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# Ceramic Art Reality in the Context of Technology History*

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The art of ceramics originates from the basic activities of human beings, and uses the tools, following the methods, and the visual production activities combined with aesthetics. Modern technology has spawned new ceramic decoration methods and provided new ideas for artistic creation. Ceramic art relies on ceramic crafts. As the most technical form of many art categories, it is the representative of the "Combination of Art and Crafts" of arts and crafts, and it is the perfect embodiment of "Beauty" in the space-time carrier. The history of Chinese ceramic glaze shows that the study of the history of ceramic technology should rely on the aesthetics of ceramics, and the problems related to the interpretation of modern ceramic art cannot be separated from the context of the history of ceramic technology.

*Keywords:* history of science and technology, pottery, technical thought, glaze

It is believed that science and art are the two wings of human nature. The embodiment of rationality and sensitivity is based on human creation and pursues universal truth. The understanding of "Technology and Art Must Be Combined" in the context of industrialization is also deepening. Ceramic art is one of the most technical forms in many art categories. It is the representative of the "Combination of Art and Crafts" in arts and crafts, and it is the perfect embodiment of "Beauty" in the space and time. In history, the brilliant achievements of Chinese ceramics are not only reflected in the artistic variety and prosperity, but also in the advancement and monopoly of technological development. The fusion of ceramic craftsmanship and artistic creation embodies the wisdom and aesthetic sentiment of ancient Chinese craftsmen. It is an important carrier of Chinese civilization, a material treasure for all human beings, and an excellent carrier for studying the relationship between science, technology and art. Combing and discussing issues related to the art of ceramic glazes will help to understand the technical essence of ceramic art. Thinking about the practical issues of ceramic art will also help the establishment and integration of the history of ceramic technology history research.

## Definition of Pottery and Porcelain

### The Word Tao in the Etymology

Tao (陶, Chinese character of pottery, pronounced as tao) was written as "匋" in ancient times which means kiln for pottery. *Fou Department, Under Five, Shuo Wen* (说文・五下・缶部) said that tao (匋) also

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pottery (匋, 瓦器也). Gu Ye Wang of Liang Dynasty said in *Yu Pian* (玉篇), tao (匋) also can be written as tao (陶). From these record, it can be basically concluded that tao (匋) and tao (陶) are the same Chinese character that was used as ancient and modern form (Ge, 2000).

The character tao (陶) first appeared in Chu Bamboo Slips of the Warring States Period (Wu, 2018), and the character tao (匋) was gradually abandoned after the Han dynasty. The ancient radical of tao (陶) was written as "阜", which is synonymous with "hill" and is written as "阝" in block letters. Due to the low and moist terrain in the south of China, caves cannot be formed. Therefore, pottery kiln built near the hill, and so was the character tao (陶) came from.

According to legend, the Sui-jen Shih (燧人氏) invented fire, Shennong Shih (神农氏) taught making pottery, and the inventor of the pottery manufacturing industry was said to be the "Kun Wu" (昆吾) mentioned in *Shuo Wen*. *Jun Shou, Lu Shi Chun Qiu* said "Kun Wu made pottery". *Diji, Shiben* (世本 • 帝纪) records, Kun Wu's real name was Kun Fan, a descendant of Zhuan Xu, eldest grandson of Wu Hui, who was the leader of the Southern Clan in the Di Ku (帝喾) period. Wu Hui was once replaced his elder brother as "fire officer" in charge of tribal fire and observation of Mars. In the ancient times, when the wisdom of the people was not yet civilized, the fire officer was extremely sacred. Wu Hui became famous after taking office, and was revered as Zhu Rong Immortal (祝融神), the God of Fire, after his death. Kun Wu inherited his ancestors to test the mantle, and his tribe first mastered the use of high-temperature technology to smelt bronzes and make pottery.

**The Word Ci in the Etymology**

Ci (瓷, Chinese character of porcelain, pronounced as ci) first appeared in Zouyang's *Jiu Fu*, a book about wine in the Western Han dynasty. It recorded, "The wine has been made while the green porcelain was also ready" (醪醴既成, 绿瓷既启), indicating that people had used "green porcelain" to hold fine wine at that time.

Some scholars believe that the word "porcelain" originated in the Wei and Jin dynasties (Yu, 1986), mainly based on the appearance of Chinese porcelain in the late Eastern Han dynasty, according to the general rule of naming that the porcelain appeared first before name it. The author believes that "porcelain" is defined within the current cognitive scope. "Green porcelain" in the Western Han dynasty is already the original porcelain. Although it has not yet reached the standard of porcelain in the modern sense, its performance mechanism has been greatly improved compared with the past, and prosperous production, "widely popular" (Chinese Ceramic Society, 1982, p. 124), is not technically a coincidence, Zou Yang called it "porcelain", which is an objective limitation of history. In addition, although the rule and logic of "first thing before life" conforms to dialectical thinking, using this logic to delay the appearance of the word "porcelain" confuses the thinking concepts of "porcelain after name" and "word after name", for it is not necessary to recreate new words for naming new things. Even if "green porcelain" is not porcelain, when the later porcelain appeared, people thought that the exquisite character "porcelain" in the past was so suitable for its exquisite use.

But there is one point that cannot be denied, that is, the emergence of the porcelain word means the great advancement of ceramic technology at that time.

**The Word You in the Etymology**

You (釉, Chinese character of glaze, pronounced as you) is glaze layer attached to the glassy surface of the carcass. It is called "ceramic enamel" on the surface of porcelain and "enamel glazed" or "enamel" on the metal surface. It will be considered as glass if it was exist alone and not attached to anybody. The ancient form of the glazed word is more chaotic, or it is recorded as "oil". *Kangxi Dictionary* said, "If there is light, there is oil", to

indicate the luster of its oil beads, or "you" (石由), or "you"（石幼）, which is expressed as stone raw materials. Otherwise it was known as "glaze drug" which indicates that the formulation as Chinese herbs as complicated deep.

