

Research on the Design of Changzhou Needlework Space under the Application of Intelligent Technology

Xinghui Zhao^{1*}, Chanoknart Mayusoh², Akapong Inkuer³, Permsak Suwannatat⁴

¹ Doctoral Student of Philosophy Program in Visual Arts and Design, Faculty of Fine and Applied Arts, Suan Sunandha Rajabhat University, E-mail: s64584948065@ssru.ac.th

² Advisor in Visual Arts and Design, Faculty of Fine and Applied Arts, Suan Sunandha Rajabhat University, E-mail: chanoknart.ma@ssru.ac.th

³ Visual Arts and Design, Faculty of Fine and Applied Arts, Suan Sunandha Rajabhat University, E-mail: akapong.in@ssru.ac.th

⁴ Program in Creative Arts Department, Faculty of Fine and Applied Arts Chulalongkorn University, E-mail: permsak.s@chula.ac.th

*Corresponding Author: s64584948065@ssru.ac.th

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ABSTRACT

This paper takes the intelligent design of intangible cultural heritage needlework space in Changzhou City as the research goal, analyzes the application of innovative products and the application effect of space intelligence display after the innovation of needlework art patterns, and uses intelligent equipment technology to realize the cultural and commercial economic value of needlework space. The qualitative research method was used to collect relevant policy and literature research data, and the quantitative research used questionnaires and evaluation forms to analyze the characteristics and development direction of intelligent design of commercial space in Changzhou through field research and interviews. The results show that: 1. The intelligent design of the commercial space of random needlework in Changzhou is insufficient, and there is a lack of influential mature space cases; 2. The design of Changzhou's intangible cultural heritage space should form a certain influence, so that the design of intangible cultural heritage space should be differentiated, the exhibition should be dynamic, and the technology should be intelligent, so as to build a future technical system for the design of Changzhou's intangible cultural heritage commercial space.

Keywords: Intelligent Technology, Random Needlework, Space Design

INTRODUCTION

In the wave of intelligent design of commercial space, the inheritance and innovation in the design of traditional cultural space are facing unprecedented challenges. As a branch of the development of traditional Suzhou embroidery, the chaotic needlework in Changzhou City, Jiangsu Province, China, itself carries a rich historical culture and unique folk customs, and the closely related space exhibition design has gradually presented the problem of insufficient adaptability in the development of the new era. In this context, this study focuses on the application and expression of the spatial design form of Changzhou needlework embroidery, aiming to create a new era of spatial experience through the innovative integration of space exhibition form and intelligent technology, provide tourists with a unique cultural and spatial experience, and provide new ideas for the protection and inheritance of Changzhou needlework cultural heritage.

The cultural value of Changzhou needlework is not only reflected in its artworks, but also in the cultural value of intangible cultural heritage. The cultural elements of needlework are linked between history, tradition and modernity, and are also an important factor in attracting tourists and promoting local economic development. Therefore, the study can accurately convey the cultural significance of Changzhou's intangible cultural heritage, which is of great significance for enhancing the cultural identity of the region, enhancing the tourism attraction and promoting the sustainable development of culture.

Research Objectives

In the form of space exhibition design and case application, the effect of intelligent design technology applied to the space design of Changzhou needlework and the promotion effect of the industry are explored.

LITERATURE REVIEW

The Features of the Exhibition Space of Non - Cultural Heritage Embroidery

Intangible cultural heritage is a living traditional culture, and in the protection and display of intangible cultural heritage, in order to truly show the characteristics of intangible cultural heritage in a specific time and space, it is necessary to participate in the theme of inheritance. (Wei, 2023) Through the clever use of color, material, layout and other elements, the limitations of time and space are broken, the connotation and cultural attributes of intangible cultural heritage are extended in the form of spatial display, and the diversity and uniqueness of intangible cultural heritage exhibition space are explored and recognized.

