

A photograph of an open metal door leading to a courtyard. The courtyard contains a tree with green leaves and some overgrown plants. The door is set in a wall of grey concrete blocks. The text is overlaid on the right side of the image.

Harvesting the port

*Strategies to
transform urban
industrial ports
into sustainable
urban
environments.*

Personal Information
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Studio
Architectural Engineering
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Argumentations for choice of studio:

The studio Architectural Engineering is in my opinion a good way to complete my education in architecture. It covers a wide scope of topics including sustainable, ecological, societal and technical challenges. Experimenting and dreaming is encouraged, but the results are still realistic and practical. The interconnected research-design approach is something I value a lot and I would like to develop this more. I am fascinated by architecture with high sustainability goals, out-of-the-box solutions and strong concepts that are visible in all scales of the design.

Furthermore, this studio has a lot of possibilities for transformation of the existing build environment. I think this studio offers a good balance between freedom and structure within the graduation project and will challenge me to do the best I can.

Introduction:

In this paper, the potential for transforming the West Port of Amsterdam into a sustainable and healthy urban environment, through interventions in metabolic fluxes, is investigated.

Climate reports show a drastic need for change and an immediate stop in the use of fossil fuels (IPCC, 2021). In order to meet the climate goals that have been set and prevent the world-temperature to rise 2°C or more, industries are changing to green and sustainable alternatives. Not only does this transformation affect the processes that take place, but also the character and atmosphere of industrial areas as a whole. In December 2019 the coal plant in Amsterdam (the Hemwegcentrale) was closed (NOS, 2019) and last September Tatasteel IJmuiden announced to use hydrogen instead of coal to reduce CO₂ emissions (Nu.nl, 2021). Future-focussed industries, like biogas production, plastic recycling, remanufacturing, windmills and solarfields are taking over the places of coal plants. The city of Amsterdam and the Port of Amsterdam are both developing strategies to transform the port into a circular energy hub in the next 10 to 30 years (Amsterdam Circular 2020 - 2050) (Visie Haven 2030). What other possibilities will the reduction of hazardous emissions and waste in these areas provide?

Urban Metabolic Flux Analysis (MFA) is an analysis and visualization method which can be used to find opportunities for circular processes and waste reduction. In this paper, the flows in the Port of Amsterdam will be researched in order to find possible interventions that increase sustainability and can be integrated into architectural design.

Keywords

– Urban Metabolism, MFA, Industrial Urban Ports, Sustainability, Circularity, Waste Reduction, Energy Transition, New Industry –

Problem Statement

- 1) There is a need for new building locations in cities. Population growth, housing shortage and urbanization put pressure on the densifying of urban areas, and the green areas that surround them. Nevertheless, these green areas are essential in growing and densifying cities. To prevent building in these valuable green areas and pushing nature further out, we have to find other places to densify within the urban fabric that already exists.
- 2) From a larger perspective, a reason to transform these areas is their large contribution to climate change. Climate reports show a drastic need for change, for instance in the Paris agreement in 2015 (United Nations, 2015) and more recently in the "AR6 Climate Change 2021"- report from the Intergovernmental Panel on Climate Change (IPCC, 2021). The industry and electricity sectors are the two biggest CO₂-emission sources in the Netherlands (figure 1). In order to prevent further climate change and temperature rise, industrial ports have to find sustainable and fossil-free alternatives right now.
- 3) From a design perspective the industrial port areas are generally unattractive, mono-programmatic, polluting areas which lack human-scale, biodiversity, identity, heritage value and social value. Their economic and energy-producing programs support the city, but they do not offer any spatial or programmatic value to urban life.

- 4) The lack of programs that serve urban life is caused by the safety- and health-regulations which are necessary for the industrial program, for instance the storage of highly flammable petroleum. These safety-regulations are possibly also part of the future industry, for instance when large amounts of hydrogen are stored. Moving industrial functions away from the city, will allow for freedom of program development, however, some industrial future industrial functions are desirable in close proximity to the city. A solution is to change the identity of these areas and transform them from being only the economic and industrial motor, into places which are valuable for urban life while also allowing for sustainable ways of producing energy, manufacturing and port-activities. Thus, erasing the hard boundaries and finding a synergy between urban life and manufacturing, nature and energy production.

By identifying the problems and potentials of these areas, the industrial urban ports could be re-evaluated and transformed into a new place for densification.

Positioning

Within the theory on urban metabolism, there are two schools of research. The first and oldest, following Odum, perceives urban metabolism in terms of energy equivalents; Metabolic Flux Analysis. The second school emerged in 1991 from the research of Baccini and Brunner and is based on the Material Flow Analysis, describing flows in mass fluxes. These two schools are non-conflicting, since they work from the same principles, only use a different form of representation. Both are referred to with the abbreviator MFA. Gerard Roemers from the company Metabolic, uses the term "Urban Metabolism Analysis" (Roemers, 2016). Since the biggest flows in this area are both energy and material-based, the term Metabolic Flux Analysis will be used. However, literature referring to Material Flow Analysis, will still be used.

