In-form: Towards a Design Science Revolution

Maria Vera[1], Jonathan Anderson[2], Ming Tang[3], Shai Yeshayahu[1]

Southern Illinois University[1], University of North Carolina at Greesnboro[2], University of Cincinnati[3]

Abstract

The late 1980's evidenced the start up of a few design corporations and academic institutions willing to devote time and money to engage students, faculty, and professionals in a decisive shift that propelled the development of digital design processes. Today, after two and a half decades of tantalizing with endless discourse about the inherent potentials and detriments of educating future practitioners with emerging technologies, the rest of the design world is pressed to grasp the expanding power of technology and dismantle previous measures of excellence.

This exigency occurred as hardware and software vastly shrank in size and exponentially expanded in computation power. The phenomenon acutely intensified the fact that, in time, digital design processes are becoming less about scripting or programming and more about the creative methods by which individual's extract, input, and output knowledge. The momentum is privileging a global design exodus from analogue practices to emerging design mediums at the precise moment when software is becoming extremely intuitive. Coincidentally, the information gap is narrowing, as access to data becomes affordable and ultimately permeates economically despaired places where intuitive problem solvers are ready to uncover knowledge that is relevant to their local needs[1].

The dismantling of cognitive divides due to socio-economic and infrastructural differences among design schools across the globe, is also allowing for a growth of collective intellect among design educators and researchers that are leapfrogging directly into the "design science revolution"[1]. Consequently, our paper demonstrates the steps we are taking to seize the moment and engage in teaching design processes based on technology. To start, the work is representative of three different design approaches taught in different university settings under by faculty members that are focusing on the pedagogic nature of the collectively intellect. Second the nexus of multiple schools and teaching techniques provides us with the ability to assess how each studio is tackling the same design problem from distinct logics and procedures. Third, the difference of delivery both in teaching and design outcomes provides us with a comparative study of the manifold ways to address the pedagogic mindset of our times. In total, the work serves for reflection as to: how and what we extract, inputs and outputs require to ignite sustainable design solutions?

Throughout 2010-2011, our briefs and exercises introduced students to methods of extracting, inputting and outputting data using the following menu:

Per-formative agents.
Human factor.
Per-formative activators.

The paper, ultimately, delineates student's work from a system of ideas that demonstrate how the process of extracting, inputting, and outputting data evolves into a rich parametric-thinking palate. The array of design principles applied, will also highlight how informational driven methodology leads to technology driven and sustainable design solutions.

Introduction

As the developed world begins to grasp how remote places on earth are intellectually connected and rapidly dismantling the cognitive divides of traditional socio-economic infrastructures, we as design educators are beginning to collectively connect and intellectually leapfrog into the design science revolution that is in part redefined by the goals of the Buckminster Fuller Institute, which seeks to aligned with Buckminster problem solving mindset when he said: *"The function of what I call design science is to solve problems by introducing into the environment new artifacts, the availability of which will induce their spontaneous employment by humans and thus, coincidentally, cause humans to abandon their previous problem-producing behaviors and devices. For example, when humans have a vital need to cross the roaring rapids of a river, as a design scientist I would design them a bridge, causing them, I am sure, to abandon spontaneously and forever the risking of their lives by trying to swim to the other shore [2]."*.

Our goal, like that of Fuller's, is to engage in developing intellectual and physical connections through design. To this end, our network system encompasses different branches of design like architecture, interior architecture, and fashion.

We work at three different universities but our aspiration is to discover the basis of a new linguistic competence for design. To do so, we are demystifying DATA and using it as a tool by encouraging students to use all aspects of the environment as an informational ground from which we can extract, input, and output any design solution. For this reason, during the calendar years of 2010-12, our programmatic goals for beginning design students at the graduate and undergraduate level focused on these principals.

In 2010-12, our students have been encouraged to extract data from a purely mathematical approach. The objective is to allow students to seek data from all forms and to digitally input their found data as parameters that may include: points, lines, or surfaces. The act enables each student to instantly realize the potential inherent properties in connecting the parameters. Students are able to easily understand how they can form parametric networks that not only develop complexity but also define the logic behind the designed solutions, a process of form finding and not form making (Moussavi, 2009) [3].

The following descriptions are not articulating the forms student's made but rather the methods they applied for extracting, inputting and outputting data.

