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Conceptual furniture that appear in many movies can be a great source of inspiration. Unique artifacts are intended to create a sense of place within the physical and psychological context of the movie. Many science-fiction movies upgrade and expand perspectives to feature the technical nature of the background. Inside those films, intriguing furniture play a huge role to create the space and such different furniture designs. Imagining the specific characteristics of the designs that seem as though they belong in outer space, how do they contribute to the overall environment?

Current furniture design spans a wide range of genres, and many recent movie films describe many new spaces with existing furniture. These designs illustrate a completely different environment, especially in science-fiction films that take place in outer space. The current technological trends affect the ongoing development of furniture design, and this thesis explores recent, past, and current trends to imagine a potential trend in the furniture industry. Therefore, my design research will find elements that explain future design and feature a body of work examining the next future furniture trends. I will develop a design process that integrates new technologies and making of furniture pieces.

REASEARCH OF FUTURE FURNITURE DESIGN: EXPLORING TRENDS AND AESTHETICS IN FUTURISM

by

Sookwang Lee

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the Faculty of The Graduate School at
The University of North Carolina at Greensboro
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APPROVAL PAGE

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First and foremost, I thank and praise my savior Jesus Christ for His care and wisdom during this time. With faith, I was able to find vision and purpose and was blessed to finish my thesis.

Starting my studies in UNCG, it was a happy turning point for me to study once again in an academic environment and make my way in my area of interest. It felt awkward to return to school, but the recognition from my committee members was helpful to me to achieve my goals. I would especially like to thank Professor Tommy Lambeth on directing my thesis with care, Professor Stoel Burrows for always giving me opportunities and having me fully motivated and inspired, and Professor Amy Powell, who posed desirable solutions whenever help was needed. My sincere gratitude goes to the members for discovering my potential and having faith in me. I appreciate the many other professors and faculty members who gave me the chance and honor to work with them.

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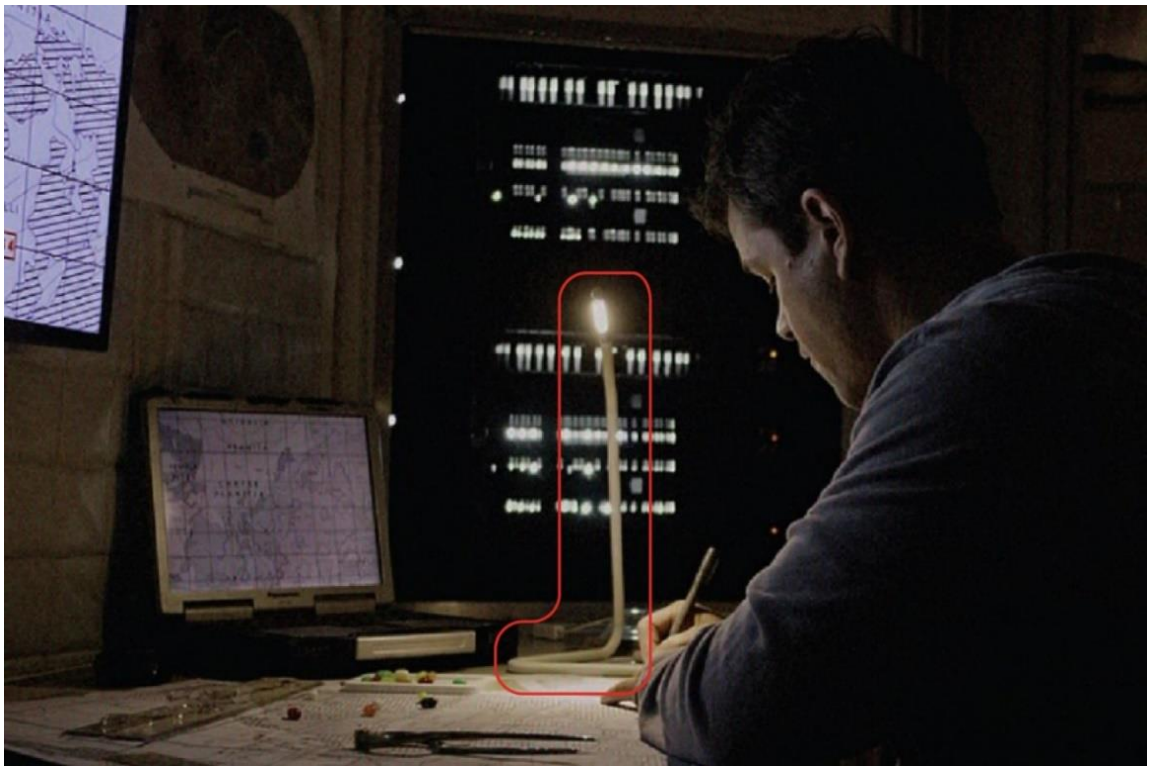
CHAPTER I

INTRODUCTION

This thesis work is inspired by the movie, "The Martian". What caught my imagination was the background where a linear lamp was on top of the desk that was of a very technical design. I wondered: what makes this setting seem so technical and futuristic? Furthermore, how does highly technical furniture design influence the environment?

Figure 1. Ikea Lamp (www.foxmovies.com/movies/the-martian)



The linear lamp from Figure 1. is a well-known company's product in which the lamp appears with a different feeling in the film. This is because the design has a uniqueness of futuristic elements, but also it matches well with the other surrounding products. The futuristic design of the lamp suggests an outer space environment as the lamp is supporting and interacting with the background. In addition, what matters the most would be a sense of survival where high-technical devices are crucial in desolate situations. The users would most likely utilize those machines for themselves to have high-technical support. The directors of futuristic movies use designed products to enhance the future concept. The article "*Tour the Out-of-This-World Sets of The Martian*" references NASA for high-tech knowledge and functional aspects for the scenes (2015). High-technical designed products create new environments with functional purposes. Accordingly, technology will affect furniture to become more creative in design. High-technology furniture has been designed with emphasis on functional aspects. For example, dentist chairs and airline seats have a clear purpose on how the design of the chairs has been made: considering the users. The design is more focused on the functional uses rather than the aesthetics. These practical furniture designs are satisfying in the context of treatment or comfort on long flights.

I have focused my thesis work on the development of furniture in the context of futurism, especially current settings that are themselves futuristic in nature, like airports. As part of the research for the development of my body of

work, I looked at the work of Zaha Hadid, especially her firm's design of the new Bejing airport. Her futuristic design vocabulary of materials and forms inspired me in the development of my own work. I envision my own work contributing to the advancement of contemporary furniture design, integrating technology, digitally-generated forms, and the human interface with new design vocabularies.

Background

What we call lines, surfaces, and forms are design components with which designers strive to make new formations. Designers are to create new formations based on functional purposes. As new high-technology appears, furniture designs are sometimes developed on the intent of functional usage or sometimes dependent only on aesthetics. Although high-technology gives changes to the industry, furniture design is considered with the object’s functionality, manufacturing, ergonomic interactions, and other various aspects.

Furniture are designed with many tools and one of the recent changes are methods in using computers. The computer is an essential tool for designers to utilize, imagine, create, and fabricate products like furniture. Designers will imagine and describe the design by using computer systems and controlling the elements with certain rules. Basically, computers were calculators, not a tool for realizing imaginations. A few decades ago, human designers would come up with an ideal design, but the limitations of computers and programs restricted the designer’s vision. However, nowadays, computer-based designs are used in

diverse contexts, and moreover, design is becoming more of a partnership with human designers. No computer can replace human designers, but there will soon be the possibility that new designs will rely more on computers than humans.

Computation design has been emerging in the past few years, and computational modeling has become a new paradigm. Sometimes, designs formulate unpredictable features through programming and making complex formations. It has been said by Kostas Terzidis that design is a mental process to strategize in the most efficient, attractive, and meaningful way. However, computers are taking these elements to address the design process to make eccentric formations that human designers cannot so easily create. (Permutation Design, 2015) He also mentions an example that patterning is one part of design that human designers have created and continuously utilized. The repeating shapes are the elements that make the patterning, and unification creates one whole design. Even though the shapes become simple, designers have to predict the continuous formation in order to complete the design. Presently, the range and variety of newly generated patterns have been expanded due to increased computing power and software innovations. Predicting patterns, are now skills that are better performed by the computer with programing. It is possible to create patterns and moreover, complex forms much faster and much easier for the designers to save time and effort. The dependency on the computer is rapidly increasing even for furniture designers. Based on the projects that I have

created, my work will explore many diverse methods with diverse tools, and they will show the future furniture design.

Theory

Throughout the history of design, predicting the design of the future was always a task that designers have to accomplish. Even nowadays, designers have to research and make assumptions of the design in order adapt to the market. Future design sometimes becomes an art in itself when designers develop elements that cannot utilize the technology of their times. Imagining things that don't exist and realizing them is one beginning philosophy that future designers seek with their given background. Then, we ask ourselves, "What is our background to predict the next future design?" Before we get to that question, we have to figure out what the definition of future design is in order to understand the background. Therefore, my thesis hypothesis relies on three fundamental principles of future design.

The first future design principle is functionality. When new inventions are made, new products appear with new functionality. "Form follows function," an edict associated with Modernist Architecture and Louis Sullivan in the 20th century, still maintains currency with contemporary products. A simple example is the smartphone. When comparing past cellular phones with current smartphones, the biggest difference is the touch screen. Touch screen

technology has greatly influenced the user interactions, revolutionizing the way phones are operated and how we communicate.

The second principle of future design involves the perceptions of historical developments relative to societal trends and narratives. The knowledge of design has been linked with various time periods of art movements. The names of each historical period represent significant events or trends occurring in society at that time. Mostly, the labels of the periods have involved the transition of time and the different types of styles, resulting in the name of each era. The industrial revolution would be a good example where industrialization provided the manufacturing industry with machinery, resulting in automation of production. This has not only influenced changes in the values of the outcome, but also the perception of manufacturing. The perspective of producing has changed with the word “auto-magical” leading to technological innovations. Our current understanding and belief in manufacturing and machining have made us familiar and comfortable with new technologies and new designs.

The last principle of future design is aesthetics. The visual design elements that designers create make it seem to look like future design. New technologies and materials enable designers to create forms and surfaces that were extremely difficult and expensive to produce in the past, resulting in design that appears futuristic… beyond current capabilities.

My hypothesis for this thesis is based on the three principles of future design that I have articulated: functionality, perceptions of history, and aesthetics. Looking into the future requires understanding of the present and analysis of the past, especially how we have historically looked at the future.

Anticipating technological development based on the past and present context of societal progress is central to the body of work that I have developed. Focusing my efforts on the design of furniture for airports, in particular the new Bejing airport designed by Zaha Hadid, has enabled me to limit the context of design to the necessary futuristic settings that airports and air travel represent. I have specifically explored the integration of furniture with the architecture: floors, walls, and ceilings.

Definitions

Future Design - the following design period after the present time

Futuristic Design - having the concept or the characteristics of futurism in design

Background - the circumstances or situation prevailing at a particular time or underlying a particular event.

High-technology - advanced technology different from the past

Space-Age Concept - began in 1957, a futuristic concept considering outer space

Emergence - when the world moves from one to another with less change.

Biomorphic - having a natural or naturalistic form

Biomimicry - man-made objects or systems imitating nature in form, system, and process

Algorithmic - computational analyzing and mathematical thinking

Body of Work

The three principles of future design helped me to navigate how and from what point I should initiate my studies. I have strived to explore forms, surfaces, and materials that express a futuristic aesthetic through the body of work, and I began with my research in airports.

In particular, I was inspired by the work of architects Zaha Hadid and Eero Saarinen in their design of two seminal airport projects: the TWA Terminal in New York by Saarinen and the Daxing Airport in Bejing, China by Hadid. Their work provide visionary precedents of futuristic design despite the fact that the projects were designed seventy years apart. The integration of the furniture within the architecture (floors, walls, ceilings), the curvilinear forms, and the sleek materials in their work were of special interest to me.

The study of furniture is my main focus, and I am interested in the way of how futuristic concepts are applied to the design to create a future furniture. With the Chaircase project, I experienced the full process of producing a future concept chair with computational production. Utilizing high-tech design software and bringing the models to computer-aided machines was a new experience for me in manufacturing high quality design.

The collaboration project with neighboring school students was to design a façade for a parking garage. Mainly, the study focused on patterning and applying those patterns to the façade. Further, the design was created in real scale so that it could be built in reality. There were many considerations and strategies that I had to make for the various issues that appeared in the practical designing process. Still, it was a working experience for me to create an actual design figure. With all these opportunities, I was able to explore how my body of work could represent future design.

CHAPTER II

REVIEW OF THE LITERATURE

Purpose of the Study

Throughout my research, inspiration came mostly from movies and video recordings. The literatures that I reviewed were creations and artworks related to futuristic themes. The following films identify potential futuristic elements of aeronautical aesthetics or outer-space products that exist in the environment. Aside from the analysis of future designs in films, other literatures describe various future settings.

The theoretical portions are referenced from books in order to listen and learn what the author said. Each author's perspective in futurism helped to navigate the direction of my research. In those perspectives, it was important for me to consider the philosophy of how they influenced their time with futuristic design. The information contained methods on observing and applying futuristic design to contribute to my thesis studies.

The Martian

This film had a specific product, a lamp, by which I was inspired. The linear shape of the lamp design was so intriguing and unique that a question.

came to mind, “How does the lamp design contribute to the environment to look so like Mars?” The actual product was used by the main character each time the action of scientific calculation occurred. In the moments he was studying, there were a laptop, a monitor, machines, and many other devices with it.

Looking closely at the design of the laptop, monitor, and other products, they were somewhat different from the other products that we see normally around us. In order for the environment to feel more like it was in outer-space, futuristic design rules had to exist according to the aesthetics of the environment. In fact, in the article “*Tour the Out-of-This-World Sets of The Martian*” by Elizabeth Stamp (2016), it is explained that the spacecraft was designed in an octagonal plan, and the reason was to amplify the efficiency of the interior as much as possible. Each facet functioned as separate rooms, such as the kitchen wall, the botany wall, bedroom, or the geology wall, in relation to the octagonal space. Articles and still-cuts of the movie were important to reference and observe the given design evidence. Below is a list of the products that appeared on the movie set and their characteristics.

Figure 2. *The Martian* (www.foxmovies.com/movies/the-martian)

Table 1. List of Inspirations

	Environment	Product	User or User Experience
The Martian	None oxygen	Shield (material)	Modular
	Butterscotch yellow sky	Solar panels	Uniform
	Machinery walls	Monitors	Compartmentalized
	Lab interiors	Lighting fixtures (lamp)	Efficient
	Zero Gravity	Functional Walls (bed)	Simple
	Triangular structure	Doors	Functional
	Desert	Uniform	Sustainable
	HVAC and Pipes	Oxygen tank	Patterns
	Temperature Control	Computers	Automatic
	Containers and Shelves	Circuits and Buttons	Electricity

In the article, Elizabeth Stamp (2016) mentions a production designer named Arthur Max. His task was to create the landscape of Mars, high-tech atmosphere of Hermes spacecraft, and other designs. The concept of the

spacecraft was designed with the aesthetics of nautical and aeronautical design. Referring to the color and light qualities in the movie, Max describes his approach:

> In *The Martian* (2015), the color palette is white and black and silver and gold and orange. Why? Because those are the colors that are functional and practical to do with solar and cosmic radiation shielding, and the materials that are to do with weight and strength and tolerance of extreme temperature. So there's always that. People will start adding color because they like color and they get bored with the same palette. But if you look at the movie, I mean even the planet is black and orange. (2015, IMDb.com)

Max also mentioned NASA as a reference. The collaboration with NASA provided various sources to assist in futuristic design. In addition, he stated,

> We found a very interesting glass geodesic exhibition building, which is nicknamed the Whale because it had a kind of a linear asymmetrical roof. That's where you see the mission control and some of the other spaces, which had very cutting-edge raw concrete walls and polished floors. (2016, Stamp)

In this case, the author has also analyzed the elements that creates futurism, according to the article, the means of "high-technology" comes from a scientific machinery-based environment that refers to the advanced development of technology.

The Jetsons

A referenced animated picture was a futuristic cartoon called "*The Jetsons*," and this cartoon was selected for two sources of inspirations. One is

the time period when the cartoon was produced, the 1960's. It was one of the most successful animated series, and Hanna-Barbera Productions had created the cartoon based on the theme of outer space. The cartoon's vision of the twenty-first century was predicting how problems would be solved in the future. According to the article "*Jetson - the Family of the Future*," it explains how the illustrator brought ideas that were way ahead of the time. The cartoon's main message consisted of possibilities and understandable situations that we desire in regards to the future. In the article, *"50 Years of the Jetsons: Why the Show Still Matters (2012),"* it was said that the inspirations were not new ideas in 1962, but the cartoon was successful with adjusting the inventions to match people's perspectives. This means that each person had different expectations of the future. The philosophical approach to why and how we get to the future was something that I needed to further consider.

The time setting of the cartoon targeted was 2025. Everything that people believed futurism to be at that time were flying cars, floating buildings, and so on. 8 years remain, and soon we will reach 2025. The technology has not yet advanced to realize these ideas, but it is assumed that futurism cannot precisely fit in the matter of our prediction. According to the article, the cartoon led to the golden age of futurism. This golden age of futurism included the visionary development of retro-futurism which also led to Disneyland's Tomorrowland, world fairs, trade shows, and space-age automobile design.

Figure 3. *The Jetsons* (https://youtu.be/2m7szptyYPY)

The article *"Mid-21st Century Modern: That Jetsons Architecture"* by Matt Novak (2013) mentions the architectures built in real life under the influence of *"The Jetsons".* This cartoon inspired many artistic styles to become real even to this day. The architecture that came from the cartoon is described by Novak as a 'Googie style' or 'Chemosphere', in which the cartoon's aesthetic intension was to search for a "mid-twenty-first century modern" design. This design is a reflection of a vision of the future, but even more so, it is the reflection of the "Space Age" design from the 60's. Therefore, the article is inferring that inspirations of futurism came from space-age design.

