



Research on the Digital Translation Model of Visual Symbols of Industrial Heritage: A Case Study of Liaoning Province

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Abstract. Industrial heritage, as a unique type of cultural resource, carries rich historical memories and aesthetic values. However, its visual symbols face difficulties in contemporary transmission due to a lack of systematic translation methods. This paper takes Liaoning Province, a representative old industrial base in China, as a case study to construct a theoretical model for the digital translation of visual symbols of industrial heritage. Based on semiotic theory and fundamental design methods, a four-stage translation framework of "extraction - classification - translation - application" is proposed. Through a systematic analysis of the visual characteristics of Liaoning's industrial heritage, including mechanical structures, factory forms, and tool profiles, a classification system and basic design translation pathways are established, providing theoretical references for the digital protection and innovative application of industrial heritage cultural resources.

Keywords: Industrial heritage; visual symbols; digital translation

1 Introduction

This paper explores the protection and revitalization of industrial heritage in Liaoning, a representative old industrial base in China. Unlike general industrial sites, Liaoning's heritage features diverse sectors—steel, machinery, and mining—each with distinct visual symbols shaped by decades of heavy industry. Amid economic transformation, these landscapes face demolition or idleness. While digital technologies aid conservation, existing studies lack systematic methods for visual symbol extraction, semiotic classification, and design-driven transformation—three key levels of digital translation that this study addresses. A structured review of related studies is provided in Section 2 to position this research within existing work.

2 Literature Review

2.1 Industrial Heritage and Its Visual Dimension

Industrial heritage encompasses sites, structures, machinery, and artifacts related to industrial activities that have historical, technological, social, architectural, or scientific value¹. Beyond material protection, scholars increasingly recognize the importance of the non-material dimension, including the visual culture of industrialization². The visual symbols in industrial heritage—such as mechanical forms, factory outlines, tool shapes, and signage—carry condensed meanings, reflecting specific historical periods, production methods, and social values.

Compared to research on architectural preservation or tourism development, studies on visual symbols of industrial heritage remain relatively limited. Existing contributions include records of industrial architectural styles³ and analyses of industrial design aesthetics⁴. However, there is still a lack of systematic methods for extracting and transforming industrial visual symbols for contemporary application. Most research views visual elements as recorded materials rather than design resources, neglecting their potential in cultural innovation.

2.2 Semiotic Foundations of Visual Symbols

Semiotics provides a theoretical foundation for understanding how visual symbols convey meaning. According to Saussure's distinction between signifier and signified, as well as Peirce's triadic model of iconic signs, indexical signs, and symbolic signs, visual symbols can be analyzed across multiple dimensions⁵. For industrial heritage, mechanical forms function as iconic, indexical, and symbolic signs of objects, processes, and culture.

Semiotics classifies industrial heritage symbols into iconic, indexical, and symbolic types, guiding digital translation strategies.

2.3 Digital Translation of Cultural Heritage

Digital translation refers to the conversion of cultural heritage elements into digital formats while transforming them into new applications without losing their core meanings. In cultural heritage research, digital technologies have been applied for recording, visualization, and dissemination⁶. However, "translation" implies going beyond the technical aspects of digitization—it involves semiotic transformations across media and contexts.

Recent studies have explored various digital methods for different types of heritage. For architectural heritage, 3D scanning and digital modeling techniques have achieved accurate recording⁷. For intangible heritage, digital storytelling and interactive media support cultural transmission⁸. Nevertheless, there is still a lack of research on digital translation models specifically targeting visual symbols of industrial heritage. Most existing work focuses either on technological preservation or design applications, without integrating both dimensions into a coherent framework. Therefore, this study proposes a four-stage digital translation model to address the gap.

3 Theoretical Framework: Digital Translation Model

Based on semiotic theory and the specific visual characteristics of industrial heritage—such as mechanical forms, material textures, and functional traces—this paper proposes a four-stage digital translation model tailored to industrial visual symbols: extraction, classification, translation, and application. Unlike conventional design workflows, this model integrates Peirce’s triadic semiotics (icon, index, symbol) into the classification stage and prioritizes culturally faithful transformation methods (e.g., geometric simplification, texture extraction) over arbitrary stylization. (As shown in Table 1).

