FUTURE STREET

– What would the future streets and lifestyles be in the context of Self-driving technology?

Author: YAO, ZHU

Master's Thesis Booklet, Matter Space Structure, Spring 2020

Chalmers School of Architecture

Department Of Architecture & Civil Engineering

Examiner: Morten Lund

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READING INSTRUCTIONS

INTRODUCTION:
Describing the purpose and framework of the project and explaining why I want to research such a topic are important. The method would show the process of this master's thesis.

DISCOURSE:
This part shows the research results and is the basis of the design, listing related focus areas and explaining how these ideas and thinking inspire me are important.

DESIGN:
The main content of this part is reflecting on the process and results of the project. Firstly, three strategies are proposed, and the site and two typical streets would be chosen and analyzed. The main design process will be divided into two parts. One is designing how these typical streets would develop in almost 20 years, while the other is discussing and evaluating several scenarios they may have in the further future.

DISCUSSION AND CONCLUSION:
Summarizing and reflecting the method and design could explain how my research answer to the main questions. Recommendations for future work on the topic would also be mentioned.

REFERENCE:
The sources of reference books, articles and videos would be listed in this part.

ABSTRACT _ INTRODUCTION

Self-driving is getting closer and closer to us, which we can know from many news and personal experiences. Of course, this change does not happen instantaneously, and may go through several development stages. But I think one day, Self-driving will completely re-place manual driving, which may become a reality within about twenty years. Many scholars are aware that this technology will bring huge changes to the city, including transportation, infrastructure, economy, and lifestyle. At the same time, as a new technology it has also received many questions, such as security, accident liability, information privacy issues and even unemployment problem.

In this thesis, street is chosen as a tool to investigate and create understanding of the impact of Self-driving and I want to focus on the change of people's lifestyle. Firstly I will discuss the change and impacts that Self-driving would bring to the whole society, including good opportunities and bad problems. After analyzing my discourses, several design strategies would be proposed. Based on that, the site and two typical streets would be chosen and designed. The main design process will be divided into two parts. One is designing how these typical streets would develop in almost 20 years, while the other is discussing and evaluating several scenarios they may have in the further future.

Some ideas, especially in the second part of the design, sound crazy and may not really happen. However, history has proved that people's fantasies and imaginations sometimes will promote the development of the society and that's why I think it is interesting and valuable to research what the future streets and lifestyle would be. I will keep criticizing and reflecting in the whole process and constantly adjust my design, making such design and discussion more practical and reasonable.

KEY WORDS: Self-Driving, Street, Lifestyle, Development Stage

CLAIM AND MAIN QUESTIONS_ INTRODUCTION

I want to discuss the impacts that Self-driving would bring to typical streets in Gothenburg, focusing on people's lifestyle. I will design how they would develop in almost 20 years, while discuss and evaluate several scenarios they may have in the further future.

What would the future streets be in the context of Self-driving technology?
How would Self-driving change people's lifestyles?

DELIMITATIONS _ INTRODUCTION
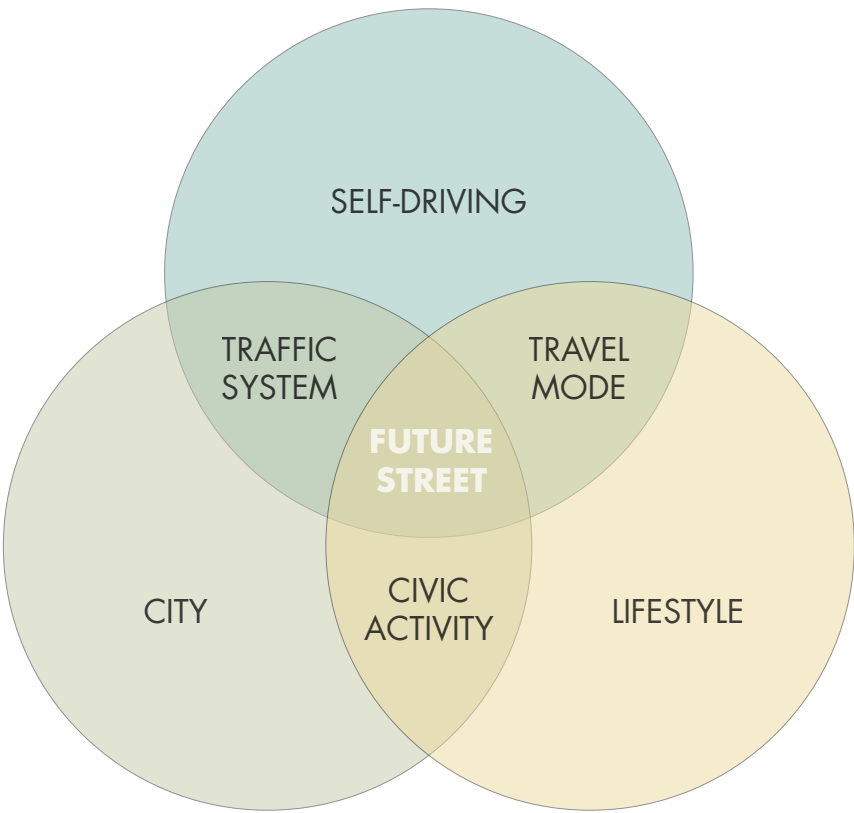
I want to discuss the relationship between the technology of self-driving, city and people's lifestyle and I will list some delimitations below.
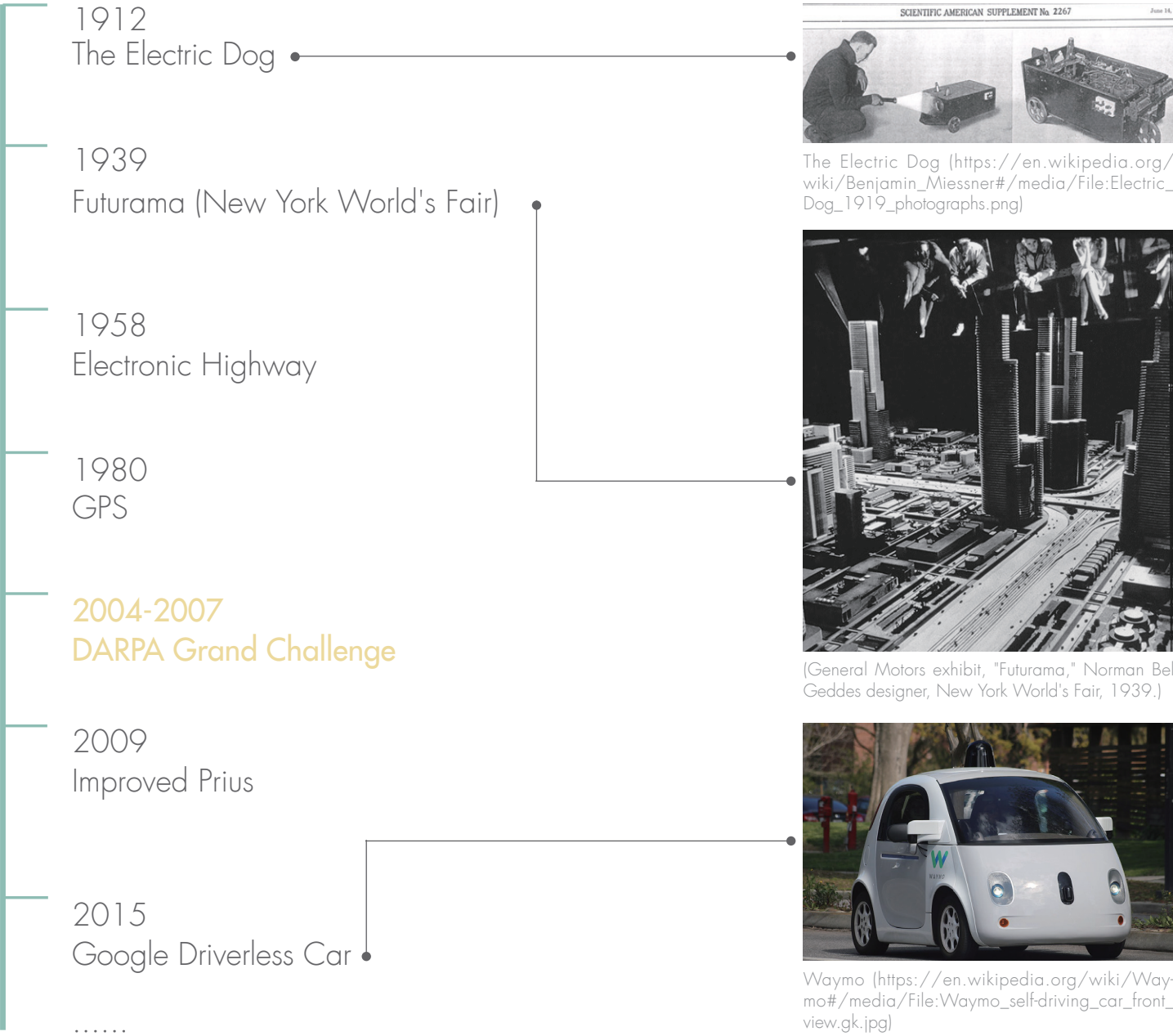
1. I do not discuss the whole transportation network and I want to focus on street level, including vehicle roads, pedestrian ways, related infrastructures, people's activities.

2. I do not research for technical issues of Self-driving. What I really care about is the impact of Self-Driving bring to the society and streets.

3. Self-driving may make a big change to people's lifestyles, and I want to focus on street-related activities.

BACKGROUND _ INTRODUCTION

This paper is based on the rapid development of Self-driving technology and the existing problems on some urban streets.

1. The idea of driverless car has a long history for almost 100 years. The first self-driving vehicle appeared around 1910s. The Electric Dog are using selenium cell to make an orientation mechanism, designed by John Hammond and Benjamin Miessner. In 1939, Futurama depicts people's life in 1960 and automated highway. A set of radio control system would benefit for convenient travel. At that time, people focused on smart infrastructure such as automated highway. However, because of the huge cost, such research has been progressing slowly. Such choice of research direction was completely reasonable at the time because the size of the computer was too large before and people would never think it could be placed in a car. Until 2004, a considered milestone is The DARPA Grand Challenge, which means that people begin to pay attention to the automation of the vehicle itself. Nowadays, most of car company have projects with autonomous vehicles. For example, Volvo are tested driverless cars in special roads in Gothenburg by 2017. Google is one of the companies that has gotten furthest with their autonomous car project. With more than 1.5 million miles driven on normal roads, under supervision of humans, Google seems to be the companies that is closest to deliver a fully autonomous vehicle.

2. Secondary, the technical problem of Self-driving may be solved in the near future. Moore's Law explains that related high technologies can grow exponentially. In addition, the breakthrough of Deep Learning is the support of many AI technologies, which can make robots become experts in a professional field, including driving field.

1912
The Electric Dog

The Electric Dog (https://en.wikipedia.org/wiki/Benjamin_Miessner#/media/File:Electric_Dog_1919_photographs.png)

1939
Futurama (New York World's Fair)

1958
Electronic Highway

1980
GPS

(General Motors exhibit, "Futurama," Norman Bel Geddes designer, New York World's Fair, 1939.)

2004-2007
DARPA Grand Challenge

2009
Improved Prius

2015
Google Driverless Car

......

Waymo (https://en.wikipedia.org/wiki/Waymo#/media/File:Waymo_self-driving_car_front_view.gk.jpg)

History of the development of Self-driving

3. Besides, Research on Self-driving has sufficient financial support. Most of car companies, automobile parts companies and electric car companies in the world are conducting research on it. Besides, Self-driving will greatly reduce the cost of companies such as Uber and Didi. The biggest cost of this type of company is the salary of the driver, which means that Self-driving can bring great profits.

4. Self-driving has used in some structured site, such as airport shuttle, sightseeing bus and ferry, which make people start to experience Self-driving. People are prone to resist new things that they don't know, while accept things they are familiar with. In addition, the data and problems collected during use are also conducive to the work of researchers.

5. In this thesis, what I focus on is the full automation. The diagram on the right is SAE Automation Levels. There is a opinion about Self-driving that it does not need to develop to full automation, but supports level 3 or 4 of the automation, which means that people need to drive in special situations. I think this would bring security risks. First of all, driving itself is a boring thing, people will not focus on the street when the machine assists driving. In addition, if people have not driven for a long time, their driving skills will also deteriorate. In the event of an emergency, a sudden request for human takeover of the vehicle may lead to a more serious accident and that's why I agree that we need to achieve full automation.

SAE level	Name	Narrative Definition
Human driver monitors the driving environment		
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*
Automated driving system ("system") monitors the driving environment		
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*
4	High Automation	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*

(Automated Driving - Levels Of Driving Automation Are Defined In New SAE International Standard J3016)

SAE Automation Levels

6. How Self-driving would affect the future streets, which has been discussed by many scholars. For example, National Association of City Transportation Officials in USA has published a blueprint for autonomous street.

7. Nowadays, many streets are not designed for pedestrian. With the emergence of motor vehicles and the increasing number of them, many new planning areas in some cities began to focus on motorways, leading to the uncomfortable experience of the pedestrian routes. One of the street in Gothenburg, named Hjalmarbrantingsgaten, faces the same problem. There are a tram way and highway in this street and they become barriers of the pedestrian routes.

8. In addition, because of the prevalence of motor vehicles, traffic accidents and air pollution on the streets have become a huge problem. A lot of scholars believed that Self-driving can decrease these two problems. Self-driving would be a better driver than people. According to the statistics, 1. 35 million deaths worldwide because of vehicle accident, while 2.4 million injuries in 2015 due to vehicle accident in 2015. Unfortunately, 94% of crashes involve human choice or error in the US. (https://waymo.com) What's more, a large number of driverless cars and trucks can form a close formation to drive close together, thereby reducing wind resistance and saving energy.

(Photo of Hjalmarbrantingsgaten)

(Photo of Hjalmarbrantingsgaten)

Traffic Pollution (https://respromasks.com/2017/06/30/dont-be-silent-assas-sins-drivers-urged)


Traffic Accident (https://www.foreigner.fi/articulo/news/road-traffic-accident-victims-rose-in-march/20200421120235005401.html)

METHOD _ INTRODUCTION

The process of my master thesis is divided into three stages, where I may use different tools and approaches. The first stage is aim for establishing a comprehensive and dialectical cognitive framework of the impact of Self-driving on the society. Reading literature extensively, analyzing different hypotheses, interviewing people in related industries, drawing mind map are main approaches at this stage. Some social issues like ethic question, information safety, responsible party and unemployment problem will be covered and discussed. **I think it is important to border my knowledge of Self-driving at the beginning, so as to prepare for going deep into the street level and people's lifestyle later.**

The second stage is start with proposing three principles of the design according to the discourse. Then a site in Gothenburg are found and analyzed by site investigation, sketches, physical models, and diagrams. Such research would help me to know the width of roads, infrastructures, atmosphere, and people's activities in current streets. After that, I will select two typical streets, containing different characteristics, from the site for further research and design.

The final stage is the main design process, divided into two parts according to time. One is designing how these typical streets would develop in almost 20 years, while the other is discussing and evaluating several scenarios they may have in the further future. In the first part, the change of streets and people's lifestyles may be relatively smooth, because citizens need time to gradually accept this new technology, and that's why I subdivided this part into different stages to show the process. In the second part, the streets and people's lifestyles will change drastically. I do not mean that these scenarios will really happen in the future, and I just want to discuss, if these new vehicles really emerge, what the changes would be and critically evaluate these changes. Some crazy ideas in history have turned out to be achievable, which is why I think such discussion is meaningful. **At last, detailed sections, planes, and perspectives would be produced to show how the streets and lifestyles change in the future.**
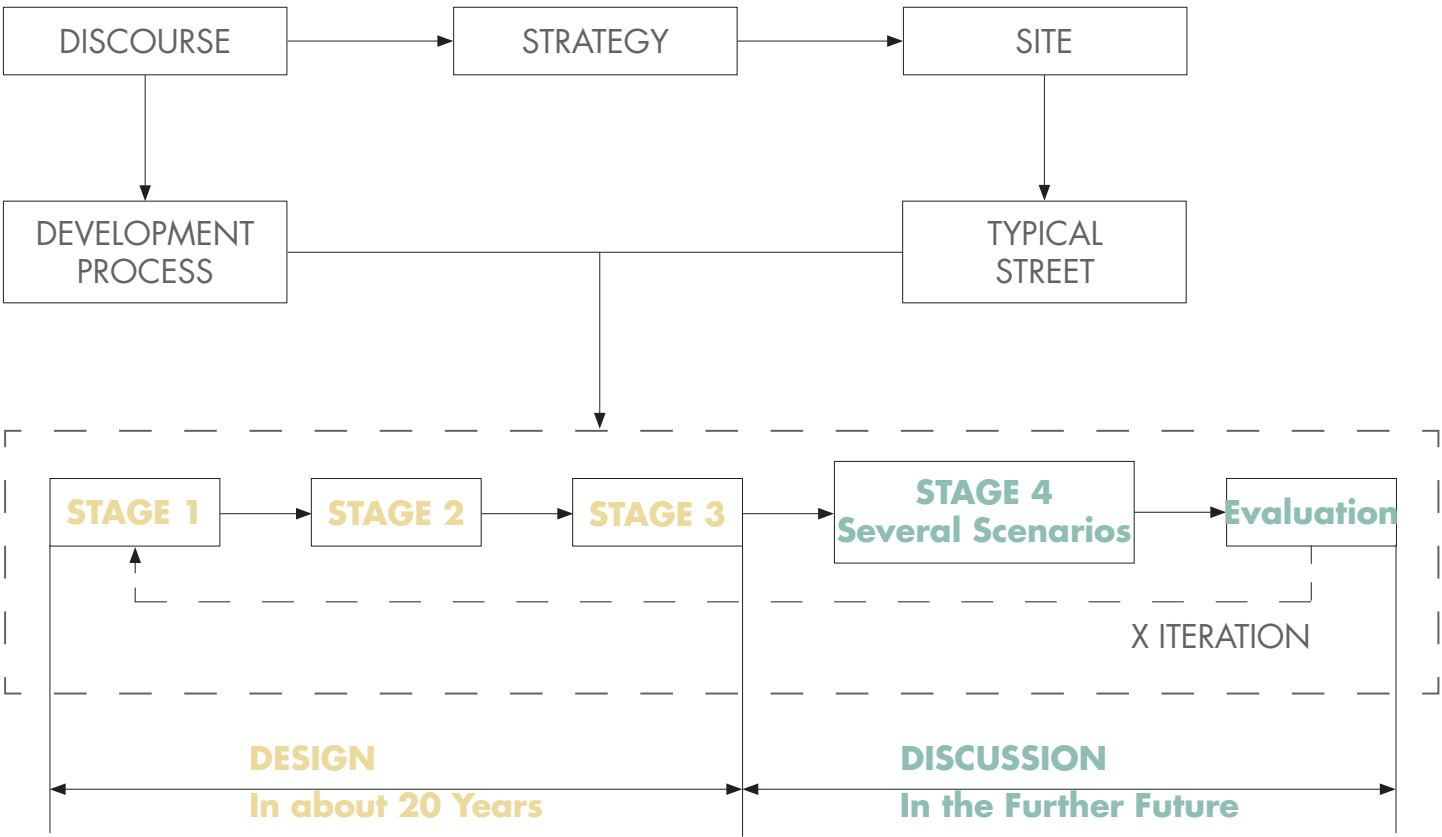

Flow Diagram Of The Thesis

IN-CAR ACTIVITY _ DISCOURSE

Human beings wanted to have autonomous driving from 20 century, which would make the time on the car more meaningful. According to statistics, 42 hours wasted in traffic each year per person. (https://waymo.com) **Self-driving could not only let people be free of driving, but also increase driving smoothness.** That's why Self-driving allows people to enjoy leisure time in driverless cars and there may even be bookstore, café, restaurants, shop, offices, printing room, kitchen, bedroom, toilet and so on.

