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THE GLOBAL GOALS

GENERATING THE TANG DYNASTY'S FLORAL MEDALLION MOTIFS USING SHAPE GRAMMAR FOR INNOVATIVE APPLICATIONS

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ABSTRACT

Purpose: This paper is an attempt to promote the SDGs of the Tang Dynasty Floral Medallion motifs in modern design, to improve the promotional value and economic value of traditional Chinese motifs, and to propose a design scheme for motif derivation based on shape grammar.

Theoretical Framework: This study synthesizes the literature on Tang Dynasty Floral Medallion motifs, shape grammars and the application of Cultural products to support the exploration of an innovative motif design for Floral Medallion motifs based on shape grammars to promote sustainable industrialization within Sustainable Development Goals (SDGs 9) within the context of the era of local design in the global marketplace.

Method: The study uses a combination of qualitative and quantitative methods to collect and analyse the cultural connotations, stylistic features and users' needs of the Tang Dynasty's Floral Medallion motifs through literature review and questionnaire survey. The data are analysed by using Spss statistical tools to ensure the scientific and reliable nature of the research results.

Results and Discussion: The innovative design based on shape grammar in this paper gives the Tang Dynasty Floral Medallion motifs vitality and sense of the times, and the design application in silk scarf cultural and creative products also verifies the feasibility and adaptability of the method.

Practical Implications: Unique and innovative Tang Dynasty Floral Medallion motifs can make the product stand out in the market and attract consumers, thus increasing the addtional value of the product, bringing more profits for the enterprise and helping the sustainable development of the enterprise.

Originality/Value: This study extracts the cultural features of the Tang Dynasty Floral Medallion motifs through digital means, optimizes the design process by referring the theory of shape grammar, achieves its sustainable protection and innovation, and provides a feasible path for the innovative development of the Tang Dynasty Floral Medallion motifs in the modern society.

Keywords: innovation, floral medallion motifs, shape grammar, cultural and creative product design, SDGs 9, sustainable development goals (SDG).

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1 INTRODUCTION

China is one of the oldest countries in the world and rich in culture and heritage. Traditional Chinese motifs, as an important part of traditional Chinese culture, are the accumulation and inheritance of history and civilisation. After 5,000 years of cultural foundation, traditional Chinese motifs have their own styles, structures, colours and deep cultural heritage in different historical dynasties, different ethnic groups and different regions. As an important traditional Chinese auspicious motif, the Floral Medallion motif has almost run through more than a thousand years of decorative history, carrying the historical and cultural value. It is found that the current application of the Floral Medallion motifs in the Tang Dynasty mainly focuses on imitation and duplication, and lacks re-innovation thinking of the traditional motifs (Cui & Li, 2021). This study introduces shape grammar into the design of silk scarf Cultural and Creative products, proposes an innovative method of redesigning traditional motifs based on shape grammar, and quantitatively evaluates the practical results to verify the feasibility of the design method.

2 LITERRATURE REVIEW

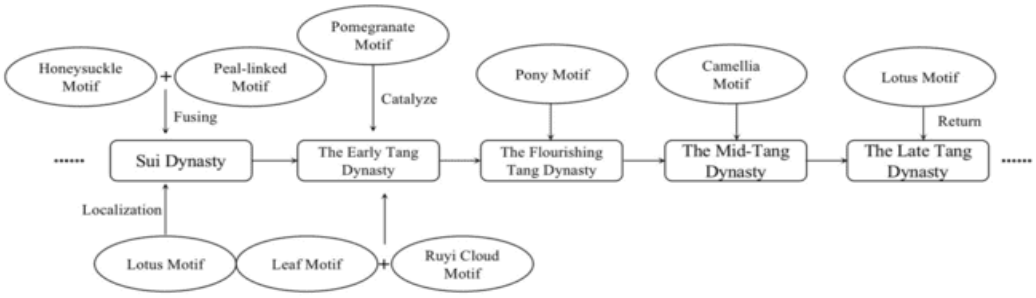
2.1 OVERVIEW OF FLORAL MEDALLION MOTIFS IN TANG DYNASTY

In Chinese history, the Tang dynasty was a period of economic prosperity and cultural flourishing. In this era, the fusion of Chinese and Western cultures contributed to the gradual formation of the stylistic features of the Floral Medallion motifs and its prevalence in the Tang Dynasty. It was found in the Chinese Mogao Cave motifs and unearthed artefact sequences materials that (Jones, 1867; Rawson, 2015; Tian, Wu & Tian, 2003), the Floral Medallion motifs in the Tang Dynasty, known as the "Flower of the Tang Dynasty", are the most recognizable of its time, with an exquisite presentation of detail that is difficult to be matched in other dynasties, and is the flourishing period of the Floral Medallion motif. The Floral Medallion motifs of the Tang Dynasty can be divided into four periods: the Early Tang (618-704 BC), the flourishing Tang (704-780

