Research on Personalized Customization Modular Design of Beichuan Qiang Embroidery

Qing Yang[1] Ya Tan[2]

[1,2] *Beijing Institute of Technology, Zhuhai, Zhuhai, Guangdong, China*
[1]*Corresponding author. Email: 6220211086@bitzh.edu.cn*

ABSTRACT

Qiang embroidery is a treasure of folk handicrafts in China. Beichuan Qiang embroidery has developed new aesthetic characteristics after the Wenchuan earthquake, making it unique among many regional Qiang embroidery styles. However, the products still face the problem of unsold sales, making the products difficult for tourists to empathize with them, especially in meeting the personalized needs of young consumers' consumption concepts. On the basis of modular design theory, this study classifies and summarizes the design elements of Beichuan Qiang embroidery, proposes principles and strategies for personalized customized Qiang embroidery product module design, and explores a new path for the digital inheritance of Beichuan Qiang embroidery.

Keywords: Beichuan Qiang embroidery, Modular design, Personalized customization.

1. INTRODUCTION

Qiang embroidery, for the Qiang people who do not have their own written language, records the emotional desires and aesthetic consciousness of the Qiang people in every stitch and thread, symbolically bonding their own ethnic cultural memory.[2] This traditional embroidery technique became the second batch of national intangible cultural heritage in 2008. In recent years, the functions, themes, patterns, composition forms, and colors of Beichuan Qiang embroidery in Sichuan have undergone changes. Through interviews with the national inheritors and embroiderers of Qiang embroidery in Beichuan area, it was learned that integrating Qiang embroidery techniques into cultural and creative products is the main exploration method to adapt to the modern consumer market. However, most Qiang embroidery products are time-consuming, expensive, and have poor sales, making it difficult to integrate into the market innovation mechanism of the digital age and meet the aesthetic and consumption concepts of today's young consumers' personalized needs. Modular design, based on the advantages of fast response and flexible configuration [3,4], can effectively improve the utilization of design resources and reduce the assembly and management costs of product

families [3]. By dividing the symbolic elements of Qiang embroidery [5] into modules and combining consumer customization needs, it is necessary to build a modular customization system for Beichuan Qiang embroidery products, which will provide a new design idea for the inheritance of Beichuan Qiang embroidery, thus improving the market competitiveness of Qiang embroidery products, and also provide more possibilities for Qiang embroidery culture to adapt to the design ecological environment of Internet+.

2. FEASIBILITY ANALYSIS OF MODULAR DESIGN FOR BEICHUAN QIANG EMBROIDERY

2.1 Theoretical Basis for Modular Design of Qiang Embroidery

2.1.1 Modular Design Theory

Modular design is a systematic design concept, whose core goal is to decompose complex products or systems into independent and manageable modules to achieve independent design, production, and maintenance of each module, while ensuring the coordination and functionality of the entire system. Modular design is not only a method of decomposing and combining product elements, but

also a standardized and combined design method based on the whole, which covers the overall design of modular systems, module system design, and modular product design [7]. This design strategy not only enhances the manufacturability, maintainability, and upgradability of the product, but also helps to reduce costs and shorten the time to market. The theoretical roots of modular design are deeply rooted in systems engineering and design theory, with a particular emphasis on the importance of system decomposition and standardization of interfaces between modules, enabling different teams to follow a unified interface specification and independently develop various modules [8]. The current research trend focuses on how to more efficiently identify and design these modules, as well as how to utilize modular design to enhance product market adaptability and response speed. With the advancement of digitalization and intelligent manufacturing technology, modular design is gradually developing towards intelligence and personalization to meet the market's demand for diversified and customized products.

In terms of the application research of modular design in clothing, Zheng Peng (2018) [9] proposed a grading and classification model for clothing modules based on consumer demand. By changing and deforming component modules, multiple design results were achieved, and the connection problem between component modules was solved in the research of personalized customized clothing product design. Based on modular design theory, Ge Yao (2021) [10] divided modules according to the characteristics of customized clothing based on consumer needs and product features, constructed a product main structure model and module matching rules, and used a combination of rules and examples to establish a module configuration model, forming a modular design scheme for personalized customization. Yan Yinong (2021) [4] introduced the modularity theory into the Mongolian personalized custom clothing design, and discussed the design of the Internet based modular design code and online order mode of custom clothing. The customization process of clothing has many similarities with the customization process of Qiang embroidery products, therefore, the theory of modular customization of clothing can serve as an important reference for the modular design of Qiang embroidery products.

