The Application of UX Research in New Energy Vehicle Innovation

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New energy vehicles (NEV) as a new thing for sustainable development, in China, on the one hand has faced the rapid expansion of the market; the other hand, for the new NEV users, the current NEVs cannot keep up with the degree of innovation. This paper demonstrates the reasons for the existence of this systematic challenge, and puts forward the method of UX research which is different from the traditional petrol vehicles research in the early stage of development, which studies from the user's essence level, to form the innovative product programs which meet the needs of users and being real attractive.

keywords: new energy vehicles; UX research; essential thinking; product innovation

1. Introduction

With the increasing severity of global environmental problems and energy shortage, new energy vehicles, a type of environment-friendly vehicle with advanced technology, has been valued by governments, enterprises and users worldwide in recent years. It has achieved leapfrog development and become the future of automotive industry. In China, the development of NEV has become a national strategy.

NEV is a product of innovative technology, which means high costs in its development and manufacturing. Even though the cost has been coming down, it fails to fall below that of ordinary cars for a long period of time to come. In recent years, thanks to beneficial policies including government subsidies, the purchase cost of NEV became close to that of ordinary cars, resulting in a rapid expansion of domestic NEV markets as well as a surge of production and sales. These subsidies, however, is reducing year on year and will end up
zero in 2020. In the meantime, the cost of NEV is still high, giving rise to a urgent problem: how to persuade users to purchase expensive NEV?

At the same time, the development of NEV in China has two problems with regards to development method and users. On one hand, influenced by the thinking patterns and methods of traditional petrol vehicles, most NEVs in China’s market are developed based on traditional petrol vehicles, so that they are developed based on stereotype thinking patterns of vehicles. As consequence, NEVs, as an innovation, cannot present their advantages and is unattractive to users. On the other, users of vehicles in China are unique in their Chinese Scenery. In other words, they are insensitive to vehicle culture due to the lack of long-term influence, and do not have thinking set with regards to vehicles. As a result, they are more willing to accept new concepts and new vehicle products compared to customers in other countries. Furthermore, the number of NEV User Groups with Chinese Scenery is quite large around the world. Therefore, “How to attract them to buy NEVs” becomes a problem that is worthy of paying attention to.

In light of the status quo stated above, this thesis aims to conduct an in-depth study on users with research methods different to those used in tradition vehicle studies so as to put forward ideas that can influence or even change the research and development of NEVs. In order to persuade users to purchase relatively expensive NEVs and to popularize their usage, it has become vital to provide safe, convenient, comfortable and satisfactory experiences for users.

2. User Experience-Based Research Methods

2.1 Principles and Status Quo of Application of User Experience

The term "User Experience" was first put forward by Donald Arthur Norman (mid-'90s), a user experience designer. It is a terminology that describes the feelings, impression and evaluation of users on a certain product after they use it. User experience exemplifies how the product connects with the outside world and how it functions, namely how users make contact with and use the product. As the concept of "human machine interaction" is receiving increasing attention, evaluation criteria of systems and machine upgraded from simple usability engineering (function-dominated product) to a wider range of user experience. This encourages developers and designers in various fields to establish product plans and models that meet the real needs of users based on users’ experience.

Despite domestic research targeting on user experience are still at its infant age, it has great development momentum, with main focus on the design of internet and mobile handheld terminal. The application of user experience research in vehicle industry is still at the initial stage, whose theories are drawn from foreign studies. In addition, the product design and development process are underdeveloped. The research findings are limited as well. The focus of user experience research application is clear and definite: it lies in how to apply research results to the design and development of vehicle products, how to spread the concept of user experience among design and development personnel, and how to generate positive experience by different usage modes.

This research aims to solve the problems stated above and to introduce the new method of user experience research to the innovative research of NEV, a relatively complex and emerging product. The research also aims to find out the insufficiency of user experience
in the early phase of product design and development and tries to adapt it to the innovation of NEV in order to provide best experience to users.

2.2 *Difference from Market Research (Traditional Pre-phase Research Method)*
The main difference between this user experience research and market research lies in its aim and results. The aim of the latter is to formulate relative commercial and marketing strategies (e.g. market positioning and commodity definition) through defining potential markets and marketing opportunities, with the results of macro commodity solutions. The aim of the former, however, is to conduct studies on target user groups in the pre-phase of design and development, to set up concept models that meet the users’ need from the prospective of user experience, and ultimately turn it into shapes and functionalities that attract users. In this way, the user’s pain points are eliminated and the attractiveness of products are improved to the most extent. The relevance of the both is shown as Fig. 1.

