# /AMSTEL HEALTH BASE

by Eliza Janmaat

AMS Mid-City graduation studio

Graduation project research book
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2018-2019

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# RE-IMAGINING HEALTHCARE:
# ENGAGING IN HEALTH FOR THE AMSTEL COMMUNITY IN 2100

P2 RESEARCH BOOK / AMS MID-CITY GRADUATION PROJECT, JANUARY 2019
/ COMPLEX PROJECTS, FACULTY OF ARCHITECTURE, TU DELFT

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## EDITORIAL

As an architecture student you are challenged with learning to create physical manifestations that will fit the demands of the upcoming future. During this process you distance yourself from being a designer and analyze at how we live our lives and what are typical human values that we want to be maintained. In that way it is more tangible to relate to future trends and how we will develop ourselves towards a future scenario.
This research book is a bundle of my personal interpretation of the needs for the future of a growing city like Amsterdam. Throughout this graduation project the focus is to shift from different perspectives regarding a healthy future.
I hope you enjoy reading it.

*Eliza Janmaat*
*January 2019*

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*image a / first own collage – octobre 2018*

# On a chilly October afternoon in 2050,

after having watched the leaves falling off the trees from our garden too long to get bored, my beautiful and overtly curious grandchild, Nina, came to me and started asking me questions.

She pointed at one of the many CubeSensors in the living room – small, very simply designed cubes which measure air quality, temperature, humidity, noise, light, air pressure and based on our personal information it adjusts the relevant factors for optimizing our well-being at home – and asked me whether I lived in a house before, what did not have such cubes. When I said yes, she looked at me with wide, marveling eyes and asked me to tell me how I lived when I was young. She liked to ask about the past. I told her about the unbearable heat in third-floor apartments during hot summer nights without proper air-conditioning and the inconvenience it caused when you could not set the right amount of light for working.

Nina was satisfied with my responses, but I had had the impression she still had something on her mind. I asked her about it. She told me that she heard a word from her fellow first graders and she did not know what that was, but one of her friends, Lyanna, told her it was from the age when people did not use smart cubes at home, so she wanted to ask me and make sure I can answer the question. So, I asked her, what that mysterious word was, and she said, hospital.
I laughed out loud. Hospital. I have a grandchild, who does not know what a hospital is. Isn't she the sweetest (and for that matter the luckiest) girl in the universe?

So, I told this charming little lady to come over and listen to her old, wrinkle-faced grandpa who will tell her the story of hospitals, doctors, nurses, pills – and pretty much how healthcare used to look like in the 2010s, in the barbaric, pre-technological era of medicine.

More than 40 years ago, patients had to go to huge and unfriendly buildings called hospitals to receive any kind of care and to measure vital signs or health parameters, for example how hearts and brains work. So when people fell sick, they had to go to that specific building instead of just getting care at home or wherever. And there, at the doctor's office, you could not just go and see the physician. Sometimes you had to wait in line for hours while other people got checked.

Do you remember, Nina, how mommy called up the doctor, she appeared on the screen and mommy showed her your ear when you said it hurt? And she also told her whether you had a fever, and what the device put into your ear for checking it properly, showed? And everything happened in your room, and also your friend, Gregor, the little salamander could be there? I wish it was so easy back in the day.

Mommy told you that this method how you speak with a doctor through the screen is called telemedicine, right? You know, back in the day it was just a shiny new thing which not many believed in. People had to travel from their homes to a different place to receive care. And as doctors where not as widely available as nowadays, sometimes people had to travel a lot. Sometimes by real ambulance cars with real drivers – no driverless cars and no drones delivering medical equipment was available.

You know, Nina, nowadays computers can send each other every health data that you have within a blink of an eye. In the 2010s not every device could communicate with each other, so sometimes physicians did not know about the patients and they had to ask all the data and information that the other doctors and nurses already had. Again and Again. [...]

Can you imagine that instead of this tiny and shiny metal lamina, doctors used as huge and expensive equipment as this living room? Measuring the electrical activity of your heart (ECG) or measuring blood pressure took time and effort – even for physicians. Medical devices were huge and scary like computers a century ago and patients had to travel to the machines to have very complex examinations, such as the so-called CT scan, by which various photos are taken from the otherwise not visible parts of your body or the MRI which examines parts of the body with the help

of a magnetic field. There was also the problem called radiation which means that invisible but harmful energy waves reached the body of the patients.

You know, Nina, that you can ask things from your little tablet, and it will eventually find you an answer? Right, I told you already that there is a technology called artificial intelligence through which devices learn a lot about you – like you do about the letters in first grade – and they eventually will give you the solution to problems that might arise. It takes just seconds to find those answers. Now, can you imagine that doctors back in the day had to do searches in huge databases [...]. That it would last days or even weeks to read through the irrelevant data to find the right answer?

Also, do you remember that the other day mommy and I went to the pharmacy with you and you observed how the 3D printer machine printed the pills prescribed by your doctor? Now, listen. In the 2010s, medicine was produced by pharma companies who made the same drugs for decades and made the same dosage for millions. Everyone received the same pills – there were no personalized medicine. So, you and Gregor would have got the same, even if you had some kind of allergy and Gregor wouldn't. [..]

I think I also told you some stories about the tiniest bits of our body, the DNA and how with the technique of genome sequencing as they call it, you can get to know more about hidden weaknesses in your organism and use that "secret" data in healing you. Right, Nina? But there was no chance for knowing so much medical information about the person in the 2010s, thus grandpa could have received a drug in a dosage that would have led to serious side effects if he were too sensitive for the particular treatment.

Nina? Are you listening? How come she always falls asleep when I talk about the past? I think these stories are better for her than fairy-tales.

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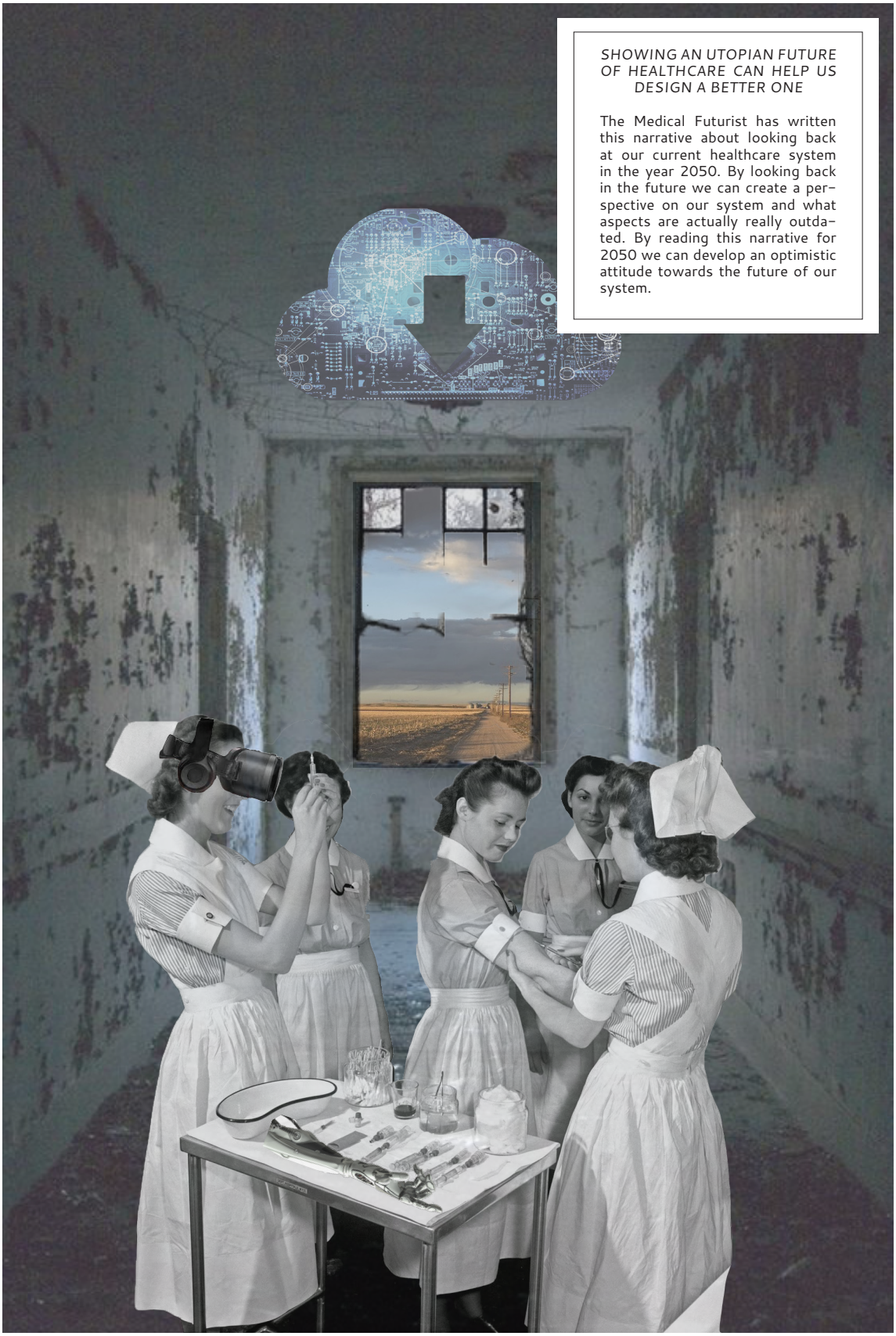
The Medical Futurist
2016



*SHOWING AN UTOPIAN FUTURE OF HEALTHCARE CAN HELP US DESIGN A BETTER ONE*

The Medical Futurist has written this narrative about looking back at our current healthcare system in the year 2050. By looking back in the future we can create a perspective on our system and what aspects are actually really outdated. By reading this narrative for 2050 we can develop an optimistic attitude towards the future of our system.

# / 00

## AMS Mid-City Graduation Design Studio

AMS MID-CITY GRADUATION
*DESIGN STUDIO*

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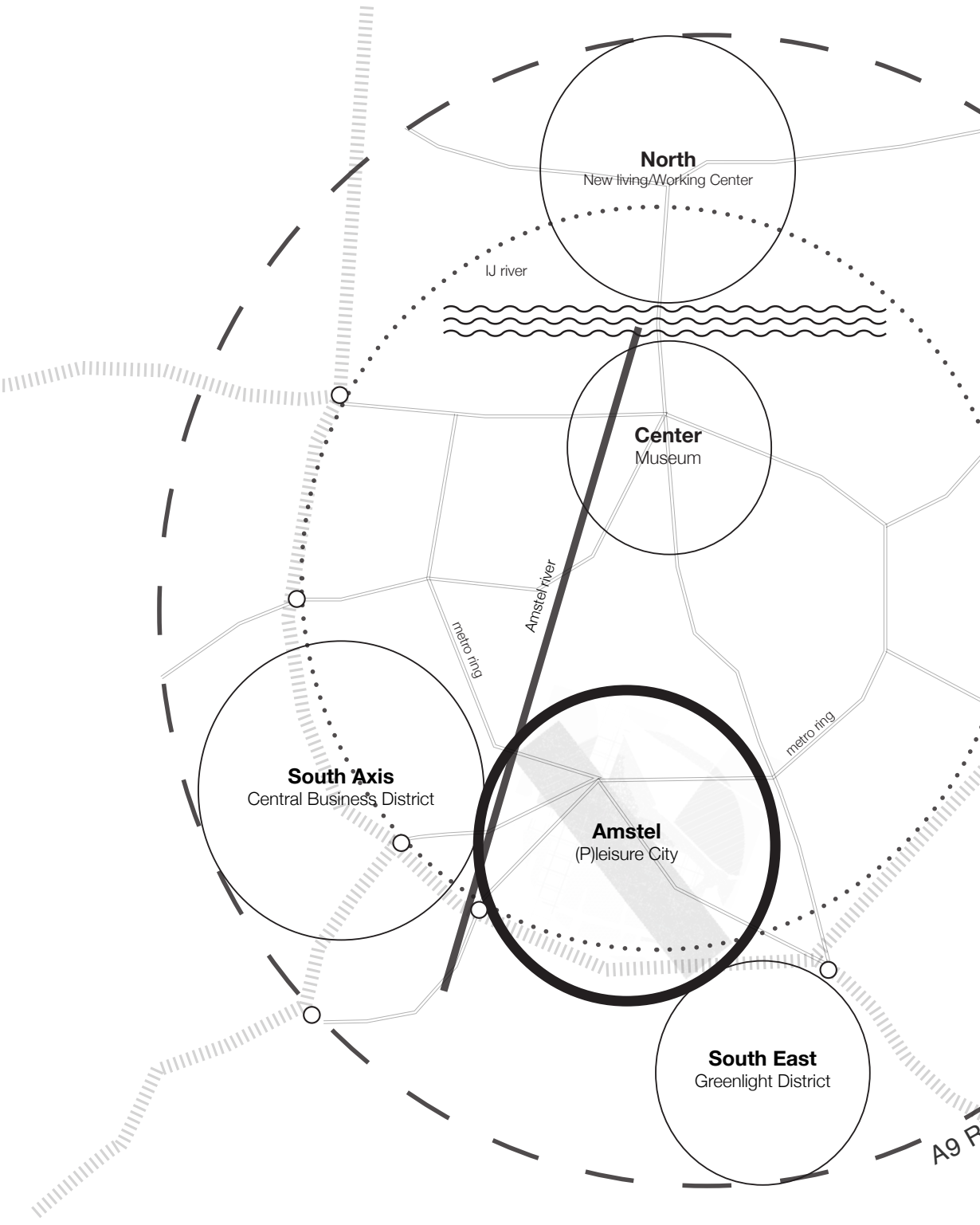
Assignment

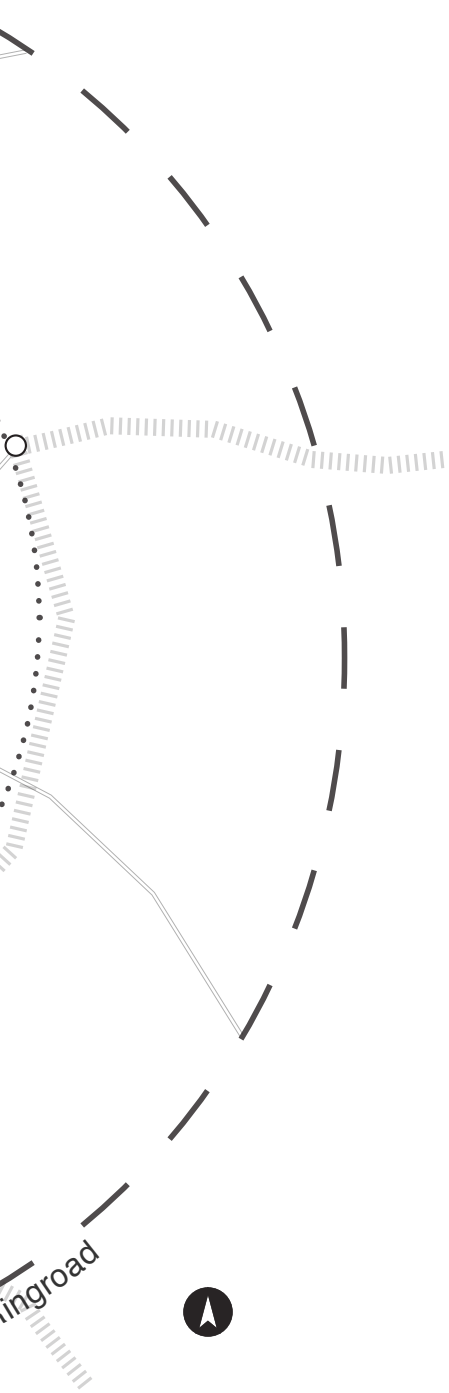
With the forecast that in 50 years more than half of the world's population will live in urban areas, a place like Amsterdam will be no different. A city with a great heritage and rapidly developing surrounding areas like the north-side of the IJ, the old Houthavens, the internationally growing Zuidas and many other areas defines it to be an interesting candidate to take it a step further. By the year 2100 technological innovations will have significantly changed our infrastructure, productivity, health, housing and our social life. And we haven't said anything about the influences of the changing climate yet.

The AMS-Mid City 18/19 studio studies the development of the 'urban zones' along the metro corridor from Amsterdam Centraal to Zuid-Oost, analyzing three sites in three separate publications:

1. Amsterdam Central
2. Amsterdam Amstel
3. Amsterdam Zuid-Oost

This research book is the answer on the findings of the group strategy for the Amstel area in 2100 based upon analysed trends, predictions and visions for this particular part of Amsterdam. Visions is mentioned, because research and analysis can only help us extrapolate to a certain point in the future. The far future is still unwritten, in the sense that it is uncomposed, unimagined and yet to be made. Understanding this concept, means we as designers can contribute into changing the future. As Alan Kay (inventor of the early laptop and tablet) once said, "The best way to predict the future is to make it". This act of imagining a future scenario and consciously contributing to achieving it can be referred to as professor Nick Montfort calls it "future-making". Research and analysis prepares us to react, or anticipate to certain trends, whereas future-making changes the attitude into a more productive stance of let's build towards a better future!


North
New living/Working Center
IJ river
Center
Museum
Amstel river
metro ring
metro ring
South Axis
Central Business District
Amstel
(P)leisure City
South East
Greenlight District
A9




*GROUP VISION*
Amsterdam 2100

Derived from the general strategy for the Amstel in 2100 there are some important developments within Amsterdam. As the city will grow, the different districts will develop along with that growth.

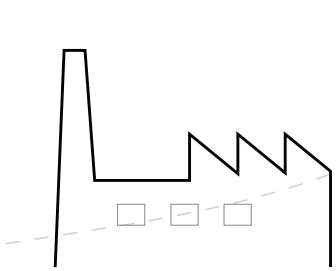
The highly densified center will have the identity of the cultural historic center with several museums, and by that known as the 'museum district'. The original trainstation is removed and does not serve as the main entrance to the city anymore.

The north has developed itself very quickly into a new living and working center. It is strongly connected to the center and the south of Amsterdam through the metro.

The South Axis has grown enormously and maintains an international business identity with the largest trainstation of the city.

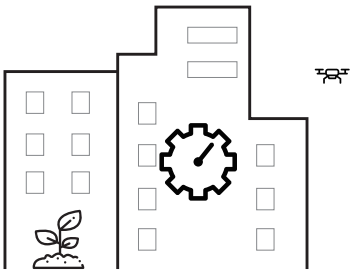
The South East district has densified as well and is now serving as the Greenlight area, providing a green urban environment with housing.
The original A10 ringroad is transformed into a city boulevard and the A9 has become the main ringroad of the city.

The Amstel area consists of certain site qualities that made the are develope itself towards the (p)leisure city of Amsterdam. As we live in an experience economy this will be a highly valued district in the future.



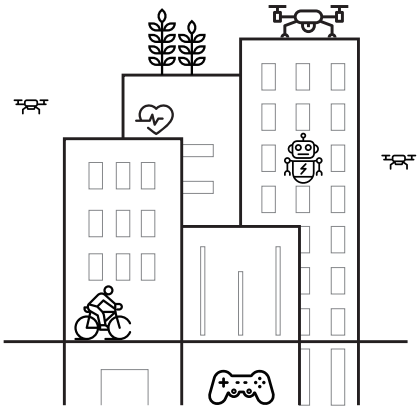
20th Century

Industrial



2050

Productive



2100

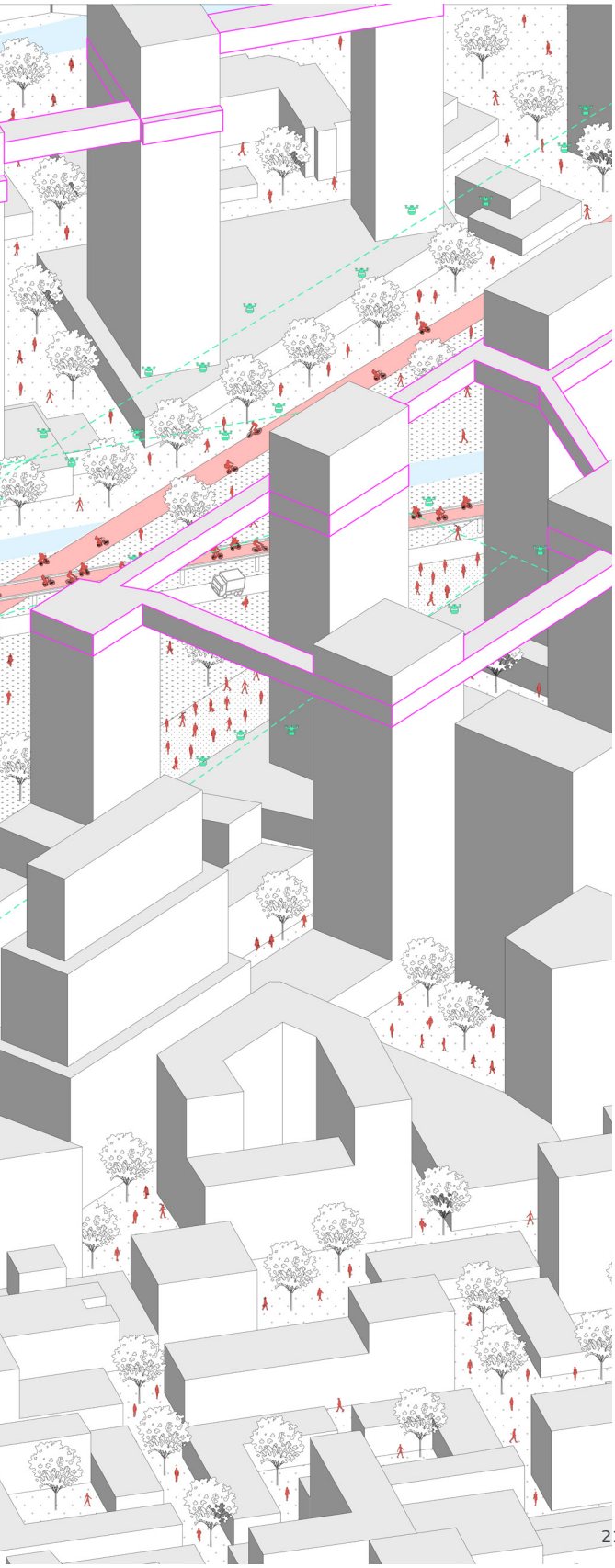
(P)leisure

*AMSTEL IDENTITY 2100*

The Amstel area anno 2018 knows much heavy industry and is not an attractive place for housing. In that moment there is a very low population density number and outdated infrastructure. The area is segregrated by this infrastructure causing multiple neighbourhoods who differ strongly from eachothers identity.
Towards 2050 the Amstel area makes a development of becoming a productive center. Productivity in a way of food, robotics, art etcetera all takes place wihtin the border of the location.

The relocation of the heavy industry opened space for the growing need of dwellings in the city of Amsterdam. This will be one of the major places for densification inside the city's ring. The new city will house 110.000 new residents in 2050, they will be housed in mixed function residential building combining work, living and production together.
Between all this densification public space is also preserved with most iconically the square park in the center of Amstel.

In the future 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 produc-



tive 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.

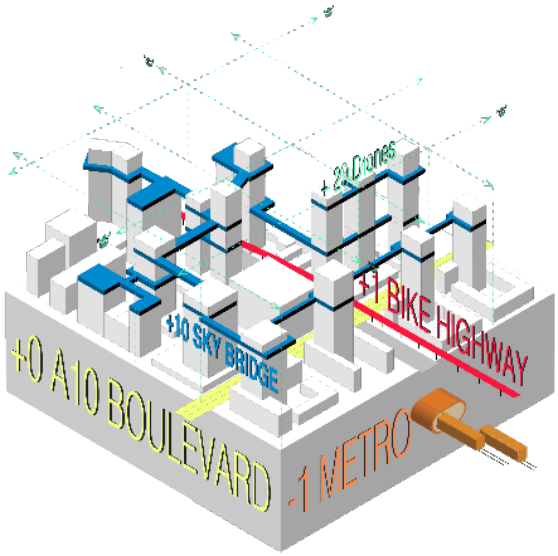
Pleasure and leisure related to the new values will be introduced in the Amstel area, evolving Amstel's productive attitude and servicing label to the production of wellness rebranding amstel as the (P)leisure city of Amsterdam. The architectural interventions(individual projects) will reinforce this brand with themes such as, healthcare centres, 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.

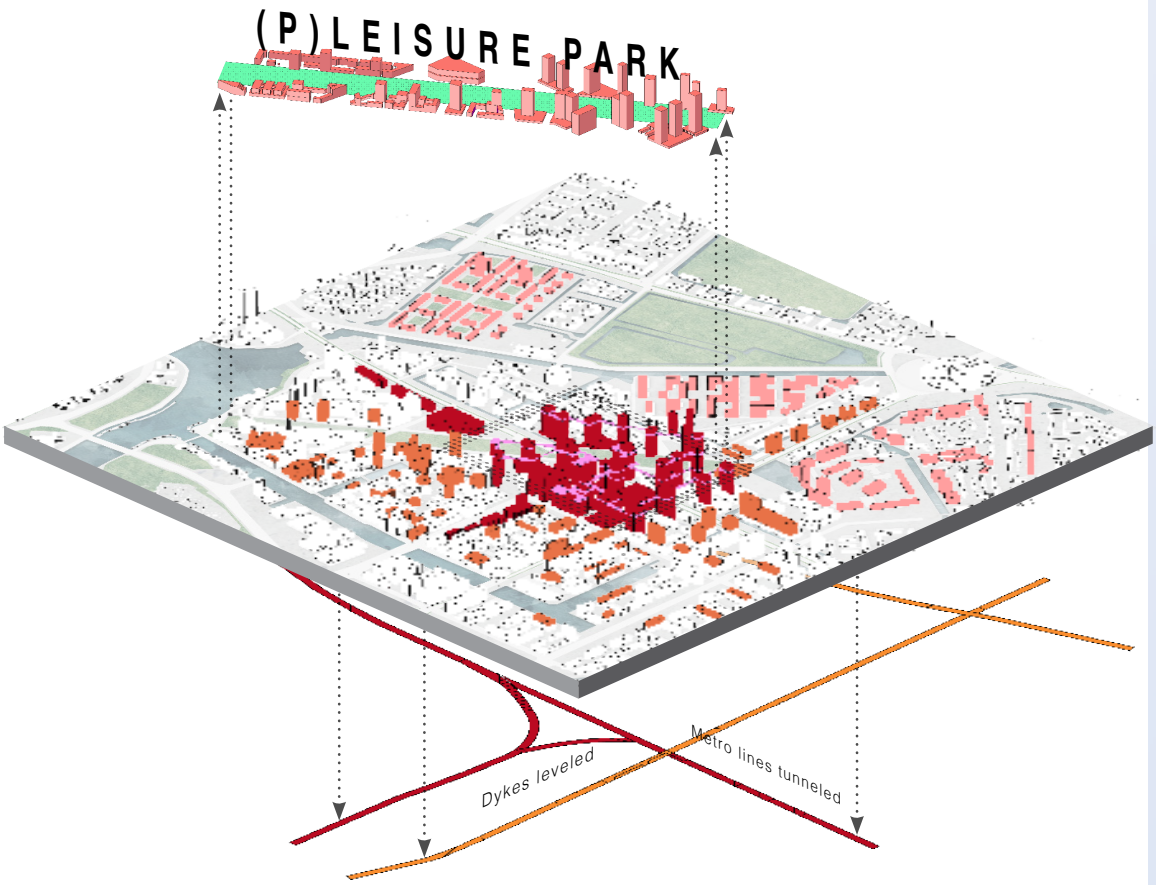
*STRATEGY DEVELOPMENT AMSTEL AREA*

1 Deal with infrastructure in the area in order to gain space for densification

2 Reinforce existing qualities in the area in order to emphasize local identity and hierarchy

3 Prepare for the vertical city and 3D urbanism




(P)LEISURE PARK
Dykes leveled
Metro lines tunneled

## *A HEALTHY FUTURE*

When looking at the future we try to imagine what will be factors in life we value the most. Will it be our career? Our living conditions? Or our family size? When it comes to focussing on the main quality of life it comes down to our health. Health has been growing in it's concept. And this perception of health will continue to grasp on multiple levels. The deviation of prevention and treatment will continue to develop in the city. Health is percepted as a lifestyle and not only a clinical state. Engaging in social, mental and physical health in an everyday life will be the main focus in a growing city.

Because with all the future developments in Amsterdam and in our lives I believe that 'the first wealth is health' - said by the American philosopher Ralph Waldo Emerson. With the predicted population growth and the rise of digital technologies, such as artificial narrow intelligence, robotics, virtual reality/augmented reality, telemedicine, 3D-printing, portable diagnostics, health sensors, wearables, etcetera health is an important foundation on which we build. Chronic diseases are growing in numbers and as the city becomes more dense, loneliness is a growing subject of Amsterdam. These circumstances result in a change in the entire structure of healthcare, as well as the roles of patients and doctors, and they will fundamentally shift from the current status quo.

Health itself is percepted in two ways: prevention and treatment. Through the past couple of decades the municipality has prioritized the prevention aspect of health by promoting and embedding physical exercise in the environment.

As the experience economy tends to grow we value experiences over material things. We live our lives to become the person who we desire to be. The self-actualization that leads from this will touch the aspect of health. Health will be used to reach this goal. More and more people are using devices nowadays like smartphones, fitness trackers, and wellness apps to stay healthy. They're showing great interest in accessing care through the digital tools they already use. Engaging in health will be an everyday life activity and will contribute in the loneliness factor, the inactivity factor and in the overall public wellbeing.

The treatment aspect of health goes deeper into the current healthcare system. There is a tendency that the ancient healing process is housed in outdated architecture but equipped with technology of the 21st century. So the centralized system of today is absolutely not sustainable when looking to the future. With the Amstel area as newly densified neighbourhood where the identity spins around leisure, it provides the ultimate location for a new typology that fits the health demand of the future. As health is seen in a more holistic way, leisure has a very strong connection to engaging in health.

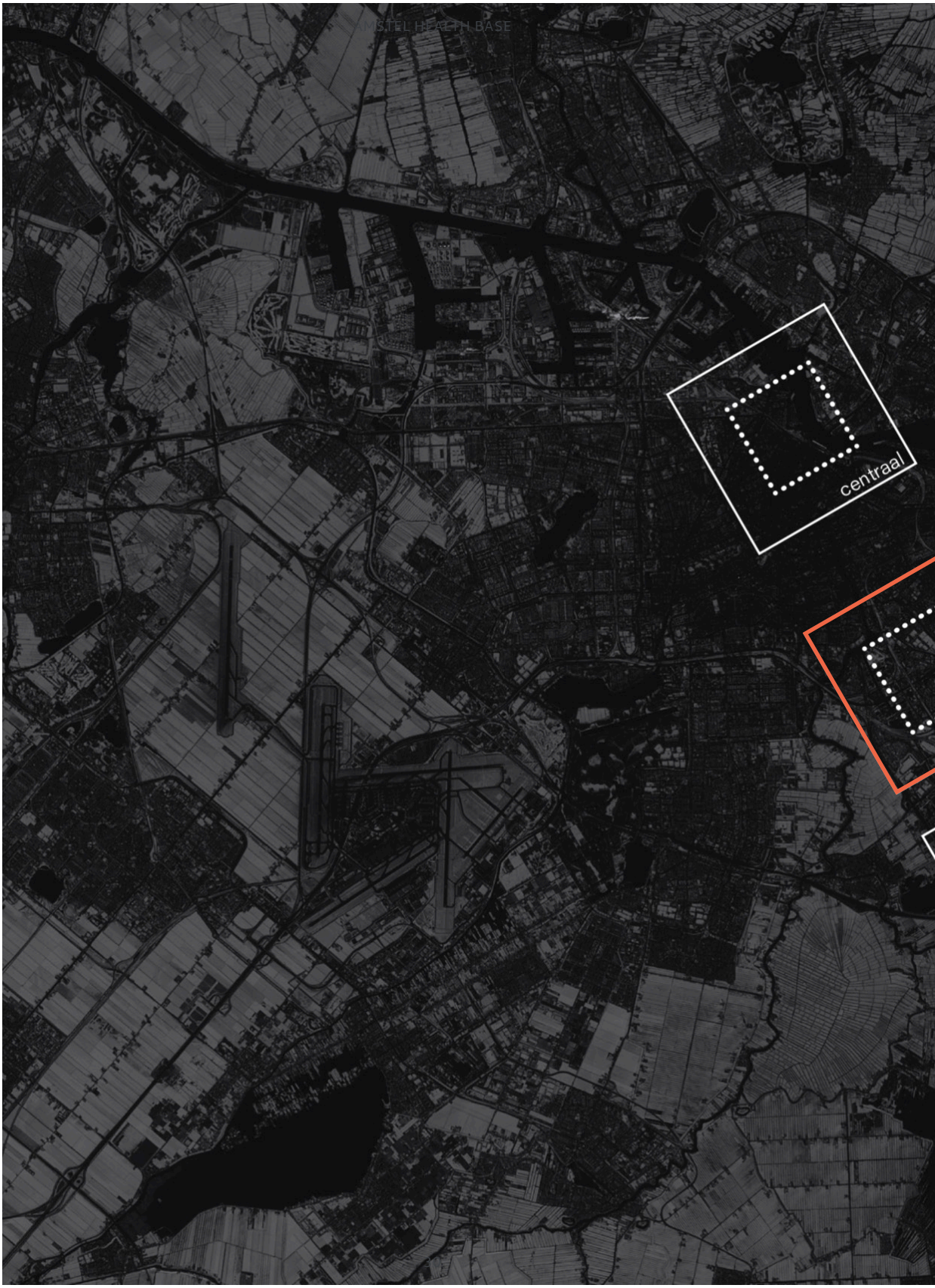
Before me lies the opportunity to develop a new type of typology which could be a leading example in the future of our healthcare system. But with that comes a task to revise our current healthcare system and trends that develop with that. As the focus on health is growing and grasping multiple disciplines of life, my attention was caught to look at the future of this. Not only engaging in the prevention aspect of health but the future of treatment and care of health is a very interesting architectural research.

