Beauty + the BIM

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INTRODUCTION

The family of Building Information Modeling (BIM) software has established itself in practice and construction as an effective tool for documentation and project management. The academy, however, views the use of BIM as a distraction from time needed to train design thinking-- preferably a design focus that is no longer form-centric but instead attentive to environmental performance.[1] The assumption that BIM solely develops efficient data schedules or coordinates Integrated Design Process (IDP) collaborators misses opportunities to utilize information as a source of visual production. This paper examines the role of beauty within design-based aspects of information modeling and fabrication strategies. For the development of design culture within a BIM practice to be viable, it will take more than ecologically regenerative designs or virtual collaboration among consultants. What becomes additionally indispensable for practice is to nurture a design process and theory with responsiveness to the visual environment alongside manners for its production. This requires considering the role of aesthetic experiences, such as beauty, in re-centering design consciousness where the architect takes on an authoritative role in the collaborative setting offered by BIM.

A seminar course entitled "Beauty + the BIM" provides a setting in which overlapping historical conditions of "sensation" and the current condition of "reason" in architecture can creatively engage one another while ultimately situating these activities in the context of a new theory of practice through representation. The course is divided into three brief but intensive projects of corresponding disparate theories of beauty. Each respective theory represents a specific resultant CAD/CAM and drawing production: the sublime as understood through Edmund Burke, the grotesque by way of John Ruskin, and *wabi-sabi* from thoughts by Leonard Koren. The projects seek to reconsider, investigate, and experiment with the possible connections that exist among these juxtaposing theories of beauty and fabrication technologies. The trajectory proposes a deeper understanding of sensuous empiricism and its definition, a potential venue for concept and production in relation to the emerging and imperative[2] BIM technology.

BEAUTY

Historically, the "idea of beauty", or aesthetics, is considered a social quality that gives some sense of joy or pleasure and can inspire sentiments of tenderness and affection. Beauty has the power to foster desire and association. In architecture, this might transpire from formal engagement or a poignant spatial mood. In contrast to this conventional definition, beauty is thought to also exist in things that are imperfect, impermanent, or incomplete. Furthermore, beauty might even be found in that which is abject or bizarre. Being cognizant of design aesthetics while grasping the use of BIM technology gives way to opportunities for meaningful exploration and interpretation. The vast topic of beauty in the arts and nature, albeit within a limited scope in this course, can then be applied to a methodology of production in order to begin applying its pursuit in the architectural discourse.

The relationship of BIM to these historical topics of beauty proposes a dubious marriage when the information model is by nature considered empirical and beauty is really intuitive or subjective. There is enormous potential to emphasize the visual within a data-driven context, allowing the information model to be more than a vehicle for documentation efficiency, thus overturning the stereotype of a BIM project acting merely as a mechanistic device for enhanced facilitation of delivery, irrespective of its content.

Pursuit

In a climate where research-driven design predominantly determines how architecture can behave, aesthetics within architectural discourse are seen as negative asides, conflating the visible with the aesthetic and rendering both superfluous. It is however an apt pursuit. As a facilitator for IDP feedback and collaboration, BIM design processes encourage a practice of middle ground compromise. In addition, BIM has a reputation as arduous design software, trading aesthetics for management functionality. The course's proposition supports specific, novel solutions and unconventional ideas rather than the consensual and generic. This in turn inspires design thinking and productivity in the BIM environment.

