Confluence: CAD and CNC Technologies Integrated into Studio Furniture Design

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CONFLUENCE:
CAD AND CNC TECHNOLOGIES INTEGRATED INTO STUDIO FURNITURE DESIGN

A Thesis
Submitted to the School of Graduate Studies and Research
In Partial Fulfillment of the
Requirements for the Degree
Master of Fine Arts

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Indiana University of Pennsylvania
May 2013
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My MFA thesis exhibition offers new approaches to the creation of studio furniture by expanding traditional methods of furniture making through new technologies such as CAD (Computer-Aided-Design) and CNC (Computer Numerical Control), which are applied to hand-finished furniture forms.

My furniture follows craft historian Muneyoshi Yanagi’s concept of Folk-crafts, which argues that function is the primary guide to design. Roland Barthes and Victor Papanek’s observations on the safety of wood as opposed to chemicals and metals, supports my choice of materials in furniture designs. In response to design educator Galen Cranz’s research, my designs provide solutions to the problems of ergonomics by incorporating acupressure points into each chair.

CAD and CNC technologies are integrated into my production process. My furniture forms demonstrate how advanced design technologies synergistically interplay with traditional woodworking techniques. The components produced by the CNC router are joined and finished with traditional woodworking techniques to create utilitarian furniture. Ultimately, my approaches engender studio furniture designers’ interests in advanced technologies.
Acknowledgements

Above all, I owe a debt of gratitude to my wife, Soyoun Kim, my beautiful sons, Yoonjae and Bradley Hyunjae, and my parents, You-kil Shin and Ik-soon Byun. Your patience and ongoing support during the completion of my MFA kept me motivated.

To my thesis committee members, Steve Loar, Lynda LaRoche and Dr. Irene Kabala, thank you for your continual support and encouragement during the last three years of my investigation. Without them, my thesis would be still drifting around its destination.

Alphonse Mattia, a mentor over last two years, you are responsible for a majority of my design knowledge and woodworking. You have inspired me to create furniture with humor.

Bradley Triana, Daniel Rivera and James McNabb, my best friends and co-workers, I would like to thank for your consideration and willing support during my three years sojourn at IUP.
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CHAPTER I

INTRODUCTION

Natural wood is a scarce and expensive material in South Korea. Korean forests were diminished during the Japanese occupation and the Korean War; as a result, wood is expensive compared to US prices. Development of the heavy chemical industry, which became a fundamental source of improvement for the Korean economy since the 1960s, has forced many Korean artists, craftsmen and furniture designers to use synthetic materials instead of wood.

I earned my first MFA degree at Hongik University working with resins, fiberglass, foam and automotive paint to create furniture. These chemicals were cheaper than natural materials, easy to work with and convenient to repair. Using synthetic materials allowed me to focus on creating exaggerated forms to visually stimulate audiences.

Long-term exposure to chemicals causes serious health problems. After the material has cured, toxic emissions from the material continue to create health issues. Ultimately, the exaggerated forms of my furniture blurred the essential function of my works, confusing the boundaries between furniture and sculpture. In order to overcome these issues, I had to shift from chemical to natural materials and start to create functional furniture.

This thesis contains an alternative furniture design processes, which combines traditional woodworking techniques with industrial design technologies. In Chapter II, I described the artistic and theoretical influences on my furniture
designs. In Chapter III, I described the processes and research involved in CAD and CNC technologies in order to elucidate potential problems. These problems could hinder the integration of these technologies with studio furniture design. In order to overcome this barrier, I illustrated the CAD and CNC processes used to create the Milk Chocolate Bowl design at the beginning of Chapter IV. The final analyses of and outcomes pertaining to the full body of my work are contained in Chapter IV and further illustrate the potential of these technologies.

I am convinced that my efforts will have a positive impact on studio furniture designers and art students who may initially find the use of CAD and CNC technologies daunting or overwhelming.
CHAPTER II
REFERENCES AND INFLUENCES

1. Function

Muneyoshi Yanagi's thoughts about Folk-crafts (mingei) came to fruition in his best known work, *The Unknown Craftsman*. Yanagi thought that there were two categories in crafts: Art-crafts, objects made to be visually admired, and Folk-crafts, objects made to be used. He believed that Folk-crafts were the essential category among the various crafts because of its functionality. He wrote about Art-crafts only because Art-crafts conflicted with function.

