

Collar style design of women's suit based on Kansei engineering

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ABSTRACT – REZUMAT

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To understand the influence of flat collar, closure collar, and shawl collar on the perceptual impression of women's suits, 12 pairs of adjectives used to describe the collar type of suits were determined by using the method of perceptual engineering and semantic difference. With the help of virtual fitting technology, 22 kinds of suit simulation pictures were drawn. Through the questionnaire survey, this paper studied the perceptual evaluation of different collar types of women's suits and then used the mean statistics and corresponding factor analysis to process the survey data. The results show that 1) the factors of stability, elegance, and style have influenced the collar design of women's suits; 2) different collars brought consumers different emotional feelings, for example, the shawl collar was simple and soft, the flat collar was professional, closure collar was elegant. The results can be used to guide the design of the female suit collar.

Keywords: 3D simulation, collar type, Kansei Engineering, Kansei Evaluation, women's suit

Designul gulerului pentru costumul de damă bazat pe ingineria Kansei

Pentru a înțelege influența gulerului plat, a gulerului cu rever ascuțit și a gulerului tip șal asupra impresiei perceptive a costumelor de damă, au fost determinate 12 perechi de adjective folosite pentru a descrie tipul de guler al costumelor, prin utilizarea metodei ingineriei perceptive și a diferenței semantice. Cu ajutorul tehnologiei de simulare virtuală, au fost create 22 de tipuri de imagini virtuale ale costumului. Prin aplicarea unui chestionar, această lucrare a studiat evaluarea perceptivă a diferitelor tipuri de guler al costumelor de damă, apoi a folosit statisticile medii și analiza factorială corespunzătoare pentru a procesa datele sondajului. Rezultatele arată că: 1) factorii de stabilitate, eleganță și stil au influențat designul gulerului costumelor de damă; 2) diferitele gulere le-au adus consumatorilor diferite sentimente emoționale, de exemplu, gulerul tip șal este simplu, moale, gulerul plat este profesional, gulerul cu rever ascuțit este elegant. Rezultatele pot fi folosite pentru a ghida designul gulerului costumului de damă.

Cuvinte-cheie: simulare 3D, tip guler, inginerie Kansei, evaluare Kansei, costum de damă

INTRODUCTION

Kansei Engineering, which appeared in the 1970s, is committed to quantifying customers' psychological needs and transforming them into product design elements [1]. This technology was first applied in the automobile industry [2], and then it also achieved success in the service industry [3], product design industry [4, 5], web page optimization field [6], colour research field [7], etc. With the development of society and economy, consumers' needs become more and more personalized, so only to meet the needs of consumers can they occupy an advantage in the market [8], especially in the clothing industry. Only by understanding the aesthetic needs of customers can precision marketing be carried out [9]. At present, with the help of the method of Kansei Engineering, some scholars have studied the field of personalized recommendation [10], functional design [11], women's suit vest design [12], e-commerce fabric retrieval [13], and fabric comfort [14]. These studies above profoundly impact the whole process of clothing design, production and sales, and provide a new

method for garment industry practitioners to serve consumers better.

Kansei engineering can break the limitations of traditional methods and fully consider the psychological demands of consumers. With the deepening of research, scholars try to combine Kansei Engineering with other technologies to explore the potential needs of consumers better. For example, Dong et al. [15] realized interactive recommendations for clothing based on perceptual evaluation and fuzzy technology. Liu et al. [16] developed the knowledge base of fashion design by using perceptual evaluation and fuzzy logic. Zhang et al. [17] applied Kansei engineering technology to construct the performance evaluation system of virtual fashion design. The studies above transform the aesthetic and emotional needs of consumers into consideration elements in the process of fashion design or sales and achieve the purpose of improving customer satisfaction and meeting personalized needs, which can increase the competitiveness of clothing enterprises.