Urban metabolic flows can be analysed on different urban characteristics; material, energy, ecological, social, political and economic. The flows that are specific for this area – mainly related to port-specific activities – are energy,

heat, water, non-organic, organic and traffic. This selection of flows are based on the main activities in the Port area. A smaller system or flow-set will be chosen for deeper analysis to make the research feasible.

Two strategies of approach

My graduation project can be separated into two parts; the urban metabolic analysis and the architectural design. There are two ways to approach this assignment. Firstly, from a research-perspective, the first step would be to make the metabolic flow analysis. This would include every flow; cacao storage, autoshops and garages etc. Thereby no flows are excluded, since all flows might potentially be valuable. In this approach, accurate research is prioritized and guiding the design.

The second approach would be from a design-perspective and would start by setting guidelines for the final design which will then guide the research. For example, whatever the design might be, it will need water, energy and materials. These flows would be the focus in the metabolic analysis, assuming that the other flows will be of less importance for the final design. The perk of this last approach is that the metabolic analysis will be much more comprehensible. However, compared to the first approach, this strategy is less objective and might rule out any unpredicted outcomes.

The two approaches represent the duality of the Master of Architecture and both approaches have their advantages and disadvantages. Finally, I decided that since research and design are always interconnected, I will attempt to use both approaches parallel to each other. Figure 2 shows a flow diagram of the two approaches, their steps and how they relate and influence each other. In figure 3 the research phases are divided over the two lanes "research" and "design" to show from which perspective they are. The meandering of the phases shows how the two approaches alternate during the project.

Preceding works

The project by Darshik J. Parejija; "Modern Industrial Heritage: A Catalyst to new Sustainable Development." (2021) is very relevant and similar in fascination. I was amazed by Parejija's results, however, I think that a closer analysis of the urban context and usage of local sources could have

