FUTURE TRUNK

: Future Design Factors for Autonomous Driving EV

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FUTURE TRUNK: Innovative Personal EV for Travel

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Executive Summary

Mobility is developing with reflecting various factors such as social, environmental, cultural things in people's lifestyle. In these days, 'Change of Motor Power Source' and 'Autonomous Driving', these two things are the hottest issues in the mobility industry. There are two purposes in this paper. One is to clarify what direction the 'Mobility' should pursue by chronological data collection and analysis of mobility development with lifestyle change. Second, the thesis aims to inspire for mobility development by proposing future mobility design concept.

For these two purposes, both future mobility trend research and future lifestyle trend research are investigated. According to the mobility development with lifestyle change, the tendency of future mobility is presented. According to the 'mapping concept' that combines both lifestyle trend and mobility trend, new mobility ideas are grouped as three : Personal mobility that is for first mile and last mile to use sharing car or public transportation(GroupA), Personal mobility that is specialized in travel or relaxing(GroupB), and ECO mobility that can be attachable, detachable each other depending on the purpose of use(GroupC). 'Future Trunk' is proposed as the development of future mobility concept GroupB. It is developed with key words of Relax, Travel, and Openness. Through design process from primary idea sketch to prototyping, core design factors are found and applied to the 'Future Trunk'. In this paper, 'Future Trunk' concept is identified that personal electric vehicle for travel with 6 core factors. The concept offers the enjoyment of moving and traveling by the 6 core factors. Finally, the concept 'Future Trunk' is evaluated by three experts that has different perspective such as design, engineering, and sociology.

Keywords: Future Mobility, Future Lifestyle, Trend, Electric Vehicle, E.V, Autonomous Driving, Travel, Luxury, Concept, Mobility Concept Design;

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Introduction

1.1 Background

Nowadays, issues of the hottest automotive industry are 'Change of Motor Power Source (Power Train)' and 'Autonomous Driving'. Just 3-4 years ago, 'Electric Vehicle' and 'Autonomous Driving' are felt like far future stories (Lisa J. Caswell et al., 2017). But now, beyond 'Hybrid Vehicle', complete 'Electric Vehicle' that only uses electricity as an energy and 'Charging Station (Figure1)' can be easily seen from all over. Also, public transportation with autonomous driving function such as 'Olli (Figure1)' is in operation. Automobiles with substantial autonomous driving level are already on the market.

Figure 1. Left is 'TESLA Electric Vehicle and Charging Station (The Tesla Team, 2017)[1]' , right is Autonomous driving bus 'Olli (Kieron Monks, 2016)[2]'

The changes of automobile show the development of 'Advanced Technologies' such as artificial intelligence and Internet of things, and 'Socio-cultural' changes that emphasize the environment. In other words, 'Mobility' is a collective that reflects the development of high technology and sociocultural change. It has major social, environmental, and other positive and negative side effects (Vukan R. Vuchic, 1999). Also, the 'Mobility' is worth to research as a factor that causes changes again in overall social culture. The background of this thesis is that the 'Mobility' has changed from 'Internal Combustion Engine Vehicle', which needs a driver, to 'Autonomous Driving Electric Vehicle'.

1.2 Research Objective

'Change of Motor Power Source' and 'Autonomous Driving'. The reason why these two are issues for the automotive industry is that they lead to major changes in overall mobility form, structure, and user experience (Figure2).
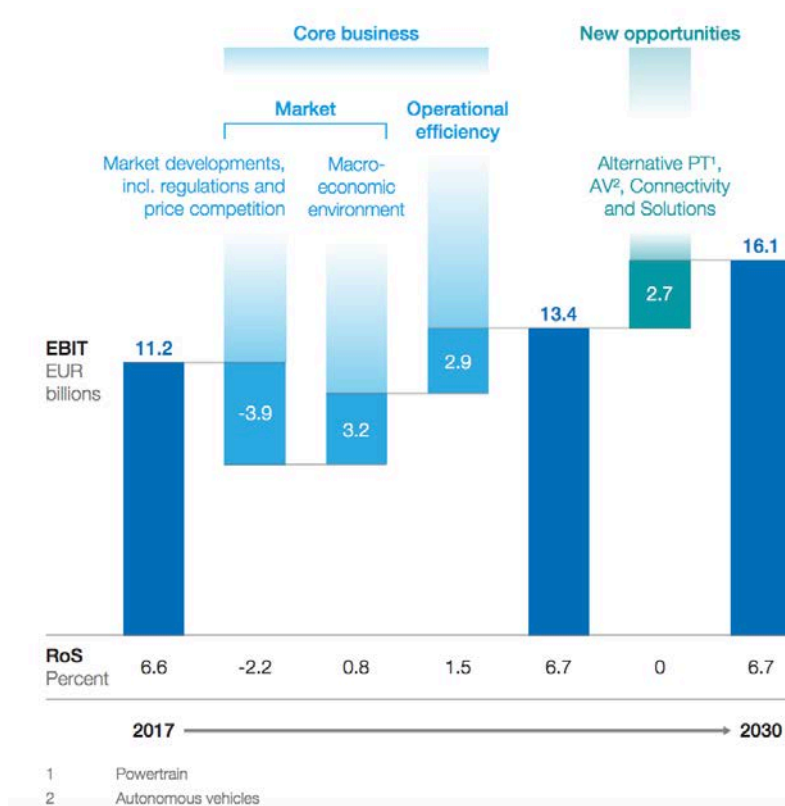
Figure 2. Issues of Automotive Industry: Industry profits will grow by EUR 4.9 billion mainly driven by operational efficiency and new opportunities (McKinsey&Company, 2018)[3].

First, as the internal combustion engine becomes an electric motor, the space occupied by internal components decreases (Yeomin Kim et al., 2014). If there is an electrical connection, then the mobility works. So, inner parts can utilize other space than only bonnet (Figure3). Because of this, the degree of freedom in 'Mobility Structure and Internal Configuration' increases. Also, the constraints of the spatial structure design to satisfy 'Indoor Collision Control Regulation' are reduced or eliminated, because no car accidents occur in fully ideal automotive driving (Sang Koo, 2018).

Figure 3. The bonnet of Tesla Electric Vehicle: This image shows that EV can get free arrangement of inner parts (AutoExpress, 2015)[4].

Second, in terms of 'Interior Design', the boundary is broken down. The interior space of current car is divided into 'Driver Space' and 'Passenger Space'. 'Driver Space' is a space for a work called 'Drive', and 'Passenger Space' is a space for 'Dwelling' (Sang Koo, 2018). However, in the era of autonomous driving, the driver is free from a fixed posture or work (Figure4). As a result, the interior design of the autonomous vehicle changes according to the concept that the driver is released from driving (Yeomin Kim et al., 2014).

Figure 4. Autonomous driving Interior design of Volvo 360c Concept: This image shows the change of car interior from 'for driving' to 'for dwelling' (Netcarshow,2018)[5].

Third, in terms of 'User Experience', various activities become possible because the user is freed from 'driving'. First, remove the 'foot' that the driver used to accelerate/decelerate. Next, remove the 'Hand' that you were holding to steer. Finally, by removing the 'eyes' that are watching the front, your interests and activities become more freely (Boram Gu et al., 2017). As a result, today, the emergence of the 'Autonomous driving E.V' will make a big change in the future city and in the future lifestyle (Seoul Design Research Institution, 2018), just like when the 'Internal Combustion Engine Vehicle' first appeared in the late 19th Century. The purpose of this thesis is to clarify what direction the 'Mobility' should pursue by chronological data collection and analysis of mobility development with lifestyle change. The future trend of lifestyle and mobility are identified and applied to a design concept, because 'Mobility' reflects changes throughout technology and socio-culture. Also, the thesis aims to inspire for mobility development by proposing future mobility design.

2
Mobility Development and Lifestyle Change

· Mobility Development and Lifestyle Change
· Future Mobility and Future Lifestyle

2

Mobility Development and Lifestyle Change

   What is next generation mobility? What is the direction of future mobility's form and role? To answer these questions, let's go back to the beginning of mobility (In this thesis, the research range of mobility to investigate is the mobility on the ground, such as palanquin, carriage, automotive and so on). Tomorrow of mobility can be predicted through yesterday and today of mobility which contains the technology and social-culture of the time. At the same time, considering the 'lifestyle of users' that have changed over the period, it would be a prediction with more practical value. Joachim Scheiner and Brgit Kasper explained that lifestyle and daily mobility are connected. Also, mobility research and transport planning should be considered for urban planning (Joachim Scheiner et al., 2003). In this thesis, 'Lifestyle' means that a composite of motivations, needs, and wants and is influenced by factors such as culture, family, reference groups, and social class (Veronique Van Acker et al., 2016). The thesis tries to predict the future that can be applied based on factors that have development potential in the flow of the times. Figure5 shows overall view of mobility development flow. This chapter will investigate the flow and trend of mobility with lifestyle change.
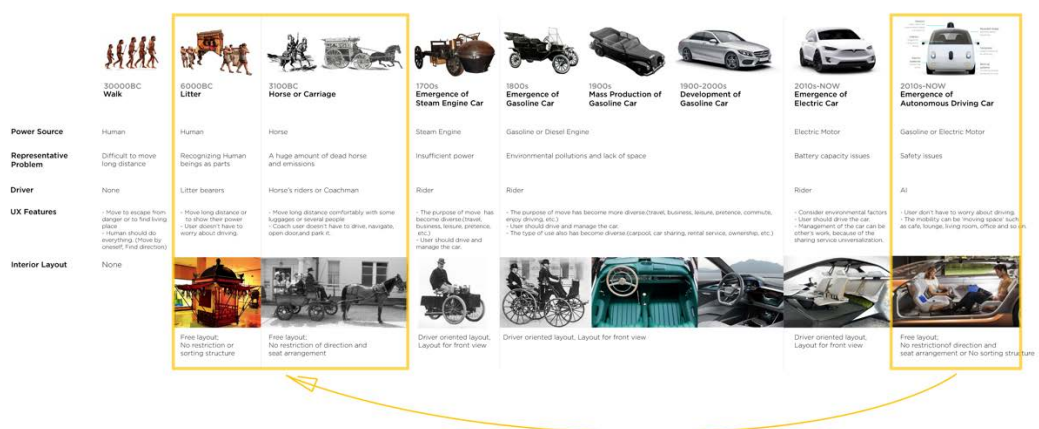
Figure 5. Mobility Development Flow

2.1 Mobility Development and Lifestyle Change

2.1.1 Palanquin

In 6000BC, a man of high power used to take the mobility 'Palanquin' with the slaves as power source in ancient Egypt (David G. Burke, 2016). The 'Palanquin' is used not only to move longer distance than before, but also to show their power (Figure6). At that time, slaves and people who are low status was treated as a component like Eqyptian sunshade's one (John McDonald, 1999). So, the power source and driver of 'Palanquin' is palanquin bearers. The 'user'(A person of high status) doesn't have to worry about driving, because 'palanquin bearers' was looking for the way to go, fleeing from the enemy, and doing all the work of burdening.

Figure6. Ancient Egypt Palanquin(Left)(Pinterest, unknown)[6]. and Ancient Egypt Throne and space(Right)(GAZETA DO POVO, 2015)[7].

Also, if the user say something, then all the requests were answered. In terms of UX, this is the first operation of autonomous driving. Users don't do any work, they just enjoy moving with looking around, talking, or eating. So, most palanquin interior have free layout (Julian CT Baker, 2014). There is no restriction or sorting structure. The user can take various poses during move. This was a form of mobility before the wheel was invented. Later, palanquin was often used in countries where mobility and road development was slow. At the time it was used, it was mainly used by high-ranking people (such as royals, and high-ranking women and so on) to travel or move. It was more useful to block the sunlight, and to avoid the rain than riding animals (Julian CT Baker, 2014). In this time, the things that palanquin offers to the users are: *Individual palanquins were highly customizable depending on the need, social status, and/or*

journey for which they were commissioned. Amenities for reading, writing, eating and sleeping were provided. In addition, depending on the mood of the traveler, readers, singers, dancers or storytellers accompanied (Chakrabarti, M., 2017). Through these things, three key factors of palanquin that offers to the user can be analyzed. First, user could experience sense of superiority by showing their customized palanquin and their appearance riding on it (Chakrabarti, M., 2017). Second, user can get a space like a small home in terms of various activity is available. In other words, user can experience various activities such as reading, writing, eating, and sleeping. They should take long time in the palanquin, because the velocity is too slow. In other words, palanquin has 'dwelling' factors. So, various activities are necessary naturally. Third, there is an 'interaction' with the vehicle through palankeen bearers or some followers as a part of palanquin. They offers services and contents such as dance, sing, story and so on. These three things are reason of palanquin is called 'the wheel-less luxury cart (Chakrabarti, M., 2017).

2.1.2 Carriage

In 3500BC, the first wheel was invented and an opportunity for mobility innovation was opened (Richard W. Bulliet, 2016). According to the book 'The Wheel: Inventions and Reinventions', starting with the invention of wheels, 'Wagons' and 'Carriage' (Figure7) were created that uses axial force as a power source. In 16th Century, European noble men gradually abandoned their attitude of ignoring wheeled vehicles, and began to ride the 'Carriage'. In early 17th century, the coach revolution is broken out in England. The carriage performed various roles (Richard W. Bulliet, 2016). At this time, people with low status were also treated as 'parts' rather than people(user) like the previous periods.
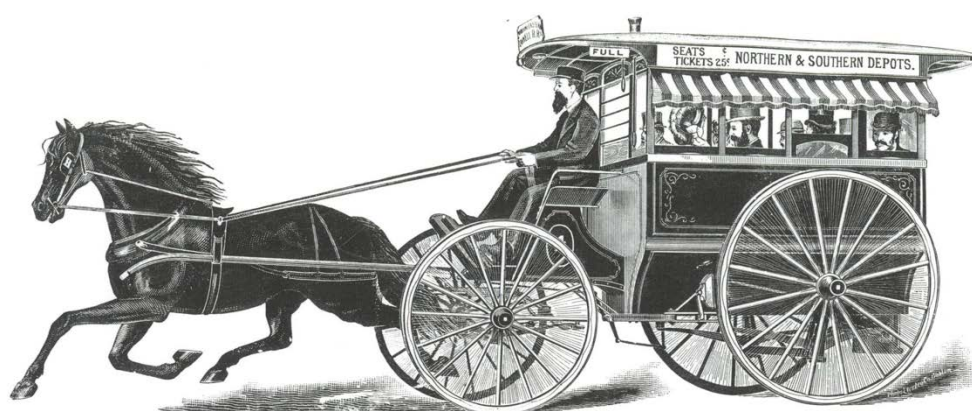
Figure7. Horseman and Carriage(Peter Herdic, 1881)[8].

In other words, people with high status were the user, and horseman was recognized as a part of the carriage. The user didn't have to worry about driving like palanquin user, because horseman did various roles such as driving, navigating, opening door, ballet parking, door-front service, V2V(Vehicle to Vehicle), etc. As the period of using the carriage was long, the user was able to experience more advanced autonomous driving more and more. Because of this automatic system, the interior and layout of the carriage was freely configured and could appear in various forms (Ara Kim et al., 2015). We can find layouts that are not related to driving such as the forward one seat layout, forward two seats layout, facing two seats layout, sitting round layout (Figure8). However, as the popularity of the carriage skyrocketed, new problems arose: the problem of horse's scum and mud, the problem that the stone pavement is broken due to the rolling wheels, the lacks of space from lots of carriages that the upper class possesses (Richard W. Bulliet, 2016). The problem was serious enough that the British Parliament had discussed a bill restricting the abuse of carriages in 1601. Research into mobility using new power sources has continued as a solution to this situation.
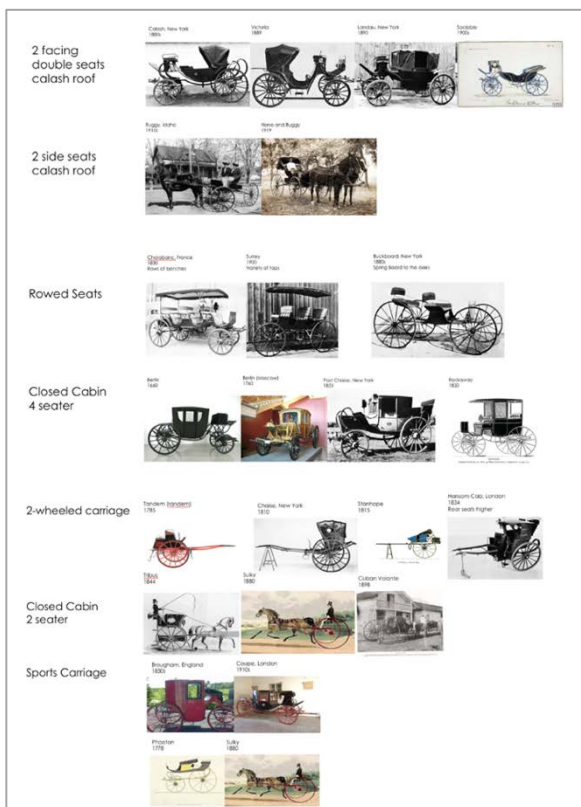
Figure8. Various Forms of Carriage depending on the interior layout

2.1.3 Emergence of Steam Engine Car

The history of mobility is in line with the history of internal combustion engine or engine development ("The history of Automotive," 2014). In 1769, Nicholas Joseph Cugnot created a steam motor mobility that led to a change from horse to internal combustion engine (Figure9). It was made to move heavy cannon more quickly and easily. But, it was difficult to steer because of the heavy boiler and cylinder in the front part. Also, there was no brake, so users could not stop the car. From this point on, the power source began to develop from horse to engine. Steam engines were revolutionary at the time, but engineers constantly studied smaller, lighter, more efficient power sources ("The history of Automotive," 2014).

Figure 9. Steam motor mobility that is invented by Nicholas Joseph Cugnot (WikimediaCommons, 2005)[9].

2.1.4 Internal Combustion Engine Car

Style of Automotive has been changed to various types that reflects socio-cultural issues since end of the 19th Century (Myung-Ki Lee, 2002). Since the invention of Daimler's wheel in 1889 (Figure10), Benz has developed the tricycle. In 1889, Daimler developed a four-wheeler equipped with a gasoline engine("The history of Automotive," 2014). With the emergence of internal-combustion engines, problems caused by the existing power source 'horse' gradually appeared to be solved (Richard W. Bulliet, 2016). Also, the disappearance of 'Coach man', a part of the wagon, has made a big different of UX. First of all, a 'driver' has emerged, because 'user' became 'driver'. Users have been involved in finding their own way and driving. In terms of interior layout, they were all limited to forward-facing layouts in order to ensure a forward view.

Figure 10. Daimler's Wire Wheel Car (Speeddoctor, 2010)[10].

In the early 1900s, the advent of mass production accelerated the supply and development of internal combustion engines. Especially, the time when the automotive became aware of its importance as an authentic design object started from 1930(Myung-Ki Lee, 2002). In the thesis of 'Forecasting Study for the Future Automotive Design Trend' (Myung-Ki Lee, 2002) and the book 'Industrial Design 150years' (Sihwa Jeong, 1991), trend of design and social factors are investigated. In 1930s, automotive became an independent commodity, and from that time the concept of 'model change' gradually began to settle. In 1940s, USA has social factors such as Art Deco, Ideology, the Second World War, and Stabilization of economy. So, box type, and lineal design is the style trend that is affected to the social factors. In 1950s and 1960s, it is called the 'Baroque era of automobiles' as the greatest generator in the automobile industry as the world moves from the long recession to peace and prosperity (Byung-gi Seo, 1981). Therefore, the most colorful and diverse designs have been tried in automobile style. In this time, some style keywords summarize mobility design trend: Wrap around window, Tail fin (Figure11), Bumper grille, Sweep side trim, Jet style rear lamp, Air scoop, etc (Sang Koo, 2010). But, the exaggerated and extravagant design was pointed out that is oblivion of design philosophy (Sihwa Jeong, 1991). In the atmosphere of this design reflection and awareness, Citroen's 'DS19', born from the spirit of French rationalism, attracted popularity with its unique value (Figure12).
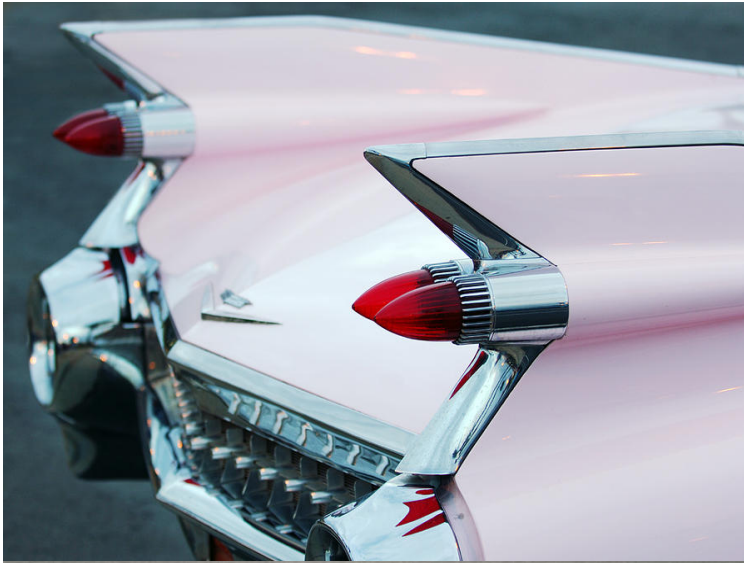
Figure 11. Tail fin of Cadillac Eldorado (Jill Reger, 2010)[11].

Figure 12. Citroen 'DS19' (Bob Marlow, 2014)[12].

In 1970, mobility design faces big change by crucial social factors such as exhausted gas, fuel consumption due to oil shock, and strengthening automobile safety standards. Compact and economic mobility design is emerged. Fuel-saving compact cars of Japan is a new trend design (Myung-Ki Lee, 2002). In 1980s, 'aero styling', which takes aerodynamics into design due to a lot of interest in science and technology, has started to become popular (Sihwa Jeong, 1991). Overall design in 1980s shows more soft and flexible form than one in 1970s. In 1990s, with the growth of electric, electronic and IT technology all over the world, the concept car concept that was not tried in the past was applied to actual production. In the middle of 1990s, the overall trend of automotive design has changed to a style that combines a sharp edge line with a bold curved surface. In 2000s, the integration of automobile and IT technology has been tried in earnest. With the development of GPS technology, navigation became very popular in that time. In addition, as people began to pay attention to environmental issues, hybrid cars began to

emerge (Sang Koo, 2010). In this way, mobility that have undergone social change have gradually begun to be perceived as living props that represent the user's lifestyle in the mechanical concept of transportation (Kyungsil Cho, 2010).

2.1.5 Electric Car and Autonomous Driving Car

In 2010s, Starting with Tesla's initial release of electric roadster in 2008 (Figure13), changes from 'gasoline'-based internal combustion engines to 'electric' motors is underway (Sangkyu Hwang, 2010). Furthermore, with the development of advanced technology, IoT and high-level AI have been applied to vehicles (Yonghoon Kim et al., 2017). With the development of AI, partly 'autonomous driving' became possible, and the application of these technologies changed the interior structure of mobility, interior design and exterior design (Sang Koo, 2018). 'AI' becomes 'Driver', and the user is released from driving. Also, the concept of 'Car Sharing' is one of the trends in all around the world (Warwick Goodall et al., 2016). 'Car sharing' is emerging as the most realistic and efficient alternative to social problems such as parking, traffic congestion, and air pollution (Jae-seung Roe, 2017). This change in mobility usage naturally affects the next generation of mobility forms and UX factors.

Figure 13. Tesla Roadster (NAVER, 2008)[13].

2.2 Future Mobility and Future Lifestyle

The emergence of vehicles and development history reflect socio - cultural characteristics like other product designs, and they are represented by the trend as the history of science civilization, and have created the image of the age (Kungsil Cho, 2010). Also, John urry, the professor of sociology at Lancaster University, said that 'Mobility' will be shown to be utterly significant in their own right and needing to be understood in terms of the social relations that surround and implicate them. And using the mobility analyses to engage with and promote new analyses of a range of social science topics through various novel concepts, especially network capital, meetingness, interspace, the post car and various scenarios of the future (John urry, 2007). In this chapter, we look at trends in lifestyle and compare how mobility reflects such trends to understand more clearly the development tendency of future mobility, because mobility development reflects lifestyle change.

2.2.1 Lifestyle Trend

Big data, IoT(Internet of Things), AI(Artificial Intelligence), Robotics, and Autonomous driving, etc. These technologies are converged to other things, and the fusion or convergences recently are called the 'Fourth Industrial Revolution'(Maynard, A. D., 2015). The revolution is leading a great change in industry and lifestyle, and is interacting with other socio-economic and demographic factors to create a perfect storm of business model change in all industries (World Economic Forum, 2016). In the following, the key findings from various lifestyle trend reports are investigated.