To sum up, as a branch of ergonomics, Kansei Engineering, which originated in Japan, and quantifies the user's emotion [18], has been widely used in the design and has gradually attracted the attention of interdisciplinary researchers. Kansei engineering design process is divided into three stages: emotional image acquisition, model building, and design optimization. Perceptual images can be obtained by indirect methods such as questionnaires, semantic difference methods, or direct methods such as testing the physiological indexes of subjects. In the modelling stage, researchers usually use linear processing technology [19], nonlinear processing technology [20] or reasoning prediction technology [21] to analyse and quantify the collected perceptual images. With the development of artificial intelligence technology and machine learning, researchers use genetic algorithm [22] and other intelligent algorithms to optimize the model's prediction accuracy. From the perspective of the perceptual image, the perceptual images obtained by perceptual engineering are mainly produced by vision, and other auditory and olfactory images [23] are less involved. The application scope of Kansei engineering is wider and wider. More and more intelligent algorithms are applied to Kansei Engineering, which improves the prediction performance of the model.

The suit has become a vital clothing category for women to attend business and leisure occasions because of its tailored, diverse and beautiful styles. The collar is located in the centre of the line of sight. Its modelling changes often have a significant impact on the style. To meet the consumers' personalized needs, collar style design is critical. A lapel collar is an important collar type for a suit. According to the shape of the collar mouth, the lapel collar can be divided into the flat collar, shallow collar, and closure collar. At present, some scholars used Kansei engineering technology to study flat lapel and closure lapel, looking for customers' favourite combinations [24].

Generally speaking, there is less research on women's suits, and the women's suits in the market cannot meet the personalized needs and aesthetic

needs of modern women. This paper takes women's suit lapel as the research object, with the help of virtual fitting technology for suit modelling, using the method of Kansei Engineering for data analysis. The research results provide some guidance for suit collar design to produce clothing that meets the aesthetic needs of consumers, and to improve the market satisfaction and competitiveness of enterprises.

METHOD

This paper first analyses the style elements of lapel collars of women's suits, then 100 samples of women's suits are collected on the Internet, and six professionals in fashion design are invited engaged to screen the samples. According to the modelling elements of lapel collars, similar collar styles are removed, and 22 representative women's suits are selected finally. We use virtual fitting technology to model 22 kinds of women's suits. Except for the collar, other design elements of these model components are consistent to ensure the accuracy of the experimental results. This paper only discusses the perceptual impression of the collar type on the overall style of the suit and does not discuss the influence of colour, fabric and other factors.

Next, we select words from fashion magazines and periodicals to describe women's suits' collar shapes, remove words with similar meaning and colloquialism, and finally select 12 pairs of adjectives. We use the semantic difference method to design the questionnaire, sort out the collected results and conduct factor analysis.

Lapel collar style

Many factors affect the shape of the lapel, such as the height of the lapel point, the width of the lapel head, and the position of the serial line. The folding point's height directly affects the length of the collar and the visual centre changes with the position of the folding point. The width of the lapel plays a key role in collar design and overall style. The position of the serial line determines the proportion between the roll and the lapel. The structure of the shawl collar, flat collar, and closure collar is shown in figure 1.

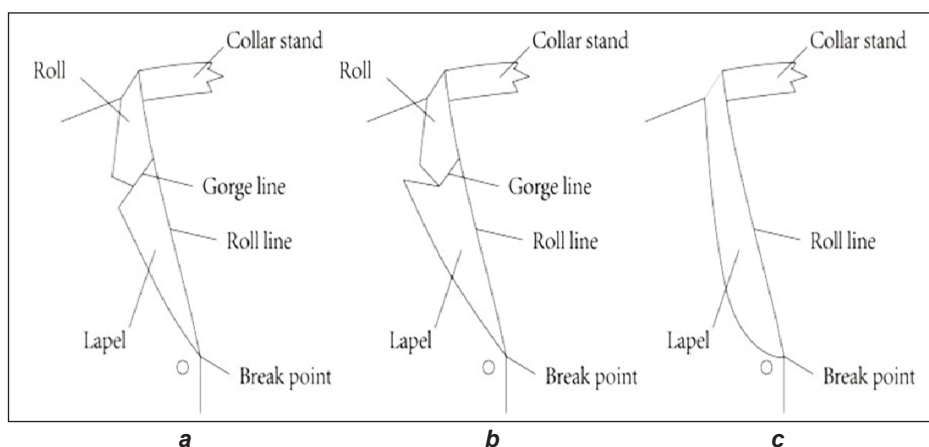


Fig. 1. Three common collar types of suits: *a* – flat collar structure; *b* – closure collar structure; *c* – shawl collar structure

Stimulus mapping

We collect 100 samples of women's suits and invite six professionals engaged in fashion design professionals select 22 different types of women's suits referring to the shawl collar, flat collar, and closure collar modelling design elements. These 22 women's suits include nine closure collars, ten flat collars, and three shawl collars. To ensure preciseness and accuracy, we need to keep the fabric, colour, shape and other variables unchanged during the experiment, and only change the collar type.