# /THE FIRST WEALTH IS HEALTH

*Ralph Waldo Emerson, 1860*

# / 01

## Context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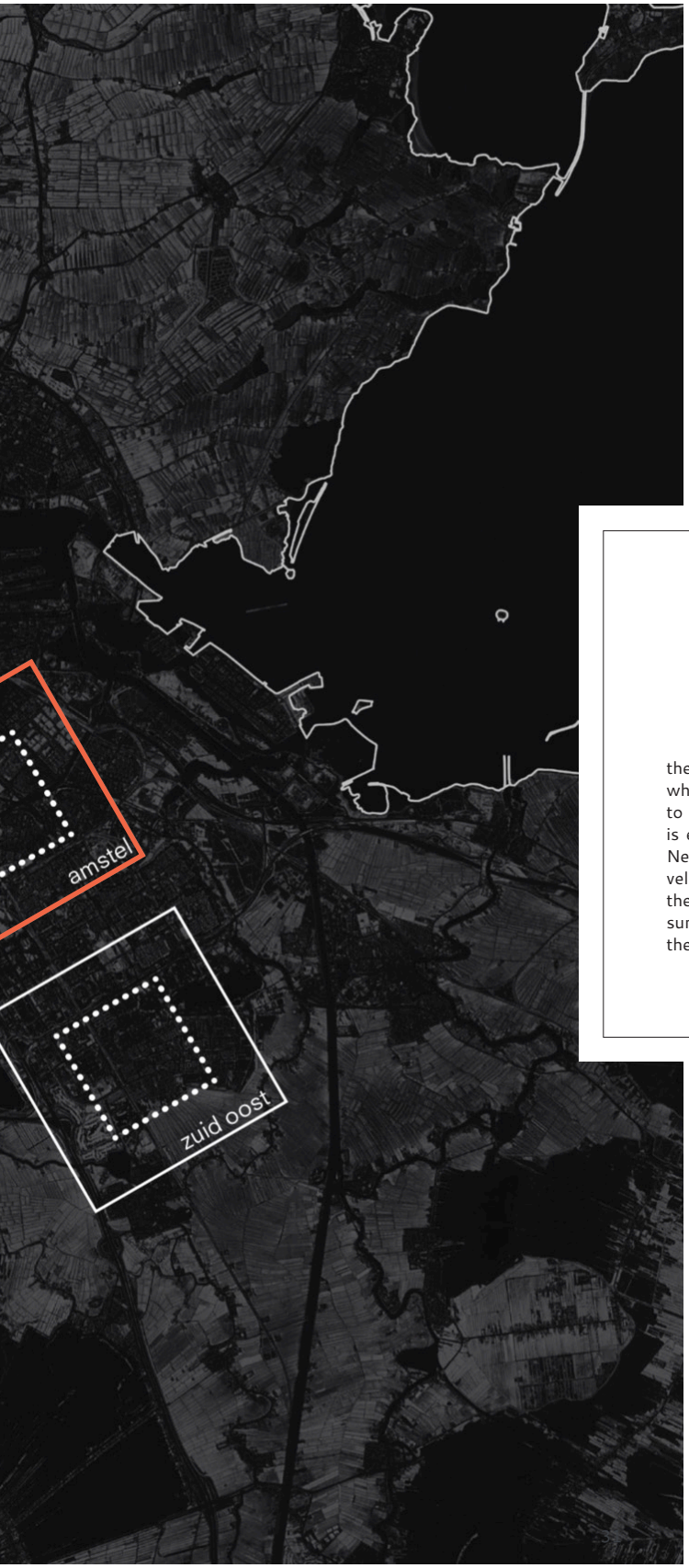
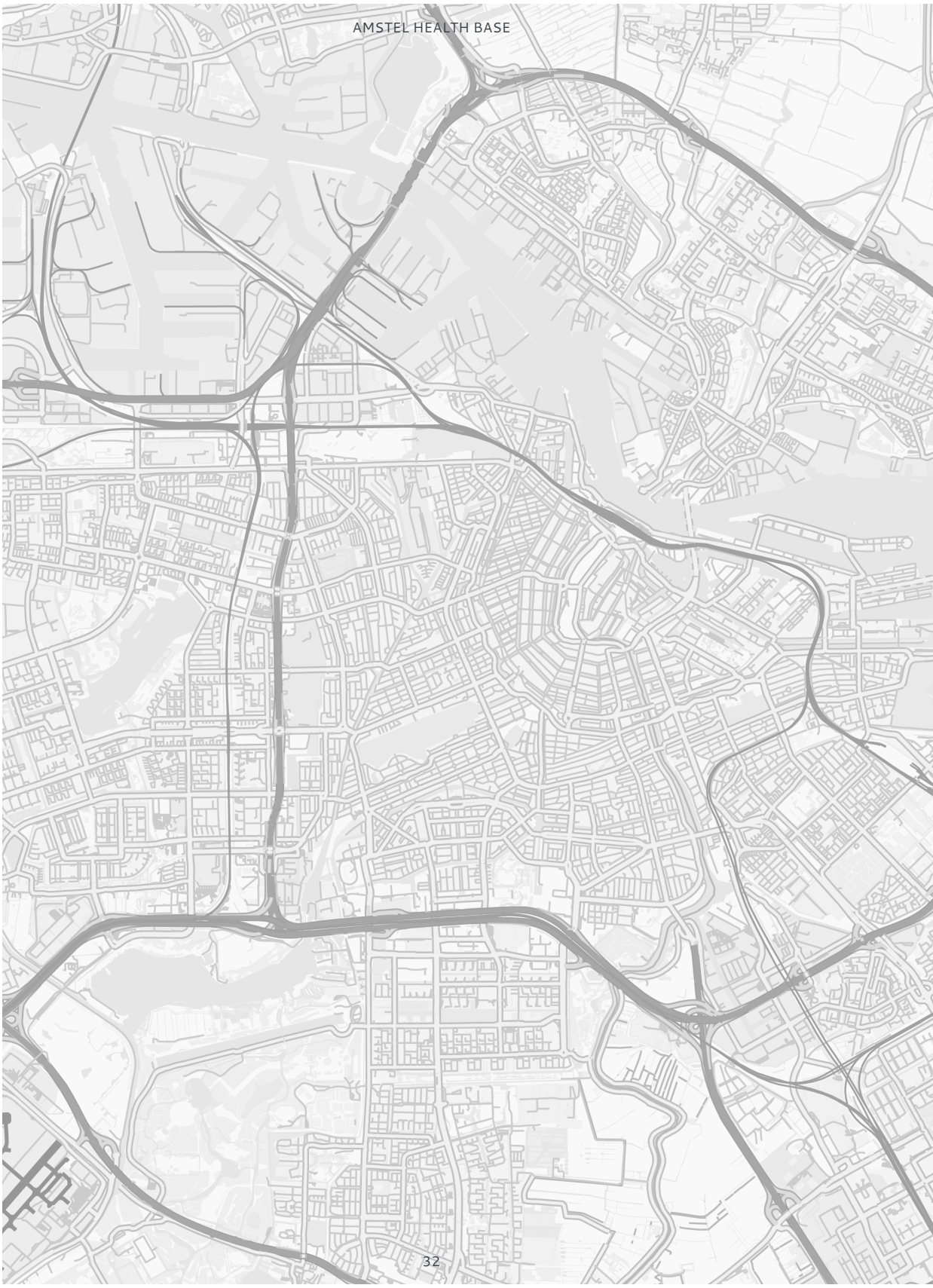
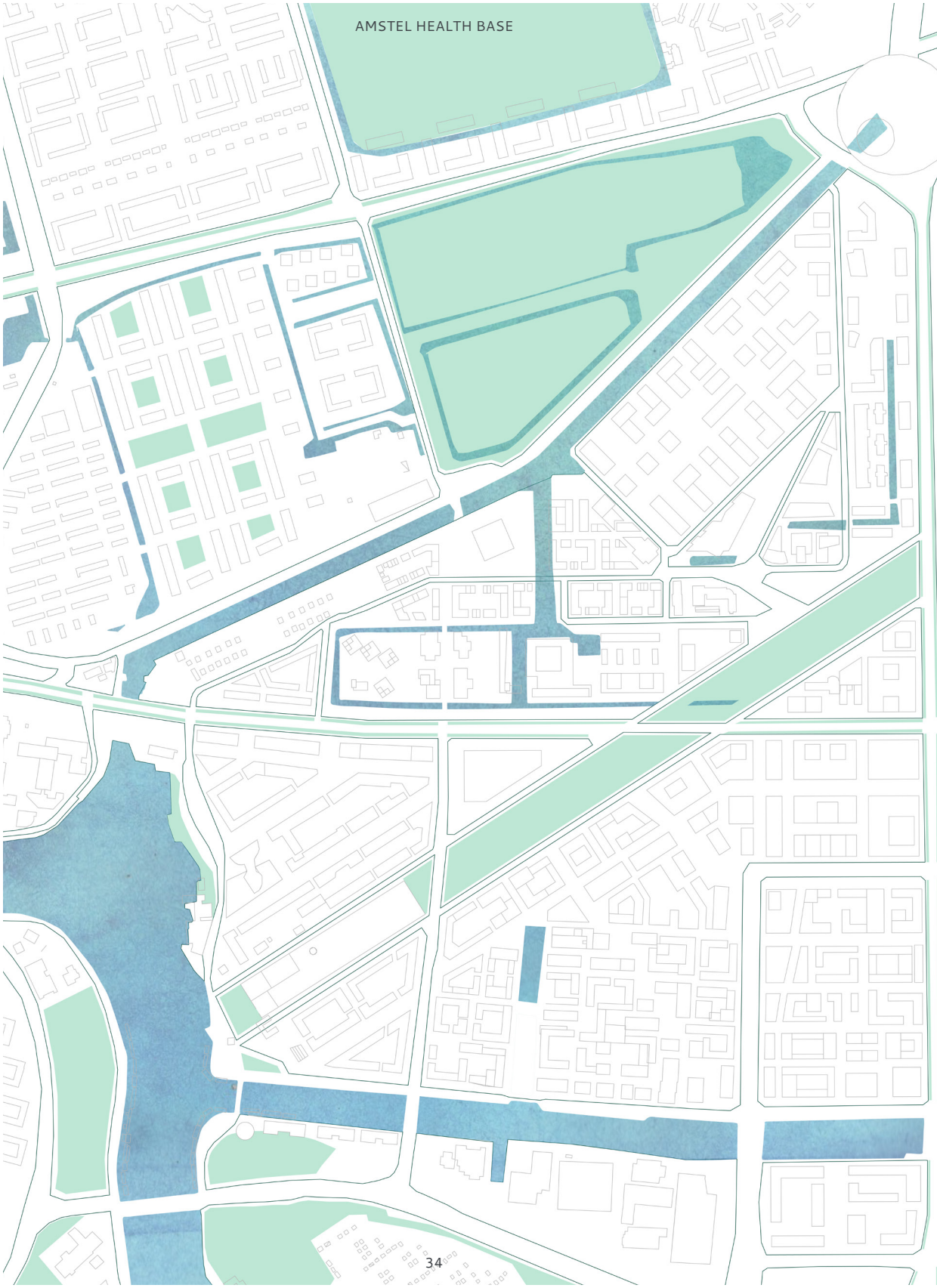
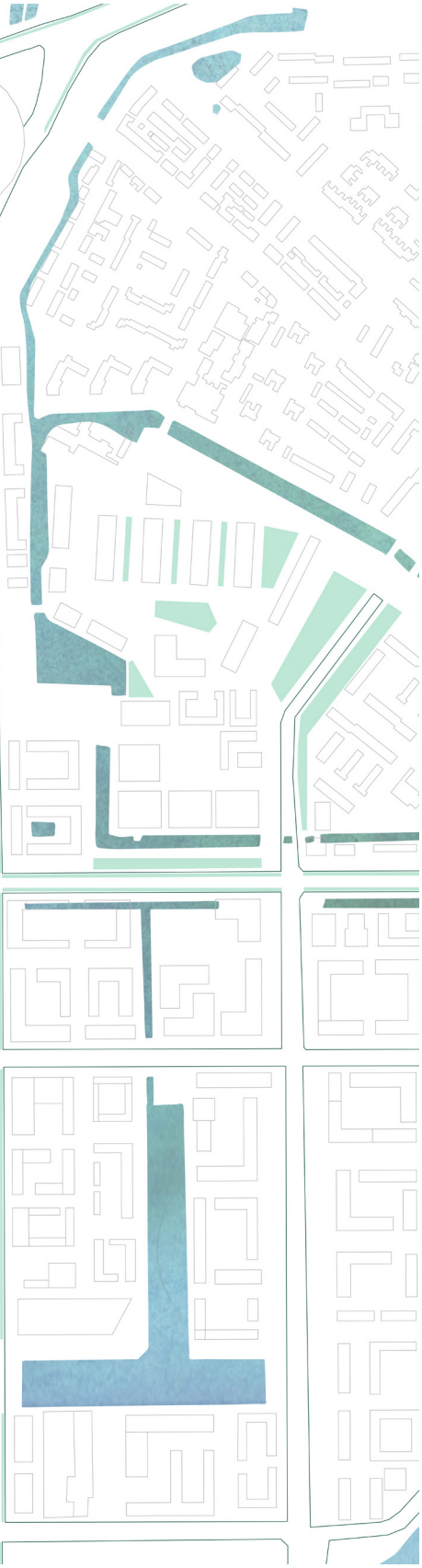


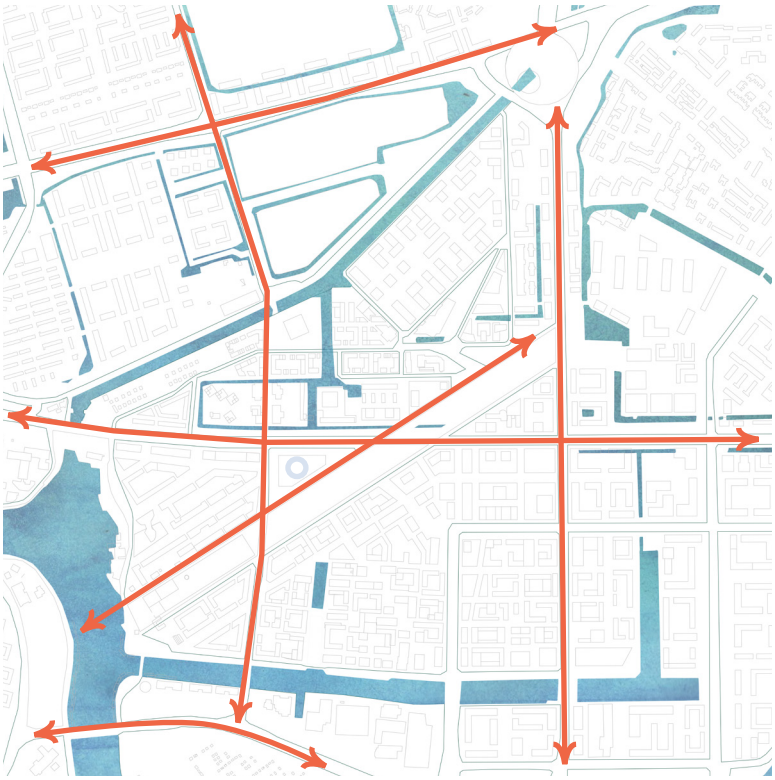

*AMSTERDAM AMSTEL 2100*

the Amstel area is the perfect area where Amsterdam will focus to densify to host the growing population that is expected in the upcoming 80 years. Next to densification, the area will develop itself to have an identity where the focus lies on being the centre of leisure in the city. The urban plan provides the roots of a healthy, densified, mobile and sustainable future.




AMSTEL HEALTH BASE



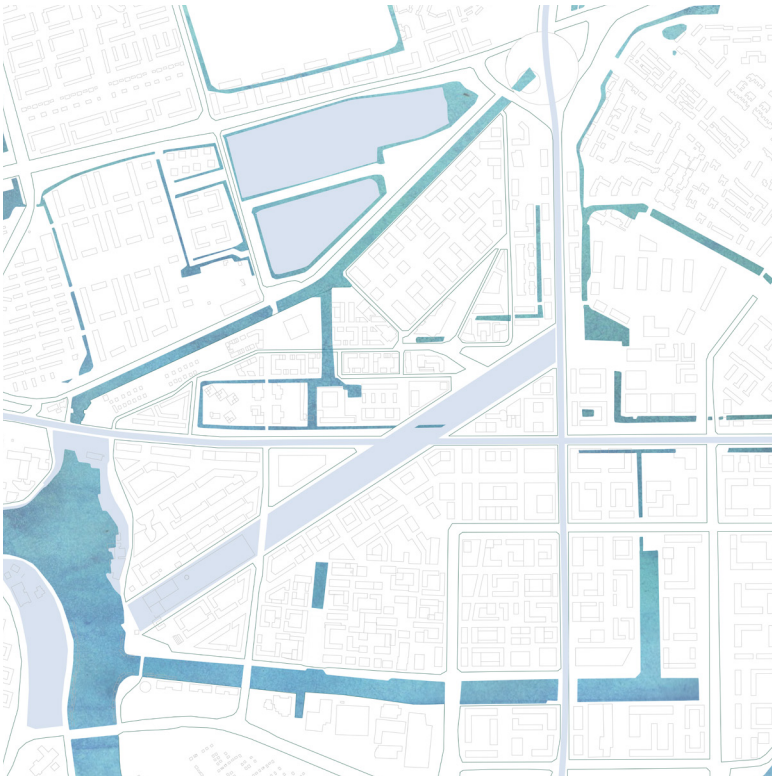


*SITE CONDITIONS*

LOGISTICS

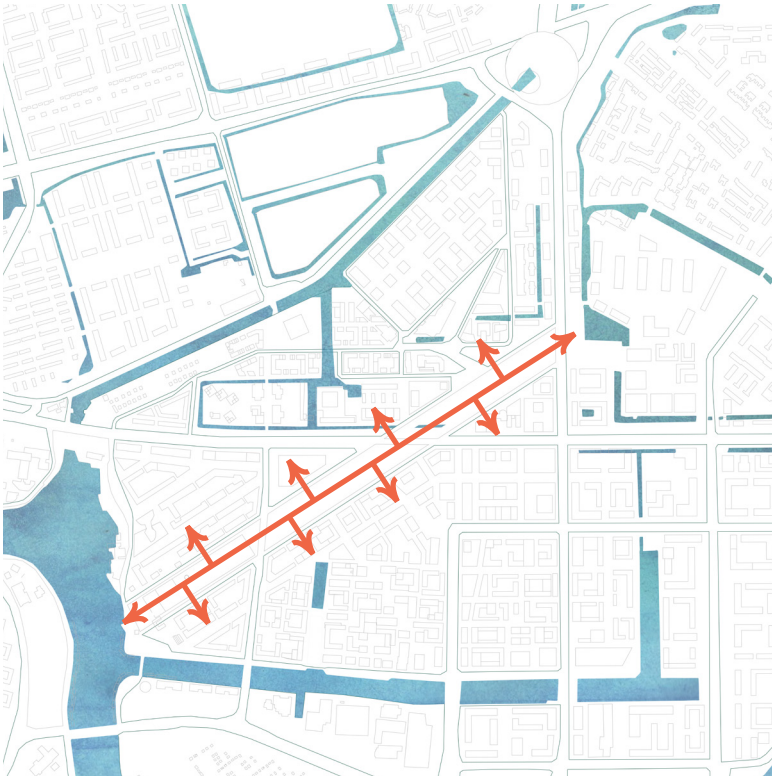
*SITE CONDITIONS*

NATURE



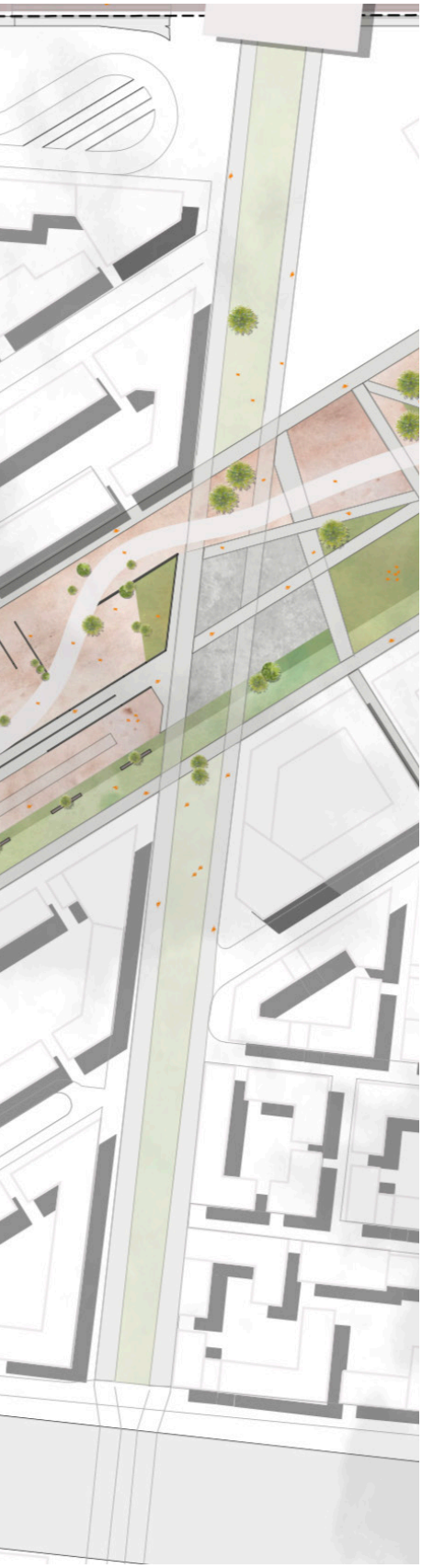
*SITE CONDITIONS*

ACTIVITY



*SITE CONDITIONS*

CENTRALITY



SITE CONDITIONS

ACTIVITY PARK

# 02 /

## Research

*PROPOSED PROBLEM*

PUBLIC HEALTH

The shaping of cities of the future is going to become more and more important as urban areas will grow intensively in their population in the upcoming decades, Amsterdam being no different. The growth of Amsterdam will force itself to become a host of a dense livable city emphasizing several qualities. But these qualities will experience a certain pressure.

> a large number of people on a small surface puts pressure on things such as hygiene, air quality, space for green and the possibility to move

To frame the possible negative sides on these qualities is to know how to value the livability in a city. The saying 'the first wealth is health' represents precisely the key value of life independently from the environmental factors. This means that no matter in what time or circumstances we live in, good health is valuable either way. Linking this belief to the context of the future of Amsterdam it means that there are some striking issues that will influence the situation of health.

Physical and mental health issues are strong focus points within this future scenario. Current physical health issues are expected to continue to increase because of unhealthy lifestyles: the World Health Organization reveals that physical activity has been engineered out of life.

> physical activity has been engineerd out of life

Technological developments within mobility, leisure and education all create a sedentary environment causing chronic diseases rates like overweight, cardiovascular diseases and diabetes to grow.

Not only physical health will have a primary focus in our future life, also mental health issues are a perceptible occurrence in a city. Good mental health is essential, not just for our personal wellbeing, but also to achieve resilient, sustainable cities. Globally, 1 in 4 people will experience mental health problems, occurring especially in city areas. For the city of Amsterdam loneliness is a big mental health issue.

> 1 in 4 people will experience mental health problems

With the city growing in population and the technology innovating more and more (isolated) individual life possibilities the

TU DELFT, CHAIR OF COMPLEX PROJECTS

"

Currently, there is a howling difference between the average hospital and the level of techno-logical development. Healing, a 19th-century process is actually taking place in 20th-century buildings while technology is already in the 21st century.

"

*The Medical Futurist, june 2017*

*PROPOSED PROBLEM*

chances of having a lack of social interaction increases contributing in a growing loneliness problem.

HEALTHCARE

With a growing engagement of health - and individual health - the healthcare system is getting a closer look as well.
The centralized system we have know experiences several negative sides. Next to the outdated concept of centralizing all specialties and letting the patient go towards the service, the costs are rising, the healing experience is decreasing and the current healthcare real estate does not meet the internal facilities. The main effect we all have with healthcare institutions is that they associate with sickness rather than with health.

> healing facilities associate with sickness instead of with health

Niels van Namen leads the UPS Europe Healthcare team as the Vice President for Healthcare. He tells in his TedTalk that 64% of the inhabitants avoid going to the hospital to get care because of the costs or the trip - for the elderly. Next to that the visit to the facility often makes us sicker than when you come in. On top of that there is a 125.000 employee shortage in the Netherlands within healthcare.

> 64% of inhabitants avoid hospital care because of the costs or the trip

In the past decades we have made extremely positive innovations within healthcare but the system itself is outdated and not sustainable for the future we have ahead of us. By re-imgaining the entire system we can focus on developing a new more suitable system for 2100. Van Namen mentions that research showed that 46% of hospital care can happen at a patients home. That's mainly for those patients who suffer from chronic diseases.

> 46% of hospital care can happen at patients home

The Amstel location experiences a severe lack of healthcare functions: hospitals are a minimum of 4,0 kilometers away and there are no small scale health functions in the area. With the low density in 2018 this isn't a large problem, but with the prospected population growth in 2100 and the great demand of engaging in health, the area is very insufficient in meeting health function demands and at the same time serves as a perfect location to develop a new type of typology that fits the future.

*Niels van Namen, TED, july 2018*

Leonard Witkamp

Special professor of Telemedicine
at the University of Amsterdam

"

The whole world is digitizing: but care remains in the paradigm of the seventies. And that is untenable. If we do nothing, the costs of care in 2040 will be doubled compared to 2015. [...] Already 50 percent of the people who are hospitalized now can be dismissed if we properly monitor them digitally.

"

Lucien Engelen

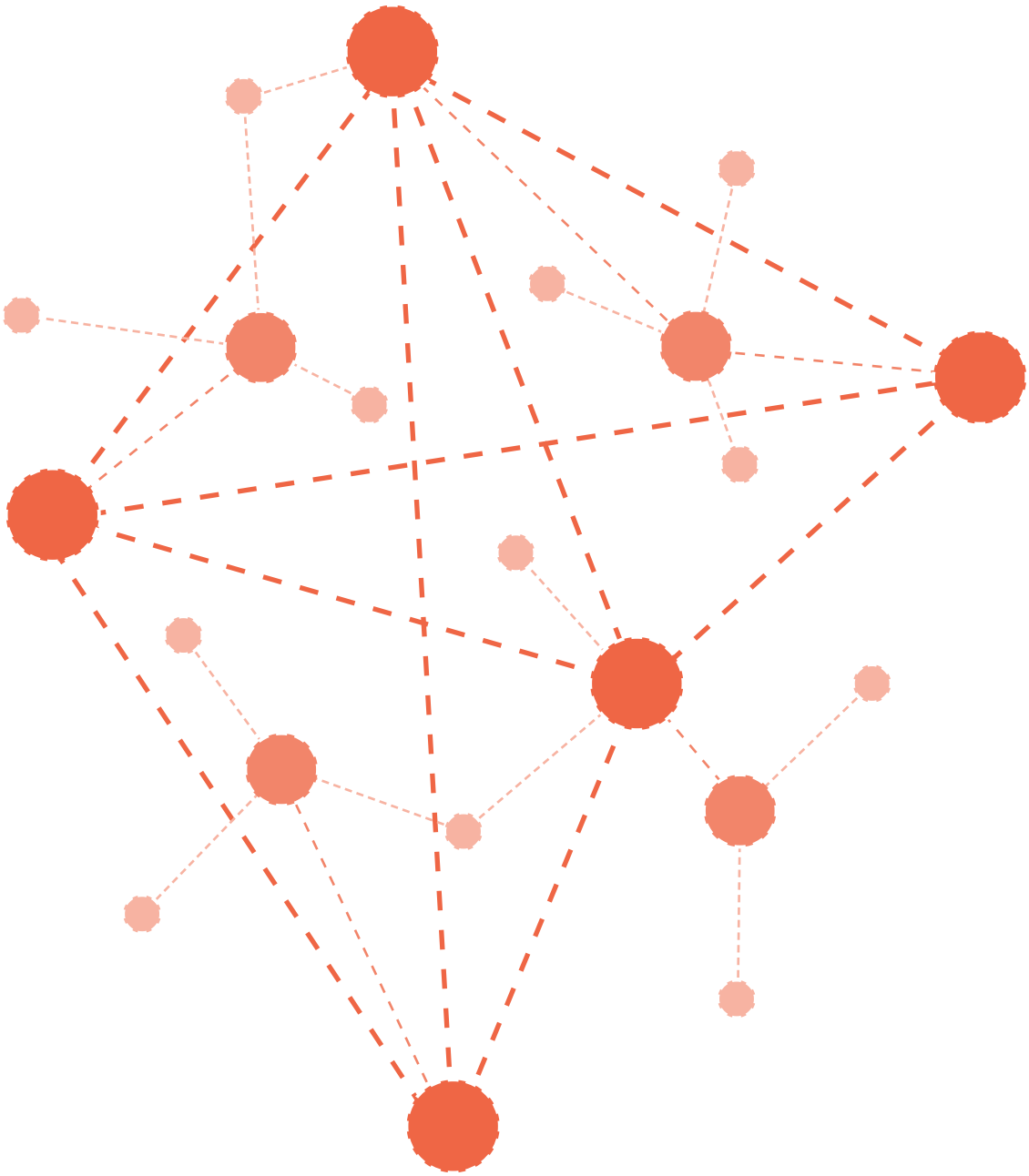
Director of the Radboud REshape
Innovation Center

"

The care of the future relies on four pillars. Care is being de-localized, democratised (data in the hands of the patient) and digitized and it's also about the money.

"

*Amsterdam Economic Board, july 2018*



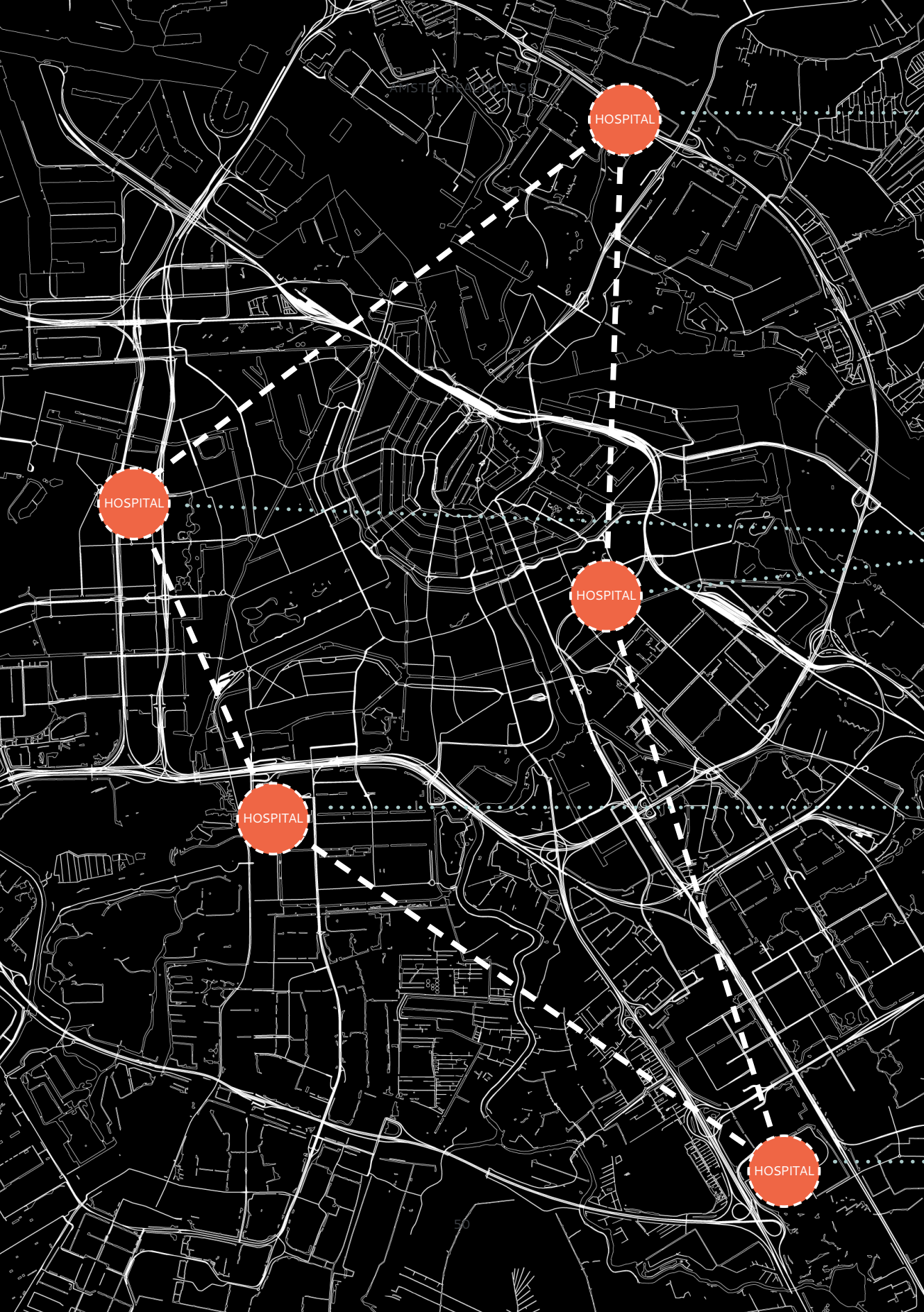
*CURRENT SYSTEM OF HEALTH*

The current system of health works spatially in wide network with different levels of care. The system works in a way where there is a limitation to connectivity when it comes to referral or other cooperations. It consists of multiple places with different care, all over a certain area. Not every facility has a connection with another one, no matter what type. An important point of this structure is that the medical data is stored in one place, and lacks good communication within the larger network.

