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Computer-Aided Design AND APPLICATIONS

Design of Intangible Cultural Heritage Products based on 3D Visualization Technology

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Abstract. The inheritance and innovation of intangible cultural heritage (ICH) must be constantly updated and developed. This paper explores the method of applying three-dimensional (3D) visualization design technology to ICH cultural and creative products. By digitizing ICH projects and displaying them in 3D visualization, not only is the effect of ICH protection improved, but a new way for its innovative development is also provided. Based on 3D visualization technology, ICH cultural and creative products are systematically studied, and the design elements are scientifically evaluated using the entropy evaluation method in information theory. The results show that under the same conditions, the ICH cultural and creative products designed with 3D visualization technology (Group X) have a click volume of 5200-5700, a comment volume of 2600-3200, and a forwarding volume of 2000-2400. In contrast, the ICH cultural and creative products (Group Y) designed without 3D visualization technology have a click volume of 3500 to 4000, a comment volume of 2000 to 2500, and a forwarding volume of 1100 to 1500. Data comparison shows that Group X ICH products show better promotion effects in all indicators. The application of 3D visualization design technology has demonstrated the unique charm of intangible cultural heritage products and verified its effectiveness in promoting the inheritance and innovative development of intangible cultural heritage through scientific evaluation methods. In the future, with the continuous advancement of technology and the deepening of its application, 3D visualization design technology will play an increasingly important role in the protection of intangible cultural heritage and cultural innovation.

Keywords: Three Dimensional Visual Design; Digital Storage Technology; Intangible Cultural Heritage; Cultural Inheritance and Innovation
DOI: https://doi.org/10.14733/cadaps.2025.S4.125-137

1. INTRODUCTION

Intangible cultural heritage is an important part of Chinese traditional culture and has high historical, cultural, and artistic value. However, in the process of rapid development and informatization of modern society, intangible cultural heritage also faces many challenges and difficulties, such as the balance between inheritance and innovation, the challenges of digital storage and dissemination, etc. Therefore, combining intangible cultural heritage with modern digital technology and design fields to achieve the inheritance and innovation of intangible cultural heritage is an important research direction and practical need. As an emerging technology, 3D visualization technology seems to be able to give a good answer. 3D visualization technology is a method that can combine computer graphics and virtual reality technology. It uses the three-dimensional information of objects to display them in virtual space digitally. Compared with traditional graphic design, this technology no longer limits objects to flat display, and designers can simulate the morphological structure and even material of objects more clearly and realistically. This can facilitate communication and feedback between customers and designers and improve customer satisfaction with the finished product. In recent years, continuous breakthroughs in science and technology have enabled 3D visualization technology to be applied in various fields. In the fields of industrial manufacturing and architectural design, 3D visualization technology has become an indispensable tool. Whether it is component design or architectural design, a clear 3D design drawing is a secret weapon that can make Party A's eyes shine. In the design of intangible cultural heritage products, the advantages of 3D visualization technology are more obvious. This technology's 3D modeling can more precisely depict the distinctive elements of artistic and cultural items and create a trustworthy digital archive for every one of them. In the current era of advanced network technology, this digital technology can make it easier for designers to combine intangible cultural heritage elements with modern design concepts, present products that are more in line with people's aesthetics and do not lose the characteristics of intangible cultural heritage elements, and promote the evolution of intangible cultural heritage in modern society. Virtual reality technology in 3D visualization technology can provide new ideas for the dissemination of intangible cultural heritage. In the virtual space constructed by this technology, people can experience the historical origins and craftsmanship behind intangible cultural heritage through interaction, enhance people's understanding and recognition of intangible cultural heritage, and stimulate the public's interest in intangible cultural heritage. It is believed that with the continuous development of technology and the deepening of its application, 3D visualization technology will play an increasingly important role in the field of intangible cultural heritage and help the inheritance and development of intangible cultural heritage.

This work investigates how 3D visualization design is applied to innovation and ICH inheritance. Taking intangible cultural and creative products as an example, the process and methods of three-dimensional visualization technology product design are introduced, providing new ideas and references for the protection and innovative development of intangible cultural heritage.

2. RELATED WORK

People can more clearly and intuitively perceive the charm and significance of intangible cultural assets thanks to 3D visualization design, which also encourages the ongoing advancement of associated technology. Among these, 3D visualization technology has been extensively applied in many industries and has cleared the path for the creation of virtual reality[1]. In the field of education, Astuti Tiwi Nur's research produced a 3D visualization program in virtual reality to improve the critical thinking ability and scientific attitude of high school students [2]. According to the test results, students who used 3D visualization achieved better results in critical thinking ability and scientific attitude, proving the effectiveness of 3D visualization in education and emphasizing its importance in promoting students' cognitive ability and scientific literacy [3]. Dykes Tim analyzed the current status of 3D visualization of large theoretical astronomical data sets through scientific portals and virtual observatory services and discussed some challenges faced by interactive 3D visualization and how it can increase user workflow in virtual observatory environments [4]. Although 3D visualization can effectively handle complex data, in practical applications, users have increasing demands for interactivity and operability, and the technology needs time to develop to meet these needs [5]. Yu Qiao proposed a solution to achieve real-time 3D visualization of outdoor scenes through artificial intelligence and visible Internet of Things. Experiments show that the proposed solution enhances the visualization of the real world to support user decision-making[6].