The virtual fitting technology can stitch two-dimensional panels into three-dimensional clothing. Its simulation is quite realistic and its operation is convenient [25, 26]. According to the steps above, the 22 stimulus maps are numbered from 1 to 22, as shown in figure 2.

Choice of perceptual vocabulary

After consulting a large number of fashion magazines and literature, we collected perceptual words to describe the collar of a suit. Six professionals engaged in clothing were invited to investigate and screen these words. Professionals eliminate adjectives with similar meanings, screen out words with vague or similar meanings, and then classify and rescreen the collected perceptual words based on the influence relationship between the remaining perceptual words and the stimulus map. Finally, 24 adjectives are determined from the aspects of use occasion, acceptance, structural characteristics and temperament. We number the 12 pairs of words from A to L number from A to L, as shown in table 1.

Questionnaire development

First, each suit is evaluated with 12 pairs of adjectives. The evaluation method is the five-scale method



Fig. 2. Stimulus map

Table 1

ADJECTIVE PAIRS							
Number	Adjective	Score					Adjective
A	Professional	-2	-1	0	1	2	Leisure
B	Female	-2	-1	0	1	2	Neutral
C	Popular	-2	-1	0	1	2	Individual
D	Elegant	-2	-1	0	1	2	Casual
E	Modern	-2	-1	0	1	2	Retro
F	Exaggerated	-2	-1	0	1	2	Introverted
G	Soft	-2	-1	0	1	2	Stiff
H	Complex	-2	-1	0	1	2	Simple
I	Vivid	-2	-1	0	1	2	Inflexible
J	Plain	-2	-1	0	1	2	Gorgeous
K	Edgy	-2	-1	0	1	2	Outdated
L	Pretty	-2	-1	0	1	2	Ugly

in the semantic difference method [27]. The score is set at five: -2, -1, 0, 1, and 2. As shown in table 1. Taking the adjective “female – neutral” as an example, the closer the score is to -2, the stronger the female feeling is; the closer the score is to 2, the stronger the neutral feeling is; 0 is the centre of the number axis, indicating that the feeling is unbiased. Next, the 22 women's suits collar type stimulus map is sorted out. Finally, the subjects scored each pair of adjectives in 22 stimulation maps according to their feelings.

RESULTS

Sample mean and analysis

A total of 106 questionnaires were collected, of which 100 were valid, 85% were female, and 15% were male. After examinees scored 22 samples of female suit collar stimulus maps, the average value was taken as the final score, as shown in table 2.

After the absolute value of the value in table 2 is taken, the larger absolute value is taken as the representative perceptual word of the stimulus graph. Then, the stimulation maps were classified according to different collar types. Stimulation maps 1, 4, 8, 10, 14, 15, 17, 20 and 22 were the closure collar, Stimulation figures 2, 3, 6, 7, 12, 13, 16, 18, 19, 21 are flat collar, Stimulation figures 5, 9 and 11 are

shawl collar. Finally, it can be concluded that the subjects generally believe that the shawl collar is relatively simple and soft among the three collar types. When the shawl collar is relatively short, it seems inflexible. The suit with a flat collar makes people feel more professional. The collar with a larger lapel shows the characteristics of neutral and inflexible, while the collar with a thinner lapel gives a strong female feeling. When the closure lapel's angle is sharp, it has a sense of edgy and exaggeration; when the collar is too small, such as in the fourth and eleventh stimulus pictures, the subjects feel that it is not good-looking.

