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Computer-Aided Design AND APPLICATIONS

Analysis and Visualization of Brand Competition in Automobile Industry

Huadi Liu[1,*] and Chenhan Xiong[2]

[1]School of Art & Design, Nanchang Hangkong University, Jiangxi 330063, China, 47045@nchu.edu.cn
[2]School of Art & Design, Nanchang Hangkong University, Jiangxi 330063, China, 2112135108001@stu.nchu.edu.cn

Corresponding author: Huadi Liu, 47045@nchu.edu.cn

Abstract. At present, the market competition environment of all industries is in an unstable state, and events such as mergers and acquisitions, new product listing, and negative news and information may lead to major changes in the market competition pattern. However, with the reform and opening up, especially the increasing competition in the automobile market in recent years, the overall survival environment is very difficult. This paper analyzes and visualizes the brand competition in the automobile industry based on CAD technology, and uses CAD technology to carry out structural design and structural analysis on the body. Although this transformation and adjustment of the development strategy has not achieved significant results, it reflects the market adaptability of the automobile brand management team to a certain extent, and provides a strong guarantee for the automobile brand to better adapt to the rapidly changing environment of the market economy. CAD technology also plays a powerful role in the manufacturing process of automobile panel dies. It can infer the weight of each attribute in the clustering process according to several nodes entered by the user, and conduct community search, while comparing and displaying the competition between them.

Keywords: CAD; Automobile Industry; Brand Competition.
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1 INTRODUCTION

Nowadays, the market competition environment of various industries is in an unstable state. Events such as mergers and acquisitions of companies, listing of new products, and negative news information may all lead to significant changes in the market competition pattern. However, with the reform and opening up, especially the increasing competition in the automobile market in recent years, under the constant impact of foreign capital, joint ventures and private enterprises, the traditional state-owned brands, which are at a disadvantage in terms of technology, brand and management, are facing a very difficult overall living environment [1]. For monopoly industries

and oligopolistic industries, because the number of enterprises in the industry is small, the scale is large, the economies of scale can be brought into play, and the competitiveness is usually strong. Therefore, the industrial competitiveness is usually not improved by increasing the industrial concentration, but more measures such as government regulation should be emphasized. It has become a major trend of international economic operation to divide the world resources and expand the global market with the backing of the brand's economic strength.

The development level of automobile industry is an important index to measure a country's comprehensive technical and economic level. It has been recognized internationally as one of the few industries that can drive the whole economy to develop rapidly and best represent a country's industrial level. It is also an important symbol of modern industrial civilization. With the continuous growth of China's economic aggregate and the continuous improvement of its development level, the people's quality of life has also been greatly improved, the consumption level and consumption power have been significantly enhanced, and the demand of individual families for cars has shown explosive growth [2]. In the visual design, the strengths and weaknesses of the car in the competitive community are reflected by the number of concerned users and the sales volume corresponding to the word-of-mouth data, so as to make judgments and choices. Finally, satisfactory design results and production drawings are output, and the design results can be enlarged, reduced, rotated and translated on the screen [3].

The research on automobile industry competitiveness is also meaningful for China. China's automobile market has ranked first in the world in terms of production and sales, but this is not the only indicator to measure the development level of automobile industry [4]. The competition between enterprises and countries depends to a great extent on brand competitiveness. Under the increasingly severe situation of multinational giants gradually completing their layout in China, the in-depth study of automobile industry concentration plays a very important role. Brand competitiveness is the ability of brands to make their products and services satisfy consumers better and faster than competitors and provide enterprises with super-value profits in a competitive environment [5]. With the help of powerful functions of CAD, rapid and efficient modeling and simulation can be realized. In the manufacturing process of automobile panel die, CAD technology also plays a powerful role. According to several nodes input by users, the weights of attributes in the clustering process can be inferred, and the community search can be carried out, and the competition among them can be compared and displayed.

