GATEWAY TO AMSTEL

Research on the future mid-city transport hub in the Amstel area.

Balder Otten

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Master of Science (MSc) Thesis | Delft University of Technology
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ABSTRACT

This thesis is about the future of transportation in Amsterdam Amstel and the large node in the area called the mid-city transport hub. Transportation will change in the Amstel area. How people will move through Amstel will change, the same is true for the connection of the Amstel area with other parts of Amsterdam or the Netherlands. The city will become too busy for the car, there will be an increasing use and demand of public transportation. Transportation is not only the transport of people but also the transport of goods. A current trend is that the delivery of goods in the city will increase, due to the increasing ordering of goods on the internet. A new system has to be implemented to accommodate these developments of goods delivery. A possible solution, to these two trends, is to combine them into one building, the mid-city transport hub. To know how this new building typology will work the following research question is raised: How will the future mid-city transport hub be in the Amstel area in the year 2100? In this research the conclusion is proposed that the future mid-city transport hub will be a combination between a node for human transport from Amstel to the rest of the city of Amsterdam and a fulfillment center for goods delivery in the Amstel area. It will have multiple roles to fulfill to become a gateway the Amsterdam Amstel.

PREFACE

This thesis research will be about the future of transportation in Amsterdam Amstel. Not only human transportation in the city will be considered but also the transportation of goods in the city. The year 2100 is set as a base when thinking about the future. As a wider context then just transportation in Amstel, a vision for Amstel is made as a group for the year 2100. As a result of this vision that is based on research, a couple of future trends emerged. These trends have certain consequence that led to a couple of problems for transportation in Amsterdam and Amstel. Questions were raised and research is done to solve these future problems. With the conclusions of the research, a future building can be designed to resolve the future problems of transportation in Amsterdam Amstel.

CONTENTS

INTRODUCTION

COMPLEX PROJECT MID-CITY GRADUATION STUDIO

"The Chair of Complex Projects (CP) investigates settlements around the world that are ambiguous in their development and embedded in the process of globalization. Students and teachers are encouraged to look critically at their surroundings; to gather, organize and question the complex forces that ultimately manifest themselves into our built environment. We are interested in the study of different urban conditions; core or peripheral, dynamic or stagnant, traditional or without history, anonymous or famous; these are the contemporary post-modern realities we must confront as a profession.

Complex Projects targets all scales of the architectural thinking: details, building, city, and region, with the purpose of expanding the knowledge about design and dense urban areas development, and of broadening the mind and thinking of future architects. The architect operates within many different scales and cultural contexts, and consequently sees the world through many lenses: as an artist, organizer, politician, economist, philosopher, strategist, humanitarian, planner and sometimes visionary. The complexity of these parameters converges into a new definition of design which in turn enables students to unpack virtually any set of design constraints, cultivating a strong critical and analytical approach to the design process.

In Complex Projects, the research-by-design zooms in from the large scale of the city itself, to the medium scale of the site, to the small scale of the building. This serves as basis for a design narrative that on its turn is a lead for the individual proposals. Through the various final products it should be visible how the research led to the narrative, and how this in its turn is translated in the design. A selection of the students' works will be part of the exhibitions periodically organized and curated by the Chair."

(TU Delft, n.d.).

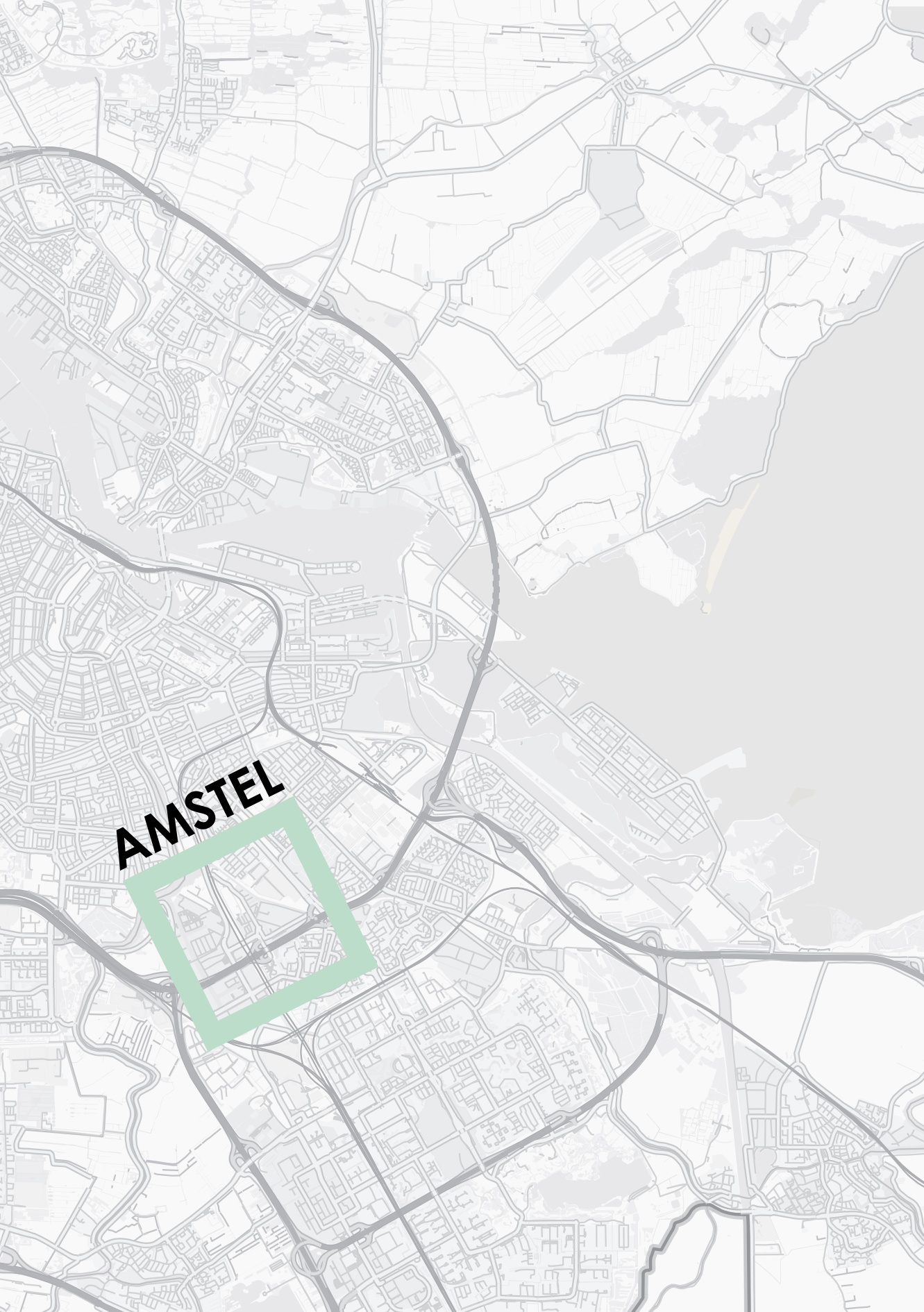
ASSIGNMENT

The assignment of the graduation studio of Complex Project AMS Mid-city is to investigate the future challenges of Amsterdam in 2100. The assignment is to develop a scenario for the year 2100 in an area in Amsterdam. "In AMS Mid-City Studio, the focus is on the growth of inhabitants and tourists, the extra demand for new housing and infrastructure. Students are asked to define the brief of new urban and architectural design interventions, analyzing and re-designing selected urban areas situated in the ring zones" (TU Delft, n.d.).

The urban area for this thesis is the Amstel, at the same time Amsterdam Central and Amsterdam South-east will be investigated. The assignment will be partially done in a group. Individually, a site is chosen within the Amstel area and further elaboration will be done on the scenario. Also individually, a design and research topic is chosen within the scenario. The scenario and individual topic will be supported by research of both hard data and more soft data like future trends.

LOCATION AMSTEL


2 km


AMSTEL

CURRENT SITUATION

Currently is the Amstel area a transition zone from the city center to the Bijlmer area. The area is of low density if one considers its location in Amsterdam. The housing in the area is relatively spread out. There are also sports fields, production companies, and retail. Also the area is divided by a metro and train track. There are a lot of oppertunities for the area because of its location in Amsterdam, but currently these opportunities aren't utilized.

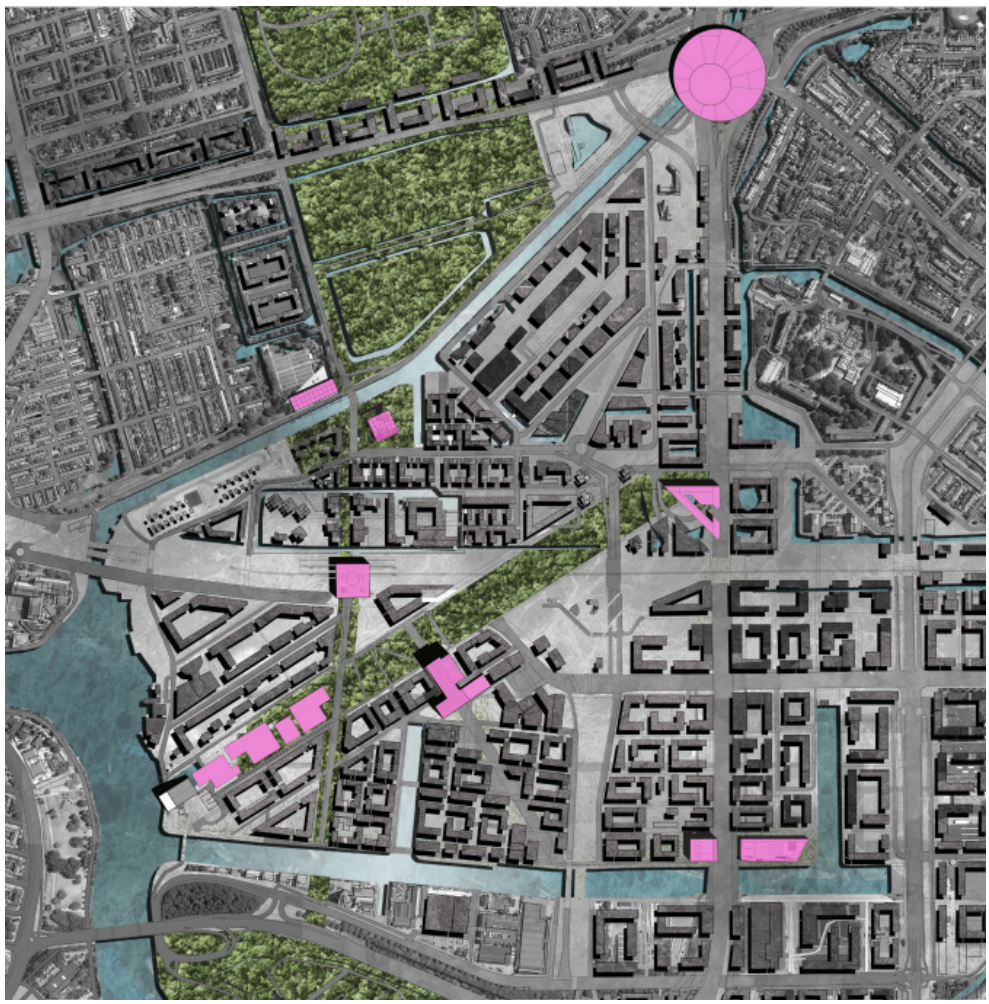
AMSTEL 2019


Kwik Fit

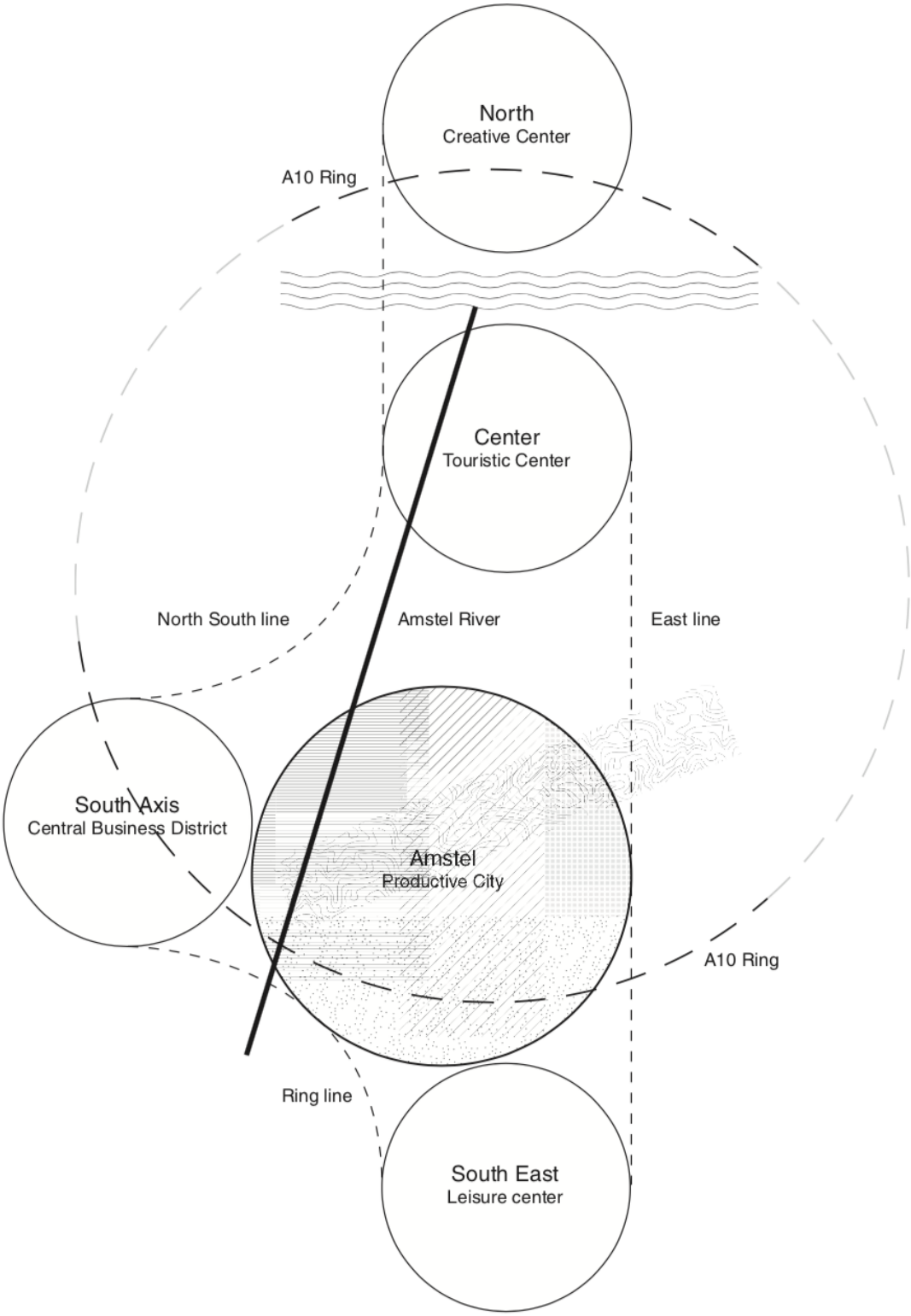
2050 SCENARIO

PRODUCTIVE CITY

In the 2050 scenario the area is transformed in a more urban environment. Housing is added and a large public parks is introduced. The area is not a transfer area anymore but really part of the city of Amsterdam. The train won't enter the area anymore but the metro is still dividing the area, although is barrier has got smaller. At this point the Amstel area has developed itself into a green lively environment with a strong connection to the center of Amsterdam. Important strategic choices implemented in the area involve the removal of the train tracks causing segregation in the area and the downscaling of the old A10 highway into a city boulevard. The presence of mixed-use functions and the emphasis on public transport still show the commuting identity of the area. The plan for 2050 is an improvement of the area, but does not make use of the full potential of the Amstel area. This is maybe due to the fact that it is not that far away in time, it is therefore relevant to look further into the future.



AMSTEL SCENARIO 2050

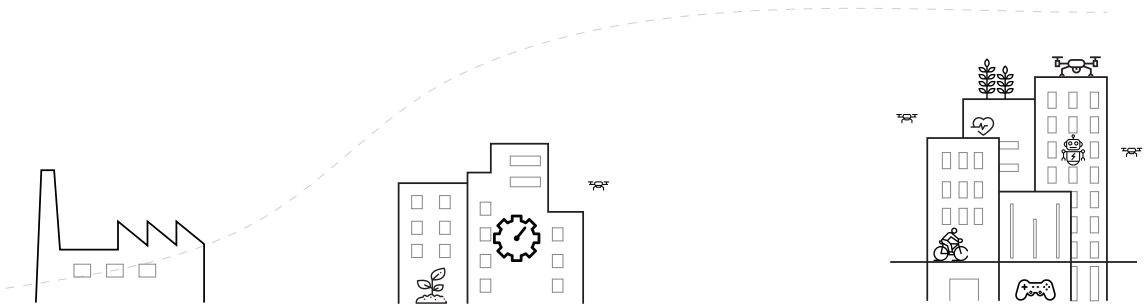


RELATION AMSTEL WITH AMSTERDAM, SCENARIO 2050

2100 SCENARIO

(P)LEISURE CITY

In the year 2100, Amstel strives for prosperity in the forms of health and well-being. New technologies have altered our cultural and personal values, they have shifted from the material based society to experience and social culture. Leisure is the next leading economy in future cities, by which the entrepreneurial productive attitude and servicing of the informational city (DIY, 3D printing and manufacturing, Industry 4.0) will evolve in the production of wellness (social cohesion and wellbeing, mental wellness, health is wealth, local entertainment, open air living etc.). It will be a life-embedding condition, for which different urban and architectural solutions have to be envisioned. Pleasure and leisure related to the new values will be introduced in the Amstel area, evolving Amstel's productive attitude and servicing label to the production of wellness rebranding Amstel as the (P)leisure city of Amsterdam. The architectural interventions(individual projects) will reinforce this brand with themes such as healthcare centers, leisure universe, co-habilitation and working, gaming community center and a transport node that joins everything together. The projects are focused around the park which transforms the green square to a (p)leisure hotspot. Whereas the historic center has the museum park, Amstel city's green square will be redeveloped into the (p)leisure park.



20th Century
Industrial

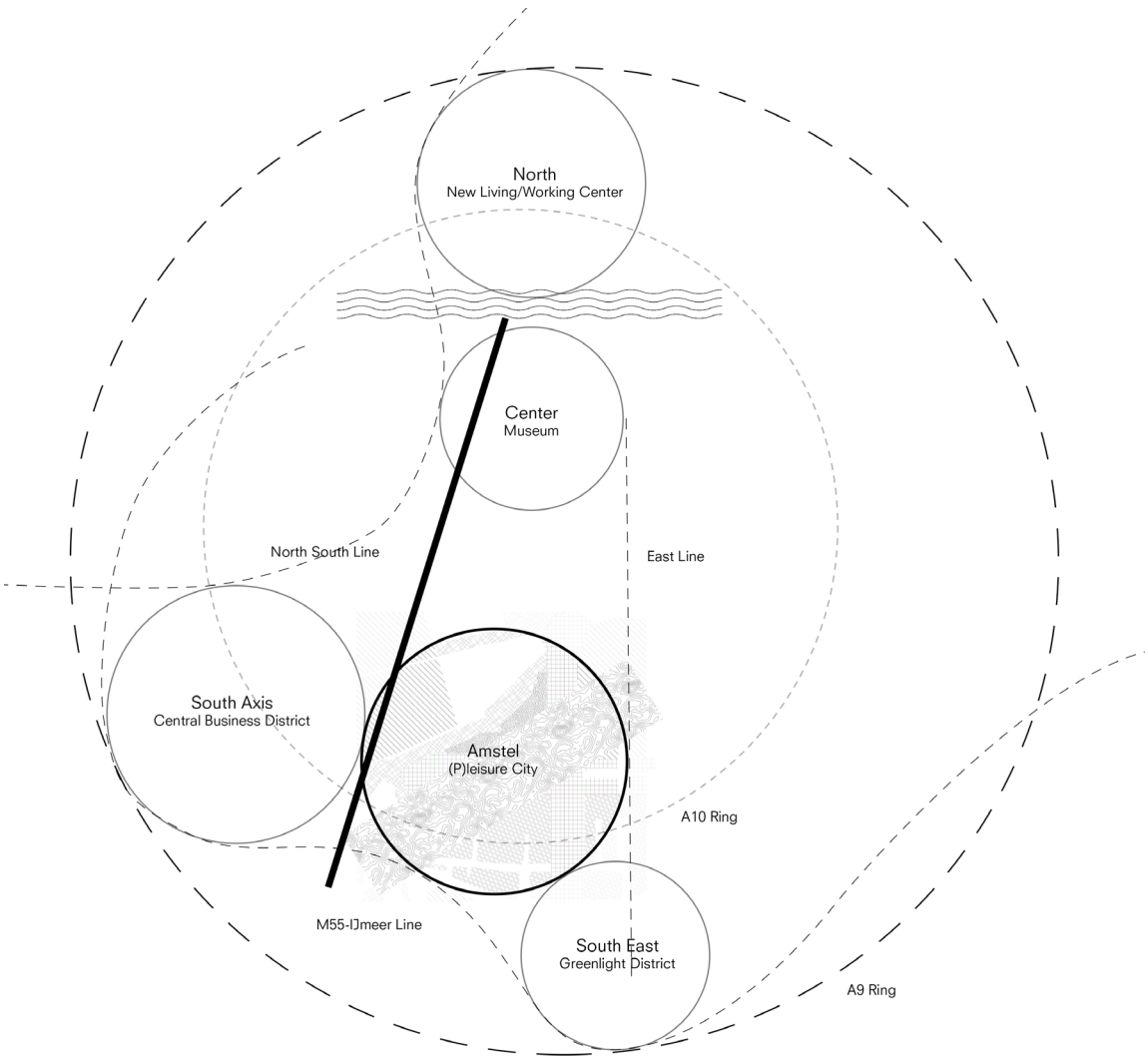
2050
Productive

2100
(P)leisure

EVOLUTION OF THE IDENTITY OF AMSTEL

In year 2100, the city of Amsterdam will have surpassed 1,5 million inhabitants. The growing population and city development has changed different parts of the city. The city centre hasn't grown in density but has stabalized his crowdiness. The South business district on the other hand has grown into a large centered area because it has attractive business features and connections. The North district of Amsterdam has developed tremendously because of stronger connections over the riverside. The Old city centre retains its identity as the the Museum area, hosting all the museums and other cultural heritage sites. The Southeast of Amsterdam has developed itself as Greenlight District of Amsterdam, developing a green urban environment for citizens who seek for nature in the city. The Amstel area places itself as the (P)leisure district of the city, where citizens can find pleisure in the abundance of different types of leisure activities.

The old ringway the A10 is developed into a green city boulevard, taking away the historic pressure and spatial border characteristics it used to have. With the A9 highway replacing the function as the city ringroad. With the termination of trains and highways at the A10 boulevard, the fragmentation segregated consequense of the infrastructure are suspended. Further developed of tunneled metrolines result in creating succes into all the connected areas, making the city grow in several areas.



RELATION AMSTEL WITH AMSTERDAM, SCENARIO 2100

GOALS

1. DEAL WITH INFRASTRUCTURE IN THE AREA IN ORDER TO GAIN SPACE FOR DENSIFICATION

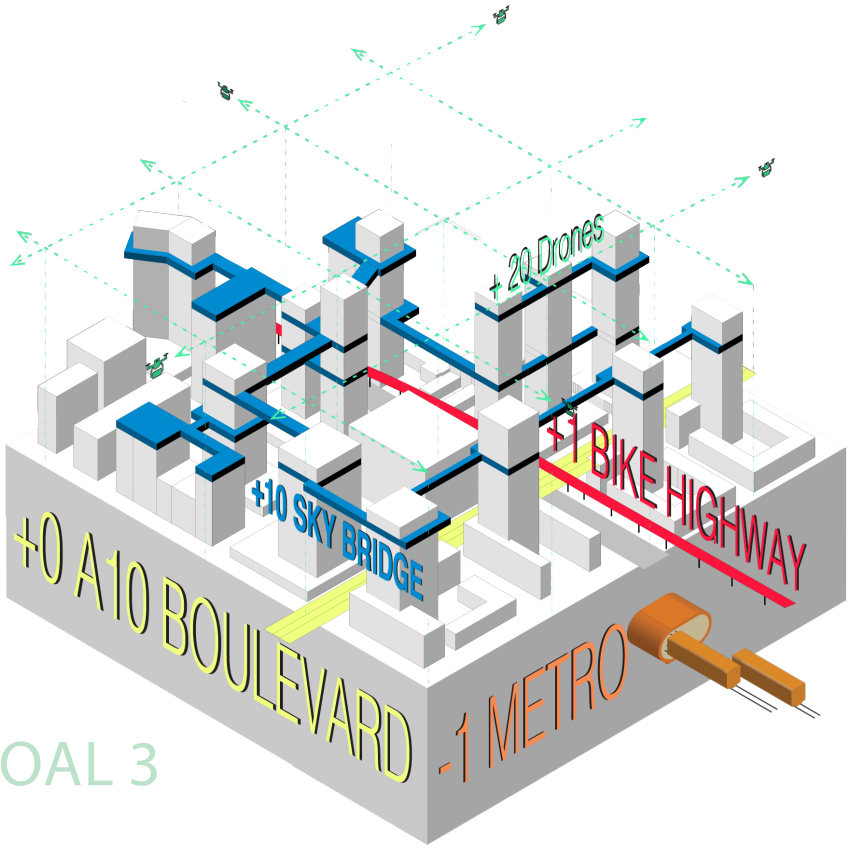
Strategy:
- Less barriers
- Transportation node
- Transport Oriented Development
- Progressive building heights & density

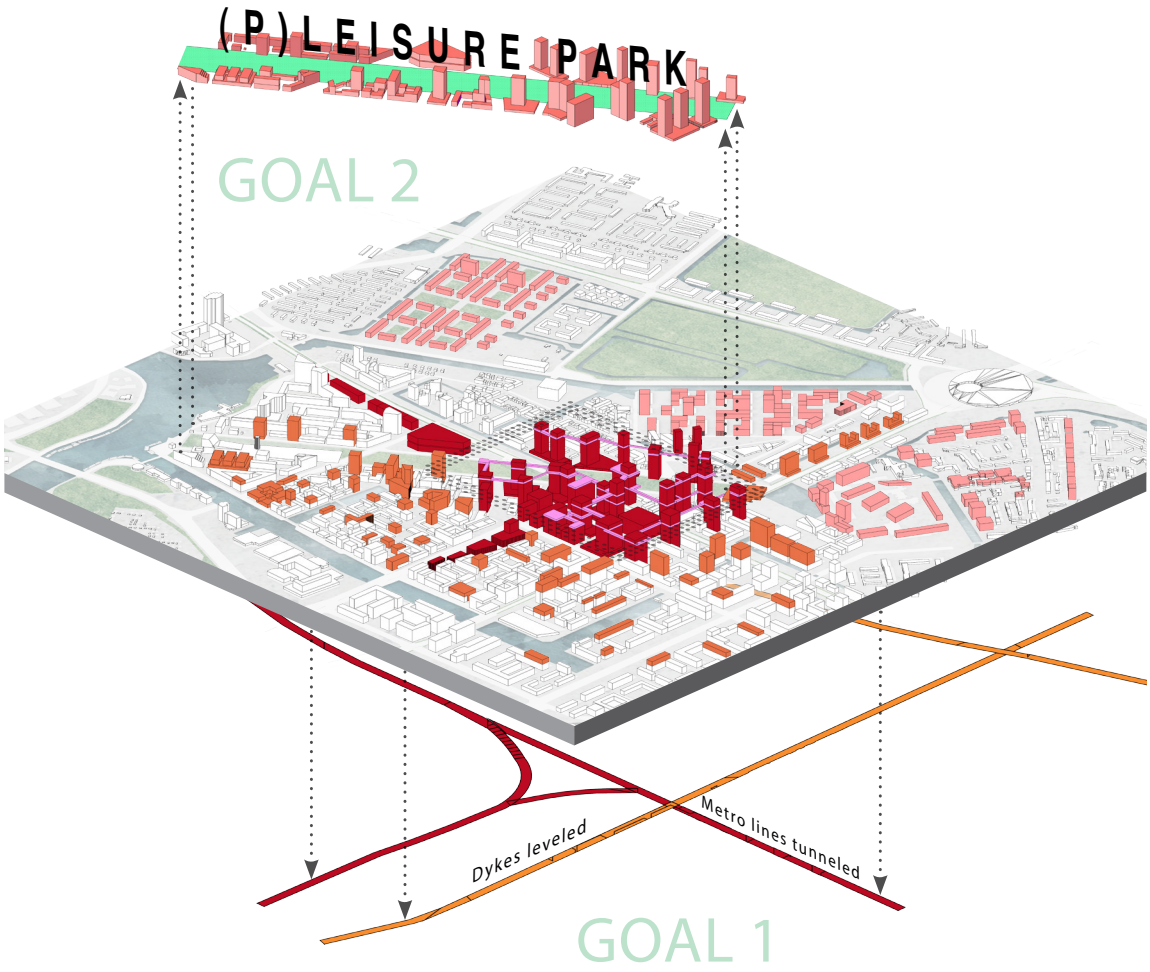
2. REINFORCE EXISTING QUALITIES IN THE AREA IN ORDER TO EMPHASIZE LOCAL IDENTITY AND HIERARCHY.

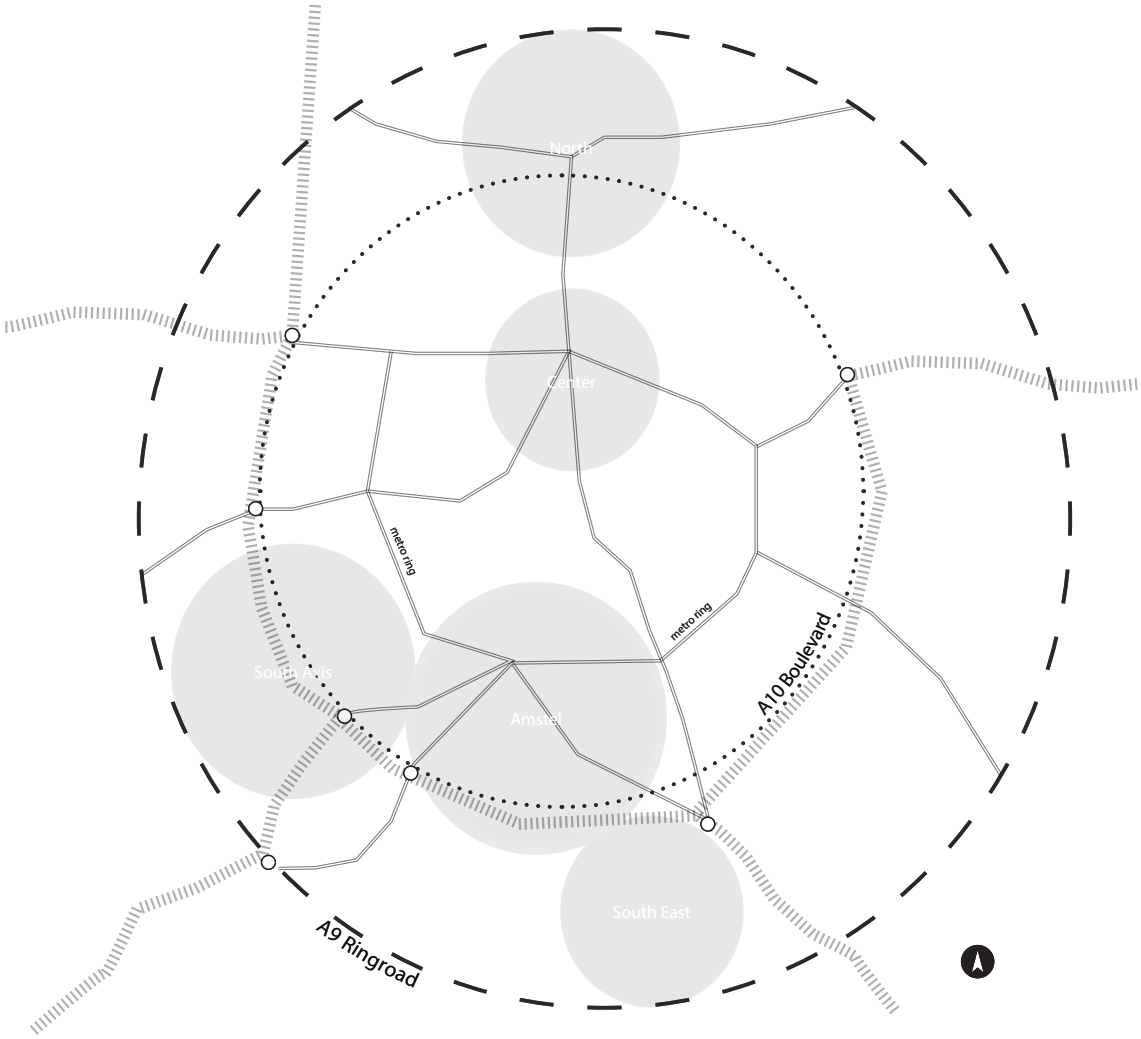
Strategy:
- Diagonal Park
- The green-blue network
- Promote a healthy lifestyle: active travelling
- A hybrid of living, working and entertaining

3. PREPARE FOR THE VERTICAL CITY AND 3D URBANISM.

Strategy:
- The aerial mobility




(P)LEISURE PARK
GOAL 2
Dykes leveled
Metro lines tunneled
GOAL 1



A10 City Boulevard
A9 City Ringroad
Main Metro lines
Main Train connections
Amstel River

SCHEMATIC MAP OF AMSTERDAM IN THE YEAR 2100

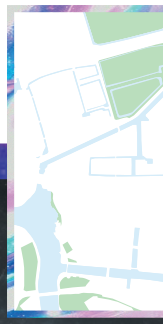
AMSTEL SCENARIO 2100

2018

12.000 inhabitants

Area fragmented

2020

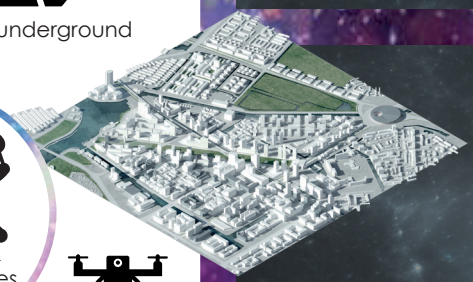


2050

A10 turn

2075

Metro put underground



More leisure & health amenities

Drones

Fewer cars

136.000 inhabitants

150.000 inhabitants

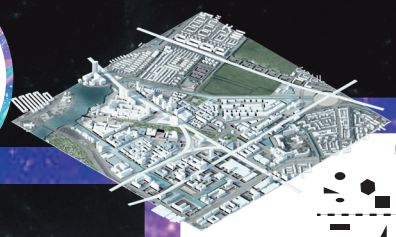
B

2100

(P)l

TIMELINE AMSTEL 2018-2100

Industrial



2030

Barrier reduced

Removing train

Light/creative industry

50.000 inhabitants

114.000 inhabitants

ns into a boulevard

Diagonal park

4d production

Bicycle highway

Leveling dykes

eisure

THESIS AND DESIGN TOPIC

PROBLEM STATEMENT

Transportation will change in the Amstel area. Commuting will become more utilized, and active travelling is promoted due to the trend that people will be less active in the future. How people will move through the Amstel area will change, the same for the connection of the Amstel area with other parts of Amsterdam or the Netherlands. The city will become more dense, more people will work, live and leisure in the Amstel area. The city will become too busy for the car, there will be an increasing use and demand of public transportation. This will mean that transportation has to become better, faster and more seamless, to process all increasing traffic.

"The city will become more DENSIFIED, more people will work, live and leisure in the Amstel area."

The metro will be moved underground to remove the barrier that is now in the Amstel area due to the metro line. This will mean that the old station will become redundant, because this station was design for a metro above ground. A new public transport station is needed in the Amstel area to accommodate the moving of the metro underground and to accommodate the changing transportation. Thought-out the city of Amsterdam are transport nodes where different modes of transport come together, one of these nodes is located in the Amstel area and will replace the old metro station. Due to the nature of the Amstel area within the city of Amsterdam, this public transportation node will probably be of a medium mid-city scale.

This is a good time to look at transportation in a broader context. Because transportation is not only the transport of people but also the transport of goods. A current trend is that the delivery of goods in the city will increase, due to the increasing ordering of goods on the internet. Currently, these goods are delivered by truck, and is relative slow, expansive, and inefficient. Because the city is to busy for the delivery truck, a new of mode of transport has to be found for the delivery

"A current trends is that the DELIVERY OF GOODS IN THE CITY WILL INCREASE, due to the increasing ordering of goods on the internet."

of goods. A new system has to be implemented to accommodate these developments in goods delivery. A place in the Amstel area has to be appointed to store and depart the goods from, to deliver the goods for the last mile in the Amstel area.

This place can be an integral mid-city transport hub where different modes of transport come together. Not only modes for public transport but also modes for the delivery of goods. Society, technology and the urban environment will change in the future in the Amstel area, a future mid-city transport hub has to be ready for this.

The research will focus on the future mid-city transport hub, that will be located in the Amstel area. Things discussed outside this scope will be for additional context/ information or will have impact on the Amstel area. An assumption is that the size of the future transport hub will be medium because of its current location in the city. The goal of the research is to make a well argued and funded prediction of how the Amstel area and a future transport hub will be in the year 2100.

FUTURE TRENDS

TRANSPORTATION WILL CHANGE

Ddensification in Amstel

THE CITY WILL BECOME TOO BUSY FOR THE CAR

GOODS DELIVERY WILL INCREASE IN THE CITY

CONSEQUENCES

HUMAN TRANSPORT

MORE DEMAND FOR PUBLIC TRANSPORT

METRO RELOCATED UNDERGROUND

FUTURE TRANSPORT NEEDS TO BE BETTER, FASTER AND SEAMLESS.

GOODS DELIVERY

NEW MODES OF TRANSPORT FOR GOODS DELIVERY NEEDED.

NEW DELIVERY SYSTEM NEEDED.

PROBLEMS

HUMAN TRANSPORT

CURRENT TRANSPORTATION NODE NOT SUFFICIENT ANYMORE

GOODS DELIVERY

CURRENTLY NO LOCATION WHERE GOODS DELIVERY CAN TAKE PLACE FROM

POSSIBLE SOLUTION

INTEGRAL MID-CITY TRANSPORT HUB FOR GOODS AND HUMANS

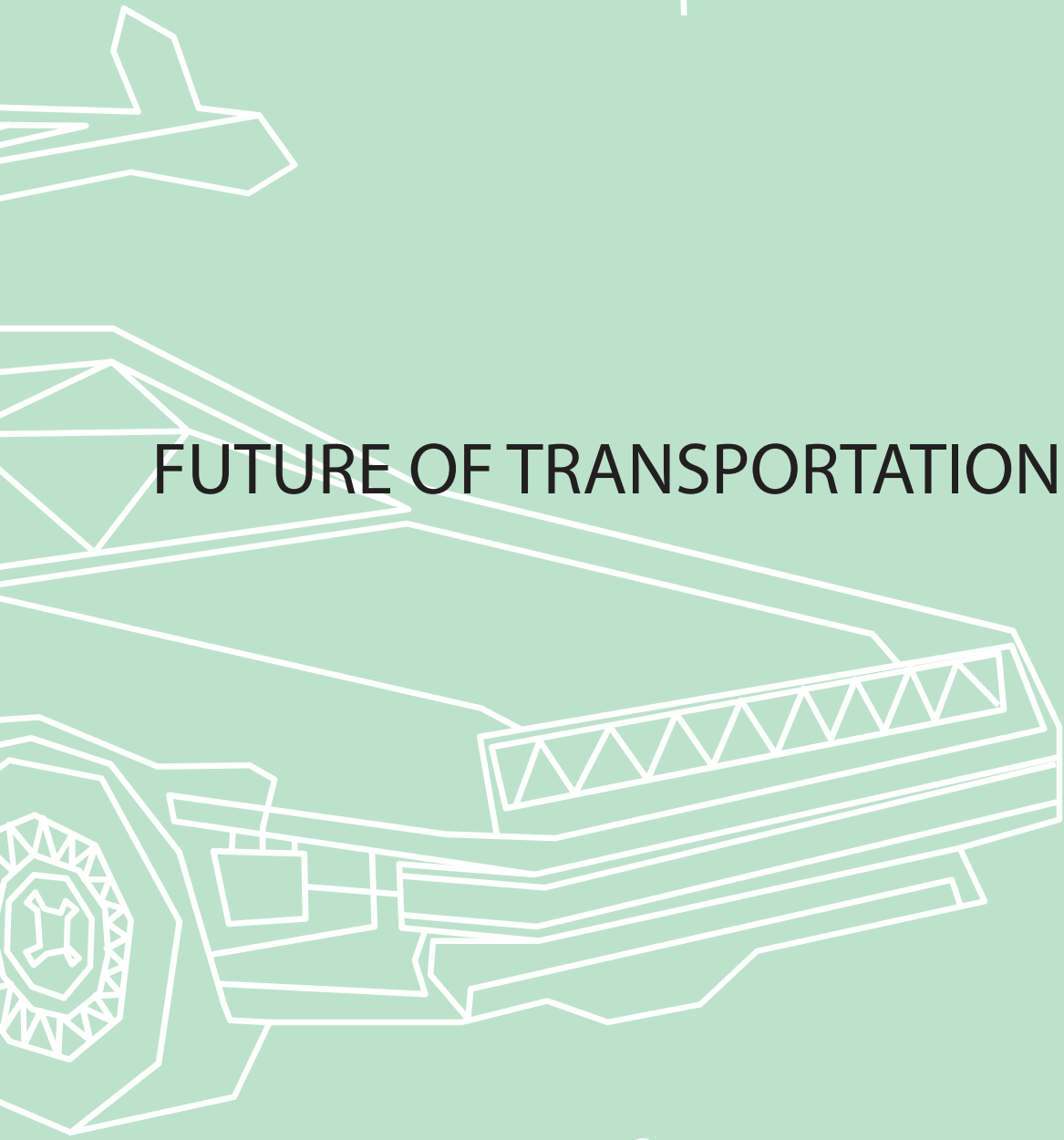
RESEARCH QUESTION

HOW WILL THE FUTURE MID-CITY TRANSPORT HUB BE IN THE AMSTEL AREA IN THE YEAR 2100?

