PHYSICAL MODELLING
IN LANDSCAPE ARCHITECTURE

exploring **a design tool for** the explorative phases in **dynamic landscape design**

MSc Thesis | J.A. (Jolanda) de Jong | Wageningen University

PHYSICAL MODELLING
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A thesis submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN
LANDSCAPE ARCHITECTURE

at

WAGENINGEN UNIVERSITY

by

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November/December 2016

Physical modelling in landscape architecture
Exploring a design tool for the explorative phases in dynamic landscape design

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This research has been partly made possible through the generous funding of Stichting NHBOS

STICHTING N·H·BOS
ter bevordering van de landschapsarchitectuur

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"It is always hard to know which [design tool] is best,
it is always about experience;
share methods which are already done;
be open to all tools"

(Landscape architect Nicole la Hausse, 2016)

VOORWOORD

In deze thesis wordt het fysieke model (de maquette) verkend als ontwerpmiddel in de exploratieve fasen van het ontwerpproces. Vanwege mijn missie om een kleine stap te maken in het vergaren van nieuwe kennis over het ontwerpproces van de landschapsarchitect, ligt de focus op het ontwerp van het dynamische landschap.

Ik begon met een zekere nieuwsgierigheid aan dit onderwerp. Mijn persoonlijke fascinatie voor maquettes als ontwerpmiddel vergrootte de waarde die ik eraan verbond. Vanuit mijn (overigens beperkte) ervaring op het gebied van landschapsarchitectuur viel het mij op dat studenten en professionals in de landschapsarchitectuur maquettes niet altijd overwegen als ontwerpmiddel in de exploratieve fasen van het ontwerpproces. Waarom? Er moet wel een reden voor zijn. Een eerste zoektocht in de literatuur binnen architectuur en landschapsarchitectuur maakte het niet veel duidelijker. Is het een ouderwetse manier van ontwerpen? Is het alleen maar interessant voor degenen die ook blijven vasthouden aan een echte boekenkast, voor degenen die weigeren mee te gaan in de digitalisering? Is het alleen voor hen die geen zorgen maken om tijd en geld? Dat geloof ik niet. Maar goed, mocht dat toch de waarheid blijken te zijn, dan moet er een manier zijn om die fysieke modellen om te zetten in een aantrekkelijk en relevant ontwerpmiddel, toch?

Hoewel – of omdat – het ontwerpproces moeilijk grijpbaar is, is het een interessant studieobject. Tot nu toe is er veel onderzoek gedaan naar de eindproducten van dit proces, maar inzicht in het daadwerkelijke ontwerpen kan bijdragen aan het beter (be)grijpen van het ontwerpproces. Dit geldt niet alleen voor landschapsarchitectuur in het algemeen, maar ook voor het gebruik van fysieke modellen. Tijdens mijn gesprekken met studenten en professionals begonnen zij zelf na te denken over wat ze eigenlijk deden en te reflecteren op hun gewoontes; en over het waarom. Toen ik dat merkte, al in de beginfase van mijn thesis proces, stimuleerde mij dat eens te meer om verder te zoeken, meer te ontdekken, meer na te denken en te reflecteren. Op alles, en met iedere geïnteresseerde die ik tegen kwam.

PREFACE

This thesis explores the physical model as a design tool for the explorative design phases. As my key mission is to make a small step in generating new knowledge on the design process of the landscape architect, the focus lies on dynamic landscape design.

I started studying this topic with a sense of curiosity. My personal fascination for physical models increased the value I assigned to these objects as a design tool. But from my (moreover limited) experience in the field of landscape architecture I found it striking that students and professionals in landscape architecture do not always consider this tool in the explorative phases of the design process. Why? There must be a reason for this. A first search in literature about architecture and landscape architecture did not make it any clearer. Is it an outdated and old-fashioned tool, only interesting for those who stick to real books as well? For those who refuse to get involved in the digitalisation? For those who don't have to care about time and costs? I do not believe that. However, if that turns out to be the truth nevertheless, there must be a way to turn physical models into an attractive and relevant design tool back again, right?

Although – or because – the design process is hard to grasp, it is an interesting object of study. Research so far has put emphasis on finished products, but insight on the act of designing can contribute to a better understanding of the design process. This goes not only for landscape architecture in general, but also for the use of physical models. I noticed that during my interviews students and professionals were re-thinking their habits and what they were doing; and they started to rethink whý they were doing things. Experiencing that in the earliest phases of my thesis process, nourished my drive to explore more, to rethink and to reflect. On everything, and with every interested person I came across.

INDEX

PART II A dynamic landscape model

SAMENVATTING

Deze thesis beschrijft het fysiek modelleren ('maquette maken') in de exploratieve fasen van dynamisch landschapsontwerp. Daarvoor is eerst het huidige gebruik van fysieke modellen in de (landschaps-) architectuur verkend, waarna een verkennende studie is uitgevoerd voor het vinden van een specifiek ontwerpmiddel voor het fysiek modelleren van het dynamische landschap.

In het eerste deel van deze thesis wordt geconcludeerd dat het fysieke model in meerdere opzichten een waardevol middel is. Het inspireert en helpt ontwerpers om te begrijpen, te denken, te testen en te communiceren. Bepaald door het type ontwerpopgave, het ontwerpproces en de ontwerper(s) zelf wordt besloten om al dan niet een fysiek model als ontwerpmiddel toe te passen. Het doel van een fysiek model hangt af van hoe het modelleren plaatsvindt met betrekking tot de abstractie en reductie van het model en de gebruikte materialen, technieken en (schaal)grootte. Hoewel alle typen fysieke modellen kunnen worden onderverdeeld in drie algemene categorieën, blijkt het fysieke model een 'transformatief' middel dat van betekenis kan veranderen. Deze eigenschap maakt het een heel effectief maar ook explosief ontwerpmiddel. Het feit dat tijd geld kost, maakt het een belangrijke beslissingsfactor om al dan niet gebruik te maken van fysieke modellen. Daarnaast speelt ook het gebrek aan kennis en vaardigheden omtrent het gebruik van fysieke modellen voor landschapsontwerp een grote rol; en het feit dat landschapsarchitecten op dezelfde manier lijken te modelleren als architecten (statisch), terwijl het vakgebied verschilt ('statische architectuur' versus 'dynamische landschapsarchitectuur'). Het lijkt erop dat de landschapsarchitectuur daarom niet alle mogelijkheden benut die het fysieke model kan hebben voor hun ontwerpproces (en dus ontwerp), voornamelijk met betrekking tot de exploratieve fasen in dynamisch landschapsontwerp.

Het tweede deel van deze thesis geeft nieuwe inzichten in het gebruik van fysieke modellen voor de exploratieve fasen in dynamisch landschapsontwerp. Daarbij wordt rekening gehouden met de factoren die het gebruik van fysieke modellen in het algemeen beïnvloeden: de keus voor bepaalde materialen, techniek(en) en grootte van het model. Binnen dynamisch landschapsontwerp ligt de focus op stromend water en groeiende vegetatie, waarvoor drie series experimenten en een daaropvolgende case-study zijn uitgevoerd. De experimenten leidden tot een weloverwogen keuze van materialen en technieken geschikt voor dynamisch landschapsontwerp. Drie dingen vielen hierbij op: het gebruik van Magic sand voor een exploratieve landschapsstudie, het gebruik van een eenvoudige 'do-try-this-at-home/the office'-opstelling voor het fysiek modelleren van stromend water (waarvoor Magic sand te gebruiken is), en het gebruik van tuinkers (*Lepidum sativum*) voor het fysiek modelleren van groeiende vegetatie (groeit op Magic sand). Deze elementen werden toegepast op een case-study, rekening houdend met het belang van de grootte van het model voor het gebruik in het ontwerpproces. Dit resulteerde ten eerste in een voorbeeld van hoe een fysiek dynamisch landschapsmodel kan worden gebouwd en ten tweede hoe dit model precies kan worden gebruikt in – en invloed heeft op – en specifiek fenomenologisch ontwerpproces (en ontwerp).

Hoewel kritisch naar dit onderzoek moet worden gekeken, laat deze thesis zien hoe fysieke modellen kunnen bijdragen aan het ontwerpproces van het dynamisch landschapsontwerp. Omdat het ontwerpproces (van het bouwen en gebruiken van het model) is vastgelegd en geanalyseerd, biedt deze thesis een uitgebreid voorbeeld. Doel is om ontwerpers (o.a. landschapsarchitecten) te inspireren om zelf aan de slag te gaan, het zelf te ervaren (en verder te ontwikkelen) om zo kennis, vaardigheden en ervaring op te doen in het fysiek modelleren van dynamische landschappen. Daarnaast heeft deze thesis als doel om de waarde en betekenis van fysieke modellen onder de aandacht te brengen. Het delen en toepassen van de vergaarde kennis, zowel in studies als praktijk, leidt hopelijk tot betere ontwerpprocessen en daarmee ontwerpoplossingen. Samen kunnen we de gewoonte van de landschapsarchitect identificeren, herkennen en verbreden.

SUMMARY

This thesis addresses physical modelling in the explorative phases of dynamic landscape design. After exploring the current use of physical models in (landscape) architecture, an explorative study is carried out to find a specific design tool for physical dynamic landscape modelling.

In the first part of this thesis is concluded that physical models are valuable design tools in many ways, as it inspires and helps designers to understand, to think, to test and to communicate. Influenced by the type of design, the design process and the designer(s) him/herself, it is decided whether or not one models. The aim of the physical model depends how physical modelling takes place, concerning the model's abstraction and reduction and its materials, techniques and size (related to scale). Although one can distinct all aims of landscape architectural physical models in three types, the physical model appears to be a transformative tool, which has the ability to shift meaning. This makes the physical model a very effective but also explosive design tool. The fact that time is an important causer of costs, makes it an important factor in deciding to use physical models or not. The existing lack of know-how and skills concerning the use of physical models for landscape design appears to be a very related issue. This adds up to the fact that landscape architects seem to model the way architects do (static), while their profession differs (static architecture versus dynamic landscape architecture). It seems that landscape architecture therefore passes over the full possibilities that a physical model can offer for their design process (and thus design outcome), mainly relating to the explorative phases in dynamic landscape design.

The second part of this thesis gives new insights on the use of physical models for the explorative phases in dynamic landscape design; by taking into account the factors that influence the general use of physical models in the design process: the choice of materials, technique and size. Focussed within landscape dynamics on flowing water and growing vegetation, three series of experiments and a subsequent case-study were executed. The experiments led to a substantiated choice for materials and techniques suitable for dynamic landscape modelling. Three aspects stood out: the use of Magic sand for an explorative landscape study, the use of a simple and easy 'do-try-this-at-home/the office'-set up for physically modelling the dynamics of flowing water (for which Magic sand is suitable), and the use of cress (*Lepidum sativum*) for physically modelling the dynamics of growing vegetation (which can grow on Magic sand). These aspects were implemented into a case-study, taken into account the importance of physical model size for the use of the model in the design process (the model should not exceed door size). From the case-study two things came out: an example of how to build a physical dynamic landscape model for exploring the dynamics of flowing water and growing vegetation, and an example of how this model exactly could be used in and influenced a specific phenomenological design process (and its design outcome).

Although some criticism should be taken into account, this thesis shows how physical models can contribute to the landscape architectural design process for dynamic landscape design. Because the design process (of building the model and using it to design) is tracked, transcribed and analysed, this thesis offers a comprehensive example. This thesis aims to inspire designers (landscape architects and others) to start modelling, to experience and apply this (or preferably an even better) way of physical modelling, in order to develop knowledge, skills and experience on physically modelling dynamic landscapes. In addition, this thesis aims to create general awareness of the value and meaning of physical models. Sharing and applying the know-how this thesis creates, as well in study as in practice, hopefully leads to better design processes, ending up in better design solutions. Together we can identify, recognize and widen the habit of the landscape architect.

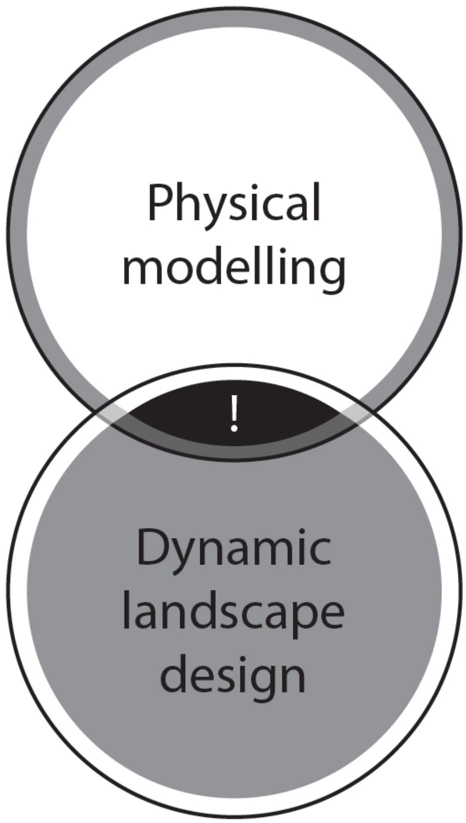
INTRO

1 TOPIC INTRODUCTION

The beauty of landscape architecture, as a specific profession within 'designing the outer world', lies in practicing and developing our own knowledge, skills and professionality. We – landscape architects (in training) – need to be aware of our experience and qualities, of the things we are good at. We need to identify and recognize them, in order to be able to share, improve and perfect them. Not only concerning design solutions, but also concerning the way in which we come to such a design solution: the design process.