![Figure 1 Relation between Market Research and User Research](image)

In addition, market research differs from UE-based user research in research objects, theoretical basis and research methods, etc. shown as Table 1.

### Table 1 The differences between this experience-based user research and market research

<table>
<thead>
<tr>
<th>This experience-based user research</th>
<th>Market research in a narrow sense</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aims</strong></td>
<td><strong>To define marketing and product strategies, to provide basis for market positioning, commodity definition and marketing decisions</strong></td>
</tr>
<tr>
<td><strong>Effects</strong></td>
<td><strong>Improve the quality of marketing decisions</strong></td>
</tr>
<tr>
<td><strong>Research object</strong></td>
<td><strong>Target groups, by summarizing the group characteristics and general characters</strong></td>
</tr>
</tbody>
</table>

**Typical individuals and its characteristics**
<table>
<thead>
<tr>
<th>Output</th>
<th>Specific innovative plans of products</th>
<th>Macro commercial strategy (market positioning, commodity definition, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theoretical basis</td>
<td>Anthropology, sociology, psychology</td>
<td>Marketing, statistics, sociology</td>
</tr>
<tr>
<td>Features</td>
<td>Mainly focus on qualitative investigation and emphasize on perceptual cognition</td>
<td>Take quantitative data as main verification basis and supplement with qualitative investigation</td>
</tr>
<tr>
<td>Methods: information gathering</td>
<td>Observation, interview, user-participated designs, life diary, etc.</td>
<td>Quantitative questionnaire (face to face interview, phone survey, online interview, etc.), focus group discussion, mystery customer interview, etc.</td>
</tr>
<tr>
<td>Methods: information Analysis</td>
<td>Scenario analysis, persona, card sorting, brain-storming, cluster analysis</td>
<td>statistics analysis</td>
</tr>
<tr>
<td>Innovative points</td>
<td>In the process of information analysis, the method of workshop is integrated. Open mind and high activeness of mind result in an effect similar to &quot;1+1&gt;2&quot;</td>
<td>——</td>
</tr>
<tr>
<td>Participants</td>
<td>Specialists in industrial design, engineering, merchandise planning and marketing</td>
<td>Specialists in statistics, marketing, merchandise planning and advertising</td>
</tr>
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</table>

Various precedents show that products which gain success in market research would not necessarily be popular after it appears on the market. The root cause for this is the lack of user research in the pre-phase of product designs and strategies, so that the product strategies cannot be implemented.

3. The Application of User Experience-Based Research in New Energy Vehicles Product Innovations

3.1 User Information Gathering

As stated above, user experience is the purely subjective feelings of users. This subjectiveness determines the multiple uncertainties of user experience. Therefore, it is necessary to develop a reasonable and effective process of user research so as to discover the innovative points that meet the users' need. This user experience research focusing on NEV helps develop plans of product innovation by an insight of user experience, discovery of typical NEV usage scenarios and an expanded analysis.

3.1.1 User Recruitment

Aim: to recruit users that fit the criteria of user research by screening the database of NEV.
Participants: researchers, user recruitment companies, NEV users
Method: data screening, phone interview screening
Output: a list of 10-12 users

The user recruitment has 2 steps.

1. Define users

The current users of NEV are mostly early adopters. Based on our research aim of improving user experience and delving into innovative opportunities of NEV, target users who have in-depth user experience are included in the research. Another reason of such inclusion is that one or a few representative target users can stand for the typical needs, habit of using, operational environment and impressions.

According to pre-phase brand research and market segmentation studies, features of NEV target user groups are drawn out (including basic characteristics, lifestyles and values):

- Age: 25 to 35
- Educational Background: bachelor’s degree or above
- Cities: Shanghai, Shenzhen, Guangzhou (first-tier cities)
- Models of Cars: BYD QIN, BYD E6, Venucia, ROEWE 550 plug in, DENZA
- Lifestyle and values:
  1. Fond of new technologies, new designs and new experience, willing to share, strong-minded, confident, proud, fond of sports, health-sensitive, environmental friendly.
  2. The main reason of using NEV is that they are in favour of NEVs and new things. (Reasons such as low licensing difficulties, government subsidies and purchase tax exemption are excluded)

Base on the lifestyle and values stated above, researchers put forward the screening standards and edit a questionnaire.

\[\text{Table 2} \quad \text{Questionnaire - SQ14. What do you think of innovative products?}\]

