From industrial equipment to communication interface: a study on the visual communicability and urban cultural IP generation mechanism of the No.1 blast furnace in Hanggang Park, Grand Canal

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ABSTRACT In the context of postindustrial cities, large-scale heavy industrial structures are gradually undergoing a fundamental transformation in their functional paradigm. This article takes Hanggang No.1 blast furnace as a typical research case, constructs a three-dimensional quantitative evaluation system for the visual communicability of large-scale industrial equipment, and extracts a fourth-order iterative generation coupling model for urban cultural IP under the guidance of industrial heritage. Firstly, clarify the core connotation, dimensional composition, and quantitative measurement indicators of visual communicability of industrial equipment, and deconstruct the three-dimensional visual symbol system of No.1 blast furnace; Secondly, a vertical review of the evolution of the entire lifecycle of blast furnaces is conducted, elucidating visual communicability as the core driving factor. Empirical analysis shows that: (1) the inherent visual communicability of industrial equipment is a prerequisite core constraint for the cultivation and formation of urban cultural IP; (2) The super tall vertical scale, corroded metal native texture, and complete continuous production flow line of the No.1 blast furnace have built an irreplaceable differentiated visual competitive barrier; (3) A multi-level composite communication interface built on physical space, short video social media, cultural and creative derivative products, and fashion and art exhibitions can promote the sustained diffusion and dissemination of industrial cultural symbols across scenes and age groups. This study expands the research and analysis dimensions of postindustrial heritage semiotics, providing a quantifiable indicator framework for evaluating the visual communication effectiveness of giant industrial structures.

INDEX TERMS Industrial equipment; Visual communicability; Urban culture; IP generation mechanism; Grand Canal Hanggang Park

I. INTRODUCTION

In the 1970s, a wave of global deindustrialization transformation swept across Europe and America, giving rise to a massive amount of postindustrial heritage resources. Compared to conventional factory buildings, giant industrial facilities such as blast furnaces have inherent visual differentiation characteristics, making them naturally endowed with high recognition symbol endowments [1]. The Western academic community has conducted a series of systematic studies on industrial visual symbols and symbolic economy, proposing that large-scale industrial structures can be reconstructed through spatial re symbolization, and then accumulate to form regional cultural symbol capital and urban visual identity system. However, existing overseas research cases have mostly focused on the remains of the European coal and steel industry, and there has been no specialized exploration of the mediated transformation logic of large steel blast furnaces in the unique regional context of the Grand Canal water system in China.

The former site of Hangzhou Iron and Steel Industry on the Grand Canal carries the dual collective memory of the water transportation civilization in eastern Zhejiang and the modern industrialization of Zhejiang Province. Among them, the No.1 blast furnace started construction in 1957 and is known as the “cradle of Zhejiang steel industry”. This renovation project preserves more than 90% of the original

main structure of the blast furnace, and initially cultivates the exclusive urban cultural IP of "Hanggang No.1 Blast Furnace and Canal Industrial Aesthetics" [2]. There is a common problem of dual homogenization development in the process of urban stock renovation practice in China: (1) the renovation work overly focuses on strengthening the building structure and preserving the style, ultimately resulting in low public awareness of the remains, leading to insufficient comprehensive dissemination efficiency online and offline; (2) Blindly copying the operation template of general cultural and creative parks in project development makes it difficult to cultivate exclusive urban cultural IP that can operate sustainably for a long time. Existing research has not yet formed a complete logical system of "industrial entity structures visual communication endowment urban cultural IP generation", and there is a lack of quantitative empirical analysis cases using giant industrial facilities such as blast furnaces as research samples [3].

Research in the field of traditional industrial heritage has long focused on structural reinforcement techniques, spatial renewal design schemes, historical value text interpretation, and other directions, with little systematic explanation of the internal mechanism of the transformation of industrial production facilities from production function carriers to media communication carriers. At present, short videos and graphic social platforms dominate the visual media communication pattern, and industrial structures with outstanding visual impact have gradually become the core filming carriers for social media content creation, giving rise to the emerging urban cultural consumption format of "industrial aesthetics check-in", which has led to three core research topics: what are the native visual characteristics of giant industrial installations? What is the inherent coupling mechanism between visual communicability and urban cultural IP generation? How to improve the visual communication efficiency of industrial heritage and the level of IP industrialization value transformation through systematic optimization of spatial form and media operation.

II. CORE CONCEPTS AND THEORETICAL FOUNDATIONS

A. CORE CONCEPTS

1. INDUSTRIAL EQUIPMENT.

Mainly covering core production facilities such as blast furnaces, coke ovens, mine derricks, large-scale steel rolling equipment, and gas storage tanks. Among them, the Hangzhou Iron and Steel No.1 blast furnace on the Grand Canal has a total height of 84.6 meters and is a representative core industrial facility in the development process of modern steel industry in Zhejiang Province. The value of industrial equipment is only reflected in practical functions such as production, warehousing, and material processing. The physical form, surface texture, spatial scale, and production process of industrial equipment together constitute a unique industrial visual symbol carrier with diverse value attributes [4].

2. VISUAL TRANSMISSIBILITY.

Based on the core visual elements such as spatial scale, color system, surface texture, and spatial sequence of industrial equipment itself, it carries multiple information such as industrial development history, urban collective memory, and industrial aesthetic connotation, promoting active shooting, sharing, and dissemination behavior among the audience, and ultimately achieving comprehensive dissemination ability of visual information across media. It includes three core dimensions: 1) recognizability of spatial narrative, covering richness of spatial hierarchy, readability of historical narrative, and integration and coordination of old and new spaces; 2) The inherent visual attributes of the ontology include scale uniqueness, texture recognition, color conflict, and production line integrity; 3) The potential for media adaptation and dissemination includes the convenience of extracting visual elements, cross media reusability and adaptability, and audience willingness to check-in, shoot and disseminate.