Show the Types of Space Technology

Holographic projection technology, also known as virtual imaging technology, interferes with the reference light wave to form an interference pattern (i.e., hologram). This pattern records all the information about the light waves of the object, including amplitude, phase, and frequency. These light waves propagate through space, forming the same three-dimensional stereoscopic image as the original object. At present, the application of the retail industry to display goods is to increase the three-dimensional and realistic effect and provide an immersive space exhibition experience.

Digital display, refers to the use of new media technology and digital technology, digital display, mainly embodies the characteristics of informatization, diversification, interactivity, these characteristics of strong support, virtual reality, augmented reality, phantom imaging, holographic imaging and other new technologies emerge in an endless stream, followed by the diversified development means of the form of exhibition, the content to be presented through digital means. Visual, auditory, tactile and other composite sensory experiences make the experience of digital media display have the advantages of diversification, all-round and immersion, which not only expands the functionality of the exhibition itself, but also increases the fun and participation of the audience. Effectively construct a three-dimensional space display and innovate the form of chaotic needlework exhibition.

Digital Intelligent Technology Display Space Design Application

The progress of technology has provided people with the possibility of understanding the multifaceted nature of things, and in the process of constantly perceiving and understanding space, it has created people's rich and diverse personality needs in the digital age.

The intelligent expression of Changzhou needlework display space under the application of technology first brings a visual experience with a sense of impact, relying on the visual system of the body, and has a very direct information acceptance state for the light and shadow, color, mechanism and scale of the space. and the processing of spatial graphics to form an internal cognitive system. This system has a reverse effect on the design of the exhibition space, so that there is a design that pays attention to the sense of experience in the space design, and the design of the immersive, interactive atmosphere in the many space displays, which is different from the static and people's inner thought activities in the traditional space, and transforms into the external direct manifestation of the behavior of people in the space, and all experiences are expressed in the form of absolute extroversion.

RESEARCH METHODOLOGY

This paper analyzes the design methods of the intangible cultural heritage exhibition space represented by the embroidery in Changzhou, including quantitative analysis, qualitative analysis, questionnaire survey and data analysis.

- **Step 1:** We will have a comprehensive understanding of research theme, and better understand the characteristics of the artworks, the characteristics of space function requirements, space display design technology and innovative methods of Changzhou's intangible cultural heritage needlework. This paper consults and analyzes all kinds of literature and materials of Changzhou needlework, and summarizes the artistic characteristics, development and inheritance of Changzhou needlework. Invite practitioners of needlework to collect views and experiences through face-to-face and telephone contact. This paper investigates and analyzes the literature on the display design of the intangible cultural heritage exhibition space and the Changzhou needlework space, analyzes and sorts out the relevant practical cases, and summarizes the design strategies and design methods for the display design of the Changzhou needlework space.
- **Step 2:** Design a questionnaire that includes participant information, needs, satisfaction, and other related content. 100 questionnaires were distributed in Changzhou City, and 94 were returned, with an effective rate of 94%. Nine questionnaires were sent to professional practitioners and experts, all of which were recovered, and the effective rate reached 100%. Hypotheses are tested and practical recommendations are made from multiple perspectives. Collect and preprocess the survey data, construct the evaluation index system of spatial experience value, determine the measurement indicators of satisfaction and consumption intention, construct a research model of the impact of perceived value on consumption intention, and put forward relevant hypotheses, such as the degree of influence of tourists' experience on consumer intention and satisfaction.
- **Step 3:** Clarify the tools used, including taking photos, recording interviews on the spot, and recording expert opinions on the spot, so as to provide data support and tool guarantee for the research. Design a questionnaire as shown in Table1.