Activities in driverless cars
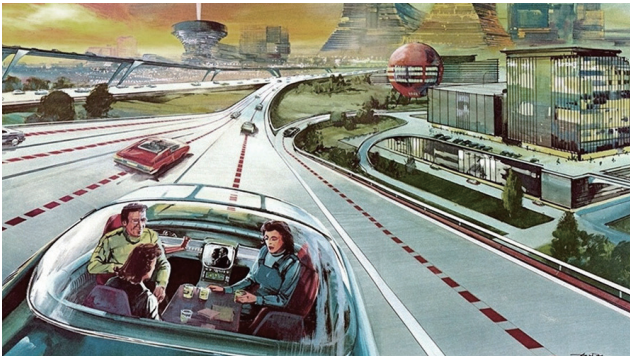
RIDE-SHARING _ DISCOURSE

The diagram below can show why I believe that self-driving can lead to the ride-sharing. Today the management issue is a big problem in ride-sharing. What should customers do after using the car? If we have driverless car, it would not be a problem anymore. Besides, accident liability will also become clearer. What can be confirmed is that passengers are not supposed to be responsible for this. Today, the main cost of taxi companies is drivers' salaries. With self-driving, the cost of rental will become very cheap. On the other hand, self-driving would increase the in-car activities, and people may want to make a better interior decoration of cars, which means they may not want to share their vehicles. **Overall, I think people may prefer to use ride-share, but someone would still have their private vehicles.**
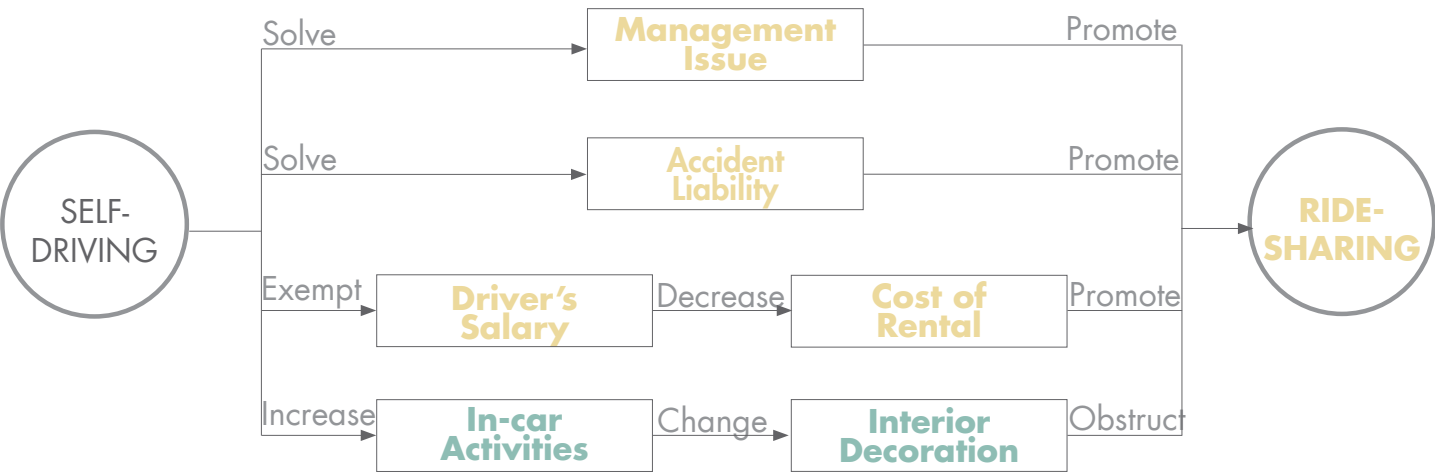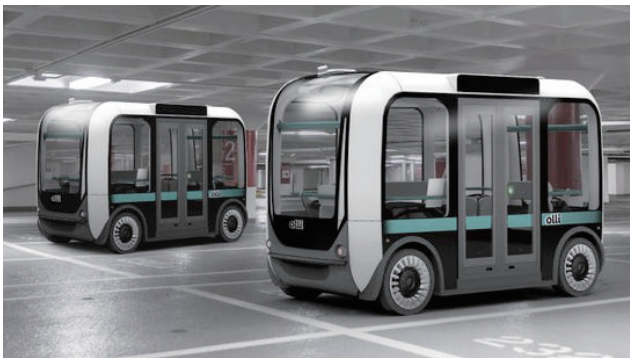

Relationship Between Self-driving and Ride-sharing

PUBLIC TRAFFIC _ DISCOURSE

In the future, ride-sharing may make travel very cheap, and traditional public transport, such as buses, trains may be gradually replaced. Many companies, like Microsoft, are promoting driverless minibuses, which may be a cheaper and more efficient way of public transportation in the future. I hope to use a simple experiment to illustrate the advantages of this kind of transportation.

The diagram on the right represents an ideal experiment, I simplified a lot of factors, for example, I let all the people are start in the first point but they have different destination. Crossing each interval need to spend one unit of time, while walking takes two units of time. Finally, I counted the time everyone spent on the road to quantify traffic efficiency. **From the picture on the right, we can find that the more flexible shared travel on the right may be more efficient than traditional public transportation.**
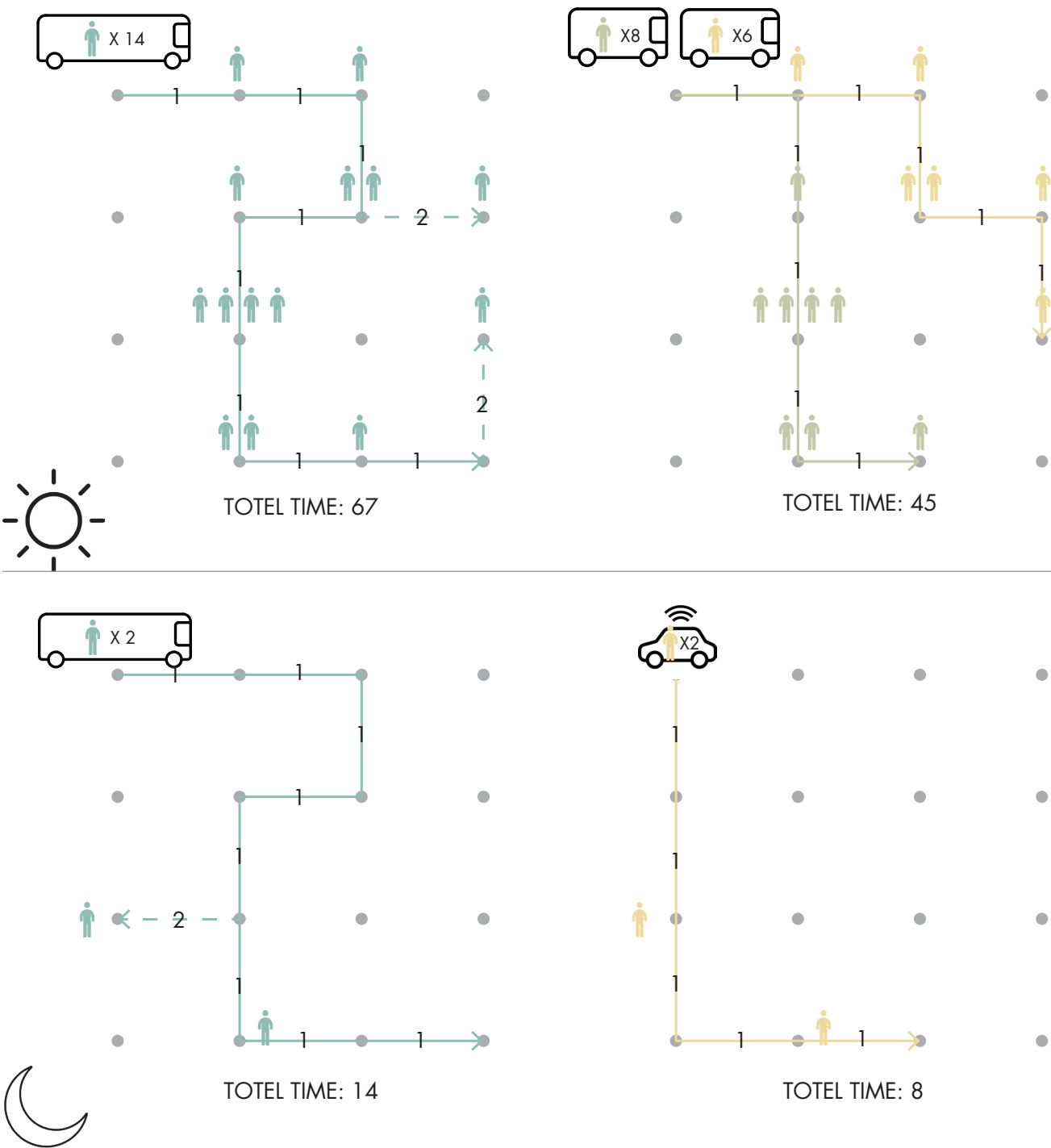
Some people may question the issue of energy consumption. Will more cars mean more energy consumption? The calculation of energy consumption very complicated, but there are some small opinions related to this question. First of all, the smart algorithm can reduce the total distance to some extent, and the fuel consumption of lighter vehicles is also low. In addition, the night buses and rail trains running in the city now often bring waste of resources.


Olli (https://localmotors.com/meet-olli/)

Futuristic Automotive Idea For 2030 (https://car-bus.club/futuristic-automotive-idea-for-2030-that-is-tremendous-stoops-the-volt-report/)

TOTEL TIME: 67

TOTEL TIME: 45

TOTEL TIME: 14

TOTEL TIME: 8

Reasons Why Self-driving Will Improve Traffic Efficiency

TRAFFIC EFFICIENCY _ DISCOURSE

There are four reasons why I think the traffic efficiency would increase because of Self-driving. First is that the self-driving can form a closer formation. Besides, the speed limit will also increase. The speed of the roads inside the city may not increase much because of the feeling of pedestrians. However, the speed of the highway may be greatly improved. When all vehicles are driverless, an excellent algorithm can improve the efficiency of the entire transportation network and determine which vehicle to pick up which per-son. Traffic light is a good invention, but in some cases it is not the most efficient measure. In the future, there will be no traffic lights on the road, and vehicles can autonomously cross the intersection in a safest and fastest way.

Closer Formation

Faster Speed

50 → 60

120 → 200

Efficient Algorithm

Cancelling Traffic Light
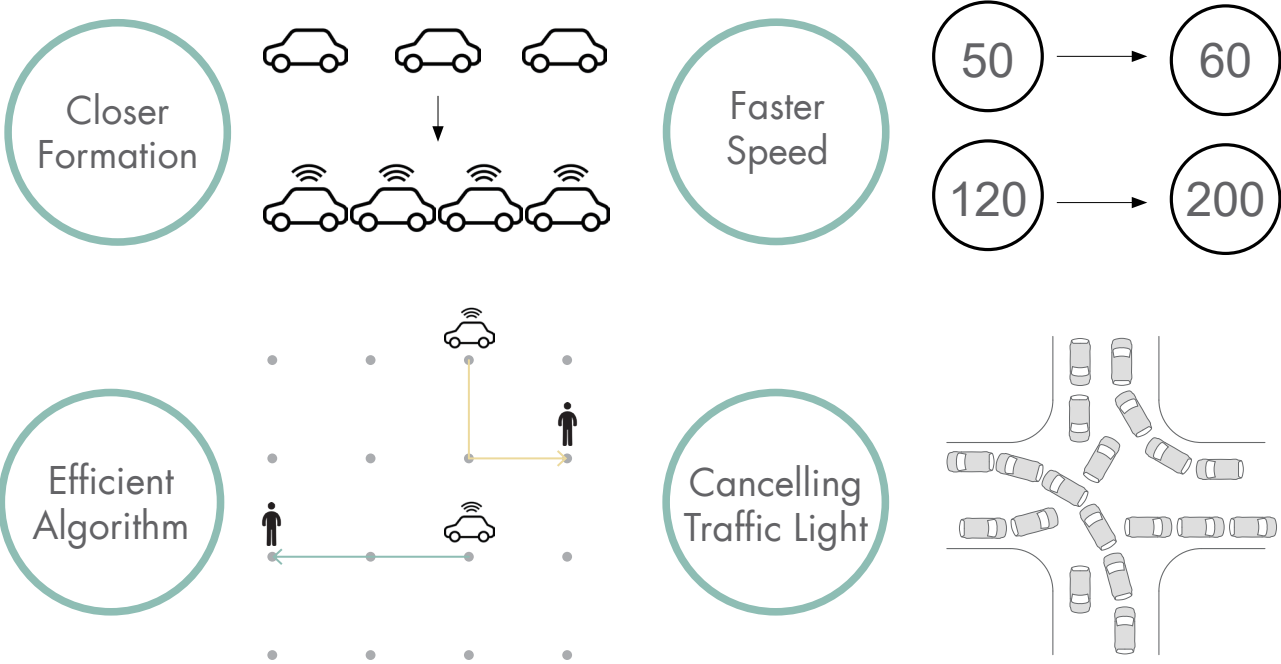
Reasons Why Self-driving Will Improve Traffic Efficiency

NEW USERS _ DISCOURSE

Self-driving can increase the group of users which are unable to drive, including children, the elderly and the disabled. Nowadays many developed countries in the world are facing population aging. According to the statistics, 3 million Americans age 40 and older are blind or have low vision and 79% of seniors age 65 and older living in car-dependent communities. (https://waymo.com) Besides, In America, parents spend 6 hours 43 minutes to pick up and drop off their children to school, and to participate in social activities. *(Driverless: Intelligent Cars and the Road Ahead)* That's why I believe that the emergence of driverless will have a huge impact on new users' living habits.
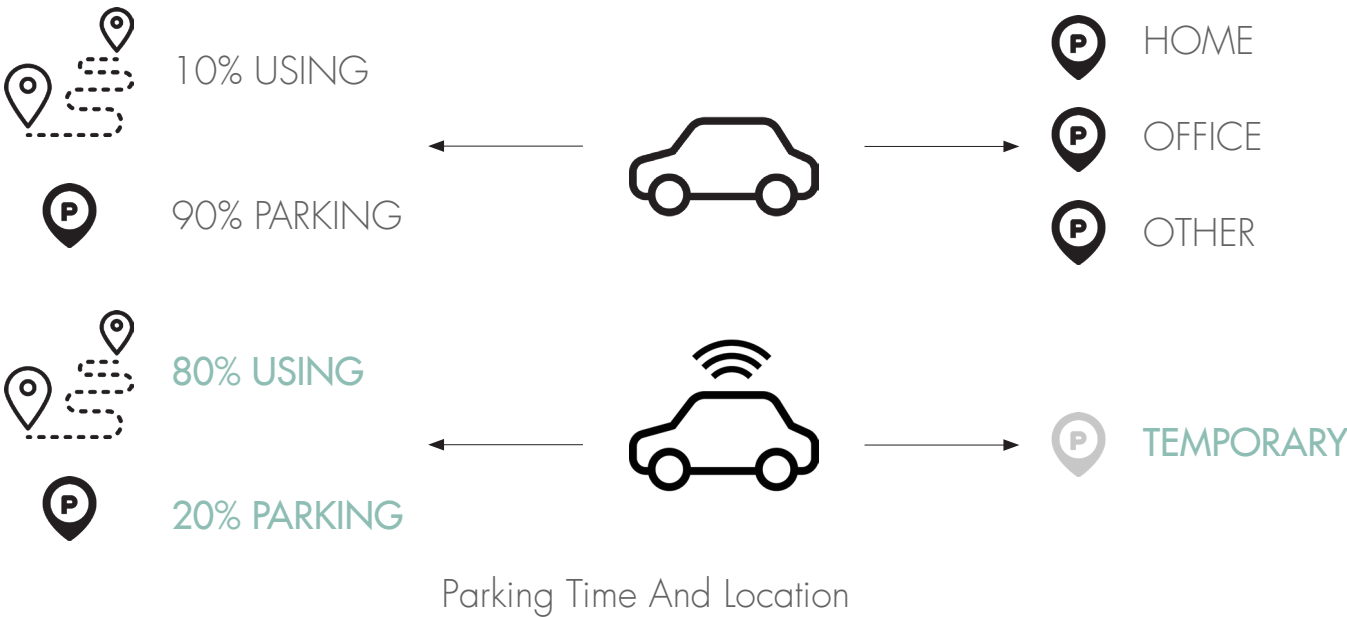
In the book named *Inclusive Urban Design: Streets For Life,* The author investigates the willingness and purpose of the elderly to travel through interviews and other methods. **The most important point is aging people are still want to go outside**, and there are several reasons.
1. Freedom And Autonomy
2. Recognition Of Dignity And Self-Worth
3. Fresh Air And Physical Exercise
4. Psychological Pleasure And Enjoyment
5. Social Interaction

PARKING _ DISCOURSE

Nowadays, parking space occupies a lot of space. One of the reasons is that a car may not only need one parking space at home, but also need parking space in the office, shopping mall and so on. *Melbourne, Australia, where the parking area is 76% of the total urban area. In Houston, Texas, car parks account for 57% of the total urban area. In old cities like London and New York, car parks occupy less urban space, about 18%. (Driverless: Intelligent Cars and the Road Ahead)* At the same time, **another serious problem is that today's private cars, according to statistics, are not been used nearly 90% of the time, which has caused great waste.** (Schneider, J. (2017). *How Self-Driving Cars Will Transform Our Cities and Our Lives* [Video])

Self-driving can solve such problem and promote a more sustainable lifestyle.

