Morphological Analysis in Creative Furniture Design

by

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Abstract

Design can be defined as a creative process that designers arrange one or more elements and principles in organized for one purpose. The purpose of the thesis is to convey a strong message to the reader so the reader can understand it correctly. As we start to create our design, whether it is a bowl or a chair, we have defined it as a purpose in both primary and additional functions. A good product has to satisfy certain criteria, not only functionally, but also psychologically and aesthetically. The aesthetic quality of a product and the fascination it inspires is an integral part of its utility (Dieter Rams, ten principles for good design). One must understand that nothing in the universe is random. Everything is deterministic and has a reason behind its existence and usage. However, everything has multiple qualities and different definitions varied by viewers from different perspectives. The role of an artist or designer is to be aware of the qualities of design elements, based on the functional purpose, creating successful visual compositions, which conveys the emotions of the artist. Better still, is understandable and acceptable. Differing from other products, furniture has far broader latitude in form creation. It is an overlapping part of architecture design, interior design, and industrial design. As an Industrial Design thesis, this research was conducted to study the morphological analysis thinking method applied in furniture design. The design focuses on morphological analysis for form studying, based on broad inspirations drawn from natural world, transferring, and applying them in the form of furniture product.

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INTRODUCTION

1.1 Problem Statement

Industrial design is the use of a combination of applied art and applied science to improve the aesthetics, ergonomics, and usability of a product, but it may also be used to improve the product's marketability and production. The role of an industrial designer is to create and execute design solutions for problems of form, usability, physical ergonomics, marketing, brand development, and sales (de Noblet, 1993). The objective of industrial design is composed of function, form, and the connection between product, the user and the environment. However, the solutions for problems of form, color, and space relationship are basic problems of a product design. From this point, morphology is the foundation of modern art of shaping and modeling, and therefore plays a crucial role throughout the course of creativity.

In product design area, the word morphology contains dual implications. One is shape, which is the carrier of function. The other is expression, which conveys the feeling and emotion given by the designer. With the aid of the outer form of a certain product, designers can merge their unique emotions and philosophies to the tangible carrier. When choosing the product, the customers also estimate and measure by looking at the appearance whether the information delivered by the product correspond with their expectations, and make their final purchasing decision. Therefore, designers should enhance their ability of expression and creativity towards solid formation. Only when we master the morphology of the physical world can we create more fresh and surprising forms purposefully.

1.2 Need for study

The product constitutes one of the classic four P's (product, price, promotion, and place) of the marketing mix, and the most fundamental characteristic of a product is its exterior form or design (Block, 1995). Not since the 1930s has product design been more creatively and strategically employed to gain advantage in the global marketplace (Berkowitz, 1987; Nussbaum, 1988). In one survey of senior marketing managers, design was mentioned as the most important determinant of new product performance by 60% of respondents; only 17% considered price most important (Bruce and Whitehead, 1988). Similarly, an analysis of the performance of 203 new products revealed that product design was the most important determinant of sales success (Cooper and Kleinschmidt, 1987).

In the industrial design background, furniture always stands out separately from other products. It is an overlapping part of architecture design, interior design, and industrial design. Actually, many architects and interior designers design furniture. Differing from other products such as electric appliances, kitchenware, medical, or other instruments, furniture has far broader latitude in form creation. As used here, a product's form represents a number of elements chosen and blended into a whole by the design team to achieve a particular sensory effect (Hollins and Pugh, 1990; Lewalski, 1988). Designers make choices regarding characteristics, such as shape, scale, tempo, proportion, materials, color, reflectiveness, ornamentation, and texture (Davis, 1987; Kellaris and Kent, 1993). Designers also decide how to mix these elements and determine the level of congruity that should exist among them (Bloch, 1995). When it comes to modern furniture design, designers from all over the world are busy thinking outside of the box to turn the concept of furniture into unique pieces of art. First, the environment for furniture design is broad. It can be in a living room, an office, a plaza, or an airport lounge. Almost every scene where people exist might need furniture. Second, the materials that can be used to build furniture are broad. Wood, metal, stone, glass, rubber, leather, cloth, plastic, and much of synthetic materials can be used to make different furniture for different uses. The functions of furniture can be summed up in few

types for use of storage, seating, surfaces, sleeping or lying, entertainment, and sometimes these functions are interchangeable. Designers have more space to make use of various materials creating any forms to realize their purpose which, at the same time, has great aesthetics for people to appreciate.

Throughout history and in every known culture, people have found pleasure and meaning in the use of their eyes. They have consciously attempted to produce objects of beauty and have delighted in them (Csikszentmihalyi and Robinson, 1990). A good design attracts consumers to a product, communicates to it, and adds value to the product by increasing the quality of the usage experiences associated with it. The physical form or design of a product is an unquestioned determinant of its marketplace success (Bloch, 1995). Marketers charge designers with the task of developing products that have appealing forms. In modern society, aesthetic sensibilities are relevant to all products, regardless of their function (Holbrook, 1980; Holbrook and Anand, 1992; Holbrook and Zirlin, 1985). In cluttered markets, product form is one way to gain consumer notice (Berkowitz, 1987; Dumaine, 1991; Jones, 1991). With new product offerings, a distinctive design can render older competitors immediately obsolete and make later competitors appear to be shallow copies (Midgley, 1977). The form or exterior appearance of a product is important as a means of communicating information to consumers (Nussbaum, 1993). Product form creates the initial impression and generates inferences regarding other product attributes in the same manner as does price (Berkowitz, 1987). Besides, the perception and usage of beautifully designed products may provide sensory pleasure and stimulation. Essentially an applied art product design has a greater impact on our daily lives than do other art forms, because we see products every day (Lawson, 1983).

Morphology, in linguistics, is the identification, analysis and description, in a language, of the structure of morphemes and other linguistic units. While in biology, morphology is a branch of bioscience dealing with the study of the form and structure of organisms and their specific structural features. About more details and definitions of morphology, we will

talk about it in the following chapters. F. Zwicky, a professor at the California Institute of Technology, first applied morphological analysis to the aerospace industry. It is actually an idea generation method that can be applied in many fields. From the books and articles found, there was no in-depth research and discussion about morphological analysis method applied in furniture design area. However, there were some that were related to product development, but they merely discussed about practical methods that can be directly used in furniture design. Therefore, a more in-depth research on creative thinking methods for furniture design was needed.

Activity	Past Large U.S. Furniture Manufacturer	Today's U.S. Furniture "Manufacturer" (in name only)	Future U.S. Furniture Model (as proposed by authors)
Furniture Design	U.S.	US	U.S. Independent Designers and Distributors
Furniture Engineering	U.S.	US or Offshore	U.S. Component and Independent Contract Furniture Manufacturer
Wood Components Mfgers	U.S.	Offshore	U.S. Independent Component Manufacturers
Furniture Manufacturing	U.S.	Offshore	US Independent Contract Furniture Manufacturers
Furniture Distribution	U.S.	U.S.	U.S.
Furniture Retailing	U.S. Independent Retailers	US Independent Retailers	US Independent Retailers

Table 1.1: Furniture supply chain activities and their location in past, current, and future business models (Phil Mitchell and Harry Watt, 2009)

Sixty years ago, when George Nelson wrote about "The Furniture Industry" in the pages of Fortune Magazine, modern furniture of top design quality was difficult to find in the United States. But this is no longer entirely the case, as today a segment of the American furniture industry is focused on producing exceptionally designed contemporary furniture manufactured with the latest technologies. And with 23,177 people visiting the 2006 International Contemporary Furniture Fair in New York City, where attendance has more than doubled since 1996, there is obviously an increasing interest in design (Olivares, 2006).

From Table 1.1 we can see that although the engineering and manufacturing locations gradually move from domestic to offshore, the design and retailing remain in U.S., and in the future business model, the independent furniture designer who creates innovative furniture designs and sells these designs to others (Phil Mitchell and Harry Watt, 2009). There will be more challenges and keen competitions among domestic furniture designers.

1.3 Literature review

It has been no more than thirty years since the first conference on design methods was held in London in 1962 (Jones and Thornley, 1963). This conference is generally regarded as the event, which marked the launch of the "design methods movement", which in turn led to the emergence of design methodology as a subject or field of enquiry. Of course, the field was based on some earlier work (the earliest reference in design methodology literature is probably Zwicky's work on morphological method published in 1948), but the 1962 conference was the first time that "design methods" received substantial academic recognition (Cross, 1993). It was harsh thing for these two founding fathers to say about their offspring, and is potentially devastating to those who were still nurturing the infant. To put the quotations of Alexander and Jones into context, it may be necessary to recall the social-cultural climate of the late 1960s and the campus revolutions, the new liberal humanism and rejection of previous values. However, it had to be acknowledged, and it was, that there had been a lack of success in application of scientific methods to design (Cross, 1993). Rittel and Webber raised the fundamental issues in 1973, who characterized design and planning problems as "wicked" problems, fundamentally unnamable to the techniques of science and engineering, which dealt with the "tame" problem.

The origins of new design methods in the 1960s lay further back in the application of novel, scientific methods to the novel and pressing problems of the Second World War from which came operation research methods and management decision-making techniques and in the development of creativity techniques in the 1950s. The 1960s also saw the beginnings

of computer programs for problem solving. The first design methods or methodology books appeared Asimow (1962), Alexander (1964), Archer (1965), Jones (1970) and the first creativity books Gordon (1961), Osborn (1963) (Cross, 2006). There is a statement by Bruce Archer (1964) that encapsulated what was going on: "The most fundamental challenge to conventional ideas on design has been the growing advocacy of systematic methods of problem solving, borrowed from computer techniques and management theory, for the assessment of design problems and the development of design solutions."

N. Cross concluded his progress in design methodology in five categories of work in his Design Methodology Review (1993): "the development of design methods origination and application of systematic methods; the management of design progress models and strategies for executing design projects; the structure of design problems theoretical analysis of the nature of design problems; the nature of design activity empirical observations of design practice; and the philosophy of design method philosophical analysis and reflection on design activity."

People began to make furniture as early as they learned to farm and lived in permanent settlements (Lambert, 2012). The earliest evidence of furniture survives from Neolithic Period. In ancient Greek, Roman, early North America, and Asian, furniture has quite distinct histories with distinct styles. "The modernist movement, at the beginning of the 20th century, marked the first time that the term 'avant-garde', with which the movement was labeled until the word 'modernism' prevailed, was used for the arts (rather than in its original military and political context)" (Orton and Pollock, 1996). Since modernism had entered popular culture, furniture becomes the product of materials and techniques, as well as a new, hurried, tense lifestyle. Their inspirations vary greatly, reflecting the fashions of the twentieth century.

As Otto Wagner stated in an address to the Vienna Academy in 1895, that "All modern forms must reflect the new materials and the new requirement of our time: If they are to meet the needs of modern man, they must express our improved, democratic, clear-thinking

selves." Designers had to "civilize technology," in the words of the architect Marcel Breuer (Florence de Dampierre, 2006). New materials and technologies provide more space for creation, and help realizing our design from sketch to product with much easier solutions. Architects, with their engineering background, were well placed to develop new chairs that were both functional and handsome. Chair design particularly appealed to architects, as it allowed them to express their design philosophies in three dimensions. As Peter Smithson wrote, "when we design a chair, we make a society and a city in miniature." One can see clearly the sort of society and city envisaged by, for example, the modernist architect Ludwig Mies van der Rohe. His chair designs project an orderly, antiseptic, and efficient world (Florence de Dampierre, 2006). It seems that chair designs for architects, are more like playing a little game. Compared to tables or cabinets, chairs have larger variability in form, and need stronger structure for supporting. Architects can develop chairs that were both functional and handsome; in other words, we can draw inspiration from architectures created by them when designing a chair.

The phrase "form follows function" was first coined by Louis Sullivan, in 1896, in his article "The Tall Office Building Artistically Considered" (Sullivan, 1896). It is a principle associated with modern architecture and industrial design in the 20th century. The principle is that the shape of a building or object should be primarily based upon its intended function or purpose. Furniture can be a form of decorative art, however, we could never discard its functional role. Form should never overwhelm function. In Principles of Form and Design, the author provides a solid foundation in design basics, with emphasis on flat, abstract forms, and demonstrates the creation of forms, focusing on representational aspects that extend the designer's visual vocabulary. "The way form is created, constructed, or organized along with other forms is often governed by a certain discipline which we call 'structure'. Structure which involves the relational elements is also essential in our studies" (Wong, 1993). This book has become classics in art and design education programs around the world. The author starts from design elements, and then the form and structure created from these

elements and their variation. From two-dimensional to three-dimensional design, Wong's principles will meet the needs of all graphic artists and designers, as well as the equipment and software that suit a designer's requirements. However, none of these principles is directly related to modern day furniture design. It is valuable to build a bridge between the principles of creating forms and furniture design. Therefore, it is important to study and understand the basic principles, and develop it to fit the needs of furniture designers.

In this age we live, creativity is seen as being increasingly important in a variety of professions. Most people associate creativity with art and literature, however, among all the fields, architecture and industrial design are the most often associated with creativity, and more generally the fields of design and design research. Creativity is the ability to find ideas that are both novel and useful (Stein and Heinze, 1960). A simple definition is that creativity is the ability to imagine or invent something new. It is not the ability to create something that does not exist in the natural world, but a mental process involving the discovery of new ideas, concepts, or new associations of the existing ideas or concepts by combining, changing, or reapplying the existing ideas. Creativity often referred to as a "divergent thinking process".

Much of the thinking done in formal education emphasizes the skills of analysis — teaching students how to understand claims, following or creating a logical argument, figuring out the answer, eliminating the incorrect paths and focusing on the correct one. However, there is another kind of thinking, one that focuses on exploring ideas, generating possibilities, looking for many right answers rather than just one (Harris, 1998). Not before the 1950s, creativity was considered a dedicated field of research, separated from related topics like intelligence research (Mayer, 1999). Looking back into the history, there are many theories of creativity focused on a variety of aspects, and among which the most dominant are usually known as the four "Ps" of creativity research proposed by M. Rhodes in his book An Analysis of Creativity, 1961. The creative person (who is creative?), the creative product (what is creative?), the creative process (which activity leads to creative products and the

creative press or environment (where does creativity happen?) (Rhodes, 1961). There is one interesting but important finding on creativity research is that creativity and intelligence are fundamentally two different things. "Creativity is often defined as a parallel construction to intelligence, but it differs from intelligence in that it is not restricted to cognitive or intellectual functioning or behavior. Instead, it is concerned with a complex mix of motivational conditions, personality factors, environmental conditions, chance factors, and even products" (Feldhusen and Goh, 1995). Even intelligence may be measured with a standardized IQ test, which is considered quite reliable and valid; it is not the case for creativity. A person who has a high IQ does not mean he is also creative. It should be a natural ability of human beings and in terms of the factors it concerns, it is easily affected by outer factors and there is not a certain approach to measure one's creativity. Therefore, it is very likely to enhance our ability of creative thinking by proper means, and explore our potential creativity.

There are books about creative thinking techniques. "A lot of creativity techniques have been proposed to foster creativity of individuals and groups" (VanGundy, 1988). Famous examples are brainstorming and writing, mind mapping, and Morphological Analysis or the Six-Thinking-Hats. These techniques define certain rules, activities or constraints for the problem solving process, promising to be more effective than less structured approaches (Osborn, 1993). Most of the books and articles about creative thinking are expert on solving problems. Although some of them relate to product development and group work, they cannot be applied directly to an activity of artistic creation. Before talking about creative methods and thinking techniques, the author likes to list some sources of creativity. Many experts provide frame works and hypotheses on the sources of creativity. It appears that the vast majority of their important contributions to the theory can be categorized as falling within Teresa Amabile (PhD in Psychology and Head of the Entrepreneurial Management Unit at the Harvard Business School)'s three circles in Figure 1.1.

There are some other factors, such as divine intervention, social environment, personality traits, chance or serendipity, mental illness, etc., which are also considered as sources of

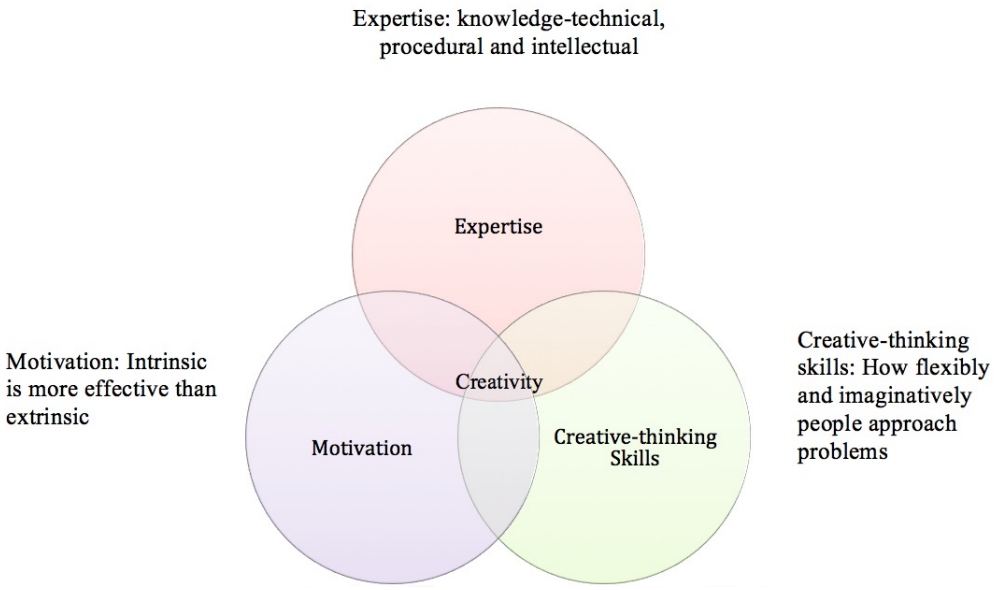

Figure 1.1: Three Components of Creativity

creativity. Several methods have been identified for producing creative solutions. Here are the most classic five from Robert Harris's *Introduction to Creative Thinking* (Harris, 1998): evolution, synthesis, revolution, reapplication, changing direction.

- **Evolution**. This is the method of incremental improvement. New ideas stem from other ideas, new solutions from previous ones, the new ones slightly improved over the old ones.

- **Synthesis**. With this method, two or more existing ideas are combined into a third, new idea.

- **Revolution**. Sometimes the best new idea is a completely different one, a marked change from the previous ones.

- **Reapplication**. Look at something old in a new way.

- **Changing Direction**. Many creative breakthroughs occur when attention is shifted from one angle of a problem to another. This is sometimes called creative insight (Harris, 1998).

There are many classic creative thinking techniques that make use of one or more of these methods. Here are some widely used creative thinking techniques. Brainstorming is a technique intended to generate a large number of ideas for the solution to a problem. It can take place either individually or in a group of two to ten, with four to seven being ideal, usually seen as the first step of a design. The method was first popularized in the late 1930s by Alex Osborn in a book called Applied Imagination. Structure of a brainstorming session can be concluded in these three phases:

- Phase I. Idea Purge

  In this phase, the problem is stated clearly. Every group member (if in group work) quickly writes his or her ideas on sheet of paper.

