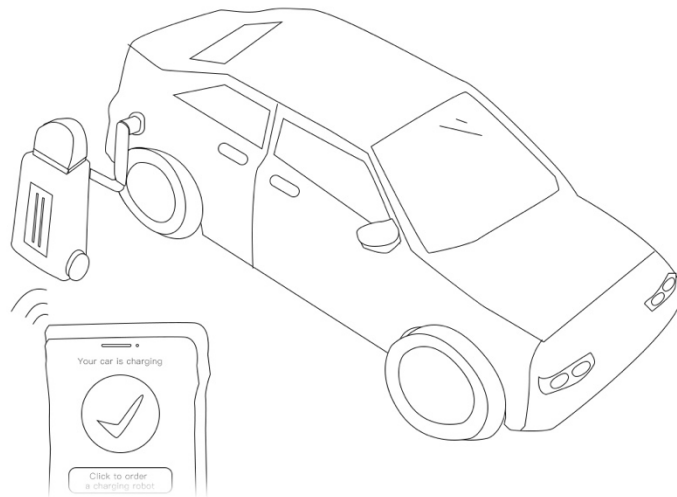


Active mobile charging product service system design research report

Charging service system based on mobile EV charging robot



-Parking Means Charging-

Reported by Yingwei

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1. Introduction

Background

With the rapid development of global science and technology, the development and utilization of energy in various countries are also increasing. Lack of traditional energy, serious environmental pollution, and excessive carbon dioxide emissions are also one of the main culprits of global warming, so all countries are trying to use and develop new energy to ensure the stable development of the economy. on the automotive industry, in terms of traditional energy vehicles, they consume a lot of oil energy and also emit a plenty of carbon dioxide.

Therefore, the development of new energy vehicles has become an indispensable choice for the global automotive industry. In 2015, the International Energy Agency (IEA) released *"The World Energy Outlook 2015"*, which also clearly states that by 2030, China will become the largest country on the consumption of oil and natural gas in the world.

As we all know, oil is a non-renewable energy source, and China is a country lacking oil resources, and a big car consumer due to its large population. These factors have led to increasing environmental problems in China. With the continuous improvement of people's living standards, people's desire for low-carbon life is getting stronger and stronger, which requires Chinese automotive industry undergoing transformation and upgrading. The advent of new energy vehicles will greatly improve my country's energy and environmental issues. question.

Compared with traditional energy vehicles, electric vehicles of new energy vehicles have considerable advantages. less pollution, more environmentally friendly, basically achieve zero air pollution, save fossil energy, and China's preferential policies for buying electric vehicles are also very powerful. Electric vehicles as the new transportation have many advantages, but they also have many disadvantages, such as weak capacity on battery life, unable to reach the mileage that matches traditional energy vehicles, insufficient charging equipment, primary centralized layout, and bad management causing difficulties for electric vehicle owners to charge, the charging pile keeping a single shape. These problems restrict the use of electric vehicles in promotion and development in China.

Significance

The rapid development of electric vehicles is of epoch-making significance, which is in line with Chinese sustainable development principle. It can also satisfy people's green travel. As an emerging industry, the electric vehicle industry has played an important role in culture, environment, technology, and other aspects in the future. However, the whole developing process is not yet mature, it needs a process of continuous improvement and innovation, not

a series of policies launched by a country and solutions to make it mature quickly.

Today, in the context of rapid technological development and continuous innovation, under the current situation, the development of electric vehicles needs to be combined with the characteristics of the current era. Chinese hotspot technologies such as cloud computing, big data, AI, are very advanced, so the development of electric vehicles must be combined with intelligent design. Nowadays, the development of Chinese industrial design field is relatively lagging other developed countries, which also requires us to design in terms of tireless learning and innovation, only continuous innovation can contribute to the development of electric vehicles. So This project expects to combine the existing high-tech means, fully integrate the concept of interaction and service design, and provide electric vehicles and car owners with a humanized, intelligent charging device that can truly achieve "things to find people" replacing "People to find things" and can improve charging difficulties and other problems, so as to contribute to our world's environmental protection and comprehensive control of carbon emissions on green travel.

Development status of Countries

Developed countries such as the United States, Japan, and European countries including the United Kingdom have a long history of development and profound cultural heritage in the automotive industry. The corresponding development strategies and policies for electric vehicles are also relatively complete, and the design innovation is also relatively novel, so it has important reference value for the development of electric vehicles in other countries.

In the United States, the technology and related policies of electric vehicles have been among the best in the world for a long time, and a considerable number of research and literature reports, on wireless charging technology and design planning around smart highway, have been released recently. During the Clinton presidency, electric vehicles have been vigorously developed and a series of policies have been introduced. When Obama took office, he proposed policies such as retrogressive subsidies and tax cuts, which further promoted the development of electric vehicles. In 2013, the United States proposed a research path for key technologies such as electric vehicle batteries and power in the next decade. In 2016, it was proposed to further strengthen government-enterprise cooperation to jointly promote the development of electric vehicles and related infrastructure. By 2022, every household will be accessible to have an electric vehicle.

In Japan, the government promotes the development of electric vehicles through policies such as car purchase subsidies and a green tax system. By 2020, the proportion of electric vehicles in the automotive industry is expected to reach 50%, but this goal has been achieved by 2013. In 2013, the government proposed the "Japan Revitalization Strategy", which improved and implemented the subsidy policy for purchasing electric vehicles. In 2014, the goal of "hydrogen society" was proposed to promote the development of electric vehicles.

Japan's efforts to promote the development of electric vehicles and the means to improve a series of government policies have important reference significance for the development of electric vehicles in other countries.

Early European new energy vehicles used hydrogen and natural gas as the main energy sources. In recent years, new energy vehicles have gradually entered people's attention, and Europe has also attached great importance to the development of electric vehicles. Germany has played an important role in promoting the development of electric vehicles in the world, with 35 electric vehicles on the market made by German cars, and Germany has also invested considerably in developing charging infrastructure, from May 2019 to May 2020. During the month, charging facilities in Germany increased by 50%.

In the UK, the government has aggressive emission targets by 2030 and 2050. It is convinced that the majority of greenhouse gas emission is contributed by transport. The UK government has therefore established an ambitious roadmap to be world leader in EV design, development, and manufacture, and to be one of the most attractive locations for EV-related inward investment in the world.

