

Research on Cultural Genes and Translation Design of Zhengzhou Second Grinding Wheel Factory within the Framework of Museum City Theory

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Abstract:

To advance the value inheritance and innovative development of industrial heritage, this study concentrates on extracting cultural genes from industrial heritage and exploring pathways for design translation. Using the Zhengzhou Second Grinding Wheel Factory as a case, methods including literature review and field investigation were adopted to gather pertinent data related to the Ersha Factory. Within a research framework based on cultural morphology, the cultural genes of the Ersha Factory were classified into four categories: material, behavioral, institutional, and spiritual levels. An evaluation system for these cultural genes was established using the analytic hierarchy process. Through expert assessment, various cultural factors were weighted and ranked, leading to the identification of core cultural genes possessing the highest heritage value. Simultaneously, the “Museum City Theory” is introduced to offer a theoretical basis for the Design Translation of the Core Cultural Gene at Ersha Factory, with the objective of completely preserving its distinctive cultural identity and infusing the city with renewed Cultural Vitality.

Keywords:

Cultural genes, Museum City Theory, Zhengzhou Second Grinding Wheel Factory, Translation

1. Introduction

Industrial heritage serves as a vital carrier of Urban Historical Context, and its Renovation and Reuse has emerged as a central issue in contemporary Urban Renewal. [1] Important directives have been repeatedly issued by President Xi Jinping regarding the Protection and Inheritance of Historical and Cultural Heritage. In 2023, the revised “National Industrial Heritage Management Measures” [2] promulgated by the Ministry of Industry and Information Technology further emphasized the objectives of “enhancing the management of national industrial heritage, promoting the Industrial Spirit, and strengthening China’s Industrial Soft Power”. It also

encouraged the use of resources associated with national industrial heritage to foster New Business Forms, including the development of Industrial Heritage Museums and the establishment of Characteristic Districts. This museum-driven strategy for advancing Industrial Culture offers a practical approach to the Revitalization of industrial heritage. Among the numerous National Industrial Heritage, the Zhengzhou Second Grinding Wheel Factory is recognized as a typical example of the National Key Industrial Project initiated during the First Five-Year Plan period. Its remaining Industrial Remains serve as a concrete medium for preserving and conveying Industrial Culture. Nevertheless, the current state of Protection and Utilization of industrial heritage in China remains relatively underdeveloped, leaving some sites vulnerable to damage or complete loss. In light of these policy and practical concerns, this study selects the Zhengzhou Second Abrasives Factory as a case study, with a focus on identifying its Industrial heritage cultural gene and investigating potential Design Translation Paths. The goal is to develop a comprehensive and Integrity cultural gene Inheritance Paradigm.

2. Research Overview

2.1. The Translation approach of Museum City Theory

Traditional museums mainly rely on Display means centered around exhibiting Static collections, often falling short in conveying the profound Historical and cultural connotations behind them. Consequently, while visitors may gain visual satisfaction, they frequently find it difficult to form a deep emotional bond with the exhibits. Yet, as material needs become increasingly fulfilled, the desire for fulfillment on a Spiritual Level grows more pressing. The conventional display approaches of Traditional museums no longer suffice to meet modern expectations, calling for a departure from traditional exhibition models and the adoption of innovative contemporary language in museum Display space design. The Museum City Theory, introduced by Kong Cenwei, [3] does not seek to create a walled-off “Urban design model”. Instead, it aims to transcend the Physical boundary of Traditional museums and turn the entire city into a legible Cultural carrier.

2.2. Translation Approach of Industrial Heritage Based on the Museum City Theory

Industrial Heritage is defined in the Nizhny Tagil Charter as remnants of industrial civilization with historical, social, architectural, and other values, encompassing buildings, workshops, factories, transportation facilities, and sites associated with industrial social activities. [4] The Charter constructs a three-dimensional value system for Industrial Heritage, comprising physical remains, institutional heritage, and spiritual heritage. Together, these three dimensions form a comprehensive map of industrial civilization’s evolution. [5] However, current conservation and renovation practices often deviate from this value framework, resulting in a narrow and simplistic approach that fails to fully preserve or express the integrated value system. Some Industrial Heritage sites lie abandoned, turning into urban “gray spaces.” Worse still, in pursuit of short-term economic gains, some projects recklessly demolish original structures and distinctive features, transforming these sites into homogenized internet-famous check-in spots. Therefore, the translation strategy should transcend the Physical boundary and functional constraints of Traditional museum, moving the emphasis of preservation and exhibition away from building an isolated industrial-

themed museum. Instead, it ought to regard the complete landscape of Industrial Heritage as the ultimate “exhibit.”