Zhong H turned his research perspective to the application of digital technology in the preservation of cultural heritage. He designed a digital preservation solution for cultural relics using 3D modeling[7]. Enhancing the presentation impact of cultural relics through the use of high-precision tools that scan items and transform them into comparable models considerably improved the effectiveness of cultural heritage protection[8]. In terms of the dissemination of intangible cultural heritage, Wang Y also made a lot of contributions. He chose to use computer vision and deep learning for research[9]. Through these technologies, the processing efficiency of cultural information can be improved, which can provide more efficient data analysis tools for intangible cultural heritage[10]. 3D visualization technology has also been widely used in the cultural and creative industries. Yan M used 3D printing to combine traditional handicrafts with modern design. His works retain the characteristics of traditional craftsmanship without losing the embellishment of modern aesthetics, which is very attractive to young people[11]. Many relevant researchers use similar methods to design and produce in some current intangible cultural heritage exhibitions. The corresponding products are often very eye-catching. Combined with virtual reality equipment, the audience can get close to and understand the details of these works. In some cases, the audience can even simulate the relevant production process [12-13]. Mathioudakis G's research is more inclined to such a combination of virtual and real. His team used augmented reality technology. Through the commonly used smartphones and tablets, people can see the relevant displays in a real environment without leaving home. This new learning experience has also attracted many young people and significantly increased people's interest in intangible cultural heritage [14]. In the view of many researchers, simply displaying objects is far from enough, so Nikolakopoulou V focused his research on the construction of virtual museums. He conducted research on the construction of virtual museums based on three-dimensional modeling and virtual reality technology [15]. Through the online platform, the museum can display precious cultural relics to the public while ensuring the safety of cultural relics, which can effectively expand the influence of these cultural relics. Some museums and cultural institutions have started to upgrade related configurations very early. For example, the Victoria and Albert Museum in the UK and the Smithsonian Institution in the United States have launched virtual exhibitions on their online platforms to showcase intangible cultural heritage projects from all over the world. These innovative measures have promoted the dissemination and inheritance of culture to a certain extent and provided more education and research opportunities.

3. DESIGN STEPS

3.1 ICH Protection and Cultural and Creative Product Design

The protection of ICH and the design of cultural and creative products are two closely related fields. To protect and inherit ICH, there is a need to carry out relevant protection work, as well as design cultural and creative products. ICH is transformed into cultural products with commercial value to promote the inheritance and development of ICH. The introduction of ICH is shown in Figure 1.

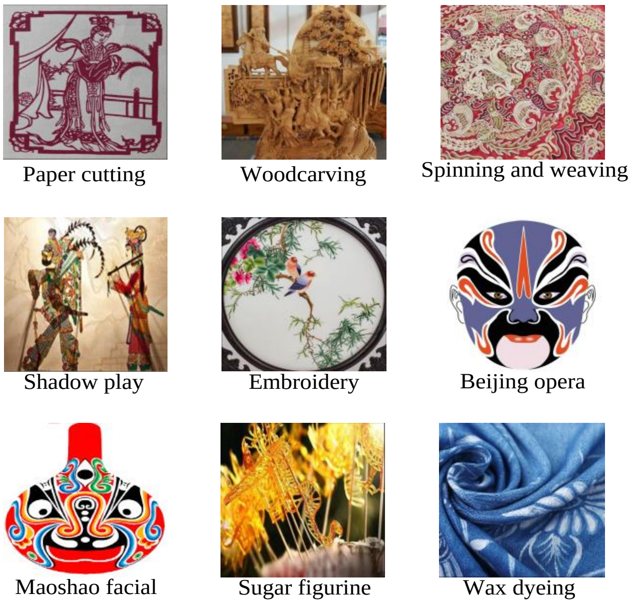


Figure 1: Introduction to ICH.

In terms of protecting ICH, multiple measures need to be taken. One important aspect is to record and organize ICH for future generations to understand and inherit. In addition, relevant research and training are needed to ensure the inheritance and development of ICH. Measures need to be taken to strengthen the protection and inheritance of ICH, such as formulating relevant policies and establishing relevant institutions.

When it comes to designing innovative and creative goods with both creative and economic value, it is important to thoroughly examine the meaning and significance of ICH culture. In addition to market demand and financial worth, the features and inheritance practices of the International Cultural Heritage (ICH) must be taken into account while designing cultural and artistic goods.

The preservation and growth of ICH may be accomplished through the creation of cultural and creative goods and the protection of ICH. Additionally, new prospects and momentum for the growth of associated businesses are created.

3.2 Using 3D Visualization Technology to Inform The Design of Products Related to Intangible Cultural Heritage

(1) Excavation of ICH elements

ICH elements refer to traditional cultural elements with inheritance and regional and ethnic characteristics and are an essential component of Chinese traditional culture. Mining ICH elements can have the following aspects:

Excavating ICH skills: ICH skills are an essential part of ICH elements, including traditional handicrafts, folk dances, traditional music, traditional opera, and so on. Information on the characteristics, inheritance, and current development status of ICH techniques can be excavated through investigation and research, on-site inspections, and other methods.

Exploring the historical and cultural value of ICH: The historical and cultural value contained in ICH elements is one of its important features, including traditional festivals, folk customs, historical legends, and so on.

Information on the background, connotation, and inheritance of ICH can be explored through literature, oral inheritance, and other methods.

