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Explicit-implicit symbiosis: narrative logic of urban industrial heritage landscapes

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Abstract: As a material carrier of industrial civilization and collective memory, industrial heritage constitutes an important component of human cultural heritage and a key object for maintaining urban context and reconstructing social identity. The protection and regeneration of urban industrial heritage landscapes contain dual narrative paradigms of the explicit and the implicit. Explicit narrative is centered on material preservation, symbolic translation, temporal-spatial layering, and identity recognition, emphasizing the physical continuity of industrial heritage and the reconstruction of spatial functions. Implicit narrative focuses on memory excavation, emotional coding, technical inheritance, and spiritual transformation, revealing the cultural genes and collective spirit embedded in industrial heritage. On this basis, this paper constructs a three-dimensional symbiotic logic model of "space-time-subject". Taking Taoxichuan in Jingdezhen as an empirical case, the study examines the feasibility of the explicit-implicit symbiotic narrative paradigm and provides a theoretical perspective and practical path for the protection and activation of urban industrial heritage landscapes.

Keywords: industrial heritage; explicit narrative; implicit narrative; explicit-implicit symbiosis; Taoxichuan

1. Introduction

Urban industrial heritage, as a material carrier of industrial civilization and collective memory, concerns not only the continuity of physical space, but also the continuation of urban context and the reconstruction of social identity. Although existing studies have made progress in exploring multidimensional values [1], dynamic protection strategies [2,3], and interdisciplinary methods [4,5], they have not yet effectively resolved the separation between explicit material remains and implicit cultural genes. For example, in some industrial site regeneration projects in China, only the shells of factory buildings are retained while production scenes are removed; in other cases, excessive commercial functions are introduced while the memories of worker communities are neglected. These tendencies

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lead to a "narrative rupture" between material space and cultural connotation, thereby weakening the cultural identity value of heritage.

How to use landscape narrative logic to address the symbiotic problem between material continuity and cultural regeneration has become an important issue in current research. Landscape narrative theory transforms the historical memory and cultural value of a place into a perceptible multidimensional narrative system through symbolic design, temporal-spatial sequencing, and the integration of multiple media. Research on industrial heritage regeneration and urban park transformation [6–9] shows that landscape narrative can effectively bridge the separation between explicit and implicit elements by constructing emotional connections among people, place, and memory, thus offering a systematic solution that balances conservation and innovation.

Accordingly, this paper proposes an "explicit-implicit symbiosis" narrative framework for urban industrial heritage landscapes. By constructing the logic of explicit narrative, implicit narrative, and their symbiotic relationship, this study aims to establish a model integrating the "authentic continuity" and "dynamic regeneration" of urban industrial heritage. The feasibility of this framework is examined through an empirical case study of Taoxichuan in Jingdezhen, so as to provide a transferable theoretical reference and practical paradigm for heritage activation in the context of urban renewal.

2. Connotation and theoretical framework of explicit-implicit symbiosis

2.1. Connotation

In the context of urban industrial heritage, "explicit-implicit symbiosis" refers to the mutually constitutive relationship between explicit material remains and implicit cultural genes. The former provides the material carrier for the continuity of the latter, while the latter endows the former with historical meaning and social value. This relationship echoes the symbiotic metaphor in Xunzi's Encouragement of Learning: "When jade lies in the mountain, the grass and trees are moist; when pearls are born in the abyss, the cliffs do not wither" [10]. Here, the "moist grass and trees" and "unwithering cliffs" serve as metaphors for the explicit elements of urban industrial heritage, including factory structures, machinery, transportation tracks, spatial scales, circulation features, and material textures. The protection of these elements shall follow the authenticity principle of the Venice Charter and the integrity requirement of the Nizhny Tagil Charter [11].

For example, in the regeneration of Guangzhou Redtory, sawtooth roofs and iron sheet walls were retained as industrial symbols, while steel-structure reinforcement and creative office functions were introduced. This approach preserves authenticity while extending industrial aesthetics, embodying the principle of "repairing the old as old and revitalizing it through adaptive use".

By contrast, "jade" and "pearls" symbolize implicit cultural genes, including the collective memory of workers, the social significance of industrialization, and the spiritual symbolism of technological innovation. The regeneration of implicit elements should be based on oral history collection and industrial archival interpretation, and realize cultural translation through the scenographic narrative of "sites of memory". The redevelopment of the Workers' Village in Tiexi District, Shenyang, follows this path: by reconstructing workers' domestic scenes and inviting former workers to conduct guided tours, "forgotten workshop memories" are transformed into perceptible cultural capital.

The essence of explicit-implicit symbiosis is not simple superposition, but a dynamic balance achieved through the temporal-spatial overlay strategies of landscape narrative. Beijing Shougang Park provides a representative example. It preserves the authenticity of industrial structures while embedding VR technology into Winter Olympic venues to recreate the scene of the first furnace of molten steel. Through the composite narrative of "industrial site + digital creativity", a former production field is transformed into a cultural landmark carrying urban collective memory. This symbiotic mechanism avoids the functional rigidity caused by static preservation and mitigates the erosion of historical information by excessive commercialization, thus opening up a path that combines theoretical guidance with practical innovation.

2.2. Theoretical framework

The theoretical framework of this study integrates landscape narratology, semiotics, genius loci, and the theory of sites of memory. It is organized around three interrelated analytical processes: spatial construction, symbolic translation, and memory reconstruction. As shown in Figure 1, these processes explain how industrial heritage landscapes evolve from material continuity to symbolic regeneration and memory reconstruction.