2.3. Translation Approach of Industrial Heritage Cultural Gene Based on Museum City Theory

The concept of cultural gene derives from gene theory in biology. Rather than a tangible entity, it is conveyed through various symbolic forms such as signs, architectural styles, and collective memory, functioning as a fundamental unit of cultural transmission and evolution. Industrial heritage represents both a distinctive landscape type in post-industrial society and a medium for the integration and coexistence of diverse cultural genes. [6] However, scholars like Xu Yongjun [7] have observed that industrial heritage protection and development in China often overlook deeper cultural cognition and interpretation, leading to projects that lack a cultural core. In response, this study conducts an in-depth exploration of industrial heritage cultural gene and facilitates its translation guided by the Museum City Theory. This approach enables physical space to serve as a vehicle of cultural expression, allowing endangered cultural genes to persist in renewed forms.

3. Research Design

3.1. Overview of the Research Site

This study focuses on the Ersha Factory as the research subject. The Former Site of Zhengzhou Second Grinding Wheel Factory is situated at No. 78 Huashan Road, Zhongyuan District, Zhengzhou City, and was founded in 1956. In October 2019, the former site of Ersha Factory was designated as part of the eighth batch of Major Historical and Cultural Site Protected at the National Level. It features the largest Bauhaus Building Complex in Asia, comprising six Production Workshops, two Auxiliary Workshops, and two Power Workshops. These structures are interconnected via Overhead Corridors, creating a layout that is both independent and integrated. The surviving Industrial Heritage on the site collectively illustrates the developmental history of Ersha Factory. As a distinctive urban landmark embodying Zhengzhou’s historical and cultural legacy, the preservation and revitalization of Ersha Factory are both meaningful and feasible.

3.2. Data Sources

Research data were mainly collected through two methods: (1) literature review, which involved gathering and analyzing research publications, factory archives, and available online resources related to Ersha Factory, (2) field surveys and expert interviews, supplemented by questionnaires and expert-based assessments to carry out Field Investigation at Ersha Factory. In-depth conversations were also conducted with retired workers from Ersha Factory to retrieve historical details from eyewitness perspectives, thus enhancing the comprehensiveness and reliability of the information.

3.3. Research Process

The research process consists of five stages: collection and organization of Ersha Factory data, extraction and classification of cultural genes, construction of the Cultural Gene Evaluation Model Tree, Cultural Gene Evaluation and Factor Screening, and Idea of Cultural Gene Translation. The detailed workflow is presented in Figure 1.

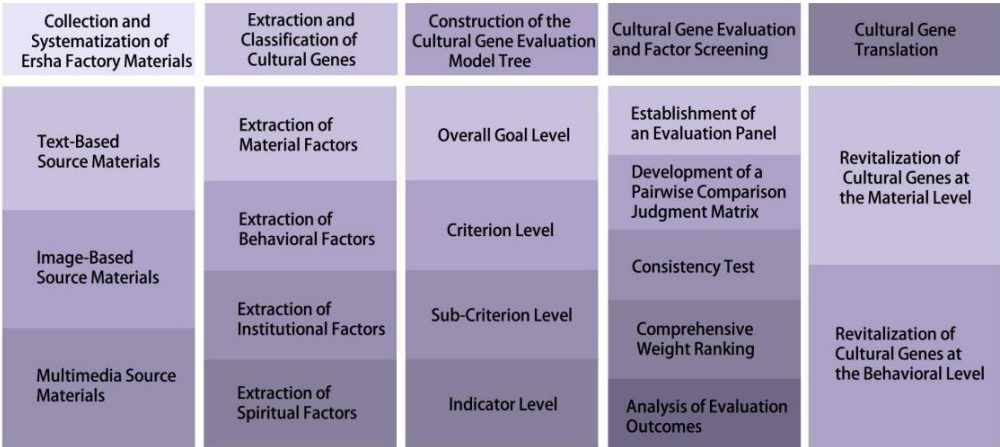


Figure 1. Study Flowchart.