Design educator Victor Papanek echoed Yanagi's view on crafts. Papanek discussed the problems inherent in contemporary art and design in his *Design for the Real World*. He chose Gerrit Thomas Rietveld's Red-blue Chair (Fig. 1), as an example of poor design. Papanek wrote:

No longer does the artist, craftsman, or in some cases the designer, operate with the good of the consumer in mind; rather, many creative statements have become highly individualistic, auto-therapeutic little comments by the artist to himself (Papanek 32).

Papanek points out that if furniture cannot be functional, it is sculpture,
not furniture. The most important function of a chair is for sitting comfortably. The chair is not a chair if a user is afraid to sit on it. Rietveld’s chair is not good furniture design, even though it is famous and widely cited as a crucial object in the history of modern furniture design.

2. Form

The content of my earlier work was a dichotomous exploration of beauty and ugliness. Italian medievalist Umberto Eco professed that it is hard to establish whether something is ugly or not. To Western eyes, certain fetishes and masks from other cultures seem to represent deformed creatures, while for natives they have positive values (Eco 131).

While designing my early works, I was inspired by the grotesque. Works by H.R. Giger, Joris Laarman and Zaha Hadid informed my ideology. H.R Giger’s organic shaped chairs and tables were based on his eroticism, Joris Laarman’s Bone Chairs, created via advanced technologies such as CAD and automotive manufacturing systems, and Zaha Hadid’s tables made of fiberglass resin, led me to create works that stimulated audiences with awkward and incongruous shapes (Fig. 2).

Against this backdrop, I applied representations of human malformations such as Polymastia and Terata to my furniture designs (Figs. 3 & 4). Although these objects functioned like furniture, they had critical problems. The
exaggerated forms were disturbing, and the sizes and heavy weights were unwieldy.

These problems required an evolution of my design language from organic shapes to a simplified style. The Bauhaus inspired me to rethink my design methodology. Architects and craftsmen of this school felt that there were some basic principles of creation.

Those principles can be understood by viewing Marcel Breuer’s Wood-slat Chair (Fig. 5). Breuer required an elastic seat and back rest, but no heavy, expensive or dust-collecting cushioning. He intended the spine to be free since any pressure on the spine is both uncomfortable and unhealthy (Droste 82). These requirements allowed the piece to be mass produced and functional. Breuer’s emphasis on productivity meant that he considered the use of machines before he started to design.

Bauhaus designers created arts, crafts and architecture, using holistic concepts, which incorporate objects with the same design principle in a space. Walter Gropius, director of the Bauhaus, believed that the goal of art education was to create buildings of the future (Droste 22). Straight lines, rectangles, circles
and arcs were the basic components for creating a form. Basic geometry shapes reflected Bauhaus designers’ desire to make work through the use of machines.

Most contemporary houses are built with straight lines and planes, and many of us reside in a space influenced by the Bauhaus and the International Style, inspired by former. According to Bauhaus design objectives, furniture designed with organic curves will interrupt a space designed with straight lines. My furniture forms are designed to be integrated into a home; I do not want my work to interrupt a space with exaggerated form. The reception of my work into a space is paramount. The design of each piece of furniture must incorporate geometric figures.

3. Material

The harmful effects of chemicals conflicted with my desire to create functional objects for daily life. I had to find more user-friendly material and this decision was the basic starting point of my furniture design.

I was influenced by Roland Barthes’ discussion on French toys in *Mythologies*, which examines the selection of materials in children’s toys: “Current toys are made of a graceless material, the product of chemistry, not of nature. It destroys all the pleasure, the sweetness, the humanity of touch” (Barthes 54). Barthes emphasized that wooden toys are safer than ones made from chemicals or metals because wood is non-toxic.
Many people remember their childhood by smelling the odor on their toys. Sarah Dowdey describes how smell works as follows:

The olfactory bulb is part of the brain’s limbic system, an area closely associated with the emotional brain. Smell can call up memories and powerful responses almost instantaneous (Dowdey).

