

The Textual Research on the Constructive System of the Porcelain Pagoda Inside of the Great Bao'en Temple

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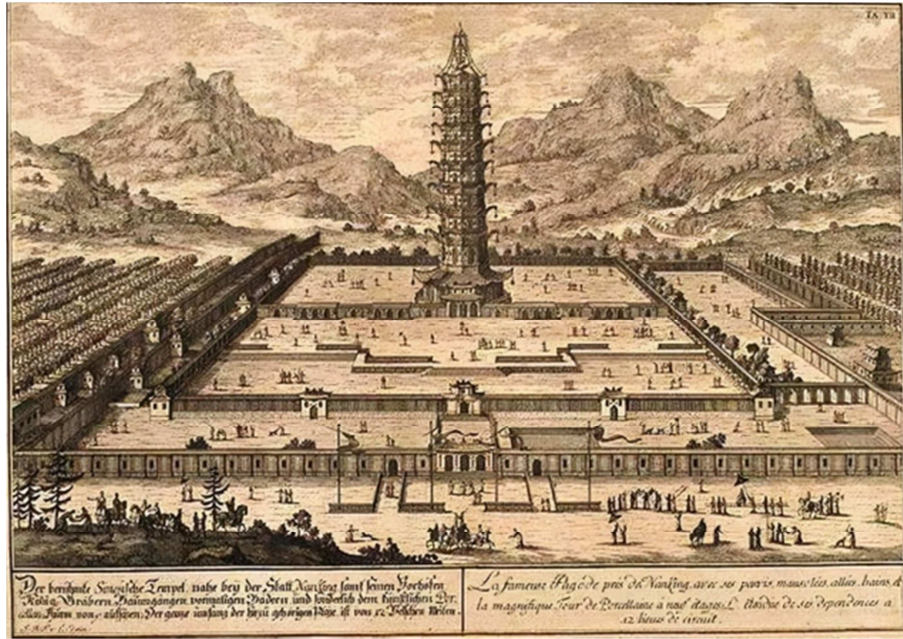
Abstract: In 1412, Zhu Di, the emperor of Ming dynasty, built the Nanking porcelain pagoda to construct the legitimacy of his rule and build a sense of national identity between Han and Tibetan. This paper bases on the porcelain pagoda's new Chinese pagoda style, analyze and conclude the construction system of it from visual, craft and production perspective. Through methodologies of literature analysis, comparative study, and physical research, this paper holds the opinion that visually, the porcelain pagoda is the representative of the feudal political culture of Ming Dynasty, technically, the building of the porcelain pagoda continued the tenon and mortise structure of traditional Chinese wooden structures, yet due to the physical properties of ceramics, which are hard, fragile, and difficult to adjust once fired, its modular precision was forced to be further improved. Therefore, I contend that the mass production of glazed ceramics in Ming dynasty is the craft reaching perfection instead of the development of technology. Despite that the ruler at that time used strict management to control craftsmen, using division of labour and regional coordination to realize the mass production of glazed ceramics, Ming was still unable to achieve industrialization. To search to the bottom, The reason that Western used machines to replace human was to enlarge profit and lower the cost of labour. On contrary, the glazed ceramics industry in Ming dynasty was not people-oriented.

Keywords: Porcelain Pagoda, Constructive System, Module, Mass Production

1. Introduction

In 1412, Zhu Di, the emperor of Ming dynasty started to build the Nanking Great Bao'en temple at the beginning of his reign, and this construction took 19 years to complete. As shown in figure 1, the porcelain pagoda was in the center of the Great Bao'en temple [1], it was made purely in five-colored ceramics, and even the supporting parts were joined by ceramics as well. Except for the diagonal crossbar on the eighth floor and the central column from the eighth and ninth floors to the top of the tower, there is no inch of wood, and the crown has a golden roof. Compared with the Kaifeng Iron Pagoda in Song Dynasty, which pioneered glazed architecture in China, instead of laying the glazed ceramics pieces on the stone tower body,

this pure ceramics pagoda with an ambulatory at the bottom was a new Chinese pagoda style created by the Ming Dynasty. [2] The porcelain pagoda was considered as one of the Seven Wonders of the Middle Ages, despite of its uncountable value, it was unfortunately destroyed by war in 1856. Currently in Chinese academic circle, the research on the porcelain pagoda of the Great bao'en Temple has mostly focused on the narrative of its grand production scale and its image expression as an Eastern symbol in the west. However, this paper aims to analyze its exquisite constructive technology and production method in order to provide valuable insights for future academic research.