Uitstoot broeikasgassen naar sector

megaton CO₂-equivalent

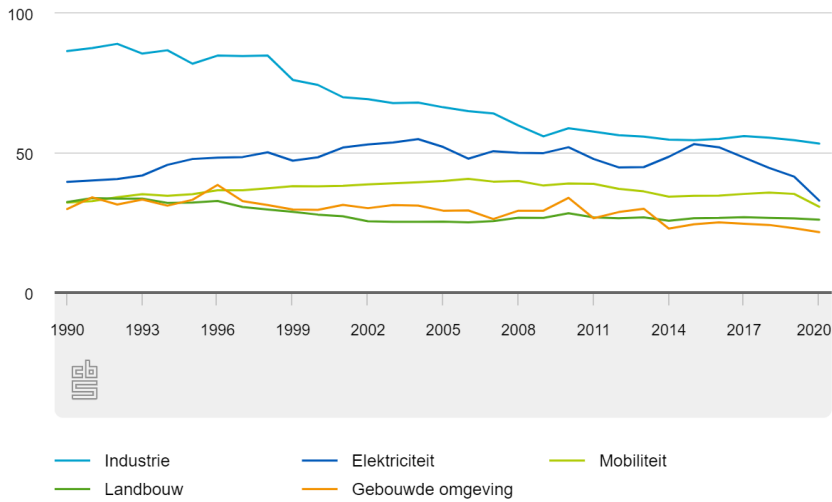


Figure 1 *Uitstoot broeikasgassen naar sector 2020. Retrieved from CBS.*

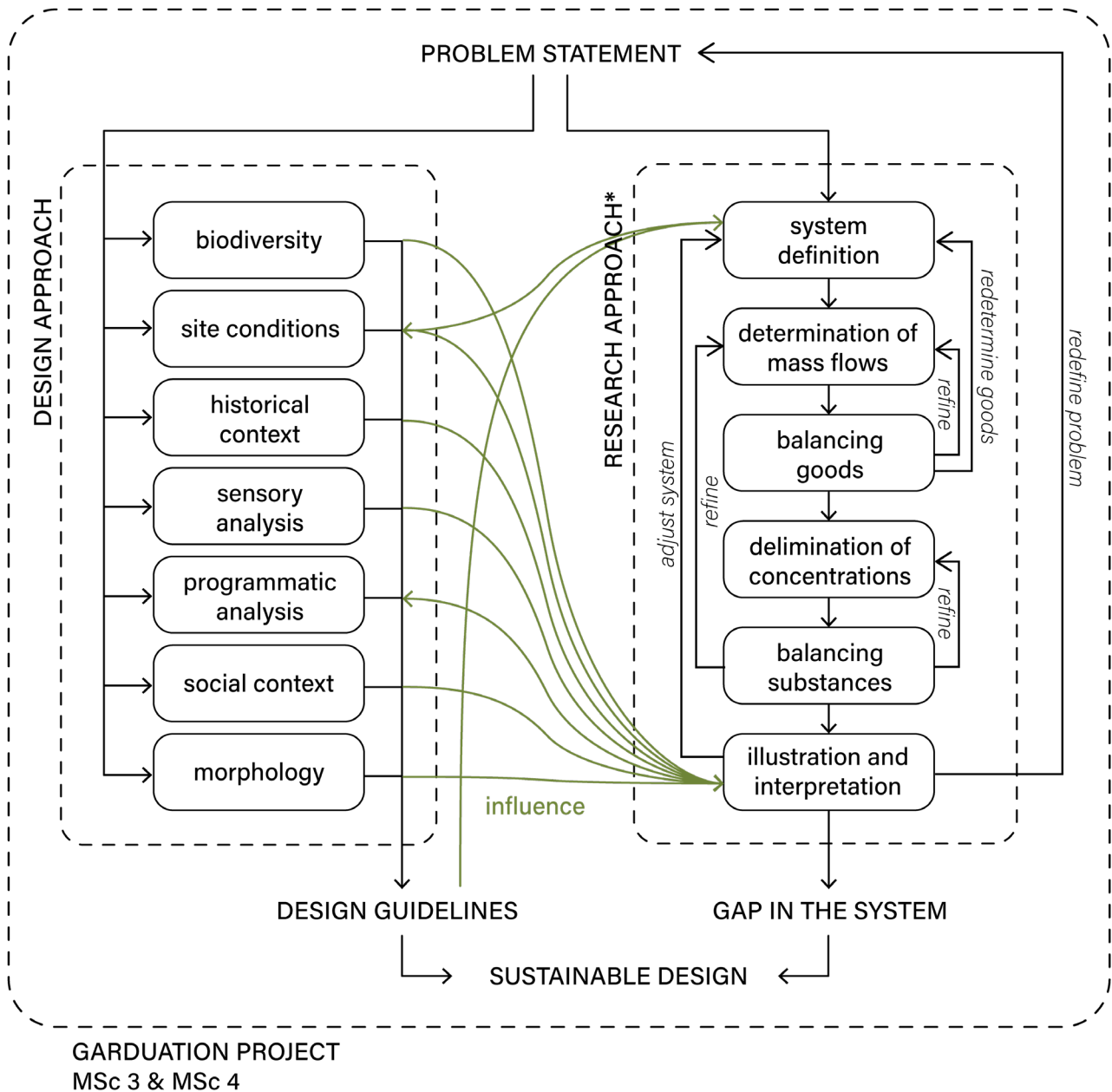


Figure 2 *Graduation project research and design approach. Own creation.*

made this project even better. I would like to add the perspective of urban metabolism, which on a larger scale than one company, looks at the potential of companies working together to reach the most sustainable circular goals.

The project by Maarten de Haas "In navolging van het voorafgaande" (Academie van Bouwkunst 2017 and winner of the Archiprix 2018) is an inspiring project from a more artistic perspective. De Haas designed a datacentre in the centre of Rotterdam by which he addressed the role of important industries and companies in the future of cities.

Metabolic is a Dutch office which performs MFA's internationally. They performed a metabolic flow analysis on Circular Buiksloterham (Galdek, Odijk, Theuws, & Herder, 2015) for Waternet and the City of Amsterdam. Their report is relevant as it not only forms a good example for performing a MFA, but also because the neighbourhood Buiksloterham is close to the West-Port of Amsterdam and certain inputs and flows are similar.

Pre-reflection

The risk of using the urban metabolism approach is that when this organismic-view is exaggerated to a degree in which natural principles are used to discover rational logic in urban processes, important nuances could be lost (Bruggeman, Juwet, & Danneels, 2018). According to Bruggeman et al. the processes of urban environments are complex and on a global-scale, an organismic-view could potentially lead to dangerous assumptions and false judgement. My perspective on urban metabolism would be more comparative to an ecosystem instead of an organism, similar to the perspective from Bunje et al. (2010).

Another question which emerges from this graduation project is: should industrial urban port areas be transformed for sustainable city densification at all? Or rather, should the mono-programmatic character of the industrial port be considered a deficiency? A big metropole needs a big energy supply, therefore there has to be an area near to the city which can supply this energy. This industrial port area can be compared to the machine-room of the city and even though its infill might change over time, the infrastructure of green energy sources and facilities like datacentres still need a place. Moreover, certain

industrial activities can take place here because there is a different safety policy compared to residential areas. It made me question whether the transformation of this area would obstruct its functionality and if urban life should take place here at all and in what way.

