Cultural Symbols Migration and User Perception: Innovation in Chinese-Style Furniture Design

Li Wang [a,b] Yu-Han Gong [c] Shi-Fan Niu [d] and Zhao-Xian Ren [e,f,*]

The design of Chinese-style furniture (CSF) strives to preserve cultural symbols and aesthetic features while enhancing user experience and emotional resonance. This paper explored how to optimize the design of CSF by analyzing the relationships between affective vocabulary, cultural symbols, and user perception, aiming to narrow the gap between designer intent and user perception, thereby enhancing emotional resonance and user satisfaction. An Affinity Diagram was employed to collect and organize affective vocabulary related to furniture design. Subjective weights of the affective vocabulary were calculated using the Analytic Hierarchy Process (AHP), and objective weights were determined through the Entropy Weight (EW) Method. The Coupling Coordination Degree (CCD) Method was applied to identify the core affective vocabulary. The artifact shapes and patterns from the Haihunhou tomb site were analyzed to extract representative design elements. Finally, the Quality Function Deployment (QFD) Method was utilized to examine the mapping relationships between core affective vocabulary and the artifact shapes and patterns, ranking the characteristics of these elements. The optimized design elements were integrated into the design of a Chinese-style chair. The incorporation of cultural symbols and affective vocabulary into Chinese-style chair design enhanced user experience and emotional identification, providing a viable path for innovation in CSF design.

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*Contact information: a: School of Design, Central Academy of Fine Arts, Bei'jing, 100102, China; b: School of Art, Dali University, Da'li, 671003, China; c: Baoshi Art college, Jiangxi University of Engineering, Xin'yu, 338000, China; d: School of Architecture & Design, Nanchang University, Nan'chang, 330038, China; e: Department of Industrial Design, School of Mechanical Engineering, Northwestern Polytechnical University, Xi'an, 710072, China; f: Key Laboratory of Ministry of Industrial Design and Ergonomics, Ministry of Industry and Information Technology, Northwestern Polytechnical University, Xi'an, 710072, China; *Corresponding author: renzhaoxian@mail.nwpu.edu.cn*

INTRODUCTION

Chinese-style furniture (CSF) is a significant carrier of traditional Chinese culture. It encapsulates rich historical, cultural, and aesthetic connotations. With societal progress and the influence of globalization, traditional CSF faces increasing pressure for modernization (Xiong *et al.* 2017). The challenge of enhancing user experience and emotional resonance while preserving cultural symbols and aesthetic features has become a pressing issue in the field of CSF design. As consumer demand for personalized and emotionally resonant furniture continues to grow, design innovation has emerged as a key direction for the development of CSF.

In recent years, scholars and designers have gradually recognized that furniture

design is not merely a fusion of function and aesthetics, but a comprehensive manifestation of culture, emotion, and user experience. By integrating shape grammar and the KANO model, Qu *et al.* (2023) proposed an innovative design and evaluation method for Chinese-style stools, optimizing the design by incorporating regional cultural symbols. Xue *et al.* (2025) used structural equation modeling for an in-depth study of the aesthetic structure of Ming-style furniture patterns, revealing that emotion, as a dependent variable, is influenced by perceived and cognitive factors. This research laid the theoretical foundation for enhancing the decorative effect of traditional patterns in product design. However, existing studies predominantly have focused on the superficial presentation of cultural symbols, often neglecting how to precisely align these symbols with users' actual perceptual needs. This results in a significant gap between design outcomes and user expectations.

To address this issue, an increasing number of studies have focused on the relationships between affective vocabulary, user perception, and design elements. Lin *et al.* (2024), through the application of Kansei engineering (KE), conducted perceptual semantic experiments on Ming, Qing, and modern Chinese-style solid wood furniture. They analyzed the morphological elements and developed a mapping model between these elements and emotional responses. Their findings revealed differences in emotional responses across the three furniture styles, with Qing-style furniture being more luxurious and individualistic, modern CSF being minimalist and contemporary, and Ming-style furniture presenting a more balanced aesthetic. Zhang and Xu (2020) combined KE evaluation and eye-tracking methods to study the design factors that influence subjective impressions of Tang Dynasty chairs. They identified decoration and shape as the two primary factors affecting evaluation, with the backrest, armrests, and chair legs being key morphological features of Tang-style chairs. This study provided valuable guidance for the design of modern Tang-style chairs. However, despite a large body of research exploring the relationship between affective design and cultural symbols, no study has systematically integrated the transmission of cultural symbols with the interactive mechanisms of user perception. This gap remains especially significant in the field of CSF design, where the enhancement of users' cultural experience and emotional identification through design innovation is still a relatively underdeveloped area of research.

This study aimed to explore how to optimize CSF design by analyzing the interactive relationship between affective vocabulary, cultural symbols, and user perception, thus narrowing the gap between designer intent and user perception. In doing so, this study sought to enhance emotional resonance and user satisfaction. Specifically, this paper employs a series of methods, including the Affinity Diagram, Analytic Hierarchy Process (AHP), Entropy Weight (EW) Method, and Coupling Coordination Degree (CCD) Method, to systematically analyze affective vocabulary in furniture design, extract representative cultural symbols, and establish mapping relationships between core affective vocabulary and cultural symbols through Quality Function Deployment (QFD). The integration of these methods not only contributes to the innovation and emotional value of CSF design but also provides theoretical guidance and practical pathways for the inheritance and innovation of traditional culture in modern design.