Exploring the regional characteristics of ICH: ICH elements have regional characteristics, and different regions have different ICH elements. The traditional cultural elements of ICH regional characteristics can be excavated through on-site inspections, local chronicles, interviews with local people, and other methods.

Digging into the stories of ICH figures: The inheritance of ICH elements cannot be separated from the efforts and dedication of ICH figures. Information on the life stories, inheritance experiences, and understanding of the traditional culture of ICH figures can be explored through interviews, literature, and other means.

By exploring ICH elements, traditional culture can be better inherited and promoted, allowing more people to understand and love ICH.

(2) 3D modeling

3D modeling refers to the process of using computer software to model, design, edit, and generate 3D objects. 3D modeling can be used in various fields, such as architecture, animation, games, machinery, and so on. The following are some basic concepts and processes of 3D modeling:

Modeling software: 3D modeling requires the use of professional modeling software such as 3DMax, Maya, Blender, etc.

Coordinate system: In 3D modeling, the position of an object is determined through a coordinate system. Usually, a three-dimensional Cartesian coordinate system is used, which includes the X, Y, and Z axes. The display in the software is shown in Figure 2.

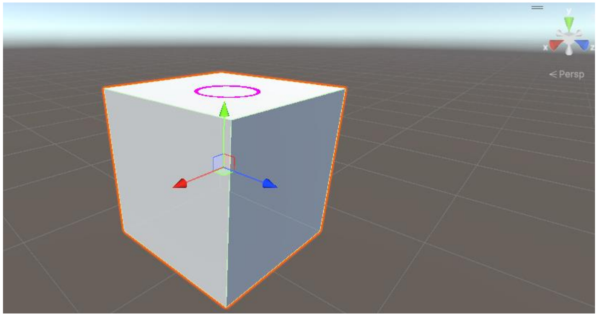


Figure 2: Representation of Coordinate System in Software.

Modeling methods: There are two main methods for 3D modeling, namely building geometry and building surfaces. Establishing geometric shapes is the process of combining and adjusting basic geometric shapes (such as cubes, cylinders, spheres, etc.), as shown in Figure 3, into the desired shape. Establishing a surface is to create the desired shape through the relationship between curves and surfaces.

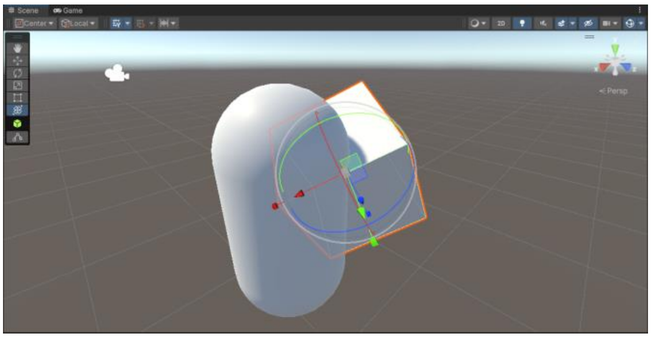


Figure 3: Geometric Shape Construction Model.

Modeling process: The process of 3D modeling usually includes the following steps: determining modeling goals and requirements, developing modeling plans, drawing sketches and model contours, establishing geometry or surfaces, adjusting model details and textures, adding light and materials, rendering, and outputting.

Modeling skills: 3D modeling requires mastering some skills, such as mastering the basic operations of modeling software, understanding the basic principles of modeling, familiarizing oneself with commonly used modeling tools, and paying attention to the details and proportions of the model.

3D modeling is a process that requires patience and skill, but it can create various forms of 3D models, providing more realistic and vivid display effects for various industries.

(3) Product design

The process of turning ideas for products into tangible shapes, structures, functionalities, and other elements depending on consumer and market demands is known as "product design."Product design not only includes appearance design, but also needs to consider multiple aspects such as product functionality, user experience, and production costs. The following are some basic concepts and processes of product design:

Aims of product design: To determine the aims and course of product design, it is necessary to provide clarity on the product's positioning, target market, demographic, etc.

Requirement analysis: Understanding target consumer wants and purchasing patterns, as well as the competition in the market, are all necessary for product creation.

Conceptual design: Constructive design, comprising ideas, drawings, samples, and other materials, is required in the first phases of product design to validate and enhance the design scheme as soon as possible.

Detailed design: After the conceptual design is determined, further detailed design is required, including the design of product structure, function, materials, technology, and other aspects.

Product prototype production: After the detailed design is determined, a prototype of the product needs to be produced for functional testing, user experience testing, etc.

Testing and improvement: After creating the prototype, various tests are required, including functional testing, user experience testing, market testing, etc., to improve and optimize based on the test results.

Product launch: After the product design is completed, production, sales, and promotion work needs to be carried out to push the product to the market.

Product design needs to comprehensively consider multiple aspects, including market demand, user demand, functional design, and material and process design, to meet user needs and achieve success in the market. At the same time, product design needs to be continuously improved and optimized to adapt to changes in the market and user needs.

(4) 3D visualization design

3D visualization design is a process of converting 2D planar design into 3D models, which are modeled, rendered, and animated through computer simulation to present more realistic and vivid effects [16-17]. 3D visualization design is mainly applied in fields such as architectural design, interior design, game design, and movie special effects [18-19]. The process of 3D visualization design generally includes the following steps:

Concept design: The basic concept and design style of the design are determined, including the requirements, goals, and style of the design.

Modeling: Computer software is used to perform three-dimensional modeling of designed objects, including settings for appearance, size, material, and other aspects.