SUB RESEARCH QUESTIONS:

1. What would human transport look like in the Amstel area in the year 2100?
2. How could goods delivery be in the year 2100?
3. What could be the future role of a mid-city transport hub in the Amstel area?

FUTURE OF TRANSPORTATION



TRANSPORT OF HUMANS IN THE FUTURE CITY

INTRODUCTION

Transport of humans will in all probability change in the future. New modes of transport could be invented and existing modes could be further developed. In this section the transport of humans in the city will be discussed. Due to the fact that the assignment is taken place in Amstel and there is already a certain scenario for the area in 2100, a focus is made for the research of transport of humans in the city. Although, there will not be any trains in the Amstel area in 2100, still will (partly) be looked at train stations in the research due to their integral properties. The knowledge gathered can be used for the design of the metro and other transportation modes. Also will be looked at current and possible future modes of transport that can become in use and how they can be connected seamlessly.

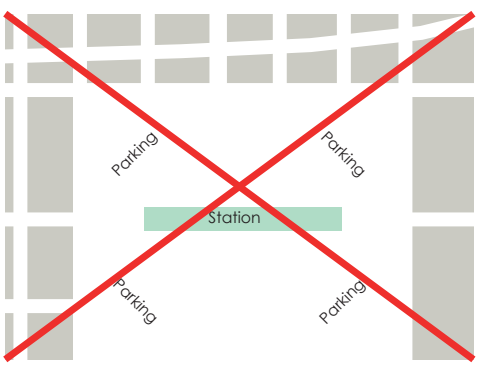
THE STATION

A part of the program of the future mid-city transport hub will be for commuting. This part of the building will therefore be a station. It is relevant to consider how this works and what the possibilities are. Because in the future multiple modes of transport has to be connected to each other, it is therefore relevant to look at integral stations. Because of the future nature of the assignment and research question it doesn't matter to look at stations that houses modes that are not in the Amstel area in 2100. This is because modes of transport that we know today may change and will maybe be work different or similar to other current modes of transport. Stations are connecting points to other modes of transport and mobility, including rail systems, light rail, cars, buses, taxis, bicycles and walking. Station design and operations strongly affect service reliability, operation speed and line capacity. There is a hierarchy of station scale and design what will differ from system types and locations (Transit oriented development institute , n.d.).

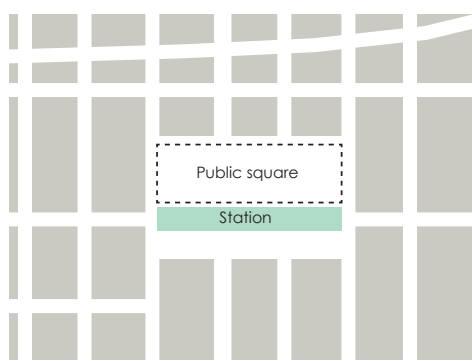
(URBAN) INTEGRAL STATION

The layout of a station is important and will lock in desirable or undesirable patterns. It will dictate many factors including pedestrian and bicycle use, the traffic around the station, development around the station and retail. A station "in a parking lot" must be avoided, where the station is isolated and separated from the city (Transit oriented development institute , n.d.).

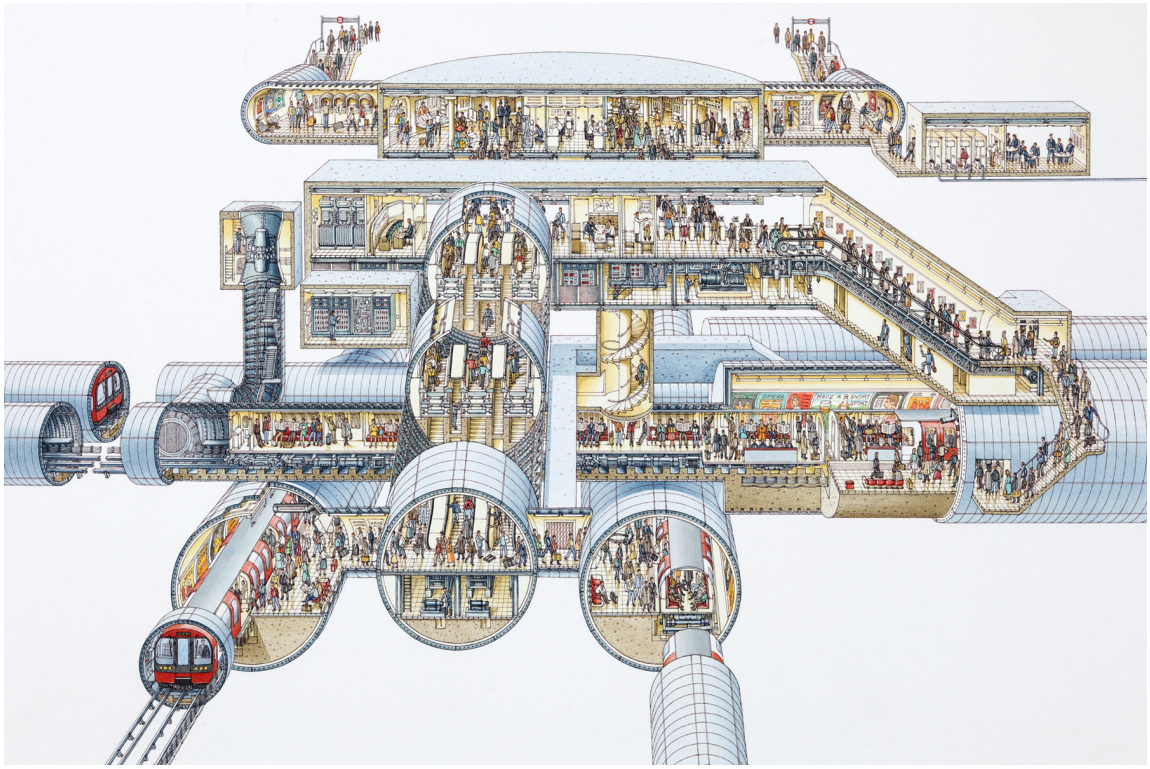
CONVENTIONAL LAYOUT



PREFERRED LAYOUT

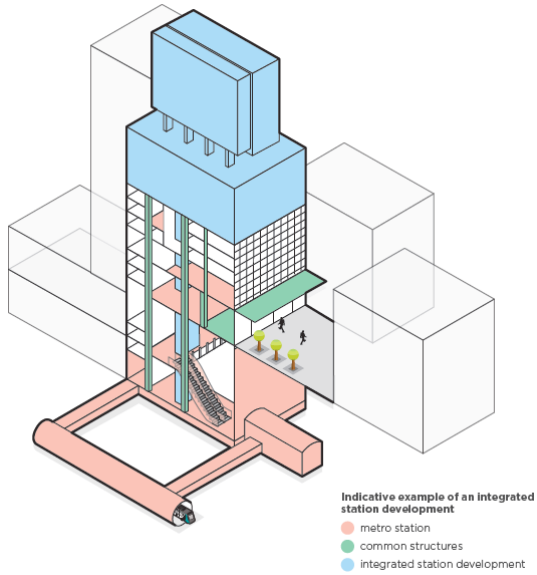


(Transit oriented development institute , n.d.).



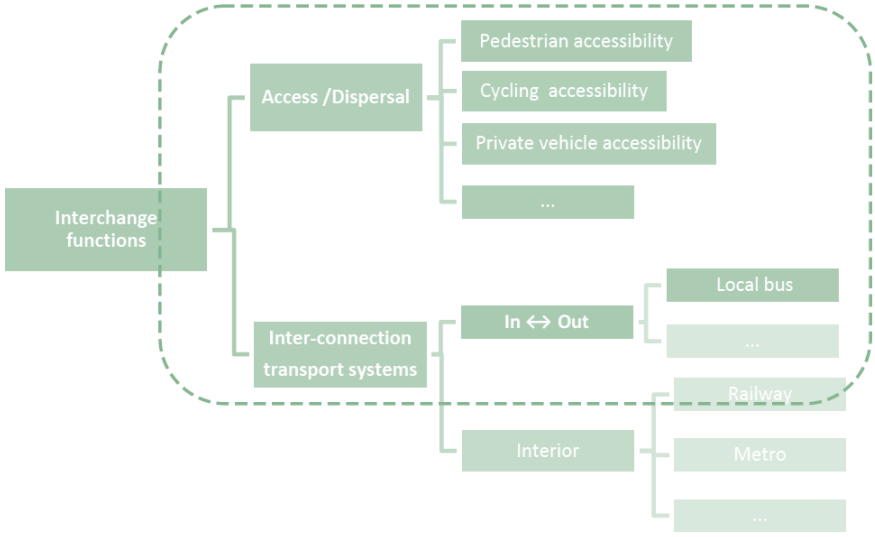
(Transit oriented development institute , n.d.).

The mid-city transport hub must accommodate the metro that is moved under ground in the Amstel area in 2100. A future trend is to make the metro integral and fitted in the surrounding urban environment. This will maximize the land use in a city that becomes more dense. It also allows residential, commercial and retail to be nearby. And it will help to activate the public space around the station (Sydney Metro, 2017).



(Sydney Metro, 2017).

The reason why the future transport hub has to be integral is because people will use multiple modes of transport for one trip. The connection between those modes has to be seamless and faster, the station is an important factor in accomplishing this. Also the urban environment is important to make the connection seamless and the interchange between modes of transport successful (Lamíquiz Daudén, Carpio-Pinedo, & García-Pastor, 2014).



INTERCHANGE FUNCTIONS AND URBAN ENVIRONMENT

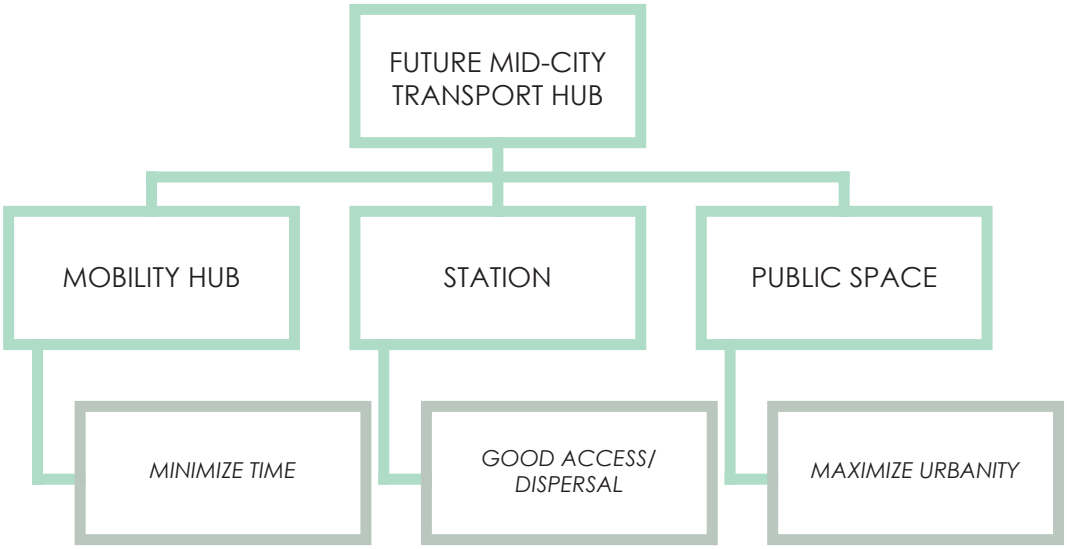
(Lamíquiz Daudén, Carpio-Pinedo, & García-Pastor, 2014).

A station is an urban space. To make a successful design a couple of things has to be taken into consideration. Bertolini has come up with a couple of goals and corresponding tips to make a station a well-designed urban space. These goals and tips can also be applied in the design of a station in 2100.

GOALS	TIPS
1. Multiple uses, both in terms of activities and flows.	-> Locate stations as close as possible to existing/new urban facilities and museums,
2. Plentiful opportunities of interaction between life inside and outside buildings.	Ex: the opening of a direct entrance to a major attraction, connection of stations and public squares or waterfronts,…
3. High visibility and presence of people at all times.	-> Treat the station and the surroundings as one single public space (visual+physical connections, but also in terms of details and materials).
4. Enough legible points of access to and exchange between different foci of activity.	-> Bring metro entrances as close as possible to the main local existing activity center (even when it means extra-tunneling),
5. An internal structure favoring the overlap of mobility flows in space and time.	-> Provide plentiful opportunities for the overlap of mobility flows: more targeted flows, accessing the metro system below ground or the urban facilities above ground + more casual flows, including passers-by.
6. Links with the wider surroundings.	-> Connect pedestrian channels in the station and pedestrian channels in the neighborhood.

INTERCHANGE AS AN URBAN SPACE BY BERTOLINI

(Lamíquiz Daudén, Carpio-Pinedo, & García-Pastor, 2014).



THREE POSSIBLE DIMENSIONS OF THE FUTURE MID-CITY TRANSPORT HUB

(Based on: Lamíquiz Daudén, Carpio-Pinedo, & García-Pastor, 2014).

The station or future transport hub can have three dimensions. It can function as a mobility hub (changing between different modes of transport), as a station (access to the mobility system), and as part of the public realm (a destination). The future stations need to have all three of these dimensions to make it as successful as possible. But in the design process will this be a complex problem to solve, since the three goals can be contradictory to each other (Lamíquiz Daudén, Carpio-Pinedo, & García-Pastor, 2014).

STATION AS DESTINATION

Train stations are or becoming a destination. Earlier, was a station just a place to pass thought, but now it has other functions then only mobility. Station are becoming lifestyle centers that further blend our commute with our lives. It is becoming a place of leisure and business (Arup, 2014, p. 39). This can also be happening for the future mid-city transport hub. That it will become a destination for Amsterdam, Amstel and the neighborhood.

LONDON'S ST PANCRAS STATION

(Arup, 2014, p. 39).

TICKET SYSTEM

The future ticketing system will be in all probability done by an app, maybe even automatically when the journey is taken. Integrated transport apps, in addition to buying a ticket, allow trips to be chosen according to optimal pricing and convenience. In this way people just have to install one app for the hole transportation system. This ticketless system will remove gates for stations and authorization to travel will be universal and automatic (Arup, 2014, p. 41).

FUTURE TICKET AUTHORIZATION SYSTEM

(Arup, 2014, p. 41).

MODES OF HUMAN TRANSPORTATION IN THE CITY

In this section modes of transport for humans will be discussed that are relevant and/or suitable for the Amstel area in the year 2100.

METRO

The London underground was built in 1863 and was the first underground railway system in the world. On the first day 30,000 people used the new metro system. Currently, the London metro carries 1.17 billion passengers a year (Lin, 2014). The metro is thus an old mode of transport. But the most metro systems are built recently. The use of the metro increases although it is an old system. The metro has a future in the city. It probably will improve but won't change that much. Potential things that can improve the metro system is automation, digitalization, remote monitoring, gathering big data and mobile data like ticketing. The metro will be a mobility solution in the future city, but it need to be integrated with other modes of transport (UITP, n.d.).

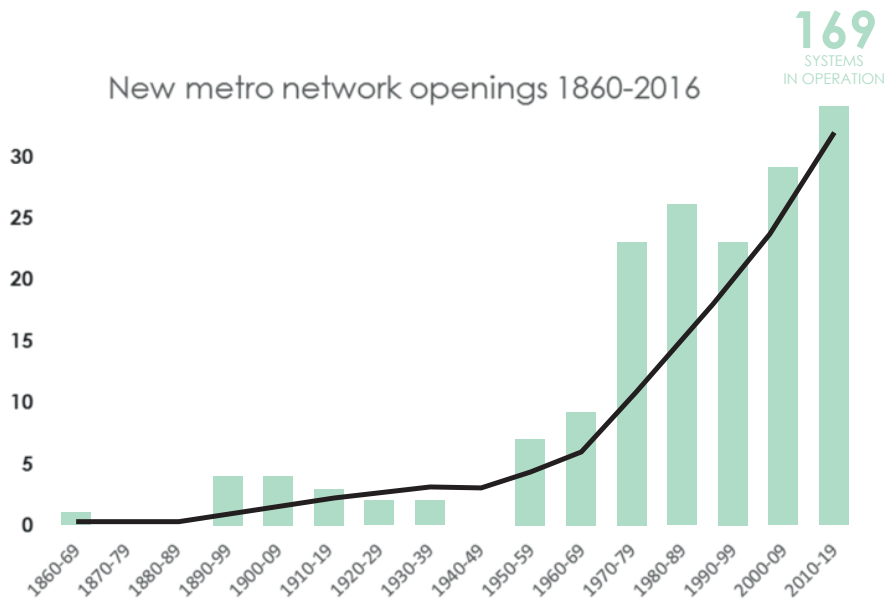
Automation is the future for the metro. Driverless passenger trains already exist in for example Copenhagen, Paris, Singapore, Dubai and São Paulo. An automated system optimize the running time and allows more train to be closer to each other, also it increase the reliability of the system (Arup, 2014, p. 31). On a station level this change will not be that visiable.

AUTONOMOUS METRO CONCEPT

(Siemens, 2013)

LONDON UNDERGROUND 1863

(Lin, 2014)



NEW METRO NETWORK OPENINGS 1860-2016

(UITP, n.d.).

LONDON UNDERGROUND PRESENT DAY

(Lin, 2014)

BUS

The bus is a successful public transport service in Amsterdam. Although it is not as fast or reliable as fixed track service, it is cheap and flexible. The use of the bus can change and also the bus itself. The main problem with the bus is that is shares roads with the car and that it has to stop a lot. This reduces the efficiency of the bus. But these problems are solvable in the future. The following principles will make the bus a better service and future proof, so that the bus will still be a mode of transport in 2100 (Byrne & Pharo, 2018):

1. Flexibility

2. Convenience

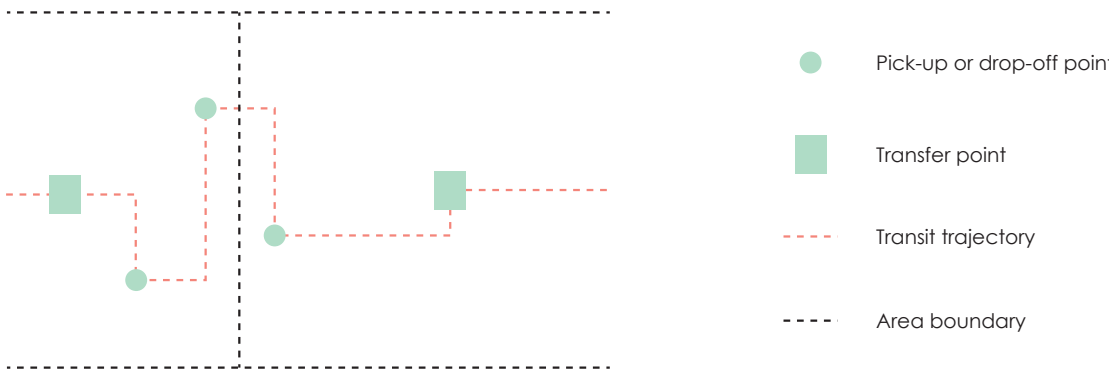
3. Reliability

4. Efficiency

5. Network integration

Future concept of the bus

The future bus concept would be in between a bus service and a taxi. Instead of a fixed route for the bus, the new bus concept would have a flexible route. Passengers would be picked up and drop off at a precise location in proximity of a fixed area. People that need to go outside the area can transfer at certain points. The service would take longer than a taxi but will be cheaper. It is also more favorable then the current bus service because passengers are pick up and dropped off at their destination (Jaffe, 2011).

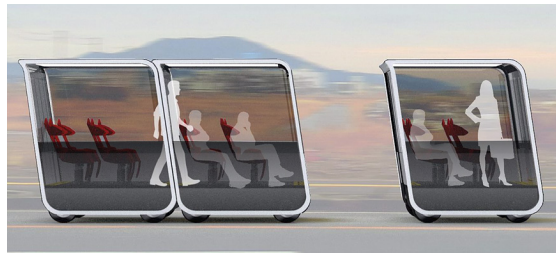


FUTURE BUS MOVEMENT CONCEPT

(Jaffe, 2011).

EXAMPLES

NEXT:
NEXT future transportation is continuing on this concept of a decentralized bus service. The bus is a small pod that can connect and disconnect from other pods. The pods are modular, electric and autonomous. The bus will go to a destination given in an app. The pods connect to each other to make the system efficient and disconnect when the pods are going different ways. This new type of bus is something that will arguably become common in the future and is suitable for the Amstel area in 2100 (NEXT future transportation inc., n.d.).



MULTIPLE PODS

(NEXT future transportation inc., n.d.).

Olli:
A self-driving intelligent pod, that can act as an on-demand service or can fill in the gaps in the public transit system. It can answer questions of passengers about the route, and transport them directly to their destination.

OLLI

(Parks, 2017)

What does this mean for the bus terminal?

Although busses will be smaller and will pick up and drop off people at their destination, bus terminals will still exist. The transport hub will be the place where passengers will transfer to different modes of transport. The need for a bus terminal is therefore still present. But the terminal will become smaller in size because of a more efficient system and because of real-time data for the need of a bus. Nowadays, a lot of space is taken by busses at bus terminals where the driver is on a break or the busses are not full but still take up the same space as a full bus. This will not be the case any more in the future. The layout of a bus terminal will look somewhat like the following:

Present

Future

BICYCLE

The bicycle is the most used mode of transport in Amsterdam. It is therefore very important to consider. The use of the bicycle is increasing in Amsterdam and this will continue in all probability in the future. Also the use of the e-bike is increasing, in the period of 2013-2016 the share of the e-bike increased with 5% (Verkeer en openbare ruimte, gemeente Amsterdam, 2017).
Bike sharing will also increase, the "OV fiets" is currently very popular in the Netherland, in the future this trend will become more dominant. In 2014 the "OV fiets" was rented 1.5 million times, in 2017 this was 3.2 million times. The use is more than doubled in 3 years (Treinreiziger.nl, 2018). With the bicycle usage increasing, storage will become more important. If a station has good facilities for bicycles, more people will use the bike to go to the station. It is therefore important to consider this in the transport hub design. Also facilitating share bike usage and e-bikes will become important.

In 2014 the "OV-fiets" was rented 1.5 MILLION times, in 2017 it was rented 3.2 MILLION times.

INTELLIGENT BIKE CONCEPT BY CHRIS BOARDMAN: "A BIKE WITH A SOLAR-POWERED BACKUP MOTOR, AN ONBOARD COMPUTER, A FINGERPRINT SECURITY SCANNER AND A SPOKE-FREE WHEEL DESIGN"

(Boardman, n.d.)

TRANSPORT CHOICE OF /TO / IN AMSTERDAM BY RESIDENTS PER WORKDAY

(Verkeer en openbare ruimte, gemeente Amsterdam, 2017)

	1986-1991	1994-1997	2005-2008	2013-2014	2015
Bicycle	**447**	**566**	**573**	**609**	**666**
Scooter	17	18	23	46	24
Public Transport	403	420	352	319	301
Walking	640	649	478	547	433
Car	622	669	521	385	440

NUMBERS OF MOVEMENTS (X1,000) FROM / TO /IN AMSTERDAM BY RESIDENTS PER WORKDAY

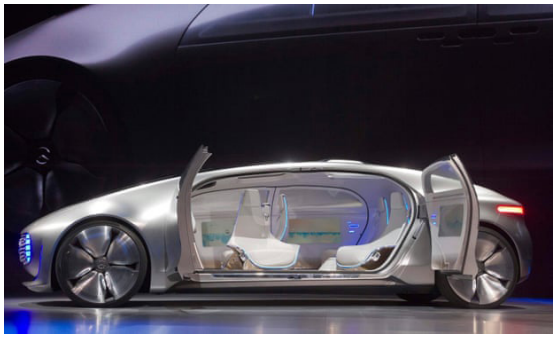
(Verkeer en openbare ruimte, gemeente Amsterdam, 2017)

The car itself and the use of the car will change. In all probability, the car will be in 2100 electric, autonomous and connected to the internet (Altran Group, n.d.). Cars won't be driven by humans anymore but autonomously by a computer. Also the car can be called by an app, what will result in fewer cars for families, because one can use the car to get to work and the car then would return home to pick up the kids for school. Also shared mobility will increase due to autonomous driving (Lewis, n.d.). Currently, cars are used four percent of the time, with most cars not full at all during that time. Car sharing can improve this and solve a lot of congestion problem that cities currently have (Ramirez, 2018). The car becomes instead of private property a public service. Already, services like Uber and Lyft provide a shared car on-demand service, this will become cheaper when the cars becomes autonomous. This will result in that a car is used more often, it can even switch to a 90% use rate. The trend of sharing a car in the city will make in all probability owning a car a luxury, because space will be limited in the city and a car takes up a lot of space (Gibbs, 2017).

"A Shared car service can result in a 90% use rate instead of 4% when privately owned."

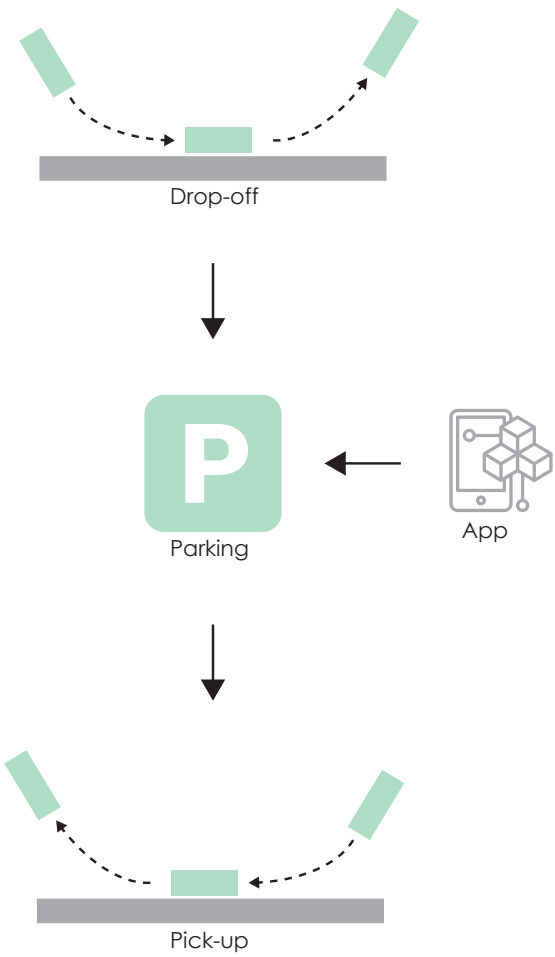
Parking a car in the future will be a lot more convenient and will take up less space, thanks to autonomous cars. "It is estimated that parking garages specifically designed for self-driving cars can take up 60% less space than traditional lots" (Citron, 2017). The parking garages don't need stairs and cars can park much closers to each other because no humans have to get out of the car in the garage. The passenger will be dropped off at their destination and the car will park itself. For the station this means that only drop off and pick up points must be available. Because the bus service is changing (in all probability) to smaller pods in the future, the same terminal can be used.

"Parking garages specifically designed for self-driving cars can take up 60% less space than traditional lots"



AUTONOMOUS CAR CONCEPT

(Gibbs, 2017)



AUTONOMOUS CAR PARKING CONCEPT

DRONES

Passenger drones can be the future of mobility in the city. These drones can be electric, autonomous and connected to the internet, they can become a flying car. The company Ehang made a quadcopter named the Ehang 184. They conducted over 1,000 test flights with human passengers. The drone can reach a speed of 130 km/h, carry 230 kilograms, is autonomous and electric (Hawkins, 2018). Although, this is promising a lot has to change to make this a reality in the Amstel area. Currently, drones can't fly above 120 meters in the Netherlands, this and other regulations has to change (Dutch government, n.d.). Also the space a passenger drones takes up is quite large in a dense city, human drone transportation will be therefore a luxury.

"The space a PASSENGER DRONES takes up is quite large in a dense city, human drone transportation will be therefore a LUXURY."

EHANG 184

(Hawkins, 2018)

TRANSPORT OF GOODS IN THE FUTURE CITY

INTRODUCTION

The future of transportation in the city will have two components that will become dominant. The first one is the transportation of people as previous discussed and second one will be the transportation of goods in the city. More people are buying goods online and these goods will be delivered at their homes. This is called business-to-customer (B2C) delivery. When companies order goods is called business-to-business (B2B) delivery. The market of internet shopping and therefore also B2C delivery is growing in the Netherlands. The estimated sales were 21.6 billion euros in 2016, the sector is growing by yearly with 14% in the next five years (Kuunders, 2017). This will mean that in the year 2100 it will be very normal to order almost all goods, and conventional stores will be used less.

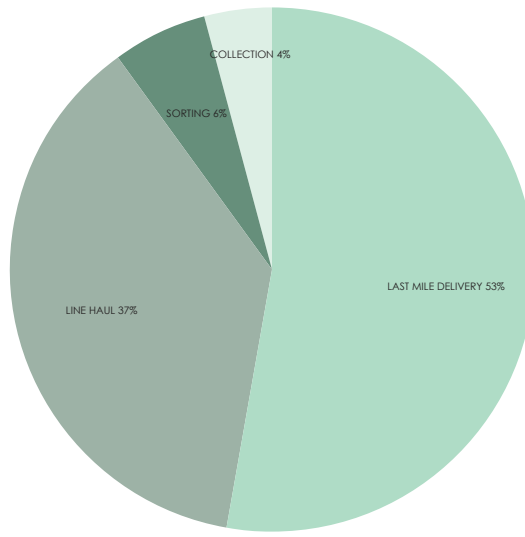
"€ 21.6 BILLION in internet sales in 2016 in the Netherlands."

Last mile delivery is a common term in the e-commerce sector that refers to the final step of the delivery process (Kuunders, 2017). This is the part of goods delivery that is most visible in the city, and will be the focus in the research. Last mile delivery is the biggest expense in the supply chain of goods delivery (Dolan, 2018). It is important that in 2100 this process of delivery is optimized and made as cheap as possible.

Due to goods delivery and other traffic, cities are becoming congested. It is even so bad that for example in New York city the fastest way to deliver goods is by walking. In U.S. cities truck traffic is about 7 percent of the urban traffic, but the congestion cost are $28 billion which is 17% of the total congestion cost. This number will only rise if nothing will be done about this problem (Zaleski, 2017). In 2100 the current system of delivering goods will not be sufficient anymore. This is because of the increase of density in cities around the world, including Amsterdam. The rise of e-commerce and urban population growth are creating new large challenges for the Amstel area. The main problem today is that cities are trying to manage this 21st-century delivery

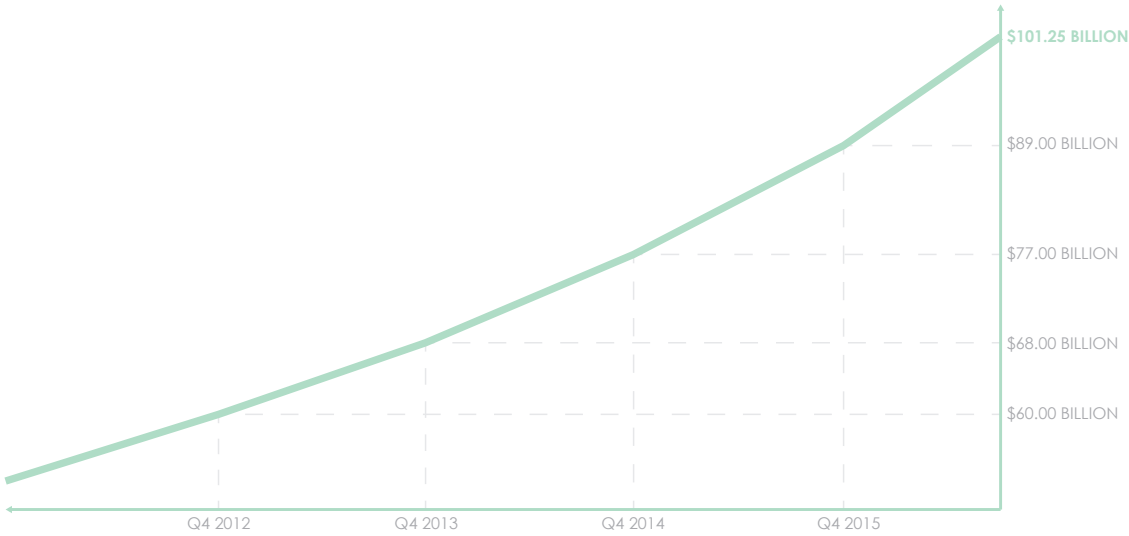
"In U.S. cities truck traffic is 7% of urban traffic and is 17% of the congestion cost."

problem, with tools that are designed for the 1800s. Another thing is that online shoppers expect the products be delivered as fast as possible, they don't want to wait a couple of days anymore (Goodchild & Ivanov, 2016). These problem and challenges will become hard to solve in the future. Currently, urbanization reaches 73% of the population in Europe, and this number will only increase. The more people living in cities imply a higher demand of goods and therefore transport to supply those goods (Cardenas, et al., 2017, p. 23).



SHARE OF DELIVERY COST, BY PART OF JOURNEY

(Dolan, 2018)



U.S. E-COMMERCE SALES

(Goodchild & Ivanov, 2016)

LAST MILE DELIVERY

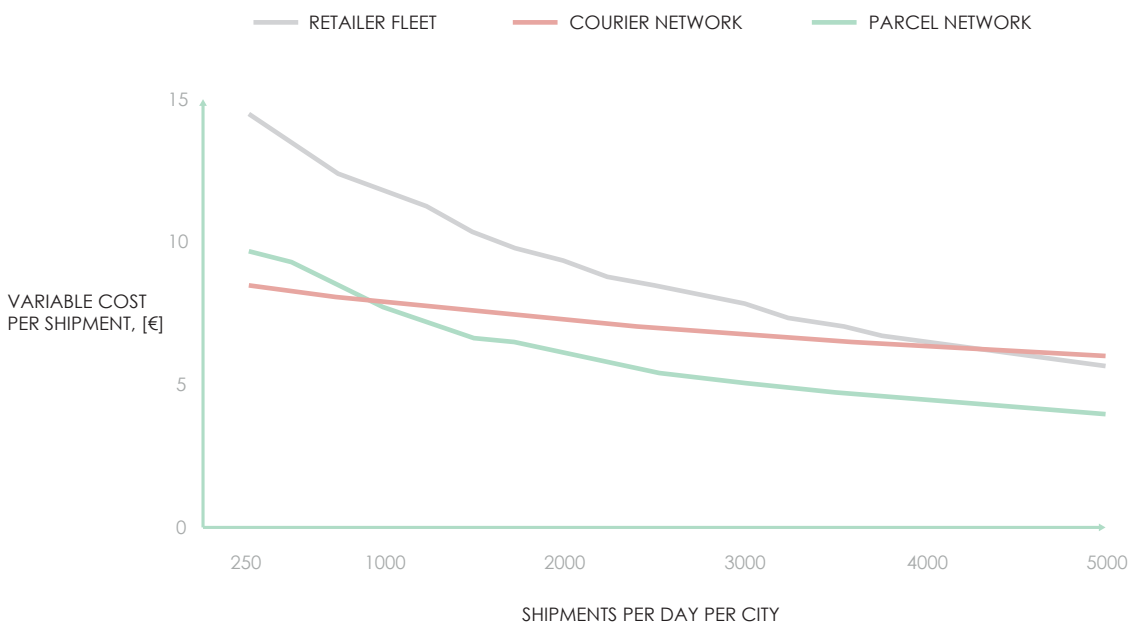
As previous concluded is last mile delivery the final step in the delivery process of goods. Last mile delivery is a term that comes from a multi-hub-and-spoke network topology, that can be compared with a tree. As goods come closer in the network to the customer, more bottlenecks occur (Cardenas, et al., 2017, p. 27). Therefore, last mile delivery is currently inefficient and the most expensive part of goods delivery (Dolan, 2018). It is therefore relevant to look at this process and predict how this will be in the Amstel area in the year 2100.

There are a couple of future trends for goods delivery and in particular last mile delivery. One trend is that people want faster fulfillment. They want their good within a couple of hours (Kaplan, 2017). If this is already the case nowadays, in 2100 this will be the standard or the minimum. It is likely that people want their goods in the same time as it takes them now to go to the store and buy them. Another trend that can be more dominant in the future is insourcing deliveries. An increasing number of companies are using their own (shared) vehicles for last mile delivery. Traditionally, companies that sell goods, don't ship them. But this is changing, more companies wants control over their delivery (Kaplan, 2017). Also city warehouses will be more common in the future. For example, Amazon Prime Now has 58 hub in the U.S. They are used for customers that want their products instantly. Amazon has built these city warehouses to have easy access to the products for fast delivery to customers. Amazon said that this is the only way to accomplish this fast type of delivery (Kaplan, 2017). In the year 2100 these warehouses will probably made more sufficient of re-invented to accommodate the increasing demand in goods. One more trend is new futuristic delivery options. This include drones, autonomous vehicle etc. Delivery is labor intensive and labor is currently responsible for 60 percent of the cost. The use of robots will reduce the cost of delivery, they can also work 24 hours per day. Drone delivery. However has its limitations in high urbanized areas due to regulation and operational issues. But in 2100 this will not be a large problem anymore (Kaplan, 2017).

"Labor is responsible for 60% of the cost of goods delivery."

If someone buys a product online, they don't think about what will happens next. But goods have to be picked (from fields or a warehouse), packaged, shipped to a distribution center, and from there delivered at business or houses. Currently, cities pay a lot of attention to efficiency and safety in the urban environment, but they do not think that much about the distribution of goods in the city (Davies, 2017). The supply chain is currently changing thank to the rising share of online retail. Alongside alternative pickup and delivery options, speed is becoming an important factor in the delivery process, in the future this will only increases. Same-day delivery is a game changer, because it combines the immediate product availability of retail with the convenience of ordering from home. The consumers are expecting more of delivery, they want convenience when buying online. They want multiple delivery options and want to receive their products as fast as possible (Hausmann, Herrmann, Krause, & Netzer, 2014).

A large network is necessary with sufficient volume to make this kind of delivery the standard. This will mean that in area with a high density (like a city) this kind of delivery can be the standard. Currently, no network exist on this kind of scale, this means that people still go to the store to get their products (Hausmann, Herrmann, Krause, & Netzer, 2014).



COST PER DELIVERY SERVICE PROVIDER

(Hausmann, Herrmann, Krause, & Netzer, 2014)

DEFERRED DELIVERY

DELIVERY TIME

3-5 days

TYPICAL USE CASE

MAIL-ORDER DELIVERIES
"I want to try on those clothes I found in the catalog at home and I don't mind waiting for a couple of days."

NEXT-DAY DELIVERY

DELIVERY TIME

1 day

TYPICAL USE CASE

E-COMMERCE DELIVERIES
"I want to get the new camera I found online for a cheaper price than in the electronics shop as quickly as possible, otherwise I'll just buy it in the shop."

SAME-DAY DELIVERY

DELIVERY TIME

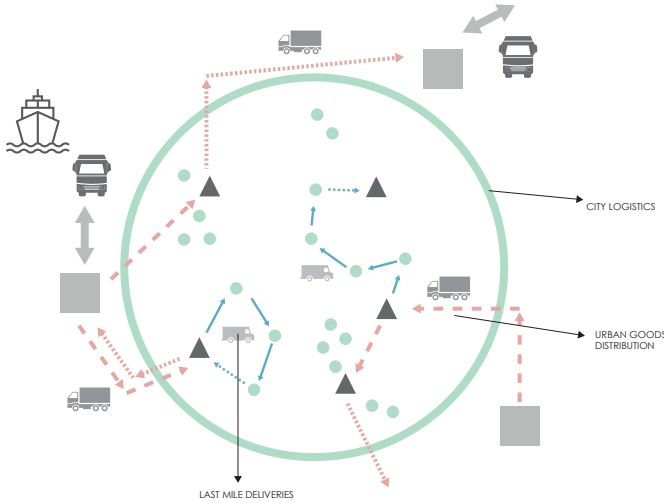
1-12 hours

TYPICAL USE CASE

URGENT DELIVERIES
"I need a new suitcase before tomorrow, but couldn't find the one I like in the shop next door. I don't have the time to check out other stores, but I need it today."

EVOLUTION OF B2C PARCEL DELIVERY

(Hausmann, Herrmann, Krause, & Netzer, 2014)



CURRENT SUPPLY CHAIN INTO THE CITY

(Cardenas, et al., 2017, p. 31).

Retailers and logistics providers have to be technologically advanced to offer fast delivery. Nowadays, four things are necessary for fast delivery, these are: product availability, real-time product visibility, fulfillment capacity, and flexible last-mile capability. First, products need to be locally available, then the travel time of goods, when they are ordered, is as less as possible. Second, retailers need to know which products they have available in their warehouses and where the products are. Then they know if the product is available and how fast it can be delivered. Third, the picking and packing process need to be fast. This will mean that there needs to be investments in logistics of the delivery process, in the future this process will probability be full automatic. Finally, last mile delivery needs to be flexible. It has to be able to do pickups the hole day and needs to be dynamic in its routing. In the future computers will play a large part in this. This will allow the logistic provides to delivery autonomous and respond immediately to new shipments. Goods delivery will become cheaper when this scale of the network becomes larger and when more competition between different companies will occur (Hausmann, Herrmann, Krause, & Netzer, 2014).

