Research on the Innovative Design of Traditional Motifs of Twisted Porcelain Based on Shape Grammar

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Abstract. Twisted Porcelain, known to a few people, is one of the world-class tangible cultural heritages, and there is an urgent need to pass on and develop the cultural factors and characteristics. This paper aims at the innovative design of motifs for the image elements of Twisted Porcelain, generating new motifs and launching the application of the products, maintaining the innovative vitality of the motifs themselves, and promoting the dissemination and development of the culture of Twisted Porcelain. Based on the theory of shape grammar, the motifs of Twisted Porcelain collected from the field survey are screened and analyzed in terms of apparent features, the target motifs shapes are determined, the motifs of Twisted Porcelain are extracted and evolved, and the questionnaire method is used for the quantitative assessment of the motifs. On the basis of retaining the artistic characteristics of Twisted Porcelain, the specific evolution data materials of five traditional motifs, including chrysanthemum motifs, weaving motifs, feather motifs, wheat motifs and wood spinning motifs, are derived, and the cultural and creative products of the representative elements of Twisted Porcelain are also constructed. Provides the innovative evolution strategy of traditional motifs of Twisted Porcelain, motifs can produce different visual experiences according to different carriers, such as the application of derivative creative products, can increase the cultural added value of the main body of Twisted Porcelain and market competitiveness, expand the influence of Twisted Porcelain culture.

Keywords: Grammar of shapes, Twisted Porcelain, Traditional Motifs.

1 Introduction

The inheritance and development of cultural heritage have received close attention from the State and society in recent years, for example, through the building of platforms, policy guidance and the standardization of protection measures adopted by national Governments. Traditional culture contains precious national skills and strong cohesion, and helps to improve cultural soft power. In the new era, how to look at the intangible cultural heritage as an important carrier of Chinese excellent traditional culture, how to realize the creative transformation and innovative development of

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excellent intangible cultural heritage, and how to satisfy the people's demand for excellent traditional culture is an important topic for better inheriting and carrying forward the intangible cultural heritage [1].

Twisted Porcelain is one of the indispensable representative products of Chinese ceramic traditional culture. Domestic and foreign found and public collections of Twisted Porcelain about 60 pieces [2]. With "the same as the surface, the porcelain in the gentleman" called Twisted Porcelain originated in the Tang dynasty, the Northern Song dynasty reached its peak, is two or more different colors of porcelain clay kneaded and together, and then twisted billet, making shape, pouring a layer of transparent glaze, fired and become [3]. Twisted Porcelain motifs is the most delicate and special, unlike other ceramics only on the surface of the process of decoration, it is the same motifs inside and outside the tire, even if the product is damaged, the internal still preserves a clear motifs, cohesion of the Chinese people from generation to generation of superb skills and aesthetic interest.

According to the current stage of research, most of the research is aimed at the production and firing process of Twisted Porcelains, while the traditional motifs of Twisted Porcelains is relatively rare. In order to promote the development and innovation of Twisted Porcelain cultural heritage, there is an urgent need to study and research on traditional motifs, combine with the theory of shape grammar for the extraction and evolution of traditional motifs of Twisted Porcelain, inject innovative power into the motifs features, and carry out the application of motifs to promote the sustainable development of Twisted Porcelain products.

1.1 Research Background

Shape Grammar (SG) was introduced in 1972 by George Stiney, a professor at the Massachusetts Institute of Technology (MIT), who laid down the theoretical foundations of shape grammar by describing the conceptual and structural system of shape grammar completely in the literature [4]. It was first elaborated as a new language theory of language transformation as well as transliteration [5], later applied to architectural design and widely extended to industrial design [6]. Shape Grammar enables products to generate new shapes and maintain brand continuity according to certain rules [7] and is also used to generate new product styling solutions [8].

