

Innovation in new energy vehicles——Take NIO as an example

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Abstract

Under the background of globalization and openness, it is a priority for enterprises to deal with the globalization of economy and strive for a place for themselves. Innovation has become a key source for enterprises to gain and maintain competitive advantage. The innovation ability of an enterprise means that through various methods and means and using knowledge and human intelligence, the enterprise can transform the correct theoretical knowledge into products, enables the enterprise to meet or create new market demands, and persuades customers to buy their own products and enhance the ability of enterprises to compete at the same time. In the face of the update iteration of the automotive industry, as the fastest invasion of new technology and the most subversive traditional industry, every role in the automotive industry chain are facing with the new technological revolution to eliminate the tide of worry. This paper takes NIO automobile as an example to study its enterprise innovation and international competition.

Key words

New energy vehicles; NIO automobile; Enterprise innovation; International competition

1. Introduction to new energy vehicles

1.1. Research background

With the ever-expanding global energy demand, urban traffic congestion and severe environmental pollution, the traditional automobile industry needs to make changes in the face of difficulties as its sales growth is slow. However, with the scientific and technological progress in the 21st century, the new generation of information technology, such as Internet, artificial intelligence, 5G network, big data, is gradually applied to the automobile manufacturing industry^[1]. Automobile companies can be divided into three categories. The first category is common companies before the Internet. Second, Internet car companies, such as tesla; The third type of car in the mobile Internet era, which is the goal of many research and development companies. Of course, we can be sure that this is the future of the development of the automobile industry, but there are huge challenges in the research and development of Internet cars, such as technical barriers in the automobile industry, sources of financing for research and development, etc. Li bin, NIO's founder, has said that when he started NIO he thought its success rate was only 5%.

China is the largest automobile production and sales country in the world. The consumption of energy and environmental pollution caused by traditional fuel vehicles has made China begin to explore the development of new energy vehicles and elevate the development of new

energy vehicles to the national strategy, providing strong support measures for the development of new energy vehicles^[2]. In 2009, the first direct subsidy policy was issued for the new energy automobile industry. By 2020, the government subsidy policy of China's new energy automobile industry will exit, and the government subsidy policy of China's new energy automobile industry will experience a complete policy cycle. In a word, the new energy automobile industry has a good prospect and faces many obstacles in its development.

