Binary Translation: A Positive Feedback Loop

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Abstract. *The proliferation of the computer as a digital design tool in architecture has allowed for the previously impossible rapid investigation of complex forms. Architects and students are borrowing ideologies and methodologies from other disciplines and utilizing computational resources in an attempt to generate unique form. This reliance on outside disciplines, while producing fascinating results, fails to consider the phenomenal properties of architecture achieved through the realization of the physical. Through a merging of these borrowed techniques from other fields and the traditional notion of architect as builder, two seemingly disparate conditions can be synthesized—ideally producing architecture that responds to questions of our surroundings and ultimately proposes new solutions to these questions.*

Introduction

This paper is about observations and experiences in teaching an undergraduate architectural design studio. The ideas have developed over three years of teaching and through my own recent education. The purpose of this paper is not to propose a methodology for teaching, but to propose a philosophy - a way of thinking. This way of thinking attempts to utilize digital design tools that have been used and abused for over a decade and bring them back into the realm of architecture. It attempts to reinvigorate the idea of the master builder in the education of an architect. It also begins to (re)define the architect in the modern era where the move to collaboration often blurs the line of the role of the architect - even erases their importance in the building process.

I do not believe an architect has to be trained in all aspects of the profession: construction documents, contracts, the writing of specifications, or even the specifics of fitting materials together. I do believe that an architect has to be taught how to think in order to make all of these necessary tools of the trade fit within the context or the boundaries of where and when the architect will be working or building. This training to think beyond industry standards and beyond normal conditions is what separates an architect from any other building related trade. This paper will begin to define the scope or the place where this differentiation should occur within academia.

For the purpose of this paper I will simplify the teaching of the design process into three phases. The first is ideation or conception. The second phase is the development of these ideas into something tangible. The third and final phase is the translation of those ideas and its tangible outcome into a form of architecture that can be inhabited. This paper will ignore many factors that I believe are vital during this process. Among these are site, program, and contextual conditions that can and should alter the design process. I leave these conditions as personal interpretations that manifest themselves into the design as individuality or artistic interpretation. I wish to concentrate instead on the thinking process involved in the design studio and how it can be altered to evolve design thinking and production. Specifically I want to concentrate on the translation from the second phase where an idea becomes tangible, to the third phase where that tangible product becomes architecture. It is this moment, this interpretation from the virtual to the real that I label Binary Translation.

Binary Translation is not a solitary moment. It is an iterative process that must navigate from one realm to the next in order to evolve and grow beyond the idea, beyond the form, beyond architecture. This iterative translation breaks the linearity of a typical design process by developing a positive feedback loop. A positive feedback loop that constantly reinforms and pushes the design process forward - reinterpreting it within the realm it performs in (digital or physical) (Wiener 1965).

The outcome of this phase is what can re-introduce the idea of the master architect. A master architect is one who not only designs, or originates the form, but understands materiality, constructability and follows their ideas into materiality and constructability in order to realize them in a physical form. It is during this phase that the potential for the invention of new materials, composites, new use of existing materials, new methods of construction, or even the (re)invention of machinery will find fruition.

Virtual

In order to understand this way of thinking we must define the phases that lead up to and through this philosophy. The initial phase, the ideation or conception of a project, is what has been defined as the virtual. The virtual can and is usually interpreted narrowly and in terms of the computer due to its misuse in the media and publications. For the purpose of these design phases the virtual needs to be defined much more broadly to include not only what happens within the computer, but also what happens during the moments thought becomes digitized. As defined by Therese Tierney, the virtual as "an architectural concept is imageless; it does not exist prior to its representation. Instead, conceptual thought evolves in a virtually formed, unfixed state and actualizes within expressive media." (Tierney 2007)

I accept the use of expressive media as a valid tool for the conception of an architectural idea or form and instead would like to focus on the moment where idea becomes architecture. Architecture is a built, physical object. If architecture remains virtual, either in the mind or in the computer, then it does not become Architecture. It is the translation from the virtual to the physical that makes architecture real.

