



EXPLORING THE MORPHOLOGY BIONIC PLANTS FOR CONTEMPORARY CERAMIC
DECORATION DESIGN



A Thesis Submitted in Partial Fulfillment of the Requirements
for Doctor of Philosophy DESIGN ARTS (INTERNATIONAL PROGRAM)

Silpakorn University

Academic Year 2023

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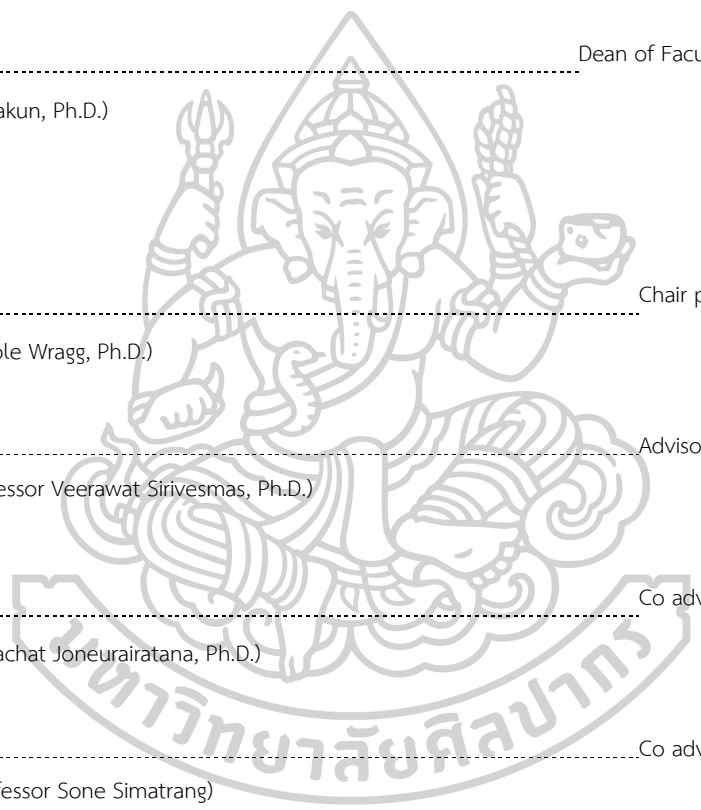
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Plants originate from nature and are one of the most important forms of nature, and the colorful plant forms are the way people can easily and directly feel the expression of nature. Bionics is from the natural world of living organisms to draw design inspiration and look for design sources, and plants as an important part of the organisms are people in the bionic design of the first to look for imitation objects. Ceramics is an art discipline that occupies an important position in the field of art and design, and it is also a unique art form. In the process of shaping and expressing plant morphology through ceramic clay, a sustainable path is explored, exploring the beauty of plants combined with the artistic language of expression. Starting from the concept of bionic, this study analyzes the basic content of plant morphology design, the scope and elements of design as well as the application of plant morphology in ceramic decorative design from the perspective of design.

The article describes the application of bionic design in ceramic decorative design in three parts. The first part mainly lays out the research background and the current situation of the article. The second part of the article briefly explores the history of bionic design in ceramics, and the third part summarizes the existence of bionic design and its characteristics in Chinese ceramics. Through this exploration and research, hope to make up for the lack of research on bionic design in ceramics and provide more reference materials and design feasibility analysis for ceramic design direction and work innovation.

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Fan SHUAI

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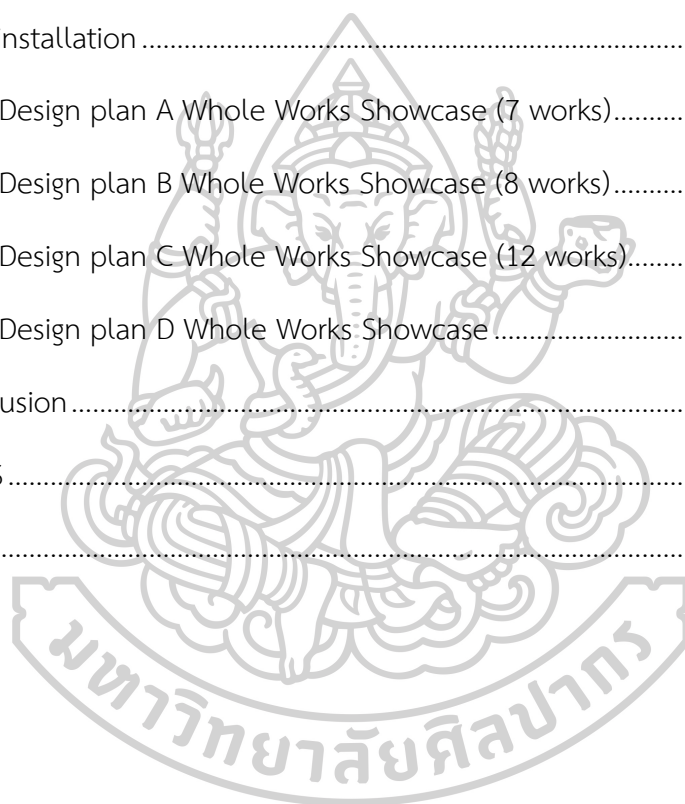
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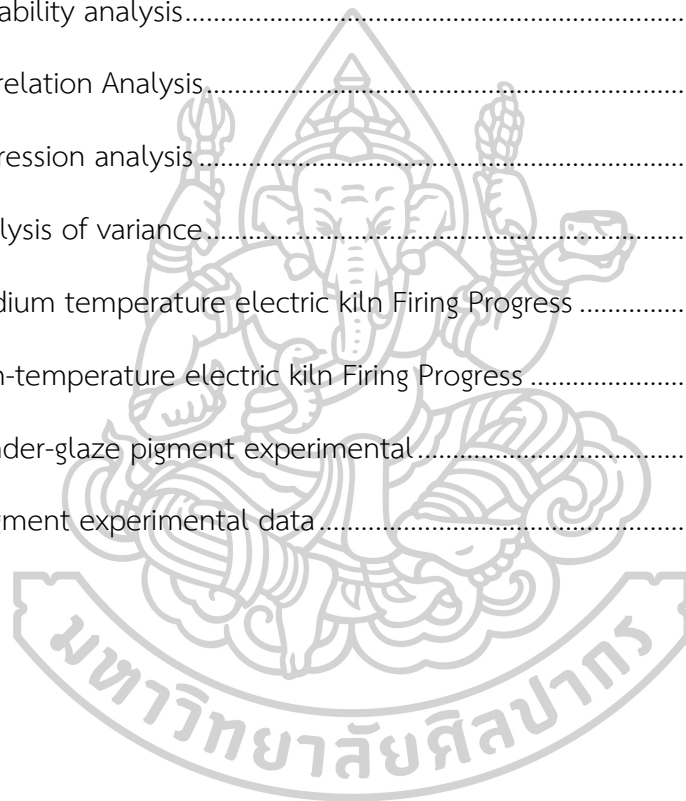
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Chapter 1 INTRODUCTION

1.1 BACKGROUND

Nature is the source of inspiration for all artistic creations and a treasure trove of materials for design. Plants come from nature and are one of the most important morphologies of nature, and the colorful morphology of plants is an easy way for people to directly feel the expression of nature. In ancient China, the earliest use of plants dates back to the Neolithic Age, when people used plant patterns to decorate their daily utensils. People knew plants, understood them and used them at the same time. The texture, color and even the lines of plants are important components of bionics and art and design research. After this morphology is processed by people's subjective consciousness, the artistic effect produced can affect people's vision and spirit, which is pleasant and joyful. At the same time, bionics draws design inspiration from natural organisms and searches for design sources, and plants as an important part of organisms are the objects that people try to imitate in bionic design. In modern art design, the aesthetic meaning, and value of the harmonious integration of man and nature is the inspiration and source. With the discovery of plant forms and the creation of shape transformation, art design works that represent the aesthetics of life and lifestyle are increasingly favored by people. Plant forms have long been used as decoration in ancient China. Ancient China took an early interest in plants, and even before the advent of writing, there were engraved botanical motifs on Neolithic pottery. The Xia Xiaozheng (Xia Xiaozheng), a book from the Xia Dynasty, is said to have determined the flowering times of certain flowers and trees and used them to determine the period for cultivation and harvesting. The development of plant forms in ancient China is a process driven by the development of modeling and the humanistic background of each era. Due to the long period of time and the many changes of dynasties in ancient China, the different humanistic background in different eras caused the development of plants

to have a stage and show different characteristics at different stages. In this paper, we will explore the categorization and classification of plants according to their stylistic characteristics and humanistic background in different stages of development.

With the development of society and the progress of human civilization, people have deepened their understanding of the world, accumulated different perceptions and a lot of life experience, which has produced a unique aesthetic. People strive for a free, simple, and beautiful way of life. They want to create pure, explain art, and so the expression of plants as decorative elements in ceramics is becoming more diverse, and the form of creation is becoming blurred, there are no more rules. Ceramic artists use a variety of ways to express their inner world and soul, reflecting their unique esthetic interests. Ceramic art is an art discipline that occupies an important position in the field of art and design and is also a unique art form. Ceramic design for the natural form of language is quite common, whether it is the original ceramic modeling or the modern ceramic design of natural bionics, most of the integration of the natural form of language for artistic expression. The natural form can give the pottery works an extraordinarily rich expression and imagination space through the medium of clay, glaze and fire, and provide a constant source of inspiration for pottery art. Therefore, the use of the natural language of form in pottery has incomparable, innate advantages.

1.2 STATEMENT OF PROBLEM:

Most research on morphology-bionics focuses on the field of industrial design and less on ceramic decorative design. This shows that morphology-bionics and ceramic decoration design are not very closely related and the morphology-bionic concept is not sufficient to be applied in ceramic decoration design. The collection and organization of the present data revealed that the plant form bionic in ceramic decorative design there are the following problems:



Figure 1 Lotus leaf bionic objective

Problem 1: There is little literature on plant forms of bionic artifacts, and even more is lacking in ceramics in this regard. Most ceramic articles dealing with the plant form of bionics only analyze the pattern of the ceramic works, so less design aspects, this is one of the problems that exist today.

Problem 2: The ancient China to plant form for the creation of biomimicry artifacts are mostly very figurative form performance, while this style of creation still continues today. Through the collection of data found that the ancient Chinese design elements and design ideas still to this day, the unified use of elements stacking techniques for the expression of biomimicry. More designs use the elements as a whole for decoration and design, for example, the Qing Dynasty famille rose carving inlaid lotus leaf citron plate (Figure 1), the ultra-realistic lotus leaf form, without considering the design basis of aesthetics and functionality, the elements copied and appropriated to the design of the form, and cumbersome piling up.

Problem 3: Most of the research of morphology bionic is concentrated in the direction of industrial design, less involved in ceramic decorative design, reflecting the morphology bionic and ceramic decorative design of adhesion is not high, biomimicry concepts in ceramic decorative design is not enough to apply the problem.

1.3 RESEARCH OBJECTIVES

In the process of shaping and expressing plant forms through ceramic clay, I would like to explore a sustainable way to create more possibilities by exploring methods of expression that combine the beauty of plants with the language of art. I want to use the beauty of plant forms to awaken the emotional resonance between man and nature, artifacts and souls, to build a more harmonious relationship between man and nature, thus satisfying the spiritual needs of modern humanity.

Objective 1: To provide a detailed description of the basic concepts of plant morphology bionic design in Chinese ceramics of different periods.

To identify the potential of plant morphology that can be utilized for contemporary ceramic decoration design.

Objective 2: To experiment innovations and improvements in the design of ceramics, selectively using plant forms to optimize the design and improve the aesthetics of ceramics.

Objective 3: To test the possibilities of ceramic design in practice. To understand the impact of the bionic method of plant morphology on ceramic innovation.

1.4 SIGNIFICANT OF RESEARCH

This research analyzes and examines the morphology of bionic design in contemporary ceramic decorative design. Based on the concept of biomimicry in bionic design, will organize and collect data from ancient and modern times, learn the advantages of successful design, and better apply the morphology of bionic plants in ceramic decoration design. Using the concept of biomimicry design. To innovate and improve the plant elements in ceramic decoration design. To achieve the harmony and unity of form, function, and semantics of their own designs. Finally, I will show the most common everyday use porcelain, installation ceramics two series of design work, my understanding of the concept of plant morphology bionic,

the former design can better understand the morphology bionic in the application of the product, the latter can be added to their own emotions about plant forms, so that the viewer resonates with them. At the same time, we can explore more possibilities of bionic plant design in ceramic decoration design. The main significance is divided into the following points.

Firstly, to correspond to the aesthetic paradigm of modern man. The use of plant forms in ceramic art promotes the development of modern ceramic art and innovation in ceramic art through the innovation of techniques and the expression of emotion, personality and freedom, and reflects the idea of symbiosis and harmony between man and nature.

Secondly, they reflect the diverse development trend of ceramic design by preserving and developing ceramics as a traditional craft, so that this traditional craft is not displaced by modern design.

Thirdly, the design of ceramic products and ceramic artworks that conform to public aesthetics and are widely accepted. Shorten the distance between ceramics and the public and break through people's inherent conception of ceramics.

1.5 KEYWORDS AND DEFINITION:

Morphology bionics: Morphological bionics, as it is known, consists of humans imitating the properties of biological forms by studying and observing natural objects and applying these natural forms to the design of the architectural appearance. This involves not only the integration of function and structure, but also the process of transcendence and sublimation of imitation.

Biomimicry: First introduced in 1997 by Janine Benyus, Biomimicry is the study of natural models and their imitation, or inspiration from natural designs and processes to solve human problems. Based on the idea that innovations are inspired by nature, such as solar cell designs inspired by leaves, Biomimicry is a new way of observing and evaluating nature, applying ecological criteria to judge the "reasonableness" of human innovations, and emphasizing that human beings should

not just take what they want from the natural world, but rather learn what they want from it. Biomimicry applies ecological criteria to judge the "reasonableness" of human innovations.

Plant Morphology: Plant morphology is a sub-discipline of botany that deals with the morphology and structure of plants and explains the morphological and structural changes of the various existing plants according to their individual development and phylogeny. The original ecology of plants is the survival state of plants and has a botanical significance; the plant pattern is the art form that emerges from the original ecology and has a humanistic meaning. The two are not equivalent, but the former can be transformed into the latter under certain conditions. The form of plants is transformed into the language of art, including the modeling of plants and patterns. Plant form as a decorative element in ceramics has a long history. Even in the time of primitive society, people painted totem plant patterns on ceramics to pray for a good harvest, to express their gratitude for the gifts of nature, their ability to express worship and admiration of the creature.

Ceramic decoration: Ceramic decoration refers to the way of artistic processing of ceramics and techniques, specific methods of monochrome glaze, color glaze, crystalline glaze, etc., decorative methods can be used individually, can also be used comprehensively. The artistic processing of ceramics can be done in different ways and with different techniques to improve the artistry and quality of the product. Decoration can be done in the glaze before the blank, but also in the glaze, under the glaze and in the glaze itself. The most commonly used specific methods are monochrome glaze, various color glazes (kiln glaze, flower glaze), crystalline glaze, crackle glaze, glaze, underglaze color, glaze color, gold and silver color, paint, decal, spray, printing, brushing, engraving, scratching, picking, plastic carving and so on. All kinds of decoration methods can be used individually or in combination.

1.6 RESEARCH METHDOLOGY:

The research methods used here are literature research, image research and market research.

Literature research method: the existing paper books, newspapers and magazines, and the Internet to access the relevant literature on the topic, through the literature research method to analyze and integrate the relevant dissertation topic, literature, writings and other materials. Summarizing the concept of bionic design and "ceramic design elements", and the bionic design is divided into five categories to study and analyze, but the article is only the bionic morphology of this category to conduct a comprehensive, specific analysis. This method can give full play to the research results to discuss research, but also for the later design practice to provide a theoretical basis.

Image research method: From domestic and foreign major websites and apps to collect a large number of images of plant form bionic design and ceramic-related design works, the collected images will be organized and classified, the images will be organized in accordance with the framework of the entire thesis for layout. Through the image research method to analyze the collected cases, so that we have a basic understanding of the works of plant form bionics in ceramic design, can objectively analyze the design advantages and design defects of the works, so as to avoid the same defects in the process of subsequent self-design. At the same time, in these cases, we can also better understand the focal point of the excellent design and summarize the excellent design, which can be used for self-study and analysis.

Questionnaire method: The questionnaire method is a widely used research method that is widely used in various fields such as social sciences, psychology, etc. In this method, data is collected by asking respondents a series of structured questions, which they then answer in writing or electronically. Depending on the research objective, questionnaires can be used to collect quantitative or qualitative information.

Questionnaires are, among other things, a form of structured data collection, which means that the questions and answer options are standardized. This makes it easier to compare and analyze the data. Questionnaires can also contain different types of questions, such as multiple-choice questions, open-ended questions, Likert scale questions, ranking questions, and demographic questions. The choice of question type depends on the research objectives and the data required.

Market research method: Visit important museums, exhibition halls and special ceramic bazaars, collect the ceramic works you see, summarize, and organize them using the form and analyze them by type and design style. The form of organizing the table will be more intuitive.

1.7 OUTCOMES

New Knowledge 1: To complete the induction and sorting of the plant bionic device type and summarize its cultural significance, its form of expression and its artistic characteristics in different periods.

New Knowledge 2: To obtain the combination of ceramic materials and other materials. Expand the types of bionic plant forms in ceramic decorative design.

New Knowledge 3: Increases the feasibility of morphology bionics in ceramic design and raises people's curiosity about ceramic products.

New Knowledge 4: To demonstrates new forms of design, breaks through people's inherent understanding of ceramics and shortens the distance between people and ceramics.

New Knowledge 5: To inherit and develop ceramic art. Satisfy users' needs for aesthetics, physical comfort, and psychological feelings.

Chapter 2 Literature Review

This thesis studies contemporary ceramic decoration design from the perspective of bionic design. The purpose is to promote the research of ceramic decoration design with ceramic as design material, ceramic design as design foundation and bionic plant design as design concept. We find more reasonable design forms and techniques and present the ceramic decoration design to the public with a refreshing visual experience. The research direction of ceramic decoration is mainly studied from two angles of shape decoration and pattern decoration. The theoretical research of ceramic art is mainly analyzed from the perspective of art, art anthropology and material science. The theoretical dimension of bionic design has two main starting points: Design methods and semiotics. From the review and analysis of the literature, most bionic designs, especially the bionic design of plant forms, focus on industrial design and environmental design. In the research of product design, it can be seen that bionic design is still a state of basic research, which is only mentioned in the specific form of operation, and the systematic and academic nature is rarely summarized. At the same time, the concept of finishing bionic design is less applied in the design of daily-use ceramic products. Mr. Yang Yongshan has pointed out a serious imbalance between ceramic modeling and decoration in *Three Topics of Ceramic Modeling*. According to the book, the proportion of ceramic modeling is light, and the proportion of ceramic decoration is large. At the same time, there are few literatures and papers dealing with the joint research of bionic ceramic modeling and decoration, which shows that this topic is a large research space. From the main search software, the number of ceramic decoration and modeling designs and the integration of bionic design into ceramic art design is small, which is the intuitive basis for explaining the problem. This chapter is divided into eight parts. The first part is the origin and development of ceramic art, including the differences between ceramics and porcelain and the clarification of the differences and similarities between them; the second part is the origin and

development of bionic design; the third part is the bionic design and ceramic technology; the fourth part is the relationship between ceramic bionic modeling design and ceramic technology; the fifth part is the integration of bionic design and plant elements; the sixth part is the investigation and case analysis of the bionic application types of plant elements. The seventh part is about the technical performance of ceramic decoration. The eighth part is the summary of literature review.

The literature review of this study comprises the following eight parts:

- 2.1: Origin and development of ceramic art
- 2.2: Origin and development of bionic design
- 2.3: Bionic design and ceramic technology
- 2.4: Relationship between bionic ceramic design and ceramic technology
- 2.5: Integration of bionic design and plant elements
- 2.6: Investigation and case analysis of the bionic application types of plant elements
- 2.7 The technical performance of ceramic decoration

2.1 Origin and development of ceramic art





Figure 2 Categorized research chart

2.1.1 Artistic perspective

Pottery and porcelain are two different materials, which are the same process in two different stages. The emergence of porcelain did not lead to the extinction or development of pottery, but shaped the situation of their respective development. Between pottery and porcelain, there is also stoneware. This article only deals with the two materials pottery and porcelain. Porcelain was developed on the basis of pottery. The main ingredient of pottery is natural clay, while porcelain is made from Chinese clay, feldspar, and other materials and there are many manufacturing processes. The terms "pottery" and "porcelain" can be used together to refer to ceramics. Pottery can refer to or include porcelain, but porcelain cannot refer to pottery. It is often used to emphasize porcelain or to distinguish between pottery and porcelain" (Zhongjie, 2003). The article distinguishes the concepts and characteristics between the two from the perspective of material science and art science, discusses them separately and clearly.

Table 1 The difference between pottery and porcelain

| | Raw materials | Firing temperature | Physical properties | Representative artifact |
|----------------|---------------|--------------------|---|---|
| Pottery clay | Clay | 600°C-800°C | <ul style="list-style-type: none"> ·Opaque ·Flimsy ·Microporous ·Dull tapping sound ·High water absorption |  |
| Porcelain clay | Kaolin Clay | 1300°C | <ul style="list-style-type: none"> ·Translucent ·Firm and fine ·No water leakage ·Metallic sound when struck ·Low water absorption |  |

If ceramics is understood from the perspective of art, it refers to ceramic art, i.e., the use of ceramics as an artistic medium and expression. The term ceramics is broad and refers to pottery and porcelain in general. Art includes both technology and art, specifically reflected in the exercise of craft skills and the expression of artistic talent. Pottery in the entire process of craft production, the technique and the art of the author are often fused together. Pottery as a discipline to study, the focus is not only on the craft and artistic effect of the product, but also through its representation to reveal the development of its pottery way. As a cultural form, pottery focuses on the humanistic spirit of a country, a nation and an era, and also reflects the scientific and technological progress and level. Therefore, in order to study the characteristics of a country's pottery, it is especially important to know the cultural characteristics of the country. According to the main function of pottery in people's life, it can be roughly divided into two categories: Ceramic design and ceramic production. As for the type of production, ceramics can be divided into two categories: handicraft production and machine production.

2.1.1.1 Ceramics creation works

The category of ceramic creation differs from industrially produced ceramic products. It is based on individual and manual creation and its materials are mainly ceramics, but also materials between pottery and porcelain and even a combination of other materials. Ceramic art is divided into two systems according to time and concept: traditional and modern pottery. However, both are based on ceramic materials and corresponding techniques to express people's esthetic ideals under certain historical conditions (Zhengan, 2002).

2.1.1.1.1 Traditional ceramic art

Traditional ceramic art refers to ceramic artifacts that are fired using traditional Chinese techniques. Its creative purpose is to conform to the mainstream aesthetics of society on the basis of practicality and to prioritize

powerful aesthetics. Ceramic art mainly focuses on utensils and sculptures. It is a comprehensive art that integrates design, painting and other arts and crafts. Traditional Chinese ceramics has the characteristics of standardization and stylization. In terms of technology, there are two types of kilns: official kilns and civilian kilns. The traditional ceramic craftsmen have extremely strict control over the production techniques and processes, especially over the utensils fired in the official kilns. They have extremely strict production standards for the degree of glaze and uniformity of appearance. This also results in ceramic works of the same period being similar in shape and decorative style. In the long-term development, design elements such as figures, animals, and plants were gradually integrated into the modeling of all dynasties. From then on, the bionic design of these creatures began, reflecting people's observation and feelings for nature and forming a unique form of artistic expression. Chinese traditional ceramic art has a history of thousands of years, has a deep cultural heritage, and can fully display the traditional spirit and national cultural characteristics of China. In the long history of traditional Chinese culture, the achievements of traditional ceramic art represent the cultural consciousness, esthetic characteristics and technological level of an era. The strict modeling and pursuit of extreme craftsmanship have formed the unique esthetic value and artistic characteristics of Chinese traditional ceramics and created the beauty of Chinese classical ceramics (Meilian, 2019, p.82).

2.1.1.1.2 Modern ceramic art

Tracing the history and exploring the origin of pottery, you will find that there are two main sources of ceramic art in the world. One is China, the other is West Asia. Modern ceramics is the acronym for contemporary ceramic art. There is contemporary ceramic art prior to the 1980s-1990s, the specific environment of contemporary technology and socio-economic and cultural development, using ceramic materials as the medium and the esthetic and creative concepts of contemporary art or mainstream art as elements of a sculptural form as the main component of new art. (Guangzhen, 2009) In the first half of the 20th century, three

events contributed to the emergence of modern ceramics. The first was the founding of the Akagi Society, which wrote in its founding manifesto: "We will explore the deep love of nature with our lives, and we will use ceramics to show the beauty that will never die." The second event was the development of the Japanese folk-art movement following the publication of Soyue Yanagi's "Letter of Intent for the Establishment of the Japanese Folk Art Museum". The third event was the emergence of the classical ceramics revival movement. Kazuo Yagi's "Samsara's Walk" is considered a classic work that broke the shackles of traditional ceramics by closing the mouth of the flower arrangement and transforming it into a non-physical object.

There are two theories about the official appearance of "modern ceramic art". One is the Japanese folkart movement and the Otis clay revolution in the United States; the other is the Japanese clay society and Otis ceramic art in the United States. Regardless of its origin, it is the heritage and development of modern ceramic art from traditional ceramic art. Modern ceramic art does not focus on people's daily needs but aims to express their own spiritual world. "The so-called modern ceramic art is a form of work in which artists use ceramic materials or use ceramic materials as the main creative medium, away from the traditional practical care, to express the ideals, personality, emotional psychology, consciousness and esthetic value of contemporary people. (Ming, 1999)

Modern ceramic art carries the craftsmanship of traditional ceramic art, but correspond to the esthetic qualities of modern art. Modern ceramic art focuses on the individual expression of spirit and thought, which is seen more as a rebellion against traditional esthetic standards. The norms of order and regularity in traditional ceramics do not apply in modern ceramic art, and artists strive to break away from tradition by exploring both materials and firing methods and making craft breakthroughs to give ceramic art a more mysterious and novel meaning. It is this spirit of exploration that has led to the development and refinement of modern ceramic expression.

2.1.1.1.3 Relationship between traditional ceramic and modern

ceramic

Traditional ceramics, as a part of traditional Chinese culture, has shown the world the unique cultural charm of China. In the long history of the development of traditional ceramic art, it has not only realized the heritage of traditional Chinese skills, but also has a significant influence on ceramic art around the world and is one of the most important media of Chinese. As a product of modern design thinking, modern pottery is the best and most powerful testimony to the innovation of traditional ceramic art in terms of its production process and decorative techniques. Esthetics, practicality and balance are no longer the only criteria for judging ceramic art. At the same time, the focus of design shifted from practicality to expressing the artist's awareness of his own thoughts and emotions. The creation of new things often goes hand in hand with the transformation of old things, and modern pottery, having freed itself from the shackles of traditional craftsmanship, has not developed smoothly. The emergence of modern pottery allows artists to pursue new forms of artistic expression and even criticize and discard traditional pottery, restricting the development of traditional ceramic art. Over time, ceramic artists have realized that by merely adopting Western art forms, not only would they fail to create new creations of their own culture, but they would also lose the profound heritage of traditional national culture. At the same time, they would lose the deep heritage of the nation's traditional culture and the foundation of the world stage of ceramic art. The only way to create outstanding works with vitality, expressiveness and national strength is to effectively integrate national culture and modern art. The heritage and innovation of traditional culture is not a one-sided copy, but requires artists to improve their own cultural competence by absorbing and understanding traditional culture to create a new era rich in their own personal symbols. It can be concluded that modern ceramic art has its origins in traditional Chinese pottery art. The relationship between the two is inseparable because they share the same raw material clay for production, including firing with

fire and molding methods. Traditional pottery art and modern pottery art are opposite but united, so that tradition and modernity blend, push the boundaries and complement each other's strengths.

2.1.1.2 Ceramic design products

Depending on their intended use, ceramic design products can be divided into daily-used ceramics, artistic porcelain, packaging ceramics, architectural ceramics, and sanitary ceramics.

2.1.1.2.1 Daily-used ceramics

Daily-used ceramics are an essential part of people's daily lives and are used everywhere and often. This type of ceramic involves containers for food and drink, which must have both a functional and esthetic form. There are a variety of products in this category, such as coffee sets, tea sets, wine sets, kitchen utensils and microwave utensils.

The market circulation of the main ordinary daily porcelain, porcelain ash (bone china), lingering daily porcelain, under-glaze color daily ceramics, easy to clean, acid and alkali resistant degree. Fine pottery, ordinary ceramics and fine ceramic cookware, etc. According to the decorative features, it can be divided into overglaze, underglaze, in-glaze color, color glaze porcelain and some uncolored white porcelain, etc. Utility ceramic is usually made of ceramic decals pasted on the glaze, or directly painted with glazed pigments on the surface of the item, and then fired at 700~850°C to make the product. Since the temperature of bisque firing does not reach the minimum melting temperature of the glaze, the image cannot sink into the glaze, but only adheres to the surface of the glaze. When you touch the surface of the product with your hand, it is concave and convex, and you can observe the unevenness of the surface with the naked eye. White porcelain usually refers to ceramics without any color decoration. This type of product is generally not widely sold on the market. The above decoration methods not only show their artistic

effect, but also the main difference between the content of lead, cadmium and other heavy metals. The underglaze color and most of the color glaze porcelain, white porcelain, lead, cadmium content is very low, and over-glaze when the ceramic decals processing with poor quality pigments, or when designing the decal surface on the pigment with lead, cadmium high with too much, or baking temperature, ventilation conditions are not enough. Due to the use of lead in the molten block glaze, lead, cadmium dissolved is a safety and health indicator for human health.

2.1.1.2.2 Furnishing porcelain(Art porcelain)

Song dynasty's porcelain can be described as the beginning of ancient Chinese furnishing ceramics. It underwent a functional change. The ceramics are presented in more artistic forms. Song dynasty ceramics are influenced by the people and their artistic style has a high esthetic appeal. Its shape is exquisite and reflects the degree of social material development and spiritual style of the time (Xinyue, X, p. 53). Furnishing ceramics also belong to the combination of viewing and using, which aims to fulfill people's emotional experience in the leisure of life. For example, it can produce indoor and outdoor flowers and various lamps. Its function is to imitate life for decoration and appreciation. Like other arts and crafts, it is a category of plastic art.

2.1.1.2.3 Packaging ceramics

Due to its unique properties, packaging ceramics has developed rapidly in some industries. Ceramic has the characteristics of strong shading and good sealing, and occupies an important place in the packaging design of food, beverage, cosmetics, etc. industries. Packaging ceramics must be space-saving and have good strength and rigidity. And it has a certain sense of design. Ceramic containers should correspond to the value of the packaged goods. They should be packaging containers, not pure handicrafts. Therefore, for lower-end goods, use pottery, while

for high-end goods, use porcelain and pay attention to decoration and design. The material selection of packaging ceramics for liquid products requires the proper selection of caps. Generally, ceramic containers with a wide opening are fitted with ceramic caps. Porcelain bottles for wine packaging can be closed with a cork and then sealed with a resin coating at the mouth. In recent years, plastic screw caps have been used for ceramic bottle flares, so circular threads must be formed at the mouth of the ceramic container. At this point, in addition to the cork stopper aforementioned, the plastic or cork sealing pad can be inserted into the plastic lid.

2.1.1.2.4 Architectural Ceramics

The history of the development of architectural ceramics can be traced back to the appearance of ceramic water pipes in the early Shang Dynasty. In the Western Zhou Dynasty, slab tiles appeared, which were used to build roofs for houses. With the rapid development of pottery in the Qin Dynasty, the phrase "Qin bricks and Han tiles" emerged. Bricks were mainly used for the construction of buildings in the Qin Dynasty. In the Han Dynasty, bricks and tiles were used in palaces and residences places. Pictorial bricks and tiles are not only widely used as exterior materials for buildings, but also have esthetic forms. In the Jin Dynasty, mural bricks were created, and in the Southern Dynasties, there were large-sized printed bricks consisting of hundreds of bricks. The colored glaze was created in the Northern Wei Dynasty, the architectural colored glaze became more popular in the Sui, Tang, and Liao dynasties, and reached its peak in the Ming and Qing dynasties. In addition to similar architectural ceramics, a piece of architectural wall decoration in Arabic was produced in Persia, now Iran, as early as 1354. The most basic function of architectural ceramics is to protect the interior and exterior walls and floors of buildings and to provide certain decorative effects for buildings.

2.1.1.2.5 Sanitary ceramics

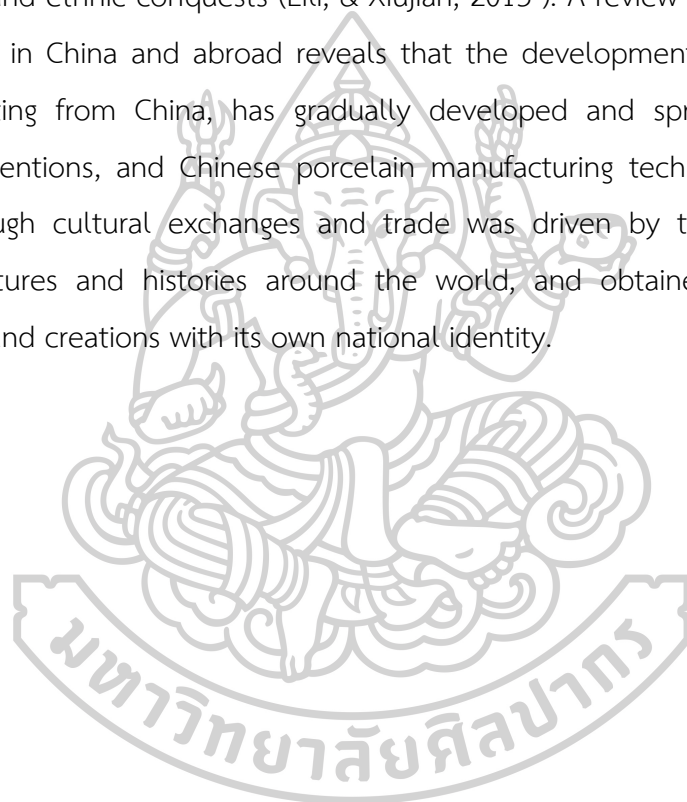
Sanitary ceramics are glazed ceramic products used in toilets, kitchens, and other places, also known as sanitaryware. Depending on the material of the products, there are four types of ceramics: clinker ceramics (water absorption less than 18%), refined ceramics (water absorption less than 12%), semi-porcelain (water absorption less than 5%) and porcelain (water absorption less than 0.5%), which can withstand rapid cooling and heat (after 5 minutes of heating in 100°C hot water) three times without cracking. The degree of whiteness of common glaze is greater than or equal to 60 degrees; the degree of whiteness of white glaze is greater than or equal to 70 degrees. In addition, there are clear regulations on the appearance quality, specification, dimensional tolerance, use function, etc. of ceramics. Among them, the performance of porcelain materials is the best. Clinker potteries are used for the production of large appliances such as vertical urinals and bathtubs, while the other three are used for the production of medium and small appliances. Sanitary ceramics in different countries are made from different materials depending on the environmental conditions. There are washbasins, urinals, urinals, ladies' washers, water tanks, sinks, bathtubs, return pipes, soap boxes, toilet paper boxes, towel racks, coat racks, coat hooks, special sanitary ceramics for trains, test containers and other categories.