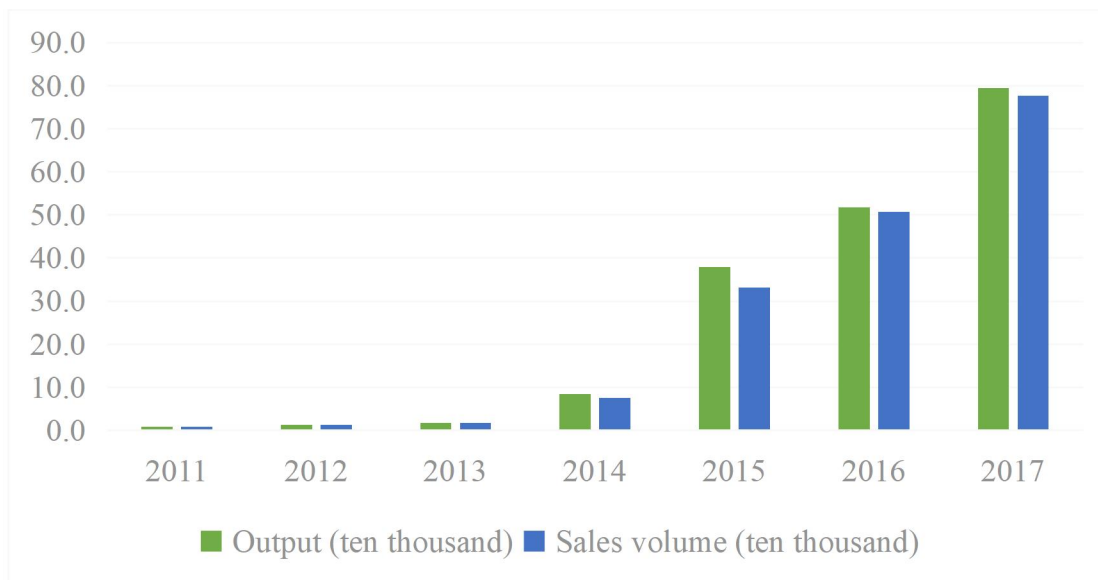


Figure 1: 2011—2017 China new energy production and sales scale chart

1.2. New energy vehicle

Energy vehicle refers to the use of unconventional vehicle fuel as a power source, integrated vehicle power control and driving aspects of advanced technology, the formation of advanced technical principles, with new technology, new structure of the vehicle. The existing new energy vehicles mainly take the power way as the classification standard. Current new energy vehicles include pure electric vehicles, hybrid electric vehicles, hydrogen vehicles, ethanol vehicles, fuel cell vehicles, extended-range electric vehicles, other new energy vehicles^[3].

2. The Case of NIO Automobile

NIO is a global-based Smart Electric Vehicle Company dedicated to creating a pleasant lifestyle for its customers by providing high-performance, smart electric vehicles and user experience to build a global consumer enterprise. NIO, a company that develops high performance, smart electric cars, was founded in November 2014 with hundreds of millions of dollars from top Internet companies and Entrepreneurs. They include Li Bin, founder of E-car; Li Xiang, founder of car home; Liu Qiangdong, founder of JD.com; And Hillhouse capital, a well-known investment firm. NIO has established R & D, design and business offices in Silicon Valley, Munich, Shanghai, Beijing, Hong Kong and London.

2.1. Evolution

It took only four years for NIO to be listed in the United States. During this period, NIO aims to focus on global distribution, domestic financing, research and development of high-end

technology, and production of high-tech new energy vehicles.

Table 1 The Main Development Course of NIO

Time	Main events
2014.11.25	The birth of NIO
2015.06.01	NIO German Company was formally established
2015.08.01	NIO British Company was formally established
2015.09.01	NIO North American Company was formally established
2016.04.06	NIO and Jianghuai reach 10 billion RMB strategy cooperation
2016.11.21	NIO's North American Strategy and the First Concept Vehicle
2017.03.10	NIO's North American Strategy and the First Concept
2018.09.01	NIO's successful listing on the New York Stock Exchange

Source: NIO Autos Prospectus

2.2. IPO financing

On September 12th, it went public in America at \$6.26 a share, offering 160m shares and raising \$1bn. Based on the company's current total share capital, the company is valued at \$6.4 billion. Four years after the delivery of 2,200 vehicles, the company is officially listed on the New York Stock Exchange. On June 23, 2015, NIO raised a total of \$295 million in A1 and A2 rounds for a group of mostly founding investors. After that round, NIO raised more than \$2.1 billion in four rounds, the most of which was \$1.14 billion in 2017. NIO's size has grown exponentially from an already staggering \$300 million^[4].

Table 2 NIO Financing Status List

Financing	Investors	Amount of money
A round	Hillhouse Capital Group, Tencent, etc.	More than \$15 million
B round	Sequoia Capital, Pleasure Capital, etc.	More than \$15 million
C round	Baidu, Tencent, IDG Capital, etc.	More than \$15 million
SI	Baidu, Tencent, IDG Capital, etc.	\$600 million
D round	Tencent, Huaxia Capital, CITIC Capital, etc	\$1 billion
E round	IPO to be listed in the United States	About \$1.5 billion

