Checking Out: The Troubling Tendencies of BIM Libraries

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Among the most prominent skills in demand in the profession of architecture is proficiency in Building Information Modeling (BIM), the leading production software in use by practicing architects. Students are keenly aware that they will need to be proficient in BIM to be employable, a need the academy increasingly recognizes and accommodates. While better training in BIM does translate into better prospects for employment and early success, Building Information Modeling implicitly promotes the use of pre-designed, industrially produced building elements such as doors, windows, stairs and railings.

Consequently, architecture students are often designating these elements rather than designing them or even just making significant modifications. In turn, these standardized elements are used to populate student (and all too often professional) design proposals. The ease with which these common and poorly designed elements are inserted into otherwise thoughtful works of architecture invites criticism and reinforces the importance of the design of a wide array of building elements.

To illustrate this tendency, consecutive advanced undergraduate seminar courses were developed to improve proficiency while revealing deficiencies in the digital tools themselves by focusing on areas of intense detail, particularly in those elements most commonly designated from standardized libraries: doors, windows, columns, stairs, handrails, etc. This process of replicating complex, modern, and entirely pre-digital details and architectural elements improves students' facility with digital tools while undermining their tendency to simply designate mass-produced industrial elements.

Consideration of each element demands the development of custom BIM content that either modifies standard elements available in the software libraries, or creates entirely new 'families' from scratch. Custom content was required to be parametric rather than simply modeled in place, unless absolutely necessary with the intention that these elements (or at least the process used to create them) are portable and capable of being reused or modified in other projects. BIM provides tools specifically for creating certain architectural elements, but the capability of these embedded tools is generally poor and necessitates using difficult and less efficient processes. These courses systematically assert that BIM (and Revit in particular) does not preclude design nor limit the presence of detail at the scale of architectural element, but rather suggest the need to develop more sophisticated tools and menus within BIM, enabling architecture students and practicing architects alike to reclaim these elements and return them to the domain of the architect.

INTRODUCTION

Computers have clearly transformed both architectural practice and architectural education as "traditional production tools (pencils, slide rules, triangles) have now substantially be superseded by more streamlined and efficient ones embedded in computer software." Architect and educator Juhani Pallasmaa notes that the shift from physical to digital tools for architects "was presented as a solely beneficial invention that liberated human fantasy," but warns that while "we acknowledge the benefits of the computers and associated digital technologies, we need to identify the ways in which they differ from previous instruments of design."[1] This is an important challenge, asking architects to be deeply critical of digital tools. As futurist Kevin Kelly writes, "We need to civilize and tame new inventions in their particulars. But we can do that only with deep engagement, firsthand experience, and a vigilant acceptance." Instilling this critical instinct in students is an essential part of architectural education today, given the growing presence and capability of computers, and the tendency to replace *design* with *designation*.

Even the earliest digital tools were intensely complicated, using tens of thousands of lines of code in computer programming languages. Ever-increasing complexity and the language barrier between software developers and architects makes it almost impossible for architects to modify their digital tools directly. Instead, software developers offer ways for users to provide feedback and participate in testing, creating a slow and homogenized evolutionary process. Fortunately, it is unnecessary to make one's own tools to influence their evolution, but it is necessary to master their use to do so. Unless architects can master the tools at their disposal, the nature and capacity of the tools themselves will be inevitably determined by others. The implications are significant as our tools inevitably affect how we work and what we make. As architect and author Richard Garber warns, "The consequences of how we consider problems of design with (digital) tools will have an impact on what buildings look like and how they perform, thereby charting a new course for contemporary architectural practice."

