A Method for Integrating Cultural Symbols and Product Structures in the AIGC Era

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Abstract. To address the challenge that Generative Artificial Intelligence (AIGC) struggles to achieve in-depth and innovative integration of cultural elements with product carriers in cultural and creative product design, this paper proposes a cultural and creative product design method consisting of three stages: demand modeling, cultural integration, and scheme generation. In the demand modeling phase, Deepseek-R1 is combined with the Analytic Hierarchy Process (AHP) to accurately identify user needs. In the cultural integration phase, the concept of Hu Moment (Invariant Moments) and Shape Grammar are introduced, and integrated with user needs to realize the structured integration of cultural symbols and product forms. In the scheme generation phase, design schemes are generated via Stable Diffusion (SD), and the Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) is applied to evaluate and select the optimal scheme. A case study is conducted using the Ming-style circular-backed armchair as the carrier and the Sanxingdui bronze patterns as the cultural elements to verify the proposed method. The results show that this method can achieve in-depth integration of cultural elements and products while satisfying user demands, effectively bridging the gap between technical rationality and cultural sensibility, and providing new ideas and approaches for cultural and creative product design in the artificial intelligence era.

Keywords: Generative Artificial Intelligence (AIGC), Cultural and Creative Products, Hu Moment, Ming-Style Circular-Backed Armchair, Sanxingdui Bronze Patterns

1. Introduction

In recent years, the cultural and creative industry has developed rapidly and emerged as a new engine for economic growth. As important carriers of cultural inheritance and emotional expression, cultural and creative products derive significant added value from the infusion of cultural connotations, which constitutes a core component of their competitiveness [1]. With the advancement of science and technology, cross-border innovation has become an inevitable trend in the development of the cultural and creative industry [2]. Adding AIGC technology to cultural and creative product design can greatly raise design efficiency and quality, and so boost the products' ability to compete in the market [3]. In relevant research in this field, Zhu Kunhao et al. [4] studied some typical local cultural elements. They used AIGC text-to-picture technology to do local cultural and creative design work. Then they put the results into simple product models and got past the limits of traditional cultural and creative design ways. But people cannot get high-quality pictures only by using text descriptions. The wide use of LoRA and ControlNet has made AIGC's image-making ability much better. Though, Zhou

Qiyao et al. [5] pointed out that AIGC only turns instructions into practical actions. This situation may easily make people misunderstand users' needs and the deep meanings of culture. Besides, AIGC's creative ability does not fully go beyond the traditional ways of creating new things. So it is necessary to use AIGC together with conventional design methods. Lu Peng et al. [6] combined AIGC with AHP and the Grey Relational Analysis. They made this combined method fit in with traditional design steps. Zhuang Qi et al. [7] made the AIGC generation workflow better and put forward a man-machine cooperation design process. They built a material database and added more human intervention to the design generation process based on AIGC. In this way, they successfully used the Xunpu Flower Hairpin IP in the design of cultural and creative footwear. Their work showed that it is valuable to combine human professional knowledge with AIGC for further study. Many studies show that even though the use of AIGC in cultural and creative product design has got a lot of attention and made some progress step by step, there are still several problems to solve. These problems include that the innovation of cultural elements depends too much on the quality and quantity of training data, the content made by AIGC is very similar to each other, and people just copy things mechanically instead of combining cultural elements with products in an effective way when doing design work. So, how to achieve deep integration and innovation of cultural elements and products while meeting users' demands is still a main research point and problem at present. To deal with the above problems, this paper offers a design method for cultural and creative products. To be specific, it uses DeepSeek-R1 to help collect users' needs. Then it uses AHP to build models for these needs. It also brings in the concepts of Hu Moment and Shape Grammar to combine cultural elements with product structures. Finally, it uses TOPSIS to choose the best schemes from the ones made by SD, and thus finishes the innovative design of cultural and creative products.

2. Framework for integrating cultural symbols and product structures

2.1. Demand modeling

DeepSeek-R1 has key skills in dealing with natural human language and searching the web in real time [8]. These skills enable the tool to get and handle all kinds of information quickly and well. In the research mentioned here, people make use of its big data search skill. They use this skill to supplement user needs and collect these needs in a full and complete way. Then, researchers combine this method with the AHP method. They calculate the relative weights of all the demand indicators through this combination. This process finally forms a demand modeling system. The system is marked by the comprehensive collection of needs and the quantification of different weights. In the end, this useful system provides a solid basis for two important steps. These steps are the product sketch design in the later stage and the weight allocation of image generation prompts.

