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Application Research of User Co-creation in Intelligent Cockpit Solutions

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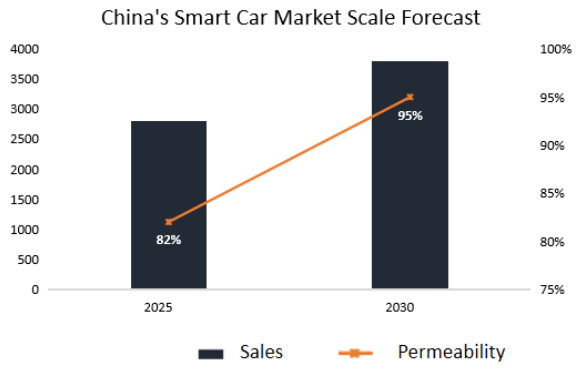
Abstract: The method of user co-creation originated in the Internet industry and gradually penetrated into other industries. In the era of "user experience as the core", the definition of intelligent cockpit functions needs to be closely centered on the user's use scenarios and needs. It refers to the user co creation workshop to obtain the user's experience, mine the user's needs, and through the participation of real users, automotive industry experts and automotive designers, Provide innovative solutions for intelligent cockpit through co creation, and carry out functional definition and engineering development.

Keywords: Intelligent cockpit, User co-creation, Usage scenarios, Innovation, Prospective study, Solution, Function definition.

1. Introduction

According to the forecast of authoritative organizations, it is estimated that by 2022, the global intelligent connected car market will reach 350 million units. What we need to know is that the total production of cars in 49 countries in the world will be 77.6216 million in 2020, and 90.4237 million in 2019. , that is to say, it is estimated that by 2022, the total number of intelligent connected vehicles in the world will reach the production scale of the entire global market for more than five years. According to the forecast data of China's National Development and Reform Commission, the penetration rate of smart cars in China will reach 82% in 2025, and the number will reach 28 million, and it will reach 95% in 2030, about 38 million. , the market prospect is very broad. (As shown in Figure 1)



Data source: National Development and Reform Commission forecast

Figure 1. Forecast of the scale of China's smart car market

Intelligent networked vehicles have more powerful perception, decision-making, and execution capabilities. Through V2X, they can achieve safety, efficiency, comfort, energy-saving behavior, intelligent driving, intelligent cockpit, and intelligent network connection. Intelligent network connection is integrated into intelligent driving and intelligent cockpit. Among them, the smart cockpit is directly contacted by the user, and it is also the hardware system that most affects the user experience. Compared with the autonomous driving that is more challenging for vehicle-road coordination, the smart cockpit is easier to implement. This has also led to fierce competition for smart cockpits in the past two years.

It is estimated that by 2025, the penetration rate of smart cockpit equipment will exceed 75%, and the market size will reach 103 billion yuan, with a compound annual growth rate of 13%. The development prospects of smart cockpit in the Chinese market are also very broad.

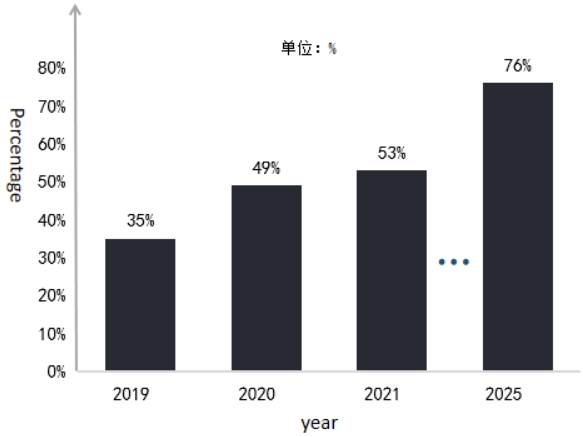


Figure 2. Penetration rate of China's automotive smart cockpit

We divide the smart cockpit into four modules according to the technical characteristics of the smart cockpit. From the perspective of users, human-computer interaction and innovative functions are the key modules that reflect the intelligence of the cockpit. According to the current smart cockpit technology path, human-computer interaction is also the main performance module that embodies the smart cockpit. Therefore, we can learn from the relevant theories and methods of human-computer interaction in the process of studying the smart cockpit. (As shown in Figure 3)

