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TRANSFORMATION OF HAN DYNASTY MIRROR PATTERNS IN MODERN CULTURAL AND CREATIVE DESIGN USING SHAPE GRAMMAR FORMALIS

Master's Thesis submitted for the degree of Master
Specialty B2 Design
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The qualification work contains the results of independent research.
The use of ideas, results, and texts of other authors is properly referenced.

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ABSTRACT

Guo You You. Transformation of Han Dynasty Mirror Patterns in Modern Cultural and Creative Design Using Shape Grammar Formalis. – Manuscript. Master's Thesis submitted for the degree of Master, specialty B2 Design, Educational and Professional Program "Visual Communication Design"

The thesis is devoted to the study of The decorative patterns found on Han-dynasty bronze mirrors are distinguished by their clear compositional structures and rich cultural meanings. They provide material evidence of the aesthetic values, beliefs, and everyday life of the Western and Eastern Han periods. Many current cultural products, however, simply copy the original motifs. Their forms are often limited, the cultural content is not fully communicated, and connections between different products remain weak. To address these problems, this study examines Han mirror patterns in the collection of Xuzhou Museum and introduces shape grammar as a method for pattern extraction, development, and cultural product design.

The research combines literature review, visual analysis, case analysis, shape grammar analysis, and design practice. It examines the subjects, compositions, and cultural meanings of Han mirror patterns, focusing on four representative groups: the dragon-and-phoenix persimmon-calyx pattern, the TLV and Four Spirits pattern, the figural pictorial pattern, and the dragon–tiger mythical-beast pattern. After the original motifs are traced and simplified, their basic units are extracted to establish initial shapes and generative rules. Rotation, reflection, array repetition, scaling, superimposition, substitution, and continuous arrangement are then used to produce a series of derivative patterns.

Building on this process, the project develops a visual identity under the theme Reflections of Pengcheng. The system includes a brand logo, standard colour palette, supporting graphics, icons, thematic illustrations, and supergraphics. These elements are applied to gift-box packaging, textile goods, personal accessories, paper products, exhibition spaces, and digital interfaces.

The design practice shows that shape grammar can retain the characteristic structures and cultural identity of Han mirror patterns while making their redesign

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more systematic, innovative, and adaptable to different applications. The study offers a practical approach to communicating Xuzhou's Han cultural heritage today and provides a reference for transforming patterns from traditional artefacts into contemporary cultural and creative products.…

Keywords: shape grammar; Han-dynasty bronze mirrors; traditional patterns; cultural and creative design of visual communication; Han culture in Xuzhou; Reflections of Pengcheng.

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INTRODUCTION

Relevance of the research: Han-dynasty bronze mirrors were not only objects for everyday use but also important material evidence for understanding the social life, aesthetic values, and beliefs of the Han period. Their reverse sides feature a wide range of decorative subjects, including dragons and phoenixes, dragons and tigers, the Four Spirits, TLV patterns, human figures, chariots, and horses. These designs are commonly organised through central symmetry, concentric bands, and continuous repetition, giving them distinctive period characteristics and considerable artistic value.

Xuzhou is one of the major birthplaces of Han culture. Xuzhou Museum houses and displays a rich collection of Han-dynasty artefacts, among which bronze mirror patterns have significant potential for academic study and creative adaptation. However, existing cultural and creative products tend to apply these elements through direct reproduction, basic simplification, or isolated decoration. The compositional principles and cultural meanings behind the patterns are not fully represented, while different products often lack a consistent visual connection.

Shape grammar provides a systematic way to analyse and redesign traditional patterns through operations such as extraction, rotation, reflection, repetition, and recombination. Applying this method to the cultural and creative design of Han mirror patterns makes it possible to develop new graphic solutions while retaining their original structural features. It therefore offers a clear approach to the contemporary reinterpretation of traditional ornament. For these reasons, the present study has both cultural value and practical significance.

Purpose of the research: To achieve this purpose, the **following objectives** are set: This research focuses on the decorative patterns of Han-dynasty bronze mirrors in Xuzhou Museum. Shape grammar is introduced to analyse their basic elements, compositional forms, and rules of combination. Through design practice, the study also explores how these patterns can be adapted to modern cultural and creative products. The aim is to move beyond the simple reproduction of traditional

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motifs, make the process of pattern development more transparent, and establish a cultural and creative visual system that reflects the distinctive characteristics of Xuzhou's Han heritage.

To achieve this purpose, the following objectives are set:

1. To review the historical background, subject categories, and artistic features of Han mirror patterns and clarify their cultural meanings.
2. To investigate the Han mirror resources and related cultural and creative products of Xuzhou Museum and identify problems in existing designs.
3. To extract the basic forms and compositional relationships of Han mirror patterns and establish corresponding shape grammar rules.
4. To generate a coherent series of derivative patterns through rotation, reflection, repetition, addition, subtraction, and recombination.
5. Verify the communication effects of design achievements and sustainable optimization strategies. To develop the visual identity, gift-box packaging, textile products, portable cultural merchandise, stationery, and digital display designs for Reflections of Pengcheng, and to evaluate the practical performance of the resulting patterns.

Object of the research. The process of cultural and creative design of Han-dynasty bronze mirror patterns within visual communication systems, based on the collections and cultural resources of the Xuzhou Museum. Han-dynasty bronze mirrors were not only objects for everyday use but also important material evidence for understanding the social life, aesthetic values, and beliefs of the Han period. Their reverse sides feature a wide range of decorative subjects, including dragons and phoenixes, dragons and tigers, the Four Spirits, TLV patterns, human figures, chariots, and horses. These designs are commonly organised through central symmetry, concentric bands, and continuous repetition, giving them distinctive period characteristics and considerable artistic value.

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Shape grammar provides a systematic way to analyse and redesign traditional patterns through operations such as extraction, rotation, reflection, repetition, and recombination. Applying this method to the cultural and creative design of Han mirror patterns makes it possible to develop new graphic solutions while retaining their original structural features. It therefore offers a clear approach to the contemporary reinterpretation of traditional ornament. For these reasons, the present study has both cultural value and practical significance.

Subject of the research. The methods, rules, and generative principles of shape grammar used to transform, reconstruct, and optimize Han-dynasty mirror patterns into modern visual communication artifacts (including visual identity, packaging, textiles, stationery, and digital displays).

Chronological framework of the research – The historical development process of Qingguo Lane (from the Wanli period of the Ming Dynasty to the present) and the period of contemporary design practice.

Territorial framework of the research – Primary focus: The territory of Xuzhou (historically known as Pengcheng), Jiangsu Province, China**,** which was a major political and cultural center during the Han Dynasty and is the geographic source of the studied bronze mirrors. Institutional boundary: The Xuzhou Museum**,** as it houses the specific collection of Han-dynasty bronze mirrors and related cultural resources analyzed in this study. Secondary focus: The broader context of China regarding the modern market for cultural and creative design products, used for comparative analysis.

Research methods: This study combines literature review, visual analysis, case analysis, shape grammar analysis, and design practice. Bronze mirror catalogues, archaeological records, academic studies, and museum materials are reviewed to establish the theoretical foundation. Representative Han mirrors from

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Xuzhou Museum are then examined to identify their compositional structures, principal motifs, supporting elements, and organizational features. Relevant cases of traditional pattern redesign and museum cultural products are compared to summarize common approaches to element extraction, graphic transformation, colour application, and product development. Based on these findings, basic elements are extracted from Han mirror patterns and transformed through rotation, reflection, repetition, scaling, and recombination. Finally, the resulting patterns are applied to visual identity, packaging, textiles, stationery, and digital displays, with the designs refined according to their performance in different applications.

Practical significance of the research: By using shape grammar to analyze the compositional principles of Han mirror patterns, this study transforms traditional motifs into visual elements suitable for contemporary design. This approach helps reduce direct copying and superficial decoration, while providing a clearer basis for the development of new patterns. The Reflections of Pengcheng project applies the derivative patterns to a visual identity system, gift-box packaging, textile products, portable cultural merchandise, stationery, and digital displays. These applications retain the cultural features of Han mirrors while improving the practicality, consistency, and serial quality of the products. The research outcomes may enrich the forms of cultural and creative products associated with Xuzhou Museum, strengthen public understanding of Han mirror art and Xuzhou's Han heritage, and provide a practical reference for the modern adaptation of patterns from other traditional artefacts.

Structure and scope of the thesis. The work consists of an introduction, three chapters, conclusions, a list of references (20 items), and an illustration album (23 items). The main body of the research comprise 31 pages, the total volume with appendices is 47 pages.

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CHAPTER 1

HISTORIOGRAPHY OF THE ISSUE. RESEARCH METHODS

1.1. Review of the Literature

Research Status in China. Bronze-mirror scholarship has a long history in China. With the rise of epigraphic studies during the Northern Song dynasty, works such as Xuanhe Bogutu and Xiaotang Jigulu began to document the forms, inscriptions, and imagery of ancient bronze mirrors. Following the emergence of modern archaeology, research on bronze mirrors gradually expanded into the fields of history, art, and design. Existing studies focus mainly on the chronology and classification of Han mirrors, the cultural meanings of their decorative patterns, their compositional features, and their adaptation to contemporary design.