Méliès Le Cinèmagicien: Méliès's Trip to the Moon

I referenced this motion picture, which is a documentary about Méliès's motivations toward film-making by Matthew Solomon (2011). What is so intense about this film is that a magician named Méliès, also a filmmaker, had created an entertainment show for the first time about going to the moon in 1902. Eventually, the attempts of Méliès to travel to the moon became the base of technology to create films. The documentary explains why magicians have tried to think out of the box to make cinematic imagination. According to Solomon, entertainment was mostly popular science and not fictional interests, but this has also influenced astronautic theory later on. There is a core relationship between thinking and exploring the future to make it into real life. In the documentary, the film explains,

> The surface of the moon is painted on canvas supported on hinged props. … A stiff rod joins the hinges and forms the horizon.

These fictional elements have been created using existing objects with the imagination from magical inspirations and customary sources. In the film, Méliès mentions,

> What does it matter if ‘A Trip to the Moon’ does not tell the same story and clearly does not take place in the same context or in the same historical period!

Amazingly, this was an unusual thought to think at this time period, and it was

possible for him to venture into the realm of amusement parks. Despite his unrealistic philosophy, the detail of his work still describes deep consideration of specific works, such as telescopes transforming into stools or cannons and 300 kilograms of gunpowder. Imagination became the invention of films. Therefore, this documentary describes how the first movie was filmed with the desire of an impossible idea but having the unexpected to come true.

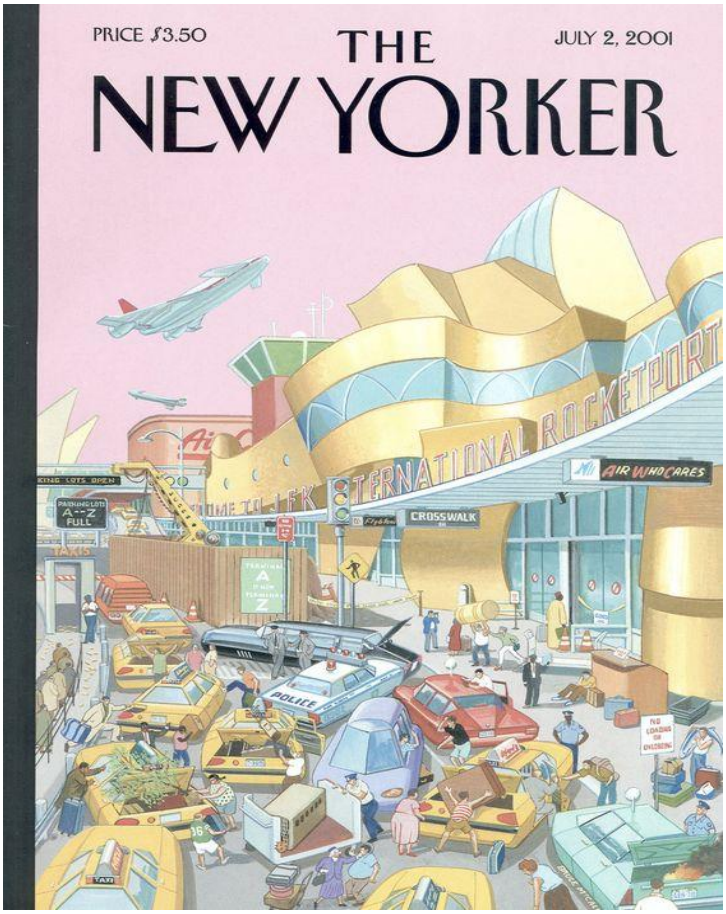
What is Retro-futurism?

Retro-futurism was necessary to look over while observing futurism. This is an art-movement and is stated as an old tradition of futurism. In other words, people have continuously anticipated the future like they do today, and early in the 1960's, technologies that were dominated by and dependent on science and war were utilized. This is how future was predicted in the earlier era. From the article *"Retro-futurism: 'Captain America' wrestles with central Marvel Comics dilemmas"* in 2011, the author Eric Pape mentions one of the famous movies from Marvel Comics, *Captain America*, and the background of that movie taking place in the retro-futuristic era. The aesthetic comes from World War II with cars, tanks, and aircrafts that represent mechanical machinery designs. Futurism in that time period refers more to flying machines combined with science, which feels awkward and almost laughable today.

Artist Bruce McCall is one of the creators of retro-futurism, and he called his own artwork "serious nonsense." This is because his illustrations come from

ideas imagining things when he was a kid. His sense of skill creating retro-futurism comes from the hilarious imaginations and bringing it to a piece of artwork. Remembering the past and predicting the future refer to nostalgia, and this is one idea to have inspired the imagining of the future. Unfortunately, Bruce mentions nostalgia as a useless emotion for humans. However, his skills and his achievements made retro-futurism, and the references have informed me on how the past considered futurism.

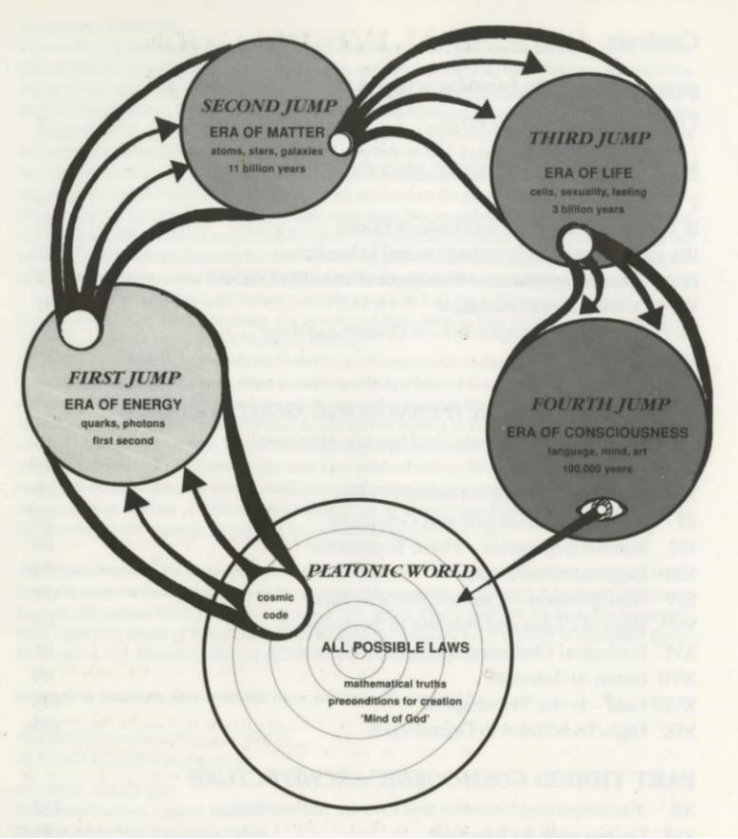
Figure 4. Bruce McCall's Illustration (https://condenaststore.com/featured/jfk-international-rocketport-bruce-mccall.html)



The Architecture of the Jumping Universe

This book by Charles Jencks (1995) was referenced for guidance on critical thinking of how to accept the next generation. The mechanism of his process in architecture provided the perspective of thinking in furniture design. The author of this book mentions that architecture has created history over time and each sets a generation, a world where architecture reflects the present time period. The following architectures implicate the culture in that period of time, which forms a distinctive universe.

Figure 5. Four Jumps to Consciousness (*The Architecture of the Jumping Universe*, 6pp)



This book explains the four jumps that were predicted from the existence of the current generation when considering the general history of the world. This indicates that acquiring the knowledge of transitions is essential and that moving from one period to the next is a mystery. Therefore, thorough research with rational analysis is needed. From a designer's perspective, I applied this research to understand what the causes and laws are that develop from this transition and how a trend appears. “Emergence” is illustrated by the author as the big jump when our world moves to another world with less change. I learned how architecture has accepted the emergence, and I have applied its philosophical method to my research and subsequent body of work.

The Permutation Design

The intent of this literature is to describe a new alternative paradigm that comes from designers and computational processes. In the book, it mentions “The Myth of the Genius” in which human designers are explained as a “gifted individual” and also outlines consequences that of contemporary design. Later, the book moves on to give the definition of permutation: “an ordered arrangement of elements in a set.” The logic of permutation is based on computer assistance, and computers are a possible solution to design as time goes by.

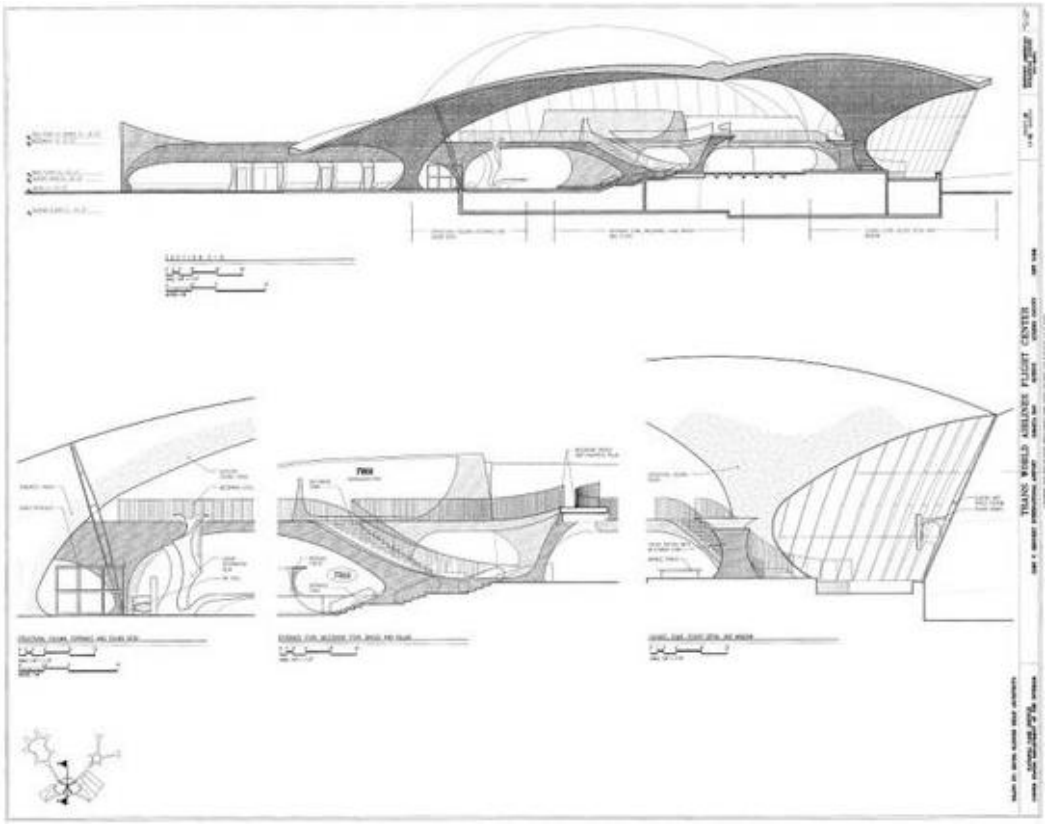
I have referenced the author’s thought about the future. The author mentions that computers are performing much better than the past, and the role of the human is more dependent on computers. It was pointed out that the

changing relationship between humans and computers will be important in the future. For instance, the area of advanced software will assist the designer to break down complex design problems and will direct the designer to better solutions. The computer's task will become larger than that of humans in the future, and designers need to have further knowledge. According to this literature, the potential of computer technology will amplify designers to create more innovative and new designs in the future. Therefore, philosophical approach to future design refers to potential values of designing in the relationship between humans and computers.

TWA Flight Terminal

The terminal was designed in 1962 by architect Eero Saarinen, and he is well-known as a futuristic designer, who creates non-linear designs. Non-linear does not always mean future design, but in the sense of the 60's, the curvy structures were built representing a new concept. The concept of the airport was to give a soaring expression where the forms were designed as wings. From this architecture, I tried to search for the futuristic design elements by comparing it with the Beijing Daxing Airport.

Figure 6. TWA Terminal Sections and Details
(https://kr.pinterest.com/pin/366691594635440650)



Beijing Daxing Airport

The Beijing Daxing Airport by designer Zaha Hadid was the first airport to study about. During the research of her futuristic design philosophy, I discovered that her designs focused on non-linear shapes and forms similar to Saarinen. The Beijing Daxing Airport has become a contemporary precedent for futuristic design aesthetics, and the design techniques that create the airport. I also studied other examples of her works to reinforce the observation because I had to imagine the other areas of the airport in relation to the design of the

atmosphere. This led me to the extension of studying and making conceptual drawings of the interior of the airport.

Figure 7. Beijing Daxing Airport Interior (www.zaha-hadid.com)

Biomimicry in Architecture

Biomimicry is a concept that has been recently utilized in architecture and various fields. Exploring answers from nature has been done earlier, but biomimicry is a different approach in regards to nature's form, system, and process. Author Leonora Oppenhiem (2008) mentioned that biomimicry is different from biomorphic, and it is not just imitating the form; it is more effective in an analytical way. In my design methodology, I used biomimicry as a design concept and derived the design of airport furniture from the form of a fern. The unfolding characteristic of the fiddlehead fern inspired the curvilinear form and

sectional modularity of the bench seating that I designed. Like biomimicry in architecture, I found potential in future furniture design as well.

Design at the Intersection of Technology and Biology

Similar to biomimicry, the lecture from Neri Oxman was another inspiration for me to know about computational design. She is a designer who uses technology and biology together to create high-resolution compositions with computational design. Her works utilize and interact with nature to find a biological manufacturing system and create complex forms into an output. For instance, one of her projects is designing capes, skirts and helmets made out of ground shrimp shells. By combining the natural source with chemical properties, the formed structures can be used as a natural plastic. Another project was building a pavilion using silk material. Imagine thousands of silkworms building a three-dimensional cloud formation, but would this even work? By analyzing their behaviors and the interactions in different environments, the silkworms were able to make flat cocoons to patch up the structure of the pavilion. I have learned that there is a potential for entering a new age of design, and the complexity of manufacturing is not an ideal when we are able to create anything, even inspirations from natural formations. (Neri Oxman, 2015)

Figure 8. Silk Pavilion (Neri Oxman & MIT Media Lab)

Summary

There were doubts about the right direction to follow in the beginning steps of the research regarding the questions “What is futurism?” and “What are the futuristic elements?” The past ideal thoughts of futurism were somewhat developed over many historical periods, and they had different perspectives with different backgrounds. In the current time period, the new future will appear with new technology but with the knowledge and the experience of our past. Neri Oxman asks in her speech,

> Why was computational design not possible 10 or even 5 years ago? (TED Talk, 2015)

and she answered that the time where we live is a rare time in history where designers can access different types of fields to generate all different kinds of things. Charles Jencks refers to “jumping to the next universe” in his book of the same title as the emergence of the next generation with the next trends. (1995) Bruce McCall is still, at this time, imagining a future with the memories of his early childhood to illustrate hilarious futurism. (TED Talk, 2008) There are various possibilities of future and many different perspectives that can possibly come to life. I would like to unite all these considerations and build up the next future design trend to the research of furniture design based on the body of my work.

CHAPTER III

METHODOLOGY

I developed my body of work using an iterative design process. Drawing, modeling (physical and digital), and prototyping were all utilized to develop the works. Using my preliminary research (airport precedents, illustrative movies, biomimicry, design theory), I produced a series of drawings and models for the design of airport furniture that explored the idea of a futuristic design vocabulary. Curvilinear forms, modularity, integration of furniture and architecture, formable materials, and digital fabrication became the focus of this futuristic vocabulary.

The beginning of the research focused on airport precedents and studying how airports embrace futuristic aesthetics. Analyzing airport environments and the design philosophy of certain designers made concrete the specific characteristics and trends of futuristic design. I chose to focus on airports because of the inherent technology of air travel, the ever-changing human interface with travel schedules, the rapid interchange of cultures, and the constant updating of airport designs.

Airport Research

Before going into airports, I had to determine which specific airports I should be focusing on and what elements I should be observing. There are

tremendous numbers of airports and fabulously designed airports all over the world, and in a recent article written by Ross Bryant in 2016, ten amazing airport designs of diverse sizes and technologies are illustrated. All airports that were mentioned in the column had their own unique design with different backgrounds and environments. It was a deliberate decision for choosing a certain airport that fit appropriately into my research. Among the existing airports, I wanted to research a more historical airport famous for futuristic design, which was the TWA Flight Terminal. Another airport that caught my attention was the Beijing Daxing Airport that will soon be built in 2018.

Observing the environments of the TWA Flight Terminal and Beijing Daxing Airport was part of the first studio project. The two airport terminals were compared with each other using precedent studies. The comparison illustrates basic information: name, designer, date and type of construction, and location of each airport. What was more important in this observation was the different language used for the aesthetics and functionality.

The TWA Flight Terminal was built in 1962 by the designer Eero Saarinen, a Finnish designer. It is one of the oldest airports that exists today and has the powerful look of the “Space-Age” concept. This airport was designed to be a distinctive and memorable structure, and by its appearance, the soaring formation was meant to express the romance of flight. (Figure 9.) Meanwhile, the curvy forms were difficult to construct; however, the terminal has now become a landmark of futuristic design that still inspires many designers. According to one

of the articles from CNN (2015), the TWA Airport design was frequently dealt as the worst national airport, but it is well known as a masterpiece in the artistic side. Soon, it is planned to be renovated into a historical hotel that will represent the old traditional futurism.

Figure 9. Exterior of TWA Terminal: Soaring Concept Formation (www.6sqft.com/wp-content/uploads/2015/09/twa-flight-terminal interior.jpg)

Most intriguing for me was the interior of the place. The interior was also of a futuristic concept resembling the curvy exterior but with the structures and furniture integrated into the building structure. The solid concrete rises up biomorphically from the floor to create seating integrated with the building form. (Figure 10.) The red fabrications were installed with the following integrated formation but also in a curvilinear shape.