Innovative content

(1) The development status of brand competitiveness of automobile enterprises is analyzed. Compared with foreign automobile enterprises, the service system of Chinese automobile enterprises is still in its infancy.

(2) The strategic model of automobile brand management is described. Use CAD technology to carry out structural design and structural analysis of the car body. Finite element analysis and crash performance analysis of vehicle body can reduce the time and cost of actual analysis. Although this transformation and adjustment of the development strategy has not achieved significant results, it reflects the market adaptability of the automobile brand management team to a certain extent, and provides a strong guarantee for the automobile brand to better adapt to the rapidly changing environment of the market economy.

2 RELATED WORK

With the improvement of residents' living standards, cars, once a luxury, have gradually turned into necessities of life and quietly entered the homes of ordinary people. By now, the connotation of brand has broken through its original meaning, formed different schools and defined from different perspectives. Until today, there is still no unified and universally recognized brand definition in the marketing and advertising circles. China's brand construction is still in its infancy. In order to promote the progress of China's automobile industry, the construction of automobile brands also needs to be strengthened.

Use computers to simulate the real world, so that real vehicles can be observed and perceived before being manufactured, so as to improve the design scheme. From surface modeling, reflection inspection and scheme configuration to ergonomics, there are virtual reality technologies. Naeem and Sami [6] has equipped the car with immersive 3D HMD (Head Mount Display) or CAVE equipment. In order to display the advantages and disadvantages and characteristics of each design scheme completely, truly and accurately, and help the design team select the best combination scheme. In the new situation, the diverse needs of consumers for cars make the design of cars need to keep pace with the times. The traditional automobile design method is gradually not adapted to the rhythm of automobile design under the new situation. Ostrosi et al. [7] discusses the application of computer aided design to automobile design, aiming to effectively guide the design of automobiles. First, the appearance of the car can be designed through relevant tools and software. Second, it can store a large number of relevant data files through computer storage technology, which is convenient for the normal operation of automobile equipment. Computer-aided design is that designers use computers and graphics equipment to carry out auxiliary design to achieve corresponding design purposes. Sindhu [8] solves several common problems in the process of automobile design with computer assistance. First, it is necessary to carry out comparative analysis and calculation of a large numbers of data for various schemes, and obtain the optimal design scheme according to the relevant calculation results. The second is to solve the storage of all kinds of digital, text or graphic information, and real-time data retrieval to improve work efficiency. Effectively solve various modification problems in graphic design. The die-casting industry needs a system to help die-casting experts free from manual and time-consuming tasks, so as to design a good gating system. Singh and Madan [9] introduced a computer-aided system for the design of multi-gate gating system of die-casting die. The last module of the system uses the parameters obtained from the second module to generate the CAD model of the gating system by updating the gating system features from the feature library. Yang et al. [10] uses AI technology to complete automatic fusion and recognition of different sensor data. Closely combine the roadside perception ability with the vehicle end perception ability, increase the information redundancy, check and integrate each other, and provide more accurate and rich information for high-precision maps. The front-end sensing device is combined with high-precision map to realize the front-end sensing data with geographical attributes, and then seamlessly integrates with the platform GIS map and can support vehicle-road collaborative data application.

If we look at the concept of brand from a broader perspective, we will find that its connotation always changes with the development of the times and the economy and society. Because the automobile is highly dependent on after-sales service, a good automobile brand is often backed by an excellent service team. By creating the brand of "Happy Experience", which is exclusive after-sales service, it has greatly enhanced its brand core strength. Based on CAD research, this paper analyzes and visualizes the brand competition of automobile industry, and uses more abundant automobile brand data, including not only text data, but also user information, the relationship between users and car systems, etc.