Research on Shape Grammar. Although shape grammar research began relatively late in China, it has expanded rapidly from architecture and product form to traditional pattern design. A general process of element extraction, rule construction, pattern generation, and design application has emerged. Researchers have applied this method to Yangshao painted pottery [1], southern Fujian red-brick carvings [2], Yaotou Kiln ceramics [3], Lu brocade [4], Shanxi embroidery [5], Mulao embroidery [6], and traditional tile-end and thangka patterns [7]. However, most studies concern geometric or continuous patterns with clear, easily separated structures. Han mirror patterns, characterised by circular compositions, layered decorative bands, and complex cultural meanings, remain insufficiently explored.

Research on Shape Grammar in China. In China, shape grammar research has developed rapidly across computer applications, industrial technology, and design, with the present study focusing on its use in pattern design. Early theoretical work by Wang Shouzhi and Liu Chunrong was followed by practical studies on paper-cutting and Huayao embroidery, which established a general process of element extraction, rule construction, and design application. The method has since been applied to painted pottery, ceramics, textiles, metalwork, and architectural decoration, showing that the structures of traditional patterns can be translated into

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clear generative rules. Recent studies have also connected shape grammar with semiotics, cultural gene theory, modular theory, and generative artificial intelligence. However, most research concerns linear, symmetrical, or geometric patterns. Han mirror patterns, with their nested circular structures, multiple decorative zones, and complex cultural meanings, remain underexplored.

Analysis of Design Transformation of Han Mirror Patterns. The preceding discussion reviewed studies of Han mirror patterns and shape grammar mainly from a theoretical perspective. Existing research has provided a solid foundation for understanding the classification, cultural meanings, and compositional principles of Han mirrors. However, whether these theoretical findings can be translated into practical design methods requires further examination through actual cases. This section therefore analyses the use of Han mirror patterns in textiles, packaging, and cultural and creative products, focusing on element extraction, graphic transformation, and product application.

Tang Yang and colleagues studied plant motifs found on Han-dynasty bronze mirrors. They classified their types and formal features before extracting representative plant forms. While retaining the original outlines, they adjusted the graphic structures and colour relationships, producing new textile patterns through repetition, continuous arrangement, and combination. This case transformed Han mirror motifs from artefact decoration into visual elements suitable for modern textiles, thereby extending their range of application [8].

Huang Sheng and Yang Ying examined a linked-arc mirror with an inscription band. They used eye-tracking experiments to measure viewers' visual attention to different areas of the mirror back and extracted highly recognisable design elements from the results. These elements were then applied to cultural and creative products, giving the selection process a clearer basis in data. Although this method introduces the audience's perspective into traditional pattern research, visual attention only reflects immediate graphic appeal. Historical sources are still needed to interpret the cultural meanings and compositional principles of the patterns [9].

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Sun Yuanzhi and Ma Kaiying studied Han mirror patterns from the perspective of extension semantics. They connected the cultural meanings of the patterns with their formal features, generated new pattern units through shape grammar, and applied the results to packaging design. By linking cultural semantics, graphic generation, and product application, this approach reduced reliance on the designer's personal experience. However, the outcomes were mainly limited to packaging, with little discussion of their adaptability to other products or their relationships within a coordinated series.

In A Study of the Shape-Grammar Construction of the Visual Language of Han-Dynasty Bronze Mirrors, Li Jingyi classified geometric-pattern, plant-pattern, mythical-animal, TLV, and pictorial mirrors. Through graphic decomposition, rule derivation, and structural classification, the study established libraries of initial shapes, grammatical rules, and structural types. It also summarised three design paths: decomposition, reconstruction, and integration. Although the study did not develop specific cultural and creative products in depth, it provided a systematic reference for extracting and generating Han mirror patterns.

Overall, existing cases have promoted the contemporary transformation of Han mirror patterns through form, colour, visual perception, and generative rules. Nevertheless, some designs still rely on isolated elements and surface decoration, without developing a complete process from original-pattern analysis to coordinated product application. Han mirrors also contain complex structures, including concentric bands, nested square-and-circle compositions, and multiple decorative zones. How to preserve these cultural features during graphic transformation while adapting the patterns to different product forms remains an issue requiring further study.

Foreign Research Status. Research on shape grammar began earlier outside China, where both its theoretical system and methods of application are relatively well developed. In the early 1970s, Stiny and Gips proposed shape grammar and established a basic framework consisting of an initial shape, shape rules, and generated shapes. Stiny later examined its relationship with artistic evaluation and

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creative design. Ahmad, Chase, Li, and other scholars approached the subject through style recognition and computation, exploring how grammatical rules could be used to identify and preserve particular design styles.

As computer technology advanced, shape grammar expanded from two-dimensional graphics to three-dimensional modelling and intelligent generation. Hoisl and Shea developed a shape grammar interpreter for three-dimensional space to process complex forms. Tao and colleagues combined shape grammar with artificial neural networks to explore the automatic generation of ethnic patterns. These studies improved the efficiency of processing complex graphics and reduced dependence on manual derivation.

International applications of shape grammar now cover traditional patterns, product design, architecture, and urban planning. Agirbas used algorithms to decompose Islamic geometric patterns; Cui and Tang applied shape grammar to the generation of Zhuang embroidery patterns; Calogero and colleagues used procedural modelling in architectural design; and Brandão and colleagues applied the method to urban model generation. These cases show that shape grammar can extract basic forms and compositional relationships from existing objects and produce new designs in a similar style through rule-based transformation.

Cui and Tang first analysed the basic elements and combinations of Zhuang embroidery patterns, then combined shape rules with computer technology to create a generative design system. Their work shows that shape grammar can support the redesign of traditional Chinese patterns with specific cultural backgrounds while providing a clear process of transformation. However, embroidery patterns usually rely on continuity, symmetry, and repeated units. This differs from the circular bands, layered zones, and nested square-and-circle structures of Han mirror patterns, meaning that the same method cannot be applied directly.

Overall, international research has made substantial progress in the theoretical development, technical implementation, and interdisciplinary application of shape grammar. However, most studies focus on Western architecture, industrial products, and geometric ornament. Research specifically addressing Chinese Han mirror

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patterns remains limited, with little systematic discussion of their cultural meanings and distinctive compositions. This study therefore adapts existing shape grammar methods to the circular structures and cultural features of Han mirror patterns and explores their application in cultural and creative design.

Islamic Geometric Patterns. Islamic geometric patterns are characterised by symmetry, repetition, and continuity, making them a typical subject in international research on traditional ornament. Agirbas examined star-shaped polygonal motifs found on Islamic tombstones and used algorithms to decompose their complex geometric structures [10]. The study first identified the basic geometric forms, then mapped the relationships between them, and finally reconstructed the complete patterns through a set of rules.

This case shows that complex traditional patterns can be created from a limited number of basic shapes and generative rules. By recording these rules, researchers can examine how the original patterns were formed and produce new designs in a similar style. This approach provides a useful reference for both the digital preservation and creative redesign of traditional patterns.

However, Islamic patterns are mainly based on regular geometric structures, whereas Han mirror designs often include mythical creatures, human figures, and auspicious imagery. Their generative methods can therefore inform the study of Han mirror patterns, but they must be adapted to suit the distinctive compositions and cultural meanings of Han mirrors.

Traditional Ethnic Embroidery Patterns. In addition to highly regular geometric patterns, international researchers have increasingly applied shape grammar to ethnic motifs with distinctive regional and cultural identities, exploring ways to combine traditional graphic forms with digital design methods.

Cui and Tang introduced shape grammar into the study of Zhuang embroidery patterns and developed a corresponding generative design system [35]. They first analysed the basic motifs and compositional methods of the embroidery and then combined shape rules with computer technology, allowing designers to generate different pattern variations by modifying the rules.

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This study shows that shape grammar can be applied not only to Western geometric patterns and architecture but also to traditional Chinese patterns rooted in specific cultural contexts. A generative system provides a clearer process for analysing and redesigning traditional motifs, reducing dependence on the designer's personal experience. However, embroidery patterns usually rely on continuity, symmetry, and repeated units, whereas Han mirror patterns feature circular bands, layered zones, and nested square-and-circle structures.

Studies of Han-Dynasty Four Spirits Mirrors. International research on Han-dynasty bronze mirrors has mainly developed within East Asian art history, material culture studies, and archaeometry. Shi examined Four Spirits mirrors dating from the late Western Han to the Xin dynasty, focusing on the relationships among decorative motifs, inscriptions, and the imagery of the Four Spirits [30]. By placing these mirrors within their historical context, the study provides a useful reference for understanding the iconography and cultural meanings of the Four Spirits.