Figure 10. Interior of TWA Terminal: Integrated Furniture (www.6sqft.com/wp-content/uploads/2015/09/twa-flight-terminal-interior.jpg)

The construction of the Beijing Daxing Airport (Figure 11.) is not currently complete, but when it is finished, it will become the biggest airport terminal in the world. Due to the delay of the completion, only few of the images were opened to the public on the Zaha Hadid design firm website. With those given images, conceptual sketches (Figure 12. 13. And 15.) were drawn as a prediction of the interior. The dimensions including the height, capacity that holds the amount of aircrafts and people, objects and furniture, and functionality of each area were all considered in the sketches. The important fact was to figure out the population that will utilize this massive place, and I had estimated the amount of people by comparing with the Dubai International Airport analysis in Figure 14. One reason

I referenced this airport was because of the available research data that was an open source to the public. The other reason was that I had recently been to this airport and experienced the overall atmosphere to include in my research.

Figure 11. Exterior of Beijing Daxing Airport (www.zaha-hadid.com)

Figure 12. Research of Capacity in Beijing Daxing Airport

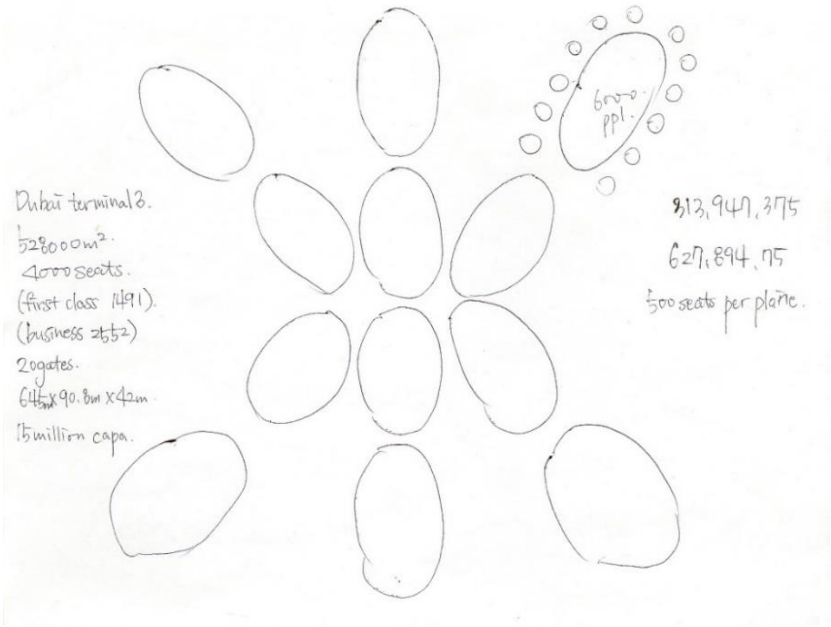


Figure 13. Conceptual Drawing: Floor Plan of Terminal Section

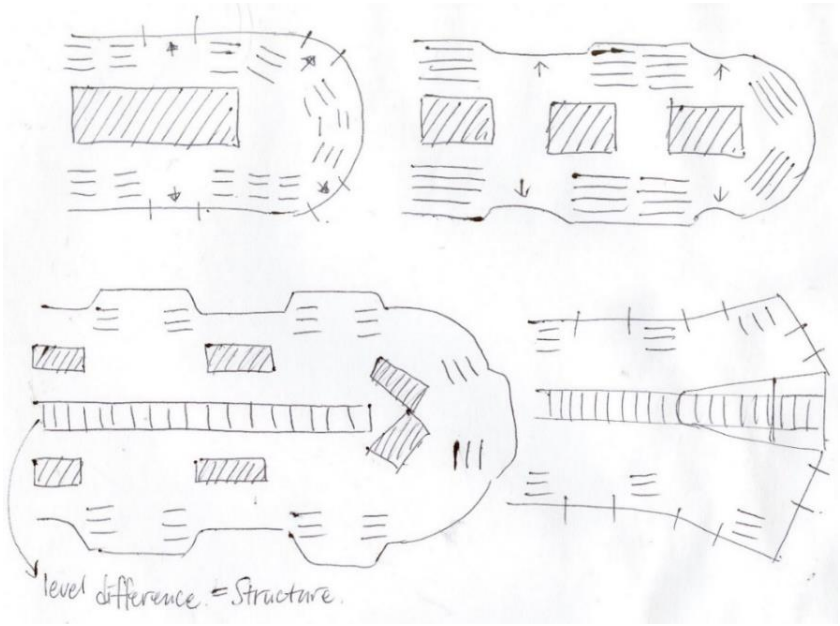
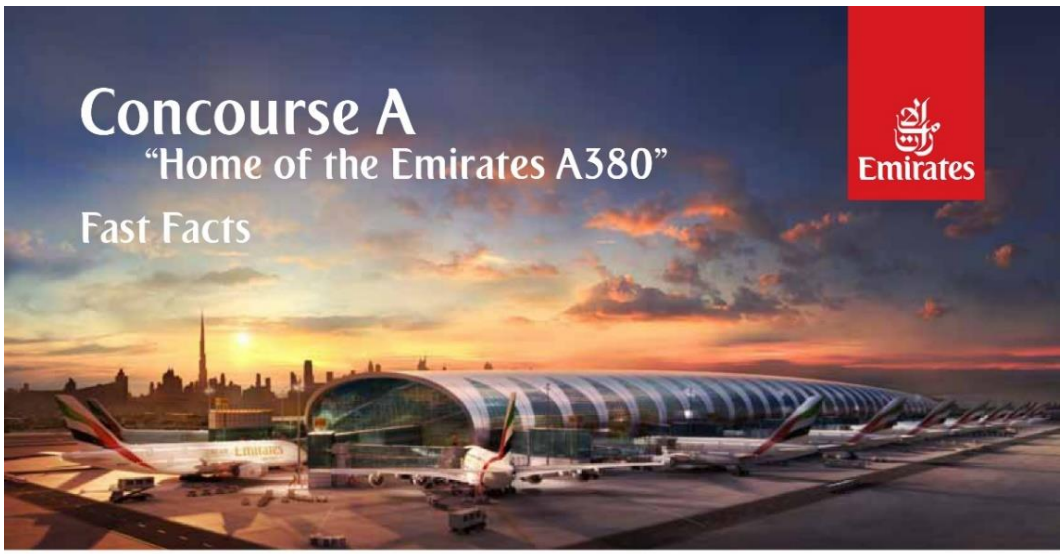


Figure 14. Comparison with Dubai International Airport (https://cdn.ek.aero/downloads/ek/pdfs/concourse/concourse_ a_fast_facts.pdf)



Emirates new A380 hub at Dubai International Airport is the first facility of its kind in the world – purpose designed and built for the world's largest fleet of A380s.

The new 528,000m² facility, spread across 11 floors, offers Emirates customers a seamless and unrivalled experience in terms of sheer comfort, convenience and choice of facilities. From the direct boarding from the lounges for First Class and Business Class passengers, to the expanded duty free shopping, dining options from cafes to fine dining, a full service Timeless Spa, hotels and other amenities. The new concourse represents another first from Emirates in providing innovative products and services that give customers an unsurpassed travel experience.

Construction budget	AED 12 Billion (US$ 3.269 Billion)
Date of completion	December 2012
Date of opening	January 2013
Total area (m²)	528,000
No. of Gates (A380) and related lounges	20
No. of remote stands	13
No. of airline counters	50
No. of hotel rooms	5 Star Hotel = 32 rooms 4 Star Hotel = 170 rooms
Building (length x width x height)	645m x 90.8m x 42m
No. of floors	11
Retail area	Approx. 11,000 m²
Area – First Class lounges	Approx. 12,428 m²
Area – Business Class lounges	Approx. 16,533 m²
Timeless Spa treatment rooms	15
No. of restaurants	14
No. of food courts/bars	3
Passenger capacity per year	15 million
Number of Emirates staff	Over 700

Figure 15. Sectional View of Terminal Area

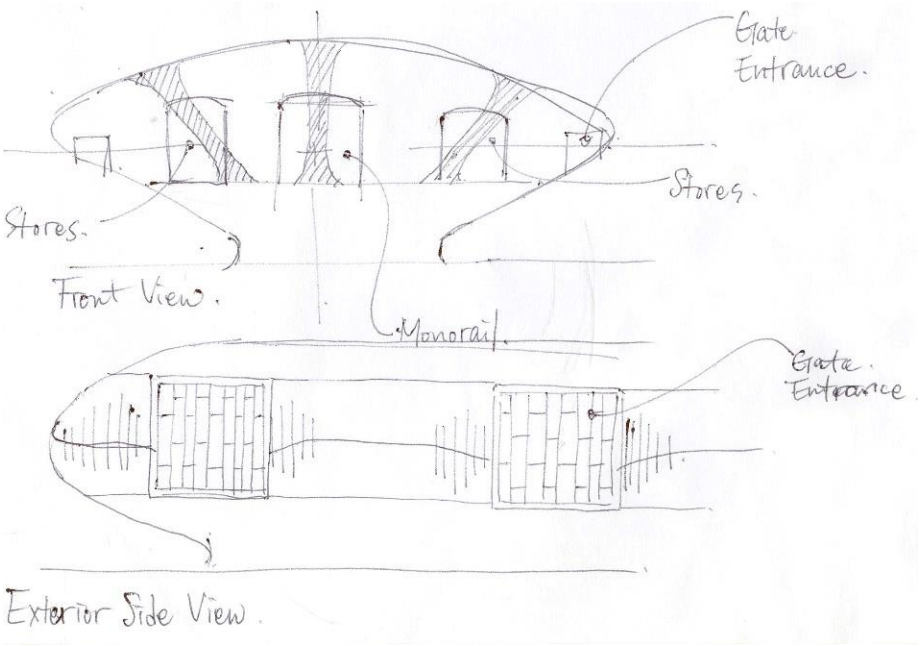
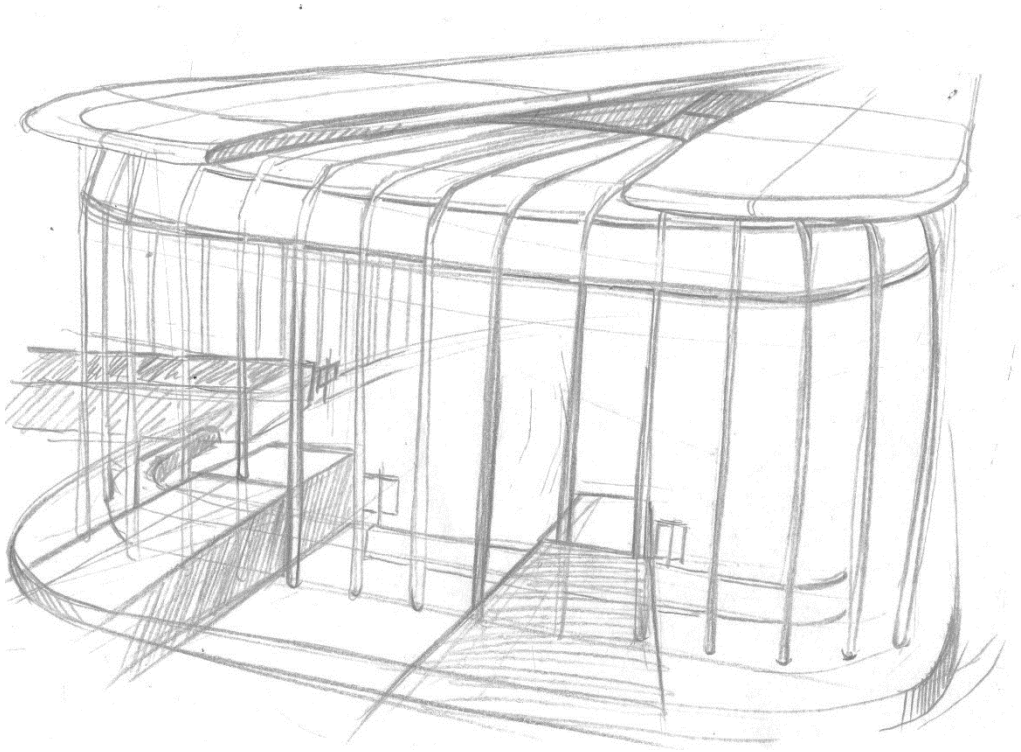


Figure 16. Beijing Daxing Airport Terminal Area (www.zaha-hadid.com)

Figure 17. Conceptual Drawing: Gate Area

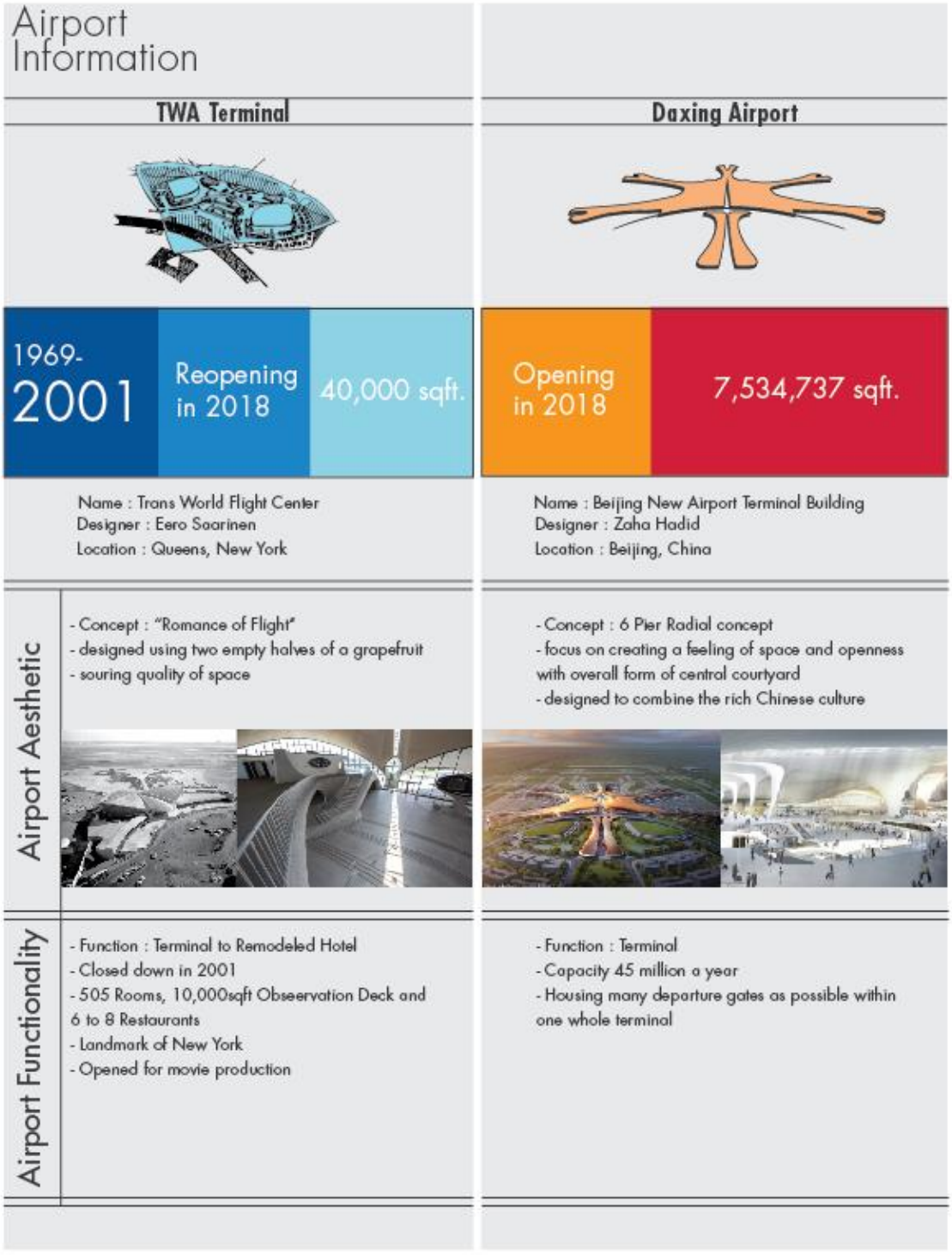


In this research, there were various insights that were observed through the comparison between the TWA Terminal Airport and Beijing Daxing Airport. First of all, both airports were designed with futuristic concepts, and they are composed of high-tech environments for users. Presently, many airports are now built utilizing futuristic concepts, and both of these airports were designed with futuristic appearances. Second, the design of the objects, integrated into the environment, attempt to be as highly informative and efficient as it can be for user interaction. Naturally, airports tend to be extremely busy places, and they are designed to be secure, informative, and efficient in regards to time and space. In the film, *The Martian* (2015), the hub interior was designed for

efficiency in space planning and functional purposes using facets as integrated structures. Likewise, the high-tech furnishings in the Beijing Daxing Airport also has many similar elements that are designed into the interior. The tremendously high ceilings with the integrated structures, information boards, and signage are combined as part of the building. Another commonality between both airports was the material used in construction. The two airports used concrete as the foundation material to construct the curvilinear structures due to its versatility in expressing various futuristic forms. *Archdaily*, a famous architecture website, explains Heydar Aliyev Center, one of Zaha Hadid's works of architecture, uses a specific concrete called Glass Fibre Reinforced Concrete (GFRC) and Glass Fibre Reinforced Polyester (GFRP). This material allows free-form creation of a structure to make it look flexible, a notable characteristic of a futuristic aesthetic.

Figure 18. Heydar Aliyev Center (www.zaha-hadid.com)

Figure 19. Comparison of TWA and Beijing Daxing Airport



Zaha Hadid's Mesa coffee table in Figure 20. was another reference to observe. The shapes of the table and the interior of the Beijing Daxing Airport have similar design elements that express repetitions of distinctive forms. Patterns and integrated structures found in Zaha Hadid's design were two characteristics on which my thesis focused. These complex-looking patterns and structures are futuristic. In terms of aesthetics, futuristic designs from many patterns and structures were visible as biomorphic formations.

Figure 20. "Mesa" Table design by Zaha Hadid (www.zaha-hadid.com)

Biomimicry is one of the emerging concepts in diverse fields with its beginning in biology. Biomimicry is a study that utilizes ecological characteristics from forms, systems, and processes in nature. In the article *"Lessons in Biomimicry - Part1 Natural Forms"* in 2008 by Oppenheim, it states that the concept of biomimicry is finding a secondary nature, the nature that makes the design. It is quite different from just imitating nature's formation; it is an analytical approach to nature. Biomimicry is a renewed direction for design, emphasizing the exploration of different languages from different backgrounds and leading to common features. Janine Benyus said in a TED Talk in 2009,

> Biomimics, are nature's apprentices. And they're focusing on function.. every time I started to invent something, I asked 'How would nature solve this?

