



Learning space of the 22nd century

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Graduation project booklet

As part of the Complex Projects Graduation studio

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Contents

Chapter 1	
THE FUTURE OF WORK	13
Automation of work	15
Chapter 2	
THE FUTURE OF EDUCATION	27
Freedom of education act	29
Learning from precedents	47
Essay: Schools that learn	73
Chapter 3	
LEARNING SPACE OF THE 22ND CENTURY	85
Design brief	87
Architectural ambition	101
Concept	119
Chapter 4	
AMSTERDAM IN 2100	127
Essay: Boundaries of infrastructure	129
Group strategy	169
Chapter 5	
VIERWINDENPLAATS	185
Project Site	187
Implementation	197
Facades	243
Chapter 6	
A PERMANENT SITUATION OF BECOMING	257
Automation of construction	259
Construction and climate installations	267
Detail and material	275
Bibliography	292

Imagine a future where most work is automated. A time when cars drive themselves, trash finds its way to the bin by itself, and buildings are being constructed and deconstructed while still in use. Envision a world where we do not have to work anymore and can focus on other things in life.

This booklet is about that future: a scenario-based design assignment by Ingmar Klappe into the future of education in the year 2100. This work is part of the Complex Projects Graduation studio 2018-2019 of the TU Delft Faculty of Architecture.



WELKOM
VRAGEN
SLEUTEL
KWIJT?
PLEISTERS





Predicting the future and acting on those predictions is humanity's obsession. We are in a collective state of working on tomorrow's tomorrow. This booklet goes 81 years into the future. How will we live in a future where most work has been automated? And more importantly, how do we educate humans for this future? Especially since the focus of education has always been to prepare individuals to participate in the labor force.





What if education becomes
an end goal in itself?
Learning would be a primary
occupation, just as important
as work is today. How
would we need to organize
our schools to make this
happen?

What is the learning space
of the 22nd century?



Chapter 1

THE FUTURE OF WORK

Automation of work

Robots for everything

The backbone of the modern society is labor; working has become synonymous with earning a living. However, if we pay close attention to the news and our daily lives, we see that the computer is becoming more and more capable of taking over that labor. What if our work will be taken over by robots in the future? What will humans do? We can refuse and oppose the robots and keep doing the work. In a capitalistic system, where efficiency is one of the drivers, this will probably not happen. Our society has to change, and what humans do in the future has to change drastically. This is not a dystopia. Imagine all the things we can do if robots take all our repetitive and tedious work, freeing us to focus on having joy in life.



Since the industrialization of the western world humans have learned to work together with machines

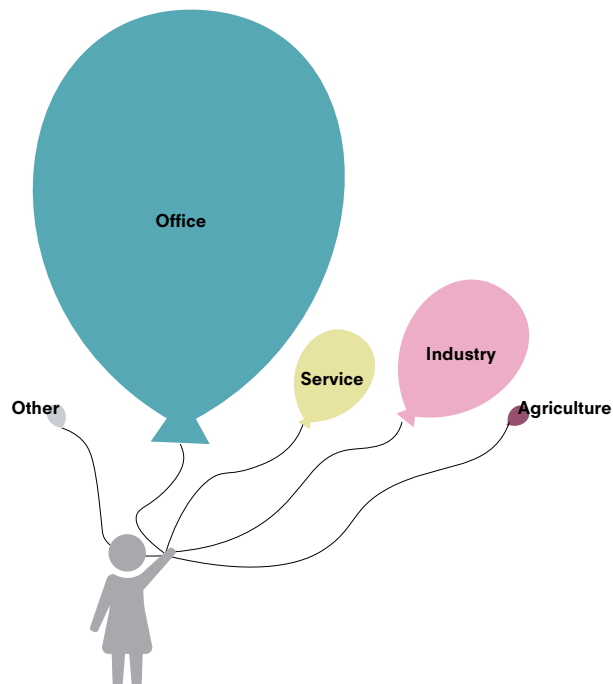
Automation of work

Automation of work is happening at this very moment; we are getting used to do our grocery with a machine. The master/servant relationship between humans and machines is shifting. Robotics are more and more capable of deciding what to do through artificial intelligence. This AI makes decisions on how to interact with other humans without the intervention of another human. We talk to robotics to turn off the light or ask for directions to the nearest pumping station. What if we extrapolate these contemporary developments to the year 2100? How would a world function where most work is automated?

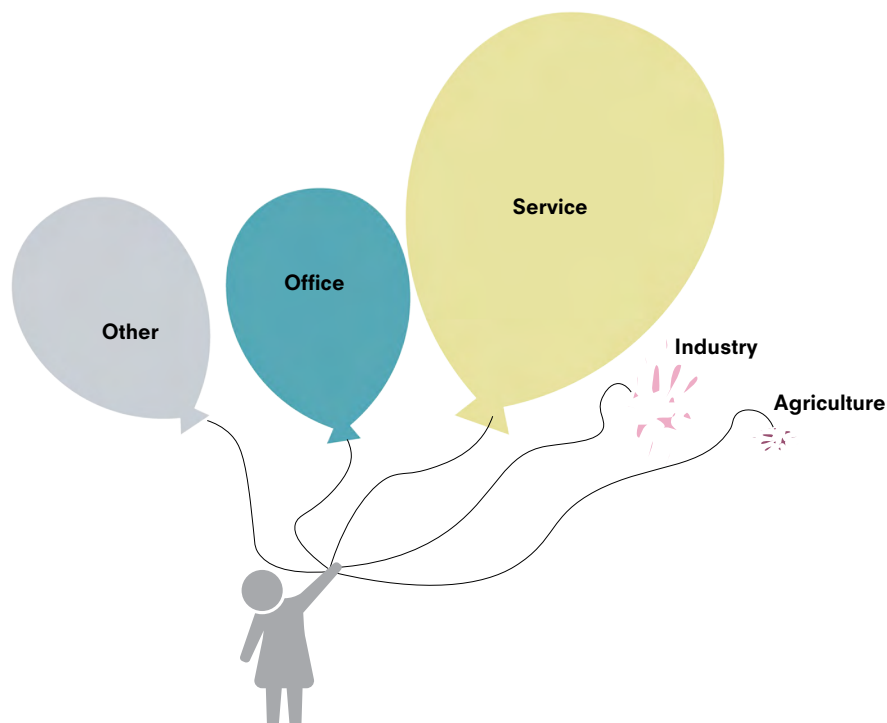


We can divide all labor done by humans in five distinct categories. If we look into the future, we might see drastic shifts in the relationship of these different working sectors

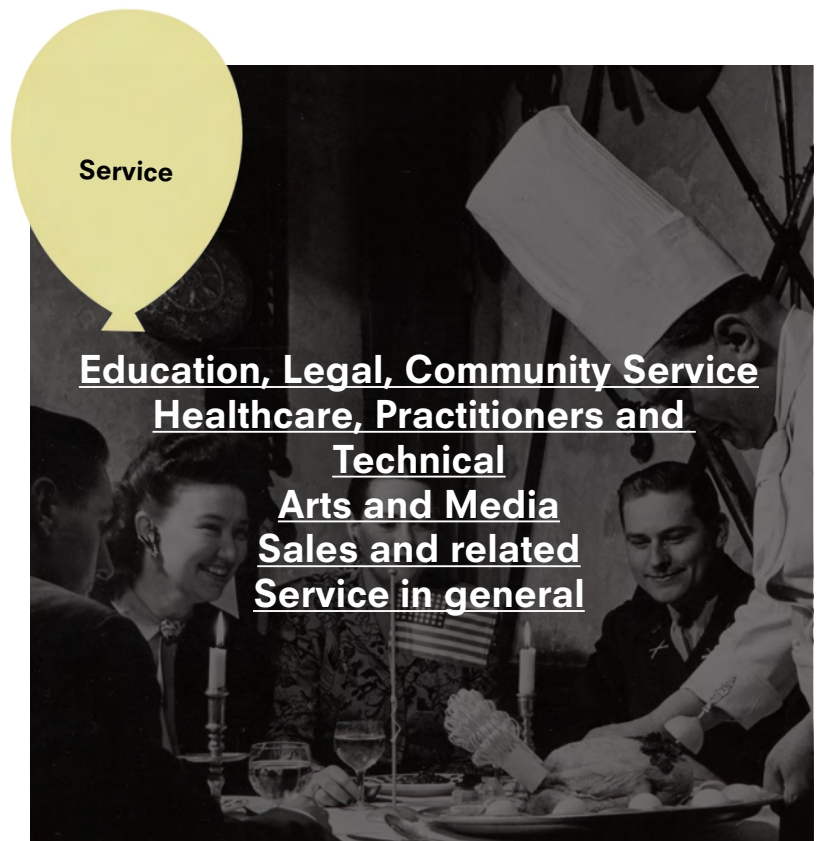
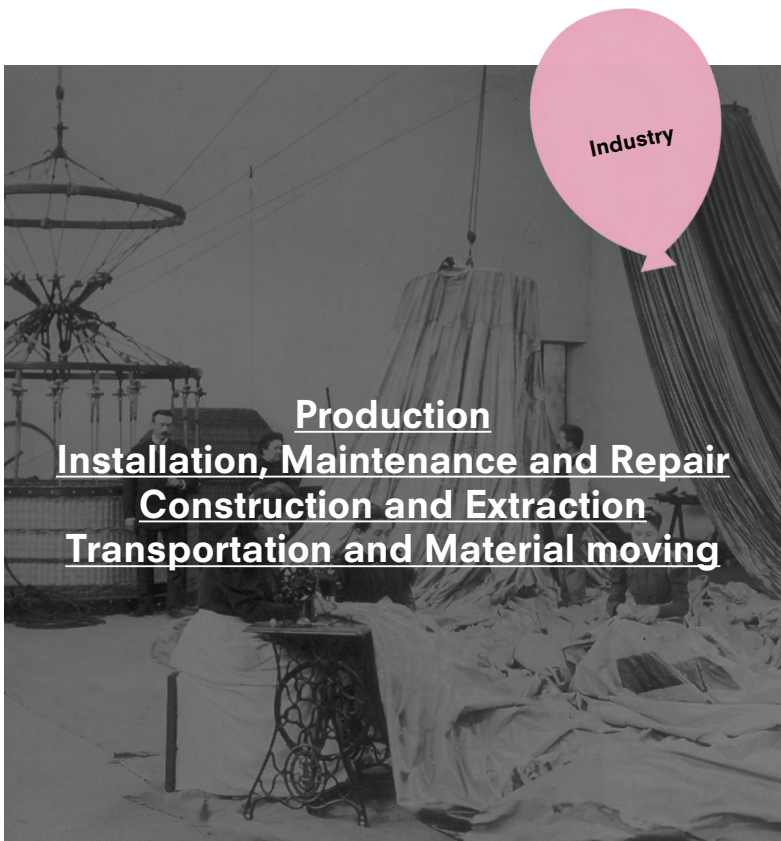
At this moment most of us work in an office. Desk jobs in administration, sales, management and engineering. What could the implications of the automation of work be? In our narrative, we state that in the year 2100, people will find work in human-related social work, high-skilled creative work. These jobs cannot be automated. A large part of society will be unemployed and do not have to work anymore.

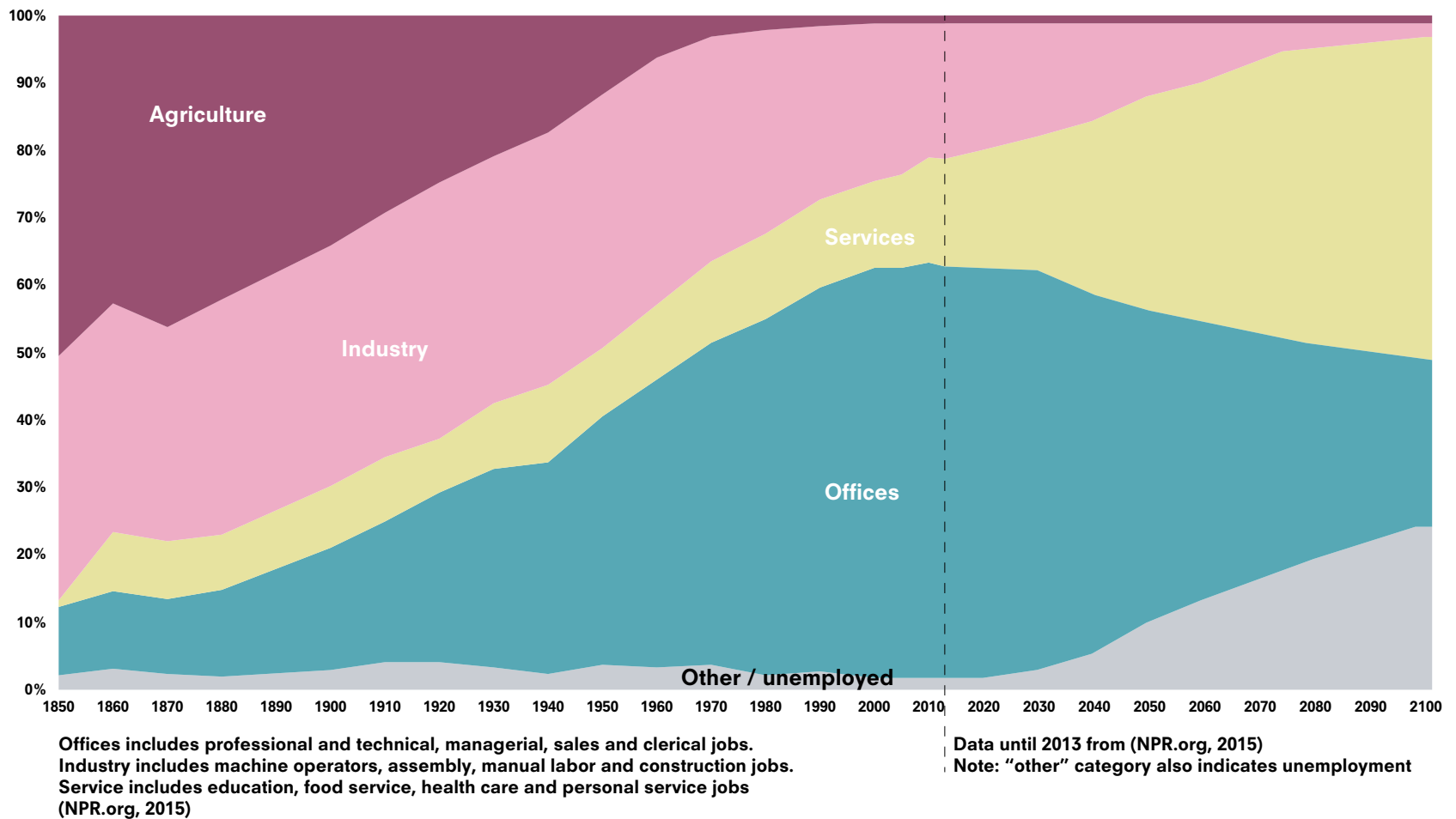


Work sectors composition in relative size in 2018

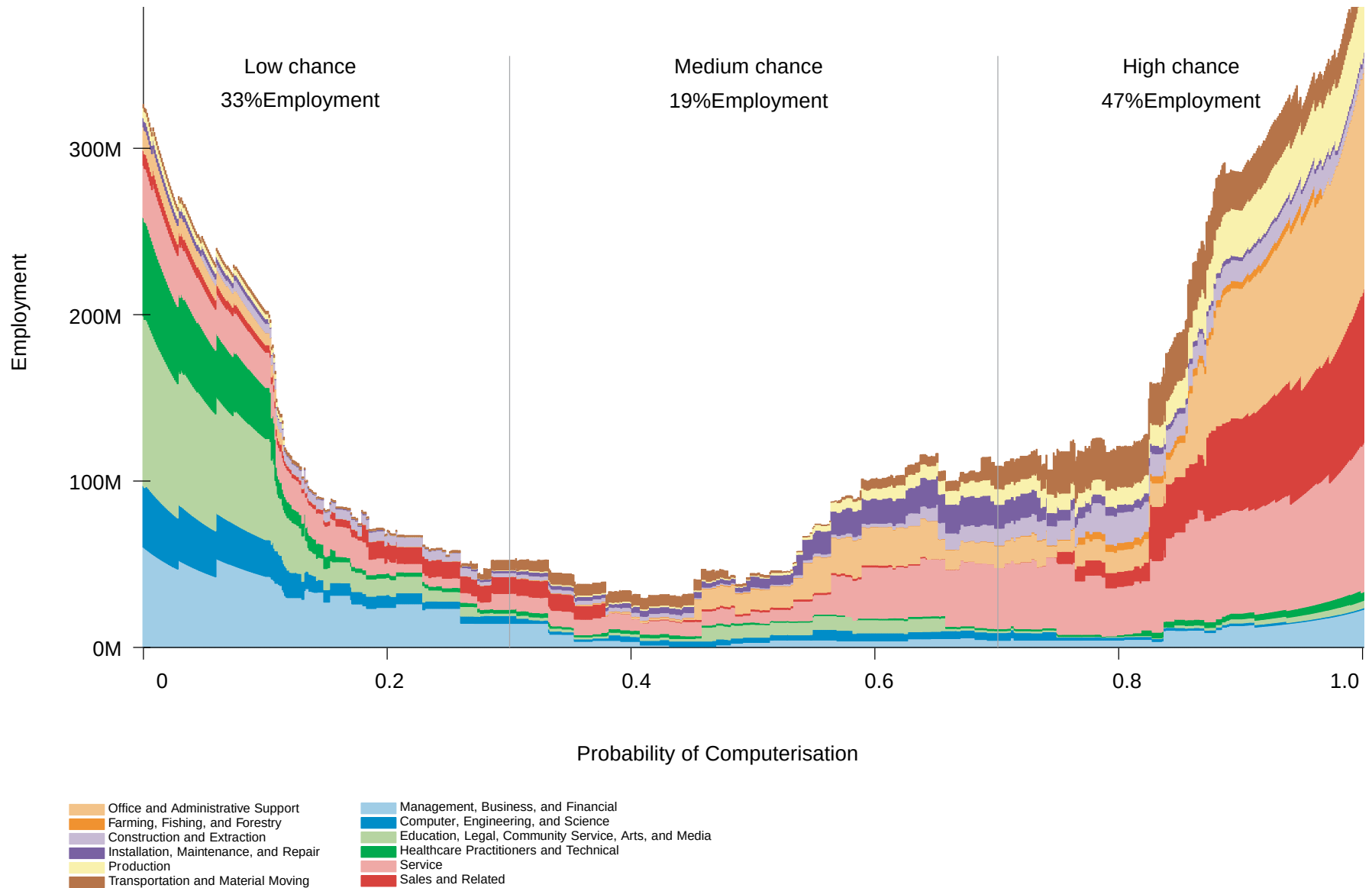


Work sectors composition in the narrative of 2100



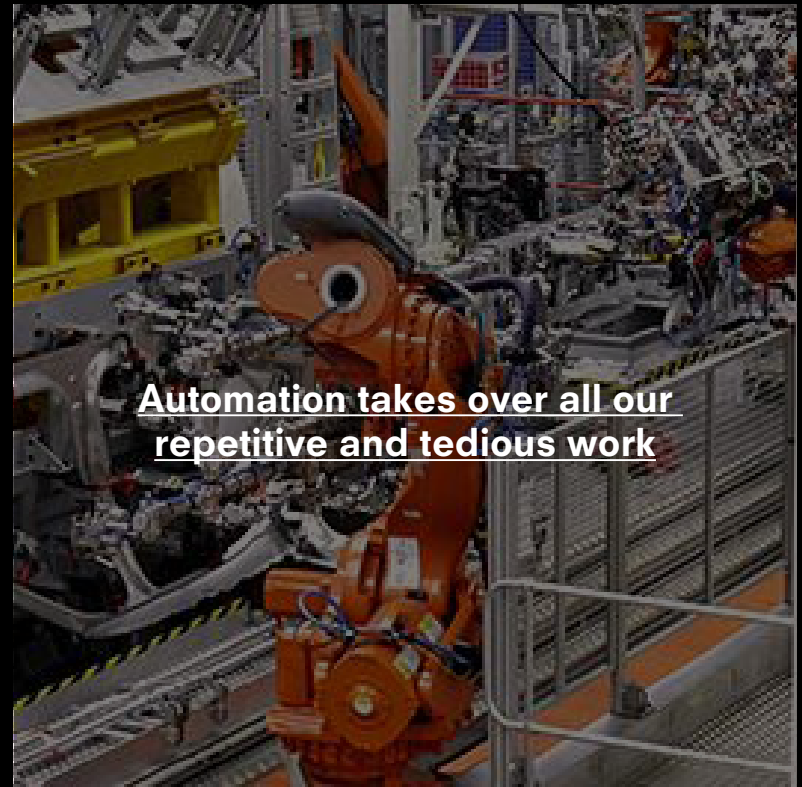


In the above graph, we can see how the composition of work has changed up to the year 2013 in the United States. Through the findings in our research, we extrapolated this graph towards the year 2100. In 2100, almost all work in agriculture and industry will be automated. The office sector will see a sharp decline, and the service sector will become the sector that offers most work.



The findings in the graph on the work composition through the years is based on this graph by Oxford University. Within this study by Frey & Osborne there has been made a classification on which work has a high probability on computerization i.e., to be automated by robotics.

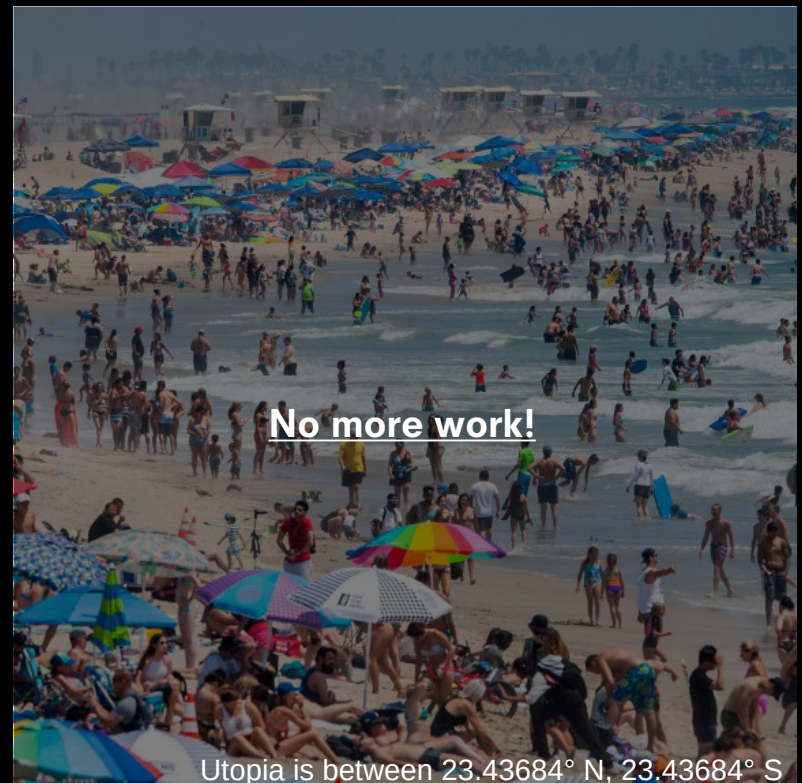
In our scenario, we say that automation takes over all our repetitive and tedious work. Does this mean that there will be no more work in the future? Some say that work is earning a living, does this then mean we cannot earn a living anymore in the future?



Automation takes over all our repetitive and tedious work

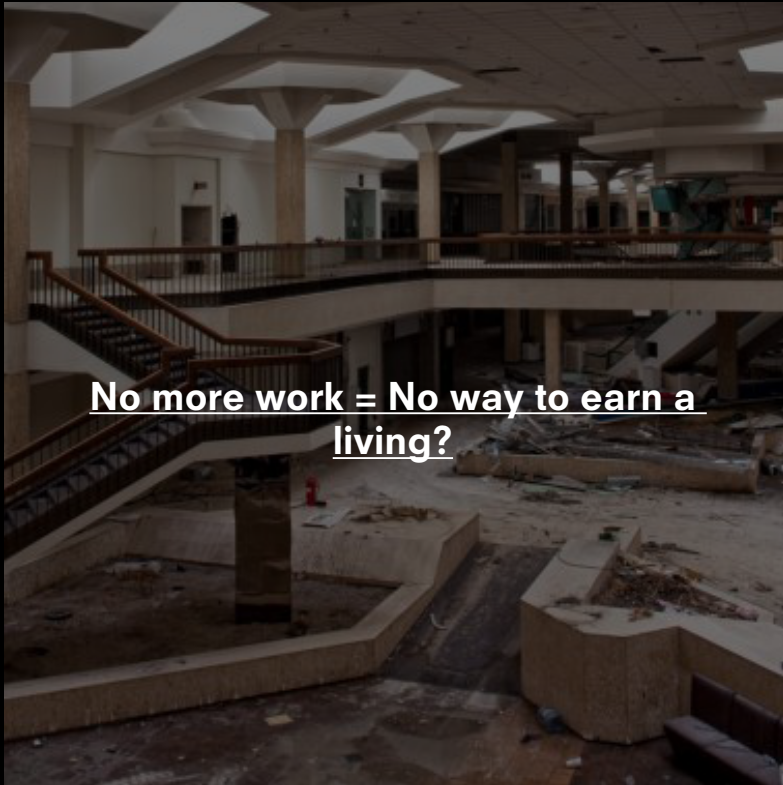
“Our findings thus imply that as technology races ahead, low-skill workers will reallocate to tasks that are non-susceptible to computerization – i.e., tasks requiring creative and social intelligence. For workers to win the race, however, they will have to acquire creative and social skills.”

- Carl Benedikt Frey and Michael A. Osborne



No more work!

Utopia is between 23.43684° N, 23.43684° S



No more work = No way to earn a living?

"Work is earning a living"

-Richard Florida



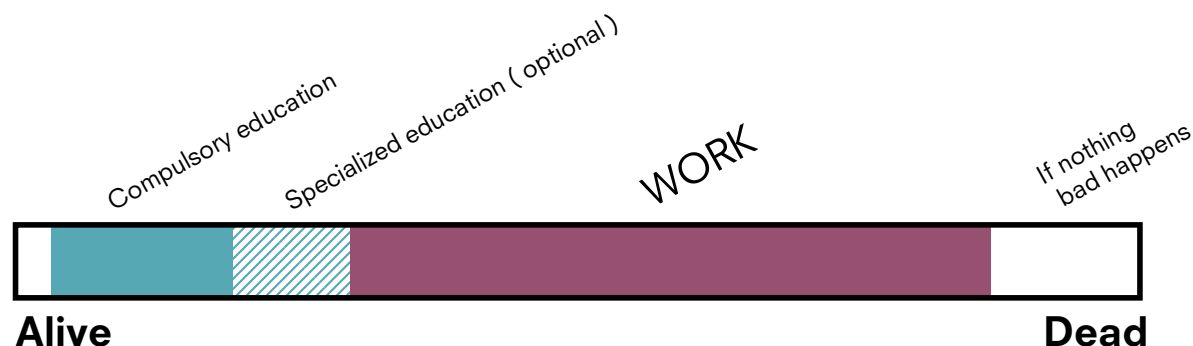
We should go back to school

"We should do away with the absolutely specious notion that everybody has to earn a living. [...] The true business of people should be to go back to school and think about whatever it was they were thinking about before somebody came along and told them they had to earn a living."

- Buckminster Fuller

Life in 2019

We need to change how society functions in the future. Life in contemporary western societies is focused on compulsory education in childhood preparing individuals to join the labor force in adulthood. The need for education rests on either one of these two paradigms, Education as a means for individuals to contribute to bringing society further and education as “bildung”, as a means for self-actualization of the individual. Our education has to change in the year 2100 to (re)-educate workers for different sectors and at the same time we need to create a less-work oriented society.



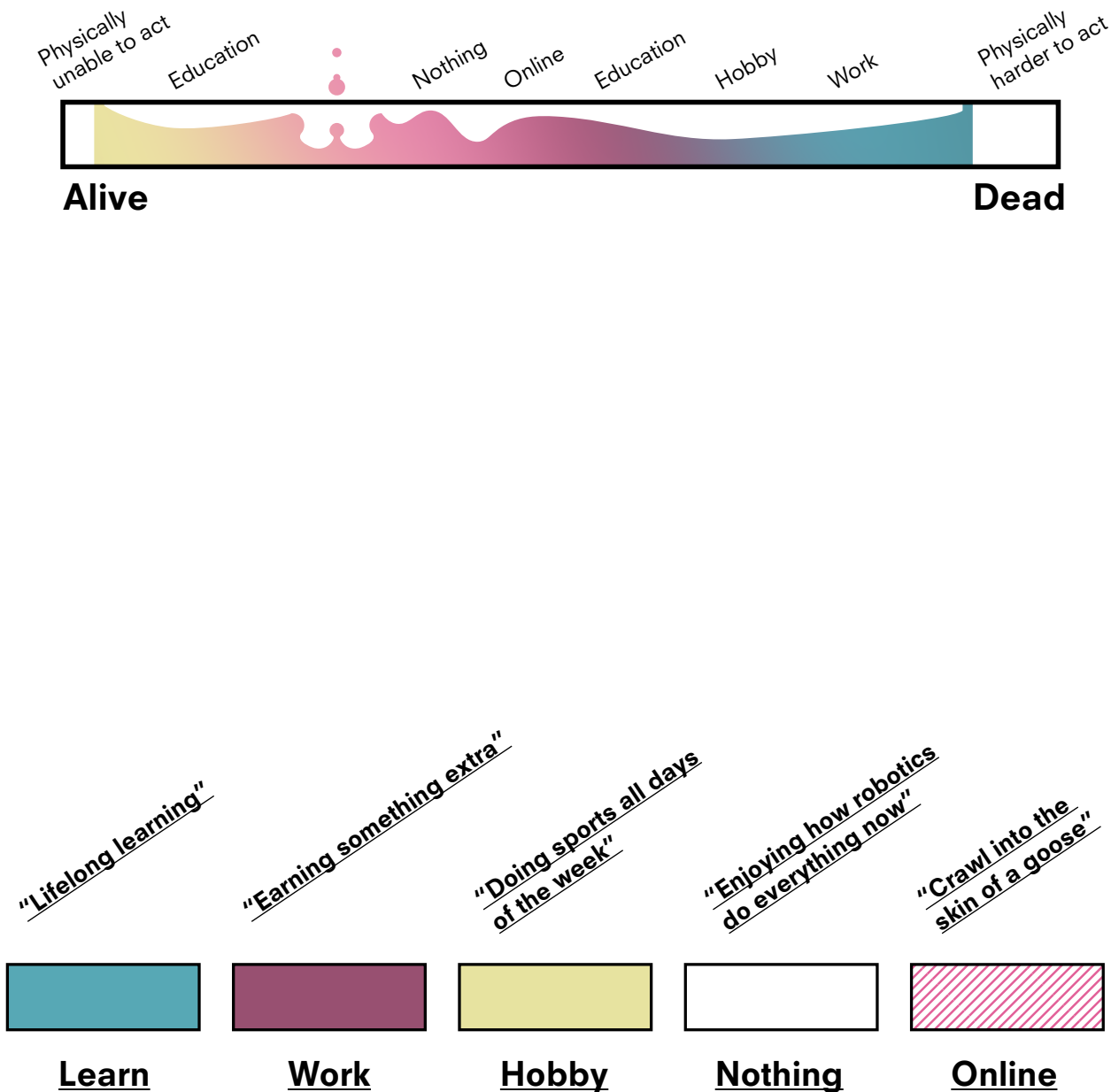
What needs to be done ?

(Re)-educate workers for different sectors

Create a less work oriented society, i.e. universal basic income

Fluid life in 2100

What if our life is more fluid in the future? Where education does not necessarily mean work in adulthood? What if the basic amenities are taken care of by governmental subsidies i.e., universal basic income. What if education does not need to create individuals that contribute to society through labor? However, through volunteering, communal assistance, and individuals that can focus on what brings joy in their life? What if we can create a non-linear focused society where learning, working, performing your hobby, do nothing or be in an online reality are equal compared to each other, and that these occupations are continuously changing over time according to the preferences of each individual. This graduation focuses on one of these occupations, learning. What if we can see education not as a means but as an end goal in itself? Lifelong learning.



Chapter 2

THE FUTURE OF EDUCATION

Freedom of education act

An overview of Dutch education and developments in pedagogy

Dutch education has been compulsory since the beginning of the 20th century. Throughout the 20th century, education has developed from a series of experiments into strictly governmentally controlled methods and systems. Pedagogy is the study on how education is given, focusing on how knowledge and skills are taught through learning in an educational setting. The Netherlands has the freedom of education act that makes it possible for everyone in society to create their type of education, bound by regulations, and a freedom of choice to send your children to schools giving that education. In the future the Netherlands will have one more type to choose from. Fluid education will be introduced to offer lifelong education with a focus on skills that matter in the 22nd century.

1806 - Education legislation makes education possible on Christian principles.

1848 - Freedom of education act within the Dutch constitution

1863 - New legislation for Secondary education: Introduction of the (higher) civil school, agriculture and polytechnic school

1874 - “Kinderwetje” by Van Houten, forbade children under 12 to work in factories

1895 - Rise of the business education of Jan Ligthart, as a defense against contemplative education



1914 - First Montessori school in the Netherlands

1895 - Rise of the business education of Jan Ligthart, as a defense against contemplative education



1857 - Education law of 1857: dictates which courses are given

1866 - Introduction of general grammar by of de Vries and te Winkel

1876 - New law on higher education: More oriented on society; Dutch becomes main language in universities instead of Latin

1900 - First compulsory formal education law in the Netherlands

1909 - First lyceum by Rommert Casimir in The Hague



1923 - First free school to Rudolf Steiner in The Hague

1934-1936 – New grammar by Marchant

1950



1963 - First Jenaplanschool in the Netherlands

1985 - Primary school introduced: kindergarten and primary school are merged together

1998 - Introduction Second Phase: the subject packages are replaced by profiles

2006 – Fresh schools campaign launched by VROM: Increase sustainability and interior climate of elementary and secondary schools



2014 – First iPadschool in the Netherlands

2014 – Onderwijs2032, Education 2032 research group with recommendations to improve Dutch education

1960

1930 - First Dalton School in

The Hague

1968 - New education system for Secondary education through the Mammoth law: Education partially compulsory until 18 years old

1976 – STARO founded by BNA, architectural research group with focus on education

1992 – First time that “Scholenvoerpreij” was rewarded, to stimulate innovation in the architecture of schools

1993 – “Basic education” introduced in elementary school: regulation that mandates that all students have the same base knowledge



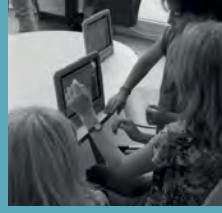
2010

2020

2008 – First MOOC, Massive Open

Online Course: Introduction to Open Education.

2018 – Curriculum.nu, research group/ thinktank to discuss the future of Dutch education.



2050

2060

2070

2011 – First Pleion school: Pleion stands Platform for contemporary education.

2080

2090

Fluid education introduced

2100

Freedom of education



Public

Different concepts and visions for education were always reserved for a minority of society. The public school has been and still is the default school within the Netherlands. The concept of the public school was to prepare all children in Dutch society for a meaningful existence in society. (Boersma, Verstegen, & Bergeijk, 1996, pp. 20–21)



Montessori

Self-development and auto-didactic education are the essence of the Montessori education concept. An essential aspect of the Montessori concept is the goal to make the child independent from adults. Education is aimed at individual work and individual interests; this individuality is countered by working in groups of switching consistency. Next to the focus on individual interests, there is attention for motor skills, the interaction between the environment and the personal experience would increase the chance on self-development.



Dalton

“Dalton is no method, no system, it's an influence!”
-Helen Parkhurst
("Daltononderwijs," n.d.). The concept of Dalton education aims to educate children for a fearless existence filled with confidence, creativity, initiative, and social responsibility. The subject matter concentrates on the individual while it is performed within a group context where social interaction is actively encouraged to create an environment of co-operation. ("Daltononderwijs," n.d.)



Jenaplan

The Jenaplan concept relies on the belief that the child is a product from the relation with his fellow humans. The education process is placed in a community that shares the same norms and values. The school has to be part of the society it reflects on and education is conducted in part through adults from the neighborhood. The space for learning has to be arranged in such a way that curiosity is triggered for a diversity of activities. (Boersma et al., 1996, p. 22)



Religious

Within public schools, there is room for parochial teaching, with freedom for specific philosophical education. This has subdivided the public school into “algemeen bijzonder”, “openbaar”, “prot. christelijk”, “katholiek”, “samenwerking, confessioneel” and more specific types. (<https://www.scholenopdekaart.nl/>, n.d.)



Vrije school

The concept of the Vrije school – Free school – relies on the school of thought of anthroposophy. The subject matter is way for self-development in the form of creativity and social interaction next to raising intellectual intellect. There is a large focus on the atmosphere of the learning environment, like color schemes to create an environment where children can function optimally. (Boersma et al., 1996, pp. 23–24)



Freinet

The Freinet concept does not follow strict methodologies but is based on the experiences of the children. The teacher and student group work together to create a meaningful education. Freinet education goes out of the classroom to visit companies and nature to experience the world firsthand. (“De Vereniging voor Freinetpedagogie - uitgangspunten,” n.d.)

Finland public

The Finnish Public school system stands out from other foreign school systems for its performance on the PISA report by OESO. (NOS, 2016) Part of the success of the Finnish education is that the teacher must have a university degree and that the teacher has more autonomy and freedom to prepare classes to his vision. (NOS, 2016) Education is given according to the ideals of phenomenon-based learning. There are no standardized tests and an atmosphere is created to improve creativity and limit the stress on students. All schools in Finland have the same concept and are publicly funded and free for all children. (“Why Are Finland’s Schools Successful?,” 2011)

Fluid education is open to everyone

Within Fluid education there is room for Self-development and auto-didactic education as thought by Montessori

In Dalton, the teacher is present to guide, in Fluid education this is also incorporated

Fluid education takes the focus on conversation, work, play and celebration from Jenaplan

Fluid education does not focus on a particular religion

Fluid education takes the focus on social, creative, technic and craftsmanship from the Vrije school

Fluid education takes the fact that Freinet experiences the world firsthand



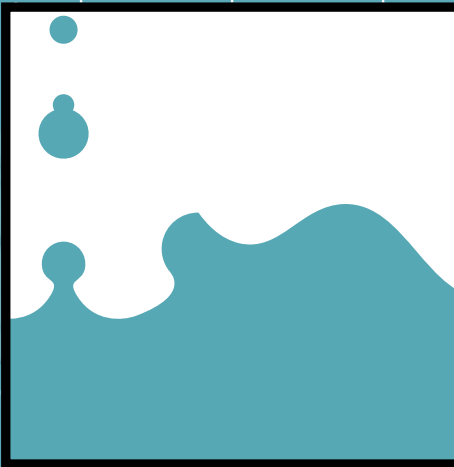
Public



Montessori



Dalton



religious



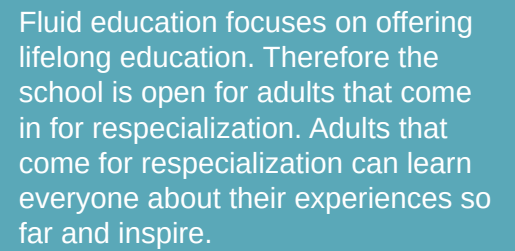
Vrije school



Freinet

Fluid education

Fluid education is a combination of all types of education we have in the Netherlands right now. The basis for Fluid education is the contemporary Finnish Public school system, where education is given according to phenomenon-based education principles; there are no standardized tests. The education is focusing on getting in contact with a broad range of different phenomena to inspire and spark interest within the student. Fluid has the characteristic to contentiously form and deform itself, applied within the context of education; Fluid education adapts itself to the student offering a broad range of subjects to learn about. Fluid education is given to all ages in one centralized location. All students teach each other; older aged students teach the younger students, and younger students teach older students.



Focus on social skills

Alain du Button, the founder of the School of Life said that “Everyone has to take the role of the teacher and learn how you get an idea inside your head, in that of someone else.”(theschooloflife.com). Social skills will be one of the most important in the future, by making everyone a teacher, they will become more social in the process.

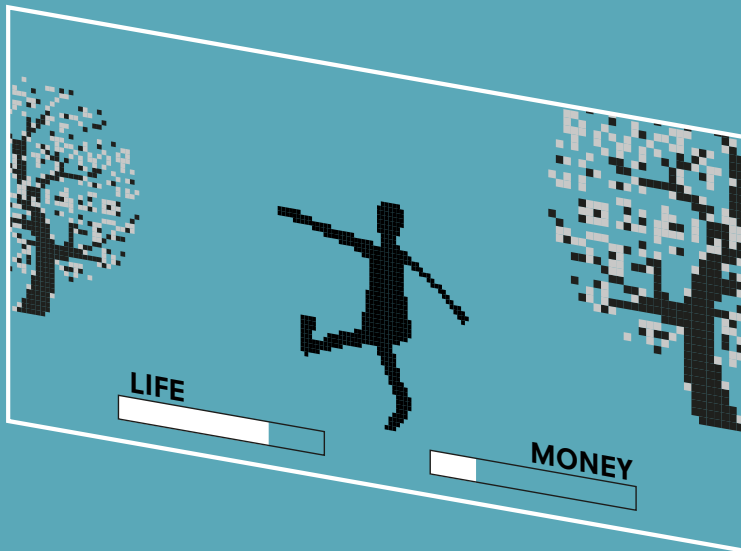
Focus on creativity

As creativity is one of the few skills that will be unaffected by automation, it will become one of the most important skills in the future. Problem-solving relies heavily on creativity. In an uncertain future, one of the only certainties is that there will be problems that need to be solved.

Focus on vocational skills

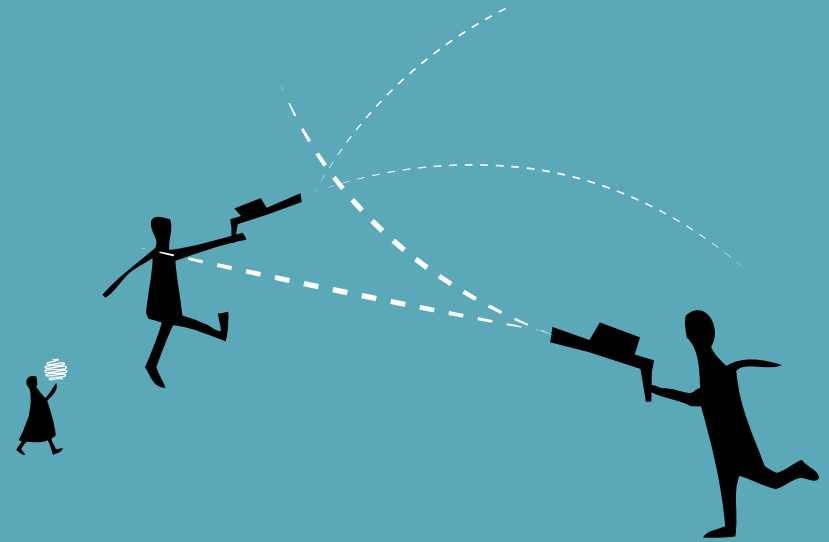
Some might say that “robotics can do it better”, but we still need to understand how the robotics clean, do maintenance on our homes and calculate rent. Vocational skills are an important part of the curriculum.

Fluid education



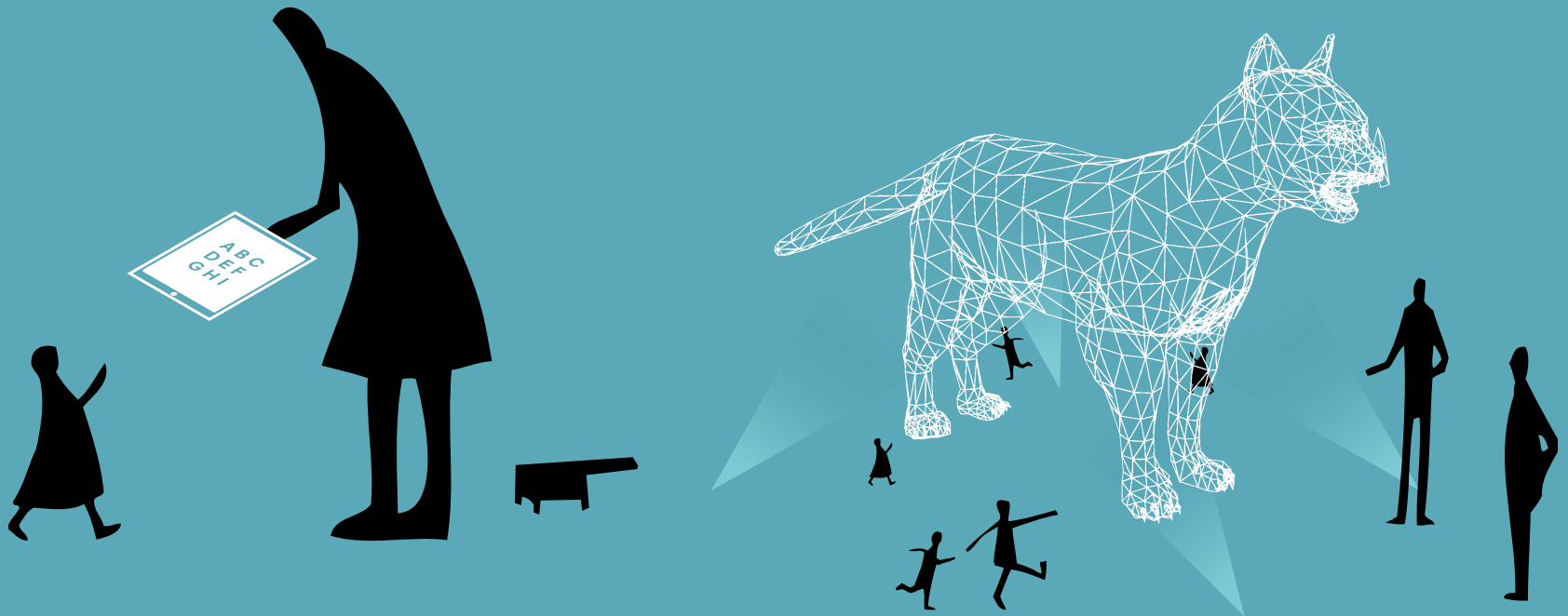
Not a digital school

In the year 2100, an online existence is a possibility, and as online education is a thing in 2019 already, we can say that all education is given online by 2100. However, fluid education is not given on the internet. First off, because online education is to be given to those who live an online existence.



Focus on the real world

Secondly, Fluid education focuses on the real world. Here you learn cognitive skills, how to behave in society, and how to work together. Interaction between humans is important, because society is a combined human effort, meeting other people, making friends, sharing knowledge, and working together are therefore important factors for fluid education.



Digital benefits the real

This does not mean we give up digital benefits altogether. Books will become more or less antiques by 2100. Fact-based knowledge is on your fingertips, and we will use these tools to focus on learning about phenomena.

Including augmented reality

Because we will not be able to create physical replica of all the phenomena, Fluid education uses augmented reality to simulate certain phenomena. These are no consumer products and need specialized equipment, spaces, and controllers to function correctly.

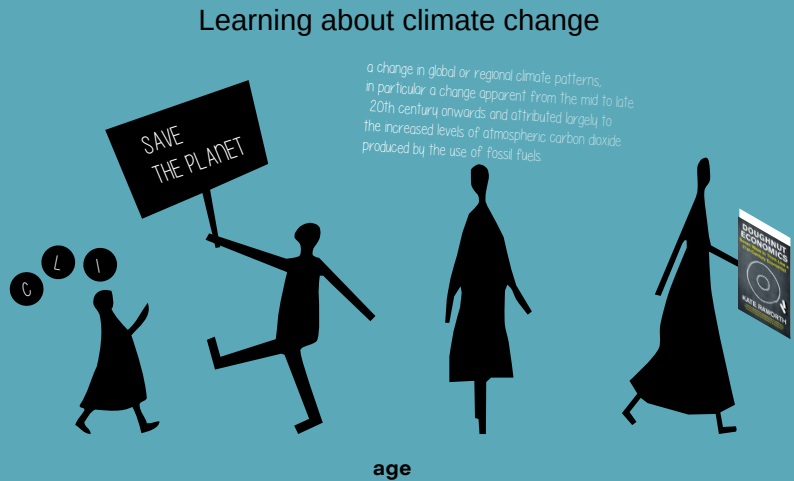
Phenomenon-based learning

Phenomenon-based learning is a type of education that enables students to learn according to their fascination and goals according to given subjects. There are no standardized tests, and there are no governmental implied goals. Phenomenon-based learning consists of five dimensions: holisticity, authenticity, contextuality and problem-based inquiry learning. (Symeonidis, V., & Schwarz, J. F. (2016). P.36) Phenomena need to be actively experienced by students and studies from different perspectives for the best results in education.



Adaptable to all ages

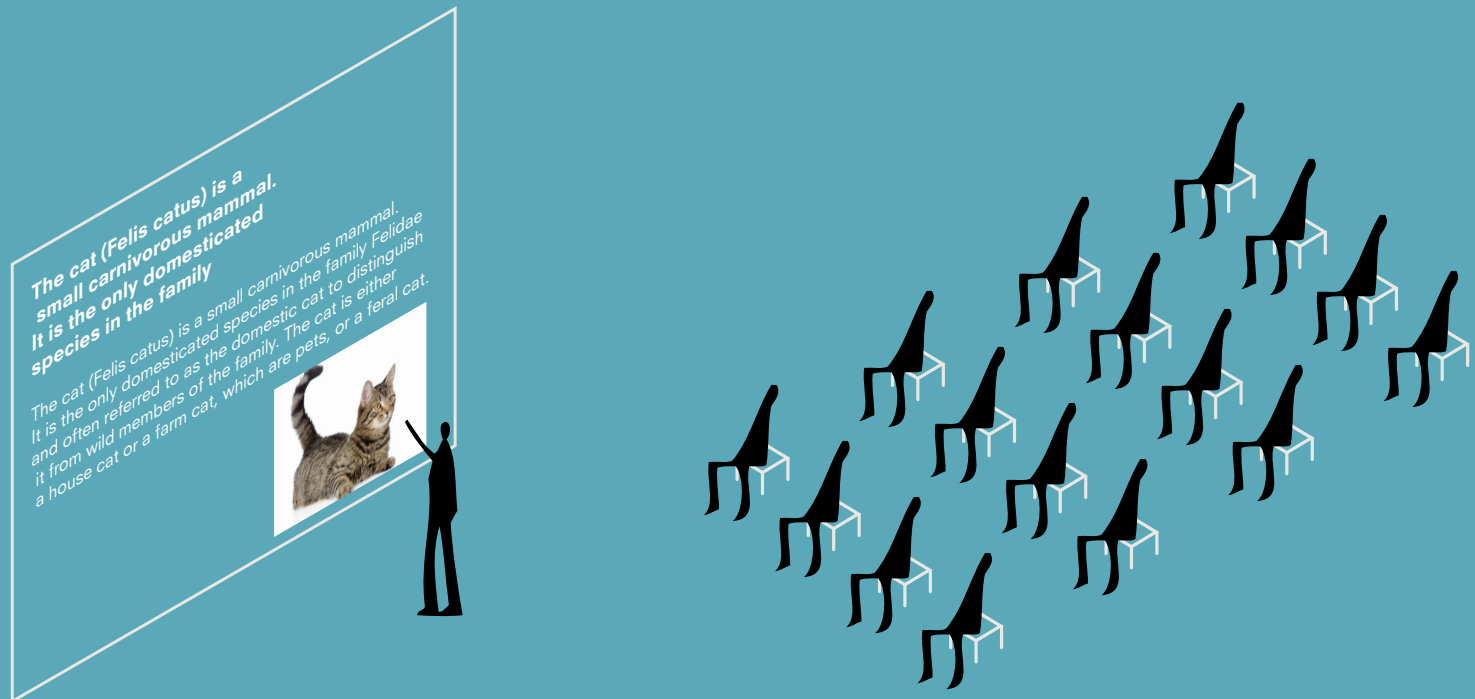
Phenomenon-based learning can be adjusted to all ages because everyone can set their goal regarding the phenomena. Young pupils learn about the words; when you are nine years old, you learn about the concept, and when you are sixteen years old you learn about the underlying mechanisms. Also you teach all ages underneath you what you have learned before.



Continuously new curriculum

Because there is an endless amount of phenomena, the curriculum of Fluid education is changing continuously. By giving students the opportunity to learn about at least one phenomena a week for 18 years long, we can inspire them with at least 800 different phenomena throughout their compulsory part of education.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday



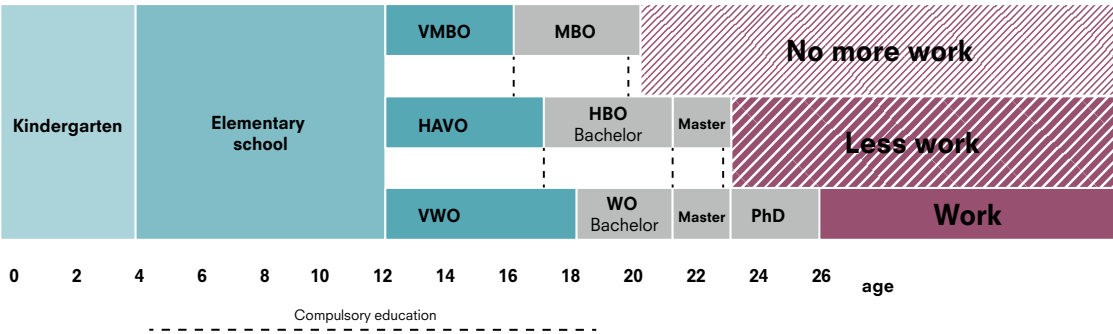
Passive decontextualized education



Active contextualized phenomenon-based education

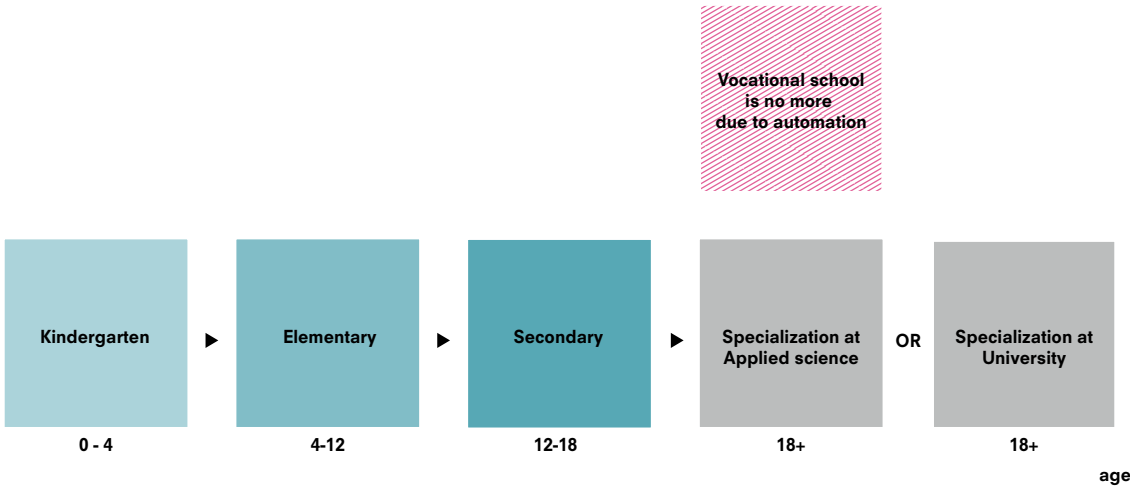
Contemporary Dutch education system

The Dutch education system is subdivided into age groups and capabilities of the students i.e., level. Education becomes compulsory when citizens become four years old and stays compulsory until adulthood.



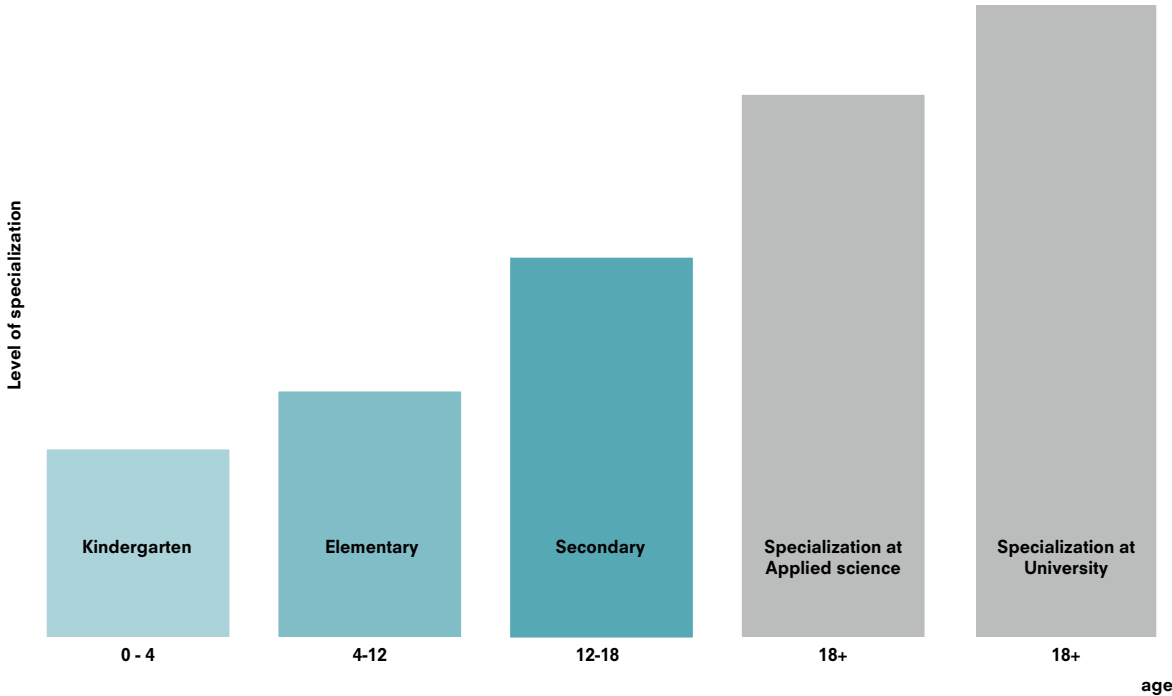
No more vocational school

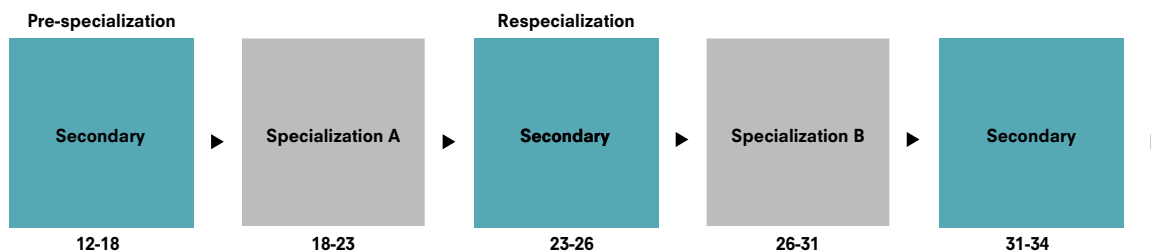
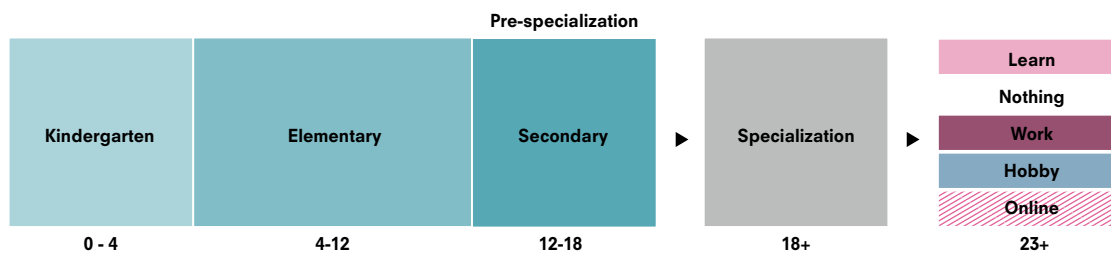
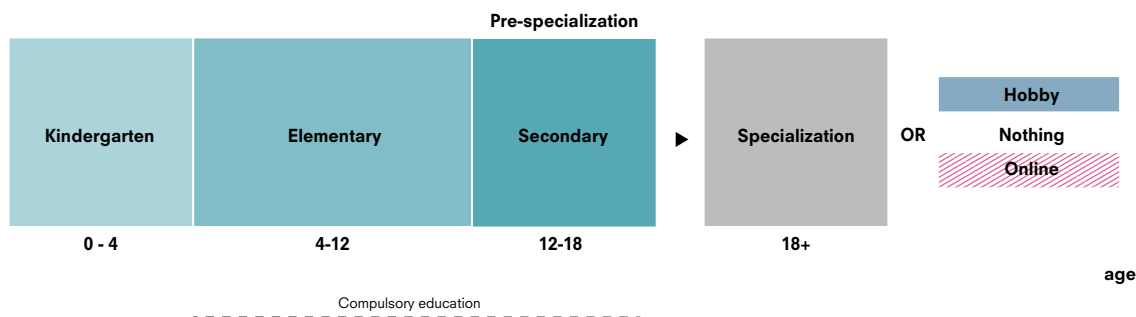
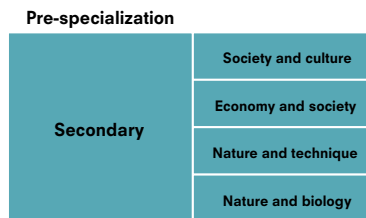
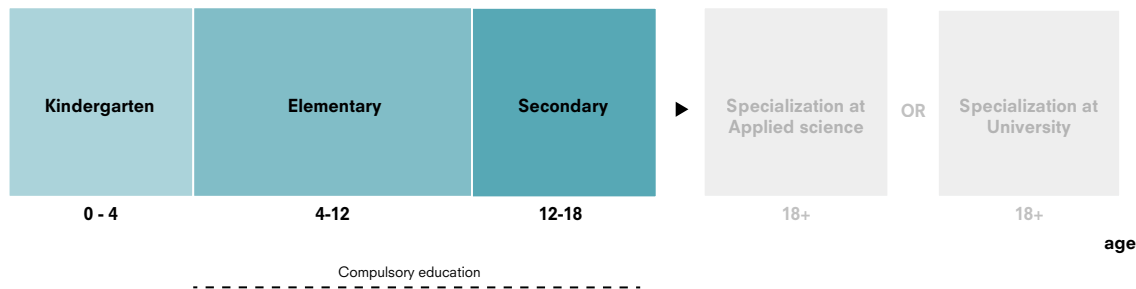
In our future scenario, all work in the vocational level has been automated. The small amount of work that remains in this sector will be thought in secondary schools.



Increasing levels of specialization

If you look into the level of specialization of schools there is a correlation with the age of the students. Fluid education is applicable for education below the specialization at applied sciences and university. It focuses on preparing students to attend these institutes.





Fluid education system

Fluid education combines the kindergarten, elementary, and secondary school into one school. For clarity of narrative, this classification will be used to explain the system further. This subdivision is however, different and not classified into kindergarten, elementary, and secondary but into playful, playful cognitive, cognitive specific, and specific.

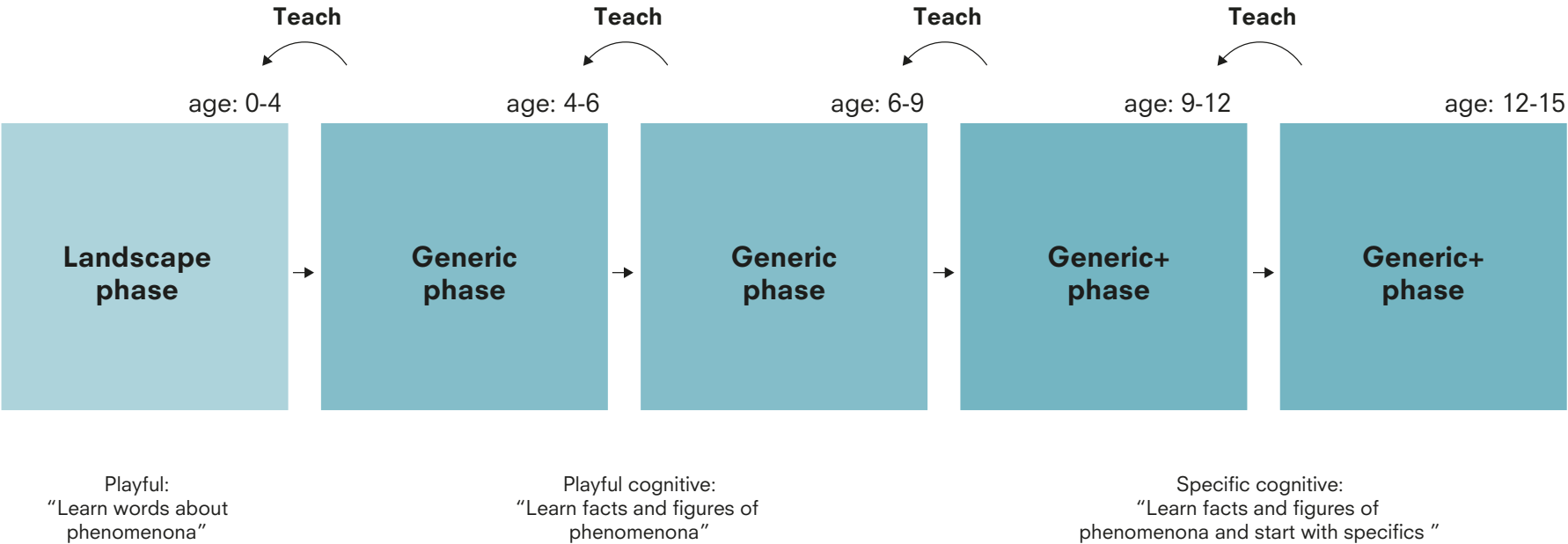
Prepared for specialization

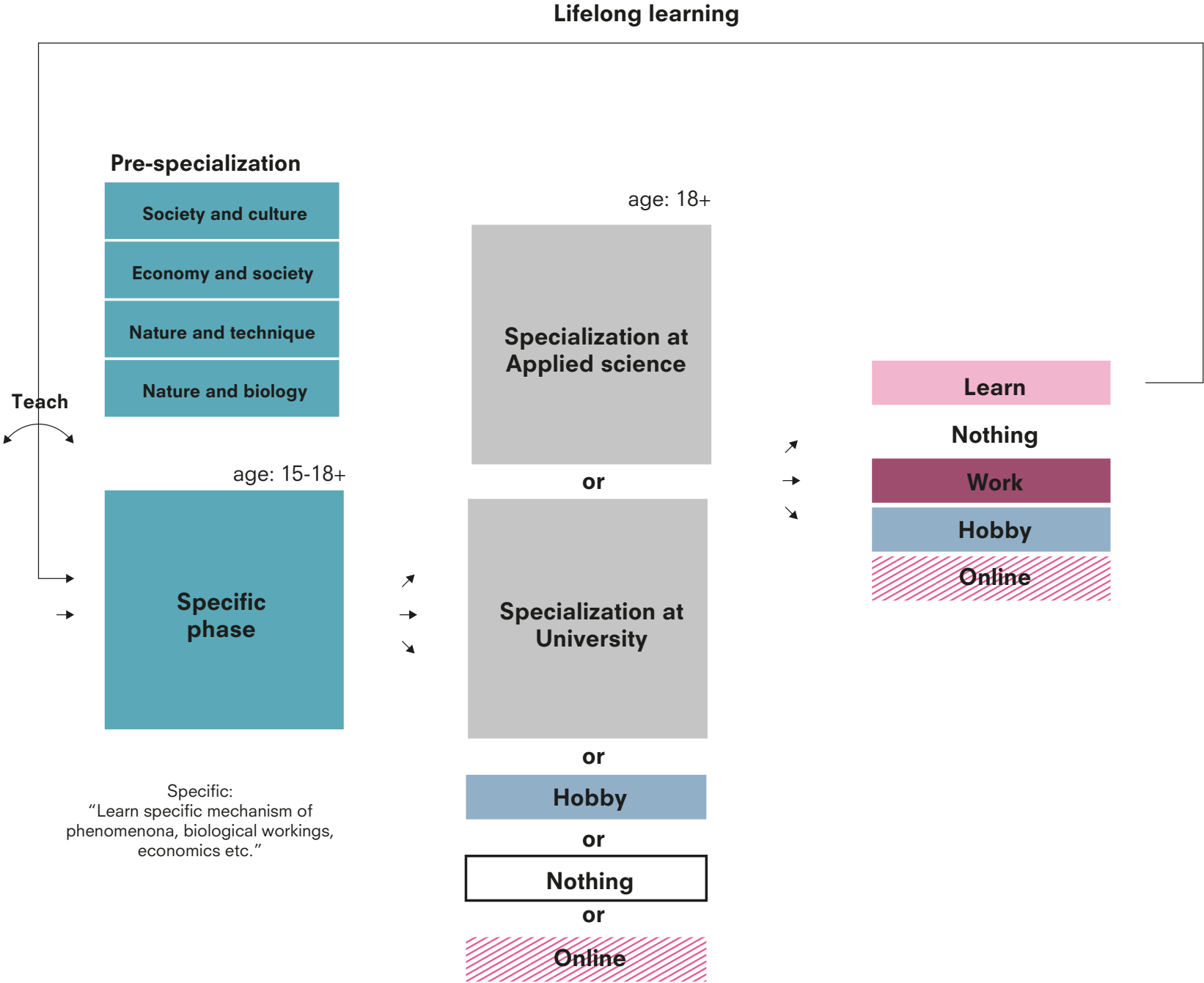
Fluid education prepares you for specialization through a pre-specialization. These are subdivided into the categories that are similar to what Dutch education offers today. Compulsory education ends after pre-specialization, then students can either go to a specialization at an applied sciences or university. Or perform hobby, do nothing or have an online life.

