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A STUDY ON THE DESCRIPTIVE SCALE OF GLOBAL VIEW FOR SHAPE CONCEPTION FEATURE

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Abstract

In this paper, we approached the issue of global shaped factors, which conceptualize the "egg-shaped", according to the egg-shape conception of people using quantitative process. First, a research sample of 30 simple outlines was examined, and 30 students participated. In order to define the "strength of the egg-shaped conception", the shape samples were evaluated according to the participants' feel on similarity of degree between samples and egg-shape conceptions, and the most typical egg-shape was selected. The shape samples were transformed into quantitative data using ODSR (One Dimension Sequence Representation), and 4 statistics were used to describe the feature factors of the egg-shapes; Average, Coefficient of Variation, Coefficient of Skewness, Coefficient of Kurtosis. The capability of these 4 statistics was used to explain the "strength of the egg-shaped conception".

Keywords: Shaped Conception, Shaped Feature

Introduction

Shape performs a very important role in the interaction between products and consumers, whether for an aesthetic purpose or a functional purpose. But the interaction between shape and consumer's recognition is very complex. In the past, designers created a style or coherence of product shape according his subjective opinion, called "the black box operation". It is difficult to understand the interaction between shape and recognition in this process. From a scientific viewpoint, we couldn't infer or predict the shape which is demanded or favored by consumers if the relationship was not defined. Thus, it is necessary to research the relationship between shape and consumer's recognition by using systematic quantitative methods. Two key points are discussed, "shape conception" and "shape descriptive on global view".

"Conception" could be formed as a constituent unit of a knowledge system on cognition psychology (Bruner, JS et al. 1956). It has a powerful impact in the action of cognition. The conception is a symbolic structure. It typifies the commonality of externals. The conception is transformed by people's categorization, though the progress of categorization to structure a variety of conception, where the more similar things are, the more homology de-excited[1].

The meaning of "quantitative description in shape" transforms from an actual shape into a quantity format. It conduces to definition, explanation, analysis, comparison of shape questions. In the typical study of Kansei Engineering (Nagamachi, M. 1995), shape is always described by several attributions formed by qualitative methods. However, it has many restrictions in the exploration of the relationship between shape and recognition, as follow.

(1) According to the Structure Mode Theory of Gestalt Psychology (Garner, WR. 1978), the conception could not be formed by single individuality and it mostly thought the analysis of commonality of shapes, so it is difficult to define the impact of single attribute on whole

recognition process.

(2) If we define a conception of shape by several common attributions, the interaction will become a problem when the statistical tool is used.

(3) The shape attribute is always biased by the researcher's subjective opinion.

Another type of shape description is the re-presentation based on mathematical format, such as curve fitting techniques (Vera, B. 1993). The advantage of mathematical representation is accuracy of representation. The data structure of this kind of representation is quite complex and lacking in commonality. It is hard to construct a relationship between shape and cognition.

It not only exists in cognition psychology and design fields to find an applicable quantitative method in description of shape. A lot of researchers are developing the description shape by quantitative approaches, such as CSM (The Continuous Symmetry Measure Method) (Zabrodsky, H. & Avnir. D. 1995) used to measure symmetry of prehistoric instruments in archaeology (Saragusti, I et al. 1998). Altogether, it is the research method used to determine the descriptive scale on global view and explore the ability of factors for explanation of shape conception.

Descriptive Scale of Global View

There is a major question in this paper: how to describe shape by suitable scales. Via those scales, the designer will be able to understand the relationship between shape and consumer's recognition effectively. We used the outline of the egg-shaped as an example. ODSR (One Dimension Sequence Representation) transforms the shape of the sample into quantitative data, and four statistics (Average, Coefficient of variation, Coefficient of skewness, Coefficient of kurtosis) are evaluated to identify the ability to explain recognition effect:

Set $v_i = sequence\ (i = 1, 2, ..., n)$

(1) Average (F_1)

$$F_1 = m = \frac{\sum_{i=1}^{n} v_i}{n} \tag{1}$$

(2) Coefficient of variation (F_2)

$$F_2 = v = \frac{\left[\frac{1}{n} \sum_{i=1}^{n} (v_i - m)^2 \right]^{1/2}}{m} \tag{2}$$

(3) Coefficient of skewness (F_3)

$$F_3 = s = \frac{\frac{1}{n} \sum_{i=1}^{n} (v_i - m)^3}{\left[\frac{1}{n} \sum_{i=1}^{n} (v_i - m)^2 \right]^{3/2}} \tag{3}$$

$$F_4 = k = \frac{\frac{1}{n} \sum_{i=1}^{n} (v_i - m)^4}{\left[\frac{1}{n} \sum_{i=1}^{n} (v_i - m)^2 \right]^{2}} \tag{4}$$

Method

The framework of this research consists of 3 parts: (1) Participants evaluated the degree of similarity between sample shape and their conception of egg-shapes, and then selected the most typical egg-shaped of all samples. (2) Researchers calculated 4 statistics for all samples by ODSR and normalization. (3) The relationships between these statistics and the conception of egg-shaped were analyzed.

Selecting The Typical Egg-Shaped

Sample

In order to expand the range of the sample and restrain the number of samples, we draw a figure as a “desired typical egg-shaped” according real egg (sample No.6). (See all samples and figures at the end of the article.) Fig.1 shows the 30 samples in this research, No.1 is a round, No2~5 are derive from No.1, No.7~15 are derive from No.6 variety of proportion, No.16~25 are derive from No.6 by irregularity, No.26~30 are derive from No.6 by rotation.

Experiment: Subjective Evaluations of Similar Degree

Every participator is asked to evaluate the similar degree between every sample and their conception on "egg-shaped" by a Likert rating scale. First of all, participants are asked to select two samples, one is the most score, the other is the less score. This was done to avoid variance is from the different of evaluation criterion among the participants.

Results of Experiment

Table 1 shows the average and standard deviation of score of all samples, No.6 have highest average in all sample (6.8), standard deviation is 0.4, that meaning the No.6 is the closest sample of egg-shaped between 15 participants, and the evaluation of all participants are very concurrent. Thus, No.6 was selected for the typical egg-shaped conception in this research.

Quantitative Representation of Shape:

The method which transforms boundary point of shape into several distances between boundary point and center of shape in sequence was used to represent a shape.

Calculation of Center Of Shape Outline

Calculation of center of shape outline

In order to Calculation the position of figure and area of shape, the sample figures were inserted into a grid (see Fig 2). In this grid, the units which be passed by outline was mark by gray. The center of sample figure was calculated by the coordinate of those gray units, as Eq. (5), (6), (7).

$$X_c = \frac{-\sum_{i=1}^{n} x_i^2 (y_{i-1} - y_i)}{2 \times Area} \tag{5}$$

$$Y_c = \frac{-\sum_{i=1}^{n} y_i^2 (x_{i-1} - x_i)}{2 \times Area} \tag{6}$$

$$Area = \sum_{i=1}^{n} [\, y_i (x_{i+1} - x_i) - x_i (y_{i+1} - y_i) \,] \tag{7}$$

where:

$C = (X_c, Y_c)$ *center of figure*
$n =$ *number of gray units*
$Area =$ *area of figure (Gree rule)*

Representation of Outline of Shape

The position of boundary points of the approximate polygon of sample shape is calculated using "Isometric angles method". Fig.3 shows the approach of search the boundary point of shape by the method of Isometric angles. The Boundary points are searched toward the outline with *C* point as hub at an interval of 11.25°, the boundary of which longest distance which be measured between boundary point (T_i) and C are deputized starting to number the boundary point from 1 to 32 ($T_1, T_2, \ldots, T_{32}$) in reversed clock direction. The outline of shapes are represented in Eq. (8)

$$S = \{ T_i = (x_i, y_i) \} \quad i = 1, 2, \ldots, n \tag{8}$$

where:
$S =$ *outline of shape*
$T_i =$ *boundrary point i*
$(x_i, y_i) =$ *the coordinate of boundary point i*
$n =$ *the number of boundary points*

Transforming Outline into Sequence

The outline of shape transformed from the coordinate into sequence (r_i) which was represented in the distance between boundary and center as Eq. (9).