Spatial construction focuses on temporal-spatial organization and provides a spatial grammar for the explicit material continuity of industrial heritage. For instance, the Ruhr industrial region in Germany uses railway tracks and pipelines as linear paths to connect coal mines and steel plants, forming a "narrative skeleton" that guides visitors to perceive the spatial logic of the industrial age [12]. Beijing 798 Art District juxtaposes mottled walls with contemporary art exhibitions, producing a sense of temporal disjunction between the past and the present and stimulating historical reflection [13]. In this process, visitors act as readers or participants who decode implicit culture through immersive experience and gradually transform spatial perception into cultural internalization.

Symbolic translation relies on Peirce's triadic theory of signs to promote the regeneration of implicit value. Iconic signs directly reproduce industrial prototypes, indexical signs trigger causal associations, and symbolic signs endow industrial remains with abstract meanings. In Shougang Park, for example, cooling towers and other physical remnants carry industrial history; rusted pipelines imply production processes; and industrial relics combined with the Winter Olympic symbol construct a cross-era narrative of "industry–sports" [14]. The composite coding of old and new signs transcends temporal boundaries and activates the transgenerational translation of cultural memory.

Memory reconstruction is grounded in the theories of genius loci and sites of memory [15-16]. Genius loci emphasizes the symbiosis of materiality and spirituality, requiring industrial remains to retain authenticity while reconstructing the atmosphere of place and stimulating people's sense of orientation, identity, and belonging. The theory of sites of memory resists forgetting through physical carriers and realizes cultural regeneration through symbolic signs and dynamic mechanisms. Together, these theories support the practical process of "authenticity protection–symbolic regeneration–dynamic memory balance" and provide a theoretical basis for the transformation of urban industrial heritage from historical survival to contemporary regeneration.

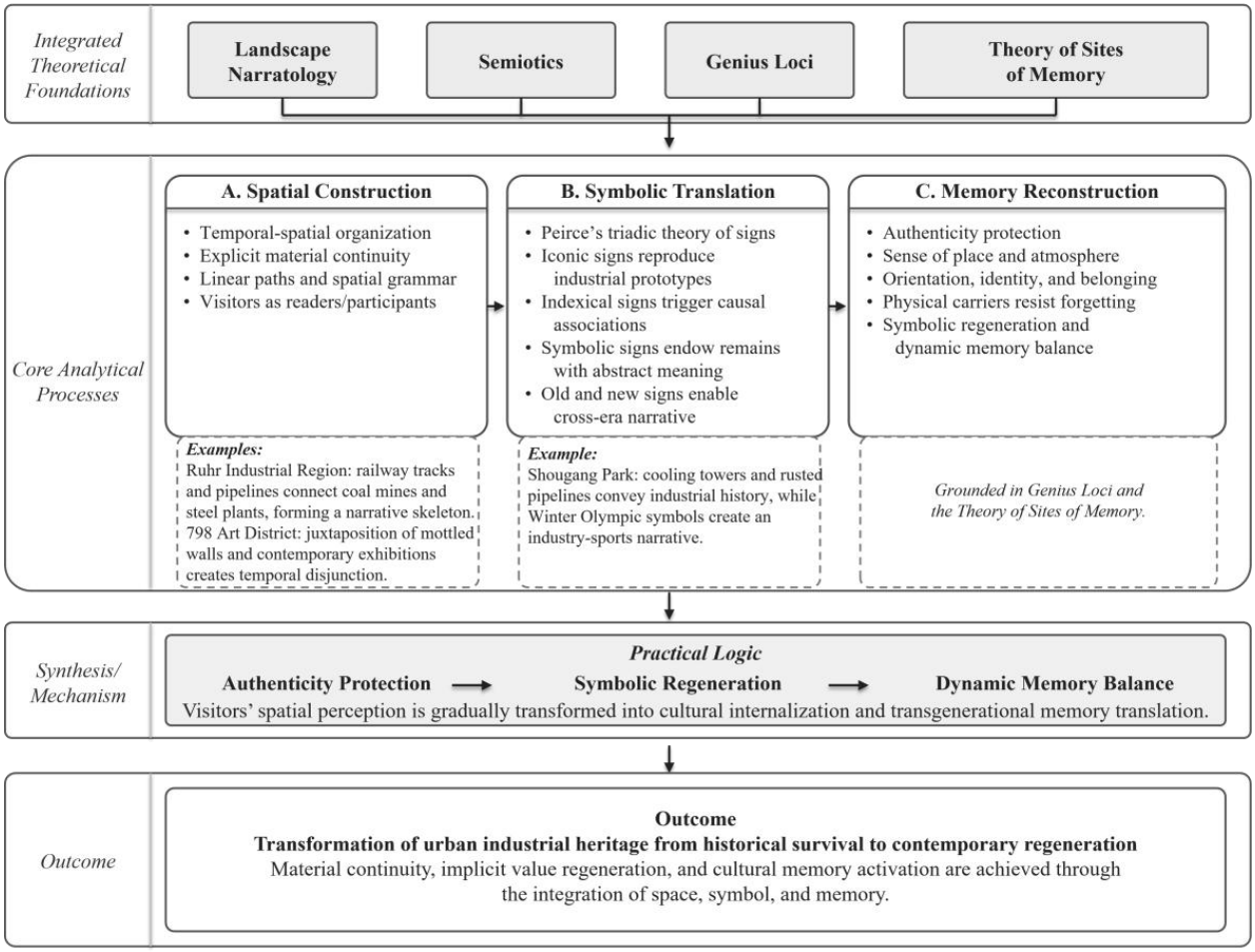


Figure 1. Theoretical framework of industrial heritage landscape regeneration.