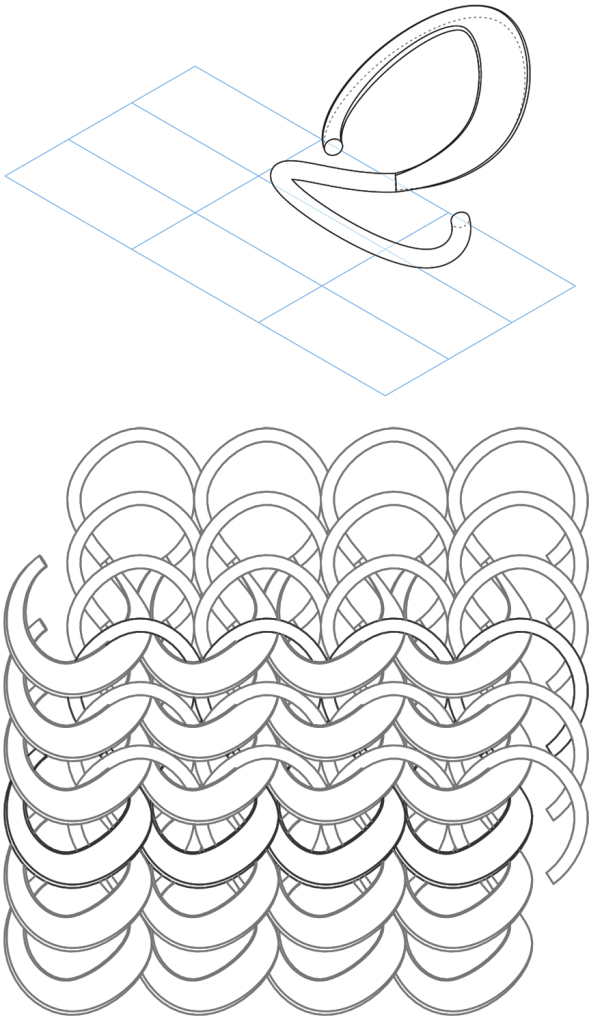

Figure 1. Example of component capabilities and system integration. (Submission by Seth Brenner, MArch Candidate '12)

Pattern making plays a critical role in the production of the unconventional in BIM. It is indeed the focus on the aesthetics of the cell unit that make up the beauty of the whole. Each element within the component takes up its own set of constraints that enable a unique moment of opportunity for novel derivation, be it proportion, scale, effect, etc. By defining aspects of aesthetics as parametric constraints, aesthetics becomes an embedded element distributed along a surface offering feedback and connectivity at multiple scales simultaneously. This breakdown of parts confers systems thinking and construct-ability; working and acting integrally.

Authorship

When dealing with hundreds of thousands of bits of information, BIM enhances the quest for beauty at the same time that it distracts from it. Because of IDP, the making of beautiful things in BIM becomes a participatory endeavor. Collaboration on the one hand means that the pursuit is an act shared by many in the virtual domain. Production of information or taste for the masses (not just the individual) can better the idea or result in a generic compromise. Who then leads the collaboration? Who is the designer? This co-generation practice can easily favor BIM competence or muted solutions over exploratory design work.

The student, then, becomes a digitally savvy craftsman, where BIM is used to mass-produce individual variations at representational and full-scale fabrication. As a designer, the student can exert granular control of the constructed outcome or aesthetic. Although the course does not directly engage collaboration with others, the fabrication aspect is by nature collaborative and ultimately relies on a framework of design negotiation. Through this negotiation irregular building components

come to fruition with the same facility as standardized parts. The notion of mass-customization is then realized in building design and production. Comprehension of fabricating non-standardized repetitive components directly from BIM data, known as "logics of seriality", puts attention to the local variation and differentiation in series.[3]

Through the transferability of information, what lies in the virtual BIM becomes the real BIM (i.e. the materialization of virtual immateriality). The design process transitions quite quickly out of representational thinking to actualization. And in this methodology of BIM and fabrication, one sole author creates beauty, with analysis as reinforcement.

PROJECTS

Sublime

Project 1 involves the translation of a virtual drawing space to a physical object. The boundary of the drawing is pushed by the use of the three-dimensional printing process directly translating information from the BIM stereo-lithography export. The goal is a precise description of a complex, three-dimensional 'space frame'. More importantly than structural resolution, students are prompted to disclose if such an endeavor could inspire awe like viewing a picturesque scene or admiration like that of a garden. This assignment initiates the course's investigation of the aesthetic of the component element and whether that tessellation can effect overall perception. Philosopher Edmund Burke specifically defines the sublime experience in his essay, "A Philosophical Enquiry into the Origin of Our Ideas of the Sublime and Beautiful," as the "strongest emotion" which causes astonishment. This requires visual interpretations into spatial conditions and can be explicit expressions of these perceptions as translated through the BIM platform.