- Phase II. Idea Trigger

  Leader calls each member for his ideas. Team members read their ideas. Leader writes them down on a board. If some ideas trigger other ideas, members should write them down. Repeat until no more new ideas are generated.

- Phase III. Idea Evaluation and Recommendation

In this final stage of a brainstorming session, the groups evaluate the ideas and select one or a few as the best solutions to the problem proposed to the group.

The term "lateral thinking" was first coined by Edward de Bono in his book The Use of Lateral Thinking, in 1967. It is an unorthodox approach to problem solving, often looking at problem from other "sides" rather than head on. "Creativity should be produced on demand. Formation of new ideas cannot merely be left to chance. When seeking new ideas, it is important to disrupt the conventional thinking patterns (linear/vertical thinking) adopted by the brain. Provocations designed to introduce random factors into thinking can help break conventional thinking patterns." According to de Bono, brainstorming is an unstructured way of supporting creativity. It merely reiterates the existing held perceptions and ideas about a topic, while lateral thinking introduces new stimuli in an effort to shift

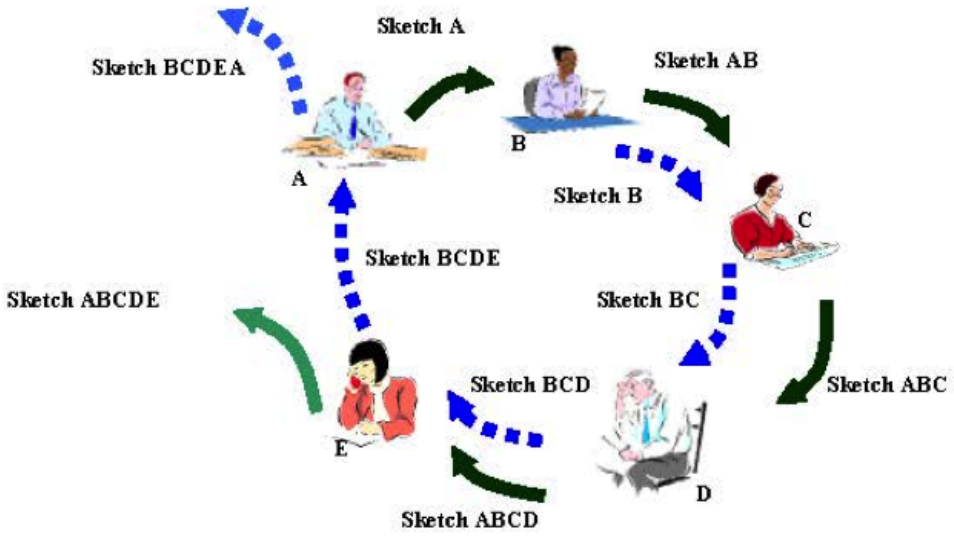

Figure 1.2: C-Sketch Process (Shah, 2001)

the thinking in new directions. This thinking technique is vital for the development of our morphological analysis for furniture design methods system. The process of our new design method system is fundamentally based on this thinking method.

Collaborative sketching was origin by Professor Jami J. Shah, Design Automation Lab at Arizona State University. His article Collaborative Sketching (C-Sketch) An Idea Generation Technique for Engineering Design was first published in The Journal of Creative Behavior in September 2011 (Shah, 2011). It is a structured, proven approach for exploring and analyzing design ideas with the key stakeholders of your project. C-sketch may be a useful strategy because it promotes team collaboration, reduces time for verbal communication, accumulates idea from multiple individuals. However, its potential problems are that it unfocused design objectives, and might occur possible misunderstanding of sketches.

Morphological analysis is an ideation technique, an approach to discovery, invention, research and construction, a technique for generating new products and service. Generally speaking, the morphological analysis is actually a group of methods that share the same structure. This method breaks down a system, product or process into its essential sub-concepts, each concept representing a dimension in a multi-dimensional matrix. Thus, every

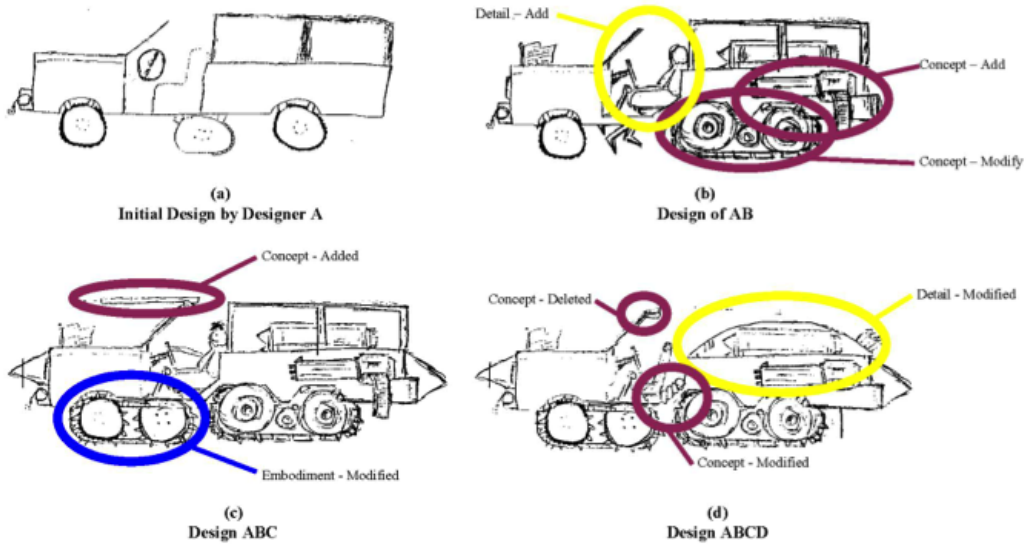

Figure 1.3: Analysis of Progressive Sketches (Shah, 2001)

product is considered as a bundle of attributes. New ideas are found by searching the matrix for new combination of attributes that do not yet exist. It doesnt provide any specific guidelines for combining the parameters. It tends to provide a large number of ideas. Morphological analysis was first applied to aerospace industry by F. Zwicky, a professor at the California Institute of Technology, in his main work on the subject, Discovery, Invention, Research through the Morphological Analysis in 1969. Zwicky summarized the procedure of morphological analysis by five steps.

Step 1: List the attributes of the product, service or strategy you are examining: Attributes are parts, properties, qualities or design elements of the thing being looked at. Example: attributes of a pencil would be shaft material, lead material, hardness of lead, width of lead, quality, color, weight, price, etc.

Step 2: Draw up a table using these attributes as column headings.

Step 3: Write down as many variations of the attributes as possible within these columns. A brainstorming would be helpful. The table shows all possible variations of each attribute.

Step 4: Select one entry from each column. Either do this randomly or select interesting combinations. By mixing one item from each column, you will create a new mixture of components. That is a new product, service or strategy.

Step 5: Evaluate and improve that mixture to see if you can imagine a profitable market for it.

"The approach begins by identifying and defining the parameters (or dimensions) of the problem complex to be investigated, and assigning each parameter a range of relevant 'values' or conditions. A morphological box also fittingly known as a 'Zwicky box' is constructed by setting the parameters against each other in an n-dimensional matrix. Each of the n-dimensional boxes contains one particular 'value' or condition from each of the parameters, and thus marks out a particular state or configuration of the problem complex." Here are some morphological analysis examples to explain how to use morphological analysis.

Example 1

I Define the problem:

A designer looks for new way to create a new lamp.

II Identify attributes and values

Attributes:

- Power supply
- Bulb supply
- Light intensity
- Light intensity
- Size
- Style
- Finish

- Material
- Shade, etc.

Power Supply	Bulb Type	Light Intensity	Size	Style	Finish	Material
Battery	Halogen	Low	Vary large	Modern	White	Ceramic
Mains	Bulb	Medium	Large	Antique	Black	Metal
Solar	Daylight	High	Medium	Roman	Metallic	Concrete
Generator	Colored	Variable	Small	Art Nouveau	Terracotta	Bone
Crank			Hand held	Industrial	Enamel	Glass
Gas				Ethnic	Natural	Wood
Oil/Petrol					Fabric	Stone
Flame						Plastic

Table 1.2: Morphological box of a lamp

III Combing items

- Solar powered/battery, medium intensity, daylight bulb possibly used in clothes shops to allow customers to see the true color of clothes.
- A ceramic oil lamp in Roman style used in themed restaurants, resurrecting the olive oil lamps of 2000 years ago.
- A normal table lamp designed to be painted, wallpapered or covered in fabric so that it matches the style of a room perfectly.

Example 2

I Define the problem:

An artist looks for new ways of creating artwork.

II Identify attributes and values and combing results:

Attributes:

- Materials: ink, oil, dye, clay, leaves
- Canvas: paper, wall, window, wood

Materials	Canvas			
	Paper	Wall	Window	Wood
Ink	Japanese style blotting paper	Graffiti	Painted	Marquetry bleed rates
Oil		Murals	Motor oil floating in glass tank	
Dye	Appliqué with dyed strips		Stained glass	
Clay		Applied directly over brickwork		Wood and clay sculptures
Leaves	Glued then painted over	Blown onto glued wall	Translucent colored leaves	

Table 1.3: Morphological box of creating an artwork

1.4 Objectives of Study

- To study the principles of form and design; identify all the design elements and element groups and the interrelationships of forms.
- To study the creative thinking techniques and morphological analysis thinking method that helps develop new principles.
- To study the types and functions of furniture.
- To summarize the inspiration sources.

- Sketches that help catching and recording the inspiration drawn from everywhere.
- Develop the principles to transform the abstract 2D graphic to 3D form of products with sketches.

1.5 Definitions of Terms

1.5.1 Morphology

The word "morphology" is from the Greek, morph = form and lgos = word, study, research. In biology, morphology is a branch of bioscience dealing with the study of the form and structure of organisms and their specific structural features, including aspects of the outward appearance (shape, structure, color, pattern) as well as the form and structure of the internal parts like bones and organs.

1.5.2 Creative thinking

A way of looking at problems or situations from a fresh perspective that suggests unorthodox solutions (which may look unsettling at first).

1.5.3 Brainstorming

Brainstorming is a group creativity technique by which a group tries to find a solution for a specific problem by gathering a list of ideas spontaneously contributed by its members.

1.5.4 Relevance tree

A relevance tree is an analytic technique that subdivides a broad topic into increasingly smaller subtopic. It has a form of a hierarchical structure that begins with a high level of abstraction and moves down with greater degree of detail in the following levels of the tree.

1.5.5 Bionics

Bionics (also known as biomimicry, biomimetics, bio-inspiration, biognosis, and close to bionical creativity engineering) is the application of biological methods and systems found in nature to the study and design of engineering systems and modern technology.

1.5.6 Lateral thinking

Lateral thinking is solving problems through an indirect and creative approach, using reasoning that is not immediately obvious and involving ideas that may not be obtainable by using only traditional step-by-step logic.

1.5.7 Collaborative sketching

Collaborative sketching is a participatory workshop activity where participants sketch their thoughts about possible design solutions, discuss reasons for drawing a particular solution, and then sketch revised versions.

1.5.8 Metaphor

A metaphor is a figure of speech that describes a subject by asserting that it is, on some point of comparison, the same as another otherwise unrelated object. Metaphor is a type of analogy and is closely related to other rhetorical figures of speech that achieve their effects via association, comparison or resemblance including allegory, hyperbole, and simile.

1.5.9 Cognitive Metaphor

In cognitive linguistics, conceptual metaphor, or cognitive metaphor, refers to the understanding of one idea, or conceptual domain, in terms of another, for example, understanding quantity in terms of directionality (e.g. “prices are rising”). A conceptual domain can be any coherent organization of human experience. The regularity with which different languages employ the same metaphors, which often appear to be perceptually based, has led to the

hypothesis that the mapping between conceptual domains corresponds to neural mappings in the brain.

1.6 Assumptions

Assumptions are factors that this study uses to support the need for research and further investigation. This study was conducted based on the following assumptions:

I American furniture industry is focused on producing exceptionally designed contemporary furniture manufactured with the latest technologies, and the domestic customers interest in furniture design keep a steady increasing in the future.

II Furniture design that processed with morphological analysis method is widely welcome by the customers.

III Most of the current furniture designers did not use a logical thinking method when they looking for inspiration of their designs.

IV Success of a piece of furniture has many phases. Innovation of form design creates more value for the products only if the final outcomes can widely accepted by customers. Additional assumptions that are not based on research include the potential to have great effect on the design and positive feedback from commercial markets.

1.7 Scope and Limits

The study was conducted based on the following scope:

I Nowadays, brands form U.S. and Europe carve up the world's high-end furniture market. Although the U.S. is the world's largest importer and consumer of home furnishings, the world's two leading furniture fairs IMM Cologne and Salone Internationale del Mobile di Milano annually are held in Milan, Italy and Cologne, Germany. The show showcases the latest in furniture and design from countries around the world. It is considered a

leading venue for the display of new products by furniture, lighting and other home-furnishing designers all over the world. The study was conducted in U.S. but yet focused on the over world trend of contemporary furniture design.

II The core of the approach is to logicalize the process of idea generation, which can be applied to all types of furniture. The application was demonstrated through a series of furniture design of various types.

Here are the limitations of the study:

I The is no in-depth and overall study on the six categories of Chinese characters, of which two types of structure and form of Chinese characters are directly used in the form design of furniture.

II There is not much discussion about materials and their characteristics in this study, though it is important phase of a furniture design. All the mockups and prototypes were made to demonstrate the methodology of form design with the limitation of time and fund.

III Ergonomic study does not go with the design method research.

IV Due to the time limitation, not each of the design technique comes out with a full functional prototype.

1.8 Procedure and Methodology

This research was to develop an idea generation method for furniture design with the following steps and methodology:

Step 1. Preparation for the research

- Collect information from books, magazines, Internet sites, and all other sources. Reviewing all articles available about creative thinking techniques applied to design and

relevant areas, evaluate and determine the content that makes a significant contribution to the topic.

- Identify some proper existing products as example to study. Analyze the design elements and organize the thoughts of design.

Step 2. Exploration and development

- Summarize the inspiration by category.
- Develop a checklist of creative thinking techniques for furniture designers to design creative and innovative products.

Step 3. Experiments and prototypes

- Sketches in this phase, the goal is to get our ideas into shape. The sketches do not have to be fine and careful with product details, it just helps write down and visualize our inspiration rapidly. Actually the more abstract we sketch our mind, the more variability it occurs.
- Mockups scale models are made to help render our ideas in a more directly perceptual way. Shapes can be modified and refined in this stage, until it comes out perfect in form and proportion.
- Prototype to create experimental variability in the product prototype so as to formally test the underlying theory at hand and in a real-world context.

Chapter 2

MAJOR CLASSIFICATIONS OF FURNITURE

People's desires and needs that they require for their home environment are always changing and being influenced. For example as population increases there has been a general shift towards smaller dwellings. On the other hand, with the human society moving forward and the developments of technology, people's lifestyle trends are shifts in the way they go through their day-to-day lives or routines. Ways of business, educating, transportation, and social activities, have been changing with each passing day. All this in turn effects how people use the space provided in all circumstances and therefore revolutionizes the furniture industry.

From ancient society to the modern world, there are lots of differentials in type, form, and description of furniture. For example, not until the 15th century did British Royal Navy establish the modern world trading system, people lived a simpler life. Over the next few hundred years, as the social division and economy develop, there are more and more commercial activities which is critical part of the structure supporting the modern society, and therefore specialized public space of a wide variety emerged in need. Furniture placed in such public places comes out to be quite different with what we have at home. It is expected to accommodate more people or people of different age and gender; it may need to be made with more durable material for being exposed to a relatively unprotected environment and a higher rate of use. Sometimes such furniture are designed and built-in under conditions of interior or landscape design for being better integrated and permanent stay, for example stadium seating, street furniture, built-in cabinet in showrooms, etc. However, no matter in what age and what condition, furniture as functional product is designed to make it suitable or comfortable for living or working in which is closely geared to people's day-to-day lives.

In this research, the study is about method of designing creative form and appearance which is expected to be applied to different types of furniture and the author chose free-standing models as the carrier, apart from those kept in special spaces such as aircraft, stadium, theater, etc. Besides, form follows function. From the standpoint of functionality, the creative furniture design should be novel but never useless design. As a starter of creative design furniture, here is a classification of furniture types with basic structure analysis organized by functional requirements.

2.1 Seating

A seat is place to sit, often referring to the area one sits upon as opposed to other elements like armrests. According to the number of person it accommodates, seat is divided into two groups: single seat and multiple seats.

2.1.1 Single Seat

There are a lot of types of single seats. Here is a list of some major types we can see and use a lot today.

Chair

A chair is a seat with raised surface people used to sit on, commonly referred to those use by only one person. Chairs are most often supported by four legs with a back on one side (however, this is not necessary condition, it can have three legs or a different shape as long as people can sit on and supported steadily). Chair has a long history of evolution which can be traced at least the Early Dynasty Period, so we can see a bunch of chair types with different shapes and different configurations such as rocking chair, recliner, Windsor chair, wingback chair, watchman's chair, etc.

Generally speaking, in most cases there are four basic factors in a chair: sitting surface, backrest, armrest, and base. In other words, these are four elements we can play with to

design a chair. For the backrest, we can transform it into different shape, height, slanting forward or backward, adjustable or non-adjustable. It is almost the same thing for the armrest. For the sitting surface, we can make changes in shape, curved shape of the surface, size and height. As for the bottom, we can make it three legs, four legs, rocker legs (connecting legs on each side to each other with two curved bands attached to the bottom), X-legs, bent one piece, or just a solid bottom. Here is a chart that shows the transformation of the three factors in a chair.