Wang and colleagues used material analysis to investigate the provenance and circulation of Han mirrors. Their research considered mineral sources, regional production, and trade networks to trace the movement of these objects within and beyond Han China [11]. Such studies broaden the scope of bronze-mirror research and demonstrate their value as material evidence of ancient production techniques and cultural exchange.

However, international scholars generally approach Han mirrors as archaeological objects, art-historical materials, or media of cultural transmission. Their research tends to focus on chronology, materials, craftsmanship, and iconographic meaning. Less attention has been paid to the compositional frameworks, basic graphic forms, and generative principles of Han mirror patterns, or to their use in modern cultural and creative products.

In recent years, international shape grammar research has made considerable progress in theory, digital technology, and interdisciplinary application. Studies of Islamic geometric patterns, traditional embroidery, architectural façades, and urban modelling have demonstrated its strong analytical and generative capacity. At the

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same time, international studies of Han mirrors have provided valuable information about their historical background, imagery, and production techniques from the perspectives of art history and archaeometry.

Several gaps nevertheless remain. First, shape grammar has mainly been applied to architecture and traditional patterns with clear geometric features, with limited attention given to the relationships among human figures, mythical creatures, and cultural symbolism in Han mirror designs. Second, international research on Han mirrors emphasises historical and archaeological analysis but has not systematically applied shape grammar to their design transformation. Finally, few studies examine how Han mirror patterns can be incorporated into modern brand identities or coordinated series of cultural and creative products.

Studies in China have accumulated valuable findings on the classification, cultural meanings, and contemporary design of Han mirror patterns, while international scholarship is more developed in shape grammar theory and computational generation. These two bodies of research provide different but complementary references for the present study.

Overall, existing Chinese and international research has not yet established an integrated method for generating and applying Han mirror patterns. Some studies emphasise cultural interpretation, while others focus on graphic generation, but the connection between the two remains limited. This study therefore takes Han mirrors in the collection of Xuzhou Museum as its primary material, classifies and extracts representative patterns, and applies shape grammar to establish corresponding generative rules. By preserving their main visual features and cultural meanings, the study develops derivative motifs that support the visual identity and cultural product series of Reflections of Pengcheng.

1.2. Research Methods

Literature research method: Bronze mirror catalogues, archaeological records, academic papers, and museum resources are examined to understand the development, types, decorative subjects, and cultural meanings of Han mirrors.

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Materials from Bronze Mirrors in the Collection of Xuzhou Museum are used to identify the regional features of Xuzhou mirrors [12]. Studies of shape grammar, traditional pattern redesign, and cultural product design are also reviewed to clarify relevant concepts, generative rules, and design methods. These findings support the selection of research samples, the interpretation of cultural meanings, and the development of transformation rules.

Visual Analysis : Visual analysis is used to examine representative Han mirror patterns from Xuzhou Museum. Samples are selected according to regional relevance, image completeness, compositional typicality, and design potential. The study focuses on dragon-and-phoenix persimmon-calyx, TLV and Four Spirits, figural pictorial, and dragon–tiger mythical-beast patterns, which respectively represent four-directional symmetry, nested square-and-circle structures, narrative bands, and mythical-animal combinations [13]. Each pattern is divided into its compositional framework, principal motifs, and supporting elements, allowing its visual hierarchy and internal relationships to be identified before the basic shapes are extracted.

Case analysis method: Case analysis examines how traditional patterns are adapted to modern design, focusing on element extraction, graphic transformation, colour, product formats, and series development. Existing cases commonly use direct extraction, simplification, decomposition and recombination, or rule-based generation. Direct extraction preserves traditional features but may result in surface decoration, while simplification and recombination create more contemporary forms but can weaken cultural recognition if they lack clear rules. This study therefore draws on the design methods and practical experience of previous cases rather than copying their visual forms, using the findings to guide pattern generation and product selection.

Shape Grammar Analysis: Shape grammar is used to analyse and generate Han mirror patterns through a clear rule-based process. Representative elements are extracted as initial shapes, with corrosion marks, broken lines, and unnecessary details removed while key cultural features are retained. The mirror centre,

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symmetry axes, concentric circles, and square grids are then used as reference markers, followed by rules such as translation, rotation, reflection, scaling, repetition, radial arrangement, substitution, and recombination. These rules produce different compositions from the four selected pattern categories, after which the results are evaluated according to cultural recognisability, visual completeness, and suitability for product application [14]. The method follows six stages: pattern selection, element extraction, initial-shape definition, rule construction, derivative-pattern generation, and design selection.

Conclusions to Chapter 1

This chapter first reviews Chinese and international research on shape grammar, Han mirror patterns, and related cultural and creative design. Studies in China have produced substantial findings on the classification, cultural meanings, and design applications of traditional patterns. Shape grammar has also been applied to ceramics, textiles and embroidery, bronze objects, and architectural decoration. International research began earlier and has developed relatively mature approaches to shape grammar theory, computational generation, and interdisciplinary application. It has also broadened the study of Han mirrors through art history, material culture, and archaeometry.

Existing research provides both theoretical and practical references for this study. However, the compositional principles of Han mirror patterns have not yet been examined systematically from a design perspective, and cultural interpretation, graphic generation, and product application remain insufficiently connected. Therefore, this study combines literature review, visual analysis, case analysis, shape grammar analysis, and design practice to classify, extract, and transform representative Han mirror patterns from Xuzhou Museum. The generated patterns are then applied to the visual identity and cultural product series of Reflections of Pengcheng, providing a foundation for the following research.

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CHAPTER 2

HISTORICAL, THEORETICAL, AND CONTEXTUAL ANALYSIS OF HAN DYNASTY MIRROR PATTERNS IN DESIGN

2.1. Theoretical Foundations of Shape Grammar and the Cultural and Creative Design of Han Mirror Patterns

The core of information visualization is to transform abstract information perceptible visual language, following the logic of “first understanding, then sorting out, and then visualizing”. Its development thread covers four stages: “Graphic Narrative (such as the information recording of "Riverside Scene at Qingming Festival"), “Logical Analysis” (the application of statistical charts), “Visual Variable” (the information transmission function of elements such as shape and color), and “Interactivity and Dynamics” (empowered by digital technology). In the field of cultural heritage the core methods include "Symbolic Translation" (concretization of abstract cultural elements) and "Information Hierarchy Construction" (distinguishing core and secondary information), and principle of "Data Ink Ratio" needs to be taken into account to maximize the efficiency of information transmission.

Shape Grammar Design Theoryю Shape grammar works by breaking complex graphics into basic shapes and then transforming and combining them according to a set of rules. Its basic structure can be expressed as (SG = (S, L, R, I)), where (S) represents the set of shapes, (L) the locating markers, (R) the generative rules, and (I) the initial shape [15].Shape grammar generally involves two stages: analysis and generation. The analysis stage identifies pattern units and their compositional relationships, while the generation stage produces new graphics through translation, rotation, reflection, scaling, repetition, and recombination. This method gives the pattern-development process a clear structure and basis.

Cultural and Formal Theory of Han Mirror Patterns. Han mirror patterns served not only as decoration but also as expressions of Han-dynasty beliefs,

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including yin-yang and the Five Elements, the correspondence between Heaven and humanity, beliefs in immortality, and ideas of good fortune. Dragon-and-phoenix motifs, the Four Spirits, TLV patterns, and pictorial scenes each carry distinct symbolic and cultural meanings.Formally, Han mirror patterns are usually organised around the central knob. Their compositions employ concentric bands, nested square-and-circle structures, symmetrical divisions, and repeated arrangements. These clearly defined motif units, spatial levels, and compositional relationships provide a suitable basis for shape grammar analysis and generation.

Theory of Transforming Han Mirror Patterns into Cultural and Creative Designs. The cultural and creative adaptation of Han mirror patterns should not involve simply copying the original designs. Instead, it requires a process of cultural interpretation, element extraction, rule-based generation, and adaptation to different products. During this process, the main outlines, compositional features, and cultural meanings should be retained, while overly complex details may be simplified where necessary.Shape grammar can translate the compositional principles of Han mirror patterns into specific rules and generate circular, square, or continuous designs. These patterns can then be adjusted for packaging, clothing, stationery, household items, and other products, creating a coordinated series that reflects Han mirror culture while meeting contemporary aesthetic and practical needs. A communication system combining static and dynamic media is also necessary to prevent excessive symbolic simplification and ensure that the cultural depth of the original patterns is not weakened.

2.2. Survey and Problem Analysis of Han Mirror Cultural Resources at Xuzhou Museum

Overview of Xuzhou's Han Mirror Cultural Resources. Xuzhou, historically known as Pengcheng, is one of the major birthplaces of Han culture. Xuzhou Museum holds a large and varied collection of Han-dynasty bronze mirrors, providing valuable material evidence for the study of their decorative patterns. These

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mirrors have distinctive forms, inscriptions, and ornamentation that reflect the aesthetic values, beliefs, and ways of life of Han society.