Source: NIO Autos Prospectus

2.3. Product Introduction

NIO's product strategy is to integrate global resources, reserve core technology and establish brand image, and then gradually explore into mass-produced models. The EP9 is an electric supercar with 1,360 horsepower. On October 12, 2016, EP9 set an electric car lap time record of 7 minutes and 5 seconds at the Nurburgring North Circuit in Germany, and on November 4, it set a new electric car lap time of 1 minute and 52 seconds at the Paul Ricard Circuit in France. NIO 003 leverages the experience of participating in top-level electric formula racing to enhance the research and development capabilities of its team and to reserve BMS technology. EP9 is characterized by its accumulated dual-motor technology, magazine-type replaceable battery system and "Know-Me" interactive design concept. NIO EVE is a driverless mobile living space, designed with the concept of "second living room", so that users can fully enjoy the pleasure of free travel time. Accompanied by Eve, NIO also released the "NOMI" artificial intelligence companion system. The ES8 is a mass-produced car, with the "E" for "electric", the "S" for "SUV" and the "8" for performance rating. ES8 is the first

mass-produced high-end product, the core technology has been inherited, ES8 has automatic driving technology, 12 ultrasonic radar with a maximum range of 60 Km / h over 500 km, ES8 manufacturing system and supply chain layout has been established, and the mass production preparation work is in good order.

3. NIO Innovation Point

3.1. Business Model Innovation

3.1.1. Focus on user experience

The problem with traditional car companies is that while they sell a lot of products, they don't really have users--the customer belongs to the gas station, to the insurance company. It simply sells the product for a profit, but the most valuable thing -- the connection to the user is not established, just the user data, not the user connection. NIO combines electric cars with the mobile Internet in an attempt to redefine the user experience in the automotive industry. In NIO's strategy, its goal is not just to build a car company, but to become the world's first "User Enterprise", the core concept is: put people first to think, it does not matter if it is the users, their employees, or their partners. "The automotive industry is undergoing profound changes, not just in products and technology, but in the direction of how to create a sense of ownership," said Li Bin, NIO's founder^[5].

As a result, NIO expects to redefine all processes that serve customers and provide them with a more enjoyable experience than expected. In the design and development prospect, NIO pays more attention to the use scene and the pain spot and uses the suitable technology to solve the requirements of user under the different scene the demand truly. In manufacturing prospect, the whole manufacturing process will be shown to customers, from the order, into the factory, off-line to transport. Customers can be in the NIO APP to track the entire order progress. In sales promotion prospect, NIO break the traditional mode of production and sales separation, and use the direct sales mode, to ensure that users have the best product life cycle experience. In the user service prospect, all services are based on the mobile Internet, making the whole process of service transparent. For example, the world's first electricity service system, cloud-based technologies and big data based on the NIO Energy Cloud, connect charging post, changing station, mobile charging car, battery, NIO car, NIO commissioner and users into a Smart Energy Interne. In terms of emotional interaction, NIO APP is more like a community, with functional content as well as information and activities related to NIO cars, and users can exchange points for merchandise.

3.1.2. Battery Leasing model

Battery leasing model is a "car electricity separation" type of business model. The most expensive part of electric car is the battery, and the cost of the NIO ES8 battery still has 100,000 yuan value when the car is completely out of commission. NIO has adopted the battery rental model, which users can choose the "interest-free loan" 100,000 yuan battery rental program. (Using the time value of the currency, if the return on capital investment can reach 9.25%, the total capital cost will be the same after 10 years using the rental payment method as the purchase payment method). In this program users only have the right of use, not the right of ownership. The company is responsible for recycling the batteries, and the

buyer saves 100,000 yuan on the purchase cost, thus reducing the initial purchase cost of the vehicle. The advantages of "renting electricity" are: First, consumers can only buy bare cars, which can reduce one-off purchase expenses and is highly acceptable to the market; second, battery leasing and charging services can help consumers to dispel their worries about battery life and Maintenance. The lessee only has to pay the charge and the battery depreciation fee according to the distance traveled, which can reduce the economic pressure of purchasing batteries. Third, provide battery recycling services, which are conducive to environmental protection, but also increase revenue.