Source: paint by Johan Nieuhof

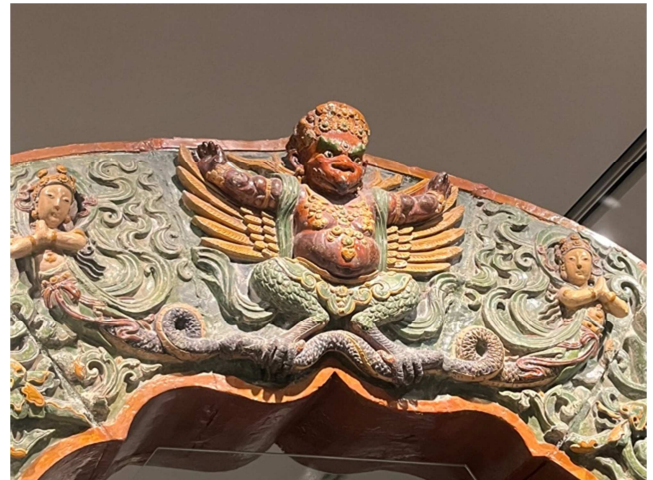
Figure 1. The full view of the Great Bao'en temple and the porcelain pagoda.

2. Visual System: Building Faith

From Eastern Wu to Ming Dynasty, the porcelain pagoda has undergone many reconstructions and repairs, from the original sandalwood pagoda to stone pagoda, and finally made of full-body glazed ceramics. This chapter aims to analyze the reason why the emperor decided to use colored glaze as the material.

Compared with wooden pagodas and stone pagodas, the impact of colored ceramics as the material for cultural construction is as follows. To begin with, as can be seen from figure 2, it is strongly decorative, and it can propagate images and culture through the surface of the architecture, just as the Christian church draws the schematic Bible on the painted inlaid glass window [3], the gorgeous carved image of the pagoda is the most direct and effective tool to promote culture, and the overall decoration maximizes the great nation's dignity and spiritual worship of Ming Dynasty. According to official records, Emperor Zhu Di of the Ming Dynasty built the Great Bao'en Temple to commemorate his gratitude to his parents. [4] However, I believe that there are other deep-seated reasons. Firstly, during Zhu Yuanzhang's reign, he ostensibly supported Buddhism, but in essence, he kept restraining Sangha from the economy, political, and ideological aspects. Secondly, it can be seen from the visual characteristics of the porcelain pagoda, such as the image of the six ornaments on the arch, that the pagoda is influenced by Tibetan Buddhism. Since the founding of the Ming Dynasty, the government has paid special attention to the rule of Tibetan areas and adopted policies such as the separation of politics and religion. In a word, Buddhism in the Ming Dynasty was a tool of national construction, was guided by Confucian culture to serve the

imperial power, and was used to secretly help stabilize the reign. It's shaping of ideology can be visually demonstrated on the pagoda through carved ceramics decoration.



Source: author took photograph at the Nanjing Museum

Figure 2. The decorative surface of the ceramics components of the porcelain pagoda.

Moreover, mass production in ceramics is relatively economical. Back in Ming Dynasty, which has not yet realized mechanized production, carving on wood and stone required a lot of manpower. The colored glaze decoration can be molded with clay and made into molds and the patterns can be reused through the modular assembly. In addition, in the decoration of large buildings, the cost can be greatly reduced by using the method of glazing for coloring compared with painting colors on wood.

Last but not least, the colorful glazes of ceramics also make the use of color become a means of etiquette. The use of