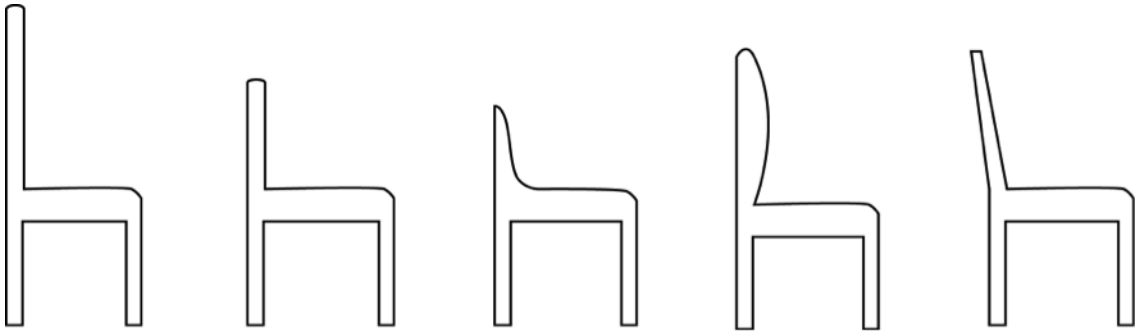

Figure 2.1: Side View (Transforming of Chair Backrest)

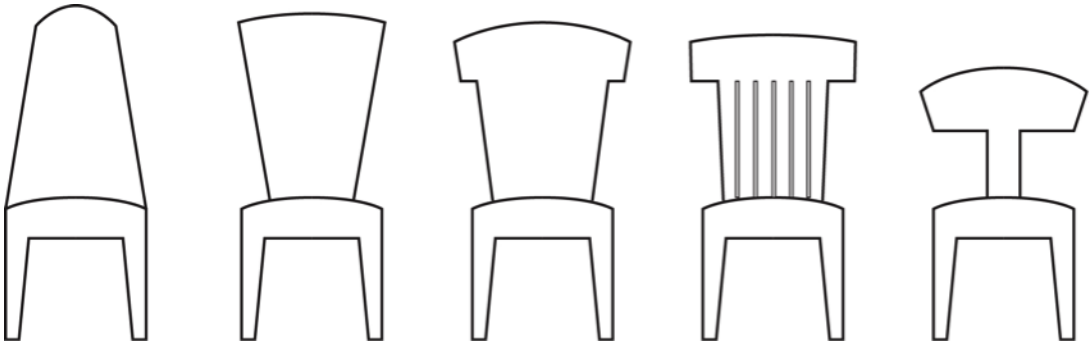

Figure 2.2: Front View (Transforming of Chair Backrest)

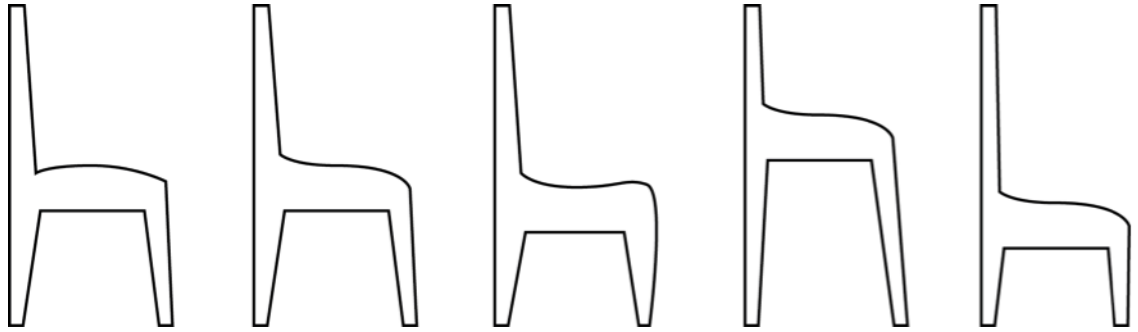

Figure 2.3: Side View (Transforming of Sitting Surface)

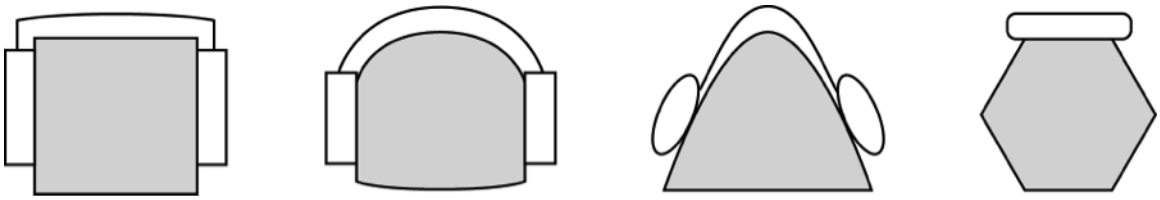

Figure 2.4: Top View (Transforming of Sitting Surface)

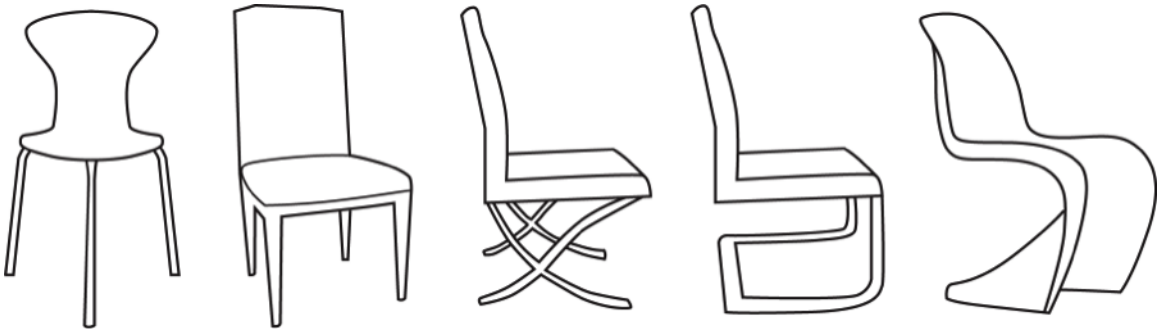

Figure 2.5: Chairs with Different Forms of Bottom

stool

A stool is also one of the earliest forms of seat furniture. In common sense, it is a "backless chair" that consists of a single seat on a base of three or four legs, distinguished from chairs by lack of arms and a back. The ways of transformation in sitting surface and legs for chairs are also applicable for stools due to the similarities. Nowadays, the image of "backless chair" becomes vague. A single seat with tall leg/legs and a small seat surface,

whether has a back or not, is usually considered as a stool. Those stools are usually used at counters, such as kitchen counter, bar counter, shop counter, or a bank counter, for temporary sitting. They in common have an adjustable seat height for better reaching the countertop, and usually can swivel for communication convenience. People sitting on these stools will not last long, and their feet hopefully leave the floor when sitting. So there is usually a place on stool leg/legs for footrest. There are also short stools nowadays. However, the short stools should not have a backrest feature; otherwise they'll be considered as chairs. There are a lot of short stools used for outdoor activities such as camping stools. Those stools are usually short and have a light weight for easy carry and store, and hopefully foldable.

Chaise Longue

Chaise longue, or lounge chair, is an upholstered sofa in the shape of a chair that is long enough for people reclining and lounging, which is thought the blend of a chair and daybed. It is thought the earliest known chaise longue models originated in Egypt, which were made from palm sticks lashed together with pieces of cord or rawhide. In the old time, the chaise longue was a symbol of social status and was often made of expensive fabrics, rare wood, decorated with gems and beautifully carved feet and arm rests, and it was usually associated with women, when they did not go out for work and rest during the day time without having to go to their bedrooms. Some French chaise longue appeared in the 16th century with a design that featured four legs and two raised ends, but nothing on the long sides, which is called Rcamier. Duchesse brise refers to a chaise longue which is divided in two parts: the chair and a long footstool, or two chairs with a stool in between them. Mridienne is a chaise longue which has a high headrest and a lower foot-rest, joined by a sloping piece, whether or not they have anything at foot end. In conclusion, a chaise longue is basically consisted of an upholstered long chair, which is long enough to support legs but not enough for fully lying down, a soft headrest on one end, feet. Armrest for one side or both sides, raised foot end, and divided footstool are optional.

Recliner

A recliner is an armchair or sofa that reclines when the occupant lowers the chair's back and raises its front. It has a backrest that can be tilted back, and often a footrest that may be extended by means of lever on the side of the chair, or may extend automatically when back is reclined. In general, a recliner chair is a very comfortable version or an armchair which featured in tiltability and comfort. Being intended to provide a completely cozy rest place, a recliner is usually immovable with a proper flexibility and softness.

Ottoman

Ottoman is a piece of furniture consisting of a padded, upholstered seat or bench, usually having neither back nor arms, often used as a stool or footstool. Some ottomans are hollow which can be used for storage. Two main features of ottoman are upholstered seat surface, and block-like shape that no legs are visible. Wooden feet may be added to the base to give it stability. They mostly appear in relax indoor environment such as bedroom, living room, sometimes in a coffee store, coordinating with armchairs, and in some cases are used as a coffee table.

Bean Bag

A bean bag (or bean bag chair) is a sealed bag containing dried beans, PVC pellets, expanded polystyrene, or expanded polypropylene with various applications. The first bean bag chair was designed by Italian company Zanotta in 1969, which was made with pear-shaped leather bag filled with Styrofoam beans. Piero Gatti, Cesare Paolini and Franco Teodoro are credited for the original design at the company. It is said they found that staff would like to sit on bags filled with Styrofoam chips during their coffee or cigarette breaks and then got the idea of bean bag. There is no more component other than a flexible ball in a bean bag. Bean bags as piece of furniture are now globally recognized and especially

popular in young people. Its birth broke through the rules of traditional chair design, but succeeded in making use of new materials and accommodating to the new lifestyle.

2.1.2 Multiple Seats

Multiple seats refer to the furniture that several people can sit on at the same time.

Bench

Benches are multiple seats which are typically made of wood, but may also be made of metal, stone, or synthetic materials. Most benches are used in public areas, both outdoors and indoors. Many benches have arm and back rests; some have no back rest and can be sat on from either side. In summary, benches share most ways of transforming in chairs due to similar structures. However, they have more variety of form and shape since they are more often used in public space. Some benches are designed and set in parks like a piece of sculpture which are both functional and art.

Couch

A couch or sofa is a piece of furniture for seating two or more persons in the form of a bench, with or without armrests, that is partly or wholly upholstered, and often fitted with springs and tailored cushions. Couches are normally used in living room, bedroom or the lounge, and also found in hotels, lobbies, stores, or waiting rooms of commercial places. A couch consists of frame as supporting structure and the soft covering. The frame can be made of wood, steel, or anything that has high strength for supporting. The coverings must be made out of soft material, usually seen as leather or cloth. Modern couch usually comes in set, one main sofa and one two or more single or double side sofa, and they usually have a lower seat height compared with most chairs.

In summary, seat design should first meet the functional requirements with its specific role. A good design should has structural stability, and be comfortable. There are a few

factors that affect the seat comfort, seat height, seat depth, seat width, seat pan angle, and material. Seat comfort should be considered with its usage and using environment. A lower seat provides a sense of safe, cozy, stable, and close, while a higher seat provides better visual field and convenience of communication, and makes people more focused and cheerful. Deeper seat and a backward seat pan make people relax, but this is not suitable for people who need to focus on what they are doing, and might result in a lower efficiency of message receive. Besides, soft materials are related to warmth, relax, intimate, and keeping people stay long; while hard material and gloss finish related to sober, clean, and durable. Furniture designers should first understand what kind of role the furniture is supposed to be as well as their basic structure, and then choose correct design language for specific situation.

2.2 Surface

Surface here refers to all kinds of free standing table or desk; in which flat surface is the functional component used to support objects, show, temporary storage or manipulation.

2.2.1 Table

A table is a form of furniture with a flat and satisfactory horizontal upper surface used to support objects of interest, for storage, show, and/or manipulation. The surface is supported from below by columns, a base, or at least three columnar stands, and must be stable. So the first design element of a table is the horizontal surface top (with a certain distance from the floor). The surface top can be rectangular, oval, rounded, semi-circular, or in virtually any irregular shape. However, for the sake of safety, there should not be a sharp angle in the table top. Also, there is a range of the heights which often reflecting the height of chairs or stools used as seating for people making use of a table, as for eating or performing various manipulations of objects resting on a table. Legs as the supporting structure are arranged in two or more similar pairs. Long tables often have extra legs for better support. The table with a single, central foot is called a pedestal table. Many tables have the feature of

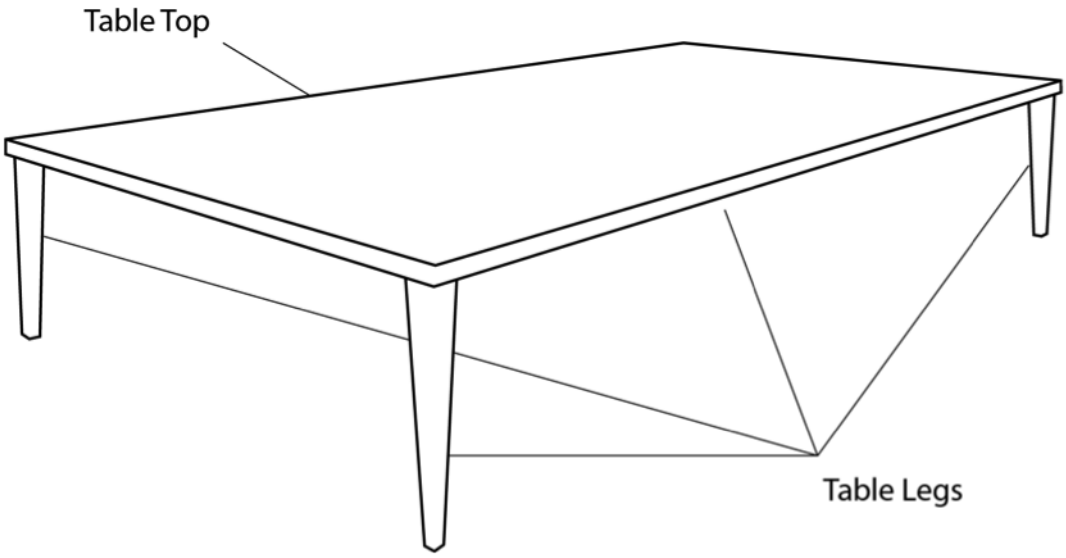

Figure 2.6: Structure of a Typical Table

adjustability. Table tops can be adjusted to change their shape or size, either with foldable extensions or sliding parts that can alter the shape of the surface top. Some with the legs that is able to collapse for easy transportation or storage when not in use.

Because table is the furniture that stands aside assisting with people's gesture, its size, height, and shape has a rule that changed with functions.

Coffee Table

Coffee tables are usually found in the living room or sitting room. It is a piece of furniture designed to be placed in front of sofas, to support beverages, magazines, books, and other small items to be used while people sitting on sofas. Therefore it is frequently a style of long, low table that fit the seat height of sofa.

Dining Table

A dining table is a table designed to be used for formal dining. Historically, in different countries with different culture, the way people seat and have food varies. Today, in terms of the scale of living area, different sizes of dining table are optional. However there is one

feature in common, the table top should be in symmetric shape for easier set in a dining room, also being able to accommodate more than two people with conversation in the meal.

Nightstand

A nightstand, alternatively night table or bedside table, is a small table or cabinet designed to stand beside a bed or elsewhere in a bedroom. It serves the role of a coffee table during nighttime hours, at a person's bedside.

Before indoor flushing toilets became commonplace, the main function of a nightstand was to contain a chamber pot. As a result, early nightstands were often small cabinets, sometimes fitted with a drawer, and usually containing an enclosed storage space below covered by one or more doors. Another term sometimes given to such cabinets was commode. French, Italian and Spanish antique nightstands usually have one drawer and an enclosed storage space with one door. They can be embellished with gold leaf finish, bronze or parquetry inlaid. Modern nightstands are usually small bedside tables, often with a drawer. They are often used to support items that might be useful during the night, such as a lamp, alarm clock, mobile phone, desktop intercom, reading matter, a glass of water, medication, etc.

2.2.2 Desk

The word desk comes from the Latin word "desca", which means a table to write on, from the mid 14th century. A desk is a generally wooded piece of furniture and a type of useful table often used in a school or office setting for various academic activities such as reading or writing on or using a computer. Desks often have one or more drawers, compartments, or pigeon holes to store office supplies and papers. Unlike a regular table, usually only one side of a desk is suitable to sit on (though there are some exceptions, such as a partner's desk). Not all desks have the form of a table. For instance, an armoire desk is a desk built within a large wardrobe-like cabinet, and a portable desk is light enough to be placed on a

person's lap. Since many people lean on a desk while using it, a desk must be sturdy. Desks were first made from wood, but are slowly being converted into harder materials that last longer. A desk is also known as a bureau, counter, davenport, escritoire, lectern, reading stand, rolltop desk, school desk, workspace or writing desk.

Davenport Desk

A Davenport desk is a small desk with an inclined lifting desktop attached with hinges to the back of the body, lifting the desktop accesses a large compartment with storage space for paper and other writing implements, and smaller spaces in the forms of small drawers and pigeonholes. The Davenport has drawers on one of its sides, which are sometimes concealed by a panel. This stack of side drawers holds up the back of the desk and most of its weight. The front of the desk stands on thick legs or pillars which are often highly carved, somewhat exaggerated, thick cabriole legs, but these are not essential. This desk owes its name to a Captain Davenport who was the first to commission the design, from Gillow's of Lancaster, near the end of the 18th century. In a sense then it could also be considered a Campaign desk though there are no records indicating if Captain Davenport was in the British Army or the Royal Navy. The desk shape is distinctive; its top part resembles an antique school desk while the bottom is like one half of the supports of a pedestal desk turned sideways. The addition of the two legs in front completes the odd effect.

Computer Desk

The most common form of the computer desk is a variant of the ergonomic desk, which has an adjustable keyboard tray and sufficient desktop space for handwriting. Provisions for a monitor shelf and holes for routing cables are integrated in the design, making it easier to connect the computer components together. The typical armoire desk provides space for a keyboard, mouse, monitor, printer and speakers. Cubicle desk designs for business and government workplaces include a range of shelves, trays and cable-routing holes for computer

systems. In some computer desks, the cabling is affixed to the modesty panel at the back of the desk, to create a neater appearance.

There are a great variety of computer desk shapes and forms. Large multi-student computer desks configured in rows are designed to house dozens of computer systems while facilitating wiring, general maintenance, theft prevention and vandalism reduction. Small rolling lectern desks or computer carts with tiny desktops provide just enough room for a laptop computer and a mouse pad. Computer desks are typically mass-produced and require some self-assembly. The computer itself is normally separate from the desk, which is designed to hold a typically sized computer, monitor and accessories. Cabling must be routed through the channels and access openings by the user or installer. Various proposals for the "Office of the future" suggested other integrated designs, but these have not been taken up. A rolling chair table configuration offers mobility and improved access in situations where a desk is not convenient. Gyratory computer tables can be used over a bed. Modular computer tables separate user interface elements from the computing and network connection, allowing more placement flexibility. The modules are connected via wireless technology.

Ergonomic Desk

The ergonomic desk is a modern desk form which, like the adjustable drawing table or drafting table, offers mechanical adjustments for the placement of its elements in order to maximize user comfort and efficiency. The ergonomic desk is usually a "stand-alone" piece of furniture allowing access to the adjustment mechanisms. Some ergonomic desks have a sufficiently large desktop height adjustment to create either a common "sit-down" desk or a less common standing desk, which allows the user to work while standing. The ergonomic desk is usually a close companion to the ergonomic chair. The ergonomic desk originated with the beginning of the field of human factors or ergonomics after World War II. Legislation stating minimal requirements for furniture used by office workers referred to ergonomic desk standards. The computer desk and related ergonomic desk are furniture

pieces designed to comfortably and aesthetically provide a working surface and house or conceal office equipment including computers, peripherals and cabling for office and home-office users.