BC), the Middle Tang (781-847 BC), and the Late Tang (848-907 BC), each period of which adds different innovative ideas and elements, making the image of the Floral Medallion motifs more abundant (see Figure 1), such as the lotus motif symbolizes good luck; the honeysuckle motif represents longevity; the pomegranate motif symbolizes prosperity for future generations; the Ruyi cloud motif symbolizes good fortune; the peony motif signifies wealth and prosperity; and the Pearl-linked motif represents treasures. As a traditional Chinese auspicious motif, the Floral Medallion motifs in the Tang Dynasty are often found on textiles, gold and silverware, bronze mirrors, murals and so on. It is especially common in the Tang Dynasty Dunhuang Mogao Caves.

Figure 1

Formation process of Floral Medallion motifs

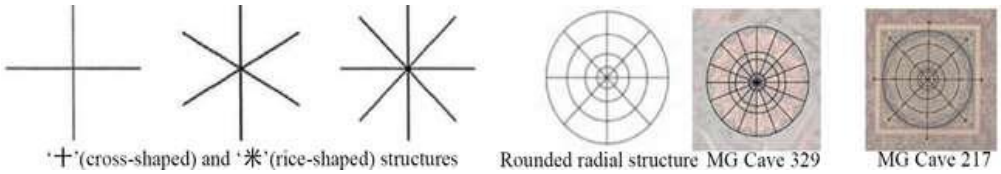


Source: Drawn by Researcher

The structure of the Floral Medallion motifs is rich and simple. In Chinese Buddhist Decoration, Ni (2000) found that early Chinese lotus motifs were four petals. Because of the influence of Indian Buddhist art, the number of petals increased during the Northern and Southern Dynasties. Later, under the local influence of the Sui Dynasty, the number of petals gradually decreased. To conclude, the Floral medallion motifs are mostly based on a '十' (cross-shaped) structure. Many of four-sided continuous Floral Medallion motifs are based on this structure. In addition, the shape of the Floral Medallion motif was a square circle, which was a cascading distribution from the centre outwards to form a rounded radial structure. In fact, this rounded radial structure was also a variation on the "十" (cross-shaped) structure (see Figure 2).

Figure 2

'十' (cross-shaped) 、 '米' (rice-shaped) structures and rounded radial structures



Source: https://www.chinadesignw.com

Tian, Wu & Tian (2003) have categorized three main types of petals which were the side curl petal, the double hook petal and the cloud type petal, which formed the unit motifs of the Floral Medallion motif. The Side Curl petal comes from the Honeysuckle motif and Pomegranate motif, the Double Hook petal comes from the flowing cloud motif, and the Cloud type petal comes from the Peony motif, as is shown in Table 1.

Table 1

Summarization of the Three Types of Petals of Floral Medallion motifs in the Tang Dynasty

Types of Petals	Shapes	Composition
The Side Curl Petal		Honeysuckle Motif Pomegranate Motif
The Double Hook Petal		Ruyi Cloud Motif
The Cloud Type Petal		Peony Motif

Liu (2000) stated the Side curl petal consists of two honeysuckle motifs facing each other. Its shape is like a peach or a pomegranate and is one of the constituent elements of the Tang dynasty. Although the honeysuckle motif has no special symbolic meaning in Buddhism, the honeysuckle motif was introduced at the same time as Buddhism by the Chinese people. In the early Tang dynasty, the peach-shaped side curl petals matured. It was decorated with pomegranate motifs in the middle and gave the petals the appearance of a blossoming pomegranate.It was in different periods had different degrees of curl. In the early Tang dynasty, honeysuckle motifs were curled deeply and had fewer layers, which displayed obvious pomegranate characteristics. In the late

early Tang dynasty and early flourishing Tang dynasty, the honeysuckles motifs in the Floral Medallion motif began to change and the side curl became shallower. After the middle Tang dynasty, the side curl petal gradually disappeared, as is shown in Table 2.

Table 2

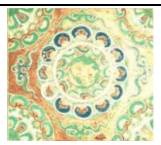
Summarization of the Side Curl Petals of the Floral Medallion motifs in Tang Dynasty

	MG Cave 375	MG Cave 335	MG Cave 217
Photographed			
Recovered			

Guan (2003) indicated the double hook petal is also known as the Ruyi cloud petal. It is inspired by a combination of the Ruyi Cloud motif and Cloud-type petal. During the Tang dynasty, when plant motifs flourished, it also incorporated delicate petals and leaves, which became ornate. It is oval with the two ends curling in to hold up the side curl petal. It is one of the most basic motifs of the Floral Medallion motif in the Tang Dynasty. The structure of the double hook petal is often used in the composition as a link between the unit motif. The form is also directly grafted onto the side curl petal and cloud type petal, which makes them heart-shaped double hook petals, or three petals or five petals of double hook petals. In the later Tang dynasty, the influence of the rounded style of the peal-linked motif led it to become a rounded petal, as is shown in Table 3.