Factor analysis

KMO and Bartlett test

As shown in table 3, the results of the KMO test and Bartlett test show that there is a correlation between variables. KMO test coefficient is 0.685, which is greater than 0.5, and Bartlett test significance is 0.000, which is less than 0.001, indicating that the questionnaire results can be further factor analysis.

The sample correlation matrix obtained by factor analysis is shown in table 4. When the absolute value of the table's value is closer to 1, it means that the two pairs of adjectives are more related. For example, there is a high correlation between exaggerated – introverted and plain – gorgeous, complex – simple

Table 2

SAMPLE MEAN SCORE												
Stimulus map number	Adjective pairs number											
	A	B	C	D	E	F	G	H	I	J	K	L
1	-0.45	-0.3	-0.12	-0.42	0.03	-0.52	-0.03	0.64	-0.27	-0.3	-0.24	-0.55
2	-1.03	0.58	-0.79	-0.03	-0.48	0.58	0.45	0.79	0.48	-0.7	0.45	-0.06
3	-0.73	-0.58	-0.85	-0.21	-0.67	0.55	-0.36	0.91	-0.21	-0.7	-0.33	-0.55
4	-0.06	-0.03	-0.06	-0.09	-0.21	-0.18	0.12	-0.03	-0.3	-0.09	-0.24	-0.3
5	0.42	-0.3	0.39	-0.09	0.12	0.18	-1.12	0.91	-0.58	-0.52	-0.48	-0.55
6	0.55	-0.27	0.09	0.27	-0.76	-0.21	-0.39	-0.18	-0.42	0.03	-0.52	-0.03
7	-0.58	-0.06	0.09	-0.52	-0.64	-0.06	0.15	-0.36	-0.3	0	-0.58	-0.64
8	-0.36	0.27	0.36	-0.18	-0.27	-0.79	0.39	-0.21	-0.33	0.18	-0.64	-0.55
9	0.36	-0.58	-0.24	-0.18	-0.21	0.21	-1	0.67	-0.67	-0.52	-0.46	-0.73
10	0.15	0.06	0.3	-0.33	0.06	-0.7	-0.12	-0.42	-0.18	0.18	-0.48	-0.64
11	0.52	0.88	-0.12	0.42	0.21	0.64	-0.85	0.94	0.55	-0.88	0.52	0.33
12	-1.12	0.21	-1.09	-0.09	-0.64	0.52	0.06	0.73	0.24	-0.61	-0.24	-0.73
13	-0.09	0.09	0.21	-0.03	-0.3	-0.15	-0.03	-0.09	0.03	-0.33	-0.21	-0.39
14	-0.55	0.03	0.42	-0.24	-0.12	-0.18	0.03	-0.64	-0.55	0.03	-0.64	-0.7
15	-0.39	-0.45	-0.36	-0.36	-0.7	0.15	-0.09	0.24	-0.18	-0.52	-0.52	-0.52
16	0.27	0.24	-0.12	0.55	-0.27	0.15	-0.24	0.64	0.39	-0.76	0.18	0.09
17	-0.06	-0.27	0.27	-0.58	0.12	-0.45	-0.58	-0.76	-0.58	-0.21	-0.58	-0.79
18	-0.88	-0.64	-0.82	-0.27	-0.88	0.48	-0.67	0.58	-0.21	-0.64	-0.42	-0.52
19	-0.36	0.64	-0.76	0	-0.76	-0.06	0.45	0.55	0.52	-0.76	0.15	-0.09
20	-0.33	-0.12	0.09	-0.33	-0.09	-0.55	-0.06	-0.09	-0.61	0.12	-0.97	-0.61
21	-0.27	0.09	-0.94	0.12	-0.82	0.3	-0.03	0.48	0.27	-0.55	0	-0.21
22	0.27	0.27	0.58	-0.15	-0.21	-0.76	0.3	-0.3	-0.42	0.15	-0.73	-0.82

and popular – individual, which means that the more gorgeous, complex, and individual perceptual impression of the stimulus map, the more exaggerated it is. On the contrary, the more plain, simple, and popular the perceptual impression of the stimulus map, the more introverted it is.