2.3 Sleeping or Lying

A bed is a piece of furniture used as a place to sleep or relax. Most of modern bed consists of a mattress on a bed frame, with the mattress resting either on a solid base, often wooden slats, or a sprung base. In North America many beds include a box spring inner-sprung base, a large mattress-sized box containing wood and springs that provide additional support and suspension for the mattress.

2.3.1 Four-poster Bed

A four-poster bed is a bed with four vertical columns, one in each corner, that support a tester, or upper (usually rectangular) panel. There are a number of antique four-poster beds extant dating back to the 16th century and earlier; many of these early beds are highly ornate and are made from oak.

2.4 Storage

2.4.1 Bookcase

A bookcase, or bookshelf, is a piece of furniture, almost always with horizontal shelves, used to store books. It may be fitted with glass doors. A bookcase consists of a unit including two or more shelves which may not all be used to contain books or other printed materials. Shelves may be fixed or adjustable to different positions in the case. In rooms entirely devoted to the storage of books they may be permanently fixed to the walls and/or floor. Bookcases frequently have doors that should be closed to protect the books from air pollution, and bookshelves are open-fronted. These doors are almost always glazed, so as to

allow the spines of the books to be read. Especially valuable books may be kept in locked cases with wooden or glazed doors. A bookshelf normally stands on some other piece of furniture such as a desk or chest. Larger books are more likely to be kept in horizontal piles and very large books flat on wide shelves. There are three common ways of arranging stationary bookcases: flat against the wall; in stacks or ranges parallel to each other with merely enough space between to allow of the passage of a librarian; or in bays or alcoves, where cases jut out into the room at right angles to the wall-cases. The stack system is suitable only for public libraries where economy of space is essential; the bay system is not only handsome but utilizes the space to great advantage.

2.4.2 Cabinet

A cabinet is a box-shaped piece of furniture with doors or drawers for storing miscellaneous items. Some cabinets stand alone while others are built into a wall or are attached to it like a medicine cabinet. Cabinets are typically made of wood or, now increasingly, of synthetic materials. Commercial grade cabinets, which differ in the materials used, are called casework. Cabinets usually have one or more doors on the front, which are mounted with door hardware, and occasionally a lock. Short cabinets often have a finished surface on top that can be used for display, or as a working surface such as the countertops found in kitchens. Cabinet making is the practice of using various woodworking skills to create cabinets, shelving and furniture. The fundamental focus of the cabinet maker is the production of cabinetry. Although the cabinet maker may also be required to produce items that would not be recognized as cabinets, the same skills and techniques apply. A cabinet may be built-in or free-standing. A built-in cabinet is usually custom made for a particular situation and it is fixed into position, on a floor, against a wall, or framed in an opening. For example modern kitchens are examples of built-in cabinetry. Free-standing cabinets are more commonly available as off-the-shelf items and can be moved from place to place if required. They may also be wall hung or suspended from the ceiling. Cabinets may have

a face frame or may be of frameless construction (also known as European or euro-style). Face frame cabinets have a supporting frame attached to the front of the cabinet box. This face frame is usually $1^1/_2$ inches in width. Mounted on the cabinet frame is the cabinet door. In contrast, frameless cabinet have no such supporting front face frame, the cabinet doors attach directly to the sides of the cabinet box. The box's side, bottom and top panels are usually $^5/_8$ to $^3/_4$ inches thick, with the door overlaying all but $^1/_{16}$ inch of the box edge. Modern cabinetry is often frameless and is typically constructed from man-made sheet materials, such as plywood, chipboard. The visible surfaces of these materials are usually clad in a timber veneer, plastic laminate, or other material.

2.4.3 Chest of Drawers

A chest of drawers, also called a dresser, is a piece of furniture that has multiple parallel, horizontal drawers stacked one above another. Chests of drawers have traditionally been made and used for storing clothing, especially underwear, socks, and other items not normally hung in or otherwise stored in a closet. They are usually placed in a bedroom for this purpose, but can actually be used to store anything that will fit inside and can be placed anywhere in a house or another place. Various personal sundry items are also often stored in a chest of drawers. Although they can be plain in appearance, chests of drawers can also be made with a fancy or ornamental appearance, including finishes and various external color tones. Traditionally, drawers would slide out on smooth wood rails. Most modern cabinets use roll-out shelf sliders, made of metal, with rollers. Most chests of drawers fall into one of two types: those which are about waist-high or bench-high and those (usually with more drawers) which are about shoulder-high. Both types typically have a flat surface on top. Waist-high chests often have a mirror placed vertically on top, which is often bought with the piece. While a user is getting dressed or otherwise preparing their grooming, he or she can look at themselves in the mirror to check their appearance. Some users may keep lamps

for lighting on top of either kind of dresser, and decorative items or photos are sometimes added for appearance.

2.4.4 Chest

A chest (also called coffer or kist) is one of the oldest forms of furniture. It is typically a rectangular structure with four walls and a liftable lid, for storage. The interior space may be subdivided. The early uses of an antique chest or coffer included storage of fine cloth, weapons, foods and valuable items. A cassone is a kind of carved or painted chest associated with late Medieval and Renaissance Italy. Cassones, also called marriage chests, were often used to carry the dowry goods in a marriage ceremony. In Medieval and early Renaissance times in Europe low chests were often used as benches while taller chests were used as side tables. By placing a chest on the side on any kind of rough table, the inner surface of its lid could be used as a proper writing surface while the interior could house writing implements and related materials, as was the case with the Bargueno desk of Spain. Many early Portable desks were stacked chests, with the top one having its lid on the side, to serve as a writing surface when opened.

2.4.5 Wardrobe

Wardrobe, also known as an armoire from the French, is a standing closet used for storing clothes. The earliest wardrobe was a chest, and it was not until some degree of luxury was attained in regal palaces and the castles of powerful nobles that separate accommodation was provided for the apparel of the great. The name of wardrobe was then given to a room in which the wall-space was filled with cupboards and lockers, the drawer being a comparatively modern invention. From these cupboards and lockers the modern wardrobe, with its hanging spaces, sliding shelves and drawers, evolved slowly. The modern wardrobe differs in one respect from the historical one for its triple partitioning: there are two linear compartments on either side with shelves as well as a middle space made up of hanging pegs

and drawers, the latter being a latter-day addition, besides a clothes' press in the higher central space on level with a person's chest.

Chapter 3

INSPIRATION SOURCES AND DESIGN ELEMENTS

As is mentioned before, the objective of studying the system of form and design is to help the designers organize the inspiration logically, and then use the morphological analysis method to develop our furniture form design. In this section, the author explored a broad range of inspiration sources and summarized them in four major categories through a series of case study on many successful furniture designs. Also, a study of design elements from Wucius Wongs theory is introduced, as well as the classic examples of these design elements in furniture design.

3.1 Nature

Liugi Colani said "The earth is round, all the heavenly bodies are round; they all move on round or elliptical orbits. This same image of circular globe-shaped mini worlds orbiting around each other follows us right down to the microcosms." Colani is a Swiss-German industrial designer who received numerous awards for his designs based on rounded organic forms, for which he claimed nature is the best soil to conventional designs. Nature is the biggest sourcebook of behavior, function, color and shape, which can inspire peoples creative invention and all kinds of design. Moreover, designing with nature not only helps to find functional solutions, but alters perceptions of beauty and meaning. In cognitive psychology, inference is drawn from visual representation to abstract knowledge (Tversky, 1999). Morphing form derived from nature always touches people's soul and emotions. Taking nature as a role model for our designed environment is a tendency among designers, which creates a feeling of unity between man, and it is origin. Throughout the history, nature has provided a rich source of inspiration for designers. Going back to the origin of art, the

earliest art activities of human being almost rooted in the imitation or extraction of natural shapes. Everything in the natural world, animals, plants, or rocks, has its beauty in perfect harmony. "Going back so that you can go forward. We need a real sudden shift. Mankind simply must go back to its origins and get back to nature. We have to be part of nature itself, not just consume it: biodesign shows us how to live harmoniously and peacefully with nature. We can learn to protect what we know and love." Luigi Colani, thinks radically towards the future. His fusion of science, art and nature identified him as an early pioneer of biodesign, generating morphing forms to interpret nature's shapes.

Figure 3.1: Speed Chair by Luigi Colani

Figure 3.2: "r.n.i." tables by Chul An Kwak

Tables shown in Figure 3.2 is amazing creative furniture. With serpentine legs that resemble nothing so much as octopus tentacles, the "r.n.i." series of tables by Chul An Kwak is actually inspired by images of running horses. Sculpted from wood, these designs offer the same sort of flat surface you would see in a conventional table but with legs that seem kinetic and alive.

From Kwak's "r.n.i." series of tables we can conclude that the designer did not generate the morphing form of the whole table interpreting the shape of a horse or an octopus, he just extracted the legs, or the "image" of animal legs, and transferred it to table legs, but kept the table surface flat to execute its functionality. This is an instance of partial form imitation from the natural shape shown in some of functional structures, such as chair or table legs, chair backrest, table top, etc.

Therefore, there is the other way to integrate the organic natural form to a whole piece of furniture. Due to the requirement of functionality, natural shapes are usually transformed or processed into abstraction before transferring to design. The abstraction aims to expressing emotional characteristics of original shapes, which leaves people more space for understanding and imagination. The Rugby Chair by Luigi Colani shown in Figure 3.3 is an instance of this application.

Figure 3.3: Rugby Chair by Luigi Colani

Figure 3.4: Bone Chair by Joris Laarman, 2006 and 2008

Joris Laarman's revolutionized the design process by using an algorithm to translate the complexity, proportion and functionality of human bone and tree growth into a chair form. In his own words, he sculpted "using mother nature's underlying codes."

First designed in 1953, this ingeniously shaped Diamond Chair is the most iconic design of Italian sculptor Harry Bertoia. Fabricated from high grade, cut and welded steel wire, the metal is formed into a distinctive diamond shape as the name suggests. The end result is not only a comfortable, supportive chair but also a visual study of form and space.

Figure 3.5: Diamond Chair by Harry Bertoia

Table 3.1 is a natural elements box listed by the author:

Natural Elements					
Live				Lifeless	
Animal			Plant	Natural Phenomenon	Natural Landscape
Leopard, tiger, lion, polar bear, panda	Whale, shark, penguin, jellyfish, coral, starfish	Snake, cicada, butterfly, dragonfly	Arbor, shrub, flower, trunk, corolla, foliage, root, bark, fruit, seed	Wind, rain, mist, thunder, bolt, cloud, storm, tornado, sunrise/sunset, polar light, earthquake, tsunami, gravity	Desert, canyon rainforest, cliff, volcano, grotto, fall, glacier

Table 3.1: Natural elements box

3.2 Architecture

A good furniture design must be harmonious with the environment it lives in. Therefore, furniture design can never separate from landscape or architecture. On the other side, furniture design is usually seen as miniature architectures. Architects with their strong engineering background and comprehensive skills and talent on structure and texture design, may approach furniture design quite differently. The interesting thing is that in many ways there is certain freedom in furniture design, which appeals to architects in general. There is a furniture company that was founded to take advantage of this design energy. They aim to push the boundaries of design and promote undiscovered talent by inviting architects from around the world to create a piece of furniture.

Actually, many architects designed furniture for their architecture works. This is a Minimalist and Trendy Bookshelves (Figure 3.6) designed by Toyo Ito, for the Italian Furniture Company HORM.

We can soon discover that the Sendai Minimalist and Trendy bookshelf is inspired by the outstanding Sendai Mediatheque building (Figure 3.7) also designed by Toyo Ito

Figure 3.6: Sendai Minimalist and Trendy Bookshelves by Toyo Ito

Figure 3.7: Sendai Mediatheque, Sendai, Japan

in 2001. The bookshelves consist of 6 shelves in pressed, sanded, varnished safety glass. Solid oil-varnished, turned black walnut and alder wood structures, with 60 turns, each at a different angle and a different diameter. By observing the outside and inside of the Sendai Mediatheque we can see the bookshelves has the similar structure as the architecture. It is just appropriate to use the unique structure of the building in a bookshelves design.

From this instance, we can get ideas about the relationship between furniture and architecture design. The furniture structure can borrow the supporting structure from architecture, since which is the essence of an architecture design. See the Bridge Table by

Joris Laarman in Figure 3.8. The table uses the classic arch bridge structure as foundation, transferring the deck to table surface, logical and stable.

Figure 3.8: Bridge Table by Joris Laarman

Besides, the texture of architecture elevation are usually inspiring elements in furniture design. In a modern architecture, the texture of architecture elevation is an important part of the design. Mostly found are some interesting and beautifully designed hollowed-out pattern surface.

Japanese architects Toyo Ito is notable in designing a special "skin" that wraps the buildings he designs, making them stand out in their surroundings. The photos below are Toyo Ito's Tod's Omotesando Building (2004) and Mikimoto Ginza2 (2005) in Tokyo, and Reiser + Umemotos' $O-14$ Tower (2007) in Dubai. These buildings feature lacy or mesh-like concrete cages with relatively small openings.

Bato Idea Chair by Peter Donders is an example of this application. The chair as well as the foot stand appears in a one-piece sheet of coated metal hollowed out with irregular circles, which not only makes it much lighter in weight but also creates an extraordinary effect of light and shadow in specific lighting environment.

Inspiration from the snow-covered landscape of the surroundings and the fluid lines of the mountains, the room adopts whole pure white walls and all custom furniture merging in a contemporary interior design. Introduce the outdoor landscape into indoor gives design a fresh way to go.

Figure 3.9: Left: Tod's Omotesando and Mikimoto Ginza 2 by Toyo Ito; Middle and Right: O-14 Tower by Reiser + Umemoto's

3.3 Geometric Shapes (Solid figure, plane figure)

Geometric elements used in design and the forming of geometric designed furniture style marks the change from convention to modern design. Geometric elements witness the course of modern design development. Charles R. Mackintosh (1868-1928) was the representative of earliest geometrical form design. He used geometrical form as his main design language, merged straight lines and simple geometric shapes into furniture design, indicated a new step into modern design in Europe.

Here are mainly two kinds of applications of geometrical form design: independent geometrical forms and compound geometrical forms:

- **Independent geometrical form:** use one single three dimension geometric figure (sphere, cylinder, cone, cube, etc.) as body, with simple modify and attain a graceful shape. This type of geometrical form furniture appears to be extremely neat and simple and usually comes with mono-color. Discard the emotional cognition and complex visual information, it enhance the beauty of pure reason, but still with much of visual impact and fun. Figure 3.13 is the famous Cone Chair design by Denmark furniture designer Verner Panton, which is a typical independent geometrical form design.

Figure 3.10: Bato Idea Chair by Peter Donders

Figure 3.11: Barin Sky Resort by RYRA Studio

- **Compound geometrical form:** use more than one three dimension geometric figures to form, or set a simple geometric shape as unit form and repeat.

Wucius Wong introduced eight types of repetition of unit forms in his book *Principles of Form and Design* (Wong, 1993).

(a) Repetition of shape: Repetitive shapes can have different sizes, colors, etc.

(b) Repetition of size

Figure 3.12: Hill House Chair by Charles R. Mackintosh

(c) Repetition of color: All the forms are of the same color but their shapes and sizes may vary.

(d) Repetition of texture: All forms can be of the same texture but they may be of different shapes, sizes, or colors.

(e) Repetition of direction: This is possible only when the forms show a definite sense of direction without slightest ambiguity.

(f) Repetition of position: This has to do with how forms are arranged in connection with the structure.

(g) Repetition of space: All forms can occupy space in the same manner.

(h) Repetition of gravity: Gravity is too abstract an element to be used repetitively. It is difficult to say that forms are of equal heaviness or lightness, stability or instability, unless all other elements are in strict repetition.

Figure 3.13: Cone Chair by Verner Panton

Figure 3.14: Vertex Collection by Karim Rashid for Vondom

Wong's theory of form and design is based on 2-D graphic design background. However, these types of repetition are logical and universal which can be extended to a three dimensions system. Faceted surface is a kind of repetition of 2-D geographic applied to 3-D, which can be found in many products as a stylish texture.

The design of Vertex Collection is ultra contemporary and visually striking. It involves the connection of a series of triangular planes so that surfaces and shapes evolve to accommodate seating and gathering, with architectural flair.

3.4 Others

In addition to the three commonly used inspirations above, there are also many other directions for designers to draw inspiration from, such as painting, still life, character, signal, etc. The most famous representative is the Red and Blue Chair by Dutch architect Gerrit Rietveld designed in 1918 and the painting Composition with Red Blue Yellow by Piet Mondrian in 1930. Although it is not a chair inspired by the painting but an inverse, the composition and deconstruction shift between 2-D and 3-D totally explain the method and possibility of drawing design elements for 3-D product from 2-D painting.

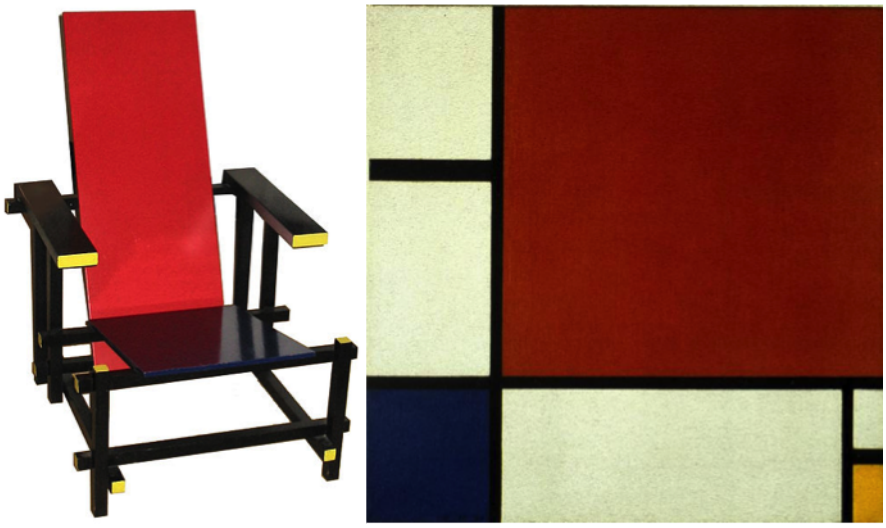

Figure 3.15: Left: Red and Blue Chair by Gerrit Rietveld; Right: Composition with Red Blue Yellow by Piet Mondrian

3.5 Shape and Form

The words "shape" and "form" is actually two different things. From Merriam-Webster Dictionary, the noun "shape" means the visible makeup characteristic of a particular item or kind of item. And the noun "form" refers to the shape and structure of something as distinguished from its material, while it has another meaning that the essential nature of a thing as distinguished from its matter, as the component of a thing that determines its kind. As for furniture, "shape" refers to the physical figure, the external appearance of the

product. The "form" represents the mental outlook, the spirit of the product. Form can be seen as the expression element of the furniture. Further, it reflects the style of furniture.

