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ROCHESTER INSTITUTE OF TECHNOLOGY

A Thesis submitted to the Faculty of
The College of Imaging Arts and Science
In candidacy for the degree of
Masters of Fine Arts

Applying the Function and Aesthetics of Structure to Furniture

By

Soohyun Lyu

Abstract

In this thesis I intend to explore the process of making furniture by using structure as an integral component of my design language. This sense of the structure will be absorbed from the architectural sources I select. I intend to investigate both the functional and aesthetic aspects of structure during the creation of this body of work. I will experiment with different approaches, and in each piece I hope to address a particular identified aspect of structure within this main theme. I anticipate that wood will be the primary material, complemented by the use of metal.

Often in furniture design structure has been understood to exist inside the form, as a functional skeleton, and it does not have any real aesthetic value. So, the structure has been considered a separate element from the expressive elements. In my investigations every project will show both functional and aesthetic aspects of structure in different ways. Structure is an area which has more possibilities for formal expression than I had expected. The architectural sources I've selected are simple but well refined forms, which have a comprehensive aesthetic. All of the works will be focused on compositions and arrangements using simple shapes. They will be born of a complex process to distill the essences of the forms and their structural sensibilities.

Another important component of my architectural sources is the use of well-designed interior spaces as formal elements throughout my thesis work. Various expressed structures are set within compositions meant to create a strong sense of both interior and exterior space. From this combination of interests I hope to create a strong sense of visual tension in the resulting work.

Approvals

Chief Advisor: Rich Tannen

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Date: 01/09/2009

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1. Introduction

Basic Premise

The purpose of this thesis is to explore the process of making furniture by using a component of the structure as a design language. The sense of the structure is absorbed in the architectural sources which are interesting to me. I intend to investigate both the functional and aesthetic aspects of structure to make this body of work.

The final outcomes are intended to apply different approaches to the theme. Each piece is expected to show the particular aspect of structure within the main theme.

I propose to use a variety of materials that will provide me with more possibilities to express these ideas. I anticipate that wood will be the primary material, complemented by the use of metal.

Background

In my working experience, one of the most difficult and challenging issues has been using structure to create any form. Considering the functional aspect of the utility of form, it is supposed to be stable and usable. My concern for the structure starts from here. Structure can be creatively used to impact the aesthetic of an artwork.

Structurally, most of furniture is a three-dimensional object, which has a

certain size and weight. It needs adequate structure for its existence in a variety of ways. I intend to apply the combination of this basic requirement and its derived effect.

¹*Structure (strkchr)*

- a. *Something made up of a number of parts that are held or put together in a particular way: hierarchical social structure.*
- b. *The way in which parts are arranged or put together to form a whole; makeup: triangular in structure.*
- c. *The interrelation or arrangement of parts in a complex entity: political structure; plot structure.*
- d. *Something constructed, such as a building*

The above definitions describe the structure. Generally, structure has been understood that it exists inside the form, it is a functional skeleton, and it does not have an aesthetic value in furniture design. So, the structure has been considered a separate element from the expressive elements. In some cases, it has been a limited element in the creation of art work. However, I believe that the structure also has its own essence of aesthetics. We can often see the revealed inside structures in the construction of buildings or structural contemporary architecture. Some of the structures provide us a dynamic sense and a visual density, which come from organic connections, arrangements and complexities.

I intend to attribute these aesthetic elements of the structure onto my thesis work. The structures which are expressed in this thesis not only serve a structural

¹ The American Heritage Dictionary of the English Language, Forth Edition 2000.

function but also play an important role in aesthetics.

Design strategies

In the design, all the thesis projects use several common strategies to achieve the theme of the thesis.

First, they apply shapes that come from architectural that are all simple and basic figures. The main issue of the design is not expressing aesthetics by the shape itself, but by creating a temperate aesthetic through structural elements. All of the works are more focused on composition and arrangements by using simple shapes. They are born of a complex process to distill the essences of the forms and their structural sensibilities.

Secondly, intentionally designed inside spaces are important formal elements through all of this thesis work. Various expressed structures are created to be recognized with the spaces as their backgrounds

Thirdly, the visual tension is another important element in this thesis. The created structure of each work ultimately expresses the visual tension. It appears in every project in various ways. The visual tensions are created by the effects such as the variation in compositions and proportions, the asymmetrical arrangements, and the intonation of densities.

Lastly, material and color are solid and monotone. Simplification of the other design elements helps to emphasize the structure's visual aspect.

