A Multi-Dimensional Design Elements Extraction Method for

Product Perceptual Image

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Abstract: Using morphological Charts to extract product parts as design variables is a widely applied method in traditional Kansei Engineering so far, but this method has low practical value for Kansei design. Taking morphological characteristics instead of product parts as extraction principle, a breakthrough point for innovative design of industrial products was presented. Using Human Interface Elements as the basic logical cell of Multi-dimensional elements, this new design method contains pattern, color, texture and sound product design elements which root in visual, tactile and auditory sense organs of human beings. The extraction framework of the product design elements is proposed based on HIEs induced by distinctive, integrative property and interactive properties. The usage of the extraction method based on HIEs was discussed and the Carbon and Sulphur Analyzer design as an example given. It is propitious to Kansei design or emotional design, but also to product customer satisfaction and experience design.

Introduction

Based on application and innovation, industrial design encircles the focus of improving people's life quality and discovers new design to influence human's life style. Perceptual image became the biggest selling point, not quality or price [1]. Nowadays, under the economic environment full with fierce market competition, Perceptual image should be confirmed and measured appropriately. The design elements have been the essential marriage between consumer's cognition and perceptual image. The consumer's pre-purchasing emotion was invoked by the multi-dimensional product attribute. An extraction method of the design elements is critical.

Kansei Engineering most used morphological Charts to extract product parts as design variables previously. It had deconstructed morphological characteristics into graphical representation of categories [2]. Its premise was that categories attribute were generally independent of each other, are not correlated with each other. A morphological chart was simplified to Geometric shape description in essence. So it had low practical value for Kansei design. This article is to extract multi-dimensional the design elements from morphological characteristics to improve creative quality in the product design field.

Multi-Dimensional Design Elements Extraction Method

The concept of Multi-dimensional features

The human interface is a medium to transfer information between the users with the product, that is, it is an interface for the human to communicate with the product, it is defined as the Collection of the design features that the users see, touch, smell, hear, operate or use. A setting is Human Interface Elements as logical cell of Multi-dimensional features [3]. It contains pattern, color, texture and sound product design elements which root in visual, tactile and auditory sense organs. Extract the smallest perceptual information factors, as a product design features logic cells. The psychological feelings to a product is apperceive its shape, color, material, texture and so on, all of which belong to the human interfaces.

As a result, the human interface elements (HIEs) are the smallest human interfaces and are the most elementary design features modeling unit. Multi-dimensional modeling features it is defined as the collection of HIEs. Not just to look, it is a look-and-feel cognitive process.

The design elements extraction principle

Because the product is extremely rich, large enterprises put increasing attention on the Product Identification. Mike Baxter put forward global precedence principle and manifested that the main appearance characteristics of product identification was depend on the edge approaches[4],that was the theoretical basis for early Kansei engineering model（mapping mode between product profile and perceptual image）. Product form contains large variety of points, lines, planes and volume shape elements. Previously, most scholars followed the traditional product parts deconstruction. All of our debates and discussions considering human perception and cognition have meaning when we take morphological characteristics instead of product parts as extraction principle

The design elements extraction three aspects

Design features has outside character, such as function, colors, textures, shape[5],and inside character, such as brand, culture[6]. Seva claimed that design features the three components of distinctive, integrative and interactive [7]. Based on the above, the extraction framework of the product design elements is proposed induced by distinctive, integrative property and interactive properties (see table.1).

The design elements code		
Individual attributes	The main body	the main modeling, the connection patterns the edge horn processing , the detail characteristic
	The components	a single attribute of form, color, texture
Integrative attributes	Perceptual grouping	an attribute collection：similar form, color, texture
		part-whole relations：array layout between perceptual grouping and the main body
Interactive attributes	Information input	the key press、 the direction of applying force
	Feedback information	flashing lights、sound effect

Individual attributes

The main bodies contain the main form, the connection patterns, edge horn processing and the detail characteristic four aspects. To be specific, the feeling about the overall outline or shape, color, texture, volume, heaviness, size specifications, it all belong to the main form. Usually one product is a comprehensive morphological by two basic objects Boolean Operation. From Morphological Tectonics view, the connection patterns are defined as the relationship between two basic objects,

such as union relationship, intersection relationship and subtraction relationship. Edge horn processing mainly is due to chamfering curvature, radian size. Processing the horn side product basically sees whether level off is smooth. Product's arc processing has brought good visual comfort. The detail characteristic includes feature points, characteristic line, feature face, etc. In fact, if morphological evolution is proper, they will become brilliant life forms, and otherwise it will strengthen its bringing cumbersome, tense feeling.