2.1.2 Artistic anthropological perspective.

As the study of the anthropology of art, we "need to know where art is produced, who makes it, what it is used for, what it does and what it means to the maker. This is the study of art in its cultural context" (Evelyn, P, 1999. p. 1). Studying ceramic art from the perspective of artistic anthropology, we can clearly find that it is very appropriate to discuss it from the perspective of the communication school of classical anthropology. The development of ceramics is not an evolutionary theory

along the development of a single culture, but from the simple to the complex, from the backward to the progressive.

Without exception, these developments are the product of history. They coexisted with society and culture and influenced each other. In different stages of history, different nationalities have created and invented different types of ceramics. In other words, the similarity of different cultures is largely due to cultural contact, and different types of cultures can develop interactively through large population migrations and ethnic conquests (Lili, & Xiujian, 2013). A review of the development of ceramics in China and abroad reveals that the development of ceramics in the world, starting from China, has gradually developed and spread. Porcelain is a Chinese invention, and Chinese porcelain manufacturing technology went to the world through cultural exchanges and trade was driven by the development of various cultures and histories around the world, and obtained more and more inventions and creations with its own national identity.



2.1.1.1 The development context of Chinese ceramics

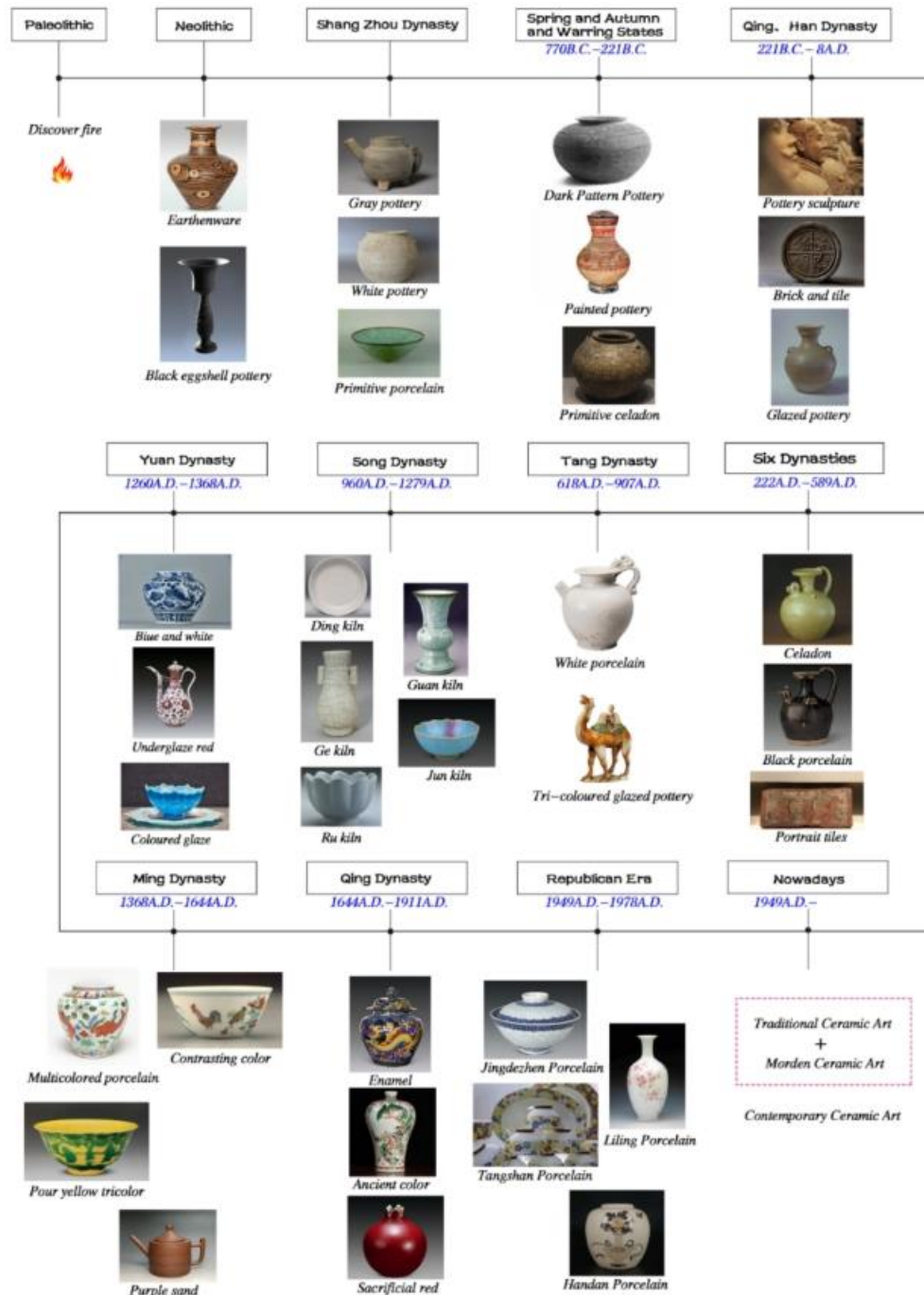


Figure 3 Ceramic Decoration products of different periods

During the Xia and Shang dynasties, the variety of pottery continued to increase and gray and black pottery emerged. At the same time, the temperature and equipment of the kiln were improved, and a small amount of white pottery was

fired, which technically supported the later appearance of primitive porcelain. In the Shang Dynasty, primitive porcelain began to appear. Primitive porcelain is the transitional stage from pottery to porcelain, the production quality is lower than that of porcelain, but higher than that of pottery. Although it is primitive porcelain, the firing temperature has increased to about 1100°C, the hardness of the tableware has increased, and there is a layer of glaze on the surface, which is different from the main characteristics of pottery.

Pottery and primitive porcelain continued to develop in the Zhou dynasty. Architectural pottery emerged in this period and was widely used. This kind of architectural pottery was called tile, which can be divided into full tiles and half tiles. Most of them are rough gray pottery and a few are red pottery or yellow-gray pottery.

During the Spring and Autumn period and the Warring States period, the variety of pottery gradually increased and decoration and technical development tended to mature, especially in terms of decoration. Architectural pottery continued to develop, and bricks and ceramic water pipes were created. The emergence of bricks used as pavement, wall or mural, mold molding, the appearance of decorative patterns, hard and flat, beautiful, and neat. Some of the pottery water pipes were used for drainage, others for water supply. This shows that the people of the Spring and Autumn Period and the Warring States Period were to some extent aware of the protection of urban hygiene.

During the Qin and Han dynasties, ceramic products developed in two main ways: on the one hand, pottery continued to develop on its original basis, and new types of lead-glazed pottery emerged; on the other hand, the high development of ceramic sculpture was evident, such as the Terracotta Warriors and Horses in the tomb of Qin Shi Huang, one of the eight wonders known worldwide. It is also a crucial part of the history of sculpture in China. Whether it is the bold and majestic pottery sculpture of the Qin Dynasty or the vivid and lively pottery sculpture of the Han Dynasty, it is incomparable to the ceramic sculpture of later generations. The Qin ruler's centralized system, violent politics and strong economic power created the momentum and huge volume of Qin ceramic sculptures, which

were magnificent. The Han Dynasty's policy of rest and tranquility and the rise of Confucianism and theology were not destined to be like the Qin pottery sculptures, but they were reflected in the arts and crafts with the characteristics of the times.

The period of the Six Dynasties was a time of new culture and the emergence of new ethnic groups. The Xianbei and other ethnic groups coexisted with the Han nationality. The emergence of the southern and northern civilizations is the era of the fusion of the Yellow River civilization and the Chang Jiang River civilization. Since the Six Dynasties, the firing of successful primitive celadon and the rapid development of the porcelain industry. The emergence of celadon replaced pottery, with better water resistance, rich decoration, and exquisite modeling, which were all factors for its spread. During the Six Dynasties, the southern region produced celadon and the northern region was dominated by black porcelain, but the development of celadon in the southern region must have promoted the production of celadon in the northern region through social exchange. At the same time, the improvement of kiln furniture and firing techniques brought the firing of porcelain to a more complete stage.

The development of ceramics during the Sui and Tang dynasties was a crucial part of the development of ceramics, and the development of porcelain during the Six Dynasties established the production of porcelain during this period as the “southern blue and northern white” production situation. From the distribution of overseas relics of Yue ware celadon, it can be seen that relics of Yue ware celadon from the Philippines, Malaysia, Indonesia, Thailand, India, Sri Lanka and other countries were found in major coastal ports, cities and islands passed by ships. On the one hand, this indicates that these areas were major destinations or important trading hubs for east-west sea voyages between the ninth and tenth centuries AD, and on the other hand, it also reflects the great demand for Chinese Yue ware celadon in these countries and regions (Jun, L, 2008, p. 133).

During the Tang and Song dynasties, Yue ware celadon was used in present-day Korea, Japan, Thailand, Malaysia, the Philippines and Indonesia, and has been excavated in more than 20 countries and regions, including Sri Lanka, India, Pakistan, Iran, Iraq, Saudi Arabia, Yemen, Syria, Turkey, Sudan, Egypt, Tanzania, and

Somalia. (Gang. L, 2008, p.118) The highly developed economy, the self-confident and open social state and the culture of the hundred schools of thought were not only able to develop their own internal culture to a great extent, but at the same time, everything in the Tang Dynasty attracted people from all over the world. At the same time, there are also Tang Dynasty three-color glazed pottery, goblets, faience porcelain, Tang blue-white and other kinds of porcelain. The Tang Dynasty not only established contact with neighboring countries via the Silk Road overland, but also opened up the Silk Road by sea. During the Tang Dynasty, there was a Department of Maritime Transport, whose main task was to manage to overseas trade. Gongxian ware is located right at the confluence of the Luo and Yellow Rivers, the transportation hub that connected the northern half of China. By water, the tide of the Luo River westward can reach the eastern capital Luoyang and the capital Chang'an; along the Yellow River eastward can reach Zhengzhou and Kaifeng, northward the Grand Canal leads directly to the Great Plains of North China, from Tianjin to Korea and Japan, southward can reach Yangzhou, an important port at that time and the domestic international trade city; then along the Yangtze River eastward can go directly to East Asia, South Asia and the Middle East. By land, the goods from Gongxian reached Luoyang, the eastern capital of the Tang Dynasty, via the Xuan Yuan Pass, which was the eastern end of the Silk Road at that time and became an important channel for the transportation of goods from Gongxian to the western region and Europe by land. All these were necessary conditions for the transportation problem that needed to be solved for the trade of Tang lapidary (Songlin, Z, & Yongmin, S, 2008, p. 85).

The ceramics of the Song and Liao dynasties were the pinnacle of ceramic development in the history of Chinese ceramics. The Song Dynasty ceramics, manifested itself in the world-famous five famous kilns, the variety of decorative techniques, the high maturity of kiln firing technology and the flourishing of domestic and foreign ceramic trade. The engraving and printing of the Ding ware and the magnetism kiln's the engraving of the white glaze engraving of the magnetism kiln and so on. In the early Ming Dynasty, Cao Zhaoge wrote in his "Gegou Essentials" recorded: "(Government kilns) Song Xiu Neiji burner, the soil veins are fine and moist,

the color green with pink, varying in intensity, with crab claw pattern, purple mouth and iron foot. Good color, and similar to Ru kiln. There is a black soil called Wu mud kiln. Fakes are Longquan burners, without pattern." Description of the Song dynasty period, the official ware, civilian ware, official ware for the ruler and the nobility to use and ornamental porcelain, reflecting the esthetic and esthetic interests of the ruling class, while the civilian kilns produced for the general public to use the living vessels, these living vessels marked the porcelain has entered the lives of ordinary people, is no longer a small amount and uneven development of the product, all represents the flourishing of the ceramic industry. As Jingdezhen has higher quality raw materials, the whiteness and transparency of the fired blue and white porcelain are higher, approaching the level of modern fine porcelain. The evolution of porcelain from transparent glaze to translucent tire was the third leap in the development of Chinese porcelain, and the Song Dynasty blue and white porcelain from Jingdezhen was the first to make this leap (Xianming, F, 1973). The ceramics of this period were esthetically strong and practical. The thinking of the literati as well as the traditional Chinese concept of making things was reflected in the wares. And it was still a best-selling product sold abroad as the demand exceeded the supply. The celadon in Japan in the twelfth century was basically Longquan celadon, and celadon was unearthed in Korea and Vietnam. Fragments of celadon from this period have also been unearthed in Egypt and other African countries.

The Yuan Dynasty was an era under Mongol rule. The porcelain from this period has distinctive Mongolian characteristics. The lifestyle habit of eating meat with a large mouth and drinking wine has made the volume of the porcelain large compared to the earlier contemporary features. The decoration corresponds to the luxurious characteristics of the Mongolian nobility. The warlike Mongols had many conquests in the west and ruled over many ethnic groups, and their territory was vast. There was a lively exchange between the various nationalities and foreigners in the country. After the Great Unification, in order to restore the economy and satisfy the extravagant life of the noble class, the Yuan government actively implemented the policy of emphasizing trade, including stipulating that the security of merchants was protected by officials and troops at all levels, strictly prohibiting the "detention

and hiring of merchant chariots", giving merchants the power to hold seals, wear tiger talismans and ride post horses, and exempting merchants from the western regions from belonging to the state's miscellaneous panchayats (Xinyu, P, 1994, p. 488).

Dynasty blue and white glaze of the Yuan dynasty, the red glaze, the white glaze etc. are the great creations of ceramics from this period. And Yuan dynasty celadon was famous for its bright colors and exquisite painting. Blue and white porcelain from the Yuan Dynasty is collected in museums around the world, especially in the Topkapsarai Museum in Turkey, where many blue and white Yuan porcelains are exhibited, such as blue and white water-caltrop bowls and water-caltrop plates. The export porcelain of the Yuan Dynasty was highly oriented. For example, some of the blue and white porcelains from the Jingdezhen kilns were tall in shape, painted with imported cobalt and decorated with dense patterns, and were mainly sold to countries and regions in West Asia where Islamic culture was practiced. The other small, simple and plain cobalt porcelains were sold to Southeast Asia. From the recent report on porcelain excavated abroad, a large number of Chinese porcelains have been found in the Philippines, with not a single kiln from northern China, but kilns from Jiangxi, Zhejiang, Fujian, Hunan, Guangdong and other places make up the majority. In contrast, among the Yuan dynasty porcelain recovered from the Sinan shipwreck in Korea, there is not a single blue and white porcelain (Zheming, Y, 2006, p.470).

In the Yuan Dynasty, the development of pottery was also quite successful. The strong development of porcelain led to the decline of pottery, its use became increasingly concentrated, and eventually pottery was used in large quantities as architectural ceramics. This was due to the low production costs and the low demands on firing technology. Since the lead glaze was used in construction potteries, this type of brick and tile was given the name of glaze. Liuli was used in a variety of buildings in the Yuan Dynasty. Nowadays, the palace in Beijing, which was built in the Yongle Palace of the Yuan Dynasty in Shanxi, is a golden and magnificent building. The Yuan Dynasty was the period when the Jingdezhen kilns were more developed. During the Yuan Dynasty, Jingdezhen craftsmen discovered kaolin as a raw material instead of porcelain stone after it was exhausted, so that the

Jingdezhen kiln, which had suffered a landslide, could flourish again. And the original monolithic formula was improved, and a binary formula was invented, with improved firing problems, higher hardness and greater density. The rulers of the Yuan dynasty were still white, and the esthetics of white as auspicious prompted the rulers to establish the Fuliang Porcelain Bureau in Jingdezhen, which greatly emphasized the status of Jingdezhen in the country's porcelain production. In the Yuan Dynasty, the appreciation of glaze colors from the Song and Liao periods shifted to the appreciation of ceramic painting, making soft ceramics develop into atmospheric wares. The exchange of cultures and the expansion of territory brought China to the world.

The ceramic art of the Ming and Qing dynasties, the craft center emerged, Jingdezhen became the national center of porcelain production. During this period, the waterways were well developed, and the porcelain production centers were built around the water, which facilitated transportation to all parts of the country. The imperial kiln factory was founded in Jingdezhen and assumed responsibility for the production of fine ceramic products for the royal family. The ruler spared no effort to develop ceramics, which not only satisfied the esthetic demands of the nobility but also became a competing commodity as a luxury product, and the influence of porcelain continued to grow. It is worth noting that the voyaging expeditions were in line with the plans that had taken shape in the Hongwu era. Once the Ming dynasty was established, it began to bring foreign missions to the dynasty: in 1369 came Joseon, Japan, Vietnam and 5 other cities; in 1371 came Cambodia and Siam; from 1370 to 1390 came the Malay Peninsula and even the lands along the Coromandel Coast. Another important purpose of Zheng He's seven voyages to the West during the Yongle era was to publicize the prestige of the Ming Empire in Southeast Asia and the Indian Ocean. And the effect was not only political but also economic, for the result of these seven voyages strengthened trade between the Chinese and the ports of Southeast Asia and South India (Jacques G, 1995, p. 360). At the same time, the variety of ceramics gradually increased during this period. The sweet white glaze in the Yongle period with the description of "white as gelatin, plain as snow", Xuande blue-white, Chenghua period blue-white with color,

Hongzhi period pouring yellow glaze, pouring yellow three colors, etc., Yixing purple sand; Kangxi period Lang red, antique color, Yongzheng period pastel, Qianlong period enamel color, etc. are exquisite ceramic categories. Gradually, the two systems of folk crafts and palace crafts emerged, with different production styles and service targets. The former is natural and simple and has a very lifelike atmosphere. The latter is decorated with a variety of stacks and is characterized by distinctive craftsmanship and artisanal gas. The esthetics of ceramics in the Ming and Qing dynasties are in decline. How to further develop folk art, how to transform court craftsmanship, that is the problem of the time. Whether it is porcelain exported to the world or China's own porcelain, after a long period of development, different civilizations have influenced each other and created a new esthetic form.

2.1.1.2 Foreign ceramics development lineage

The origins of pottery are diverse, while porcelain is a creation of the Chinese people. Outside of China, ancient Greek painted pottery originated 3,000-4,000 years ago. It has its own origins with Chinese painted pottery, one from the East and one from the West. Although it originated later than Chinese painted pottery, its fineness in production and painting was higher than that of Chinese painted pottery. This was the beginning of the development of Western pottery.

Islamic pottery (West Asia, North Africa, the Middle East bordering Europe) refers to the 8th century to the 17th century of the Islamic era in the Middle East region as the center of firing smooth pottery at low temperatures and multi-colored glazed pottery, with Lustreware being the most representative. According to the Kassam pottery record of 1301, the production process of Lustreware is: first coated with a layer of white glaze, placed in the kiln after firing and cooling, with a mixture of copper and silver oxide. After drawing the pattern, the second firing. There is also milky tin glaze, pearlescent color painting. Until the 18th century (some say 15th-16th century), no real "porcelain" was made in the Islamic world, the firing temperature was about 1100°C, but never reached the porcelain firing temperature of 1300°C. At the same time, the Tang Dynasty scrambled to imitate "silver-like snow"

Xing kiln white porcelain through the spread of Islamic potters. In the 8th century, Islamic potters mastered the use of tin oxide glaze to make pottery appear white and milky. As late as the 12th century, Egyptian potters developed stoneware frit (also known as stone paste), a material made from crushed quartz, crushed glass and clay. By adding siliceous materials, the melting point of the material was lowered so that it could be fired at lower temperatures. Until the 18th century, when Europeans discovered the secrets of Chinese kaolin, stone paste was used by Islamic potters to make white billets (the role of paper clay), but stone paste is actually a type of "earthenware" between stoneware and porcelain.

In the middle of the eleventh century, the Seljuks invaded West Asia under the leadership of the Uyghur tribes, and the Seljuk Empire (1037-1194) was founded and began to dominate the Islamic world. The ceramic works from this period are known as Seljuk pottery. As the Islamic potters came into contact with Chinese ceramics, which had just completed its golden period of development, another wave of imitation began. The thin, translucent seven-pot tea bowls made in Kashan and Rey in Iran in the twelfth century, which are in the Louvre collection, are remarkably close to the level of Chinese porcelain. This period of Chinese Song Dynasty porcelain excellence, through India in large quantities to the Arabian Peninsula and Egypt, resulting in the late eleventh century to the twelfth century Islamic pottery manufacturing technology has been subversive changes. Potters were in a frenzy to imitate Chinese porcelain. Although winch-pulling was not yet widespread, it was possible to simulate the appearance of Chinese products by hand alone. Tire Shi used composite clay; the suspension is a transparent alkaline glaze, the color of the finished product is very close to Chinese blue and white porcelain; the pattern was also transferred from the earlier Greek model to the Chinese style; shape and decorative techniques tried to reproduce the charm of Chinese celadon or white porcelain. Therefore, it can be said that the Seljuk era is the era in which Chinese porcelain is most widely used.

Iznik was the production center for Turkish pottery from the fourteenth to the eighteenth century and was known as the "Jingdezhen" of Turkey. Underglazed pottery, white-glazed polychrome pottery, white-glazed green pottery

and other pottery were produced here. The types of utensils include bowls, plates, water jugs, bottles, lamps, etc. Chinese blue and white porcelain from the Yuan and Ming dynasties had a great influence on the Iznik pottery industry, so you can see products imitating Chinese porcelain everywhere in Iznik. However, compared to Chinese porcelain, Iznik products still belong to the category of pottery, and the firing temperature is less than a thousand degrees Celsius (850-900C). The siliceous clay is white, but the degree of density does not reach the standard of porcelain.

In the 9th century, cobalt blue ore, also known as sober blue, Sumaliqing, and so on, was found in Persia. One theory is that the name comes from the translation of the Persian word "Sulayman". The villagers believe that a man named Suleiman discovered this cobalt material and named it after him. Another theory is that Sulayman Green should actually be Sulayman Li Green, which is the translation of the English smalt and means a kind of blue glass. It spread via the Silk Road and came to China. It was the most important material for Dynasty blue and white painting of the Yuan Dynasty and formed a solid material basis for the creation of the Yuan blue and white.

During the Tang Dynasty, after two stages of development, namely the "Reign of Zhenguan" and the "Reign of Kaiyuan", the economy and culture developed strongly and society experienced unprecedented prosperity. Cultural exchanges increased, inter-ethnic harmony and cooperation were emphasized. It was also a period of close interaction with foreign countries. The world-famous Silk Road created an important platform for the spread and exchange of culture. In the East, interaction with Korea and Japan was even closer. The great invention of low-temperature lead glaze pottery by Tang Sancai reached Japan and was successfully copied by Japanese potters, known as "Nara Tricolor". In 1223, Japanese pottery ancestor Kato Shiro went to Jian Ware to study, returned to Japan after five years and successfully fired black-glazed porcelain known in history as "Setomono", also known as "Tenmoku glaze". In the early 16th century, Gora Taura went to Jingdezhen to learn porcelain technology and returned to Japan, in Arita and Nara where he did research work near the firing of porcelain. In the 16th century, at the end of the Japanese lord Toyotomi Hideyoshi, troops moved to Korea and brought Korean

potters with them. They brought potters from Joseon with them and so the advanced ceramic techniques of Joseon were brought to Japan. Japanese potters had traveled to China specifically to learn the firing method for blue and white porcelain. On their return, they opened the kilns of Iwanli and Kabeyama, which specialized in firing blue and white porcelain. This blue and white porcelain is very similar in shape and decoration dynasty folk kilns of the Chinese Ming dynasty and was brought to the international market in large quantities during the Ming and Qing dynasties (Wei, L, 2008, p. 539). Since then, the porcelain produced in Arita was exported overseas via the Japanese port of Iwami, and from then on Iwami porcelain was born. In the mid-17th century, China was in the late Ming War period, there was social unrest, and handicraft production was severely affected. The production and development of porcelain in Jingdezhen was at a low ebb. As a result, the export of Iwami porcelain replaced the export of Jingdezhen porcelain and reached the European market in large quantities. Iwami porcelain largely imitated the decoration of Jingdezhen porcelain, with the same blue and white porcelain and painted pieces.

From 1294-1300, the Thai king Ramakkhaman visited the Yuan Dynasty twice and brought potters with him to teach the Thai people how to make pottery.

Since the beginning of the export of Yue celadon in the Tang Dynasty, it has not only circulated around the world as a commodity, but also an associated cultural exchange has played a significant role in the history of human civilization around the production and use of Yue celadon. At that time, ceramists from different countries competed to imitate the celadon of Yue ware. The first country to learn the techniques of celadon production was North Korea. Since the late Silla period, Joseon maintained close relations with the Wu-Yue dynasty of the Fifth Dynasty, which produced celadon, and continued to do so until the Goryeo era. With the celadon of Yue wares imported to Joseon, the technology of porcelain making was also introduced to Joseon at the same time. Joseon craftsmen finally set up a kiln in Kangjin in 918 (corresponding to the fourth year of our Five Dynasties, Liang Zhenming) and successfully fired the secret color porcelain of Goryeo, also known as "Fei Se" porcelain.

The Maritime Silk Road, with Guangzhou as its port, reached as far as South Asia, crossed the Indian Ocean and led to Africa and along the entire Mediterranean coast, scattering ceramics all over the world along the ships' route. At the same time, many Chinese craftsmen also went abroad to learn their skills, bringing with them materials and techniques for Chinese ceramics. In the early 14th century, a kind of tin-glazed pottery decorated with gold and blue was also popular among the Islamic peoples. It was brought to Spain by the Moors and became the famous Italian Majolica. Italian Majolica pottery is influenced by the development of Spanish Moorish tin pottery, and the production technology has greatly improved, the color from gold and blue to cobalt blue, purple, yellow, brown, green lights a variety of colors.

At the end of the 15th century, a large amount of Chinese porcelain appeared on the European market, which inspired European potters to study porcelain. Italian Florentine potters from Florence successfully fired soft-paste porcelain because the porcelain raw materials were mixed with glass powder rather than the raw material used to fire feldspar, known as soft-paste porcelain.

The late 16th century Huguenot potter Bernard Burridge created a combination of realistic and highly skilled low temperature pottery - Palissy Lead Glazed Pottery. The French Huguenot potter Bernard Parisi, known for his rustic work, is an important French decorative artist. Parrish studied Chinese porcelain for 16 years and worked hard on what he observed in Chinese ceramics to create a rustic "Parrish Ware" style that became famous. Wild animals are a characteristic element in Bernard Parisi's work. In particular, the use of the serpentine element gives his work a spiritual and mysterious touch. He followed a similar style to the Italian artists Vasari and Michelangelo to complete the commissioned works for the Chateau d'Ecuyne. His vibrant colors, mastery of technique and achievements in the study of glazes have gradually made him one of the most important decorative artists in France.

Delft tin-glazed pottery (Dutch) is also known as Delft Blue pottery. In 1508, a number of Italian potters immigrated to the Netherlands and introduced the craft of tin-glazed pottery to the Netherlands. In the 16th and 17th centuries, the Dutch East India Company imported a large quantity of Chinese porcelain. The large

potteries began to imitate Chinese porcelain, blending Eastern and Western cultures. It was underglazed to achieve a similar appearance to Chinese porcelain. The Delft kiln also led to other areas of the Netherlands gradually imitating Chinese blue and white porcelain. Then Delft fired five-color pottery to imitate the Shantou porcelain from southern China and focused on adding its own cultural elements to match European habits (Yong, C, 2008, p. 525). Tiles were also made from tin-glazed earthenware, which was a popular building material at the time.

From 1712 to 1722, the missionary François Xavier d' Entrecolles carried out investigations in Jingdezhen with the help of Chinese Catholics in order to learn about the techniques of porcelain production there, and recorded them in detail on two occasions. He sent what he recorded back to Europe in the form of letters. In response, Europe began to study the ceramics in detail according to the content of the letters. European porcelain was born in 1709, the first porcelain factory in Europe - Germany Meissen porcelain factory Meissen - successfully developed kaolin, feldspar and quartz as three raw materials for hard porcelain, heralding the birth of the Meissen porcelain factory.

In the 18th century, the English potter Thomas Wilton invented low-temperature glazed earthenware decorated with oxides in various colors. In 1745, the first factory in England to produce porcelain was founded: the Chelsea Porcelain Factory. In 1759, the famous Wedgwood Porcelain Factory was founded by Josiah Wedgwood, who succeeded in producing a beige-colored, lead-glazed earthenware with a fine texture and low cost.

Thomas Frye invented bone china in England in 1748. Later, in 1789, Josiah Spode improved the material formula of bone china based on Frye by adding 30% animal bone powder to the raw material, so that the bone china produced is purer than ordinary porcelain and has a thin and delicate translucent feel.

German art porcelain 19th century The Meissen porcelain factory occupies a leading position in the field of porcelain portrait production.

From this, we can see that Chinese ceramics began to develop in the Eastern Han Dynasty and spread throughout the world during the Tang and Song

dynasties, bringing cultures and technologies from around the world and forming the "globalization" of the ancient world.

Globalization has not only existed since today, but has always existed, only in ancient times, when the various cultures exchanged and spread very slowly, until the sixteenth century, when European navigation technology was improved and the great geographical discovery was made.

Global interaction and diffusion only began to accelerate. All this is reflected in the development of Chinese ceramics in each period, so that the history of Chinese ceramics has always been part of the history of world ceramics, world trade, world economy, world politics, world culture and world art. Another important concept of anthropology is the "field"," which is the site where anthropologists can obtain first-hand information for their research and where they can directly encounter cultural groups. In the field of history, there are no longer specific living groups with whom we can interact and speak, but the "fields" of ancient culture have not passed away, they remain in the silent vessels, ruins, and sites. As long as we do serious research, we can still talk to the ancients, and the culture of the ancients can also become a mirror of our culture today, helping us to reflect and find the way forward (Lili, F, 2013, p. 7).

2.1.3 Material science perspective.

From a material science perspective, ceramics are known to be subordinate to the silicate material system and are scientifically referred to as an inorganic, non-metallic material. Traditionally, the term ceramic refers to all hard substances formed from clay as the main raw material and other natural mineral raw materials after proper proportioning, crushing, molding and a series of physicochemical reactions under high temperature firing, such as our daily ceramic products, building ceramics and electro porcelain, also known as traditional ceramics. Since its raw materials are derived from natural silicate minerals (such as clay, feldspar, quartz, etc.), it can be classified as a silicate material and product (Baoxiang, J & Hao, G,

2019). Ceramic materials are generally composed of three types of materials, namely body, glaze and decoration.

The body material is, in simple terms, clay. In early times, it was also called clay. Clay is the main component of ceramic materials. It is the material that shapes the appearance of ceramics and, due to its properties, gives the work a variety of color and texture effects as well as artistic effects.

2.1.3.1 Types of pottery clay and porcelain clay

2.1.3.1.1 Pottery clay

In "Craft Culture", Soetsu Yanagi mentions that "materials are heavenly music in which many mysterious elements are condensed that are unpredictable to human intelligence. The mission of craft is to make effective use of the mysterious elements of materials, and excellent authors are often able to play the role of materials, which can fully reveal their natural beauty under the discovery of their skills" (Soetsu, Y, 2018). In the development of modern pottery, the characteristics of ceramic clay continue to be explored, and together with the expression of the artist's own emotions and the casual atmosphere of creation combined with fire, clay as a material is interpreted to the fullest extent.

Common pottery clays include red pottery clay, gray pottery clay, black pottery clay, yellow pottery clay, Sichuan clay, purple sand clay, coarse pottery clay and sagger clay.

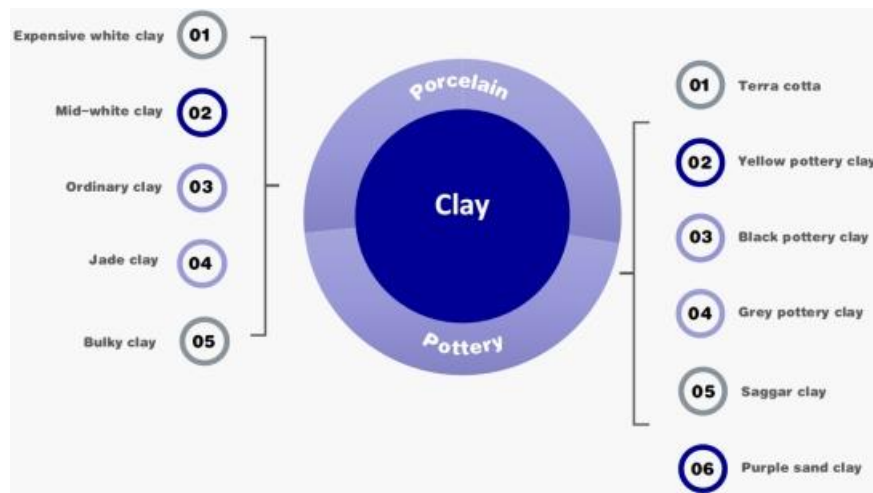


Figure 4 Existing types of pottery clay and porcelain clay

1) Terracotta

The color of terracotta clay is reddish, so pottery that is earthy red, maroon, brick red or red in color is called terracotta clay. The recipe is: ferric tetroxide 6%, ebonite 30%, kaolin 30%, potassium feldspar 5%, soda powder 5%, alumina 8%, dolomite 6%, quartz 4%, water 6%. The terracotta clay in pottery is due to firing in an oxidizing atmosphere. When the fuel is fired with sufficient air, the iron in the clay is reduced to ferric trioxide, hence the red color of the surface of the object as described above. The clay is soft to the touch, malleable and has a relatively hard and fine texture. The firing temperature is between 1180°C-1280°C. This clay is suitable for almost all molding methods (especially for throwing); due to the reddish color of the clay, it is mostly used for large pottery. The difference in color before and after firing is small.



Figure 5 Terra cotta in various states of color expression

2) Yellow pottery clay

The color of yellow potter's clay is light yellow, the clay feels harder than red potter's clay, but the overall feel is one of soft, highly plastic, good viscosity, non-toxic and odorless. The recipe is: ebonite 30%, kaolin 30%, potassium

feldspar 5%, soda 5%, alumina 8%, dolomite 12%, quartz 4%, water 6%. Firing temperature 1200°C- 1280°C. The composition of the yellow pottery consists mainly of hydromica, kaolinite, montmorillonite, quartz, and feldspar. The chemical composition is similar to that of general clay. Compared to kaolin and bentonite, the alumina content is lower and the silicon dioxide and iron oxide content is higher. The color is often light gray and yellow. The water absorption, adsorption and plasticity after the addition of water is average and the drying and sintering properties are good. This clay is more cost-effective and is the clay of choice for teaching and basic training. It is also suitable for various molding methods and is lighter in color after firing than before firing.



Figure 6 Yellow pottery in various states of color expression

3) Black pottery clay

Before firing, black potter's clay is grayish-black in color and feels soft, malleable and sticky. Black clay is often used in modern pottery. The recipe is: ferric oxide 12% ferric tetroxide 6% kaolin 22% talc 9% potassium feldspar 8% sodium feldspar 6% bentonite 12% calcined kaolin 15% water 8% sodium humate 2%.



