

The Study of the Evolvement Rule of Product Modeling Features Based on Big Data — Taking the Sense of Decoration as an Example

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Abstract:

As time goes by, the modeling design of industrial products changes continuously in style. The grasp of its evolvement rule will be helpful for product design and manufacturers to predict the direction of its change in order to design the models of products that can meet the aesthetic demands of customers better. With the advent of the age of big data, it is more convenient to study the evolvement rule of product modeling features through the collection, arrangement and analysis of historical data. This study takes “the sense of decoration” of modeling styles of mainstream products in the hundred years of the 20th century as its object to quantify the modeling feature and then analyze the data in order to find out the corresponding evolvement rule. After that, the study analyzes the reasons for the formation of the rule, and puts forward the referential thought to improve the study combining with related technologies of AI in the further study.

Keywords: *Big date, Data mining, Evolvement role, Product modeling, Decoration.*

I. INTRODUCTION

At the beginning of creating things, human beings pursued the beauty of creations. In the period of handicraft production, craftsmen would decorate their creations. After the Industrial Revolution, the assembly lines of factories only paid attention to the practical function of a product at first in the process of production. However, people were soon not satisfied with products without beauty, and their aesthetic demands were changing continuously, which aroused the continuous emergence and evolvement of various artistic styles in the history of industrial design. Especially in modern society, the industrial sector of many countries has been very developed, which brings out the homogenization of numerous products in function and quality. Under the circumstances, product modeling design becomes very important, because only products that can meet aesthetic demands of customers can occupy a greater share of market [1]. Therefore, for enterprises and designers, it is very necessary to grasp the rule that

people's aesthetic demands for models of products change with time.

To explore the evolution rule of people's preferences to models of products, it is an effective approach to start with the styles of design and the most popular models of products in different historical periods, because only after recognized by people can a concept of design form a kind of style with some influences gradually. Similarly, every hot product was highly popular in the market at that time. Therefore, if we can find those products from historical data and analyze the evolution rule, it is likely to get the result we need. With the development and advancement of related technologies in the field of big data [2], it is more convenient and faster to get the data of representative products of mainstream design styles in different historical periods through the Internet, which provides convenience for us to study the evolution rule of product modeling features based on that information.

In this study, we will take "the sense of decoration" of modeling styles of mainstream products in the hundred years of the 20th century as the research object, and will quantify the modeling features, and then analyze these data to find the corresponding change law. After that, we will analyze the reasons for the formation of the rule, and put forward the referential thought to improve the study combining with related technologies of AI in the further study [3-5].

II. ANALYSIS AND METHODS

2.1 Basic Ideas and Methods

The study aims to analyze the evolution rule of product modeling features as the time passes by. Here we take a psychological phenomenon as the prerequisite of the study: the threshold value of people's neural excitatory response to an external fresh stimulus will increase with the persistence of the stimulus. More generally, people often "love the new and loathe the old". The phenomenon is widely recognized, so we do not need to certify it. In the study, we believe that people's preferences to product modeling features change with the passage of time, which is reflected on the different strength of a certain feature on the most popular products in different historical periods [6]. If we take time as the abscissa and the strength of a feature as the ordinate, we can observe and analyze the evolution rule after we find the modeling drawing of the most popular product at every point of time, adopt the quantitative method to assign the strength of the feature on those products, and then show corresponding data in the established coordinate system.

Several critical problems need to be tackled in order to realize the thought of study. First of all, we need to select a proper feature that can be extracted from the models of products and assigned with the quantitative method, which will be discussed in the 2.1 of the paper in details. It is worth mentioning that in the earlier stage of the study, the team of task put forward the quantitative method based on Reduced

Dimensional Assignment and Aesthetic Emotional Features, which is also one of important referential thoughts to realize the assignment of product modeling features [7]. Secondly, we need to find out the most popular models of products in different historical periods, complete related information collection and data integration, reduction, cleaning and conversion, and then conduct the most important process of data mining. In that process, according to the data in database, our main task is to select proper tools for analysis to deal with information with the methods including statistical method, case-based reasoning, decision tree, rule reasoning, fuzzy set, neural network, and genetic algorithm in order to produce useful analytic results [8]. The study will apply the above methods selectively according to its actual demand. In addition, we need to show the results gained through data mining in a direct and vivid way. We analyze the change rule of patterns through combining the measurable feature of a linear dimension and the axis of time into the change chart of feature on a two-dimensional plane.