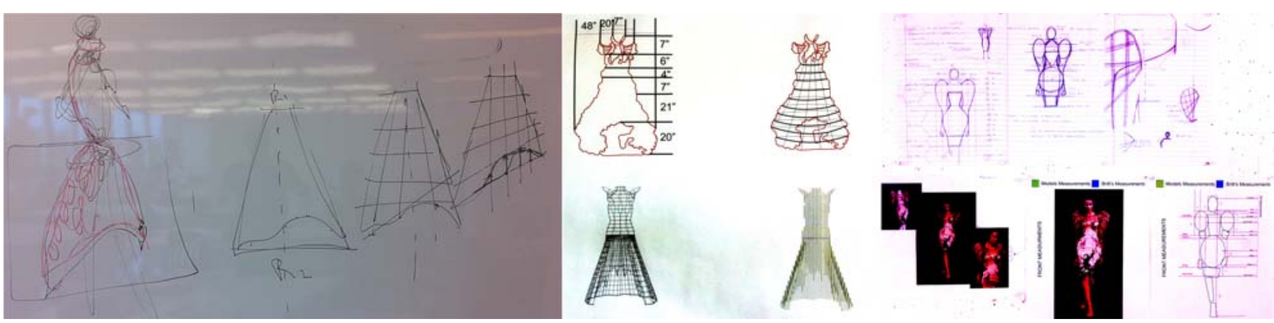

Fig. 1. Deciphering data structure and contextualization. Information is then extracted analyzed and discussed on the manner in which it may serve to inform an output. (SIUC, Fall 2011, Brittney Mount and Taylor Behl.

The project, *Anthropometric Branching*, introduced students to observing and extracting data from the human body. Students had to extract information by analyzing the anthropometric and ergonomic nature of the human structure. This exploration was fundamental to ignite the process of how to place points in space and link these points together to form data. The process was personal and simple, a playful framework for each student to engage in developing measuring techniques and in learning how to log it as data that would help them construct a body of information.

Yes, this agenda is rooted in history and it has everything to do with the awareness that humans are instrumental in structuring and developing all the knowledge that shapes our current environment. Learning how to digitally document the human body is not only contextual to the existing environment but a force for understanding how to design future interactive environments. Thus, even if the exercise seems brutally renaissance-nesque, especially when we recall how Leonardo da Vinci's detailed drawings of human parts and organs that later aided medicine, the goal remains fundamentally a utilitarian task. Furthermore, we can even acknowledge that this study is ancient like that of Vitruvius who prototyped the human body to specific geometric proportions or modernist like Le Corbusier's who standardized the body to fit into acutely customized living systems. Yet, for our pedagogic goals the human body is reduced to dots that aid the student to discover an interactive object that is structurally informative. Indeed, the locus of the exercise lies in the human structure and the various scales through which we perceive the world around us. This understanding allows for an examination of the ways movement and proportions influence designers into diverse design branches that can later inform multifaceted environmental objectives.

Conversely, while the exercise is seemly about the human body, the student is actually engaged in constructing movements and digital skins using divisions of mathematical proportions and related trajectories. The results are about how diverse skins embody an active body. Such outcome leads to the understanding of an anthropomorphic branching: a structure that is personified by simulating the motion and changing form of the human body. Thus, the exercise deals with specific body measurements as components and walking or climbing stairs becomes numerical data to detect common movements in 3D formats and the end result is not a garment but translations of structural subdivisions and gestures from an infrastructure of possible movements.