Janine Benyus makes us realize how much we can learn from nature, not just imitating the shapes but more in advanced way. According to research of a fern called the Fiddlehead Fern (Figure 21.), it has a characteristic of rolling itself up to make a swirl like a furled umbrella. This is a natural behavior for the ferns to fold their large leaves into buds and photosynthesize when it unfolds. The shapes of these ferns are in a curling formation so that they can control the leaves in an efficient way when the operation starts.

Just as Janine Benyus had said, "I was able to learn how this kind of fern crumbles up the leaves and take benefit of the fern's specific action."(2009) I wanted to apply this insight of the fern's behavior to the design of the bench so

that it could also provide a benefit in regards to spatial usage. As the formation of the curl rolls up to the center of the spiral, people can gather to the center of the bench encouraging interactions for small groups of people. Moreover, I imagined the design would convert to a spreading formation whenever people approach the bench, just like the natural habit of the fern. Due to the thermal divergence that the people would experience, the material will interact and transform into the shape so that it would be possible to provide more seats for the waiting crowd.

Figure 21. Biomimicry Concept: Fiddlehead Fern (https://asknature.org/strategy/folds-allow-efficient-leaf-deployment/#.WgaR1WhSzIU)

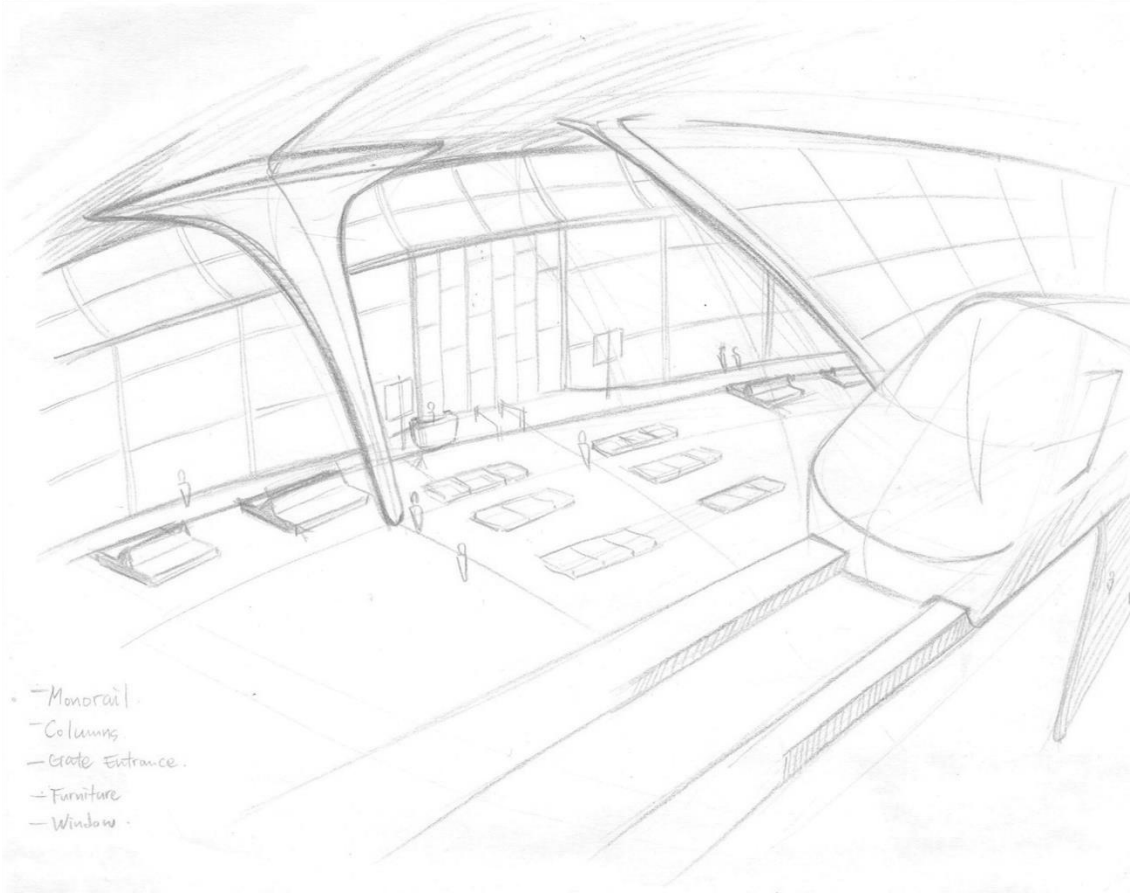
Biomimicry is presently used in the architecture field, and the complexity of nature inspires many contemporary buildings. Even for the Fiddlehead Fern, the complex shapes can potentially be made with a design technique called parametric design. Parametric design is suitable for expressing multiple shapes and patterns like those in nature, and it has already been used as a common architecture technique. So, adapting this architecture technique to furniture design has the potential to create a futuristic aesthetic.

In this next phase, the future design elements from the previous research, patterning, and integrated structure were applied to the design project. The goals were to apply futuristic elements to parametrically designed furniture and explore the outcome of combining future concepts. From building these bodies of work, my research was observed more closely in the practical process of design and my thesis will capture the lessons learned from each individual project.

Parametric Bench in Beijing Daxing Airport

The site area for the object was the gate terminal area of the Beijing Daxing Airport. With the previous investigations of the site, conceptual drawings were sketched with the furniture installed in the selected place. The furniture I planned on designing was a parametric bench, imagining it would not only have the future aesthetics but also impressions of an artistic object.

Figure 22. Conceptual Sketches: Beijing Daxing Airport Interior



My intention was to design a bench for the location in front of the gate area in the terminals and to develop a curvilinear form for the bench in order to enhance the interactions of travelers as they wait for a flight. Beginning with the conceptual drawing, I designed a computer model of the gate area (Figure 23.) so that the airport bench would be placed with consideration of the interior. The modularity of the form provides opportunities for diverse seating options and adaptive installation to be accommodated into a variety of location parameters. The bench is designed with the futuristic concept that was mentioned in previous

sections, focusing on the patterning and integrated structure. The idea sketches in Figure 24. feature mass studies of how the bench would look without the patterns. Once the overall design was confirmed, I applied the patterns using two different methods. The first method was building a prototype model with industrial clay, and the second method was using computer modeling.

Figure 23. Computer Modeling the Gate Area

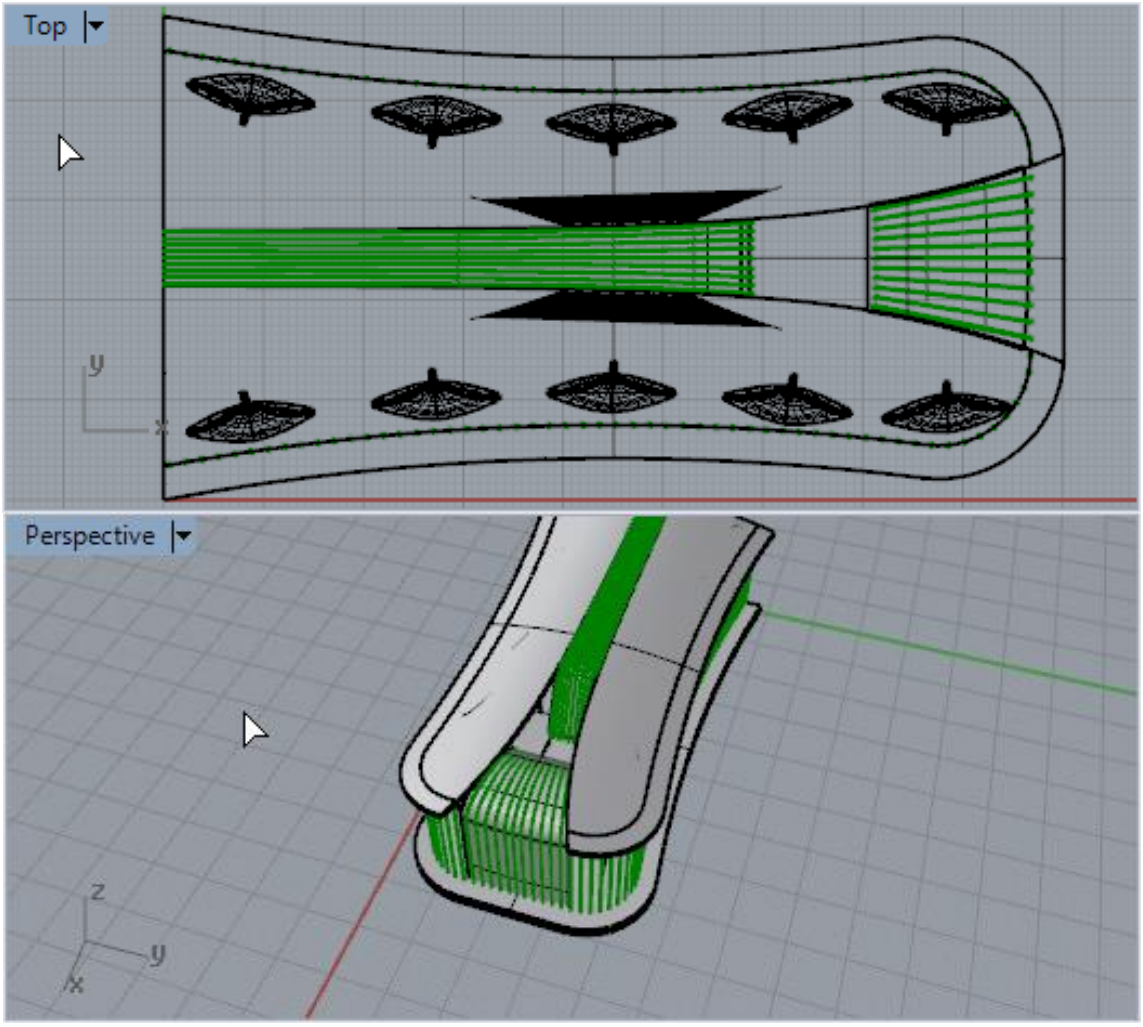


Figure 24. Idea Sketch: Airport Seating

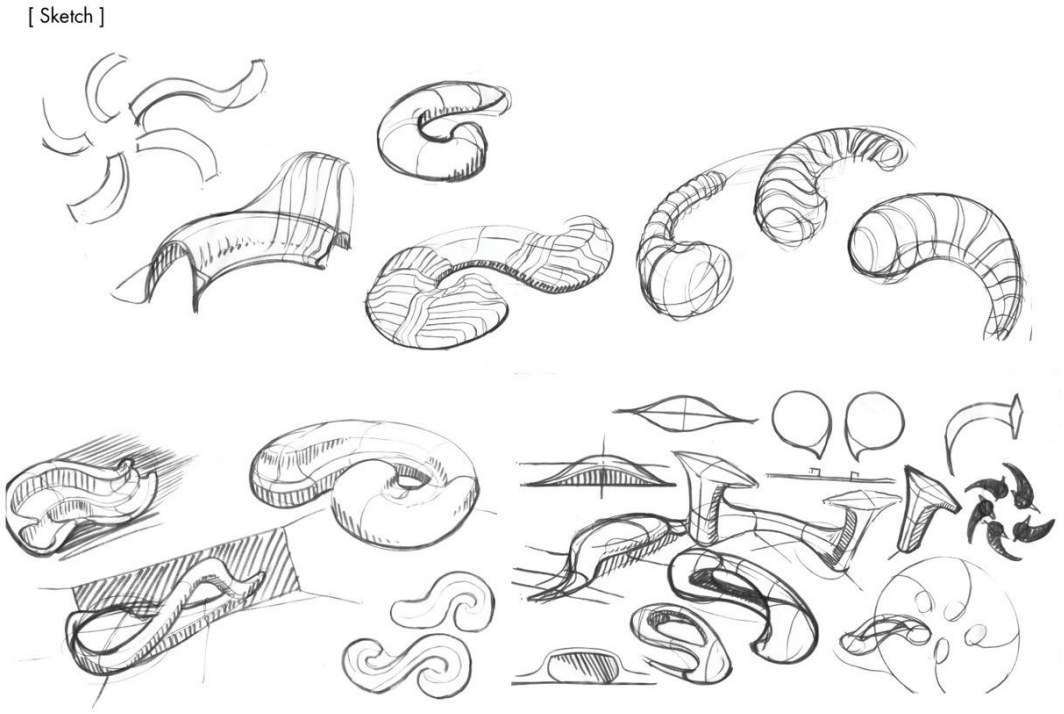
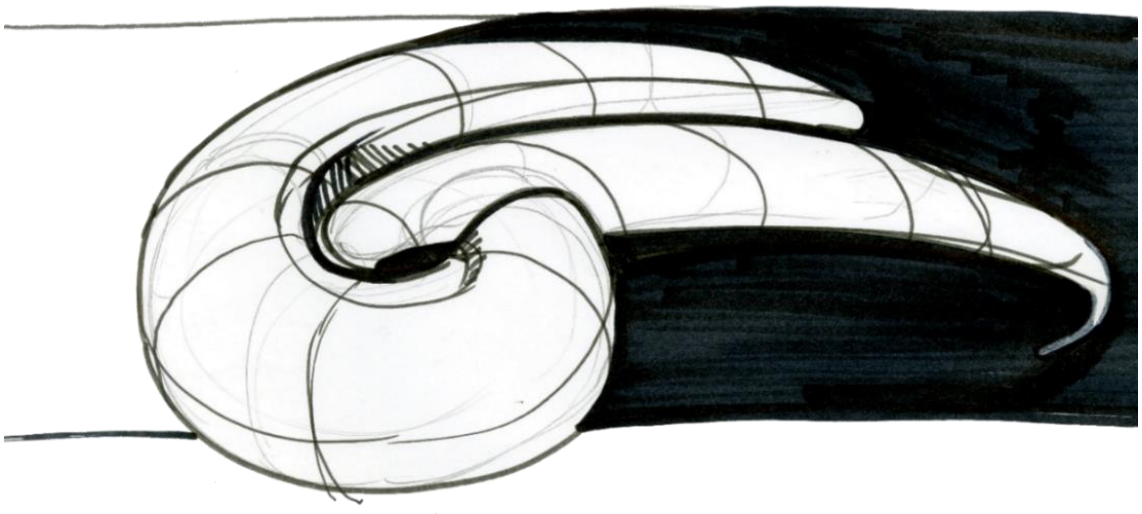


Figure 25. Bench Design



Clay modeling was an interesting experience because industrial clay is primarily used for modeling automobiles, and the details of the bench could be expressed at the same level of depth that is possible with automobile designs. In Figure 26 and 27, clay model studies were conducted of the three-dimensional figure where grooves created a gradual segmented pattern. One benefit of using clay was that I was able to allocate the material to create multiple designs and play with them separately or placing them together in groups. An individual bench would circle up with another bench to create a small communal space for the users to interact with each other (Figure 28). Another idea that came to mind was using the material of the floor and having it continue up to the furniture, resulting in a mounted integrated structure. The unified formation provides design elements for the user to interact with the floor design leaving intuitive indications of directions to the gate terminal. However, the patterns posed challenges and constraints when handcrafting the figures, so moving forward, assistance was sought from the computer.

The computer modeling was done with a software called 3D Rhinoceros because it was the most appropriate program to help create the curvature lines and biomorphic structures. This software was suitable to create the shapes, but the patterning of the structure pieces was a challenge that needed to be solved. (Figure 29.) Awareness of limitations in the modeling process provided an extension of the research, and I referenced more architectural projects that

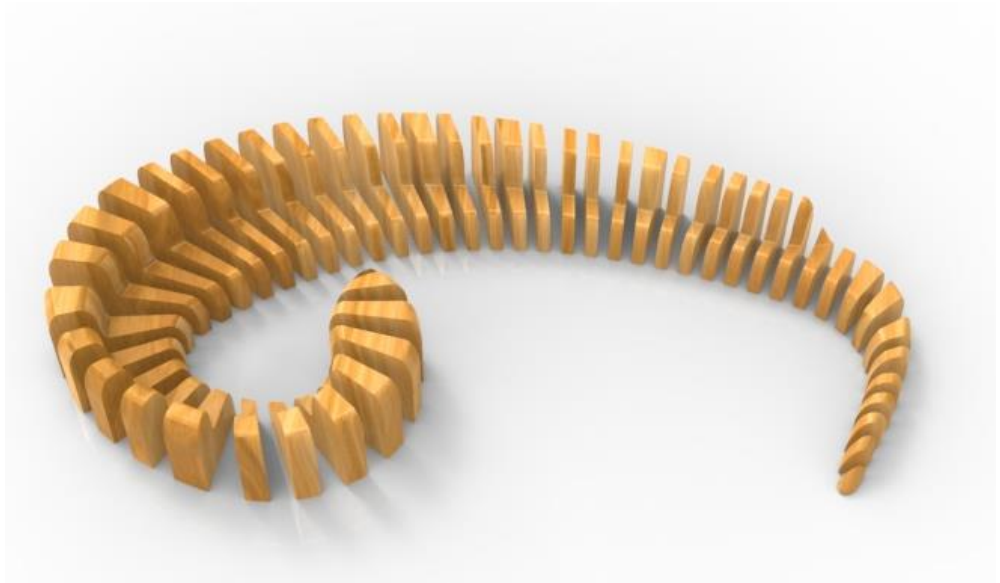
utilized biomorphic shapes and patterns. My research study went more in depth with interests in computational production and manufacturing.