2.2 Select the Object of Study

The modeling feature of a product is the combination of various factors, such as form, color, material and pattern from the perspective of product modeling elements. The form of a product can be divided into point, line, surface and their syntagmatic relations; its color includes such elements as hue, lightness, and purity. Given the complex syntagmatic relations among those factors, the analysis of the rule based on basic factors will make the starting point of the problem so complex that the study is difficult to continue. As to this point, Kansei Engineering provides good inspiration for the thought of study.

In 1970, Mituo Nagamachi of Hiroshima University in Japan put forward that “the age of sensibility” was coming, which showed the personalized needs of consumers. After that, more and more studies began to pay attention to psychological and emotional responses that the model of a product would bring to people. Those responses are quantified mainly through semantic method in Kansei Engineering [9]. The meaning of a product’s model is the linguistic description of people for the product they see from the perspective of emotion, and different semantic words represent their different feelings, while the same semantic word can represent the strength of a feeling through assigning quantitative value, which provides a thought to quantify emotional responses to models of products.

In the practical application, we can adopt semantic method to find out the modeling features that we pay attention to. Those features need to meet the following requirements: the feature is one of semantic words to describe the emotional response after people see the model of a product; different models vary in the strength of the feature, so the feature can be assigned with the methods such as psychological scale, analytical hierarchy process, and fuzzy comprehensive evaluation. After assigning, we can study the change rule of the value of the feature.

There are many features that meet the above requirements, but the study selects “the sense of decoration” as its object based on these reasons: the feature is obviously shown in various types of industrial products, so the study can get extensive information of products in virtue of data mining; in the time axis of history in yearly unit, the strength of the sense of decoration has a great range of change, so the assigned data becomes more obvious visually in its rule of change after it is shown in a chart.

2.3 Determine the Scope of Study

The change rule of product modeling features can be gained through extracting data from mainstream products in different points of time, so it is important to select a proper range of time. In general, a range of time as long as possible is conducive to observe the long-term change rule of modeling features, while the length of time needed to be selected according to the feature of the feature itself.

For example, the sense of coldness or warmness of colors changes quickly, which is suitable to be measured by the time axis in monthly unit. From the perspective of psychology, that is because people vary in their sensitivity of different features and the length of time to adapt them. The sense of coldness or warmness is a kind of more direct feeling, so the more acute people respond, the more quickly they adapt, and the more rapidly they “love the new and loathe the old”. Therefore, the popular cycle of colors is shorter relatively [10]. However, as to the sense of decoration selected by the study, people need more time to feel and adapt the feature, so its change is suitable to be measured in yearly unit. Combining with the observation in the later study, we find that the sense of decoration can generally be saw a relatively obvious change in the range of five to ten years. The cycle corresponds to mainstream artistic styles exactly, which brings an extra result to the study; the sense of decoration is one of important representative characteristics in various artistic styles.

Therefore, the study chooses year as its basic unit and the hundred years of the 20th century as its range of time. Starting from the end of Victorian Style with the strongest sense of decoration, the span of time basically covers the mainstream design styles of the whole industrial age after the Industrial Revolution. Therefore, we can analyze the sense of decoration in product modeling well combining with the evolution of artistic styles.

III. RESEARCH AND DISCUSSION

3.1 Collect and Arrange Data

In the study, the collection of information is completed through writing web spider by Python. Through searching given keywords, the study searches products with the highest frequency of

occurrence per 3-5 years from 1901 to 2000 according to the determinative elements including the range of time, artistic style, industrial product, and modeling drawing. Then the study carries out data integration of every product's attributes including the most popular year, type, and artistic style, and its corresponding picture to form a data set package of the product.

After that, through artificial assistance, we carry out the first pretreatment of the data before quantification. Through cluster analysis, we cluster popular products of every period according their artistic styles. Through the step, we can find a phenomenon that more than two different artistic styles of product modeling were highly popular in some years, which demonstrates that even for the sense of decoration, the change rule of its eigenvalue is very likely to be relatively complex, and cannot be described through curve fitting with the methods such as simple multiple regression or fourier series. Therefore, in the later study, we choose to show quantified data in the way of a comprehensive planar graph through integrating them into artistic styles, and then analyze the reasons based on observation.