This thesis is written from the point of view that there is not one right method of designing (Lawson, 2006; Amsterdam Academy of Architecture, 2015a; from practice). As Horlings and Van Dooren (Amsterdam Academy of Architecture, 2015a) state, every design assignment is essentially unique and every designer has the freedom to shape the design process: *"Through his or her knowledge, skills, opinions and, in particular, previous experience, the designer knows what to do and then to do that"* (p. 8). While designing we use a lot of design tools, as well visual as verbal (**figure 1.1**), of which the physical model is one. The value of a certain tool is caused by the combination of use with other tools. In this way we can also say: there is not one right design tool, we need to use the

1.1 Overview of design tools divided in visual and verbal tools by Christian Gänshirt (Gänshirt, 2007, p. 102)



1.2 Thesis focus: physical modelling in dynamic landscape design right tool for the right moment. Therefore we need to know every tool deep-down, by sharing, improving and perfecting them. *"It is always hard to know which* [design tool] *is best, it is always about experience; share methods which are already done; be open to all tools"* (La Hausse, 2016). Like Riedijk (2009) wrote about drawing in architecture: "The drawing is the architect's instrument as well as during designing as the result at the end of a design process. This almost tautological relationship is typical for architecture: the drawing is the design tool and the end result. Thinking about the nature and meaning of the drawing therefore is by definition thinking about the architectonic designing." (p. 7-8). For a comparable purpose, this thesis aims to contribute to knowledge on the act of physical modelling in landscape architecture – and therefor also the act of landscape architecture itself – by offering a unique insight in the use of physical models as a design tool in dynamic landscape design (**figure 1.2**).

1.1 Physical modelling

The physical model is an analogue and elusive tool, used by architects and landscape architects since the earliest manifestations of architecture.

An historical tool

A physical model is something everyone understands – in comparison to a drawing –, as the physical model is deeply involved in our history. Today's physical models date back to the miniatures of the gardens in Egyptian graves and the doll's houses from the 17th century. Since the early Renaissance architects made models as preliminary studies for building cathedrals and domes of Florence, Como, Milan and Bologna. These models were not only made to show the design, but also to test the building methods and load-bearing capacity of the design. In addition, the judgement of these designs occurred partly through comparing the models. (Wingender, 2016; Lepik, 1995; Smith, 2004; Milton, 1997) According to the images Daniel Ganz (landscape architect based in Zürich) showed me, even Napoleon Bonaparte planned wars against Switzerland with physical models (Ganz, 2016). Nowadays, models are still very important to architects. Herzog de Meuron (a well-known Swiss architecture office) recently built a new building, just to store their models (Moll, 2016). In contrast with the expectations I had six months ago, the physical model also (more than) often plays a role in the design process of the landscape architect.

An analogue tool

The physical model as an analogue design tool is closely related to a hand sketch, as a physical model can be seen as a way of sketching in three dimensions. A lot of research is done on the importance of hand sketches in the design process. Purcell and Gero (1999) collected and reviewed results of research on the role of sketch in design. They relate it to similar research about the role of drawings in problem solving in other disciplines. Some years later Berger (2007) wrote on the role of drawing in the design process and in 2009 Juhani Pallasmaa emphasizes the importance of hand sketches in the design process in his book *The Thinking Hand. Existential and Embodied Wisdom in Architecture*. Christian Gänshirt (2007, p. 78) states that 'doing' is important in the design process: *"The interplay of seeing, thinking and doing, the reflection of one in* *the other through perception and expression, forms the basis for all design activity"*. Supplemented by Alice Foxley (2010) who states: *"Making is thinking"* (p. 28), I assume that 'doing' in an analogue way is a more direct way of coming up great ideas than by 'doing' tasks digitally, as hand sketches are important to generate ideas directly on paper, by not having the extra 'translate-step' that would take place when drawing on a computer. Like what Riedijk (2009) writes about the act of drawing in achitecture, relates enormously to the act of physical model making in (landscape) architecture: *"The architecturel design arises in the drawing by drawing. The designs somethings seem to be steered by the drawing. After the making of the first sketch, a new sketch can be made. The drawing shows the current situation of the design and includes the germ for a new step in the thinking process. Every next step forms an evaluation of the other sketches. In the act itself, while the pen or pencil still go about the white paper, the design arises."* (Riedijk, 2009, p. 7-8) Therefore, we should not underestimate the value of the analogue tool in our digital age.

An elusive tool

The physical model appears to be an elusive tool. Not only in the way it can be used, but also in the way it can be defined. According to Otl Aicher (1991) *"designing means constructing models"*. Aicher here sees the model as *"an construction made of statements, concepts and conceptual operations"* (p. 195). When taking a deep dive in the world of models, one learns that it is hard to give a clear and comprehensive definition. *"Various planes of meaning can overlap in one and the same model in a way that makes it into an object onto which a whole variety of different ideas can be projected."* (Gänshirt, 2007, p. 149). The model appears to be an elusive tool, due to different linguistic, disciplinary and personal views on the term. For example, the fact that *"models are traps for capturing the world"* (Vilém Flusser, 1993, p. 14), yet makes no distinction between (the incomplete list of) digital models (e.g. 2D/3D simulations), physical models (e.g. 'maquette'/'working model') or general models (e.g. a projection/construction of statements and concepts); and yet does not say anything about the act of modelling (e.g. making digital graphs/ cutting cardboard).

In addition, the term 'model' is closely related to 'prototype', 'sample' and 'miniature', although the latter can be defined easier. Gänshirt (2007) indicated that our linguistic usage lacks a clear definition for 'model', but Horlings and Van Dooren (Amsterdam Academy of Architecture, 2015a) come up with a quite comprehensive definition.

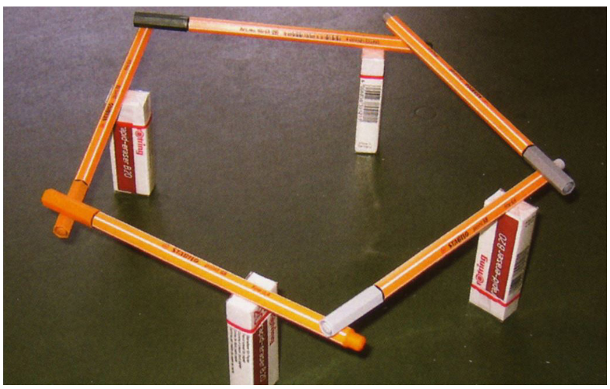
Prototype	=	Life-sized constructed and materialized part of a building completed as an experiment, the dimensions can extend to trial structures (Gänshirt, 2007, p. 150)
Sample	=	Life-sized constructed and materialized thing to compare building materials and the ways in which they can be handled, to make choices (Gänshirt, 2007, p.150)
Miniature	=	A scaled three-dimensional representation of an existing building (Amsterdam Academy of Architecture, 2015a, p. 79-80)

Model (EN) = A scaled three-dimensional presentation of a design;
a projection, a tool looking forward to the future;
a conversation piece in the design process (a temporary, independent crystallisation of a design, and, as such, talks back to the designer, it questions the design and its underlying ideas);
a conversation piece in the negotiation process (that is inextricably linked to the design and execution of buildings
(Amsterdam Academy of Architecture, 2015a, p. 79-80)

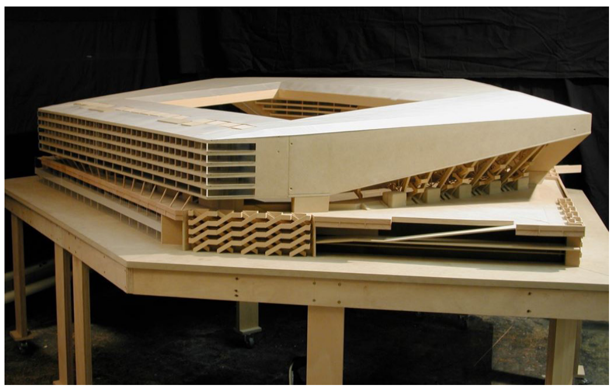
As I am educated in the Dutch language, the difference between the Dutch words 'maquette' and 'model' are relevant as well, which Wingender refers to as:

Model (NL) = Representation: static scheme (**figure 1.3**)
'a tool for examining a design and the underlying idea';
coming from the Latin word 'modulus' as 'measure, knowledge' and the Dutch meaning as not only 'copying on a small scale', but also 'an example of the basis of which a work is executed', 'an interpretation of a system' or 'a paragon of something (role model);
scale invariance and material; offers opportunities for abstraction, essence and suggestion;
a conversation piece for a simultaneous internal and external discussion about the design, for study, reflection and inspiration in the design process
(Amsterdam Academy of Architecture, 2015b; Wingender, 2016)

Maquette = Presentation: really explains everything (**figure 1.4**);
'a more or less precise and objective representation';
coming from the Italian word 'machietta' as 'raw sketch tool' and the Dutch meaning as 'a three-dimensional miniature model of a building, village district';
fixed scale and true-to-life representation of space, structure and materials;
irrespective the design phase, it suggests an end point
(Amsterdam Academy of Architecture, 2015b; Wingender, 2016)



1.3 Example of the Dutch term 'model': a static scheme which contains an idea *(Amsterdam Academy of Architecture, 2015b, p. 84)*



1.4 Example of the Dutch term 'maquette': it really explains everything, contains a 'thorough design' *(Wingender, 2016)*

Peter Koorstra (assistant professor at the Faculty of Architecture, TU Delft) makes this distinction for the Dutch terms:

Model	=	mutable
Maquette	=	a representation of the end result (Koorstra, 2016)

To prevent confusion in using the word 'model', to not exclude the Dutch meaning of the word 'maquette', but to exclude the extension to digital simulations, I will use the term 'physical model' in this report. With 'physical model' I mean 'a physical three-dimensional representation of a design idea, not necessarily suggesting an end point of the design project'. This can be both with or without a fixed scale; functioning as a conversation piece in and after the design process; and containing a certain abstraction, essence and suggestion. When I use the verb '(physical) modelling' I mean 'the act of making physical models'.

1.2 Dynamic landscape design

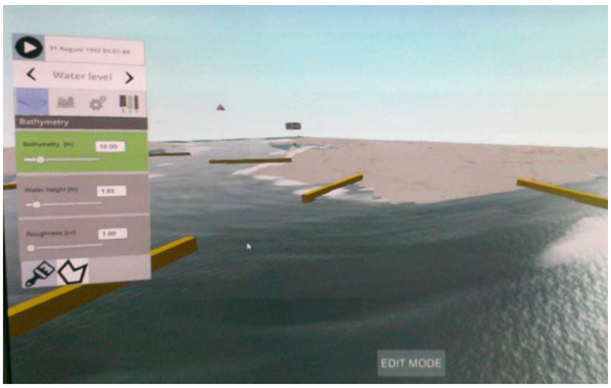
By 'dynamic landscape design' the design (and research) of dynamic landscapes is meant, done by (landscape) architects and others in the field of environmental design and research. In general, dynamic(s) has to do with change, development and movement inside a group or system (Cambridge Dictionary, n.y.). Concerning landscapes, this includes change, development and movement of landscape (systems) through the course of space and time. Dynamics that have effect on landscape are for example sunlight, seasonality, wind, traffic flows, people's behaviour, water and vegetation. This research focusses on the last two dynamic aspects: flowing water and growing vegetation.

1.3 Modelling dynamic landscapes

To understand and analyse dynamic landscapes, modelling is used as a tool to simplify the landscape's complexity and to interrelate what we observe and experience. There are different strategies in which modelling can be applied in landscape architecture research, of which dynamic modelling is one. One can distinct two categories of dynamic models: process models and simulation models. Process models represent the way that landscapes function; simulation models represent the way complete landscapes change over time under different combinations of conditions and decisions. (Deming and Swaffield, 2011)

In general, modelling can be done in a digital and analogue (physical) way. The Chair of Christophe Girot at ETH Zürich (*Swiss Federal Institute of Technology*) for example investigates possibilities and new opportunities for landscape modelling. Recently they did a project on 3D-mapping mountains using new scanning technologies. (Moll, 2016). If it comes to water dynamics, a lot of digital modelling is done to predict the impacts and possible interventions throughout the water system (e.g. urban water system, river system, coastal area). For example, Deltares has developed D-HYDRO Suite, software which simulates and shows the interaction between floods, storm surges, hurricanes, waves, flooding caused by heavy rainfall, sediment transport and morphology, water quality and ecology (Deltares, n.y.a). This tool can be used to calculate and simulate rainwater management and storm water runoff in urban areas, also in a three dimensional mode (**figure 1.5**). Another comparable digital model is 3Di. This tool is specifically developed to deal with issues like water safety, flooding, calamity management and spatial planning. Decision makers and civilians can visualize the impact of the proposed measures in various climate scenarios (**figure 1.6**). (Stichting 3Di, 2016) If it comes to growing vegetation, several digital (hydro/)ecological models exist. For example, Manfreda et al. (2013) used a hydrological/ecological model which included the influences of soil moisture, solar radiation distribution and seasonality of climatic forcing on the spatial organization of vegetation.