10% USING

90% PARKING

HOME

OFFICE

OTHER

80% USING

20% PARKING

TEMPORARY

Parking Time And Location

There is competition in Houston, and one idea is "Shuffle City", which is aim to promote shared transportation pattern to create a denser Houston. Freeing up all the wasted space in not-quite-dense-enough areas like Downtown to be grouped into dense, walkable "city cells" (i.e. neighborhoods). You'd have your office, your gym, your wine bar all right there inside your cell: It's called "Shuffle City." These bottom 2 maps show how much space there might be Downtown, if you got rid of the parking lots and garages. (Those are denoted by pink.) **We can recognize from this how much urban space is occupied by parking areas today.**

EXISTING STRUCTURES
CAR-PARKS
PARKING LOTS

(http://swamAplot.com)

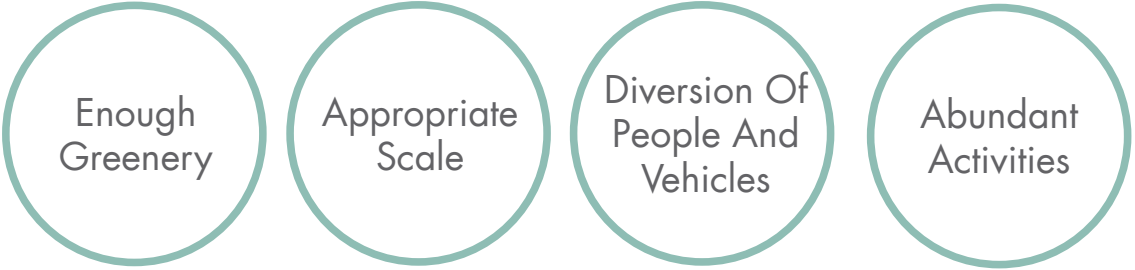(http://swamAplot.com)
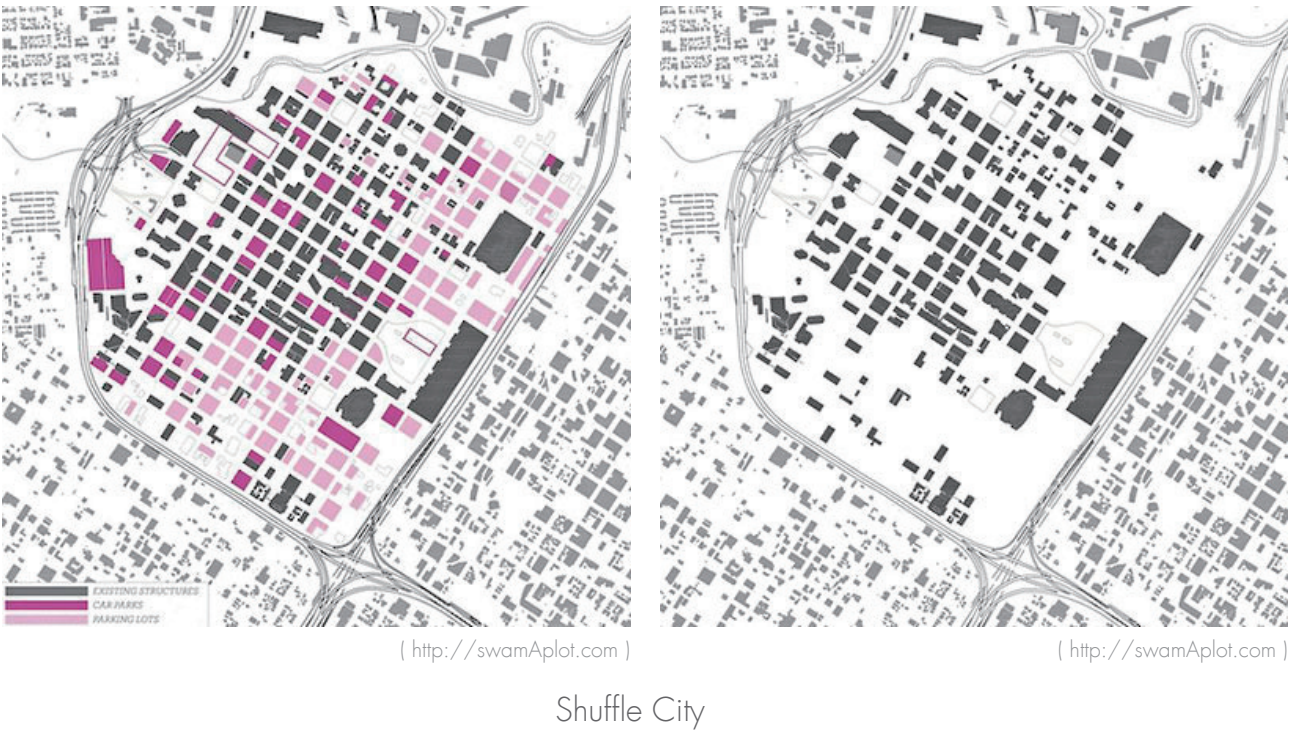
Shuffle City

QUALITY OF STREET _ DISCOURSE

What represents the quality of the street? What are the characteristics of good streets? I think it's a very important question. The discussion and Research on this issue is helpful to guide my later design.
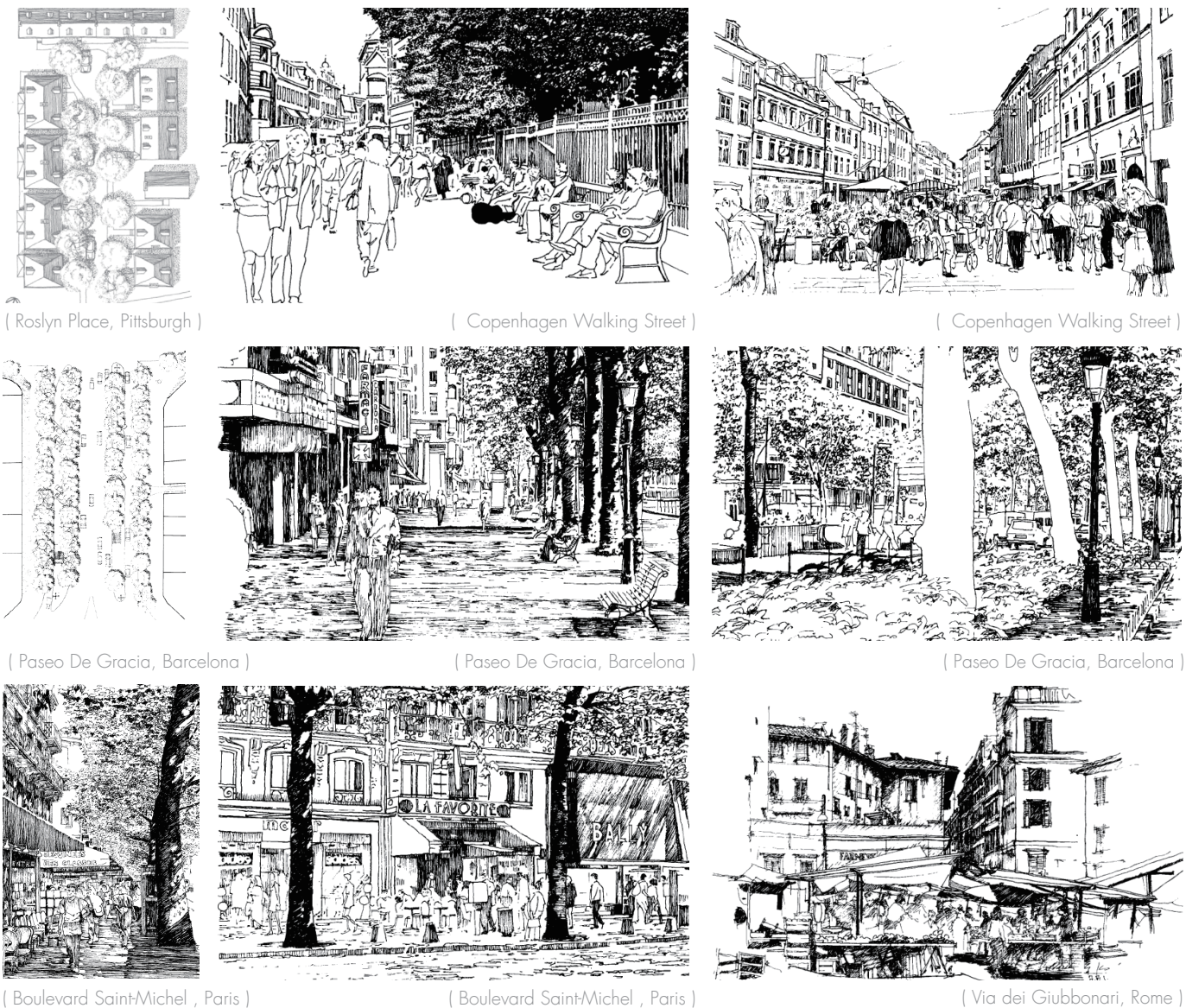
Great Streets, whose author is Allan B. Jacobs, introduces some great streets in the world that people like to stay. Plans, sections and scenes are drawn to analyze and understand the streets. **I figure it out that there are four common characteristics that are important in these great streets, including enough greenery, appropriate scale, diversion of people and vehicles, and abundant activities.** These characteristics creates excellent walking space and has unique attraction to pedestrians.

Streets are an important public space and an important place for people to enjoy city lives. Jan Gehl said that **there are three types of activities on the street,** in his book named *Livet Mellem Husene : Udeaktiviteter Og Udemiljøer.*
1. Necessity Activities: School, Work, Shopping, Waiting, Express
2. Spontaneous Activities: Walking, Watching Activities, Basking In The Sun
3. Social Activities: Talking, Playing Games

Enough Greenery

Appropriate Scale

Diversion Of People And Vehicles

Abundant Activities

Characteristics of Great Streets

(Roslyn Place, Pittsburgh)   (Copenhagen Walking Street)   (Copenhagen Walking Street)

(Paseo De Gracia, Barcelona)   (Paseo De Gracia, Barcelona)   (Paseo De Gracia, Barcelona)

(Boulevard Saint-Michel , Paris)   (Boulevard Saint-Michel , Paris)   (Via dei Giubbonari, Rome)
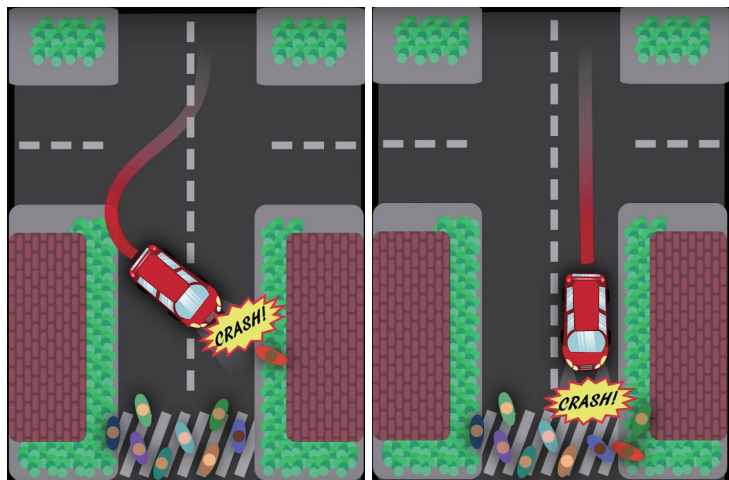
Diagrams in *Great Streets* (Jacobs, A. 1995)

At the same time, as a new technology Self-driving has also faced many challenges and questions. There are also moral and ethical issues. Should the algorithm of driverless driving be based on the principle of protecting the driver or the principle of minimizing the loss? In addition, which party should be responsible for the accidents of driverless vehicles? Users, car manufacturers, or software developers? In addition, there is the problem of information privacy. If I use driverless, does it mean that my travel information will be in danger of leakage. Someone may also question safety, whether driverless technology is reliable, and whether it is really safer than human drivers. If the car system is hacked, will it bring unexpected danger? Finally, Self-driving may cause serious unemployment. A large number of truck drivers, taxi drivers and private drivers will lose their jobs. Canadian truck drivers have jointly protested because of a large number of dismissals.

Ethics Question

Responsible Party

Information Safety

Unemployment Problem

The Social Dilemma Of Driverless Cars (https://www.youtube.com/watch?v=n-hCh1pBsS80)

Negative effects of Selfdriving

Possible Ethics Question
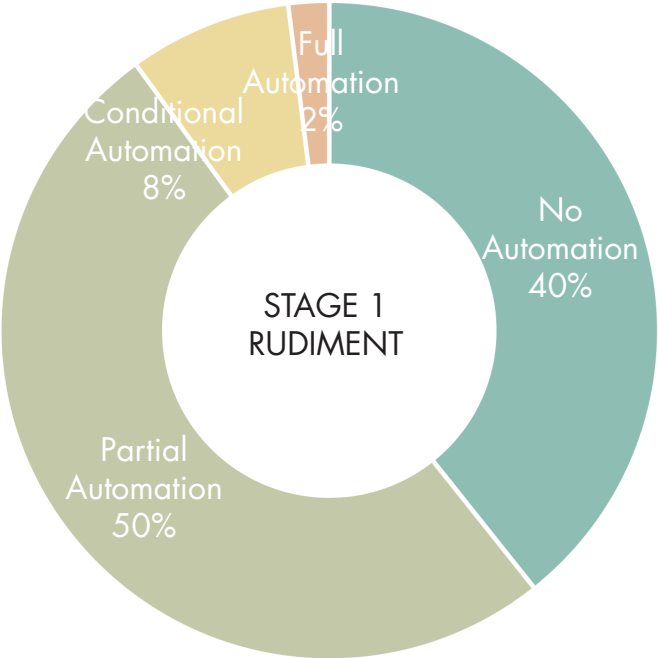
As a new technology, Self-driving is bound to be questioned and challenged by people. Of course, this change does not happen instantaneously, and may go through different stages. But I think one day, Self-driving will completely replace manual driving, which may become a reality within about twenty years. Only when Self-driving is fully recognized by people can it enter a rapid development stage, bringing many possibilities for changes to the streets and lifestyles.
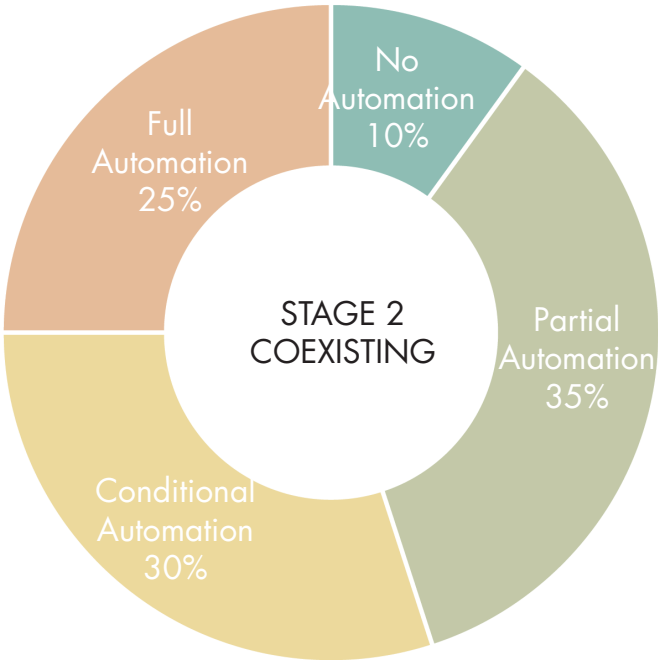
After reading relevant literatures, I divided the development of Self-driving into four stages, rudiment, coexisting, transformation, and multiple possibilities, which will be a factor I will consider when designing later. With the different stages, the proportion of driverless vehicles is increasing, and ultimately driverless will dominate because of the convenience and safety. Different stages will have different effects on the street and change its space and people's lifestyles on the streets.

The first three stages discuss how Self-driving would be accepted step by step within 20 years, and change streets and people's lifestyles. In the last stage, some future scenarios are discussed and evaluated. The content of the last stage may be a little unrealistic, and some ideas may sound crazy. However, I still hope to discuss them with an open mind, and I will critically evaluate their advantages and disadvantages in the end in order to make such discussion more practical and valuable.

DEVELOPMENT STAGE _ DISCOURSE

STAGE 1 RUDIMENT

No Automation 40%

Partial Automation 50%

Conditional Automation 8%

Full Automation 2%

At the first stage, Self-driving as a new thing would have not been fully accepted by public. There are only one tenth vehicles in the street are driverless. Taxi companies, like Uber and Didi would take the lead in promoting driverless driving because of great profits. More people, like old people and kids, can travel freely by themselves

STAGE 2 COEXISTING

No Automation 10%

Partial Automation 35%

Conditional Automation 30%

Full Automation 25%

At the second stage, people would gradually accept this new technology. The streets began to change dramatically because of driverless vehicles. With the increase of the number of driverless vehicles, demand for parking would fall.

STAGE 3 TRANSFORMATION

Conditional Automation 15%

Full Automation 85%
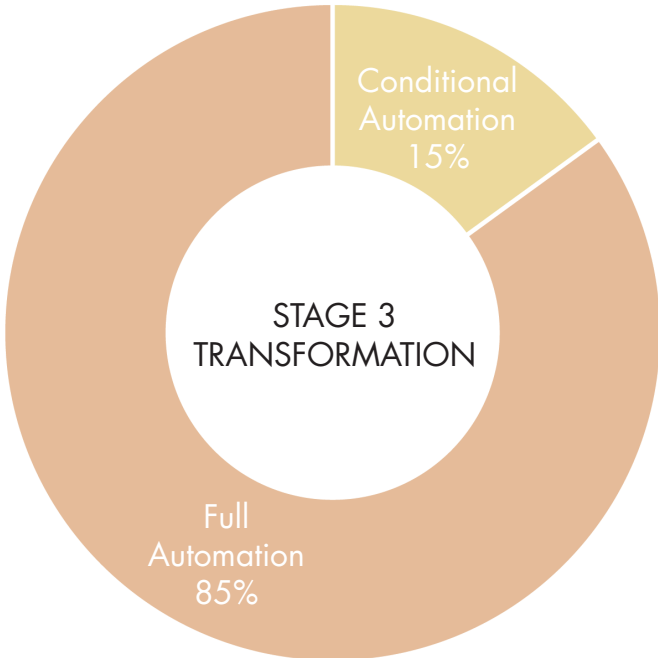
At this stage, all the vehicles would have been transformed into driverless vehicles. Traffic efficiency would increase greatly and the road width would begin to adjust for the self-driving car. Smart infrastructures would also be built to create a better transportation system. Traditional public transport, like buses and trains may be replaced by ride-sharing.