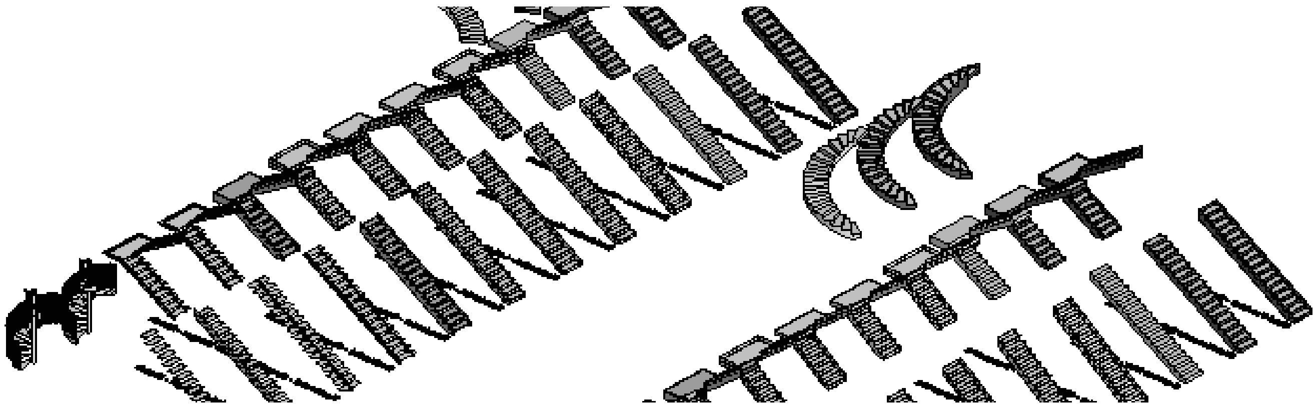

Figure 1: Revit stair library.

Certainly the digital toolkit of architects is expanding, but rarely through the advent of new tools made specifically for architects. Rather, architects have tended to adopt software originally intended for other disciplines. AutoCAD is perhaps the most widely used (or misused) computer program for architects but was originally developed as a drafting program. Drafting is understood as a technique deployed by architects but it hardly attempts to capture how architects think. Garber rightly notes that, "the first CAD packages were a sort of analogue for what designers traditionally did manually, meaning that they provided a virtual working environment; however they did very little to challenge the design process itself. CAD simply changed the medium of architectural production from a physical one to a virtual one."[2]

Perhaps the most prominent example of this transposition in digital tool usage is Frank Gehry's adoption of CATIA®, software created by French aerospace company Dassault Systemes® to resolve complex curvature in the metal skins of aircraft into panels. This arguably uses the software for the purpose for which it was designed, though for a different product. In a sense, this willingness to adopt tools designed for other disciplines illustrates a kind of evolution, but it is an evolution of format rather than an evolution of function.

Although architects readily adopt technological developments to improve efficiency for existing tasks, they can also predict the need for digital tools that do not yet exist. As architectural theorist Robert Somol recognized, architect Peter Eisenman's "transformational diagramming techniques anticipate the need for (and predict the possibilities of) the later development of 3D modeling and animation software."[3] This is not to say software was developed specifically to accommodate Eisenman's process, but rather to enable a way of thinking three and four-dimensionally that is common but not exclusive to architects.

A few software programs are now being developed specifically for architects and in turn for architecture students. One category of architectural software developed for architects intensely at the turn of the 21st century is known as Building Information Modeling (BIM). Working from the premise of digitally constructing an entire building at full scale, "building information modeling (BIM) provides … the ability to digitally coordinate the often-complex process of building prior to actual construction."[4] Architectural drawings are created by controlling how the digital model is seen, often through the use of architectural conventions which are built into the software.

MASS MARKETING

BIM is understandably geared towards the broadest segment of the market of practicing architects. Use of BIM has increased rapidly and is expected to be an $11 billion industry by 2022. Though determining market share precisely is currently not possible, Autodesk Revit® is generally accepted as the most popular BIM platform for architectural practice. By focusing on the features most desired by architecture firms in practice, BIM becomes less suited for students but is by no means unusable and has many features that are incredibly useful. To clarify, BIM doesn't prevent the design of architectural elements and details, but comes loaded with extensive libraries of elements that are tempting substitutions for design.