2.2. Cultural integration

Hu Moment is a kind of expression that can highly condense the features of images [9]. People can find out the shape similarity degree between two images by comparing their Hu Moments. Hu Moment is widely used in the computer vision field. But its application in cultural and creative product design is quite limited. In this paper, researchers use Hu Moment to match cultural element features with product structure features. They can pick out cultural element structures that are very similar to product structures in this way. Then, people apply Shape Grammar to make creative changes to the selected cultural element structures. This method keeps the deep meanings of cultural elements. It realizes deep and creative integration with product structures from local parts to the whole. In this way, it deals with the problem of effectively combining cultural elements and products.

2.3. Scheme generation

SD is a generative model based on deep learning, and it can control image output in a stable and reliable way [10]. The model is able to produce high-quality images of different types, and these images can keep all the original information well [11]. In the field of cultural and creative product design, SD can effectively keep all the cultural characteristics of products. It also shows very clear advantages in passing on cultural elements and making innovations on them. By picking out suitable models and making proper changes to parameters, people can generate images with stable styles. This ability helps people express design sketches and renderings in a quick and effective way.

With the help of all the content mentioned above, researchers set up a three-stage design model for cultural and creative products. The three stages of this model are demand modeling, cultural integration and image generation. The detailed structure of this model is shown in Figure 1.

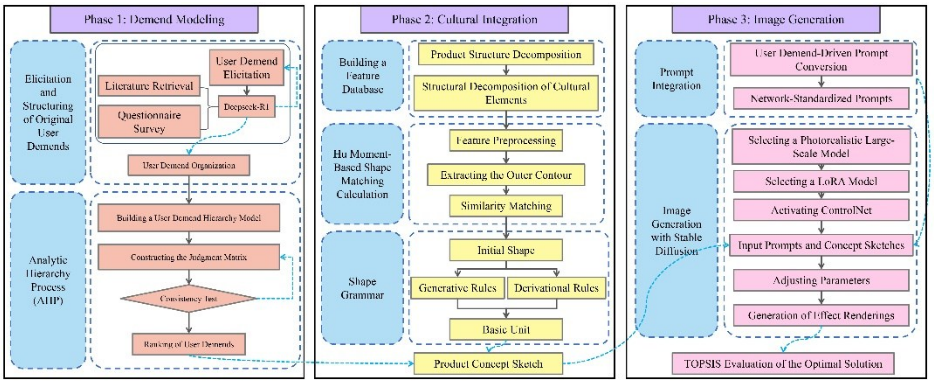


Figure 1. Framework for integrating cultural symbols and product structures

3. Construction of the demand model

In this paper, the Ming-style circular-backed armchair is used as the carrier, and the Sanxingdui bronze patterns are integrated as cultural elements to verify the effectiveness and feasibility of the proposed method.

3.1. Acquisition of user needs for circular-backed armchairs

Literature retrieval was conducted to collect demand information related to circular-backed armchairs. Using keywords and their derivatives such as "circular-backed armchair", "user needs", "user evaluation", "furniture", "future", and "user experience", searches were performed in academic databases including CNKI and Web of Science, yielding a total of 196 demand-related terms. With the help of Deepseek-R1’s web search and data analysis functions, people expanded these terms and removed their repeated parts. After putting all the related content together, they identified 73 user needs in total. These needs cover four main dimensions: cultural emotion, appearance design, functional design and technical craftsmanship.

People carried out a questionnaire survey based on the identified needs. They collected 137 valid questionnaires in this survey. Researchers used Deepseek-R1 to do data analysis work. They removed repeated needs and made the needs more precise and clear. Finally, they determined 18 core demands. Based on these core demands, they built a hierarchical model. This model is for the design of circular-backed armchair cultural and creative products, as shown in Figure 2.