3.1.3. Choosing OEM model to build cars

In terms of manufacturing, NIO hopes to conduct in depth cooperation with existing enterprises, which is a win-win development idea. Looking for manufacturing partners is an economical and rational cost-sharing consideration. Instead of participating in the industrial manufacturing part of the automobile, it injects Internet genes and technologies into the automobile company through strategic cooperation and investment. NIO Automobile and Jianghuai Automobile signed the Manufacturing Cooperation Framework Agreement. According to the content of the agreement, both parties agree to cooperate in the production of new energy vehicles. NIO Automobile will authorize Jianghuai Automobile to use its trademark and related technologies. The manufacturer will customize the new energy vehicle models, and Jianghuai Automobile will be responsible for the production of the cooperative models. The cooperation between Jianghuai and NIO is an "innovation model". This innovation comes from the reintegration of resources. The manufacturing of NIO Automobile adopts the model of cooperative production and independent research and development of parts and components, which is one of the biggest innovations of the automobile industry in recent years. NIO Automobile needs to be "light". For NIO Automobile, design and development is the most important part of NIO. The production and manufacturing process should not invest too much money, so that more energy can be invested in R&D and user services, not just manufacturing. The cooperation between Jianghuai and NIO is not only a simple OEM production, but a deep cooperation involving the entire industrial chain^[6].

3.2. Technology Innovation

3.2.1. Batteries are good at computing and security

In the "three power" core areas of electric vehicles, the battery, motor, electric control system are controlled by NIO. In the manufacturing process, NIO cooperated with Jianghuai and made initial investment by Jianghuai. NIO battery has an intelligent management system, which can use the best algorithm and the most energy-saving way to obtain the maximum power, including the waiting time of traffic lights, and use the minimum power to meet the maximum kinetic energy. NIO's patented technology can enhance the heat dissipation performance and modularization characteristics of the lithium battery pack, helping the lithium battery pack to better dissipate heat at high power output. At the same time, different models can configure lithium battery packs with different capacities based on the modularization concept, and the interfaces between the bottom of the whole vehicle and the lithium battery pack fully consider the design of power exchange. Through the cross frame structure, the cells in each module of the lithium battery pack can get effective heat dissipation. NIO announced the test specifications for lithium battery packs. The entire lithium battery pack needs to undergo

continuous fire test, free fall test, seawater immersion test and thermal shock test. The patented cross frame structure of lithium battery pack plays a huge role^[7].

NIO battery is in the form of a battery pack, which is wrapped with high-strength aluminum alloy and is passed all crash tests to meet the requirements. Adding other systems, such as liquid cooling temperature control system, ensures the temperature control of the battery. However, NIO's modular battery pack divides the batteries into pieces and folds them like bricks. The number of stacks can be determined according to the length. Moreover, an advanced battery management system is designed and each battery is managed separately. When any one of them has problems, it will automatically cut off power, automatically block and will not affect the work of other batteries.

3.2.2. Comprehensive Charging and Switching Solution

As the biggest life gate of pure electric vehicles at present, cruising mileage is also one of the biggest obstacles that it is difficult to popularize. However, NIO's comprehensive charging and switching solution covers not only charging, but also switching and "powering up" to make up for the congenital defects of insufficient cruising range of electric vehicles in many ways.

NIO has three countermeasures for endurance: the first is the user-oriented home charging device "Power Home"; the second is the launch of the fast mobile charging service "Power Mobile"--mobile charging vehicles provide fast charging service, charging for 10 minutes, and the endurance can reach 100 kilometers. The other is the "Power Swap" innovative battery replacement service - which realizes "3 minutes power exchange" through an intelligent unmanned power exchange station. The power exchange speed is only one aspect, and the key is the unmanned power exchange mode. In addition, NIO is also the only new force to support the power exchange service. When the battery energy density is rapidly increased, the high-density battery pack is replaced by a relatively low-density battery pack through the power-changing mode, thereby achieving the endurance improvement.

3.2.3. Intelligent terminal car

NIO's ES8 mass production car is loaded with the most advanced auto-pilot system NIO Pilot, which has up to 23 sensing devices, enabling the auto-pilot hardware to be in place in one step. It is also the world's first mass production vehicle with the Mobileye EyeQ4 automatic driving chip. In addition, NIO launched the world's first in-vehicle artificial intelligence system "NOMI", based on powerful in-vehicle computing capabilities and cloud computing platform. NIO has integrated voice interaction system and intelligent emotion engine, creating a brand-new way of human-vehicle interaction and turning the vehicle from a machine into an emotional partner.