**STAGE 4 MULTIPLE POSSIBILITIES**

Full Automation 100%
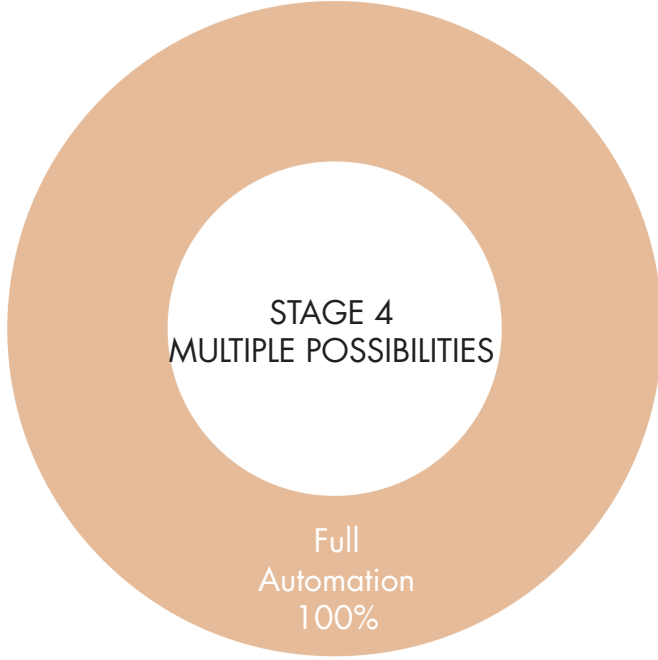
As the world enters the era of driverless driving, there may be many bigger changes. In the last stage, I want to explore some more possible scenarios, which are related to the Self-driving and try to evaluate their possibilities, advantages and disadvantages. It's proved that sometimes people's fantasies will promote the development of new technologies at the end. That's why I think this kind of discussion is interesting and valuable.
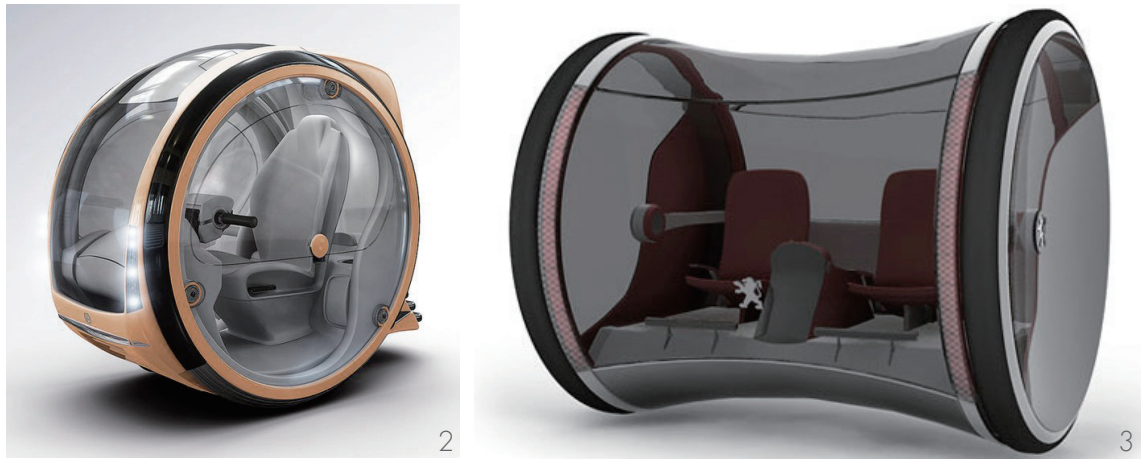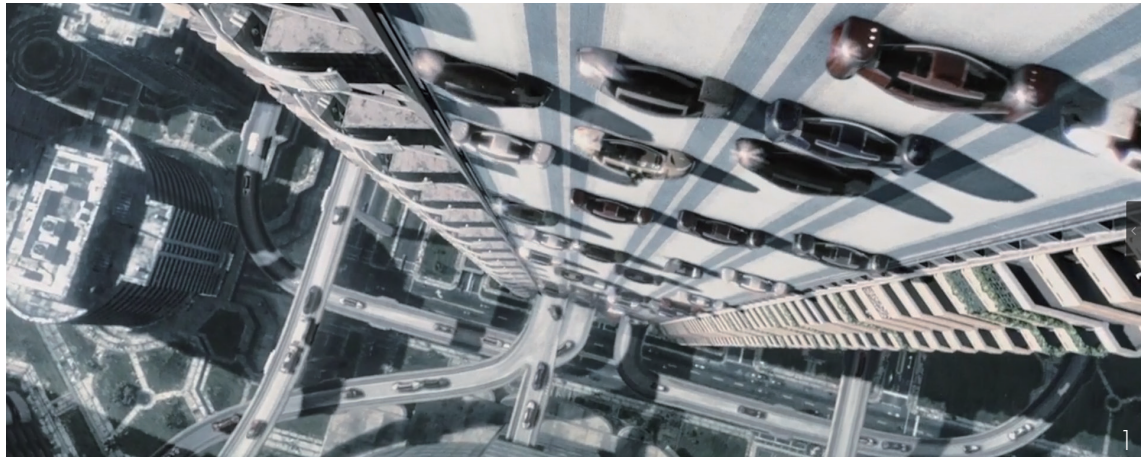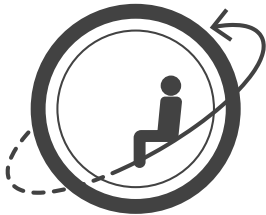
FUTURE SCENARIO _ DISCOURSE

There are already many design concept diagram of future vehicles, many of which can travel freely in the vertical direction or even in the sky. Of course, these vehicles will face many technical and cost issues, but there is also a problem that cannot be ignored is the great driving difficulty. **When the vehicle is not only driving on a horizontal street, there would be problems such as blocked sightseeing, weightlessness, and disorientation. The complexity of this traffic space will also increase greatly in these situations.**

However, the problem of driving difficulty can be well solved by driverless technology, which is why I want to discuss the following possible scenarios in the context of driverless. I try to maintain an open mind, assuming that if these scenes really happen, discuss how this will change the streets and life, and try to comment on the advantages and disadvantages of these changes.

(Blocked Sightseeing) (Weight-lessness) (Disorientation) (Complex Scene)

Possible Problems With Future Vehicle
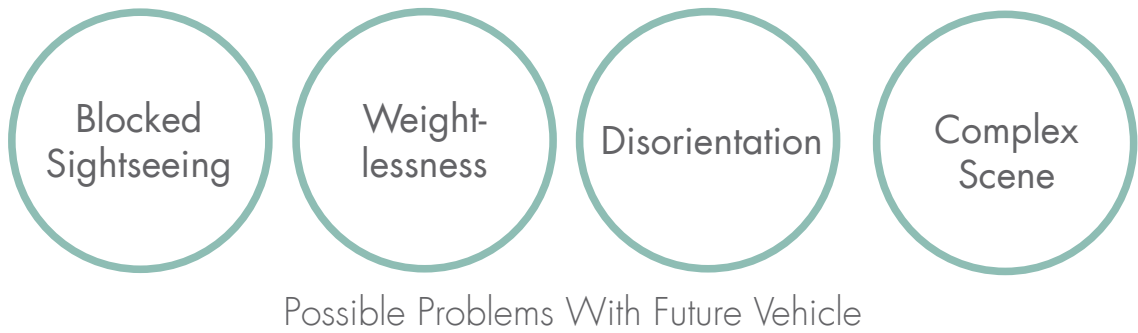
SCENARIO 1: Multidirectional Vehicle

Self-driving may lead to multi-directional vehicles. The streets are not only horizontal, but also vertical. In this scenario, the facade of the building has been transformed, and the entrance may not only locate in the ground floor. The number of viaducts in cities is likely to rise, and people will be more accustomed to shuttling between different heights.


1. (Movie: Minority Report, 2002, Steven Spielberg)
2. Concept Vehicle (https://www.behance.net/gallery/305201/SNAP)
3. Ozone concept car (https://www.luxuo.com/motoring/automobile/ozone-concept-car.html)
4. Liesenborghs, Bubbles (http://www.art7d.be/virtualmuseum50.html)

FUTURE SCENARIO _ DISCOURSE
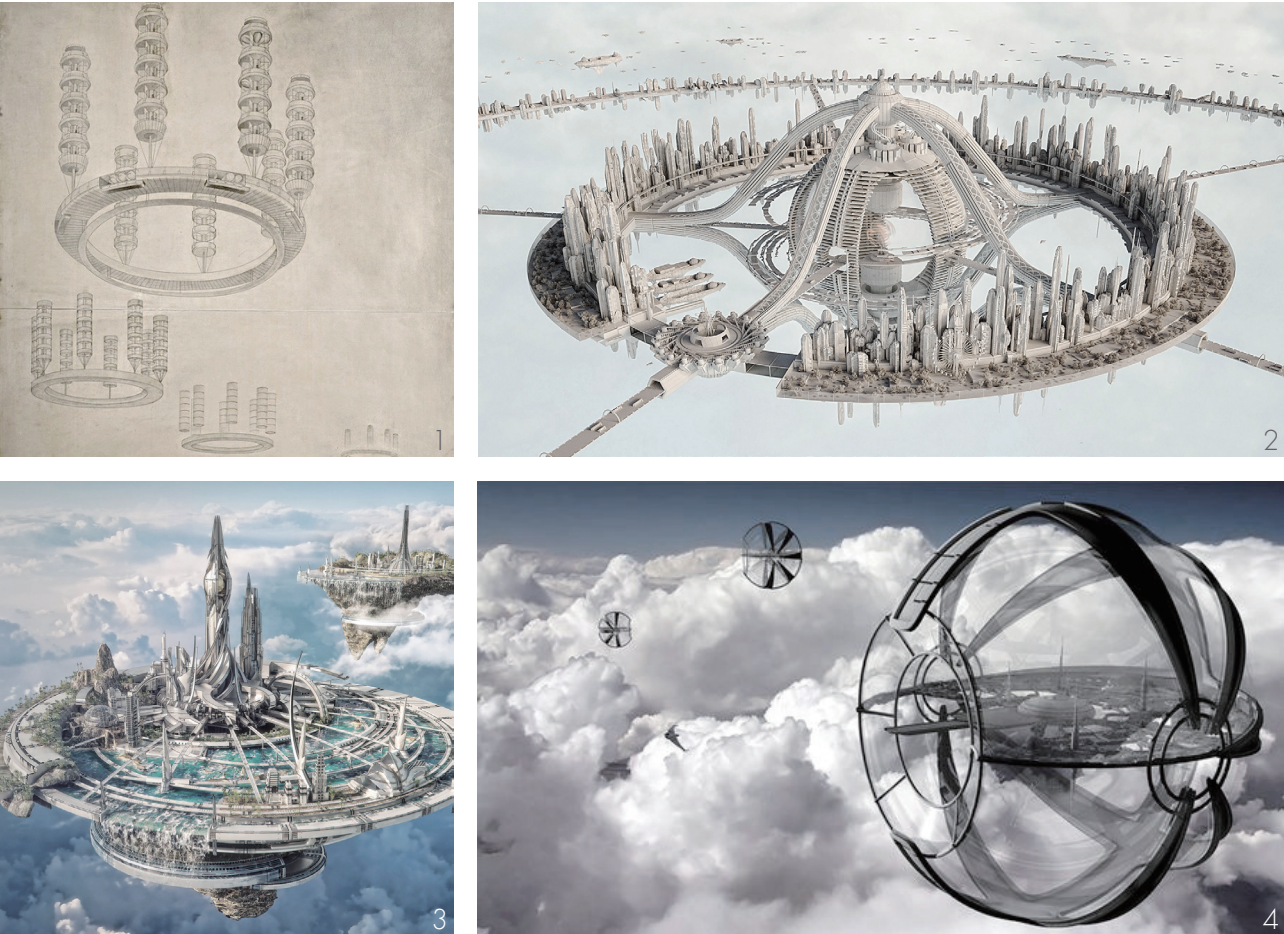
SCENARIO 2: Driverless Aircraft

Self-driving would solve the problem of difficult driving of aircraft and greatly improves the safety. People would get rid of the shackles of gravity and make use of the sky as a traffic space. As the result, the ground floor can be opened for pedestrian. The entrances of buildings may change to different height and there would be more activities happening on the roof. Better transportation efficiency will also greatly affect people's lives.
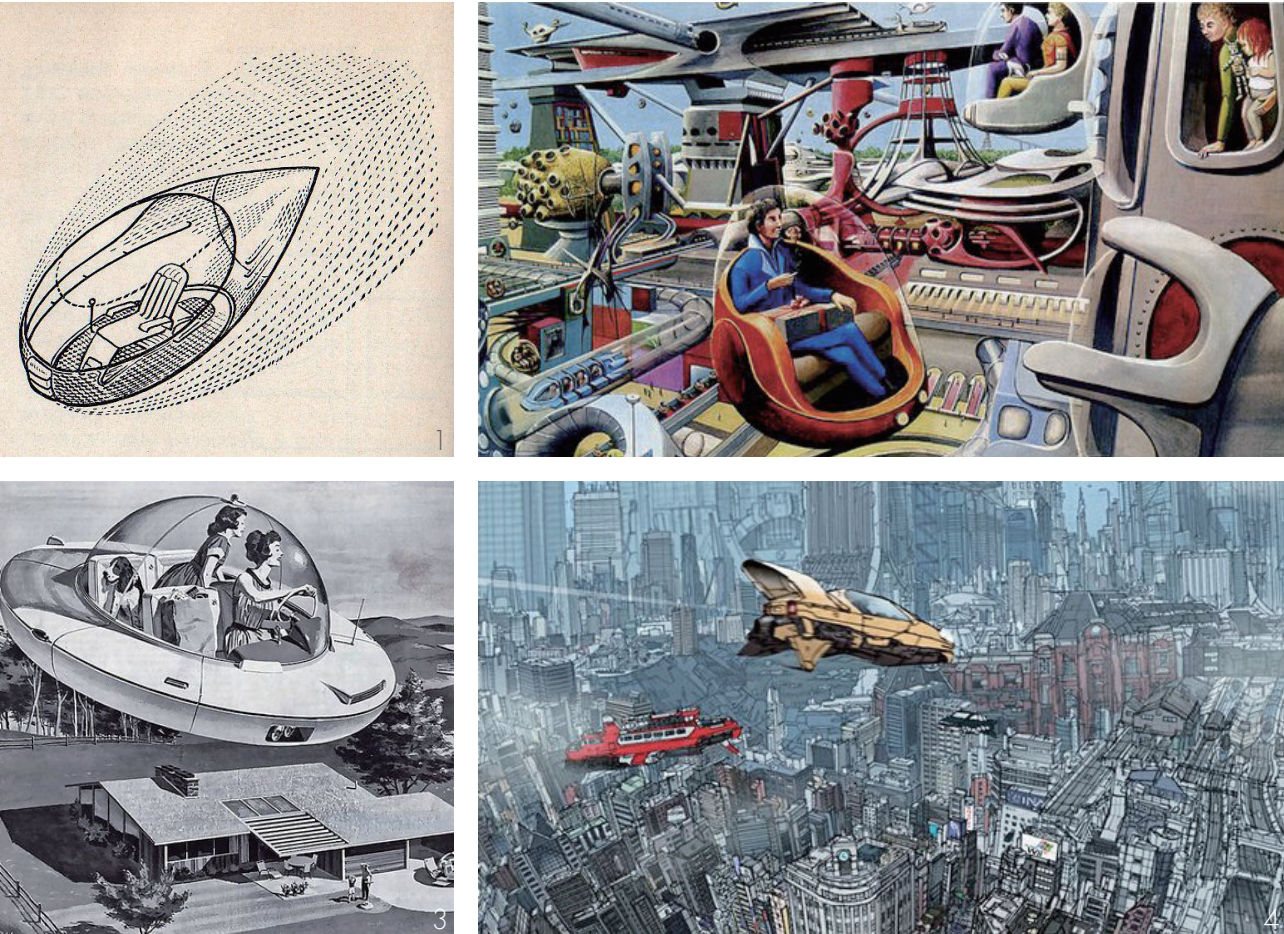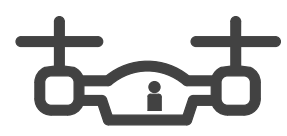
SCENARIO 3: Flying City

This seems like the next stage of driverless aircraft. Most of the buildings would fly and the ground floor can be opened for citizens. There would only be necessary buildings to create street vitality, and more space would become green space, farmland and sports area. People may have two completely different living areas. One is the sky area where they live and work, while the other is the ground area where they play and get close to nature.
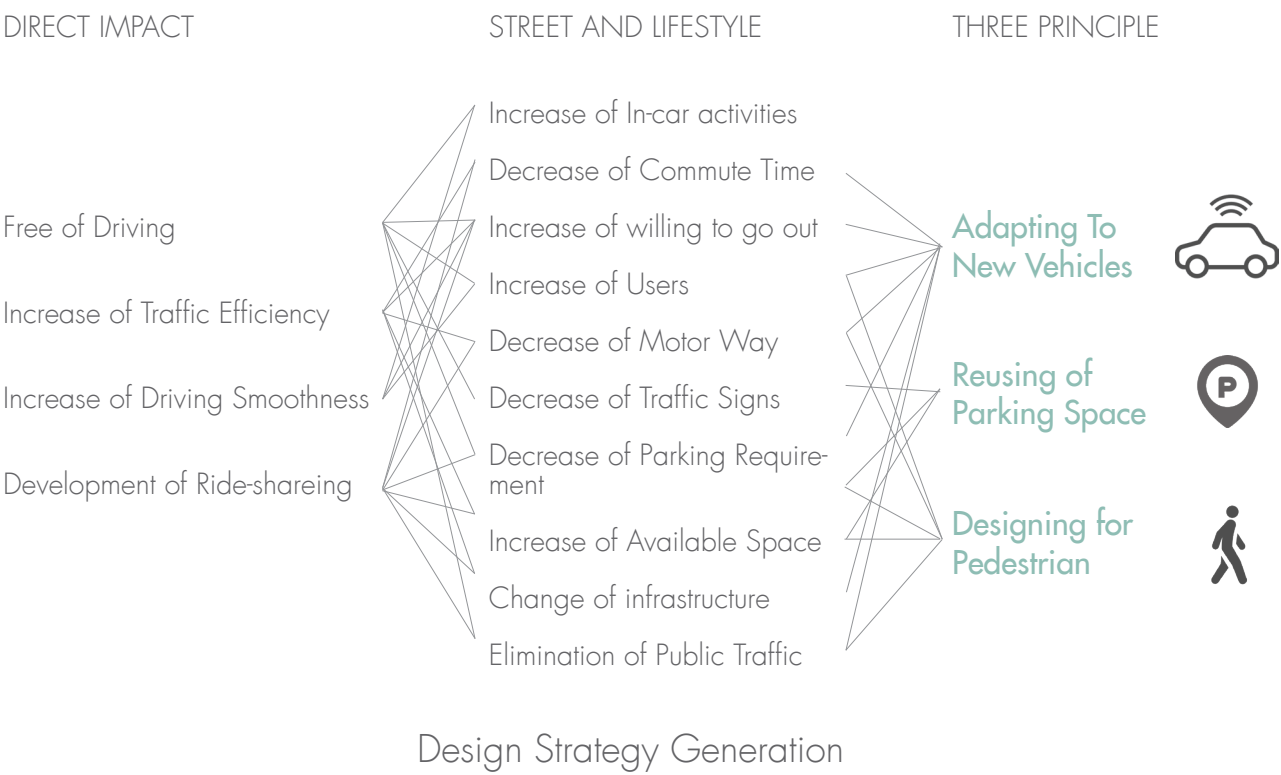
1. The Flying City Project 1928 (https://thecharnelhouse.org/2013/05/20/georgii-krutikov-the-flying-city-vkhutemas-diploma-project-1928/)
2. (https://pour15minutesdamour.blogspot.com/)
3. (http://matt-landofnod.blogspot.com/2012/02/)
4. Retrofuture Tokyo (https://twitter.com/Oniropolis/status/593069002307567616)

1. The Flying City Project 1928 (https://thecharnelhouse.org/2013/05/20/georgii-krutikov-the-flying-city-vkhutemas-diploma-project-1928/)
2. Dreamstate (https://www.behance.net/gallery/29356327/DreamState-Los-Angeles-San-Francisco-more)
3. Dreamstate Australia 2017 (https://www.behance.net/gallery/58600817/Dreamstate-Australia-2017)
4. Liesenborghs, Bubbles (http://www.art7d.be/virtualmuseum50.html)

STRATEGY _ DESIGN

Through the previous discourses, some changes that Self-driving would bring to the streets and lifestyles are listed. I identified three design principles based on these trends.

Firstly, The future streets should be better adjusted in scale and layout to adapt to the new motor vehicles, which are different in size and function. Besides, how to use the spare space in the future streets is very important because Self-driving will greatly reduce the demand for parking. At last, cities dominated by motor vehicles have been proved to have many problems. In the future, streets can take advantage of the opportunities brought by Self-driving to readjust and design for pedestrians.

DIRECT IMPACT	STREET AND LIFESTYLE	THREE PRINCIPLE
	Increase of In-car activities	
	Decrease of Commute Time	
Free of Driving	Increase of willing to go out	Adapting To New Vehicles
	Increase of Users	
Increase of Traffic Efficiency	Decrease of Motor Way	
	Decrease of Traffic Signs	Reusing of Parking Space
Increase of Driving Smoothness	Decrease of Parking Requirement	
	Increase of Available Space	Designing for Pedestrian
Development of Ride-shareing	Change of infrastructure	
	Elimination of Public Traffic	

Design Strategy Generation

LOCATION _ SITE _ DESIGN

In order to better respond to the design principles and comprehensively show my ideas about the future streets and lifestyle in the design, I hope that the design site is sufficiently complex and typical. Finally, I picked a site in the center of Gothenburg.