Chinese-Style Furniture Design

CSF design, as an important embodiment of traditional Chinese culture, integrates both practicality and aesthetic value. The design principles of this furniture often reflect profound historical, cultural, and philosophical thought. Cui *et al.* (2025) employed conjoint analysis and eye-tracking technology to study consumer preferences for

contemporary Chinese-style wooden furniture, using the traditional Chinese round-back armchair as the object of study. Their research revealed that materials played the most significant role in subjective evaluations, while decoration type significantly influenced visual search behaviors, and cultural emotions also affected consumer decisions. Wan *et al.* (2018) found that people were more focused on the New CSF, with gender having a significant impact on cognitive processing, and a heightened interest in the decorative details of the furniture. These findings offer valuable insights for CSF design. Using the example of wicker sofas, Chen *et al.* (2024) applied KANO Model, the AHP, and TRIZ Theory in their innovative design research on wicker furniture. Their study determined user need priorities, quantified demand weights, and resolved design contradictions, ultimately yielding a design solution that met market trends. Using Ming-style furniture as an example, Xue *et al.* (2024) explored strategies for the cultural sustainability of traditional CSF based on the "Methodology of Affairs and Principles". Their study focused on both internal factors (such as shape, function, structure, and connections) and external factors (such as political, economic, and cultural changes) to propose strategies for the inheritance and development of traditional furniture in modern society.

Existing research mainly has concentrated on consumer preferences, cultural inheritance, and design innovation, but it often has focused on superficial market demands or the surface-level application of cultural symbols. While some studies have addressed cultural symbols and emotional factors, most have failed to delve deeply into how cultural symbols resonate with users' emotional cognition, resulting in a lack of emotional depth in design and limited improvement in user experience. Moreover, traditional design approaches tend to emphasize the combination of functionality and aesthetics, with limited attention paid to how cultural symbols can effectively align with users' emotional needs. This study addresses this gap by exploring the connection between affective vocabulary, cultural symbols, and user perception, integrating multiple quantitative analytical methods. It seeks to uncover the intrinsic links between cultural symbols and user emotions and validates the role of cultural symbol mapping in enhancing emotional resonance through specific design case studies. This research thus fills the gap in existing studies regarding the emotional resonance of design.

Cultural Symbol Transfer

In the field of furniture design, the transfer of cultural symbols is not a mere replication of traditional elements but a complex process involving the recreation and reinterpretation of these elements. This process requires not only consideration of the cultural background and aesthetic preferences of the target user group but also a focus on their emotional needs to ensure the effectiveness of the design and its resonance with users' emotions. Drawing on contextual theory and image sensing technology, Chen (2022) analyzed the needs of elderly users in smart home environments, using Ming-style furniture elements. They proposed design strategies for voice user interfaces in aging-friendly smart home products. This study emphasizes that modern CSF design must prioritize not only aesthetics and artistic value but also innovation from the user experience perspective, enhancing emotional resonance. Wu *et al.* (2021) conducted research on decorative design in Taiwanese bamboo furniture, employing methods such as content analysis, expert interviews, and participatory action research, alongside theories of East-West symbolic codes. They explored the application of functional, emotional, communicative, and human recognition codes in the decorative design of bamboo furniture, verifying the correlation between these codes and bamboo furniture decoration, thus offering new directions for

Taiwanese bamboo furniture design. Using the example of the traditional Chinese Ming-style waist table, Xue and Chen (2024) applied shape grammar in wooden furniture design. By constructing a DNA library for the waist table, they derived three design solutions through shape grammar. Xue and Chen (2025) utilized semantic extension and shape grammar, taking Su-style stools as an example, to explore innovative strategies for the design of existing wooden furniture. By analyzing the regional culture of Suzhou, studying traditional stool structures, and conducting design practices, this research effectively guided the design of wooden furniture with regional cultural characteristics. Wu (2022) conducted a questionnaire-based study to better integrate traditional elements into contemporary furniture design. They analyzed public attitudes and identified issues, offering development suggestions such as actively embracing change and delving into cultural connotations.

Existing studies primarily focus on the symbolic transformation and innovation of traditional cultural symbols. However, the exploration of how cultural symbols can effectively evoke emotional resonance in design remains underdeveloped. Current research tends to emphasize the recreation of symbols, innovation in forms, and adaptive changes in cultural backgrounds, with relatively less attention paid to how the transfer of cultural symbols can be precisely aligned with users' emotional needs, thereby enhancing emotional identification with the design. Furthermore, during the transfer of cultural symbols, there is often a lack of systematic analysis of the emotional needs of the target user group. This study addresses this gap by mapping cultural symbols to affective vocabulary, integrating specific artifact elements, and using the QFD to effectively connect cultural symbols with users' emotional needs. This approach provides a novel innovation pathway for CSF design and bridges the emotional resonance gap in current research.

User Perception

Kansei engineering (KE) employs scientific methods to translate human emotional needs into design parameters, ensuring that designs not only meet functional requirements but also elicit emotional responses from users. In the context of furniture design, the application of KE can effectively enhance users' emotional identification and satisfaction. Fu *et al.* (2024) proposed a method for evaluating and designing Ming-style furniture that integrates KE, Game Theory, and Particle Swarm Optimization-Support Vector Regression. By collecting users' emotional needs, calculating both subjective and objective weights to identify key requirements, and constructing a mapping model to find optimal design parameters, the method was validated through practical examples. Chen *et al.* (2017) focused on the evaluation system during the design phase of panel furniture, combining KE and AHP to establish the assessment framework. Wang *et al.* (2024), using Yangzhou Sanwan Park as a case study, applied emotional design theory and the Kano model to develop an emotional design evaluation system for street furniture. They analyzed users' emotional needs, prioritized them, and proposed design strategies such as functional integration and cultural fusion, offering useful insights for street furniture design. An *et al.* (2022) conducted quantitative research on the linear elements and emotional imagery of traditional screens using KE, discovering that the key linear elements influencing the modern aesthetic of screens were the screen caps, straight bars, and bases, with the screen caps and bases having the most significant impact on the "modern" emotional imagery.

Despite the progress made in applying KE in furniture design, existing studies predominantly have focused on quantifying the alignment between users' emotional needs and design parameters, with limited exploration of how cultural symbols can enhance users'

emotional identification and satisfaction at an emotional level. Most of the existing literature centers around the alignment between the emotional functions of designs and users' needs, yet how the transfer of cultural symbols combined with user perception can further strengthen emotional resonance remains a relatively underexplored research area. This study addresses this gap by examining cultural symbols as a starting point and exploring how the theoretical framework of KE can be used to optimize the expression of cultural symbols in furniture design. Specifically, by refining symbols from historical artifacts, this research aims to enhance emotional resonance and user experience, thereby contributing to the innovation of furniture design and enhancing emotional identification.