$r_i = d\ (T_i, C) \quad i = 1,2,\ldots,n$ (9)

Where:

$C = (x_c, y_c)$ *coordinate of center*

$T_i = (x_i, y_i)$ *coordinate of boundary point i*

$d\ (T_i, C) =$ *the distance between* T_i *and* C

Normalization

Find out the unit of which largest distance in sequence V_{maxi}, and sequence unit r_i is normalized into v_i follow Eq. (10). Normalization could drown the impact of difference of scale between samples. The number of sequence v_i intervenes between 0 to 1 (see Fig.4)

Analyses And Results

Calculation Of Feature Factors

Four feature factors of egg-shaped (Average F_1, Coefficient of variation F_2, Coefficient of skewness F_3, Coefficient of kurtosis F_4) are calculated according to Eq. (1), (2), (3), (4) (see Fig.5).

Calculation Of Distance Between Sample And Typical Egg-Shaped

Follow the conception of this research, we assume the number of feature factors of typical egg-shaped equal to the sample which was the largest strength of egg-shaped in all (F_1=0.71, F_2=0.08, F_3=0.78, F_4=0.05). In order to verify the supposition, we calculate the distance between every sample and No.6 sample (the typical egg-shaped) on 4 feature factors. No.1 sample was not calculated, because it is around, the numbers are equality on 4 feature factors.

Multiple Regression Analysis

The regression analysis model consists of 4 feature factors as independent variable; it was constructed to test the statistical significance of those feature factors in explanation of egg-shaped conception. Table 3 shows the results of ANOVA, the relationship between independent variable (a feature factors) and dependent variable (the strength of egg-shaped conception) are re presented. P=0.05, F=6.26, sig of F=0.01, meaning the relationship between feature factors and strength of egg-shaped are regression.

The *ADJ* R^2 value deters the ability which explains the strength of egg-shaped conception of 4 feature factors. In Table 4,ADJ R^2=0.429,meaning in the regression model 4 feature factors only reduced 43% variance of strength of strength of egg-shaped conception. Scilicet, 57% variance comes of undiscovered factors.

In order to check whether there are powerful feature factors which explain the strength of egg-shaped conception or not, stepwise regression is used. Average F_1, Coefficient of variation F_2, Coefficient of Kurtosis F_4 is excluded in this model (see table 5). Specifically, those feature factors have no significant to explain the strength of egg-shaped conception.

Through significance testing, only the Coefficient of skewness (F_3) is reserved in all feature factors (see table 6). The Coefficient of skewness (F_3) is performed to construct another regression analysis, and its ability which explains the strength of egg-shaped. R^2=0.399 (see table 7), and compares with first regression model the regression which consists by Coefficient of skewness (F_3) have a significant effect to explain the variance.

Conclusions

(1) The capability of the 4 statistics in the explanation of the “strength of egg-shaped conception” is identified. The Coefficient of Skewness, which has a significant capability in explaining the" strength of egg-shaped conception" is 43%; in other words, 57% of variance comes form undiscovered factors.

(2) The Average, Coefficient of Variation, Coefficient of Kurtosis have no significant impact in explaining the relationship of shape and egg-shaped conception.

(3) By putting the Coefficient of Skewness into practice, we could understand its meaning. When the Coefficient of Skewness is 0, the sequences would centralize near the average and more approximate a round. When the Coefficient of Skewness is greater then 0, the greater part of sequences would be less then average, meaning a slender shape. When the Coefficient of Skewness is 0.78, the egg-shaped conception reaches towards the top; the clos3r to the top, the more strong the conception.

