Article

Flower Patterns from the Murals in Yongle Palace Inspire Innovative Cultural and Creative Product Design in the Digital Age

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Abstract: ***Background:*** The floral patterns found in the murals of Yongle Palace represent a significant cultural and artistic legacy from Yuan Dynasty in China. These motifs, which are deeply rooted in religious and symbolic traditions, have great potential for reinterpretation in modern design contexts. ***Purpose:*** This study explores how traditional patterns from the Yongle Palace murals can be digitally extracted, reimagined, and integrated into modern cultural and creative product design. The goal is to find new strategies for preserving and restoring heritage through technological means. ***Methods:*** An interdisciplinary methodology was employed, combining art historical analysis, design research, user studies, and digital visualization. Tools such as CiteSpace enabled literature mapping, while generative AI platforms supported motif extraction and design iteration. ***Results:*** Three primary pattern types — botanical, geometric, and composite — were identified and adapted for contemporary applications use in textiles and household items. Digital reconfiguration preserved traditional aesthetics while aligning with modern design sensibilities. ***Conclusion:*** The integration of AI with traditional cultural assets demonstrates a promising model for heritage innovation. This research highlights how digital design tools can enable the reinterpretation of historic visual culture, offering new relevance in creative industries and global cultural discussions.

Keywords: Mural pattern; Digital heritage; Cultural design; AI-Assisted design; Yongle palace

1.Introduction

1.1 Research Background

Known for its grandeur and exquisite artistry, the Yongle Palace mural represents an important example of Yuan Dynasty mural paintings. They are considered a treasure of the world's ancient mural art and are among the first batch of national key cultural relics protection units in China. With the rise of China's soft power and traditional culture, the government has pursued a policy of cultural renaissance and boosting self-confidence by promoting designs based on traditional culture. The State Council's newly revised Law on the Protection of Cultural Relics embodies General Secretary Xi Jinping's call for the protection and utilization of cultural relics. Director Liang Ying emphasizes the need to promote the development of cultural and creative industries, aiming for them to become a new growth engine in the national economy.

In November 2024, the spokesperson for the Ministry of Culture and Tourism and the State Administration of Cultural Heritage highlighted the need to strengthen the excavation and interpretation of cultural relics. They noted that while ensuring safety, priority should be given to social benefits. Cultural relic resources should be utilized to provide diversified cultural products and services, enhancing cultural creativity to develop innovative cultural products that satisfy people's spiritual and cultural needs.

The arrival of the digital intelligence era dissolves the barriers between disciplines

and knowledge, stimulating creative innovation. The promotion of new technologies aims to discover traditional patterns, deepen the integration of new ideas and design, and adapt to modern needs. This approach promotes design renewal to meet material and cultural demands, while also providing a new way to showcase traditional culture and enhance cultural confidence.

1.2 Research Purpose

Chinese culture is rich and vibrant with diverse forms and numerous expressions. The dress patterns, colors, and lines of the Yongle Palace mural paintings exhibit distinctive cultural characteristics, which are important carriers and expressions of cultural elements, as well as a source of inspiration for designers (Zhang, 2024). In the digital age, cultural creative products are discovering more possibilities through technology, which promotes a sustainable development cycle of "protection-development-utilization" for Chinese historical and cultural heritage. The development and application of cultural and creative products from Yongle Palace represent an advancement in the digital intelligence era and provide a strong foundation for data-driven and AI-assisted design (Song et al., 2025). This evolution satisfies the public's growing demand for historical and cultural renewal.

1.3 Research Methodology

Literature analysis method: This involves obtaining literature from various sources, including CNKI and other database platforms, as well as libraries from local and international colleges and universities. By organizing and reviewing this literature, we can develop a scientific understanding of the research subject.

User research method: Using a questionnaire distributed to a target group, along with analyzing big data regarding the current status of Yongle Palace, the information gathered from user product demands, and related factors was summarized to design mural cultural and creative products that align with market demand.