EXPERIMENTAL

Proposed Framework

This study explored how cultural symbols can be transferred in the design of CSF and optimize the design by analyzing the relationship between KE and user perception, thereby enhancing emotional resonance and user satisfaction. A systematic research framework encompassed the entire process from the collection of affective vocabulary to the mapping of cultural symbols. A detailed illustration of the framework is presented in Fig. 1. The framework consists of the following key steps:

- *Collection and Organization of Affective Vocabulary:* The Affinity Diagram Method is employed to collect and organize affective vocabulary related to CSF design. Through a review of relevant literature and expert interviews, a set of affective terms that reflect the emotional aspects of CSF design are extracted.
- *Weight Calculation of Affective Vocabulary:* The AHP is used to calculate the subjective weights of the affective vocabulary, allowing for an analysis of users' emotional needs and preferences for different design elements. Additionally, the EW Method is utilized to calculate the objective weights of the affective vocabulary, ensuring the scientific and objective nature of the evaluation.
- *Selection of Core Affective Vocabulary:* Based on the aforementioned analyses, the CCD Method is employed to identify core affective vocabulary that is highly correlated with user perception. The CCD method effectively identifies the coordination and interdependence among different affective terms, prioritizing those design elements that most significantly enhance emotional resonance with users.
- *Extraction of Cultural Symbols and Artifact Elements:* Representative cultural design elements are extracted by analyzing the artifact shapes and patterns from the Haihunhou tomb site. These elements not only hold strong cultural symbolism but are also closely related to the traditional aesthetic characteristics of CSF.
- *Mapping Analysis of Cultural Symbols and Affective Vocabulary:* The QFD Method is applied to analyze the mapping relationships between affective vocabulary and cultural symbols. This approach facilitates the organic integration of affective vocabulary, cultural symbols, and furniture design elements.
- *Design Practice and Feedback Analysis:* Based on the analysis results, selected cultural symbols and affective vocabulary are applied to the design of a Chinese-style chair, followed by design optimization. Finally, user feedback and evaluation are gathered to analyze the practical application of cultural symbols and affective vocabulary, assessing their impact on user experience and emotional identification.

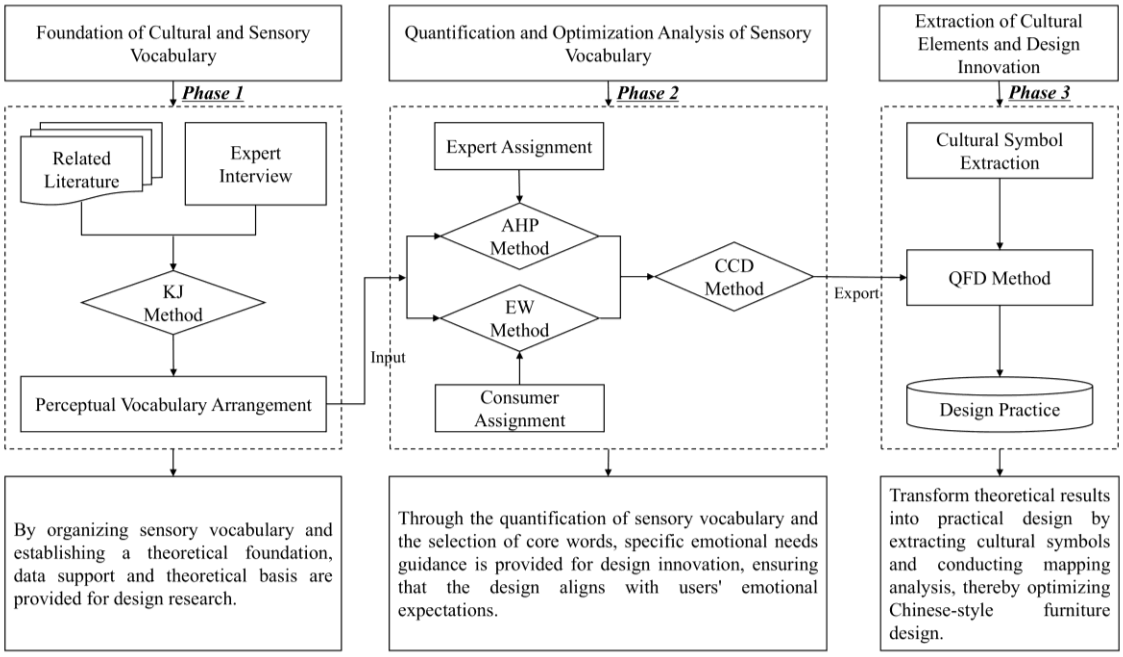


Fig. 1. Proposed framework

Kansei Engineering and Affinity Diagram Method

Kansei engineering (KE) is a methodological approach that quantifies and systematizes the design process by studying users' emotional needs and sensory experiences. The primary goal is to transform these emotional requirements into specific design criteria, thereby optimizing product design and enhancing user satisfaction and emotional identification. In the context of CSF design, KE enables designers to derive scientifically grounded decisions by analyzing consumers' emotional responses to different design elements. Affective vocabulary represents users' emotional needs concerning furniture design, encompassing multiple dimensions of perception, from visual and tactile to emotional responses.

In this study, the Affinity Diagram Method is employed as a tool for organizing and categorizing affective vocabulary to ensure a comprehensive and accurate extraction of users' emotional cognition. A variety of data collection methods, including literature review, expert interviews, and user surveys, are used to gather affective vocabulary related to CSF design. The Affinity Diagram Method is then applied to classify and organize the collected vocabulary. This technique involves group discussions and data organization, with the following basic steps: first, all affective terms are written on individual cards; these cards are then grouped based on shared emotional characteristics. By doing so, a manageable and coherent set of categories is derived from the vast array of terms, providing structured data for subsequent quantitative analysis. Finally, based on the sorting and categorization process, effective affective vocabulary that influences design innovation is extracted.