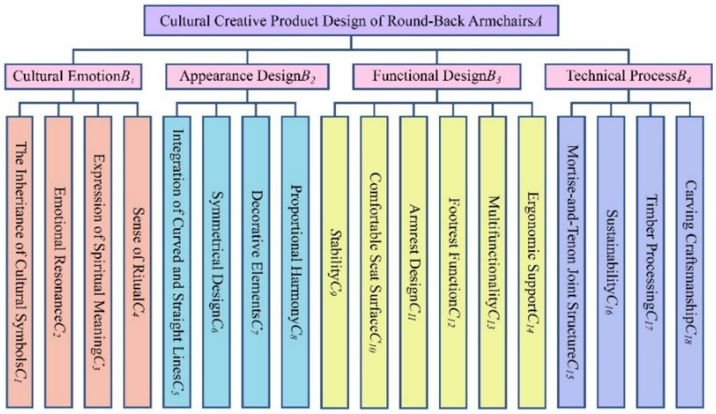


Figure 2. Hierarchical model for the design of circular-backed armchair cultural and creative products

3.2. Relative weight calculation based on AHP

AHP is a commonly used decision-making analysis method. It decomposes complex decision-making problems into multiple hierarchical levels (e.g., goals, criteria, and schemes), and determines the relative importance of each factor through pairwise comparisons and consistency checks [12]. The steps for analyzing the relative importance of Ming-style circular-backed armchair demands are as follows.

First, 17 professionals including furniture designers, professors, and industry practitioners were invited to evaluate the demands of Ming-style circular-backed armchairs and construct pairwise comparison matrices. The geometric mean method was adopted to aggregate the valid judgment matrices, resulting in the final judgment matrix C. Let n be the number of demand indicators, and C_{ij} be the importance scale value of indicator $C_i$relative to indicator C_j. Next, the weight vector W_i of matrix C was calculated as the relative weight values of user demands.

CI is the consistency index, and $CR = CI/RI$is the consistency ratio, where RI can be obtained from standard tables.

$$\lambda_{max} = \frac{\sum_{i=1}^{n} C_{ij} \times W_i}{\sum_{i=1}^{n} 4W_i} \tag{1}$$

$$CI = (\lambda_{max} - n)/(n-1) \tag{2}$$

Validation results showed that all CR values are less than 0.1, indicating the rationality of the data results. The relative weights and preliminary priority rankings of the demand indicators are presented in Table 1.

Table 1. Analysis results of relative weights of demand indicators

Primary Indicator	Weight	Secondary Indicator	Weight	Relative Weight	Ranking	Secondary Indicator	Weight	Relative Weight	Ranking
B_1	0.140	C_1	0.471 7	0.066 0	6	C_3	0.164 4	0.023 0	17
		C_2	0.256 1	0.035 9	13	C_4	0.107 8	0.015 1	18
B_2	0.278	C_5	0.390 5	0.108 6	2	C_7	0.195 3	0.054 3	9
		C_6	0.276 1	0.076 8	4	C_8	0.138 1	0.038 4	10
B_3	0.361	C_9	0.088 8	0.032 1	15	C_{12}	0.105 8	0.057 0	12
		C_{10}	0.377 1	0.136 1	1	C_{13}	0.071 8	0.025 9	16
		C_{11}	0.189 4	0.068 4	5	C_{14}	0.167 2	0.060 4	8
B_4	0.220	C_{15}	0.389 1	0.085 6	3	C_{17}	0.157 1	0.034 6	14
		C_{16}	0.174 0	0.003 8	11	C_{18}	0.279 8	0.061 6	7

4. Cultural integration of sanxingdui cultural and creative circular-backed armchairs

4.1. Establishment of feature databases

4.1.1. Circular-backed armchair feature database

The Ming-style circular-backed armchair is a representative seating form of Chinese Ming Dynasty furniture. Designed around the philosophy of "heaven is round, earth is square", its curved chair circle and S-shaped backrest are ergonomically optimized. It uses a mortise-and-tenon joint structure. It shows the beauty of simplicity and the great wisdom from traditional times. The armchair has neat and simple lines, good-quality hardwood materials and small, delicate decorative details. It shows the aesthetic tastes of literati and the culture of rituals. It can be taken as a fine example of traditional furniture design [13].

Researchers did literature research and carried out surveys on furniture markets both online and offline. They found out the main structural parts of the Ming-style circular-backed armchair. These parts include the chair circle, armrests, back panel, seat surface, arched apron, legs, footrest rail and tooth strip, as shown in Figure 3. To take apart its structural features in a systematic way, people used a multi-perspective analysis method. They split the armchair into planar structural diagrams. These diagrams were given specific codes and saved as A01–A08, as shown in Figure 4.