Representative Han Mirror Patterns. The museum's collection includes dragon-and-phoenix persimmon-calyx patterns, TLV and Four Spirits patterns, figural pictorial patterns, and dragon–tiger mythical-beast patterns. These motifs are usually arranged symmetrically around the central knob or distributed across concentric bands, creating clear visual levels, rigorous structures, and strong decorative effects. Images of the Four Spirits, dragons, phoenixes, and mythical animals served not only as decoration but also expressed wishes for good fortune, protection from evil, and longevity.These patterns follow recognisable compositional principles and can be divided into the centre, decorative zones, concentric bands, and borders. This structure provides a basis for extracting visual elements, establishing shape grammar rules, and developing new patterns.

Current Adaptation of Han Mirror Cultural Resources. At present, Xuzhou's Han mirror culture is communicated mainly through museum displays, illustrated catalogues, and replicas of historical objects. Some cultural and creative products use the circular form or traditional patterns of bronze mirrors, but most rely on direct reproduction and simple decoration. The underlying structures, cultural meanings, and rules of combination have not been explored in sufficient depth.

Analysis of the Main Problems. Three main problems can be identified in existing Han mirror cultural and creative design. First, the available patterns have not been systematically classified, and the compositional relationships among different types remain unclear. Second, current methods of transformation are relatively limited and often stop at the direct application of individual motifs. Third, many products are not closely connected with modern lifestyles, resulting in a weak relationship between cultural meaning and practical function.It is therefore necessary to organise, extract, and classify the Han mirror patterns in Xuzhou Museum and use shape grammar to identify their compositional rules. By recombining and developing these patterns while preserving their main traditional

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features, Han mirror culture can be incorporated into cultural and creative products in ways that better suit contemporary aesthetic preferences and practical needs.

2.3. Design Principles and Core Requirements for Cultural and Creative Design Based on Han Mirror Patterns

Principle of Cultural Integrity. The redesign of Han mirror patterns should respect their original cultural meanings. Their typical structures and recognisable features must be retained to prevent excessive simplification from weakening their cultural significance. The design should also reflect Xuzhou's Han heritage so that the final outcomes possess a distinctive regional identity.

Principle of Innovation. The use of Han mirror patterns should go beyond direct reproduction. While preserving their basic features, the motifs can be simplified, recombined, rotated, and repeated. Integrating traditional elements with modern visual forms can give the designs a more contemporary character and respond to current aesthetic preferences.

Principle of Practicality. Cultural and creative design should take account of product function, materials, and usage contexts. The scale, density, and arrangement of the patterns need to be adjusted for different applications. The final designs should express the cultural features of Han mirrors while remaining suitable for modern production and everyday use.

Core Requirements. Based on these principles, the core requirements are grouped into four areas: cultural identity, rule-based generation, visual innovation, and product application. Representative Han mirror patterns should first be extracted to create recognisable cultural symbols. Reusable shape grammar rules should then be established to make pattern development more systematic. Variations in colour and composition can be used to create a visual series that is consistent yet diverse. Finally, the derivative patterns should be applied to different cultural and creative products to improve both their practical value and their potential for communication. The subsequent design process therefore follows four stages: pattern extraction, rule construction, graphic development, and product application. This approach explores

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practical ways of adapting traditional patterns to contemporary design while retaining the cultural characteristics of Han mirrors.

Conclusions to Chapter 2

This chapter examines the theoretical foundations and practical conditions of cultural and creative design based on Han mirror patterns. It first reviews shape grammar and its application to traditional pattern design, establishing a basic approach to pattern extraction, rule construction, and graphic development. A survey of the Han mirror resources in Xuzhou Museum then identifies the main pattern types, compositional features, and cultural meanings, while also revealing problems in the organisation, transformation, and practical application of existing cultural products.

Building on this analysis, the chapter proposes four design principles: cultural integrity, systematic design, innovation, and practicality. It also identifies four core requirements: cultural identity, rule-based generation, visual innovation, and product application. These findings provide the theoretical basis and design direction for the subsequent extraction of Han mirror patterns, construction of shape grammar rules, and development of cultural and creative products

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CHAPTER 3

PRACTICAL REALIZATION OF THE PROJECT: FROM SHAPE GRAMMAR RULES TO CULTURAL AND CREATIVE COMMUNICATION PRODUCTS

3.1. Design Concept and Ideation

Core Design Philosophy. The central concept of Reflections of Pengcheng is to use Han mirrors as cultural carriers and shape grammar as the design method, transforming traditional patterns into visual forms suited to contemporary aesthetics. The design follows four stages: element extraction, rule-based transformation, pattern generation, and product application. This process gives each new pattern a clear source and design basis.Typical features of Han mirrors are retained during graphic development, including their circular outlines, central knobs, nested square-and-circle structures, and concentric decorative bands. Motifs such as dragons and phoenixes, the Four Spirits, figural scenes, and key-fret patterns are simplified and recombined [18]. This approach preserves the cultural identity of the original designs while improving their adaptability across different products.Rather than directly copying patterns from historical objects, the project reinterprets Han mirror culture through contemporary colours, graphic compositions, and product formats. The resulting cultural and creative products share a consistent visual style and form a coordinated series, allowing Xuzhou's Han heritage to be communicated in a more accessible way and brought closer to everyday life. (APPENDIX B.1)

Design Positioning. The project centres on Xuzhou's Han heritage and the Han mirror patterns in the museum collection. Its target audiences include museum visitors, young consumers, and people interested in traditional culture. While preserving the basic forms and recognisable features of Han mirrors, the design uses contemporary visual language to make the cultural content easier to understand. The products are intended to combine cultural value, decorative appeal, and practical use.

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Design Approach. The design first extracts elements from Han mirrors, including the central knob, square grids, the Four Spirits, dragons and phoenixes, figural scenes, key-fret patterns, and beaded borders. These elements are then geometrically simplified and developed through shape grammar rules such as rotation, reflection, array repetition, scaling, superimposition, and substitution.The visual system retains the circular bands, central symmetry, and nested square-and-circle structures associated with Han mirrors. A palette of Mirror Blue-Green, Cinnabar Red, Han Orange, and Pengcheng Rose creates a distinctive and consistent visual identity. The generated patterns are ultimately applied to brand identity, thematic illustrations, gift-box packaging, silk scarves, folding fans, canvas tote bags, badges, and paper goods, forming a relatively complete Reflections of Pengcheng cultural and creative product series.

3.2. Project Description

Core Graphic Design. Brand Logo Design. The logo draws on three features of a Han mirror: its circular outline, central knob, and square inner frame. Floral and leaf motifs are also taken from the mirror decoration. By rotating, reflecting, and rearranging these elements in four directions, the design forms a balanced composition in which circular and square structures echo one another.

The four Chinese characters of Jing Ying Pengcheng are presented in a typeface with a traditional character and paired with a modern English wordmark. Although the logo retains the main visual features of Han mirrors, its simplified structure makes it easy to recognise and apply. Full-colour, monochrome, and reversed versions are prepared for different backgrounds and uses.

Extraction and Generation of Han Mirror Patterns. Four representative source patterns are selected: the dragon-and-phoenix persimmon-calyx pattern, the TLV and Four Spirits pattern, the figural pictorial pattern, and the dragon–tiger mythical-beast pattern. The original images are first traced as line drawings and geometrically simplified. Basic units are then extracted, including the central knob, square framework, principal motifs, key-fret patterns, beaded borders, and outer contours.

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New patterns are developed by rotating, reflecting, scaling, overlapping, substituting, and continuously repeating these units. Circular arrays are also used to produce radial compositions, nested square-and-circle patterns, and continuous borders. Throughout this process, the central symmetry and concentric divisions of the original mirrors are preserved. The derivative patterns therefore appear new while remaining connected to their historical sources.

Brand Visual System Design. Mirror Blue-Green serves as the main colour of the project. It is combined with Pengcheng Rose, Han Orange, Cinnabar Red, Cloud-Water Blue, and Xuan Paper White. The blue-green tone refers to the aged surface of bronze mirrors, while red and orange bring warmth and energy to the compositions. Pale blue and white soften the stronger colours and keep the overall appearance balanced. Together, the palette carries a traditional atmosphere without appearing outdated.

The supporting graphics are based on four-petal flowers, TLV patterns, beaded borders, and cloud-scroll motifs. Different layouts are created through rotation, continuous repetition, and the recombination of circular and square forms. The icon system includes bronze mirrors, dragons and phoenixes, dragons and tigers, mountains, city gates, museum buildings, chariots, and horses. A consistent outline weight and rounded treatment give these icons a shared visual character. (APPENDIX B.2)

Theme Illustration and Supergraphic Design. A Han mirror occupies the centre of the theme illustration. Around it are dragon-and-phoenix motifs, TLV symbols, chariot processions, Pengcheng architecture, clouds, mountains, and water. The composition combines radial organisation with bilateral symmetry, linking the imagery of Han mirrors with the regional culture of Xuzhou.

