From infrastructure to flowscape

The Houtribdijk as an operative landscape structure

Report

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# Table of content

## I INTRODUCTION

1 Fascination 01
2 Problem field 02
2.1 Infrastructure: Dutch dike 02
2.2 The future of the landscape infrastructure 02
2.3 Problem statement 03
3 Research objective 04
4 Research questions 04

Reading itinerary 05

## II Methodological framework 06

1 Flowscape 06
2 Design concept 06
4 Research methodology 07
5 Research model 07

## III UNDERSTANDING THE SITE 09

1 Context analysis 10
1.1 The form and the process 10
1.2 Nature system in the IJsselmeer 10
1.3 Urban system in the IJsselmeer: 3x3x3 analysis 10

2 Analysis conclusion and potentials 19
2.1 Two orientations of the Houtribdijk 19
2.2 Reformulate as potential of the Houtribdijk 20

3 Nature processes around the Houtribdijk 21
3.1 Wind setup and waves 21
3.2 Sediment resuspension 21
3.3 Seasonal water level changing and drifting ice 21
<table>
<thead>
<tr>
<th>IV DESIGN PRINCIPLES</th>
<th></th>
<th>V APPLICATION</th>
<th></th>
<th>VI SYNTHESIS CONCLUSIONS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Case study: Existing design principles</td>
<td>25</td>
<td>1 Master plan of the Houtribdijk</td>
<td>34</td>
<td>1 Conclusion</td>
<td></td>
</tr>
<tr>
<td>2 Design with natural processes</td>
<td>27</td>
<td>2 Landscape design of Tintenhaven phase</td>
<td>35</td>
<td>2 Reflection</td>
<td></td>
</tr>
<tr>
<td>2.1 Wind setup and wave</td>
<td>27</td>
<td>2.1 Existing situation and potentials</td>
<td>36</td>
<td>2.1 Reflecting objective</td>
<td></td>
</tr>
<tr>
<td>2.2 Sediment resuspension</td>
<td>27</td>
<td>2.2 Ecological analysis</td>
<td>37</td>
<td>2.2 Lessons learned</td>
<td></td>
</tr>
<tr>
<td>2.3 Seasonal water level changing and drifting ice</td>
<td>27</td>
<td>2.3 Ecological design</td>
<td>38</td>
<td>2.3 Research-design relation</td>
<td></td>
</tr>
<tr>
<td>3 Strategy design based on natural processes</td>
<td>30</td>
<td>2.4 Dynamic landscape design</td>
<td>39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1 Strategy design in layers approach</td>
<td>30</td>
<td>3 Detailed design</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2 Strategy design models</td>
<td>30</td>
<td>3.1 New marshland</td>
<td>41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Spatial quality on the Houtribdijk</td>
<td>31</td>
<td>3.11 Existing situation</td>
<td>42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Landscape structure of the Houtribdijk</td>
<td>34</td>
<td>3.12 Case study: Marshland Oostvaardersplassen</td>
<td>42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Initial design of the Houtribdijk</td>
<td>36</td>
<td>3.13 Experimental design</td>
<td>42</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.14 Achievement</td>
<td>42</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.2 Two connections</td>
<td>44</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.21 Existing situation</td>
<td>44</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.22 Case study: Bootsboot aan stenen</td>
<td>44</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.23 Experimental design; the form of the opening</td>
<td>45</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.24 Landscape architecture design</td>
<td>45</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.241 Tunnel</td>
<td>45</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.242 Bridge</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REFERENCE
I Introduction

1 Fascination

During the landscape architecture design, I am always looking for the harmonious interaction between form (architecture) and process (landscape).

One of the most impressive projects that inspired me is Coastal Work Katwijk by OKRA, Arcadis and RHDHV (see Fig 1). In this project, the “Dyke-in-Dune” solution was introduced to reinforce the Katwijk’s coast while offering the parking space by integrating the underground parking garage with current dunes. A dike of sand inside the new, wider dunes was constructed seaward from the current dunes.

Within this dune landscape area, vegetation were planted following the curve surface of the sand dune. It prepared a livable habitats for the fauna and flora groups which would become dynamic during the dune transition. At the same time, the entrances of the parking garages are hidden under the sand skin without disturbing the landscape process. Moreover, the paths, which connect the parking space, beach, boulevard until the high street of the village are going through the landscape, providing people with a comfortable walkway and a unique dune experience.

Bringing these inspiring features, I started my landscape architecture graduation research in order to seek the formative power and its transforming con-sequences.
2 Problem field

2.1 Infrastructure: the Dutch dike

Infrastructures are tremendous components of the urban landscape by virtue of their very great amount, scale, ubiquity and inability to be hidden (Strang, 1996). Nowadays, they have been gradually conquering nature because of the human domination. As a result, the environment has been denied its natural dynamism in favor of colonization that relies on more controlled and static systems (Nijhuis and Jauisin, 2015).

The Dutch dike, as a symbolic image of the infrastructure in the Netherlands, has been playing a significant role in the urban development since the late Iron Age. “A look into the long Dutch tradition of dike building gives us insight on a deeply rooted culture of trial and error in a country where the sea level rises and the ground level is dropping” (Dutch Dikes). The dikes were built up as a flood defense, water storage or as carriers of traffic lines. Until now, a massive and highly-dense dike network has been formed on a national scale (see Fig 2).

At the early ages, the attention was drawn on the safety and structure of the dikes which were regarded as a pure technical production. However, from 1985, there has been a slow change in attitude towards the Dutch dikes and its surroundings because of several natural and human disasters. A radical transformation in attitudes to water quality was triggered by an accident of chemical pollution in the Rhine in 1966. “This was the era in which environmental activism, nature conservation came of age.” Furthermore, “after the flooding of 1993 and 1995, it became clear that raising the prescribed norm or reinforcing the dike was not the only solution to flooding”. Instead, the smart integrated landscape solution like “Space for the River” could have more effective and sustainable consequences to the environment.

2.2 The future of the landscape infrastructure

With the rapid development of technology, the technological utilitarian features of massive infrastructures are swelled. To some extent, these man-made functional monsters were superimposed on and at the same time disturb the surroundings. However, the public awareness has raised up to seek for more harmonious urban landscape infrastructures, which pay close attention on the environmental issues.

At the beginning, the idea of “infrastructure as landscape” appeared. It proposed that urban infrastructure could provide the space and landscape conditions for the urban and nature developments. Also there are successful cases of interdisciplinary design-related research on the infrastructure landscape themselves. As an example, the Landschaftspark Duisburg-Nord (Germany) in 1991 by Latz + Partner as a redevelopment case of industrial brown-fields to transform the industrial waste infrastructure into urban landscape which benefit the natural and urban systems. Besides, there were more cases done, such as the sewage farms, green necklace Emscherpark and so on. After that, the dialectic between landscape and infrastructure shift into the next stage which is “landscape as infrastructure”. For instance, the New City Park competition for Manhattan (New York, USA) in 2009 by Morphosis Architects considering the park as an urban armature of functional infrastructure is a typical case for that concept.