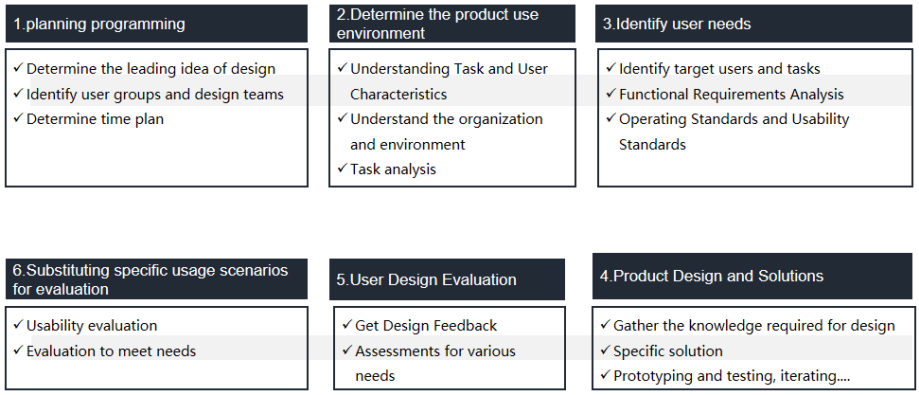


Figure 3. Design process of automobile human-computer interaction

According to the automobile human-computer interaction design process, it can be divided into six steps in general, including design rule determination, product use environment determination, user demand determination, product scheme design, user design evaluation, and usability testing brought into specific usage scenarios. We simplify this process, which can actually be attributed to three processes: requirement acquisition, program design, and program evaluation.

"Scene-Defined Cars" continue to stimulate users' infinite reverie about the multi-dimensional uses of cars, and "Software-Defined Cars" create more possibilities for the continuous derivation of new demands for cars. Smart cockpit is an important carrier to expand the space and time of automobile use. Continuous innovation is the only way out for the development of intelligent automobiles. This requires smart cockpit designers to continue to explore intelligent ideas based on user needs. Next, we will focus on the introduction of the creative design method of the smart cockpit.

2. Creative Design of Smart Cockpit Solution Design

2.1. Innovative thinking of creative design

To analyze the internal relationship between functional innovation and user needs, first of all, functions can be divided into two situations: ① the equipment of functions, that is, the presence or absence of functions; ② the performance of functions, that is, the advantages and disadvantages of functions. According to the two situations to analyze the relationship between functions and user needs, the key innovation strategy is to improve existing functions to meet user needs and fully creative output to meet user needs. (As shown in Figure 4)

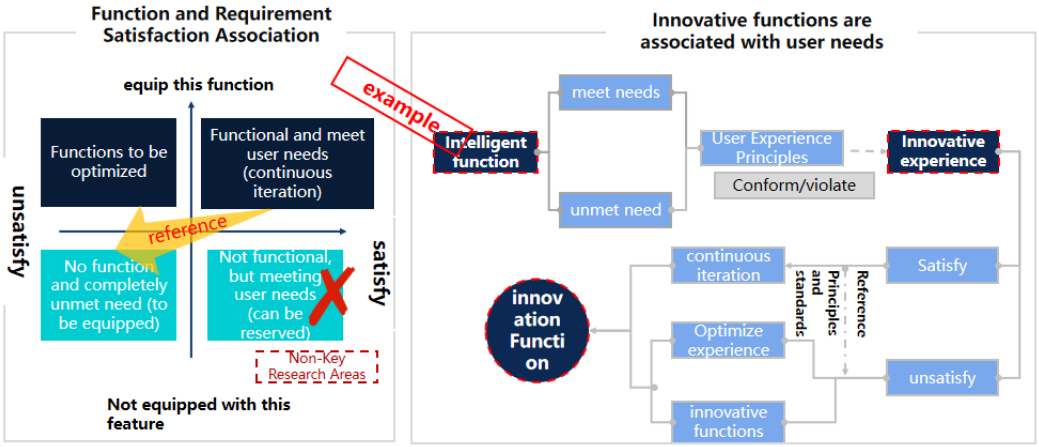


Figure 4. Inner relationship between functional innovation and user needs

2.2. Research methods of creative design

The whole process of creative design can be divided into two stages, the stage of creative exploration and the stage of creative verification, both of which are centered on user needs. Explore smart cockpit innovations based on user needs, and verify target users to verify their acceptance of smart cockpits.