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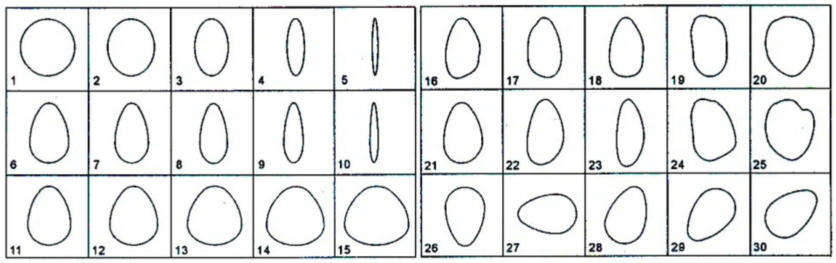

Figure 1 Samples

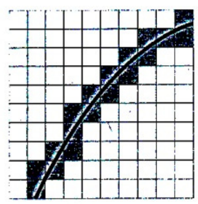

Figure 2 An outline of shape be represented by grid

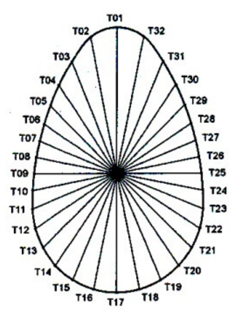

Figure 3 Calculation the approximate polygon of egg-shaped

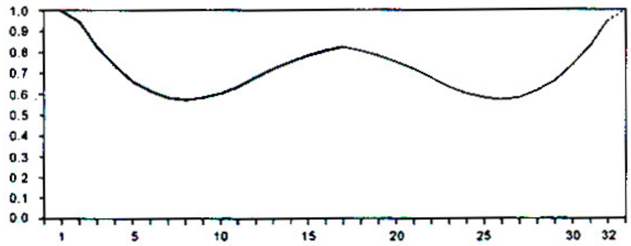

Figure 4 Sequence represent of shape

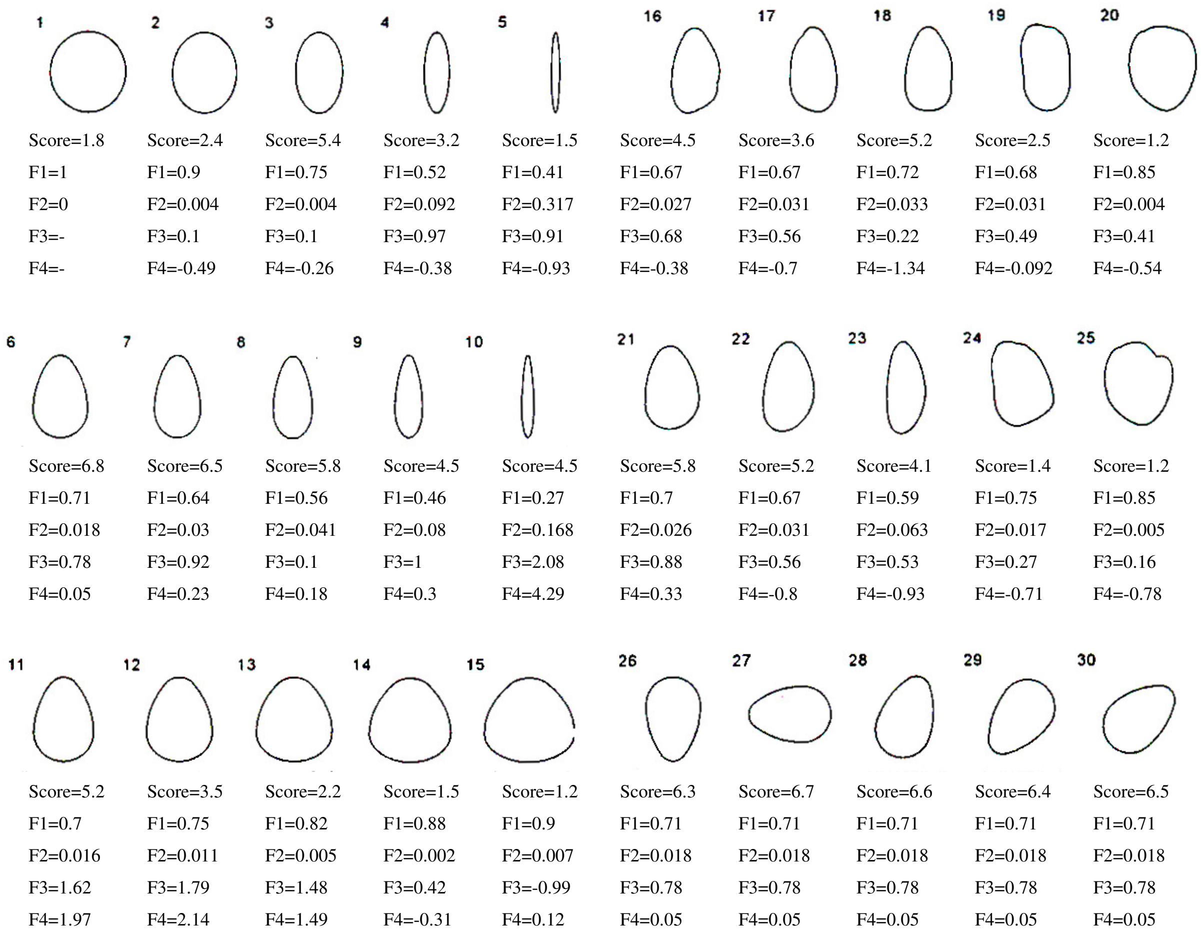

Figure 5 Result of calculation of 4 feature factors

Table 1 The result of evaluation

sample	average	SD	sample	average	SD
1	1.8	1.2	16	4.5	1.7
2	2.4	0.8	17	3.6	2.0
3	5.4	0.7	18	5.2	0.9
4	3.2	1.3	19	2.5	1.7
5	1.5	0.4	20	1.2	0.6
6	6.8	0.4	21	5.8	0.6
7	6.5	0.6	22	5.2	1.4
8	5.8	0.7	23	4.1	2.3
9	4.5	1.2	24	1.4	0.5
10	1.5	0.9	25	1.2	0.3
11	5.2	1.5	26	6.3	1.2
12	3.5	1.0	27	6.7	0.8
13	2.2	1.7	28	6.6	0.6
14	1.5	0.8	29	6.4	0.8
15	1.2	0.3	30	6.5	0.5

