

Research on the Trend of Automotive Front Facade Design in the Context of New Energy Technology Development

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ABSTRACT

This paper aims to explore the trends in the design of the front facade of new energy vehicles, with a particular focus on the differences and innovations compared to traditional fuel-powered cars. The article begins by reviewing the design characteristics and functions of the front facade of traditional fuel-powered vehicles from their development history and technological reasons, and analyzes the design from an artistic perspective. Following this, it analyzes the front facade of new energy vehicles from the perspectives of lighting systems, air intake grilles, horizontal element decoration, and functional components, exploring the changes in automotive front facade design under different energy types. It combines technology and aesthetics to analyze and summarize the changes in design. Finally, it emphasizes the important role of the front facade design in automotive styling and provides recommendations for changes in the design trends.

Keywords: *New energy vehicle, Artistic design, Automotive front facade design, Automotive styling design.*

1. INTRODUCTION

In the context of the current global energy crisis and increasingly severe environmental issues, new energy vehicles, as an important means to alleviate these problems, are rapidly becoming a new focus in the automotive industry. The wave of technological innovation has propelled the rapid development of new energy vehicles. Although China started relatively late in this field, it has made significant progress in new energy technology and contributed to the development of the global new energy vehicle market. However, the field of new energy vehicle styling design research is relatively weak, which has become one of the bottlenecks restricting the comprehensive development of China's automotive industry.

The development of new energy vehicles should not be limited to breakthroughs at the technical level but should also focus on their impact on consumer usage experience and their contribution to sustainable development. Automotive styling design serves as an important bridge connecting

technology and user experience, playing a key role in showcasing the unique charm of new energy vehicles and conveying future concepts. Therefore, exploring the development trends of new energy vehicle front facade design aims to combine the advantages of new energy technology with artistic design innovation to explore new directions for front facade design, which is of great significance for the comprehensive innovation of automotive styling design.

2. OVERVIEW OF THE DEVELOPMENT OF NEW ENERGY VEHICLE BRANDS

The history of new energy vehicles can be traced back to 1881, five years before the birth of the first internal combustion engine car invented by Karl Benz in 1886. The first electric car was invented by French engineer Gustave Trouvé. The early automotive landscape was divided into steam cars, internal combustion engine cars, and electric cars. In the following nearly one hundred years, due

to the rapid development of internal combustion engines, internal combustion engine cars dominated the automotive industry, and it was during this period that many classic car brands were born. In the 1990s, due to severe environmental and oil energy issues, new energy vehicles re-entered the focus of countries around the world. New energy vehicles have gone through three periods, namely the early development stage (1930s to the 1930s), the technology accumulation stage (1930s to the 1990s), and the current industrialization stage. Today, the automotive industry has undergone significant changes. With the development and maturation of emerging technologies such as intelligent driving, the proportion of new energy vehicles in the industry is growing. Tesla is committed to changing the position of new energy vehicles in the automotive industry. Therefore, on June 21, 2014, Musk opened up all of Tesla's patents, directly promoting the rapid development of the new energy vehicle industry. In 2017, the global passenger car sales volume was 70.85 million, and the total sales volume of new energy passenger cars was about 1.22 million, accounting for about 1.7%. By 2023, the global sales volume of new energy vehicles reached 14.28 million, accounting for 16% of the total global car sales. Thus, it is evident that the development momentum of new energy vehicles is rapid and they will occupy a significant market share in the future automotive industry landscape.

3. TRADITIONAL GASOLINE-POWERED VEHICLE FRONT-END LAYOUT

In the development history of gasoline-powered vehicles, the front-end design has always been a key aspect of vehicle aesthetics and practicality. The design layout of this area typically involves several core functions, including engine cooling, the introduction and expulsion of air, the setting of the lighting system, the protective function of the bumper, and the integration of decorative elements. In the design of gasoline-powered vehicles, the radiator grille is essential as it allows air to enter the engine compartment to cool the engine. The intake system is responsible for delivering the necessary air to the engine, while also ensuring air filtration to prevent impurities from entering. Additionally, the vehicle's front-end includes an exhaust system for expelling exhaust gases, although this part is mainly located at the rear of the vehicle, sometimes exhaust outlets are designed at the front to optimize aerodynamics. The lighting

system plays an important role in the front-end design, including the headlights, which not only provide nighttime illumination but also serve as a means of vehicle identification and safety signaling. The bumper, as a protective device at the front of the vehicle, is designed to reduce damage caused by low-speed collisions, while also integrating auxiliary lighting components such as fog lights.

