Time space

Campbell, Cameron [1]

Keywords: Grasshopper 3D; Rhinoceros 3D; time-lapse

Abstract Time-based media and parametric modeling are two distinct and rapidly developing medias that can be combined to offer architecture and design students the opportunity to visualize and design with the benefit of considering change over time. These two important technological developments have occurred in digital media but have rarely been linked in the exploration of conceptual representation. The first development is the ability to produce time-lapse video with readily accessible equipment and the second is the ability to visualize form making and changing in advanced ways through parametric modeling such as Grasshopper3D. In an advanced media class, these medias have come together to teach students about the many ways in which architecture can address change of building relative to change of time and how that can influence the layout of the built environment. This paper presents the position that this is a valuable and productive pedagogy by showing specific examples as well the context of the discipline.
Time is an important component of architecture, but it is one that is difficult to study because students are commonly focused on the immediate product. Students are accustomed to seeing architecture in singular ideal conditions rather than experiencing architecture in its many scales of time. Over the course of an hour, an entire day, a season, a year and even the result of decades can be sources of inspiration for design objectives. The ability to gather visual data to assist in this analysis is paramount for this study to work. It provides inspiration as well as direct evidence of change. Time-lapse is the first interface because it offers a medium that requires long spans of time to create, anticipation of what may occur relative to what is actually witnessed in the film and discoveries of the unexpected.
However, simply witnessing the situation is only the beginning, doing something with that discovery requires the ability to record and manipulate change as an aspect of design. Parametric modeling allows students to “program” these various conditions by breaking them down into their component pieces called “parameters”. By manipulating the parameters, the designer both realizes the elements that impact change and can analyze the design potential as parameters are manipulated. This process results in a time-based presentation that records change and allows the student to focus attention on the subject matter developed through the medium.

1. Department of Architecture, Iowa State University, Ames, United States of America

Parametric after the honeymoon

Parametric modeling is not new, although it seems new when we see the vast expansion of expressions and discourse about the digital tool. (Garcia, 2012, p 109) It is now ubiquitous because software has been developed to such a degree that designers, without computer programing experience, can visually create scripts (e.g. Grasshopper 3D plugin for Rhinoceros 3D). However, there is still a significant learning curve that renders learning the software a burden in the discipline of architecture because there are simply so many things to learn. The result is that parametric design curriculum is often focused primarily on the tool through tutorials and examples. This paper is about the search for a way beyond the tool and into the deeper concepts that frame the use of the software. Ultimately, the combined result of understanding the tool and framing it in a conceptual way will have influence on the architecture produced.

There are many exciting and dynamic works being developed using scripting tools. In his book, *Digital Architecture*, Jacobo Krauel surveys the various examples of complex form generation of architecture through digital instruments. To be sure, there are many wonderful examples of the products of the tool. (Krauel, 2010, pp. 119-121)[1] However, the industry has also produced many project types that simply adjust the finer points of skinning a complicated form and using the parametric tool to do so. Some call these "twisted torso" forms and this style of work could become cliché if it has not become so already as evidenced in work by Gehry with the Guggenheim in Bilbao or, Mad Architects design of the Absolute Towers in Canada. While these forms are a legitimate product of the tool, the focus of the pedagogy should move from its ability to rapidly facet a complex form to using the medium in a generative way. In other words a focus on how to use the tool conceptually is necessary for the academic pursuit of the medium.

Finding a Parametric Pedagogy

Teaching the tool (e.g. how to use Grasshopper 3D) is both the necessary part of parametric design and it is the trap of teaching parametric definition design. The lesson that has been learned over time is that one should not start with the tool itself, as the tool becomes the problem that the students solve. Students must come to the tool with a conceptual problem to solve or they focus on the example solutions already created and tend to recreate those existing problems rather than inventing their own. In this seminar, the students are asked to create a time-based analysis of an architectural condition. That is the departure point for this project. Time-based productions add a new perspective and dimension to student projects because with parametric modeling, time can actually be considered and change over time can be significant aspect of the parameters studied and ultimately recreated accurately in the digital design.