Table 3

Summarization of the double hook petals of the Floral Medallion motifs in Tang Dynasty

	MG Cave 321	MG Cave 123	MG Cave 323	MG Cave 85
Photographed				
Recovered				

The cloud-type petal is an evolution of the leaf motif inspired by the shape of the pomegranate flower and the short and rounded petals of the peony. During the Kaiyuan period, the cloud-type petal was usually combined with the double hook petal to form a petal form, or appeared as a modification of the side curl petal. After the Kaiyuan period, the cloud type petals began to completely replace side curl petals to form the Floral Medallion motifs, and gradually disappeared at the end of the Tang dynasty, as is shown in Table 4.

Table 4

Summarization of the Cloud type petals of the Floral Medallion motifs in Tang Dynasty

	MG Cave 323	MG Cave 123	MG Cave 166
Photographed			
Recovered			

2.2 SHAPE GRAMMER

Shape Grammar was proposed by George Stiny and James Gips in the 1970s, it was applied to painting and sculpture creation and later extended to innovation design, product brand identity and other fields. It is a design method based on 'shape' operations (Stiny & Gips, 1971). Nowadays, Shape Grammar has been successfully applied to modern product designs and architectural designs, and its feasibility has been proved by a large number of practical cases.

Ebru & Şener (2009) extracted the decagonal motif from Islamic art and architecture and used Shape Grammar to generate a new Islamic geometric motif. Lee *et al*. (2013) investigated the Korean traditional motif called 'Bosangwhamun' and used Shape Grammar to deconstruct this motif and decompose it step by step to obtain a series of innovative motifs. Yu, Lv and Pan (2020) studied the traditional batik flower motifs and used Shape Grammar to evolve the motifs' reasoning, which resulted in a large number of innovative designs in different shapes. Luo and Yu (2021) studied the Cloud motifs of the lacquerware of the Han Dynasty, and used Shape Grammar to extract the basic elements, and then deduce them to form new motifs and apply them to suitable carriers for Cultural and Creative products. From the cases above, it can be seen that Shape Grammar mainly deduces and creates new elements according to certain rules by changing the shape elements and maintaining certain continuity to the properties of the original elements.

3 METHODS

In order to answer the research questions of this study, a mixed approach (qualitative and quantitative) is used for the investigation. Firstly, a literature review and a visual survey are used to explore the traditional motifs in order to extract their cultural features. Visual data collection on the Floral Medallion motifs are carried out by visiting the Dunhuang Mogao Caves located in Gansu Province, China, especially the Tang Dynasty caves. Next, motif innovation is designed and applied to products using shape grammar. Finally, products with innovative motifs are evaluated through a questionnaire survey.

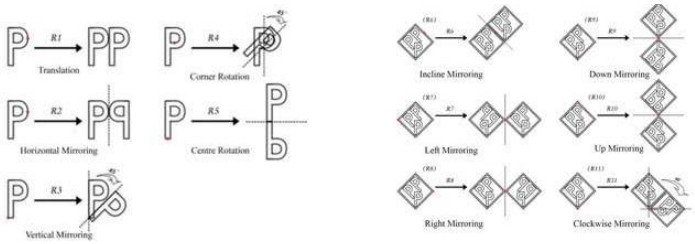
3.1 SHAPE GRAMMAR RULE

According to the definition of George Stiny and James Gips, Shape Grammar can be expressed as a quadratic formula: SG=(S,L,R,I). In the formula, SG is a shape set derived from S through translation, rotation, mirroring, etc. S represents a finite set of shapes; L is the finite set of labels; R is the finite set of inference rules, and I is the initial shape (Lu *et al*, 2010).

The rules of Shape Grammar are divided into generative rule and Derivative rule (Said & Embi, 2007). They have fixed evolutionary rules, but new rules can be customised to suit specific situations. In the deduction process of actual traditional motifs, the initial shape are the typical motifs extracted from the traditional motifs. A simple graphic is used as an example (Figure 3). P is assumed to be the initial shape extracted, which varies according to the five rules in the generative rule: R1: Translation; R2: Horizontal mirroring; R3: Vertical mirroring; R4: Corner rotation; R5: Centre rotation. The motifs newly generated are applied to the derivation rules, which produces more motifs. The derivative rules can be classified into six rules. R6: Incline mirroring; R7: Left mirroring; R8: Right mirroring; R9: Down mirroring; R10: Up mirroring. R11: Clockwise mirroring 90 degrees.