Field research method: Collect, summarize, and analyze relevant information to investigate the development status of cultural and creative products related to the Yongle Palace mural paintings.

Interdisciplinary Research Method: This approach combines the fields of digital intellectualization, technology, and art. Through an interdisciplinary perspective, it uses theories, methods, and results from different disciplines to explore cultural and creative products, their development status, technical means, and artistic presentations.

1.4 Thesis Synthesis

As of April 10, 2025, the keywords "Yongle Palace mural painting", "Yongle Palace mural pattern", "Yongle Palace mural group flower pattern", "cultural and creative products and digital technology" or "cultural and creative and intelligent technology" were entered into the CNKI database, and using CiteSpace, a bibliometrics analysis software, the visualization parameters were set to analyze data (Figure 1).

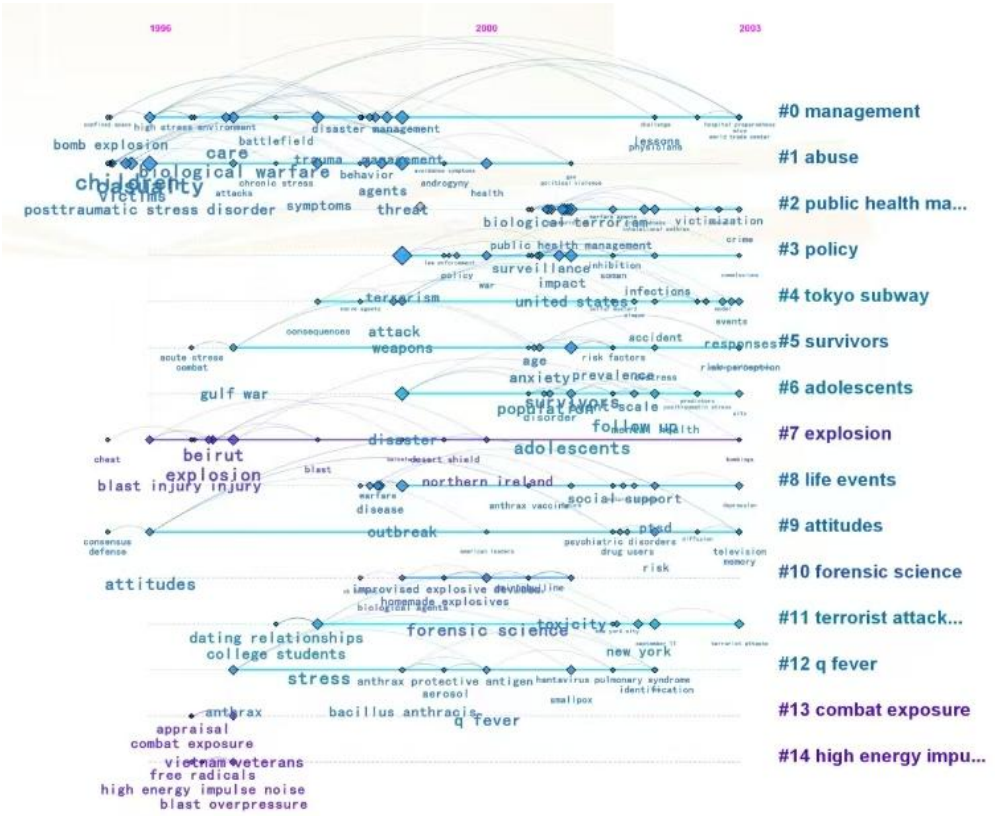


Figure 1: Keyword clustering of domestic research on Yongle Palace regimental flower patterns
Source: CiteSpace