Architecture students are most vulnerable to this temptation given their limited experience. Garber recognizes that "a number of building product suppliers have already made available libraries of products such as windows doors and railings, most commonly in Autodesk Revit® file format. Such openness should be received with both caution and embrace – while the idea that architectural design can be reduced to the selection and organization of pre-existing building components that effectively negates the authorial creativity."[5]

Though seemingly convenient, selecting elements from predefined lists presents a false choice, especially to students with limited experience. As technological ethicist Tristan Harris explains, "When people are given a menu of choices, they rarely ask: 'What's not on the menu?'; 'Why am I being given these options and not others?'; 'Do I know the menu

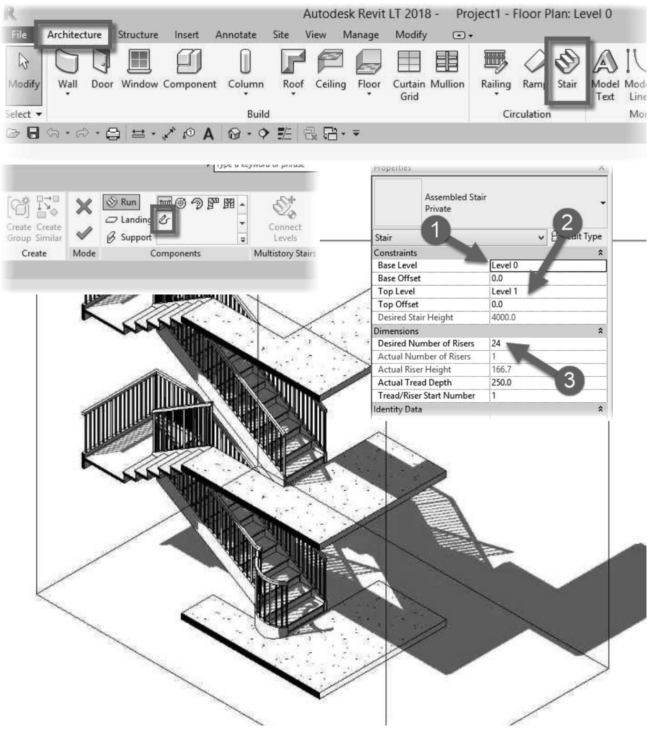

Figure 2: Revit stair tool menus and options

provider's goals?' and, 'Is this menu empowering for my original need, or are the choices actually a distraction?'"[6] The elements in question that populate software libraries are surely curated towards the convenience and economic benefit of the primary users: practicing architects. By simply selecting from a predefined menu, users accept the agenda of the software creator and in turn the economics driving contemporary architectural practice. Without an in-depth knowledge or even mastery of the software in question, it is difficult to recognize what choices are not included.

For students who are inevitably learning new software while learning to design architecture, this temptation is almost overwhelming and the results are troubling: otherwise thoughtful design proposals populated with commercial products that are inappropriate and inconsistent. More and more building product suppliers also make their products available online, and Revit now includes an embedded internet search feature to expedite this process.

As a compromise, students are encouraged to use neutral elements that lack articulation and are therefore less objectionable than double hung windows or six panel doors, connoting traditional homes. Almost unintentionally, these placeholder elements allude to the worst examples of the International style or at best provide a bland and inoffensive version of modernism. Architect and author Vittorio Gregotti warns against this kind of convenience, saying, "It is false to think that culture of industry or building (by now distant cultures from design) could solve the problem of detailing; this might be convenient or economic to the architect, but lead to unprecedented downfall of architecture."[7]

Alvar Aalto clearly had similar concerns, having "experimented with and quickly abandoned most of the elements of the International Style Modernist vision – standardization, geometric forms, mechanistic finishes, and the doctrine of material efficiency."[8] This "definitive break from the International Style"[9] coincided with Villa Mairea's completion in 1939. Aalto's thoughtful and intense focus on the elements of architecture provides a critical example of details designed and constructed in a modern but entirely pre-digital era. Edward Ford confirms Aalto's unique status in this regard, recognizing that "at the level of detail Aalto was the great humanizer, the enemy of rigid and arbitrary standards, responding with sensitivity to the minutest of functional concerns, softening the harshness of industrialization."[10] Studying Aalto's work quickly reveals the intense attention paid in the design and construction process to architectural elements such as columns, windows, stairs, handrails, and door handles, among many others. By doing so, Aalto also helps ensure these elements remain in the domain of the architect rather than surrendering them to standardization.