Material mapping: Apply material mapping to the modeled object to make it more realistic and natural, including texture, color, reflection, and other settings. The texture drawn in the model is shown in Figure 4.

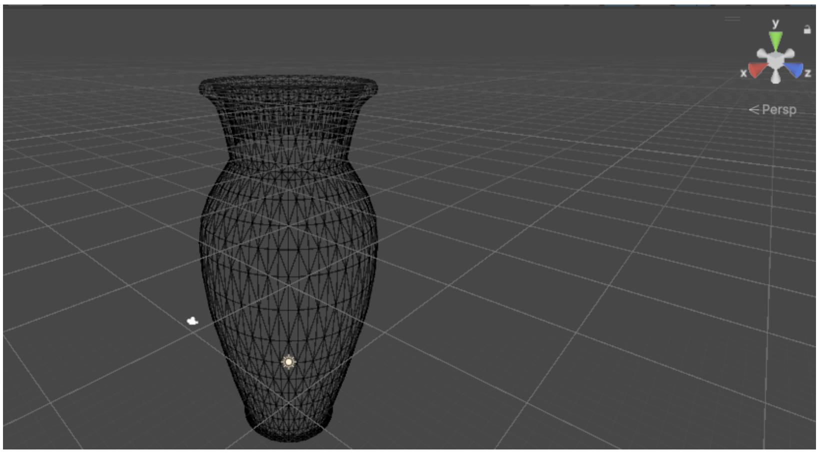


Figure 4: Model Texture Drawing.

Lighting settings: The design includes lighting to achieve the best visual effect, including settings for light source type, brightness, color, etc. The direction of light will have different presentation effects, as shown in Figures 5 and 6.

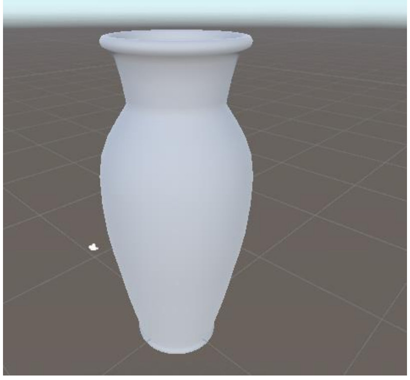


Figure 5: Model without lighting settings.

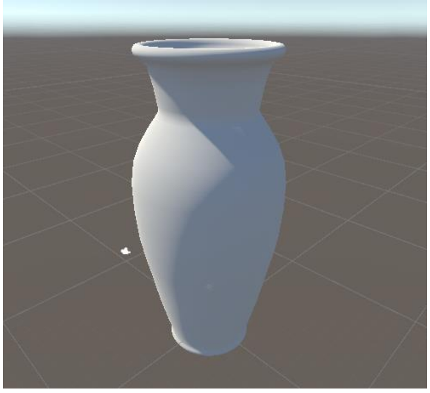


Figure 6: Model after setting the lighting.

Rendering: Integrate and render modeling, material mapping, lighting settings, etc. to generate the final 3D image, as shown in Figure 7.

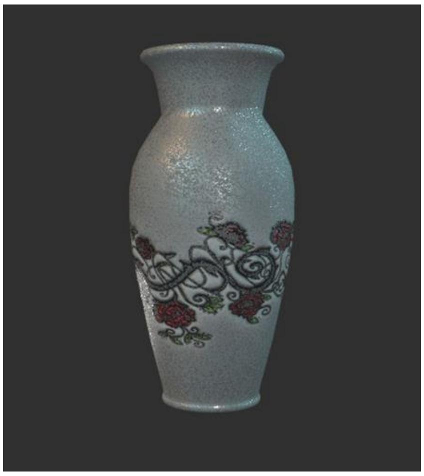


Figure 7: Final product model.

Animation production: 3D models are animated to achieve effects such as object movement, rotation, and scaling to achieve better visual effects.

3D visualization design can achieve realistic simulation and presentation of design effects, help designers and clients better understand and communicate design concepts, and also improve design efficiency and quality [20-21]. The nonlegacy of cultural and creative products designed through 3D visualization is shown in Figure 8.

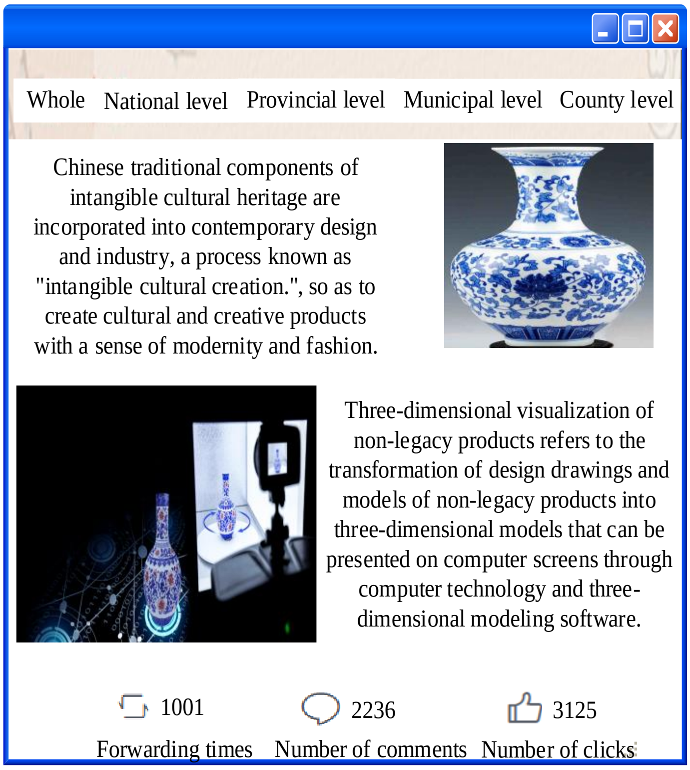


Figure 8: Nonlegacy cultural and creative products designed through 3D visualization.