3. Explicit narrative logic of urban industrial heritage

The logic of explicit narrative expression serves as the core link through which material space is transformed into cultural meaning. Following the progressive axis of "material preservation–symbolic translation–temporal-spatial layering–identity recognition," silent industrial remains are transformed into readable cultural texts. Material preservation provides the physical basis for symbolic translation; symbolic translation then stimulates identity recognition through temporal-spatial layering, forming a complete chain of materiality, culture, and meaning. As shown in Figure 2, the explicit narrative logic of urban industrial heritage can be understood as a progressive process that moves from the preservation of material carriers to the construction of collective identity through symbolic and spatio-temporal mediation.

3.1. Material preservation

Material preservation is the physical foundation of explicit narrative. Based on Kevin Lynch's urban image theory of "landmarks–paths–nodes" [17], urban industrial heritage reconstructs spatial grammar through structural retention, trace translation, and scale control. First, structural retention uses iconic industrial structures as landmarks and establishes narrative authenticity through the visual impact of original forms. In the Ruhr region, a 117-meter-high gas holder was preserved as a core landmark. Its

rusted steel shell was retained, while the interior was transformed into a cultural exhibition space. Multimedia technology further turned the huge inner wall into a dynamic industrial chronicle, coupling visual shock with historical layering.

Second, trace translation converts infrastructure into paths that guide cognitive rhythm and strengthen narrative continuity. Shanghai Yangpu Riverside provides a representative example: the crane tracks at the former Xiangtai timber yard were transformed into an "industrial heritage corridor." By preserving the texture of tracks and embedding a pedestrian system, the project created a narrative axis connecting wharves, warehouses, and water towers [18]. Third, scale control creates immersive nodes through superhuman-scale structures and stimulates bodily resonance. In Beijing Shougang Park, the 70-meter-high No. 3 blast furnace was preserved, while a glass viewing platform was added to the top. The juxtaposition of glass and rusted steel evokes a temporal dialogue between industrial epic and

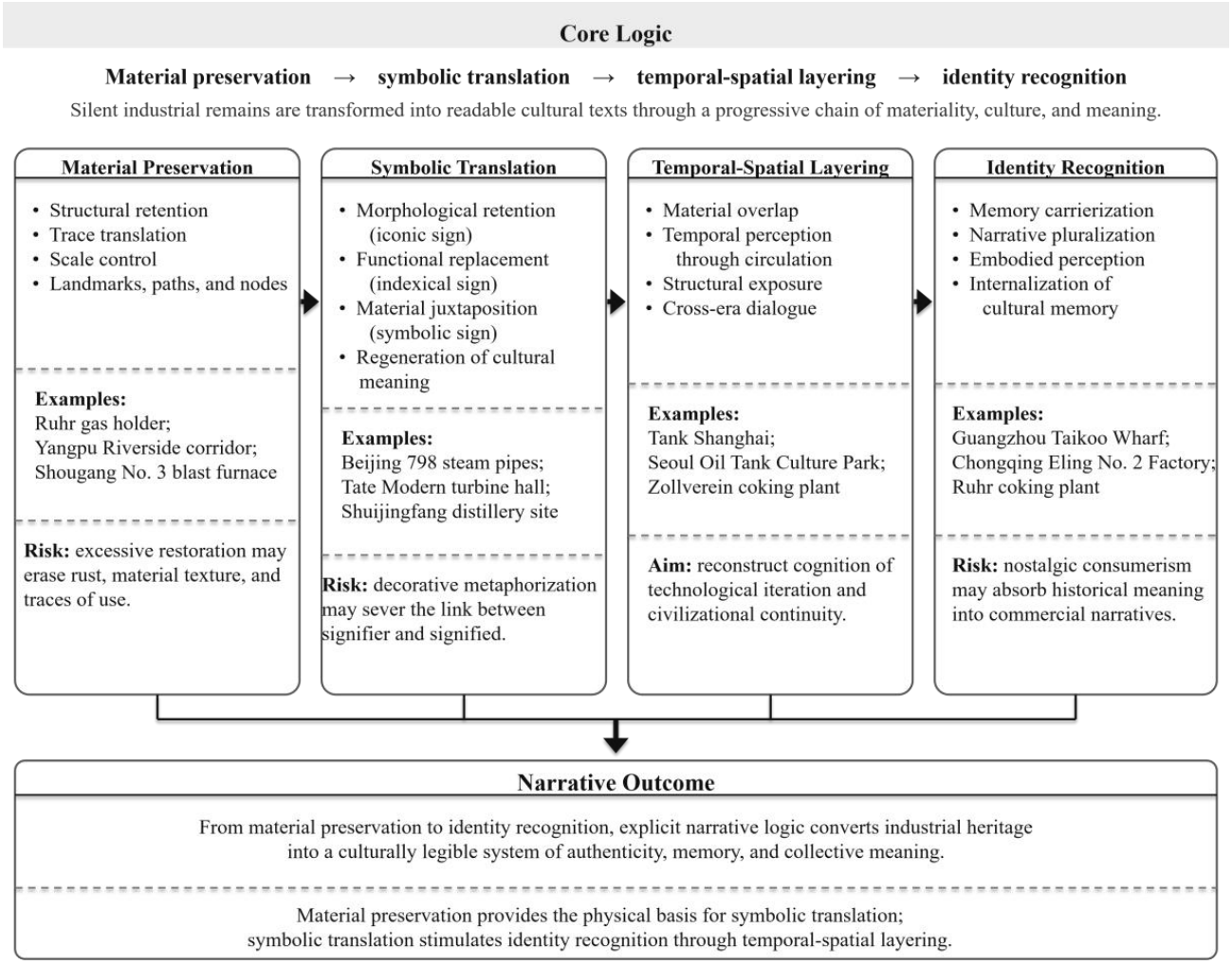


Figure 2. Explicit narrative logic of urban industrial heritage.

digital future [19]. However, material preservation should guard against static conservation. Excessive restoration may erase rust, original material textures, and traces of use, thereby weakening historical authenticity.