2.1.2 Research Status of Digital Inheritance of Qiang Embroidery

In the digital field of Qiang embroidery inheritance, scholars have conducted detailed data collection on traditional embroidery products through high-resolution equipment to ensure accurate capture and comprehensive recording of information. Hu Hui (2021) [11] conducted an in-depth deconstruction of the artistic essence of Qiang embroidery by developing a database of patterns and needlework techniques. In addition, by constructing a multi-level and comprehensive classification system for cultural heritage information resources, scholars have provided a convenient platform for information sharing and interaction in Qiang embroidery, thereby promoting the dissemination and exchange of Qiang embroidery culture. In terms of user experience design, Ye Zifei and Zhou Yi (2024) [12] focused on the design and research of Qiang embroidery apps, aiming to enhance the interactive experience between users and Qiang embroidery culture through digital interfaces. Meanwhile, Liu Xiangge (2021) [2] delved into the artistic characteristics and spiritual and cultural connotations of Qiang embroidery through the use of visual methods, further enriching the digital expression forms of Qiang embroidery. Li Yan (2023) [13] used the collected data to establish a three-dimensional model of Qiang embroidery and applied it to digital dynamic graphic design practice. This not only makes Qiang embroidery pattern products more integrated and interactive, but also injects modern technological vitality into the traditional art of Qiang embroidery. Although existing research has mostly focused on the surface level of Qiang embroidery, such as the digital processing of needlework, patterns, colors, and structures, there is still insufficient discussion on customized product design to meet consumers' personalized needs. Future research can explore how to combine the digital resources of Qiang embroidery with modern design to create personalized Qiang embroidery products that better meet the needs of contemporary consumers.

2.2 Artistic Features of Beichuan Qiang Embroidery

2.2.1 Theme and Style

The themes of Qiang embroidery are diverse, covering flowers, birds, fish, insects, birds, and animals in nature. The belief in the existence of

spirits in all things in Qiang culture has made natural spiritual objects such as the sun, moon, and stars the main themes of embroidery. These patterns are not only a tribute to the beauty of nature, but also a worship of mysterious forces. The pattern styles of Qiang embroidery are diverse, including realistic depictions of natural objects and abstract variations based on traditional symbols. They can be divided into three categories: plant patterns, animal patterns, and abstract geometric patterns ("Figure 1").

Figure 1 Plant patterns, animal patterns, geometric patterns, and character design patterns, embroidered by Chen Yunzhen.

Compared with other Qiang embroidery regions in Sichuan, especially after the Wenchuan earthquake, Beichuan Qiang embroidery has a design style and themes that are closer to modern aesthetics. The patterns are colorful and the shapes are saturated and vivid. On the basis of traditional Qiang embroidery characteristics, it also has individual features and adds character themes, which are more easily accepted by modern young people.
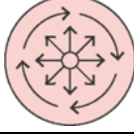
2.2.2 Color and Composition

The color expression of Qiang embroidery mainly includes two types: plain embroidery and colored embroidery. The application of plain embroidery in Qiang emb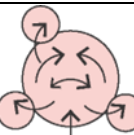roidery is mainly reflected in black background white embroidery, black background yellow embroidery, blue background white embroidery, and white background black embroidery, mostly presented in the form of geometric patterns. The color impact of plain embroidery is not as strong as that of colored embroidery. Colored embroidery has bright colors and strong contrasts, giving people a bright, generous, and simple visual effect. This frank and bold way of using colors not only brings a strong visual impact to people, but also allows them to fully feel the optimistic attitude towards life of this nation.

Beichuan Qiang embroidery inherits the artistic realm of advocating complete and saturated forms as a whole. By comparing and analyzing some traditional Qiang embroidery plant patterns in the Beichuan Folk Customs Museum with the works of Chen Yunzhen, the inheritor of the modern Beichuan National Intangible Cultural Heritage ("Table 1"), it can be seen that Beichuan Qiang embroidery not only follows the artistic effect of "beauty, fullness, completeness, and grandeur" of ancient Qiang embroidery, but also has richer and more delicate color layers.

