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The Modern Practice Path of Traditional Local Architectural Decoration Art in the Border Area of Jiangsu, Shandong, Henan and Anhui Under the Framework of Local History and Culture Protection

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SUMMARY: *The traditional rural architectural decoration art in the border area of Jiangsu, Shandong, Henan and Anhui carries profound historical and cultural significance. In the context of regional cultural heritage protection, exploring its modern implementation strategies is of great importance for inheriting regional culture, enhancing local cultural identity, and promoting sustainable development of regional culture. This article analyzes the characteristics of this traditional decorative art, and explores the practical path of protecting this unique architectural art form and promoting regional cultural sustainable development from multiple dimensions such as architectural restoration, cultural heritage education, and cultural industry development. By constructing a comprehensive evaluation model with semantic similarity and pattern feature similarity as the core evaluation elements, quantitatively evaluating the symbolic inheritance status of decorative patterns, and analyzing the differences in comprehensive inheritance degree of different patterns through data calculation models. Through modern practical paths such as building restoration and reuse based on the principle of authenticity, constructing a cultural heritage education system, developing cultural industries and brand building, and digital protection and dissemination, traditional local architectural decoration art in the border areas of Jiangsu, Shandong, Henan, and Anhui can be effectively protected and inherited, injecting new vitality into the sustainable development of regional historical and cultural heritage.*

KEYWORDS: *Rural architectural decorative art; Regional cultural protection; Inheritance of Decorative Patterns; Development of cultural industry; Digital protection communication*

1 Introduction

The junction area of Jiangsu, Shandong, Henan and Anhui provinces is located in the Central Plains, with a unique geographical location [1, 2]. Historically, it has been a place where multiple cultures have intermingled and converged. Its traditional local architectural decoration art, as an intuitive carrier of regional culture, integrates a variety of cultural elements and forms a unique artistic feature. From exquisite wood carvings and brick carvings to unique architectural layouts and decorative patterns, all embody the wisdom and aesthetic taste of our ancestors. However, with the acceleration of the modernization process, these precious traditional architectural decoration arts are facing many challenges, such as natural erosion, man-made damage and the impact of modern architectural styles. Today, when the

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protection of local historical culture is receiving increasing attention, in-depth study of the modern practice path of traditional local architectural decoration art in the junction area of Jiangsu, Shandong, Henan and Anhui provinces is of undeniable value for inheriting regional culture, enhancing local cultural identity and promoting the sustainable development of regional culture.

2 Artistic Characteristics of Traditional Local Architectural Decoration in the Junction Area of Jiangsu, Shandong, Henan and Anhui Provinces

2.1 Cultural Foundation of Multicultural Integration

As a transitional zone between northern and southern cultures, the diversity of architectural decoration art in the junction area of Jiangsu, Shandong, Henan and Anhui provinces stems from the continuous cultural integration in history. During the Qin and Han dynasties, with the implementation of the prefecture and county system, the Central Plains culture laid the foundation for ritual architecture here [3]. The stone que carvings in the existing Xuzhou Han tombs not only retain the solemnity of the bronze ware patterns in the Central Plains but also incorporate the flexible cloud patterns of the Chu culture. During the Wei, Jin, Southern and Northern Dynasties, ethnic migrations led to the unique combination of the "pearl-roundel pattern" of the Xianbei people and the "intertwined branch pattern" of the Han people in the temple buildings in Yuncheng, southwestern Shandong [4]. The honeysuckle patterns on the beams and brackets not only maintain the plant characteristics of the Western Regions prototype but also are endowed with round lines like peony petals by local craftsmen.

The flow of merchant groups during the Ming and Qing dynasties further promoted the integration of decorative arts. The northern brick carving techniques brought by Shanxi merchants combined with the local clay characteristics, evolving into the "shallow relief" technique-carving multi-layer patterns on bricks less than 1 centimeter thick. For example, the screen wall of the Shaanxi-Shanxi Guild Hall in Bozhou presents the life scenes of "fishing, woodcutting, farming and reading" with only three layers of carving. This technique not only continues the three-dimensional sense of Shanxi brick carving but also adapts to the brittle characteristics of northern Anhui clay. At the same time, the "three carvings"(wood carving, brick carving and stone carving) techniques introduced by Huizhou merchants collided with the folk beliefs in Jiangsu, Shandong and Henan regions, resulting in the phenomenon of "one pattern with multiple meanings" in architectural decoration. The same group of "bat patterns" not only retains the realistic style of Huizhou carving but also is endowed with the homophonic meaning of "good fortune coming" in the north. This cultural adaptation is particularly evident in the door hood carvings of the ancient dwellings in Hubu Mountain, Xuzhou.

2.2 Rich and Diverse Decoration Forms

2.2.1 Wood Carving Art

The wood carvings in this area are characterized by "carving hard wood with soft techniques". Local abundant catalpa wood and pagoda tree wood are mostly used as raw materials, and the artistic effect of combining hardness and softness is achieved through three processes: "shoveling, carving and polishing" [5, 6]. In the Qing Dynasty ancestral hall in Zaozhuang, southern Shandong, the "Twenty-four Filial Piety" wood carvings on the beam frame adopt

the "layered openwork carving" technique. The clothes patterns of the figures are shoveled with an oblique knife to create a depth change of 0. 5 mm, making the relief have a three-dimensional sense similar to round carving; the mountains and stones in the background are treated with flat carving, forming a visual hierarchy of "front solid and back virtual". The lattice wood carvings of ancient dwellings in Suzhou pay more attention to the unity of functionality and decoration. The intersections of the lattice strips of the "step-by-step brocade" lattice core are all carved with "hidden tenons", which not only enhances the structural stability but also forms the "cross flower" decorative pattern. This wisdom of "replacing carving with structure" reflects the in-depth integration of practicality and aesthetics in the craftsmanship.