3.2. Symbolic translation

Symbolic translation is the key mechanism for cultural meaning generation. Peirce's triadic semiotics provides a stepwise strategy for the regeneration of industrial remains: morphological retention, functional replacement, and material juxtaposition. Morphological retention operates as an iconic sign and directly evokes historical memory and technical imagery through the authenticity of components. For example, the steam pipes in Beijing 798 Art District, with their metallic texture and curved forms, map technical memory as iconic signs. Functional replacement reconstructs causal relationships and works as an indexical sign. The Tate Modern in London transformed the turbine hall of a power station into an art space, juxtaposing crane rails with exhibition functions and thus forming an indexical relationship between production history and the artistic present.

Material juxtaposition further overlays cultural meaning through contrast or fusion between old and new elements, elevating industrial remains into symbolic signs of collective identity. The Shuijingfang distillery site in Chengdu, for instance, uses the juxtaposition of blue bricks and recycled concrete to imply the continuity of brewing techniques across time. At the same time, symbolic translation must avoid excessive metaphorization. When pipes, gears, and other components are detached from their production context and turned into purely decorative sculptures, the semiotic link between signifier and signified is broken, and industrial heritage risks becoming a consumer-oriented visual spectacle.

3.3. Temporal-spatial layering

Temporal-spatial layering constructs cross-era dialogue through material overlap, temporal perception, and structural exposure. Material overlap makes technological iteration visible and tangible through the juxtaposition of old and new materials. The Tank Shanghai Art Center retained the original concrete shells of oil tanks while adding weathering steel plates and glass curtain walls, creating visual tension between industrial remnants and ecological regeneration. Temporal perception can be created through circulation design. The Oil Tank Culture Park in Seoul inserted spiral steel staircases into abandoned oil tanks. Rusted traces at the bottom, exposed steel structures in the middle, and an urban panorama at the top form a diachronic transition from past to present and future. Structural exposure reveals the historical cross-section of technological evolution. In the Ruhr Zollverein coking plant, exposed brick layers, concrete repairs, and steel reinforcements form "industrial growth rings," demonstrating the growth of industrial civilization. The essence of temporal-spatial layering is to reconstruct people's cognition of history through spatial design, enabling visitors to decode both technological iteration and civilizational continuity during movement.

3.4 Identity recognition

The ultimate purpose of identity recognition is the internalization of cultural memory. It resists the dominance of single narratives through memory carriers, narrative pluralization, and embodied perception. Memory carrierization transforms implicit technical knowledge into readable texts. At Guangzhou Taikoo Wharf, red-brick walls were restored *in situ*, and historical photographs and technical diagrams were inserted into historic buildings, translating technical knowledge of the wharf into a mixed-media carrier. Narrative pluralization breaks the monopoly of official narratives through

community participation. In Chongqing Eling No. 2 Factory, community graffiti reconstructs unofficial memories of factory life and transforms individual experiences into emotional signs of collective identity[20].Finally, embodied perception relies on spatial grammar and bodily experience. In the Ruhr coking plant, chimneys, conveyors, cooling towers, and rusted rivets activate sensory memory and strengthen the spiritual anchoring of industrial civilization. Nevertheless, identity construction must resist nostalgic consumerism: when industrial memory is simplified into retro cafés and cultural markets, historical meaning may be absorbed by commercial narratives.

4. Implicit narrative logic of urban industrial heritage

Implicit narrative logic is grounded in Pierre Nora's theory of sites of memory. Following the progressive axis of "memory excavation–emotional coding–technical inheritance–spiritual transformation," it addresses the invisibility of implicit culture and realizes the transformation from historical genes to cultural meaning. As shown in Figure 3, implicit narrative logic operates through four interrelated processes: memory excavation, emotional coding, technical inheritance, and spiritual transformation. Together, these processes transform hidden industrial memories, emotions, skills, and spiritual values into cultural meanings that can be perceived, inherited, and reactivated in contemporary urban space.

