

Innovative Design and Research of Xi Character Patterns Based on Shape Grammar

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Abstract:

In contemporary society, innovative designs of traditional patterns have attracted much attention. The character “Xi” pattern, as a typical representative of traditional Chinese patterns, has profound cultural connotations and its innovative design holds significant importance. Based on the theory of shape grammar, this paper conducts literature collection and case analysis, extracts the cultural characteristics and shape elements of the character “Xi” pattern, and conducts three-dimensional innovative design for it to expand its possibilities in modern design. By applying the theory of shape grammar and using operation rules such as translation, rotation, scaling, and symmetry for generative and derivative deductions, the planar patterns are transformed into three-dimensional ones. This design method not only solves the construction problem of traditional character “Xi” patterns in three-dimensional space, breaks through the limitations of traditional planar design, but also provides a new technical path for pattern innovation. Research shows that the theory of shape grammar can effectively enhance the innovativeness of character “Xi” pattern design. Through three-dimensional design, its application possibilities in wedding products, product packaging, etc. are expanded, providing a reference method and path for the modern innovation of traditional patterns.

Keywords:

Xi Character Pattern, Shape Grammar, Design Method, Traditional Pattern; Innovative Design

1. Introduction

As one of the important symbols of traditional Chinese culture, the “Xi” character pattern, with its distinctive form and profound cultural connotations, has repeatedly served as a source of artistic inspiration throughout history. Its core meaning extends beyond the notion of “Xi” and also embodies people’s aspirations and wishes for a better life, reflecting a strong sense of romance. With the passage of time, the application of traditional patterns faces the challenge of adapting to modern aesthetic and functional demands, making the innovative design of the Xi character pattern increasingly important. Although there are many studies on the design of Xi character patterns, few have combined it with shape grammar theory. Moreover, existing research based on shape grammar has primarily approached pattern design from a

two-dimensional perspective. This paper, grounded in shape grammar as a design theory, explores innovative design pathways for the “*Xi*” character pattern. By analyzing its cultural background and artistic characteristics, and integrating theory with practice, this study seeks effective ways to combine traditional elements with modern design concepts, thereby promoting the reinterpretation and re-creation of the “*Xi*” character pattern in contemporary art and daily life.

2. Tracing the Origins of the Xi Character Pattern

Since ancient times, the character *Xi* has been widely regarded as an auspicious symbol. Over time, it evolved into a decorative written motif, often embedded within the joyful culture of celebration and happiness. “*Xi* signifies festivity, good fortune, and contentment [1]”. Generally, it refers to the positive emotions people feel when encountering satisfying, pleasant, or delightful events—emotions commonly experienced in daily life. “A well-known folk poem, *Four Xis*, vividly summarizes the four great happy occasions in one’s life [2]”. People seek and express “*Xi*” through various celebratory activities and specific customs. This cultural phenomenon takes different forms across ethnic groups and regions, yet shares the common goal of bringing good fortune, averting misfortune, and pursuing a peaceful and happy life. In short, “*Xi*” is not merely an individual emotional experience but also a social and cultural phenomenon.

“Throughout life, people pursue auspicious happiness—wedding *Xi*, the *Xi* of a newborn’s full month, the *Xi* of longevity, and so on—all of which call for design based on the *Xi* character culture, aiming to express aspirations for a better life and add happiness to daily life [3]”. The origin of traditional Chinese auspicious *Xi* culture can be traced back to the Neolithic period, when human society underwent significant transformations. Black or red patterns began to appear on primitive pottery, and the techniques for producing painted pottery gradually matured, reflecting both the aesthetic pursuits of early ancestors and a positive attitude toward life. Later, with the development of productive forces and the refinement of recording tools, people placed increasing importance on object decoration, hoping that auspicious patterns would express wishes for a good life, ward off evil, and bring positive visual impressions. As a character-based motif, the *Xi* pattern also embodies the Chinese philosophy of seeking the golden mean, emphasizing symmetry and balance, which gives a sense of stability and beauty. In the Han Dynasty, the strokes of “*Xi*” varied in thickness, resembling silkworm heads and swallow tails, and the character form became more symmetrical and orderly. In the Ming Dynasty, the “*Xi*” character was widely used as a decorative font on various products. Representative examples include the crimson gold-woven “*Xi*” patterned satin with intertwining lotus flowers excavated from Dingling Mausoleum, featuring the “*Xi*” character in regular script of high artistic and symbolic value, as well as other pieces such as the “wood-red ground with white lingzhi and *Xi* pattern double-layer brocade mounting piece,” the “yellow ground with green large hooked lotus and “*Xi*” pattern two-color satin scripture cover,” and the “red auspicious ribbon with ten-thousand “*Xi*” pattern gold-woven satin scripture cover.” These “*Xi*” brocades were widely used not only in court and folk festival decorations but also in important occasions like weddings, reflecting the aesthetic judgment and appreciation of auspicious meanings. By the Qing Dynasty, “*Xi*” patterns became very popular in embroidery, especially during the Qianlong period, when double “*Xi*” characters were often used. During the Xianfeng period, dragon robes, waistcoats, and various robe materials featured excellent works adorned with