Table 3

KMO AND BARTLETT'S TEST		
Kaiser-Meyer-Olkin measure of sampling adequacy		0.685
Bartlett's sphericity test	Approximate chi-square	253.416
	df	66
	Sig	0.000

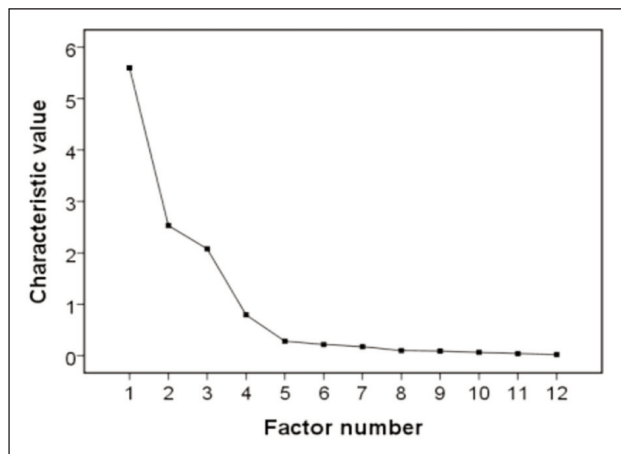


Fig. 3. Sample gravel map

Table 4

SAMPLE PERCEPTUAL VOCABULARY CORRELATION MATRIX												
Adjective pairs	A	B	C	D	E	F	G	H	I	J	K	L
A	1.000	0.060	0.594	0.416	0.493	-0.281	-0.483	-0.120	-0.203	0.161	-0.031	0.263
B	0.060	1.000	0.000	0.506	0.164	0.022	0.461	0.060	0.706	-0.133	0.603	0.551
C	0.594	0.000	1.000	-0.172	0.676	-0.735	-0.081	-0.662	-0.585	0.717	-0.515	-0.269
D	0.416	0.506	-0.172	1.000	-0.084	0.394	-0.144	0.444	0.606	-0.448	0.647	0.826
E	0.493	0.164	0.676	-0.084	1.000	-0.398	-0.310	-0.188	-0.290	0.261	-0.085	-0.120
F	-0.281	0.022	-0.735	0.394	-0.398	1.000	-0.351	0.750	0.518	-0.859	0.617	0.424
G	-0.483	0.461	-0.081	-0.114	-0.310	-0.351	1.000	-0.361	0.301	0.319	0.037	-0.015
H	-0.120	0.060	-0.662	0.444	-0.188	0.750	-0.316	1.000	0.510	-0.848	0.627	0.434
I	-0.203	0.706	-0.585	0.606	-0.290	0.518	0.301	0.510	1.000	-0.658	0.892	0.726
J	0.161	-0.133	0.717	-0.488	0.261	-0.859	0.319	-0.848	-0.658	1.000	-0.758	-0.510
K	-0.031	0.603	-0.515	0.647	-0.085	0.617	0.037	0.627	0.892	-0.758	1.000	0.801
L	0.263	0.551	-0.269	0.826	-0.120	0.424	-0.015	0.434	0.726	-0.510	0.801	1.000

Main factor selection

In this study, principal component analysis is used to extract factors, and the total variance table of adjective pair interpretation is obtained, as shown in table 5. Principal component analysis (PCA) reduces the dimension of variables and uses relatively few variables to replace the original variables while retaining more than 85% of the original information. The cumulative contribution rate of the first three common factors is 85.038%, so first, the three common factors' choices can explain most of the information of 22 stimulus graph adjective pairs.

Figure 3 is the gravel map of the sample. The first factor has the highest eigenvalue and makes the greatest contribution to explaining the original variables. From the fourth point, the broken line gradually tends to be flat, and the final eigenvalue is almost close to 0, that is, from the fourth point, it has little contribution to the overall variable. The broken line of the gravel diagram shows that principal components 1, 2 and 3 can describe the perceptual design of women's suit collar.