3 APPLICATION OF CAD TECHNOLOGY IN BRAND COMPETITION OF AUTOMOBILE INDUSTRY

3.1 Development Status of Brand Competitiveness of Automobile Enterprises

Compared with foreign automobile enterprises, the service system of Chinese automobile enterprises is still in its infancy. Car sales, maintenance, repair, parts supply and other service functions are not perfect. Weak service capability will not only affect product sales, but also affect the image of products and the competitiveness of enterprises. According to the above analysis, the competitiveness development status of automobile enterprises can be analyzed from five aspects, as shown in Figure 1.

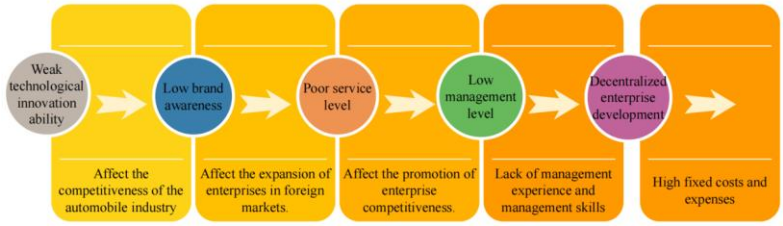

Figure 1: Current situation of competitiveness development of automobile enterprises.

In joint ventures, because Chinese enterprises have no independent intellectual property rights and brands, and lack management experience and technology, they are often in a passive position in actual operation, and independent enterprises are also faced with the problem of backward management level. In this paper, the car series is taken as a document, the document set is named $S=(s_1,s_2,...,s_v)$, and the users who pay attention to a certain car series are taken as the words under the corresponding documents. Then calculate the similarity between cars by cosine similarity formula as the weight of the edges in the figure, that is

$$w(i,j)=\frac{p_i^T}{\|p_i\|^2\cdot\|p_j\|} \tag{1}$$

How to train the weight matrix A is a classic distance metric learning problem. This paper adopts the objective function.

$$A=\arg\min\left(\sum_{(i,j)\in P_s} f_i-f\right) \tag{2}$$

Among them, f_i-f ; P_s is all the train pairs extracted from the input train set V_s.

After the matrix A is obtained, the weight of each edge in the graph is recalculated.

$$w(i,j)=w(i,j)/(1+(f_i-f_j)) \tag{3}$$

In the recalculated figure $G(V,E)$, the bigger the weight of the edge, the more likely the cars at both ends are in the same competitive community. In this paper, conductivity ϕ is used to evaluate the quality of community C, namely:

$$\phi(C,G(V,E))=\frac{\sum_{(i,j)\in E} w(i,j)}{\sum_{i\in C} w(i,j)} \tag{4}$$

Wherein, the molecule represents the sum of trimming weights of the internal nodes and external nodes of the community C.

Calculate the maximum eigenvalue of the judgment matrix and its corresponding eigenvector. For the judgment matrix, in order to test the consistency of the judgment matrix, we introduce the consistency index, and its value is calculated as follows:

$$CI = \frac{\lambda_{\max} - n}{n} \tag{5}$$

Obviously, if the judgment matrix has complete consistency, then there is $\lambda_{\max} = n$, then $CI = 0$; If $\lambda_{\max}$ is slightly greater than n, the judgment matrix has satisfactory consistency.

The consistency ratio of the judgment matrix is expressed in CR, namely

$$CR = \frac{CI}{RI} \tag{6}$$

If $n = 1$ or 2, then the judgment matrix has complete consistency and $CR = 0$ is defined; If $n > 2$ and $CR < 0.1$ are obtained, then the judgment matrix has satisfactory consistency.

3.2 Analysis of Strategic Model of Automobile Brand Management

Although China's automobile brands have the above problems, and their competitiveness needs to be improved, they still have geographical advantages in the local market and respond quickly to the domestic market. In addition, it has advantages in low R&D investment cost, low manufacturing cost, low enterprise management cost and government policy protection. It is reflected by the proportion of these enterprises' sales and other indicators in the total economic output, which examines the dominance of a few giant enterprises in a country in the whole economy. Therefore, to strengthen quality management, improve the quality of automobile products and increase production efficiency, first of all, in the production process of new parts, we should strengthen supervision to ensure that every part, even a screw, is a qualified product.