The front-end styling design of a car, as the most intuitive part of the overall car styling design, serves not only to carry the practical driving functions of the car but also to showcase the brand's family language and interpret the design concept. Well-known traditional luxury brands have distinct and recognizable features in their front-end designs. The familiar German car brand, from the very beginning of its establishment, has established a "twin grille" front-end styling language that continues to this day. Although the brand has undergone multiple iterations and each model has its own unique size and shape of the "twin grille", whether the viewer is knowledgeable about cars or not, just seeing the classic "twin grille" design can confirm that it is the brand. This illustrates the importance of car front-end styling design to the entire enterprise. In the early days of automobile development, designers drew inspiration from the appearance of horse-drawn carriages, and the front-end design of early cars did not follow specific rules or develop a unique style. In the 20th century, the Ford Model T marked a turning point in car design, promoting the transition from horse-drawn carriage style to box-like structures and drawing more attention to front-end design. By the 1980s, front-end design had become an indispensable part of the overall car design and development process. Due to the long-standing historical accumulation of traditional automakers, most brands have their own unique front-end design language, which is often emphasized in the grille or headlights, etc. For consumers, they can even identify the car model brand through a single form element. Therefore, car front-end design has a significant weight in the traditional gasoline-powered car styling design.

4. TRENDS IN THE FRONT-END DESIGN OF NEW ENERGY VEHICLES

Just as the face is crucial to a person's appearance, so is the front of a car to the overall aesthetics of the vehicle. The design of a car's front end directly determines the overall look of the car, much like the facial features of a person. The front

end of a car is where the functional components and design elements are most concentrated, and it is the area where the brand's characteristics and design style are most prominently reflected. The shape of the front end plays a decisive role in the overall 颜值 (aesthetics) of the car. At the same time, the image of the front end determines the brand's recognizability and consumers' perception of the brand.

With the rapid development of new energy vehicles (NEVs), new emerging NEV brands are constantly emerging, and traditional automakers are also expanding their research and development models to include NEVs. Unlike the early design mode of "converting from fuel to electric," the design of NEV models is gradually changing due to technological advancements and evolving aesthetic preferences. In addition to technological characteristics such as intelligence level, driving range, and battery safety, the exterior design of NEVs is increasingly becoming a focal point of public attention. A unique exterior design is one of the key factors that attract consumers to purchase, and thus design plays a crucial role in promoting NEVs. Technologically, compared to NEVs, the body development of traditional fuel vehicles is relatively mature. Aesthetically, the public has formed fixed preferences for the appearance of traditional fuel vehicles. Therefore, the design of NEVs is often significantly influenced by traditional fuel vehicles in both technology and aesthetics. A lack of distinctive NEV exterior design not only hinders the promotion of design innovation but may also have adverse effects on the long-term development of the entire industry.

For a long time, people have developed a visual habit of "judging by appearance," and in design, there is an unconscious tendency to imitate the facial features of living beings. This is particularly evident in the product of cars. In the traditional fuel vehicle training, people directly correspond the facial features to the car's functional components: headlights correspond to eyes, grilles correspond to noses, air intakes correspond to mouths, and side mirrors correspond to ears. With the development of new energy vehicle technology, the design trends of the front end of new energy vehicles are directly reflected in the following most obvious aspects.

4.1 Changes in Lighting System

The evolution of the lighting system is a significant innovative area in the design of new energy vehicles. With technological advancements,

these changes are not only reflected in lighting functionality but also in aesthetics and intelligent interaction. Traditionally, people often equate a car's headlights to the car's "eyes," but with the rise of new energy vehicles, the front end of cars has been equipped with radars and cameras, making these systems that perform visual functions the true "eyes" of the car in a functional sense. However, from the artistic concept of "triple court and five eyes," placing the laser radar typically mounted on the roof or tiny cameras as the "eyes" in the "front face" seems somewhat far-fetched. Therefore, people still regard the car's lighting system as the "eyes," and functionally, the lighting system assists the visual system, enabling it to work properly through light.

The most direct and sensitive way humans convey emotions is through "eye contact," and in the front end of a car, the lighting system, located in the position of the "eyes," performs the same function. Especially at night, the lighting system directly determines the temperament of the front end. Traditional fuel vehicles usually focus on the design of the headlights. As an important visual aid system, headlights play a significant role in safety. Therefore, there are various constraints on headlights in regulations, and even in 2024, with technological advancements, the thickness of the headlight module is still at least 15 millimeters. Consequently, in the context of new energy technology, the design of the car's front end often incorporates daytime running lights. Thanks to technological advancements, the size of the headlights does not need to be as large as in the era of traditional fuel vehicles, so many new energy vehicle models place the daytime running lights in the position of traditional fuel vehicle headlights, reducing the size of the headlights to some extent and lowering them, to a certain extent, reducing the modeling function and taking on more of an auxiliary visual function. People often refer to the "slit eyes" as the current daytime running lights as the car's "eyes".

