Image evaluation and analysis of fabric with a geometric motif in dress style design

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ABSTRACT – REZUMAT

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To explore the differences in sensory imagery produced by different geometric patterns and dress silhouettes, this study selected and extracted 4 different types of geometric patterns and 4 typical dress silhouettes as research carriers, determined the research samples through cross-combination, and used 8 pairs of sensory word pairs as research semantic space. Consumer sensory evaluations of the dress samples were collected through a survey questionnaire. The results were analysed using SPSS26.0 software, which showed that three sensory factors affect the appearance of the dress style. According to their main characteristics, they can be named as personality factor, temperament factor, and style factor. In terms of the silhouette of the dress, the neat and regular geometric pattern is most affected by the silhouette of the dress, while the other three types of geometric patterns are relatively weak. In terms of geometric pattern rules, different geometric patterns have different effects on the overall appearance of the dress after being combined with the silhouette of the dress, and some dresses play a certain role in all three factors.

Keywords: *Kansei engineering, geometrical pattern, profile, dress, style design, SPSS, factor*

Evaluarea imaginii și analiza materialului textil cu motiv geometric în designul rochiei

Pentru a explora diferențele în imaginile senzoriale produse de diferite modele geometrice și siluete de rochii, acest studiu a selectat și extras 4 tipuri diferite de modele geometrice și 4 siluete tipice de rochii ca obiect de cercetare, a determinat eșantioanele de cercetare prin combinare încrucișată și a folosit 8 perechi de cuvinte senzoriale ca spațiu semantic de cercetare. Evaluările senzoriale ale purtătorilor mostrelor de rochii au fost colectate printr-un sondaj. Rezultatele au fost analizate folosind software-ul SPSS26.0, care a arătat că au existat trei factori senzoriali care afectează aspectul stilului vestimentar. În funcție de principalele lor caracteristici, ele pot fi denumite ca factor de personalitate, factor de temperament și factor de stil. În ceea ce privește silueta rochiei, modelul geometric regulat este cel mai afectat de silueta rochiei, în timp ce celelalte trei tipuri de modele geometrice sunt mai puțin afectate. În ceea ce privește regulile modelului geometric, diferitele modele geometrice au efecte diferite asupra aspectului general al rochiei după ce sunt combinate cu silueta rochiei, iar unele rochii joacă un anumit rol în cadrul celor trei factori.

Cuvinte-cheie: *inginerie Kansei, model geometric, profil, rochie, design, SPSS, factor*

INTRODUCTION

A geometric pattern is a complex pattern created by different edges, angles, and lines arranged and combined in an orderly or disordered way [1]. And in the architectural design, art design clothing design and many other fields have been widely used in [2]. In the field of clothing design, geometric patterns make clothing more artistic and fashionable by creating unique and powerful visual effects [1]; at the same time, the geometric pattern plays an extremely important role in influencing the overall shape, style and style of clothing with its special formal beauty law [3]. Point at the application of geometric patterns in clothing design, Zhou et al. [4] selected 12 one-piece bathing suits with geometric patterns as the research objects. Then, analysis using Kansei engineering summarizes the difference in perceptual evaluation produced after applying the geometric patterns of different aesthetic rules to the same style of one-piece swimsuit, It proves that the geometric pattern has an

important influence on the appearance and modelling style of the swimsuit; Zhang [2] combines different types of geometric patterns with the formation process of men's sweaters. Summarize by using specific case applications, the geometric patterns can enhance the fashion sense and fashion sense of men's sweaters by enriching the colour of clothing and enhancing the texture effect; Hu et al. [5] selected a traditional style of men's shirts as the research object, apply geometric patterns of different forms to the men's shirt, apply geometric patterns of different forms to the men's shirt, then use the theory of Kansei engineering for analysis, to conclude that the geometric patterns of different forms will have different effects on the overall shape of men's shirt; Li et al. [6] started from the consumption trend of the elderly clothing market, investigated the geometric patterns commonly used by the elderly clothing, summarize the geometric pattern type, the production process and the position on the clothing, thereby

providing suggestions for designers to create clothing that better suits the consumption psychology of the elderly.