The scheme above shows the current situation in goods delivery in a city. Goods arrives in larger quantities to a distribution center (far away) outside the city. From there they go to smaller centers inside the city to be ready for last mile delivery or go directly to the costumers.

As you can see a lot of steps has to be taken to deliver goods. Because the large distributions centers are outside the city, large distances has to be covered to deliver the goods. The result will be that more time is needed for delivery, more costs, more road congestion, and currently more CO2 emissions. To improve this in the future, a good connection of urban distributions centers, city terminals and logistic centers need to be made possible in the dense urban environment. Ideally, these centers would be connected by a water way of railroad. This concept of a cargo tramway, as a connection between a city terminal and logistic center is already tested in a couple of European cities. Without these connection there would only small logistics centers possible within the city. Currently, because of the cost and status of logistics companies, no large city distributions terminals are built in cities. However, it can be justified to build modern an efficient city terminals of multiple stories, equipped with modern technologies and solutions so that goods take less space (Ljubičić & Pavlović, 2015).

PRODUCT AVAILABILITY

REAL-TIME PRODUCT VISIBILITY

FULFILLMENT CAPACITY

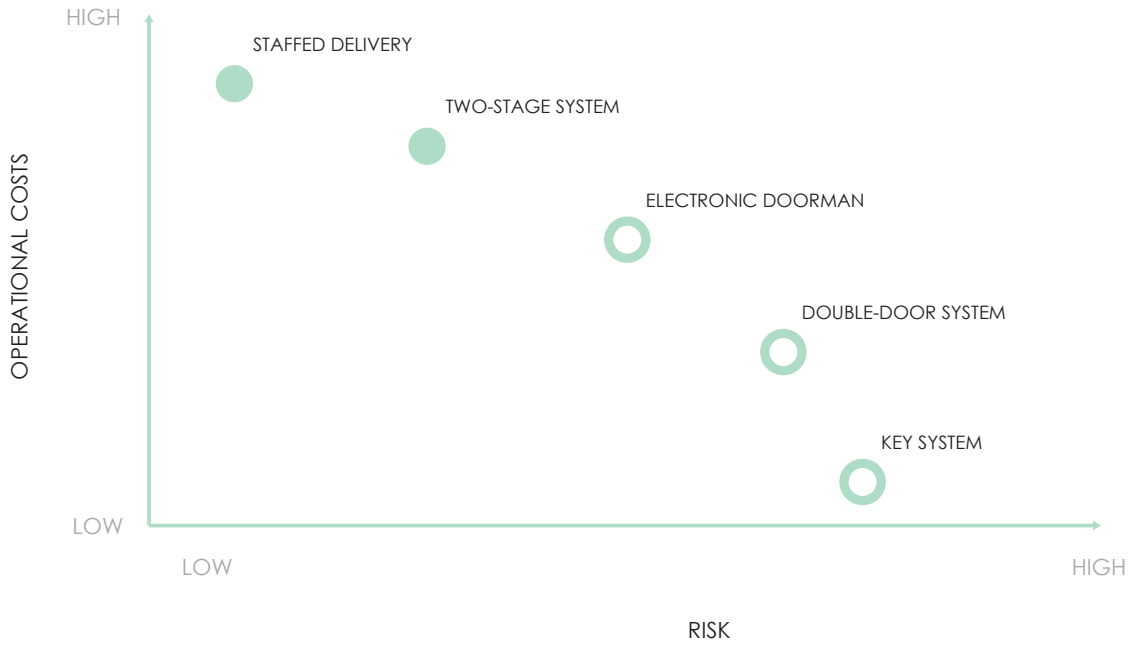
FLEXIBLE LAST-MILE CAPABILITY

NECESSARY IMPROVEMNTS TO MAKE SAME-DAY DELIVERY POSSIBLE

Currently, one of the larges disadvantages of goods delivery to customers is that people must be home to receive packages. Another way of receiving a package is delivery without a physical receiver. Currently, people can pick their packages up at train stations or at pick-up points in store, next to home delivery. This method is not ideally and new systems are invented to make this part of the delivery process more efficient (Kuunders, 2017).

There are nowadays already a couple of concepts for goods delivery, as one can see in the figure below. The first two concepts need people present when the delivery is made. The other three don't need people present and are therefore more future proof. Currently, these concept are used for night delivery but these are also suitable for delivery during the day (Ljubičić & Pavlović, 2015).

The double-door system, allows delivery within the building, without access to the whole building (Ljubičić & Pavlović, 2015). This can also be lockers that are near the customers location or in a part of the building. These can act as temporary storage for packages, they would be the future mailboxes (Cardenas, et al., 2017, p. 28). With a key system the delivery can take place within a building without anyone present. This can be in the form of an electronic key system that can be opened with a password. Also a possibility is an electronic doorman, where by delivery can take place within the building and will be opened by someone that is at another location, and can verify delivery by camera's and identification checks (Ljubičić & Pavlović, 2015). Amazon is already looking at these possibilities, they develop Amazon Key that let the delivery guy into your home (Kuunders, 2017). In the future these option will be fully develop, and no one has to be present, it will be the future mailbox.



OPERATIONAL COST VERSUS RISK FOR GOODS RECEIVING CONCEPTS

(Ljubičić & Pavlović, 2015)

FUTURE FULFILLMENT CENTER

Fulfillment centers are physical locations where online orders of customers are fulfilled for ecommerce retailers. Most of the time this is done by third-party logistics companies (fulfillment provider), although larger companies (for example Amazon) have their own fulfillment centers. These center have as goal to get online orders to customers in a timely manner. Products will be stored shortly in a fulfillment center because the goal is to turn inventory over quickly. Constant movement takes place within a fulfillment center to get orders out. When customers complete their purchase in an online store, the inventory is picked, boxes are packed and then labeled for shipment. This is therefore quick different form a warehouse. A warehouse is designed for long-term storage and there is not a lot of movement in it. Because of this difference it is made possible for retailers to short-term store inventory in fulfillment center near their customers. This will reduce distance of travel to the customer and therefore delivery time. A fulfillment center has various activity like: receiving inventory, picking products, kitting (combining) items, packing boxes, labeling shipments, shipping orders, managing returns. In modern fulfillment center technology plays an important part. Companies have to know what their inventory is and where it is, without being in the fulfillment center. This is possible when fulfillment centers systems are integrated in the ecommerce platforms and marketplaces. This integration makes it possible that the order is automatically sent to the fulfillment center (Lopienski, n.d.). In the future this maybe can be combined with autonomous systems, to make it possible to order products online and delivering it to the customer without any human intervention.

Receiving inventory

Picking products

Combining items

Packing boxes

Labeling shipments

Shipping orders

Managing returns

FULFILLMENT CENTER ACTIVITIES

Autonomous mobile robots (AMRs) can be used for picking and transporting goods around the fulfillment center. These mobile robots are more flexible and scalable than traditional automation. One AMR is from inVia Robotics and it can pick light stackable items that can be stacked or arranged on shelves into totes on another robot platform using light arms with suction cups. The robots are operated by a robotic management system that helps to optimize picking operations (Banker, 2017). This robot can make a part of the fulfillment process autonomous in the future.

But there are also other automated solutions that can be the standard in the future for fulfillment centers. One is an automated fulfillment center in Andover of the online-only supermarket Ocado. It has a grid with more than thousands of robots on it. They have the size and shape of a washing machine, and moving groceries day and night. The robots are picking crates with products in it for selves and putting is inside the robot. Then it moves it to a new location, where it drops it in the a vertical chute to store them. This result in huge stacks of up to 17 crates high. The position of the crates are decided by an algorithm, frequently accessed items places on the top and rarer purchases near the bottom. From this grid crated are taken to a picking station, where currently still humans are working. But new technology is develop to make this task also automated. At the picking stations products are taken from the crated and put in shopping bags. Crates that are still full are send back into the grid. This is all controlled by a central computer, this makes it possible to make all robots communicate with each other. The fulfillment center processes 3.5 million items or around 65,000 orders every week. The robots will be lifting, moving and sorting the products. Although the robots do a lot of work, there are still humans working in the building (Vincent, 2018). An average order of 50 items takes just 5 minutes to pick and pack. The fulfillment center has an area of the equivalent in size to three football pitches, what is around 20,000 m2 (Godwin, 2018).

"An average order of 50 ITEMS takes just 5 MINUTES to pick and pack."

"The fulfillment center processes 3.5 MILLION ITEMS or around 65,000 ORDERS every week."

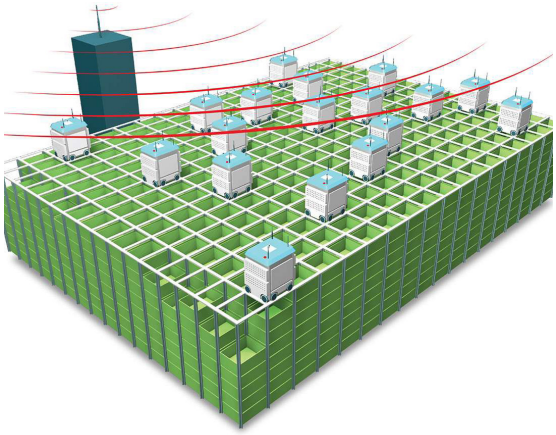
The system of fulfillment is currently separated. This mean that crates where products are moved around in the fulfillment centers are not used for the delivery of the goods. To optimize this process is would maybe be better if this was possible. Fulfillment center are integrated in the ecommerce web shops, so it would be only logical to do the same with the physical process of

INVIA AUTONOMOUS MOBILE ROBOTS

(Banker, 2017)

goods delivery. So that the hole process of goods delivery will be one system that is as effective as possible. Amazon is looking at this integration of systems. The company has currently control over its fulfillment and ordering of orders, and wants in the future also control over the delivery. It patent an idea of a fulfillment center in the middle of the city, where the delivery will be done by drones (Amazon, 2017). They see the whole delivery process ideally as one system. This patent will later more elaborated as a case study.

"The fulfillment center has an area of the equivalent in size to THREE FOOTBALL PITCHES, what is around 20,000 M2."

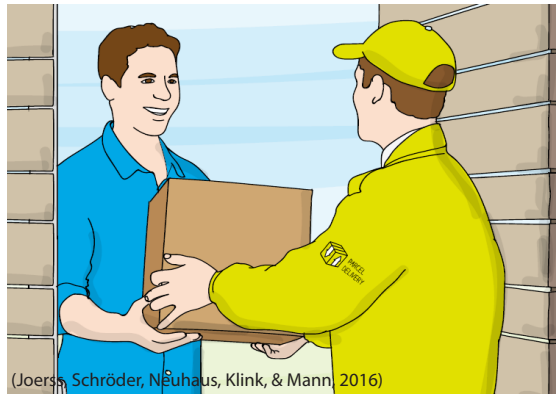


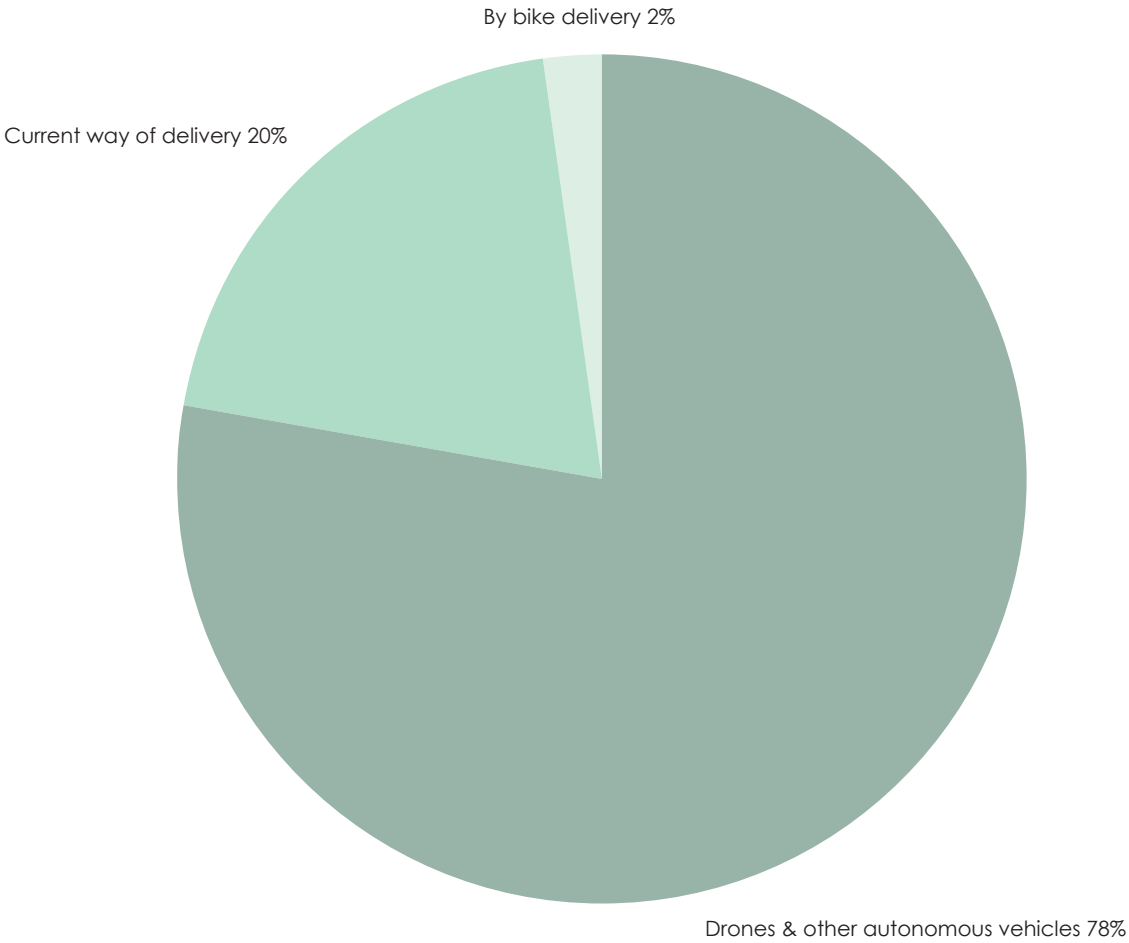
FULFILLMENT CENTER OCADO

(New Scientist, 2016), (Vincent, 2018), (Business Inside UK, 2018).

VEHICLES

Vehicles will change in the future, McKinsey envisions a future where 78% of goods will be delivered by drones and other autonomous vehicles, 20% of goods in the current way of delivering goods and 2% by bike couriers (Kaplan, 2017). Currently, the way goods are delivered is by a dedicated delivery person employed by the parcel delivery service provider, large vans are typically used for this (Joerss, Schröder, Neuhaus, Klink, & Mann, 2016). This type of delivery will change in the future as previous discussed. It is therefore good to look at with what kind of mode the goods will be delivered in the future.


(Joerss, Schröder, Neuhaus, Klink, & Mann, 2016)

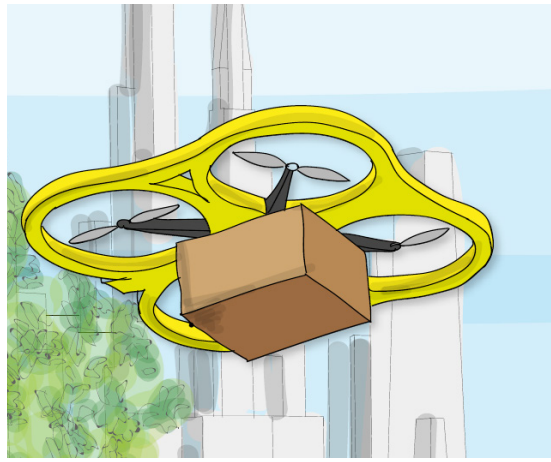


FUTURE USE DELIVERY VEHICLES

(Kaplan, 2017).

DRONES

Drones is one of the most promising mode of transport to use for good delivery. A drone is a small (autonomous) aircraft that can carry small packages up to 15 kg. They can go relative fast and directly to their destination. They do need to be supervised, it is believed that one supervisor can control about eight drones (Joerss, Schröder, Neuhaus, Klink, & Mann, 2016). Currently, a lot has to happen to make this a reality but in 2018 the first drone distribution network has become a reality, the company Matternet has permission to fly there drones over high populated area's in Switzerland (Kuunders, 2017). If drones become a reality, the cost of goods delivery will decrease raptly, because currently labor is 60% of the cost of goods delivery (Kaplan, 2017).



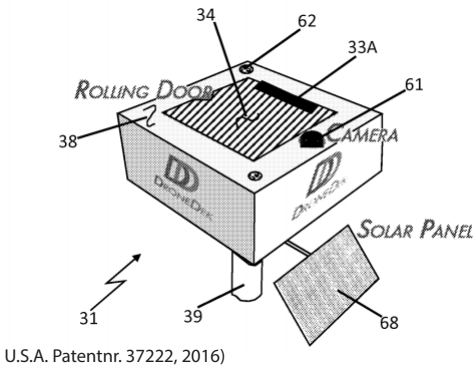
(Joerss, Schröder, Neuhaus, Klink, & Mann, 2016)

(Matternet, 2018)

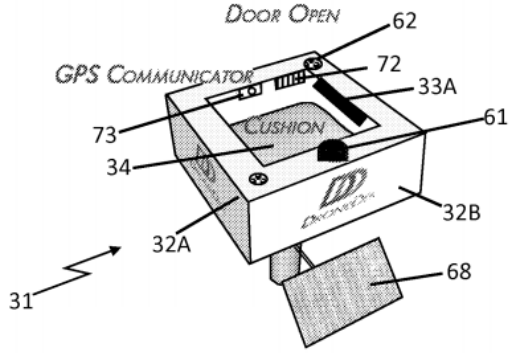
SCAN THE QR CODE TO HAVE AN LOOK HOW THE FUTURE DRONE CAN LOOK LIKE!

https://youtu.be/dD1yyWuULCs

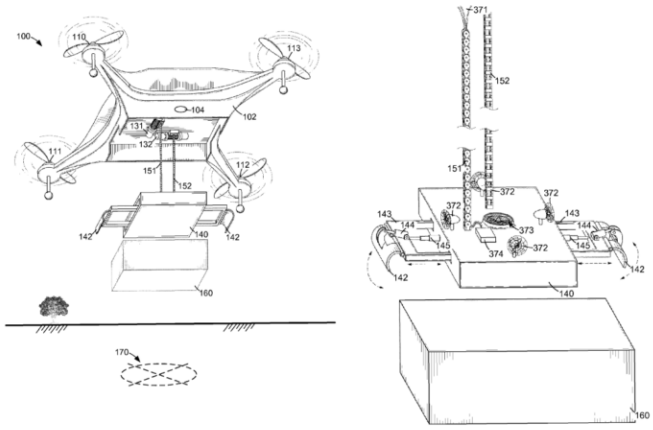
DroneDek is a company that has also a drone delivery station concept. The concept consist of a box where the package can be delivered in, by the drone. It is self-powered by a solar panel and the drone can also be charged at this dock. The package is safely stored in the box until the customer pick it up (U.S.A. Patentnr. 37222, 2016). Currently are the docking stations detached from the building, but maybe in the future these system can be integrated in the buildings.



U.S.A. Patentnr. 37222, 2016)

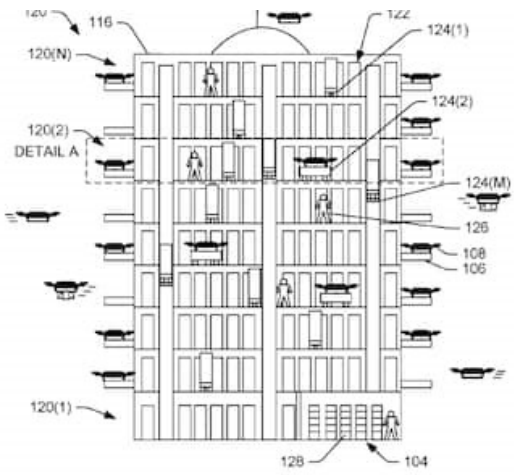


Amazon has submitted a lot of patents concerning last mile delivery by drones. In one of those patents Amazon describes a winch mechanism secured under a drone, which allows the drone to lower and deliver packages without landing (CB Insights, 2017).

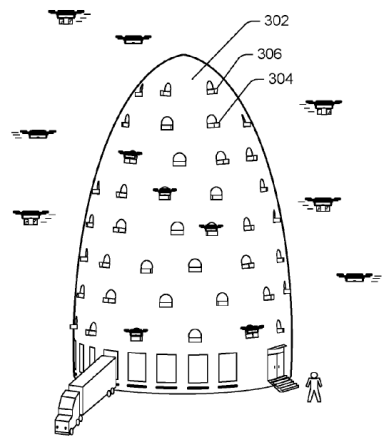


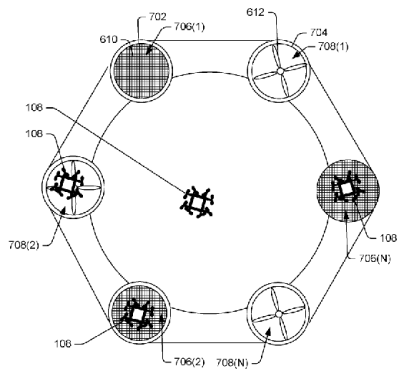
(CB Insights, 2017).

Amazon though also about the fulfillment center side of drone delivery. A patent illustrate a multi-level fulfillment center that could accommodate inbound and outbound delivery drones. Drones could land on multiple landing and take-off locations. In the drawing platforms are showed that have impact dampers, launch assist mechanisms and platform can move around the structure. In addition, the fulfillment center could include multi-faced robots that can move around the goods and service the drones (CB Insights, 2017).



(Amazon, 2017)





(CB Insights, 2017).

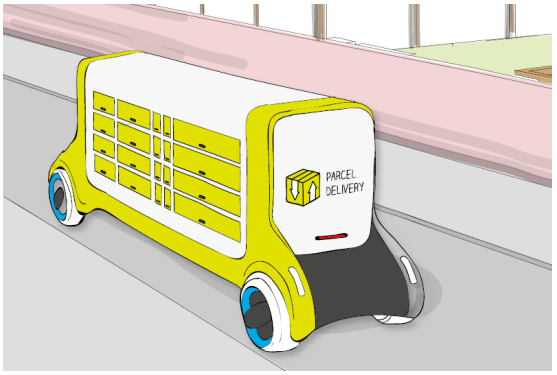
DROIDS

Next to drones, are also small droids possible. They make use of the existing sidewalks and can deliver heavier goods. Because they make use of the sidewalk they have to apply to less regulations then drones and are therefore easier to implement in the urban environment. Droids are slightly larger than a regular parcel, and can deliver products at the homes of people. They move slow, 5 to 10 km/h. They still need to be supervised but due to their speed and size, it is believed that one supervisor can manage 50 to 100 of them (Joerss, Schröder, Neuhaus, Klink, & Mann, 2016). Domino's pizza is already starting to do test with droids, they work but are not jet fully autonomous (Kuunders, 2017).

(Joerss, Schröder, Neuhaus, Klink, & Mann, 2016)

AUTONOMOUS GROUND VEHICLE

Also a possible future mode for goods delivery is autonomous vehicles that can deliver larger parcels but are autonomous. A new concept is an Autonomous Ground Vehicle (AGV) with lockers. These AGV deliver parcels without any human intervention. People get notified when they arrive at their destination (Joerss, Schröder, Neuhaus, Klink, & Mann, 2016). This mode can be combined with parcel boxes, then the vehicles don't have to wait at people who pick up their packages.



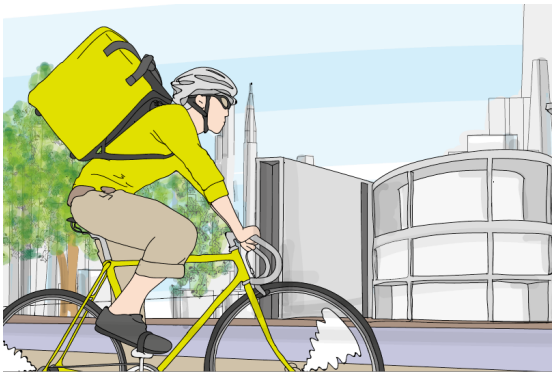
(Joerss, Schröder, Neuhaus, Klink, & Mann, 2016)

BIKES

Goods can also be deliver on bikes, this can be normal or electric bikes. An E-bike combines the power of an electric motor with that of humans (GreenBiz, 2017). It is a heathy and sustainable way of delivery, and suitable for goods that are non-standard. Nowadays, bike couriers are often used for point-to-point delivery, especially for documents and prepared food. Arguably, this will still exist in the future, although it will be a very small percentage of the goods delivery (Joerss, Schröder, Neuhaus, Klink, & Mann, 2016).

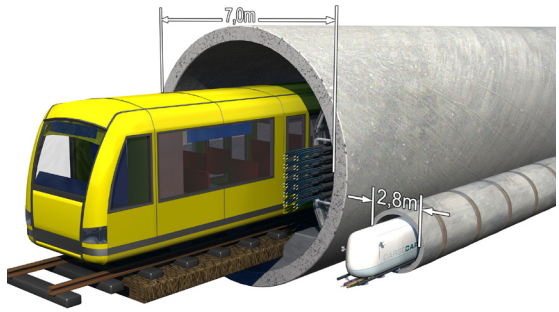
BOATS AND METRO

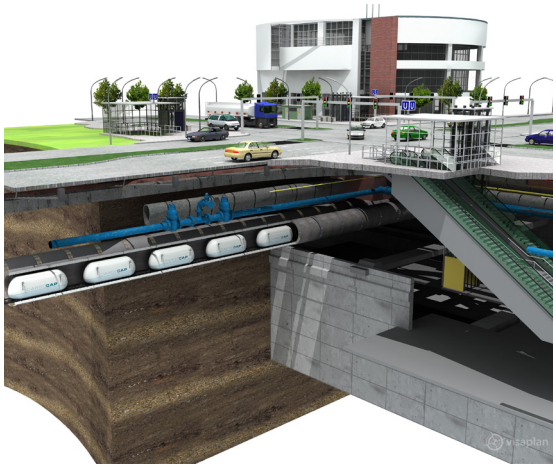
As previous discussed, are getting the road in the cities congested. The last mile delivery is now coming by road from outside the city into the city. To solve this problem is to look at different ways to transport goods into the city (Ljubičić & Pavlović, 2015). A way to do this, is using boats and the existing/new metro network. Both modes of transport can become autonomous in the future. These two modes won't be used for last mile delivery, but for inhaul of good into the city. This way other modes of transport don't have to cover that much distance within the city.

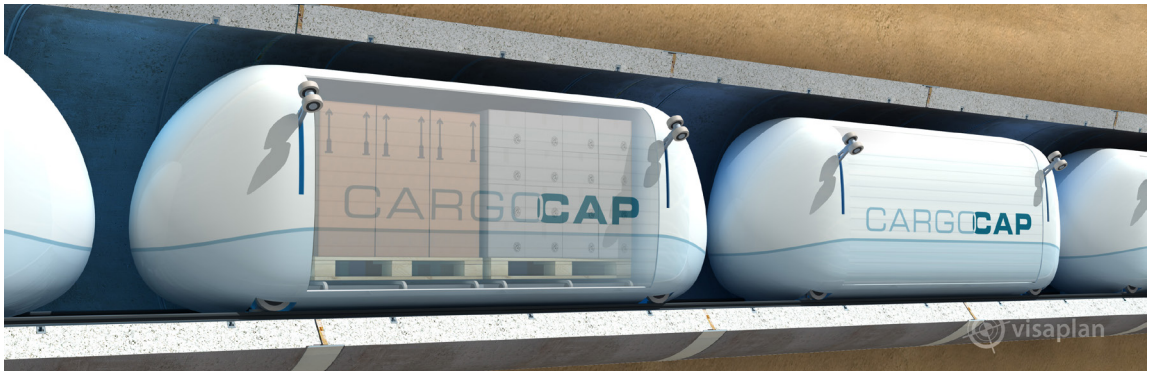

(Joerss, Schröder, Neuhaus, Klink, & Mann, 2016)

FREIGHT PODS

The German company CargoCap came up with the idea of transporting freight within or between urban areas using underground pipelines. The system relies on intelligent, autonomous and individual pods moving thought pipelines. The pods are aerodynamic and powered by electricity. This makes the pods sustainable, use less energy, low in initial cost, low maintenance needs and a long lifespan (Arup, 2014, p. 33). The freight concept is the outcome of the interdisciplinary collaboration in research and development at the Ruhr University of Bochum supported by the Ministry of Innovation, Science, Research and Technology of the State of North Rhine-Westphalia (CargoCap, 2007). In each pod fits two euro-pallets, which represent the majority of the general inner-European cargo transportation. This makes it possible to make a pipe that is 2.8 meters wide, in comparison a metro pipe is 7 meter wide. The pods can be re- or unloaded automatically at stations, this makes this system very effective (CargoCap, 2007).







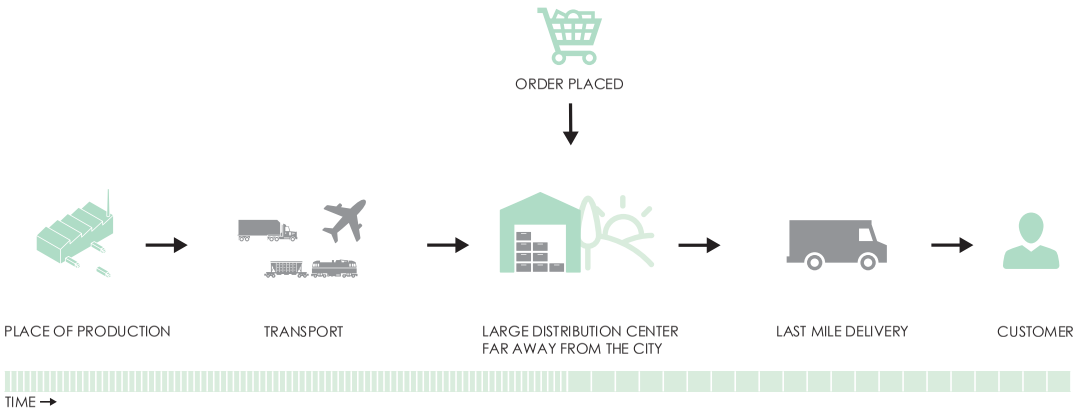
(CargoCap, 2007)

SUPPLY CHAIN GOODS DELIVERY 2100

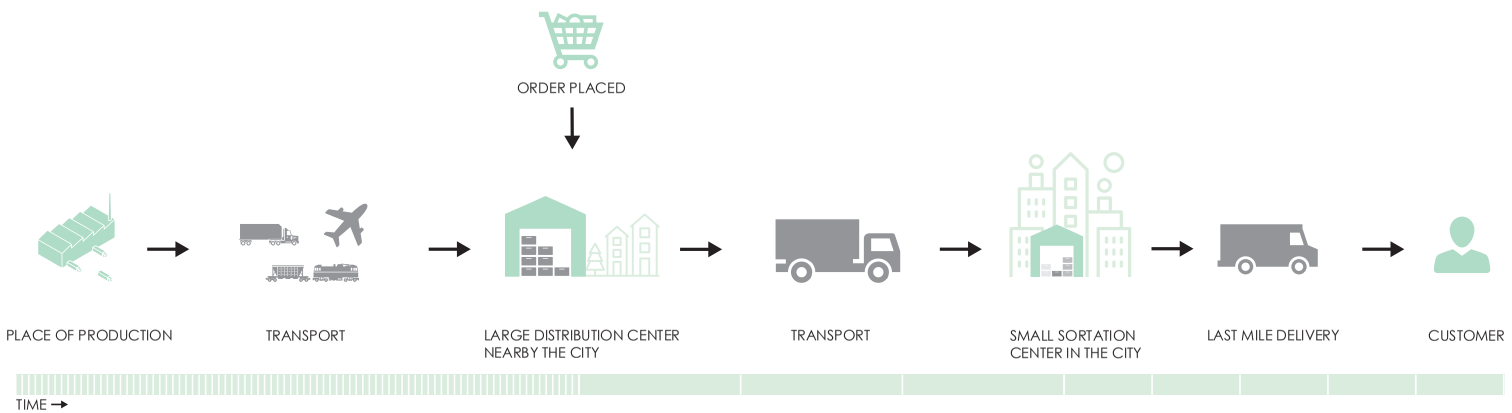
CURRENT GOODS DELIVERY SUPPLY CHAIN INTO A CITY

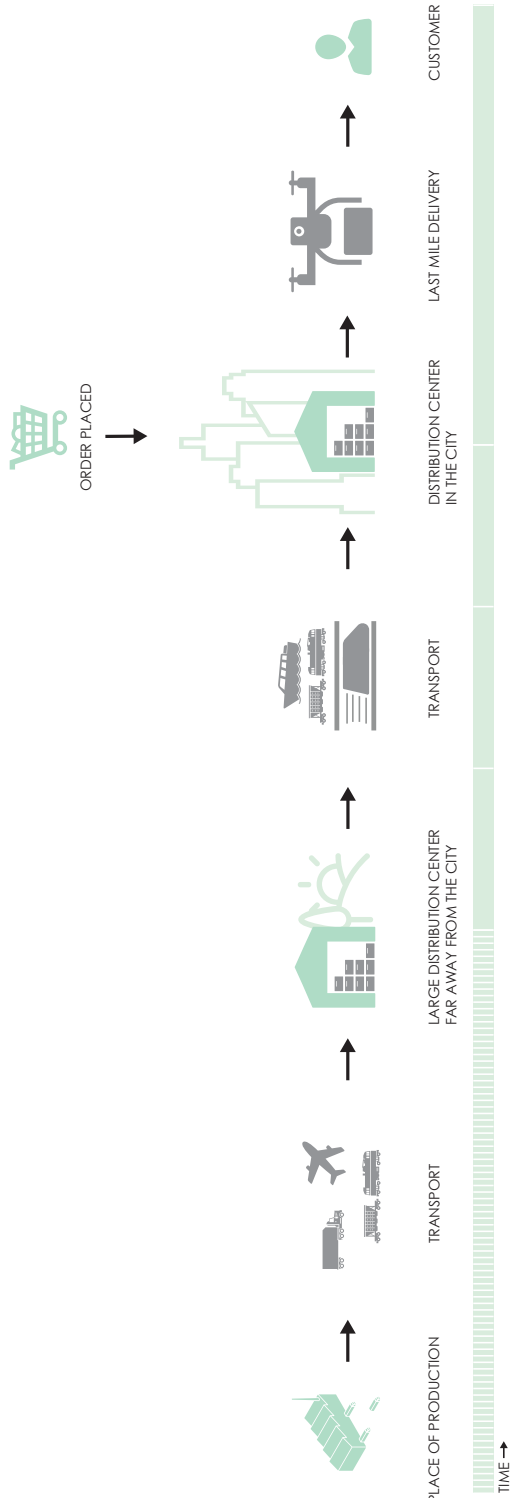
Based on: (Frazier, 2016)

Traditional:



Same day:

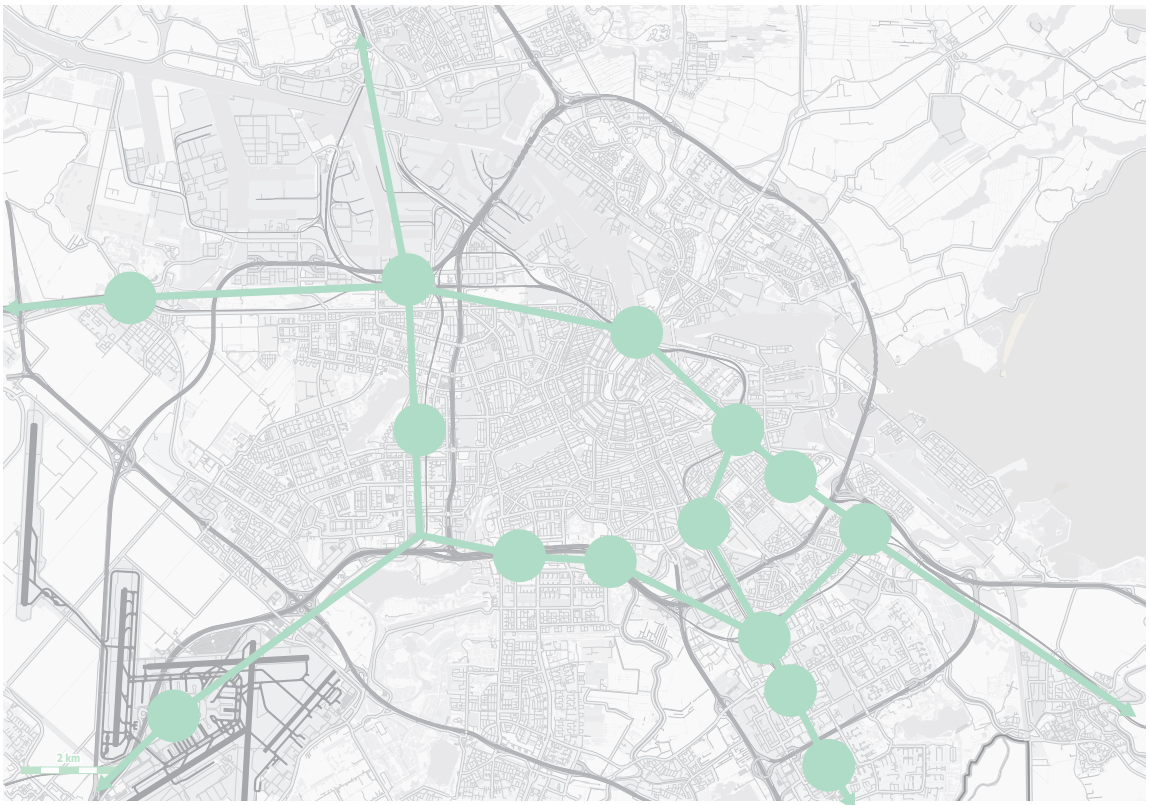



ORDER PLACED
PLACE OF PRODUCTION
TRANSPORT
LARGE DISTRIBUTION CENTER FAR AWAY FROM THE CITY
TRANSPORT
DISTRIBUTION CENTER IN THE CITY
LAST MILLE DELIVERY
CUSTOMER
TIME

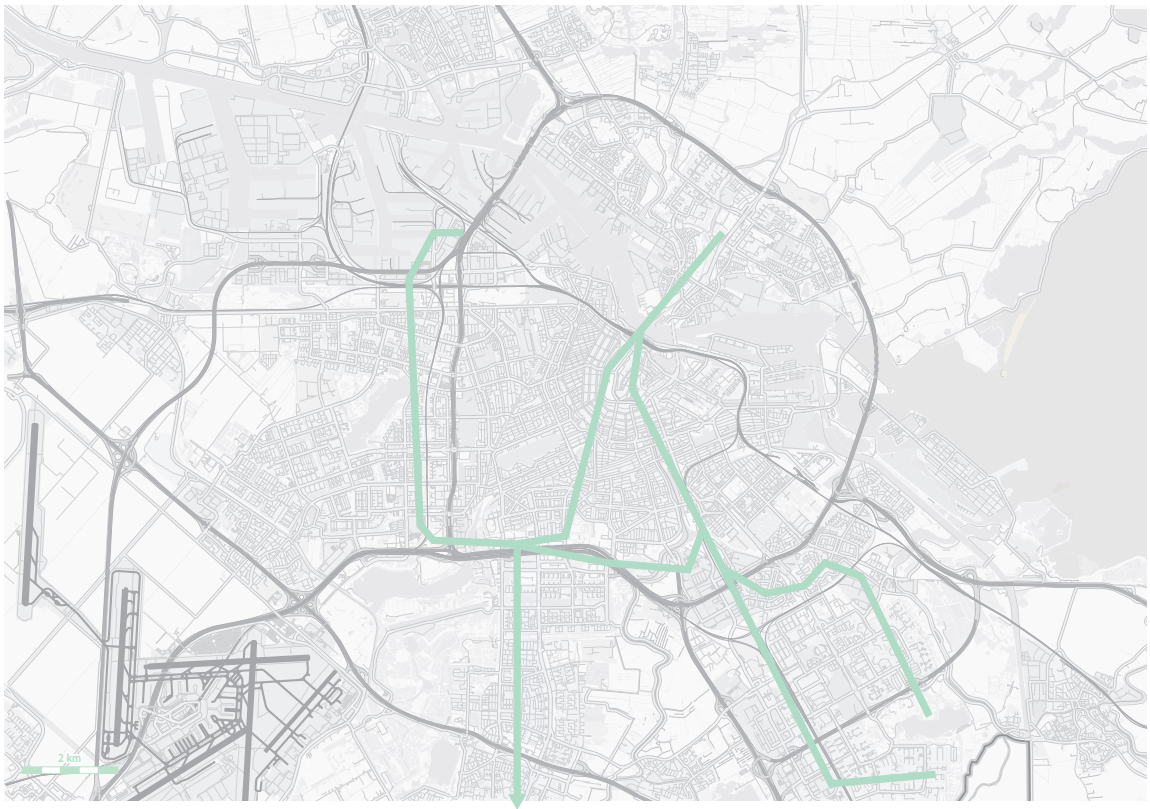
SCALES OF TRANSPORT IN THE FUTURE CITY OF AMSTERDAM

HUMAN TRANSPORT

In this section is the scale of the transportation in 2100 considered. First, is the existing network of the train and metro given. Secondly, is an overview for possible modes of transport in 2100 in the city of Amsterdam. Thirdly, are sizes and types of different nodes considered. Fourthly, is a map of Amsterdam with a proposed transportation network for the year 2100. Finally, is looked at Amstel area and the transportation within. There is a division of human transport and goods transport for clarity. At the end of this section a possible 3D network for the city is proposed. Everything in this section is a possible scenario for the city of Amsterdam in 2100. This scenario is based on literature about the future of transportation of humans and goods in the city.