Investigative study found Lee H C, Tang M X [9] analyzed the product in the form of Shape Grammar (SG) rules to derive shape features and then encoded the rules into code scripts represented by Genetic Algorithms (GA) to generate new Shape Grammar rules defining new combinations of shape features for alternative designs.This framework supports the design of product components and product configurations.Sayed Z, Ugail H. Palmer I et al [10] used shape syntax to generate new forms of Islamic geometric motifs (repeating units of motifs) to provide good aesthetic effects.Cui J, Tang M X [11] developed a two-stage generative shape syntax based on shape decomposition approach using free spline curves along with new interpolation algorithms for deriving initial design concepts in an application of Zhuang embroidery design. The shape method is better able to simultaneously obtain morphological elements from products of the same family and other reference products, and can max-

imize the proximity to the design goals and meet the user's needs can support the design applications in the field of art and culture [12]. Dai Hohong et al [13] extracted the cartoon image feature information, disassembled into the design elements applicable to the design, and then the design elements through the transformation, combination, abstraction, deformation of the way transplanted to the tram styling design, and then the formation of a cartoon image of the regional culture can reflect the design of the tram program.

In the Northern Song Dynasty, the Twisted Porcelain has “white as snow, red as Zhu, green as green, thin as paper, bright as a mirror, sound like a chime, flowers like brocade, condensed as grease, moist as jade,” the appreciation, known as China's history of a great porcelain [14]. The inspiration for the creation of Twisted Porcelain is to imitate the rhinoceros skin lacquerware concave and convex surface to start, in the rhinoceros skin lacquerware due to the high and low lacquer layers show different motifs, resulting in brilliant color characteristics of the process of inspiration. The most cultural genes and uniqueness of Twisted Porcelain is the motifs motifs produced during the process of churning, adopting different decorative techniques with ordinary ceramics, ordinary ceramics are mainly under the glaze decorations, in the surface of the surface of the clay or the body of the art of processing using a variety of techniques such as carving, sticking and painting, etc., and Twisted Porcelain is in the molding process will be twisted in the motifs in the body of the blanks (see Fig. 1).

Fig. 1. Comparison of the motifs of the porcelain body before and after forming.

Motifs elements basically belong to the level of artifacts, through the interpretation of the relationship between the elements, the background (material, technology and other material basis and the spirit of the times, social structure, value orientation), to understand its cultural spirit and the inevitable connection between the elements [15]. Twisted Porcelain will be texture and texture for the intermingling of the internal motifs and the external artifacts are natural, is the perfect embodiment of the good “harmony”, so that we feel the internal and external coherence, the beauty of the harmony of a single breath [16]. Twisted Porcelain motifs as an important cultural expression of Twisted Porcelain, behind the cohesion of people's aesthetic interests and the cultural needs of the society at that time, the urgent need for this visual symbol language for inheritance and development.

2 Innovative Path of Traditional Motifs of Twisted Porcelain

2.1 Research Process of Twisted Porcelain Motifs Based on Shape Grammar

Shape Grammar is inspired by Phrase Structure Grammar [17], the rules are applied to syntactic structures composed of natural language, and Shape Grammar consists of rules for selecting, processing, and applying the inner and outer contour shapes of shapes. When applied to design work, it is sufficient to replace words and shapes correspondingly in the grammar rule base. The focus is on extracting the desired internal keypoints, deconstructing the keypoint shapes into unit shapes, and subsequently performing the unit derivation operation mechanism. The theory is capable of transforming a set of initial shapes into more two- or three-dimensional shapes with "sum and difference" characteristics according to specific rules [18].

According to the intrinsic rules of the shape grammar theory, a product shape grammar is defined as a quaternion SG = (S, L, R, I), where SG represents the set of deformations of S such as copying, adding and deleting, and mirroring. S in parentheses represents the set of all contour shapes of the product, L is the aggregated set with a distinct identifier number, R is the finite set after rule inference, where all shapes obtained by inference are shown, and the final I in parentheses is the initial form of the shape, which represents the basic unit.

SG analysis is used to extract the elemental features into shape rules, and the SG set simulates the mapping, and the contained diffeomorphic shapes are derived from the initial regular shapes. In shape grammar theory, the most commonly used Euclidean geometric transformations and Boolean transformation rules, such as copy, translation, rotation, perpendicularity, combination, and mirroring, evolve from the initial shapes that retain the original features (see Fig. 2), which displays the shape transformation of the unit represented by the letter D.

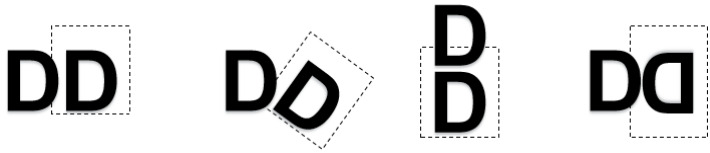


Fig. 2. Transformation of the shape and position of the letter D.