Figure 3

Generation Rules and Derivation Rules



Source: Drawn by Researcher

3.2 QUESTIONNAIRE DESIGN

According to the 2024 survey on the consumer population of silk scarf Cultural and Creative products in Zhejiang Province, China, it is found that the main force of consumption is young and middle-aged women, especially those between 25-55 years old, who have a high pursuit of fashion and beauty and also have a certain purchasing power. Therefore, the female population aged between 25-55 years old is selected and divided into three groups: 25-35 years old, 36-45 years old; 46-55 years old as the main group of the questionnaire survey. After removing 12 invalid questionnaires, a total of 86 valid questionnaires are collected back.

The questionnaire (see Table 5 below) uses a 5-point Likert scale ((1) Strongly does not confirm, (2) Not conform, (3) Partially conform, (4) conform,

(5) Strongly confirm)). The 5-point Likert scale was used to rate the level of conformity and non-conformity (Albaum, 1997; Johns, 2010).

Table 5

The list of questions sample for the online survey

Q1: Customized silk scarfs meet the personalized, high- quality accessories Q2: I can identify the source of traditional motifs Q3: Such a design can increase the cultural connotation of the silk scarf Q4: I am impressed by the design of the Floral Medallion motif Q5: I would recommend my friends to buy	Like scale: 1) Strongly does not confirm, (2) Not conform, (3) Partially conform, (4) conform, (5) Strongly confirm

4. RESULTS AND DISCUSSION

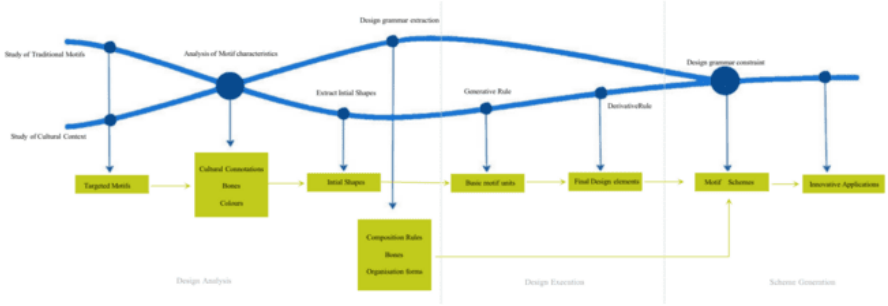
4.1 APPLICATION FRAMEWORK

In order to promote the sustainability of the Tang Dynasty Floral Medallion motifs in modern design. Based on previous studies (Wang & Peng, 2022; Cui & Tang, 2013; Tang & Cui, 2014), this paper proposes an application framework based on shape grammar in the evolutionary design of traditional motifs. The deduction process of shape grammar application is divided into three stages (see Figure 4): motif analysis, design execution, and scheme generation and application. The motif analysis stage includes consulting traditional motifs and their cultural backgrounds to extract typical motifs and conducting in-depth analysis and collation in terms of cultural connotations, bones, colours and other dimensions. Typical motifs are representative of traditional motifs and can reflect specific cultural features. The design execution stage includes using computer-aided design methods to extract the typical features of the motifs and forms initial shapes I, to establish the main motif design elements bank. Then the initial shapes are evolved by applying the rules of shape grammar to generate basic motif units, which are derived to obtain a variety of innovative motif elements. The scheme generation and application stage includes the designer's screening of the derived innovative motif elements, and then reasonably combining and reconstructing the

innovative motif elements by the constraints of the design grammar, and finally applying it to modern product designs.

Figure 4

Shape Grammar Deduction Process (Summarized by this study)



4.2 DESIGN EXECUTION

4.2.1 Determine the motif import

After selecting the motifs involved in the deduction of the Floral Medallion motifs in the Tang Dynasty, motif design factors are extracted by using the deduction rules of shape grammar. According to the methods of Translation, Horizontal mirroring, Vertical mirroring, Corner rotation, etc., new motifs are deduced. The motif of the deduction plan is the Dunhuang Mural with the characteristics of the Floral Medallion motif. Finally, the deduction results of the motifs are combined to form a new motif scheme.

First, use Procreate to recover and decolourize it to extract the essential part of the motif and remove its non-essential parts. On the premise of retaining the cultural characteristics of the motif, the sense of the form of the Floral Medallion motif is enhanced, and it is given richer visual expression and tension, and the process Mural motif is recorded as I, as is shown in Figure 5.

Figure 5

Initial shape drawing

Dunhuang MG Cave 329, Early Tang I

Source: Plotted by the author in Procreate Software, 2024

Secondly, deconstruct and encode the motif elements of the mural motif I after operation processing. The deconstructed elements form the initial shape of the shape grammar to establish the basic Tang Dynasty mural painting Floral Medallion motif design element library I, I= {I1,I2,I3. .In} (see Table 6).