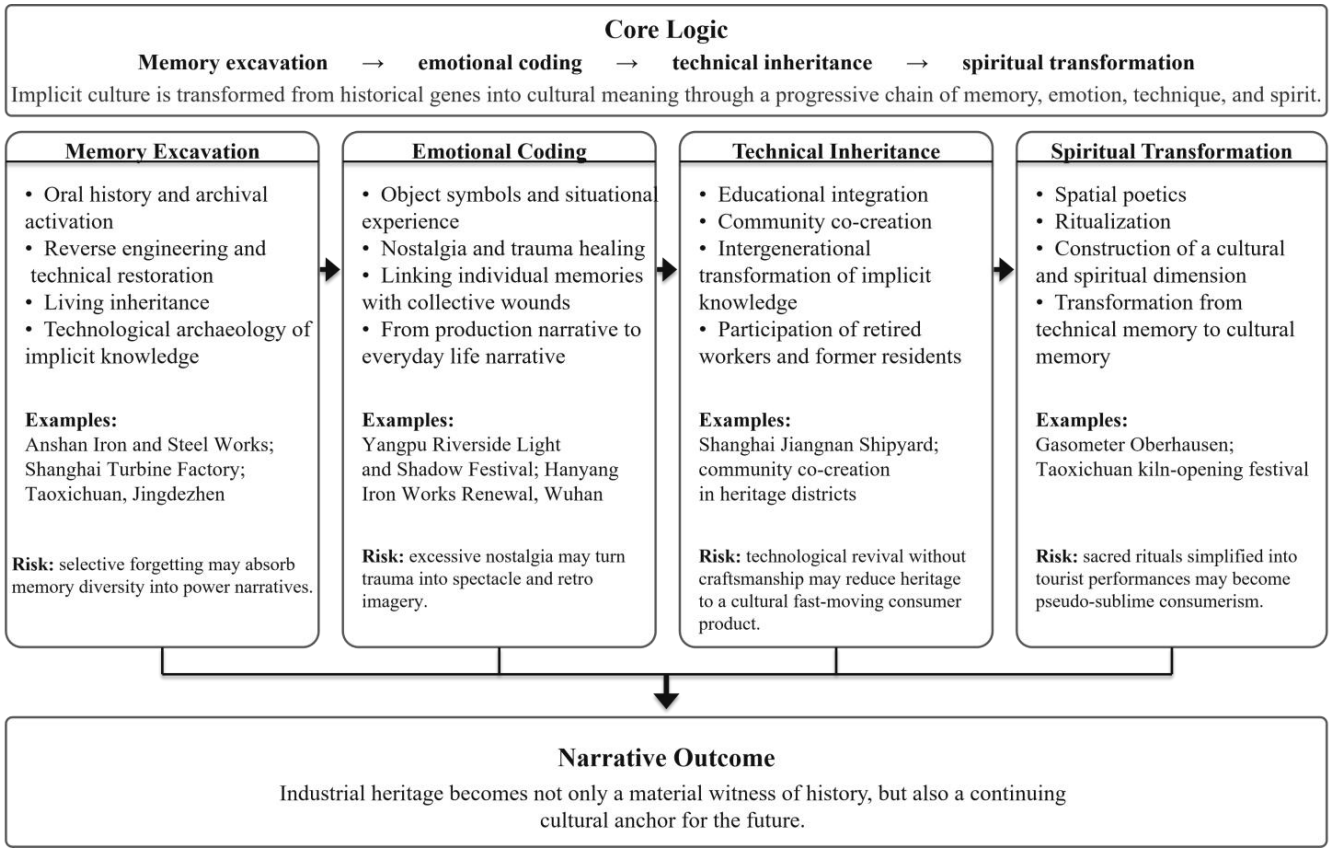


Figure 3. Implicit narrative logic of urban industrial heritage.

4.1. Memory excavation

Memory excavation is a form of technological archaeology of implicit knowledge. It includes oral history and archival activation, reverse engineering and technical restoration, and living inheritance. Oral histories, worker interviews, and family photographs can build an "unofficial memory archive." In Anshan Iron and Steel Works, oral archives of former workers supplement official historical materials with details and perspectives, adding human warmth and diversity to history and avoiding a single grand narrative. Reverse engineering and technical restoration can be achieved through digital technology. For example, Shanghai Turbine Factory used 3D scanning to reconstruct parts of old turbines and combined engineers' experiential data to generate maintenance guides. Living inheritance involves artisans teaching on site and activating intergenerational transmission. Taoxichuan in Jingdezhen uses kiln-opening ceremonies as a medium through which senior craftsmen teach skills and young artists engage in co-creation, allowing traditional porcelain-making techniques to be reborn across generations. However, memory excavation should avoid selective forgetting. If oral histories focus only on model workers while neglecting laid-off workers, the diversity of collective memory may be absorbed by power narratives.

4.2 Emotional coding

Emotional coding operates as a dual process of nostalgia and trauma healing. Through object symbols and situational experience, implicit emotions connect individual memories with collective wounds. Industrial artifacts function as indexical signs that trigger causal associations. During the 2024 Shanghai Light and Shadow Festival at Yangpu Riverside, weathering steel plates suspended above old wharf crane tracks attracted attention. Their silhouettes were derived from worker images in historical archives, while broken textures simulated the weathering of walls, implying the physical reshaping of urban texture by industrial labor. At night, 3D projection generated dynamic shadows on the steel surfaces, creating a visual dialectic of "bodily disappearance–memory rebirth."

Situational experience evokes immersive resonance through everyday traces. The renewal of Wuhan Hanyang Iron Works uses layered updating as a method, juxtaposing industrial remains with contemporary materials to construct a dialogue interface of folded time and space. In the residential quarters, core components and alley layouts were retained and adaptively adjusted, maintaining the spatial relationship and sense of place of original life symbols while upgrading infrastructure. This shift from the macro-narrative of production to the micro-narrative of daily life makes industrial heritage a medium that activates collective memory. Yet excessive reliance on nostalgic aesthetics can turn trauma into spectacle, reducing experiences such as layoffs to consumable retro imagery.

4.3 Technical inheritance

Technical inheritance concerns the intergenerational transformation of implicit knowledge. It is realized mainly through educational integration and community co-creation. Vocational education can integrate traditional industrial skills into modern training systems. Shanghai Jiangnan Shipyard, for example, incorporated riveting and wooden mold making into vocational curricula, allowing traditional techniques to retain their cultural meaning within a modern educational framework. Implicit narrative should also move beyond top-down authoritative discourse by introducing retired workers and former residents into

participatory design. Community co-creation provides a social basis for technical inheritance, safeguards narrative plurality, strengthens residents' emotional attachment to industrial heritage, and builds an affective connection among the past, the present, residents, and the city. However, when AR technology is used merely to revive spectacular scenes while ignoring the core of craftsmanship, technical inheritance may be reduced to a cultural fast-moving consumer product in the digital age.