The supergraphic is developed from selected parts of mirror rims, dragon-and-phoenix patterns, and TLV motifs. Reflection, joining, square-and-circle reconstruction, enlargement, and cropping are used to create a more flexible graphic form. It can be adjusted to suit packaging, exhibition panels, and cultural products, allowing different applications to retain the same brand identity.

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Overall Visual Consistency. The three dimensions achieve visual language consistency"vintage color system, reusing the structure of concentric rings / timeline, and the unified extraction of regional symbols (Qingguo Lane architecture, Changzhou landmarks, ensuring that the audience can still establish an overall understanding of the "Qingguo Lane Cultural Complex" when switching between different modules

3.3. Technical Support and Testing

Cultural Product Packaging and Gift-Box Design. The gift box is developed around the concept of Jing Qi (“Opening through the Mirror”). The name suggests that the Han mirror serves as a point of entry into the history and culture of the Han dynasties in Xuzhou. A two-tier drawer structure is used: the upper layer holds the main product, while the lower layer contains inner trays of different sizes for smaller items. A circular Han mirror pattern forms the main visual focus on the lid. Parts of the supergraphic appear around it, while continuous patterns extend across the belly band, side panels, and inner lining. This creates a visual connection between the exterior and interior of the package.

Xuan Paper White and Pengcheng Rose are used as the main colours, with Mirror Blue-Green and Han Orange added as accents. The circular mirror motif contrasts with the square form of the box. As a result, the package remains visually simple while retaining a clear connection to Han mirror culture. (APPENDIX B.3)

Exhibition and Digital Applications. The exhibition content follows four stages: the origins of Han mirrors, shape grammar rules, pattern generation, and product application. This sequence allows visitors to trace how an original artefact is gradually transformed into a contemporary cultural product [19]. The exhibition may be divided into four sections: Origins and Grammar, Patterns and Visual Design, Cultural Products, and Digital Interaction.

The digital interface includes pattern browsing, cultural information, and product displays. An interactive screen presents the extraction of Han mirror elements and the generation of new patterns step by step. Online and on-site displays

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support one another, enabling visitors to view the finished designs while also understanding how shape grammar is used in the creative development of Han mirror patterns (APPENDIX B.4).

Conclusions to Chapter 3

This chapter puts the Reflections of Pengcheng design proposal into practice. It first defines the theme, positioning, and central design concept of the project. Drawing on Xuzhou's Han heritage, the design uses Han mirror patterns as its main visual source. Shape grammar is then employed to extract, simplify, rearrange, and develop the traditional motifs. In this way, the designs preserve recognisable cultural features while gaining a more contemporary visual form.

Based on this approach, the project develops a brand logo, four groups of core patterns, a colour and typography system, supporting graphics, icons, and thematic illustrations. Together, these elements form a unified visual identity. The derivative patterns are then adapted to the shapes and functions of gift boxes, silk scarves, umbrellas, folding fans, canvas bags, badges, and paper goods. Their use is also extended to exhibition spaces and digital interfaces. These practical applications demonstrate the feasibility of using shape grammar to reinterpret Han mirror patterns and provide a new design approach to communicating Xuzhou's Han cultural heritage.

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CONCLUSIONS

This study examines Han mirror patterns in the collection of Xuzhou Museum. It responds to several common problems in cultural and creative design, including direct copying, limited visual forms, and insufficient expression of cultural meaning. Shape grammar is introduced as a method of extracting and developing the patterns, with the aim of exploring how Han mirror culture can be adapted to contemporary products.

Literature review, field research, case analysis, and design practice are used to examine the forms, pattern types, compositional features, and cultural meanings of Han mirrors. Four representative groups are selected from the museum collection: the dragon-and-phoenix persimmon-calyx pattern, the TLV and Four Spirits pattern, the figural pictorial pattern, and the dragon–tiger mythical-beast pattern. From this analysis, four design principles are established: cultural integrity, systematic development, innovation, and practicality. These principles guide the later stages of pattern generation and product application.

During the design process, the original patterns are traced, simplified, and divided into basic units. Shape grammar operations—including rotation, reflection, array repetition, scaling, superimposition, substitution, and continuous arrangement—are then used to create derivative patterns with different compositions. Under the theme Reflections of Pengcheng, the project develops a brand logo, colour and typography system, supporting graphics, icons, thematic illustrations, and supergraphics. Together, these elements turn separate motifs from historical objects into a more coherent visual system.

The final designs are applied to the Jing Qi gift box, silk scarves, umbrellas, folding fans, canvas bags, badges, key rings, bookmarks, notebooks, and postcards. They are also extended to exhibition spaces and digital interfaces. These applications present the artistic qualities and cultural meanings of Han mirror patterns in a form that can help the public better understand Xuzhou’s Han heritage. The project also offers a practical route for extracting, reorganising, and developing patterns from

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traditional objects as a coordinated series. At the same time, it expands the ways in which Han mirror motifs can be connected with products used in everyday life. Overall, the study transforms Han mirror patterns from “artefact decoration” into “contemporary visual symbols” and provides a new design approach to the communication of Xuzhou’s Han culture and the development of related cultural products.

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APPENDIX A (analogues)

(analogues)Ключовий еталонний проєкт/Key Reference Projects

Visual outcome(s):

1. Extraction of Han mirror elements and shape-grammar-based pattern generation;
2. Brand logo and visual identity design for Reflections of Pengcheng;
3. Xuzhou Han culture-themed illustrations and supergraphics;
4. Han mirror pattern-based products and gift-box packaging;
5. Digital interaction and museum exhibition applications.

Design [historical figure]using software such as

PS,AI,XD,AE,etc



A.1

Design of Information Visualization Charts for Other Historical Figures in China

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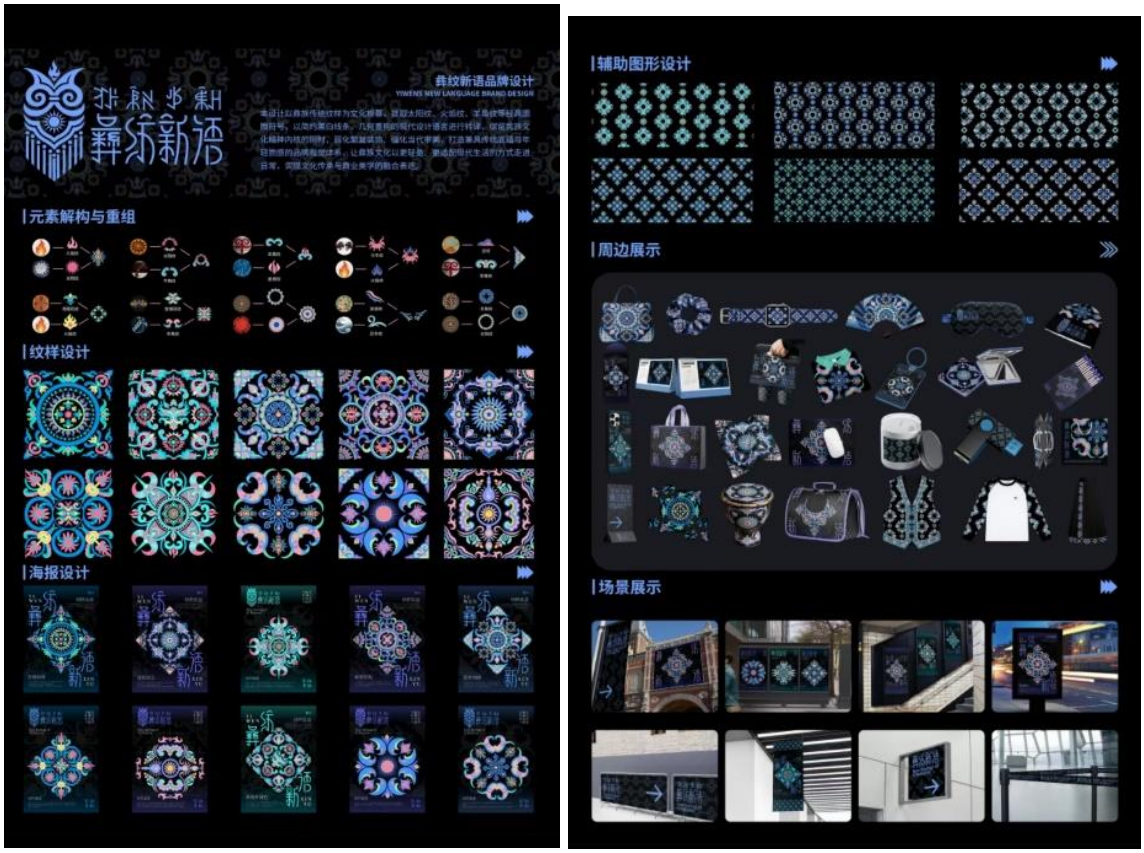

