



# Automated Driving: Acceptance and Chances for Young People

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**Abstract.** Young people aged 18–24 are the main force of consumption in China, are more inclined to buy self-driving cars and are willing to pay higher prices, which makes them an important potential user of autonomous vehicles. Automated vehicles seem to provide more possibilities in terms of independence and safety. In order to explore the user needs of the young people, we set up a study based on semi-structured interviews and a role play. Our results demonstrated that 90% of the young people ( $n = 20$ .) are pleased to drive the automated vehicles, they are looking forward to the aging of automated driving. The remaining 10% of young people were unwilling to try out automated driving systems owing to the nondeterminacy and suspicion (fear of mechanical failures), and they are deeply worried about safety. In the exploration of demand, regardless of the level of acceptance, young people have shown a high demand for safety and security facilities. In addition, we have explored the needs of young people for entertainment and human-computer interaction. This will likely provide arising opportunities for young people.

**Keywords:** Automated driving · Young people · User needs · User study · Semi-structured interviews · Role play

## 1 Introduction

In China, young people are a huge potential user for autonomous driving. As of 2017, the youth, aged 18–24, accounted for 32.4% of total consumers, ranking first in all age groups, is the main consumer group in the future. At the same time, according to data from the 2019 Automotive Consumer Survey, Chinese consumers are still generally optimistic about the potential advantages of autonomous driving [1]. In addition, Ben [2] has found out that young respondents were willing to pay (WTP) the most, \$8,921 or 36% above the initial purchase price, compared to the average WTP of 24% above the purchase price.

On the other hand, in China, due to the low rate of private car ownership in China, a lot of young drivers appeared after passing the driving tests. They were called “carless young drivers”, mostly aged between 18–25, already own a driver’s license but have little chances to practice driving skills on account of owning no car. So the safety problem related to them has aroused great attention in China. The study showed that young drivers

who don't have their own cars made far more mistakes, attention lapses, and violation behaviors than those who do [3]. Previous researches have shown that the more likely causes of traffic accidents among young driver are a large quantity of decision mistakes (e.g., improper speed), dangerous driving action (e.g., one hand driving), distracted driving (e.g., using mobile phone) and the existence of peers. Although inexperience may have played a part, a plenty of these accident-contributing factors infer poor driving skills. In recent years [4], the road traffic problems caused by young drivers have caused widespread concern in China, and this problem may also become a situation commonly faced by developing countries with similar national conditions and driving environments as China. If this technology is integrated into the lives of young people, it will generally improve the driving standards of young people and greatly reduce the chance of accidents [5]. Therefore, it is necessary to explore and analyze the needs of the main consumer group of young people, while trying to meet their needs. According to a McKinsey survey [6] of about 3,000 consumers in the United States, China and Germany, young people living in big cities more interested in automatic cars. In this work, we analyze exploratively the needs, problems, challenges and the future opportunities of young people in regard to highly automated vehicles (SAE level 4 and 5). By the results, we want to find out how the automotive industry should act for the sake of providing better services to the target group.

## 2 Related Work

Existing surveys [7] have shown that people are generally positive about automated vehicles. However, these researches ignore that automatic cars have different degrees of automation, and that User Experience (UX) and User Experience Acceptance (UA) with automatic systems diverse in terms of system autonomy. Several studies have shown that not only the apparatus itself, but driver's characteristics such as age, gender and experience have an influence on acceptance of ADAS and automatic vehicles. Joshi [8] et al. find that personality aspects are related to the ADAS's acceptable level. Holtl and Trommer [9] show that drivers who have used navigation equipment have lower acceptance to them than people who have not. Piao [10] et al. find that men and younger drivers are less pleased to spend money on the Intelligent Speed Adaptation System (ISAS) than women and older drivers. In another study, Haboucha, Ishaq, and Shiftan [11] found that the youngsters, students and the people who are more educated will be early adopters of automated vehicles and will spend more time on cars.