However digital models keep developing, physical models are also still used. In the 50s and 60s the Dutch 'Waterloopkundig Laboratorium' (Hydraulics Laboratory) build physical pilot models to do water research on water flow and the effect of waves. These models were located in Marknesse, where nowadays some of them are still recognizable and given the status of Rijksmonument (**figure 1.7a,b**). (Natuurmonumenten, n.y.) Recently, Deltares build a new 'Deltagoot' (Delta Flume), which is a life-size scale model to test

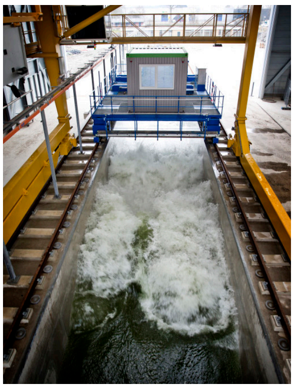


1.5 Example interactive 3D-modelling: Westerschelde in D-HYDRO Suite *(Deltares and Rijkswaterstaat, 2015)*

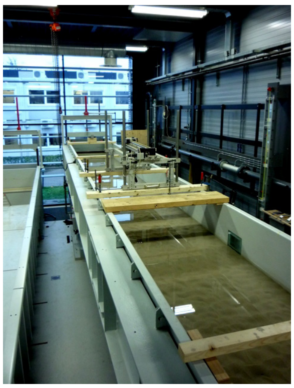
1.6 Example modelling floods with 3Di for the city of Amsterdam *(NRC, 2014)*

1.7a Physical models in the 'Waterloopbos' (*Hydraulics Laboratory*): Willemstunnel Rotterdam (schaal horizontally 1:75, vertically: 1:37.5)

1.7b Physical models in the 'Waterloopbos (*Hydraulics Laboratory*): Koelwaterwatervijver Maasvlakte-centrale (scale unknown*)* the effect of extreme waves on dikes, dunes, breakwaters and offshore structures (**figure 1.8**) (Deltares, n.y.b). On a smaller scale, several sediment basins are made to do research on sedimentation, for example at the Kraijenhoff van de Leur Laboratory for Water and Sediment Dynamics in Wageningen (**figure 1.9**). Current research topics are in the field of stream restoration, gully erosion and side channels created by longitudinal dams (Wageningen University, n.y.). Another type of physical water models are the models for educational purposes. At Neeltje Jans for example a water park is located where children can play and learn with and about the Dutch Deltaworks (**figure 1.10**). Something similar can be found at the recently developed Park Vliegbasis Soesterberg (**figure 1.11**), where children can play with scaled inundation fields; and at the Waterline museum at Fort Vechten a scaled version of the Dutch Waterline can be found (**figure 1.12**). Overall, all ways of modelling above are quantitative ways of research, except for the play-models for educational purposes. These are meant to give an impression of water flow rather than an exact image. When it comes to designing dynamic landscapes, a qualitative approach cannot be denied, which raises the questions whether qualitative models are used for design purposes.



1.8 The Delta Flume of Deltares in Delft *(Deltares, n.y.b)*



1.9 The Tilting flume at WUR *(Wageningen University, n.y.)*

1.10 Waterpark Neeltje Jans at Vrouwenpolder *(Rijkswaterstaat beeldbank, n.y.)*

1.11 *Water playground at Park Vliegbasis Soesterberg in Soesterberg*

1.12 Water playground at Waterlinie museum Fort Vechten in Bunnik *(Waterliniemuseum, n.y.)*

2 RESEARCH INTRODUCTION

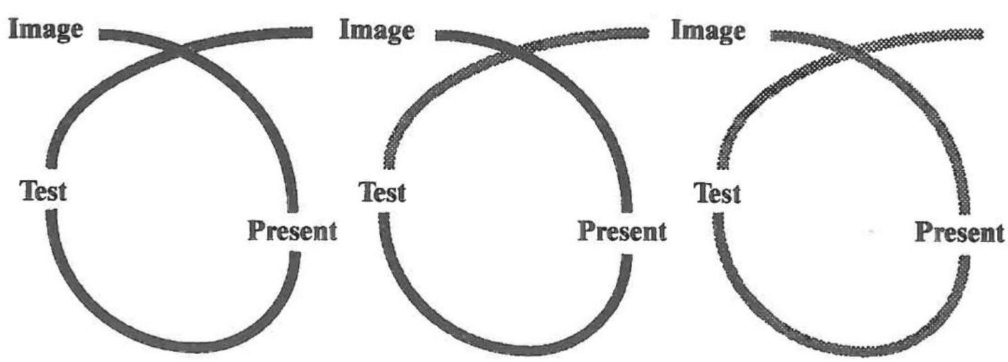
This chapter describes the way in which the research and design are carried out in an iterative thesis process by explaining the research design and the method of inquiry taken for this thesis.

2.1 Research design

2.1.1 Landscape architectural perspective

There are as many models of the landscape design process as there are landscape designers (Walker, 1981). The design process is often imagined as a series of discrete parts, following each other in a set sequence. But this ignores the fact that it is an interactive, iterative and circular, process (Kempenaar, 2015; Walker, 1981; Jones, 1970; Heath, 1984; Rowe, 1987; Shoshkes, 1989; Lawson, 1994; Yaneva, 2009). Therefore the design process is rather cyclical than sequential, as shown in **figure 2.1**. This model of the design process as a continuing spiral by Zeisel (1981) is based on the idea that at every next iteration the subject is further developed. Because the approach taken in this research will be on exploring and understanding the meaning of students, academics and professionals to the use of physical modelling, the design and research will be conducted from the point of view of constructivism. It is about understanding and theory generation by bringing personal values into the study. And because very few concrete knowledge about the topic is yet available, the goal of the research is to rely as much as possible on the participant's view (experience and opinion of students, academics and professionals) of the use of physical models in (landscape) design. Altogether in order to create an agenda for change or reform about the design process in landscape architecture.

During my studies I have learned that a landscape architect can have different roles. There is more to the act of landscape architecture than designing nice plans. With this thesis the role of a landscape architect as 'researcher' comes more to attention, but of course without losing the wonderful role of a landscape architect as 'designer'. However, 'design' in this thesis should be perceived in a broader way than 'designing nice plans'.



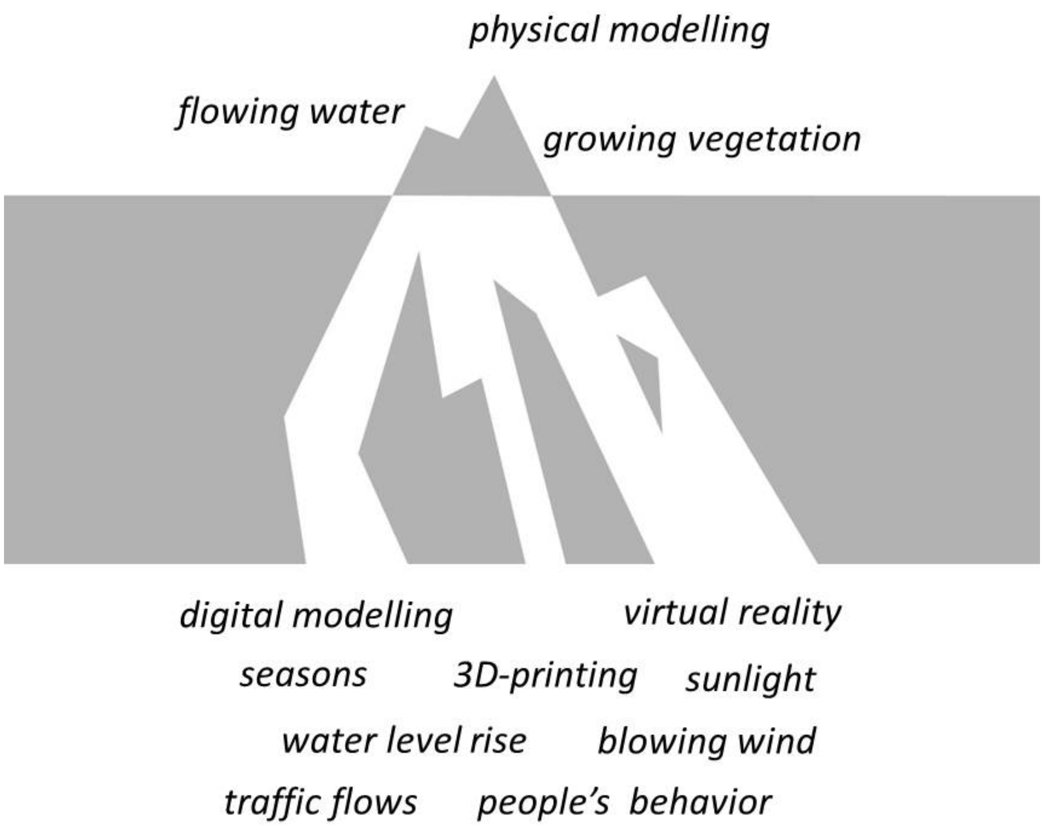
2.1 The design process according to Zeisel *(Zeisel, 1981, p. 30)*

2.1.2 Problem statement

This thesis deals with two things: on the one hand the lack of literature (and expected lack of knowledge) on physical modelling in landscape architecture, and on the other hand the explorative phases of dynamic landscape design. As introduced in chapter 1, the physical model is a relevant design tool for (landscape) architects. However, there is only a few literature available about the use of physical models, which is also mostly focussing on the field of architecture. I believe that physical modelling can be of great value of the design process of a landscape architect as well, as it offers possibilities for qualitative exploration. This qualitative exploration is expected to be of use for dynamic landscape design.

2.1.3 Research objective and questions

The objective of this thesis is to explore the physical model as a design tool for the explorative phases in dynamic landscape design to (1) offer a unique insight in using physical models in the design process of a landscape architect; and to (2) improve methods and techniques for dynamic landscape exploration, by making it more accessible



2.2 This thesis focusses only on the top of the iceberg concerning dynamic landscape modelling: physical modelling concerning flowing water and growing vegetation and scientifically valid. Since this thesis had a duration of six months, it offers only a small step in the development of theory and experience of the topic. This is also visible in the focus of the second part of this thesis (experiments and case-study) on the use of physical models concerning flowing water and growing vegetation (**figure 2.2**).

The main question I will answer by writing this thesis is the following:

'What can physical models contribute to the landscape architectural design process for dynamic landscape design?'

This question will be answered through several sub questions, which consists of questions related to 'research-on-designing', questions related to 'research-through-designing' and a design question:

Questions research-on-designing
In what ways are physical models used as a design tool in (landscape) architecture?

a. What is a physical model?
b. How, why and when are they used; when and why not?
c. What are the differences and similarities of the use of physical models within the fields of architecture and landscape architecture?

Questions research-through-designing
In what ways can physical models be used as a design tool to deal with a dynamic landscape design?

a. What are the factors that influence the use of physical models?
b. How can these factors be used to model a dynamic landscape?

Design question
How can physical models be used as a design tool to improve the design (process of) the reclamation of a post-mining landscape for research and educational purposes in Quadrilaterero Ferrifero (Brazil)?

2.1.4 Research significance

This thesis aims not only to be of significance for (landscape) architects and others in the design field by raising awareness of the possibilities of using physical models, but also by increasing knowledge on physical modelling. The results and conclusions of this thesis are meant to show what physical models can contribute to the landscape architectural design process for dynamic landscape design by elaborating on a case-study in which is shown how a dynamic physical model can improve the design process, and thus design, of a specific dynamic landscape assignment. This, in order to inspire and encourage landscape architects to use the physical model in this way, to convince them to try and to develop further.

2.2 Method of inquiry

2.2.1 Research approach

In order to reach the aim of this thesis, a qualitative research approach will be applied. This approach involves the collection and analysis of qualitative (open-ended) data. Creswell (2014) mentions several characteristics of qualitative research. I will touch upon some of them and couple them to my thesis research.

According to Creswell (2014), qualitative researchers tend to collect data in the field at the site where participants experience the issue or problem under study. One major characteristic he points upon is this up close information gathering by actually talking directly to people and seeing them behave and act within their context. In this thesis this will be done by conducting interviews and doing observations in the professional field of (landscape) architecture. In addition to this the researcher (me) functions as key instrument, which is another characteristic Creswell mentions. Data collection will be done through examining documents, observing behaviour and interviewing participants, all by myself. This also touches upon the characteristic of using multiple sources of data. After collecting this data, I will review it to organize it in overarching categories or themes that cut across all of the data sources. For this thesis participants' meanings will be important to keep focus on learning the meaning that the participants hold about the use of physical models, instead of the meaning I bring myself to the research. Because the phases of the process may change or shift during research and design, the research process is an emergent design. The thesis research will be a form of interpretive inquiry, in which an interpretation will be made of what I see, hear and understand (see also section 2.2.2 about interpretive strategies). Finally, the qualitative research has a holistic account. A complex picture of the use of physical models will be developed. There is an interface between interpretation and analysis (Hesse-Biber and Leavy, 2004, 2006; Hunter and Tan, 2002).