Though, there are lots of contemporary critical thinking and debate about the discipline researched and applied on the urban landscape infrastructure, the potentials of infrastructure for facilitating the processes that reshape the built environment and dynamic landscapes are largely unexploited (Nijhuis, S and Jauisin, 2015). As landscape architects, we start to rethink the relationship between processes and formal aspects of the urban landscape infrastructures. Instead of “forms follow function” defined in the architectonic fields, “forms follow processes” is proposed in the landscape fields. Here, the landscape processes are introduced as a formative power to transform the single-purpose infrastructure into a more comprehensive form of urban landscape architecture. As a conceptual result, it is interpreted as “flowscape” which regards the infrastructure as an operative landscape structure. The concept states that the infrastructure is a part of landscape and the surrounding environment is a part of the infrastructure. As a result, they form a landscape zone instead of a linear structure.
Fig 3: The Houtribdijk and the South western polder plan

Fig 4: The present situation around the Houtribdijk.
2.3 Problem statement

There are massive infrastructures with a single functionality superimposed on the environment regardless of the dynamic nature and urban development. It is unexplored regarding how to transform the infrastructure and thus reshaping the built environment and dynamic landscape based on the processes (Nijhuis, S and Jauslin, D., 2015). The same problems happen within my research site.

The Houtribdijk was built up not only to connect Enkhuizen and Lelystad, but also to make the new southern port for agriculture (see figure 3). However the new poler plan was cancelled. Instead of becoming the edge of the land, the Houtribdijk became an edge of two water bodies: the Ijsselmeer and the Markermeer (see figure 4).

With the development of the natural and urban system, the Houtribdijk became superimposed into the environment and it causes ecological and social problems. For instance, the dike blocks the two water bodies from water exchanging and fish migration. Especially the Markermeer is completely closed by the dike without water flow input. As a result, the turbidity in the water is traped within the Markermeer which leads to a poorer water quality. Moreover, the dike carries a long-distance and high-speed traffic line but there is almost no accessibility to shelters and a place to stay. Even though there are beach areas for recreation on both sides of the Houtribdijk, there is no connection between the two dike shores.

Furthermore, instead of facing to the open water and horizon, two landing cities: Enkhuizen and Lelystad are pushed inward to the land by the linear dike. Though the Houtribdijk connects these two different urban tissues, there is a lack of social communication and sympathetic response between a traditional city (Enkhuizen) and a new poler city (Lelystad).

Overall, as a single-purpose technical infrastructure, the Houtribdijk does not have the initiative towards the dynamic natural and urban environment.

3 Research objective and Research Questions

The research objective is to develop the Houtribdijk as an operative landscape structure. It is about the natural processes as a formaative power to transform the Houtribdijk into a “flowscape” from a single-purpose technical structure.

4 Research objective and Research Questions

When it turns to face the specific design project, there are four main research questions designed to study the research objective.

- The forth research question is to reflect the research objective and elaborate the lessons learned from the Houtribdijk transformation project in order to apply the principles on the generic landscape infrastructure design within the “flowscape” framework. Furthermore, to reflect the design-related research and explain the relation between the research and design.

- The second research question is “What are the existing principles applied to shape the Houtribdijk based on landscape layers? And Which principles can be used in landscape architectural design under the formaative power from natural processes?”. Referring to the first principles explored from case studies, the landscape architecture design principles need to be elaborated through iconic drawings and principle models. In this step, it is important to realize that the dynamic natural processes as a formaative power are the emphasized research aspects we focus on.

- The third research question is on the transformative process and how to apply the transformative principles into the transformation design of the Houtribdijk.
Reading Itinerary

The thesis started from describing my fascination for a landscape architecture design: harmonious interaction between form (architecture) and process (landscape). Secondly, the problem field of the research and design of the infrastructure landscape was defined. Thirdly, the research objective, research questions, research methodology and research design model which illustrated the main structure of the thesis were stated.

In the second chapter, the theoretical background of "Flowscape" and the design-related research concept guided by the "Flowscape" theory will be introduced.

From the third chapter, through explaining the design process of the Houtribdijk landscape architecture transformation project, I will start to answer the research questions under the structure of:
- "Understanding the site"
- "Problem/potential evaluation"
- "Design principle"
- "Application"
- "Conclusion"

At the same time, the research by design methodologies, such as mapping in 4D, case study and experimental design, will be synthetically demonstrated within the project presentation.

At the end, in the reflection chapter, the research objective will be reflected and evaluated on in order to see if transforming the Houtribdijk into an operative landscape structure is achieved. Moreover, generic lessons learned from the Houtribdijk design case will be elaborated within the "Flowscape" framework. The new principles could be brought into other urban infrastructure landscape design projects as a reference. Finally, I will rethink the relation between research and design from a landscape architect's attitude.
II Methodological framework

1 Flowscape

According to Nijhuis, S and Jauslin, D. (2015), the 'Flowscape' is regarded as an advanced landscape design framework, because it does not only aim at solving problems or adapting to the environment, but also reacting to the dynamic landscape processes and creating the conditions for the development of natural and human society in a specific context.

As landscape architects, besides achieving the vision of a multi-functional urban landscape infrastructure, it is also significant to understand the content of a dynamic landscape. In this transformation, besides "the space of place", it pays special attention on the space of flows as well. The landscape processes and the interactions between natural and human elements are the formative power to shape "the space of flows".

The "Flowscape" aims to transform the single-purpose infrastructures, which only have a linear connection between two places, into the operative landscape structures, which consider about the surroundings and have the interaction between the environment.

2 Design-related research concept

In the concept diagrams, it illustrates how a mono-functional liner infrastructure (see figure 3) gradually is being reshaped by the flows in the landscape system (see figure 4, 5, 6, 7, 8). Moreover, the forces which shape the flows are further characterized into three types: promote force, attractive force and repulsive force. When it overlaps and integrates these flows, multiple zones are formed. Within this dynamic framework, the spatial quality, program, ecological system and social behavior can be further developed based on the environmental conditions.

Under the guideline of "flowscape" design concept, the Houtbdijk is regarded as a landscape zone integrated into the environment instead of a linear technical structure which has a single purpose. During transforming the design, the landscape processes of the nature and urban systems are the main formative power to re-shape the Houttdijk.

Figure 7: Mono-functional liner infrastructure

Figure 8, 9, 10, 11, 12: Conceptual design of transformation from infrastructure to flowscape
3 Research Methodology

From the designer's perspective, design-related research methodology is "a heuristic approach for knowledge based and creative design" and it is used to "explore a possible or predictable future and the methodical discovery of the right composition" (Nijhuis, 2014). In this paper, it illustrated the specific design-related research methodology, such as the case study method, mapping in 3D method and experimental design method, which are applied in the research and design process. It discussed the reason why to choose, how to apply and what is the innovative thinking and critical reflection of these methods based on an in-depth understanding of a design-related research methodology in landscape architecture.

For instance, the interdisciplinary maps could illustrate a lot of different elements and the interactions between these elements. It would be challenging and confusing to read everything in one layer of a map. So decomposing the map into different layers is a good approach to make the map more readable. In this case, there is a layering system for the maps created based on the "flowscape" framework and 3X3X3 analysis framework (Nijhuis, Jauslin, 2015; Meyer, and Nijhuis, 2013).