EXISTING TRAIN NETWORK



EXISTING METRO NETWORK

POSSIBLE MODES OF TRANSPORT FOR HUMANS IN THE CITY OF AMSTERDAM IN 2100

Walking

Neightborhood | 0-1 km | Cheap, flexible

Bicycle

District/City | 0-15 km | Cheap, relative fast, flexible

Car

City/Country | 0-500 km | Expensive, flexible, convenience

Metro

City | 0-15 km | Efficient, fast, reliable

Bus

District/city | 0-15 km | Flexible, reliable

Boat

City | 0-15 km | Sometimes necessary

Passenger drone

City | 0-15 km | Fast, efficient, expensive, convenience

Train

Regional | 15-50 km | Relative cheap, fast, efficient

High speed train

Country | 15-200 km | Fast, efficient, reliable

Hyperloop

International | 50-1,500 km | Very fast, efficient, flexible

Airplane

Continental | 1,500-20,000 km | Fast, expensive

Name
Bus stop

Size
XS

Scenario
District travel

Location
Neightborhood

Name
Drone station

Size
XS

Scenario
City travel

Location
Building

Name
Train station

Size
M

Scenario
Regional travel

Location
Edge of the city

Name
High speed train station

Size
L

Scenario
National travel

Location
Edge of the city

Name
Metro station

Size
S

Scenario
City travel

Location
Neightborhood

Name
Mid-city transport hub

Size
M

Scenario
City Travel

Location
District

Name
Hyperloop station

Size
XL

Scenario
International travel

Location
Edge of the City

Name
Shiphol

Size
XXL

Scenario
Intercontinetal travel

Location
Airport

S Metro

M Train/transport hub

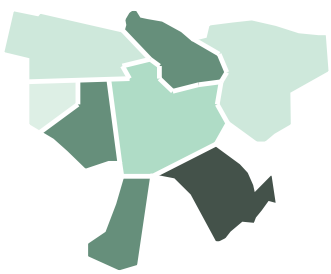
XL Hyperloop

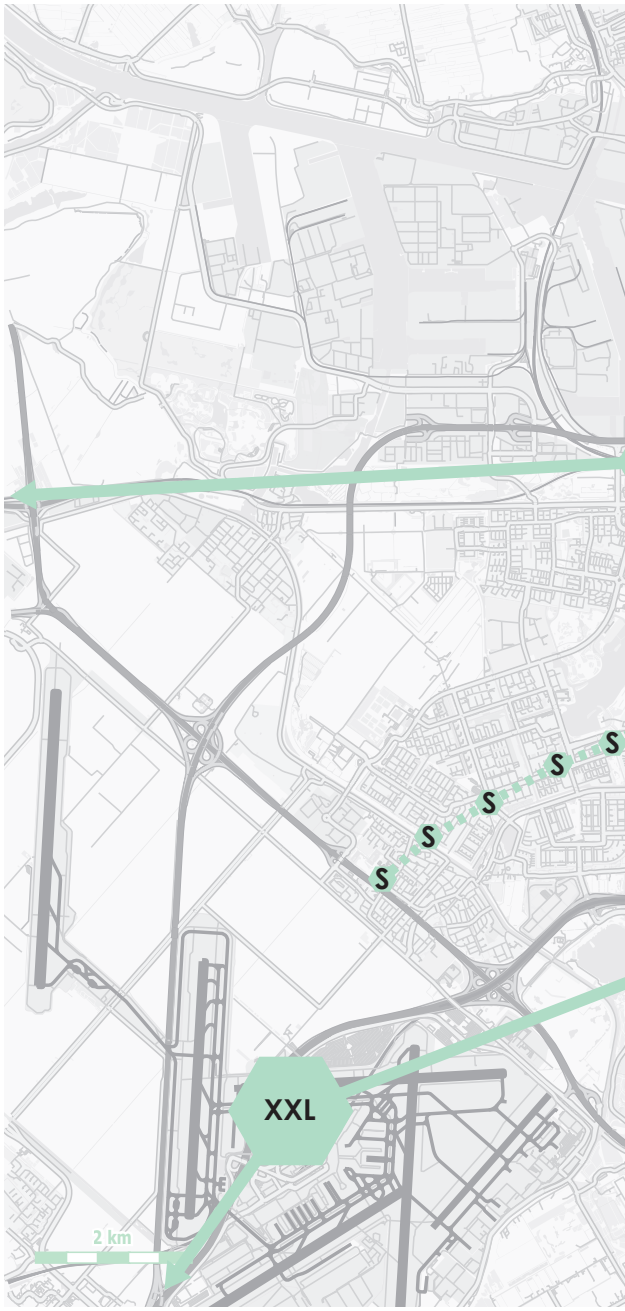
XXL Airport

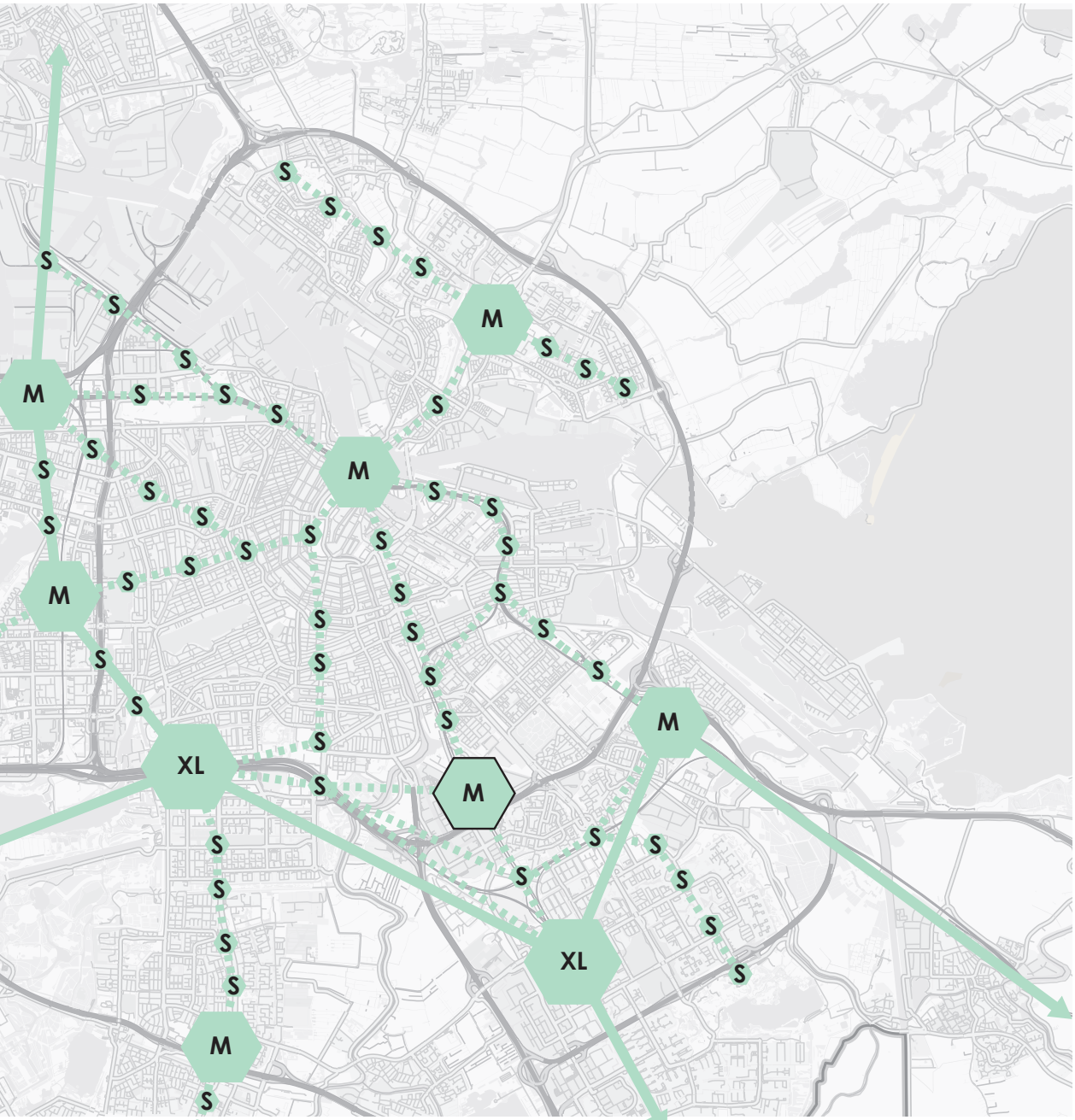
Train track

Metro track

Density Amsterdam






M
M
M
M
M
XL
M
XL
M
S

Modes of transport in Amstel

Walking

Bus

Bicycle

Boat

Car

Passenger drone

Metro

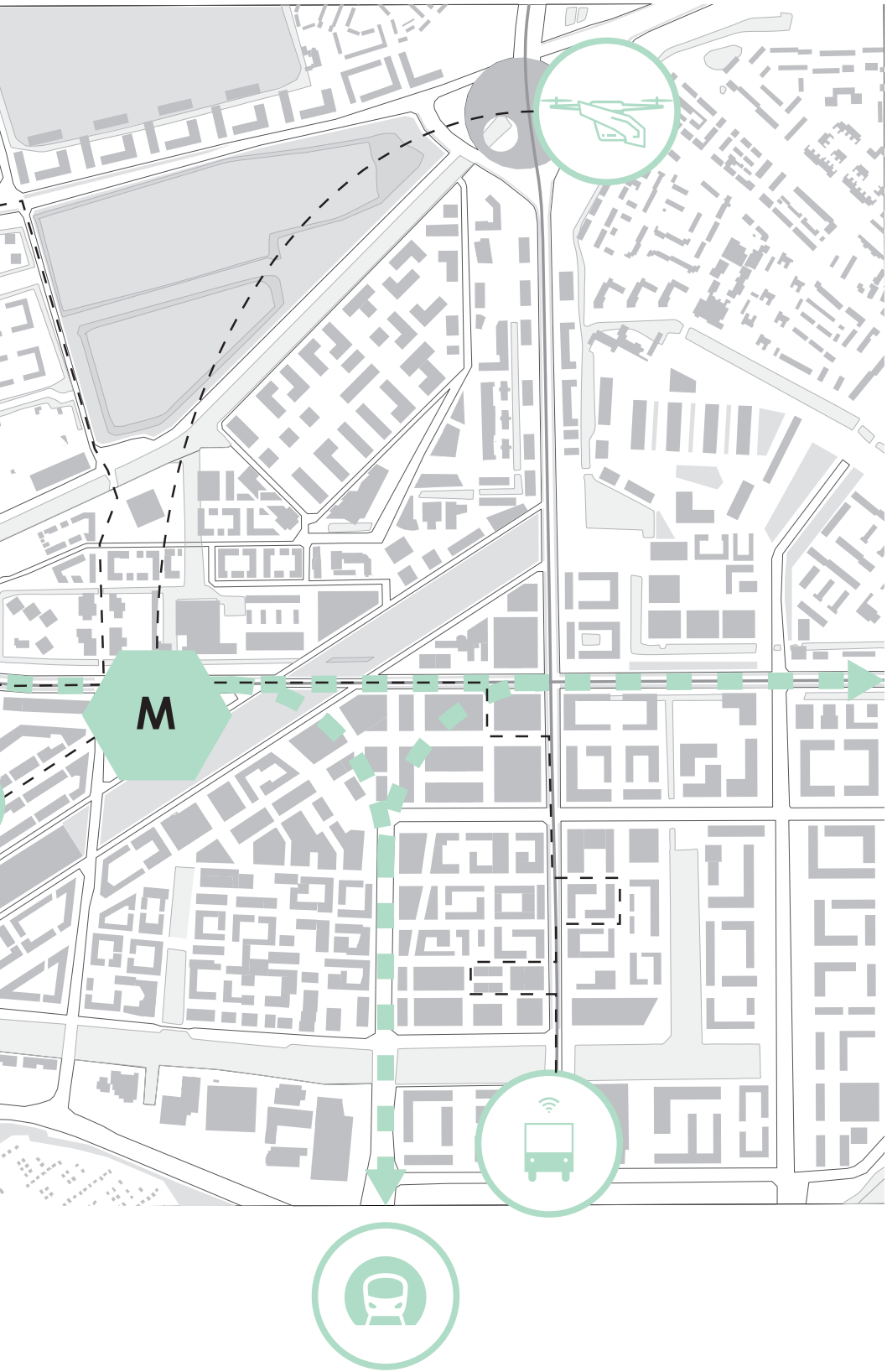
Node in Amstel

Name
Mid-city transport hub

Size
M

Scenario
City Travel

Location
District


M

TRANSPORTATION OF GOODS

POSSIBLE MODES OF TRANSPORT FOR GOODS IN THE CITY OF AMSTERDAM IN 2100

Bicycle

District/City | 0-15 km | Last mile delivery, non-standard goods

Droids

Neightborhood | 0-2 km | Last mile delivery, heavy small goods

Autonomous ground vehicle (AGV)

District | 0-5 km | Last mile delivery

Drone

District | 0-5 km | Last mile delivery, fast

Delivery Truck

District/city | 0-15 km | Last mile delivery, large or heavy goods

Pod

City/regional | 0-30 km | Inhaul of goods into the city

Boat

City/regional

0-30 km

Inhaul of goods into the city

Train

Regional/country

15-200 km

Inhaul of goods into the city/distribution center outside the city

Truck

Country

50-200 km

Inhaul of goods to distribution center outside the city

Hyperloop

International

50-1,500 km

Import of goods

Freight ship

Continental

500-20,000 km

Import of goods

Airplane

Continental

1,500-20,000 km

Import of goods

Name
Distribution center

Size
XXL

Scenario
Import/distribution for goods

Location
Airport/port

Name
Distribution center

Size
XL

Scenario
Distribution for goods

Location
Outside the city

Name
Fulfillment center

Size
M

Scenario
Distribution for goods

Location
District

Name
Sorting center

Size
S

Scenario
Sorting for goods

Location
Neightborhood

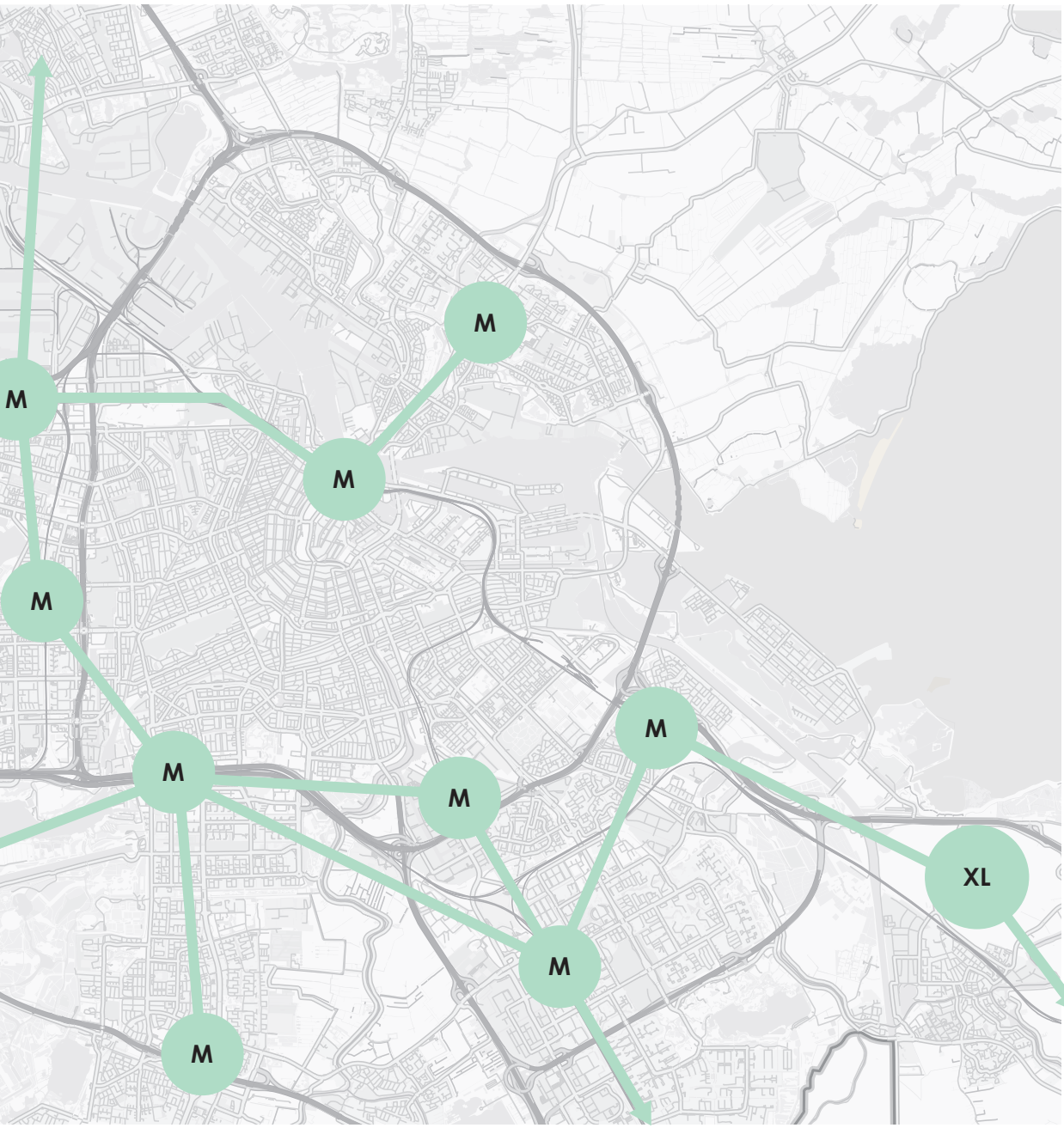
M — Fulfillment center in the city

XL — Distribution center outside the city

XXL — Distribution center airport

Connection

Density Amsterdam


M
M
M
M
M
M
M
M
XL
M

Modes of transport in Amstel

Bicycle

Drone

Droids

Delivery Truck

Autonomous ground vehicle (AGV)

Pod

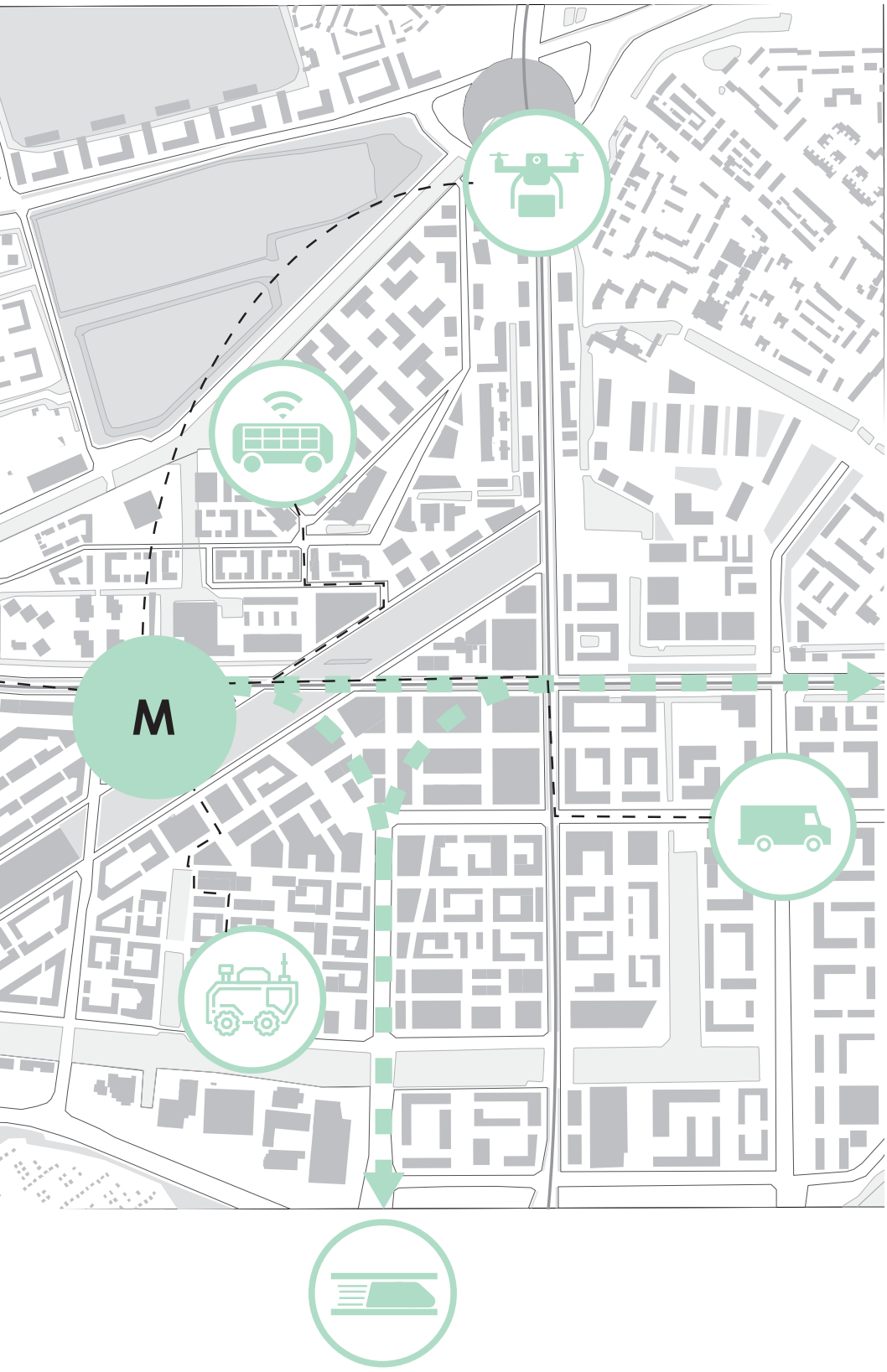
Node in Amstel

Name
Fulfillment center

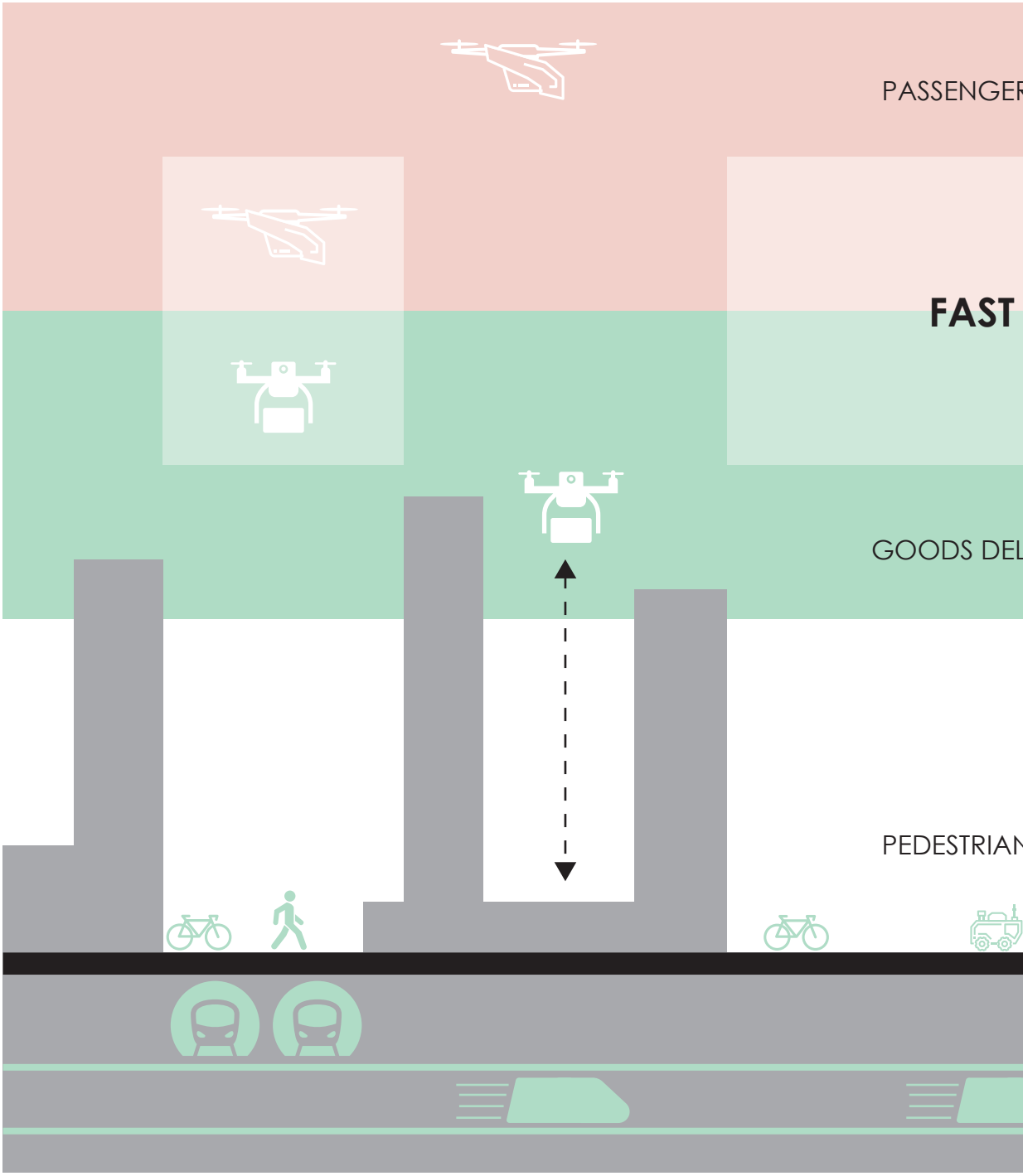
Size
M

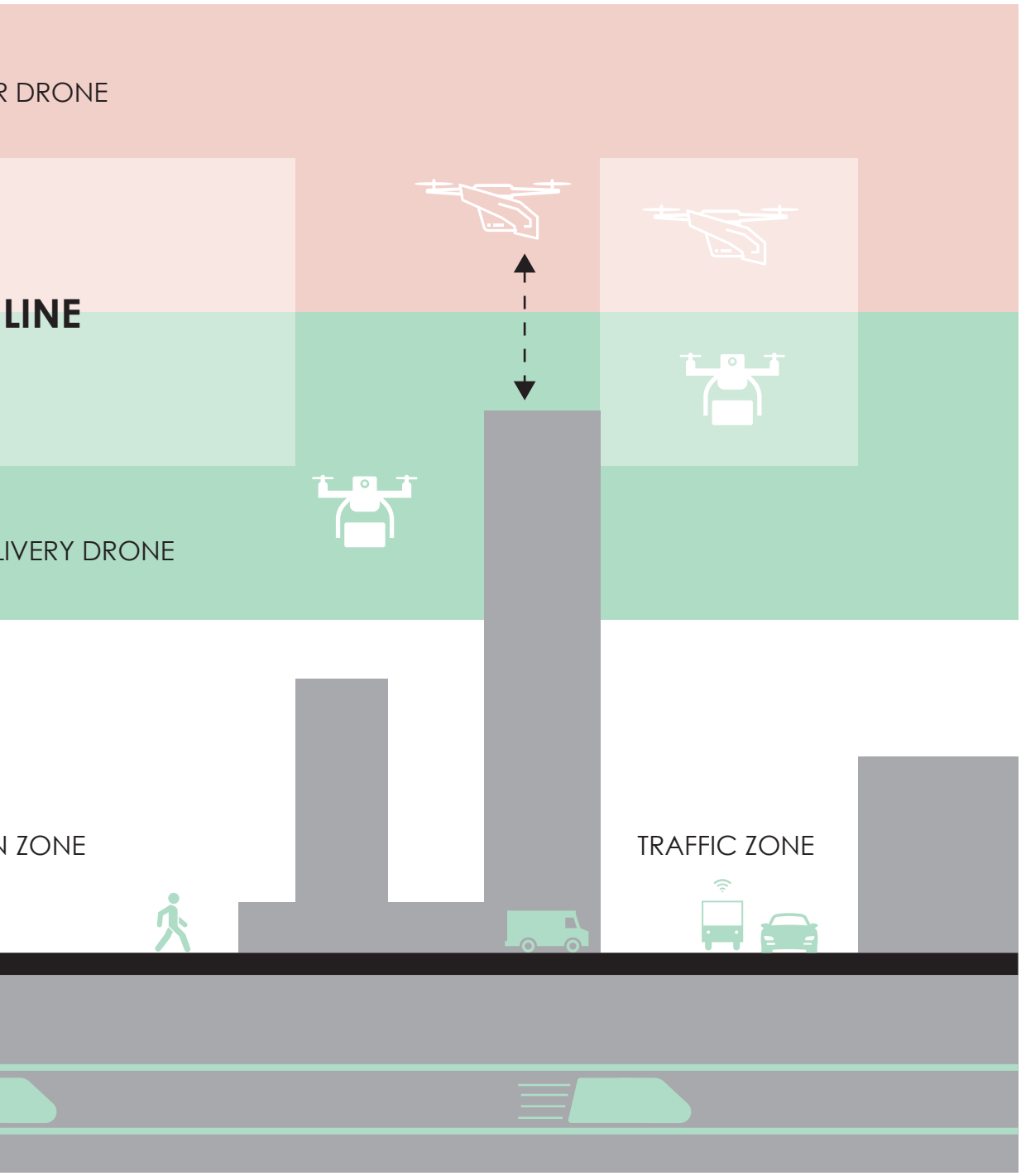
Scenario
Distribution for goods

Location
District


M

POSSIBLE 3D NETWORK IN THE CITY IN 2100




R DRONE
LINE
LIVERY DRONE
N ZONE
TRAFFIC ZONE

CASE STUDIES

UTRECHT CENTRAL TRAIN STATION

KEY FIGURES

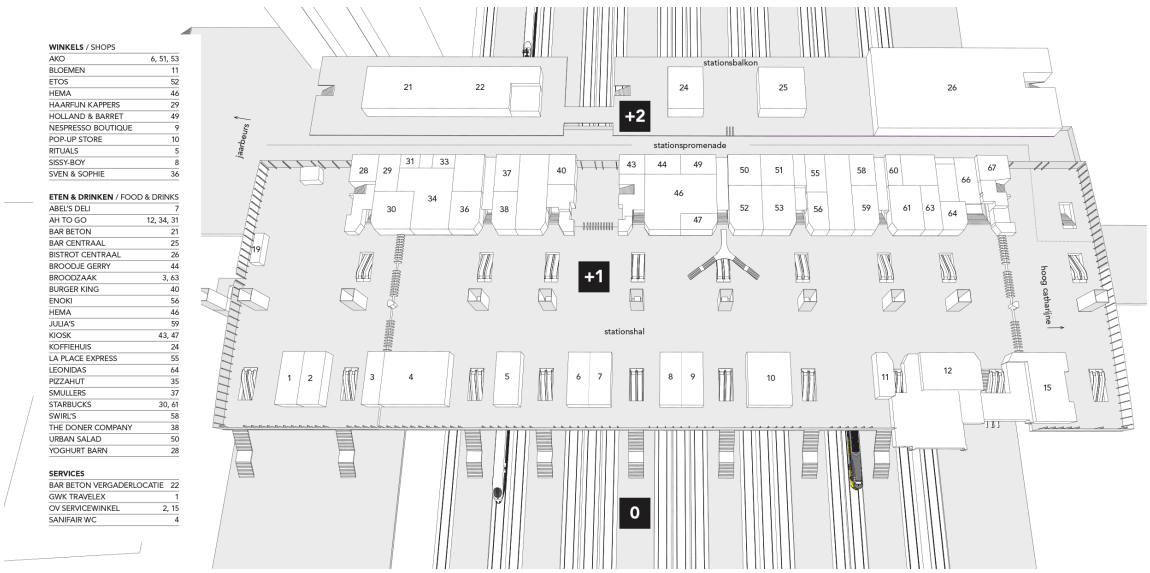
Place	Utrecht, Netherlands
Client	ProRail, Utrecht
Architect	Benthem Crouwel Architects
Gross floor area	25.000 m2
Start design	2003
Completion	2016
Travelers per year	88 million

INTRODUCTION

Utrecht Central train station is the largest and most busy train station in the Netherlands. Currently, the station is used by 88 million people every year. But this number will increase in the future, predicted is that 100 million people will use the station. The station is rebuilt several times in its life span. The last time is in 2016, this will be the station analyzed in this case study. The station has multiple modes of transport under one roof. Next to the train, houses the station also the tram and busses. Because of these different modes of transport the station is an integral complex, and is sometimes called a public transport terminal instead of a train station. The building is located autonomous in the urban environment with two city squares at both entrances. Under the square on the city side of the station is a large bicycle parking build, which can houses 12,500 bicycles. In the central hall are a lot of shops. Shops that are oriented for travel, like a coffee shop and bakery. But also shops for normal shopping like a book shop and small department stores. Because the station is relative low in height compared with the urban surroundings, the station is clearly recognizable among the surrounding urban environment. On one side of the station a promenade is located. This is a public street that crosses the railroad tracks. This makes it possible to move people from one side of the station to the other, without having to pass through the gates that are present at the train station part of the building. The building is designed in a way that it connects to the urban environment around the station. Also the integrated approach to the station and the urban environment reinforces the identity and vitality of the city (Benthem Crouwel Architects, n.d.).

Section Utrecht Central, (Architectuur.nl, 2016)

Central Hall, (Benthem Crouwel Architects, n.d.).

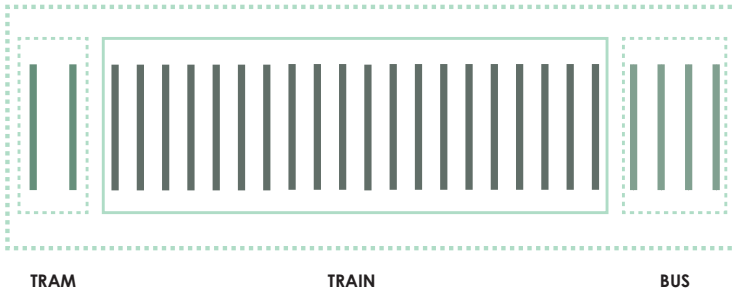


Plan Utrecht Central, (Mijnstation.nl, n.d.)

ANALYSIS

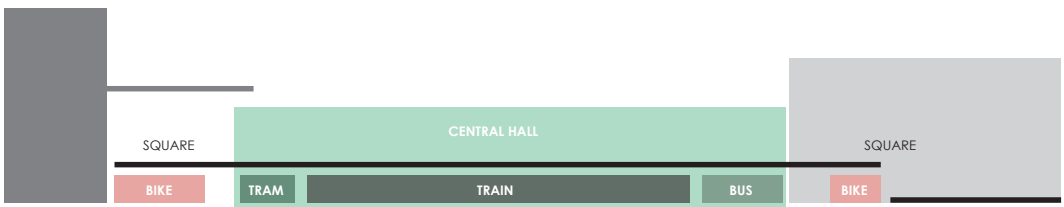
THREE MODES OF TRANSPORT PARALLEL TO EACH OTHER

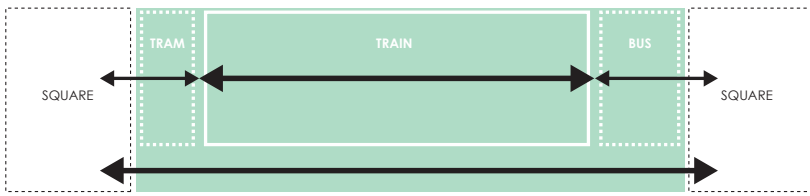
One of the main characteristics of this station is the integral design with the three modes of transport under one roof that are running parallel to each other. This makes the building very universal in its design expression.



INTEGRATION IN THE URBAN ENVIRONMENT

The station is integrated in the surrounding urban environment. Although there are gates at the train station, the station is instead of a barrier a bridge over the tracks because of a promenade.





CONCLUSIONS FOR 2100

The station has multiple modes of transport under one roof for a good connection between transport modes. Due to the parallel orientation of the different modes, transfer is relative easy and seamless. Gates of the train part are a barrier in the station, this is something that in 2100 has to be solved. There are a lot of shops in the central hall, a trend of the last years is that stations have more amenities. The station is integrated in the urban environment, instead of an building that is disconnected. The station is not an object in the surrounding urban environment, but part of it.

(Benthem Crouwel Architects, n.d.).

SHANGHAI SOUTH TRAIN STATION

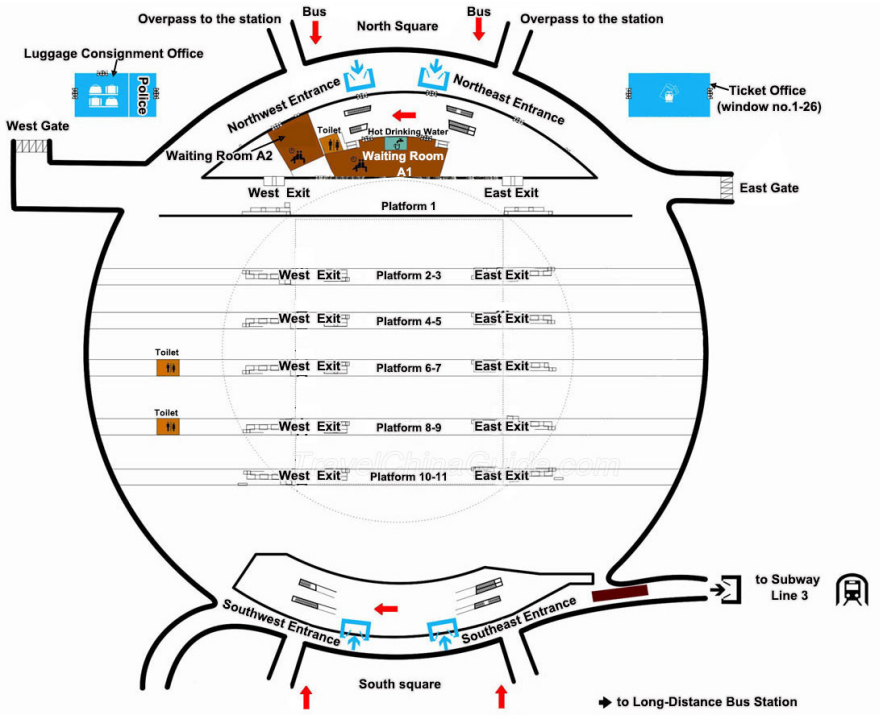
KEY FIGURES

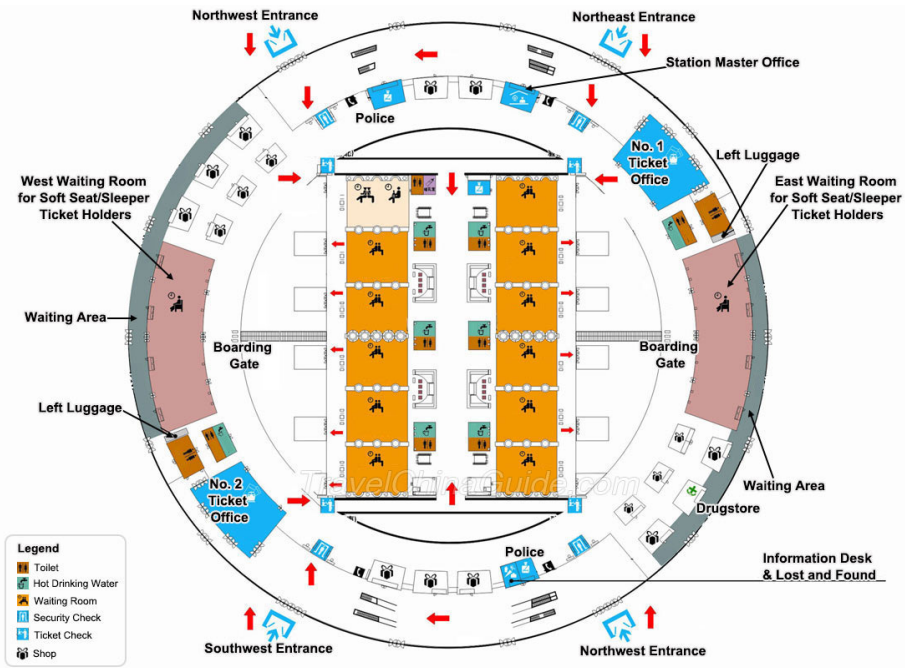
Place	Shanghai, China
Client	Railways Ministry for the station, Shanghai Municipality for urban development, access and infrastructure
Architect	Arep Group
Site area	47.000 m2
Start design	2001
Completion	2006

INTRODUCTION

Shanghai South Station is a large integral train station. The building has a round shape, which houses six levels with each level its own traffic flows. This optimize the exchanges with other modes of transport and controls the access to the trains. The station has a 60,000 m2 roof structure, which has a diameter of 255 meters, to cover the hole station (Arep, n.d.). The station can be roughly divided into three layers. The middle layer is the platforms with the trains, the upper layer is the departure floor with an elevated ring road for car traffic, and the lower layer is the arrival floor with outbound tunnel for travelers to other modes of transport (Top China Travel, n.d.). This separation of layers makes the station look a lot like an airport, where traffic flows also are divided in departure, gate level, and arrivals. This is done to make the flow of people so efficient as possible. The station is integral and houses a lot of different modes of transport (trains, buses, metro, taxis, private vehicles, etc.). Also the station is a social active place in the city, with a wide range of shops and services. The station is also a gateway to the city of Shanghai, "a symbol of its energy, its economic, financial and cultural leadership, and its creative, avant-garde spirit". This results in a station that is both a mobility hub and an architectural landmark (SNCF, n.d.).

(SNCF, n.d.)



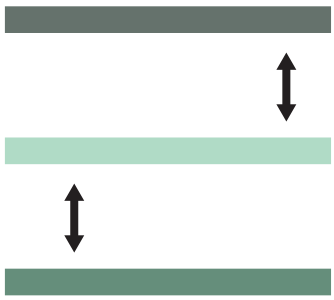


(Travel China Guide, n.d.)