Figure 26. Clay Modeling of Airport Seating: Segmentation

Figure 27. Clay Modeling of Airport Seating: Single

Figure 28. Clay Modeling of Airport Seating: Group

Figure 29. First Modeling in 3D Rhinoceros



Many designers face constraints from their design methods, and I was having this same problem in modeling the bench until I realized there was a certain software to produce parametric formations. The software I learned was called Grasshopper, and it is an add-on software that allows 3D Rhinoceros to overcome the limitations of the original software, especially in making patterns. Building the model with parametric design made more sense, and it was better suited to express complex forms like biomimicry patterns. I have articulated these patterns and integrated structures with the understanding of how modeling works in Grasshopper. The patterns were much easier to build by formulating simple equations that can generate visible formations. It took less effort than inputting the usual command to create patterns because the design is activated via the equation. In the equation, there are also tools that feature a graph component where inputting different coordinates of a graph changes the resulting form. According to Figure 30, by designating different values on the graph, the user is able to freely control the coordinates that indicate points of the curvature and change the formation of the design. This helped to create the segmented pieces as a pattern without repeating the commands over and over again. Therefore, Grasshopper is a more efficient and precise tool to generate parametric design onto the bench than clay modeling, but on the other hand, clay 3D modelling provided an important step from mass study to controlling the figure in development of the bench.

Figure 30. Modeling with Graph Tool

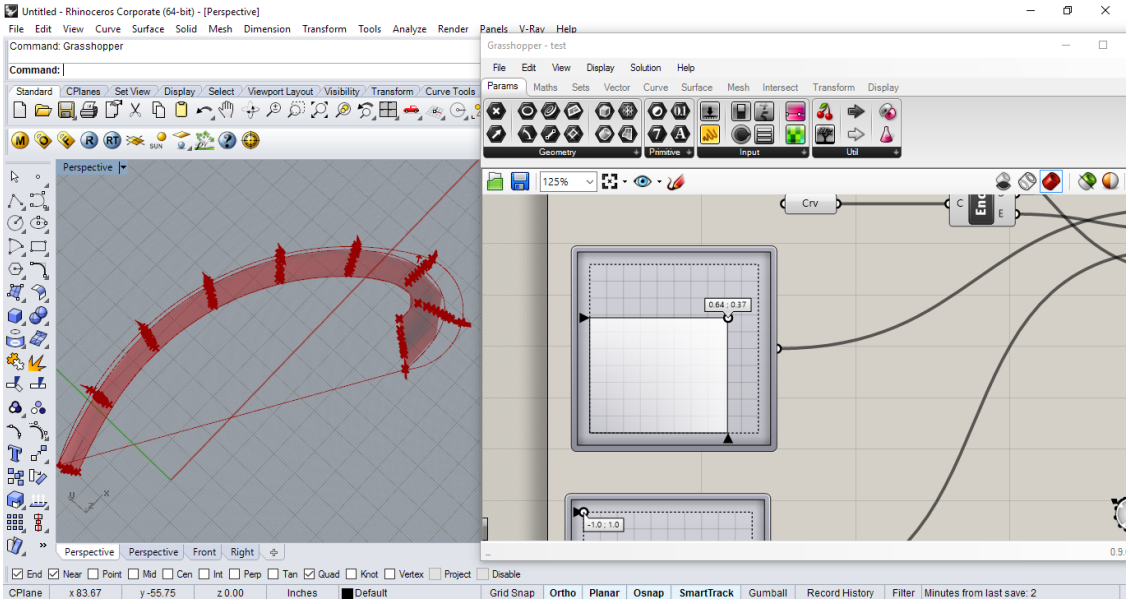


Figure 31. Second Modeling in Grasshopper

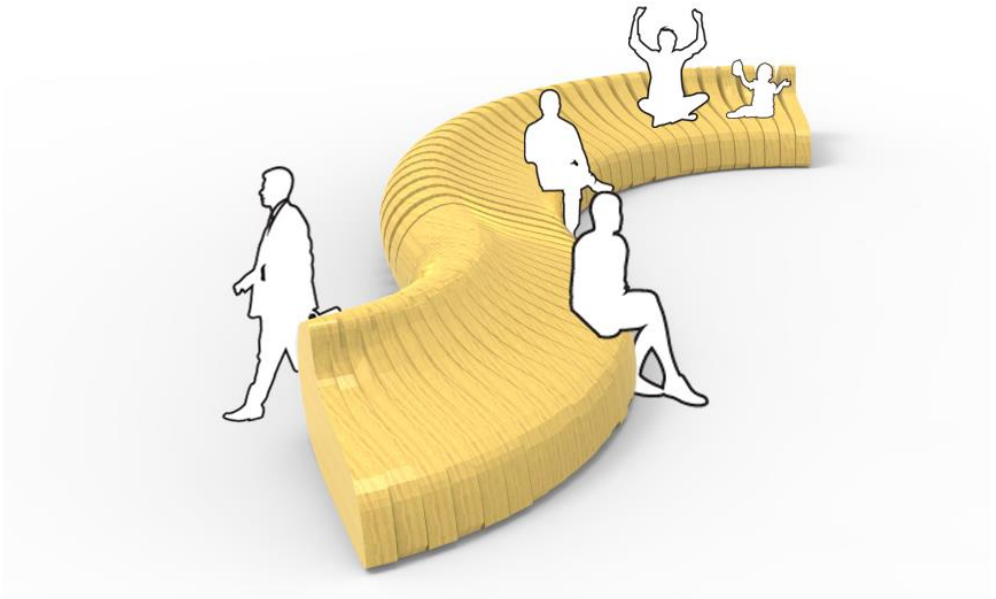
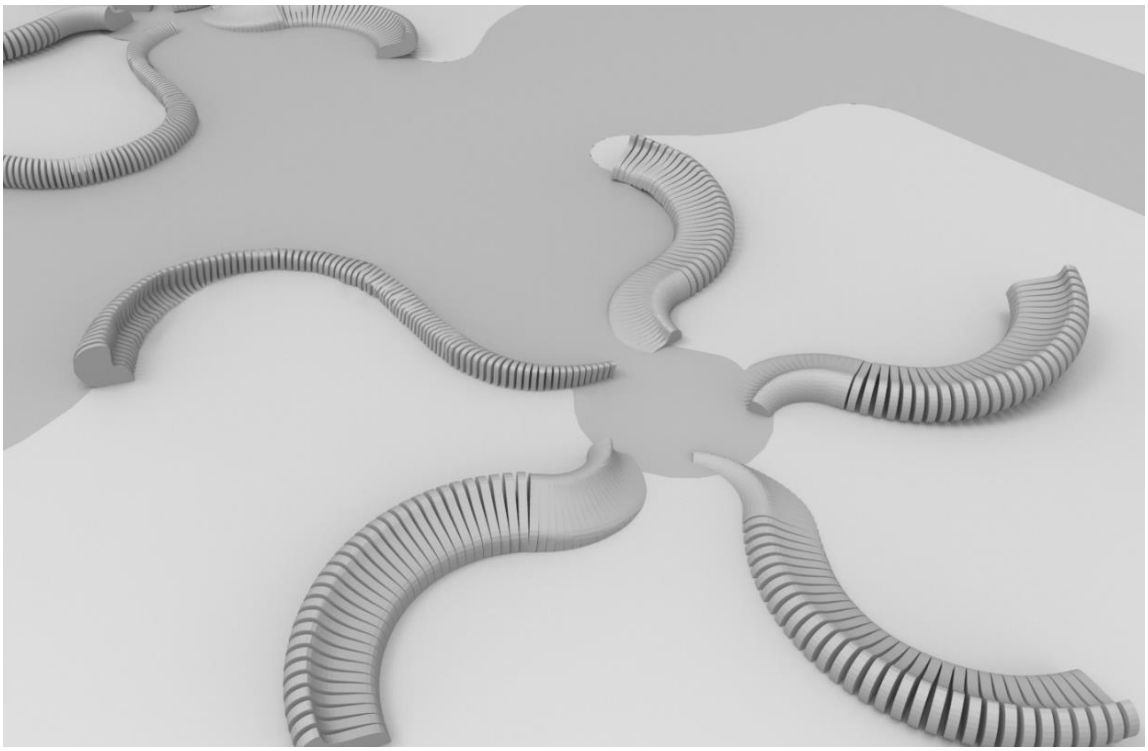


Figure 32. Modeling with Graph Tool: Group



Chaircase

The Chaircase, produced for a studio exploring experimental methods, is an extension of my study in regards to applying a futuristic concept to furniture design. I focused on the digital fabrication (CNC) of the modular pieces, exploring the potential of modularity and patterning as futuristic qualities. The local book café called Scuppernong, located in downtown Greensboro, was the reference site to be researched and observed in an effort to capture the aesthetic that is likely seen in bookstores and cafés. The conceptual idea is to combine the function of a chair and a bookcase, while aligning the segmented pieces together to make a patterning formation. The chair features curved lines flowing from the

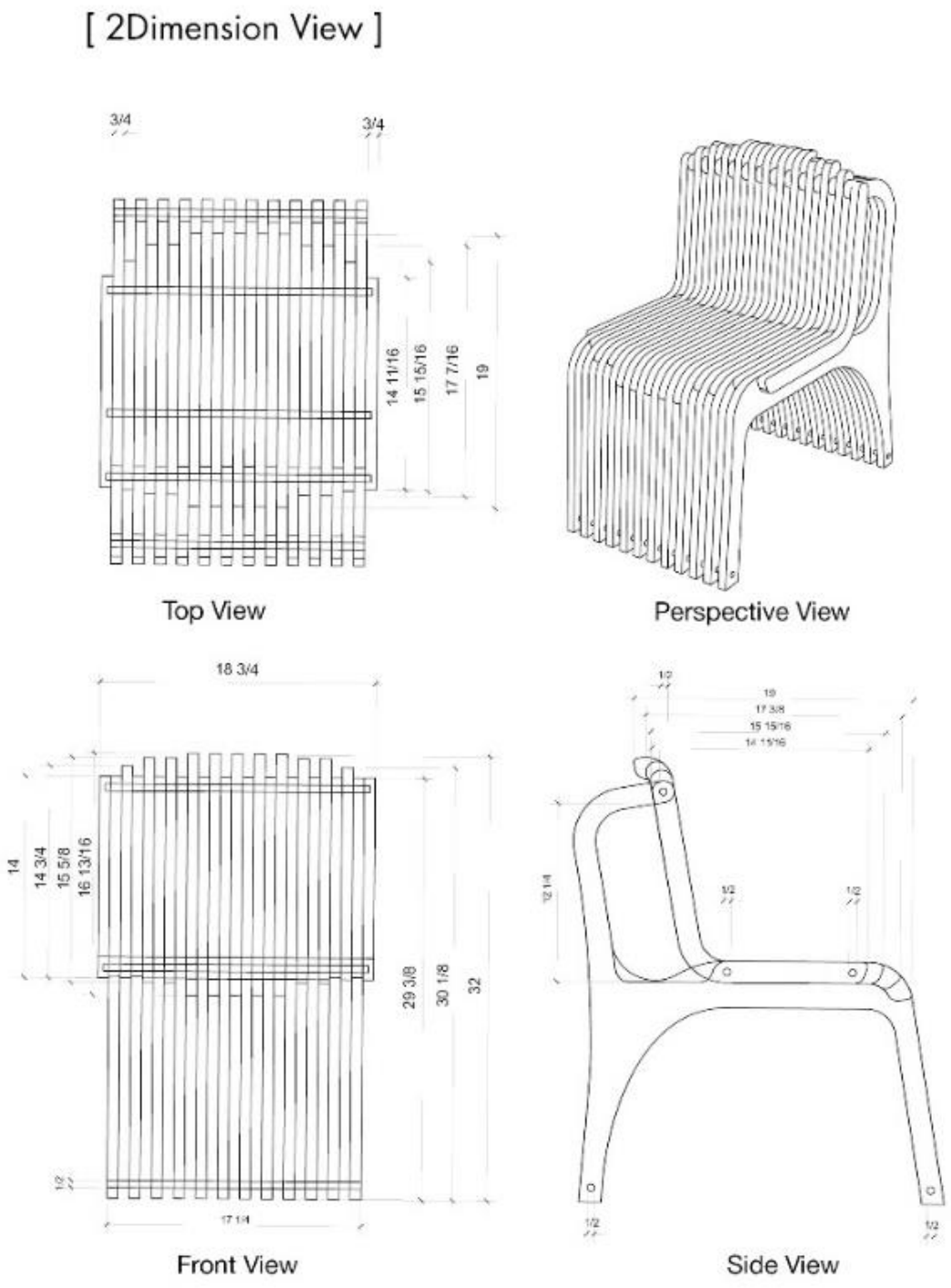
back and to the front legs of the chair, and the curved lines are stacked to create a negative space behind the back of the chair, which is used for storing and displaying books. When the furnishing is viewed from the side, its back and the seating area forms the shape of an open book. To create this organic curve pattern, the structure was designed to become a conceptual element.

Figure 33. Chaircase, 2016

Chaircase was built in real production mode going through the full design process. The chair is made up of 7 different pieces cut from 3/4 inch plywood sheets, and these pieces were stacked to form a three-dimensional mass. The two main curves are the basic foundation and body structure for the chair to stand, and the rest of the curves serve as the seating. In order to produce these curves, the CNC machine was utilized to make precise cuts and experiment troubleshoots. (Figure 37.) Dowel joints were used taking advantage of the accuracy offered by the CNC process, and all the pieces were glued with the base of five dowels that goes through the width of the chair. (Figure 38. and 39.)

The full scale of the chair is 31 inch tall, with the width of 19 inch and 25 inch in depth and this scale is based on the ergonomic experiment of using a 5 feet 8 inch dummy with other furniture that exist in the book café environment. Before I got to this process, I went through making prototype models and doing simulations to have the precise dimensions. (See Figure 34.)

Figure 34. Two-Dimensional View



Like the airport furniture, I tested mounting down the chair structure to the floor to investigate the appearance of the integration.(Figure 35.) The overall design process of the Chaircase project was similar in the normal design process; however, utilizing the CNC machine constituted a big portion of the process which was a valuable experience to understand manufacturing with a futuristic method, i.e. a computational process.