Large healthcare facility
*hospitals*

Healthcare on referral
*specialisms*

Small healthcare facilty
*general practicioner*


HOSPITAL
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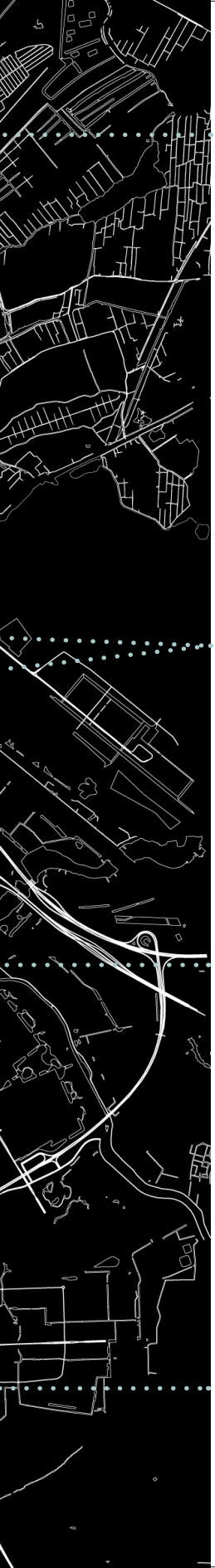



Core numbers major Amsterdam hospitals
Jaarverslagen AMC, VUmc, OLVG, BovenIJ
2017

SYSTEM OF HEALTH WITHIN AMSTERDAM

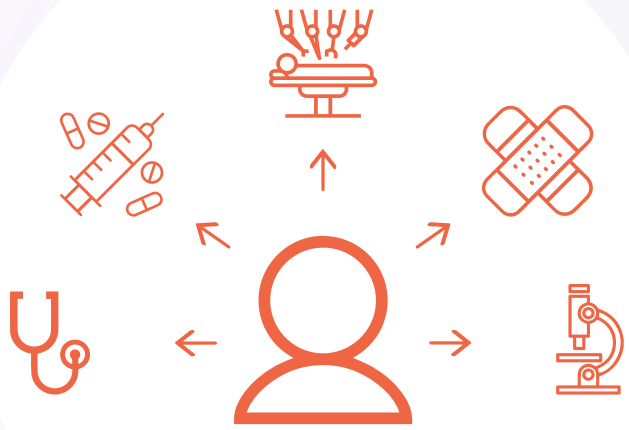

*PROBLEM STATEMENT*

with the future population growth and technological developments the current healthcare system is not sustainable

## AMBITIONS

My ambitions for the Amstel 2100 are based upon the basic angle of approach that health care needs to be brought back towards the Amstel resident. Health is a basic need and as municipality, urban planner, developer or architect we need to give this a primarly place within the future urban fabric.

Instead of moving along a path of different health facilities, in the future every neighbourhood will have a community based health care base. This base will bring health care towards the inhabitant.



from sending patients to health care
on their own

To imagine this new facility I've stated three main ambitions for the project:

1. it is part of a decentralized network of community-based healthcare
2. this healthcare facility is part of the public realm - responding to the broad engagement of health
3. it has multiple functions related to health concomitant with future technological innovations

to providing health care
to the patients

# RESEARCH

What type of architectural program and design
fit a sustainable healthcare network in 2100
for the Amstel community?

## SUB RESEARCH

- what do we understand as a healthy lifestyle in 2100?
- what is the functional and spatial demand of the future healthcare system?
- what architectural framework contributes in public health?
- what architectural principles provide a healing environment?

## *A HEALTHY LIFESTYLE*

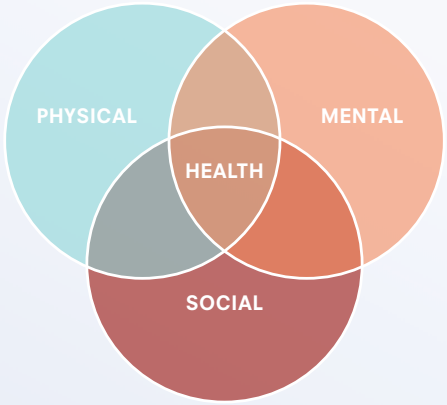
In the year 2100 there will not only be a lot of changes in the way Amsterdam Amstel looks like, but there will be a lot of changes in the way people live their everyday life because of the fast development of technology. Health in general is an area that develops simultaneously with these future changes. Not only will it change within healthcare in the technological field due to future developments and research, but if we look at the past century our perspective on health also has shifted.

The conception of health is different compared to 80 years ago. If you ask your neighbour if they are healthy, they will answer based upon their lifestyle instead of if they are battling a disease at the moment. You can state that our perspective has shifted towards the patient's perspective. Healthcare is trying to help the patient understand the drivers that impact their chronic condition better so they can play a more active role in managing it. This could be getting involved in health rather than just sickness, supporting and coaching them in relation to their sleeping, eating, smoking, drinking and exercise as well as all aspects of managing their condition properly, such as adherence to medication. As we learn more about sickness or other conditions in the upcoming 80 years, we can improve and encourage the ways of prevention with the emphasis on how to involve architecture in this. The aim is to proactively keep eachother well rather than react when we become ill. The idea of maintaining people's wellbeing rather than reacting to an episode makes sense in combination with the future technological opportunities.

From thinking of health as a treatment to cure diseases, we have broadened the term health in the past couple of years and made it a lifestyle. Nowadays our perspective on health is more focussed on prevention of diseases and maintaining a consistent healthy status, next to the treatment of diseases. The rise of wearable health trackers is only increasing, and dealing with health in a holistic way is more and more common.
The holistic approach of health means to engage in your individual health on a social, mental and physiscal level.

Treatment

Prevention

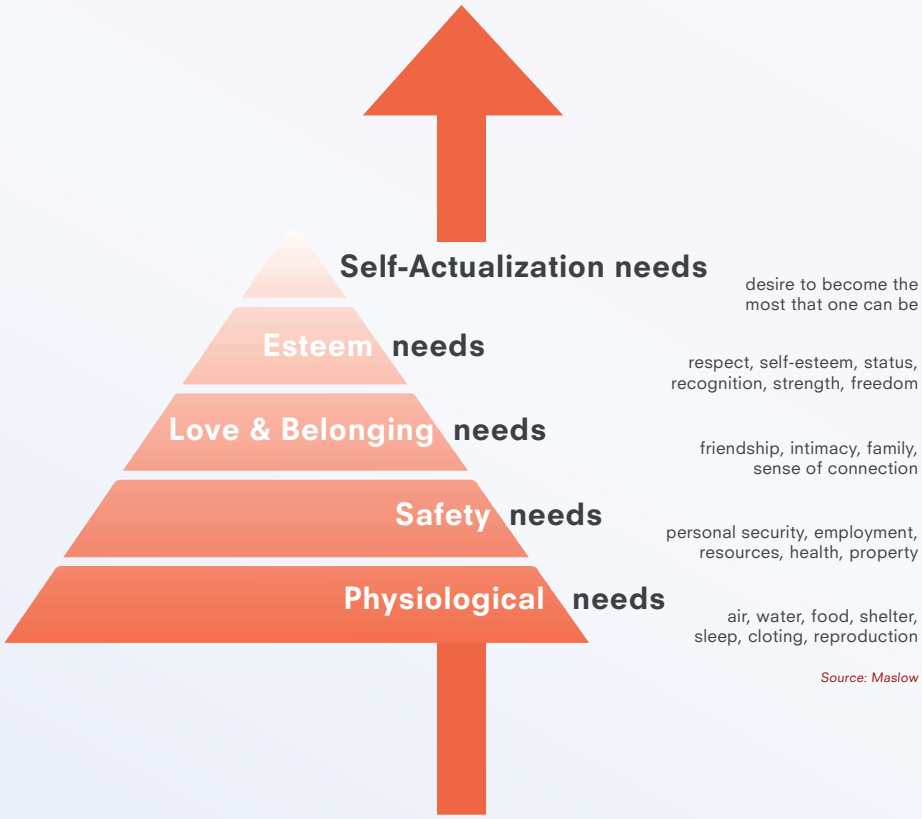



own images

If we look at global trends on the subjects of how we live our life we know that in the past decades life is turning into an experience economy. This means we value the experience of things more than the materiality of things. We see this in the way retail is developing their actual stores, of the amount of money that is in the travel business. Research found that 78% of millennials prioritize experiences over products or things (Eventbrite, 2016). Once in a lifetime has become another Saturday afternoon with social media as it's main catalyst. This experience economy leads to self-actualization, which we know from Maslow's pyramid (Trendwatching, 2016).
The self-actualization means an endless search to realize the idealized version of themselves that they carry around in their head. Self-actualization isn't about avoiding or treating illness. That's a matter of survival that belongs at the bottom of Maslow's pyramid. Physical, mental and emotional peak performance are a fundamental part of self-actualization. Being healthy on all levels means a state of a certain richness of your life. The self-actualization serves as a very important motive to engage in health.

This means that with all influencial technological developments health is an important factor. Like the inventiomn of autonomous mobility. The accessibility of this sedentary transportation mode is being thourouhly discussed by city municipalities, cause it is in coflict with public health.

***Health as self-enrichment***




***Health as a matter of survival***

*Hierarchy of needs, Maslow 1943*

*THE HEALTHCARE SYSTEM*

In the earlier days, healthcare services happened in the comfort of your own home: doctors and nurses made house calls when needed. But when modern medicine developed it resulted in centralized healthcare. A large typology like hospitals and specialised clinics originated replacing home-based care. They could store expensive and comprehensive medical equipment, provide multidisciplinary collaboration and accomodate a large amount of patients[1]. But with rising costs, poor quality of healthcare services, a recent bankruptcy of a large Amsterdam hospital and the unequal pressure on different departments, it makes me revise the quality of the current healthcare real estate system.

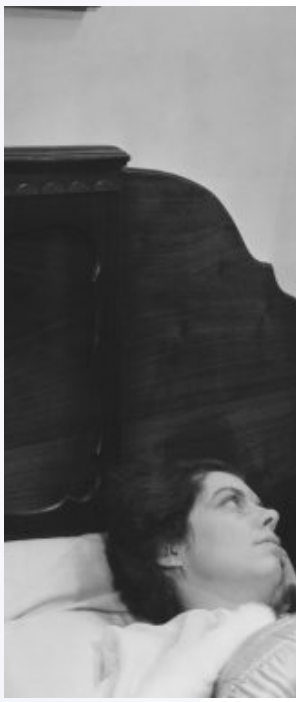


*image a / doctor making a house call*
*https://healthclic.co.uk/blog/where-did-the-house-call-originate/*

Home visiting doctors accounted for around 40% of medical consultations back in the 60s. However, by the 80s this had fallen to less than 1%; mainly due to restricted resources and growing populations. The reason so many doctors made house calls and visited patients at home up until the 60s was actually due to inaccessibility and lack of fast transport options. If you lived in the 1800s, you would not be able to get on a horse with a splitting headache. When transportation created possibilities, the logical step was made to centralize all the different healthcare specialisms under one roof. This resulted in a totally different system of how healthcare was treated. Instead of calling your doctor when you experienced a problem and he came to your house, it was now turned around and the patient has to go towards his doctor.

/5

http://www.throughouthistory.com/?p=2900

*image a / historic healthcare system – a doctor makes a housecall when needed*
*own image*

This centralized healthcare system is still the current basic situation for the healthcare system for any patient in the Netherlands. By this I mean the centralized healthcare in large institutions like hospitals.
But it's is not only one trip to a hospital. There are a few steps before that. When there is an occurence of a health problem, we make an appointment with the 'first line' of health, in most cases our general practitioner. After a first impression diagnosis he'll refer you to a specialist in a hospital. If the diagnosis is still not fully clear for the specialist, the chance will be big that he'll refer you to other specialists in the same hospital resulting in a tiring road in the medical world and bad communication between disciplines with the patient feeling more like an object then the focussed party. In most cases we'll be sent home due to lack of costs to provide a full recovery period.

The quality of the healthcare itself will not be the focus of my research, but the influence of the hospital typology is. In what way does this typology influence the way the healthcare system works? The initial benefits of creating one building that hosts all medical specialisms had logical reasons. Centralized healthcare could provide multidisciplinary communication between different specialisms, it also accommodates treatment for a large number of patients which is ideal for scientific research

/1 *Why we need distributed healthcare now more than ever – D. Smith, 2018*
/2 *De patiënt in beeld – Layout 06, C. Niemeijer, C. Wagenaar 2008*
/3 *Een overbodig ziekenhuis met een huiselijke sfeer – NRC, J. Wester, J. Kooiman 2018*
/4 *Extra bedden bij AMC door drukte op spoedeisende hulp – Het Parool, M. Sevil 2016*

*image b / centralized healthcare system – a patient goes to the healthcare facility when needed*
*own image*

and because of all the expensive medical equipment and expensive doctors the costs could be shared[2]. But the current data of Amsterdam hospitals shows a shift in the use of this large typology.

The recent bankruptcy of the Slotervaart hospital in Amsterdam showed that the hospital had many empty beds for years[3]. A different example is at the Academic Medical Centre Amsterdam in Amsterdam-Southeast. They have made an increase in their available beds in the past couple of years. They made an decrease from 1028 to 750 beds. This was made possible due to better care, more outpatient procedures and day treatments. But they experienced that this was not a good solution because of the influx of elderly people who needed care[4] and there is no proper alternative for them. The opposite of this is that the emergency department in all Amsterdam hospitals is experiencing the highest level of pressure.

With these developments a trend emerged in revising the traditional healthcare real estate system. It makes me wonder why we need to host the patients of all of the procedures, day treatments and elderly care in relatively expensive hospital beds in a centralized hospital - most of the time isolated in the outskirts. It is a clear contradiction if the real estate costs are high and the amount of square metres can go down.

> The vast majority of operations in hospitals are feasible and most actions are relatively simple[5]

The vast majority of operations in hospitals are feasible and most actions are relatively simple, while the ambience of a hospital has a patient-unfriendly character.

The patient-unfriendly character of hospitals has a strong connection with the architectural aspect. The excessive concentration of functions that have too little to do with each other leads to logistical problems that are very detrimental to the functionality. This character is due to the lack of clarity of logistic processes:

- lack of privacy
- the farewell of family and friends
- spending the night with strangers in a room
- the minimum contact with the responsible doctors
- the overabundance of contacts with always different staff members
- the mostly poor acoustics
- the feeling of loss caused by logistics and the often poor signage

This list of negative aspects of a centralized healthcare institution leads to an interesting assignment for the future. By dismantling the large typology and supplementing the parts with medical related functions, a typology can arise that is not only smaller, but also has a completely different character. By decentralizing the healthcare function and adding location-specific functions it can be a valuable public building integrated into the urban network of a neighbourhood.

Next to focussing on improving the above written negative aspects, there are more architectural advantages of creating distributed small clinics:

- a more functional logistic plan
- it creates a possibility to design buildings that no longer look like appearance and design does not matter (because the patient will come either way)
- to breach the location-isolated character of the medical companies and to reintegrate it into the urban fabric of the city

Distracting from these findings we can conclude that healthcare needs to shift from the hospital-based medicine to be patient-oriented again.

/5 *De patiënt in beeld – Layout 06, C. Niemeijer, C. Wagenaar 2008*
/6 *De patiënt in beeld – Layout 06, C. Niemeijer, C. Wagenaar 2008*

## UNFRIENDLY CHARACTER OF HOSPITALS

lack of privacy

the farewell of friends and family

spending the night with strangers

minimum contact with responsible doctors

overabundance of contact with different staff

poor acoustics

feeling of loss by logistics

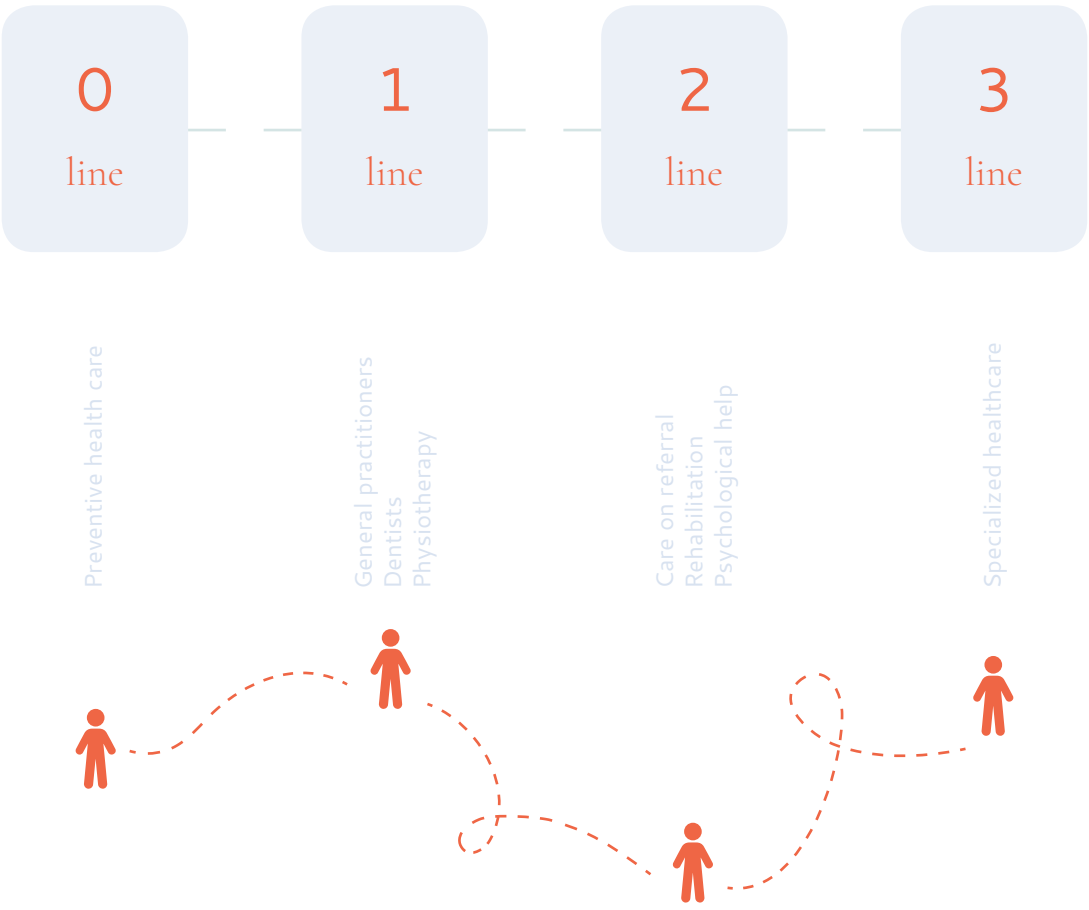
If we zoom out of the built healthcare focussed function and look at the discipline itself, we can state that healthcare is a service. We know that we live in a time where services are shifting from a consumer going to a service to a service comes to the consumer. The same should happen with healthcare.

> Why should healthcare be the only service that still maintains to the old system of getting the consumer to the service instead of providing the service towards the consumer?

To make this possible we need to dissect the different types of healthcare. In general healthcare is made up of four types of care: zero, first, second and third line healthcare[7]. In the zero-line of healthcare it matters about the earlier mentioned prevention aspect of health. Under prevention we understand the areas of adequate physical exercise, nutrition and mental health. It focuses on maintaining health in a holistic way.
Then there is the first-line of healthcare. By this we mean the general practitioners, dentists, physiotherapy etcetera. Services where you can make an appointment without a referral. Logically, the follow up of the second-line of healthcare means care that needs a primary referral or preliminary diagnosis like different types of specialists, rehabilitation or physiological help.
The third-line of healthcare consists of very specialized care. Most of the time, this care happens in hospitals or other specialized institutes (sometimes even in a foreign country).

The insight in this function division as it works in 2018 is a useful tool for creating a healthcare function of the future. If this is considered the starting point of the healthcare system with current day circumstances, I can analyze predicted shifts in this system due to future healthcare trends with the introduction of several technology developments.

Nictiz. (n.d.). Zorgdomeinen – Nictiz

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Nictiz. (n.d.). Zorgdomeinen – Nictiz

# FROM CHAN
# TO CHOICE


## From chance to choice

In the current system we rely on chance. Whether you catch a symptom, get professional help in time, receive the right kind of help with the right tests that are performed properly and someone else is making the right decisions for you. With future health indicators the focus of health will shift to your own responsibility, primarly focussing on the prevention of health.

*THE EVOLUTION OF TELEMEDICINE*

Telemedicine is the use of telecommunication and information technology to provide clinical health care from a distance[1]. It has been used to overcome distance barriers and to improve access to medical services that would often not be consistently available in distant rural communities. It is also used to save lives in critical care and emergency situations. Telemedicine is where health care and technology connect. It allows people to get care electronically anytime, from anywhere. It's transforming care delivery and changing the way people think about healthcare, providing opportunities to change the infrastructure and design of future healthcare.

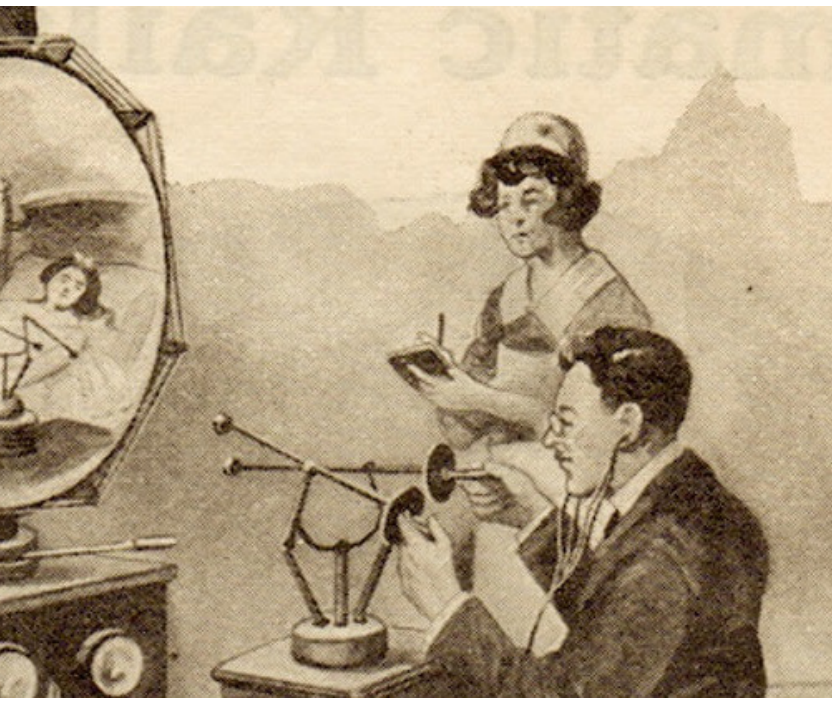


*image a / Teledactyle by Hugo Gernsback 1925*
*The Medical Futurist*

Jules Verne (French writer and father of science fiction) imagined sensitive mirrors connected by wire as devices for telecommunication, a German technologist, Hugo Gernsback went for the "teledactyle" allowing doctors to not only see their patients through a view screen but also to touch them from miles away with spindly robot arms. These concepts help us understand the development curve of telemedicine and what we could expect in the future.

Past visionaries have always been very imaginative when it came to pushing the outermost boundaries of humankind even further off the usual. One of the most genius thinkers was French writer and father of science fiction, Jules Verne. He mentioned one hundred and eight sci-fi concepts and inventions in his vast oeuvre – seventy was already realized: the spaceship, the televi-

/1 https://medicalfuturist.com/the-history-of-the-future-of-medicine-remote-care

sion, the machine gun, air conditioning or the atomic bomb.

Regarding communication technology, Verne predicted that news would be read out to people instead of written down in newspapers, and in his article *In the Year 2889*, he described the "phonotelephote"—a forerunner to today's video conferencing technologies. The device allowed "the transmission of images using sensitive mirrors connected by wires," Verne wrote. He was the first to daydream about conference calls – and thus the technology enabling telemedicine.
The one who translated the idea of the "phonotelephote" into medicine was called Hugo Gernsback. At the dawn of the radio age, in 1925, the never-resting German technologist invented the concept of the "teledactyle" that would allow doctors not only to see their patients through a view screen but also touch them from miles away with spindly robot arms. As Gernsback explained it, the device would have made it possible to "feel at a distance". He basically described the function and aim of telemedicine – going a "tiny bit" further than technology would allow it today.

He wrote that "The doctor of the future, by means of this instrument, will be able to feel his patient, as it were, at a distance. The doctor manipulates his controls, which are then manipulated at the patient's room in exactly the same manner. The doctor sees what is going on in the patient's room by means of a television screen. Every move that the doctor makes with the controls is duplicated by radio at a distance. Whenever the patient's teledactyle meets with resistance, the doctor's distant controls meet with the same resistance. The distant controls are sensitive to sound and heat, all important to the future diagnosis."

June 25, 1989, marked a real breakthrough in telemedicine. That was the first time a patient was successfully defibrillated by telephone – and that was just a beginning of the myriads of ways how phones could play a role in telemedicine. The advancement of telecommunication technologies brought new forms of patient-doctor remote communication all the time.

/1 *https://business.kaiserpermanente.org/insights/telehealths-potential-to-transform-care-delivery*

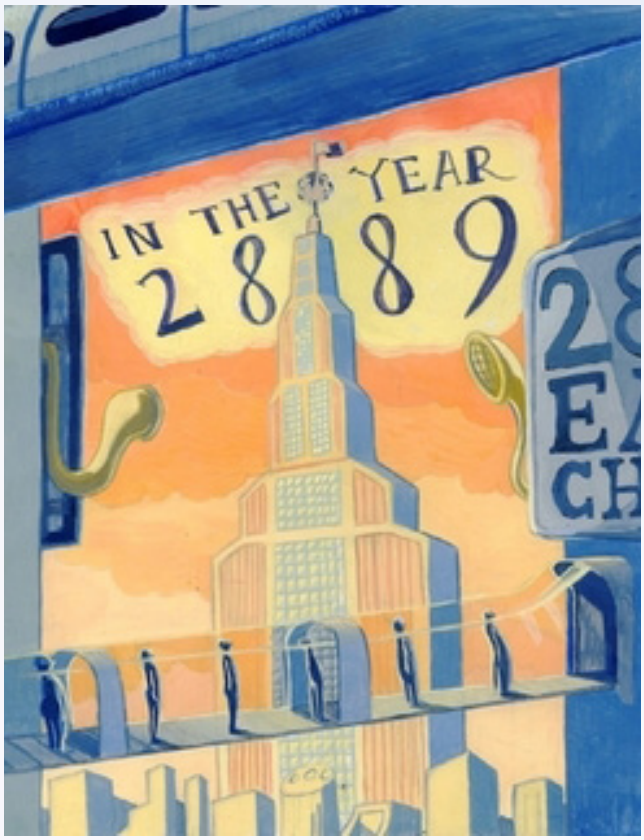



image a / *In The Year 2889* by Jules Verne 1889

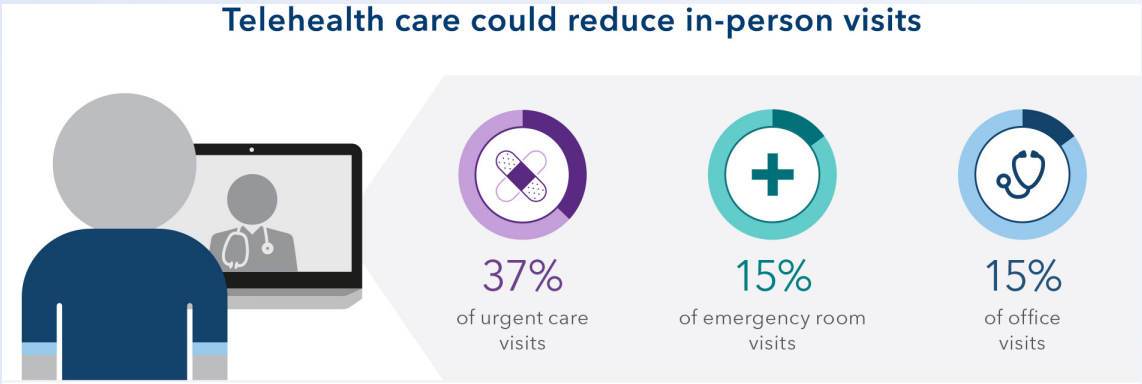



*image a / reduction in-person visits*
*Willis Towers Watson, 2014*

*THE IMPLEMENTATION OF TELEMEDICINE*

Looking at the implementation of telemedicine in our current time it enables patients to connect with a doctor by phone, video, or secure email — or get advice from a medical professional 24/7. So patients never have to choose between waiting for an appointment or making an unnecessary trip to the emergency room, or worry about missing work to go to urgent care.

Effective use of telehealth technology could eventually reduce the demand for clinic space and other resources that can drive up individual and employer health care costs. That's because some of the most convenient ways to access care quickly — like communicating with a provider by phone or email — are also the least expensive.

Telehealth connectivity also expands provider reach. Doctors can care for people in multiple locations — people who live in remote areas, or have mobility or trans-

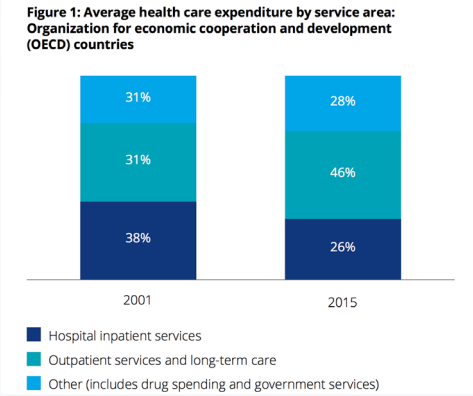
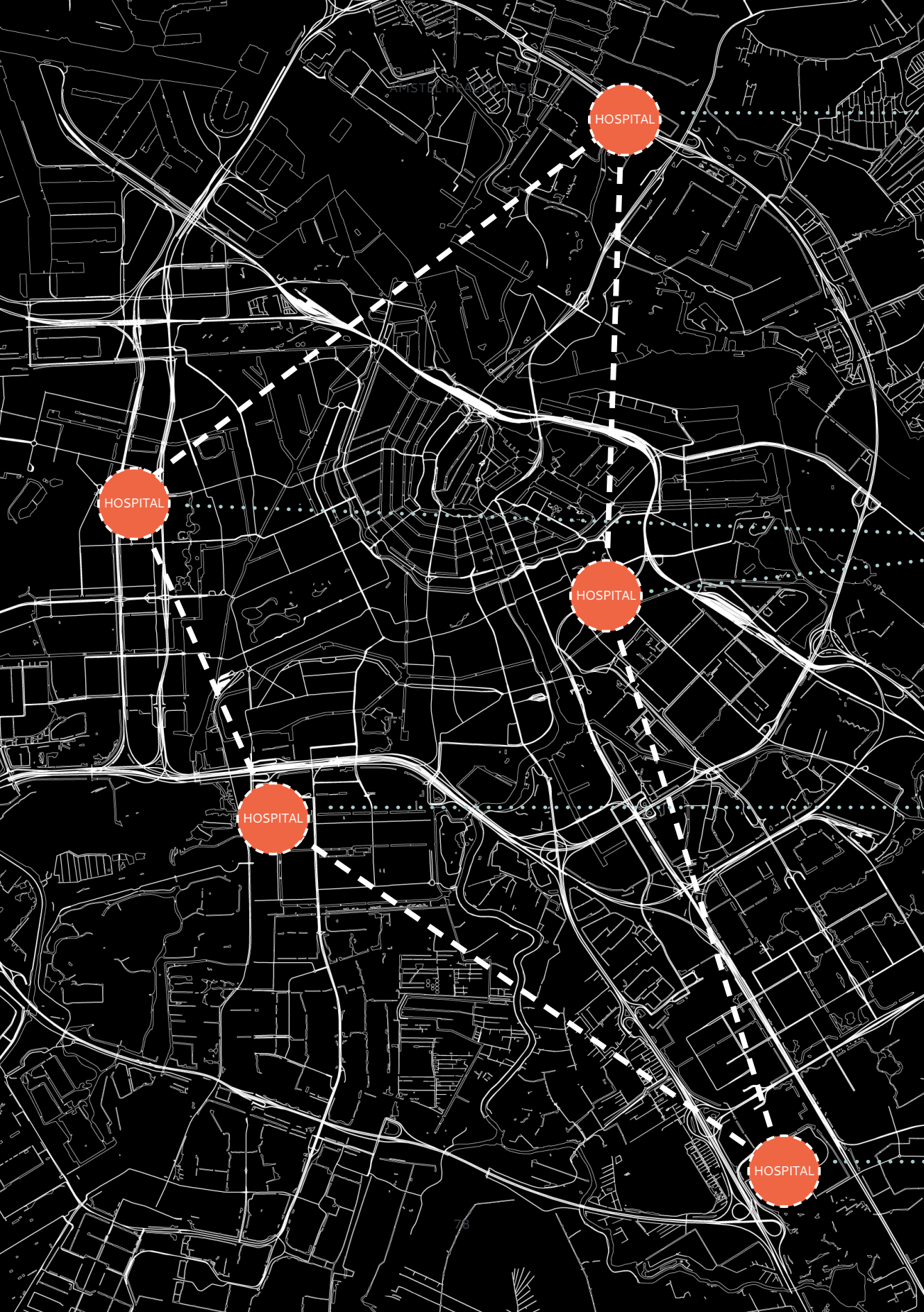



*image b / Telehealth influences services*
*Health at a Glance 2001–2017, Organization for Economic Cooperation and Development, 2017*

portation issues — addressing growing concerns about provider shortages. And when telehealth is part of a connected system, it helps providers deliver care sooner, resulting in fewer procedures, shorter hospital stays, and healthier outcomes — all of which can potentially lower health care costs.