Table 1 Questionnaire on customers' cognition of random stitch art and space

	Correction Item Total Correlation	Item Deleted alpha coefficient	Cronbach Alpha coefficient
Your gender:	0.000	0.946	0.945
Your age	0.000	0.946	0.945
Your professional background:	1.000	0.939	0.941
Your education background	0.000	0.946	0.945
How do you usually learn about random stitch work?	0.000	0.946	0.945
Whether you are willing to try a random stitch commercial space with intelligent design	0.000	0.946	0.945
How often do you visit a business show or mall	-1.000	0.984	0.947
What do you think are the important features of the commercial space display design?	-1.000	0.956	0.935
Do you understand the role of intelligence in the display design of random stitch commercial space?	0.000	0.946	0.945
What techniques or elements do you want to include in the design of the display space?	0.000	0.939	0.942
Whether the diverse interactions enabled by smart technology bring you happiness	1.000	0.939	0.937
During the experience, I felt very comfortable	1.000	0.939	0.940

Source: Author

Step 4: Through the literature retrieval method, collect information about the intangible cultural heritage artworks and space design of Changzhou random needlework, and screen relevant papers. From the perspective of data collation, the research of Chinese intangible cultural heritage art has a certain foundation, and the theoretical

system needs to be further improved. However, the design of the exhibition space for intangible cultural heritage is relatively weak, the theoretical foundation of the design is weak, and there is no effective support, which needs to be further improved. In the process of research, we conducted field research on the space of needlework in Changzhou and surrounding cities, and photographed and recorded the artworks and space design of needlework. It is found that most of the display and space design of random needlework are based on traditional display methods, which are seriously homogeneous, lack the use of modern digital exhibition technology, and have a weak sense of space interaction and scene. In the study, experts and artists of Changzhou needlework were interviewed, and the development and inheritance of needlework were summarized, and the intangible cultural heritage connotation of needlework was deeply understood. Questionnaires were developed and distributed, and the data and information obtained were used for practical research by conducting research on the status of needlework products and the state of the space design industry. Questionnaires designed for experts. See Table 2.

Table 2 Satisfaction degree of space design experts on the design of commercial and cultural space in Changzhou Random stitch embroidery

Primary index	Secondary index					
cultural	Cultural and creative products are integrated into history	5	5	5	4	5
	Cultural and creative products incorporate technical features	4	5	5	5	4
	The space is incorporated with artistic features	5	5	5	5	5
Aesthetic character	The visual aesthetics of the space design	4	5	4	5	5
	Harmony of space design styles	5	5	4	4	5
	The design of the space exhibition is innovative	5	5	5	4	4
Designability	The space is designed with rich details	5	5	5	4	5
	The rationality of the connection of the spatial functional area	5	5	5	4	5
	The space is designed for dimensional comfort	4	4	5	5	5
	Ease of space streamlining design	5	5	5	5	5
Technicity	The number of intelligent equipment bodies is reasonable	5	5	5	5	5
	The richness of the spatial interactive project	5	5	5	4	4
Experience	Experience the comfort of the process	4	5	5	5	4
	The uniqueness of the interactive process	4	5	5	5	4
	Tour the sense of entertainment in the space	5	5	4	5	5

Source: Author

Effect of opinion level on average score range, Table 3

Table 3 Standard reference for score values

Average value	Scores correspond to the meaning of applicability
4.51 - 5.00	As good as gold
3.51 - 4.50	Good
2.51 - 3.50	Normal
1.51 - 2.50	Standard
1.00 - 1.50	Need improvement

Source: Author

When evaluating the average of all aspects, a value of 3.51 or higher is required to pass the evaluation criteria of the experts. Table 2 shows that the data are cultural, aesthetic, design, technical, and experiential, and 3-4 core questions are set for each aspect to obtain relevant values. If the value exceeds the value between 4.51 and 5.00, the set content passes the evaluation criteria. In Changzhou, the cultural and technical character of the commercial culture experience space design has a high weight. This shows that these factors have a significant impact on the overall experience quality, and need to be strengthened in three aspects: aesthetics, design, and experience, so as to enhance the artistic and economic value of the space.

RESEARCH RESULTS

This chapter will elaborate on the main findings of this study, including the innovation of Changzhou needlework artworks and the application of cultural and creative products, the concept of Changzhou needlework

art exhibition space design, and the design of specific schemes for Changzhou needlework commercial and cultural experience space design, including the analysis and design of space functional areas, space modeling design, space experience evaluation, and the design guidelines for Changzhou needlework space exhibition design.