In terms of theme selection, it presents the characteristic of "appealing to both refined and popular tastes". The mansions of literati and officialdom prefer elegant themes such as "qin, chess, calligraphy and painting" [7]. For example, the study partition of the former residence of Li Pan, the top scholar in Xuzhou, is carved with simplified "Mi Family Landscape" patterns, with lines as sparse as the flying white in calligraphy; while ordinary dwellings mostly use themes with" auspicious meanings". The lintel wood carvings of farmyards in Heze combine" chicken(auspicious)", "fish(surplus)" and "bat(fortune)" into continuous patterns, forming a visual blessing language through homophony. What is more distinctive is the wood carvings with opera themes. On the railings of the opera house in Shangqiu, eastern Henan, the image of "Mu Guiying Takes Command" adopts the "exaggeration and deformation "technique. The pompons on the helmet are carved into the shape of grape clusters, which not only retain the characteristics of the role but also imply the folk psychology of "more children, more blessings".

2.2.2 Brick Carving Art

Brick carving techniques have formed a north-south division due to regional differences in raw materials: in northern Jiangsu, silt bricks from the Yellow River are mostly used, which are fine in texture and suitable for "intaglio" expression; in southwestern Shandong, blue bricks fired from clay are used, which have higher hardness and are more suitable for "relief" creation. The gate towers of commercial buildings in the old city of Suixi concentrate this diversity. The "business name" plaques above the lintels adopt the yang carving technique, and the edges of the font strokes deliberately retain knife marks, forming a rough sense of power; the "Eight Immortals Hidden" patterns on both sides use shallow relief, with round and smooth lines, forming a contrast between hardness and softness with the fonts [8, 9]. Screen wall brick carvings often adopt a "panoramic composition". For example, the screen wall of Zhang Family Courtyard in Guoyang, northern Anhui, with the theme of "qushui liushang (a pastime of floating wine cups on a winding stream)", shows the spatial relationship between the river bank, figures and pavilions through multi-layer openwork carving. The most exquisite part is the use of hollow carving to represent the water flow, which can produce an illusion of "momentum" when viewed from different angles.

The masonry technology of brick carvings also contains wisdom. To prevent rain erosion, craftsmen will reserve "drainage grooves" on the back of brick carvings and lay a "waterproof layer" during masonry-linen soaked in tung oil to isolate moisture from the wall [10]. The "brick carving brackets" in southwestern Shandong even integrate structure and decoration. On the pendant flower door of Zhu Family Courtyard in Heze, the brick carving brackets not only bear the overhanging weight but also form a visual effect of "auspicious clouds curling" through layered and stacked carvings. The end of each arch piece is carved into a petal shape. When the sun shines, it will cast on the ground, creating an artistic conception of "lotus growing at every step".

2.2.3 Stone Carving Art

Stone carvings mostly use local limestone and granite, and are applied to the "load-bearing decoration" parts of buildings, forming a visual rhythm of "stiff below and soft above". The street paving stone carvings in the ancient city of Shangqiu adopt a "modular" design. The edge of each stone slab is carved with "female and male buttons", which is convenient for lying flat and can prevent displacement. Among them, the "street-crossing stone" at the cross street is carved with" four sacred beasts", pointing to the east, south, west and north city gates respectively, which has both marking function and symbolic significance. The "column base stone" of the building foundation has the richest carvings [11]. In eastern Henan, "drum-shaped bases" are popular, with twined branch patterns carved on the surface and "sea water and river cliffs" patterns decorated on the abdomen, implying "stable foundation"; in northern Jiangsu, "square bases" are common, with "corner beasts" carved on the four corners and "antique pictures" embossed on the front, reflecting the aesthetic preferences of different regions.

Stone railings pay attention to the "balance between safety and decoration". For the railings of the ancient buildings by Yunlong Lake in Xuzhou, the panel carving adopts the "hollow but not penetrating" technique. The surface is carved with patterns of "plum, orchid, bamboo and chrysanthemum", while a 1 cm thick stone layer is retained inside, which not only ensures a sense of transparency but also enhances the structural strength. The carvings of the baluster capitals are designed differently according to their functions: the capitals of the stair railings are mostly "spherical", which is convenient for grasping the handrail; the terrace railings are carved into "small stone lions", with a majestic shape, playing a warning role [12]. The most regional characteristic is the "hitching post" stone carvings. The hitching posts in southwestern Shandong are mostly carved into the image of "Hu people leading lions". The Hu people have deep eyes and high noses, and the lions are naive and lovely, which not only reflects the cultural exchanges on the Silk Road but also embodies the folk belief of "protecting the house from evil spirits".

2.3 Decorative Patterns with Profound Meanings

The combination of decorative patterns follows the principle of "every picture has a meaning, and every meaning is auspicious", forming a complete symbolic system. The "ruyi pattern" has different expressions in different parts [13]: the ruyi patterns on the waist boards of doors and windows are mostly combined with "copper coins" to form "ruyi brings treasure"; the two ends of the beams and brackets are often connected with "cloud patterns" to form "ruyi promotion". The application of the meander pattern is more rhythmic. In the window grilles of northern Jiangsu dwellings, the meander pattern forms a border with "continuous" broken lines, and flower patterns are inlaid in the middle, symbolizing "wealth and longevity"; in the carvings of bedding racks in southwestern Shandong, the meander pattern is processed into a "positive and negative alternating" form, implying "yin-yang harmony".