A.2

Derivative product design



A.3

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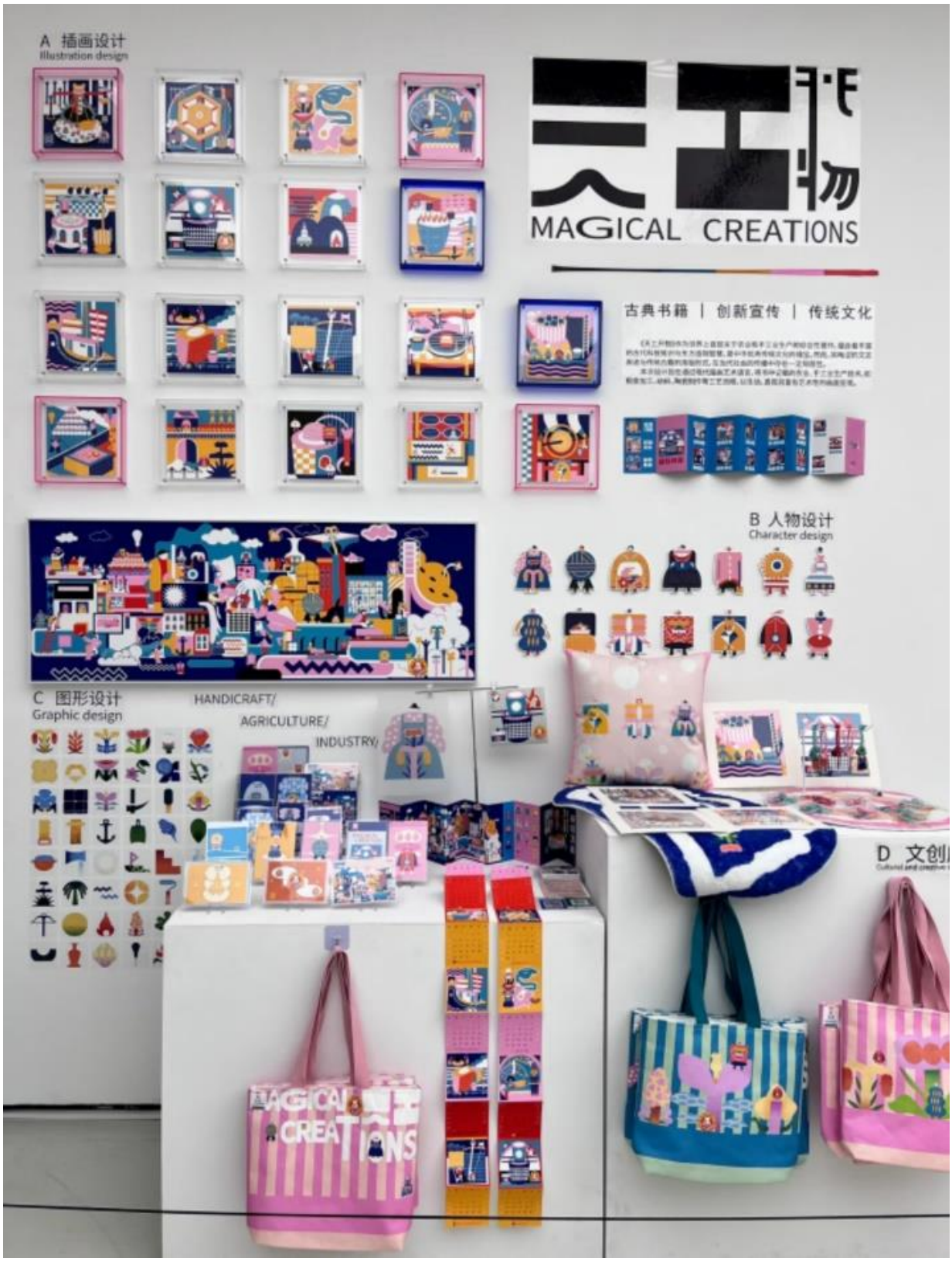
Physical display

A.4



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APENDIX B (sketch and project proposal)



B.1



B.2



B.3

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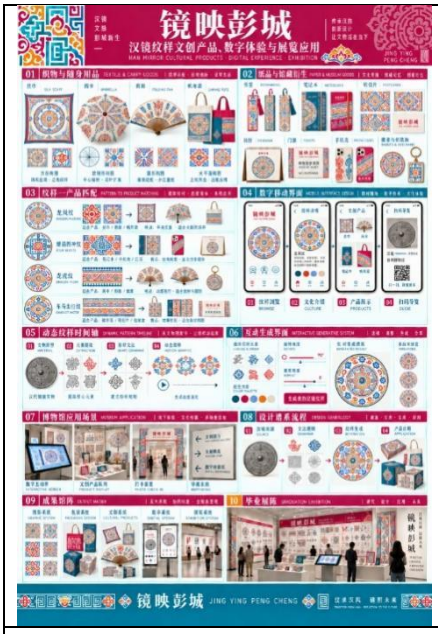

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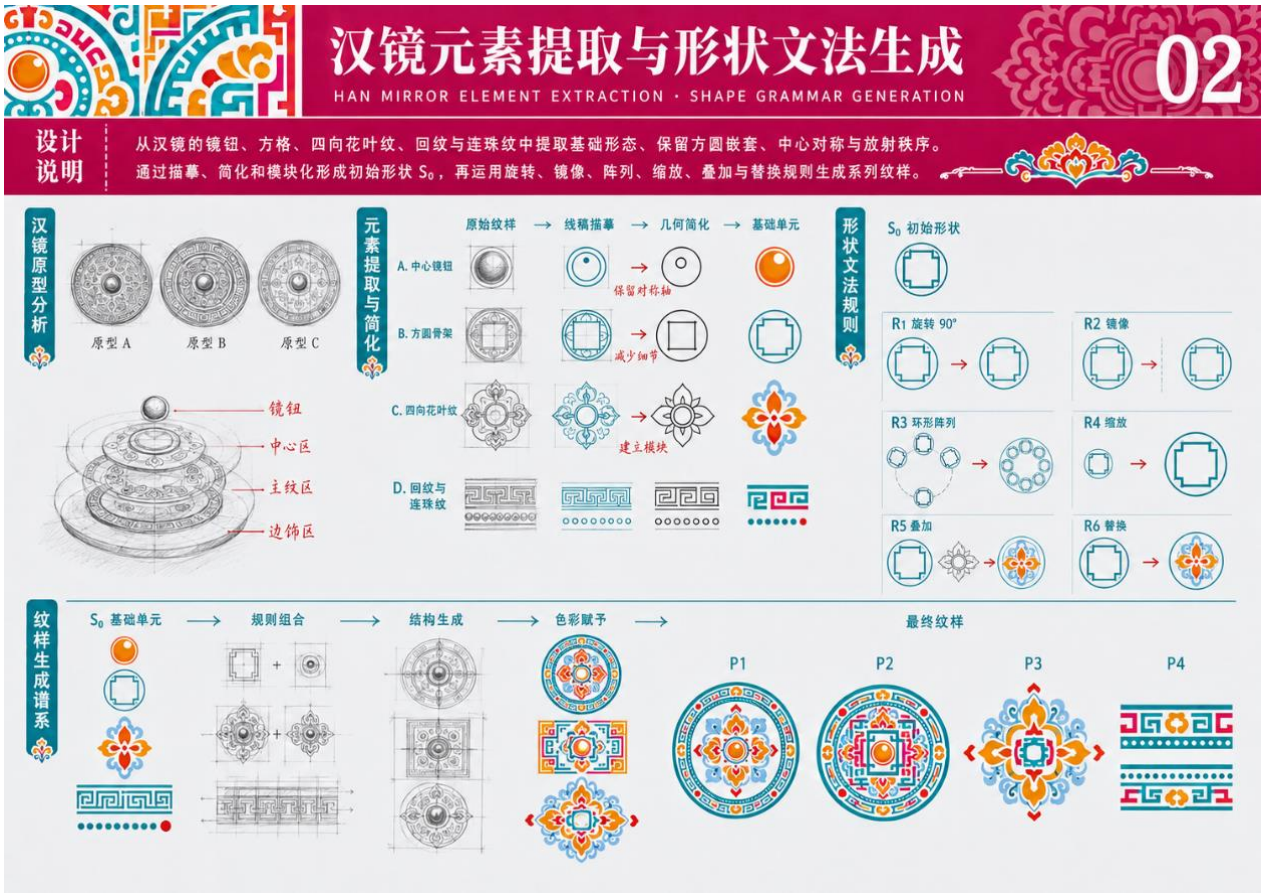
B.5