1. Changzhou Needlework Artwork Pattern Innovation and The Application of Cultural and Creative Products

As a treasure of traditional Chinese embroidery art, Changzhou random needlework has profound cultural heritage and artistic value. Because of its unique embroidery method, it has developed into an art form with local characteristics of Changzhou after the traditional Suzhou embroidery. After a century of development, it has become one of the important art forms in Changzhou that reflects local characteristics. With the rise of the cultural and creative industry, the cultural and creative products of the embroidery gradually entered the public eye, from the artwork to the cultural and creative products close to the lives of the people, Changzhou embroidery in the current situation with the characteristics of the times for inheritance and innovation.

Changzhou Needlework Artwork Cultural Connotation Cognition

Integration provides a new avenue for cultural exchange between China and the West, and promotes the diversity of art forms and mutual learning of cultures. As one of the first batch of intangible cultural heritage in Jiangsu Province, needlework is not only a cultural symbol of Changzhou, but also a vivid embodiment of the cultural diversity of the Chinese nation. Needlework is not only a presentation of visual art, but also a carrier of cultural inheritance, with the cultural value of international exchange.

The Innovation of Changzhou Needlework Art Patterns

Starting from the technique of chaotic needle embroidery, as shown in Figure 1



Figure 1 Staggered lines of chaotic needlework and stitching

Source: Author

In the innovation of patterns, related patterns are found around staggered and seemingly messy lines, as shown in Table 4.

Table 4 Extraction of multiple patterns

Basic form	Extract form	Combined form	Innovative application form
			/
			/

Source: Author

Changzhou Needlework Art Exhibition Space Design Concept

The design of the exhibition space of Changzhou random needlework embroidery is a bridge connecting the intangible cultural heritage culture and the modern audience, which affects the visiting experience and cultural communication effect. Based on the theory of technical affordance, it is the core of the design to choose modern technology suitable for the spatial characteristics of random needlework to maximize the expression of its exhibition characteristics.

1. *In the design of space scheme, it is necessary to pay attention to space planning and layout*

Reasonable space planning through the layout of functional areas, ground signs, signs, lighting guidance, etc., Guide visitors to understand the history, inheritance and technical characteristics of needlework in an orderly manner, enhance the coherence and experience of the visit, and avoid crowding or emptiness to ensure comfortable viewing.

2. *Intelligent display effect*

Through digital intelligent technologies such as intelligent interactive equipment and multimedia interaction, product display and random needlework scenes are more vivid and three-dimensional. The excellent design of the exhibition space highlights the exquisite and delicate embroidery works, pays attention to the color expression of the space, and highlights its rich and delicate colors with the different use of color lines. At the same time, the design of space lighting and materials is used to achieve high-quality display, enhance the visual experience of visitors, intuitively feel the exquisite design, and deepen the understanding and feeling of the art of needlework.

3. *The application of new technologies enriches the four-dimensional nature of the design of the exhibition space of the intangible cultural heritage of random needlework*