Figure 3. Structure of the circular-backed armchair

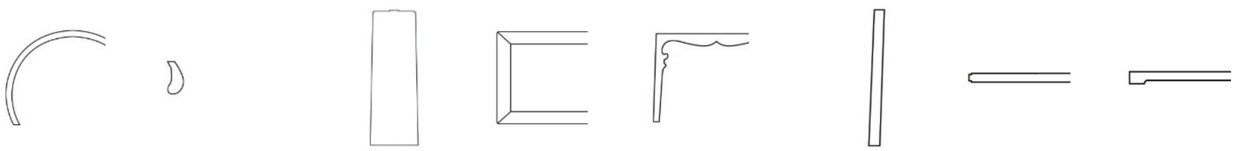


Figure 4. Decomposition diagram of circular-backed armchair structural features

4.1.2. Sanxingdui pattern feature database

The bronze patterns are core visual symbols of Sanxingdui culture. They are mainly displayed on the surfaces of bronze artifacts. These patterns have abstract motifs and symbols as their key features. They include human faces, sacred trees, birds and beasts. They carry deep religious and mythological meanings [14]. The patterns mainly take a combined form. They are made up of several independent small motifs. Directly applying these composite patterns to product design may lead to too much visual information. This problem comes from their complex structural features. And it will affect the overall coordination of the design scheme. It will also influence the functional adaptability of the scheme. So, decomposing the composite patterns into independent motifs can improve the applicability of cultural elements. It can also provide a solid basis for the shape matching work in the later stage.

Researchers carried out field research at the Sanxingdui Museum. They collected 34 image samples of bronze artifacts by taking photos. After classifying these collected images, they split the patterns on different types of artifacts into independent motifs. This work finally got 81 individual patterns. These patterns were numbered from B01 to B81, as shown in Figure 5.

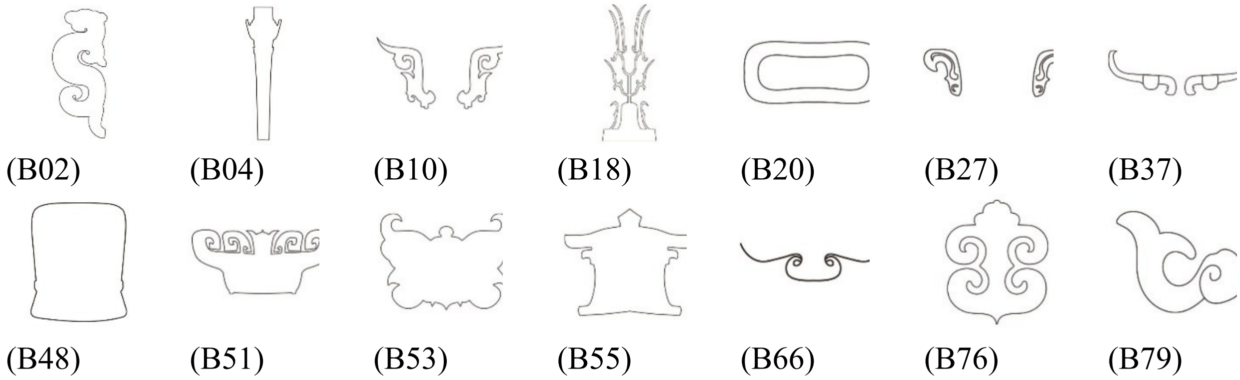


Figure 5. Decomposition diagram of Sanxingdui bronze pattern structural features (partial display)

4.2. Similar feature matching based on Hu Moment

Hu Moment is a kind of method for describing the morphological features of images. It was first put forward by Hu in the year 1962 [15]. This method is widely used in many computer vision fields. These fields include pattern recognition, target classification, image encoding and reconstruction [16]. However, Hu Moment has not been studied much in the area of product design. It has a clear and big advantage. The advantage is that it can describe object shapes in a stable way. This description keeps invariance to translation, grayscale, scale and rotation [17]. The specific definition of Hu Moment for a single image is presented as follows.

For a discrete digital image $f(x,y)$, where M and N represent the height and width of the image, the $p+q$ -order moment m_{pq} of the image is defined as:

$$m_{pq} = \sum_{y=1}^{N} \sum_{x=1}^{M} x^p \, y^q f(x,y) \quad p,q = 0,1,2 \ldots \tag{3}$$

The $p+q$ -order central moment μ_{pq} is defined as:

$$\mu_{pq} = \sum_{y=1}^{N} \sum_{x=1}^{M} (x-\bar{x})^p \, (y-\bar{y})^q f(x,y) \quad p,q = 0,1,2 \ldots \tag{4}$$

The normalized central moment η_{pq} is defined as:

$$\eta_{pq} = \mu_{pq} / \mu_{00}^{(1+(p+q)/2)} \tag{5}$$

Hu Moment consists of 7 invariant moments $M1 \sim M7$ constructed from second-order and third-order normalized central moments. These invariant moments are highly condensed image features that represent the essential mathematical properties of image shapes. Based on this, the similarity between two images can be determined by quantifying the relationship between their invariant moments.