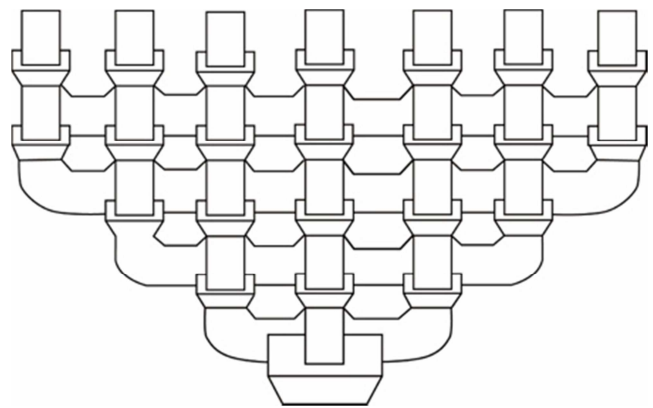
colored glaze in architecture has been strictly restricted since Song Dynasty because of its mold-forming processing method. Under the centralized ritual system, in the 26th year of Hongwu's reign in Ming Dynasty, there was a detailed hierarchical regulation on the ridges, arches, and other decorations used in the official residences from the first grade to the ninth grade. For common people, there was a decree that "arch of wooden architecture is not allowed to be used and colored". According to the imperial edict of Zhu Di when building the porcelain pagoda, "collect craftsmen who do their best to make five-color colored ceramics" [5], the porcelain pagoda has "a five-color lotus platform on the top... it is a series of eight sides of the red couplets... covered with blue tile scales, the dragon head and the leopard tail, and the top and bottom are overlapped... The walls are dark (chalk), and the arches are red." In addition, there is material evidence that the archaeology report shows that the surface of the colored ceramics bricks unearthed from the ancient well of the Great Bao'en Temple was yellow, green, red, black, white, and other multi-colored glazes. [6] Compared with the iron tower in Kaifeng in Song Dynasty, which was decorated with brown glaze ceramics, and the 13th level ceramics tower of Wenshu Temple in Mountain Wutai, which was decorated with yellow, green, and blue colored ceramics, [7] it can be seen that the porcelain pagoda of the Great Bao'en Temple is a ritual building only available in the royal temple which was built according to palace reconstruction regulations", and its production scale represents the top level of ceramics technology in Ming Dynasty.

3. Craft System: Modularization from Structure to Decoration

After investigation, it can be seen that the colored glaze components often copy from one piece as a model, this is an important feature of the mass production of glazed ceramics in the Ming Dynasty. The batch production of glazed components mainly adopts three methods. The first is the wheel tile method, which is mainly used for tiles, the second is the mold method, which has a wide range of applications and can be applied to the production of most structural and decorative parts, the third is the combination method of mold and sculpture, that is, molding with mold first, and then carving details by hand, which applies to components with strict requirements for patterns, such as the Zhengwen. In this part, the author takes the bracket system of architecture, which is a supporting structure made by mold method, as an example to analyze the highly standardized production characteristics that the glazed ceramics industry in Ming Dynasty shows compared to traditional wooden structure buildings.

The key to the successful assembly of bracket systems [8] of architecture is the precise fitting of tenon and mortise. In Song Dynasty, it was clearly stated that "the eight Division had to make a detailed plan before any construction. It is not allowed to reform at any time. If it has to change during construction, it must be reported." That is to say, in an ideal

situation, building construction should be carried out in accordance with the design step by step. Through the division of design and construction, the strict management of material specifications and budget quota can be achieved, which can also promote the efficient implementation of the project under the supervision of the government. However, in reality, due to the existence of many variables such as the changing of personnel, materials, and site environment, constructors often need to constantly adjust components to adapt to unexpected changes during installation. Taking the bracket system of Falun wooden Temple as an example, the craftsman inserted the pink powder mark on the top of the bucket during installation to observe whether the connection between the two is loose and repeatedly adjusted the size of the bucket to make them fit. [9] This action proved that the wooden parts still need manual adjustment after being made according to the drawing. However, the adjustment of modules requires that the constructors have certain knowledge of engineering structure, wood processing and design, which shows that the design, production, and construction personnel are not effectively divided, and different professionals cannot maximize efficiency.



Source: draw by the author

Figure 3. The side view of the bracket system.

In conclusion, the biggest difference between the ceramics bracket system and the wooden bracket system is that wood can be adjusted at any time from production to construction, while the proportion of glazed ceramics cannot be changed by conventional means once it is fired and shaped, because once the glaze layer is ground off, it cannot be restored and glazed ceramics, as a hard material, is extremely time-consuming to alter the shape and easy to damage. Therefore, the physical characteristics of glazed ceramics forced the craftsmen of Ming Dynasty to further improve the design accuracy and overall planning ability. The integration experiment between modules was transferred from construction to mold production, which further promoted the standardization process of glazed components in the Ming Dynasty.

In the meantime, the application of glaze ceramics further deepens the idea of replacing large components with small components in wood modules to make full use of materials. In addition to the bracket systems, parts such as architraves and

glazed columns are also composed of components, which can effectively reduce the rate of substandard products during production, also, maximize the use of kiln space, and reduce fuel costs during firing, at last, reduce the inevitable damage rate and labor costs of transporting large quantities of fragile goods during construction. It is also because of size of the components used in the porcelain pagoda is so precise, once the mold is lost or damaged, it is difficult to reproduce. Therefore, all components are stored in triplicate in the basement of the Great bao'en Temple in case of emergency.