- *Solo Economy*
- *Millennial generation:* Change of values, Increase of desire for self-realization
- *Ethical Consumption*
- *Bleisure: Secure travel and leisure time in business*
- *Generalization of Luxury Industry*

#Solo Economy

Eric M. Klinenberg, a professor of sociology at New York University, noted that 'one of the most rapid changes in modern social phenomena' is 'Increase of single-households'. The reasons for the increase of 'Single-households' are the rise in women's status, the

telecommunications revolution, the formation of large cities, and aging (Eric M. Klinenberg, 2012). Euromonitor predicts that single person households will be fastest growing household profile in 2016-2030 worldwide (Lydia Gordon, 2017) (Figure14).

Global Households by Family Type, 2016–2030
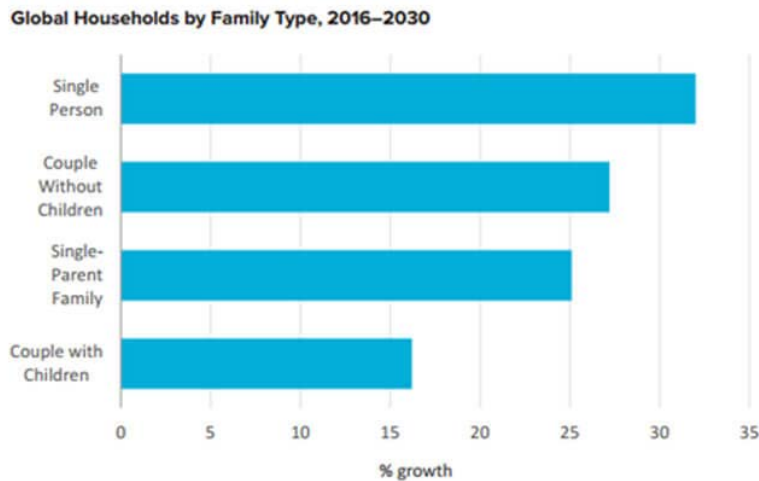
Figure 14. Proportion of Single Person Households Worldwide (Euromonitor International, 2014)[14].

This lifestyle has had a major impact on consumption habits and mobility patterns. The book 'Going solo(Eric M. Klinenberg, 2012)' bespeaks that the increase of people living alone makes the increase of demand in 'Single personalized service' such as share-house or apartment(not a detached house), small-sized furniture and small-sized home appliances(There is no need for large-volume products for those who eat alone), personal mobility(bikes, Segway, electric kick-board), small-amount food and convenience foods(Figure 15). The phenomenon of offering products and services on an individual basis is increasing. They express their lifestyle by living in small residential area that is compact and practical, and purchasing the small-sized modular furniture (KIDP, 2017).

How often do you buy
single-amount or convinience foods?
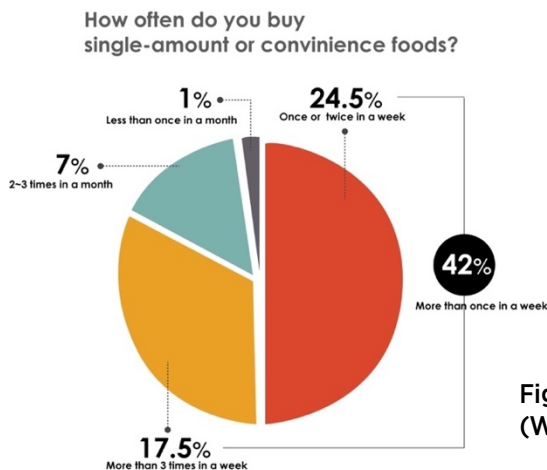
Figure 15. Food consumption pattern (Weber Shandwick, 2014)[15].

#Millennial generation: Change of values, Increase of desire for self-realization

Mr. Choi, American factory in Los Angeles, said that "In many groups of single-household, 'millennial generation' is a noticeable consumer group that is the biggest consuming group mainly in the USA.". The US Census Bureau predicts that the workforce of the Millennial generation will surpasses one of the baby boomers, so the purchasing power of the millennial generation will increase even more in 2015 (Jongwoo Choi, 2017). The features of Millennial generation are that they have high self-esteem, personality, and firm their own taste more than any other generations. They pursue individual happiness, and prefer value-centered consumption and experience consumption (KIDP, 2017). As a result, there has been some consumption trend: Share economy, Ethical consumption, vaule-centered and experience-centered consumption. 'Share economy' is led by growth of sharing service and products, because Millennial generation has less repulsion to the concept of 'Share'. The strength of 'Share economy' is that user can use the products without the burden(accompanying financial costs from maintaining and repairing) that emerges as user owns something. The main user group of 'car sharing' is young generations 'Millennial generation' because of financial crisis of 2008, radical development of public transportation, the extension of downtown area, the maintenance cost of personal ownership car (Carplus, 2015). 'Sharing' is representative one of the most popular service types that is emerged by the Millennial generation's lifestyle. Additionally, 'car sharing' is considered to be the most realistic future mobility to alleviate the burden of vehicle ownership and alleviate the chronic traffic problems in the city (Briggs et al., 2015). The service is growing up with getting support of automotive corporates and government because of this popularity and strength. For instance, 'Uber', that is the representative enterprise of ride-sharing service, is the platform that can connect user and personal taxi (Figure16). In London, England, explosive growth of about 850% was recorded in two years (KIDP, 2017).

Figure 16. Ride sharing service 'Uber' (Ride Sharing Forum, 2017)[16].

#Ethical Consumption

As mentioned in the paragraph above, millennial generations tend willing to pay high prices if they can get the 'value' they think. According to the 'Financial Times', the organic food consumption has doubled in 11 years since 2003 to $29.4billion (Wonsung Na, 2018). Also, according to the Deloitte research, the millennial generation is likely to pursue eco-friendly consumption in automobile purchases. So, Bloomberg predicts that electric vehicles would account for 35% of all new vehicle sales (Figure17).
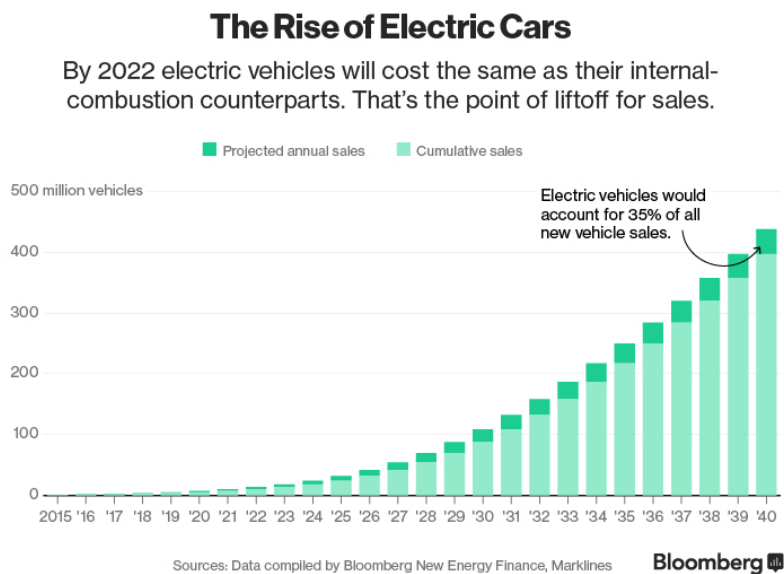
Figure 17. The Rise of Electric Cars (Bloomberg, 2016)[17].

In these days, millennial generation tend not to buy unconditionally new cars like the past generations, but to purchase by considering eco-friendly performance. 59% of 75% respondents who said they wanted to buy answered that they would opt for cars that use eco-friendly alternative powers(Hybrid electricity-27%, Plugged in Hybrid-8%, Electric battery-7%, Natural gas-7%, Diesel-6%, Fuel cell-4%) when purchasing a car (Deloitte, 2018).

#Bleisure: Secure travel and leisure time in business

Millennial generation values on the experience and valuable activity, they move

aggressively to secure travel and leisure time in business for balance of their life (KIDP, 2017). Especially, the phenomenon that the boundary of work time and rest time is removed work time makes that people secure their personal rest time in the extra time of business trip. The report 'Future of travel' of Expedia, global travel enterprise, focuses on the millennial generation, and their travel features that their business trips lead to personal travel (expedia, 2013). This shows that there is a need to utilize the extra time among the business schedules. The proposal of some contents about the needs can be attractive point of service and products. Also, Stephanie Joseph-Flatts, manager of brand integration and marketing solutions, refers 'Bleisure(Mixing business and leisure)' is the new concept of travel that is from the features of Millennials that base their entire career decisions around the ability to travel (Figure18).

Figure 18. Infographic of 'How Millennials Are Changing Travel' (Stephanie Joseph, 2017)[18].

In millennials' traveling trend, five features are summarized: Online engagement, Be

mobile, Secure loyalty through better rewards, Embrace spontaneity, and Be authentic (Stephanie Joseph, 2017).

#Generalization of Luxury Industry

According to experts, it is impossible to plan for the future with centering on the values that existing luxury brands are aiming before. The younger generation became more familiar with digital, and the consumption tendency is changing from the old one. According to the consulting agency 'Bain', in 2025, the largest consumer segment, which accounts for 45% of the luxury market, has selected the Millennium generation and the Z generation (Consulate general of the Republic of Korea in Los Angeles, 2017). For targeting the millennial generation, Louis Vuitton and Supreme collaborated together to show fresh image and new expression of young generation (Figure19). Additionally, the collaboration was so popular that young buyers waited in line for all the night (Jiyeon Yoo, 2017)(Figure19). So, millennial generation's core value impacts on the various industries, even the luxury industry. Especially, luxury products are generalized to millennial generation, because they generously invest in what they want to do, and what they can express themselves. Also, they share the luxury products to experience various luxury things. Wim pijbes, who is the director of Rijksmuseum, said that "The luxuries of a few upper class and elites have ended. Now you can find luxury anywhere on the street. It is supplied to anyone. It is time to redefine the definition of popularized luxury. Luxury is moving rapidly from 'ownership' to 'being', and 'sharing' is becoming 'ownership' of a new concept. There is no luxury that one person can only own. It is a real luxury to be able to express your own experience of enjoying luxury in the way you want. Also, the freedom to express yourself, and your own unique presence is a real luxury."(Hana Goo, 2016). According to the luxury market trend materials of 'Samsung Fashion Research Institution', The trend of global luxury market is changing from 'purchasing the products' to 'expereincing the luxury' (Jimi Kim, 2015). A world-class luxury company such as LVMH began to invest in the hotel industry by considering that experience is more important in many consumers (Glion, 2018). Synthetically, The existing luxury was the culture and property of the upper class, but future luxury should become 'Luxury for everyone', because the point of view and aiming value are completely changed. Experts emphasize

that there is a future trend in the convergence of luxury and IT, and products that can sell experience (Glion, 2018).

Figure 19. Top image is Collaboration of 'LOUIS VUITTON & SUPREME', and Bottom image shows that people who waits for the collaboration products sales in front of Louis Vuitton Store in Los Angeles(wonhee Cho, 2017)[19].

2.2.2 New tendency of Mobility Concepts

Automotive companies show their future vision through concept car. The concept cars presented by various automobile company are grouped and summarized with the following three key items:

- *Emergence of Modular and Extendable ECO mobility concept*
- *'Personal Electric Vehicle' that specialized in distinct purpose*
- *Differentiation through 'Luxury'*

Emergence of Modular and Extendable ECO mobility concept

Recent mobility is changing to provide more various and comfortable 'mobility services' that pursue the value of time between moving and moving. Also, it is recognized that actively accepting and coping with such conceptual changes are important by mainly car companies(OEM) (Jaeseung Roe, 2017). Sung-keun Kim, who is the head of future strategy department in Hyundai, said that "Automotive market' is changing from 'Manufacturing business' to 'Service business', so we should focus on the 'contents' that mobility delivers." in 2018 smart Transportation Innovation Global Workshop. Also, Deloitte in 'The future of mobility: What is the next? (Scott Corwin et al., 2017)' predicts that "The experience of mobility(In-vehicle) will be the factor that define the future of mobility more and more.". Volvo already announced through partnership with Netflix in January, 2016, that user can enjoy the live streaming in commuting time (Jordan Golson, 2016). At this point that internal content becomes important, automotive companies are proposing concepts that can change types of internal contents(interior or role of the mobility) variously by using modular basic form rather than fancy form. As a sharing vehicle, it is a concept that combines two exterior things: The platform that offers moving function, and module that interior can be changed. So, this 'ECO' concept is economical, and eco-friendly concept that physical part of the mobility is used sustainably by considering environmental impact, and interior contents can be changed. Sharing concept is embed into the system: not only by users, but also by the mobility itself.

The representative example concept that can show this 'ECO' concept is 'E-Palette' of Toyota (Figure20). E-palette is an automated, electric, flexible vehicle concept by Toyota that can be tailored to various needs and lifestyles (Nargess Banks, 2018). The car was announced at CES alongside the e-Palette Alliance, a partnership which will see Amazon, DiDi, Mazda, Pizza Hut and Uber collaborate on vehicle planning, application concepts and vehicle verification activities. Toyota, says its president Akio Toyoda, is planning to develop a suite of connected mobility solutions through this new business partnership with a focus, at this stage, on developing the e-Palette concept vehicle (Nargess Banks, 2018). Renault published 2018 'EZ-PRO' concept (Figure21) that is sharing service mobility to offer moving business opportunity such as delivery, café, etc. More specifically, the concept of how to change the module is also presented, and the 'EZ-GO' concept of

a urban sharing EV is proposed with a similar basic formative exterior (Figure22).
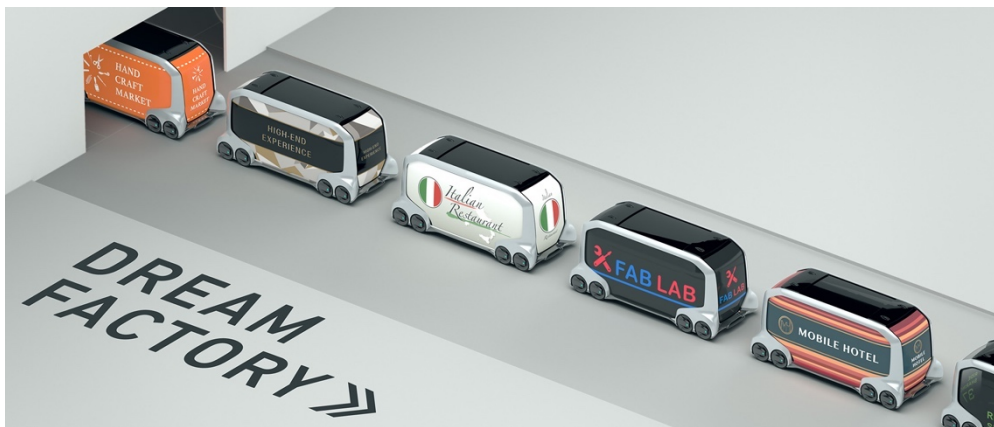
Figure 20. Toyota 'e-palette' Autonomous EV Concept (Toyota Global, 2018)[20].

Figure 21. Renault 'EZ-PRO' Autonomous EV Concept (Netcarshow, 2018)[21].

Recently, Mersedes-Benz presented '2018 Vision Urbanetic Concept (Figure23)' that can share a mobility like as public transportation. Figure 26 shows the combination of

platform and people-mover module. Mercedes-benz says that it enables on-demand, sustainable and efficient movement of people and goods- and applies an innovative approach to fulfil the needs of cities, businesses from diverse sectors as well as city dwellers and travelers (Mercedes-Benz, 2018). It has main platform that offers moving function, and optional cabin that define its' use (Figure24). As a future mobility concept trend, various automotive companies suggests their own systemic platform with the vision how the concept can utilize.

Figure 22. Renault 'EZ-GO' Autonomous EV Concept (Netcarshow, 2018)[22].
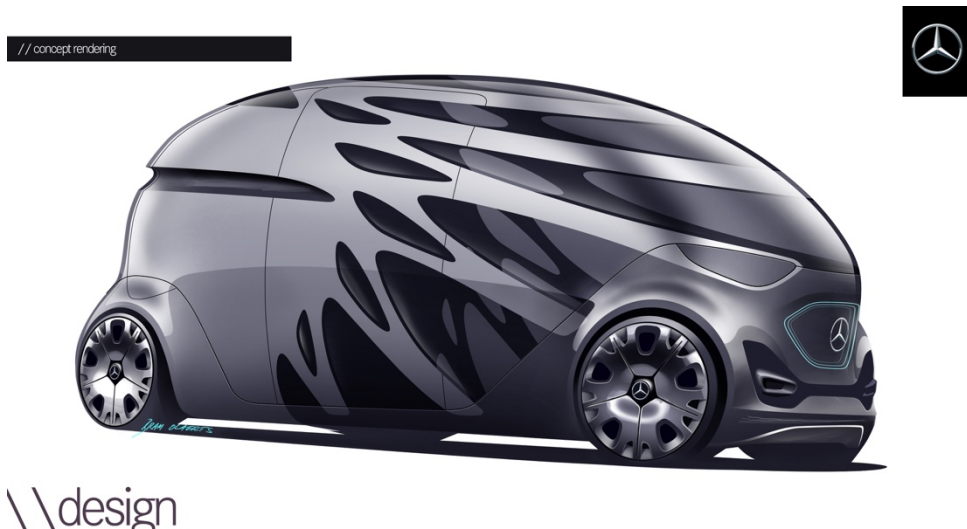
Figure 23. Mercedes-Benz 2018 'Vision Urbanetic Concept' (Daimler Media, 2018)[23].

Figure 24. Mercedes-Benz 2018 'Vision Urbanetic Concept' modules and Main platform (Mercedes-Benz, 2018)[24].

'Personal Electric Vehicle' that specialized in distinct purpose

One of the trends in future mobility is micro-sized personal mobility, although it can be thought of as a reverse vision from the above sharing concept. Cheolbae Lee, who is director of innovation business center in LG electronics, said "Personal mobility will be used like as smartphone." (Jaemoon Kim, 2015). According to a survey by the Korea Transport Research Institute, the personal mobility market in 2016 was 60,000 units. In 2017, it grew by more than 20% up to 75,000 units in the first half of the year. Currently, 66% of workers in urban areas have private cars, and the average distance traveled by private vehicles is 60% within 10km. Also, most the number of passengers is less than 2 persons (Heecheol Shin et al., 2016). Likewise, One of the big trends of future mobility is the 'Personal Mobility', as the share cars increase. Below will take a closer look at the direction future mobility should pursue. Giorgio Rizoni, a professor at the Ohio State University in the United States, said of Smart City: "To develop into a smart city, a proper compromise between 'personal transport' and 'mass transport' is necessary (Giorgio Rizoni, 2017)." In the book 'Moving Future' written by Seoul Design Research Institute, the flow of the various parts of the region must has 'Continuity', and 'personal mobility' is essential to combine with urban infrastructure. In particular, 'Personal Mobility' connects the parts that public transportation and sharing services cannot fill.

In addition, Sang-woo Lee, a cultural critic of transportation and humanities, said "Personal mobility, a small personal transportation system with the concept of one or two passengers by using environmental-friendly fuels such as electricity, is emerging as the core in the smart mobility era" (Sang-woo Lee, 2016). Single-household is increasing, and as it evolves into smart city, easy-to-use personal mobility will take charge of the last miles in public transportation (Seoul Design Research Institute, 2018). Experts emphasize focusing on the coexistence of both personal mobility and sharing car, and focusing on the role each can play, rather than seeing just one of the two (Warwick Goodall et al. 2017). What about automotive companies' vision for this personal EV? Looking at the trends in the concepts presented at recent motor shows, they present a concept that is specialized to a specific purpose that can fill the empty part in the role of sharing services or public transport.   First, look at the concept EV presented by Honda, they presented the concept by segmenting the mobility depending on the purpose: NeuV, Urban EV, Sports EV, 3E-A18, 3E-B18, 3E-C18, 3E-D18. NeuV concept(Figure25), which stands for New Electric Urban Vehicle, was conceived to take advantage of the fact that privately-owned vehicles sit idle for 96% of the time. The pure-electric concept car explores a financially-beneficial ownership model for enterprising customers, by functioning as an automated ride sharing vehicle when the owner is not using the car (Netcarshow, 2017). The rest concept is specialized mobility to other roles rather than the concept of 'sharing'. Urban EV Concept (Figure26) is a private mobility for commuting in the city and Sports EV Concept (Figure27) is specialized in enjoying more speedy driving and traveling.

Figure 25. Honda 'NeuV' EV Concept (Netcarshow, 2017)[25].

Figure 26. Honda 'Urban EV' Concept (Netcarshow, 2017)[26].

Figure 27. Honda 'Sports EV' Concept (Netcarshow, 2017)[27].

Additionally, the 3E concept series (Figure28), Robotic Personal Mobility, interact with people and have a slightly more specific purpose. The 3E-A18 is a communication robot concept developed with "empathy" as its theme, to have compassion toward and blend in with people's lives. The 3E-B18 is a platform mobility device designed upon the concept to "empower," to support everyday activities, and mobility right up to the desired destination. The 3E-C18 is an AI-equipped robotic device designed to "experience" and grow together with people. By interacting with people, the 3E-C18 learns, and grows to be more useful to people. Replacement upper attachments allow the 3E-C18 to act as a platform for product sales and mobile advertising. The 3E-D18 is an AI-equipped platform robotics device built to "empower," to expand the possibilities of people. By replacing the upper attachment, the 3E-D18 can perform various tasks such as fire-fighting, farm work and sports training support. Its off-road capabilities allow autonomous operation on rugged terrain such as farms and mountains (Honda, 2018).

Figure 28. Honda '3E(Empathy, Empower, Experience)' Concept (Honda,2018)[28].

In addition to Honda's concept, Smart's 'Vision EQ for two' concept (Figure29) is presented as the electric mobility for urban users. 'CoCo' mobility (Figure30), that is not a concept car, but it is used by Korea Yakult. It can be the example of personal mobility that has specialized use purpose. It is for individual beverage delivery in the city.

Figure 29. Smart 'Vision EQ For Two' Concept (Netcarshow, 2017)[29].

Figure 30. 'CoCo' mobility of Korea-Yakult (Korea-Yakult, 2014)[30].

 # Differentiation through 'Luxury'

'Future Mobility' is recognized as a living area beyond the meaning of simply moving products (Hokwang Ryu, 2008). The interior design is changing into the emotional factors that can give different satisfaction and experience through the digitalization and diversification of the CMF, from the technology-centered design in the past (Yeomin Kim

et al., 2014). Therefore, interior design is developing influenced by user's characteristics and lifestyle change. Especially, concept cars with contents aiming 'high culture' are proposed by the integration of 'Generalization of Luxury' concept mentioned in the above '2.2.1 Lifestyle Trend' and the tendency that 'contents' are considered importantly. Also, some concepts express luxury through the way of reinterpreting the culture of the past in a modern way. Particularly, Renault's EZ-Ultimo (Figure31) is presented as a future concept that gets motifs from the carriage 120 years ago (Figure32).
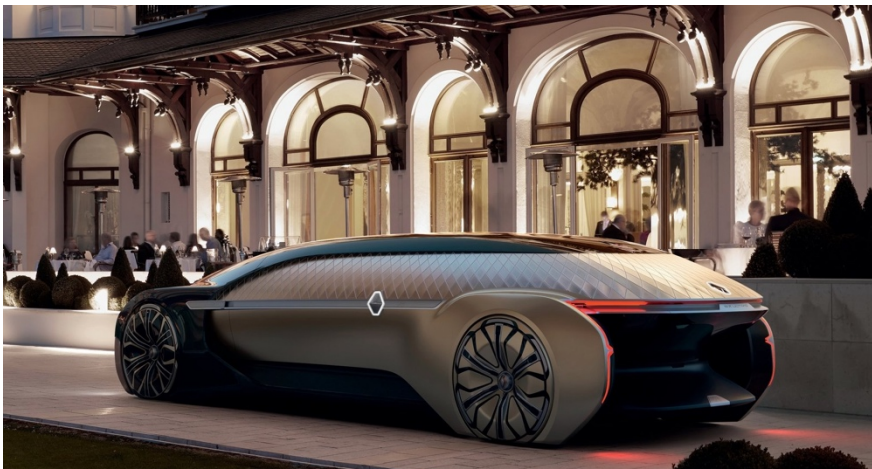
Figure 31. Renault 'EZ-Ultimo' concept (Netcarshow, 2018)[31].
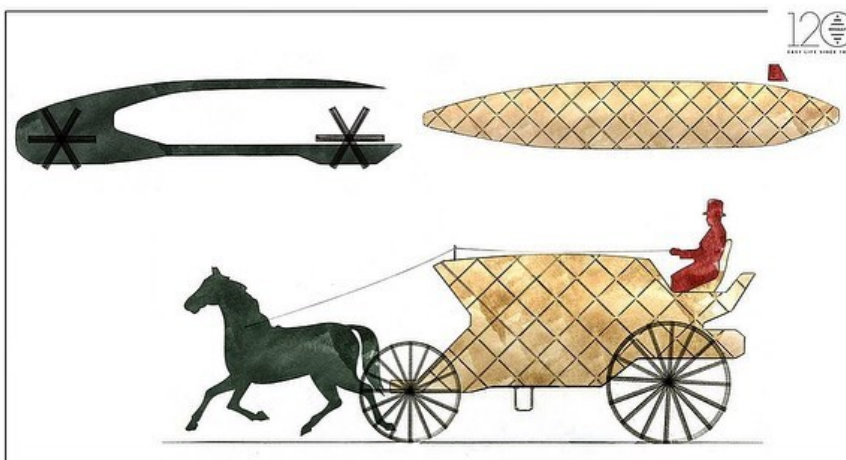
Figure 32. The motif image of Renault 'EZ-Ultimo' concept (Netcarshow, 2018)[31].