Not everything in the world has a shape, but from the philosophic point of view, everything has its form. Mountain, ocean, animal, plant, are all concrete form. They are objective, touchable, and transferable by human. That is the reason that morphology exists. Architect, furniture, appliance, etc., are also concrete form. They are products of human's activity. We may call it artificial form. However, there are also forms that can only be cognized through words, or exists under certain concept (defined by words, formula, etc.), which we call abstract form, or concept form. For example, air is concept form. It cannot be touch or transferred under a natural circumstance, but people can know it is a mixture of gas. We can describe it as fluid, transparent, invisible, etc., and now we can feel it. Then all these words above can be considered "image" of air.

Figure 3.16 is a chart that shows the classification of forms.

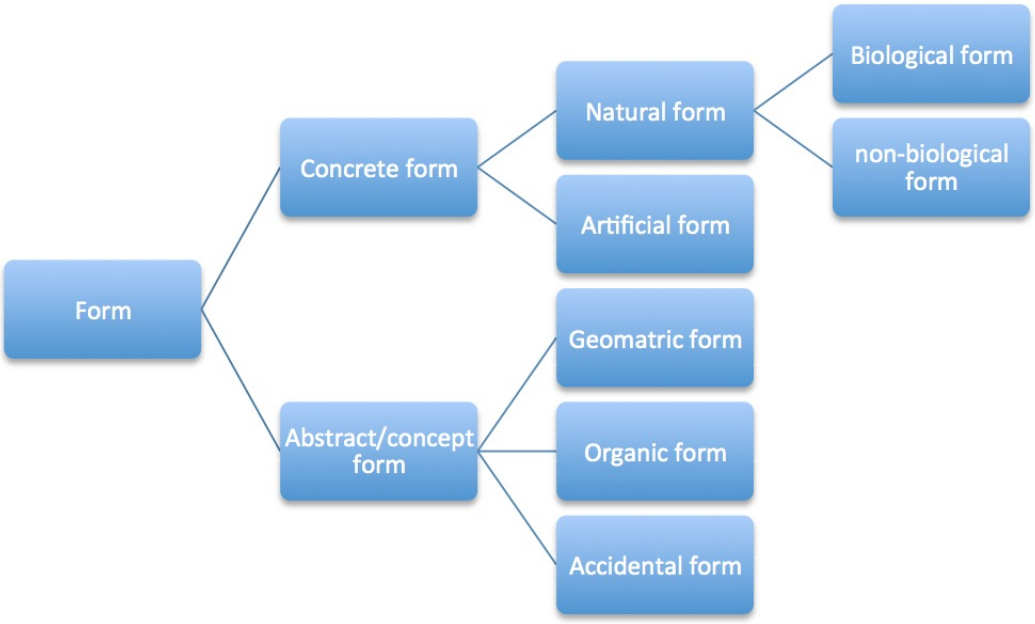

Figure 3.16: Classification of forms (Yu, 2009)

To some extent, concrete form and concept form are interconvertible, and therefore leaves designers more space for imagination and creation. There is not much significant of

the classification itself, however, as a designer, it can help us organize inspirations logically in the process of creativity. Furniture, as an objective substance with concrete form, leaves us much space and chance to grant it emotion and spirit. That is the significance for designers to study the forms of furniture. There are two objectives for studying form design of furniture:

- Generalize a conclusion what are the forms that people most accept and love. Why do they prefer it?
- Study some specific furniture forms and the background they born, so as to figure out how people created these proper forms for furniture, which can be the guidance for our design methods development.

3.6 Basic Elements of Design

Visible points, lines, or planes are forms in the true sense, although forms as points or lines are still simply called points or lines in common practice (Wong, 1993).

3.6.1 Point

It is the most basic form unit. In the book Principles of Form and Design, Wong describes point like this. "Smallness, of course, is relative. A form may appear fairly large when it is confined in a tiny frame of reference, but the same form may appear rather small when it is put inside a much greater frame of reference." The most common shape of a point is that of a circle which is simple, compact, non-angular, and non-directional. However, a point may be square, triangular, oval, or even of a somewhat irregular shape. Thus the main characteristics of a point are:

(a) its size should be comparatively small, and

(b) its shape should be rather simple.

3.6.2 Line

In geometric, a line is the path of moving points. Line is the dominating element and spirit in art and design. The movement and form of line sketch the outline of furniture, and express its emotion, strength, characteristic, and style. There are straight line and curve two systems of line.

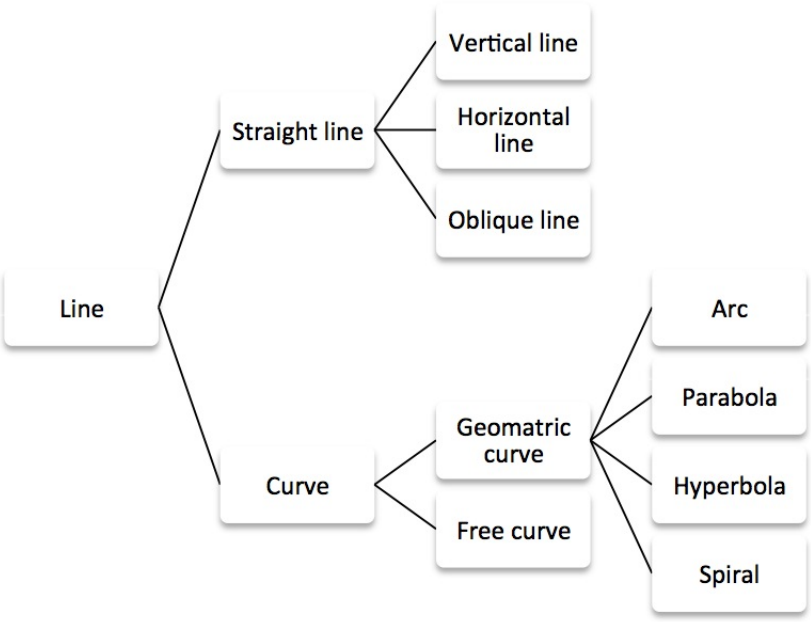

Figure 3.17: Classification of line (Yu, 2009)

A line conveys various feelings depending on its length, thickness, form, and position, which we call the expression of line.

(a) Straight line strict, simple, logical, powerful

(b) Vertical line upright, rise, serious, supporting

(c) Horizontal line extending, broad, calm and quiet, stable

(d) Oblique line radiate, active, break, unstable, variation

(e) Geometric curve reasonable, lively

(f) Arc plump, full

(g) Parabola speed, flowing

(h) Hyperbola symmetrical, balance

(i) Spiral line elastic, vivid, rhythm

(j) Free curve freedom, vigorous, unrestrained

Figure 3.18 and Figure 3.19 are the exercise examples of the variation of straight lines and curve lines. Through the exercise designers can gain more techniques in making use of the design elements and transfering them to good design.

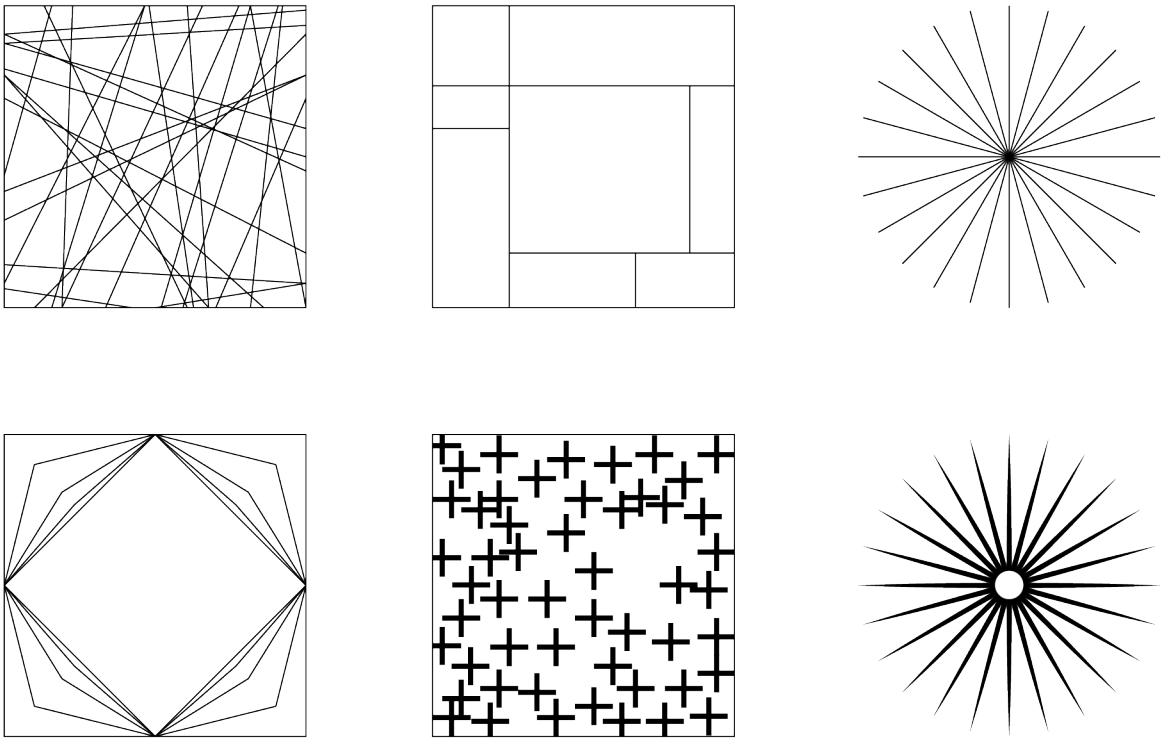

Figure 3.18: The variation exercise of straight line

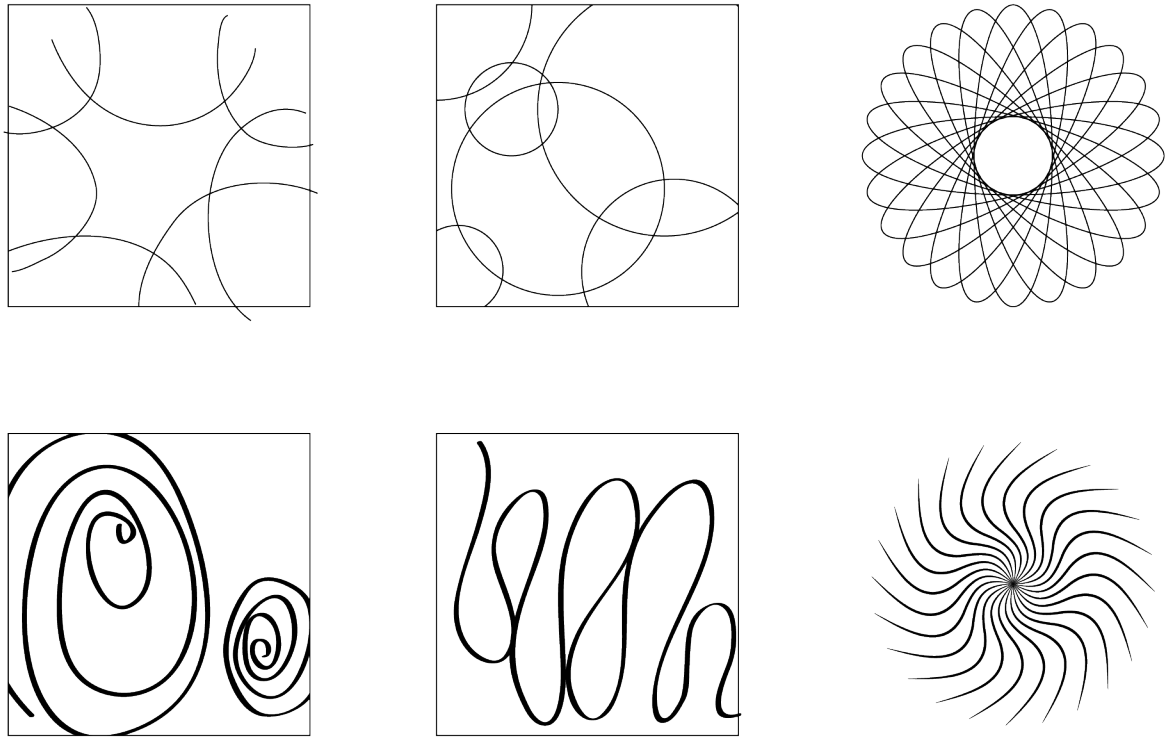

Figure 3.19: The variation exercise of curve line

In furniture design, composition of lines decides the expression of product. Furniture designed with all straight lines looks strict, simple, and austere.

Ming and Qing style furniture reaches a fairly high level of Chinese furniture design. Its characteristics can be summarized as simple and clean in form, strict structure, and moderate in decoration, elegant texture.

In Figure 3.21, this highly sculptural chair was first designed in 1934 as a response to Theo Van Doesburg's call back in 1924 for introduction of "oblique" lines in furniture design. Architect Rietveld's response was to create a simple cantilevered chair constructed at 45 degree angles, thus resolving the tensions between the vertical and horizontal elements. All he used was just straight lines to design this amazingly simple work. The final result is a chair that is not only beautiful but also extremely strong and highly functional. Furniture designed

Figure 3.20: Ming and Qing Dynasty style furniture, China

with all curves looks graceful, smooth, flowing, and romantic. The most representative work of this type should be Panton chair. This chair was the first in the world to create a form-molded chair in plastic without any joints. It is one-piece cantilevered design with its sinuous shape, which made it synonymous with 1960's pop culture, and without doubt one of the most significant chair designs of the 20th century.

Furniture designs integrate straight lines with curves can be seen everywhere. It is accepted by most designers and users, because the combination of the two types of line make the design neither too plain nor too novel.

3.6.3 Plane and curved surface

On a two-dimensional surface, all flat forms that are not commonly recognized as points or lines are forms as plane. A planar form is bound by conceptual lines, which constitute the

Figure 3.21: "Zig Zag" Chair by Gerrit T Rietveld, 1934

Figure 3.22: Panton Chair, 1967

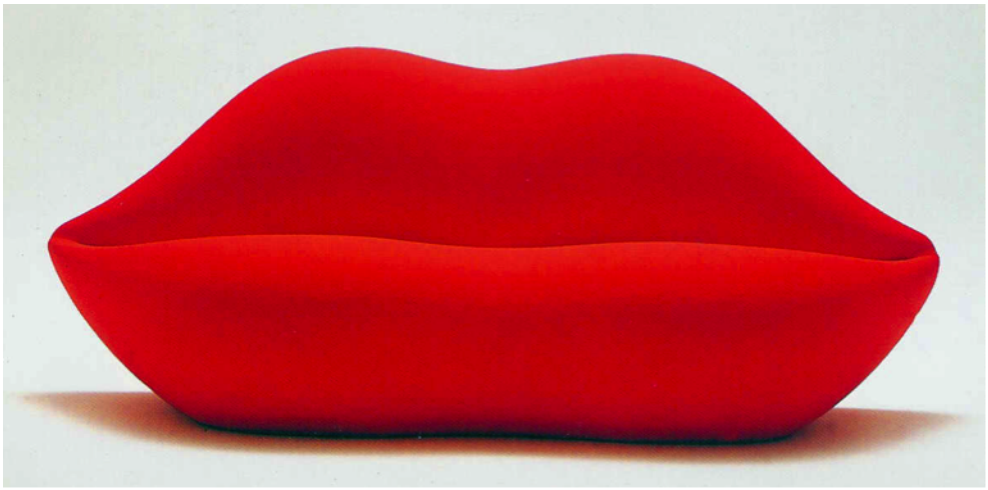

Figure 3.23: Bocca Marilyn lip sofa by Studio 65, 1972

edges of the form. The characteristics of these conceptual lines and their interrelationships determine the shape of the planar form (Wong, 1993). There is also a three-dimensional surface that is not mentioned in Wongs book called curved surface. A curved surface may be a result of curves moving in a path that is not on the same plane as the curve is. Plane and curved surface give people distinguished emotions. In the planar form, there are a variety of shapes. Square, rectangle, or triangle gives us an expression of brief, neat and pleasing simplicity. Circle feels much friendly and cute. On the other hand, curved surface has an emotional characteristic of tender, soft, and lively. Due to the more freedom in variation, curved surface designed furniture always looks surprisingly and shows much personality of its designer.

Chapter 4

MORPHOLOGICAL ANALYSIS AND APPLICATION IN FURNITURE DESIGN

4.1 Morphological Analysis in Design Work

In 1984 Nigel Cross published "Developments in Design Methodology", collecting influential articles about design methods and procedures. Its approach was defined as "...the study of how designers work and think; the establishment of appropriate structures for design process; the development and application of new design methods, techniques and procedures; and reflection on the nature and extent of design knowledge and its application to design problems" (Wiley, 1984). First generation researchers such as Archer and Jones proposed that the design process is based on logical analysis and creative thinking (Archer, 1963).

Any exploration of a furniture design should be on the premise of consumers' demand, and improving the quality of peoples' lives. Usefulness and functionality should be the first consideration, which reflects on the demand of ergonomics it meets, strength and stability of structure, nonhazardous and safe. But there is more we should take into consideration. In the early 1980s Memphis design period, the Italian shouted the slogan that "human development, if only in order to meet their most basic physical needs, then mankind is too low level. Design of new era should be: function is not important, important is that I like." Today in the business world, the design philosophy that form follows function is no longer that sufficient, and the aesthetic aspect of a product has become a more and more important element for success. It is important for the designers to understand how invention works, where and how it breaks down in design. Designers should have more in-depth discussion about consumers' preferences and satisfaction, as well as the changing trend.

Archer identified that drawing is a basic technique of modeling and modeling is the language of design (Archer, 1965; Cross, 1984). The term graphicacy appears in many publications of the time to emphasis that drawing is a valid mode of modeling and presentation (Brazil, 1975; Boardman, 1982). A sketch is a visual representation for modeling or thinking about something else such as attributes which demand a greater cognitive contribution from the viewer than other types of representation (Purcell, 1998). Observation is an activity related to visual perception, and it is also the first step of sketch and design. Morphological analysis in furniture design will focus on observation from inspiration sources, and transferring the 2D sketch to design, which is conducted in the following procedures.

4.1.1 Observation from Inspiration

The world we live in is an information sourcebook of behavior, function, sound, color, and shape, which can stimulate us in various sensory ways, influence on our moods, and inspire design and invention. The inspiration can be triggered by direct observation and captured then visualized in 2D or 3D. As input, design requires a designer's observations. Observation in the early phase of design process is the starter and also the answer of "how to make things?" and "what to design?" The importance of sketches from inspiration objects has been addressed from many aspects such as visual thinking. It goes without saying that visual perception is the prime channel for contact with external world.

In terms of cognitive psychology, the mental operations of receiving, storing and processing of information require sensory perception, memory, thinking and learning (Amheim, 1969). Surrounded by design, sketches have been used as a research media for visual perception (Cross, Dorst, Roozenburg, 1992; Kramer, 1994; Landay, Myers, 1995). Although these studies belong to different domains, they focus on conceptual development. In conceptual design the designer observes the natural world and employs sketches to elaborate the concept (Schn and Wiggins, 1992; Goldschmidt, 1994; Kavakli, Suwa, Gero and Tversky, 1999).

