Knowledge Mapping and Visual Analysis of Semiotics Research in Product Design

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Abstract:

This paper focuses on the semiotic research literature in the field of product design, analyzes the relevant findings with the help of visual analysis software Cite Space, and then excavates the influencing factors, hot spots and development trend of product design research from the perspective of semiotics. The results show that the application of semiotic theory in the field of product design is affected by many factors, such as industry development, national policies, social life needs and so on. In recent years, more and more researches focus on the methods and approaches of symbolic application of traditional culture. Relevant researches also show a more comprehensive, systematic and detailed developing trend.

Keywords: Product design, Semiotics, Cite space, Research hotspot, Development trend

I. INTRODUCTION

With the rapid development of science and technology, the public raise increasingly higher demand for material conditions and spiritual culture. As a result, design has attracted more and more attention. Consumers have put forward higher requirements for various factors such as function, appearance and connotation of product design, which also poses new challenges to the depth and breadth of semiotics research in product design and the maturity of its application. Under the background of big data technology, the analysis of data visualization will help people better understand semiotics research and its application in product design. Therefore, this paper will use knowledge mapping to explore the hot spots and future development trends in this field.

II. THE APPLICATION OF SEMIOTICS IN PRODUCT DESIGN

Semiotics is a systematic discipline that explores the deep meaning of symbols by studying the target object-symbols. The purpose of semiotics research is to establish a communication rule that can be widely used, and to provide guidance for human practice based on it. [1] As a research theory covering almost all fields of humanities and social sciences, it can be used to guide all human activities containing systematic symbols, thus turning abstractions into concrete images and making humanities and social sciences more logical and scientific.

The phrase Design Semiotics originates from semiotics, which is an applied discipline that applies

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semiotics principles to design activities to improve the language expression ability of products, enrich the spiritual culture of products and convey the connotation and function of human thoughts. In design semiotics, all things are regarded as symbols, which embodies the unity of signifier (design expression) and the signified (design connotation). [2] The form, shape, material, color, texture and other related elements of the product are all interpretations of the meaning of the product itself. In fact, the designer's understanding of semiotics, the connotation of the product and the depth of the culture behind it will directly or indirectly affect the clarification of the product and the clarity of its message. At the beginning of design, by analyzing the behavior and psychology of the target users, the designers transform the users' needs and potential needs into symbolic language, and project them into the designed products through elements such as shape, structure, human factors and color, so that the users could achieve the harmony and unity of physiology, psychology and spirit.

III. DATA VISUALIZATION ANALYSIS OF THE APPLICATION OF SEMIOTICS IN PRODUCT DESIGN

3.1 Data Acquisition and Research Methods

The samples were collected from CNKI periodical database on June 6th, 2021. According to the principle of semiotics and its application in product design and taking "semiotics", "product semantics" and "product design" as the key words, document retrieval was carried out with search time ranging from 2000 to 2021. Articles with low relevance to the research, such as conference notices, patents and news reports, were excluded, and finally 496 valid documents were obtained.

Cite Space, a data visualization software, takes author cooperation network, organization cooperation network, co-occurrence of keywords and burst keywords as important indicators to study the origin and development of disciplines. Based on the application of this visualization software, this paper focuses on quantitative analysis of relevant literature research of semiotics theory in product design.[3] By analyzing the chart features of data, it is found that the construction of knowledge map applied by semiotics in product design is characterized by loose distribution and low cooperative network characteristics, and the cooperation between relevant authors and institutions is low, so that a wide cooperation situation has not yet been formed in this field. Therefore, this article analyzes from the perspectives of co-occurrence of keywords and burst keywords, so as to explore the research hotspot and frontier trends in this field.

3.2 Data Visualization Analysis

3.2.1 Hotspot analysis of keywords

The core words summarized of a paper are called the keywords of the paper. Analyzing the co-occurrence map of keywords can reveal the research hotspot in different periods and the development trend of research hotspot in this field. [4] Due to the slightly long search range, which is about 22 years, the time slice is set to 3 years, and the post threshold, font size and node size are 5, 8 and 40 respectively. As