Figure 7 Black pottery clay in various states of color expression

4) Sagger clay

Sagger clay: as the name suggests, the clay is used to make the sagger. The recipe is: alumina 20%, calcined kaolin 25%, kaolin 10%, daido sand 6%, crushed pebbles 9%, bentonite 20%, water 10%. The sagger first appeared as a kiln

appliance in the Song Dynasty, replacing the original kiln tools such as nails. It is one of the landmark inventions in the firing process of Chinese ceramics. It significantly improved the quality and output of ceramic production. The sagger is used to protect the ware during the firing process and create a cleaner firing environment for the billet during the firing process, making the glaze less susceptible to kiln ash and other contaminants. The high-temperature resistant material properties of the sagger also ensure even heating of the billet during the firing process and prevent it from breaking due to expansion or contraction. When firing mature and large quantities of everyday porcelain, such as cups, plates, etc., several objects are usually fired in one through-burner, with the surface of the object being half-glazed or scraped in a circle after glazing the inner base to prevent the glaze from sticking to the object. Expensive fine porcelain is a sagger, which is loaded and fired with one object, not stacked objects. Tang Ying wrote in the "Tao Ye Tuo": "porcelain billet should be clean, a sediment of mud, that is, into a speckled. And kiln wind and fire gas, conflict injury billet, that is why must use the box bowl. Sagger of mud, from Jingdezhen northeast of Chun village, there are black, white, red three. And the jewel mountain has black and yellow sand. With in mud, refine human fire." In ancient texts, the box bowl made of clay was described with the colors black, white and red. Because of this clay after firing the clay itself texture effect as well as color and plasticity, low firing difficulty, not easy to deform and other characteristics, has become a limited choice of clay materials for potters.



Figure 8 Sagger clay in various states of color expression

2.1.3.1.2 Porcelain clay

The clays commonly used in porcelain clay are classified according to their degree of whiteness from high to low: jade clay, high white clay, medium white clay, common clay and large clay pieces. Extra white clay, high white clay and jade clay, The main difference between the clay and ordinary clay is the whiteness and translucency of the clay after firing, which depends on the whiteness of the raw material itself and the ratio of the clay material. During the batching process, iron and titanium are removed from the original clay, which can increase the whiteness of the clay itself to a certain extent. The whiter the original clay is, the whiter the piece will be after firing.⁴⁸

1) Expensive clay

White ball clay with disordered kaolinite as the main mineral component. Strong bonding and a certain degree of dryness, sinter ability and whiteness after firing as well as other special properties make it one of the raw materials for ceramic production. Expensive porcelain clay has an off-white color, is expensive, almost free of impurities, has an average plasticity and a firing temperature of 1250°C-1330°C. This clay has a whiter color after firing and is the clay used in many porcelain factories for daily use and in the creation of potters. The recipe is: Longyan kaolin 58%, high purity potassium feldspar 5%, magnesium oxide 3%, sodium chloride 2%, alumina 6%, dolomite 10%, quartz 4%, water 12%.



Figure 9 Expensive white clay in various states of color expression

2) Mid-white clay

Quartz 28%, feldspar 20%, Daido sand 25%, Jiujiang clay 20%, alkali powder 7%,. Medium white porcelain clay has a yellowish-white color, a fine clay texture, an average plasticity and a firing temperature of 1200°C -1300°C. This

clay is more difficult to control the degree of wet and dry than the white porcelain clay, due to the plasticity of the general, pulling billet forming, then need skillful pulling technique, otherwise pulling billet make you doubt life; rolling clay pieces also need to pay attention to the degree of wet and dry and techniques, otherwise the mud is easy to crack after drying; medium white porcelain clay is suitable for a variety of decorative techniques, light transmittance is better.



Figure 10 Mid-white clay in various states of color expression

3) Ordinary white clay

Common clay has a grayish-white color and lightens to a light gray color after firing. Ordinary white porcelain has a gray- white color, a fine clay texture (less impurities), but a general plasticity, firing temperature 1200°C -1300°C. This clay needs to master the right degree of wet and dry when forming, otherwise it will easily crack and collapse during the manufacturing process. Ordinary white porcelain clay has good translucency after high temperature firing, with transparent glaze can show the warmth of white porcelain.



Figure 11 Ordinary white clay in various states of color expression

4) Jade clay

As the name suggests, it is a clay that has a jade-like effect after firing. The formula is 55% high-purity potassium feldspar 10%, sodium feldspar 8%, dolomite 12%, quartz 8%, calcined kaolin 7% and water 8%. The formula of jade clay is relatively special compared to other porcelain clays. It mainly contains a high silicon, high potassium, and low aluminum, with a relatively high content of feldspar.

High white, medium white etc. feldspathic porcelain The formula, the potassium and sodium content is generally not more than 4 percentage points, while the potassium and sodium content of jade clay is generally more than 6%, resulting in the glass phase content of porcelain firing is very high, has high translucency, coupled with the high whiteness of the mud, and is generally fired with the oxidation flame, so that Mr. Cheng has a warm white hue and a natural jade sense of strong performance. So, the cost of jade clay is high, the clay is sold at expensive prices and mostly used for making handicrafts.

2.2 Origin and development of bionic design

2.2.1 Bionic design

Bionic art and bionic design are the result of bionic interventions in art and design. Art design is a science that overlaps with the natural and social sciences. The main purpose of bionic design is to imitate nature and focus on the practical function of products, to develop and design products only for the functionality of a single nature of use. Bionic design is based on the study of bionics and gradually forms a new design method, which is the application of bionics in design. Bionic design studies the functional structure, morphological appearance, material composition, information control and even color of natural biological systems and their principles, and selectively applies them to the design of human creatures (Ningna, S, 2014). With the improvement of people's living standards, the requirements for products are also increasing day by day. Product design must not only utilize the function of excellence, but also be aesthetically interesting, that is, meet people's growing material and cultural needs. It is therefore necessary for the discipline of art and design to emerge. In this way, bionic art design can meet the public demand for aesthetics, but also achieve the functional design of the product, and the production time is inseparable from the combination of technology, materials and technology to reflect; is a comprehensive embodiment of science, art, economy and other factors.

2.2.2 Semiotics perspective

A symbol is a typical sign that, when people see it, immediately reflects in their minds the specific thing it refers to (Naran, B, 2019, p. 298). Therefore, symbols have the function of conveying emotions and information. The earliest semiotics emerged from the study of linguistics. Later, the influence of philosophy and esthetics was added to produce some theoretical branches, which include art semiotics and design semiotics. Saussure divided the sign into 2 parts: "energy" and "reference". These two concepts were later introduced into the study of product semantics and evolved into the "extended properties" and "connotative properties" of products. When designers create products, they have other "sources" besides function that can be designed. Here, energy refers to the external properties of the work and reference refers to the connotation of the work, which includes, for example, the symbolic design of nature worship or what we now call bionic design. The relationship between the two can be expressed in the design process as a concise and abstract representation of what is being imitated with a high degree of generality. It allows the newly designed work, that is, the new symbol, to be given a new allegorical meaning. This is in line with the theory of the American philosopher Morris. Starting from the perspective of pragmatism and behavioral habits to design works with practical functions, his theory is widely adopted and used. While Peirce's interpretation of symbols is more "open", if Saussure's dualistic relationship is only in the context of psyche, Peirce's theory of "three natures" of symbols can be the theoretical basis for connecting the idea of mind with the external (Xingzhi, Z, 2017). The so-called "three natures" refer to the three indispensable parts of the signification process, without any one of which the sign will not be able to function as a "sign" (John, D, 2012).

2.2.2.1 Art Semiotics

Art semiotics is a new discipline that emerges at the interface of art and semiotics. Semiotics is a necessary way to study contemporary art. Understanding art from a semiotic perspective and developing art is based on the ability of semiotics to simplify and generalize complex things. Philosophers have defined art in four main categories: functional theory, expressive theory, formal theory, and historical theory. Art expresses culture in the sense of pleasure and edification. The development of society gives people a sense of beauty and thus creates things of beauty that are works of art. The Concise Oxford Dictionary defines art as "artificial skill or technique as opposed to natural". In Chinese, the original meaning of the word art is planting. In the oracle bone characters, the left half of the character “艺” has the radical “木” (wood), which means plant, while the right half of the character represents a person using their hands to manipulate. In *Shuowen Jiezi*, the character 艺 is interpreted to mean "path" or "means", which we can understand as technique, skill. In comparison, both Chinese and Westerners understand the word art as manual skill. A purely natural thing becomes a work of art through the transformation of symbols. But a purely natural thing is not art. There is only one way to turn a natural thing into a work of art, and that is art display: a tree root, a piece of stone is not art, the displayer adds the meaning of intention, then it becomes an artificially created work of art; the human body is not art in most cases, only when it is displayed "as a work of art" does it become art; the mountain ranges in Zhangjiajie become art when they are displayed. Once they are displayed, these objects are no longer purely natural objects, but objects with artistic intent (Yiheng, Z, 2018). Artistic symbols have both a practical ideographic function and an artistic ideographic function. The process of transforming a simulation of nature into a work of art by incorporating human perception and the designer's consciousness into the work of art is called artistic creation. And this process is bionic design. When practicality and aesthetics become a common need, the relevance of artifact design takes on a strong driving force. These expressions of time, the pursuit of belief, the

knowledge and understanding of technology and art have outstanding esthetic value and cultural connotation. The designer is the most important creator of the symbols and as a user he is the best receiver of the expression of the symbols. From the perspective of semiotics, design semiotics is of realized significance as a theoretical basis for practical creative activities. Design semiotics is a branch of semiotics. It is a symbol with a complex meaning or a specific intellectual culture and expresses this through specific techniques. The meaning carried by design symbols is expressed through elements such as images, shapes, colors and design thinking, forming various symbols.

In reality, there is no such thing as "art" in a general sense; art is always linked to the national cultural soil on which it is located. Specifically for a given work of art, there is inevitably a heterogeneous perspective on its external field, and we need to explore the various ambiguous tensions in the work to establish a dialog with existing art experience and art history. Only in this way can we effectively communicate the diverse art phenomena with the universal semiotics of art (Jing, A, 2022).

2.2.2.2 Function of art semiotics

Art symbols have the function of abstraction, symbols can replace abstract things or a concept. For example, the flag, which can represent any country, the mandarin duck, which stands for love, etc. They also have the function of simplification, in that visual symbols can be reduced to a kind of notation. For example, + and = are mathematical symbols. The red cross can represent a hospital, and heart icon, ♥, can represent a favorite emotion. After the completion of creation through artistic processing, art semiotics is popularized by the ability of communication in the society at large. The symbols created by designers or artisans are used regularly and regularly. After reaching a certain level of social recognition, they are accepted by the public and adapt to the social environment. They are passed on and developed in the process of cultural and social development. It is passed on from generation to generation. Thereafter, the public uses the art form as

a symbol after following the established conventions of design, indicating that symbols have a normative and binding effect on people. Symbols also have the consciousness activity of dealing with the information inherent in establishing a connection between people and the outside world, the essence of which is to make a connection between one symbol and another. The cognitive function is to understand the world objectively, when the symbols must be used to interpret, to preserve and reinforce the knowledge in the cognitive process, and to constantly advance. At the same time, the law of combination between the symbols is diverse and has infinite possibilities, and in this constantly innovative ideology lies a certain flexibility in the creation of symbols.

Ceramic elements contain many cultural symbols, which can be divided into two main types: linguistic symbols and non-linguistic symbols. Linguistic symbols are the most commonly used media symbols, which include the language of oral communication and written language, mainly in the form of written records. The linguistic symbols of traditional ceramic elements are divided into two categories: ceramic dialect terms and standard terms. Non-verbal symbols mainly include the shape, decoration, and color of ceramic objects. Through these non-verbal symbols, the world can understand the culture and spirit behind the creation of art. These two types of symbols in ceramics will be explained later.

2.3 Bionic design and ceramic craftsmanship

Design originated with human creation, and in the land of China, the wisdom of countless people since the Stone Age has been reflected in stone tools, porcelain, jade and even clothing and houses (Li, W, 2015, p. 9). The famous ancient Chinese handicraft book "Kao Gong Ji" uses the phrase "Knowing the creation of things, knowing the creation of things, and the skillful person who describes the guardianship of the world is called a worker" to describe design, which is the earliest description of design in known literature. This is the earliest description of design in known literature. At the same time, the phrase "the skillful one" is an expression for the designer. This phrase is translated as follows in modern Chinese: "A wise person

creates the artifact, a skillful person writes it down, and the craft is passed down from generation to generation, and the world calls this skill a production process." This book was written in the Spring and Autumn and Warring States Period as a document that records the specifications and production processes of various crafts. The book contains a large number of handicraft production techniques, arts, and crafts of the Qin Dynasty. Arts and crafts and the book records a series of production management and construction systems, which to some extent reflect the ideology of the period concepts of the time.

As a traditional art and craft, ceramics play a pivotal role in modern design. In terms of production methods, ceramics is a traditional handicraft that combines design and production with individual work, so that the designed artworks and products have more character and personality. At the same time, ceramics mainly use natural materials, and the concept of green ceramics is widely advocated in today's society, and the materials are updated and improved to make the raw materials and emissions more environmentally friendly. Ceramics has undergone thousands of years of development as a traditional arts and crafts, leaving a valuable legacy to today's society, both in terms of technology and art, which is of great significance to the development of modern design.

Bionic design is widely used in various fields. The most important areas of application are bionic design in architecture, bionic design for clothing, bionic design for packaging, bionic design for product forms. Bionic product design is mainly created by imitating the following aspects: bionic product morphology, bionic product function, bionic product texture and color, and bionic product structure (Ningna, S & Jiali, D, 2010).

2.3.1 Analysis of the bionic design of ancient Chinese ceramics

The traditional Chinese concept of making things, preparing them for use, and establishing them as benefits for the world describes the importance of the shape of artifacts. Ancient ancestors began worshipping totems by drawing worship and prayers on the objects to decorate their utensils. Later, with the diversity of

objects, the esthetics were improved, and hand-twisted totem shapes gradually appeared, decorating the mouth rim of the object and other parts to strengthen the practical function. In primitive society, people worshipped God and asked the gods for a life of peace, an abundance of grain, food, and clothing. Later, with the establishment of feudal dynasties, the worship of gods triggered a race to follow the rulers and thus consolidate society and strengthen the rule of the kings. Totem worship meant that people shared a common belief and had something to live for. Eventually, totem worship became an indispensable form of expression in bionic design.

The use of artifacts to express meaning and symbolism is the most acceptable and visible way. History proves that the ancients did this with meaning. The symbolic meaning represented by ceramic objects became the carrier of cultural exchange between people, and in this way culture permeated every aspect of life and was closely related to everyone's life. At the same time, the speed of cultural transmission was increased. "The sage system of the apparatus is still the image, carrying the way to hang into, not to pass on the subtlety and the use of the apparatus between the legacy of future generations, so that the magnificent knowledge of the people, that is, the apparatus for the intention, the heart to understand the purpose of the eye-catching fate of things, know the rituals and music law and not to say the secrets of the day and night to look at the view, there is no escape from the virtue, than the Tang and Yu painting clothes and crowns for the discipline, and so that the people do not commit in the Division, do not migrate dazzling beauty capital play, as a device to please the eyes!" Li Gonglin in the "archeological map - preface" in a paragraph, is to illustrate the unique charm of bionic modeling in cultural dissemination. Today and later, when people see the shape of a vessel, they can recognize which species it was modeled after, and they use such a creation to seek the inner pursuit. "Using certain points of similarity between the stylized image and the referred meaning as a conduit and lead, leading our visual consciousness from the concrete image of reality to the vast world of intended spiritual meaning, this is the special function of symbolism" (Jusheng, W, 2000, p. 150).

2.3.1.1 Imitation of animals

The esthetic interest of the ancients lies in the pursuit of auspicious things this to pray for a smooth life, peace, and happiness. Therefore, the simulated object in the bionic modeling should carry a cheerful, auspicious, pleasant, and other good intentions. In traditional Chinese auspicious symbolism, a part of the animal is harmonized with its name to express the auspicious symbolism. For example, the mimicry of the deer and the harmonious sound "禄", which expresses the meaning of good luck, the meaning of auspicious longevity and the meaning of promotion. The original meaning of "禄" refers to good fortune and good luck. The word "天禄" comes from "The Analects of Confucius - Yao said", which refers to heavenly blessings and longevity. At the same time, it conveys the meaning of blessing, longevity, and longevity to people when it is combined with blessing and longevity and becomes a good wish for people to express their blessings. The form of the fish is simulated, and the sound of the fish is the same as "余" and "裕", which has the auspicious meaning of "having a surplus in the year" and "having a full house of gold and jade". It has the auspicious meaning of "year after year" and "gold and jade full hall". During the Sui and Tang dynasties, the story of "the "carp leaping over the dragon gate" also appeared in folklore. The fish that jumped over the dragon gate became a dragon, while those that could not jump remained ordinary. Later, the story of the "carp jumping over the dragon gate" was used as a metaphor for victory in the imperial examination and promotion to a higher rank. Now it is no longer just metaphorically going against the tide, but upwards. Ancient writers often used fish and geese as messengers to deliver letters and called the letters fish book, carp, Hong book, etc. The elephant simulates the form of the elephant, the sound of the elephant is the same as "Xiang", which is a metaphor for good luck. The elephant has become a symbol of good luck in China and around the world because it is considered honest and loyal. An old proverb says: "An elephant at peace means good luck. In traditional customs, the elephant is the embodiment of "good luck". The "elephant" can bring luck to the earth and symbolizes the peace of the world,

"elephant" means peace, good and luck. Elephants are powerful and mighty, but gentle and meek. It is said that the elephant is generated by the star of shaking light, which can bring good fortune, and the old Buddha descends from sky through the elephant; only when the king rises will the spiritual elephant appear. The elephant's trunk downward is called the "water-absorbing elephant", which is placed in the position facing the water source to create a pattern of water-absorbing wealth, which means that the size of the source of wealth has been taken, the source of wealth, prosperity and fortune. Simulation of the shape of the sheep, sheep in ancient China symbolized good luck, usually dressed with sheep in the pattern by the auspicious, auspicious symbolism.

2.3.1.2 Imitation of plants

The bionic shapes that simulate the morphology of plants consist of pomegranate, gourd, garlic, lotus, peach, bamboo and so on. The objects of these simulations all have the beautiful symbolic meanings they represent. About the pomegranate, Jiang Yan's "Ode to the Pomegranate" has this description: "A beautiful and colorful tree that looks forward to the one who waits." There are two important symbols and meanings of the pomegranate. The first is that it has an auspicious and auspicious meaning in our traditional cultural consciousness and is usually given as a gift to couples who marry, signifying many children and many blessings. The second point is that the color of pomegranate is very bright, i.e., red, and hot, which symbolizes the importance of people's life and career prosperity. The peach is also a common shape in morphological imitation, which expresses the following three meanings, one is auspicious longevity, the peach is a common fruit with auspicious symbols, which used to be regarded as a fruit eaten by immortals in ancient times and carved into furniture, walls, etc. It can signify longevity, which is why the peach is also called the immortal peach or longevity fruit. Nowadays, when people wish elderly people a happy birthday at home, they give birthday presents with peach elements to wish them a long and healthy life so that they can lead a happy and fulfilling life in their old age. The second is a symbol of love, the peach can also

symbolize the love story between men and women, it can symbolize that two people like each other, show affection to each other, there is a line in the poem that describes this. You can give peach-shaped jewelry to the woman to express the feelings of the two who love each other. Also, the peach blossom is used as a lucky charm for the opposite sex, which means that it is liked by many people of the opposite sex and is a sign of popularity. Third, to bring good luck, peach wood has the role of warding off evil spirits, avoid bad luck, avoid some bad things in life, peach can bring good luck, can mean that home life can be better and better, other bad things will be driven away. And "peach" harmonizes with "逃" and symbolizes escape from bad luck, avoidance of misfortune. In the search for the application of botanical forms in ceramic decoration, the information on botanical forms was divided into two categories: modeling and patterns. The data on patterns were collected in chronological order, while the data on forms were divided into four major points, namely the roots, leaves, flowers and fruits of the plants. The data is collected in the form of a table, which is intuitive and allows vertical analysis.

2.3.1.3 Imitation of characters

Another category of morphological mimicry is the design of morphological mimicry of figures. In ancient societies, especially in the matriarchal period, women were the main actors in handicrafts. Therefore, women were also the first to produce pottery. In the West there are female body statues made of ceramics, and in the East there are colored pottery bottles symbolizing the female body. Both, as representatives of the splendid pottery culture of the East and the West, are also the first works of art to imitate the human form.

Apart from the works of art that have no practical value, the other design works that use the human body as a bionic object have the human form as a container and give the container the same functional properties as a person. The containers made from the practical aspect not only have the same life as people, but also provide people with rich design nutrients and also have the protective function of sealing as well as the spiritual property of housing things.

The creation of artifacts has its origin in the attributes of people's lives and is closely connected with their lives, since they correspond to the needs of life. All artifacts created by humans are the outward expression of emotions, and human ideology is united in the integration of subject and object emotions. According to the form of simulation of the human body, so that the object represents a complete living body, full of human emotions. Confucius said, "The one who started everything is not followed by him," indicating that the earlier society used human beings to become the funeral of Confucius era was carved from wood to become a human statue for the funeral, while the two Han Dynasties, Wei, Jin, Sui and Tang, many ceramic

Material figures appear, such as the Terracotta Warriors and Horses of the Qin Shi Huang Tomb.

In addition to the overall humanoid bionic artifacts, part of the ceramic in the shape of the main body of the parts of the form of the bionic. Such as the Miaodigou bottle of Yangshao culture with human head, the humanoid bionic ceramic bottle and so on. To Gansu unearthed portrait of colored pottery bottle, for example, the shape of this pottery like a bottle-shaped objects, the main body of the shape of the middle large, two small oval, human head-shaped container mouth, slender slightly bulging belly, the bottom is flat; bottle mouth position of a human head, the front of the forehead neatly combed with short hair, the five senses are clearly visible, more realistic, the nose and ears with pinch molding techniques, the eyes and mouth hollowed out processing, the face is clean, more like a young girl. The bottle body is painted with a continuous curved triangular pattern, shaped like a girl in maroon dark clothes. The overall form is rich, dynamic and a beautiful sculpture artwork.

2.4 The relationship between bionic ceramic modeling design and ceramic craftsmanship

2.4.1 Craft is the technical support for ceramic modeling

The art of ceramic modeling describes “modeling”: “What is commonly referred to as ‘modeling’ has two meanings: One is the activity of creating the form of an object, the other is the specific form of the object created. The former refers to the creative activity, the latter to the creation of the form and style of the object.” It is emphasized that modeling is a purposeful and conscious human act. Pottery making in ancient China was already part of people’s lives in the Stone Age. According to archeological data, pottery shards that are about 10,000 years old were unearthed in the Xianren Cave in Wannian, Jiangxi, indicating that Chinese pottery making has a long history. “Pottery making originated from the application of clay to prepared or wooden vessels to make them fireproof.” The technique of pottery production originated in the early Neolithic period, when small vessels were made by pressing, while larger objects required a molding process using clay strips to roll up. In the late Neolithic period, after the decline of painted pottery, the Longshan culture emerged on the lower Yellow River and in the eastern coastal areas. The technology for making black pottery from this period was partly made and molded with wheels, a great technical innovation. With the development of pottery technology, decoration it was also added, which was combined with craft and made Chinese ceramic craftsmanship more and more sophisticated. The development of pottery art up to the Qin Dynasty was of high artistic level, and the terracotta figurines, the outstanding art of pottery in the Qin Dynasty, were mostly made by the combination of mold and plastic method. For example, the terracotta warriors and horses of the terracotta warriors and horses in pottery are first molded with a mold and covered with fine sand. The head, body, legs, and other parts were made in separate molds and then bonded together. During the Six Dynasties period, primitive

celadon appeared, and the celadon of the Six Dynasties period was rich in shape, and most of the production methods were made by hand kneading. For example, The green porcelain vessel with lotus flowers from the Six Dynasties period is chic in design and novel in shape. The three layers of lotus petals on the upper belly, arranged in layers, and the seven layers of lotus petals on the bottom are now kept in the National Palace Museum. During the Sui and Tang dynasties, the overall technology of porcelain making was improved. The thick and heavy mass of the early Six Dynasties was abolished and the body became thin and delicate, and the method of the wheel system was developed and matured. The Tang tricolor was made using the wheel-rolling system, mold assistance system, sculpture, and other techniques. Round vessels are mostly made by the wheel-rolling system, irregular seven-star are made by the mold system, and typical figures and animals are mostly made by the sculpture method. The level of craftsmanship is high. After the Song Dynasty, the production level of ceramics reached a new peak and continued to improve. Official kilns, folk kilns and porcelain emerged, which were beautifully crafted and popular. Therefore, the production process of ceramics can be roughly divided into the production methods of pinch, wheel-rolling system, mold assistance, and sculpture. At the same time, the book "The Early Chinese "Mold Method" of Pottery Making" summarizes the technique of clay sheeting as the most primitive technique of clay sheeting. In the long history of Chinese ceramics, the number of clay tablet forming techniques has increased, and the most common ones can be divided into five types: coil- building, clay pinch, clay mount forming, clay roll molding, and mold assistance.

2.4.1.1 Coil-building

The clay piece veneering technique is one of the most commonly used techniques in ancient Chinese pottery, which appeared earlier and is also an integral part of modern pottery, with clay piece veneering and clay piece inlay belonging to the clay piece veneering category. In clay piece veneering, the clay is cut into larger or smaller pieces and then enclosed or decorated depending on the

shape of the vessel to be produced. With the increase in productivity and the development of tools, the enclosing can also be done with a slow wheel. When decorating, small pieces of clay are usually used for decoration and wooden molds to emboss a uniform pattern. This decorative technique can be traced back to Neolithic pottery, and these uniform patterns serve not only as decoration, but also as representative totems of tribes or cultures.



Figure 12 Coil-building technology

2.4.1.2 Clay Pinch

Clay pinch is a technique often used in the production of ceramic sculptures. The soft nature of clay allows for a variety of shapes and is therefore favored by many sculptors. In clay pinch, the pieces of clay are flattened into different sizes and shaped in various states of dryness and wetness.



Figure 13 Clay pinch technology

2.4.1.3 Clay mount forming

In ancient times, it was also known as the clay-plate method. The technique of clay mounting is widely used in the production of inlays. A slab of a certain thickness is formed with the help of a tool. When the piece of clay is slightly dry and not easily deformable, it is cut into a suitable shape with a knife or other tool and then filled with the prepared jointing clay between the two pieces of clay. For larger inlays, it is necessary to make an inner support piece to prevent the inlay from deforming or collapsing during the firing process. At the same time, this technique reached its peak in the Ming and Qing dynasties, forming a complete production system for the production of Zisha pots.



Figure 14 Clay mount forming technology

2.4.1.4 Clay Roll Molding

The rolling process is a production method in which clay of various desired textures is beaten into pieces, rolled into columns of different sizes and then shaped. This production method is relatively primitive and offers a variety of possible combinations. It is mostly used in the production of environmental potteries and sculptures. In this era of modern pottery development, the author focuses on the application of clay tablet roll molding in environmental pottery. Zhu Lekeng is an artist who has mastered the technique of clay flake rolling sculpture very well. In his work "Life" series (picture), he uses the technique of clay flake sculpture to portray

organic life, such as corals and leaves, and then contrasts it with inorganic life, such as ceramic stones, and places it in space to express the infinite reverence for nature.



Figure 15 Clay roll molding technology

2.4.1.5 Mold assistance (printing blanks)

As the name suggests, this technique uses a mold as a basic form. The clay pieces are slapped or pressed onto the inside of the mold and then assembled and pieced together. This technique has been used to make Zisha pots since the Ming Dynasty. The use of molds in the production of Zisha pots is divided into inner molds, outer molds and component molds, such as the galls in Gongchun's Gall Pot, which is the first of its kind in Zisha. The mold can also be used to make a regular or different shape.



Figure 16 Mold assistance (printing blanks) technology

2.4.1.6 Slip Casting

The method of making plaster molds was developed in England in the mid to late 18th century. The maker mixes the plaster thoroughly with water and pours it into the actual object to be turned. After a few minutes, the plaster hardens and forms the desired concave mold. Once the mold has dried and been removed, the other side is turned. Due to its physical properties, plaster has difficulty sticking to clay and is therefore an excellent material for turning molds. Nowadays, the slip casting process is widely used in the production of everyday ceramic products. The slip casting process enables basic consistency of the product mold while increasing productivity and efficiency. It also has the effect of increasing the yield of the final product in a mature production line. For example, ceramic factories use roller head machines for press molding.



Figure 17 Slip casting technology

2.4.1.7 Wheel roll system (Throwing)

The so-called wheel roll system refers to a molding method that utilizes the inertia and centrifugal force of a rapidly rotating wheel. The force of the rotating windlass is used in conjunction with the movements of the hands to pull the clay into a hollow cylindrical shape, which is then richly varied. This traditional way of making pottery allows the production of round, curved, and other concentric

shapes such as plates, bowls, pots, etc. It is characterized by the regularity of the work and at the same time leaves a rotating pattern on the surface or inside the object. The emergence of the potter's wheel marked a milestone in Chinese pottery technology.

With the development of the wheel roller system in modern times, the degree of mechanization has improved. Using the production principle of the wheel rolling system, a new type of electric billet drawing machine has been invented, which has the advantages of high speed, uniform speed and speed control compared with traditional wheel forming and is a universal molding method. Whether large or small vessels, regular or irregular objects can be finished with the billet pulling car. China started using the windlass as early as the Han Dynasty, and then it was also introduced to Korea and Japan. Although most of the billet pullers can only make round vessels, the development of billet pulling technique has greatly improved the efficiency of ancient potters in making pottery, facilitated mass production and enriched the shape of pottery. The rolling system is a purely technical process from the perspective of forming, it is only a means of modeling, not the purpose of making pottery. The pottery of the vessel category produced by billet forming is a unique art form of pottery that uses the esthetic properties of the vessel to shape it.



Figure 18 Wheel roll system (Throwing) technology

2.4.2 Decoration methods are the medium through which bionic ceramic shapes are realized

Confucius of the pre-Qin Dynasty, "Analects of Confucius - Yongye" (《论语·雍也》), wrote: "Quality above text is wild, text above quality is history, text quality and refined, then the gentleman." (质胜文则野，文胜质则史，文质彬彬，然后君子) This sentence, translated into modern text, is to emphasize the design aspect of harmony and unity between inner beauty and outer form. Here, "text" refers to the pattern, the decoration. And "quality" refers to the essence, the practice. The two achieve a balanced state, impartial to show good design, in line with the modern design concept of practical and decorative unity. The idea of "quality" expresses the ancient Chinese culture of creation, emphasizing the practical, utility-oriented; at the same time, the focus is on esthetic and spiritual expression, respect for emotion, is the best expression of form and function. The decorative approach and ceramic modeling are precisely a realm of art and aesthetics, the realm of aesthetics and design. Decoration is a large category, and ceramic decoration contains numerous elements, including color glaze, texture, traces of the production process, etc., in addition to basic pattern decoration. At the same time, bionic modeling itself is a kind of decoration. Ceramic modeling is the carrier of decoration and the medium through which the function of ceramics is realized.

Ceramic modeling and decoration are an important expressive aspect of bionic ceramic design. And this expressive aspect is reflected in the molding process described above. The decoration of ceramic bionic design is inseparable from flat decoration. In the three-dimensional expression of modeling, the two-dimensional decoration plays a complementary overall effect, like the icing on the cake.

2.5 Integration of morphological bionic design and plant elements

Luigi Colani, a famous German designer, once said: "The basis of design should start from the truth, which is the life created in nature." This means that nature

contains infinite design resources. The traditional Chinese design concept once said that skillful workers should respect nature, and the design behavior and design methods should follow the laws of nature so that the work can be accomplished.

As the name suggests, morphological bionic design is the imitation of the external form of an object, the simulation of the "shape" and "state" of the object. The shape of an object is what we call the external outline of an object, which mainly refers to the image, shape, appearance, etc. The meaning of form has been described in ancient China, such as "both the form and the spirit", "the inner movement, the outer shape", based on the "shape" of the object, that is, the shape of the outer contour of the ceramic. The bionic shape design focuses on the simulation and transformation of static, flat "shapes" that meet the bionic ceramic design specifications. Morphological bionics can be divided into two aspects: the "shape" and the "state" of the object to be imitated. The bionic state of the form is more vivid, complete, and dynamic than the bionic modeling of the shape. Therefore, the design itself has a stronger esthetic and expressive power. As can be seen in the figure, this article focuses on the bionic forms of plants, namely the rhizome, flowers, leaves, and fruits of plants. The investigation and observation therefore focus on the characteristics of the bionic ceramic works made from these four parts.

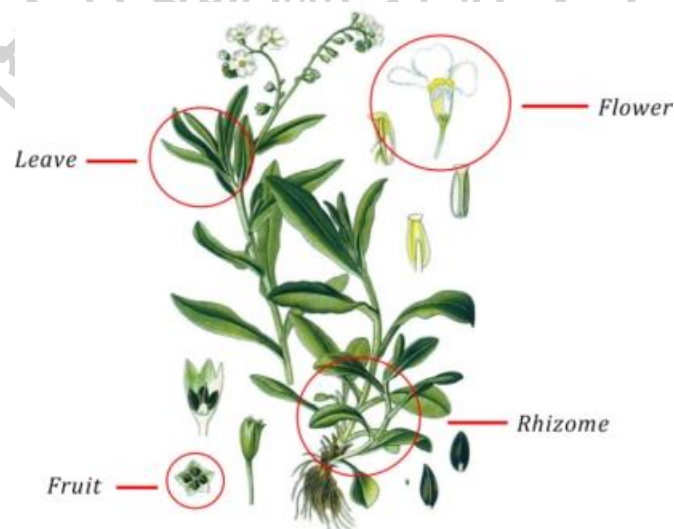


Figure 19 Distribution of plant structures

2.5.1 Expression of plant form bionic in ceramic decoration design

2.5.1.1 Applied to ceramic decoration design in the form of patterns

Morphological pattern bionic. Flowers, a botanical element in ancient and modern Chinese and foreign ceramic decoration. They are often a symbol of the good life, a representation of a better life, to express people's reverence for nature and longing for good things. Decorating with plant patterns was a qualitative leap in the esthetic consciousness of the ancients. The transformation of esthetic totem worship from animal patterns and symbols of power to the pursuit of the spiritual world led to the emergence of plant patterns during the Wei Jin and North-South dynasties. In the case of the Cizhou kiln, for example, botanical patterns were the main decorative patterns of the Cizhou kiln. During the Song Dynasty, the state policy of emphasizing literature and suppressing martial arts led to the emergence of literati, and the aesthetics of literati became the mainstream of social aesthetics. Both in ancient and modern times, there are countless poems and books dealing with plants. Under the influence of esthetic forms, they began to enter into a dialog with nature and pursue the ideology of the "unity of heaven and man". The form of flowers cannot only play a positive role in life. From the Tang Dynasty onwards, tea culture took hold, and in this context the art of illustration was born. The Song literati's pursuit of flowers is reflected not only in the decorative effect on space, but also in the recreation of plant patterns and their integration into designs.

There are three main types of decorative motifs in the Cizhou kiln: the peony pattern, which symbolizes wealth and good fortune, the grass pattern, which originated in the Wei-Jin period, and the lotus flower pattern, which has a religious consciousness. As for the way of imitating flower patterns, there are two types: realistic and realist. The realistic form of morphology is the realistic morphology of the flower with painting decoration, which reproduces the form of the flower without much distortion. The petals are full and heavy, layered, and clustered, complex, and uniform. Most of these floral motifs are displayed in frontal form, with the stamen as

the center of the circle and the petals spread out in all directions. The realistic form of imitation is to abstract the lines, and the leaves and petals are summarized by brushstrokes, reflecting the essence of literati and elegance. It reflects the self-confidence of artisans who are well prepared and the ability to decorate with skill and understanding.