Table 6

Library of initial shape design factors of Floral Medallion motif in the Tang Dynasty

I1	I2	I3	I4	I5	I6	I7
						

4.2.2 Design executive grammar deduction

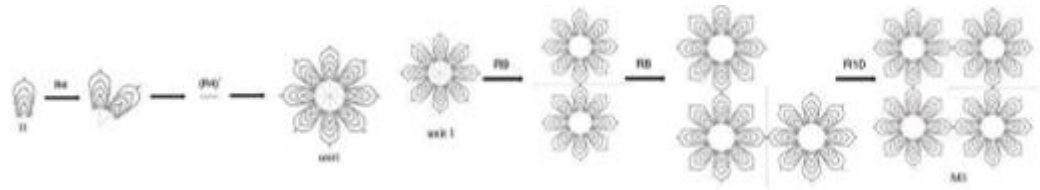
The motif elements I1, I2, I3, I4, I5, I6, I7 containing the cultural characteristics of the Floral Medallion motif in Tang Dynasty are extracted as the initial shapes, and set the shape grammar generative rules R1, R2, R3, R4 and R5 to correspond to translation, Horizontal mirroring, vertical mirroring, Corner rotation and Centre rotation respectively to derive different basic motif units. Then, the basic motif units generated in the first stage are used to derive various innovative motif elements by using R6, R7, R8, R9, R10 and R11, which correspond to incline mirroring, left mirroring, right mirroring, down mirroring, up mirroring and clockwise mirroring 90 degrees respectively. During the deduction process, the main frame of the motif element I is preserved to inherit the genes of the original motif.

Deduction I1:

Step 1: Apply the generative rule, enter I1 and execute R4 eight times to get unit1; Step 2: Apply the derivative rule, enter unit1 and execute R9→R8→R10. At the end of the deduction, the final deduction result is recorded as M1. The deduction process is shown in Figure 6.

Figure 6

Basic unit 1 evolution design

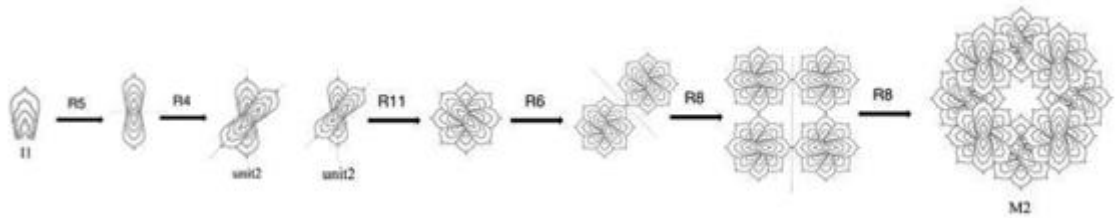


Source: Plotted by the author in Procreate Software, 2024

Step 1: Apply the generative rule, enter I1 and execute R5→R4 to get unit 2; Step 2: Apply the derivative rule, enter unit 2 and execute R11→R6→R8 twice. At the end of the deduction, the final deduction result is recorded as M2. The deduction process is shown in Figure 7.

Figure 7

Basic unit 2 evolution design



Source: Plotted by the author in Procreate Software, 2024

Deduction I2:

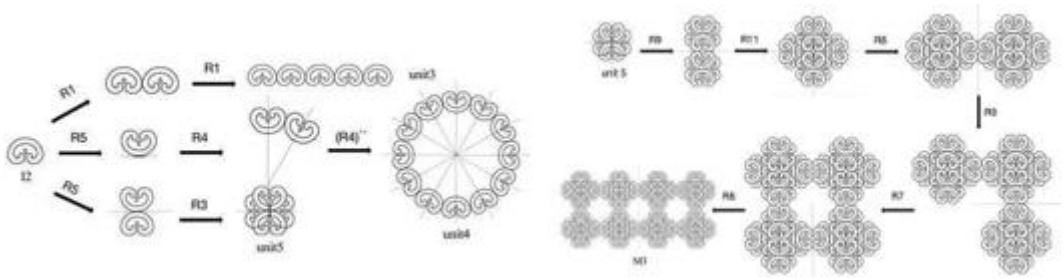
Step 1: Apply generative rule, enter I2 and execute R1 twice to get unit3;

Step 1: Apply generative rule, enter I2 and execute R5→R4 twelve times to get unit4;

Step 1: Apply generative rule, enter I2 and execute R5→R3 to get unit 5; Step 2: Apply derivative rule, enter unit5 and execute R9→R11→R8→R9→R7→R8. At the end of the deduction, the final deduction result is recorded as M3. The deduction process is shown in Figure 8.