Physical

The end product of an architectural process is a physical space that is inhabited by humans. This seems like an obvious statement, but it is the denial of the physicality of building that leads to the design of form that imitates nature, evolutional theory, or any other form derived from borrowed science. I am not saying that form cannot be created from these tools or disciplines but must be taken beyond the given result in order to be translated into a physical object that allows for human population or use.

The translation of the virtual to the physical, forces the architect to make decisions based on many criteria that architects have been dealing with for centuries; materiality, gravity, physics, scale and human interaction. Through materiality architects are required to look at material properties for compressive or tensile strength, manufacturing procedures for sizes, and craftspeople or machinery for how to use or shape the material. Architects must obey the laws of physics and gravity which do not exist in the computer environment. Issues of scale require architects to make spaces reasonable for occupation and building. The human interface requires floors to be level where necessary, for light to penetrate dark spaces, for air and people to circulate both horizontally and vertically. All of these issues have driven architecture for centuries and no amount of computational power changes that. It is the translation into physical form that first give a hint as to how this can (if it can) be accomplished. This translation is a vital step in the design of architecture.

Translation

I use two separate examples from a design studio in order to show the potential of Binary Translation as a pedagogical tool. These two projects occurred within the same studio but took different routes to get their results. These results are but the beginning of the potential of this process and have caused me to rethink how I teach digital tools in conjunction with an architectural studio. I am now forced to consider many of the points of translation previously discussed.

Digital to Physical

The first project began with a current practice of borrowing an idea or a set of rules from another discipline. This borrowing and use of other computational tools to serve architecture is a form of 'expressive media' discussed by Tierney and one that I accept as a form of ideation. The student used the study of the flocking of birds to inform a digital model with rules of flocking behavior. These rules directly influenced the limits or boundaries of the virtual object that was created. Rules that governed the flight of the birds and their relationship to each other in space, also governed the movement of created nodes within the software. As external or internal conditions of site, program or other architectural conditions were altered; these conditions were fed back into the system to alter or shift the nodes in space and in turn shift the nodes of the 'architectural flock.' Figure 1 shows a screenshot of the architectural flock as it

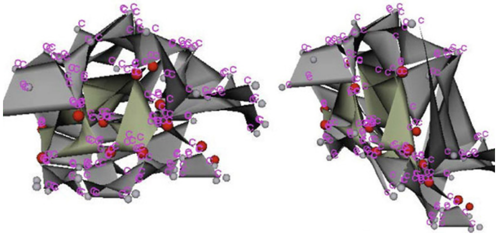


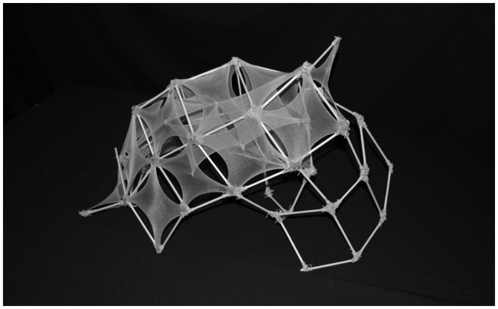
Figure 1
Digital model

exists in the computer.

This computational model created fantastic forms that did not have to respond to a physical world. The digital model surfaces had no material properties and could be bent, stretched or shaped to any form that the rules of the model forced them into. There was no gravity or mass to the model so it remained suspended within the digital environment and not liable to the rules of architecture.

After creating the digital model the student was asked to create a physical model from the digital model. It was during this translation where fascinating questions began to arise. The student was not given directives on how or what material to replicate the digital model with and was forced to utilize materials and tools that they were familiar with or knew how to use. This student chose to use a combination of wood rods, rubber bands, and nylon leggings at first (Figure 2). Upon realizing that the flexibility and thinness of the nylon was a material weak point in the model, the student decided to coat the nylon with fiberglass which took the shape of the nylon and dried to a hard surface (Figure 3). None of these materials are novel by themselves, but the novelty of bringing these materials together in a unique combination to replicate the digital world, led me to believe that the translation from the digital to the physical is a vital step for the creation of an evolving architecture and the invention of new potentials.