ANALYSIS

SEPARATION OF TRAFFIC FLOWS

The station is divided in three layers: departures, platform level, and arrivals. This makes traffic flows within the building as efficient as possible. Outside the building is a ring road for cars, to make this flow as efficient as possible.



Different layers

Ring road

MOBILITY HUB AND AN ARCHITECTURAL LANDMARK

This station is both a mobility hub and an architectural landmark. Because of this the station becomes the gateway to the city of Shanghai.

Mobility hub + Landmark = Gateway to the city

CONCLUSIONS FOR 2100

The use of transportation will increase in 2100, more people will use public transport. It is therefore relevant to look at how traffic flows within a station are organized. Although Shanghai South station is for long distance trains and the transport hub in Amstel will be for short commutes, it is still relevant to look at the traffic organization. Currently, the arrival flow and departure flow are meeting each other in station in the Netherlands. This is inefficient and maybe in the future due to the increase of use of public transportation does this change. Also is the Shanghai South station a gateway to the city. It is relevant to consider that this is maybe also the case for the future transportation hub for the Amstel area in 2100.

(SNCF, n.d.)

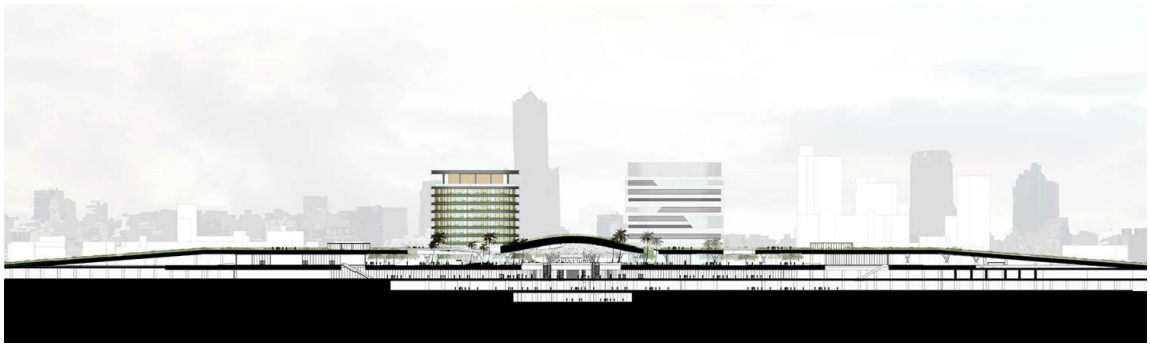
KAOHSIUNG STATION

KEY FIGURES

Place	Kaohsiung, Taiwan
Client	Railway Reconstruction Bureau/Pacific Engineers & Constructors, Ltd
Architect	Mecanoo
Gross floor area	182.000 m2
Start design	2014
Completion	Ongoing

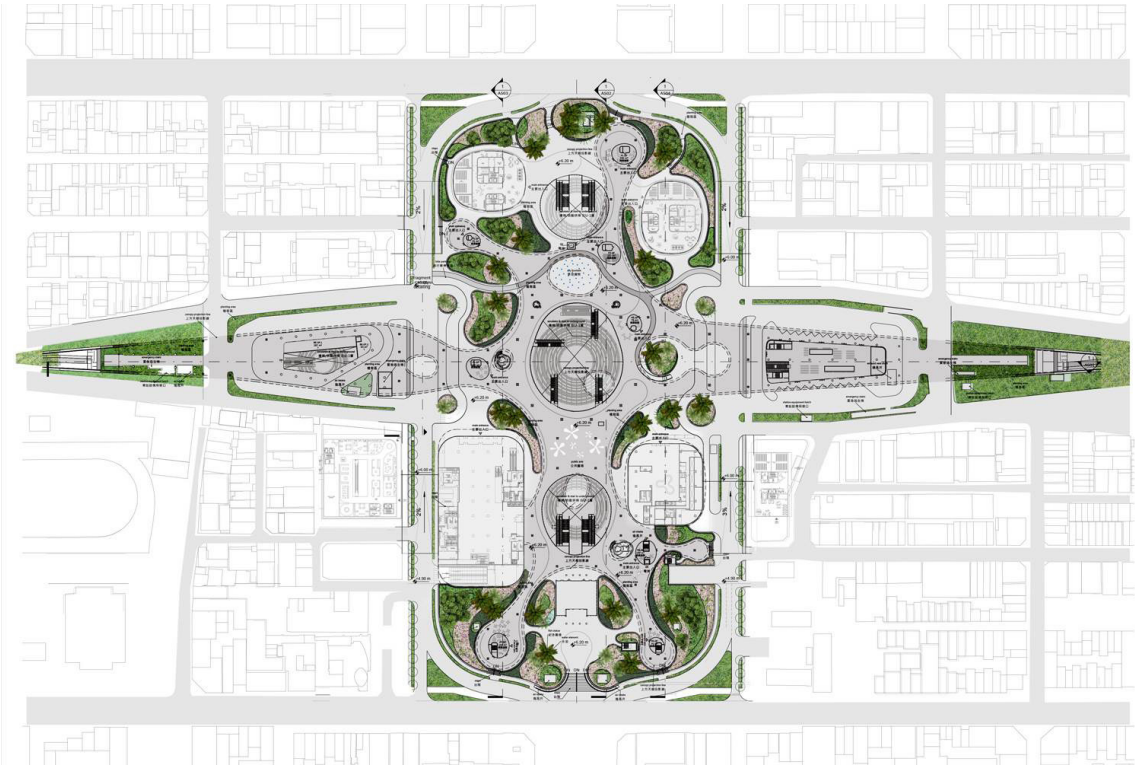
INTRODUCTION

The new Kaohsiung station is part of the Kaohsiung Metropolitan Area Underground Railway Project, which includes seven stations that are made underground along a 9.75 km railway tunnel. It will be a transportation hub integrating train, metro, local and intercity bus services, taxi and bicycles. The site of the station is large with its 8.5 ha. The program consist of a sunken station plaza (13.000 m2), a green canopy (35.000 m2), multi-layer bicycle path, landscape (60,000 m2), hotel (22,000 m2), commercial building (52,000 m2), and a local and intercity bus terminal. The part of the station that is above ground is design in a way that it is an added value to the public space. It is a green space and activate the local community. The central hall of the station has a bright lit patterned ceiling that is a "public stage" for the city. The green canopy acts as a green connector, that unifies different modes of transport. A cycling path runs on top of the building and the station multi-layered landscape makes that there is a lot of public space in the city. This makes the building not only a place of travel but also a destination for both the local community and travelers. The green canopy has also the function to protect the people under it from the tropical climate, under the canopy people can meet or events can take place. To make room for the large station, an existing viaduct will be demolish. New road are made next to the station for car traffic. With this a lot of different flow of traffic will run thought or near the station (Mecanoo, 2018).



Section, (Mecanoo, n.d.)

(Mecanoo, 2018)

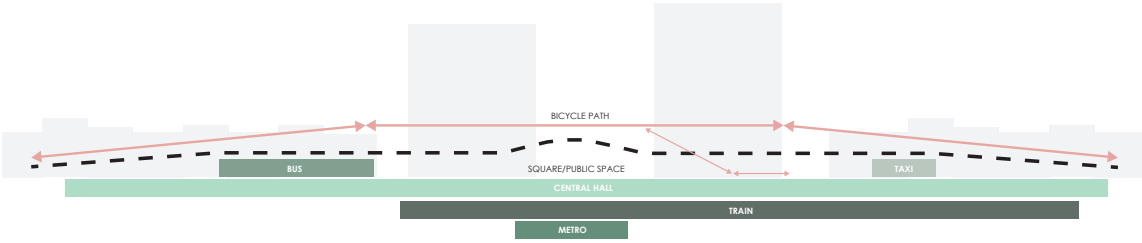


(Mecanoo, 2018)

ANALYSIS

MULTI-LAYERED INTEGRAL STATION

The large roof houses a lot of different modes of transportation. These are therefore integral connected with each other and multi-layered. The roof/green canopy is a connector of all the different modes of transport.

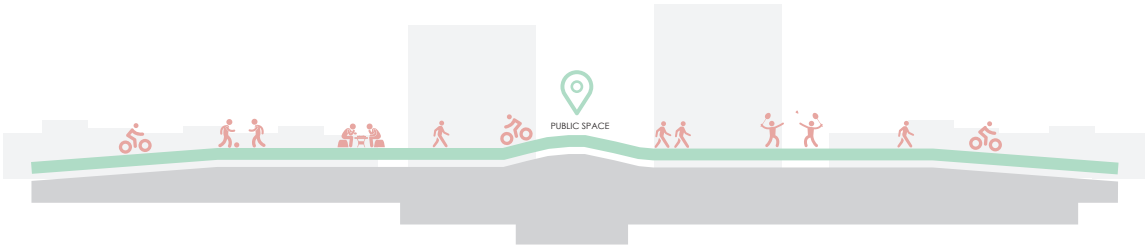


INTEGRATION IN THE URBAN ENVIRONMENT

The station is integrated in the surrounding environment. The public space that is traditionally around a station is inside the station under the large green canopy.

STATION AS DESTINATION

The station add value to the public space. Thanks to the green roof a lot of public space is present and is active. This makes the station next to a place of transfer a destination for the local community.



CONCLUSIONS FOR 2100

Although the station has integration of different modes of transport, the distances between them are quite large. In 2100 the connection between different modes has to be seamless and fast. This means that the distances people walk must not be too long. The station is integrated in the urban environment and the public space is within the station, this is something that is also suitable for 2100 because this will make the distance between modes less. This station is next to a mobility hub also a destination for the local community, maybe is will also be the case in 2100.

(Mecanoo, 2018)

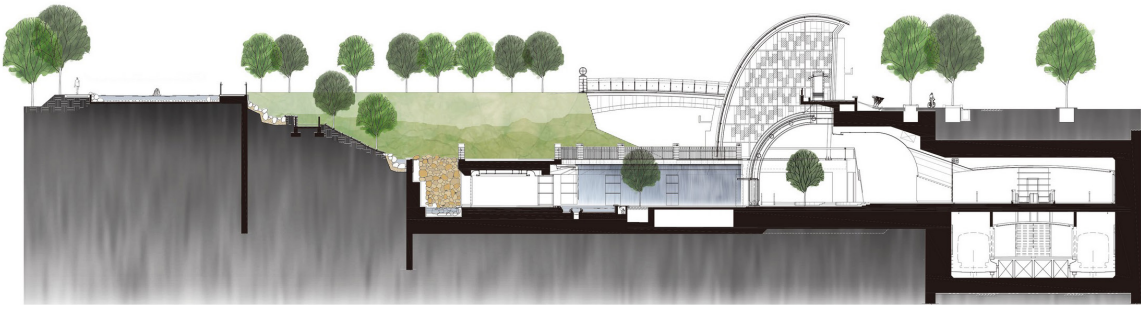
DAAN PARK MRT STATION

KEY FIGURES

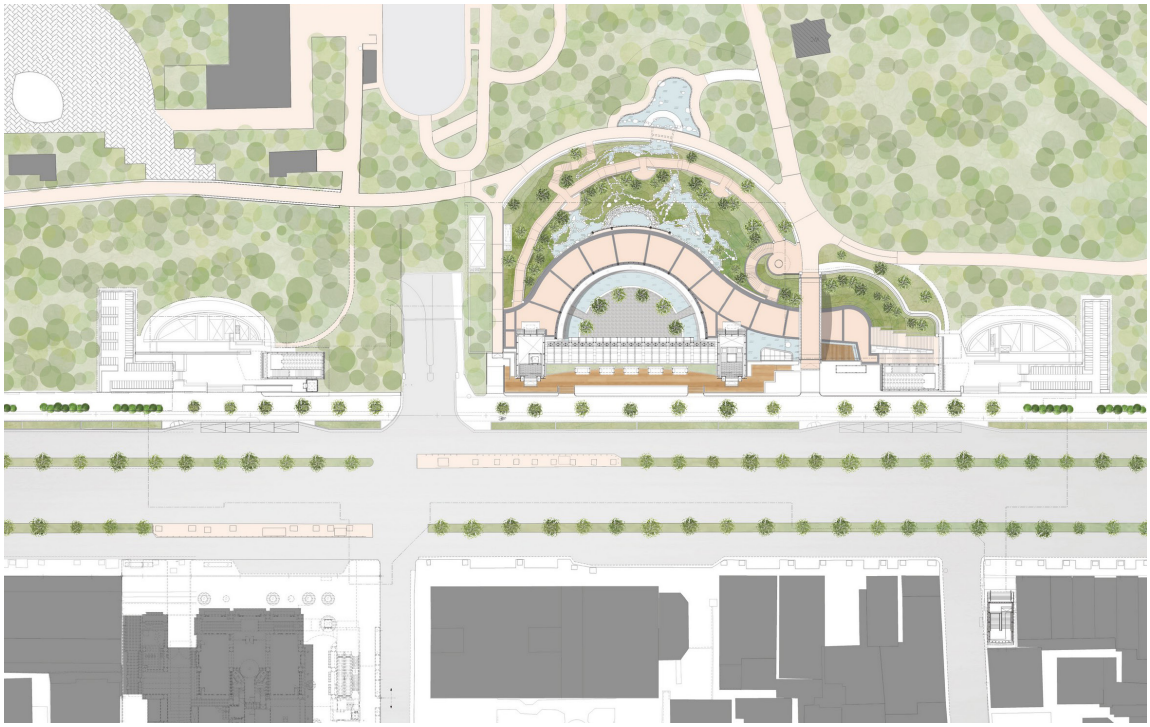
Place	Taipei, Taiwan
Architect	SCFC Architects
Start design	2013
Travelers per day	16,000

INTRODUCTION

Daan Park MRT station is a metro station in the city Taipei in Taiwan. The station is located adjacent to a large green city park, with a lot of high building around it. The park itself is an attraction because it is the largest park of the city, so the metro station is next to commuters for work in the surrounding buildings also for the people that go to the park. A standard metro station of an underground system has small openings on the street level to enter the metro station. It does not really interact with the urban environment. The Daan Park MRT Station is not like a standard metro station. It is a station in the park, which breaks the boundary between the park and the street that is running partly above the metro station. The metro station design tries to transform the metro station from a passive transport service into a vibrant city hub. Because the metro station is embedded in the park, it became a gate in the north of the park, making the park more accessible and active. The station has a semi-circular sunken shape, from where access is to the platforms. This makes it possible to get natural light inside the station. Because of this people are following their biological natural instinct to go to the light, and in this way they walk directly into the park. Normally, stations are dark and not that attractive place to be at. But because the metro station has multiple levels that get sunlight and has public spaces of high quality, the station has become, contrary to other metrostations, a nice place to be at (Archello, n.d.). The station has four entrances running along the road and two entrances from the park side of the station. This will allow for a better division of people which will prevent congestion during rush hour.



(Archello, n.d.).

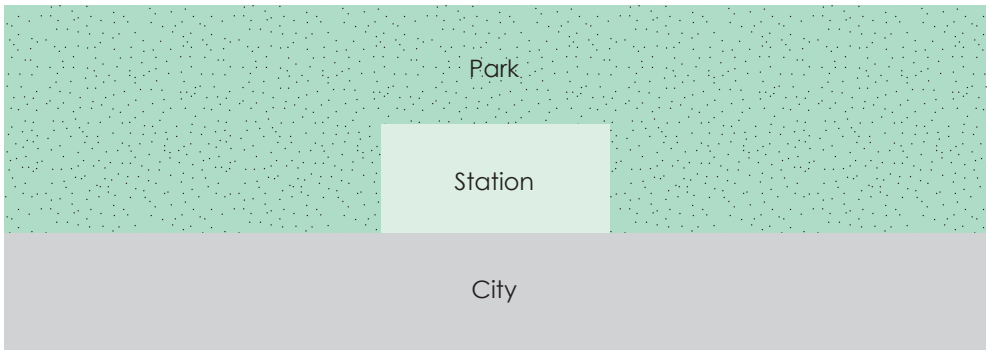


(Archello, n.d.).

ANALYSIS

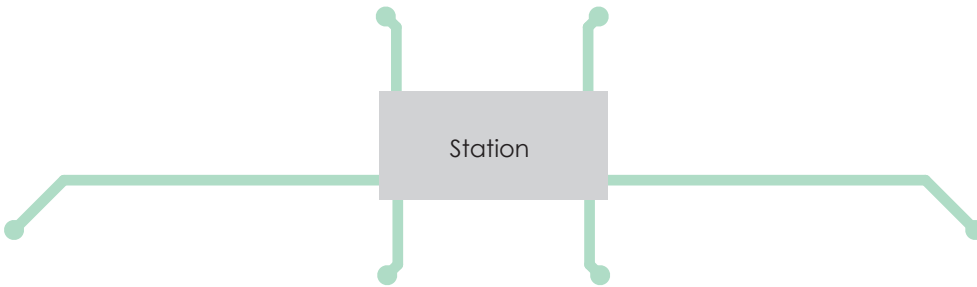
STATION IN THE PARK

The station is built on the edge of a large park. The design of the station makes the station part of this park, it is integrated in the green urban environment.



MULTIPLE ENTRANCES

The station has not a central entrance but multiple entrances that are spread out and are connected to the main hall by tunnels. This ensures that at rush hour the station is not congested.



CONCLUSIONS FOR 2100

This integration of a public building with a green public park would also be a possibility for the transportation hub in the Amstel area in 2100. The station has become part of the park, and is now a gate to this park. This makes this case study relevant to the Amstel area due to the fact that next to the transportation hub a park is located. The station uses multiple entrances to prevent congestion. This will also be a problem in 2100, so it is good to consider the possibilities to prevent this.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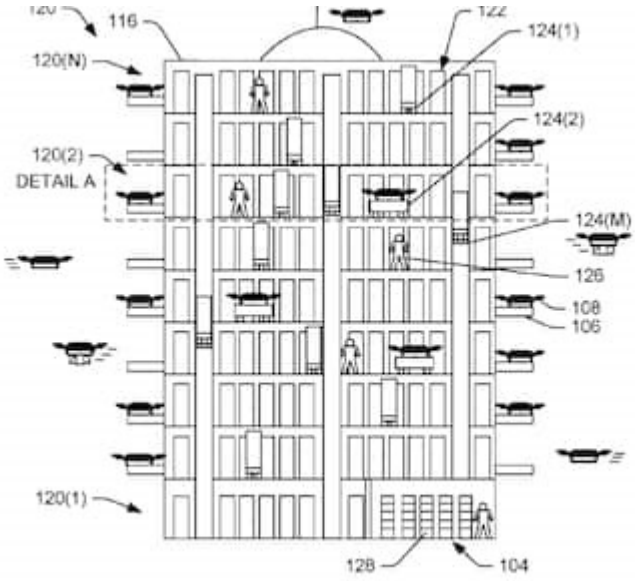
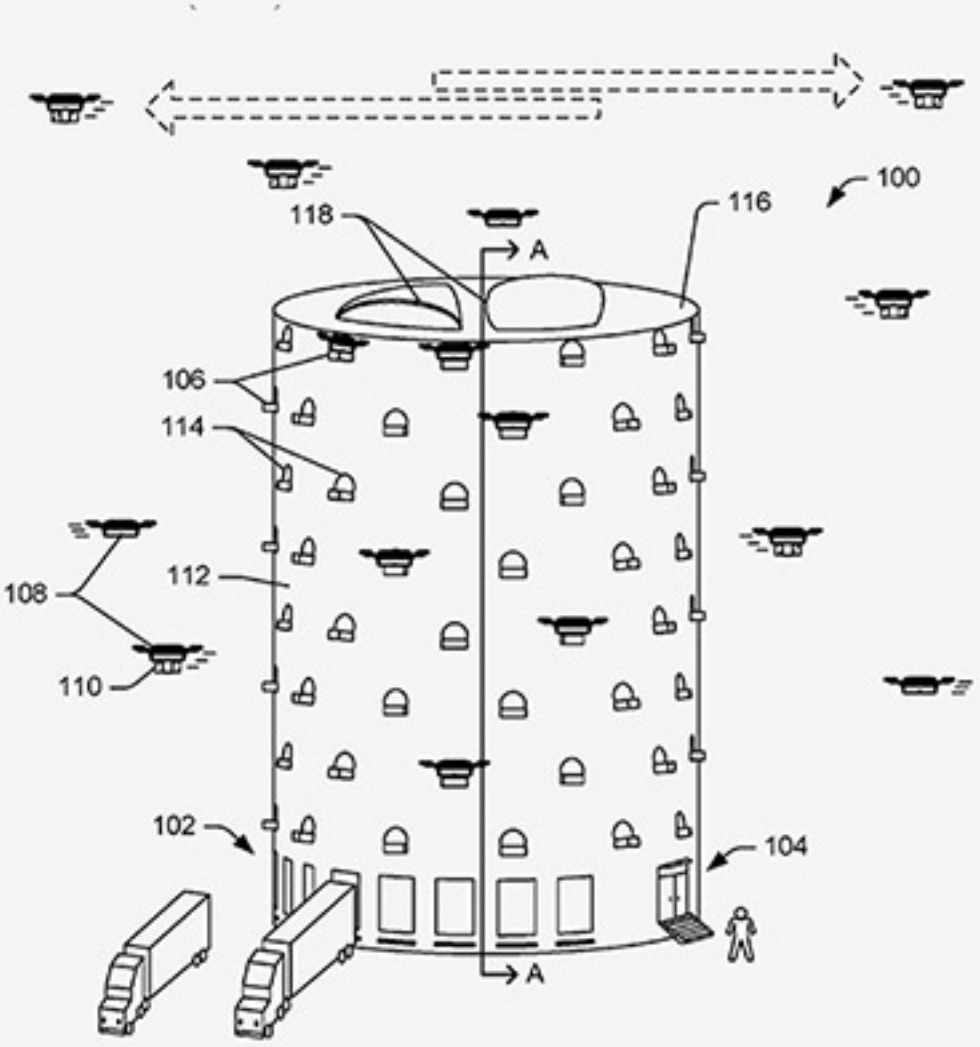
AMAZON DRONE DELIVERY CONCEPT - BEEHIVE

INTRODUCTION

Amazon filed in 2015 a patent for a multi-level fulfillment center that would accommodate the landing and takeoff of drones in dense urban areas. Amazon envisioned a Beehive structure in the middle of the city, making fast delivery possible in the city. Amazon published in its patent a number of drawings of tall cylinder-shaped buildings that would be placed at central locations. These center would allow Amazon to part from traditional single story building outside the city to multi story buildings inside the city. Buildings at the edge of the city or even outside the city are not suitable for fast delivery in the city. Amazon notes that populations of cities continue to swell, making delivery in the city even harder. Amazon states in the patent application the following: "By locating the fulfillment centers within the cities, items may be more quickly delivered to the growing population of people that live in the cities, as well as the large population of people who work in the cities". The new drone center could fulfill hundreds of thousands of orders every day. The drones would be controlled by a central command center, similar to air control of airplanes. The building would allow traditional inhaul vehicles to dock, even a boat could dock if the center was near water (Levin, 2017). Inside the fulfillment center are robots that can fulfill orders, ferry items around the building, carrying drones around, restock drones, recharge drones or receive maintenance. Also in the patent are people shown to assist the robots. Amazon came up with a system that can make sure no rogue drones can enter the fulfillment center. Via a wireless communication system can be check if the drone is allowed to enter, the landing platforms will be locked if a rogue drone tries to enter (Glaser, 2017).



(Amazon, 2017)



(Amazon, 2017)

ANALYSIS

MULTI-STORY BUILDING

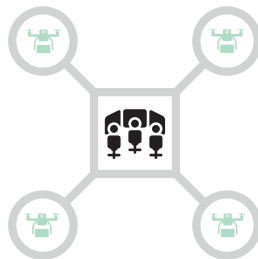
The fulfillment center is instead of a large single-story building, a multi-story building. This makes it possible to have the same square meters of space but a smaller plot size.

MOVING INTO THE CITY

The fulfillment center would move from outside the city into the city. With cities getting more dense and congested and delivery times shorter a fulfillment center outside the city is inconvenient.

CENTRAL COMMAND

The drones will be controlled at a central location. This will be the same concept as air control of airplanes currently.



CONCLUSIONS FOR 2100

This concept for last mile delivery can be the future. A lot has to change to make this possible. But for the year 2100 will this be a very likely scenario. It is therefore good to consider every aspect of the patent for this new type of fulfillment center in the city. That the building can change from a single-story to a multi-story building will be important for the integration into the urban environment. Also having a fulfillment center in the middle of the city will make same-day delivery possible in 2100. From a program point of view it is important to consider new program as a central drone command center.

(Roberts, 2017)

THE ROLE OF THE MID-CITY TRANSPORT HUB

INTRODUCTION

This part will be a synthesis on the (possible) future role of the mid-city transport hub. These different roles will built a scenario for the future mid-city transport hub in 2100. First in this chapter will be possible future roles of the transport hub considered. These roles can be complementary or contradictory to each other. It will be therefore important to consider the relations of the different roles with each other, this will be discussed in the second part of this chapter. Information and possible roles are gathered from previous chapters and supplemented with additional information if necessary.

POSSIBLE ROLES OF THE FUTURE MID-CITY TRANSPORT HUB

FULFILLMENT CENTER

The first possible role of the future mid-city transport hub is that of a future city fulfillment center. At this place goods come in, are stored shortly and the shipped out. Goods will be brought in under ground by freight pods and most of the time delivered by drones. Because of this the fulfillment center will really become part of the future vertical city, this can also be called 3D urbanism. This will make the transport hub and the fulfillment center inside of it part of the urban environment of the city. The fulfillment center will become the lifeline for Amstel, the building where all their goods comes from. The role of the fulfillment center will therefore be not only practical but also architectural important, to become part of the urban environment.

MOBILITY HUB

The second possible role of the mid-city transport hub is that of a mobility hub. A node where people can transfer from different modes of transport. The connecting has to be fast, seamless, that it takes minimal to transfer to other modes. This role is also part of the vertical city or 3D urbanism. This is because different modes are existing above each other. The metro underground, the passenger drone in the air and every other mode in between. This mobility hub role is important because Amstel is becoming more dense and has to be connected to other parts of the city of Amsterdam. Because the density is increasing, the use of (public) transport will also increase. The mobility hub will therefore become rather large. For example, it will have the size and type of a train station then a metro station (the largest mode for human transportation in Amstel).

STATION

The third possible role of the mid-city transport hub is that of a station. This role differs from that of a mobility hub. A station has the role of good access/dispersal to the transportation system or the urban environment (which is Amstel in this case) and a mobility hub has the role to minimize transfer time between modes. The station role has to accommodate the need of its users. For the transport hub in Amstel are this residents, people working in the area and people finding leisure in Amstel. The station role will be integral and part of the city. The analysis of the connections and passengers flows both inside and outside play a fundamental role (Gompel, 2015). The station has to be connected to the rest of the Amstel area.

PUBLIC SPACE

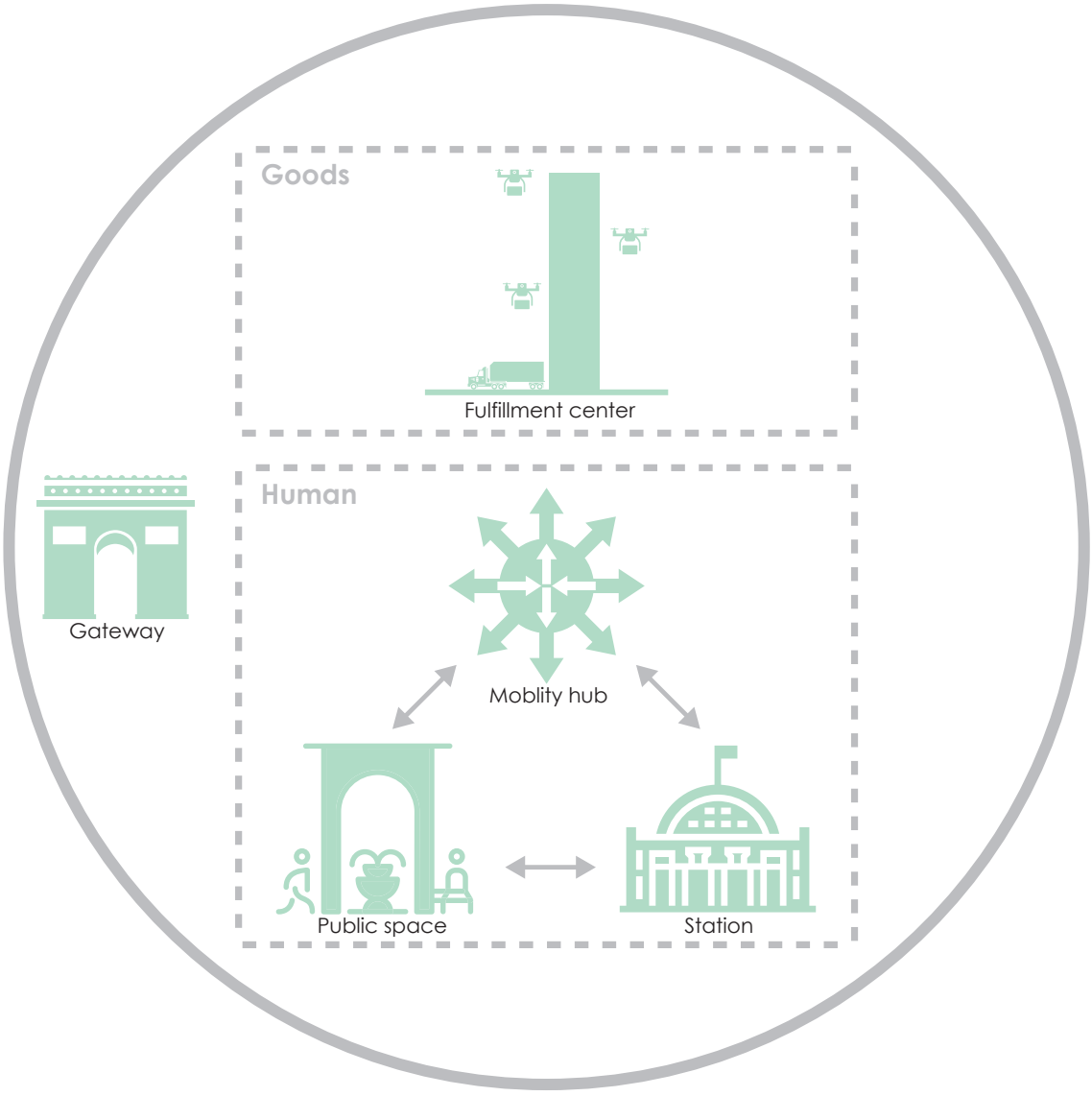
The fourth possible role of the mid-city transport hub is that it becomes part of the public space. The transport hub will then become more then just a station and mobility hub but also part of public space, this will maximize the urbanity in Amstel. Currently, you see that station are having a lot of retail and becoming kind of life centers. The transport hub can follow this trend, and really become a destination. A location where public life takes place, where people for example can work, do business, meet, shop and relax. In this way the transport hub can have the role of a public space and become part of the (p)leisure city, the identity of the Amstel area in 2100.

GATEWAY

The fifth possible role of the mid-city transport hub is that it becomes the gateway to Amstel. Stations are becoming destinations currently themselves. This will also in all probability happening to the transport hub in Amsterdam Amstel. Cities began seeing station as buildings to boost their image, to serve them as a symbol and eye-catching entrance into the city (Gompel, 2015). The transport hub can adopt (partly) the roles described previously and be an architectural landmark at the same time. That way the station can have the role of a gateway to the (p)leisure city of Amstel.

POSSIBLE ROLES OF THE FUTURE MID-CITY TRANSPORT HUB AND THE RELATION TO EACH OTHER

The roles previous described can be complementary, contradicting or may have no relation to each other. The fulfillment center role is quite independent to the other roles. This is because it has its own modes of transport and does not interact with the other functions and therefore other possible roles of the transport hub. The mobility hub and station/public space roles are contradicting each other. The station and public space can work together and be complementary to each other. But the mobility hub is contradicting to the other two roles. This is because the mobility hub has as role to minimize time. The other two roles are integrating the transport hub in the urban environment. This is not the most efficient or fastest way of making a connection. The role of the transport hub as a gateway has in a way a relation with all the other possible roles. Because of the other roles and their influence the transport hub can become a gateway.



RELATIONS BETWEEN POSSIBLE ROLES FOR THE TRANSPORT HUB


PARQUE LINEAL
MANZANARES

PROGRAM DEFINITION

HUMAN TRANSPORTATION

This chapter will discuss the possible program for the future mid-city transport hub in Amsterdam Amstel will be discussed. A distinction will be made between a program for human transportation and for goods transportation. The possible program is derived from the previous chapters. For the square meter of every program is data collected, or a weighed estimate is made.

KEY FIGURES

Inhabitants Amstel	150,00
Users per day (entries/exits)	103,000*
Users per year (entries/exits)	37,595,000
Main functions in the Amstel area	Offices, residential, leisure
Human transportation modes at the transport hub.	Metro, bus, car, bicycle, passenger drone, walking

*reference: City of Arnhem(157,000 inhabitants) has 43,000 users going in or out the train every day (Belderbos, 2018). So, if we use this comparison as a starting point for Amstel (150,000 inhabitants), then would 41.000 users go in or out the transport hub in 2017. The grow percentage of the public transport in Amsterdam from 2011-2016 is 1.12% (Vink, 2018). From 2017 till 2100 is 83 years. This would make 41,000*1.0112^83=103,000 users going in or out the transport hub every day in 2100. This number is a indication, it is hard to make a prediction so far into the future.

POSSIBLE PROGRAM

GENERAL FUNCTIONS

Central hall

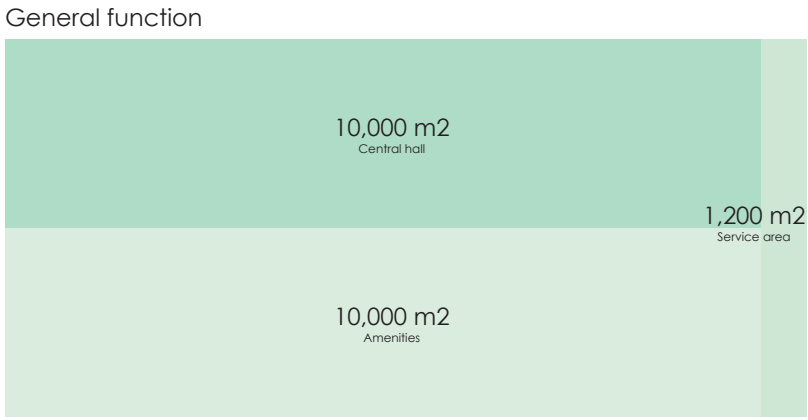
For the size of the central hall of the transport hub we can use a reference of a integral hub that has currently the same amount of travelers as the transport hub will have in 2100. A good reference is therefore Rotterdam Central with 110,00 travelers every day. The central hall is 10,000 square meter large, and at some places 30 meters high (Gemeente Rotterdam, ProRail, NS, n.d.). This 10,000 square meter area is also possible for the transport hub.

Amenities

Also is the possibility that there are shops in the future transport hub. It is hard to predict how this trend will develop. Because nowadays there is a trend that shops are becoming more prominent in stations (Gompel, 2015), but when transport becomes faster and the connection seamless, it will be a question whether this trend will continue. But to have a reference, it is relevant to look at Rotterdam Central as a new large integral hub and the shopping amenities. It has a passage with shops that is 49 meters by 149.5 meters, what results in an area of 7,325 square meter of shopping space. This is quite large, due to the fact that a lot of this space is used for getting to the platforms. Taking this factor in, one can see that 6000 square meter is possible used for shopping in the future transport hub. Also has Rotterdam Central as many integral hub in the Netherlands offices and catering. This is an area of 4000 square meter, which is also possible for the transport hub. Making the total of amenities 10,000 square meter.

Service area

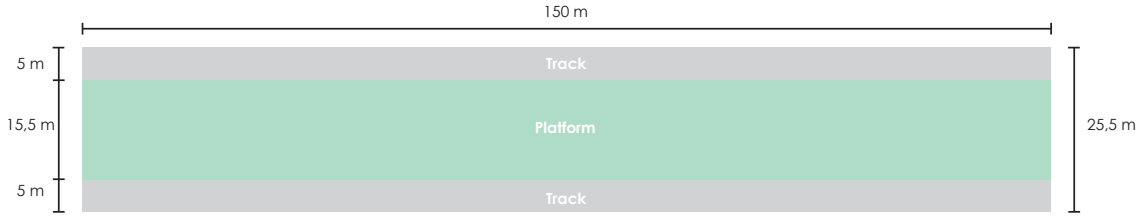
It is hard to say how much service area is needed for all the other program in the station. Therefore, a seperate estimation of how much service area is needed will be made for every program. Shops are the only ones that need service areas. For Rotterdam Centraal this means about 20% of the area. So, this would mean that the transport hub needs 1,200 square meter of service area for the general function.



METRO

Platforms

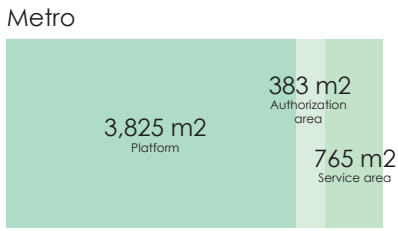
The metro will be autonomous in the future, the rest will not change that must. It is therefore possible to use a reference to get a sense of how large the metro part of the transport hub has to be. As a reference will be the Taipei City Hall MRT Station used. This station has one line that transport more than 44 million passengers per year to and from this station. The station is a two-level, underground station with an island platform and four exits (Metro Taipei, 2018). It is therefore relevant to use as a reference. The platform is 150 meters long and 25.5 meter wide, is make the program of the metro platform 3,825 square meter.



REFERENCE: PLATFORM TAIPEI CITY HALL MRT STATION

Additional program

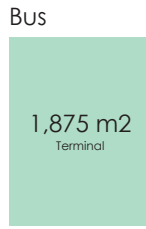
Gates will not be necessary anymore in 2100, but still has there be an area from where on people need a ticket. This authorization area needs to be large enough for passengers to realize to buy a ticket. This area does not have to be physical enclosed but can be virtual. This makes it possible to combine it with other functions or public space. Currently, the area in a metro station between the gates and the escalators down is about 10% of the platform size, what would result, if we look at the reference of the Taipei City Hall MRT station, in an area of 383 square meter. Currently, a metro station will have a hall with a couple of amenities. The transport hub will in all probability have a central hall thus this hall will be unnecessary. Also a metro station needs service area, this varies depending on a couple of factors. It will definitely be hard to predicted how much service area is necessary, when in 2100 the metro is fully autonomous. A prediction is that 20% of the platform size is needed, what would result in 765 square meter service area.

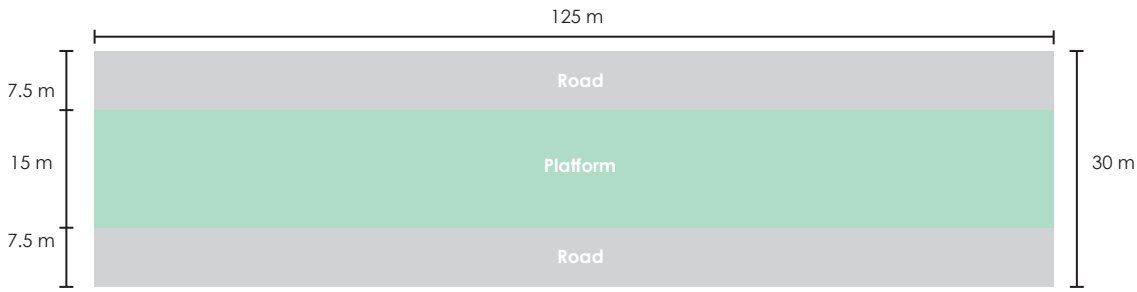


BUS

Terminal

The bus terminal will be different from how we know it now. It will look more like a large taxi stand than a bus station. But to get a feeling of the scale of the future bus terminal we can look at the bus terminal of Rotterdam central. This terminal is 30 meters by 125 meters. But the future bus terminal can be much smaller, it can be half of current bus terminals. This will make the future bus terminal 30 meters by 62.5, what is 1,875 square meter.





REFERENCE: BUS TERMINAL ROTTERDAM CENTRAL

FUTURE BUS TERMINAL

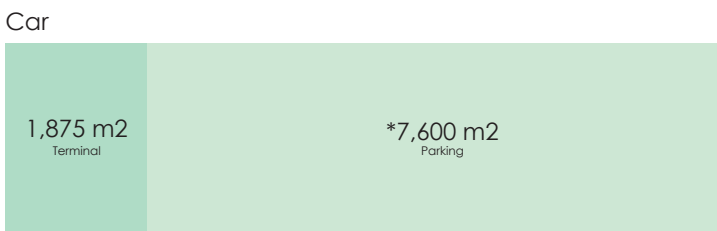
CAR

Terminal

Currently is a station only accessible with the car via a kiss & ride or parking. Also taxi's have a place near the station. Due to autonomous vehicles, taxi's will be a thing of the past. Only shared and private autonomous cars will drive in the future city. Because autonomous cars can drop of people and pick up people in a similar fashion as the bus system. It is hard to predict what the use of the car in 2100 will be. An assumption is made that shared and private cars will need the same space as the bus, what is 1,875 square meter.