4.1.2 Learn from Morphing Form through Sketch

The designer's sketches and ideas are instantiations of ideas and inspiration for design. In the conceptual development stage of design, different tools and media have been used: paper and pen, computer graphics, RE equipment and scale models (Archer, 1997). 2D sketching is a continuous and developing process made up of visual elements such as points, lines and planes (Wallschlaeger and Busic-Snyder, 1992; Linda, 1996). Meanwhile, they learn how to construct a reasonable form, which lays the foundation for manipulation of 3D form in product design (Jenkins and Martin, 1993). In this phase, sketching is a tool for mind recording, and also the media to associate the morphing form to product prototype. This section discusses some sketching methods and their suitability for conceptual development. In the analysis step, the natural object is examined in order to find relations between form, structure, and the geometry within as well as the functional principles (Stokholm, 2006). With analyzing the object and recording its characteristics by sketching or photography some information such as morphological structure, connection mechanisms, functional principle and environment influences is gained (Colombo, 2007).

In terms of Zwicky's procedure of morphological analysis, the first step is to list the attributes of the product. Attributes are parts, properties, qualities or design elements of the thing being looked at. Here, the product is furniture, and a breakdown of furniture parts is filled on the side, because sometimes the product is partial transformed instead of the whole body. If the object is fixed, list the parts of the object only. Next step, draw up a table using these attributes as column headings. Then we can choose a topic from the inspiration sources mentioned in chapter 2 for this morphological box. The table is going to be filled in with sketches which may take up some space, so draw the table on a larger board, and remember to stay one topic one box to keep your thinking organized and focusing. If you want to try something else, just draw another one. Write down as many inspiring elements as possible that interest you. In this phase, thumbnail sketches instead of writing for both furniture structure and inspiring elements are recommended, which will help

visualize your thinking process and discover the insights and relations easier. Now select one entry from each column and fill in your findings or all seemingly possible features you can think about. Either do this randomly or select interesting combinations. By mixing one part and one element from each column, you will create a new mixture of components. That is a conceptual form of your design. Generally speaking, the morphological analysis here is not only a creative thinking method, but also a progress of form study for both design element forms and furniture forms. Here is an example of morphological analysis in furniture design from natural elements.

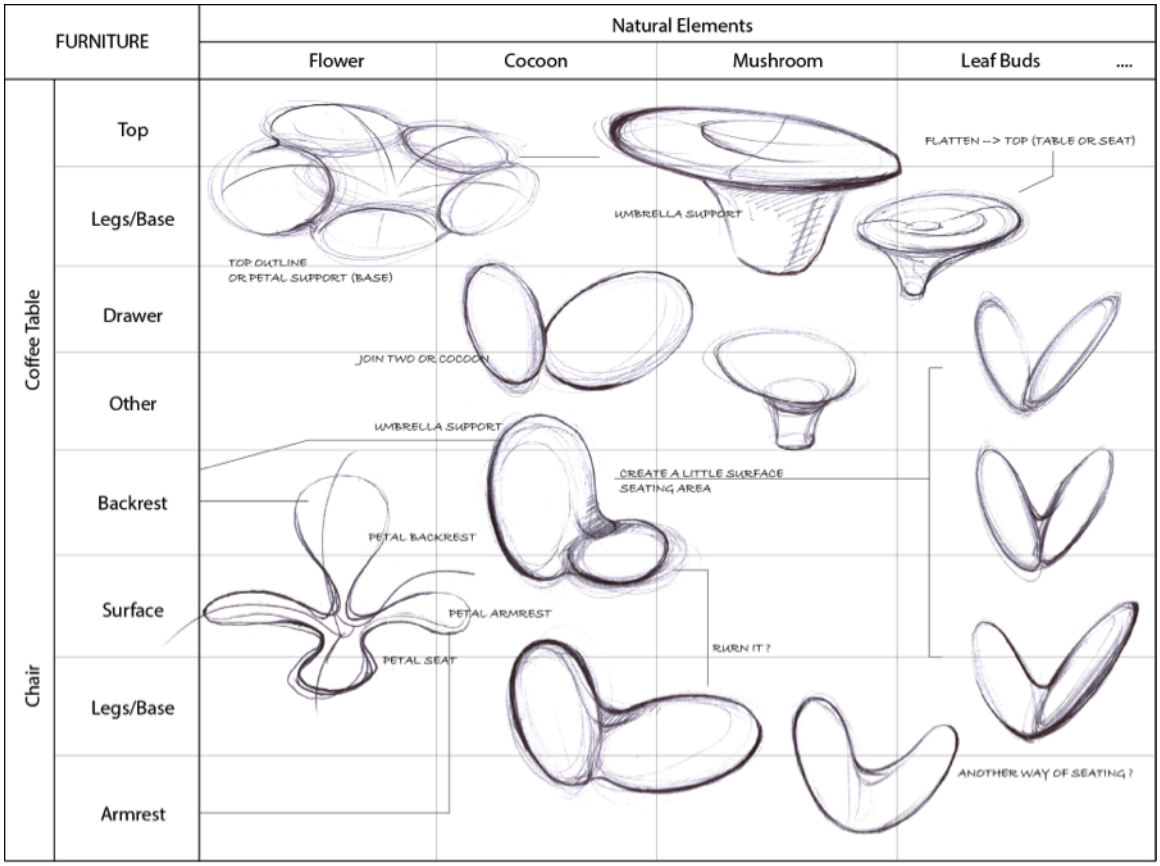

Figure 4.1: Morphological analysis of natural elements in furniture design

4.1.3 Drawing Feature of Form Aesthetics

In this phase designers should refine the morphing form and make it beautiful. The beauty of shapes is "the place of geometry in a sculptor's thinking" (Plato, Philebus). Besides functional characteristics, designers observe many form elements of a natural object as form aesthetics which will improve the marketability of manufactured products. Aesthetics consists of several elements which interact with each other in different ways. Design aesthetics is interested in the appearance of products; the explanation and meaning of this appearance is studied mainly in terms of social and cultural factors. This aesthetics section focuses on form aesthetics. Even though aesthetics includes several elements such as tactility, color and texture, the study is limited to product design. Additionally, artistic form is the ensemble of choices intended to realize the point or purpose of a work (Carroll, 2004). Artists, designers and architects have been concerned with the proportions of the parts of their works. Particular length ratios are preferred, also sometimes entire systems of proportion. Some systems are based on the form of natural objects where elements are derived from the evaluation of a perceiver of a perceived object or product. The evaluation of the dimensions includes (but is not limited to) the proportionality, sense of balance, rhythmic impression and sense of unity (Wen, 2008). Ulrich and Eppinger pointed out that identity focuses on a single dimensions of aesthetic needs leading to products with stable markets and technology, which are highly dependent upon identity to create aesthetic appeal and, hence, differentiation (Ulrich and Eppinger, 1995). According to Huntley, Fechner's experiments were repeated by Witman, by Lalo, each a leading psychologist of his time, and each obtained similar results. Huntley's listing of Fechner's data is presented in the Figure below.

They used one of the oldest concepts in aesthetics in which people prefer a certain proportion known as the Golden Ratio, which pervades mathematics and aesthetic visual design, architecture, etc., to provide an aesthetic form. Fechner found that shapes with a ratio of 1:1.618 are more pleasing to the eye than shapes with other proportions. There seems to be a small set of real numbers which human observers prefer (Fechner, 1997).

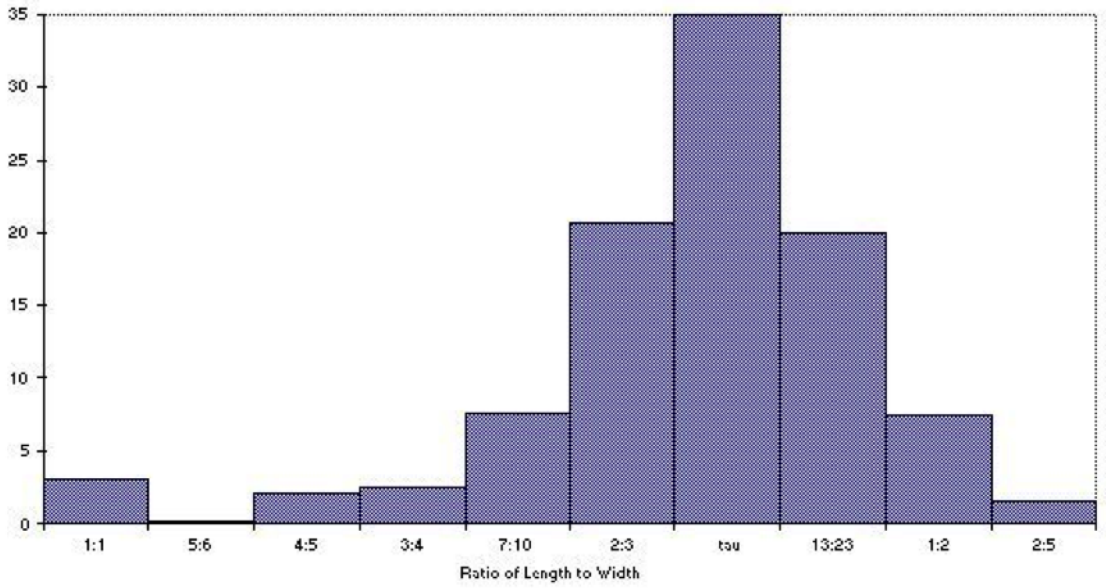

Figure 4.2: Fechners Results (Golden Ration 5:8)

4.2 Techniques of Transferring Sources to Design

Since the morphing form is drawn from the sources, how to integrate it into a physical product? This session will introduce four methods of applying the elements to furniture products.

4.2.1 Bionics

Bionics is an interdisciplinary field which looks for inspiration in nature to provide solutions for design problems in different fields and various brances of industry such as design, tissue engineering, bioengineering, aeronautics, space science and biomaterials (Colombo, 2008). Its applications range from emotional translation of form to utilization of functional principles (Kepler and Stokholm, 2004). It is widely considered as a useful tool for generating concepts and developing products, which is visually pleasing and environmentally sustainable. Definition given by Neuman implies that Bionics has to do with interactions between bio systems and their environment, and Nachtigall, one of the German pioneers in Bionics, acknowledges the importance of learning and inspiring from nature, instead of

directly copying its principals into technical solution (Neurohr and Dragomirescu, 2007). Many examples from aviation technology demonstrate this approach in borrowing inspiration from nature, as well as other fields of Bionics application such as well-known example of lotus-effect which was applied in dirt-repelling and self-cleansing surfaces (Colombo, 2007). To conduct a design project with a Bionic design approach, the requirements of the artificial system must be defined initially, and then a natural system which performs a similar function is investigated (Vakili and Shu, 2001). In the analysis step, the natural object is examined in order to find relations between form, structure, and the geometry within as well as the functional principles (Stokholm, 2006). With analyzing the object and recording its characteristics by sketching and photography some information such as morphological structure, connection mechanisms, functional principle and environment influences is gained (Colombo, 2007). In bionic furniture design projects, the analysis mainly concerns on the forms related to functions.

In transforming the inspiring sources to a furniture form, a deeper understanding of the form-structure relations and functional principles is gained and these principles are transformed to a geometrical and mechanical model, which can be done with sketches and 3D modeling in addition to physical models or prototype. The core of the morphological analysis and transforming to technical solution is an abstraction and simplification phase (Colombo, 2007). Furthermore, it is necessary to incorporate all effective aspects in an industrial design concept, to have a rational and producible conceptual development, which follows the product development steps as "industrial design process". See Figure 4.3.

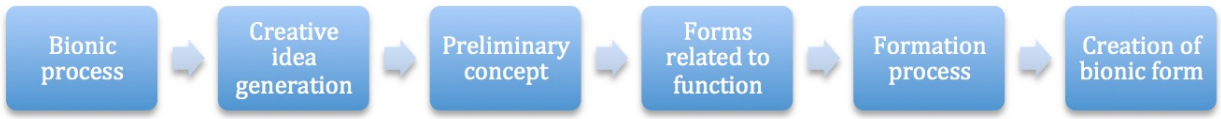

Figure 4.3: Bionic design process

4.2.2 Metaphor

A conceptual domain can be any coherent organization of human experience. The regularity with which different languages employ the same metaphors, which often appear to be perceptually based, has led to the hypothesis that the mapping between conceptual domains corresponds to neural mappings in the brain (Feldman and Narayanan, 2004). This idea, and a detailed examination of the underlying processes, was first extensively explored by George Lakoff and Mark Johnson in their work Metaphors We Live By. Other cognitive scientists study subjects similar to conceptual metaphor under the labels "analogy" and "conceptual blending". Conceptual metaphors typically employ a more abstract concept as target and a more concrete or physical concept as their source. In Lakoff's theory, metaphors are not merely stylistic, but that they are cognitively important as well. They are pervasive not just in language, but also in thought and action.

In Mark Blechner's book The Dream Frontier, the author describes musical metaphors, in which a piece of music can "map" to the personality and emotional life of a person (Blenchner, 2001). There can also be a metaphoric mapping between other art forms and human experience. The art theorist Robert Vischer argued that when we look at a painting, we "feel ourselves into it" by imagining our body in the posture of a nonhuman or inanimate object in the painting (Blenchner, 1998).

Abstraction was the key aesthetic device employed by the majority of designers. Essentially, abstract art was understood to be that which eliminated figurative or symbolic elements in favor of the manipulation of "pure" form. The search for purity was closely related to the idea of truth: "Although one has always to operate more or less speculatively in the domain of abstraction, there is good reason to accept this latter manner of visionary thinking about plastic art as true" (Greenhalgh, 1990). Obviously abstraction implied an outright rejection of figurative elements in design and, consequently, a severe reduction in

the potential of the object as a conveyor of narrative or symbol (Greenhalgh, 1990). Therefore, unlike the ornament, the abstract form of an object was normally developed within the parameters of the structure, rather than as an addition to it.

Designing furniture form in a metaphor way considers these aspects: underlying meaning of the inspiring elements, common perception of human, correct design language. Here is a discussion about association and the metaphor of some objects. When people say "something like something", both nouns can either refer to a physical object or an abstract concept. For example, the cloud is like a marshmallow. Both cloud and marshmallow are physical object and visible. However this is not a good metaphor because it just associates the two objects that is visually close in the appearance, but failed to discover any underlying insight in neither of them. When people say time is money, money is a more concrete concept which can be presented in the form of currency and exchanged to other things at equal values, while time is perceptible, but untouchable. When people associate these two things together, it needs some description or understanding in certain environment or social background. Sometimes people talk something with metaphor or something presents itself with a metaphor way, leaving the space for imagination, is more interesting and touching to the information receiver.

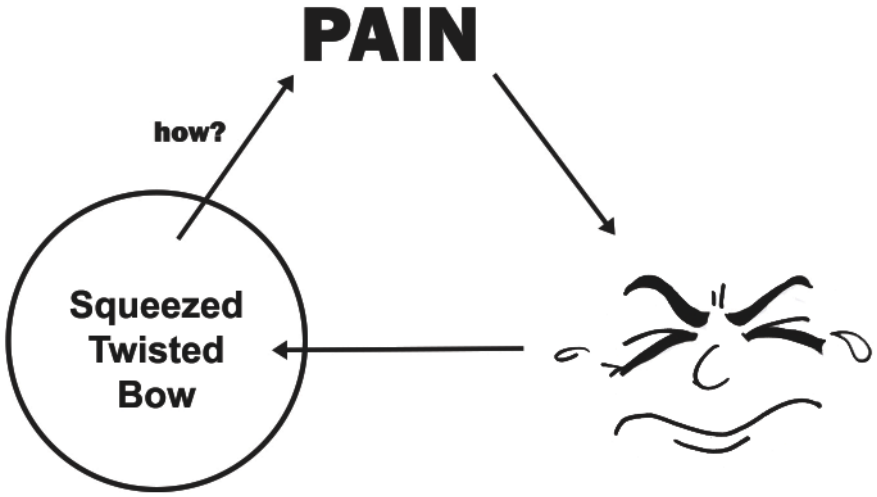

Figure 4.4: How it is pain?

Here is an example of applying the design in metaphor method. The first step is to find an abstract concept, for example: pain. Then, try to visualize this word in mind and give it an expression or an action. For example: twist (see 4.4). Find something from the inspiration sources book as a carrier of form which is adaptable to this topic. Doing form study with what you found in sketches. To simplify the sketching, the author just uses a cuboid as the carrier.

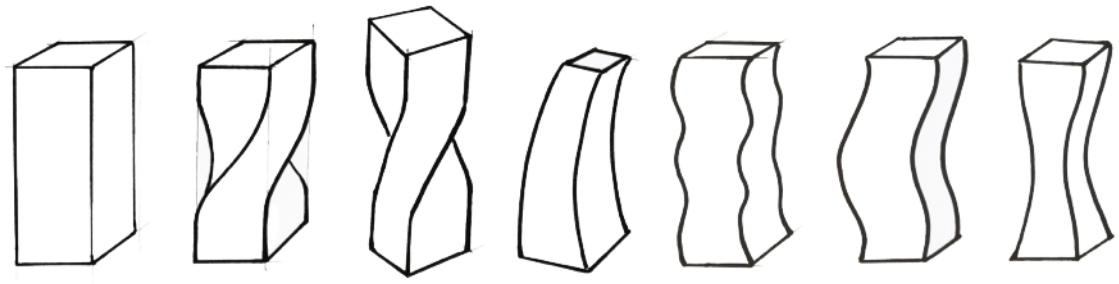

Figure 4.5: Form study of pain in a cuboid

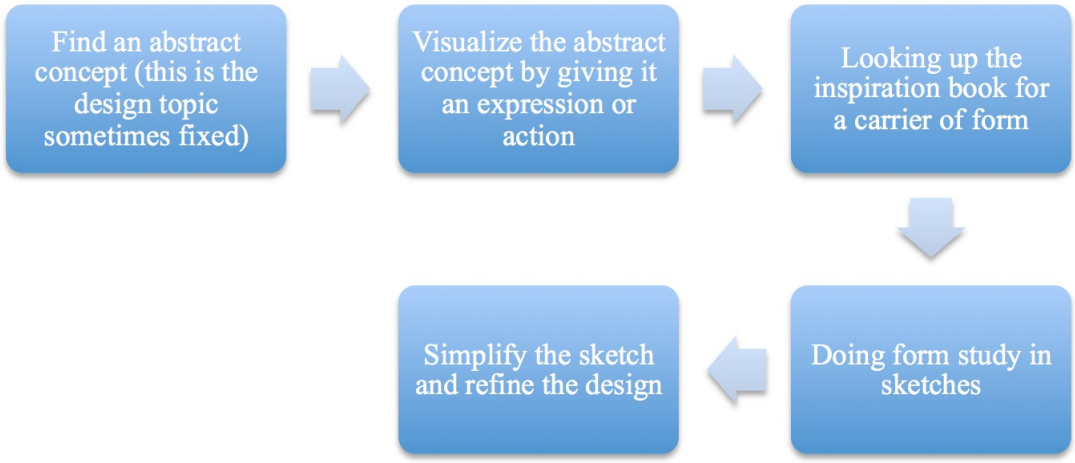

Figure 4.6: Flow chart of Metaphor design

4.2.3 Detailing

"Small is the new big." As a creative director at IDEO, Paul Bennett reminds us that design needs not invoke grand gestures or sweeping statements to be successful, but instead can focus on the little things in life, the obvious, the overlooked, and his design approach

reflects this philosophy. For often, it's not the biggest ideas that have the most impact, but the small, the personal, and the intimate. Design is in the details. "The goal of embracing details is to get you to think critically and present the best possible design you can." (Hamid, 2008) The start of a great furniture design begins as a sketch but what it really comes down to is the details. It is a functional yet decorative product people use with a very close aesthetic appreciation in their daily life. In this section, the author will introduce how to apply designs to furniture detailing through case study.