In addition to the progress of standardized production, the carving details of the glazed pagoda highlight the ancient idea of "changing within consistency" in arts and crafts. The so-called "consistency" refers to the coordination and unity of the whole, while "change" refers to the richness and differentiation of partial details. The porcelain pagoda was praised by Wang Shizhen as "exquisite as a ghost's work".

According to the discovery of the Nanking Museum's finding, the unearthed colored glazed tiles were made from the same mold, despite they have the same size and pattern, the details are not completely coincident after comparison. As shown in Figure 4, these two images are the arch brick components of the porcelain pagoda restored in Nanking Museum, which are symmetrical, I mirrored the left image to show the difference clearer. It can be seen that the vine decorations of the two images are slightly different in detail, which proved that the decorative parts of the porcelain pagoda were also manually decorated after taking out of the mold, to achieve artistic personality. In the view of creation in ancient China, art should conform to nature. Reproduction and imitation are not the goals, but constant change and adjustment to obtain a new form. Ming craftsmen created subtle differences in the sequence of reproduction to break the stylization of decoration to create a dynamic feeling.



Figure 4. The comparison between two arch brick components of the porcelain pagoda.

4. Production System: Mass Production and Labor Division

Although the craftsmen of Ming Dynasty controlled the construction process of glazed ceramics almost to the extreme, there was no substantive breakthrough in the construction structure and production technology of glazed ceramics. I believe that this limitation has much to do with the political environment and production system at that time. Back then, Zhu Di ordered the Ministry of Works to construct according to the blueprints of the porcelain pagoda designed by the imperial palace, and recruit high-quality craftsmen from all over the country to gather in Jubao mountain official kiln then prepare materials and parts according to the law, and conduct assembly and splicing after rating.

4.1. Strict Quality Control by Carving Names on Manufactured Pieces

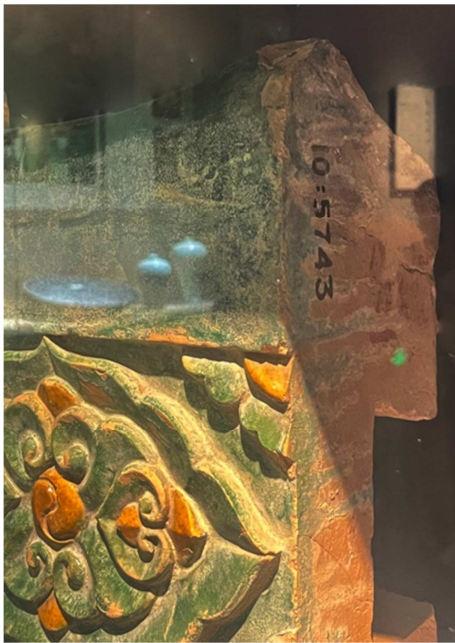
To consolidate the imperial power, Zhu Yuanzhang, the first emperor of Ming Dynasty, carried out policies such as sea ban, emphasizing agriculture, and restraining commerce many

times. [10] Although his successors made some policy adjustments, they continued Zhu Yuanzhang's thought of ruling the country, that is, to build a large agricultural country in strict order, so as to gain a stable government. Although Ming Dynasty was the most important economic entity in the world at that time, its economic growth was mainly due to the steady growth of population and cultivated land area, rather than technological breakthroughs. Therefore, behind the apparent prosperity of the economy in Ming Dynasty, the income of common people remained unchanged, and the production activities of craftsmen were mostly limited to providing services for the royal family, rather than for market exchange and expanded reproduction. In particular, compared with other official works, the production demand for building materials for the royal family was not long-term, it was more likely a temporary institution.

As Zhu Di described the construction of the porcelain pagoda: "It is the military and civilian people who are diligent in their efforts. The number of people who are eager to work, just like the water flowing down was invincible. The goal is to create something new, expand the temple, and redesign the blueprint. The production scale is ten thousand times bigger than before." [11] In order to ensure that the country can

collect a large number of craftsmen in a short time, the ruling class will use the craftsman system to restrict the freedom of handicraftsmen, they are forced to provide free labor, and even travel expenses need to be raised by themselves. Through the multiple cooperation of administration, justice, supervision, and the military, they can promote the orderly development of the government-run handicraft industry and gather huge productivity. [12]

Because there were many kilns in Jubao mountain kiln, in order to ensure the quality and clarify the responsibilities, the kilns were managed in different areas, and each kiln had a specific number, as can be seen in figure 5, which continued the quality inspection system by writing the craftsman's name on the manufactured pieces. Ernst Boerschmann quoted a picture of the external ceramic plate of the porcelain pagoda from the Victoria & Albert Museum in his book "Western Mirror: China's Pagoda I (Part 2)", the installation position and number were marked on the edge of it, also there was a sign of the kiln's logo. [13] Words such as "Weiqing Chang" and "Taiping Chang" were also found on the bricks of the existing Bao'en Temple bricks. There are even some relics with a more clear division of labor stamp, and there are corresponding records of the chief, the head, and the craftsman in charge of making, coloring, and firing. [14] According to the Ming Huidian, "Anyone who does not behave as the law will be given 40 lashes." [15].