In the creative exploration stage, four steps of research are mainly completed, including in-depth interviews with cross-border experts, in-depth interviews with immersive high-end players, user co-creation workshops, and creative design and development. The first two steps are mainly the overall macro scanning to stimulate the creativity of the smart cockpit. The purpose of the in-depth interviews with cross-industry experts is to tap the intelligence to satisfy the external intelligence development trend through a cross-industry perspective, and provide creative inspiration for the industry's smart cockpit design. The purpose of the immersive high-end player in-depth interview is to deeply immerse yourself in the life of high-end players of technology products, and to explore the needs of smart cockpit users forward-looking. The most important of these steps is the development of the user co-creation workshop, which lays an important link for the development of intelligent creative design. (As shown in Table 1)

Table 1. Research methods in the stage of creative exploration

Stage	Research method
Step1	In-depth interview with cross-border experts
Step2	Immersive in-depth interviews with high-end players
Step3	User co-creation workshop
Step4	Creative design development

3. Research Method of User Co-creation Workshop

3.1. The purpose and significance of the user co-creation workshop

The so-called user co-creation workshop is a user-centered workshop brainstorming in which designers participate. The purpose is to carry out creative design on-site or after the meeting based on the needs of users.

The purpose of the user co-creation workshop is mainly to provide a platform for direct dialogue between designers and users. At the same time, by blurring the role boundaries between the two, it can enhance users' decision-making power in the product design process, enhance users' sense of participation in the product creation process and deeply stimulate the user's imagination, so as to facilitate the direct collision between the supply side and the demand side, and generate more "innovative thinking" sparks.

3.2. Participation elements of user co-creation workshop

The participation elements of the user co-creation workshop are the core of the success of the workshop. People, venues and props constitute the three elements of the workshop development. People, that is, the participants of the workshop, as the co-creation workshop, the main part of the real automotive product user workshop participants, including automotive industry experts, most of them come from the strategic planning department. Engaged in forward-looking research work, you can be a product manager, or a department manager, and then a designer. The so-called "user co-creation" requires the designer to give a design plan on the spot, which can be output in the form of a sketch or a conceptual description form output.

Finally, representatives of automobile companies are mainly customers involved in research projects. They can participate in the discussion of each group moderately. Of course, their more roles are to listen to user needs, understand expert views, comment, analyze and respond to solutions proposed by designers based on the current technical capabilities and product planning of the enterprise, respond to user needs, and respond to the needs of the meeting. Combined with the company's technical planning reserves to show the company's research and development strength to the attendees, but also to take the opportunity to promote new products for the enterprise. (As shown in Table 2)

Table 2. Participants and Responsibilities of User Co-creation Workshop

Participant	A brief description	Job Responsibilities
Lead user	Representative leading group of users	Combining the usage scene and the experience under the scene, open the brain hole, stimulate creativity, and put forward needs
Designer	Automotive creative designer	Combined with user needs, carry out creative scheme design
Industry experts	Practitioner in the automotive industry strategy and planning sector	Interpret innovative development trends from an industry perspective, interpret user needs from their own perspective, and inspire innovative solutions
Representatives of car companies	Cooperation/intended customer personnel	Listen to user needs, evaluate solutions, and moderately participate in co-creation

In terms of the workshop venue, it should be far away from the downtown, the environment should be quiet and comfortable, and the participants should not feel anxious. Three tables can be put down for three groups to discuss freely. At the same time, the spacing between the tables is more than 2 meters, which can form a space interval to ensure that each other is not disturbed. In terms of regional setting, it is mainly divided into user co-creation area, explanation area, equipment area, tea break area and observation area. In fact, when choosing workshop venues, most of them are teahouses and cafes, especially teahouses. Considering the area, lighting and environment, teahouses are the best places to hold user-created workshops. In the specific implementation, the whole first floor or a hall of teahouses can be taken as the site, and the position of each area can be adjusted to ensure the site is in place. Props are also a key part of user workshops. Props are mainly used for two purposes, one is to assist participants to produce more valuable ideas, and the other is to create a good atmosphere for participants to stimulate more ideas. Mainly involved props can be divided into equipment category, draft category, project output category. (As shown in Tables 3 and 4)

Table 3. Venue Configuration of User Co-creation Workshop

Area	Area location	Area function
User co-creation area	Middle of the venue	In the core area of the venue, creativity is produced through brainstorming
Explanation area	Front of the venue	The moderator's station area and each group's program presentation area
Equipment area	The front side of the venue	Mainly display audio equipment, online conference equipment, etc.
Tea break area	The end of the venue	When there is a break in the middle of the venue, a snack area will be provided
Observation area	Both sides of the venue (back)	The area where representatives of car companies sit when they attend the meeting