Analytic Hierarchy Process

The AHP is a systematic decision-making tool that decomposes complex problems into multiple levels for both qualitative and quantitative analysis, ultimately providing a scientific basis for decision-making (Lin *et al.* 2008). In this study, AHP is primarily employed to allocate weights to affective vocabulary, thereby offering specific guidance

for addressing emotional needs in CSF design. The basic steps of AHP are as follows:

(1) *Construction of the Judgment Matrix:* Initially, an expert panel is invited to assess the role of affective vocabulary in CSF design through pairwise comparisons, creating a judgment matrix. Experts use a scale of 1 to 9, as well as their reciprocals, to indicate the relative importance of each affective term based on their experience and understanding of design needs. The scale values are defined as follows:

Table 1. Scale Values for Judgment Matrix

Scale Value	Meaning
1	Two factors are equally important
3	Factor *i* is slightly more important than factor *j*
5	Factor *i* is significantly more important than factor *j*
7	Factor *i* is strongly more important than factor *j*
9	Factor *i* is absolutely more important than factor *j*
2、4、6、8	Intermediate values between adjacent scale values

(2) *Calculation of Weight Vectors:* Once the judgment matrix is constructed, the next step is to calculate the weight vector for each matrix. The geometric mean method is commonly used for this purpose. For each row of the matrix, the product of the elements in that row is calculated, as shown in Eq. 1,

$$M_i = \prod_{j=1}^{m} b_{ij} \ \ (i = 1,2,\cdots,m) \tag{1}$$

where b_{ij} represents the element in the *i*-th row and *j*-th column of the judgment matrix, and *m* denotes the number of affective vocabulary terms.

(3) *Calculation of the Geometric Mean:* Based on the product results from each row, the geometric mean is calculated. This serves as the preliminary weight for the affective vocabulary. The formula for the geometric mean is as follows:

$$a_i = \sqrt[m]{M_i} \ \ (i = 1,2,\cdots,m) \tag{2}$$

(4) *Normalization of Weights:* To derive the relative weights of the affective vocabulary, the geometric mean values are normalized. The normalization formula is:

$$w_i = \frac{a_i}{\sum_{i=1}^{m} a_i} \tag{3}$$

(5) *Calculation of the Maximum Eigenvalue(λ_{max}):* To test the consistency of the judgment matrix, the maximum eigenvalue is computed using the following formula, based on the weight vector w_i:

$$\lambda_{max} = \frac{1}{n}\sum_{i=1}^{n} \frac{\boldsymbol{B}_{w_i}}{\boldsymbol{w}_i} \tag{4}$$

where $\boldsymbol{B}_{w_i}$ represents the vector obtained by multiplying the judgment matrix by the weight vector, and n is the number of affective vocabulary terms.

(6) *Consistency Test:* The consistency test is a critical step in AHP to ensure the rationality of the judgment matrix (Zhu *et al.* 2015). First, the consistency index is calculated using the formula:

$$CI = \frac{\lambda_{max} - n}{n-1} \tag{5}$$

where n represents the order of the judgment matrix, corresponding to the number of affective vocabulary terms.

(7) *Calculation of the Consistency Ratio (CR):* Finally, the CR is computed to determine whether the judgment matrix exhibits acceptable consistency. The CR is calculated as follows,

$$CR = \frac{CI}{RI} \quad (6)$$

where RI is the random consistency index, whose value depends on the order of the judgment matrix n (see Table 2). If $CR \leqslant 0.1$, the judgment matrix is considered sufficiently consistent. If $CR > 0.1$, the matrix must be reassessed and adjusted.

Table 2. Average Random Consistency Index

Matrix Order (n)	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49

Entropy Weight Method

The EW Method, based on information entropy theory, is an objective weighting technique commonly used in multi-attribute decision-making analysis. In KE, the entropy weight method determines the relative importance of affective vocabulary by assessing the information entropy associated with each term. Information entropy reflects the distribution of information for each affective vocabulary in the design; a higher entropy value indicates a more even distribution of information, suggesting greater uncertainty and thus a smaller weight. Conversely, a lower entropy value signifies higher information concentration, indicating stronger representativeness and a larger weight (Wang *et al.* 2024).

In this study, the EW Method is employed to allocate weights based on the objective information content of affective vocabulary, thereby ensuring the scientific and objective nature of the weighting process (Li *et al.* 2014). Compared to the AHP, the entropy method does not rely on expert subjective judgment but instead calculates weights based on intrinsic data patterns, effectively avoiding biases and inconsistencies that may arise in expert assessments.

(1) *Data Normalization:* To eliminate the influence of inconsistent units among affective vocabulary terms, data standardization is performed. The following formula is used for normalization,

$$x'_{ij} = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})} \quad (7)$$

where $max(x_{ij})$ and $min(x_{ij})$ represent the maximum and minimum values of the *j*-th assessment for all affective vocabulary terms, and x'_{ij} is the standardized value, ensuring that all data are in the same dimensionality.

(2) *Calculation of Entropy:* After normalization, the proportion value of each affective term in each assessment is computed using the formula,

$$p_{ij} = \frac{x'_{ij}}{\sum_{i=1}^{m} x'_{ij}} \quad (8)$$

where p_{ij} represents the proportion value of the *i*-th affective term in the *j*-th assessment, and m is the total number of affective vocabulary terms. Next, the entropy H_i for the *i*-th

affective term is calculated using the formula,

$$H_i = -k \sum_{j=1}^{n} p_{ij} \ln(p_{ij}) \quad (i = 1,2,\dots,m) \tag{9}$$

where n is the number of assessments, and $k = \frac{1}{\ln(n)}$ is a constant to normalize the entropy value. The entropy H_i represents the uncertainty of the *i*-th affective term across all assessments. A smaller entropy value indicates greater concentration of information, resulting in a higher weight for that term.

(3) *Calculation of Entropy Weight:* After determining the entropy for each affective term, the entropy weight w_i is computed using the following formula,

$$w_i = \frac{1-H_i}{\sum_{i=1}^{m}(1-H_i)} \quad (i = 1,2,\dots,m) \tag{10}$$

where w_i is the weight of the *i*-th affective term, and H_i is its entropy value. A smaller entropy value results in a larger weight, indicating that the affective term contributes more to the design.