Lifelong learning

If students want to keep learning after finishing a specialization at an applied sciences or university they can go back to a school that offers fluid education. Lifelong education is possible through a respecialization into a different category of pre-specialization. This makes it possible that students become / learn about becoming an architect, doctor, biologist and lawyer all together in one life.

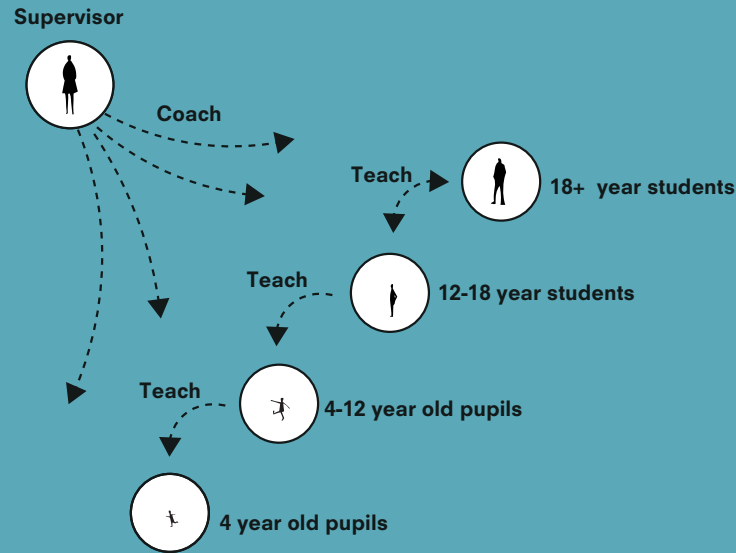
Fluid education system





Users

The main difference from contemporary education is the fact that all users use the same building at once, this is a requirement because everyone is a teacher. You teach what you have learned, and this is a reciprocal relationship until you are old enough to go to specialized schools like applied sciences or universities.



0-4 year old pupils

This is the equivalent of the Kindergarten pupils in contemporary education. This user group focuses on playful learning. Applied on phenomena, they learn about words.



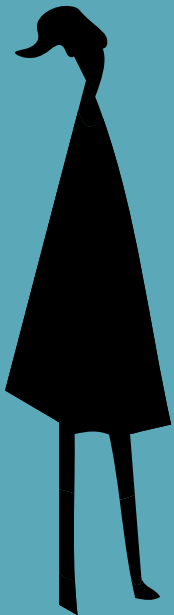
4-12 year old pupils

This is the equivalent of the primary school pupils in contemporary education. This user group focuses on playful cognitive learning. Applied on phenomena, they learn about facts and figures.



12-18 year old students

This is the equivalent of secondary school students in contemporary education. This user group focuses on specific cognitive learning until 15 years old. Applied on phenomena, they learn about facts and figures and start with specifics. From ages 15+ onward, they have specific courses, learning about specific mechanisms of phenomena.



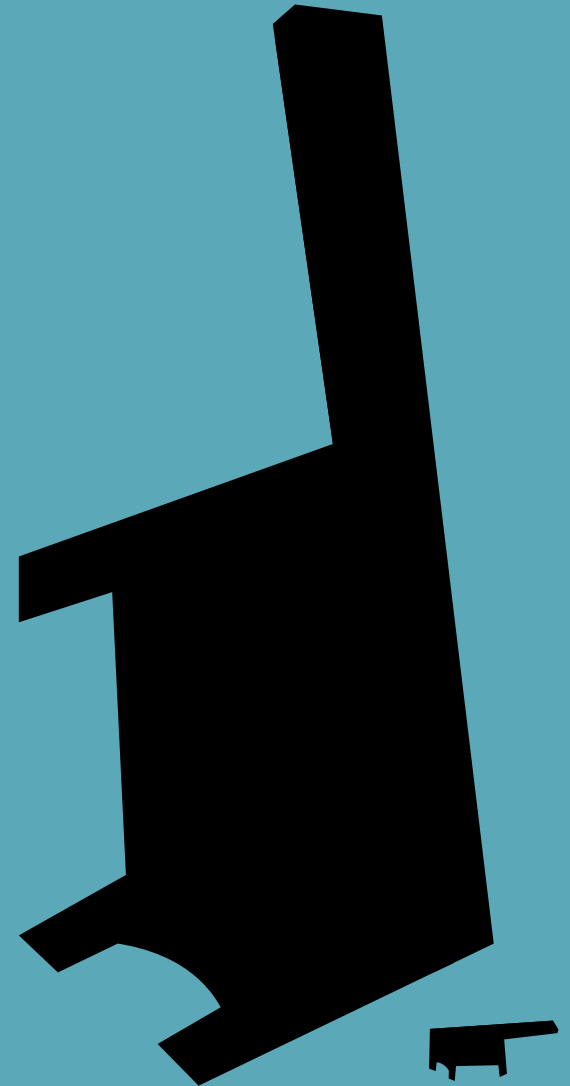
18+ year old students

Lifelong learning is possible at Fluid education, these students come back to school or stay at school and join the students from the ages 15+ onward, they participate in specific courses, learning about specific mechanisms of phenomena and teach aswell.



Supervisors

Everyone is a teacher in Fluid education, so there are no traditional teachers. Nevertheless, Fluid education has teachers in the form of supervisors; these are specifically trained to give assistance, coach, keep order and introduce new phenomena, and impart on students to study phenomena through various perspectives.



Robotics

The building is maintained, cleaned, constructed and deconstructed, financially controlled, managed, etc. by robotics. All boundary conditions are taken care of by robotics, freeing the humans to focus on their primary occupations.

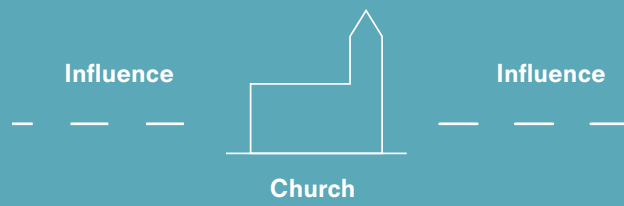


Learning from precedents

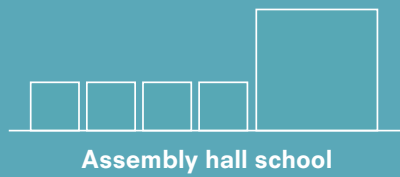
How did the learning space typology develop?

School buildings, alike other civic building types have been developed mainly from the 18th century onward in western society. However, schools have been part of the built environment since ancient Greece. Since education has become mandatory at the beginning of the 20th century in the Netherlands, the development of school buildings has taken off. Architects believed in the fact that a good design for the physical environment of education would influence the pedagogic capacities of education positively.

1700



1800

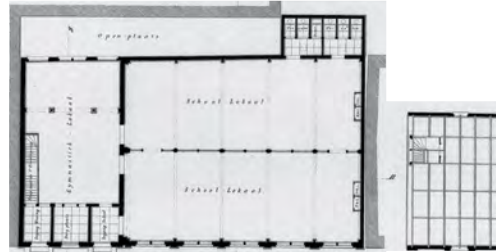


Timeline of the typological developments in the design of school buildings since 1700.

The learning space of the 18th and 19th century

Private institutions for the higher class in society

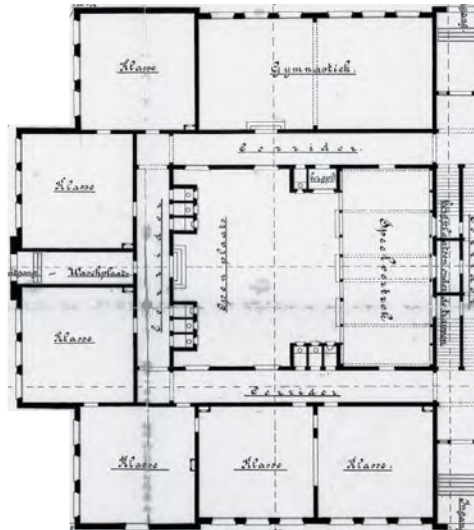
Before education became mandatory in the Netherlands, schools were a private affair. The teacher was living in the adjacent schoolhouse, and there were no more than two classrooms, mostly one classroom to accommodate the students.



Generic school building - single classroom with
teacher housing

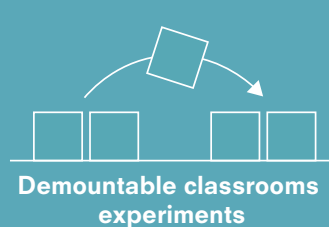
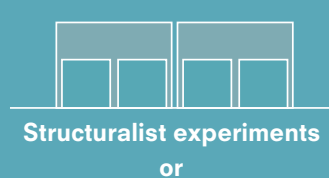
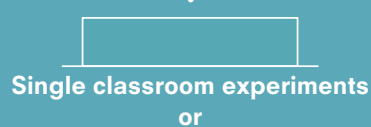
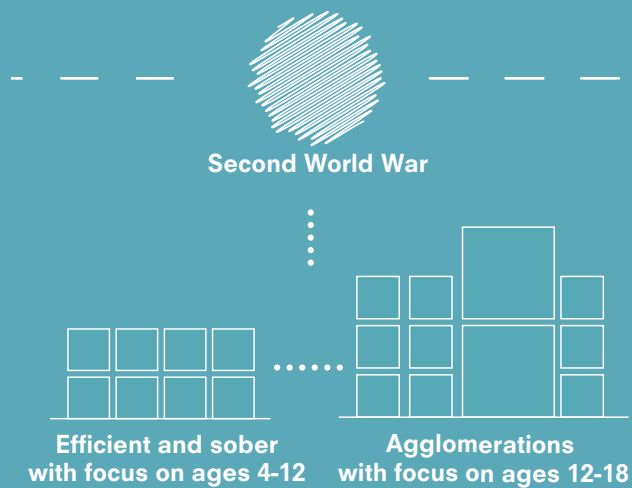
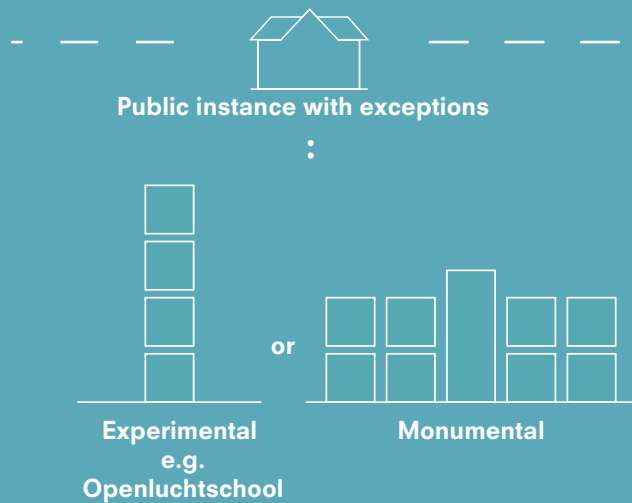
Centralized facilities that could accommodate several classrooms at once.

When education became mandatory in the Netherlands, the private school buildings began growing in size, this growth demanded different spatial configurations to be implemented in the design of school buildings.



Generic assembly hall school-
Increased size requires new layout, assembly hall as
formal entrance to different classrooms

1900

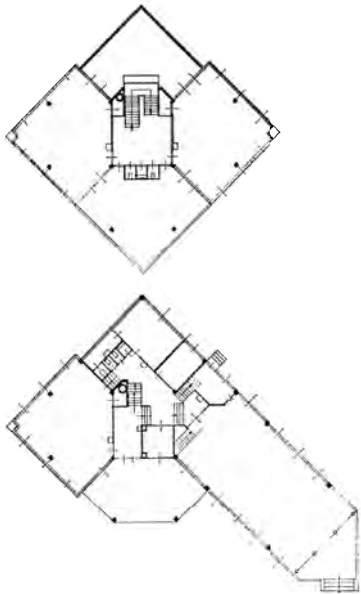


Modern society reflects on the state of school buildings. Schools become physical manifestations of their educational ambitions

The learning space of the 20th century is a contingent collection. Most types of school buildings have been developed throughout the 20th century, due to education being a civic affair. The beginning of this century was occupied with, on the one hand, generic school buildings found throughout cities and rural areas of the Netherlands like the corridor school type. Parallel to this generic development was a more experimental search, e.g., Bauhaus and the Openluchtschool. These experimental school buildings sought to develop optimal learning spaces for their specific types of education. The post-war reconstruction neighborhoods had similar prefabricated and standardized school buildings as their housing e.g., H-Type school. This trend was opposed by more

structuralist experiments in school buildings, for example those designed by Herman Hertzberger. The school buildings always seem to reflect the architectural idiom of their time and could be described as architectural artifacts. This becomes more apparent in school buildings that behave more like icons, e.g., the university library of TU Delft. What can be concluded from the 21st century is that there is not one school building type. However, schools have several similar elements, e.g., classrooms. These are laid out in different spatial configurations that not necessarily have a direct influence on the didactic capacities of the education, this is besides any functional requirements like proper daylight entry, fresh air supply, and proper interior.

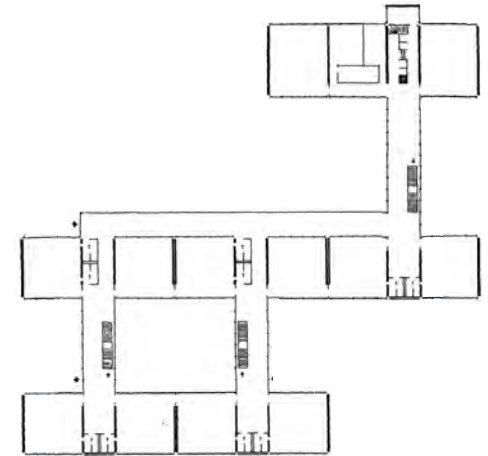
The learning space of the 20th century



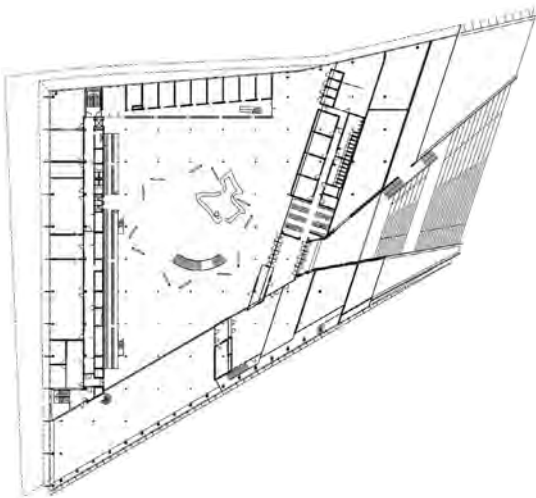
Openluchtschool, Amsterdam -
School as an expression of
ideals of education



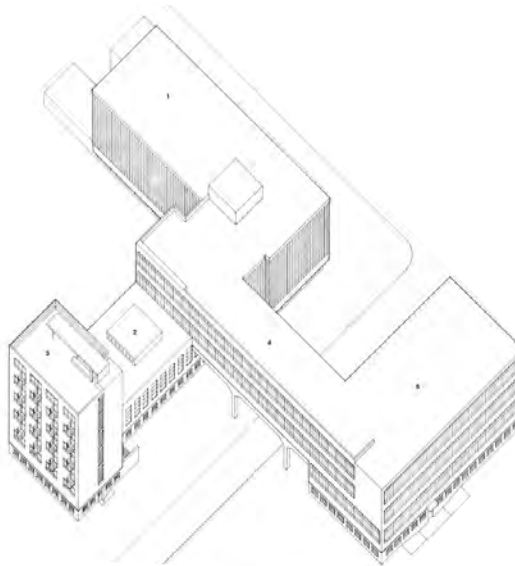
Montessori school, Delft -
Structuralist notions as
basis for design



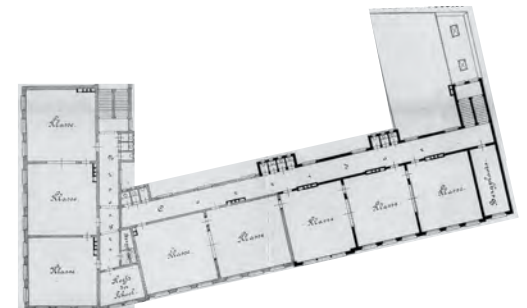
Generic H-type School -
Sober, efficient and modular school



UB TU Delft -
School buildings as icons

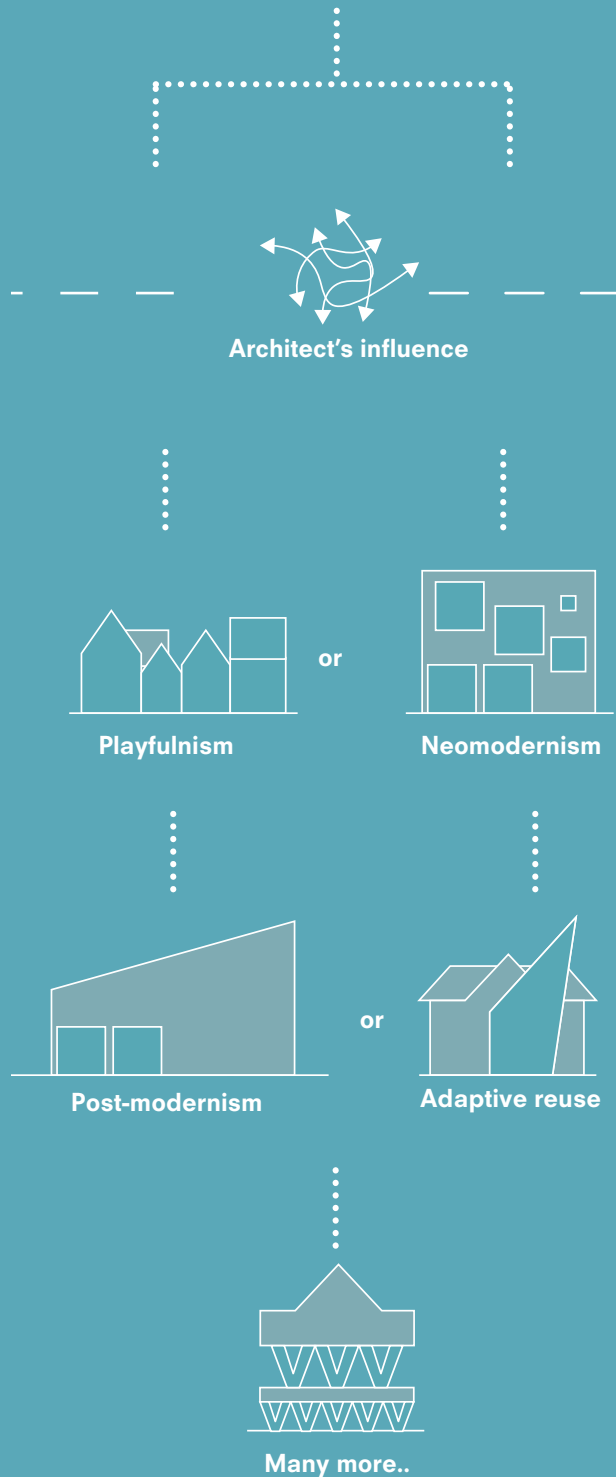


Bauhaus, Dessau -
School as an expression of
ideals of education



Generic corridor school-
Increasing size requires
concatenation of spaces

2000



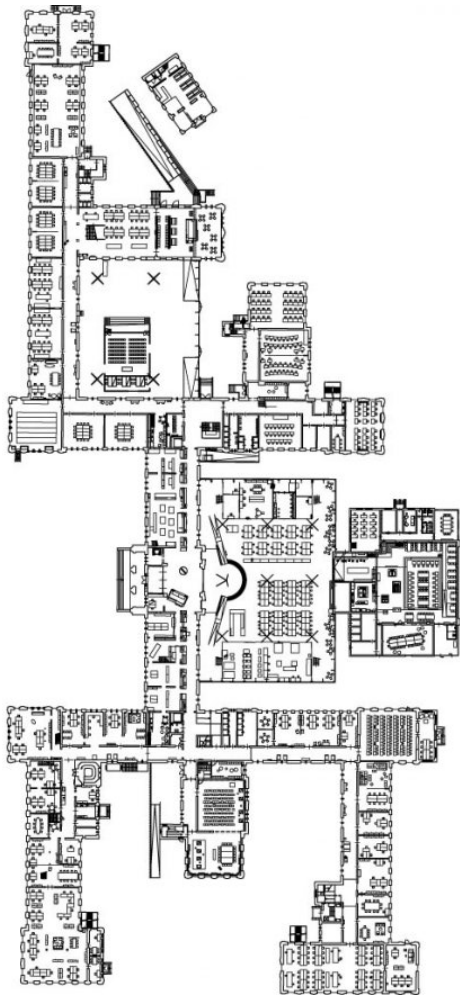
The first 20 years of the 22nd century have seen a continuation of trends set in motion in the 21st century.

Architectural trends and the personal branding of a particular architect still seem to be the main motive behind the design of new school buildings. However, school buildings, more often than before, are renovated or use existing buildings as a starting point for their new accommodation e.g., BK City. On the other hand, due to stricter governmental regulations and financial restrictions; kindergarten, elementary and secondary

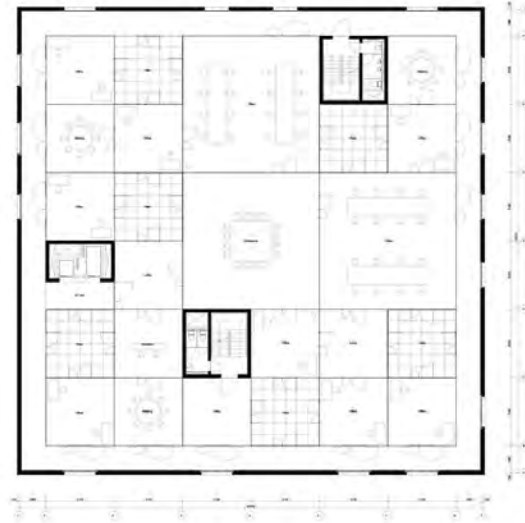
schools begin to conglomerate into single larger facilities. These large facilities tend to be similar in size to university faculties, yet they still only attract students from the nearby neighborhoods instead of global attractiveness of universities and alike e.g. The International School Copenhagen. Experiments in the type of school buildings still happens, be it in exterior or interior spaces e.g., Zollverein School, WeGrow.

2100?

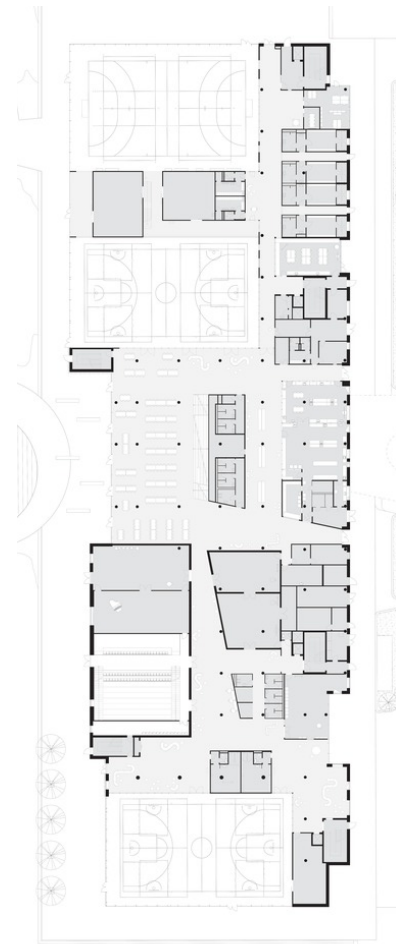
The learning space of the 21st century



BK City - Adaptive reuse



Zollverein School of Management and Design -
Formal expression



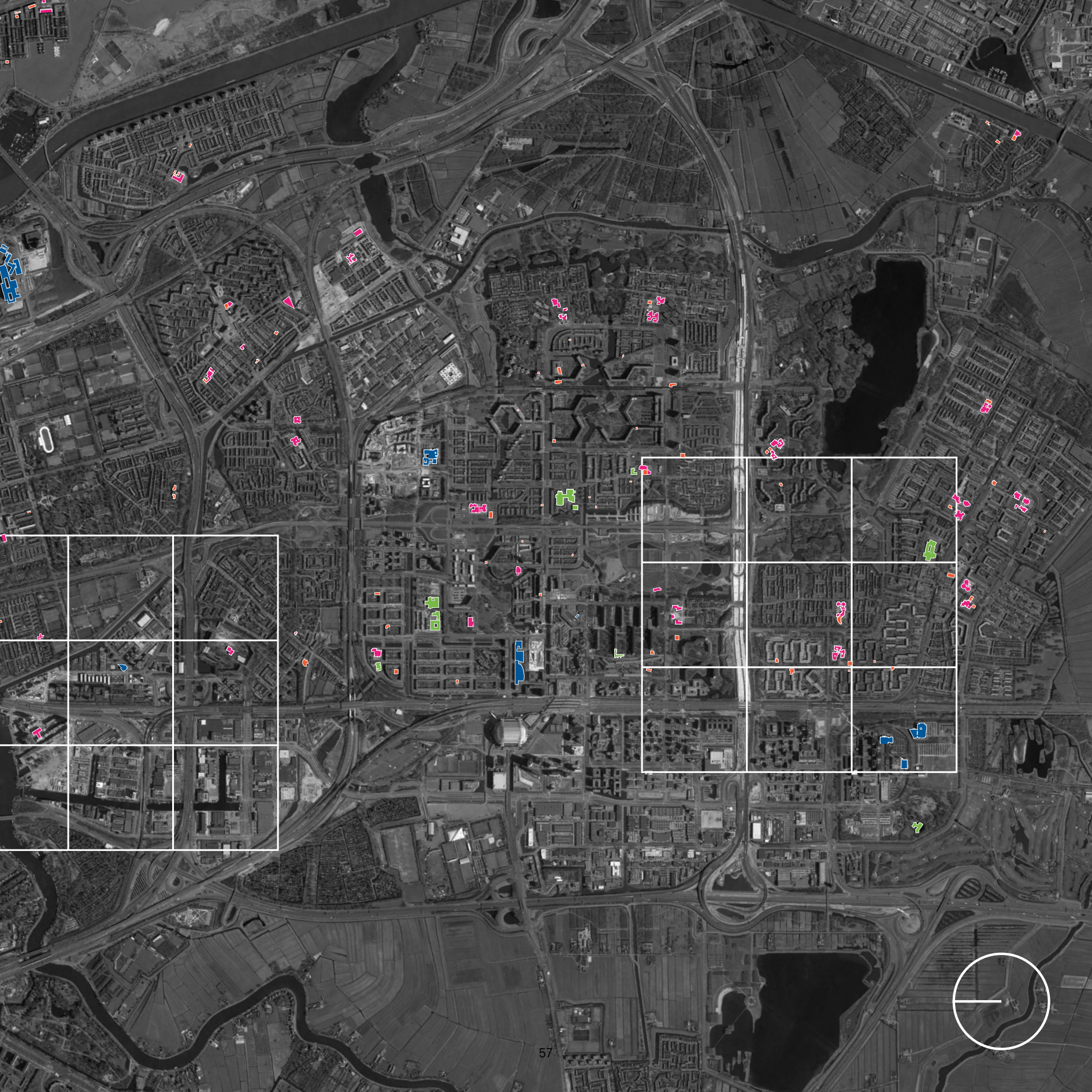
The International School Copenhagen -
Concentrated learning centers with a lot
of functions

Learning spaces in Amsterdam

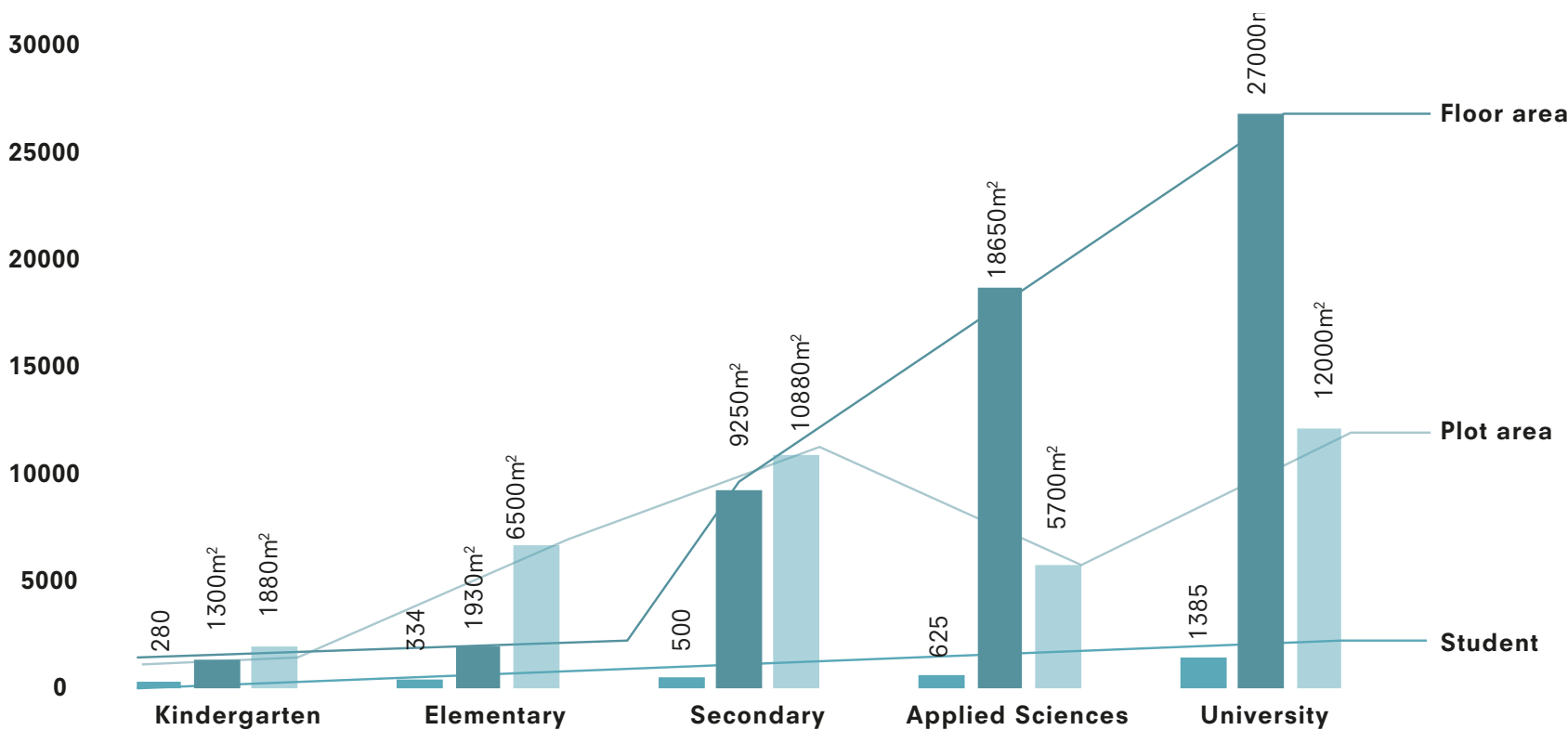


Legend

- Universities, Applied sciences, Vocational schools
- Secondary schools
- Elementary schools
- Kindergartens



The learning spaces in numbers



The school grows along side the student (Data based on quantitative research)

[illegible]

WeGrow



Data

Location

New York City, USA

Architect

BIG

Target age (total students)

Elementary(65)

Learning principle

Kindergarten

School principle

Varied environment

Year of construction

2018

Plot area

930m²

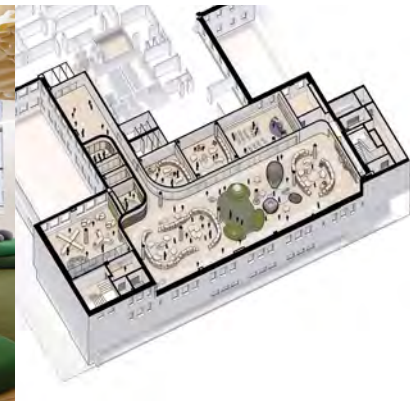
Floor area

930m²

Floor area ratio

1

Layout typology

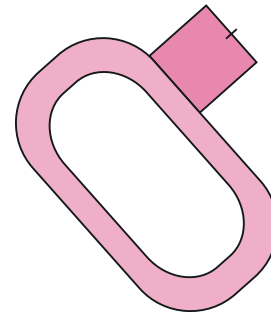


73

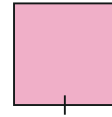
AMS CENTRAAL

Quantitative research has been performed on more than 60 school buildings in Amsterdam, and outside the city on historically interesting school buildings. This research forms the basis for m² and design principles for this project.

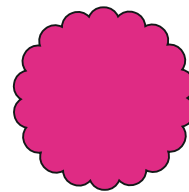
Elements of learning spaces



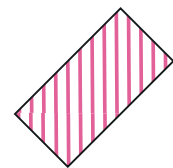
Sports



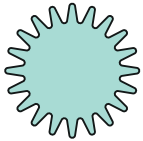
Classroom



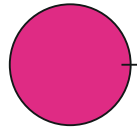
Playground



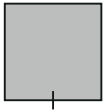
Circulation



Organization office



Teachers room



Storage



Toilets



Montessori school Delft

Herman Hertzberger - first renovated version

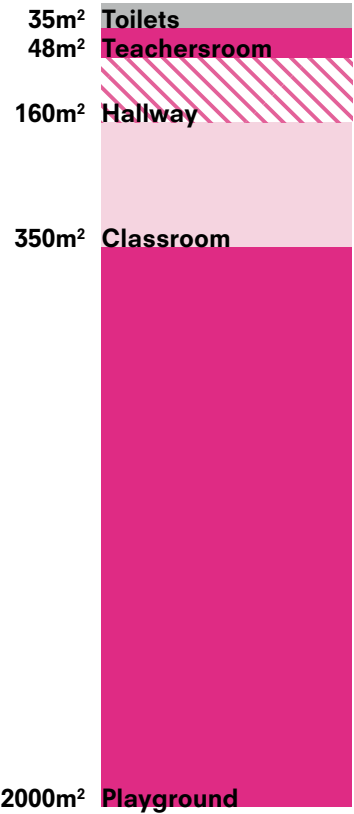
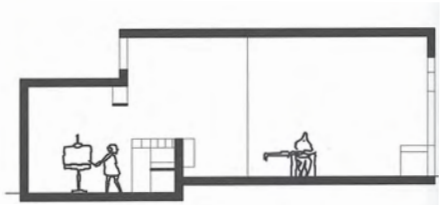
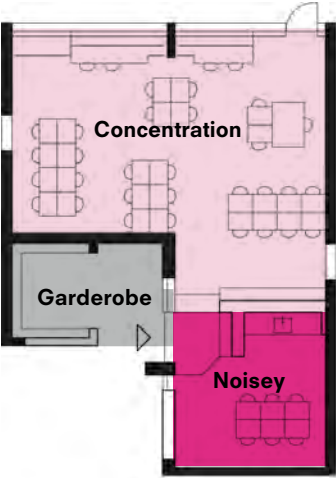
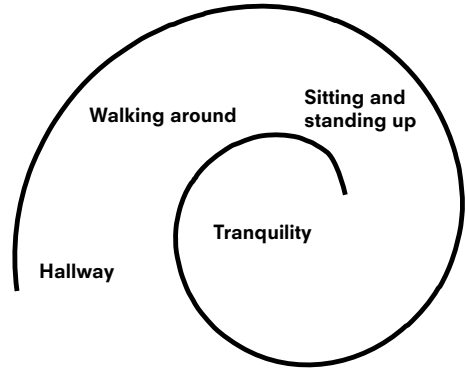
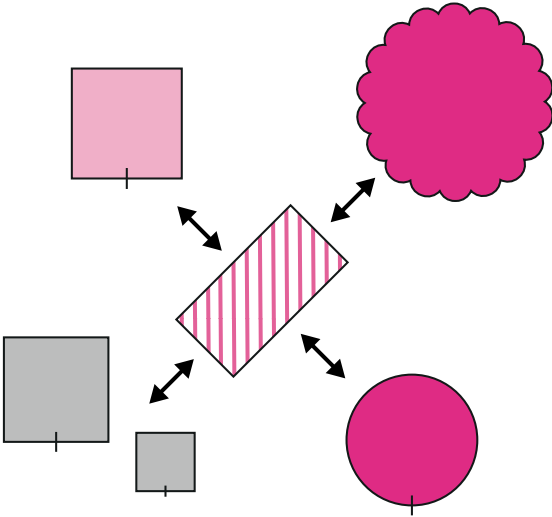
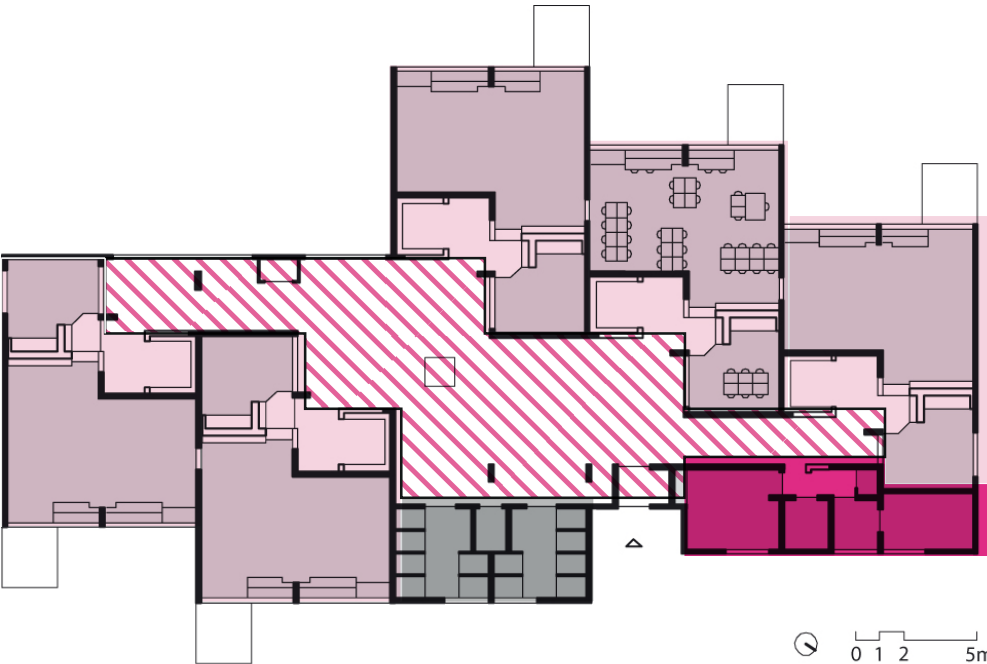
The Montessori school in Delft by Herman Hertzberger is an example of structuralist ideals realized along side Montessori educational principles

The Montessori school in Delft has been expanded several times over the course of its existence. Each time Herman Hertzberger was involved in looking over the process. The school building is a compilation of the same classroom typology, stamped alongside a central hallway that also serves as a playground. The classrooms are all the same and consist out of different spaces with a different atmosphere. Each space caters to different needs of the students in their educational journey.



“The school for which we are to find a form is one of less education and more learning. What is needed is an environment that stimulates and incites learning by asking questions, a climate that provokes exchange and confrontation, intellectually, culturally and politically.”

– Herman Hertzberger



Fuji Kindergarten

Tezuka Architects

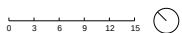
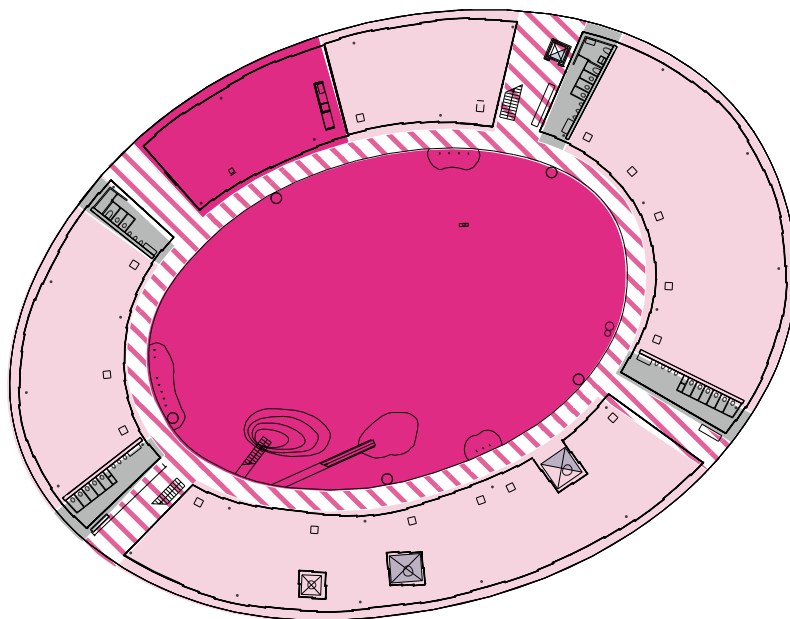
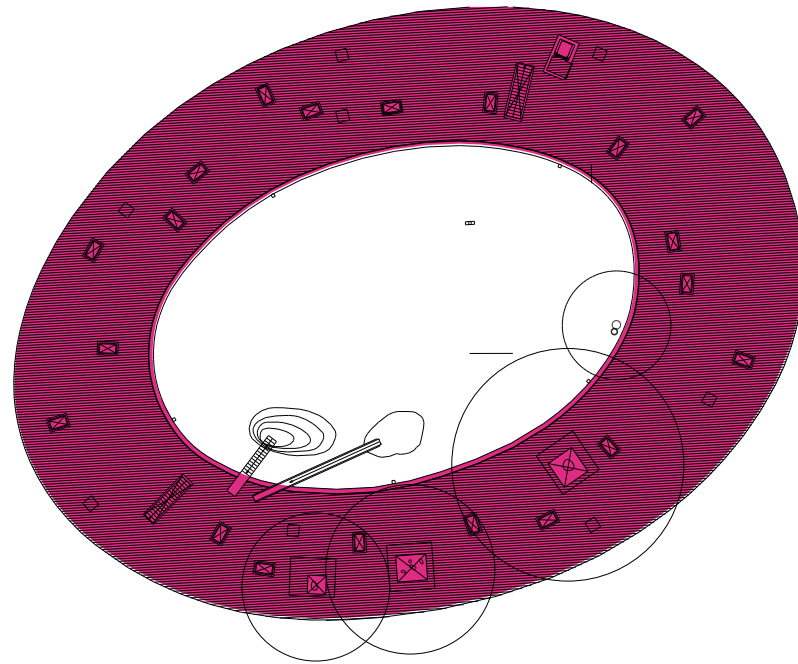
Diffused interior and exterior spaces,
simultaneously safe and secure from the
outside world

The Fuji Kindergarten in Tokyo by Tezuka architects is a large kindergarten which functions as one big playground. The inner courtyard can be reached through large sliding glass walls. By opening several large classrooms onto the courtyard, the building becomes one with inside and outside spaces blurring into each other. Upon that is the accessible roofscape that functions as the extension of the playground on the ground floor.



“Help me to do it myself! a real paradox which involves
developing self-sufficiency and which assumes that the capacity
for learning lies within the child.”

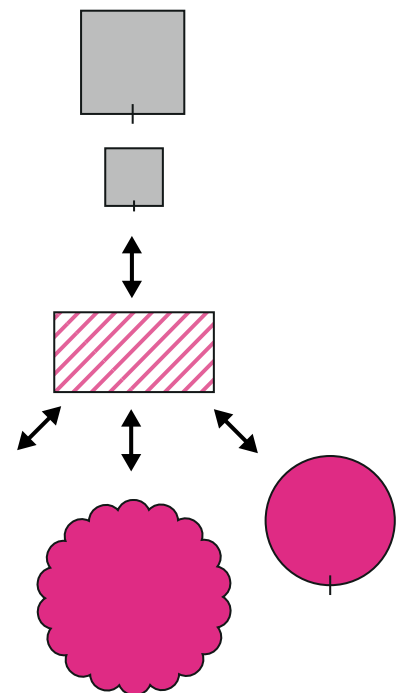
- Yui y Takaharu Tezuka



Toilets	110m ²
Teachersroom	141m ²
Hallway	316m ²
Classroom	1130m ²
Playground	2570m ²

Shape and function are aligned.

The oval shape of the kindergarten with its courtyard in its center frames the space from the outside world. The entrance to the building is through four covered outside alleys, that are all connected via exterior hallways to the classrooms.



Openluchtschool

Johannes Duiker

The Openluchtschool by Johannes Duiker is the embodiment of the modernistic movement

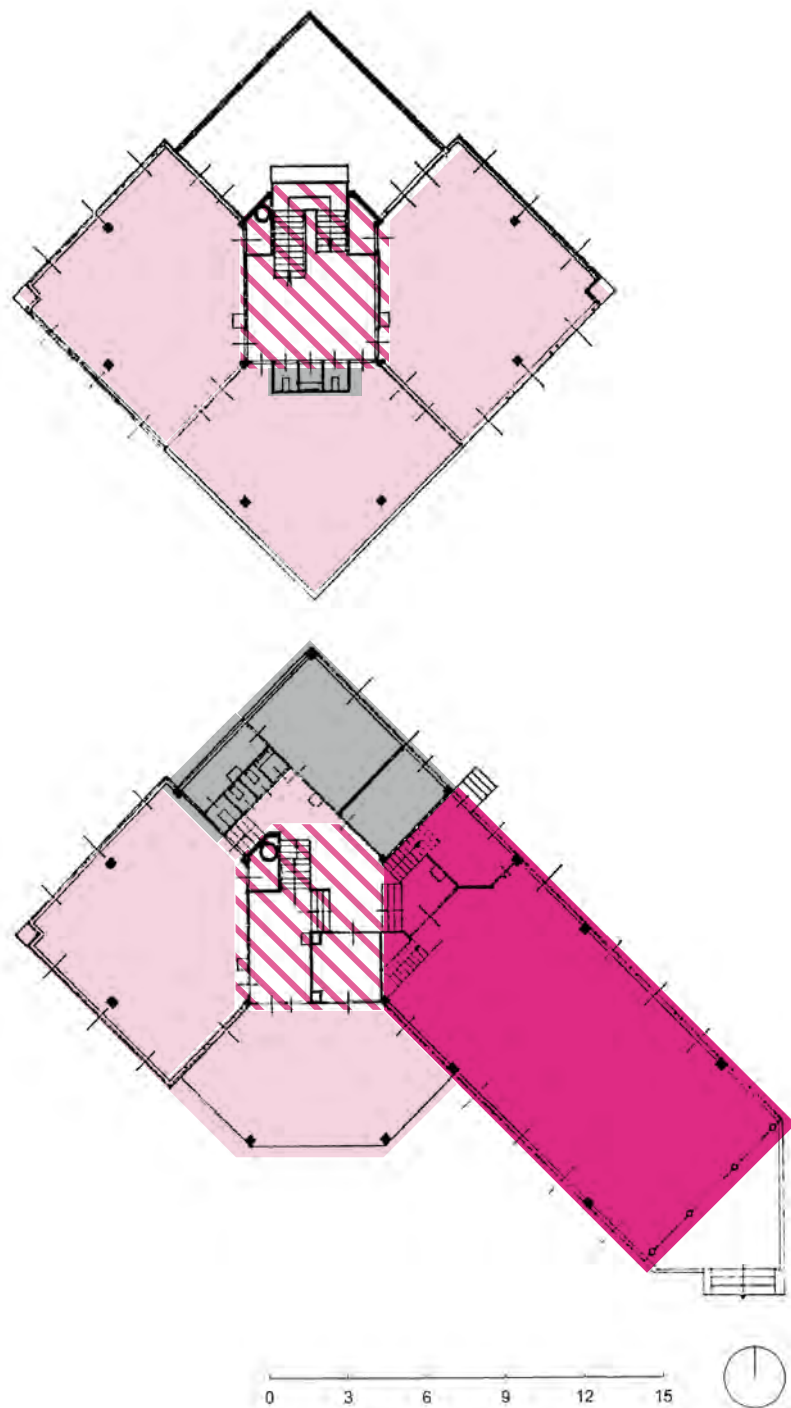
The school building by Duiker was set on the periphery of the city of Amsterdam, outside of the messy and dirty city. Convinced that fresh air education would benefit the pedagogic capacities of the pupils a wave of Openluchtschools have been created throughout the Netherlands. Part of the curriculum was given in the outside air and all classrooms had more daylight and fresh air than schools have had since then.

Revolutionary in this design is the vertical displacement and the elimination of the corridor, instead a core with stairs would function as a vertical hallway. Each level comprised out of two inside classrooms and one outside classroom, including two toilets and a small landing. Stacking the building would leave more outside playground on the premises of the school to be used by the students.

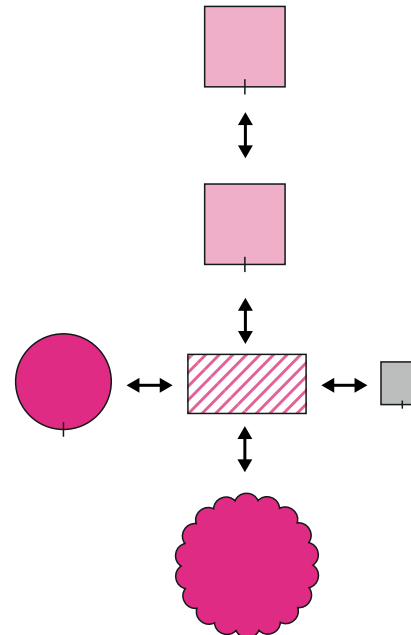


“Het is een sterke hygienische kracht, die ons leven beïnvloedt en die tot een stijl: een hygienschie stijl zal uitgroeien.”

- Johannes Duiker



Toilets	62m ²
Teachersroom	66m ²
Hallway	152m ²
Specific	278m ²
Classroom	434m ²
Playground	1180m ²



H-Type and Schoolparasites

ir. Koops, WiMBY!

What if we could modify our schools towards our changing likings?

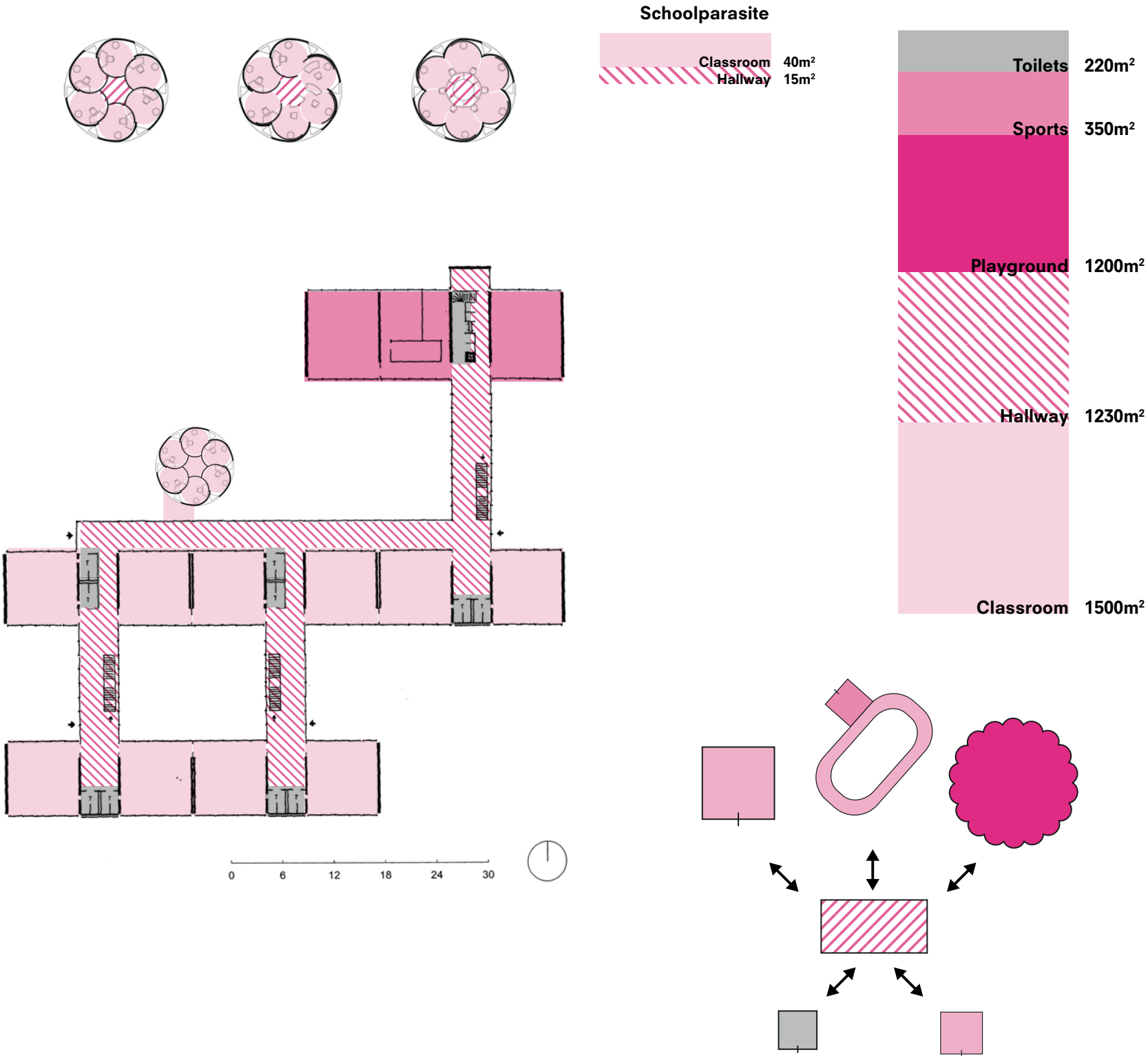
The H-type school building was created out of a need for efficient and competent educational buildings in the post-war reconstruction era. The H type school was comprised out of a set of four classrooms connected with a hallway, over two elevations. Each H could concatenate with other H stamps to create a school building that could expand endlessly. A system that could function in theory, but never worked in practice. From the 1960s onward the Netherlands has seen a series of education revisions. These revisions made small alterations on configuration of all school buildings and classrooms. Over time all these small alterations have accumulated in a totally different school building.

Part of the WiMBY! movement at the beginning of the 21st century in the Rotterdam neighborhood of Hoogvliet, a post-war neighborhood, is the Schoolparasites experiment. Instead of creating the same repeating elements, it was proposed to create spaces that could move between different schools where there was a need for these spaces. When the spaces became overabundant, they were decommissioned and displaced to other locations to be reconstructed and used.

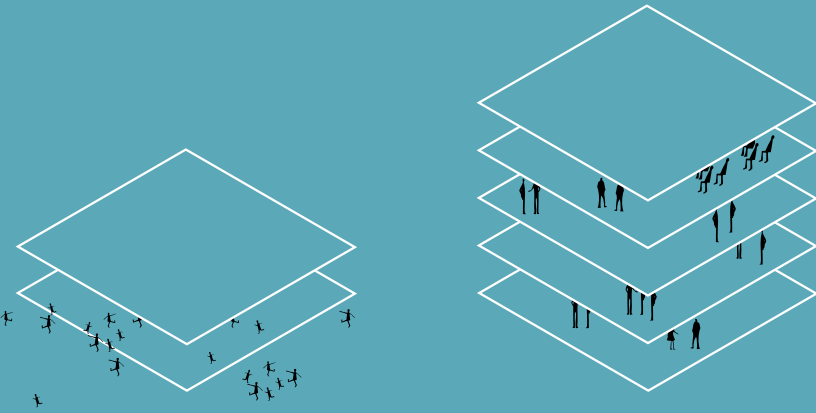


“Schools must constantly adapt to new demands, visions and demographic developments, a process to which the school building, in practice, is not well-suited.”

- Schoolparasites



Learning from precedents



School buildings tend to grow in size alongside the growth of their students.

Moreover, in the early years of education, school buildings have larger outside spaces than inside spaces. Their Floor Space Index seems to indicate relatively flat buildings with much outside space. At more specialized educational institutions like Applied Sciences (includes vocational schools) and University buildings, this shifts. In favor of more floor space, the buildings begin to stack floors on top of each other, losing part of the relation with the outside environment .



School buildings are everywhere

The nature of growing humans, the physical and psychological limitations of children compared to adults seem to dictate the need for school buildings to be located in the vicinity of their students. Every residential neighborhood has its own or multiple school buildings to choose from. School buildings become more centralized by the age of the students; this creates extensive facilities that are further away for some students. Travel time increases due to this.



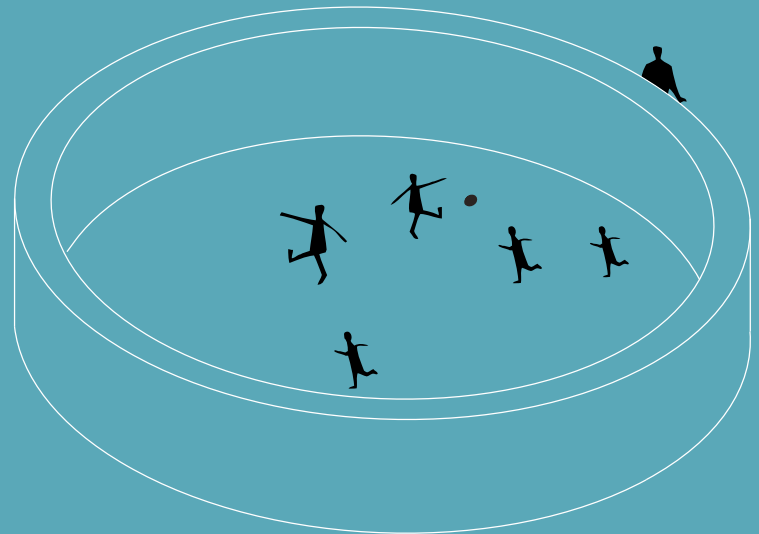
Private
spaces

Public
spaces



Spaces for
the individual

Spaces for
groups



The school could be envisioned as a micro version of the real city.

Hertzberger writes about the design of school buildings as if you were journeying through the city. The assembly hall can be envisioned to function as a public square with the classrooms connected as individual dwellings. Within this whole all the individual spaces are connect with communal spaces. The classroom is an important space for a pupil, as this the pupils own space within the whole of the school. A space the pupil can appropriate. This notion should be incorporated in the learning space of the 22nd century.

Students attending the kindergarten are out of the control of their parents and are in large quantities compared to their adolescent teachers.

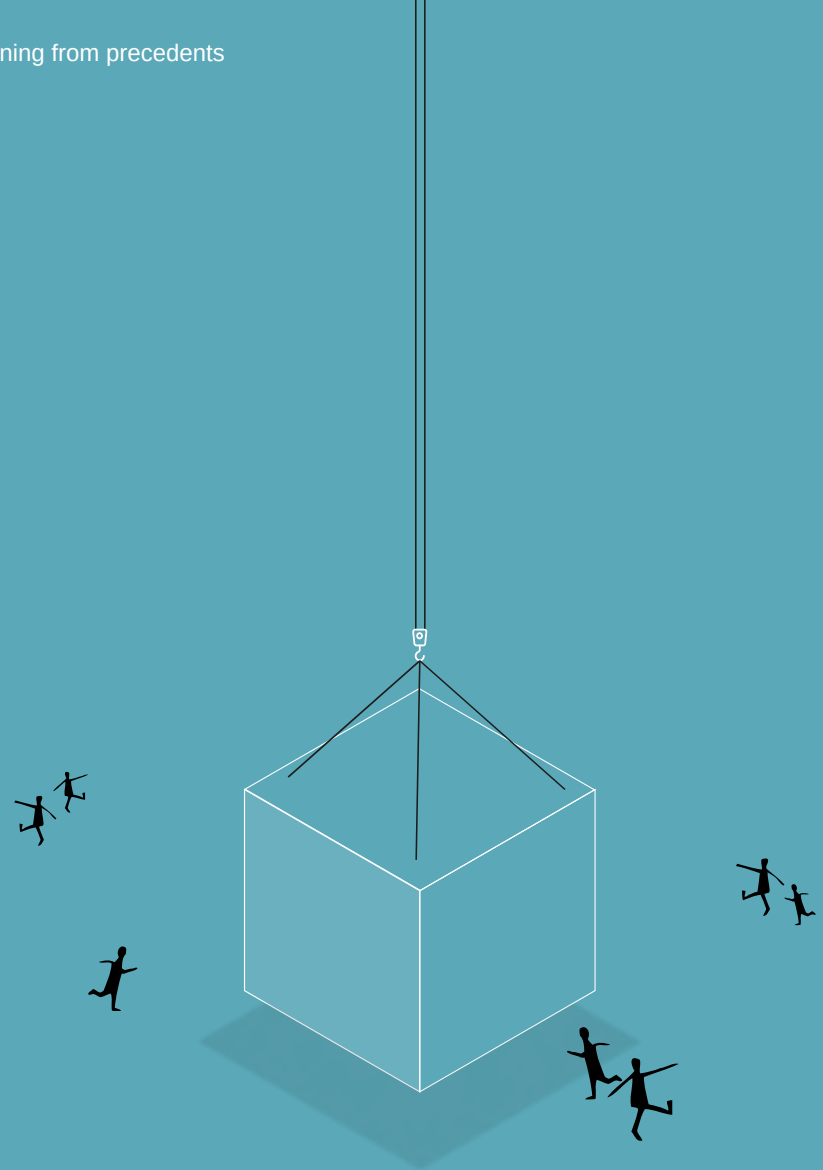
The children are protected from the outside world through the structure of the building. However, the playground is not harmless at all; the students are able to climb in trees, stumbling over each other in the sandpit, play with water and run around, this is all allowed within the greater scheme of protection. The playfulness is measured, and minor injuries from this playing have become part of the education. This notion should be incorporated in the learning space of the 22nd century.

Learning from precedents



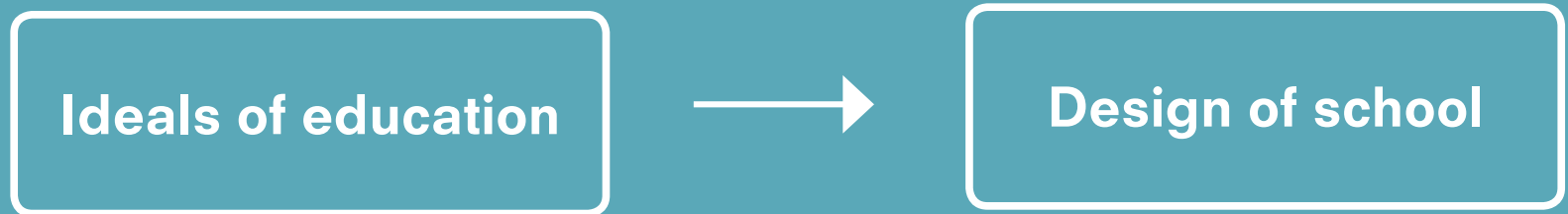
The cleanliness of the structure and the lack of ornamentation reflect the ideals of the school.

The Openluchtschool by Johannes Duiker is the embodiment of the ideals behind the education given at the school. This reflexive motion between the ideals of the school and the physical appearance are essential characteristics of this design. This notion should be incorporated in the learning space of the 22nd century.



The Schoolparasites teach us that it is possible to create qualitative spaces that are of temporary nature, while the H-type building shows the possibilities of an endless repetition of modular building elements within a school building.

If school buildings are subject to a changing public opinion, why would we still build school buildings that would last forever. We could better construct our schools like the Schoolparasites and create spaces that are temporary and of high quality. This notion should be incorporated in the learning space of the 22nd century.



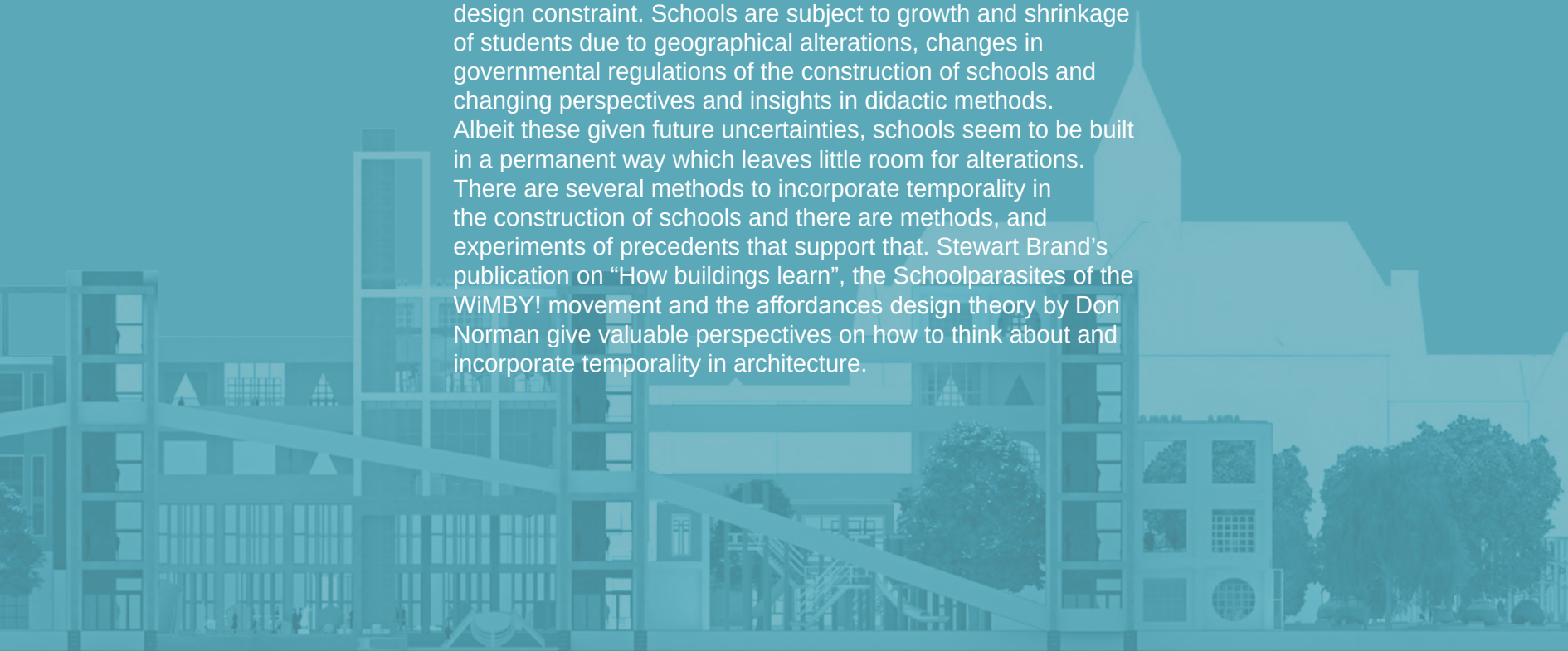
The ideals of the type of education is the main influence on the design and configuration of school buildings

If we compare all the school buildings that have been research there seems to be one overarching aspect. All the school buildings have been adapted to the specific type of education given. We can conclude that the ideals of education influence the design of the school.

Essay: Schools that learn

Temporality is an important design constraint in the architecture of school buildings

The relationship between permanency and temporality in school buildings is important. The architecture of school buildings should incorporate temporality as an important design constraint. Schools are subject to growth and shrinkage of students due to geographical alterations, changes in governmental regulations of the construction of schools and changing perspectives and insights in didactic methods. Albeit these given future uncertainties, schools seem to be built in a permanent way which leaves little room for alterations. There are several methods to incorporate temporality in the construction of schools and there are methods, and experiments of precedents that support that. Stewart Brand's publication on "How buildings learn", the Schoolparasites of the WiMBY! movement and the affordances design theory by Don Norman give valuable perspectives on how to think about and incorporate temporality in architecture.





Introduction

The world around us is witnessing tremendous changes; the introduction of new technological advancements in our daily lives have a lasting impact. However, our buildings, especially seen from the outside, seem to be a consistent unchangeable entity. One of the building typologies that everyone in Dutch society has been able to experience to full extent is the school building, a public institution that has the goal to educate young humans and prepare them for life in Dutch society. The school building is one of the places you spend most of your time in the beginning of your life; it deserves to be of utmost quality.

The school building, just as many other buildings, seems to be a permanent entity. Nonetheless, I would argue that the opposite, the school as temporarily entity, is true. The architecture of school buildings should incorporate temporality

as an important design constraint. Temporality in school buildings would not only give schools more freedom to adapt to future tendencies. It will generate opportunities for the physical environment of education to adapt, consequently improving their didactic capacities. Moreover, temporality has the potential to make schools more sustainable towards the future.

So, if we make temporality a compulsory design constraint, it raises the question of how this temporality can be translated into form and function and what limitations and opportunities arise from this. This essay will shed light on why we need to incorporate temporality in the design of school buildings and how we can achieve this through methods and experiments of precedents.

Why temporarily should be incorporated

Three years ago, in 2016, I had the opportunity to do a design project about the repurposing of the E.W.I. (Faculteit Elektrotechniek, Wiskunde en Informatica) of the TU Delft, designed by Geert Drexhage, built in the year 1972. This iconic functionalist tower in the middle of the Mekelpark was at that time nearing the end of its 50-year technical lifespan. The goal of the design project was to research the possibilities for repurposing the tower to avoid demolition. The architect Anne Lacaton from the architecture office Lacaton & Vassal was our guest professor guiding this design project. Her stance on the built environment: "Transform, add, re-use, never demolish!" or our design proposals after finishing the course have not been able to convince the board. (TU Delft, 2016)

The plan to demolish the high-rise is still on, despite from multiple efforts to save the building. (Docomomo, 2019) What is happening when such a massive school complex as the E.W.I. building can only last for 50 years in the eyes of those in charge of its fate? The E.W.I. building

seems to be unable to adapt and it has fundamental flaws in its technological performance e.g., large amounts of asbestos have been used throughout the building. Although the technological challenges of repurposing are real, the embodied energy within the building is screaming to be reused and not thrown away. A good example of adjustability is the architecture faculty of the TU Delft that has repurposed the former science faculty after the disastrous fire of the de Broek and Bakema faculty building in 2008. Yet, this freedom of adjustability cannot always apply to the much smaller and decentralized elementary or secondary schools in the Netherlands.