2. Body of work

Constructed Space I

The title of this chest of drawers is *Constructed Space 1* (28 x 29 x 56 inches), which is the first project of this thesis. This work requires mentioning another piece (see Table 1) which influences this project.

Table 1 was my first wooden piece which was made in 2000. The main purpose of this table design was to express complex structural aesthetics. I tried to express a strong visual sense of structure that we can often see in the structural elements in contemporary architecture elements such as organic connection, arrangement and division of space. Structurally, it is stable and strong to serve



its function in any position. After I had finished this table I found it a possibility to apply these elements to another piece of furniture. It showed a good direction for the combination of structural and aesthetic aspect of furniture.

Constructed Space1 is based on the same design background. But theoretically it is closer to deconstructive architecture. When we see the

conventional architecture, we just can see the simple form of the appearance. But if we imagine the structure within, it must be more complicated, unexpected, and interesting. The concern of mine started from this point. In contrast, assuming that the complicated inside structures are exposed to the outside, and simple forms go into the structures, it would be more dramatic and creative. The structure not only plays a role of its own practical function, but also serves the main role of aesthetic expression.

In particular, the main design elements of this work are a complexity and an exaggeration. I intended to express the image of the structure which is normally understood. To achieve this, the shape of units in the structure came from the objects in the construction that anyone can recognize, such as a beam, a bar, and a frame.

Visually, all the sizes of units in this work are different. They seem randomly composed and arranged. However, every connection follows the rule of joining together vertically and horizontally to systemize this work.

The linear compositions construct the inside spaces. The spaces which were divided by linear structure provide room for the drawers. The shapes of two carcasses are normal rectangular shapes, and the one carcass which has two drawers is an overturned stair shape. All the shapes of the carcasses imply the simple and basic forms which come from geometric architecture shapes. They are positioned at three different levels which constitute the composition of the inside spaces. Most of the joints, the cross halving joints which stick out to each side of a

joint part, reinforce the structural sense. The material, ash, is chosen for its bright color and clear grain. In particular, the quarter-sawn ash which has a straight grain pertains to the straight linear vertical and horizontal structure.

Technically, this project was a challenge. Forty-nine joints were all different sizes and depths. They need to be accurate because they are exposed and interconnected at multiple sites. In the construction process, numerous sketches, technical drawings, and scale models were required. The scale model was very important in the design process to determine the proportions, sizes, and connections. All of the four drawers are relatively big and have enough space. The drawer pulls were fabricated with aluminum and have the same shapes as the structural wooden parts. They are effectively shaped and placed to accentuate the entire shape as details. The aluminum was chosen for its plasticity and color. The tone and color of this material harmonize with the color of the ash, and give us a more contemporary sense. The devised drawer stops, which are made of a spring mechanism, are comfortable and substantial to use.



Constructed Space I

ash, aluminum, 71x74x142 cm

Constructed Space II

The second work of this thesis is a bench which is entitled *Constructed Space II* (107 x 60 x 50 inches). This is a comparably large scaled bench that eight people can sit on at the same time. As we know, seating furniture, such as chairs, stools and benches needs strong structure to support the weight of many people. The functional aspect of its structure needs to be seriously considered. Since the bench will be placed in a public area, it is appropriate to apply both functional and aesthetic aspects to the structure.

In the appearance, two vertically positioned, nine-foot long planks form the middle support for the bench. Two run parallel to the floor, and one is tilted up to form the back. The heaviest and thickest part of this work, the first plank is an axis with all the structural parts coming out from it. The tilted one is a subordinate structure and plays a role as the back of the seat. Visually, they present a dynamic directional force and tension. The parallel gap which was created between them shows the inside structures. Bar-shaped cantilevers penetrate into them from both sides. At differently levels, the seats of each side rest on the cantilevers. Structurally, they are the main parts in this work and have the same directional force with some variation. Two front feet are shaped similar to the cantilevers supporting the vertical main structural parts. And two back legs penetrate into each side of the seats and down to the floor. The front feet and the back legs are

different shapes and perform separate operations. Both uphold all the heavy structures as well.

Because of the bench's huge size, the original plan was that the cantilevers could be disassembled from the vertical main structures by using wedge joints. It would make the bench easy to install and handle. However the joint fittings were getting worn out and loose due to wear from assembly and disassembly. Therefore, they were glued together. However, the main forces of the structure are still physical joints and organic connections. The cantilevers are gradually longer and shorter according to the curve of the seating plank. The lower side cantilevers penetrate two vertical main structures, and support the other side's cantilevers. The shape of the seats came from a refined rectangular and trapezoid. They are combined with the vertical main structure and create an entire form as a result.