Taking shape grammar as a design method, we excavate the artifact motifs on Twisted Porcelain, carry out spatial reorganization and application of elements, and expand the decorative language and cultural connotation of Twisted Porcelain. Collecting the characteristics of the texture examples of Twisted Porcelain products, decomposing the original texture through the shape grammar, recursively applying the expressions derived from potentially complex shapes, and carrying out design analysis and generation(see Fig. 3), the research process is divided into three stages. Firstly, the

product motifs form collection of Twisted Porcelain is carried out to extract the common representative traditional motifs, and summarize and screen out the non-similar motifs characteristic elements with high frequency. Secondly, the characteristic elements of the grain motifs of Twisted Porcelain are obtained, and the rules of inference are used to combine with the design condition constraints, such as modeling, proportion and size, to carry out the evolution of the grain motifs module. The final stage is to generate the motifs scheme, select and refine the motifs scheme obtained from the inference, and then carry out the evaluation and inspection of the scheme to determine the output of the final motifs scheme, which is able to realize more modernized conversion of Twisted Porcelain motifs from plane to three-dimensional.

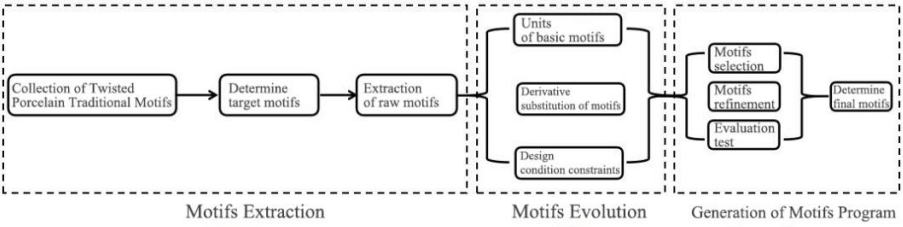


Fig. 3. Research path of innovation of twisted porcelain motifs based on shape grammar.

3 Extraction and Evolution of Traditional Motifs in Twisted Porcelain under Shape Grammar

3.1 Extraction of Original Motifs

The city of Jiaozuo in Henan Province, China, was named after the Jiao family workshop, which specialized in the production of Twisted porcelains, and from which an endless stream of beautifully crafted porcelains were unearthed. The former glory of stranded porcelain is still preserved in the area. Most of the motifs of Twisted porcelain are modeled on the f-form characteristics of plants, with a lifelike technique.

Field investigation and sampling were carried out in Xiuwu Dangyangyu and Jiaozuo Stranded Porcelain Museum in Jiaozuo, Henan Province, where 300 stranded porcelain samples were randomly collected and compiled, and quantitative statistics of the motifs were summarized. The highest frequency of style motifs is 36 pieces of chrysanthemum motifs, 31 pieces of weaving motifs, 28 pieces of feather motifs, 25 pieces of wheat motifs, 23 pieces of wood spinning motifs, 18 pieces of petal motifs, the remaining Twisted Porcelain products were diamond motifs, back to the motifs and quicksand motifs motifs, the basic characteristics of motifs is not obvious and the number of less, do not have the role of the popularization and promotion of information, and ultimately selected six motifs images as the object of study.

Twisted Porcelain is made of kaolin stained color clay for kneading and pulling stranded production, the same external and internal motifs, mainly flora and fauna and geometric motifs, some scholars image of its decorative effect such as floating clouds

and flowing water, changes in steam [19]. Chrysanthemum motifs around the center of the radial row, line repetitive superposition; weaving motifs is in accordance with the relative direction of the combination of arrangements, such as woven mats, staggered; feather motifs modeled on the outline of the feathers of the animal wings, showing a feather superposition of the form; wheat motifs is in the same direction of the successive superposition of the arrangement of the same direction; wood spinning motifs structure and the same motifs of the tree cross-section, as the wheel of the year a circle wrapped around the circle, full of dynamism; flower petal motifs Arranged by a fixed position of the curve, surrounded by pieces of petals, gradually upward trend, with rhythm and rhyme.

Determine the initial motifs expression of Twisted Porcelain products, the external contour of the research object as the initial shape of the shape rule reasoning, mainly used for the boundary fixed shape rule reasoning [20]. The starting point for extracting the target motifs is the whole motifs, and the contours of the branching units found from the whole motifs, similar to the tree structure branching of the neural network coupling model, are extracted to represent the elements that have their commonality, such as the extracted target motifs (see Fig. 4). The target motifs has the characteristics of standardization and generalization, which plays an important role in the subsequent design and application of Twisted Porcelain motifs.