In terms of exploring users' needs, automated driving brings different needs of user. An important aspect mentioned by Kun [12], Boll, and Schmidt publishes so-called non-driving related activities or tasks (NDRAs): the "driver" can get a variety of activities and can put their hearts into these activities (for example, putting something down, playing games) when the driving is highly automated or fully autonomous. As Kun et al. specially mentioned, cars can be considered as a place to increase productivity and entertainment. This biases the research focus of needs towards NDRA. Investigations in these areas have been carried out by carinsurance.com, McKinsey and J.D. Power [13] and they have investigated the question of what the driver will "use of the newly released time". Sending message and communicating were the most constantly mentioned activities (26%), and

“others” accounted for 21% (including enjoying the scenery along the way), besides, “reading” accounted for 21% followed closely. In addition, “sleeping” accounts for 10%, “watching a movie” accounts for 8%, “playing games” accounts for 7%, and “working” accounts for 7%, these activities were not mentioned often. In the research of Pfleging, Rang, and Broy [14] they made specific research on user’s needs in NDRA. Due to technical limitations, analyzing users’ needs regarding highly automated driving (HAD) is different from studying traditional AutoUI now. In order to estimate future usage in the absence of users’ HAD experience, they used WEB SURVEY, CONTEXTUAL OBSERVATION: SUBWAY, and IN-SITU INTERVIEWS IN SUBURBAN TRAINS to survey users’ needs for NDRA. And their final findings show that in addition to highly common activities (chatting with passengers, enjoying music), daydreaming, texting, having something to eat, surfing on the Internet and making phone calls are the most needed activities when people can drive highly automated. And we can know the portable and omnipresent multimedia applications’ potential through it.

Although previous studies have shown that people broadly are optimistic about highly automated vehicles, the research does not give a consensus, and the controllability and acceptability of these systems is still a disputed issue. Our research’s purpose is exploring the acceptance of young users (ages 18–24) for automated vehicles at L4 and L5 levels. We asked questions by simulating scenes inside autonomous vehicles for the group of people. And we specifically explored the acceptance and demands of young people for highly automated vehicles through the data analysis. In the experiments of Rodel [15] et al. they mainly used online surveys to conduct research, and described disparate standings of autonomy in the shape of scenarios, which can enable participants to visualize disparate standings of autonomy. However, in the experiments by Rodel et al., participants scored their acceptance based on imagination rather than actual experience. While in our study, participants were placed in a small room to simulate the autonomous driving scenarios. These increases the realism of the participants’ experience and can further obtain more accurate data. Previous research has shown us the NDRA needs of users in automated driving, but they have not investigated the specific needs of specific group of users, and the setting of the scene is to simulate the autonomous driving scenarios through existing public transport. In terms of exploration users’ needs, it is limited to the needs for NDRA and does not study other types of requirements. The research area to explore users’ needs is expanding, and it is necessary to study the specific needs of specific group of users. Therefore, we have specifically divided users based on previous research, and try to expand from as many as possible when exploring requirements. Mining the subjective needs of users, and then further tapping the potential needs of users.

### 3 Method

To investigate the attitude of young people towards automated driving detailed, we conducted semi-structured interviews and organized a role play.

### 3.1 Interviews

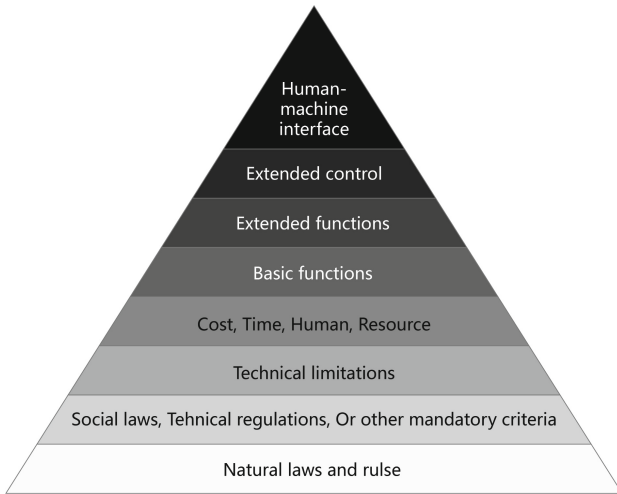
We used a semi-structured interview method and recorded each subject to discover the acceptance and trust of the young people in automated driving, we used a semi-structured interview method and recorded each subject. We interviewed a total of 16 subjects, these subjects were 18 to 24 years old. These results were used when setting up our role-playing scene. At the end of the interview, the five-point scale was used to respondents to rate their overall acceptance of autonomous driving, and used this to classify them into high, medium and low acceptance groups [16].