Chemicals emit fumes, but the fibrous cells in wood emit personal odors when children play with their wooden toys. Wooden toys are more durable than plastic toys. Furthermore, natural wood grains on a toy’s surface allow the user to appreciate the beauty of nature.

Victor Papanek mentioned Fingermajic, a wooden toy designed by Jorma Vennola and Pekka Korpiaakko, to emphasize the excellence of wooden toys (Fig. 6). Papanek suggests that Fingermajics were designed to give both pleasure and training in such skills as twisting, turning, threading, pressing, pushing, etc (Papanek 107).

Papanek further suggests that many contemporary toy makers regard their products as supplements to Fisher-Price or Sesame Street. As a result, toy makers force children to believe that it does not matter if the quality of a toy is good or bad, and that toys must be covered with glittering ornaments. Papanek states that wooden materials are best, and toys should be designed to develop a
child’s intelligence and physical fitness (Papanek 107).

I feel that the same principles hold true in furniture design. Since my furniture will be located in a user’s personal space and directly experienced by one or more individuals, I decided to use wood as my primary material.

4. Design Methods

It seems that South Korean design principles are inextricably linked with industrial design (Fig. 7). The economic devastation after the Japanese occupation and the Korean War forced educators and designers to develop a standardized design process in order to manufacture products in a short period of time, a process that ultimately affected furniture design.

In contrast, American studio furniture design educators focus on developing the creativity of a student through experimentation with many different materials. My work is not about evaluating these pedagogical approaches. Instead, I select and choose from these two different approaches to create a design process that fulfills the main purpose of my design.
I executed a simple comparison, which allowed me to select the following processes (Fig. 8): first, I will use traditional woodworking techniques with digital technologies, as I feel it is essential to demonstrate the potential of the combination. Second, I will pursue standardized furniture product design processes such as brainstorming, preliminary sketching, rendering, digital modeling, mock-ups, critiques, and feedback. Third, I will create objects for a specific consumer. Fourth, I will use natural wood as the primary material, which will fit into the mid-to-high price range category. Fifth, advanced technologies will ensure productivity and will allow me to save all design data as digital files in order to duplicate limited editions of my furniture. Sixth, my choice of traditional woodworking techniques will result in a solid piece of furniture, which I believe is necessary for furniture that is used daily. Seventh, I will design furniture based on the physical size of a specific user. This process of selection allows me to draw these two tables design positioning, which will be a blueprint for my designs (Figs. 9 & 10).
Fig. 9 Design Positioning (Form & Function)  

Fig. 10 Design Positioning (Purpose)
1. CAD & CNC

1) CAD

Computer-aided design (CAD), also known as computer-aided drafting, is the use of computer systems to assist in the creation, modification, analysis, or optimization of a design.

I studied furniture design in South Korea for about nine years and worked about three years as a designer and educator. Most South Korean design schools require students to learn CAD for more than two semesters. In South Korea, digital-based design is stressed as one of the most important educational elements in most design schools because it is believed that the main purpose of a designer is to create virtual reality. A designers’ digital ability will save money by making actual design samples redundant. Manufacturers or company owners want to confirm the virtual object on a monitor or a print to identify the shape, texture and function of a design, even though it does not exist physically. The standardized curriculum obviously reflects societal needs.

2) CNC

My CAD experiences in conjunction with the use of a CNC router allowed me to create successful designs. I came to understand that the transformation from virtual reality to a physical object can be applied to the creation of studio
I created a basic manual that explained how to use these technologies, performed demonstrations, and had informal discussions about the potential of these technologies with graduate students. Students erected a psychological barrier built from misconceptions about or fears of these new technologies. Only two graduate students successfully used a CNC router to create their work.

The fear and anxiety exhibited towards new technologies suggest that new methods appear threatening in some way to the traditions of woodworking. It seems to me that some students viewed advanced technologies as a sort of enemy of traditional woodworking. These students’ prejudice toward advanced technologies made them regard CAD and CNC as suitable only for industrial or interior design.

However, these technologies are not based on alchemical processes, but are only one of many tools for furniture makers to explore. Tradition is not a permanent phenomenon. In time, as new technologies are applied to traditional crafts, the repetitive usage of these technologies will eventually establish them as traditional.