Figure 35. Integration with Floor Structure

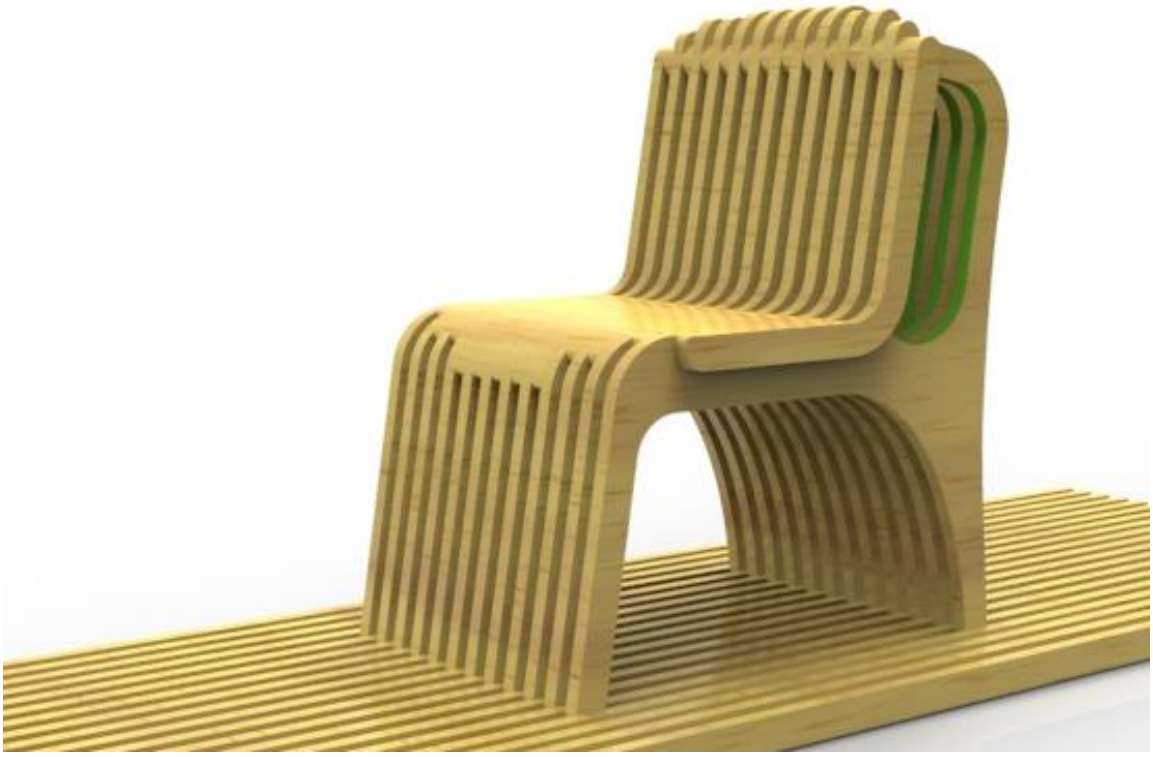


Figure 36. Finishing Phase

Figure 37. CNC Machining Process

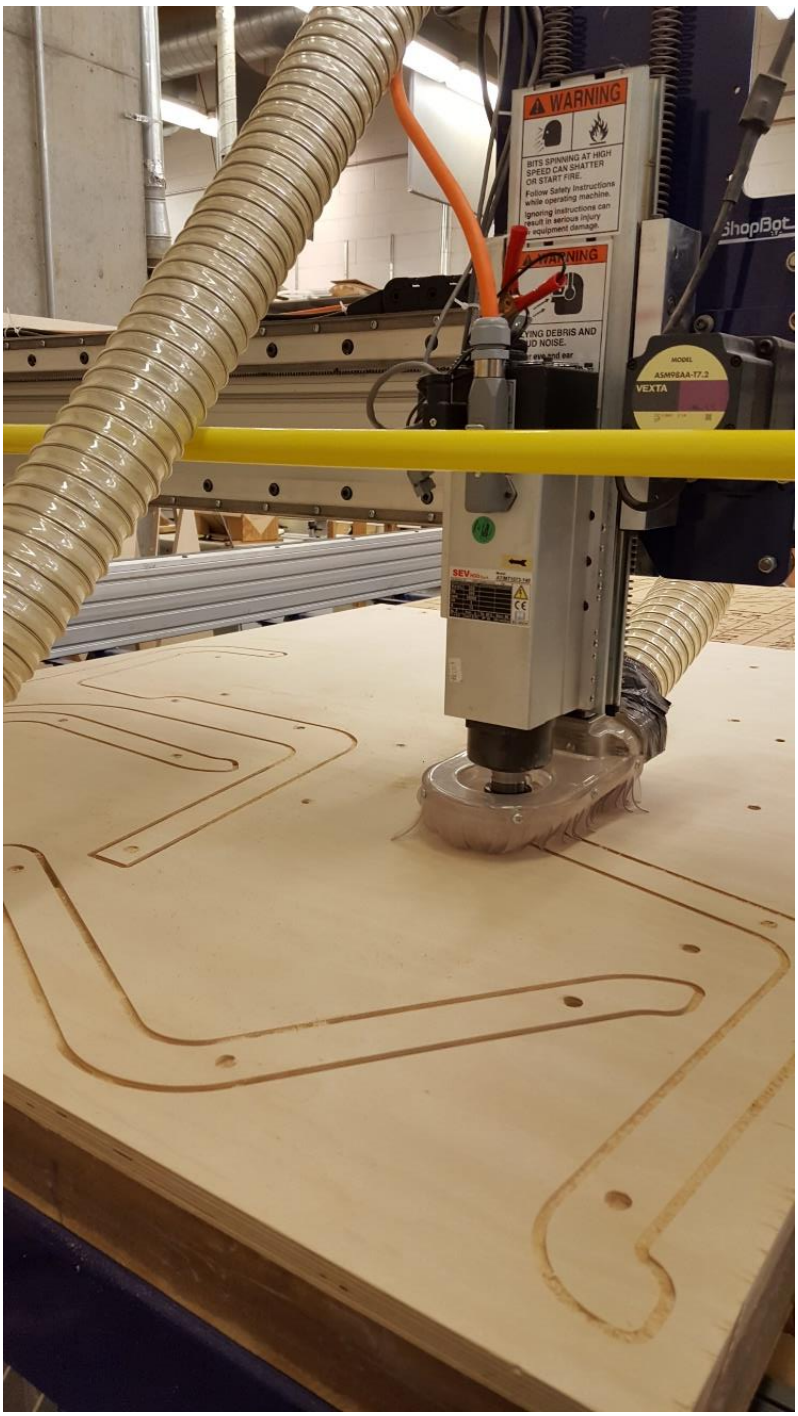


Figure 38. Dowel Experimentation for Joinery

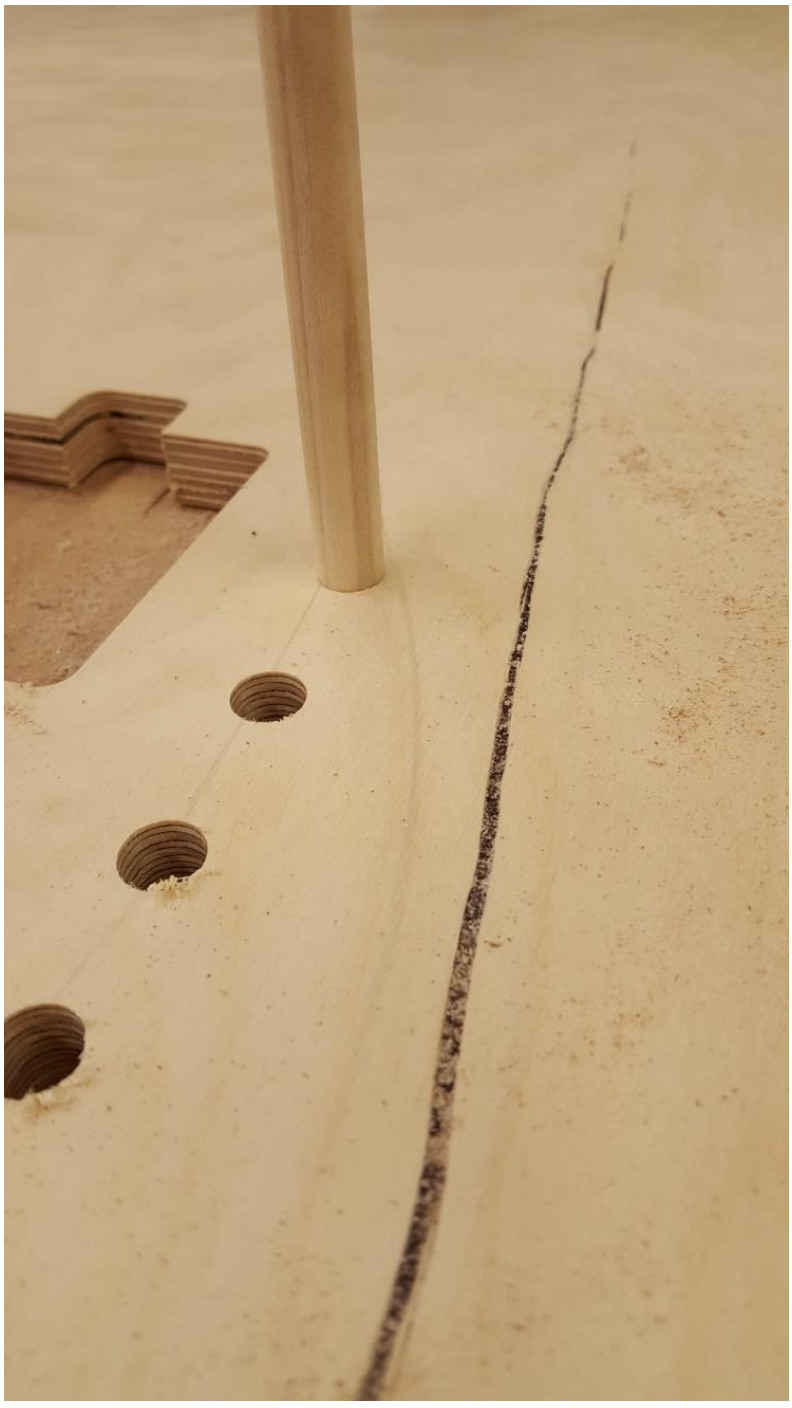


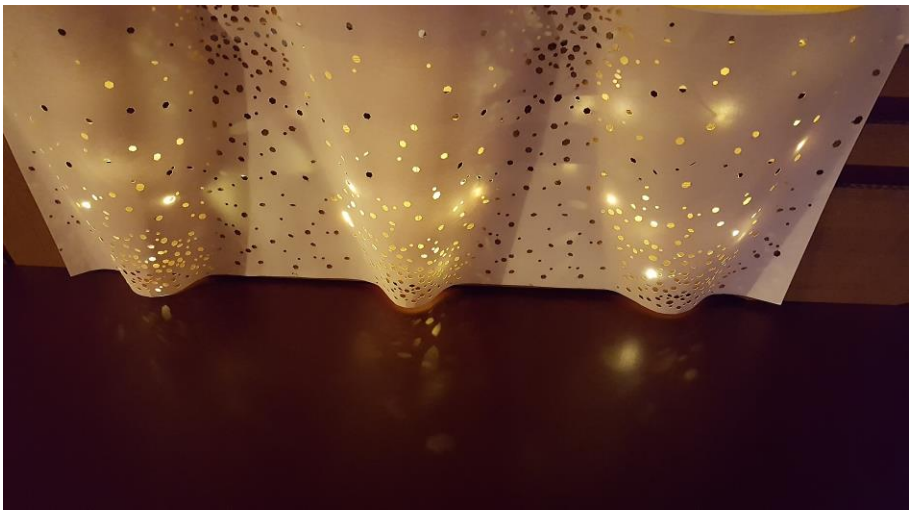
Figure 39. Assembling Pieces Together

Parking Garage: Breathe

The internship that I participated in 2017 was with the Community Foundation of Greater Greensboro. The internship involved the design of an assembly to enhance the façade of the parking garage, mainly in regards to the lighting and aesthetics while preserving and expanding Greensboro's sense of community. The location of the site area was a parking garage on North Elm Street between Summit Avenue and North Davie Street of Greensboro.

Fundamentally, the study of this project was relevant due to the patterning on the façade. The concept of the project was called "Breathe," and it started with the thought of what a futuristic honeycomb would look like because of our concept related to community was to "Breathe together into the future." The goal was to apply a pattern on the undulated surface for the breathing motion to look organic.

Figure 40. Prototype Experiment of Façade



The process of building the surface with the patterns was challenging, and this step was when I relied on creating the pattern on a flat surface more than three-dimensional modeling. (Figure 40.) In fact, making this into a practical model was less intense because the prototype model was easily visualized in a flat shape utilizing only the patterns. After the prototype modeling process, the computer modeling still had to be made so that the surfaces could be examined closely by the engineer and fabricators for better understanding. The undulated surface was built with using 3D Rhinoceros and Grasshopper (See Figure 41, 42 and 43) while the patterns were placed manually onto a flat surface and converted into a three-dimensional template.

Figure 41. Computer Modeling of Façade

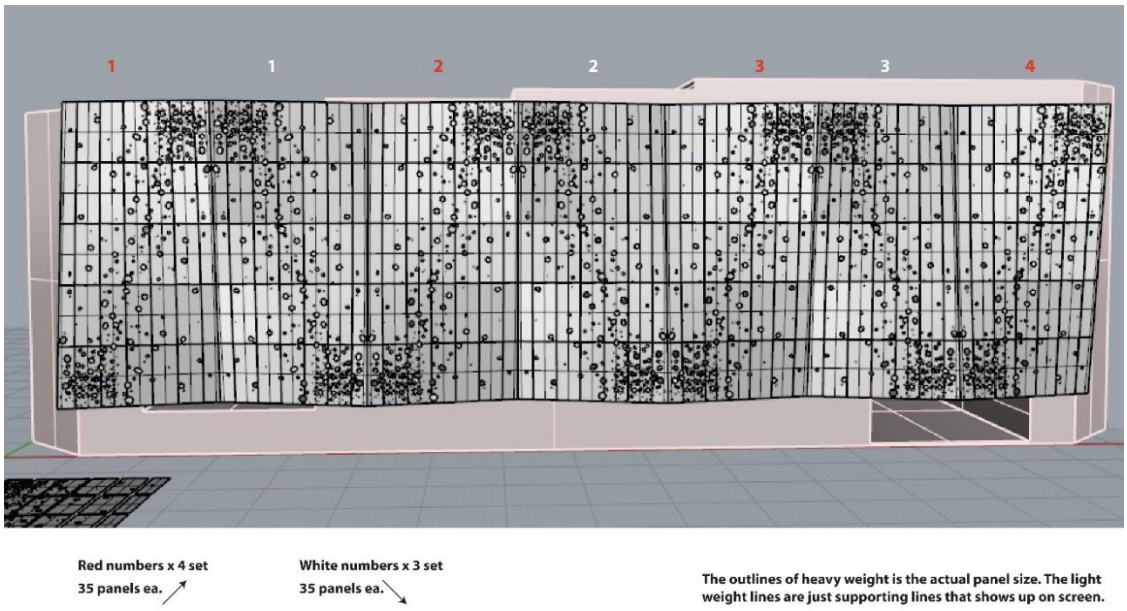


Figure 42. Computer Modeling of Façade

Figure 43. Computer Modeling with Grasshopper

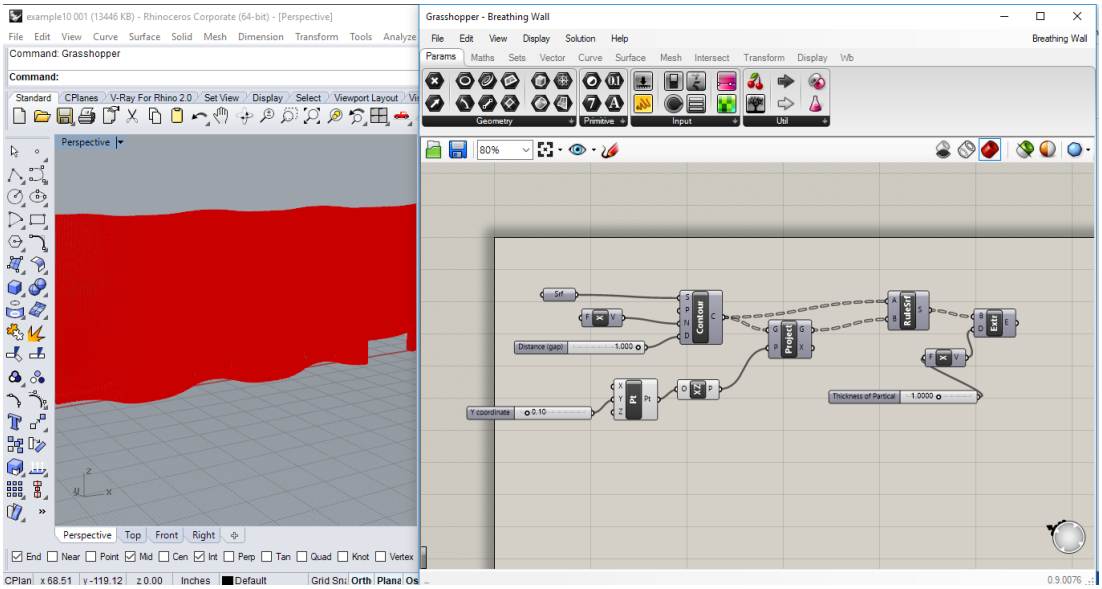


Figure 44. Computer Modeling in 2D

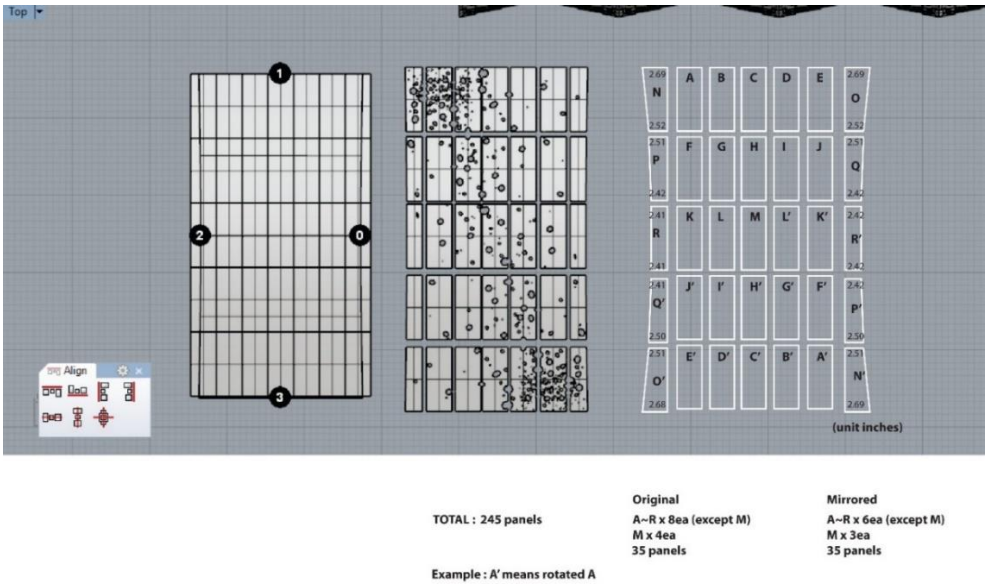


Figure 44. shows the two-dimensional process where the separate pieces of panels (4 feet by 10 feet panels) were counted to know the number needed to create the surface. I had to plan a 2D portion of the process and 3D portion separately to create the final design of the façade. Ultimately, there were difficulties in applying the complex patterns onto the surface in 3D modeling, but this project consisted of a combined method using both computer-assisted and handcrafting processes. In addition, this internship was a learning experience when it came to utilizing the laser cutting machine for patterns and working in both digital fabrication and handcraft.

Figure 45. Computer Rendering of Breathe

Summary

In all the projects I went through, my intentions were to apply patterns and integrated structures to examine aesthetic appearances. Furthermore, each project provided an experience with the making process and details to precisely figure out the knowns and the unknowns of the process. The results that I have created gave me more knowledge and confidence to the direction of my exploration. The ongoing study will concentrate on producing patterns and integrated structures as well as figuring out how to incorporate algorithmic thinking into the process.

CHAPTER IV

ANALYSIS

Before moving forward, there is a difference between algorithm design and parametric design. When we define algorithm design, it has an intimate relation with calculation while parametric design process is a more visual method. Moreover, parametric design is based on algorithmic thinking and brings algorithmic method into design.

Parametric Design

To iterate, parametric design is about making complex geometries and structures based on the process of algorithmic thinking and computational design. In order to understand parametric modeling, it is important to know the basics of parametric design and algorithmic thinking. High-tech engineering software Grasshopper is an algorithm generator to build parametric formations. This specific software is an efficient design tool that allows new forms and patterns to be applied to furniture. The program starts with basic points, lines, and surfaces, and these come together to create circuits of components to form an equation. The mechanism is to gradually upgrade the forms with each component. In the past, the design process for computer modeling was different, originally combining, cutting, and transforming objects in more of a building

process. Now, there is no need for the knowledge of program interfaces, but rather knowledge in algorithmic thinking is needed. In fact, it requires inputting number values and commands for the creation to be made.

One huge benefit of creating parametric design is that you do not have to start all over again. There are many times when there is a point where the model cannot be turned back. In Grasshopper, arranging the components to make a sequence in building the structure is the main idea of the modeling process. Therefore, it is possible to go back to the history and edit or change the design of the figure. Another benefit is that parametric design modeling gives whatever shape the user wants by inputting values, which is vastly different from traditional 3D modeling software. A simple building of an equation with a certain value is likely to yield some design. This kind of method in creating a model gives way to benefits in making repetitive patterns and complex shapes with an equation. In other words, patterns are designed with simple equations, and it is easier to customize the components that represent the shapes rather than changing each shape of the pattern. Very complex or organic shapes are able to be made in an equation with combinations of components. If at a certain point everything gets complicated, the model becomes tedious to change in the way users want, but with parametric design, because the model consists of components that are combinations of values, it becomes possible to edit.

Going back to the airport furniture, building the model with parametric design was much more suitable to express forms of the biomimicry concept. I

have articulated the patterns and integrated structures to upgrade the design of the model with Grasshopper. The patterns were much easier to build and to create the repetitive segmentation of the pieces precisely.