RESPONSE

Architecture students are rarely afforded the opportunity to design the elements Aalto focused on with such care: door handles, handrails, stairs, and columns, to name a few. To challenge this trend, a professional elective course was created for undergraduate students. The course posits that faithfully recreating architectural elements that were designed and constructed in the modern era before the use of computers would expose deficiencies in both student skill and in the standardized elements and the content creation tools provided in BIM. Effectively, the complexity of the details under consideration forces students to dramatically develop their ability to design and create custom details digitally. Ford's book *The Details of Modern Architecture Vol. II: 1928-1988* provides a concise canon of modern but pre-digital architecture that inherently serves as an intense and ongoing challenge to these trends.

In a series of exercises organized by element, precedents from Ford's book were assigned with the challenge of rcreating all the constituent components parametrically through Revit families. While the exercise of replicating Ford's drawings by simply drafting or through basic three dimensionl modeling is relatively simple, generating fully parametric 'families' is intensely challenging in most cases, especially for students. This process often demanded the creation of significant new content, or what Revit calls 'families': collections of similar items tracked through embedded information about their identity and properties. As the level of detail gradually progressed to the most complex aspects and smallest scales,

Figure 3: Villa Mairea main stair, copyright Alvar Aalto Foundation.

every effort was made to initially use the tools included in the software ostensibly designed for such elements.

For instance, the iconic main stair in Aalto's Villa Mairea was first attempted by simply using the stair tools available in Revit. Not surprisingly, and much like the actual construction of the real staircase, the complexity involved demanded an innovative combination of tools and techniques available. This process was incredibly important: by attempting to replicate the wondrous and idiosyncratic details of Villa Mairea, students almost unwittingly plunged deep into the libraries and related menus that inform and define the elements in question. This process inherently developed their knowledge base and skill set, but also established the internal limitations of the software itself and encourages creative adaptation of other tools in ways that completing tutorials online simply does not.

The main staircase required deviation from the standard stair tools in Revit from a team of three students working in concert: one on the carriage structure and columns, one exclusively on the treads and landings, and one on the handrails and mounting hardware. These three students sat together and worked in intense collaboration over a period of three weeks to model the staircase in intense detail, taking great pride in the accuracy of their modeling and in their efforts to translate the Finnish captions in the original construction drawings. The results were impressive: a highly detailed digital version of the Villa Mairea stair, composed entirely of geometrically flexible components laden with information about their dimensions, materiality and location in space.

The stair in particular illustrates the critical interrelationship of the first two points made in the abstract: that architectural software should (1) automate menial and repetitive tasks, and (2) make difficult tasks easier. BIM software effectively suggests that designing stairs is more like the former than the latter, seeing stairs and rails as a highly repetitive and mathematically predictable assembly therefore prone to automation. The main stair of Villa Mairea, while obeying most rules governing good stair design has an eclectic approach that BIM is incapable of addressing inside the dedicated stair tools. By seeing the design of stairs as a difficult task that should be made easier, one could envision and entirely different set of dedicated stair tools.