Source: author took photograph at the Nanjing Museum

Figure 5. The number marked on the ceramics components of the porcelain pagoda.

In case of quality problems, not only the craftsmen will be punished, but also the supervision at all levels will be punished accordingly. [16] Although this strict management ensured the quality of the products, the craftsmen were miserable and there were many fugitives. The Ming government even needed to set up a special "glazed kiln army"

to suppress the craftsmen and maintain order. The essence of this feudal handicraft production relationship is that the ruling class uses imperial power to exploit the people in a disguised form. Andre Gunder Frank once said in his book "Reorient: Global Economy in the Asian Age" that the invention of mechanized production often exists in the system of high salary, which is to save manpower and expand profits. [17] On the contrary, the huge group of craftsmen under the coercion of Ming government and its harsh treatment system could not effectively stimulate the invention of machinery. In addition, as front-line participants in the production, craftsmen can only do their utmost to complete repetitive work to protect themselves which lost their autonomy. These factors are part of the reasons why Ming Dynasty successfully achieved mass production, but failed to take the lead in industrialization. Therefore, the greatness of the construction of the porcelain pagoda is reflected as the peak of Ming Dynasty craftsmanship, rather than technological innovation and progress. Behind the prosperity of its appearance is the lament of countless craftsmen. As a result, after the middle of Ming Dynasty, the phenomenon of official craftsmen slacking off and escaping continued to increase, and the conflict between the ruling class and craftsmen broke out completely.

4.2. Cross-regional Cooperation Between Design and Production

In addition to various management systems, the Ming rulers also achieved the maximum efficiency of craftsmen through the division of labor and cross-regional cooperation. According to the scientific and technological analysis of firing temperature and water absorption, Ding Yinzong and others determined that there were porcelain sculpture samples from Jingdezhen in Jubao mountain kiln. Nanking Museum also found a piece of white porcelain in the third ditch of the ceramics Kiln in Jubao mountain, the shape is consistent with the flying "Molaga" component shape on the arch of the porcelain pagoda. Therefore, it is speculated that the master mold of the pattern of the glazed tile may be made in Jingdezhen. In terms of efficiency, the same pattern can be filled in different positions of the porcelain pagoda and the same structure can be combined with different patterns. This flexible combination mode improved the utilization rate of molds, reduced production costs, and made it easier to realize the personalized representation in batch production described in the previous chapter. In terms of division of labor, the production of a single part is divided into several steps. Therefore, the division of labor and cooperation between Jingdezhen sculpture making and Nanking Jubao mountain mass production can be carried out simultaneously. The further refinement of the division of labor between brickwork and pattern reproduction has led to the further specialization of the ceramics industry and the improvement of production efficiency. Therefore, the raw materials used for the construction of the porcelain pagoda are from Dangtu, Anhui Province. From the collection and transportation of materials to carving, molding, production, and installation, craftsmen from all over the country need to be temporarily organized to

carry out division and cooperation in all links. The logic behind the reasonable operation of the system is through a strict management system. However, with the gradual maturity of manufacturing technology, labor division, and ancient transportation, the labor cost has become increasingly low, and to a certain extent, it has deviated from the historical track of industrialization.

5. Conclusion

In terms of production purposes, the porcelain pagoda of the Great Bao'en Temple is a visual product of the feudal political culture of Ming Dynasty. In terms of production relations, Ming Dynasty was far more enthusiastic about administrative governance than the pursuit of technological progress, which prompted craftsmen to master the ceramics craft more and more sophisticated. The Ming government achieved this through large-scale mobilization of resources, division of labor, and strict management. The parts of the arch tiles alone involved the division of labor and cooperation in many places, such as Dangtu, Jingdezhen, and Nanjing, which made it possible to manually realize the mass production of modules at that time. I believe that this may also be one of the reasons why China missed entering modern industrial production earlier. Instead of people, the government-oriented the entire process of production by effectively controlling the sufficient cheap labor force, resulting in the lack of endogenous incentives to realize mechanized production in Ming Dynasty. Therefore, it is considered that common people's lacking of creativity was one of the reasons that caused the stagnation of science and technology.

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