Parking

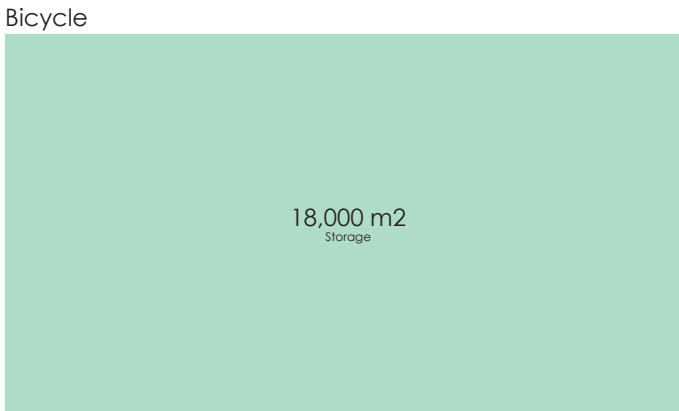
After the autonomous car has dropped off its passenger and is not in use, it can park itself. Because a lot of cars will be shared less parking is needed because these cars will be in all probability 90% of the time in use. So, only the private cars and 10% of the shared cars has to be parked. Because they are autonomous, parking garages will be taking 60% less space. It will be hard to say how many parking spots will be needed. But we can take Rotterdam Central as an example. The parking garage near the station has 760 spots. If we take the current average of 25m2 per parking spot (TU Delft, n.d.) and 60% less space is needed for autonomous driving, the parking area would be 7,600 square meter large. Because of autonomous cars, this parking don't has to be necessary be in or really close to the transport hub.



BICYCLE

Storage

The use of bicycles will increase in the future, that's for sure. The future transport hub has to accommodate this trend. But is hard to predict how many people will use their bicycle to go to the transport hub. This will be necessary to know how many bicycle parking spots are needed. To know how much space is needed per bicycle parking spot, we can look at the bicycle parking at Delft train station in the Netherlands. It has a bicycle parking with 2700 spots (Uffelen, 2017), and is approximately 25 meter by 65 meter. This would result in an average area of 0.6 square meter per bicycle. A prediction has to be made how many bike will be necessary, we also use Delft train station as a reference. Delft station will have 10,100 bicycle parking spots (Uffelen, 2017), with 35.454 entries and exits per day (Belderbos, 2018). If we scale this number to the 103,000 entries and exits of the future transport hub, then about 30,000 parking spot are needed. So, the square meter needed for bicycle storage is 18,000 for the future transport hub. The use of the bicycle will increase in the future, but a part of this will be shared, what will result in less bicycles in storage. Shared bicycles can use the same facilities as private bicycles because they can be rented and opened by a app in 2100.



PASSENGER DRONE

Landing platform

Typologies for passenger drones do not exist currently, but in all probability it will come closes to the heliport as typology. It must therefore have a landing platform that is large enough for a passenger drone to land. A helicopter needs an minimal area of 24 meter by 24 meters to land with a safety zone included (Kodsi, 2015). This could also be suitable for the passenger drone in 2100, so the square area for one landing platform would be 576 square meter. The drone will be a luxury so four platforms will be enough for the transport hub in Amstel. This would result in 2,304 square meter of landing platform area.

Waiting area

Passengers have to wait is short moment before they can enter the passenger drone. This area don't have to be large because there will not be that much people using the drone. A predicting is that 500 square meter will be enough.

Drone control center

The drone are autonomous but still have to be monitored. This can be done in a central control center, that can be located in the transport hub but doesn't have to be. The size will be depending on how many drones it have to monitor but a prediction is 300 square meter is necessary to monitor the drones of the four landing platforms.

Storage/recharge station

The passenger drone also needs to be stored and recharged. This can be done at the transport hub or at another location. It is hard to predict how much space is needed for this. But four drones can land at the same time, if every drone ride is 15 minutes then 16 drones will be needed for the transport hub. The landing area is four time the span width of the drone so the storage/recharge area will be the same as the landing area, which

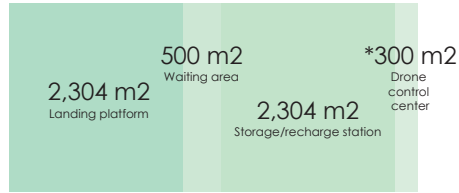
is 2,304 square meter.

PEDESTRIAN

Public space

A lot of public space is already in another program. But extra public space can be added to make the transport hub better integrate in the urban environment, or to make it a destination. During the design process will be therefore decided how large this program will be.

Passenger drone



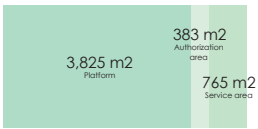
Pedestrian

OVERVIEW POSSIBLE PROGRAM MID-CITY TRANSPORT HUB IN 2100

General function

= 21,200 m2

Metro

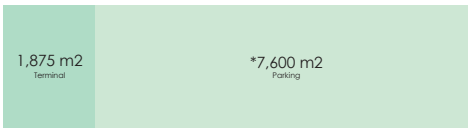


= 4,973 m2

Bus

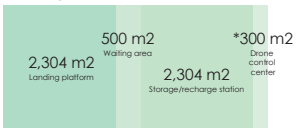
= 1,875 m2

Car



= 1,875-9,475 m2

Passenger drone

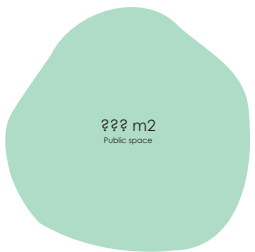


= 5,108-5,408 m2

Bicycle

= 18,000 m2

Pedestrian



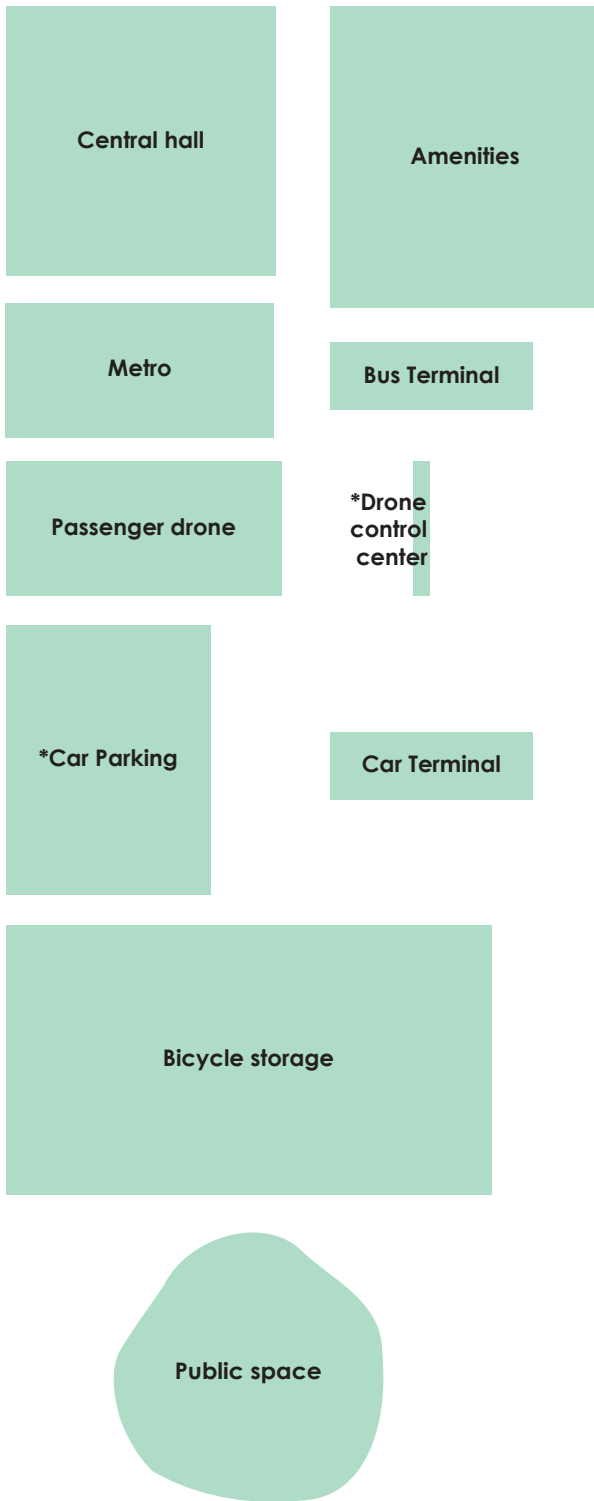
= ??? m2

+

53,031-60,931 m2

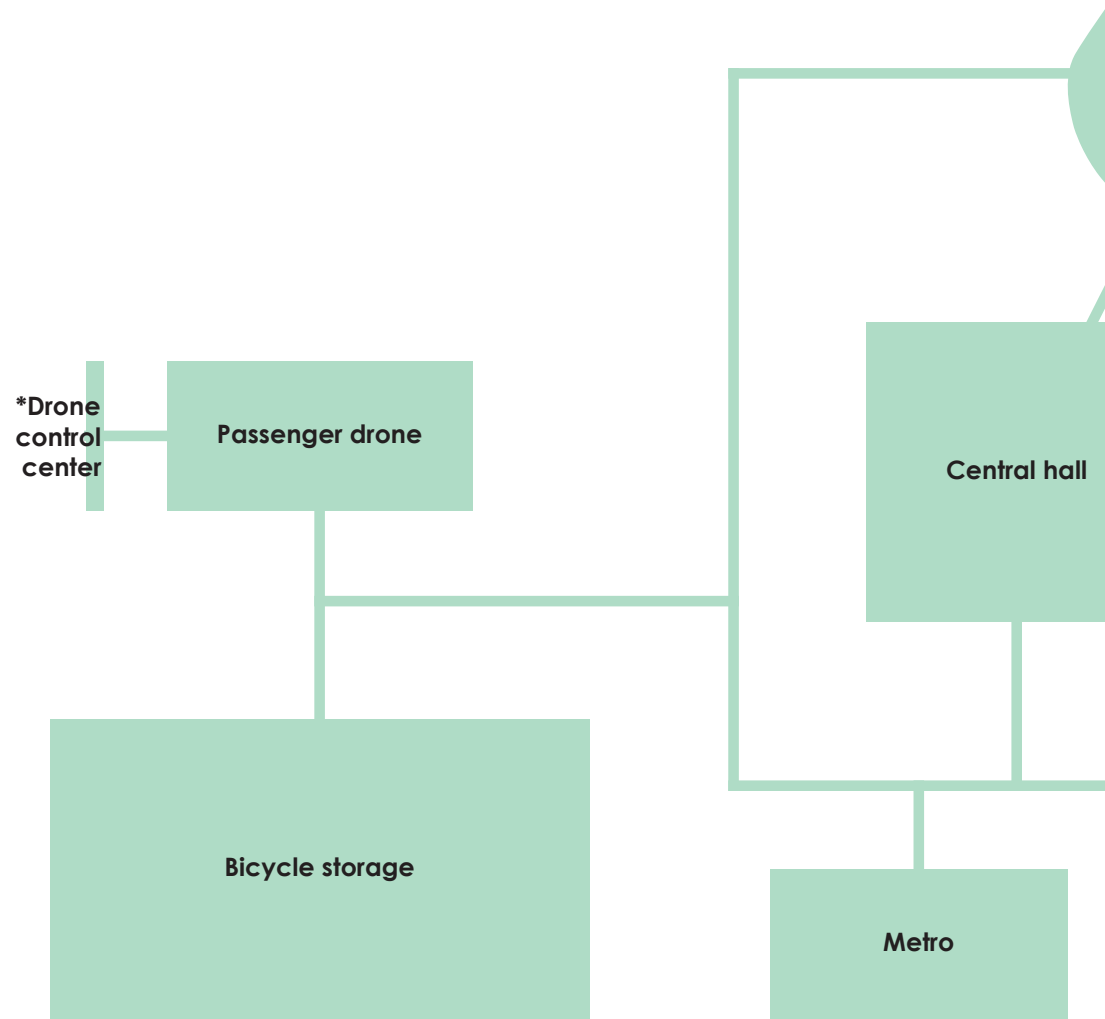
*this program is not necessary to have at the transport hub but can also be located somewhere else.

PROGRAM COMPONENTS

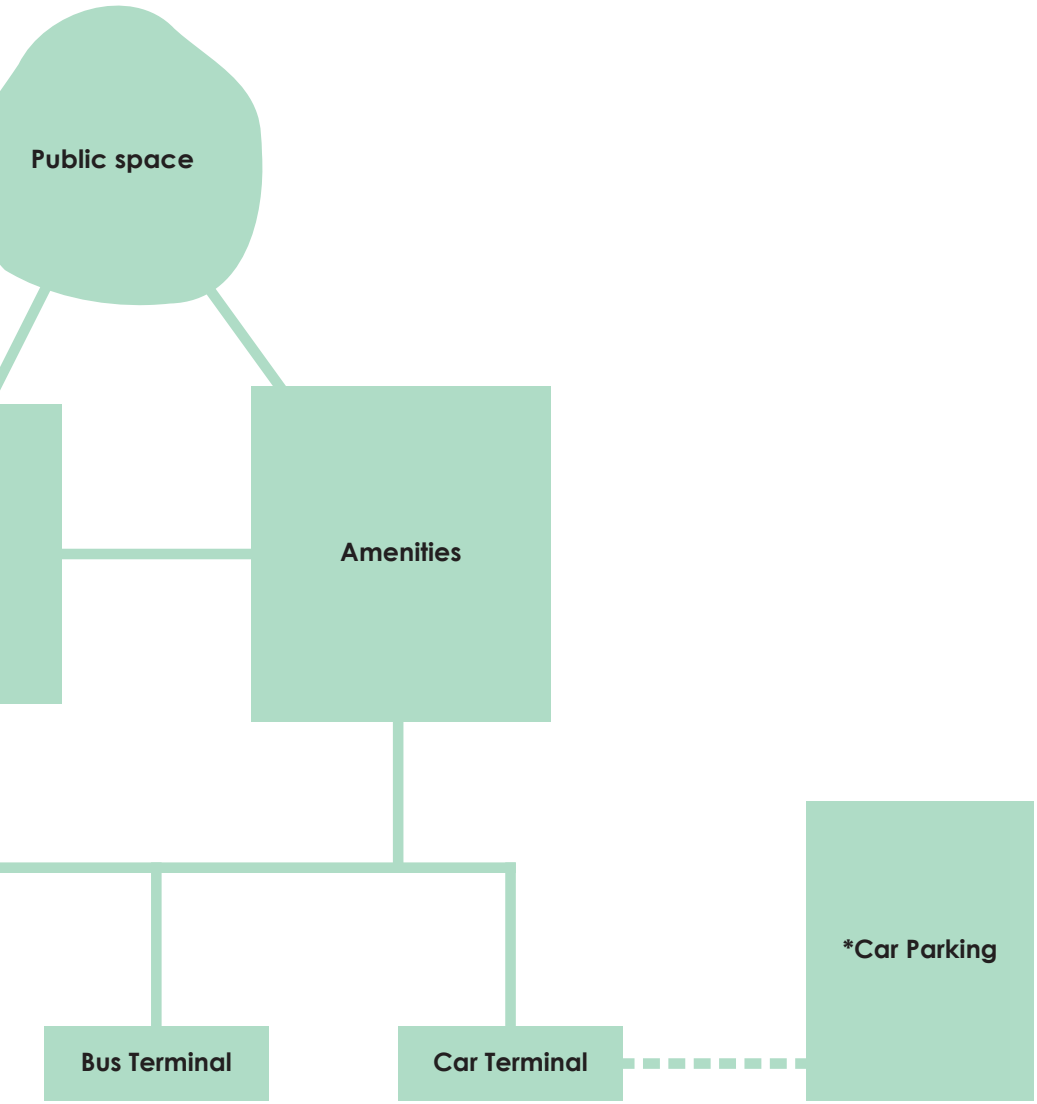


PROGRAM RELATIONS

For a fast and seamless connection all the different modes of transport must be connected with each other. To have good access to the transport hub all the different modes, amenities and the public spaces must be connected to the central hall. To make the transport a destination, amenities and the public space and the central hall must be connected.



*this program is not necessary to have at the transport hub but can also be located somewhere else.


Public space
Amenities
*Car Parking
Bus Terminal
Car Terminal

GOODS TRANSPORTATION

KEY FIGURES

Inhabitants Amstel	150,00
Items processed every day	20x150,000=3,000,000
Orders per day	300,000
Maximum delivery time	24 hours
Goods transportation modes at the transport hub.	Freight pod, delivery truck, drone, AGV, droid, bicycle

POSSIBLE PROGRAM

FULFILLMENT CENTER

The program of a modern fulfillment center is previously described. The reference fulfillment center processes 3.5 million items or around 65,000 orders every week with an area of around 20,000 km2. For the Amstel area this would mean that 3,000,000 items per day that have to be processed, would need 120,000 square meter of space. How this floor area is divided is not specified due to companies secrecy. An estimate is made how the program is divided within the future fulfillment center in 2100.

UNLOADING INHAUL AREA

Freight pod

Freight pods will be responsible for the inhaul of goods to the future transport hub. In a pod fit two euro pallets (800mm*1200mm*2100mm) (Advanced on trade, n.d.). A prediction is made that per pallet an average of 300 items can be transported. To inhaul 3,000,000 items every day would mean that 10,000 pallets per day are needed. What would result in 5,000 pods per day are needed to go to the transport hub. If trucks would be used for the inhaul, 303 trucks (33 pallets per truck max.) would be needed (Advanced on trade, n.d.). This would not be preferable in a dense city. The freight pods need an unloading area and possible recharging station. If every unloading and the turn around of the pods takes 2 minutes, then 7 unloading station are needed for 5000 pods incoming every day.

Unloading inhaul area

SHORT-TERM STORAGE/PICKING AREA, COMBINING ITEMS AREA, PACKING AREA

The short-term storage is a storage area and picking area at the same time, as described in previous chapters. The items can be dry goods, outsized good, irregular good and refrigerated goods. After the items are picked they are combined with other items from the same order. After this the items go to the packing area, to be prepared for shipment.

Short-term storage/picking area

Combining items area

Packing area

SHIPMENT AREA

Delivery truck

Twenty percent of the goods will be still delivered by delivery trucks in 2100. Therefore must be parking, recharging stations, repair areas available, and facilities for the employees. In one day 300,000 orders have to be delivered. If one truck can deliver on average 400 orders in one day, then 150 delivery trucks are needed per day.

Bicycle

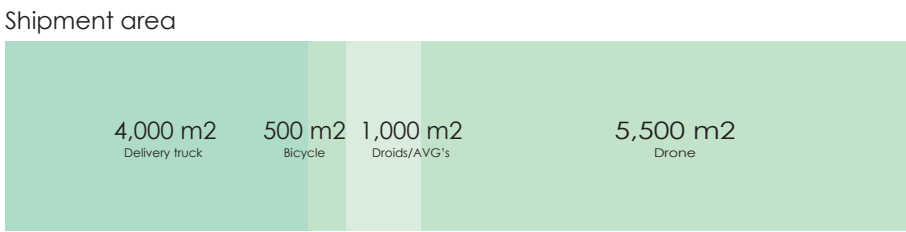
Two percent will be delivered by bicycle. Therefore must be parking available and facilities for the employees. If two percent is delivered by bicycles, this would mean that 6,000 orders has to be delivered by couriers. If a courier can delivery four orders per hour on a 12 hour work day, then 125 couriers and bicycles are needed.

Droid/Autonomous ground vehicle

Droids and Autonomous ground vehicle both deliver a small percentage of the goods. They need storage and re-charge stations, also an area for repairs is needed. Five percent of all packages can be delivered by droid or AVG's, this would then result in 15,000 packages per day. If they can deliver an average of 20 orders per hour, then 32 droids and AVG's are needed.

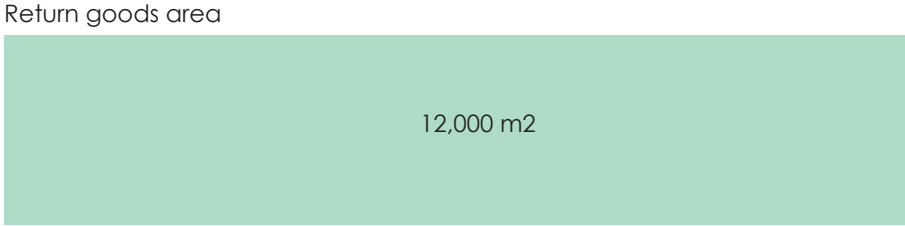
Delivery drone

Drone docking will be the landing platform for delivery drones. They are smaller then passenger drones and can land on a docking station from where packages are attached. When not in use or empty, drones need to be stored or recharged. Also there need to be a place to repair the drones. And finally their needs to be a drone control center to monitor of the drones. This is the only program that doesn't fit in the existing shipment area of the modern fulfill-ment center. This will be the same size as that of a passenger drone, what is 300 square meter. Drones deliver 73% of all the goods, if one drone can delivery 10 orders per hour, then 913 drones are needed.



RETURN GOODS AREA

Return goods are brought in by the shipment department. After the goods are processed and are still good enough they go again to the short-term storage and picking area.

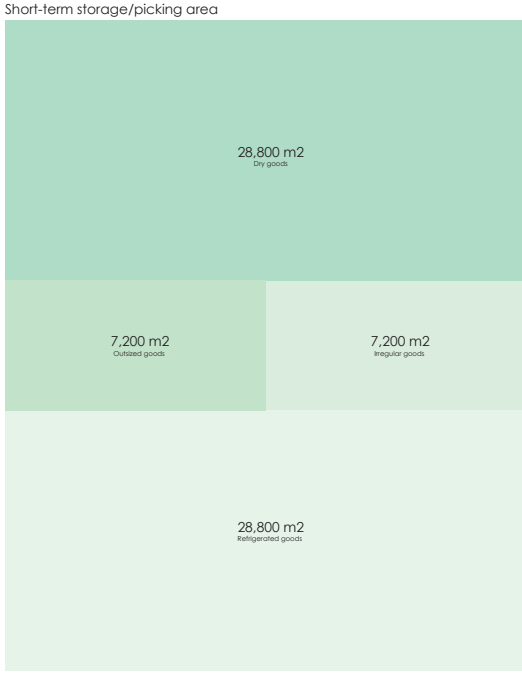


OVERVIEW POSSIBLE PROGRAM MID-CITY TRANSPORT HUB IN 2100

Unloading inhaul area

= 12,000 m2

Short-term storage/picking area



= 72,000 m2

Combining items area

= 6,000 m2

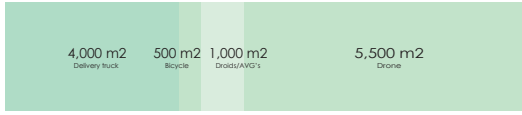
Packing area

= 6,000 m2

Return goods area

= 12,000 m2

Shipment area



= 12,000 m2

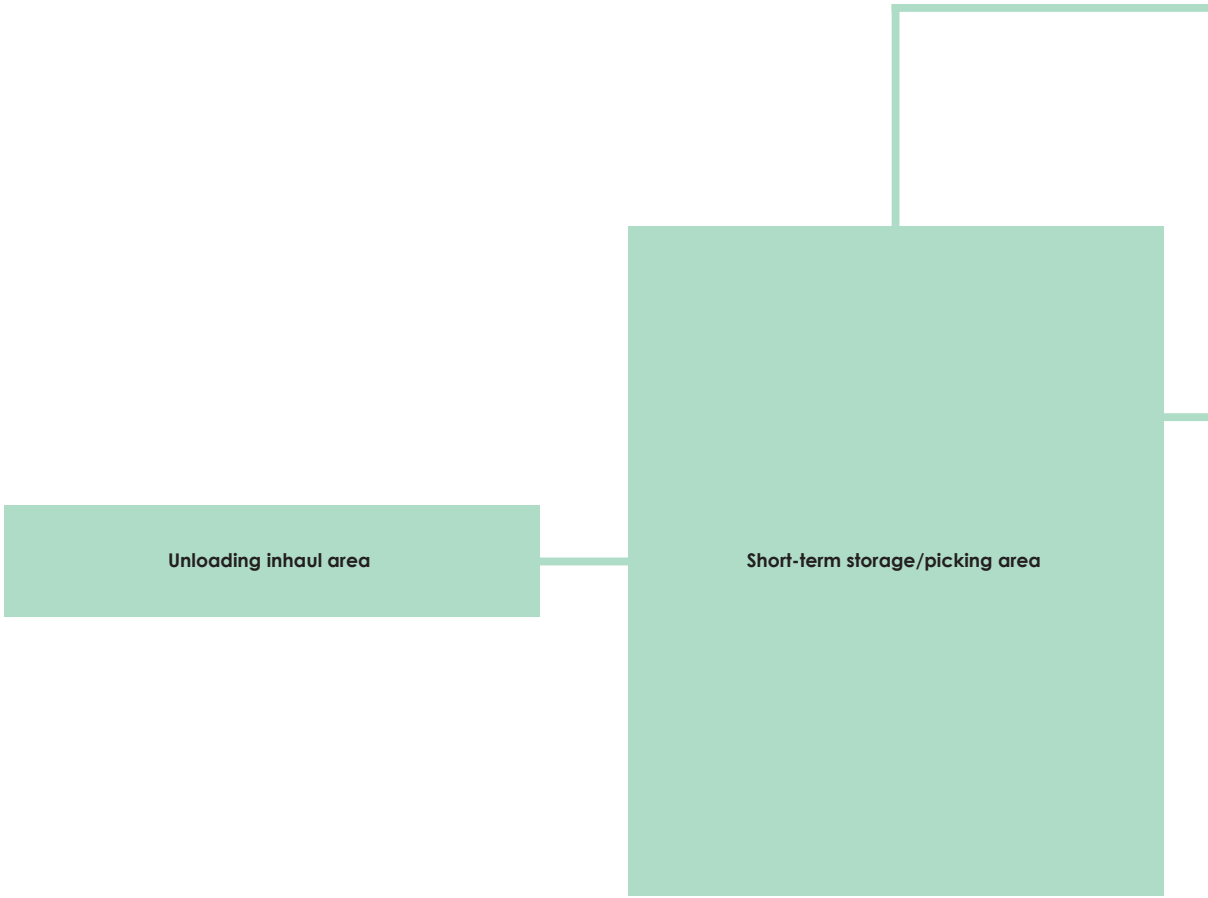
+

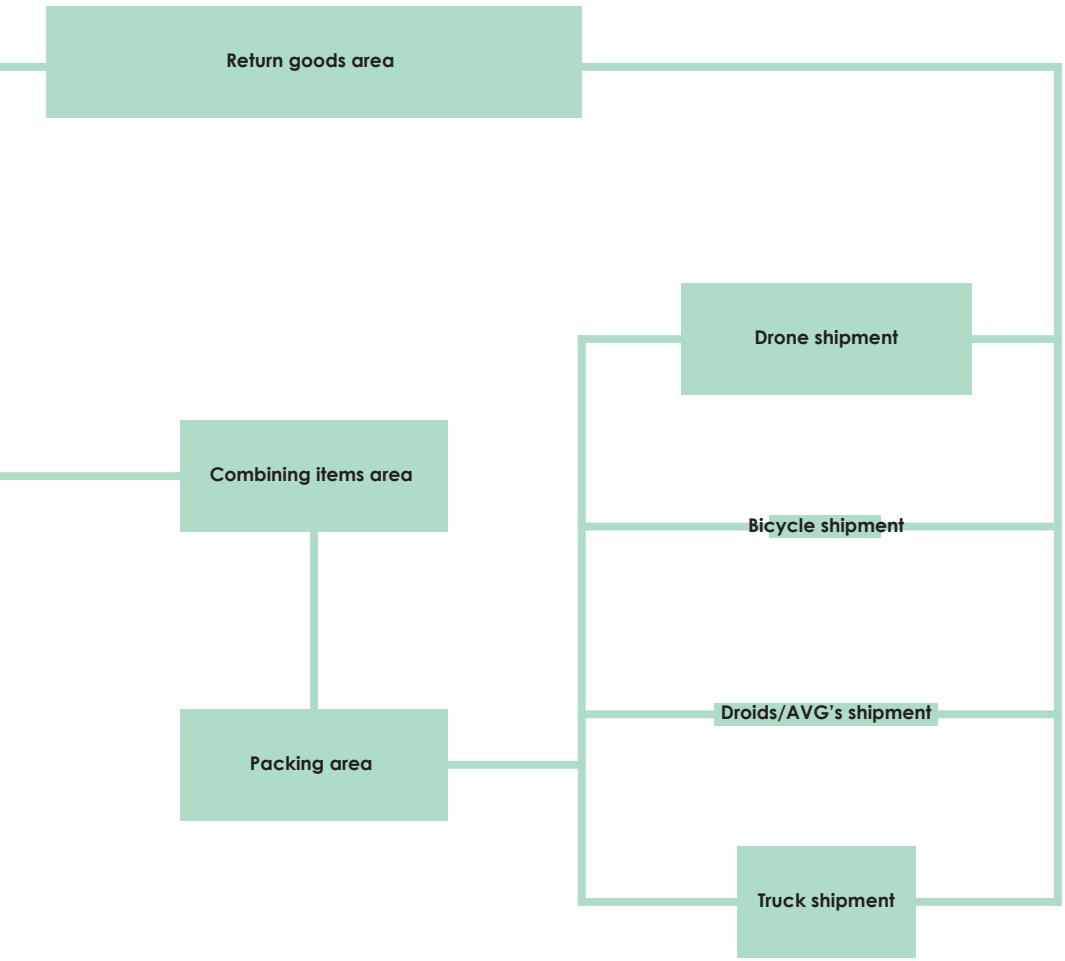
= 120,000 m2

Graduation Thesis - Balder Otten

PROGRAM RELATIONS

The fulfillment process for goods delivery is a linear process. This also visible in the program relation diagram below. The different types of short-term storage are in this diagram considered as one, due to the fact that for the relation between program thisnot a factor is. A distinction is made between different shipment because this will take place in different parts of the future transport hub.




Return goods area
Drone shipment
Combining items area
Bicycle shipment
Droids/AVG's shipment
Packing area
Truck shipment

CONCLUSION

INTRODUCTION

In this part a conclusion is given on the research that is conducted on the future mid-city transport hub in Amsterdam Amstel. Before anwsering the main question, the sub questions will be anwsered. The results and conclusion from this inquiry can be used during the design process that will follow this research. The research and conclusion are based on academic sources but also on other sources less academic, like news articles with future trends. The literature study is supplemented with case studies and mapping. Due to the futuristic nature of the research a lot of variables can occur. It is therefore good to emphasize that the conclusion is one of the many possibilities of how the future transport hub will be in Amstel in the year 2100. Although the research is executed accurately, other possibilities can become a reality in 2100 than in the following conclusion that is given.

SUB RESEARCH QUESTIONS

WHAT WOULD HUMAN TRANSPORT LOOK LIKE IN THE AMSTEL AREA IN THE YEAR 2100?

The transportation of humans in Amstel will change in 2100. The trains won't go to the city center anymore, and the metro network is expanded. The metro is moved underground so that the barrier that was the metro and train disappears. The number of metro stops won't increase on existing lines, instead other modes of transport will fill in the gaps between nodes, like futuristic busses and shared cars and bikes. Walking and cycling will become even more dominant in Amstel. Passenger drones can land at certain places in the city, among which the larger transport nodes. Nearly all transport will be electric and autonomous in 2100. This will have on some modes not that much of an impact and on other it will have a lot of impact. The metro will be similar, but the bus will change. Because of autonomous driving, the bus terminal and the car drop off at nodes will be similar. Because of this, these functions can be combined. Throughout the city of Amsterdam are larger nodes, that constitute to a fast network of transportation. People will transfer more often, but the connection between modes will be faster and seamless.

"People will transfer more often, but the connection between modes will be faster and seamless."

In the center of Amstel will be a medium sized node, with pedestrians, cyclist, busses, cars, passenger drones and a metro. The nodes has to be integral and integrated in the urban environment, to make this connection also as fast and seamless as possible. Ticket system will change in 2100, so there will no need any more for gates, that are currently a barrier in stations.

HOW COULD GOODS DELIVERY BE IN THE YEAR 2100?

Goods delivery will change in Amstel in 2100. People want there online ordered goods as fast as possible. Also in 2100, most of the goods will be ordered online. This will mean that the system of goods delivery has to change to accommodate this increase, because the current system and cities are not suitable anymore. Fulfillment centers will move from outside the city, to the center of the city. A network of fulfillment centers is made, where one of those centers is located in Amstel in 2100. Goods come into Amstel by freight pods under the ground to the city fulfillment center. Most of the last mile delivery will be done by autonomous vehicles. Where drones will be the most used of all autonomous transport modes, although there are still humans necessary to delivery outsized, irregular and fragile goods.

WHAT COULD BE THE FUTURE ROLE OF A MID-CITY TRANSPORT HUB IN THE AMSTEL AREA?

"Fulfillment centers will move from outside the city, to the city center."

The future mid-city transport hub will have different roles that have to be balanced within or outside the building. The first roles is quite obvious, and that is the role of fulfillment center. The second roles is that of a mobility hub. This roles has as goal to the minimize time to transfer to other modes of transport. The third roles is that of a station, which has the goal of good access or dispersal from the building. The fourth role is that of a public space, the transport hub will then be a place for the public and maybe becoming a destination instead of a place of movement. The fifth and final role is that of a gateway to Amstel. This role will make the transport hub a building that will be the entry of Amstel. For this to happen, must the building become of importance, not only on a transport level but also architecturally.

The role of a mobility hub, station and public space can be conflicting on some parts, but all are important. The future mid-city transport hub will therefore not only have one role or will have all roles in their entirety, but will be a balance between different roles.

"The future mid-city transport hub will be a balance between different roles."

MAIN RESEARCH QUESTION

HOW WILL THE FUTURE MID-CITY TRANSPORT HUB BE IN THE AMSTEL AREA IN THE YEAR 2100?

The future mid-city transport hub will be the connection between different modes of transport that will be seamless and fast. There must also be a good connection and integration with the urban environment of Amstel. The transport hub will become part of the vertical city of Amstel with the metro and pods under ground, drones in the air and all the other modes in between. This will make the future mid-city transport hub a node where goods and people come together to be transported throughout the Amstel area. The role of the transport hub will be a mix between a fulfillment center, mobility hub, station, a public space and the gateway to Amstel. In short, the future mid-city transport hub will be a combination between a node for human transport from Amstel to the rest of the city of Amsterdam and a fulfillment center for goods delivery in the Amstel area.

"The future mid-city transport hub will be a combination between a node for human transport and a fulfillment center for goods delivery in the Amstel area."

DESIGN REQUIREMENTS

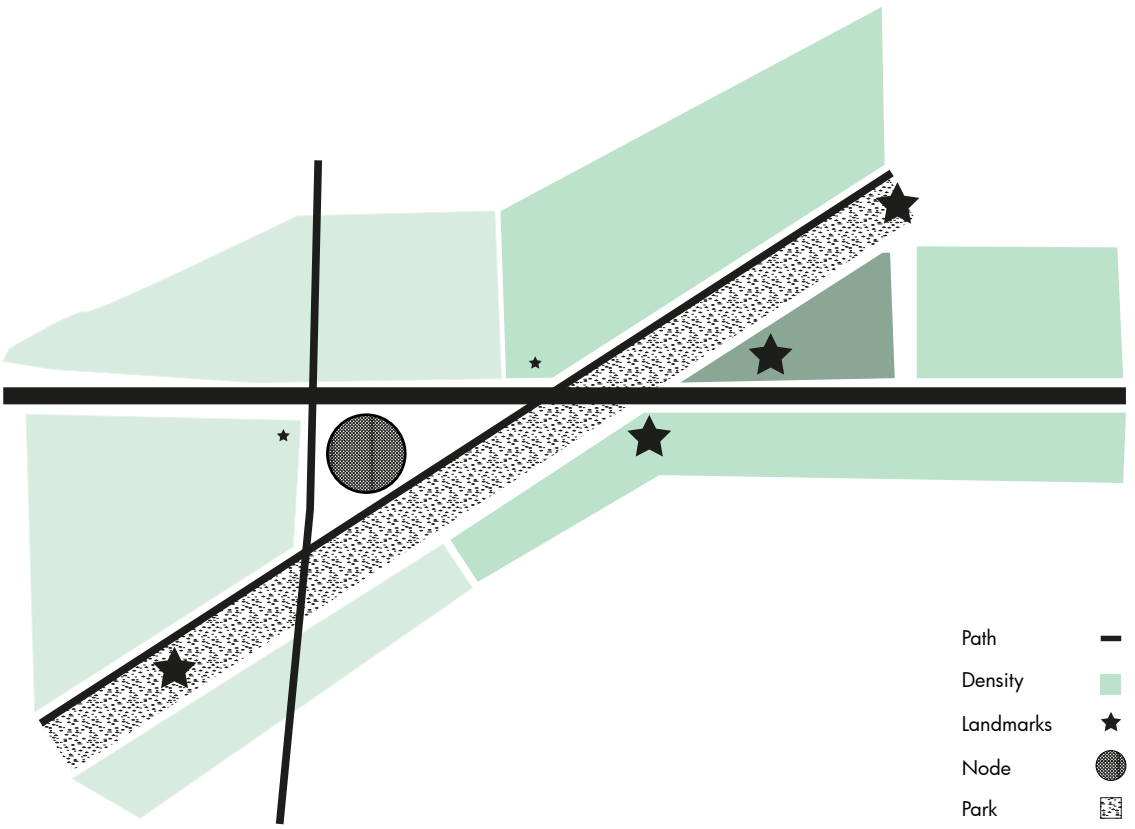
SITE CONDITIONS

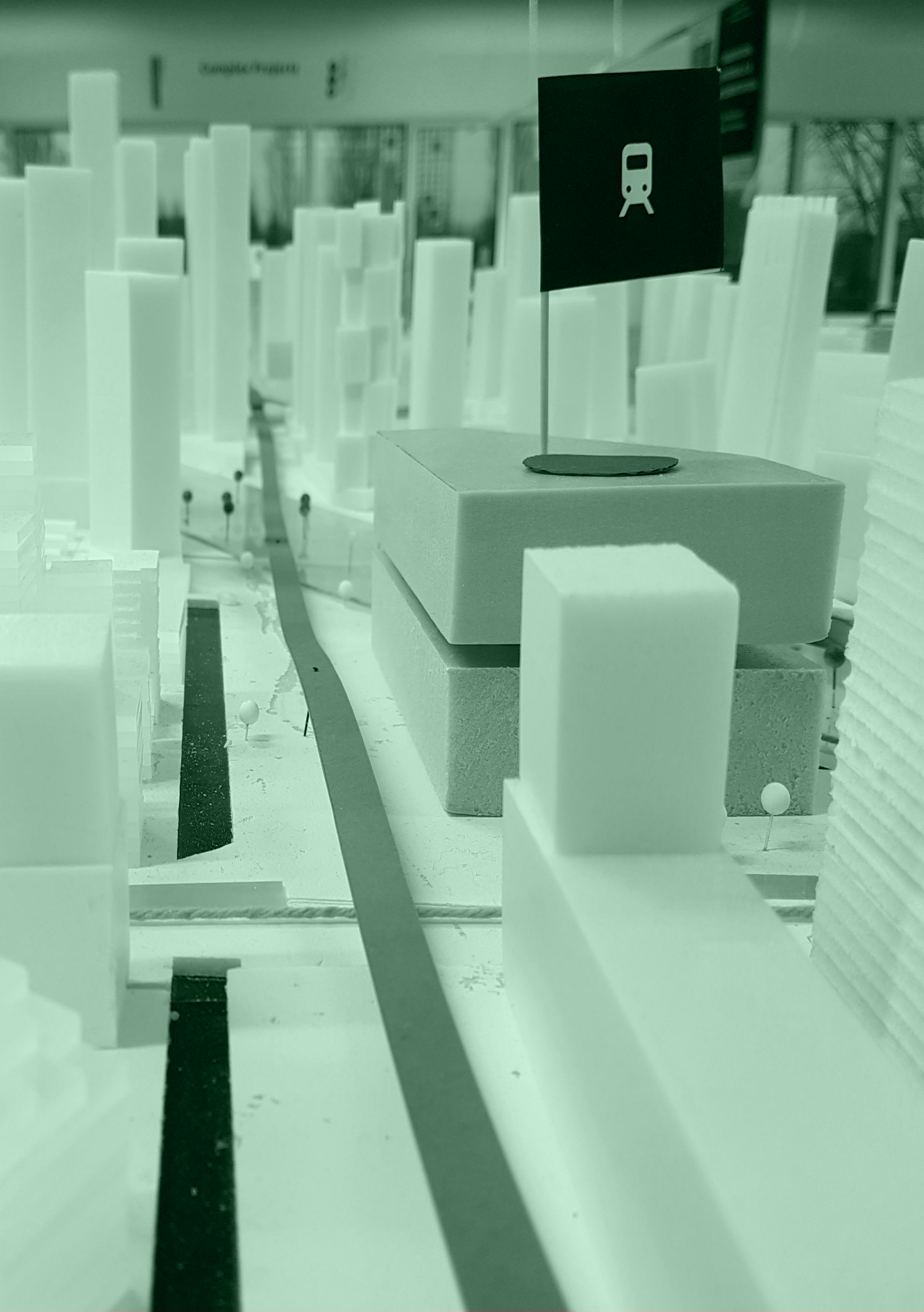
KEY FIGURES

Inhabitants Amstel area	150,000
Users transport hub per day	103,000
Modes of transport for commuting	Pedestrian, bicycle, car, bus, passenger drone, metro
Modes of transport for goods delivery	Pods, delivery truck, drone, AVG, droid, bicycle
Main functions of the the Amstel area	Offices, residential, leisure

INTRODUCTION

The site is located in the center of the Amstel area. It is surrounded by a public park and bike line on one side, on another side is also a bike line and a road, and on the last side a road and bike highway. This makes the building site a triangle. Around the site is a couple of landmarks that will stand out in the urban environment. The density of buildings around the site is higher on the south side then on the north side. But due to the park, the site is located in a quite open space in a urban environment that is quite dense. The bike highway is elevated of the ground, about six meter high. The other bike lines are on the ground floor, this will mean that these two flows have to be connected to each other. All these conditions make the site conditions quite complex.