4. Extraction and Classification of Ersha Factory Cultural Gene

The Cultural Gene of the Ersha Factory were extracted using the classification framework of Cultural Morphology theory and initially grouped into four categories: material, behavioral, institutional, and spiritual.

4.1. Material Cultural Factor

Material Cultural Gene at the Ersha Factory were classified into three broad types: natural environment, fixed carriers, and mobile carriers. The natural environment is exemplified by the preserved plane trees. Fixed carriers are dominated by Bauhaus-style architecture, featuring distinctive arched sawtooth roofs and red-brick exterior walls. Additional structures such as water towers and chimneys were also identified as key elements for genetic extraction. Mobile carriers consist of various physical artifacts that embody the historical memory of the factory site.

4.2. Behavioral Cultural Factor

The extraction of behavioral Cultural Gene is based on official behavioral-level documents recorded in the Ersha Factory Annals. At this level, the Cultural Genesystem can be divided into four main categories: daily life activities, production activities, educational activities, and festival and folk customs activities. Among these, daily life and production activities form the core carriers of behavioral Cultural Gene. Specifically, employees revolved their living and working lives around the “work-unit compound,” following a dual structure of collectivized living and collaborative production. In terms of daily life, staff participated in various cultural and sports activities, while also engaging actively in broader social practices, fostering a closely-integrated communal living environment. On the production side, the collective collaboration model was evident not only in routine tasks but was also reinforced through the distinctive “master-apprentice inheritance” system. All employees adhered rigorously to standardized production procedures and safety protocols, and the enterprise implemented well-defined production management regulations. At the level of educational activities, political and ideological education programs are conducted by the factory, along with safety production training and military preparedness exercises. During traditional festivals, employees and their families gather within the “work unit compound” to take part in various celebrations.

Meanwhile, production-related ceremonial events are also organized to strengthen collective spirit in a cheerful and engaging atmosphere.

4.3. Institutional Cultural Factor

In the extraction of institutional Cultural Gene, the institutional Cultural Gene of Ersha Factory is classified into two major categories: local institutions and factory-site institutions. At the local level, the factory strictly adhered to regulations under the planned economy system, reflecting the economic approach of state-owned enterprises to “concentrate resources on major undertakings.” Full compliance with societal institutions was maintained, covering essential areas such as employee salaries, welfare, and social insurance, which helped create a stable environment for corporate development. On the factory-site level, well-defined production standards were implemented to ensure efficient, orderly, and safe operational processes. Regarding quality of life for workers, a comprehensive welfare system was established, including housing allocation and medical care policies, underscoring the factory’s commitment to employee well-being.

4.4. Spiritual Cultural Factor

The spiritual and cultural aspect of Ersha Factory can be divided into two main categories: corporate cultural spirit and historical memory. At the heart of its corporate ethos lies collectivism, which is vividly embodied in the mutual-aid daily practices of the workforce, forming a cohesive spiritual foundation throughout the factory. Within specific production contexts, this spiritual culture takes tangible form: quality inspectors meticulously examine glass products with magnifying glasses, demonstrating a rigorous dedication to craftsmanship. Moreover, employees consistently strive for progress rather than settling for current accomplishments. Guided by an innovative mindset, they actively pursue new production methods and seek improvements in manufacturing equipment. On the other hand, as a vital element of spiritual culture, historical memory preserves valuable traces of the factory’s evolution. The remarkable contributions of historical figures associated with the factory are commemorated and perpetuated, forming vivid symbolic representations within this collective memory. Together with the ethos of corporate culture, these elements constitute a comprehensive and profound spiritual and cultural framework of the Ersha Factory.