The qualitative approach is of great value for this thesis, because it is a useful strategy to develop a better understanding for the use of physical models as a design tool, by first collecting and analysing qualitative data and then applying and testing the results on a case study. By describing the design process of the case study, the results of the qualitative research will result in an interpretation and conclusion on the use of physical models as a design tool for dynamic landscape design. In this way, the design and research is done in an exploratory and evaluative manner.

2.2.2 Research strategy

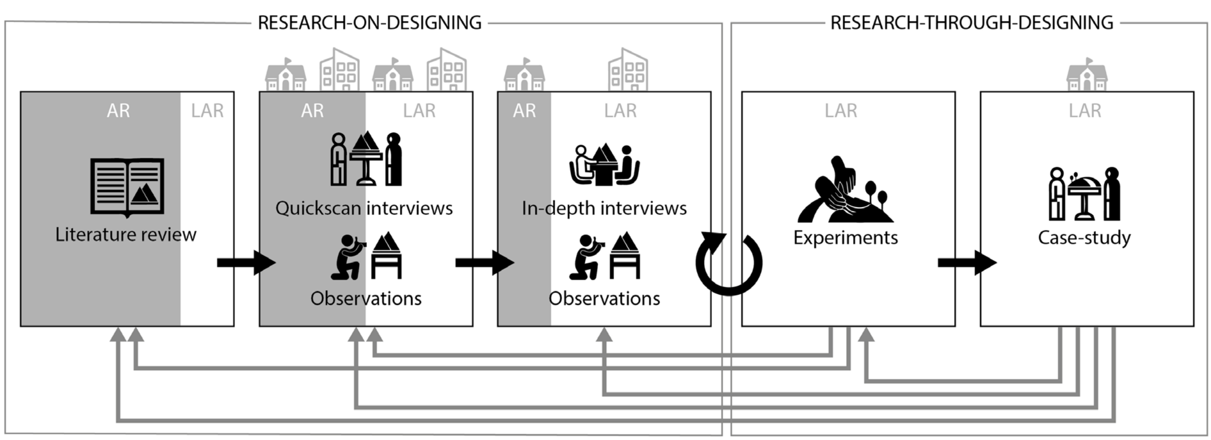
Three things characterise the iterative research and design strategy of this thesis. Firstly, it is an explorative study which tries to solve a concrete problem, but aims to explore a specific part of the design process. Secondly, it is the way in which research and design are combined: a combination of 'research-on-designing' and 'research-through-designing'. Lastly, it is the interpretive research that is carried out.

Explorative study

The study that will be carried out consists of an explorative search and in-depth study in literature and practice, supplemented with experiments and a case-study. Interviews, observations and experiments are conducted in a parallel process. This means that the findings of every individual part are considered in the other parts. By continuously arranging the preliminary findings, making preliminary conclusions from that and taking that into account in the next step (another interview/another experiment), the preliminary conclusions grow and develop till they can be tested in the case-study, leading to the final result.

Combining research on- and research-through-designing

As shown in **figure 2.3** the research and design starts with a 'research-on-designing'-phase. Besides the literature review on the use of physical models, data will be collected by doing quickscan-interviews and observations in the field. This SEARCH is focussed on architecture as well as landscape architecture. After that, a more IN-DEPTH STUDY will take place, with in-depth interviews and observations. This is the point at which research-on-designing and research-through-designing come together in an iterative process, as the in-depth study also consists of explorative experiments (which are part of the research-through-designing-phase). The experiments are based on results from in-depth interviews and observations; and at the same time the experiments will raise questions which can be questioned in the in-depth interviews, supplemented with observations in the field of (landscape)architecture. The resulting data of the in-depth study will then be analysed and lead to a more focussed EXPLORATIVE STUDY. This last step enhances a case study as an experimental research of the results of the SEARCH and IN-DEPTH study. The purpose is to experience the use of physical models in the design process of a specific dynamic landscape design and to reflect on that, in order to explore the use of this design tool further for landscape architecture in general and for dynamic landscape design in

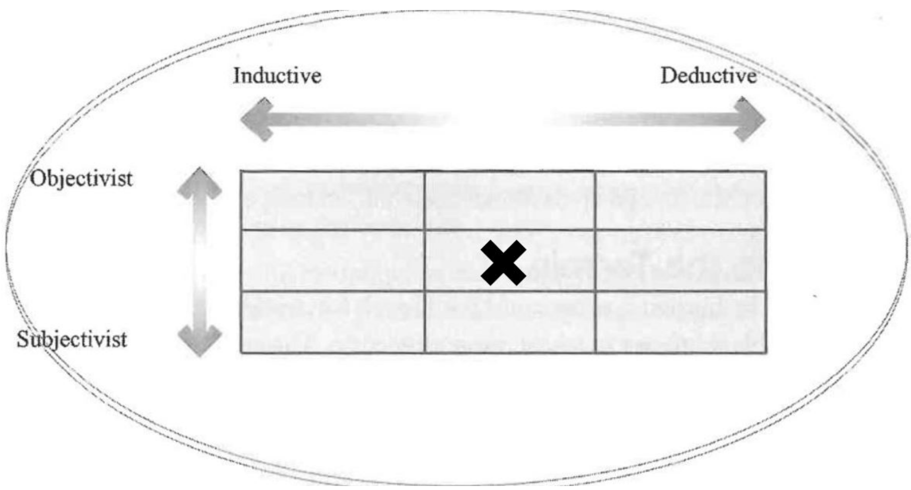


2.3 Research strategy

specific. For the sake of time, the focus is on one specific case: the design process of a landscape architecture master student who is making a design for the reclamation of the post-mining landscape of Quadrilaterero Ferrifero (Brasil) for research and educational purposes. The research-through-designing phase with the experiments and case study are executed to bridge theory and to build knowledge to enhance design practices, and examining the tools and processes of design thinking and making within the design project. Materials research and the critical act of recording and communicating the steps of the design process will be included here. The latter is important to contextualize and communicate design action during the study. (Hannington and Martin, 2012)

Interpretive research

Interpretive research produces knowledge by identifying, naming, and assigning new significance or meanings to dimensions, themes, or narratives within a data set. (Deming and Swaffield, 2011) In this thesis, the meaning of objects (physical models) and actions (the use of physical models) are not always plain and obvious. Therefore it is required to actively engage in 'making sense' of the phenomena. In this case understanding is actively constructed through mediation between researcher and the data. (Deming and Swaffield, 2011) According to Orlikowski and Baroudi (1991), interpretive researchers attempt to understand phenomena (the use of physical models in the design process) through accessing them with the meanings participants assign to them (results of interviews and observations). According to Deming and Swaffield (2011), the interpretive strategy sits between the objective and subjectivist positions, and between induction and deduction (see the cross in **figure 2.4**). It is a constructionist approach to understanding. According to Creswell (2014), interpretations cannot be separated from my background, history, contexts and prior understandings. Attention therefore is paid to be open minded during the research and design process.



2.4 Interpretive strategies in the classification scheme of Deming and Swaffield *(2011, p. 8)*

2.2.3 Methods and tactics

This thesis research has an interface with ethnography. According to Clifford Geertz this is about the researcher's own interpretation of what he or she learns in the field (Geertz, 1973; Leavy, 2009). The researcher seeks to establish the meaning of a phenomenon from the views of participants (Creswell, 2014). In this research this is the use of physical models as a design tool in the field of (landscape) architecture. Overall a qualitative method is applied, with the use of different techniques, which will be described below.

Literature review

Literature review is used to collect and synthesize research on the use of physical models as a design tool in architecture as well as in landscape architecture. The aim of using this method is to get more information before doing the interviews and observations in practice. (Hannington and Martin, 2012)

Interviews and observations

To collect first-hand personal accounts of experience, opinions, attitudes and perceptions on the use of physical models in the design process, interviews are conducted. This fundamental research method provides direct contact with participants. (Hannington and Martin, 2012) Two types of interviews are applied, which I refer to as 'Quickscan interviews' and 'In-depth interviews'. To verify and humanize the data, the interviews are supplemented by a complementary method, namely observations. For an overview of all interviewees, see **figure 2.5**.

By doing Quickscan interviews short conversations with students at different studies in the design field will be held. Hereby the use of physical models in the design process of students in architecture, landscape architecture and one other study will be explored. Aim is to explore the current use of physical models from an open point of view, with attention to the closely related fields of architecture and design.

The Quickscan interviews are followed by In-depth interviews at nine professional offices. Eight of them are practicing landscape architects, one of them is an office specialized in the making of physical models (commissioned by (landscape) architects). Aim is to explore the current use of physical models in landscape architecture in specific, taking into account the previous findings.

Parallel to both types of interviews observations were done on the (use of the) physical models on site. Doing observations means attentive looking and systematic recording of phenomena – including people, artefacts, environments, events, behaviors and interactions – in order to speculate on the meaning and motivations behind actions (Hannington and Martin, 2012). As the interviews were supplemented by the observations, the Observations consisted of taking photos on site and writing a supportive text about what I observed there.

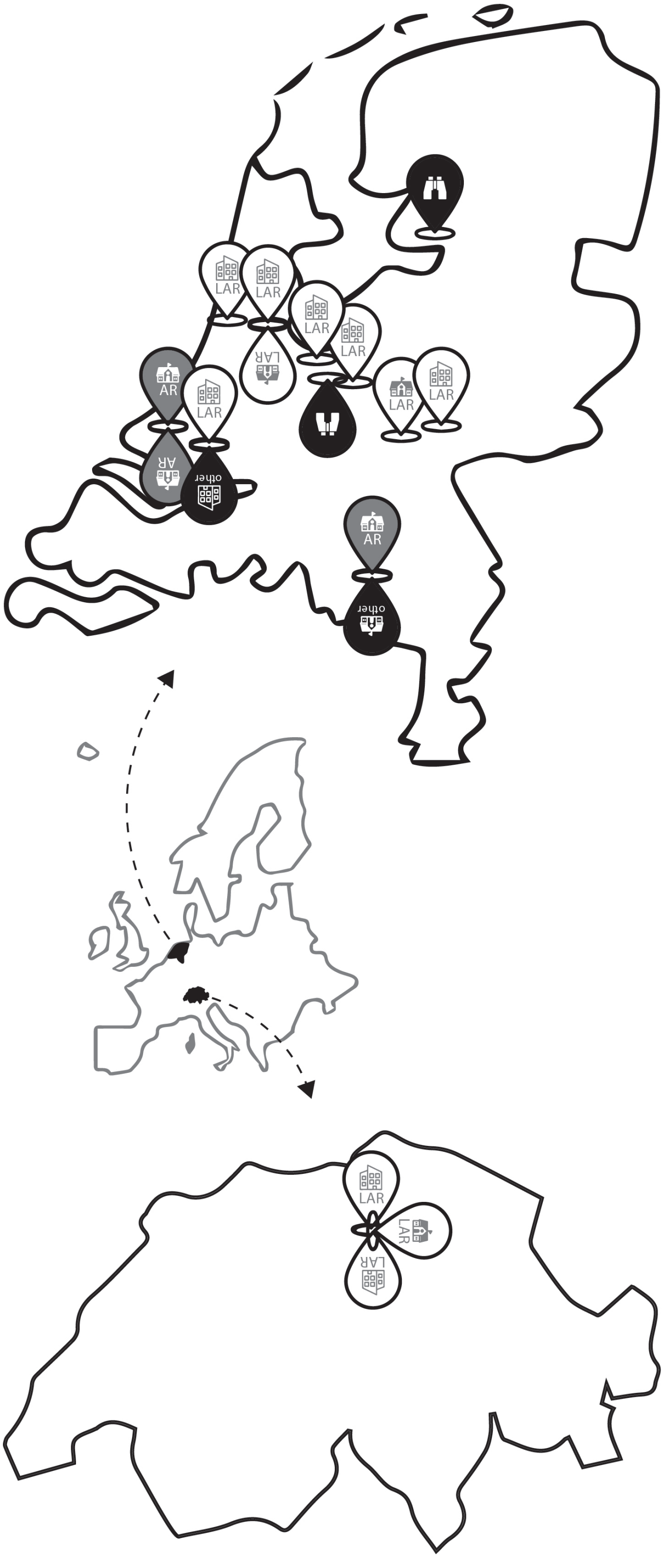
Content analysis

Results from both interviews and observations are on site captured by handwritten

notes and photos. Directly after each interview, these are transcribed into a digital Word-document, printed and kept in a binder. These documents (**appendix 2a,b**) contain also thoughts which I had directly after the interview, concerning the content of the interviews related to earlier findings and expectations. In this way, every interview has a complemented set of questions (**appendix 1**), as new knowledge and insights are generated throughout this series of appointments.
As the main characteristic of my research strategy was a study conducted in a parallel way, content analysis was done throughout the process. In this way previous findings are constantly supplemented by the insights from recent interviews. Content analysis means "the systematic description of form and content of written, spoken, or visual materials expressed in themes, patterns, and counted occurrences of words, phrases, images or concepts", in order to analyse new materials generated through the interviews (Hannington and Martin, 2012). By this process of gathering, arranging and concluding new insights are generated and new questions will pop up, which are input for the next step in the research and design process. In this way, content analysis is not only done on the outcomes of the interviews and observations, but continues throughout the experiments and case study (see below).