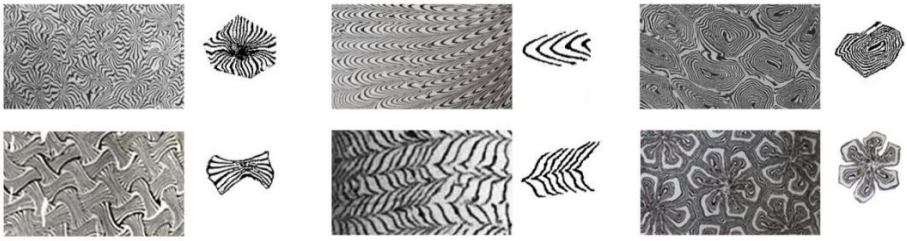


Fig. 4. Extraction of representative traditional motifs of twisted porcelain.

Extracted from the original motifs motifs shape broken up and split, random petal number, arrangement and distribution and direction of position and other rough spatial calculations, designate the petal curve segment as a major feature to identify the original motifs (this stage can be specified by the designer or the user). For example, Figure 5 Twisted Porcelain chrysanthemum motifs curve of a single feature recognition, extracted Twisted Porcelain motifs structure exists in a common qualitative language features, follow the style of the original motifs, enhance the motifs three-dimensional sense, showing the natural order of beauty.

Although there are different visual effects of different motifs of Twisted Porcelain, most of the motifs are based on repetitive fission, vertical and horizontal links with each other, and the image style is simple and elegant, with logical simplicity and regularity of expression. The theory of shape grammar emphasizes the beauty of rich changes and the pursuit of simple and clean decorative beauty. Some of the outlines have different shapes, but they are consistent in visual style expression and literary

meaning. These characteristics indicate that the use of the rules of shape grammar is allowed to create a balanced and smooth spatial effect, which is conducive to the iteration of the elements of the motifs, and side by side confirms the feasibility of using the shape grammar to express the creation and design process of the Twisted Porcelain motifs.

Fig. 5. Evolution of basic motifs units.

3.2 Derivation of Motifs

The basic unit deformation of tattoos, in addition to using a large number of rules such as translation, copying and rotation for external curve transformation, there are also methods such as replacement, addition and deletion. For the angle of the motifs as well as part of the position of the combination of single or multiple motifs elements to change the arrangement, can be retained in the traditional motifs characteristics at the same time to obtain a large number of innovative design solutions, and easy to form a unified style [21]. The decomposition and deduction of Twisted Porcelain motifs graphics is a crucial part for the subsequent output of innovative solutions.

As shown in Figure 6, the chrysanthemum motifs is deduced three times in finite variables according to the fixed rules of shape grammar. In line with modern aesthetic standards, the rules need to be selected according to the characteristics of the chrysanthemum motifs spreading from the center to the surroundings, and the arrangement will be grouped through the change of different forms to increase the number of basic units generated, in order to enrich the diversity of motifs modeling. The motifs elements will generate many variations according to the number, distribution, and proportion between two motifs adjacent to each other, showing all the possibilities of motifs shape transformation without worrying about repetitive sequences and overlapping spatial relationships, and the emergence of motifs shapes helps to stimulate the creativity of designers in the conceptual design stage[22].

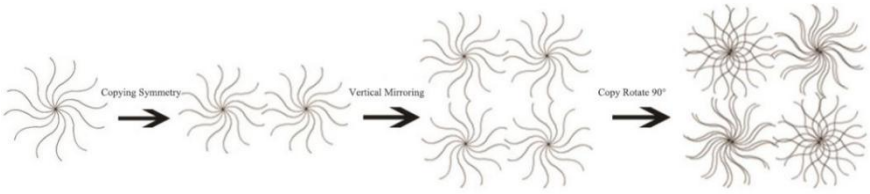


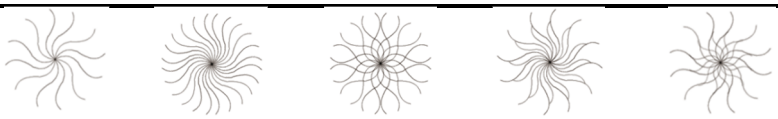
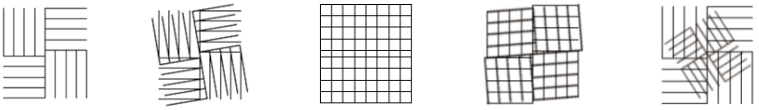
Fig. 6. Evolution of the basic unit of chrysanthemum motifs.