Schools grow and shrink, new neighborhoods full of children age over time and the need for schools decreases, while the opposite happens on different locations. The age of the students dictates the total walking distance from house to the school. Therefore schools have to be in close vicinity to the students that attend it.

Functional requirements of schools change over time due to shifting perspectives on didactics, learning from educational precedents, and societal changes like digitalization and globalization. The amount of students in classes is bound with fluctuation, and

thus the physical environment, this being the classroom, has to be adjusted to give proper space to all students. Nonetheless, school buildings are unchangeable, mainly because of pragmatic constraints like finance, maintenance and governmental regulations that stand in the way of an evolution of the typology of the school building into a temporary existence. (Stuhlmacher, van der Pol, & Lagae, 2007, p. 27)

The recent emphasis on sustainability in architecture only strengthens the notion for temporality in the construction of school buildings. Reusing the existing is one of the main principles of the circular economy. Incorporating temporality, in the sense of room for future alterations, geographical or functional, is, in its essence more, durable than a permanent building. School buildings should embrace temporality as a design constraint to prepare them for the inevitable contingency in societal perspectives, demographic changes demanding changes in the necessity of school buildings, functional changes due to technological advancements and to be better at combatting sustainability challenges of the future. If we embrace temporality in the design of school buildings, it raises the question of how we can incorporate temporality successfully in the typology of school buildings?

"How to combine permanent and temporary, growth and shrinkage? Schools are by nature changeable, yet we would also like them to be permanent and recognizable. Is it possible for both of these principles to be expressed in the design?"

How temporarily could be incorporated

"How to combine permanent and temporary, growth and shrinkage? Schools are by nature changeable, yet we would also like them to be permanent and recognizable. Is it possible for both of these principles to be expressed in the design?"

- Wilma Kempinga
(Stuhlmacher et al., 2007, p. 33)

How buildings learn

The first direction I would like to touch upon is the paradigm on temporality described in the book "How Buildings Learn: What Happens after They're Built" by Stewart Brand

"Almost no buildings adapt well. They're designed not to adapt; also budgeted and financed not to, constructed not to, administered not to, maintained not to, regulated and taxed not to, even remodeled not to. But all buildings (except monuments) adapt anyway, however poorly, because the usages in and around them are changing constantly."

- Stewart Brand (Brand, 1994, p. 2)

By analyzing buildings over the course of years, Brand tries to argue that a more temporal approach binds the future of architecture because adjustments are a predictable consistency in the existence of buildings. Brand describes the building, as seen in figure 2, which expands the view of Frank Duffy.(Brand, 1994, p. 12) Different layers of change surround the

inner core of the building; these layers are in constant interaction with each other. The six layers that Brand describes are from the outside inward; site, skin, structure, services, space plan, and stuff.

Each of these layers has a different functional or technological lifespan according to Brand and thus has to be replaced because of deterioration or be adjusted through time to accommodate new usages.(Brand, 1994, p. 12) He differentiates that the site and the structure, on the one hand, are the more slowly changing layers while all the other layers are in a continuous state of change. (Brand, 1994, p. 17) Due to this difference in alteration ability, the less adjustable layers limit the rest of the building. This seems to be also in play in the construction of school building, incorporating the perspective of Brand on the configuration of a building into the design of school buildings gives a perspective that can take temporality into account. Not only temporality in stuff, services, skin and space plan, but temporality in site and structure as well

Within the construction of school buildings, I can see three main types of school buildings that can offer adjustability and temporality. The first is an inner core consisting out of a modular construction that can expand and retract over time while spaces are added and removed on the outside. The second is an outer core that provides the necessary protection from precipitation, a covered hall that has its adjustability on the inside. The last one is a school building that offers space for a multitude of activities through oversizing the overall building.

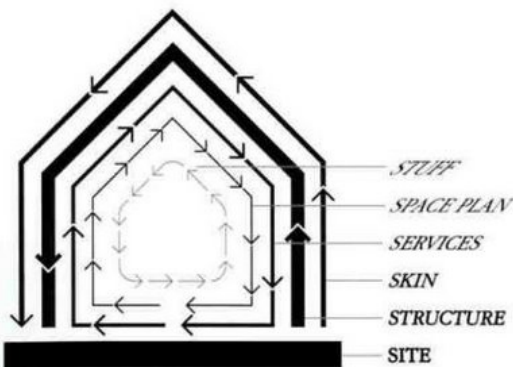


Figure 2 "Shearing layers of change. Because of the different rates of change of its components, a building is always tearing itself apart." – Stewart Brand (Brand, 1994, p. 13)

Qualitative temporality

The work of Stewart Brand still has its origin in the permanent building; however, another example of temporality in the design of school buildings can be found within the parasite foundation that has seen a lot of attention in the early 2000s. In the publication "The city of small things" parasites are described as "Prototypes for Advanced Ready-made Amphibious Small-scale Individual Temporary Ecological houses" and they can be seen as buildings that make use of the existing infrastructure in a parasitic way. (Stuhlmacher & Korteknie, 2000, p. 5) The goal of the movement is to construct lightweight, individual architecture that uses the existing space and does not occupy space permanently. (Stuhlmacher & Korteknie, 2000, p. 6)

One of the off-springs of this movement are the Schoolparasites foundation, which were also part of the WiMBY! movement in Rotterdam Hoogvliet. The Schoolparasites were a project that sought to improve the condition of the standard temporary classroom, which is little more than the portacabin seen adjacent to a building site. (Kempinga, Aarsman, & Bouvier, 2004) Rotterdam Hoogvliet is a post-war reconstruction neighborhood and this can be recognized through its urban layout and architecture.

Throughout the Dutch post-war neighborhood standard system-build strip housing blocks were constructed, public functions like school buildings were strategically placed throughout these residences. These school buildings are

based on the system principle of the H-type school designed by ir. Koops. (Kempinga et al., 2004, p. 23) This school could be readily built with standardized components, and through this standardization, the school has modular properties that allow it to expand over time by linking, mirroring, and repetition. (Kempinga et al., 2004, p. 31)

The Schoolparasites have brought the modular intentions of the H-type school towards the 21st century by giving insight into the alteration nature of schools over time and point to the temporary portacabin as an example of a solution for a permanent problem. (Kempinga et al., 2004, p. 81) A problem that needs a more permanent solution by using qualitative temporary spaces.

The Schoolparasites created a series of temporary, demountable classrooms that could be relocated throughout the neighborhood to offer that much needed extra space for schools. One of the organizers of the project, Wilma Kempinga writes in OASE journal #72 that the project has fallen forgotten despite the positive reactions. (Stuhlmacher et al., 2007) One of the primary reasons she cites is the discrepancy between aiming for the ideal scenario and pragmatic limitations of building schools as a civic affair, pragmatic limitations like finance, maintenance, and governmental regulations.

One of the primary reasons she cites is the discrepancy between aiming for the ideal scenario and pragmatic limitations of building schools as a civic affair, pragmatic limitations like finance, maintenance, and governmental regulations.



Figure 3 Schoolparasites, the flower - Barend Koolhaas ('Barend Koolhaas', n.d.)



Figure 4 Nantes School of Architecture by Lacaton & Vassal ('lacaton & vassal', n.d.)

Affordances

The theory about affordances was first introduced to me through the New Urban Questions lecture of Andrej Radman about linear vs. non-linear thinking. This led me to investigate the notion of affordances in more detail in the "The design of everyday things" written by Don Norman it is explained. (Norman, 2013, p. 11) Norman tells the reader that the term affordance refers to the relationship between an object and an user, an affordance is what action an user can perform with an object, i.e., Norman gives the example of a chair, which can be sat on, the chair "affords to be sat on", next to sitting, the chair can be moved by the user and so on. (Norman, 2013, p. 11)

Thinking through affordances in the design for school buildings can be useful to make them more adaptable through temporality, this can be achieved in several scales. Looking at the school as a whole; it is a library filled with potential affordances to be explored. Zooming in on the classroom it has a limited set of affordances compared to the school as a whole. On the scale of an object, for example, a pencil, the affordances are in grasp for students, i.e., what you can do with a pencil. This gradient of possibilities through the scale of the school is also subject to change with time. The uncertain contingency that is produced by time and through changing affordances is paradoxically also the most certain in the design of a school building.

This ambiguity should be embraced through the incorporation of temporary

spaces that offer a range of affordances. Spaces that can rapidly adapt to future alterations, together resulting in a school building that is a more organic entity instead of a timeless artifact. An organic entity that has the ability to offer appropriate spaces for education, because uncertainty has been embraced.

"School architecture is imbued with an air of timelessness, permanency and formal fixity. Yet the life of most schools is nowhere near so timeless and constant. The ideal of an appropriate and unchangeable school is a dream." - Wilma Kempinga (Stuhlmacher et al., 2007, p. 28)

In a recent publication of AplusT #50 about learning systems there is an excellent example that incorporates uncertainty in use. (a+t, 2018) Javies Mozas writes about the Nantes School of Architecture by Lacaton & Vassal quoting Herman Hertzberger about the architecture of Lacaton & Vassal as "a building in state of becoming". (a+t, 2018, p. 32)

"Wouldn't it be better to regard our buildings less as completed products and more as works in progress, where each final situation can represent the beginning of a following stage within a permanent situation of becoming." – Herman Hertzberger (Herman Hertzberger as cited in a+t, 2018, p. 32)

The school of Lacaton & Vassal is a framework of programmatic variations, which is modifiable over time. (a+t, 2018, p. 35) A school where usefulness is more

important than the outer appearance. One of the primary strategies to establish this, according to Mozas is that the design of the school building should transgress the established program, which leaves no room for evolution. (a+t, 2018, p. 35) Only by ignoring the tables that "correlate floor area and number of users". Increasing the space that ignores the program can the quality of the school building be increased over time. (a+t, 2018, p. 35)

This strategy for designing a school can be related to the design theory about affordances through consciously thinking about what the space can and cannot be used for and leave sufficient space for alterations that cannot be predicted at the time of its creation. The school is never finished and always expanding its affordances and simultaneously abandoning affordances that are not necessary anymore.

"Wouldn't it be better to regard our buildings less as completed products and more as works in progress, where each final situation can represent the beginning of a following stage within a permanent situation of becoming."

Conclusion

To summarize, we can point out several methods that have the opportunity to incorporate temporality in the design of school buildings. We can oversize, add modularity or see spaces as moveable and thus demountable spaces, and a combination of all of these. There are several advantages and challenges for each of these methods.

Oversize

Oversizing schools allows them to adapt to more future uses. One of the disadvantages of oversizing is the increased costs for maintenance and energy over time of primary use.

Modular

Modularity can work if it is done right, e.g., the Montessori school in Delft by Herman Hertzberger has been altered by the same architect over time to add more classrooms. (Hertzberger, Swaan, Brinkman, & Jackson, 2009) One of the major disadvantages is that modular buildings are caught up by technological advancements and that their modularity is referenced through only by their functional layout and materiality and not by technical standards that have been improved over time, or that have been altered by governmental regulations, or have been proven to be flawed over time.

Demountable and moveable

The Schoolparasites are an excellent example of demountable and thus moveable spaces. However, looking through the city, we can see countless examples of moveable spaces, markets on the squares are set up in a matter of hours, when the fair is arriving in the city, trucks filled with entertainment unload and create new spaces and activities not available before at that place. One of the major disadvantages of moving spaces is that their dimensions have to be adapted for travel and that the whole construction has to be designed to be demountable.

Combination

A combination of these methods is for example, the Luchtsingel by ZUS architects in Rotterdam Pompenburg. This elevated footpath that goes through buildings, over streets, and train tracks is designed to be modular, can be dismantled and placed somewhere else, and the surrounding site has an oversized feeling. This oversized feeling is achieved because the Luchtsingel connects several vacant sites that can accommodate a great variety of activities within themselves.

The time is now

The Dutch government has set the goal to build one million houses till 2030 in the Netherlands. (TU Delft, 2018) The accompanying schools for all these residences have the opportunity to be

better than their precedents, better in offering space for growth and shrinkage, better in offering space for contingency in affordances, and overall a more sustainable situation not only for the users but also for the climate.

We have to set aside the pragmatic governmental regulations and tend more towards an architecture based on idealism, by taking the notion of different building layers that have a diversity in lifespan and arranging these layers in such a way that we can achieve qualitative temporality in use and materiality. Either through oversizing, modularity, demountability, and movability, or a combination of these. There is an opportunity to achieve a better pedagogic environment that is ready to be explored and used by the future generations to prepare themselves for life.

This essay is a reference to the work of Stewart Brand, I want to emphasize its importance in this matter. By incorporating temporality as an important design constraint in the architecture of school buildings, we do not only improve the pedagogic properties of the spaces. We can improve the pedagogic capacity of the school building itself, creating schools that can adapt over time to the changing requirements, creating schools that learn.



Figure 5 The construction of the Luchtsingel - ZUS architects (ZUS Architects, n.d.)

Chapter 3

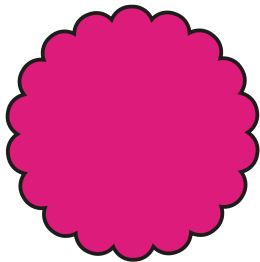
LEARNING SPACE OF THE 22ND CENTURY

Design brief

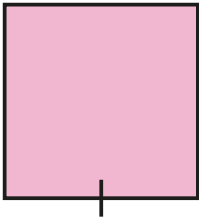
Learning space of the 22nd century

Out of which elements does the learning space of the 22nd century exist? School buildings consist of similar elements, i.e., spaces that are used for specific activities. Thinking about school buildings, we immediately think of classrooms. These can be classified as one of the element of a school building. In the learning space of the 22nd century, we can find various elements and together they can be arranged to create an ensemble.

Generic elements

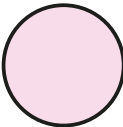


Playground
3000m²



Classroom
Per classroom 60m²

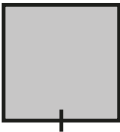
Reception
30m²



Toilets
300m²



Storage
300m²



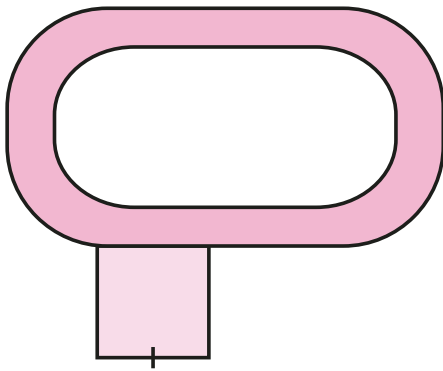
Infrastructure
5% of total m²



Facilities

These elements are more or less solid and give structure to the school but are flexible inside.

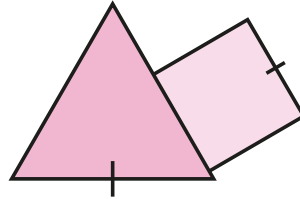
Specific elements



Sports

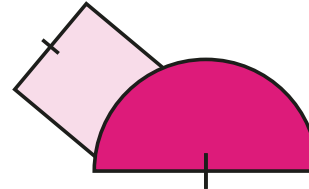
3200m²

(only the running track of the field)



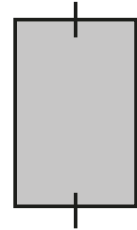
Workplace

1600m²



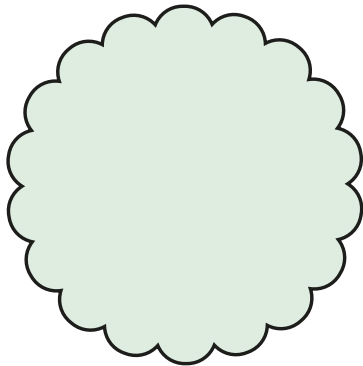
Theatre

2000m²



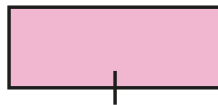
Laboratory

2000m²



Natural habitat

3000m²



Kitchen

300m²



Library

1200m²



Empty space

1200m²

These consist of solid and interchanging elements. The spaces within these elements are specifically constructed to experience certain phenomena.

The m² for the specific elements are taken from reference projects from Neufert 4th edition.

The elements explained

When thinking about a school, the generic elements are the ones many think of instantly. But the learning space of the 22nd century requires more elements to experience fluid education. Education becomes more specialized while growing up, and the school must accommodate new spaces to learn in a more specialized way. This accommodation of spaces is up to a certain level, until

the curriculum has become too specific that it is required for the student to go to either an applied science or university campus. For the pupils of the learning space of the 22nd century, four different pre-specialization directions are available. Each of these directions will require different specific elements to experience and learn about the various phenomena. Each direction requires a set % of

empty space for the changing curriculum. These are reservations of space that are filled up with temporary spaces where certain phenomena can be experienced. This could, for example, be an ice skating rink that is temporarily placed.

We can place all the generic and specific elements in a Venn diagram to see which elements are used by which pre-specialization directions.

All pre-specialization directions also use a lot of the same elements within the building.

Generic elements

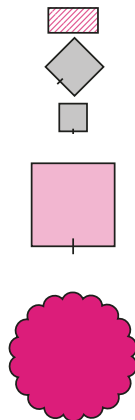
5% infrastructure

Storage

Toilets

Classroom

Playground



Specific elements

Empty, reserved for changing curriculum

Library

Kitchen

Laboratory

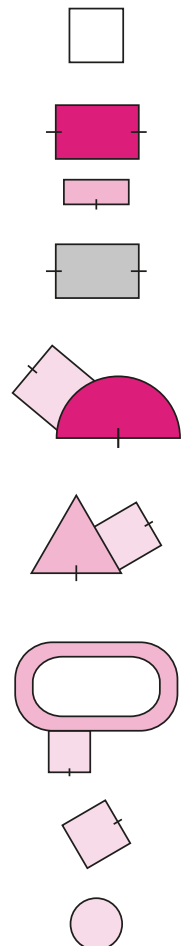
Theatre

Workshop

Sports

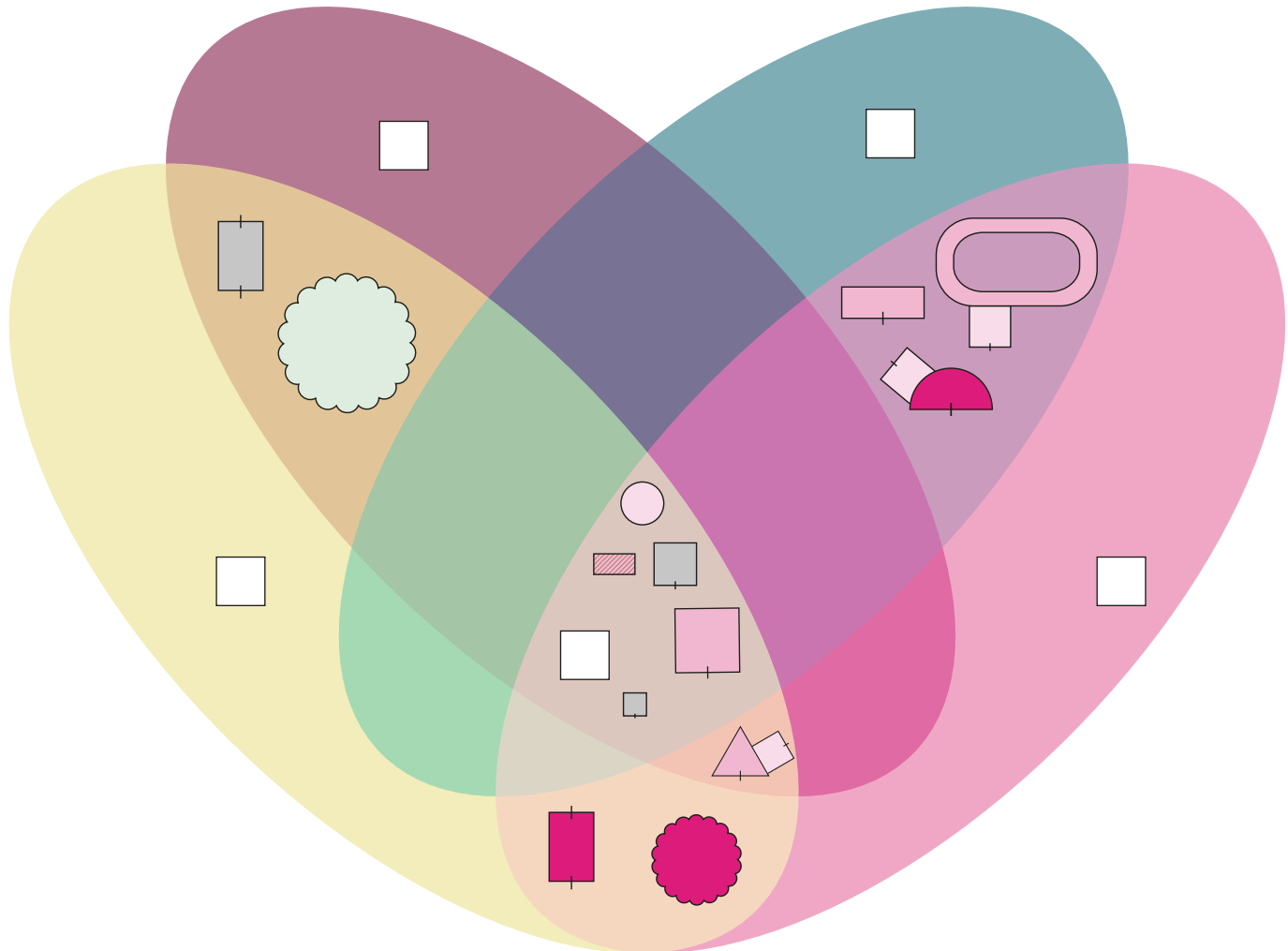
Dressing room

Reception



Nature and biology

Economy and society



Nature and technique

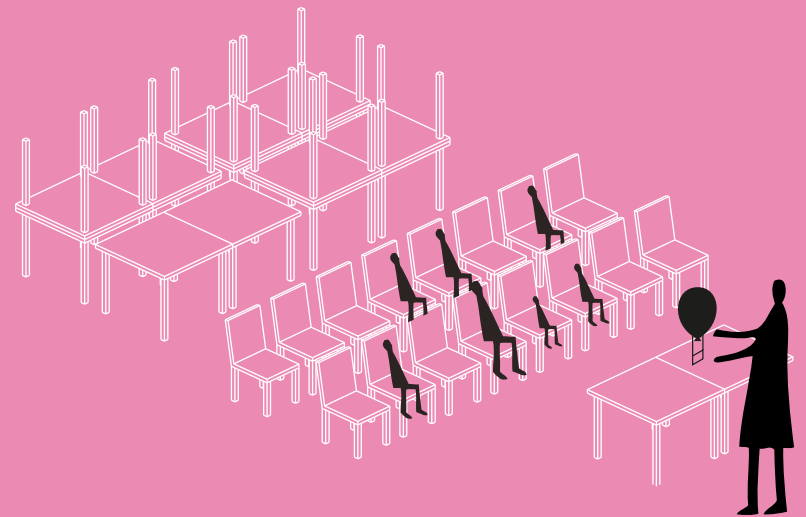
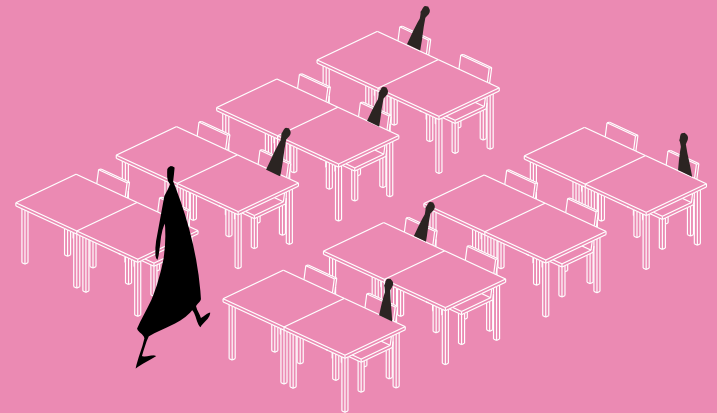
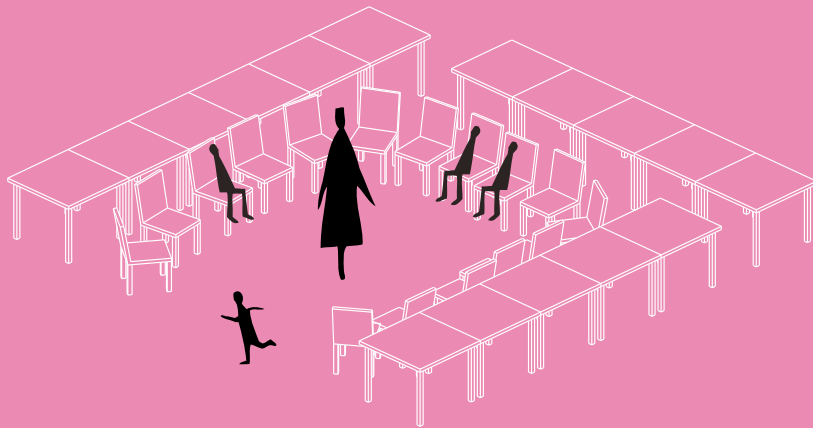
Society and culture

Specific elements





Classrooms



The classroom is an essential space in the school. The class is the place where students can retreat from the communal spaces and focus on individual work. But the classroom is not only for individual work, it will also be used to work in groups with your class and it will be used for all sorts of social

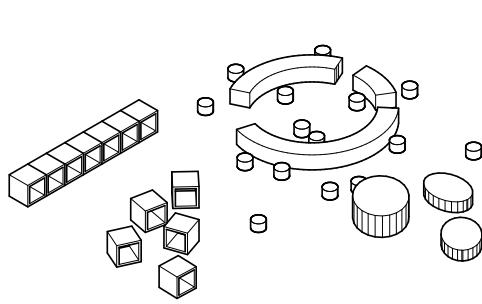
gatherings, e.g. birthdays, presentations and for example experiencing phenomena that do not require specific elements.

There have been experiments in the Netherlands to get rid of the classroom in favor of one big open space. These

experiments resulted in the return of classrooms, because of the limitations of an open space in regards to acoustics and climate control.

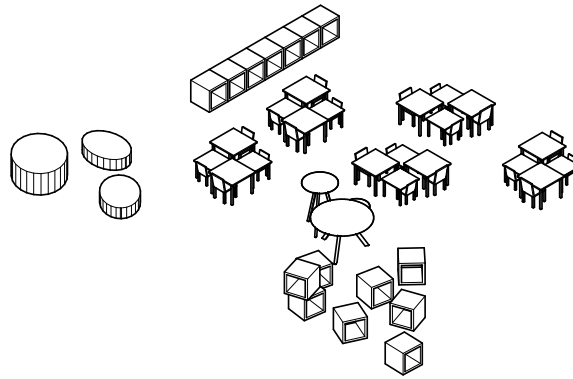
The classrooms in the learning space of the 22nd century will be of the same size, but the class size will decrease

while the students grow. Kindergarten (Landscape type A) pupils will be with 40 in the same space as pre-specialization students (Specific type F), who are with 15 students in the classroom.



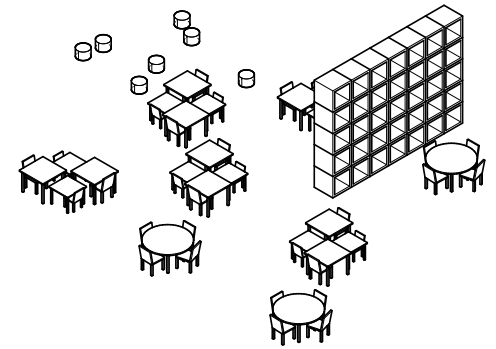
Landscape

age: 0-4



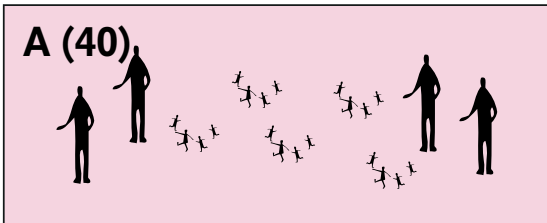
Generic

age: 4-6



Generic

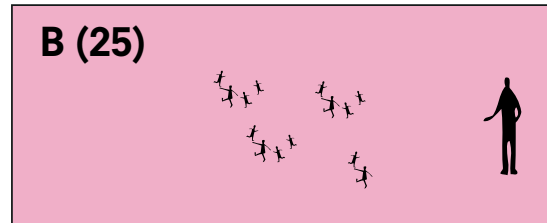
age: 6-9



Represents

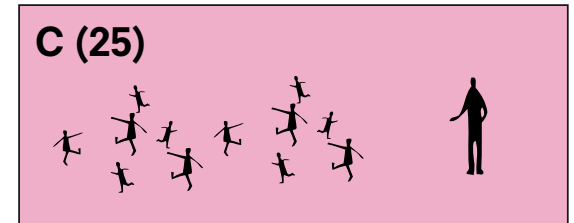
Kindergarten

40 students 0-4 and 4 supervisors



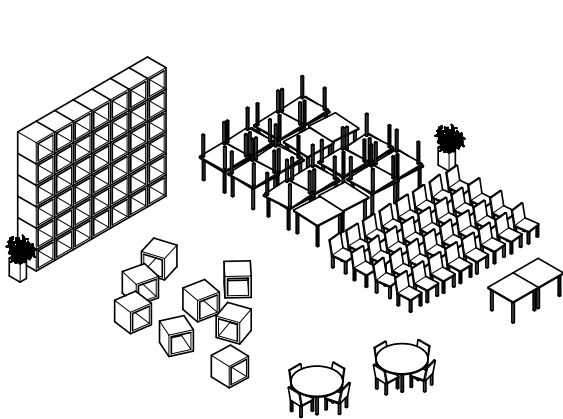
Elementary

25 students 4-6 and 1 supervisor



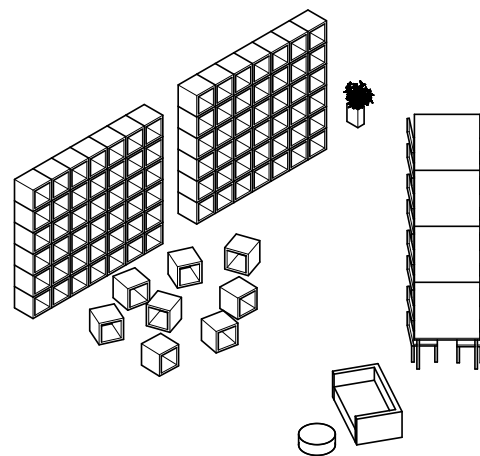
Elementary

25 students 6-9 and 1 supervisor



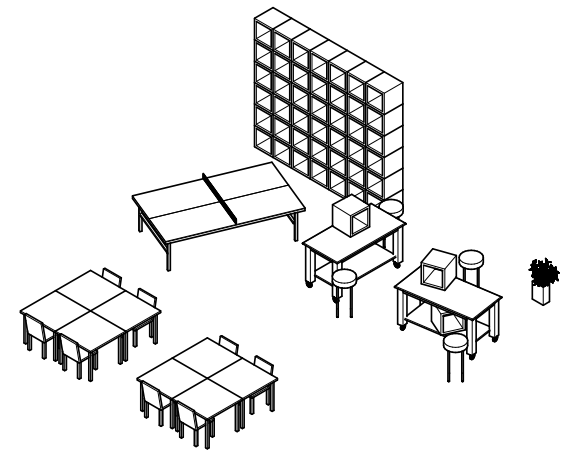
Generic+

age: 9-12



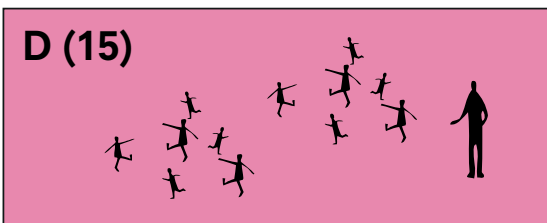
Generic+

age: 12-15



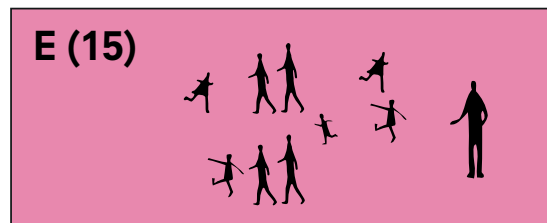
Specific

age: 15-18+



Elementary

15 students 9-12 and 1 supervisor



Secondary

15 students 12-15 and 1 supervisor



Secondary:Specialization

15 students 15-18+ and 1 supervisor

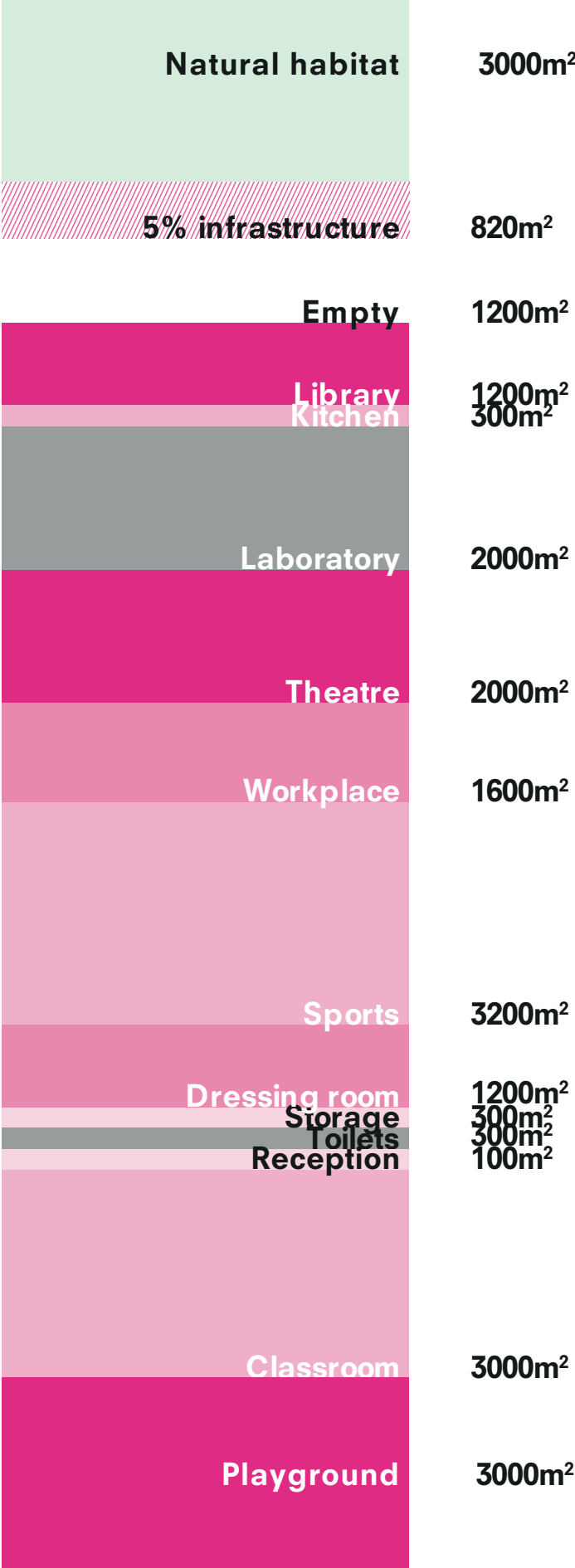
Program bar

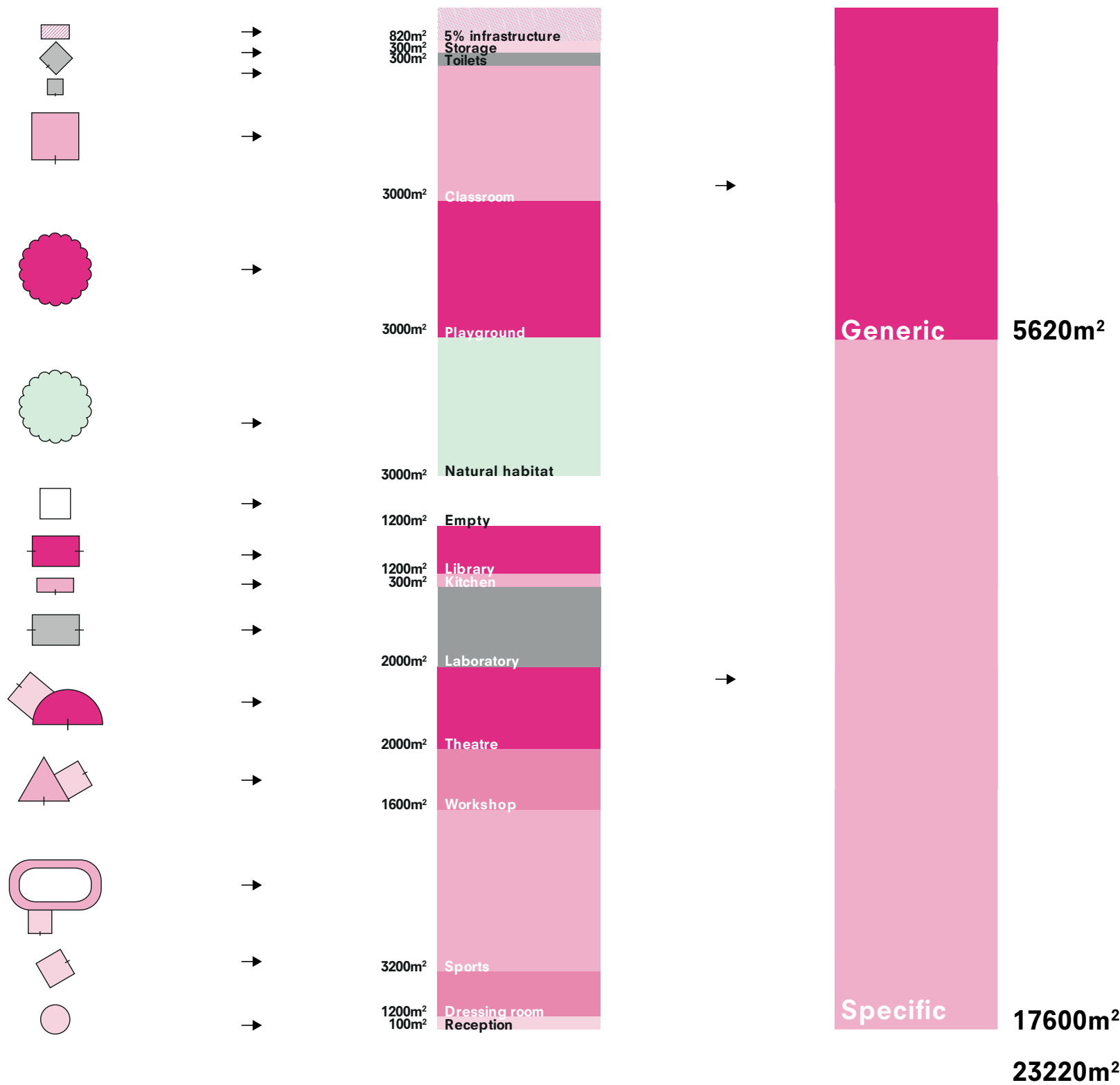
Out of quantitative research into m² schools in the Netherlands, I have concluded that the learning space of the 22nd century will house a total of 1000 students.

Each of the six phases of the education on the school will house around 150-200 students. Because all students will stay at the same school for their compulsory education, this level has to remain stable; otherwise, the school will exceed the 1000 students.

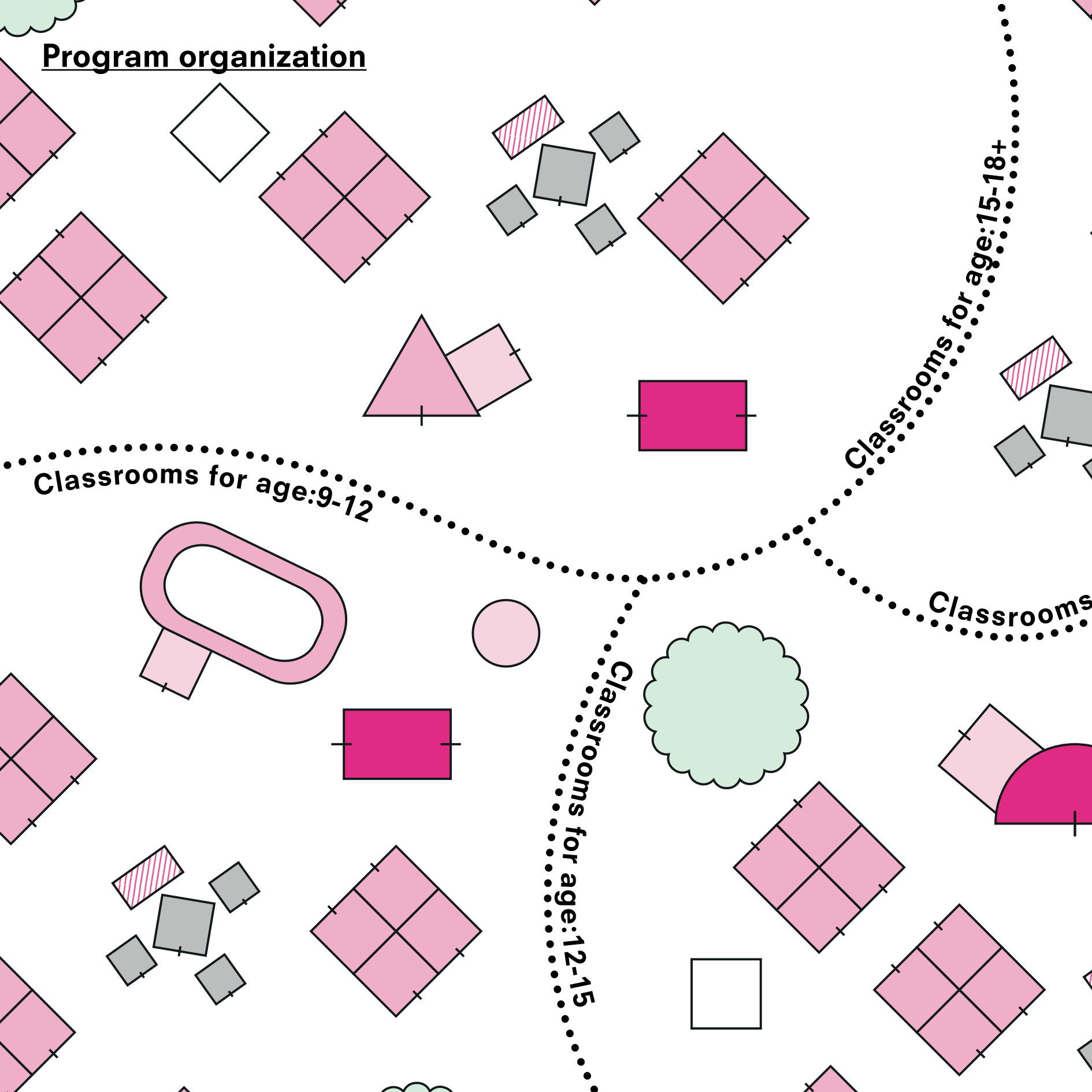
If the learning space of the 22nd century houses 1000 students, we need 60 classrooms.

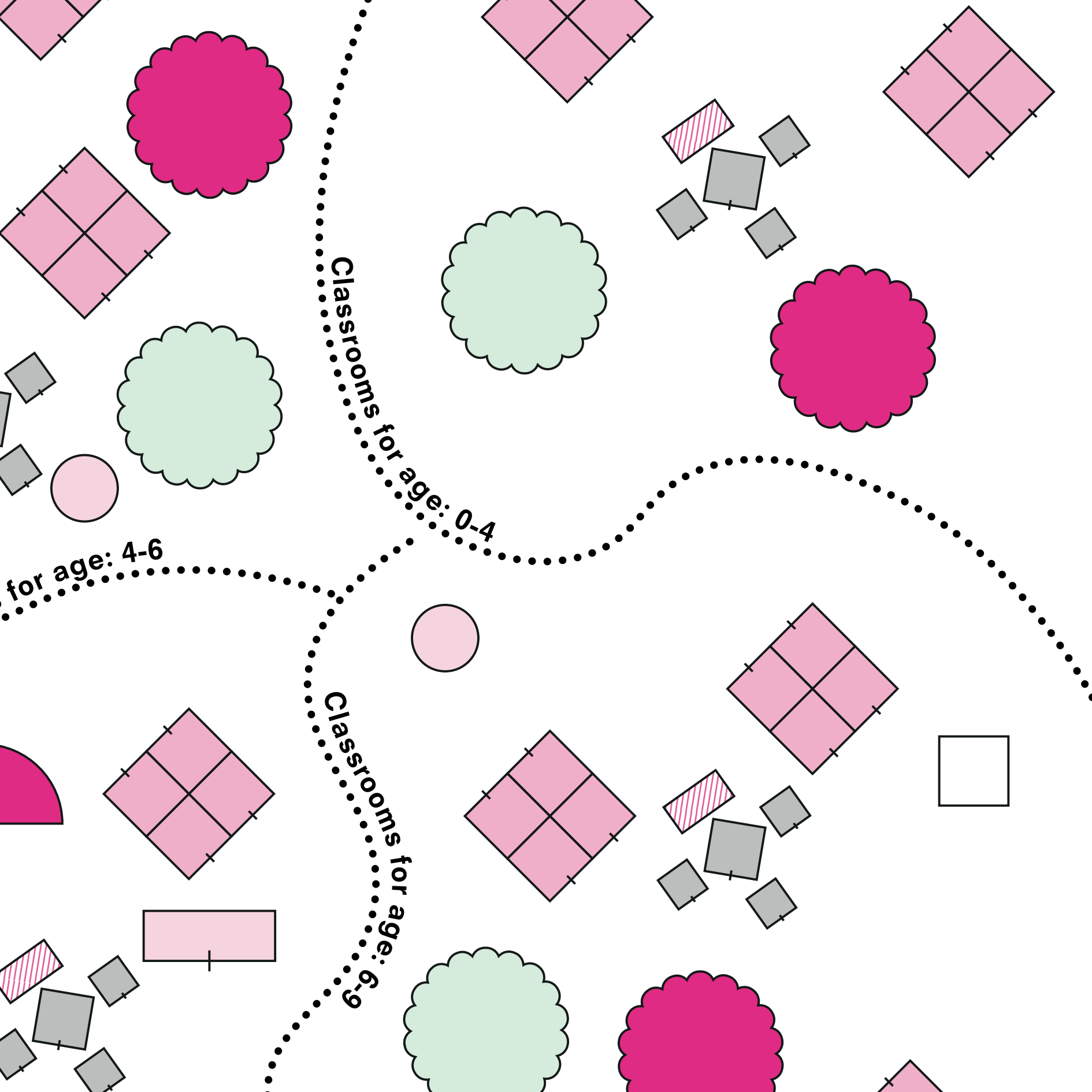
Dutch regulations in 2019 mandate schools to have 3,5m²-14m² of space per student, covering the whole school¹. Ranging from primary schools to secondary schools. The learning space of the 22nd century will have 23220m². This means there is around 23m² of space per student, covering the whole school.





Program organization





Classrooms for age: 0-4

for age: 4-6

Classrooms for age: 6-9

**An optimal learning
space**

**Dichotomy of permanent
and temporary**

Schools that learn

**Materials and
construction reflect the
ideals**

Architectural ambition

A learning space for fluid education

“If there is one place where architecture can be of significance, it is in the school building.”

- Herman Hertzberger

We have conducted our research and laid out our goals of what the learning space of the 22nd century should be. Now it is time to define how. The architectural ambition is the theoretical substantiation of the project. Through showing examples of precedents, we can create a framework to validate design decisions made. The architectural ambition is subdivided into four categories: an optimal learning space, dichotomy of permanent and temporary, schools that learn and materials and construction reflect the ideals.



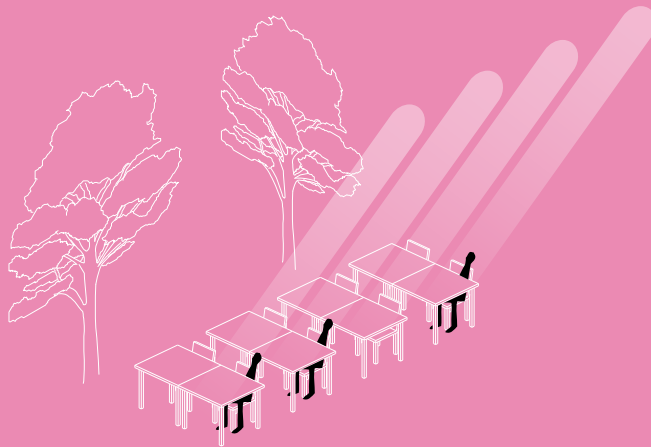
Functional needs as a basis

The learning space of the 22nd century should meet some basic requirements to make it possible for the rest of the building to function on a high standard. These are requirements concerning the location of the school and spaces for individual work i.e., classrooms that are exclusive to certain classes.

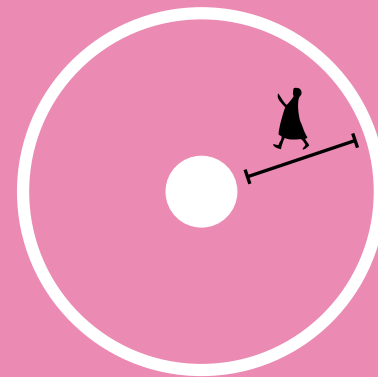
We also need communal spaces that can make the building function as a social condenser. Lastly, the school should grow alongside the students. Younger students have classrooms near or on the ground floor, while older students have their facilities more on the top elevations of the building.



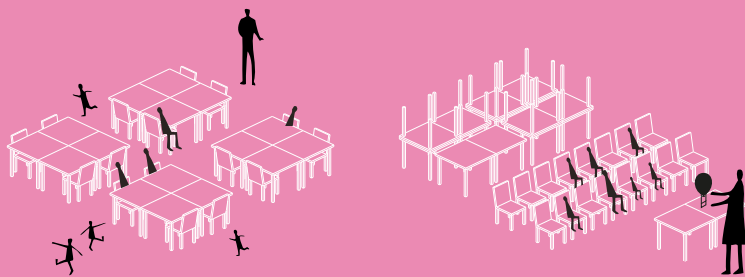
Communal spaces for meeting others



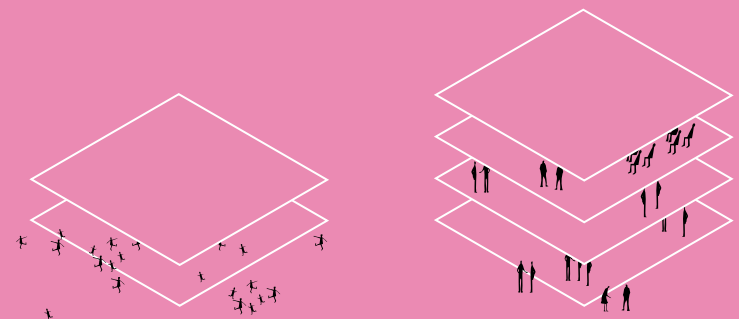
Good interior climate



Walking distance from home



Classrooms for structure and privacy



0-12

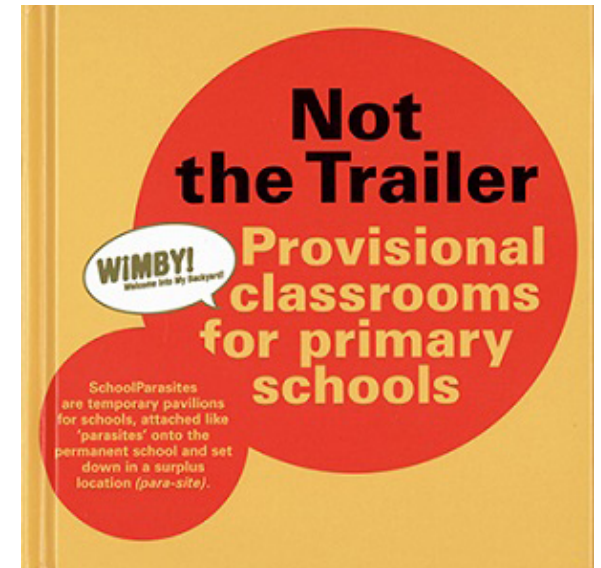
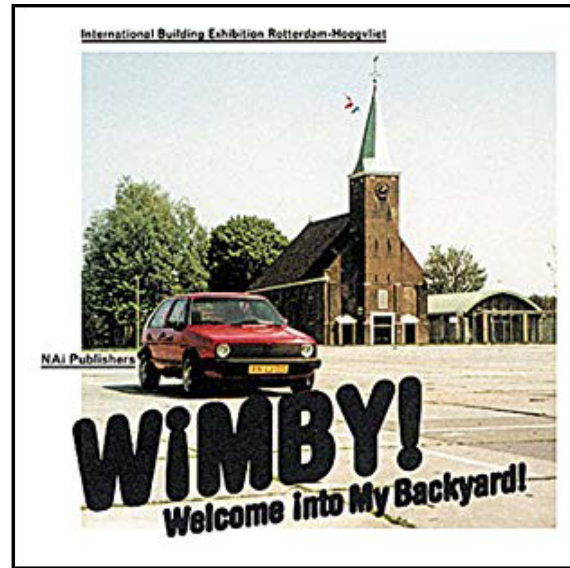
12+

The school grows alongside the students



Qualitative temporary classrooms

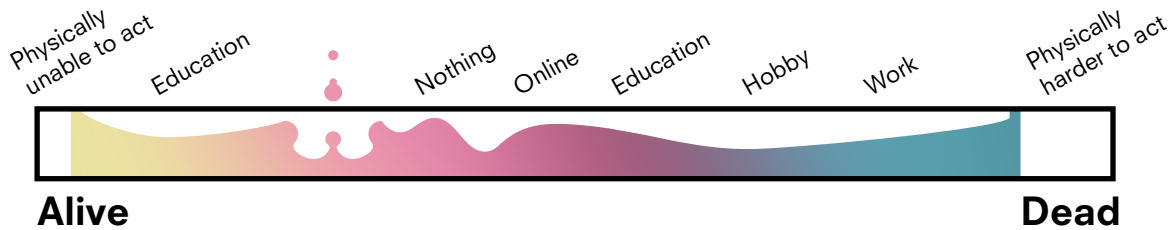
Rotterdam-Hoogvliet is a post-war neighborhood; within the neighborhood there are some post-war school buildings that do not meet the functional requirements of contemporary education. Instead of demolishing the schools, the Schoolparasites movement suggested to create good temporary classrooms, that expand the existing schools. Within the design of these classrooms, demountability was an important design constraint. Through demountability the classrooms could be dislocated and be used by different schools when they needed extra space or facilities.



Part of the WiMBY! International Building Exhibition in Rotterdam-Hoogvliet was the Schoolparasites movement. Pictured above are the two publications on the research conducted back then.

“School architecture is imbued with an air of timelessness, permanency and formal fixity. Yet the life of most schools is nowhere near so timeless and constant. The ideal of an appropriate and unchangeable school is a dream.”

- Schoolparasites



We need to rethink how our buildings are conceived

If our life becomes fluid, then we need an environment that can facilitate uncertainty. Buildings are by nature more or less permanent; we do not construct them to move them around much. If our school buildings right now are as permanent as monuments and we want them to be more fluid, should we then construct our buildings more like festivals? Spaces that are created to be temporary and demountable. Both sides of this dichotomy offer their advantages and disadvantages, what if we could combine them? What if we could create a building that is conceived as a gradient of temporality, a building where we can allocate quality to spaces according to the activities that take place after its initial construction.

“Wouldn’t it be better to regard our buildings less as completed products and more as works in progress, where each final situation can represent the beginning of a following stage within a permanent situation of becoming.”

-Herman Hertzberger



Permanent



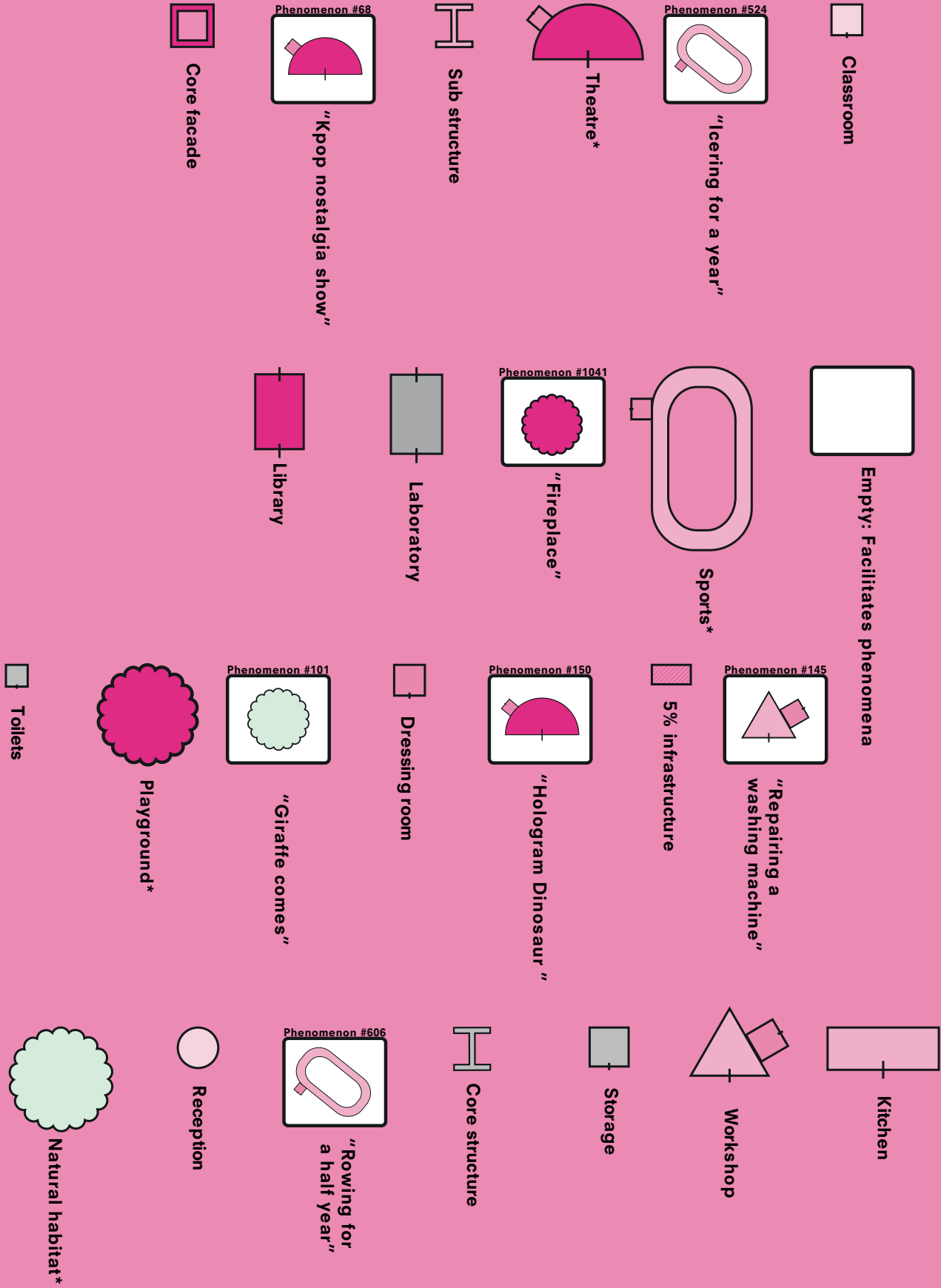
Temporary



Gradients of temporality

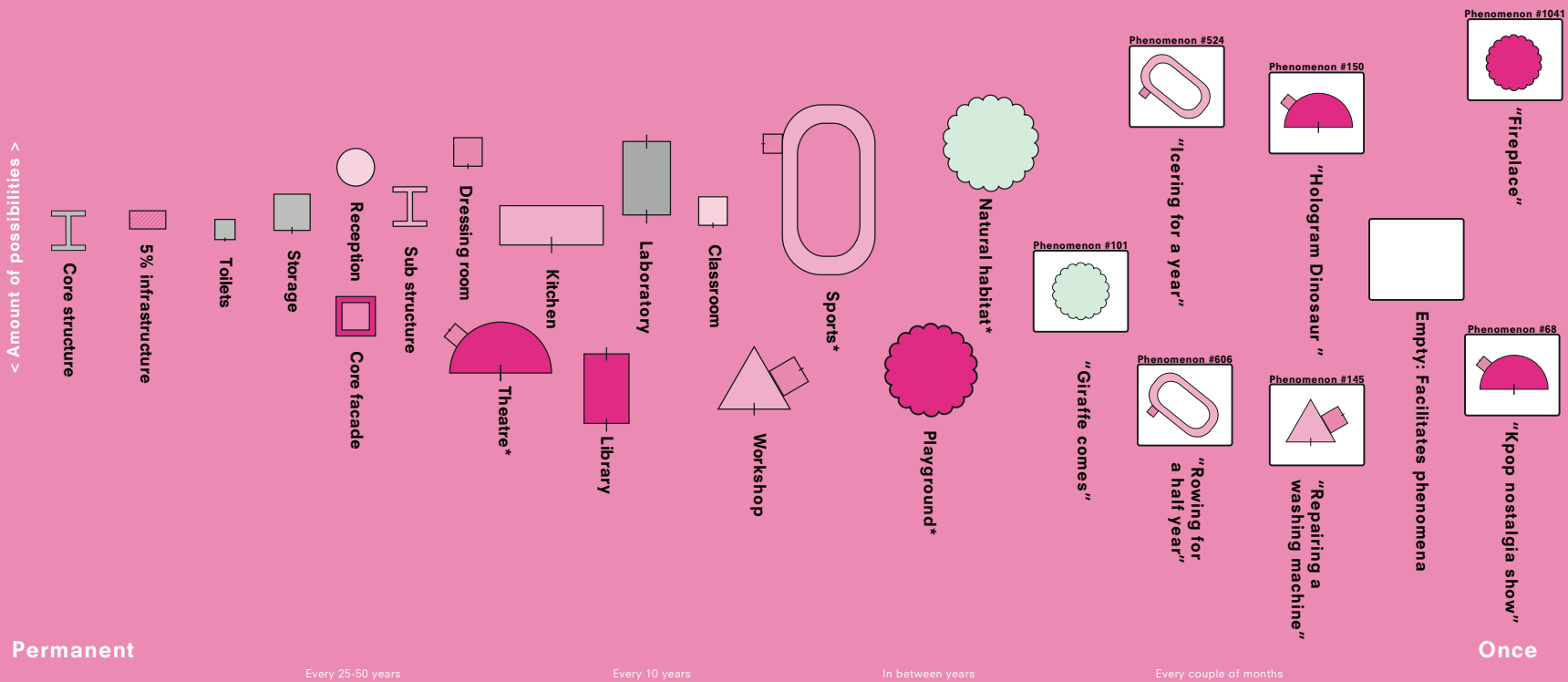
A matrix of spatial elements, construction elements and events

All materials, spaces, and activities within the building should be indexed, including the possibilities of materials, spaces, and activities that can be added in the future.

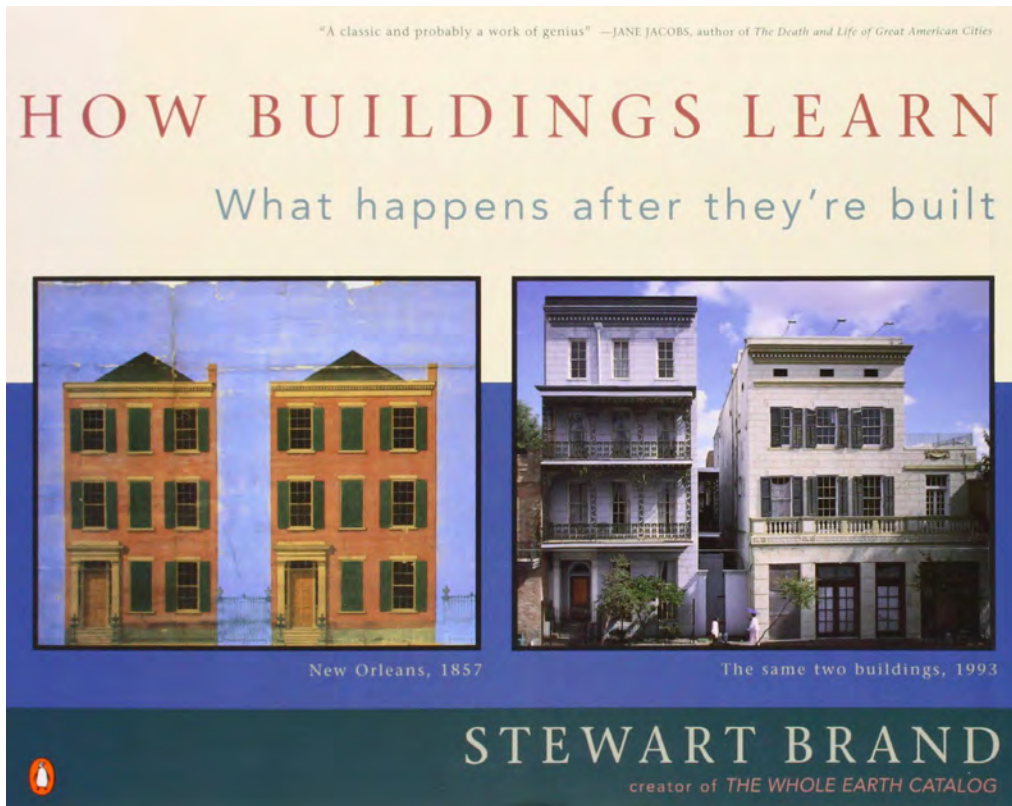


Categorize the building according to the temporariness of its elements

If we take all materials, spaces, and activities we can classify them according to how temporary they are. Some structures in the building will be permanent, meaning being there for always. Other activities or events only take place once.



< Spaces and activities on a scale of how temporary they are >



A building that learns and adapts

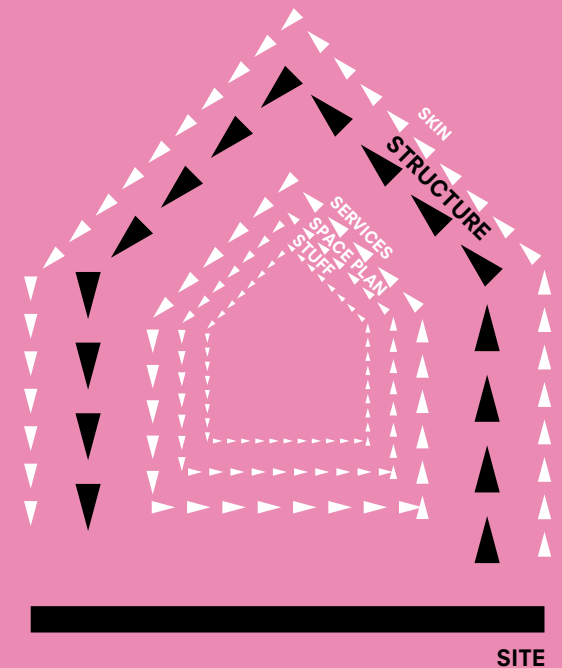
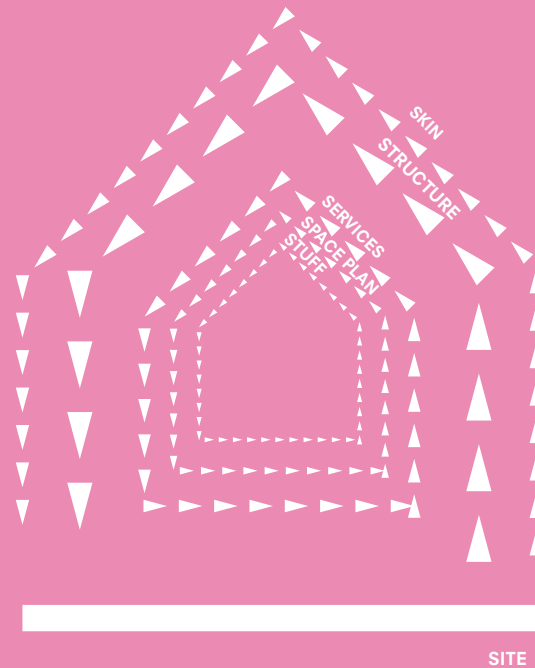
If we categorize our building according to the temporariness of its elements, we are creating a building that has the ability to adapt. The need for buildings to be adaptable is the subject of research within the work of Stewart Brand. Brand believes that we need to create buildings that can learn over time because that is the way how buildings function. The problem he states, is that the design of most buildings are not adaptable and that this has to change.

"Almost no buildings adapt well. They're designed not to adapt; also budgeted and financed not to, constructed not to, administered not to, maintained not to, regulated and taxed not to, even remodeled not to. But all buildings (except monuments) adapt anyway, however poorly, because the usages in and around them are changing constantly."

- Stewart Brand

The lifespan of a building

Steward Brand categorizes the building into six elements; he states that the elements of the building have a different "lifespan". The structure and the site of the building have the longest lifespan and are, therefore the limiting factor in the ability to adapt over time. The structure and site have to be chosen carefully to make a building that can learn over time.



“How to combine permanent and temporary, growth and shrinkage? Schools are by nature changeable, yet we would also like them to be permanent and recognizable. Is it possible for both of these principles to be expressed in the design?”

- Schoolparasites

Framework for variation

An example of a carefully chosen structure can be found in the work of Lacaton & Vassal on the Nantes School of Architecture. Within a modular rectangle grid the program has been sub-divided into permanent functions and changeable program. The permanent spaces can be adjusted/increased in size by taking space from the changeable program.