The site is located near götaplatsen and contains many important public buildings, including Gothenburg Gallery, Gothenburg City Library, Gothenburg City Theater, etc.
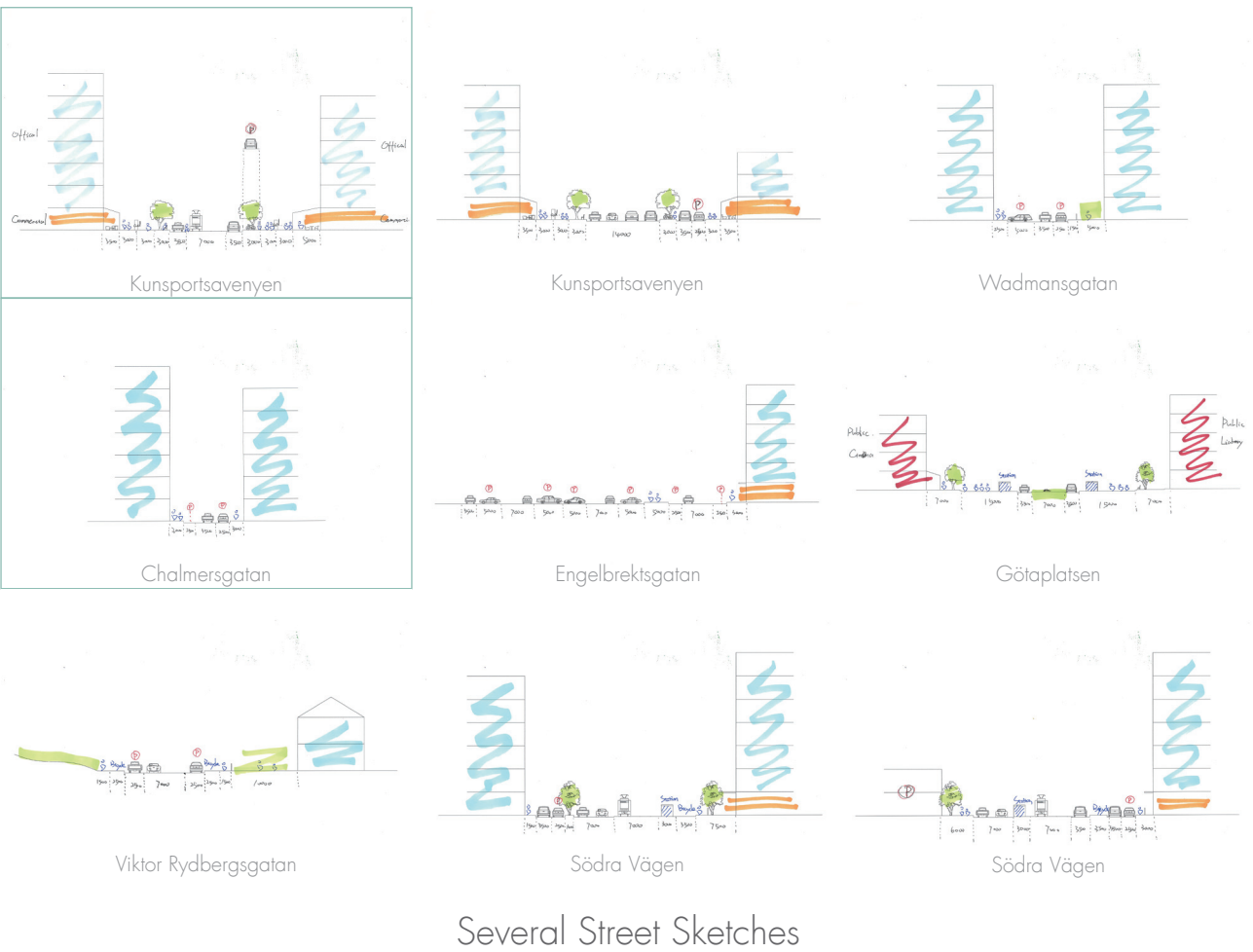

Map

Photos

ANALYSIS _ SITE _ DESIGN

The impact of Self-driving on future streets is complex and diverse. I chose this site because it is complex and challenging enough to serve as an example of different types of future street design. The site is a mix-used area, containing public building, residence, offices, villa, and greenery area. There are different roads in this area and their types are different. Kungsportsavenyen is a famous commercial street in the city, while Engelbrektsgatan and Sodrä Vägen are traffic streets. Besides, many residential streets are also located in the site. As you can see in this diagram, a lot of street parking areas are located in the site. There are two parking buildings and a huge outdoor parking space in the area, which brings potential for further development in the future.

Mix-Used

Different Road

Lots of Parking

- VILLA
- PUBLIC BUILDING
- GREEN AREA
- RESIDENCE & OFFICE
- STREEET PARKING
- INDOOR PARKING LOT
- OUTDOOR PARKING LOT
- SECONDARY STREET
- MAIN STREET
- FOCUS NODE

Site Plane 1:7000

MAPPING _ SITE _ DESIGN

After site analysis, I quickly mapped and drew some sketches of different streets which are marked with red dots in the picture on the left. **The mapping makes me become familiar with different elements of the streets in the site, including types, scales, infrastructure, people's life-style, surrounding buildings, etc.**

After analysis and comparison, I chose the street with blue border, as my typical street for further design. I'll explain on the next page why I chose these two streets

Kunsportsavenyen

Kunsportsavenyen

Wadmansgatan

Chalmersgatan

Engelbrektsgatan

Götaplatsen

Viktor Rydbergsgatan

Södra Vägen

Södra Vägen

Several Street Sketches

TYPICAL STREETS _ SITE _ DESIGN

On the right is a photo of the physical model of the site. The points marked above are the locations of two typical streets I chose. The table below analyzes the differences between these two streets from several aspects, including types, scales, user, and activity. **Because they are very different, they can show the future streets and living habits more comprehensively and dialectically.**
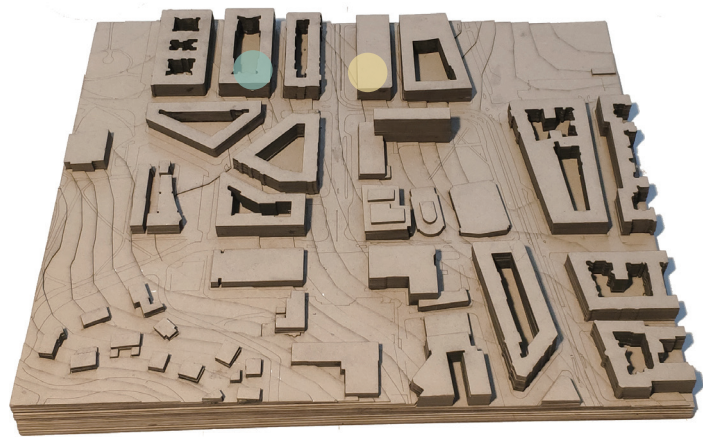
Physical Model

Name	Chalmergatan	Kunsportsavenyen
Type	Residential	Commercia
Scale	Small	Big
User	Single	Diverse
Activity	Simple	Complex

Comparison Of Two Typical Streets

PRESENT SITUATION _ STREET 1 _ DESIGN

Firstly, I will introduce first typical street, Chalmersgatan, which is a small street located between two residential blocks. The car lane in the middle is a one-way road, but two pedestrian ways are still lack of activities and feel isolated because there are parking areas on both sides.

Most of the pedestrians are residents, but few would like to stay here. People can not stay in 60% of the streets.
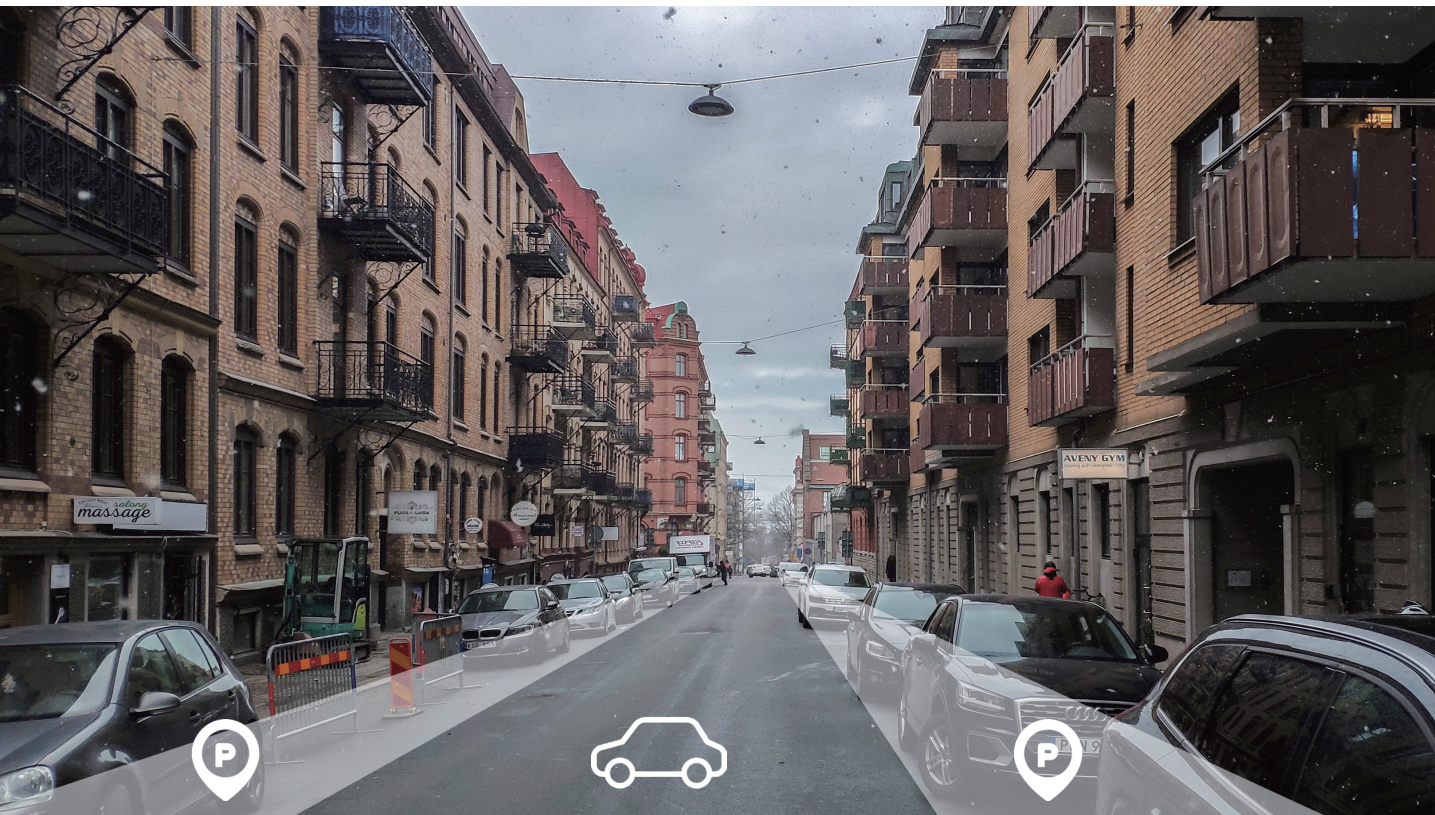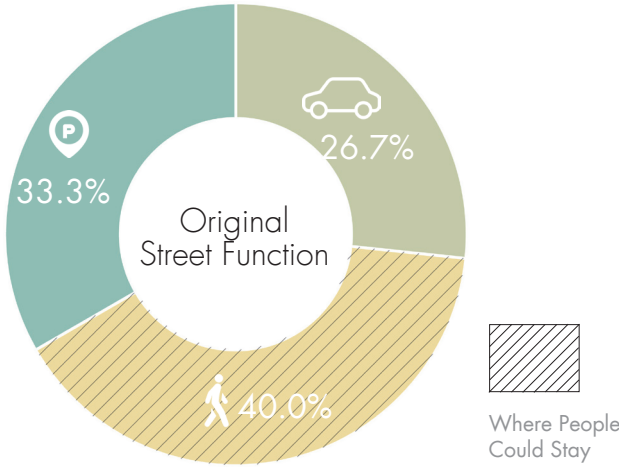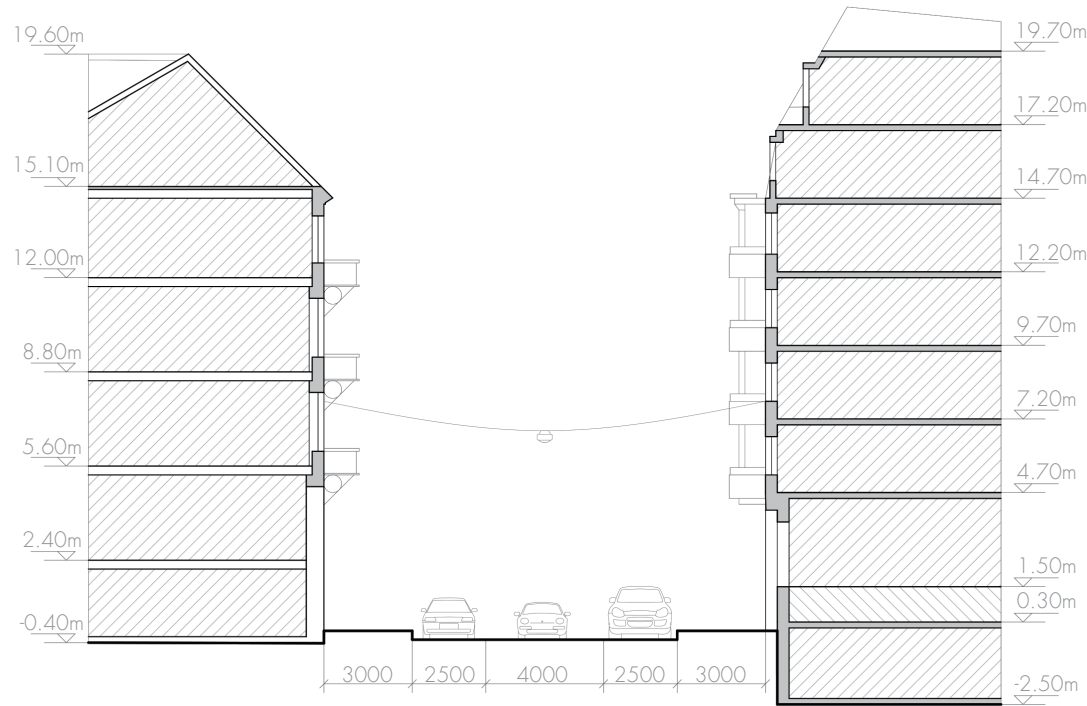

26.7%
33.3%
Original Street Function
40.0%

Where People Could Stay

Photo Of Chalmersgatan

DEVELOPMENT _ STREET 1 _ DESIGN

19.60m
19.70m
17.20m
15.10m
14.70m
12.00m
12.20m
9.70m
8.80m
7.20m
5.60m
4.70m
2.40m
1.50m
0.30m
-0.40m
-2.50m

3000 | 2500 | 4000 | 2500 | 3000

The original streets lacked activity, and parking areas and roadways caused a strong sense of isolation. People only pass the street but not stay in here, although the walkway is 3m wide
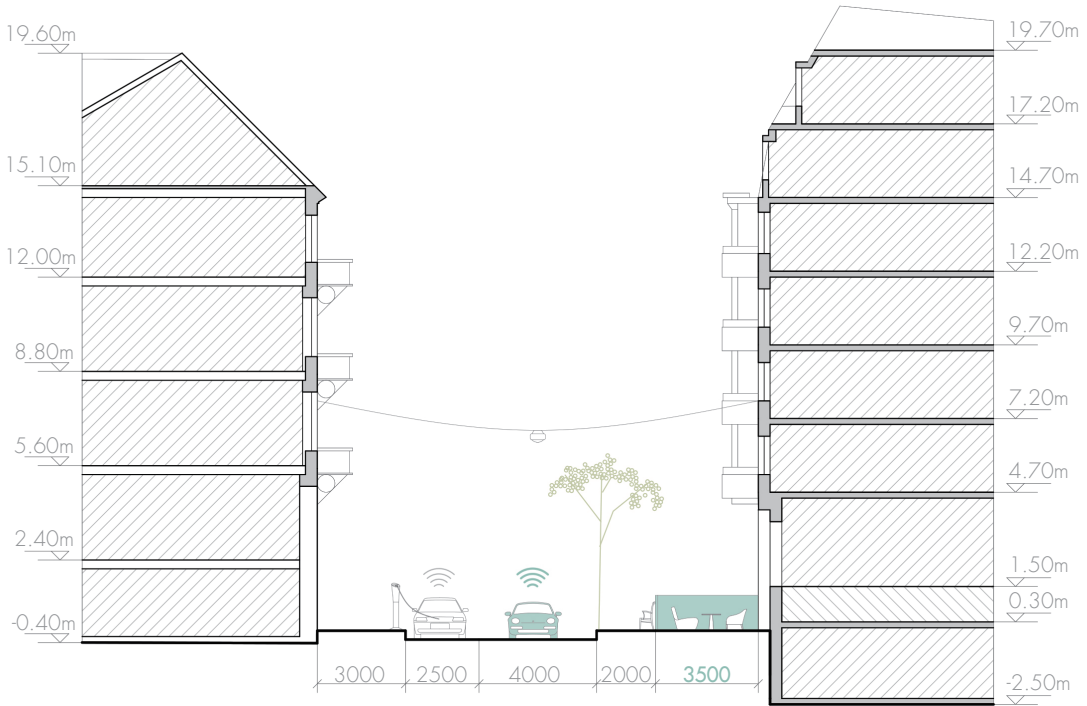
Original
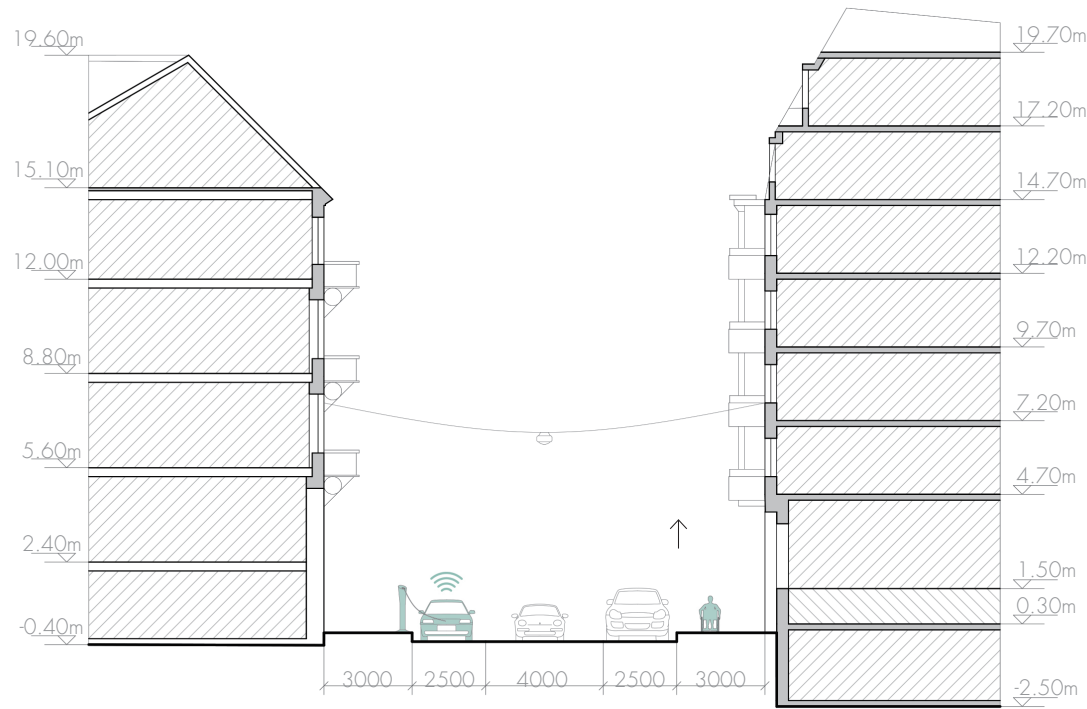
In stage 1, driverless cars would begin to appear, and related infrastructure such as charging piles will be built. New users of car, such as old people and disabled people would start to have a try with Self-driving and be able to go outside by themselves.
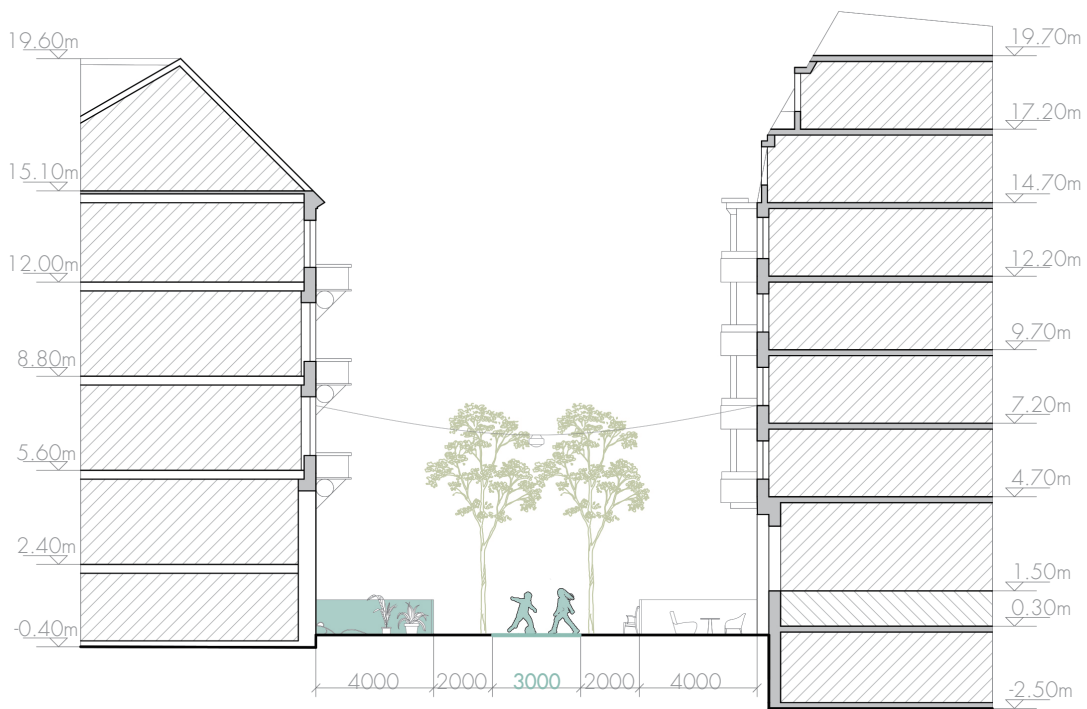
Stage 1: Rudiment

In stage 2, the demand for parking would gradually decreases because of the increasing proportion of driverless vehicles. More street space can be used for greenery, courtyard and outdoor coffee.