Local characteristic patterns carry historical memories. The patterns of Han Dynasty stone reliefs in Xuzhou area have been inherited by later architectural decorations. For example, the "chariots and horses traveling" picture was simplified into the "light carriage pattern" in the stone carvings of Ming Dynasty dwellings, retaining the dynamic characteristics of Han Dynasty art; the image of "Queen Mother of the West" evolved into the brick carving theme of "Magu presenting birthday", reflecting the inheritance and variation of culture. The "peony pattern" in southwestern Shandong is the most regionally recognizable. Different from the graceful peonies in Luoyang, the peony carvings here emphasize "sturdy branches and stems", and the edges of the petals are mostly carved into serrated shapes, showing the vigorous

temperament of northern flowers. They are often combined with "vases" to form the pattern of "peace and prosperity", which is particularly common in wedding room buildings [14]. The color matching of the patterns also has hidden meanings. In painted wood carvings, the five colors of "green, red, yellow, white and black "correspond to the "five elements", symbolizing the five directions of east, south, middle, west and north respectively. This color system makes the decorative patterns not only visual symbols but also a microcosmic presentation of the cosmic order.

To accurately measure the inheritance status of the symbolic meaning carried by decorative patterns, a comprehensive evaluation model can be constructed, which takes semantic similarity and pattern feature similarity as the core evaluation elements. We set up a symbol system, using S_{ij} to represent the semantic similarity between pattern i and pattern j, and F_{ij} to represent the feature similarity between these two patterns. Based on the above settings, the comprehensive inheritance degree T_{ij} between pattern i and pattern j can be determined as follows [15]:

$$T_{ij} = \alpha S_{ij} + \beta F_{ij} \tag{1}$$

where, α and β are weight coefficients that satisfy $\alpha+\beta=1$ and $\alpha, \beta \geq 0$.

When considering semantic similarity S_{ij}, a word vector model (such as Word2Vec) can be used to accurately calculate the degree of similarity between the semantics contained in the pattern. Assuming that the semantic vectors corresponding to pattern i and pattern j are $\vec{v}_i$ and $\vec{v}_j$, respectively, the following analysis can be conducted based on this:

$$S_{ij} = \frac{\vec{v}_i \cdot \vec{v}_j}{\left\|\vec{v}_i\right\|\left\|\vec{v}_j\right\|} \tag{2}$$

where, $\vec{v}_i \cdot \vec{v}_j$ represents the dot product of vectors, while $\left\|\vec{v}_i\right\|$ and $\left\|\vec{v}_j\right\|$ represent the magnitude of vectors, respectively.

For the calculation of pattern feature similarity F_{ij}, we can first carry out multi-dimensional feature extraction work on the pattern, covering key feature elements such as color, texture, and shape. Subsequently, feature matching algorithms such as SIFT, SURF, and other mature algorithms are used to accurately calculate the similarity between the extracted features. Assuming that the feature vectors obtained by processing pattern i and pattern j are $\vec{f}_i$ and $\vec{f}_j$ respectively, further related operations can be carried out on this basis:

$$F_{ij} = \frac{\vec{f}_i \cdot \vec{f}_j}{\left\|\vec{f}_i\right\|\left\|\vec{f}_j\right\|} \tag{3}$$

Based on the above data calculation model, an example of the comprehensive inheritance evaluation data for traditional decorative patterns is shown in Table 1.

Table 1: Comprehensive Inheritance Evaluation Data of Traditional Decorative Patterns

Pattern for (*i*, *j*)	Semantic similarity	Pattern feature similarity	Weight α	Weight β	Comprehensive Inheritance Degree
Pattern A & Pattern B	0. 85	0. 78	0. 6	0. 4	0. 822
Pattern C & Pattern D	0. 72	0. 85	0. 5	0. 5	0. 785
Pattern E & Pattern F	0. 90	0. 92	0. 7	0. 3	0. 906

From the data in Table 1, it can be observed that each pattern presents significantly different levels of overall inheritance. Comparing patterns, A&B with patterns C&D, the semantic similarity between patterns A&B is 0. 85, which is higher than the 0. 72 similarities between patterns C&D; However, in terms of pattern feature similarity, pattern A & pattern B's 0. 78 is lower than pattern C & pattern D's 0. 85. When the weights are set to α=0. 6, β=0. 4, and α=0. 5, β=0. 5, the comprehensive inheritance degrees of the two are 0. 822 and 0. 785, respectively. It can be seen that when the weight of semantic similarity is greater, the effect on the comprehensive inheritance degree is more prominent. Continuing to observe patterns E and F, their semantic similarity reaches 0. 90 and pattern feature similarity is 0. 92, both of which have high values. Under the conditions of weight setting α=0. 7 and β=0. 3, the comprehensive inheritance degree of this pattern pair is as high as 0. 906, ranking first among the three groups of pattern pairs. This fully demonstrates that when patterns have high similarity in both semantic and feature dimensions, the inheritance effect of their symbolic meaning is better, and further confirms that the model can scientifically and reasonably reflect the inheritance of pattern symbolic meaning.

3 Challenges Faced by Traditional Local Architectural Decoration Art under the Framework of Local Historical and Cultural Protection

3.1 Building Damage Caused by Natural and Man-made Factors

The junction area of Jiangsu, Shandong, Henan and Anhui provinces belongs to the temperate monsoon climate zone, with distinct seasons and concentrated precipitation. This climate characteristic causes continuous erosion to traditional local architectural decorations. The surface runoff formed by summer rainstorms scours along the eaves and walls of buildings, gradually expanding the gaps of brick carving patterns, and the convex parts of the reliefs peel off due to repeated wet and dry alternations; the freeze-thaw cycle in winter exacerbates the decay of wooden components, and the painted colors at the joints of beams and columns after the ice and frost melt, making the outlines of door gods, flowers and birds and other patterns gradually blurred. In the sandy soil areas around the old course of the Yellow River, the fine sand carried by spring sandstorms abrades the wood carvings of building door and window lattices, and some hollowed-out patterns have lost their original delicate forms due to years of sandstorm impact. The alluvial layers caused by the repeated changes of the Yellow River in history have also led to the settlement of some building foundations, which in turn caused wall cracks and the dislocation of the stone carving waist lines inlaid in them [17, 18].