Experiments

In the 'research-through-designing' phase experiments play an important role. 'Experiment' should not be understood as a scientific experiment, to proof or withdraw a certain hypothesis, but as a qualitative research method which aims to explore several possibilities within the use of physical modelling for dynamic landscape design. 'Experiment' therefore should be understand as 'an explorative and iterative trial and error process in exploring how to use physical models in landscape architecture'. Hereby I will focus on the use of several materials and techniques for dynamic landscape modelling and carry these experiments out by myself. Trial and error is led by the findings from literature and practice, and previous experiments. The case-study in the last part of the 'research-through-designing' phase (see also the description below), can also be taken as an experiment. According to Creswell (2014), experimental research seeks to determine if a specific treatment influences an outcome in a study. In the case study, the 'treatment' is the use of a physical model and the 'outcome' is the influence on the design process of and design of a dynamic landscape. However, the way of experimenting that is carried out in this research, misses a critical aspect that Creswell mentions in addition to which stands above: "This impact is assessed by providing a specific treatment to one group and withholding it from another group and then determining how both groups score an outcome". As the design process is not something which can be carried out twice in the same way, or by two different groups in the same way, this experimental research is for that matter unilateral. In addition, as this is a qualitative research, it is not possible to control all other factors that might influence the outcome of the experiment. In order to make it still a valid research, all possible constraints are discussed before and after the design experiments. These, and also the exact execution of the experiments, are further explained in Part II, chapter 5 and 6.



Studies | Architecture

TU Delft	**15 students** (QS, Ob) architecture and urbanism **Peter Koorstra** (ID) assistant professor
TU Eindhoven	**11 students** (QS, Ob) architecture and urbanism

Studies | Landscape architecture

A'dam Academy of Architecture	**Jan Peter Wingender** (lecture) lecturer, architect (landscape) architecture, urbanism
WUR Wageningen	**7 students** (QS, Ob) landscape architecture
ETH Zürich, CH	**Claudia Moll** (QS) researcher at Chair Girot

Studies | other

Design Academy Eindhoven	**2 students** (QS, Ob) diverse design studies

Offices | landscape architecture

Bureau B+B *Amsterdam*	**Raf Rooijmans** (ID, Ob) landscape architect
karres+brands *Hilversum*	**Lieneke van Campen** (ID, Ob) landscape architect, managing partner
H+N+S *Amersfoort*	**Arjen Meeuwsen** (ID, Ob) landscape architect
Veenenbos en Bosch	**Willem Brouwers** (ID) landscape architect
ZUS *Rotterdam*	**Kinga Bachem** (ID, Ob) landscape designer
HOSPER Haarlem	**Ronald Bron** (ID, Ob) landscape architect, co-owner
Ganz LA Zürich, CH	**Daniel Ganz** (ID, Ob) landscape architect, director
Vogt LA Zürich, CH	**Nicole la Hausse** (ID, Ob) landscape architect

Offices | other

Made by Mistake	**Dick Sman** (ID, Ob) model maker, co-owner

Excursions

Waterloopbos, Marknesse
physical scale models Waterloopkundig Laboratorium

Park Vliegbasis Soesterberg, Soest
water playground as model of Dutch Waterline

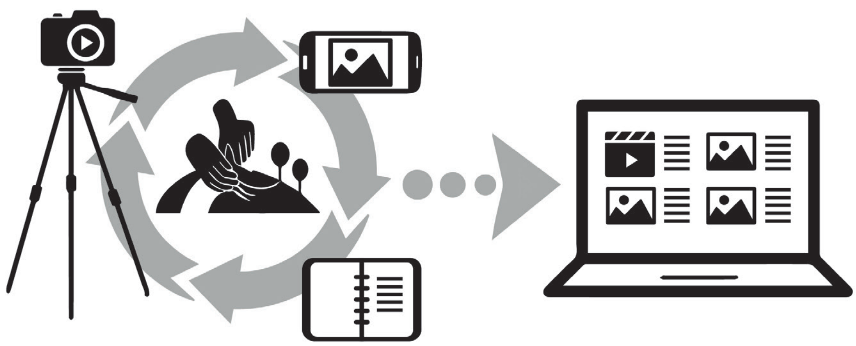
2.5 Overview of interviewees

Case study

To test my findings from interviews, observations and experiments I will use a case study in order to explore the use of a dynamic landscape model for a specific landscape architectural design process. One can take the case-study as a new experiment. As a result of the preliminary conclusions, I will focus on dealing with growing vegetation and flowing water in a physical model. After weighing several options, the case of Carlo Leonardi is most suitable: the design process of a landscape architecture student on the reclamation of a post-mining landscape. Carlo Leonardi is a fellow master student at Wageningen University who was halfway his design process at the moment the case-study starts. He designed a masterplan for the site, but struggles with designing it further, as he cannot grasp the scale and topography of the site. Carlo approaches his research and design from a phenomenological point of view. Thus, the case study is about exploring Carlo's design process influenced by the use of a physical model and to study the effects of the use of physical models, on the design process and the design itself. Therefore it is important to describe the process while doing the case study; Carlo will be asked to think out loud, while the situation is filmed (SLR camera on a tripod) and subsequently fully transcribed. In addition, Carlo will keep a half-day logbook in which he also captures his mood about his design progress during the case study. By documenting the design process in these ways, the potential to contribute to a repository of design case studies pops up. (Hannigton and Martin, 2012; Creswell, 2014) The case study will be further explained in Part II, chapter 6.

Tracking design process

To track my own research and design process throughout the thesis process, I will keep a daily logbook (**appendix 3**). In this logbook I write down what I did every day, how long it took, where it took place and how I felt about my design process that day. The latter I will do by giving a smiley to every day. This smiley represents my mood about my thesis process on that particular day. When I lose faith in the progress of my thesis process, an analysis of the former period can help me to realize why I did lose faith, as I saw my mood of the period before and how I got back on track after previous downfalls. After



2.6 Keeping track of my research-through-design process: making notes while experimenting, taking photos of the main steps, taking movieshots while experimenting, writing my first thoughts directly after the experiments completing my thesis, the logbook and mood diagram (**appendix 4)** give specific insight in the research and design process I went through. During experiments I keep track of my research and design process by making notes (paper and pencil) while experimenting, by making photos of the main steps I take (smartphone) and/or taking movie shots while experimenting (SLR camera on a tripod), and by writing down my thoughts directly after experimenting in relation to previous experiments and findings from literature and practice (laptop) (**appendix 5**). (**figure 2.6**)

2.2.4 Research reliability and validity

Reliability in this thesis is ensured in three ways. Firstly, by documenting the procedure of the interviews, experiments and case study. Secondly by including the raw-results of the interviews and observations in the attachment (**appendix 1**). And thirdly, by recording and communicating the steps taken in the research-through-designing phase by filming and transcription to contextualise and to communicate design action (appendix 5).

To ensure a qualitative validity in the thesis research, several aspects gain attention. Overall, triangulation is used to corroborate evidence from several different angles by using multiple methods on the same research question (Hannigton and Martin, 2012). According to Denzin (2006), this is a form of Methodological triangulation, consisting of literature review, interviews & observations and experiments. In addition, all findings from literature and practice need accurately referencing by using consistent footnoting and/or endnoting, and bibliographical style (according to Hannington and Martin, 2012, p. 112). Besides, observations should *"differentiate between factual behaviours witnessed, and interferences, speculating the meaning and motivations behind actions"* (Hannington and Martin, 2012, p. 120). These interferences will be verified through interview questions with participants during or following observations. Although this thesis aims to do reliable and valid research, descriptions from a single researcher should be cross verified to enhance reliability of participant accounts. Although single cases are not enough to support or reject hypotheses, they may shed light on theory (Sommer and Sommer, 2002). In addition, caution is exercised to avoid to *"find what you are looking for"* (Hannington and Martin, 2012, p. 120). Therefore, an open minded view is needed while doing the research. Because, as Orlikowski and Baroudi (1991) stated: *"The interpretive research approach towards the relationship between theory and practice is that the researcher can never assume a value-neutral stance, and is always implicated in the phenomena being studied"* (p. 16).

Of course not every designer assigns the same value to the use of physical models, as it is a very personal act. And of course not everyone uses a physical model for the same reasons or in the same way. But by writing this chapter, I collect and order my findings from literature review, interviews and observations; in order to offer insight in the current use of physical models in architecture and landscape architecture.

PART I

current use of models

3 EXPLORING THE USE OF PHYSICAL MODELS

3.1 The value of physical models

The reason why architects and landscape architects are applying physical models in their design process is led by the value they attach to the tool. From literature I learned that the design evolves through modelling and that it therefore creates a bridge between thinking an making. By entering the design practice it became clear what value practicing architects, landscape architects and students assign to the physical model; and why and when they do or do not use physical models in the design process.

3.1.1 A physical thing around

Probably the most obvious and characterizing characteristic of a physical model is that it is a physical object with a physical appearance. This aspect makes the design (idea) more present, as it becomes part of daily life. It makes it something you can (or even have to) face all the time, even when you are not working on it. When you pass by, you realize things. This is something Christian Gänshirt (2007) writes about, which Alberta Yaneva (2009) observed in the studio of OMA and which was confirmed by a lot of interviewees in practice. *"The physical thing is the key somehow"*, answers Daniel Ganz, landscape architect and director at Ganz Landschaftsarchitekten (Zürich, Switzerland), to my question why his office uses physical models so often (Ganz, 2016). He compares model building with his devotion for having a catalogued library where you can physically open a book: you can touch it, feel it: *"It is like you walk outside: surprised that you notice something new: you can be more aware"*. In this way, a physical model is not only useful and valuable for the project it is made for, but it inspires beyond; also for other projects. The ideas are kept in the model, it is 'a thing in the office' – in comparison to the products of digital tools, which often are kept in the digital world, less accessible and present. Physical models are always around in the studio, like a drawing, and should consciously be considered as a source of inspiration for future projects. (Amsterdam Academy of Architecture, 2015b; Wingender, 2016; from practice)

Vogt Landscape architects and Ganz Landschaftsarchitekten are two examples of studios arranged around models (both in Zürich, Switzerland). Ganz LA has a small studio, but one

3.1 Modelling room at Ganz Landschaftsarchitekten, Zürich, Switserland

3.2 Modelling room at Vogt Landscape architects, Zürich, Switzerland *(Vogt Landscape Architects, n.y.)*

floor down a room full of models can be found (**figure 3.1**). Some models find their way up to the office and become part of all designer's daily life. (Ganz, 2016) Vogt LA is a 'one size bigger-office' – at least in square metres – and has a large cellar full of models and model materials (**figure 3.2**; unfortunately I was not allowed to take pictures by myself). But also throughout the office a lot of models are spread around. Here not only models, but also other physical objects are standing and lying around for inspiration (amongst others, books, drawings, stuffed animals, old binoculars, stones, pieces of wood, artworks, an herbarium with frogs, dried see sponges) (**figure 3.3**). The architects print and pin up a lot of their works as well, to stimulate serendipity and creativity when designing. Also (parts of) things (for example models) of previous projects are kept: and everything is photographed, to not get lost: *"Probably it can be of relevance for a later project; don't throw it away"* (La Hausse, 2016) Jan Peter Wingender, architect and partner at Office Winhov and lecturer at the Amsterdam Academy of Architecture, notes that studios are becoming emptier in a digitalised world: *"Hanging up a drawing and placing a model is an extremely conscious act in a 'paperless' office"* (Amsterdam Academy of Architecture, 2015b, p. 90) Like what I have experienced in the Swiss landscape architecture practice, models should still be considered – and treated – as a source of inspiration for future projects. The Dutch landscape architecture offices I visited were all to a lesser extent 'steeped' with the presence of physical models. To a lesser extent, so they all had at least some models around. karres+brands (Hilversum), one of the larger offices – at least in square metres – had quite a large 'model-making-and-model-keeping-space'. A number of their physical models are deliberately put down along the way to the meeting room (**figure 3.4**). Before a meeting one literally stops by to show these examples, reflecting the project width of the office.

3.1.2 Bridging thinking and making

As a bridge between thinking and making the physical model is used in a lot of different ways. From literature and practice the following ways could be distinguished: using the physical model to understand, to think, to test and to communicate.