5. Ersha Factory Cultural Gene Evaluation Model Tree and Importance Evaluation

5.1. Design of Cultural Gene Evaluation System

The Analytic Hierarchy Process is a multi-criteria decision-making approach that breaks down complex issues into a hierarchy of factors. [8] To identify the most representative cultural genes with significant Heritage Value from Ersha Factory, an AHP model is constructed based on the cultural genes previously identified. A subjective evaluation matrix is then developed, in which decision-makers assign quantitative scores according to their expert judgment of relative importance. The weight of each factor is calculated, and a consistency check is performed to ensure the reliability of the results. Once the model passes this validation, the cultural genes are ranked based on Weight Ranking, offering clear and targeted support for Translation Design. [9] The detailed procedure is illustrated in Figure 2.

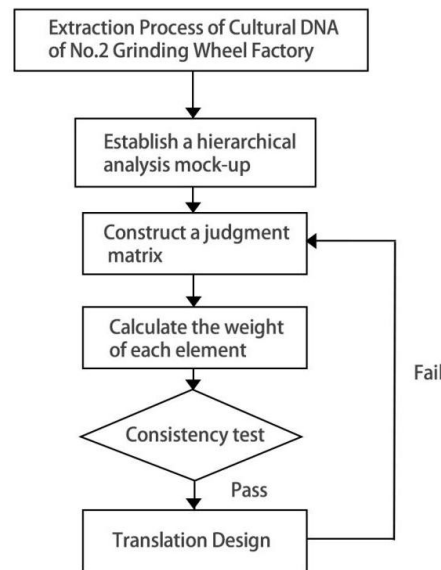


Figure 2. Process of Cultural Gene Selection and Analysis at Ersha Factory.

5.2. Construction of Ersha Factory Cultural Gene Evaluation Model Tree

A model tree framework was first established, consisting of four hierarchical levels: the Overall Objective layer, the Standard layer, the Sub-criterion layer, and the Indicator layer. Each level was then assigned a specific code: A for the Objective layer, B for the Standard layer, C for the Sub-criterion layer, and D for the Indicator layer. The cultural gene evaluation system A of Zhengzhou Second Grinding Wheel Factory was designated as the Overall Objective layer A. Material gene B1, behavioral gene B2, institutional gene B3, and spiritual gene B4 were identified as the comprehensive evaluation layer B. The Sub-criterion layer C included natural environment C1, fixed carriers C2, mobile carriers C3, daily activity behaviors C4, production activity behaviors C5, educational activity behaviors C6, festival and folk activities C7, local institutions C8, factory institutions C9, corporate cultural spirit C10, and historical memory C11. Finally, the 38 cultural gene elements corresponding to the Indicator layer were encoded as gene node D. A four-tiered Cultural Gene Evaluation Model Tree is constructed, in which each level remains independent and self-contained while being interrelated with the others. [10] (Figure 3).

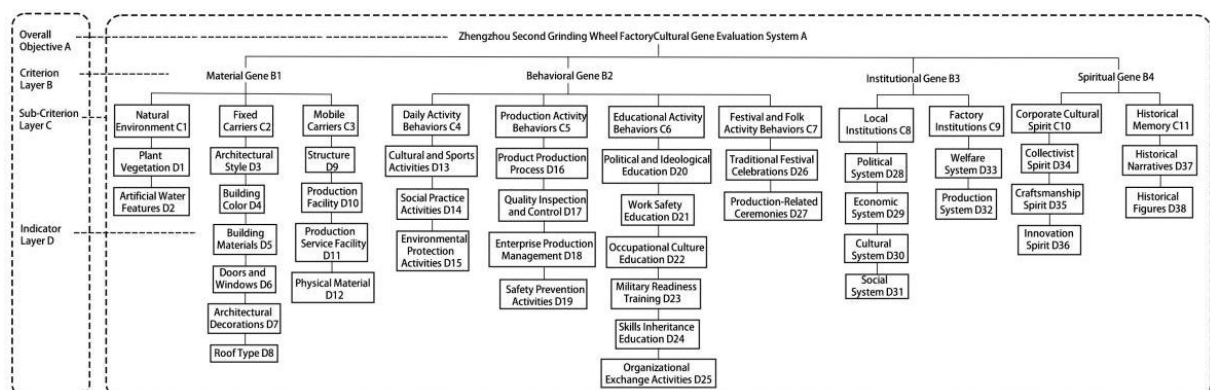


Figure 3. Ersha Factory Cultural Gene Evaluation Model Tree.