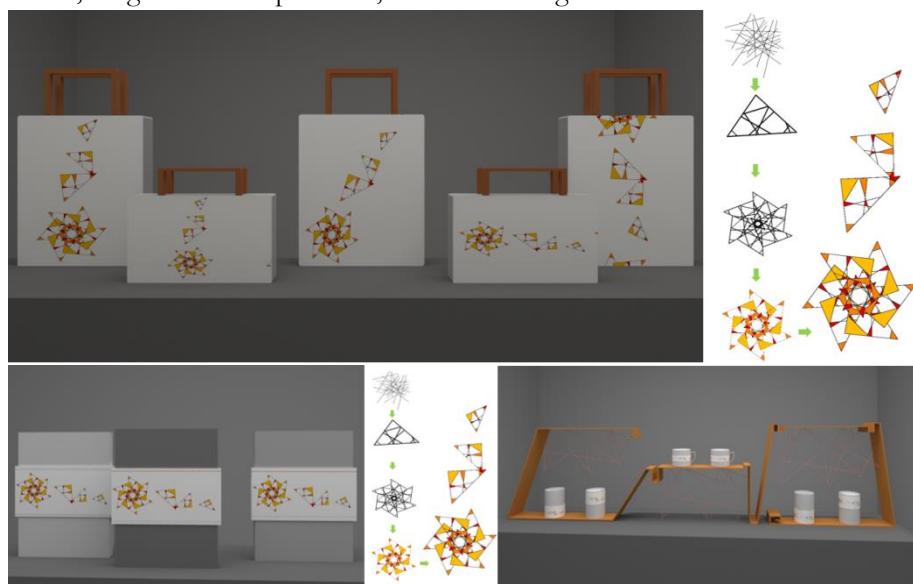
In the case study, the design of the intelligent ground interactive projection corridor skillfully uses the time dimension combined with the three-dimensional space, and guides the audience to experience the historical changes and the depth and breadth of spatial design of Changzhou random needlework in the passage of time through visual dynamics and rhythmic changes.

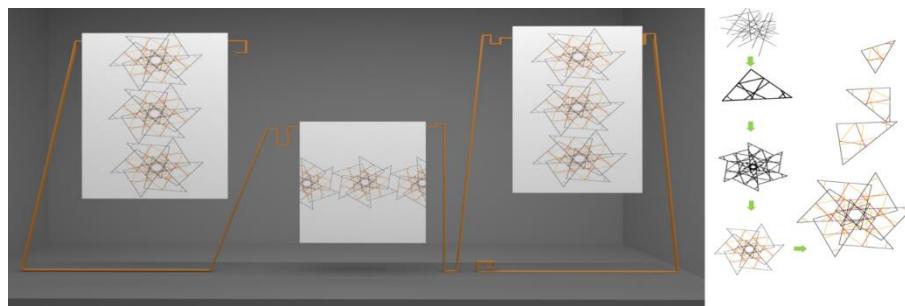
4. *Problems faced by the development of random needlework and space design in Changzhou*

Lack of inheritance and innovation, designers try to combine traditional techniques with modern design concepts to create works with both traditional charm and modern beauty. However, there are few new forms in the form of expression and the atmosphere of the exhibition of works. The space function is single, the application is not extensive, and the space application is no longer limited to the traditional home decoration, and has begun to be applied to hotels, clubs and cultural exhibition spaces, but because of the characteristics and form of the work itself, there are few breakthroughs in the form and content innovation, and it is more of a traditional extension and inheritance, and the same is true in the form of space design.

The Design of Changzhou Needlework Artworks and Exhibition Space Design

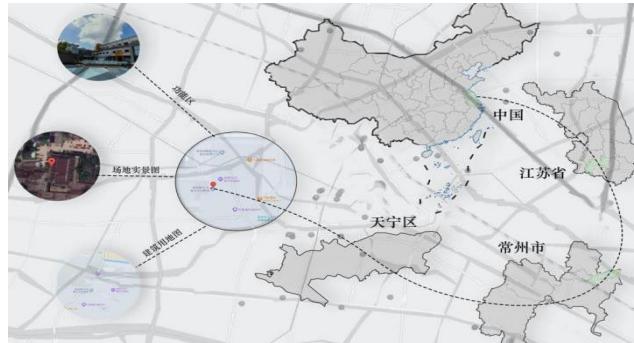
Based on the innovation of the early needlework stitch method, the graphics are dedicated to the application of handbags, silk scarves, mugs and other products, as shown in Figure 2



**Figure 2** Innovative product application of chaotic needlework pattern

Source: Author

On the basis of pattern innovation, the design and pattern application of the Cham space of needlework embroidery are carried out. For the specific case space, the space is set to the old factory site of Changzhou Black Peony Group, with an area of 678.6 square meters, and the location analysis and research of the space are carried out, as shown in Figure 3