Moreover, regarding the book from Yin, R. K. (2003), the method of choosing the case study is clearly explained. In my opinion, the case study selection highly depends on the database relevant to the topic and the sensitivity, instincts, and abilities of the researcher. Compared with the case study selection method, the principle elaboration method needs further development.

At the end, the goal of the experimental design is to have a visualized conclusion of the consequences of the forms. It combines the physical modeling and digital modeling methods.

4 Research design

In general, the research is designed to start from a generic problem field, "Flowscape", narrowing down to the research objective, then to a specific landscape design project. At the end, it generalizes the study into the next level which is the lessons learned within the problem field (see figure 5). The Houtblijd transformation design project under the specific context is regarded as a case study for the entire "Flowscape" design-related research. So the outcome of the Houtblijd transformation design is not the end of the research. Instead, the lessons learned and elaborated on from the design case study are the end results of the research process.

Within that scope, it neither simply combines different knowledge nor goes very deep into one professional aspect. As landscape designers, we are developing the balance and integration among different disciplines. Going one step further, we also aim to add landscape values on the research and design objects. The landscape value here means the dynamic context and the synergy between nature and urban development.

In the research design model (see fig. 5), it is shown the structure of the problem field, research objective, four main research questions and the synthesis conclusions within the "flowscape framework.

![Figure 5: Research structure](image)
Figure 6: Research design model (reference from Mijlisi, S.)
III UNDERSTAND THE SITE

1 Context analysis
1.1 The process and the form
1.2 Nature domination in the IJsselmeer
1.3 Urban domination in the IJsselmeer
2 Analysis conclusion and potentials
2.1 Two orientations of the Houtribdijk
2.2 Reformulate as potentials of the Houtribdijk
3 Nature process around the Houtribdijk
3.1 Wind setup and waves
3.2 Sediment resuspension
3.3 Seasonal water level changing and drifting ice
II UNDERSTANDING THE SITE

1. Context analysis

1.1 The processes and the form

The research and design project is the Houtribdijk, which is between Enkhuizen and Lelystad and located in the IJsselmeer area. In order to have a primary image of the site, I did a research about the processes and the form in the IJsselmeer.

From google maps, we only can see the surface of the water and the top view of the dike. While by using the landscape design tools: GIS (Geographic Information System), Grasshopper and Rhino, a digital model of the IJsselmeer lake bed is made to illustrate the sub surface of the site (see Figure 2).

The patterns under the surface of the site are clearly shown in the model. Through the research and analysis, it is found that there are two main processes shaping this area: the natural and human dominated processes. For example, in the northern side of the Afsluitdijk, the natural-shape eroding ravines under the sea water are formed by sea water erosion. In the other side of the Afsluitdijk, the IJsselmeer lake bed has a natural gradient which is formed by the sea water erosion before constructing the Afsluitdijk and the wind set-up and wave erosion after the IJsselmeer is closed up. On the other hand, the linear bulge at the edges of the water body and polders are the dike and dam built up artificially. Moreover, the deep rills in the Markermeer are the man-made ditches for marine traffic. Human also take soil from the lake bed to reclaim the land and it results in those deep concaves in the lake bed.

Overall, by looking into the dynamic forms of the IJsselmeer sublayer, we can recognize many types of processes from which the forms are a result. Landscape design tools can help to represent the information more clear and readable.

Mapping is a designing way to represent the history, data and text into a visual drawing during the context analysis. The spatialization, timeline and materialization are the three essential elements in a creative map. In my opinion, there are three main issues during the mapping process: How to make the map readable and systematic? How to show the three dimension-space and 4th dimension-time in a mapping system? What can we do with all these maps to find out possible answers to the research question?

1.2 Nature domination in the IJsselmeer

The “flowscape” regards the landscape process as a formative power to reshape the infrastructure. The process here is talking about the time which is the 4th dimension along the spatial world. Seeking the way to represent time into maps and finding the clues and hints from the time should be the instinct of landscape designers. In the “Drawing time”, it is said you can not express the time and changing in one map. By making the sequences and the dynamic changing within one scale could be very impressive.

During the creation of the nature domination maps in the IJsselmeer area between 5500 BC to 800 AD (see figure 11), I focused on three natural processes: sea erosion (blue zone and yellow arrow), flood sand plain (dark gray zone and orange arrow) and the river bed (black zone).

By comparing these, the sequences of natural landscape changes in the IJsselmeer, we can conclude that the IJsselmeer and the Markermeer areas were highly dynamic and they were once one connected water system.

Besides that, I would suggest not only to draw from a two dimensional planning perspective, but also to change the attitude to draw in a section or three dimensional perspective. For instance, in this case, a vertical section is made to represent the changing of the fundamentals of the IJsselmeer (see figure 2). The section is transformed from five planning maps of the IJsselmeer at five different time periods. There are 2 zones - IJsselmeer and Markermeer in horizontal direction divided by the Houtribdijk. It is very clear to compare the different conditions and natural dynamics under the water of the two sides of the dike. Mapping the time is a landscape designer’s attitude to stand at the present while looking at the history and the future. We can find the problems, solutions and potentials by mapping the history and discovering the process unfolding over time (Correa, J.).

1.3 Human domination in the IJsselmeer

The interdisciplinary maps could illustrate a lot of different elements and the interactions between these elements. It would be challenging and confusing to read everything in one layer of a map. So decomposing the map into different layers is a good approach to make the map more readable. In this case, there is a layering system for the maps created based on the “flowscape” framework and 3X3X3 analysis framework (Nijhuis, S., Jouslin, D., 2015; Meyer, H. and Nijhuis S., 2013). This layering system consists of substratum layer, network layer and occupation layer (see figure 13).
Figure 11: Nature domination in the Ijsselmeer (made by author)

Figure 12: The changing of the fundamentals of Ijsselmeer in action (made by author)
**IJsselmeer Scale**

During the 16th century, the "Dutch pearl lakes period", there were a lot of fresh water lakes connected with the Wadden Zee. All these water systems were connected with each other. After Afsluitdijk was built up in 1932, the IJsselmeer became a fresh water lake. Until 1960, the pearl lakes and open water areas were reclaimed into polders which are used for agriculture and urban function. The water systems of these polders and the IJsselmeer are connected with each other through ditches and pumps. There is also a water connection between the IJsselmeer and the sea through the Afsluitdijk. When the Houtribdijk closed up the Markermeer from the IJsselmeer, there is no direct connection between these two water systems apart from two locks for marine traffic.

**Markermeer Scale**

Here it is made clear how the Markermeer was transformed from salt-water to fresh-water to closed lake water. The water areas and sand plains were shrunk. The water system pattern in the west of the Markermeer and the east of the Markermeer are distinguished.

**Lelystad Scale**

Within the Enkhuizen area, the sand plain is shrunk and the soft shore of the Houtribdijk is gradually disappearing by water erosion. Lelystad has a very spread-out water management network while Enkhuizen has a more dense and traditional water system.
From Infrastructure to Flowscape
The Houtribdijk as an operative landscape structure

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June, 2015
Ljsselmeer scale
In 1570, a main traffic line ran along the water body and connected with the inland cities. In 1932, the Afsluitdijk connected cities on both sides of the Ijsselmeer and this formed the main traffic ring. The secondary traffic lines branched from the main traffic line. In 1975, the Houtribdijk also had a transportation function and connected the two landing cities.