Overt Joinery

Joinery is a part of woodworking that involves joining together pieces of wood, to produce more complex items. It is the most important detailing of a piece of furniture. Strength, flexibility, toughness, appearance, etc., are a few characteristics of wooden joints, which derive from the properties of the joining materials and from how they are used in the joints. "Because of the actual physical existence of Egyptian examples, we know that furniture from the first several dynasties show the use of complex joints, like the Dovetail, were used over five thousand years ago. This tradition continued to other later Western styles. While Western techniques focused on concealment of joinery, the Eastern societies, though later, did not attempt to 'hide' their joints. The Japanese and Chinese traditions in particular required the use of hundreds of types of joints due to the lack of suitably strong glue or the development of nails." Overt joinery as decorative detailing can be seen in many cases of contemporary furniture design. In the world of machine manufacturing, the overt joinery shows a hint of vintage and aesthetic of craftsmanship.

The Plastic Nature (Figure 4.7) is a series of furniture designed by Alexander Pelikan, which exemplify the connection of the plastic material and the world of wooden furniture with beautifully designed joinery. The designer juxtaposes natural wooden texture and shiny plastic surface. The combination of rustic and modern sparks at the point of joinery detailing.

Figure 4.7: Plastic Nature by Alexander Pelikan

A generation disconnected from time-honored skills, technique and know-how seeks experiences marked by quality, craftsmanship and evidenced humanity. Furniture rooted in nature is always valued and enhanced by those factors throughout the history.

Fake Joint

There is a wide variety of materials can be used for making furniture, wood, metal, leather, cloth, plastic, glass, etc. Each material is related to one or more specific crafts to join pieces/parts together. For example, sewing is the craft to join or attach cloths, leather, or other fabric material using stitches. For another example, riveting is widely used to join sheet-metal where welding is not preferably as deformation and modification of material properties can occur. Both of the two methods mentioned above are seemingly impossible to be applied to furniture joint. However, they can still appear in a furniture design since both stitches and rivets are decorative elements on surface.

Figure 4.8: Stitching Concrete by Florian Schmid

Stitching Concrete (Figure 4.8) is a stool developed by German designer Florian Schmid using concrete cloth, which is a flexible cement impregnated fabric that hardens on hydration to form a thin, durable water proof and fire proof concrete layer. The rope stitches assist to fasten and form the structure during the watering and drying process, and in the finished product it is the highlight and decorative part of the stool.

Aviator Chair (Figure 4.9) manufactured by Restoration Hardware is an aerodynamic-curve chair hugged in aluminum accented with exposed rivets. The combination of leather and riveted metal reinterprets the look and feel of an old fighter plane from the golden age of flight. It is worthwhile to note that the recurring rivets change the accent and texture of the surface, and create an interesting visual impact.

Figure 4.9: Aviator Chair by Restoration Hardware

Figure 4.10: Flow chart of Detailing design

4.2.4 Pattern

As is implied by the name, it is to transfer any inspiration to 2D graphical element and simply apply them to furniture by painting, dyeing, etching, attaching, CNC or laser cutting, etc. Visible Structures (Figure 4.11) by Nendo is a series of furniture made from foam core and reinforced with industrial strength carbon tape. Strips of black tape on white foam core operate as graphical element on each piece of furniture but create a magical visual effect when put together.

In the Visual Structures by Nendo, the designer created an interesting 3D visual effect with very simple graphical elements. Inspired by his design, we can make use of the light and a surface hollowed out with patterns to cast magical shadow on the floor. Pattern

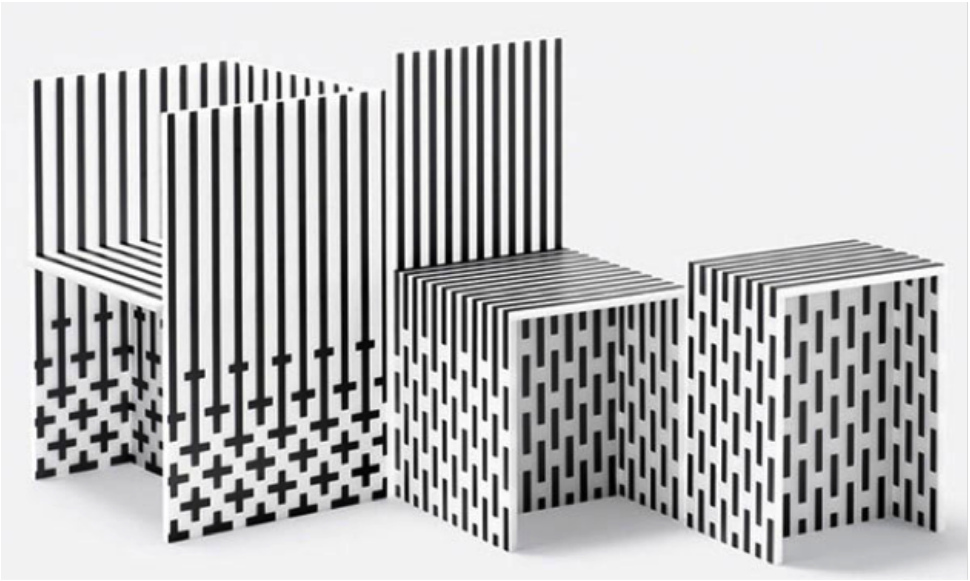

Figure 4.11: Visual Structures by Nendo

design does not mean the design stays on decorative art or graphic design level. Never forget when presenting the patterns, we still have the design tools of color, material, lighting, etc. Through making different combinations of various tools, delightful surprises may take place unexpectedly.

Figure 4.12: Flow chart of Pattern design

Chapter 5

APPLICATION RESULTS

In this chapter, the design method developed in previous chapters will be applied to four furniture designs that one-to-one corresponds to the four techniques in chapter Four. Generally, the design starts from a morphological box as in Figure 5.1.

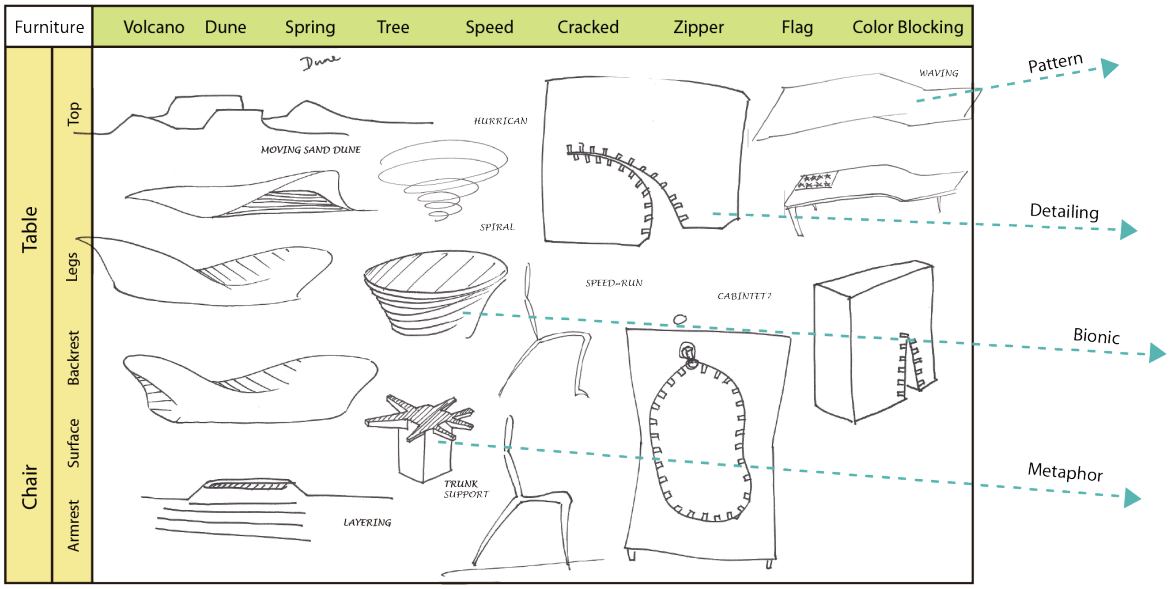

Figure 5.1: Morphological analysis of final projects

Chosen elements are listed in the column heading of Figure 5.1. Some of the elements are natural sources, while the others are abstract concepts. And the furniture as well as a breakdown of parts is filled in the row heading of Figure 5.1. Actually each of the ideas can go by all of the 4 techniques for application. However, we choose the flag to go with pattern, the zipper to go with detailing, the volcano to go with bionic, and the tree to go with metaphor.

5.1 Specification

5.1.1 Caldera

Caldera is a side table inspired by the natural landscape. There are two versions of the design: one is positive that looks like sand dune in desert; the other one is negative that looks like a caldera. The designer develops a deeper understanding of the form-structure relation of the inspiring sources (dune and caldera) and functional principles of a side table, and then transforms it to a geometrical and mechanical model. Here the "Bionic" technique is applied. The contour curves of the great landscape and the rhythm of its changing is drawn, abstracted, and simplified through morphological analysis with sketches and 3D modeling in addition to prototypes.

5.1.2 Greenfall

Greenfall is a wood table inspired by a leafless tree in late fall. In which the "Metaphor" technique is applied. The table is shown in raw and rustic wood material, which remind us the perfect gift from the nature tree. The designer draws a silhouette of a tree on a rectangle, splitting the trunk and the leaves part. By developing the shape of a tree and the functional parts of a table, the design is refined by the process of morphological analysis. The trunk part works as supporting structure of the table, and the leaves parts as table surface fall onto different heights. Now the word "fall" is a pun, which has the first layer of meaning implied in the table that it is the season that leaves depart from the trunk revealing the shape of a trunk. The second layer of meaning shown in the table is the green parts of a tree falling onto lower levels.

5.1.3 Zipper

Inspired by the great invention of zipper, this coffee table is integrated zipper detailing to the table surface. Zipper was invented by an athlete who was too lazy to tight his shoes,

but wanted to fasten his shoes faster. It was originally used to join two pieces of cloths or leather. While in the table, both zipper and the table are made with wood. It is not designed to zip the split tabletop, but works as decoration. The small opening on the tabletop does not affect the table's functionality, but breaks through the faceless rectangular coffee tabletops.

5.1.4 Union Jack

In this project, the graphic of the British flag is painted on the wood coffee tabletop. There are a lot of flag lovers all over the world, and there is a royal trend of using the Union Jack motif in home decor has been around for decades and it is still going strong. Smoked glass, oxidized woods, nuanced black and gunmetal color, a revolt against the slick, white, modernist aesthetic, the smoky remnants stand as iconic and enigmatic symbols of survival and endurance.

5.2 Performance Criteria

Figure 5.2: The Test of Performance Criteria

The four furniture designs one-to-one correspond to the four design techniques developed in this research. A test can be carried out to test if the methodology and principles are understandable to other designers. The left column is filled with the pictures of the four furniture mock-ups; the names of the four designs are in the middle; what on the right are the four techniques for design. All the names and pictures are listed by random. The participants are designers (or people from related fields) who had read the design process of morphological analysis and the descriptions of the four techniques, but not informed of any information about the four designs. They are required to draw lines to match the designs and the techniques. The accuracy rate of the results from the participants speaks for the performance of the design methods.