People made use of the feature databases that had been built before. They applied the Hu Moment algorithm to carry out matching calculations. The Ming-style circular-backed armchair shows the cultural meaning of "heaven is round, earth is square" in a clear way. As core features that reflect this special cultural connotation, three parts from the product feature database were kept for the design. These parts are the chair circle (A01), legs (A06) and footrest rail (A07). Then, shape matching calculations were done between two groups of elements. The first group includes five structural components. They are armrest (A02), backrest panel (A03), seat surface (A04), arched apron (A05) and tooth strip (A08). The second group is the 81 independent pattern units (B01–B81) from the bronze pattern database.

Prior to calculation, the original images of A02, A03, A04, A05, A08, and B01–B81 were preprocessed. First, the images were converted to grayscale to reduce dimensionality and computational complexity. Then, binarization was performed, where background pixels were set to 0 and target feature pixels to 255 to highlight the maximum contour of the features. Finally, the Hu Moment algorithm was used to measure shape similarity. The top three matching results for pattern-product feature similarity are presented in Table 2.

Table 2. Top 3 pattern-product feature similarity matching results

Rank	A02	A03	A04	A05	A08
1	B27 (0.172 1)	B20 (0.201 3)	B48 (0.004 3)	B53 (0.827 4)	B61 (0.839 4)
2	B79 (0.227 5)	B55 (0.431 9)	B49 (0.040 3)	B81 (1.960 8)	B68 (1.506 7)
3	B78 (0.275 4)	B51 (0.626 7)	B22 (0.079 5)	B37 (3.118 1)	B58 (1.964 8)

4.3. Shape transformation based on shape grammar

Based on the matching results of Hu Moment similarity, people made corresponding transformation rules for each similar pattern. They used Shape Grammar to carry out systematic design transformation work. Shape Grammar is a kind of computer-aided design method. It can realize the generation of design elements through fixed rules [18]. Shape Grammar is typically defined as a 4-tuple. The expression of this 4-tuple is SG = (S, L, R, I). Here, S is a finite set of shapes. L refers to a finite set of symbols. R stands for a set of related rules. Each single rule is expressed as a production $\alpha \rightarrow \beta$. And I is the initial shape of the design.

In the process of the design transformation, people applied two types of rules. The first type is generative rules, including R1 (Addition) and R2 (Subtraction). The second type is derivational rules, including R3 (Scaling), R4 (Stretching), R5 (Mirroring), R6 (Copying), R7 (Rotation) and R8 (Fine-tuning). These rules can achieve two important goals at the same time. They can make the patterns retain the cultural characteristics of Sanxingdui. They can also make the patterns fit perfectly with the structural features of the circular-backed armchair. For example, the initial shape B20 was transformed into the innovative pattern of Basic Unit 01. The transformation followed a clear sequence: first R7 (Rotate 90°) + R2 (Subtraction), then R8 (Fine-tuning) + R1 (Addition). The specific transformation processes of other different patterns are shown in Figure 6.

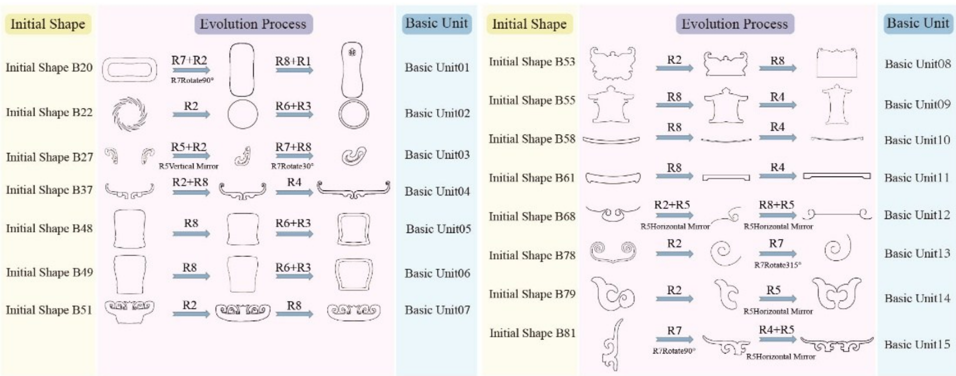
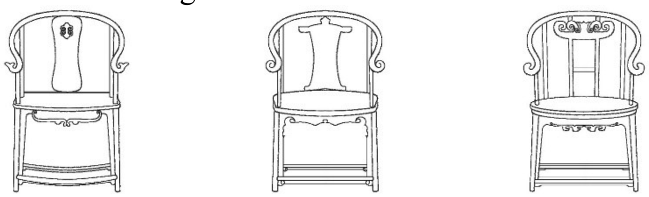