Stage 2: Coexisting

In stage 3, the width of the motorway will be reduced, as well the demand for parking. Pedestrians can use more areas of the street, and they can even play games in the motorway because in such residential street, only community vehicles can enter. The height of motorway and sidewalk is consistent in order to create a sense of space as a whole.
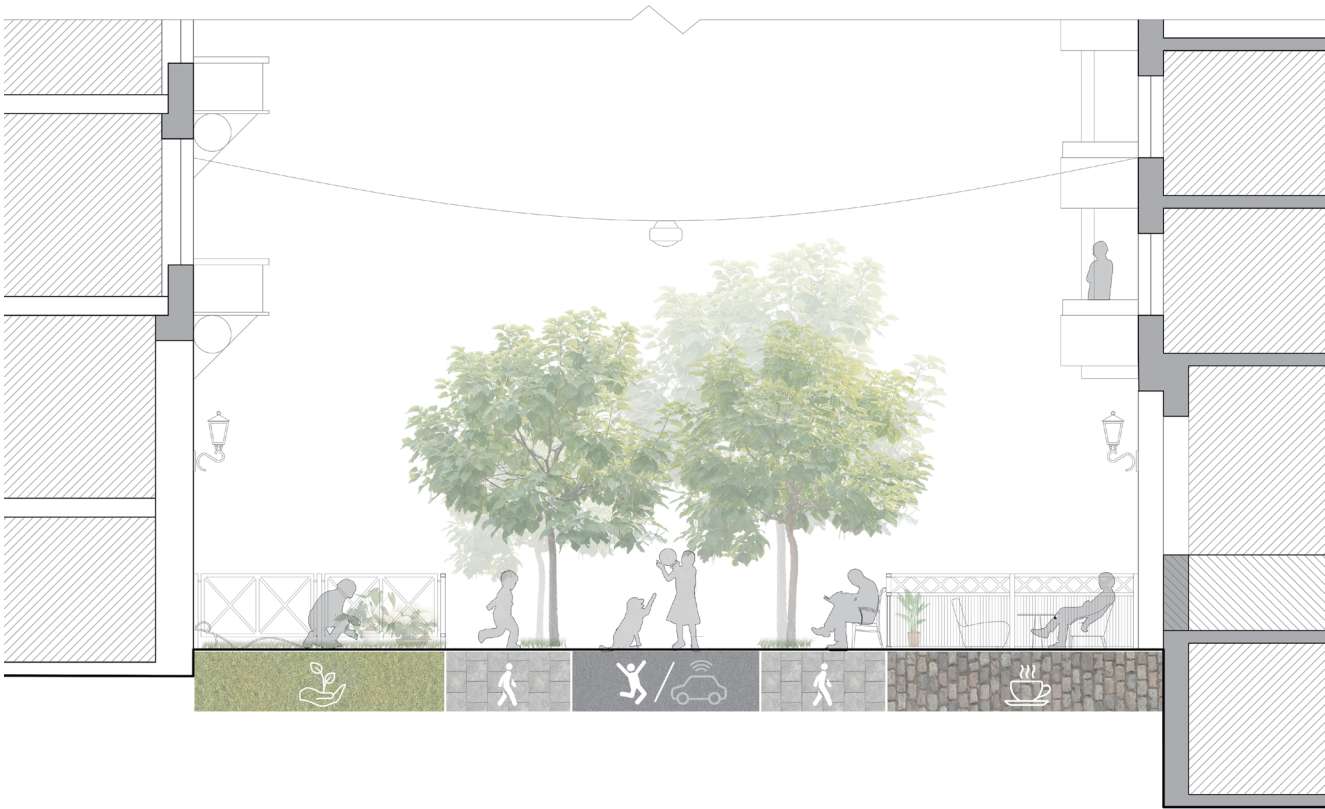
Stage 3: Transformation

3000 | 2500 | 4000 | 2500 | 3000

3000 | 2500 | 4000 | 2000 | 3500

4000 | 2000 | 3000 | 2000 | 4000

Street Section 1:250

Street Section 1:250

DETAILED SECTION IN STAGE 3 _ STREET 1 _ DESIGN

This is a street scenario in summer. The removal of parking space and the reduction of vehicle width create a more comfortable street environment. In addition, only allowing community vehicles to enter the such small residential street is also conducive to making nearby residents like to stay on the street. The people who rest on the balcony, the people who works in the courtyard, the children who play on the road, the people who read the newspaper on the bench have the opportunity to communicate with each other because of the street.

In winter, the number of pedestrians on the street decreases due to the weather, and most of residents choose to stay at home. However, the Christmas decorations of each family still make the streets look friendly and the exquisite snowman in the street also attracted people's attention.

Street Section (Summer) 1:120

Street Section (Winter) 1:120

# DETAILED PLANE IN STAGE 3 _ STREET 1 _ DESIGN

We can see more clearly the activities of different people on the street through the plane. Disabled people in the community are now free to travel, because of the popularity of driverless vehicles. Don't worry about the kids playing in the street when some community vehicles entering the street. If the driverless vehicles are coming, it would slow down and give a warning.

Street Plane 1:120

PERSPECTIVE IN STAGE 3 _ STREET 1 _ DESIGN

This perspective shows people's life in stage 3. Although you don't see many driverless vehicles in the picture, there are many potential impacts that Self-driving bringing to this street. First, streets can be used as courtyards and outdoor cafes instead of being occupied by parking areas because of Self-driving. Besides, the improvement of traffic efficiency has changed the urban traffic network, making it possible to restrict some vehicles in such small residential streets.

20.0%

53.3%

Stage 3 Street Function

26.7%

Where People Could Stay
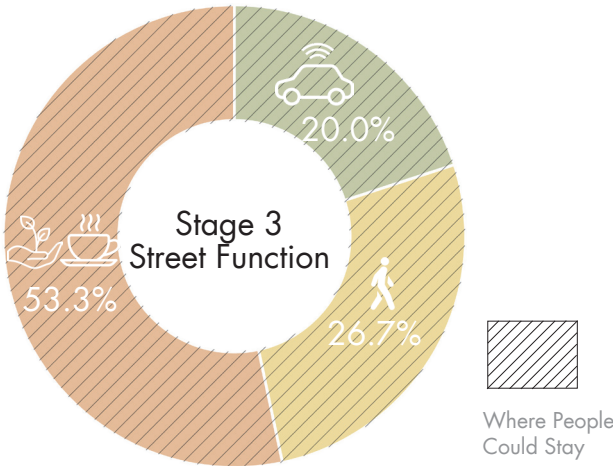
Perspective Of Chalmersgatan

DIFFERENT SCENARIOS IN STAGE 4 _ STREET 1 _ DESIGN

The first scenario is Multidirectional Vehicle. The section and perspective of the streets show what happens to Chalmersgatan in this scenario. In addition, I hope to evaluate this idea by listing the advantages and disadvantages in the diagrams.
People do not need to use stairs.
People can see more scenery.
The privacy of indoor people may be violated.
The cost of such special vertical streets are high.
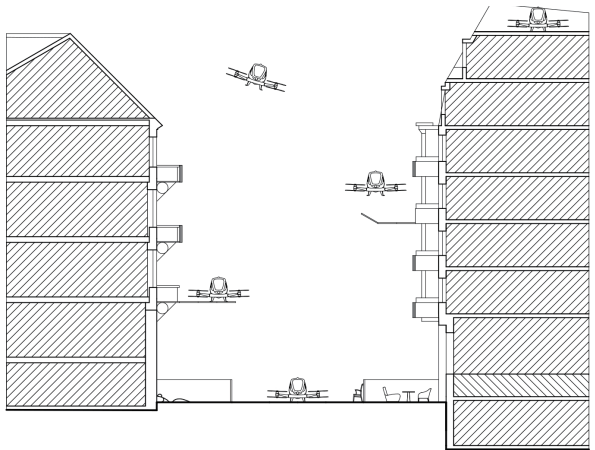Such vehicles may make the room noisy.

Section Of Scenario 1   1:400

The second scenario is Driverless aircraft. The section and perspective of the streets show what happens to Chalmersgatan in this scenario. In addition, I hope to evaluate this idea by listing the advantages and disadvantages in the diagrams.
Most space on the ground floor can be opened to people.
People do not need to use stairs.
People's travel efficiency is greatly improved.
People can see more scenery.
The privacy of indoor people may be violated.
Such vehicles may make the room noisy.
The aircraft consumes a lot of energy.
The trees need to be removed for aircraft.

Section Of Scenario 2   1:400

45

Perspective Of Scenario 1

Perspective Of Scenario 2

46

DIFFERENT SCENARIOS IN STAGE 4 _ STREET 1 _ DESIGN

The third scenario is Flying City. The section and perspective of the streets show what happens to Chalmersgatan in this scenario. In addition, I hope to evaluate this idea by listing the advantages and disadvantages in the diagrams.
The space on the ground floor can be opened to people.
The streets are not shaded by buildings and have plenty of sunshine.
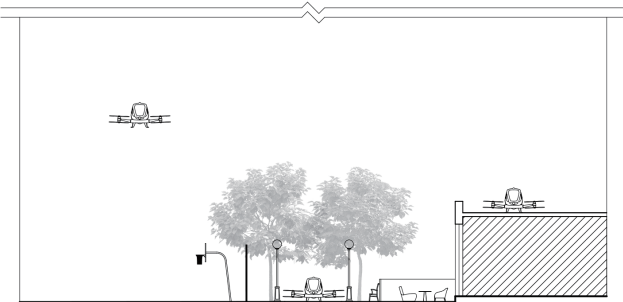There are more green and sports venues in the city.
Insufficient sense of space enclosure in the street.
There will be great technical difficulties.
People may not use the streets on the ground.
The energy consumption of flying city cannot be ignored.

Section Of Scenario 3   1:400

Perspective Of Scenario 3

DETAILED SECTION IN STAGE 4 _ STREET 1 _ DESIGN

Because I don't have the ability and time to study every scenario, so I choose driverless aircraft, which I think is interesting and practical, for deeper discussion. The balconies may become new building entrances. This change can make people who are inconvenient to move do not need to walk stairs. Besides, it can also reduce the amount of ground traffic, improving walking experiences. The facade of the building may use special glass, which can be seen through in single direction, to protect the privacy of the interior.
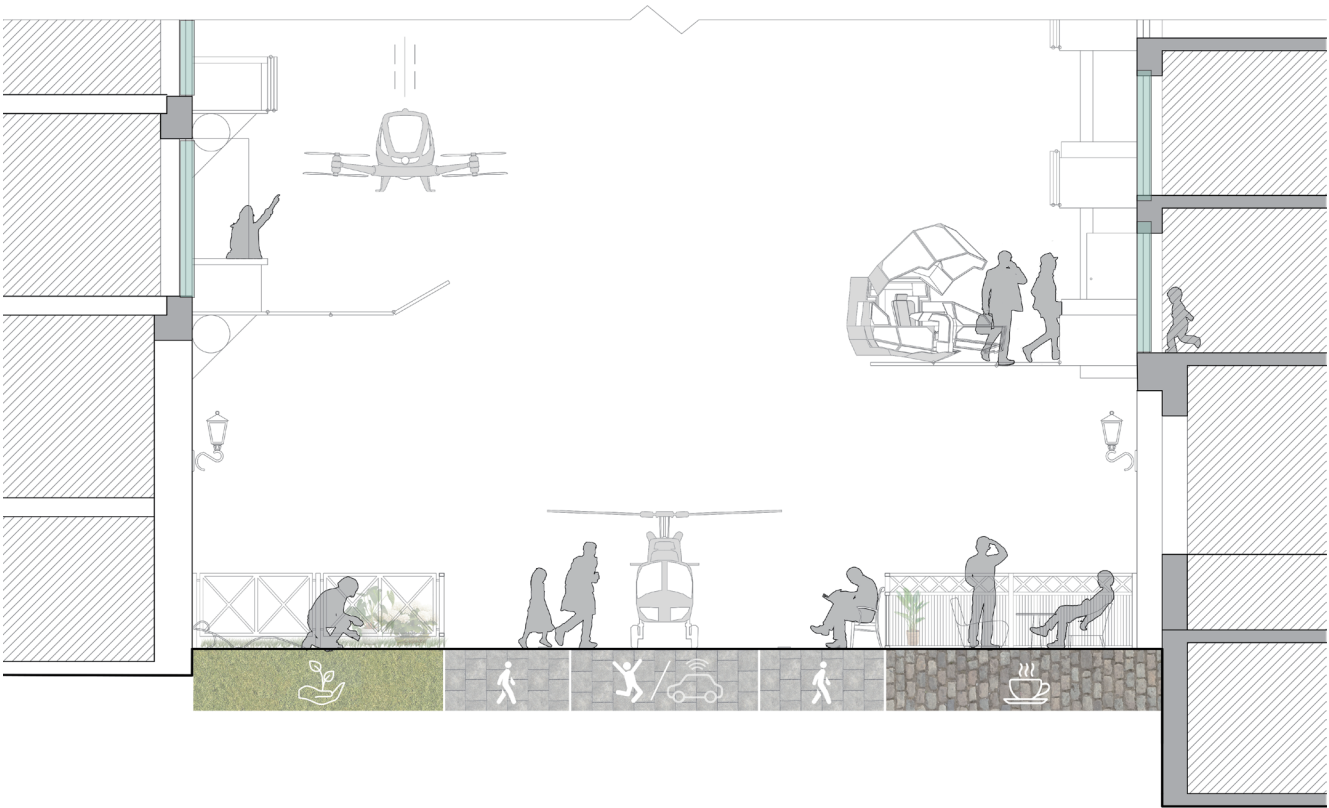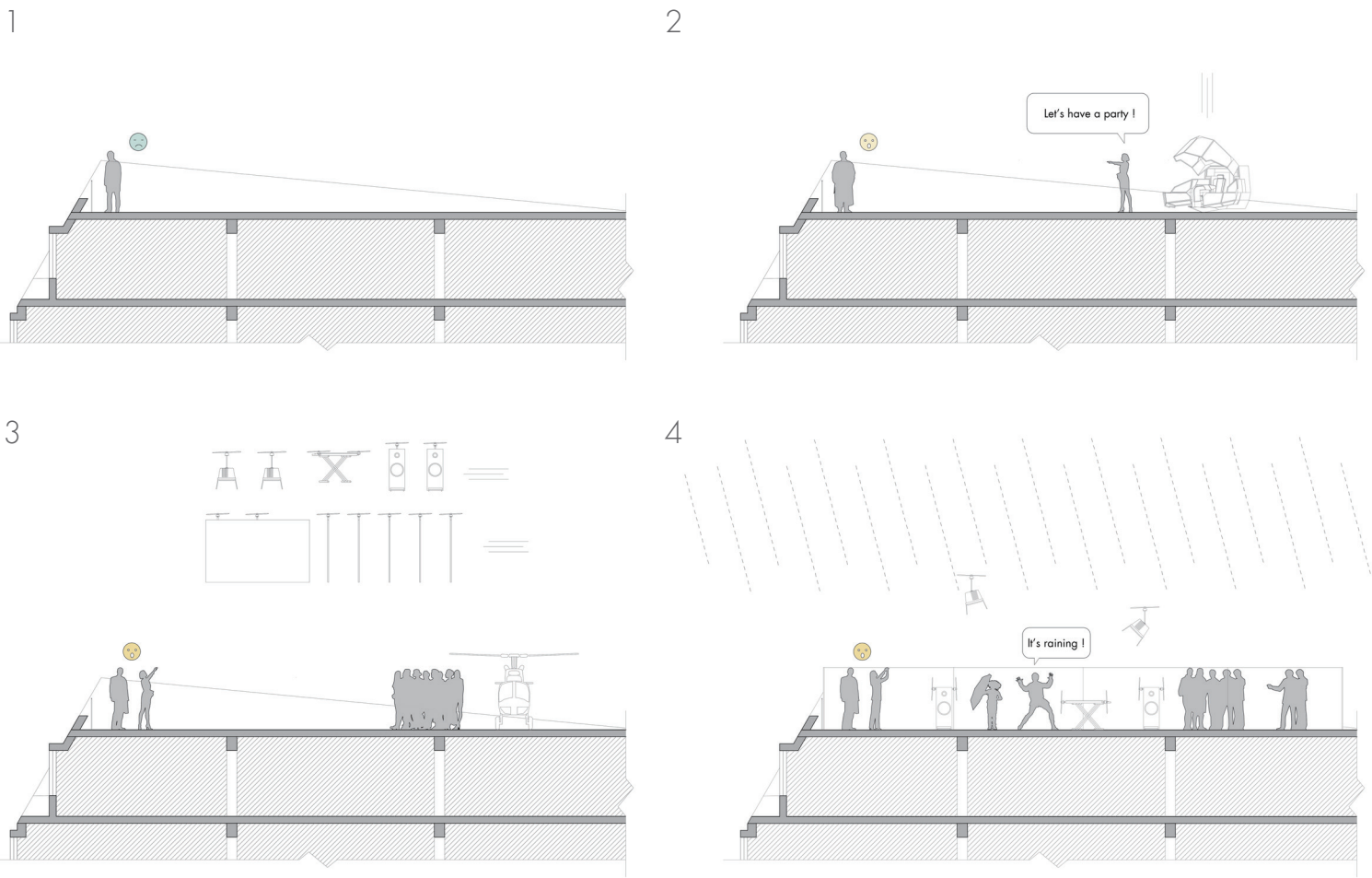
Street Section Of Scenario 2   1:120

ROOF SECTION IN STAGE 4 _ STREET 1 _ DESIGN

The emergence of driverless aircrafts may make good use of the roof space, because the roof will become a convenient building entrance in this scenario. People can get there naturally and easily, and get together on the roof. Self-driving would bring changes to the transportation industry. Equipment handling will become flexible and simple, which also creates conditions for the roof to be active.