The concept is a robo-vehicle for a premium mobility service experience (Renault, 2018). "As consumer trends change and people are enjoying ride-hailing services more and

more, a new paradigm for mobility will emerge. Embodying this revolution, Renault EZ-ULTIMO offers a unique luxurious experience aboard a robo-vehicle that can be adapted depending on the service provider," said Laurens van den Acker, SVP Corporate Design. "EZ-ULTIMO will provide an exclusive experience for all. With autonomous, electric and connected cars, we are entering a new exciting era in automotive design (Renault, 2018)." Maybach's Vision Maybach Ultimate Luxury concept also shows an example of delivering luxurious and premium images through past cultures (Figure33). In this concept, Maybach brings the Chinese "tea" culture into the interior design and provides the experience of being in an antique living room.

Figure 33. Interior image of Maybach 'Vision Maybach Ultimate Luxury EV' concept (Netcarshow, 2018)[32].

In addition, Volvo's 360c Concept (Figure34) offers a VIP experience in the first lounge (Auto & Design, 2018). Through Peugeot's E-legend concept (Figure35), Peugeot wants to provide their users feel as comfortable in their car, but the user will in their own home (Peugeot, 2018). The various concepts that are emerging recently are pursuing differentiation through high quality luxurious experience. The 'luxury' contents highlight the advantages of EV, which can freely configure the indoor space. Also, 'Luxury' experience and design can enhance the trustworthy image so that there is no doubt about the reliability of the EV.

Figure 34. Volvo '360c' Concept (Netcarshow, 2018)[33].

Figure 35. Peugeot 'E-legend' Concept (Netcarshow, 2018)[34].

2.3 Conclusion

Chapter2 examined the mobility development with the lifestyle change, and investigated the future lifestyle trend and new tendency of future mobility. In conclusion, future lifestyle trend is concluded with 5 lifestyle trend keywords as below:

5 Future Lifestyle Trend Keywords

- *Solo Economy*
- *Millennial generation*
- *Ethical Consumption*
- *Bleisure*
- *Generalization of Luxury Industry*

Also, future mobility trend is concluded with 3 tendency keywords as below:

3 Future Lifestyle Trend Keywords

- *Emergence of Modular and Extendable ECO mobility concept*
- *'Personal Electric Vehicle' that specialized in distinct purpose*
- *Differentiation through 'Luxury'*

Through these trend keywords, mobility concepts that can reflects the key trends are conclude with below 'Concept Mapping Table (Table1)'. The table has two axises that is composed of lifestyle trend and future mobility trend. The matching point shows the potential opportunity concepts by combining both the lifestyle trend and future mobility trend. In the table, various concepts are suggested, and repetitive and similar concepts are categorized into a group using KJ method. Finally, 3 groups are categorized, and becomes the base of further ideation and final design output of this paper. Three main groups from the concept mapping table is as below:

3 main Groups from Concept Mapping Table

- *Personal Mobility that is for first mile and last mile to use sharing car or public transportation(Group A)*
- *Personal Mobility that is specialized in travel or relaxing(Group B)*
- *ECO Mobility that can be attachable, detachable each other depending on*

the purpose of use (Group C)

Table1. Concept Mapping Table

Future Lifestyle \ Future Mobility	Modular and Extenedable ECO mobility	Personal EV specialized in distinct purpose	Differentiation through 'Luxury'
Solo Economy	Personal Mobility that is for fist mile and last mile to use sharing car or public transportation	Personal Mobility that is specialized in the user's work Personal Mobility that is specialized in relaxing or travel	ECO Mobility that has customized interaction or interior only for the user
Millennial Generation	ECO mobility that can be attachable, dettachable each other depending on the purpose of use	Personal Mobility that is for fist mile and last mile to use sharing car or public transportation Personal Mobility that is specialized in relaxing or travel	Personal Mobility that express user's personality with luxurious brand
Ethical Consumption	ECO mobility that has systemical uniformity ECO mobility that can be attachable, dettachable each other depending on the purpose of use Personal Mobility that is for fist mile and last mile to use sharing car or public transportation	Personal Mobility that is for fist mile and last mile to use sharing car or public transportation	Luxury Personal Mobility that is composed of eco-friendly CMF, and inner parts. Personal mobility like as masterpiece so it can be used for a long time, and it is easy to change the interior or inner parts(like a house)
Bleisure	ECO mobility that can connect people who travel to same place Sharing ECO mobility for travellers ECO mobility that can be attachable, dettachable each other depending on the purpose of use	Personal Mobility that is specialized in travel or relaxing Personal Mobility that is specialized in business(work and meeting) Personal Mobility that is specialized in balancing life(work and rest)	Personal Mobility that offers cruise travel experience Personal Mobility for travel that form factor or metaphor from past culture or past mobility
Generalization of Luxury Industry	ECO mobility that offers luxurious experience like open-lounge ECO mobility that can be attachable, dettachable each other depending on the purpose of use(When it attached toghther, it makes more space like open-lounge or party room)	Personal Mobility that express user's personality with luxurious brand Personal Mobility that is customized only for the user	Sharing ECO Mobility that offers first class experience Personal Mobility like as masterpiece of fashion item

The definition and detail keywords of the groups are explained as follows. Also, related figures show the representative idea image that helps understand the group's definition and application:

A. **Group A: Personal Mobility that is for first mile and last mile to use sharing car or public transportation (Figure36)**
First mile means that user should walk or move some distance to use sharing car system or transportation system such as walking from home to the bus stop. Last mile means that user should walk or move to the exact destination from the sharing car parking lot or transportation station such as walking

from the bus stop to the office. Group A concept is the solution of the first mile and last mile problem that is the one of the main issues in using sharing car and public transportation. It is the personal mobility that connects user and public transportation or sharing car, so it offers 'Continuity'. Also, the mobility has 'Compact' size, because it is used just short time comparatively. Also, when it is not used, the compact size makes more space to park other mobility. Also, the feature of 'Transformation' can offer benefit to get more space as it is not used. In conclusion, group A can be summarized as follow:

Group A Keywords
 # Compact
 # Continuity
 # Transformation
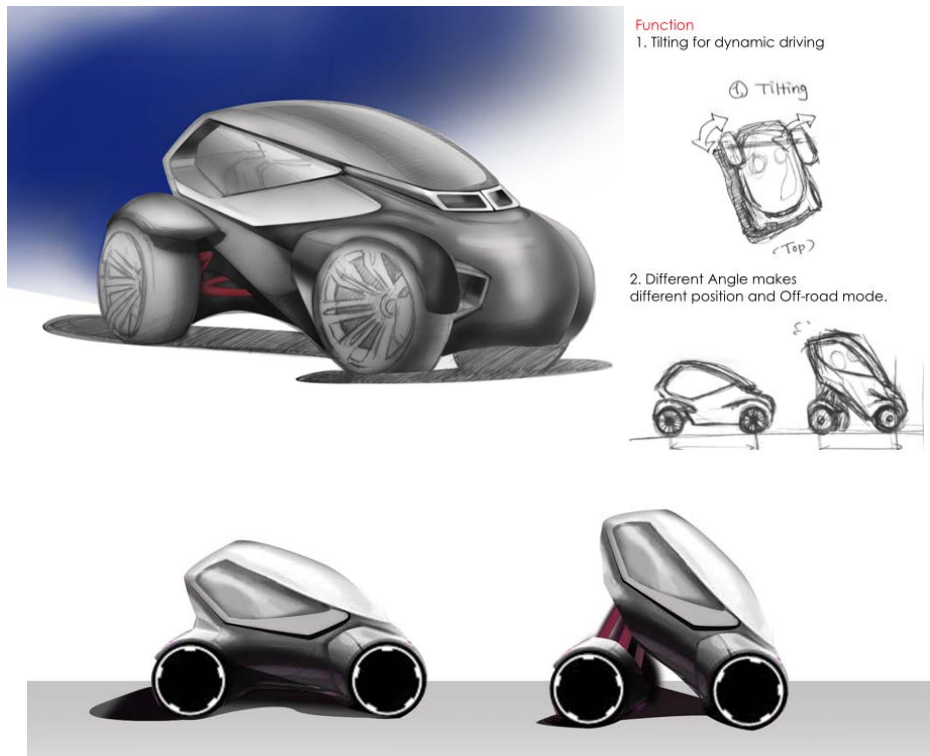
Figure 36. Concept Image of Group A

B. Group B: Personal Mobility that is specialized in travel or relaxing (Figure37)
Millennial generation has the tendency that keep balance of work and rest. So, 'bleisure' is the following phenomenon of the tendency. Group B improves

the quality of life by offering time for 'Relax' and leisure in busy days. In urban life, user can enjoy the travel or relax by the Group B concept. So, the feature of 'Openness' makes user feel 'Travel' experience and offers benefit to admire the scenery that they usually missed. 'Openness' in the place that user wants to stay makes user feel the breeze and the splendid scenery more. Group B can be summarized as follow:

Group B Keywords
 # Relax
 # Travel
 # Openness

Figure 37. Concept Image of Group B

C. ***Group C: ECO Mobility that can be attachable, detachable each other depending on the purpose of use (Figure38)***

ECO Mobility is eco-friendly, and economic concept through sustainably using the platform and module that can be changed depending on the purpose of use. Group C is the ECO mobility concept that offers another experience and appliance of space by using extendable the platform. So, there is a basic sharing unit like a platform, and the units are attachable and detachable. The unit has 'Uniformity' to connect efficiently. Also, the interior of the unit can be chosen by the user. So, the unit has 'Modular' features. User can make various module combination depending on their purpose of use. Also, 'Connected' factors are necessary to communicate each units, and to make users communicate in the mobility. In conclusion, group C can be summarized as follow:

Group C Keywords
 # Uniformity
 # Modular
 # Connected
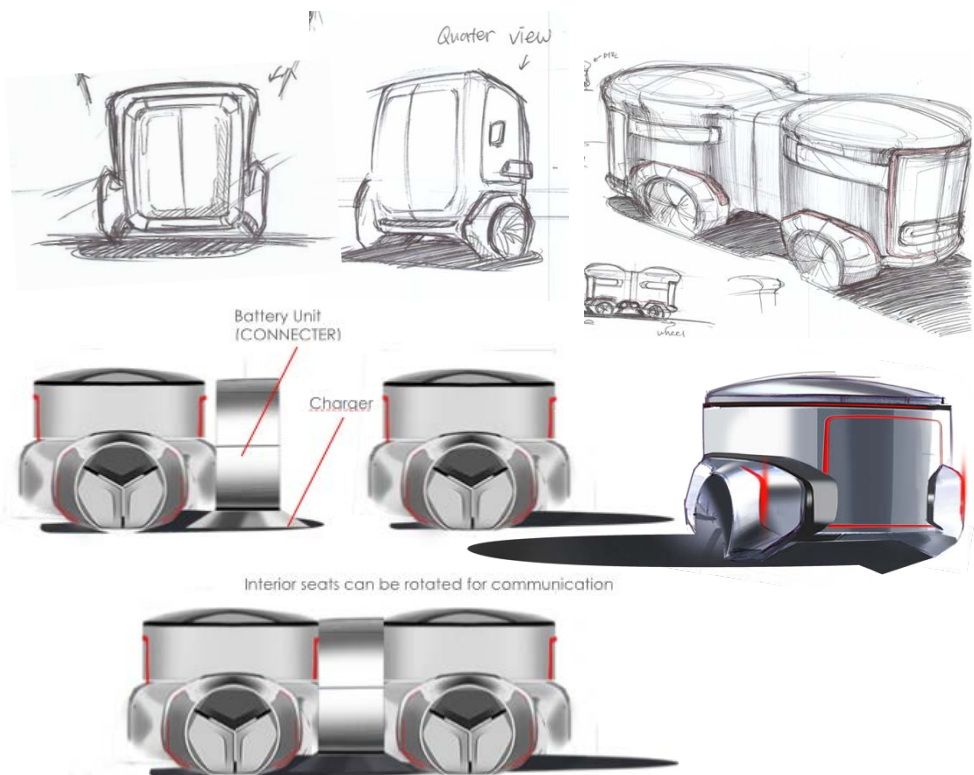
Figure 38. Concept Image of Group C

Three groups' features are defined as above. In next chapter, one group is selected to develop the concept more concretely among these groups. In the Concept Mapping Table, 'Group B' is mentioned as the largest number of solutions. Also, because the concepts of Group A and C were presented as concepts in other automotive companies, Group B is considered a group that could show more potentials and opportunities than other groups.

3
Future Mobility Concept Proposal

- Design Insights
- Design Process
- Concept Proposal

3

Future Mobility Concept Proposal

3.1 Design Insights

In this chapter, detail process of design development is explained. Before the design development of the Group B(Personal Mobility that is specialized in travel or relaxing), design insight research are investigated. In this chapter, design insight of the Group B development is explained. The insights will serve as a basis for further ideation and final design concept. The key words of Group B are 'Relax', 'Travel' and 'Openness'. In development process, 'Differentiation through Luxury' concept is also integrated to the key words to reflect the tendency of future mobility more. The developed design should contain and reflect the key words by form factors, functions, and user experience. The combination of key words makes more potential direction to develop. As the follow, design insights are organized related to the key words.

Design Insights from
- *Travel & Luxury: LOUIS VUITTON*
- *Relax & Luxury: Palanquin and Carriage*
- *Openness & Relax: Sunbed or bench in outdoor*

More detail background information and factors that is inspired are explained as below:

3.1.1 Travel & Luxury: LOUIS VUITTON

'LOUIS VUITTON' is the representative brand that has brand philosophy and design essence in combination of travel and luxury. The brand 'Louis vuitton' is originated from design of the 'Trunk'. In 1837, at the age of sixteen, Louis Vuitton stepped on the land of Paris and began his apprenticeship of 'Monsieur Maréchal'. At that time, wagons, boats and trains were the main means of transport, and the suitcases were treated roughly. The traveler commissioned craftsmen to protect their personal belongings and to pack them.

Louis Vuitton, who worked at the Paris workshop at Schumarelshall, soon gained credibility (Louis Vuitton, unknown). The history at this time is the root of Louis Vuitton's special deal. Also, the 'Trunk' of Louis Vuitton became famous and lots of people used 'Trunk' in their travel or move. At that time, there was no space for loading or storing luggage in the car. So, people carried the luggage bag 'Trunk' hanging on the back of the car with a strap (Figure39). Later, the space to load the back of the car is called as a 'trunk', because it was considered as a 'custom' that Louis Vuitton 'Trunk' tied on the back of a car, and so many people used it repeatedly. So, people began to use the word 'Trunk' as the meaning of 'Travel bag' and 'Luggage'.
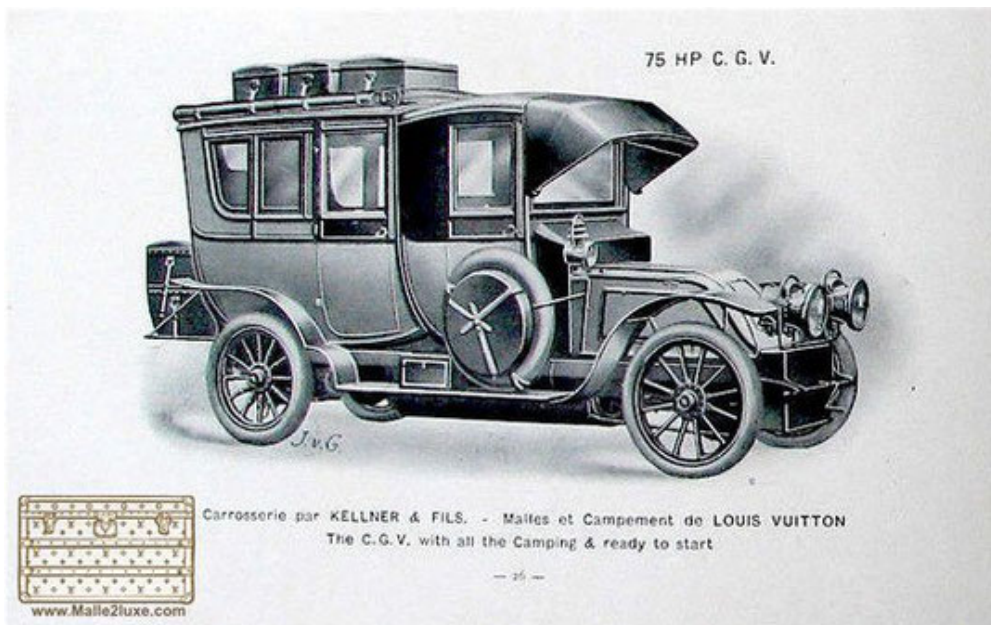
Figure 39. LOUIS VUITTON Trunk on the car in 1897(Malle2Luxe, unknown)[35].

With the brand heritage history, Louis Vuitton keep their 'Trunk' identity, and Trunk design of Louis Vuitton is evolving depending on user's life style and the way to travel. So, the design language of Louis Vuitton inspires to the concept development that has the theme both 'Luxury' and 'Travel' in terms of reflecting the lifestyle trend through the product and experience design. Especially, trunks reflect and contains each user's feature and life habit through customizing by the user. The trunk protects the contents with

substantial exterior, and offers the specialized experience that user pursue as opening it. According to the purpose of use and the contents that trunk should contain, the form and proportion of the trunk is changed appropriately. For example, in 1875, Louis Vuitton invented the first Wardrobe Trunk (Closet Trunk) to be installed vertically (Figure40-1). User can hang on both sides of this trunk, mainly considering the style of the user's apparel at the time that usually wear the dresses or long jackets. In addition, 'shoe trunks (Figure40-2)' is designed for 'shoe seller' users who have to carry many shoes in 1912, which are designed to be able to organize shoes efficiently for each size. In that time when people frequent take train travel and long-time travel, people in the past carried typewriters and books in trunk. Considering this, in 1954, Louis Vuitton produced a 'Special Library Trunk (Figure 40-3)' of monogram canvas material, and filled the contents with actively reflecting the lifestyle of people at that time. Through these Louis Vuitton products and heritage, two design insights are gotten to apply to this concept development:

Figure 40. Various Designs of LOUIS VUITTON Trunk depending on the purpose of use: Figure 40-1 is 'Wardrobe Trunk', Figure 40-2 is 'Shoe trunk', and Figure 40-3 is 'Special Library Trunk' (hae-In Kim, 2017)[36].

Summary of Design Insights

- ***The specialized functions and experiences are normally hidden and protected, and it provides users that as opening.***
- ***As providing the contents that focus on the user's lifestyle and the purpose of use, such a product can provide specialized expertise.***
- ***It is a travel-specialized concept. Users will be able to concentrate more on the specialized contents by offering travel-related products or necessary goods related to traveling because of 'Continuity' in use.***

3.1.2 Relax & Luxury: Palanquin and Carriage

According to the paragraph of ***# Differentiation through 'Luxury'*** of '2.2.2 New tendency of Mobility Concepts', many automotive companies get inspiration of 'Luxury' from past culture or past mobility. As the part of this tendency, going back to the past, this concept will be able to refer to the design elements of the palanquin and carriage, which are early examples of autonomous driving vehicle. Some design insights are found from the antique luxury of a palanquin and a carriage ride that expresses the combination of 'Relax' and 'Luxury'. There are many palanquins and carriages. Particularly, Korea palanquin shows the luxurious feature of palanquin (Figure41). The cloth that is foldable and spread makes the features that make a canopy, and that users can selectively show or hide their appearance. The foldable cloth has benefits that can make more space as it is not used, make shade, and make mysterious luxury mood. Also, there are form factors as design motif of the carriage. There are dominate, sub-dominate, sub-ordinate form factor in overall shape of the carriage. Dominate form is the cabin that user rides on, sub-dominate form is the wheels that makes movement, and sub-ordinate form is other factors such as lamps, or the seat of horseman. Also, the cabin shape is found in 'palanquin'. The cabin shape makes more space to do more activity, and make user take various posture. Through these design insights from palanquin and carriage are summarized as follow:

Summary of Design Insights

- ***Multi-functional factor that offers many benefits with one part***
- ***'Cabin shape' as main form factor that offers more space and opportunity to take free posture and do more activity***

- ***Luxurious factors by borrowing form factors of past mobility such as palanquin and carriage***

Figure 41. Left image is Korea Palanquin 'Gama (National Palace Museum of Korea, unknown)'[37], and right image is 'Continental Carriage (pngtree, unknown)[38]'

3.1.3 Openness & Relax: Sunbed or bench in outdoor

Openness gives more natural and fresh mood. Also, relax makes cozy and comfort mood. Two keywords are searched in on-line image search sites such as 'Google image', 'gettyimagesBank' to find intuitive and universal image of openness and relax (Figure42). Based on this search, 'nature scenery' images and 'sitting and talking with friends' images are found mostly. According to the image searching and combining the image, 'Sunbed with canopy' express well both openness and relax. So, the main UX image of 'Relax' in the urban is that user is lying on the Sunbed or bench with canopy in outdoor (Figure43). To specify the mood of 'relaxing in the urban' with luxury, many related images are investigated. In this process, the investigated images offer design insights in the design of UX concept and overall mood as follow:

Summary of Design Insights
- ***Experience that has relaxed time and space with beautiful scenery***
- ***User can feel breeze, fresh air, and scenery in luxury***

Based on above all these design insights, next step is 'ideation' of the Group B concept development (personal mobility that is specialized in travel or relax).
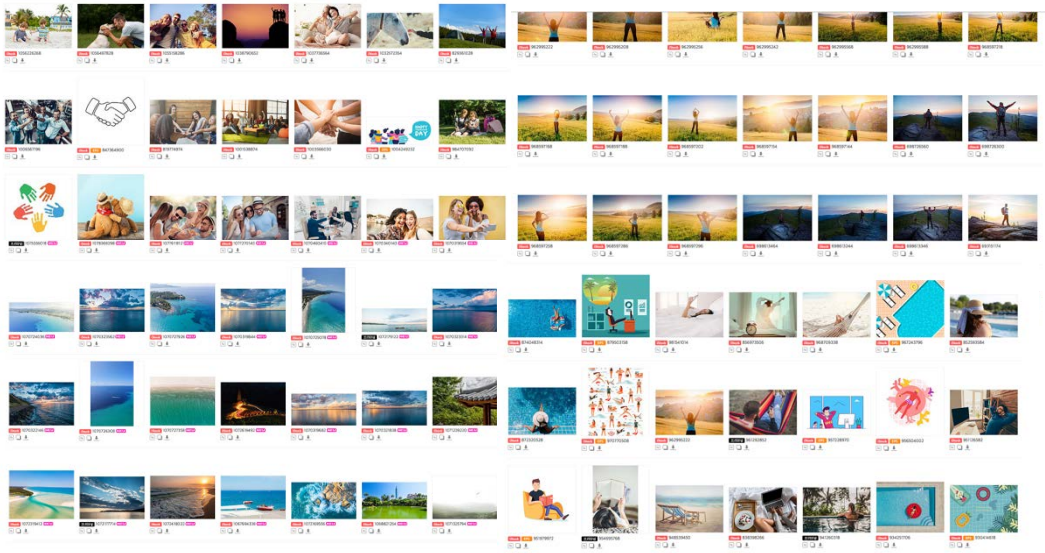
Figure 42. Example image by searching the keywords 'openness' and 'relax' (gettyimagebanks, 2018)[39].

Figure 43. Example image of target UX (Encompass, 2018)[40].

3.2 Design process

In this chapter, the concept development process is explained specifically. From the inspiration image collage to the prototyping that presents and visualizes the design concept, there are lots of design iteration until concept proposal. This detail process would be helpful to design other mobility concept.

3.2.1 Inspiration Image Collage

Before design and sketch the idea, inspiration image has a role of milestone that helps focus on the objective of the mobility and target. Above keywords and design insights are also important key factors that should be considered in design. It is not easy to consider all the things at the same time, the inspiration images summarize all the things and show not only core factors, but also abstract factors that can't be explained in words such as mood, experience, and emotion of form factors. As the same keywords are read, if you have had a different experience, then there is a possibility to approach in different ways of thinking and to misunderstand the other direction. Therefore, this is one of the frequently used methods of design work to communicate with others who need to understand this concept direction. The inspiration image collage would make communicate better to understand the process in this paper. For more objective approach to express the keywords and design insights, 5 design students are participated in collecting inspiration images in this step. After explaining above research and design insights, 5 participants made a UX image collage board from design magazines and fashion magazines and explained the meaning and implication (Table2). Participant A focused on the future mobility is one of the self-expression ways for millennial generation. So, the form, interaction and some items will show the user's identity. So, the images of participant A express a moving contemporary architecture, and user that has a professional job and busy schedules. Also, ambient lights and light interaction images are easily found to express relax mood. Participant B express the comfort and relax space through hotel images. Participant B focused on the boundary-less of mobility and space because of autonomous driving. The images of participant C expresses private and individual time, and the experience like in a lounge. Participant C focused on the 'communication with people' and 'individual rest'. Participant D emphasizes both the private space and connecting the space. The quality of life will improve through the

mobility by getting more individual time and doing various activities in the mobility such as group B concept. Participant E focused on the joy of moving and traveling rather than systemic uniformity car that focus on the efficiency. The images of participants E shows traveling with joy and pleasure. Based on these inspiration image collage, primary ideation and rough sketch step is progressed.