“Xi”. In the Tongzhi and Guangxu periods, “Xi” remained a primary decorative pattern for festive occasions, as seen in the exquisitely structured “silver-gilded Xi candle holder” and the “silver-gilded double butterfly Xi powder box.” The evolution and development of the Xi pattern not only demonstrate the exquisite thoughts and practices of craftsmanship but also reflect the historical progress of Chinese character decoration. After thousands of years, the “Xi” character pattern has become a visually symbolic motif rich in auspicious meaning, serving to connect hearts, spread ideas, and facilitate cultural exchange. As social culture diversifies and economic development accelerates, China’s excellent traditional culture must also continuously innovate to adapt to rapidly changing modern aesthetics and market demands.

3. Cultural and Artistic Characteristics of the Xi Character Pattern

3.1. Cultural Imagery of the Xi Character Pattern

The “Xi” character pattern, as a traditional Chinese auspicious motif with a long history, carries profound cultural imagery and historical context. In Chinese culture, the Xi pattern is closely linked to the concept of the Five Blessings (wufu), which include fortune, prosperity, longevity, “Xi”, and wealth. As an essential part of the Five Blessings, “Xi” reflects the Chinese people’s pursuit of happiness and festive atmospheres. It is also an indispensable element in traditional festivals, wedding ceremonies, and home decorations, used to express good wishes.

This ancient and symbolically rich pattern also embodies the continuity of core Chinese values. “On a literal level, auspicious cultural patterns featuring the character Xi include: Double Xi, Shared Xi, Bamboo and Plum Double Xi, Good News Pattern, Xi Before the Eyes, Xi at the Eyebrows, Spring News of Xi, Universal Xi, Xi from Heaven, Hearing Good News, Double Xi, Happy Union, Joyful Crane on a Plum Blossom, and many more [4]”. The cultural imagery embedded in Xi—such as “festivity,” “happiness,” and “reunion”—is a direct manifestation of the harmonious life pursued by the Chinese nation for thousands of years. Since the Han Dynasty, “Xi” culture has been deeply integrated into folk life, closely associated with festive culture, marriage customs, and views on life and death. During the Spring Festival, whether in cities or villages, households paste Spring Festival couplets and “Fu” characters with “Xi” to pray for good luck and happiness in the coming year. In wedding celebrations, “Xi” appears not only on window decorations and bedspreads but also on wedding invitations and candy wrappers. In the event of a funeral, items bearing Xi are put away and not displayed. Through the bond of “Xi” culture, the Chinese people’s emphasis on family values and kinship ties is conveyed, playing an important role in maintaining family unity and passing down family culture. Even today, the Xi character pattern is still believed to have the power to bring good luck, and its application has expanded beyond traditional festivals and rituals toward decorative and aesthetic purposes. According to market research, design elements of the “Xi” pattern are widely applied in modern home decor and fashion accessories, such as ceramic vases with “Xi” characters sold on major shopping platforms, “Xi” photo frame lamp ornaments, and Chow Tai Fook’s Xi-themed wedding gold bracelets. This application not only broadens the channels for disseminating “Xi” patterns but also injects new vitality into the inheritance and development of their cultural imagery.