The vertical and horizontal structures create the inside spaces between them. These spaces show the inside structures and cantilevers. Furthermore, they run back to the other spaces that are created by the two crossing back legs. This transition offers the three-dimensional composition of the space. Additionally, the combination between structures and space was planned as an entire shape. This is the paradigm of this work.

In the detail, compound chamfers and warped bevels not only reduce the sharp edges but also unitize the formal elements. It is the minimum decorative element, considering it is such a large work and could be boring and its content less at the slightest slip.

Using solid material, ash was chosen for its bright color and natural grain. The hardest part in the process was choosing the lumber. Because of the size required, it was difficult to find lumber from the same wood. The colors and tones of the chosen lumber were quite different, even though from the same species. And they needed to be unitized. To solve this problem, all pieces were bleached. The bleaching provided brighter uniform color to emphasize the structures of this work.

This work is the largest project in this thesis. This project informs me as to how to deal with large-sized work in its many aspects. In particular, using computer programs was efficient for making full-sized technical drawings. I attached the drawings to each piece and cut the exact shapes without any mistake. Hand tools and portable power tools--such as a jigsaw, portable planer, laminate trimmer and orbital sander--were more useful than other, larger machines. Normally, after gluing and sanding, we can do painting, staining and finishing. However, this work required bleaching and lacquer finishing on the individual parts first, and then gluing them because of its large scale. In the bleaching, the most difficult thing was to get an even color on all surfaces. Each turned out a little different in tones, even though each was sampled and tested several times. This kind of information from the working process will inform other projects with such technical data.



Constructed Space II

Bleached ash, 273x127x152 cm

Structured Space I

This small and dense side table, entitled *Structured Space 1* (12 x 11 x 33 inches) was the third piece for my thesis. The concept of this work is creating pure form through the use of structural elements as a design language. I believe that a skeleton is a kind of structure, and that any object has its own skeleton. Normally, we can infer the shapes of skeletons by their appearance. However, I used a skeleton as a main theme and primary element in this work. The construction of a structural skeleton informs the entire figure of this work. Assuming that this figure is covered with skin, we can imagine the inside of the skeleton in many ways. This structured skeleton, *Structured Space 1*, is my suggestion and is one of many skeletal structures that can be imagined.

I intended that the created figure have a visual tension, which is one of my goals in this body of work. To achieve this, I shaped it vertically slim and tall, and designed it larger at the top and smaller at the bottom. These efforts give us a visual sense of instability to create tension. The figure seems a relatively simple oval-shaped cylinder. The oval-shaped top and bottom have different centers, diameters, and directions. They are connected with thirty-seven layers which create a gentle curved outline and imply the entire figure. Simple looking, the outlines are all compound curves. They show different views from every angle. Stacked with an inch gap, thirty-seven layers are all different shapes. The size and

directions of the repeated layers are gradually changed and moved to create a tight figure with directional force.

The two curved concave parts on the outside emphasize the spaces which were derived from stacked structures, and they appear as the same qualitative shapes with the inside spaces. The inside spaces, which start both from the top and bottom, meet each other inside the piece. These two spaces create an unexpected new shape of space, which is not directly evident but which is assumed from the top and side views. This corresponds with the main theme of this work. Connecting all the layers, four vertical linear structures are positioned in consideration of both visual and structural aspects. Some parts are revealed and some parts are hidden inside, both holding and sustaining all the layers effectively. The bottom side of the linear structure is shaped to match the top layer. This presents a strategy of design which is unity within repetition, variation, and emphasis. The number of parts and complicated structures are absorbed into a figure, and speak one word.

There were three primary working processes involved in the construction of this project. First, the most important and distinguishing process is its design using a computer program, which provides not only technical effects but also the formal information of the design process. I made many similar shapes of three dimensional models and forms to create this design in the virtual space of 3D computer programs. And I achieved proper sizes, proportions, and structures

without making physical models. This process was helpful to determine all the formal elements in the design. Then, this information was sent to a CAD (computer-aided design) program to concretize actual sizes and positions of all the layers. I cut all the cross sections which are placed in thirty-seven layers, and I confirmed and modified by this program any formal errors and the mistakes of connected spots between the linear structure and the inside spaces. Accurate forms, proportions, and measurements came from this process.