Table 4. Props of user co-creation workshop

Category	Props	Number	Description
Equipment	Music	5 songs per game	10 minutes tea break in the middle, play 5 pieces of music
	Audio	A set	
	Microphone	4 and above	Ensure that each group has a fixed microphone to avoid delays due to passing the microphone
	High-definition television(HDTV)	1	Show ppt
	Live equipment	1	For viewing access for external clients
Draft class	Carbon pen, marker pen	Multiple	
	A3 paper	5 sheets	Co-creation description of the concept outline of the vehicle
	A4 paper	Multiple	
	A2 paper	Multiple	
	Sticky note	More than 3 colors	Write ideas and present them in the process
Program output class	User Journey Map (A2 paper)	9	Complete the analysis of user experience journey in various scenarios and use it to stimulate the formation of user experience stories
	Concept template (A4 paper)	Multiple	Users and designers co-create and output product ideas
	Inspirational card	A set	Use to better evoke user memories, state usage scenarios and experience feelings
	Slides	1	Used for the host to control the field and guide the workshop

3.3. The development process of the user co-creation workshop

3.3.1. Participant Recruitment

Participants are the core elements to ensure the effect of the workshop. First of all, in terms of user sample screening, the purpose of the user-created workshop is to output creative ideas. Therefore, users need to be the "leading users" in the market, who have a stronger interest in and perception of new things

At the same time, I have a higher level of cognition and familiarity with technology products than ordinary users, and can forward-looking lead the market demand and stimulate creativity. We need to set screening conditions for the screening of user samples, which mainly limit the basic characteristics, personality characteristics, growth experience, family situation, work situation, interests and hobbies, and the characteristics of friends circle to identify leading users. In addition, our researchers need to screen the user samples submitted by telephone one by one, and confirm whether they meet the conditions of "leading users" required by us through our further detailed question setting.

In the development of the workshop, it is particularly important to point out that we have designed a total of 2 user co-creation workshops, one of which is for women, that is, the user samples are all female. Such workshop convening method is extremely rare in the industry. In the past, most of the workshops would be male, while adding 1-2 female user samples. Female users are a group that cannot be ignored, and the needs of female users need to be paid more attention, including the specific scenes and needs for women such as "child care", "pet rearing", and "pregnant woman driving" can be used as highlights of the product. In this new era, the role of women is constantly changing to diversity, resulting in more complex and broad scenes of their car use, so there is greater potential for innovation.

Table 5. Screening conditions for user samples

Group	Morning group	Afternoon group
Gender	Male	Female
Sample size	9	9
Age	25-40	
Education background	Bachelor degree or above	
Character	Extroverted, not afraid of crowds	
Expressiveness	Willing to express, good at expressing personal views and opinions, clear thinking, good eloquence	
Teamwork	Able to quickly form a team with unfamiliar people to complete tasks	
Knowledge of automobiles	Like cars, often study and learn about cars, pay attention to and understand the intelligence of cars	
Experience feelings	Having a deep experience in the use of cars, especially with many pain points and many expectations and ideas for improvement	
Vehicle use	Commuting to and from get off work, business negotiation	Commuting to and from get off work, taking children to school/training classes/nurturing classes/going to the elderly's home to ask the elderly to take care of them
Usage scenario (necessary condition)	Have more than 2 camping experiences	Have camping experience
Travel entertainment	Like short or long-distance self-driving travel, often have dinner with friends or drink tea to discuss business	Like short or long-distance self-driving trips, and occasionally enjoy private space with girlfriends
Working condition	Relatively busy, have 996 or white plus black experience	Have their own stable job or business, but the work is not busy, most of the time can be used to take care of family
Family role	The main economic pillar, career-oriented male	Mainly take care of family and children, family-oriented women

On the other hand, industry experts are recruited. Industry experts mainly come from several organizations and fields such as car companies, suppliers, professional teachers in colleges and universities, professional media, etc. They must have a relatively familiar understanding of automotive intelligence or intelligent technology industry, and at the same time have a relatively familiar understanding of forward-looking technology functions. At the same time, the job or industry needs to be closely around the smart technology industry. In terms of position definition, the middle level and above should be the best, because the management has a more macro perspective of information and problem consideration, but it has more flexibility in creative output than the engineer, and the engineer is often in the role of passive acceptance of tasks, and his thinking may be limited and he may not dare to put forward new ideas.