The components are defined as a single attribute of form, color, translucency, texture and so on.

Integrative attributes

An attribute collection is defined as the collection of design features those similar forms, colors, textures, such as the keys permutation and colors combination among the elements. Part-whole relations [8] like positional relation, proportion relation, and color-matching relation, is explained as correlative relationships of array layout between perceptual grouping and the main body. Based on topological perception and visual perception theoretical analysis, integrative attributes of perceptual object is a special focus.

Interactive attributes

The HIEs of information input contains operation properties such as its direction, magnitude and point of application. The information feedback HIEs is defined feedback signals such as sound effect, indicator light blinking.

Extraction method and Procedures

The approach consists of 4 steps: (1) define multi-dimensional features; (2) decompose product features from individual attributes, integrative

Fig.1 the design process

attributes, and interactive attributes three aspects (3) conduct cognition experiments and (4) analyze critical design features. (See Fig.1)The most important is the step2: decompose product features from individual attributes, integrative attributes, and interactive attributes three aspects. The details are as follows:

First, separate the product's individual attributes, integrative attributes, and interactive attributes three aspects. Then, separate the product's individual attributes to the main body and the components. Collect the HIEs of the main body design features from the main modeling, the connection patterns, edge horn processing, and the detail characteristic four aspects by the vision sensory channels. The HIEs can be collected from form, color, translucency, texture the quantitative feature. Second, the integrative attributes are classified into perceptual grouping components and Part-whole relations. Gestalt Aesthetics attaches importance to the whole, the outcomes of certain structures. Third, subdivide Interactive attributes into information input and information feedback from the visual, aural, tactual or olfactory multi-senses channels.

Comprehensive above factors, taking morphological characteristics instead of product parts as extraction principle, the obtainment of multi-dimensional design features is of paramount importance to deconstruct the product's full-range HIEs. A more precise design elements extraction method to product shape features is proposed to address the problem how to use customer cognitive
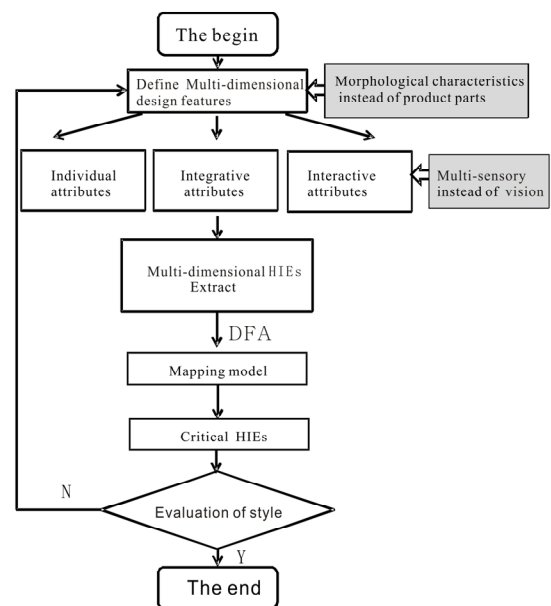
knowledge to support product shape design.

The example of applied study

Sample selection

With the practice through the design, the Carbon and Sulphur Analyzer as instrumental product, basic geometrical form is rectangular solid. The Carbon and Sulphur Analyzer HXE-7B Product Series as simpler models are given as an example.

Participants selection

Samples of 50 users at an average age of 20 to 45, and 5 industrial designers, 10 industrial design students and 25 operators were tested. On the participants' selection, the operators from the Carbon and Sulphur manufactures have been chosen which requires three-plus years of related experience. To ensure the good cognitive, physical prototype were provided as the Tests with manufacturers' support.

The Carbon and Sulphur Analyzer HIEs code

Specific to the Carbon and Sulphur Analyzer, the sense of smell and vibration sensation isn't studied. Refer to table 1, the HIEs were extracted, in relation to shape, color, texture, and layout. 22 HIEs have been collected, the extraction results are as follows, (see table 2).