Next to the costs, the time of access is important. Telehealth gives working people the freedom and flexibility to access care when and where it works for them — whether it's from home in the middle of the night or from work on a lunch break.

As the majority of cases will go down due to telemedical methods, people will consider telemedical visits the norm, and the personal visit a highly valued, rare asset due to the shortage of medical professionals. This will have a direct effect on the space needed for healthcare functions.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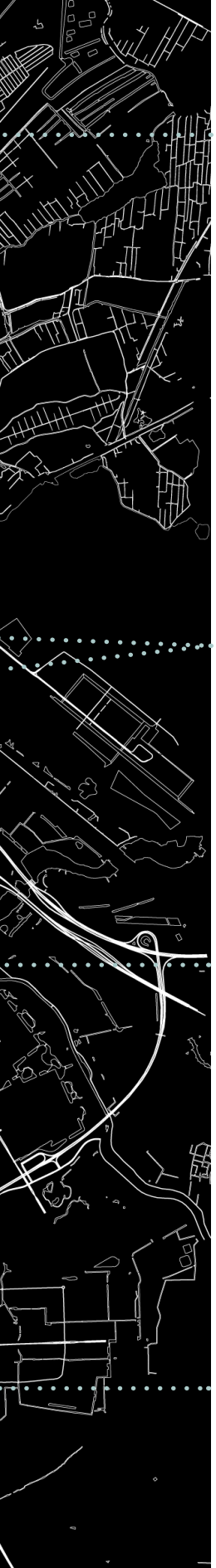


*BOVENIJ HOSPITAL*
*bed count: 313 beds*

*OLVG HOSPITAL*
*bed count: 748 beds*

*VUMC HOSPITAL*
*bed count: 733 beds*

*AMC HOSPITAL*
*bed count: 1002 beds*

*Core numbers major Amsterdam hospitals*
*Jaarverslagen AMC, VUmc, OLVG, BovenIJ 2017*

*DECENTRALISATION CARE CLINICS*

As healthcare is a service it is a field that also needs to shift towards the user, in this case the inhabitant of the Amstel area. By creating a community-focussed health clinic it can be the first of many, providing different neighbourhoods in Amsterdam taking away the pressure of the major hospitals around the city.

| AMC | VUmc | OLVG |
|---|---|---|
| 1002 beds<br>24000 admissions<br>16 surgery rooms | 733 beds<br>21000 admissions<br>16 surgery rooms | 748 beds<br>22000 admissions<br>25 surgery rooms |

Great Amsterdam inhabitants: 1.500.000

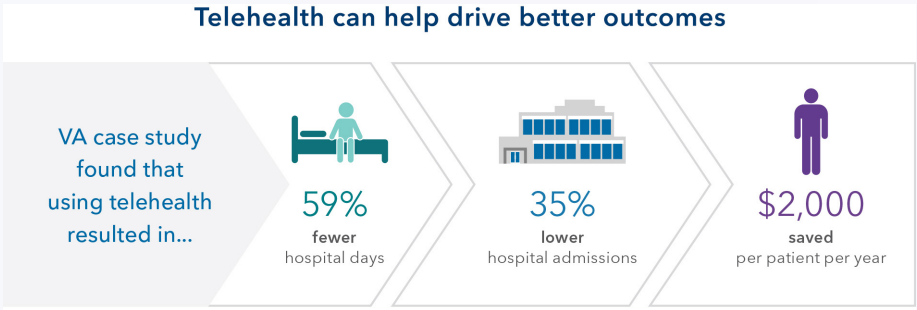
1 clinical admission per 22,5 inhabitants

*Core numbers clinical admissions major Amsterdam hospitals*
*Jaarverslag AMC, VUmc, OLVG, 2017*

### *HOW BIG ARE WE TALKING?*

To elaborate on the trend of decentralization of healthcare I must do some research in the statistics of the different departments. As technology will reduce the physical pressure on healthcare facilities they can be designed more efficiently for the care needs still present in the future.
To have a basic view on the numbers of clinical admissions in Amsterdam divided over the three major hospitals (OLVG, VUmc and AMC) I've set out their core numbers next to the number of inhabitants over the entire district of Amsterdam (note that foreign patients aren't included so it is not a narrow calculation, but an estimation to get a sense of people flow).

In the image above the number of clinical admissions in 2017 of the major hospitals is shown. With at least 57 surgery rooms in the city, there were approximatey 67000 clinical admissions in the year 2017. If I divide that number through the total amount of inhabitants of Great Amster-




Amstel 2100 inhabitants: 150.000

1 clinical admission per 35 inhabitants

*image b / outcomes Telehealth*
*Telehealth Services in the United States, Department of Veterans Affairs, 2013*

dam (1.500.000 inhabitants) you would get an estamation of 1 clinical admission per 22,5 inhabitants of Amsterdam.
Note that this is an estamtion based upon the healthcare pressure as it is now.

In the image on the previous page there is stated that due to telemedicine, the amount of hospital admission will reduce with 35%.
For the situation of Amsterdam Amstel it means the following:

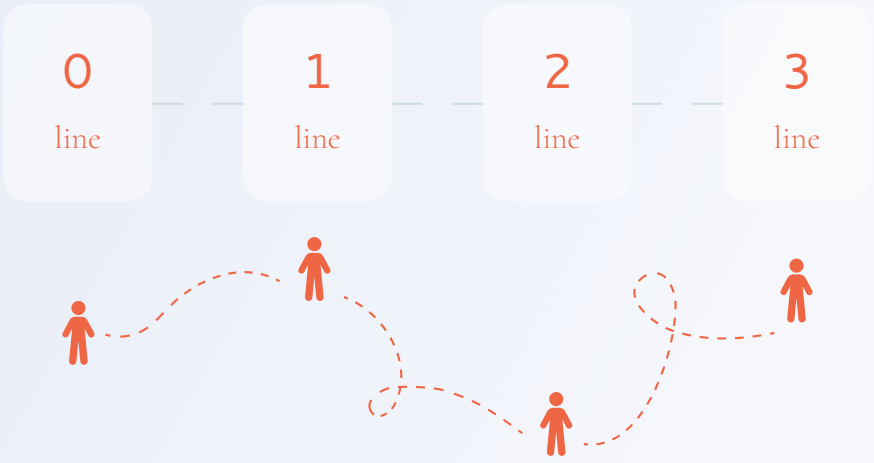
The predicted inhabitantnumber will be 150.000 inhabitants. That means in the current system there will be approximately 5300 clinical admissions per year.
But with the reduction of 35% of admissions by technological developments this will mean a decreasde of 1860 admission, meaning there will be about 3460 clinical admissions per year in the neighbourhood. That means 1 clinical admission per 35 inhabitants.

# SUMMARY HEALTHCARE SYSTEM

from health care service to the patient – housecalls
to patient towards the health care service – centralized

+ Advantages centralized healthcare
1. multidisciplinair communication
2. scientific research
3. sharing costs

- Disadvantages centralized healthcare
1. located at far distance
2. relatively expensive beds
3. customer-unfriendly character




Current health care system sends patient from medical specialist to medical specialist
with no efficient sharing of medical information and different locations

# SUMMARY HEALTHCARE SYSTEM

## Care becomes more home-based

Telemedicine will reduce in-person visits

**37%**
reduction of urgent care visits

**15%**
reduction of emergency room visits

**35%**
lower hospital admissions

**AMC**
1002 beds
24000 admissions
16 surgery rooms

**VUmc**
733 beds
21000 admissions
16 surgery rooms

**OLVG**
748 beds
22000 admissions
25 surgery rooms

2019 — Great Amsterdam inhabitants: 1.500.000

1 clinical admission per 22,5 inhabitants

1 emergency case per 8 inhabitants

2100 — Amstel 2100 inhabitants: 150.000

1 clinical admission per 35 inhabitants

1 emergency case per 10 inhabitants

## *HEALTHTECH*

Contact lenses that detect the glucose levels of diabetes sufferers. A device that can analyse DNA in under 15 minutes. Blood test results processed at a patient's bedside. 3D printing of replica body parts to help with surgical procedures. Not only telemedicine will have a big impact on the future healthcare system. There are several important healthtech trends that are going to influence our lives and healthcare. In this chapter I'll explain several developments that I see as reality for the year of 2100 and will have an effect on how to change the healthcare system. By implementing these trends, a true predicted scenario for the way healthcare is treatened can be drawn.

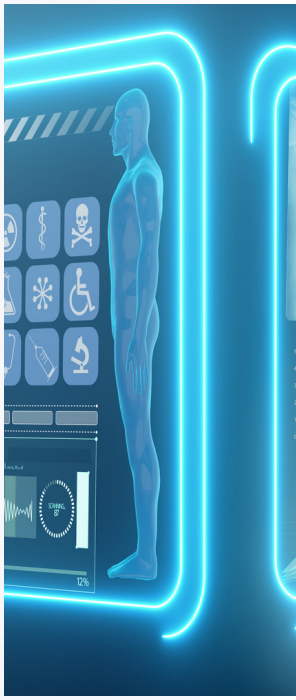



*image a / Teledactyle by Hugo Gernsback 1925*
*The Medical Futurist*

In the last couple of years, the fundamental principles of healthcare seem to be under massive attack from technology. While in the past, the question was how to measure vital signs, currently, the problem is how to measure them more accurately and easily.

Medical devices are becoming more and more miniaturized, digitized and connected objects for personal use and so towards a more preventive medicine.

Nowadays we still only react on health problems only when they occure focussing on reactive healthcare. But with future technological developments the entire focus shifts to making the patients the point-of-care for diagnostics, bring healthcare from a proactive to a preventive field, provide personalized care for the people not for

/1 https://medicalfuturist.com/the-history-of-the-future-of-medicine-remote-care

populations. This means that a big part of healthcare would become invisible in practice and the moment of treatment does not involve a postponed and thus bigger health issue. Some of the major healthtech trends that I take into account for the future:

*Wearable health indicators: digital tattoos*

Wearable health indicators will give us the opportunity to unlock your phone or get you access to entrance doors or measure your blood pressure or hydration level constantly in the background only giving you a signal when your conditions act irregularly.

Digital tattoos could make healthcare more invisible and act as minilabs. Next to tattoos on your skin, in the future there will also be nanobots that swim through your body fluids measuring different types of biomedical processes.
By tracking vital signs 24 hours a day, without the need for a charger, it is especially suited for following patients with high risks of stroke, for example. The digital tattoo could send alerts to medical systems, it might call the ambulance and transmit pertinent data, too.

They can measure:
- heart rate
- glucose level
- hydration level
- electrical activity of the brain
- track muscle movements

*Virtual reality for making painful or scary experiences more pleasant*

Virtual reality could mask the entire healthcare reality for patients, which is often full of pain, discomfort, and fears. VR can be of support in chronic pain, anxieties, phobias or painful events like childbirth. A patient can travel anywhere or customize his surroundings how he or she likes it.

*Nutrigenomics for the best food at every meal*

After having your DNA sequenced, a smart app could let you know which food you should eat and what you should avoid at all cost. As we are all genetically different, our diet should be personalized. That's nutrigenomics in a nutshell.
In the future you can order or buy the ideal meal for your vital conditions.

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*image a / wearable health indicators*
source
*image b / VR in healthcare*
source
*image c / personalized meal*
https://www.fastcompany.com/3064833/this-startup-sells-you-meal-plans-based-


SKIN HYDRATION: PROPER
TEMPERATURE: 35 °C
HEART RATE: 103 BPM
ECG: PROPER
BLOOD PRESSURE: 110/60
BLOOD PRESSURE: 120/70
TEMPERATURE: 35 °C
HEART RATE: 110 BPM
FETAL HEART RATE: 120 BPM
BLOOD PRESSURE: 120/70
TEMPERATURE: 35 °C
HEART RATE: 150 BPM


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Protein
SEEKER
VEGGIES
64%
Your
HERO FOODS
CAULIFLOWER, MUSHROOMS,
BROCCOLINI
34%
PROTEIN
CALS
390

*Chatbots could become the first line in primary care*

Beyond telemedicine, chatbots will also make healthcare more invisible through radically reducing waiting time. Chatbots are essentially applications powered by smart algorithms; they help patients track and make sense of their health data, support medication management and disperse simple medical advice.
For example, Izzy helps women track their period and serves as a birth control pill reminder. Bots like HealthTap or Your.Md aim to help patients find a solution to the most common symptoms. In the future, chatbots could become the first contact point of patients with healthcare – anytime, anywhere, so they could never feel being left alone.

*Medical drones for delivering aid to emergency situations*

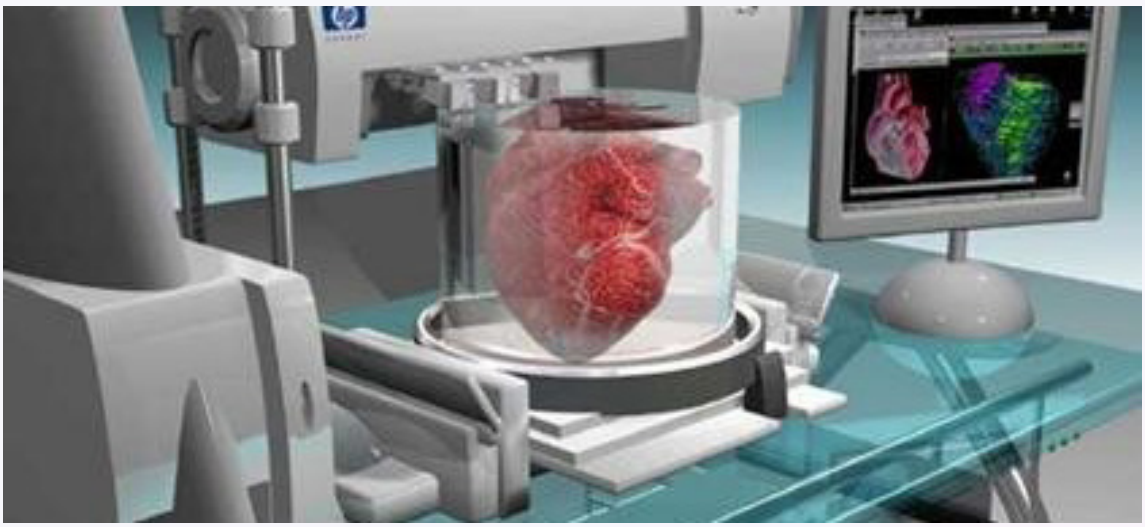
In future medical emergencies or in territories where the transportation infrastructure is broken or scarce, medical drones will mean the fastest answer. They will fly the extra mile in delivering drugs, vaccines, blood or organs.
One of the finest examples on the market is the Silicon Valley start-up, Zipline. In 2016, the Rwandan government teamed up with the company to operate the first national scale drone delivery service for medical supplies. After its Rwandan success, the White House reached out to Zipline. They expressed interest in delivering medicine and blood to rural parts of the US.

*3D printers for creating anything from casts to tissues on-site*

In the future, 3D printing could ensure that all the necessary medical equipment is near the patient whenever it's needed. Do you need finger splints or plaster casts in remote areas of the Amazonas jungle? It's already possible! Ian McHale, a senior at the US Steinert High School, created a blueprint for producing finger splints. A low-end 3D printer can print his splint quickly and affordably, about 2¢ worth of ABS plastic in about ten minutes!
However, it's not just about medical equipment. We can already print out drugs! Imagine that your doctor would prescribe you some pain medication and by the time you arrive home, your 3D printer created it in the right dosage. Would be amazing, isn't it?

---

*image a / wearable health indicators*
source
*image b / VR in healthcare*
source
*image c / personalized meal*
source



*FEAR FROM THE UNKNOWN*

The previous developments can cause many concerns regarding ethics within healthcare. The fear from the unknown is as old as mankind itself, thus the fear from technological development has the same age as advancement itself.
When the telephone was introduced to Sweden in the late 1800s, people were afraid that the contents of the lines would spill out in some way if there was a break and many elderly persons refused to touch a telephone for fear of electrical shock.

The fear is even scarier when it comes to one's health. Shortly after Wilhelm Conrad Röntgen introduced his discovery about the X-Ray, people got scared that it might read their thoughts, and they were afraid that such omnipotent gaze will see through their body and soul. Merchants even offered X-Ray proof underwear.

One of the main concerns about data in the cloud is ofcourse privacy. With the wearable health trackers, your medical records will be owned by you and not by other companies or healthcare institutes. The advantage of having them digitally is that you can choose to share them with the medical parties you want to.

A big question for every job of workfield is if robots will take the place of people?
The main advantage is ofcourse their efficiency. Robots can disinfect health facilities, work as receptionists, they are able to lift and move patients in and out of bed into a wheelchair or shower, help patients to stand, and they are able to draw blood in less than a minute. In the case of surgical robots, human control is irremissible. Technology is only there to assist us.
When interviewing several medical students, their opinion was that robots can never replace the first interpretation of the story of the patient to set a right diagnosis. Having immediate results by a robot in combination with the human interpretation of the story of the patient will be the foreseen future ideal situation.

*image a / wearable health indicators*
*source*
*image b / VR in healthcare*
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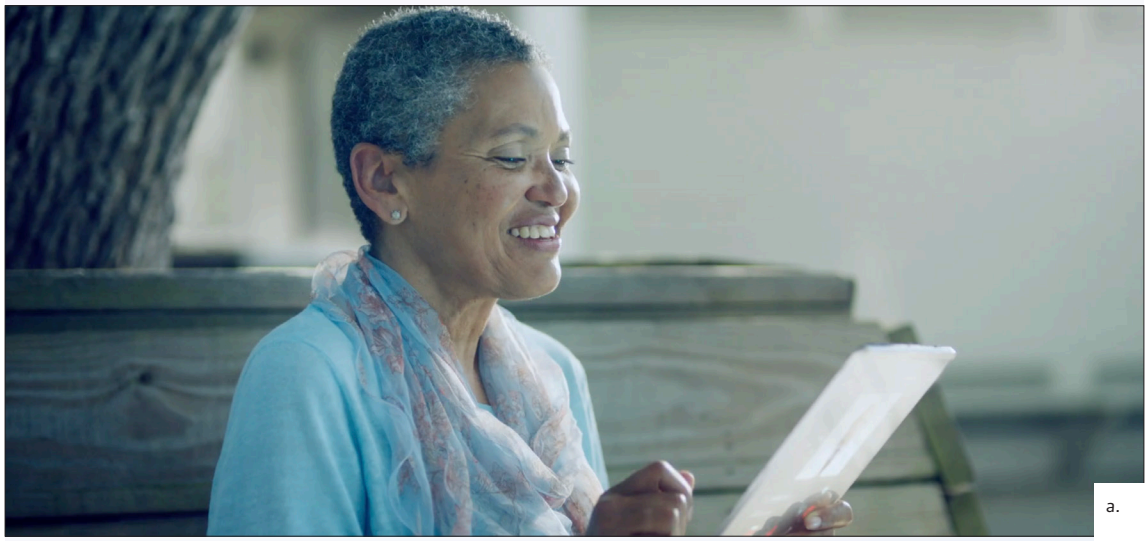


a.


b.

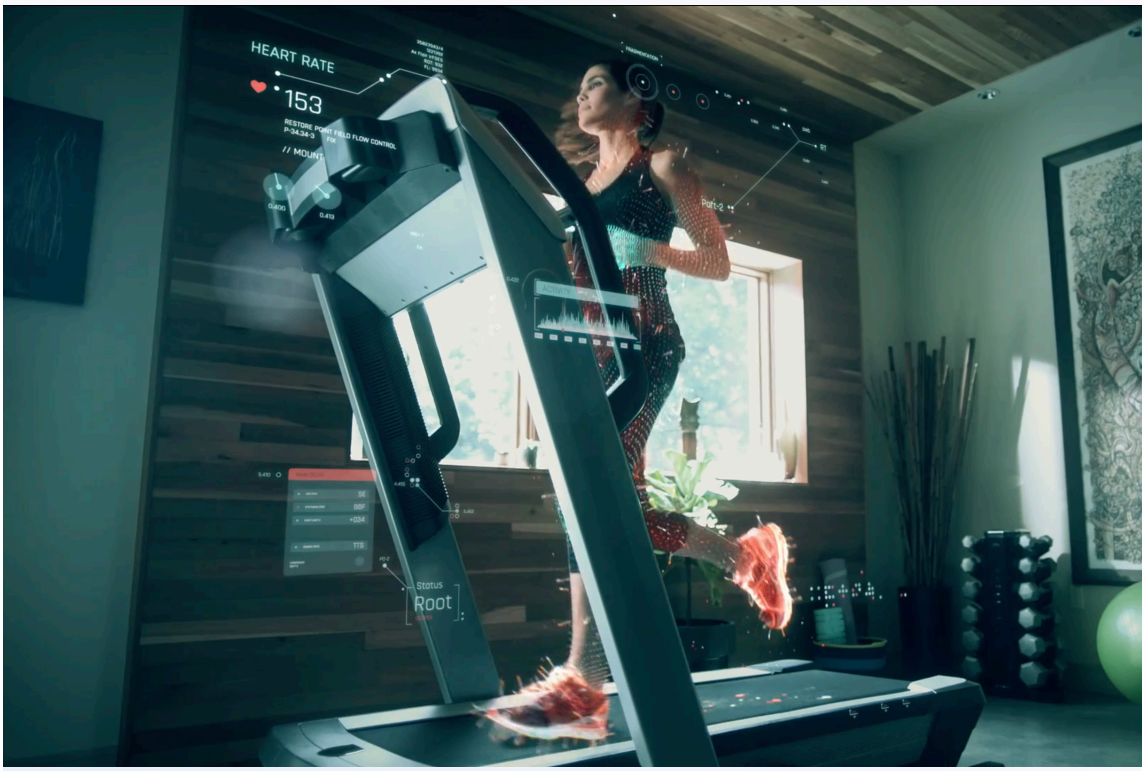



image a / More attention on health prevention with wearable health trackers
*Florida Hospital Future Vision*


image a / More attention on health prevention with wearable health trackers
*Florida Hospital Future Vision*

*image a / Use of hologram within medicine*
*Florida Hospital Future Vision*

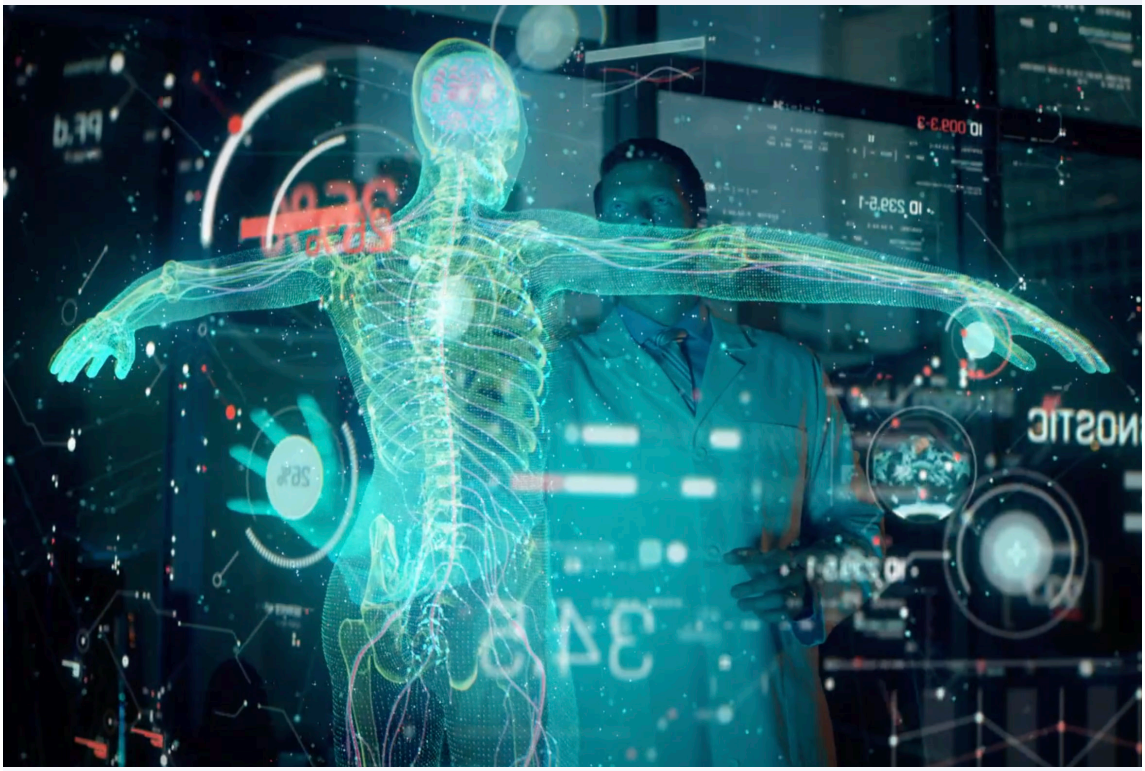


*image a / Use of hologram within medicine*
*Florida Hospital Future Vision*

## *THE ENHANCED HUMAN*

Glam-ma's are the new grandmas. They are glamourous, youthful, photo-shoot ready and plan to stay that way for a long time. "It is increasingly common for women and men in their 60s and 70s to seek out the expertise of facial plastic surgeons to maintain a youthful appearance," says Dr. Fedok. Over the last two decades, facelifts and cosmetic eyelid surgeries have doubled among people 65 and up.

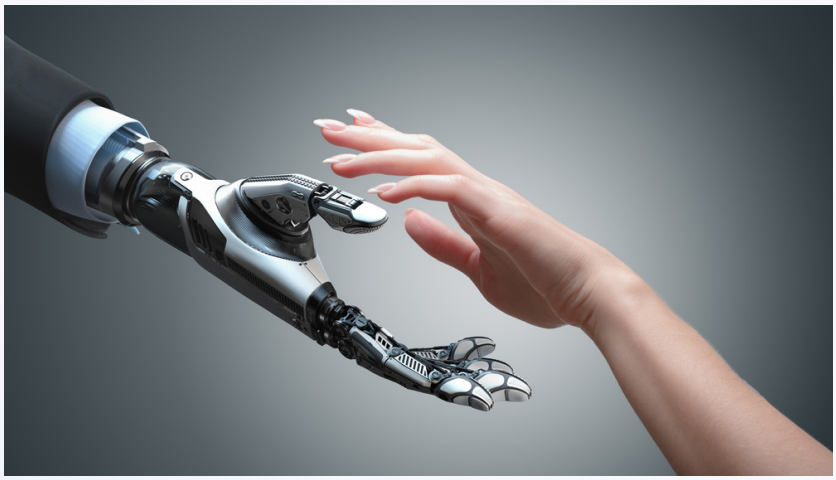
Not only enriching yourself with robotic parts for cosmetic reasons is growing, but the development in plastic surgery with robotical replacements will also only increase.
Having a disability will be a minimum problem in the future because of the attractiveness of robotic prothesis.

Robots doing nip, tuck, snip are not new to the medical industry. There is already a robot that is a light-weight, versatile precision surgical assistant that will probably redefine open surgery as well as minimally invasive surgical procedures like endoscopic heart surgery. These types of robots weighs almost 10 kg and has dimensions similar to those of the human arm.
They can assist the surgeon directly at the operating table especially if there is lack of space.

Over the last couple of decades, one of the most headline-making applications for AI in medicine has been the development of surgical robots.

In most cases to date, surgical robots (the da Vinci is the most well-known) function as an extension of the human surgeon, who controls the device from a nearby console. One of the more ambitious procedures, claimed to be a world-first, took place in Montreal in 2010. It was the first in-tandem performance of both a surgical robot as well as a robot anesthesiologist (cheekily named McSleepy); data gathered on the procedure reflects the impressive performance of these robotic doctors.

In 2015, more than a decade after the first surgical robots entered the operating room, MIT performed a retrospective analysis of FDA data to assess the safety of robotic surgery. There were 144 patient deaths and 1,391 patient injuries reported during the period of study, which were mainly caused by technical difficulties or device malfunctions. The report noted that "despite a relatively high number of reports, the vast majority of procedures were successful and did not involve any problems." But the number of events in more complex surgical areas (like cardiothoracic surgery) were "significantly higher" than in areas like gynecology and general surgery.



https://futurism.com/ai-medicine-doctor

## *SOCIAL AND MENTAL HEALTH*

The connection between social and mental health lies in the scale of urban design. Historically, cities were designed to increase the spread of infections and other diseases. In that line of thought urban planners and architects were seen as practicioners of a health profession. Soon, city parks and other green systems were embedded in the standard city plan, also seen in the urban expansion of Amsterdam by C. van Eesteren. Nowadays the spread of diseases are not the major public health issues, but mental and social health in the city are and the assignment on the table is to find design principles that accomodate this public health issue. Mental wellness is a key component of daily well-being and a healthy life.

*image a / Urban planners Van Eesteren and Mulder in white lab coat as planning was seen as health profession*
*Van Eesteren Museum*

According to a report of the Canadian chief officer of Health a healthy neighbourhood is based upon three factors: promoting physical activity, provide healthy food options and create a supportive environment. We already know that physical activity contributes in our mental state of health. The first two are included in our group vision for the Amstel area in 2100. So I'll look at the principles needed for providing a supportive environment.
First, a 'healthy neighbourhood' results in the following contributions to public health: the reduced risk for obesity and diabetes, the reduced risk for poor mental health, and improving mental wellness.

Looking at designing a supportive environment there are some factors to take into account. Social support and low stress have

/1 https://medicalfuturist.com/the-history-of-the-future-of-medicine-remote-care

been strongly linked to good health. It is thought that social support is linked to better health because it promotes healthy behaviours and helps people deal with difficult situations. Feeling socially isolated or lonely can increase the risk for premature death and poor health. Research shows that a sense of community belonging contributes in having a good physical and mental health. For the fast growing area of the Amstel it is key to create a sense of community belonging to retain the feeling of social isolation or loneliness.

Then there is the question why we put everyone to bed-rest when Dr. Morton Creditor already in 1992 wrote that there is no therapeutic value to strict bed-rest. In fact, immobilization of patients leads to muscle breakdown, which can be quantified: approximately 2 percent per day for an elderly person and 1-1.5 per cent for a younger adult. Thus, staying in bed is not only super boring and depressing, but it actually causes damage, especially to the elderly. So why don't we design hospitals with smaller rooms and more space for therapy? Why don't we design more lively social spaces to keep up a more positive and less lonely environment? Why don't we use the corridor spaces more effectively – where medical professionals and family members could meet, chat, while patients might keep themselves fit by walking around more?

To do this a supportive environment needs to be designed. A supportive environment needs to provide social interactions. According to the Canadian report, social interactions have a connection to a neighbourhood:

- have green spaces
- are pedestrian friendly
- have walkable destinations and accessible public transit
- are clean
- have low traffic and parking
- have places where people gather (e.g., places of worship, local tavern, coffee shops, restaurants, parks, recreation areas and facilities, community centres, libraries)
- are places where people walk for leisure and people see each other out and about
- create feelings of safety

These facts are mostly solved in our future group vision. But if we summarize the design principles for having a social and mental healthy neighbourhood:

1. Green places: ensure access to welcoming, attractive green spaces of all sizes
2. Active places: enable physical activity to become incidental and move away from sedentary lifestyles, ensure this remains into older age with walkable neighbourhoods
3. Pro social places: facilitate social interaction and engagement with others through public art and community gardens
4. Safe places: design spaces which are safe for residents of all age groups, where children are encouraged to play outdoors

This means that next to these design principles, a public function that creates a sense of community contributes into the

*Public Health Agency of Canada. (2017). The Chief Public Health Officer's Report on the State of Public Health in Canada 2017. Geraadpleegd van https://www.cip-icu.ca/Files/WTPD/2017-designing-healthy-living-eng.aspx*

*Dr. Bertalan Mesko & Dr. Diana Anderson, The Medical Futurist, June 2017*

## SOCIAL AND MENTAL HEALTH PRINCIPLES

access to welcoming, attractive green places of all sizes

active places which enable physical activity for every age

social places that facilitate engagement with others through public art

safe places for residents of every age group

## A HEALING ENVIRONMENT

When building for healthcare, hygiene and logistics are no longer central, but the user experience is becoming increasingly important. The concept of a 'Healing Environment' is not a new development. The fact that people heal faster when they look towards a green wall than on a blank wall is now widely known. In the line of thought of the municipality of Amsterdam (creating a human scale city), the design of healthcare functions shifts to humanizing architecture. Designing for the comfort of the user.

There is a broad range of research available when it comes to design principles concerning healthcare environments. The following is quickly found:

Spatial comfort

The functional, personal, and social evaluation of a space determines feelings of comfort (Buttimer & Seamon, 1980; Sixsmith, 1986). For a patient room, this means the room should be spacious enough, for example, to get in and out of bed, move around, and host company, and is there an opportunity to personalize the room. Rooms associated with spatial comfort are room dimensions, space that can be personalized, interior design, and views and access to nature.

Privacy

For patients, a lack of privacy, either visual or auditory, can lead to feelings of discomfort (van de Glind, de Roode, & Goossensen, 2007). Single rooms seem to increase feelings of privacy, dignity, and overall satisfaction and improve sleep.

Autonomy

Lack of control is associated with stress, depression, high blood pressure, and weaker immune system (Devlin & Arneill, 2003; Ulrich, 1992). Healthcare rooms associated with autonomy are the possibility to control the environment such as opening a window, adjusting lighting and temperature settings, closing the door, and shutting lines of sight.

Sensory Comfort

We use sensory comfort as a collective term for comfort provided by the environment on human senses, such as (day)light, fresh air, scent, temperature, and noise. In sum, windows, appropriate lighting and temperature settings, number of beds, sound absorbing materials, and ventilation type (fresh air) are DCs associated with sensory comfort.