Using *Conceptual Mass* and *Component* files, the provocation of a space frame promotes the reciprocity of a component and system relationship. Given a 12' x 12' boundary in BIM space, students are asked to create a volume to initiate the process. For one surface of the volume, the *Divide Surface* pattern functionality of BIM is utilized and served as the generator of the space frame. The scale of a component, its parts and overall surface are critical determinants of a "successful" outcome. The surface is then exported through an *STL Exporter*[4] in order to translate the BIM model to 3D print representation. An accompanying drawing frames a particular view for discussion.

Guided by Burke's reading, the production of work is intended to be astonishing with effects of admiration, reverence, and respect. Anxiety takes over the student when asked to produce something they deem beautiful (of any magnitude), much less that of the sublime. For some students simplicity is beautiful (whereby a square component is distributed along a simple surface), while others manifest notions of maximum visual and geometric complexity (see Figure 2).

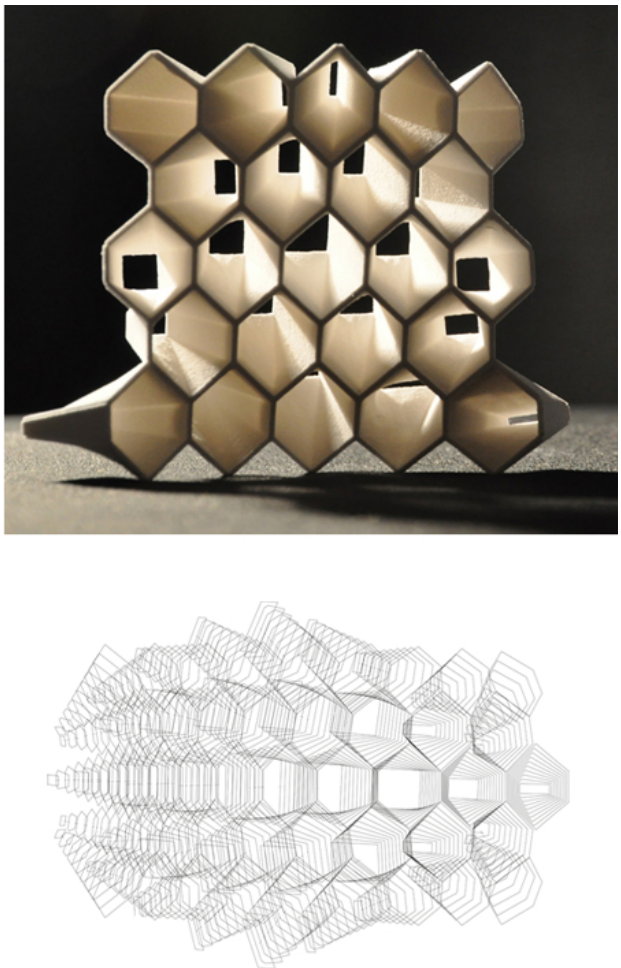

Figure 2. Example of a Sublime project- 3D Print and corresponding drawing below. (Submission by Blake Smith, MArch Candidate '12)

The unit and system chosen to distribute the work references a selected geometry that organizes itself through imbedded and constructed parameters in BIM. There is constant compromise to what the student/designer wants and what the designer gets within this work environment. Whether a system is obvious at first glance or is found through intensive inquiry, it always reflects a subliminal desire of the pursuit. It is through the unit that the work evolves and that the organization and systematic principals can be discovered. "The manipulation of these elements provides the theatrical framework in which the work is realized. Beauty is no longer a utopian ideal that is unapproachable, untouchable and unobtainable. Beauty is now sensible."[5]

Like many generative design software platforms, BIM has the capacity to create form and space through component and system logic. To a certain extent, the repetition of the component and system produces relative monotony which one could argue leads to visual boredom. On the other hand, this repetition has an effect of infinity whereby every slight shift of the component must check and interrupt, at every alteration commencing a new series. Whether these parts are uniform and uniformly disposed gives the figure its full force. Parametric capabilities of the information database allow for algorithmic variability and mass customization in order to relieve banal iteration and further notions of reason or performance of the component. In most of the student submissions, distinction is derived from the asymmetrical, spectacular, or unusual in the component itself, not the volume or surface the component adheres to.

