Research on DNA Elements Extraction and Design of Mower Based on DFA and Eye Movement Experiment

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Abstract. Due to the serious problem of product homogenization, many companies realize that they need to differentiate their designs to shape their own products style. However, there is no mature theory as a guide. In this study, the design format analysis (DFA) method was used to find the common or similar elements of the enterprise products, namely, the family genetics. The eye movement tracking experiment method was used to analyze and extract the product modeling features, and the product sketching and computer aided modeling were carried out. Showcase and finally make a prototype. The feasibility of the above method is verified by evaluating the prototype, which provides a reference for the enterprise to design the product family.

Introduction

Under the fierce competition pressure, homogenized products are becoming less and less competitive. Therefore, enterprises have begun to pay attention to the commercial role of brands. Branding has developed rapidly. Few companies have not used brands [1], and many companies have recognized the importance of familyization branding and taken some attempts. For example, Xiaomi Eco, Geely Automobile, etc. but from the overall design industry, we are just getting started in this field. Many manufacturers lack long-term brand design planning.They only blindly follow the trend, and the image of their products is constantly changing during the iteration. This may be successful in designing one product, but it does more harm than good for the entire product line of the enterprise. The chaotic product image will also lead to chaos in the brand strategy of the entire enterprise, which is not conducive to the long-term development of the company [2]. At the same time, enterprises still have great problems in the branding and promotion of brands. They lack long-term planning, blindly follow the trend, and the product inheritance is not strong, heritability and identification are weak. In this study, we use the lawn mower as an example to try to extract the genetics (product DNA) of the target object (mower) by design matrix analysis [3], and combine the eye movement experiment with questionnaire to design the modeling trend. Then verify the feasibility of the method.

Extraction Elements Of Product Family Characteristic

Existing Problems and Target Tasks. When planning and designing products, enterprises consciously make the product family show some similar unified characteristics to form a family image [4-5]. This unified feature is the product family DNA. The family DNA is applied to each product of the product family through different coding combinations, so that the recognition characteristics of the vertical product affinity and horizontal homogeneity of the brand product group are continued and developed [6-8], as shown in Figure 1, but The extraction of family DNA has subjective ambiguity and uncertainty. Taking a lawn mower as an example, this study attempts to analyze the typical characteristics of products and the correspondence between products by

design format analysis(DFA), and analyze the core elements of brand design to form product DNA.
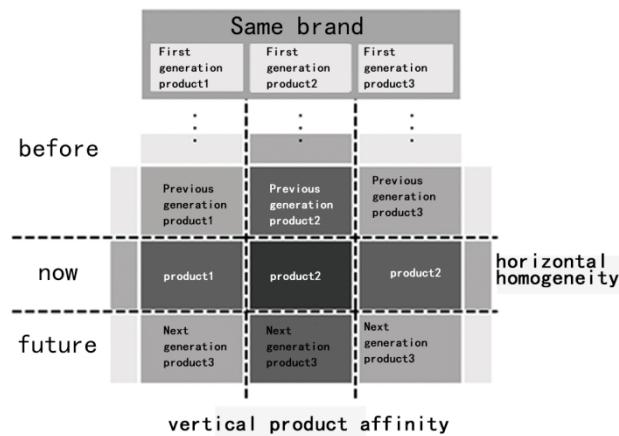