Social Comfort

Social comfort refers to emotional, informative, and instrumental support by friends, family, staff, and other patients (Kahn & Antonucci, 1980; Kaunonen, Tarkka, Paunonen, & Laippala, 1999; Koivula, Paunonen-Ilmonen, Tarkka, Tarkka, & Laippala, 2002; Prevosth & van der Voordt, 2011). Social support seems to improve patients' physiological well-being (Kaunonen et al., 1999; Koivula et al., 2002). The need for social support increases in stressful events such as admission to a hospital.

*Schreuder, E., Lebesque, L., & Bottenheft, C. (2016). Healing Environments: What Design Factors Really Matter According to Patients? An Exploratory Analysis. Geraadpleegd van https://www.ncbi.nlm.nih.gov/pubmed/27101834*

# HEALING ENVIRONMENT PRINCIPLES

spatial comfort

privacy

autonomy

sensory comfort

social comfort

## *AMBIENT EXPERIENCE DESIGN*

In the previous chapter I've discussed how design can contribute to a healing environment for the patient's wellbeing. Not only the patient's wellbeing is important in healthcare architecture, but also the wellbeing of the staff and visitors. Philips Healthcare has done research in 'Ambient Experience design'. With this research several clinics all around the world popped up using the Ambient Experience design principles. The principle believes in changing healthcare into human care by turning painfully long waiting hours into consciously designed time periods.

When Corporate Pebble Partner Philips Healthcare is asked to design a medical environment, the group brings a decidedly creative perspective to the table. Leveraging the global resources of parent Royal Philips, the company assembles a multidisciplinary design team tasked with refocusing Architecture, lighting, and technology to create a more positive experience for patients, as well as hospital staff.

Best practices from high-end medical imaging technology, lighting, and consumer lifestyle industries are put to use in Ambient Experience design, introducing innovative elements to transform the space. George Marmaropoulos, design director, Ambient Experience North America, explains the thought process: "People are stressed when they find themselves in an unfamiliar environment and lack control over events that involve them. Our goal is to comfort both physically and emotionally, by designing spaces around perceived needs, with an easy-to-understand layout-using advanced technologies to allow personalization of the environment."

A holistic design approach

Every Ambient Experience project is a customized solution based on individual institutional needs, guided by four overriding principles:

- Comfort: create an architectural environment that contributes to the wellbeing of patients and clinical personnel
- Contact: maximize interaction between medical personnel, patients, and loved ones by decreasing physical barriers
- Workflow: remove disjointed, cluttered, and isolated work areas that adversely impact staff efficiency and satisfaction
- Personalization: give patients a sense of control over their experience by allowing them to affect their surroundings

The team helps create this immersive, multisensory experience by using technology to deliver the identified needs and values of all project stakeholders.

At the outset, the experience of every stakeholder, every person who is involved in the targeted routine, is studied in depth. From expectation, through treatment, to completion, each pathway and every interaction, is mapped. Patients, families, nurses, and physicians are all quietly shadowed for insight into their emotional and physical experiences.

Wishes and challenges are identified and translated into a list of opportunities for improvement. A visual map of the clinical workflow is created and overlaid with the "experience flow" of each stakeholder.

*image a / Ambient Experience*
*Philips Healthcare*

"Hot zones," where a confluence of events indicates a major need, then become apparent. From this, design concepts emerge:
better line-of-site monitoring for nurses
areas for sensitive conversations with families
an appropriate play or lounge area for children
intelligent lighting during patient positioning
Once important experience areas have been articulated, and concepts to address them proposed, a decision is made as to which areas will be included in the current project. Often, a multiphased implementation approach is taken, which can be an appealing option for administrators.
The Ambient Experience design values are then brought to life. "We custom design every experience," explains Joe Robinson, senior vice-president of Philips Healthcare, Sales and Marketing, Imaging Systems, North America. "We do so by selecting from a series of Ambient Experience technology blocks. These are tested products, ready to be installed, that have been designed in accordance with our philosophy of patient-centric healthcare."

Ambient Experience
transforming the healthcare environment

Principle is designing a people-focused healthcare environment that combines design and technology to create a more comfortable experience for patients and staff, potentially increasing operational effectiveness.

A holistic design approach
Every Ambient Experience project is a customized solution based on individual institutional needs, guided by four overriding principles:

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2. Contact: maximize interaction between medical personnel, patients, and loved ones by decreasing physical barriers
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# AMBIENT EXPERIENCE PRINCIPLES

environmental comfort

social contact

workflow

personalization

# 03 /

## Case studies

## *THE CONCEPT ROOM*

The 'Concept Room', a prototype for an innovative ambulatory surgery center designed by Clubster Santé and the University Hospital in Lille, offers a view of the future of patient care. The Econocom-sponsored project, which was already shown at the latest 'Health and autonomy' expo, won the 2013 HIT innovation prize. Their goal: to design an optimized ambulatory organization (the patient enters the morning and goes out the same evening), contributing to the well-being of the patient and facilitating the work of caregivers.

A team of American designers developed a prototype in 2009 called the 'Patient Room 2020'. It combined state-of-the-art architecture with the latest technology, such as sensors, monitors and touch screens to manage medical data and bring patients into contact with the outside world.

*The specific architecture and 'connected' device for ambulatory surgery*

Professor Michael Möllman, an expert in the field of future-oriented design of ambulatory surgery centers, outlined the ideal ambulatory facility in a recent publication and recommends a separate area, which is physically connected to the hospital, but with a specific device for optimizing and streamlining of personnel tasks while waiting, preparing, examining and restoring the patient and monitoring the work from a centrally located access area.

Professor Möllman also recommends a system developed by professors from the University of Adelaide in Australia, where a risk assessment takes place over the telephone before the operation. The surgeon sends relevant patient information to a call center, which then contacts the patient. The hospital staff, including the anaesthesiologist, have access to the data from the preoperative screening and can thus determine whether an examination or treatment is required for the patient to be operated on.

Day treatment: lower costs and better care for patients
Day treatment is not only a cost-effective alternative to long-term admission, but also ensures more efficient care for the patient. Centers for ambulatory surgery in the United States realized a cost saving of 7.5 billion dollars between 2008 and 2011 and this saving could increase to as much as 57.5 billion dollars over the next ten years (according to a research report from the University of California, Berkeley for the Ambulatory Surgery Center Association).

In OECD countries (OECD stands for Organization for Economic Co-operation and Development), 80% to 90% of all interventions can take place on an ambulatory basis, but ambulatory surgery, for example in France, only accounts for 40% of all treatments, according to the AFCA. (the French organization for outpatient surgery).

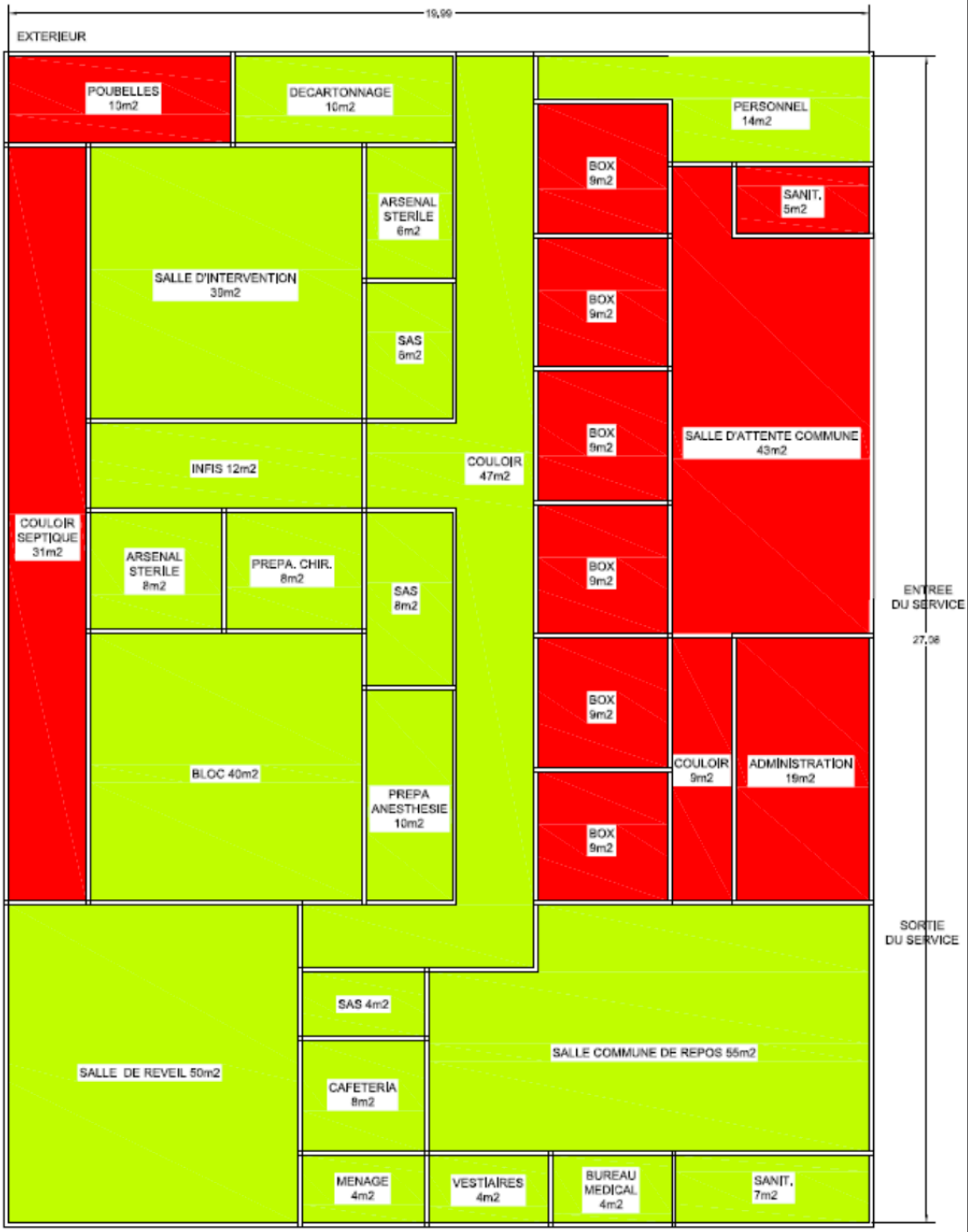
*image a, b, c / title*
https://www.conceptroom.fr/la-mise-en-oeuvre-2/

a.

b.

c.

# PLAN FONCTIONNEL



Day treatment for the well-being of the patient

A survey, conducted in France, revealed that, despite these figures, 8 out of 10 people would prefer to be treated against cancer as an outpatient. Day treatment is seen as a way to avoid the feeling of isolation that comes with hospitalization, which promotes the psychological well-being of the patient.

The fundamental principles of the design:

- the Walking forward principle
- the Autonomy of the patient

The Walking forward principle of the organization means that the patient and material journeys which consists of a progression without the possibility of going back (especially in contaminated areas).

The design is divided in three zones for optimal development:

1. A zone "Reception and care of the patient"
2. A zone "Intervention and surveillance"
3. A zone "Restoration and exit"

The forward march is only possible by a comprehensive rearrangement of the outpatient service designed in three parts.

PRE-INTERVENTION BOXES, STARTING POINT OF THE MARKET FORWARD

Functions of the zone:

- Completing the paperwork
- To prepare
- Take care and entertain
- Ensure your well-being

AN AREA OF INTERVENTION AND SURVEILLANCE

Functions of the zone:

- Transfer SAS = the chair-bed becomes an intervention table
- Intervention block
- Septic corridor
- PC Nurse
- Recovery room

THE ROOM OF REST, END OF THE COURSE OF THE PATIENT

Function of the "Recovery and Exit" Zone

- Keep your privacy
- take care
- Entertainment
- Restore
- Go out

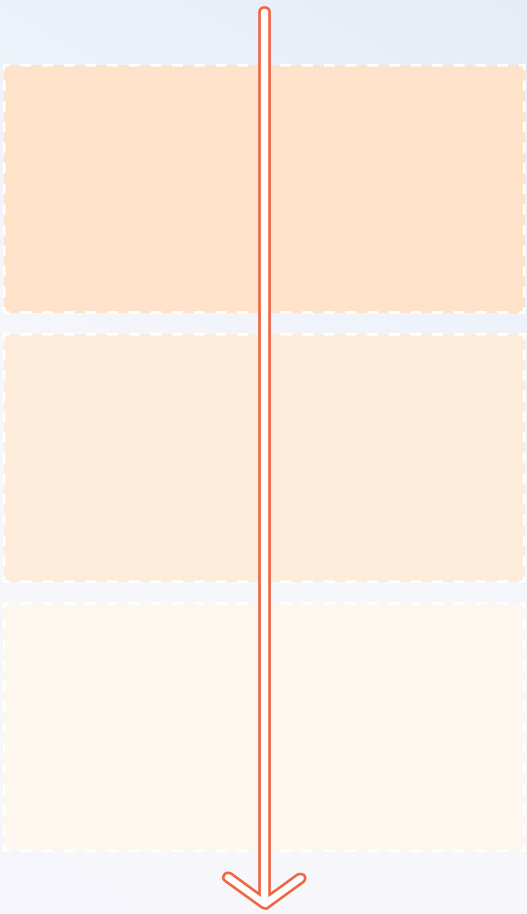
DESIGN ANALYSIS

Focus per zone

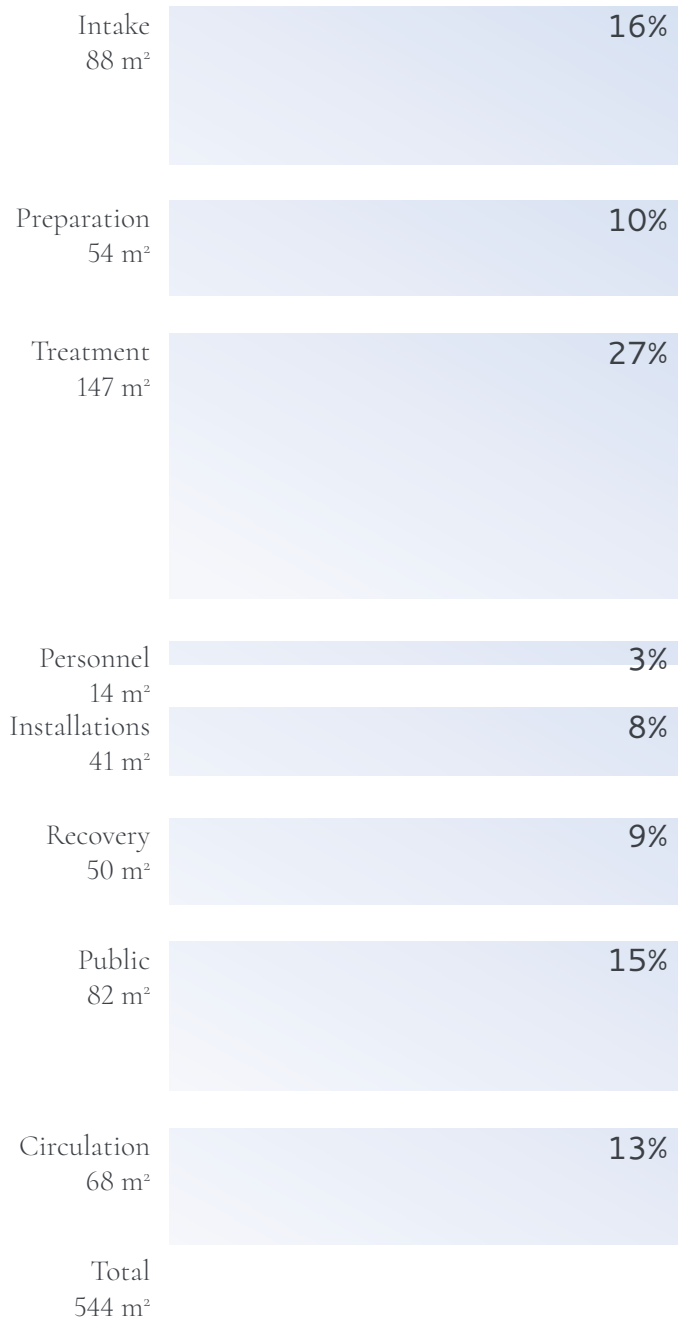
Intake zone:
entertain
well-being

Intervention zone:
preparation

Recovery zone:
restore
privacy
entertain



logistic and well-being
efficiency


Intake
88 m²
16%
Preparation
54 m²
10%
Treatment
147 m²
27%
Personnel
14 m²
3%
Installations
41 m²
8%
Recovery
50 m²
9%
Public
82 m²
15%
Circulation
68 m²
13%
Total
544 m²

Specifics

Program:
20 clinical functions
Size:
115,000 square meters
570 single patient rooms

## New North Zealand Hospital, Hillerød
*Herzog & de Meuron*

rethink the role a hospital plays

Herzog & de Meuron have designed a patient-centred hospital – a beautiful, healing and functional building that supports our patients' recovery in the best possible way," said hospital director Bente Ourø Rørth. "The hospital's great strength is its highly successful and fundamental fusion of form and function.

The New North Zealand Hospital in Hillerød, Denmark planned for 2020 will serve as the primary access point for citizens who need acute or planned treatment. The new hospital aims to offer the most up-to-date, efficient and inviting setting for patients, while also being a workplace offering the best conditions for staff. Five principles for planning the New North Zealand Hospital aim to ensure a high quality hospital that operates effectively for many years: A hospital that offers the best possible treatment, an efficient and professional hospital, a safe hospital, a welcoming hospital, and a hospital that works across organisational boundaries.

Unlike traditional hospitals, the outstanding architecture designed by Herzog & de Meuron and Vilhelm Lauritzen Architects will be kept on a human scale. The horizontal building will have a four floors at its highest point and short internal connections that will foster exchange across the various departments. A horizontal building is an appropriate building typology for a hospital, because this fosters exchange: across the various departments, the employees work on a shared goal: the healing of the ailing human being. The new hospital shall overcome conventional operational borders.

Viewed in section, the arrangement of the functions is simple: two floors for examination and treatment form a pedestal upon which a two-story ribbon of wards is placed along the perimeter, forming the large central garden. In the pedestal, on both levels, connections to the outdoors are created in various ways. Courtyards provide daylight and vistas, and ease orientation. Large connected areas, the repetitive arrangement of the interior courtyards, and uniform room sizes offer a high degree of flexibility. Later changes of functions can be easily realized.

The goal is to design a hospital that doesn't look or feel like a hospital but more like a home. The vision is to provide a new take on what it means to be hospitalized in the years to come. It serves more than 310,000 citizens and conduct about 500,000 outpatient treatments each year. The acute hospital will host 20 clinical functions and about 4,000 employees.

Design principles:
1. The more frequented a department, the more central its location.
2. The main streams of outpatients and inpatients are separated vertically. Each level of the pedestal serves one primary stream.

1.

3.

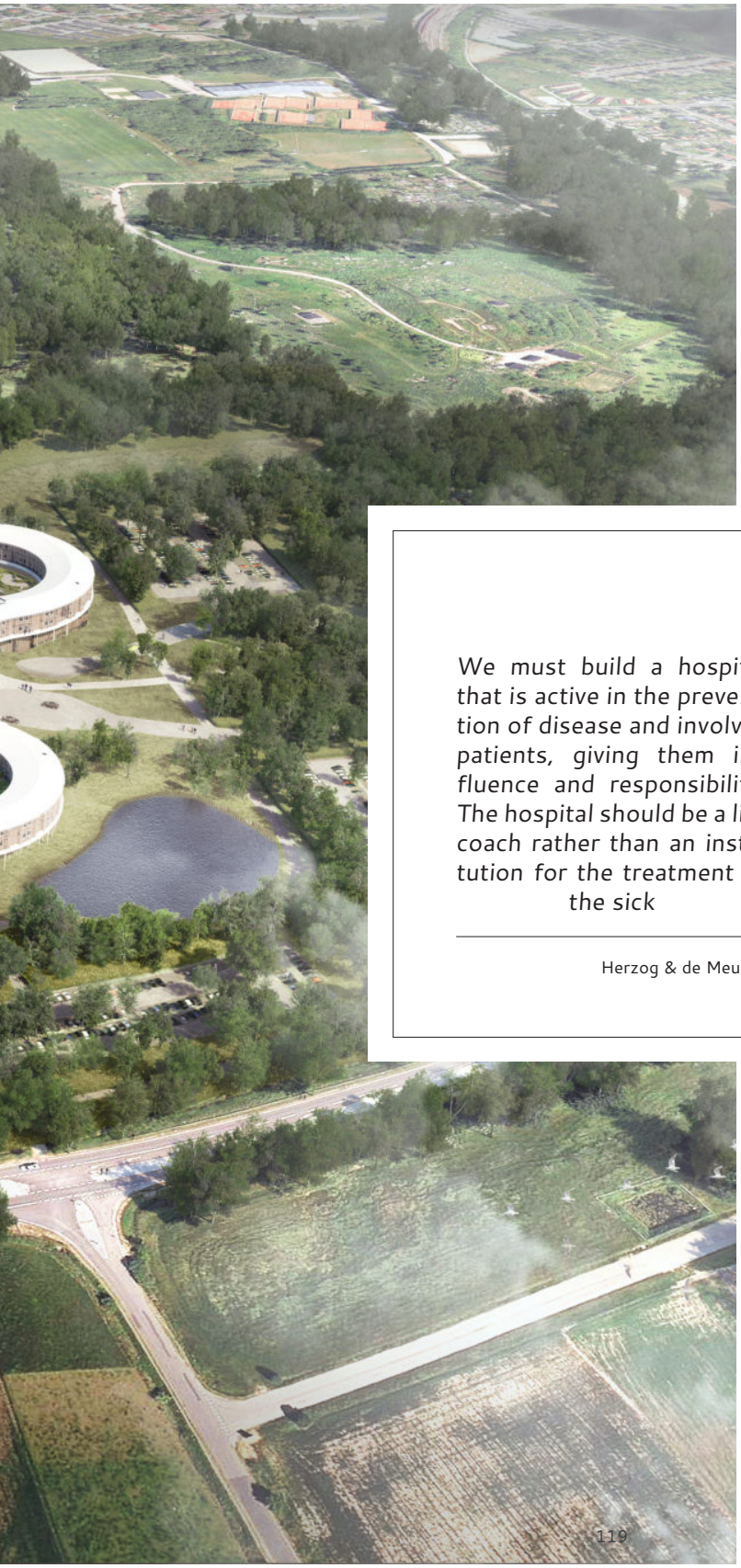
2.

4.

*image 1 / the building is conceived as a low-rise pavilion-like structure*
*image 2 / the design never exceeds four storeys height*

*image 3 / a large garden will be located on the roof*
*image 4 / title*

*all images retrieved from https://www.dezeen.com/*



*We must build a hospital that is active in the prevention of disease and involves patients, giving them influence and responsibility. The hospital should be a life coach rather than an institution for the treatment of the sick*

Herzog & de Meuron

## DESIGN ANALYSIS

Organic form

Strong connection nature

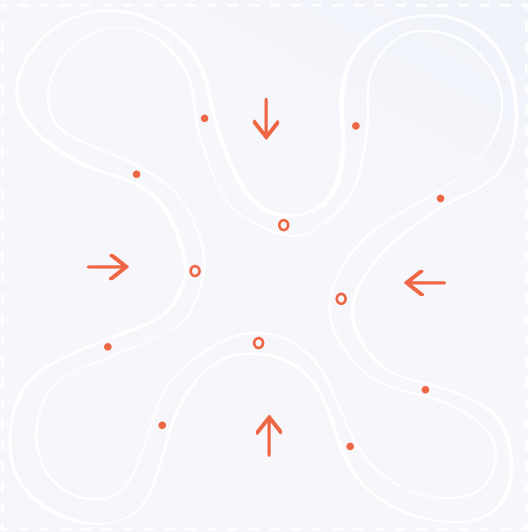
Public lower two departments

Private ward in upper departments

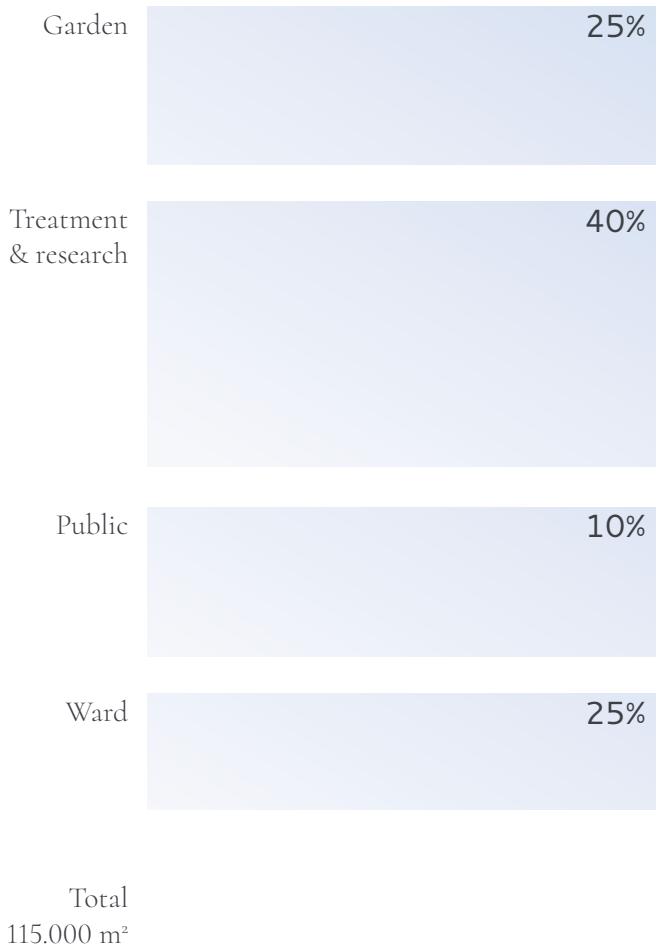


Focus

short internal connections



PROGRAM ANALYSIS




*Healthcare, D. (2018, 17 januari). Re-imagining the future of distributed healthcare environments. Geraadpleegd op 12 december 2018, van https://medium.com/@d.healthcare/designing-distributed-healthcare-d23e2f3ddef0*
https://www.herzogdemeuron.com/index/projects/complete-works/401-425/416-new-north-zealand-hospital.html
https://www.healthcaredesignmagazine.com/projects/acute-care/first-look-new-north-zealand-hospital/

Specifics

Program:
health, culture, leisure
Size:
4,000 square meters
570 single patient rooms

## Ku.Be House of Culture and Movement, Frederiksberg
*MVRDV & ADEPT*

bring people together and improve the quality of life

The project is a new typology, responding to a brief that solely asked for a building that would bring people together and improve the quality of life. In reply ADEPT and MVRDV answered with one that blends theatre, sport and learning into a space where body and mind are activated to promote a more healthy life for everyone, regardless of age, ability or interest; creating links between people that would not otherwise connect with each other.

Health, culture, leisure and education should smoothly blend together to create a spectacular architectural experience that will become a destination. The main building, the House of Culture and Movement, or Ku-Be (Kultur- og Bevægelseshus) is a rectangular glass volume containing six stacked ideal programmatic elements. The space in-between can be programmed flexibly as a 'play zone' with various activities and main circulation. The stacked elements hold more specific uses: a theatre, a health zone, food zone, a zen area, a study centre and exhibition hall, fitness and activity centre, a wellness centre and an area for the administration.

The theatre is flexible and can be used in different stage and audience settings; in addition its large window allows it to be used as an open air theatre where the public stays in the garden. The building is a truly multifunctional public centre which engages its users. The 3 volumes are wrapped in an 'urban curtain' that acts as frame for the garden.

The 3,200m2 Ku.Be House of Culture and Movement was designed for the municipality of Frederiksberg as a focal point for both the immediate community and also the wider area of Copenhagen; one that the people themselves could take ownership of and that would evolve its programme based on the specific wants and needs of its users. The project is a new typology, developed out of the response to a brief that solely asked for a building that would bring people together and improve the quality of life. In reply, MVRDV and ADEPT answered with one that blends theatre, sport and learning into a space where body and mind are activated to promote a more healthy life for everyone, regardless of age, ability or interest; creating links between people that wouldn't otherwise connect with each other.

The six primary volumes which make up Ku.Be, each with their own programme, are clad in a unique colour and material, clearly defining them within the building; from outside these shapes are hinted at in the fragmented tile façade. "We designed Ku.Be to encourage the unexpected," explains MVRDV co-founder Jacob van Rijs. "Larger volumes are suited to hold performances or public meetings, smaller ones can be for exhibitions or debates. The fast-pace rooms are perfect for dance or parkour, and zen rooms give you the contrast of yoga or meditation. It's between these volumes where the real fun will happen, though; spaces where we hint at a use, but which will become entirely user-defined."

The route through the building focuses on developing and encouraging alternate forms of movement. The Labyrinth gets people on their hands and knees climbing through a three-dimensional network of cubes from the second to third floors; or alternatively, they could take the Mousetrap, a vertical maze. A net which spans several floors throug-

Design principles: 1. In-between functions space is flexible and seen as 'play zone'.
2. Seamless transition of care as patient progresses through recovery.

1.

3.

2.

4.

*image 1 / the building is conceived as a low-rise pavilion-like structure*
*image 2 / the design never exceeds four storeys height*

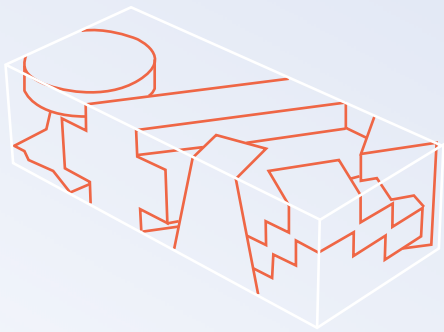
*image 3 / a large garden will be located on the roof*
*image 4 / title*

*all images retrieved from https://www.dezeen.com/*

hout the building, lets users climb up from floor to floor – suspended over the voids – and slides and fireman poles offer a fast way to get back down.

The urban gardens outside form the connection between Ku.Be and the urban realm, playing an important role in expressing the eight volumes and the activities happening inside. The diverse landscape - a system of microclimates with changing sounds, lights, and scents which blend seamlessly into a hill with integrated slides - reaches out into the gardens and ends in an amphitheatre outside. By becoming an extension of the urban landscape of Frederiksberg and integrating the community to such an extent, the House of Culture and Movement looks to become an incubator for further development within the neighbourhood.

## DESIGN ANALYSIS



Gave every program it's own optimal function mass

Space inbetween is circulation and meeting place

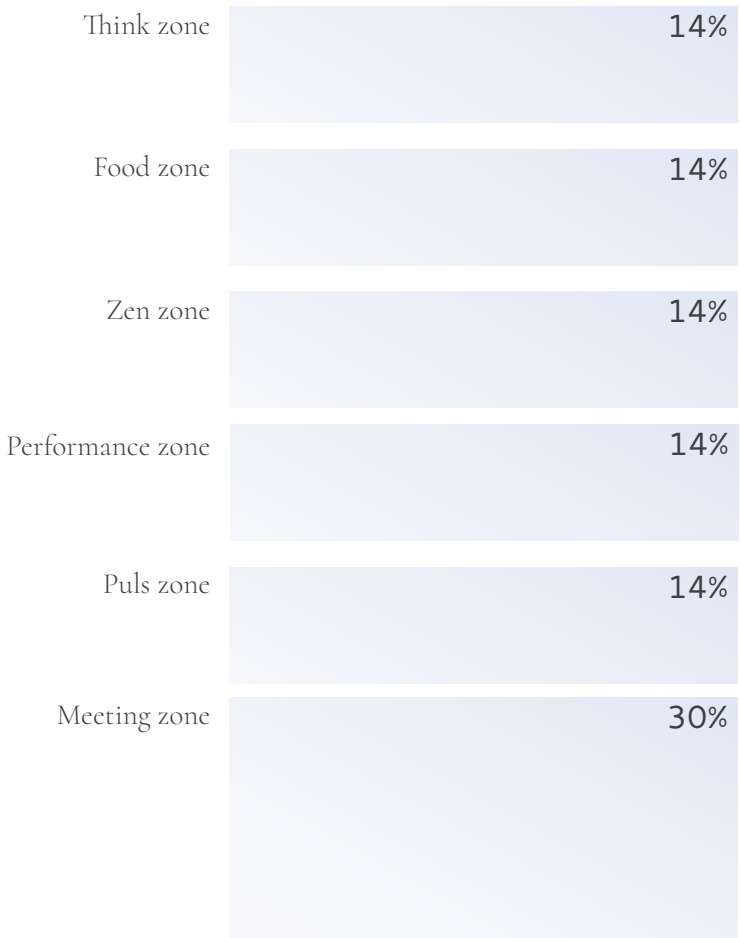
Every function has it's own ambiance

creating links between people that wouldn't otherwise connect with each other



Focus

social engagement


Think zone
14%
Food zone
14%
Zen zone
14%
Performance zone
14%
Puls zone
14%
Meeting zone
30%
Total
3200 m²

Specifics

Program:
psychiatric clinic
Size:
3,300 square metres
14 private rooms

## Nuuk Psychiatric Clinic, Greenland
*White Arkitekter*

an open, healing and caring environment for the patients and a safe and attractive work place for the staff

In designing the 35,521 square-foot building, the White Arkitekter design team chose to emphasize the beauty of Greenland's natural landscape and create a tranquil atmosphere with a strong connection to the hospital's surroundings. By analyzing and recognizing the impact of architecture on the hospital's patients, the design team has attempted to create a calm, healing environment for its visitors.

The built atmosphere in which we live has a profound impact on our mood and well-being. For those with mental health issues, this fact is particularly important to understand. This raises the question: can architects successfully design a space that has an overall positive influence on the healing process? What integrated elements of the building, in particular, aid in the process while fighting the prejudice and stigma of mental health issues?
The building strikes the perfect balance between a calm, healing and trustworthy atmosphere and the natural landscape and the existing hospital facilities. Echoing the materials and colours of Nuuk – where hospitals are traditionally yellow – the architecture cuts an instantly recognisable figure from both near and afar.