Table 1. Four-Stage Model of Digital Translation

Stage	Core Task	Main Methods	Output Results
Extraction	Identification and Collection of Visual Symbols	Field Shooting and Archival Research	Original Symbol Library
Classification	Establish a Typology System	Semiotic Analysis and Morphological Classification	Classified Symbol Catalogue
Translation	Convert into Basic Design Assets	Vector Drawing, Graphic Simplification, Color Extraction and Structural Reorganization	Digital Symbol Library
Application	Adapt to Design Scenarios	Brand System, Wayfinding Design and Cultural & Creative Product Design	Design Application Scheme

3.1 Extraction

Extraction identifies visual symbols from Liaoning’s industrial heritage, including sites, machinery, tools, infrastructure, and archives. Methods: field photography, archival research, and literature review using representative sampling across sectors, periods, and characteristics, while recording context like source, function, and materials. Sample screening criteria were strictly formulated: only physically accessible heritage sites with prominent visual features and complete historical archives were included. The validity of symbol extraction was verified via archival image comparison and expert evaluation conducted by three professional design scholars.

3.2 Classification

The classification stage uses a dual-axis system: semiotic type (iconic, indexical, symbolic) and form category (geometric, organic, structural, texture), providing a basis for differentiated translation strategies.

3.3 Translation

Translating through basic design operations, the classification symbols are transformed into digital visual assets. For different types of symbols, the following methods are used:

Basic geometric simplification. - simplifying complex forms into basic geometric shapes such as circles and squares, suitable for geometric and structural symbols.

Line drawing extraction and vectorization. - extracting outlines to generate vector graphics, suitable for all types of symbols.

Positive-negative shape conversion. - reversing the relationship between the figure and background, suitable for clearly outlined or hollow symbols.

Color system extraction. - sampling from industrial materials like rust red and cement gray to form a 3-5 color industrial palette.

Repetition and compositional restructuring. - organizing into continuous or grid patterns using techniques like repetition and rotation.

Local magnification and detail emphasis. - selecting highly recognizable areas to magnify as visual focal points. The above methods are simple to operate, requiring only basic design software while maintaining cultural recognizability.

3.4 Application

The application stage deploys the translated digital symbols into design contexts, including visual identity systems (brand logos), wayfinding systems (signage design), cultural products (notebooks, canvas bags), exhibition visuals (displays, posters), and publication design (illustrations, decorative elements). The application principle is "cultural adaptation"—using symbols in a manner that respects their original contextual meanings, avoiding misuse or distortion.

4 Case Application: Industrial Heritage in Liaoning

4.1 Overview of Liaoning's Industrial Heritage

The industrial development of Liaoning spans three major periods: the late Qing Dynasty (establishment of modern enterprises), the Republic of China period (further industrial growth), and the socialist industrialization period after 1949. Major industrial sectors include steel production (Ansteel, Benxi Steel), machinery manufacturing (Shenyang Machine Tool Factory), coal mining (Fushun Open-pit Mine), and chemical industry. These sectors have formed their unique visual symbol systems.

4.2 Symbol Extraction from Representative Cases

Case 1 (Shenyang Machine Tool): lathe outlines, gear patterns, modular structures. Case 2 (Anshan Steel): blast furnace forms, molten steel tanks, pipeline networks, massive volumes and metallic textures. Case 3 (Fushun Mine): terraced excavation profiles, mine cart shapes, coal seam textures, horizontal layering and rigid outlines.

4.3 Classification Results

As illustrated in Table 2, three categories of visual symbol cases of Liaoning industrial heritage are summarized.

Table 2. Classification of Visual Symbols of Liaoning Industrial Heritage

Form Category	Icon	Index	Symbol
Geometric	Gear, Wheel, Bolt	Cutting traces, scale lines	Factory Contour Lines
Organic	Curves of Cooling Tower, Turning Pipes	Rust patches, weld texture	Chimney Smoke Morphology
Structure	Truss, Conveyor Belt, Assembly Line	Structural deformation traces	Workshop Group Contour
Texture	Rivet Arrangement, Brick Texture	Wear marks, scratches	Scaffold Grid

4.4 Basic Design Translation Examples

This study applies three translation pathways using selected symbols(As shown in Figure 1):

1. Lathe outline (Shenyang): geometric simplification + vectorization – simplifying spindle box, guide rail, tailstock into basic shapes for brand logos.
2. Steel rust texture (Anshan): color extraction + repeated composition – creating an industrial palette and rivet dot patterns for packaging or covers.
3. Terraced mine profile (Fushun): local magnification + positive-negative transformation – generating abstract graphics for wayfinding icons or cultural prints.