3.3 Entropy Evaluation of Design Elements for Non-Heritage Cultural and Creative Products

Entropy evaluation refers to the process of evaluating the degree of order of a system, where the higher the entropy value, the higher the degree of disorder of the system. In the design of nonlegacy cultural and creative products, the orderliness of elements is also very important. Therefore, designers can assess the orderliness of elements to determine the entropy value of the product, thereby better grasping the overall design direction and quality requirements of the product.

The balance between historical and cultural inheritance and inventive development, as well as elements like market demand and product user experience, must also be taken into account when designing non-heritage cultural and creative products.

Based on information theory, information entropy is introduced into the evaluation process of product design elements. By measuring the uncertainty information of changes in various design elements and the probability information of simultaneous occurrence of two design elements, the relative importance of each design element is measured. Based on feature analysis, research sample set A is conducted and the research results are summarized to obtain the probability of single design element occurrence and the probability of pairwise design element occurrence. Therefore, the technical method of information entropy is applied to complete the evaluation of each design element by comparing the correlation degree between two design elements.

(1) Establishing information entropy model

When evaluating the design aspects of non-heritage cultural and creative items, the information entropy theory is employed to develop an information entropy model. Taking all the design element sets $F = \{ \mathrm{I}, \mathrm{II}, \ldots, k\}$ of a certain "thing" (where k represents the number of elements in the design element set F) as a system, and defining the different modeling features that may appear in a certain design element f as a subsystem, it can be obtained:

$$f = \{f_1, f_2, \ldots, f_p\} \tag{1}$$

According to study findings, each non-legacy cultural and creative product's design characteristic has a cumulative probability of $q(f)$ of 1. Then, the probability of a design element and its modeling features can form a probability space $[f, q_f]$. The expression is:

$$\begin{bmatrix} f \\ q(f_p) \end{bmatrix} = \begin{bmatrix} f_1 & f_2 & \ldots & f_p \\ q(f_1) & q(f_2) & \ldots & (of_{\square}) \end{bmatrix} \tag{2}$$

Among them, $q(f_p)$ represents the probability of the p-th nonlegacy cultural and creative product design feature appearing among the f elements.

In the probability space, the smaller the occurrence probability of a certain modeling feature, the greater its uncertainty, and the greater the amount of self-information generated when it occurs. The self-information of any nonheritage cultural and creative product design feature for each design element is $C(f_p)$, which is the negative logarithm of the probability of the nonheritage cultural and creative product design feature occurring:

$$C(f_p) = \ln\frac{1}{q(f_p)} \tag{3}$$

Among them, $C(f_p)$ represents the self-information of a non-heritage cultural and creative product design feature. Under normal circumstances, people are more concerned about the average amount of information in the system. Therefore, the average information amount of all variables in the system is defined as information entropy $J(H)$:

$$J = -\sum_{f=1}^{p} q_f \ln q_f \tag{4}$$

Among them, J represents the information entropy value.

(2) Judging mutual information entropy

The information entropy model is also suitable for exploring the relationship between multiple systems and can be applied to the evaluation process of product design elements.

$$J_{\mathrm{I},\mathrm{II}} = -\sum_{f=1}^{p}\sum_{f^*=1}^{p^*} q(\mathrm{I}_f \mathrm{II}_{f^*}) \ln q(\mathrm{I}_f \mathrm{II}_{f^*}) \tag{5}$$

(3) Calculating mutual information coefficient

The mutual information coefficient quantitatively reflects the relationship between the two subsystems and the degree of their influence. When assessing the design components of non-heritage cultural and artistic goods, the mutual information coefficient between two design elements (such as design elements I and II) can be obtained from the information entropy of a single design element and the mutual information entropy of two design elements:

$$i_{\mathrm{I},\mathrm{II}} = \frac{H_{\mathrm{I}} + H_{\mathrm{II}} - H_{\mathrm{I},\mathrm{II}}}{H_{\mathrm{II}}} \tag{6}$$

$$i_{\mathrm{II},\mathrm{I}} = \frac{H_{\mathrm{I}} + H_{\mathrm{II}} - H_{\mathrm{I},\mathrm{II}}}{H_{\mathrm{I}}} \tag{7}$$

Among them, $i_{\mathrm{I},\mathrm{II}}$ represents the impact of design element I on II, which is the information coefficient of I on II. On the contrary, $i_{\mathrm{II},\mathrm{I}}$ represents the impact of design element II on I, which is the information coefficient of II on I. Through the calculation of the mutual information coefficient, each design element of product modeling can be compared in pairs, and the relative importance of each design element can be obtained, thus judging the personality design element and platform design element of product modeling.

4. THREE-DIMENSIONAL VISUALIZATION OF NON-LEGACY ARTISTIC AND CULTURAL PRODUCTS

4.1 Design Processes for Innovative Cultural and Creative Goods

It can be executed in the manner described below:

Data collection: Information related to the production process, materials, structure, and other aspects of ICH products is collected, and digital means are used to record and process this information.