There are many formats for education in the architecture discipline. The studio, the lecture, the seminar, the discussion and the lab are all formats that are used throughout the curriculum. Some are entirely about the professor-student dialog while others are lecture only and even others employ discussion both physical and through digital blogs. The challenge is where best to deliver this type of instruction. The studio is at the core, but so much rides on its success that students are not willing to fail (nor are the faculty). The seminar, which at this institution is an elective course with three credit hours and meets three times a week for one-hour during the term, provides a format where students can create small scale case studies, can try techniques and medias that are out of their comfort zone and employ strategies that have been untested. These are all risks that sometimes fail, and in this class, students are encouraged to fail – but to fail well.

Consideration of how digital design relates to theory and conceptualization is necessary to understand. Rivka Oxman describes a new terminology from Computer Aided Design (CAD) to Digital Architectural Design (DAD) and is distinguished by a shift from replicating paper processes in the computer as understood in CAD to DAD that is a "different medium of

[1] Krauel describes multiple applications of parametric tools to the development of architectural form.

conceptualization." (Oxman, 2008, p. 106) To state in another way, there is an attitude shift to using the tool to conceptualize rather than using it to record what has been conceptualized. Shifting the attitude of the learning objective in this way changes how the student engages the work. At the outset, it is established that one can only fail if they do not engage themselves and they must have a position or something to say in the work. This is the concept stage and they begin by using non-traditional media in the practice of architecture. The focus on generative elements allows the combination of "formation models, performance models and generative models" as described by Rivka Oxman as a series of current approaches toward digital design.

Formation models are defined as "dynamics and heterogeneity of topological versioning." In digital design using parametric modeling tools the value is that one can "flex" the parameters. In design, the author can determine the areas of most concern and put values on the range of flexibility. Examples of this in practice are recently common as these systems can be used to more efficiently skin a building or allow a complex form to be made of a small kit of parts.

Generative models are "computational mechanisms of generative processes." Here "shape grammar" is the popularized application in recent trends where the parameters of shapes in nature inform the design. The use of a natural condition or bio-mimicry to inform the formation model is how a generative model differs. One example of this may shape the building to match a form in nature. Another example is growth structures and examining how things in nature change over time and applying those to structure. Sagrada Familia is an interesting example because it is both historic and contemporary in this condition. However, many recent buildings also employ this technique to push the limits of computation and construction sophistication.

Performance models "Performance-based simulations can directly modify designs" and are based on analysis software. However as Oxman describes it, this is not yet quite possible. Furthermore, this is likely not ever possible because it suggests that the performance simulation could eventually have enough parameters that it would "design" autonomously. Controlling and manipulating the parameters would ultimately be the design. The cliché "which came first? The chicken or the egg?" comes to mind because the problem student's encounter in this approach is that they need a building shape to study in order to run the analysis. Such plugin applications as DIVA and Ecotect are used in the analysis phase. While the "autonomous" capability may be impossible to achieve, the iterative process that employs careful performance analysis is very possible and necessary in current practice. Studying how concept can be developed through highlighting certain performance characteristics is key. Just like the Generative Model, the Performance Model is a way to more specifically define the formation model.

There are many ways to go about teaching the digital design types such as Formation, Generative and Performance Models. However, teaching the tool becomes a contradiction because the students must trust that the concept can inform the use of the tool without first understanding the tool. Conversely, the students need to understand what the tool can do in order to undertake developing the content. Consider how many students and even practicing architects make design decisions related to the availability or knowledge of a tool. This problem is exacerbated in the institution because students often know very few tools and have to become comfortable working with concepts prior to engaging a tool. When the tool becomes more complex, then so does the fear that they will not be able to translate concept into that tool. One primary objective of this class is to teach students to bring concept to the digital process to avoid the tool becoming a means to its own end.

Project description

The semester work is broken into three parts. The first part is the aforementioned time-lapse production where students generate a short video analyzing an architectural condition in the environment. The video is less than two minutes and employs the use of many types of cameras. Significant to the work is the easy access to cameras that can do this. Many digital SLR cameras have built-in intervalometers and now many smaller format cameras have timers built into them.

One popular camera is the GoPro HD camera because it is small, waterproof and has a built in 170 degree angle lens. Students are able to use the technology to automatically record conditions and they are aided by relatively quick feedback so students can make many iterations of the film and modify for conditions or circumstances. Some students employ small egg timers that allow them to slowly rotate the camera over a long period of time. Other students employ ultra-long (sometimes semester-long) studies and others address weather or contextual conditions.