Table 1. Comparative analysis of some plant patterns in ancient and modern Qiang embroidery in Beichuan

Plant pattern name	Legend of exhibits in the Qiang Embroidery Museum	Color extraction		Structure extraction	Composition form	Cultural implication
Sheep horn flower		Main color: Auxiliary color: Base color	8D127C D91B4D EDF7F8 005357 56BB97		Up, down, left, right Centrifugal symmetry	Marriage flowers symbolize love and marriage. Embroidered on waistbands, headbands, and headbands.

Pattern	Image	Color	Symmetry	Pattern Type	Description
		Main color: BF1A20, 36A5C0, EAB51E Auxiliary color: 71BB72 Base color D8CCC5		Multi-layer connected heart Fill in type	Becoming the most representative pattern, symbolizing love and happiness. Embroidered on waistbands, headbands, headbands, or individually depicted.
Chrysanthemum		Main color: D1242B, 19A0BF, DFAB16 Auxiliary color: 348744 Base color D5C9BB		Rotational symmetry Centripetal type	Symbolizing the continuity and longevity of descendants. Embroidered on waistbands, headbands, bed wraps, etc.
		Main color: CF8286, E6B11D, EA7338 Auxiliary color: 1C8759 Base color 100E0C		Theme style	Symbolizing the continuation of descendants and the blessing of longevity. Embroidered on clothing, waistbands, and headbands.
Peony		Main color: AF4A56, C9C1AC, 327638 Auxiliary color: 2B526E Base color 100E0C		Edge decorations corner	Implying wealth, prosperity, and splendor, frequently used in clothing, apparel, shoes, and bedding.
		Main color: DB7C85, EEE8E4, BFDC99 Auxiliary color: 755A26 Base color 100E0C		Theme style	Symbolizing wealth, auspiciousness, and a happy and fulfilling life, and being frequently used.

a   compiled by the author

2.2.3 Craftsmanship and Needling Techniques

The traditional process of Beichuan Qiang embroidery mainly includes drafting, material selection, embroidery, and finishing. When making drafts, embroiderers will design patterns according to their own preferences or customized requirements. They will either draw on their own without sketching or hire someone to use colored pens to draw on cotton or linen. Clothing and accessories should be made of linen or pure cotton fabric; Artworks and high-end gifts use silk forging as the base. The thread used is generally thick and dull cotton thread, acrylic yarn, swollen yarn, etc. In contrast, the silk threads of Sichuan embroidery, which is also a local embroidery in Sichuan, have a strong luster, more realistic patterns, and richer transition layers in needlework. In recent years, the patterns and needlework of Beichuan Qiang embroidery have become increasingly similar to those of Shu embroidery. After stretching the base material, it can be embroidered. Small embroidery pieces can be directly embroidered on the hands; Large and medium-sized wall mounted screens must be embroidered on the picture frame or large square frame. There are over thirty types of Qiang embroidery techniques, including neat needle, nested needle, twisted needle, buttoned needle, blended needle, sewn edge, and seeded needle. The commonly used embroidery techniques and needlework in Beichuan Qiang villages include "cross picking", "string picking", and "weaving picking". After embroidery, it needs to be ironed and sorted to ensure a smooth and beautiful appearance.