A brief look back at the past development of electric vehicle charging facilities in the UK. In 2009, the UK government initially released an Ultra-Low Emission Vehicle (ULEV) strategy to encourage the growth of the ULEV market. Ultra-low emission vehicles are vehicles that emit less than 75 grams of carbon dioxide per kilometer, the vast majority of which are hybrid electric or pure electric. Launched in September 2013, a strategy called "Driving the Future Today" works to reduce carbon emissions in transportation, with the goal of achieving zero emissions from virtually all cars and vans by 2050. Key elements of the proposed package to support ultra-light electric vehicles for 2015-2020 were developed the following year. The Automation and Electric Vehicles Bill 2017-2019 was introduced in the House of Commons in October 2017 to help achieve the 2050 zero emissions target. For EV rollout, in addition to making EVs more affordable, an effective charging infrastructure network is another fundamental part of driving further rollout and wider use of EVs across the country.

The Electric Vehicle Charging Infrastructure Grant Scheme is the UK's effort to promote the construction of charging services, and since 2010 it is not difficult to see a series of grant schemes emerging. The government established the Plug-In Places (PIP) scheme in 2010 to provide funding for local businesses and public sector consortia to build their own charging stations. The scheme ceased operations in 2013 and was succeeded by separate installation grants for public sector agencies and local authorities, focusing respectively on workplace and street residential charging points. Earlier in the year, the Office for Low Emission Vehicles (OLEV) launched a £13.5m grant scheme to subsidise households installing charging equipment. In recent years, OLEV has released three separate grant programs for the installation of home, workplace, and street residential charging infrastructure.

For technical standards for charging facilities, in addition to some basic standards, such as British Standard BS1363-13 (Plug and socket adapters and connection units) and British Standard BS EN 60309-2 (Industrial plugs, sockets and couplers), for general Domestic and

industrial plug and socket systems, there are two specific electric vehicle charging systems in the UK, namely the British Standard "EV Conductive Charging System" (BS EN 61851) and the British Standard "Plug, Socket, Vehicle Connectors and vehicle inlets - Conductive charging of electric vehicles" (BS EN 62196). These documents specify requirements from plugs, sockets, vehicle connectors and vehicle inlets to charging modes and communications.

The development of EV infrastructure has been encouraged since 2009. A government strategy for plug-in vehicle infrastructure was published in 2011 called "Making the connection", which sets out a framework for the development of charging infrastructure to support EV owners and industry in the UK, with the aim of stimulating EVs Growth of the market. In 2014, the European Union (EU) agreed to the Alternative Fuels Infrastructure Directive, and although the UK voted to leave the EU in June 2016, the UK is legally obliged to implement these requirements.

Additionally, the October 2017 Act allows the government to regulate where necessary to improve the consumer experience of EV charging infrastructure, ensure supply at key strategic locations, and require charging stations to have "*smart*" capabilities. It can be seen that, whether the UK is subject to the implementation of this directive or to promote the development of its own electric vehicle industry, further consideration of the planning layout and design innovation of electric vehicle charging facilities is a direction worth considering.

Challenges in China

China is relatively backward in the development of the electric vehicle industry,

- the core technology is weak
- the innovation power is relatively weak
- People's low overall awareness of electric vehicles and low carbon emissions

However, Chinese confidence and strong momentum in the development of electric vehicles cannot be underestimated. Under the influence of Domestic introduction and implementation of preferential policies for electric vehicles, electric vehicles have gradually entered people's field of vision, and people's acceptance of them has also continued to rise. For example, the Beijing government has set up a special lottery pool for electric vehicles, which can enjoy local subsidies and state subsidies; the Guangzhou Municipal Government is also in line with the national preferential policies, and the subsidy for electric vehicles can reach up to 120,000 yuan, and there are no restrictions on policy impact; after buying electric vehicles in Tianjin, there is no need to lottery and can also get subsidies from the local government; The incentives are also very large. The license fee for electric vehicles is exempted, and the purchase of electric vehicles can get a subsidy of 40,000 Yuan. Governments at all levels in my country have adopted strong preferential policies for electric vehicles, which has made electric vehicles develop rapidly in my country. In 2014, the sales of electric vehicles in my country increased by 1.2 times compared with 2013, but from 2016 to 2019, although the

production of electric vehicles in my country continued to increase, the sales volume was declining. The lack of independent innovation capability in my country's auto industry, the reduction or cancellation of subsidies by local governments for the purchase of electric vehicles, and the lack of charging facilities have all affected the sales of electric vehicles in my country. Even though my country has encountered a lot of setbacks in the promotion of electric vehicles, it is undeniable that electric vehicles are still the inevitable choice for the future development of the automobile industry.

The difference between the development status in China and abroad

In the field of electric vehicle charging equipment, research directions in China and abroad are still different. Represented by BMW in foreign countries, they have developed wireless charging technology, which provides a new development direction for the charging of electric vehicles, and at the same time broadens the design ideas. To put it bluntly, wireless charging technology corresponds to the charging base and the receiving end on the car to achieve the effect of charging electric vehicles. This technology does not require a physical connection line, is less restricted by the environment, and is more convenient to charge.

In China, the key development is the infrastructure construction of charging equipment, that is, the extensive construction of charging piles. Represented by BYD, they designed charging towers and three-dimensional charging piles. These two designs not only increase the number of charging piles, but also save space and alleviate the problem of lack of charging equipment to a certain extent.

Project research path and Goals

Relying on the promotion of innovative design and construction of urban infrastructure, the automobile industry, as a pillar industry of the country, proposes and draws effective and reasonable service design innovation ideas and practices in advance, which can fully promote the sustainable and healthy development of the electric vehicle industry in China, thereby radiating to the world, contributing the multiple benefits.

Firstly, the research background and significance have been outlined in this section. Secondly, Through the analysis of charging products and service models in the existing market, the shortcomings and merits of existing products and areas that need to be improved are summarized to guide innovative charging products. At the same time, in the service system, in addition to the relationship between various elements, we should pay more attention to service recipients, users of vehicles. We should pay attention to their experience in the entire charging service process and carry out design practices based on user-centered design principles. Furthermore, combined with the design thinking of interaction design and service

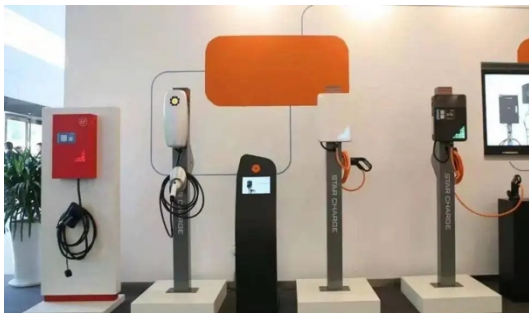
design, the report analyzes the improving trend of existing products and services, and further proposes innovative points in the design scheme.