The second part is the translational aspect of the semester. The students are challenged to convert the underpinning concepts of the analysis into a series of parameters to be evaluated and manipulated. It is at this point in the semester that parametric modeling is considered. Here students design the problem through an analysis of parameters established in the time-lapse project. This step is crucial in the success of the work because it is not product oriented, rather it is conceptual and they are required to give physical presence to the conceptual idea. Because they have this background, the students also can see the applicability and they can use the "problem" statement to help direct the tutorials and education used while learning the software. The product of this phase is rather challenging because it is a script. Students have to take on the role of instructor to teach their peers about how they converted concept into the definition and they ultimately "flex" the parameters to prove how it works.

The third and final phase of the semester is devoted to the product of the parametric definition. They must use media to record and illustrate the objective and parameters that have been defined. In this case, the limitation of the software is a benefit to the curriculum because the students must convert the work to a consumable and understandable format. Here we return to the movie making process, but in this case it is to use it to tell a story about the work. Students are encouraged to use materials developed and add additional media such as nicely rendered models of the parametric product and other video elements that illustrate the conceptual condition.

Example Projects

The first project example is the work by Sean Taylor-Davies who was a true experimenter with the time-lapse media. He created many devices to manipulate the camera over time and used the devices to record change of light over time. It is a phenomenon that is understood, but rarely considered at its most basic state. During phase two, Sean created a model of the earth's rotation around the sun including an elliptical orbit and its rotation on its axis. This exercise was about being accurate to the angles of the sun -- often generically produced for certain software applications. Finally, these parts were put back together to analyze particular light conditions in space.

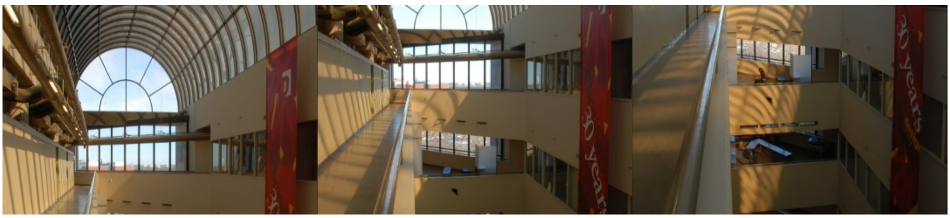

Fig. 1 Tracking time-lapse of shadows moving through space

The second example project also considers light. Rikkie Ran began her project with video studying the various dynamics of light on glass surfaces. The time-lapse studies show how windows are both transparent and reflective depending on time of day and change of light levels between inside and outside. This is a performative model.

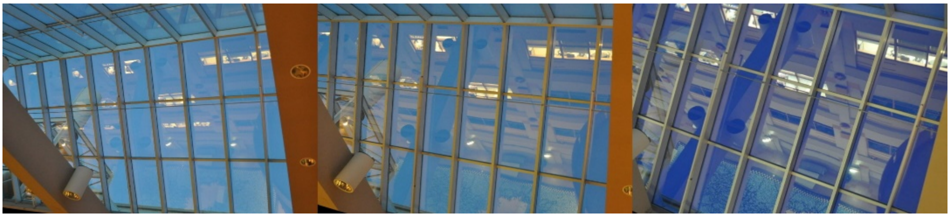

Fig. 2 Time-lapse of light changing on surface

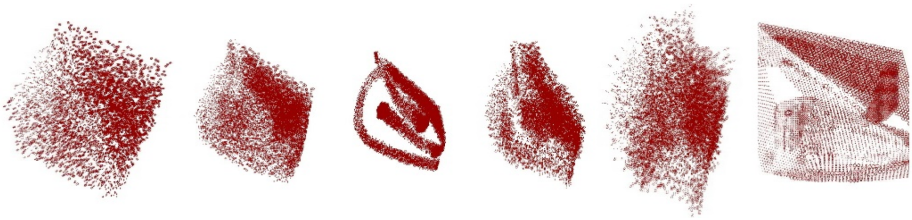

Fig. 3 Grasshopper model light particles manipulated

While both previous examples are conceptual, they are both related to physical experience and attempt to use parametric design to analyze a known architectural condition. They also are examples of Performance Modeling. The following two examples illustrate using the same sequence to define a formal or expressive condition but they are also both what can be considered "Generative Models". Alex Michl, began a semester-long project with a time-lapse video of a decaying pomegranate. Ultimately, it was a study that lasted the whole semester, but he was able to pull pieces of the time-lapse out as he worked to study the form changes. This is a form study, but the product is informed by the direct act of nature – more specifically that of decay.