The next pretreatment is data cleaning. The specific popular products in different periods we collect exist great difference in their quantity, which is related to the economic, social and cultural backgrounds of different periods. For example, in a period of economic depression or war, industrial enterprises would launch less new products. However, the change of quantity in the types of products does not affect the continuous change of people's psychological demand to the strength of the sense of decoration with time. Therefore, for the smoothness of assignment through the quantitative method, when a large number of products in the same style and similar degree of decoration occurred in some periods, we only retain 5 representative products according their artistic styles and clean the data of other repetitive products, because they are repetitive from the perspective of the assignment of the sense of decoration.

Through the above work, we have found the most representative products of different periods and styles. The next step is to assign the sense of decoration. We hand out psychological questionnaires to senior students in industrial design major, and let them evaluate the strength of the sense of decoration on every product according its picture. We adopt a psychological scale with seven optional grades including "very high, high, little higher than medium, medium, little lower than medium, low, and very low".

The reason for this assignment is that: the object of this study is the sense of decoration, which is a kind of psychological feeling, so it is suitable to adopt a psychological scale for measurement. In addition, from the perspective of professional capability, senior students in industrial design major can make relatively accurate judgments on the strength of the feature of products, so they are suitable as respondents of psychological questionnaires. In the study, we invite 75 students to participate in the survey. According to their choices, we assign 7 to 1 score(s) to the seven options from "very high" to "very low" respectively, and get corresponding data through calculating the average score of every

product.

3.2 Data Analysis

According to data gained from the above work, we find that the quantified value of the sense of decoration has obvious correspondence with the mainstream artistic style in every period. For the observation by making a chart in the later study, we cluster the main representative products of mainstream artistic styles again, calculate average value of the sense of decoration of all products in the same style, and then divide them into seven grades of strength according to the final scores. Data gained from the above steps is shown in the TABLE I.

TABLE I. The chart of quantitative results of the sense of decoration in mainstream artistic styles

ARTISTIC STYLE	STARTING YEAR	ENDING YEAR	SENSE OF DECORATION	DIVISION OF GRADE
ART NOUVEAU	1901	1910	6.43	6
EXPRESSIONISM	1905	1918	4.24	4
CUBISM	1908	1923	4.85	5
FUTURISM	1910	1918	4.17	4
ART DECO	1921	1928	6.17	6
DE STIJL	1917	1931	3.31	3
BAUHAUS	1920	1933	1.88	2
CONSTRUCTIVISM	1919	1935	4.25	4
MACHINE AESTHETICS	1923	1940	1.37	1
STREAMLINING	1932	1942	3.94	4
AMERICAN MODERNISM	1937	1957	1.33	1
NEOMODERNISM	1950	1960	2.31	2
COMMERCIAL DESIGN	1945	1965	4.11	4
POP STYLE	1958	1973	5.35	5
RATIONALISM	1960	1980	2.78	3

HIGH TECH	1978	1988	2.42	2
ORGANIC DESIGN	1945	1996	3.89	4
STRUCTURALISM	1980	2000	5.23	5
MINIMALISM	1980	2000	1.05	1

The 19 names in the table cannot represent all artistic styles that occurred in the history, some of which are more inclined to be an ideological trend or community of design, such as Bauhaus. However, those products are gained through the cluster analysis of big data at the earlier stage, which demonstrates that they were once popular in a certain period. It is likely that some products in other artistic styles do not be selected through data mining because they were popular in a short time or with low popularity. In the chart, “starting year” and “ending year” refer to the duration of popularity that a representative product becomes a mainstream artistic style. Therefore, “ending time” does not mean that the model of product in the style will never occur in the future, but shows that due to the reduction of its popularity, the products ranked on the top are in other styles. The value of the “sense of decoration” refers to the average score of 5 selected representative products in the duration of a style with high popularity. The “division of grade” is to draw the analytic chart of the evolvement rule more clearly in the next step. In the chart, the abscissa represents the hundred years of the 20th century, while the ordinate is the 7 grades which represent the strength of the sense of decoration. Through filling the corresponding place of every style with a gradient block of colors, we can get the result in Fig 1.