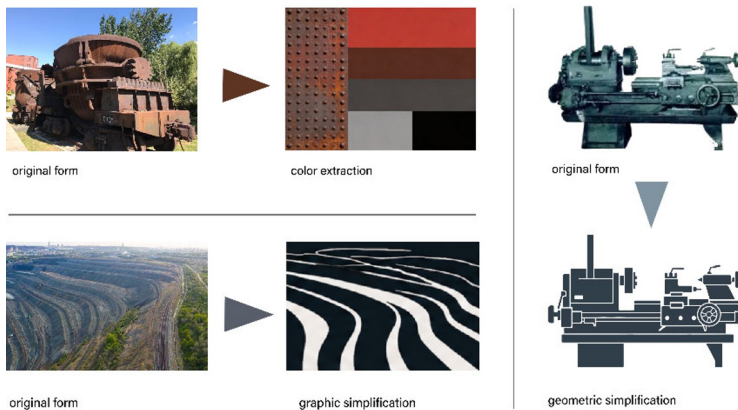


Fig. 1. Schematic of Digital Translation Samples.

4.5 Design Application Illustration

Integrating the above translation results into an illustrative design application scheme.(As shown in Figures 2, 3 and 4).

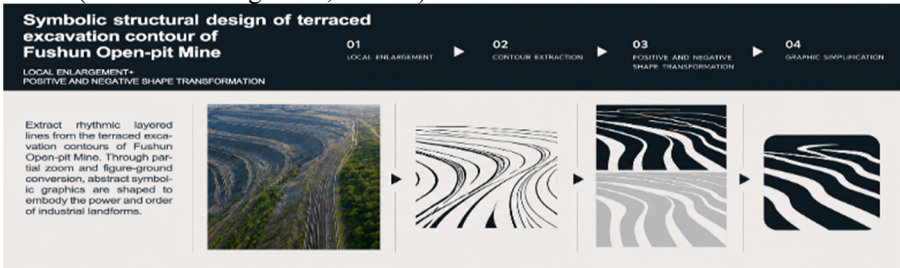


Fig. 2. Schematic Diagram of Digital Translation for Fushun Open-pit Mine.



Fig. 3. Schematic Diagram of Digital Translation for Anshan Iron and Steel.

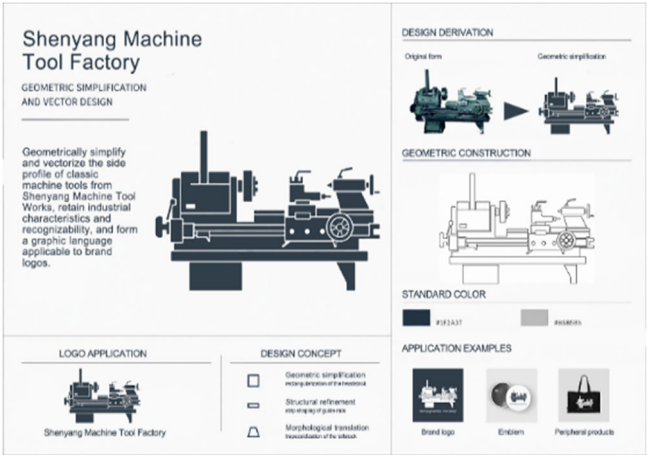


Fig. 4. Schematic Diagram of Digital Translation for Shenyang Machine Tool Factory.

5 Discussion

5.1 Theoretical Contributions

This study contributes a systematic framework for industrial heritage visual symbols, integrates Peirce's semiotics with basic design methods, and proposes "digital translation" to preserve meaning beyond mere recording.

5.2 Advantages of Basic Design Translation

Basic design translation offers high operability (fundamental skills), low tool threshold (common software like Illustrator), strong controllability (no black-box issues), and high cultural fidelity (retains original characteristics), avoiding risks of excessive technical processing.

5.3 Limitations and Future Research

Limitations: heavy industry focus, cultural context needs, and lack of validation. Future work: expand symbol database, conduct design practices, and integrate with 2D animation or dynamic posters.

6 Conclusion

Using Liaoning's industrial heritage, this study proposes a four-stage model—extraction, classification, translation, and application—integrating semiotics and basic design. Validated through three cases, it shows that basic design-driven digital translation retains cultural recognizability and transforms industrial heritage into adaptable digital assets for revitalization.

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