Table2. Inspiration Image Collage and Implication

Contents / Participant	Collage Boards	Implication
Participant A		Participant A thought future mobility is one of the self-expression. So, form, interaction, and some items shows user's identity. Also, the emotion is the most important design factor for 2030lifestyle user. In terms of interior design, the future mobility is a moving space that offers specific emotion and mood.
Participant B		Participant B thought the mobility can communicate with user, and the boundary of mobility and space will be ambiguous. So, the future mobility becomes more comfortable like a hotel that is fit for user.
Participant C		Participant C thought both 'communication with people' and 'individual rest' becomes important factors in the future life. So, the future mobility will reflect these things. User will spend their private or individual time in the future mobility. At the same time, the mobility will be used as 'lounge' for communication.

Participant D		Participant D thought the future mobility performs both roles: private space and connecting space. So, user can do various things in the mobility, and it means that the quality of life improves. User can focus on their individual time in everywhere.
Participant E		Participant E thought the future mobility offers magical interactions and experience for user. Through the UX, user can feel the joy and pleasure as if the user is with a friend.

3.2.2 Primary Ideation

In this step, the rough ideation and rough sketch to express and develop Group B concept (personal mobility that is specialized in travel or relax) are progressed and explained step by step. At first, overall box shape is considered as appropriate form to offer large space like as the cabin shape of palanquin and carriage (Figure44). The mobility would be compact size than other camping car that is specialized mobility in traveling. Also, overall part is composed of 'black glass' without the parts that should consider mechanical inner parts and safety. By using the black glass, it offers the 'Openness' that is one of the group B key words. Also, the position of trunk as usual is changed to battery pack part that is easy to exchange the electric battery in their travel.
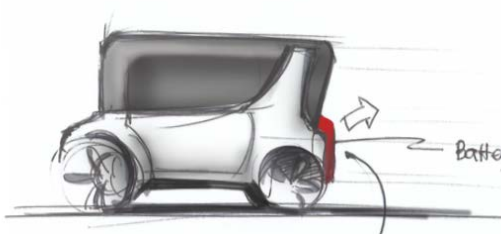
Figure 44. Primary ideation sketch #1: Box shaped design

However, the box shaped design looks a mechanical box that the 'Pleasure' and 'Relax' emotions are not considered. The form is just focused on the efficiency rather than emotional user experience of traveling. So, overall shape is changed to soft shape such as with keeping the 'cabin' space as the dominant part (Figure45). The shape of main part is not perfect oval, it looks a running waterdrop with considering air flow.
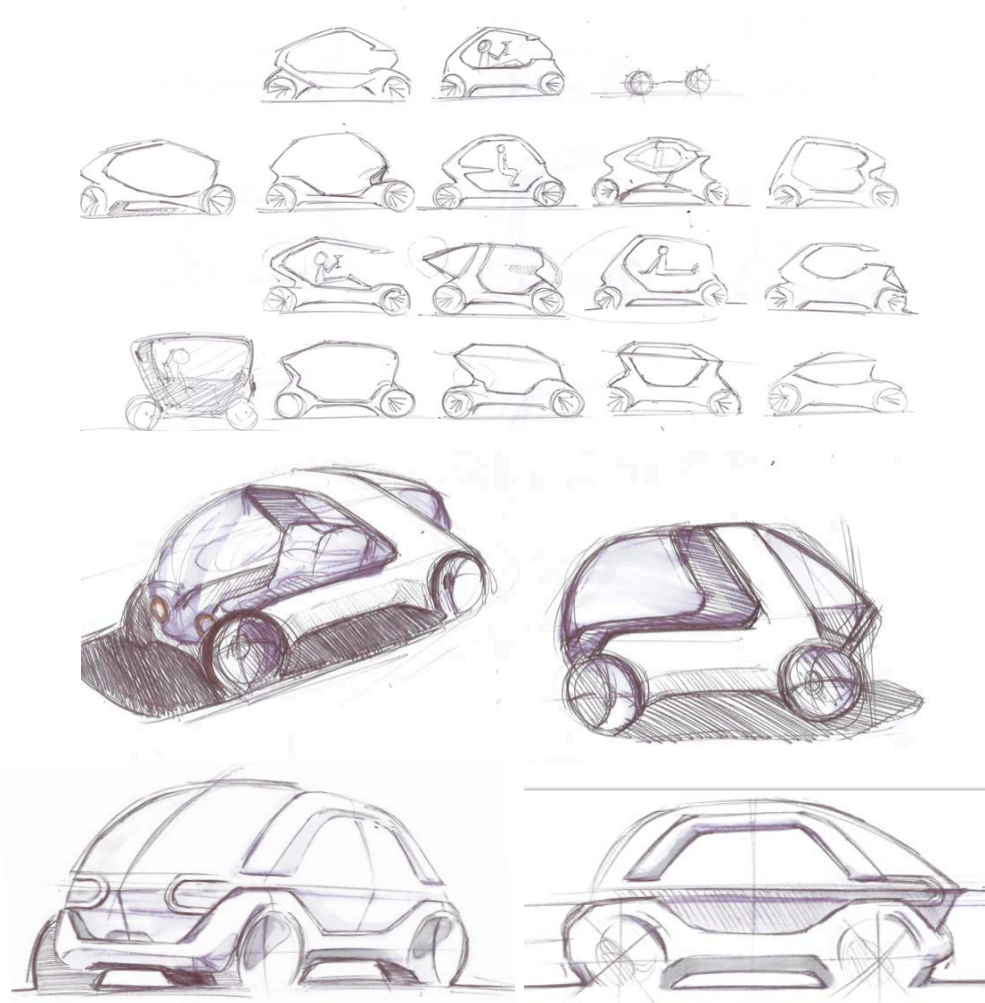
Figure 45. Primary ideation sketch #2: waterdrop shaped design

Based on this shape, overall form is revised to reduce offensive form factors such as sharp edge, because it looks dangerous and offers anxiety to user who pursues 'relax' time (Figure46). Also, the main part would be better to keep the glass part because of 'Openness'.
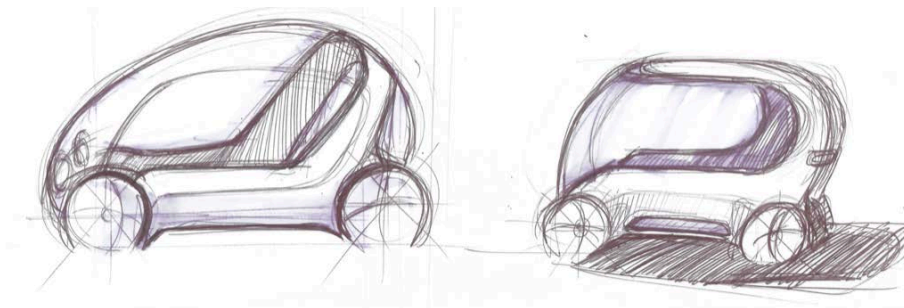
Figure 46. Primary ideation sketch #3: round shaped design

Considering the engineering materialization, pillar structures that support the large glass are reflected on the developed idea sketch (Figure47). Also, electric vehicle doesn't need the bonnet part that cover front view. So, the part of front bump is designed 'glass' to improve the openness and emphasize light and simple feature of EV. In the side view, the door shape shows the character of the mobility, because there's not edges such as character line that can be found easily in existing internal combustion engine car.
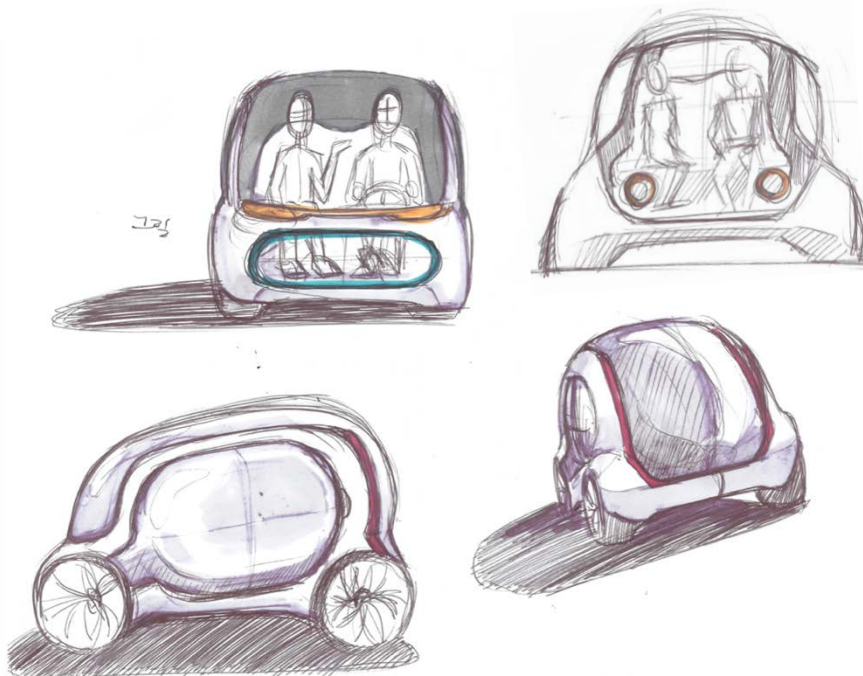
Figure 47. Primary ideation sketch #4: developed round shaped design

After the refining rough idea sketch, more exact and detail sketch is progressed to see overall specific shape and some detail parts' design on the real car image that has some

transparency (Figure48). This process helps defining volume of the shape, and more realistic proportion. Also, draft size of the mobility is defined as follow: 1450x2050x1557(mm), wheelbase is 1850(mm). Specific size makes the design consider more realistic proportion, and it makes easy to predict specific detail factors such as position of user, the height and shape of door line, lamp design that is appropriate proportion and shape and so on. The door is opened by rotating around the wheel axis to keep more space rather than opening existing way. The angle of oval shaped door is considered the motion of user that get on and off the mobility. Head of the user is positioned on the backward, and the foot is positioned on the forward. When opening the door in front, the tilting oval shape is more appropriate to secure the space that user can board on and off.
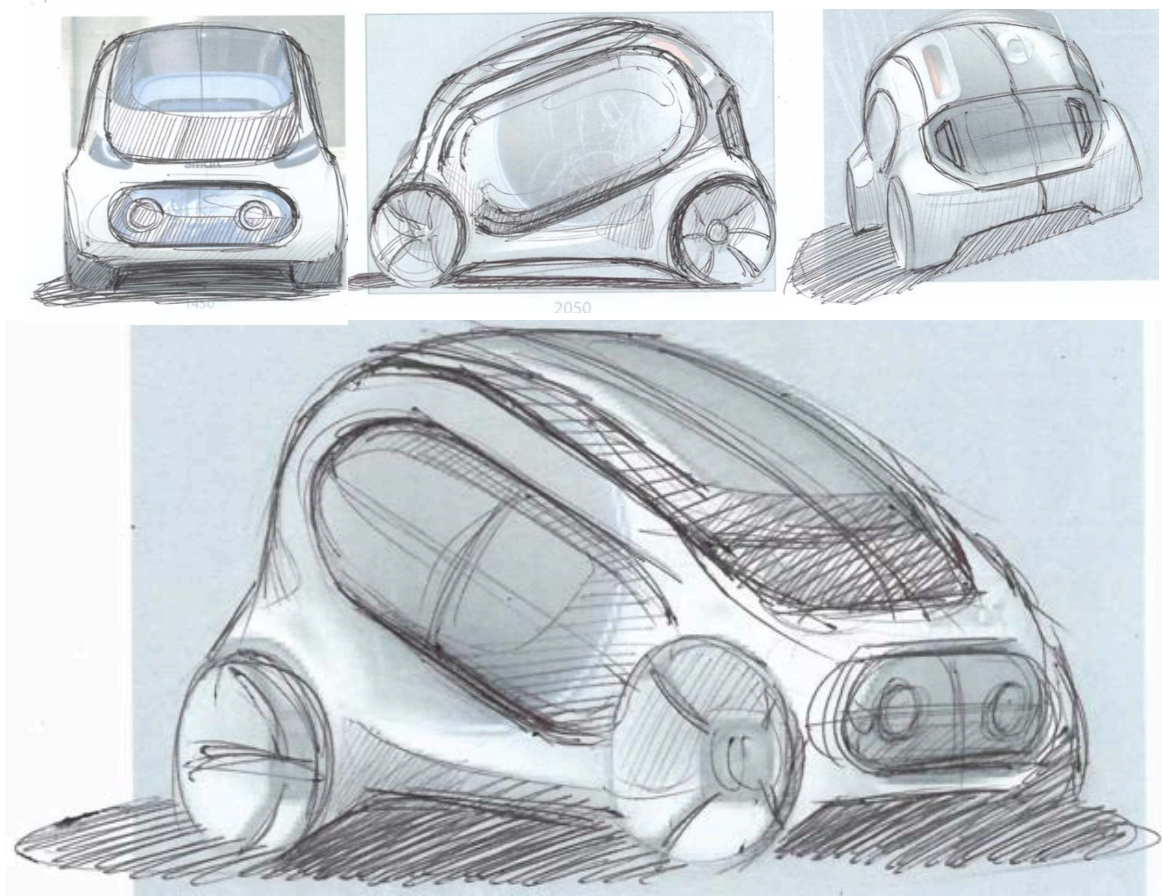
Figure 48. Primary ideation sketch #5: final refined design

Through the continuous sketching process, two core features, concept name, and potential factors that can be developed are specified as follow:

Core features and Concept name

- *Core Feature1*
  Secure large space like as the cabin shape of palanquin and carriage, and the dominant parts offers 'Openness' by using glass or transparent materials.
- *Core Feature2*
  Round shape that can show 'Relax' and 'Pleasure' emotion in 'Travel'
- *Concept Name: Future Trunk*
  It means the mobility that is essential thing to travel like as the Louis Vuitton's Trunk. Also, it contains 'Future things' such as future lifestyle trend, and future mobility trend. So, if it is opened, then it offers the future things to user.
- *Potential Factors*
 *Interior design to specify activity that user can experience in the mobility, and developed exterior design to consider the interior design factors*

3.2.3 Secondary Ideation

Considering above core features, and potential factors to develop the concept more, 'Secondary Ideation' is progressed. Interior design is ideated (Figure49). The point of interior design was to utilize the space more that user can do various activity and take free posture efficiently in compact sized space. So, interior factors such as seat, item storage, and door trims are combined as uni-body. Also, there are some item storage for carrier or some stuffs for user under the seat. Utilizing the space under the seat can secure more space by fixing the seat with uni-body structure that seat is connected to side. There is a blind that can offer the shade when user wants. The blind would make user feel 'dwelling' like as in a house. After the ideation of interior design, the interior factors such as blind roof, and space under the seat influences into the exterior design of 'Future Trunk'. First of all, in the other side, the blind makes boundary or severance from the scenery rather than 'Openness'. So, next developed sketch shows the open mobility that has just the seat and canopy without any blinds, even the window (Figure50). All sides are opened and user can feel fresh air and the scenery directly. Also, there are two straps that grasp and fix the roof like as a pillar. It offers light image than using existing thick pillar, and brings the palanquin and carriage image as a metaphor that is used to tie up

the luggage or loads. After fixing the design of side view, quarter view design is specified
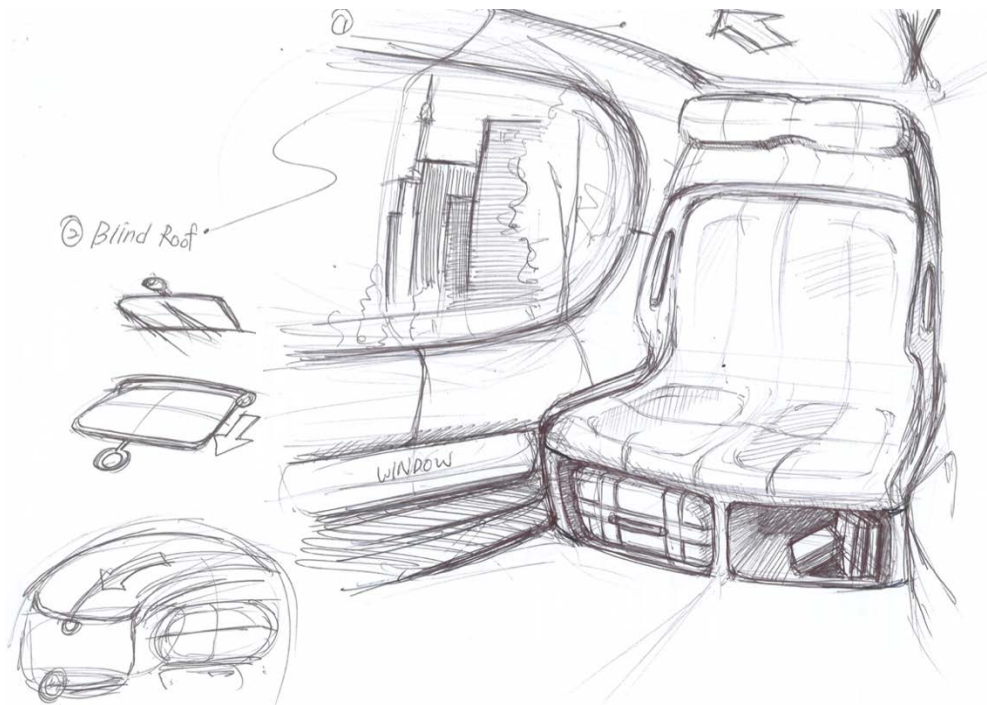
Figure 49. Secondary ideation sketch #1: Interior Design
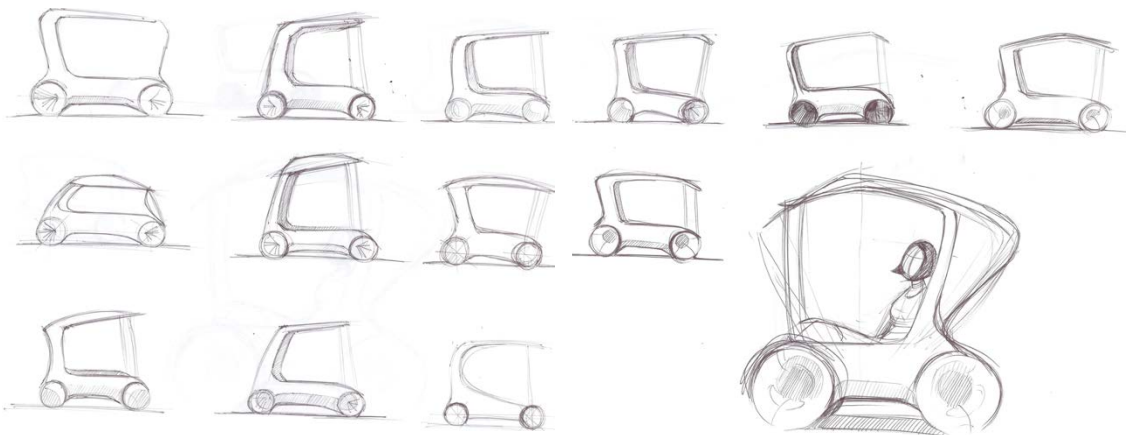
Figure 50. Secondary ideation sketch #2: Revised Exterior Design

more (Figure51). In Figure 51, the development of overall shape and the handle to support user ride easily can be found. To offer more openness and relax like a lounge or sunbed, tilting function of the roof is considered by using tension of the strap and hinge that is operated by motor (Figure52). The tilting roof makes user take more relax posture like

as lying on the sunbed that is the target UX. In this process, the footstep of front part
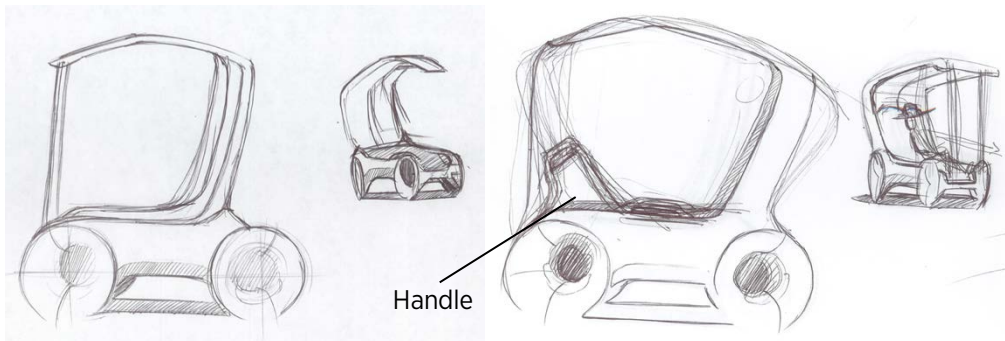
Handle

Figure 51. Secondary ideation sketch #3: Developing quarter view

design is ideated. The height of inner seat is little bit high to get on easily because of the minimum ground clearance(150~180mm). The square shaped footstep and handles on the both sides are devised to help the user get on and off easy.

Vinyl or fabric material is considered

Tilting roof sketch

Tilted roof sketch
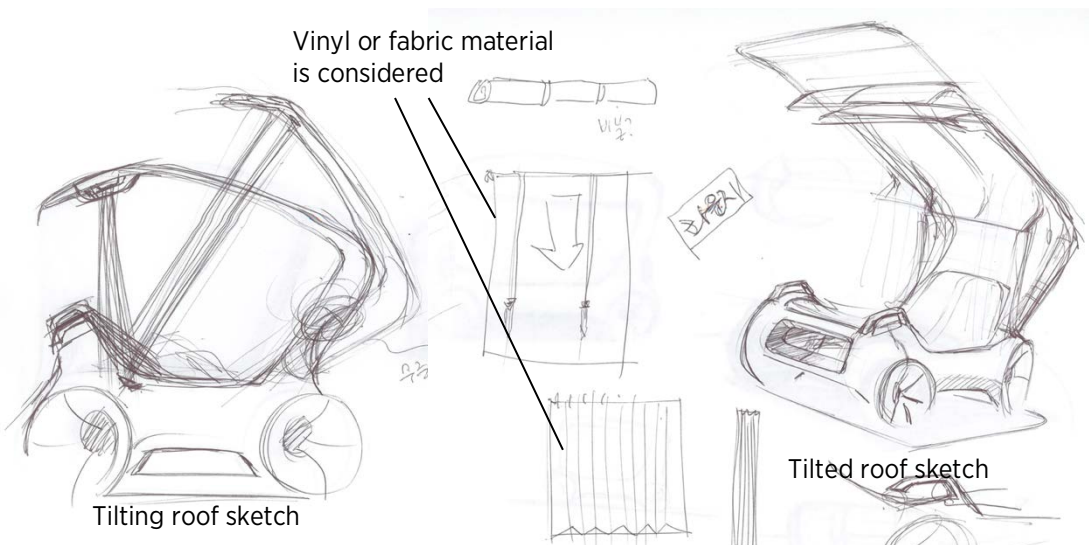
Figure 52. Secondary ideation sketch #4: Tilting roof function

Additionally, other materials such as pleats fabric like a curtain or rolled vinyl blinds are considered as window, because the glass material is not easy to control the sunlight. So, if user can choose to shade the sunlight, then the rolled blind can be pulled down. But it is not applied because if the tilting roof is opened, user cannot pull down the blind by their hand power. Instead of using manually operated blind, the window that has shade

function by using electric technology is considered in this concept. Fixing the form of quarter view, rear view is also ideated. In the rear view sketch (Figure53), there are embed trunks with each void. It is developed from the luggage space under the seat, because user should bring the luggage to the interior in previous design. Bringing the luggage into the mobility causes inconvenience to utilize the narrow space. By designing the void for trunk with offering the embed trunk for this mobility, users can get off with bringing their portable trunk, and they can put their luggages before getting on the mobility. The portable trunk that is embed in the mobility can offer user feel the moving with 'Future Trunk' as a 'Travel'. The item can emphasize the concept that is specialized in traveling and relaxing.