Definitions

Urban metabolism:

According to Kennedy et al. (2008) urban metabolism can be defined as; *"the sum total of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste."* (p.44)

The following definitions are all part of the vocabulary used in Metabolic Flow Analysis. They were originally developed by Baccini and Brunner in 1980, but for this paper I will use the definitions written by Brunner and Rechberger (2005).

Material Flow Analysis:

"Material Flow Analysis (MFA) is a systematic assessment of the flows and stocks of materials within a system defined in space and time." (p.3)

Process:

"A process is defined as a transport, transformation, or storage of materials." (p.4)

Stocks:

"Stocks are defined as material reservoirs (mass) within the analysed system, and they have the physical unit of kilograms." (p.4)

System:

"A system comprises a set of material flows, stocks, and processes within a defined boundary." (p.4)

Substance:

"A substance is any (chemical) element or compound composed of uniform units. All substances are characterized by a unique and identical constitution and are thus homogeneous." (p.35)

Good:

"Goods are defined as economic entities of matter with a positive or negative economic value. Goods are made up of one or several substances." (p.36)

Overall design question

How can the West Port of Amsterdam be transformed into a place that allows for both sustainable urban densification and sustainable industrial activities in 2050?

Thematic Research Question

How can interventions in flows that are available in the industrial program between now and 2050 contribute to making the West Port of Amsterdam more sustainable and how can these interventions be integrated in architectural design?

Sub questions

- 1) Which developments and transitions are influencing the area (including the flows) now and in the future? (Reports and policies)
- 2) Which flows are and will be there? (Large scale MFA)
- 3) Which systems are relevant to zoom in to based on sub question 1? (Options)
- 4) What flows and processes are part of this system? (Small-scale in-depth MFA)
- 5) How can an intervention in this system increase sustainability?
- 6) How can this intervention be translated into an architectural design? (Strategies)
- 7) What is the impact on the small and large scale?

Hypothesis

- 1) Sustainability of the West Port of Amsterdam can be increased by interventions in the flows that are part of the industrial programs in this area in the future.
- 2) These interventions can be integrated into architectural design.
- 3) In order to make the Port more sustainable, Metabolic Flow Analysis is a viable method.

Antithesis

- 1) In spite of the energy transition and optimization of urban metabolism flows in

industrial areas, these areas are not suitable for urban densification.

- 2) The interventions in flows necessary to make the port more sustainable cannot be integrated in architectural design. In this scenario the architectural design might aim to support the intervention. *For example, when the intervention is part of an industrial process of the sewer purification company, the design might include a water separation system which helps the process before the water arrives at the company.*
- 3) The port can be made sustainable, but Metabolic Flow Analysis is not the right method to achieve this goal. Other methods should be tested.

Research outcome will probably be somewhere in between as interventions in flows can only improve sustainability to a certain degree. Policies and other strategies are necessary to reach maximum results.