Research scholars begin by examining the costumes of the characters in the mural paintings to explore the contents of the Yongle Palace murals, including the color matching of the costumes and their decorative patterns (Du, 2016). They analyze the costume matching and briefly sort out the patterns (Pan et al., 2021), but do not conduct a detailed or separate analysis. Other scholars mainly study the feasibility of the costumes worn by gods and goddesses and analyze the patterns through the aspects of secular costumes, religious needs, and artistic absorption (Pan, 2022). In Yongle Palace mural paintings, the focus of pattern analysis is often limited to the clothing's motifs, arrangement, and color matching, with only simple examinations conducted (Dong, 2021). However, in-depth analysis of a particular pattern is lacking. Additionally, some scholars study the elemental composition of the clothing patterns (Liu, 2022). Most studies on Yongle Palace murals focus on the artistic aspects, such as color schemes, lines, and the depiction of characters (Wang, 2023). Similarly, most studies on the patterns in the murals focus on their colors, painting techniques, and compositions, with fewer theses addressing the design aspects.

Secondly, from the perspective of digital intelligence, in the past three years, the research on digital intelligence technology in cultural and creative design mainly focuses on the themes of "intelligent development of cultural and creative products" and "intelligent image processing", and the research hot spots include the migration of national style to intelligence (Hu, 2023); generative artificial intelligence (GAI); and the development of mural painting; and generative artificial intelligence empowered in cultural and creative design (Zhu et al., 2024); the extraction of cultural genes from traditional culture for intelligent design (Liang et al., 2025); accurate ethnic pattern design by analyzing large amount of information through artificial intelligence (Song,

2024); and generating design patterns via intelligent semantic analysis (Liu et al., 2025). Some scholars mention AI in their research, while others discuss the functional differences between related AI technologies, such as AIGC Midjourney, and the need for technology integration (Zhou & Zhao, 2025). They propose the digitalization, personalization, and integration of cultural and creative design methods (Wu & Geng, 2023). Additionally, another group of researchers and scholars notes that, under the current environment of Digital Intelligence and China, the steps of the design process have gradually become more streamlined (Yang et al., 2024), and that the intelligent semantic analysis has contributed to this streamlining (Liu et al., 2025). Others focus on AI-assisted design development and evaluation, emphasizing integration (Zhao, 2024) and the need for designers to cultivate interdisciplinary professionalism more to adapt to the popularization of digital intelligence technology (Song et al., 2023). There is also discussion of the application of AIGC in the symbolic processing of cultural elements, including an analysis of its application in design innovation through the cases of the Shenyang Imperial Palace Cultural Creation and Wufangzhai's digital practice, as well as the specific practice path (Gui & Yang, 2025).

Foreign research on the Yongle Palace mural paintings has focused on religious culture and color analysis, as seen in studies such as "Lv Dongbin and Yongle Palace Pure Yang Hall Mural Painting," among others. However, the traditional patterns of mural paintings and the combination of "mural painting + digital intelligent technology" are less explored. Although Italy, France, Japan and the United States have established mural painting resource banks, their main focus is on resource protection, and research on pattern art that remain even more scarce (Kong & Yang, 2022).

Table 1: Literature summary characteristics

Research Direction	Article	Trait
Shape of clothing	The Yuan Dynasty Mural Paintings in Yongle Palace <Chaoyuan Tu> Study of Costumes; The Patterns of Figures in Mural Paintings of Yongle Palace.	Starting from the perspective of ancient costume research on the content of Yongle Palace mural paintings as well as its clothing form, color matching research, the composition of the pattern, the arrangement of the pattern and the pattern in the clothing on the collocation of the discussion.
Digital Intelligence Technology Cultural and Creative Design	A Review of Research on Generative Artificial Intelligence - Assisted Literary and Creative Design Methods; A Synthesis of Research on the Application of Digital Intelligence Technology in Cultural and Creative Designs.	Interactive media relying on digital technology are changing the way of communication between people and their objects, and the relative antagonism between the view ability of traditional media and interactive digital media is proposed from an empirical point of view in order to clarify the social significance of digital media art.