Markermeer scale
The traffic lines followed the water systems (ditches) structure. So the transportation infrastructures on both sides of the Markermeer have different patterns. The linear traffic line on the Houtribdijk is mainly high-speed without stops.

Landing city scale
The transportation network grows very fast in Lelystad. The Houtribdijk is a short and main traffic connection between the two landing cities.
**Ijsselmeer scale**

The cities started to grow near the water. Amsterdam, Haarlem, Alkmaar, Groningen were the main metropoles which were surrounded by several satellite cities in 1960. Nowadays, there is a high-density occupation around the Amsterdam area.

**Markermeer scale**

The new occupation areas followed the appearance of the new polders. They reduced the pressure on the land in the form of occupation and agriculture.

**Landing city scale**

New cities like Lelystad grow rapidly. The growing speed is much higher than a traditional city like Enkhuizen.
2 Analysis conclusion and potentials

2.1 Two orientations of the Houtribdijk

As the conclusion of the context analysis of the site, it is found that there are two orientations of the Houtribdijk: natural landscape orientation and urban landscape orientation.

The Houtribdijk blocks the two eco-system which result in different water qualities, flora & fauna diversity, gradient, etc. The dike is the edge of two water bodies.

The Houtribdijk connect two different urban systems. However, the dike pushes the city growth inward to the land instead of facing the water.
2.2 Reformulate as potentials of the dike

However, if we regard the Houtribdijk as a part of whole landscape system, there are high potentials make it operative.

The dike can act as an interface to the water.

The dike can offer places to stay instead of only quickly passing by.

The dike can be developed as a cultural center.
3 Nature process around the Houtribdijk

3.1 Wind setup and waves (see figure x)
Storms cause incidentally high water tables on the windward side of the lake (several times per year).
Waves and turbulence causes erosion and movement of silt. Shelter creates gradients between dynamic or muddy water and less dynamic or clear water.

3.2 Sediment resuspension
Turbid water area in Markermeer is shallow. And because the wind waves can re-suspend sediment from the bed of the lake.
Retrieved surface Total Suspended Matter (TSM) from remote sensing matched resuspension predicted from wind and water depth.
The Markermeer has a high risk to increase in trophic state (eutrophication) and for cyanobacterial blooms.
Clockwise direction of the water currents.

3.3 Seasonal water level change and drifting ice
Seasonal water level changing in IJS and MM:
Because of melting ice, the amount of rain, IJssel inflow and the water management in polder system, the water level in IJS and MM will change along different seasons. For instance, during the winter, the polder area needs more water and the amount of IJssel inflow is low, so the water level in the IJS is lower than in the MM. During the summer, this is the opposite.
The huge ice shelves are effortlessly pushed up against the gravity and can slide around the dikes. The blocks of ice or ice fields may raise higher than the dams, as they slide over each other.
The construction around the Houtribdijk functions as a defense against the drifting ice.
IV DESIGN PRINCIPLE ELABORATION 22

1. Case study: Existing design principles 23
2. Design with natural processes 27
   2.1 Wind setup and wave 27
   2.2 Sediment resuspension 27
3. Design based on natural processes 30
   3.1 Strategy design in layers approach 30
   3.2 Strategy design model 30
4. Spatial quality on the Houtribdijk 32
5. Landscape structure of the Houtribdijk 34
6. Initial design of the Houtribdijk 36
1 Case study: Existing design principles

In order to get a grip on the dynamic forms and first design principles, I made the iconic drawings based on the existing design projects. In this step, there are three main elements summarized from every case: land, water and dike. The understanding of spatial language among these elements helped me reflect on the forms in my transforming design process.

In this case, because the Markermeer and Houtribdijk are a popular research topic, the related database is relatively abundant and systematic. For instance, “24 cases Markermeer en Ijsselmeer” (SAMM, 2009) is a good example of a case study collection. It organized 24 design projects of the Markermeer in the same scale of planning maps and remarked by professional committees.

Based on the 24 cases, I illustrated the principles of existing design projects through iconic drawings (see figure x). As a designer, it is important to represent the data and principles in a design language which is drawing in a three-dimensional perspective instead of only enumerating the two-dimensional maps or words explanation. Here, the iconic drawing is a design-based research tool to elaborate the principles of transforming the Markermeer and the Houtribdijk. There are three main elements, land, water and dike, summarized from every case. The spatial relationship among these elements and the transforming process are illustrated in an analytical drawing language.

There are several strengths of the iconic drawings as a case study elaborate method. Firstly, it highlights the core elements while leaving out and simplifying the secondary information. Secondly, “the space of the flows”, “the space of place” and their composition are clearly shown in analytical symbols. Thirdly, it is intuitive for readers, who are not only professional designers but also the public, to understand. Lastly, it is convenient for the next step to classify the principles according to similarities and differences, in order to be useful for the development of new principles.

For instance, the principle to make levees in the water in order to break the wave and wind setup and reclaim the new land is applied in many design cases. Even though they share the same basic principle, the final forms of the landscape are multiple and diverse. It results from the different composition of the levees and the way they take use of the water and wind erosion. Some projects take use of the Houtribdijk as levee structure building up new land around it. Some projects create external levees outside the Houtribdijk reclaiming the new land in between the levees.

It is also necessary to consider about the latest design projects in this area and learn from them, such as “Marker Wadden” by Vista, “Trintelzand” by H+N+S and opening in the Houtribdijk by Van Eesteren. For instance, “Marker Wadden” is making the five marshland in a very deep water area. There are three main aspects of principles I learned: the form of the levees combined with port function, the erosion pattern on the marshlands and the ditches in square and linear shape to catch the sludge. Moreover, “Trintelzand” shows the composition of several layers of sand plains which wider the foreshore of the Houtribdijk and provide richer habitats for local fauna groups. At last, the opening in the dike by Van Eesteren illustrated the new hypotheses of water exchanging between the Ijsselmeer and the Markermeer as well as the composition of wave defense structure.
Foreword

The spatial design oriented landscape architecture MSc graduation studio Flowscapes explores infrastructure as a type of landscape and landscape as a type of infrastructure. This thesis considers the Houtribdijk or Markerwaarddijk to be an operative landscape structure where natural dynamics are employed and social interactions are facilitated through the spatial development of a surviving trace of an unfinished polder project. The work reflects an intelligent journey of discovery where research inquiry and design thinking are systematically combined. Here the spatial design is used as a vehicle to draw up hypotheses that fully exploit the potential qualities of this landscape structure over time. The plan is thoroughly grounded in the body of knowledge on spatial design, engineering and landscape ecology while applying principles that have proven to work, as exemplified by precedents. It showcases the vital role that the design disciplines landscape architecture, urban design and architecture can play in actual environmental issues through interdisciplinary approaches and multi-scale design. The graduation work beautifully testifies the potential synergy between natural processes, multi-functionality and scenic beauty. The effective use and graphic quality of computer renderings in combination with hand drawings and physical models is a significant added value of the work.