Greenland has 57,700 inhabitants of which 14, 700 live in Nuuk. On behalf of the Greenlandic Sundhedsvæsenet, a steering committee has initiated the project for a new psychiatric clinic at the hospital in Nuuk. Patients come from the city of Nuuk and from along the extensive coastline.

Daylight is abundant in all patient rooms thanks to the large windows and generous height of this part of the building. Looking out the windows, patients have views of the dramatic landscape and the fjord. The rooms are spacious and offer good internal overview of the premises to provide safe surroundings for both staff and patients. Wood is the primary material used here; apart from being a long-lasting solution, wood is proven to have a calming and stress-reducing effect.

Common areas are designed to connect with nature. An atrium with an open-air garden protected from the wind has an open south-west facing corner where patients can experience the landscape outside. This clear connection to the landscape combined with the daylight inlet are also of great importance for the orientation and communication in the building.

The courtyard and landscape create a protected, flexible outdoor space that invites to different activity; conversations with visitors, exercise in the outdoor gym or a game of table tennis. An unprogrammed garden area facing the atrium is semi-climatised and acoustically independent from the rest of the building can adapt to suit a variety of functions.

Design principles: 1. Digital technologies that customize patient rooms and improve communication.
2. Seamless transition of care as patient progresses through recovery.

1.

3.

2.

4.

*image 1 / the building is conceived as a low-rise pavilion-like structure*
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*image 4 / title*

*all images retrieved from https://www.dezeen.com/*

The design of the clinic balances visual qualities of its own character with specific elements and materials inspired by the special identity of Greenland. The appearance is changing not only from different perspectives of the site, but also throughout the day and year. From a precise assemblage to a fuzzy glowing beacon, this constant change gives form to the individuality of its users, while at the same time generating a dialogue with those viewing the building from the surrounding neighbourhood.

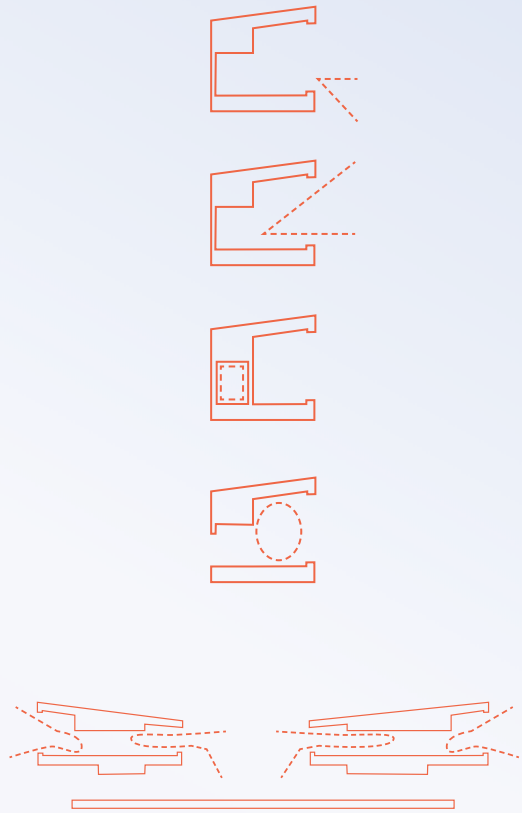
Many of the main gathering areas throughout the structure, such as the atrium, will be transitional spaces that meld the protection of a confined space with the beauty and clarity of the landscape. These flexible spaces are catered to various activities including family and friend visits, exercise, and personal reflection.

## DESIGN ANALYSIS

Strong connection with nature

Private parts of the building more enclosed

Atrium for social place and different activities



**Specifics**

*Program:*
heart and transplant functions
*Size:*
830,000 square metres
620 private rooms

## Cleveland Clinic Abu Dhabi, Abu Dhabi
*HDR*

creating a facility that looks more like a seven-star hotel than a hospital

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"The term 'hospital of the future' is used quite often, but I can't imagine another facility that reflects that phrase more than the Cleveland Clinic Abu Dhabi," says Mohammed Ayoub, lead HDR designer for the project. "It's a building that blends cutting-edge technology, evidence-based design, world-class care, and Arabic culture with elegant architecture—creating a facility that looks more like a seven-star hotel than a hospital."
The image of the campus, with its verdant gardens, glowing double-skinned patient tower, distinctive diamond-glazing, modern interiors and colorful massing exemplifies the best of what medical care can be. The design is overlaid with a suite of cultural references that ground the project firmly in Abu Dhabi. The color palette represents surrounding natural elements, such as the turquoise of the Gulf waters and the array of neutrals of the desert, and interior patterns and motifs reflect the local vernacular, as seen in Arabesque patterned screen elements throughout the building.
To avoid the characteristic maze of many hospitals, each healthcare component is expressed in an individual architecture form, arranged to express the continuum of healthcare—the Cleveland Clinic model. The blocks are elegantly stacked around a central reflecting pool; the entire design literally and figuratively founded on water, a universally recognized source and symbol of serenity and healing. This grouping of blocks creates efficiencies for the staff and obvious wayfinding for visitors, replacing winding hallways with sleek glass walkways that connect the inpatient spaces with the 340-exam room outpatient clinic, 210 faculty offices, conference center, simulation center and administrative building.

The characteristic maze-like layout of other healthcare facilities was avoided by housing each healthcare component in its own individual architectural form. The straightforward stacking of the forms creates efficiencies for staff, intuitive wayfinding for visitors and an architectural icon that can be seen for miles.
The hospital is overlaid with a suite of cultural references that ground the project in Abu Dhabi. Arabesque patterns and regional color palettes are integrated into the interiors to provide patients with a sense of familiarity.
On the exterior, much of the building is enclosed by distinctive diamond glazing, with the diamond shapes representing a subtle nod to Islamic geometry. The exterior colors were inspired by the region's landscape; glass echoes the striking blues of the sea, while onyx pays tribute to the desert and arid landscape.

Design principles: 1. Digital technologies that customize patient rooms and improve communication.
2. Seamless transition of care as patient progresses through recovery.

1.

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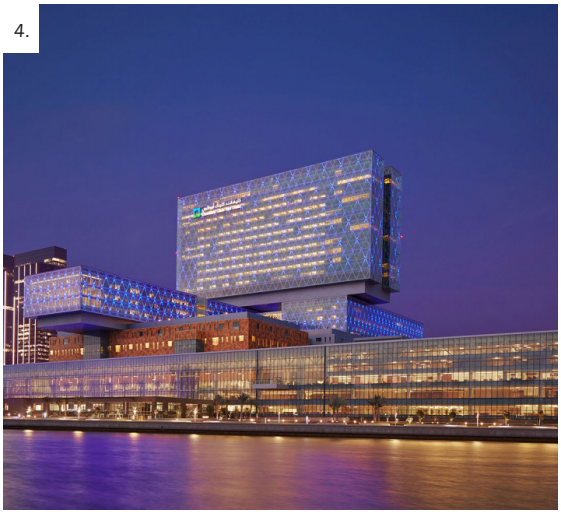

4.

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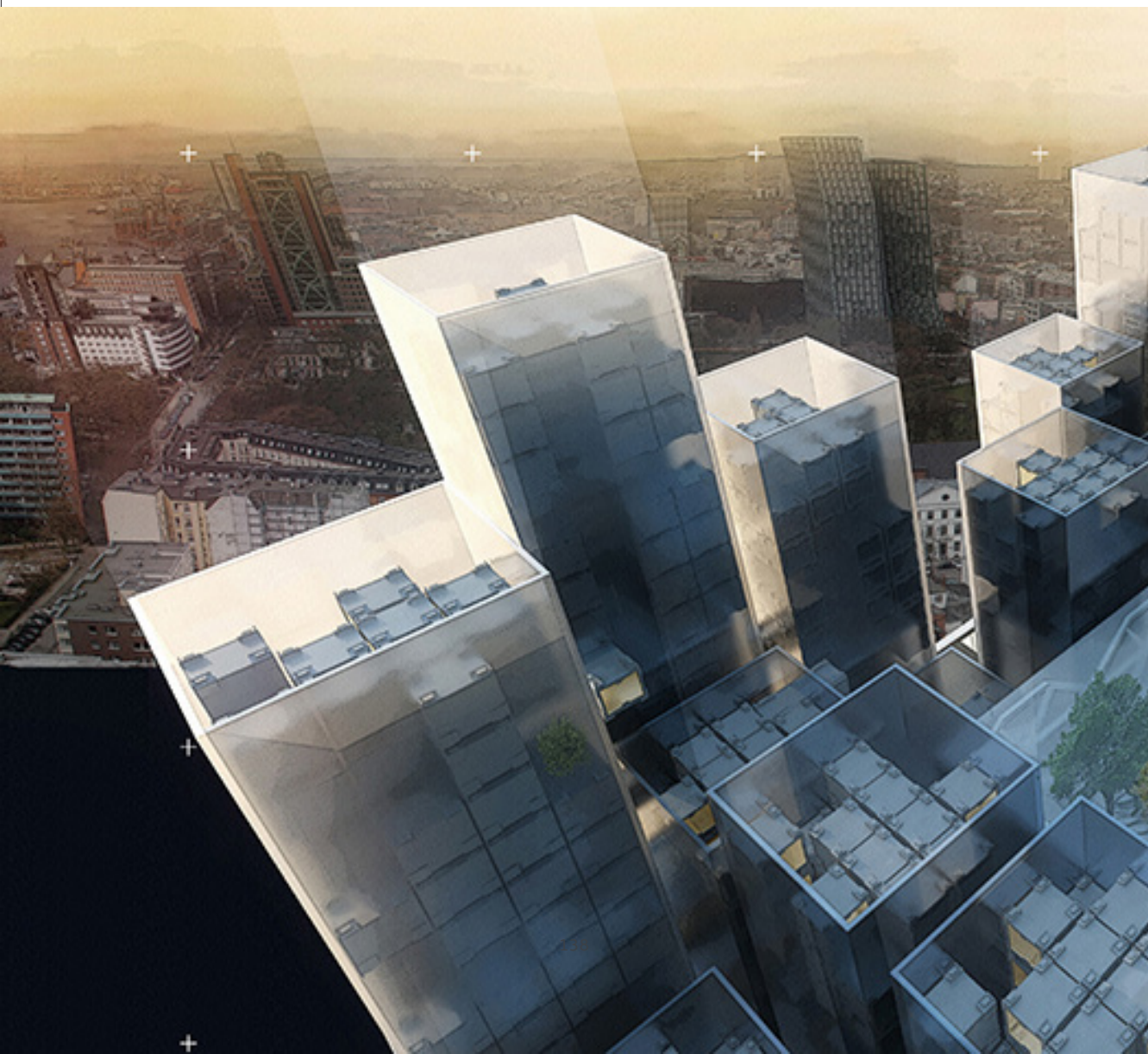
*all images retrieved from https://www.dezeen.com/*

## Evolving Infirmary

*Yanko Design*

a transpital that revolves around being flexible and mobile

A hospital must adapt to its requirements. In the event of a physical natural disaster, the Emergency Rooms would get occupied, but in that situation, the Infection department, or the rehab centre would pretty much lie vacant. And this would operate the same way for say a viral epidemic. The Transpital is a pretty futuristic hospital concept that revolves around being flexible and mobile. Individual patient units can be allotted to any given department, expanding it or contracting it based on the requirement. Each department is a massive transparent chamber that travels up and down, allowing medical staff to swiftly move not just between departments, but between individual rooms/units too.



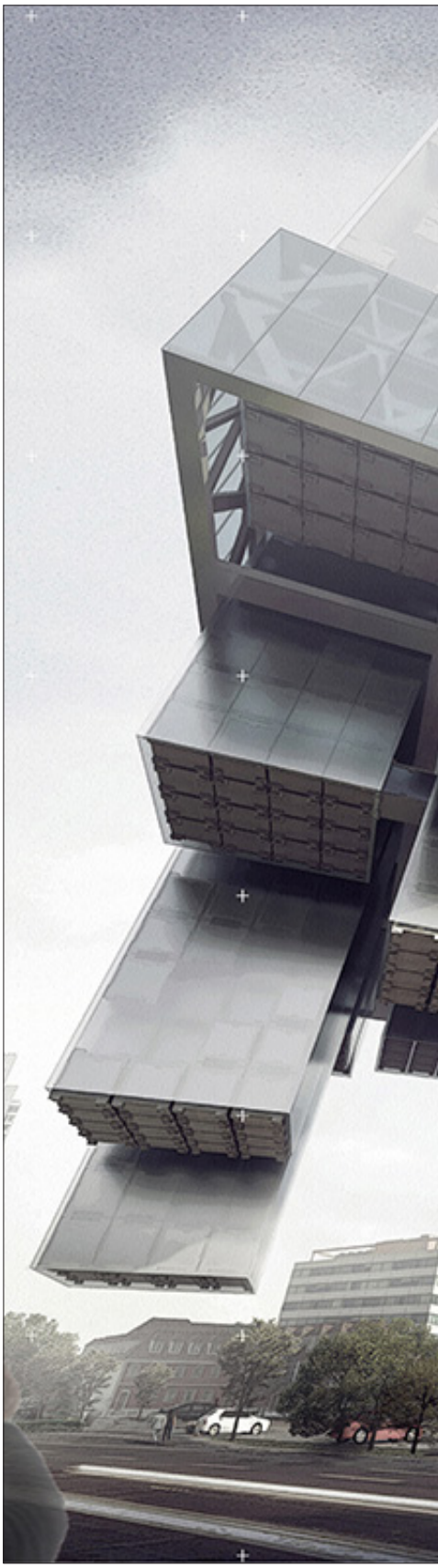
Design principles:
1. Patient units adapt to the patients requirements and move to the assigned department.
2. Each department is a massive transparent chamber that travels up and down

*all images and text retrieved from http://www.yankodesign.com/2016/03/30/evolving-infirmary/*

## DESIGN ANALYSIS

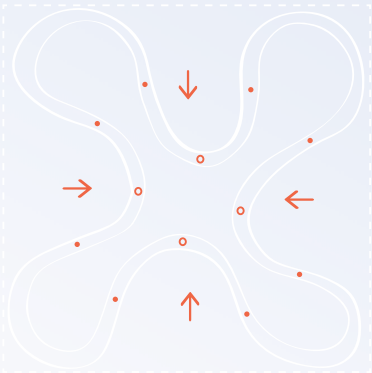
Every patient unit moves towards the right department. The unit itself transforms into the required spatial configuration.
The vertical tubes are the departments.





## CASE STUDIES

New North Zealand Hospital, Hillerød
*Herzog & de Meuron*

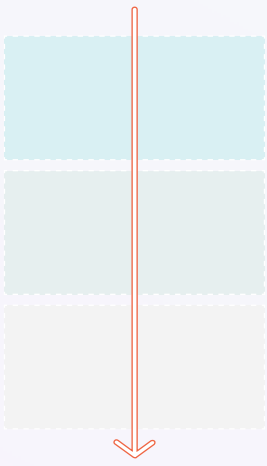


Ku.Be House of Culture and Movement, Frederiksberg
*MVRDV & ADEPT*

Evolving Infirmary
*Yanko Design*



Concept Room, Lille
*Clubster Santé*



# 04 /

## Ambitions

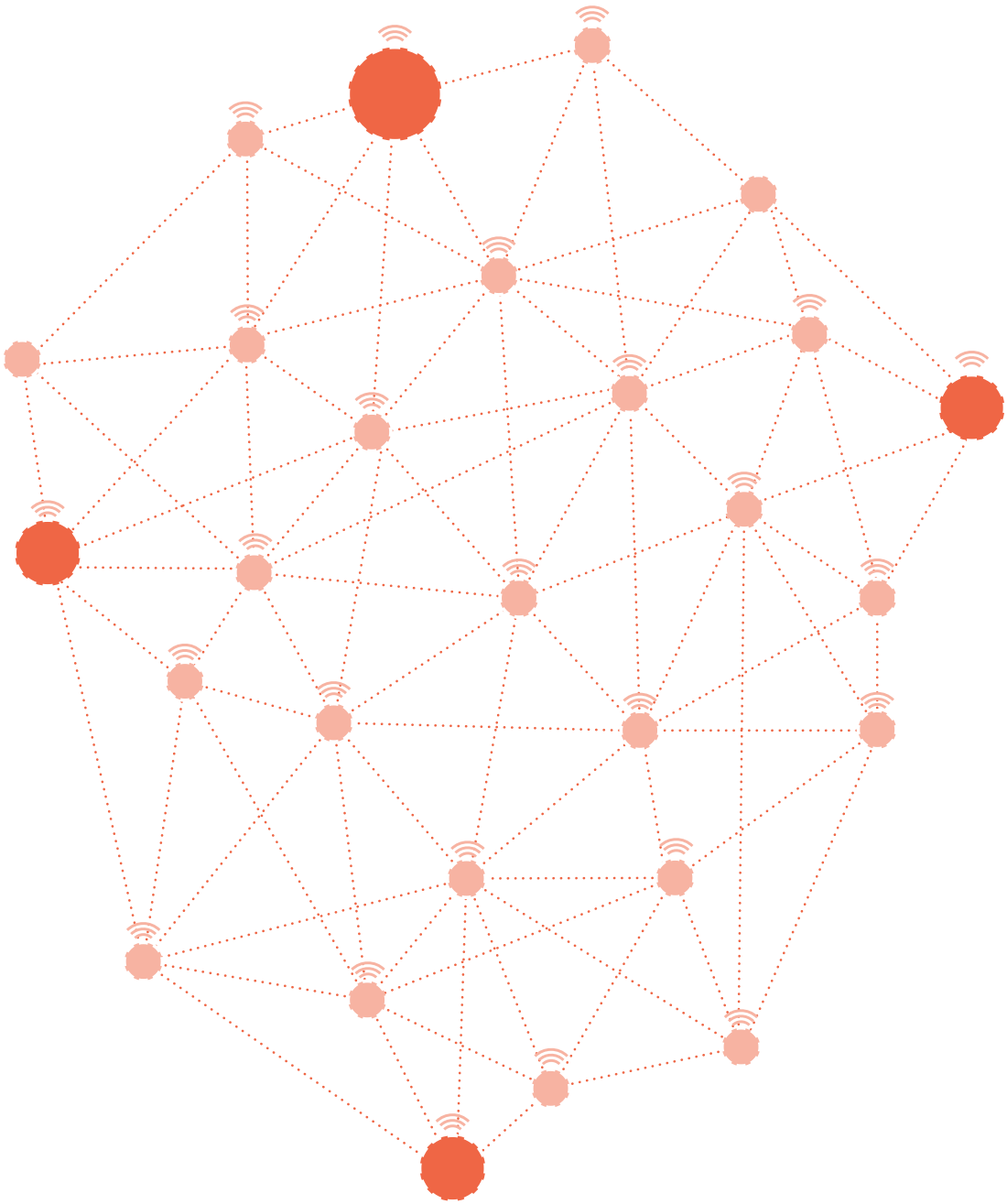
*PROJECT PROPOSAL*

# AMSTEL HEALTH BASE



a multi-specialty health facility that provides all facets of engaging in health. It houses acute and outpatient treatment, mental health care and promotes other health activities.

The base is connected to the healthcare network of the city of Amsterdam and serves as a public building transforming engaging in health into a primary life activity.



*FUTURE SYSTEM OF HEALTH*

The future system of health is seamlessly connected with all the types of facilities. The patient will be treated in the place where he or she wants to be treated - very copmplex procedures or long stay excluded. The medical data is owned by the patient itself and he or she can choose with whom to share that data. In case of emergencies, the overall connected network knows where the quickest available emergency department is, and the data will be available for the urgent caretakers.

Large healthcare facility
*multi-specialty facilities*

Neighbourhood health base
*short term care and treatment*


HOSPITAL
CHB
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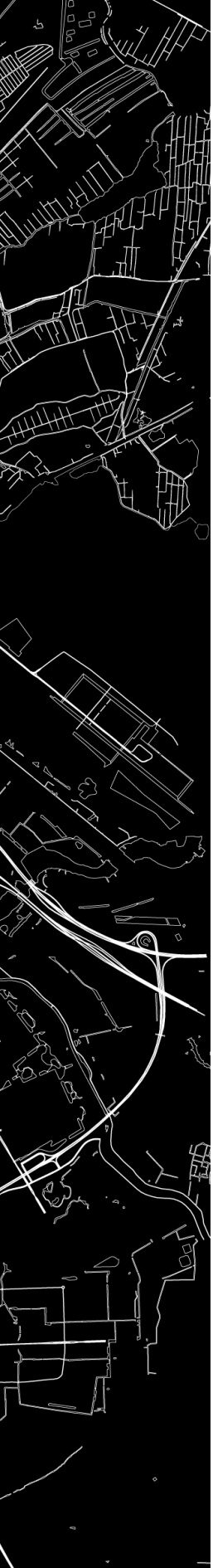
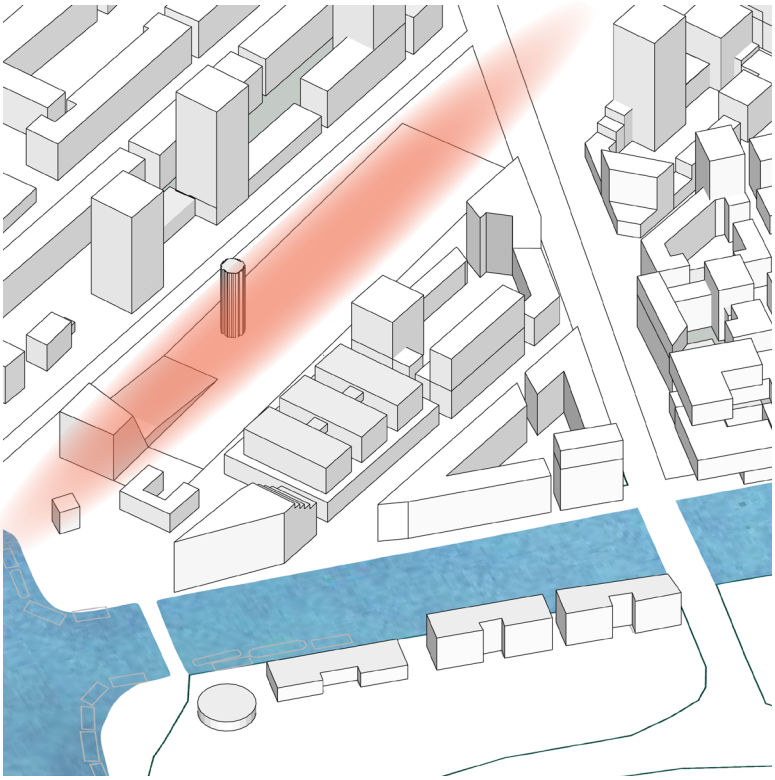


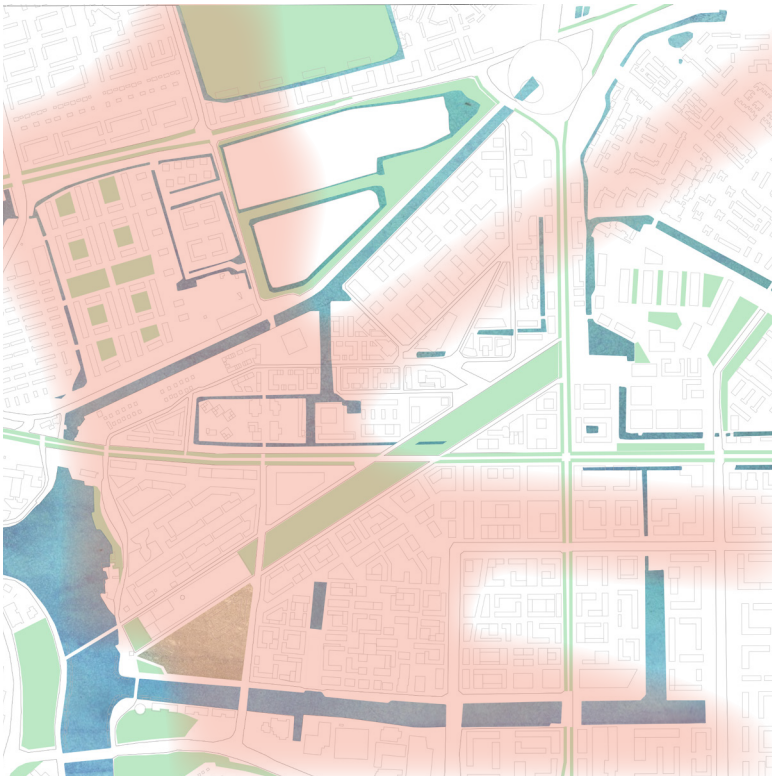
*DECENTRALISATION CARE CLINICS*

In the year 2100 healthcare facilities will be distributed and designed in a sustainable way. Every community will have their own base with acute and outpatient care. The major hospitals around the city will likely to be transformed into factories for medical 3D printing, and long stay complex care facilities. They form a complete health network.