At present, domestic research primarily focuses on the dress modeling, color matching, and arrangement of the Yongle Palace mural patterns (Table 1). In the context of digitization, using AIGC, Midjourney, and other technologies enables the analysis and reorganization of traditional patterns, giving them new vitality, and designing creative solutions in line with the aesthetics of the new era, which holds certain innovative significance.

1.5 Framework of the Paper

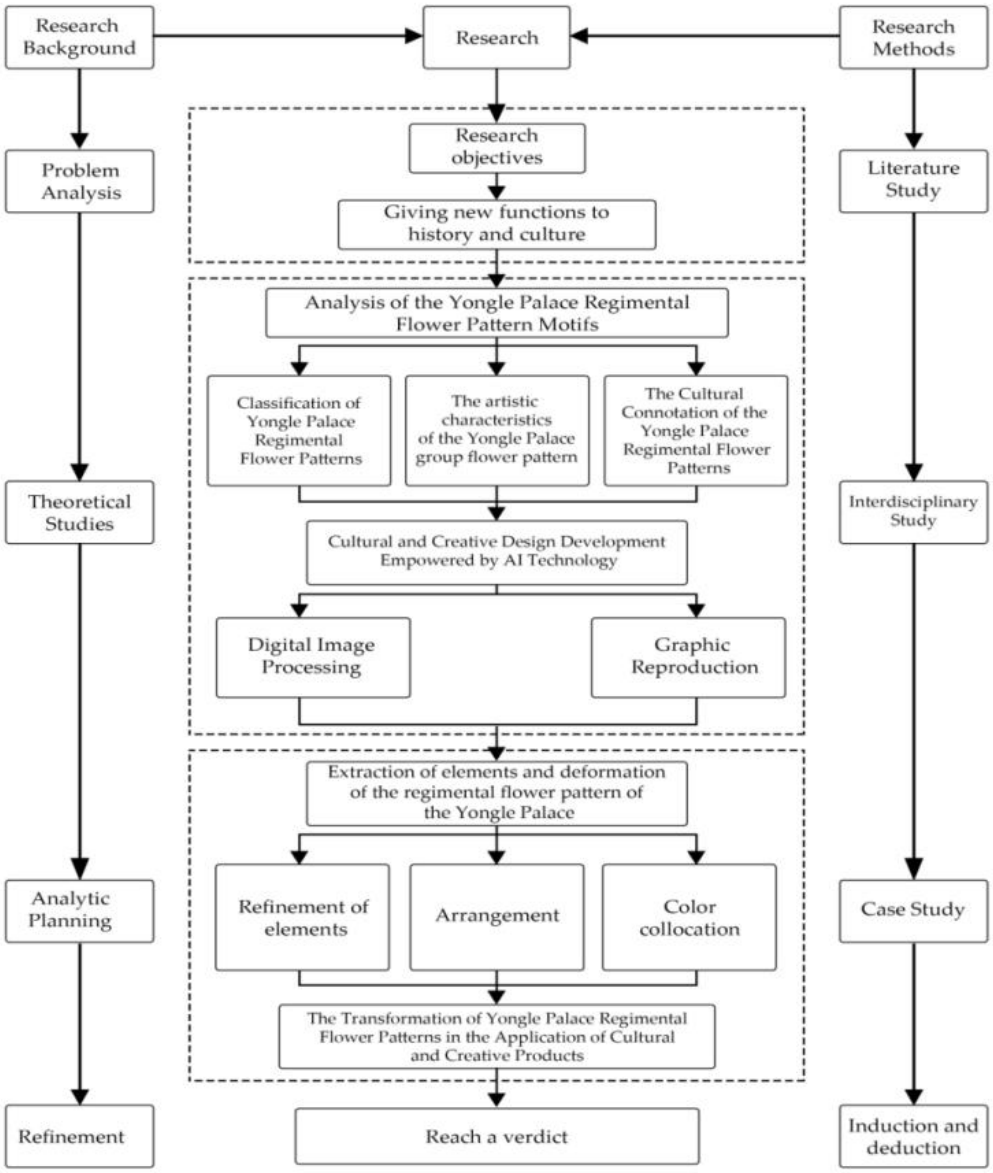


Figure 2: Framework of the paper

2. Image Analysis of the Yongle Palace Regimental Flower Pattern

2.1 Classification of Yongle Palace Regimental Flower Patterns

The Yongle Palace mural is an outstanding example of Chinese Taoist art in the Yuan Dynasty. It is located in Yongle Palace in Ruicheng County, Shaanxi Province, and is famous for its grand scale, excellent skills, and deep cultural heritage. The mural paintings display a vibrant variety of character images, composition styles, colors, and dress patterns, reflecting the wisdom of ancient thought and a high level of artistry. The entire mural area exceeds one thousand square meters, with the three clear halls in the "Chao Yuan Tu" being the most typical. A common decorative motif in these murals is a regimental pattern, which appears in various locations such as the clothing, altar background, throne decorations, and architectural components. This pattern not only enhances the visual appeal of the artwork but also carries deep cultural meanings (Zhang, 2024). The motifs in the murals are divided into three main categories: botanical realism, geometric abstraction, and composite motifs.

2.1.1 Botanical Realistic Cluster Flowers

The botanical realistic floral group is based on natural plants and uses realistic techniques to detail petals, branches, leaves, stamens, and more. Common flower types include begonias, peonies, and ivy. Among these, the Ruyi peony group floral pattern is more common and is often used on the sleeves and hems of clothing (Zhang,2024). The shapes in this pattern are regular and layered, with the overall arrangement typically featuring radial symmetry, as shown in Figure 3. This type of pattern emphasizes the accurate depiction of natural forms, creating elegant and beautiful visual effects. It is often seen in local decorations, such as character costumes and artifacts, symbolizing good fortune, wealth, and prosperity.