**The Difference Between Pottery and Porcelain in Ancient Times**

In the middle of the Shang dynasty, people invented a new technique of "Glazing on the Surface of the Pottery", which improved the surface mechanism of the pottery, making the surface of the fired utensils smooth and shiny, which was different from the appearance of unglazed objects. There are many records in the visual description of this visual perception.

*Kao Sheng Qie Yun* (考声切韵) by Zhang Jian in Tang dynasty recorded, "Porcelain, tiles are also added, and the medicine surface is also bright (瓷, 瓦类也, 加之以药面而色泽光也)". *Ji Yun* (集韵) in Song dynasty "Porcelain is strong pottery (瓷, 陶器致坚者)". *Tian Gong Kai Wu* (天工开物) by Song Yingxing in Ming dynasty recorded, "The porcelain is a sort of fine arts, which appears white muscles and jade bones (陶成雅器，有素肌玉骨之象焉)".

Thus seen, the early people only pay attention to their appearance and elegant luster glaze, and then gradually recognize its carcass of solid and semi-transparent, that is, awareness of porcelain glazed from the exterior change to the internal body feature by step.

**The Concept of Modern Ceramics**

Narrow or traditional ceramics refer to glazed or unglazed silicate products that are processed and fired from clay or other natural mineral rocks. With the development of technology, the concept of traditional ceramics has been broadened. It is believed that all inorganic non-metal materials and products manufactured through the main processes of preparing powders, shaped bodies and fired bodies are called ceramics. In popular terms, the inorganic non-metal materials and products produced according to the basic ceramic production process are collectively referred to as ceramics.

In the broad sense, in addition to traditional ceramic products, ceramics also include cement, glass, lime, gypsum, artificial crystals, and various non-metallic materials and products with various functions. Together with metal materials and organic materials, it constitutes the three pillars of modern materials.

## Definition and Types of Ceramic Decoration

**Cognition of Decorative**

The word "decoration" (装饰) was from *Hou Han Shu* (后汉书): "Marrying soon, she started dressing and decorated herself (及嫁, 始以装饰入门)", originally referred to two meanings of clothing and wearing, now was used as a noun be called apparel (服饰). This shows that decoration is the basic activity of human beings, and it has been used throughout the history of human beings. Since its birth, it has been accompanied by the use of tools. It is an important feature and symbol that is different from animals. This innate nature created the most important behavioral practice of mankind-visual production activities.

The essence of visual production activities is the behavior based on human practical activities. It shows the use of tools and techniques to generate designs from images, so that objective images are transformed into subjective images. On the process of reification, therefore, the level of cognition and transformation of the material world, or the background of the knowledge framework and the level of science and technology are the basis of visual production activities, and it is embodied in the decoration with a strong era.

Now people have transferred the original concept of decoration to objects, formed and borrowed the concept of decoration, which can be understood as a means to modify or beautify the objects. Decoration does not affect the use of original articles function under the premise of, or be engraved directly on the surface of items, such as painting modification and beautification, or in the local add appendages beautification.

Therefore, decoration is also an aesthetic activity to meet the psychological needs for beauty in line with aesthetic taste. Aesthetic taste is a kind of psychological expression, which is derived from the individual's aesthetic viewpoint, accomplishment and ideal, and is a complex of perceptual thinking, such as creativity, imagination, sensation, judgment. The influence of human personality on aesthetic taste cannot be ignored. It is the individual differences that make the aesthetic activity rich and diverse, full of taste and personality, and also make decoration an important expression channel and carrier to achieve the aesthetic activity form.

**Ceramic Decoration Method**

In the narrow sense, ceramic decoration refers to the process of beautifying the semi-finished ceramic body before the final firing. It can be divided into two parts, body decoration and glaze decoration.

The object of the body decoration is the ceramic body. In the molding stage, plastic modeling of mud or a combination of multiple colors of mud is often used for modeling, known as winches, or for molding, printing, stacking, and patching. For dried blanks, there are decoration by carving or bonding, or applying a thin layer of cosmetic clay on the surface of the green body to improve whiteness, or infiltration of the green body by infiltration of the green body; and 3D printing molding technology directly new technology for making various modeling blanks.

Glaze decoration contains two aspects of glazing and painting, which are important means of beautifying the blank. Glaze is used to cover the surface of the body with glaze. After firing, the body glaze is combined, and the glaze forms a smooth and homogeneous glassy layer on the surface of the body. The painting process can be directly implemented on the surface of the green body, or it can be decorated on the glazed surface. After high temperature treatment, the pigment is finally combined with the green body or the glaze to show the decorative effect of the pattern.

The object of ceramic decoration can also be the ceramic product after firing, which is called after decoration. Ceramic products can be processed by grinding, splicing or adding accessories, or they can form a comprehensive decorative body alone or in combination. For example, the silver-coated technology of the kiln ware has a burr mouth due to overheating. After the mouth is covered with silver, it not only improves the touch, but also improves the visual experience. Another example is the porcelain repairing process, porcelain and gold cymbals. The processed ceramic products not only restore the original functions, but also add new decorative elements due to the introduction of metal. There are also painting decorations that use glass paints directly on the glaze. The paints are not subjected to high temperature treatment, they are tough and firm after natural curing, and they are not easy to fall off.

## The Development Context of Ceramic Glaze Decoration Technology

**The Definition of Ceramic Glaze**

Glaze is the use of special colored materials to paint on porcelain to increase the beauty of the utensil and increase its artistic value. This process is called "painting". The emergence of painted porcelain is an important

milestone in the history of Chinese ceramics. The Ming and Qing dynasties were the period of great development of painted porcelain in China.

In the 1950s, the term "ceramic glaze" (陶瓷釉彩) first appeared in textbooks. In 1952, the lecture "Ceramic Glaze" of Jiangxi Ceramic College was published. This textbook was written by Mr. Wang Fan, who was the pioneer of ceramic higher education in China, and the pioneer of modern ceramic industry. According to the formal version, people enriched, edited and published (Mo, Rui, Miao, Xiong, & Zheng, 2013).