For instance, Revit does not offer the capacity to design individual treads, thus ruling out the inclusion of the figured initial tread. Similarly, the stair tools do not allow for repetitive stair treads to be designed independently as constituent families then loaded into the stair design. This approach would effectively hybridize the parametric approach to stair

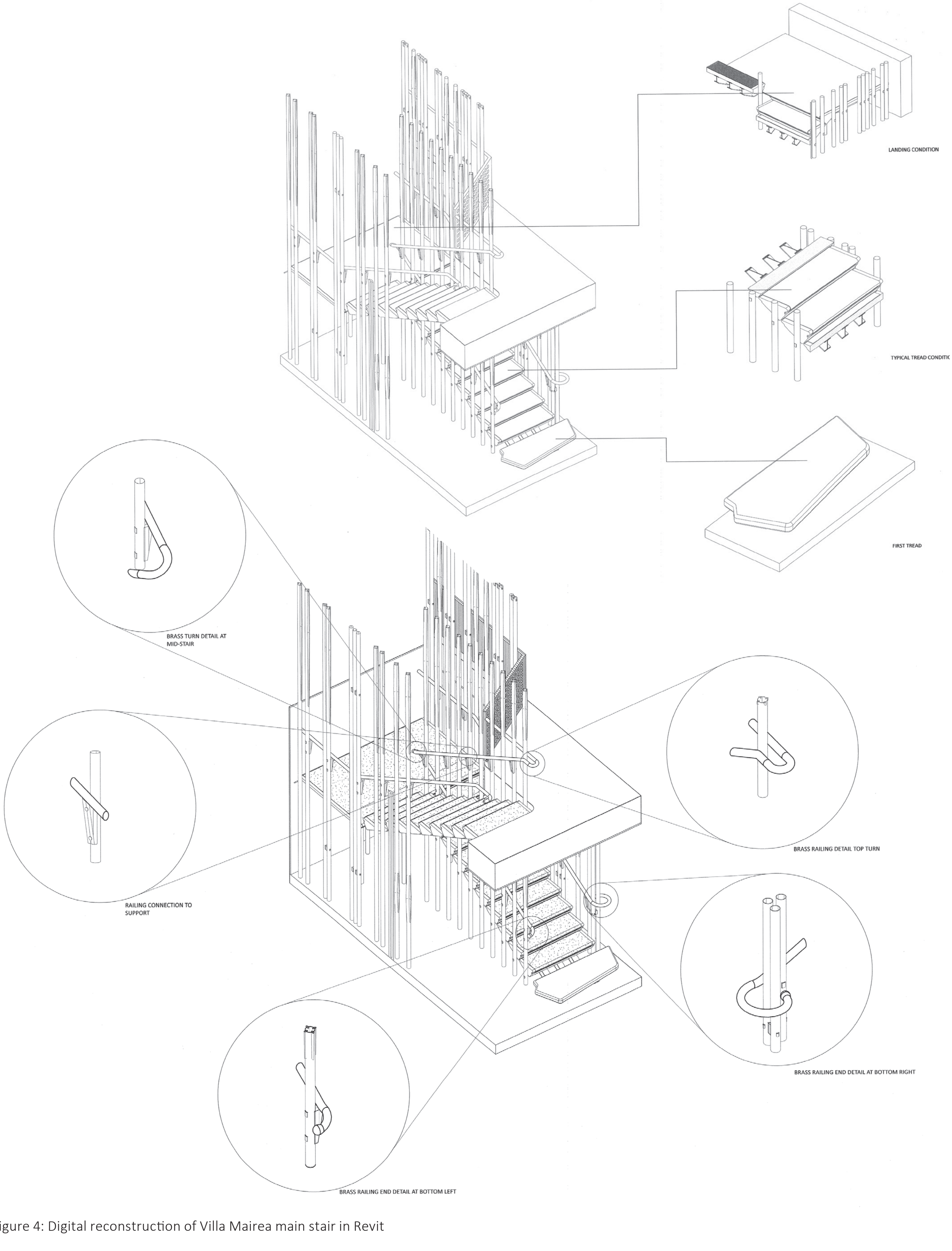

Figure 4: Digital reconstruction of Villa Mairea main stair in Revit

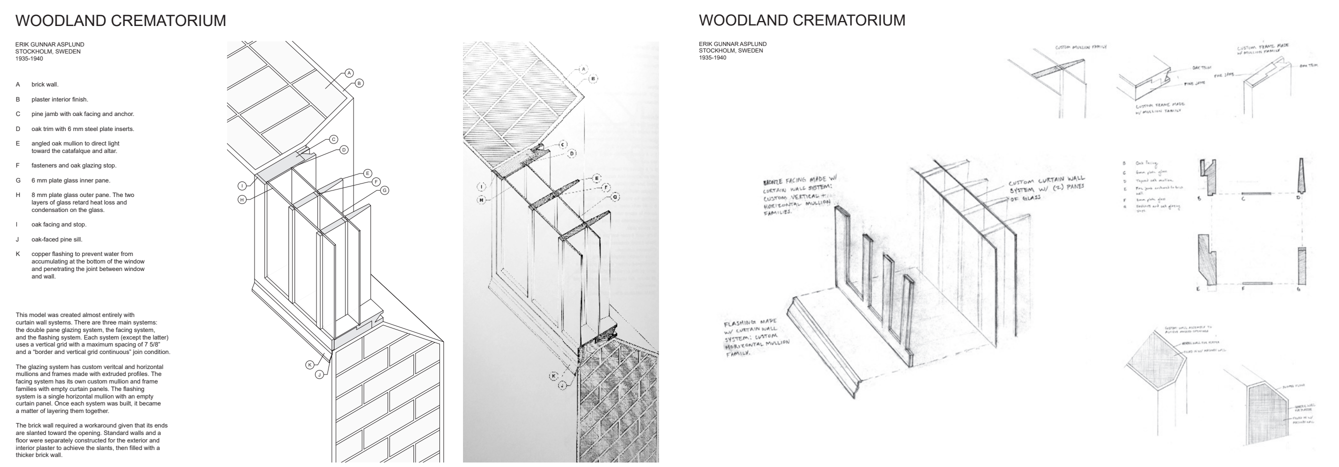

Figure 5: Replication of Ford drawing in Revit (left). Analog deconstruction of construction elements (right)..

design (the menial and repetitive portion) with the power of custom family creation (the difficult task portion.) Each tread could simply be assigned a type and then governed by the calculations that currently control the distribution of treads and risers. This approach could also be used for the design and articulation of the landing which currently offers no significant controls beyond depth.

Although Villa Mairea was completed 80 years ago, our digital tools are shockingly incapable of replicating the elements designed by Aalto and simply do not make the design process easier. Rather, the biases and limitations of the software steer architects and especially students towards simplistic, standardized solutions.

In subsequent exercises, students were challenged to replicate as faithfully as possible the axonometric cutaway drawings in Ford's book by creating entirely parametric, flexible familes. This process further built students' proficiency but also challenged the graphic capabilities and representational options offered in the software. The precise angles chosen by Ford for each drawing varies in order to best reveal the content and character of each assembly under investigation, while Revit offers only a standardized viewing angle.

CONCLUSION

As a conclusion to the course, each student created three presentation boards related to each of three precedents they studied: one chronicled the drawings and photographs they used to inform their work, one completed by hand to document their process of deconstructing Ford's drawings for digital reassembly, and another to illustrate the work itself. The latter board required the isolation of the details or assemblies with the various 'families' and constituent profiles identified in order to illustrate all of the various pieces the students made to duplicate the original. These drawings were essentially exploded axonometric drawings, but they deconstructed the digital development process rather than the physical construction process. Coupled with the presentations were 3D printed fragments that further illustrated the level of detail embedded in the digital models. The presentation boards and printed models were exhibited together to illustrate the scope of the course and the depth of detail the students achieved and were reviewed by Edward Ford in person.

The course clearly achieved a significant elevation of student proficiency in Revit, but simultaneously revealed the limitations of the program and the challenges of creating architecture of the highest aspirations, especially at the scale of the element. Unfortunately, the process of selecting pre-existing components in BIM will only become easier and more commonplace unless students are taught to resist this trend.

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