Table 2 Distance between sample and typical egg-shaped

sample	score	F_1	F_2	F_3	F_4
2	2.4	0.19	0.014	0.68	0.54
3	5.4	0.04	0.01	0.31	0.31
4	3.2	0.19	0.074	0.19	0.43
5	1.5	0.30	0.299	1.13	0.98
6	6.8	0.00	0.000	0.00	0.00
7	6.5	0.07	0.012	0.14	0.18
8	5.8	0.15	0.023	0.68	0.13
9	4.5	0.25	0.062	0.22	0.25
10	1.5	0.44	0.149	1.30	4.24
11	5.2	0.01	0.002	0.16	1.92
12	3.5	0.04	0.007	0.01	2.09
13	2.2	0.11	0.013	0.30	1.44
14	1.5	0.17	0.016	0.36	0.36
15	1.2	0.19	0.011	1.77	0.07
16	4.5	0.04	0.009	0.10	0.43
17	3.6	0.04	0.013	0.22	0.75
18	5.2	0.01	0.015	0.56	1.39
19	2.5	0.03	0.013	0.29	0.97
20	1.2	0.14	0.014	0.37	0.59
21	5.8	0.01	0.008	0.10	0.28
22	5.2	0.04	0.013	0.22	0.85
23	4.1	0.12	0.045	0.25	0.98
24	1.4	0.04	0.001	0.51	0.76
25	1.2	0.14	0.013	0.62	0.83
26	6.3	0.00	0.000	0.00	0.00
27	6.7	0.00	0.000	0.00	0.00
28	6.6	0.00	0.000	0.00	0.00
29	6.4	0.00	0.000	0.00	0.00
30	6.5	0.00	0.000	0.00	0.00