**Figure 3** Location analysis of spatial addresses

Source: Author

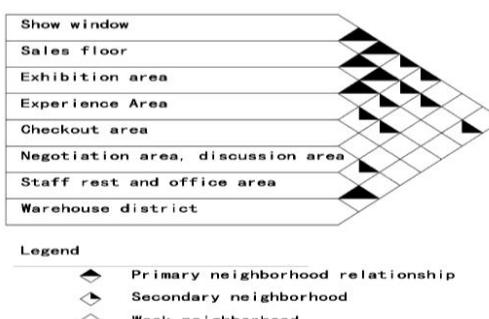
For the planning of the functional area of Changzhou needlework commercial and cultural experience space, the asterisk marked in the table is the key display, which involves the application of AI, digital projection and other technologies, as shown in Table 5

Table 5 Functional areas of intangible cultural heritage needlework cultural experience space

Function region	Characteristic point
Show window	Highlight themes and features
Sales floor	The main design products and peripheral extension products
Exhibition area	It mainly introduces and exhibits history
Checkout area	Image presentation and collection services
Warehouse district	Storage of goods and consumables
Negotiation area, discussion area	Space third function development
Staff rest and office area	Humanized management
Experience zone	Focus on hands-on experience and emotional cultivation

Source: Author

According to the types of spatial functional areas, the relationship between functional areas is analyzed, and the relationship between functional areas is set by matrix analysis. See Figure 4

**Figure 4** Matrix analysis of intimacy in spatial functional areas

Source: Author

According to the analysis of the advantages and disadvantages of the space, combined with the original framework diagram, the space is designed, and the relevant plane planning and design are carried out, in which the area marked with an asterisk is equipped with intelligent equipment and interactive equipment to create an intelligent interactive effect of space. See Figure 5

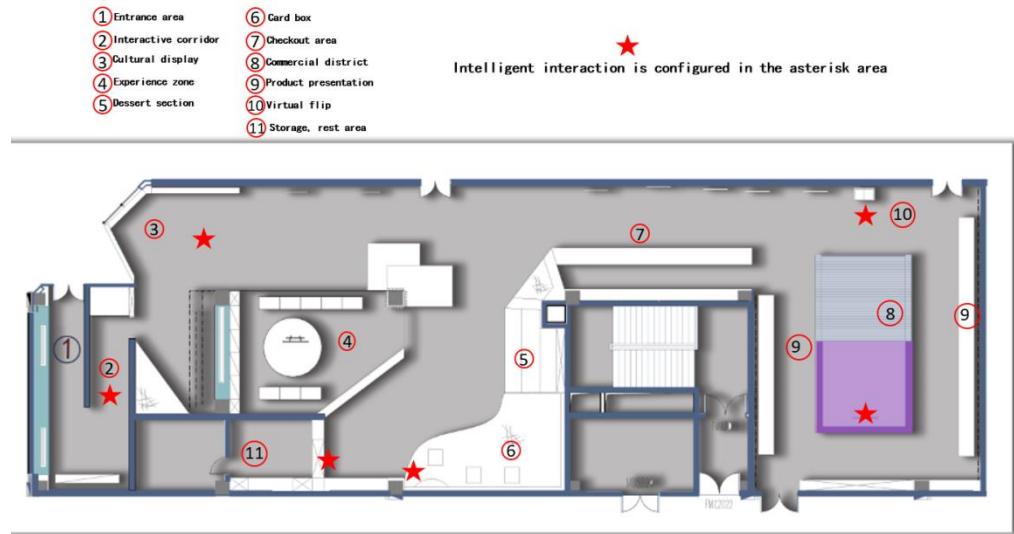


Figure 5 Spatial plan layout

Source: Author

According to the plane planning and design, the final space exhibition design effect is shown in Figure 6.