Luggage space and portable trunk that is embed in the mobility
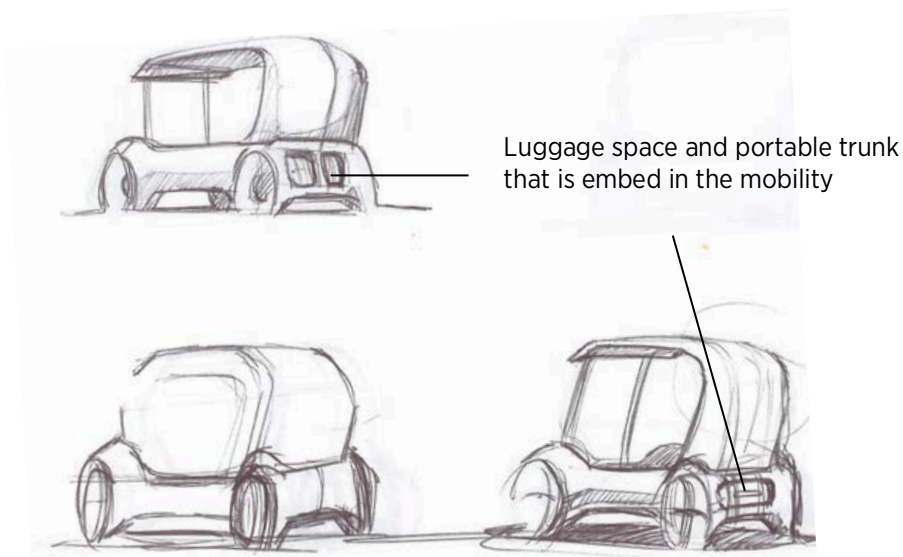
Figure 53. Secondary ideation sketch #5: Rear view development

Based on these all defined design, the actual volume and details of the sketch are determined more specifically trough the Photoshop rendering and making concept board. The concept board summarizes overall process and draft of final concept. In the concept board (Figure54), the orange colored roof can be tilted depending on the angle of seat. Also, the straps grasp both sides and connects the roof and main body. In the rear view, embed trunk can be found. Through the draft of final concept, user can enjoy the moving and traveling with opened mobility. However, in this concept, if it is rain, then user should get rained on. There's no other choice. The degree of openness is too much to offer inconvenience for user. In addition, it is not luxury experience that user should be

in outside all the time using the mobility. Therefore, in next step, the potential points are revised and developed. Below shows the core factors from this step and potential factors that can be developed in next step:

Figure 54. Secondary ideation sketch #6: Concept Board

Core features and Potential factors
- ### *Core Feature3*
  Portable trunk that is embed in the mobility can be the item that make user enjoy the moving and traveling.
- ### *Core Feature4*
  Tilting roof can offer more openness and relax mood that makes user take lying posture like as on the sunbed.
- ### *Potential Factors*
  Bad weather should be considered, also luxurious factors should be considered.

3.2.4 Concept Refinement

Considering the potential factors that is found above step, it is modified to the glass door and windows surrounding the whole (Figure55). Other form factors such as round shape and small void and embed trunk are kept, and various window line is considered. Bearing in mind the experience of lying on a sun bed, the exterior design is revised.
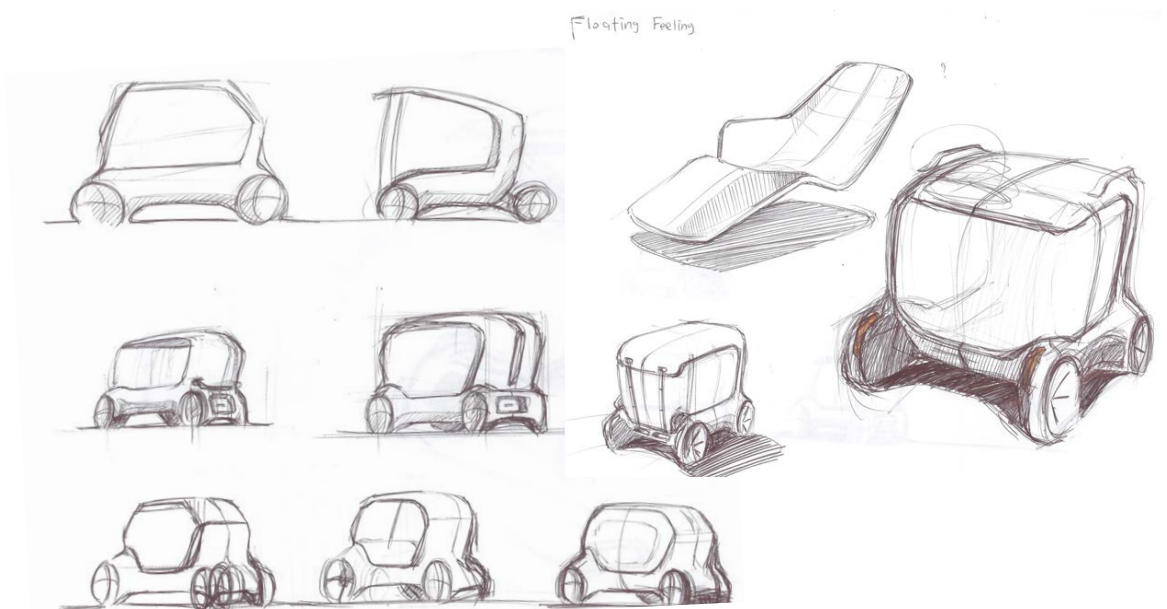
Figure 55. Concept Refinement Sketch #1: Revised Exterior Design

After revising the whole form, the footstep of front part is also developed. In Figure 56, the development process can be found. At first, the footstep with split partition in center is considered, but it revised to open footstep, because the area of footstep is wider that there is no obstacle to the user's foot. Also, the trunk is more specified that has leather handle and round corners. Additionally, the way of opening is changed to opening the

part of front glass. The door that opens forward has a benefit that user don't have to bend forward. User can get on the mobility by just walking like on the road. After this development process, form specification proceeded with the application of the 'Louis Vuitton' brand image (Figure57). Because, using brand image of 'Louis Vuitton' makes the mobility is not only for driving, but also for expressing personality like as fashion item. In front of the glass door,
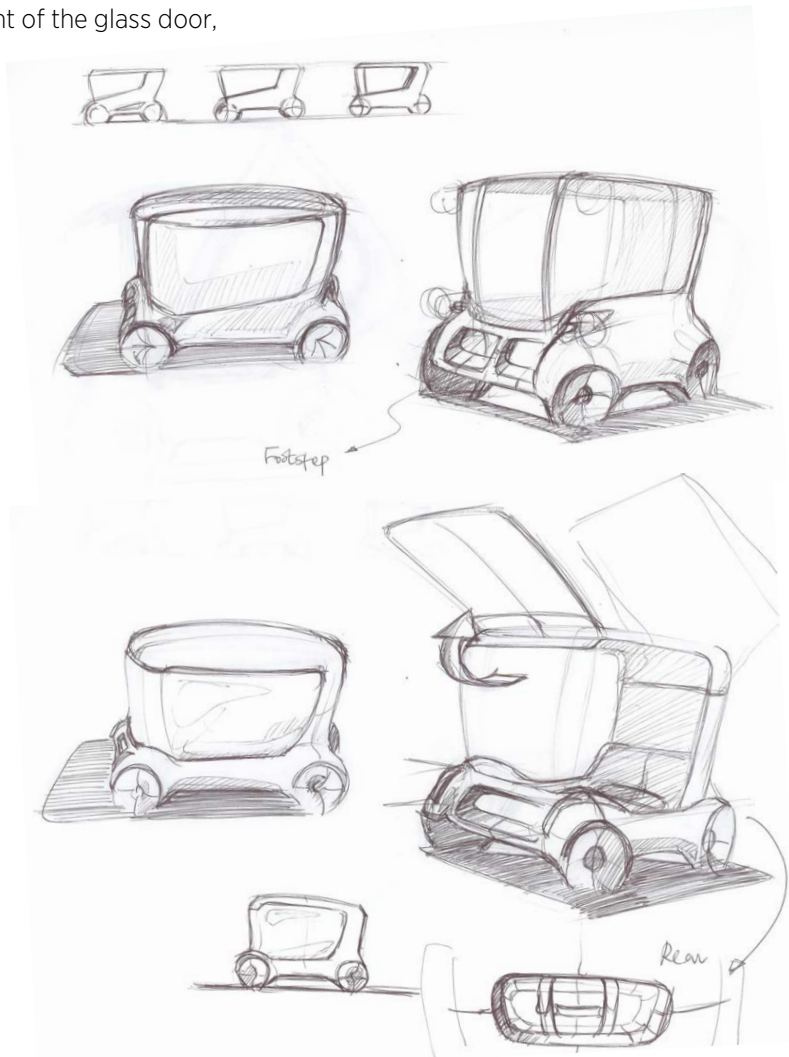
Figure 56. Concept Refinement Sketch #2: Developed Exterior Design

pentagonal shaped factor is applied that shapes the grill internal combustion car had. It is considered that all the glass in front part makes user who wear the skirt inconvenience. All the transparent part makes user nervous, because the user cannot enjoy the comfort enough with free relaxed posture. Also, small capsule shaped sensors are applied at each

corner. The sensor is essential part for autonomous driving technology. The 'LiDAR(Light Detection And Ranging)' sensor should secure the view of 360 degree, the capsule shaped sensor become the part of design by considering the feature of the sensor. In the right side of Figure 57, side view image shows to consider changing position of void from rear to side, because side part is more useful for the user to put the load directly before getting on. The idea of a window opening to both sides is inspired by the idea of opening the door forward. Various advantage is gotten through the feature that the side window open. Opening window makes more 'openness' that user can enjoy the scenery, and opened window can have a role of 'Canopy' that protect the user from sunlight, rain and so on.
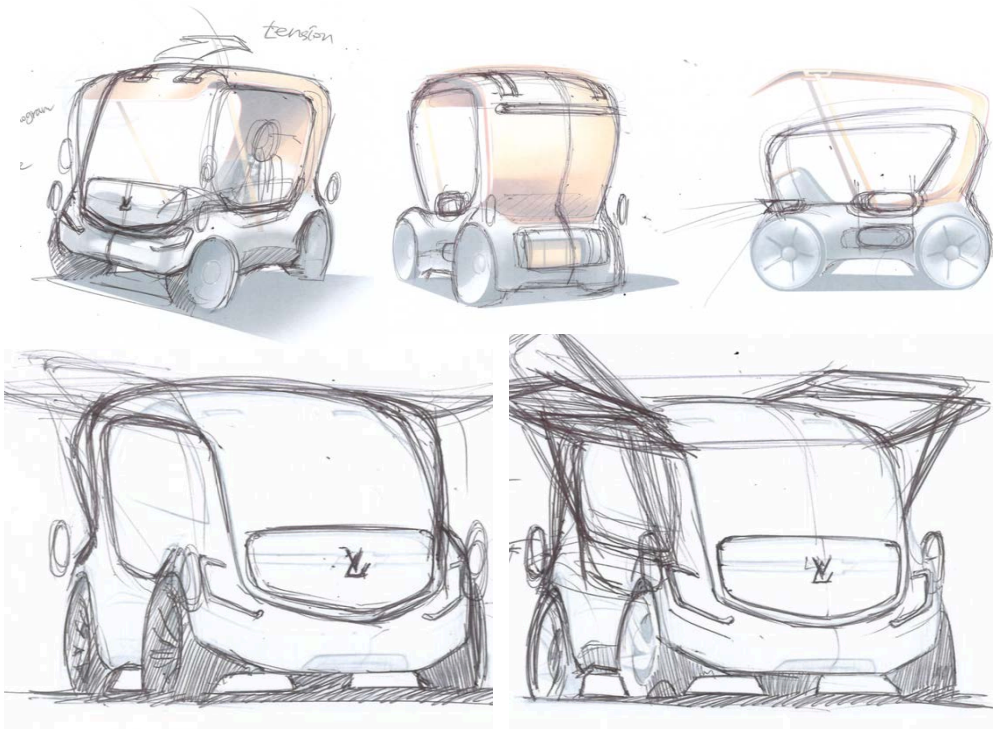
Figure 57. Concept Refinement Sketch #3: Developed Exterior Design

All these new factors are applied next ideation sketch (Figure58). It has various voids for trunk on the both sides and rear. The strap changed to grasp the roof to support the opening door by using the tension of it. Also, right upper sketch shows the front view and interior seat like a sofa. And then small tables can be found on the both sides. The tea table and sofa make the luxury and relaxed experience like as in a small villa. Bottom

sketched shows door line and window line with the trunk void that has continuous shape to the window line.
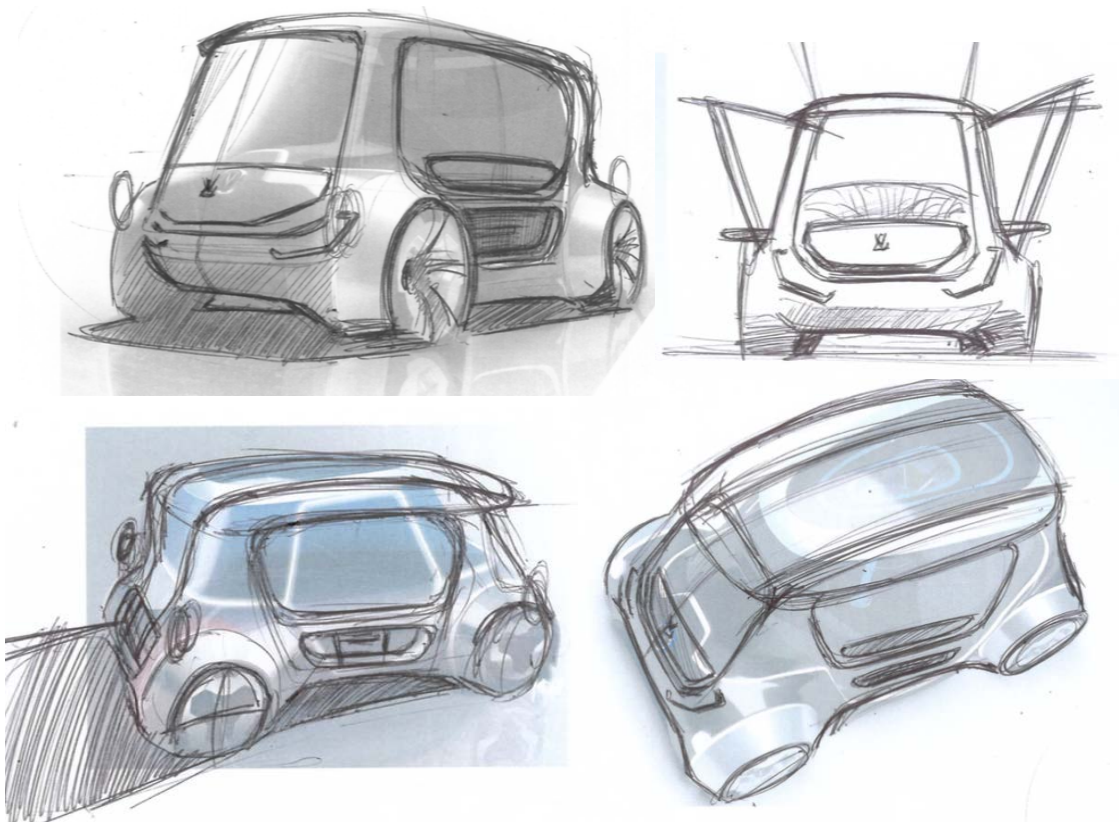
Figure 58. Concept Refinement Sketch #4: Developed Exterior Design and details

Based on these exterior design, next sketch development emphasizes the 'Openness' factor to make more shade through larger area of the side window, and to make user feel relax (Figure59). In this sketch, there are pattern partition for user's comfort and privacy on the side view. Also, the center of the pattern has a void for the trunk. Instead of the pentagonal shape in front of the door, the 'Louis Vuitton' logo line separates the upper part that user can see front view, and lower part that makes user take comfort. The line makes 'continuity' from the front door to side window pattern. So, too much visual factors looks like arranged, because the alignment makes visual unity.
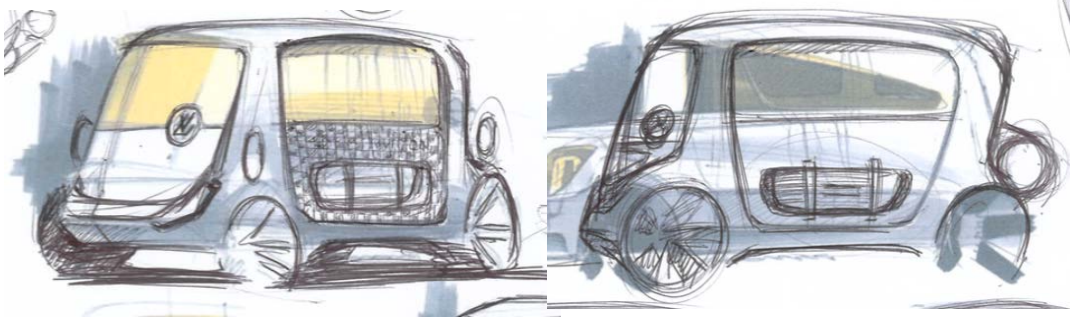
Figure 59. Concept Refinement Sketch #5: Developed Exterior Design

After this ideation sketch, the overall shape has evolved again in the form of a moving cabin. And the elements mentioned above have been more specifically sketched. In Figure 60, the ceiling changes to a wider form, inducing the user to experience the interior space rather than the vehicle. In the side view, there are trunk void and embed trunk that is proper position to take on and off. Additional load can be stocked on the rear trunk. Like these antique factors offers 'Luxury' mood that is originated from past mobility such as palanquin and carriage. Overall shape follows the shape of crown, but the roof part has aggressive edges, so it is developed in next development sketch.

Figure 60. Concept Refinement Sketch #6: Developed Exterior Design

In the 7th concept refinement sketch (Figure 61), the edges on the roof are rounded and handles that help user get on easily are tried on the front door. But, it would be better to open all the front part without any additional handles, because if the door is opened, then user cannot grasp the handles on the door. So, it is deleted. In the process of developing the sketches again and again, many core features are found in this step. On the basis of these core design factors, it needs to be modified to match the actual dimensions and proportions. '3D modeling (CAD; Computer-Aided Design)' is appropriate method to simulate actual size and shape step by step. Also, the 3D data from the modeling work can be made by 3D printer or milling machine. In addition, the anthropometry should be considered in the modeling process. In next step, the design iteration process in 3D modeling and development of the 'Future Trunk' design can be found.
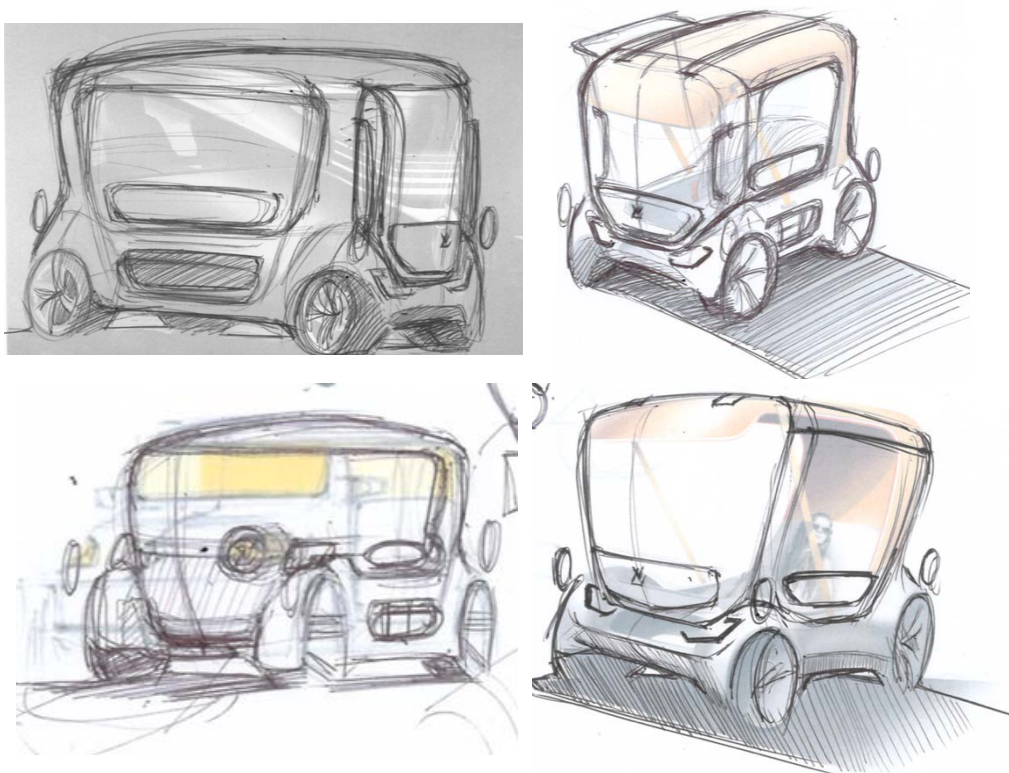
Figure 61. Concept Refinement Sketch #7: Developed Exterior Design

The core features and potential factors are summarized as follow:

Core features and Potential factors
- ***Core Feature5***
  Uni-body interior that can secure more space such as under the seat
- ***Core Feature6***
  Opening side window offers various benefits such as role of canopy, and providing more openness.
- ***Core Feature7***
  The side part is appropriate as the position of portable trunk according to use flow
- ***Core Feature8***
  Crown shaped cabin is more proper to express relaxing space like as a home or luxury villa.
- ***Potential Factors***
  Match the actual dimensions and proportions, and consider the anthropometry

3.2.5 Primary 3D Modeling

To make the 3D model, it is essential that the precise dimensioning and confirming the form of the design. In this step, the process and sequence of converting 2D data(sketch or rendering images) into 3D modeling work will be explained as follow:

At first, determine the exact basic dimensions such as horizontal, vertical, height, and wheelbase. And then make a sheet defined as a ratio to the exact dimension (Figure62).
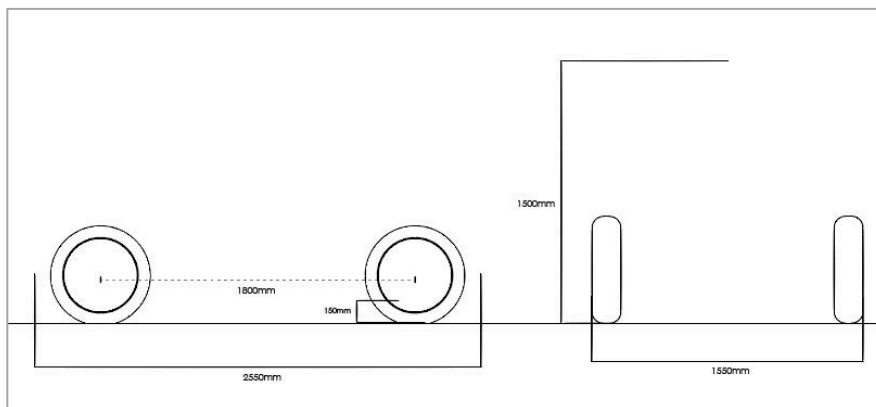
Figure 62. Data sheet to convert 2D data into 3D modeling

Second, the dummy silhouette overlays on the dimension sheet to determine the position and posture of the actual user to sit on by using the anthropometry (Figure63).
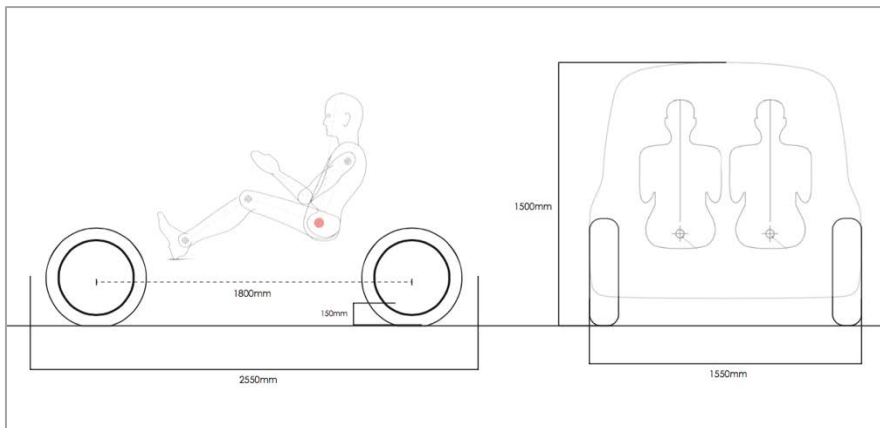
Figure 63. Data sheet with dummy

Third, apply the concept design form based on the silhouette on this dimension by sketching on the sheet (Figure64). Confirmed data for all section view is needed, at least front view, side view, top view, and rear view are essential data. The quarter view data is needed as an image to refer to connecting each section view as intended. Then, specific proportion and form is defined by the sheet. Especially, in the course of this step, it takes longer to modify and develop the design with the correct dimensions. In this paper, the side view and rear view are developed firstly. In first iteration, the formative correlation among the side window line, void of trunk, and crown shaped cabin are considered in various ways.
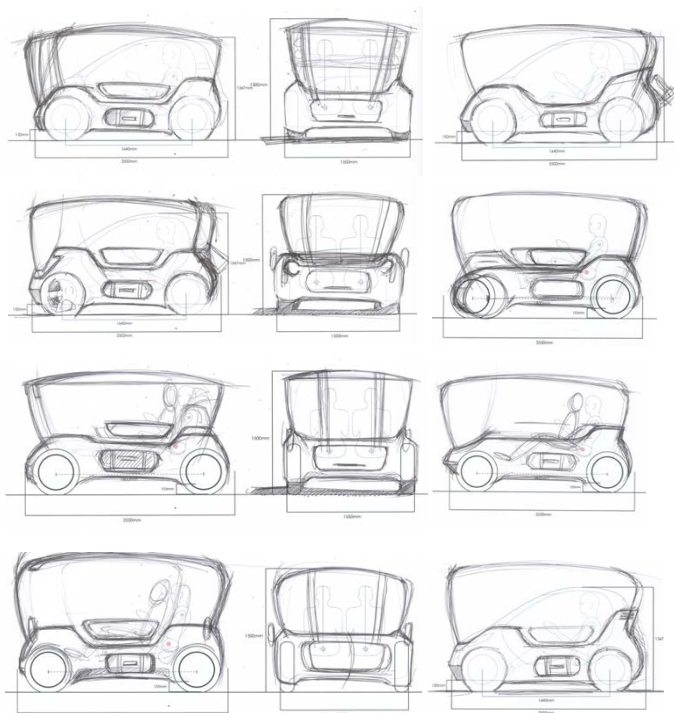
Figure 64. Developing process on data sheet #1: Side view and Rear view