Making adaptability possible

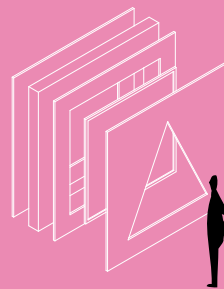
To make a building that can adapt and learn we need to incorporate the notions of modularity, demountability, and circular construction within the building. A modular construction relies on a repetitive sequence of the same size or multitudes of the same size.

To make it possible for the building to be moved to other locations they have to be transported. Therefore, some elements have to be demountable. Other elements last for decades but may run out of use through unforeseen changes in the future.

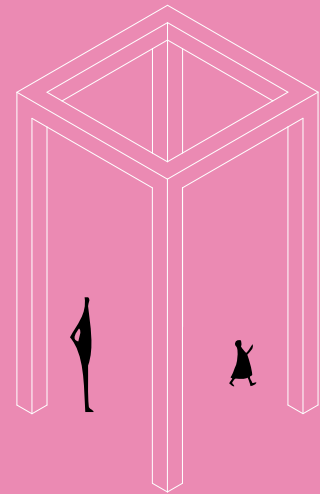
Therefore almost all elements must be created to be used in other buildings beyond school buildings. By making construction elements a bit oversized it increases the future possibilities of the material. Oversizing is a paradoxical benefit towards creating a circular building.



Modular



Demountable



Circular

The construction and materials communicate their temporariness

If we take the matrix of temporariness of elements, we can classify their construction and materiality according to the temporariness of the elements. Permanent elements should have a high-end finish while spaces that change every five years should be modular build, being able to change over time according to the needs of the building.

> Amount of possibilities <



Core structure



5% infrastructure



Toilets



Storage



Reception



Core facade



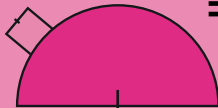
Sub structure



Dressing room



Kitchen



Theatre*



Library



Laboratory

High-end and permanent

Circular and semi-permanent

Used over longer periods of time built with circular economy in mind

Permanent

Every 25-50 years

Every 10 years

Modular

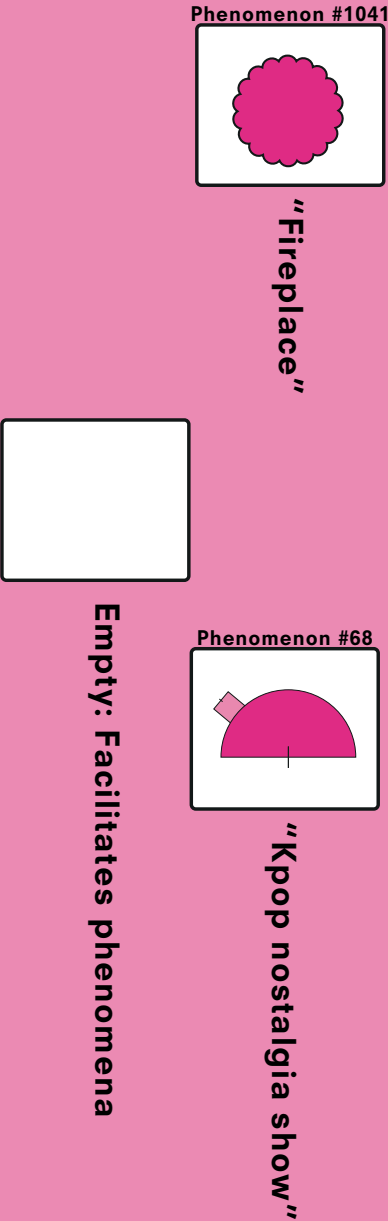
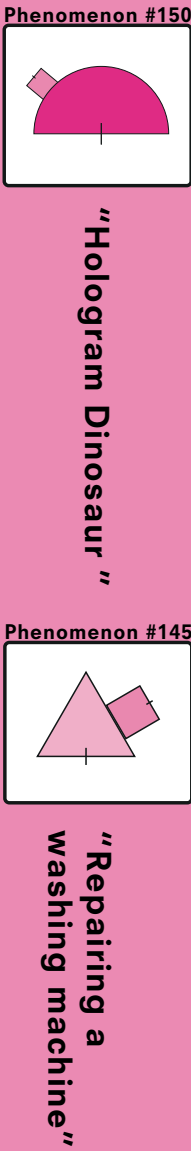
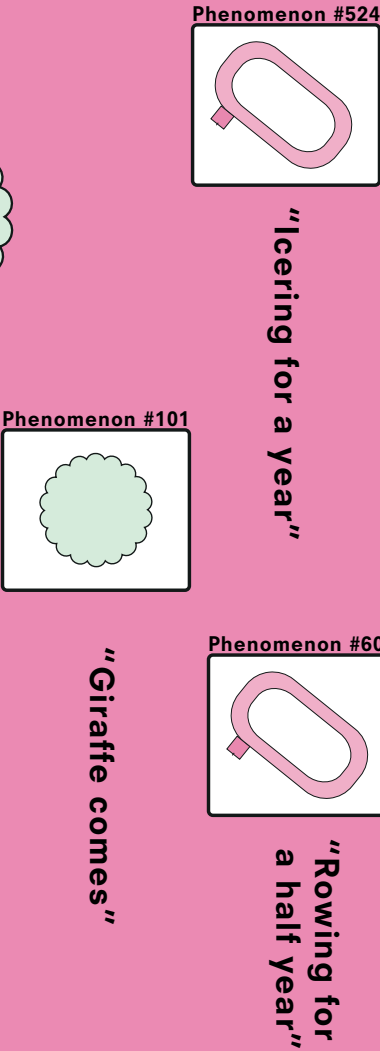
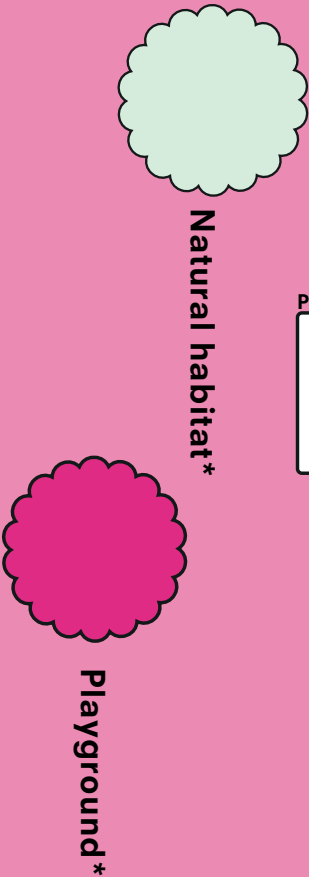
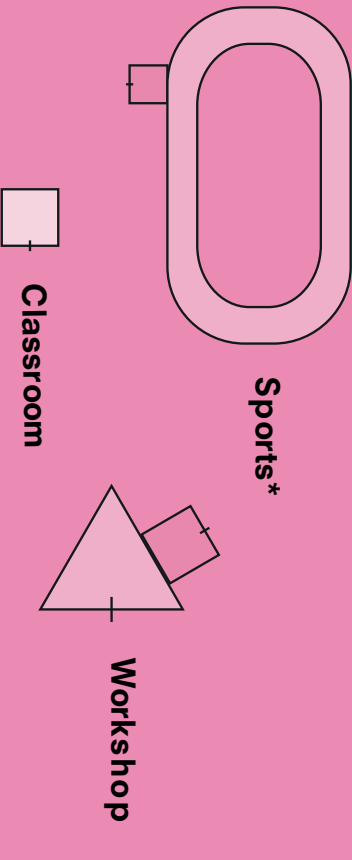
Structure can be moved and used throughout the building

Demountable

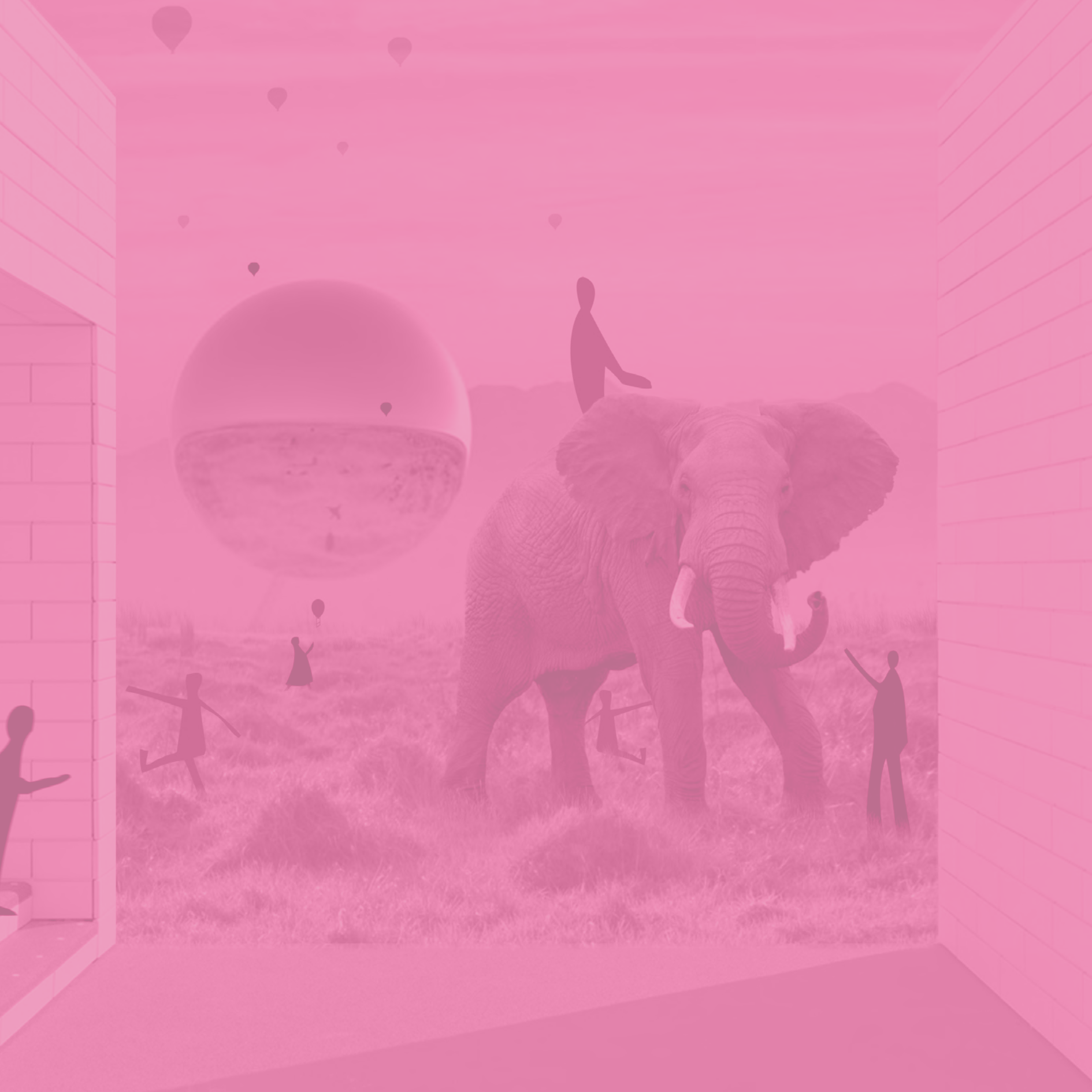
Spaces and stuff that are demountable and can be packed up and moved.

Using other spaces

Spaces and stuff that need other spaces, e.g. changing curriculum and events



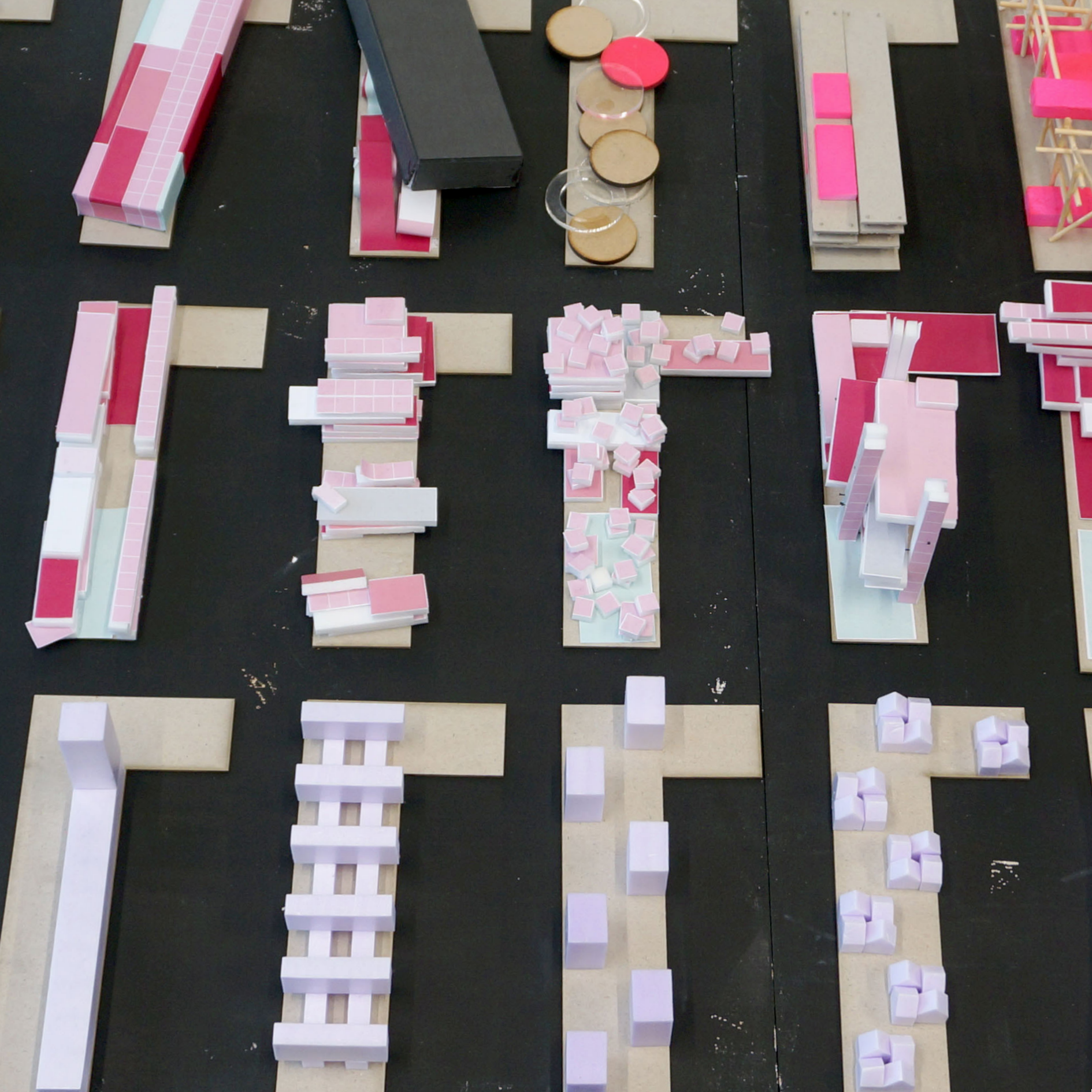
Once



Concept

What could the learning space of the 22nd century be?

The design process was commenced by creating a concept for the building. A guiding theme for the building helps to conceive the design on an abstract level. The starting point for creating a concept was the creation of a series of concept models through research and a personal fascination. These provisional concepts have been developed further into the guiding theme of the project.



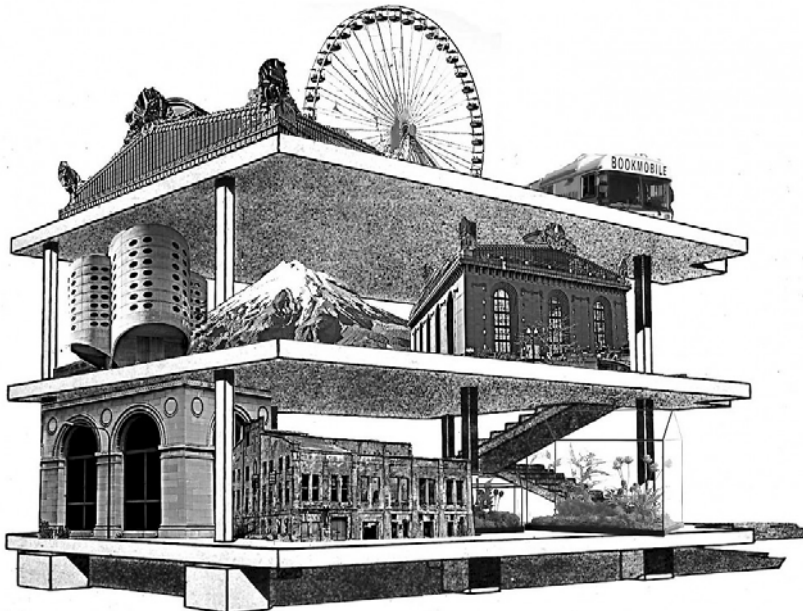


Shelving racks

A framework of modular shelving racks on the scale of the building facilitates the placing and removal of different spaces over long periods. We can translate the notion of placing stuff into a shelving rack on the scale of spaces that can be inhabited by humans.

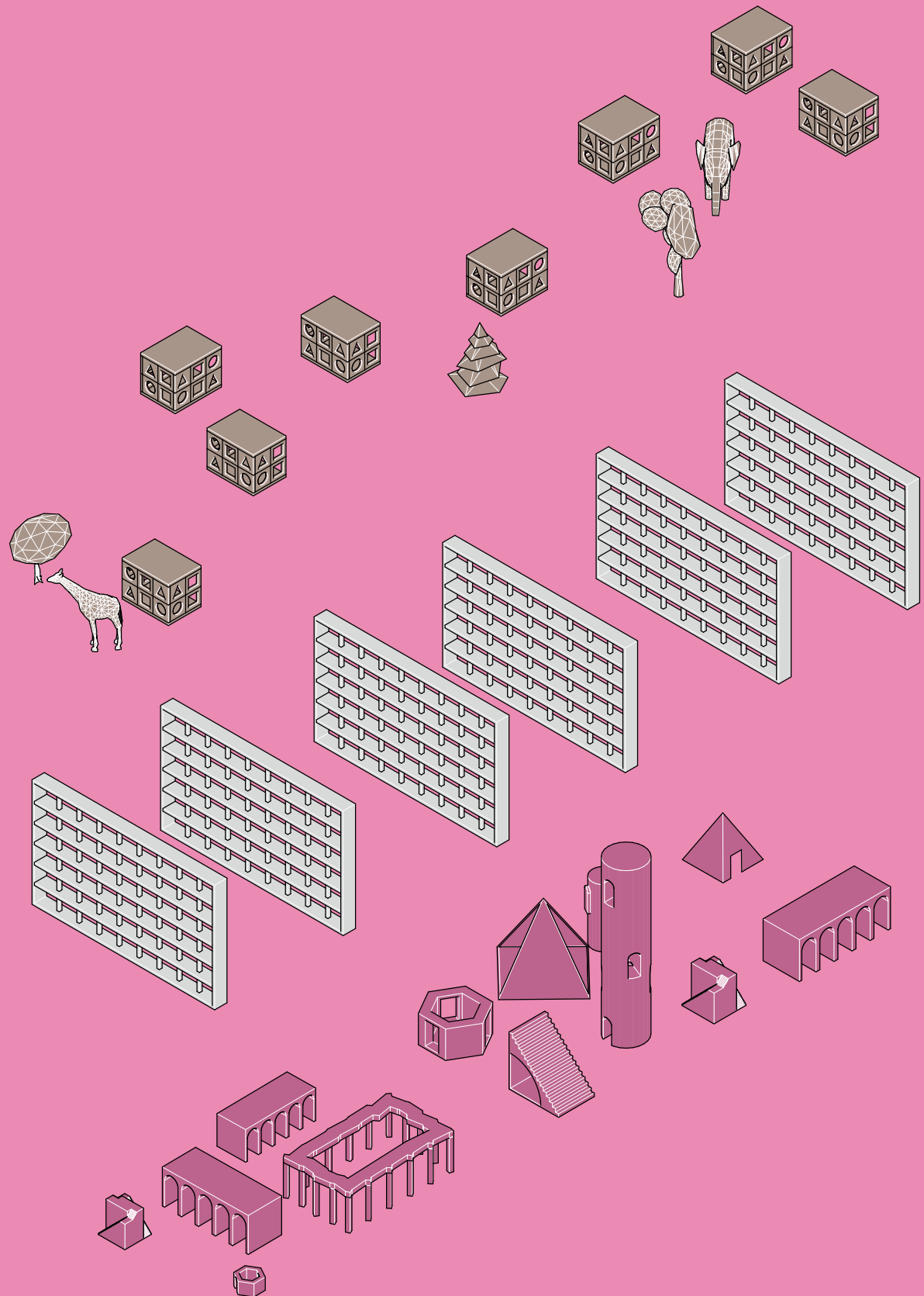
Order vs. chaos

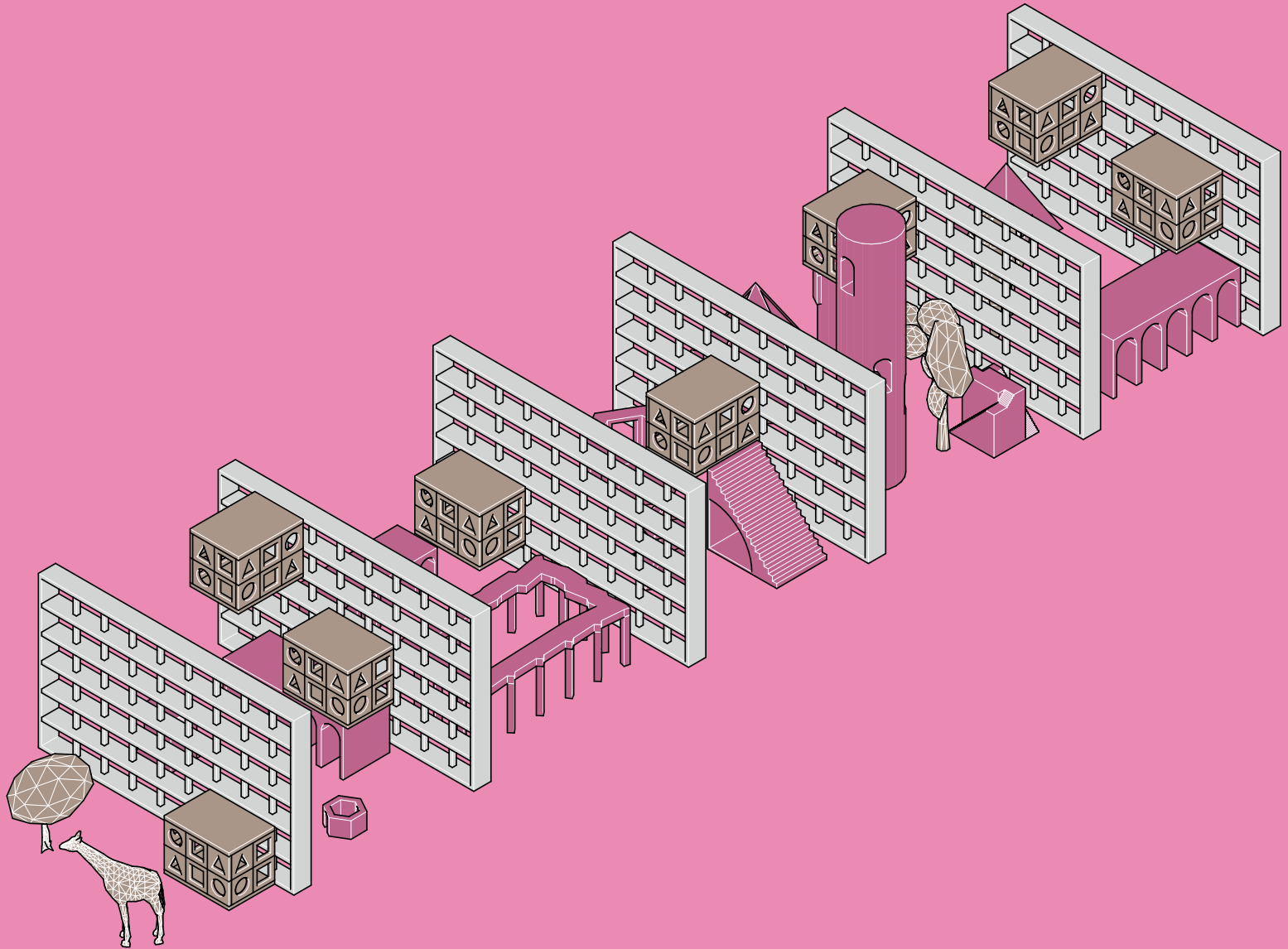
What if we create a building that is a series of ordering elements juxtaposed with chaotic elements. Their interdependent relationship strengthens the overall perception of the building.

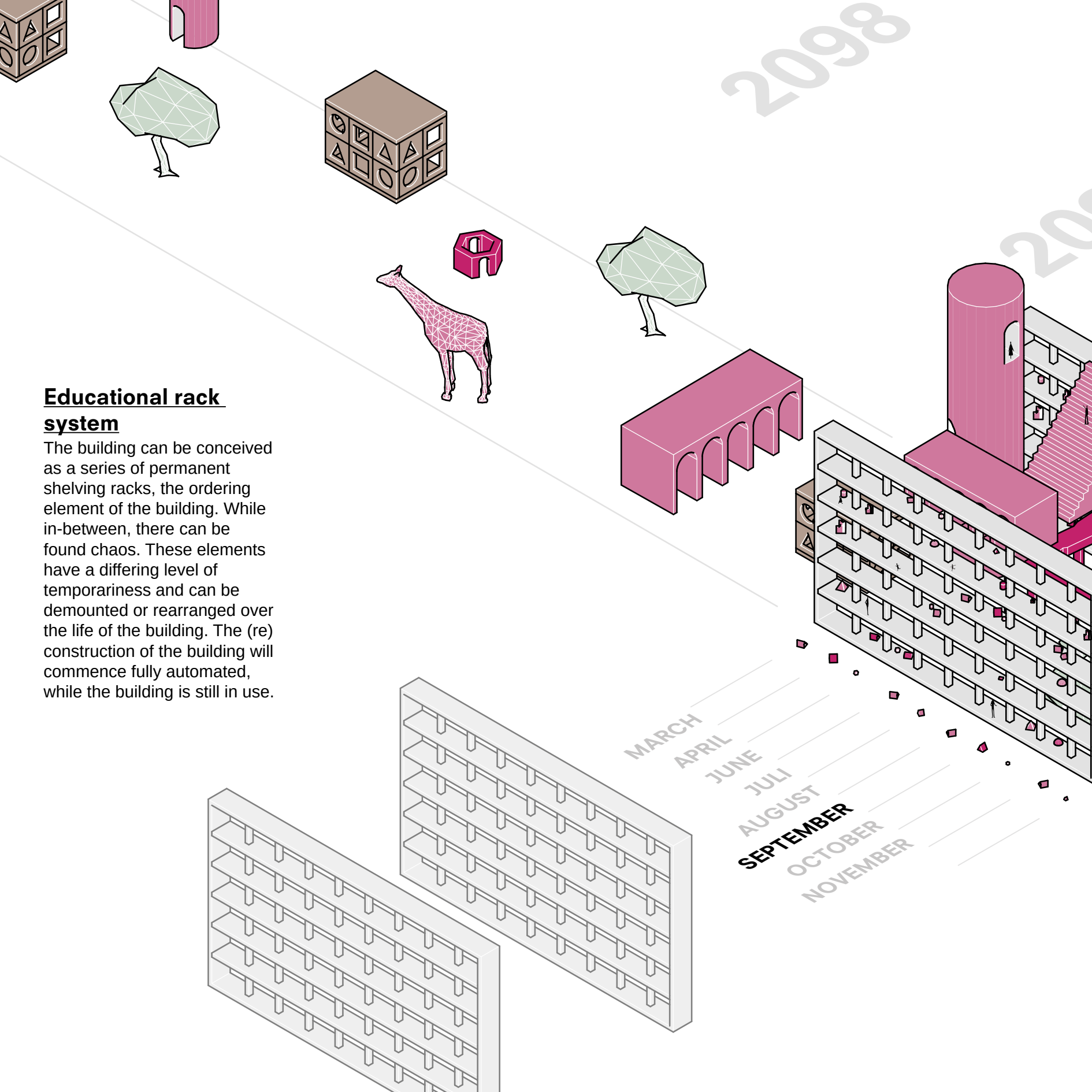


A stratification of different levels of temporariness

The building as a whole can be sub-categorized into three layers according to the matrix of temporariness that is defined for the project. There is a layer of permanent structures, these are the shelving racks. In-between there are two distinct layers. A layer of temporary elements that change every 1-5 years and a layer of semi-permanent elements that change every 5-50 years.

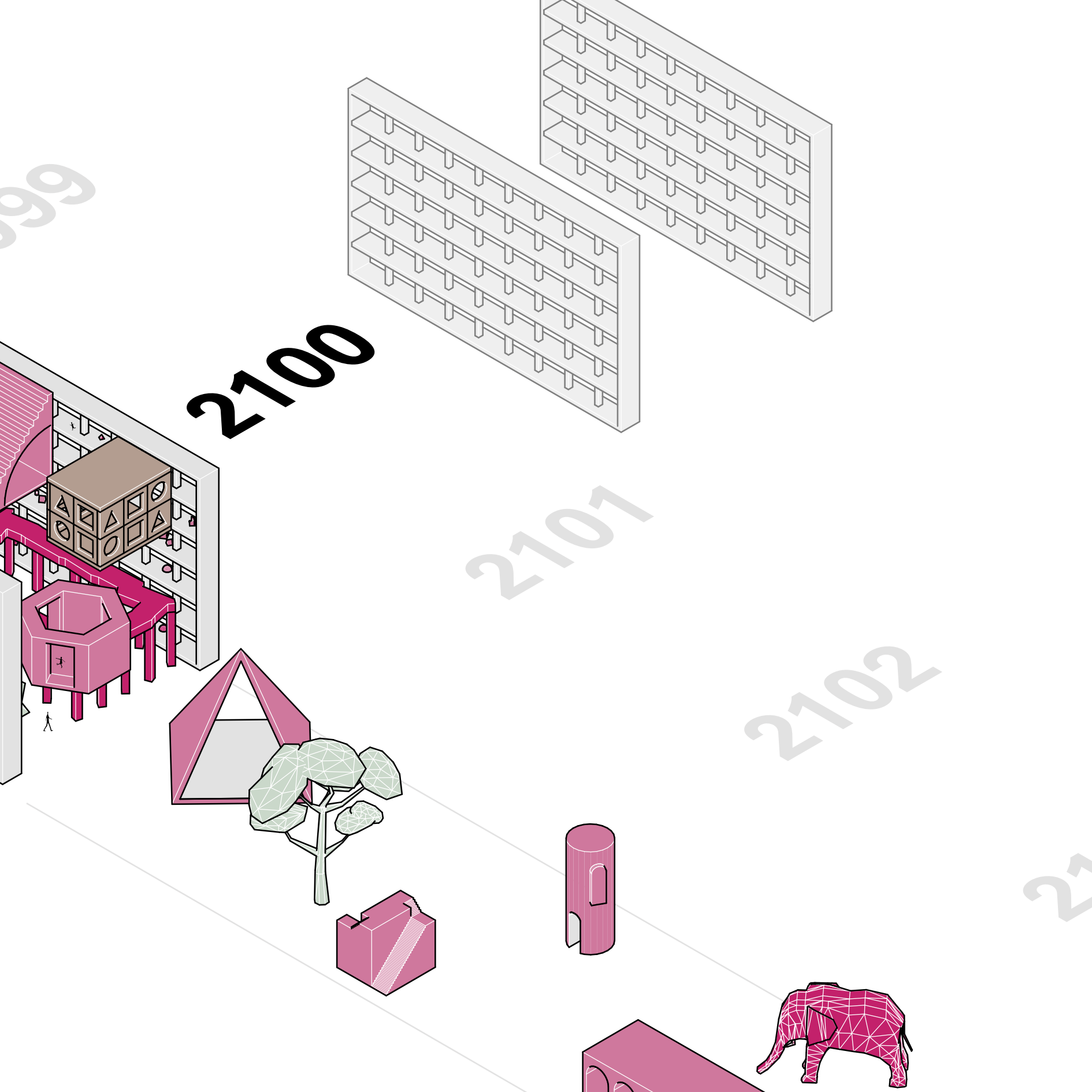






Educational rack system

The building can be conceived as a series of permanent shelving racks, the ordering element of the building. While in-between, there can be found chaos. These elements have a differing level of temporariness and can be demounted or rearranged over the life of the building. The (re) construction of the building will commence fully automated, while the building is still in use.



2100

2101

2102

21

Chapter 4

AMSTERDAM IN 2100



Essay: Boundaries of infrastructure

The open waterfront of Amsterdam

How did the open waterfront of Amsterdam develop, and what impact did technological advancements in the transportation of goods have on this development? Which opportunities and limitations do technological advancements give to specific physical locations, and what does this mean for the future development of the open waterfront of Amsterdam? To find an answer, we will look into the history of the transportation of goods, the history of the urban configuration of the open waterfront, and look at plans for the open waterfront that were never realized. This research will show the gradual development of the most crucial piece of Amsterdam through history. By distinguishing the interventions on the open waterfront of Amsterdam we can see how the different modes of transport are competing and cooperating with. How they are holding developments back and simultaneously creating space that can be used for large scale redevelopments. This paper shows how infrastructural works ultimately dictate how the city is shaped on a large scale and why it might be necessary to propose new large scale infrastructural works for the future of Amsterdam.

Introduction

“If a city has a memory, then the legacy of discarded infrastructural works forms an important part of that memory.” - Han Meyer (Meyer, Camp, & Pel, 1999, p. 9)

If discarded infrastructural works are part of the memory of the city, then the traditional Dutch port city has its memory intertwined through the whole urban configuration of the original city boundaries. Water is the main characteristic of the urban setting of the Dutch port city. In recent centuries, the relation of Amsterdam with the water has seen some dramatic changes which have their origin from the technological advances the world has seen from the 19th century onward.

So, if we say that discarded infrastructural works are part of the memory of the city, then the technological advances that are responsible for this discarding are the subject to research, to get a grasp on, how the urban configuration of Amsterdam can develop towards the future. Boats will take a central role in this paper since, from a historical standpoint, this has been the primary transportation vehicle used within the open waterfront. The research question is: how did the urban configuration of the open waterfront of Amsterdam change due to technological advances in transportation of goods and what opportunities and limitations do these changes have on the future development of the open waterfront? Basically, this paper tries to find an answer on how the open waterfront transformed from the painting of Jan ten Compe, created in 1752, towards the present-day situation we are all familiar with.



Figure 3 Open waterfront 1752 Jan ten Compe (Compe, 1752)

AMSTERDAM IN HET JAAR 2000
R. Das, 1967

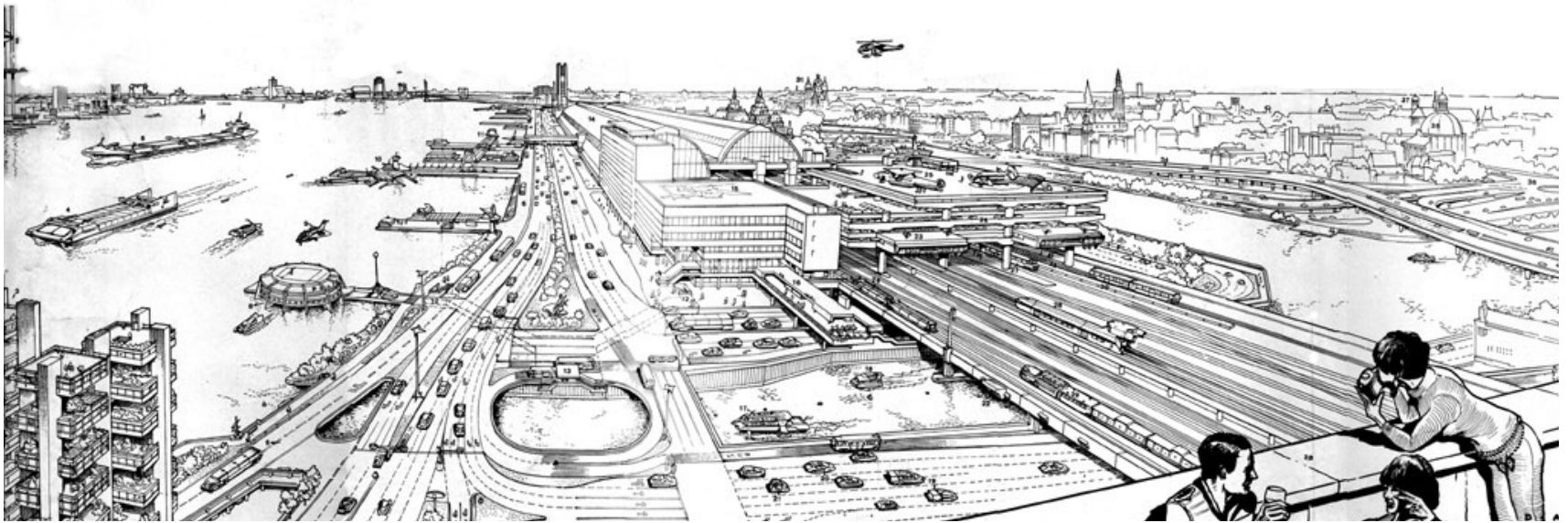


Figure 2 "Amsterdam in het jaar 2000" Das brothers (Das & Das, 1967)

Technological advancements

Transport of goods

Seen from a historic perspective water, has always been the preferred choice for the transport of goods for trade over long distances. The need to trade had two reasons: the overabundance of a specific good and the need for another good that you lack. Seen from the perspective of Holland in the middle ages, this would mean an overabundance of dairy and fish products and a lack of wine and beer or ingredients to brew beers. (Gilijamse, Bonke, Moes, Kurpershoek, & Misset, 2009, pp. 14–17) From the 14th century onward trade started within the boundaries of what we now call the Netherlands, vastly growing towards the boundaries of what we now call Europe. The focus of trading was on the Scandinavian countries and independent cities like Hamburg and Copenhagen. (Gilijamse et al., 2009, pp. 14–17)

These countries preferred to pay toll to the Dutch to travel in the relatively calm and safe waters of the Waddenzee, Zuiderzee and the inner rivers of the Netherlands compared to the dangerous North sea. (Gilijamse et al., 2009, p. 16) This transformed the small settlement of Amsterdam into a transit harbor between the north and the rest of Europe. The trade mentality got stuck with the Dutch, and not before long their trade routes had expanded over the whole earth. The VOC (Verenigde Oost-Indische Compagnie) can be seen as the paradigmatic example to resemble this “golden age” of the Netherlands.

The techniques used to make all trading possible have not seen much innovation

until the end of the 19th century. The use of water seems quite obvious since it is a relatively flat and overabundant medium where vehicles – read: boats- can transport large amounts of goods relatively fast over far distances. Nonetheless, the vehicles were limited by the size of the trees and undeveloped technological skills. These technical disadvantages in combination with the sometimes unsafe, and unpredictable weather – since wooden boats relied on wind to function - put limitations on the reliability, travel speed and cargo capacity of wooden boats. (Ham & Rijsenbrij, 2012, p. 2)

These limitations started to change with the introduction of steam engines at the beginning of the 19th century. The steam engine had several obvious advantages over traditional transport processes, but the most important difference was the possibility to implement steam engines both on the medium water and land. (Gilijamse et al., 2009, pp. 73–75)

**Seen from a historic
perspective water has always
been the preferred choice
for the transport of goods for
trade over long distances.**



Figure 4 Eerste stoomschip op het IJ, Pieter Gerardus van Os 1816 (Gilljamse et al., 2009, p. 74)

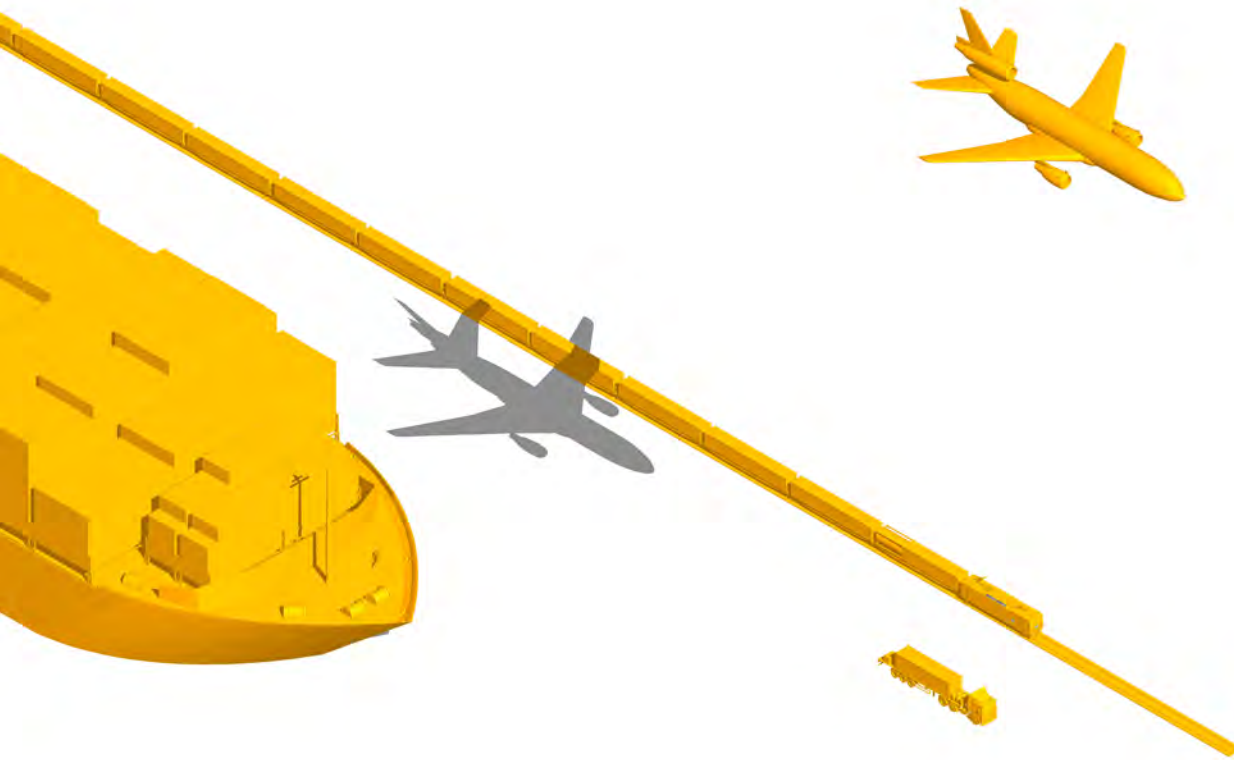


Figure 6 Four different types of transport vehicles, models from Google Sketchup 3D warehouse.

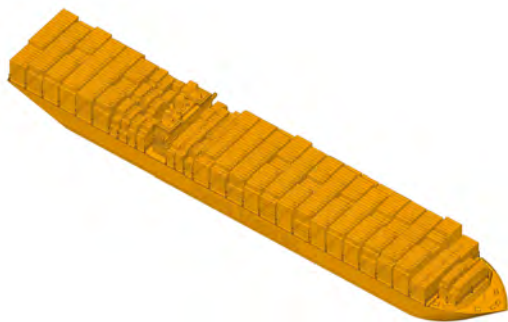
Industrialization

Steamboats made of metal started to take over the traditional wooden transport vessels slowly, and on land, the introduction of the railways has started to claim land. The traditional route to mainland Germany was over the Rhine, but with the introduction of the railway, a worthy alternative was constructed.

During the industrialization, technological advances were following up with each other at a rapid pace. The introduction of fossil fuel engines, especially diesel engines within the transport sector, has had a big impact on the reliability, travel speed, and cargo capacity of global trade

and transport. (Ham & Rijsenbrij, 2012, p. 2) The refinement of the fossil fuel engine would ultimately lead to the invention of the car and the airplane. These latter forms of vehicles for transport have only been matured after the Second World War, and their impact on the urban configuration of cities is unquestionable. The medium of the car is a smooth road and its travel speed can be improved by creating a specialized infrastructure that offers a safe environment for these speeds. The medium of the airplane is more flexible, over-abundant, and safe than water, yet the transition from air to land requires huge infrastructural interventions.

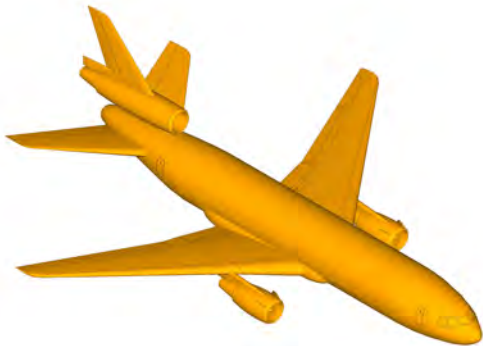
The continuous interaction between the price and speed of transport has made four distinct categories that take care of the transport of goods. Boats can transport gigantic amounts of goods, but they are much slower. Airplanes can deliver goods within a day all over the globe, yet the operating costs are high.



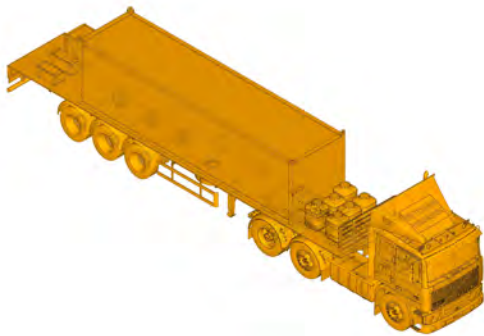
Ship	
Maximum TEU*	20000
Medium	Water
Short or long distance	Long
Price	+++
Speed	---



Train	
Maximum TEU*	592
Medium	Rail
Short or long distance	Long
Price	++
Speed	-



Airplane	
Maximum TEU*	4**
Medium	Air
Short or long distance	Long
Price	--
Speed	++



Truck	
Maximum TEU*	6
Medium	Land
Short or long distance	Short
Price	+
Speed	+

Figure 7 All images are based on models from Google Sketchup 3D warehouse. ("Longest trains," 2018; "Modes of Transportation," 2018; "OOCL Hong Kong," 2018) * TEU is explained under the section "Containerization"
** Has a different container standard, the total dimensions are comparable to 4 TEU.

Dimensions

The dimensions for ships have seen the most substantial shifts in the last century. If we look at how the size of ships has increased through the previous centuries, we might get a grasp on how large the transport sector is right now and what implications this has on the urban configuration of Amsterdam. One of the smallest inland boats used in Amsterdam from the 16th century onward is the trekschuit. About 8 meters in length, this ship could fit easily in the canals of the historic inner city of Amsterdam. The seaworthy ships of that time, e.g., the VOC ship t' Duyfken is about five times longer in length, which seems tiny compared to the HMS Victory from the 18th century which is almost four times longer at 94 meters in length. With the introduction of metal as construction material, ships would increase in size beyond comprehension. One of the largest cargo ships floating on the ocean right now is the Anna Maersk and measures 224 meters long, 28 times longer than a trekschuit.

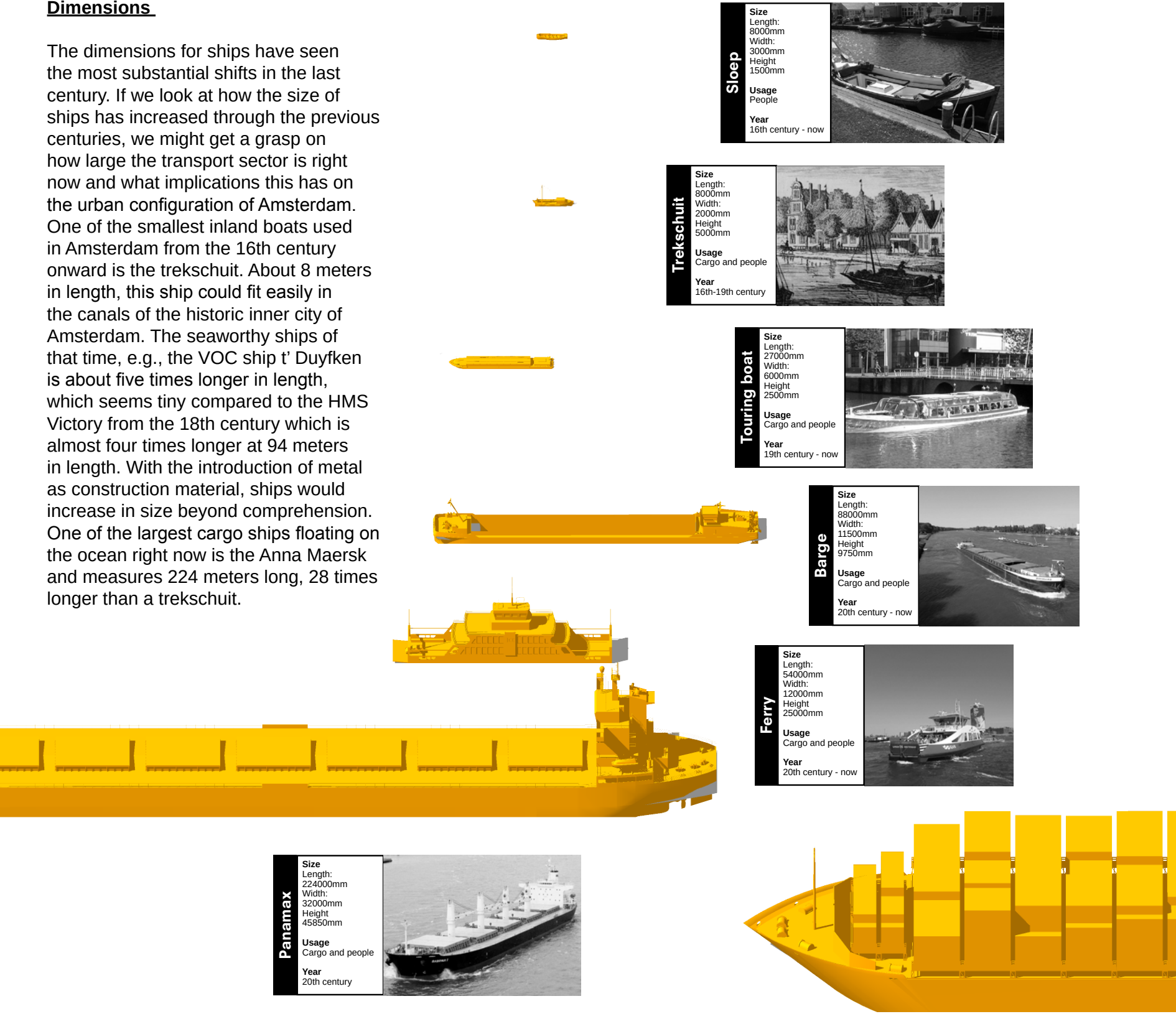
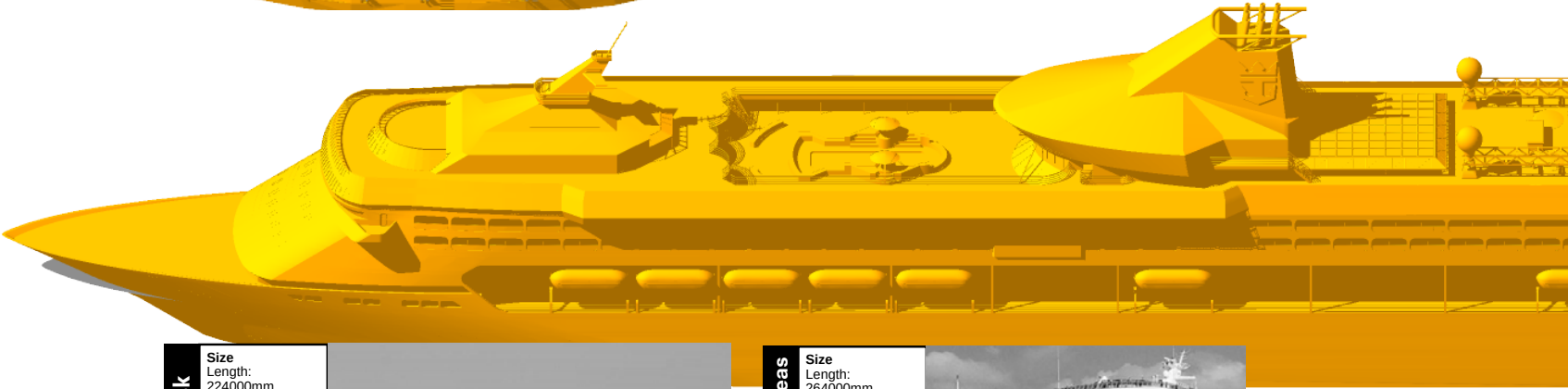
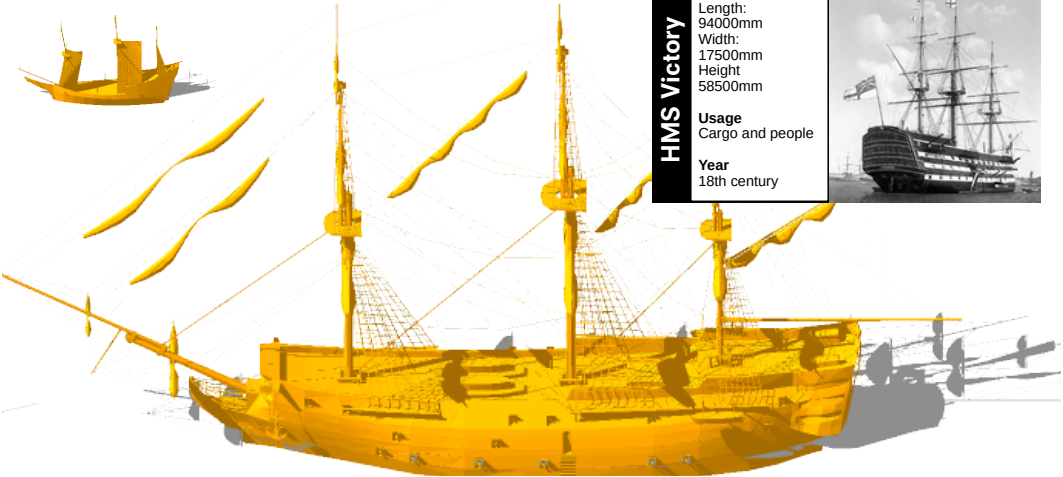
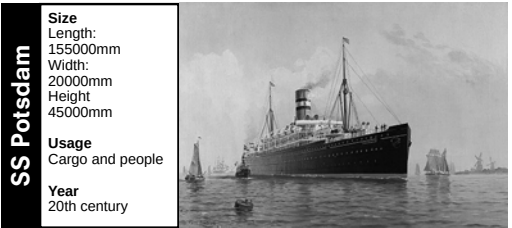
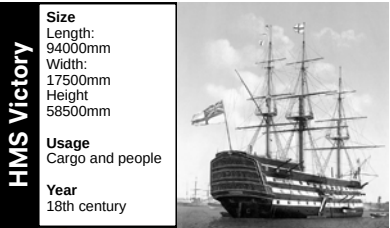
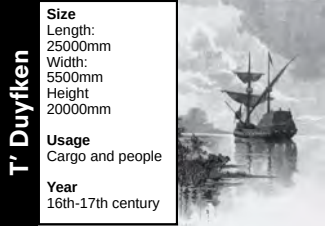


Figure 8 Models from Google Sketchup 3D warehouse. Images from Trekschuit ("Trekschuit," 2018), Sloop (Palmkvist Knudsen, 2004), T'Duyfken ("Duyfken (schip)," 2018), Potsdam ("SS Potsdam (1900)," 2018),Panamax ("Bulkcarrier," 2018),Legend of the seas (New Zealand Cruise Association, n.d.),Anna Maersk (Vesselfinder, n.d.), measur

Amsterdam in 2100 - Essay: Boundaries of infrastructure



Containerization

One of the most recent developments in the transportation process is the introduction of intermodal containers in the 1960s. (Meyer et al., 1999, pp. 46–47) Intermodal means that the type of vehicle changes during transport. The advantage of this type of container was that it could be transported by ocean-going vessels, inner-water vessels, trains, and trucks. (Ascher & Marech, 2005, p. 61) Using the advantages of each medium. A container was the ideal solution to speed up the transportation process. Transportation companies lost money when docked in harbor in the form of labour costs and harbor docking costs. For example, each bag of rice had to be unloaded separately and required different machinery. (Ascher & Marech, 2005, pp. 68–79) With the growing size of ships, the unloading process of goods could take a couple of days. (Gilijamse et al., 2009, pp. 245–246) With the introduction of the standard intermodal container, the unloading and loading time could be significantly reduced.

The introduction removed a lot of intermediate steps in the loading and unloading process of goods since they were sealed at the origin and unsealed at their destination. The standard container also reduced packaging costs, reduced chance of theft, and a reduced chance of damaged goods. (Gilijamse et al., 2009, p. 246) In return, a huge investment had to be made in the construction of containers, specialized equipment that has to be adjusted to the containers, machinery that handled the loading and unloading of ships, trains, and trucks. The vehicles had to be adjusted themselves as well. (Gilijamse et al., 2009, p. 246)

The size of containers is measured by

TEU (Twenty Foot Equivalent Unit), 1 TEU measures 20 foot long, 8 foot wide and 8,5 feet high, that is 6,10 meter long, 2,44 meter wide and 2,59 meter high. ("TEU," 2018) The most common intermodal container is actually 2 TEU in size.

Medium for infrastructure

Each technological advancement in the transportation process is related to a pragmatic or strategic notion to strive towards a higher efficiency in every step of the process. Nonetheless, the physical infrastructure puts more restrictions on some modes of transport than on others. Hence, the fact that there are no cargo trucks with the same dimensions as the largest cargo transporting vessels. Roads do not have the same flexibility that water has as a medium. These restrictions and limitations originate in part from the self-referring practice of standardization, which streamlines processes on a global scale but limits future growth in dimensions of the same process.

For example, due to the ever-increasing amount of cars and cargo trucks on the highways, the amount of traffic jams keeps going up. The medium cannot cope with the congestion, and vehicles become stuck. All over Europe, infrastructure is being built to give room for more vehicles or replace redundant infrastructure that was not designed to take the contemporary load. The collapse of several highway bridges in Europe this year shows what the dramatic result is of a medium that is unable to cope with the technological advancements in transportation. The bridge in Genoa that collapsed earlier this year was never designed to handle such traffic intensity and weight. (The economist, 2018).

Nonetheless, the physical infrastructure puts more restrictions on some modes of transport than on others. Hence, the fact that there are no cargo trucks with the same dimensions as the largest cargo transporting vessels. Roads do not have the same flexibility that water has as a medium. These restrictions and limitations originate in part from the self-referring practice of standardization which streamlines processes on a global scale but limits future growth in dimensions of the same process.

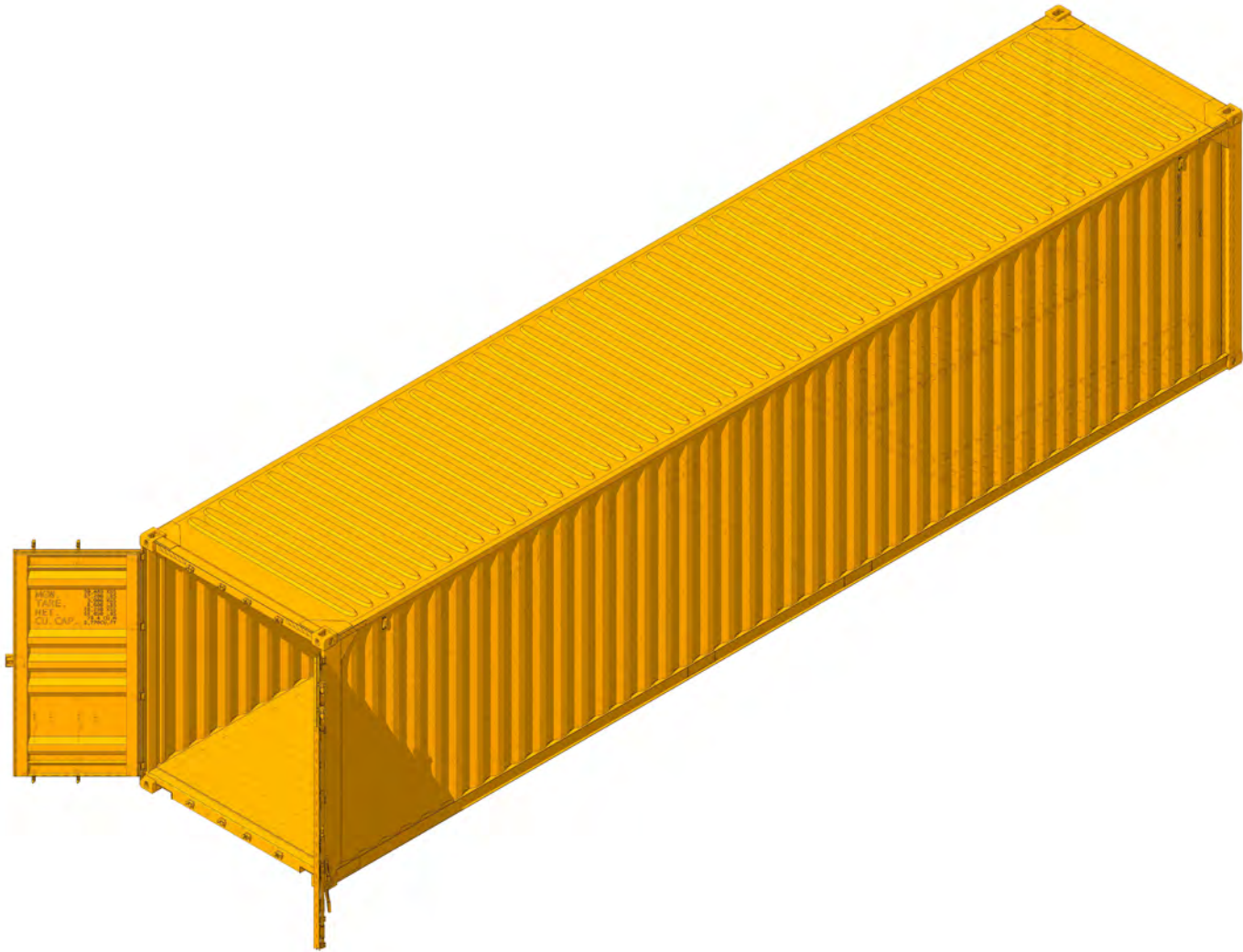
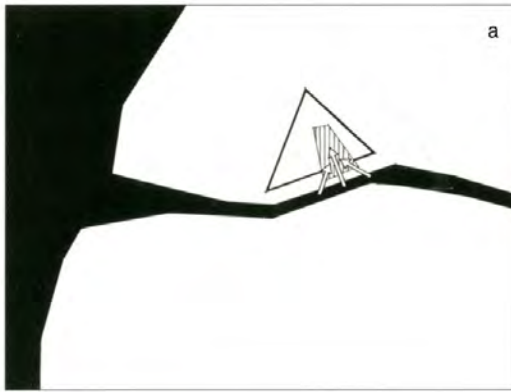
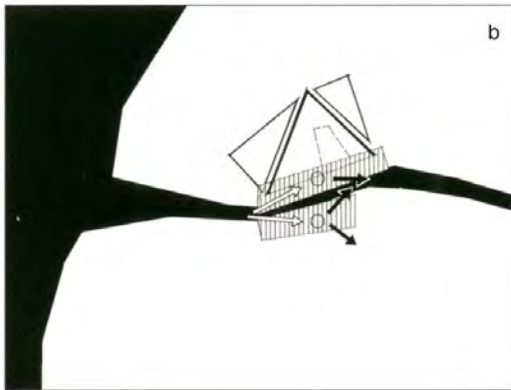


Figure 8, 2 TEU container, model from Google Sketchup 3D warehouse.

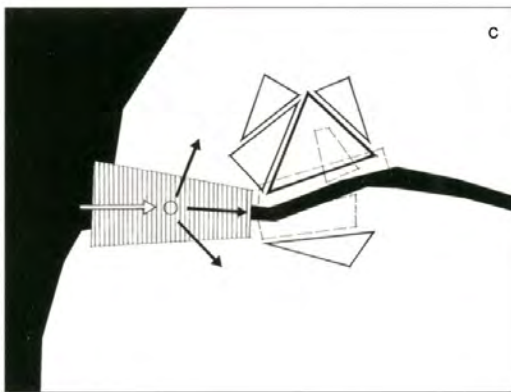


Distinct changes in the relationship between towns and their ports from the nineteenth century onwards.

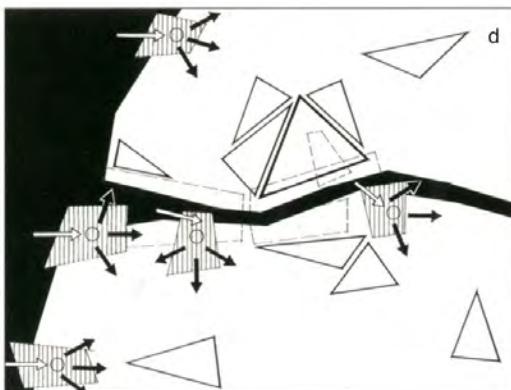
a) Entrepôt: the harbor in the enclosed town. Goods are stored and traded in the town; the quayside is also a public street, until the middle of the nineteenth century.



b) Transit port: the port is next to the open town. The flow of goods goes around the town. The separation of town and port has begun, from the end of the nineteenth century.



c) Industrial port: a harbor next to a functional city, as two autonomous entities. Goods are processed in the harbor area, from the mid-twentieth century onwards.



d) Distribution port and network city. The port has been rediscovered by the city as part of the urban landscape, and the city rediscovered by the port as a potential nerve center for organizing logistics and telecommunications.

(OverHolland 16 / 17., 2015, p. 152)

(Meyer et al., 1999, p. 23)

Figure 9 Structural changes seen in port cities (Meyer et al., 1999, p. 23)

Impact on Amsterdam

Port city typologies

To better understand the present-day complexity of the urban configuration of the port city Amsterdam we need to rewind the urban interventions chronologically and systematically. The diagrams proposed by Han Meyer to explain the structural changes in port cities from the nineteenth century and onwards are a helpful tool to explain what changes in the urban configuration. (Meyer et al., 1999, p. 23)

If the diagrams of Meyer are combined by the maps of the inner city of Amsterdam created and provided by MUST stedenbouw published in "Amsterdam terug aan het IJ" we can distinguish the separate interventions in Amsterdam. The maps of Amsterdam in 1350, 1725, 1930, and 2010 can be found on the next pages.

In 1350 Amsterdam consisted out of the dam and some streets adjacent to the inner harbor, the structure clearly resembles the "a) Entrepôt". The harbor and the city are one and the same entity.

In 1725 Amsterdam has grown significantly according to the ideal city structure of Simon Stevin. (Meyer et al., 1999, p. 285) The rampart on the north side of the city functions in-part as a fortification wall and harbor dock. The strict division of harbor and city is taking shape but the harbor is still an essential facet of the city, which makes the

resemblance with the "b) Transit port".

The Amsterdam of 1930 does not fully cover the "c) Industrial port" as described by Meyer. The port and the city are still in close vicinity of each other. Despite the construction of the railway station on the open waterfront of Amsterdam there is still a lot of industrial and transport activities within the inner city borders. In the north of Amsterdam the residential neighborhoods for the dock workers were constructed adjacent to the docks. Due to the construction of the Noordzeekanaal in 1876 there has been a large shift of harbor activities towards the west of Amsterdam. The situation of Amsterdam is best described as a combination of the "b) Transit port and c) Industrial port".