With the application of CAD technology, 3D parametric modeling and NC machining have entered the design and production field of automobile panel dies. The design of automobile panel die mainly includes two parts: process design and structure design. In the theory of industrial organization, industry is a group of enterprises, and the products produced by this group of enterprises have sufficient substitution elasticity, while the market refers to a specific group of buyers and sellers. In the view of buyers, the products of this group of sellers have sufficient substitution elasticity, and only when the products have excellent functional value can they have spiritual value at the level of brand image. Especially durable consumer goods like automobiles, whose quality is valued by consumers. Strategy adjustment refers to the change of the strategic direction or route that has been implemented in the past in the process of enterprise management and development.

This transformation and adjustment of development strategy, although it has not yet achieved remarkable results, reflects the market adaptability of automobile brand management team to a certain extent, and provides a strong guarantee for automobile brands to better adapt to the rapidly changing environment of market economy. Plan the strategic model of automobile brand management based on CAD, and get Figure 2.

An excellent brand must have an excellent management team behind it. It depends on its long-term operation to establish a good corporate image, so that consumers can have a good sense of trust in the enterprise.

$$CI = \sum_{i=1}^{m} aCI_i \tag{7}$$

$$RI = \sum_{i=1}^{m} aRI_i \tag{8}$$

Where CI_i and RI_i respectively represent the consistency index and random consistency index of judgment matrix in C hierarchy corresponding to A_i.

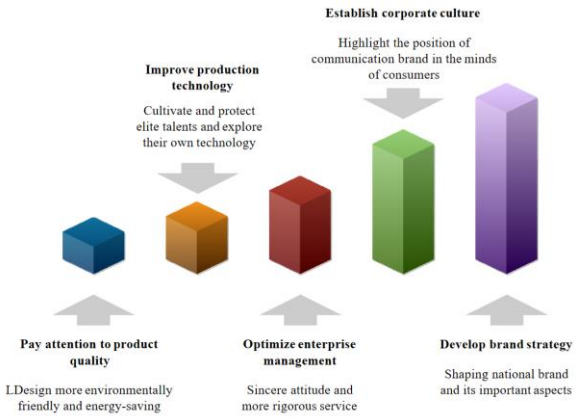

Figure 2: Strategic model of automobile brand management.

Using the calculation model $Z = WR$ of fuzzy comprehensive evaluation, the fuzzy evaluation vector Z_1 of brand market ability is obtained.

$$Z_1 = W_1 \times R_1 \tag{9}$$

From the fuzzy evaluation vector, it can be seen that the membership degree of "good" grade is the largest, and its value is 0.1254. According to the principle of maximum subordination, brand market ability should belong to a "good" level.

Get the fuzzy evaluation vector Z_2 of brand market ability.

$$Z_2 = W_2 \times R_2 \tag{10}$$

It can be seen from the fuzzy evaluation vector that the "better" photo is the largest, with its value of 0.1045. According to the principle of maximum subordination, brand management ability should belong to a "good" level.

Using the calculation model $Z = WR$ of fuzzy comprehensive evaluation, the fuzzy evaluation vector Z_3 of technological competitiveness is obtained.

$$Z_3 = W_3 \times R_3 \tag{11}$$

It can be seen from the fuzzy evaluation vector that the "better" photo is the largest, with its value of 0.1725. According to the principle of maximum subordination, brand management ability should belong to a "good" level.

Using the calculation model $Z = WR$ of fuzzy comprehensive evaluation, the fuzzy evaluation vector Z_4 of technological competitiveness is obtained.

$$Z_4 = W_4 \times R_4 \tag{12}$$

It can be seen from the fuzzy evaluation vector that the "better" photo is the largest, with its value of 0.0341. According to the principle of maximum subordination, brand management ability should belong to a "good" level.