3. MODULAR DESIGN PROCESS DESIGN FOR BEICHUAN QIANG EMBROIDERY

3.1 Customized Qiang Embroidery Modular Design Process

The modularization of Qiang embroidery is a complete process from design to production, and the result of production is not only embroidery pieces, but also decorative or functional products such as illustrations, notebook covers, pillows, etc. Through module subdivision, a Qiang embroidery module design library can be established to further enrich the design instance library. The specific module setting process framework is shown in "Figure 2".
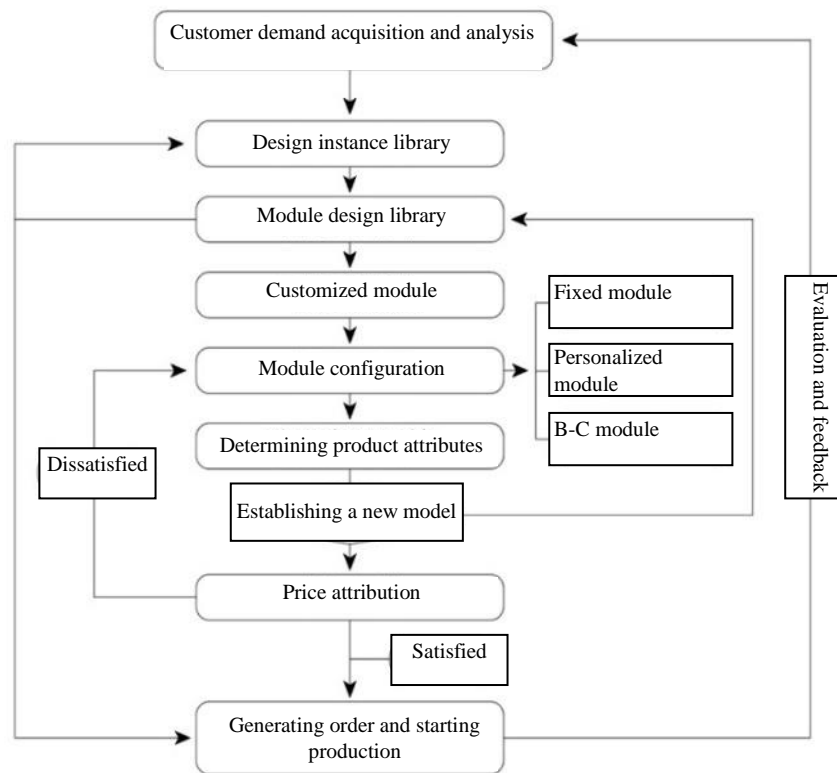
Figure 2 Process diagram for modular customization of Qiang embroidery.

Step 1: the first step is to extract customer needs and analyze them. According to a survey of 506 questionnaires from tourists in Beichuan Banaqia Scenic Area and Shiyi Qiang Village, it can be concluded that the demand for customized Qiang embroidery among young consumers is mainly reflected in four aspects: appearance, functionality, interactivity, and price (see "Figure 3"). Therefore, when customizing modules, it is necessary to fully consider the adaptability and practicality of the modules.
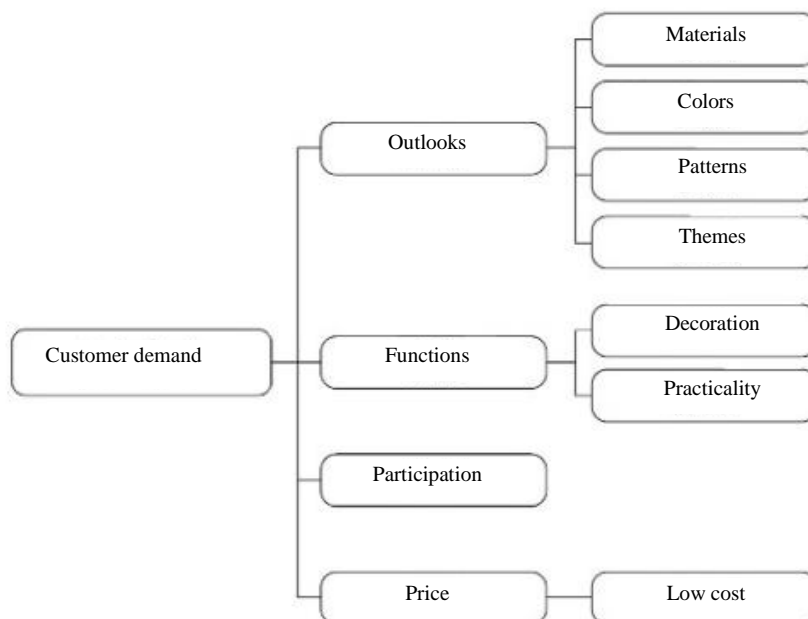

Figure 3 Customer personality needs analysis.