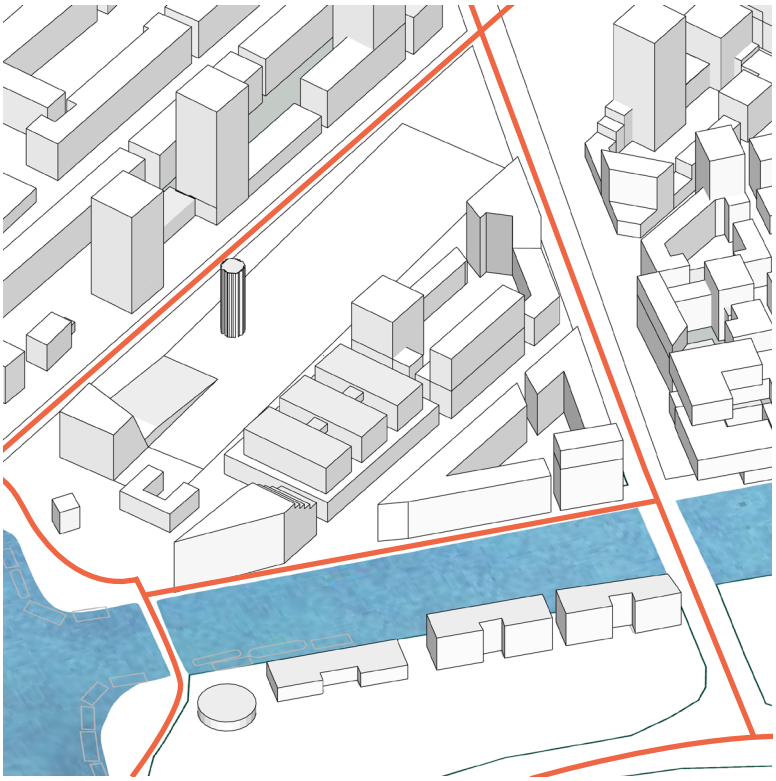
*LOCATION CONDITIONS*

A PUBLIC CONNECTION



*SITE CONDITIONS*

HEALING ENVIRONMENT

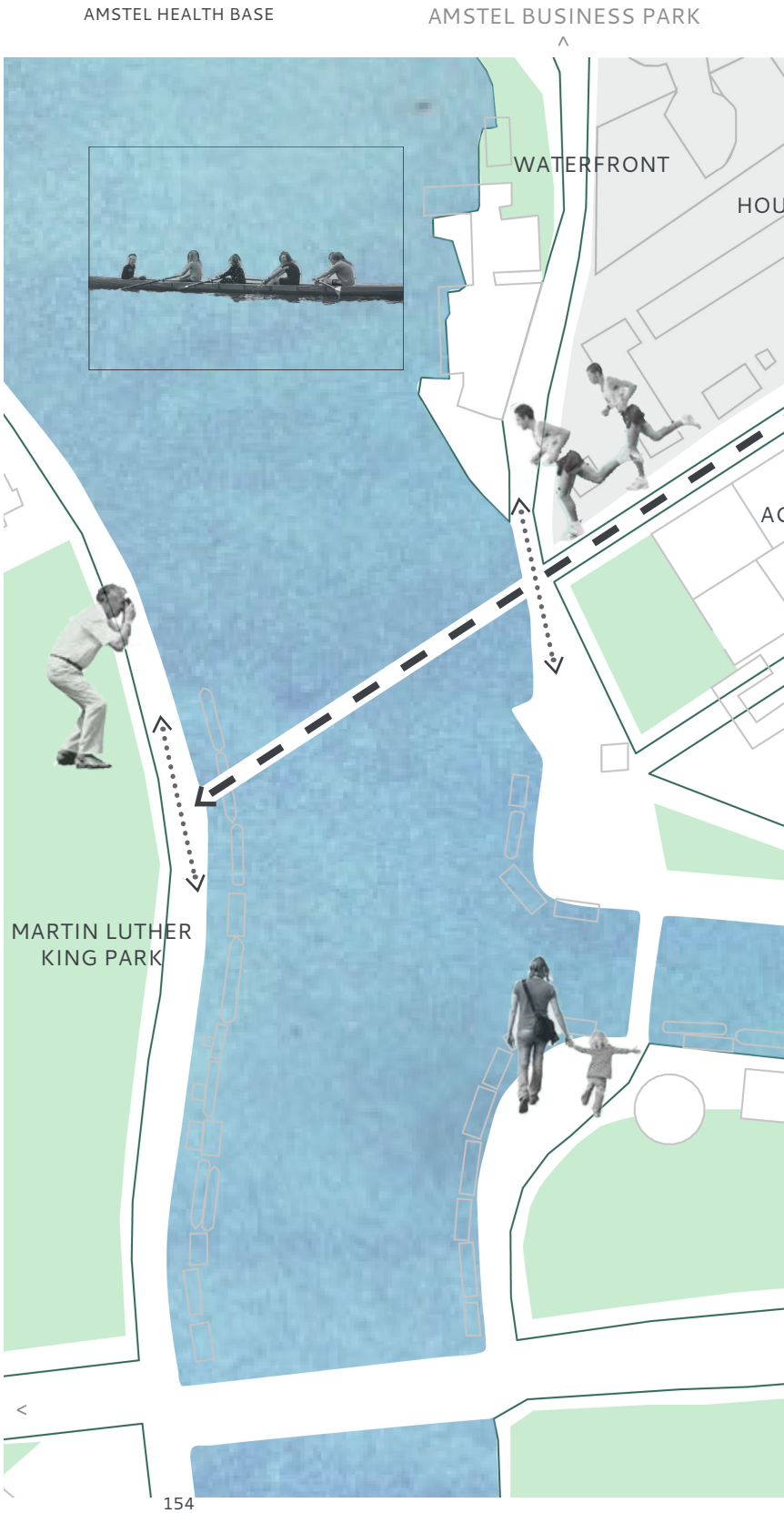


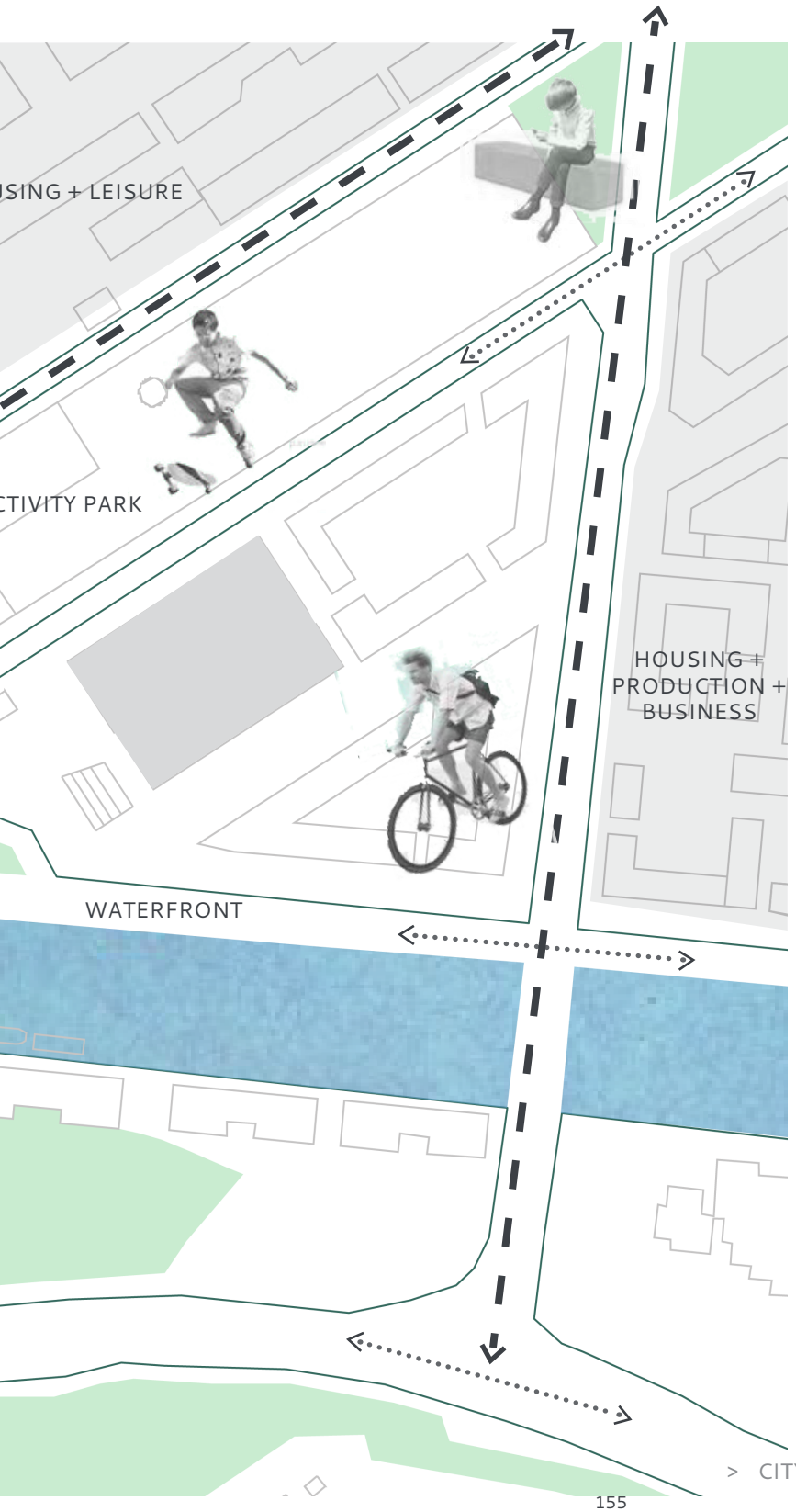
*SITE CONDITIONS*

LOCAL LOGISTICS

*SITE CONDITIONS*

CENTRALITY


AMSTEL HEALTH BASE
AMSTEL BUSINESS PARK
WATERFRONT
HOU
AC
MARTIN LUTHER
KING PARK
CITY CENTER


TRANSPORTATION HUB
USING + LEISURE
CTIVITY PARK
HOUSING +
PRODUCTION +
BUSINESS
WATERFRONT
> CITY BOULEVARD

## A JOURNEY OF PROGRESSION

## DISTINCTION IN PATIENT FLOWS

EFFICIENT PATIENT LOGISTICS

HEALING ENVIRONMENT

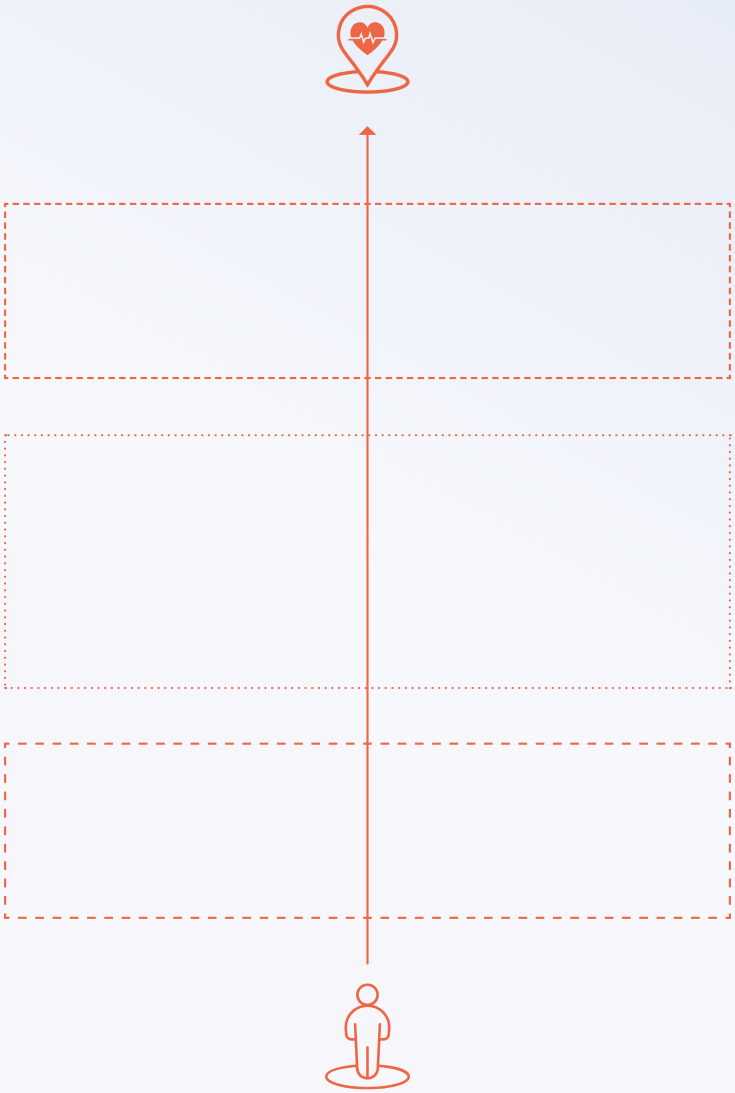
PUBLIC ROLE

## Journey of progression

From entering the building the patient will start a journey of progression. Meaning that the patient will pass a protected movement or flow through the building without going back to a zone previous in the journey.
The journey consists of different zones that describe the different phases the patient undertakes, moving towards the destination of betterment.
Along the journey there is a constant environment that needs to elimante stress, feeling of loss or other stressfull components that can influence the patients well-being. Because of the forwarding journey there is no possibility of going back in a zone. This gives the patient a feeling of progression and there is a minimum chance of contamination in the facility.
The journey is divided in zones towards this betterment. It starts with a zone of intake: there will be a diagnosis, estamation of severeness and a clear following step of the patients journey - leading them to the department the patient needs to be. In the second zone the purpose of the patients' visit has his outcome. This could either be an operation, intervention or counselling
Throughout the journey, each zone has his own type of ambience that has a strong connection with a healing environment.
Where in the first zone overview and logistics play an important role, in the next zone calmness and trust is very important. In the third zone a feeling of social contact and rest is prioritized.

This has several advantages that deal with:

- contamination
- no feeling of loss or standstill



## Distinction in patient flows

When entering the building there are numerous types of reasons people come to the base. From a high level of severeness and time-sensitive cases to having a periodic appointment. These different type of patient flows come into contact nowadays causing stress or other types of emotions that negatively influence the well-being of the patient. By distincting these patient flows, the logistics and experience of the facility can exceed to the most efficient outcome and can contribute to the patients' well-being.

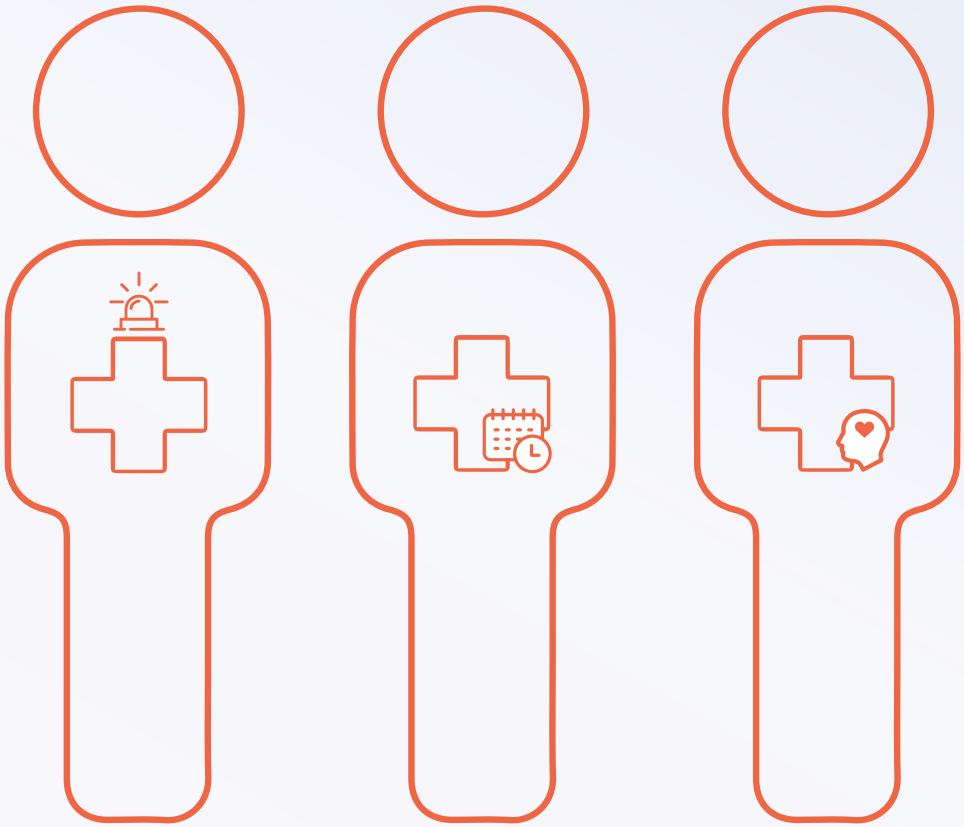
For this type of facility the patient flows will be distincted by level of urgency. There is a difference in:

- acute care patients
- scheduled outpatients
- scheduled mental health patients

Acute care patients are the most sensitive group and need help immediately. They need a thourough check and and the most likely to be emotional instable.
Scheduled outpatients are groups that can be very nervous for their procedure but are prepared for it. They have had a previous visit for the operation.

This has several advantages that deal with:

- experiencing stress from other patients

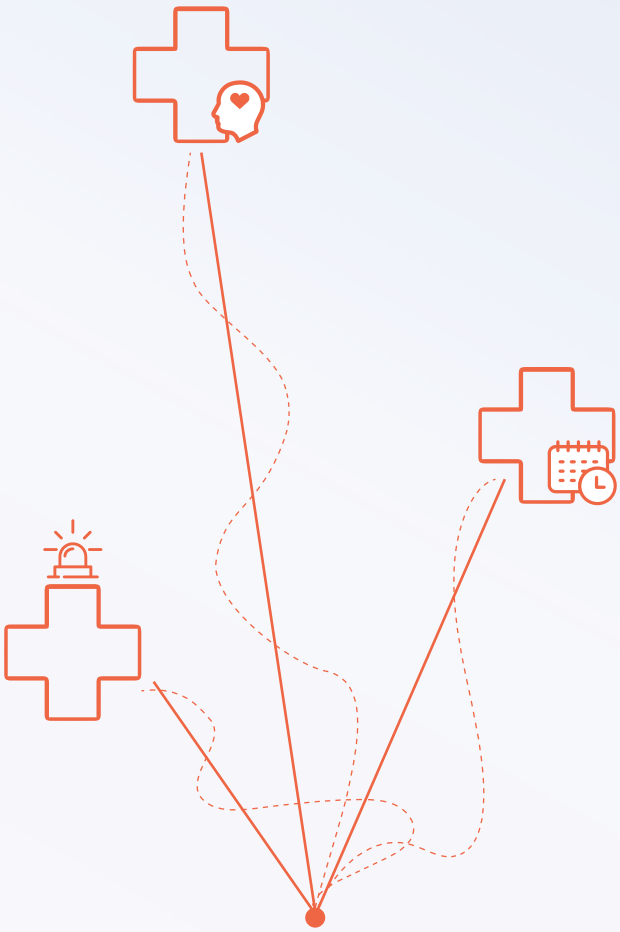


*STRATEGY*

## Efficient patient logistics

To facilitate the distinction in different types of patient flows, the logistics are the key part. One of the main disadvantages of major hospitals is the feeling of loss and poor logistics and/or signage. Next to the feeling of loss there is the negative influence of the waiting room. I strive to design a facility where there is no concept of a waiting room. This ambition relies on the efficient work of future technology. Every patient group is assigned to it's own journey of progression, one shorter than the other.
The concept of the patient logistics is as follows:
For all cases there are main technological applications. The entrance of the facility features a total body check scan - just by passing the entrance corridor. After entering the reception is supplied with mobile health chatbots. The health chatbot comes up to the patient and knows the basic emergency information through the body scan. The chatbot is programmed or supplemented with a medical officical, that can communicate with the patient if needed. After the efficient intake, an autonomous patient pod drives up to the patient. This pod can be adjusted to all the preferences the patient desires. It consists of a chair that can be transformed into a bed and is enclosed by a capsule that can be closed - noise cancelling - or open. The patient pod transports the patient to the appointed department and will stay with the patient until he exits the building.

In the case of the acute care patient, he or she has been brought in by a future ambulance or has reached the facility on his own. The pod takes him to the emergency department where he will receive immediate care.



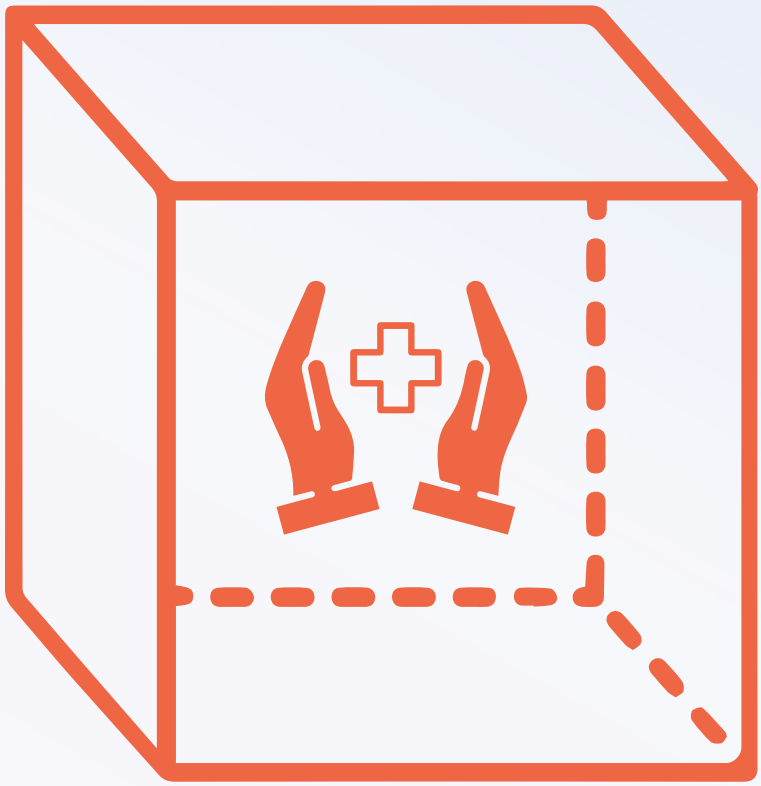
STRATEGY

## Healing environment

Every zone of the building will have a healing environment. Through my research the Ambient Experience has great influence on this. But to design a healing environment is not only about creating daylight, autonomy and providing comfort, it is also about taking away stressfull influences. In this new typology the concept of a waiting room is removed from the program. The principle of a healing environment is designing a people-focused healthcare surroundings that combines design and technology to create a more comfortable experience for patients and staff, potentially increasing operational effectiveness.

A holistic design approach is key in this design. Comfort, Contact, Workflow and Personalization cover the focus of a holistic design. The program will be combinated with public functions to enhance the broad concept of health, healing an the public realm.

This has several advantages that deal with:
- ease the sensitive side of dealing with health
- stimulating the healing process

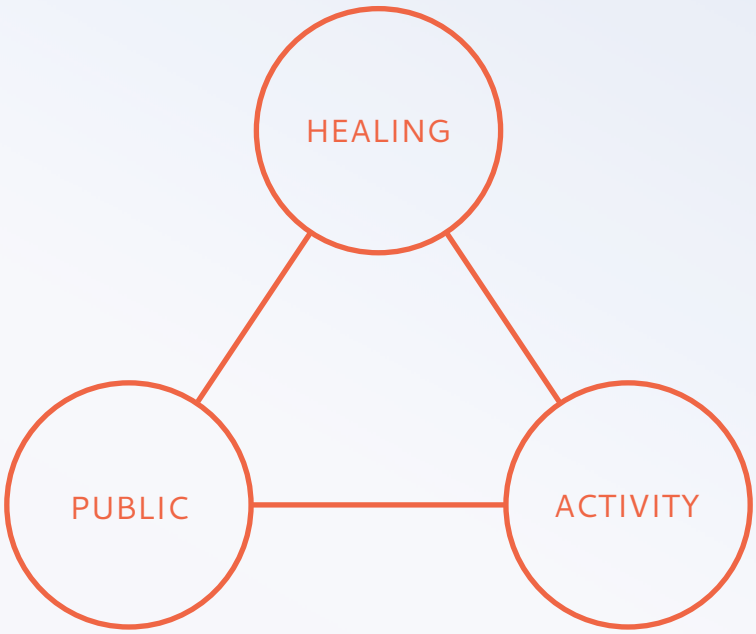


STRATEGY

## Being part of the public realm

Being part of the public realm is realized by providing space that is shared communally by the public. As the location is in front of the waterside, activity park and adjacent to important logistic flows it serves as a perfect spot to have a strong public connection.
With health broadening the engaging in health will be stimulated to be something everybody will do and gives attention to. Health will be a public function.
To emphasize this connection there is a big part of the program that contains public functions that fit the site and the theme of health. Making them connect with the activity park in front if the site it provides a public zone and makes the building part of the diagonal park.

This has several advantages that deal with:
- enlarging the participation in health
- providing social health


HEALING
PUBLIC
ACTIVITY

AMSTEL HEALTH BASE

PROGRAM

---

| General | | Acute care | | Outpatient care | | Mental health | | Public | |
|---|---|---|---|---|---|---|---|---|---|
| entrance | 50 m² | trauma center | 80 m² | preparation center | 600 m² | exam room | 50 m² | visiting area | 700 m² |
| foyer | 100 m² | operation center | 200 m² | operation center | 60 m² | group therapy | 100 m² | food area | 400 m² |
| pod storage | 500 m² | treatment center | 400 m² | recovery center | 200 m² | consultation rooms | 220 m² | playground | 250 m² |
| logistic circulation | 150 m² | recovery center | 320 m² | employee space | 50 m² | employee space | 50 m² | exhibition space | 400 m² |
| office | 50 m² | employee space | 50 m² | employee cafeteria | 70 m² | toilets | 30 m² | | |
| installation space | 100 m² | employee cafeteria | 70 m² | toilets | 30 m² | circulation | 150 m² | | |
| drone logistics | 300 m² | toilets | 30 m² | installations | 200 m² | | | | |
| medical supplies storage | 80 m² | installations | 200 m² | circulation | 250 m² | | | | |
| | | circulation | 250 m² | | | | | | |

| 20% | 24% | 22% | 8% | 26% |
|---|---|---|---|---|
| 1330 m² | 1600 m² | 1460 m² | 600 m² | 1750 m² |

6740 m²

Amstel 2100
inhabitants: 150.000

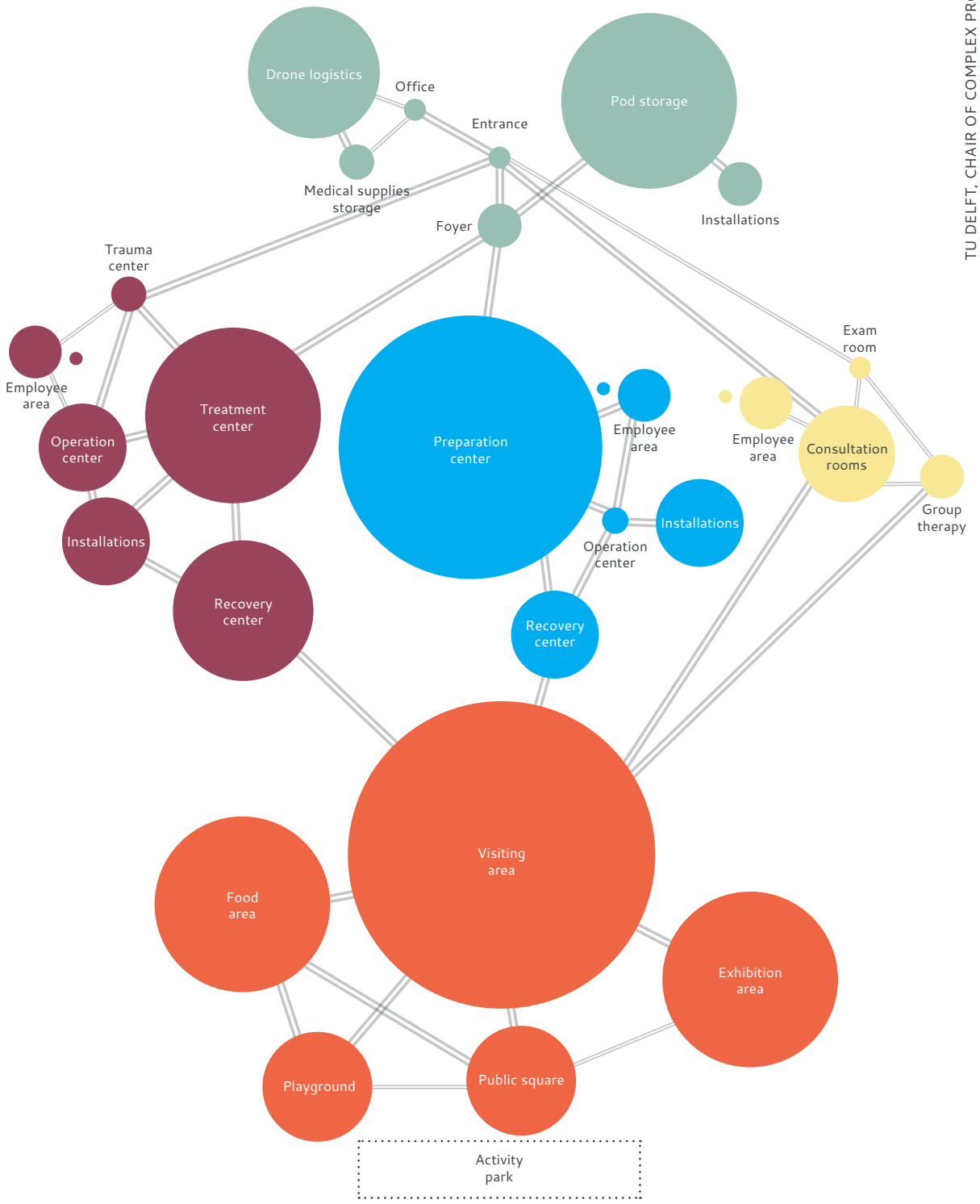
1 clinical admission per 35 inhabitants

1 emergency case per 10 inhabitants

Outpatient care: 12 admissions a day

Acute care: 42 admissions a day

168


Drone logistics
Office
Pod storage
Entrance
Medical supplies storage
Installations
Foyer
Trauma center
Exam room
Employee area
Treatment center
Preparation center
Employee area
Employee area
Consultation rooms
Operation center
Installations
Group therapy
Installations
Operation center
Recovery center
Recovery center
Visiting area
Food area
Exhibition area
Playground
Public square
Activity park

*PROGRAM*

Every department will have their own ambiance that fits the program. In that way the acute care department  has a different feeling than the mental health department.

Within every department the ambiance also shifts towards a more healing and clear feeling, following the journey of betterment.

The concept of the program will be in the meaning of being in balance.

MIND – BODY – SOUL

PUBLIC



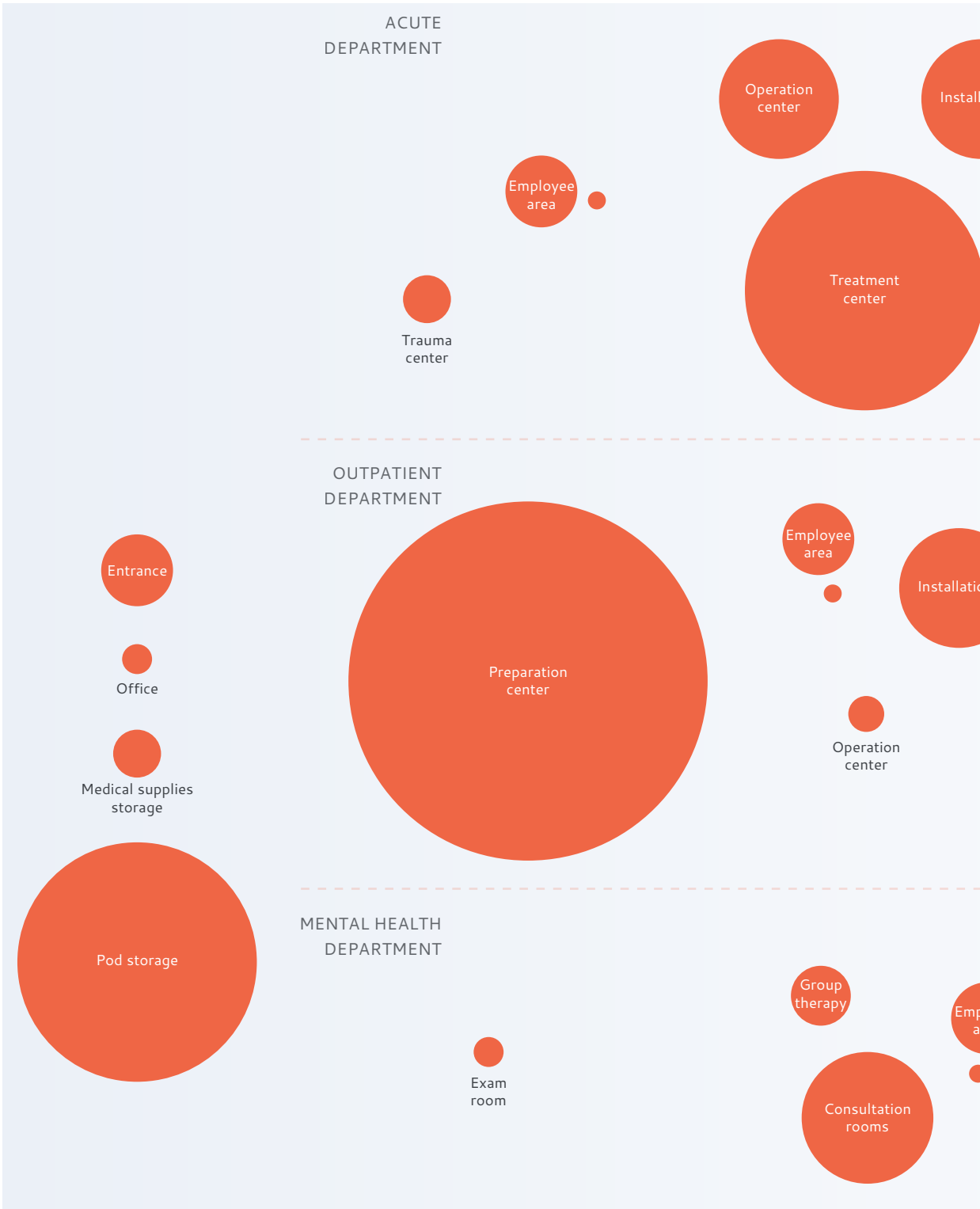
RECOVERY

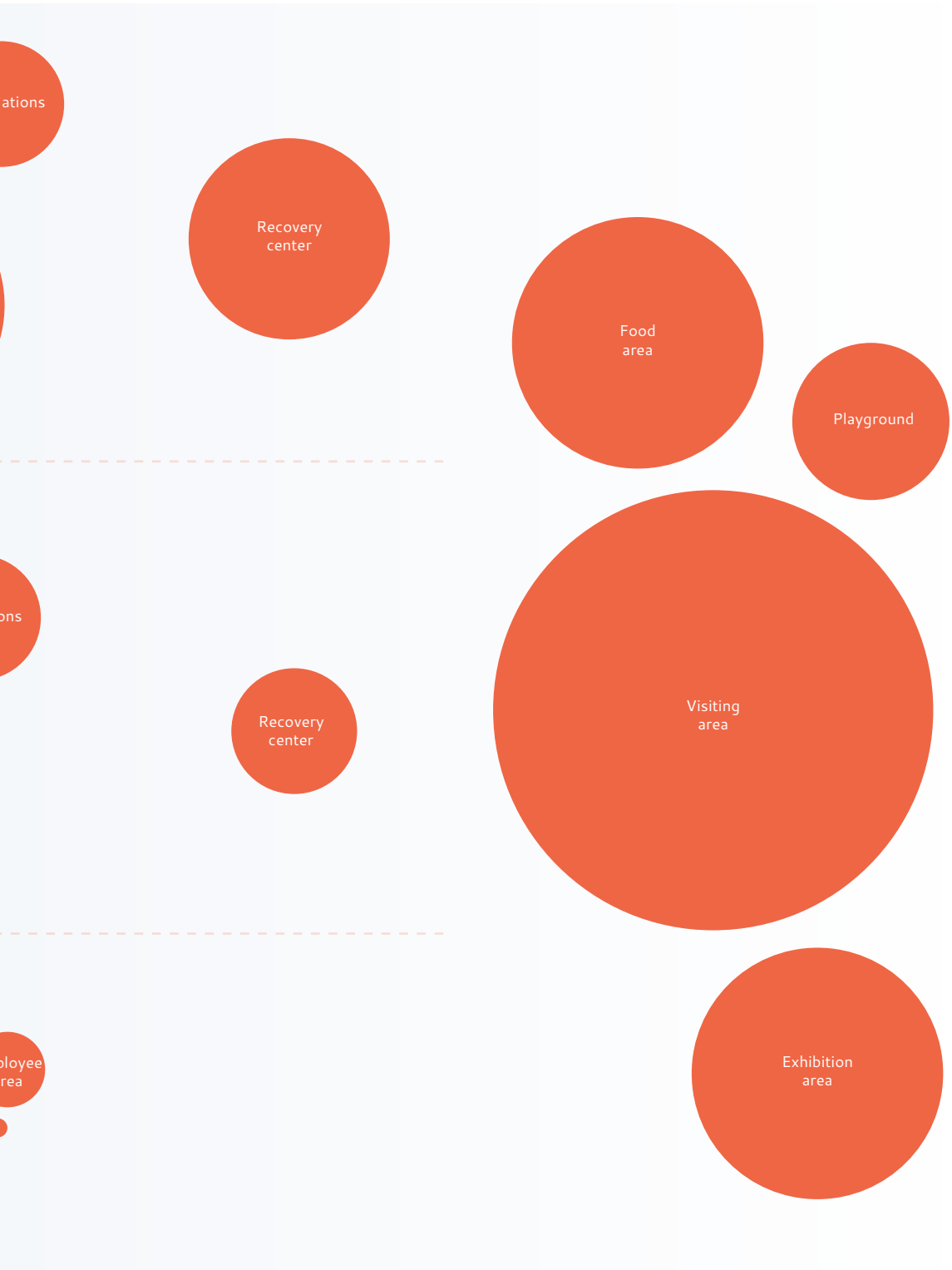


TREATMENT



INTAKE


ACUTE DEPARTMENT
Operation center
Employee area
Treatment center
Trauma center
OUTPATIENT DEPARTMENT
Entrance
Office
Medical supplies storage
Preparation center
Employee area
Operation center
Pod storage
MENTAL HEALTH DEPARTMENT
Group therapy
Exam room
Consultation rooms
Intake
Preparation
Treatment


ations
Recovery center
Food area
Playground
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Recovery center
Visiting area
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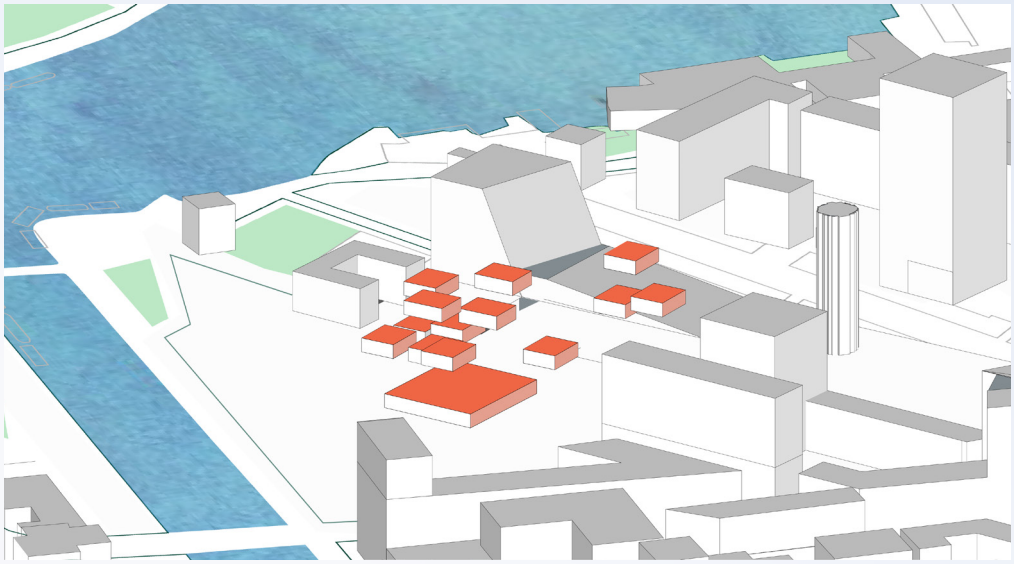
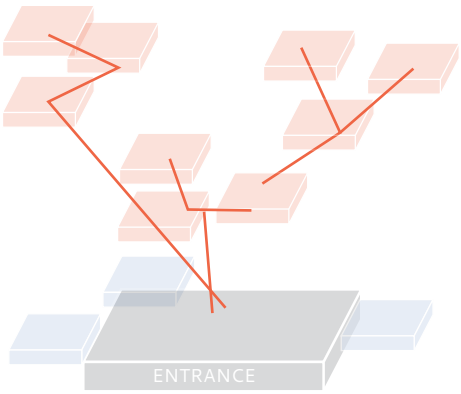
Exhibition area
Recovery
Public