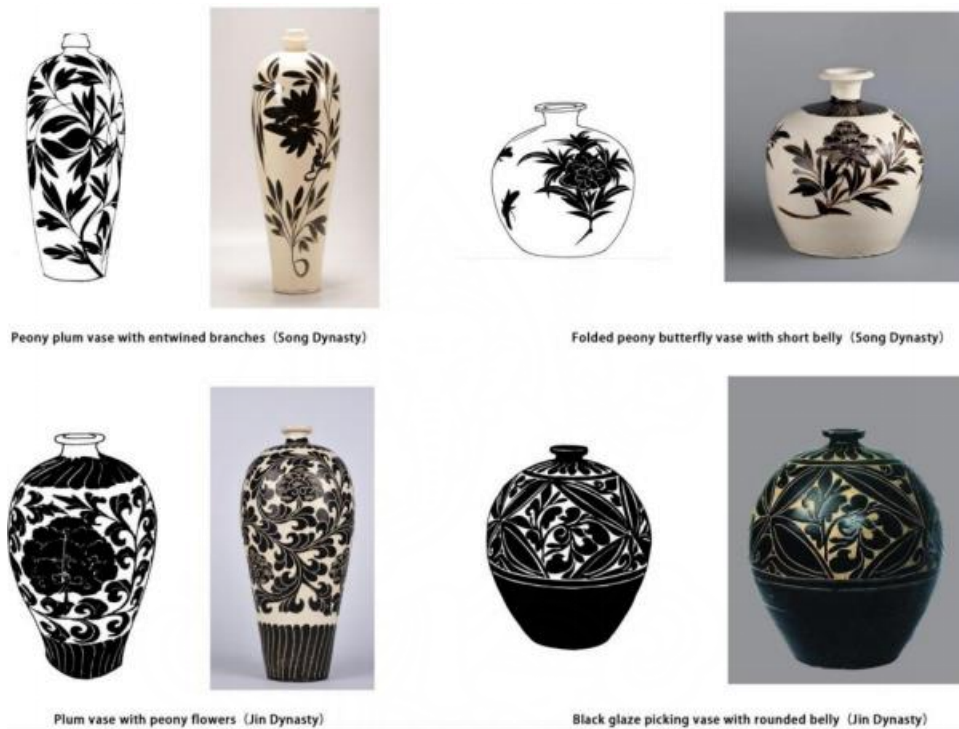


Figure 20 Decorative motifs of the Cizhou Kiln

2.5.1.2 Partial application in ceramic decoration design

We can understand a part as a specific part of the utensils. Generally speaking, the examination of the lid knob, the handle, the mouth part, or the body part of the utensils. The components of these utensils reflect the ancestors' understanding of life and also place new functional demands on the utensils. They reflect the early emotional design. Throughout the history of ceramic development, morphological mimicry has had a functional effect on form. It is expressed in the components of the objects, such as the handles, mouths and streams. The construction of the whole object occupies a relatively small part, and this kind of local morphological mimicry can not only enhance the practicality, but also make

the whole object more interesting, play a role in embellishment, and is also a form of decorative expression.

2.5.1.2.1 Cover button

The cover button expresses the function of the object to play the role of sealing, to put the interior of the object in a closed state, to make it moisture-proof and dust-proof, to preserve heat and to fulfill other purposes. Over the centuries, there have been many ceramics with lids, and the bionic parts of the vessels made in imitation of plant forms are worth sorting out and observing. The design of the lid part of the vessel appears in the painted pottery culture, imitating animals in the early stage and turning to plants in the later stage. This Longquan kiln porcelain jar with a celadon lotus leaf-shaped lid is the only jar of its kind found in Song porcelain in the world with a lotus leaf shape. The entire lid is shaped like an upturned lotus leaf and has a delicate, small knob that resembles the stem of a lotus leaf and is also easy to reach. The porcelain is glazed with plum green both inside and out, making it appear thick and lustrous as a whole, the ultimate expression of the potter's "thousand tips of green color".



Figure 21 Celadon porcelain jar with lotus leaf-shaped lid from Longquan kiln

2.5.1.2.2 Handle or lifting beam

It is generally customary to attach to the side of the main body of the apparatus, as the end of the holding component called the handle; across the shoulder, above the mouth, as the lifting component called the beam" handle or lifting beam is with the pot, jars and other objects and appear. Generally, the handle is mostly seen on teapots, while the handle is mostly seen on the shape of pots, cups and so on (Yongshan, Y, 2004, p.225). Compared to the handles, the number of handles is relatively small, and the more design-oriented handles are found on Yixing clay vessels. Fan Chengda of the Song dynasty wrote in the volume "Wu ship record": "Pi tube, cut large bamboo two feet long, the following section left for the bottom, carved its outside for the pattern, on the cover, with iron for the beam, or Zhu or black or not lacquer, the large rate of taking the wine bamboo tube ears."(郾筒，截大竹长二尺，以下留一节为底，刻其外为花纹，上有盖，以铁为提梁，或朱或黑或不漆，大率挈酒竹筒耳)This is the source of the handle. Almost all of these handles or beams are hand-kneaded and shaped in three dimensions. As shown in the picture, the handle of this Qing-glazed melon-shaped handle pot from the Five Dynasties has a leaf shape that has been pinched and shaped on the original single handle, which not only increases the flexibility of the object, but also facilitates the placement of the thumb in terms of use, increases the force area, and makes it more stable for use.



*Celadon Melon-shaped Handled Ewer
Five Dynasties*

Figure 22 Handle morphology bionic

Morphological bionic design plays the role of innovative functional forms, or morphological bionic design gives function to new forms, mainly from the main body of pottery modeling. Here, bionic morphology refers to the existence of a biological form as the object to be imitated first, and then takes this form as a carrier to give or storage, or cast a function, the bionic form involved in pottery modeling becomes a little clearer in the sense of design. It is often said that good product design is based on good function, in other words, good product design must also have a good function, the design of the pursuit of functional superiority is not wrong, but the design is not always the only function to follow, and not only to the function, through the design of the innovative function of the new forms to meet.

2.5.1.3 Use in a holistic way in ceramic decoration design

As the name suggests, the overall shape of the utensils is presented in the form of the designed object. The general bionics of morphology focuses on the figurative nature of the animal and plant images that are imitated. Some of them even reflect the function of the object. The overall bionic design is a newly designed form based on the entirety of the bionic modeling artifact. The overall bionic design includes the overall bionic design and the overall bionic design.

The lotus seed-covered bowl of Jingdezhen ware from the Song Dynasty white and pure clay, highlighting the clear and moving glaze color, white with green. The lotus element is fully utilized in this design. The lid and the body of the jar are in the shape of a whole lotus, the lid mimics the face of the lotus and even the raised shape of the lotus seeds can be clearly seen. Not only is the decoration reflected in the piece, but it is also a remarkable expression of Song dynasty porcelain technology.



Figure 23 Holistic way in ceramic decorative design

2.5.2 Classification study on the use of plant morphological bionics in ceramics

2.5.2.1 Two-dimensional plant bionics morphological mimicry

Ceramic vessels and modern pottery and other works with a spatial, three-dimensional shape. It is made up of the basic design elements of point, line, and surface. These basic two-dimensional elements form the variations in shape such as undulation and articulation, which enrich the form. Kandinsky took painting as the basis of analysis and used point, line, and surface as the basic elements of abstract art. In fact, these elements are not directly visible on the product form and depend on us to perceive their existence. A point moving in one direction becomes a line, a line moving in one direction becomes a surface, and a surface and a surface will form a body (Qingyu, G, 2007).

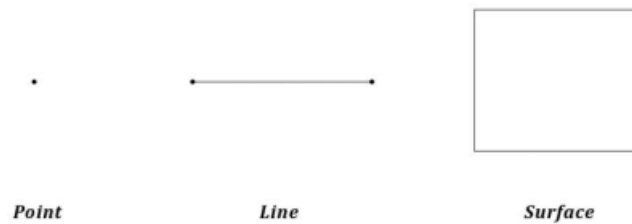


Figure 24 Plotting of points, lines, and surfaces

2.5.2.1.1 Points

As far as ceramic shapes are concerned, the morphological design of some ceramic categories, such as porcelain for everyday use, must meet not only the functional and practical design but also the esthetic needs of the time. Such designs can lead to bionic ceramic designs pushing the boundaries of form through two-dimensional elements. In modern ceramic design, these two-dimensional elements are usually one of the expressive techniques that potters use, using repetition, stacking and other compositional techniques to express the connotation of the work. Normally we understand the point, that is, in a geometric sense, in a plane without size, color or shape. If we look at it from an artistic point of view, it represents the smallest unit that makes up the shape. In ceramic decorative art, we can change the form and size of the point, rearrange it and combine it to create the point as we need it. Looking at the ceramic object, the object as a body, the lid and the handle of the object are all visual dots. These so-called points, which together make up the decoration of the vessel, play a pivotal role in bionics in design. As in Figure 25, this is the work of Mina Karwanchi, an artist from country x. The work consists of dots of different sizes. These dots are protruding dots. The visual effect of these raised dots, which are not obscured in any way, is remarkable when illuminated by light. They convey a strong sense of envelopment. The work mimics the form of plant seeds, and the whole is lively and dynamic, offering scope for visual reverie. You get the feeling that you want to embrace but have some distance.



Figure 25 Mina Karwanchi's work

If these raised dots are visually remarkable, the concave dots also have their artistic visual impact. Regardless of whether they are raised or concave dots, they are accompanied by the intersection of lines and faces, or they disappear at the intersection of the first faces. As shown in Figure 26, this is a blue and white porcelain chrysanthemum petal box made in the Jingdezhen kiln during the Song Dynasty, with the words Duanjia hezi printed on the bottom. The overall shape is in the style of chrysanthemum petals, with blue and white glaze inside and out. The jar has a hemispherical lid with an inset mouth that can be opened and closed and has practical functions such as storage. The shape is small and chic, and the design is interesting. The wavy lines move towards the center of the circle and form an intersection with the center in which they are embedded. The intersections reach the edge of the object at equal distances. All the recessed points intersect and form a central point. It resembles the symbolism of a melon and a pumpkin, but has the style of an apple tip. It has an undulating and twisting esthetic.



Figure 26 Celadon Chrysanthemum Petal Box

2.5.2.1.2 Line

Compared to points, lines are more diverse in their representation. Lines are more intuitive, there are long lines, short lines, straight lines and curves. There are even lines with different thicknesses and widths between the lines. The outline of an object can also be considered as a contour line. Lines and contours can characterize the appearance of ceramic works, and this appearance has become a key part of bionic design. In ceramic bionic design, the application of line is mainly reflected in two aspects. One is the abstracted, unspecific form of the line, the other is the intuitive line that is directly expressed in the form of the line. The twists and turns are clear and unambiguous. The line is divided into straight lines and curves, and the curve is divided into two types of geometric curves and free curves. The geometric curve is a regular curve under certain conditions, such as positive circles, ellipses, etc., which gives a sense of smooth turning, relatively neat, rational, more common in the shape of china for daily use. The free curve has a strong randomness, the line direction is not particularly regular, rich, and free, the line is lively and dynamic, most of the hand-molded ceramic artworks naturally show the free curve. The picture on the left is a work by Japanese artist Seiko Wakasugi. The overall work

imitates the petals of a lotus flower, with the meridians of the petals neatly distributed and extending in one direction, converging at the end points of the petals. The work is inspired by nature, and the white color of the ceramic in combination with the budding form appears contemplative and soft. It gives people a feeling of sacredness and elegance. The lines are as gentle as flowing water. On the right is the work of Jennifer McCurdy, an American artist with 40 years of experience in ceramics, whose observation of nature and her sense of plants give her work dynamism. She uses her work to reflect the beautiful practical experience of life. She sees Mallee pods bursting open in a field, glowing seeds suffused with sunlight. The orderly symmetry and asymmetry of forms in nature correspond to the cycles of nature. With her works she explains the environment of her life. This free curve is the best verbal expression of the work. It has an extremely strong rhythm. The works of both artists are imitations of plant forms, but the curve forms used are different and the works present different artistic effects.



Figure 27 Jennifer McCurdy's work

2.5.2.1.3 Surface

There are several types of surfaces in bionic ceramic design: the surface composed of straight lines, which gives people a rational, orderly, and serious feeling. The visual impact of the surface is obviously greater than that of points and lines because of its shape and undulating changes, which are a combination of

movement and stillness and are intertwined; the surface composed of curves, which is more undulating and smoother than the surface composed of straight lines, is full of changes and gives people a pleasant and natural feeling and is very personalized and interesting; the irregular surface composed of straight lines is the result of the intersection of two surfaces, some of which are natural shapes that have arisen by chance, and some of which are created according to the artist's subjective needs, and its feature is that the picture is rich in changes, giving people different visual forms at different angles and a richer picture. The surface is composed of a variety of lines, and the types of planar shapes are mainly divided into organic and inorganic forms: organic forms, such as fruit shapes, people or natural objects, flowers and plants, have a more concrete shape, this form of the surface to close the psychological distance between people and ceramics, looks more natural and simple. The inorganic form is mainly a random shape, an irregular, undefined shape or a geometric shape. This form itself may not be meaningful, but its surface composition has a dynamic, flowing visual characteristic, giving people a dynamic visual experience that is rich in philosophy.

2.5.3 Imitating the state of plant morphology

The proportion of the state is also an important part of morphological imitation. The state can make the work more vivid, lively, energetic, and complete, and reflect the expression of the emotion of the work and the interest of the decoration. It plays a more important role in the design of interest. In the bionic modeling of the state, the state can be divided into dynamic and static expressions. "Morphology generally refers to the expression of things under certain conditions is the result of the interaction between the physical, chemical and biological properties of things themselves and external factors is the form of a certain content has the concept and characteristics of space and time (Fan,Y & Nen C, 2005)"

2.5.3.1 Dynamics

Dynamic, which in nomenclature means a changing development. In artistic image, the expression of an active attitude; of or investigating a state of change in motion. Dynamic bionics is the creation of a dynamic sense of bionic modeling by capturing the kinetic posture of living things. It is the simulation of the momentary image of a biological form full of motion expressed through the visual imbalance of form, creating a dynamic effect with a strong sense of moment and non-stability. Dynamic bionic modeling reflects the observation and generalization of different postures, dynamics, states and esthetic features of simulated objects to find their best dynamics and transfer them to ceramic modeling. In bionic plant form, this is generally expressed by simulating the opening and closing of flowers, the turning and undulating of leaves, etc.

2.5.3.2 Static

Static bionics is relative to dynamic bionics. Static biomimicry refers to the simulation of a biological form in a static state of equilibrium. It refers to a continuous and unchanging action in relative time, and static bionic design is to represent a moment in which a temporal state of the mimicked organism is fixed. And the main bionics is the imitation of the external form represented by this action. The simulation of this static form in bionic modeling is mainly reflected in a state of relative stillness. Static modeling gives people a sense of peace and tranquility. Therefore, static bionics also has its unique artistic and esthetic qualities.

Both dynamic and static bionic designs focus on the form of the imitated object. The expression is the clever design thought of the designer. The designer's self-assessment flows into the work, whereby the work and the artistic expression simultaneously enhance the beauty of the decorative bionic shape. The rhythm of movement and stillness is the rhythm of design, and it is this rhythm that brings rhythm and movement to the design.

2.5.4 Realistic degree of imitation of plant forms

2.5.4.1 Figurative imitation

Figurative and abstract bionics stand for the key element of form. Figurative form means that the viewer can recognize at a glance which object is being imitated, which type of object is being imitated and which part of the object is being imitated. Those that can be directly perceived or touched by people are called figurative forms. These forms are both natural and artificial, so they are divided into natural and perceived forms. Natural plants and animals, clouds, the sea, etc. belong to natural forms, while various items of life belong to the synthetic forms (Fan, Y, & Neng, C, 2005). The characteristics of figurative form imitation are emotional, natural and affine. In figurative form imitation, the degree of reality of the imitated object is emphasized, and people can tell at a glance which creature the object is supposed to imitate, and the ideological and artistic content is low. There are three types of figurative forms: imitation of figurative patterns, imitation of a general figurative form and imitation of a local figurative form. Yang Yongshan said: "Mimicry or semi-mimicry is a basic method in the development of Chinese ceramic modeling, and from the primary imitation, people gradually moved to the advanced figurative form to adopt the meaning." The importance of the language of natural forms in the process of modeling can be easily seen by reading the catalogs of ancient Chinese ceramic modeling, which went through a gradual process of transition from realism to figurativeness.

2.5.4.2 Abstract imitation

Compared to figurative imitation, it is not easy to recognize the more realistic and clear features of figurative imitation, but to identify the abstract and vaguely imitated objects with the help of the explanation of the name, function, or role of the objects, which often capture some of the most expressive features and

attitudes of imitation. It embodies a thinking activity and has a certain distinctiveness. Abstraction as a design technique in art emphasizes the use of highly simplified and generalized forms, rich associations, and generalizations. It is a process that leads from figuration to abstraction by taking living organisms in nature as a model for modeling and generalizing and developing the image through the eyes of the artist's creative thinking. He emphasizes the similarity, even the subtle difference between similarity and non-similarity. The abstract bionic ceramic form appeals to human vision, which is more capable of triggering human associations and reflections and is closer to the ambiguity characteristic of thought. The abstract form emphasizes the extraction of the essential characteristics of the inner form of the designed object and is an artistic design activity that starts from the basic form and stands above it. It is an artistic creative activity that starts from the basic form and stands above it. Due to the different understanding and realization of the designers themselves, the same abstracted object will have a different form after design. The perception of the natural world by primitive peoples gradually evolved from figurative forms to abstract geometric patterns, a high degree of realism that was fully displayed in painted pottery. Moreover, abstraction is not so much an expression of achieving innovation as a method of artistic creation, specifically exaggeration, deformation, simplification and so on.

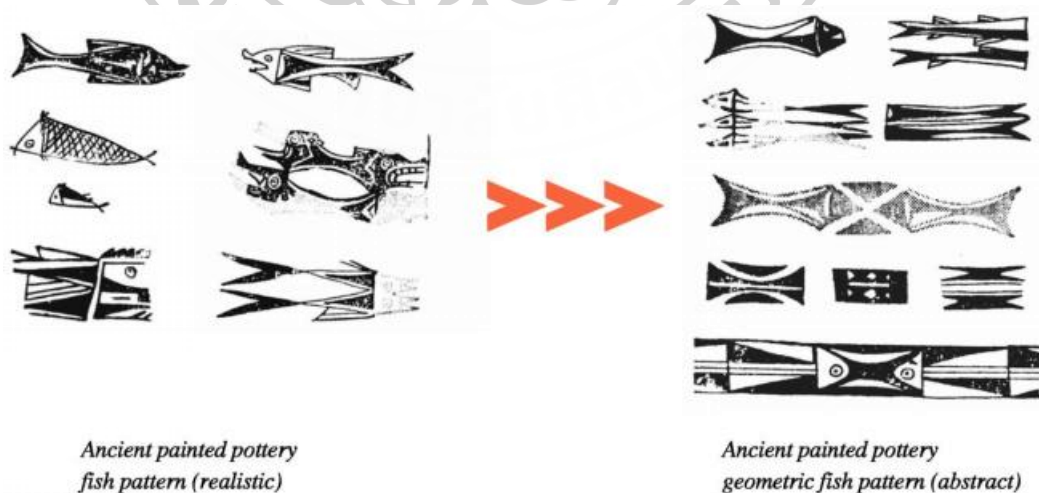


Figure 28 The Evolution of Fish Patterns from Figurative to Abstract

Whether abstract bionic or figurative bionic design, ceramic bionic design has a certain degree of symbolic properties in the design process. As an

original design method, the proper use of this design method in plastic arts reflects the effect of subtlety, depth and image; and in ceramic modeling, symbols can also make the performance of ceramic modeling more vivid. The abstract form of bionic ceramic modeling can reflect the creator's effort to deal with the relationship between ceramic materials and art forms. Based on the relationship between imitation and innovation, imitation, that is, consciously or unconsciously repeating the behavior of others, is one of the most important forms of social learning. Especially in the early days of human beings, the understanding gained from the biological world exercised human thinking ability, so imitation and innovation are not diametrically opposed, and in terms of the historical development process, imitation has greatly contributed to the development of human beings.

At the same time, innovation only exists on the basis of imitation and when experience has been accumulated to a certain extent. The relationship between imitation and innovation is applied to bionic ceramic modeling, and the abstract form of bionic ceramic modeling is more capable of reflecting the innovative activities based on imitation.

2.5.4.3 Image imitation

The imitation of the image form is the highest level of bionic design. In general, the bionic image form is that there are symbolic, anthropomorphic, metaphorical, and other bionic actions to satisfy people's esthetic heart for induction and generalization. A release is designed by associating the object to be imitated in a wireless and deep reverie and finding the relationship between the object itself and the imitated object. This type of design requires the designer to have a deep perception of objects and a high ability to generalize the concept of creation, so that he can exchange his perception with the device and then express his understanding and generalization in the design of the object. Whether it is to observe objects and make images or give meaning to images, although the limitations of natural objects have been broken through, it is still limited to the grasp of "objects" and "images", which to some extent still does not completely open up the idea of modeling

creation, and there is more freedom in modeling. With a more flexible means of modeling, thinking can be summarized as "creative three-dimensional". If we say that the "observation of objects to take the image" after the "pictogram to take the meaning" seems to be quite far from our industrial art design today, the latter still maintains the pictogram factor, but at the same time constantly goes beyond it to take its shape contained in the "meaning" to play creatively. The "creative three-dimensional" that "meaning" is creatively played, should be realized and applied in many places. Understanding the source of imagery and the process of creative thinking will help us to better explore the industrial art design that is closely related to modern life and seek a more benign and in-depth development (Yang, G, 1995).

Through the design method of "making vessels and images", the purpose of "vessels that carry the way" is achieved. The design approach is both real and imaginary, with form and morphology, forming an aesthetic that transcends the practicality of the area. The image imitation in morphological imitation is not able to feel the object directly, but usually requires a deeper understanding and feeling. The understanding and resonance of image imitation is achieved through psychological feelings. The created objects are imitations of images and shapes from outside, but they can retain and integrate the image theory and virtue in the imitation of the image, making the shape of the object symbolic and thus interpreting it into an important attribute inherent in our creations, namely imitation and symbolism (Yanzu, L, 1999).

2.5.5 The connotation and characteristics of ceramic bionic design

2.5.5.1 Practicality

Thousands of years ago, when pottery was created, practicality was the first element. People fired pottery for their own use. The later emergence of decoration was also designed and produced with practicality in mind. Pottery gradually evolved from the simple shape of bowls, plates and basins to complex

vessels such as bottles, jars, and jugs. The three-dimensional decoration of the vessels through the lid knob, the handle of the pot and the flow of the mouth, as well as the double ears of some jugs, made to adapt to practicality and decoration. From the beginning, the emergence of decoration was never an add-on product, but a product of organic integration with utility.

Ceramic utensils should first fulfill their practical value. This does not mean that the esthetic requirements do not need to be considered, but that the premise of practicality should be fulfilled, and then consider how the design can be better adapted to the esthetic needs of the times to achieve a better combination of practical and ornamental. Therefore, reasonable practicality is a necessary condition to enhance the beauty of the form of modeling, practicality, and ornamental both are united, on top of practicality to enhance the beauty, the two changes in the unity to form.

A Jingdezhen kiln lidded cup, of the Song Dynasty, with a lotus knob of shaded celadon and engraved with lotus petals, as shown in Figure. xx.. This cup with lid can be opened and can be regarded as a container for storing food, such as tea leaves. It can also be used as a vessel for serving soup and has an insulating effect to a certain extent. On a bionic level, the overall design mimics the object of the lotus flower. It is particularly noteworthy that the lid knob of the lidded mug is designed as a reclining lotus shape so that it is easy to grip and echoes the overall decoration. It is a practical and decorative design object. The rise of civil officials in the Song Dynasty led to the development of a spiritual entertainment culture in society, which included drinking wine and tea. Drinking tea and wine in the Song Dynasty was not just a way to quench thirst and sorrow, it was a culture. The Chinese matcha culture experienced a boom in the Song Dynasty and developed into a tea banquet. In the Song Dynasty, great importance was attached to tea drinking. Tea drinking is divided into two categories, one is pure tea drinking, where tea leaves ground into powder are brewed, and the other is tea and other foods mixed with ground and brewed beverages. At the same time, the tea culture of the Song Dynasty became an important form of tea drinking in the struggle for tea. The lives of Song people centered on the sense of ceremony, and the sense of

ceremony is the most direct way for people to express their inner feelings. Song dynasty people drink tea while paying attention to the practicality and beauty of teaware. At that time, in addition to the official kilns of the famous kiln system that made the vessels, a sharp wind was also blowing in Jianjian from Fujian. Cai Xiang said in the "Tea Record": "Jianjian turns black from the cyanine, lines like rabbit hair." Jianjian meets this criterion, tea battle is about the clean white tea soup, black glaze as a bright glaze can highlight the color of tea water marks, is the perfect partner of Song people in tea battle.



Figure 29 Song dynasty lidded cup with a lotus button and engraved lotus petals

2.5.5.2 Scientific

Take, for example, the evolution of the shape of the handle pot, it is the embodiment of science. The entire handle pot is divided into three parts: the spout, the body, and the handle. Let us start with the design of the spout, which is designed as a spout to pour out the liquid and control the direction of the liquid flow and the size of the flow. The design of the spout is crucial and has a direct impact on the comfort of the jug itself and its usability.

Many short spouts are combined with bionic designs incorporating animal, plant or human shapes to add esthetic interest and play a decorative role. The short spout is usually located on the shoulder of the jug, with a round tube, a four-pronged tube, a five-pronged tube and so on. Due to the short spout and the

short path of the water, the short spout has the characteristic of providing fast and smooth water. Part of the magazine or soup with food will not clog the water.

The difference between the basic shape of the slightly curved spout and the shape of the short spout is that the overall shape is elongated and has an outward curvature of 30 degrees and the spout is directed slightly downwards. The physical principle states that the lower the bottom of the spout, the greater the position of the spout and the horizontal surface of the pot, the greater the water pressure. This slightly curved spout can increase the pressure due to its downward positioning, so that the water flows more evenly. Break the overall form of the vertical sense in the direction of outward expansion, so that the overall form becomes softer and more beautiful. This sense of line in the shape of the spout makes the overall shape of the pot more varied.

The spout of the double-curved shape is still longer and thinner than the slightly curved shape, and the curvature of the spout becomes greater, with the base of the spout becoming larger. The basic shape of the curved spout determines the parabolic course of the water, and the line of the water when pouring is particularly beautiful. The position of the spout on the body of the pot is more downwards, which also determines the water pressure.



Figure 30 Handle pot evolution of the shape of the spout of the stopper

The overall design of the Clincher corresponds to the golden ratio. The so-called golden ratio was discovered by the ancient Greek mathematician Pythagoras, who divided the whole into two parts, with the larger part corresponding to the whole. This ratio is considered to be the most esthetically pleasing and is

therefore known as the golden ratio. In the case of this lion-headed melon plug from the Hutian kiln, we can see from the diagram that the ratio of the plug from the belly to the bottom and from the neck to the mouth is about 1:1.618, which is very close to the golden ratio. If we place the stopper in the golden spiral diagram, we can see that the body and the various accessories of the stopper are remarkably close to the golden spiral. The proportions and dimensions of the handle are a perfect representation of the exact proportions.



Figure 31 The Golden Ratio in the shape of a handle pot

During the Five Dynasties period, the Yaozhou kiln began firing celadon, and its development reached its peak during the Northern Song Dynasty. The Yaozhou kiln was best known for its engravings, and its smooth lines and sharp blade-carving patterns are typical. The most famous example from the Yaozhou kilns of the Five Dynasties is this green-glazed flow backward handle pot, shown in Figure 32. This pot is very scientific, with an imaginary lid and an overall operational design of the pot based on the principle of a physical linker, and is now in the Shanxi History Museum, where it is one of the "town treasures". The green-glazed pot with a handle on the back is a relic from the Five Dynasties period that was excavated in Bin County, Shanxi Province, in 1968. It is 18.3 cm high, has a diameter of 14.3 cm and a foot diameter of 8.7 cm. The lid of the vessel is connected to the body of the vessel. The phoenix serves as the supporting beam and the lion as the stream, rich in imagination and lively in appearance, with a fresh and lively interest in life. The lower

body is fully engraved with four blooming peonies, with sharp and rounded knives and a strong decorative effect. The spout in the shape of a plum blossom, also called inner pipe, is placed in the center of the bottom of the pot. There is a leaking column inside the pot to separate it from the water. The pot is turned upside down when it is filled with water and when it is full, it is turned upright so that no water leaks out. It is one of the pot styles that began in the Spring and Autumn period, became popular in the Tang and Song dynasties, and was perfected in the Ming and Qing dynasties. The peculiar structure and ingenious interior design of the inverted pot reflect the wisdom and extraordinary creativity of ancient craftsmen, and such objects were once sealed as national treasures.



Figure 32 Green-glazed backward handle pot (Five dynasties)

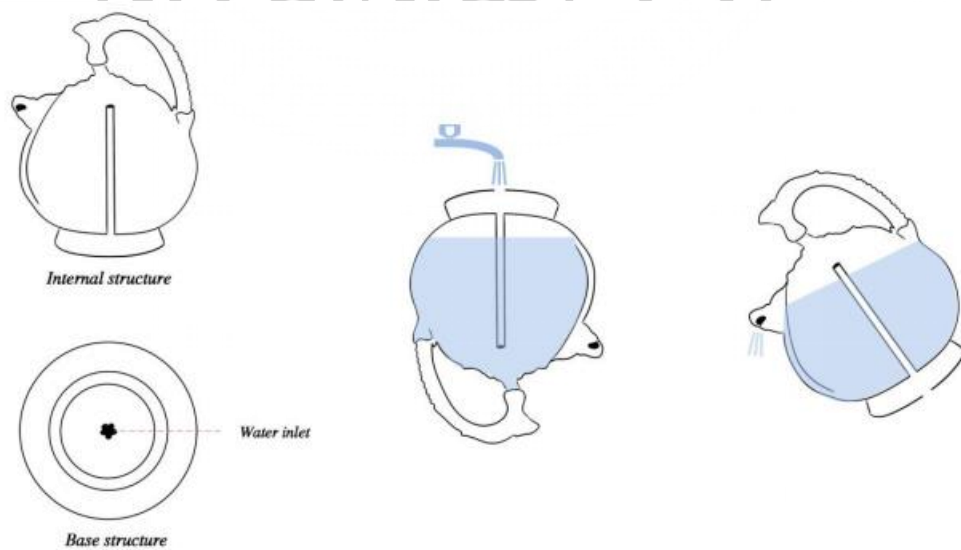


Figure 33 Illustration of how to use the Green-glazed backward handle pot

2.5.5.3 Artistry

Artistry means applying the esthetic laws of the time to create works that are of formal beauty and correspond to the esthetics of the time. The way of reflecting the state of man and design, and environment and harmony.

2.5.5.3.1 Reflecting religious awareness

Even in the Stone Age, people had a primitive religious devotion; the first humans conquered fire and made pottery from it and from clay. Originally, pottery was used as basic living utensils and additionally decorated, whether decorative or stylized, to satisfy primitive people's worship of totems that personified natural objects and protected them to develop production, live smoothly and have prosperous descendants. It is a kind of marking pattern and also the earliest decoration with practical significance. The fish pattern in Yangshao culture, the bird pattern in Miaodigou culture and the frog pattern in Majiayao culture are all clan totems and cults. They carry the belief in the original ancestors. Outside of China, the pottery sculpture "Venus" found in the Czech Republic is one of the earliest surviving works of art, although it was not used as a living vessel. The Venus was not a pure work of art, but had a primitive religious function, expressing the worship of fertility by emphasizing the female sexual organ. At that time, human productivity was low and individuals were at the mercy of nature, and only wealthy tribes were able to survive. Later, the cult of fertility was projected onto the natural world and people called the Earth Mother because of her ability to produce crops and livestock. Religion and ritual are the main lines in the history of ceramics, which were created in the service of religion and later porcelain (You, Q, 2018). In the Han Dynasty and the subsequent Northern and Southern Dynasties, Buddhism was widely practiced and was valued and supported by the rulers. Emperor Wu of Liang made every effort to promote Buddhism and make it the state religion. The arrival of monks from the West, from India, brought not only culture but also a new style of art and craft. The

lotus flower, a pure and beautiful plant in nature, was the form that artifacts competed to bionic. In Buddhism, the lotus has an even greater significance. It is an image that can be seen everywhere in temple architecture. Bodhisattvas with lotus feet holding lotus flowers or with fingers twisted into lotus shapes. The lotus is so closely associated with Buddhism that it can be said that the lotus is a symbol of the Buddha. The sacred nature of the lotus flower, which is untainted by mud, symbolizes the transcendence of the Buddha and the Bodhisattva from the red world and the emptiness of the four great things. The lotus flower does not die the root, the next year again, symbolizing the death of the soul, the constant reincarnation. The blue-glazed lotus flower zun from the Wei, Jin and Northern and Southern Dynasties is large, with a total height of about 75 cm, exquisite production techniques and high difficulty in molding. The imitation of the life shape is also very cleverly chosen. The blue-glazed lotus stature mimics the appearance of a layered lotus flower and has a long neck, sloping shoulders, a bulging belly and a high foot rim. There is a bridge ear at the mouth rim. The whole has thirteen layers of decoration, with the exception of the neck, which is embossed with the flower and the animal group, and the others are lotus flower patterns. The lid is double-covered with lotus leaves, the rim of the lid is curved upward and decorated with double upward lotus petals, the upper belly is covered with three layers of lotus petals, and the lower belly is decorated with double upward lotus petals. The overall ornamentation is a neat and delicate sculpture that echoes from above and below, rich and splendid. The ornamental content of the lotus flower is closely related to Buddhism and was used for burial to represent the spiritual trust of the deceased.