As the maximum value is close to the second maximum value, the validity of the principle of maximum membership should be tested.

$$\beta = \frac{\max}{\sum_{j=1}^{n} r_j} \tag{13}$$

$$\gamma = \frac{\sec}{\sum_{j=1}^{n} r_j} \tag{14}$$

$$a = \frac{n\beta - 1}{2\gamma(n-1)} \tag{15}$$

Because the principle of maximum subordination is inefficient, according to the result of normalization, the competitiveness of corporate culture belongs to the "average" level.

CAD technology can also carry out stamping process design and generate NC programming program according to the mathematical model of the car body. In the manufacturing stage of the car body, CAD technology can realize more automatic, accurate and efficient manufacturing. Adhere to the simultaneous development of cooperative introduction and independent research and development, while maintaining the leading market share of core products, continue to expand market areas and improve core competitiveness. At present, a product line covering cars, SUVs, buses, trucks and other models has been formed. Relying on the platform resources of FAW Group, auto brands have received strong support and guarantee in technology research and development, enterprise management, marketing and other aspects.

4 RESULT ANALYSIS AND DISCUSSION

The comparison of automobile industry concentration between China and foreign countries, and the investigation of the level of China's automobile industry concentration in the world, can we get the position of China's automobile industry in the international competition. The cultivation and expansion of independent brands symbolizes the development level of domestic cars and shows the progress of China's automobile industry. However, compared with foreign countries, there are too few independent brands in China and their competitiveness is weak. Learn to cater to the wishes of consumers, improve after-sales service and market operation, build a good brand image and reputation through proper channels of CAD technology, gradually occupy a place in the domestic market, and achieve the ultimate goal of improving international competitiveness, going abroad, occupying a certain share of foreign market, and improving international reputation. In this paper, "BMW 3 Series" and "Cadillac ATS-L" are used as input vehicle series. Table 1 lists seven vehicle series and some attributes in the community based on CAD technology.

Chexi	*Price*	*Oil consumption*	*Model*
Cadillac-L	27.66~44.78	12.42	Medium vehicles
3 series BMW	27.54~58.37	11.08	Medium vehicles
Lexus ES	28.42~63.18	7.15	Medium and large vehicles
Mercedes-Benz c class	32.56~60.35	10.21	Medium vehicles

Table 1: Case comparison shows car series and some attributes.

A total of 20 sets of input vehicle series are set in the experiment, and the results obtained are the average values. Figure 3 shows the relationship between conductivity and the number of community nodes k. Since the SVM algorithm only searches the community based on the topological structure, the conductivity is low, that is, the internal edge structure of the output community is relatively tight. The output result of this method is not different from AI, even when k=160, the conductivity is lower than the latter; The results of this method are significantly higher than the other two algorithms. The user can click the branch of the flow chart to switch the segmented bar chart to display the sales volume of the model under which model series. Move the mouse to the bar chart to display the average sales price of the model in the current month.

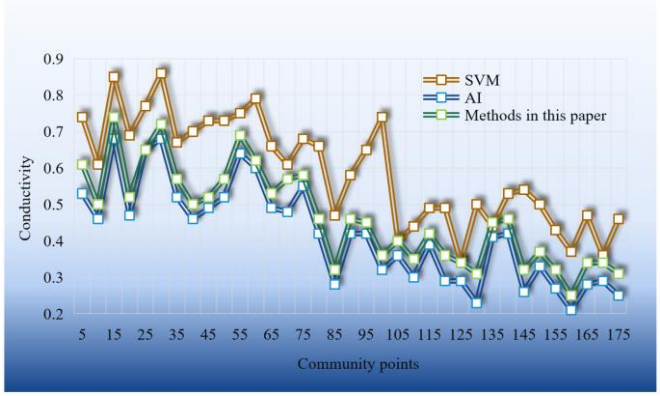

Figure 3: Comparison between conductivity and the number of community nodes.