### 3.2 Role Play

A total of 8 participants participated in the role-playing, and some of them have participated in previous interviews. We set the role-playing scene in a similar environment to the interior of the car. In role-playing, we let two familiar participants execute exercises together, because our interview experience shows that they will be more willing to express, but a larger team size will reduce the efficiency of the express. Asking about their demographic information and the acceptance of autonomous driving (mainly those who did not participate in the first interview) is the first step. Then, we showed them a video about the development concept of the future autonomous vehicles and a video showing the first perspective of autonomous vehicles. Watching the videos is for the sake of clarity. Afterwards, we explored the subjects' expression in different scenarios, which were developed based on the previous interviews and "eight levels of requirements" [17]. This "eight-level requirement" was once used to explore the requirements in product design. Subjects need to answer several questions which we set in advance in the "automated car". During the experiment, the interviews of all subjects were recorded throughout the course, and their statements and behaviors were analyzed in the subsequent research process. We use qualitative analysis to analyze our interview data. First, we summarized several theme guides based on the questions we asked, and then formulated questions integrating post-it notes before discussion and during the interview. The combination of these topics and finally formed a thematic framework, which is used to analyze the respondents' quotes. By combining the results of our analysis with the results of the interviews, we finally gained a preliminary understanding of the acceptance and needs of young people for automated driving.

### 3.3 Question Settings

The questions were developed based on the previous interviews and "eight levels of requirements" (Fig. 1). Firstly, we raised a few general questions in different aspects through "eight levels of requirements", then we made Q & A post-it notes based on the initial answers of the users in the role play. After getting these post-it notes, we based on the initial answers and subjects replies to post for further scene settings and questions to get the specific needs of the user (Table 1).



**Fig. 1.** Eight levels of requirements

**Table 1.** Question settings

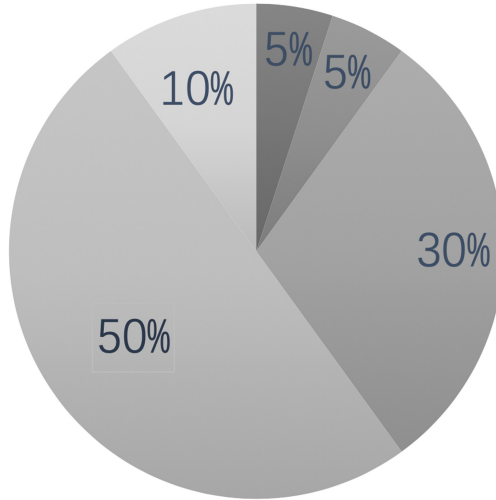
Eight levels of requirements	Questions
Human-machine interface	<ol style="list-style-type: none"> <li>1. Is it necessary to add a tracking line? (In the videos)</li> <li>2. Is it necessary to add voice navigation?</li> <li>3. Wanted control system (input and output) (audio/visual/touch)</li> <li>4. Is it necessary to connect with another autonomous vehicles?</li> </ol>
Exception control	<ol style="list-style-type: none"> <li>1. Demand in emergency situation (before and after)</li> </ol>
Extended functions	<ol style="list-style-type: none"> <li>1. Special needs (In addition to the basic functions)</li> </ol>
Basic functions	<ol style="list-style-type: none"> <li>1. Fundamental requirements (seats, windows)</li> </ol>
Cost, time, human, resource	None
Technical limitation	<ol style="list-style-type: none"> <li>1. Demand for autonomous driving levels</li> <li>2. Improvement of specific technology</li> </ol>
Social laws, technical regulations or other mandatory criterial	<ol style="list-style-type: none"> <li>1. Legal needs</li> </ol>
Natural laws and rules	None

## 4 Result

### 4.1 Acceptance of Young People

Our interviews show that 90% of the participants are willing to drive autonomous vehicles. Highly acceptance accounts for 60%, medium acceptance accounts for 30%, and low acceptance accounts for 10% (Table 2).