Step 2: the second step is to enter the design instance library and module customization library. If customers encounter suitable modules in the instance library, they can place orders directly. If not, they can enter the module design library for filtering. Similarly, they can also place orders directly.

Step 3: the third step is to customizable modules: When entering the customizable stage, the first is to screen and configure the modules. The customer selects the segmented Qiang embroidery modules (see "Figure 3") and completes the prototype design of the personalized module. When dissatisfied with the prototype, the B-C (Business to Customer) module can also be chosen. The B-C module is the content obtained by enterprise designers through direct communication with customers, which makes the results more unique and distinctive. At this stage, a pattern design with Qiang embroidery style can be generated.

Step 4: the fourth step is to determine product attributes. Attribute refers to the carrier of Qiang embroidery patterns, such as making Qiang embroidery patterns into decorative paintings, scarves, or embroidery pieces for clothing and accessories, which generates new modules.

Step 5: the fifth step is the price attribute. In the price attribute step, customers can decide whether to place an order based on the value evaluation results. If the customer is not satisfied with the price, they can return to the module configuration steps, re-select and confirm the order.

By streamlining the process, from customers' direct needs to product implementation, each step can be returned to the previous level for modification and testing. The customization platform and embroiderers can directly negotiate with customers to design and place orders for production. After the order is completed, customers can also evaluate and provide feedback on the entire process. The completion of this process can effectively meet the real needs of customers for Qiang embroidery products, solve the contradiction between the complex production mode of multiple varieties and small batches and the effective combination of efficient production. It can achieve flexible changes in customized design and production, and realize the adaptability of products to personalized market demands.

3.2 Module Division

Guided by modular design theory, through element analysis, designers can identify the key artistic features of Qiang embroidery patterns and use modular thinking to classify and extract these features. Based on the integration of personalized user needs and product functional types, designers can evaluate the value of design elements to ensure that the selected elements meet both user needs and market trends. When pre-partitioning modules, the following principles should be followed: the first is that modules need to have mutual independence and correlation; the second is that module design should ensure that the process, materials, and functions of customized products can be implemented; the third is the replaceability of each module to meet the different needs of customers. At the same time, it is necessary to pay attention to the number of control modules to reduce the complexity of subsequent combinations and management.

In the implementation stage of module division, it can be concluded from interviews with inheritors of Beichuan intangible cultural heritage and analysis of Qiang embroidery works that embroidery types, needle techniques, colors, patterns, and composition forms can be key factors affecting the style of Qiang embroidery works. Based on this, these elements are classified into first-level module. The construction of the second-level module is further developed on the basis of the first-level module. Through user research and market analysis, it deeply understands the specific needs and market dynamics of consumers, and determines the specific quantity and content of the modules. For example, in the color module, although Qiang embroidery has rich and diverse colors, in order to facilitate consumer selection, it is subdivided into second-level module such as base color, main color, and auxiliary color. The content of the third-level module is a refinement of the second-level module, and it is also the specific manifestation of the most aesthetic characteristics and cultural factors in Beichuan Qiang embroidery ("Figure 4"). For example, in plant patterns, the azalea is the guardian flower of the Beichuan Qiang ethnic group, symbolizing love and marriage. In the process of design practice, designers should continuously optimize modules to ensure that each module can efficiently meet design requirements. At the same time, they need to control the number of modules to avoid excessive complexity.
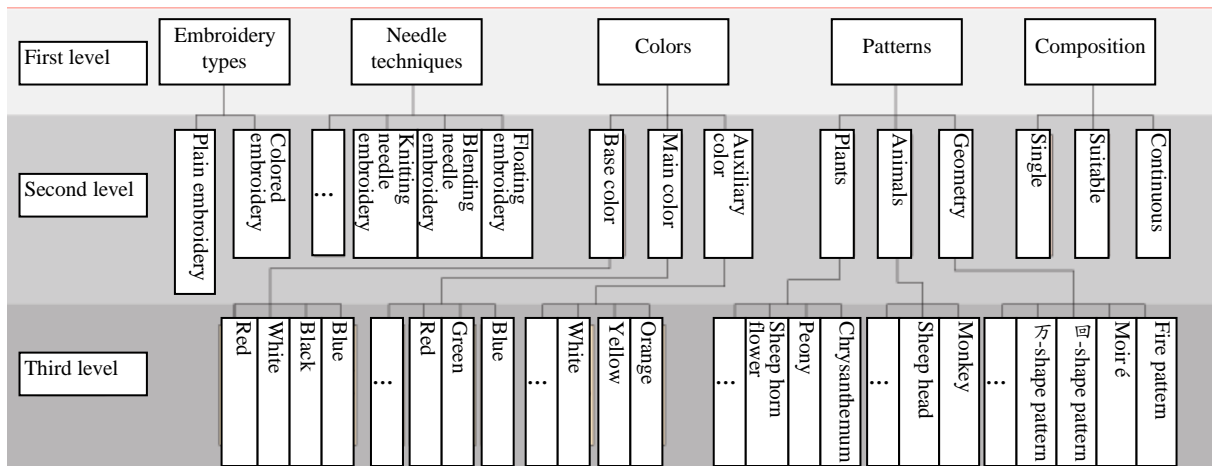
Figure 4 Three level module division of Qiang embroidery.