2. Traditional & Digital Technology

Many traditional-based craftsmen and designers tend to regard machine-aided works as pieces that are not original, although these crafts practitioners do not state that work cannot be modified by a power tool. Many contemporary furniture makers like to be called traditional woodworkers, even though most of
them use jointers, planners, table saws, and band saws as basic tools in their wood shops (Schwarz).

Until the mid-twentieth century, there were only a few people using power tools and machines, and no one called these tools traditional. However, the conception of power tools has recently changed. These once non-traditional tools have become integral to the woodworking process. I assume the reason for this phenomenon is due to the falling prices of woodworking machinery.

The following graph highlights some of contemporary woodworker's thoughts about CNC technology (Johnstone):

![Graph showing changes in CNC ownership over time.](image)

**Fig. 11 Changes of CNC Ownership**

According to a survey carried out by *Woodworker’s Journal*, the number of CNC owners in 2012 increased from twelve to sixty people during the past ten years. It seems that this phenomenon reflects the falling prices of CNC machines. According to the research I have conducted, many internet forums for CNC users quote a price of approximately seven hundred dollars for Do-It-Yourself CNC kits.
(Fig. 12). These machines do not require expert engineering knowledge to assemble.

The same situation applies to the price of CAD software. In 1980, the first CAD software sold for $125,000 (Atraccion1982), more expensive than the average price of an American house (Adams 73). In contrast, Autodesk 3D Studio Max 2012, one of the most expensive CAD software today, is approximately $3,000. In addition, any student with authorization from the company is able to download the program for free. In the case of Rhinoceros 3D, which is widely used for making three-dimensional drafts, the price is approximately $300. There is also varied free software such as SketchUp, Autodesk 123D, etc., some with functions equivalent to, or surpassing, those of the programs mentioned above. Falling prices of CAD software will be the main reason it gains popularity in the future, and will possibly become a traditional drafting method for furniture designers.

I presume that falling prices of CNC machines and CAD software will allow woodworkers more affordable options for in-house manufacturing. At this time, out of 1793 individuals polled, only 117 (6.52%) owned CNC machines. Despite my research, falling prices, and personal communication with those currently working in the field of woodworking, it remains unclear why such a small percentage of furniture designers use these technologies.
3. Fear of Advanced Technology

There is still a lingering barrier that is hard for potential CNC and CAD users to overcome. The obstacle seems to be fear or anxiety. I am convinced that traditionalizing these advanced technologies will be possible if there is a way to help potential users to overcome their reluctance to use these technologies. To that end, I created a manual that outlined the processes through diagrams and detailed descriptions. Nine furniture forms, which synthesized traditional woodworking techniques used CAD and CNC technologies were created. CAD and CNC are especially effective when utilized to transform virtual reality into physical reality.

It is difficult to find a case study for a design piece created by CAD and CNC, although many internet forums support basic theories about the nature of CAD and CNC. These theoretical discussions will confuse users who hope to use these technologies for their project.

In the following Chapter IV, I illustrate the design and production processes used to create Milk Chocolate Bowl in order to show how I apply industrial design processes. Illustrating the complete production processes of an object created with these technologies, will allow studio furniture designers to apply my production methods to their projects. Furthermore, I uploaded my digital files consisting of AutoCAD draft, 3D Studio Max, and G-codes to my website (www.shinyongjun.com) to help hypothetical users easy access these programs.
CHAPTER IV
ANALYSIS OF WORKS

This chapter analyzes nine works, which grew from my research on form, function, material, design methodology, and new technologies. I describe my design processes including CAD and CNC, through the analysis of Milk Chocolate Bowl. While my other eight designs varied in form and function from Milk Chocolate Bowl, all of my designs utilized CAD and CNC to build the forms.

1. Milk Chocolate Bowl

1) Basic Design Processes

Before I started to design Milk Chocolate Bowl, I adapted an industrial design method which is used for clarifying a target consumer. In industrial design this approach is called a conceptual design and is widely used to help students understand the product design processes. It usually begins with basic research on a selected product line for a specifically targeted, hypothetical consumer. Adhering to this methodology, I selected Hershey Chocolate Company as my imaginary consumer.