Coupling Coordination Degree Method

The CCD method is an analytical tool used to examine the interactions and coordination between various factors within a system (Tang *et al.* 2022). In this study, the method is applied to evaluate the degree of coordination between subjective and objective weights of affective vocabulary, thereby assisting designers in identifying the optimal set of terms. The detailed steps for applying the CCD method in this study are outlined as follows:

(1) *Calculation of Coupling Degree:* The subjective and objective weights of the affective vocabulary are treated as two distinct systems. The coupling degree between these systems is calculated to assess their level of alignment. The formula for calculating the coupling degree is,

$$C_n = \left\{ \frac{(u_1 \times u_2 \times \cdots \times u_n)}{\prod(u_1 + u_j)} \right\}^{\frac{1}{n}} \tag{11}$$

where $u_1, u_2, \dots, u_n$ represent the weights of the individual systems.

In this study, the subjective and objective weights of affective vocabulary, derived from the AHP and EW Methods, were treated as two systems. The coupling degree between them was calculated using the following simplified formula,

$$C_2 = \left\{ \frac{(u_1 \times u_2)}{(u_1 + u_2) \times (u_1 + u_2)} \right\}^{\frac{1}{2}} \tag{12}$$

where u_1 and u_2 represent the subjective and objective weights, respectively.

(2) *Construction of the CCD Model:* After calculating the coupling degree, a CCD Model was developed to quantify the degree of coordination between the subjective and objective weights. This model was used to evaluate whether the interaction between the two systems had reached an optimal integration state, thereby providing a basis for the optimization of CSF design. The formula for the coordination degree model is,

$$D = \sqrt{C \cdot T} \tag{13}$$

where C represents the coupling degree and T is the coordination adjustment factor. Given that in this study, the influence of subjective and objective weights on the design outcomes

is considered equal, the coordination adjustment factor T is defined as,

$$T = \alpha u_1 + \beta u_2 \quad (14)$$

where α=β=0.5, indicating that the influence of both subjective and objective weights on the design is equally important.

Quality Function Deployment

Quality Function Deployment (QFD) is a systematic tool designed to translate user requirements into technical specifications, ensuring that product designs comprehensively meet customer expectations (Fazeli and Peng 2022). In this study, the QFD Method was employed to map core affective vocabulary and cultural symbols into the design of CSF. This approach provides a structured framework for furniture design by constructing a "affective vocabulary - cultural symbol" matrix. Through this matrix, the prioritization of cultural symbols was further calculated, assisting designers in optimizing design solutions based on user emotional needs. The goal was to ensure that the final design not only meets emotional requirements but also conveys the profound cultural significance of traditional heritage.

RESULTS AND DISCUSSION

Collection of Affective Vocabulary

The collection of affective vocabulary is a crucial step in understanding user emotional needs and preferences within the context of CSF design. In this study, a comprehensive set of affective vocabulary related to CSF design was initially gathered through a literature review and expert interviews. The literature review involved extracting vocabulary from 50 academic papers covering descriptions of aesthetic characteristics, cultural symbolism, and emotional experiences associated with CSF.

In addition to the literature review, expert interviews and user surveys were conducted to supplement the vocabulary collection. The expert interviews involved 10 established designers and scholars specializing in furniture design and cultural studies. Participants were selected based on their professional expertise and contributions to CSF research and practice. The interviews followed a semi-structured format, where experts were asked to describe key emotional attributes associated with CSF and evaluate the relevance of previously collected affective vocabulary. The specific questions used in the semi-structured interviews are provided in Appendix A.

Following the initial collection, the study employed the affinity diagram method to organize and filter the terms. Through group discussions with five designers, three researchers, and four user representatives, similar terms were categorized and generalized into cohesive labels. This systematic process ensured the consolidation of key affective vocabulary with high relevance to CSF design (Cheng and Leu 2011).

After filtering and optimizing the vocabulary through the affinity diagram method, the study finalized a set of core affective terms, as detailed in Table 3. These terms not only encapsulate users' aesthetic and cultural identity needs in relation to CSF design but also reflect the emotional experiences and resonances users encounter during the usage process. The inclusion of both expert and user perspectives enhances the credibility and reproducibility of the study, ensuring that the selected affective vocabulary is both academically robust and practically relevant.

Table 3. Affective Vocabulary for CSF Design

Category of Affective Vocabulary	Affective Vocabulary
Aesthetic Features (E_1)	Elegant (E_{11}), Refined (E_{12}), Simple (E_{13}), Symmetrical (E_{14})
Cultural Symbolism (E_2)	Majestic (E_{21}), Antiquated (E_{22}), Traditional (E_{23}), Confucian (E_{24})
Emotional Experience (E_3)	Relaxing (E_{31}), Cozy (E_{32}), Comfortable (E_{33})

Analysis of Subjective and Objective Weights

Building upon the collection and categorization of affective vocabulary, this study further calculated the subjective and objective weights of affective vocabulary using the AHP and the EW Method, respectively, to provide a comprehensive analysis of user emotional needs and preferences in CSF design.

First, the AHP was employed to calculate the subjective weights of the affective vocabulary. The primary categories of affective vocabulary (aesthetic features, cultural symbolism, emotional experiences) were set as the criterion level, while the secondary vocabulary (*e.g.*, elegant, antiquated, comfortable, etc.) formed the alternative level. A hierarchical structure model was established based on these categories. A panel of 10 experts (7 professors specializing in furniture design and 3 furniture design engineers) performed pairwise comparisons within each level and constructed judgment matrices. The weights were then calculated using formulas (1)-(6), and consistency checks were performed. The CR for all judgment matrices were found to be less than 0.1, indicating satisfactory consistency, as shown in Tables 4 and 5.