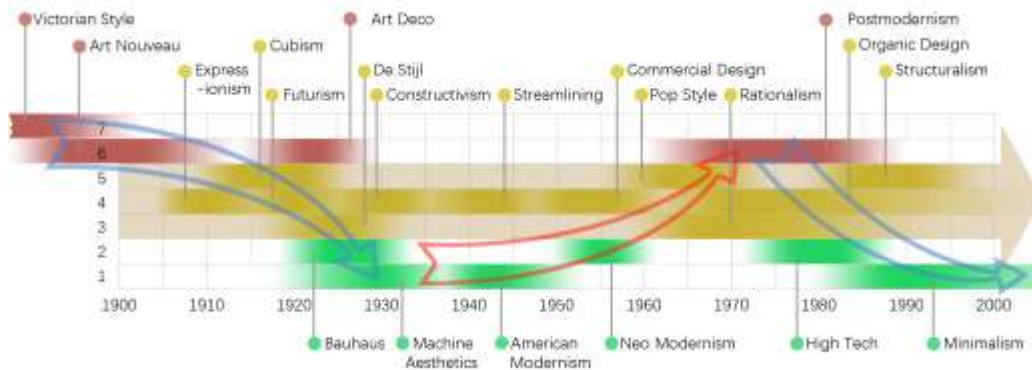


Fig 1: the analytic chart of the evolvement rule of the sense of decoration of mainstream artistic styles

3.3 The Discussion of Results

Through the observation and analysis of Fig 1, we can reach the following conclusions:

First of all, in the chart, the cover of color blocks is more concentrated at grade 3, 4 and 5, especially at grade 4 where the cover almost has no interruption. It means that there are always a certain amount of popular products with medium strength in the sense of decoration in the hundred years. However, the coverage of color blocks at grade 6 and 7 with high strength in the sense of decoration and grade 1 and 2 with low strength is smaller obviously than that of 3 grades in the middle position, which demonstrates that products with medium strength in the sense of decoration are always the most acceptable to people.

Secondly, although the models of products with medium strength in the sense of decoration are always popular, different styles of design with the same strength in the sense evolve alternately. That demonstrates that people still “love the new and loathe the old”, but the main method to deal with the psychology is not to change the strength of the sense of decoration but to change the specific elements of decoration, such as color, pattern, style, etc.

Finally, although they are not always the mainstream, styles with very high or low strength in the sense of decoration can also occupy the list of popularity alternately for a period. Furthermore, it is obvious that there are three stages of evolution during the hundred years: the mainstream sense of decoration reduced from the beginning of the 20th century to 1930s, gradually increased to its peak in 1980s, and then continuously reduced until the 20th century, which shows a wavy change on the whole.

According to the above conclusions, we can find that the aesthetic psychology of “loving the new and loathing the old” is verified again, but in the practice of product modeling design, we should pay attention to: the sense of decoration is not a feature of modeling that just show a wavy change, because the modeling style with medium strength in the feature is always the mainstream, and as popular as some more “advanced” design (the feature of modeling deviates from the moderate position obviously along the direction of general trend). Meanwhile, products with medium strength in the sense of decoration are the mainstream for a long time, which does not mean the model of products cannot be changed. In order to meet the psychology of “loving the new and loathing the old”, if the strength of the sense of decoration cannot be changed in the practice of design, we should innovate specific elements of decoration, such as new patterns and styles in accordance with hot spots of the age.

IV. CONCLUSION

On the whole, based on big data, the above process of study gets the final results through extracting, selecting, inducing, and summarizing massive data step by step. Although a simple chart is shown finally, the rule can be seen in the chart at a glance, which benefits from various methods of data mining based on big data on the Internet. Therefore, in terms of the results, the whole thought of the study is feasible. The flexible application of methods of data mining based on big data can also realize the analysis and study on other features of product design except the sense of decoration, and reach effective

conclusions.

At present, with the continuous development of AI technology, it is possible to recognize and analyze pictures by means of apply effective machine learning algorithms. If they are applied to improve the method of the study, two points need to be paid attention to. First of all, at the earlier stage, when collecting and arranging massive data on the Internet, the study mainly applies web spider to retrieve and recognize related keywords. However, many pictures gained in preliminary information are incomplete or incorrect, which increase the complexity of further data screening and sorting. If proper machine learning algorithms can be used to improve the preliminary recognition of pictures, the efficiency of study will be improved greatly. In addition, when observing the picture of a product and assigning one of its features, the study adopts psychological questionnaires due to the features of research objects and the limitations of research conditions. However, if related technologies of AI can be applied, the step will be carried out more conveniently and rapidly. Of course, problems like the accuracy of assignment still need to be solved by the optimization and improvement of relevant machine learning algorithms, which is also a direction that is related to the study and can be further expanded.

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