## MASS STUDY

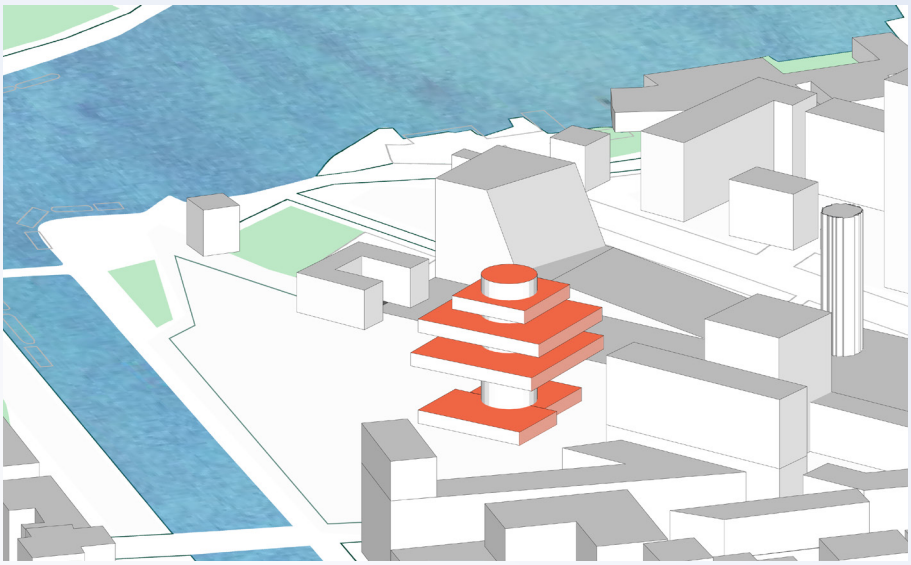


## CONCEPT




## INSPIRATION

## MASS STUDY



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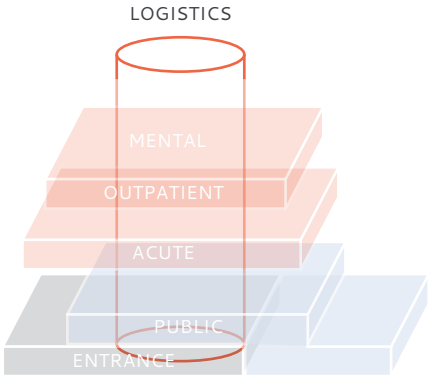


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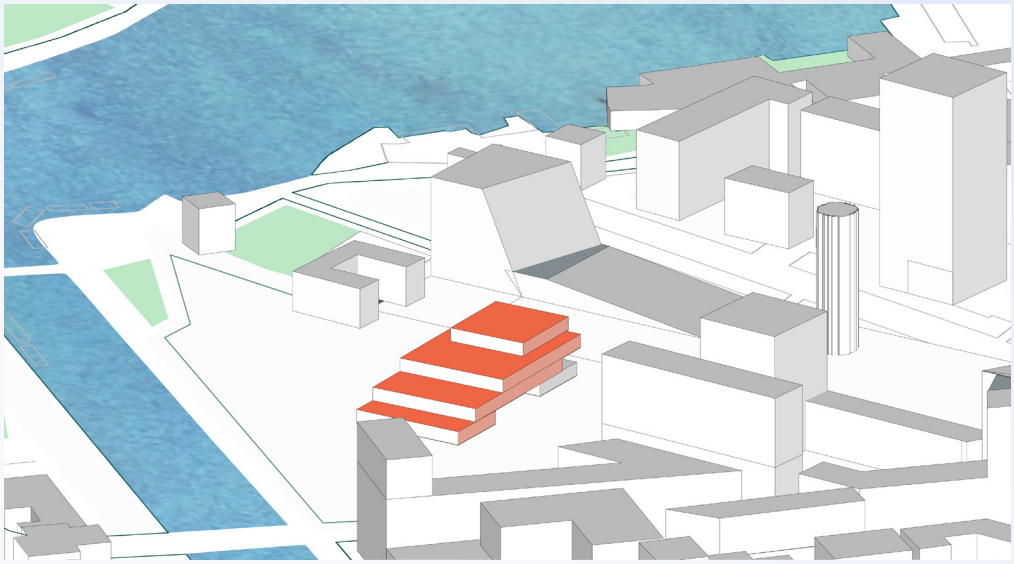
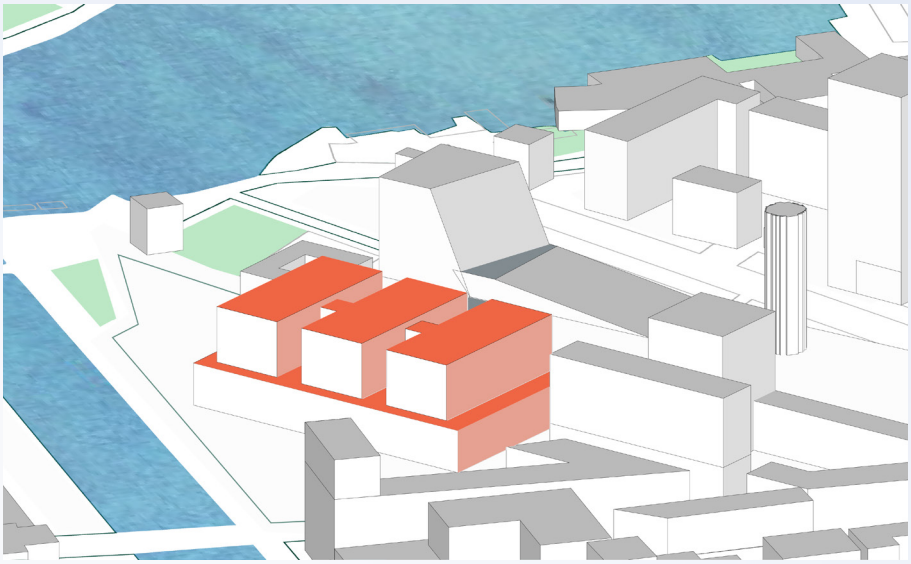


## CONCEPT




## INSPIRATION

## MASS STUDY



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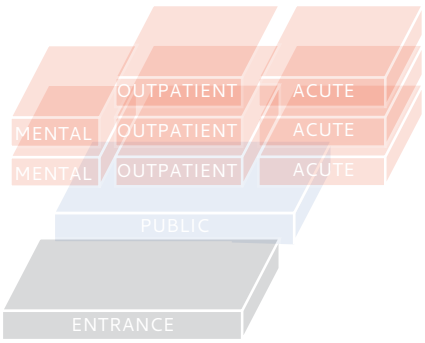
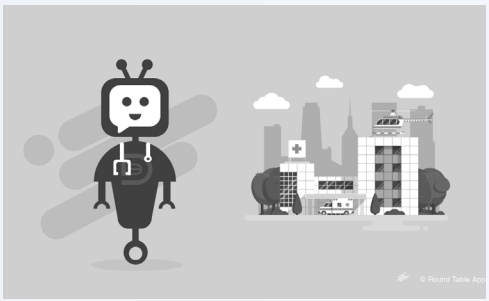



## INSPIRATION

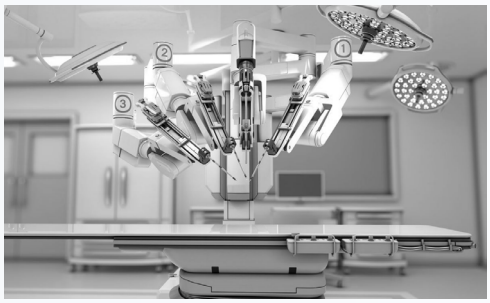
## *THE EXPERIENCE*

When entering the entrance does an automatic body scan so the system is immediately provided with not only your health data, but also if you have an appointment or if you are an acute patient.
Passers-by can use this entrance to get vital data for individual use - for sports or food etcetera.

After your check there happens an direct intake, the patient will be approached by a medical chatbot that received the scan data and will help you with your questions, purpose or other requirements while the aptient pod comes yoiur way. The feeling of loss will be removed by this structure.

The next step is getting in
will be your personal space
can be completely persona
privacy - and it will drive
ment you need to be. This
chair or bed if there is an




side your patient pod that
e for the rest of the visit. It
alized - light, temperature,
e you towards the depart-
will also be the treatment
operation necessary.

The adjacent phase is the intervention phase which depends on the visit. Here there can happen acute operations, but also outpatient operations or small procedures that are not life endangering, like getting a robotic arm for extra precision as a surgeon. The operations will be assisted by robots.

The final phase is getting recovered and back into the social life. This is the destination of betterment, no matter how severe the visit was. There are public parts but also private areas, depending on the patients need. This part can also be visited without having a treatment, and is connected to the public space.

# 05 /

## Writings


fully-automated and driverless driving, Bosch and Daimler (2018)

# AUTONOMOUS VEHICLES VERSUS PUBLIC HEALTH

## TOWARDS A HEALTHY SCENARIO FOR AMSTEL 2100

With the forecast of city populations growing rapidly the means of living a healthy life in a dense city becomes very important. The introduction of Autonomous Vehicles will change how we use our infrastructure. They will decrease traffic accidents and provide us a way of transporting where we can spend our travel time doing more efficient things than driving. But the attractiveness of autonomous driving is an enemy of public health. Where nowadays the emphasis lies on reaching enough physical exercise and stimulating active travel in order to maintain a healthy lifestyle and prevent chronic diseases, the autonomous vehicles provide an attractive sedentary way of commuting only when they are given complete access to residential areas. There is a balance between the privately owned and shared AVs and their accessibility in the urban environment. Research shows that with a comparable urban environment like Copenhagen the AV system should be at least 27% shared to benefit from the advantages and regain 8.3% of the road and parking space to use for active transportartion or green space.

*Keywords: public health, autonomous vehciles, Amsterdam Amstel*

## Introduction

As we live in the year 2018 we can only make assumptions of how the future will look like, but more importantly how it will work. How will we live? How will our environment change? We think about what are the most important subjects in our current everyday live that will - or need to - change? The predictions say that more than half of the world's population will live in urban areas within the upcoming decades so it is necessary that the city living conditions will be optimal but most important: healthy. With the extreme rapid rise of the autonomous vehicle this type of mobility will have an demonstrable influence in the way infrastructure is designed and how inhabitants will move through the city. You can even say that the autonomous vehicle can create a new transportation revolution. But with the introduction of this new type of mobility we have the chance to evaluate the predicted use and measure how this will affect public health and by that set up a policy for the accessibility in the developed area. As we treat health as a lifestyle nowadays, the complete access of the use of autonomous vehicles will mean a step backwards regarding our personal health.

## Future of Public Health

"The first wealth is health" is what American philosopher Ralph Waldo Emerson wrote in 1860 and it reminds us that health is the foundation on which we build[1]. But health(care) will undertake future changes. It will not only change within their technological field due to future developments and research, but if we look at the past century our perspective on health also has shifted[2]. We have shifted our perspective towards the patient's perspective and try to help the patient understand the drivers that impact their chronic condition better so they can play a more active role in managing it. We focus on proactively keep ourselves well rather than react when we become ill. With health as our starting point for the future we need to look at how autonomous mobility will affect this and how we need to control this.

As said before the future of health has much to do with prevention. We all know that physical exercise needs to be stimulated to develop or maintain physical fitness and overall health[3]. Taking this future aim into account it is interesting to see that the development of automation within the field of transportation has a certain counterpart to this. But first let's have a look at autonomous vehicles.

## Autonomous Vehicles

Autonomous vehicles (also referred as self-driving cars or AVs) is a subject that is in the news at least once a week. This topic is a popular subject because the development in this area is moving in a rapid pace. All over the world there are ongoing projects for the testing of the self-driving cars

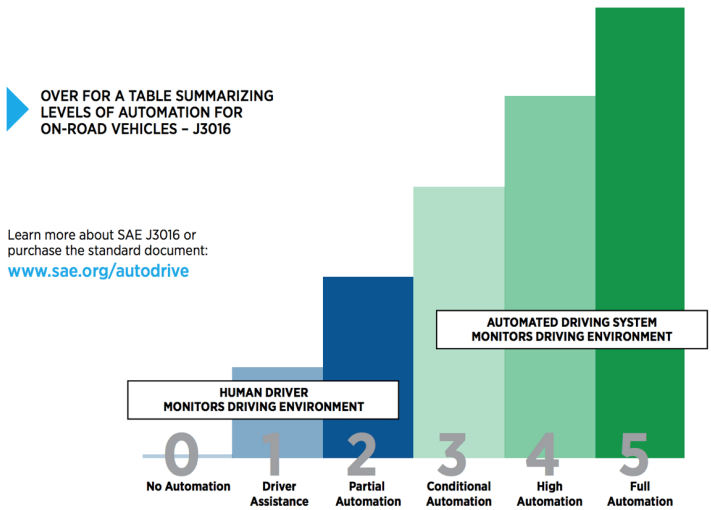


Figure 1, image source: SAE International – Levels of Driving Automation (2014).

in rural areas as well as in inner city areas. It speaks for itself that the development of the self-driving cars should be parallel to our future living ambitions.

'Self-driving' is a term that has a wide perception. The Society of Automotive Engineers has provided a standard of all automotive levels vehicles could have[4]. The levels go from 0 (no automation) to 5 (full automation).

Level 3 still requires a human driver to take the wheel for a fallback performance. Most big car companies want to jump right towards level 4 because it means a self-driving system for any metropolitan area. This means this level of automation gives the driver the chance to do any other activity in the vehicle like sleep or work. For this article the self-driving cars refer to level 3 and up.

## AVs trend

To give a timeline that I use as leading in my predictions for the future car company Ford has declared to develop a fully autonomous car by 2021. This means it will launch a vehicle in 2021 that has no gas pedal, no steering wheel, and the passenger will never need to take control of the vehicle in a predefined area[5]. But as we know with technological inventions, it is not due to the possibility of the engineering part but it is about regulations. The Foundation for Road Safety Research has announced that the introduction of fully autonomous vehicles will only start around 2065[6].

This seems far away - and frankly it is - but for the situation of Amsterdam in 2100 we can assume it will be the daily course of events. This prediction in combination with the globally growing importance of living a healthy lifestyle contains of a very strong relation where we need to find a balance in.

## Advantages introduction AVs

A short introduction in the advantages of the self-driving car:
Research shows that the introduction of self-driving cars will reduce up to 90 percent of car crashes[7], making traffic a lot more safe. Self-driving cars recognize all traffic conditions and can react on sudden actions appearing in front of them. Next to that impaired driving, drugged driving, unbelted vehicle occupants, speeding and distraction of the driver will have no influence on the road[8].

Ofcourse the disabled, elderly, the blind or anyone with a condition will be capable of self-sufficiency and can be mobile for a greater time of their life. Enhancing their quality of life and contributing in their mental health. Especially in the case of the elderly it can help with the loneliness problem at an older age, giving them the chance to see and visit their families.

Further on all costs of personal transportation, crashes with medical bills, insurance, lost work time, vehicle repair will all reduce. During your drive inside an autonomous vehicle you can spend your time on

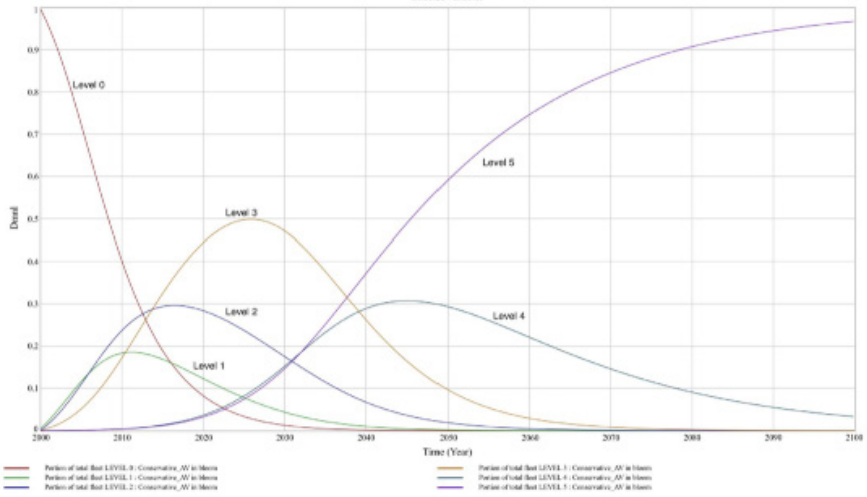



Figure 2, image source: M.F. Legêne - Market penetration AV (2018).

working, catching up on the news or entertainment etcetera. The time itself of the drive will also decrease. There will be less congestion because of the consistent flow between autonomous vehicles and you'll have no time wasted on searching for a parking spot - something that is highly present in Amsterdam. At first glance the introduction of self-driving cars will be a highly positive development in the city.

If we look further and move ourselves in the future scenario in my opinion the goal of the autonomous development is being idealized. The overall line of thought is extremely enthusiastic about this development and there is talk about the whole automation of the transport world. What will be some immediate results of this automation for Amsterdam?

## AVs in Amsterdam

On the 13th of september 2018 there was a symposium held at the TU Delft about the future of autonomous vehicles and their influence on the public space. One of the speakers mentioned the following article: 'Why driverless vehicles should not be given unchecked access to our cities' (sept 2018[9]). In this article there were several points I find interesting. If the door-to-door mobility of a resident in a city is optimized their travel time will be reduced. Reducing the travel time for active travellers is focused on things like a seamless transfer from modes of transport, and is one of the pillars of the municipality of Amsterdam.

If we think about the traffic situation in Amsterdam, it is known for the behaviour of cyclists and pedestrians. Residents and cyclists see themselves as the main role in traffic. If you imagine self-driving cars - that are programmed to not crash against other traffic participants - alongside cyclists and pedestrians who 'take' their right of way, there will be a continuous traffic jam for the self-driving cars and they will lose their initial advantages. So segregation of transport modes is needed which will lead to specific points of crossing in the infrastructure. Which is a contradiction of an optimized route for every transport mode.

Finally, the more accessible and pleasant the drive of your transportation is the less important the distance between your home and your work will be. An urban sprawl will follow resulting in the inefficiency of public transport systems. They will not keep up with the spread of living locations making them undesirable[10].

## AVs and health

These are some direct results for the automation for the transportation system, but don't forget our future aim; what are the consequences on health of the accessibility of the autonomous car in the future everyday life?

If the roads will get safer, there will be less accidents. It seems a positive development but it will have an impact on the organ


Figure 3, image source: D. Stead – Impacts of different levels of vehicle access and ownership (2018).

donors. Currently a fifth of all organ donor transplants come from car accidents11. If this will vanish, it will result in an organ shortage. If the development of autonomous travelling won't happen simultaneously with the nanotechnology of fabricating working organs this will cause a problem in the transplantation industry.

The next influence on health will be the fact that autonomous mobility will cause a serious level of physical inactivity. More than 90% of the negative health impacts of cars result from the effects on physical activity, sitting, and chronic disease[12]. As mentioned before door-to-door mobility will be so attractive and efficient for everyone that 'active travel' will lose their use. With just one click away you can order anything you want right at you front door step. Nowadays physical inactivity is already a growing problem causing chronic diseases and diseases of affluence, and this will only grow if we don't appoint them. Especially for people at a young age it is important to be taught the importance of physical activity referring back to the perspective of prevention within healthcare[2].

Then there is a prediction that is less obvious but not less important for health. Analysts at Morgan Stanley (an American multinational investment bank and financial services company) have looked at the impact autonomous mobility will have in the future. Alcohol consumption will increase because the drink and driving combination will no longer occur. There will be more opportunities to drink before or during a drive in the car. They see this trend already in the use of Uber, because there are lower drink-driving rates in the cities they are driving[13].

To conclude, there are for both sides numerous advantages and disadvantages when it comes to the relation between autonomous vehicles and health. If we want to look at the future situation in Amsterdam Amstel we need to know the expected traffic situation and the difference in data of the area. In the following image you can see the difference in how the autonomous vehicle can be used in the future.

## Use of AVs: the scenarios

There are four types of usage of the future autonomous vehicle in the city differing in terms of automation and the level of sharing. The lesser automation levels are still having a vehicle where the passenger is sitting in a car seat in front of a steer for fallback performance (mentioned in paragraph 4). These types come in car ownership or in shared cars. Next to that there are the more future scenario types. There is a difference in having a shared drive in a vehicle where you are free to do anything (full automation) and taking a private drive where there are no other passengers in the car and the car can be shared or privately owned.

To set up a system of accessibility for the Amstel area we need to know the narrative for 2100. In this scenario I believe that mobility is a service. From now on the

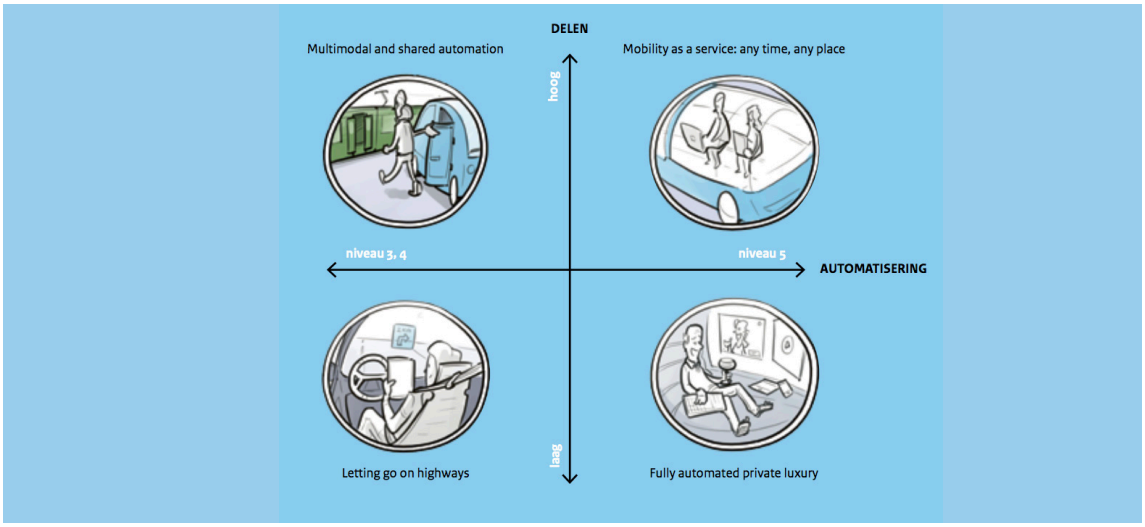



Figure 4, image source: Ministerie van Infvrastructuur & Milieu - Different use scenarios AV (2015).

car will serve as a butler; cars find their own way, the majority of cars in the entire city are shared, they are more expensive during rush hour or in the city centre and you can choose between a private or a shared drive.

**Spatial impact AVs in Amstel**

To get a good insight in what this will mean for Amstel we need to look at some data shown in figure 5. Currently there are about 30.000 people living in the Amstel area. The average population density is 2630 residents per square kilometre. According to the CBS there are approximately 0,2 cars per person in the Amstel area[14]. This means there are 6.500 cars in the area in total. If one car takes up about 6 square metre, it means that 39.000 square metre of space is used for cars at the moment.

With the expected density for the area it will host 75.000 people more by the year of 2100. In a logical sense it would mean that the autonomous vehicles would need more space due to more residents. The result would be that the Amstel area needs to have access for 15.000 vehicles to react on the demand - if it would have the same demand as in 2018. A quick calculation leads to 90.000 square metre to store vehicles for all the residents with the same demand as nowadays. Only the important notion here is that the demand and the system will not be the same in 2100. To research an estimation of the spatial impact for the new densified Amstel and the demand of AVs I've come across a case study for the AV impact in the city of Copenhagen.

**Case study: Copenhagen**

Martijn Legene did a research into the spatial impact of AVs in the Greater Copenhagen Area. For the conclusions of this research I've used the results and statistics of the City Centre zone of Copenhagen, because this is comparable to the new Amstel area of 2100.

In his research 'Transportation and spatial impact of automated driving in urban areas' Legene divided the city in different zones with different characteristics. He distinguished the areas based upon attractiveness. This attractiveness is again rated upon accessibility: population, access to jobs, congestion, road/parking surface, time in the house (measures degree of movement), average trip distance, Value of Time in AV. The higher the VOT the higher the accessibility[15].

In figure 7 he set out the indication of impact a private and a shared system of AVs would have on urban spatial variables. The biggest difference between the use of private AVs and Shared AVs is in the traffic volume and parking reduction. The reason for this is simple:
A privately owned AV drives the owner to his destination. After getting there he drives away autonomous to park after the drop-off. At the end of the visit of the owner the vehicle drives from the parking spot towards the

| | Population density Amstel | Cars/person Amstel |
|---|---|---|
| **2018** | 2630 residents/km$^2$ | 0,2 cars per person |
| **2050** | 9500 residents/km$^2$ | 0,2 cars per person |
| **2100** | 12500 residents/km$^2$ | ? cars per person |

Figure 5, image source: own image (2018).

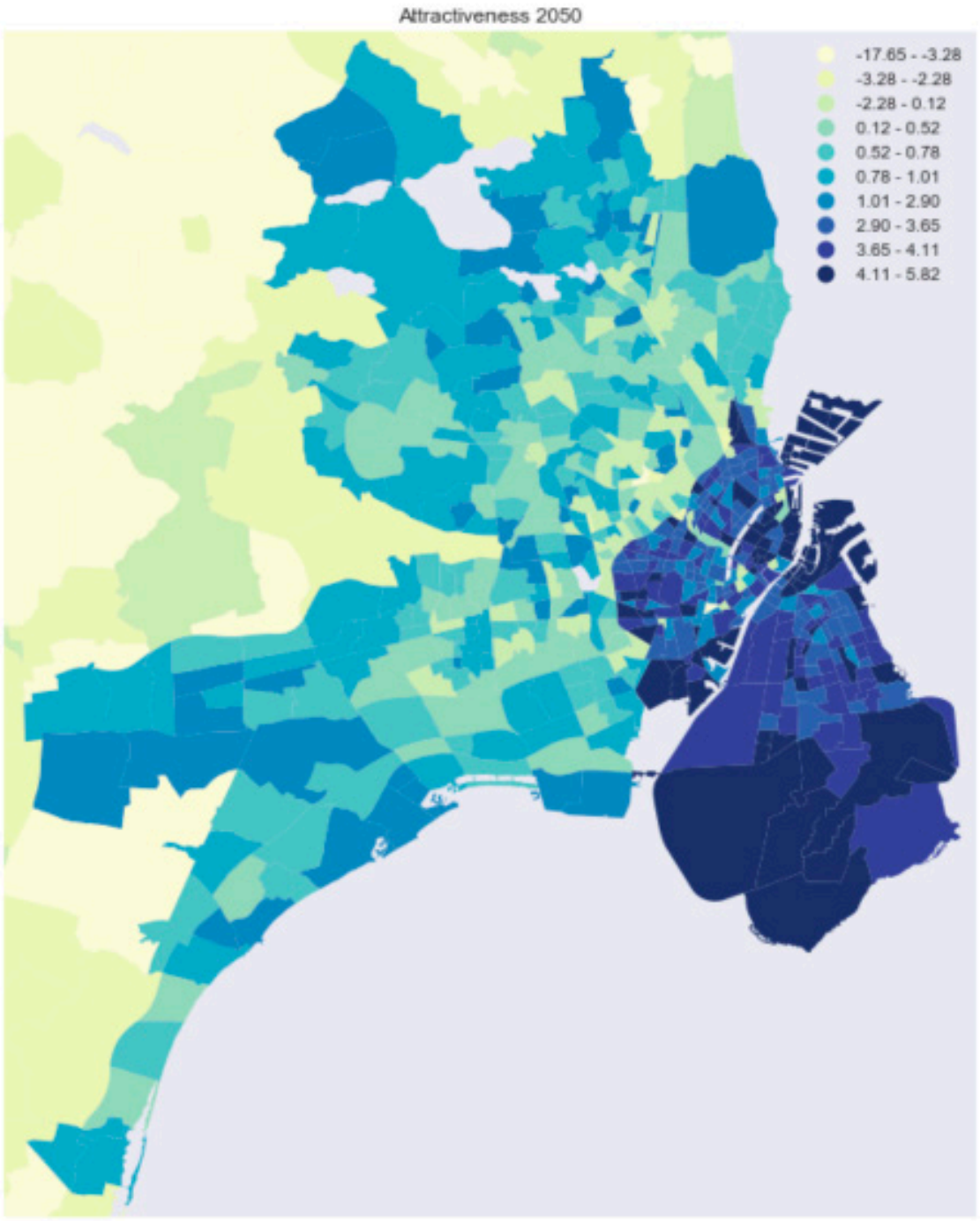



Figure 6, image source: M.F. Legêne - Attractiveness zones Greater Copenhagen Area (2018).

owner for the pick-up. This results in more drives and thus more road capacity and that causes worse traffic and no change in relative to the current traffic situation. In a shared AV concept there will be fewer cars on the road and the use will be higher. Because the vehicles are more efficiently used there is less need for parking and in that way the surplus of parking spaces can be used for active modes of transport or green areas.

This final scenario is ofcourse the most attractive. But for the infrastructure design of the Amstel area this regained space needs to be estimated. In the research of Legene he came to the following conclusion for the City Centre zone:

The car-sharing ratio of 27% in the city center could compensate for the unwanted effects of AVs and allow a decrease in required road and parking space which takes up at least 8.3% of the land currently being used for parking in city centers.[15]

## Conclusion

Because the introduction of the Autonomous Vehicle will change the use of our future infrastructure it has a great importance to investigate the spatial impact the AV will have. By researching this, the new Amstel are can be developed in a way that active transportation modes like cycling and public transport can be prioritized and are not taken over by the full accessibility of the AV. It is clear after several researches that in the foreseen future a mobility system needs to be developed where the AV is used in a shared concept. Privately used AVs will not contribute in future public health aims and will decrease the advantages the AV brings. With the predicted population density for the Amstel area the demand for AV usage will go up. The center of Copenhagen has comparable characteristics as the new developed Amstel. In an extensive case study results show that with a shared AV concept of at least 27% (of all AVs) the advantages of AVs are reflected and there will be road- and parking space regained for the design of active transportation modes or green spaces. With a minimum of 27% shared AVs, there will be a road space regained of 8.3%. This number is an estimation which can be used for the new infrastructure plan of the Amstel area in comparison to the current infrastructure situation.

| Variable | Private AV | Shared AV |
|---|---|---|
| Road capacity | + | + |
| Traffic volume | ++ | + |
| Public transportation | - - | - - |
| Bike use | 0/+ | - |
| Urban sprawl | ++ | + |
| Equal mobility | + | ++ |
| Livability | - | + |
| Parking reduction | 0 | ++ |

Figure 7, image source: M.F. Legêne - Indication of private versus shared AVs (2018).

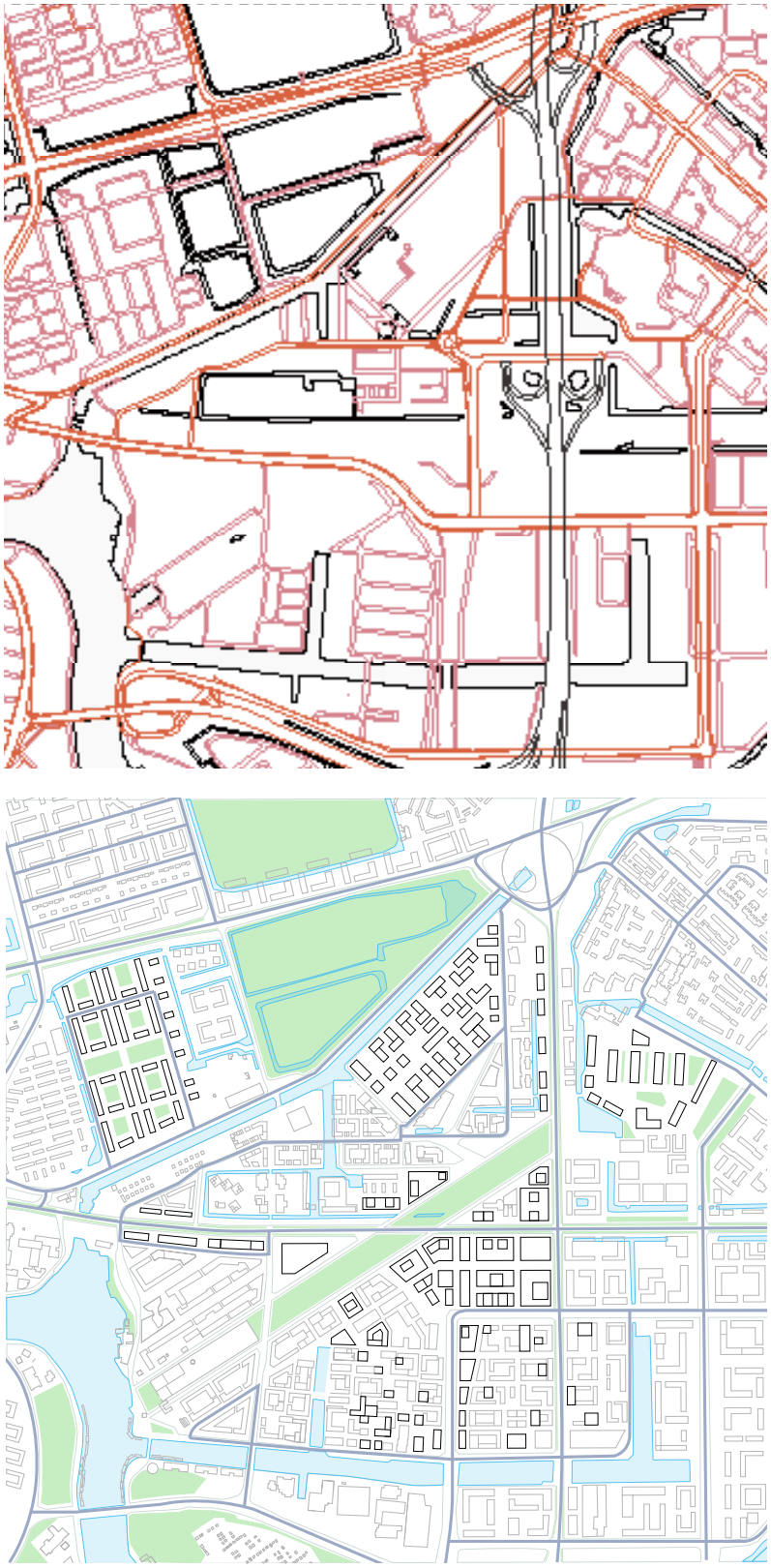


Figure 8, image source: up: AMS MID City 17/18 - Amstel car infrastructure 2018 (2017)
down: own image - Amstel car infrastructure 2100 (2018)

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