On these two pages, I try to use a series of profiles to express the life that people might happen in this scenario. Today's roofs, as shown in the first picture, are empty and boring, and no one wants to stay for a long

time. In the future, someone may suddenly propose to hold a party on the roof, and book the related audio facilities through an app. The facilities would be small driverless aircrafts at that time and can be transported quickly. Flying shelters can make sure that people can enjoy this music party although it would be rainy.
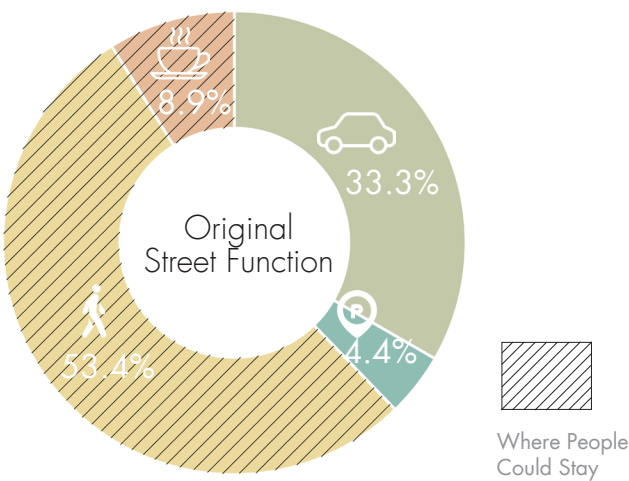

Roof Section Of Scenario 2 1:200
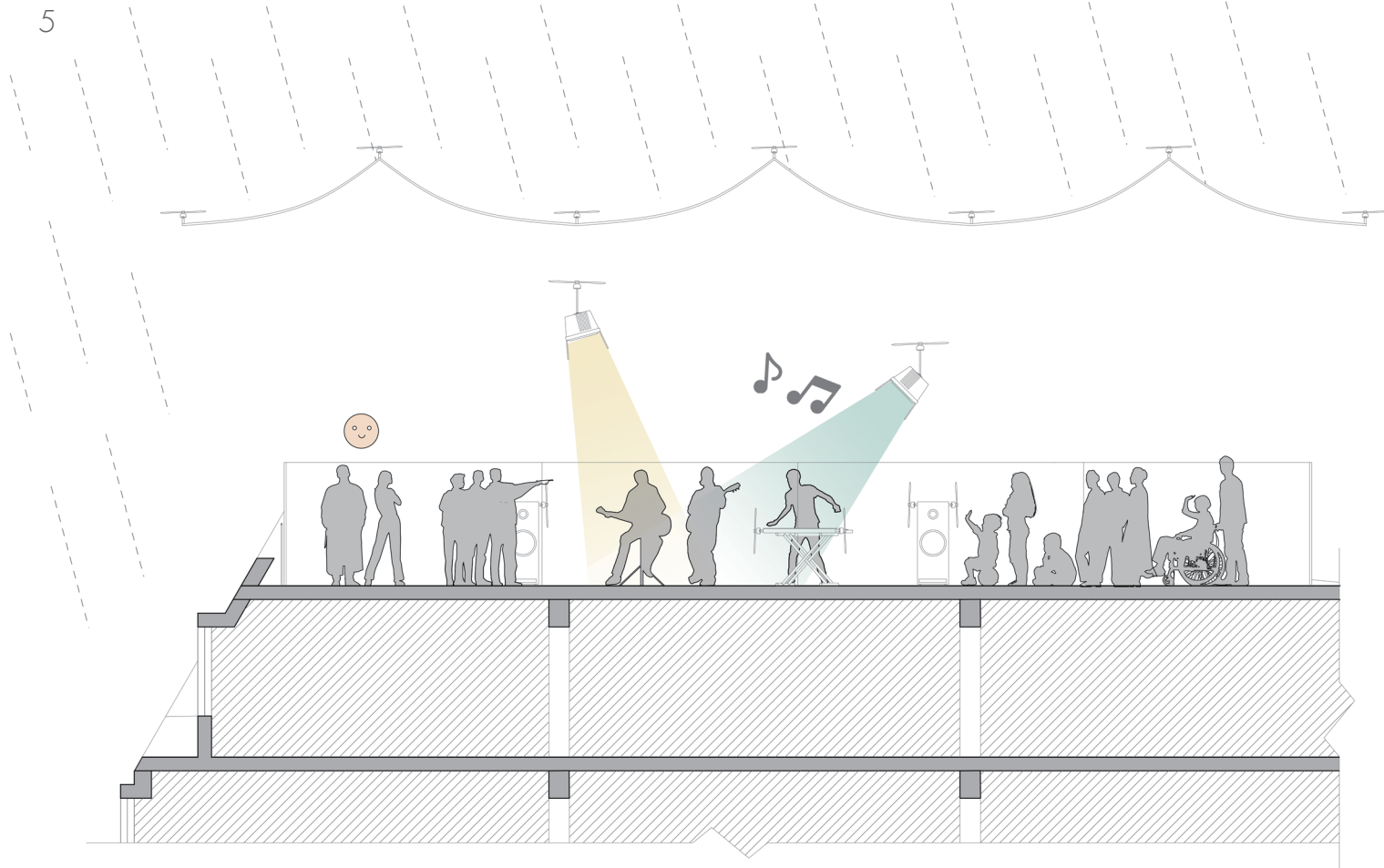
Roof Section Of Scenario 2 1:100
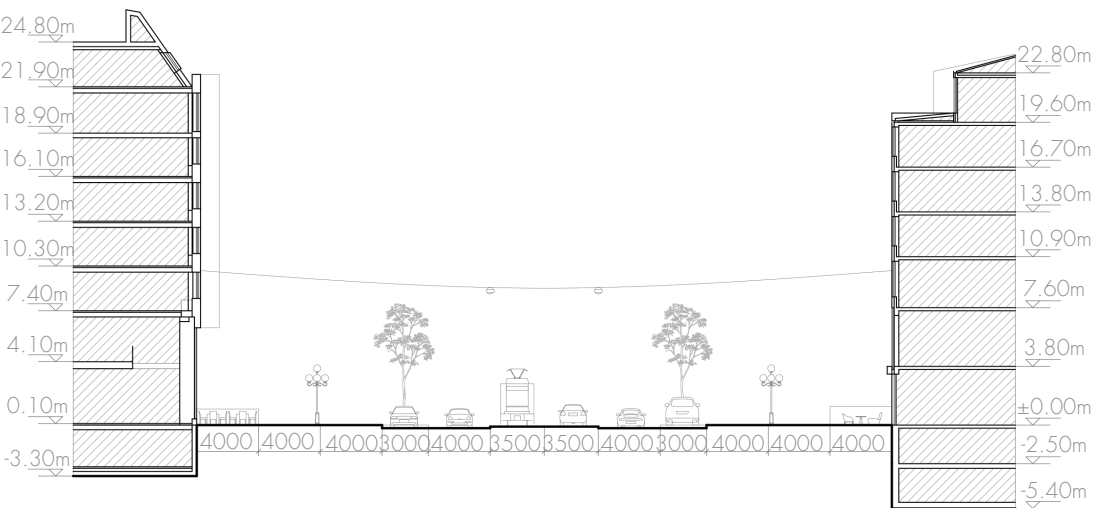
PRESENT SITUATION _ STREET 2_ DESIGN

Kunsportsavenyen is the second typical street, which is a commercial street. There are four motorways in the middle and some temporary parking areas along the street. A row of trees is planted on the both side of the street, but it seems a little sparse.

Users come from different places and most of them are attracted by nearby malls and restaurants. Overall, the streets are attractive, but most of the time there are not many people staying.


Original Street Function

33.3%

8.9%

53.4%

4.4%

Where People Could Stay

Photo Of Kunsportsavenyen

DEVELOPMENT _ STREET 2_ DESIGN

24.80m
21.90m
18.90m
16.10m
13.20m
10.30m
7.40m
4.10m
0.10m
-3.30m

22.80m
19.60m
16.70m
13.80m
10.90m
7.60m
3.80m
±0.00m
-2.50m
-5.40m

4000 4000 4000 3000 4000 3500 3500 4000 3000 4000 4000 4000

Original

The original streets include different modes of transportation, like rail trains, cars, bicycles, and walking. There are many shops on both sides of the street, which brings huge people flow and street vitality. There is only one row of trees, which can't provide good shelter and space enclosure.

24.80m
21.90m
18.90m
16.10m
13.20m
10.30m
7.40m
4.10m
0.10m
-3.30m

22.80m
19.60m
16.70m
13.80m
10.90m
7.60m
3.80m
±0.00m
-2.50m
-5.40m

4000 4000 4000 3000 4000 3500 3500 4000 3000 4000 4000 4000
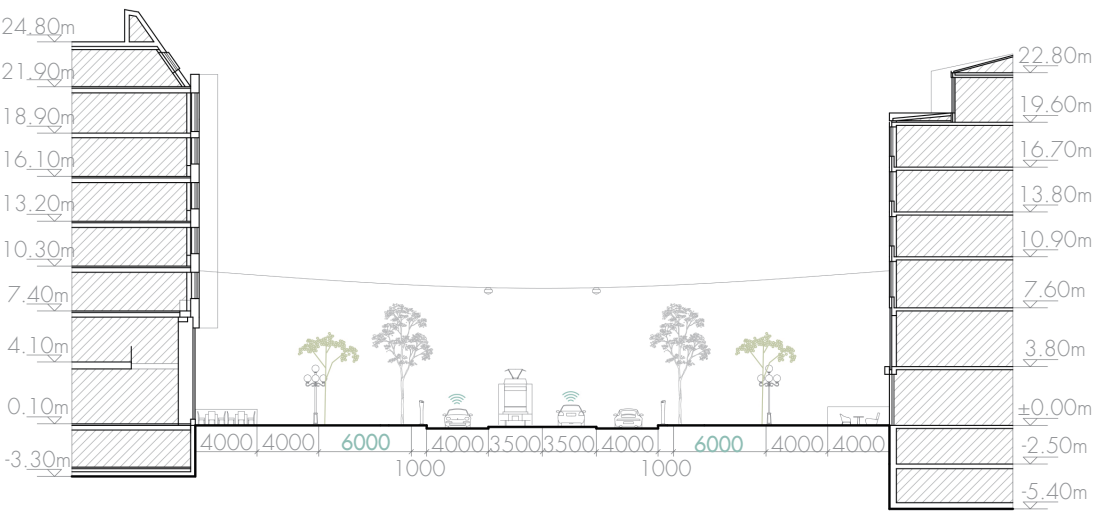
Stage 1: Rudiment

In stage 1, the change would be quiet the same with the Chalmersgatan, including the appearing of the charging piles and the new users of Self-driving vehicles. Temporary parking areas on the street may become more important because of the convenient and popularity of driverless taxis.
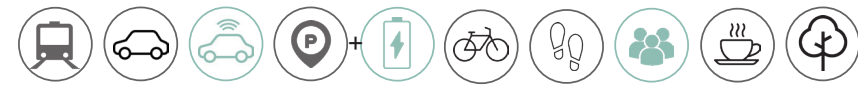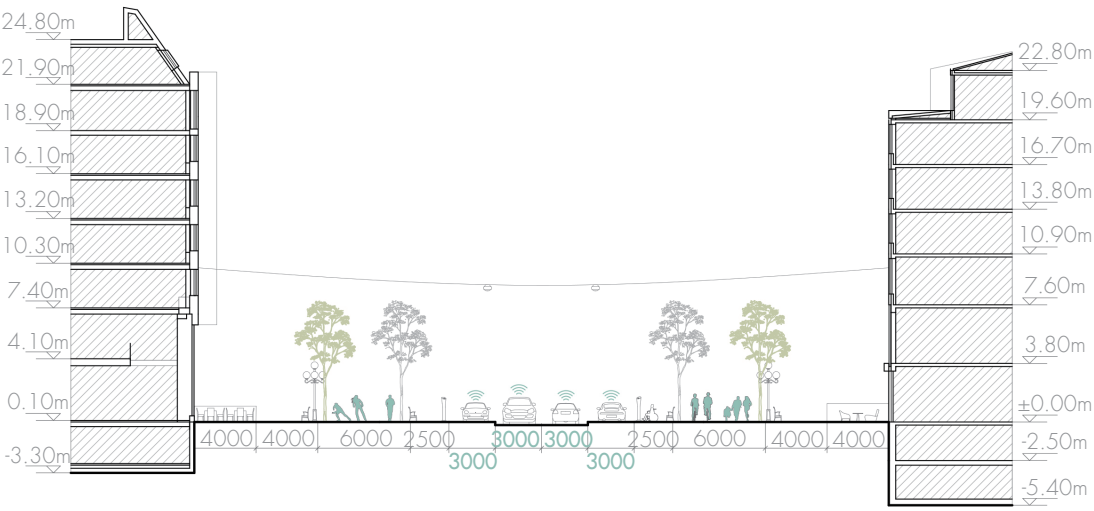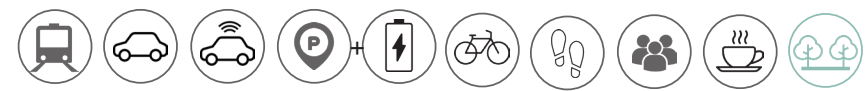
Street Section 1:500

DEVELOPMENT _ STREET 2_ DESIGN

In stage 2, two car lines would disappear because the improvement of traffic efficiency. A new row of trees might be planted and could divides the originally larger walking space into two parts. People who want to pass and people who want to stay will not disturb each other.

Stage 2: Coexisting

In stage 3, Trams will disappear because ride-sharing would replace traditional public transportation. The width of the motorway will be reduced because driverless vehicles can drive more stable. As the trees grow, the boulevard will become more popular and different people can enjoy the street space together.

Stage 3: Transformation
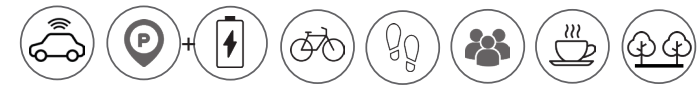
DETAILED SECTION IN STAGE 3 _ STREET 2 _ DESIGN

This section shows people's activities. The boulevard now became the center of the street, where there were cyclists, skateboarders and runners. A possible business model is shown on the right side of the section. Because driverless vehicles run smoothly and make people be able to do some complex activities inside. Therefore, movable restaurants, bookstores, and cafes are possible.
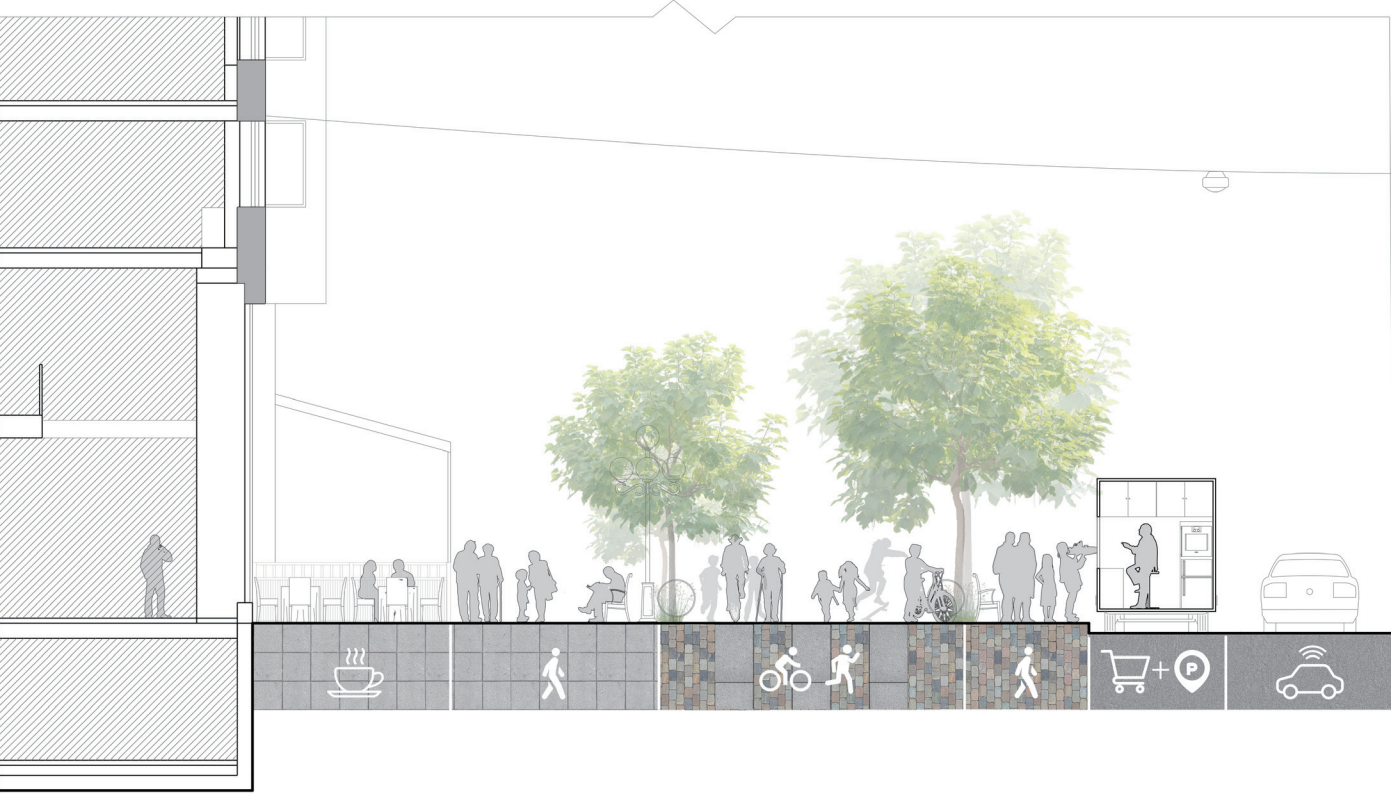
Street Section 1:150