Fig. 4 Time-lapse of decaying pomegranate

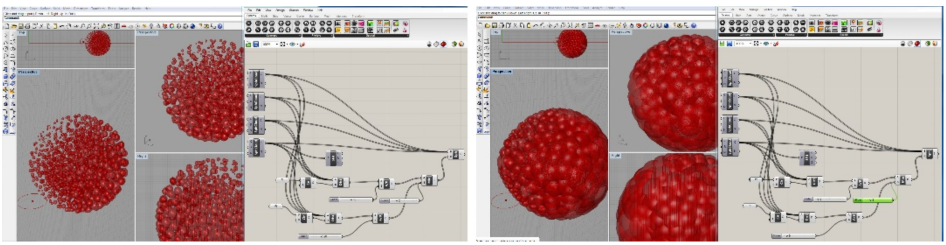

Fig. 5 Grasshopper model manipulated with variables (distance, scale and density)

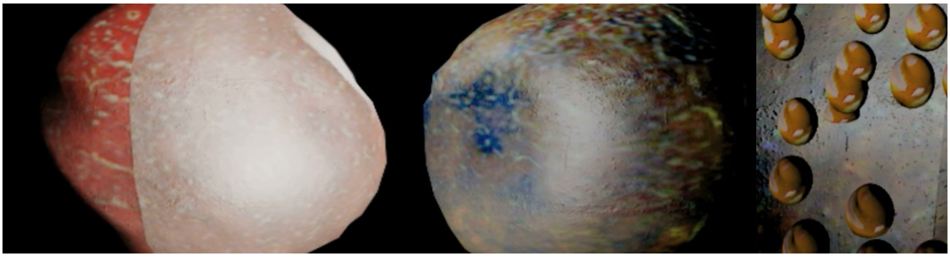

Fig. 6 Final model showing the decay sequence

Michael Vanderpleog studied growth and death through planting and growing grass, followed by depriving it of resources and showing its demise. This study of lifecycle became his focus and the concept for his study of growth patterns. This is also an example of a generative model but growth patterns are studied. A complex script had to be written in order to describe parameters that are random within a prescribed system.

Fig. 7 Time-lapse of grass growth and decay

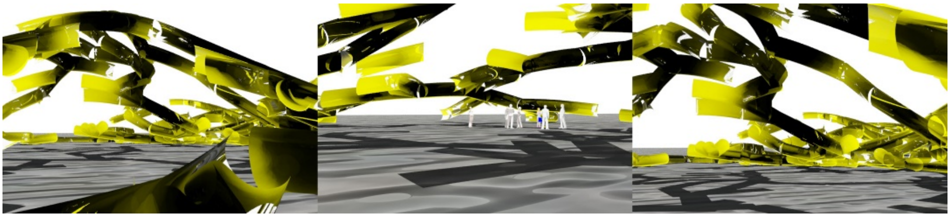

Fig. 8 Grasshopper model manipulated with automated growth script

Conclusion

Methods change as fast as they are developed and there is no pretense that anything proposed in this paper could be a singular solution, however there must be pursuit, testing, failure and experimentation in order for new technology to grow. According to Rivka Oxman, "concepts whose theoretical source is digital design are beginning to occupy a central role in current architectural language and discourse." (Oxman, 2008, p. 102) This statement changes the game for the way digital design is considered in the architecture curriculum and many frameworks for teaching digital design must exist in order for the discourse to have depth.

References

Burry, J., Burry, M. (2010). *The New Mathematics of Architecture*. New York, NY: Thames and Hudson.

Garcia Alvarado, R., Jofre Muñoz, J. (2012). "The control of shape: origins of parametric design in architecture, Xenakis, Gehry and Grimshaw. *METU JFA*. 107-118.

Guzowski, M. (2010). Towards a Zero-energy Architecture: New Solar Design. London: Laurence King. 124-146.

Krauel, J. (2010). *Contemporary digital architecture: design & techniques*. Barcelona, Spain: Jonqueres.

Oxman, R., (2008). "Digital Architecture as a Challenge for Design Pedagogy: Theory, Knowledge, Models and Medium." *Design Studies* 29 Great Britain: Elsevier Ltd. 99-120.