**Table 2.** Acceptance of young people



■ Strongly disagree ■ Disagree ■ Not sure ■ Agree ■ Strongly agree

Options	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
Number	1	1	6	10	2

Mostly are enthusiastic of this progress and expect the coming of automated and AI age. Almost half of high acceptance subjects stated they will give priority to cars with self-driving capabilities when buying a car. However, most of them don't trust the technology deeply and worry about security issues recently. The remaining 10% pointed out, that that artificial intelligence is always untrustworthy. They are extremely distrustful of automated vehicles and doubt to the technology. Many of them point out that they will never drive or take automated vehicles.

During the role-playing process, most participants stated that after watching the introductory video, there was an increase in trust and acceptance of autonomous driving. Therefore, we guess that the fear of unknown things is the source of most people's distrust of autonomous vehicles. Once this new thing materializes in their minds, their acceptance of such things will increase to extent. Through the interview, we learned that due to media reports on autonomous vehicle accidents and the lack of popularization of

automated cars, making the technology is a major concern for participants, and it also a key issue that affects whether they accept autonomous vehicles.

Meanwhile, the government should strictly control the use of autonomous vehicles, and promulgation relevant laws and regulations, especially the resolution of the problem of liability for accidents in autonomous vehicles, will greatly increase user trust.

## 4.2 Needs of Young People and Further Chances

Through analyzing qualitative data [18], we sorted out the analysis ideas and methods (Table 3).

**Table 3.** Analysis ideas and methods

### TOPIC GUIDE(extract)

#### *User needs*

User needs are reflected in

Social laws : Which aspect ; necessity  
 Extended functions : What ; why; degree ; interconnected ; data record  
 Technical limitations: Which level; why; technology needs  
 Exception control: How; when; what;  
 Basic functions: Interior layout  
 Human-machine interface: What; why ; where; degree ; necessity

### RESEARCH NOTES AND JOTTINGS

Seat layout  
 Needs for data record  
 Privacy needs  
 Storage function  
 Medical device

### INDEX(extract)

#### *Patterns of needs*

- 1.1 Attribution of legal responsibility
- 1.2 Traffic laws
- 1.3 Necessity of law
- 2.1 Preferred automated driving levels
- 2.2 Car performance needs
- 2.3 Other
- 3.1 Window and seat layout
- 3.2 Number of windows and seats
- 3.3 Functions of windows and seats
- 3.4 Ride experience
- 3.5 Storage function
- 4.1 Specific needs for the kitchen
- 4.2 Specific needs for entertainment
- 4.3 needs for data record
- 4.4 Internet needs
- 4.5 Privacy needs
- 5.1 Control method
- 5.2 Control content
- 5.3 Pre-emergency control
- 5.4 Control after an emergency
- 6.1 Necessity and extent of voice control
- 6.2 Necessity and extent of gesture control
- 6.3 Car-to-human feedback
- 6.4 Display identification content and display degree

We first asked the subjects questions and asked them to write their answers on post-it notes (Fig. 2).





**Table 4.** Questions

Requirements	Results
Social laws, technical regulations or other mandatory criterial	1. Law on attribution
Technical limitation	1. Prefer L5 automated car 2. High-performance cars 3. The identification range and identification of the car are not affected by the environment 4. New energy
Basic functions	1. Window with single or adjustable light transmittance and large field of view 2. Flexible seats 3. Excellent shock absorption device for office study
Extended functions	1. Information recorder (like the black box of an aircraft) 2. Entertainment device (easy to store) 3. Kitchenette facilities 4. Medical equipment 5. Connected with internet
Exception control	1. Automated alarm (post-accident) 2. More responses (preceding-accident) 3. Timely remind
Human-machine interface	1. Alarms of tracking box 2. Voice and gesture interaction

### Automated Cars Level

In terms of the choice of automated cars, they said that they prefer L4 self-driving cars to L5 self-driving cars because they currently have low trust in self-driving cars. They are more willing to go intervene in autonomous driving for the response procedures provided by autonomous vehicles in emergency situations, and thus are more at ease. They also think it is necessary to have an information recorder like the black box on an airplane. Nonetheless, most of them said that they are looking forward to the era of autonomous driving, but also said that they will buy it until the popularity of autonomous vehicles reaches a heavy population.

### Technology and Law

For the needs in technology and law, young people hope that use automated cars with security technology and stronger laws. "If there is a car accident, whose responsibility is it? I didn't drive but sitting in the car, whose responsibility is it?" Asked by a subject.