According to the existing literature results, it can be seen that the application status of geometric patterns in clothing design is very extensive, and it has become a widely accepted, creative and practical design element. However, existing research results have only focused on studying the same silhouette of a specific type of clothing, lacking research on the perceptual evaluation differences that arise from variations in silhouettes. At the same time, there is relatively less research focused on women's clothing among the existing research subjects. However, geometric pattern is also a highly popular design element in women's clothing, exhibiting a trend towards diversity and innovation [3]. Additionally, women's clothing holds a significant position in the fashion market [7]. Given this research status, this paper takes the summer dress widely used in women's clothing as the research object, and 4 common dress silhouettes and 4 representative geometric patterns are selected for cross-combination and identified 80 study samples. On this basis, using the theory of Kansei engineering, analysing the perceptual differences of users' evaluation of summer dresses combined with different profiles and different forms of geometric patterns, then, summarizing the principles and strategies for designing and applying geometric patterns for summer dresses based on Kansei engineering.

DETERMINE THE STUDY PROTOCOL

Theory of Kansei engineering

The theory of Kansei engineering was first proposed by Kenichi Yamamoto, a famous Japanese design master, in the 1980s [8], As a scientific method to study the correlation between users' subjective feelings and product modelling characteristics through industrial technology means [9], Kansei engineering can quantify and transform people's subjective needs for products and the product attribute features [10]. While meeting the subjective needs of consumers, it provides designers with more efficient product design and development ideas [11]. At present, this product design method oriented to meet the ultimate needs of users has been widely used in the field of clothing design [12].

Determine the geometric pattern

Geometrical patterns are composed of various shapes and lines through repetition, symmetry, crossover, rotation and other rules. Because of their varied combinations, the geometric patterns are also formed in various styles [5]. Based on the formal law of geometric patterns, this paper collects and classifies geometric patterns by consulting relevant literature, expert interviews, market research and browsing clothing brand websites and other forms; To ensure that the collected patterns are applicable, the geometric patterns collected are all from the existing garment styles, and the Vizoo professional scanner is used to scan the fabric patterns to ensure that the pattern texture is consistent with the fabric and the light is evenly received. On this basis, the scanned geometric pattern is imported into Pix Plant 3.0 seamless texture-making software, then the pattern is continuously processed in four directions to generate the final geometric pattern; In addition, to avoid the representational elements of the geometric patterns from interfering with the final judgment of the perceptual imagery of the geometric patterns (e.g., seeing cartoon animal patterns produces cute, young subjective images), the geometric patterns selected in this paper are composed of lines and shape elements that contain no specific objects and scenes; and according to the formal laws of geometric patterns, four kinds of formal laws represented by neat and regular, dynamic and rhythmic, zoom and translation, abstract and unique, a total of 20 geometric patterns as the subsequent pattern research samples. To ensure that the perceptual evaluation results are not affected by the colour, brightness and size of the geometric patterns, using Adobe Photoshop 2021 software, 20 selected geometric patterns were processed consistently and processed black and white pictures with consistent proportion and brightness. At the same time, the geometric patterns with higher similarity are arranged reasonably separately, to avoid visual interference from the approximate patterns. The specific geometric pattern style is shown in figure 1, among them, the form law of geometric pattern no. 1–5 are neat and regular; no. 6–10 are dynamic and rhythmic; no. 11–15 are scaled and panne; no. 16–20 are abstract and unique.

Determine the dress sample

The most common profiles of the dress are X profile, A profile, H profile and O profile [13], in this paper, we select a basic dress as the sample, and use the CorelDRAW 12 software to fill the geometric pattern in figure 1 into the dress style diagram successively, then, adjust the layout, proportion and angle of the geometric pattern, finally generate 80 dress study sample space, the specific dress study sample is shown in figure 2 (X profile: 1–20, A profile: 21–40, H profile:41–60, O profile: 61–80).