The main purpose of studying ceramic glazes is to understand the content, manufacturing principles, research methods and results of glazes. We must repeat the experiments, touch the by-pass, and master the theoretical knowledge to solve many practical problems on ceramic glazes in China (Wang, 1952). So far, the branch system of "ceramic glaze" has been formally established, and its learning objectives, methods and means also indicate the technical and practical nature of ceramic decoration.

**The Glaze Decoration**

The practical purpose is the driving force for the development of technology. The technical root of the appearance of glaze is to improve the physical properties of pottery and make it waterproof and easy to clean. The emergence of new things has inspired people's instinct to produce beauty. People explore the multi-phase characteristics of glaze combined with artistic expression, so that the glaze gradually becomes the medium and carrier of decoration, resulting in many immortal works.

**Green glaze.** As mentioned above, the surface of the ceramic glazing technology appears in mid supplier. This glaze is classified as cyan glaze and contains 15-20% calcium oxide, also known as calcium glaze. The glaze is applied to the inner and outer layers or only the outer layer of the utensil. Although it is not very beautiful in appearance, this glaze spreader is the originator of various celadon porcelains in later generations of China. It is now called primitive porcelain. The thickness of the original porcelain glaze is uneven, and the combination of the tire and glaze is generally poor, and it is easy to fall off. This kind of glaze has a high Fe content, the glaze is blue, or it is cyan, yellow or brown, with a single color and no other ornaments.

How did the original porcelain glaze be invented? What is the process of glaze preparation and glazing? There is no exhaustive research on this enough to fully explain. Based on the analysis of the existing physical science and technology and the investigation of traditional glaze-making technology, the academic community generally believes that the glaze appeared in the Shang dynasty was grass-wood gray glaze, that is, it was made of grass-wood ash mixed with tire mud. Plant ash is easy to obtain and contains a variety of fluxing metal elements, which reduces the firing temperature. The fluctuation of its chemical composition shows that the exploration and attempt of the glaze-making process is in the initial stage without a systematic method.

The emergence of glaze has epoch-making significance, making primitive porcelain together with printed hard pottery attributed to the second milestone in the history of the development of ceramic technology. By the late Eastern Han dynasty, porcelain of real modern significance—Yueyao (越窑) glazed porcelain appeared.

The mysterious porcelain (秘色瓷) of the Tang dynasty is considered to be the exquisite piece of Yueyao celadon. It was once a small tribute, and was once unknown to ordinary people. Some people believe that the word "secret color" is the meaning of glaze green and mysterious, and now it is considered the meaning of the secret formula of glaze. The mature technology and monopoly of the formula guarantee the royal quality and the visual texture of the glazed green and moisturized.

From Shang and Zhou dynasty to Tang dynasty, blue glaze was the mainstream of ceramic glaze in China. During the same period, other art forms such as painting, calligraphy, murals, and sculptures showed an all-encompassing prosperity in expression. At this time, high-temperature color glazes and blue and white pigments have not yet been popularized. On-glaze and under-glaze painting techniques have not yet appeared. The simplicity of porcelain glaze color is not a subjective limitation of aesthetic taste, but an objective constraint of technological development.

Yaozhou kiln (耀州窑) is representative of northern celadon, began burning in the Tang dynasty to the Song dynasty celadon-based, its green glazed smooth hypertrophy, glaze elegant green, commonly known as "ginger".

Longquan kiln (龙泉窑) is also an important representative of celadon. The kiln yard is located in the hinterland of southwestern Zhejiang. It follows the celadon firing tradition of Zhejiang Province, and it continued to the Qing dynasty from the creation of firing in the Wei and Jin period. The glaze layer is light, thick, and of high quality, is widely loved, and is widely spread around the world. Europeans named Longquan kiln as celadon, making proper nouns Chinese celadon.

**Lead glaze.** Existing archeological data of lead glaze indicate that lead-glazed pottery first appeared in the Han dynasty. Lead compound is lead glaze as a main flux, copper or iron as a colorant low frit, firing temperature about 600-700 °C. Fired in an oxidizing atmosphere, copper gives the glaze a beautiful emerald green and iron makes the glaze appear yellowish brown and brownish red. Lead glaze manufacturing technology is generally simpler than calcium glaze, and the firing temperature is lower, but China's lead glaze is 1,000 years later than calcium glaze.

Lead glaze is bright, clear and transparent, but also rich in color. Its invention was the basis of various low-temperature color glazes that appeared later, and gradually enriched the glaze decoration.

For example, Tang Sancai (唐三彩) is a typical lead-glazed pottery. After the green body is fired at a higher temperature, the lead-glaze is applied and fired at a low temperature. "Three" (三) generally refers to a variety of glaze colors, including yellow, green, brown, white, blue and other glazes, with bright and vivid styles and visual impact. It is the artistic essence of the Tang dynasty and the heyday of Chinese pottery. Its decorative method is known for its body shape and color glaze decoration, and most of the objects have no specific decoration. The only decorative patterns are strips or spots, or stacked, decaled, and printed to achieve rich and full shapes. The stripe decorative patterns are decorated with brush glaze, stamped glaze, dropped glaze, etc., or painted with glaze. Most of them are decorated with yellow-green or yellow-white two-tone decoration on the horse's mane, and a few are on the saddle or camel saddle. Some of them make up floral patterns, showing colorful glazes.

**White glaze.** During the Sui and Tang dynasties, technological breakthroughs were made in northern China. Xing, Gong, Ding (邢, 巩, 定), and other kiln yards improved the raw material formula and achieved an increase in firing temperature. The improvement of key processes has greatly improved the quality of tire glaze, increased the density of ceramics, improved the whiteness, hardness, transparency and other properties, and gradually changed the process of whitening with cosmetic clay. The white glaze at this time is actually a colorless transparent glaze. Although the content of Fe and other elements in the green body is reduced, it is still gray. The new feldspar crystals are formed in the middle layer of the tire glaze. Opaque white glaze in the strict sense did not appear until modern times, and is now collectively referred to as white porcelain.