In the process of rapid urbanization, traditional building complexes often face the paradox of "protective demolition". The Qing Dynasty dwellings around the ancient pear garden in Dangshan, northern Anhui, were relocated as a whole because of the expansion of the factory area for the development of the fruit processing industry, and the brick carving patterns of two of the houses cracked due to improper fixation during transportation. In the shantytown

renovation project outside the ancient city of Shangqiu in eastern Henan, some residents demolished the decorative components such as wood carving flower windows and stone carving door piers of the original buildings by themselves to obtain more demolition compensation, and then built simple brick-concrete structures, resulting in the loss of a large number of decorative artworks. What is more noteworthy is that the damage to architectural decorations caused by the spontaneous transformation of aborigines is hidden: the "inner raw and outer ripe" walls(inner adobe, outer blue brick)common in the junction area of Jiangsu, Shandong, Henan and Anhui provinces have been changed to all red brick structures by some residents, and the original brick carving cornerstones have been directly chiseled off; in order to improve lighting, the traditional grid windows have been replaced with large-area glass windows, making the wood carving que ti on the window lintels lose their attached carriers.

To scientifically evaluate the damage caused by natural factors to building decoration, we can start building a damage prediction model, which takes environmental parameters and decorative material characteristics as key basis. Let D represent the degree of damage to building decoration, use E to represent the vector composed of environmental parameters (including temperature, humidity, rainfall, and other elements), and use M to represent the vector formed by the characteristics of decorative materials (including hardness, toughness, corrosion resistance, and other characteristic indicators). Based on this, the following analysis can be conducted [19]:

$$D = f(E, M) \tag{4}$$

where, f is a function that can be selected as a linear function, polynomial function, or neural network depending on the actual situation.

To simplify the model, we can assume a linear relationship between the degree of damage and environmental parameters as well as the characteristics of decorative materials, namely:

$$D = \sum_{i=1}^{n} w_i E_i + \sum_{j=1}^{m} v_j M_j + b \tag{5}$$

where, ω_i and v_j are weight coefficients, b is a bias term, and n and m are the quantities of environmental parameters and decorative material characteristics, respectively.

3.2 Impact of Modern Architectural Styles

The infiltration of global architectural trends has gradually marginalized regional characteristic decorative arts. Newly-built residential communities in the junction area of Jiangsu, Shandong, Henan and Anhui provinces generally adopt a minimalist style [20, 21]. The exterior walls are mostly made of flat paint or ceramic tiles, replacing traditional stone and brick carvings; the design of unit doors emphasizes anti-theft functions, and the thick metal doors completely abandon traditional decorations such as door hairpins and door knockers. Behind this style preference is the practical consideration of building cost accounting: the labor cost of traditional brick carving per square meter is 8-10 times that of ordinary ceramic tiles, and the production cycle of wood carving lattice is more than 5 times that of modern aluminum alloy grilles. In commercial real estate development, this cost difference is more significant. Although the newly-built commercial block in Heze, southwestern Shandong, claims to be an "ancient-style building complex", it only has simple painted symbols on the cornices, and key parts such as column heads and brackets are made of precast concrete components, lacking the craftsmanship details of traditional decorations.

The innovation of building materials has also formed a substitution effect on traditional

decorative techniques. The reinforced concrete frame structure has made the traditional mortise and tenon connection technology useless, and the standardized production of prefabricated components is difficult to be compatible with the personalized expression of hand-carving [22]. For the common "hard "(a type of gable roof) dwellings in the Jiangsu, Shandong, Henan and Anhui regions, concrete is mostly used to pour the roof in modern construction, and the original ridge beast decorations are simplified into gypsum lines; the stone carving plinths used for moisture-proof in traditional buildings are replaced by moisture-proof coatings and overhead layers in modern buildings. A more profound impact lies in the change of material properties: the loose texture of traditional blue bricks is suitable for carving delicate patterns, while the high-density characteristics of modern machine-made bricks make carving tools easy to wear, leading young craftsmen to prefer alternative processes such as machine sandblasting, which makes the decorative patterns lose the texture of hand-carving.

The change in the aesthetic taste of the younger generation has exacerbated the inheritance crisis of traditional decorative arts. In interviews with people aged 20-35 in Xuzhou, Heze and Suzhou, more than 60%of the respondents believed that traditional architectural decorations are "too complicated" and "out of touch with modern life". This cognitive bias stems from changes in the growing environment [23]: young people born in the process of urbanization have mostly lived in brick-concrete houses since the 1980s in their childhood memories, and lack emotional connection with decorative arts such as brick carvings and wood carvings. The lack of regional architectural culture in school education has further led to a cognitive fault-in the local textbooks of primary and secondary schools in the border areas of Shandong, Henan and Anhui, the content involving local architectural decoration art is on average less than 3 pages, far less than that of cases such as the water towns in the south of the Yangtze River and ancient Huizhou buildings. This intergenerational inheritance has made traditional decorative techniques face the risk of "the art dying with the person". At present, among the registered inheritors of traditional architectural decoration techniques in the four provinces of Jiangsu, Shandong, Henan and Anhui, those under 50 years old account for less than 20%, and most of them are concentrated in tourist development areas.

To quantify the impact of modern architectural styles on traditional decorative arts, we can establish an evaluation model based on style feature similarity and market acceptance. If I represent the degree of influence, S represents the similarity in style features between modern architectural styles and traditional decorative arts, and A represents market acceptance, then [24]:

$$I = \gamma S + \delta A \tag{6}$$

where, γ and δ are weight coefficients that satisfy γ+δ=1, and γ, δ≥0.