3D modeling: Based on the collected data, 3D modeling software is used to model and design a 3D model of ICH products.

Virtual display: The designed 3D model is imported into the virtual display software to display the appearance and structure of ICH products, and interactive experience functions are added.

User experience testing: Users are invited to conduct experience testing, and their feedback and suggestions on virtual displays and interactive experiences are collected.

Optimization design: Based on user feedback and suggestions, the three-dimensional model of ICH products is optimized and designed to meet user needs and experiences better.

Release application: The optimized 3D model is released to the application market or nonlegacy cultural and creative product sales channels for users to download and use.

During the experiment, each step requires detailed records and statistics, including the tools and methods used in the data collection process, the details and difficulties of 3D modeling, the effectiveness of virtual display and interactive experience, and the process and effectiveness of user feedback. At the same time, it is necessary to compare and analyze different experimental results to draw reliable conclusions and provide optimization suggestions for the design scheme.

4.2 Customer Intention Survey

Nonheritage cultural and creative products are products of the integration of traditional and modern culture.3D visualization design can help consumers better understand ICH culture and stimulate their purchasing desire [22-23]. To conduct a control experiment, this article can be divided into two groups.

Group X, an experimental group, develops non-legacy cultural and creative items using 3D visualization technology.

Group Y, the control group, does not employ 3D visualization technology in the creation of non-legacy cultural and creative goods.

Both X and Y groups need to choose the same ICH culture for design to ensure comparability of results. Before the experiment begins, participants need to be screened and classified so that the number, age, gender, and other factors of the two groups of participants are similar. At the same time, it is also necessary to control the influence of other variables, such as design style, material selection, etc. The basic profile of the participants is illustrated in Table 1.

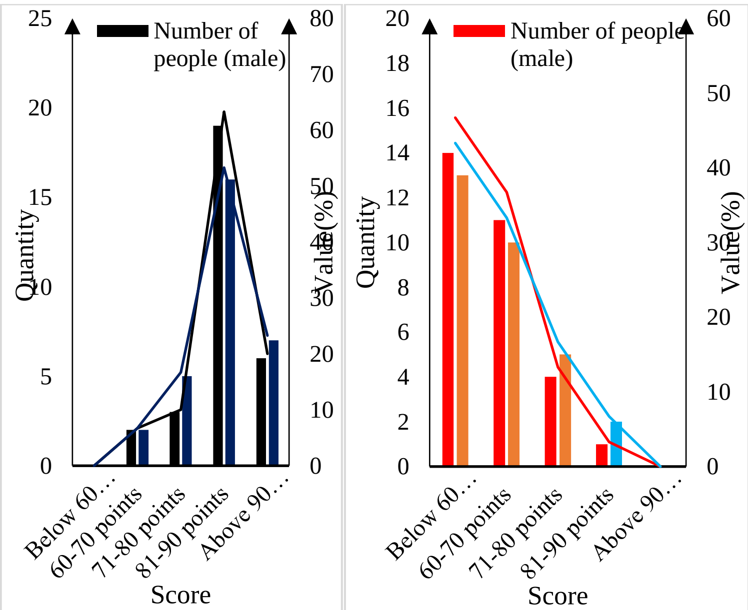
Group		*X group*	*Y group*
Number of participants		60	60
Gender	Male	30	30
	Female	30	30
Age	18-30 years old	20	20
	31-50 years old	20	20
	Over 50 years old	20	20

Table 1: Basic profile of participants.

During the experiment, data can be collected through on-site visits to analyze the differences in product popularity, purchase intention, and visit intention between the two groups and further explore the effectiveness of 3D visualization technology in promoting ICH [24-25].

(1) Popularity

Popularity refers to the degree to which a person, item, or thing is loved, welcomed, or recognized by others. Popularity can usually be evaluated and measured through various channels, such as the number of followers, likes, comments, etc., on social media, as well as market research, questionnaire surveys, and other methods. In fields such as business, entertainment, and politics, popularity often directly or indirectly affects the success of a person or thing. This article rates the popularity of nonlegacy cultural and creative products designed by Group X and Group Y through on-site visits, with a maximum score of 100. The results are shown in Figure 9.



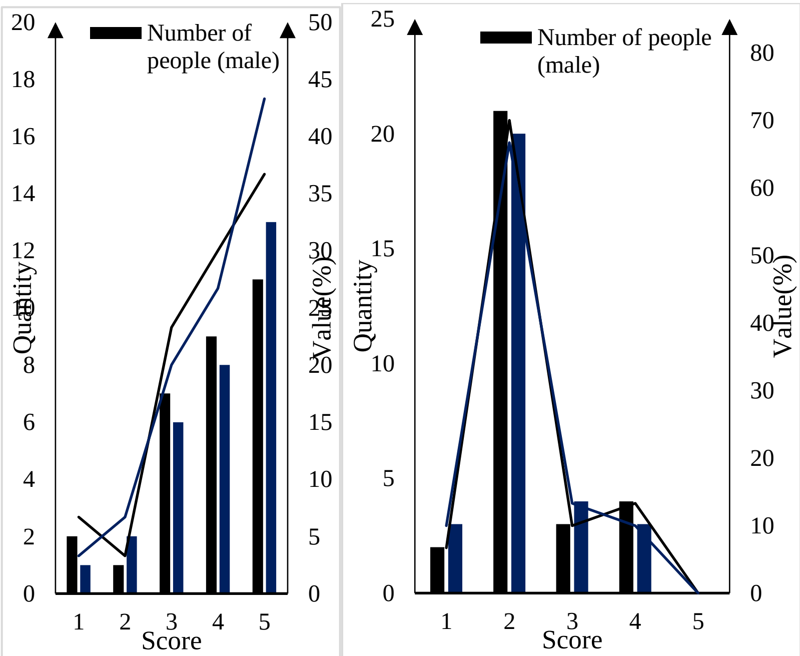
(a) Group X (b) Group Y

Figure 9: Two categories of non-legacy creative and cultural items' popularity ratings.