<table>
<thead>
<tr>
<th>Compared to others, I am willing to buy innovative products</th>
<th>1</th>
<th>Continue</th>
</tr>
</thead>
<tbody>
<tr>
<td>I will think twice and I will buy them after a friend recommend it to me.</td>
<td>2</td>
<td>Stop</td>
</tr>
<tr>
<td>I will buy them after they are widely accepted in the market.</td>
<td>3</td>
<td>Stop</td>
</tr>
</tbody>
</table>

2. Screening process (see Figure 2)

- Sample database screening of users: 100 users are screened out from a user database of approximately 1000 NEV users based on their basic characteristics (age, educational situation, model of cars and cities)
Questionnaire screening: According to the screening results of the questionnaire on lifestyle and values, researchers conduct telephone interview on 100 user samples, and 11 users included are willing to serve as the objects of the research.

Figure 2  Screening process

3.1.2 Insights of Users Based on Scene Mining
Aim: to discover typical scenes of NEV use by having an insight on user experience on vehicles.
Participants: researchers, NEV users
Methods: observation, interview, participatory design, life dairy
Output: typical scene/ persona models
Researchers gather information through observing the user experience of typical NEV users. They will enter into their daily life, listen to their story on using NEV, observe their usage habit, and discover their needs. The aim is to analyse and integrate the information gathered and to establish several typical scenes of car usage.
A scene is defined as a process that users have to go through when they use the product to fulfil their goal. It can also be called as a Story. Some scenes describe successful results, while others reflect the problems in the usage of NEV. Through scene mining, researchers are able to delve into scenes to discover pain points and aspects that need to be improved, so that they can innovate on products.
It needs to pay attention that users and NEV have thousands of possible interaction situations, so scene mining should be targeted. This also explains why typical users are selected as research objects in the beginning.
In the observation of typical user experience from the 11 users selected, specified methods on user research are used, including observational technique, interview, participatory design and life dairy.
1. Observational technique: Researchers observe how users interact with NEV in real-time usage, including their usage of charging devices, in-car connectivity and in-car storage space. After observing static interaction, researchers stays inside the car while the user is driving and keeps observing his petty actions, operations and other more detailed experience in specific usage scenes. During observation, researchers take notes and use digital voice recorder, instant camera, digital camera and DV to record.
2. Interview: Researchers adopt the situational in-depth interview method. After observing the routine usage of NEV, researchers help users recover the life story about NEV by using visual tools such as cards and stickers, and collect materials that constitutes a scene.

3. Participatory design: Under user experience-based participatory design, users no longer accept ready-made products passively; instead, they participate in and make positive influence on design and development, so that the products can really meet their need. In this research, researchers help users to piece together an ideal NEV model and create ideal vision of cars with the aid of scene cards, so as to delve into the potential needs and aspirations of users.

4. Life diary: Users record the life diaries of weekdays and weekends in chronological order and sent them to researchers through Wechat. After receiving these diaries, researchers summarize them as elements to build up typical scenes.
3.2 Analysis of user information

3.2.1 Compilation and analysis of user information
Researchers compile the information and elements stated above into typical scenes and intensify typical features of users and set a foundation for the development of innovative plans.

Due to the fact that the information gathered is at a large quantity, in order to extract valuable information, researchers adopt several analysis methods including card-sorting, cluster analysis, scenario analysis and persona. Research results such as NEV users’ model and usage scenes are drawn from these analyses.

1. Using card-sorting to record the scene: Researchers record the scene by taking notes and photographs, drawing tables and diagrams and put them on cards. Users are required to give a clear and concise description of the scene without comments from others.

2. Using cluster analysis to merge the scenes: Researchers go through the scenes, find out the clues and common features, and sort the scenes and merge similar ones. Scenes will be analysed in this way twice with different perspectives as the clue. At last, researchers integrate the results of the three-round cluster analysis.

Figure 5  Examples of users' diary on Wechat

Figure 6  Process of cluster analysis
3. Using scenario analysis and persona to analyse and build up scenes: With scenario analysis, researchers combine segmented scenes and supplement them for the later development of innovative plans. During this process, researchers also adopt the method of persona to find out the actions, views of point and motive of real users and summarize their discovery as the description of typical users.

3.2.2 Discovery on Typical Users and Scenes
After three rounds of cluster analysis, researchers form typical scenes of 50 NEV users. With the use of persona analysis, researchers obtain two user models from the 11 users selected.