Table 2 The Carbon and Sulphur Analyzer HIEs code

HIEs	P1 the number colors of the main body	P12 the rotary knobs shape
	P2 the main body delicate texture	P13the rotary knobs sound feedback
	P3 the main body regular shape	P14 the Titration Button location and layout
	P4 the chamfering of the main body	P15 the Titration Button shapes
	P5 the Front Panels Style lines	P16the Titration buttons flowery color
	P6 the Front Panels color proportion	P17 the Titration buttons sound
	P7 the Front Panels chamfering curvature	P18 the Titration buttons touch
	P8 the Overall color ratio	P19 the colors of lights module
	P9 the Logo and text layout	P20 the layout of lights module
	P10 the rotary knobs touch	P21 the layout of lights module rotary knobs
	P11 the rotary knobs colors	P22 the layout of On/Off Button Titration buttons

The Perceptual image cognition

For the certain category of certain Perceptual image, an element with moderate strength is assigned as the standard stimulus and the numerical value 1 is designated as its sensory amount. Take "Sober" for example. P3 (the main body regular shape), is appointed by testers in cognitive experiment as the standard stimulus, and the numerical value 1 is designated as its sensory amount.

According to research analysis and expert discussions, the Carbon and Sulphur Analyzer as instrumental product, "simplicity""sophisticated""Sober" were selected as the Perceptual image vocabularies. The samples were classified 3 groups, sample 1-3 as simplicity Perceptual image group,sample 4-6 sophisticated Perceptual image group, sample 7-9 Sober Perceptual image group. Refer to DFA scoring method [9-10] , "strong"、"weak"、"nothing" as the different levels(see table 3), a simple and quick Style image score were obtained. Collect the evaluation result for 9 Samples from 50 Participants. The product's modeling interrelationship between the design elements and perceptual image has been explored.

Table 3 The DFA rating form for the Carbon and Sulphur Analyzer

	sample 1	sample 2	sample 3	sample 4	sample 5	sample 6	sample 7	sample 8	sample 9
P1	■	■	□	■	■	□	■	□	■
P2	■	■	□	■	□	■	■	■	□
P3	□	□	■	■	■	□	□	■	□
P4	■	□	■	■	□	□	■	□	■
…	…	…	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…	…
P21	□	■	□		□	■	□	□	□
P22	■	□	■	□	■	□	□	■	□

Notes：（"■"strong occurance, 2 point;"□"weak occurance, 1 point; Blank "no occurance",0 point）

Analysis of test results

Complying with Manufacturers requirements, the improved ranges are the front panel for economic reasons. The theory guiding practice, series scheme were designed (see table 4). Key HIEs as the key design elements prove decisive for design strategy. Scheme 2 was acceptable, were put into production。

Table 4 The key HIEs and the scheme design

Perceptual image	simplicity	sophisticated	sober
Critical HIEs	（P1）the number colors of the main body （P4）the chamfering of the main body	（P5）the Front Panels Style lines （P6）the Front Panels color proportion （P7）the Front Panels chamfering curvature （P20）the layout of lights module	（P2）the main body delicate texture （P3）the main body regular shape （P9）the Logo and text layout （P10）the rotary knobs touch （P18）the Titration buttons touch
Styling Proposals	scheme1	scheme2	scheme3

The results prove that, simplicity perceptual image was closely related to P1（the number colors of the main body） and P4（the chamfering of the main body.P5（the Front Panels Style lines） P6（the Front Panels color proportion）P7（the Front Panels chamfering curvature） and P20（the layout of lights module） were the key affected to sophisticated Perceptual image. Sober Perceptual image depend on P3（the main body regular shape）、P9（the Logo and text layout）P10（the rotary knobs touch）、P18（the Titration buttons touch）P2（the main body delicate texture）

Conclusion

In conclusion, it's a Multi-Dimensional Design Elements Extraction Method research design during the Perceptual image research period. Taking morphological characteristics instead of product parts as extraction principle, the extraction framework of the product design elements is proposed based on HIEs are detailed analyzed. This study reached the following conclusions:

(1)The scientific way of Perceptual image design is a system with many levels, forms and elements. Multi-dimensional design elements contain pattern, color, texture and sound, which root in visual, tactile and auditory sense organs.

(2) The extraction framework is proposed which induced by distinctive, integrative and interactive three properties. It puts forward product's overall HIEs deconstruction method to obtain more comprehensive design elements. It can improve the practical value of KE model.

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