Methodologies

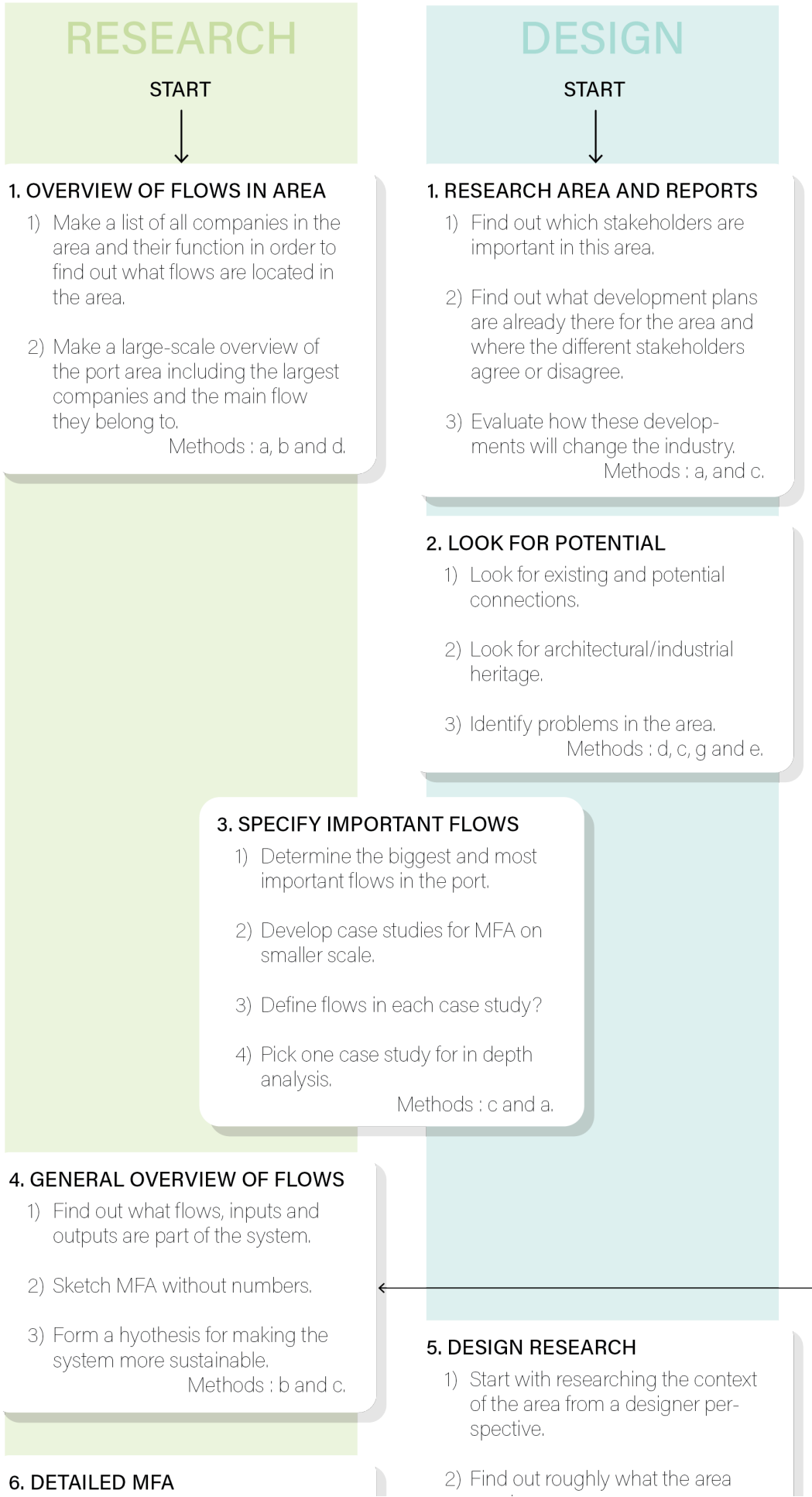
(The use of these methods can be found in the planning diagram on the next page.)

- a. Literature research
- b. Urban metabolism analysis (Balance sheet, and Sankey diagram, Activity based Spatial Material Flow Analysis)
- c. Reference analysis (of both other industrial ports and area development projects based on circular urban metabolism)
- d. Site visits and mapping
- e. Sensory mapping
- f. Contamination-degree and (bio) cleaning-methods
- g. Heritage value analysis
- h. Material research
- i. Design research (sketching, modelling, conceptualizing)

*If during the research other methods seem more suitable, these will be added.

Planning

Graduation calendar can be found in the appendix.