shown in Figure 1, there are 316 nodes and 358 connections in the keyword co-occurrence map, and the network density is 0.0132. Among them, the size of nodes can reflect the research focus, and the color of nodes can reflect the change of research content with time.
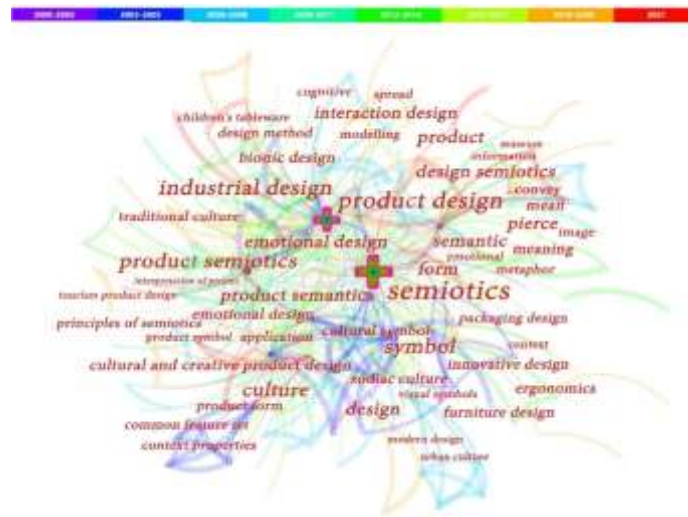

Figure 1. Co-occurrence map of keywords.

Through word frequency analysis, the theories closely related to semiotics in product design mainly include design semiotics and product semantics, and the major related design disciplines include cultural and creative product design and emotional design. It can be seen from Figure 1 that the related content of semiotics research in product design is increasingly extended and detailed, and an outward scattering pattern centered on product design and semiotics is gradually forming. In addition, the correlation between the related elements is obvious, and the overall map presents a cross-network distribution pattern.

The centrality of keywords reflects the importance of the entry in this research, which is determined by the comprehensive factors such as the degree of connection between the entry and other entries and the frequency of the entry. As shown in Table I, the top 30 keywords related to semiotics research in product design in the past 22 years are classified and arranged according to their nature.

Table I. Statistics of keywords

Theory	Research Content			Others
	Discipline	Element	Product	
Semiotics Design Semiotics Product Semantics Product Semiotics.	Industrial Design Product Design Cultural and Creative Product Design Emotional Design Creative Design Packaging Design Furniture Design Bionic Design Interactive Design Modern Design	Application Symbol Emotion Culture Meaning Semantics Form Cognition	Zodiac Cultural Products Tourism Products Children's Tableware Museum Cultural and Creative Products	Annotation Term Pierce Brand Name Spread

From the perspective of theoretical elements, semiotics theory can be refined into more specific characteristic theories in product design, such as design semiotics, product semantics and product semiotics. Regardless of different theoretical names of these three theories, they have relatively consistent research contents, and are used as theoretical guidance for semiotics in product design.

From the perspective of subject classification in the research content, this theoretical research is often used to guide industrial product design, such as cultural and creative product design, packaging design and furniture design, which are often involved in design subcategories at present. More attention is given to the design research of emotional and innovative items. For example, in the process of designing cultural and creative products such as Zodiac cultural products, tourism products and museum cultural creation, the Zodiac, tourism and museum are interpreted symbolically, and their deep-seated culture and emotion are integrated into the products, which are upgraded. Symbolic abstract expression is used instead of figurative intention pattern presentation, so that these products conveying cultural details can be better understood and accepted by the public, and users can understand their deep meaning and achieve cognitive and emotional resonance, thus better realizing the cultural communication function of products. [5] For another example, through the theoretical guidance of semiotics, abundant modeling and emotional substitution are injected into the design of children's tableware, which can guide children's eating habits and cognition on the basis of meeting their physiological and psychological needs. [6]

At the same time, the appearance of keywords such as annotation item and Pierce indicates that the research and analysis of basic theory is the foundation of other derivative disciplines. The emergence of such commercial keywords as brand and communication indicates that product design based on semiotics theory is increasingly concerned by market economy, and its commercial value is self-evident.

3.2.2 Analysis of periodical hot words

Burst words are the general name of periodical hot words that have drastically changed in the short term, such as author, keyword, topic, etc. By analyzing this kind of burst information displayed in Cite Space, we can measure the deeper change information such as sudden increase, sharp decrease and trend.[7] Using Cite Space burst word algorithm to detect the sudden increase of research interest in a certain subject area within a period of time and analyze the intensity can often reveal the impact of technological innovation, periodical macro-micro condition changes, industrial policies, etc.; duration reflects the length of time that the academic field pays attention to this research topic, and reveals the duration of research in this direction.[8] Based on Cite Space, the keyword mutation operation is carried out to filter and sort out top 9 burst keywords as shown in the following table, including 1 burst word about theory, 2 burst words about disciplines, 5 burst words about research elements and 1 burst word about products.