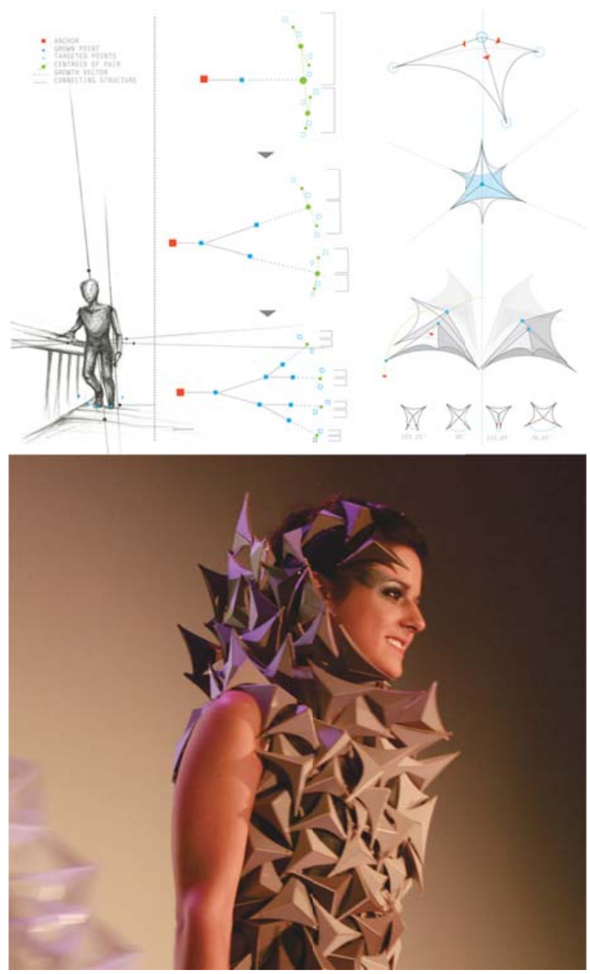

Fig. 2. Anthropometric Branching project. By student Laura Kimmel, University of North Carolina at Greensboro

While these branching systems are densely complex, like those found in the intricate networks of blood vessels in the lungs or other biological bodies they are basic properties of growth, subdivision, and organization and as such can be utilized to better understand individual motion and relationships with the environment we move through.

To Input Data:

Ephemeral Membrane was a project developed by second year students and provided them a platform to engage in to the act of re-composing data. The goal was to input a parametric network of points and lines, which tessellate to form a 3 dimensional surface. The student's learned to tessellated structures by first exploring how to push dimensional limits of flat vector geometry. They learn to invert digital data and as a result of this digital exploration a form was generated using order and symmetry under the confines of a simple equilateral hexagon. The exploration was ignited by using Rhino's grasshopper software to facilitate a relax control of points and to create a division of a hexagon in half. Once the ability to instantly appreciate the subdivided modular pattern emerged, the half hexagon was then built in the third dimension through a series of controlling central points, their relationships to one another and to the hexagon grid. The three different volumes create complexity in their own form and between each other yet, the language of how they are generated and fabricated is always the same. Each of the modular components was built as developable surfaces that could be unrolled and tabbed to create a flat laser-cut pattern. Students viewed this final assembly as a parametric network that directly responded to the logic behind the design.

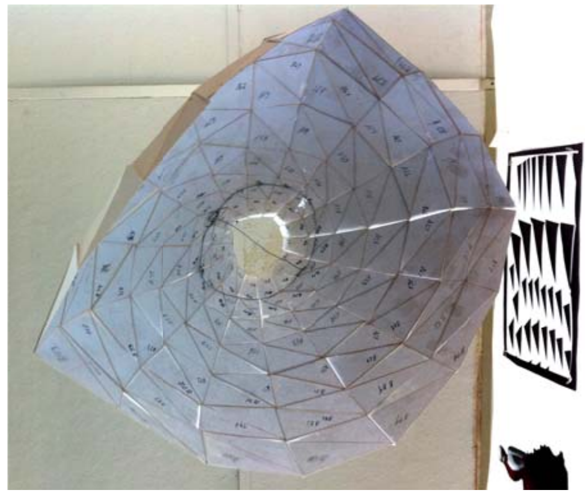

Fig. 4. Digital logic and its correlation to making (digital fabrication) using Rhino and Grasshopper. (SIUC, Fall 2011, Students: Soldner, Alexander C., Caron, Alyssa B., Eilering, Debra S.)

The Output of Data:

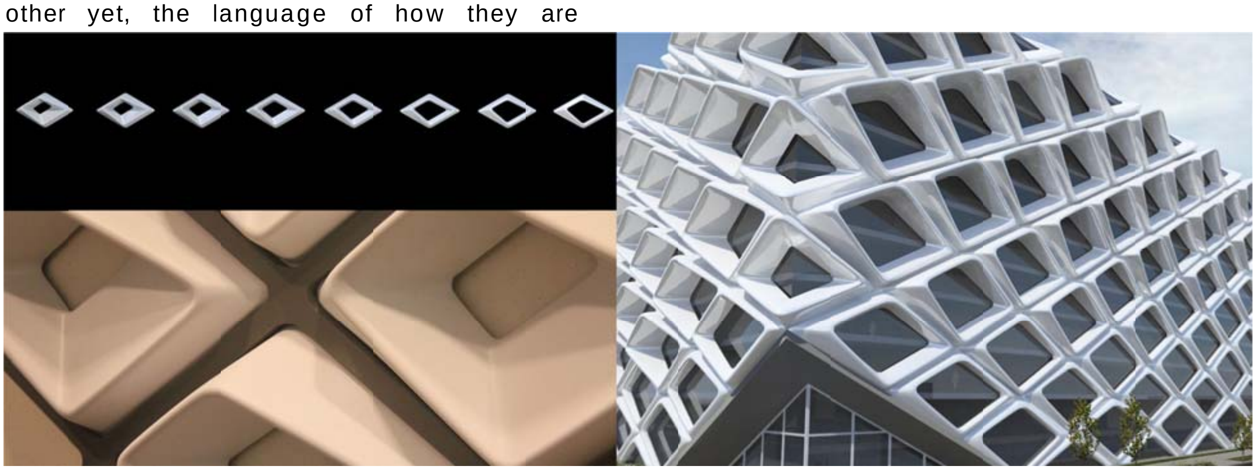

Fig. 4. SCUTA project. Adaptive wall panel. By student Drew Newman. University of Cincinnati.

In both the *Interlock Block* and *Scuta* projects, students learned to explored the generation of a modular unit by regulating a series of parameters and their relation to another in order to produce an output of organizational and spatial qualities that forms a systems which is directly influenced by the forms of geometry and fabrication methods.

Interlock Block was a basic exploration of parametric thinking where the translation of data/knowledge into a set of parameters defines order and allows for an exploration in a derivative process where operations and variables have a strict set of relationships to another. Historically, the concept of folding and tessellating in order to produce artifacts was greatly advanced by two designers/mathematicians/visionaries: *Buckminster Fuller and Ron Resch*. Their initial investigations explored simple orthogonal actions – fold, press, score, bend, cut, weave, compress, tessellate and unfold. This project used these innovators as a foundational study to drive form and develop a unit by manipulating a standard sheet of material with a goal of obtaining an artifact that responds to scale, proportions and altered perceptions.

Scuta[1], is a building paneling system that includes all the components that make up the shell or skin of the building. The skin therefore acts as an interface of sort, between the controlled space and the existing phenomena of place. Using natural influences from scales of reptile skin as the concept analysis, the goal of scuta is not only providing an aesthetic function, but also delivering performative value with regard to climate, ventilation, and energy consumption within the structure. The concept of *Scuta* was very "parametric" not only because of its modularity, but more importantly for its geometrical divergence based on the location on the animal body. This metaphor provided an interesting way of looking at the site, façade of a building, and the prototypical window components.

The parameters of each window prototype vary according to its performative function, which depends on its location within the envelope. A family of components used aerodynamics as a precedent for fabrication and design development process.

The design started with using Ecotect as a simulation tool to capture existing thermal and radiation values across the entire façade. Then the student created a paneling family in Maya with several parameters as drivers. Each component used sun azimuth angles to drive the form. On the south side of the building the components feature a larger extrusion at the top of the window to provide shade from harsh sunlight and delineate glare to the interior. On the east and west side, the component will have a larger extrusion on the left and right side of the component to create a similar effects as vertical fins shading. .

Conclusion:

The studies have multiple commonalities, although each approach seems to entail a different intellectual trajectory. Still the common aspects of this pedagogic approach are rooted in the emerging need for extracting, inputting and outputting data in order to engage in adaptive design solutions. The approach is therefore "seemingly" different, but the logic is the same. Behind each of the projects, the

[1] A Scuta (latin scutum, meaning "shield") is the bony external plate or scale, as on the shell of a turtle, skin of crocodilians, and some feet of birds.

assemblage of the parts speaks about the language of beginning design from the perspective of existing designed environments. We are not focusing in safekeeping exclusive computation or mathematical approaches; our interest are about the learning / teaching aspects that lie within the nature of the exercises; those that are attentive to the methods by which cognitive development occur so that we can promote end results that are based on logic and reasoning.

We don't teach software nor train technicians, we promote meditative thinkers that will seek to understand how to used software as a means or a vehicle for intellectual craftsmanship – the student's work is about the ideation and iterative process. The final output is viewed as experimentation. It moves past the technical notion and moves into the reasoning processing..

Notes

1 verS, Lecture Series 2011. Universidad Espiritu Santo.

2 Fuller Richard Buckminster. *Cosmography*, Macmillan Pub Co, 1992.

3 Moussavi, Farshid. *The Function of Form*. Actar, New York, New York, 2009.