As a signal light, the daytime running lights have less functional impact than the headlights, which also means fewer restrictions in terms of design, giving designers of new energy vehicles more room to express themselves. Among the new domestic carmakers, the "star ring" light band that runs across the front end of all models of Li Xiang Auto has become the visual focus of the front end; Zeekr, except for the 001, uses the wide light band "StarGate" as the brand's design language, whose wide light band can not only serve as a daytime

running light but also allows for custom editing of the display content; AITO M9, although it does not transfer the position of the headlights and taillights, also uses the "horizon" daytime running light band to run through the headlights and taillights and places an "ISD" light matrix for interaction below them.

As technology updates, the lighting system on the front end generally moves towards a more technological, streamlined, and informative direction. Compared to the era of traditional fuel vehicles, it is more diverse and rich, embodying the concrete manifestation of technological development in the new energy era.

4.2 Weakening of the Grille

The grille is an essential part of a vehicle's front end, primarily designed to allow air into the engine bay to assist with engine cooling. Typically made of metal or plastic, grilles prevent debris from entering the engine. In traditional fuel-powered vehicles, grilles are often designed to be large to ensure sufficient airflow for cooling the engine. Since traditional fuel vehicles derive their power from internal combustion engines (ICE), the larger the air intake, the more powerful the car is. Aesthetically, the grille acts as the "nose" of the car, underscoring its importance in the design of a vehicle's front end. Looking at the familiar BBA brands—Mercedes-Benz with its louvre design, BMW with its twin-kidney design, and Audi with its hexagonal design—the grilles speak volumes about the brand's design language, which has been carried forward to their electric vehicle lines, where they still retain the grille's overall shape, even though the grilles are sealed off and the texture is treated in a parametric way.

The rise of new energy vehicles has prompted a re-evaluation of traditional automotive design, particularly concerning grille design. Due to the different operating principles between electric motors in NEVs and ICEs, the need for air intake is significantly reduced, which means that grille design is no longer constrained by traditional engine cooling requirements. Consequently, the weakening or elimination of grilles has become a new design trend.

Firstly, with technological advancements, NEVs' cooling systems are also evolving. When NEVs were not widely trusted, many companies chose a range-extended energy supply method, and the engines in those range-extended vehicles still

required air intake. Therefore, grilles remain necessary, but they do not need to be as large as those in traditional fuel cars. Many models are sold with both range-extended and pure electric options, and the grille design differs for the same model depending on the energy form, with the pure electric versions often removing the grille entirely, resulting in a more streamlined front end. The weakening of grilles follows the change in energy form, aligning with the adage "form follows function" from an artistic design perspective. The process of grille weakening is a revolution against traditional aesthetic concepts. In our traditional impressions, better-performing vehicles tend to have larger grilles, but now, the newer the energy form, the smaller or even absent the grille.

Secondly, the weakening of grilles can improve the aerodynamic efficiency of vehicles. After reducing or eliminating the grille, the front end can be designed with a smoother surface to reduce air resistance, enhance driving range, and energy efficiency. Some NEVs adopt a closed front-end design, utilizing adjustable aerodynamic components to optimize airflow and achieve optimal performance. Due to the nature of NEVs' energy forms, lower air resistance and more efficient aerodynamics are crucial, not to mention the marketing need for differentiation. Thus, the weakening of grilles is a necessary trend of the times.

Lastly, the weakened grille offers more creative space for automotive designers. In some designs, the traditional grille is replaced by other design elements, such as LED light strips, smart screens, or decorative patterns, enhancing the visual impact and distinctiveness of the vehicle's front end. As mentioned earlier, the emergence and evolution of signal lights like daytime running lights.

In conclusion, the simplification of grilles is an important trend in the design of new energy vehicles. This change not only enhances the vehicle's performance but also provides designers with a broader creative space, reflecting the future direction of automotive design. Although it poses a challenge and revolution to traditional aesthetics, considering the comprehensive factors, this change is an inevitable path dictated by the development of new energy technology.

4.3 Decorative Horizontal Elements

In automotive design, decorative horizontal elements are crucial for shaping the vehicle's

exterior. These elements typically refer to the horizontal lines that run across the front or sides of the car. They not only serve to connect various design components but also enhance the vehicle's visual width and stability, creating a low-slung, sporty aesthetic. Due to the weakening of the front grille mentioned earlier, the front space is now directly left blank. Moreover, since electric vehicle (EV) batteries are usually placed at the bottom, EVs tend to have a greater thickness compared to their gasoline-powered counterparts. The thickness of the front, whether subjectively or objectively, poses a design challenge. To visually mitigate the impact of this thickness from an artistic perspective, the current blank front can be segmented with horizontal design elements.