Dr. Steffen Nijhuis
Team leader Landscape Architecture Research Programme,
Coordinator Landscape Architecture Graduation Laboratory
Delft University of Technology, Faculty of Architecture and The Built Environment

The aesthetic of almost nothing.

Prof. Piet Palmboom
Van Besteren chair at TU Delft, Faculty of Architecture and the Built Environment

Dear Shan,

You showed an amazing talent to implement all the new things that crossed your path in your design.

Peter Koorts
Head of Modelling Studies in the Form & Modelling Studies Group
Delft University of Technology, Faculty of Architecture and The Built Environment
On one hand, the iconic drawings focus on the spatial aspects of the cases. On the other hand, to get a conclusion from the selected case studies, a systematic evaluation in other different aspects is necessary. It is important to keep in mind that all the aspects planned to be evaluated have to be helpful to answer the research question and to relate with the research objective or further designs. For example, in my research, I focus on water management, ecology, recreation, spatial urbanization, culture, value, cost, and time. These aspects are also important evaluation points for my final design. Moreover, quantitative, qualitative, and the combination of the two are three kinds of assessment. The choice should be made based on the resource type and the goal of your assessment. In this case, I chose to assess a qualitative value by using “+OK−” to show the positive or neutral or negative aspects. Within the 24 cases, it is found that less projects focus on the water system, natural ecology and cultural value. Some projects even have negative impact on the natural environment or have a high cost. So it is calling for an environment-friendly and sustainable design to transform the Houtribdijk and its built environment.

As a result, the case study helps me to elaborate the first principles and recognize the potential aspects and blank fields through comparing and analyzing relevant cases. It is an effective method to help to answer the first research question: “What are existing principles and working methods applied to shape the Houtribdijk based on landscape layers?”
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2 Design with natural processes

Before directly diving into the design of forms, I decided to search for the formative power, which is the natural process based on the flowscape concept. Furthermore, the strategic thinking based on these natural processes is driven to optimize the environment.

The three main natural processes happening in the IJsselmeer are wind setup, sediment resuspension, and seasonal water changing.

2.1 Wind setup and wave

The longer distance of wind traveling on the water surface, the water surface will be pushed up higher than the water horizontal line.

Strategy thinking:
Take use of wind and wave erosion to help with creating soft foreshore or produce energy or recreational function.
Prevent the wind and wave from destroying the dike.

2.2 Sediment resuspension

Causes: wind stress, current erosion, shallow water, lake seiche, fish, dredging

Strategy thinking:
Bio mussel fields: mussel filtration, sediment deposition
Bio marshland (three kinds: floating, lake bed, water plant): filter water, reduce the white froth
Ditches: enrich the gradient of the lake bed, increase the water depth, sediment deposition, at the same time for marina traffic
Water channels: create water connections between IJsselmeer and the Markermeer. Exchange water between two lakes by the power of the wind setup, reduce the turbid lake in the Markermeer by exchanging the water quality between two lakes.

Artificial elements: block the wind and waves, create the accessibility between two lakes, facilities for visitors.

2.3 Seasonal water level changing and drifting ice

There is 2400m2/s as a draft standard maximum drainage system from IJssel in 2015. And the drainage system from the polder system leads to a seasonal water level changing in the IJsselmeer and Markermeer.

In summer, the water level in the IJsselmeer is +0.50m NAP plus 1.1–1.8m wave and the water level in the Markermeer is -0.50m NAP plus 1.2–1.7m wave. In winter, the water level in the IJsselmeer is -0.50m NAP plus 1.1–1.8m wave and the water level in the Markermeer is +0.50m NAP plus 1.2–1.7m wave. The water level difference is between 0.2m to 2m.

As a result, in summer the water level in the IJsselmeer is normally higher than the Markermeer. And in winter the situation is opposite. If there is a water exchanging between the two lakes, the water would flow from the IJsselmeer to the Markermeer in summer and the other way around in winter. If it pluses the wind setup, the exchanging could be more effective.

Strategy thinking:
Take use of water level difference to achieve water exchanging or recreational experience. Offer the place to stay experiencing the drifting ice in winter.

3 Strategy design based on natural processes

3.1 Strategy design in layers approach

Design in layers approach helps the designers to built up their own stratgetic system and highlight the focusing aspects. Because the natural processes are within a very complexed system, it is complicated to consider every element in one time. As a solution, the layering approach aims to decompose the whole environment into several systematic landscape layers. And those layers are classified into two groups: natural process system and urban system. Under the "flowscape" design concept, we do not only consider the "space of place" but also "the space of flow". In that sense, the maps highlight the interactions between different elements, the movement of flows and the boundary of different layers.

In this step, I was trying to figure out the formative consequences result from the natural processes in a strategic drawing. For instance, in the water exchange in summer and winter layers, it shows how the water exchanging and wind erosion influence the movement of the sludge on the surface of the water.

Green layer
Mussel field layer
Gradient layer
Soil layer
Artificial elements layer
- Wind setup and waves
- Sediment resuspension
- Seasonal water level change and drifting ice
Decomposed layers of strategic design

Since the natural system is very complexed in the IJseelmeer, it cannot be shown in one map. Mapping in layers as a design principle helps to decompose the design into several layers: water exchange in summer and winter layers, green layer, mussel field layer, gradient of lake bed layer, soil layer and artificial elements layer.
3.2 Strategy design model

Soft shore of the Houtribdijk based on the shallow water area. Expand the sand plain to offer more habitats for fauna and flora. Deep water fluid by creating man-controlled opening in the dike. It also can service the marine traffic.

Small opening in the dike in order to enhance the eco-exchange between USM and MM. At the same time, it can carry the walking facility under the dike for visitors.

Big opening in the dike but in man-controlling. Besides, it need the elements to break the wave.

To create more gradient by digging the sand and fill it in the new land. Ditches can service for marine traffic and cleaning the water.

To improve the green space which will provide good condition for natural and urban development. Depends on the different water condition, there are multi-type of green islands: on shore, floating.

Mussel fields act important role in nature and human development. Cooperate with other elements to clean the water. At the same time can be local production to simulate the economy and recreations.

Artificial elements aim to create hard embankment to protect the dike and offer the space for people flow. They are in the water or in the space to stay and view.

Soft sandy shore and green marshland break the wave, create new habitats and clear the water. Based on the topography of the specific spot, there could be different types and forms of green areas.

One method is to build up levees or other structure to break the waves, and let the soil sediment, which is pushed by the water and wind erosion, drop near the levees. The other method is to fill up the green area with soil taken from other places. Then vegetations are planted based on the soil types and water levels.

Mussel fields clear the water and enrich the lake bed gradient. Sediment resuspension will drop when there is a deeper water zone. Moreover, the local mussel groups eat the silt and help to purify the water. At the end, the mussel farms can also bring the economic benefit to local people. And it could be a part of food sources for the birds.

Artificial elements of connection, exchange and accessibility between the USM and MM. It regards the Houtribdijk itself as an operative structure to connect two water ecosystem and two different urban tissues.