a   Drawn by the author.

4. CODE SETTING FOR PERSONALIZED CUSTOMIZATION MODULE OF BEICHUAN QIANG EMBROIDERY

In the modular design of Beichuan Qiang embroidery, in order to achieve efficient information management, personalized customization, and fast communication, it is necessary to logically code the modules. On the basis of module division, a combination of letters and numbers is used for encoding, aiming to simplify module descriptions and improve information processing efficiency. The Qiang embroidery module code consists of two parts: a universal code and an attribute code, ensuring the uniqueness and recognizability of each module code, facilitating database management and module configuration.

The design of the universal code follows the principle of hierarchy, with each module consisting of 4 to 6 bits of code. The first letter represents the first level main module and is represented by uppercase letters; The second letter represents the secondary structural module, using lowercase letters; The next two digits represent the third level subdivision module. If there is no subdivision, it is represented by "00". The last two digits represent the fourth level subdivision module. For example, the color module code for a decorative painting of Qiang embroidery is "Cb0302", where "C" represents the main module (color), "b" represents the structural module (base color), "03" represents the subdivision module (white), and "02" represents creamy white. The specific design is shown in "Table 2".

The attribute code is used to describe specific attributes of the Qiang embroidery module, such as decorative paintings (001), scarves (002), pillowcases (003), shirt collars (004), shirt placket (005), shirt cuffs (006), etc., to meet personalized customization needs. The setting of attribute codes is flexible and can be extended according to actual situations to adapt to future design changes and ensure the configurability of the coding system.

Table 2. Personalized customization universal module coding design for Beichuan Qiang embroidery

1st level module (coding)	2nd level module (coding)	3rd level module (coding)	4th level module (coding)
Embroidery seed module (E)	Plain embroidery (p)	—	—
	Colored embroidery (c)		
Stitch module (S)	Knitting needle embroidery (n)	—	—
	Cross stitch (c)		
	Floating embroidery (f)		
Color module (C)	Base color (b)	Red (01)	Deep red (01) Rose red (02)…
		White (02)	Raw white (01) Creamy white (02)…
		… …	…
	Main color (s)	White (01)	Raw white (01) Creamy white (02)…

		Yellow (02)	Light yellow (01) Yellow (02) …
		Red (03)	Dark red (01) Light red (02)…
		… …	…
	Auxiliary color (a)	Dark green (01)	—
		Green (02)	
		Light green (03)	
		… …	
Pattern module (P)	Plants (p)	Sheep horn flower (01)	Single (01) Single (02) Single (03)…
		Peony (02)	Suitable (01) Suitable (02) Suitable (03)…
		Chrysanthemum (03)	Continuous (01) Continuous (02) Continuous (03)…
		… …	…
	Animals (a)	Sheep head (01)	Single (01) Single (02) Single (03)…
		Monkey (02)	Suitable (01) Suitable (02) Suitable (03)…
		… …	Continuous (01) Continuous (02) Continuous (03)…
		… …	…
	Geometry (g)	万-shape pattern (01)	Single (01) Single (02) Single (03)…
		回-shape pattern (02)	Suitable (01) Suitable (02) Suitable (03)…
		Moire (03)	Continuous (01) Continuous (02) Continuous (03)…
		… …	…
	Figure (f)		—
Fabric module (F)	Cotton cloth(c)	Cotton cloth (01)	—
		Cotton cloth (02)	
		… …	
	Linen (l)	Linen (01)	—
		Linen (02)	
		… …	
	Silk fabric (s)	Silk fabric (01)	—
		Silk fabric (02)	
		… …	
	Chemical fiber (h)	Chemical fiber (01)	—
		Chemical fiber (02)	
		… …	
Composition module (M)	Module (m)	Module (01)	—
		Module (02)	
		… …	
	Custom (c)	Custom (01)	—
		… …	