3. SPREAD INTERFACE.

This study divides the propagation interface of Hanggang No.1 blast furnace into three layers: 1) physical interface, mainly including offline physical space scenes such as the blast furnace body, supporting exhibition halls, and public squares; 2) Digital media interface, covering mainstream image and text, short video social communication platforms such as Xiaohongshu, Tiktok, etc; 3) Derived physical interfaces, including offline derivative communication carriers such as cultural and creative products, fashion shows, and theme music festivals.

4. URBAN CULTURAL IP.

Industrial heritage urban cultural IP has four core characteristics: resource uniqueness, emotional resonance, media extensibility, and industrial sustainability. They correspond to non replicable industrial heritage resources, urban collective industrial memory, cross carrier reuse of visual symbols, as well as diversified industrial monetization paths such as cultural and tourism integration, cultural and creative development, theme activities, and digital content creation. The core core of Hanggang No.1 blast furnace urban cultural IP can be summarized as three dimensions: the core carrier of Zhejiang steel industry development along the Grand Canal, the benchmark of post industrial cyberpunk characteristic aesthetics, and the core carrier of urban industrial memory in Hangzhou's Banshan area [5].

B. THEORETICAL BASIS

1. PIERCE'S THEORY OF TERNARY SEMIOTICS.

The symbol system is divided into three categories: image symbols, indicator symbols, and symbolic symbols. The shape of the giant furnace body of Hanggang No.1 blast furnace belongs to typical image symbols, while industrial components such as the iron outlet and conveying pipeline

remain as indicator symbols. The theme slogan of "1958 First Furnace Molten Iron" and the exclusive IP image of the blast furnace are symbolic symbols. The hierarchical composition of ternary symbols is the underlying logic and core theoretical basis for the generation of visual communicability in industrial devices.

2. MEDIA SPACE THEORY.

Urban physical space has media attributes and can fully realize the entire chain of media communication process, including information encoding, audience perception and reception, and symbol secondary reproduction. The renovated Hangzhou Iron and Steel No.1 blast furnace has been transformed into a physical encoding carrier of industrial cultural symbols. The audience's on-site visits, check-in photos, and other behaviors have completed the secondary production and initial dissemination of visual symbols, and based on this, a three-level communication interface of digital media and physical cultural and creative has been derived, constructing a multi-level spatial communication system.

3. LANDSCAPE VISUAL PERCEPTION AND VISUAL COMMUNICATION THEORY.

The audience's preference for landscape space, memory retention effect, and willingness to spread and share are the result of the coupling effect of objective visual indicators of space and subjective emotional perception of the audience [6]. Visual symbols with high recognition and uniqueness have natural advantages in viral dissemination, and are the pre core resources for cultivating and constructing urban cultural IP. The two theories support and complement each other, providing a theoretical basis for the construction of a three-dimensional evaluation system for the visual communicability of industrial devices in this study.

4. THEORY OF CULTURAL IP INDUSTRY GENERATION.

The unique industrial visual symbols are the core foundational resources for the construction of cultural IP, and the multi-level communication interface is the key channel for the global diffusion of IP. The sustained emotional identification and cultural resonance of the audience are the core guarantees for the long-term survival of IP. The integration of culture and tourism, cultural and creative development, commercial theme activities and other formats are the core carriers for the transformation of IP cultural value and economic value. The above four elements form a continuous iteration and virtuous cycle industrial generation mechanism for industrial heritage cultural IP.

C. INTEGRATED ANALYSIS FRAMEWORK

This article integrates Pierce's theory of triadic semiotics, media space theory, landscape visual communication theory, and cultural IP industry generation theory to construct a progressive and closed-loop analysis framework for industrial heritage visual communication and IP generation: (1) pre resource layer. The three-dimensional evaluation index based on the visual communicability of industrial devices is the fundamental prerequisite for the dissemination of visual symbols and the cultivation of cultural IP. (2) The intermediary communication layer undertakes the intermediary transmission function of visual symbol encoding, translation, and diffusion. (3) The iterative layer follows the iterative logic of "symbol extraction interface reconstruction media resonance industry monetization" to achieve a systematic transformation of cultural symbols into urban IP values. Introduce four external moderating variables, namely the cultural linkage effect of the Grand Canal, site operation policies, audience digital literacy, and spatial aging adaptation level, to explain the differential empowerment and constraint effects of the external environment on the communication and transformation chain. Figure 1 shows the framework diagram for the integration analysis of industrial heritage visual communication and urban cultural IP.

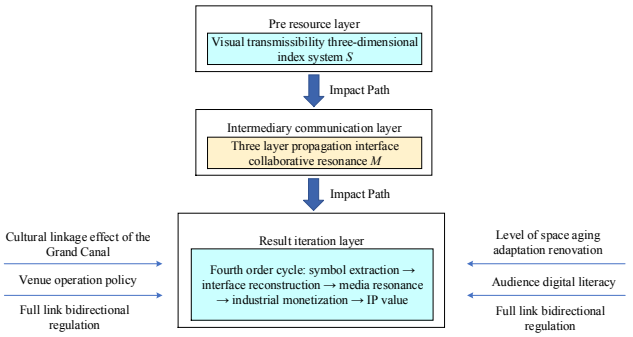

FIGURE 1: Analysis Framework for the Integration of Industrial Heritage Visual Communication and Urban Cultural IP

Mechanism of action: The visual communicability of industrial equipment has a positive driving effect on the symbol output and translation efficiency of the three-layer communication interface. The collaborative resonance of multi-dimensional communication interfaces further promotes the continuous evolution and iterative generation of urban cultural IP. A series of external regulatory variables can effectively amplify or suppress the overall transformation efficiency of "visual resources communication interface IP generation".