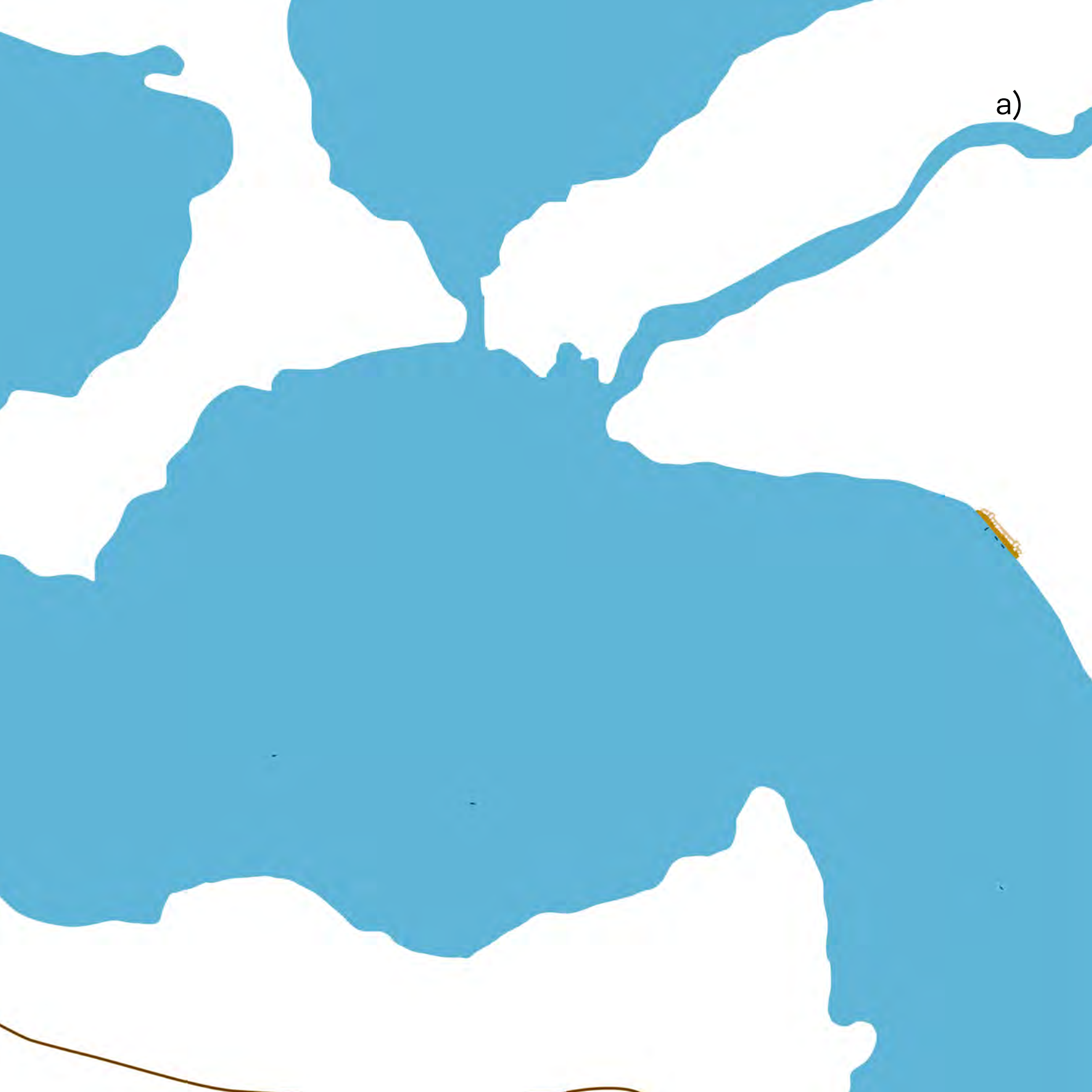
The properties of the "d) The distribution port and network city" are visible in the contemporary situation of Amsterdam and the 2010 map by MUST stedenbouw. Almost all harbor activities have moved outside the inner city as described in the "c) Industrial port typology". Large scale redevelopment projects repurpose these brown areas. The harbor activities of Amsterdam now stretch towards Zaanstad and IJmuiden with their respective city boundaries and residential concentrations to facilitate workers, this in combination with the enormous growth of Schiphol as Mainport, a specialized railway and highway infrastructure facilitates a good connection with mainland Europe for the import and export of goods. The logistic nerve center, as described by Meyer can be found in places like Hoofddorp, Amsterdam Zuidas, and Sloterdijk.

In 1350 Amsterdam consisted out of the dam and some streets adjacent to the inner harbor, the structure clearly resembles the "a) Entrepôt". The harbor and the city are one and the same entity.

1350



Figure 10 Amsterdam in 1350 (Must Stedebouw, 2012)



a)

1725

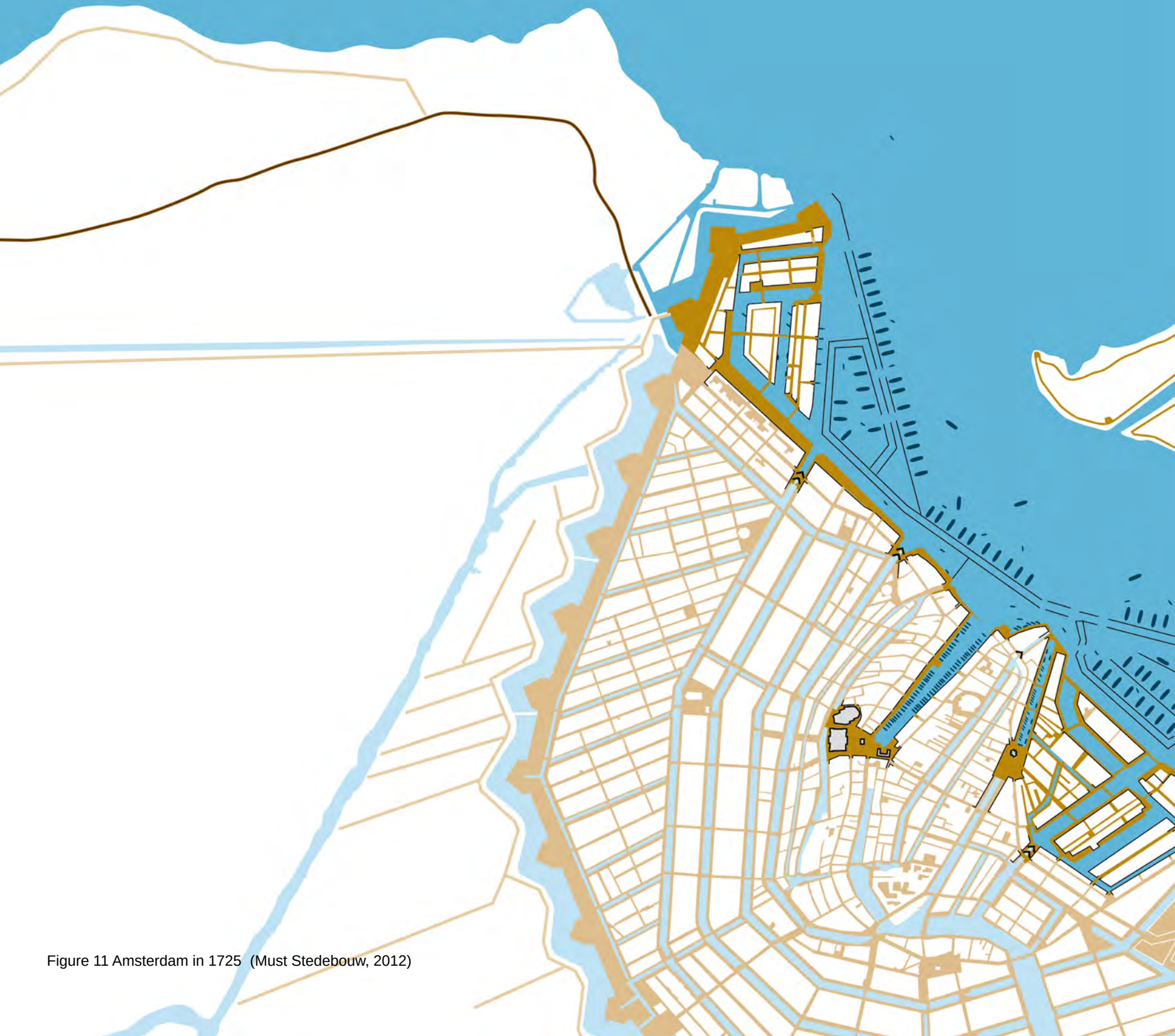
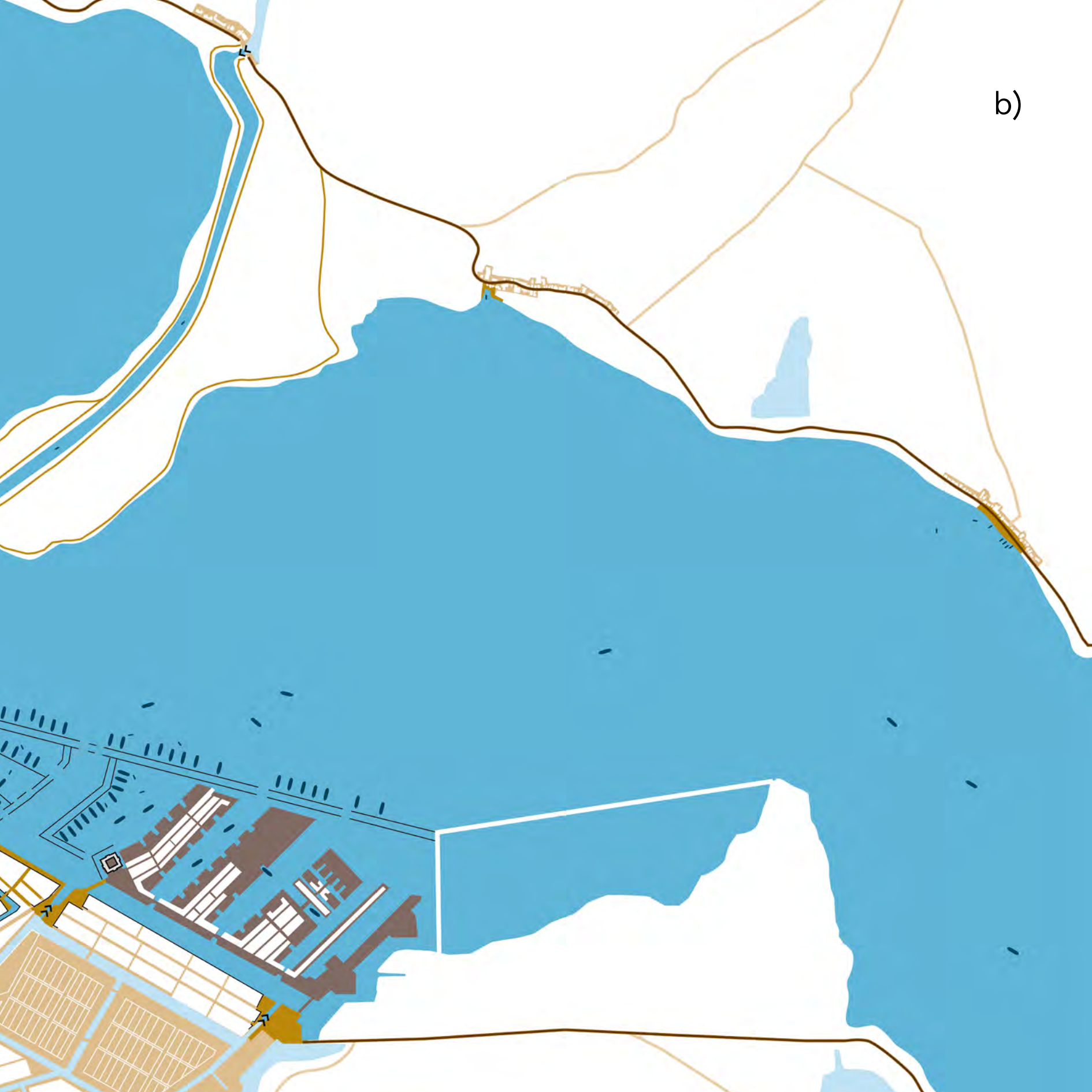


Figure 11 Amsterdam in 1725 (Must Stedebouw, 2012)



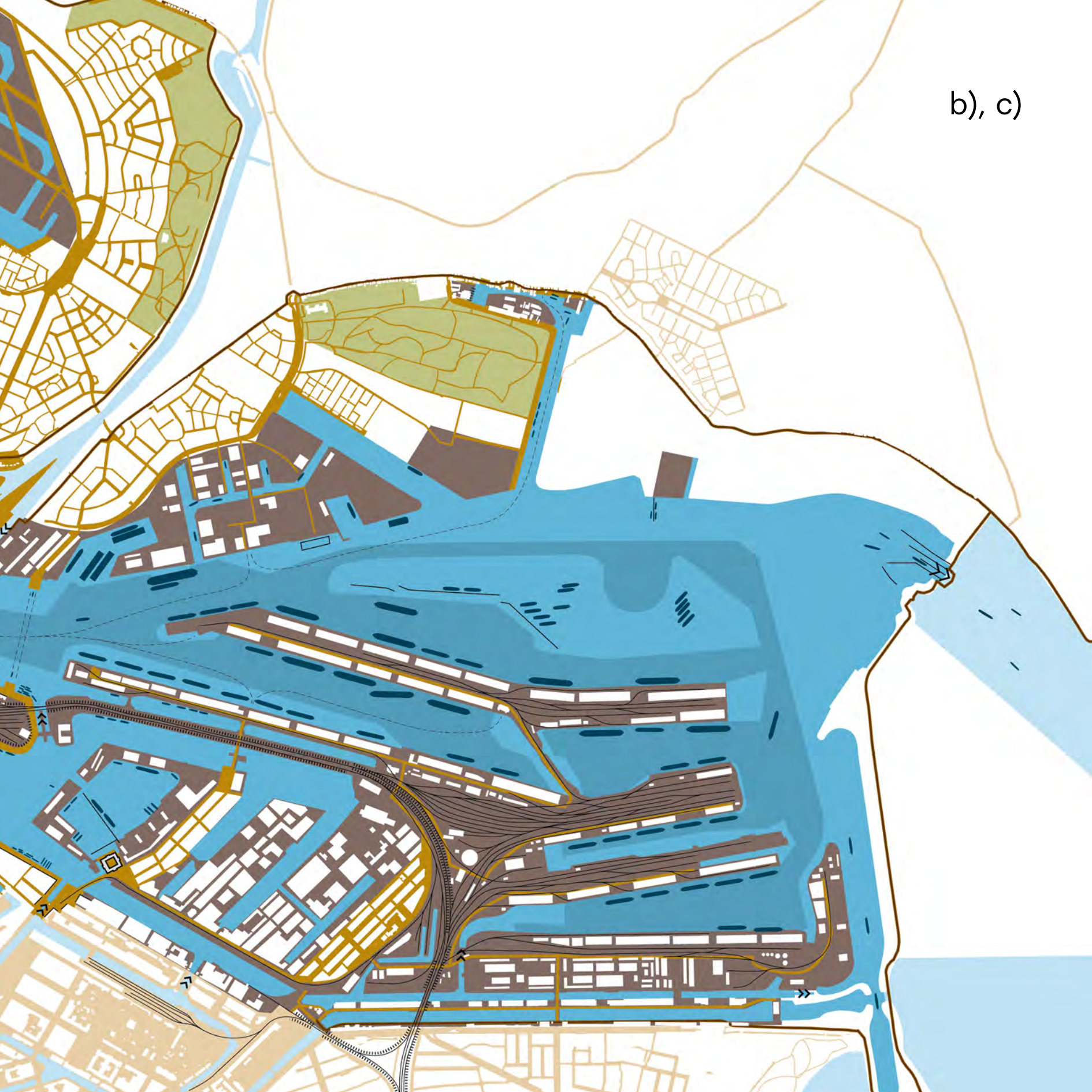
b)

1930



Figure 12 Amsterdam in 1930 (Must Stedebouw, 2012)

b), c)



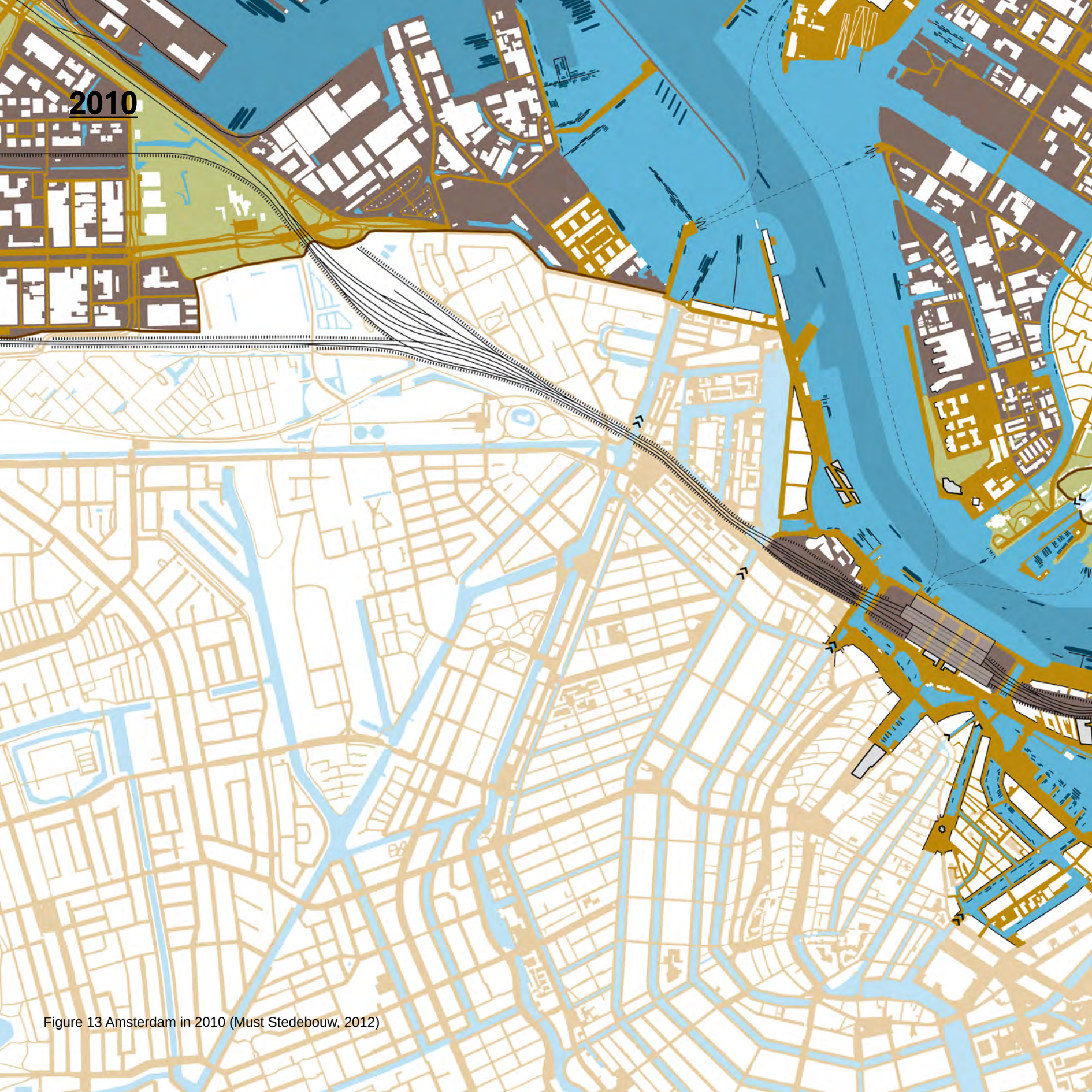


Figure 13 Amsterdam in 2010 (Must Stedebouw, 2012)



d)

Construction of the Noordzeekanaal

In the middle of the 19th century, the port of Amsterdam and Rotterdam had to compete with the more positively geological positioned port of Antwerpen. Antwerpen was the largest port in the vicinity since 1850 due to the accessible Westerschelde and because of the connection with a railway to Germany, named the "Iron Rhine". (Giljamse et al., 2009, p. 91) To compete with the

Belgians, the Dutch started with the construction of the Noordzeekanaal and the Nieuwewaterweg. (Giljamse et al., 2009, p. 91) In Amsterdam, the IJ was clogging up due to the tides of the sea. This clogging up meant that ships were getting stuck and could not deliver their goods on time. The construction of the locks at IJmuiden and the Oranjesluizen at the Zuiderzee happened simultaneously. (Giljamse et al., 2009) The construction of the locks stopped the

clogging up and made of Amsterdam a tideless harbor.

The construction of the Noordzeekanaal, with its opening in 1876, meant a reversal in approaching the city of Amsterdam. Ships always used to arrive on the eastern part of the city via the Zuiderzee. Now with the creation of the Noordzeekanaal the ships could approach the city from the western flank, this had repercussions for the location of



Figure 14 North Holland in 1876 (Reimeringer, Gebr., Buffa & Zonen, Frans, 1876)

the expansion of the city of Amsterdam. The western part of Amsterdam, with its vicinity to the sea would mean a shorter distance from sea to land transit. Nonetheless, the goods still had to come through the city of Amsterdam to be delivered to mainland Germany. The plans for the construction of the Merwedekanaal made choosing a location for the harbor to expand more urgent. (Gilijamse et al., 2009, pp. 91–95)

This lengthy discussion about where to expand the harbor of Amsterdam might explain why the city has been stuck relatively long in the transit towards “industrial port” as described by Meyer. The stupendous growth of the vehicles for transport ultimately dictated where the harbor would expand to.

At one point, the ships just could not fit through the IJ anymore and would need to transfer their load on the western side of Amsterdam on smaller ships for inland

transport via the Merwedekanaal towards the Rhine. The problem of the size of vehicles versus the medium is also a contemporary issue with the IJmuiden locks. The locks of IJmuiden are being replaced by new locks which will be “the biggest seaworthy lock of the world” to meet future demands. (NOS, 2016)



Railway infrastructure

Western harbor district

Plans were made to drastically increase the western harbor district that was closer to the north sea, this would function as the transit harbor where goods would transfer from seaworthy and thus large ships towards smaller vessels or other types of vehicles. (Gilijamse et al., 2009, pp. 255–257) These harbors would not only facilitate the larger ships but would also have all the specialized equipment needed due to the containerization of the global trade.

Amsterdam-Rijnkanaal

After the Second World War, the construction of the Amsterdam-Rijnkanaal had begun. The Merwedekanaal was not meeting the demands of the growth of the transport sector. The plans for the

construction of the Amsterdam-Rijnkanaal were already made before the Second World war but due to the bad economic situation leading up to the war and the reconstruction work after the war has led to the delay. (Gilijamse et al., 2009, p. 237)

The Amsterdam-Rijnkanaal would offer a modern connection between the harbor of Amsterdam with the river Rhine and thus to mainland Germany. The construction was finished in 1952. After a couple of years of use it was already the busiest shipping canal of Europe. (Gilijamse et al., 2009, p. 237)

The construction of the Amsterdam-Rijnkanaal has condemned the bend of the IJ in being one of the busiest shipping transport corridors of the Netherlands. Since all the harbor activities have moved

towards the western harbor district and the Amsterdam-Rijnkanaal being situated on the eastern side of the city, all transport vessels have to pass through the open waterfront.

This piece of water has been transformed into the intersection of many different types of modes of transport and we can start to see the boundaries of each of these modes. The next pages will discuss the position of the central train station in Amsterdam, an intervention that has put a lot of pressure on the open waterfront.



Figure 17 Container harbor of Amsterdam (Gilijamse et al., 2009, p. 247)



Figure 15 Steamship at the open waterfront (Beeldbank Amsterdam, 1900)

These harbors would not only facilitate the larger ships but would also have all the specialized equipment needed due to the containerization of the global trade.



Figure 16 "Het Westelijk Havengebied in 1980" (Giljamse et al., 2009, p. 256)



Figure 18 Two separate stations at the periphery of Amsterdam, map based on (Must Stedebouw, 2012; TAK architecten, 2015, pp. 14–15)

Location for the central station

With the introduction of the railway, the transport of goods over the medium water had a trustful, efficient, and thus worthy competitor that could reach places that boats could never reach on land. However, the introduction of the railway was not a public affair; different companies would connect different cities, each with their own train stations. The first railway in the Netherlands was “de Hollandse IJzeren Spoorweg” that would go towards Haarlem and then towards the south. This railway had a station at Willemspoort. (Engel & Claessens, 2007, pp. 67–68) The second railway in Amsterdam was the “Rijnspoorweg” that would go towards Utrecht and had a station at Weesperpoort. (Engel &

Claessens, 2007, p. 68)

Due to the competition with Antwerpen and their “Iron Rhine” the Dutch were proposing to construct the “Oosterspoorweg” which would lead towards mainland Germany. (TAK architecten, 2015, pp. 14–15) Minister Thorbecke had proposed to connect all the separate train stations at one new central station. Thorbecke gave in total three options, a station at the “Open waterfront”, the “Leidsepoort”, and at the existing “Weesperpoort” train station. (TAK architecten, 2015, pp. 14–15)

Thorbecke preferred a station at the Open waterfront for its connection with the harbor of Amsterdam, which would be

useful for the transition of goods between ships and the train. (TAK architecten, 2015, pp. 14–15) The municipality was against the construction of a station at the historic open waterfront. In Dutch tradition, a compromise was made to separate the passenger and transport stations from each other, which would make it possible to construct the train station at the open waterfront and still leave room for harbor activities at the narrowest part of the IJ. (TAK architecten, 2015, pp. 14–15) The transport station would be made at the “Rietlanden” and the passenger station would be made at the open waterfront.

Compared with other port cities

The decision to construct the station on the historic open waterfront was historic in itself. Compared with for example, similar port cities like Rotterdam and Antwerp. Rotterdam, had separate stations on the periphery of the city. The “Delftsche poort” was to the north and the “Maasstation” was next to the river Maas and would also serve as a transit station for the harbor. (Cavallo, 2008, pp. 39–40) Antwerp had a train station at the periphery of the city on the east and a station on the south side of the city at the end of the new neighborhood “het Zuid”, which would also serve as a transit station for the harbor. (“Station Antwerpen-Zuid,” 2018)

Despite the similar context of train stations only Amsterdam had created a new central station and on the original location of the entrance towards the city at the open waterfront. Antwerp redeveloped their east station to a central station and Rotterdam redeveloped the Delftsche poort to its main station.

In Antwerp and Rotterdam, the main entrance to the city has shifted from the water towards the inland, this is a fundamental difference from what happened in Amsterdam, where the entrance towards the city has remained at the open waterfront. Only the type of vehicle and the medium have been transformed to meet the demands of its time. The decision to leave space for

ships seems to be made as a gratitude for all the wealth and prosperity the boat has given to the city of Amsterdam in the first place.

The location for the train station has been condemned by many. Cor Oudendijk, the old harbor master of Amsterdam thinks this decision is a big mistake: “why did the train need to be on the open waterfront?” (Schram et al., 2012, p. 103) Since the construction of the central station, this part of Amsterdam has always been associated as being dirty, noisy, and unsafe. (Schram et al., 2012, p. 103)

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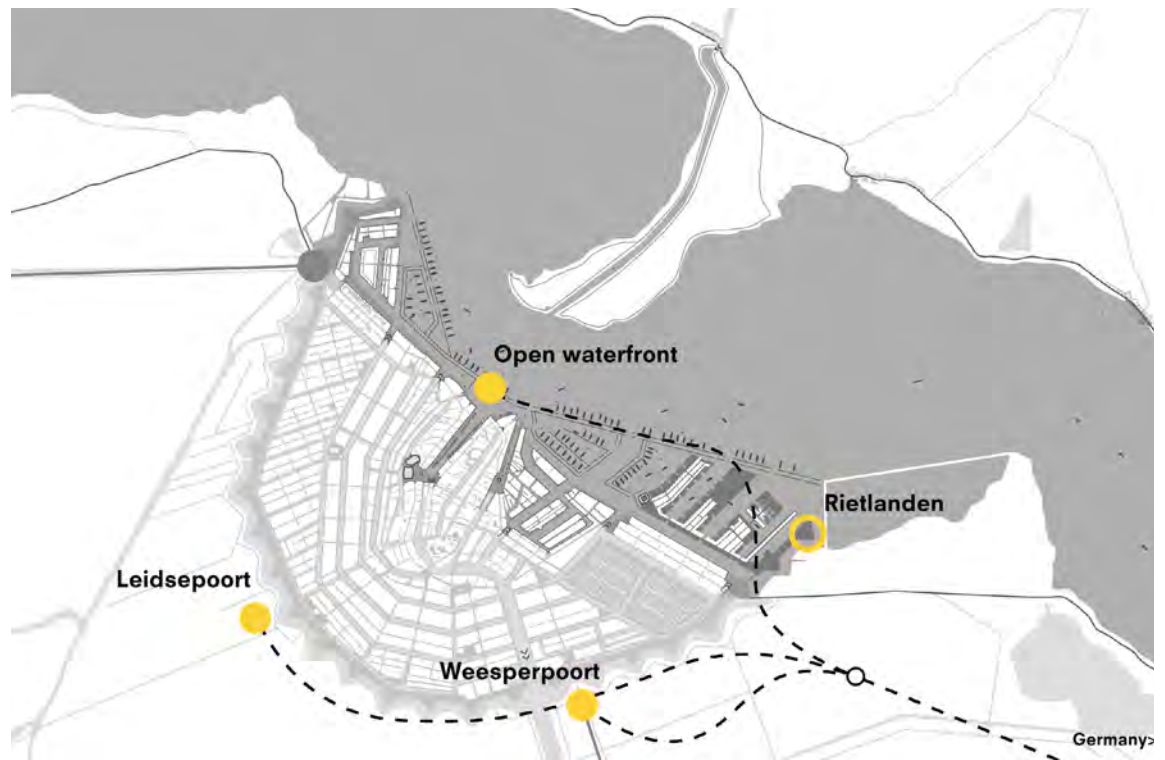


Figure 19 Three options for a new central station, map based on (Must Stedebouw, 2012; TAK architecten, 2015, pp. 14–15)

The train station

The entrance to the city has remained, but its appearance has been fundamentally changed. Through the years the train has become a more and more important means of transport. Adjacent to the developments of the trains are the developments of “the last mile” mobility modes. The addition of the subway systems, first the Eastern line and just recently the North-South line, have altered the surroundings of the train station. A new bus terminal on the banks of the IJ has transformed the central train station into a major transportation hub for people. All these small strategic interventions over the course of years have made it possible for the train station to accommodate more significant densities of travelers. These interventions have had some big consequences for the open waterfront.



Figure 20 Before the central train station (Eickelberg, 1871)

The central station island has almost been tripled in size through years of interventions by adding more train tracks, expanding the bus terminal, and the addition of a metro station. The width of the IJ initially been about 550 meters but has already been reduced to half. If these small scale interventions keep reclaiming land from the IJ, we might have no IJ left in the future. Even more worry-some is the fact that the construction of the railway along the banks of the IJ caused alienation between the city on the one side and the IJ on the other side, the railway functioned as an infrastructural barrier between these two parts of the city. While the IJ functioned as the barrier between the north and the south. (Meyer et al., 1999, pp. 372–373)

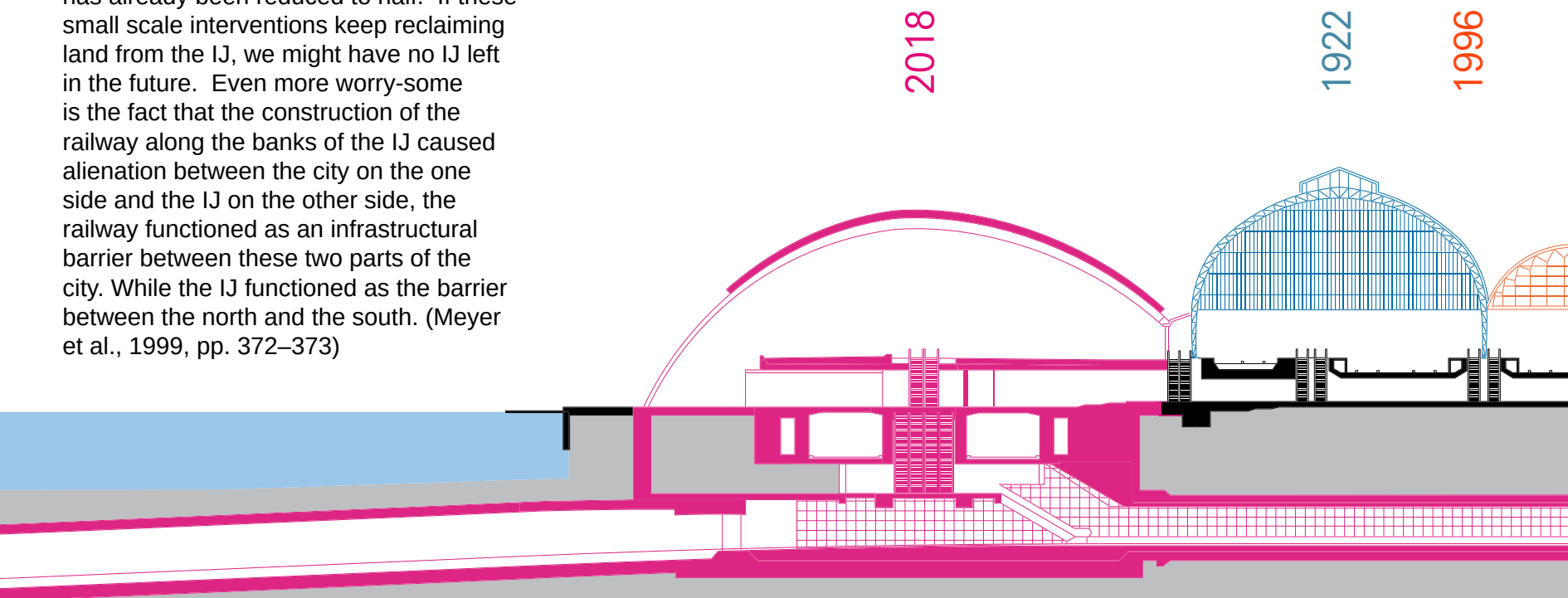




Figure 21 After the central train station was built (Oosterhuis, 1887)



Figure 22 Section of the Central train station, based on drawing in the Amsterdam Centraal site book 2017-2018 (Davide Niccolini ,Victor Koot, 2018, p. 327)

Conflict

With on the one hand, the demand for large harbors for the ever-increasing size of cargo ships and on the other hand the decreasing width of the open waterfront, which needed to be passed by the ships to reach the Amsterdam-Rijnkanaal, a conflict of interest was taking place in the middle of the city. The eastern docklands of Amsterdam were becoming redundant and the harbor fell into disuse since more and more industrial facilities moved to the western harbor district. (Meyer et al., 1999, pp. 372–373)

As fast as industrialization has taken control over the city, the industry is gone again. Leaving behind its redundant infrastructure in favor of other locations to do business. (Schram et al., 2012, p. 40) Almost all harbor activities have been abandoned in the vicinity of the historic inner city, but the IJ is still the

busiest shipping corridor. The medium water is the most crucial infrastructural work and it crosses right through the city of Amsterdam. Cargo ships starting their journey at the western harbor district pass by all the disused industrial facilities along the way towards the Amsterdam-Rijnkanaal

Redevelopment

This process of de-industrialization was not unique to Amsterdam, in all major western port cities that were transforming towards the distribution port and network city, old harbor districts fell into disuse. Moreover, in all major western port cities, the concept of activating the waterfront for redevelopment was adopted. (Schram et al., 2012, p. 41)

The AWF (Amsterdam waterfront financing company) was started to generate new ideas and visions for the

south bank of the river IJ. One of the major architects associated with the redevelopment plan of the IJ banks was Rem Koolhaas. Koolhaas presented the concept of a “balcony on the IJ” adjacent to the central station to open the city towards the water, accompanied by a large office park. (Schram et al., 2012, pp. 61–62) This plan, however, met its end due to several reasons, one being that the plan was too competitive with the office development at the Zuidas, which was commenced at the same time. Ultimately the southern banks of the IJ were developed through separate plans; these plans had a minimal impact on the width of the open waterfront. (Schram et al., 2012, pp. 59–64) However, these plans have changed the appearance of the open waterfront drastically with the addition of the new bus terminal canopy and large scale residential and office developments.



Figure 25 “New bus terminal with station roof” Bentham Crouwel architects (“Amsterdam Central Station - Bus Terminal,” n.d.)

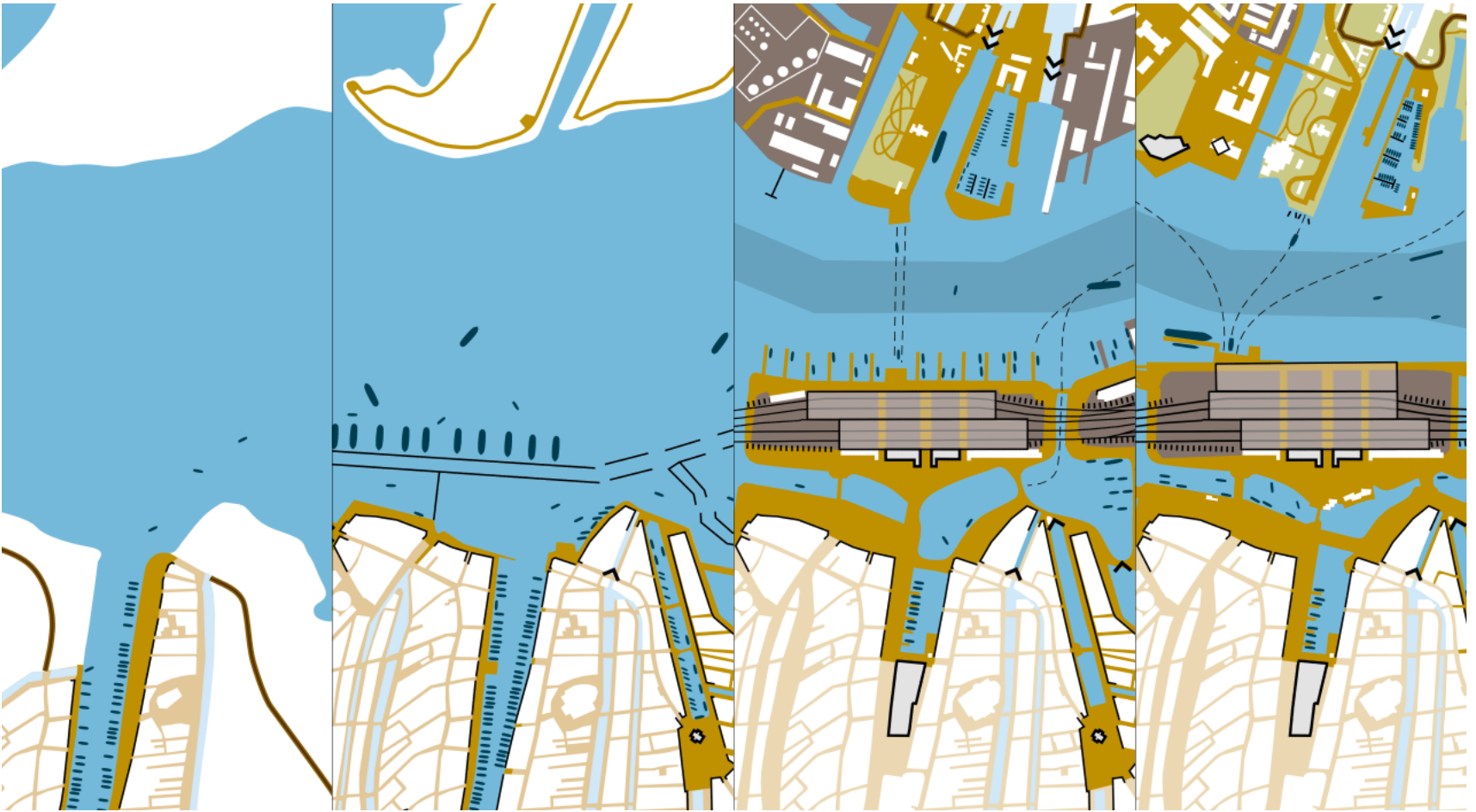


Figure 23 The open waterfront has been decreasing in size since the beginning of Amsterdam (Must Stedebouw, 2012)

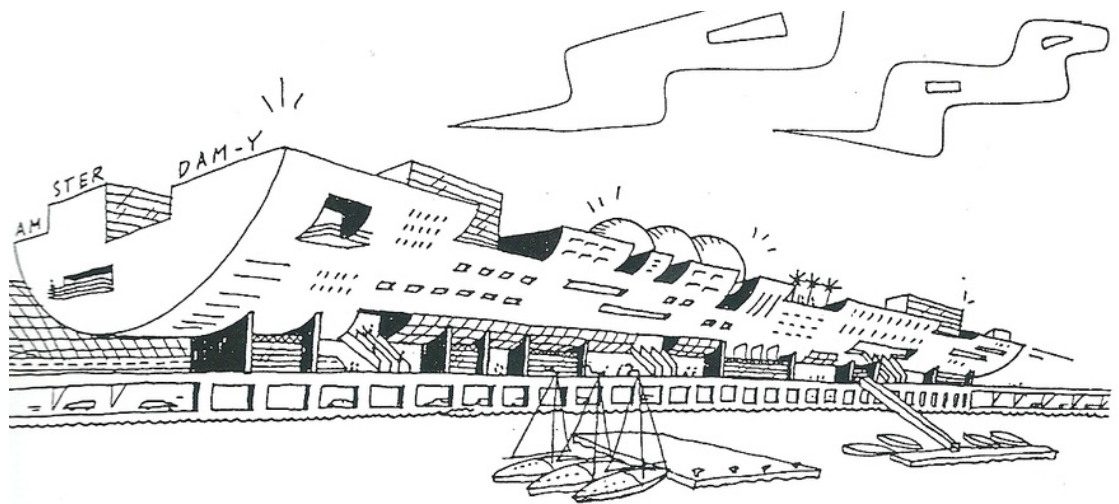


Figure 24 "Plan Koolhaas" (Pakhuis de Zwijger, n.d.)



Figure 26 Noordzeekanaal A. Huët (Huët, 1874)

The future of the open waterfront in Amsterdam

Bypass

The open waterfront of Amsterdam has seen some drastic changes throughout the years, from a misty lagoon towards an industrial canal and into a city district, mobility hub and transit canal right now. Nonetheless, the amount of plans that were never realized is just as impressive. The reasons why these plans were not realized is unclear; they always seem to be politically and economically motivated. The central aspect of these plans is the

constant interaction between the different modes of transport and mobility.

Two plans for the open waterfront in the 19th century stand out from the rest. One is from engineer A. Huët who proposed to prolong the Noordzeekanaal through the agricultural land in the north and have the central train station on the location it is right now. The other plan is from Jan Galman, an engineer who proposed dozens of designs for bridges over the IJ. (Bock & Smit, 1996) As early as 1857, he proposed to follow the example of London, where the Tower Bridge over the Thames had already connected the two sides of the river. (Bock & Smit, 1996, p. 19) Every attempt to convince the municipalities to construct a bridge over

the IJ was met with disappointment. First off, it was unnecessary to construct an expensive bridge to nowhere because the north was not developed at all. (Bock & Smit, 1996, p. 7) Secondly, the nautical sector saw problems for the free transit through IJ and lastly the municipalities were worried that with the construction of a bridge, the IJ would clog up even more. (Bock & Smit, 1996, p. 7)

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Secondly, the nautical sector saw problems for the free transit through IJ and lastly the municipalities were worried that with the construction of a bridge, the IJ would clog up even more.



Figure 27 "Amsterdam uitgelegan aan de IJ-zijde" Jan Galman (Galman, 1857)

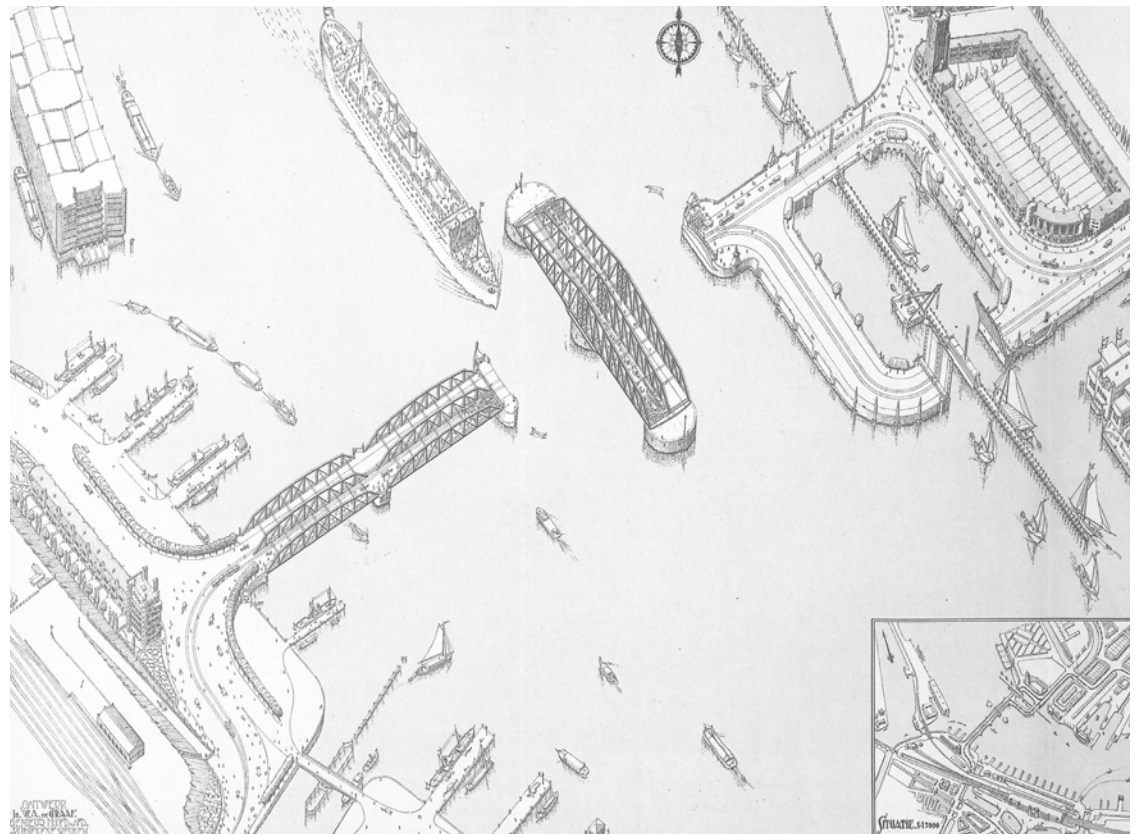


Figure 28 "Rapport inzake een vaste verbinding der IJ-oeveren van Amsterdam" W.A. de Graaf (Bock & Smit, 1996, p. 79)

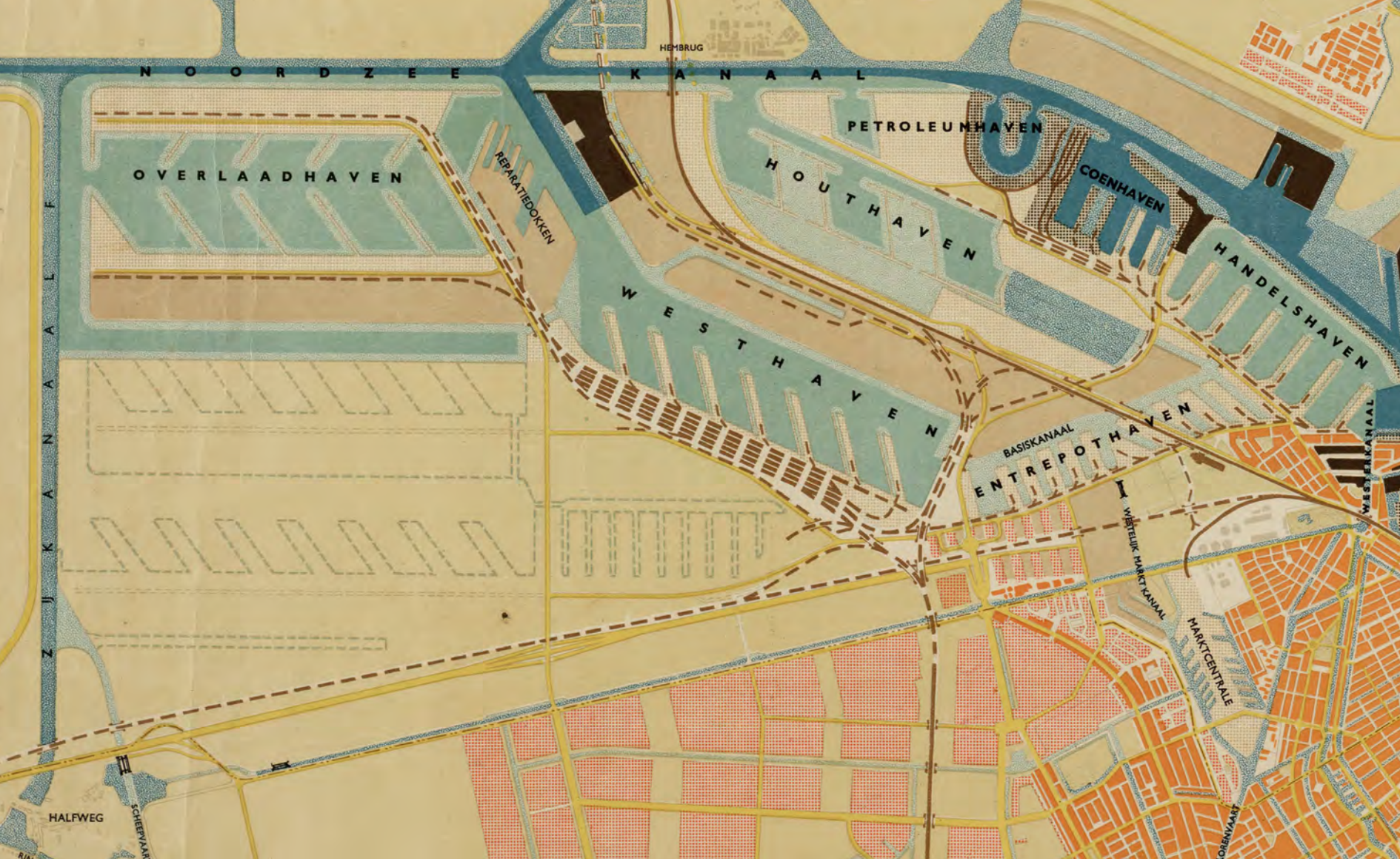


Figure 29 “Algemeen Uitbreidingsplan van Amsterdam Schaal 1:25000” (van Eesteren, 1935)

Kanaal om de Noord

Despite the efforts of Jan Galman, a bridge would never be constructed over the IJ, plans would always be proposed and they always seem to be positioned near or at the central train station. In 1919 the “Dienst Publieke Werken” did several studies to the feasibility of a bridge adjacent to the central train station. By the 1930s, the North of Amsterdam had developed from agricultural land to an industrial harbor with accompanying city district. One of the most promising prospects to physically connect the

north and south of Amsterdam was from Cornelis van Eesteren in the AUP (Algemeen uitbreidings plan – General expansion plan) for Amsterdam. The AUP proposed two canals that would bypass the bend in the river IJ.

The canal “om de Noord” would bypass the IJ through the Buiksloterham, an idea proposed by Johan van Hasselt that has similarities with the plan from A. Huët. (Bock & Smit, 1996, p. 22) Due to the high costs of constructing the canal, the central government of the Netherlands canceled the plan. (“Johan van Hasselt

(1850-1917),” 2018) Amsterdam already started with the partial construction of the canal, this partial construction is still visible and the harbor inlet is named after the engineer who proposed the canal: “Johan van Hasseltkanaal”.

The most ambitious plan was to create a canal around the whole city district of Amsterdam North. This plan was incorporated in the AUP. This canal would make room to create physical connections (read: bridges) with the north of Amsterdam for the expansion of residential neighborhoods. The urbanists



from the municipalities were against the further expansion of North as a residential district and favored harbor activities in the north. (Gilijamse et al., 2009, pp. 101–103) The reason why the canal around the north of Amsterdam was never constructed is unclear. Maybe the canal was never constructed because of the rise of motorized vehicles. The canal is on the same location as the A10 highway is right now. I hypothesize that it follows the same reasoning as why large parts of the AUP were not executed directly. The bad economic situation in the interbellum caused a recession in

urban growth. Furthermore, when the Second World War had wreaked havoc on the Netherlands, there were different priorities, like rebuilding residential and public works. (Feddes & Mader, 2012)

I hypothesize that it follows the same reasoning as why large parts of the AUP were not executed directly. The bad economic situation in the interbellum caused a recession in urban growth.



Figure 30 "Vogelvlucht van het noordelijk stadsdeel, 1934" (Galman, 1857, p. 99)

IJtunnel

The physical connection of North and South eventually came through a tunnel under the IJ. In 1953 the municipality proposed to construct a tunnel for motorized vehicles. (Bock & Smit, 1996, p. 96) The construction of IJtunnel was met with massive protests since, for its construction, large parts of the historic inner city were destroyed. This caused a public outcry in combination with the construction of the new eastern subway. The municipality of Amsterdam had to cancel further redevelopment of the historic inner city and were extra cautious to propose new large scale redevelopments.

Next to the harsh treatment of the historic inner city was the fact that the tunnel was inaccessible for pedestrians and bicyclists. The discussion for a bridge over the IJ is still going on. The decision to construct the tunnel solely for motorized traffic has resulted in overcrowded ferries with over 60,000 ferry users a day (22 million ferry users a year). (Kok, 2018) It seems that Amsterdam has to choose a side, either stick to its historical connection as a port city and leave the IJ for the nautical sector or choose for urban expansion and densification, which requires a good and livable city that has a good function mobility plan.

Ironically, while this discussion is going on, another Dutch port city had already realized a bridge. Rotterdam has the Erasmus bridge over the Maas that symbolically and physically connects the two city districts.

Figure 31 Historic inner city demolished in favor of the subway and motorways (G. Jaeger, 1975)



Conclusion

The urban configuration of the open waterfront of Amsterdam has drastically changed due to technological advances in the transportation of goods. The invention of the train has replaced the cities reliance on the ship as a mode of transport. The functionality of the open waterfront has changed, from a transit harbor into a mobility hub and transportation corridor. This ambiguity starts to be conflicting; it seems that Amsterdam is not shy of large scale interventions in its historic inner city. However, the importance of being a port city with a river (read: the IJ is a lagoon) without obstacles seems to limit further urban developments of the city.

Within the historical urban development of the open waterfront we can distinguish large scale strategic interventions that have had a significant impact on the appearance and functionality. However, we can also distinguish small scale intermediate interventions that meet the needs of that particular time. At the end of the line, all these small scale interventions have just as big of an impact as the large scale strategic interventions. It is because of their intermediate nature that the changes are not experienced as drastic. For example, the large scale intervention of placing the railway station at the harbor of the open waterfront has limited the width of the IJ. The IJ became too narrow for ships -that were increasing in size simultaneously- resulting in the decline of harbor developments on the eastern side of the city, historically the port side of the city of Amsterdam.

It remains questionable if a bypass would have resulted in still having an

eastern harbor district or that relocation of the harbor activities to the west was merely because of new technological requirements of containerization, that could be easier implemented in empty polders than on existing harbors on the eastern side of Amsterdam.

What is clear is the importance of connecting the western harbor district to the Amsterdam-Rijnkanaal, since Amsterdam acts mainly as a transit harbor for mainland Germany. This reason alone would suffice as an argument to construct a bypass around the northern city district of Amsterdam to free up valuable space in the inner city.

We end up in a situation that every small scale intervention eventually leads us to an ever decreasing width of the open waterfront. The small scale interventions over time have a more significant impact on the open waterfront than the big scale interventions. Because these interventions are happening in silence and meet the demands of that particular time. The result is ignored in favor of short term benefits, the question we need to ask is if the open waterfront needs more small scale interventions or if it needs a large scale intervention like a diversion of the canal or a bridge to physically and symbolically connect the two city districts.

It seems logical for Amsterdam to follow the attempts of other cities like Rotterdam to bridge over the river. Amsterdam has already been developed into a distribution port and network city, as described by Meyer. It is time for the IJ to be transformed into a piece of discarded infrastructure and thus become part of the memory of the city instead of meeting the functional needs that are reaching its limit. Old unrealized plans to construct a

bypass around the city district Amsterdam North offer good solutions to meet the economic demands of the transit sector while opening up the banks of the IJ for redevelopment.

This big-scale intervention has the opportunity to bridge the gap between the northern and southern banks of the IJ. Within the history of Amsterdam and its large scale plans, it seems only logical to propose a future scenario that fully bridges the IJ and creates space for further development for the densification of the city. While simultaneously constructing infrastructure for the transport sector around the city district Amsterdam North.

It is this logical intervention that we as group propose as future scenario for Amsterdam in the year 2100, a scenario that can meet the future demands of the city of Amsterdam.

Figure 32 What if we reclaim land from the IJ, create connections and construct a canal around north that bypasses the IJ? (Ingmar Klappe , 2018)





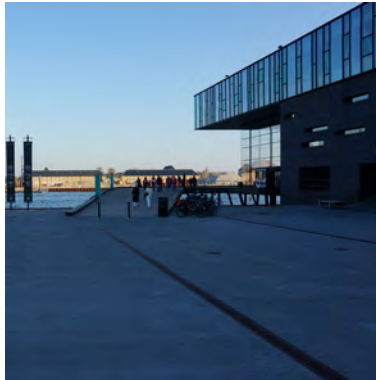
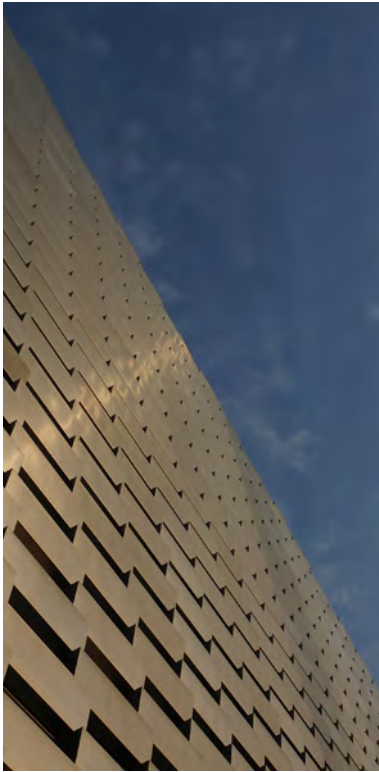
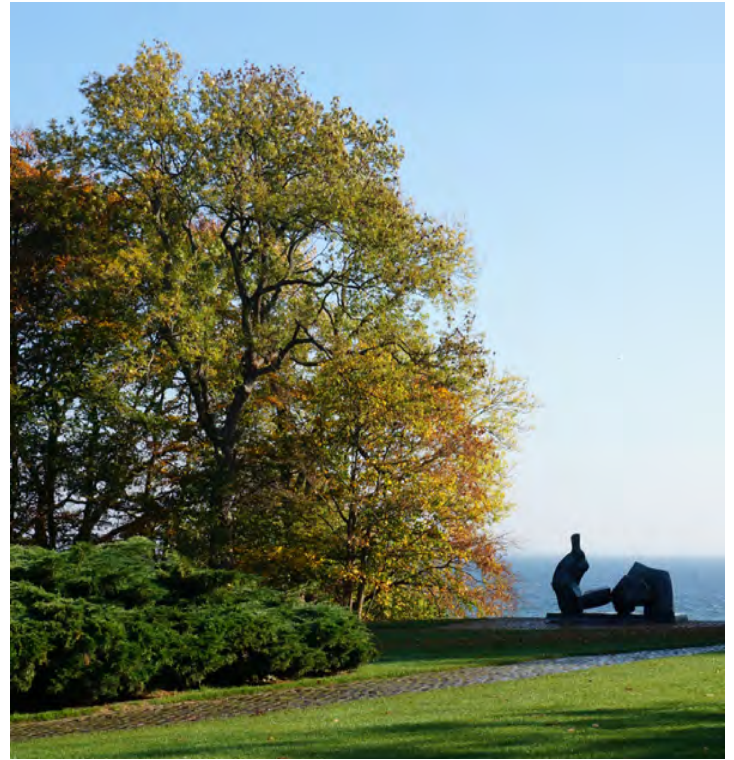
Group strategy

A vision for Amsterdam in the year 2100

As a group, we have created a strategic vision for Amsterdam in the year 2100. This vision is based on socio-economic and cultural research into the future and density studies on the possibilities of densification in the city center of Amsterdam. The vision was also influenced by a field trip to the city of Copenhagen, where urban regeneration of the waterfront has changed the city drastically. Our starting point is the group vision of the previous Complex Projects graduation studio. They created a vision for Amsterdam in the year 2050.

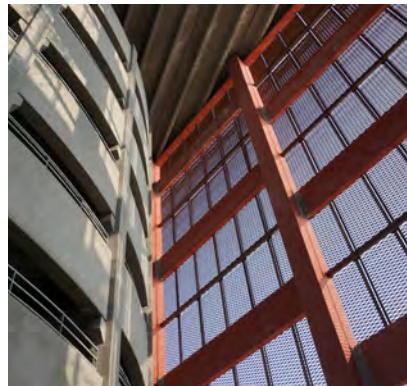
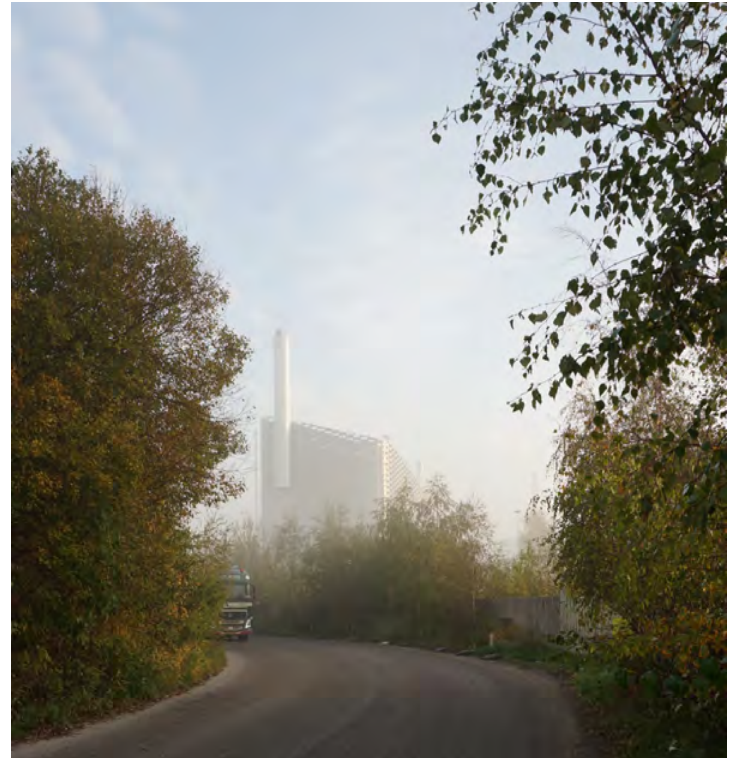
Field trip to Copenhagen

From the 13th to the 18th of October 2018, we have visited the city of Copenhagen to get more inspiration for our group visions on Amsterdam in the year 2100. Part of the field trip was a visit to various architecture firms that have influenced the urban changes in Copenhagen.



Pictures taken during the field trip to Copenhagen

Amsterdam in 2100 - Group strategy





Westerdok in construction

Challenges and opportunities for densification of Amsterdam in the year 2100

In 2100 the population of Amsterdam will grow to 1.571.994 inhabitants. Within the existing boundaries of Amsterdam, there is an opportunity to densify the North district of Amsterdam, Making it the largest district according to inhabitants in the year 2100. By making the North district the largest, we need to pay attention to the IJ, which remains a significant barrier between the two sides of Amsterdam. The IJ is in the middle of our site and we have made several density studies to research what possibilities to densify the center of Amsterdam there are.

Amsterdam central

Within our project area, there are three options for further urbanization: The historical center, the IJ, and the city district North.

Historic center

The historical center is an attractive and popular to visit or settle with a diverse and mixed profile of users and functions. However, this site has a scarcity of building plots and all construction is bound by UNESCO regulations which have certain high-rise restrictions that limit densities.

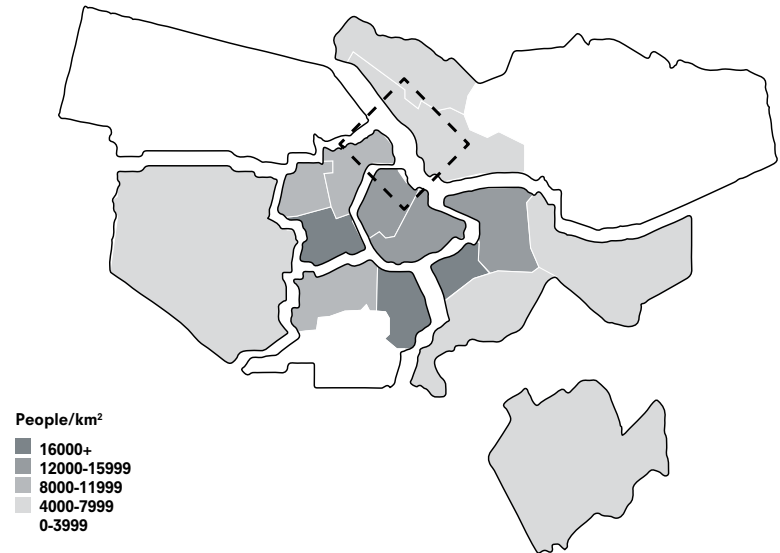
North district

The North district is a post-industrial area which is already under development since the beginning of the 21st century. The North district has a major limiting factor for densification due to its lack of connection to the rest of the city due to the IJ river functioning as a barrier.

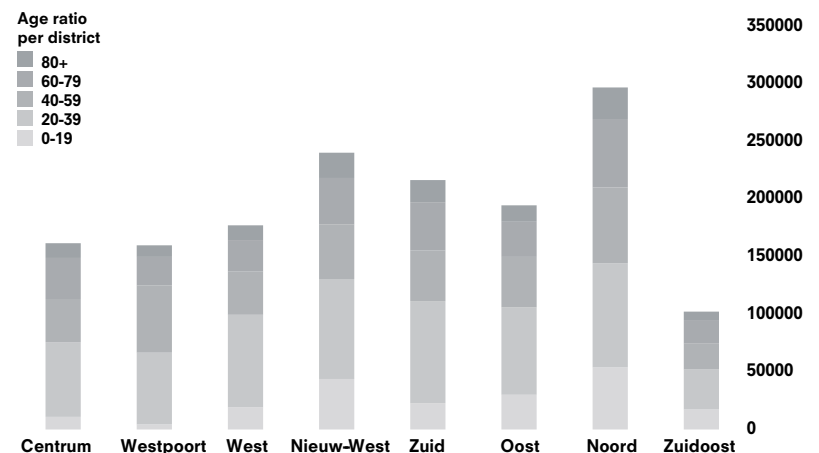
IJ river

The IJ river is historically seen as an crucial nautical laguna for the city of Amsterdam. Nowadays, the IJ functions as one of the most important cargo routes between the port of Amsterdam and the mainland. Upon that, the IJ has grown the last couple years into as a landmark and orientation point for the city. The challenges for the IJ river are the lack of leisure at the banks of the IJ, mainly due to the commercialization of the view of higher-priced residential projects.

Density



Age



Densification potential per district and per age group in our narrative of Amsterdam in 2100

Density studies



What if New York City?

Upper East Side

Area: 455.8 ha
Inhabitants: 192660
Density: 42270 people/km²



What if Barcelona?

Barcelona grid

Area: 469 ha
Inhabitants: 144516
Density: 30814 people/km²

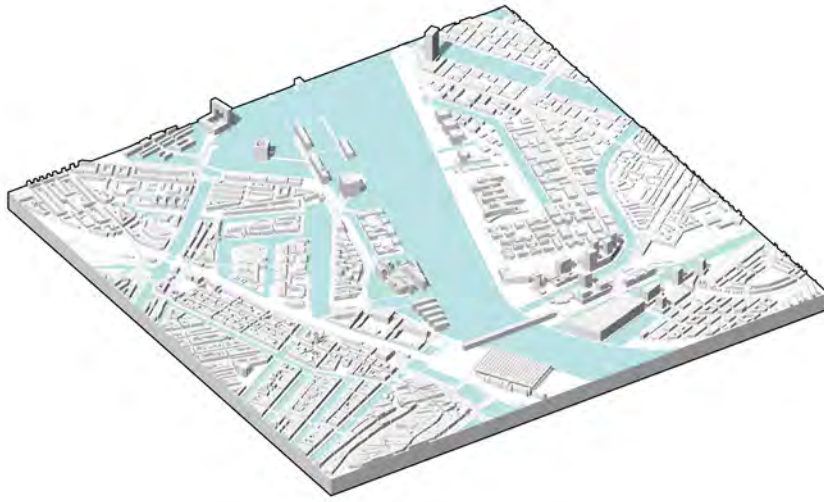


What if de Pijp?