4.4 Spiritual transformation

Spiritual transformation refers to the construction of a cultural and spiritual dimension for industrial heritage through spatial poetics and ritualization. Spatial poetics gives ruins a metaphor of redemption through architectural intervention. In the Gasometer Oberhausen in Germany, the juxtaposition of a rusted metal megastructure and light installations creates an intense experience in which viewers reconstruct historical cognition through the tension between ruin and art. Ritualization transforms technical memory into cultural genes through periodic performances. Taoxichuan's kiln-opening festival, with rituals such as worshiping the kiln god, reciting ancestral instructions, and breaking defective products, turns experiences of failure into public cultural symbols and elevates technical memory into cultural memory. Nonetheless, if sacred rituals are simplified into tourist performances, spiritual transformation may degenerate into a pseudo-sublime form of consumerism. The value of implicit narrative lies in ensuring that industrial heritage is not only a material witness of history but also a continuing cultural anchor for the future.

5. Explicit-implicit symbiotic narrative logic of urban industrial heritage

Explicit-implicit symbiotic narrative logic promotes the transformation of industrial heritage from historical remains into cultural living entities through the three-dimensional coordination of "spatial anchoring–temporal layering–subject co-governance." It is not a simple overlay of explicit and implicit elements, but a dynamic process in which material continuity and cultural renewal mutually support and transform each other. Based on the spatial, temporal, and social dimensions of heritage regeneration, spatial anchoring constructs material carriers, temporal layering organizes historical narratives, and subject co-governance activates social networks. Through their interaction, industrial heritage maintains a living evolution within urban renewal, as shown in figure 4.

5.1. Spatial dimension

In the spatial dimension, explicit-implicit symbiosis is reflected in the coordinated innovation of material restoration, symbolic translation, and technological intervention. Shougang Park's non-invasive restoration strategy for blast furnaces is representative. By using precise inspection technologies to identify material risks, the project conducts localized reinforcement while retaining the texture of rusted steel plates and the original appearance of equipment as much as possible. This approach maintains the function of material carriers for historical information and moves beyond the limits of traditional static protection. It resonates with the layered restoration of the Ruhr region, where traces from different periods are retained to construct a temporal narrative grammar in physical space.

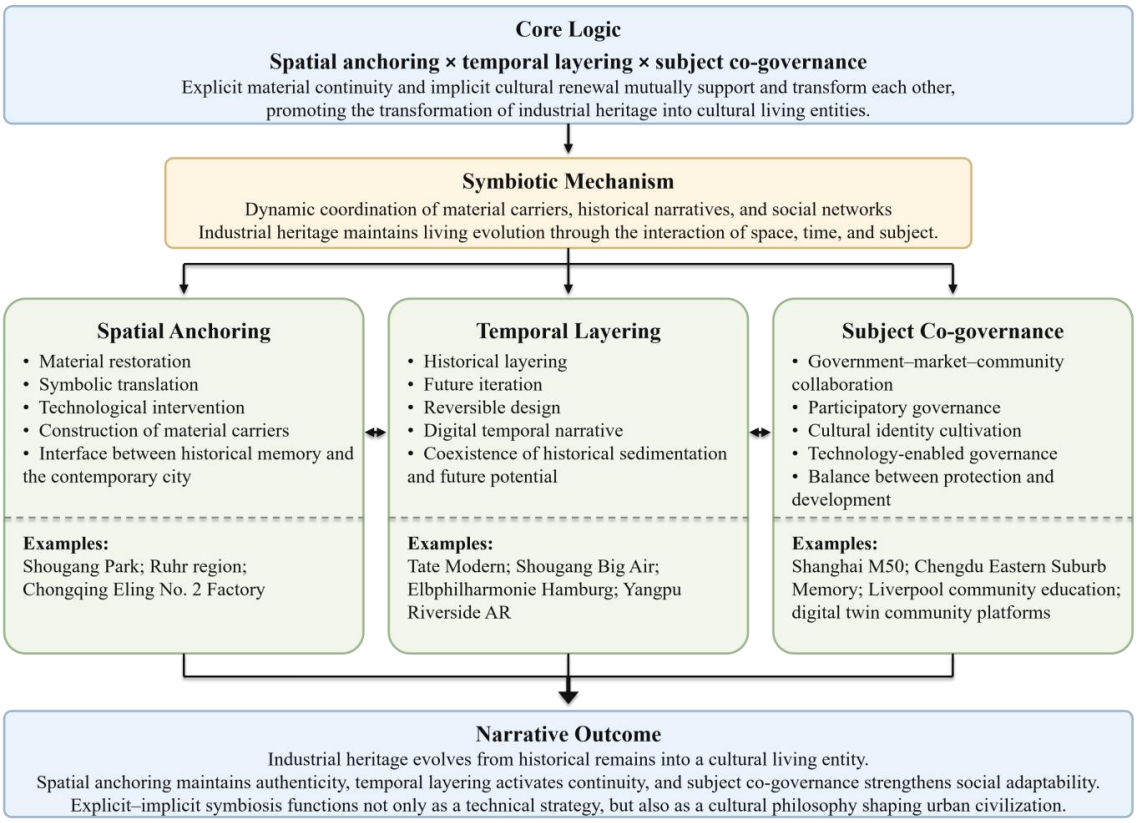


Figure 4. Explicit–implicit symbiotic narrative logic of urban industrial heritage.