Figure 3: Botanical Realistic Cluster Flower

2.1.2 Geometric Abstract Cluster Flowers

The geometric abstract floral patterns in the structure exhibit a tendency toward geometric symmetry, emphasizing a programmed composition. Common elements in these compositions include the swastika and various repetitive patterns, as shown in Figure 4. For example, the collar and sleeves of the Jade Maiden are decorated with a geometric floral pattern. The center of this floral design features a minimalist circle and the word “human”, arranged in an orderly and unified shape. This design choice shows the aesthetics of neatness and order, allowing people to feel the unity and clarity of the pattern.

Figure 4: Geometric Abstract Cluster Patterns

2.1.3 Composite Pattern Type Group Flower

The composite group pattern integrates the elements of the curly grass pattern, cloud and air pattern, and the Baoxiang flower pattern, as shown in Figure 5. For example, the Jade Emperor's chair is decorated with a terracotta ten-thousand-character lion ball group pattern, which combines abstract and figurative elements. The whole design is based on a diamond shape, with each diamond-shaped grid transformed into a variant of the Wanzhi pattern. At the innermost part of the large grouping of floral patterns is a lion motif, which is surrounded by an arrangement of smaller circular life patterns. The overall design features a balance of structure and openness.

Figure 5: Composite pattern type group

2.2 The Artistic Characteristics of the Yongle Palace Group Flower Pattern

2.2.1 Styling Features

In the Yongle Palace murals, one of the most prominent features is the morphological diversity of the group flower pattern. This diversity is evident in both the plant-type group flowers and the geometric group flowers. In the plant group of flowers, whether it is peony or begonia flowers, there are beautiful forms, such as the rolls of grass and layered petals. The lotus is represented with a complete and rounded shape, while the peony pattern displays grace and elegance, and the leaves turn naturally. On the other hand, the geometric type of group flower emphasizes abstract processing. Whether a geometric group of flowers or a swastika pattern, these designs evoke a dynamic feeling through the contrast of straight and curved lines. This approach not only brings a sense of rigor but also showcases a smooth and dynamic quality in the geometric patterns.