Grotesque

Reliance on established taste has forever preoccupied architecture. In a classical manner, beauty is primarily found in measure and proportion and secondly perfected by symmetry manifested in form and space. For others, such as Dadaism or Kant's early text "Observations on the Feeling of the Beautiful and the Sublime," the definition of beauty opposes that convention. The sculptor Eva Hesse openly expressed her distrust of beauty-- for "prettiness"-- and shunned it as distasteful in her *Expanded Expansion* (1969). This thinking negates beautification to the role of a beautician or aesthetician; one that simply does nails or skin care.[6] The pursuit of the grotesque from John Ruskin's *Fall of Venice* seminal reading directs "the study of the workman to the most strange and ugly conditions of animal form...the finds are oftener ludicrous than terrible."[7] Even Burke agrees "terror is a passion which always produces delight when it does not press too close."[8] Through the distrust of beauty, the designer ultimately tends toward unity in composition and proportion as with Hesse's own sculpture.

The definition of the word 'grotesque' comes from the Latin root *grotto* which means small cave; prompting the exploration of cavernous margins of thought that insinuate a grotesque architecture[9] or to take the term more literally into a cave-like dwelling or grotto. The play of a perforated form can imply mood and dank sensation through its ability to shade an interior space for dark, shaded protection (see Figure 3). Burke also finds darkness more productive of sublime ideas than

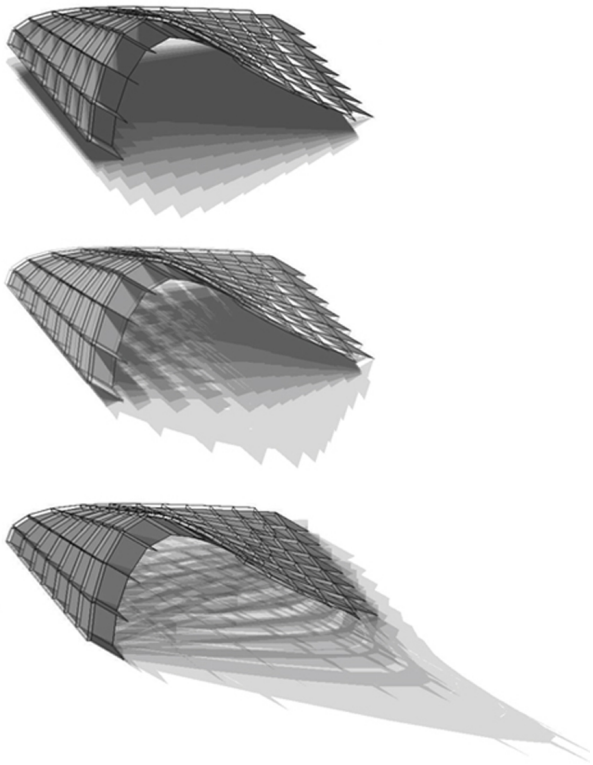

Figure 3. Example of Grotesque Sun Study Drawing (Submission by Joseph Boyle, MArch Candidate '11)

light. "All edifices calculated to produce an idea of the sublime, ought rather to be dark and gloomy, and this for two reasons; the first is, that darkness itself on other occasions is known by experience to have a greater effect on the passions than light. The second is, that to make an object very striking, we should make it as different as possible from objects with which we are conversant."[10]

Ideas of the grotesque force Project 2 to manifest alternate and iterative spatial understandings. This assignment invites feedback from analysis[11] and to develop and demonstrate how conditions of optimization mutate what is deemed "beautiful." Conceptual massing and solar analysis guide (and potentially optimize) the manipulation of form to heighten conceptual and experiential provocation. The grotesque comes to mean for many an architecture that is odd or unnatural in shape, appearance, or character, fantastically ugly or absurd. If BIM "objects (of which the grotesque materializes) were contemplated in their true light, and with the entire energy of the soul, they would cease to be grotesque, and become altogether sublime."[12] Other perceptions detail form and space that is fantastic in the shaping and combination of forms, as in decorative work combining incongruous human and animal figures with scrolls, foliage, etc. The methodology of component and system is used again but in this context becomes a device for achieving excessive ornamentation leaning toward the grotesque, much like the popular highly decorative grotto typology in eighteenth century England.[13] The faceted nature of such a system allows for localized information to determine aesthetic. Through a rigorous and consistent method of study, space is prioritized given the BIM ability to locate place through lighting conditions, altitude and azimuth.