For the calculation of style feature similarity S, image processing techniques such as edge detection and texture analysis can be used to accurately extract the features of architectural style. After completing feature extraction, use feature matching algorithms to calculate the similarity between different architectural styles.

For the evaluation of market acceptance, A, we can collect relevant data through methods such as questionnaire surveys and market data analysis. Assuming the number of respondents participating in the survey is k, among these k respondents, p respondents explicitly stated their acceptance of the fusion of modern architectural styles and traditional decorative arts. Based on this, further analysis can be conducted:

$$A = \frac{p}{k} \tag{7}$$

3.3 Lack of Protection Funds and Professional Talents

Insufficient local financial investment makes it difficult to form a systematic protection work. Most areas in the junction of Jiangsu, Shandong, Henan and Anhui provinces are major agricultural cities, and the local financial budget for cultural heritage protection is generally low. Take Bozhou in northern Anhui as an example, the special fund for the protection of traditional architectural decorations in the municipal finance in 2023 was only 12%of the total funds for cultural relic protection, far lower than the provincial average of 25%. This financial constraint has led to protection work mostly staying at the level of emergency rescue [25]: priority is given to structural reinforcement of buildings on the verge of collapse, while the restoration of decorative components is repeatedly delayed. For the stone carving group of Wushi Temple in Jining, southwestern Shandong, due to lack of funds, some stone carvings with serious weathering are only simply covered with plastic cloth, and professional desalination and reinforcement have not been carried out in time. The predicament of county-level finance is more prominent. The application for the restoration of the wood carving plaque of the ancient building group of Baiyun Temple in Minquan County, eastern Henan, has been shelved for three years because the local finance cannot afford the material cost of traditional gold foil decoration.

The imperfection of the social capital participation mechanism limits the sources of funds. At present, the protection of traditional buildings in this area mostly relies on government-led project-based operation, lacking a market-oriented protection model. Although some areas have tried to carry out "adoption" activities, such as the "private protection" pilot project of ancient dwellings in Hubu Mountain, Xuzhou, due to vague property rights and unclear profit distribution mechanisms, the participating social forces are mostly focused on symbolic donations, failing to form continuous investment. The disorder of the private collection market has instead exacerbated the loss of decorative components [26]. In the antique markets in the border areas of Jiangsu, Shandong, Henan and Anhui, the transaction price of stone carving door piers from the Qing Dynasty ranges from several thousand yuan to tens of thousands of yuan. This commercial interest-driven has led to the illegal demolition and sale of decorative components of some existing buildings.

The structural shortage of professional talents restricts the quality of protection and restoration. The restoration of traditional architectural decorations requires "double talents"-those who are proficient in traditional construction knowledge such as "Yingzao Fashi" (a classic book on ancient Chinese architecture) and master manual skills such as carving and painting. However, current practitioners in this field are mostly folk craftsmen, lacking systematic knowledge of architectural mechanics, and often causing "protective damage" during restoration: using modern cement to repair cracks in brick carvings, resulting in accelerated cracking of original blue bricks and repair materials due to different expansion coefficients; using chemical adhesives to paste wood carving components, which instead accelerates the aging of wood fibers. There are insufficient relevant professional settings in the higher education system [27]. There are only 2 universities in Shandong Province offering ancient architecture majors, and they focus on architectural design rather than decorative restoration; vocational training is mostly concentrated on short-term skill quick training, lacking systematic teaching on the regional decoration styles of Jiangsu, Shandong, Henan and Anhui, leading to the dislocation of "applying southern style in the north" in restored works. The lag in talent training has put the protection work in an awkward situation of "restoration is worse than no restoration". In the wood carving restoration project of Guandi Temple in Zhoukou, eastern Henan, because no local craftsmen mastering "openwork carving" skills could be found, masters had to be hired from Zhejiang. Although the restored works are exquisite in craftsmanship, they have lost the unique rough style of eastern Henan

wood carvings.

To further explore the impact of the shortage of protection funds and professional talents on the protection of traditional decorative arts, we can construct a comprehensive evaluation model, which takes the funding gap and talent gap as the core evaluation indicators. Let L represent the degree of deficiency, use F to represent the specific numerical value of the funding gap, and use T to represent the relevant situation of the talent gap. Based on this, the following evaluation system can be constructed [28]:

$$L = \epsilon F + \zeta T \tag{8}$$

where, ϵ and ζ are weight coefficients that satisfy $\epsilon+\zeta=1$, and $\epsilon, \zeta \geq 0$.

The calculation of the funding gap F can be achieved by comparing the actual investment in protection funds with the amount of funds necessary to ensure the smooth implementation of traditional decorative art protection work. Assuming that the actual amount of funds invested in the protection of traditional decorative arts is A_{fund}, and in order to achieve comprehensive and effective protection effects, the required protection funds for this field are R_{fund}, based on this, the funding gap F can be calculated as follows:

$$F = \max\left(0, R_{\text{fund}} - A_{\text{fund}}\right) \tag{9}$$

The quantitative evaluation of talent gap T can be accurately calculated by comparing the difference between the current number of professional talents and the actual demand. Assuming that the actual number of professional talents in the field of traditional decorative arts protection is N_{current}, and the number of professional talents necessary to achieve effective protection goals in this field is N_{required}, the calculation method for talent gap T can be obtained as follows [29]:

$$T = \max\left(0, N_{\text{required}} - N_{\text{current}}\right) \tag{10}$$

Assuming five representative regions (Region A, Region B, Region C, Region D, and Region E) at the border of Jiangsu, Shandong, Henan, and Anhui provinces are selected as samples, the values of their funding gap F and talent gap T will be calculated separately (simulated data will be obtained according to the previous formula). At the same time, set an ideal standard value (funding gap standard value and talent gap standard value), based on the above calculation model, the relevant simulation data is shown in Figure 1.