The expected results of this project can be, based on the current development status and industrial development trends, a set of charging products and service systems that can effectively solve the difficulty of charging electric vehicles in the process of industry development and are highly integrated with future intelligent information development. The main design achievements of this project are, based on the new charging service model, reflected in the charging robot product and charging service terminal platform design, which can figuratively illustrate how the service is delivered to the user.

2. Analysis of existing electric vehicle charging facilities and equipment

At present, there are basically five charging methods for electric vehicles.

1) The first type is the three-dimensional charging pile charging. Influenced by the charging current limitation standard formulated by the state, charging equipment is divided into two types: DC charging and AC charging, which are the most common and common charging methods. DC charging is faster, and AC charging is relatively slow. For private charging piles, this is a relatively convenient and common way to charge vehicles. It is generally installed in private parking spaces and used independently by electric vehicle owners.



The picture shows the charging pile equipment independently developed by China's three major charging service operating companies, Star Charge

2) The second category is supercharging stations. Charging stations represented by Tesla are very fast charging and are mostly used for emergency use. It can efficiently meet the travel needs of users and reduce the waiting time for a large number of users. Usually, half of the EV battery can be charged in less than half an hour.

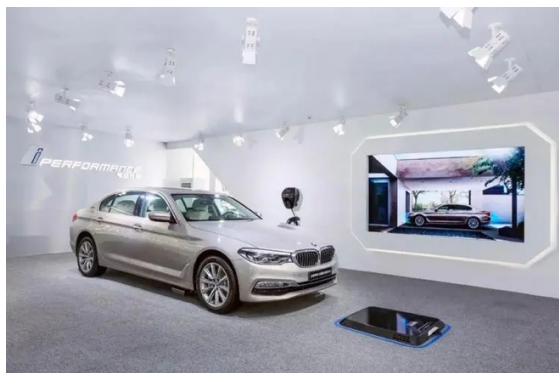


3) The third category is the power supply method of replacing the battery represented by NIO. Electric vehicle owners can go to the corresponding merchants to obtain more power by replacing their own batteries with fully charged batteries by leasing and form a charging service chain by recycling and leasing.



4) The fourth category is wireless charging. The core technology of this charging method is mastered by BMW, and there is no corresponding international standard to regulate it, so it has not been popularized in China.

It is undeniable that this charging method does save a lot of time for users to operate charging equipment. At the same time, wireless charging technology is also used in various fields, which must be one of the future development trends. Users only need to park the vehicle on the corresponding base wireless power charging pad to start charging the vehicle.



5) The fifth category is mobile charging, which mainly refers to the charging of the vehicle while it is moving and the charging equipment can be moved to the vehicle location to charge it. In the former case, with the rapid development and popularization of electric vehicles, the state proposes to design and layout charging roads, so that electric vehicles can be charged while driving. But the current situation is that the technology is immature and the cost is quite high, so this idea only stays in the ideal stage. The latter is a commercial charging service project for mobile charging vehicles represented by NIO. The essence of a charging vehicle is a vehicle carrying a set of distributed power sources. If there is no electricity while driving, the car owner can call the service phone at any time, and the service personnel will drive the charging car to charge the electric car. It should be noted that this charging service is very expensive.



According to the scope of use, EV charging devices is divided into public charging and private charging.

	Advantages	Disadvantages
Public Charging Devices	The charging speed is faster, the distribution is more extensive, and the charging is more convenient	You may encounter queues and other indiscriminate charges.
Private Charging Devices	The charging cost is low, and the charging is not use queuing	The installation process is cumbersome and complex, and the installation fee is relatively high

Advantages and disadvantages of public charging piles and private charging piles in China

Since China's electric vehicle equipment and facilities are still in the development stage, the existing ones are not widely distributed, mostly concentrated in urban centers, and there are fewer manufacturers producing charging equipment, which makes the function and appearance of the charging equipment relatively simple and less diversified.

I conducted in-depth practical research and thought, and analyzed some charging equipment of charging brands, and obtained the following analysis through on-the-spot inspection and desktop practice inquiry:

	Information	Payment	Appearance
1	Single shape, lack of sense of design; screen position is high, difficult to operate; the weight of the charging gun is heavy; vertical; there is an emergency stop button;	APP scan QR code	 Star Charging

2	Rough and bulky in shape; the charging gun is in a high position, which is not conducive to taking and putting it back; there is an operation screen; a shutter is installed to block light and rain; the charging is stable and the service is comprehensive; there is an emergency stop button; it can display whether the machine is normal operation	Swipe card, APP scan QR code	 National Grid
3	Mainly serving clustered commercial charging services, with systematic management arrangements, Simple shape; takes up less space; no screen, all info. needs to be viewed in the APP; low maintenance cost;	APP scan QR code	 TELD

Typical Charging Equipment Analysis in China

The existing charging equipment and infrastructure have many drawbacks, which are not only caused by the backward core technology and insufficient innovation ability, but also have many social reasons that hinder the development of charging equipment. Through on-the-spot investigation and public information collection, social factors are listed as follows:

1	Too concentrated	The promotion and application of new energy vehicles in my country is very regional. Due to the vast territory of China, the development gap between the north and south and the east and west is large, so the layout of charging facilities is also very concentrated. It is relatively concentrated in urban centers, and there is basically no construction along roads in rural provinces, which is more troublesome for car owners who run long distances.
2	Insufficient equipment	The number of charging facilities represented by charging

		piles is seriously mismatched with the number of electric vehicles. As of June 2019, the ratio of electric vehicles to charging devices was 8:1.
3	Slow charging speed	Slow speed wastes individuals' time. The charging time has also dropped from the original ten hours to more than an hour now, and 80% of the power has been fully charged in 30 minutes. However, compared with refueling of fuel vehicles, the charging speed still restricts the promotion of new energy vehicles.
4	Complicated operation	The interaction is not perfect, many APPs are complicated to operate, and there is a phenomenon of arbitrary charges.
5	Single shape	It is basically biased towards industrial style and has a weak sense of design.
6	Cumbersome procedures for private charging	The installation procedures for private charging piles are complicated, and the idle time is long and wastes resources.
7	Neglect of management	Many fully charged car owners do not move their cars away in time, and fuel vehicles occupy the parking spaces of electric vehicles, which also affects the convenience of electric vehicle charging.

Outstanding Cases

1) NIO mobile charging car and replacing battery station



In order to expand the sales market and meet the charging needs in various scenarios, NIO has designed mobile charging vehicles and swapping stations. The mobile charging car is a way for the car owner to get in touch with the charging car staff. After determining the location, the staff drives the charging car with the power pack to the destination to charge the electric car. Swapping is the replacement of a low battery with a full battery. The work efficiency of the power exchange station is very fast. The power exchange process is automatically completed by the machine and only takes 3 minutes. However, the car owner still needs to find a fixed power exchange station to go there by himself. At present, the points provided by this service are very limited. The layout is greatly affected by funds and policies.