Project 2 also asks for experimentation in the realm of the drawing. The production of novel representation prompts a playing field for ideas of the abject or bizarre. The drawing itself uses BIM representational capabilities of auxiliary, axonometric, stereotomic views, or a combination thereof, in order to intersect experimentation with analysis. Notions of time, body, and movement are potential aspects that a drawing, in the conventional sense, can convey through techniques of projection. The use of graphic devices from BIM such as tone, line-weight, and line-type are essential for furthering notions of the grotesque in spatial representation- through drawing as well as formal investigation. The output is meant to disclose conditions of optimization that mutate intended BIM geometry. Namely, what might be considered beautiful is altered to accommodate analysis from information model. Ultimately, Ruskin claims that one will discover, through the consideration of the noble grotesque, the true appreciation of beauty."[14]

Wabi Sabi

The ideas of *wabi-sabi* come from a Japanese worldview centered on acceptance or transience. This aesthetic is sometimes described as that which is imperfect, impermanent, or incomplete. *Wabi-sabi* depicts a beauty of things modest, humble, and unconventional.[15] With an acceptably high tolerance for the unfinished piece, proponents of this ideology see it as the ideal aesthetic, likewise, as an anti-aesthetic. Leonard Koren places it in opposition to the uniformity of the digital realm, which he claims to be devoid of all sensory experience.[16] Therein lies the challenge: the productions of the 'worn and weathered' when in fact BIM and CAD/CAM methodologies are unequivocally rational and precise.

This project asks for a shift in scale and investigation toward material sensations and/or effects. These sensations can include aspects that articulate surface through qualities of light, texture, and pattern. *Wabi-sabi* might also be explored through serendipitous material selection or digital corruption. Students are asked to consider if the investigation of these factors help determine its outcome.

The use of bitmaps registers notions of beauty and correlates the parametric control of the information model. The real power of the pixel comes from its molecular nature that, in a sense, is a unit within a system and can store information as such to manifest and manipulate the whole. A pixel can be part of anything, from text to lines to photographs. From those mediums, a pixel can hold information pertaining to performance beyond or in addition to aesthetics. To adhere the pixel to three dimensional space means control from the database can remain visual, instead of formulaic, for sake of the designer in a code and script environment. With an adequate number of pixels, and sufficient bits per pixel, articulated surface treatment achieves exceptional display attributes. Component and system are now controlled through visual imagery input. The irregular

pattern of the bitmap literally becomes the instruction for the construction of the milled plywood piece. Some students' selection of gray-scale bitmaps start with images of what might be deemed beautiful in the more literal sense (image of Marilyn Monroe or this mountain scape) while others tend toward irregularity or abstract pattern. Further, the pixel has the potential to imbed deeper meaning into built form. The more pixels, and more bits per pixel used, the more memory (both sensual and technological) resides in the output.[17] Granularity of the database then determines the facility and depth of otput.

Burke speaks of the difference between "Clearness" and "Obscurity" with regard to the passions and claims that the picture of something considered beautiful can at most affect only as a palace, temple or landscape would have affected in reality.[18] This proposal treats beauty as mimetic, whereby nature and art are one. The mountain scape (Figure 4, bitmap 1) is considered a beautiful scene and thereby the reduced resolution bitmap (Figure 4, bitmap 3) retains information from the original image and translates that beauty.