Table 4. Affective Vocabulary Weights

Goal Level	Criterion Level	Weight	Alternative Level	Weight	Composite Weight
Affective Vocabulary	Aesthetic Features (E_1)	0.4286	E_{11}	0.5650	0.2421
			E_{12}	0.1175	0.0504
			E_{13}	0.2622	0.1124
			E_{14}	0.0553	0.0237
	Cultural Symbolism (E_2)	0.1429	E_{21}	0.5650	0.0807
			E_{22}	0.2622	0.0375
			E_{23}	0.1175	0.0168
			E_{24}	0.0553	0.0079
	Emotional Experience (E_3)	0.4286	E_{31}	0.6370	0.2730
			E_{32}	0.2583	0.1107
			E_{33}	0.1047	0.0449

Table 5. Consistency Test Results

	Goal Level	Criterion Level		
		E_1	E_2	E_3
λ_{max}	3.0000	4.1170	4.1170	3.0385
CR	0.0000	0.0438	0.0438	0.0370

The EW Method is an objective weighting approach based on the degree of data dispersion, which helps to mitigate potential biases in subjective evaluations (Kumar *et al.* 2021). This method analyzes the distribution of each affective vocabulary based on consumer feedback data, and entropy values are computed to assess the relative importance of each term. In this study, 30 consumers were invited to evaluate 11 affective vocabulary terms, rating them based on personal preferences on a scale of 1-9, where 1 represents

"completely disagree" and 9 represents "completely agree". Using Eqs. 7 to 10, the weights were calculated, and the results are shown in Table 6.

Table 6. Standardized Matrix and Objective Weight Values

Affective Vocabulary	User 1	User 2	User 3	…	User 19	User 20	Weight
E_{11}	0.3333	0.0000	0.3333	…	0.0000	1.0000	0.0673
E_{12}	1.0000	0.5000	0.0000	…	0.2500	0.5000	0.1445
E_{13}	0.3333	1.0000	0.3333	…	0.6667	1.0000	0.0586
E_{14}	0.2500	1.0000	0.0000	…	0.7500	0.5000	0.1179
E_{21}	0.8000	0.4000	0.0000	…	1.0000	0.4000	0.0968
E_{22}	0.4000	0.8000	0.6000	…	0.4000	0.8000	0.0509
E_{23}	0.3333	1.0000	0.0000	…	1.0000	0.6667	0.0884
E_{24}	0.5000	0.6667	0.1667	…	0.6667	0.3333	0.0982
E_{31}	0.6667	0.3333	0.6667	…	0.6667	1.0000	0.0424
E_{32}	0.2000	1.0000	0.0000	…	0.2000	0.4000	0.0963
E_{33}	0.0000	0.8000	0.0000	…	1.0000	0.2000	0.1388

Core Affective Vocabulary Selection

To optimize the emotional experience in CSF design, the CCD method was employed to analyze the coupling degree, coordination index, and CCD of the affective vocabulary. This analysis identified the most influential core affective vocabulary, providing guidance for design decisions (Ren and Qu 2024). Based on the grading criteria for coupling coordination levels outlined in Table 7 and calculations using Eqs. 11 through 14, six affective vocabulary terms demonstrated good coordination between subjective and objective evaluations. These six terms were retained as core affective vocabulary, as shown in Table 8. The core affective vocabulary selected were: Elegant (E_{11}), Refined (E_{12}), Simple (E_{13}), Majestic (E_{21}), Cozy (E_{32}), and Comfortable (E_{33}). The core vocabulary selection method using CCD provides a clear optimization direction for CSF design and reveals the dynamic relationship between cultural symbols and user perception. The selection of core affective vocabulary using CCD analysis not only provides a precise optimization strategy for CSF design but also reinforces the intricate link between cultural identity and user experience. By emphasizing the design expression of these key affective terms, designers can ensure that traditional cultural elements are effectively translated into contemporary furniture forms, bridging the gap between heritage preservation and modern user expectations. This approach fosters a harmonious balance between historical authenticity and functional innovation, ultimately enhancing the cultural and emotional significance of CSF in modern contexts.

Table 7. Grading Criteria for CCD

D Value Range	Coupling Coordination Level	D Value Range	Coupling Coordination Level
0.0~0.1	Extremely Disordered	0.5~0.6	Barely Coordinated
0.1~0.2	Severely Disordered	0.6~0.7	Primary Coordinated
0.2~0.3	Moderately Disordered	0.7~0.8	Intermediate Coordinated
0.3~0.4	Slightly Disordered	0.8~0.9	Well Coordinated
0.4~0.5	Near Disordered	0.9~1.0	Excellent Coordinated

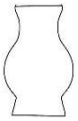
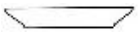
Table 8. Results of CCD Calculation

Affective Vocabulary	Coupling Degree (*C*)	Coordination Index (*T*)	Coupling Coordination Degree (*D*)	Coupling Coordination Level
E_{11}	0.83	0.562	0.683	Primary Coordinated
E_{12}	0.703	0.579	0.638	Primary Coordinated
E_{13}	0.912	0.281	0.506	Barely Coordinated
E_{14}	0.558	0.402	0.473	Near Disordered
E_{21}	0.95	0.406	0.621	Primary Coordinated
E_{22}	0.991	0.106	0.323	Slightly Disordered
E_{23}	0.563	0.247	0.373	Slightly Disordered
E_{24}	0.266	0.278	0.272	Moderately Disordered
E_{31}	0.199	0.500	0.315	Slightly Disordered
E_{32}	0.989	0.459	0.673	Primary Coordinated
E_{33}	0.685	0.541	0.609	Primary Coordinated

Extraction of Design Elements

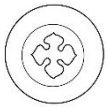
To explore representative cultural symbols and effectively incorporate them into the design of CSF, lacquerware forms and patterns from the Haihunhou Tomb site (Table 9) were used as research samples for the extraction and recreation of morphological and decorative features. The aim was to extract design elements with strong cultural symbolism and visual impact, providing inspiration and a foundation for innovative CSF design. These objects include Western Han Lacquer Vases, Gold- and Silver-Inlaid Lacquer Wine Vessel, Black Lacquer Jugs, and Li Ju's Lacquer Cup. Each item possesses unique contour features and structural designs. A meticulous analysis of these forms allowed the extraction of their key outline lines, which were then drawn using abstract spline curves to create highly recognizable morphological feature diagrams.