Figure 6. Shape grammar transformation results

4.4. Design of creative sketches

Based on the shape transformation results and the priority ranking of user demand relative weights, the circular-backed armchair design focused on satisfying users' progressive needs from comfort and practicality to cultural emotion. Integrating traditional craftsmanship and functional requirements, three design sketch schemes were developed. For example, Scheme 1 adopted Unit 14 for the armrests, Unit 01 for the backrest panel, Unit 05 for the seat surface, Unit 04 for the arched apron, and Unit 10 for the tooth strip, combined with the original structure of the armchair to form an innovative design expression. All schemes are shown in Figure 7.



(a) Scheme 1 (b) Scheme 2 (c) Scheme 3

Figure 7. Display of product creative sketches

5. SD image generation

5.1. Prompt conversion for image generation

To ensure clear and unambiguous prompts that are easily interpretable by SD, the user needs identified above were converted into specific design points in English according to their weight rankings, as shown in Table 3.

Table 3. Prompt conversion results

User Demand Term	Converted Prompt	User Demand Term	Converted Prompt
Comfortable Seat Surface (C10)	Soft seat cushion	Minimalist (C8)	Minimalist
Integration of Curved and Straight Lines (C5)	Combination of curve sand straightlines	Sustainability (C16)	Sustainable material sand crafts manship
Mortise-and-Tenon Joint Structure (C15)	mortise-and-tenon joint design	Footrest Function (C12)	Slightly downward curved footrest
Symmetrical Design (C6)	Symmetrical over all structure	Stability (C9)	Excellent structural stability
Armrest Design (C11)	Chair with armrest ends gently curve dupward	Multifunctionali ty (C13)	Chairs have multiple functions
Inheritance of Cultural Symbols (C1)	Sanxingdui bronze motifs integrated into structure	Emotional Resonance (C2)	Emotional resonance,soulf ul and meaningful design
Carving Craftsmanship (C18)	Intricate carved decorations,high-quality texture	Timber Processing (C17)	Natural wood finish,smooth wood texture
Ergonomic Support (C14)	S-shaped curve ature backrest	Expression of Spiritual Meaning (C3)	Emphasizing spiritual symbolism
Decorative Elements (C7)	Delicate decorative elements	Sense of Ritual (C4)	Artistic and culturally rich

Meanwhile, to ensure the consistency and high quality of images generated by the SD model, standardized terms such as white background and 3D rendering were added to the positive prompts. Standardized prompts collected from professional design websites and industry forums were used as negative prompts, forming a complete prompt system. In addition, in the prompt weight design phase, weights of high-ranked prompts were increased within a reasonable range, weights of low-ranked prompts were decreased, and no weights were assigned to medium-ranked prompts, as shown in Figure 8.

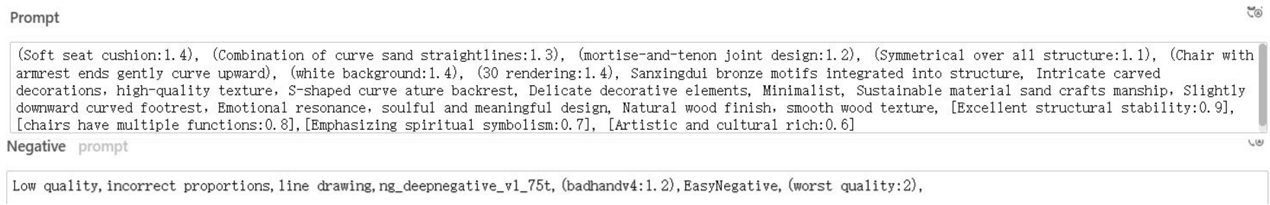


Figure 8. Content of positive and negative prompts

5.2. Generation of product design schemes

Based on the SD model's graphical user interface, the realistic-style large model *realisticVision V6.0 B1_V6.0 B1.safetensors* was selected. A pre-trained LoRA model *Mahogany Circular-Backed Armchair_v2.1:1* was chosen from the model library. The ControlNet v1.1.455 module was enabled to input creative sketches, achieving precise control over local structures through sketch constraints and preventing structural distortion in the generated images. The specific input content and parameter settings are shown in Figure 9.