Finally, the field designers, usually come from UI and UX designers of interaction design companies, or from teachers and graduate students of colleges and universities engaged in automobile interaction design. In terms of the form of participation, on-site participation is as much as possible. Due to the fact that the execution city of the workshop is not fixed, the designer team needs to follow the project team to carry out on-site design in the execution city. Due to the restrictions of the epidemic, if the on-site participation is not possible, the designer can participate online, and the designer is the only workshop participant who can participate online.

3.3.2. Event setting and city selection

The minimum number of sessions of the workshop is 2. If the workshop is held in one city, it can be arranged in the last afternoon. If the workshop is held in two cities, it can be arranged in two afternoons.

In terms of city selection, it is recommended to give priority to first-tier cities, but Beijing is the best among first-tier cities, and Hangzhou can be selected among second-tier cities. These two cities are more engaged in Internet and high-tech companies, rich in industry experts, high cultural quality of users, and strong acceptance of scientific and technological products. (Shown in Table 6)

Table 6. Screening conditions for user samples

Time	Sessions	City
Morning (9:00-12:00)	1	Sort by priority: Beijing, Shenzhen, Shanghai, Guangzhou, Hangzhou, Chengdu
Afternoon (14:00-17:00)	1	

3.3.3. Intermission tea break

The total duration of the workshop is 180 minutes, and the tea break is set up at 90 minutes to provide time for participants to relax their minds, communicate and eat snacks. The key point of the tea break time is to play music. The choice of music should be careful, and the music type suitable for them should be selected according to the characteristics of the participants. Go to the music software to retrieve the music content under the corresponding category. (Shown in Table 7)

Table 7. Screening conditions for user samples

Sessions	Music list
Male group	<Ta shan he>, <Ni de da an>, <Wu shi nian yi hou>, <Mo he wu ting>
Female group	<Cong qian shuo>, <fei niao he chan>, <gu yongzhe>, <qiong cha cha>

The choice of music should be arranged in order. For example, the male group started with loud and exciting music, and then ended with soft music. The female group started with soft music and ended with dynamic music. At the same time, female users also chose music with a wide audience of children, and formed the same rationality with female users.

3.3.4. Host guidance

The host's control and guidance skills mainly come from his deep understanding of the project and his adaptability to special situations. In terms of props, the ppt of the workshop outline is the main guide tool for the workshop. At the same time, the off-site assistant staff should cooperate with the tools to distribute.

3.3.5. User co-creation process

The process can be divided into four stages: ice breaking and warming up the field, imagination and divergence, demand insight and creative stimulation. (Note: The grouping of the workshop is recommended to be completed before the meeting. The researcher divides the participants into three groups A\B\C in advance based on the background information of vehicle type, age, work and so on through the basic information and screening of users and experts.)

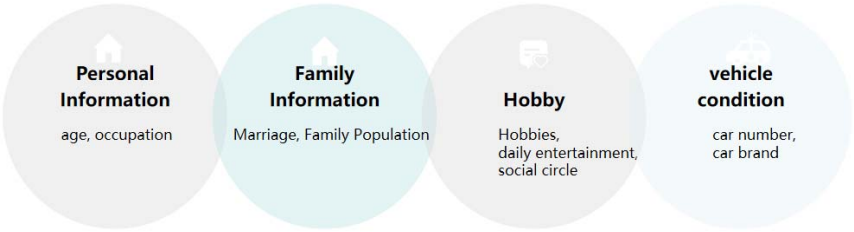


Figure 5. Ice-breaking and warming-up topic labels

The main way to break the ice is to ask each group to introduce themselves, which can be clockwise or counterclockwise, mainly involving labels containing personal information, family information, interests, and vehicle information. The main purpose of this stage is to let the participants warm up and establish the opportunity of opening speech, the host must not pay attention to control the time, because the number of participants is 9, the number is large, if each person is introduced in turn, 2 minutes will occupy 20 minutes, and in order to avoid the participants "improvisation", the opening host first points out the dimensions of the introduction, and introduce himself first. To demonstrate to the attendees. (As shown in Figure 5)

The stage of imagination divergence is the first task of user co-creation. Each group designs an intelligent car for itself from the perspective of individual needs and designers, covering the basic parameters, market segments and intelligent functions of this car. The main significance of this stage is to initially understand the basic needs of users for a car, the expectation of intelligent functions of a smart car, and to initially understand customer needs from a macro perspective. It should be noted that this stage does not have to pursue the output effect too much, but can be more used as a warm field for users to enter the state.