The earliest appearance of white porcelain was due to the excavation of Cao's mausoleum in Anyang (安阳曹操墓). It is believed that a white porcelain pot unearthed from his tomb has the characteristics of white porcelain and is the earliest white porcelain. The earliest white porcelain that is commemorated is a group of white glazed porcelain unearthed from the tomb of Fan Cui (范粹墓) during the Northern Qi dynasty. This batch of white porcelain is applied with a pale yellowish white glaze, and a band of emerald green is applied on the ventral side. The green glaze has not been tested, and it is not yet sure whether it is a high-temperature copper glaze (Chinese Ceramic Society, 1982). Its enamel is delicate and bright, and it is the colored porcelain currently found. The emergence of white porcelain and colored porcelain changed the single tone of the past and laid the foundation for the future of colored porcelain.

Dingyao (定窑) white porcelain is the pinnacle of white porcelain in the Song dynasty. Technically inherited from Xing Kiln (邢窑), the technology is mature, and it can fire black glaze, sauce glaze and green glaze porcelain.

In the Yuan dynasty, Jingdezhen (景德镇, means Jingde Town) created a burnt egg white glaze. Part of the glaze was introduced into feldspar, which is a lime-lime glaze. It has a high temperature viscosity and is not easy to flow. The glaze layer is thick.

The sweet white porcelain appeared in Yongle Period of Ming Dynasty (明永乐) is an important white porcelain variety, which developed from the egg white glaze. The high content of $Al_2O_3$ in the tire glaze shows the mature application of the process of adding kaolin binary formula. The successful firing of sweet white glaze created favorable conditions for the development of Ming dynasty colored porcelain.

Dehua kiln (德化窑) white porcelain is unique in the "Celadon in South and White in North" System, and is famous for firing white porcelain. Its fetus is pure white and has good transparency. It is also called lard white or ivory white.

Monochrome glazes such as blue glaze, blue-white glaze, and white glaze in the Song dynasty are in line with the simple and bland but delicate and elegant artistic aesthetic of the Song dynasty. The Yuan dynasty set up a floating beam porcelain bureau in Jingdezhen to burn a large amount of white porcelain, but not only because the Yuan people were still white. During the period of the Song dynasty, Jingdezhen was given the town name of "Jingde" (景德) because of the production of high-quality porcelain, which has a technical foundation. At that time, artisans in the kiln yards, such as Xing and Gong in the north avoided chaos in the south, and the Yuan dynasty slaughtered artisans were avoided. A large number of porcelain artisans gathered in Jingdezhen to establish their technological advantages. The discovery and application of kaolin in Jingdezhen further established the status of the future porcelain capital of Jingdezhen from the basis of raw materials.

**Color glaze.** After entering the Tang dynasty, in addition to green glaze, high-temperature colored glazes, such as green, red, and black began to appear. The history of ceramics gradually opened the colorful glaze era.

Red is one of the three primary colors and is an essential base color for decoration. The red color in the glaze is colored by the copper element. The copper effect can only be achieved by reducing and separating the copper. Due to the difficulty in controlling the atmospheric temperature and the difficulty of firing, it has attracted much attention in history. According to the existing opinion, the high-temperature copper red glaze was successfully fired at the earliest in Sichuan kiln before Changsha kiln (长沙窑).

The kiln was burned during the Tang and Song dynasties. The most distinctive feature is the colorful high-temperature glaze known as the "Qiong Sancai" (邛三彩). Different from Tang Sancai, it is painted or spot dyed with copper, iron, manganese, and diamond as colorants on and under the glaze, and fired in one shot. At first, it was three colors of black, green and brown, and later developed into paintings based on yellow, green, brown, blue and other colors. Its process technology and products continued to the Ming dynasty (Xu, 2013).

The high-temperature copper red glaze has matured and stabilized since Jun kiln in the Song dynasty, and the area of copper red hair color has gradually increased. Developed into the Ming dynasty, the whole body high-temperature copper-red glazed porcelain in Jingdezhen was created with bright red, varieties of red, sacrifice red, accumulated red, ocher red, chicken blood red, cattle blood red and other varieties, pure and stable hair color. Later, its technology was lost for a while, and the Qing dynasty was successfully re-burned again. Langyao Red (郎窑红), Beauty Drunk Red (美人醉), Cowpea Red (豇豆红), and other varieties appeared. Its red color was bright and cheerful, and it was very dynamic due to its high temperature fluidity. Relevant research shows that the sudden change of the chemical composition of the red glazes during the Ming and Qing dynasties may imply that the glazing process of the Ming dynasty was lost in the Qing dynasty, but developed itself in the Qing dynasty (Peng, 2008).

After the Song dynasty, a large number of low-temperature glazes began to appear. Low temperature porcelains, such as green glaze and peacock glaze are produced in Cizhou kiln (磁州窑), Jizhou kiln (吉州窑) and kiln yards in northern Liao dynasty.

**Crack glaze.** Crack glaze is the use of the difference in the expansion coefficient of the tire glaze. The glaze crack caused by the glaze is used as decoration. It originated from Longquan ge kiln (哥窑) in the Song dynasty. *Chunyutang Essay* (春雨堂随笔) by Lushen in Ming dynasty recorded, "Ge Yao's light white broken lines, and the number of rubbish pieces is broken". The crack defect was originally obtained occasionally, and the texture was naturally formed after the crack. It has a decorative effect, so it was used and developed. Become an important glaze decoration variety. The glazed surface of the Ru kiln (汝窑) in the Song dynasty was often scattered with small openings, commonly known as "cicada wings", which is one of its decorative features.

**Phase-separated glaze.** The modern testing method has confirmed that the glaze is not a uniform single-phase substance. Glaze will form liquid-solid phase or liquid-liquid phase in the melt phase. This phenomenon is particularly obvious. The types of glazes that can be observed by the naked eye are called crystalline glaze and liquid-liquid phase glaze respectively. Light will be diffracted and scattered in the multi-phase structure of phase-separated glaze, or phase separation will occur, or the refractive index of light will be affected to produce opacifying effect.

