaces resulting from the cut. Though this is not a form of orthography, since automated telemetric processes are present, other automated processes are surpassed as the section cut is constructed rather than taken from another view. In some ways, the method mimics CAD processes more than BIM. However, this method needs another sectional method as basis for comparison.

The section box (Fig. 3), serves as a tool in creating sectional relationships in Revit. It is applied to a three-dimensional view in order to limit the geometry shown in the view.[11] For the purposes of this studio, elements that lie beyond the plane of the section cut are modeled as elements rather than lines. They are categorized as modeled or cut elements. This descriptive effort is put forth to better define the role of these elements in the output image. A Modeled Element, for example, is a three-dimensional object placed behind the "drawn" section cut. It is automatically categorized by Revit

according to its role in the building assembly. A Cut Element is a three-dimensional object that is cut through or it is hidden by the section box. Though the element is not deleted from the model and the data for the element is still present, the element is not visually present. Ultimately, the modeled lines constructed upon the vertical work plane in a two-dimensional section view and the modeled and cut elements created by a three-dimensional section box result in two methods for making section cuts in Revit.
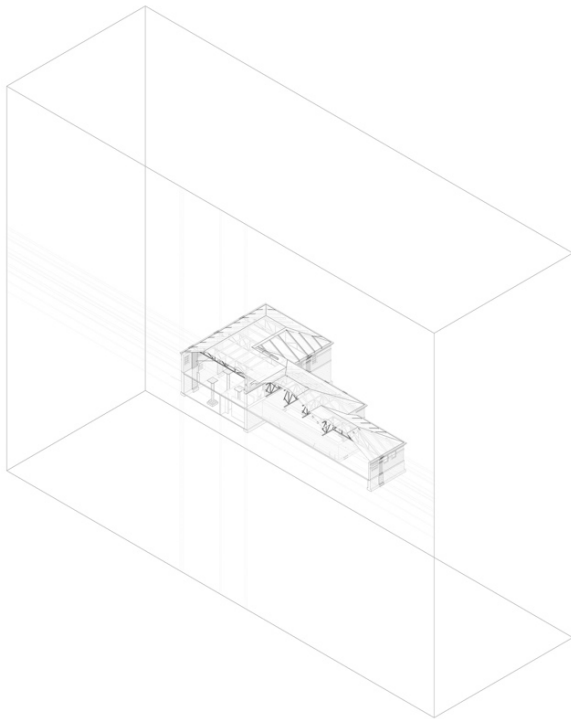

Fig. 3. The Section Box.