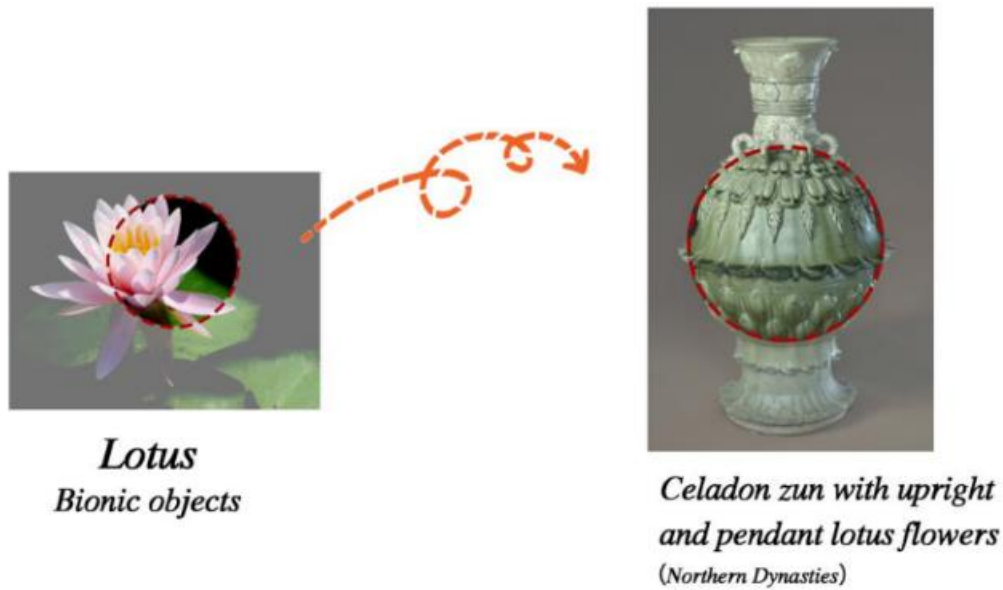


Figure 34 Part of lotus biomimicry of celadon zun

2.5.5.3.2 Beauty design form

The Song people liked to drink wine, and the wine they drank was rice wine or yellow wine, which was not very strong. Wine was drunk at important festivals such as the Cold Food Festival, the Dragon Boat Festival, and the New Year Festival. A warm wine vessel was needed for drinking wine, especially at the Cold Food Festival, on New Year's Day and in winter, when temperatures were lower and the banquet lasted longer. The celadon wine warmers can be clearly seen on the heirloom "Han Xizai Night Banquet" from the Song Dynasty, so the celadon glaze wine warmers are matured for use. Descriptions of wine can also be found in Song lyrics and ancient poems. So, it is clear that the Song people's love of drinking led to the proliferation of warm wine vessels. In the *Memoirs of the Eastern Capital* (《东京梦华录》), it says: "Most of the customs of the people extravagant, a little broad, where the hotel does not ask who, stop two people sitting to drink, but also need to carry the injection bowl a pair, two pairs of plates and glasses, fruit and vegetable dish each five pieces, fruit bowl three or five, that is, nearly a hundred silver two carry on." Description of the Northern Song Dynasty, when the injection pot and bowl were very popular.

The objects that become bionic through the flower mouth-ware are flowers in nature. Most of them are lotus type, sunflower type, and rhombus types. This kind of flower mouth ware has a beautiful appearance, warm glaze color and exquisite firing techniques. A look at the bowl of warm wine, soft lines, beautiful and elegant, like a blooming lotus. Usually, this kind of bowl is used with the pot, which was more common in the Song Dynasty. Its appearance is different from the general furnishing porcelain, decorative is built on the basis of practicality, in the fall and winter season to warm a pot of wine, which is a lot of fun to live. The details reflect the pursuit of beauty, and the mouth of a warm bowl is not a human contact surface, regardless of whether the function is meaningful. The mouth of the vessel is either six- or eight-petaled, and the bowl is surrounded by the petals as if they were lotus flowers with a lotus tassel. This is a particularly important aspect of the design of this vessel as it is used together with the bowl. There is a distinction between secondary and primary functions, and the idea that the secondary functions support the primary functions is evident in the systematic thinking and holistic conception of the design of the vessel. Although the form of flower-mouth pottery has been diverse since its creation, and there are many more styles over time, the main principle of its modeling is based on the characteristics of the shape of the object, which is cleverly conceived, and the natural form is purposefully artistically processed, so that the main body of the shape or the mouth of the shape becomes flower-mouth-shaped to achieve the purpose of decoration. Among the flower mouth molds currently available, the flower mouth molds mainly have: five curved plum blossom molds, five curved sunflower molds, six curved lotus mouth molds, eight curved sunflower mouth molds with compound petals, ten curved sunflower mouth molds, ten curved five petal lotus shape, twelve curved flower mouth shape, sixteen curved octagonal rhombus shapes, thirty-two curved, forty-eight curved and other various curved chrysanthemum petal-shaped flower mouth, as well as eight curved square mouth shapes, four curved rectangular, four curved oval flower mouth shapes, octagonal and lotus leaf-shaped (Yalin, Z & Miaomiao, W, 2011).



Han Xizai's Evening Banquet (Tang Dynasty)



Song Dynasty Warm Pot



Song Dynasty Tea Tray

Figure 35 Bionic Porcelain Used in Han Xizai's Night Banquet Painting

2.5.5.3.3 Auspicious symbol of life

In bionic design, many of the bionic objects have symbolic and auspicious meanings that are compatible with the national culture because of their appearance or the harmony of their names. People pray for a good reality in which they can live and for this reality to continue. The symbol of auspicious life reflects the folklore meaning, the particularity and the era. It is a concentrated expression of mass consciousness, a certain cohesion of the national spiritual world. At the same time, it embodies the creative talents and wisdom of artisans and combines culture with social politics and folklore. It is a perfect combination of national art and folk culture, showing the origin of a nation's culture and the expression of its emotions.

The "Celadon Melon Box" from the Northern Song dynasty is a very mature imitation design. The overall glaze of the object is warm and greenish-white, the tire under the glaze is flawless white, the shape of the object looks like a

pumpkin with sharp corners, the shape is neat, and the lines are simple and smooth. The lid and the body are tightly sewn together. The ceramic production process is very complicated, the ancient 72 processes, and the most critical is the refinement of the fire to become a vessel, even in today's ceramic firing process, after 1300°C calcined porcelain is also very easy to deform, it can be seen that this Northern Song Dynasty melon-shaped box is how hard to come. In ancient times, melon is still relatively common as an object of imitation. On the one hand, the melon is very practical because of its shape, on the other hand, its shape is simple and simple, simple and bright, quite in line with public esthetics. In addition, in traditional Chinese culture, the pumpkin has the symbolic meaning of many sons and many blessings, because its fruit contains a large number of seeds, so people give it the auspicious symbolism of many children and grandchildren. It also has the symbolic meaning of good luck in life, because the flesh of the pumpkin has a high sugar content and a sweet taste, which indicates a sweet and happy life, and the pumpkin plant grows fast and the vine is long, so the pumpkin also has the symbolic meaning of long luck.

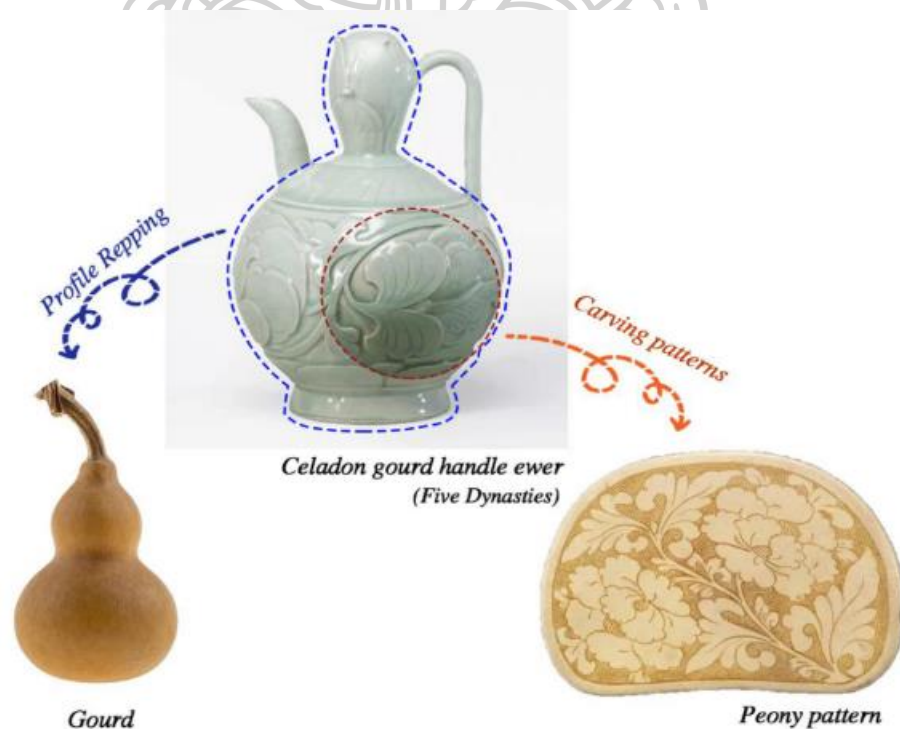


Figure 36 Analysis of the bionic elements of the five dynasties gourd handle pot

This closure pot from the Five Dynasties period is a good example of the combination of morphological imitation and decoration. The outer outline imitates the shape of a gourd, while the carved decorative pattern is a peony design symbolizing wealth and vitality. The gourd has the following symbolic meanings: 1. As "gourd" and "福祿" sound, it is a symbol of wealth and prosperity, representing longevity and good fortune, folk with colored gourd as an ornament, is based on this concept. 2, is to ward off evil. In ancient times, couples who got married in the bridal chamber drank "合巹" wine, 巹 is the gourd, which means that the couple's souls can merge together after a hundred years, so the ancient people regard the gourd as a lucky charm to protect the body and avoid evil spirits. The relationship between gourds and immortality is close. The legendary mythological (《列仙传》) figures of Mr. Iron Crutch, Yin Xi, An Qisheng and Fei Changfang have always been associated with the gourd, which later became one of the symbols of immortality. 3, indicating the prosperity of the offspring. As the gourd vine expands and produces many children, it is also considered an auspicious object to pray for the offspring of all generations. Proverb: "All a gourd, family style will be rich"(厝内一粒瓠, 家风才会富), meaning that a gourd in the house, rich, will be rich. 4, is the totem worshipped by some ethnic minorities. In China, there are at least 20 ethnic groups that worship Lagenaria, they worship pumpkin and are accompanied by gourd myths. The gourd is a climbing plant whose fruits can grow between 10 cm and one meter in size. In ancient times, people dried gourds and hollowed them out to make objects. The name "gourd" is derived from the fact that the two characters in Shuowen Jiezi teach each other. The word "gourd" is derived from the word "melon", which means that the ancients regarded it as a kind of melon. The name "gourd" derives from the fact that the two characters in the Shuowen Jiezi are mutually intelligible. In addition, Confucius mentions the "Lagenaria gourd" in the "Analects of Confucius", which is also a good explanation. Later, these names were passed on, and gradually the two-syllable name potlu emerged. This name appeared around the time of the Three Kingdoms, when the scholars of the time mentioned the "long-stemmed pot" in the "New History of the World". This is a special period in the promotion and development of China's national auspicious culture.

2.5.5.3.4 Lifestyle changes

From the perspective of ceramic bionic modeling, the change in lifestyle has led to the appearance and disappearance of many kinds of commodities. In the Tang Dynasty, the "tea sage" Lu Yu said in the "Tea Book": "Bowl: Yuezhou up, Dingzhou, Wuzhou second, Yuezhou up, Shouzhou, Hongzhou second. Or to Xing in the state of Yuezhou, is not. If Xing porcelain class silver, Yue porcelain class jade, Xing is not as good as the Yue one; if Xing porcelain class snow, then Yue porcelain class ice, Xing is not as good as the Yue two; Xing porcelain white and tea color Dan, Yue porcelain green and tea green, Xing is not as good as the Yue three." This is his evaluation of Xing white porcelain and Yue porcelain at that time, which he writes in the article. In the Tang Dynasty, the style of tea drinking prevailed, which promoted the rapid development of tea sets, as well as the advancement of porcelain technology. People's esthetic pursuit of containers merged with their lifestyle habits. Take, for example, the bowl products excavated from the kiln of Changsha in Hunan province. The inscription "Cha Tu Wan" and the round convergence bowl with the inscription "Cha Tu Wan" account for 81% of the bowl products from the Changsha kiln, and the round open bowl "Yueluji Tea Tu Wan" accounts for 17% of the bowl products from the Changsha kiln (Weijing, C, 2006, p. 312). From this archeological data, the number of tea sets is huge. The rise of tea culture led to the development of tea sets to a certain extent, but also promoted the development of porcelain technology at that time. The Yuan Dynasty, established by the Mongols in 1271, ended with the Five Dynasties and the Ten Kingdoms, in which multi-ethnic regimes coexisted for more than three hundred years. The Mongolian esthetic of white and blue encouraged the development of blue and white porcelain. At the same time, the overall size of the vessels is large, the inner diameter of bowls and plates is deeper and the overall thickness and coarseness is greater. This corresponds to the Mongolian people's habit of eating meat and drinking wine. With the establishment of the "Grassland Silk Road", the culture of ethnic groups spread to each other, decorative themes have been updated, commodity trade has been strengthened, so

there are many foreign ethnic groups on the porcelain orders, these orders are like riding a horse, riding a boat to culture, the development of craft has played a vital role.

2.5.5.3.5 Reflecting social concepts of propriety

Confucius once said in the Analects of Confucius (《论语·先进》):

"The state is governed by rituals, and its words are not allowed, so it is relevant (《为国以礼，其言不让，是故哂之》). The idea of "ritual rule" originated in the Western Zhou Dynasty. It had a profound influence on the development of the ritual system and the formation of the "State of manners" in later times. During the feudal period, the rulers implemented the "ritual system" through the sages to consolidate their supremacy and maintain social stability". This regulated moral standards and ritual systems. From the beginning of the Western Zhou Dynasty, the ritual system prevailed, which was expressed in ceramics, using ceramics to imitate the shape of bronze vessels, as ritual vessels, or Ming ritual vessels. The meaning given to pottery often had an allegorical meaning that went beyond practical significance. It seems to be able to represent the status of state power. As an old proverb says: "One word, nine pots, the son of heaven used the pot, the scholar and the great man used the pot, while the common man was deprived of the right to use the pot, and from then on the pot served as a symbol of power. The production of ceremonial vessels made of simulated bronze is in a sense a continuation of the development of bronze vessels, which expresses the symbolic function of bronze ceremonial vessels

and becomes the embodiment of the materialization of the ritual system. In addition to the imitation of bronze models, there is also the imitation of dragons and phoenixes. The ancient people have a long history of totem worship of the dragon and the phoenix, the dragon and the phoenix represent the supreme ruler, but also the supreme ruling power, which includes "Han Shu - Emperor Xuan Ji" (《汉书·宣帝纪》): "Ganlu first year of summer in April, the yellow dragon sees Xinfeng. Three years edict said: the phoenix set Xin Cai, the flock of birds in all directions rows, all standing on the phoenix, to the number of ten thousand", "Shen Jue two years in the spring of the second month of February edict said: the first month of yichou Phoenix The phoenixes, the manna, rose to the capital, and the birds from the flock were counted by tens of thousands. In the fourth year of winter, in October, the phoenix set 11, Duling. In December, the phoenix set Shanglin".(“甘露元年夏四月，黄龙见新丰。三年诏曰：凤凰集新蔡，群鸟四面行列，皆向凤凰立，以万数”、“神爵二年春二月诏曰：正月乙丑，凤凰、甘露降集京师，群鸟从以万数。四年冬十月，凤凰十一，集杜陵。十二月，凤凰集上林”) People's knowledge of the dragon also includes, that it symbolizes the mysterious, noble "Han Shu - Emperor Cheng Ji"(《汉书·成帝纪》): "Hongjia first year winter, the yellow dragon to see the real Ting. Yong Shi two years in February, the imperial edict that the dragon in the East Lai see, the sun has darkened, the sky with a change, i am very anxious (“鸿嘉元年冬，黄龙见真定，永始二年二月，诏书曰龙见于东莱，日有蚀，天著变异，朕甚惧矣”). There are also descriptions of the unpredictable movements of the

dragon, the book of the later Han Dynasty . Wu Xing Zhi (《后汉书.五行志》)" contains: Emperor Ling Guanghe first year of June dingchou, there is a black gas fall into the North Palace Wenming Hall East Court, black as a car cover, up and fast, body five colors, a head, body length of more than ten feet, the shape of the dragon. In the 24. In the 24th year of Jian'an in the Eastern Han Dynasty, the yellow dragon appeared in Wuyang Chishui and disappeared after a stay of nine days, for which a temple was built, and a monument erected (灵帝光和元年六月丁丑，有黑气堕北宫温明殿东庭中，黑如车盖，起奋迅，身五色，有头，体长十余丈，形貌似龙。东汉建安二十四年，黄龙出现在武阳赤水，逗留九天后离去) . So, it can be seen that the rulers used the people's worship of dragons and phoenixes to develop themselves into their own spokespeople, to find a legend for their own origin that could subjugate the people. Often the rulers compared themselves to the true dragon son of heaven, while their consort was another supreme deity - the phoenix. Therefore, in the exclusive use of the imperial paraphernalia in the shape and decoration of artifacts, mostly with imitation of the dragon, phoenix, decorative patterns are also diverse, pan-dragon pattern, phoenix dance nine days, the dragon and phoenix and other patterns are widely used. One thing is worth mentioning, the dragon, phoenix as the patent and symbol of the king, from its political significance. In popular culture, "dragon and phoenix are considered auspicious.", "dragon and phoenix bring double happiness" and an ode to marital happiness. In the religious system, the dragon is the "dragon king" and the phoenix is the "fire god", and in

ancient times there was a phoenix-bird totem, both as natural objects of worship and as totem worship objects. So, you can see that the dragon and the phoenix are a mishmash of ideas, with different symbolic meanings depending on the occasion and meaning of their use.



Figure 37 Evolution of the shape of double-dragon handles in different periods

2.5.5.3.6 The influence of literati thought on creation

Ideology is often the real driving force behind social innovation. If technology is the key driver of development, then ideology is the key driver that enables technology to innovate. There is no doubt that ideology determines the development and direction of society. In the development of Chinese porcelain in the long river, the thinking of the literati determines the direction of social development, the rulers of the Qin dynasty burned books and Confucianism, the tyranny under the rule of arts and crafts to show the magnificent, majestic momentum; In the Han and Tang Dynasties, Confucianism prevailed, treating people generously and reflecting the magnificent and masculine beauty of Confucian culture. In the Song dynasty, under the ideology of Cheng Zhu, the objects displayed a kind of immovable beauty of magnificence, the beauty of nature, the ultimate pursuit of natural beauty and inner beauty. The focus on an invisible realm of life. During the Song Dynasty, the development of porcelain was dominated by the five famous kilns,

and it is easy to see that the esthetics of the literati and elegant people removed the elaborate and ornate color decoration and used plain porcelain in blue and white. Even when the decorative technique of engraving appeared in the Ding kilns, the technique used was that of carving.

It is vaguely expressed in the artifacts and has clear and sharp lines. The Song Dynasty, which espoused Taoist philosophy, was dominated by the ideas of its founder, Laozi. Lao Tzu advocated "great ingenuity is like clumsiness" and the beauty of nature, simplicity and the concept of design against artificial decoration. Zhuangzi, on the other hand, suggested that "no one in the world can compete with the beauty of simplicity and simplicity" and that "carving is carving, and then return to simplicity". Both advocate following the laws of nature and being natural in every way. In Laozi's view, real "genius" is not to violate the laws of nature to show one's cleverness, but to conform to the laws of nature everywhere and in this conformity to realize one's purpose naturally. The realization of this "great ingenuity" is a realm of art and esthetics, a realm of esthetics and design. If it is said that from the Wei and Jin dynasties to the Tang Dynasty, the esthetic style of Confucianism with its strong and majestic form and spirit and the esthetic style of Taoism with its light, elegant and detached form were reflected in each other, then the Dynasty the literati after the Song dynasty tended towards the artistic thinking of both Taoism and Buddhism (Houze, L, 1981).

If ideology was the inner driving force of innovation, literati painting formed the basis for the innovation of ceramics. Su Shi, the founder of the concept of "literati painting," believed that painting should not only reflect the skills of brush and ink, but also pursue the mood of poetry. In the Ming Dynasty, the style of literati painting developed further. The intention was to "express one's own feelings" and "forget the world". The painters' expressive interest was mainly focused on nature or landscape, or on bringing ink and brush to the edge of emotion. There are many motifs in the paintings depicting immortal monks and literary hermits. The literati and hermits are playing qin, drinking tea, discussing and chanting poems in the pine forest, deserted suburbs and hut courtyard, or riding horses followed by schoolboys walking through hills and gullies, springs and rocks, smoke, clouds and

bamboo trees. Such images were sometimes depicted in ceramic painting of the middle Ming period. Before the Middle Ming period, Chinese ceramics were mainly decorated with patterns. Of course, there were also some pictorial decorations depicting scenes of people and stories in Yuan Dynasty blue-and-white painting, but it was a single-line, flat expression. It was the first time that literati painting in the form of ink and wash was directly transferred to ceramic decoration, as was the case after the middle Ming Dynasty. Since blue and white is an underglaze color, a brush dipped in blue and white water can be directly applied to the unfired water-absorbing billet to fully express the effect of ink dripping and staining in literati painting. When painting, artists tried to imitate the expression of wet ink and light color, dripping and sparseness in literati painting of the time on the one hand, and on the other hand, they played freely with it to make the picture more vivid and interesting. In addition to the above-mentioned wares, some bottles and jugs of the period also adopted this expression, with some simple and random rim patterns on the neck of the bottles and jugs (Yuan, Tie, 2001, p. 113). At the same time, the prints from the Ming dynasty played a crucial role in the study of ceramic decoration. The richness of the decorative subjects played a crucial role in the development of the porcelains and celadons that followed. The subjects of printmaking include all aspects of life, a variety of genealogies, folk tales, local legends and so on. And performance in the decorative techniques, blue and white porcelain pioneered the technique of white, purely using lines to express, rather than in the use of mixed water this way of expression with lines and areas. Many skillful craftsmen used dots and lines, and used the degree of sparseness of the two to express the yin and yang side of the pattern, a concrete expression of change in decorative style.

2.5.6 Development trend of plant form bionic in ceramic decoration design

2.5.6.1 Horizontal

Due to the rapid development of modern ceramic art, the functional and technical complexity of ceramics has made the morphological characteristics of bionic design complex and diverse. On the one hand, the development aims to enable the users of ceramic objects to recognize their utility functions by the morphology of bionic design. On the other hand, the beauty of form and era contained in bionic design can be appreciated through its morphology in contemporary ceramic decoration design. With the development of human civilization, esthetic needs, price and function have taken a back seat to the perception of beauty. To say that the creation of bionic ceramic works, whether living vessels or pottery, does not meet the basic need for beauty, which is undoubtedly disapproved by the times.

2.5.6.2 Longitudinal

In the development of the ceramic bionic design, the nutrients are drawn from the plant side, which provides inexhaustible resources for the design. And the vitality of plants and the knowledge of plants given by nature is summarized as the state of being alive. It is this good morality that has made plant form a top priority in ceramic modeling. And bionic ceramic design is based on the heritage of tradition, combined with practice, political, economic, cultural, and other social development factors to enrich the bionic approach. So, it can be said that bionic design has a heritage. The creation of new shapes always develops and renews itself on the basis of heritage. Through the study of traditional culture, understanding the understanding and creative thinking of bionic design of previous generations, the use of traditional and modern Yuan art, combined with the development trend of modern design to fulfill the contemporary esthetic paradigm.

The shape of bionic ceramic design is created on human initiative and is the result of harmony and unity with nature. The bionic design is the result of a design with ingenuity based on nature, combined with the way ceramics are used, techniques and properties. At the same time, the bionic shape designed in such a scenario meets the growing material culture needs of people, but also spiritual needs.

2.6 Research and case study of plant element bionic application types

2.6.1 Tableware

This tableware design comes from the Japanese designer Nae Tamura and bears the name "Seasons." The creative inspiration comes from Nae Tanaka's rediscovery of nature and the Japanese national diet. In an interview, Nae Tanaka explained about this design: "In my hometown, in spring, people wrap sweets in the leaves of cherry trees; in summer, people slice ripe tomatoes to serve food; in fall, maple leaves are used to decorate the table and the fragrance of bamboo leaves is prepared for winter. The cold comes and goes, and the flowers bloom and grow," she says. Her designs are typically Japanese, delicate and elegant, but innovative in terms of materials and craftsmanship. These fresh and leafy plates are made of silica sand, which is uniquely flexible to use and transport. It can be flexibly rolled up like a natural leaf or layered freely for presentation. As silica sand is relatively inexpensive, this product can also be produced in large quantities. It is also produced by the Italian brand COVO. From this design, we can see how bionic design thinking has been incorporated into the product. In the design, the material of the product is also an important consideration, which can be closer to the design to a certain extent, which can reduce the production cost, but also reduce the purchase cost, so that the design is close to the public.



Figure 38 Nae Tamura's work - Seasons

Below you can see two designs of dinner plates imitating lotus leaves. The researcher has analyzed the two designs together because they are quite similar in appearance and share similarities. The design of the tableware on the left is by Hou Mengyuan, a graduate student at Jingdezhen Ceramics University, whose design concept is based on the shape of a lotus leaf. The reflection is transformed into a plate mat, and in the functional use of the plate together with the plate mat, the imitated form is a more vivid image.

The right is HASU's lotus leaf tableware, designed by the designer KAICHI DESIGN Kaichiro Yamado. The "notch" on the edge of the lotus leaf serves as a drainage opening or as a tray for knives and forks. The ice crack pattern resembles the veins of the lotus leaf, and the four colors are so appealing. Although it looks very simple, it conveys a beautiful mood, as if the table were a calm pond with a few flat lotus leaves floating on it.

The two tableware designs simulated with the same bionic object are almost identical in function and form. It is worth thinking about.

It is about whether the design of the accessory can be used with the main product, which is a relatively new design idea and design direction for bionic design.

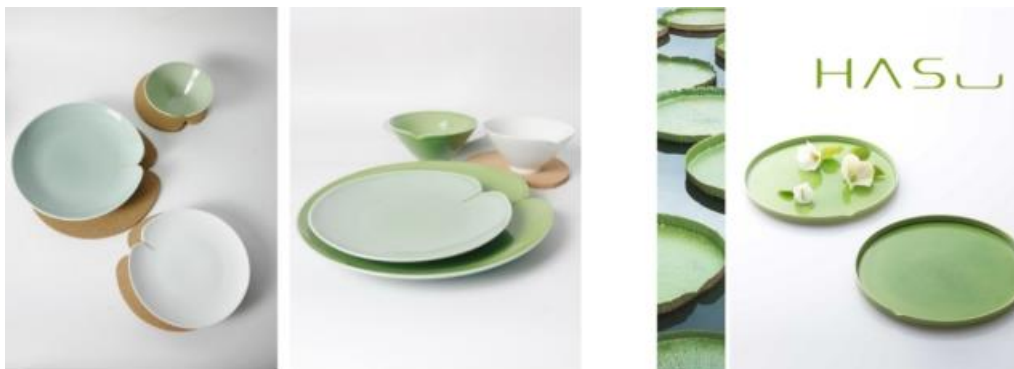


Figure 39 Kaichiro Yamado's work - HASU

2.6.2 Lamps

Louis Poulsen was born in Denmark in 1874 as a lighting brand in Northern Europe. In 1924 the designer Poul Henningsen started working with Louis Poulsen and two years later he started selling lamps. The light source is gently and evenly dispersed in the space by the refraction of the individual leaves. In many Danish homes, a pinecone is draped under the ceiling. Pine cone lamp, the entire spherical lamp body with 72 metal leaves wrapped composition, according to the order of different leaf size from top to bottom a total of 12 layers, each layer has 6 pieces, the fixed position and angle of each leaf have been calculated by a precise mathematical program, so it is like a leaf of staggered stacking arrangement, to hide a direct light source not only in the leaves, but also through the refraction of the leaves, so that the light source is distributed softly and evenly. The wonderful design not only hides the direct light source in the leaves, but also distributes the light source softly and evenly in the space through the refraction of the leaves. No matter from which angle you look up, you will not see the hard light source, and it is considered the most classic lighting creation of the 20th century to date.



Figure 40 PH Artichoke Pinecone Light

PELLE, a private studio in Brooklyn, USA, was founded in 2011 by Jean and Pelle, two designers. The fixture, called Nana Lure, is inspired by nature and has the form of a large palm leaf designed as a chandelier. It is full of exotic style. The lamp as a whole is hand-carved, elegant and imaginative. The huge banana leaf envelops

the light and gives the space a serene atmosphere. The design material is "cast paper", created by the designer Pelle. This is a type of paper fiber that is formed by casting and is removed and painted after the cast has dried and hardened.



Figure 41 Nana Lure lamps

Bloom petal lamp is a classic flower form of bionic work. It is a lampshade composed of multiple petal forms. When the slider is released at the top, the whole lamp looks like a blooming flower, as if you were looking at a time-lapse photograph of a blooming flower. Bloom's design perfectly combines the natural form with the lamp, and the symmetry and beauty are fully displayed. The three rows of 30 petals are angled outwards and become bud-like when closed. Made using a process called selective laser sintering of nylon, the 30 petals are combined in such a way that the light shines diffusely, seeping through the gaps between each petal. However, a sliding disk at the top allows the petals to fall outwards using Bloom's intricate mechanism, so that the light inside shines brighter than before. This works like a dimmer knob to enhance the esthetics of the luminaire.



Figure 42 Bloom lamps

2.6.3 Household

This bionic design bionic pine needles. The Outside/Inside design can be used in different ways depending on the user's needs and understanding. This design conveys a feeling of upward growth. The artfully arranged pine needles play a natural role and can easily hold some small objects of life and play a role in storage. This design gives a new understanding of the form of containers and a new experience of using them. Designer Gaurav MK Wali explains the product: "This is a response to the direction of modern product design. The modern product design industry is currently filled with the plastic smell of 3D product renderings and we wanted to bring a breath of fresh air into the design industry. We don't want a computer-generated utopia; we want to design for the real world." It is a return to natural and authentic design that will give people new hope for life and a completely different mood.



Figure 43 Gaurav MK Wali's work - Outside/Inside

"At a party with friends one day, we had olives as a snack. It did not take long for me to notice an awkward situation: there was nowhere to put the olive pits. Some people put it on a napkin, others just threw it on the floor, and some sneaked it into their pockets. This prompted me to come up with this idea." This is how PhotoAlquimia explains its inspiration.

The overall shape corresponds exactly to that of a peeled olive, in which half of the stone is revealed. The bowl is an abstracted olive pulp, while the shape of an olive stone can be seen in the center. The lid can be opened to store fruit or snack waste. TITOBOWL is handmade from coarse ceramic and olive trees.



Figure 44 TITOBOWL

2.6.4 Daily necessities

The design of the PhotoAlquimia seasoning jar comes from Spain. The design is a bionic design that follows the form of the garlic and is mainly made of ceramic. The designer cleverly uses the garlic cloves to form the garlic head, which is used for organizing and storing spices and other condiments. This kitchen utensil has space for six containers for storing solid salt, pepper, etc. and liquid for storing olive oil, fish sauce, etc. Adapt to the different types of condiments in each country. Interesting shape that suits the habits to meet the storage needs is the perfect combination of form and function. Not only the product itself, but also the outer packaging is inspired by the garlic peel, using natural, biodegradable materials, in line with the green design concept.



Figure 45 PhotoAlquimia - Seasoning Jar

This tea set is all about the shape of bamboo, which is combined in the design with the tea set. It consists of a teacup, a teapot and a teaspoon, which are stacked on top of each other to form the shape of bamboo. The stacking is a symbol of the different steps in the traditional tea making process. The bamboo shape blends elegantly into the tea ceremony. The minimalist bamboo shape not only shows the elegant outline of the product, but also fulfills the function of a combination of teaware. The layers of teacups, teapots and teaspoons are stacked on top of each other, corresponding to the steps before and after the tea ceremony, reflecting the beautiful symbolism of the rising of the tea ceremony. Tiny green

leaves are transformed into spoons that emphasize the elegance of bamboo. This tea set is a tribute to the landscape and the bamboo fields and will appeal to any minimalist who wants to bring a touch of Zen into their life.



Figure 46 Zuko Tea Set

2.6.5 Pottery

This series of bionic ceramic works entitled "From Lake Field to Alfred" is the work of Zhao Lantao from Jingdezhen Ceramics University. Since 2005, the simple and elegant elements of the lotus have been the subject of his research. He loves the budding flowers, the small and delicate lotus and the thorny stems, which most artists do not care about. The series "Lotus Pond by the Lake Field" is a representative work of his continuous exploration and deepening of such elements, and the series "From Lake Field to Alfred", created during a visit to Alfred University in the United States last year, is a further development of this series. The three colored porcelains we are proud of. Lotus, lotus, buds, and roots are embodied in this work, which is a bionic art design based on the traditional teapot shape.



Figure 47 Zhao Lantao's work - From Lake Field to Alfred

Phoebe Cummings received her MA in Ceramics and Glass from the Royal College of Art in 2005. She went on to study three-dimensional processes at the University of Brighton. It is often believed that ceramics have a long, albeit fragile, life and that the beauty of a ceramic piece can last forever. Therefore, Cummings wanted to emphasize the value of the fleeting life of plants by creating floral artworks from unfired clay. We can sense this in Cummings' work. She uses her expertise to express her love of flowers, plants, and nature. Phoebe Cummings' designs are made using the traditional flower-twisting technique. However, due to the large number of pieces produced and for technical reasons, she has developed a range of leaves and petals for film tools. Using a milling and embossing technique, the petals can be quickly shaped and then assembled.



Figure 48 Phoebe Cummings's work

2.7 Technical expression of ceramic decoration

"Painted porcelain, porcelain with painted decoration, distinguished from plain porcelain. It can be divided into four main categories, namely underglaze, overglaze, overglaze and combined underglaze and underglaze doucai." This is described by Mr. Feng Xianming in *The Illustrated Dictionary of Chinese Ancient Ceramics*.

2.7.1 Under-glaze color

Underglaze coloring is a method of decorating ceramics with glaze. Various patterns are drawn on the blank with ceramic pigments, then transparent glaze is

applied to the surface and fired immediately. After firing, the pattern is under the transparent or green glaze. The color cannot bleed easily, the color is light and soft and the surface of the object is flat and smooth. The most common underglaze colors are blue and white, underglaze red, underglaze five colors, etc. The firing temperature is 1,280-1,300°C. Compared with underglaze pigments such as blue and red, underglaze pigments are extremely stable and difficult to flow, and the firing temperature is lower, usually between 990 and 1250°C. The underglaze pigment is a carrier of raw or plain billet that has been fired at a low temperature. Because raw ingots or plain billets have strong water absorption and fast water absorption rate, and the underglaze pigment is a water-based pigment, it is more difficult to pull and not easy to change. Therefore, underglaze coloring is a ceramic decoration technique with a high degree of difficulty.



Figure 49 Illustration of Under-glaze color

2.7.2 In-glaze color

In-glaze color is a new porcelain decoration material and a new technique that was only systematically developed in the 1970s, named because the color material is in the glaze layer. Depending on the position of the color material in relation to the glaze layer, there are other common types of colored porcelain such as overglaze, underglaze and doucai. Underglaze color decoration has the effect of underglaze color with delicate crystal, nourishing and shaking eyes, corrosion resistance and wear resistance. Brown color in glaze", "brown-green color in glaze" and "green color in glaze" of Qionglai kiln in Sichuan Province and Changsha kiln in Hunan Province in Tang dynasty are characteristic varieties. This shows that the "glaze color" was successfully created in the Tang Dynasty. Since the Yuan and Ming

dynasties, underglaze blue and white became the main varieties of official and private kilns in Jingdezhen porcelain production, but in the production of some special varieties, the method of using glaze to show the effect of "class blue and white" was also developed. After the Republic of China, the process of high-temperature glaze coloring appeared in China. In the seventies, the system of glaze color decoration technique developed. A kind of "production glaze color". Glaze in color porcelain refers to the color material "sandwiched" in the glaze layer, two production methods, see "craft techniques" above. In production in accordance with the outside to inside "glaze - color - glaze - tire" glaze, color hierarchy relationship for the glaze, painting, and firing. For example, in the "cowpea red" glaze from the Qing Dynasty of Kangxi, the bottom glaze is applied first, then the color, then the surface glaze, and then the firing. Another type of "firing glaze in color". In this method, the glaze is fired on the painted surface, then the color is lowered into the glaze and formed in the glaze.