Therefore, the customer wants to customize a decorative painting with a sheep head shape that is suitable for patterns, featuring colored embroidery, cross stitch technique, off white base color, and orange main color. The code is: 001 Ec00 Sc00 Cb0302 Cs0302 Ca01 Pp0104 Fc01MM02. The generated style order is shown in the "Figure 5". If the customer is not satisfied with the generated results or needs further adjustments in details, they can proceed to the B-C stage. Through this coding method, each module of Beichuan Qiang embroidery can be accurately identified and called, and the standardization of coding also facilitates communication between consumers, designers, and producers, as well as information processing in computer systems.

Figure 5 Personalized customization of Beichuan Qiang embroidery generates order diagram.

a   Drawn by the author.

5. EVALUATION OF MODULAR DESIGN FOR BEICHUAN QIANG EMBROIDERY

In the modular framework diagram of Qiang embroidery, the starting point is the customer's needs, constantly exploring the customer's intrinsic consumption motivation and improving the customer's consumption experience, which is the driving force for this process to repeatedly occur. [16] During the process of production, the Qiang embroidery patterns have been passively deconstructed due to the subdivision of modules, especially after the B-C stage where the product has a more personal style. In addition, the secondary creation of the embroiderer and designer, from the perspective of image studies, the Beichuan Qiang embroidery products under the new model order lack certain ethnic genes of ancient Qiang embroidery. However, in the digital age that pursues individuality and represents differentiated consumption, the inheritance of intangible cultural heritage craftsmanship is inevitably impacted by technology.[17] Qiang embroidery is more of a practical item for the Qiang people, and when Qiang embroidery enters the market environment, it needs to start from the symbolic meaning of Qiang embroidery [15], so that the cultural symbolic meaning of Qiang embroidery matches the potential symbolic consumption meaning of consumers. In the context of reflection and reshaping, the rational utilization of traditional culture, endowing it with modern life value, and achieving the public and shareable nature of skills have become the demands of the times.

With the help of modularization theory, taking the personalized customization of Qiang embroidery as the research object, and taking the needs of young consumers as the guide, this paper discusses the classification, design process and principles of Beichuan Qiang embroidery patterns based on the types, colors, stitches and other elements, with a view to providing a feasible scheme for the promotion and application of Beichuan Qiang embroidery in the market environment in the context of the Internet. The modular design process of personalized customization of Beichuan Qiang Embroidery under the Internet is a dynamic change process that takes the consumer's individual needs as the starting point, constantly assigns values to various variables of module screening, module configuration and clothing attribute setting in the process of pattern modular design according to the design goal, and finally generates the optimal configuration scheme for consumer satisfaction, so that consumers can experience the sense of achievement of participating in the design, realizing the goal of digital personalized design and production of Qiang Embroidery based on the Internet, laying the foundation for the digital standardization and intelligence of Beichuan Qiang Embroidery custom design, and also providing a feasible design and operation scheme for the personalized customization of Qiang Embroidery products on the Internet.

6. CONCLUSION

With the continuous integration of digital technology, the modular design of Qiang

embroidery is expected to achieve more intelligent and precise customized services. For example, using AI algorithms can analyze customer preferences and automatically recommend the most suitable module combination; By utilizing virtual reality technology, customers can preview the effects of customized products in a virtual environment, further enhancing their shopping experience. At the same time, strengthening cross-border cooperation with other cultural industries will also open up broader development space for the modular design of Qiang embroidery.

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