5.3. Evaluation of Meme Factor Importance

5.3.1. Formation of the Evaluation Panel

To mitigate subjective bias in the decision-making process, an evaluation panel was formed comprising five postgraduate students specializing in environmental design and five professional teachers. The panel was tasked with scoring the importance of each indicator of the Ersha Factory cultural genes.

5.3.2. Construction of Pairwise Comparison Judgment Matrices

Following the establishment of the evaluation panel, each evaluator performed pairwise comparisons of factors within the same level according to the four-tier structure of the Ersha Factory Cultural Gene Evaluation Model Tree. Quantitative ratings based on the 1–9 scale were used to assess the relative importance of the factors. The scores provided by each evaluator were collected, and the average value for each dataset was computed. Judgment matrices reflecting the importance of cultural genes at each level were then developed using these averaged scores.

5.3.3. Consistency Test and Comprehensive Weight Ranking

Consistency tests were conducted for all constructed judgment matrices using the SPSSAU platform, with the consistency ratio (CR) value computed for each matrix. A CR value less than 0.1 indicates that the judgment matrix passes the consistency test and can be used for subsequent weight calculation. If CR is greater than or equal to 0.1, the evaluator's scoring data must be revised, and the judgment matrix reconstructed and rechecked until compliance is achieved, thereby minimizing the impact of subjective bias. Based on the matrices that satisfy the consistency criteria, single-layer weight tables for factors at each hierarchical level were generated. A hierarchical weighting approach was then applied to determine comprehensive weights: first for Level C factors, followed by Level D factors. Finally, all Level D factors were ranked in descending order of their comprehensive weights to complete the importance assessment of cultural gene factors for Ersha Factory, thereby providing data support for the selection of Core Cultural Gene.

5.3.4. Analysis of Quantitative Evaluation Results

Based on the evaluation procedure described above, the results of the Ersha Factory Cultural Gene evaluation system were compiled into a summary table (see Table 1). Within the comprehensive evaluation layer B, the order of importance was found to be $B1 > B2 > B4 > B3$, suggesting that material Cultural Gene is given priority during the translation process.

Table 1. Summary of Weighting Coefficients for Evaluation Indicators of Ersha Factory Cultural Gene.

Overall Objective A	Criterion Layer B	Sub-Criterion Layer C
Zhengzhou Second Grinding Wheel Factory Cultural Gene Evaluation System A	Material Gene B1 (0.3502)	Natural Environment C1 (0.0598)
		Fixed Carriers C2 (0.1703)
		Mobile Carriers C3 (0.1201)
	Behavioral Gene B2 (0.3498)	Daily Activity Behaviors C4 (0.0924)
		Production Activity Behaviors C5 (0.0924)
		Educational Activity Behaviors C6 (0.0413)
		Festival and Folk Activity Behaviors C7 (0.0182)
	Institutional Gene B3 (0.0999)	Local Institutions C8 (0.0833)
		Factory Institutions C9 (0.0166)
	Spiritual Gene B4 (0.2001)	Corporate Cultural Spirit C10 (0.1751)
		Historical Memory C11 (0.0250)

6. Cultural Gene Translation Strategy

6.1. Core Translation Concept

Extraction of the Cultural Gene from the Zhengzhou Second Grinding Wheel Factory indicates that material genes and behavioral genes constitute the core Cultural carrier. Accordingly, the design strategy emphasizes the Revitalization translation of these genetic elements. Given that the conventional “exhibition of artifacts within museum walls” model of Traditional museums falls short in conveying the “spatial integrity” and “genetic continuity” of Industrial Remains, the core idea of “museum blockization” derived from the Museum City Theory is incorporated. This method involves identifying physical entities and behavioral contexts within the factory zone that exhibit “museum qualities,” thereby establishing a pan-museum system structured “by block units and guided by genetic narrative.” The overall landscape of the Industrial Remains is treated as the most essential and comprehensive “living exhibit,” embodying the principle that “the factory itself is the museum.”