This graduation project can combine mobile charging and automated unmanned operation.

2) Tesla's Supercharger



In 2012, Tesla proposed the concept of building a super charging station. Tesla improved market competition rate by building its own closed loop of industrial ecological development and using equipment supercharging technology to achieve fast charging of vehicles. With the introduction of super charging stations into the market, this charging service model provides a strong guarantee for Tesla electric vehicle owners on long-distance driving. The charging stations are widely distributed in a city and the location selection is very targeted. It is built in shopping malls, restaurants, etc., so that EV owners have more choices in their spare time when charging. The super charging station is equipped with fast charging, the appearance of the charging pile is very simple, and the color matching also makes people's eyes bright and highly recognizable. Although Tesla's super charging station has many advantages, its shortcomings are also obvious. It only provides services for its own platform vehicles. At the same time, the charging cost is high and the owner needs to find a charging spot, which will waste the owner's time and bring certain inconvenience.

3) Mochi charging robot produced by Envision Tech.

In 2021, Envision has designed a mobile charging robot. The operation process is that the EV owner places an order through the APP. After receiving the instruction, Mochi will automatically go to the location of the vehicle. "It is worth learning from and learning from the transformation of "pills looking for a car". However, the shape design is relatively rough, and the robot arm is too exposed, which makes the robot have great potential safety hazards. The whole charging system is not very perfect, for example, the appointment can only be made after arriving at the selected location, and the user cannot accurately grasp the charging situation.



Product analysis for project guidance and reference

The relevant departments of the local government in China are now focusing on the construction of charging equipment and facilities from unilaterally subsidizing the purchase cost in the past. Based on this, an effective analysis of the current general infrastructure construction and overall industry-level development can effectively guide and in-depth carry out this design practice project.

Thanks to the huge advantages of the development of informatization services led by Alibaba and Tencent, people do not encounter too many obstacles in the process of registration, use and payment, and they can easily access the corresponding services.

Therefore, in the whole service system, we should combine the existing advantages and the disadvantages that have been found in the above analysis to propose more effective service products and methods, which are mainly reflected in the following points:

- 1) The appearance of the product should be improved innovatively, which cannot fully satisfy people's spiritual satisfaction and cannot reach a higher level of emotional design.
- 2) The provision of charging services is proactive, avoiding the need for users to spend more time looking for locations and paths to provide charging services.
- 3) The layout design of the charging mode should be more reasonable, and users should not spend too much to meet unpredictable travel needs.
- 4) The charging mode in the service system can fully combine mobile charging and automated unmanned operation to improve user convenience and accessibility.
- 5) The functional structure of the products in the service system should fully consider the service field to effectively improve the user's service experience during the charging process.

3. User service needs analysis

People are a core element in the service system, and all the experience quality of users in the service process reflects the overall service quality of the service system. Therefore, analyzing

and evaluating the impact of each key part of the existing service system on users and their subjective feelings can effectively guide the next design practice.

User analysis in the service

Through the relevant investigation and analysis of electric vehicle owners and various relevant personnel in the service system (the stakeholder map can be seen in the portfolio), we can grasp the current situation of electric vehicle charging equipment and understand people's expectations for the improvement of the entire charging system. Summarize the operation of electric vehicle owners in the process of using charging equipment, analyze and summarize a series of needs of people in the charging process, organize relevant information useful for this design research, and provide charging equipment and service systems for subsequent electric vehicles. provide the basis for design innovation. On the basis of the existing charging equipment, the needs of users and potential personnel are integrated, and the fundamental needs of electric vehicle owners are clarified through a series of research methods.

Research methods :

1) Observation method

The observation method is to collect information on the user's use behavior during the charging process, and to make the most realistic record of the user's operation steps and behavioral habits during the use process. This method can truly understand some states of users in real life and can also obtain some details that are deliberately concealed by people in questionnaires and interviews.

2) Questionnaire survey method

Thanks to the convenience of Tencent QQ Survey questionnaires, the questionnaires can be delivered to target users in a targeted manner. Collect information in the form of car owners and relevant personnel in the service system answering relevant questions and summarizing data to draw relevant conclusions. This research method can quickly collect relevant information, complete the relevant content of this research, and identify people's specific needs.

3) Interview method

Through interviews with electric vehicle owners and relevant personnel in the service system, the information related to this design study is collected and organized in the form of face-to-face or online interviews. In this way, people's living habits, living environment, etc. can be deeply understood, and people's needs and the disadvantages of charging equipment can be understood in a more detailed and comprehensive manner.

Qualitative Analysis Summary :

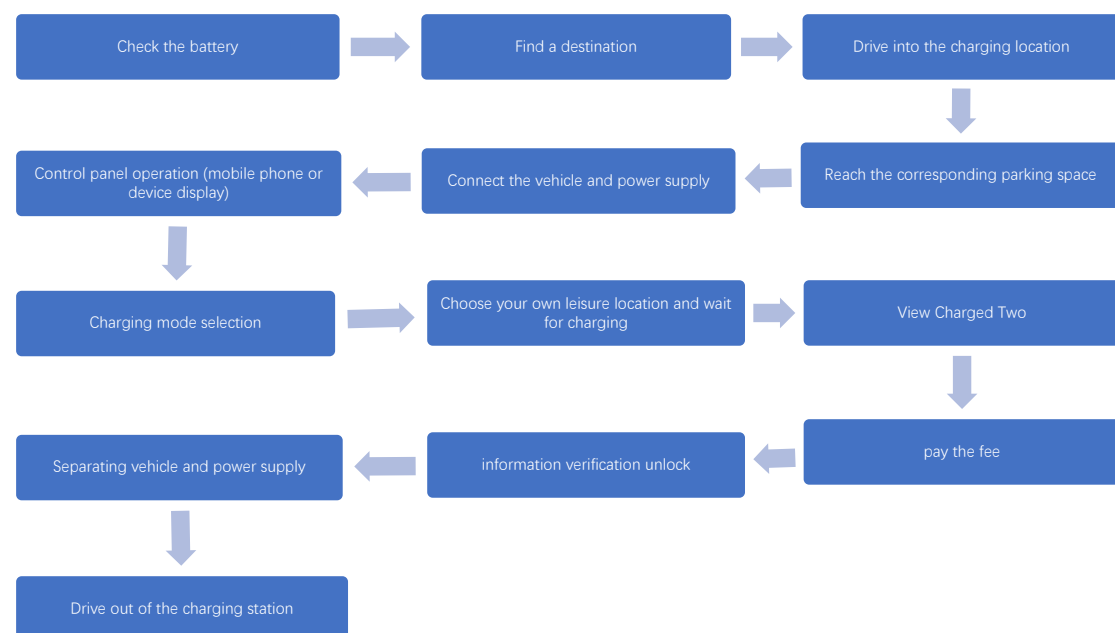
The electric vehicle service path is different from the traditional gas vehicle charging mainly divided into two categories, the first is private charging, and the second is public charging. Outlining and analyzing the user's charging respective process and conducting a dialogue with the user can effectively understand the user's situation and feelings, and further guide

the design.