The evolution of motifs for the Twisted Porcelain motifs provides a wealth of material to help produce the same category of innovative decorative modeling, but the changes in this process also need to pay attention to the overall structure of the motifs, the balance of the relationship between the lines of movement, etc., can not simply randomly adopt the arrangement of motifs between the evolution of the distance, and secondly need to examine the constraints of the design conditions, such as the size of the product, the style of the judgement and the modeling constraints and so on. At the same time, we need to pay attention to the influence of modern aesthetic concepts and humanistic aesthetics.

3.3 Reorganization of Motifs

Without affecting the original characteristics of the motifs attributes, you can reproduce the combination of their own motifs. After the last stage of Twisted Porcelain motifs after the deduction, in order to ensure that the original motifs of the basic features continue to innovate and enrich, under the conditions of the motifs change position is unchanged, the use of motifs to fill in the changes in its own method, from the Twisted Porcelain samples screened and extracted chrysanthemum motifs, braided motifs, feather motifs, wheat grain, as well as the wood spinning motifs and other five motifs, the original motifs for the innovation of the changes. For the law of evolution, which has a high repetitive usage rate, the basic unit of the motifs must go through more than two iterations to get it, and this process is called initial evolution.

Table 1. Reconstruction of twisted porcelain motifs.

Category	Initial Motifs	Reorganization A	Reorganization B	Reorganization C	Reorganization D
1					
2					
3					
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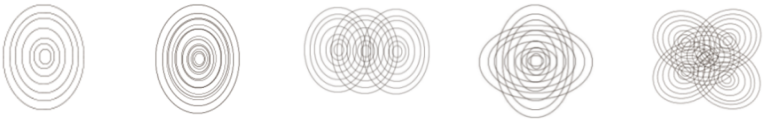
5					

Five tattoos are used as initial shapes and are reorganized 4 times to form different tattoos. The variations of recomposition include shape rules such as motifs mirroring, displacement, rotation and array to get the final motifs graphic(see Table. 1). Among them, the chrysanthemum motifs, weaving motifs and wood spinning motifs shape variations on the composition is complex and full, and in line with the laws of formal beauty. While the feather motifs, wheat motifs motifs elements are relatively simple, the line direction is slightly monotonous, resulting in small modeling changes.

In order to select the final motifs, a questionnaire was used for the evaluation of motifs screening, the scoring standard of the questionnaire is divided into 1-5 points, the higher the score represents the higher the degree of satisfaction of the user's favorite motifs. The motifs is divided into 5 groups, each group has 5 motifs, a total of 25 motifs as evaluation options.

A total of 100 questionnaires were distributed online, with no geographic restrictions, to users who participated in the questionnaire according to a randomized format. The results of the questionnaire were 86 valid sample sizes were recovered, 59.4% of the questionnaires were from females and 40.6% were from males, of which 13 questionnaires were from people with art and design backgrounds.

Users are required to review the original features of the tattoos, as well as to understand the cultural attributes and meanings of the tattoos, and to set a uniform standard to reduce the error, the tattoos will not be affected by the color, size and dimension, and so on. Finally, the average score of all the scores is calculated, and the highest rated tattoos are selected to be applied to the products, and the results of the questionnaire scores(see Fig. 7).

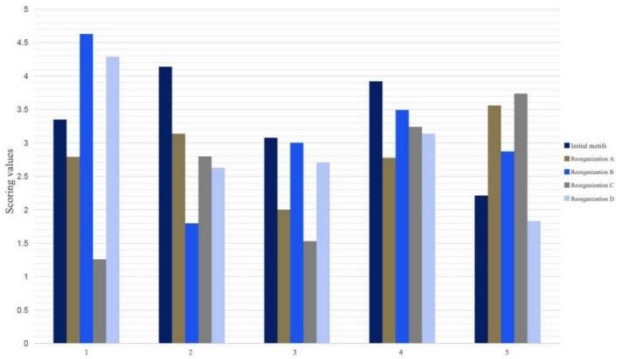


Fig. 7. Statistics of mean scores of questionnaire survey on coiled porcelain motifs.