Semiotic theory provides methodological support for the regeneration of implicit value. Chongqing Eling No. 2 Factory reorganizes discarded components into art installations, transforming industrial parts into metaphorical signs of labor spirit. Digital technology further expands the spatial dimension [21]. Through the integration of material anchors, symbolic systems, and virtual images, industrial heritage becomes a functional interface for dialogue between historical memory and the contemporary city.

5.2. Temporal dimension

The temporal dimension focuses on the two-way dialogue between historical layering and future iteration within present space. Through spatial design, abstract temporal attributes become perceptible and dynamically extendable. The turbine hall of Tate Modern retains the brick turbine base while adding contemporary exhibition functions, materializing the transformation from industrial building to art space. In Shougang Park, blast furnace groups are juxtaposed with the Winter Olympic Big Air venue, creating a temporal fold between industry and sport through the visual tension between rusted textures and contemporary materials. Reversible design leaves flexibility for future evolution. The Elbphilharmonie in Hamburg uses special springs to connect old and new structures, establishing a balance between heritage protection and technological innovation. Digital technology also renews temporal narrative: AR interactions at Yangpu Riverside overlay virtual historical production scenes onto physical remains, allowing visitors to perceive the continuity of industrial civilization through interaction. Thus, time is not a single linear axis; it is a coexistence of historical sedimentation and future potential generated through the dialectic of material continuity and digital regeneration.

5.3. Subject dimension

The subject dimension reflects the collaborative governance of government, market, community, and other actors. The evolution of Shanghai M50 Creative Park demonstrates the effectiveness of participatory governance: artists initially formed a creative ecology through informal spatial practices, and later government mechanisms balanced commercial and artistic functions through gradual renewal. The cultivation of cultural identity also relies on technological innovation. Chengdu Eastern Suburb Memory enhances visitors' narrative participation through AR guidance, while community education projects in Liverpool strengthen local identity through place-based engagement. Future governance may explore digital twin community platforms through which residents participate in decisions by voting systems, enterprises match rights and responsibilities through smart contracts, and governments monitor heritage conditions in real time. Such technology-enabled governance can improve consultation efficiency and transparency and help balance protection and development.

The coordinated interaction among space, time, and subject constitutes the generative mechanism of industrial heritage as a cultural living entity. Spatial anchoring maintains historical authenticity through material restoration and digital technology; temporal layering activates cultural continuity through narrative reconstruction; and subject co-governance realizes social adaptability through governance innovation. This dynamic balance shows that explicit-implicit symbiosis is not only a technical strategy, but also a cultural philosophy that enables industrial heritage to participate in and shape the evolution of urban civilization.

6. Empirical analysis: Taoxichuan in Jingdezhen

As a representative case of industrial heritage activation in China [22,23], Taoxichuan Creative District in Jingdezhen is selected as the empirical object, with the former Universe Porcelain Factory as its core carrier. Based on the explicit-implicit symbiotic narrative framework proposed in Section 2, this study verifies the three-dimensional collaborative logic of "space–time–subject" through the double-helix mechanism of "explicit material continuity–implicit cultural activation". The core findings demonstrate that the organic integration of physical remains (chimneys, kilns, *etc.*) and implicit cultural elements (intangible techniques, collective memory) can effectively overcome the narrative rupture between material preservation and cultural continuity in traditional conservation practices. The detailed empirical results are summarized in Table 1.

6.1. Spatial dimension: symbiosis of material continuity and memory activation

In the spatial dimension, explicit-implicit symbiosis follows the path of "historical texture restoration–sensory experience reconstruction", realizing the living translation of cultural genes through precise intervention. (1) The park adopts a dialectical restoration strategy for remaining industrial structures: original firing traces are retained on red-brick masonry, and wooden truss roofs are reinforced with carbon-fiber composite materials, creating an intergenerational dialogue between traditional construction wisdom and modern technology. (2) Multi-sensory interactive design is embedded to activate implicit memory: interactive installations simulate kiln temperature gradients, and burnt pinewood atmosphere is introduced to transform abstract firing technique knowledge into embodied

memory. (3) Functional switching realizes dynamic value translation: the renovated crushing workshop serves as a ceramic market during the day, while laser projection reproduces historical production scenes at night, turning static industrial buildings into memory media connecting the past and the present.

Table 1. Empirical analysis of Taoxichuan in Jingdezhen**.**

Symbiotic dimension	Explicit preservation strategy	Implicit activation strategy	Narrative meaning
Space: symbiosis of material continuity and memory activation	Preserving old factory buildings, chimneys, red-brick walls, kilns, and timber trusses; restoring historic materials; introducing interactive installations that simulate kiln temperature gradients.	Projecting production archive images; activating tactile and olfactory experiences through firing traces; reconstructing immersive scenes in the crushing workshop.	Industrial buildings become memory media that connect past production with contemporary public experience.
Time: symbiosis of historical layering and technical inheritance	Juxtaposing concrete frames, historical slogans, coal-fired tunnel kilns, and restored architectural components.	Using spectral reverse engineering, 3D printing, AR technology, and intergenerational craft collaboration to transform traditional ceramic knowledge.	The site becomes a tangible chronicle of ceramic industrialization and a laboratory of craft inheritance.
Subject: symbiosis of policy intervention and emotional contract	Introducing cultural policies, markets, exhibitions, maker spaces, and public activity venues.	Strengthening community identity through seasonal markets, kiln rituals, young ceramic makers, and cross-disciplinary experiments.	Government, market, makers, artisans, residents, and visitors jointly participate in the living regeneration of heritage.