QUESTIONNAIRE INVESTIGATION AND ANALYSIS

Determine the perceptual word pair

Through reading the clothing professional literature, a large number of adjectives suitable for describing the appearance and modelling style of the dress are collected, after removing words with highly similar meanings and improper expressions, we invite professional fashion designers, college fashion design teachers and women's wear sales staff 10 people each to refine the collected adjectives again, finally, 8 pairs of adjectives with the highest recognition, most can reflect the dress appearance modelling style and adjective pairs with opposite meanings were determined as the perceptual words of this
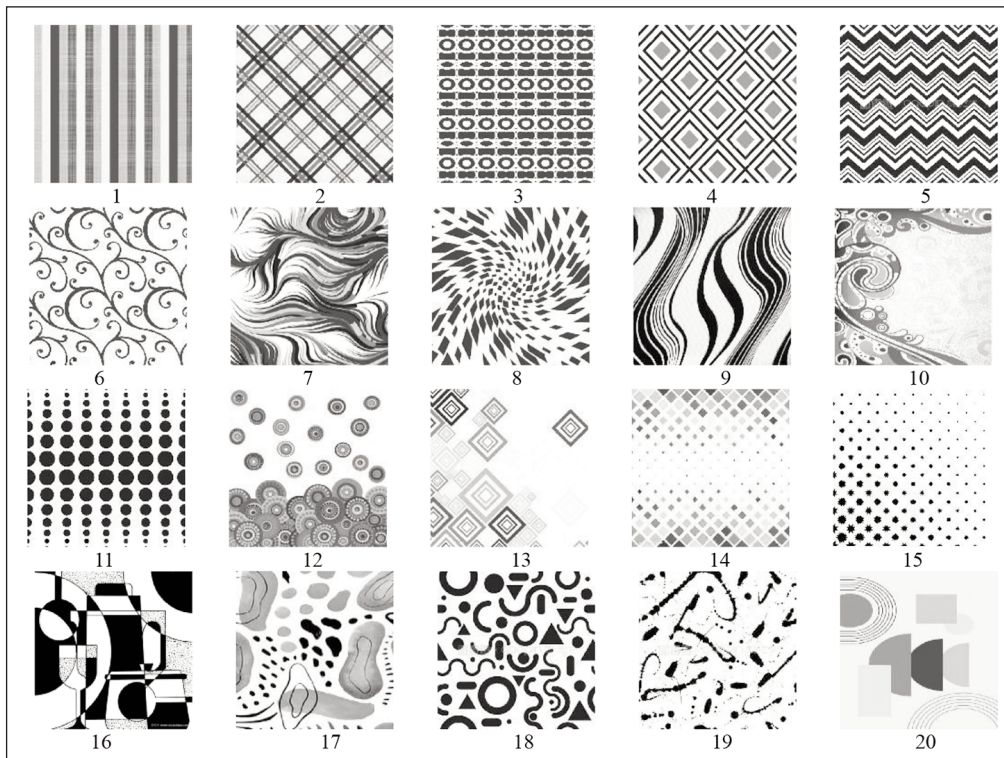
Fig. 1. Study sample of the geometric patterns

study. The specific 8 perceptual word pairs are respectively: monotonic - changeable, young - mature, plain - gorgeous, delicate - rough, sedate - active, conventional - avant-garde, flowing - rigid, unromantic - artistic.

Questionnaire survey

This survey questionnaire uses the 5-point semantic difference method [14], allowing the respondents to subjectively score the dress study samples according to the specific meanings of the 8 pairs of perceptual words, the score indicates the degree of association with the dress sample, which is respectively –2, –1, 0, 1, and 2. Taking the adjective "monotonic - changeable" as an example, –2 represents particularly monotonic, –1 represents comparatively monotonic, 0 represents neither monotonic nor changeable, 1 represents comparatively changeable, and 2 represents particularly changeable.

Because the questionnaire survey content has a certain professionalism, the questionnaire survey content is more, the questionnaire recipients are easy to be tired or anxious in the scoring process, so the questionnaire should not be issued in large numbers, To ensure the validity of the questionnaire survey results, we selected professional clothing designers, college clothing professional teacher, women's clothing sales personnel and consumers with dress experience to distribute the questionnaire, a total of 120 questionnaires were issued, and 118 valid questionnaires were collected, with a recovery rate of 98.33%, which met the sample number standard of the survey questionnaires. By calculation, the average score of the perceptual evaluation of 80 dress

samples in the valid questionnaires was obtained, and find out, the different combinations of dress silhouette and geometric pattern will affect people's subjective impression and evaluation of the silhouette of the dress. That is to say, no matter when the silhouette of the dress is the same but the geometric pattern is different, or the geometric pattern of the dress is the same but different, people's subjective and perceptual evaluation of the overall shape style of the dress will be quite different. To more intuitively reflect the degree of correlation between the modelling characteristics of the dress research sample and the perceptual words, the ranking method was used to rank the absolute perceptual scores of all the