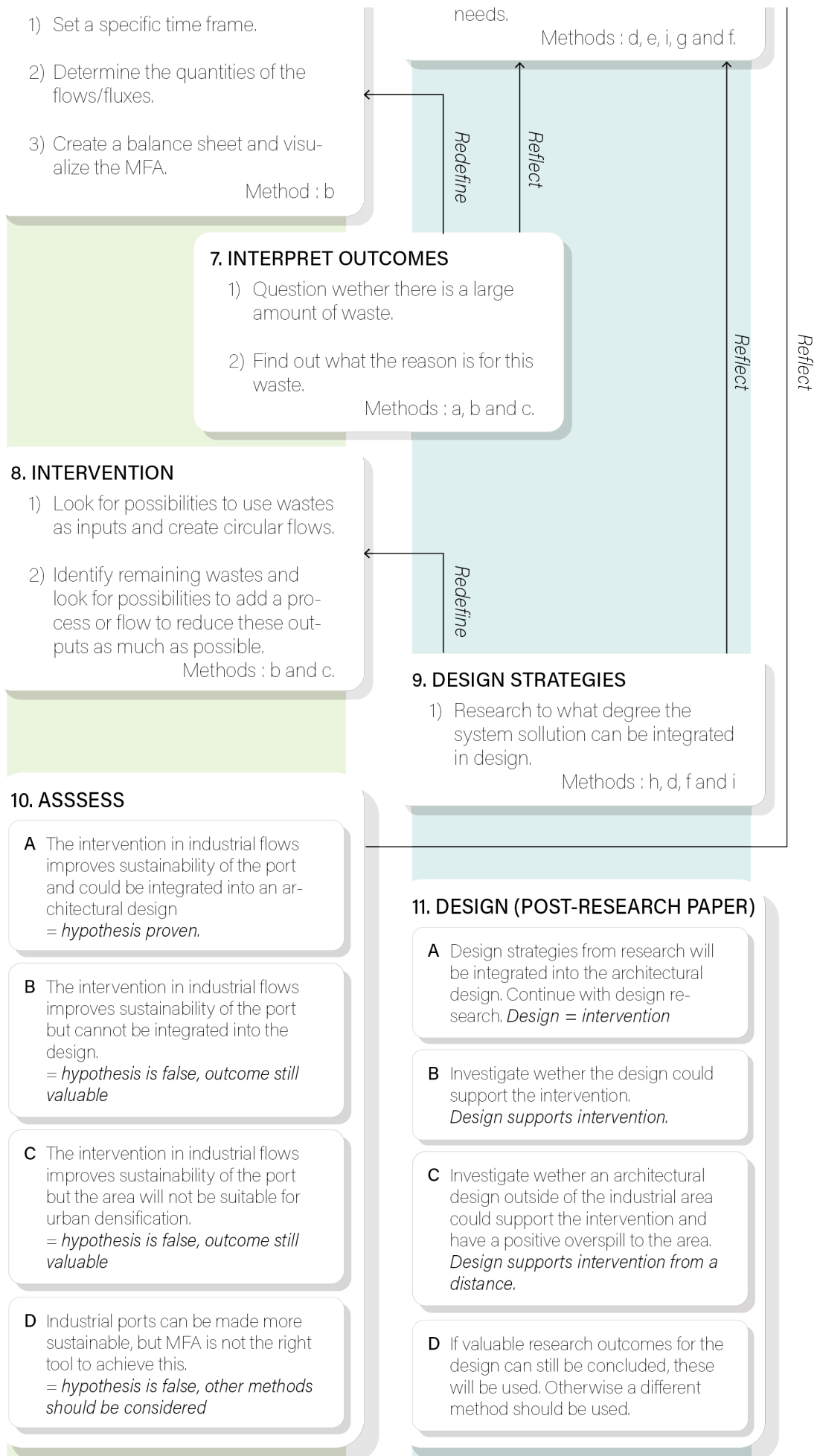


Figure 3 Planning in phases. Own creation.

* Methods are ordered on relevance and refer to the methods on the previous page.

Relevance

Since the system boundary of the metabolic flux analysis will include processes and flows that are available in the West Port of Amsterdam, the outcomes will be specific. However, the research approach and design strategies that result from it are to a certain degree applicable to all industrial urban port areas. Furthermore, by addressing the potential for city-densification in future urban ports, re-evaluation of these areas on a global scale will be encouraged. This re-evaluation will not only benefit the cities on a regional scale in (economic and social) value, but could also be a step towards countering climate change worldwide.

Municipalities and other policymakers are already aware of the necessary changes, which can be seen in for example the "omgevingsvisie Amsterdam 2050" (Gemeente Amsterdam, 2021) in which plans for creating a circular hub and energy hub in the West Port of Amsterdam are mentioned. What this means for the transformation of the port; its aesthetics, buildings, program and character, is not defined. Researching the potential of urban ports could help setting this transformation in motion.

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- Cover *The only pretty thing in the Port.* Own photograph. (sep 2021).
- Figure 1 *Uitstoot broeikasgassen naar sector.* CBS (2020).
- Figure 2 *Graduation project research and design approach.* Own creation.
- Figure 3 *Planning in phases.* Own creation
- Figure 4 *Procedures for MFA.* Retrieved from Brunner & Rechberger, 2005.
- Figure 5 *Flow diagram coal plant.* Own creation.
- Figure 6 *Graduation calendar with phases.* Own creation.

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Appendix

Relevant projects by former students

Darshik J. Parejija

Kim Hooiveld

Coen de Vries

Samuel de Vries

Maarten de Haas – In navolging van het voorafgaande (Academie van Bouwkunst 2017)

Relevant previous research

MSc1: Delft lectures on architectural design and research methods. Research into squatters at the ADM-terrain located in the West Port of Amsterdam. Our research was focused on the vernacular way of building, which includes building from 'waste' and reuse of the existing.