Nowadays, parametric designs are being made in a precise and large-scale manner. The outputs are created with laser cutters, 3D printers, or CNC machines where the computers are doing the work more accurately and more efficiently than humans. In fact, many manufactured objects are created with parametric design. I would like to call this computational production, and Chaircase, one of my projects introduced previously, was manufactured using this method. I have learned basic computation patterning using the software and machines within the computational process. In this project, a study of a simple pattern was done with the repeating 25 pieces that form the chair. In fact, I found out there are some preferred patterns that designers like to utilize based on possibilities in the production method. Chaircase uses one of the preferred patterns, which I like to call segmentation patterns, and I have used this in the airport furniture as well. This patterning is made with strips of material aligned like books on a shelf to construct a three-dimensional form. Many past designers have developed this pattern and made various creations with it. Presently, with the support of the software, it has become much easier and much faster to create the pattern. This pattern is rebuilt as a design element as it is made into a three-dimensional or structural form.

My next body of work is a desk designed with this specific pattern. Knowing the background of the airport, I created a desk that could also be used in the gate area. The provisions of the design were to accommodate the segmented pattern, the function of a desk, and the surrounding environment. I went through the steps of concept and idea sketches (Figure 46.), proceeded to computer modeling using 3D Rhinoceros and Grasshopper (Figure 47.), and last, printed the model with a 3D printer. (Figure 48.)

Figure 46. Idea Sketches: Airport Desk (Segmentation Pattern)

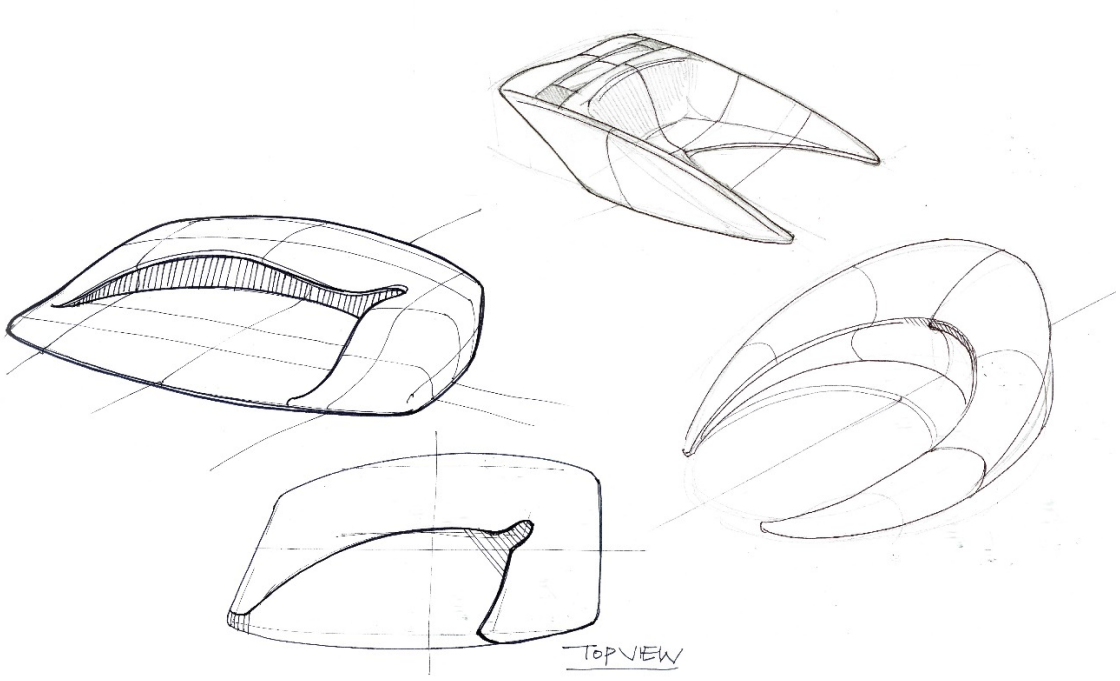
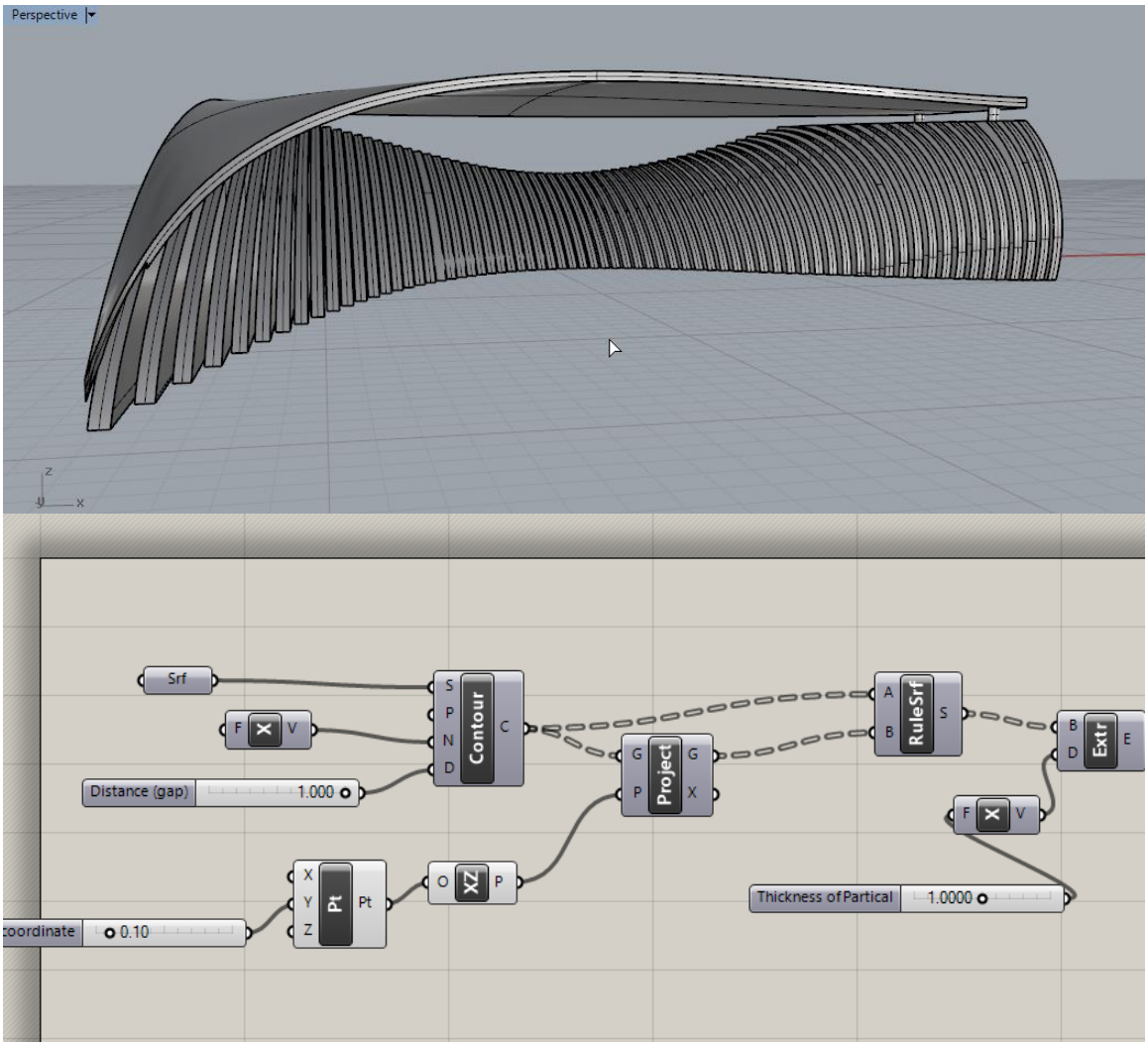
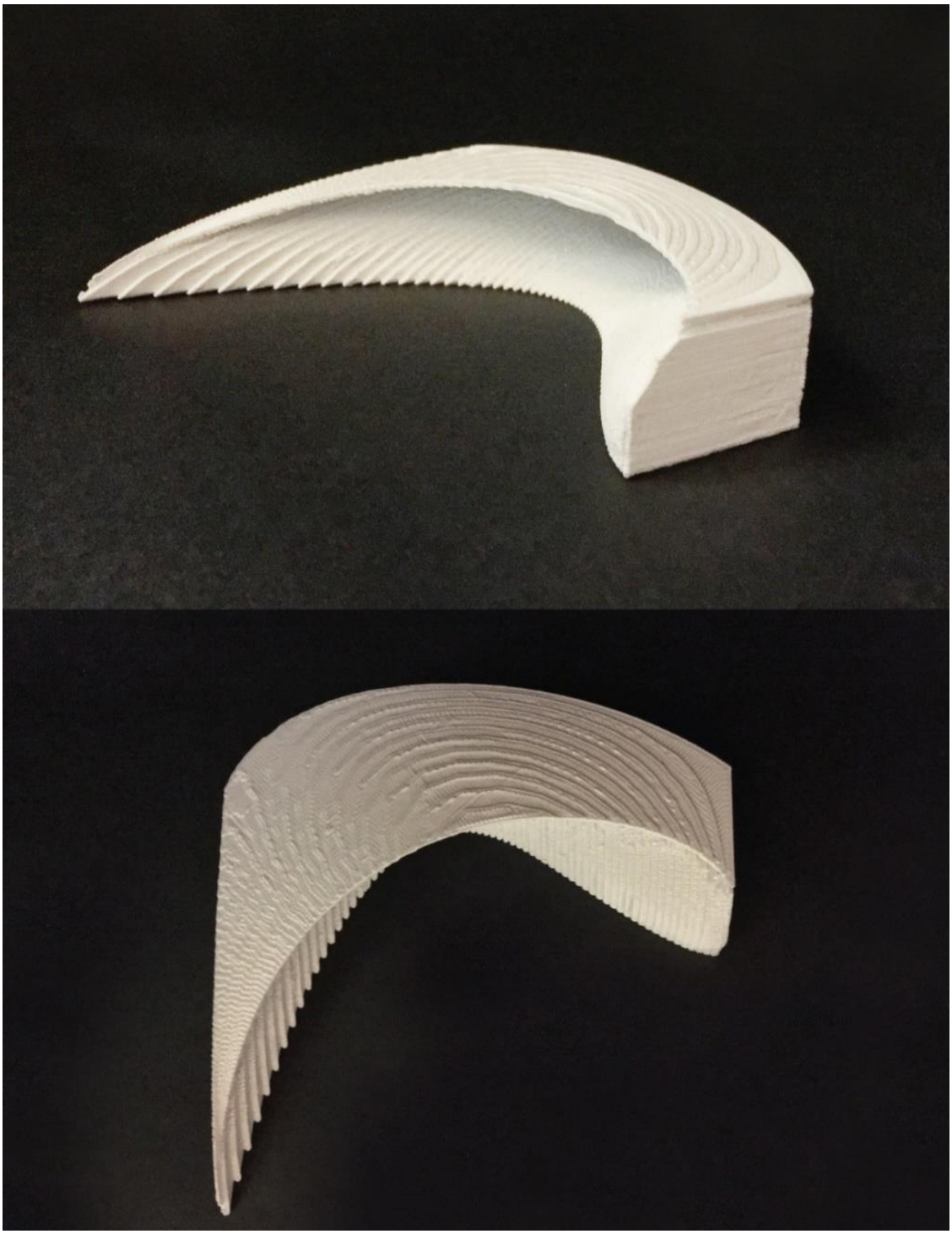


Figure 47. Computer Modeling: Airport Desk (Segmentation Pattern)



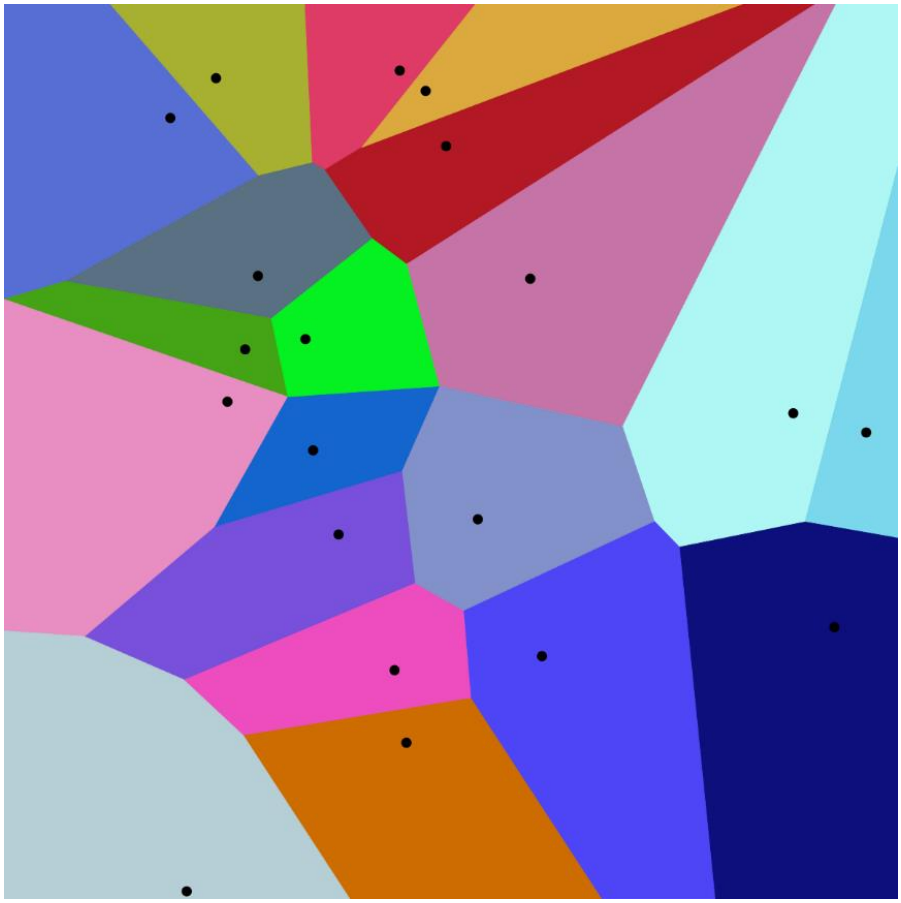
Starting from a surface and four components, I was able to create a simple wall with the segmentation patterning. I controlled the thickness of each piece, the distance of each gap, and the curvature of the pieces to create an in-and-out wave figure. I used the wave figure as the bottom part of the desk and added the top portion to finish the design of the desk.

Figure 48. 3D Printing: Airport Desk (Segmentation Pattern)



Grasshopper provides another basic pattern called Voronoi pattern, which is manipulated as a tool component in the program. Originally, this pattern is based on partitioning the planes with specific points in subsets of each plane like in Figure 49. These planes are formed to create shapes of cells, and they make two-dimensional and three-dimensional tessellations. When the patterns transform into a three-dimensional form, the objects resemble complex formations of biomorphic structure. An example is from the bottom portion of the Mesa coffee table that Zaha Hadid designed. (Figure 20.)

Figure 49. Voronoi Pattern (Google Image)



I utilized the Voronoi pattern in an attempt to make a similar parametric design and apply it to a parametric table that could potentially be used at an airport. The software Grasshopper was used throughout the computer modeling process and to build up the equation map to make the Voronoi Parametric table. The equation consists of 40 components, and when the values are accessed, each command plays its role in creating the object in sequence. When the value of the “count” component changes, the number of loops changes. Inputs of the different values create different designs, and the visualization adjusts whenever a change has been made. In brief, the values of inputs for my Voronoi Parametric table were as follows.