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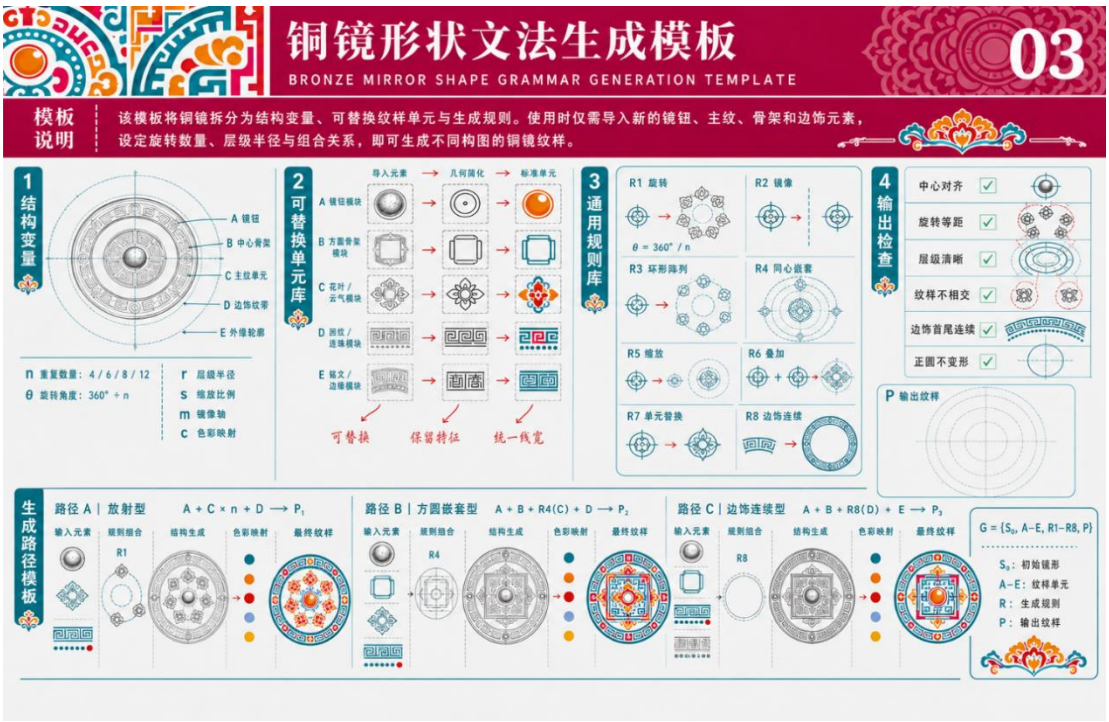

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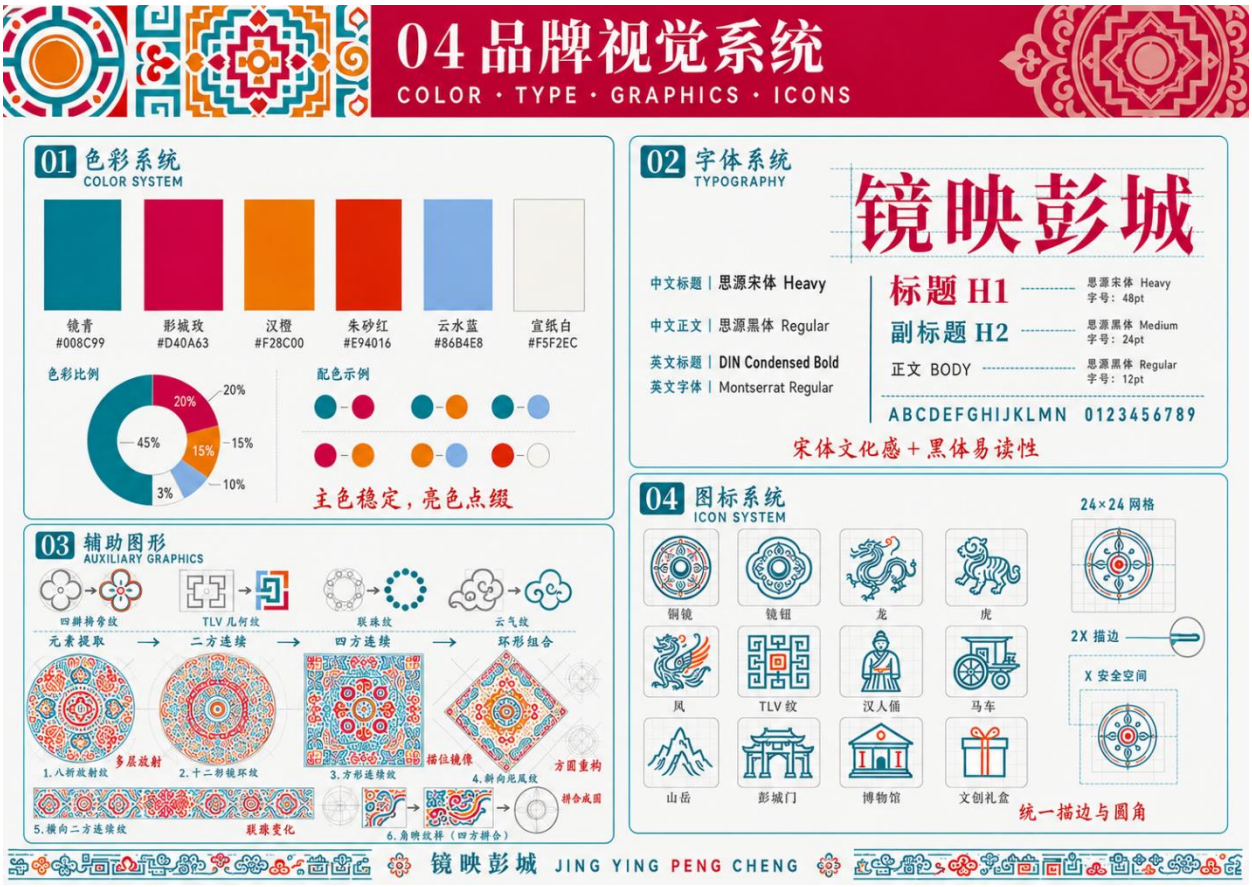

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B.10



B.11

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B.12

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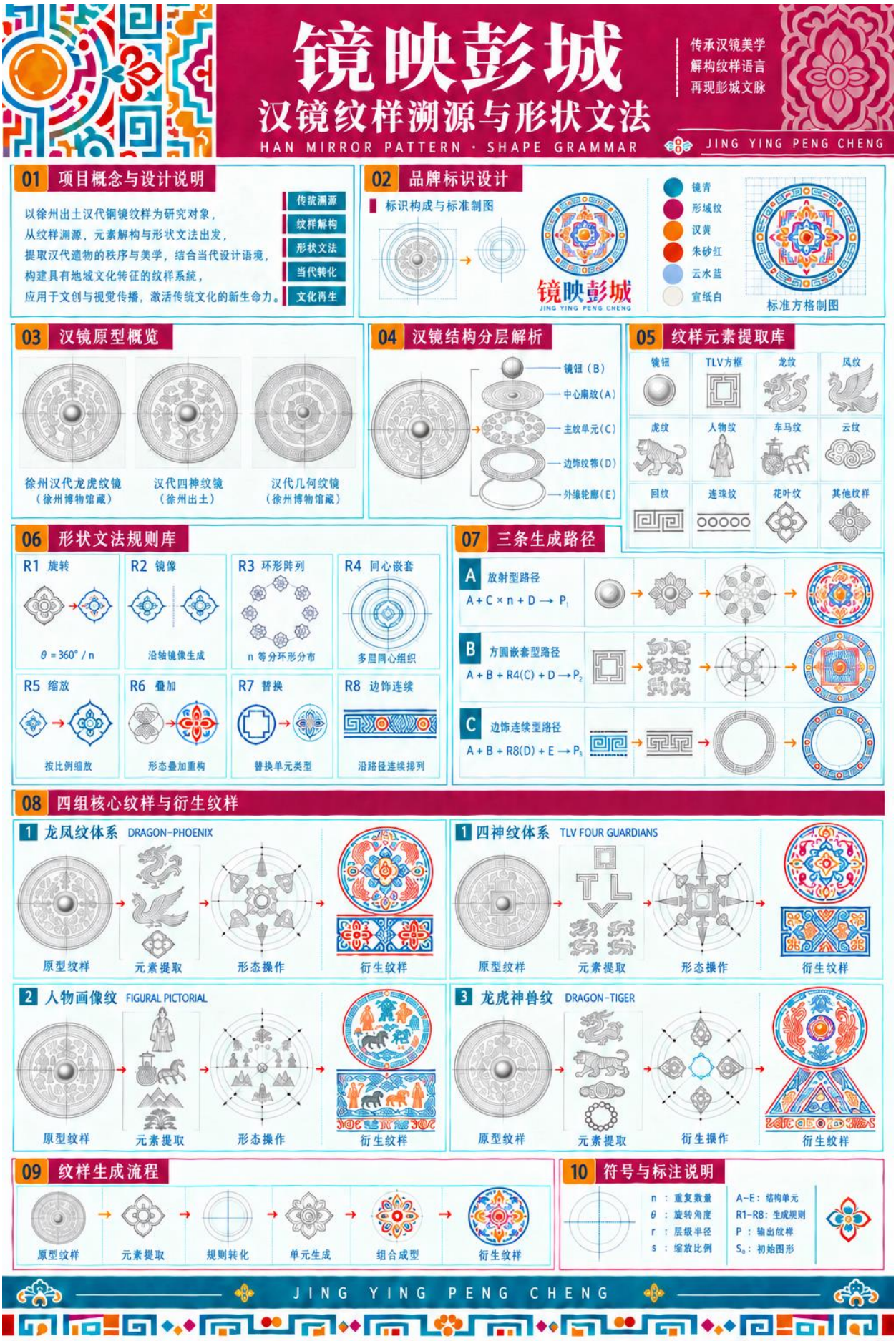