3.3 The office of Vogt Landscape architects (sometimes used as case studio for ETH students): a lot of inspiring things hanging and lying around *(Vogt Landscape Architects, n.y.)*

3.4 The model as a physical thing that hangs around and inspires at the office of karres+brands, Hilversum

To understand

During designing or ideally even before starting to design, one needs to understand the site and it's scale. That is why the designers at Vogt LA – an office in which the designers' habit largely exists of making physical models – starts almost every new project with making a model already for or during the kick-off meeting (La Hausse, 2016; Foxley, 2010). Kinga Bachem, landscape designer at ZUS (Rotterdam), sees the physical model as a very valuable tool as well for their architectural as landscape architectural projects, as *"the landscape is as spatial as architecture"*. The use of physical models helps to grasp the scale and to give the design ideas a spatial dimension. Kinga Bachem: *"It is important to make a direct step to spatiality; by drawing in two dimensions one often errs in scale, while it can be suddenly directly clear by approaching it in three dimensions".* The ease of making mistakes in thinking about scale or proportions in a two-dimensional drawing is something Ronald Bron, landscape architect and co-owner at HOSPER (Haarlem), also mentions. Likewise Daniel Ganz (Ganz LA) believes that a physical model can create spatial awareness. That is also why designers at Ganz' office always start with a model. Making that first model is about doing survey and at the same time thinking about the site and plan: 'what could be possible for this site?'. As the offices of Vogt LA and Ganz LA are surrounded by the Swiss alps, an evident topography more than often create complex situations in their design assignments. Daniel Ganz: *"Modelling is always about topography, we do that in a model, because it is so important and difficult to understand"*. (Bachem, 2016; Bron, 2016; Ganz, 2016) Offices that are less soaked with the habit of physical modelling – and (as I am speaking about the Dutch offices I visited) often are dealing with flatter situations – admit their need for a physical model when the situation turns out to be too complex to understand in maps and sections. Raf Rooijmans, landscape architect at Bureau B+B (Amsterdam), explains that a physical model is really needed when height differences are present at the project site: *"Than making a model is necessary to create a good understanding of the area"*. He points at a model of Stationsplein Arnhem where a physical model was made in a quite late phase of the design process. This physical model was made to see how the conceived height differences and routing worked out, as that made it a very complex situation. Another example is a model for Bureau B+B's project Vlietdijk in Rosmalen (**figure 3.5**), where a presentation model was made to give insight in the height differences and the location of the island. (Rooijmans, 2016) The latter is an example of the fact that using a physical model to understand is not only of relevance for the designers themselves. Sometimes they notice that their clients or other external participants need a model to understand the proposed design. Like what Lieneke van Campen, landscape architect and managing partner at karres+brands (Hilversum), said: *"Laymen cannot read a map; sometimes residents cannot even find their own homes on the map"*. (Van Campen, 2016)

To think

According to Christian Gänshirt (2007) the physical model offers the ability to study forms, to sketch in three dimensions and to think with your hands: *"Seen as a design tool, the model makes it possible 'to think with one's hands'"* (p. 149). Landscape architect Daniel Ganz mentions that by doing model making so much is happening in your brain, that it brings a lot of richness for the design process. He points upon the thoughts that can pop up when working with the model. He explains that when one sometimes does *"stupid things like gluing roads"*, one has several thoughts at the same time, *"like thinking about your wife, the project, the topography"*, which makes the model a stimulator for creativity (Ganz, 2016). *"The good accident"*, a term which Peter Koorstra (TU Delft) touches upon, has to do with stimulating these creative thoughts. Conforming Peter Koorstra physical models helps to interpret ideas in a broader way. He declares that it requires openness to unexpected reflections, for instance caused by incoming light or a Stanley knife that could pass for something else: *"A model is about imagination; about allowing the unexpected and not invented"*. Until you make the physical model, you can see it, *"once you have the model, it is fantastic"*. (Koorstra, 2016) In addition, the physical model helps to regulate your thoughts. Ronald Bron (HOSPER) says that that not only goes for yourself as a designer, but also for others in the design process. HOSPER regularly uses physical models as a design tool to offer participant several design options in a participation process (**figure 3.6**). At the moment the office prepares the models for a meeting, thoughts are arranged, checked and proved. *"Some resistance is needed to be challenged to get the ideas clear"*. (Bron, 2016) Also the architecture students at the Technical University of Eindhoven mention this characteristic: *"When you make a model, you will see much faster where you have thought about and what still should be thought of"*. (students TU/e, 2016)

Thinking helps developing, and therefore a physical model spurs the development of the design. Jan Peter Wingender (Office Winhov and Amsterdam Academy of Architecture) notices that *"you can bridge between idea and design by making a model"* and that *"models really guide the development of our work"* (Wingender, 2016). At Vogt LA the

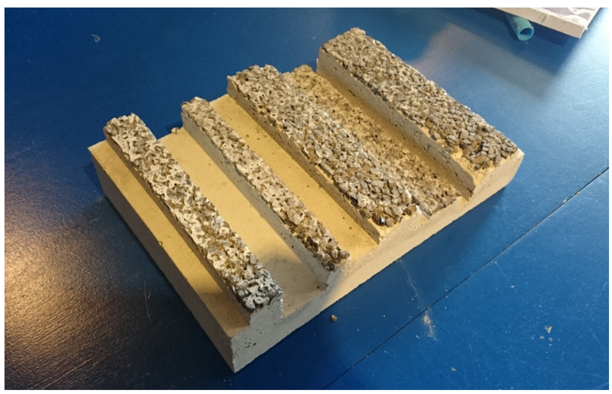
3.5 A physical model of Vlietdijk, Rosmalen by Bureau B+B: for understanding in and beyond the office *(Bureau B+B, n.y.)*

3.6 Participatory process with physical models for project Wilhelminaplein, Naaldwijk by HOSPER *(HOSPER, n.y.)*

characteristic of being able to be concrete by making physical models is appreciated much and seen as a leading factor for an efficient design process. Not really concerning time, but concerning the development of the design over time. *"When doing physical modelling, questions pop up which help to make decisions"*. (La Hausse, 2016) Daniel Ganz adds to this that modelling is always about trial and error, about *"yes/no/yes/no in your head"*. This decision making process goes hand in hand with the construction and modification of the physical model. According to Ganz, one naturally thinks about materials and shapes (like the steepness of a hill), about what is possible and what is not possible, by building it. One feels when a certain configuration will work or not. Architect Jan Peter Wingender declares this by writing the following: *"Models bridge the gap between thinking and making. Which material suits the expression of the idea? How is the model made? What is the role of joints and transitions between materials? How is the model finished? These are the same questions that are posed for the architectural design. The way in which these questions are answered in the model says a lot about the actual architectural design. Models anchor the thought process in materials and execution techniques in a design process. They are a crucial step in the transformation of an idea into a building."* (Amsterdam Academy of Architecture, 2015b, p. 83)

The physical presence of a physical model offers a unique way to approach your design idea: one can really 'crawl into it'. This characteristic of the physical model helps to think and is the one almost everyone points upon when talking about the value of physical models. Peter Koorstra: *"you can sit next to it on your knees, you can look, take pictures"*. Jan Peter Wingender: *"you can lift it up and look into it; you can turn it around, it has no backside – like a drawing has –"*, he continues: "the model is a fantastic feature; you can suddenly look at it from another side and see something you didn't see yet". Several architects pick up their models or look through it when trying to explain me this fantastic phenomenon. (Koorstra, 2016; Wingender, 2016) Lieneke van Campen (karres+brands) shows me *"the office's pride"* – a physical model of the Columbarium, an urn wall, at the Amsterdam cemetery De Nieuwe Ooster (**figure 3.7**) – and, while she bends over to the model, says enthusiastically: *"you can have a lovely view along"* (Van Campen, 2016) The

3.7 The pride of karres+brands: physical model for Columbarium (urn wall) at De Nieuwe Ooster, Amsterdam



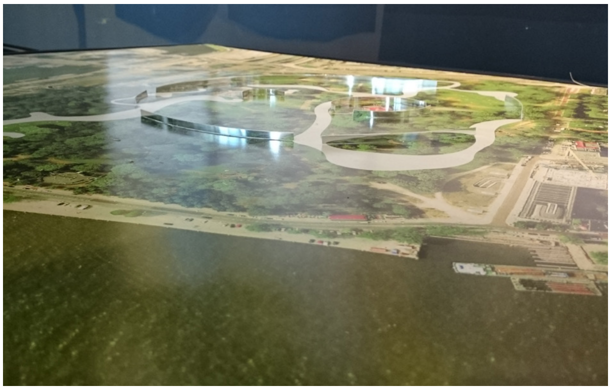
3.8 Example of a 1:1 material test for a sluice wall by ZUS fact that a physical object is tangible adds up to the possibility to crawl into the model. Ronald Bron told me: *"Architects want to have something in their hands, want to know how it [the design] will feel, how it will be"*. And that was exactly what I learned from the architecture students at the Technical University of Eindhoven. They told me a model is tactile, which is something what their teachers want: *"Our teachers want to hold the final product, they want to turn it, see it"*. Landscape architect Nicole la Hausse (at Vogt LA, Zürich) also mentions the tactility of a model as an advantage for the public or the client to give a direct connection with the design, to let them relate easily: *"they can touch it, move it with them"*. That's why Vogt LA invests time to do that, *"it* [a physical model] *is really worthwhile to use"*. (La Hausse, 2016) Using the model's physicality as the ability to 'crawl into a model' can, according to Gänshirt (2007, p. 155), *"be enhanced by building oneself as a "model" on the same scale as the one present or – astonishingly – by looking at models through a sheet of white paper with a peephole in it."*. This adds up to the idea of Jan Peter Wingender that using models is also something quite active (as he shows an image of someone sitting on a table, playing with the model): *"I think you have full control of your idea by playing with it"*.

To test

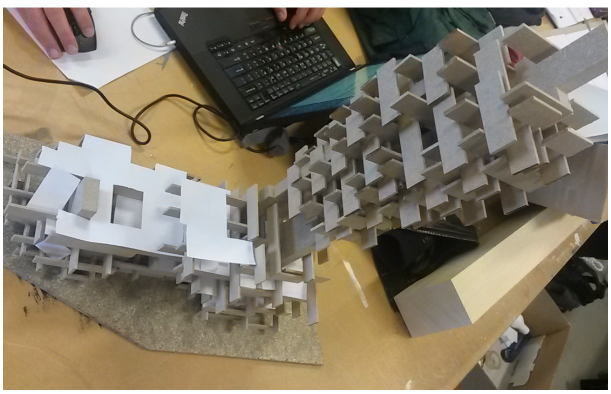
The ability to test design ideas with a physical model is widely applied. Kinga Bachem (ZUS) captures this in the following words: *"it is all about testing things, trying it in a model"* (Bachem, 2016). Overall, materials, functions, shapes and proportions are tested in a physical model. The latter is the most outstanding characteristic of a physical model over other design tools like drawings or sections.

Materials are tested in two ways. On the one hand it is about testing the real material and its editing process; and on the other hand it is about testing the effect of a certain material, whereby not necessary the real material is used. To test materials in the first way, 1:1 mock-ups are most worthwhile to use. For example, ZUS tests and develops materials and their editing process by testing these 1:1, for instance for the wall of a sluice house (**figure 3.8**). But, as sometimes the model will become too large (in a practical manner), scaled models are made. An example of this is an architecture student at TU Delft who

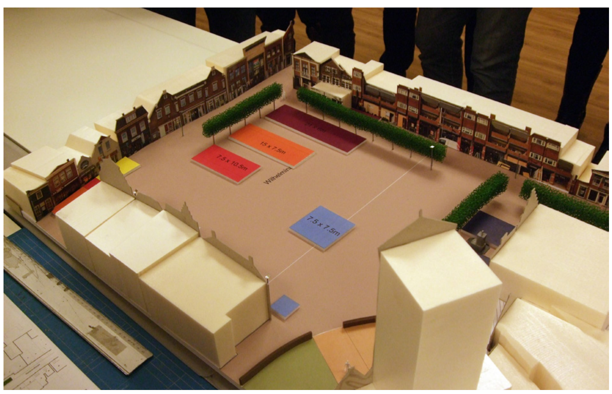
3.9 Example of testing different 1:5 models for an ornament by an architecture student at TU Delft



3.10 Example of testing the effect of a material: a mirroring wall on a satellite image by ZUS made four 1:5 models to test the effect of concrete for the design of an ornament in four ways. She made four plastic malls with different proportions in height and depth and then based her choice for a certain ornament on the result of these models (**figure 3.9**) (students TU Delft, 2016). An example of the second way – testing the effect of a certain material – comes from the fact that some things are (almost) not possible to represent with another tool, like Photoshop. For this reason, ZUS made a simple model to test the effect of mirroring walls in a park (**figure 3.10**). The base of this model was very simple (a satellite photo) and only the mirroring walls were represented with pieces of mirroring cardboard. By making pictures on eye-height in this model, the effect of the walls could be analysed. In addition, these photos were of use to create a realistic Photoshop visualization. (Bachem, 2016) Testing materials in a model is a way of checking reality. But this is not only done for materials. As Gänshirt (2007, p. 157) aptly put this down: *"Feeling and understanding, perceiving with the fingers and thinking with the scalpel make it possible to get to know the qualities of the materials directly, to explore their formal language, but also to assess the load-bearing capacity of a structure or anticipate difficulties in joining elements together at an early stage."*. This is something I clearly saw in the field of architecture, but what also can be recognized in the field of landscape architecture. An architecture student at TU/e made a simple cardboard model to test the capacity of the building (**figure 3.11**). With this model he could see whether it could be build (in reality) or not, as every partition had to be carried by two other partitions. Several students at TU/e and TU Delft told me *"If you cannot make it in a model, you cannot build it in real"*, what Peter Koorstra also mentioned: *"A model is a means of control: 'does it fit in that reality?'"*, *"Building a model is building on a smaller scale"*. Checking reality with a model is at the same time convincing yourself of the fact that your design can be put in reality, that your design can be real. That is why Ronald Bron says that models are always useful. *"In drawings, maps, visuals and sections everything is beautiful, but a physical model makes it special"*. Even if he would lose a design competition with a model, he is still happy: *"It is a kind of evidence that it could have been"*. (students TU/e; students TU Delft; Bron, 2016)