In order to further verify the visualization method, this paper invited three different groups of users. After they are familiar with the automobile brand management strategy, they rate and give feedback on six aspects of the content: visual design, ease of use, interactivity, performance, function and expandability. The results are shown in Table 2.

Evaluating indicator	*Car purchasing group*	*Sales team*	*Vendor Group*
Ease of use	7.4	8.8	8.1
Interactivity	7.8	8.4	8.3
Scalability	8.7	8.5	8.5
Visual design	9.4	9.2	8.8

Table 2: Feedback results of user survey.

Through the comparison of three groups of users, they gave a high evaluation on visual design, ease of use and performance. Most users believed that the visual representation of automobile brand management strategy was intuitive, rich in content and friendly in interface, easy to use after introduction, and had good response speed.

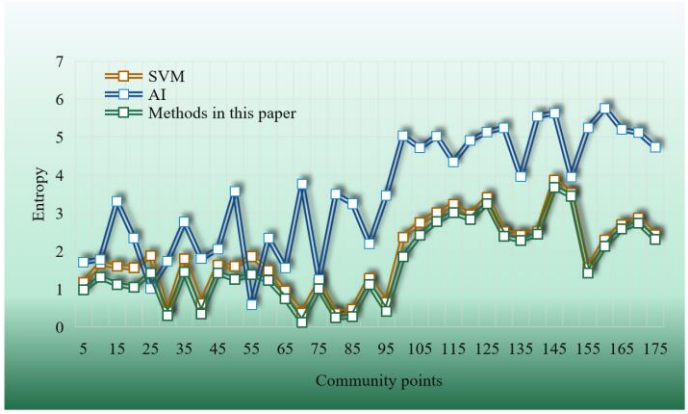

Figure 4: Comparison between entropy and number of community nodes.

Figure 4 shows the relationship between entropy and the number of community nodes k. The entropy value of the method in this paper is slightly lower than that of CODA. Since AI is only applicable to clustering based on the topological structure in the non-attribute graph, its entropy value result is significantly higher than the other two, indicating that the similarity of the community obtained by this method in key attributes is high.

The index numbers of China's automobile industry CRl, CR4 and CR8 calculated in this paper are shown in Table 3. It can be seen from the analysis that from 2015 to 2022, the industrial concentration of China's automobile industry has been significantly improved and the market competitiveness has been strengthened. It can be seen from Table 3 that the concentration of China's automobile industry has increased significantly in the past eight years. The scale of leading enterprises in the industry has gradually expanded, the financial and technical strength has increased, and the market competitiveness has improved. With the growth of China's automobile and product exports, the international competitiveness of China's automobile enterprises, especially the leading enterprises, has increased.

Particular year	*CR1*	*CR4*	*CR8*
2015	12.21	45.25	58.25
2016	15.24	53.45	70.12
2017	19.24	51.25	72.25
2018	25.35	56.18	76.25
2019	17.25	53.48	80.13
2020	19.36	56.52	74.85
2021	24.12	53.17	77.45
2022	28.56	62.45	84.72

Table 3: Industrial concentration and changes of automobile industry.

Because of the large number of regions and the large sample size, the time span will be 2015-2022, which will be tested in Shanghai, Zhejiang, Beijing, Hubei, Chongqing, Tianjin, Jilin and Fujian, instead of following the previous parts from 2015 to 2022. Through data collation and

calculation, three types of location quotient coefficients can be obtained: A1 represents the location quotient coefficient of the whole automobile industry, A2 represents the location quotient coefficient of the whole automobile industry, and A3 represents the location quotient coefficient of the automobile parts, in order to identify the concentration phenomenon of China's automobile industry.