3.2. Morphological Forms of the Xi Pattern

“Traditional Chinese patterns are not direct imitations of reality; rather, they incorporate the aesthetic thoughts and emotional aspirations of ancient working people, forming decorative motifs through the interplay of multiple elements [5]”. Having undergone a long process of evolution, the formal qualities of the “*Xi*” pattern are worthy of in-depth investigation, as its structure and morphology reveal underlying philosophical concepts.

Structurally, the “*Xi*” pattern is often presented in a symmetrical, harmonious, balanced, and stable form, reflecting the traditional Chinese pursuit of stability and equilibrium. The horizontal and vertical strokes of the “*Xi*” character emphasize a square and upright feeling. The regular script form is fixed as a symmetrical structure with a “scholar” top and a “mouth” bottom, which may imply the Confucian moral concept that “a virtuous scholar earns a good reputation.” In contrast, the cursive script is more free and unrestrained, not confined to strict horizontals and verticals. Although these calligraphic styles differ slightly in form, they share similar structures and obvious symmetrical features, each carrying different historical and cultural backgrounds and reflecting the individuality of the calligrapher and the spirit of the times.

In terms of morphology, the design forms of the “*Xi*” pattern are diverse, including single *Xi*, double *Xi* combined into a single character, round “*Xi*”, and variations of “*Xi*”. When combined with motifs such as plants and animals, the possibilities become even richer (i.e. Table 1). In wedding documents from the Qing Dynasty, the *Xi* character is often linked with fine lines symbolizing lasting affection. In Minnan brick carvings, the “*Xi*” character is surrounded by auspicious symbols such as flowers and magpies, forming a compound meaning of “*Xi* within prosperity.” A five-color porcelain basin with “*Xi*” patterns from the Jiaqing period of the Qing Dynasty features double *Xi* motifs accompanied by intertwining melon and fruit patterns and ruyi motifs, symbolizing auspiciousness and a bountiful harvest. This combinatory approach not only enriches the expressive forms of the “*Xi*” pattern but also strengthens its transmission of cultural emotions, meeting both aesthetic and decorative needs while providing an effective means of conveying meaning. By varying its forms, the “*Xi*” pattern becomes more adaptable to applications in crafts, interior decoration, apparel design, and other fields.

Table 1. Collation of the “*Xi*” character pattern.

Xi Pattern Sample	Sample Name	Font Connotation	Color Characteristics	Pattern Composition
	Small bowl with red <i>Xi</i> characters on yellow ground	Festive and Auspicious	 #a20b10 #cdaa56 #ad8718 #a66a22	Fully decorated with “ <i>Xi</i> ” character patterns
	Porcelain basin with Wucai <i>Xi</i> pattern, Jiaqing period, Qing dynasty	Double <i>Xi</i> , Auspiciousness, Bountiful Harvest	 #a51f00 #e78228 #1cb3aa #f4e258	Four groups of “double <i>Xi</i> ” characters, painted with intertwining melon and fruit patterns and ruyi motifs

	Bowl with famille rose <i>Xi</i> pattern	Perfection, Auspiciousness, Fortune and Prosperity	 #d16036 #e4c3bc #adc7d6 #a9c094	“Round <i>Xi</i> ” pattern, supplemented with vase patterns, fish patterns, floral patterns, and endless knot patterns
	Brown satin woman's cape with embroidery of a hundred butterflies, gold “ten” motifs, and circular double <i>Xi</i> characters	Festive and Auspicious	 #35211f #dfcda9 #8fa53c #cfceaf	“Round double <i>Xi</i> ” pattern, supplemented with colorful butterfly and ruyi motifs
	Chair with wooden red lacquer and gold-painted motifs: ten thousand bats, round flowers, winding water, and double <i>Xi</i> characters	Happiness, Health, Auspiciousness, Perfection	 #803432 #ac874a #b49a82 #986b53	“Round double <i>Xi</i> ” pattern, supplemented with bat patterns, floral patterns, and water patterns
	Cloisonné enamel candlestick with <i>Xi</i> character	Festive and Auspicious, Perfection	 #712621 #ba9552 #ba9552 #4c77b2	“ <i>Xi</i> ” character pattern, supplemented with bat patterns, cloud patterns, and intertwining branch patterns

3.3. Color Characteristics of the *Xi* Pattern

The design application of the “*Xi*” pattern is inseparable from color. Its unique cultural heritage and historical development give it distinctive color expression in use, especially the use of red, which symbolizes festivity, passion, and vitality. In traditional culture, red is not merely a color but also an auspicious symbol, embodying people's aspirations for a better life. The ancients even gave different names to red based on the concentration of the color, such as jiang, chi, zhu, dan, hong, each with its own story. These diverse shades of red also make the color of the “*Xi*” pattern complex and charming, as different shades of red are used in different application contexts, creating a rich and lively visual effect. The “*Xi*” pattern is not limited to a single red color; it is often combined with other auspicious motifs to express more meanings and convey additional emotions. Therefore, in application, it often maintains color diversity, blending red with yellow, green, and other colors to achieve better results (i.e. Table 1).