Observing research Location : Ren Shou Community /VFC& International Shopping Mall in Wuhan

-Private Charging Process

-Public Charging Process



It can be seen that the charging conditions and states are significantly different between the personal charging process and the public charging process due to changes in the service field. Personal charging equipment is installed near the place of residence. As mentioned earlier, the disadvantage is that the installation cost is high, the preliminary application process is complicated, and the personal space is tight, but it is a once and for all thing to deal with. Compared with personal charging, the public charging process is very complicated, and the user's anxiety will continue to increase due to factors such as the unclear status of each charging process, high costs, and long waiting time. Effective optimization of service paths is

a real improvement. The key to the quality of charging service.

-Interview analysis summary (Through WECHAT video call)

Select different categories of key users from the questionnaires and open interview invitations and make an outline of the required interviews before the interviews begin. During the interview process, it is recorded by means of voice or video to prevent the written record from affecting the normal dialogue between the two sides of the interview.

	Interviewee	Object identity	Object occupation
1	Ms. Fang	User	Civil servant
2	Mr. XIE	User	PR
3	Mr. Zhang	User	Taxi driver (EV)
4	Mr. Zhang	Charging Station Stuff	Charging Service Stuff
5	Ms. Zhao	Brand Experience Staff	Consultant
6	Mr. Wang	Parking lot Stuff	Managing Stuff

Finely screen the interviewed groups, and select representative identities to refer to a category. For example, the same user identity is the user of the vehicle in the service system, but due to different occupational backgrounds, their understanding of the service itself and the EV industry will also vary widely. At the same time, for different stakeholders in the service system, it is helpful to guide the later design around people who are closer to the user.

After the end of the interview, summarize the data of the interview, and extract the effective and guiding design information.

Interviewee 1	Ms. Fang
Date	2022.05.23
Place	Wuhan, Online interview
Background	Vehicle used: Tesla Model 3 Workplace : Tax department Family's first electric car
Reason for buying a EV	National policy support, environmental protection
Purchased use	Commuting to work, out for entertainment and excursions
charging method	Charging at the charging station, charging at the workplace
Payment	Scan QR code
Problems encountered while charging	-Private charging piles cannot be installed without private parking spaces The number of charging piles around the community is small, and the charging queue time is long -The service management of public charging piles is poor, and bad charging piles are often encountered -The charging gun of the charging pile is relatively heavy,

and the experience effect is poor

Interview Information Summary Table 1

Interviewee 2	Mr. XIE
Date	2022.05.25
Place	Wuhan, Online interview
Background	Vehicle used: Peng Workplace : TianHu Education Tech. Family's first electric car
Reason for buying a EV	Unlimited road traffic, charging price is much lower than fuel price
Purchased use	Commuting to work, picking up children, going shopping
charging method	Charging at the charging station , charging station in community' s underground parking lot
Payment	Scan QR code
Problems encountered while charging	- Charging time is too long - The temperature has a great influence on the power of the vehicle - The number of charging piles near the residence is small, and He can drive home to rest after charging is complete

Interview Information Summary Table 2

Interviewee 3	Mr. Zhang
Date	2022.05.25
Place	Wuhan, Online interview
Background	Vehicle used: BYD Han E2 Workplace : DIDI Taxi Tech. Family's first electric car
Reason for buying a EV	Cheap electricity prices, various commercial travel subsidies such as bridge tolls, green travel incentive fees
Purchased use	Mainly used to make money online car-hailing
charging method	Charging at the charging station
Payment	Scan QR code
Problems encountered while charging	- The installation process of private charging piles is complicated and has many procedures - The charging speed is slow and the number of external charging piles is small

Interview Information Summary Table 3

Interview with shareholders in the service system

Interviewee 4	Mr. Zhang
Date	2022.06.04
Place	YueXiu City mall, Star Charging Station
Main content	Although The parking lot has also increased the service of charging electric vehicles, not only charging for parking spaces, but also charging a certain service fee. There are relatively few parking spaces for electric vehicles. Many owners of traditional energy vehicles do not distinguish between electric vehicle parking spaces, which is a big problem for electric vehicle owners.

Interview Information Summary Table 4

Interviewee 5	Ms. Zhao
Date	2022.06.04
Place	New City Shopping with multi- dimensions, NIO Store
Main content	When people go to a brand store to inquire about buying an electric car, they usually ask some questions about charging, such as: the installation of private charging piles, whether it is possible to pull out a charging cable at home to charge the electric car if there is no private parking space, and so on. In this consultation, I also learned about the charging time of NIO electric vehicles. It takes about 2 hours for fast charging and about 6 hours for slow charging.

Interview Information Summary Table 5

Interviewee 6	Mr. Wang
Date	2022.06.07
Place	VFC underground parking lot in Wuhan
Main content	Tourists and nearby residents who come to the mall will ask where the charging equipment is every time they drive an electric car into the underground parking lot, and have heard complaints that it is very inconvenient to enter the mall after parking.

Interview Information Summary Table 6

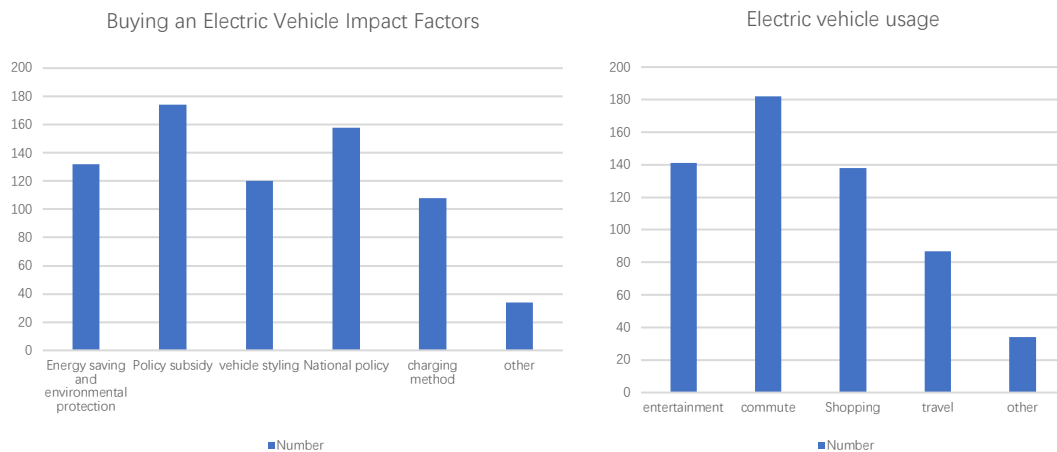
In general, judging from the current self-description of EV owners, there are still many drawbacks in the entire electric vehicle charging, not only in the charging equipment itself, but also in service management. And some of these may come from the constraints of urban planning and government policies. Many older communities do not have enough parking spaces to install private charging piles. The layout of charging piles near the community is not extensive, which affects the convenience of charging. This should be considered to the greatest extent when outputting the design scheme.