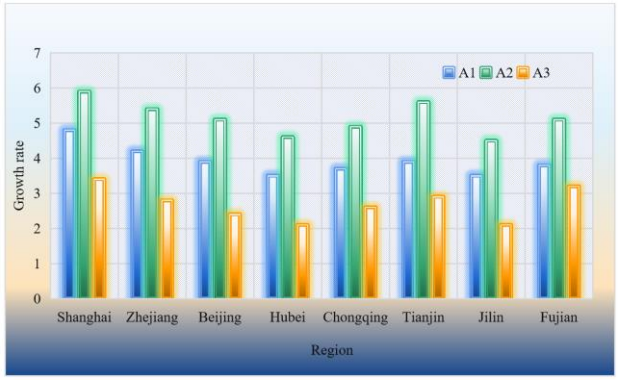

Figure 5: Provinces and cities with concentrated automobile industry.

As can be seen from Figure 5, some of the three types of A1 values in these areas are almost close to 4, and some indicators even exceed 4. For example, the location quotient A1 of Shanghai's overall automobile industry and the location quotient A2 of the whole automobile industry are greater than 4, and the location quotient A2 of parts industry is 5.9, and the average growth rate of the location quotient of other provinces' overall automobile industry is above 31%.

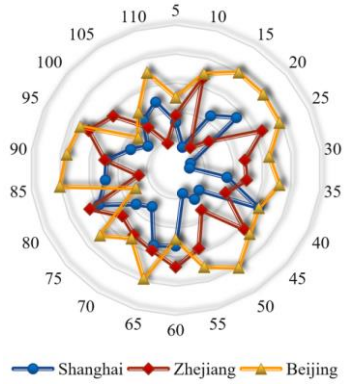

Figure 6: Provinces with concentrated spare parts。

As can be seen from Figure 6, the values of Shanghai and Zhejiang are small, with the average values of 0.92 and 1.19. Although Beijing has a large value, the average value is 1.63. All in all, the above three regions do not have a complete automobile production industry chain, but a certain concentration of production has been formed in parts manufacturers, which has a certain hindering effect on automobile industry agglomeration.

This chapter can better reflect the differences through comparative analysis. Because of the gap between Chinese and foreign automobile brands and the growing worship of foreign brands in recent years, many consumers have the psychology of worshipping foreign brands. To improve the competitiveness of automobile enterprises based on CAD technology, we must protect the legitimate rights and interests of consumers, promote the steady and rapid development of automobile industry and economy, and strengthen supervision and law enforcement, so as to eliminate the phenomena of producing, selling and using fake and inferior automobile parts, false propaganda, commercial bribery and consumer fraud in automobile sales. Therefore, the development of independent brands should be the core in the analysis and visualization of brand competitiveness of automobile industry based on CAD technology.

5 CONCLUSIONS

After more than 30 years of reform and opening up, China's automobile enterprises have initially possessed the strength to participate in international competition, especially the rapid development after China's entry into the WTO. Technological innovation is the source of maintaining the vitality of the brand and the driving force of the brand's lasting prosperity. With the rapid development of modern science and technology and the rapid change of market demand, automobile brands must increase the investment in brand science and technology research and development, increase the strength of technological innovation, constantly improve the scientific and technological content of products, and optimize the quality structure in order to maintain a lasting competitive advantage. This paper analyzes and visualizes the brand competition in the automobile industry based on CAD technology, and uses CAD technology to carry out structural design and structural analysis on the body. Finite element analysis and crash performance analysis of vehicle body can reduce the time and cost of actual analysis. Although this transformation and adjustment of the development strategy has not achieved significant results, it reflects the market adaptability of the automobile brand management team to a certain extent, and provides a strong guarantee for the automobile brand to better adapt to the rapidly changing environment of the market economy. Chinese automobile enterprises must further cultivate and improve their core competitiveness by means of improving independent technological innovation, building independent brands, improving service levels, strengthening enterprise management, and strengthening enterprise concentration, so as to better participate in the increasingly fierce international competition and realize the leapfrog development of China's automobile industry.

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Huadi Liu, https://orcid.org/0000-0003-2165-4364
Chenhan Xiong, https://orcid.org/0000-0002-0342-7371

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