Figure 50. Voronoi Equation Map

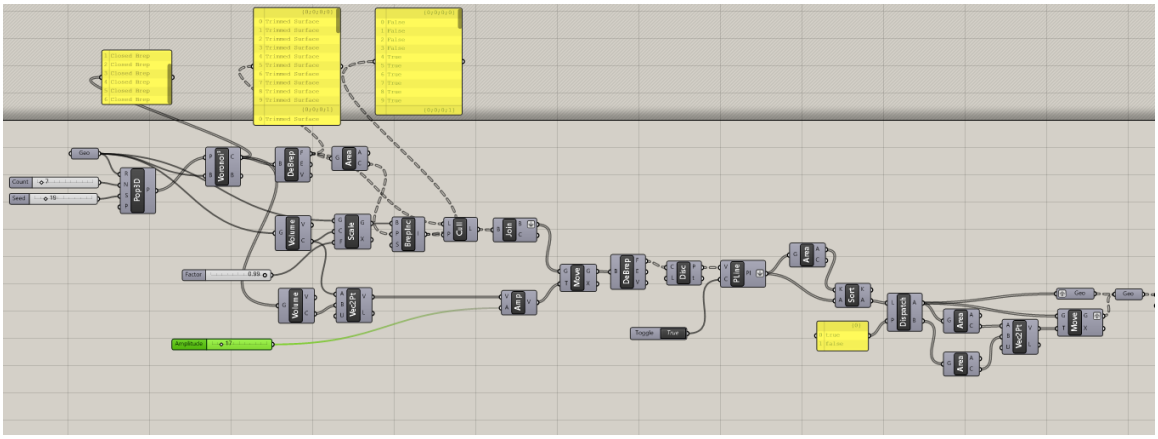


Figure 51. Voronoi Table Input

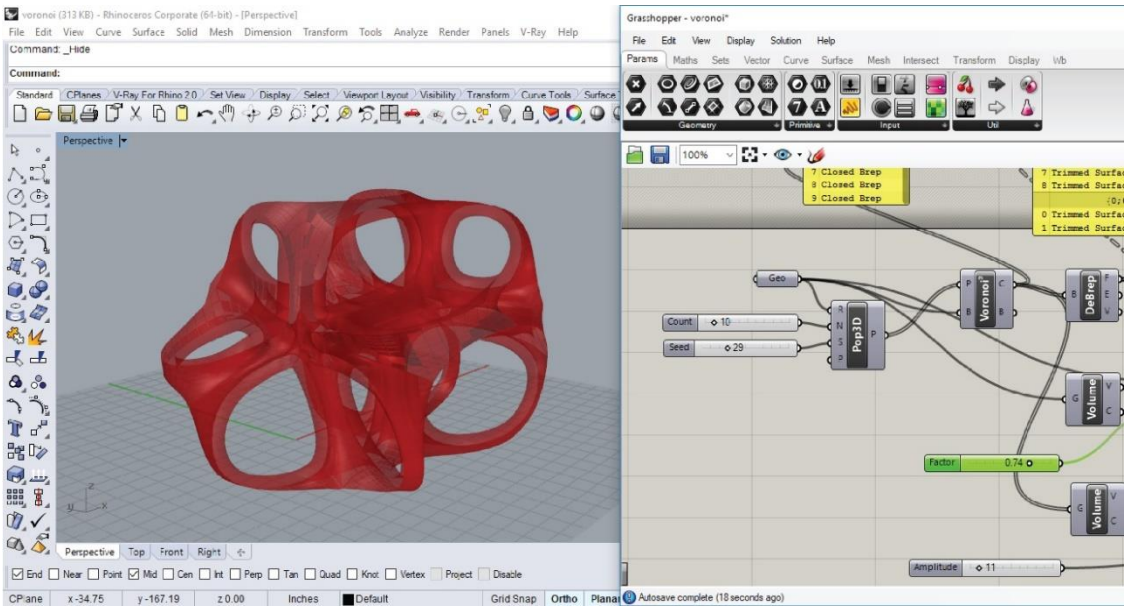
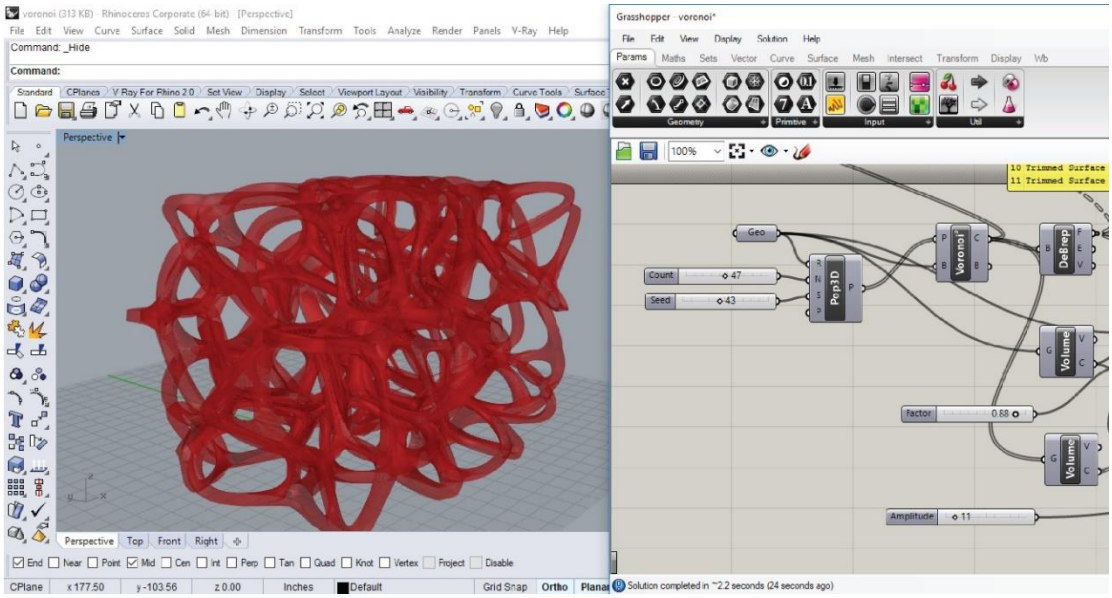


Figure 52. Experiment of Different Inputs



1. Count (the amount of loops): 7

2. Seed (the points in the subset planes): 19

3. Factor (overall size of object): 0.99

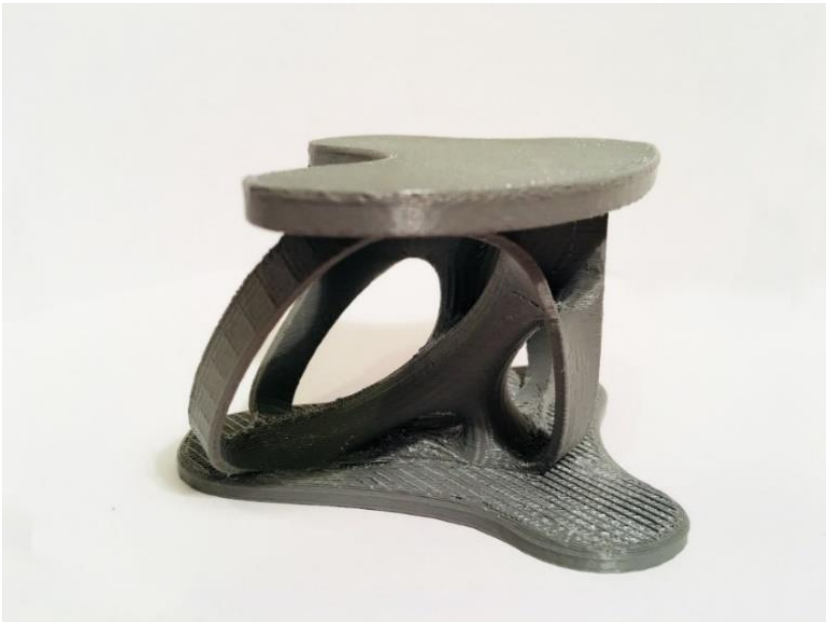
4. Amplitude (the size of each loops): 17

5. Level (controlling the roundness of structure): 3

6. Distance (thickness of each stem structure): 5.4

After creating the mass, the structures were converted into a polygon unit in order to be used in 3D Rhinoceros. A top and base were added to finish the table. I have also formulated many variations with the same pattern with Figure 53. showing the most stable design out of the many variation.

Figure 53. Voronoi Table Design



Summary

There are several ways and programs that can create parametric design, and there is no right answer to its creation process. Segmentation patterns were first made and used by many designers in the past, and designers still utilize this pattern to create surfaces of different figures. Many designs were developed with Voronoi patterns that were used sometimes as a template. The programs that we use today have been developed to a very advanced technical level for helping designers create such patterns in more efficient ways. As time passes, it will develop even further to save time and effort to allow the designers to become more creative and make more innovative designs.

Now, computational design is preferred by many designers to create new forms and explore new methods. My research has investigated the use of parametric design in the airport environment with computer modeling and computational production. Today, parametric designers prefer repetitive aesthetics of quality and efficiency of the design. (Sakamoto, 2008) Grasshopper is a high-technical software that creates many curvilinear patterns and integrated structures; however, it is important for the designer to think deeper and apply more advanced thinking to utilize the algorithm method. Going back to the design of the airport furniture, user interaction with the furniture is a major element that contributes to the humanism. So, high-technology does not restrict or overtake the humanistic features of furniture design.

CHAPTER V

CONCLUSION

Parametric design is highly preferred in many different industries, including movie productions that creates science-fiction movies and outer-space concepts. New technology and high-tech engineering software are always welcomed in such field and parametric design is one aspect that contribute to future environment.

Then, if we go back to *The Martian*, what about the Ikea Harte LED lamp make the design seem so futuristic, even though it did not have parametric design? It can be assumed that the uniqueness of being a high-technical device makes the lamp seem futuristic. Where the lamp was a simple product looking towards futurism, the TWA Airport was a landmark of futurism. Not only did it function as a terminal as intended, the external structure embodied curvilinear forms that had once been deemed impossible. It is a fully futuristic concept where users feel the emotions and humanistic elements of travel, and it still remains a famous futuristic architecture today. The Beijing Daxing Airport takes the futurism concept even further than the TWA Airport. The biomorphic curves that make up the exterior and the integrated structures are added elements that will allow the airport to become widely known as a new futuristic architecture.

Through my body of work, I have brought the elements of futurism that were seen in the airports into the designs of my furniture. This exploration of futuristic furniture allowed the distillation of elements of futurism into 3 different aspects.

The first is the visual aspect of curvilinear forms and transitions at the edges, which are representative visual forms that come to mind when thinking of TWA or Beijing Daxing airports. The uniqueness of the curve feels new and futuristic because it is difficult to construct. Another element is when the forms is defined by the shells, only the appearances, The exterior was intentionally created to look futuristic as mentioned in the hypotheses. The interior of the TWA and Beijing Daxing airports show an integrated structure that play multiple roles of structure as well as furniture. Textures are minimalized, and material is selected based on its ability to form the structure.

Second is the functional aspect of futurism. Automation is a convenience that comes with the rising dependence on machines. Integrated technologies will continue to add to the development of futuristic designs not just for the end product but also the manufacturing of the product with digital production and fabrication, laser cutting machine, CNC, 3D printer, etc. Form will surely follow function, but it can change, and modularity allows various new interactions and functionality to emerge. New manufacturing methods with new materials will inevitably lead to new designs.

Last is the theoretical aspect where the perception of time, various ideas of the future, and the progress of high-technology all have their share of influence over futurism. Acceptance over time and the flow of the era determine the design technology of the era. Therefore, new and futuristic designs are unavoidably made. The background of technology, climate, geography, society, and infrastructure impacts the various ideas designers formulate, especially when it comes to predicting ideas of the future. Retro-futurism is an example, when the art-period was influenced basically by war and science. Despite highly-advanced technology, the machine cannot lead the design process. However, we cannot deny that technology has rapidly developed and is continuously developing. The combination of the designer and computer to create new designs is an evolution to futurism, and the merging of different technologies and my ideas are apparent in the results of my various project works.

Future furniture design is inevitable from these elements. All futuristic design can be represented with high-technology but that is not necessarily true. Future design may not be able to replace antiquity and strong humanistic qualities of furniture, but it proposes new ways of thinking and producing furniture of previously inconceivable aesthetics. If I were to ask Neri Oxman, “Can computational design be the future furniture design?” I have no doubt that she would say, “Yes, but in a more collaborative way.” If I were to ask Bruce McCall, “What is your future furniture design?” He might say, “Have it your way. It is the designer’s choice.” With the diverse capabilities and opportunities high-tech

software provide, the designer's role in coming up with new aesthetics for furniture becomes even more important than what it is today.

The resulting body of work that I have created for this thesis suggests to me that the potential of futuristic design options lies in the application of digital fabrication methods, parametric modeling design techniques, and humanistic envisioning of the future. New technologies, materials, manufacturing methods, modeling and prototyping techniques, not to mention scientific and technological discoveries to come, will all contribute to the vocabulary of futuristic design. Therefore, future furniture design is not achievable only with high-technology, but in tandem with an augmented imagination of the furniture designer.

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APPENDIX A

IMAGE SOURCES

All Images are by the author unless otherwise stated below.

Figure 1. https://www.foxmovies.com/movies/the-martian

Figure 2. https://www.foxmovies.com/movies/the-martian

Figure 3. https://youtu.be/2m7szptyYPY

Figure 4. https://condenaststore.com/featured/jfk-international-rocketport-bruce-mccall.html

Figure 5. The Architecture of the Jumping Universe

Figure 6. https://kr.pinterest.com/pin/366691594635440650/

Figure 7. http://www.zaha-hadid.com/

Figure 8. Neri Oxman & MIT Media Lab

Figure 9. http://www.6sqft.com/wp-content/uploads/2015/09/twa-flight-terminal interior.jpg

Figure 10. http://www.6sqft.com/wp-content/uploads/2015/09/twa-flight-terminal-interior.jpg

Figure 11. http://www.zaha-hadid.com/

Figure 14. https://cdn.ek.aero/downloads/ek/pdfs/concourse/concourse_

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Figure 16. http://www.zaha-hadid.com/

Figure 18. http://www.zaha-hadid.com/

Figure 20. http://www.zaha-hadid.com/

Figure 21. https://asknature.org/strategy/folds-allow-efficient-leaf deployment/#.WgaR1WhSzIU

Figure 49. Google Image

APPENDIX B

INTERNSHIP: PROJECT OF “BREATHE”

This internship project was created by a group of students from neighboring Greensboro colleges, NCAT, UNCG, and Greensboro College. Renaissance Plaza and Richardson Properties agreed to put this project together to integrate the façade of Renaissance Plaza parking garage with LeBauer Park through the public art collaboration. Under selected faculties’ supervision, the students have spent the past three months coming up with the best design solution for the building. The project was designed to solve aspects of the garage such as lighting, participation, maintenance, and aesthetics. This design was aimed to capture the best overall interpretation of the Greensboro community.

The project, titled “Breathe,” started off with site research and analysis in order to initiate the design with consideration of the overall surroundings. Renaissance plaza is located on North Elm Street, between Summit Ave and North Davie Street. The parking garage is across from LeBauer Park facing each other and the parking garage is currently surrounded by trees to hide the harsh light that comes from inside the garage. Our goal was to create an interesting and lively composition for an existing concrete façade while preserving and expanding Greensboro’s sense of community. The process started with brainstorming figuring out what would be the best keyword for Greensboro representative a sense of community. We divided into three groups each with

keywords to develop and create design proposals. The mapping and textile group had the title of their group as “You are Here,” and the idea was to overlay the map of Greensboro onto the façade. The team researched historical places and designated them as the important spots of Greensboro to design the uniqueness of the façade. “Bio-playground” team’s concept was to have nature expressed as cells in three dimensional form. The cell structure was inspired by trees, and the diverse patterns became the seating for people to sit. Plus, the theme matched with the playground in the LeBauer Park and therefore, was called the “Bio-playground.” Last was the “Participation” team that developed the idea called “Breathe.” The concept of the design was breathing together as a community, and the motivation came from the behaviors of bees in beehives. The idea consists of kinetic patterns of hexagon panels that use the wind to drive motion. Our intentions were for the façade to be interactive with the community as well as be visually attractive by using the honeycomb pattern.

A mid-project critique was held with the clients to know what their thoughts were by experiencing these three projects. Ultimately, “Breathe” was chosen as the main design; however, with the various feedback, the three projects were useful and we decided to merge those ideas into the “Breathe.” The seating idea was from the “Bio-playground” team, reinforcing the concept of participation, while “You are Here” team contributed to the structural ideas where supporting beams would have to be used in order to be attached to the building.

The initial design was a beehive, a shape representative of the sense of community. Most anybody would be able to easily get the impression of community and relate when they see the hexagon shape. From the start we wanted an interactive façade, whether it would be powered by nature or by people because the hexagon needed a unique element rather than just being a universal symbolic shape. The group investigated what a futuristic honeycomb would be, and by looking at the insides of a honeycomb, honey filled and empty cells were the design solution. The hexagon patterns emulated the motion of breathing with direction, rhythm, various sizes, and shapes.

Therefore, the final concept had been fixed with inhalation and exhalation of breathing overlaid on a honeycomb and the universal shape denoting community. Breathing is life regardless of who you are or where you are from. Together, we breathe and live and thrive in Greensboro as a part of the community. The expectations were to reinforce of the sense of community in Greensboro, but also create an experience of visual pleasure. The inspiration behind this idea was how bees communicate with each other through dance as well as scents. Another inspiration was the artwork of Richard Serra, who made special effects with the opening and closing of façades. Richard Serra was a big influence behind “Breathe,” especially how the placement of his sculptures allowed his audience to participate with the art.

The composition of the hexagon patterns were laid on the façade based on the action of breathing. There are approximately 180 hexagon cut-outs in

total, and the sizes are planned to be 3 to 12 inches large. The sizes were based on the site research, and the team found out they should stay six feet above the floor to keep them out of easy reach. Aside from the hexagon patterns, 3 seating areas were applied right in front of the façade with different elevations to have separate functions. The far left seating starts at a height of 6 to 8 inches to form a platform, the middle seating becomes a bench at 15 to 18 inches high, and the far right a bar stool at 33 to 35 inches high. The different levels of seating follow the pattern of the hexagons, gradually rising, and this will enhance community participation by allowing people to functionally use the space.

The lightings was one of the core design elements of the façade design. The team wanted to apply extra lighting to enhance the hexagon pattern so that it could reinforce the brightness onto the sidewalk. We decided on using R-W 48 wall washing LED lights, which are long strips of LED light fixtures. There will be three yellow lights placed at the top of the façade at the exhale point, and at the bottom, there will be two red lights at the inhale of the façade. The color scheme that was chosen for the façade relates to the concept of our design. The yellow represents the sense of community and the red represents the elegance of the building.

Materials were decided on with quotes from fabricators and ended up with 270 “Core Ten Solid Weathering” panels. Each panel is 48 by 120 inches and will total up to 16,124.29 inches. This is an affordable material but also, it is unique due to its evolution over time, developing a rust coating that protects the metal

from further decay. The rendered image was made with the assumption that the material will change within fifteen years. This material was also used by Richard Serra, who inspired our design.

The gutter will be placed between the façade and the parking deck for accessible cleaning purposes. The gutter will act as a net catching any garbage or debris from the outside of the façade and will be placed on the lower level of the façade at an angle. The gutter will start at the platform and rise as it makes its way to the end of the exiting garage door.

In summary, the group of local college students created a site-specific artwork for the Renaissance Plaza Parking Garage. Since the parking garage is located right next to LeBauer Park, the team suggested creating a strong sense of Greensboro community by incorporating the playfulness of LeBauer Park and elegance of the Renaissance Plaza. The “Breathe” design aimed to solve several issues that concerned the clients. The façade is designed with curated color LED fixtures, while the organic figuration of façade with hexagon patterns inspired community sense much like a beehive.

My personal goal for this project was not only to design the façade, but also to collaborate with various professionals and students together to create the artwork. First, this experience was a chance for me to work in the practical field where multiple types of coordination and other participants are involved. I experienced and learned from collaborating as a team, made great synergy with

teammates and established networks. Second, the artwork will be engaging in the parking garage site as one of the projects relating to my graduate thesis work. The curved surface structure and the pattern works were quite challenging but gave me the knowledge of how it could be applied as part of the design. I am glad to have participated on a project that focuses on human behaviors and interactions to help and change our community. The final presentation that was made from the team was successful in garnering interest from the community, and we are hoping to surprise the rest of the community after the design is built.