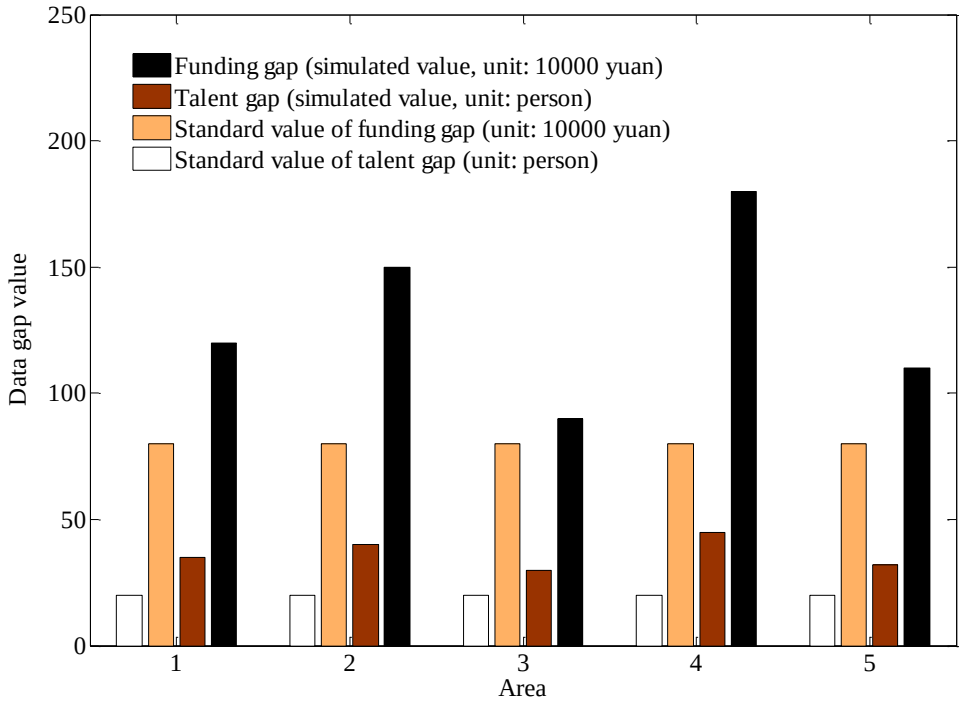

Figure 1: Comprehensive simulation evaluation model for the border area between Jiangsu, Shandong, Henan, and Anhui provinces

4 The Modern Practice Path of Traditional Vernacular Architectural Decoration Art in the Border Area of Jiangsu, Shandong, Henan and Anhui

4.1 Architectural Restoration and Reuse Based on the Principle of Authenticity

4.1.1 Formulation of Scientific Restoration Plans

The practice of the principle of authenticity must be based on systematic surveys and interdisciplinary collaboration. Professional teams should conduct hierarchical research on architectural decorations by integrating knowledge from various fields such as architectural archaeology, materials science, and craft history: determining the production age of wooden decorations through carbon-14 dating, detecting the crack distribution inside brick carvings using X-ray flaw detection, and restoring the original color gradation of paintings with the help of spectral analysis. In the restoration of ancient dwellings in Yuncheng, southwestern Shandong, the team found a copy of Yingzao Zeli(Building Regulations)preserved by the descendants of the construction craftsmen by comparing the list of construction craftsmen recorded in local chronicles. Based on this, they restored the unique blanking technique of the "Five Blessings Surrounding Longevity" brick carving in the main hall—first, the outline is lightly knocked out with a willow hammer, and then a horn knife is used to finely carve the "rounded corners" at the turning points of the patterns. The restoration of such craft details makes the restored works transition naturally with the adjacent undamaged areas.

The restoration plan also needs to establish a "reversible intervention" mechanism, using identifiable modern materials for components that must be replaced, and marking the

restoration time and craft information in hidden places. In the restoration of the Qing Dynasty opera house in Xiaoxian County, northern Anhui, for the decayed woodcarving balustrades, craftsmen adopted the" inlay and repair method": retaining the core framework of the original components and only replacing the damaged surface parts. The newly added wood needs to be buried in local soil for more than half a year to make its moisture content consistent with the old wood. Aiming at the common salt efflorescence disease in the old course of the Yellow River, a "dry-wet cycle test" is specially designed in the plan. By simulating the local three-year climate data, the number of desalination times and the concentration of the reinforcing agent on the stone carving surface are determined to avoid secondary damage to the traditional stone by modern chemical materials.

4.1.2 Exploration of Reuse Modes

Reuse design needs to balance the relationship between cultural display and functional adaptation to form a "spatial narrative" system. In the renovation of the ancient dwellings in Hubu Mountain, Xuzhou, the three courtyards are given different themes: the front yard retains the original "Shang" (business)character door brick carving and courtyard layout, serving as a regional architectural art exhibition hall; the middle yard is transformed into an intangible cultural heritage workshop, with glass display cabinets added under the original woodcarving windows to display carving tools and semi-finished products, allowing tourists to intuitively understand the process flow of"seven parts blanking, three parts finishing"; the back yard is transformed into a traditional construction technique research center, retaining the study furnishings of the original owner, and a digital projection screen is hung on the wall, which can call up the previous restoration files of the building in real time. This hierarchical utilization not only maintains the integrity of the building but also constructs a progressive cultural perception path from viewing to experiencing and then to researching.