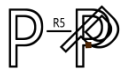
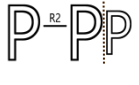
4. Innovative Methods of the Xi Pattern

4.1. Theoretical Framework

Shape grammar is a design method theory that increases derivative solutions through certain derivation rules. It was first proposed by George Stiny and James Gips in 1972. “By training organic forms and skillfully combining or manipulating various elements, shape grammar can generate an infinite variety of forms, conveying rich visual aesthetics and concepts [6]”. As a rule-based design generation method, it emphasizes rule formulation, shape generation, and evolution in the design process. The derivation process of shape grammar is generally divided into two stages: generative derivation and derivative derivation. Generative derivation involves simple transformation operations such as translation, rotation, symmetry, scaling, and mirroring. Derivative derivation, based on generative derivation, applies rules further to perform more complex transformations, generating a richer set of shape variants.

Using shape grammar as a design methodology, R serves as a finite set of inference rules defining how basic symbols are transformed to generate new shapes. The English letter P is selected as the initial symbol for demonstration, and corresponding derivative shapes are constructed based on the derivation rules of shape grammar. The rules R1 to R8 are as follows: R1 denotes translation, R2 scaling, R3 horizontal mirroring, R4 vertical mirroring, R5 rotation around a point, R6 rotation around an axis, R7 addition, and R8 subtraction. This process is called generative derivation (i.e. Table 2). By continuing to apply the derivation rules to the generated basic shapes, more novel shapes can be created; this process is called derivative derivation. Using this as the core theoretical guidance for the innovative design of the “Xi” pattern not only facilitates a systematic analysis of the structural elements of the traditional “Xi” pattern but also provides a new creative model for design.

Table 2. Generative deduction.

Rule	No.	Legend	Rule	No.	Legend
Translation	R1		Rotation Around a Point	R5	
Scaling	R2		Rotation Around an Axis	R6	
Horizontal Mirroring	R3		Addition	R7	
Vertical Mirroring	R4		Subtraction	R8	

4.2. Innovation Strategy

From the perspective of art and design, translation is a systematic process. “Its core lies in reshaping existing patterns into new forms through regularized design methods [7]”. “In contemporary “Xi” pattern design, the cultural design of the “Xi” character fails to leave a deep impression, convey aesthetic feelings, or transmit auspicious meanings [3]”. “Although the “Xi” pattern is a representative auspicious motif, its design and application remain confined to traditional approaches [8]”. As a design

method theory, shape grammar can not only define the basic elements of patterns and their planar derivatives but also generate spatial relationships among them. “By applying a series of rules-such as translation, rotation, scaling, and symmetry operations-complex three-dimensional patterns can be generated, creating a sense of real motion, light, spatial volume, and weight [9]”, thus offering more possibilities for design.

Tracing the origin of the “Xi” pattern and exploring its cultural and artistic characteristics reveals that its thematic content is extremely rich and embedded with profound cultural connotations. Through in-depth analysis of font connotations, cultural imagery, and color combinations, the “Xi” pattern and its variants are selected as initial motifs. Based on this, generative derivation using shape grammar is applied to the initial motifs to establish basic units. Then, combined with past and contemporary artistic contexts, derivative rules are applied to these basic units to achieve three-dimensional expressions of the “Xi” pattern. Through different forms of arrangement, innovative design solutions for the “Xi” pattern are developed that are highly adaptable, aesthetically pleasing, and fashion-forward.