Figure 8

Basic unit 3, unit 4 and unit 5 evolution designs



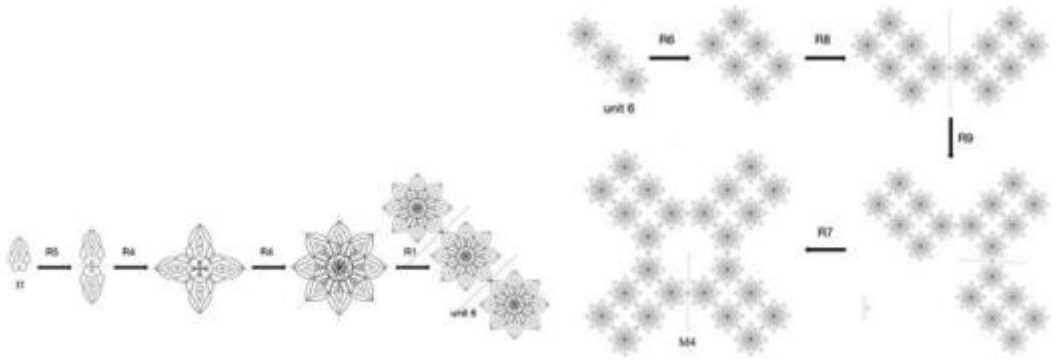
Source: Plotted by the author in Procreate Software, 2024

Deduction I3:

Step 1: Apply the generative rule, enter I3 and execute R5→R4 twice→R1 to get unit6; Step 2: Apply derivative rule, enter unit6 and execute R6→R8→R9→R7. At the end of the deduction, the final deduction result is recorded as M4. The deduction process is shown in Figure 9.

Figure 9

Basic unit 6 evolution design



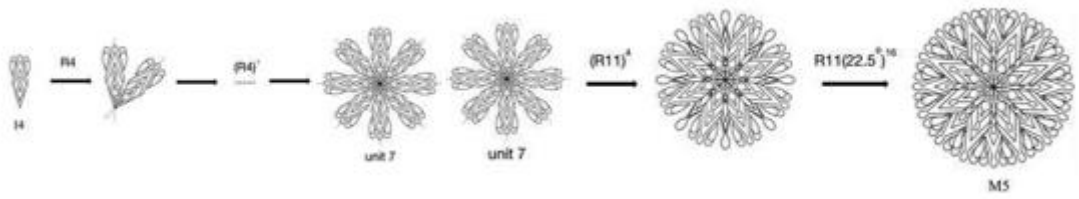
Source: Plotted by the author in Procreate Software, 2024

Deduction I4:

Step 1: Apply generative rule, enter I4 and execute R4 eight times to get unit7; Step 2: Apply derivative rule, enter unit7 and execute R11(90°) four times→R11(22.5°) sixteen times. At the end of deduction, the final deduction result is recorded as M5. The deduction process is shown in Figure 10.

Figure 10

Basic unit 7 evolution design



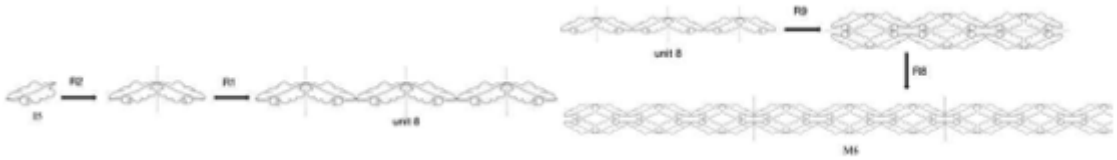
Source: Plotted by the author in Procreate Software, 2024

Deduction I5:

Step 1: Apply generative rule, enter I5 and execute R2→R1 to get unit8; Step 2: Apply derivative rule, enter unit8 and execute R11→R8. At the end of deduction, the final deduction result is recorded as M6. The deduction process is shown in Figure 11.

Figure 11

Basic unit 8 evolution design



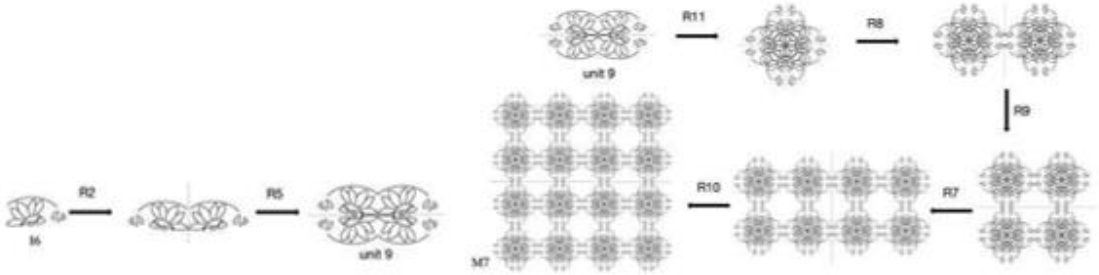
Source: Plotted by the author in Procreate Software, 2024

Deduction I6:

Step 1: Apply generative rule, enter I6 and execute R3→R5 to get unit9; Step 2: Apply derivative rule, enter unit9 and execute R11 R8 R9 R7 R10. At the end of deduction, the final deduction result is recorded as M7. The deduction process is shown in Figure 12.