### Privacy

Further requirements are having privacy in car. Young people tend to have single light transmission or glass with adjustable light transmission performance windows which can also provide large field of view.

### Chair Setting

For the chair settings (Fig. 4), they would like to be rotatable, movable and foldable, and the interior of the car can be flexible to adapt to various scenarios. Some people have suggested that the seat can be laid flat and then spliced to form a bed. Others have suggested that the interior of the car should be able to change color and style. Young people also demand office and entertainment. They pointed out that the car should be equipped with excellent shock absorption devices so that they can read and write along the trip. Subjects also wanted a small table that could be folded and stowed, which some said can be combined with a chair. Young people have a variety of entertainment needs (Fig. 5).



Fig. 4. Subjects placed chairs



Fig. 5. Subjects placed chairs

### Entertainment

Many mentioned that they want to install a projector in their car for them to watch movies and television. Entertainment devices such as computers and game consoles in the car

which are easy to store also be referred. “It’s better to be stored, and the space will look like more comfortable in that case”. Said by a subject. In addition, almost all subjects mentioned the need for a small kitchenette, they said that they hope to do same cooking while commuting to save time. It has also been mentioned that it is desirable to provide a space for a picnic device in the car.

### **Emergency**

As almost all the subjects are confused and nervous about how automated vehicles handle emergency situations, it is necessary for vehicles to meet their emergency needs. All subjects said that automated cars need to be equipped with emergency medical boxes, they hope that the car can provide them with more medical assistance in order to respond to emergency situations after the accident.

Before an emergency, quickly analyses of multiple situations are be required. At the same time, they want the car to quickly alert people in the car to prepare. After the emergency, they all want the car to have an automatic alarm function. Some people said that the car should call immediately to save rescue time, and most of the subjects hoped that the car could ask them if they want to call an ambulance before action to avoid unnecessary personnel consumption.

### **Voice Assistants**

In terms of interaction, they prefer intelligent voice assistants to gestures to facilitate their manipulation of the car. “I feel that there(gestures) should be a lot of mistakes. It is the same case with mobile phones, and you gestures may not be fully recognized.” Said by a subject. They desire to focus more on voice feedback. They don’t need real-time voice of the car to tell them what the car is going to do. They state that it will disturb them to rest. But they desire to be reminded when the car makes more wild movements, such as a sudden braking. And they also want the car to have more intelligent voice navigation, for example, when the car drives to a famous scenic area or representative landmarks in a non-resident city, it can give them a brief introduction and report whether the current scenic area is crowded.

### **Front Windshield**

Most interviewees pointed out that they need self-driving cars to show their identification of the surrounding environment on the front windshield, but there are differences in the level of detail in the selection of objects. The young people with low acceptance of autonomous driving desire to select only small objects that they can’t notice, such as roadblocks and distant pedestrians, because they have the strongest needs for driver-assistance. It will not obstruct their view of the front, and facilitate them to drive. Some highly-accepted young people desire to show everything on the road so that they can know the road conditions even in foggy weather or other extreme weather. At the same time, they can also know what self-driving cars have specifically identified. And some highly-accepted young people desire to switch between the two modes.

### **Association**

A part of interviewees believe that it is necessary to conduct road condition analysis by linking with other autonomous vehicles, but they expressed their concerns about privacy leaks at the same time.

## 5 Conclusion

Most young people are more receptive to autonomous driving for it brings convenience to people and saves people's time. At the same time, autonomous driving systems improve the driving safety of young people and other drivers, which can effectively reduce accidents. Through our research, we found that increasing the expenditure on autonomous driving technology and the publicity of realized technologies can strengthen the support and trust of young people for new technologies to a certain extent. We found in interviews that the distrust of automated cars among young people who do not accept automated cars is mainly related to safety restrictions.

Therefore, meeting the young people's needs for safety is an important opportunity for such people to more accept automated cars. In role-playing, we found that young people like flexible interiors and have high storage requirements for other extended functions. They are looking forward to the convenience that high technology brings to life, but they are skeptical of the technology itself. People who have low acceptance of autonomous driving prefer to use this technology to assist themselves in driving. Therefore, the improvement of autonomous driving technology and interaction technology is necessary. At the same time, most young people hope to buy their own automated cars when autonomous driving has become widespread.

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