Figure 50 Illustration of in-glaze color

2.7.3 Over-glaze color

Overglaze is the process of painting motifs directly onto the porcelain tires, which are then coated with a transparent glaze. After firing at a high temperature, the porcelain is sintered. The glaze is then painted onto the corresponding pieces and fired a second time at a low temperature in the kiln, with a firing temperature of around 700-800°C. The common glaze colors are antique, five-color, blue and white plus color, pastel, enamel, etc. The development of glaze painting has a long history. As early as the Northern Qi Wuping Six Years (575 AD), exquisite white and green

wares were unearthed in the Fan Cui Tomb, Her color dot decorations can also be seen in many Jin Qing wares. This is the first discovery of glazed painted porcelain. The development of Chinese glaze painting, from underglaze to glaze, from monochrome glaze to multicolored glaze, and then from monochrome painting on glaze to multicolored painting on glaze. In the Song Dynasty, this technique was further developed by the Cizhou kiln, and many monumental masterpieces were created. From the Jin to the Yuan Dynasty, the red and green colors of the Cizhou kiln became the precedent for the Ming Dynasty, and in the middle and late Ming Dynasty, the production of five-color porcelain reached a very high level in the Jiajing and Wanli periods. But the really fine and beautiful colored wares are still in the Qing dynasty Kang, Yong, and Qian five-color and pastel-colored wares. Among them, the Yongzheng famille rose enamels are the best, both in terms of the fineness and detail of the production process and the painting. The enamels were famous for a long time and the prices were always high, and they were also rare. Among them, there are blue and red enamels, doucai and blue and white enamels, which are all mixed enamels.



Figure 51 Illustration of over-glaze color

2.7.4 Ceramic carved technology

Ceramic carving refers to the use of sharp tools to carve a pattern in various shades into the semi-dry surface of the object, which is then glazed for firing. Carving can be divided into two types: Yang carving and Yin carving. Yang carving, when the pattern emphasizes the object itself, so that the pattern is shallow and deep, showing the same effect as a relief: Yin carving is lower than the object itself, if it is deeply carved, it also shows the same effect as a relief, also known as bas-relief.

The lines of the carving have different forms of width and narrowness, and there are a variety of twists and turns, with the artistic effect of points, lines and planes. It can also be carved directly on the blank with a carving knife, making the pattern lines smooth and vivid. If the strength is greater, the pattern is deep and layered, with a strong sense of three-dimensionality and a better overall decorative effect. The engraving is represented by Shaanxi Yaozhou ware. Carving is widely used in ceramic decoration and is often used in combination with scratching and picking. It was especially popular in the Wei-Jin, Northern and Southern Dynasties and the Song-Jin period. The lotus pattern is carved into the surface of the porcelain with a knife, including lotus petals, leaves and rosettes, which are harmonious and rhythmic.



Figure 52 Carved technology

2.7.5 Incised technology

The decorative technique of incising is more flexible, the lines are natural, smooth, and lively, and the strength is weaker compared to carving. Tools are used to incise directly into the surface of the blank, the processing technique is simple and the overall sense of the pattern is relatively strong. Incising is also often used in combination with engraving and picking. The technique of incising appeared relatively early, already on the original porcelain of which the late Tang Dynasty to the Northern Song Dynasty Yue ware emerged as representative. Lotus pattern engraving uses sharp tools to scratch lotus petals, lotus leaves, lotus puffs and other patterns into the blank body of ceramic objects, and the forms are diverse. When decorating ceramics with the engraving and incising technique, the general outline of the pattern is first drawn with the engraving, and then the texture of the pattern is drawn with

the incising technique. Moreover, the single-line incised decoration is also used in the kilns of Yue ware, Longquan ware and Ding ware.



Figure 53 Incised technology

2.7.6 Moulding technology

Moulding, also known as mold printing, refers to the production of Moulding molds (usually made of pottery) with patterns in them. Templates for moulding patterns dabbed onto the surface of semi-dry blanks to create decorative patterns, or molds with patterns printed directly onto the vessel body and then fired. The mold can be used repeatedly. The moulding technique is relatively easy to use, which not only saves production time, but is also more efficient, economical and environmentally friendly. However, moulding also has its disadvantages. Due to the repeated use of the mold, the pattern is relatively simple and not as witty as the craftsmen who draw it, and the smoothness of the lines and the intention of the craftsmen are relatively poor. Moreover, the decoration of the molds will be worn or damaged to a certain extent due to repeated use, and if care is not taken, the finished product will have certain defects. The technique of mold decoration appeared early (as early as pottery printing in the Neolithic Age), by the Sui and Tang dynasties, the printing technology has developed greatly, reaching its peak in the Song dynasty, which is represented by the printing plate of Ding ware. In addition,

compared with the finished ware, the impression is characterized by a clear and complete pattern, which is also a valuable device for studying the lotus pattern on porcelain. Archeologists have found impression molds for lotus pattern decoration at kiln sites such as Huangbaozhen, Hebiji and Jizhou in Tongchuan.



Figure 54 Moulding technology

2.7.7 Raffito design

There are two types of floral decoration: ground floral and flower floristry. In the "ground picking" method, the make-up is removed from the pattern, leaving the body with the make-up, which is then fired. In the opposite case, the pattern is fired by removing the paste from the pattern and leaving the paste on the pattern. The decorative technique of picking provides a contrast between the pattern and the blank in color and texture and shows a different texture. Moreover, the decorative technique of flossing has a certain artistic effect of shallow relief, and a sense of three-dimensionality is created. The decorative technique of flower picking was popular in the Song, Jin, and Liao periods and was mainly found in Hebei, Henan, Shanxi, and other kilns.

Some of the kilns, including Dangyu ware, magnetic state kiln and famous. The black-glazed porcelain of Dangyu ware is the most representative. The distinctive and unique pattern is emphasized by the brown ground, and its artistic influence is far above that of similar kiln decorations in the magnetic state system. The floral

decoration appeared in Magzhou ware from the late Five Dynasties to the early Northern Song Dynasty and has a strong northern cultural character.



Figure 55 Raffito technology

There is a reason for the popularity of flower-picking in the north, for the northern porcelain is thicker than that of the south, making it easier to pick than the thin tires of the south. It is possible that the flossing was originally imitated in gold and silver, perhaps in the sense that the relief-like layering on gold and silver inspired the porcelain artisans of the time. The relief effect in wood, stone, and brick carvings from the same period also influenced the flossing process. These carvings can be found everywhere in folk architecture and handicrafts, from which the flossing process in porcelain also drew much inspiration for artistic creation.

2.7.8 Applique

Appliqué is a decorative technique in which colored patterns are transferred from a decal to a ceramic blank or glaze using tools such as hot water and sponges. A distinction is made between over-glaze and under-glaze applique, etc. In the case of glaze decals, there are film transfer, water decals and glue decals. Under-glaze decals are only printed on the decal paper, pad printed and then filled with artificial color; there is also a one-time paste on the color lines, which is called water decal. Decal paper has two kinds of paper and plastic film, with paper flower paper needs to be uncovered, washing and other processes, after the invention of film flower paper, it does not need to uncover the paper and other processes, and facilitate mechanization, continuous operation.



Figure 56 Applique technology

Ceramic decal paper is mainly used for the decoration of ceramic vessels with patterns and colors, and the resolution of silk-screened ceramic decal paper can reach 40-50 lines/CM. After the silk-screened ink patterns on the ceramic decal paper are attached to the ceramic vessels, they need to be fired at 700-800°C or 1100-1350°C to make them adhere firmly. Ceramic decal paper is the carrier of ceramic ink and is divided into ceramic overglaze decal paper and ceramic underglaze decal paper, and the types of decal paper are different according to the composition. With the development of modern ceramic science and technology, three-dimensional applique has been developed successfully, and the effect is remarkable.

2.7.8 Engraving

Ceramic engraving is a decorative technique in which a carving knife is used on a dried ceramic body. Ceramic engraving is a combination of painting and engraving, painting, calligraphy, and other art forms on porcelain a special artistic medium that is not painted on white porcelain but engraved with painting or text. Engraving on vessels such as plates, bowls, vases, tea sets, stationery etc. still has the function of tools; engraving on a porcelain plate with a mahogany frame is pure art. The origin of ceramic engraving According to records, the Qing Dynasty specialized in ceramic engraving, but most of the flat carvings, dotted line composition and artistic expression appear monotonous, plain and without much attention to the world. In the late Qianlong period, due to the economic prosperity and needs of the imperial cultural life, the court deliberately established the "Office of the Manufacture", which

specialized in the production of handicrafts for the court. Through the patronage of the various social classes at this time, the art of engraving calligraphy was further developed, and people were even able to use steel knives to engrave paintings of landscapes, flowers, birds, grasses and insects on porcelain plates or other vessels in a vivid manner. In a sense, ceramic engraving developed into a new, independent art of porcelain decoration during this period. In the years from Tongzhi to Guangxu, the Beijing calligrapher and painter Deng Shi Ru and other people who were involved in the self-inscription and self-painting of porcelain promoted the development of ceramic engraving.



Figure 57 Engraving technology

2.8 Conclusion

Plant morphology, the research of the morphology and structure of plants, can be a source of inspiration for bionic design, which is about using ideas from nature to create new technologies and designs. By looking at how plants have evolved to fulfill different functions, designers can learn from nature and create more efficient and sustainable designs.

Bionic design inspired by the morphology of plants can also be applied to ceramic design. Ceramics have been used for thousands of years for a variety of applications, including pottery, tiles and building materials. By incorporating plant-inspired designs into ceramic products, designers can create more functional and aesthetically pleasing objects. For example, the structure of plant cells can inspire the development of new types of ceramic materials. The cell walls of plants consist of

complex structures that provide strength and flexibility. By mimicking these structures in ceramic materials, designers can create new types of ceramics that are more durable and flexible.

The morphology of plants can also inspire the design of new textures and patterns for ceramic surfaces. The intricate patterns and structures of plant leaves, flowers and stems can be recreated on ceramic surfaces using techniques such as glazing and etching. This can create beautiful and unique designs that reflect the beauty of nature.

Another possibility is the use of plant-inspired shapes in ceramic products. The organic shapes of plant leaves, petals, and branches can be used as inspiration for the design of ceramic vases, bowls and other objects. This can create a sense of harmony and connection with nature in the objects of our daily lives.

Overall, bionic design inspired by plant morphology can open up new possibilities for ceramic design, creating functional, durable and beautiful objects that reflect the beauty and efficiency of the natural world. Bionic design inspired by plant morphology can lead to more sustainable, efficient and innovative solutions to design challenges.



Chapter 3 Research Methodology

This research method is divided into five stages, the purpose is to determine the current status of development and existing problems of plant morphology

bionics in contemporary ceramic decoration design and to explore its development direction by collecting quantitative and qualitative data.

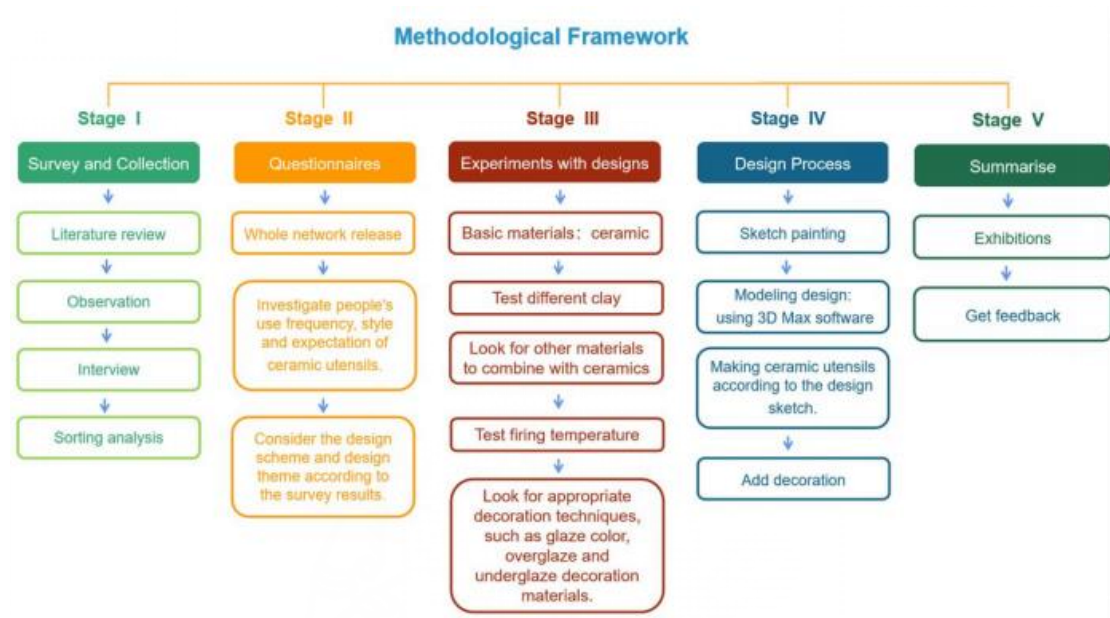


Figure 58 Stage of the research step diagram

3.1 Research Methodology

Research methodology is the systematic process of collecting, analyzing and interpreting data in order to answer research questions or test hypotheses. It includes a range of techniques and approaches used in research to ensure that the findings are dependable, valid and generalizable. The process of research methodology generally includes the following steps:

1) Formulating a research question or hypothesis: This involves identifying a topic of interest and formulating a clear and precise research question or hypothesis to guide the study.

2) Designing the research: This involves selecting an appropriate research design, sampling strategy and data collection method.

3) Collecting data: This involves collecting data using various methods such as surveys, experiments, observations or interviews.

4) Analyzing the data: This involves processing and analyzing the data using appropriate statistical or qualitative techniques to identify patterns, trends or

relationships.

5) Interpreting the results: This involves interpreting the findings and drawing conclusions based on the analysis.

6) Communicating the results: This involves presenting the results in a clear and concise manner using tables, graphs or written reports.

The choice of research methodology depends on the nature of the research question, the type of data to be collected and the research context. The two broad categories of research methodologies are qualitative and quantitative research. Qualitative research aims to explore and understand complex social phenomena using subjective data such as interviews, observations and case studies. Quantitative research, on the other hand, uses numerical data and statistical analysis to test hypotheses and establish causality.

3.2 Mixed research methods

3.2.1 Quantitative research methods

Quantitative research methods are a type of research in which numerical data and statistical analysis is used to explore or investigate a particular phenomenon or relationship. They involve a structured approach to data collection, often involving surveys or experiments, and the analysis of data using statistical techniques.

Examples of quantitative research methods include:

Surveys: In surveys, a large number of respondents are asked a series of questions. The results are then analyzed to determine trends, patterns or relationships between variables.

Experiments: Experiments involve manipulating one or more variables and observing the effects on another variable. They are often used to test hypotheses and establish causality.

Statistical analysis: In statistical analysis, mathematical models are used to

analyze data and draw conclusions. These can be descriptive statistics, such as mean, median and mode, or inferential statistics, such as t-tests or regression analysis.

3.2.1.1 Questionnaire survey

1) Analysis of questionnaire data

Table 2 Questionnaire on the use of ceramic utensils in daily life

| Questionnaire on the use of ceramic utensils in daily life | | | | |
|--|----------------------------|---|------------------------------|-----------------------------|
| | | | | Answer : 196 |
| 1. Your age? | | | | |
| A 15~25 years old | B 25~45 years old | C 45~65 years old | D Over 65 years old | |
| 2. Your gender? | | | | |
| A male | B female | | | |
| 3. What is your occupation? | | | | |
| A educator | B Merchant | C Healthcare worker | D Other | |
| 4. How concerned are you about ceramic products? | | | | |
| A very concerned | B more concerned | C is not very concerned | D is never concerned | |
| 5. Do you use ceramic products in your life? | | | | |
| A Use | B Do not use | If you do not use, please terminate the filling of this questionnaire | | |
| 6. What do you think are the applications of ceramic products in daily life? (multiple choice) | | | | |
| A Tableware | B Lamps | C Ornament | D Sanitar y Ware | E Accessories Jewelry |
| F Sculpture | G Other | | | |
| 7. Do you think your current use of ceramic products is healthy? | | | | |
| A very healthy | B moderately healthy | C not very healthy | D unhealt hy | |
| 8. What is the replacement frequency of ceramic products in your home or work? | | | | |
| A 3-6 month | B one year | C Change to | D when it breaks | |

| | | | | |
|--|-----------------------|-----------------|------------------|----------------------|
| | | | other | |
| 9. What are your favorite types of ceramics? | | | | |
| A cup | B Plate | C bowl | D Lamp | E Sculpture Ornament |
| F Vase | G Jewelry Accessories | I Other | | |
| 10. How much do you spend on ceramic products in a year? | | | | |
| A 100 yuan | B 101~500 yuan | C 501~1000 yuan | D other | |
| 11. Which type of ceramic products do you like most? | | | | |
| A cute | B Retro | C Simple | D Private Custom | E other |
| 12. Will you give ceramic products to your friends as gifts? For example, a friend's birthday. | | | | |
| A Yes | B No | C Other | | |

1. What is your age? [Single option]

| Options | Subtotal | Ratio |
|---|------------|--------|
| A 15~25 age | 49 | 25% |
| B 25~45 age | 66 | 33.67% |
| C 45~65 age | 77 | 39.29% |
| D Over 65 | 4 | 2.04% |
| Valid persons to fill in this question | 196 | |

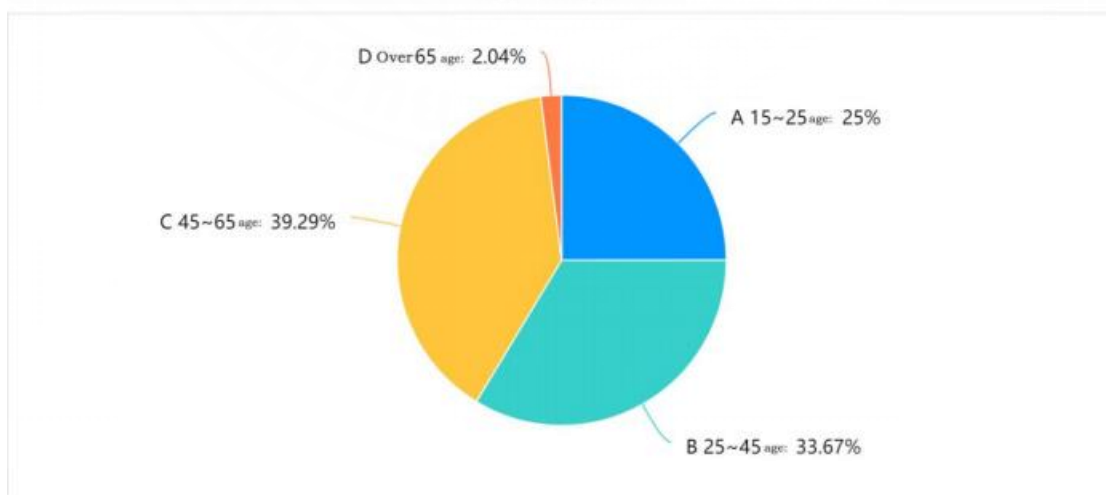


Figure 59 Age distribution of investigators

4. How much do you care about ceramic products [Single option]

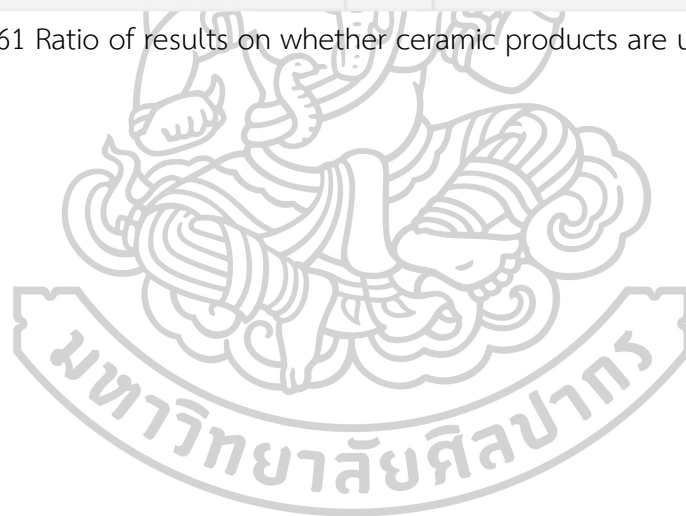
| Options | Subtotal | Ratio |
|---|------------|--------|
| A Very concerned | 31 | 15.82% |
| B More concerned | 70 | 35.71% |
| C Not very concerned | 84 | 42.86% |
| D Never pays attention | 11 | 5.61% |
| Valid persons to fill in this question | 196 | |

Figure 60 Concerns about ceramic products ratio

5. Do you use ceramic products in your life? [Single option]

| Options | Subtotal | Ratio |
|---|------------|--------|
| A Use | 190 | 96.94% |
| B Do not use <small>If not, please terminate the filling of this questionnaire</small> | 6 | 3.06% |
| Valid persons to fill in this question | 196 | |

Figure 61 Ratio of results on whether ceramic products are used in daily life



6. What do you think are the applications of ceramic products in life? (Multiple option)

| Options | Subtotal | Ratio |
|---|------------|--------|
| A Tableware | 189 | 96.43% |
| B Luminaires | 94 | 47.96% |
| C Pendant | 157 | 80.1% |
| D Sanitary ware | 143 | 72.96% |
| E accessory jewelry | 81 | 41.33% |
| F Sculpture | 96 | 48.98% |
| G Others | 24 | 12.24% |
| Valid persons to fill in this question | 196 | |

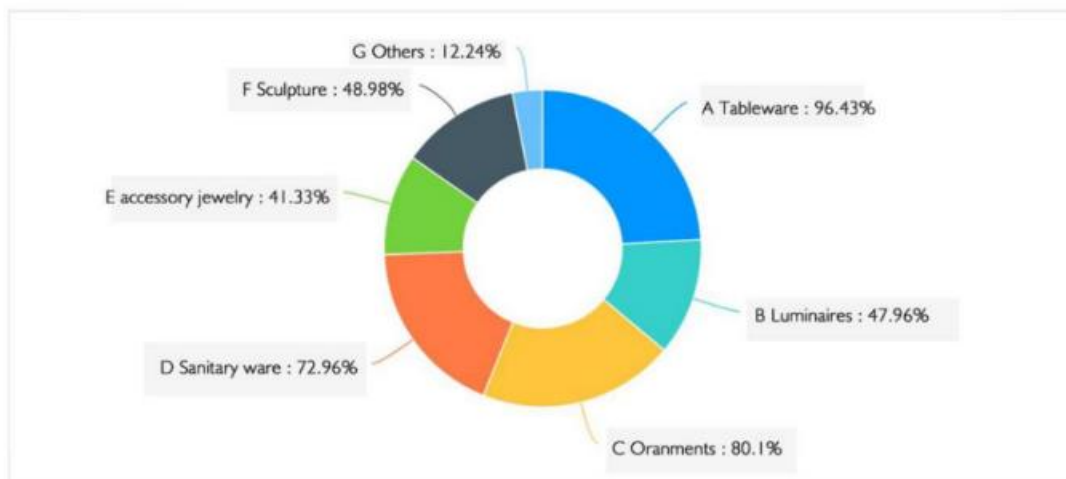


Figure 62 Categories of ceramic products for daily-used

8. What is the replacement frequency of ceramic products in your family or work? [Single option]

| Options | Subtotal | Ratio |
|---|------------|--------|
| A 3-6 month | 8 | 4.08% |
| B One year | 23 | 11.73% |
| C Is not replaced until it is broken | 161 | 82.14% |
| D Others | 4 | 2.04% |
| Valid persons to fill in this question | 196 | |

Figure 63 Frequency of replacement of ceramic products

9. What are your favorite ceramic categories? (Multiple option)

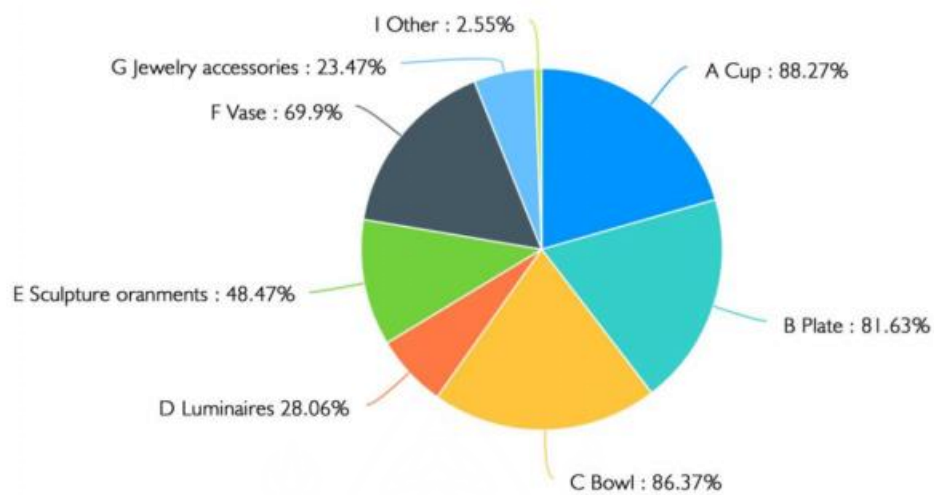


Figure 64 Categories of investigators favorite ceramic types

10. How much will you spend on ceramic products in a year? [Single option]

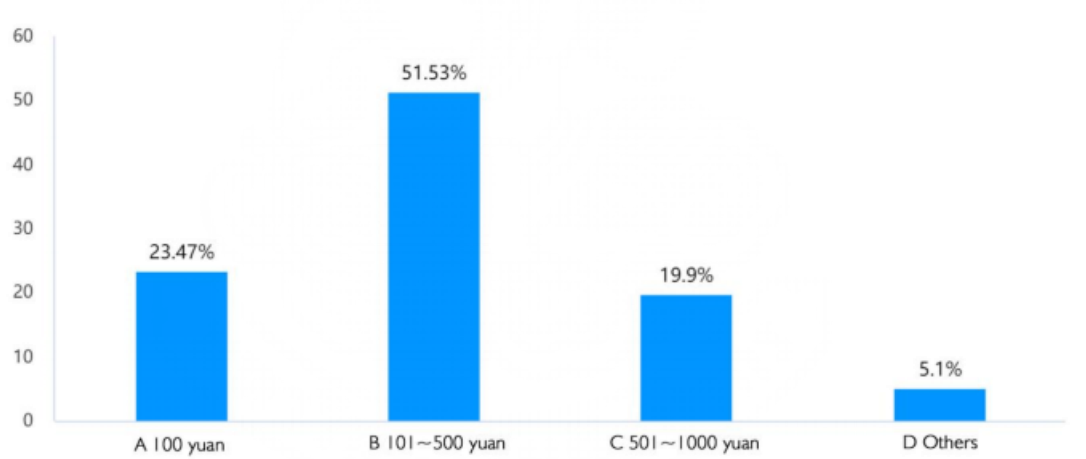


Figure 65 Investigators' annual spending on ceramic products

2) Analysis of spass results

Table 3 Validity analysis Commonality

| Projects | Factor 1 | Factor 2 | Factor 3 | Common degree |
|---|----------|----------|----------|---------------|
| First. Your age? | -0.79 | 0.06 | -0.21 | 0.671 |
| Second, your gender? | 0.30 | 0.21 | -0.49 | 0.372 |
| Third. What is your occupation? | 0.37 | 0.42 | -0.01 | 0.316 |
| Fourth, how much attention you pay to ceramic products? | 0.57 | 0.38 | -0.09 | 0.483 |
| Fifth. Do you use ceramic products in your life? | 0.17 | 0.27 | 0.48 | 0.335 |

| | | | | | | | |
|--|------|------|---------|------|-------|-------|---|
| I. Your age? | 2.18 | 0.83 | 1 | | | | |
| Fifth. Do you use ceramic products in your life? | 1.03 | 0.17 | -0.18* | 1 | | | |
| Ten, in a year, how much money you will spend on ceramic products? | 2.07 | 0.80 | 0.34** | 0.06 | 1 | | |
| Third. What is your occupation | 3.16 | 1.19 | -0.25** | 0.13 | -0.05 | 1 | |
| Eleven, which type of ceramic products you like best | 2.62 | 0.92 | -0.00 | 0.11 | 0.12 | -0.02 | 1 |
| * p<0.05 ** p<0.01 | | | | | | | |

Table 6 Regression analysis

| Projects | Regression coefficient | t-value | p-value | VIF |
|---|------------------------|---------|---------|------|
| Constants | 2.29 | 5.60 | 0.000** | - |
| I. Your age? | -0.22 | -3.11 | 0.002** | 1.13 |
| Second, your gender? | 0.06 | 0.54 | 0.590 | 1.06 |
| Eight, your home or work in the frequency of replacement of ceramic products is? | 0.15 | 1.35 | 0.177 | 1.06 |
| Ten, in a year, how much money you will spend on ceramic products? | -0.15 | -2.05 | 0.042* | 1.19 |
| Eleven, you will give ceramic products as a gift to your friends? For example, a friend's birthday. | 0.32 | 2.62 | 0.010** | 1.08 |
| Sample size | 196 | | | |
| R ² | 0.144 | | | |
| Adjustment R ² | 0.122 | | | |
| F | F(5,190)=6.415,p=0.000 | | | |
| * p<0.05 ** p<0.01 | | | | |

Table 7 Analysis of variance

| Options | Sample size | Average value | Standard deviation |
|--|-------------|---------------|--------------------|
| Use | 190 | 1.18 | 0.44 |
| Not used If not used, please stop filling out this questionnaire | 6 | 1.67 | 1.03 |
| F | 6.507 | | |
| p | 0.012 | | |

3.2.2 Practice-oriented research methods

Practice-oriented research methods are research approaches that focus on addressing practical challenges, problems or needs in real-world contexts. These methods aim to generate knowledge and insights that can be directly applied to improve practices, processes or outcomes in different areas.

Case Studies: In case studies, a specific case or situation is examined in depth. Researchers collect detailed data through a variety of methods, such as interviews, observations and document analysis. The focus is on understanding the complexity and nuances of the case. The results can provide valuable insights and lessons that can be applied to similar situations.

Design-Based Research: Design-based research combines research and design activities to develop and test innovative solutions or interventions in the real world. It is an iterative cycle of design, implementation and evaluation of interventions that focus on improving practice or solving specific problems. The findings contribute to both theoretical understanding and practical application.

Participatory Research: Participatory research involves actively engaging and collaborating with stakeholders or participants who are directly affected by the research topic. It aims to include their perspectives, knowledge and experiences in the research process. Participatory methods such as focus groups, workshops or community consultations are used to collect data and involve stakeholders in decision making and problem solving.

These practice-oriented research methods emphasize collaboration with stakeholders, participation, and focus on generating actionable knowledge. They

bridge the gap between research and practice with the goal of improving real-world situations and informing evidence-based decision making.

3.3 The criterion of selection of the samples

3.3.1 Manufacturers and scattered craftsmen

The first part is the manufacturers and scattered artisans involved in the production of traditional ceramic utensils; the factory is the place where one can best observe the development of ceramic utensils. The interviews and data collection provided a good picture of the order details of ceramic utensils. It is extremely useful to know which types of ceramics have the most orders, which types of ceramics have long production cycles and how long it takes for the products to be replaced.

3.3.2 Educators and students

The second part are the educators and students who work in this subject. The educators keep the "traffic code" for the subject, they make the basics known to the students and guide the creation. We must admit that the creativity of the students is always endless and unpredictable.

3.4 Data collection methods

1) In-depth interviews were conducted with the first group of producers and craftsmen. The aim is to find answers to the questions posed by the authors of this work. The interviews are conducted with the artisans and simultaneously recorded on video; the entire process of making ceramic wares by the artisans is superimposed.

2) Questionnaires, photographs, video recordings and group discussions are used

to collect information and data from educators and students. Communicate with educators in advance to agree on course content, record students' lessons and document the completion of their drafts after class.

3) The third group used data collection in the form of a questionnaire posted on the web.

3.5 Data analysis

1) For the first group of producers and artisans I interview, I obtained data on the factory's orders between four years, from 2018 to 2022, by product type of ceramic ware, which allowed me to deduce the production of the same product over a period of four years, represented in a bar chart and labeled with a growth curve.

2) For the second group of educators-student combinations, I organized and analyzed the data in the form of tables and pictures.

3.6 Design process

3.6.1 The first phase (1st phase) exploration

3.6.1.1 Experiments of combining ceramics with other materials

1) Ceramics combined with metallic materials

Excellent heat resistance can be used as a high-temperature insulation material. Studies have shown that metal containers must not be used in the microwave oven, otherwise the heating time will be affected, the microwaves will come into contact with metal sparks, which is dangerous, and in severe cases the magnetron will be damaged. Stainless steel placed in the microwave oven will not explode, but will produce electric sparks because microwaves placed in stainless steel dishes cannot penetrate the stainless steel, are transmitted to the stainless

steel and reflected back, resulting in electric sparks and reflected microwaves, both of which damage the oven housing and cannot heat food.

2) Ceramics combined with glass material

For glass products: It has been shown that some can and some cannot. Borosilicate glass, microcrystalline glass, crystalline glass made of titanium oxide, which is made of utensils, is suitable for long-term use in microwave ovens because of its good microwave permeability, physical and chemical stability, and high temperature resistance (up to 500 degrees Celsius or even 1000 degrees Celsius). Ordinary glass from glass cups, milk bottles, nursing bottles that are heated for a long time can easily break. Cut glass, reinforced glass, crystal glass products, due to the uneven thickness of the material, explode when cooking oily food, not suitable for use in the microwave oven.

3) Ceramics combined with wood material

Wood, paper, and other utensils: When wet, these utensils can be used in the microwave oven for a short time. However, if the time is too long, drying the utensils will result in severe burning. Painted utensils of this type are prohibited in the microwave oven, as the paint contains benzene, which is released when heated in the microwave and contaminates the food.

4) Ceramics combined with plastic material

Polypropylene, polypropylene resin, polypropylene composite, polysulfone and other materials of various types of utensils, temperature resistance up to 120 degrees Celsius or more, can be used for microwave heating. Cling film also belongs to plastic products: one kind of ordinary cling film can be used for heating vegetables; another kind of cling film for microwave oven can be used for heating meat, poultry and sugar. Heat-resistant polyethylene, styrene, phenol, dense amine and other utensils should not be used in the microwave oven, because these materials are and receive microwaves, when heated, they will melt, some also emit toxins and odors that are harmful to human health. At the same time, ordinary plastic containers should also not be used in the microwave oven: For one thing, hot food deforms the plastic containers, and for another, ordinary plastics release toxic

substances that are harmful to human health. Use special microwave-safe dishes to heat food in the microwave oven.

5) Summary

Therefore, the current market on the main materials in the production of tableware through a longitudinal comparison analysis, ceramic utensils in terms of quality, environmental protection, safety and other aspects still have a certain degree of advantage and other materials cannot be replaced, the production and sales of ceramic utensils from a certain point of view, is still not threatened and has great potential for development.

3.6.1.2 Experiment on firing temperature

Different clays with different firing temperatures will appear in different colors, so the experiment of firing temperature is particularly important.