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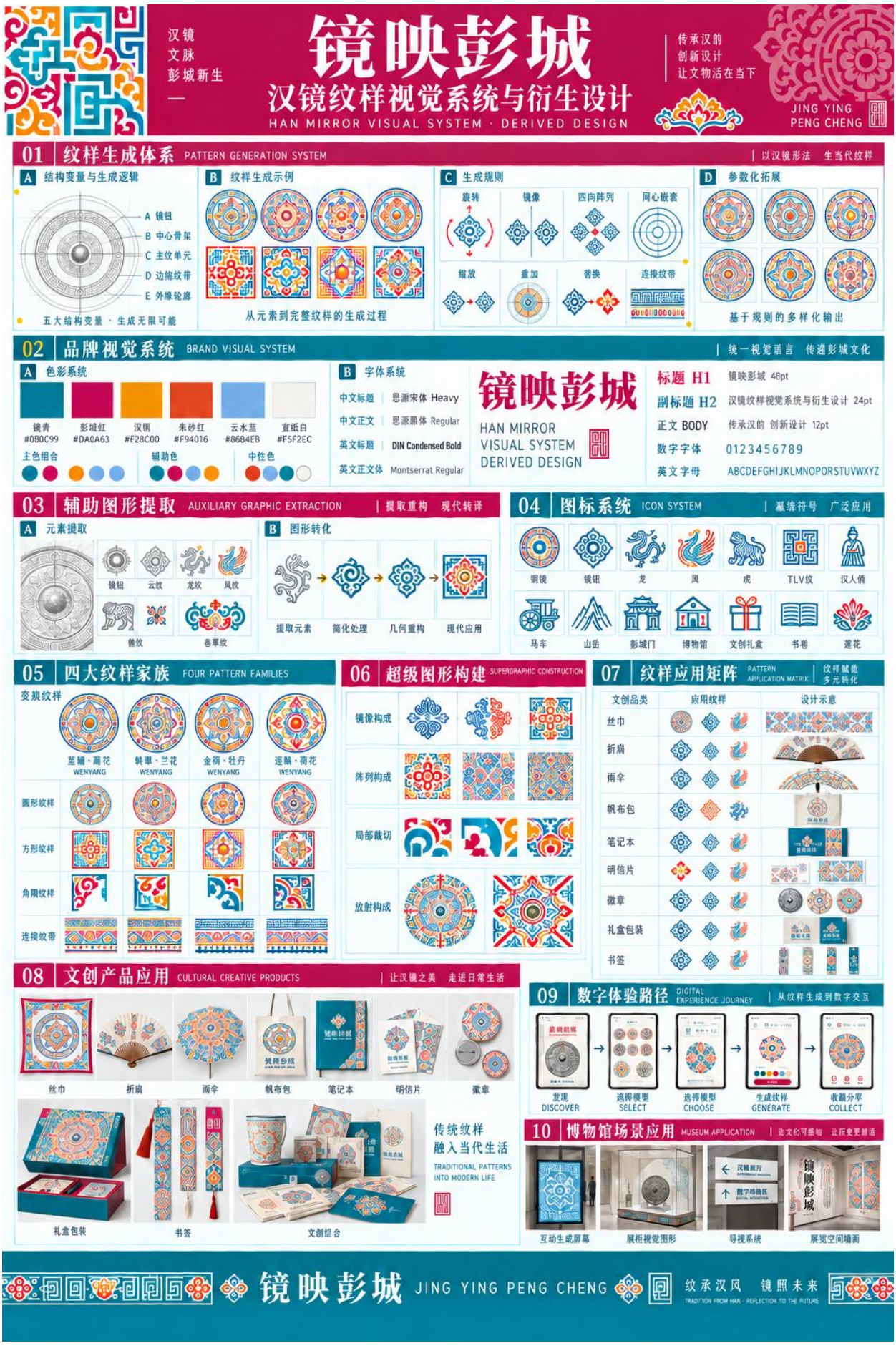

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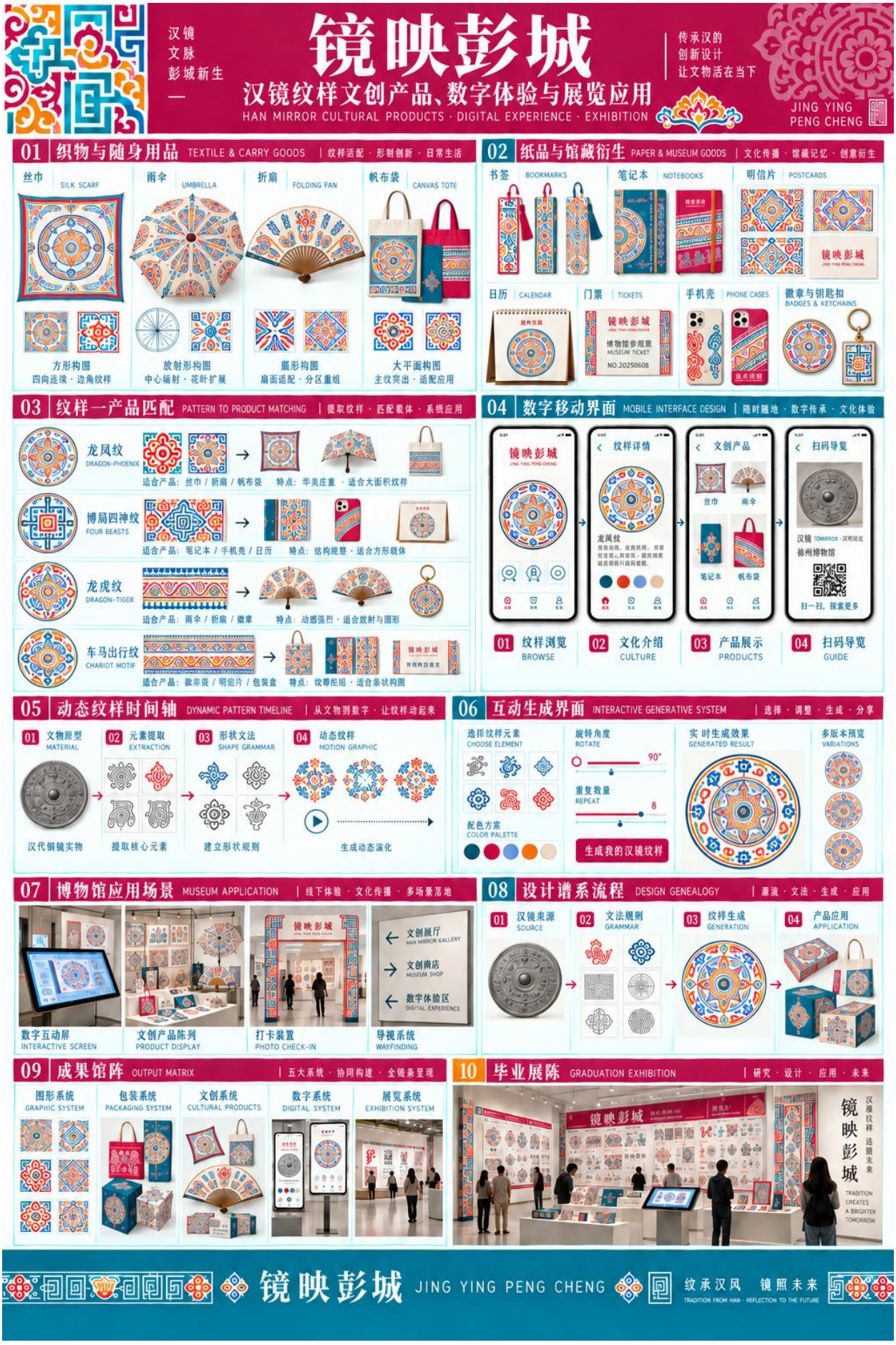

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B.19



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B.20



B.21