Based on the dike structure (peak, turning, etc.), the form of the connection follow the dike body. There are mainly two kinds of the intervention: bridge and culvert (canal). The connection aims to balance the two different water system and increase the accessibility for visitors.
During the strategy design, there are three main landscape strategies are elaborated:

Firstly, to create the soft shore of the Houtribdijk. By designing the marshland in the shallow water area and expanding the sand plain to offer more habitats for fauna and flora at the same time, it can reinforce the dike and prepare the dry feet area for accessibility.

Secondly, to enrich the lake bed gradient would help to reduce the sediment resuspension.

At the end, the artificial elements carry the functions of resource exchanging between the IJSM and MM and the accessibility crossing the high speed traffic line on the Houtribdijk.
4 Spatial quality on the Houtribdijk

The history of the Houtribdijk design:

- Dancing dike by Van Eesteren
- The bay and the cape: spatial quality of a linear structure. The bay is enhanced and the cape is open to the horizon.
- Perspective view on the dike. The views on the bicycle path is different from the views on the vehicle path because of the changing of the dike peak and the speed of the movement.

Starting points: High subsoil layer. Building island-Trintelhaven. Landing cities-Enkhuizen, Leystad
Ending point: deep water zone, hard to construct
Dike turning points follow the benthometry layer also to form the harbour space near the landing cities
Spatial Quality

While from human perspective view, all the design eventually should make people appreciate the spatial quality in human scale. In that case, a panorama installation is designed specific to represent the open view of this dancing dike. Within a view range of 13km horizon, every elements we design will matter. And it is clear to show the bay and the cape around the dike.
5 Landscape structure of the Houtribdijk

Design in layering approach:

- Natural process system
  - Construction elements
    - ISO height layer
    - Water depth layer
    - Soil type layer
    - Fauna clusters layer
    - Flora clusters layer
    - Natural power layers (sediment resuspension, wind, waves, drifting ice)
  - Expression elements
    - Spatial form of natural elements layer
    - Spatial structure layer
- Urban system
  - Construction elements
    - Civil engineering layer (plan, section, technical aspects of the infrastructure)
    - Program layer (urban function, harbor, recreation)
    - Social and cultural layer (event)
  - Expression elements
    - Architecture layer (spatial quality, dancing line, landing city)

Based on the previous analysis and design, it came up with a landscape structure which highlight the potential landscape spots.
6 Initial design of the Houtribdijk

To some extent, the landscape structure gave a direction to my initial design. However, after trying to make three initial design for the Houtribdijk, I lost the sense of the scale. And I found out later it result in a lot of massive intervention. But this step is very helpful to figure out the possible forms for my design.

When I zone in, I found surprising potentials. So I choose one area on the Houtribdijk with higher potentials to develop. The Trintelhaven is chosen because there is shallow water area to the north and sand plain to the south of the dike. Moreover, there are also urban activities happening around the restaurant and recreational beach here.
2 Landscape design of Trintelhaven phase

2.1 Existing situation and potentials

Around the Trintelhaven, there is a low-level dynamic landscape in the Markemeer and the Ijselmeer. Because of the mono-gradient lake bed, there are less natural habitats for flora and fauna. The only "soft shore" is the sand plain in the Markemeer near the Houtribdijk. At the same time, because of the sediment resuspension, the water quality in the Markemeer is very low.

2.2 Ecological analysis

In the section of the Trintelhaven, there is one high land above the water level on each side of the Houtribdijk, the left side of the dike (the Markemeer) is a sand plain formed by the drifting ice defending structure; the right side of the dike (the Ijselmeer) are the high points in the lake bed (reference from google maps). In the Markemeer, the sand plains in the shallow water area offer habitats for the birds, such as Dweersten, Topper, Bonte standloper, Enriuiker, etc. But the existing sand plains are too narrow to hold larger population of the birds. Moreover, the turbid water and less rich gradient of the lake bed make fish lose their habitat. On the other side of the dike, because of the lack of the foreshore and large waves there is empty zone of fauna and flora groups. Furthermore, there is large amount of white froth which is the dead body of plankton appearing near the stone edge of the Houtribdijk. Because the alive plankton is the food for fish, the cycle of predator and prey is broken.

Overall, there is highly unbalanced eco-system on both sides of the Houtribdijk. The water quality and the diversity of the water-related species need to be improved. The new fauna and flora habitats need to be created.
2.3 Ecological landscape design

In the design, the decision was made to expand the foreshore of the Houtribdijk by creating the marshland in the shallow water area of IJsselmeer and widening the sand plain in the Markermeer. At the end, the social activities is also integrated in this area.

It takes use of shallow water area to grow the fresh water forest. The shallow water near the Houtribdijk is transformed into a foreshore where different vegetation can grow, at the same time it can offer a habitat for fauna groups as well as recreational space for the public. The shallow water area to the north of the Houtribdijk could be transformed into a new marshland which can break the wave and wind setup in order to create a peaceful water area for the fauna groups to live on and at the same time it can filter the water and offer more nutrients for the local fish as well as the birds.

As a result, the diversity of the fauna and flora would be increased which could form a more stable and self-repaired ecosystem. Moreover, the foreshore, marshland and the mussel fields would help with clearing the water. At the end, humans could also benefit from the new ecological landscape by integrating recreational infrastructure into the environment.
2.4 Dynamic landscape design
Floating path and plants to the north shore

Accessibility to two sides intervention

Floating plants shore structure to the south shore
Enlarge the marshland by wind erosion to the north shore.

Long path to the open horizon view intervention.

Mussel field enlarge sand plain to the south shore.
3 Detailed design

3.1 New marshland

3.1.1 Existing situation

The new marshland is located within a shallow lake area around 700 meters to the northwest of the Trinteltaven. In the current situation there is an enormous open water surface. Under the dominant northwestern set-up of the wind, without a barrier, the rolling waves travelling until the Trinteltaven will reach their peak and hit the northern shore of the Houtribdijk.

Near the dike, there are some fishing stakes and nets. Moreover, the storms and the phytoplankton dying in large numbers causes "spume", which is a phenomenon of white foam existing of persistent and low-density bubbles which can be blown by on-shore winds.

These spumes have a very negative impact on the environment. For instance, if birds wade through the spume on the water, the surfactant molecules in the spume will get stuck between their feathers, resulting in the degeneration of their waterproof capabilities. As a result, the birds will die of hypothermia. Perhaps this was the reason for the dead birds I found during my explorations near the dike. The local fish are losing their foodsource as well with the death of the phytoplankton, causing them to die of starvation and anoxic.

Furthermore, the spume is also harmful to humans. For example, the beaches and other hydrophilic spaces on the foreshore of the dike can be polluted by spume with viruses and other contaminants which may have an unpleasant odour as well. Direct contact with the foam or breathing it in as it dries can cause skin irritation or respiratory discomfort respectively.

Overall, the existing situation is a massive unpeaceful open water area with large waves and white polluted spume. It leads to the decline of birds and fish. At the same time, people will have an unpleasant experience in this kind environment. Especially near the beaches and Trintelhaven, a place that is supposed to let people stay near and get close to the water.