According to Hershey’s website, their line is composed of more than sixty products. Most of them have milk chocolate included in their names, and it seems that Hershey tries to use this expression as an identity marker, which inspired me to play with various puns on the word milk.
The diagram above shows the development of an idea. Many of my designs' forms and functions, even the type of material I chose, were created using this process (Fig. 13). Functionally, the object is a container for Hershey's milk chocolates. The form was inspired by the shape of a cow udder, and four nipples were transformed into legs in order to give the bowl stability. Milk paint covered the exterior.

I executed dozens of preliminary sketches and then selected the final form for the bowl (Fig. 14). The sketch was refined through several freehand drawings and was then used as a source for building a digital three-dimensional model with CAD software: 3D Studio MAX and AutoCAD.

2) Digital 3D Modeling

For creating the 3D models, I used 3D Studio Max, which is one of the most powerful and accessible CAD programs. I additionally used AutoCAD 2009 to draw a digital draft of detailed parts. Then the two digital files were joined
together as single object in 3D Studio Max. The completed 3D model was used for generating G-codes, which define the path of the CNC machine, and Vectric Cut 3D enabled the G-codes to control the Centroid CNC router.

The figures above show the process for making a bowl by extracting an overlaid hemisphere (Figs. 15 & 16). The extraction was enabled by using the ‘pro-boolean’ command located under the ‘combined objects’ toolbar in 3D Studio Max (Fig. 17). The ‘pro-boolean’ command allows removal of the overlaid part between two different objects.
I then created four bowls with the ‘pro-boolean’ command. Four hemispheres were created using the ‘sphere’ command under ‘standard primitives’ on the toolbar (Fig. 18), then the created objects were merged into one object by using the ‘attach’ function under ‘editable polygon’ (Fig. 19). I arranged 165mm-diameter hemispheres on top of the attached object. The ‘pro-boolean’ command was used to remove overlaid parts (Fig. 20).

![Fig. 20 'Pro-boolean' Execution for Milk Chocolate Bowl](image)

One interesting aspect of this digital modeling process is that the four legs (nipples) of the bowl were generated by Auto CAD. Both 3D Studio Max and Auto CAD are provided by Autodesk, and compatible with each other. I drew a cross-section of a leg with the line and ‘fillet’ function, located under the ‘object’ toolbar of Auto CAD (Fig. 21), then saved it in the DWG format, so that 3D Studio Max could load the Auto CAD file. I imported the saved file to the window of 3D Studio Max where I was making the body of the bowl.

The imported file turned into a line. I used the ‘lathe’ function located on
the ‘modify list’ to make the line a solid object (Figs. 22 & 23). The rotated object was located on the bottom of each bowl by using the ‘magnet’ command (Fig. 24). All of the created objects merged into one by using the ‘attach’ command under the ‘editable polygon.’

Figure 25 shows the simulation rendering or choice of materials (Fig. 25). I used the material editor to apply a mapping source to the object, and Mental-Ray renderer was used for the rendering. Mental-Ray renderer is a plug-in tool used to make a photorealistic image. After confirmation of the digital form created in 3D Studio Max, I exported and saved the model in the stereo-lithography (STL) file format because Vectric Cut3D, G-code generating software, supports only 3D models created in STL format.
3) G-code Generation

The generated STL file generated by 3D Studio MAX could be read by Vectric Cut3D. There are three important dimensions to put into the parameters. This program needs the decimal x, y, z sizes of the object, material, and the type and size of router bits. I input 25% for the distance between 1/2” end mill roughing tool paths, and 3% for the 1/4” ball nose finishing path (Fig. 26).
After the input processes are finished, the program supports a virtual cutting simulation (Fig. 27). This simulation illustrates the direction and movement of the router bit, which is impressive because it is useful in preventing an accident. After confirmation that there was no problem in the cutting simulation, I saved the two generated G-codes into a thumb drive.