After the first iteration, front view is ideated that is centered on the parts surrounding the wheel and the parts that cover the user's legs in the front (Figure65). The shape of grill-like parts is changed in considering the coordination with door line and wheel cover form. On the top part, straps are depicted as small squares. The capsule shaped sensor are depicted as the floating pills on the both sides. Also, the head lamps are designed primarily as circles, a form often used in past mobility such as carriage or past internal combustion engine car to emphasize the antique theme.
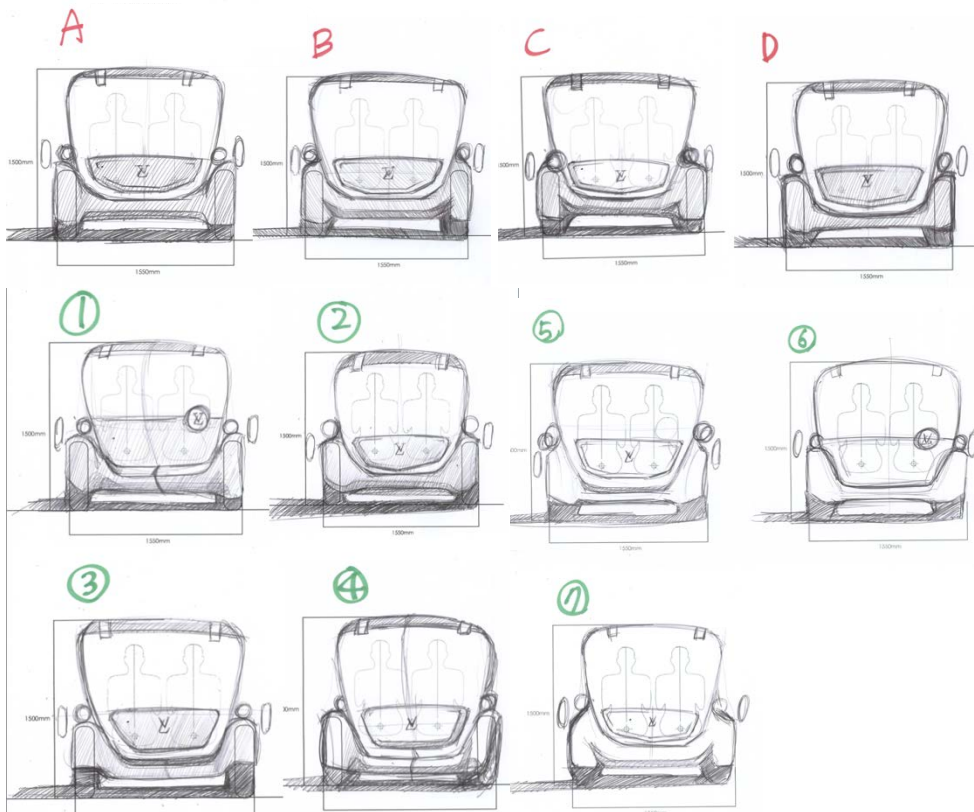
Figure 65. Developing process on data sheet #2: Front view

In third design iteration sketch, side view and rear view developed again depending on the changed shape of the front view (Figure66). The side view was disturbed by the main window string and trunk void. The rear view is ideated which rear lamp shape is most likely to match the side view 's character line or feature. Various form of rear lamp is considered, mainly with continuity in the form of trunk void on the side. After developing the variations in the side view and rear view, the main sketches of front, side, rear view is
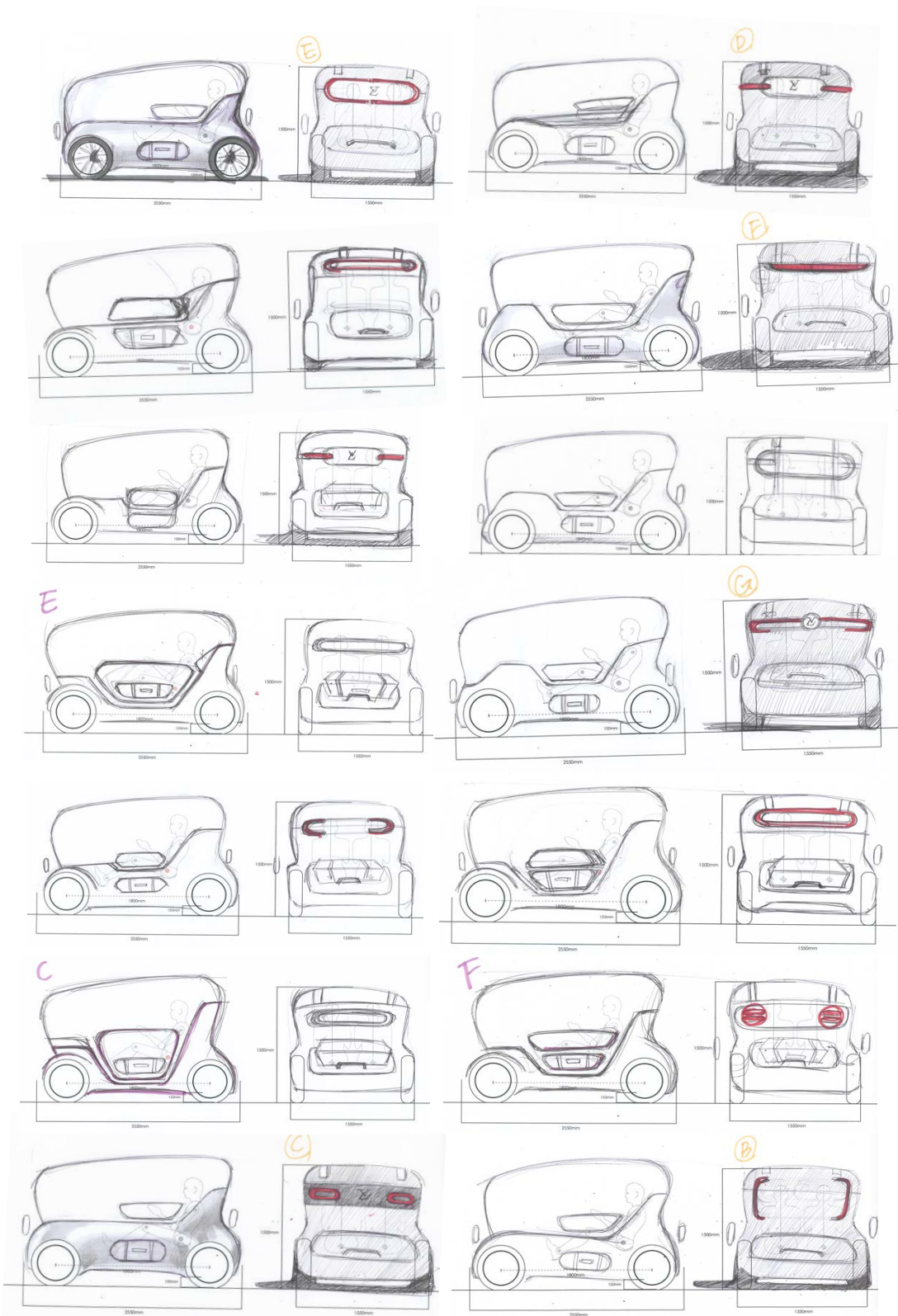
Figure 66. Developing process on data sheet #3: Side view and Rear view

determined (Figure67). Front grill-like part is designed as separated door parting by the logo line, because there are lots of independent factors. Too many independent elements distract visual attention and make the subject look away from the nature of the mobility design. Since the trunk and mini table shape on the side have a role of design character, it is important to make the other elements look more connected mono-body.
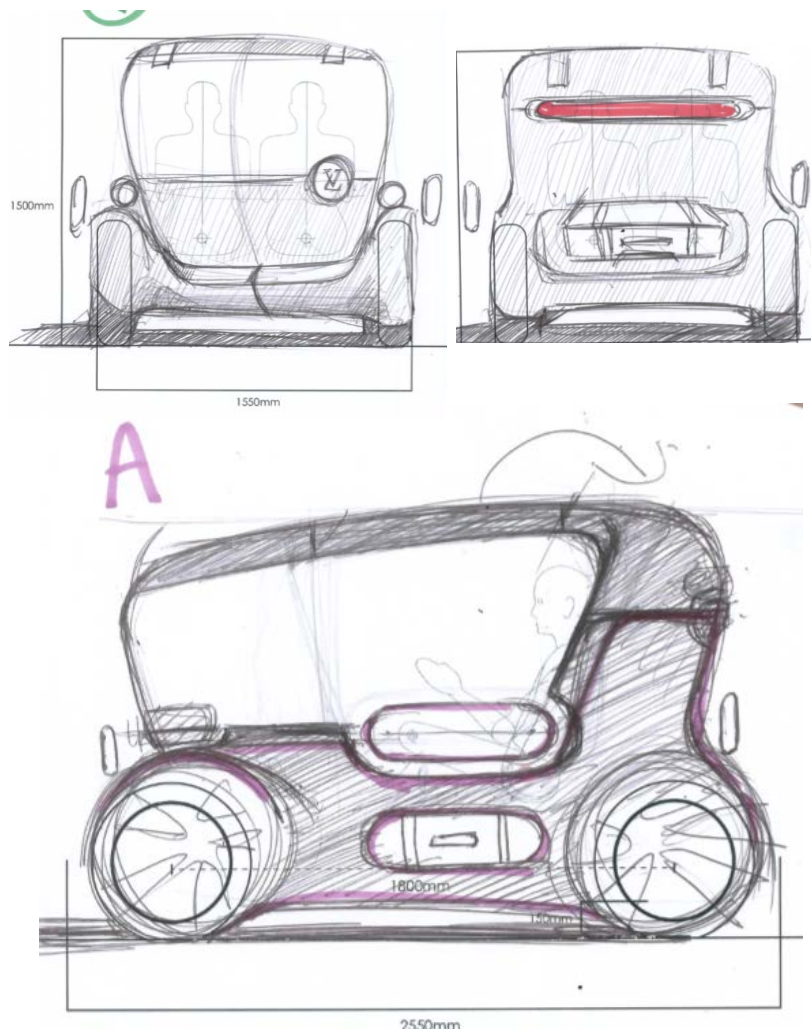
Figure 67. Developing process on data sheet #4: Final Design Sketch

Fourth, scan the sheet. And the scan data is loaded into the modeling program (Figure68). It is used as the base design guide of the cross section views of the front, side, top and rear. Also, bring the 'dummy' data to the modeling program. That is also guide of anthropometry in 3 dimensional program. There are two ways to make a 3D modeling:

Top-down way, Bottom-up way. In this concept design process, 'Top-down way' is used that make a model from dominant form to more specific and detail parts. In this concept design, the crown shaped cabin is the dominant body. Based on four wheels, the cabin shape is made as the center at start. So the four wheels and dominant mono body can be found in Figure 68.
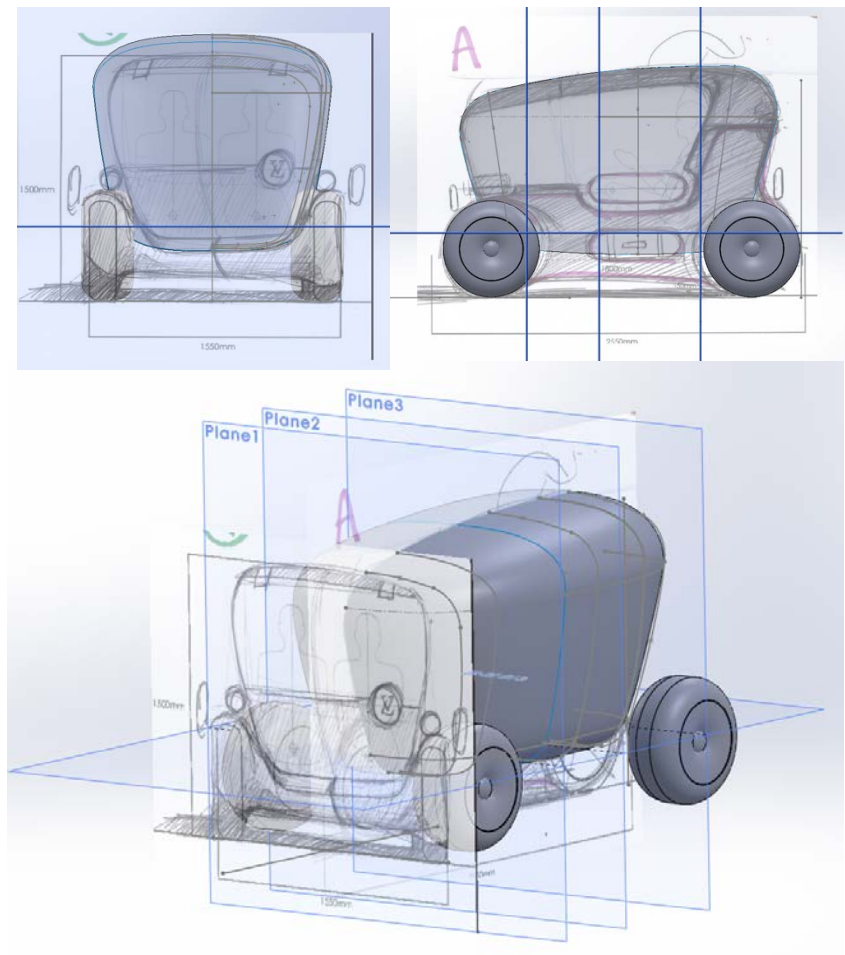
Figure 68. Loaded scan data into 3D Modeling Program

Fifth, make a 3D model based on the guide. In the process of 3D Modeling, some dimension data can be revised to better way. 3D Modeling work is also design development way. That has just a difference whether it is for 2 dimensional development or for 3 dimensional development. Actually, there are lots of developing and revising process in 3D Modeling, because of the error in geometry problem that certain form

cannot be materialized. But, compressed and simple sequences will be explained in this paper. Figure69 shows a part of 3D Modeling development processes. It would be better that complex curved form is made by the 'surface' rather than 'solid'. 'Surface' is the surface data that express the form as a surface. It is more freely bent and composed easily. But, the surface data cannot be printed or made in real, because it is just visual data rather than actual data. So, the surface is mainly used to outline the complex shape of the beginning. When the surface is finished, the design is materialized as solid data by solidifying it. Below Figure69 is the design development step by using the surface.
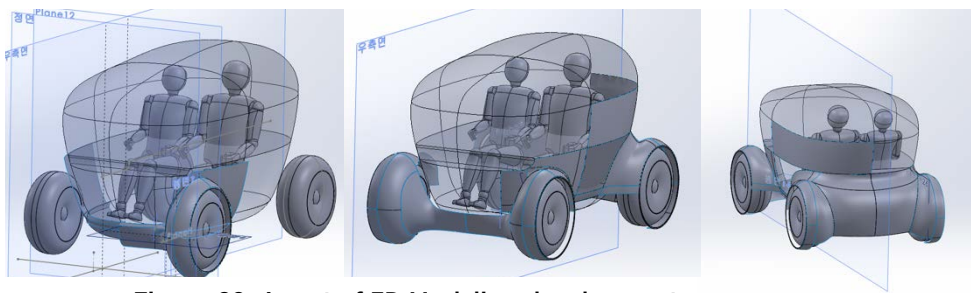
Figure 69. A part of 3D Modeling development processes

Through such a number of surface operations, 3D modeling draft has completed that shows the overall shape (Figure70). The revised dimension is W1530xL2550xH1557(mm), and the dimension of wheelbase is 1850(mm).
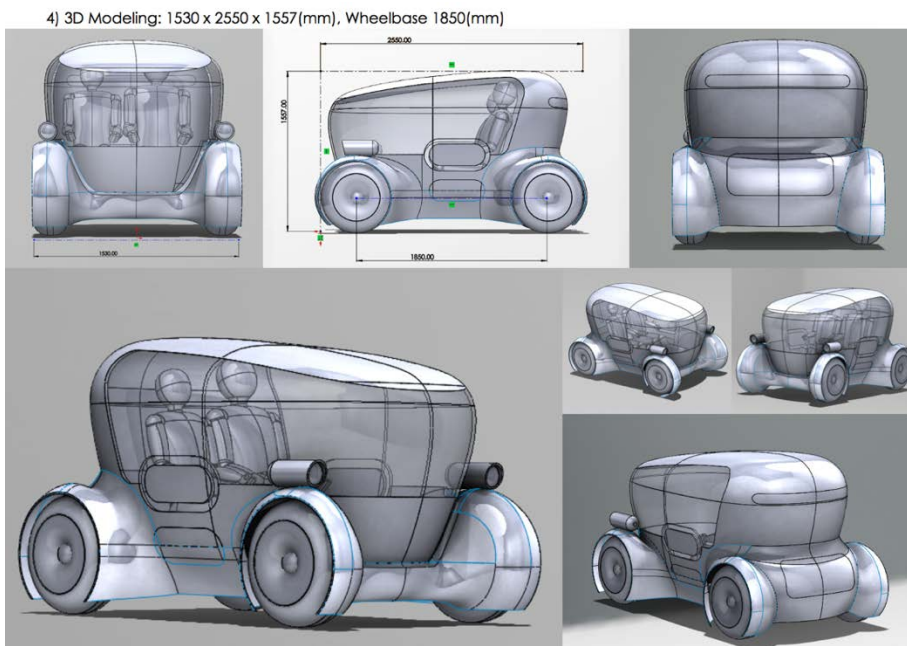
Figure 70. 3D Modeling draft

Sixth, capture the 3D model data, and print it. Make sure each view matches the design that designer intended. Check the direction in which the inconsistency is improved. Identify which part needs to be revised and sketch it on the printed paper. Figure 71 shows the sketch that is needed to be developed more. In this process, the design of head lamp is considered to change, because of the sensor. The sensor part should be placed at each corner, but the parts collide with each other because of head lamp. So, it is ideated the capsule shaped sensor contains the head lamp function through this development.
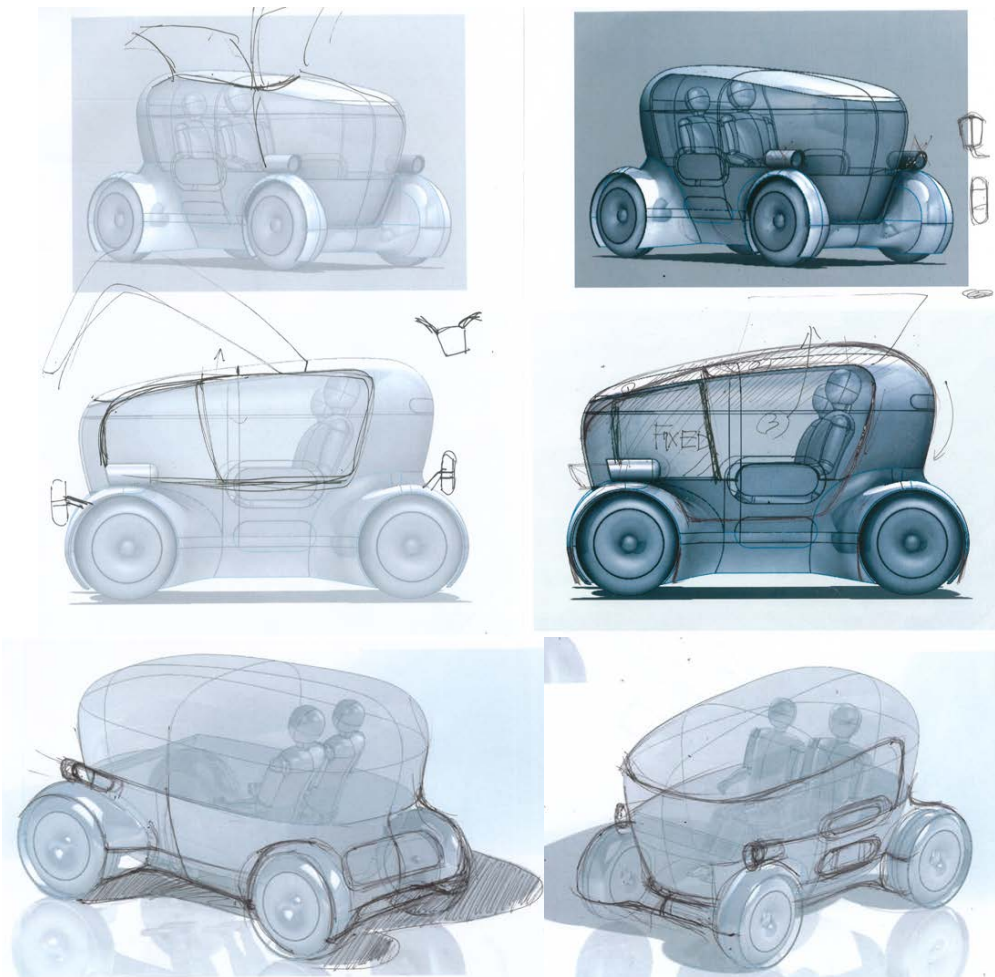
Figure 71. Design development on the scan data

Seventh, apply the revision points to the 3D modeling. And, next step is design iteration that revise and develop design again and again by repeating the above steps.

3.2.6 Concept Refinement

After the 3D Modeling step, design is revised again reflecting the development feedback of the advisors in this step. Advisors commented that Figure72 shows more relaxing and luxurious emotion and experience. Based on the 3D model data, Figure 72 is integrated as reference sketch.
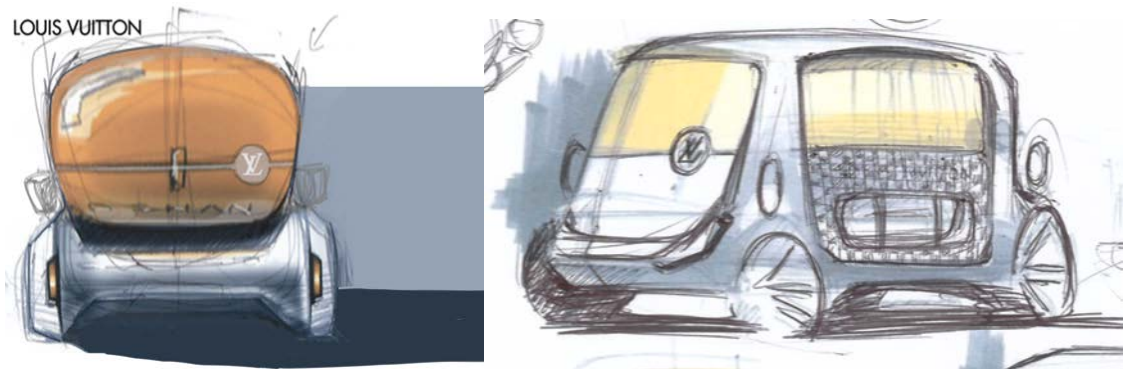
Figure 72. Reference Concept Sketch

In the previous model, it is difficult to see ahead because the visibility of the passenger is obscured by the roof. Considering the problem and reference sketch, the process of revising to a cabin with volume than the existing model is shown (Figure73). This form helps the user to feel more spacious and stable inside space. As the dominant shape changes, there is also a change in the form of other specific elements. Especially, in the side view, it is continuously changed that the window line that shows openness and the shape of trunk void harmonizing with it. In addition, the shape of the pillar line is considered which stably supports the glass with maintaining the openness at the same time. Through these modifications, it has developed into a design that is more stable and smoother than previous models. The function of capsule shaped sensor combined with head lamp is also ideated in this development. The sensor has a role to detect user, and interact with lights to welcome the user. This function is considered to offer 'luxury travel' experience that greets the user. Additionally, the function of offering the embed portable trunk is also considered as luxury function like as 'bell-boy'. With these functional and morphological development, the secondary 3D modeling work is carried out as next step.