The design of horizontal decorative elements can range from simple lines to complex patterns. They are combined with other design elements of the vehicle, such as headlights, grilles, window lines, etc., to create a unique style. Leaving aside the changes in lighting systems mentioned earlier, the pioneering new energy vehicle "Tesla" has set an excellent example. Tesla's front end is divided using sculptural techniques, with horizontal lines creating a protrusion similar to a catfish mouth. This ensures a minimalist design style while visually providing a new "nose" to the front face, which has lost its functional "nose."

For new energy vehicles, horizontal design elements are often used to convey a sense of technology and futurism. Designers can create dynamic decorative lines using modern technologies such as daytime running light strips or ISD light matrixes. These lines can produce unique visual effects at night or under specific conditions, making the vehicle appear more modern and innovative.

In summary, horizontal design elements play a significant role in automotive design. They not only enhance the aesthetic appeal of the exterior but also reinforce the vehicle's functionality and technological feel. With the continuous advancement of automotive design technology, the application of these elements will become more diverse, offering vehicles a richer and more unique visual experience. Although born out of a necessity following the removal of the front grille, to some extent, they provide designers with a broader canvas.

5. CONCLUSION

New energy vehicles are rapidly becoming a focal point of the automotive industry, with their significance extending beyond technological breakthroughs to encompass user experience and sustainable development. Despite China's notable progress in new energy vehicle technology, there are still certain deficiencies in styling design, which have become one of the bottlenecks hindering the comprehensive development of China's automotive industry. The front-end design of automobiles is a crucial component for brand recognition and for conveying future concepts, playing a significant role in the market competitiveness and consumer appeal of new energy vehicles.

With the rapid development of new energy vehicles, there have been significant changes in the trends of front-end design. Firstly, changes in the lighting systems reflect technological advancements and aesthetic innovations. The lighting systems of new energy vehicles have not only improved in functionality but also showcase new design directions in terms of aesthetics and intelligent interaction. For example, the design of daytime running lights has become the visual focal point of the front end, while the headlights and taillights tend towards a more streamlined and technologically advanced approach.

Secondly, the weakening or elimination of the front grille has become an important trend in the design of new energy vehicles. As new energy vehicles require less air intake, the traditional grille design is no longer constrained by the cooling needs of conventional engines, allowing designers more creative freedom in the front-end design. At the same time, a weakened grille can improve the vehicle's aerodynamic efficiency, enhancing performance and energy efficiency.

Lastly, the decoration of horizontal elements plays a significant role in the front-end design of new energy vehicles. These elements not only connect different parts of the vehicle but also increase the visual width and stability of the vehicle. Designers use modern technology, such as LED light strips and ISD light matrices, to create decorative lines with a dynamic feel, making the vehicle appear more modern and innovative in visual terms.

In summary, the innovative trends in new energy vehicle front-end design reflect not only technological progress but also the perfect integration of artistic design and technology. These

design trends are significant in enhancing the market competitiveness of new energy vehicles and promoting the overall development of the automotive industry. As new energy vehicle technology continues to innovate and design concepts expand, future front-end designs will become more diverse and rich, offering consumers a more unique and appealing visual experience.

REFERENCES

- [1] Chen Jingchun. Challenges and Countermeasures of China's New Energy Vehicle Industry Under the "Dual Carbon" Goal [J]. Times Automobile, 2023(24): 119-121. DOI: 10.3969/j.issn.1672-9668.2023.24.037.
- [2] Li Yong, Wu Yinlu. Research on Influencing Factors and Characteristic Design Trends of Exterior Styling of Battery Electric Vehicles [J]. Packaging Engineering, 2020, 41(6): 72-80. DOI:10.19554/j.cnki.1001-3563.2020.06.011.
- [3] Wang Keda, Liu Lingling. Front Face Design of Miniature New Energy Vehicles Based on User Image Cognition [J]. Hunan Packaging, 2023, 38(1): 1-5. DOI:10.19686/j.cnki.issn1671-4997.2023.01.001.
- [4] Wu Lixu. Research on Front Face Design of New Energy Vehicles Based on Shape Grammar [D]. Lanzhou Jiaotong University, 2022.
- [5] Yin Lei. Research on Electric Vehicle Front Face Styling Design Driven by User Image [D]. Jiangsu: Jiangsu University, 2021.
- [6] Tang Yin, Zeng Yong, Tao Yu. Research on the Development of Automotive Styling Design Under the Background of New Energy Technology Development [J]. Times Automobile, 2023(2):119-121. DOI:10.3969/j.issn.1672-9668.2023.02.038.