![Cutting Simulation](image)

**Fig. 27 Cutting Simulation**

4) CNC Router Execution

I put the G-codes into the CNC router through its USB port. I then embedded the laminated plywood on the CNC and found the center point of the top surface (Fig 28). I put a 1/2” end mill into the router and then moved the router onto the center point of the material by
pressing arrow keys on the control panel. When the end of the router bit touched the center spot, I made the CNC recognize that point as its starting point to work with operating the input device of the machine (Fig. 29). After setting up the zero points, I executed the roughing cut. I changed the router bit to a 1/4” ball nose right after the roughing cut was finished, then I loaded the finishing tool path and applied it onto the material (Fig. 30).

5) Hand Finishing

I refined the form and surface of the CNC result by using traditional chisels, scrapers and sandpaper. The refined surface was painted with gesso and milk paint.
Fig. 31 Milk Chocolate Bowl (Plywood)

Fig. 32 Milk Chocolate Bowl (Painted)
2. Walnut & Plywood Tables for Milk Chocolate Bowl

These twin tables were designed to contain the Milk Chocolate Bowls and were made from two different materials. I applied natural walnut for the first piece and the second piece was made from rough-grade construction plywood. Walnut is associated with luxury, refined furniture making, while plywood is regarded as a material for making a cheap box, work table or wall. I examined how two different materials could be juxtaposed in the same form.

During the exhibition, those in my audience who were not familiar with woodworking processes and the materiality of wood reacted favorably to the plywood table rather than the walnut table due to the striated pattern formed by the laminating process of plywood. These reactions reminded me of Israeli designer Ron Arad's production processes. Arad's hand-crafted aluminum furniture form is one of the most famous contemporary furniture works (Fig. 33), and while he is recognized for the aluminum form, he produced the same form out of different materials using mass production methods with the furniture companies Vitra, Kartell and Moroso (Fig. 34).

Many designers focus on creating distinctive one-off pieces, but if their work could be mass produced in alternate materials and processes the consumer would have choices in the look and cost of the furniture. I assume this
synthesized production allows artist and designers to keep their craftsmanship and productivity.

Although these tables have the same form, I had to build them in different ways. Except for CNC routing, which produced the hole in the center of the table top, I used general woodworking techniques such as domino jointing and wood turning to create the walnut piece. In contrast, laminated plywood does not have strength to endure the pressure of the lathe as it is turned into a spindle. Therefore, I had to put a 1/2-inch thick steel rod into the laminated plywood (Fig 35).
Fig. 36 Milk Chocolate Bowl Tables
3. Milk Chocolate Bowl Shelf

This shelf plays with the Milk Chocolate Bowl and natural walnut. Cracks in the walnut slab were joined by butterfly joints, which are known as George Nakashima's icon for woodworkers (Fig. 37). I manipulated the CNC router to make a hole in the slab so the bowl could sink into the shelf. The combined shape allows audiences to imagine the shape of a cow and its udders (Figs. 38 & 39).
4. Candle Table I

Tables are one of the most frequently used pieces of furniture. People use them for eating, reading, displaying, etc. However, they usually forget actions and events that took place at the table, despite the fact that tables are usually imbued with the rituals of everyday life.

The mahogany Candle Table was inspired by this lapse of memory. Many tour guides usually mention the size of stalactites in a lime cave to help tourists understand the age of a cave, although dating a cave by the size of its stalactites is controversial. I assumed that if a table is imprinted with a person’s experiences, the user will be able to remember the past.

In the same way that a tour guide uses stalactites to explain the history of a cave, I decided to apply candle wax to record how long a user and a table shared their time. I designed a tilted 75mm diameter shallow candle holder to fit a same-size candle (Fig. 40). I also designed a shallow bowl area for gathering the wax and four holes at the corner of the table top, which create paths for the wax to flow onto the leg.

CAD and CNC technologies were used for precision in executing the candle holder, shallow bowl part and holes.
5. The Unknown Craftsman Bookcase

Books are my teachers and the foundations for my designs. My passionate attitude about books makes me question the use of books as ornaments decorating libraries. The Unknown Craftsman bookcase contains my playful commentary about the ornamental use of books. Some people use books in order to show their non-existent knowledge for a guest. These absurd behaviors inspired me the transformation of a book into a pot stand (Fig 43). The Unknown Craftsman bookcase pokes fun at these alternate uses for books in order to inspire people to read.