It is clear from Figure 3(a) that both boys and girls in Group X, or 6.7% of the population, gave non-legacy cultural and creative items popularity ratings between 60 and 70. The popularity ratings between 71 and 80 were between 3 and 5, accounting for 10% and 16.7% of the population, respectively. The number of people between 81 and 90 points was 19 and 16, accounting for 63.3% and 53.3%, respectively. The number of people above 90 points was 6 and 7, accounting for 20% and 23.3%, respectively. There was no score below 60 points. From Figure 3 (b), it can be learned that the number of boys and girls who rated the popularity of nonlegacy cultural and creative products in Group Y below 60 points was 14 and 13, respectively, accounting for 46.7% and 43.3%. The number of people between 60 and 70 was 11 and 10, accounting for 36.7% and 33.3% respectively. The number of people between 71 and 80 points was 4 and 5, accounting for 13.3% and 16.7% respectively. The number of people between 81 and 90 points was 1 and 2, accounting for 3.3% and 6.7% respectively. There was no score above 90. Figure 3 illustrates that the proportion of individuals in Group X who scored 81 or higher for non-heritage cultural and creative items was equal to the proportion of individuals in Group Y who scored 70 or lower for the same products. There were 25 boys and 23 girls, making up 83.3% and 76.7% of the total population, respectively. This suggests that innovative and non-heritage cultural goods created in Group X are more well-liked by the public.

(2) Purchase intention

Purchase intention refers to the willingness and ability of consumers to purchase a certain product or service at a specific time, place, and environment. Purchase intention is usually influenced by various factors, including personal needs, price, brand reputation, promotional activities, market environment, and so on. The level of purchase intention directly affects the sales situation of products or services and the performance of enterprises. Therefore, understanding consumers' purchasing intentions is crucial for the formulation and implementation of marketing strategies for nonlegacy cultural and creative enterprises. Through on-site inspections, the readiness to buy innovative and non-legacy cultural items created by Groups X and Y was also assessed. The rating was divided into 5 levels, each ranging from 1 to 5 points. The outcomes are shown in Figure 10.



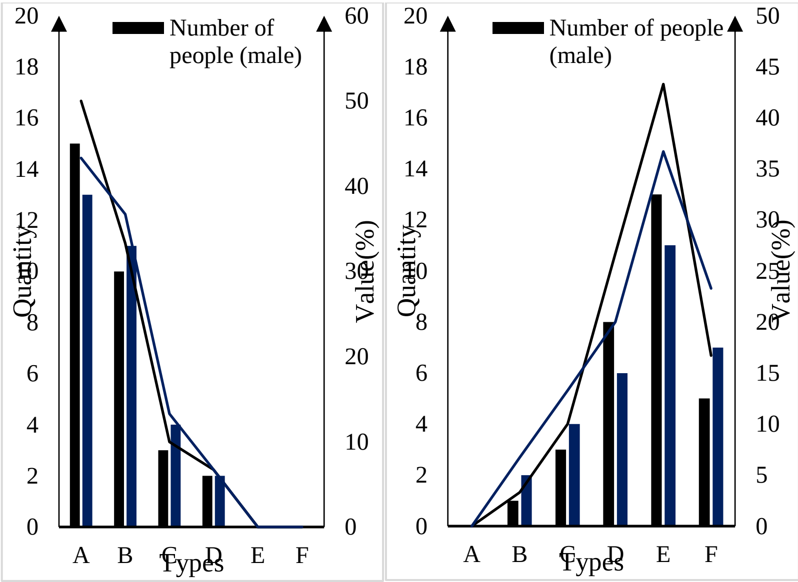
(a) Group X (b) Group Y

Figure 10: Rating of purchase intention for two groups of nonlegacy cultural and creative products.

From Figure 10 (a), it can be seen that the number of boys and girls who scored one on their willingness to purchase nonlegacy cultural and creative products in Group X was 2 and 1, respectively, accounting for 6.7% and 3.3%. The number of people with a score of 2 was 1 and 2, accounting for 3.3% and 6.7% respectively. The number of people with a score of 3 was 7 and 6, accounting for 23.3% and 20%, respectively. The number of people with a score of 4 was 9 and 8, accounting for 30% and 26.7%, respectively. There were 11 and 13 people with a score of 5, accounting for 36.7% and 43.3% respectively. From Figure 10 (b), it can be seen that the number of boys and girls who scored one on their willingness to purchase nonlegacy cultural and creative products in Group Y was 2 and 3, respectively, accounting for 6.7% and 10%. The number of people with a score of 2 was 21 and 20, accounting for 70% and 66.7%, respectively. The number of people with a score of 3 was 3 and 4, accounting for 10% and 13.3%, respectively. The number of people with a score of 4 was 4 and 3, accounting for 13.3% and 10%, respectively. There was no 5-point rating. From Figure 4, it can be seen that the total evaluation of purchasing intention for nonheritage cultural and creative products in Group X was 236 points, while the total evaluation of purchasing intention for nonheritage cultural and creative products in Group Y was 136 points. The score of Group X is much higher than that of Group Y, indicating that the nonlegacy cultural and creative products designed by Group X are more popular among people.