Quantitative Analysis Summary :

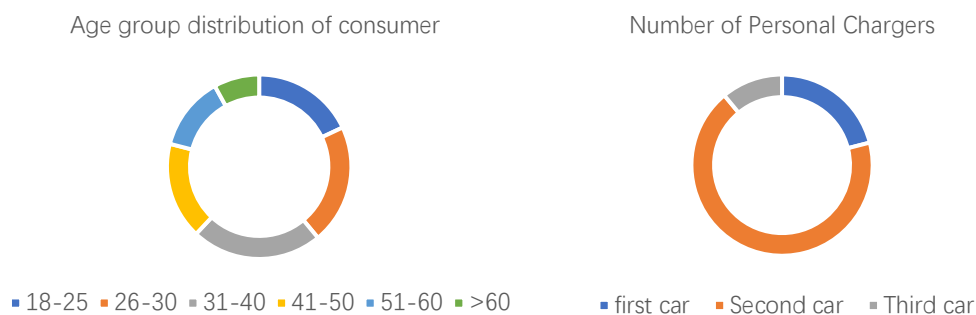
Questionnaire survey analysis and summary

The questionnaire survey was mainly produced through Questionnaire Star and published online with the help of QQ and Wechat. After that, information was collected through three channels: WeChat group, QQ group and Autohome platform. A total of 206 questionnaires were collected in this questionnaire survey, there are 13 invalid questionnaires, and the effective rate of the questionnaires is 93.7%. The following is the analysis of the specific content of this questionnaire.

- 1) EVs are developing rapidly. However, it is still unable to compete with traditional energy vehicles, and many potential users are continuing to wait and see the development of EVs. However, affected by local government and national policies, the number of electric vehicle owners is also increasing. And EVs are mainly used for commuting and short-distance travel.

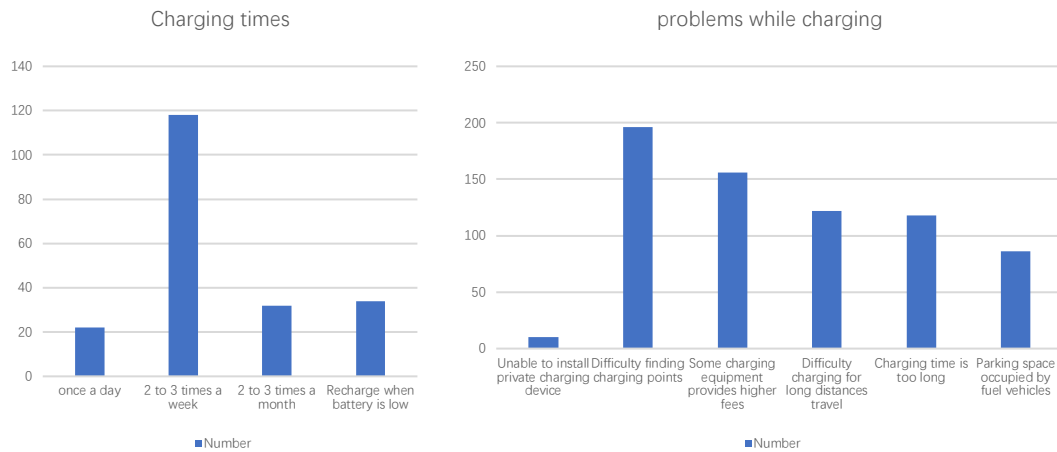


- 2) The age of electric vehicle owners is relatively concentrated between the ages of 25 and 40. They are the major consumers of electric vehicles. Most consumers will use an electric vehicle as their first or second vehicle.

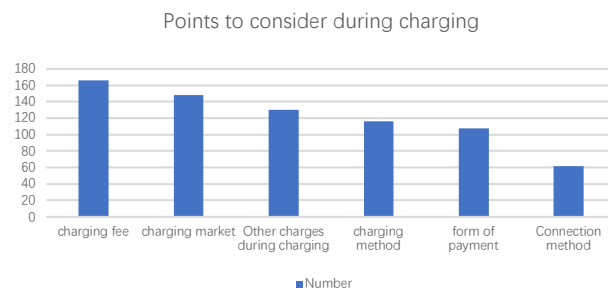


- 3) The current electric vehicles are still weak in terms of battery life, and they will encounter many inconveniences during the charging process. During the research process, it is not difficult for most consumers to worry about finding a charging pile and waiting too long

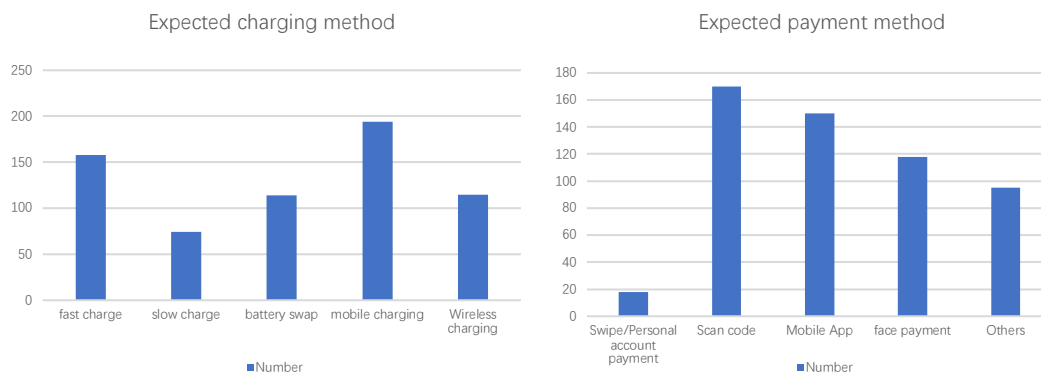
for charging.