3.3. Innovation of Internet Mode

3.3.1. Combine online and offline to "activate" users

The combination of online and offline, and deep binding with users, create a unique interactive travel lifestyle, expanding the user experience outside the car. NIO takes automobile as the starting point to build a community that grows together with users. NIO shares and communicates with users instantly through its APP online and provide users with interactive experience through its NIO House bases throughout the country offline. In addition to basic functions such as sharing, online entertainment stores and online booking, NIO APP

also has user functions such as mileage calculator, one-click power-up and search for charging piles, as well as new functions such as “friend circle” and “sign-in points”. Through NIO APP, users can not only chat with other car owners, but also build groups to chat, and even interact and directly talk with NIO employees, including the founders. This is almost impossible in traditional car companies, but NIO has done it. Openness is the core principle of NIO APP, and this openness makes NIO APP not like a “channel for selling cars”. Similar to the development method of game APP, only users with sticky demand are willing to stay and consume.

Internet thinking focuses on “everything is based on user value”. Through good user experience and service, it establishes brand and reputation, and makes users become loyal followers of the brand, thus expanding and enriching product lines and business opportunities. At present, this model is taking place in the new power-making enterprises, promoting the integration of automobile manufacturing and related derivative industries, and promoting the reconstruction of the value chain of the automobile industry. NIO has become a connector through which users can enjoy a series of very high-quality services, rather than just the travel functions that any car can bring^[8].

3.3.2. Internet helps networked collaborative manufacturing

The new model created by “integration and interconnection” has greatly expanded the layout of the industry. The integration of Internet thinking and traditional automobile industry, especially in the emerging automobile service industry, has brought more new energy to the industrial ecology. With the help of the Internet, car companies can bring together the world's best manufacturing resources to achieve remote networked collaborative manufacturing. NIO Automobile promotes the cross-enterprise gathering and docking of innovative resources, production capacity and market demand by building an Internet - based collaborative design, research and development, manufacturing and supply chain collaboration platform, integrating research and development systems, information systems, operation systems, etc. to realize parallel organization and collaborative optimization of design, supply, manufacturing and service. Nowadays, NIO's global R&D and manufacturing layout network have been formed. Shanghai is NIO's global headquarter and R&D center for mass production cars. Beijing is NIO's global software R&D center. Nanjing is NIO's call-drive system manufacturing base, vehicle trial production Line. Hefei is the manufacturing base of NIO. San Jose is the headquarters of NIO North America and the global autonomous driving research and development center. Munich is the global design center of NIO. London is the global extreme performance research and development center of NIO.

4. Conclusion

The new generation of Information Technology has been deeply integrated with the automobile industry, the automobile industry has risen from the ashes, and the industrial pattern has been completely reshaped. As an Internet car company, the purpose of making cars on the Internet is not to disrupt but to reshape the automobile industry. NIO has a long way to go, and its ultimate goal is not to be a car company in the traditional sense, but to build a service-oriented community with the dual attributes of Internet and car making.

In order to service users to the extreme, NIO innovatively creates a subversive integrated

charging solutions and unique and thoughtful travel lifestyle. Technological breakthroughs are great, but user experience and business model innovation are just as important. NIO's business model, in general, is platform, partnership and cooperation. In addition to its star-rated portfolio of 56 investors, it has 19 global offices and three production plants (Jianghuai, Changan and GAC) working with it. There are more than 4,000 partners from more than 40 countries and regions for its "saddle horse". NIO's business model is different from traditional 1.0, which only focuses on the car itself, and Tesla's 2.0, which advocates direct sales of software defining hardware, but moves from design to production to service. NIO features 3.0 version controlled by whole industry chain.

For NIO, a brand-new enterprise, it has technological innovation and a service model and business model that are different from those of traditional vehicle enterprises. Once NIO makes a big contribution, spreading its tentacles from home to abroad and extending its tentacles to all major vehicle enterprises, trying to contract the entire automobile industry chain operation, the final test is the NIO mass production, commercialization and experience.

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