(3) Visiting intention

Visiting intention refers to the willingness of tourists to visit a certain scenic spot, product, or venue at a certain time, location, and environment. While maintaining the same approach, the willingness of Group X and Group Y was evaluated to visit nonlegacy cultural and creative products, with 6 evaluation levels: A: very willing, B: willing, C: more willing, D: unwilling, E: relatively unwilling, and F: very unwilling. The statistical results are shown in Figure 11.



(a) Group X (b) Group Y

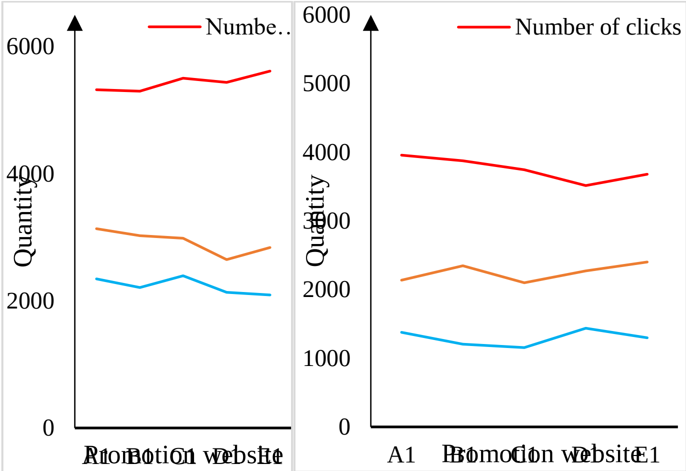
Figure 11: Evaluation of willingness to visit two groups of nonheritage cultural and creative products.

As indicated in Figure 11(a), 13 and 15-year-old boys and girls in Group X were eager to see non-legacy cultural and creative items, accounting for 50% and 43.3%, respectively. The number of willing participants was 10 and 11, accounting for 33.3% and 36.7% respectively. The number of people who were more willing was 3 and 4, accounting for 10% and 13.3%, respectively. The number of relatively unwilling people was 2, accounting for 6.7%. There were no unwilling or very unwilling evaluations. From Figure 11 (b), it can be seen that there were 1 and 2 male and female students who were willing to visit nonheritage cultural and creative products in Group Y, accounting for 3.3% and 6.7%, respectively. The number of people who were more willing was 3 and 4, accounting for 10% and 13.3%, respectively. The number of relatively unwilling people was 8 and 6, accounting for 26.7% and 20%, respectively. The number of unwilling people was 13 and 11, accounting for 43.3% and 36.7% respectively. The number of very unwilling people was 5 and 7, accounting for 16.7% and 23.3% respectively. There is no very willing evaluation. From Figure 11, it can be seen that the number of boys and girls who had a positive evaluation of their willingness to visit nonheritage cultural and creative products in Group X was 28, accounting for 93.3%. The number of people who had a positive evaluation of their willingness to visit nonheritage cultural and creative products in Group Y was 4 and 6, respectively, accounting for 13.3% and 20%. This further indicates that nonlegacy cultural and creative products designed by Group X are more popular among people.

4.3 Product Marketability Survey

To understand the impact of 3D visualization technology on the promotion of intangible cultural heritage products, this article promoted the ICH products of Group X and Group Y on the ICH Window (A1), National ICH Network (B1), Voice of ICH (C1), ICH Inheritor (D1), and ICH Journey (E1) for six months. After the end, the number of clicks, comments, and reposts of both were counted. The results are shown in Figure 12.

From Figure 12(a), it can be found that the number of clicks, comments, and retweets on ICH products in Group X was in the range of 5200-5700, 2600-3200, and 2000-2400. From Figure 12(b), it can be found that the number of clicks, comments, and retweets on ICH products in Group Y was in the range of 3500-4000, 2000-2500, and 1100-1500. Figure 12 shows that Group X's non-heritage cultural and creative items had a far stronger promotion impact than Group Y's, suggesting that 3D visualization technology can enhance this effect.



(a) Group X (b) Group Y

Figure 12: Promotion effects of two groups of nonlegacy cultural and creative products.

5. CONCLUSIONS

Utilizing 3D visualization technology in the design of items related to intangible cultural heritage can raise the standard of intangible cultural and creative goods while also increasing design efficiency. This paper uses the entropy evaluation method to evaluate the design elements of intangible cultural and creative products and sets up a control experiment. By analyzing the popularity, purchase intention, visit intention, and promotion effect of the two groups of products, the relationship between them is studied, indicating that the design of intangible cultural heritage products based on 3D visualization technology has great prospects and application value. Through the above comparative experiments, the role of 3D visualization technology in promoting intangible cultural heritage can be evaluated more objectively, providing an effective basis and support for the development of the cultural industry.

6. FUNDING

This work was supported by Guangzhou Institute of Technology's horizontal project "Shanghai Shoude Brand Planning and Cultural and Creative Gift Design Services" Project Number: GZLGHT2023403.

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