MSc2: Public Building studio. Design of a contemporary forum in Den Haag, based on demountability and urban harvesting. We developed a timeline for building elements, which could easily be

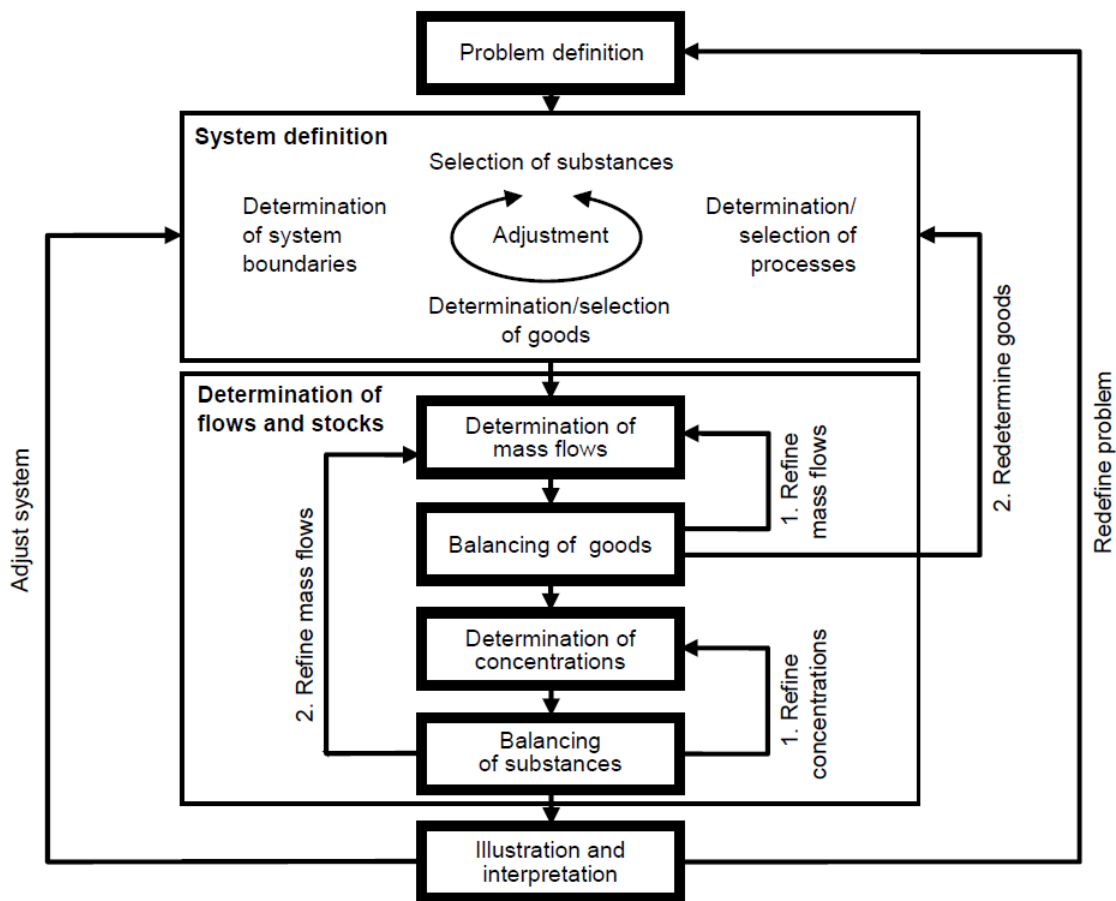
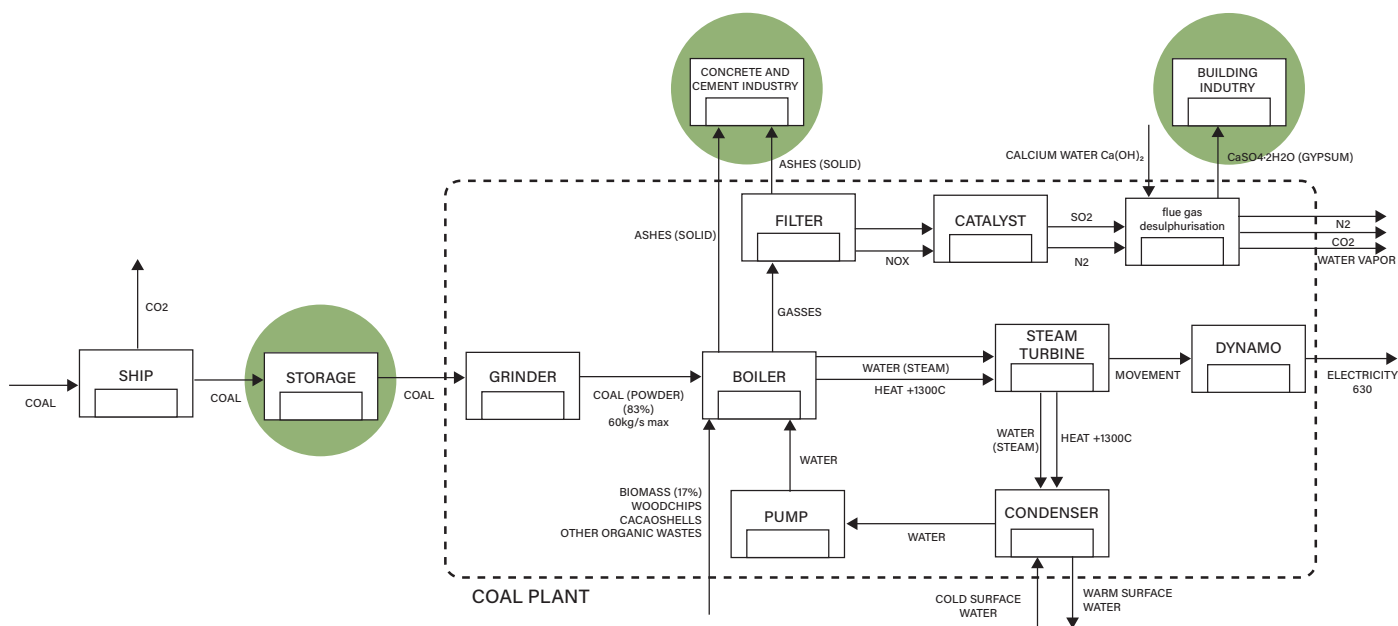