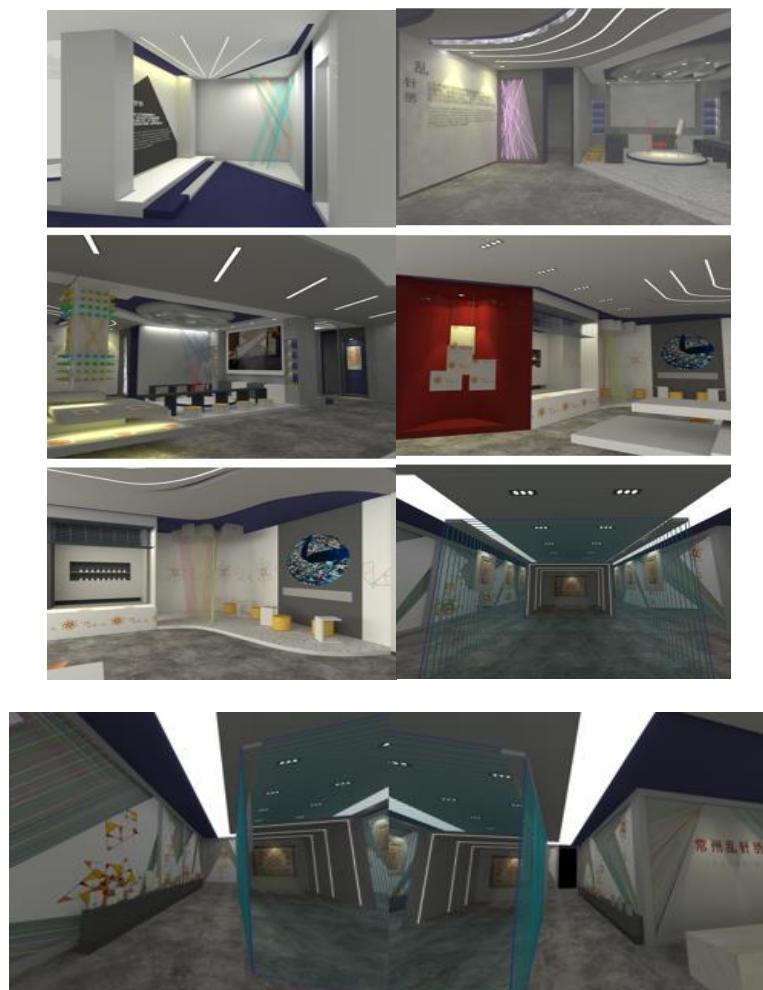


Figure 6 Final rendering effect of space

Source: Author

Changzhou Needlework Space Design is Perfect

The researchers improved the cultural souvenirs of the needlework, including pattern design, design concept, pattern design evaluation, application design pattern, product evaluation and creative product design display. These improvements are aimed at improving the cultural value and market communication of needlework.

Pattern Innovation

In terms of pattern design, the researchers extracted the interlaced patterns and symbols of the threads from the chaotic needle stitch method and transformed them into a modern graphic language to meet the aesthetic needs of modern consumers.

Color Matching

In terms of color matching, the researchers used the red, orange and yellow colors of the silk thread to create a modern color scheme, and in the space design industry, they used blue, lake blue, yellow, green, red and gray, which accounted for a relatively low proportion of space usage, to present the color matching required for the exhibition space in the new era. See Figure 7



Figure 7 Proportion of color matching in spatial display design

Source: Author

Design Concept

Based on the theory of technical affordability, the design concept emphasizes cultural inheritance and innovation, aiming to reflect the cultural value and the value of the times through the innovation of needlework products and the innovation of space display design.

Product and Space Design Evaluation

Through user surveys and market analysis, the researchers evaluated the effectiveness of the innovative art products and space designs to ensure that they met market needs and consumer expectations.

To ensure the accuracy and reliability of the assessment, this study used a combination of online and offline methods to comprehensively evaluate the use of needle space. The evaluation object is the consumers visiting the chaotic needle embroidery space and the people in the surrounding business district. The assessment instrument was the set assessment questionnaire, which was validated by pretest and reliability validity analysis. The Likert scale used in the questionnaire ranges from 1 (very unsatisfactory) to 5 (very satisfactory). A total of 301 questionnaires were distributed and 209 valid responses were collected, covering consumers of different age, gender and educational background. To ensure data representativeness, missing data were processed by multiple induction, followed by data cleaning and final analysis. The data analysis process includes data cleaning and processing missing data. The analysis methods used include descriptive statistics, correlation analysis, multiple linear regression analysis, to get a comprehensive understanding of the impact of various spatial design items on overall satisfaction.