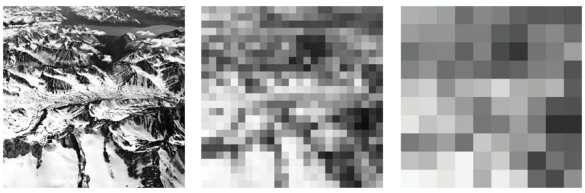

Figure 4. Example of Wabi-Sabi project bitmap derivatives. (Submission by Chris Renke, BArch Candidate '13)

Using the CNC mill, students are asked to fabricate a 20" x 20" full-scale, articulated surface that translates an image based parameter algorithm. This procedure requires a black and white bitmap image to respond to defined parameter constraints within a conceptual mass file. The "construction" document should be milled from wood or other wood products, such as laminates, MDF, etc. The thickness of material and pattern articulation discloses the thesis, while the additional drawing /documentation submission conveys the specific instructions of the process necessary for someone else to create the proposal again.

The corresponding pattern making of this project exposes a secondary design agenda whereby the plywood laminate (Figure 5) exposes even more articulation through the subtractive CNC process, whereby the plywood is milled away layer by layer. Material qualities lead to a characteristic of dissolution. Such dissolution of a low-grade material can be deemed 'beautiful' as it is associated with the process of aging or decaying, even if that process leads to a nonentity. It is the control of this weathering that is noteworthy, and is that which makes it a desirable output. The findings from this final project possess moments whereby unpretentious, materially explored pieces were defined and produced; and reinforcing the ideas covered in the first two projects.

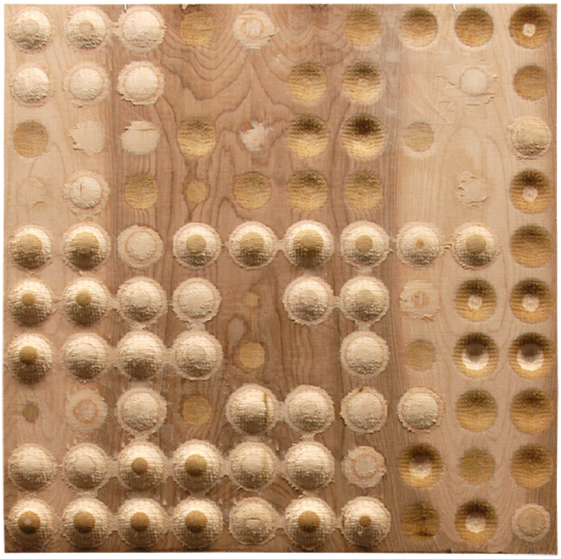

Figure 5. Corresponding Example of Wabi-Sabi project 20" x 20" CNC milled piece. (Submission by Chris Renke, BArch Candidate '13)

OUTCOMES

In the negotiation of IDP feedback and collaboration, BIM design decision-making needs a leader that innovates and controls the aesthetics of future building. The results of the students' projects demonstrate that historical meanings of beauty (the most radical interpretations of the principles of beauty put forward) can inspire new techniques or procedures within a BIM practice, ones that do not forfeit design in the expense of other capabilities. The work produced goes beyond archetypal space and thus the assumptions that BIM technol-

ogy dictates the look of the drawing and arguably the content of design. The design process indeed requires from students a level of focus above and beyond traditional or conventional standards, as so many variables are offered as design determinants. These determinants require more immediate attention to structural and mechanical comprehension-- knowledge that students cannot always be expected to have, particularly as a prerequisite for a seminar course. Is this expectation too soon for student design pedagogy?

Even with its steep learning curve, novice BIM users are (perhaps unconsciously) able to design and accomplish projects with great facility and efficiency. The capabilities of BIM challenge the act of origination, when anyone can accomplish something complex with very little skill or time investment. Unlike traditional drawings, the work is not derived from a relationship with the making of the model, whereas the BIM becomes an instrument of physical contact between the drawing or object and the maker.

Importantly, the implementation of BIM with CNC fabrication in this academic agenda supports the pedagogical focus on developing student design knowledge (not just technical computer skills). Although this additional expectation raises the workload of an already intense undertaking, the process can be viewed as assisting the design thinking necessary for self-authorship equal to design leadership in the collaborative process. The IDP project would then occur between the designer of the BIM and the fabricator (if that happens to be another person). This scenario makes training a quick aesthetic eye within the BIM environment essential for total project delivery.