6.2. Temporal dimension: symbiosis of historical layering and intergenerational technical inheritance

The temporal dimension realizes symbiosis through the triple coding of "material layering–craft translation–media iteration", forming a tangible chronicle of ceramic industrialization. (1) Material layering constructs a tangible historical sequence: concrete frames of Soviet-aided factory buildings, political slogans from the Cultural Revolution period, and preserved coal-fired tunnel kilns are juxtaposed to present the evolution context of the local ceramic industry. (2) Technical translation realizes intergenerational inheritance: spectral reverse engineering of glaze formulas interprets historical technical knowledge, and 3D printing + ultrasonic testing realizes the dialogue between traditional craftsmanship and digital thinking. (3) Media iteration activates dynamic inheritance: the father-son collaboration mode of craftsmen combines traditional kiln repair tools with AR virtual firing parameter technology, completing the cross-generational transformation of experiential technical knowledge.

6.3. Subject dimension: symbiosis of policy intervention and emotional contract

The subject dimension unfolds through a threefold framework of "institutional empowerment–emotional connection–technical collaboration", constructing a multi-stakeholder co-governance mechanism. (1) Institutional empowerment at the policy level: the Jingdezhen municipal government supports ceramic creative clusters through cultural finance and supporting policies, guiding the transformation of former porcelain-factory communities into participants in contemporary ceramic culture. (2) Emotional connection at the community level: periodic activities including seasonal markets, night tours and kiln-firing rituals reconstruct local identity, and digitally presented rituals are transformed into communicable cultural IP. (3) Technical collaboration at the industrial level: digital design tools are connected with traditional vessel form databases, promoting the resonance between digital makers and handcraft communities.

6.4. Summary of empirical verification

The case of Taoxichuan fully verifies the three-dimensional activation logic of urban industrial heritage proposed in this study: (1) Spatial dimension: functional replacement of historical remains constructs a temporal-spatial dialogue interface.(2) Temporal dimension: intergenerational craft innovation connects traditional techniques with modern technology.(3) Subject dimension: multi-stakeholder collaborative governance provides sustainable momentum for heritage regeneration .Its double-helix model of "explicit preservation–implicit activation" provides an important reference for the theoretical construction and practical activation of industrial heritage. Meanwhile, it should be noted that the potential impact of over-commercialization on cultural authenticity needs to be guarded against, so as to maintain a dynamic balance between heritage protection and technological innovation.

7. Conclusion

This study proposes an explicit-implicit symbiotic narrative framework for urban industrial heritage landscapes, aiming to break through the dual dilemma of material continuity and cultural rupture in heritage regeneration practice. Taking Taoxichuan in Jingdezhen as an empirical case, the study verifies the feasibility of the three-dimensional collaborative logic of "spatial anchoring–temporal layering–subject co-governance". The results demonstrate that industrial heritage can be regarded as a living and evolving composite system: spatial anchoring avoids the alienation caused by purely symbolic development, temporal layering mitigates the rigidity of static preservation, and subject co-governance mediates the tension between capital growth and cultural identity. The core essence of this process lies in the continuous dynamic translation that balances historical genes and contemporary needs.

This study complements existing industrial heritage research in two aspects. First, it breaks the binary thinking of "material-culture" separation in previous studies, and constructs a systematic analytical framework of explicit-implicit symbiosis from the perspective of landscape narrative. Second, the three-dimensional collaborative logic verified by empirical cases provides an operable practical path for the regeneration of industrial heritage in the context of urban renewal.

This study also has certain limitations. The empirical case focuses on light cultural industrial heritage represented by ceramic production, and the applicability of the proposed framework to heavy industrial heritage such as steel plants and coal mining sites needs further verification through multi-

case comparative research. In addition, the quantitative measurement of the symbiosis effect has not been carried out yet, and a quantitative evaluation system can be constructed in subsequent studies to improve the generalizability of the framework.

In future practice, intergenerational symbiosis of industrial heritage should be promoted through the coordination of institutions, technology and ethics. At the policy level, the social value of heritage can be incorporated into the assessment system, and oral histories and memory maps can be included in local protection regulations. Technological intervention should follow the principle of reversibility, and prefabricated structures and non-invasive digital tools should be prioritized to reserve flexible interfaces for future reinterpretation and technological renewal. At the ethical level, technological innovation should be transformed into a memory medium through temporal-spatial narrative. In this sense, explicit-implicit symbiosis goes beyond spatial regeneration, contributes to the intergenerational transmission of cultural genes, and provides an important response to the contemporary value of industrial heritage in urban renewal.

Declaration of generative AI and AI-assisted technologies

During the preparation of this manuscript, the authors used generative AI and AI-assisted technologies only for language editing and improving the readability of the manuscript. The authors take full responsibility for the content, integrity, originality, and accuracy of the manuscript.

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Authors' contribution

Conceptualization, C.X.and L.H.; methodology, C.X.; validation, C.X., H.L. and L.H.; formal analysis, C.X.; investigation, H.L.; resources, L.H.; data curation, H.L.; writing—original draft preparation, H.L.; writing—review and editing, C.X. and L.H.; visualization, H.L.; supervision, L.H.; project administration, L.H.; funding acquisition, L.H. All authors have read and agreed to the published version of the manuscript.

Conflicts of interest

The authors declare no conflicts of interest regarding the publication of this manuscript. The authors have no financial, commercial, or personal relationships that could be construed to have influenced the work reported in this paper.

Ethical statement

Ethical statement Ethical approval was not required for this study under the applicable institutional and national regulations. This study was based on field investigation, on-site observation, spatial recording, and documentation of industrial heritage sites. It did not involve human or animal experiments, clinical intervention, experimental manipulation, or the collection of personally identifiable information. Therefore, ethical approval was not applicable.

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