The task of the demand insight stage is to use the high-frequency scenarios obtained from the previous research as a model, and to explore the user's detailed usage scenarios, user experience (mainly pain points), and product expectations through the user journey map. High-frequency scenarios mainly include commuting, short distance travel, business negotiation, and picking up children, among which commuting and short distance travel are common scenarios for male users and female users. Business negotiation is mainly a high frequency scene for male users, and picking up children is a high frequency scene for female users. When conducting workshops, each topic should start with the mother scene, and the description of the scene can only be guided, not limited to a fixed template to describe, because the concept of the scene belongs to the professional vocabulary, and the vast majority of users do not understand what is the scene. Therefore, users can be guided to describe the scene in their own accustomed language, and later researchers will sort out the qualitative transcripts. (As shown in Figure 6 and Figure 7).

User Journey Map

Scene	**Scene elements:** five aspects of time, place, character, behavior, feeling **Example:** User wants to go somewhere. Description:" At 8 o'clock in the morning, Xiao Ming came to Hangzhou East Railway Station by train and wanted to travel to West Lake. But the first time he came here, he was not familiar with the place. Then open the map app, enter the West Lake Scenic Area, and click the navigation, and found that it is very convenient and cheap to take the bus. So according to the navigation of the bus route, he reached the West Lake. "						
car stage	before boarding	boarding	ready to drive	driving	close to destination	parking	after leaving the car
Behavior (what function to use)	remote heating	Take phone and turn on the sensor to unlock	Voice wake up QQ music	Voice setting navigation location	.....	.....	.....
Purpose	• Warm up the car in advance •	• open the door •	• turn on the music •	• Navigate to a place sent by a friend •	• Finding a parking space •	• automatic parking •	• lock the car • .....
Get Feelings (Pain Points)	Unable to turn on the electric heated rearview mirror remotely	Induction unlocking is not sensitive	Can't switch audio source	The location received by WeChat cannot be sent to the car navigation	.....	.....	.....
Futurre	hope.....	hope.....	hope.....	hope.....	.....	.....	.....

Figure 6. User Journey Map

Figure 7. Usage Scenario (Example of Scenario)

Finally, the creative stimulation stage, that is, according to the needs and pain points obtained in the previous stage, each group is asked to give the creative concept of solutions. In this stage, each group gives the concept of solutions mainly for other groups, but also for this group. The main participants who give solutions in this stage are industry experts and designers. There are direct face-to-face contact opportunities with users, and co-creation is carried out in the demand stage, so the empathy for users' needs is stronger, and the willingness to put forward plans is stronger, and the implementation is stronger. The tool used in this stage is the concept creative template, and the "concept name," "target population," "suitable model," "solution concept description" and "pain point solution" are filled in successively.

3.3.6. Output of Smart Cockpit Innovative Solutions

Finally, the user researchers sorted out the whole research results and got a detailed user experience story, while the designers presented the story through the storyboard, further developed and optimized the design scheme according to the co-created scheme concept, and finally produced the design sketch.

At present, the intelligent cockpit platform research team of the Automotive Consumer Research and Communication Department of China Automotive Information Technology Co., Ltd. has jointly carried out intelligent cockpit user co-creation projects with a number of automobile companies, and established the automotive intelligent cockpit creative library. At the same time, according to the target model development needs of specific products of automobile enterprises, we have separately carried out innovative solution design projects, providing consulting services for product planning and product development of enterprises. For design and r&d layout, creative design of intelligent cockpit is a key link. In the future, CNAHC will continue to optimize design methods, innovate theoretical models, further iterate the idea base and finally produce more high-quality solutions.

4. Conclusion

The concept of user co-creation originated from the Internet industry, and later expanded to electronics, FMCG and other industries. In recent years, the automobile industry has also paid more attention to the needs of users and begun to emphasize the user-centered approach. The automobile industry has also begun to introduce the way and concept of user co-creation. According to the current market situation, automobile enterprises have used user co-creation more for "brand building" and "model name", etc. In particular, there are not many solutions produced by user co-creation in intelligent functions.

With the continuous development of automobile intelligence, coupled with the continuous empowerment and influence of the Internet, metaverse and block chain on the automobile industry, user co-creation will be more and more widely used in the definition of automobile products, and provide output for the next engineering development, user co-creation will be more and more widely used.

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