5.3 Sketches

5.3.1 Caldera

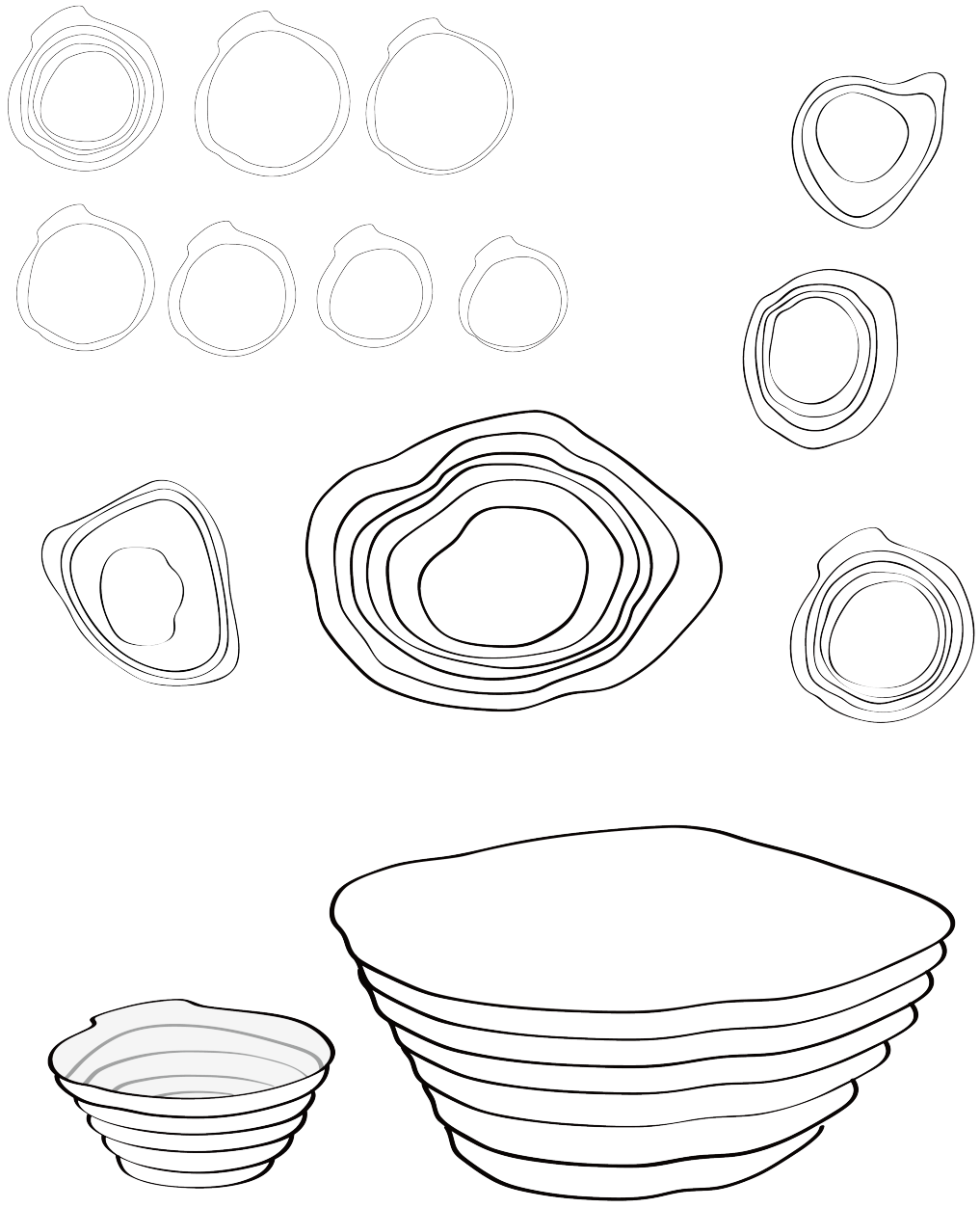

Figure 5.3: Caldera Table Sketch

5.3.2 Greenfall

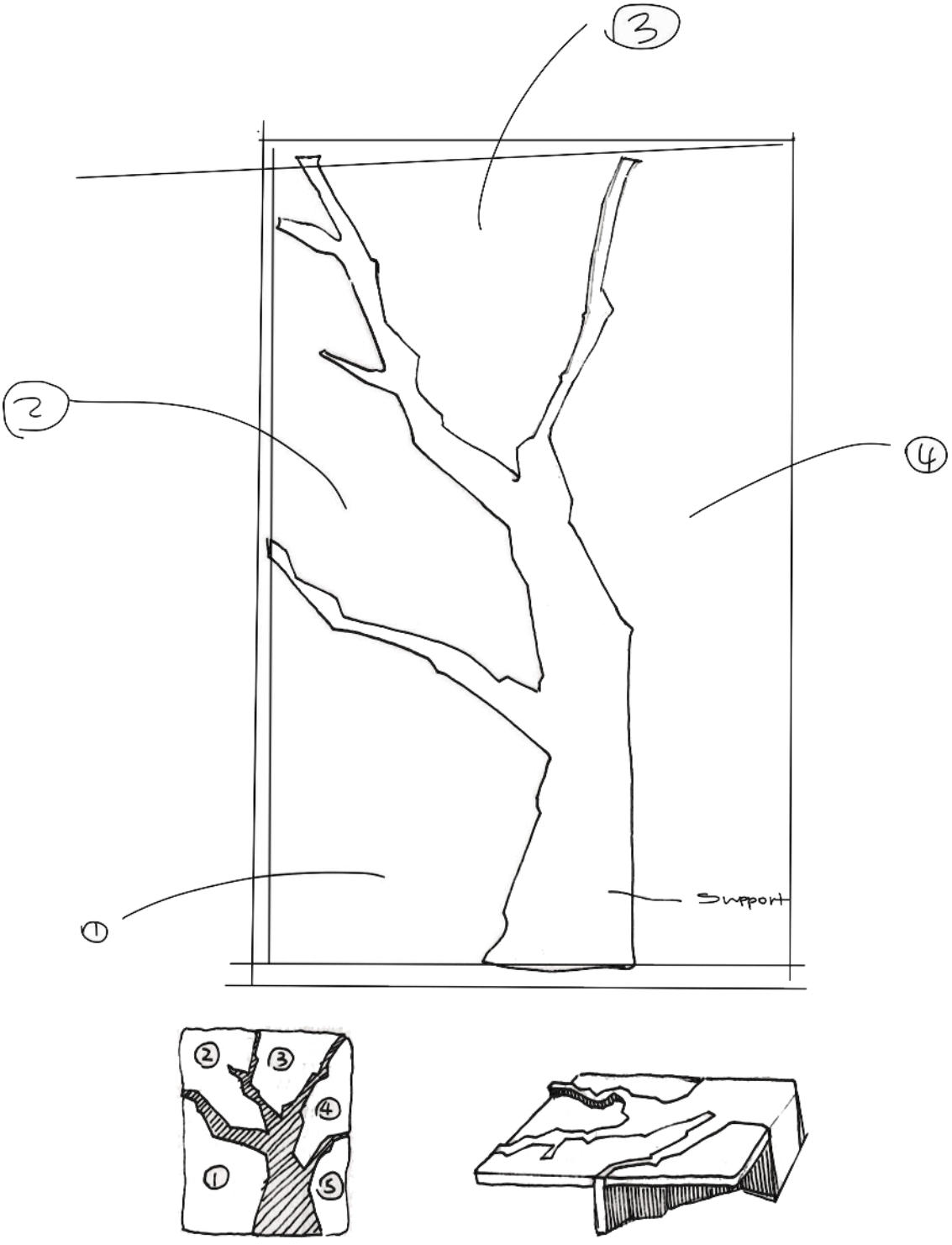

Figure 5.4: Greenfall Table Sketch

5.3.3 Detailing

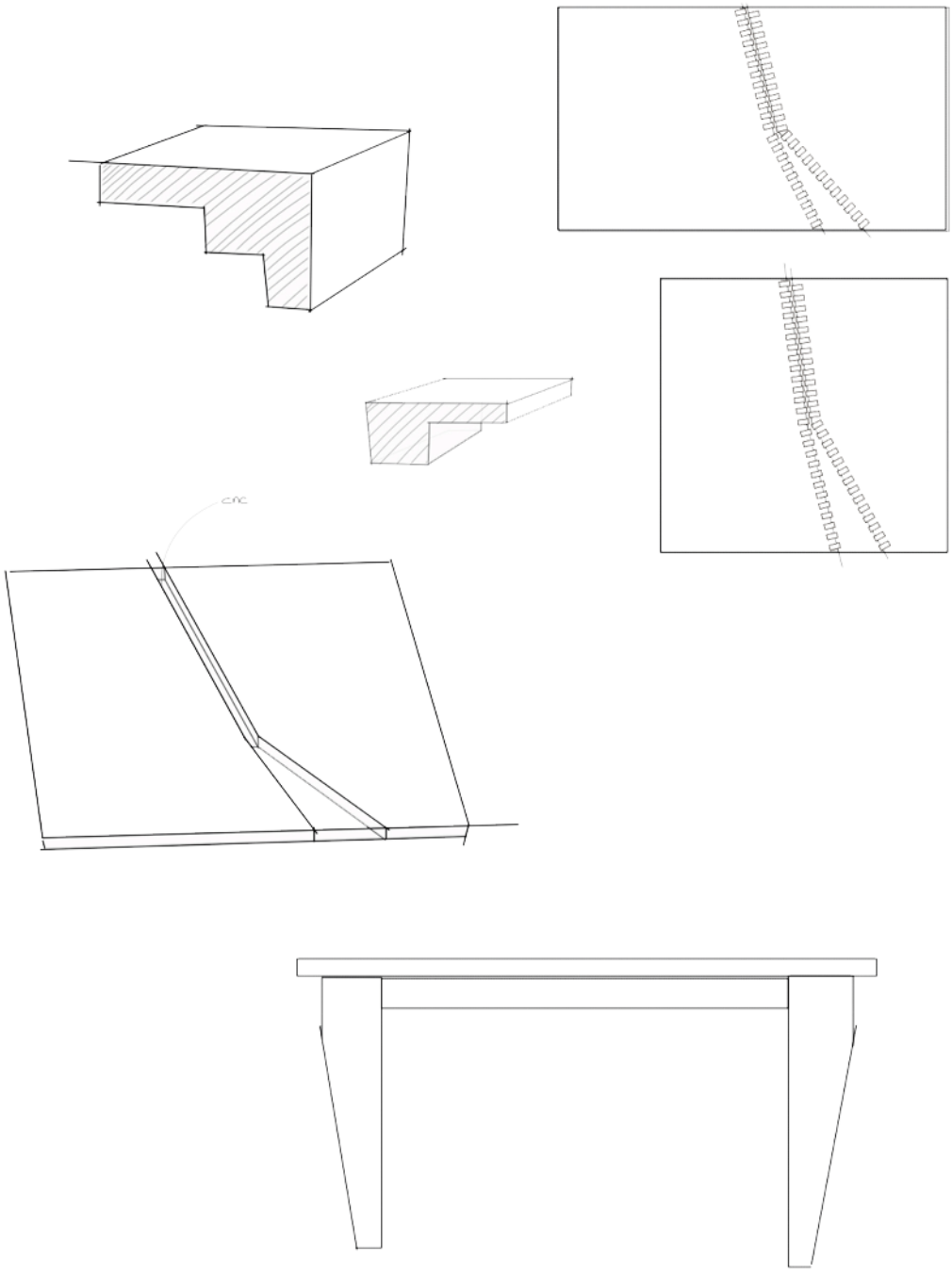

Figure 5.5: Zipper Table Sketch

5.3.4 Pattern

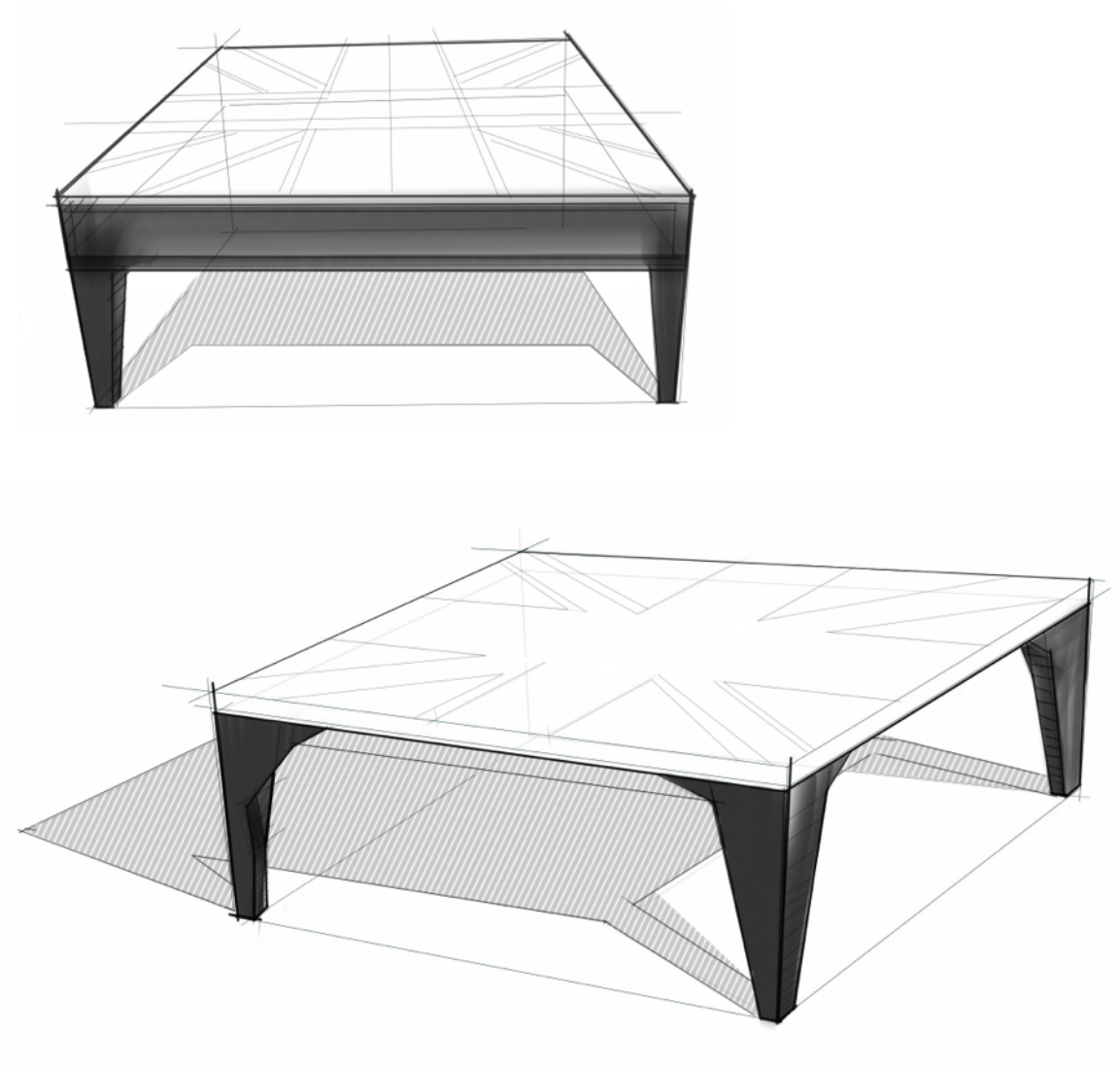

Figure 5.6: Union Jack Table Sketch

5.4 Sketch Models

5.4.1 Caldera

Figure 5.7: Caldera Sketch Models

5.4.2 Greenfall

Figure 5.8: Greenfall Sketch Model

5.4.3 Zipper

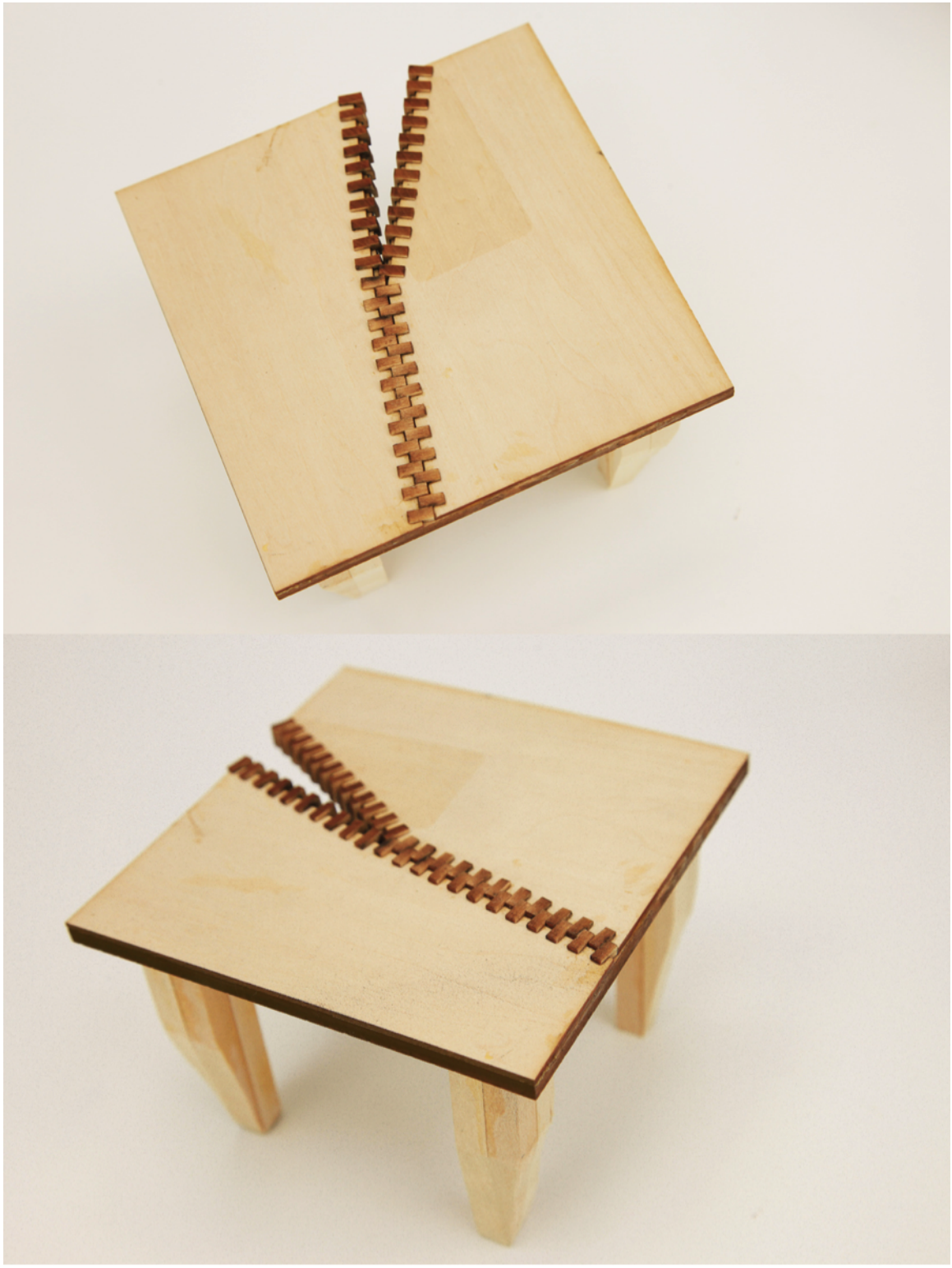

Figure 5.9: Zipper Sketch Model

Figure 5.10: Zipper Full Size Model

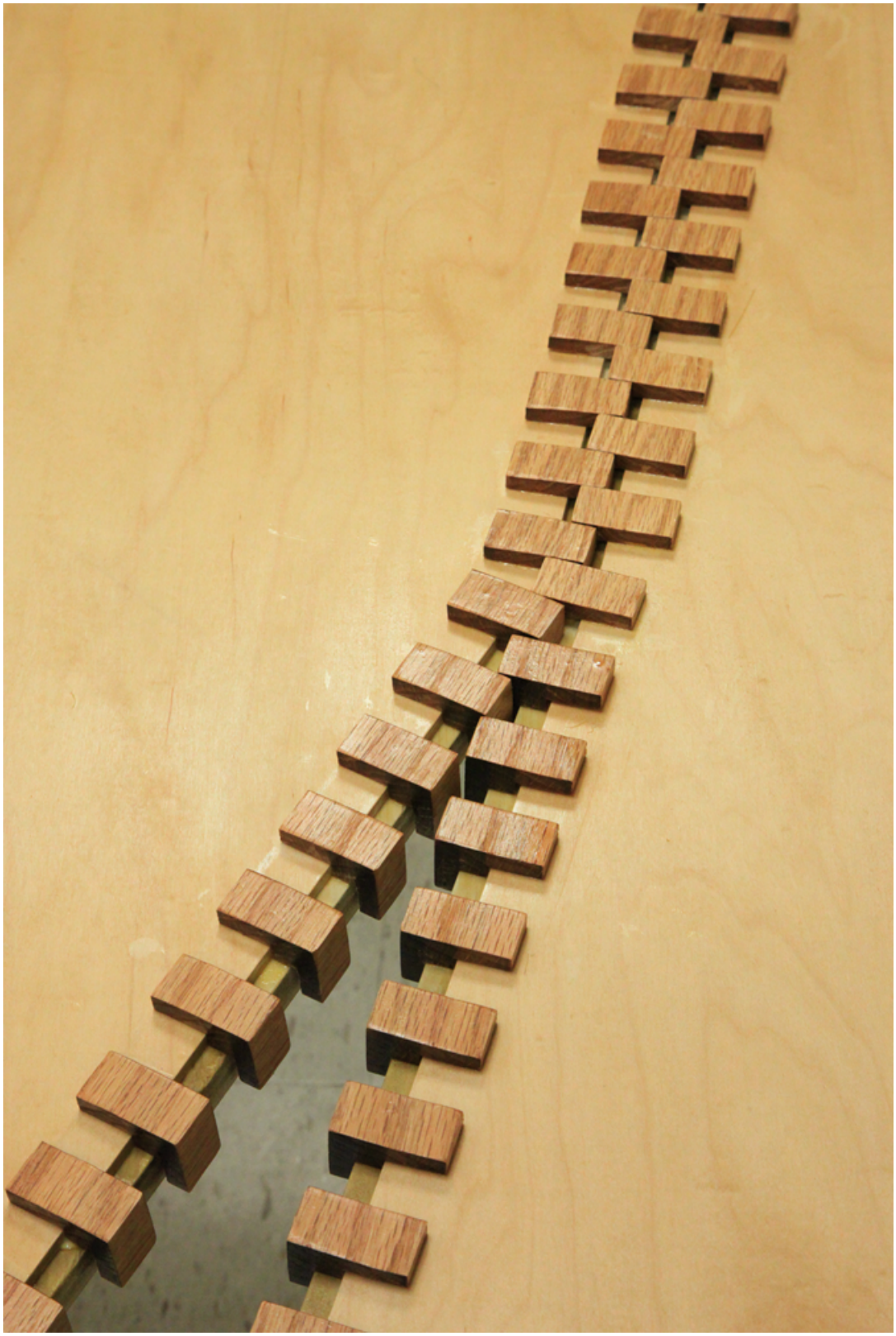

Figure 5.11: Zipper Full Size Model Details

5.4.4 Union Jack

Figure 5.12: Union Jack Sketch Models

Chapter 6

DISCUSSION AND CONCLUSIONS

The objective of this study is to develop a method using morphological analysis to design creative furniture. The results of the literature review and studies of existing design methodologies show that there was no direct approaches to use morphological analysis in furniture design. The traditional morphological analysis was invented and applied most in industrial engineering area, which mainly focused on looking for solutions for engineering problem or in the process of product development. In this research, morphological analysis is introduced into furniture design area, and the key to design creative furniture is to borrow inspirations from a broader range of sources and apply them to the product successfully.

Study of major classifications of furniture as well as its structure is carried out in Chapter Two, because designers need to know what can be changed or redesigned and what cannot. The basic principles of functional furniture design should be followed since the creative furniture cannot be just sculptural but lose its functionality. Chapter Three develops a map of usable inspiration sources from the planet and basic design elements are introduced to transfer the inspirations into visible graphical elements. Chapter Four introduces the existing morphological analysis method and develops it for design work by cooperated with observation and sketching. Morphological analysis is not just about creative thinking method to create the maximum solutions, but also about form study and the possibility and diversity of transformation. In furniture design, designers should mostly use sketching as visual thinking tools filling the morphological box, instead of writing. After the process of morphological analysis, four techniques representing four directions for transferring sources to physical design. They may not be the only techniques for furniture design, but sorted and summarized from all case studies in the research.

To evaluate the four techniques are understandable and convincing, an unofficial test was carried out by the author for curiosity sake. Participants are ten industrial designers or designers from related fields who have understanding of art and design to a certain degree. The author interpreted the four techniques after a brief introduction of this study, and let the participants play a simple matching game. Here is the result of the test. Nine of the ten participants can make four correct matches. There is one participant of the ten confused the Bionics with the Metaphor. So the total accuracy rate is 90%. Accuracy rate of Bionics and Metaphor is 90%, and the Detailing and Pattern is 100%. Due to the area and time limitation, the sample size of the test is small and not selected randomly. The result is not that reliable. However, such a test may be an indication that the approach developed in this research works. Another test among a bigger sample can be carried out, or more designs developed from these approaches can be included into the test in the future.

Based on this study, designers can gain a clearer route to do creative furniture design starting from broadening their design inspirations. However, in terms of different cultures and proposals, designers should limit their design to follow certain rules and customs. Also, trends of home decor and aesthetics change all the time. Designers should always be aware of what is going on and what should be abandoned to survive in the commercial market.

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