6.2. Revitalization of Material-Level Cultural Gene

The revitalization of material Cultural Gene follows a progressive framework centered on “conservation–narrative–experience.” Authentic preservation of the Industrial Heritage serves as the foundation, where core industrial components—such as the steel trusses of the main workshop and sawtooth roofs—are repaired using traditional craftsmanship while preserving traces of time. Auxiliary structures are restored with contemporary materials, creating a visual contrast that highlights historical layers and establishes a dialogue between old and new.

The site’s natural vegetation forms an ecological base, with native landscapes like plane tree avenues and cedar forests retained to establish a green memory corridor connecting various zones. Fixed carriers, including Bauhaus-style factory buildings, are repurposed into thematic sections. A grinding wheel production history zone is arranged along the physical route from the raw material entrance through the Production Workshop to the finished product warehouse. Key equipment is exhibited, and production processes—such as abrasive mining, wheel forming, and heat treatment—are recreated to reconstruct historical scenes.

Inside the main workshop, grinding machines and kilns are displayed in their original positions, complemented by directional audio devices that activate simulated operational sounds when approached. Holographic projections recreate collaborative labor scenes from the 1960s, resulting in an immersive narrative that integrates artifact exhibition and situational restoration. Production facilities and everyday objects, serving as mobile carriers, are incorporated into their respective functional zones based on specific scenarios. This integration allows the natural environment, along with both stationary and mobile elements, to collectively create a seamless museum space without boundaries.

6.3. Behavioral-Level Cultural Gene Revitalization

In the revitalization of behavioral Cultural Gene, the approach guided by the Museum City Theory—“using urban districts as carriers to activate cultural interactions”—is adopted. The behavioral memories of Ersha Factory are used as a narrative thread to transform different zones into revitalized fields of collective memory. In the “production activity zone,” the original workshop space has been

repurposed into an “industrial labor practice workshop.” Labor competition scenes are recreated, allowing visitors to wear historical workwear and operate vintage machinery, thereby immersing them in the collective collaborative production behaviors of the past. Simultaneously, a “neighborhood memory theater” has been developed within the “daily life activity zone.” The former staff canteen is converted into the “1956 Time Restaurant,” where the original brick-wood structure and checkered windows are preserved. Nostalgic meals, such as stew served in enamel basins, are offered to evoke sensory memories. Additionally, residential units have been restored as an “Industrial Neighborhood Museum,” depicting typical 1970s dual-income family settings. Artifacts such as food coupons, work uniforms, and enamel mugs are displayed. Visitors can activate dedicated audio narratives by touching these objects, reconstructing vivid everyday interactions. Collective scenes—such as master-apprentice training and holiday dumpling-making—are also replayed on digital screens, establishing a multisensory memory resonance through visual, auditory, and tactile channels. These efforts work together to reinforce the collectivist ethos intrinsic to the industrial era.

7. Conclusions

This study systematically deconstructs the four key dimensions constituting the cultural genes of Ersha Factory. Based on this, a Cultural Gene Evaluation System for Ersha Factory was established using the AHPAnalytic Hierarchy Process, through which the most preservable Core Cultural Gene with significant Heritage Value was identified. It was found that material and behavioral genes serve as crucial carriers of the core Industrial Culture of Ersha Factory. Thus, the research further concentrates on translating these two genetic types. By adopting the “museum block” display approach derived from museum city theory, the cultural genes of Ersha Factory were reinterpreted. This strategy not only systematically maintains the authenticity of its Industrial Heritage, but also—through immersive environmental design and public engagement mechanisms—transforms Ersha Factory from a confined historical relic into an active center for cultural exchange, fostering the sustained evolution of Industrial Culture within the modern urban context.

Conflicts of Interest

The author declares that there is no conflict of interest regarding the publication of this article.

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