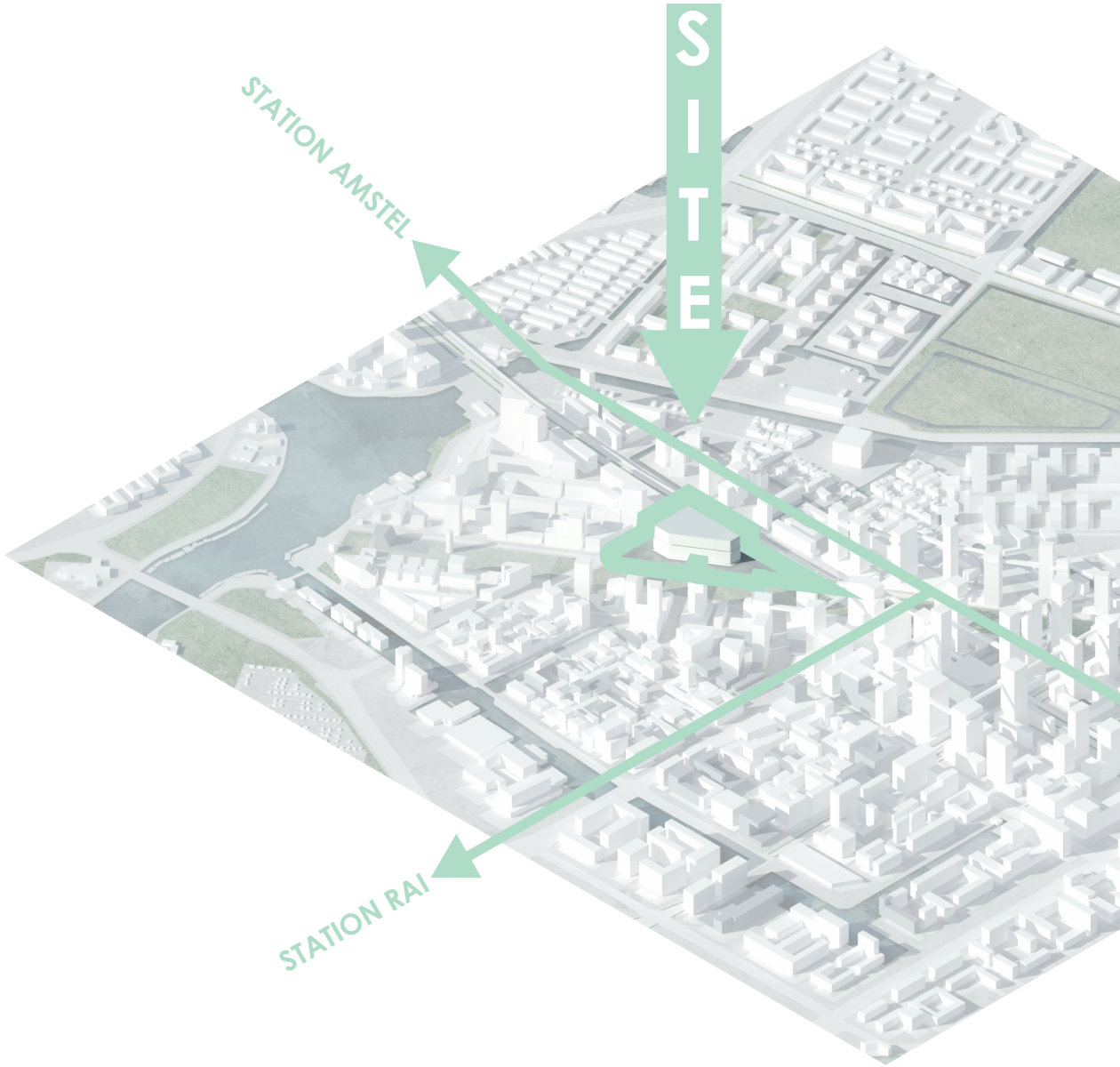
LOCATION PLOT IN AMSTEL

CHOICE SITE EXPLANATION

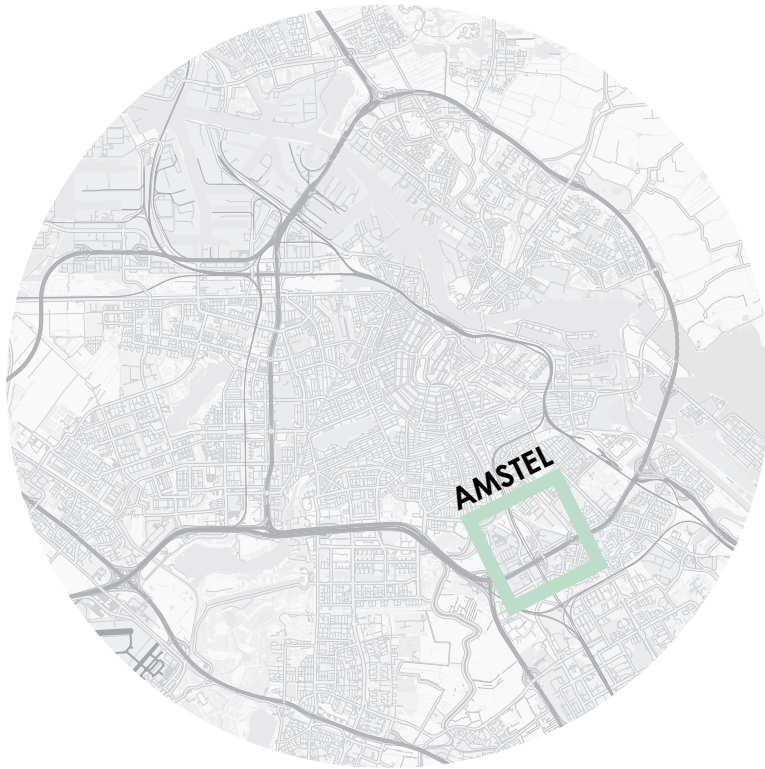
Existing metro network

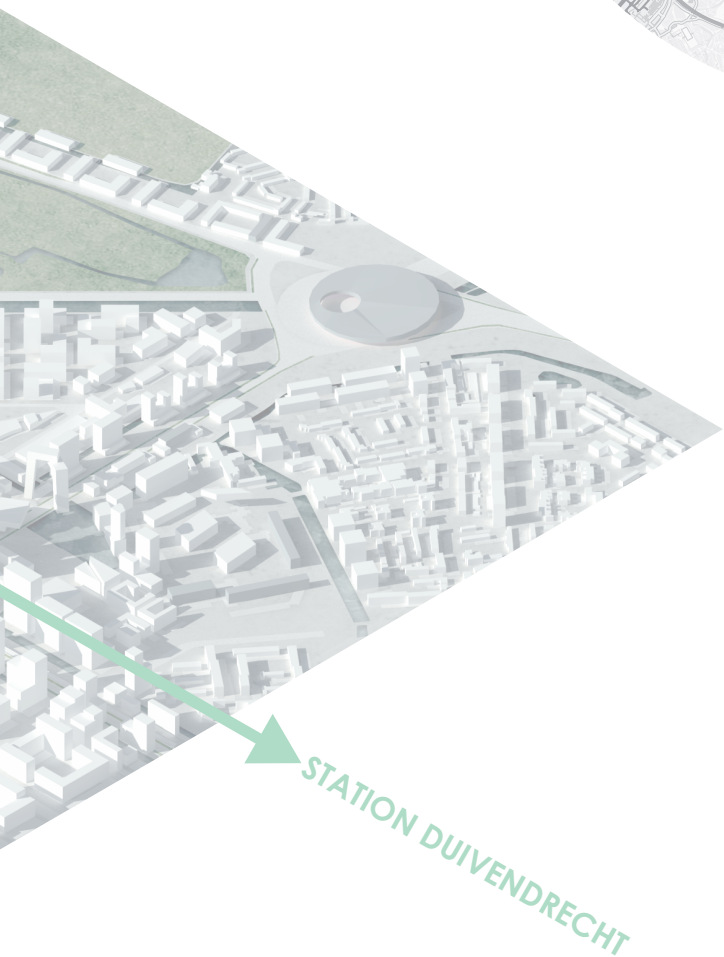
In the middle of the Amstel area

Next to the bike highway

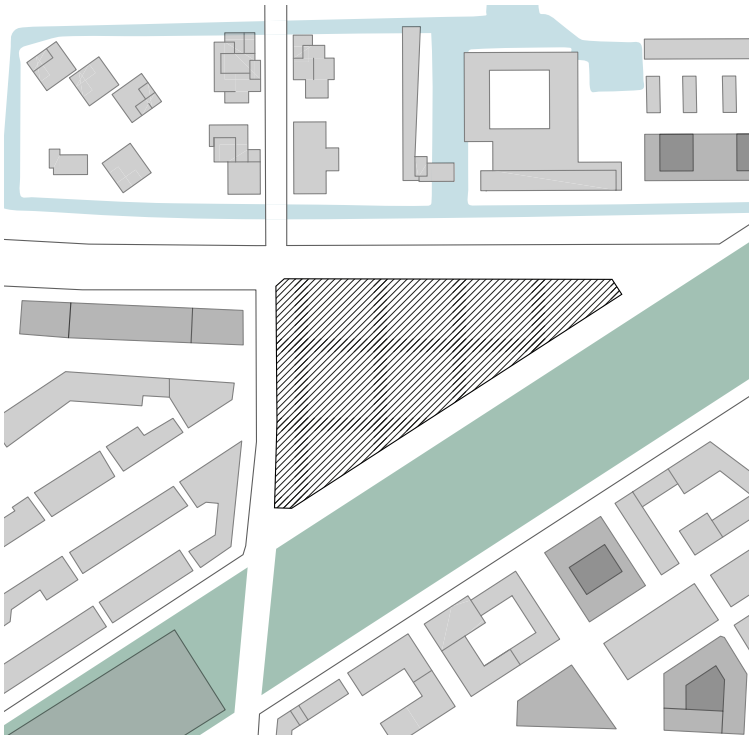


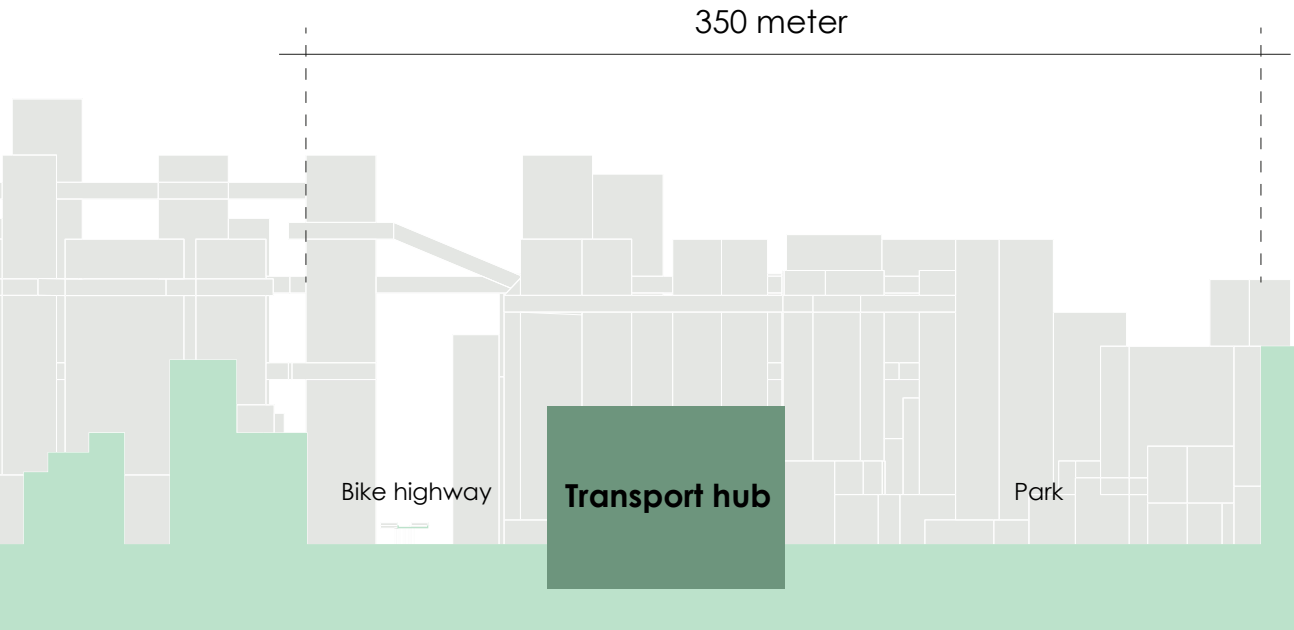
Next to the diagonal park



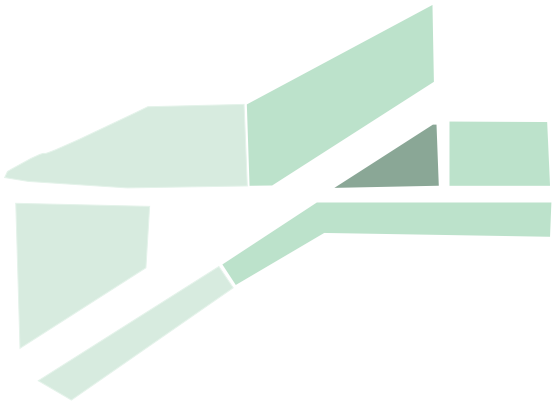


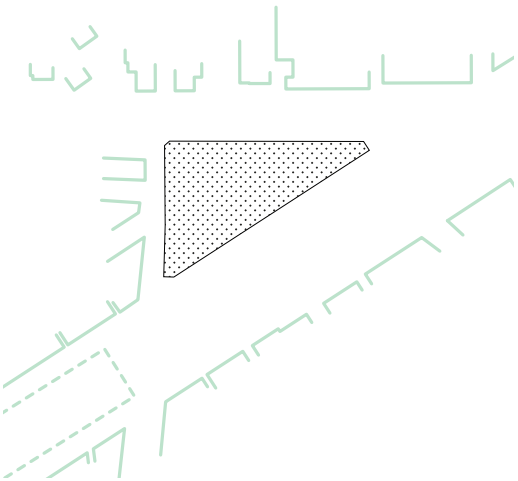
SITE



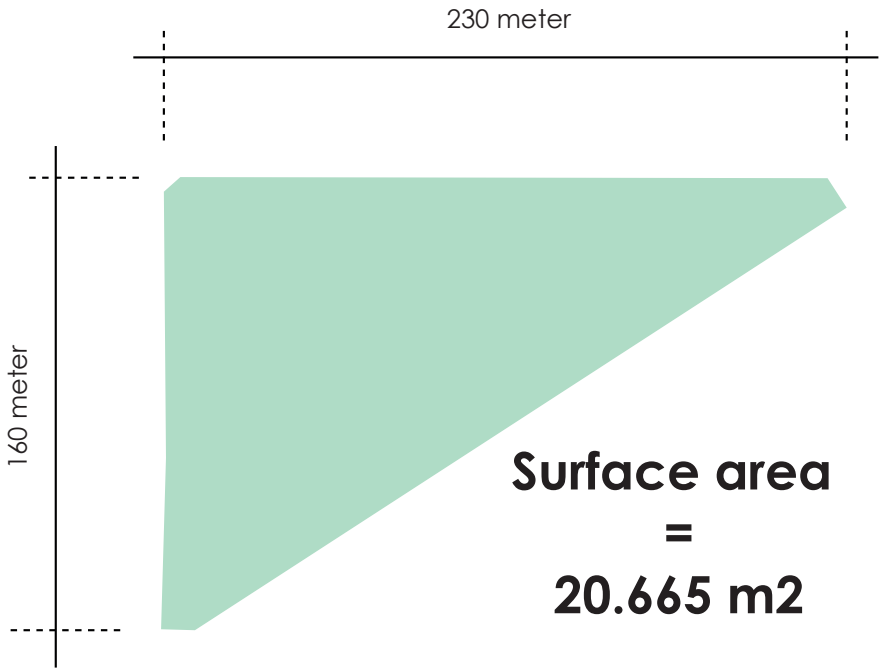


SPACE ENCLOSURE

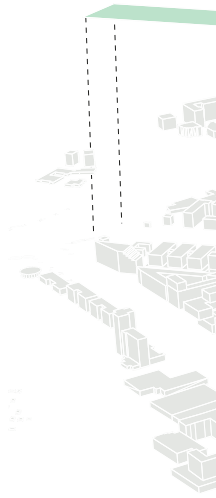




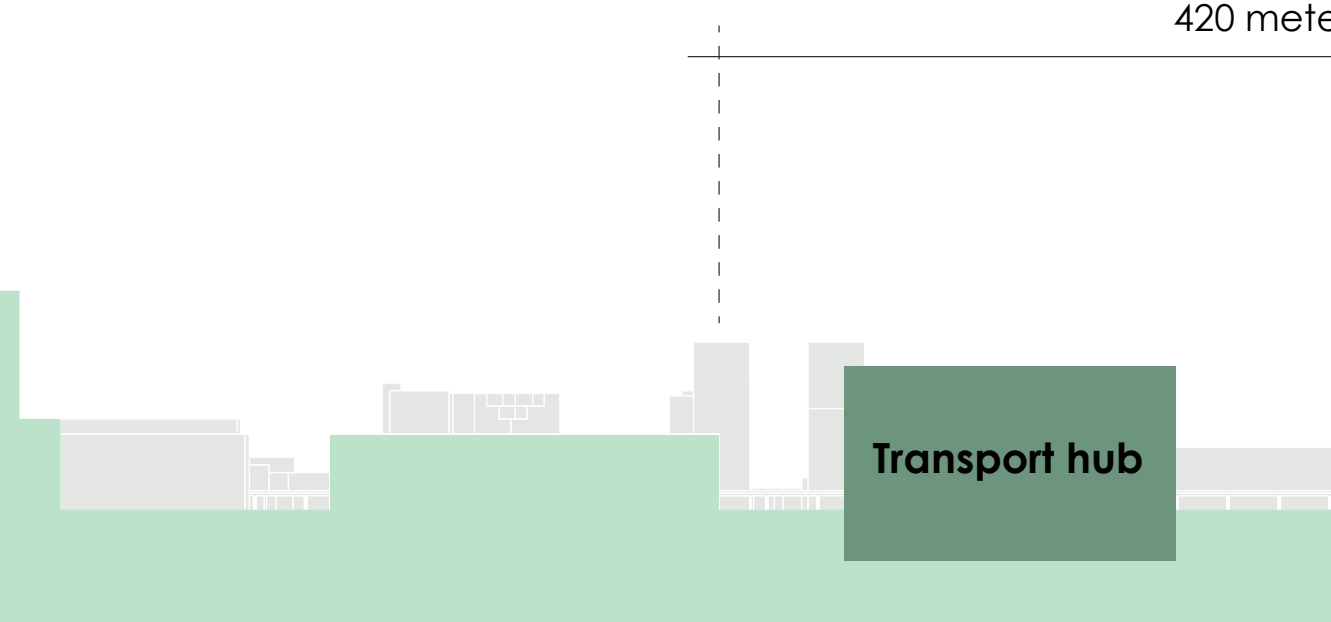
PLOT DIMENSIONS



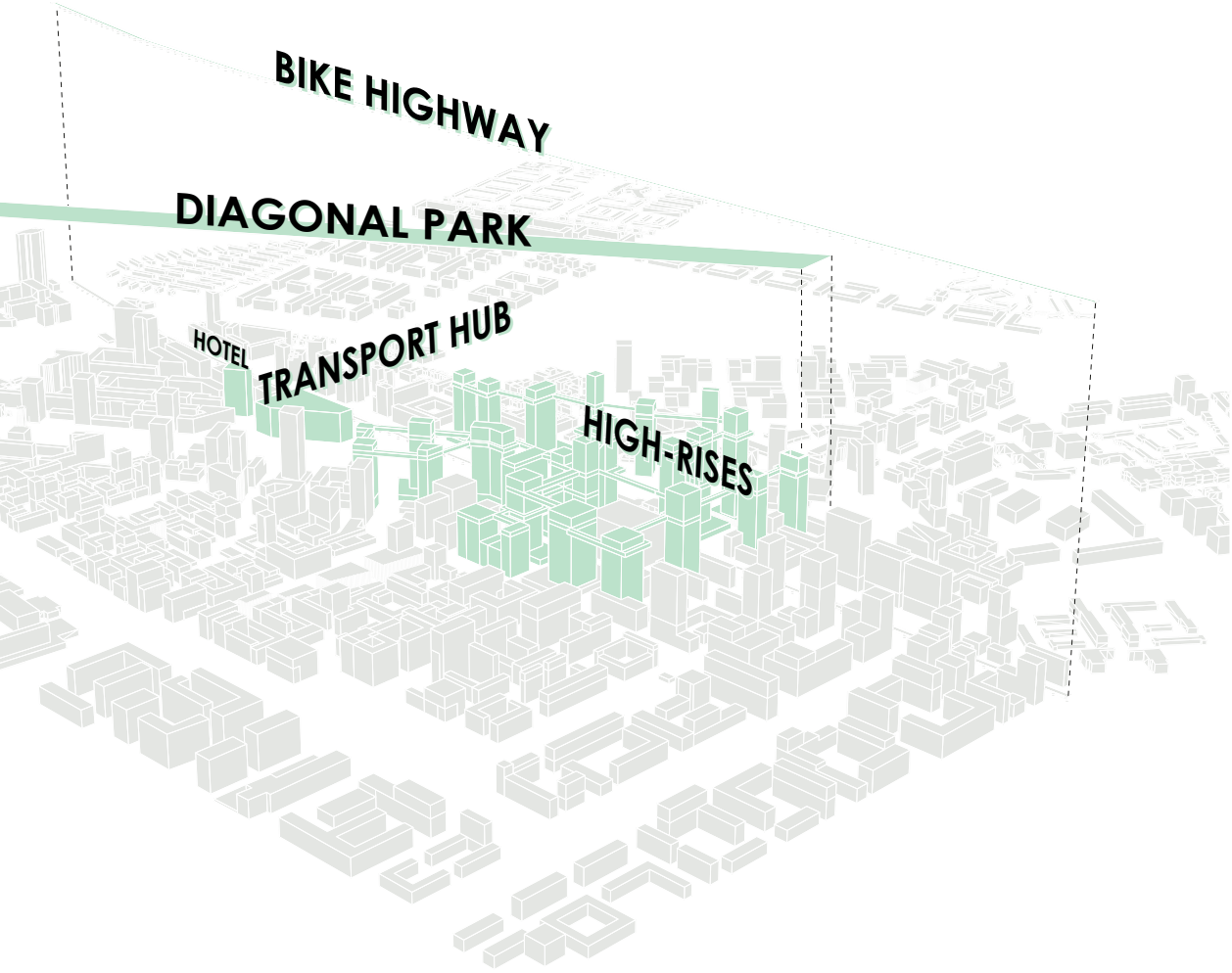
Surface area
=
20.665 m2



420 mete



IMPORTANT ELEMENTS AROUND THE SITE



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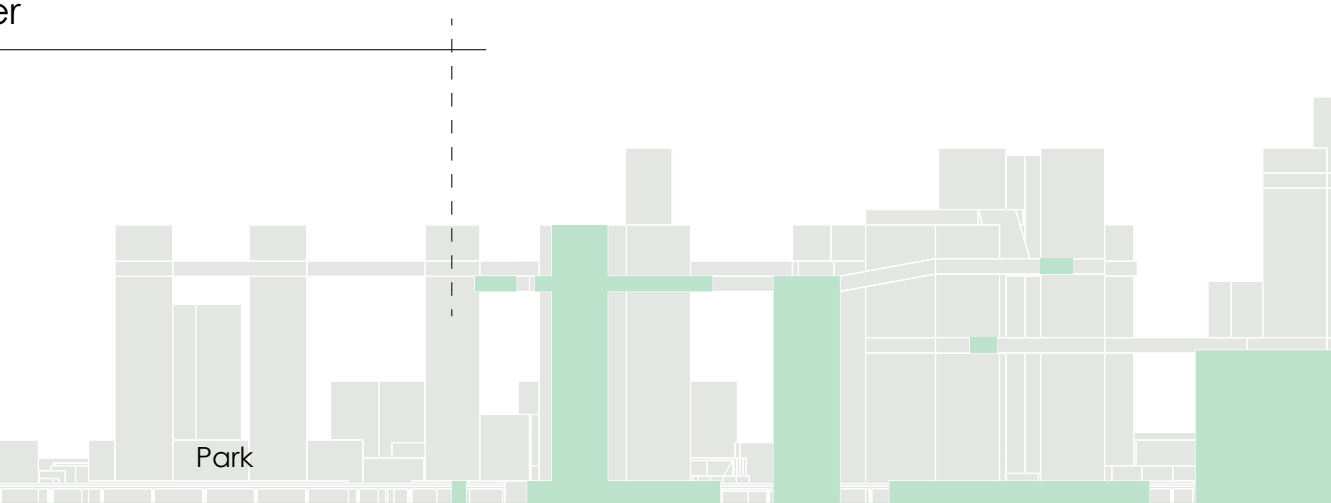
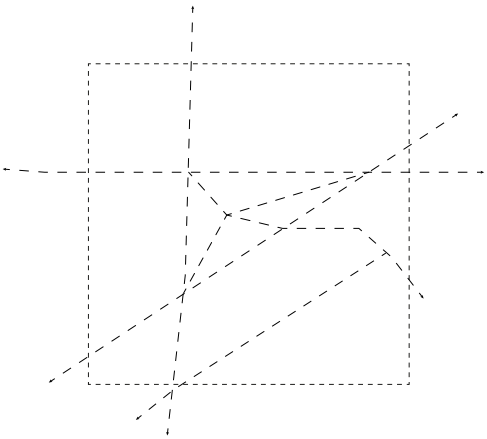
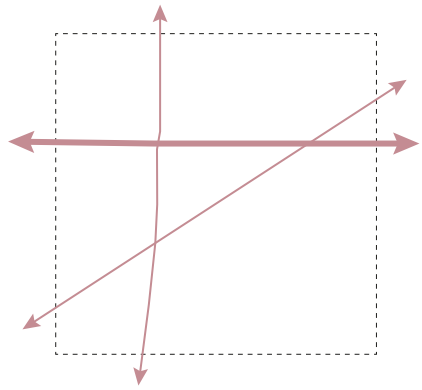
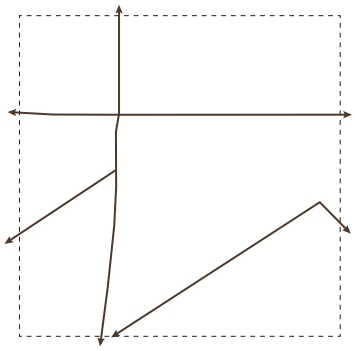
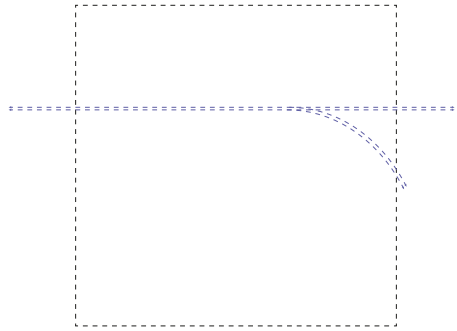
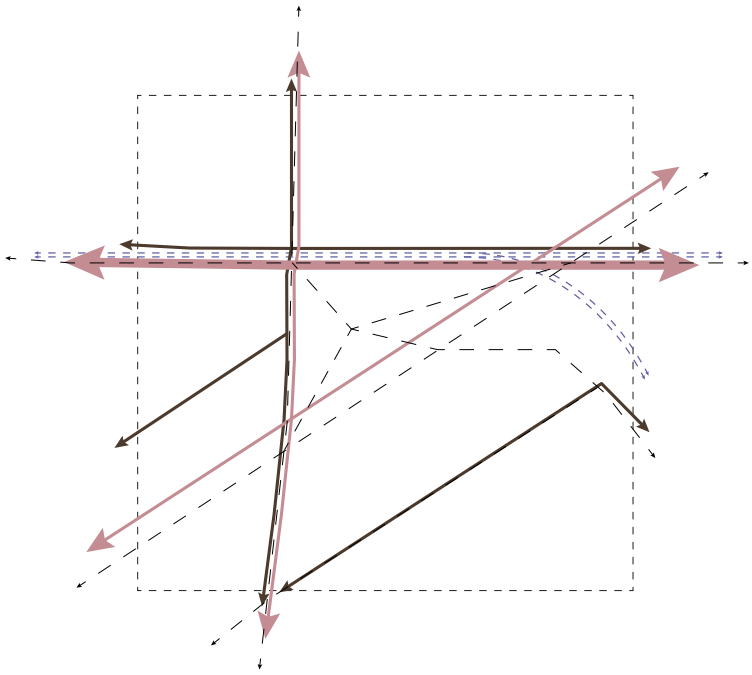


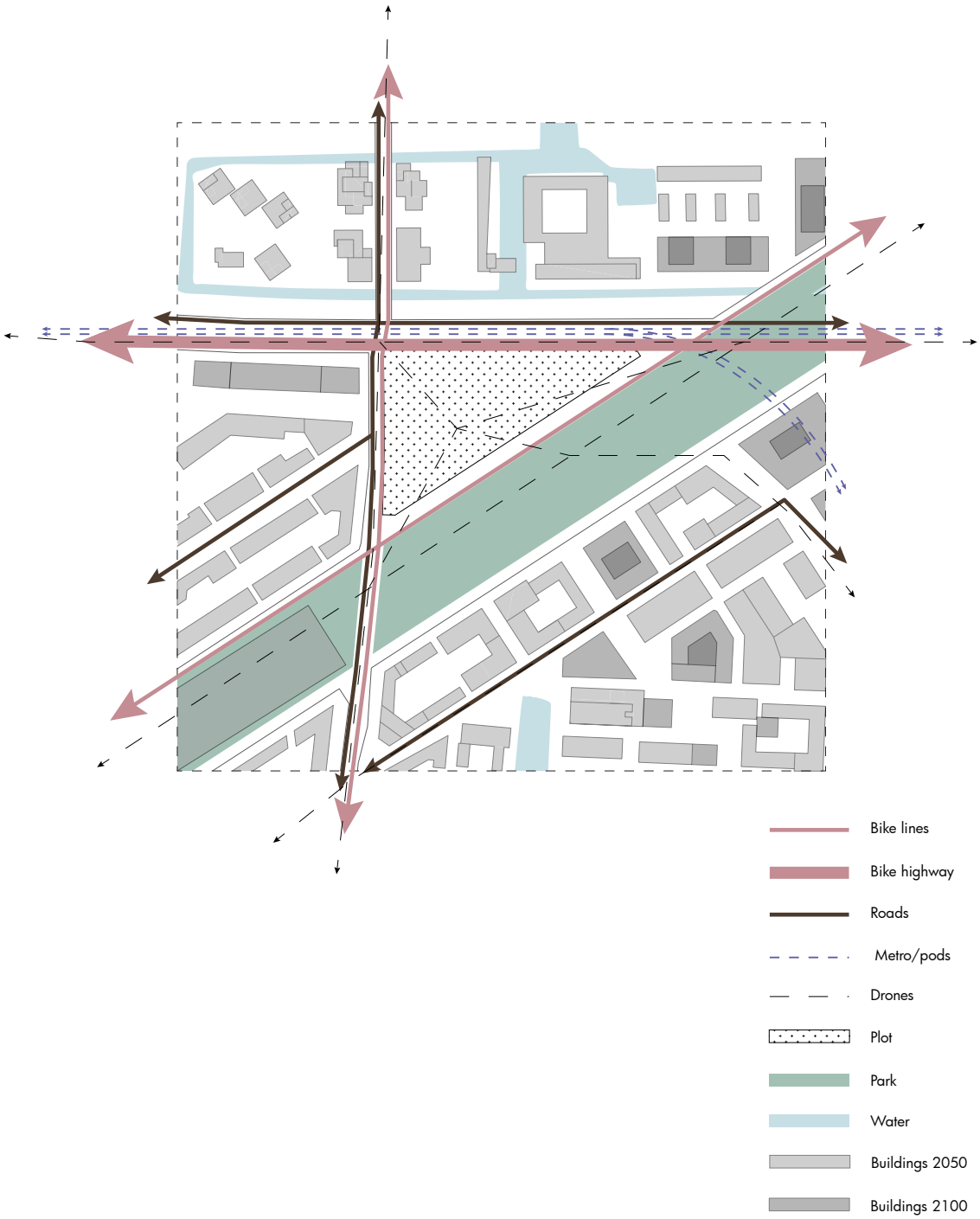


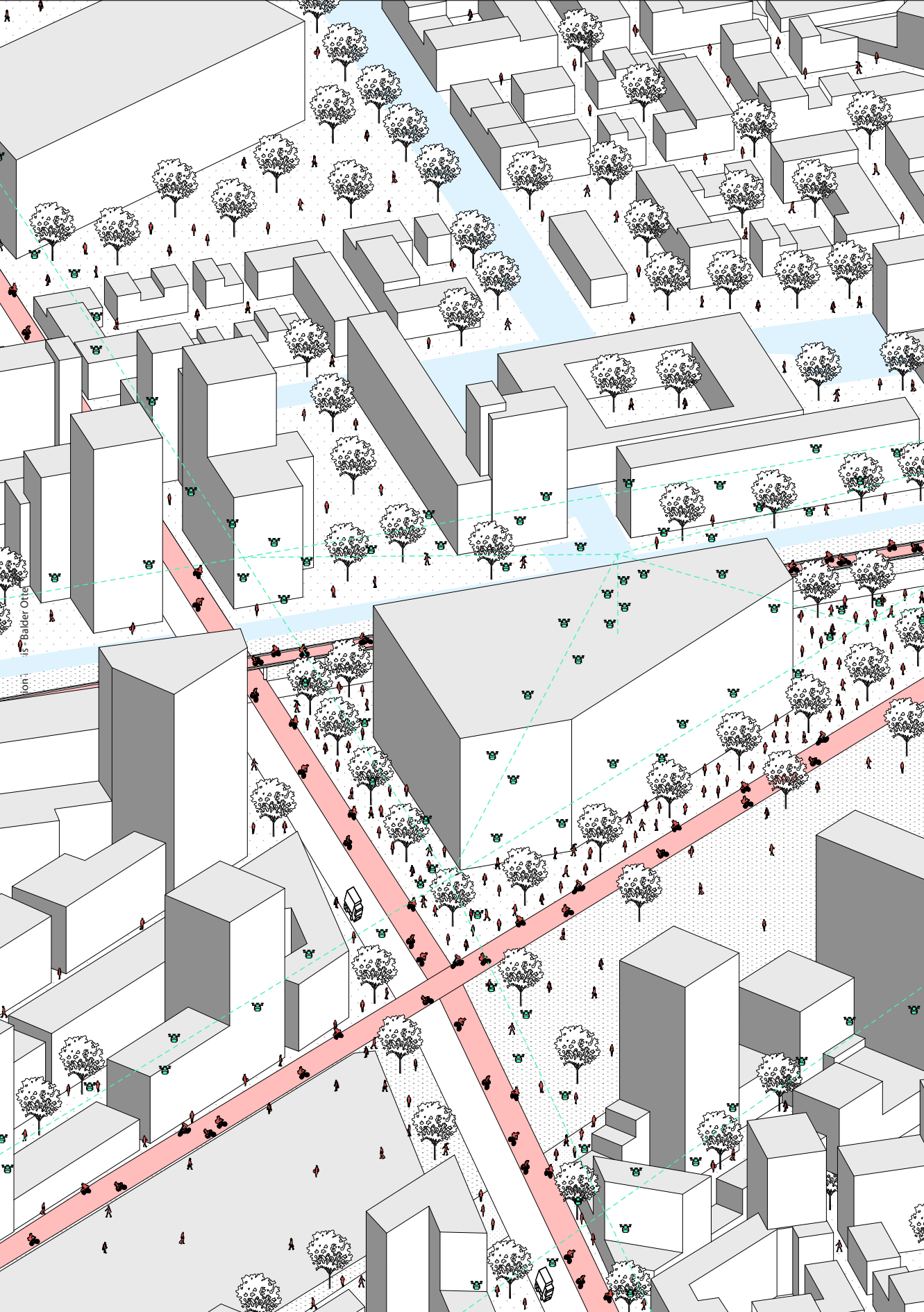


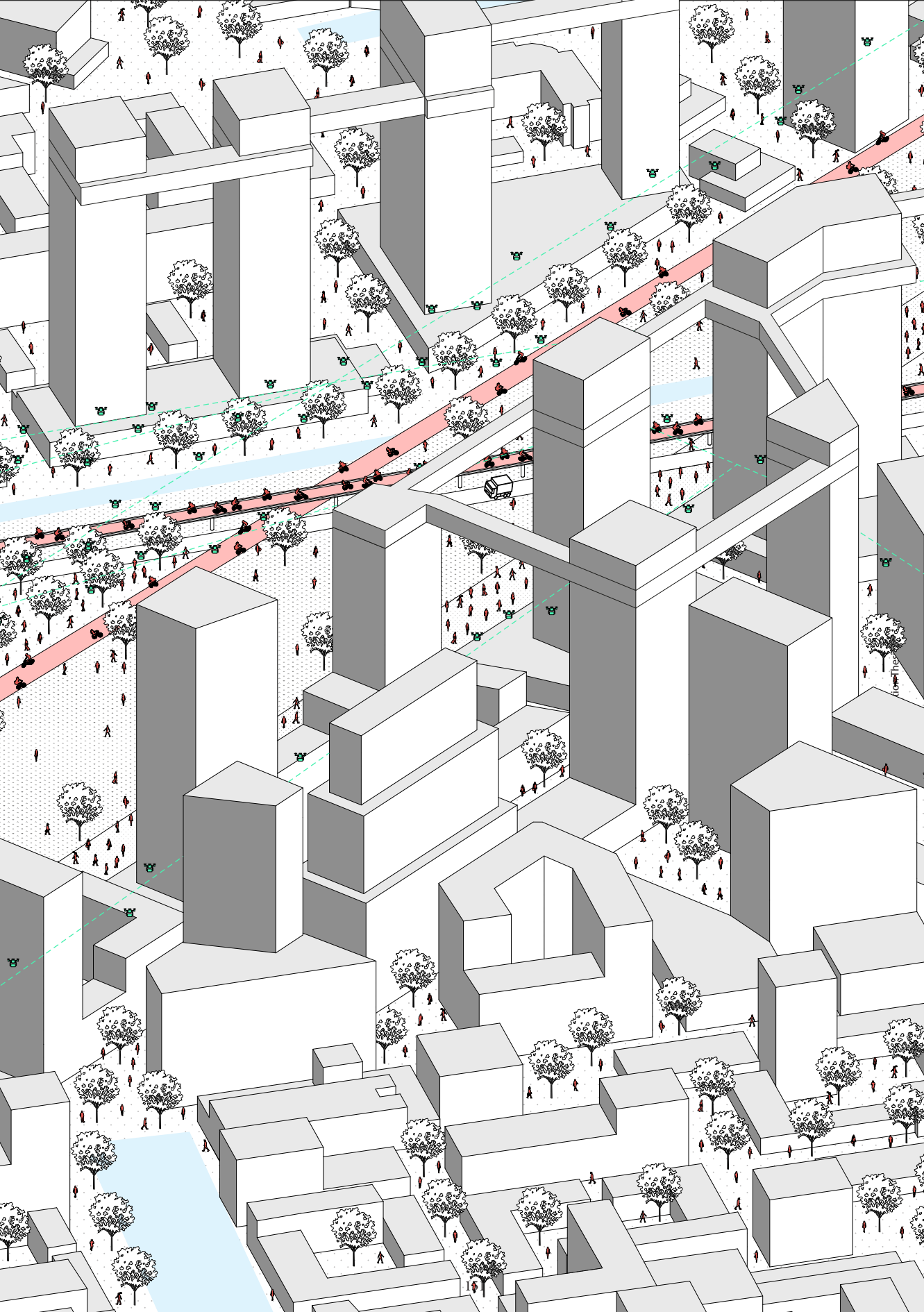





Bike lines
Bike highway
Roads
Metro/pods
Drones


Bike lines
Bike highway
Roads
Metro/pods
Drones
Plot
Park
Water
Buildings 2050
Buildings 2100





BUILDING PROGRAM

PROGRAM

Human

- Central hall = 5,000 m2
- Amenities = 10,000 m2
- Public space = 5,000 m2
- Metro = 5,000 m2
- Bus & Car Terminal = 3,750 m2
- Car Parking = 7,600 m2
- Passenger drone = 5,100 m2
- Bicycle storage = 18,000 m2

Goods

- Unloading inhaul area = 12,000 m2
- Short-term storage/picking area = 72,000 m2
- Combining items area = 6,000 m2
- Packing area = 6,000 m2
- Return goods area = 12,000 m2
- Truck shipment = 4,000 m2
- Droids/AVG's shipment = 1,000 m2
- Drone shipment = 5,500 m2
- Bicycle shipment = 500 m2