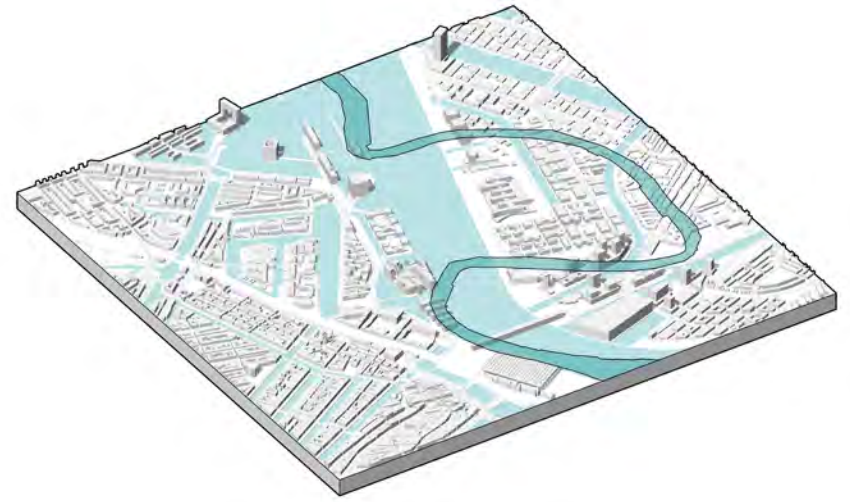
De Pijp

Area: 149.27 ha
Inhabitants: 37361
Density: 23689 people/km²

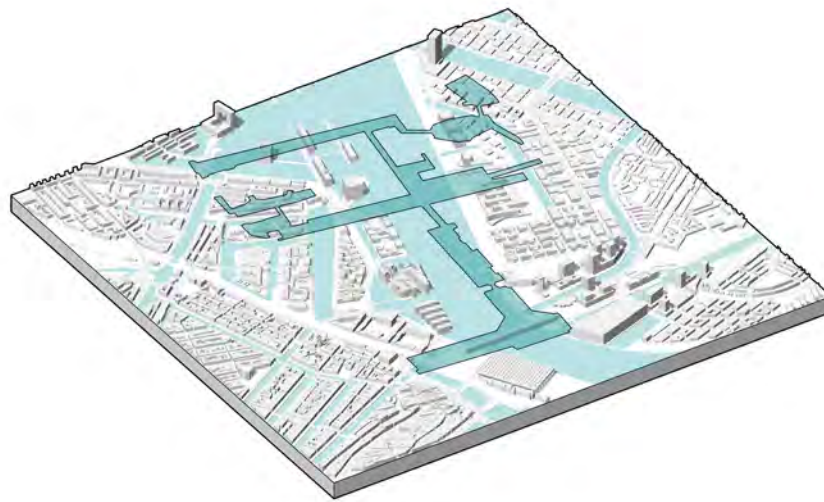
Mixed strategy



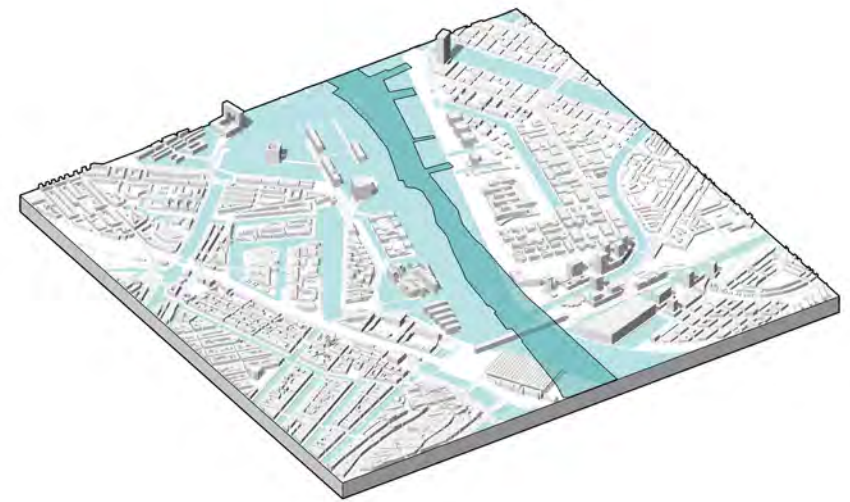
Situation in 2050



Superimposed Venice



Superimposed Canary wharf



Superimposed Copenhagen

Density studies



What if complete infill

28% land added
Added population:
36000



What if river on center side

22% land added
Added population:
26000



What if river with canals

16% land added
Added population:
21000



What if river in middle

16% land added
Added population:
22000



Anno

de Oude kerk	122	Het Prinszen Hoff
de Nieuwe kerk	229	Hetoonstijghing huis
de Synagoge	324	Het vestinghuis
de wester kerk	425	Amoesersers huis
de Noorder kerk	526	Het Tuich Inds
de Nieuwezijns Cappel	627	Het weers huis
de Oudezijns Cappel	728	Het dolhuis
de wale kerk	829	Het Spinhuis
Het stadhuis	930	Het oude Mandhuis
de buurs	1031	Umarvins gasthuis
de vaach	1132	Tivourens gasthuis
de Nieuwe waach	1233	de Chalkhuysen
Van Roozendorps Toorn	1334	Het Ronde bagmeke
Marinckpuckers Toorn	1435	S Ioris Hof
Wanckelbuens Toorn	1536	de garenermarkt
Sijmrscheck Toorn	1637	de vismarkt
Reguliers Toorn	1738	de 2 vleeshallen
Het Rondeel	1839	de Steethuis
de Chavniers doelen	1940	Het gielhuis
de Harboochs doelen	2041	Leproosen
voetboochs doelen	2142	de kolek

Dirck Cornelisz

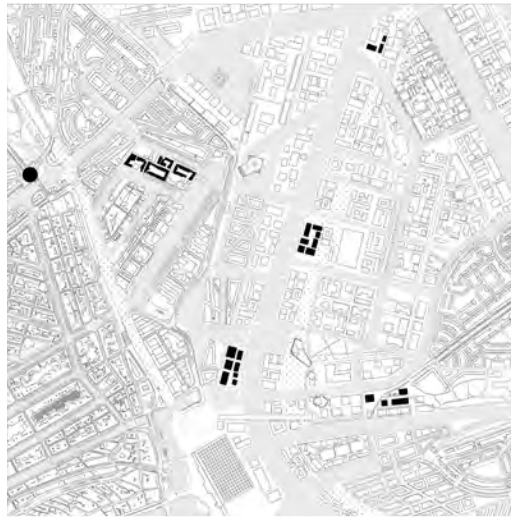
Smart feed

2100 Group strategy

2050



2100



Reclaim land



By reclaiming land from the IJ, we do not have to densify the historic city center.

Densify



Bridge



Complete plan



The plan to create a bypass for the IJ around Amsterdam, proposed back in the AUP in 1936 by Cornelis van Eesteren will be included in our strategy.





Chapter 5

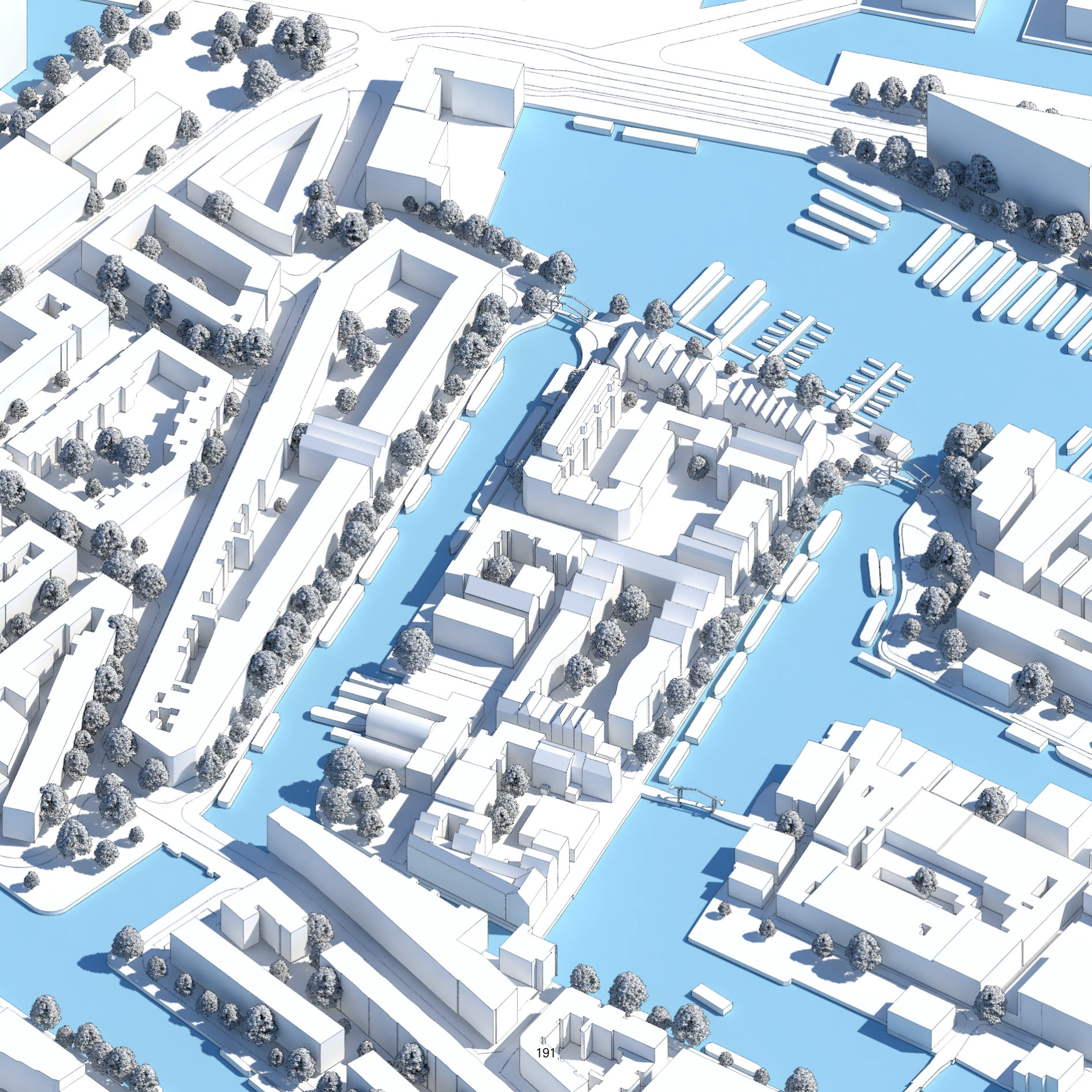
VIERWINDENPLAATS

Project site

Realeneiland

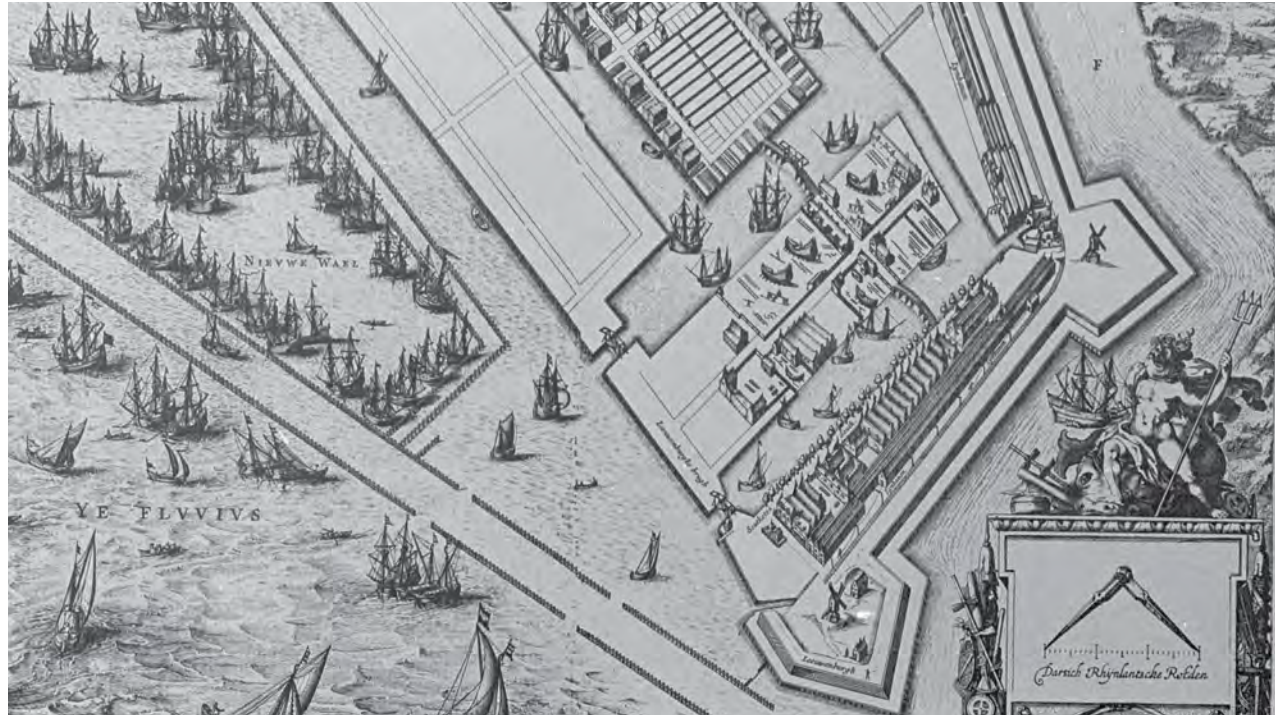
The learning space of the 22nd century will be built on the Realeneiland in Amsterdam. The Realeneiland matches all requirements that have been set for the location of the schools. First off, the island is in the middle of a residential district. Therefore it is in close vicinity of its younger pupils. Secondly, the site reflects the ideal of the school, the Realeneiland has seen drastic changes over the course of its existence and those have left their tracks. Lastly, the site fits within the greater network of school buildings, covering the whole of Amsterdam. By placing learning spaces that offer fluid education on strategic sites throughout the city it offers the opportunity for everyone to participate in this type of education.





1625

Realeneiland has been part of the third expansion of Amsterdam anno 1620. On this map, the outlines of Realeneiland are visible. The island has served as a harbor and as an industrial part of the city since then.



1950s

Until the 1950s Realeneiland used to be filled with factories and harbours. Over the years, after the Second World War, the industry moved to the new periphery of the city, leaving the factories abandoned on Realeneiland.





1970s

Vacant plots are visible in this picture where factories used to stand. Urban regeneration from the 1960s onward left its mark on this part of Amsterdam.



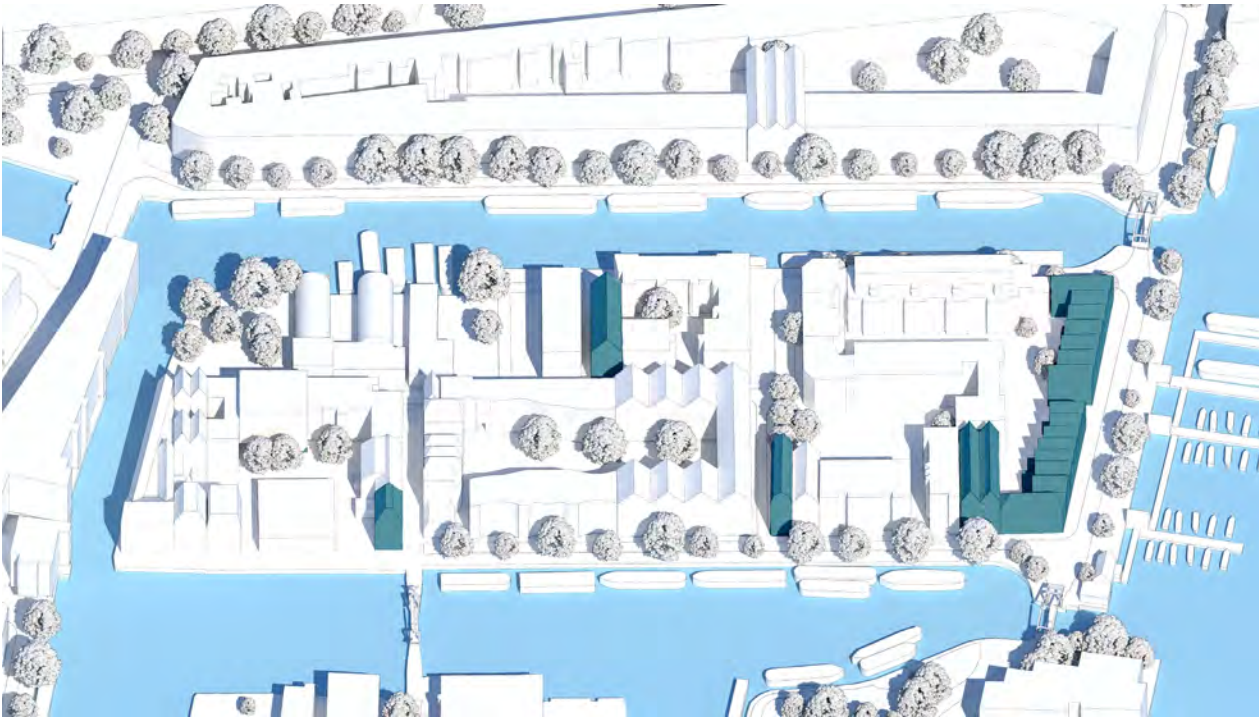
2010s

The vacant lots have been filled with social housing in the 1980s. This aerial is the most recent view on Realeneiland, now a residential district. Scattered throughout the island there are buildings that remind of the past.

Vierwindenplaats - Project site

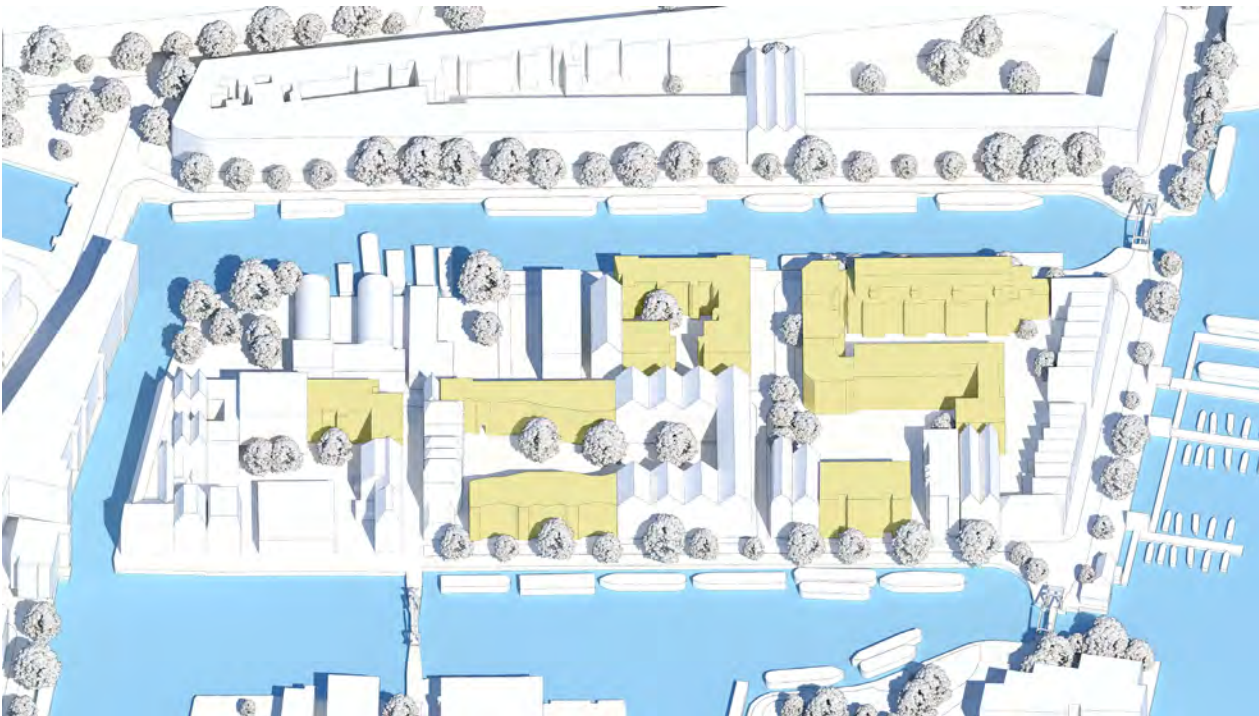


Pictures and images of Realeneiland



Monuments

The Realeneiland is a mixture of old and new buildings. The island has been part of the third expansion of Amsterdam in the 17th century. On this map, the monuments have been highlighted. There is a row of captain quarters of the former VOC on the east side of the island, and throughout some other monuments are still visible throughout the plot.



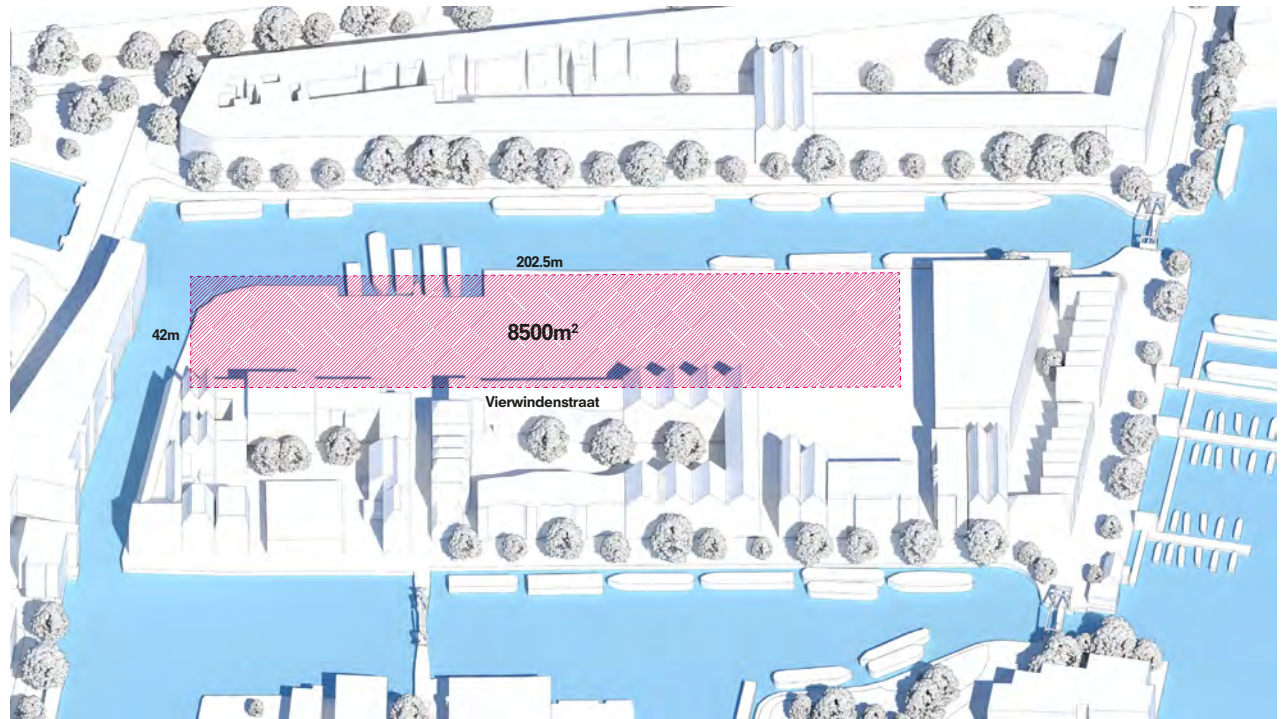
Social housing

Most of the buildings on the island are residences. A big part of these houses are social houses from the 1980s. As seen on the aerial on the previous page the vacant plots have been filled with social housing blocks over time. Their estimated functional lifespan of 50 years is already in 2030. How will this part of the city look like in 2100?

Site

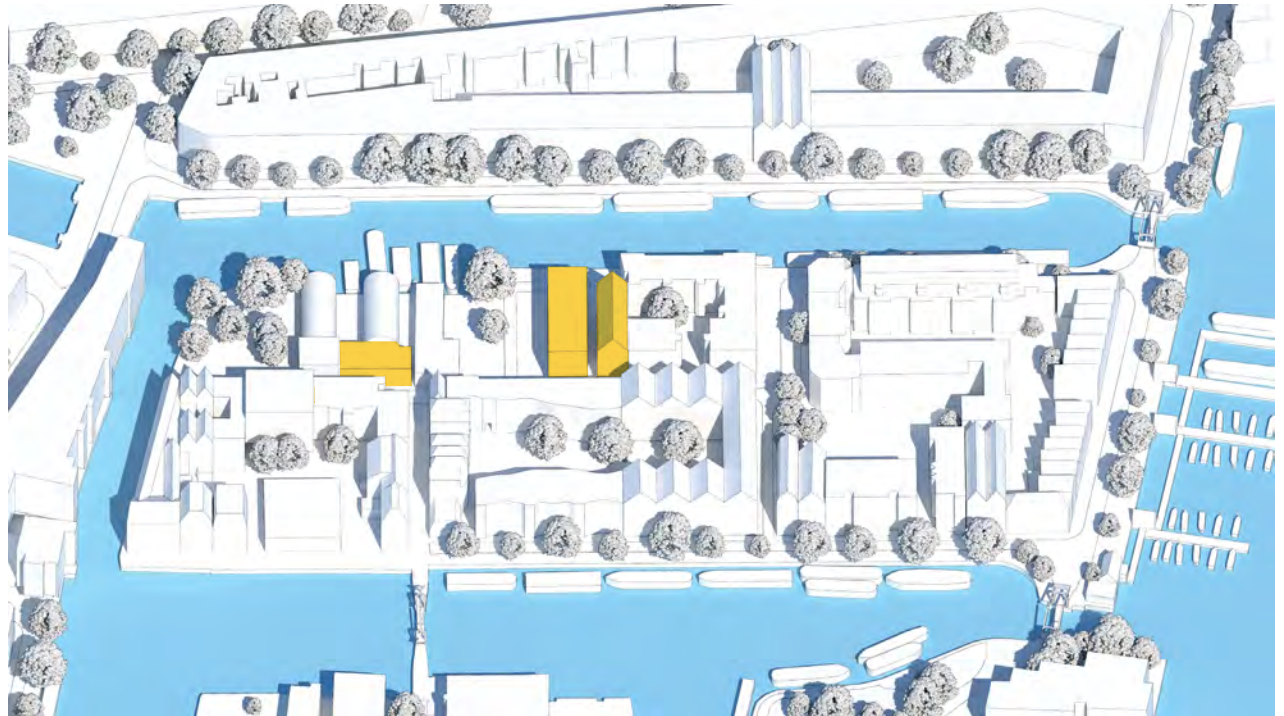
The building site of the project is 10800m². It is on two sides adjacent to canals and on the two other sides to residential blocks.

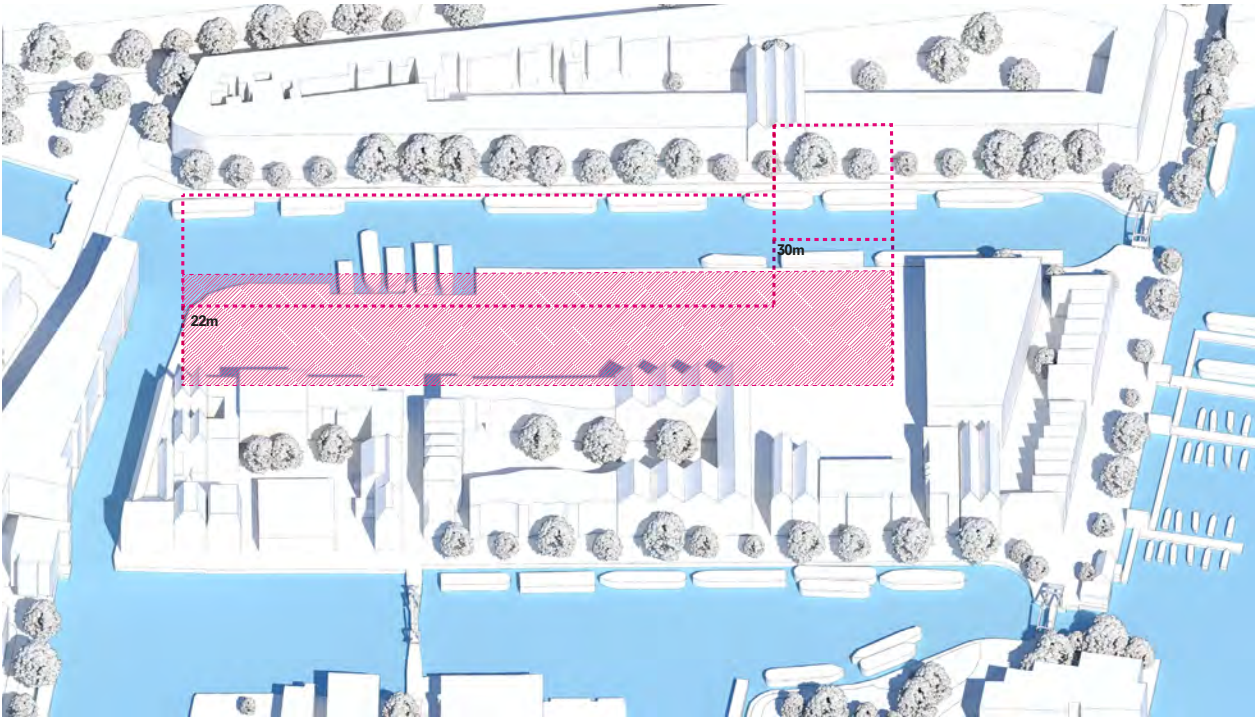
The main street along the site is the Vierwindenstraat.



Repurpose

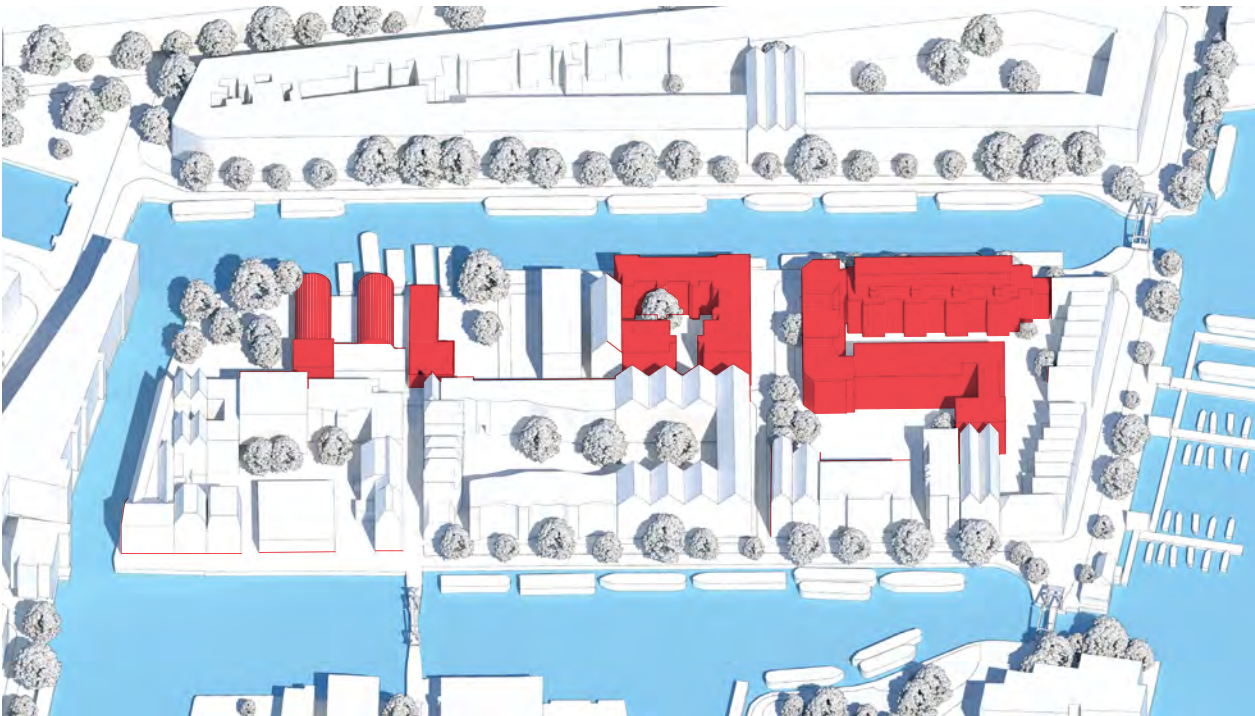
The project will re-use some existing buildings that are already on the site. These buildings are either monuments or of a high aesthetic and historical value for the city of Amsterdam.





Height limit

The building height of the site is limited to adjacent buildings and sunlight restrictions. Because the site is on the northern corner of the island, there is much shadow on the water and not directly on other buildings. There is space for a height accent on the east side of the site.



Demolish

Within the project site, there is a need to demolish some buildings to make room for the school building. Therefore the social housing blocks have to be demolished. By demolition, we can restore the structure of the urban plan of the island by placing a new residential block perpendicular to the project site and parallel to an existing street.

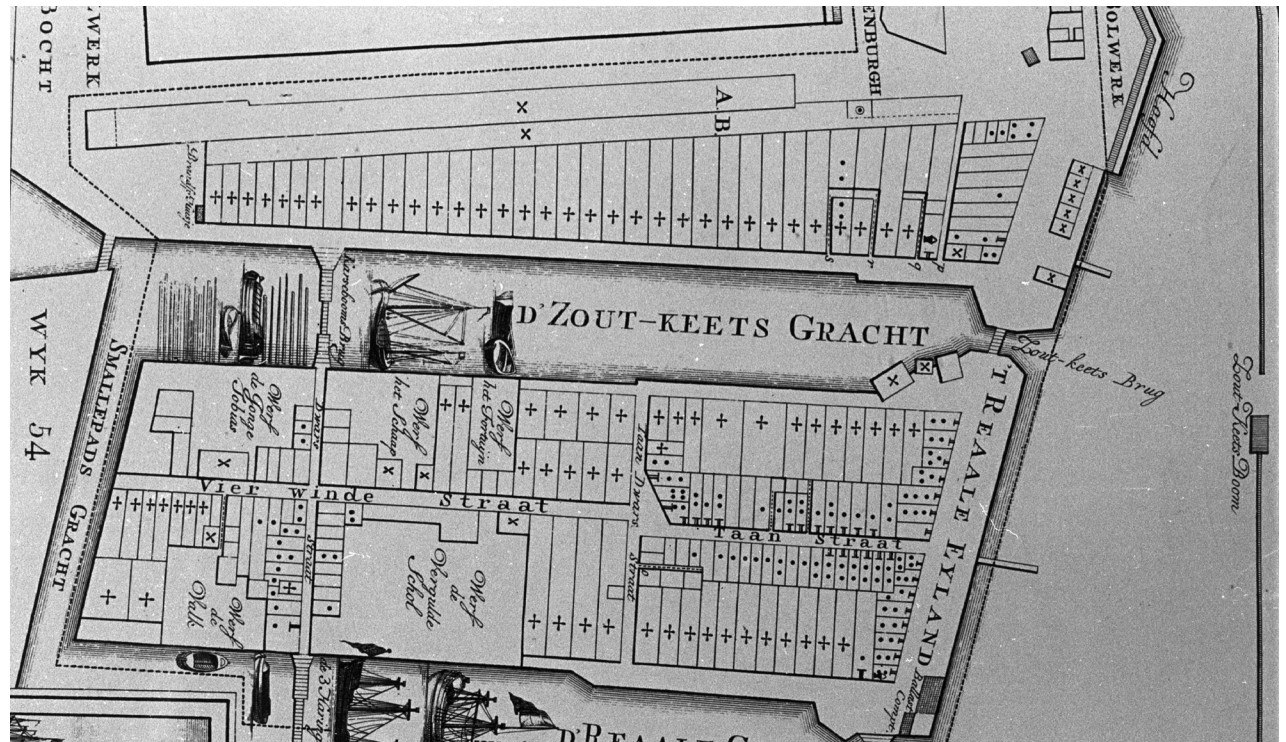
Implementation

Vierwindenplaats

The project is, on the one hand, a clear derivative from the concept, but challenges and opportunities of the context have had a significant impact on the implementation of the project. Set in a different context, not on a site that is rectangle, the building would have looked and functioned differently. The next pages will give more insight into how the project has been implemented in the urban fabric of Realeneiland. We need to give our school a name as well, since the learning of the 22nd century is a set ambition covering a multitude of school buildings, the name of the school has a relationship with Realeneiland.

Vierwindenstraat

In the year 2100, Realeneiland will have been part of Amsterdam for almost 500 years. The Vierwindenstraat has been part of Realeneiland for this period as well. The Learning space of the 22nd century is located along the Vierwindenstraat.





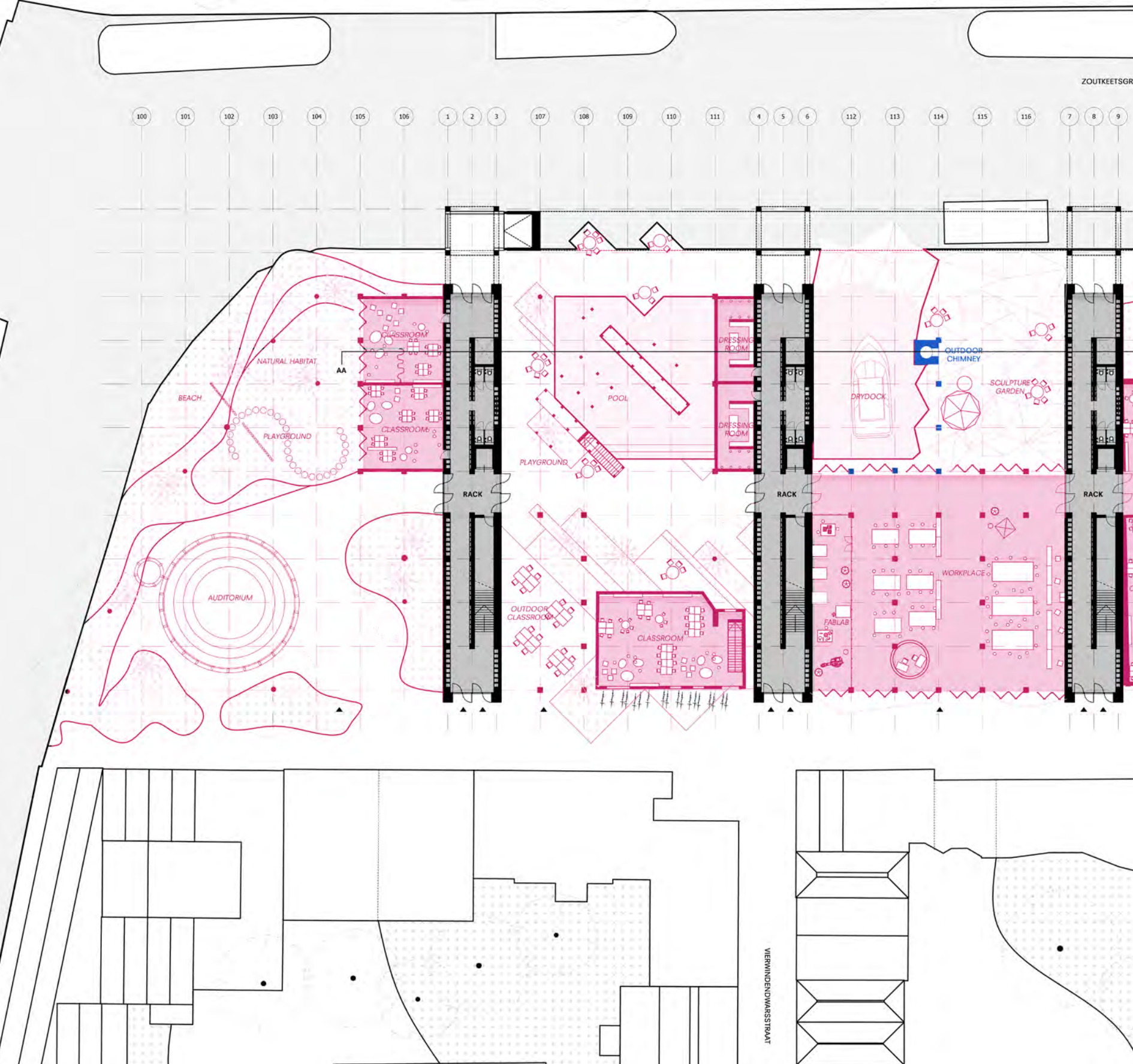
Vierwindenplaats

The learning of the 22nd century is a set ambition covering a multitude of school buildings, therefore we need to name this specific school. As the address of the school is the Vierwindenstraat, the school will be named Vierwindenplaats.

Vierwinden stands for the four wind directions and plaats is dutch for place.

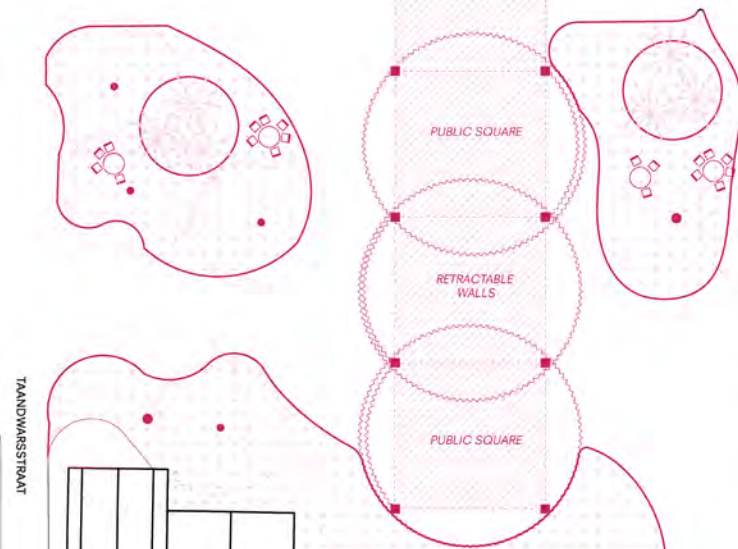
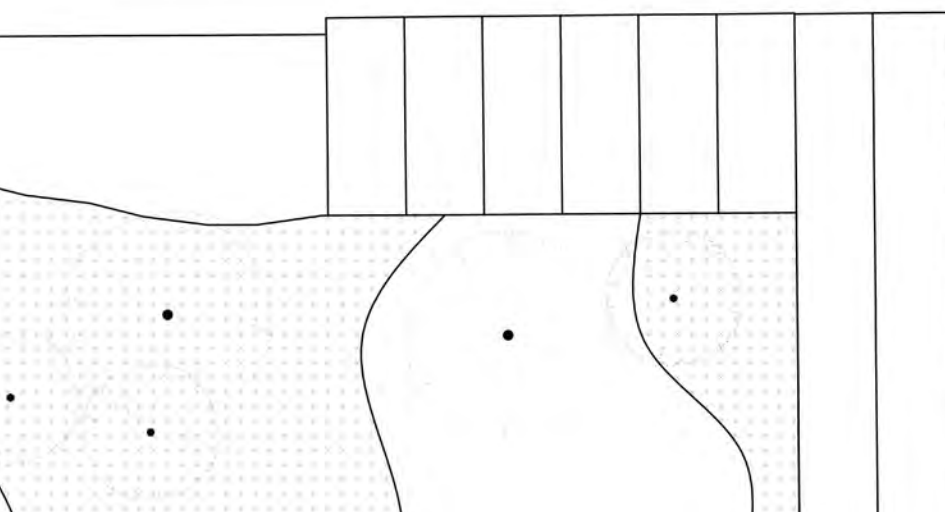
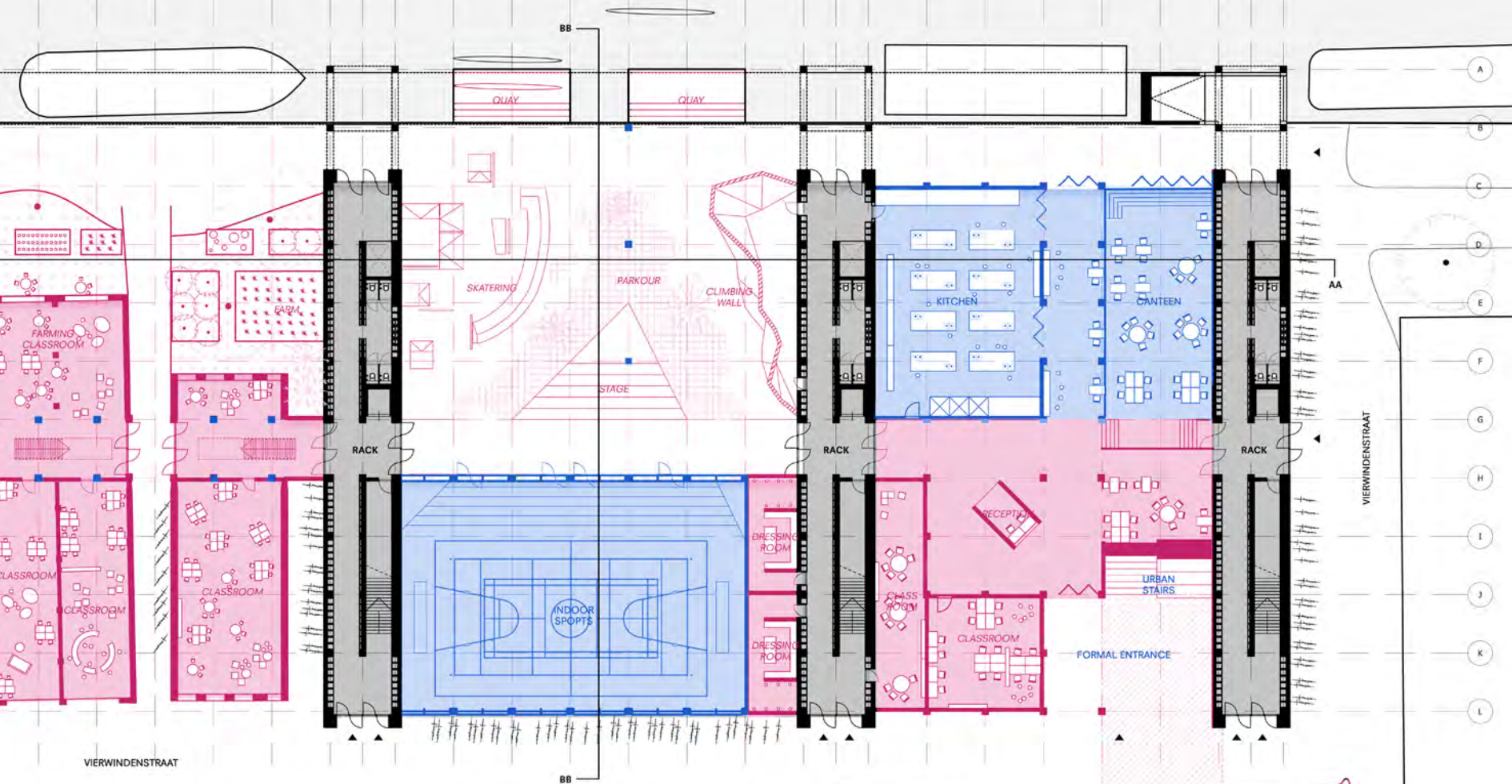
Ground floor plan

ZOUTKEETSGR



ACHT

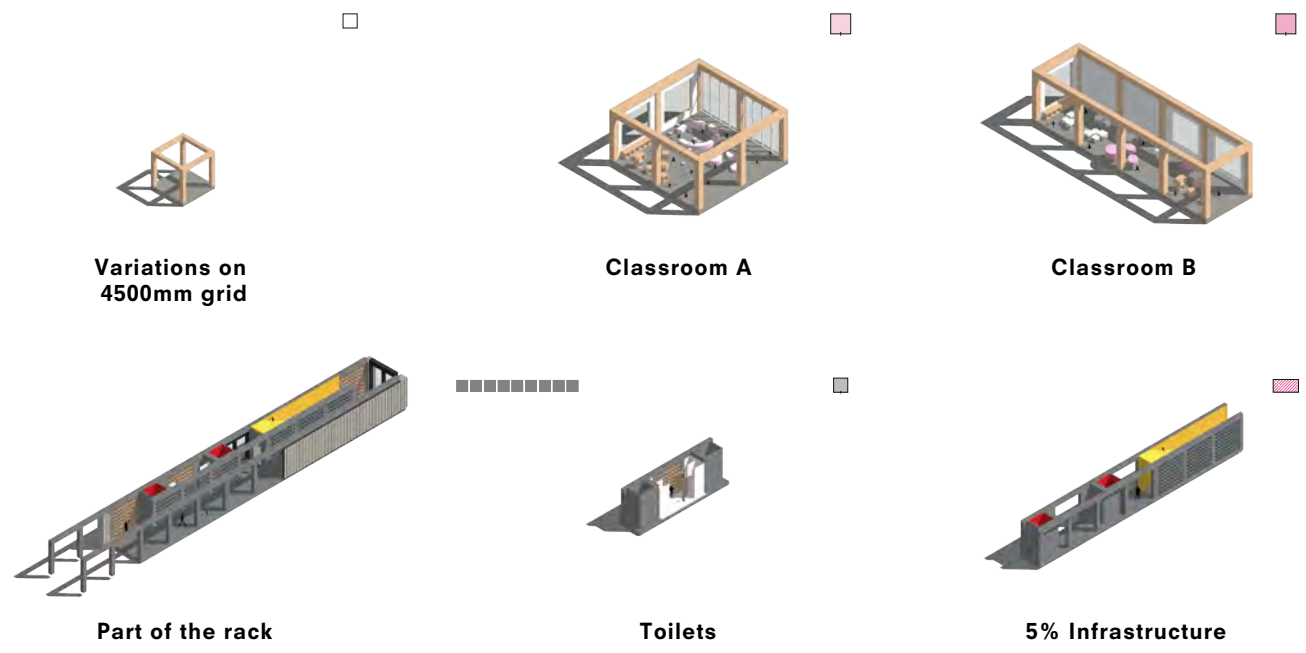
117 118 119 120 121 10 11 12 122 123 124 125 127 128 13 14 15 129 130 131 132 133 16 17 18



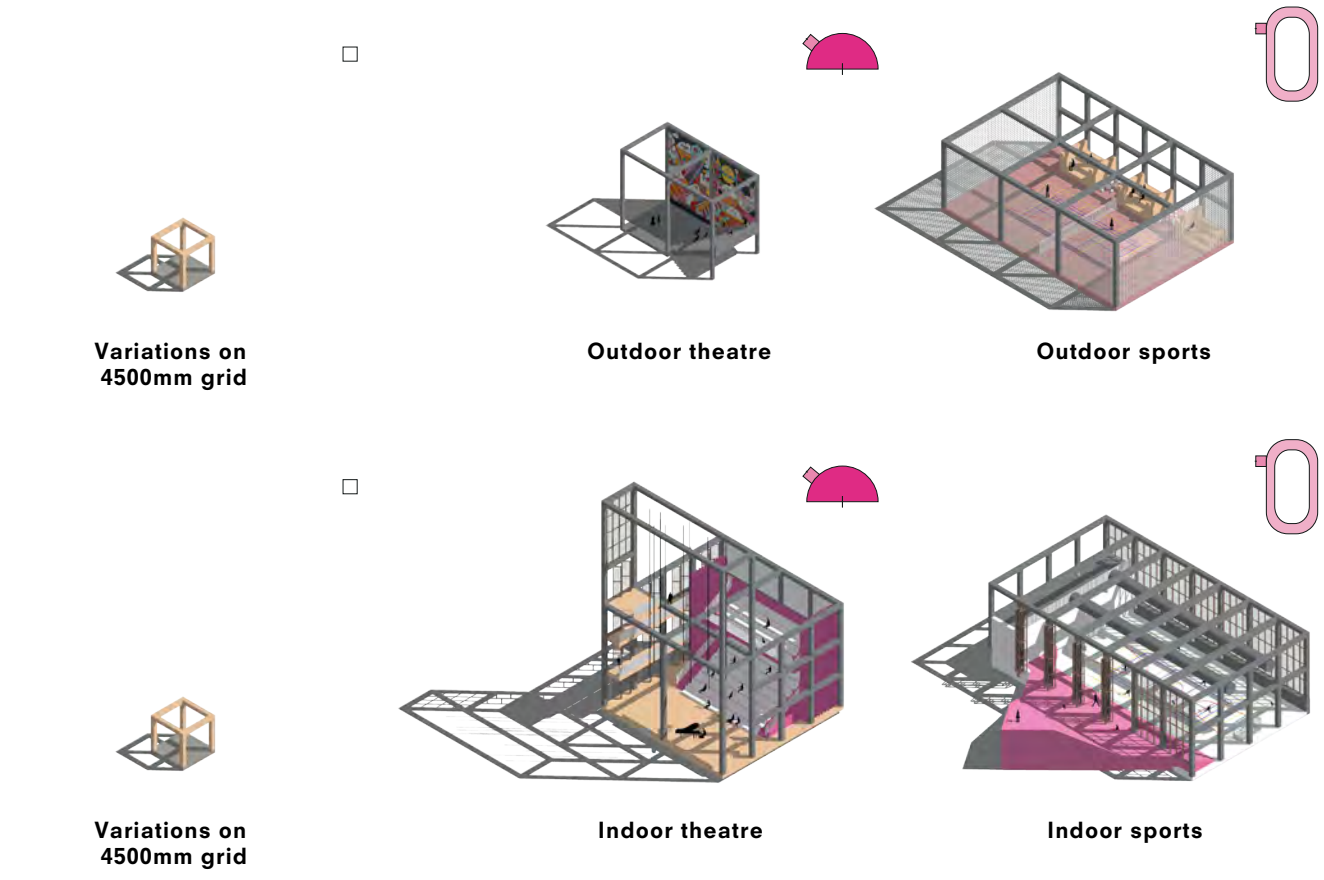




Generic ele



Specific ele





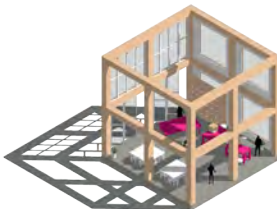
Classroom C



Classroom D



Classroom E



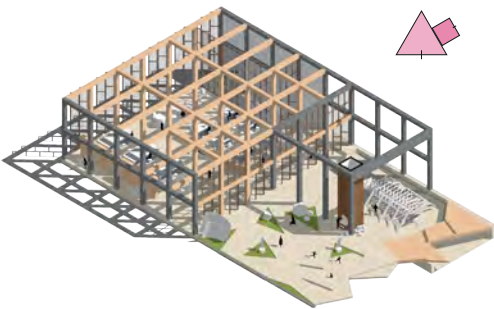
Classroom F



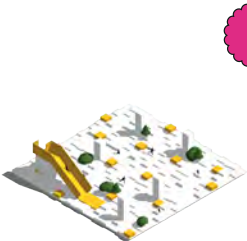
Storage



Reception



Workshop



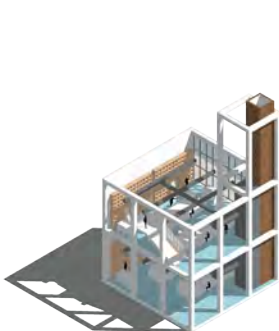
Playground



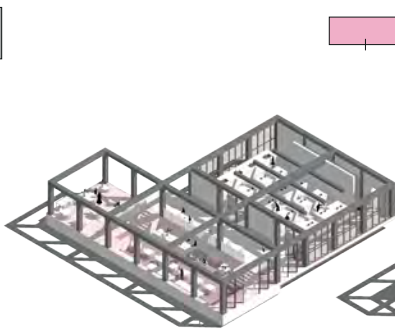
Natural habitat



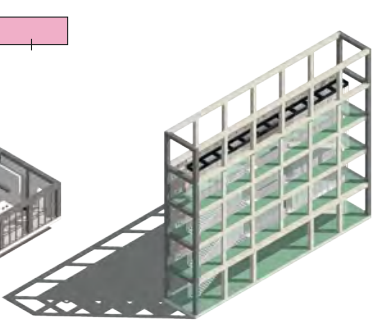
Empty



Laboratory



Kitchen

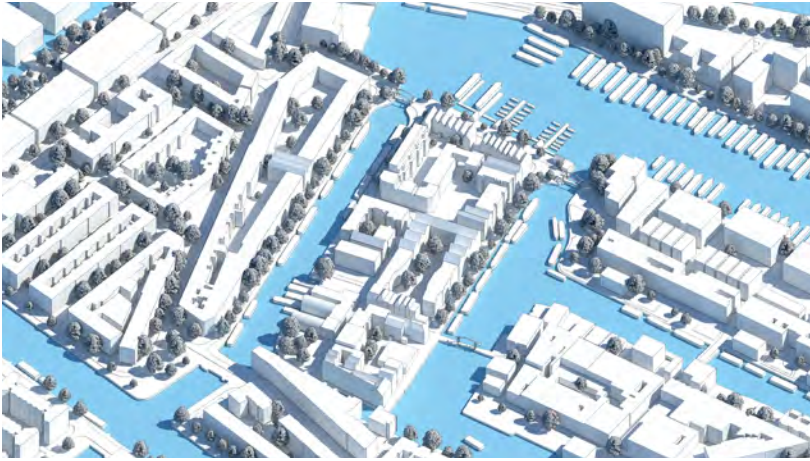


Library



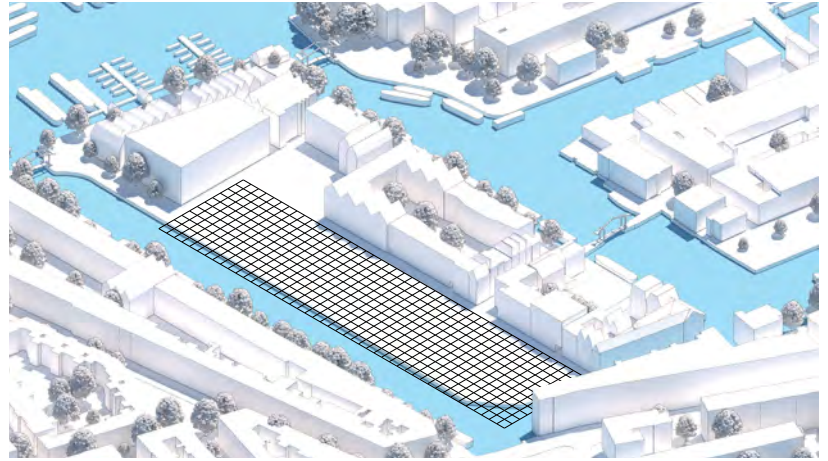
Existing structures

Existing situation



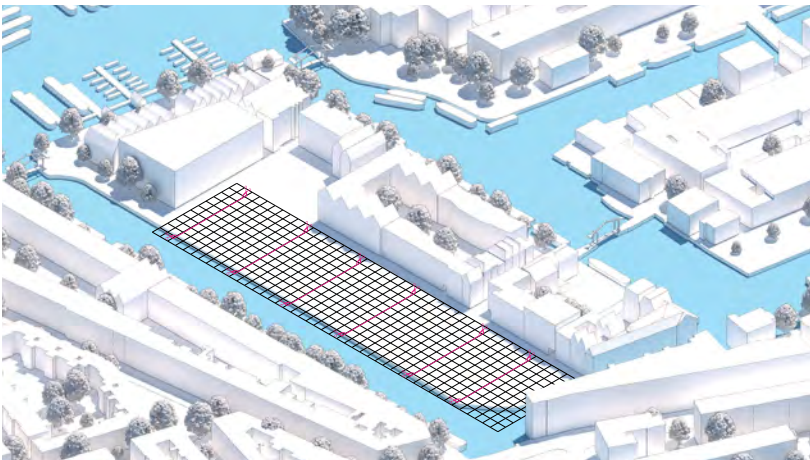
The site is located on the Realeneiland, on the edge of the historic city center of Amsterdam.

Modular grid



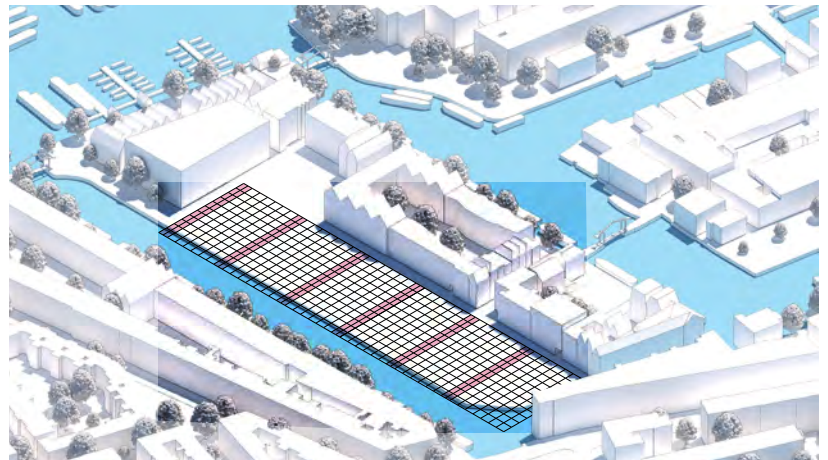
The modular grid of 4500mm x 4500mm is laid out over the plot along side the canal.

Cutout sections



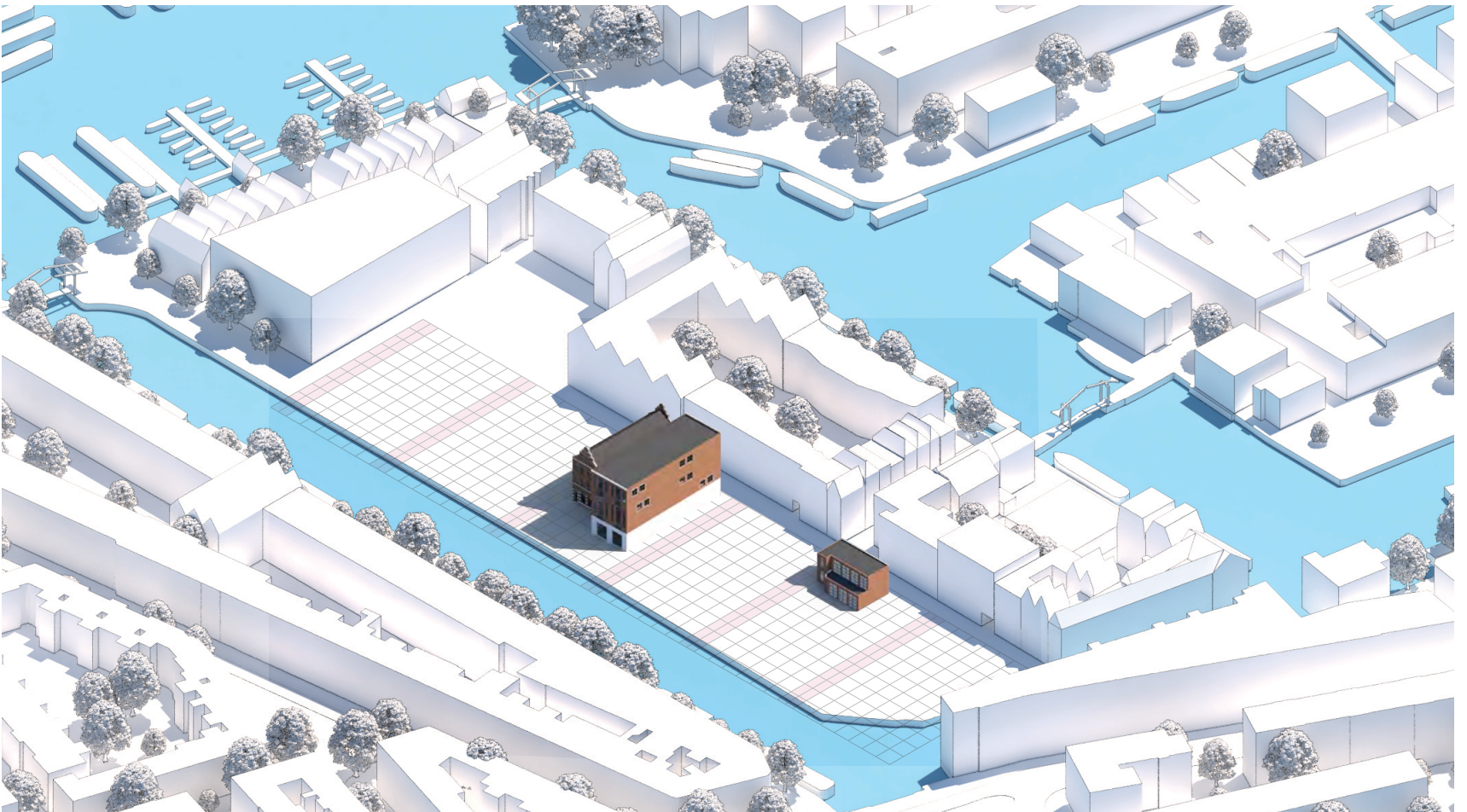
The modular grid is cut into pieces along its width.

Second modular grid



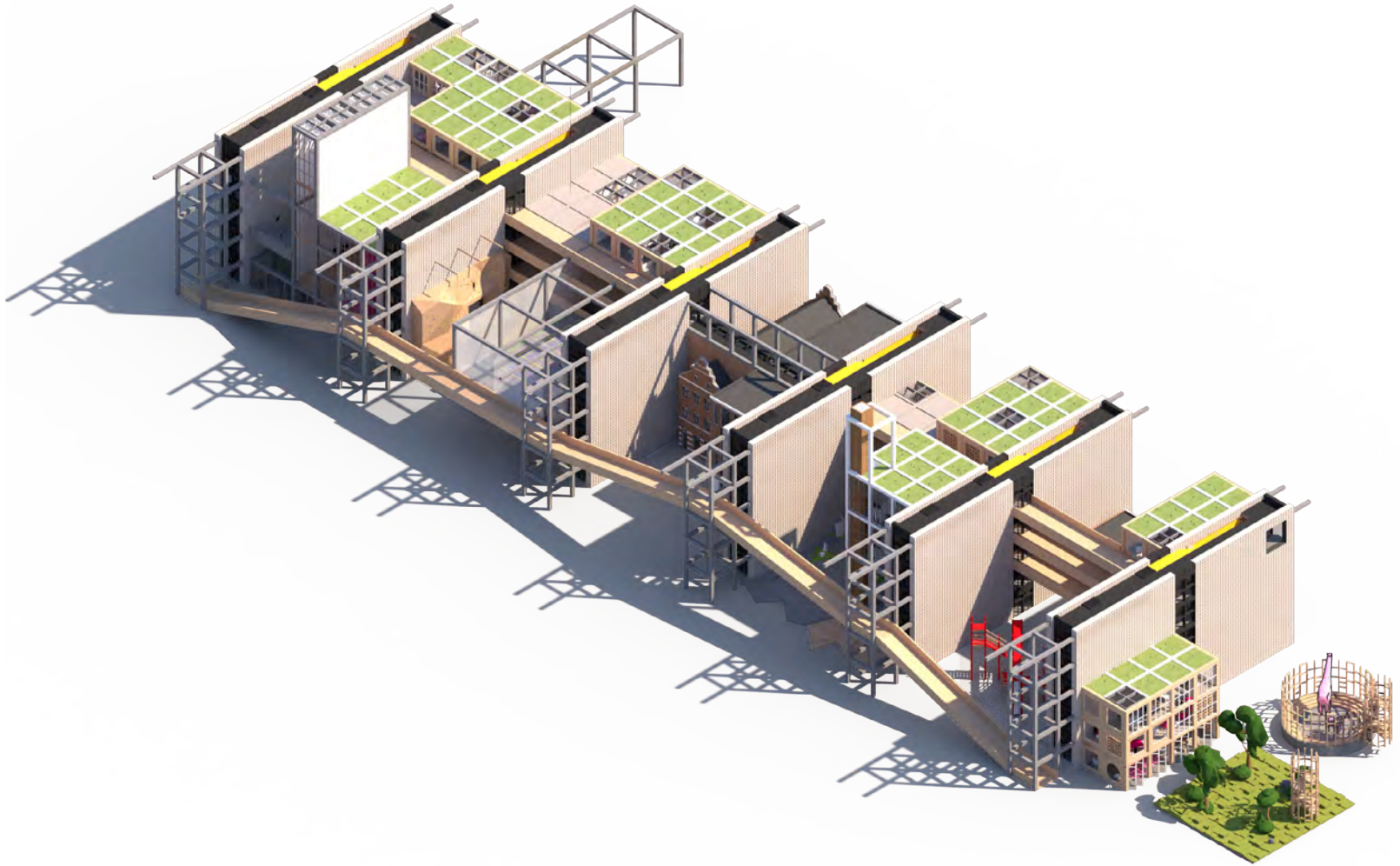
Along the width of the grid, a second modular grid is laid of 4500mm x (2500mm x 2). This second grid is solely for the racks to make them stand out.

Absorb existing structures



The grid now absorbs the existing structures that will be re-purposed.

Whole ensemble



Adding racks



The first floor of the racks is set on the second modular grid dividing the space in different districts.

Adding specific elements



Each district is filled with their specific elements for this particular moment of time.

Adding classrooms



Each district will now continue to grow vertically. More layers of the racks are added. Along side classrooms are added which are connected to the racks.

With facade and roofs



To conclude, the façades are added on all the structures and the slope and bridges in-between the racks over the sectors are created. The roofs are finished with greenery.