5. Innovative Design Practice of Xi Pattern Based on Shape Grammar

5.1. Xi Pattern Design Sample Library

The establishment of a design sample library is an important foundation for achieving design outcomes. By carefully classifying the collected “Xi” pattern materials and digitizing them, a retrievable data resource library can be built, facilitating the summarization of effective design elements and providing rich theoretical support and creative inspiration for subsequent innovative design. Based on preliminary research, this design library extracts and organizes representative “Xi” patterns and auxiliary motifs (i.e. Table 3).

Table 3. Design Resource library.

Design Sample	Element Extraction	Initial Element	Design Sample	Element Extraction	Initial Element
					
					
					

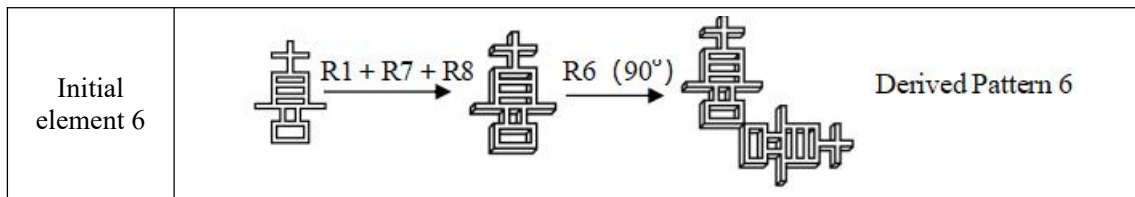
5.2. Derivation Process Based on Shape Grammar

By applying shape grammar to the “Xi” pattern design sample library, design solutions can be increased and design efficiency improved. Initial element 1 undergoes R1 (translation), R7 (addition), and R8 (subtraction), followed by further translation

and subtraction to form the innovative combined pattern of Derived Pattern 1. Initial element 2 undergoes R1 (translation), then R7 (addition) and R8 (subtraction) to obtain a three-dimensional Xi character, followed by regular and orderly translation using R1 to obtain Derived Pattern 2. Initial element 3 undergoes R7 (addition) and R8 (subtraction) to generate Derived Pattern 3. Initial element 4 is designed using R1 (translation), R7 (addition), and R8 (subtraction) to obtain a new three-dimensional basic form, and then undergoes processes such as R3 (horizontal mirroring) and R4 (vertical mirroring) to generate orderly Derived Pattern 4. Initial element 5 undergoes R7 (addition) and R8 (subtraction) to obtain Derived Pattern 5 with a rhythmic quality. Initial element 6 applies R1 (translation), R7 (addition), and R8 (subtraction), and then undergoes R6 (rotation around an axis by 90°) to obtain Derived Pattern 6 (i.e. Table 4). These generative and derivative derivations carried out through specific rules can transform a single initial design element into new derived patterns rich in variation and regular arrangement.

Table 4. Deduction process.

Initial element 1	$\xrightarrow{R1+R7+R8}$ $\xrightarrow{R1+R8}$ Derived Pattern 1
Initial element 2	$\xrightarrow{R1+R7+R8}$ $\xrightarrow{R1}$ Derived Pattern 2
Initial element 3	$\xrightarrow{R7+R8}$ $\xrightarrow{R1+R4}$ Derived Pattern 3
Initial element 4	$\xrightarrow{R1+R7+R8}$ $\xrightarrow{R3+R4}$ Derived Pattern 4
Initial element 5	$\xrightarrow{R7+R8}$ $\xrightarrow{R1+R4}$ Derived Pattern 5



5.3. Color Extraction

Color psychology points out that “color has the ability to influence human behavior and emotions” [10]”. In contemporary design practice, the integration of the color characteristics of the “Xi” pattern with modern aesthetics is crucial. By studying market and user needs, a diverse set of color formulas can be developed to add rich visual layers to the design. “Red is the most commonly used color among the Chinese people, symbolizing auspiciousness and festivity [11]”. Based on color theory, by adjusting elements such as hue, saturation, and brightness, and using advanced color tools such as Khroma, personalized color schemes can be generated while maintaining red as the core color of the “Xi” pattern. In addition, the Ostwald color solid and the Munsell color solid can be used to expand the range of color choices, applying techniques of color contrast and harmony to enhance the visual impact of “Xi” pattern design, thereby creating design works with unique character and artistic beauty.