Table 9. Extraction of Morphological Features

Name	Shape	Line Extraction	Feature Extraction
Western Han Lacquer Vase (M_1)			
Gold- and Silver-Inlaid Lacquer Wine Vessel (M_2)			
Black Lacquer Jug (M_3)			
Li Ju's Lacquer Cup (M_4)			
Cloud Loong Pattern Lacquer Plate (M_5)			

A key feature extraction method was applied, alongside transformation rules such as cutting, rotating, symmetry, and combination, to extrapolate and reconstruct the typical patterns. The lacquerware patterns from the Haihunhou Tomb are highly decorative and symbolic, containing many intricate and culturally rich elements, such as the Persimmon Stem Pattern, White Tiger Pattern, and Cloud-Breath Pattern. By extracting these patterns' key features, their essential similarities were preserved, and the patterns were reinterpreted to create new design elements, as shown in Table 10.

Table 10. Extraction and Recreation of Pattern Features

Name	Pattern	Key Feature Extraction and Reconstruction
Persimmon Stem Pattern (P_1)		
White Tiger Pattern (P_2)		
Single Hooked Cloud Pattern (P_3)		
Cloud-Breath Pattern (P_4)		
Coiled Loong Pattern (P_5)		

Optimization of Chinese Chair Design

The core objective of this study is to integrate traditional Chinese cultural symbols with modern design concepts to create furniture that satisfies both aesthetic and functional requirements. Initially, the subjective and objective weights of core emotional vocabulary were summed and averaged to determine the comprehensive weight of each core term. Subsequently, five professors specializing in furniture design were invited to utilize the QFD methodology to construct a "core emotional vocabulary – cultural symbol" mapping model, as shown in Fig. 2. By evaluating the relationship strength between the core emotional vocabulary and cultural symbols, and incorporating the comprehensive weight of each term, the weight of each cultural symbol was calculated. The results indicated that the Black Lacquer Jug (M_3) and the Persimmon Stem Pattern (P_1) were the cultural symbols most aligned with the core emotional vocabulary, with weights of 2.40865 and 2.40555, respectively.

In the design practice, the elegant features of the traditional Taishi chair's form were combined with a modern, simplified design philosophy. The contour features of the Black Lacquer Jug were extracted and transformed into the overall design language of the chair (see Fig. 3). The backrest was designed with a three-segment division: the top section features a slightly upward arc to echo the lip contour of the Black Lacquer Jug; the middle segment incorporates a concave curve that conforms to the natural curvature of the human

spine; and the bottom section employs a horizontal line to enhance visual stability. The backrest's curved surface was achieved using laminated bending technology, creating a smooth, continuous transition that preserves the ceremonial feel of the traditional Taishi chair while meeting modern ergonomic standards. The armrests were designed based on the gripping curve of the Black Lacquer Jug, with small Persimmon Stem wood carvings at the ends that visually align with the backrest's pattern, further reinforcing the guiding principles of the core emotional vocabulary.

			Cultural Symbols									
		Comprehensi-ve Weight	M_1	M_2	M_3	M_4	M_5	P_1	P_2	P_3	P_4	P_5
Core Sensibility Vocabulary	E_{11}	0.15470	△	●	◎	△		●	△	●	△	●
	E_{12}	0.09745		◎	●			●	△	△	△	◎
	E_{13}	0.08550	●		●	●	●	△	◎	◎	◎	◎
	E_{21}	0.08875	◎		●	△	△	◎	◎	◎	◎	◎
	E_{32}	0.10350		◎	◎	△	△	●	△	◎	△	△
	E_{33}	0.09185	△	△	◎			◎		△	△	●
Cultural Symbol Weight			0.9403	1.4682	2.40865	0.77445	0.61975	2.40555	0.8784	1.79605	0.97025	2.15135
Ranking			7	5	1	9	10	2	8	4	6	3

Graphical Explanation				
Degree of Association	Strong Correlation	Moderate Correlation	Weak Correlation	No Correlation
Symbol	●	◎	△	
Score	5	3	1	0

Fig. 2. Mapping model

Fig. 3. Chinese chair design practice

In addition to optimizing the aesthetic appearance, further performance enhancements were incorporated. The backrest was manufactured using laminated bending technology to create contours closely conforming to the human body, thereby enhancing ergonomic comfort. An improved lacquer material was adopted to ensure refined craftsmanship and meticulous material usage, with the chair's main body fully decorated

using lacquer art. These features distinguish the optimized chair from the traditional Taishi chair, which is recognized for its dignified yet static appearance. The design retains the harmonious form characteristic of traditional Chinese furniture while infusing a modern minimalist and dynamic design ethos. Moreover, the selection of solid wood and velvet was strategically made: the solid wood, processed with innovative techniques, reduces material waste and lowers production costs, while the velvet seat cushion, enhanced by embroidery techniques, produces a dignified decorative effect that complements the smooth curves of the wood. These improvements contribute to a consistent overall visual expression and superior product performance in terms of comfort, durability, and efficiency.

Design Feedback and Evaluation

To comprehensively evaluate the performance of the optimized Chinese-style chair design, a comparative user study was conducted involving 30 consumers. The evaluation included five key dimensions: Aesthetic Performance, Cultural Identity, Comfort, Practicality, and Innovation, with a rating scale from 1 to 5 (1 = "very dissatisfied", 5 = "very satisfied"). The optimized design (Scheme A) was compared against two traditional Chinese-style chairs (Sample B and Sample C) to assess its relative advantages. The evaluation results, summarized in Fig. 4, demonstrate that Scheme A achieved the highest overall scores across all five criteria.

The optimized design outperformed both traditional samples, particularly in Comfort and Practicality, reflecting the effectiveness of ergonomic improvements, modern materials, and production techniques. Notably, Cultural Identity remained consistently high across all designs, underscoring the success of integrating traditional cultural symbols into the new design without compromising authenticity.