Table II. Statistics of burst keywords

Nature	Key words	Strength	Start	End	2000-2021
Theory	Design Semiotics	1.6639	2016	2018	
Discipline	Cultural and Creative Products Design	9.1669	2019	2021	
	Bionics Design	1.6367	2007	2007	
Element	Semantics	3.2168	2008	2011	
	Culture	1.8228	2017	2018	
	Traditional Culture	2.5923	2020	2021	
	Application	1.7287	2020	2021	
	Shape	1.7032	2019	2019	
Product	Museum Cultural and Creative Products	1.6239	2017	2019	

According to the duration, the burst keywords are classified into three categories. The first category is keywords that start earlier and last longer, and are not in the burst stage at present, such as "semantics". This kind of keywords are in the initial stage of the discipline and are widely concerned and studied by people in the industry. After several years of research, they have become the basic vocabulary in the discipline, and are not studied extensively. For example, "bionic design" has appeared as a hot research object in the academic circle during this period, and a large number of experts and scholars have associated it with the developing semiotic theory for research. However, due to the limitations of relevance, the studies on the relevance between the two have also decreased dramatically after bionic design faded out of public view.

The second category is keywords that start late, last shorter, and are not in the burst stage at present, such as "design semiotics". After a long period of development, the number of studies on the relevance between design and semiotics has surged, and "design semiotics" has attracted the attention of the public as an independent research theory. For example, words like "museum cultural creation" are greatly influenced by industrial changes and national policies. The *Museum Regulations* officially implemented in 2015 promotes the standardized and professional development of museums with institutional guarantee. In addition, "culture" and "shape", which are burst element keywords deriving from the study of keywords with long duration such as "design semiotics" and "museum cultural creation", can explain the main

research points in the research of theory and products: giving concrete "shape" to abstract "culture" to design products that meet the needs in terms of both symbol and design. [9]

The third category is keywords with short burst duration and still in burst period, which can explain the hot spots and directions of semiotics research in product design at present. As a representative discipline keyword, "cultural and creative product design" has a great correlation with the promulgation of national policies and decrees in the past two years, such as the *Cultural Industry Promotion Law*, which was submitted for approval in 2019, and the *Copyright Law*, which was revised in 2020 to more specifically stipulate the copyrights of various cultural industries to promote the development of cultural industries, all of which provided a fertile soil environment for the vigorous development of cultural and creative product design.[10] The burst-in of keywords such as "traditional culture" and "application" shows that "cultural and creative product design" should be rooted in "traditional culture", and be concretely "applied" through means and methods of design. As the combination of epistemology and methodology, they reveal the concrete application method of semiotics research in current product design, and have been widely concerned and recognized.

3.2.3 Research frontiers and trends.

According to the analysis of hot keywords and burst keywords, we can sum up the development trend of the application of semiotics in product design:

1) The research content is increasingly expanded and detailed. From simple semiotics-based research to theoretical refinement research extended by combining semiotics with design, and then based on design, this paper explores the application of semiotics in various disciplines such as creative design, packaging design, furniture design and interactive design in product design. From theory to application and from point to line to surface, the research is gradually refined and has guiding significance for practice.[11] It can be predicted that with the refinement of design categories and the improvement of people's spiritual and cultural needs and under the guidance of social appeal and national policies, all aspects in product design will pay more attention to the application research of semiotics theory in design, and a more complete theoretical system will be formed to provide guidance for practice.

2) Creating brand symbols of products in an all-round way. Keeping up with life and spiritual and cultural needs of people as well as the requirements put forward by the market economy and focusing on the most prominent needs at present are the characteristic advantages of this theoretical research. From pursuing "semantic meaning" to expressing "emotion", and from spreading "culture" to creating "brand", product design based on semiotics is always advancing and at the forefront of the trend, and is closely related to social life. Brand symbol refers to the degree of recognition that an enterprise brings to a product by shaping its style and features. It is the main competitive core of an enterprise, and consumers can distinguish between good and bad products by distinguishing differentiated brand symbols. [12] In fact, Chinese enterprises have not yet been able to fully form brand symbols with strong discrimination and high prominence. The brand symbol is the inherent gene of product design, the necessary condition for the

continuation of enterprises, and an important part of giving vitality to products. This research will be an inevitable research trend.

IV. CONCLUSION

Based on Cite Space, a data analysis technology, this paper analyzes the research literature of semiotics research in product design by knowledge map, sorts out the development process of semiotics research in product design in China since 2000 and the hot keywords appearing in the process, and predicts the future development trend. However, in the future development, there are still some difficulties to be overcome in the concrete implementation of semiotics research in product design in China. On the one hand, under the social background of more detailed design categories, comprehensive improvement of people's spiritual and cultural needs and increasingly obvious guidance of national policies, more attention should be paid to semiotics research of product design, and the theoretical research content should be expanded and refined. We should use more refined theories to guide practice and further improve theories with positive practices. On the other hand, it is necessary to keep up with the inherent needs of the socialist market economy and build brand symbols in an all-round way to endow Chinese products and enterprises with vigorous vitality.

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