By positioning the project deliverables as approaches to optimized "design for fabrication," the seminar course gives students the opportunity to explore ways in which alternative themes of beauty might be realized, whether it is the accepted beauty or the anti-aesthetic. Because the projects are derivations from the parametric capabilities, rules of CNC production and analysis capabilities within BIM allow for an adaptable mode of aesthetic pursuit. In particular, the ideas behind grotesque thinking propose pedagogy that questions established tastes. The student's notions of beauty derived through BIM augment distinct models of asymmetry, complexity, and mimetic design that can then push the information model in novel directions.

CONCLUSION

With beauty comes desire. We see something we like and recognize it as beautiful. Desire to translate individualized wants determine the objects and aspects of engagement. As such, desire is essentially borrowed from others. With conceptualization through BIM, the information becomes a recipe for exchange of aesthetics (among other things). It is this ability-- the reproduction of quality design-- that could manifest a period of cultivated taste wherefore contemplation of natural beauties and beautiful design of artistic genius. The cross-fertilization of beauty with the information model leads to recipes for production, and thus, technique for reproduction. The open-source nature of information exchange means design of built space and form can be improving exponentially as a collective for a progressive process.

As the incubation period of BIM comes to an end, the ability of designers to manipulate the performance of aesthetics will become more apparent. What is evident is that beauty abhors mediocrity. By paying attention to design aesthetics at all levels of detail creates a platform for cultivation of pleasing design, disclosing BIM capabilities that can truly heighten the cultural awareness and the actions of external affection. The academy is able to test ways that BIM might be used to its full potential as a design tool. Through BIM this work can proliferate. In Burke's words "Mere light is too common a thing to make a strong impression on the mind, and without a strong impression nothing can be sublime."[19]

ACKNOWLEDGEMENTS

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ENDNOTES

1 Argument raised by Renee Cheng. "BIM: Implications for Architectural Pedagogy". Yale BIM Symposium, April 19, 2010.
2 Although there are several software platforms offering Building Information Modeling capability, this author considers *Autodesk Revit as* the industry proprietary standard.
3 Kolarevic, Branko. *Designing and Manufacturing Architecture in the Digital Age*– (Pennsylvania: Architectural Information Management, 05 Design Process 3, 2001), pp 122.
4 An *Autodesk Revit* plug-in
5 Graduate student Taylor McNally Anderson (MArch Candidate '13) thesis statement from Project 2.
6 Danto, Arthur. "Beauty and Beautification" *The Abuse of Beauty*. (Chicago: The Paul Carus Lectures 21. Open Court Publishing, 2003), pp 61-80.
7 Ruskin, pages 146.
8 Burke, Edmund. A Philosophical Enquiry into the Sublime and Beautiful. (London: Routledge, 1958), pp 46.
9 Singly, Paul. 'Devouring Architecture: Ruskin's Insatiable Grotesque'. *Assemblage 32* (Massachusetts: MIT Press, 1997). pp. 108-126.
10 Burke, 80.
11 The assignment calls for the use of analysis platforms demonstrated in tutorials and by guest speakers, Brian Johnson of Autodesk. These range from Conceptual Form Simulation Extension, Solar Radiation Technology Preview Extension and/or Ecotect 2011 to create and substantiate what might be deemed 'unusual' or 'fantastic'.

12 Ruskin, John. *The Stones of Venice, Volume III: the Fall*. (New York: Cosimo Classics, 2007), pp 150.
13 Barbara Jones. *Follies and Grottoes*. (London: Constable & Co. Ltd, 1953). pp. 143-175.
14 Ruskin, 160
15 Koren, Leonard. *Wabi – Sabi*. (Berkeley: Stone Bridge Press, 1994), pp. 7-23.
16 Koren, pp.8.
17 Negroponte, Nicholas. *Being Digital*, (New York: Vintage Books, 1995) pp. 106-107.
18 Burke, pp. 60.
19 Burke, pp. 66.