Black glazed porcelain is a well-known ceramic variety in the Song dynasty, and its main feature is liquid—liquid phase separation. The CaO in the glaze is 6.88 to 22.99%, which belongs to calcareous gray glaze. The glaze color is determined by the total iron content and the FeO ratio in the iron content. When the FeO content is high, the black color is darker, and when the FeO content is low, the color becomes brown. The changes in the content of $P_2O_5$ and $Fe_2O_3$ in the glaze and the firing conditions caused a distinct liquid phase separation phenomenon in the glaze melt during firing, and rabbit hairs (兔毫) and Tortoiseshel (玳瑁) were formed. Oil droplets (油滴), transition (耀变), and other crystals show different decorative effects.

Jun kiln (钧窑) porcelain is a typical delaminated color glaze variety. The characteristics of Jun glaze in chemical composition: low content of $Al_2O_3$ and high content of $SiO_2$; it also contains 0.5 to 0.95% $P_2O_5$. The mechanism of phase separation of various oxides of Cu and Fe in the glaze is complicated and delicate. In the end, colors such as red and blue are intricately melted, with rich colors, complex shapes, and unpredictable changes. They are called "Kiln Changes" (窑变). In the era when the technical rationality and scientific system have not yet been formed, the random change of the glaze effect has brought uncertainty to ceramic production, but at the same time, it has also made ceramic art creation more abundant and prosperous.

Ru opaque glaze enamel metal phase, in addition to the characteristics of the opening piece, the glaze was azure, powder blue, sky blue more, there glaze green beans, green, pale blue, orange peel, etc., glazed shiny hypertrophy, shiny and soft like jade. The main component of the agate in the glaze is $SiO_2$, which is no different from adding quartz in technology. It is particularly precious because of its scarcity.

The common varieties of iron crystal glazes in ancient China are tea powder, sesame dots, rust flowers, etc., because they contain elements, such as iron and manganese, they are common in dark glaze porcelain, such as black and brown. Like the firing requirements of copper red glaze, the reduction of the metal elements by using a reducing atmosphere is required to separate the phases, so it appears later. Tea powder is one of the most representative varieties. It was first burned in the Tang dynasty and belongs to a high-temperature yellow glaze. Due to some differences in the firing process, there are various changes in its hue, some like the belly color of catfish, commonly known as "catfish yellow", and some like the finely ground color of tea, commonly known as "tea powder". The tea leaves were fired in Yaozhou kiln in large quantities, and Jingdezhen in the Qing dynasty was very successful in imitating the fire, and it became a valuable color glaze variety. Judging from the actual objects handed down, the products of the Yongzheng and Qianlong periods are more common. Most of the Yongzheng tea glazes are yellowish, and the Qianlong tea glazes are greenish.

Modern crystalline glazes first appeared in Europe. In the 1850s, the earliest research on modern crystallized glaze was started in France. Using pre-seed technology, artificially control the distribution and growth of crystals, and dye with different colored oxides, large crystal enamels of various colors can be made under a reasonable firing system. The emergence of this technology has enriched the expression methods of glaze decoration, making the ceramic art creation with crystal glazes rich in means and controllable processes.

**Salt roast, soda roast and raku roast.** In recent decades, modern ceramics has used some non-traditional firing processes, such as salt roast, soda roast, raku roast, etc., to make a batch of works with a special glaze decoration effect. This type of process breaks the relatively closed and stable traditional kiln environment, introduces alkali metals, directs the flow of fire, or forcibly migrates the firing space. The traditional law of the quiet growth of the original glaze is broken, one by one, and a brand new Processing technology and decorative techniques.

Salt roasting is not a traditional process of Chinese ceramics. It first appeared in the 12th to 14th centuries in Europe, and was mainly used for stoneware. Salt is table salt, and it is called glaze because it is glazed with salt. This process changes the glaze preparation method of raw material glaze or frit glaze. It does not need to be prepared in advance. When the product is calcined to high temperature, salt is put into the kiln. At high temperature, the salt gas reacts with $SiO_2$ in the surface clay of the product, that is, a glaze layer is formed on the surface. The characteristics are also obvious. This process does not have a relatively standardized and stable glazing process. Under the influence of high temperature, the salt feeding action needs to be rapid. The resulting glaze is rich in mechanism, random in effect, and full of interest.

The early soda roast originated from the improvement of chlorine pollution caused by salt-baking. The basic principles and methods inherited salt roast, and it is currently one of the firing processes widely used in modern ceramic art. Soda ionized sodium is not as lively as table salt and produces a unique glaze effect. The post-improvement process sprays soda water through a set spray port, so it is now called a steam glaze process.

Raku roast originated from the Japanese shogunate in the 16th century. When the raw green body is re-burned to 700 °C with lead glaze, we quickly use the tongs to pierce the green body one by one into an iron barrel. The red body will ignite organic matter, such as broken newspapers, wood chips, or dried leaves in the barrel in advance. When the cover lid to be jumped big fire, smoldering restoring state about 15-30 minutes and then relying on the water immersion, to prevent re-oxidation, carbon dust remove impurities serve cooling surface adhesion. This process of carburizing and carburizing similar to sealing kiln can be traced back to the production of black pottery of Longshan culture (龙山文化) in the Neolithic Age in China. The shape of Longshan black pottery is dignified and beautiful, and the surface is delicate and smooth, showing that the craft technology is mature and stable. Contrary to this, Le Shao expresses the real brushstrokes of fire flowing on the surface of the carcass.

Together with salt roast soda roast, raku roast presents a simple, disorderly and rough decoration style. Perhaps this is the rigor of giving up the craft, magnifying the uncertainty of the firing stage. The technical concept of returning to the true, free and casual is the true charm of modern ceramic art.