According to the results of the questionnaire data analysis, the average (\bar{x}) of overall satisfaction was 4.41 (standard deviation of 0.54), which indicated that the commercial cultural space after innovative design was favored by consumers (Table 4.6).

Table 6 Evaluation Results: Design of commercial needle Space in Changzhou (N=209)

Project name	Quantity	Minimum	Maximum	Mean value	Standard deviation	Median
Space culture	209	2	5	4.7	0.46	5
Spatial story	209	2	5	4.35	0.54	4

Spatial inheritance	209	3	5	4.55	0.5	5
Space color	209	2	5	4.55	0.55	4
Space material	209	2	5	4.42	0.52	4
Rationality of moving line planning	209	3	5	4.6	0.49	5
Intelligent application of technology	209	2	5	4.1	0.6	4
indication of interest	209	2	5	4.2	0.55	4
Meet the market demand	209	2	5	4.36	0.54	4

Source: Author

CONCLUSIONS AND DISCUSSION

1. The exploration of modern intelligent technology expands the cultural and commercial nature of the space design of needlework

Modern intelligent technology provides a broader performance platform for the dissemination of needlework culture, and the application of virtual flipbooks, interactive induction equipment, and interactive projection corridors in space design makes the perfect integration of traditional embroidery and modern technology, bringing new opportunities for the space design of needlework, and expanding its cultural and commercial nature. Modern intelligent technology provides strong support for the market expansion of needlework and provides new means for the marketing and promotion of needlework. In short, modern intelligent technology has brought infinite possibilities for the cultural and commercial aspects of needlework.

2. With the help of intelligent technology to innovate chaotic embroidery exhibition space design

Through intelligent technologies such as virtual flipbooks and interactive projections, it can break through the static display form of traditional needlework exhibitions, so that the audience can feel the artistic charm of needlework from multiple angles and in an all-round way. Through touch screens, interactive projections and other technologies, the audience can personally participate in the design and production of needlework, understand the stitching method, color matching and other knowledge of needlework, provide a rich interactive experience, and enhance the audience's sense of participation. The combination of intelligent technology and needlework products and space design can give rise to new cultural and creative products and business models. It is of great practical significance and value to enhance the soft power of local culture, promote the development of cultural and creative industries, promote the construction of smart commercial exhibition space, and help the protection of intangible cultural heritage through intelligent technology innovation in the design of the exhibition space.

3. Implement the design practice of intelligent technology innovation and exhibition space with specific cases

Based on the above research and exploration, the old factory site of Changzhou Black Peony Group, with an area of 678.6 square meters, was taken as the case address. Conduct research and analysis on the surrounding road network, location, business format, crowd, etc., and innovate the pattern of random needlework according to the characteristics of random needlework and customer needs, and apply it to cultural and creative products such as handbags and silk scarves. In the space design, the space is divided by location, and corridors and wall decorations with intelligent technology and equipment are set up in the front, middle and rear areas, so as to enrich the frequency and mode of space interaction, so as to provide customers with a good sense of space experience.

4. Evaluate the innovation of Changzhou's intangible cultural heritage needlework cultural and creative products and the satisfaction and acceptance of the exhibition effect of space design

Using the five-point Likert scale method, the satisfaction of the product and space design of the innovative pattern application of random needlework was evaluated, and the questionnaire survey and expert evaluation were used, and the data and weights met the standards of the scale. From the five aspects of culture, aesthetics, design, technology and experience, it is concluded that the cultural and technical aspects of cultural and creative product innovation and space design have higher weights, and the research results have achieved the expected results, while the aesthetics, design and experience need to be strengthened in three aspects.

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