3.1.2 Potentials

Though there are many environmental issues, there are still potentials found within the foreshore zone of the Houtribdijk. In Google maps, it is clear to see more than ten spots of dry land with a diameter of 10 to 20 meters (highlighted by white dotted circles in figure x). These high land spots are in the shallow IJsselmeer area (light yellow zone, highlight by white dotted lines) to the northwest of the Trinteltaven, where the new marshland will be. In a larger scale of Google Maps, it is shown that there are vegetation growing on those spots even with water erosion patterns on the sand edges.

This shallow water zone near the Houtribdijk in the IJsselmeer has a high potential to be developed into a natural barrier marshland that can break the wave and filter the water in the future. As one of the consequences, there will be a peaceful water area created between this marshland and the Trinteltaven where visitors can have a comfortable place to stay and a nice view to the water. Additionally, more activities related with water, such as sailing, fishing, jogging even swimming, could happen when a higher water quality is realised.

From an ecological aspect, the marshland could improve the diversity of the local flora and fauna. A wetland ecosystem that grows in the water provides more habitats for them. It could also bring more healthy nutrients to the water and at the same time filter the water. Finally, vegetation can be grown on the marshland that would hold the soil and protect it against water and wind erosion, which could in turn prevent the softshore of the Houtribdijk from disappearing.
3.13 Case study: Oostvaardersplassen

The Oostvaardersplassen is a nature reserve in Flevoland, the Netherlands, which is covering about 56 square kilometres. It is 56 times larger than the new marshland in the design. The Oostvaardersplassen is located in a polder which was created in 1968, taking nearly 20 years to realise. By 1983 it had international importance as a Ramsar wetland.

There are three aspects this case study focuses on:
- Wet and dry areas

In Google maps of Oostvaardersplassen, it is found that the marshland has wet and dry zones with boundaries composed by water, soil, reed, grass and trees.

The wet area is located in the northwest along the Markermere, there are large reedbeds on clay, this area is home to great cormorant, common spoonbill, great egret, white-tailed eagle and Eurasian bittern, among many other animals.

The dry area was a nursery for willow trees where they could rapidly reproduce. This would lead to a dense woodland which could significantly reduce the value of the habitat for water birds. To avoid this, the managers of the Oostvaardersplassen brought in herbivores to keep the area more open.

However, in my project, the new marshland is apart from the mainland, which means there is no possibility to introduce herbivores. In that case, this area would need manual control through a marshland planting design.

- Water erosion pattern

The second learning point is the marshland pattern formed by natural powers like the water and wind erosion. I concluded that the erosion always forms a circular pattern. The main erosion circle will branch into smaller ones. As a result, the edges of the marshland are a series of smooth curves in a row. Moreover, the linear water erosion will continue in to the dry area from the wet area.

- Marshland growing process

The marshland needs time to grow itself so there is a process from lot of marshland cells that together form a continuous connected land. In Google maps, you will see four different levels developing simultaneously. First, the small circle cells which are isolated in the water, similar to the existing situation of shallow lake area near the Tintelhaven. Second, a group of cells are growing together. In the zoom-in image, the soil structure is still exposed to the air without being covered by vegetation. Third and forth, the large dry lands in brown and green color show different layers of vegetation.

To conclude, through this case study, the knowledge of the marshland and the principles of their formative patterns can be applied in the design.

3.14 Experimental design

Besides the case study, I also did a real site experiment on the Kijkduin beach. The goal of the experimental design is to have a visualized conclusion of the consequences of water erosion caused by natural powers. In order to simulate similar water erosion phenomena, a real site in Kijkduin was chosen, because there is no accessibility to the design project location.

During the experiments, the focus point was which kind of forms will be result of water erosion with and without wave break structures.

Considering the difference between the wave formed by the wind setup in the lake area and the wave formed by the tide in the sea area, in the preparation phase, I recorded the ending line of the wave on the beach. Then chose the middle line, where there was more stable water erosion, to set up a high land.

Furthermore, from each recorded video I chose to show the moment that displayed the most influential result. On top of these moments I made an analyse drawing (highlight lines on the photos).

Compared with having no wave breaking structure, the water erosion took a longer time to take the high land away than with a wave breaking structure. At the end, the high land formed with an erosion line at the bottom. The top layers of the sand remained relatively stable.

As a result, the simulated experiment in a real site provided a visualisation of formative consequences under natural processes. For the sake of experience, sometimes this method can be a more powerful design tool than making a digital or technical simulation. These kind of methods could lead to further, more practical, research about which kind of form or additional reinforcements will break the wave more effectively and contribute in the growth of the marshland. The results of this test proved my proposal is logical to be developed further.
3.15 Marshland growth proposal (see figure x)

Based on the site analysis, the case study of the Oostvaardensplazen and the experimental design, I propose these new marshland growing principles, taking use of the high lands in the shallow lake area. By setting up a wave breaking structure and reeds plantbed, the high lands can be protected from water erosion. Afterwards, sand can be dug in the surrounding lake bed and be used to refill the shallow water zones. When a regular maintenance for the vegetation like willow, buckthorn, etc. is needed, at that moment the accessibility (bridge, infrastructure) will be introduced within the marshland. In the long run, the marshland will keep growing within the cycle of the micro ecosystem.
3.17 Achievement

The achievement is illustrated from a perspective view on a human scale. It shows how the landscape design brings the spatial quality to the users: nature groups and human society. The principle I use to represent the spatial quality is to use several steps of drawings to show the process of new marshland growth. Before the final result, I use lines and emotional colors to show the change over time. This method is applied specific for this kind of project: a dominant empty and linear structure (the dike) will influence the spatial quality significantly. At the end, I will have rendered images to demonstrate future proposals with a realistic material design.
Case Study: Yoth and his arts

Respectful landscape: man is a tiny creature in a great, big world and even his largest monuments are no more than a modest sign of human life in Mother Nature’s empire, like a scratch on a rock. Artists can express themselves in an extreme way, while landscape architects are responsible for the corresponding to the surrounding environments.
Experimental design: the form of the connections

Principle application through experimental modeling: "The Form Studies programme is concerned with the furthering of knowledge, insights and skills concerning Composition and Perception in the domains of landscape architecture. In research, the emphasis lies upon the exploration, visualisation and explication of elementary formal phenomena in the context of the discipline of architecture, making active use of digital and physical modelling applications." (Form and Modeling Study, TU Delft)
After researching more possibilities of dike forms by modeling, I gradually introduce the design concept and emotional effects into the models. For instance, the project is about the Houtridijk standing in the middle of the lake and facing to the open horizon. The sky and water are the main background of the environment. So the emotional colors of them changing through time and weather matter a lot to the landscape design. To cross the discipline of art, the paintings of Mark Rothko as reference are applied into the dike models. They lead the design into the cultural and social values which are parallel to the scientific and technical design of the dike.
Redesign by Physical Modeling

Delete the top glass in later design.
A hollow space been pushed into the dike. A clean cut through and an inverse space come out from the other side of the Houtribdijk. Normally you enter this space from Tintelhaven by walk, boat or bicycle, arrive on the beach open horizon.
Initial design of bridge
VI CONCLUSION

During the design related research, by mapping in layers and time, we know there were and are highly dynamic processes happening in the IJsselmeer area. The space of flows and the interactions between different natural and social system are highlighted in the design process. These dynamic flows reclaim the space of place, which results in an integrated landscape system in potential forms. This landscape system provides the environmental conditions for the natural and urban development.