Figure 4 Procedures for MFA. Retrieved from Brunner & Rechberger, 2005.



BECAUSE OF THE CLOSING OF THE COAL PLANT, THESE INDUSTRIES ARE NO LONGER BOUND TO THEIR LOCATION IN THIS PORT

Figure 5 Flow diagram coal plant. Own creation.

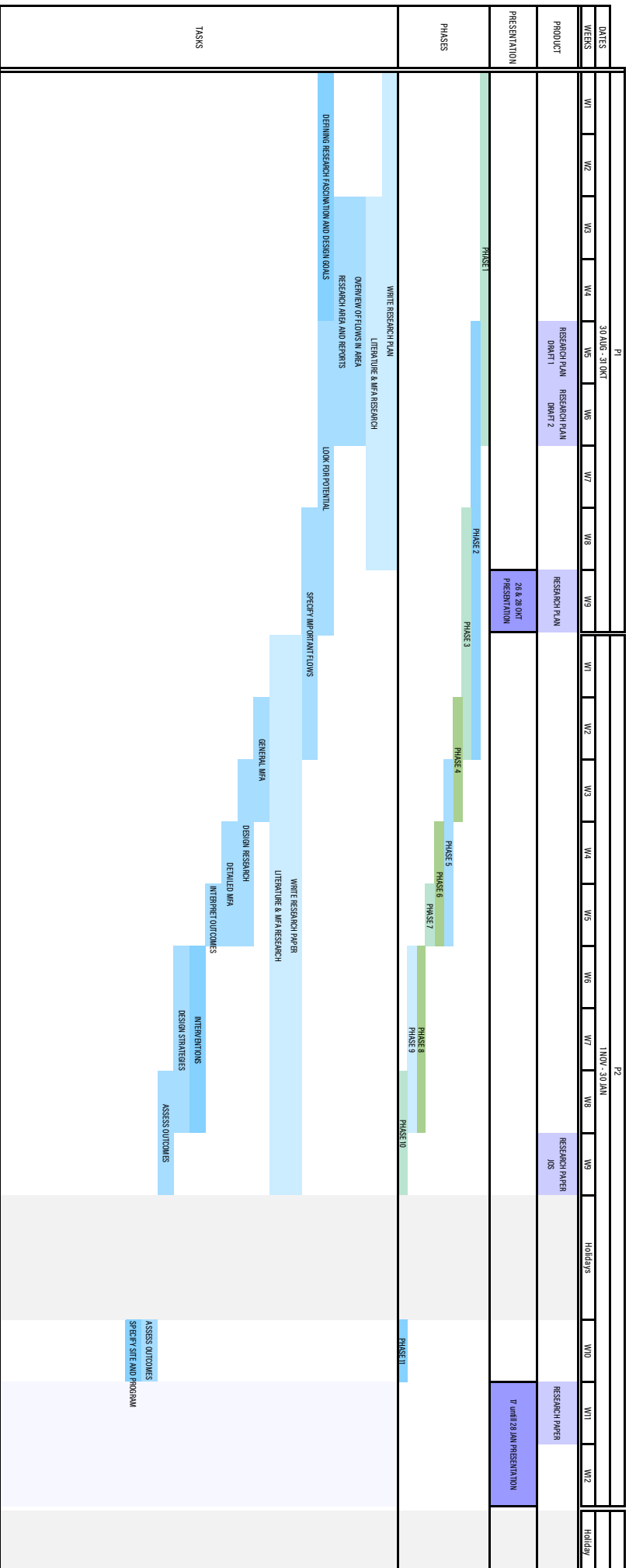


Figure 6 Graduation calendar with phases. Own creation.