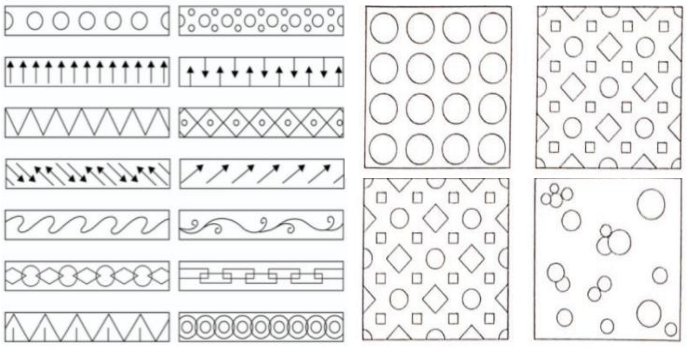


Figure 6: Bipartite continuous composition form and Four-square continuous

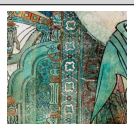
2.2.2 Compositional Features

The Yongle Palace group flower pattern mainly adopts two organizational forms: two-part continuous patterns and four-part continuous patterns. As a traditional national art pattern, the two-part continuous pattern is composed of a unit pattern that extends circularly in both horizontal and vertical directions. This pattern can be categorized into five types based on its skeletal structure: scattering type, straight-line type, wave type, chain type, and comprehensive type (Figure 6). The four-square continuous pattern is characterized by arrangements based on flips, symmetry, and organized at the 12, 3, 6, and 9 o'clock positions. Yongle Palace mural paintings are categorized into two main types: scattered four-square and continuous four-square patterns. The scattered patterns feature flat rows and trapezoidal arrangements, whereas the continuous patterns utilize visual connectivity to strengthen the overall continuity (Figure 6). Both forms reflect the infinite extension characteristics of traditional motifs (Yang, 2023).

Through analysis and generalization, the corresponding schematic diagrams of the structure are collated. Different arrangements can produce different visual effects, which can be applied in different characters' costumes and artifacts to create a different

atmosphere, as shown in Table 2.

Table 2: Bipartite continuous doughnut pattern and Quadripartite continuous regimental pattern

Decorative Parts	Illustration of the character where the pattern is located	Form of composition
Areolate floral pattern		Trapezoidal scattered quadrilateral continuity with a combination of geometric and regimental motifs
Ruyi Peony Cluster Flower Pattern		The peony pattern is a unit pattern in a continuous quadrilateral pattern
Ivy Cluster Flower Pattern		Splintered quadrilateral pattern with regiments as unit motifs
Decorative Parts	**Illustration of the character where the pattern is located**	**Form of composition**
The pattern of the body of a chain of pikes		Interlocking bipartite continuity with geometric patterns as unit patterns
Chained Flower Pattern		Interlocking bipartite continuity based on geometric patterns
Terracotta Ruyi Peony Cluster Flower Pattern		Interlocking bipartite continuum with peony and butterfly groupers

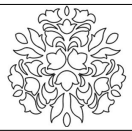
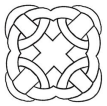
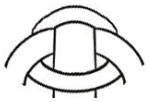
3. The Extraction and Metamorphosis of the Yongle Palace Regimental Flower Patterns

3.1 Element Extraction

This paper extracts three types of core pattern elements: botanical realism, geometric abstraction, and composite pattern, as shown in Table 3. This classification is achieved by systematically analyzing the regimental flower patterns found in the wall paintings of Yongle Palace. By breaking down and extracting the key elements of these patterns, we not only preserve the essence of traditional aesthetics but also create a foundation for the subsequent digital transformations and innovative applications.