Table 5

TOTAL VARIANCE			
Ingredients	Initial eigenvalue		
	Total	Variance/%	Cumulative variance contribution rate/%
1	5.597	46.643	46.643
2	2.531	21.089	67.732
3	2.077	17.306	85.038
4	0.795	6.621	91.659
5	0.282	2.354	94.012
6	0.219	1.826	95.838
7	0.176	1.469	97.307
8	0.100	0.835	98.143
9	0.090	0.750	98.893
10	0.067	0.557	99.450
11	0.042	0.348	99.798
12	0.024	0.202	100.000

Naming and analysis of principal factors

To get the components of each factor, rotate the component matrix to get the rotating component matrix table, as shown in table 6. This paper analyses the composition and connotation of public factors.

It can be seen from table 6 that the following five groups of adjective pairs, namely female – neutral, vivid – inflexible, pretty – ugly, edgy – outdated, elegant – casual, have a greater load on the first factor. According to the meaning of these five pairs of adjective pairs, the first factor is named the “elegant factor”. The following four adjective pairs, namely exaggerated – introverted, plain – gorgeous, complex – simple, soft – stiff, have a greater load on the second factor. According to the meaning of these four pairs of adjective pairs, the second factor is named “style factor”. The following three pairs of adjectives, namely professional – leisure, modern – retro, and popular – individual, have a greater load on the third factor. According to the meaning of these three pairs of adjectives, the third factor is named the “occasion factor”.

Table 6

ROTATING COMPONENT MATRIX			
Adjective pairs	Factor		
	1	2	3
Female-neutral	0.898	-0.244	-
Vivid-inflexible	0.848	0.316	-0.351
Pretty-ugly	0.826	0.353	0.132
Edgy-outdated	0.802	0.494	-0.109
Elegant-casual	0.752	0.363	0.276
Exaggerated-introverted	0.196	0.876	-0.263
Plain-gorgeous	-0.343	-0.871	0.178
Complex-simple	0.256	0.846	-0.114
Soft-stiff	0.357	-0.640	-0.638
Professional-leisure	0.152	-	0.912
Modern-retro	-	-0.251	0.732
Popular-individual	-0.159	-0.643	0.692

Discussion

Women's suits, as a necessary item for professional women to attend business and leisure places, are a popular choice for fashion talents to match clothes, which plays an important role in the clothing category. The collar is located in the visual centre of the clothing, which has a relatively great impact on the overall style of the clothing, but there is not much research on the collar type of women's suits at present. Because of this, the authors choose a flat collar, closure collar and a shawl collar to study the influence of these three common collar types on the overall perceptual impression of suit style.

With the development of society and the economy, the consumers' personalized demand is increasing. Only to meet consumers' needs and achieve the purpose of improving customer satisfaction, enterprises can better survive in the market [8, 9]. Authors use the semantic difference method to investigate the

perceptual impression of the subjects on the collar type and make mean statistics and factor analysis on the survey data. The results show that the perceptual impression of the three different collar types is different, which had an impact on the perceptual impression of the overall style of the suit. This study can provide a reference for consumers to buy suits, and a guide for enterprises to design suits.

Due to the limited time, this paper only discusses the perceptual impression of the collar type on the overall style of the suit and does not discuss the influence of colour, fabric and other factors. Different colours bring different sensory experiences to consumers, such as warmth, cold, distance, and weight [28]. The softness, texture, drape and lustre of fabrics also affect the appearance, width and clothing style [29]. Style, colour and fabric are three important factors in fashion design. In the process of women's suit design, in addition to considering style design, research should also comprehensively refer to the two elements of colour and fabric, to produce clothing more in line with consumers' aesthetic needs and personalized needs.

CONCLUSION

This study takes the female suit collar type as the evaluation object, uses the semantic difference method, and draws the stimulus map with the help of virtual fitting technology to investigate consumers' perceptual impression of the collar type. Finally, the author processes the data and makes factor analysis, and obtains the following conclusions:

- Three main factors influencing the collar shape of women's suits are obtained: “style factor”, “elegance factor” and “occasion factor”.
- The three different collar types, closure collar, flat collar, and shawl collar, are the overall perceptual impression of the suit. The designer should carefully choose the collar type to match the suit according to the style.
- The perceptual impression of the shawl collar is relatively simple and soft. The flat collar is relatively professional, a lapel with a wide lapel shows neutral and inflexible characteristics, collar with a thin lapel gives people a strong feeling of being female. A closure collar with a round shape line makes people feel very elegant.

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