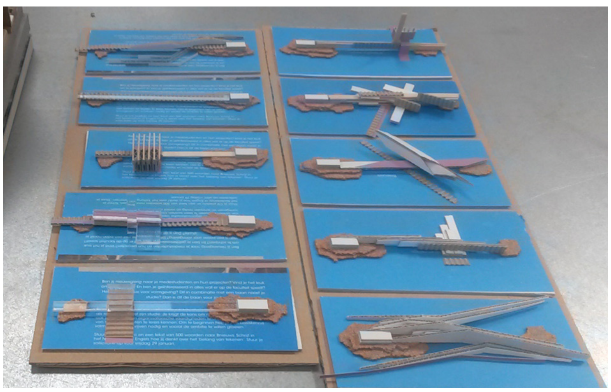
3.11 Example reality check construction by an architecture student at TU Eindhoven



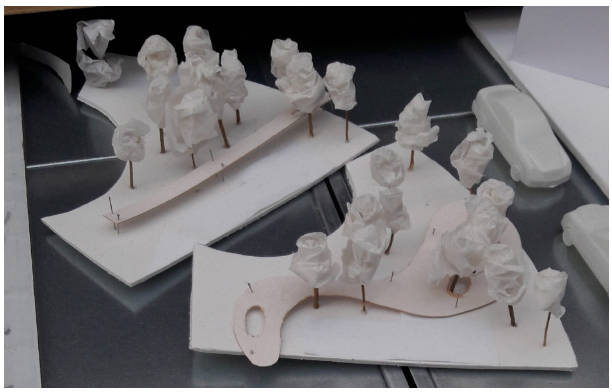
3.12 Example of testing functions with a physical model for Wilhelminaplein, Naaldwijk by HOSPER *(HOSPER, n.y.)*

Testing functions is something that is done often, but not often in a very obvious way. Testing functions can be about thinking of the ratio public space, semi-public and private space, or about testing the ratio of building blocks, public green and infrastructure. However, landscape architects at HOSPER did test functions with a physical model in a very obvious way (**figure 3.12**). For the design of the Wilhelminaplein in Naaldwijk they made a simple physical model of the square and its direct surroundings (foam blocks with photos of the facades) in which participants literally could place functions they would like to have, represented by wooden plates with certain functions written on it, like 'market' or 'terrace'. In that way it became clear how much space every function needed, what should be and be not somewhere. (Bron, 2016)

Shapes and proportions are very much related to each other if it comes to testing these. 'Testing shapes' can be about the shape of an object, like an architecture student at TU Delft and landscape architects at Bureau B+B did (**figure 3.13** and **figure 3.14**); about shaping topography, like Veenenbos en Bosch (a landscape architecture office from Arnhem) did for Dorp Siza (**figure 3.15**) and Ganz LA did on a smaller scale (1:50) (**figure 3.16**); about shaping the path system, movement and choreography (what I did during the Atelier (**figure 3.17**) and Vogt LA also did); or about the configuration of a neighbourhood, like karres+brands did for De Draai in Heerhugowaard (**figure 3.18a,b**). (Rooijmans, 2016; Brouwers, 2016; Ganz, 2016; Van Campen, 2016). The latter already relates to testing proportions, as the height of buildings comes in as well. For Veenenbos en Bosch, a landscape architecture office in Arnhem, physical models help most and for all as a tool for spatial study: *"Within our spatial studies it is nice to be able to turn the knobs. Experiencing and changing the effect of mass and space by replacing, heighten or even deleting a building."* , according to Willem Brouwers, landscape architect at Veenenbos and Bosch. (Brouwers, 2016). As a building has a very clear presence of mass, it is a very logic element to test proportions in a physical model. And that is what architects are often doing: testing their building in relation to its surroundings by placing it in its context. They do that by making a (layered) model of the existing situation, which can be the topography or the existing housing blocks. For example like a student did



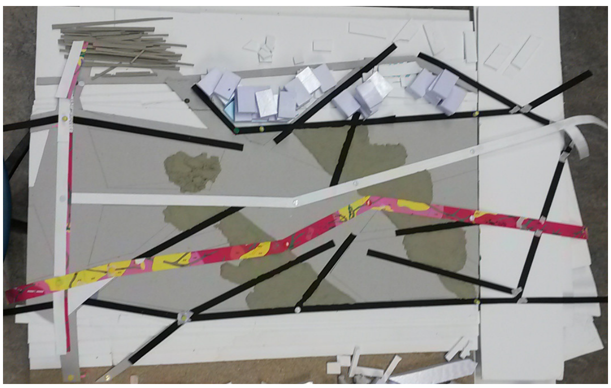
3.13 Example of testing shapes with physical models by an architecture student at TU Delft



3.14 Example of testing shapes with physical models by landscape architects at Bureau B+B at TU/e (**figure 3.19**). As landscape architects, in contrast to architects, are specialists in designing the context of the buildings, they are more often dealing with trees and other spacious 'green' elements, instead of the clear spacious element of a building. Nonetheless, the physical model is useful for landscape architects to test proportions as well. The placement of trees is very often tested in a physical model. Ronald Bron: *"A tree is the spatial means of the landscape architect"*. HOSPER uses physical models to test the 'space that trees make', as one cannot see that clearly in a collage. Also on a larger scale than individual trees physical models are often used by landscape architects to test the proportions of groups of trees or even whole forests. In that way, HOSPER once made a model of afforestation in the province of Friesland. The forest needed to be like an island in the open landscape, which was according to Ronald Bron only possible to show in a physical model, as a two dimensional map did not comply. Designers at Bureau B+B did also design the placement of groups of trees in a 1:500 model of an estate (**figure 3.26**). In this model they could *"point, stoop, pick, shift, look, test and judge"*. (Bron, 2016; Rooijmans, 2016)

To communicate

Communication is a characteristic of all design tools. As in general a design tool is a way of representing; and representing is a way of communication: by making a certain representation one chooses to communicate a specific message. Peter Koorstra explains: *"Studying and communicating is something you do continuously: with a model, but also in drawings"*. He adds: *"A model is about communication: not only to others, also to yourself"* (Koorstra, 2016). Jan Peter Wingender makes an even more extensive statement on this: *"A model is a conversation piece"*, which he elaborates from different perspectives: (1) with yourself as a designer and manufacturer, (2) with others about the project, and (3) when you take your model out to the client or another presentation (Wingender, 2016). This is confirmed by Daniel Ganz who also says that a model makes it easier to communicate, as a model makes the design more present (Ganz, 2016). Apart from these three ways of using a model to communicate, we can distinguish two types of communication: explanatory communication and steering communication.

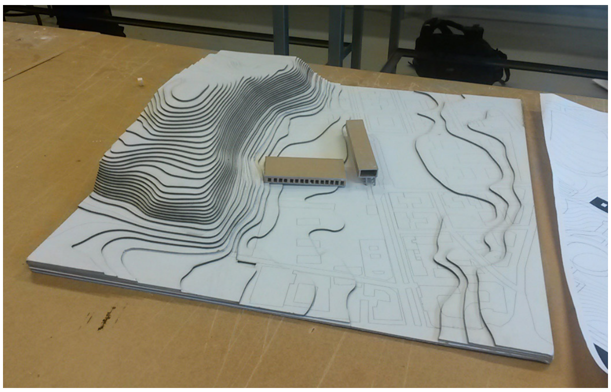


3.15 Example of shaping the paths system in a physical model, my individual Atelier project

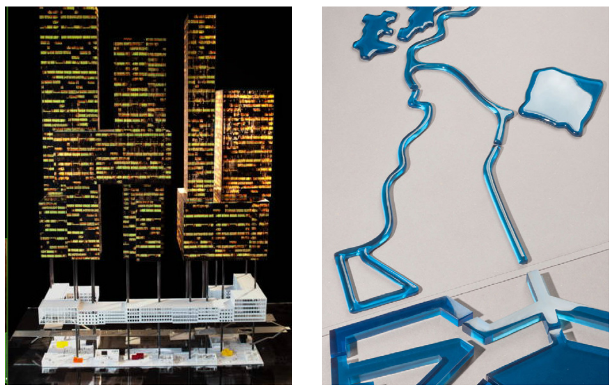
3.16 Example of (a) a model for De Draai, Heerhugowaard in which (b) parts could be taken out like a toolbox by karres+brands *(b: karres+brands, n.y.)*

By ‘explanatory communication’ I mean the ability of a physical model to bridge the gulf between laymen and experts, as Gänshirt (2007, p. 149) states: *“As a vivid means of communication, models help to bridge the gulf between laymen and experts.”*. As mentioned before, laymen are understanding a model rather than a two dimensional map. That is why HOSPER used physical models in their so called ‘Open planprocessen’. A model makes it for the participants easy to relate to their own place in and to project their own use in the project area. (Bron, 2016) In a similar way, Veenenbos en Bosch use physical models when talking to other members within their project group, or to residents of a project site (Brouwers, 2016). Amongst designers in the office itself, a physical model also helps to discuss the design, as for designers *“it is much more pleasant to be able to point at something, than to read that in a drawing”*; according to Kinga Bachem, a conversation evolves better when having a physical model around (Bachem, 2016).

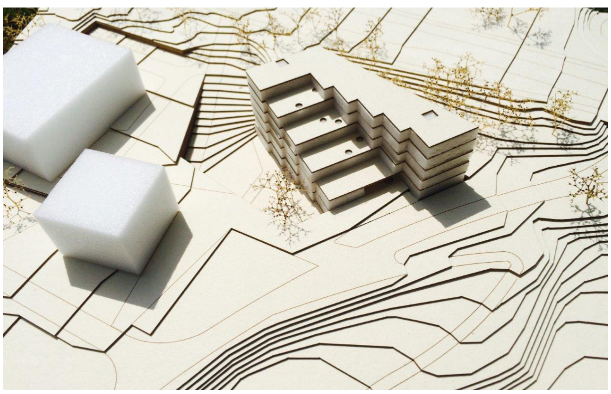
By ‘steering communication’ I mean the ability of a physical model to manipulate perception and decision making. This characteristic of the physical model is determined by its ambiguity: *“The ambiguity of the model [...] make it a particularly seductive medium.”*;



3.19 Example of testing a building in relation to its context by an architecture student at TU Eindhoven



3.20 Examples of concept models of (a) ZUS and (b) Delva; these models are pieces of art in itself, both by Made by Mistake *(a: Pinterest, n.y.; b: Delva, n.y.)*



3.17 Example of testing topography (Dorp Siza by Veenenbos en Bosch); and shape (Architect DoepelStrijkers placed their building in context here) *(Veenenbos en Bosch, n.y.)*

3.18 Example of shaping topography in a physical model by Ganz Landschaftsarchitekten

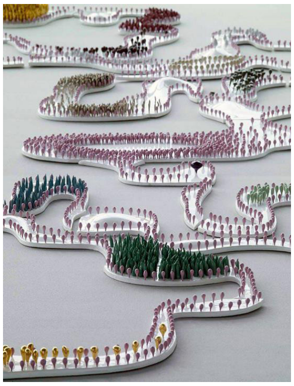
"Combining all these approaches – abstraction, reduction, changes of material and meaning – permits observations and experiments, but also manipulations that go well beyond the possibilities of drawing." (Gänshirt, 2007, p. 153). Gänshirt refers to architect Alberti who writes: *"The presentation of models that have been coloured and lewdly dressed with the allurement of painting is the mark of no architect intent on conveying the facts; rather it is that of a conceited one, striving to attract and seduce the eye of the beholder"* (Alberti, 1485, p. 34). So models can be used to seduce, rather than to convey the facts.

A physical model to manipulate perception is on the one hand about using the physical model to visualize the design idea, which Jan Peter Wingender calls "model making as an aim" (Wingender, 2016). This can be a physical model of the preliminary idea, like a concept (**figure 3.20a,b**), or statement (**figure 3.21**), a final design (**figure 3.22**), or even as office promotion (**figure 3.23**). On the other hand it is about making a physical model to make another type of representation: a two dimensional visual, which calls Jan Peter *"photo or collage as an aim"* (Wingender, 2016). Hereto (parts of) the physical model are photographed and (eventually after editing) used to show the design idea. As photography can be used to show a place as good as possible to someone who has never been there – *"With a critical edge, it can be a unique way of communicating many levels of places to those who will never see them first-hand."* (Lippard, n.y., p. 169) – photography is used here to show the design as good as possible to convince someone to once go there, or at least, to let it be realized. Taking a picture of a model is creating a world that does not exist and using photography as a tool to let that world come to life, as realistic as possible. Nobody has ever been there, but pictures can represent the (possible) reality. At Vogt LA a photo of a physical model is often used as end product/ representation, as Nicole la Hausse explains: *"A photo of a physical model might be better than a rendering, because of scenography, of light"* . She says that these two factors are very important in a good representation. Essential in their way of working is that the pictures are taken from a human perspective: *"It needs to be possible to see that"*. Sometimes, a birds eye-view is chosen, like when there is a large building on the site from where the project site can be seen. (La Hausse, 2016). Photos taken from physical models can also function as a research tool during designing, for example for the atmosphere of a space, as *"They literally offer a stage for aspects that are more difficult to lay down in drawings."* (Amsterdam Academy of Architecture, 2015b, p. 85). Images of the model imply a story, "they have a suggestive power more than the model itself". (Amsterdam Academy of Architecture, 2015b, p. 85) However, HOSPER prefers to make digital visualizations if it comes to visualize atmosphere and details, as they see the model as something to test 'what it will be' and not 'what it really will be like' (Bron, 2016).