Fig 1. Relationship within the product family

Steps and Results. Firstly, the matrix shown in Figure 2 is constructed, and four representative products of a certain brand are selected as "columns" and six product elements that can represent the characteristics of the enterprise products as "rows", and the correlation between products and features is carried out. Questionnaires were scored, strong correlations were marked with black scores of 2 points, weak correlations were marked with gray scores of 1 point, and no correlations were marked with white scores of 0 points. Each row and each column in the matrix is summed, wherein the vertical score indicates the importance of a certain feature to the brand image, and the horizontal score represents the fit of a product to the brand image.
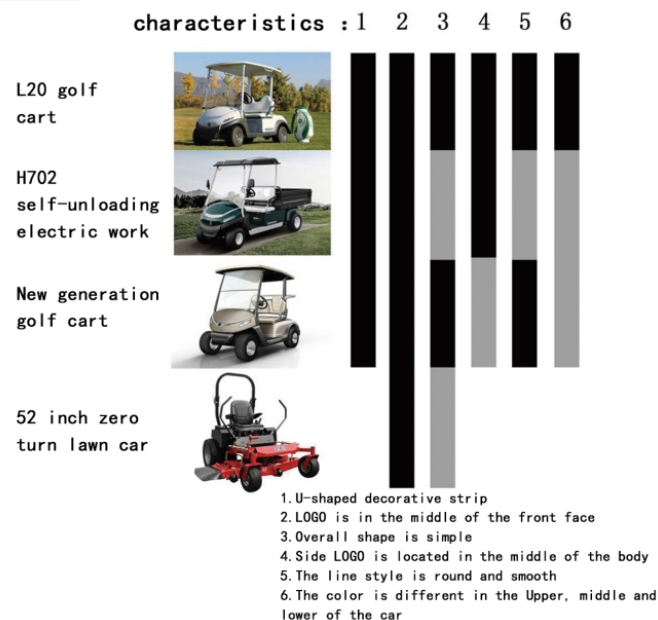

Fig 2. Building a DFA analysis matrix

There are four genetic characteristics that are more important through matrix calculation: as shown in Figure 3.

First, the front face of the product has a "U"-shaped decorative strip; second, the LOGO is located in the middle of the front face; third, the overall shape is simple; fourth, in terms of color matching, roughly follow the upper, middle, and lower three-part color separation The principle that the chassis, the body and the roof have their own uniform colors.

These characteristics are highly inherited in the vertical iteration process of enterprise products.

They are also prominent in the product design of the enterprise during the same period. They can be applied to the future product design of the enterprise to ensure the continuity and recognition of brand characteristics.

Fig 3. Important genetic feature extraction

Determination of the Modling Style

Enterprise Problems in Product Modeling. The company hopes that the new product (mower) will convey the brand intention of "affinity" and "exquisiteness". The research team attempts to determine its shape through the combination of eye movement experiment and semantic difference method [9-10].

For the mower with the basic structure shown in Figure 4, 20 different images were selected, and 30 samples were tested to track the eye movements of the subjects (the experimental scene is shown in Figure 5) to study different morphological features and shapes. The degree of attention to style. The experimental results (see Figure 6 for some hotspots) show that: first, the nameplates, headlights, logos and other relatively small details are highly concerned; second, the car body has a higher degree of attention than the chassis, and the more important styling features are mainly concentrated in the front. Part of the hood, lower mowing tray and rear seat.
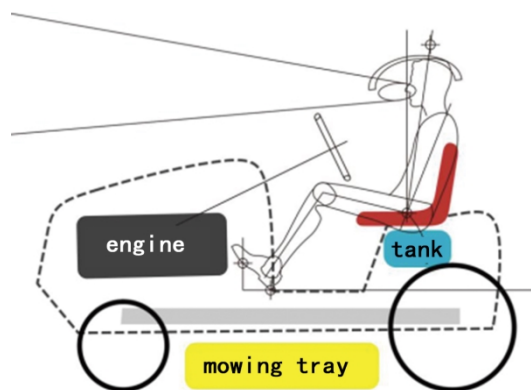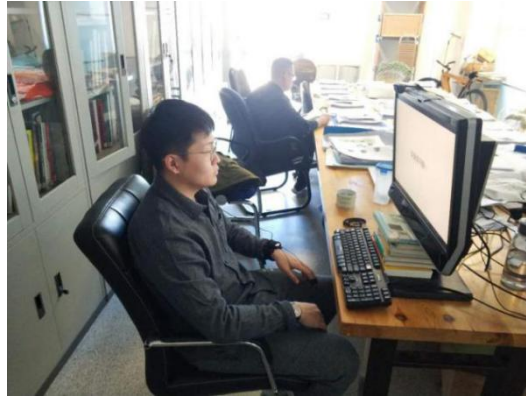

Fig 4. Lawn mower concept illustration

Fig 5. Experimental scene

Fig 6. Eye tracking experiment results (partial)

Then through the questionnaire and expert interviews, the five intentions of security, modernity, affinity, fashion sense and exquisiteness are summarized, and the questionnaire is designed to explore the average of the perceptual knowledge of the sample images. (Partial results are shown in Table 1), and the product images with higher and lower evaluations are selected to analyze the characteristics of the product to guide the final mower design.