Figure 73. Concept Development Process

3.2.7 Secondary 3D Modeling

Through above concept refinement step, the guide sketch for secondary 3D Modeling is confirmed like as Figure 74. In the side view, the window line has similar shape with the trunk void, and it makes more stable coordination of each form together. Also, the horizontal parting line of side has continuity to the front logo line. Rough 2D rendering visualizes the concept images, and the concept and development process are summarized on a board (Figure75). The board is applied to the design continuously during 3D modeling. In the board, the functions of each factor such as sensor that has interactive light, trunk, logo line and so on are visualized that is same as above explanation.
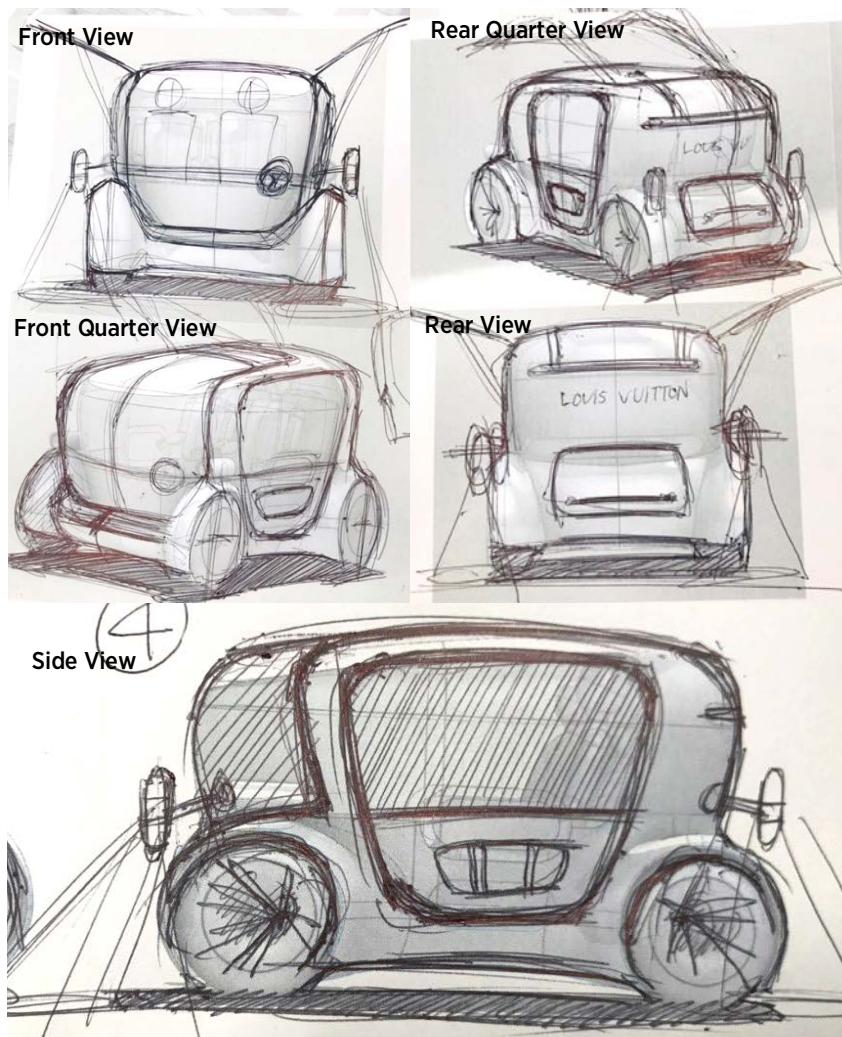
Figure 74. Secondary 3D Modeling Guide Sketch
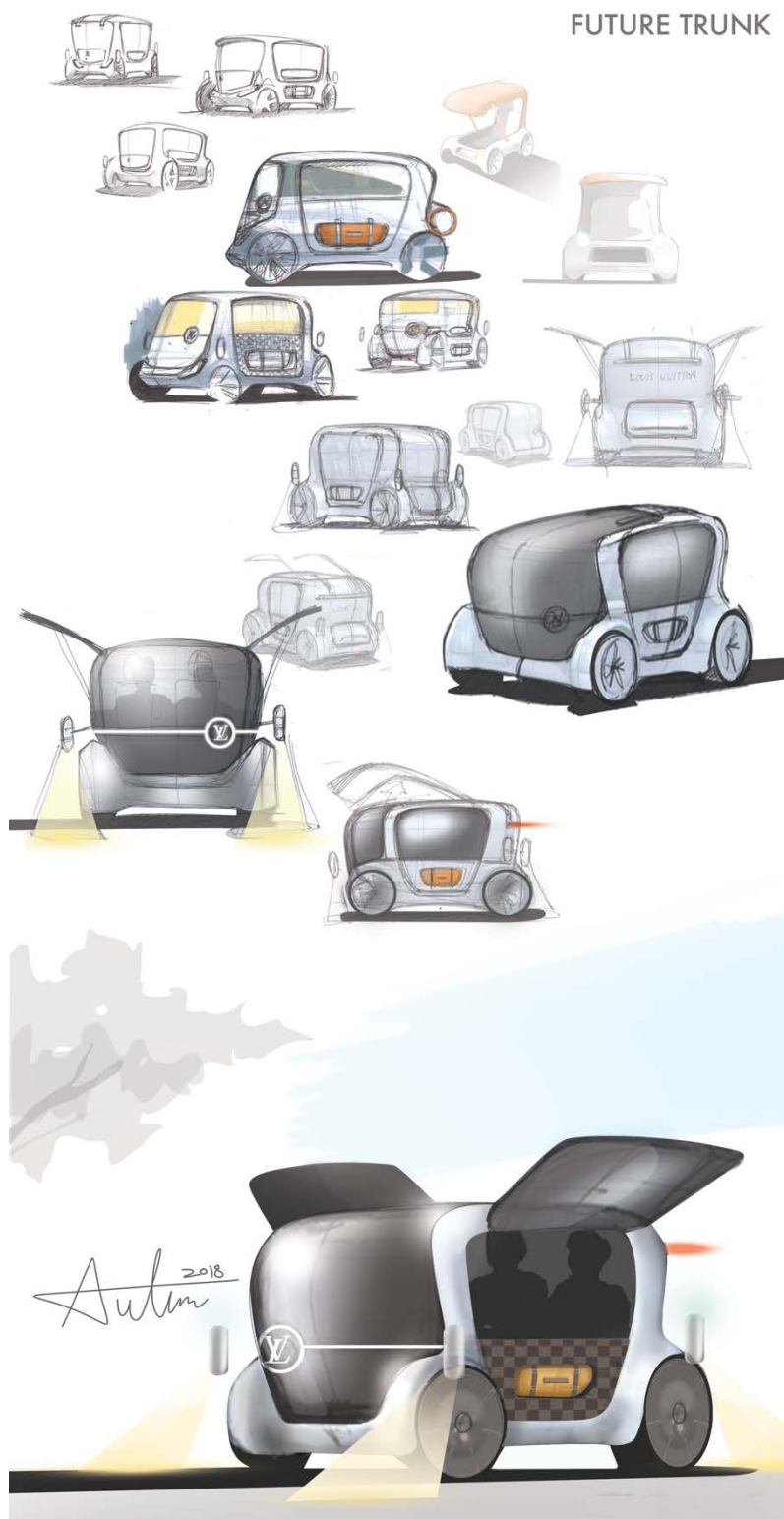
Figure 75. Concept Summary Board

Next, the 3D modeling is used to implement the newly developed design. The overall shape modeling was carried out by starting from the dominant form based on four wheels by the order described in the primary 3D Modeling step above (Figure76).
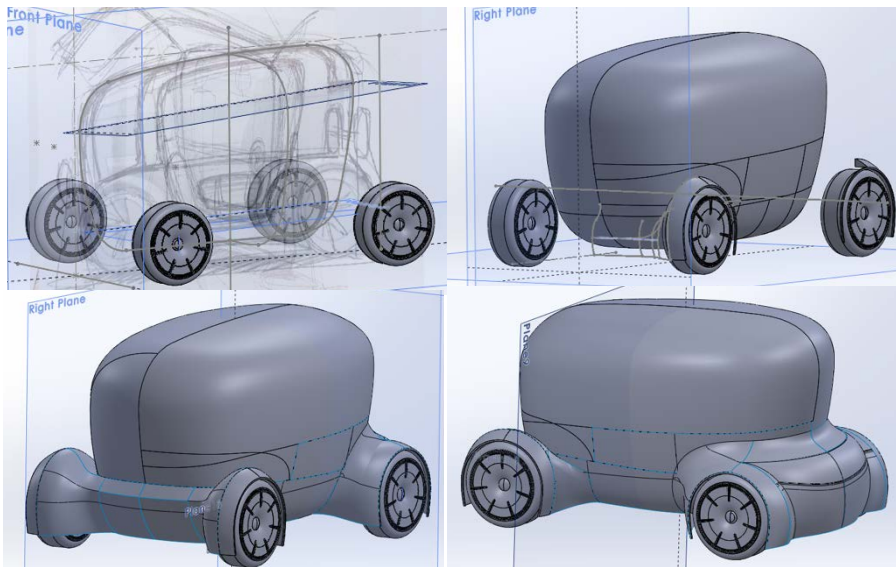
Figure 76. Secondary 3D Modeling #1

After the main shape was outlined as a whole, some details were made with solidification. Figure 77 shows the details of the door parting, side window line parting, capsule shaped sensor and wheel design. Rear lamps and pillar are also shown. The silhouette of the rear and side is changed by mitigating the overall shape flow of rear that seems to be too bloated and angular.
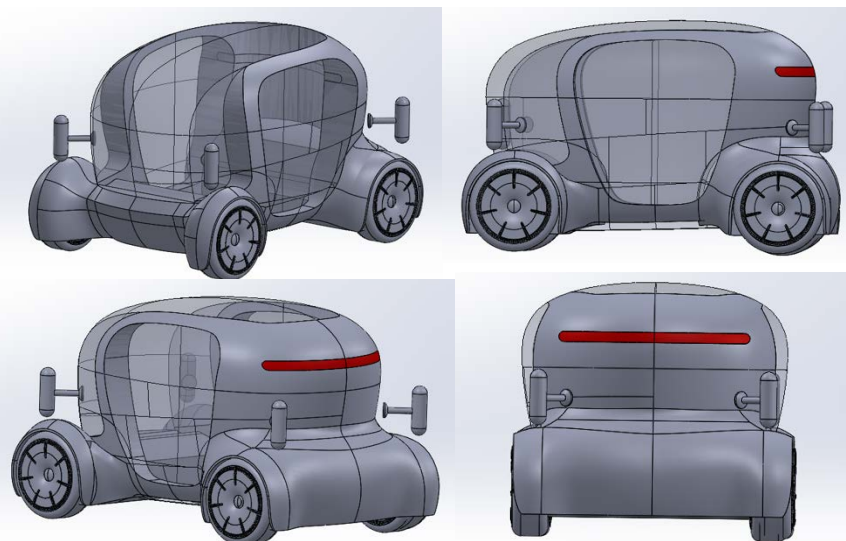
Figure 77. Secondary 3D Modeling #2

3D modeling of the most basic form that can show the concept is almost finished. After this step, it is constantly simulated that the dummy's ride scene and modified the details accordingly (Figure78). The mechanical elements that can perform the proposed function in the concept are also made so that can be shown conceptually. For example, the details in hinge of door, small tea table that is foldable, multifunctional capsule that contains head lamp, interactive light and sensor, trunk are designed and shown in this step. In addition, seat design, interior design, and interior detail elements are also embodied.
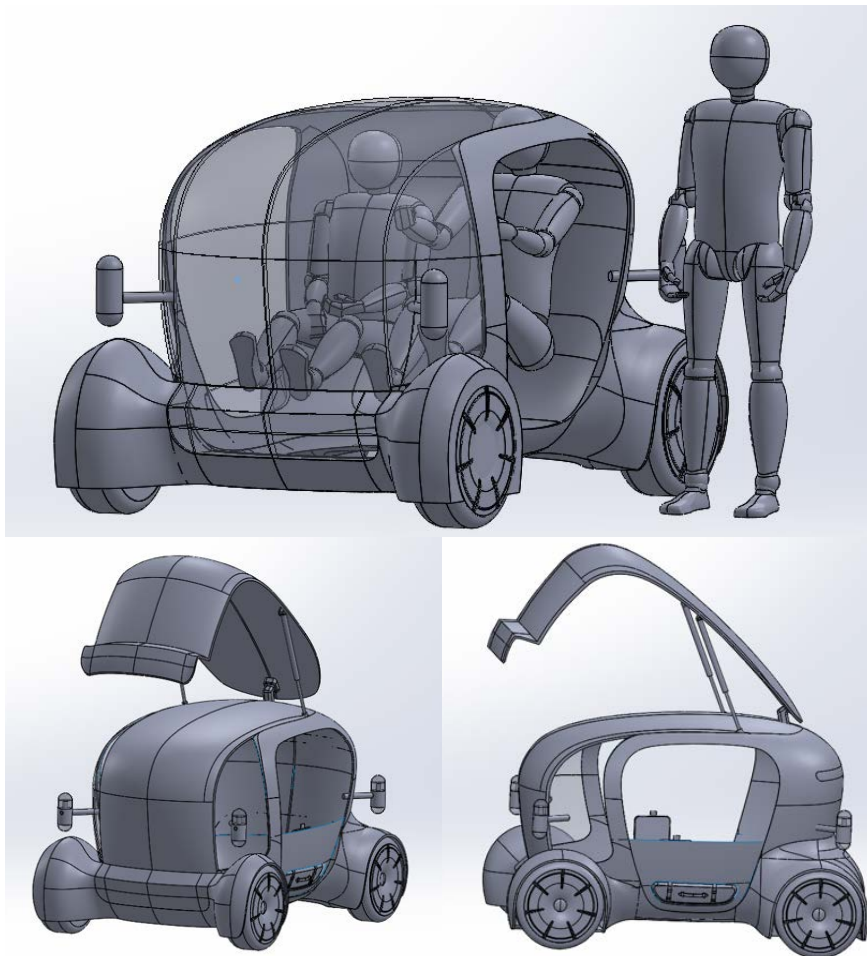
Figure 78. Secondary 3D Modeling #3

Once all the details have been modeled, it is also necessary to pre-change the colors in the 3D modeling file for the part designer want to change to other materials or colors for 3D rendering (Figure79). When the 3D modeling file is opened in the 3D rendering

program, all the bodies are recognized as the same material, and same color. So, this process is necessary to subdivide the parts. Through Figure 79, Side windows open on both sides, specific sensors, logo lines and interior are shown.
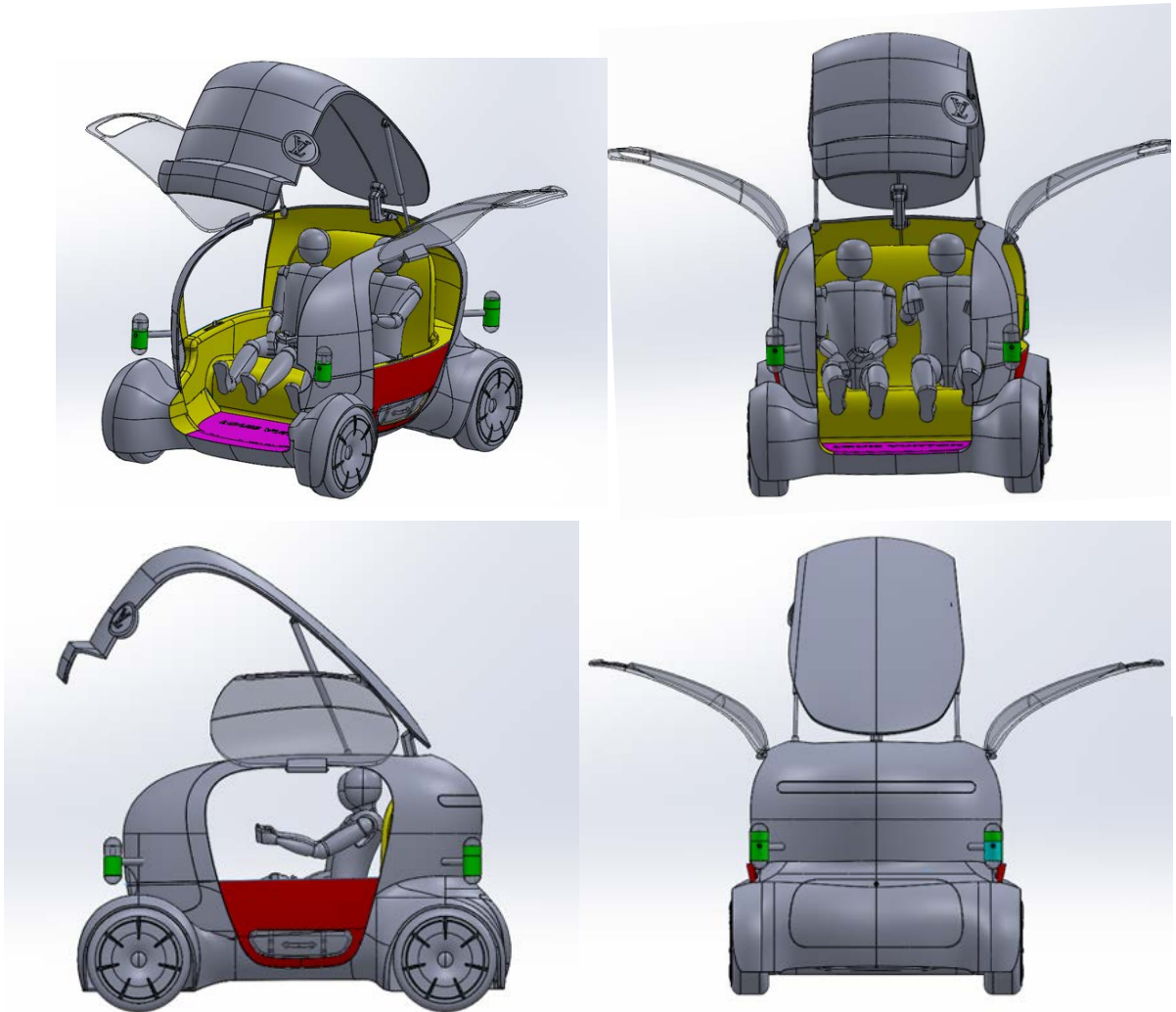
Figure 79. Secondary 3D Modeling #4

The 3D Rendering program is useful for showing 3D modeling data in more realistic materials and colors. Since it is easy to apply motion, it is effective for producing demonstration video. 3D Rendering is helpful to communicate with others who doesn't understand the concept exactly as words. In the Figure 80, a part of 3D rendering process is shown.
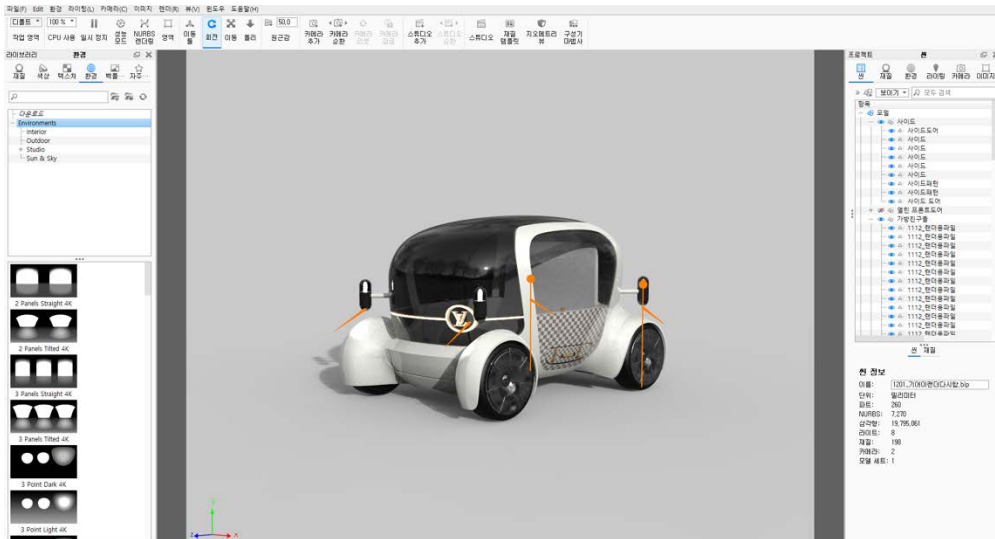
Figure 80. 3D Rendering by using 'Key shot' render program

3.2.8 Prototyping

Prototypes are designed to identify the reality and actuality of concept design and to understand about the concepts and to communicate better with others. Based on all the completed 3D Modeling data, the process of making a 6:1 scale mockup will be explained in this step. First, before prototyping, make predicted figure (Figure81) how each part will be divided and what material and color will be used by 3D Rendering. And then, Divide the parts of 3D data to be produced based on this image by material or color. Although various methods can be used for prototyping, CNC(Milling machine) is used in this paper.

Figure 81. 3D Rendering for Prototyping

Parts divided by color or material must be made separately. If these parts work separately, they do not affect other colors when painting (Figure82). In addition, it can act as a 'parting line' that also affects actual production and production. It should be considered that all the parts must to be assembled.

Figure 82. Left is 'Parts made with CNC', Right is 'Assembled Model'

Depending on whether the color of the part is glossy or matt, the painting process is slightly different. It is easy to buy a glossy spray and a matte spray separately online, but if the difference is not that much, then paint one more 'Transparent Polish' to emphasize the difference in gloss. In this prototyping, polish was used to highlight the difference. In Figure 83, each part of the concept design is shown. When painting is completed, wait for 2-3 days until it is completely dried. The paint is not sprayed once, it is thick because it is sprayed repeatedly many times on each part of the model. This thickness should be

Figure 83. Parts painted differently depending on color and gloss

considered as a tolerance at the stage of 3D printing or CNC manufacturing. Because the paint thickness is thicker than expected, existing parts with small tolerances may not be assembled and may have to be reworked. This rework wastes time and can affect the quality of the final design prototype. When each part with considering all these conditions are assembled together, the assembled prototype will be coincident almost with the predicted figure. Below Figure 84 is a prototype image showing the overall shape of the 'Future Trunk' with considering these things. This prototype shows only the overall form, and since it is not a working prototype, a demonstration video to show working scenarios is also produced.

Figure 84. Assembled Prototype Model

This prototype is exhibited in '2018 UNIST Design Show' at November 20 to 24, 2018 (Figure85). Many posters and boards explaining the concept showed the interior and functions not seen in the prototype.

Figure 85. Exhibition image with the prototype

3.3 Concept Proposal

3.3.1 Concept Proposal

Through all of the above design processes, the concept of 'Future Trunk' has been specifically defined and the design has been confirmed. In this chapter, the concept of 'Future Trunk' is shown and explained with above core design factors and keywords. The concept explanation such as keywords, and core factors of 'Future Trunk' is summarized as follow:

'Future Trunk' Concept Summary

- **Future Trunk**
  'Future Trunk' is personal Electric Vehicle for travel (Figure86). The concept name 'Future Trunk' means the mobility that is essential thing to travel like as the Louis Vuitton's Trunk. Also, it contains 'Future things' such as future lifestyle trend, and future mobility trend. So, if it is opened, then it offers the future

things to user. 'FUTURE TRUNK' is an innovative trunk for travel. 'FUTURE TRUNK' offers the mood that users get a small vacation home in everywhere, it induces being well content to move and travel. When user wants to take a rest, user can open side doors, and can enjoy the travel like in a small lounge. It features like 'a trunk' that can storage a space and items for enjoying travel. Open side doors function as a sun shade, and it can offer the mood of canopy. Also, there are two portable trunks on each side. These are parts of the mobility that makes user carry personal items. At each corner of the mobility, there are smart light that looks like a capsule. It contains sensor for autonomous driving, light, and projector. The projector of smart light welcomes user by projecting some words on the ground. Then, users can walk into the mobility without bending their back because of tilting roof and door. Interior has mono body that user can take various postures like in their home.
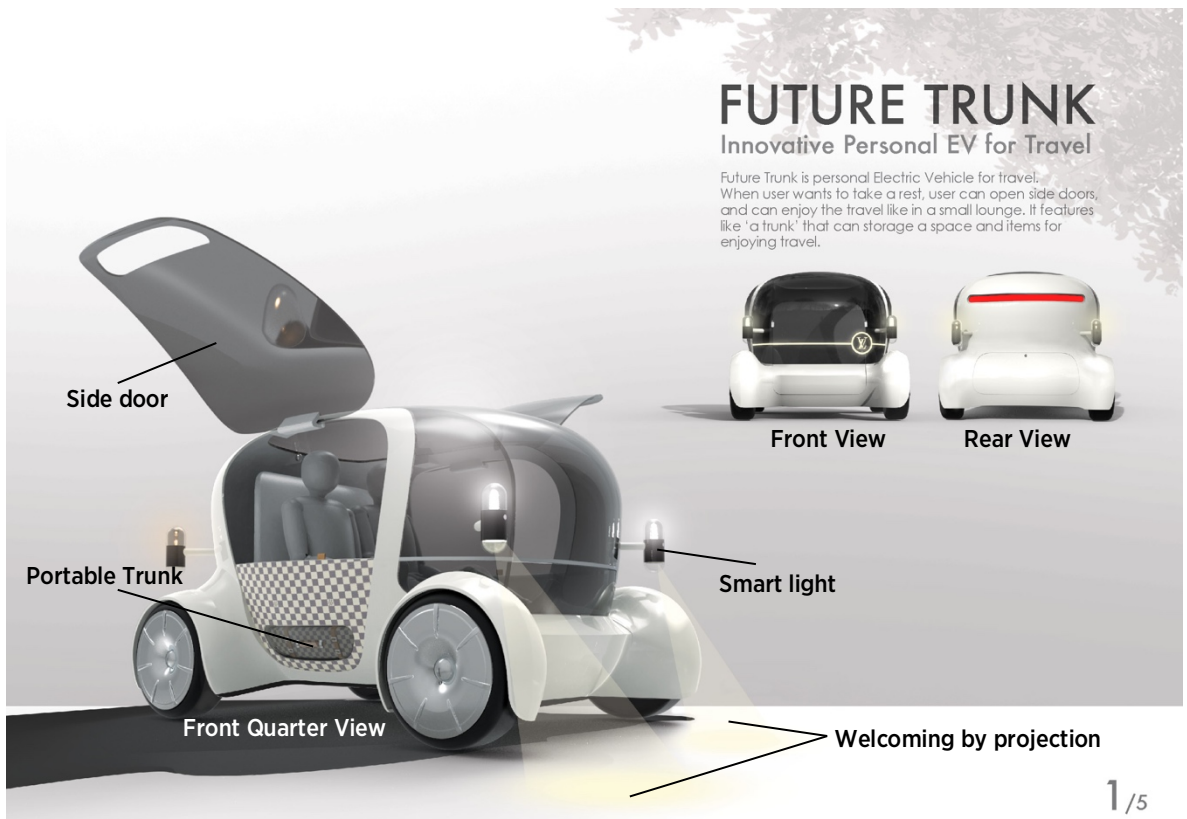
Figure 86. Future Trunk

- **Concept Keywords**
  # Relax   # Travel   # Openness

- **Core Factor1: Cabin shape and Transparent Material**
  Secure large space like as the cabin shape of palanquin and carriage, and the dominant parts offers 'Openness' by using glass or transparent materials. Also, 'Crown shape' is appropriate as the cabin shape, because round shape that can show 'Relax' and 'Pleasure' emotion in 'Travel' The crown shaped cabin is more proper to express relaxing space like as a home or luxury villa.