Figure 12

Basic unit 9 evolution design



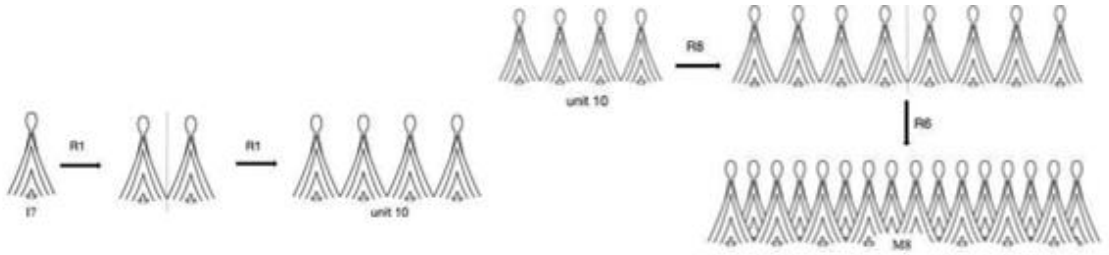
Source: Plotted by the author in Procreate Software, 2024

Deduction I7:

Step 1: Apply generative rule, enter I7 and execute R1 twice to get unit10; Step 2: Apply derivative rule, enter unit10 and execute R9 → R6. At the end of deduction, the final deduction result is recorded as M8. The deduction process is shown in Figure 13.

Figure 13

Basic unit 10 evolution design



Source: Plotted by the author in Procreate Software, 2024

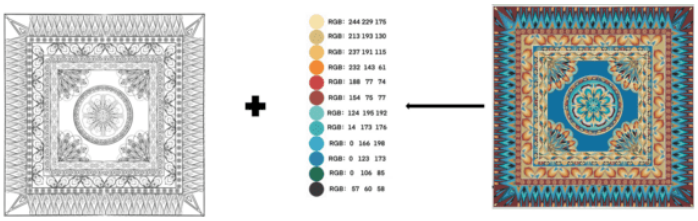
4.2.3 Design scheme generation

Shape, colour and layout are the three main elements that make up a motif, and innovative motif design will be developed from these three aspects (Dinçer, & Kartal, 2022). According to the deduction results above, unit1, unit2, unit3, unit4, unit5, M4, M6 and M8 are selected for scheme generation. In terms of the innovative application of the scheme, its shape and colour should follow the characteristics of traditional motifs. First, the scheme needs to abide by the skeleton structure of the traditional original motif. The layout is based on a cross-shaped, rice-shaped and rounded radial structure, using the deduction

rules of shape grammar to form a new motif combination. At the same time, change and unity, symmetry and equilibrium, rhythm and rhyme, and other characteristics of the design grammar are fully demonstrated in the picture, so that each element is filled with a strong sense of order. Secondly, because the early Tang Dynasty Dunhuang mural Cave 329 containing the Floral Medallion motif has been passed down through a long period of time, the actual colours are overall dark and partially damaged, which is not suitable for direct application in modern innovative motifs. Therefore, the scheme needs to adjust the hue, brightness and purity of the traditional colours to add youthful vitality to the innovative motif. Finally, the design of the Floral Medallion motif of Cave 329 of the early Tang Dynasty is generated, as shown in Figure 14.

Figure 14

Final Design Scheme



Source: Plotted by the author in Procreate Software, 2024

4.3 DESIGN APPLICATION

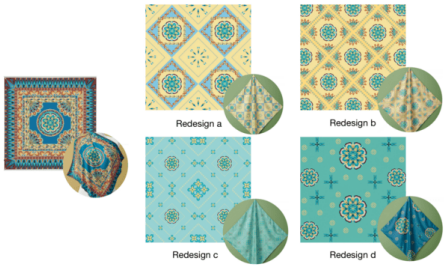
The silk scarf, as a familiar and frequently contacted Cultural and Creative product in people's daily life, not only has practical value, but also has a certain decorative function, and therefore is loved by many consumers (Liu, Yusoff & Alli, 2024). Applying the design scheme of the Floral Medallion motif from Cave 329 of Dunhuang in the early Tang Dynasty to the design of silk scarf products not only enhances the degree of personalisation of the Cultural and Creative product scarf, but also meets the consumers' demand for the retention of the aesthetic value and cultural characteristics of the traditional motif, and links the Tang Dynasty Floral Medallion motif with the times.