These techniques did not stop at the first attempt. The iterative process caused the student to bring knowledge learned from the physical world to the digital model which in turn allowed them to utilize alternative methods to a second and third physical model. The constant vibration between



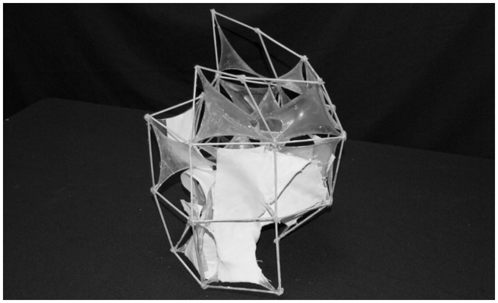


Figure 2
Wood rod, nylon and rubber band model

Figure 3
Wood rod, nylon, rubber band, epoxy and plaster model

the digital and physical informed all aspects of the design process and quickly broke what is typically a linear process.

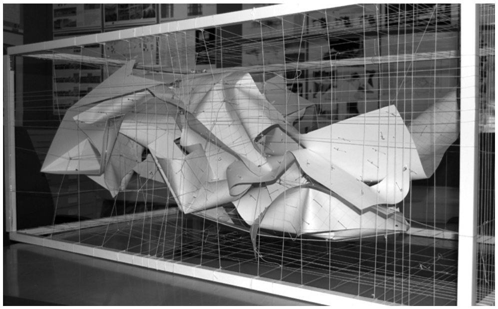
Physical to Digital

The second project took the opposite route of the first. The student was more comfortable with modeling physically so began by creating a large paper and cardboard model based on rules established through a two dimensional collage. The material choices of the model caused the student to make design decisions based on the properties of the chosen materials and on physical laws. There was an attempt to suspend some of these laws through a frame that housed the model, but the laws of physics still played a part. Figures 4 and 5 show the physical model as it was built.

The student was then asked to create a digital model from the physical model. During this translation the student was able to go beyond the physical properties of the model (paper and cardboard) and the laws of physics to alter or change the design to respond to the techniques used within the digital environment. An interesting result of this translation was that the student had assimilated the properties of the chosen material through trial and error by using it, and tried to utilize those properties while digitally modeling the object.

As with the previous student, this student continued to navigate between the digital and physical work, re-informing both models as they did.

In the end these two students did not produce work that I would like to call architecture in the sense that I have defined it. But their persistence and struggle between the digital and the physical led to the ideas in this paper. It is the ideologies developed from working with these students that I intend to explore in future design studios.