Through case study, it is found that the existing principles and working methods applied to reshape the Houtribdijk are rarely based on the natural processes. They consider more about the development of the spatial and recreational value in the Markermeer area. So there is a blank research field about the landscape processes as a formative power needs to be explored.

At the end, the physical and digital experimental modeling methods that are applied to test the landscape based design approach is positive to apply in the transformation design of Houtribdijk. These research processes and the end results are the lessons that can be learned for other infrastructure projects within the "flowscape" framework.

From a theoretical perspective view, the "flowscape" is a feasible and high potential design concept for transforming the single-purpose infrastructure into a dynamic landscape system. It aims at providing the environmental conditions for natural and urban development in the long term. The design-based research integrates multi-disciplines to search for the problems, possibilities and potentials to reshape the Houtribdijk. In this design process, it regards the natural process as a formative power. The three main design related research methods: case study, mapping in 4D and experimental modeling are effectively applied in the research. As a result, the "flowscape" concept is further developed into an applicable level.

In this study, the outcome of the Houtribdijk transformation design is not the final goal. Instead, the systematic design-related research methods and the landscape architecture way of thinking need to be elaborated based on the design process. Within the urban landscape infrastructure field, there are many projects with distinguished content and form. One specific design result can not be fit in different context. So a generic "flowscape" methodology is a necessary outcome in order to be applied in the operative landscape infrastructure design.

VII REFLECTION

1 Reflecting objective

The theme of the graduation lab is "flowscape". "flowscape" as a landscape infrastructure is not only a technical structure but also a carrier of natural and urban processes. It is proposed to solve the environmental problems and adapt to the surroundings as well as providing the appropriate environmental conditions for the long-term dynamic natural and urban development. (Nijhuis, S and Jauhlin, D., 2015).

Transforming the Houtribdijk into an operative landscape structure as the subject is under the guidance of "flowscape" concept. The Houtribdijk is located between two different eco-systems, IJsselmeer and Markermeer as well as two different urban tissues, Enkhuizen and Lelystad. There are highly dynamic nature processes and urban development happening in this area. However, the Houtribdijk was designed to make the southwestern polder. Since that polder plan was canceled, the Houtribdijk, this fixed infrastructure has not fit in the environment any more. Nowadays, the Houtribdijk becomes a barrier between two lake eco-system and a linear traffic line between Enkhuizen and Lelystad. As a result, the transformation design of the Houtribdijk into an operative landscape infrastructure, which provides a coherence landscape condition for nature and urban development while considering ecologic, technical, architectural and social aspects, is proposed within the "flowscape" framework.

Furthermore, within a wider social context, the public has low identity of the Houtribdijk because the dikes acts as a mono-functional and high-speed traffic line instead of a place people can stay and meet. Recently, there are many stakeholders, such as government, sports organizations (surfing, sailing etc), ecologists, tourism companies, archaeologists as well as local people, involved in this project in order to develop the potentials in this area (reference is from the meeting "Versterking Houtribdijk" organized by Rijkswaterstaat 7-4-2016). The intervention of the Houtribdijk is highly demanded to provide a coherent landscape condition and to achieve the accessibility to the recreational facilities. During the meeting "inspiration IJsselmeergeld" on 1-4-2015, it is said that most people like people (crowd urban area), but most people would also like a contrary environment with open horizon and peaceful landscape. As a result, the landscape transformation design plays a significant role to develop the spatial quality which make people appreciate and experience the environment.

2 Lessons learned

Paradox of the scales

In the bathymetry map of IJsselmeer, the depth difference between each isohyget line is 50cm. In the lake area, the appropriate gradient slope of the water level is between 0 (NAP) to -300cm, which means there is a depth of 200 cm in difference between 5 layers of isohyget lines. When this gradient of the IJsselmeer is made into a physical model in A3 (297mm x 420mm) with a scale of 1:255000, the 200
om water depth is scaled down to 0.0078mm, which is not visible in the model. To solve this problem, in this case, the vertical scale in the physical model of IJsselmeer is exaggerated compared to the horizontal scale in order to visualize the gradient under the shallow water and emphasize the spatial changes around the Houtribdijk.

However, there is an argument about the accuracy of this method. Especially, engineers highly suggest to be accurate in the scale and to make calculations on the water level in order to get scientific results. From a landscape architect's attitude, we are a group of researchers who work with and focus on the "Spatialization, Timeliness, Materialization" of the design objects. In human visual range, invisible objects like 0.0078mm thickness do not have the characteristics of space and we even cannot match a material to it.

Case study as qualitative research

Case study is a means to gain knowledge when there is a research question in a specific direction. But compared with the quantitative research, the case study is less validated. Because the data collection and analysis are highly depending on the sensitivity, instincts and abilities of the researcher. Moreover, the amount of the cases are limited to get a general conclusion.

However, in this case, the final goal of the case study is to offer rich phenomena and background information in order to have a deep insight and a complex investigation to the design project. At the same time, it also helps to define the scope of the landscape architecture by learning the existing design projects.

Overall, instead of getting a scientific result or a predictable future, the case study in a design-related research methodology aims to explore more possibilities and tentative hypotheses which will contribute to further research.

3 Research-design relation

Design-related research is to take use of design as a powerful vehicle to visualize the spatial, materialized and dynamic characters of the research objective. Moreover, during the process of designing, the problems, potentials and solutions of the research questions are generalized.

There are two types design-related research methods: design research and research by design. They are two separate parts but correspond to and work with each other.

Design research is the phase that analyses previous and existing situations and designs in order to understand the site and first design principles. In this case, mapping in 4D and case study are the main research tools used in this step.

On the other hand, research by design is the phase to discover the innovative design principles and apply them into the project in order to formulate the new designs. Here, the experimental design and modeling methods are utilized to develop the transformation design. By mapping in layers and time, we know there were and are highly dynamic processes happening in the IJsselmeer area. The space of flows and the interactions between different natural and social system are highlighted in the design process. These dynamic inflows reframe the space of place, which results in an integrated landscape system in potential forms. This landscape system provides the environmental conditions for the natural and urban development. Furthermore, the drawing methods are using the power of lines and different perspective view as well as bird's eye view to research the spatial quality of the project. (Reference is from "seeing-drawing-flying" "Drawing the ground", Piet Paelbooma)

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At the end, the physical and digital experimental modeling methods are applied to test the design in three dimensions. In that mean I am finding the possibilities of the design proposals and address them into the site. On the basis of the physical model, it provides a real sense of three dimensions of the objective and simulates the tactile impression for the material. To some extent, the physical model is more realistic compared with the digital model. Also, it gives a close scene for the scale and the space. Whereas, the digital modeling in Rhino is to get the accurate data and offer the reference for physical modeling. The combination of these two modeling methods is highly required and it can be very powerful to convince people with the design. (Model guides from Peter Kooistra and the Camlab, EK City)