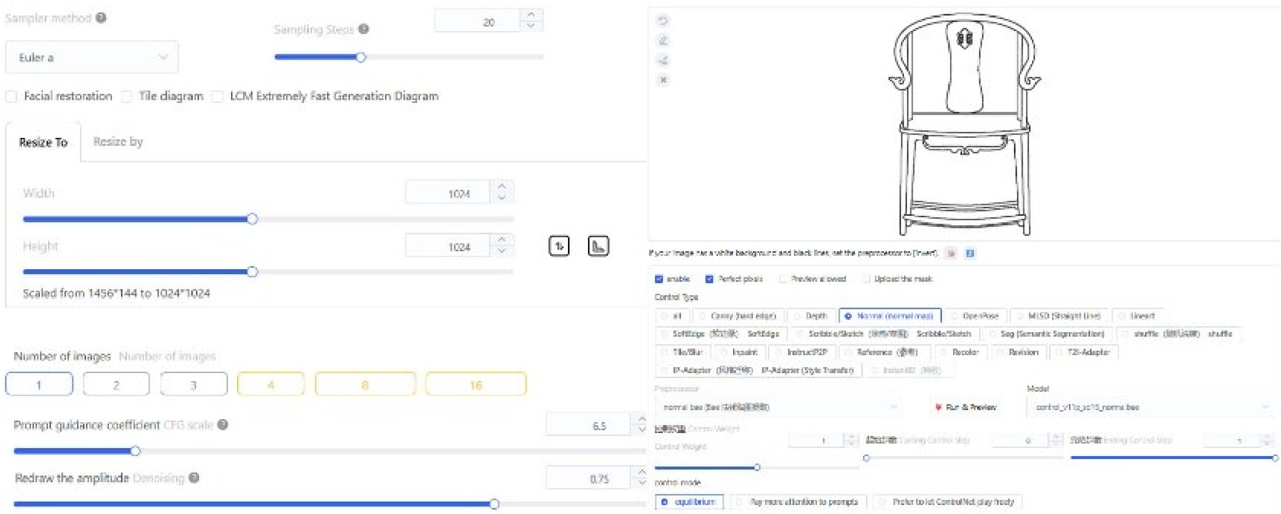


Figure 9. Relevant parameters for product scheme generation

Multiple generation operations were performed for the three product creative sketches, with parameter settings optimized during the iteration process. Low-quality, excessively distorted, and otherwise unsatisfactory product design schemes were eliminated. Finally, 4 qualified product design schemes were selected for each of the 3 sketches, numbered P1 to P12 in sequence, as shown in Figure 10.

Figure 10. Renderings of generated product schemes

5.3. Evaluation of design schemes based on TOPSIS

Twenty evaluators, including target users, furniture designers, and industry experts, were invited to score the 12 design schemes using a 1–10 scale based on the 18 user demand indicators. A decision matrix was constructed based on the scoring data, and TOPSIS was applied to calculate the relative closeness of each scheme. The specific calculation results are presented in Table 4.

Table 4. Evaluation results of product renderings

Scheme	Relative Closeness	Ranking	Scheme	Relative Closeness	Ranking	Scheme	Relative Closeness	Ranking
P1	0.980 6	5	P5	0.977 4	8	P9	0.976 1	9
P2	0.980 8	4	P6	0.978 7	6	P10	0.982 1	3
P3	0.978 1	7	P7	0.983 4	2	P11	0.975 4	10
P4	0.987 1	1	P8	0.974 9	12	P12	0.975 3	11

According to the ranking of relative closeness calculated by TOPSIS, design scheme P4 was identified as the optimal solution. In terms of structural design, P4 features a padded backrest and seat surface, an overall symmetrical structure, a downward-curved footrest, and armrests with slightly upturned ends. It achieved the best performance in the comprehensive evaluation of the 18 user demand indicators, effectively balancing functional requirements and ergonomic design.