Table 1

DRESS SAMPLE MAIN IMAGE STYLE			
Sample	Sequencing of perceptual words		
	1	2	3
1	monotonic	avant-garde	unromantic
2	unromantic	flowing	monotonic
3	gorgeous	flowing	unromantic
4	flowing	active	monotonic
5	unromantic	monotonic	flowing
⋮	⋮	⋮	⋮
76	avant-garde	artistic	changeable
77	avant-garde	rough	artistic
78	artistic	young	gorgeous
79	gorgeous	artistic	mature
80	artistic	rough	avant-garde

Fig. 2. Dress study sample

dress samples from large to small, and the three perceptual words with the highest absolute value were extracted to obtain the main perceptual imagery style table of the dress samples, as shown in table 1.

It can be seen from table 2 that the change of the profile has the greatest influence on the geometric pattern whose formal law is "neat and regular". The main expression is that the dress with the geometric pattern of this formal law only has a high consistency in the image evaluation of the perceptual word "monotonic", this is because the geometric patterns of this formal law usually lack change and innovation, giving people a symmetrical, rigid stereotype; in addition, the geometric pattern of this formal rule is most prominent in the "elegant" perceptual score in the dress samples of X and A profiles, this is because the X silhouette and A silhouette dress is relatively loose in the hemline part, which has a strong sense of flow and lightness, thus giving people a kind of elegant feeling. When the geometric pattern of this formal rule is applied to the dress sample of the H profile, the absolute value and occurrence frequency of the perceptual word score of "sedate" are higher, because the H profile of the dress profile is usually slightly loose or presents a straight line shape, the lines are usually relatively simple and capable, to look more stable and mature; since the O profile dress is usually loose, comfortable and activity freely, the O profile dress with "neat and regular" geometric pattern shows a strong emotional image of "young". While the formal law of "dynamic and rhythm", "zoom and translation", and "abstract and unique" geometric patterns are relatively weak affected by the change of the shape of the dress, mainly reflected in, 4 dresses with different profiles, the formal law of "dynamic and rhythm" geometric pattern dress samples mainly reflect the perceptual image of changeable, flowing and artistic; the formal law of "zoom and translation" geometric pattern dress samples are mainly reflect the changeable, active and artistic perceptual image; the formal law of "abstract and unique" geometric pattern dress samples are mainly reflect the artistic, avant-garde and rough perceptual image.

KANSEI ENGINEERING ANALYSIS

Factor analysis

To better study the perceptual differences between the geometric patterns of different form features and the cross combination of different dress profiles, we conducted a factor analysis on the mean value of the perceptual scores of 80 dress samples, accurately studying the visual effect and appearance characteristics of the dress, and the influence relationship between different factors.

Using SPSS26.0 software, KMO validity analysis and Bartlett sphericity test were performed on the mean perceptual scores of the study samples, the KMO value obtained was 0.833 > 0.500, and the Bartlett test parameter significance probability P value was 0.000 < 0.05, which was suitable for subsequent factor analysis [15]. In addition, principal component analysis was used to extract common factors for factors with initial eigenvalue >1, and the total variance of interpretation of perceptual word pairs was obtained, as shown in table 2.

According to table 3, principal component analysis can be used to extract 3 common factors with eigenvalues >1, and most of the information of 8 perceptual word pairs can be fully expressed, to carry out a reasonable and effective perceptual evaluation of the research samples. To obtain a more explanatory factor variable, the extracted principal component factor load matrix is orthogonally rotated using the maximum variance method, and the rotated factor load matrix is shown in table 3.

The factor load after rotation can reflect the degree of correlation between the factor and the variable. The greater the absolute value, the stronger the correlation between the perceptual word and the stronger the image expression in the corresponding factor [16], it can be seen from table 4 that the perceptual word pairs that contribute more to the first factor are "monotony - changeable", "traditional - avant-garde" and "plain - artistic". According to the specific meanings of these three perceptual word pairs, the first factor is comprehensively summarized as the "personality factor"; the perceptual word pairs that contribute more to the second factor are "young - mature",