**Painted Decoration**

**Underglaze painting.** The emergence of painted decoration is based on the discovery and use of painted pigments. The underglaze painting first appeared in the Changsha kiln in the Tang dynasty, and was widely used in Cizhou kiln (磁州窑) after the Song dynasty. During production, the painted pigment is applied to the surface of the carcass, and then glaze is applied. After firing, the pigment is located in the middle of the tire glaze, so it is called “underglaze color”.

The social and cultural prosperity of the Song dynasty and the development of art and technology were at a high level, laying the foundation for the development of underglaze colored porcelain. To the Yuan, Ming, and Qing dynasties, underglaze color decoration technology represented by blue and white and red glaze has become the mainstream of ceramic art decoration technology.

The blue and white flowers first appeared in the Tang dynasty, and they were gradually burned in the Yuan dynasty, and reached the peak in the Ming and Qing dynasties. The blue and white glaze contains cobalt oxide, and after a high-temperature firing in a reducing atmosphere, the texture is cobalt blue, and the color is clear and beautiful. The decoration inherits and carries forward the traditional Chinese ink painting techniques. It has various forms and extensive materials, and is rich in the essence of traditional Chinese culture. The blue and white cobalt material originated from the Western regions through the Silk Road. Western culture not only brought new decorative techniques, but also brought changes in the style of decorative arts. Because of the affected Islamic culture, there is the emergence of many unique characteristics of exotic decoration patterns.

In-glaze red is a high-temperature under-glaze copper red pigment. Because it is rare in the world, it is regarded as a precious and important under-glaze decorative variety. The blue and white glaze matched with the blue and white, the red of the copper-red pigment contrasted with the blue and white, the contrast is strong, and the decorative effect is excellent. Due to the difficulty of firing, the firing was stopped in the Ming dynasty and refired in the Qing dynasty. Yunlong, flowers, landscapes, and characters are more common in the subject

matter. The decoration methods are red and blue, interspersed and combined, and the primary and secondary harmonious combinations create an elegant and simple artistic style.

**On-glaze painting.** On-glaze painting is a method of decorating on the glaze layer. This method is of various types, complicated techniques, varied themes, rich colors, and outstanding decorative effects. With the advancement of materials chemistry and other technologies in recent times, there have been new developments.

The earliest glazed decoration appeared in the Northern Song dynasty. It was a glazed painting of precious metals after firing. This kind of decoration is rich and luxurious, with few real objects handed down. *Zhi Ya-Tang Miscellaneous Copy* (志雅堂杂抄) by Zhoumi in Song dynasty contains, "Golden set the bowl with garlic draw, and then re-entry kiln firing, Nevermore off". But, according to the only remaining gilt porcelain objects, such golden set most of the decorations have fallen off and obviously cannot be promoted. This method was not widely used until the 19th century when Germany began to melt gold with aqua regia to make gold water.

On-glaze paintings appeared in the Song and Yuan dynasties and began to be dominated by red and green colors. Mineral raw material contains a transition metal element as coloring agents, by 700-780 °C grilling cured. The decoration now known as "old color" or "multicolor" was developed on this basis.

Francois is a kind of decorative painting on the glaze introduced from the West in the Qing dynasty. It was processed and fired by Jingdezhen's finest white porcelain by the Qing Palace Office. In the middle and late Qing dynasties, after the manufacturing office ceased to burn, this technology was transferred to Jingdezhen, where it was slightly remodeled, and was called "pastel". Its roasting temperature is slightly lower than that of old color, which is 650 to 720 °C.

In the middle and late Qing dynasty, Guangzhou became an important port for ceramic exports. Western emerging chemical industry pigments entered Guangzhou and added color to the white porcelain in Jingdezhen, saying "guang color" or "foreign color". After 1949, it was called "new color". Its roasting temperature is 550-600 °C.

**Dou color (斗彩).** Dou color is a decoration that combines underglaze painting and overglaze painting. The pattern is dominated by figures of flowers and birds. The word "dou color" has a beautiful artistic conception and the meaning of combining together, and its decoration style is just as appropriate as the contention. Dou color creates fire in the Xuande Period of Ming Dynasty, to Chenghua period of the most respected. During production, first draw blue and white flowers on the surface of the green body cover it with a transparent glaze, fire it once at high temperature, paint on the glaze, and then fire it at low temperature.

**Middle colored glaze.** The concept of middle colored glaze was introduced into China from Japan late 19th century, first appeared in Liling. At the end of the last century, it became widely used in China. Paint early after glazing, and then apply a thin layer of glaze. At the end of the last century, most of them painted on porcelain glazes, and then burned at a temperature slightly lower than the original porcelain. After the second firing, the colored materials sink into the glaze. The glaze medium color overcomes the shortcomings of falling off on the glaze and heavy metal exceeding the standard, and has the decoration effect of underglaze.

**The comprehensive decoration of enamel glaze.** In the Qing dynasty, the ceramic glaze decoration technology developed to the peak, and there were utensils that comprehensively used various decorative techniques. The most typical is the various large glazed vases of the Qianlong period of the Qing dynasty. There are as many as 15 layers of glazing and color decoration from top to bottom. It combines a variety of high-temperature and low-temperature glazes and colors. It needs to be roasted several times from high

temperature to lower. Such a complicated process can be successfully completed only in the full grasp of various glaze and color properties. Therefore, the only large-bottle glazed decoration that has been handed down for generations is called “mother of porcelain”, which embodies the superb porcelain making skills at that time.

**Modern glaze decoration.** The development of modern technology led to the rapid development of European science and technology represented by Germany after the middle of the 19th century. Therefore, the chemical and materials industry has developed extremely rapidly. Under the guidance of modern science, high-temperature technology has made great progress; many inorganic pigments have been synthesized, transfer printing has been realized, and decal decoration has become the mainstream of glaze decoration. Printing technology is also applied to glazed decoration, and has experienced the evolution from screen printing to inkjet printing technology.

## Technology and Ceramic Art Reality

### Technology and the History of Technology

Ceramic art has a long topic, but it seems that it cannot answer questions, such as “Can the linguistic expression of art history touch the reality of art works?” (Chinese Ceramic Society, 1982). The linguistic expressions of the history of technology can help reach the reality of works of art.