5.4. Innovative Design Process

In exploring the innovative design process of the “Xi” pattern, the principles of formal beauty are adopted as the guiding framework for design practice. These principles emphasize aesthetic elements such as harmony, balance, rhythm, and contrast. “Moreover, shape rules have a formal sequential combination, which gives different pattern forms shaped by the same culture a natural inherited expression [12]”. Through careful arrangement and combination, not only is the traditional charm of the Xi pattern preserved, but fresh blood of modern aesthetics is also infused. (i.e. Figure 1) the endless knot (Panchang) pattern is used as the background. On this basis, the derived pattern from initial element 1 is placed in the upper layer. Through overlapping relationships, color contrast, and shadow effects, the visual hierarchy and depth of the design are enhanced, creating a spatial effect within a two-dimensional plane. (i.e. Figure 2) Figure 2 presents another dimension of innovative “Xi” pattern design. By considering the three factors of length, width, and depth, and using perspective for arrangement and combination, a spatial effect with a sense of depth is created. This design approach not only enhances the visual appeal of the “Xi” pattern but also brings new vitality to traditional cultural elements in modern design.

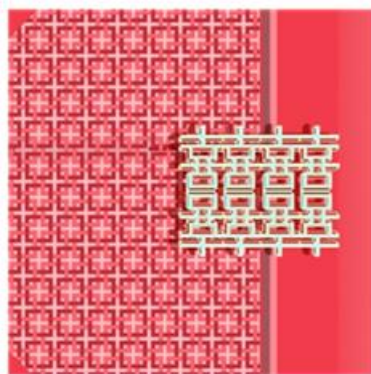


Figure 1. “Xi” Pattern: Innovative Design 1.

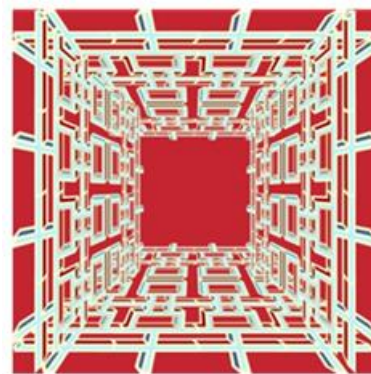


Figure 2. “Xi” Pattern: Innovative Design 2.

5.5. Innovative Design Application

As a pattern symbol deeply rooted in traditional Chinese culture, the “Xi” pattern can be innovated through graphics, color, or materials to create designs that meet modern aesthetics. “The decorative patterns derived from this process can be widely applied to various types of cultural and creative products [13]”. The “Xi” pattern can be used in weddings, celebrations, and other occasions, transforming it into contemporary products with a sense of the times to enhance the festive atmosphere (i.e. Figure 3, Figure 4). This design practice reflects respect for and inheritance of traditional culture, while also meeting modern consumers’ demand for personalized and culturally rich products.



Figure 3. Design application Figure 1.



Figure 4. Design application Figure 2.

6. Conclusions

As a highly representative visual symbol in traditional Chinese culture, the “Xi” character pattern, with its unique artistic form and profound cultural connotations, provides a rich source of inspiration for artistic creation. This study takes shape grammar as a theoretical tool. In terms of innovation methods, shape grammar offers a systematic model for the generation and evolution of “Xi” pattern design. Through generative derivation and derivative derivation, the deconstruction and recombination of traditional Chinese patterns can not only improve design efficiency but also ensure innovation. In terms of innovation strategy, the study breaks through the limitations of the traditional two-dimensional plane by constructing three-dimensional spatial relationships of the “Xi” pattern using shape grammar, and, in combination with the context of modern art, creates design solutions that are both practical and aesthetically pleasing. This innovative exploration offers a three-dimensional design pathway for the “Xi” pattern in a modern context, providing new ideas and methods for the contemporary transformation of traditional patterns.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Author Contributions

Conceptualization: Wenqing Ma.; Methodology: Wenqing Ma.; Software: Wenqing Ma.; Validation: Wenqing Ma.; Formal analysis: Wenqing Ma.; Investigation: Wenqing Ma.; Resources: Wenqing Ma.; Data Curation: Wenqing Ma.; Writing – original draft preparation: Wenqing Ma.; Writing – review and editing: Wenqing Ma.; Visualization:

Wenqing Ma; Supervision: Cong Wu; Project administration: Cong Wu; Funding acquisition: Cong Wu.

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