Table 2

	PERCEPTUAL WORD PAIRS EXPLAIN TOTAL VARIANCE					
Ingredient	**Initial Eigenvalue**			**Extraction of the sum of squares of loads**		
	Total	**Variance (%)**	**Accumulation (%)**	**Total**	**Variance (%)**	**Accumulation (%)**
1	3.050	38.126	38.126	3.050	38.126	38.126
2	2.168	27.106	65.232	2.168	27.106	65.232
3	1.359	16.982	82.214	1.359	16.982	82.214
4	0.620	7.747	89.962	-	-	-
5	0.396	4.946	94.908	-	-	-
6	0.238	2.969	97.877	-	-	-
7	0.144	1.802	99.679	-	-	-
8	0.026	0.321	100.000	-	-	-

FACTOR COMPONENT ROTATION MATRIX			
Perceptual word pair	**Factor**		
	1	**2**	**3**
monotonic - changeable	0.933	0.287	0.056
conventional - avant-garde	0.904	0.051	−0.172
unromantic - artistic	−0.748	−0.208	0.386
young - mature	−0.293	0.770	0.406
plain - gorgeous	−0.177	0.694	0.496
sedate - active	0.517	0.654	0.067
flowing - rigid	0.014	−0.591	0.853
delicate - rough	−0.497	−0.103	0.596

"plain - gorgeous" and "sedate - active". According to the specific meanings of these three perceptual word pairs, the second factor is named "temperament factor"; On the third factor, the perceptual word pairs with greater contribution are "delicate - rough" and "flowing - rigid". According to the specific meaning of the perceptual word pairs, the third factor is named "style factor".

To more intuitively reflect the perceptual correlation between the dress research sample and the factor, the triangular coordinate relationship diagram between the two is drawn, the equilateral triangle △ABC and the 3 factors at the 3 vertices of the triangle, where point A represents the personality factor, point B represents the temperament factor, point C represents the style factor; point D, point E and point F are the midpoints of the three sides of the triangle respectively, and point G is the midpoint of the equilateral triangle. According to the factor name corresponding to the perceptual word pair with the highest perceptual score for each dress sample, the dress sample is placed in the corresponding position

of the equilateral triangle according to the effect score on the factor. The closer the dress sample is to a factor in the figure, the more prominent the effect of the sample on the factor, and vice versa; The closer to the midpoint of the three sides, it indicates that the role of the dress sample on the two factors is close or consistent; Similarly, the closer the dress sample is to the G-spot, it indicates that its role in the three factors is close or consistent. For example, the main perceptual images of dress samples No. 16 and No. 36 are reflected in "personality factor", so the two dress samples are placed very close to point B (personality factor), and because dress No. 16 plays A greater role in personality factor than dress No. 36, so dress sample No. 16 is closer to point A. The triangular coordinate diagram between specific dress samples and factors is shown in figure 3, where figure 3, *a* represents the relationship between samples 1–40 and various factors, and figure 3, *b* represents the relationship between samples 41–80 and various factors. It can be further verified from figure 3 that the appearance of the dress formed by the combination of geometric patterns of different form rules and different profiles will give people completely different perceptual images. In factor 1 (personality factor), abstract and unique, neat and regular, scaling and translation play an important role in reflecting the personality characteristics of dresses, among them, the number of geometric patterns that are abstract and unique and neat and regular by formal law is the largest and equal. This is because "abstract and unique" geometric patterns compared with traditional design elements, more prominent personality, creativity and imagination, and more flexibility and freedom in design, break the traditional frame and shackles, so that the appearance of the whole dress in more changes, avant-garde and artistic subjective imagery; "Neat and regular" geometric patterns usually have
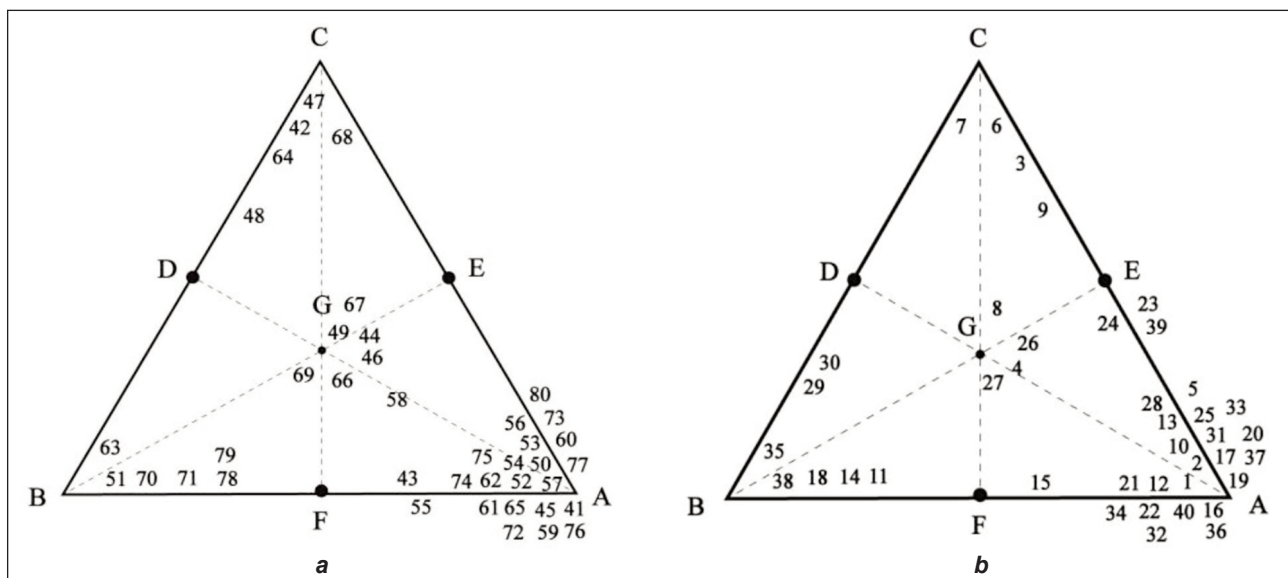