1) Medium temperature electric kiln

Temperature test: 1150-1250

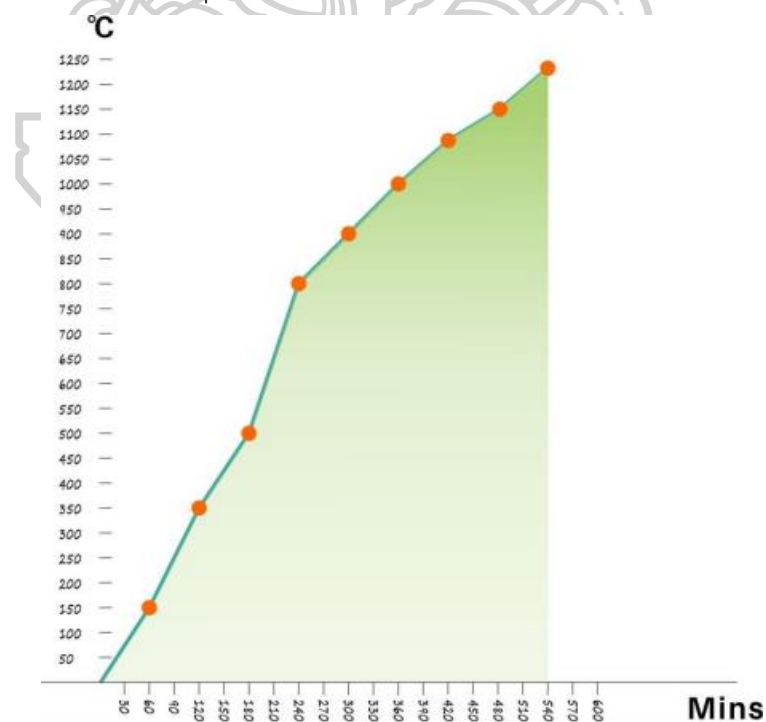


Figure 66 Medium temperature electric kiln firing temperature graph

Table 8 Medium temperature electric kiln Firing Progress

| Mins | Degree | Firing Progress |
|------|-----------|---|
| 60 | 50-150 | Drying temperature section |
| 120 | 150-350 | Preliminary drainage evaporation temperature section |
| 180 | 350-500 | The temperature range of removing large water molecules 400 degrees is the point where the body is easy to fry |
| 240 | 500-800 | Exclusion of crystalline water temperature section, because the exclusion of water will lead to the molecular structure of tight overall size reduction |
| 300 | 800-900 | Organic matter oxidation and loss of temperature |
| 360 | 900-1000 | Organic oxidation and loss of temperature |
| 420 | 1000-1080 | Temperature range for the beginning of sintering |
| 480 | 1080-1150 | The temperature at which the glaze begins to melt, and the crystals begin to react |
| 540 | 1150-1230 | Temperature range for crystallization reaction of glaze and kiln reaction of high-temperature chemistry |

2) High-temperature electric kiln

Temperature test: a 1280

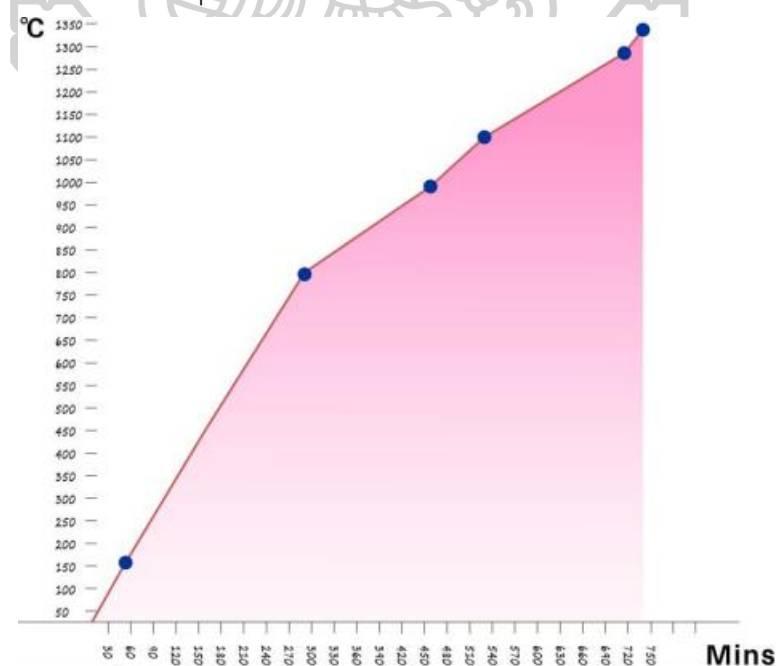


Figure 67 High-temperature electric kiln firing temperature graph

Table 9 High-temperature electric kiln Firing Progress

| Mins | Degree | Firing Progress |
|------|-----------|--|
| 45 | 0-150 | Ignition of the two innermost guns to adjust the upper half of the flame to yellow and the lower half to blue. |
| 165 | 150-450 | Start to close the kiln door, light half of the guns, and let the temperature rise steadily to 450 degrees, air pressure 0.002, chimney gate half open. |
| 285 | 450-800 | Ignite all the guns in the kiln, turn the flame to blue, and open the chimney gate 1/3 of the way to a pressure of 0.015. This process will increase the temperature to 800 degrees for 120 minutes. |
| 465 | 800-980 | This stage is the key oxidation temperature during 800-980 degree Celsius, and the temperature increase rate is one degree per minute. |
| 525 | 980-1100 | This stage is 980-1100 degrees began to weakly restore the gate plate closed 2 / 3 upper fire hole blocked air pressure to 0.02-0.05 observe the lower fire hole fire control in 6 cm length adjust the gate control. |
| 705 | 1100-1280 | This stage is 1100-1280 degrees strong reduction stage, the gate closed 3/4 lower fire hole fire control within 8 cm length, the speed of heating up to slow more than 1 minute 1 degree, the slower the effect of the fuller. |
| 755 | 1280-1330 | Fire 1330 degrees need to extend this time heating speed control at one degree per minute |

3.6.1.3 Experiment on ceramic glaze

This is a test piece with a glaze color from the blue series. The researcher experimented with the blue glaze and found that the glaze produced different effects depending on its placement in the kiln and the kiln temperature. The glaze has a more even color development. The temperature setting is appropriate.

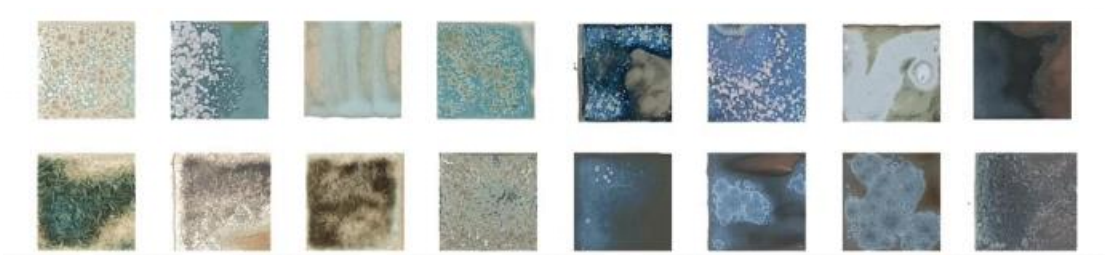


Figure 68 Blue glaze test

The red series of the glaze has always been a difficult process during firing. The color development is more laborious than expected. There are more trial firings during the experiment, and the color development tends to be stable in the later stage.

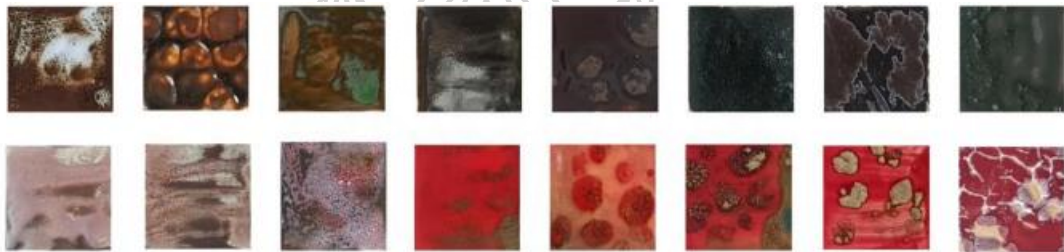


Figure 69 Red glaze test

The firing process for this type of glaze is smoother. Basically, all these products meet expectations. There are no special requirements in regarding the firing temperature and the kiln position.



Figure 70 General glaze

3.6.1.4 Experiment on ceramic under-glaze pigment



Figure 71 Under-glaze pigment

3.6.1.5 Experimental data recording

Table 10 Under-glaze pigment experimental





Figure 72 Pigment test



Figure 73 Pigment test 2

Table 11 Pigment experimental data

| Name | Color pigment (g) | Paper clay (ml) | Ratio |
|--------------|----------------------|-----------------|-------|
| Test piece 1 | Sunflower yellow 10g | 100ml | 1: 10 |

| | | | |
|---------------|------------------------------------|-------|--------|
| Test piece 2 | Red 10g | 100ml | 1: 10 |
| Test piece 3 | Vanadium zirconium blue 10g | 100ml | 1: 10 |
| Test piece 4 | Chrome titanium yellow 10g | 100ml | 1: 10 |
| Test piece 5 | Lilac purple 10g | 100ml | 1: 10 |
| Test piece 6 | Light brown 10g | 100ml | 1: 10 |
| Test piece 7 | Chrome aluminum green 10g | 100ml | 1: 10 |
| Test piece 8 | Deep yellow 10g | 100ml | 1: 10 |
| Test piece 9 | Orchid 10g | 100ml | 1: 10 |
| Test piece 10 | Orchid 5g | 100ml | 0.5:10 |
| Test piece 11 | Deep yellow 5g | 100ml | 0.5:10 |
| Test piece 12 | Lilac purple 5g | 100ml | 0.5:10 |
| Test piece 13 | Light brown 5g | 100ml | 0.5:10 |
| Test piece 14 | Sunflower yellow 5g | 100ml | 0.5:10 |
| Test piece 15 | Vanadium zirconium blue 5g | 100ml | 0.5:10 |
| Test piece 16 | Red 5g | 100ml | 0.5:10 |
| Test piece 17 | Chrome titanium yellow 5g | 100ml | 0.5:10 |
| Test piece 18 | Chrome aluminum green 5g | 100ml | 0.5:10 |
| Test piece 19 | Light brown 5g+Sunflower yellow 3g | 100ml | 0.8:10 |
| Test piece 20 | Lilac purple 5g+Orchid 5g | 100ml | 1:10 |

3.6.2 Phase II (Stage 2) Inspiration and conception

Inspiration and conception are the initial stage of a design study in which all ideas and concepts are developed and refined. This phase is crucial as it lays the foundation for the project and influences the direction and outcome of the work presented. In this phase, it is critical to define the purpose and goals. Clearly define the purpose and goals of the design work. Understanding the problem and need that the actual research is targeting will give you a clear focus and direction for the design. Encourage the free flow of ideas without judging or restricting.

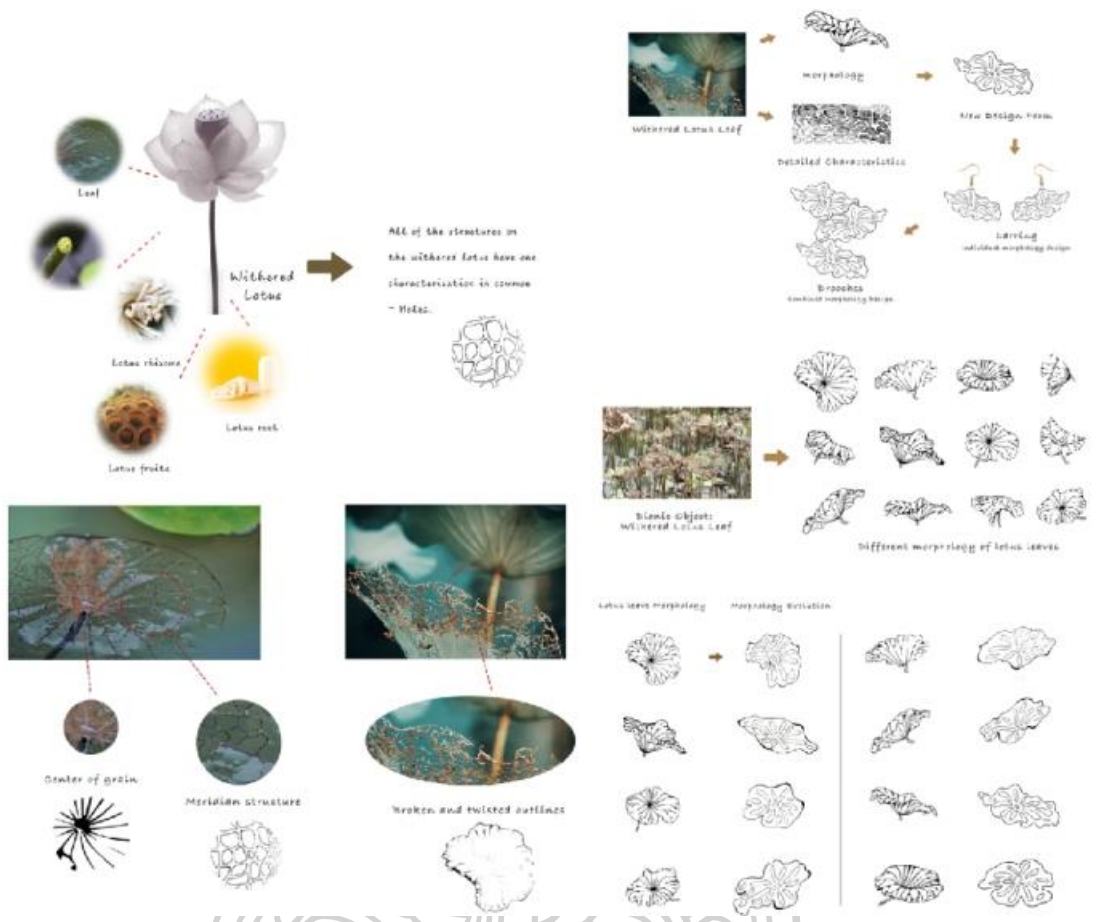


Figure 74 Previous Design 1 Concept



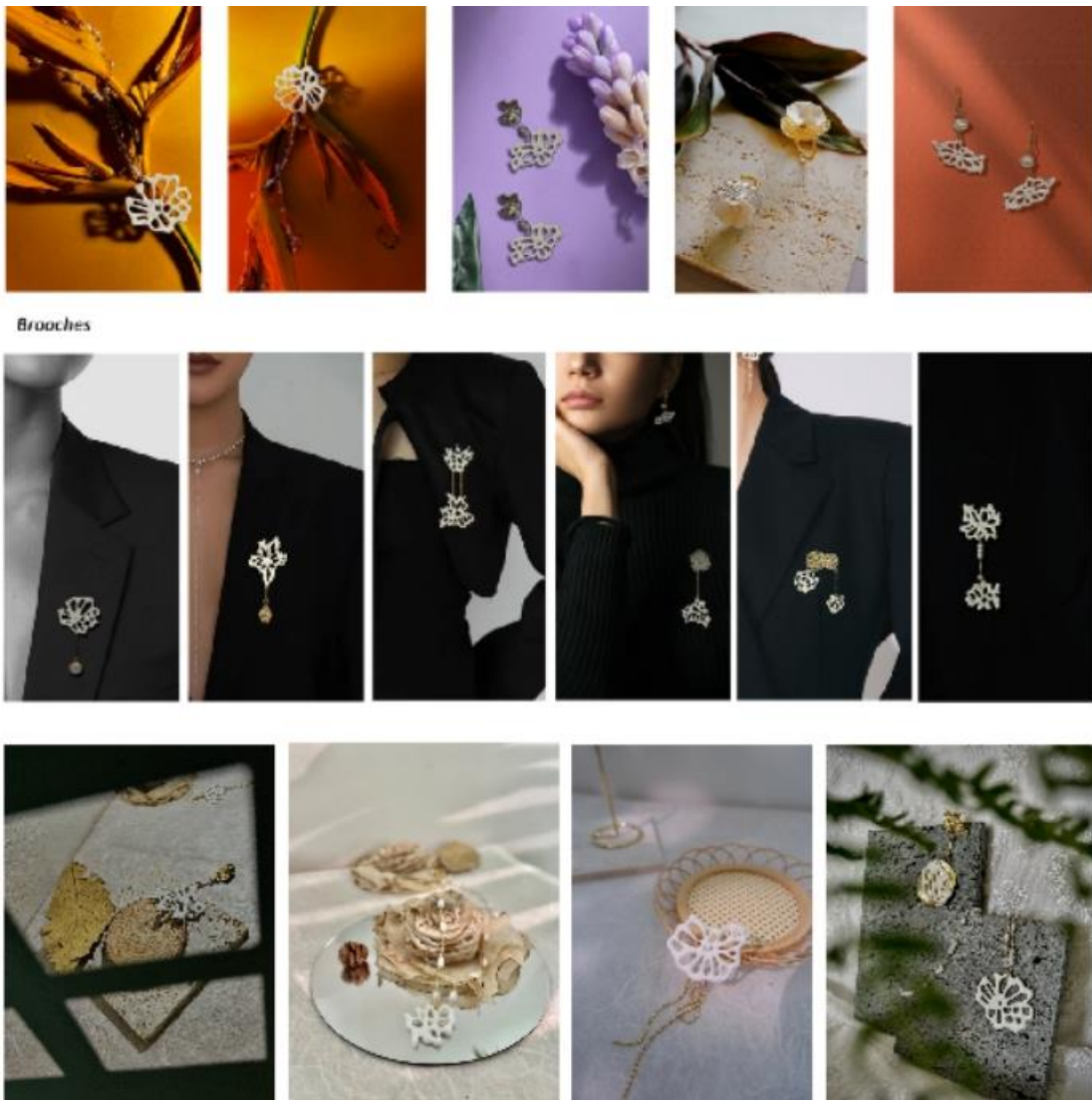


Figure 75 Previous Design 1 outcomes

Explore different perspectives, possibilities, and approaches. This phase is more about quantity than quality, as it allows you to develop a wide variety of ideas. Review the ideas developed in the previous phase. Consider factors such as feasibility, viability, impact, and alignment with project goals. Identify the most promising ideas and discard those that are not feasible or relevant. Refine the selected ideas to make them more concrete and feasible.

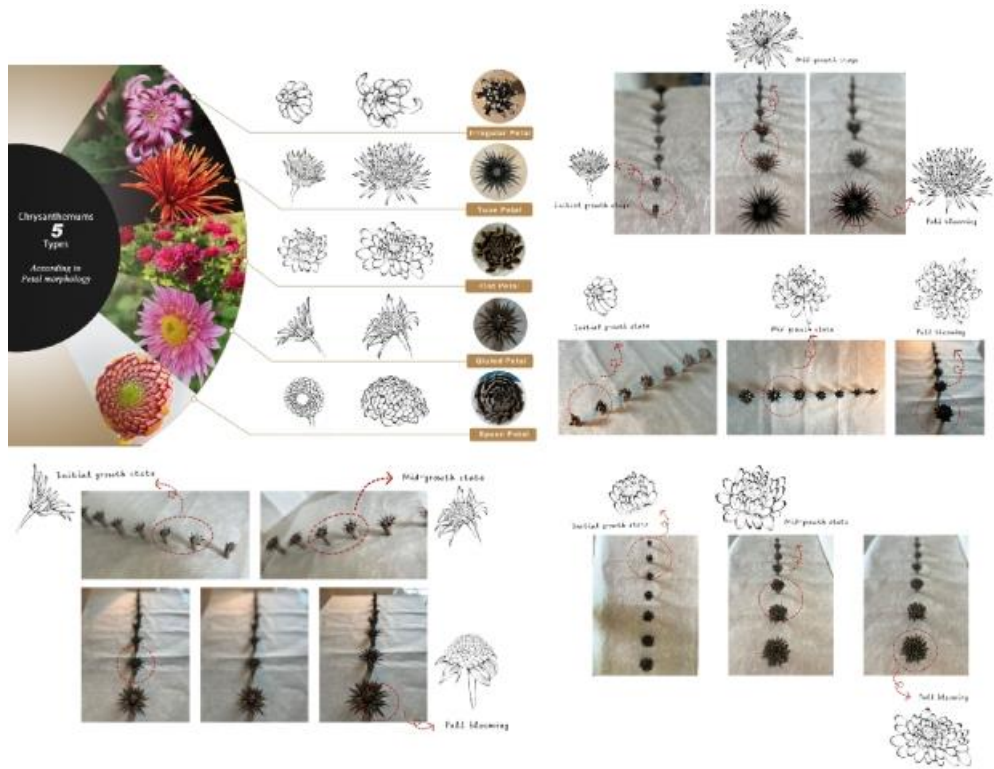


Figure 76 Previous Design 2 Concept



Figure 77 Previous Design 2 outcomes



Figure 78 Previous Design 3 Concept



Figure 79 Previous Design 3 outcomes

To visualize and test your ideas, you need to design, sketching, or model a concept. This can be done through paper sketches, digital mockups, or low-fidelity

prototypes. These visual representations will help you to further communicate and refine your ideas.

3.6.3 Phase III (Stage 3) Implementation Phase

The implementation phase is a critical stage of research in which the planned design solution is put into practice. It involves executing the research plan, providing, and thinking about solutions, and moving from the conceptualization phase to the execution of the creation phase. A research direction and research plan must be developed that provides a clear and practical research direction that outlines the specific tasks to be addressed by the research, the timeline for implementation and the resources available. The research should also take in account factors such as repetitive situations.

3.7 Summary of this chapter

- 1) To complete the induction and sorting of the plant bionic device type, and summarize its cultural connotation, expression form of expression and its artistic characteristics in different periods. (in chapter 1)
- 2) Literature reviews to explore the morphology of bionics plants that can be used for contemporary ceramic decoration. (in chapter 2 and 3)
- 3) To experiment with the design of selected the morphological bionic plants for contemporary ceramic decoration design. (in chapter 3)
- 4) To demonstrate a new design that breaks with people's ideas of traditional ceramic decoration. Based on people's lifestyles today, the application of bionic design of ceramic decoration form has shortened the distance between people and ceramic art. (in chapter 4)

Chapter 4 Design Implementation and Reflection

In this chapter, the results are applied to the design based on the experiments and studies in the first three chapters. These findings are derived from the questionnaire survey, the compilation and analysis of the literature, the experimental results, and the feasibility analysis conducted previously. In this chapter, the problem to be solved and the goal to be achieved are clearly stated.

Create a detailed design by planning the implementation process based on the research goals and directions. This includes architecture diagrams, flowcharts, wireframes or mockups. Consider factors such as usability, scalability, etc. in the design phase. Implement the design by using appropriate tools and techniques, whether hand-drawn or computer graphics software. Summarize all the results and think about the problems encountered during the process and the things that can be improved.

4.1 Design Rationale

Biomimicry can be a rich source of inspiration for artists and designers, leading to the creation of unique and innovative works of art. By observing and studying the patterns, colors, textures and forms of plants, artists can incorporate these elements into their work, resulting in esthetically pleasing and conceptually meaningful pieces. Here are some ways in which bio-mimicry can influence art and design.

4.1.1 Form and Structure

Plants offer an incredible variety of different and intricate forms and

structures. Artists can be inspired by the shapes of plants, e.g., the patterns of trees or leaves. These organic structures can be incorporated into sculptures, installations or even functional objects such as furniture to create visually stunning and harmonious designs.

4.1.2 Conceptual Exploration

Biomimicry can also inspire artists to explore deeper conceptual themes. Artists can explore themes such as sustainability, adaptation, interconnectedness and ecological balance, and reflect on our relationship with the natural world. By using biomimicry as a starting point, artists can raise awareness and engage viewers in a thought-provoking dialog about our place in the environment.

4.1.3 Interactive and Kinetic Art

The dynamic and interactive properties of plants can inspire artists to create artworks that respond to their environment or interact with the audience. Artists can incorporate biomimetic principles into interactive installations, kinetic sculptures or immersive experiences that convey the feeling of being in nature and emphasize the beauty and complexity of natural processes.

Biomimicry offers artists and designers a multitude of opportunities for creative exploration. By observing, learning and integrating the principles of nature, artists can create works of art that not only engage the senses, but also inspire a deeper connection and appreciation for the natural world.

4.2 Design Inspiration

In the ancient book "The Book of Rites" it is recorded that "in the autumn month the chrysanthemums have yellow flowers". The chrysanthemum is a popular decorative theme that has been used in various fields over the centuries and is therefore the subject of research in many disciplines. In the second chapter of the literature review of the data organization, it was found that the chrysanthemum theme is widely used in ceramic design, cut and life are closely related. In traditional Chinese culture, the chrysanthemum occupies an important position as a cultural symbol. The decorative meaning of the chrysanthemum emphasizes the pursuit of a natural and calm state of mind. The decorative meaning of the chrysanthemum began to embody the symbolism of people's pursuit of a happy life. At the same time, the chrysanthemum is one of the ten most famous flowers in China. In the course of nature's development and human's cultivation, the categories of chrysanthemums have reached more than 3,000 species.

The design is inspired by the different types of chrysanthemums that open in patches in a lively way. The researcher has translated the forms of the chrysanthemum into ceramic. The imitation of the chrysanthemums is made using the traditional squeezing technique.

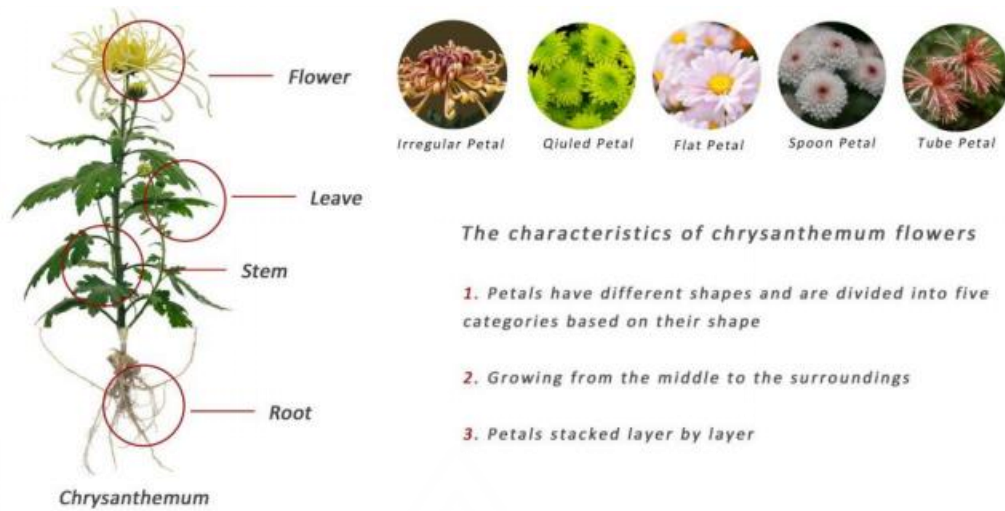


Figure 80 The characteristics of chrysanthemum

4.2.1 Design plan A

4.2.1.1 Design thinking:

Designed by combining the three elements of a plant: root, stem, and flower. Symbolizes the meaning of growth. Plants grow upwards, surrounded by a warm environment. The semicircle stands for the shape of the packaging, the lush root system for a good state of growth.

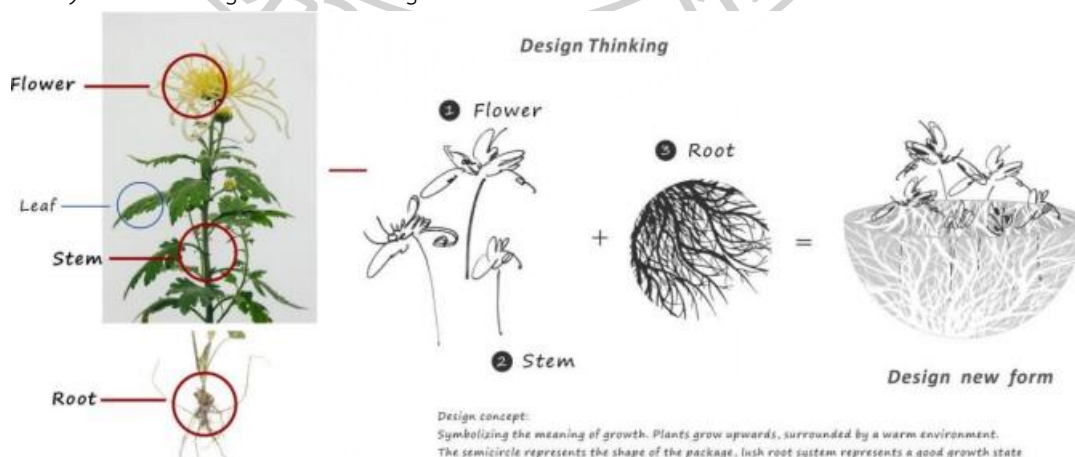


Figure 81 Design A sketch

This is the effect of the previous experimental section. I have created

a style that is more in line with the root morphology based on the growth morphology of the rhizome. At the same time, it will also take on a certain thickness to achieve a solid state as a whole. HOLLOWED OUT AREAS CAN HAVE DIFFERENT LIGHT AND SHADOW EFFECTS NO MATTER WHAT ANGLE THEY ARE LIT FROM.

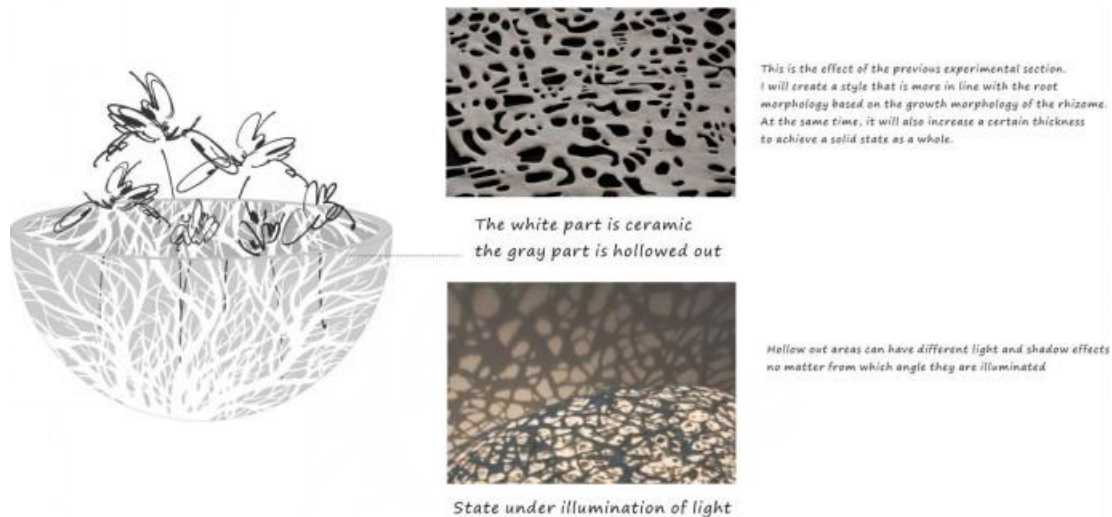


Figure 82 Textural representation

I will present the final effect of the work with a combination of ceramic and iron. The stems of the plants are replaced by wire and the flowers are made by pinching. The colors are black, white, and gold.



Figure 83 Conceptualization of the effect of each part

4.2.1.2 Design plan A Making Process

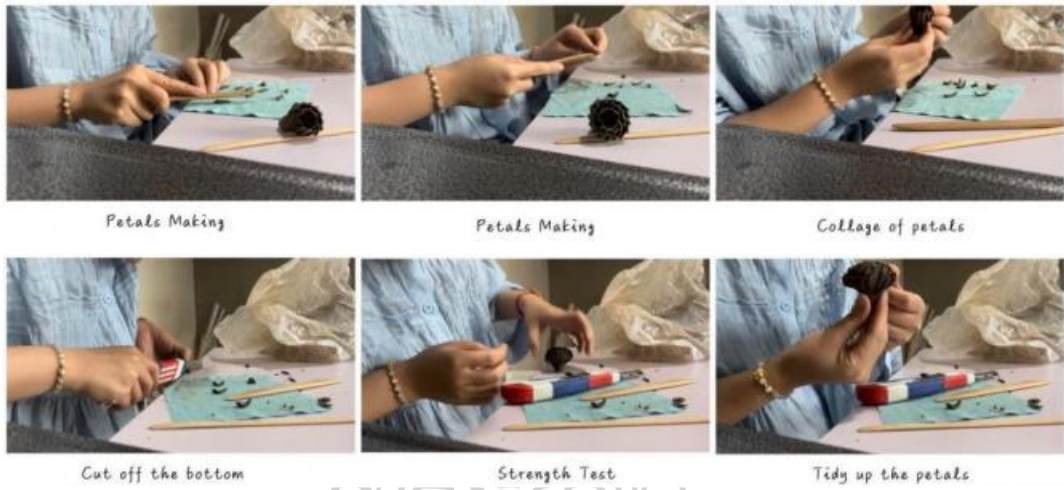


Figure 84 Ceramic pinch making process

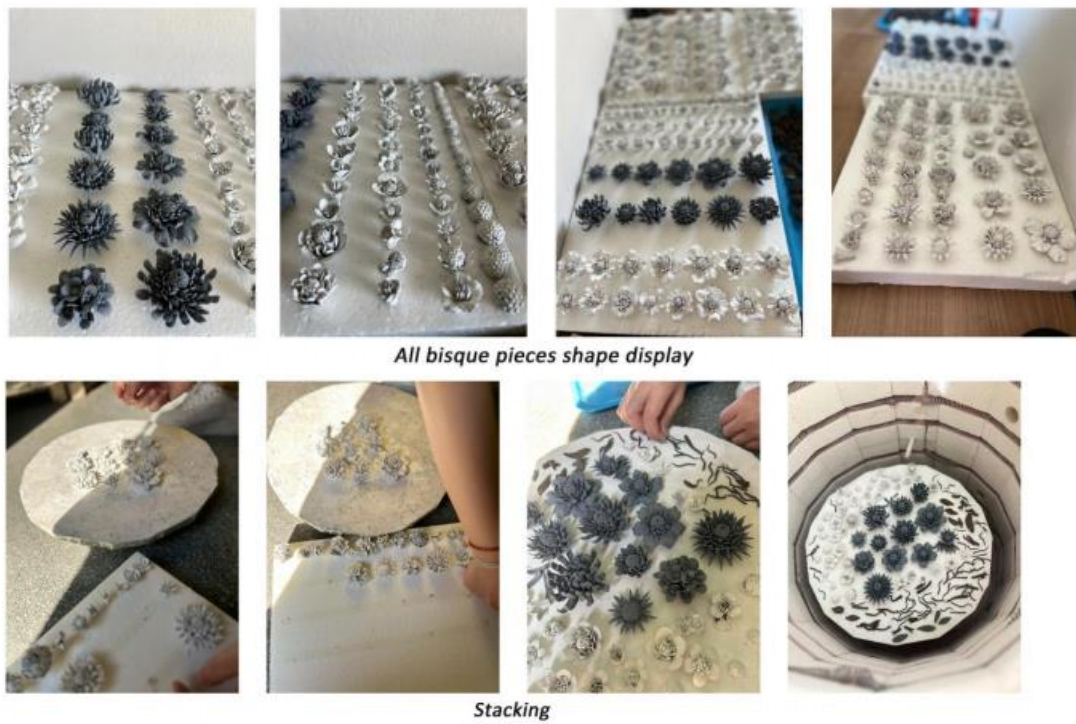


Figure 85 Ceramic part firing



Figure 86 Part of root effect display

Ceramic Handmade pinching flowers are difficult to make and require full mastery of the characteristics of the clay, molding, pattern making, and splicing at the right time.