The renovation of characteristic homestays pays more attention to "restoration of life scenes". In the quadrangle homestay in Minquan County, eastern Henan, craftsmen reproduced the traditional "diyinzi" structure (underground storage space)and transformed it into a constant-temperature wine cellar, retaining the original brick arch decoration; the woodcarving bed frame in the bedroom continues to be used after reinforcement, and adjustable modern lighting is added at the head of the bed, which neither damages the integrity of the decoration nor meets the needs of modern living. What is more innovative is the "functional grafting" mode. For example, the ancient city area of Heze transformed a Qing Dynasty bill office building into a traditional financial museum. The original "abacus pattern" brick carvings and the displayed ancient banknotes form an intertextuality. The stone carving drainage system in the courtyard is designed as an interactive device, allowing tourists to observe its "four waters returning to the hall" drainage wisdom by injecting water. This functional transformation makes architectural decorations become living cultural commentators.

4.2 Construction of a Cultural Inheritance Education System

4.2.1 Integration into School Education

At the basic education stage, it is necessary to develop a "sensory cognition" curriculum system. In the local textbook Hometown's Houses jointly compiled by Jiangsu, Shandong, Henan and Anhui, a practical course "Touching Brick Carvings" is set up: students compare the differences between the "rough lines" of the Ming Dynasty and the "dense composition" of the Qing Dynasty by rubbing samples of patterns from different periods; in the "Building a Small Tile House" handicraft class, local clay is used to make miniature bricks to experience

the traditional "one along and one ding" masonry method. A primary school in Suzhou transformed the campus wall into an "Architectural Art Corridor", where each brick replicates the typical patterns of local ancient buildings, so that children can be familiar with decorative symbols such as "meander patterns" and "ruyi patterns" during recess games.

At the higher education level, a "production, education, research and application" collaborative mechanism is established. The course "Research on Huaihai Architectural Decoration" offered by Xuzhou University of Technology adopts the "double tutor system": school teachers are responsible for teaching architectural history and theory, while folk craftsmen teach in practice workshops. Students need to complete the entire process from surveying and mapping local ancient building decorations to replicating a brick carving work. The major has cooperated with local cultural relics protection departments to establish an internship base, and students have participated in the stone carving restoration project of the Han Emperor's Ancestral Mausoleum in Fengxian County, mastering the combined application of traditional "chisel carving" techniques and modern 3D scanning technology in practice. This educational model has cultivated the first batch of compound talents who are familiar with both Yingzao Fashi (Treatise on Architectural Methods) and laser engraving machines, and some graduates have returned to their hometowns to set up traditional architectural decoration design studios.

4.2.2 Promotion of Social Education

Public cultural spaces have become important carriers for inheritance education. The "Craftsman School" established in Bozhou Museum holds monthly themed activities: in spring, it teaches "rubbing techniques", allowing participants to copy the stone carving patterns of the Flower Opera House using traditional rice paper and ink; in autumn, it offers "painting experience" where participants use mineral pigments to copy door god patterns on wooden boards following the traditional process of"one base, two colors, three clear coats". On a larger scale is the "Architectural Art Carnival". At the 2023 event held in the ancient city of Shangqiu, a "Pattern Puzzle Competition" was set up, decomposing brick carving components from different buildings into hundreds of puzzle pieces. Participants had to complete the assembly according to style characteristics. This gamified design enabled the public to quickly grasp the regional differences in decorative art in the Jiangsu-Shandong-Henan-Anhui region—for example, northern Jiangsu prefers the theme of"fish turning into dragons", while southwestern Shandong often features patterns of"kylin presenting a child".

Community education focuses on "intergenerational inheritance". The "Old Craftsmen Teaching New Apprentices" program carried out in Mudan District of Heze organizes retired carpenters to form pairs with community teenagers for teaching in renovated ancient building courtyards. Master Wang, a 72-year-old wood carving artist, has innovated a"step-by-step teaching method": first, students practice knife techniques on soap, then move on to poplar wood, and finally use paulownia wood, a local specialty. This gradual approach lowers the learning threshold. The community also regularly holds a collection of stories titled "My Old House", encouraging residents to tell the history of their own architectural decorations. Excellent works are compiled into a book and exhibited in the community library, forming a collective inheritance of "architectural memories".

4.3 Cultural Industry Development and Brand Building

4.3.1 Development of Cultural and Creative Products

Cultural and creative design needs to dig deep into the symbolic connotations and craft genes of decorative art. The "rubbing set" developed based on Xuzhou Han Dynasty stone reliefs

includes replicated original stone pattern templates, traditional mineral ink, and rubbing pads of different thicknesses. The instruction manual explains in detail the life worship implied by "Fuxi and Nuwa copulating" in the patterns. The tea set series inspired by the northern Anhui brick carving "Eight Immortals in Concealment" uses modern glaze on the inner wall of the cups, while the outer wall retains hand-carved bas-reliefs, which not only meets practical needs but also shows the craft beauty of "knife marks revealing brush intention". More innovative is the "growable" product, such as the "brick carving seed paper" developed in Heze. Traditional patterns of "abundant harvest of five grains" are carved on degradable paper pulp. After users plant it, the paper pulp turns into fertilizer and the seeds grow into plants, realizing the transformation of cultural symbols into natural life.

Industrial development focuses on "skill transformation". The wood carving workshop in Suzhou applies the traditional "openwork carving" technique to modern lamp design. The lampshade is carved from multi-layer basswood, with patterns gradually transitioning from rough outer layers to fine inner layers. When the light passes through, it creates a layered light and shadow effect. To solve the problem of low efficiency in traditional crafts, craftsmen have collaborated with universities to develop a "digital blanking" system. First, computer-generated initial patterns are created, then craftsmen perform manual finishing, shortening the production cycle by two-thirds while retaining the "knife flavor" and "wood charm". This model of "taking tradition as the foundation and modernity as the application" enables cultural and creative products to have both regional cultural recognition and meet the needs of mass production.