Fig. 4. Radar chart of evaluation results

CSF Design Strategies

As modernization progresses and the need for cultural heritage preservation intensifies, the design of CSF faces several challenges. A key issue in contemporary design is how to blend traditional culture with the needs of modern users, enhancing emotional resonance and the user experience. Based on the analysis of cultural symbol transfer, KE and user perception in this study, the following design strategies are proposed to foster the innovation and development of CSF.

Integration of cultural symbols and emotional needs

CSF is not only a functional product but also a carrier of culture and emotions. By analyzing the relationship between emotional vocabulary and cultural symbols, this study underscores the importance of emotional experience and cultural identity in furniture design. Design strategies should focus on core emotional vocabulary, integrating these

emotional needs with representative cultural symbols. The design process should emphasize extracting cultural significance, avoiding superficial decorative elements, and instead, delving into the emotional resonance behind the culture to shape the design

Optimization of KE and user experience

KE provides a systematic approach to evaluating emotional needs in CSF design. Based on this, designers should conduct a comprehensive analysis of users' emotional needs and reactions to furniture design (Lévy 2013). Special attention should be paid to modern, younger consumer groups, emphasizing emotional design in contemporary CSF. The designs should balance simplicity and functionality while retaining the symbolic meaning of traditional elements, ensuring the furniture both reflects modern aesthetics and evokes emotional associations with traditional culture.

Innovative transformation and re-creation of cultural symbols

Effective cultural symbol transfer involves not only the re-creation of symbols but also consideration of the acceptance and emotional resonance of these symbols with modern users (Korpi and Ahonen-Rainio 2010). By identifying the most influential core emotional words and integrating traditional cultural elements, the design can be guided toward precise innovation. Rather than adopting a simplistic transformation of traditional symbols, the design should employ modern design languages to re-interpret them. For example, the traditional "Persimmon Stem Pattern" can be re-imagined using modern techniques to form intricate carvings, retaining its cultural depth while satisfying contemporary aesthetic preferences.

Balancing modernization with traditional elements

Modern CSF design should not merely replicate traditional forms but instead seek innovation through heritage. Case studies in this research demonstrate that integrating modern design concepts with traditional furniture elements not only conveys cultural depth but also meets the comfort and functionality needs of modern users. The design should highlight the synergy of function and aesthetics (Cropley and Kaufman 2019), ensuring that elements such as chair back curves and seat materials are modernized, allowing traditional furniture to maintain its cultural elegance while blending seamlessly into contemporary home environments.

While this study offers a valuable theoretical and practical framework for innovation in CSF design, some limitations remain. First, while KE methods can comprehensively capture user emotional needs, the limited sample size may not fully reflect individual differences in emotional cognition among consumers. Second, although cultural symbols were re-created through the extraction of artifact elements, challenges persist in how to effectively convey these symbols in a globalized context. Ensuring that these symbols are understood across different cultural backgrounds remains an area for further exploration.

Future research can expand and refine these findings. First, the inclusion of data from consumers in different cultural and regional contexts could help analyze emotional cognition differences across various groups. Additionally, as the market for CSF becomes increasingly diverse due to globalization, future studies will need to balance traditional cultural symbols with modern aesthetic demands, particularly in terms of their effective communication across different cultural settings. Lastly, while KE offers valuable insights into emotional needs, its application in furniture design could be further improved. Future

research could explore more detailed emotional experience models, incorporating physiological and psychological data to further optimize emotional parameters in design, ensuring that the furniture not only satisfies emotional needs but also enhances comfort and functionality during use.

CONCLUSIONS

1. This study thoroughly explores the relationship between cultural symbol transfer, Kansei engineering (KE) and user perception in Chinese style furniture (CSF) design, aiming to optimize emotional resonance and user experience through innovative design. By combining emotional vocabulary, cultural symbols, and modern design approaches, this research provides both theoretical foundations and practical methodologies for the innovation of CSF.
2. The primary contribution of this study is the proposal of an innovation pathway for CSF design, grounded in KE and cultural symbol transfer. First, through systematic analysis of emotional vocabulary, the study reveals the critical role of emotional needs and cultural identity in furniture design. Using analytic hierarchy process (AHP) and entropy weight (EW) methods, the study calculated the subjective and objective weights of emotional vocabulary and applied the coupling coordination degree (CCD) method to identify core emotional words, providing precise emotional guidance for the design process. Second, by analyzing the form and patterns of artifacts from the Haihunhou tomb, the study extracted design elements with profound cultural symbolism and proposed strategies for the re-creation of cultural symbols. This approach breaks the limitations of traditional CSF design, preserving traditional aesthetics while addressing the emotional needs of modern users.
3. Through practical design cases, the research validates the effectiveness of the theoretical findings, with the optimized furniture design receiving high user ratings and demonstrating significant improvements in emotional resonance and cultural identity.

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Appendix A

Section 1: Background Information	
1	Can you briefly introduce your professional background and experience in furniture design and cultural research?
2	How familiar are you with the design principles and emotional characteristics of CSF?
Section 2: Identification of Affective Vocabulary	
3	Based on your expertise, what emotional attributes do you associate with CSF?
4	Are there any commonly used descriptive terms that best capture the emotional and aesthetic qualities of CSF?
5	How do you perceive the relationship between cultural symbolism and emotional experience in CSF design?
Section 3: Evaluation and Refinement of Affective Vocabulary	
6	We have gathered a preliminary set of affective vocabulary from literature and case studies. Could you review and evaluate its relevance and completeness?
7	Do you think any key emotional descriptors are missing from the current vocabulary set? If so, what terms would you suggest adding?
8	Do you believe certain affective terms are more significant than others in shaping user perception of CSF? Why?
Section 4: User Perception and Market Relevance	
9	In your opinion, how do modern users emotionally connect with CSF?
10	How do you think affective vocabulary can influence user preferences and purchasing decisions regarding CSF?
11	Do you have any recommendations on how designers can better incorporate emotional attributes into CSF design to enhance user experience?
Section 5: Additional Comments	
12	Is there anything else you would like to add regarding the emotional aspects of CSF design?