The multi-level progressive coupling model adopted in this study is as follows:

$$M = \alpha_0 + \beta_1 S + \sum_{k=1}^{4} \gamma_k C_k + \mu \tag{1}$$

$$IP = \delta_0 + \theta_1 M + \sum_{k=1}^{4} \varphi_k C_k + \nu \tag{2}$$

Where, S is the comprehensive score of visual communicability for industrial equipment; M is the level of collaborative resonance at the three-layer propagation interface;

IP is the maturity and industrialization value of urban cultural; C_k is four external moderating variables: the cultural linkage effect of the Grand Canal, venue operation policies, audience digital literacy, and spatial aging adaptation level; α_0 and δ_0 are constant terms; The regression coefficients of β_1 and θ_1 as the main effects; γ_k and φ_k are moderating variable coefficients; μ and ν are random error terms.

III. RESEARCH DESIGN AND DATA COLLECTION

A. RESEARCH METHODS

Adopting a mixed research paradigm that combines qualitative and quantitative approaches, and enhancing the scientific validity and credibility of research conclusions through multi method cross validation. The implementation process is as follows [7]:

1. FIELD SPATIAL MAPPING.

Completed three systematic on-site surveys, accurately surveyed and recorded the spatial scale, production flow lines, and new and old space update nodes of Hanggang No.1 blast furnace, and systematically disassembled the image symbols, indicator symbols, and symbol system of the blast furnace landscape based on Pierce's ternary semiotic theory.

2. VISUAL PERCEPTION EXPERIMENT.

Recruit 60 visitors of different age structures to conduct an eye tracking experiment on blast furnace landscape space (using computer cameras and RealEye software), objectively collecting and quantitatively analyzing core visual perception indicators such as visual gaze hotspots, effective gaze duration, and regional visual attractiveness of the audience.

3. BIG DATA CRAWLER ANALYSIS.

With the period from April 2025 to June 2026 as the time interval, data crawling was carried out for mainstream social platforms such as Tiktok and Xiaohongshu, and 4267 short videos and graphic samples related to Hanggang No. 1 blast furnace were obtained, and the characteristics of its popularity, high-frequency visual tag system and audience sentiment tendency were systematically excavated to clarify the characteristics of cross media communication of industrial visual symbols.

4. STRUCTURED QUESTIONNAIRE SURVEY.

450 structured questionnaires were distributed to offline visitors in the park, using the Likert five level scale as a measurement tool to quantitatively measure the audience's perception of visual communicability of blast furnace industrial equipment, their level of awareness of urban cultural IP, and their willingness to actively spread and share.

5. SEMI STRUCTURED IN-DEPTH INTERVIEWS.

Conduct in-depth semi-structured interviews with a total of 18 research subjects, including park operation managers, site renewal designers, senior Hangzhou Iron and Steel workers, and scholars in the field of culture and tourism, to supplement qualitative information from multiple dimensions such as operation management, spatial transformation, cultural and creative development, industrial history, and academic research.

B. VISUAL COMMUNICATION EVALUATION SYSTEM

Based on the theoretical analysis framework constructed in the previous text and existing research results in the field of visual communication of industrial heritage, following the principles of scientificity, systematicity, and pertinence, a three-dimensional twelve item quantitative evaluation index system for the visual communicability of industrial installations is constructed [8]. All indicators are standardized and quantified using a five level Likert scale, and multi-source data cross validation is carried out by combining objective gaze data from eye tracking experiments and social media communication popularity data. The specific indicators are as follows (see Table 1):

(1) Visual intrinsic attribute indicators of ontology (weight 40%). Focusing on the visual characteristics of the original entity of the blast furnace, reflecting the visual uniqueness and original preservation quality of the industrial heritage itself, including four indicators: vertical scale uniqueness, metal texture recognition, industrial color conflict degree, and complete production line preservation degree.

(2) The recognizability index of spatial narrative (weight 35%). Reflecting the comprehensive ability of the venue space to carry industrial history, create a scene atmosphere, and adapt to public viewing and framing, it includes four indicators: the coordination of dialogue between new and old spaces, the degree of visualization of historical narratives, the richness of spatial hierarchy, and the richness of check-in and framing spaces.

(3) Media adaptation and dissemination potential indicator (weight 25%). Measuring the adaptability of industrial visual symbols to new media communication, public perception, and industrial derivatives, it includes four specific indicators: ease of visual element extraction, adaptability to short video images, visual friendliness for all ages, and adaptability to cultural and creative derivatives.