The third and final misuse of the tool involves the layering of both sectional methods into a final stitched view. In Revit, a Stitched View combines multiple views, plans, sections, elevations, and 3D views onto a layered sheet or image. It is as much a construction as the building and project itself. The overlap of both sectional methods introduces visual inconsistencies in the gap between both types. As one student pointed out in their completed project, these inconsistencies and gaps in information serve as opportunities for exploring imprecisions inherent in the platform. The initial focus of this student's project centered on the existing building working as a constructed building system rather than an assembly. The student observed how window openings were driven by units of brick rather than a pre-fabricated window component. Most brick units remained fully intact throughout the existing building. When modeling these observations, the student used measurements to calculate the amount of bricks used in a section cut. To advance the project through an addition to the museum, the student continued the language of the building assembly by implementing a series of Gaussian vaults. Using the work plane in the section view, the student first used model lines to model each brick and arranged them accordingly. Stitching this view with the modeled and cut elements that comprise the section box view revealed a gap between both types of section. In spite of perceived comprehensive notions laid upon the digital model, the gap exhibited how pertinent information, like the precise module of a brick, can be left behind (Fig. 4). The imprecision this student found countered another student's examination of demolition processes in BIM. This student found the tool to be too precise in demolishing masonry components to the point that demolition worked more like disassembly. The sectional practices employed by both students not only generated a final addition to the existing museum, but also critically examined moments of precision and imprecision in the platform. Another student challenged the presentational platform of Revit. Post-orthography is rooted in presentation or the ability to present all possible outcomes at once. Orbiting a model or zooming in and out infinitely supports this notion. The student discovered that the constructed section, which is based in orthographic representational practices, resisted detail in three-dimensional space (Fig. 5). Matching the precise moment in which the section cut through the clay tile roof, did not match the modelled elements behind the cut. These observations were not criticized for their limits, but were supported by explorations in the misuse the tool.
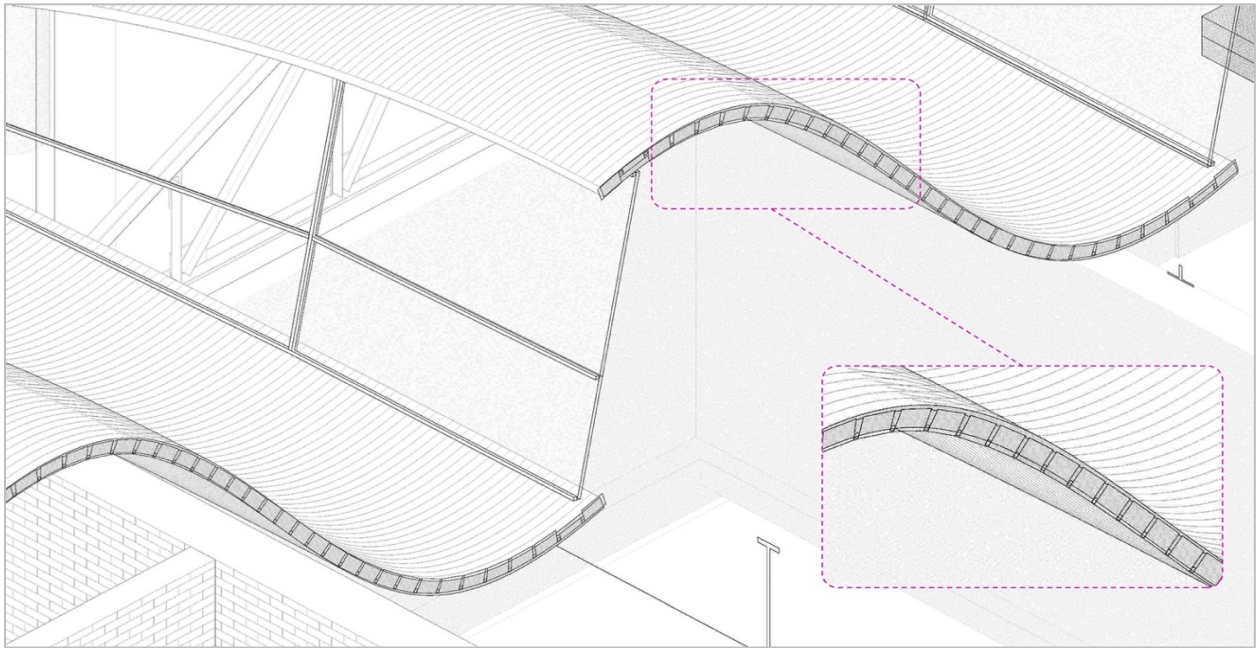
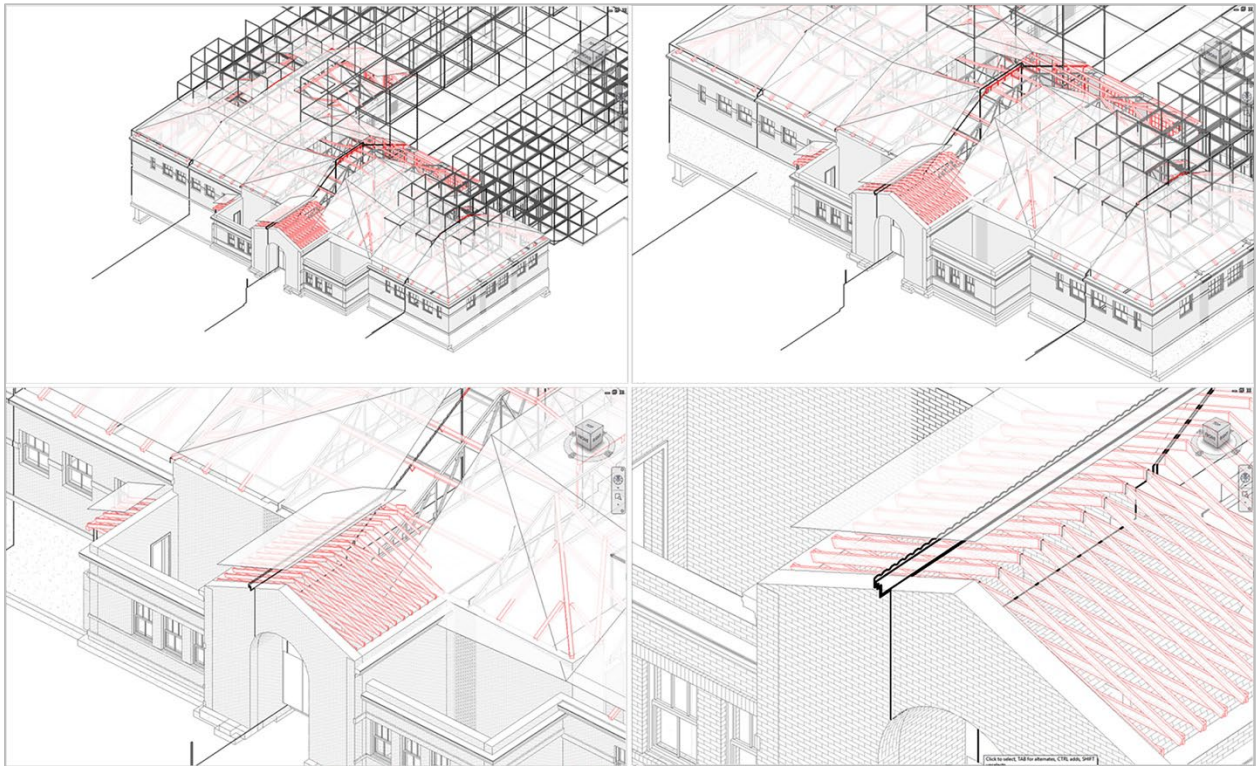*Fig. 4. When overlapped, the different methods for making section cuts in Revit present gaps in information.*