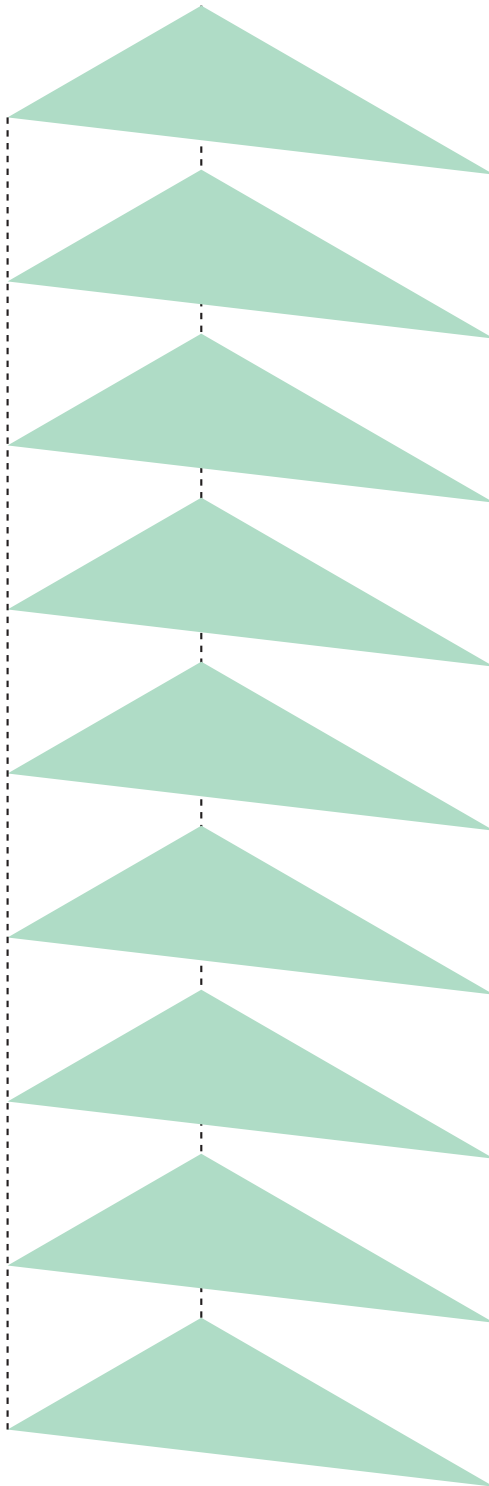
Human = 59,450 m2

Goods = 120,000 m2

+

Total = 179,450 m2

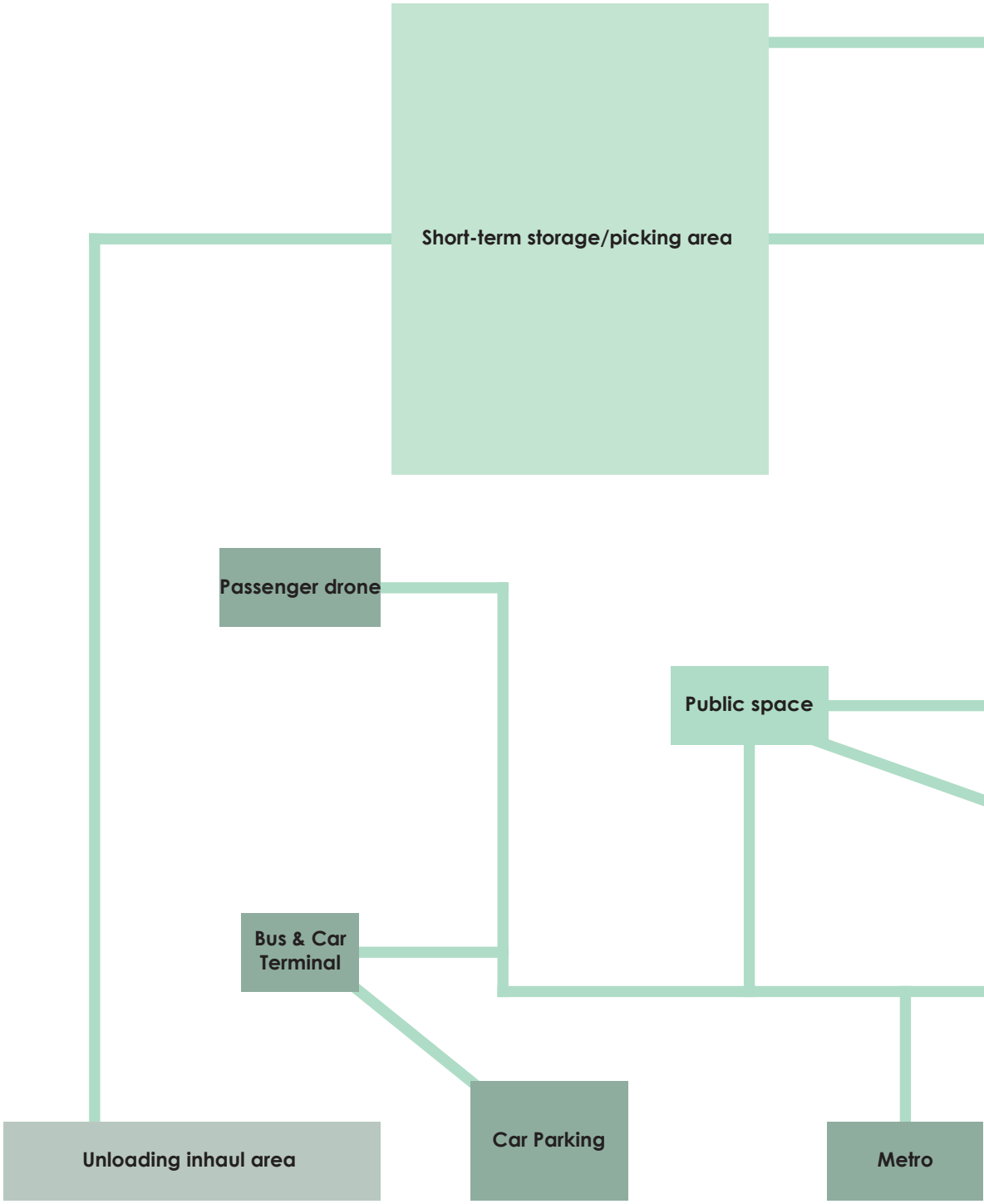
9X SIZE PLOT

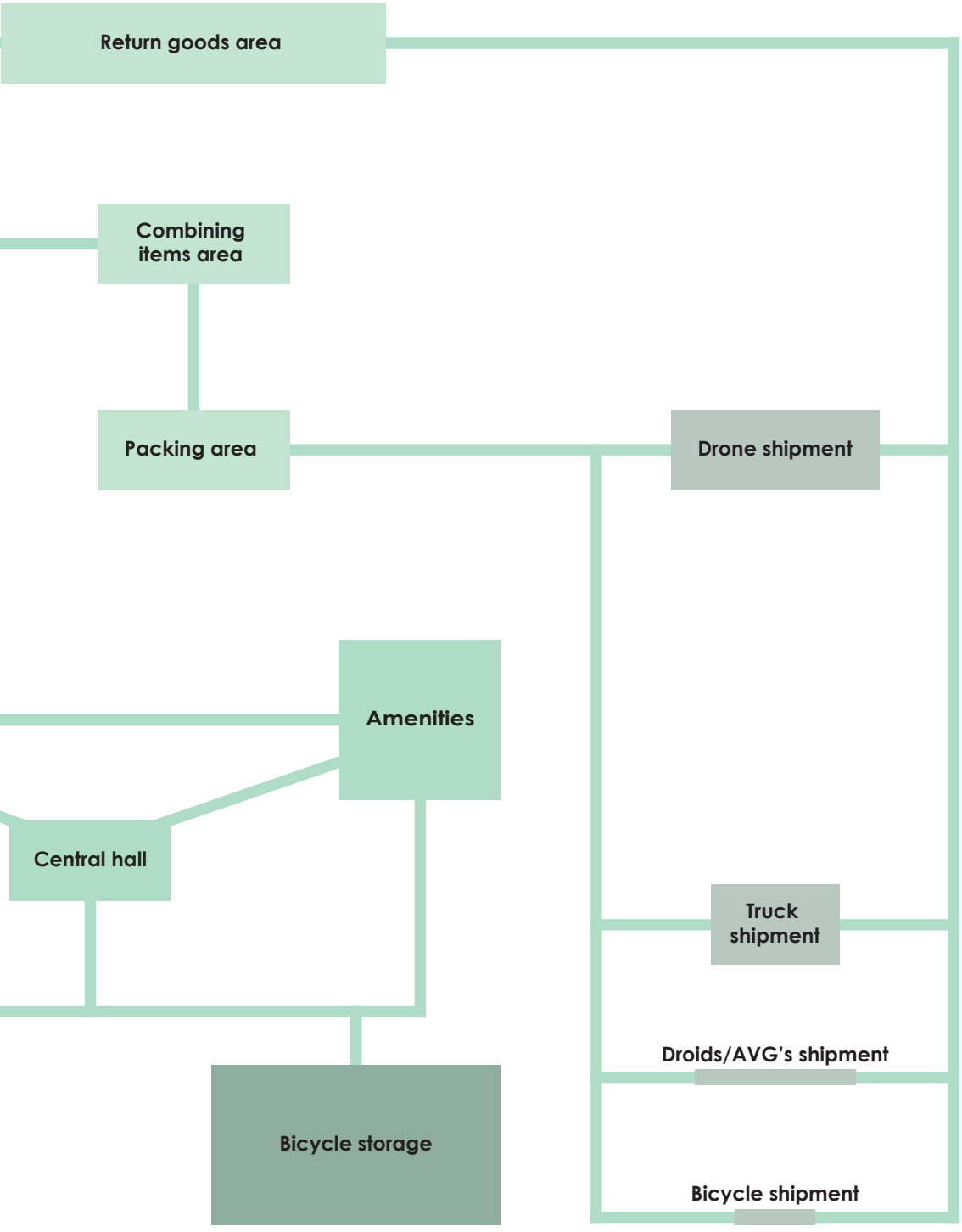


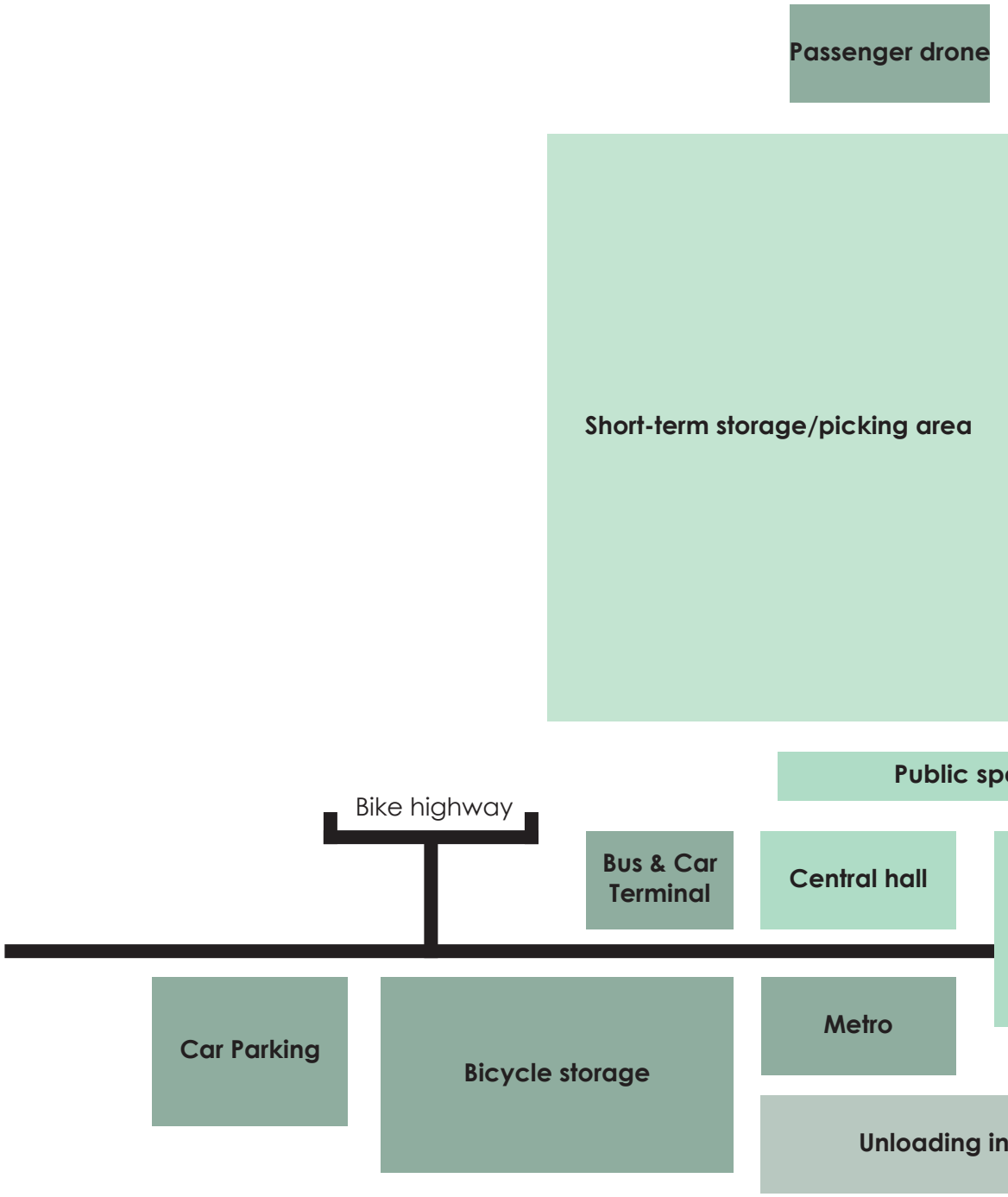
180,000 M2

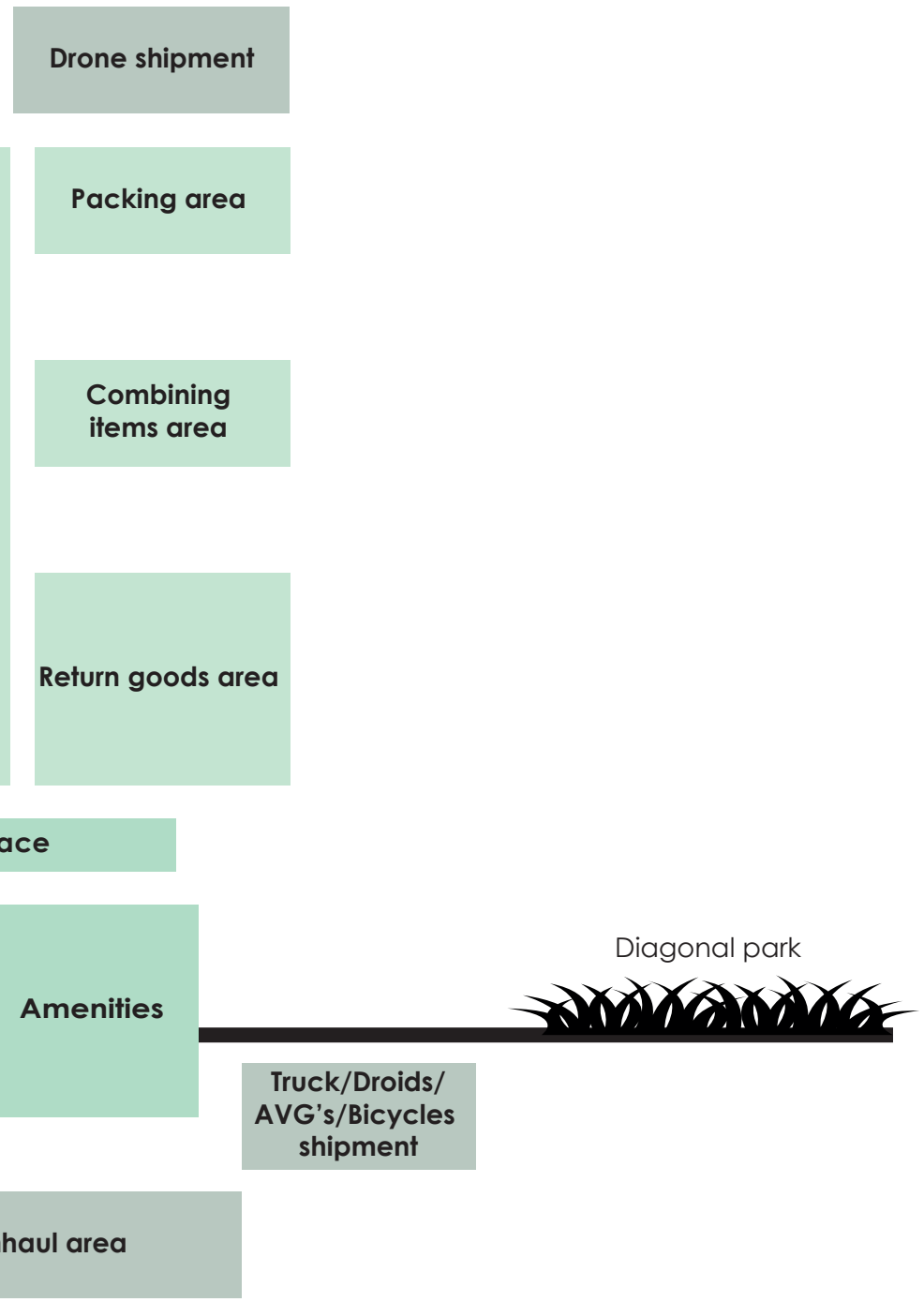
Calculation:

All human program (except bicycle):	41,450 m2 * 6 m=	248,700 m3
Bicycle:	18,000 m2 * 3 m=	54,000 m3
Unloading, combining, packing, return goods:	36,000 m2 * 6 m=	216,000 m3
Storage/picking:	72,000 m2 * 8 m=	576,000 m3
Shipment:	12,000 m2 * 3 m=	36,000 m3
	Total =	1,130,700 m3


Short-term storage/picking area
Passenger drone
Public space
Bus & Car Terminal
Unloading inhaul area
Car Parking
Metro


Return goods area
Combining items area
Packing area
Drone shipment
Amenities
Central hall
Truck shipment
Droids/AVG's shipment
Bicycle storage
Bicycle shipment


Passenger drone
Short-term storage/picking area
Public sp
Bike highway
Bus & Car Terminal
Central hall
Car Parking
Bicycle storage
Metro
Unloading in


Drone shipment
Packing area
Combining items area
Return goods area
ace
Amenities
Diagonal park
Truck/Droids/ AVG's/Bicycles shipment
haul area

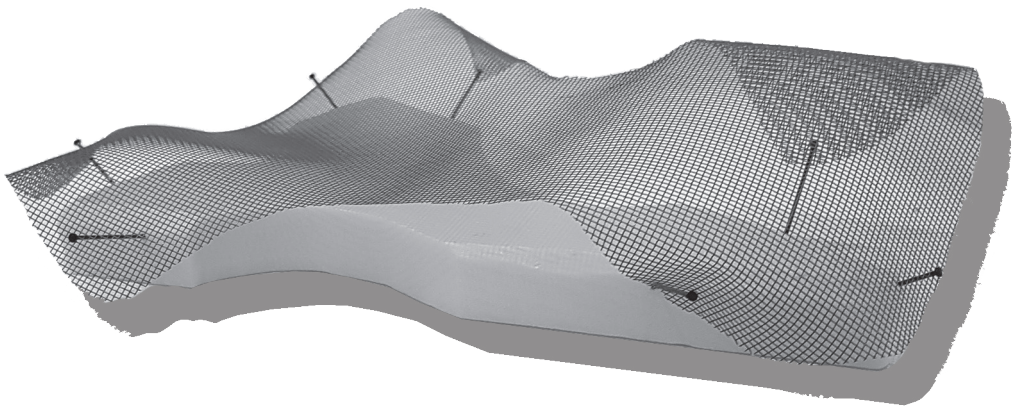
MASSING STUDIES

CANYON

Different program merged
into one shape.

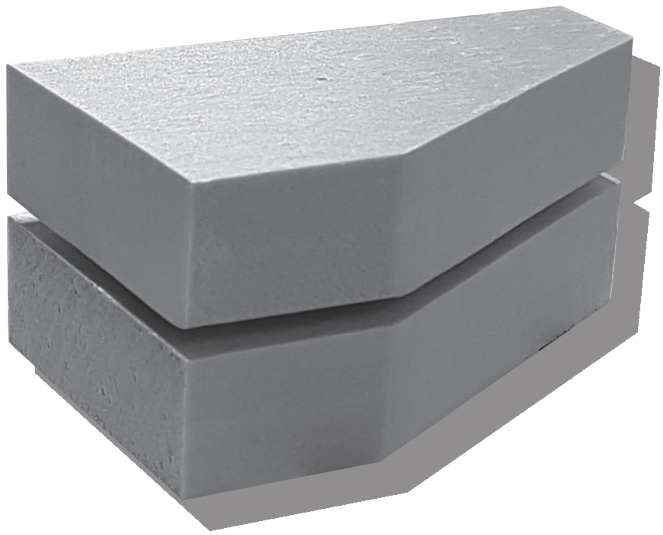
CANOPY

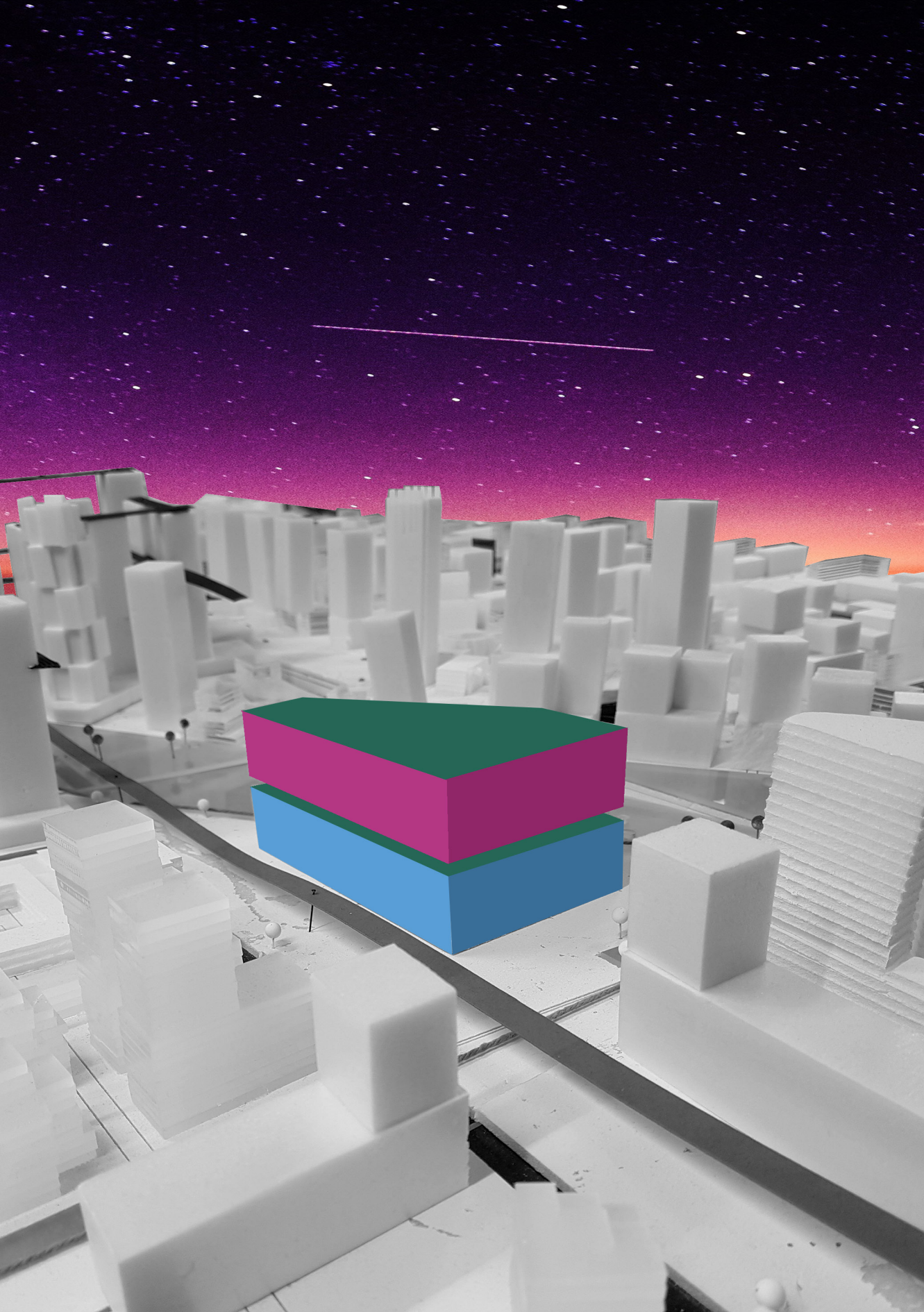
All the functions hold together by a canopy, that is connected with the surroundings.



BLOCK

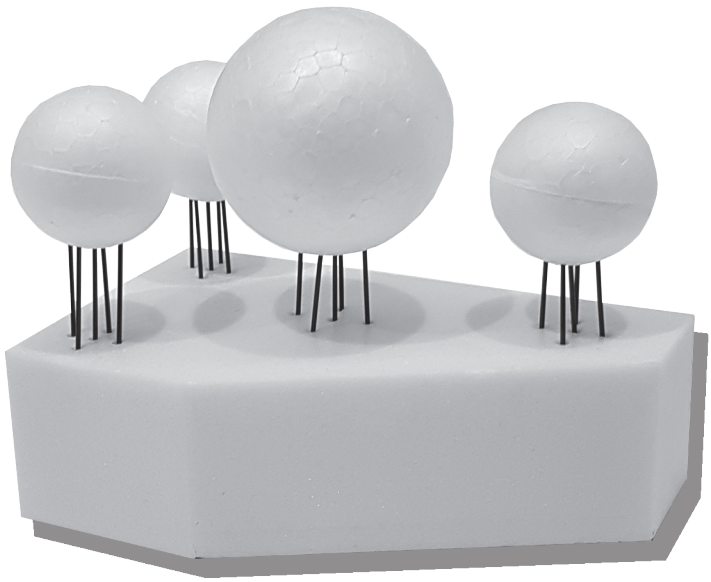
Separation between program that is restricted to the ground and program that is restricted to the air, in a subtle way.

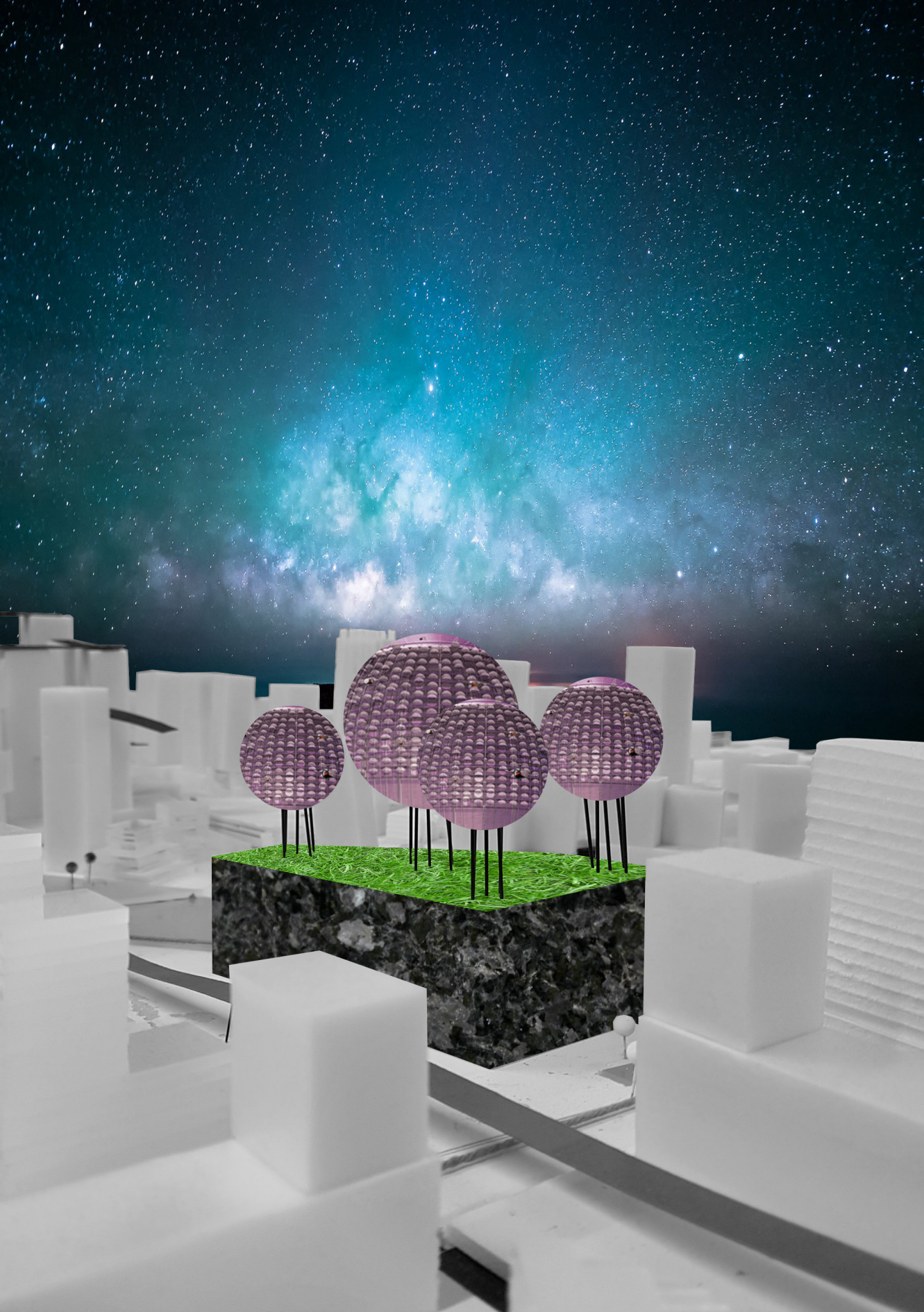




SPHERE

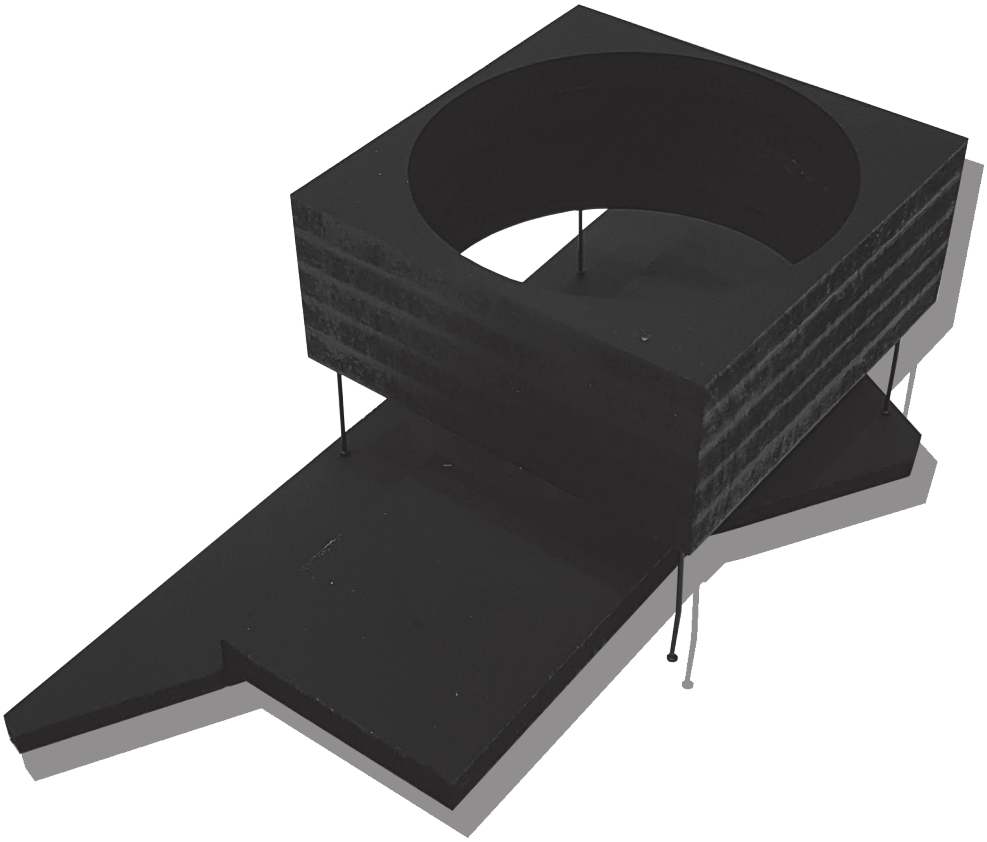
Clear separation between program that is restricted to the ground and program that is restricted to the air

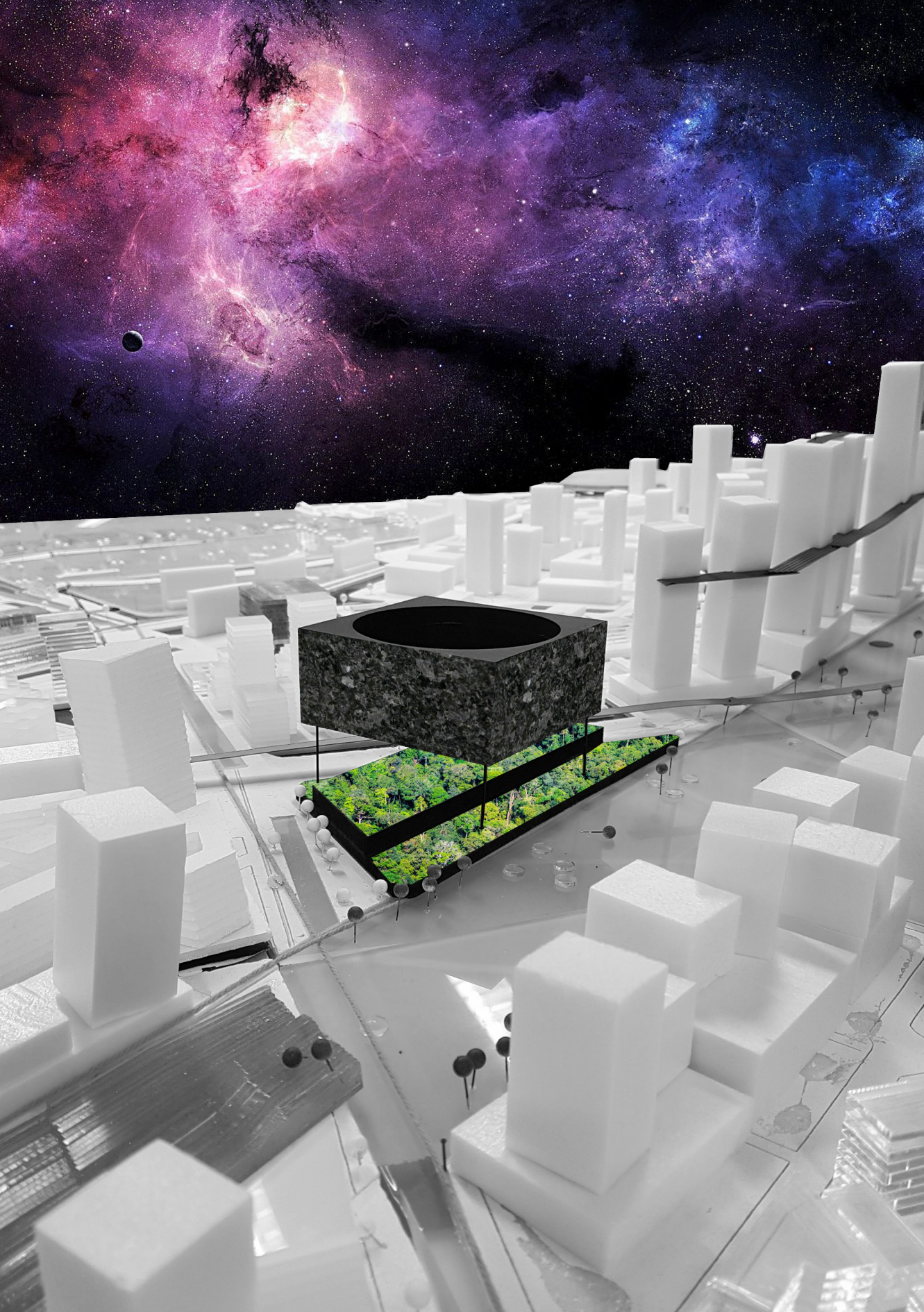




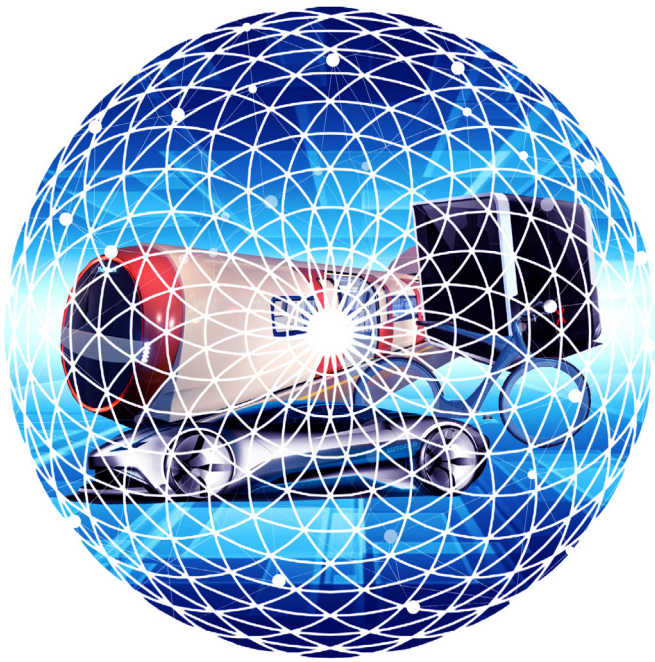
CILINDER

Clear separation between program that is restricted to the ground and program that is restricted to the air.





DESIGN AMBITIONS



SEAMLESS CONNECTION BETWEEN MODES

In 2100 the transfer between modes of transport has to be fast and seamless. The transport hub has to be designed to minimize time of transfer between modes.

PART OF THE PUBLIC SPACE

Transport hub has to be part of the public space, both the human and goods transportation part of the building. In this way it can become a destination and it will become part of the identity of Amstel, (p)leisure city.

INTEGRATED IN THE URBAN ENVIRONMENT

The transport hub has to fit in the urban environment of Amstel in 2100. This mean that is has to be integrated in the (vertical) city and have good access/dispersal to the Amstel area.

GATEWAY TO AMSTEL

The transport hub has to become the gateway to Amstel. For not only humans, but also for goods. To archive this must the transport hub have different roles and has to become an architectural landmark.

GATEWAY TO AMSTEL

THE FUTURE MID-CITY TRANSPORT HUB

"A new typology that is a combination between a node for human transport and a fulfillment center from where goods can be distributed to Amstel. At this new kind of building, the mid-city transport hub, people can transfer fast and seamless to other modes of transport and have access to or dispersal from the mobility network of Amsterdam. It is a building that is integrated in the (vertical) urban environment and is part of the public space. The future mid-city transport hub will become the gateway to Amstel."

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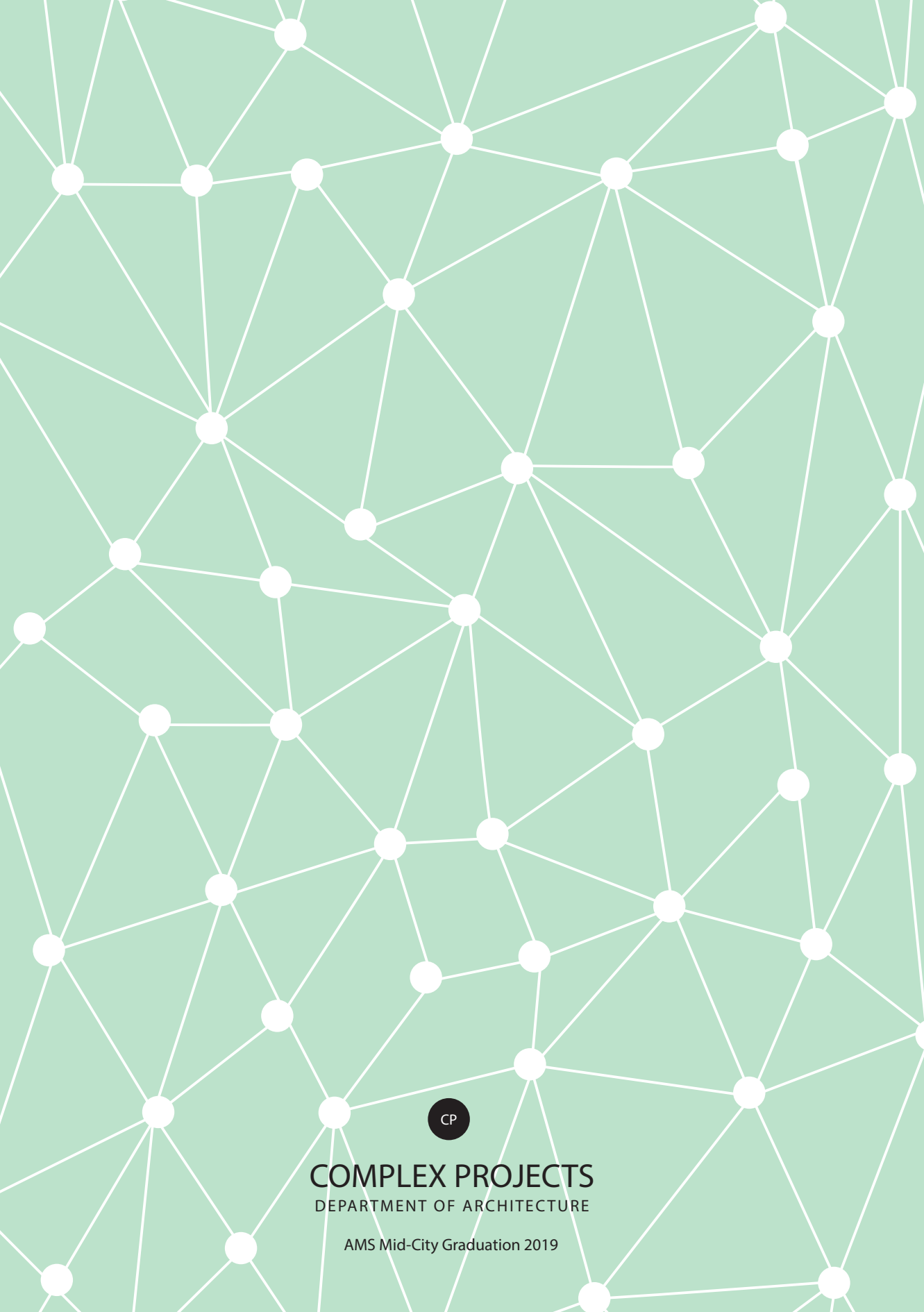

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