The so-called technology is “the means by which man strives to control the inorganic and organic environment”. Technology begins with the process by which humans make tools to meet their main needs; it arises from practice and can only be passed on through practice. That is, “a technology is an operation that is created by individuals and maintained by society” (Berner, 1959).

Technology has a double-edged nature, that is, technology has both a positive and a negative side. On the one hand, technology, as a tool and means for people to transform nature and society, is benefit for mankind; on the other hand, technology is not a white jade and it has a side that harms humanity. Technology is also lagging, and often only the beneficial side is seen in the initial stage; after a certain period of time, people will gradually discover the negative side.

The study of technological history is an interdisciplinary field devoted to discovering technological traditions and researching technological development mechanisms. Its research does not have specific discipline boundaries. Ceramic technology is ceramic technology, including basic principles, operating methods and measuring methods. The study of the history of ceramic technology includes the investigation of ceramic technology and ceramic aesthetics.

### The Characteristics of Ceramic Art

Ceramic art is the most solid concrete carrier of beauty” made on human scale. The starting point of ceramic art reality is beauty, and the ultimate goal is to meet people’s physiological and psychological needs. To a certain extent, the means of realizing ceramic art reality are rational, because the fundamental characteristics of technology and art are consistent. The combination of technology and art produces function and aesthetics, and contains both rational and emotional components.

Ceramic technology is rational and the basis of artistic presentation. It includes three main stages, raw material preparation, molding, and firing, where raw materials are the basis and firing is the key. Ancient Chinese first mastered the ceramic raw material selection and refined, such as the use of “dual formula” and

kaolin; first to achieve a breakthrough improvement and firing temperature furnace technology improved, such as the northern white porcelain Sui and 1380 °C for firing temperature—a major breakthrough. It is the leading and independence of these foundations and key technologies that can make Chinese ceramics dominate the world for more than 1,000 years.

The core of Art Nouveau, Henry van de Velde, in his article "Removing Obstacles for Art", stated that "functional works made according to the laws of rationality and reasonable structure are Seek the first condition for beauty". *Kao Gong Ji* recorded, "Sometimes, the earth has gas, the materials are beautiful, the craftsmanship is clever, and the four are combined, and then they can be good" (天有时, 地有气, 材有美, 工有巧, 合此四者, 然后可以为良) (Peng, 2008). Zhang Zao in Tang dynasty said, "nature outside, in the heart of the source" (外师造化, 中得心源); it reflects the art or design process not only pay attention to the main lyrical and performance, but also according to the nature of the objective conditions, and rely on the technical characteristics of raw materials and craftsmen can only output good quality.

Although modern ceramic art no longer puts too much emphasis on "form obeys function", the use of purpose separation can also not affect the expression of aesthetic functions, but the divergence of technical thinking is still an important spiritual source of the diversity of ceramic art. The development and evolution of the characteristics of the era of decorative technology confirm that the barriers between product functions and forms are gradually eliminated under production conditions, and it also reflects the important relationship between ceramic art and craftsmanship.

**The Problem of "Unspoken" (Hang, 2005)**

In modern ceramic art, "modern ceramic art" itself does not need to be defined. It is the use of all available technical means available for the aesthetic activities of ceramic products. Just as "craft art" cannot be interpreted as "modern design", "modern ceramic art" cannot be separated from the origin of its craft. Craft is not industry, but craftsmanship, a combination of manual skills, procedural methods and labor. Chinese porcelain has such brilliant achievements in ancient times, not because the decorative techniques or artistic styles are crowned the world, but because of the technological monopoly of foundation and key craftsmanship.

Modern ceramics has many problems, not only "poor of the modern ceramic art theory and criticism" (Yang, 2011). In essence, it is the lack of technical means, or the concept behind the technology. In last century, the fifties traditional decorative ceramics improvement in daily basis is a manifestation of ceramic art to be placed under the technical background of the rational thinking at home rise and fall of the historical destiny of the country. The lack and backwardness of the technical means in the period of a hundred wastes have directly affected the level and height of ceramic art creation, which is determined by the technical nature of ceramic art.

The practical problem of modern ceramic art lays in the departure of the horizon of objective technical historical attributes, that is, the deviation of the problem domain. The topic of aesthetics and practical aesthetics has tried to separate the relationship between technology and art. But in ceramic art, any attempt to deviate from the actual technology fails. In history, many ceramic technologies have been lost and difficult to resurrect, which truly records the risk of technological inheritance in the absence of a scientific system. The "rectification of arts and crafts", which originated from the last century, also lacks basic recognition and understanding of the tool technology and method of ceramic art.

Does design affect the development of the process? The author is still seeking answers, but the combination of design and expression is the fundamental way of visual production activities. Expression, that is,

technology, means, methods, and craftsmanship, is a kind of rationality that can be mastered and inherited, while design cannot.

The controversy over the "tradition" and "innovation" of traditional ceramic crafts is essentially a dialectical reflection on the relationship between crafts and design. In the art of ceramics, craftsmanship is not design, but means. Tradition is the basis of innovation, and innovation is the inevitable of technological development.

**The Realistic Significance of Technology for Ceramic Art**

The reality of ceramic art is the fusion of already existing ceramic craftsmanship and artistic creativity. Historically, the development of science and related technologies of ceramic technology has influenced the historical trend of ceramic art forms.

Nowadays, the practical effect of technology on ceramic art lies in:

(1) Technology discovers the practical defects that ceramic art cannot find, and solves them. Chinese traditional glaze raw materials lead is commonly found in low-temperature lead glazes, and chromium is often painted on glazes, so these two elements are likely to exceed the standard. Two hundred years ago, people had no idea about the dissolution of heavy metals in acids. After the 20th century, people gradually realized the impact of lead and chromium dissolution in glazes on the human body. Today, through the improvement of the process, the dissolution of lead and chromium is reduced, and daily porcelain is guided to use under-glaze and middle-glaze, which effectively avoids such problems.