The form of the body consist of straight lines, organic curves, two asymmetrical legs and an artificial book, titled The Unknown Craftsman same as the title of Yangi’s book that has inspired me (Fig. 44). I used CAD and CNC technologies to make the body, and I turned two legs using a lathe. The title on the surface of the fake book was made by a laser engraver.
6. Drinking Machine

Many Koreans love to drink, and they have an unwritten code of acceptable social behavior for drinking, which transforms the act into a communal rite. A person who pours and drinks alone in a drinking session is an ill-mannered person. This is because most Koreans believe that drinks are to be shared among friends.

Addressing this cultural ritual, I was interested in Poseokjeong, a Korean cultural heritage monument built around the 900s (Fig. 46). The Korea Tourism Organization describes the site as follows:

![Poseokjeong](Fig. 46 Poseokjeong)
Poseokjeongji (Poseokjeong Pavilion) was named so as the shape of the rock grooves, winding and shaped like an abalone. It is said that the Namsan Valley water was brought here, and was spewed out through a stone turtle, but the stone turtle does not remain today. This is where the Silla Kings had come with their officials and nobles. It is said that they would float their wine glasses on the water where the water would flow along the stone groove, and they would recite poems before their glasses floated up to them. (Korean Tourism Organization)

This game was called Yoo-sang-gok-soo (流觴曲水), which means floating cups on curved watercourses. I thought this concept reflected Korean drinking culture, and I decided to integrate its function and purpose into my design. To this end, I slightly reinterpreted and simplified the form of Poseokjeong and applied a fulcrum to create the flow of water or alcohol.

The reinterpreted form was constructed by executing a CNC router. The surface was then refined by scraping and sanding. I used an epoxy resin finish to prevent the absorption of liquids into the wood.

Fig. 47 Drinking Machine (Detail)
Fig. 48 Drinking Machine
7. Chairs

Acupressure Points Chairs are my responses to Galen Cranz’s remarkable analysis of contemporary chairs. In *The Chair: Rethinking Culture, Body and Design*, Cranz observes that “We design them; but once built, they shape us. As sitting in chairs spread to the common person over the centuries, it left its mark on the human body and human consciousness” (Cranz 15). Her mention of the problem inherent in the foldable Everett and Jones wheelchair shows how a poorly designed chair negatively affects a user’s posture. “Wheelchair users often develop bad posture while using these chairs. A sling instead of a plane, it allows the sitter’s pelvic bowl to fold in on itself, which allows the entire spine and rib cage to drive down and collapse inward” (Cranz 156). She refers to the transformed spine, from an S-shape to a C-shape, as a ‘C-shape slump’.

Cranz’s analysis drove me to examine how I could make users push their backs against the back of a chair because I assumed that this was one of the most efficient ways to prevent the C-shape slump from occurring. Therefore, I experimented with seat back designs that invited the user to lean against the back.

I chose acupuncture and acupressure therapy as one way to encourage the user to lean against the chair back. Ruth Kidson explains how acupressure therapists understand diseases holistically, and she uses heart disease as an example. Heart disease does not mean that there is a problem with a heart in an otherwise healthy body, or even that the heart itself needs to be treated. What it
does mean is that the patient’s vital energies have become disrupted in a way that has manifested as a disease of the heart (Kidson 26). Interestingly, this concept is widely used in daily Korean life.

In South Korea, many parents unconsciously use acupuncture or acupressure therapy as a first aid pain relief for their children’s digestive problems, headaches or insomnia. This therapy is performed by stimulating and pressing specific points on the back, belly, finger, ear, etc., for a certain period of time.

I began to focus on the similarities between how the therapy is executed by people, including acupuncturists, and how a chair gradually reshapes a person’s back to a C-shape slump. These two different actions occur when a part of body is directly pressed by other materials or a person. This intervention on the body made me apply a medical function to my chair design in order to encourage users to push their backs into the seat back. In other words, my Acupressure Points Chairs are intended to solve a user’s health problem and the C-shape slump in a single action.
1) Acupressure Points Chair II