6. Conclusion

This study takes the Ming-style circular-backed armchair as the design carrier. It integrates Sanxingdui bronze patterns into the design as key cultural elements. People used Deepseek-R1 together with AHP in this research. They collected user needs for the armchair in a comprehensive way. They also analyzed these needs in a systematic and careful manner. Finally, they got a set of accurate and reliable demand data. The study introduced Hu Moment and Shape Grammar into the design work. It used these two methods to create detailed and proper design sketches. This process built a clear path for the deep integration of cultural elements and products. It also effectively avoided the problem of mechanically copying cultural elements in design. Through the mode of human-machine collaboration, people put demand keywords and creative sketches into the SD model together. They used the model to carry out scheme generation work. This practice improved the output accuracy of AIGC in cultural and creative product design. It also ensured that the core cultural semantics could be completely passed on. But this study only chose the Ming-style circular-backed armchair as a single design carrier. It only did practical verification based on this single carrier. The study has not tested the applicability of the method across different cultural carriers and product types. So the generalizability of the method still needs to be further verified in later research. Future research will carry out design practices under a variety of diverse cultural backgrounds. These practices will cover multiple different product categories. Researchers will verify the method from many different dimensions. They will use the results to improve the cultural and creative product design framework. They will also enhance the versatility and inclusiveness of this design framework in a better way.

References

[1] Luo, S. (2025). Cultural and creative consumption booms: From emotional resonance to a new industrial engine. China Accounting News, 016.

[2] Niu, S. Q. (2025). Prospects for the development of the archival cultural and creative industry facing the 15th five-year plan. Shanxi Archives, 06, 98-100.

[3] Wei, J. C. (2025). Exploration of rural plastic cultural and creative product design based on AIGC technology. China Plastics Industry, 53(02), 171-172.

[4] Zhu, K. H., Xu, X. F., & Qi, R. W. (2024). Research on the path of AI empowered local cultural and creative product design—Taking Jiangxi local culture as an example. Packaging Engineering, 45(S1), 191-197.

[5] Zhou, Q. Y., & Zhao, W. D. (2025). A review of cultural and creative design methods assisted by generative artificial intelligence. Packaging Engineering, 46(04), 121-133.

[6] Lu, P., Wu, F., & Tang, J. (2024). Product form design and evaluation method based on artificial intelligence generated content. Journal of Graphics, 45(06), 1277-1288.

[7] Zhuang, Q., & Huang, S. Q. (2025). Artificial intelligence generated content technology empowers the design of cultural and creative shoes and boots for Xunpu hairpin flower wreath. Leather Science and Engineering, 35(04), 88-95.

[8] Zhang, H. M. (2025). How was DeepSeek-R1 made? Journal of Shenzhen University Science and Engineering, 42(02), 226-232.

[9] Zhang, T. F., Li, Z., Jing, X., et al. (2020). Research on low-resolution pattern coding recognition method based on Hu-DBN. Journal of Northwestern Polytechnical University, 38(06), 1218-1224.

[10] Li, L., Mao, Z. H., Lü, S. Q., et al. (2024). Experimental research on generative AI in national pattern design. Research and Exploration in Laboratory, 43(09), 84-90+102.

[11] Song, C. L., Li, J. M., & Zhao, W. Q. (2025). Design exploration of applying AIGC to traditional shadow puppet IP image. Packaging Engineering, 46(02), 226-237.

[12] Xu, J. F., & Wang, S. Y. (2022). Design of intelligent household kitchen waste recycling products based on AHP-TRIZ. Journal of Machine Design, 39(09), 128-134.

[13] Liu, J., & Liu, W. L. (2023). Research on the minimalist beauty and inheritance development of Ming-style round-backed armchair design. Furniture & Interior Design, 30(06), 26-31.

[14] Luo, X., Qian, Y. J., Xu, W. D., et al. (2024). Innovative design and application of Sanxingdui bronze patterns in knitted garments. Knitting Industries, 10, 61-64.

[15] Hu, M. K. (1962). Visual pattern recognition by moment invariants. IRE transactions on information theory, 8(2), 179-187.

[16] Yao, W. J., Zhu, H. B., & Yin, Y. L. (2021). Real-time automatic extraction of ROI based on Hu moment template matching and target tracking. Modular Machine Tool & Automatic Manufacturing Technique, 09, 52-56.

[17] Ku, L., Geng, Q., & Zhan, W. (2024). Zero-watermarking algorithm for remote sensing images based on NMF and Hu invariant moments. Geography and Geo-Information Science, 40(06), 6-10+15.

[18] Hao, P., Gao, H. H., & Liu, Z. L. (2023). Innovative design and application of Dawenkou painted pottery patterns based on shape grammar. Packaging Engineering, 44(S1), 474-479.