(2) Technology reproduces the flawed beauty of ceramic art unimaginable. There are many non-quantitative factors in the ceramic process, and the probability of failure or defect is high. Defects are processed through process reproduction to make them artistic.

(3) Technology expands the realistic expression of ceramic art. The development of science and technology has broadened the means of artistic recognition and expression. At the moment, new color concepts, such as "structure color" are being proposed, adding new means of expression for visual production. It is foreseeable that ceramic glaze decoration technology will have a newer understanding.

The opportunity-driven technological change of the times also affects the ceramic art reality. Visual production has always been deeply influenced by politics, as well as ceramic art. For example, the Emperor Yongle of Ming dynasty was also influenced by northern cultures and preferred white porcelain. The direct intervention of the Emperor Qianlong of Qing dynasty in the production of ceramic art pushed Jingdezhen ceramics to the top and so on. The aesthetic preferences of the rulers, the concentration of production organizations, and the monopoly of technology gangs together form the destiny community of technology and art, the state and the nation. In this context, the development track of Chinese ceramic art coincides with the basic process of the development of world history, and is now marching towards the highest state of human liberation and free development advocated by Marxism.

**The Evolution of Ceramic Technology Thought: From the Worship of the God of Porcelain Industry to the Respect of Technology**

Some people think that there was no science in ancient China. Based on the investigation of the evolution of ceramic technology, until the end of the Qing dynasty and the beginning of the Republic of China, it was true that the establishment of a scientific system was not found, and more of it was the inheritance of technological traditions.

The non-quantitative composition of ceramic raw materials and the difficulty in controlling the temperature and atmosphere during the firing stage have made the ancestors worship the ceramics. The porcelain god, the fire god, the kiln god in the production of ceramics, and even the story of "Kiln Scarify of Human Body" clearly expresses the complexity of ceramic firing, the awe of technical risks and the psychological sustenance of good wishes. The absence of the worship of molding and decorative gods is also strong evidence that the raw materials and firing stage are the difficulties in the ceramic process, and the key point to focus on the ceramic technology.

With the development of modern materials, thermal energy, machinery and other related disciplines, the establishment of ceramic industry standards and production systems, ceramic production has gradually got rid of the shackles of worship and turned to a production method that relies on science and technology. In this evolution, the traditional supremacy of pragmatism and "Yin and Yang Change", the inertia of thinking influenced the process of transformation from the ancient Chinese science and technology to the traditional system, which is also attempts to answer the "Joseph Question" from the specific dimension of ceramics.

Nowadays, the establishment of an organic balance between ceramic art and technology can truly build a bridge between technology and art, craftsmanship and machine production under the conditions of industrial civilization. The innovative development of ceramic art can follow the technological tradition and approach the material civilization science of the industrial age. The direction of the system is changing.

**Scientific and Technological Progress Brings New Discoveries, Doubts and Thoughts**

Science and technology are constantly progressing and developing. New testing methods and techniques have also been widely used in ceramic technology, and people have begun to re-examine previous forms of decoration. For example, the microscopic analysis of the glaze in Changsha kiln shows that this is a high-temperature glaze technique, which has overturned the previous understanding of underglaze. Mu Ye Tianmu (木叶天目) raised a new question about whether this decoration method is on-glaze or in-glaze decoration. Cognition has historical limitations, and technology is a powerful means of re-cognition. These new cognitions give us important inspirations: the technological tradition needs to be broken, and the boundaries of artistic forms need to be broken.

Throughout the global history, the basic development law is from production practice to the gradual establishment of a scientific system. Visual production and the formation of scientific systems have a close internal correlation and era benchmarking. From the perspective of Giotto's era to the establishment of Copernicus, the establishment of classical mechanics from Da Vinci's realistic art to Newton's establishment of classical mechanics system, from the artistic revolution represented by Manet to the scientific revolution represented by Einstein, illustrating art and science all belong to the universal connotation of human practical exploration activities.

For the answer skills, the ancient Chinese have appropriate theoretical understanding, Zhuangzi said, "Technology approach to the Road", Wei Yuan developed it into a "Technology may be almost into the road, Arts can pass unto God" rationale theory. In an era of relative lack of material and productive forces, in addition to satisfying basic functions and aesthetic tastes, technological innovation did not enter the scientific spiral of substantial spiral, but summarized it into the ambiguous "Tao" and "God" Theories, the metaphysics of the illusion, these are not the precise scientific spirits advocated at the moment. Through the investigation of Chinese ceramic glaze decoration, it was found that ancient China relied on the transfer of practical first

technology, and traditional concepts were not enough to support the breakthrough of empirical constraints. With technical rationality, there is insufficient motivation to form a scientific system.

The author would like to leave questions here; can ceramic art creation continue to advance from technological respect to the free realm of scientific rationality? Can ceramic art creation continue to break through the process conventions and obtain true technical freedom? I believe that the context of the history of technology will eventually answer these two questions.

## Conclusion

A history of decoration is almost the history of human visual production. This article takes a close look at the development process of Chinese ceramic glaze decoration, tries to think rationally on the concrete carrier of "beauty" in the context of the history of technology, tries to lead the thought collision between the history of technology research and the study of visual culture, and initially builds a paradigm for the history of ceramic decoration research.

Ceramics is the first man-made material, rich in scientific and technological and artistic and cultural connotations. In addition to meeting people's daily functional needs, it also generates unique artistic forms. To study the history of ceramic decoration technology, we must start from two aspects: ceramic technology and ceramic aesthetics. Therefore, breaking the professional barriers, establishing a corridor to communicate in different fields, and combining internal and external history of technology history with multi-disciplinary cross-research, can become a stepping stone for the expansion and progress of ceramic art. Continued research into the history of ceramic glaze decoration should draw on the artistic essence of ceramic aesthetics; similarly, the interpretation of issues related to modern ceramic art cannot be separated from the context of the history of ceramic technology.

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