TABLE 1 Three-dimensional twelve item quantitative evaluation index system for visual communicability of industrial equipment

FIRST-LEVEL DIMENSION	DIMENSION WEIGHT	SECONDARY INDICATOR	CONNOTATION OF INDICATOR MEASUREMENT
Inherent visual attributes of ontology	40%	Vertical scale uniqueness	The degree of difference between the vertical height and spatial volume of blast furnaces and the conventional urban landscape
		Identification of metal texture	Integrity of the original texture and uniqueness of visual recognition of corroded steel
		Industrial color conflict degree	Comparison effect of rust red, steel structure gray, surrounding greenery, and building decoration colors
		Preservation of complete production line	Authenticity preservation level of the entire smelting process including pipelines, tapping ports, ore tanks, and operation consoles
Recognizability of spatial narrative	35%	Coordination of dialogue between old and new spaces	Integration of newly built walkways, exhibition halls, and original blast furnace structures for visual appeal
		Visualization level of historical narrative	Restoration of industrial historical scenes, physical exhibits, and richness of image carriers
		Richness of spatial hierarchy	Long view landmarks, mid view pipelines, and close-up equipment with multiple levels of viewing hierarchy
		Check in the richness of the filming space	Number and diversity of shooting points suitable for portrait, panoramic, and detailed close ups
Media adaptation and dissemination potential	25%	Ease of extracting visual elements	Simplified design of blast furnace contour and component patterns, and difficulty in IP extraction
		Short video screen adaptability	Light and shadow, vertical composition, dynamic lens adaptation for short video platform creation
		Visual friendliness for all ages	The difficulty level of recognizing and understanding the narrative of the venue for low vision and elderly groups
		Adaptation of cultural and creative derivatives	Visual symbol conversion: adaptability to stationery, clothing, digital collectibles, and other products

The comprehensive score of visual communicability for industrial equipment is S, and the calculation model is as follows:

$$S = W_1 S_1 + W_2 S_2 + W_3 S_3 \tag{3}$$

The sub scores of each dimension are calculated based on the average of four internal indicators:

$$\begin{cases} S_1 = \dfrac{1}{4}\displaystyle\sum_{i=1}^{4} x_{1i} \\ S_2 = \dfrac{1}{4}\displaystyle\sum_{i=1}^{4} x_{2i} \\ S_3 = \dfrac{1}{4}\displaystyle\sum_{i=1}^{4} x_{3i} \end{cases} \tag{4}$$

Where, S is the comprehensive score of visual communicability, and the higher the score, the stronger the communication ability; W_1 is the intrinsic visual attribute weight of the ontology; W_2 is the weight of spatial narrative recognizability, and W_3 is the weight of media adaptation and dissemination potential; S_1 is the average score of the intrinsic visual attribute dimension of the ontology, and x_{1i} is the Likert score for the four indicators of this dimension; S_2 is the average score of the spatial narrative recognizability dimension, and x_{2i} is the Likert score for the four indicators of this dimension; S_3 is the average score for the potential dimension of media adaptation communication, and x_{3i} is the Likert score for the four indicators of this dimension.

C. DATA COLLECTION PROCESS

The specific implementation details of various research and experimental work are as follows:

1. FIELD SURVEY AND SPATIAL MAPPING.

This study completed three rounds of systematic exploration and spatial mapping from March to May 2026. The system recorded the visual landscape elements of key areas such as the blast furnace body, supporting exhibition halls, and public squares, and sorted out the planning drawings and spatial change characteristics before and after the site renovation.

2. EYE MOVEMENT VISUAL PERCEPTION EXPERIMENT.

Visual tracking tests were conducted using Tobii portable eye tracking devices, which collected core objective indicators such as the first fixation point, total fixation duration, and proportion of visual hotspots, accurately quantifying the visual attention intensity of the audience to different spatial interfaces of industrial devices.

3. DATA CRAWLER ANALYSIS.

Based on Python crawler technology, with “Grand Canal Hanggang No.1 Blast Furnace” and “Hanggang Park Industrial Wind” as the core search keywords, systematic crawling of relevant communication content on mainstream social platforms is carried out, covering communication heat indicators such as video views, likes, and collections. Through word frequency statistics and emotional tendency analysis, the network communication characteristics of blast furnace visual symbols and audience emotional attitudes are clarified.

4. STRUCTURED QUESTIONNAIRE SURVEY.

The questionnaire was distributed using a random stratified sampling method at the entrance and exit of the park, covering all age groups. The questionnaire content consists of four core modules: basic information of respondents, spatial visual perception, media communication behavior, and urban cultural IP cognition.

5. SEMI STRUCTURED IN-DEPTH INTERVIEWS.

Conduct one-on-one in-depth interviews with different target groups, and use NVivo qualitative analysis software to perform hierarchical coding and clustering analysis on the interview texts. Systematically extract core research conclusions from dimensions such as site operation management, spatial renewal and transformation, and cultural and tourism IP development.

D. RELIABILITY AND VALIDITY CONTROL

This study conducted strict quality control from multiple dimensions, including questionnaire scale optimization, pre survey correction, statistical testing, experimental variable control, and big data cleaning. Based on mature landscape visual perception scales at home and abroad, localized adaptation and adaptation were carried out to correct item expression deviations and optimize scale structure dimensions [9]. Conduct a pre survey of 50 samples before the formal investigation, and eliminate ambiguous, vague, and poorly adapted items based on feedback results.

The reliability and validity test results showed that the Cronbach's alpha coefficient of the overall scale in this study was 0.871, significantly higher than the standard threshold; The KMO test value is 0.846, indicating excellent overall structural validity of the scale. At the experimental and data collection level, eye movement visual perception experiments uniformly control interference variables such as environmental light and observation distance. Social media crawler data undergoes multiple cleaning mechanisms, and the system removes duplicate samples, marketing promotion, and ineffective samples from the navy to ensure the authenticity and objectivity of the communication data.