![Figure 7 Example of NEV user persona and typical scene](image)

3.3 Formation of Innovative Plans

3.3.1 Innovation Workshop of Specialists
Aim: To formulate new ideas for individual scenes from the results of observation.
Participants: Hosts of workshops and their assistants, cross-divisional personnel of the company (12 to 16 people)
Method: brainstorming, World Coffee
Output: a bunch of innovative ideas on NEV
In innovation workshop, specialists of related fields are divided into several groups to brainstorm on the results of observation, and try to come up with as many innovative ideas as possible. Open-minded teamwork with highly active thinking results in an effect workshop.
In specialist selection, the experience of integrated new product development (iNPD) is borrowed to combine with models and principles of new product development. Specialists of design, marketing and engineering develop an integrated group during the "fuzzy initial phase" when the concepts of products are unformed. This group adhere to the sense of "user-oriented" during the design and development of product. With this in mind, products are more likely to be successful, more revolutionary and innovative.
Details of innovation workshop:

1. Participants are divided into 4 groups; each group shall contain specialists of design, marketing and engineering.

2. Within 2 or 3 days, researchers take NEV persona models and typical usage scenes as materials and weigh on the pros and cons of each scene with the perspective of users and under the help of hosts and tools. In this way, participants are able to focus on specific targets, discover opportunity points and problems and produce a great amount of NEV new ideas.

3.3.2 Summary of New Ideas and Formation of Innovative Plans
Aim: To formulate the final results of this research by summarizing the new ideas from the innovation workshop: innovative plans of NEV

Participants: researchers
Method: cluster analysis
Output: innovative plans of NEV
1. **Phase 1 Screening:** a preliminary evaluation of all ideas. Unreasonable ideas are screened out.

2. **Phase 2 Summarizing:** researchers cluster and deduce the ideas that are selected from different perspectives and complement them.

3. **Phase 3 Define products:** researchers integrate and analyse the cluster innovative concepts to form general innovative plans and innovative plans of individual car models.
   - Innovative plans for individual car models: researchers integrate new ideas and put forward corresponding individual model concepts. Details include car models, main/auxiliary functional features, persona, usage scene/mission.
   - General innovative plans: new ideas that are applicable to most NEV are integrated as general innovative plans. Details include specific functional features.

4. **Research Findings and Prospects**

   Through the application of user-experience based user research method on NEV innovation and summary, researchers discover 2 types of NEV user models and 50 typical usage scenes during pre-phase information collecting and analysing. By analysing user models, researchers find that NEV users (excluding those who use NEV because of reasons such as licensing difficulties, government subsidies and purchase tax) have different values than traditional vehicle users. In other words, traditional gasoline vehicles are unable to satisfy the needs of these users. Therefore, new technologies and design plans are needed to produce new products, which prove the theories stated above.

   In addition, the 50 typical usage sceneries are drawn from unique usage habits and experience of using NEVs. For example, as NEVs generate less noise while driving, users must be particularly careful when traveling on roads where pedestrians and vehicles are not separated in different paths; users must formulate detailed traveling beforehand so as to avoid “range anxiety”. These findings illustrate that the qualitative research methods used in this research can help discover substantive characteristics of new vehicles as well as advantages that traditional petrol vehicles do not have. These methods are suitable to apply on NEV research for the benefit of subsequent innovative plans.

   In the final stage of innovative plans formulation, about one hundred ideas are formed; 10 breakthrough general innovative plans and 3 innovative plans of individual car models are put forward. These plans include technological breakthroughs such as charging the car in rainy days and open fields and combined traveling schemes that can reduce parking difficulties when users have parked their cars and are still miles away from their destinations. The plans also include ideas of unrealized technologies, such as photovoltaic charging films on the roof of the car and automatic winding machine for charging cables.

   In conclusion, these plans provide an important basis for upcoming NEV products.

   This research also preludes the feasibility study in engineering, in which innovation plans with marketing potentials are analysed and samples that may go to mass productions are made.

   The automotive industry is undergoing changes. The user-oriented innovative thinking that originates from industrial designs and becomes perfect in Internet industry is expanding to automotive industry. Future vehicle products will start from user experience,
based on technological innovation and develop a “new value” that the users are willing to ‘buy’. Automotive user experience will become a commercializing pivot and source of driving force that support this energy-saving, environment-friendly and safe technological innovation.

References

About the Author

**XIAO Ning** has a composite engineering background of Automotive Engineering and Industrial Design. He is the first batch certified as one of the top ten domestic outstanding designers. He pioneered and led the Trumpchi brand of industrial design innovation.