- 4) There are many charging equipment and facilities provided by various service providers on the market. Electric vehicle owners are more concerned about the charging time and cost, which all affect the attitude of users and potential consumers towards electric vehicles.



- 5) There are many charging methods in the current market, and users prefer access-type fast charging. The charging time and convenience of other charging methods also affect people's views on electric vehicles. In terms of payment forms, people also tend to use mobile phones to scan codes for online payments.



Through the user research part, the design direction of this project is obviously to meet the needs of users, solve the shortcomings of charging equipment, and explore and practice in the direction of intelligence and humanization.

4. The application of interaction design and service design thinking in product design

Based on the previous research results, fully apply the thinking and methods of interaction design and service design throughout the design process, and further explore the pain points and needs of electric vehicle owners, so as to propose a service system design more suitable for electric vehicle users.

The application of interaction design in product design

The concept of interaction design involves the design between people and people, people and things, and the relationship between things and things. By building an organic connection between them, we can improve people's physical and psychological experience and the various dimensions of objects. quality, so as to better help users achieve their goals

1) The application of interaction design on charging devices

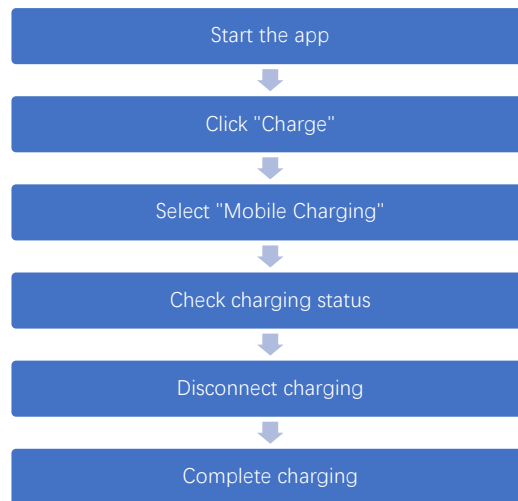
Good interaction design can improve the overall experience and satisfaction of a product. Entering the digital information age, and even the future intelligent age, the Internet of Everything is an inevitable development direction. Therefore, it is necessary to design an intelligent product that combines software and hardware.

- Demand point :
 - Reliable and safe use of charging equipment
 - Simplified charging operation
 - Reasonable charging peak charge
 - Wide range of models for charging equipment
 - The charging appearance is novel and full of era or regional characteristics
- Product Positioning
 - A mobile charging robot for charging electric vehicles with APP operation

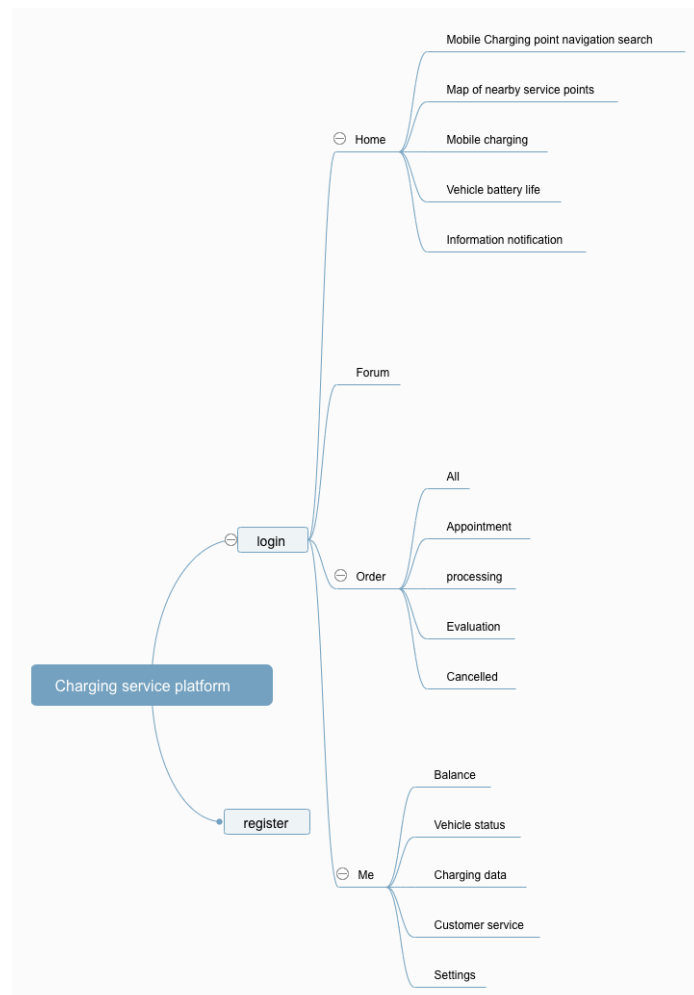
2) The application of interaction design in charging service information products

- Demand point :
 - No need to spend time looking for charging points
 - Simplified charging process
 - Don't worry about your car's battery
 - Charging service experience and evaluation improvement
- Product Positioning
 - A charging service app that combines automatic charging equipment to improve the quality of charging services for users

- Key charging process



- Information Structure



Application of “User-Centric” Design Principles in Service Design to Product Design

At the beginning, industrial design is a design research direction carried out around the scene where the product is applied. In the past, people were only considered as a necessary element in the scene to consider the design of objects, but we know that all kinds of designs serve people.

The reason why service design is closely related to industrial design is that the concept of people-oriented is used as a design principle to guide design in service design, and the final product designed by industrial design needs to serve people and be satisfied with service design. Service design integrates information and data analysis and plans for each service link. We can find the real needs and difficulties of people, and, by means of optimizing the touching point, improves the service ports including specific products, so that it can better serve people.

Through the above user research, the following points can well reflect the characteristics of service design :

- User-centric
Different from a principle, it should be an element that needs to be considered throughout the entire design process. Starting from the visual level and behavioral level, build a service system around users, so as to help them truly meet their needs and achieve emotional satisfaction.
- Practicality
The design of the product can indeed be carried out, and it can effectively solve the problem of the user during the charging process, rather than solve the situation that does not exist and even produces unexpected results.
- Economy
We need to consider the economic effects in the service system to ensure that multiple parties can benefit in order to effectively promote the development of the service system for a long time. This requires us to balance economy and utility when designing these service ports. This is also to ensure that people can receive the corresponding services effectively in the long term.
- Environmental protection
Low carbon emission is the initial requirement of our design and the final goal that needs to be achieved. This is the key to ensuring sustainable development, which will ultimately benefit mankind. Therefore, considering the whole and part of the service system with the design thinking of green design, such as how to encourage and reward carbon emissions, or optimize the recycling mechanism of service equipment itself, these can effectively implement the concept of sustainable development in the early design stage and let the natural environment also benefit from it.