4.3.2 Building a Cultural Tourism Brand

The construction of a cultural tourism brand needs to build an experience system of "architectural decoration+regional life". The brand core of Suixi Shuangmo Pavilion Hotel is"living architectural culture of the Lianghuai region": room numbers adopt the replicated shape of Qing Dynasty "door hairpins"; the wall decoration in the elevator hall is made of local old bricks, with glass tubes embedded in the brick joints to display samples of building materials from different eras; the hotel regularly holds "architectural night talks" activities, inviting scholars to talk about the decorative characteristics of "merchant gang architecture" in the Lianghuai region—for example, brick carvings in Shanxi merchant courtyards mostly reflect wealth accumulation, while Huizhou merchants prefer reading themes. This cultural interpretation makes architectural decoration a key to understanding regional merchant gang culture.

Regional linkage forms a brand matrix. The four provinces of Jiangsu, Shandong, Henan, and Anhui jointly launched the "Yellow River Old Course Architectural Tour" route, connecting ancient dwellings, opera houses, guildhalls, etc. along the route, and designed a unified visual identity—based on the unique "cross pattern" brick carving in the border area of the four provinces, integrating representative decorative elements from the four regions: water patterns in northern Jiangsu, peonies in southwestern Shandong, auspicious clouds in eastern Henan, and meander patterns in northern Anhui. Attractions along the route implement a "one-ticket pass". Tourists can learn rubbing in Hubu Mountain of Xuzhou, experience brick carving in the ancient city of Shangqiu, and watch wood carving production in Heze. This immersive experience combines scattered architectural resources. In 2023, the number of visitors to this route increased by 47%year-on-year, driving the sales of surrounding traditional craft products up by 32%.

4.4 Digital Protection and Communication

4.4.1 Establishment of Digital Archives

Digital archiving requires a "multi-dimensional collection" technical system. For the common large-scale stone carving groups in the Jiangsu-Shandong-Henan-Anhui region, ground 3D laser scanners are used to record pattern details with a point cloud accuracy of 0.5mm, combined with hyperspectral cameras to capture chemical composition information of painted pigments, establishing a dual database of "form+material". For vulnerable wood carving components, "microscopic photography" technology is adopted to shoot texture characteristics of each square centimeter surface through a 4K lens, providing a basis for wood selection during restoration. In the digital project of Xuzhou Han Dynasty Stone Relief Museum, a specia l"environmental correlation" module is developed to correlate the weathering degree of stone carvings with data such as pH value and annual average humidity of surrounding soil, establishing a prediction model to early warn areas in need of protection.

The archive system needs to have a "dynamic update" function. The "digital twin" platform of ancient buildings in the ancient city area of Heze presents the previous restoration processes in a timeline: the brick carving screen wall restored in 2018 not only has photos of damage before restoration but also records the whole process video of craftsmen using traditional "glutinous rice mortar" for repair. The newly added 2023 monitoring data shows the moisture content change curve of the repaired part. The system also sets up a "craftsman knowledge base", which includes oral histories of 12 old artists. Among them, the traditional taboos such as "no wood carving on rainy days and no bricklaying on snowy days" provide a localized time selection basis for modern restoration plans. This dynamic archive forms a traceable complete chain for protection work.

4.4.2 New Media Communication Strategies

New media communication needs to design a "hierarchical content" system. The "Architectural Decoration Class" series of short videos on Douyin (TikTok) focuses on one knowledge point in each 90-second video: slow-motion shows how horn knives carve "negative lines" in brick carvings, and comparative experiments explain the differences between traditional tung oil and modern paint in wood protection. The WeChat official account launched the "Pattern Code" column to interpret the cultural connotations of decorative patterns. For example, the common "grape pattern" in southwestern Shandong architecture is not only a symbol of harvest but also implies the concept of "more children, more blessings". The article illustrations adopt the "ancient-modern contrast" form, with ancient building photos on the left and contemporary photos of mothers holding babies on the right, forming emotional resonance.

Interactive technology creates an immersive experience. The "Cloud Ancient Architecture" VR system jointly developed by Jiangsu, Shandong, Henan, and Anhui allows users to "disassemble" architectural decorations: clicking on the wood carving brackets of the opera house, the system will demonstrate the assembly process of its mortise and tenon structure; zooming in on the brick carving screen wall, users can see the knife marks left by craftsmen during carving. More innovative is the AR filter. When users scan the walls of modern buildings, traditional decorative patterns will be superimposed on the mobile phone screen. For example, when scanning the wall of their living room, users can choose to add Han Dynasty stone relief patterns from Xuzhou or peony brick carvings from Heze. The system will automatically match the proportion and angle, allowing users to intuitively feel how traditional decorations can integrate into modern life. This technical application breaks the limitations of time and space, enabling traditional architectural decoration art to enter

public daily life in a more flexible way.

5 Conclusion

The traditional vernacular architectural decoration art in the border area of Jiangsu, Shandong, Henan, and Anhui, as an important part of local historical culture, has unique artistic value and cultural connotations. Under the framework of local historical and cultural protection, this precious architectural decoration art can be effectively protected and inherited through modern practice paths such as architectural restoration and reuse based on the principle of authenticity, construction of a cultural inheritance education system, development of cultural industries and brand building, and digital protection and communication. At the same time, these practice paths will also inject new vitality into the sustainable development of local historical culture, enhance local cultural soft power, and promote the coordinated development of regional economy and culture. In the future, with the continuous improvement of society's awareness of traditional cultural protection and the continuous improvement of relevant technologies and policies, the traditional vernacular architectural decoration art in the border area of Jiangsu, Shandong, Henan, and Anhui will surely radiate new vitality in modern society.

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