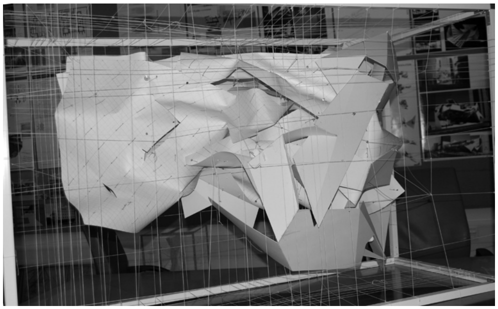


Figure 4
Paper and cardboard mode, view 1

Figure 5
Paper and cardboard model, view 2

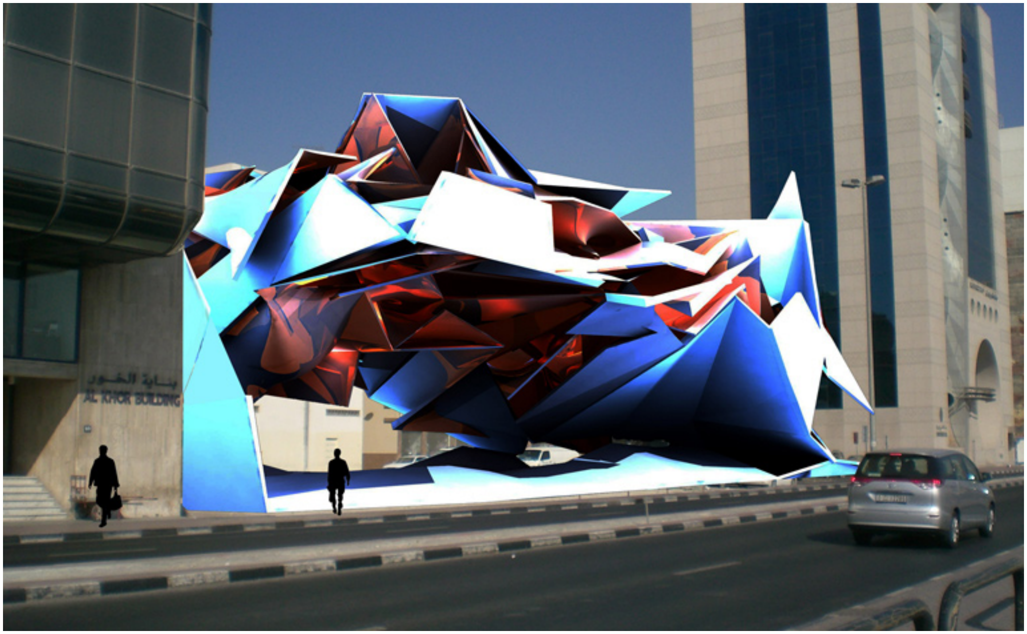


Figure 6
Digital translation of card-board and paper model

Challenges

There are many challenges with incorporating this way of thinking in an architectural studio: materials, facilities, and student knowledge. Some of these may be attributed to regional or cultural differences among students but I suspect these challenges are universal and vary only in degree of severity. Some of these challenges will become more pronounced as this way of thinking pervades studios and requires tools, machines or facilities to invent new materials or methods of working with them.

The first is a material challenge. Sourcing a variety of materials was difficult in the studios that I ran. Access to basic materials was a challenge and access to materials that are not as common became nearly impossible. This often caused the students to become very creative in material choices as was the student in the first example.

The quality of the school's work shop poses a challenge. A conventional shop is needed to deal with conventional materials but as the complexity of form or the invention of new composites - which could include a hybrid between conventional and digital fabrication - becomes common place, schools will need to rely on CNC tools in conjunction with traditional tools. At some point schools should begin to 'invent' their own tools by combining existing tools, or invent new ones with schools of engineering or commercial vendors.

A final challenge is a prior or existing (or lack of) knowledge by the students on fabrication techniques of any kind. Students from my school do not come into school with any working knowledge of tools, fabrication or the skills needed to make anything. While this is a disadvantage at first, the students lack of preconceived notions of building or making often became an advantage as they approached the problem from a unique perspective.

Conclusion

There are countless examples of the virtual as defined by Tierney throughout academia and even in the professional world. What is missing from the academy and is present in very few firms in the professional world is the translation of this virtual ideology into a physical reality. The few avant-garde firms that are testing the boundaries are limited by funds and clients. But these firms should not be taking the lead in this area. Academia should be the force that drives the profession and not the other way around as it is in architecture. If we truly want to utilize the methods of other sciences and fields of study should we not also emulate them in how the research of the academy is what pushes the profession forward?

Architects are masters of the physical environment. It is this concept that is often forgotten in academic design studies that choose to remain in the virtual. This is only half of the education required by contemporary architects. How the virtual translates to the physical and to materials is a vital step in education. In order to push the limits of current building technologies to accommodate advanced virtual simulations, the architect has to propose how to deal with those simulations in the built environment. The architect also has to begin to drive research into new materials and composites that will allow these virtual conceptions to become a reality. Without exploring how to do this the architect remains oblivious to the phenomenal properties of architecture - the properties that differentiate architecture from other fields.

Research should not only involve new materials. The current trends in digital fabrication should also be a driving factor into new research. We tend to take tools as they are offered and never propose new machinery or techniques. By teaching this way of thinking in school we are training students and future architects to demand more from their tools and materials. We are training them to think beyond what is in front of them and are asking them to develop or invent the tools or materials necessary to achieve what they want.

As architects we are quick to adopt the tools of others. Rarely do architects or schools of architecture take a pro active role in the development of their environment and demand more from those that they borrow from. It is the responsibility of academia to take the lead and begin to train architects and designers that evolve the profession and move it forward. Without taking this stance, the academic institution runs the risk of becoming extinct to a form of apprenticeship with firms that are willing to take the risks develop the necessary tools and techniques to practice their trade.

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