DETAILED PLANE IN STAGE 3 _ STREET 2 _ DESIGN

This plane clearly shows different areas of the streets. On the right is the main motorway, with driverless vehicles forming a tight queue. Next to it are temporary parking and commercial areas, equipped with charging piles. Located in the center of the street, the boulevard is limited by two rows of trees, which is convenient for people to pass in a hurry. On the left side is the sidewalk, where people can seat down or wander, enjoying their leisure time.
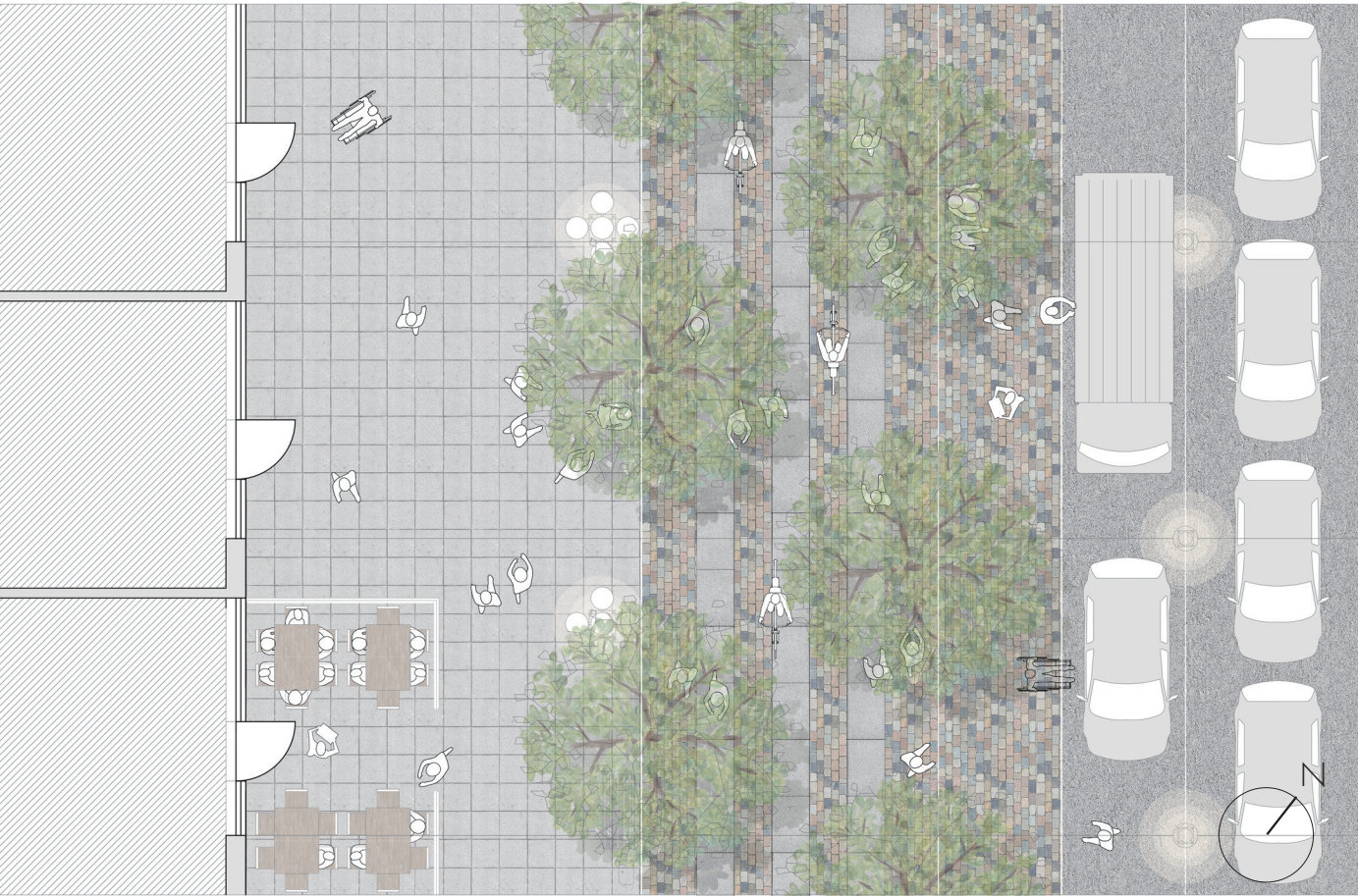
Street Plane 1:150

PERSPECTIVE IN STAGE 3 _ STREET 2 _ DESIGN

This street has a lot of walking space nowadays, and sometimes it seems to be a bit empty. And as driverless vehicles reduce their size and more areas are used for walking, the problem may become more serious. How to respond to this problem is what I have been thinking in the process. Finally, the solution is that using the boulevard to divide the oversized walk areas into three parts, creating a suitable scale and sense of enclosure. In addition, people doing different activities will not interfere with each other in this street.

17.8%

27.0%

Stage 3
Street Function

Where People
Could Stay
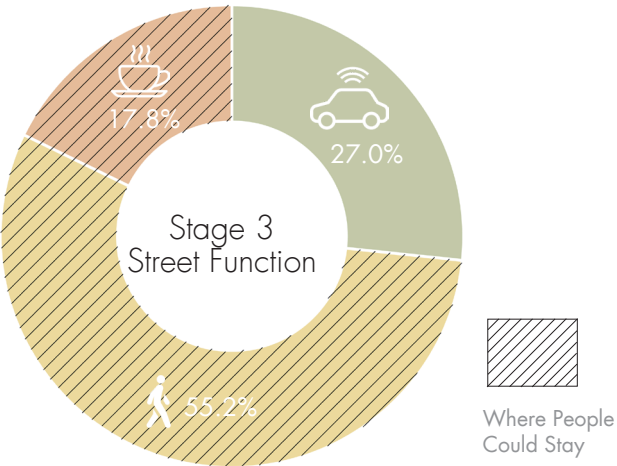
Perspective Of Kunsportsavenyen

DIFFERENT SCENARIOS IN STAGE 4 _ STREET 1_ DESIGN
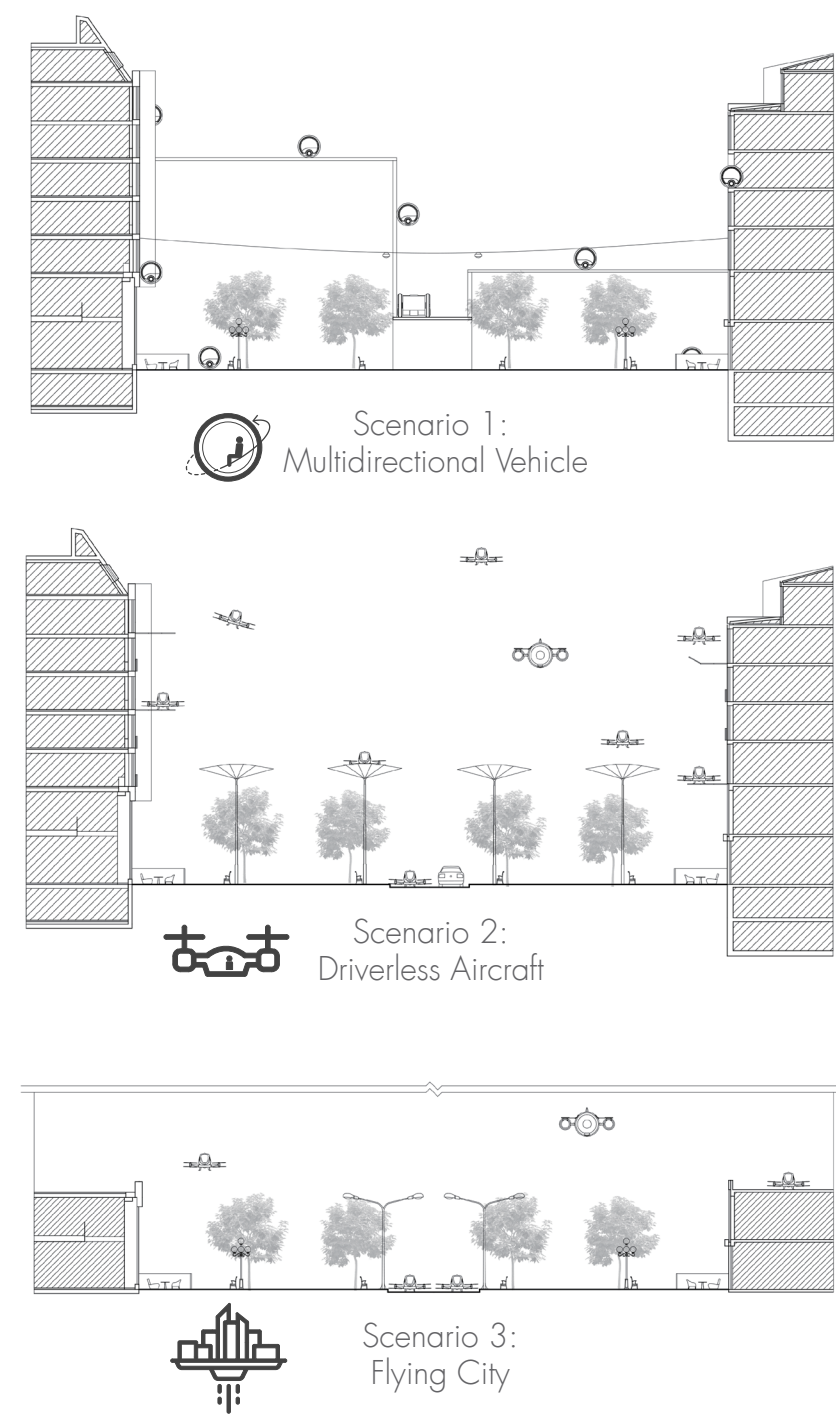
Scenario 1:
Multidirectional Vehicle

Scenario 2:
Driverless Aircraft

Scenario 3:
Flying City

Street Section 1:600

In stage 4, I will discuss and evaluate the three scenarios that Kunsportsavenyen may have and list their advantages and disadvantages one by one.

Scenario 1: Multidirectional Vehicle
Pedestrians can cross the road directly.
People do not need to use stairs.
Space of different heights is fully utilized.
The privacy of indoor people may be violated.
The cost of viaducts and vertical streets are high.
Such vehicles may make the room noisy.

Scenario 2: Driverless Aircraft
Most space on the ground floor can be opened to pedestrians.
People do not need to use stairs
People's travel efficiency is greatly improved.
People can see more scenery.
The privacy of indoor people may be violated.
Such vehicles may make the room noisy.
The aircraft consumes a lot of energy.

Scenario 3: Flying City
The space on the ground floor can be opened to pedestrians.
The streets are not shaded by buildings and have plenty of sunshine.
Insufficient sense of space enclosure in the street.
People may not use the streets on the ground.
There will be great technical difficulties.

PERSPECTIVE IN STAGE 4 _ STREET 1_ DESIGN

Because I don't have the ability and time to study every scenario, so I choose driverless aircraft, which I think is interesting and practical, for deeper discussion. The flying boxes may appear in this scenario. Each box has its own internal functions, such as dining room, kitchen, study room, etc. Different boxes can also be combined with each other to meet the needs of different functions. As shown in the upper left corner of the figure, the facade of the building may be modified to allow some small aircrafts to enter the room.

Perspective Of Scenario 2

DETAILED SECTION IN STAGE 4 _ STREET 1_ DESIGN

The section also shows the idea of flying boxes and windows as building entrances. Some restaurants have opened sky restaurants to attract customers. In addition, solar street lamps may also appear, which can be used as a charging post and a temporary parking area for aircraft.

Street Section Of Scenario 2 1:150

SUMMARY _ DESIGN

In the first part of the design, from stage 1 to stage 3, the changes of the street and people's lifestyle are gentle because people need some time to accept this new technology. In stage 4, Self-driving m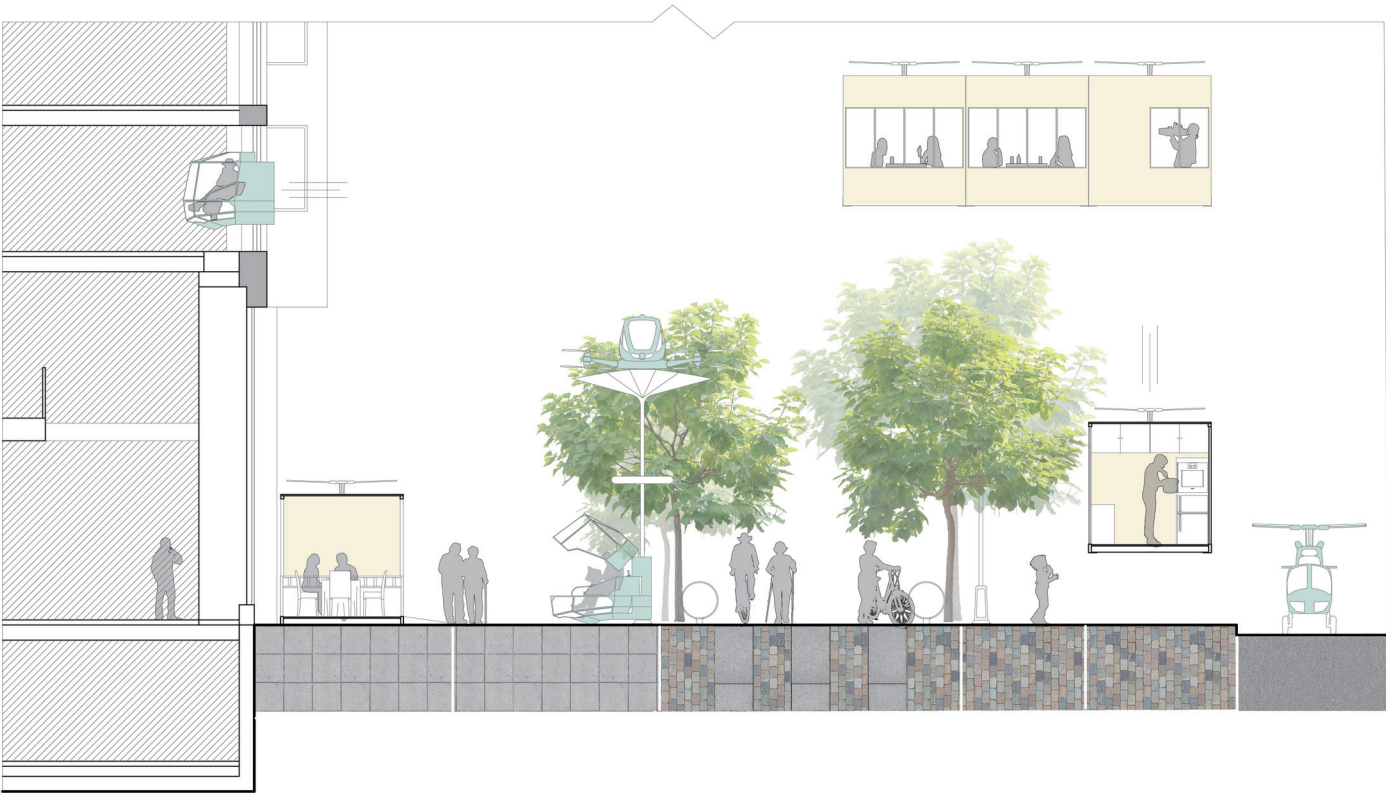ay promote the development of many conceptual vehicles. In this thesis, because I don't have the ability and time to study every vehicle, so I choose aircraft, which I think is interesting and practical, for deeper discussion. People's lifestyles and buildings are also affected by this new driverless vehicle.

Original

Stage 3 (20 years later)

Stage 4 (Further Future)

FUTURE LIFE _ DESIGN

In this part, I want to introduce the daily life of one Swedish boy, John, to show the change that self-driving would bring to the future lifestyle. Using this interesting and novel way to show my ideas is to let people better understand and experience the changes of lifestyles in the future.

In Friday morning. John is going to school alone by a driverless aircraft. On the way, he could also call his friend for today's teamwork. Her mother is saying goodbye to him on the balcony with a smile. In the past, she had to drive him to school in person for half an hour.

FUTURE LIFE _ DESIGN

Today he is supposed to do a survey in the suburbs with his teammates. The teacher has booked several flying boxes to form a temporary camp, which is convenient for real-time data entry and analysis. After the investigation, they can also directly return to school by these boxes.

After school, he takes a floating car and went home with his classmates. In the past, he always had to wait at school for his parents to pick up. Because of driverless technology, such residential streets are now more comfortable, which makes more people willing to stay in the streets and enjoy their leisure time.

FUTURE LIFE _ DESIGN

In the evening, because the family has decided to come back to hometown and visit his grandparents this weekend, so his father order a driverless room vehicle, which is common now. Thanks to this new mode of transportation, John can arrive their hometown after a nice dream.

Sounds good, right?

However, will everything really be as good as I expect?

CASE STUDY _ FUTURE LIFE _ DESIGN

In *The High Cost of Free Parking*, the author Donald Shoup discusses two cases of music hall. **These two concert halls have completely different impacts on the surrounding area due to the different parking lots.**

People who go to the Walt Disney Concert Hall can directly go to the huge underground parking lot and they do not need to walk on the street near the concert hall. The new concert hall attract people to downtown Los Angeles, but these people do not visit nearby restaurants or shopping malls.

Whether the people going to Louise M. Davies Symphony Hall choose public transportation or walk a distance after parking, their appearance will add vitality and popularity to the surrounding streets.

(https://www.pinterest.ch/studioformadsgn/opera-houses/)

Walt Disney Concert Hall
Underground Parking Lot (2188 Parking Lots)

(https://en.wikipedia.org/wiki/Louise_M._Davies_Symphony_Hall)

Louise M. Davies Symphony Hall
Nearby Parking Lot (618 Parking Lots)

Unfortunately, Self-driving may also have similar problem.

Destination

FUTURE LIFE _ DESIGN

People can go directly to where they want to go, even directly inside the building. Pedestrians on the street are getting fewer and fewer because people don't "need" to walk on the street anymore. The dull streets, in turn, make people even less want to stay on the streets. In the end, there will be no one would stay and walk on the street as before. **Street, once an important social public place in the city, will slowly die in the future.**

Dead Street

DISCUSSION AND CONCLUSION

This thesis aimed to discuss what would the future streets and lifestyles be in the context of Self-driving technology and I two typical streets in Gothenburg are chosen and designed to show my research and thinking about this issue. There are many different characteristics between these two streets, which is conducive to a more comprehensive view of the future streets and people's lifestyles.

In my opinion, citizens need time to gradually accept such new technology, which will make a big difference to their lives. Besides, a new technology also needs time to establish a mature industrial chain and integrate with other fields. That's why the main design process is divided into two parts according to time. One is designing how these typical streets would develop in almost 20 years, while the other is discussing and evaluating several scenarios they may have in the further future. I tried to keep criticizing and reflecting in the whole process and constantly adjusted my ideas in order to make such design and discussions more practical and reasonable.

As I mentioned at the end, I am not sure whether Self-driving will eventually lead to the 'death of the street'. This question is interesting and important, so future studies could research on this issue through questionnaire survey, experimental simulation and other methods.

To be honest, it is not easy to discuss things that have not happened and the development of things often exceeds people's imagination. However, history has proved that people's fantasies and imaginations sometimes will promote the development of the society and that's why I think it is interesting and valuable to research such a topic. I'm not saying that the changes mentioned in the thesis will happen in the future, I just want to discuss some possibilities and make dialectical evaluation of them.

STUDENT BACKGROUND

Education

Bachelor
South China University of Technology (Sep. 2013- Jul. 2018)
Bachelor of Architecture, GPA: 3.71/ 4
Guangzhou, China

Master
Chalmers University of Technology (Sep. 2018- Jul. 2020)
Master of Architecture (Expective)
Gothenburg, Sweden

Previous Course

2018 - 2019
Future Vision for Healthcare Architecture, ARK 263
(This course inspires me think about future lives.)
Spatial Morphology Design, ARK 142
(My project is about transportation of Hjalmarbrantingsgaten, and tried to improve the experience of pedestrian routes.)
History, Theory and Method 3: Emergent Media and Representation, ARK600
(The subject of this course is about The Second Digital Turn, discussing the recent technologies.)
Sustainable Development and the Design Professions, ARK650
Design and Communication Tools, ARK 442

2019 - 2020
Sustainable Building: Competition, ARK350
Architectural Geometry, MVE 560
(This course helped me to learn scripting and grasshopper, which are useful tools.)
Building Design Lab, ARK 415

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