- **Core Factor2: Interactive Light and Sensor**
  The function of capsule shaped sensor combined with head lamp. The sensor has a role to detect user, and interact with lights to welcome the user. This factor is considered to offer 'luxury travel' experience that greets the user.

- **Core Factor3: Portable Trunk**
  Portable trunk that is embed in the mobility can be the item that make user enjoy the moving and traveling. The side part is appropriate as the position of portable trunk according to use flow. Additionally, the function of offering the embed portable trunk is also considered as luxury function like as 'bell-boy'.

- **Core Factor4: Tilting Roof**
  Tilting roof can offer more openness and relax mood that makes user take lying posture like as on the sunbed. Then, users can walk into the mobility without bending their back.

- **Core Factor5: Uni-body Interior**
  Uni-body interior that can secure more space such as under the seat. The point of interior design is to utilize the space more that user can do various activity and take free posture efficiently in compact sized space. So, interior factors such as seat, item storage, and door trims are combined as uni-body. Utilizing the space under the seat can secure more space by fixing the seat with uni-body structure.

- **Core Factor6: Opening side windows**
  Opening side window offers various benefits such as role of canopy, and providing more openness and relaxing space. All sides are opened and user can feel fresh air and the scenery directly.

Through below concept figures, these core features are found in the design 'Future Trunk'(Figure87).

Core Feature2:
Interactive Light and Sensor

Core Feature1: Cabin shape
and transparent Material

Core Feature4:
Tilting Roof

Core Feature6:
Opening side windows

Core Feature3:
Portable Trunk

HOW FUTURE TRUNK USE

'FUTURE TRUNK' offers the experience that users get a small
vacation home in everywhere, it induces being well content
to move and travel. There are three different modes to enjoy driving.

Length	2400mm
Width	1630mm
Height	1480mm
Wheelbase	1700mm

DRIVING

Wheelbase 1700mm

Length 2400mm

WELCOMING

RELAXING

Core Feature5:
Uni-body Interior

Figure 87. Future Trunk with core feature

'FUTURE TRUNK' is inspired from Korea Palanquin 'Gama' and 'Coach', because past mobilities can be said as 'initial autonomous driving vehicle'. In 'FUTURE TRUNK' offers luxury and leisurely experience by applying the past mobility features. For example, the capsule shaped smart light at each corner is designed as technical replacement of what palanquin bearers and coachman did. These things make 'luxury' experience in this concept design (Figure88 Top). 'FUTURE TRUNK' offers the experience that users get a small vacation home in everywhere, it induces being well content to move and travel (Figure88 Bottom).

Figure 88. Luxury Experience of Future Trunk

There are 4 details of Future Trunk: Travel Bag, Smart Light, Ambient Light, and Storage (Figure89). 'Travel Bag' is a portable trunk that is a part of this mobility. When user want to carry some stuffs, then they can use it. It also automatically opens the glass door for user. The function is inspired from 'Bell-boy'. 'Smart Light' is the combination of light and sensor for autonomous driving. The form and function are inspired from the 'Kerosene lamp' and 'Carriage Lamp' that past mobility has. The bottom part of this light projects interactive massages, and welcomes user by the light. 'Ambient Light' offers the mood of luxury lounge or small villa with the interior that is mono body like a soft and luxurious sofa. In rear body, there is a storage with smart sensor. When user just touches the sensor, the it opens the door for user.

FATURE1
Travel Bag
It is a part of this mobility. When users want to carry some stuffs, then they can use it. It also automatically opens the glass door for user. The function is inspired from 'bellboy'.

3/5

FATURE2
Smart Light
It is lights with the sensor for autonomous driving. The form and functions are inspired from the 'kerosene lamp' that palankeen bearers carried. The bottom light projects interactive massages.

Ambient Light
The interior is mono body like a soft luxurious sofa. There is ambient lights that offers the mood of lounge.

FATURE3
Storage
In rear body, there is a storage with smart sensor. Just touch the sensor, then it opens the door for user.

4/5

Figure 89. Details of Future Trunk

Finally, the dimension of 'Future Trunk' is shown in Figure90. As all the door is closed, Length is 2400mm, Width is 1630mm, and Height is 1480mm. The wheelbase is 1700mm. As the side door is opened, the maximum height is 1870mm. Also, the proportion can be seen by the sitting woman in the Figure90.
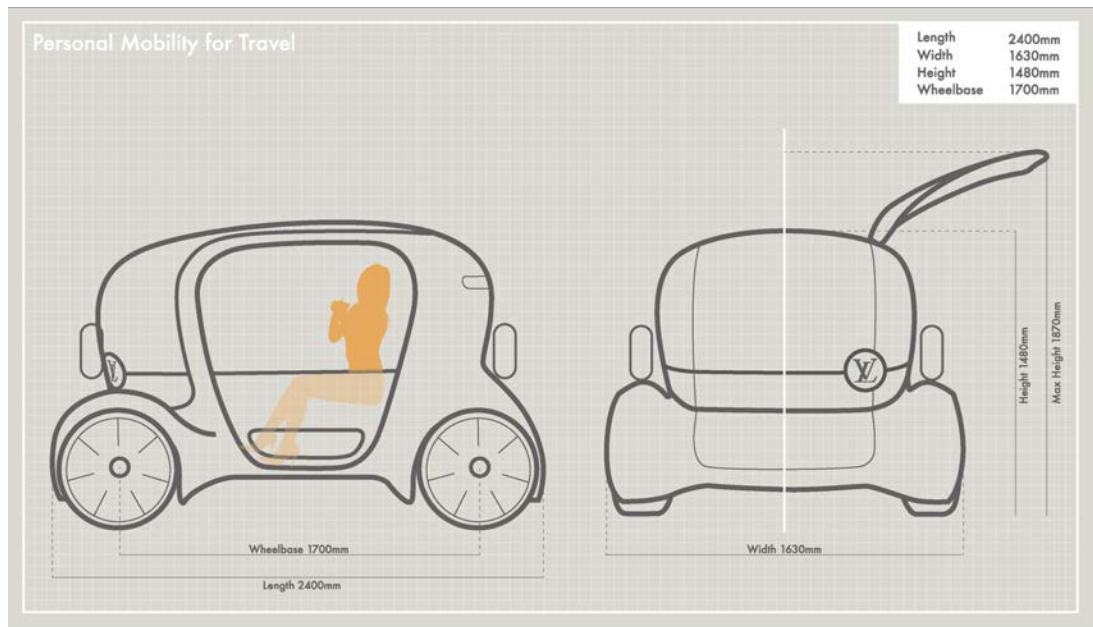
Figure 90. Future Trunk Dimension

3.3.2 Expected effect

'FUTURE TRUNK (Figure91)' is an innovative trunk for travel. In these days, travel may be a luxury behavior, because people live fast and busy. In this daily routine, 'FUTURE TRUNK' can offer an opportunity of taking a rest in everywhere. Systemic sharing car is one of the trendy mobility in these days, but many users are losing their enjoyment of moving and traveling. 'FUTURE TRUNK' can show user's personality by offering the form factors that is different from the uniform and systemic mobility. 'FUTURE TRUNK' offers the enjoyment of moving and traveling by spreading side door. It makes people use more EV than internal combustion engine cars for traveling. To apply EV in the future, sharing car needs integrated system. So, it takes long time to induce more use of EV. Individual car is more open to apply immediately(without any systemic control). Replacement of existing internal combustion engine make more sustainable mobility use. Mobility is not

only for 'Moving', the mean of mobility in life can be extended by 'FUTURE TRUNK'. Users don't need to find cafe or some place to rest during travel. By spreading side doors, 'FUTURE TRUNK' becomes a small lounge, so they can focus on their travel and enjoy the scenes surrounding around them.
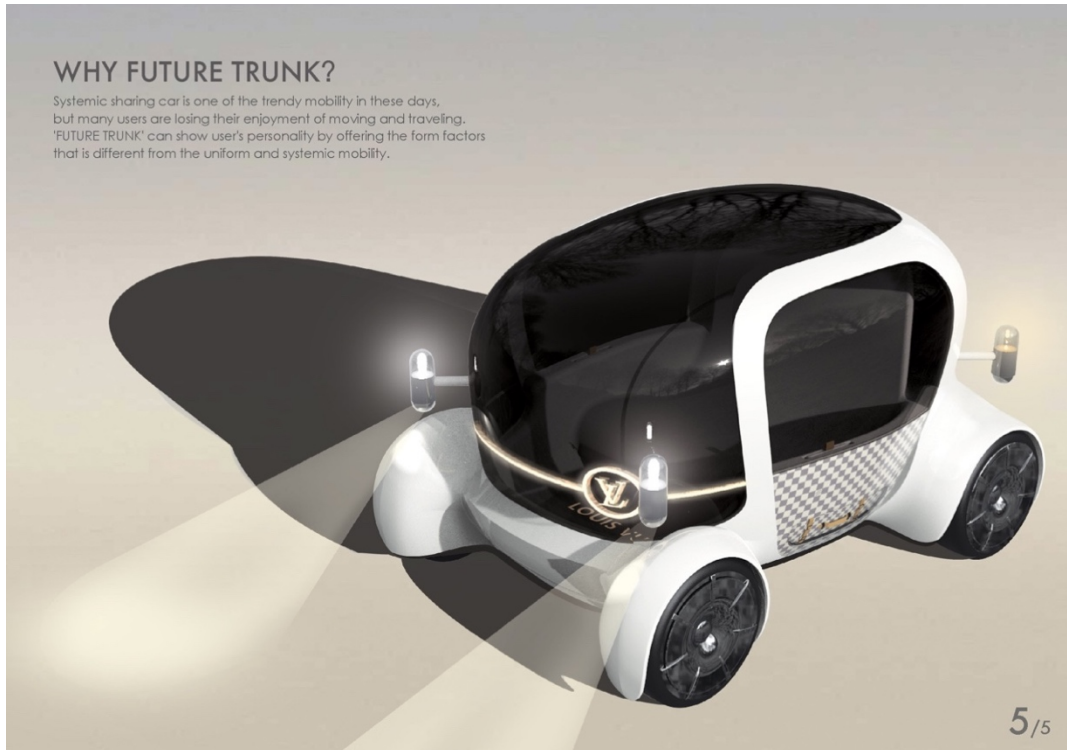
Figure 91. Future Trunk

4

Concept Evaluation
& Discussion

· Expert Interview and Concept Evaluation
· Discussion

4

Concept Evaluation & Discussion

4.1 Expert Interview and Concept Evaluation

4.1.1 Evaluation in Design Perspective

Design expert 'Professor sooshin Choi' who is the professional product and automotive designer evaluated 'Future Trunk' in design perspective. This chapter describes the expert's evaluation of the 'Future Trunk' concept in terms of design. The evaluation can be explained as follow:

First, the overall shape had a good evaluation from Professor Choi. The overall exterior looks like a capsule, and it got a good evaluation. Because of it, the interior looks wider than the actual interior space. The exterior looks like a bubble, it is possible because autonomous vehicles do not have to be in the form of cars. He has experience 'Taxi' design as a graduation project in RCA(Royal College of Art). The taxi driver has to drive with uncomfortable posture throughout all the day, and it is inconvenient for the passengers to board the taxi. To the taxi driver, it is not a car but a work station, or office. For passengers, it is not a car, but a space that can be used while moving and traveling. So, in his taxi design project, the form was not derived from automobiles but from others. This 'Future Trunk' concept is similar to the taxi in that it does not look like a car. It is reasonable to get inspired by 'palanquin' because the passengers do not operate but move like as the concept of autonomous driving. These parts are well expressed in formative way. As an added advice, he said it would be better to add a form to cover the rear wheel. As seen in his taxi project design and Honda's first electric car 'Insight (Figure92)', the wheel-hiding design make the mobility that does not look like a 'car'. The front wheels are hard to cover because they have to be steered, but if the rear wheels are covered, it will offer a trunk-like effect. Also, it seems not for off-road, but wheels are big. If it is only for on-road rather than on the rough road, there's no reason for the wheels to be big.

Figure 92. Honda Insight (Tony swan, 2002)[41].

Second, 'Opening side windows' design element that make the shade like as 'canopy' are good. This element makes ventilation is also possible. However, there is a question about why the front part should be opened as a door. It is good approach that the user does not need to bend one's back, but it is not necessary if the overall height of the car increases. The side windows open like a gullwing door, so this element can be used as a door for the user to get on without bowing. If another way to ride on should be considered, then it is more proper to ride backwards. It is helpful to refer to the vehicle design called 'BIGA (Figure93)', which can be used by a person in a wheelchair because of backward-entry way.
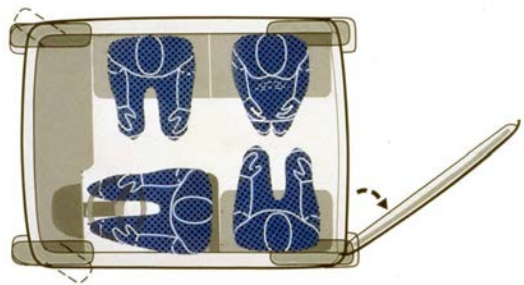
Figure 93. Italdesign 'BIGA' (Italdesign, 1992)[42].

Third, having elements that welcome user on both corners is a good element in emotional design. Additionally, it is an interesting element because as it feels like showing the past

mobility such as carriage.

Fourth, this mobility focused on the personal mobility that the individual had, not the car for sharing. It is evaluated positively. There are various kinds of cars around us, because people choose what suits their personality. However, today's future of mobility focused on only 'sharing mobility'. In the East Germany before the unification of Germany in the past, there was only the same 'Trabant (Figure94)' model in the whole town. In the future, let's assume that the personality of the car is not that important, and most people are going to share the car. If so, a terrible thing will happen, only dull box-shaped vehicles exist on the road. However, this mobility is not for sharing, but a mobility for an individual. It has the quality of a luxury brand represented by Louis Vuitton, and it will not be shared because it is a luxury concept. Users will feel the luxury experience through this mobility, and they will feel different from other ordinary cars. He said "Is not genuinely ideal autonomous driving a Cinderella's pumpkin carriage? This mobility seems to represent it." And then, he advised it would be better to give more details about how to express such a sense of quality in interior.

Figure 94. Seven of these eight cars on the State Council of East Germany parking lot in 1986 are a Trabant (Wikimedia Commons, 1986)[43].

As more and more cars lose their personality and become the same shape, on the other

side, someone will definitely want to be able to show off one's personality, and to feel a bit of high quality. It is the role of the designer to shape the image that such a user requires. He advised that the personality of the person who buy Louis Vuitton can be revealed more in this concept design. If the design is focused on 'empathy' to a person who uses Louis Vuitton, another form can be came out. In this design process, do not use the bag image of Louis Vuitton as a reference, but it would be better to reflect the images of the target as a reference. The personality should be acquired through what food people who wear Louis Vuitton have, where they go, and so on. The designer should be immersed to this personality. A design language that can feel Louis Vuitton without a logo or a pattern should be added in a formative way. For example, people come up with 'sporty' from 'BMW' car's form. In the case of 'Volvo', a conservative feeling is thought. Without any logo or front grills, all the lines and elements in the design reveal their identity.

4.1.2 Evaluation in Engineering Perspective

Engineering expert 'Professor Huisung Lee' who is the professor of design and human engineering school in UNIST evaluated 'Future Trunk'. This chapter describes the expert's evaluation of the 'Future Trunk' concept in terms of engineering as follow:

First, in terms of the philosophy and vision of autonomous driving mobility, 'Future Trunk' has proper approach. The F015 concept of the Mercedes-Benz in CES2015 demonstrates the autonomous driving concept and vision (Figure95). The two visions of autonomous driving, which Mercedes has been suffering for years, are 'Private Space' and 'Quality Time'. Future Trunk' fits both visions. This vision is important because it solves social negative perspective and doubts in technology and engineering. Mercedes is considering about the role of SUV or larger vehicle that have an autonomous driving concept. In case of 'Future Trunk' concept, the role of smaller mobility for two that has 'autonomous driving' technology is considered. It would be better to suggest more various activities that can be performed inside during moving.

Second, it seems difficult to engineer mechanically the 'side door' part that looks similar to the Gullwing door. Although it can be proposed conceptionally, the actual used inner parts take up a much larger volume. Because of it, the overall form can be changed. When

the concept is designed with mechanical or technical limitations, the proposed design can be fabricated as designer's intension without any design change.

Figure 95. Mercedes-Benz 'F015' concept (Mercedes-Benz, 2015)[44].

Third, stability and safety issues should be considered. Many people expect that there will be no accidents as autonomous driving is worked, but it is a very ideal case. Accidents will happen. Therefore, the stability and safety must be considered. It is very dangerous that the dominant body is made of glass. Frame structure must be constructed under glass. Nowadays, due to the stability and safety, there is a tendency not to use sunroof. Also, it would be better to minimize the protruding elements.

Fourth, when looking at the car seat and the portable trunk, there is almost no space underneath of the seat because there should be a cushion sheet, a frame, and so on. Due to the stability, the remaining space is about 15cm, so the concept may be possible. But, it should be considered whether users will be satisfied with the size of portable trunk. In an engineer's point of view, the important thing is how effective it will be compared to the cost in the question whether a product can be manufactured or not.

4.1.3 Evaluation in Sociology Perspective

Science Technology and Society expert 'Professor hyomin Kim' who is the sociology professor in UNIST evaluated 'Future Trunk'. This chapter describes the expert's evaluation of the 'Future Trunk' concept in terms of sociology as follow:

This concept pursues 'what user can enjoy' rather than 'sharing'. Among them, enjoyment

is defined in two ways: One is reacting and responding to user, another is leisure, luxury. First, people usually think of mobility as just a practical product, but the approach to the other side is interesting. The combination of 'autonomous driving vehicle' and 'consumer demand' that people want to show off or to be leisurely is interesting, because it means that the mobility is accepted as a 'place'. The mobility is no more vehicle that move from pointA to pointB, but it is a combination of emotional, social and psychological factors. It is very important point in sociology. 'Space' means just physical arrangement, but 'Place' is different.

Second, it is interesting that luxury has become popularized. Luxury is something that no one else can do. When only the user can do, the user can feel luxury. But, it became a coveted element as it became popularized. And it is very interesting that the 'Luxury' has higher marketability due to the generalization. The proper tension between the 'rarity of luxury' and 'the popularization of luxury' must be achieved. It should not be too popular or too luxurious. When there is such a line, as a social technology expert, it is interesting that traditional or conservative factors such as bell-boy and palanquin are composed of autonomous driving mobility as luxury factors. It is possible to be a luxury factor when very hyper-modern and pre-modern are mixed. There will be related research in the perspective of science technology and society. People thought it was a disappeared technology, or they thought it was an unnecessary technology, but people sometimes revive the technical and social elements. There are many reasons for it. First of all, there are cases in which technology of developed countries are recovered from underdeveloped countries. On the contrary, when trying to give a very luxurious, ultra-exotic experience, there is a case of reviving the past technology. A typewriter is an example. The typewriter has declined and now people are using 'word process'. Rather than using a typewriter, it revives for an 'antique' when it decorates in a cafe.

Third, the book 'Gendered Innovations' introduced Volvo's concept car (Figure96). All those who designed this vehicle are women. Female engineers, female historians, and female sociologists participated in the project. The overall organizer of this project is a sociologist 'Londa Schiebinger'. In this project, the vehicle is designed considering elements that women would like with the theme 'By Women, For Women'. Various elements are considered such as space for storing bags, easy parking function, and convenience for getting on and off, etc. Not only the women who were targeted, but also

men favored this car. Likewise, 'Future Trunk' is built on the concept of luxury, but it is thought that a much wider range users than the target may favor. The exact result will be from consumer survey, but it can be evaluated by referring to the above anecdote.

Figure 96. Volvo Concept car in 'Gendered Innovations' (Nordic Labour Journal, 2015)[45].

4.2 Discussion

Through above expert interview and evaluation of the 'Future Trunk', some discussion points can be derived. The evaluation in each field implies what part for further development is. In this chapter, each discussion point will be summarized in the each perspective of design, engineering and sociology.

Design Discussion

Design all the parts with logical reason. In this concept design, smaller wheel would be better. If it is only for on-road rather than on the rough road, there's no reason for the wheels to be big. To express the moving space rather than a vehicle, the wheel-hiding design will visualize the image that does not look like a 'car'. In terms of 'opening side window', the side windows open like a gullwing door, so this element can be used as a

door for the user to get on without bending the back.

Also, express the user's personality by the design language. The personality should be acquired through the user's behavior, habit, and lifestyle. The designer should be immersed to this personality. A design language without any graphic surface such as a logo or a pattern should be expressed in a formative way. Especially, 'Luxury' is one of the important personalities to express in this design. It would be better to give more details about how to express such a sense of quality in interior.

Engineering Discussion

Design with the consideration of stability and safety issues, and mechanical feasibility. When the concept is designed with mechanical or technical limitations, the proposed design can be fabricated as designer's intension without any design change. In this design, the dominant body that is made of glass, and side door has low feasibility. Also, design with considering how effective the design will be compared to the cost.

Sociology Discussion

In terms of 'Luxury', the proper tension between the 'rarity of luxury' and 'the popularization of luxury' must be achieved. It should not be too popular or too luxurious. Various activities and factors of interior design can be concerned with this appropriate luxury. Also, think about which factor makes the mobility is accepted as a moving 'place'.

5
Conclusion

5

Conclusion

Mobility is developing with reflecting various factors such as social, environmental, cultural things in people's lifestyle. In this paper, future mobility design concept 'Future Trunk' is proposed with the investigation of both future lifestyle trend and future mobility trend. As the lifestyle trend, new tendency of consumption pattern and industry is emerged, because value that people pursue is changed. solo economy, millennial generation, ethical consumption, blesuire, and generalization of luxury industry are found. As the mobility trend, ECO mobility concept, personal EV that specialized in distinct purpose, and differentiation through 'Luxury' can be summarized. According to the 'mapping concept' that combines both lifestyle trend and mobility trend, new mobility ideas are grouped as three : Personal mobility that is for first mile and last mile to use sharing car or public transportation(GroupA), Personal mobility that is specialized in travel or relaxing(GroupB), and ECO mobility that can be attachable, detachable each other depending on the purpose of use(GroupC). All these three ideas can be developed and proposed in further study. In this paper, 'Personal mobility that is specialized in travel or relaxing(GroupB)' is developed that has more possible potential design factors. The group B has key words of Relax, Travel, and Openness. Based on these three keywords, 'Future Trunk' is developed with three design insights such as Louis Vuitton palanquin and carriage, and sunbed or bench in outdoor. Through design process from primary idea sketch to prototyping, design core features are found and applied to the 'Future Trunk'. Total 6 core factors can be summarized as follow: 'Cabin shape and Transparent Material', 'Interactive Light and Sensor', 'Portable Trunk', 'Tilting Roof', 'Uni-body Interior' and 'Opening side windows'. Finally, 'Future Trunk' concept is identified that personal electric vehicle for travel with 6 core factors. This concept is expected that new tendency of mobility that can express user's personality in uniform and systemic sharing mobility trend. 'FUTURE TRUNK' offers the enjoyment of moving and traveling by the 6 core factors. It makes people use more EV than internal combustion engine cars for traveling. The concept is evaluated by three experts that has different perspective such as design,

engineering, and sociology. As the evaluation, the 6 core factors are evaluated as having good potential capacity. If some discussion points are considered more in this design, the concept can solve realistic problems and offer practical benefits to users: logical factors in all the design factors, safety and stability issues, engineering feasibility, the appropriate tension of Luxury. Also, more various activities in the interior of 'Future Trunk' would be needed to present. In this paper, although other two groups(GroupA and C) are not more developed, these groups also have potential development possibility as future mobility design concept. Further development of not only the 'Future Trunk' concept, but also other two concept groups would be necessary.

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