Fig. 3. Diagram of the dress sample and the factor: *a* – plot of samples 1–40 and factors; *b* – plot of samples 1–40 and factors

symmetry, repetition, balance and other characteristics, compared with random and free patterns, often give people a sense of stability and order, lack of change and innovation, so it will appear more monotonous or plain, easy to produce monotonous, traditional and plain subjective imagery; The form rule is the geometric pattern of "scaling and translation", which produces a variety of combination effects and increases visual interest through the changes in the size and position of the design elements. It has the characteristics of variety and rich layers and produces strong changes and avant-garde emotional evaluation in the style of dress.

In factor 2 (temperament factor), the geometric patterns of "dynamic and rhythmic" and "zoom and translation" play a more obvious and balanced role in the shape of the dress temperament, followed by the geometric patterns of "abstract and unique" and "neat and regular"; for factor 3 (style factor), only the geometric patterns of the two formal laws, "dynamic and rhythmic" and "neat and regular", play a role, among which the geometric patterns of "dynamic and rhythmic" are most strongly reflected in this factor, because the geometric patterns of this formal law usually adopt smooth arcs and curves. In the line thickness, curvature and spacing of the adjustment and change, the formation of a flowing and active visual effect, with different silhouette dresses combined, can convey a sense of fluency and rhythm of the subjective image.

In addition, it can be seen from figure 3 that some dress samples not only have a high perceptual image in one factor but also play a certain role in the other two factors. For example, the No. 8 dress sample is reflected in the three factors, of which the style factor has the greatest impact, followed by the temperament factor and personality factor.

CONCLUSION

- By analysing the mean value of perceptual image evaluation of dresses, it can be seen that the geometric pattern form features most obviously affected by the change of dress profile is "neat and regular". The perceptual image of the overall appearance of the geometric pattern dress of the other three formal laws is relatively weak under the influence of profile.
- Through factor analysis, three common factors can be extracted, which are named personality factor, temperament factor and style factor respectively. Because the contribution rate of the personality factor is higher than the other two factors, it plays a decisive role in the perceptual style characteristics of dress appearance.
- The dress formed by the cross combination of geometric patterns of different formal laws and different dress profiles will produce different perceptual images in appearance. In personality factors, the geometric patterns of "abstract and unique", "neat and regular", and "scaling and translation" play the same role; Among the temperament factors, the geometric patterns of "dynamic and rhythmic" and "scaling and translation" played the most prominent role in the temperament characteristics of dresses, while the geometric patterns of "neat and regular" played the weakest role. The geometric pattern form laws that play a role in the style factor are "dynamic and rhythmic" and "neat and regular", and the other formal law geometric patterns have little or no effect on the factor.

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