Table 3: Extraction of elements of regimental pattern

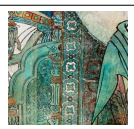
Decorative Parts	Illustration of the character where the pattern is located	Pattern Extraction	Element Extraction
Aerobated floral pattern			
Ruyi Peony Cluster Flower Pattern			

Ivy Cluster Flower Pattern			
The pattern of the body of a chain of pikes			
Chained Flower Pattern			

3.2 Color Collocation

Color is a crucial element in the interior design of a building. When creating the murals of the Yongle Palace, the artists considered the unique characteristics of the environment and the viewing conditions. To adapt to the dim light of the hall, the painters enhanced the visual recognition by increasing the color contrast, ensuring that the murals remained vibrant even in limited light. As shown in Table 4, the combination of colors creates a solemn and elegant atmosphere, reflecting the traditional Chinese color aesthetics of "beauty through neutrality and harmony." This approach exemplifies the technique of thick-brush figure painting.

Table 4: Color Extraction of Group Flower

Decorative Parts	**Illustration of the character where the pattern is located**	**Pattern Extraction Element Extraction**
Ruyi Peony Cluster Flower Pattern		
Ivy Cluster Flower Pattern		
The pattern of the body of a chain of pikes		
Chained Flower Pattern		
Flower pattern of crabapple blossoms		
Aerobated floral pattern		

3.3 Innovative Design of Patterns

This text combines botanical motifs such as peonies, curly grasses, and vines with

geometric patterns, offering a modern interpretation of traditional designs through the principle of dichotomous continuous composition. It focuses on the unity of dynamic rhythm and orderly aesthetics. The border of the square scarf is decorated with peony motifs, and the circular composition suggests Taoist cosmology. At the center is an innovative composite fan pattern displayed on a red background, featuring a deconstructed and reorganized lion ball fan, which is dynamically processed, as shown in Figure 7.

Figure 7: Innovative Combination of Group Flower Patterns at Yongle Palace
Innovative Design of the Regimental Flower Pattern of Yongle Palace

The color system is based on the green hue of Yongle Gongshi, with vermilion, which retains the texture of mineral pigment, while enhancing color brightness and adapting to modern aesthetics. The Hermes innovative color collision aesthetic preserves the traditional color symbols while introducing new visual tension through the combination of contrasting colors. The design highlights the details of the carefully crafted lines. The cloud pattern, for example, shows the texture of "Cao Yi out of the water", and the digital smoothing technique enhances the sense of flow. The lotus pattern breaks away from the traditional forms by adopting geometric deformation technology. This retains the connotation of religious symbols and strengthens the language of modern design, as shown in Figure 7. The fusion of traditional religious art and modern fashion design in the rhythm of lines provides a model for the modern transformation of non-heritage art.

Intelligent generation introduces new creativity into traditional tattoo design. As shown in Figure 8, the deep learning algorithm randomly generates innovative solutions while preserving the core elements and compositions. It integrates various artistic styles to present a new visual form of the regimental flower pattern. AI-assisted design transcends traditional limitations, providing infinite possibilities for the modern transformation of the regimental flower pattern and revitalizing it for the digital era.