Acupressure Points Chair II, inspired by Bauhaus’ straight lines, was designed for Bradley Triana. In this case, I measured Triana’s acupressure points while he was sitting on 450mm high chair. I then applied the location to the 3D seat back model using 3D Studio Max. After the transformation of the model to G-codes by Vectric Cut3D, I executed the CNC router to make a physical seat back on laminated ash.
2) Acupressure Points Chair IV

The form of this chair was inspired by Hans Wegner’s designs. His well known nickname ‘chair maker of chair makers’ illustrates his pivotal role in revolutionizing chair design. Among them, the structure of Round Chair was the most influential in my design (Fig. 51). The joinery I used to fix the seat back to the legs was influenced by Wegener’s inventive approach by using a shaping machine to connect his chair back to the rear legs. However, my joinery is different from Wegner’s because most of his leg designs are separated from the seat back. In contrast, I envisioned my chair legs as branches growing down from the back of the seat (Fig. 52).

Fig. 51 Round Chair

Fig. 52 Acupressure Points Chair IV (Detail)
I applied eight bumps for spleen and stomach acupressure points. This chair was designed for my digestive system. For acupuncturists, the spleen is the root of depression, the main cause of indigestion. I anticipated that if my chair could stimulate both acupressure points at the same time, the effect on the body would be holistic.

I used the same design and manufacturing processes in Acupressure Points Chair II for making the raised areas. I also used an angle grinder, files, rasps, chisels and a spoke shaver for shaping and refining the organic curves that were inspired by modern Danish chairs.
3) Acupressure Points Chair V

Acupuncture Points Chair V embodies my beliefs about the functionality of furniture. Most pregnant women suffer from edema due to decreased kidney function. I designed this piece for the relief of my wife’s symptoms during her pregnancy. After a discussion about her favorite styles of chairs and types of woods, we came to an agreement on a modern Danish chair and dark brown wood. For the design of this chair, I measured the location of my wife’s kidney acupressure points on her back. Their location was 240mm above the 440mm height seat. I then used AutoCAD and 3D Studio Max to create two bumps on the right position of the 3D-modeled chair back. The 3D model was created by using a CNC router on a laminated mahogany block.

Fig. 54 Acupressure Points Chair V
I have two children. Yoonjae, my first son, was born in 2005 while I was using chemical materials to construct my sculptural furniture forms. My second son, Bradley Hyunjae, was born in 2012. Yoonjae had eczema on his face for more than a year right after he was born. In South Korea, eczema is one of the most common infant diseases. It is known that there is no essential therapy because of its unknown cause. Many physicians suspect only some issues such as genetic inheritance, fumes from constructive chemical finishes, or air pollution.

I felt guilty for a long time whenever I looked upon his face, even though there was no evidence that his symptoms were caused by my use of chemical materials. I now assume that it was one of the main reasons why I tried to switch from chemical to natural materials. Fortunately, my newborn second child does not have any symptoms like his brother. Does it mean that my new choice of materials was right?

I do not know and can not know the answer to the question. However, I believe that design has to serve people and for that reason, I always try to consider the user first when creating my designs. The function of my design must satisfy specific users’ needs, and the material should not be harmful to them. These are the fundamental principles of my design. I created nine functional furniture forms, which embodied my design principles for my thesis exhibition. Confluence.
I wanted to integrate CAD and CNC technologies into traditional studio furniture practices through my MFA exhibition. I expected that I could predict how the studio furniture designing method will be changed in the future through my preparation. I had to adjust myself to the materiality of wood, and the research about CNC mechanism was also to be conquered. I spent a long time teaching myself to use the CNC machine in the Center. It sometimes exhausted me because it was very difficult to find useful information. There were many problems I encountered until I understood the system. However, my passion and endless curiosity about the machine ultimately fed the exploration. I can not forget the night when I succeeded in making my first CNC piece, and the vivid memory still thrills me.

That experience made me realize that CNC technology is only a tool. I started using it as a supplementary tool for my functional furniture designs, especially when the design was hard to solve with traditional woodworking processes. While I enjoy the potential of the technology, I assume that if there was an instruction manual for the CNC router, I could have learned it much faster. That is why I described my design processes including CAD and CNC for Milk Chocolate Bowl design in Chapter IV. I hope the result of my long-term efforts may be useful to art students and studio furniture designers.


WORKS REVIEWED