Specific elements





Outdoor theatre

Indoor theatre

Reception

Indoor sports

Kitchen/ canteen

Outdoor sports

Library

Workshop

Laboratory

Sculpture garden

Playground

Auditorium

Natural habitat



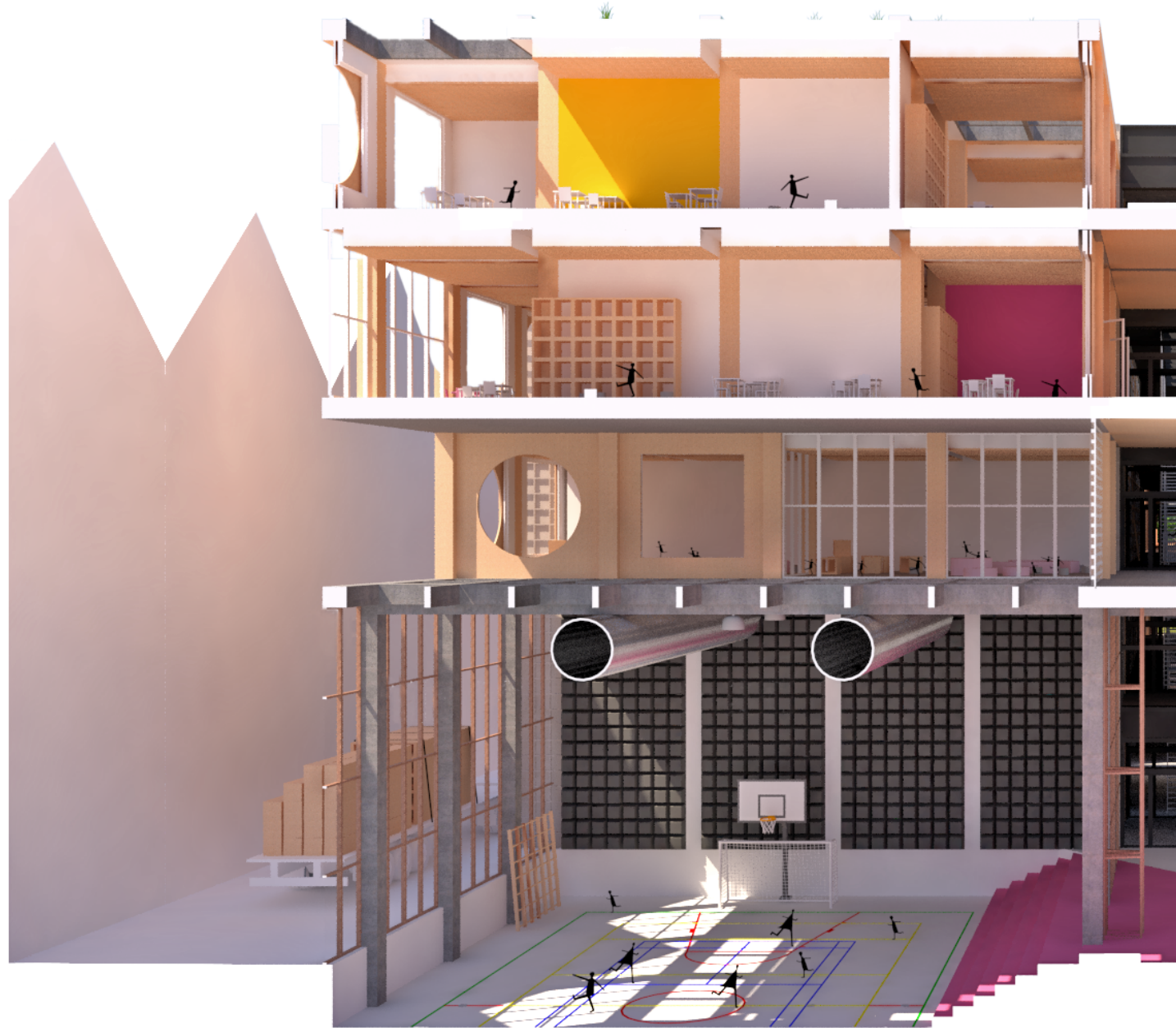
Section AA

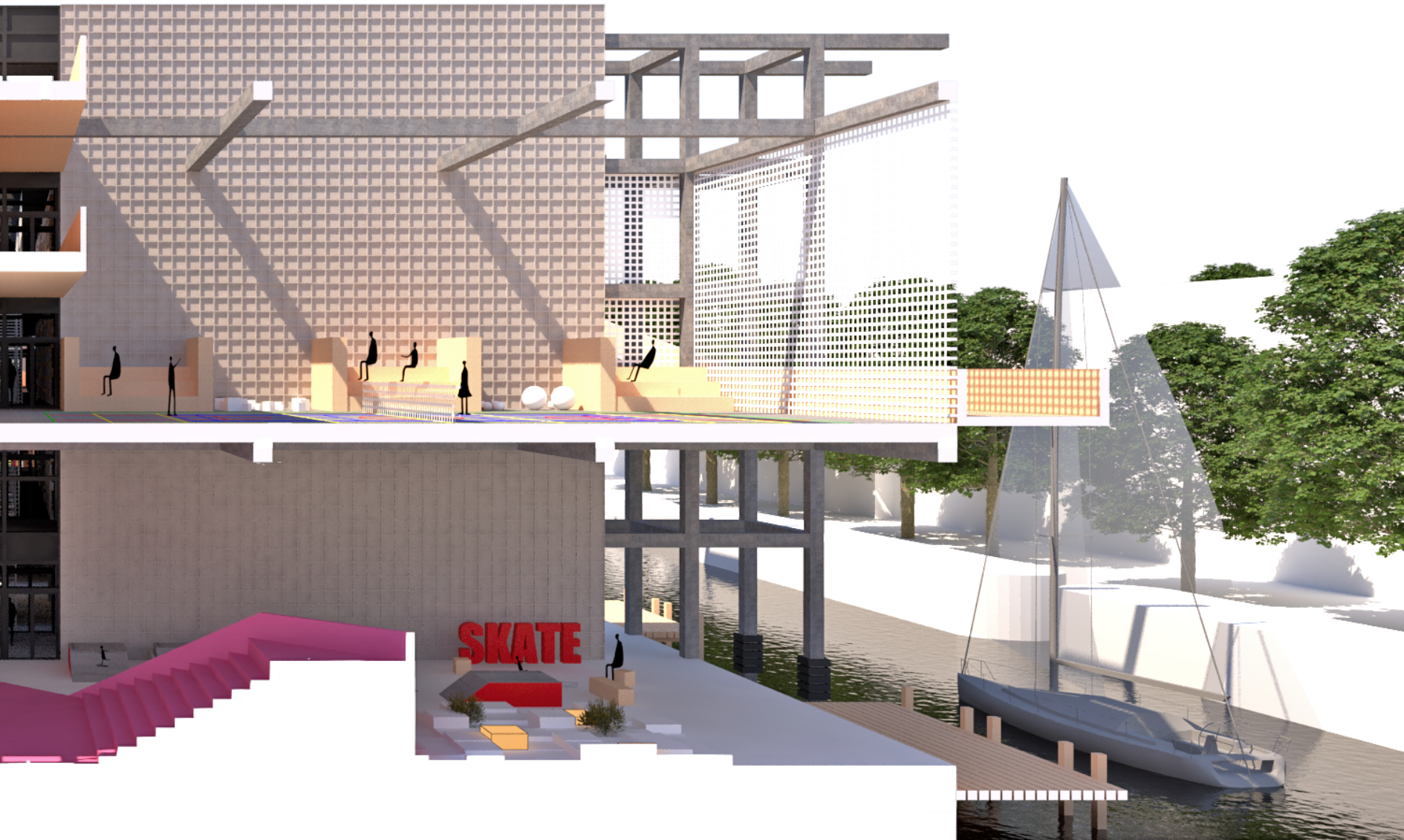
The longitudinal section of the building



Section BB

The section of the sports district

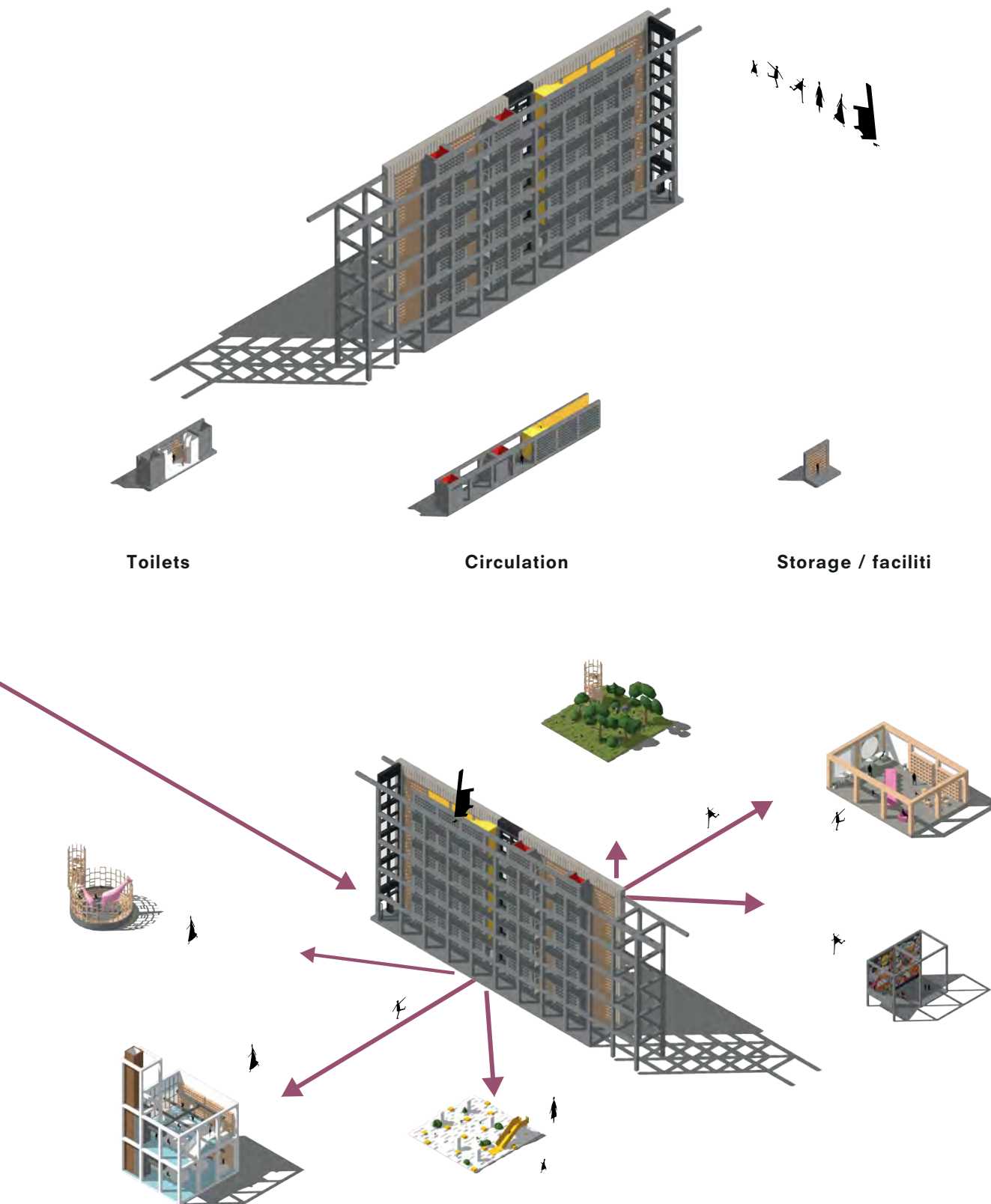








Viewwindenplaats - Implementation



Rack

There are six shelving racks in this building. All racks facilitate change in-between them.



Rack

Within the rack there are
toilets, storage, installations
and all circulation goes
through the racks.







Classrooms

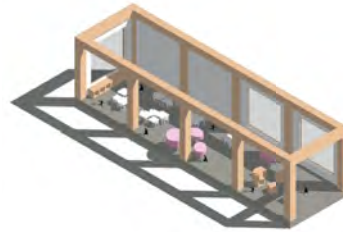
The configuration of the classrooms is endless, these are examples. They exist out of at least four modules.



Landscape

age: 0-4

A (40)



Generic

age: 4-6

B (25)



Generic

age: 6-9

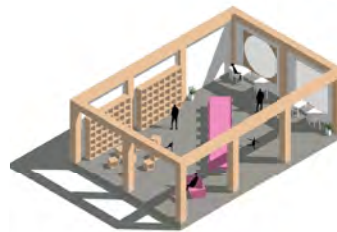
C (25)



Generic+

age: 9-12

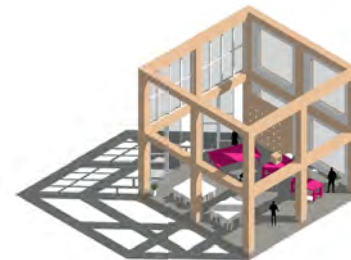
D (15)



Generic+

age: 12-15

E (15)

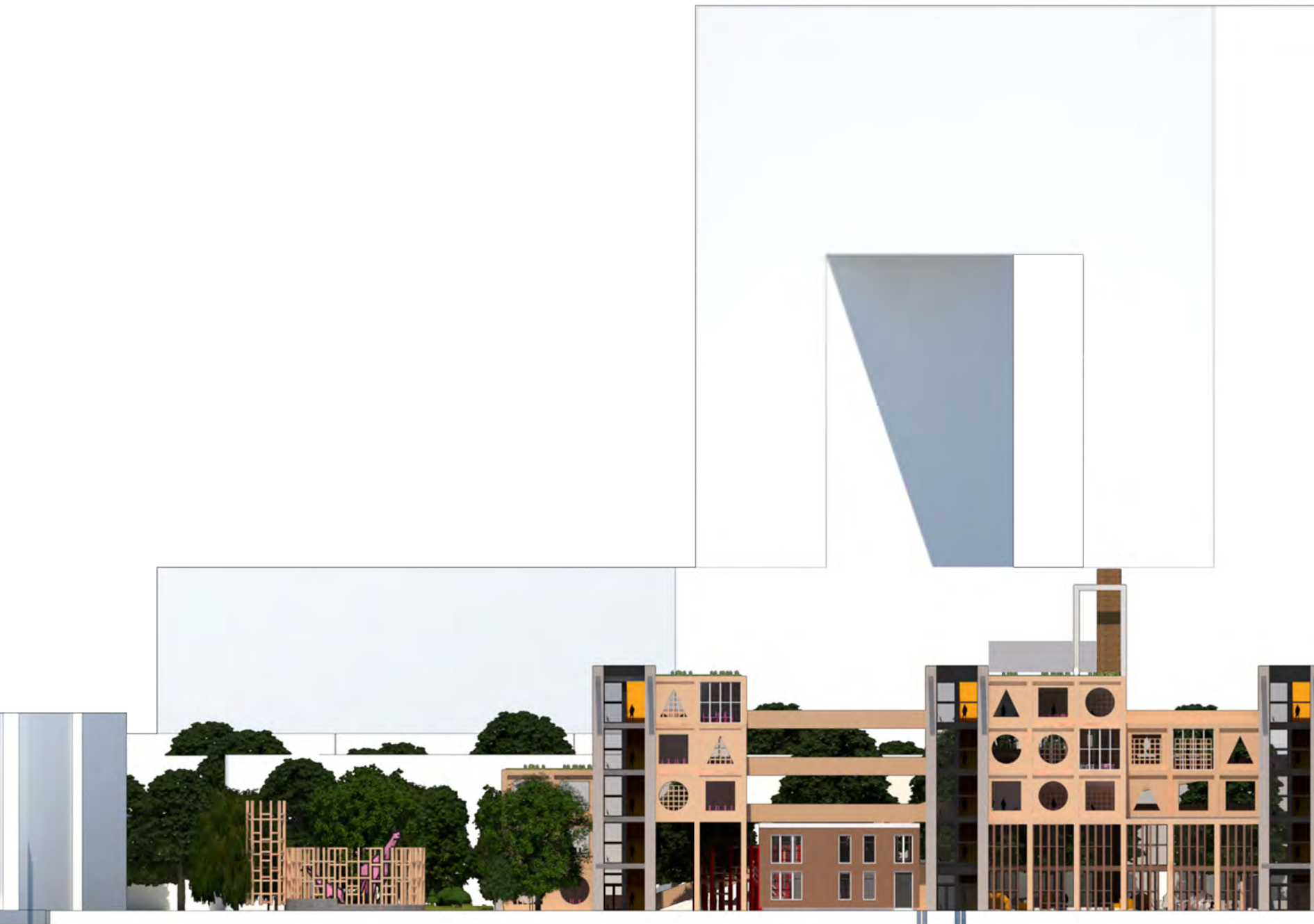


Specific

age: 15-18+

F (15)





South elevation

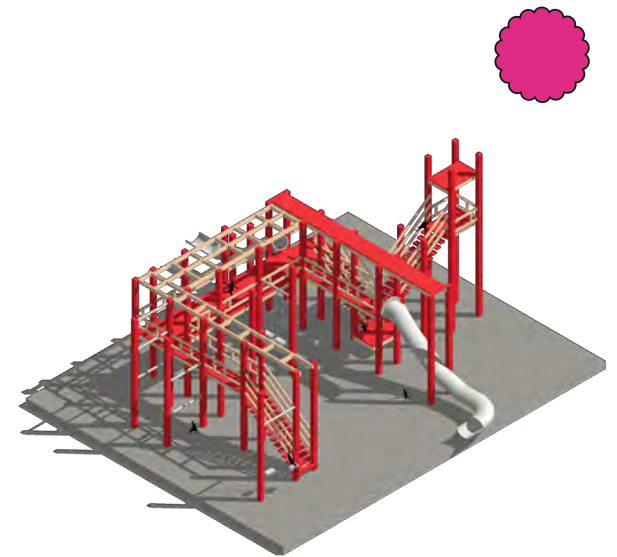
This side of the building is situated along side the Vierwindenstraat.











Playground

10m

20m



North elevation

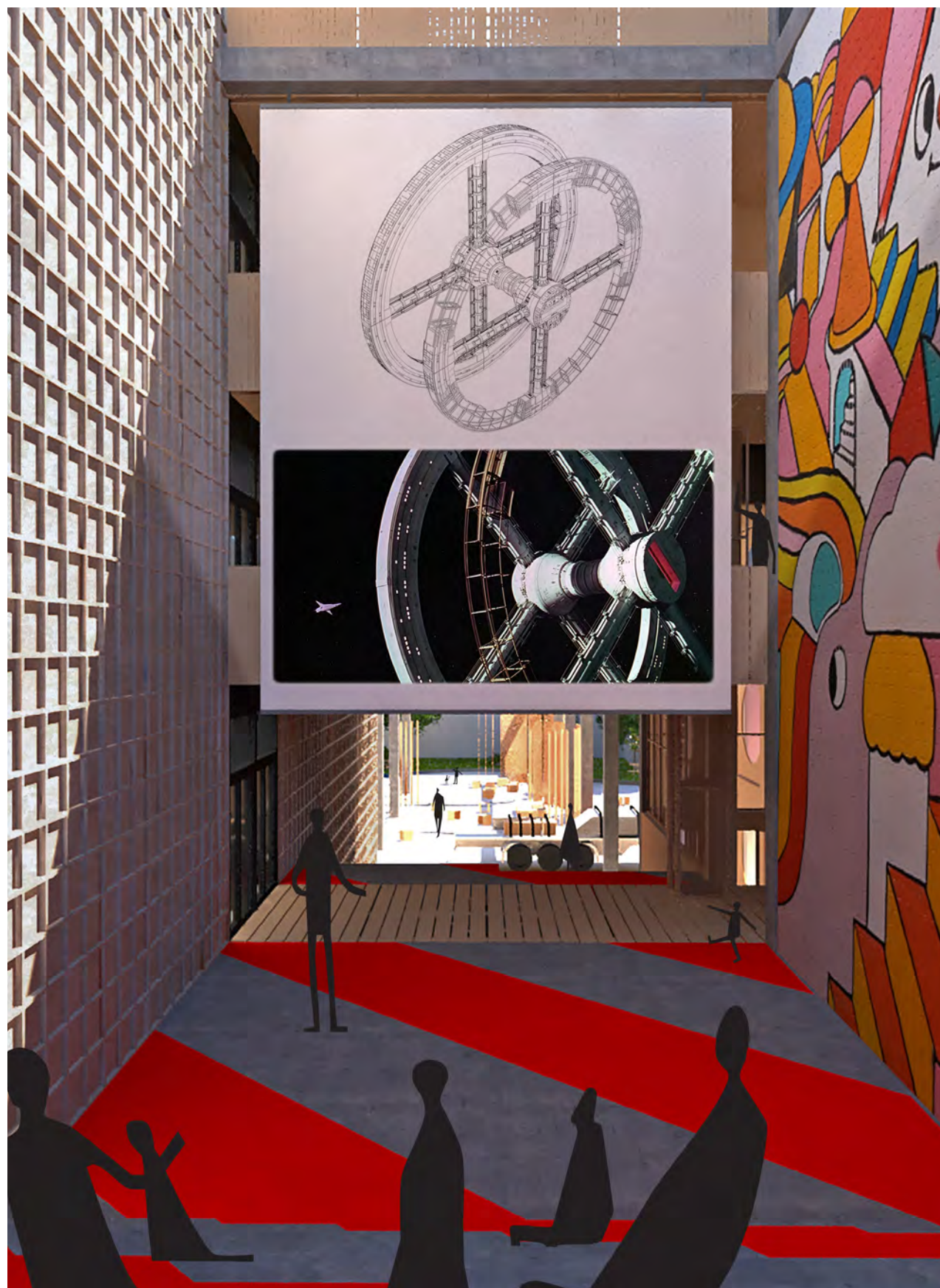
This side of the building is situated along the Zoutkeetsgracht.



Theaters

There is an inside and outside theatre.

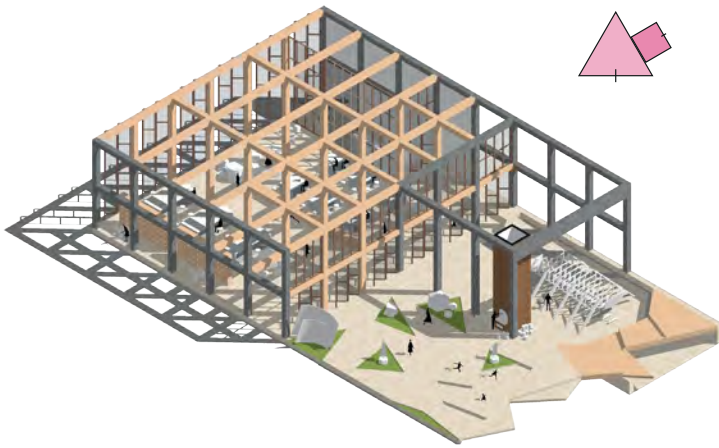




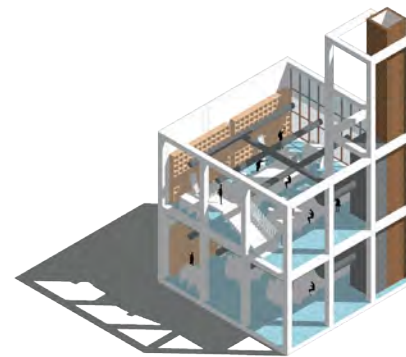


WELKOM
VRAGEN
SLEUTEL
KWIJT?
PLEISTERS





Workshop



Laboratory





East elevation

This side of the building is more urban.



West elevation

This side of the building is less urban and forms a park.









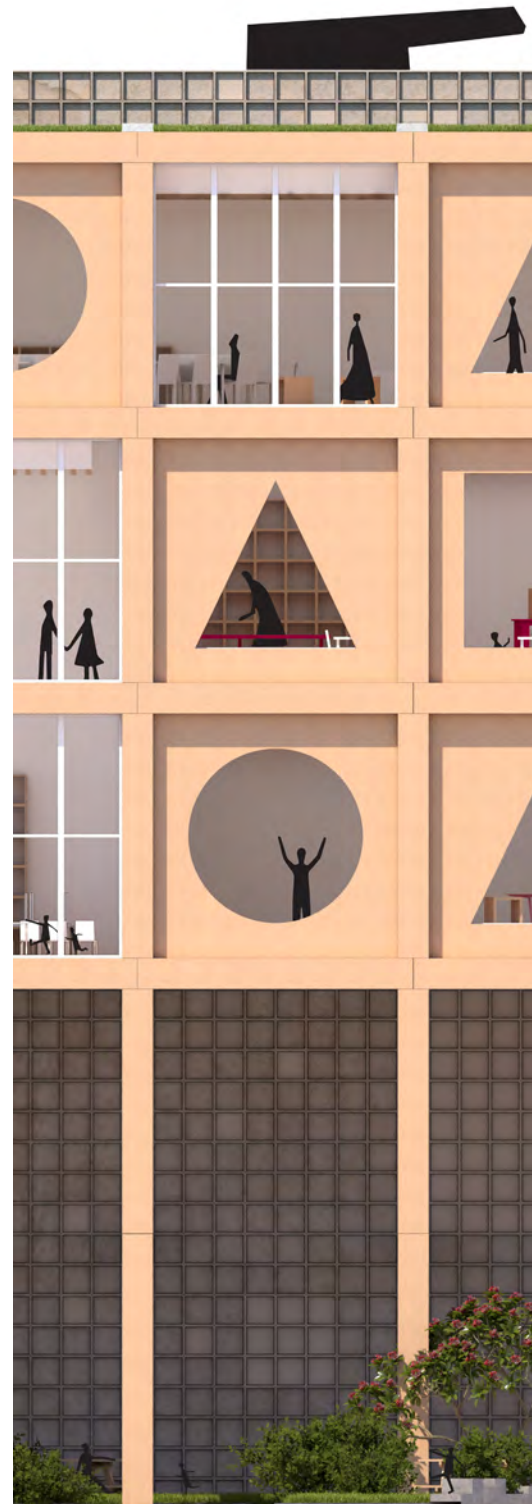
Facades

Design principles for exterior and interior finishes

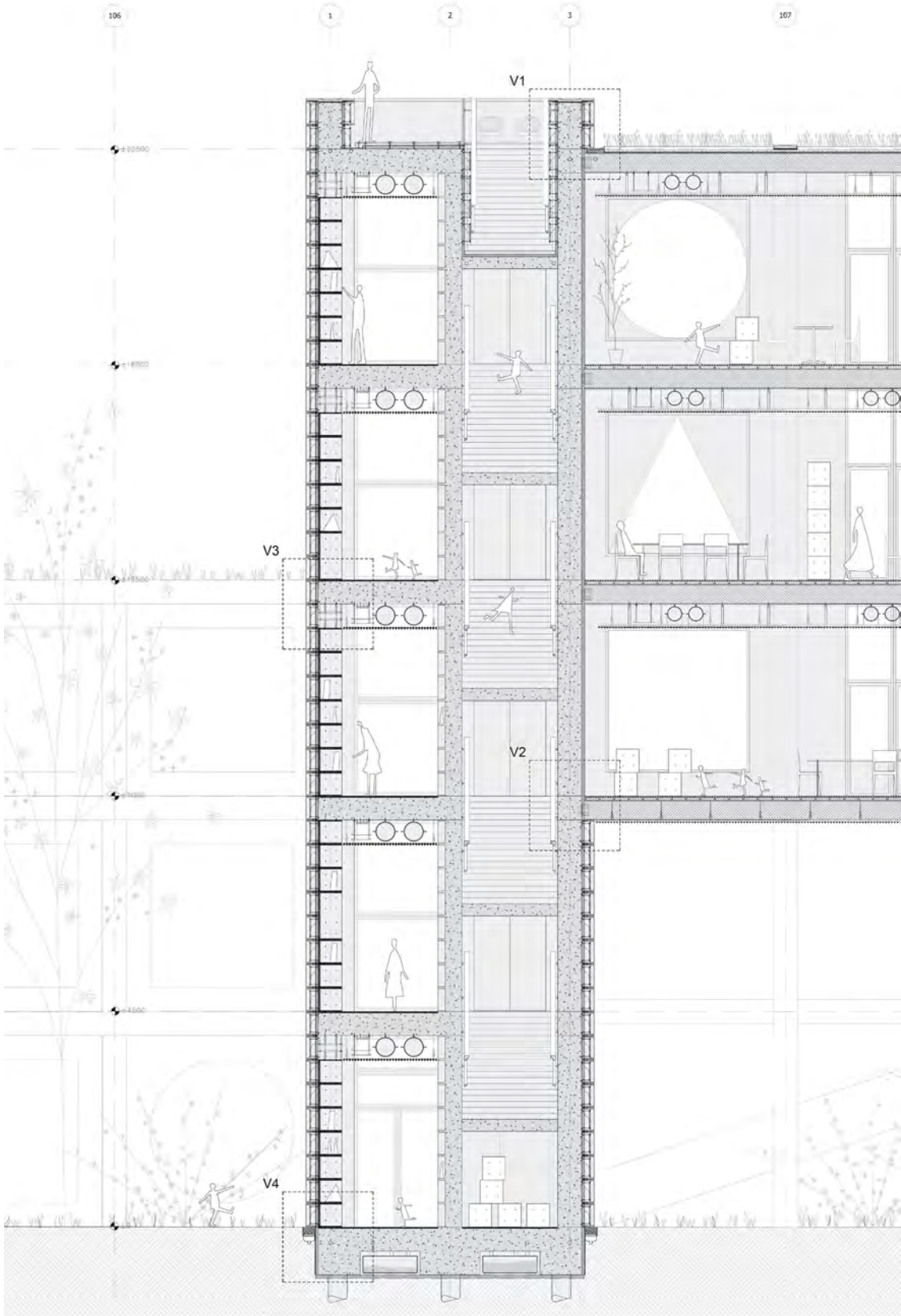
One of the architectural ambitions is that the materials should reflect the ideals of the building. To meet this requirement, a matrix of temporariness was set up that formed the basis for the design decisions. The facade is one of the most important parts of the building. Next to the fact that people use buildings, they are appreciated, appropriated and opinionated mostly by people who do not use them, or will never look inside. A facade that is welcome in your backyard is a welcoming feature in all architecture. The facade of the Vierwindenplaats is a mixture of different types of facades, each representing the various types of elements present within the building.



Facade of a rack



Facade of a classroom





Three types of facade

There are three distinct types of facades corresponding with the stratification of the project into three distinct layers: permanent elements, semi-permanent elements, and temporary elements. This is the 2100 situation, the project can adapt itself away from any preconceived ideas surrounding the facade.

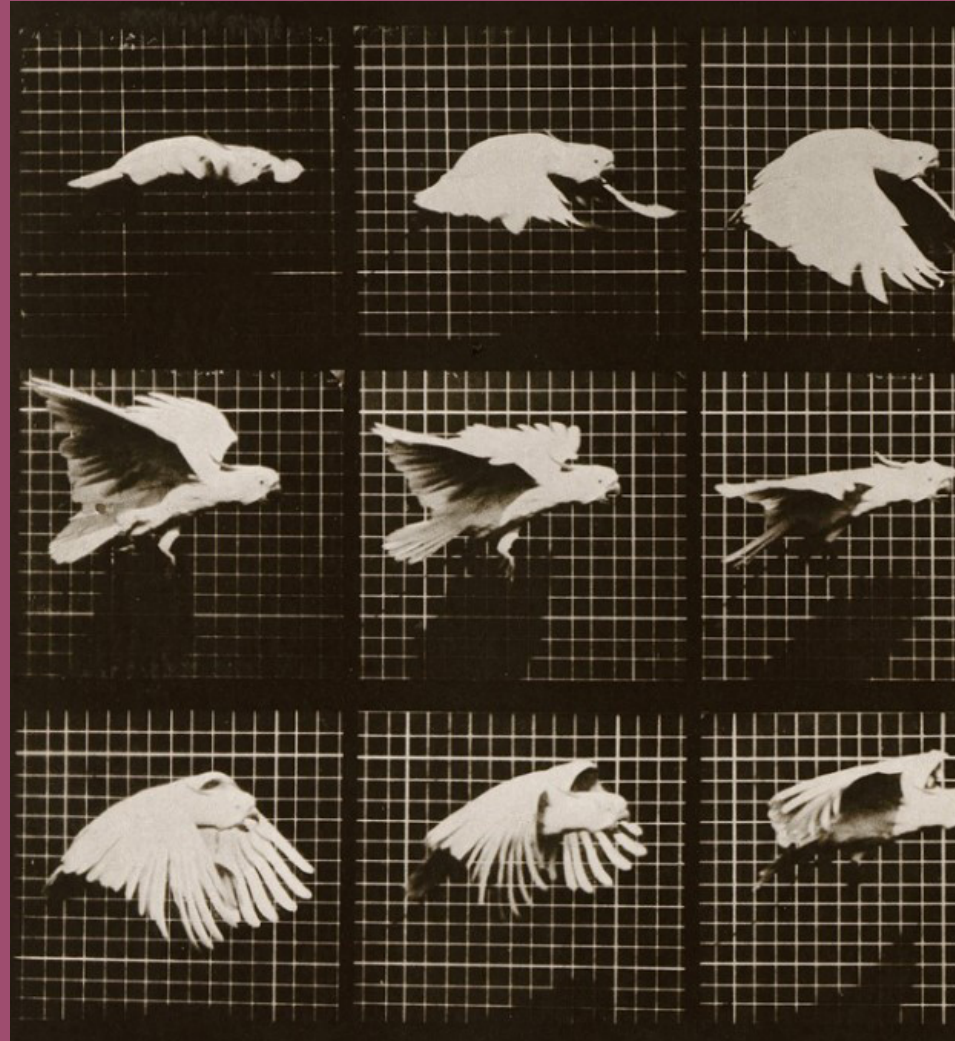


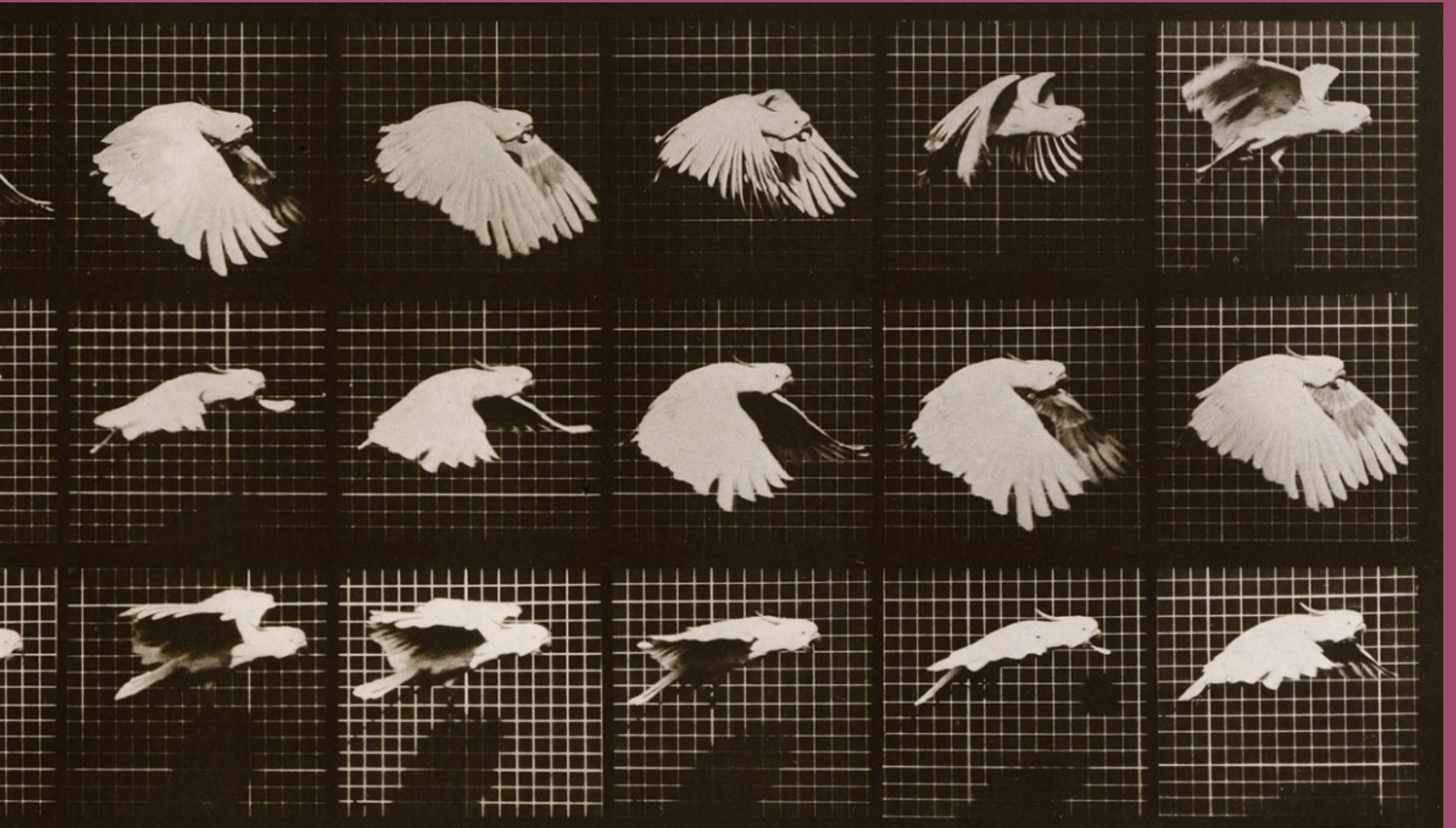
How to show change

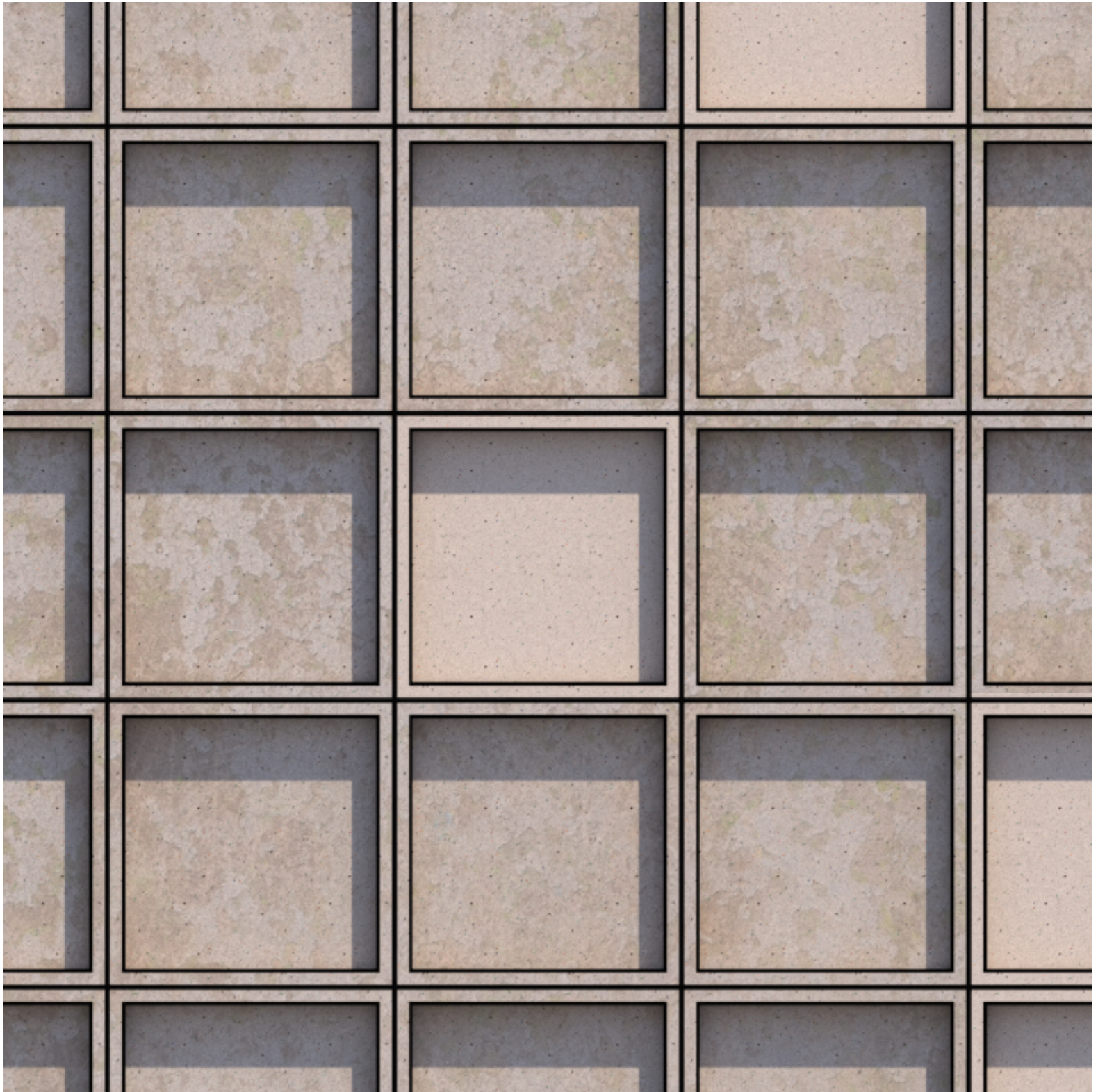
If the concept of the building relies on the notion of putting spaces in and out of a building, just as you put stuff into a shelving rack, then it would be necessary for the design to communicate this movement. Because this is an architectural ambition set by the project. How to show change when change is slow, like in the construction of a building? If we look into the work of Eadweard Muybridge we find a direction. Muybridge was a photographer from the 19th century capturing movement that was until then unable to be seen by the human eye. A new invention, the camera made it possible

to capture the increments in-between the movement. It shows how animals and humans were using their muscles to move.

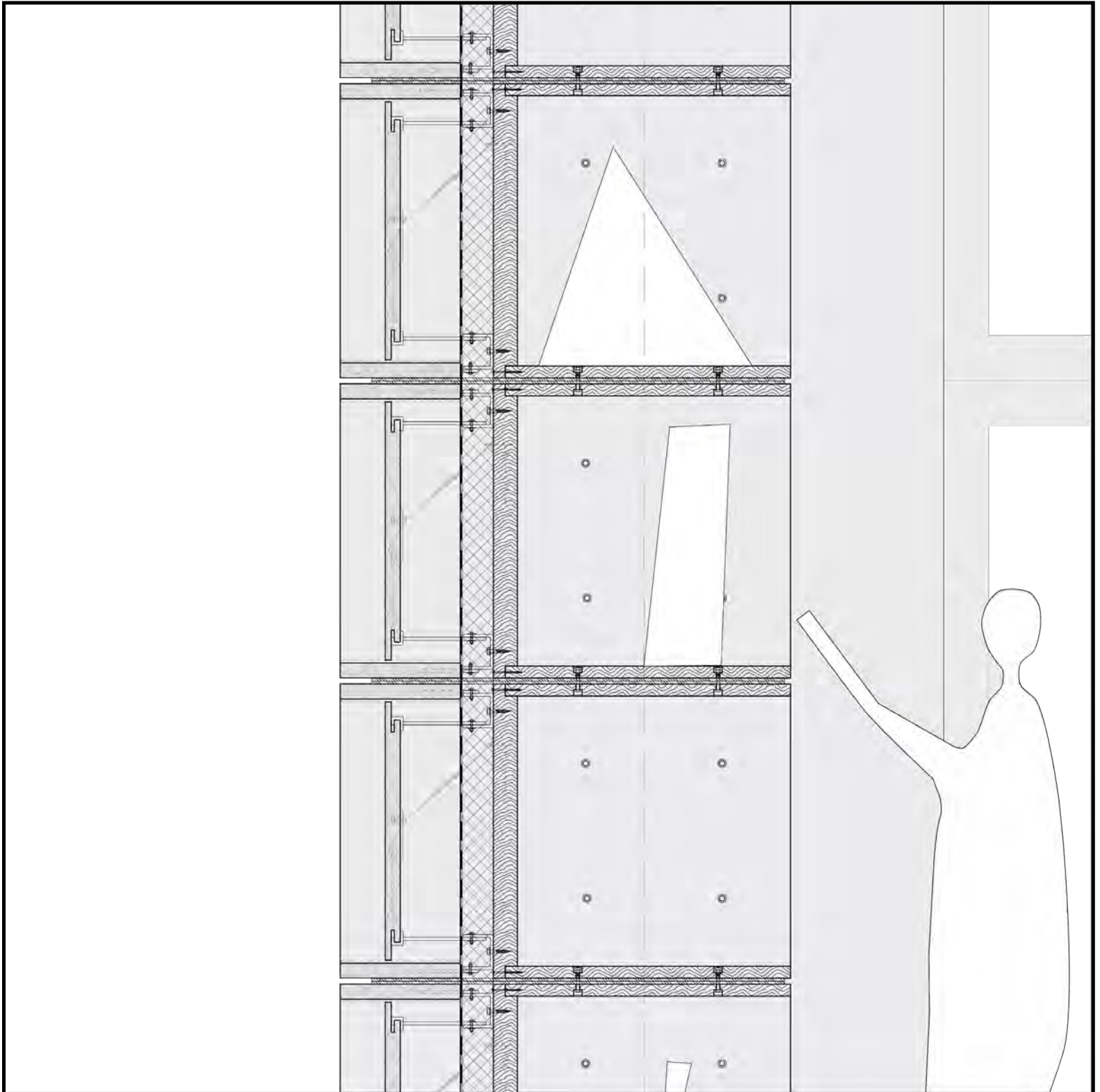
Within the pictures taken by Muybridge the movement is juxtaposed to a strict grid. The grid makes it possible to relate the movement to something abstract. What if we could use a grid in our building to show movement as well?

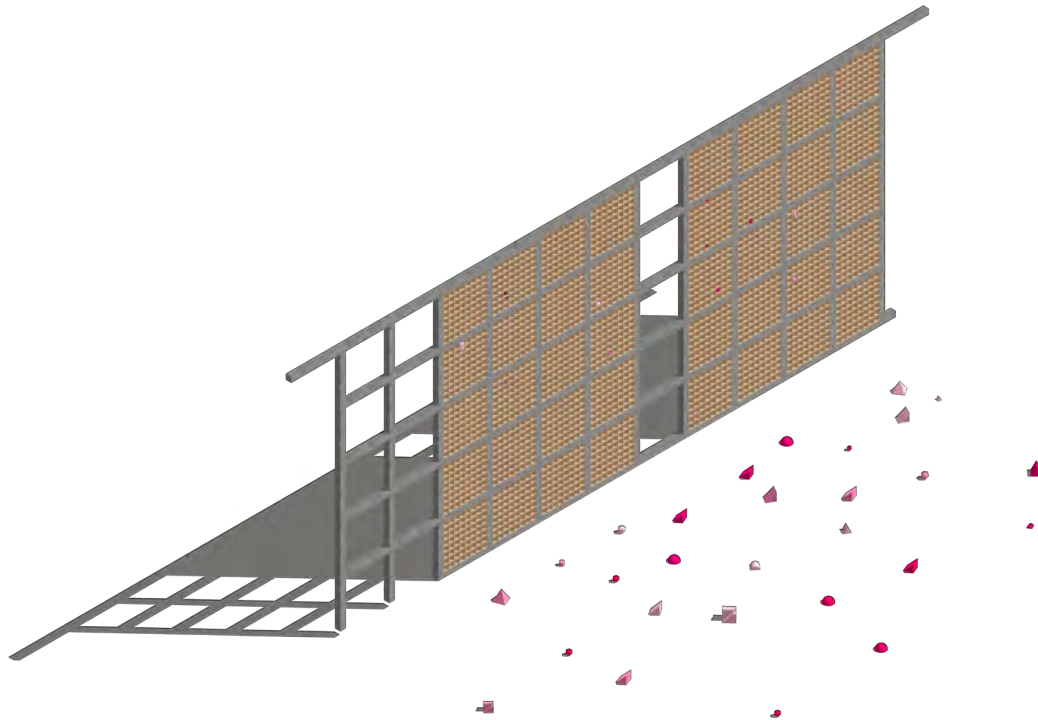






Detail of rack facade





A rack for spaces and a rack for stuff

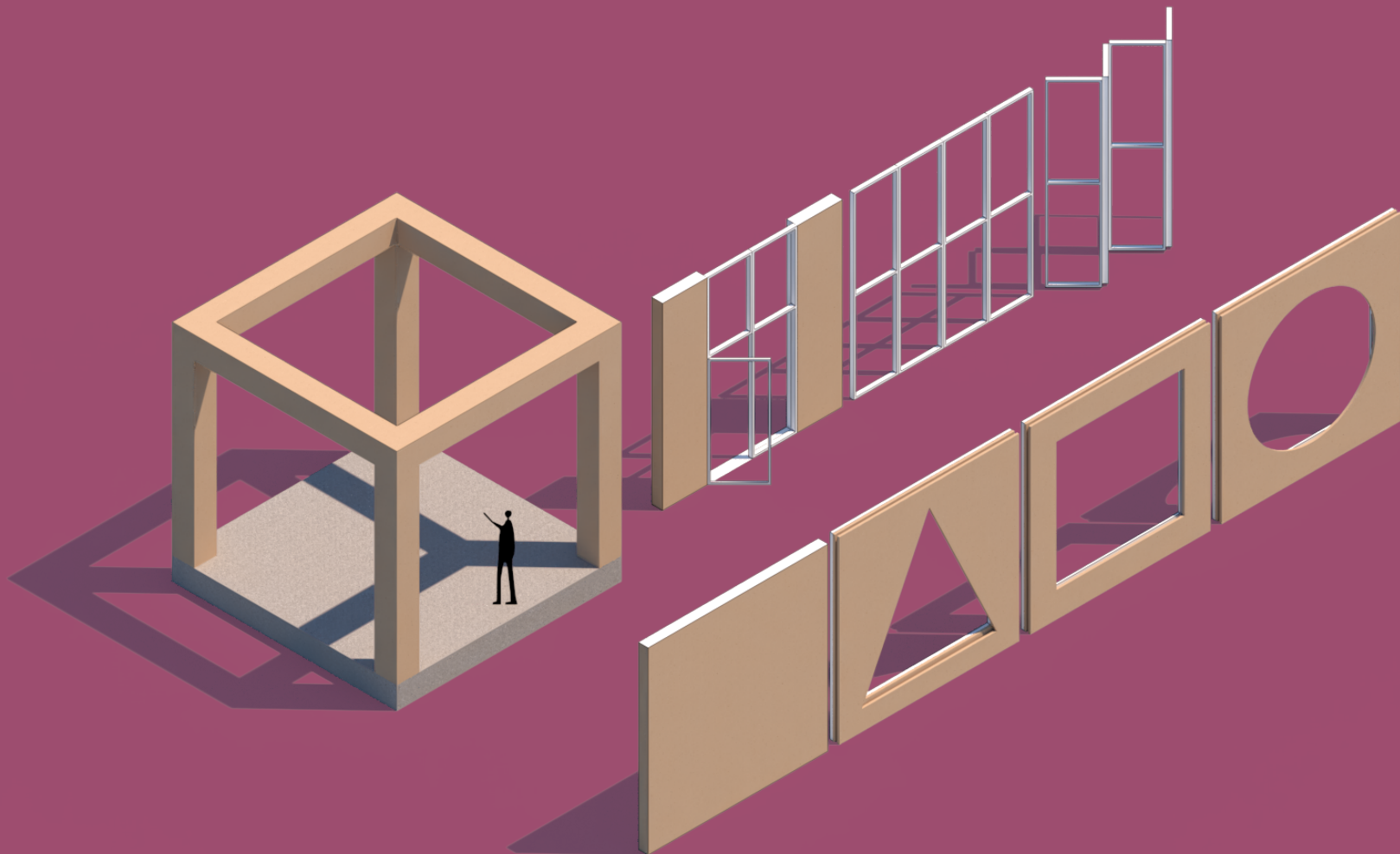
While the building as a whole can be understood as a rack for spaces, the interior is made out of racks for stuff. This makes a human connection with the notion of putting stuff into and out of the building. A notion that, on the scale of the building, is not related to humans anymore because this is a totally automated process. The boxes that form the shelving racks come in different modules for different purposes.



Modular elements

All classrooms and some other supporting facilities will be made out of modular elements, which will be entirely demountable. The facades of these elements consist of modular parts which can be replaced and transported by preference of the users. All windows in-between the 4500mm grid construction will be rectangle on the inside. On the outside is a second

layer of wooden skin that sits above the rectangle window. This wooden skin can be either a triangle, circle or rectangle. This gives identity to the building on the level of youngest pupils. The wooden skin is made out of a slab of CNCed CLT and is structurally connected to the framework to help stabilizing the structure.



Variations on grid

The specific elements are based on the 4500mm modular grid. But this is only valid for the 2100 situation, over time the building absorbs and excretes elements that might not fit the grid anymore but are the best fit to house their specific activities



Chapter 6

A PERMANENT SITUATION OF BECOMING





Automation of construction

Buildings constructing themselves

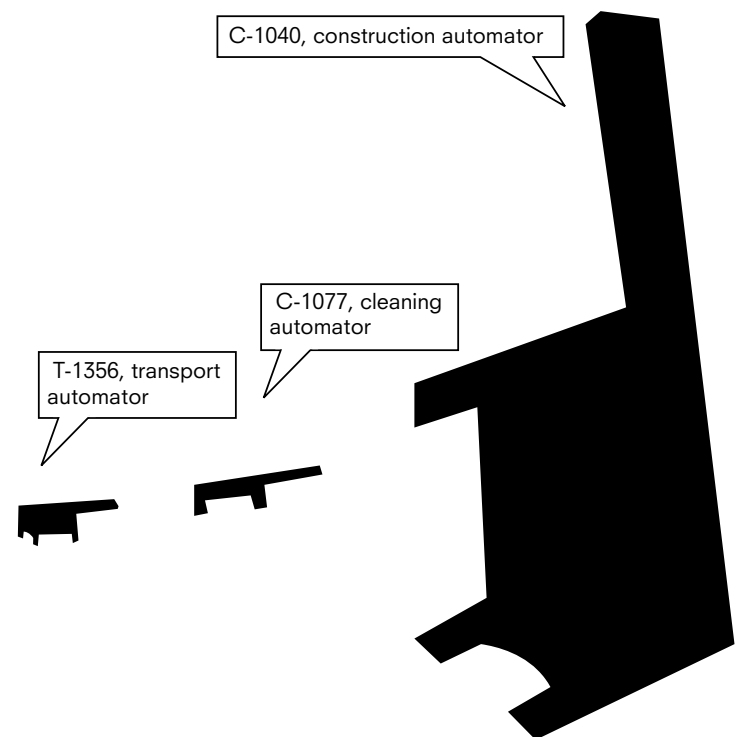
What if we live in a world where buildings construct themselves? Robotics that direct all materials to the predefined places to be assembled into new spaces for humans to inhabit. How would a school function in such a science fiction?



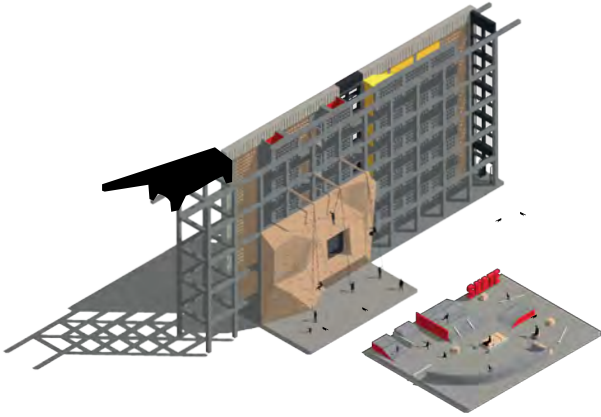


Construction automated

In the year 2100, when most work is automated, the construction of our buildings will also be mostly automated. Robotics will live beside us and take care of our maintenance, cleaning, and other repetitive tasks.

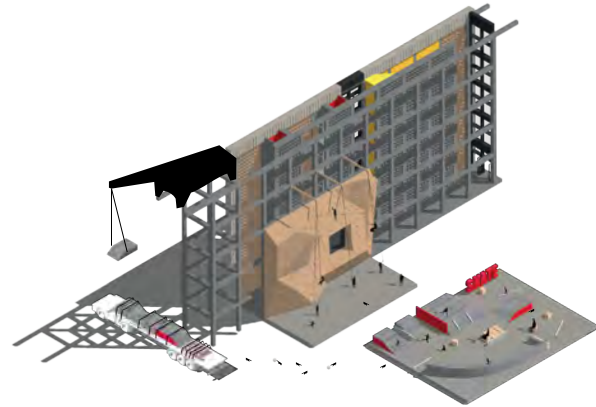


A building that adapts



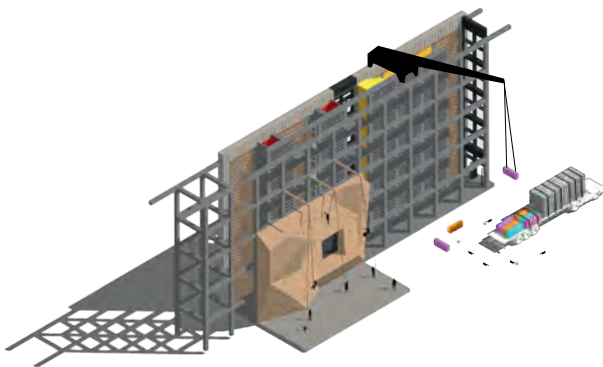
Throughout the building, robotics are scattered doing tasks imposed by humans.

While in use



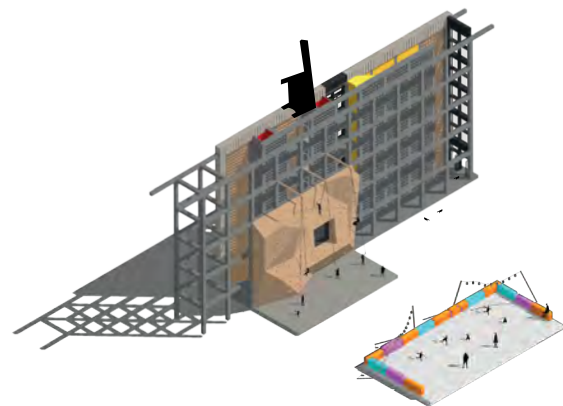
The building is changing all the time to offer the students new facilities for a changing curriculum that focusses on active participation and experience of phenomena.

Automation transports elements



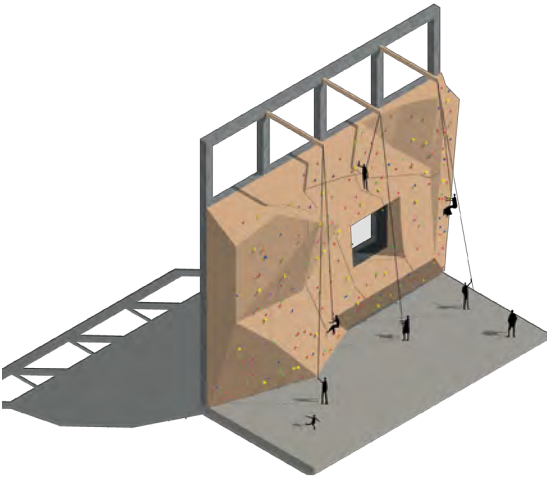
Because these elements are demountable and the transport and (de)construction as well, all elements are loaded on trucks or boats to be transported from and towards other schools.

New spaces

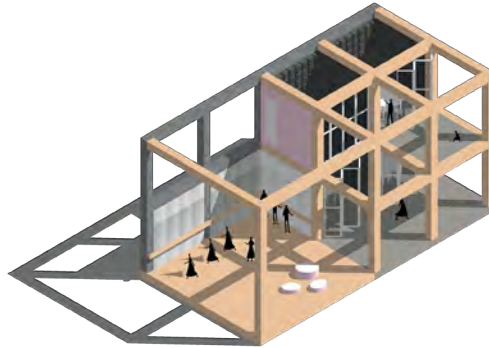


While the building is still in use, new elements are constructed, and new facilities are added, while the core functionality within the racks facilitates all necessary amenities.

Continuous changing elements



Climbing wall



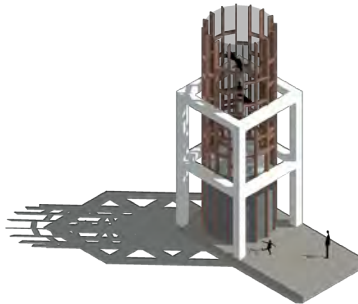
Dance studio



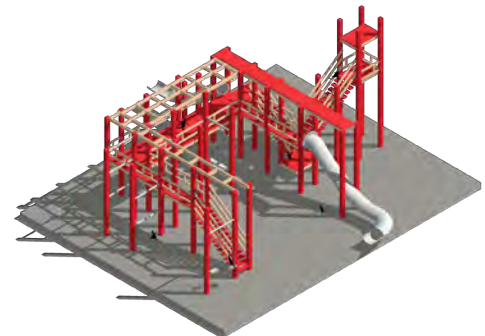
Ice skating rink



Skate ring



Indoor skydive

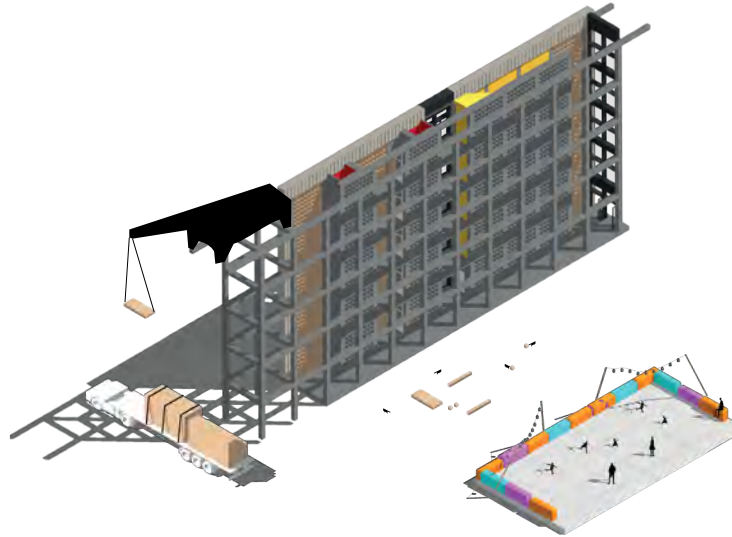


Playground

This is a selection of temporary elements in the building that are up for change.

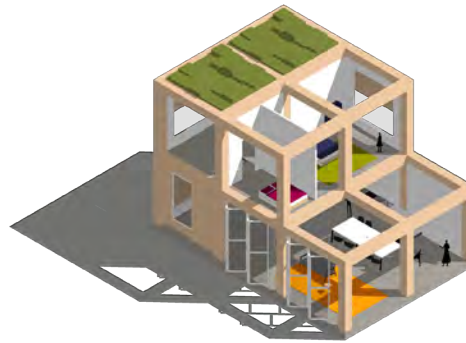
Demountable

Some parts of the building have to be constructed with demountability in mind. These elements are changing from a daily to a yearly basis and will be re-used in different schools.



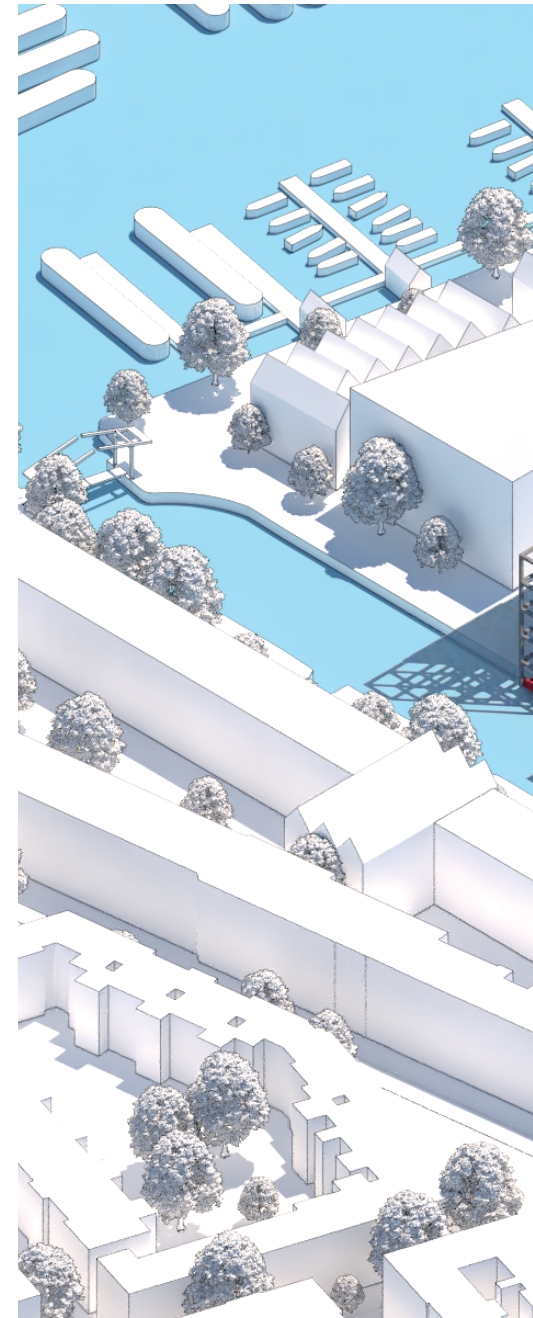
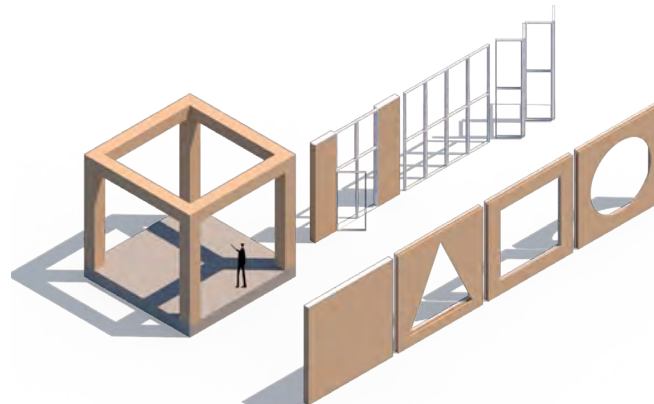
Circular

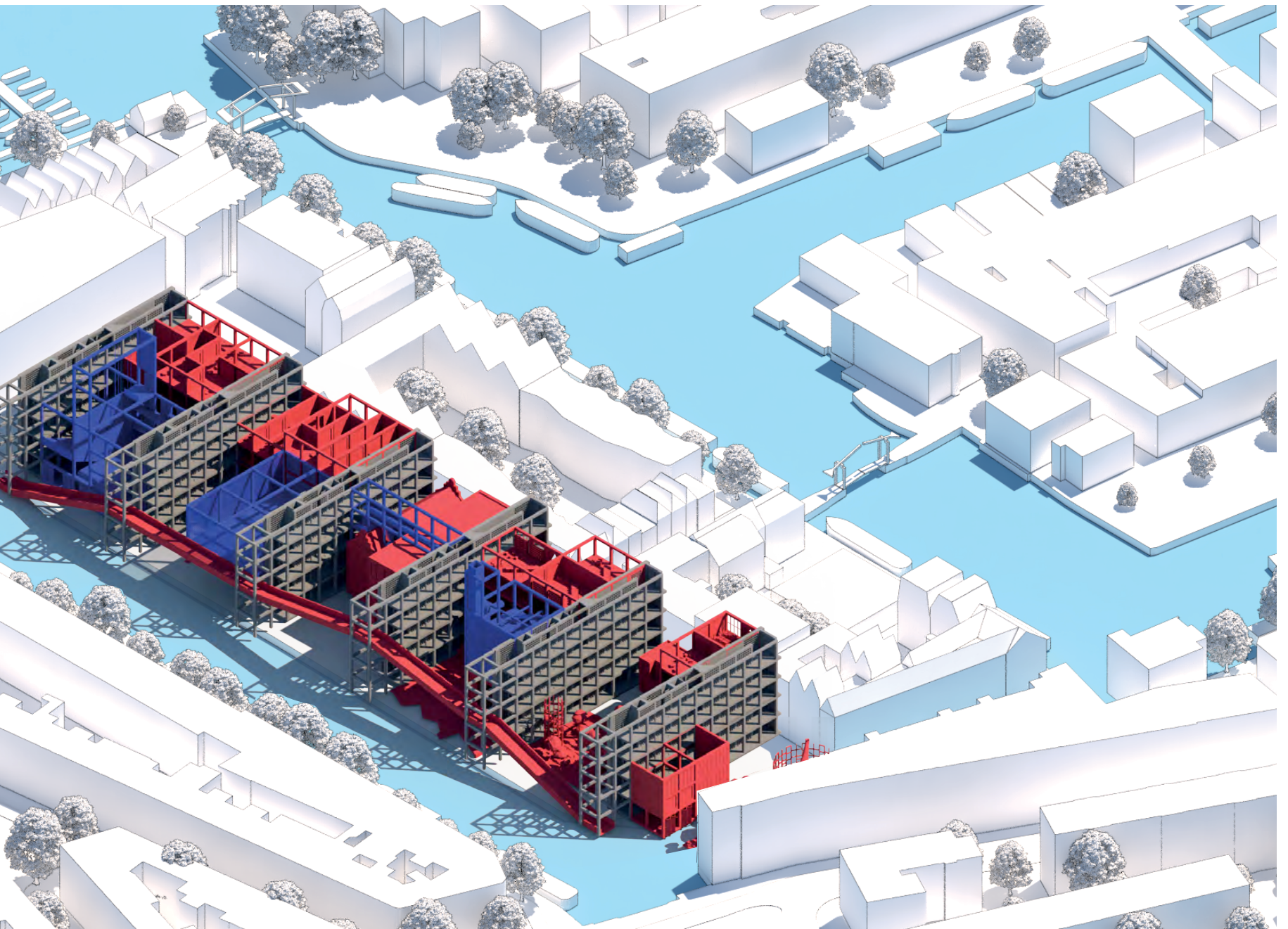
All parts of the building should be constructed to be able to be used in a circular economy (it is the year 2100). Therefore most elements are slightly over-dimensioned to increase the future potential of the materials.



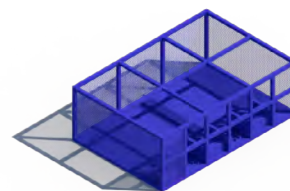
Modular

Some parts of the building have the ability to change according to the need of the users. To make this as efficient as possible, parts of the building are constructed to be interchangeable with each other, using the same modules to “click” together.





Permanent



Semi-permanent



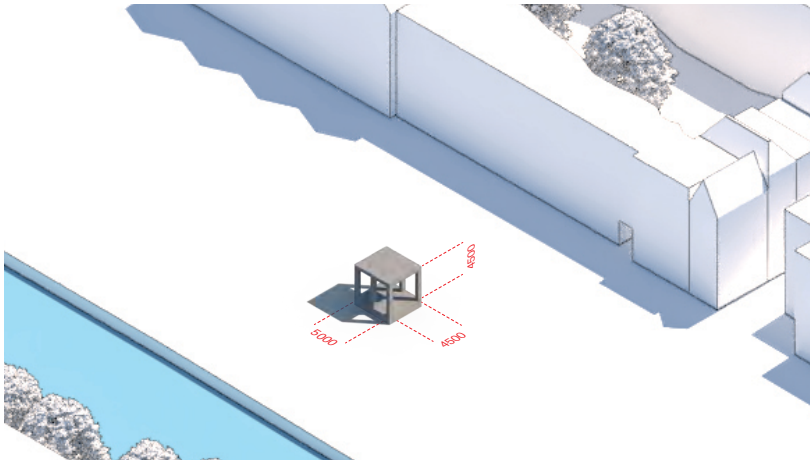
Temporary

Construction and climate installations

How it's made

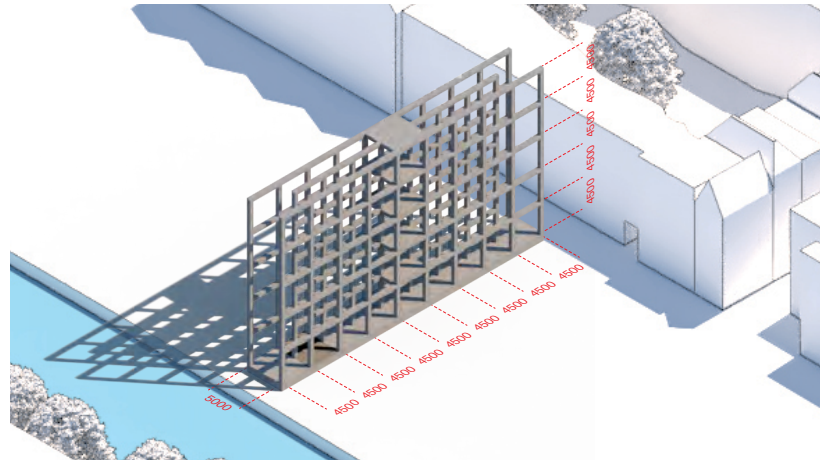
The following pages will give more insight into the construction of the building and which climate installations are present to provide a pleasant interior environment. The structure of the building is a hybrid; different materials have been implemented within the design to reflect the diverging levels of temporality of the elements. Wood has been allocated for the most temporary structures while concrete is used for the most permanent structures. All climate systems within the building are constructed to be demountable and must have the ability to be altered throughout the lifespan of the building.