Therefore, the design of the preliminary Tang Floral Medallion motif design is innovatively 'redesign' to blend with the silk scarf in a better distribution style, as is shown in the Figure 15. The innovative central elements

of the design are mainly rearranged in the form of a four-sided continuous motif of dots in four directions to enrich the positional relationship between the motifs.

Figure 15

'Redesign' scheme



Source: Plotted by the author in Procreate Software, 2024

4.4 EVALUATION AND ANALYSIS OF PRODUCT APPLICATION

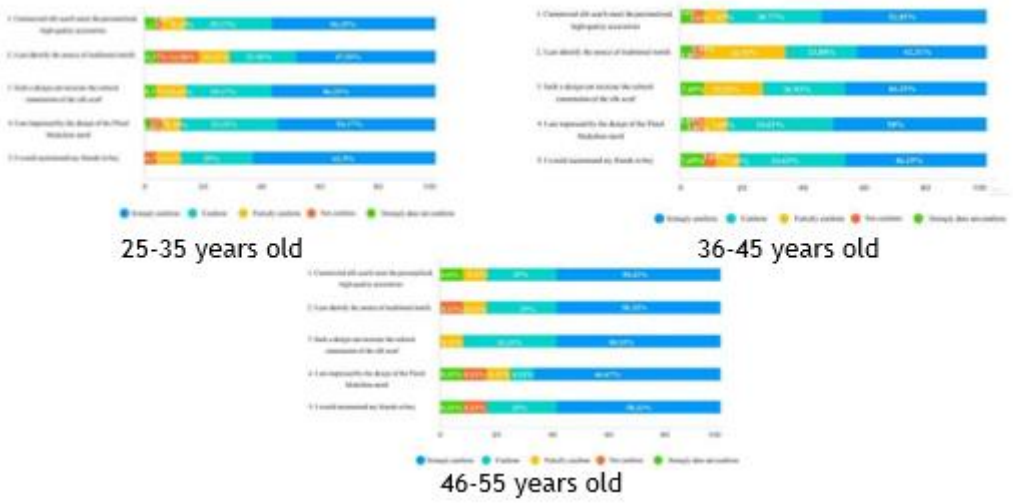
The data are analysed by cross-analysis the three different age groups of female consumers on the design options of the 'Redesign' scheme, as is shown in Figure 16. Women aged 25-35 have a strong willingness to recommend their friends to buy the 'Redesign' silk scarf series, which not only has a strong cultural recognition, but also helps female consumers to understand the origin and cultural connotation of the traditional Floral Medallion motif to a certain extent; The 36-45 age group is less likely to recommend a friend to buy this collection than the 25-35 age group, but they feel that this collection still impresses consumers with the Floral Medallion motif and that this collection meets the needs of personalised and high-quality lifestyle accessories; the proportion of women aged between 46-55 comes the second in recommending a friend to buy this collection, but they feel that this collection not only allows them to identify the origins of the traditional Floral Medallion motif, but they also believe that the innovative Floral Medallion motif design adds a new level of cultural identity to the collection.

In summary, the 'Redesign' application is recognised by all three age groups of women. This questionnaire turns abstract subjective feelings into real data, providing a more comprehensive understanding of the recognition of the 'Redesign' silk scarf product by female consumers aged 25-55 in Zhejiang

Province, China, which in turn improves the accuracy of the product and ensures the effectiveness of the innovative design process.

Figure 16

Subjective Evaluation of 'Redesign' application



Source: Plotted by the author in SPSS software, 2024

5 CONCLUSION

The significance of the introduction of shape grammar to the design of the Floral Medallion motifs in Tang Dynasty is that it provides a feasible and powerful design method. The method can obtain a large number of innovative design solutions while preserving the characteristics of traditional motifs, and it is easy to form a unified style. At the same time, its procedural design rules are easy to be implemented in design software.

This paper illustrates the application process of shape grammar in the evolutionary design of traditional motifs by taking the example of Cave 329 of Dunhuang mural paintings in the early Tang Dynasty, which contains the cultural characteristics of the Floral Medallion motif. By analysing the typical features of the Floral Medallion motif in the mural paintings, extracting the typical motif as the initial shape, using the shape grammar to generate a new motif design scheme, and finally combining the innovative design with modern product design. The design method is also applicable to the design re-innovation of other traditional motifs. In addition, other more complex motifs or motif designs can also apply this method to obtain more options, so as to better meet

the needs of consumers.

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