Fig. 5. Zooming presents no scalable or finite detail between the "drawn" section and the modelled elements.

Conclusions

The focused examination of the commands, tools, and interfaces used in BIM platforms like Revit not only point to a shift from mechanical processes like drawing to telemetric processes like digital modeling, but also point to an ontological shift in thinking. The development of ideas and their execution is directly tied to the tools and technical process that manifest them. The detailed history of the origin of section and its associated rules and standards are further tied to this notion. From Renaissance to Contemporary section cuts, the emergence of tools and methods impacted the spatial outcomes in each of these eras. In Revit, the automation of sectional practices disrupted the orthographic standards that developed over the course of centuries. In no way does this study negatively judge this disruption. Instead it places orthography in history and attempts to make sense of sectional practices through post-orthographic methods. Working against the default work plane, modeling with lines, and layering different methods for making sections together in Revit are attempts to slow the process for cutting sections in order to understand the resulting spaces as well as imprecisions or hyper precisions in the tool. Ultimately, the work exemplifies a pedagogical approach that stems from the "misuse" of Revit as an archaeological and generative sectional tool for exploring gaps in information.

Beyond Conclusions

Because the work presented here forms the pedagogical foundation for a studio, the ubiquitous question students receive during reviews, "what would you do next", seems applicable here too. Though the methods implemented in the studio are post-orthographic, in examining the individual outcomes of the projects, the output of images align with more familiar orthographic representations. Therefore, future versions of the studio must consider methods for reviewing the work. How should a post-orthographic review unfold? Work must be presented rather than represented meaning perhaps the live or animated model should be reviewed or performed rather than representing the project through plans, sections, and elevations that are output from the model. Though section cuts provide the impetus for a project, they do not necessarily need to constitute the output.

Notes:

1 John May, "Everything is Already an Image," *Log 40*, (New York: Anyone Corporation, 2017), p 9.

2 John May, "Everything is Already an Image," *Log 40*, (New York: Anyone Corporation, 2017), p 14.

3 Phillip G. Bernstein, "Parameter Value" in *The Politics of Parametricism: Digital Technologies in Architecture,* ed. Matthew Poole and Manuel Shvartzberg (New York: Bloomsbury Academic, 2015), p 205.

4 Skylar Tibbits, "From Automated to Autonomous Assembly," *Architectural Design* 87, no. 4 (2017): p 13.

5 John May, "Life, Autocompleted," *Harvard Design Magazine: No Sweat* 46, (2018): p 14-15.

6 Paul Lewis, Marc Tsurumaki, and David J. Lewis, *Manual of Section* (New York: Princeton Architectural Press, 2016), p 6.

7 Marcus Vitruvius, *The Ten Books on Architecture*, trans. Morris Hicky (New York: Dover Publications, 1914), p 13.

8 Michel Foucault, *The Archaeology of Knowledge and the Discourse on Language*, trans. A.M. Sheridan Smith (New York: Vintage Books, 1972), p 7.

9 Jacques Guillerme and Hélène Vérin, "The Archaeology of Section," *Perspecta 25*, (1989): p 226-227.

10 "Work Planes," *Autodesk Knowledge Network: Revit Products,* last modified January 15, 2019, https://autode.sk/2PmCm06.

11 "Change the Extents of a 3D View," *Autodesk Knowledge Network: Revit Products,* last modified April 09, 2019, https://autode.sk/2UJkDpn.

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