IV. EMPIRICAL ANALYSIS OF VISUAL COMMUNICABILITY

A. EVOLUTION OF VISUAL CARRIERS THROUGHOUT THE ENTIRE LIFECYCLE

1. PRODUCTION PERIOD (1958-2015).

The core function of Hanggang No.1 blast furnace is the smelting of molten iron. The entire body adopts a stainless-steel structural system, matched with densely arranged industrial pipelines, and the overall production area is in a closed control state. The blast furnace is only open to close range contact scenes for internal staff in the factory area, and the public outside the city can only observe its giant spatial outline from a distance. There is no public open viewing and interactive interface, and the visual dissemination range is strictly limited to the interior of the factory area. The visual symbols of the blast furnace have not formed cultural narratives and industrial aesthetic values that can be disseminated externally [10].

2. IDLE AND ABANDONED PERIOD (2015-2020).

The blast furnace has entered a long-term storage and idle state, and the rust texture formed by long-term natural weathering further strengthens the industrial age texture of the site. However, due to the lack of physical interaction scenarios and market-oriented communication channels, the visual symbols of blast furnaces are only retained in the subjective memories and historical image materials of local residents, and the visual communicability of industrial facilities is in a dormant state.

3. UPDATE THE OPERATING PERIOD (2025 TO PRESENT).

This update and renovation is led by the Liu Jiakun team, aiming to preserve the industrial essence to the greatest extent possible. The project has added a light red concrete corridor as an immersive exhibition trail, which retains the original industrial components such as hot air ducts and iron making equipment. The exterior is linked to a 45000 square meter central lawn and a retro railway landscape system, creating a diverse scenic space with clear distance and rich scene types. The transformed blast furnace has been transformed into a composite visual communication carrier that integrates the shaping of distant landmarks, close range texture viewing, indoor historical narrative, and outdoor public activities, achieving comprehensive activation and upgrading of the visual communicability of industrial installations.

B. THREE-LAYER VISUAL SYMBOL DECOMPOSITION BASED ON PIERCE SEMIOTICS

1. IMAGE SYMBOL LAYER.

The core visual elements include an 84.6-meter ultra-high vertical furnace body, reddish brown corroded metal skin, criss crossing steel pipes, giant ore tank structures, cast iron operating platforms, old-fashioned steel valves, and retro track locomotives, which are native industrial components with strong vertical scale impact and unique texture recognition. Eye tracking experiment data shows that the average gaze duration of the audience towards the vertical core area of the blast furnace can reach 12.7 seconds, significantly higher than the 4.2 second average gaze level of the conventional landscape in the park, confirming that the original industrial style is the core advantage of the blast furnace's visual communication ability.

2. INDICATOR LAYER.

Construct an industrial historical indicator system, including the restoration scene of the first furnace of molten iron production in 1958, traditional steel operation equipment, complete smelting production process diagram, historical image data of the factory area, "Zhejiang Steel Cradle" themed stone carving slogan, and mining lamp spark shaped themed device. The questionnaire data verification shows that the audience who fully visited the internal narrative exhibition hall had a 68.3% increase in awareness of the modern steel industry in Zhejiang and the development history of Hangzhou Iron and Steel compared to the non-visiting group [11].

3. SYMBOLIC LAYER.

Based on the core of the blast furnace industry, a series of exclusive symbolic symbols have been extracted, including the minimalist IP image of Blast Furnace No.1, the exclusive visual logo of "1958 Hanggang", the steel spark theme logo, and the creative pattern of the fusion of canal and molten steel. These customized cultural symbols have high independence and transferability, and can be separated from the physical body of the blast furnace. They are widely used in various communication scenarios such as cultural and creative products, urban posters, theme shows, and urban promotional videos. They are the core carrier for cross circle and cross carrier communication of derived physical interfaces and digital media interfaces.

C. QUANTITATIVE EMPIRICAL RESULTS OF THREE-DIMENSIONAL VISUAL COMMUNICABILITY

1. INTRINSIC VISUAL ATTRIBUTES OF ONTOLOGY (DIMENSION AVERAGE 4.62).

Hanggang No.1 blast furnace relies on the vertical scale of the super high-rise building and the complete set of original industrial equipment relics, combined with the highly recognizable corroded metal texture and unique color system, to build a strong visual competitive advantage. The frequency statistics of social media words show that "giant blast furnace", "industrial rust color", and "cyberpunk" are high-frequency core tags for audience dissemination. The defect is that after the vegetation withers in winter, the landscape hierarchy of the bottom space of the blast furnace weakens and the interface is relatively monotonous, resulting in insufficient seasonal landscape stability.

2. THE RECOGNIZABILITY OF SPATIAL NARRATIVE (DIMENSION AVERAGE 4.27).

The site renovation has formed a multi-level viewing interface that is scattered far and wide, coupled with the in-situ preservation of a large number of native industrial equipment and production scenes, effectively enhancing the completeness and spatial readability of industrial historical narratives. The drawback is that: (1) the narrative of the venue relies heavily on the presentation of text display boards, which poses a high information reading threshold for the elderly audience, resulting in insufficient visual adaptability of spatial narrative for all ages. (2) The existing narrative system focuses solely on the history of the steel industry, with a lack of visual symbols for the linkage between the canal and industry, resulting in insufficient expression of the cultural context of the site and weak narrative coherence.

3. THE POTENTIAL FOR MEDIA ADAPTATION AND DISSEMINATION (WITH AN AVERAGE DIMENSION OF 3.81 AND A GLOBAL WEAKNESS DIMENSION).