Second, I attached all thirty-seven drawings on the milled wood pieces and cut them. I drilled the holes in which the linear steel structures would be placed, and each layer was separated by an inch-length of the steel pipe. A noticeable texture on the side sections of all layers was made by a band saw. The natural sense of texture balances the other mechanical and artificial formal elements such as shape, structure, and form.

Third, it was a finishing process. The table needed uniform color in the ash's wood grain. I applied stain on the layers instead of bleach, which I had applied in the second project. I wanted it to be more white and uniform in order to emphasize the structure. In addition, the staining took less time and so was a simpler process than the bleaching. After sanding and cleaning all the surfaces, I applied a water-based white stain which penetrates fairly deeply and yields the clearest finishes. I put two coats on them. After they completely dried out, I sanded on each coat. The process provided a clean and white surface that was barely transparent. I believe this to be an efficient way to create uniform surfaces that appear to be

naturally white.

I selected ash not only for its tone and color, but also because it is the same materials that I used on my previous thesis projects. I believe that this choice helps to thematically unify all my thesis projects. The white stained ash was a particularly effective material for this work. All the layers are relatively thin and have delicate connections. This work required wood that has both hardness and flexibility. The material of the linear structure is steel, which is a hard and firm metal. I fabricated it with silver soldering. TIG (Tungsten-Insert Gas) welding is the useful way to join steel pieces. Welding provides a stronger joint than does silver soldering. But after welding, the piece needs a cleaning process such as grinding and sanding to mitigate rough welding spots. Because linear structures consist of many pieces of steel rods, silver soldering is the more efficient process due to its cleaner welding spots. More care needs to be taken when silver soldering, because the steel surface might easily be oxidized. Oxidized surfaces do not solder together, so I had to do silver soldering quickly to prevent the oxidization of the welding surfaces. All the hardware used to assemble this work was made by me, and my doing so made this project better structurally and aesthetically.



Structured Space I

white stained ash, 31x28x84 cm

Structured Space II

Entitled *Structured Space 2* (67 x 45 x 16 inches), a wall-hung shelf is the last project of this thesis. I focused on emphasizing the compound structural sense which came from two different formal elements in this project. A simple vertical and horizontal composition represents a strong sense of seriousness, calm, and contemplation. A directional force and space sense are added on the composition. It is intended to emphasize a structural sense which comes from the harmonization between static and dynamic formal elements. Another distinction is a simplification which comes from a process of refinement. This work shows a simple appearance and structures, but it possesses complex details and structural elements. However, the common essences, which can be tied with other thesis works, are still included.

Structurally, this work can be divided into three parts which are a vertical structural part, a horizontal structural part and drawers. The vertical structural part and the horizontal structural part cross each other and create an asymmetrical cross figure. The crossing part is on the left side, and the drawer part is placed on right side at the front. This composition asymmetrically makes the entire shape balanced. Visually, the long vertical part looks as if it touches on the floor but it is floating and hangs on the wall. The horizontal part and drawers are placed up from the floor. This composition creates a visual tension, which is one of the most important design elements of my work.

The vertical structure consists of two parts which are connected with the horizontal part, and these can be disassembled. The cutting rectangular shape in the upper part holds the glass layers which serve as the spaces for shelves. At the same time, it plays a role as a window which connects two divided spaces. This gives an open sense of space. Variations of the basic form, result in shapes, all are born of a process of refinement. The glass shelves can be adjusted to ten different levels with metal holders. This paradigm connects with the layered structure of the previous work, *Structured Space 1*. The gaps, which are in the connections between the two vertical parts and the horizontal part, are the details for the same purpose as the other negative spaces. These kinds of revealed connections emphasize the structural sense.

The main shelf part, a horizontal structure is connected with a vertical structure and sustains the entire piece. The simple shape of this part shows a strong sense of movement and direction. In the form, it possesses character which can mitigate two different designs of vertical structure and drawer. Minimizing the touching surface with the wall creates a floating sense for creating visual tension. This effort which transforms a wall-hung two dimensional work to a three-dimensional piece, gave me an opportunity to express a structure which technically cannot exist in a three-dimensional art works.

The shelf has two different sized drawers. The shape of the carcass which contains two drawers is an overturned irregular trapezium. Considering most of the carcass's shape is square or rectangular, it is an unusual design. This design was

intended to emphasize a visual tension and direction. The gentle curved line, which is carved on the front of the drawers, implies the movement of the entire composition. Fabricated with steel, the drawer pulls were shaped with the same design background as other parts. I believe that these details reinforce the main design strategies, which are rhythm, repetition, and variation within unity.