Table 1   Scale questionnaire statistics

OBJECT	SAFE	MODEN	AFFINITY	FASHION	EXQUISITE	OVERALL IMPRESSION
FIG 1	4.52	4.34	4.31	3.59	4.07	4.41
FIG 2	4.55	3.21	3.17	3.14	3.28	3.69
FIG 3	4.38	4.41	3.66	3.90	4	4.10
FIG 4	4.59	4.07	3.86	3.97	3.93	4.48
FIG...						
FIG 16	4.39	4.52	4.07	4	4. 28	4.43
FIG 17	4.39	4.96	4.18	4.21	4.46	4.68
FIG 18	4.07	4.07	3.79	4.32	4.36	4.29
FIG 19	3.5	3.86	3.39	3.46	3.25	3.61
FIG 20	4.57	4.07	3.89	3.57	3.71	4.07

Combine the results of the scale with the eye movement test to establish a mapping relationship between modeling features and cognitive evaluation, as shown in Table 2.

Table 2 Mower mapping table

	SAFE	MODEN	AFFINITY	FASHION	EXQUISITE
POSITIVE MODLING ELEMENT	Front engine, the whole machine is mainly in straight line, the head cover is relatively thick, the seat has armrests, gives a strong sense of wrapping, and has a bumper.	No tubular bumper, strong overall sense, simple style	The overall shape is dominated by arc curves, with fewer right-angled turns and no bumpers	The overall shape is between straight lines and arcs. The head cover is small or no cover, and the overall style is light.	The overall shape is coordinated, and there are many covering parts, especially the details of the head part are rich in details, and the workmanship is also good.
NEGATIVE MODLING ELEMENT	Rear engine, no front cover or the cover is small, no bumper, poor package	The overall shape is dominated by a circular curve, and the frame structure is prominent.	The shape of the whole machine is mainly straight, the structure of the frame is strong, and more structural parts are exposed, rear engine	More right angle turns, rear engine, strong mechanical sense	Less cover parts and fewer parts, more exposed parts

Combined with the above experiments and data to determine the design of the guiding suggestions: the overall shape is mainly arc curve, less right angle turning, no bumper, the overall sense of the shape is strong; overall shape coordination, more cover, details of the head part are rich in details. These can be used as the general direction of the subsequent product design.

Project Design and Display

Sketch the sketch plan according to the design recommendations, and use Alias software for computer-aided modeling and rendering. The design scheme emphasizes the "intimacy" and "exquisite" modeling intentions. The overall shape is sleek but not bloated. The front face adopts U-shaped family elements, and the logo is placed in the middle of the front face, but the overall shape is more concise and coordinated. Maintaining family characteristics is also in line with contemporary design trends. In terms of color matching, draw on the color and emotional value table of Japanese designer Daisaburo Saburo to select the color matching [11], and choose the color combination of light beige, light blue and gray black to reflect the brand's "affinity" and "exquisite" value tendency. It can bring people an affinity, stable and clean color association, which is in line with brand positioning [12]. The final renderings and models are shown in Figure7.

Fig 7. Plan sketch and renderings

Conclusion

Product family design is very important. In order to explore a suitable method for enterprises to analyze the product family characteristics, this research takes the lawn mower product as a case, studies and analyzes the genetic elements of the product, and completes the common features of the enterprise product. The elements are the work of product DNA extraction and design practice. The specific conclusions are as follows:

(1) It is feasible to determine the product's DNA characteristics by designing matrix analysis method combined with questionnaire scoring, analyzing the correlation of 4 products and 6 characteristics of a brand, and then combining eye movement experiment and questionnaire interview to determine the product modeling style. The product can be effectively family-designed in terms of styling, color matching, and materials.

(2) On the basis of the basic structure and function of the product, through the computer-aided design means, combined with the needs of the enterprise, the DNA features of the product's shape, color and other products were innovatively designed, and the model was completed to show the design effect.

(3) After comparing the prototype with the enterprise products and the feedback after the market launch, it can be found that the above methods can help the enterprise to determine its unique product feature elements to achieve design differentiation, and can also provide reference for related product design.

Acknowledgments

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