The overall outline of the blast furnace is simple, atmospheric, and highly recognizable, with low difficulty in extracting visual symbols. It is naturally suitable for secondary dissemination behaviors such as short video editing, photography creation, and cultural and creative derivatives. The shortcomings are: (1) the exclusive derivative visual symbol system is relatively thin, the landing application scenarios of standardized IP images are limited, and the development of symbol industrialization is insufficient; (2) The single night lighting landscape design and lack of visual hierarchy limit the all-weather dissemination ability of short video media; (3) There is a clear phenomenon of circle differentiation in communication media, and the problem of uneven adaptation of audience media is prominent.

V. BOTTLENECKS IN VISUAL COMMUNICATION AND URBAN IP DEVELOPMENT

A. SINGLE VISUAL SYMBOL SYSTEM AND INSUFFICIENT CULTURAL INTEGRATION

The cultural dimension of IP visual symbols is single, focusing only on single industrial elements such as blast furnace steel smelting and industrial production, without deeply exploring and integrating regional cultural resources such as Grand Canal water transportation, waterfront industrial symbiosis, and canal material transportation, and failing to form a differentiated composite IP core of "canal empowering industry and industry anchoring canal". Exclusive symbol categories are scarce and scene segmentation is insufficient, limited to basic IPLOGO and small cultural and creative decoration patterns [12]. A segmented symbol system has not yet been constructed for different age audiences, diverse communication scenarios, and industrial development needs, making it difficult to adapt to the needs of omnichannel and multi format IP derivative development and cross media communication. The spatial narrative presents structural defects of dense text and weakened visual presentation. The proportion of visual narrative carriers that are graphical and scene based is relatively low, greatly reducing the visual recognizability and audience information reception efficiency of spatial narrative. This is particularly detrimental to the cultural perception of the elderly and youth groups, and limits the overall dissemination efficiency of industrial heritage cultural narrative.

B. LAYERED RUPTURE IN MEDIA DISSEMINATION, WITH BARRIERS IN DIGITAL ACCESS

At the level of communication channels, the online dissemination of blast furnace IP is highly dependent on short video youth social platforms, and has not yet built a diversified communication system that is suitable for middle-aged and elderly groups. There is also a lack of offline paper propaganda carriers, traditional TV cultural and tourism themed content, and other communication channels that are suitable for middle-aged and elderly audiences. The overall media coverage capability is insufficient. At the level of visual adaptation for all ages, the visual and physiological characteristics of the elderly population have not been fully considered, and there is insufficient supply of age-appropriate

communication facilities such as large character guidance systems, fully automatic voice explanations, and minimalist interactive interfaces in the venue, significantly reducing the overall potential for age-appropriate media adaptation communication. In terms of the quality of communication content, most of the content focuses on superficial industrial aesthetic check-in and landscape visual presentation. Shallow communication content mainly consisting of fun check-in and landscape photography accounts for a high proportion, and there is a scarcity of deep narrative short videos that carry the development context of the steel industry, the historical memory of the factory area, and the symbiotic relationship of the canal industry. It is difficult to achieve a deep communication transition from "traffic check-in" to "cultural identity".

C. INSUFFICIENT LINKAGE OF COMMUNICATION INTERFACE AND WEAKNESSES IN THE DERIVATIVE INDUSTRY CHAIN

Offline large-scale exhibitions and cultural and sports activities can continuously produce high-quality, high dissemination potential native visual image materials, but such high-quality scene resources have not been systematically collected, standardized, and serialized for secondary development, blocking the complete transmission chain of "physical material production digital traffic diffusion physical value landing". At the level of IP industry transformation, there is a clear gap in the high value-added IP product system, lacking new digital and high-end derivative formats such as brand cross-border collaboration, digital IP collections, immersive interactive experience products, etc. The industry iteration ability is insufficient, making it difficult to support the long-term industrialization development of urban cultural IP. The nighttime visual landscape system of the site has obvious shortcomings, with a single design form, lack of hierarchy, and a lack of thematic narrative, which cannot shape a differentiated nighttime industrial visual style. The insufficient supply of high-quality communication materials at night directly misses the incremental scenarios of social media check-in, short video dissemination, and nighttime cultural and tourism consumption, which restricts the breadth and depth of IP media resonance.

D. LACK OF LONG-TERM IP ITERATION MECHANISM AND INSUFFICIENT UPDATING OF VISUAL RESOURCES

The investment structure of operating income in the park is unreasonable, and the proportion of special budget for iterative updates of visual symbol systems, spatial visual quality upgrades, and refined production of digital communication content is low, resulting in a lack of stable resource support for optimizing and upgrading visual communicability, updating communication interfaces, and secondary development of IP symbols [13]. The venue has not yet established a normalized mechanism for audience visual perception research. Space renovation, landscape updates, and visual design rely heavily on static planning results and empirical judgments, and there is no periodic mechanism for tracking audience visual experiences, conducting perception preference research, and collecting feedback on usage. As a result, the optimization and adjustment of spatial visual perception lags behind changes in audience aesthetics and communication markets. The channel for transforming IP narrative resources is blocked, and the park has not established a normalized visual transformation channel for implicit cultural resources such as industrial oral history, memories of old workers, and historical materials of canal transportation industry. It is difficult to continuously produce fresh and topical communication content, which cannot inject new momentum into media resonance and IP dissemination, and restricts the long-term vitality of urban cultural IP.