In the technical aspect, the primary requirement was the mechanisms for connections and hanging systems. Considering they have to sustain heavy wooden pieces and drawers, they are supposed to be firm. Some of the connections are revealed. They were made by me and chosen carefully for the aspects of function and aesthetics. The hanging mechanism of the vertical structure is from the connection of a bed's structure. The reason for using this was its strength and convenience. When it is installed, one just needs to push the piece onto the wall and pull it down. This is simple but more effective than other complicated mechanisms. The other hanging mechanism is in the back of the carcass. This is also a simple clip-styled mechanism which is easy to install. The connections between the vertical and horizontal structures were made with T-nuts which are a negative metal screw with four gimlets for holding into the wood. The revealed three-connections between the vertical and horizontal structures are covered with bushings which I made. Small cylinder shapes, these designs followed the holder of the glass-layers.

The primary material is a white stained ash. Fabricated hardware and

drawer pulls are made of mild steel. A cold sensed color, mild steel is discriminated from warm sensed colored ash, and emphasizes revealed connections as a structural element. At the same time, the combination shows the harmony which comes from the composition of two different materials.



Structured Space II

White stained ash, white glass, steel

114x40 x 171 cm

Conclusion

The applications of structure in this thesis were advanced differently by aspects of each work. The first piece, *Constructed Space 1*, attributes the inside structures of architecture to a chest of drawers. The intonation of density creates the visual tension in the arrangement of the structural elements. The exaggeration and complexity are intended for the design elements. This work is more focused on the aspect of the expression than the functional aspect of the structure. It is significant as the first piece, the one that inspired a focus on structure. Exploring the organic connections and the applications of the space in the work are the primary profits that I have achieved from this project. And it was an opportunity to search the aesthetic structure and the effect which comes from complex and multiple connections. This work required much time in the construction process and gave me the chance to think about the patience and modesty. This work is biased toward direction of the structure considering both functional and aesthetic aspects of structure, which is the main theme. This project was a turning point in evolving the next project.

The second piece, *Constructed Space 2*, is a bench which is more approaching the theme of this thesis: the functional and aesthetic aspects of structure. In particular, this project was designed and constructed considering its function, as a bench. The forms which comprise the entire structure are more contained by my sensibility, and the process of refinement to the form is genuinely

applied on this project. The curved lines which first appeared from this project provide me more possibility in the expression. As an architectural element, the cantilever not only plays a role of functional structure, but also emphasizes the structural sense. The contained revelation of the structures shows the contrast of structural aesthetics compared with the previous work. The formal compositions create the interior and exterior shapes of space which can be interpreted as another form. This work is at once energetic and contemplative. Its huge size imparts a sense of architectural structure and reinforces structural aesthetics. In its construction, this project informed me on the technical aspects required by a large sized work, complexities such as handling, choice and application of the lumber, and the use of portable hand tools.

The small table, *Structured Space 1*, was the third project. The main concept of this work was shaping the form by the use of structure. The structure clearly shows the main formal element which expresses the appearance of this work. Repetition and variation are used to achieve the goal as a design tactics. The variation of the layers evokes the sense of movement in the repeated layer structure which can be languid. The unstable pose of the work which comes from larger disks at the top and smaller ones at the bottom, expressed the visual tension well. This work represents the most contained formal aesthetics in the entire thesis. Using mixed material, wood and metal, is regarded as the efficient choice for the concept. However, the structure which was intended to intimate the form was much too obvious and overly informed. The conspicuous technical aspect was applying

computer programs which not only provide technical effect but also played an important role in the design.

The last piece, *Structured Space 2*, was about arrangement, which is one of the elements of structure. This work was an experimentation in the visual effect of the arrangement. The static sense of simple vertical and horizontal structure combines the dynamic sense with the directional force. And this combination creates the new complex sense. The details in this work accurately express the common formal elements which are in the pieces. This was intended to tie all the different directions of these thesis works. This project represents simplicity and at the same time complexity. The complex is absorbed by the simplicity, and the simplicity shows organic composition by the use of complex details.

Overall, the various directions of the structures that I intended are successfully expressed. Every project shows both functional and aesthetic aspects of structure in different ways. The premised design strategies allow me a varied expression in the structure and play an important role in the consistent expression of the theme. Structure is an area, which has more possibilities for formal expression than I had expected. The architectural forms which I applied on all the projects are simple but well refined forms which have a comprehensive aesthetic. The use of computer programs provided me the synergic effects in both the technical and design process and requires more systematic study. I believe that the process of design and technical information, which came from this investigation, will be an important base from which to develop my next work.

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