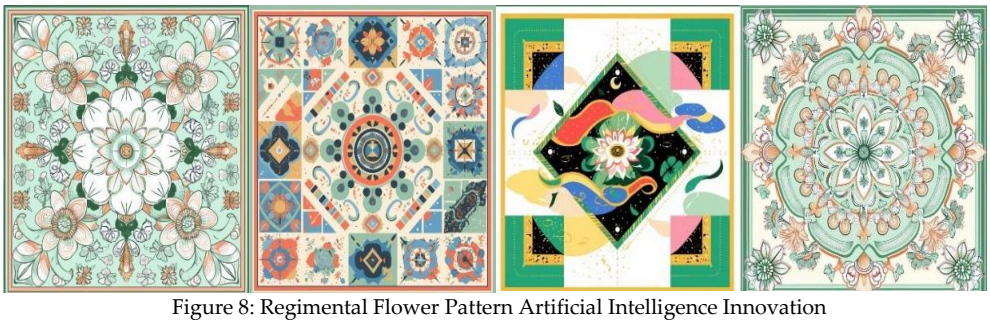


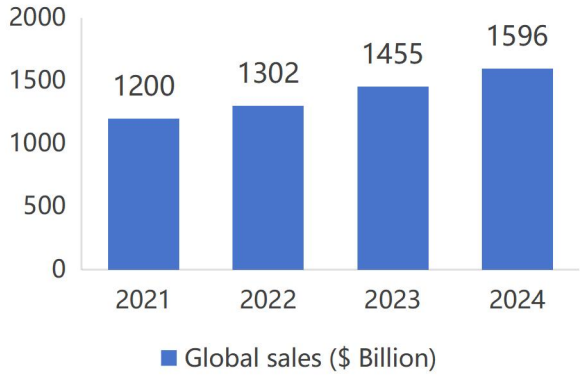
Figure 8: Regimental Flower Pattern Artificial Intelligence Innovation

4. The Transformation of Yongle Palace Regimental Flower Patterns in the Application of Cultural and Creative Products

The market size of the cultural and creative industries has continued to expand in

recent years, driven by growing consumer demand and government support. As the national economy upgrades and people pursue a more enriched spiritual and cultural life, the consumption of related products has grown steadily, as shown in Table 5.

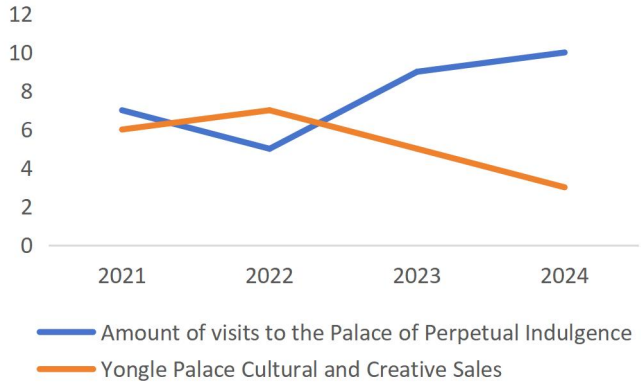
Table 5: Global Sales of Cultural and Creative Products



Source: China Report Hall Network

The development of digitalization and network technology has transformed the way cultural and creative products are disseminated and consumed. There is a wide range of consumer groups, including individuals from various age groups and professional backgrounds, all of whom have high demands for the cultural value, creativity, design, and artistry of these products. At present, Yongle Palace cultural and creative products primarily consist of direct reproductions of mural characters, resulting in insufficient pattern innovation and application, which has led to a decline in sales (Table 6).

Table 6 : Comparison of sales of cultural creations in Yongle Palace



Source: Yongle Palace official website statistics

The application of the Yongle Palace group flower pattern in cultural creative products is a continuation and modern interpretation of traditional art. During the transformation process, the pattern has been refined, reorganized, and simplified to better meet the demands of contemporary design. In the field of textiles and home furnishings, the patterns often appear in the form of miniaturization and modularity, creating a sense of rhythm and order. The tableware series utilizes the under-glaze process to replicate the texture of mineral pigments, while home furnishings focus on fabric choices that can be dyed, as shown in Figure 9.

Figure 9: Cultural and Creative Product Designs of Yongle Palace Group Flower Patterns
Source: Self-made by the author

5. Conclusion

The Yongle Palace Fancy Patterns have been creatively transformed from traditional art into elements of modern life, preserving cultural heritage while reimagining their "form and spirit". The systematic approach gives a practical function and fashionable expression. The innovative use of materials bridges the dialogue between ancient and modern styles. This proves that traditional cultural elements possess a strong regenerative capacity within contemporary design, maintaining their aesthetic appeal, activating cultural memories, integrating into modern life, and providing an innovative paradigm for non-genetic inheritance. With the development of intelligent technology, this kind of integration will unveil even richer possibilities.

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