VI. DEVELOPMENT OPTIMIZATION PATH

A. HIERARCHICAL ITERATIVE VISUAL SYSTEM, INTEGRATING THE COMPLEX CULTURAL GENES OF THE GRAND CANAL

To address the shortcomings of IP symbol singularity, cultural fragmentation, insufficient adaptation of spatial narrative, visual seasonal imbalance, and lack of nighttime dissemination, we will carry out a reconstruction of the visual symbol system and upgrade the refinement of spatial scenes

(1) Building a three-level differentiated and integrated visual symbol resource library, constructing a complete symbol matrix of "industrial base+canal region+composite innovation": based on elements such as blast furnace outline, steel pipes, and corroded metal texture as industrial symbols, using canal transport ships, canal dams, water texture, and canal blue standard color system as canal water system regional symbols, using artistic patterns of blending steel and river water, standard framing perspective of blast furnace canal, and visual patterns of steel flowing water coexistence as fusion composite symbols, breaking the symbol separation problem between steel industry and canal culture, and forming the unique differentiated composite IP visual core of Hanggang No.1 blast furnace.

(2) Promote the lightweight, visual, and aging friendly transformation of spatial narrative. Significantly streamline large text display boards and replace them with strong visual and lightweight display forms such as giant historical images, industrial physical installations, scene restoration sculptures, and dynamic projection narratives, carrying historical information in a visual and scene based manner. Equipped with fully covered intelligent voice guidance, high-definition large character graphic and textual signage, and minimalist venue interpretation interfaces, weaken barriers to age and cultural reception, and significantly improve the narrative experience and historical information reception efficiency of the elderly population.

(3) Implement seasonal landscape adaptation and upgrade the nighttime visual system. Install vegetation with rich seasonal variations in the bottom area of the blast furnace to

balance the visual hierarchy of the site in different seasons. Synchronize the upgrade of the nighttime layered lighting system, create clear and industrial textured nighttime light and shadow narrative scenes, shape exclusive nighttime industrial aesthetic style, expand new communication scenes such as nighttime short video dissemination, night scene check-in, and nighttime cultural and tourism experience, and achieve stable output of venue visual communicability throughout the season and time period.

B. OPEN UP COMMUNICATION MEDIA FOR ALL AGES AND ELIMINATE DIGITAL BARRIERS

To address the communication shortcomings of the existing digital communication channels, such as single channels, severe content homogenization, prominent intergenerational media gaps, and insufficient adaptability to the elderly population, we will construct a dual track communication system that focuses on youth cultivation and provides support for the elderly, as well as an age friendly visual service system

(1) Build a diversified dual track digital communication system. For the core youth communication groups, we will continue to deepen the cultivation of mainstream UGC short video platforms such as Tiktok and Xiaohongshu, focus on the core of differentiated culture, create a series of in-depth thematic content such as industrial history science popularization, canal industry symbiosis roaming, and historical records of veteran workers, and continue to stimulate the vitality of secondary creation and spontaneous communication of youth groups. Targeting the middle-aged and elderly population, breaking free from the barriers of short video platforms, we will collaborate with local television stations to launch a special program on industrial heritage tourism. We will compile and distribute community paper tourism manuals and site history guidebooks, adapting to the communication habits of middle-aged and elderly people and filling the gap in online communication for the elderly population [14].

(2) Promote comprehensive aging friendly visual transformation. Carry out a comprehensive upgrade of the park's signage system, uniformly enlarge the size of signage text, use high contrast color matching, deploy one click triggered intelligent voice explanation devices throughout the area, configure a minimalist operation interface, eliminate complex touch steps, achieve one click access to historical explanations, venue guidance, and cultural interpretation, and comprehensively reduce the visual operation and information acquisition threshold for the elderly population.

(3) Establish a normalized volunteer digital assistance mechanism. Establish dedicated digital assistance volunteer positions in the park, providing convenient services such as shooting guidance, online content publishing, cultural and tourism check-in and sharing for elderly visitors on a regular basis. Through the dual guarantee of hardware aging adaptation and manual digital assistance, the problem of media stratification imbalance is effectively solved, and the dissemination of blast furnace IP is promoted from a single circle of youth to a full age, all domain, and all staff dissemination upgrade.

C. STRENGTHEN THE COLLABORATIVE LINKAGE OF THREE-LAYER COMMUNICATION AND EXTEND THE VALUE OF THE ENTIRE IP INDUSTRY CHAIN

To address the shortcomings of the three-layer communication interface operation, low material conversion efficiency, short IP industry chain, single value realization, and insufficient sustainability of communication heat, we will build a full chain improvement system for material linkage and sharing, diversified business extension, and normalized IP operation

(1) Establish a three-level communication interface material linkage and sharing mechanism to break down the barriers of "physical output digital communication derivative applications" transformation. Unified shooting, image editing, and standardized archiving will be implemented for large-scale offline events such as music festivals, fashion shows, themed exhibitions, and public performances in the park. A dedicated visual material resource library for blast furnace IP will be built, which will be fully open to online digital communication platforms, cultural and creative design teams, and urban publicity ports. This will enable single content production, multi-channel reuse, and full scene adaptation, solving the problems of disjointed physical, digital, and derivative interface content and resource waste.

(2) Expand the multi-level IP physical derivative industry chain and build a three-level gradient IP product matrix: 1) Develop a mass affordable cultural and creative system, develop lightweight products such as stationery, daily cultural and creative products, and commemorative peripherals; 2) Cross border joint high-end product system, linking trendy brands, outdoor brands, urban cultural and creative platforms, developing high value-added products such as industrial style clothing, outdoor equipment, and artistic trendy products; 3) Develop a digital IP asset system, including digital collectibles, virtual visual IP, and immersive VR canal steel symbiosis experience scenes. At the same time, relying on the core IP resources of the blast furnace to connect the canal terminal, old factory buildings, and waterfront industrial relics, a dedicated canal industrial themed City walk cultural and tourism route will be created to improve the landing scenarios of the IP industry.