Among them, chrysanthemum motifs reorganization B has the highest score among all motifs, followed by reorganization D and the initial motifs of weaving motifs. According to the questionnaire, it can be found that the innovative motifs with their own rules and individual flavor characteristics are more likely to be recognized and loved by users, and in this regard, it is necessary to capture the personalized marks of traditional motifs in the process of motif reorganization and evolution.

4 Product Applications of Twisted Porcelain Motifs

According to the results of the above analysis, among the motifs obtained by combining the evolution of shape grammar, the chrysanthemum motif marking reorganization B of Twisted Porcelain receives the highest score, with a strong rhythmic line structure, capable of representing the cultural connotation of Twisted Porcelain that conveys meaning by shape and simplicity and naturalness. Next, the product application of motifs, chrysanthemum motifs reorganization B geometric motifs to repeat the increase in the use of, if necessary, can be enlarged and reduced, the position of the rotation and other operations, the purpose is to apply to the specific product contour modeling, increase the line characteristics of the motifs of the utility, but also conducive to the expansion of the visual impact of the product.

Twisted Porcelain chrysanthemum motifs are applied to cultural and creative products in a geometric line plane way, pursuing smooth and rounded curves to reflect the rhythmic motifs of the chrysanthemum motifs when following the main tone of the product color, and the design of the cultural and creative product motifs application is shown in Fig. 8 and 9. The application is to apply the extracted chrysanthemum motifs to products, such as canvas bags, cell phone cases, umbrellas, mugs, postcards and other daily life, so that people can recognize and understand the culture of Twisted Porcelain in the process of using. By harnessing modern design techniques and the fusion of diverse cultures, porcelain products exude a contemporary allure that resonates with present-day aesthetics and market demands[23].

Twisted Porcelain motifs provide more characteristic elements of the culture, in addition to the application of color, shape and other elements of these elements, are able to promote the development of cultural products, such as the Forbidden City cultural relics behind the fire of cultural and creative products, the Forbidden City's cultural relics, architecture, historical stories, and other elements of the application of products, not only to show the beautiful mood of the culture, but also to let people feel the charm of the traditional culture at a close distance, to increase the non-heritage culture of the economic Added value, and at the same time also promote the dissemination and development of Twisted Porcelain culture.

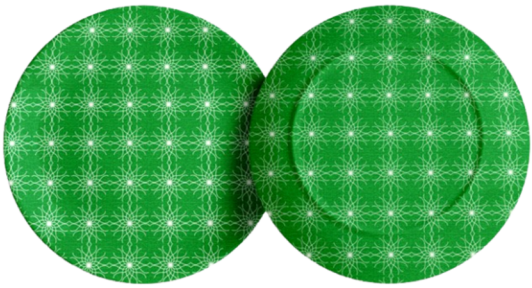


Fig. 8. Examples of Twisted Porcelain Chrysanthemum Patterns Applied to Ceramics

Fig. 9. Examples of twisted porcelain chrysanthemum patterns applied to different products

5 Conclusions

This paper applies the shape grammar theory combined with Twisted Porcelain to propose the strategy of innovative design of traditional motifs of Twisted Porcelain. Based on the motifs of Twisted Porcelain objects, we capture and analyze the characteristics of motifs, and carry out research and analysis from three major aspects, such as extraction of motifs, deduction and reorganization of motifs, and then get the motifs that represent the traditional culture of Twisted Porcelain in the survey and evaluation of the users for the subsequent application of the products. The shortcomings are the limited number of experimental samples, the need to expand the sample, and secondly, the survey and evaluation of motifs should maintain a high degree of objectivity, the need to dig deeper into the investigation of the user's needs, in order to meet the user's needs at the same time, maximize the effectiveness of the optimization of the traditional motifs, in order to play the effect of the practice of the application. This study not only collects and extracts the representative motifs of Twisted Porcelain, but also systematically transforms the motif characteristics into creativity, and concludes that it can help ceramic products of the same kind to extract the characteristics of the motif elements and establish a mechanism of deduction of the motifs to further obtain the application of the products with traditional cultural factors, which provides a new way of thinking for the innovative development of traditional culture.

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