Rack element



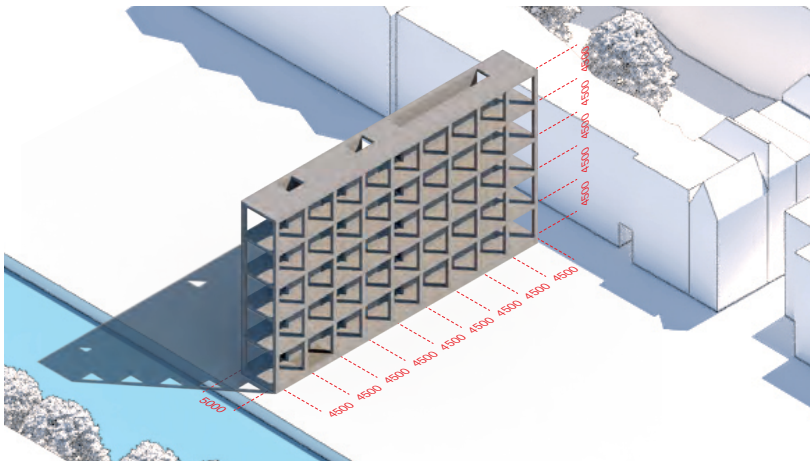
The rack has an alternative grid size of 5000mm x 4500mm.

Vertical and horizontal expansion



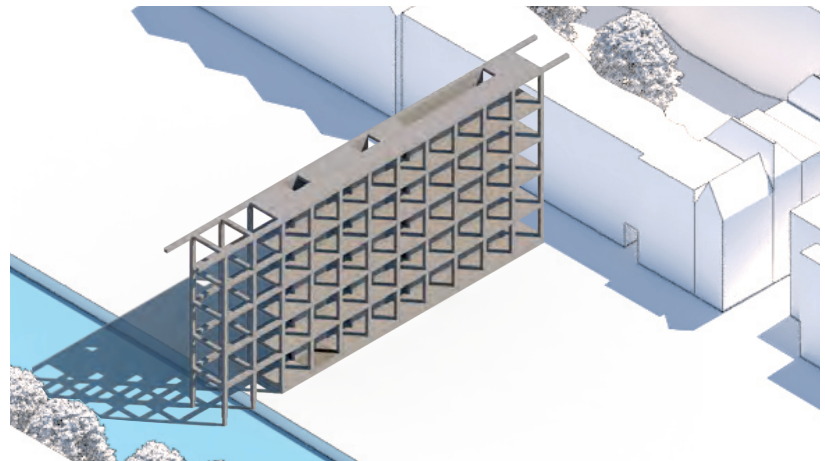
The rack element is copied horizontally and vertically on a 4500mm grid.

Adding mass



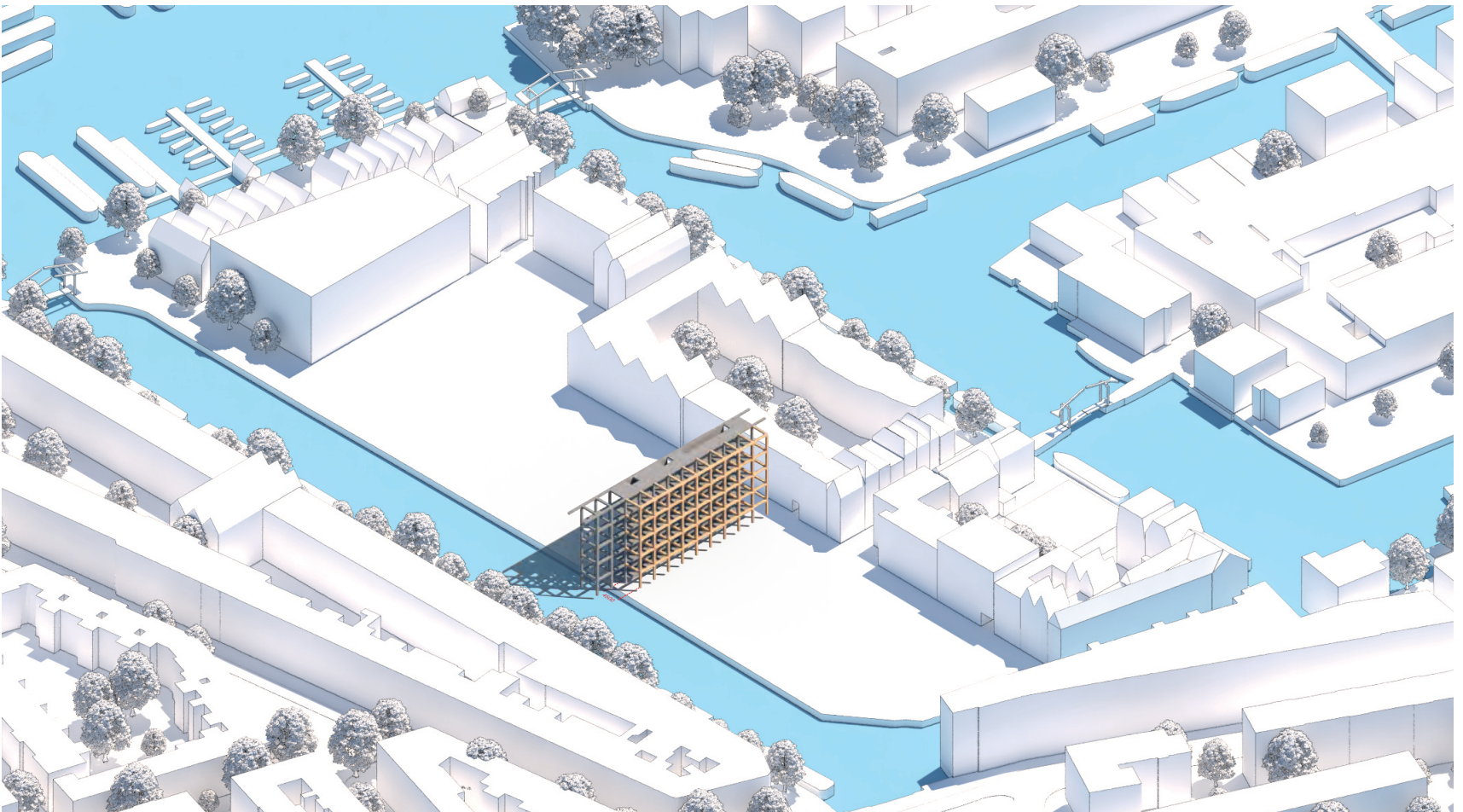
Mass in the form of elevator cores, stair cores and shafts are added to stabilize the structure.

Adding hoisting equipment



On either side of the building, hoisting equipment is added. These elements are above the street or the canal. The building has now gained similar properties as the historic canal houses.

Sub-structure



The solidity of the rack can absorb and stabilize different sub-structures that are added and removed from the building. All the facilities, like storage, vertical circulation, toilets and communal spaces can be found within the rack. The sub-structure is solely for classrooms and specific elements.

A hybrid form of construction



The 2100 situation of the building is a hybrid form of construction, a building where the construction reflects temporariness.

Wooden sub-structure



Elements that according to their temporariness need to be demountable or modular are made out of a wooden sub-structure. Wood is chosen because it is a sustainable construction material and it can be handled easily in a demountable environment, lighter to transport, easier to drill in- and out from.

Specific sub-structure



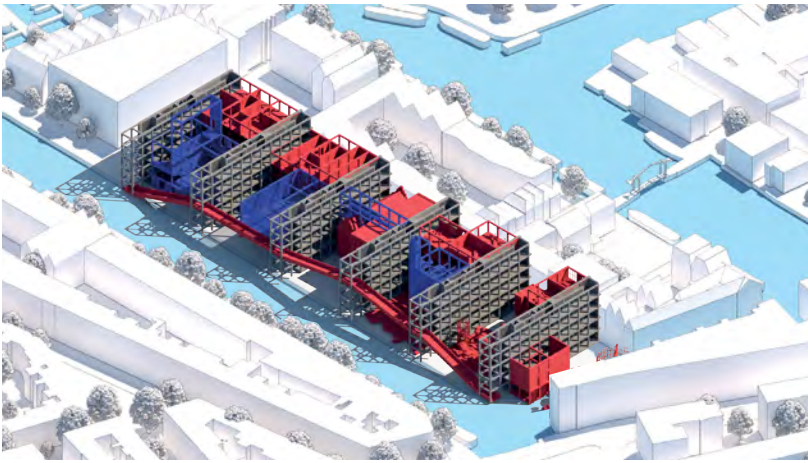
Specific elements that require special equipment, like a theatre, will be constructed out of a more permanent sub-structure.

Existing buildings



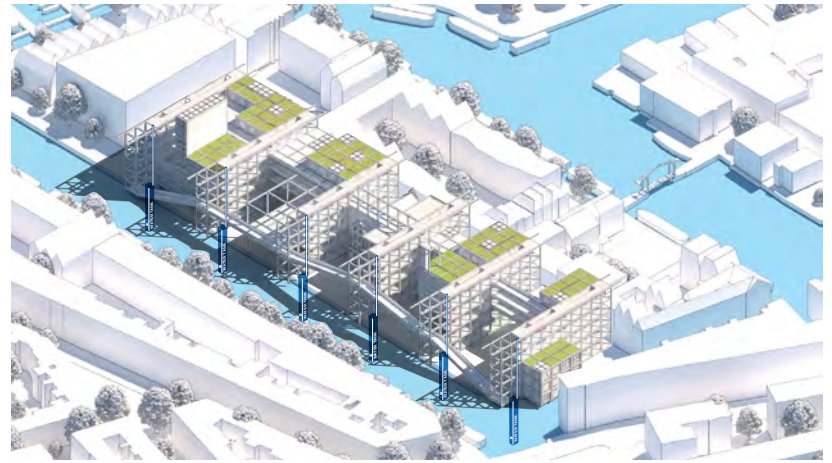
Some existing buildings on the site will be absorbed and integrated with the ensemble. These buildings have an individual support structure but are connected to the facilities of the whole building.

Built with lifespan in mind



The adaptability of the building is one of the most important climate measures. The building can reduce its waste by reusing materials in different configurations.

Green roofs and water collection



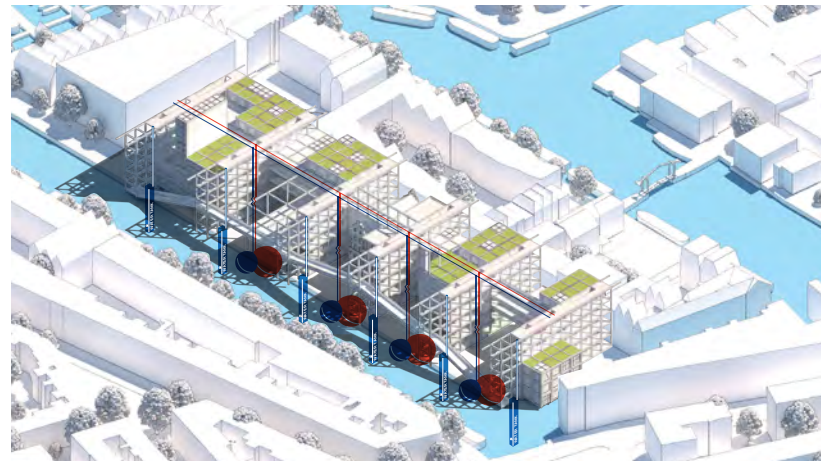
The building has a green roof that is connected to decentralized water basins. The water in these basins is cleaned and reused throughout the building.

Centralized and demountable installations



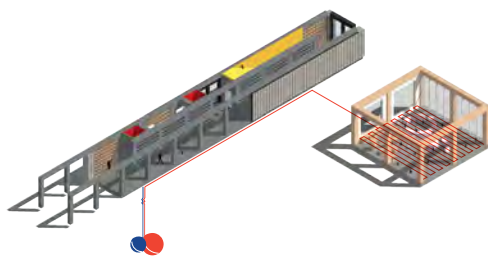
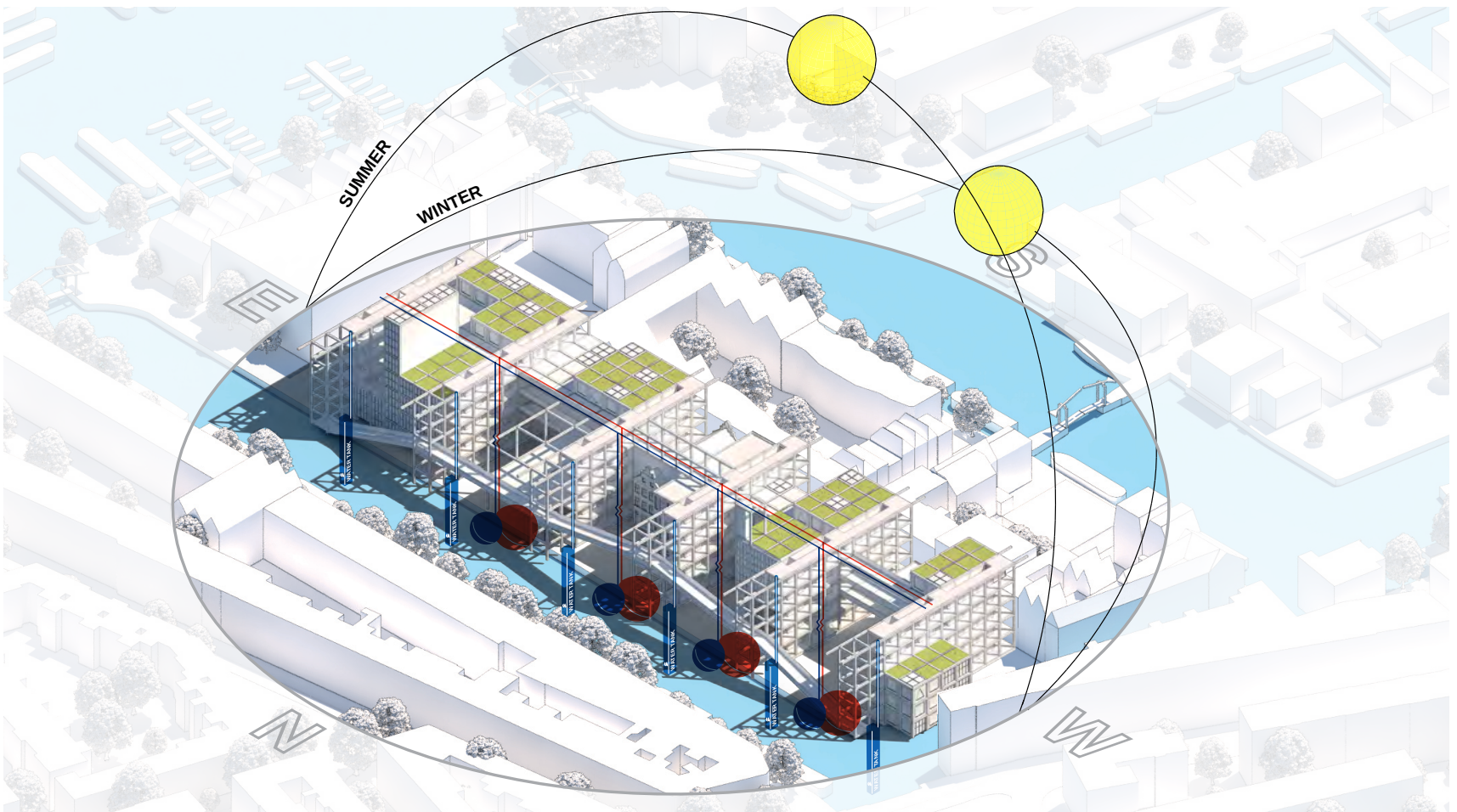
All installations enter the building via racks. When the building adapts, the cabling and ventilation are rerouted to provide the new spaces with proper climate and amenities. The classrooms have the ability to open windows next to a centralized ventilation installation, managing fresh air.

Thermal heat storage

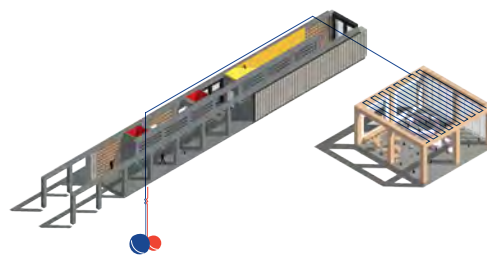


Below four racks, thermal heat storage units are placed, these are connected to the different spaces to provide heating and cooling via climate ceilings and floor heating panels.

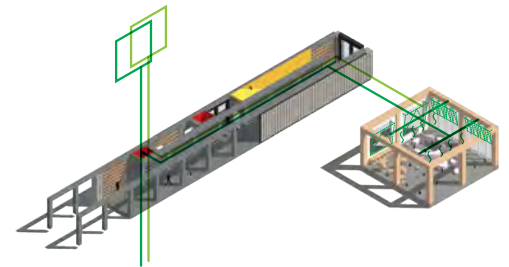
Whole system



Winter



Summer



Ventilation

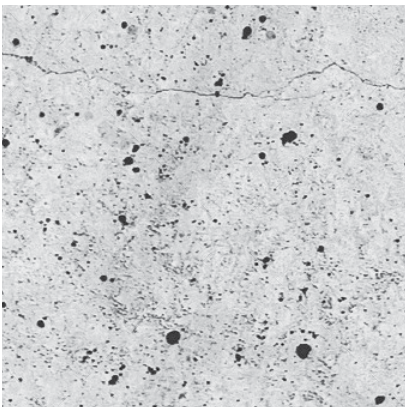
Detail and material

A hybrid construction and reservation of space

The details of this project focus on showing the possibilities of a hybrid construction that is continually restructuring itself. The rack takes a central place in all details since this is the element where all elements relate to spatially. The materials used throughout the Vierwindenplaats reflect the temporariness of the elements. For an honest representation, a lot of the materials used on permanent elements will not be cured or painted at first instance. Deterioration is a welcome quality for permanent elements, as found within the racks. All the semi-permanent elements have a varying palette of finishes, which is bound by the functionality of the space. The temporary elements, like classrooms, use a modular system which offers a limited amount of modular pieces, but an endless amount of configuration of these elements.



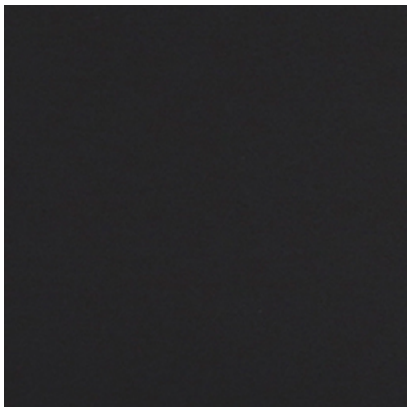
14



A



9



5



B+C



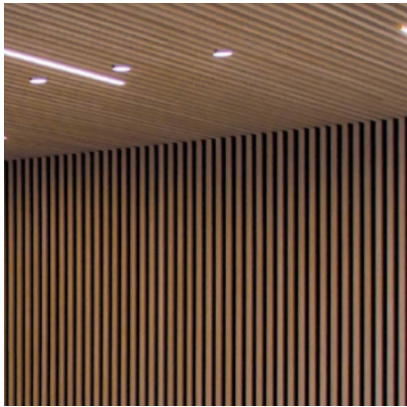
10



101



6



7



1



6

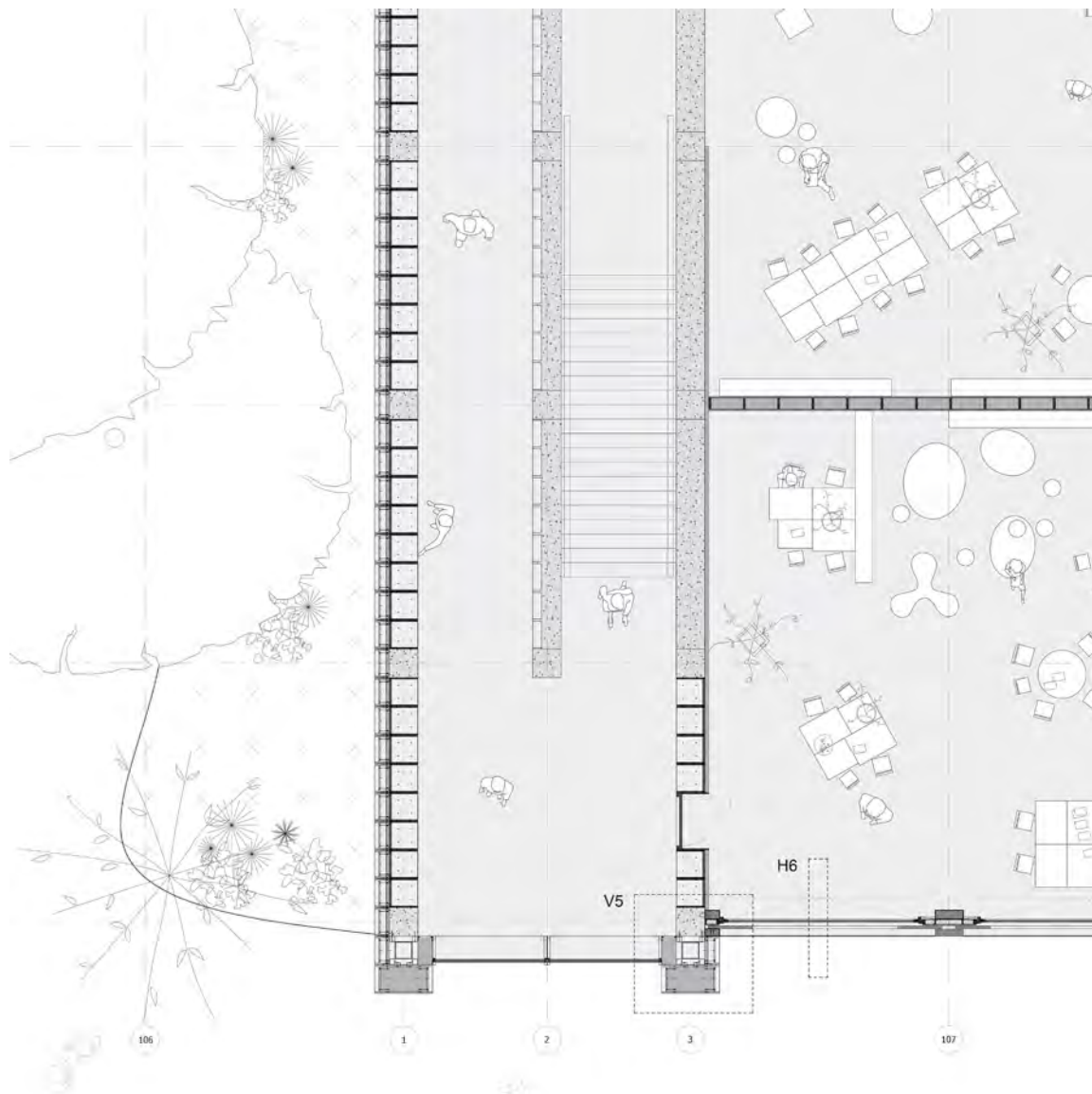


102

STRUCTURE		105	Drainage gutter connected to the water collection basin for reuse
A	Cast in-situ concrete with steel reinforcement for the floors, with prefabricated concrete columns	106	Integrated rainwater pipe connected to water collection basin for reuse
B	Exterior timber beam, Douglas fir, impregnated	107	Integrated automatic window opener
C	Interior timber beam, spruce wood, impregnated	108	Reserved space for installations
		FINISH	
D	Prefabricated timber rib floor with inner insulation	1	Off-white, white clay panels, structurally strengthened by carbon fiber, matt and visible aggregate, porous material to enable algae growth
E	Prefabricated wooden facade element with inner insulation		Glass panel
F	Steel rectangle hollow section framework	2	Timber window frame
G	Steel bracket as reinforcement of the timber beam and to connect it to main construction of (A)	3	Outer facade padding panel 50mm thickness of CLT wood
H	Facade fastener, steel anchor in concrete	4	Curtain wall system with matt black finish, 50mm width
I	Facade fastener, steel anchors, connected to cast-in dowels and grooves of (1)	5	Wall finish to preference
J	4x4 bolt connection, possible to be individually dismantled for future alterations	6	Timber paneling finish
K	Adjustable ceiling hanger	7	Steel mesh grate cover for (20)
L	Adjustable frame to correct vertical elevation of boxes	8	Beechwood panels, impregnated with child-safe fire retardant, matt finish
M	Waterproof membrane	9	Brass cap
N	Regular insulation	10	Stair railing
O	High-density insulation	11	Demountable wall panels
INSTALLATIONS		12	OSB placed on timber beams - reserved space for future alterations
100	Demountable climate flooring with waterproof PVC floor panel finish	13	Coarse aggregate concrete (visible gravel) floor finish
101	Demountable climate ceiling with wooden finish (for cooling,light fixtures and fresh air, with acoustic capacity), 500mm edge along ceiling with upward light fixtures	14	Gravel
102	Green roof		
104	Outlet of HVAC installation		

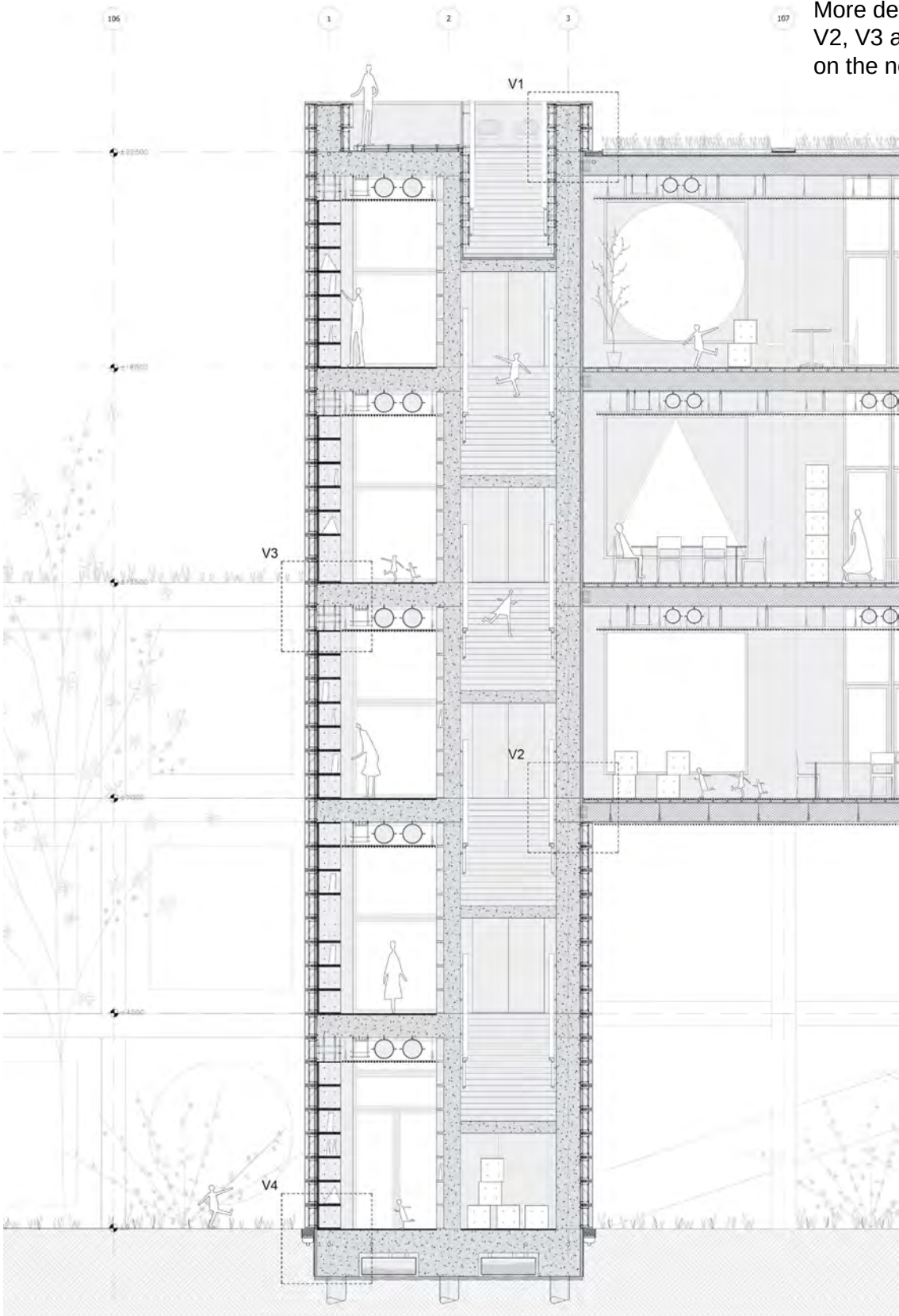
Horizontal detail

More detailed drawings of V5 and H6 can be found on the next pages.

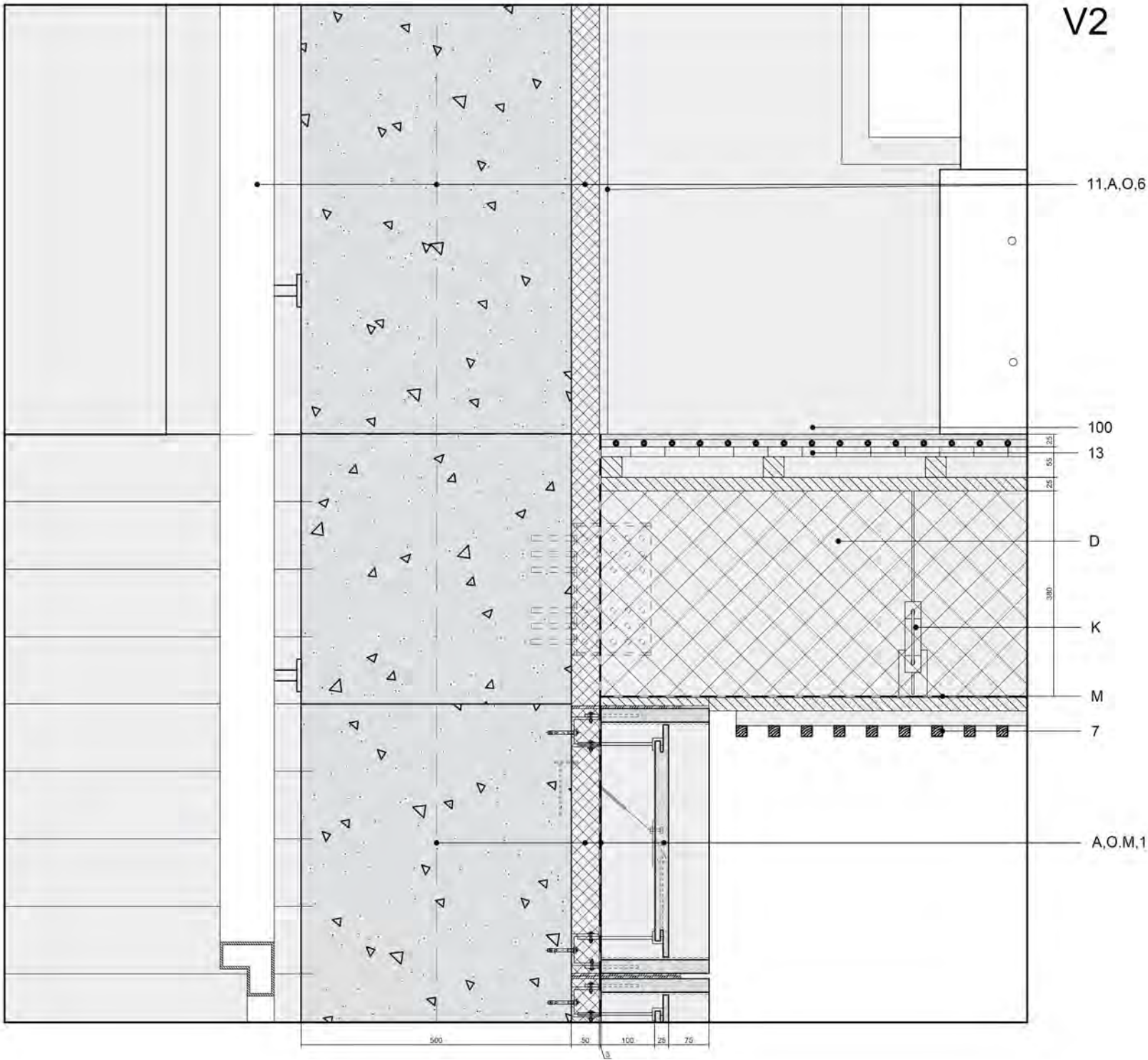


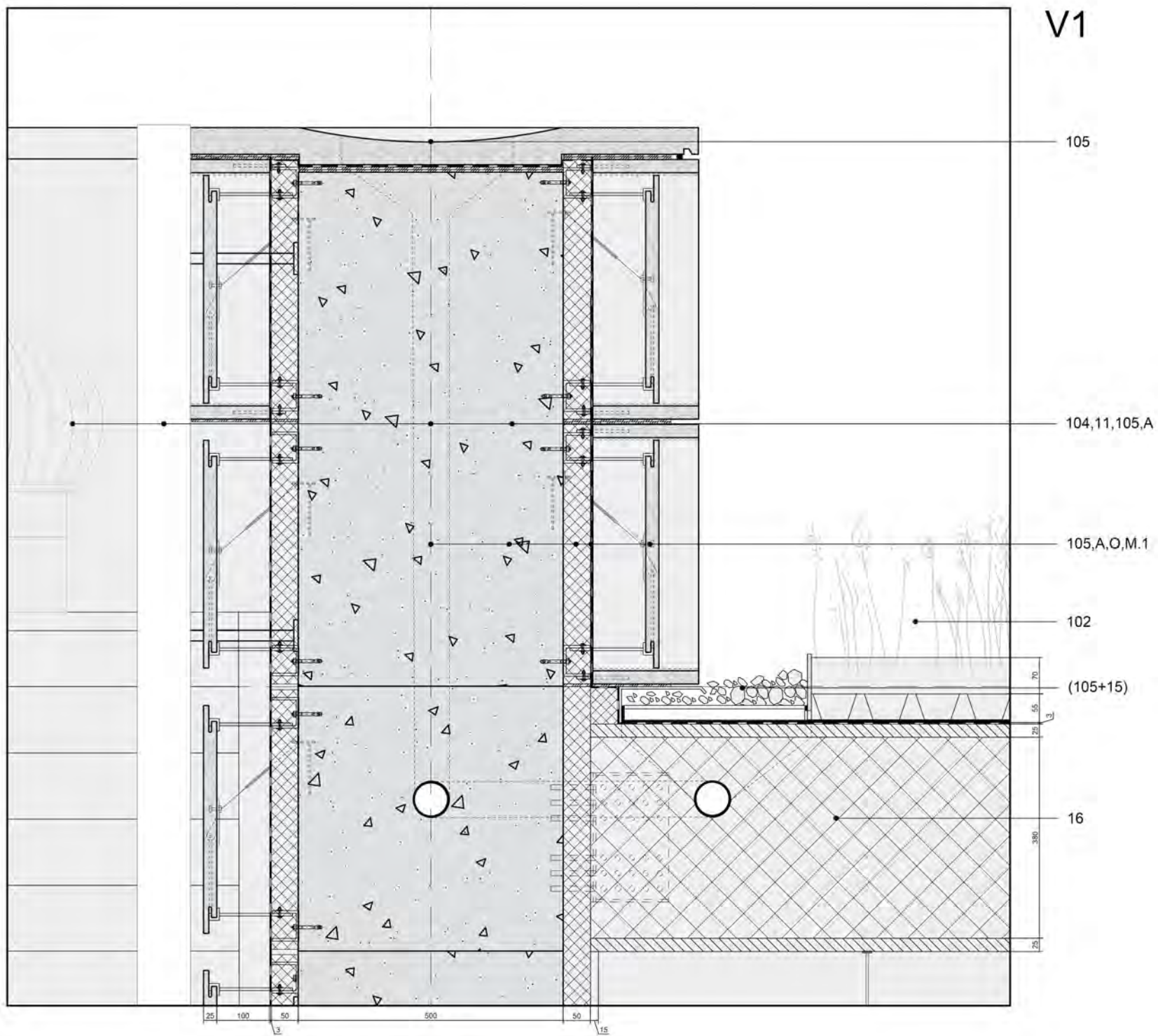
Vertical section

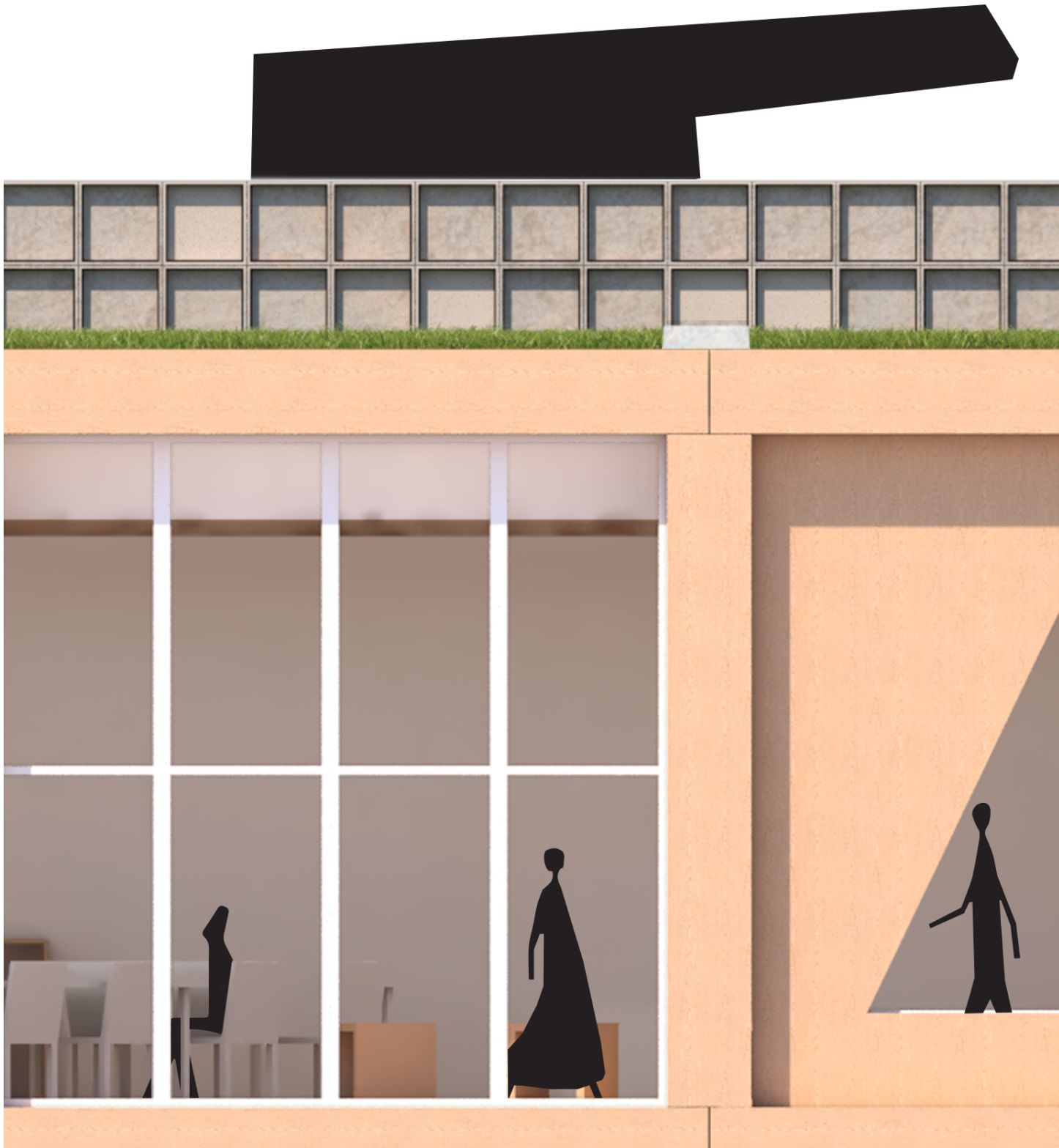
More detailed drawings of V1, V2, V3 and V4 can be found on the next pages.



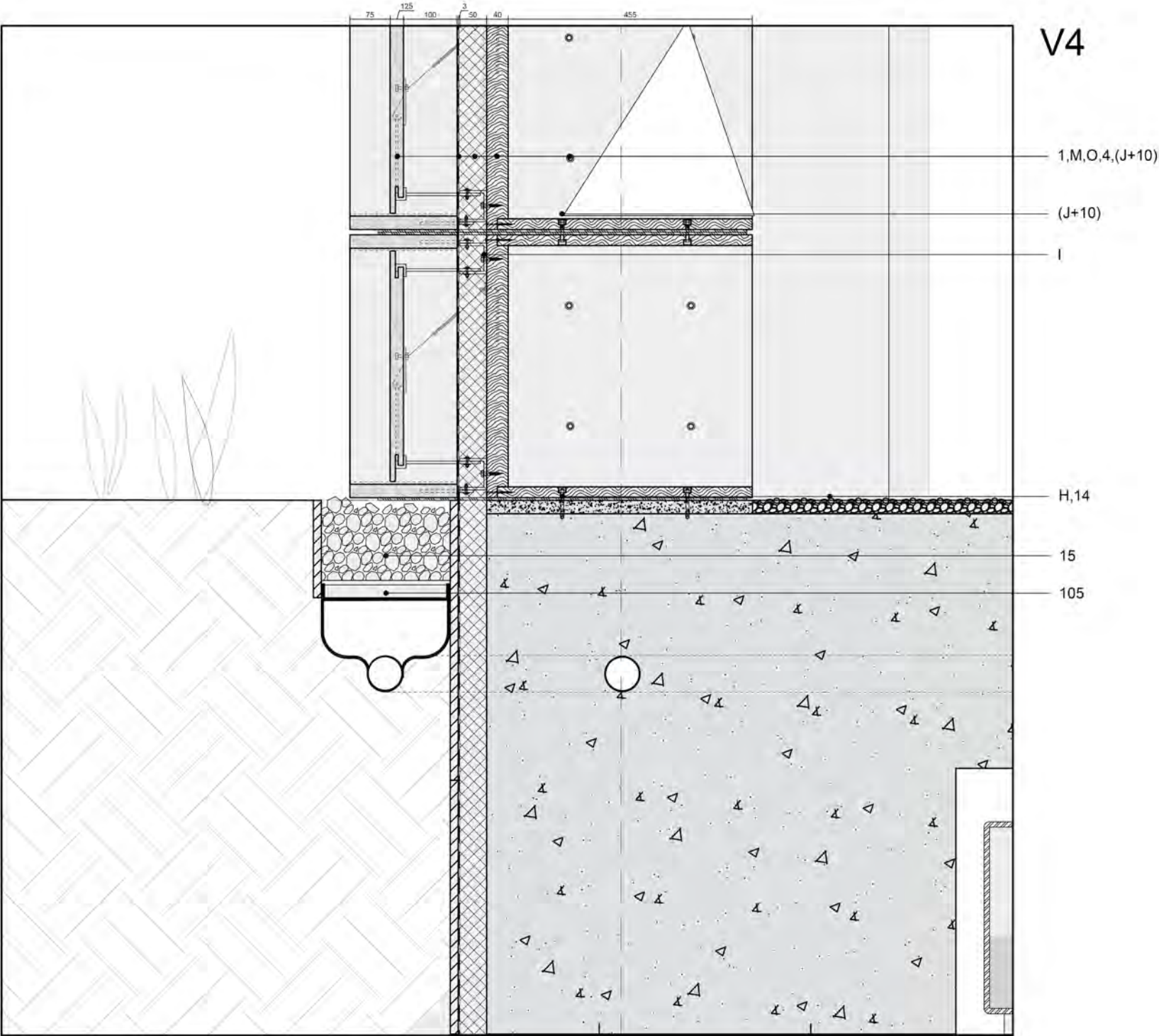






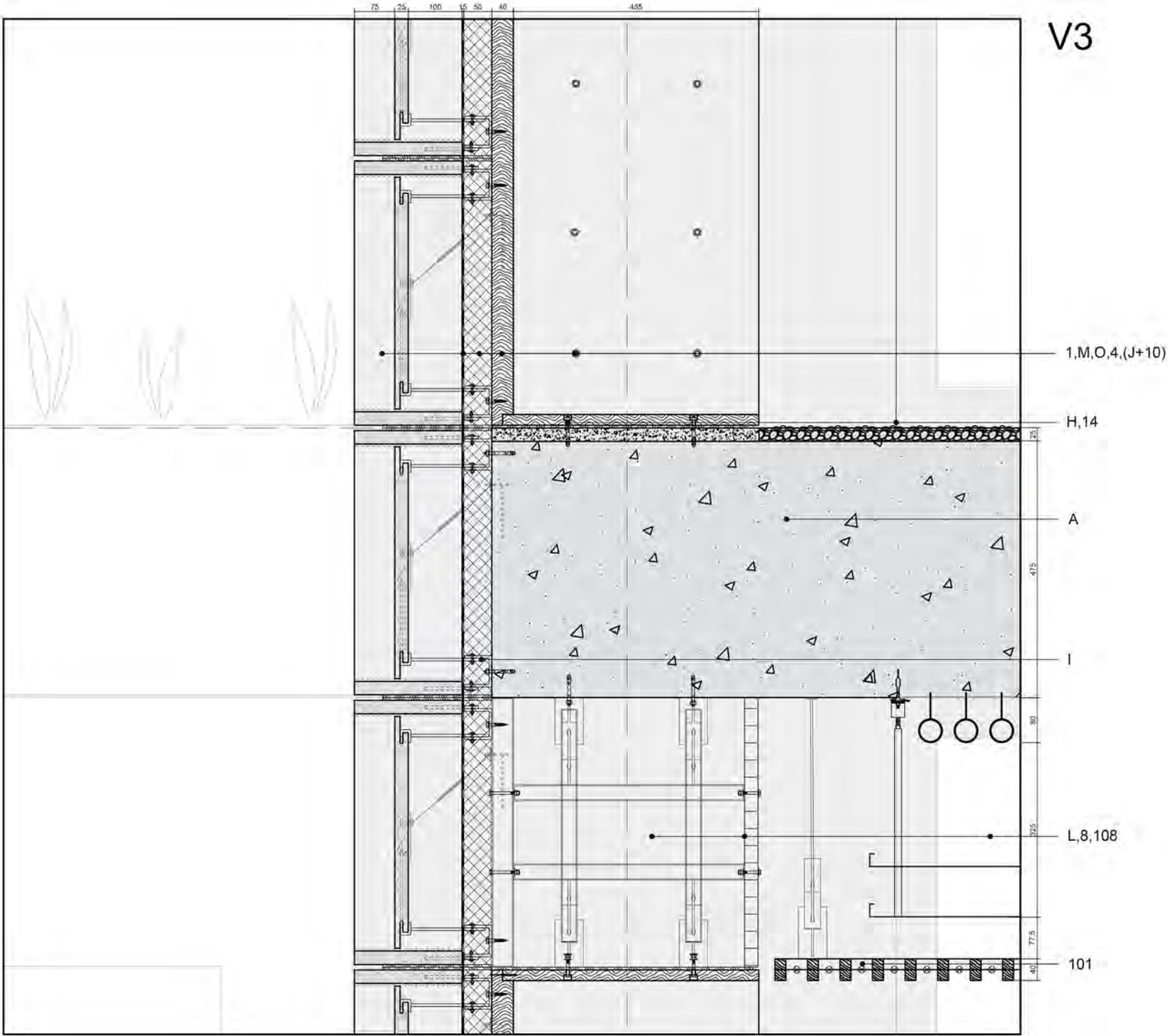






250mm

500mm

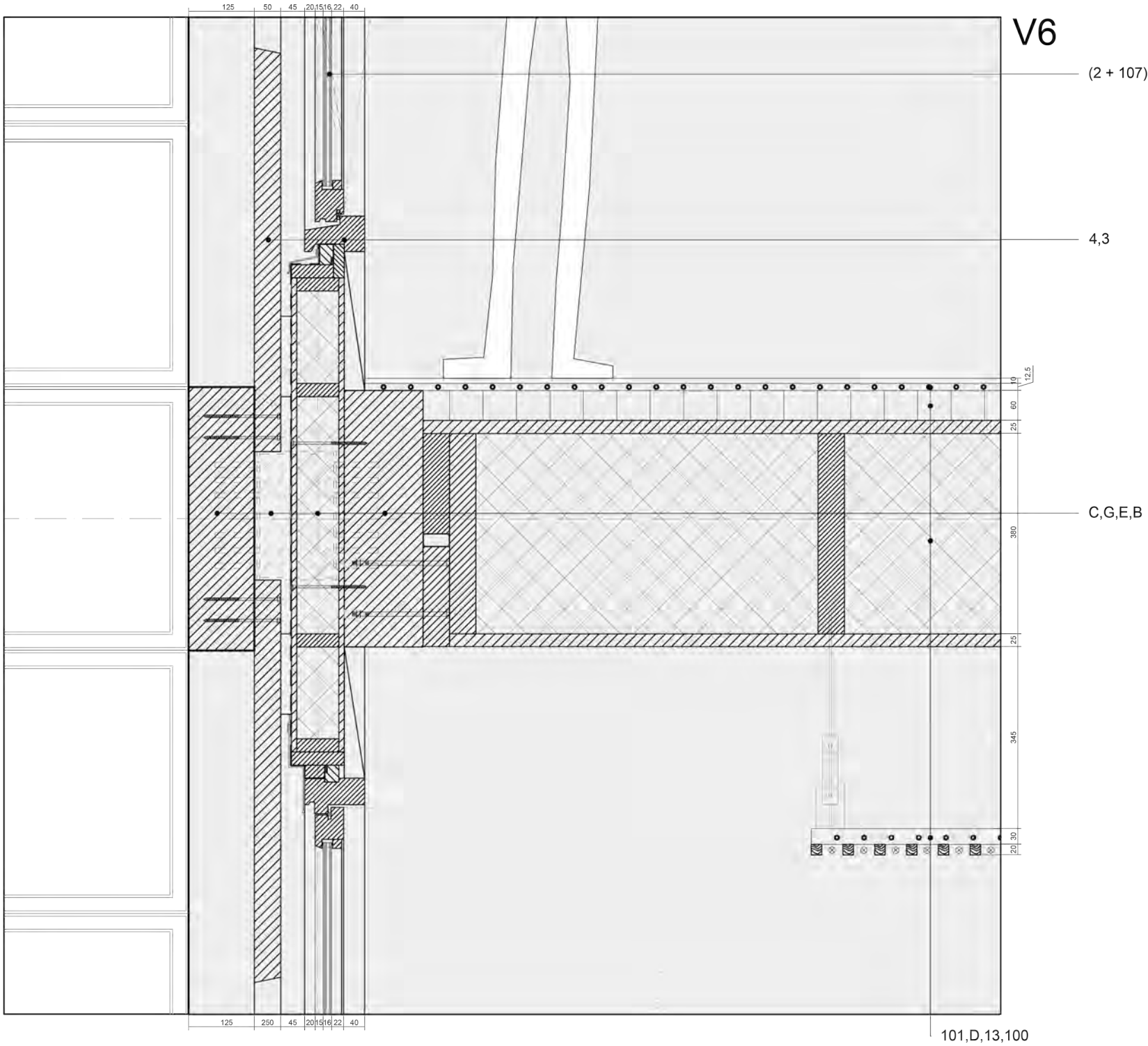


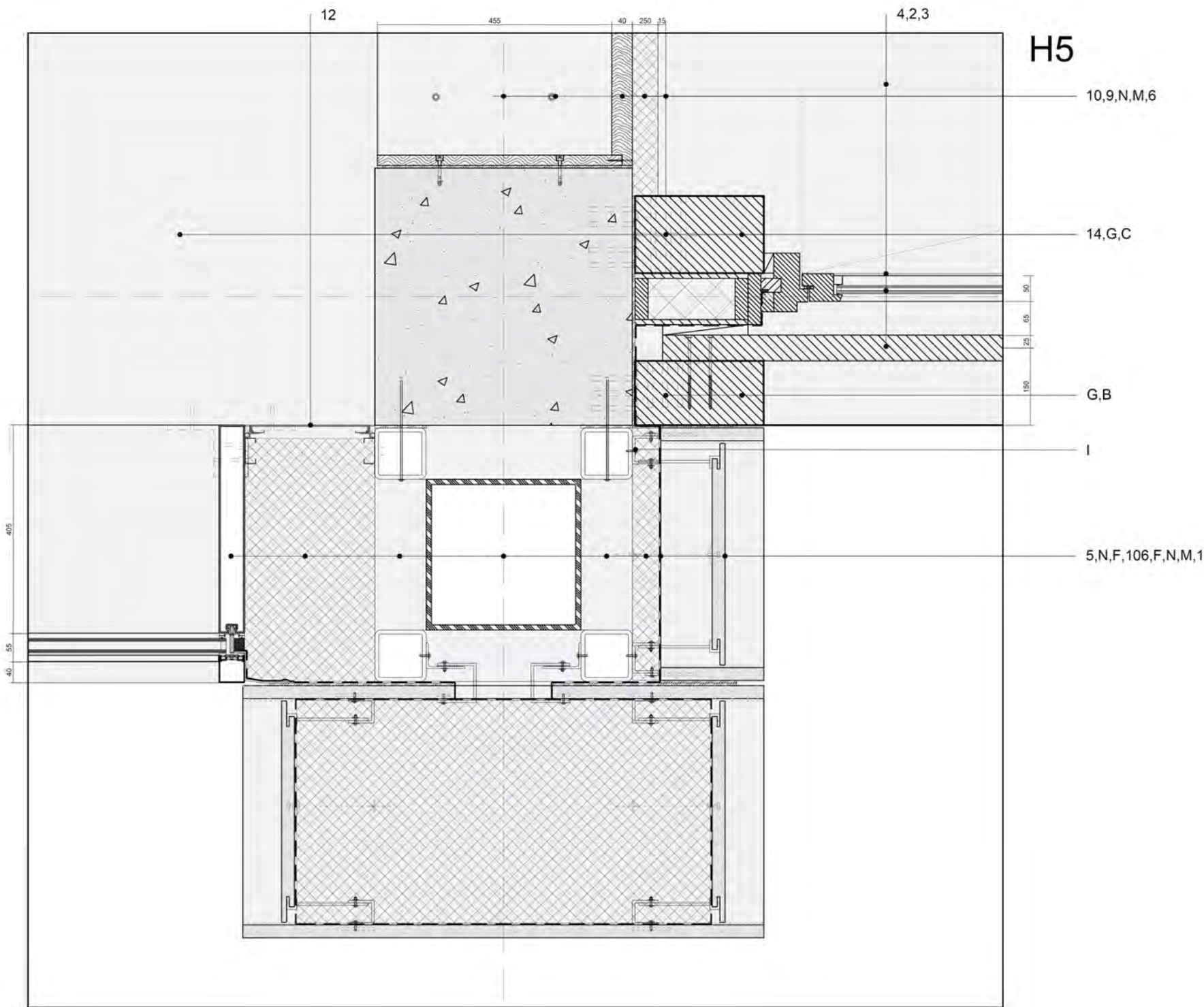
250mm

500mm











Recommended literature list

SchoolParasites: nieuwe noodlokalen voor naoorlogs Nederland = provisional classrooms for primary schools

ISBN: 978-90-808185-1-4

This small publication on the Schoolparasites project was of unprecedented helpfulness for this graduation if you are interested in specific project knowledge around the WiMBY! Movement I would recommend this one!

AplusT 50: Complex buildings: Learning Systems

ISBN: 978-84-09-01867-3

This issue of A+T has a focus on recent developments of school buildings, ranging from small local kindergartens in Copenhagen to large university complexes. The writing is sharp and the whole publication gives a useful oversight of contemporary school building architecture.

Ruimte en leren

ISBN: 978-90-6450-645-1

This publication from Herman Hertzberger gives excellent insight in the ideals and parameters that Hertzberger set in his vision about education and the architecture of school buildings. With precise examples from his buildings and of schools buildings created by others. If you want to understand the Montessori school in Delft you will want to read this.

How buildings learn: what happens after they're built.

ISBN: 978-0-670-83515-7

This theoretical manifesto for creating buildings that becomes alive through the ability to adapt their spatial configurations over time is one of the backbones of this graduation and is one book that I would recommend to anyone.

The schools of Herman Hertzberger

ISBN: 978-90-6450-646-8

If you are searching for a good overview of all the schools created by the architect Herman Hertzberger, including plans, sections, and theoretical substantiation, then you will want to pick this one up.

The design of everyday things

ISBN: 978-0-465-05065-9

This essential publication for industrial designers also gives excellent insight into the functioning and explains how the appearances of buildings and spaces are as they are. Norman gives a list of recommendations to create better design: make things visible, exploit natural relationships that couple function and control, and make intelligent use of constraints.

OASE 72, Back to School

ISBN: 90-5662-583-2

This issue of OASE journal focuses on the school building design in Belgium(Flamish) and the Netherlands. It shows how, at the beginning of the 21st-century conditions start to change, which requires architects to act differently.

City of permanent temporality

ISBN: 978-94-6208-220-5

This publication by ZUS architects shows how their approach to rehabilitating the Schieblok and the area of Pompenburg has progressed over time, showing the importance of temporal structures the facilitate second-order effects.

Speculative everything: design, fiction, and social dreaming

ISBN: 978-0-262-01984-2

This overview of Speculative design gives good inspiration on how to think about this branch of design. The overview of different projects is complemented with short theoretical writings about speculative design.

De school in de 21ste eeuw

ISBN: 978-90-809335-1-4

This overview of the former sub-association from the Dutch BNA; Staro is the publication on a research about the state of Dutch education and the possibilities for school buildings in the 21st century.

De transformatie van het schoolgebouw

ISBN: 978-90-6868-581-7

This publication shows the research into the possibilities of transformation of existing school buildings in the Netherlands. This research, including plans, sections and isometric drawings is complemented with a series of essays, one from Hertzberger

Nederland naar school: twee eeuwen bouwen voor een veranderend onderwijs

ISBN: 978-90-5662-021-9

This publication shows a good overview of the evolution of Dutch education before the 21st century. It has been part of an overview exhibition at the NAI museum in Rotterdam in the 1990s. The writing concludes with a series of typologies for school buildings.

Building for bouwkunde: open to ideas: open international ideas competition and think tank

ISBN: 978-90-79814-03-9

This publication was part of the search for a new home for the TU Delft faculty of architecture after a fire in 2008 destroyed the former school building. Within this publication is an overview of all the competition entries for a new building.

Building and dwelling: ethics for the city

ISBN: 978-0-7139-9875-7

I have been reading the trilogy of Sennett during my graduation and would want to recommend this one especially. Sennett explains the vital differences between the ville and the cité and advocates urbanists to go for a more open city.

Utopia forever: visions of architecture and urbanism

ISBN: 978-3-89955-335-2

This is one of the first architecture related books that I bought before I studying architecture myself. I would never know that it would be useful in my graduation. This book gives an epic overview of speculative architectural designs.

Structuralism reloaded

ISBN: 978-3-936681-47-5

This publication about and partly written by architects that are part of the structuralist movement, gives excellent insight into the architectural movement. It shows how buildings can be created through rule-based design. I would recommend to read the essay from Herman Hertzberger inside.

City and port

ISBN: 978-90-5727-020-8

This theoretical backbone is part of the research into the effects of large-scale industrialization on urban configuration of the city. Comparing London, Barcelona, New York, and Rotterdam.

De sprong over het IJ

ISBN: 978-90-6868-161-1

Why has Amsterdam never built a proper bridges over the IJ? Unlike many other cities in Europe, Amsterdam has always been reluctant to connect its two city halves. Within this book, it becomes clear that it was not because of the engineers and architects that have proposed numerous designs for the crossing of the IJ.

A millennium of Amsterdam: spatial history of a marvelous city

ISBN: 978-90-6868-595-4

This book gives an excellent chronological overview of the most important spatial changes of the city of Amsterdam over the past 1000 years. A good starter for further investigation.

Amsterdam, terug aan het IJ: transformatie van de Zuidelijke IJ-oever

ISBN: 978-94-6105-443-2

Especially the maps by MUST stedenbouw in the beginning of this publication give a good overview of the spatial changes Amsterdam has seen over the last 750 years. Overall, this publication shows how the Southern banks of the IJ have transformed at the end of the 20th and beginning of the 21st century.

Graduation project booklet

Graduation project booklet

As part of the Complex Projects graduation studio
Ingmar Klappe

8 November 2019
Faculty of Architecture
Delft University of Technology

Complex projects graduation studio of 2018-2019

Ingmar Klappe

Group members involved

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Sebastian Bok
Twan Goossens
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 18/19 - Beeldbank Amsterdam
 22 - Hub.jhu.edu, ocregister.com
 23 - besttraveltale.com, fastcompany.com
 49 - Beeldbank Amsterdam
 51 - De transformatie van het schoolgebouw, architectureandeducation.org, mecanoo.nl, archdaily.com, Beeldbank Amsterdam
 53 - herbestemming.nu, archdaily.com, (a+t Complex Projects)
 54/55 - Google Earth
 58/59 - Beeldbank Amsterdam
 60/61 - Architectureandeducation.org
 62 - De transformatie van het schoolgebouw
 63 - Tezuka Architects
 64/65 - De transformatie van het schoolgebouw
 66 - Barendkoolhaas.com
 67 - De transformatie van het schoolgebouw
 105 - Schoolparasites
 107 - Wikipedia
 111 - How Buildings Learn
 113 - Lacatonvassal.com

121 - Factory interior of Vitra Campus - SANAA, Design with company, Stewart Hicks and Allison Newmeyer
 172 - Beeldbank Amsterdam
 177 - Beeldbank Amsterdam
 181 - Beeldbank Amsterdam
 190/191/192 - Beeldbank Amsterdam
 196 - Beeldbank Amsterdam
 248-249 - Eadweard Muybridge - Wikipedia
 276 - 14: <https://midwayconcrete.com.au/concrete/exposed-aggregate/>, A: <https://jooinn.com/concrete-texture-21.html> , 9: <https://jkinter.org/our-team/natural-beech-wood-background-texture-2/> , B+C: <https://www.sketchlasercutting.co.uk/products/5mm-spruce-wood-sheet-100-x-457mm>, 101: <http://makemebel.info/wood-ceiling-panels-with-fresh-home-design-ideas.html/pvc-wood-ceiling-panels>, 1: <https://www.skheme.com/products/ranges/aggregate/>, 10 http://www.abvent.com/support/forum/realistic-metal-brass_f-atl_shaders_us-2459.html , 6: https://www.freepik.com/premium-photo/old-concrete-paint-plastic-pink-cement-wall-texture-background-with-space_3859325.htm, 5: <https://www.montis.nl/metaal/>, 102: <https://www.sempergreen.com/us/about-us/news/sky-view-parc-nyc-n-the-smartest-green-roof-of-north-america> , 6: <https://www.pexels.com/fr-fr/photo/beton-concevoir-couleur-designer-122458/>, 7: <https://ceilingdistributors.com.au/product/timber-blades-by-ceiling-distributors/>

Quotes & Figures

[Pagenumber - Source]

18 - 19 Different sectors in work (NPR.org, 2015)
 20 - Altered version of graph found on (NPR.org, 2015)
 Note: "other" category also indicates unemployment
 21 - "The distribution of bls [U.S. Bureau of Labor Statistics] 2010 occupational employment over the probability of computerization, along with the share in low, medium and high probability categories. Note that the total area under all curves is equal to total us employment." (Frey & Osborne, 2017, p. 40)

22 - Oxford University (Frey & Osborne, 2017, p. 45)
 23 - (Florida, 2004, p. 18), (LLC, 1970, p. 30)
 30/31/32/33 - (Boersma, Verstegen, & Bergeijk, 1996; Dam, Komossa, Swakman, & Schouten, 2011; "Geschiedenis van het onderwijs in Nederland," 2016; Steijns & Koutamanis, 2004)
 35 - ("The Future of Work," n.d.)
 40 - ("Education in the Netherlands," 2019)
 54/55 - Data from municipality of Amsterdam, year of inquiry 2019
 60 - (Hertzberger & Gieskes, 2008, p. 70)

62 - (Y. Tezuka as cited in a+t, 2018, p. 17)
64 - (Duiker J. as cited in Dam, Komossa, Swakman, & Schouten, 2011, P.41)
66 - (Kempinga, Aarsman, & Bouvier, 2004, p. 163)
74/[.]/83 - See page 297
96 - (1) (<https://wetten.overheid.nl/BWBR0008562/2014-01-01>)
101 - Ruimte en Leren, p.45
105 - (Stuhlmacher et al., 2007, p. 33)
106 - (Herman Hertzberger as cited in a+t, 2018, p. 32)
111 - (Brand, 1994, p. 2)
112 - (Stuhlmacher et al., 2007, p. 33)
128/[.]/167 - See page 298
175 - (1) ("Amsterdam," 2018), (2)(Gemeente Amsterdam, 2018)

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Essay: Schools that learn - Images

Figure 1 Demolition of the Mariaschool in Zandvoort (Courant & B.V, 2008)

Figure 2 "Shearing layers of change. Because of the different rates of change of its components, a building is always tearing itself apart." – Stewart Brand (Brand, 1994, p.13)

Figure 3 Schoolparasites, the flower - Barend Koolhaas ('Barend Koolhaas', n.d.)

Figure 4 Nantes School of Architecture by Lacaton & Vassal ('lacaton & vassal', n.d.)

Figure 5 The construction of the Luchtsingel - ZUS architects (ZUS Architects, n.d.)

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Essay: Boundaries of infrastructure - Images

Figure 1 Superimposing old and new ships (Ingmar Klappe, 2018)

Figure 2 “Amsterdam in het jaar 2000” Das brothers (Das & Das, 1967)

Figure 3 Open waterfront 1752 Jan ten Compe (Compe, 1752)

Figure 4 Eerste stoomschip op het IJ, Pieter Gerardus van Os 1816 (Gilijamse et al., 2009, p. 74)

Figure 5 All images are based on models from Google Sketchup 3D warehouse. (“Longest trains,” 2018; “Modes of Transportation,” 2018; “OOCL Hong Kong,” 2018)

Figure 6 Four different types of transport vehicles, models from Google Sketchup 3D warehouse.

Figure 7 Models from Google Sketchup 3D warehouse. Images from Trekschuit (“Trekschuit,” 2018), Sloep (Palmkvist Knudsen, 2004), T'Duyfken (“Duyfken (schip),” 2018), Barge (“Binnenvaartschip,” 2018), Touring boat (Partyvaart Harlingen, n.d.), Ferry (“Amsterdamse veren,” 2018), HMS Victory (“HMS Victory (schip, 1765),” 2018), SS Potsdam (“SS Potsdam (1900),” 2018), Panamax (“Bulkcarrier,” 2018), Legend of the seas (New Zealand Cruise Association, n.d.), Anna Maersk (Vesselfinder, n.d.), measurements checked via Wikipedia.

Figure 8 2 TEU container, model from Google Sketchup 3D warehouse.

Figure 9 Structural changes seen in port cities (Meyer et al., 1999, p. 23)

Figure 10 Amsterdam in 1350 (Must Stedebouw, 2012)

Figure 11 Amsterdam in 1725 (Must Stedebouw, 2012)

Figure 12 Amsterdam in 1930 (Must Stedebouw, 2012)

Figure 13 Amsterdam in 2010 (Must Stedebouw, 2012)

Figure 14 North Holland in 1876 (Reimeringer, Gebr., Buffa & Zonen, Frans, 1876)

Figure 15 Steamship at the open waterfront (Beeldbank Amsterdam, 1900)

Figure 16 “Het Westelijk Havengebied in 1980” (Gilijamse et al., 2009, p. 256)

Figure 17 Container harbor of Amsterdam (Gilijamse et al., 2009, p. 247)

Figure 18 Two separate stations at the periphery of Amsterdam, map based on (Must Stedebouw, 2012; TAK architecten, 2015, pp. 14–15)

Figure 19 Three options for a new central station, map based on (Must Stedebouw, 2012; TAK architecten, 2015, pp. 14–15)

Figure 20 Before the central train station (Eickelberg, 1871)

Figure 21 After the central train station was built (Oosterhuis, 1887)

Figure 22 Section of the Central train station, based on drawing in the Amsterdam Centraal sitebook 2017-2018 (Davide Niccolini, Victor Koot, 2018, p. 327)

Figure 23 The open waterfront has been decreasing in size since the beginning of Amsterdam (Must Stedebouw, 2012)

Figure 24 “Plan Koolhaas” (Pakhuis de Zwijger, n.d.)

Figure 25 “New bus terminal with station roof” Benthem Crouwel

architects (“Amsterdam Central Station - Bus Terminal,” n.d.)

Figure 26 Noordzeekanaal A. Huët (Huët, 1874)

Figure 27 “Amsterdam uitgelegd aan de IJ-zijde” Jan Galman (Galman, 1857)

Figure 28 “Rapport inzake een vaste verbinding der IJ-oeveren van Amsterdam” W.A. de Graaf (Bock & Smit, 1996, p. 79)

Figure 29 “Algemeen Uitbreidingsplan van Amsterdam Schaal 1:25000” (van Eesteren, 1935)

Figure 30 “Vogelvlucht van het noordelijk stadsdeel, 1934” (Galman, 1857, p. 99)

Figure 31 Historic inner city demolished in favor of the subway and motorways (G. Jaeger, 1975)

Figure 32 What if we reclaim land from the IJ, create connections and construct a canal around north that bypasses the IJ? (Ingmar Klappe, 2018)