(3) Build a long-term operation model of "activity empowerment+IP iteration", establish an annual fixed theme activity system, and form a normalized content output mechanism. We will regularly hold brand events such as the annual blast furnace industrial aesthetic art exhibition, the Canal Steel Culture Theme Forum, and the Industrial Heritage Public Art Season. We will continuously iterate and update the visual scenes, themed installations, and artistic content of the venue. Through periodic brand activities, we will continue to activate media dissemination heat and provide fresh communication content for short video and graphic

social media platforms, maintaining the long-term media resonance effect of IP [15].

D. BUILDING AN IP CLOSED-LOOP PROTECTION MECHANISM TO CONTINUOUSLY IMPROVE VISUAL COMMUNICABILITY

To ensure the continuous implementation of visual symbol updates, optimized communication interfaces, and closed-loop industry operations, and to solve the deep-seated problems of imbalanced funding allocation, lagging dynamic optimization, fixed narrative content, and limited communication boundaries, a long-term guarantee mechanism is constructed from four dimensions: dynamic evaluation, funding guarantee, content iteration, and regional linkage:

(1) Establish an annual visual perception dynamic evaluation mechanism, and update the three-dimensional index scores of the site's visual communicability annually based on multi-source data such as eye tracking experiments, public questionnaire surveys, and in-depth audience interviews. Based on the quantitative evaluation results, iterate the spatial landscape, guidance system, night lighting, and narrative scene design in a targeted manner, forming a scientific update logic of "data monitoring problem diagnosis precise optimization".

(2) Establish a special iteration budget for IP vision, adjust the distribution structure of operating income in the park, and allocate a fixed proportion from core revenues such as venue leasing, cultural and tourism activities, and cultural and creative retail as the special budget for IP vision development. The budget will be dedicated to the iteration of visual symbol systems, upgrading spatial visual quality, optimizing nighttime lighting landscapes, creating deep digital content, and updating aging friendly facilities, providing stable and sustainable financial support for the fourth-order closed-loop iteration mechanism.

(3) Build a collaborative innovation platform between industry, academia, and research, linking university design disciplines, journalism and communication disciplines, and historical research teams. Continuously explore implicit cultural resources such as the narratives of Hangzhou Iron and Steel's old workers, memories of factory production, and historical materials of the canal transportation industry symbiosis. Regularly update spatial narrative scenes, visual pattern systems, and digital communication materials, continuously output new IP cultural content and visual symbols, and solve the bottleneck of IP narrative solidification and insufficient production of new content.

(4) Build a cross regional linkage alliance for the industrial heritage of the Grand Canal, break free from the limitations of single site development, and link the industrial heritage resources of cities along the canal such as Suzhou, Wuxi, and Jiaxing. Establish a collaborative development alliance for the industrial cultural IP of the Grand Canal, empower through regional IP collaboration, break down barriers to single scene dissemination, and achieve an upgraded transition from a single point city IP to a regional canal industrial super IP.

VII. CONCLUSION

In the context of postindustrial urban renewal, this article takes the No.1 blast furnace in Hanggang Park of the Grand Canal as an empirical research sample, integrates spatial semiotics, media space theory, visual communication theory, and cultural IP industry theory, constructs an integrated analysis framework for the visual communicability of industrial heritage and the iteration of urban cultural IP, and systematically reveals the generation mechanism, practical bottlenecks, and optimization paths of cultural IP in large-scale industrial installations. The main conclusions are as follows:

(1) Large industrial facilities have a natural endowment of visual communicability resources. Hanggang No.1 blast furnace, with its rare giant vertical scale, fully preserved corroded steel production lines, and highly recognizable industrial texture, has formed a differentiated visual competitive advantage from ordinary urban landscapes, providing an irreplaceable material visual resource foundation for the shaping of independent urban cultural IP.

(2) The visual communicability of industrial equipment is the core endogenous driving force for the iterative upgrading of industrial heritage IP, forming a fourth-order closed-loop generation mechanism of "visual symbol extraction - communication interface reconstruction - cross media resonance communication - IP industry value transformation". The empirical results of structural equation modeling confirm the progressive coupling logic of "visual resources communication interface cultural IP", revealing the inherent mechanism of the transition of large-scale industrial relics from physical space to cultural IP in the postindustrial era.

(3) At present, there are still structural bottlenecks in the revitalization and development of the IP of Hanggang No.1 blast furnace. This study constructs a comprehensive, implementable, and recyclable optimization path from four dimensions: iterative integration of visual symbol system, opening up of communication channels for all ages and regions, extension of multi-level IP industry chain, and systematic long-term iteration guarantee, fully unleashing the cultural dissemination value and tourism industry value of industrial heritage.

In response to the large number of industrial relics along the Grand Canal, revitalization and renewal should pay more attention to evaluating and enhancing the visual communicability of industrial facilities, building multi-level, composite, and linked communication interfaces, and relying on scarce industrial visual symbols to shape differentiated urban cultural IP. In the future, through multiple case comparisons, long-term longitudinal tracking, and quantitative model optimization, the theoretical system of industrial heritage visual communication and cultural IP iteration generation can be further improved, providing more universal theoretical

support for postindustrial renewal and canal cultural IP revitalization in China.

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