The innovation of service system design based on “user-centered”

1) Innovation in the design of charging equipment

- The use of APP software and the combination of charging equipment can fully solve the problems encountered by consumers in the charging process. Whether it is software or

hardware, sufficient theoretical basis has been accumulated in the process of preliminary research.

- The design and interaction design of charging equipment are integrated into service design, and the charging equipment is redesigned to break people's fixed thinking about robots in terms of modeling.
- The user does not need to drive to the charging place by car and does not need to manually connect the charging gun to the car, which is more user-friendly and more convenient to operate.
- The charging robot itself is equipped with a power display function. The body can be made of a combination of sheet metal and acrylic, which is safe, beautiful and environmentally friendly.
- The supporting facilities for battery replacement are designed. When the charging robot has many tasks, it is too late to replenish its own power. It can go to the emergency battery storage to replace a battery with sufficient power and then proceed to the next charging task.

2) Innovations in Interaction Design on the service platform

- Charging pile query: Enter this operation interface to check whether this area is within the service range of the charging robot, check whether there is a charging robot that is not working and the remaining power of the charging robot.
- Real-time query of charging process: Entering this interface, you can check the charging status of your car, and choose to continue charging or end charging according to your actual situation.
- Charging reservation: If there is no idle charging robot, you can choose this function, or you can
Time to choose when the charging robot will charge your car.
- One-key charging: After the car owner parks the car, select a charging robot with good power and place an order and then leave. After waking up, the charging robot will automatically come to the parking space to charge the car, and the user does not need to search for a charging pile and use the charging station. gun.
- Communication with riders: This design allows users to better understand the charging robot in addition to convenience, users can also communicate with each other about the problems they encounter, and merchants can also collect product deficiencies based on this function, to make the product more perfect.
- Planning charging: According to the user's usage and preferences, a suitable charging plan can be formulated in advance for the user's vehicle. When the user enters a charging scene that meets the requirements or may require pre-charging, the active push can even help the user to make the most appropriate decision to eliminate travel anxiety.
- Improve the APP operation interface, add innovative points, enhance the user's experience, and make the whole charging process more comfortable and smoother.

5. Foresight of Design Practice

Pre-thinking about the expected solution before practice, effectively knowing the subsequent practice creation

Why be “ active” ?

Active service means that users are no longer passively receiving services. By actively understanding users' feelings and behaviors during the service process, they can bring users a more satisfactory service experience.

First of all, the most basic initiative in the service can be seen by actively searching for the vehicle through the charging device, rather than driving the car to find a charging parking space, which is determined by the movable characteristics of the device.

Secondly, we should pay more attention to the details of the overall process of the service and the user's experience in it. Imagine that the original user took the initiative to check the vehicle mileage information to receive the charging reminder according to the user's car habits, which will reduce the user's worries.

Is every service touchpoint an opportunity ?

The user's figurative contacts have changed from directly contacting the charging device in the past to the present, and the entire charging operation can be completed through the online service terminal platform. The service path has changed, but the service process is also similar. How can we plan and design each contact? Experience plays a vital role in improving the quality of the entire service system.

If you can actively inform the user of the charging needs or even initiate a charging request during the process of the vehicle entering the parking lot with the charging station, I believe that you will feel the quality of the service more than the self-reservation and also reflect the initiative.

Do Fewer steps mean a better experience ?

We made the service much simpler and removed very tedious steps. But users' fear of change will be much bigger than we imagined. How can we make them less anxious? I believe that it is necessary to strengthen the visibility of services and users' control.

It is not difficult to imagine that after the user parks the vehicle, he makes an appointment for the charging robot on the mobile phone, so that they want to leave?

They will worry about whether the connection will be successful, and what if they cannot charge. Although the phone can check the status, they cannot afford the risk of turning back to the parking lot and moving the vehicle after a failure. So, what if you could see it with your own eyes not long after you stopped the car?

The above is part of what I learned and thought in this module, and can better guide and support my later design practice,

Thanks for viewing the report

Attachment :

Electric Vehicle Charging Infrastructure Questionnaire

Hello, thank you for participating in this research. I am a student at the School of Science and Design of UWTSD. I am investigating electric vehicle charging infrastructure. Your answer is only used for academic research and will not expose personal information. thank you for your support.

1. Do you know the existing charging methods? [Single choice]

- ☐ Very understanding ☐ General understanding ☐ Don't know

3. Do you like the shape of the existing charging pile? [Single choice]

- ☐ Like ☐ General ☐ Do not like

3. Do you prefer charging piles with strong appearance design? [Single choice]

- ☐ like ☐ Do not like ☐ It doesn't matter

4 Which one is your current electric car? [Single choice]

- ☐ First car ☐ Second car ☐ Third car

5. What are the factors that influence your purchase of an electric vehicle? [Multiple Choice]

- ☐ Energy saving and environmental protection
☐ National Policy
☐ Vehicle design
☐ Other

6. What is the purpose of your electric vehicle purchase? [Multiple Choice]

- ☐ Self-driving tour
☐ Commute to work
☐ shopping
☐ Other

7. What is your favorite charging method? [Single choice]

- ☐ Fast charge
☐ Slow charge
☐ Change the battery
☐ Removable charging

8. How do you find charging equipment when you are outside? [Multiple Choice]

- ☐ Map
☐ Charging APP
☐ Introduced by someone
☐ Fixed area

☐ Other

9. What factors should be paid attention to during the charging process? [Multiple Choice]

- ☐ Charging time
- ☐ Charging fee
- ☐ Charging surcharge
- ☐ Charging method
- ☐ Payment method

10. What charging forms do you expect in the future? [Multiple Choice]

- ☐ Fast charge
- ☐ Slow charge
- ☐ Change the battery
- ☐ Mobile charging
- ☐ Solar charging
- ☐ Wireless charging
- ☐ Other

11. Which payment method do you prefer? [Multiple Choice]

- ☐ Swipe your card
- ☐ Account and password payment
- ☐ Scan code to pay
- ☐ Mobile APP payment
- ☐ Mobile NFC payment
- ☐ Other

12. How do you want the charging pile to operate in the future? [Single choice]

- ☐ Full automatic
- ☐ Full manual
- ☐ Hand, combine

13. Are you satisfied with the existing charging pile and APP interface? [Single choice]

- ☐ Satisfied
- ☐ dissatisfied
- ☐ General

14. Which operating interface of the existing charging APP are you dissatisfied with [Multiple Choice]

- ☐ Lots of advertisements
- ☐ The interface is cluttered
- ☐ Complicated operation
- ☐ Other

15. What problems do you encounter during the charging process? [fill in the blank below] *

Thank you for your participation ! ^_^~

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