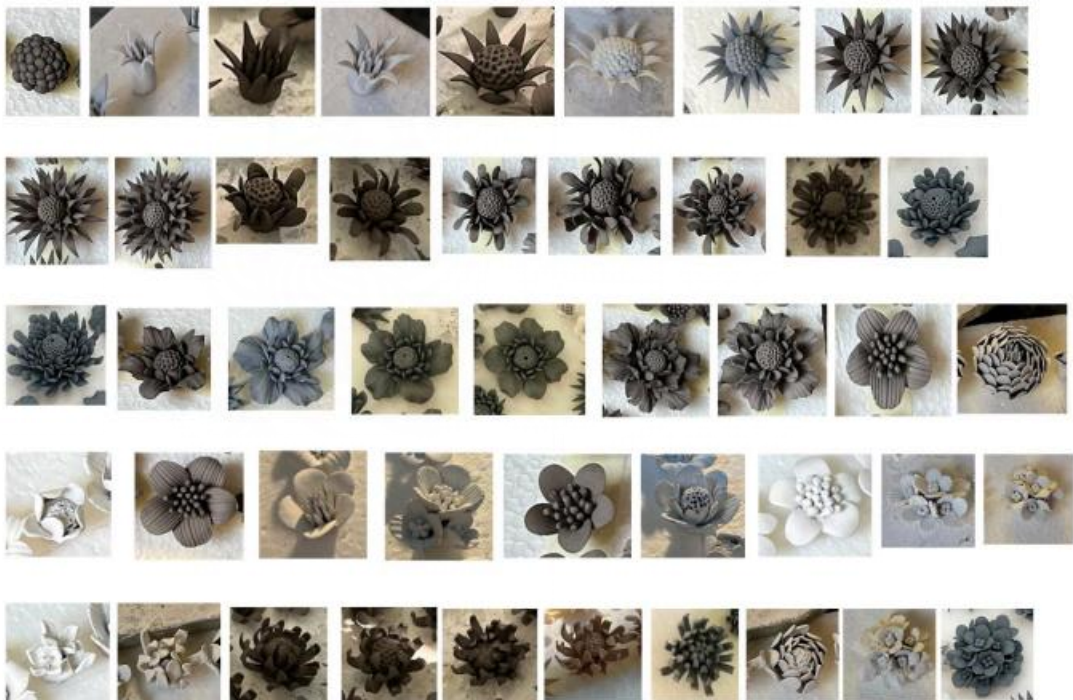


Figure 87 50 different shapes of chrysanthemums

A researcher tries to produce 50 different shapes of chrysanthemum. Each chrysanthemum consists of 20-80 handmade clay petals, with different sizes requiring different numbers of petals.

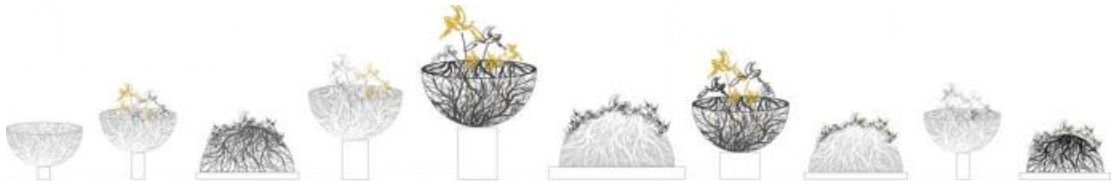


Figure 88 Overall effect display

4.2.1.3 Dimension of the work

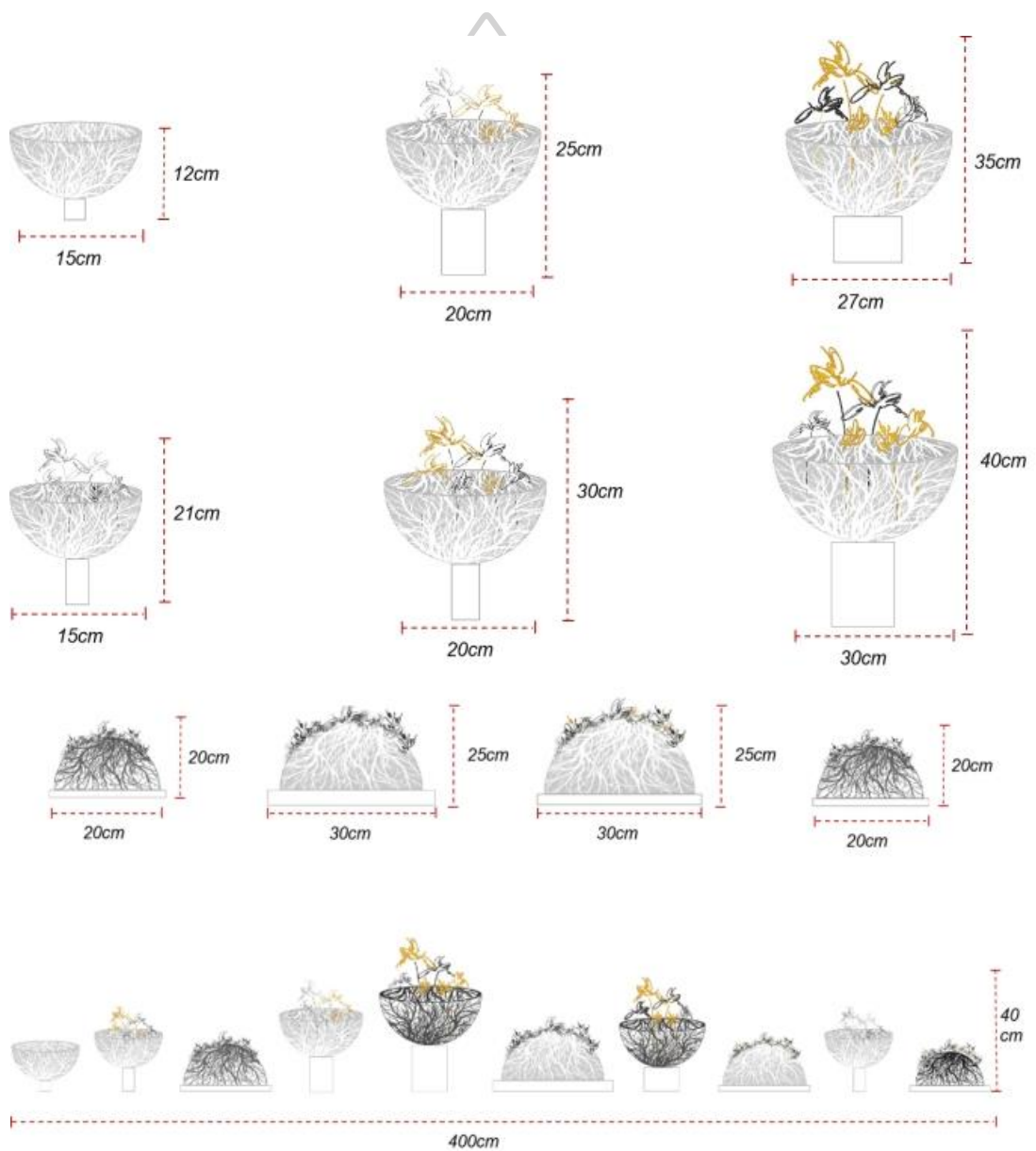


Figure 89 Dimension of the whole works

4.2.1.4 Acrylic accessories production

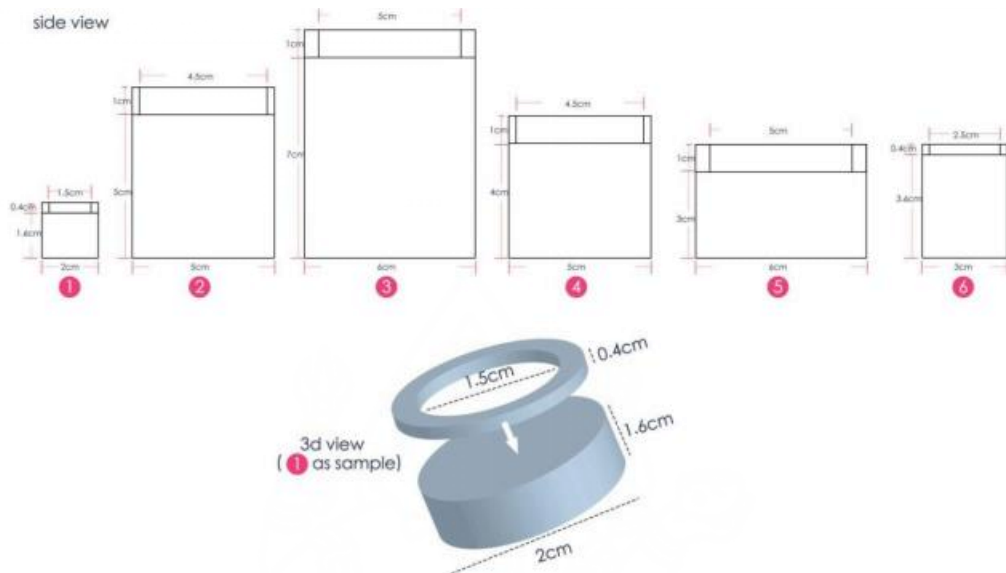


Figure 90 Acrylic accessory rendering



Figure 91 Acrylic making

After the preliminary tests, the electric kiln is stable, so the bisque is

fired before coloring. After firing, the blanks exhibit a certain degree of hardness and water absorption to ensure safety for the subsequent production process.

4.2.2 Design plan B

4.2.2.1 Design concept:

The exquisite porcelain shape of the Song Dynasty is restored and combined with pinched ceramic chrysanthemums. Other materials such as iron wire and wood are used to combine them and get a new design. The overall layout and trend of the flowers, the use of the design concept of the Ikebanna and the combination of the base to show the sense of the power of ceramics.

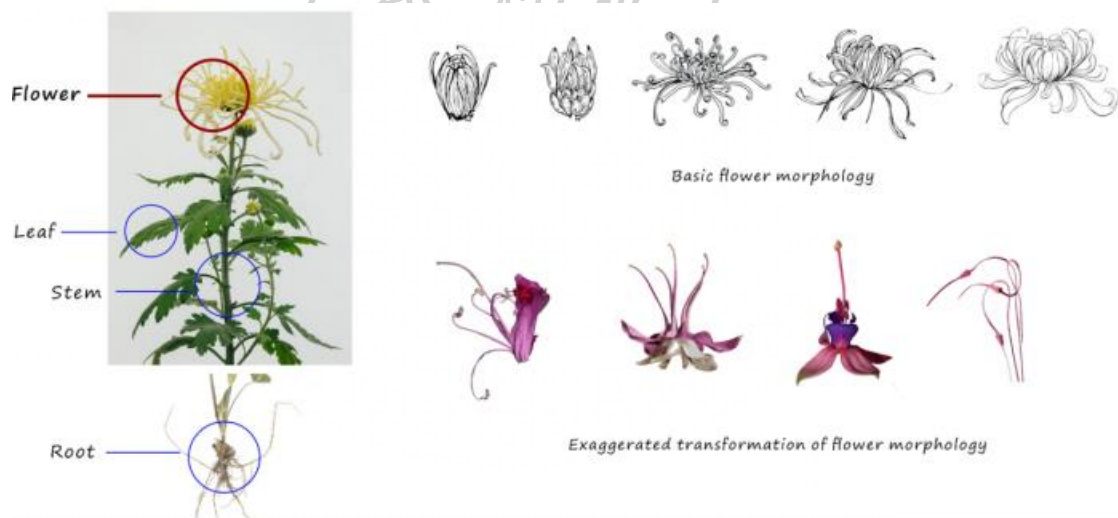


Figure 92 Plan B design thinking 1



Figure 93 Plan B design thinking 2

The basic idea behind all Ikebana artworks is the harmony and unity of "heaven, earth and man", a natural and philosophical concept that is peculiar to the Orient. Ikebana can reflect the inner world of its creator. When you are in a good mood, the floral arrangement you make looks full of positive energy (Yuji Ueno , 2022).

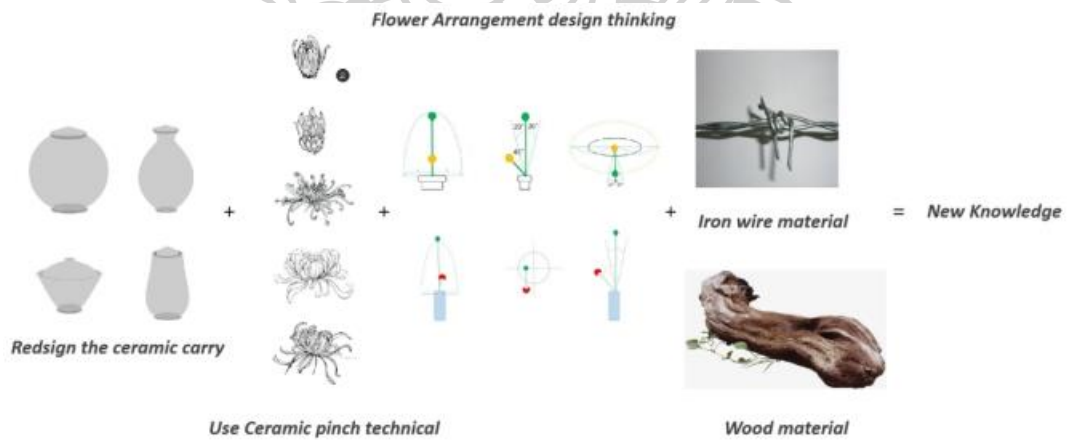


Figure 94 Design concept

4.2.2.2 Stylistic analysis of Ikebana:

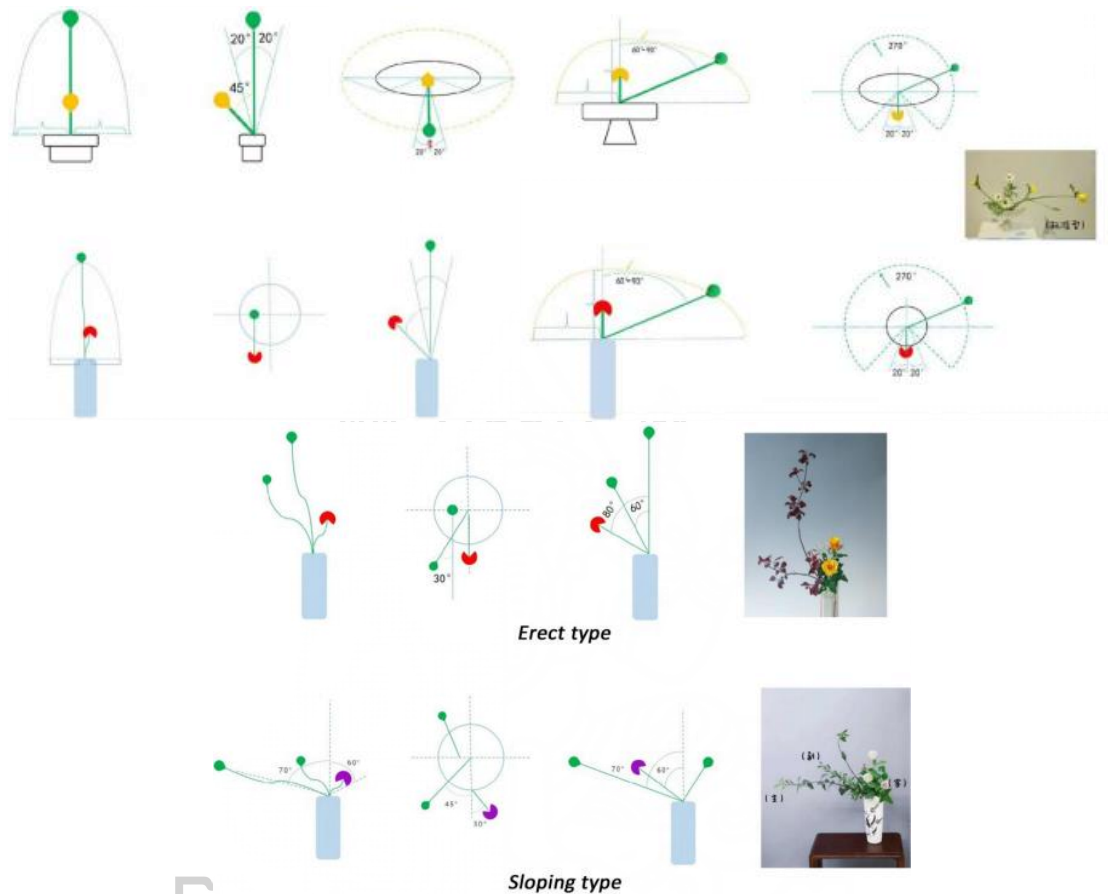


Figure 95 Stylistic analysis

Diane Norman is an expert in the Ohara School, known for her modern interpretation of traditional styles. Michelle Cornell has a background in art history. Together they have written a book that brings ikebana into the twenty-first century, explaining how its sculptural qualities and calm creative techniques fit perfectly into today's interiors and are an ideal antidote to the stresses of modern life (Diane, N, & Michelle, C, 2007).

4.2.2.3 Design plan B Making Process



Figure 96 Plan B ceramic part making process



Figure 97 Plan B flower part making process

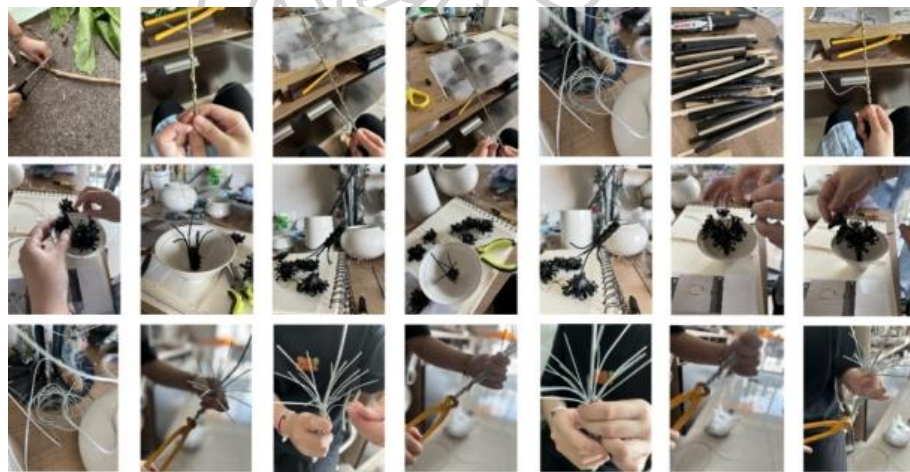


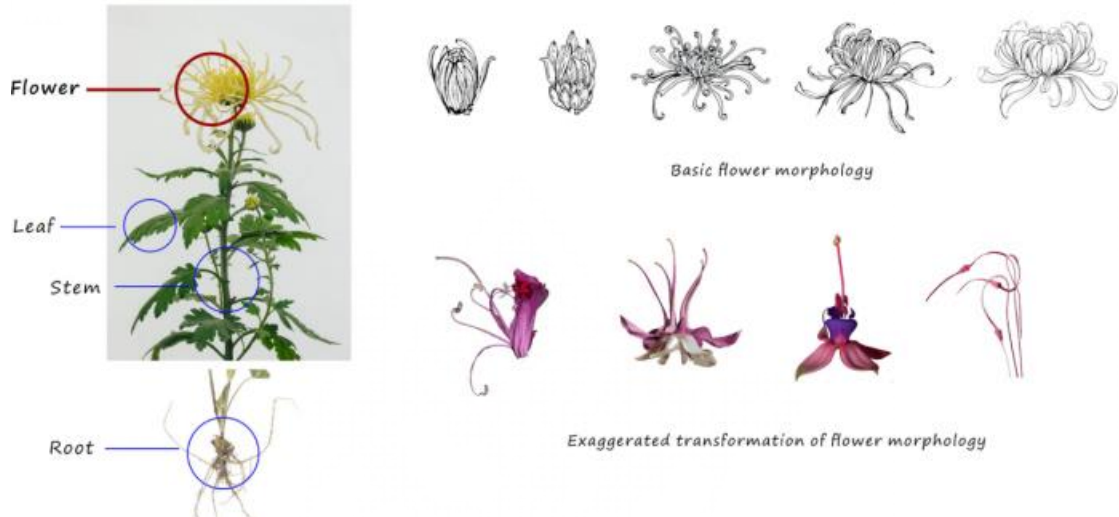
Figure 98 Plan B metal accessories part making process

4.2.3 Design plan C

4.2.3.1 Design thinking

The dry landscape is the essence of Japanese garden design. It has no mountains and no water. It uses stone instead of mountains and sand for water. The

texture of the white sand used to rake the water, the piling of soil or the placement of stones to form islands or mountains. Different moods create different artistic concepts, showing the beauty of solitude and the spirit of sitting still and entering the land. A few strokes have created a high level of artistic beauty.



Water droplet



Karesansui
uses stone instead of mountain
sand as water

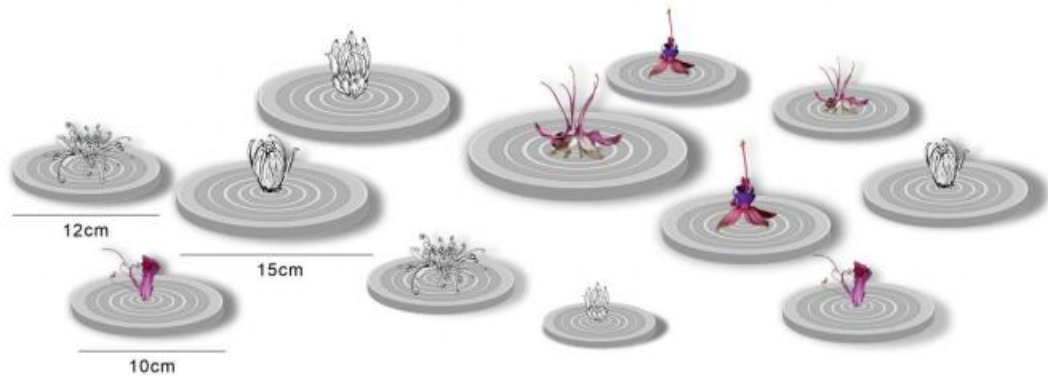
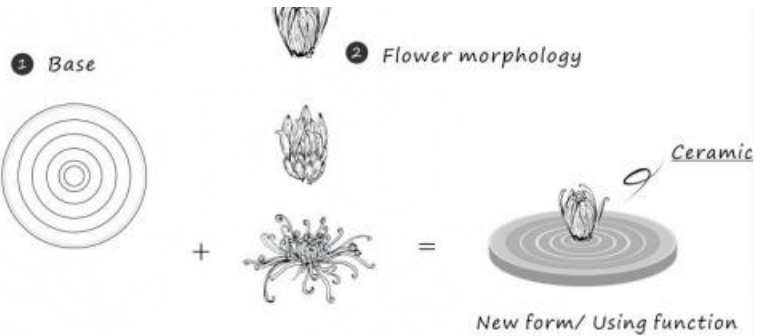


Figure 99 Plan C design thinking

4.2.3.2 Design plan C making proces

Figure 100 Plan C Making Process 1



Figure 101 Design C making process 2



4.2.4 Design plan D

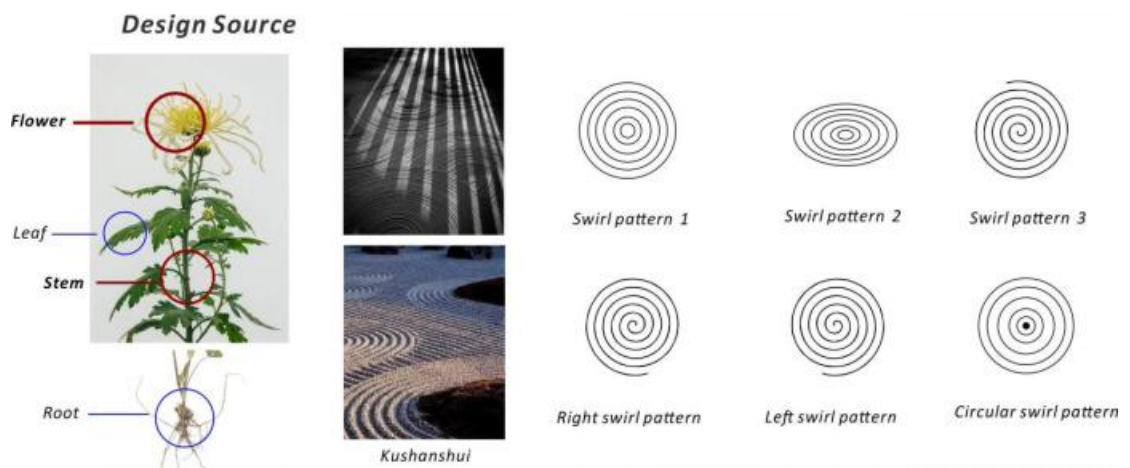


Figure 102 Plan D design thinking 1

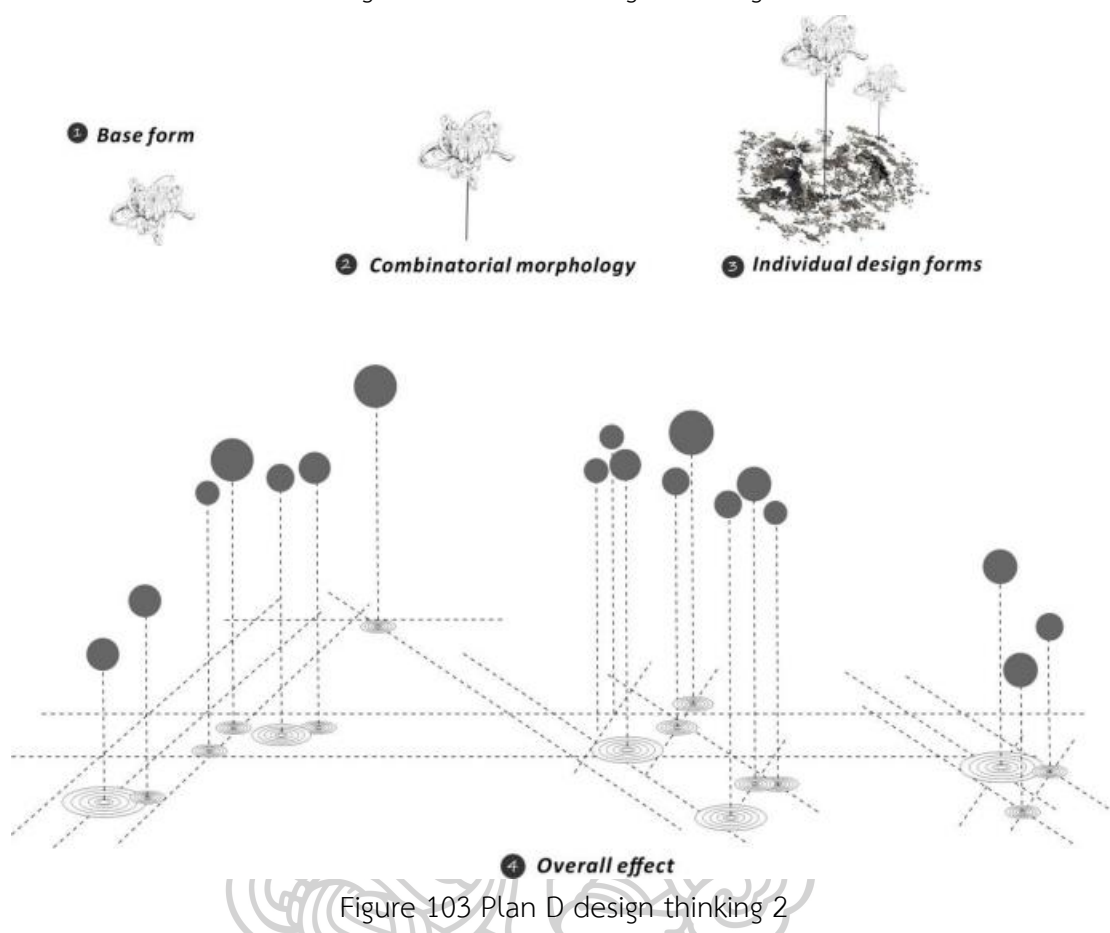


Figure 103 Plan D design thinking 2

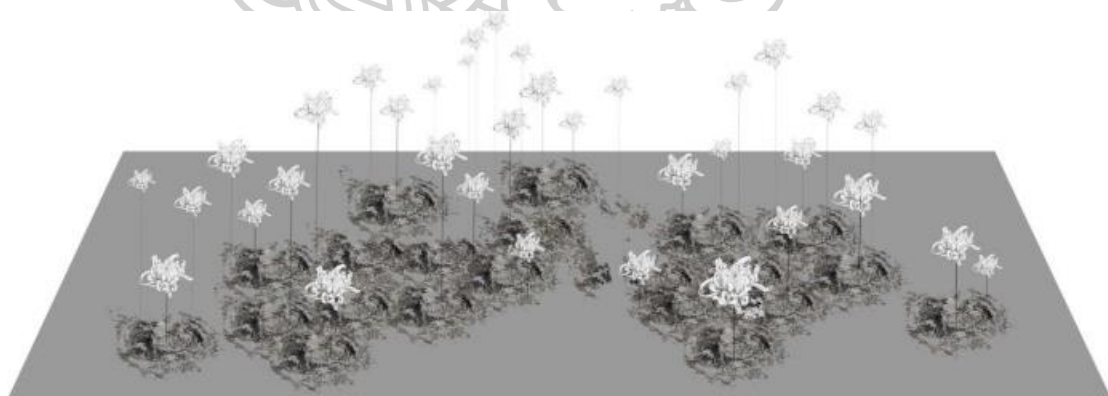


Figure 104 Plan D design thinking 3

4.2.4.1 Design plan D making process

When spraying the glaze, it turned out that the shape of the flowers and the texture of the petals were clearly visible during the stacking process, which

made the spraying process more difficult. After experimenting, it was found that the stacked grooves and the deeper lines on the petals did not adhere to the color pigments and could not be colored. Therefore, the brush was used to fill the grooves and lines for the first time, and then the glaze was sprayed over a large area. When spraying on the glaze, it is necessary to do this at several angles (as seen in the picture) to ensure that the pigment adheres evenly to the blank.



Figure 105 Pigment spraying

At the end of the paint spraying, the petal pattern was maintained, the overall shape did not appear to have changed, and it was noted that the overall paint spraying was more uniform and the desired graininess and texture appeared.

4.3 Final installation

4.3.1 Design plan A Whole Works Showcase (7 works)



Figure 106 Detailed part of design plan A shape 1



Figure 107 Detailed part of design plan A shape 2



Figure 108 Detailed part of design plan A shape 3



Figure 109 Detailed part of design plan A shape 4



Figure 110 Detailed part of design plan A shape 5



Figure 111 Detailed part of design plan A shape 6

4.3.2 Design plan B Whole Works Showcase (8 works)



Figure 112 Detailed part of design plan B shape 1



Figure 113 Detailed part of design plan B shape 2



Figure 114 Detailed part of design plan B shape 3



Figure 115 Detailed part of design plan B shape 4



Figure 116 Detailed part of design plan B shape 5



Figure 117 Detailed part of design plan B shape 6



Figure 118 Detailed part of design plan B shape 7

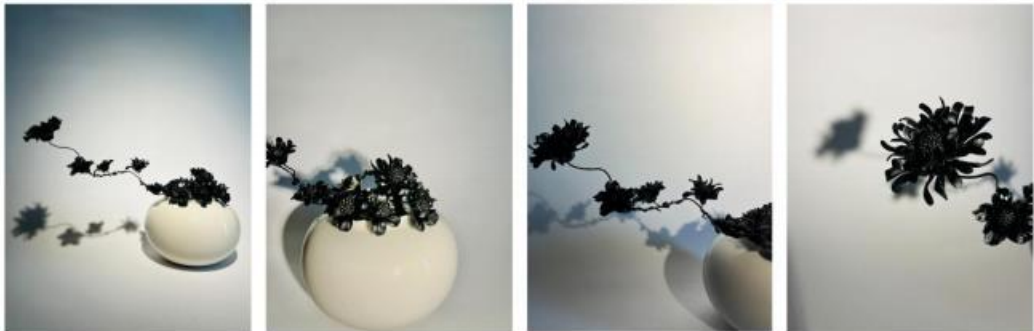


Figure 119 Detailed part of design plan B shape 8

4.3.3 Design plan C Whole Works Showcase (12 works)

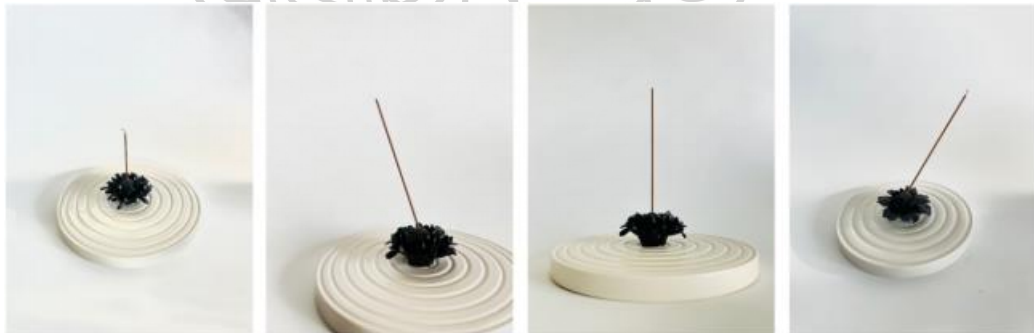


Figure 120 Detailed part of design plan C shape 1



Figure 121 Detailed part of design plan C shape 2

4.3.4 Design plan D Whole Works Showcase



Figure 122 Detailed part of design plan D shape 1



Figure 122 Detailed part of design plan D shape 2

4.4 Conclusion

The researcher's general approach to the artworks is bionic. Inspired by the patterns, colors, textures and forms of plants, the design is inspired by the researcher's love of plants in her daily life as well as her aspiration and longing for

nature. Plants are everywhere and symbolize life and vitality. At the same time, they remind us of the changing of the years and seasons. Plants and clay have an inseparable relationship and, coincidentally, ceramics and clay also have an inseparable relationship. The diversity of plants and the artistry of ceramics are inextricably linked to the key element of clay.



Figure 123 Design Process

In the early stage of the design process, there were several design solutions that were all put into practice at the same time. In practice, figurative expression is not enough and abstract expression is rather limited, so we have to keep rethinking. Through a series of sketches, reflections, design processes, but also on the basis of painting, combined with the effect of light and shadow to achieve the expression of representation.

In the design process, the form of the silhouette is used to express the form of the plants. This is an expression of the virtual and the real, arranging and combining information in an accurate, and multidimensional way. The contrast of the image is deliberately increased. At the same time, you can recognize a plant in the overall picture, but you do not know what kind of plant it is, or you can not recognize the detailed parts of the plant, such as the veins of the leaves. It is like a specimen, and a kind of record that becomes immortal.

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