A physical model to manipulate decision making can be used in a participation process with laymen and experts, in conversation with your client(s), or in the assessment of design contests. The design process for the Wilhelminaplein by HOSPER is an example of the first way of manipulating decision making. In a certain phase in that project, HOSPER made three design variants of the square. These three ordered thoughts ('steering step one') could be assessed by the feedback group. But as there was at some point need for a clear decision, the designers of HOSPER steered upon a preferred model ('steering step two'). Here, the physical model has also a psychological effect: at the beginning of the project the residents had the feeling that they had no say in the decision process at all, but as the project progressed, one started to notice how many decisions were needed to be taken and how many things were possible. Then at some point, people started to say: 'We do have an architect amongst us, right? Why can't he solve this?'. (Bron, 2016) The second way of manipulating decision making, is when (landscape) architects communicate to their clients by showing a physical model. For example, when designers at Veenenbos en Bosch make a physical model to study internally, the model can be used later in a meeting with the client (Brouwers, 2016). The other way around, designers at Bureau B+B made a 1:500 model to show their work to their client, but at the same time the model helped as a design tool for the design team itself, to study proportions (Rooijmans, 2016). Last but not least, decision making with physical models takes place at design competitions. The model as a physical object has a certain objectivity when every competitioner has to deliver a physical model of their design on a specific scale, with specific materials and in a specific colour. This is the case in Swiss (architecture) design competitions, where everyone gets a plaster model of the existing situation from the organisation, and then have to make their own plaster model in the first round of the competition assessment. (Wingender, 2016)

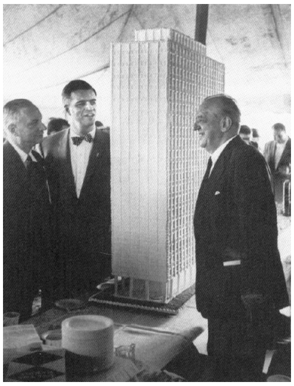
3.1.3 To model or not to model

From the Quickscan interviews it became clear that architects could not design without a model. In contrast, landscape architects not always implement models in their design process. When I asked landscape architects during the In-depth interviews when they use physical models and when not, a comprehensive answer was never given. Sometimes they even start modelling without knowing if it will make sense. And sometimes a model



3.21 Example of statement model: porcelain model by Anouk Vogel *(A'dam Academy of Archi-tecture, 2015, p.* 90)

3.22 Example of a presentation model for cemetry De Nieuwe Ooster Amsterdam by Made by Mistake for karres+brands



3.23 *Example of a model as office promotion: a building as a cake (Wingender, 2015)* brings more than they expected on forehand. Anyhow, it turned out that in general the decision to implement physical modelling or not, is depending on several factors: the design itself (type of project), the design process (availability of time, space and budget) and the designer(s) him/herself (their habit) (**figure 3.28**).

The design

'The design itself' includes three factors: the type of assignment (e.g. urban planning/regional landscape), the scale of the assignment (small (e.g. site design)/medium (e.g. urban design)/large (e.g. park design)/extra-large (e.g. regional design)) and the wishes of the client (sometimes a physical model is part of the commission). A landscape architect decides (on the basis of experience, knowledge and skills (see below 'The designer(s)')) whether or not it is useful to implement physical modelling in the design process for that particular project.

The design process

Some aspects of the design process are taken into account when deciding to use a physical model or not: the complexity of the process concerning involved stakeholders, the physical environment in which the design process takes place and the available time and budget.

When several commissioners or feedback groups are involved, a lot of things are going on in the design process at the same time and on different scales. It does not seem to make sense to make a physical model at the start of such a project, as there is a lot of information popping up and being researched (also outside the design office) where one cannot have good grip on from the start. When the project is somewhere halfway the design process (between project start and delivery of the final plan), the project is still seen as too much 'moving' to make a physical model of it. However, when arriving at a 'final delivery phase', a physical model can be made, also in a such a complex project, to present the final idea. In projects which are less complex, several intermediate steps can be recognized at which a certain phase is completed. Then, it is seen as more useful and doable to make physical models at these in-between moments too. (Bron, 2016)

3.24 Model making space at HOSPER *(HOSPER, n.y.)*

3.25 Model making space at karres+brands

The physical environment in which the design process takes place, seems to influence the intensity in which physical models play a role in a design process. A design process at Vogt LA for example, (almost) always includes modelling, as a large part of the office is model making space (**figure 3.2**). The same goes for the office of Ganz LA (**figure 3.1**), and (although to a lesser extent) HOSPER (**figure 3.24**) and karres+brands (**figure 3.25**). But at Bureau B+B for example, not that much model making space is available, which makes it less attractive and easy to just start (or try) modelling with every new project. Raf Rooijmans (Bureau B+B) showed me a model of an estate at scale 1:500 (**figure 3.26**) and explained that if the project area would be bigger or the scale smaller, they would not make a physical model, as *"there is no room for that at the office"* (in comparison with their former building). (Rooijmans, 2016) Jan Peter Wingender works at an architecture two offices, of which one has a bigger model making space. According to him, who held a lecture on the value of physical models, *"more model space is even better"* (Wingender, 2016).

Available time and budget are closely related to each other. As 'time is money', the time it takes to build a model is crucial for the openness of (landscape) architects towards applying a physical model. This is what Erez (architect at OMA, Rotterdam) explains to Alberta Yaneva (2009) when talking about a very complicated design: *"We really worked very hard, but we only obtained three models from it. Because we just couldn't build it. At that point we constructed it on the computer, and the final model was built from the 3-d computer file. Some outsourcing guy built it for us on the computer because we couldn't. Again it's time and knowledge. We can do it. But in the process in which the office works we need to produce something new for tomorrow morning, so to speak. So, we cannot spend three days building a model"* (p. 77). Every landscape architect I came across, saw the value of using physical models for the design process, but they all had to admit that making a physical model takes time. When you make an abstract (and very generalized) distinction between my interviewees of 'those who want to model and always model' and 'those who want to model but don't model that much', one can say that the first group of interviewees sees physical model making time as a problematic limitation and that

3.26 A physical model of an estate on scale 1:500 by Bureau B+B

3.27 Thé example of a physical model made of 'stuff' at the office of Peter Koorstra at TU Delft the other group sees physical model making time as an investment. Peter Koorstra, who teaches a course in which students are only allowed to design by making physical models, explains that it does take time, but that it does not always need to be complicated or advanced: *"You can just make something with 'stuff'"*. With 'stuff' (spul) Peter Koorstra means things that are just around at that moment, like leftover pieces of cardboard, of wood, a match-box, a plastic cup. One of those 'models of stuff' has deserved the honour to be part of Peter's office decoration (**figure 3.27**). As making a model takes time, Peter recommends students to focus on making working models: simple models in the explorative phases of the design process, for example made of grey cardboard. At the moment in the design process that you want to know more, one needs to develop the idea – and the model – further. In that way, your design and model will develop until you get to the final presentation model. As you have gained a lot of insight (for example in construction and level of accuracy) during the process of making the working models, making the presentation model will not take that much time anymore. He explains: *"It is an investment in time, but later in the process you win time, as you don't have to do further checks because you tested your idea on that already in the starting phase of your design process"* (Koorstra, 2016)

Ganz LA and Vogt LA are two landscape architecture offices that also see the amount of time spend to make a model as an investment. Striking is that both offices have developed their own 'model making standard'. At Ganz LA the models are generally made in the same way, which one of the interns captured in a booklet. Daniel Ganz: *"There is always a good reason to make a model"*. Although making a model generally takes one to two weeks at Ganz LA, they see it as an investment to make the project easier to keep up and to continue the project. Daniel explains that at the end of a design process the time spend on the model is negligible. Vogt LA also invests time to make the physical models, as, according to Nicole la Hausse, *"it is really worthwhile to use"*. Also Vogt LA developed their own model making method: an intern publication (which every new accepted employee has to read) includes the whole model making process and examples of what is already done and tried. In this way, certain standards are developed to have an efficient method, which helps the office as a whole to not invent the wheel for the second time, but to develop their method even further. Although the booklet itself is protected like 'the secret of the cook', two smart things were standing out when I was guided through the office. Firstly, designers at Vogt LA do not model the whole project area for every design, because then the model becomes too big. But they think about making a specific part of the design, and/or making it on another scale (1:100/1:200) than the preferred 1:50 scale. And secondly, they make models in a group, which allows them to make quick productions. These factors, together with the other secret ingredients, make that the (landscape) architects at Vogt LA found a way to balance the value of making physical scale models with its time and costs.

The designer(s)

The habit of the designer(s) seems to be an important factor in the decision making process to use a physical model or not. This habit appears to be formed by the individual and design-team's know-how and skills, based on study-background and experience.

If you know-how to fulfil a task, the task becomes easier, less time-consuming, thus more attractive to do. This can be observed in the practice of physical model making as well. ZUS and HOSPER admit that urban planning assignments are 'easier' to make in a physical model, than landscape assignments. Because a square design for example consists of a horizontal base and vertical facades, in comparison to a complex landscape design which has in general a larger surface-area, often more height-differences and will be designed on a larger scale. In addition, characteristic of a landscape is texture. But as there is not enough know-how on how to represent these, ZUS always struggles with vegetation in their models. As well ZUS as HOSPER often outsource their final presentation models to Made by Mistake, an office specialized in model making, because they have the know-how to fulfil this task (Bachem, 2016; Bron, 2016). The lack of know-how might be caused by the study-background of the (landscape) architects. In general, my Swiss interviewees make more models than my Dutch interviewees. At first sight, this could be explained by the fact that the Swiss offices have to deal more often with a more outstanding topography than their Dutch colleagues. But when talking to Claudia Moll, scientific researcher at the Chair of Christophe Girot at ETH Zürich (Swiss Federal Institute of Technology), it appeared to be possibly caused by the differences in study-background. Swiss landscape architects are for a large part educated as architects. This makes sense if you put this in relation to the fact that in general architects are making more often physical models for their projects than landscape architects. Kinga Bachem noticed – justly – that all architecture students at the technical universities have to make models for every project. *"You cannot present without a model"*, is what one of the students said (Bachem, 2016; students TU Delft, 2016; students TU/e, 2016). While at our (Kinga and me) landscape architecture study at Wageningen Univeristy, it gets relatively less attention in comparison to other design tools. However, this remains gambling and not yet based on clear evidence.

What we do know, is that the habit of a designer is something very personal. Nonetheless, we could make some general assumptions. There seems to be a difference between architecture and landscape architecture concerning the designer's way of thinking, acting and desired final product. Regarding the way of thinking, a landscape architect is more concerned with the spatial quality concerning landscape experience and the history of the site, than an architect who to a larger extent builds with volumes. Landscape architects seem to be not used to work with models as we are more used to think in two-dimensions. Often a landscape architect draws a map and clarifies the plan with some sections. In architecture this seems not to be satisfying, as they also take care of the construction, for which they often need to think in three dimensions. In addition, the general assumption is that one expects a landscape architect to know what he or she is doing and therefore to not have to proof that. (Bron, 2016; Van Campen, 2016) About the way of acting, it can be noticed that architects deal with other elements than architects. Architects design for example with building blocks and concrete materials, while landscape architects deal with growing vegetation, dynamic materials and systems. What I noticed in practice, is that the more architectonic an assignment is (e.g. urban planning), the more often one sees a landscape architect building a model. However, landscape architects at Vogt LA still use models, even though they realize that landscape is changing over time. Therefore they use other and combine different techniques, like videos and stop-motion, to grasp and show the factor of time. Last but not least, there is a difference in profession concerning the desired final product. Nicole la Hausse explained that in a very nice way: *"Architects finish with the perfect day, while the end product of a landscape architect can only get better"*. When an architect's design is executed it shows its best expression, while a landscape architect's design still has to grow. In addition, Dick Sman, physical model maker and co-owner at Made by Mistake (Rotterdam), noticed that in presenting the design a model is of large importance for an architect, while a landscape architect also puts more emphasis on other representations of the plan. (La Hausse 2016; Sman, 2016)

Besides know-how, skills and study-background, experience is an important influencing factor for the habit of the designer and therefore for the choice to model or not. This is also what Raf Rooijmans noticed when comparing his experience at Vogt LA and at Bureau B+B concerning the making of physical models. At Vogt LA everyone is keen to make models, at every project; a habit that everyone learns once started to work at this office. Raf Rooijmans noticed that at Bureau B+B this attitude is different, not having physical models in their 'standard process'. Designers at Vogt LA already start thinking about physical modelling during the kick-off meeting of a new project. Based on the final deliverables and its scale(s), they decide how to get there and whether they can or want to use a physical model in that design process. They can make these decisions based on their experience, which partly also is based on their know-how and skills, which are captured in their internal 'model-making-standard-publication'. (Rooijmans, 2016; La Hausse, 2016)

3.28 The decision to implement physical modelling or not, is in general depending on three factors: the design, the design process and the designer(s) him/herself

3.2 The making of physical models

Some specific aspects needs attention when model making, as these form the basis of a useful physical model. From the interviews and literature I concluded (1) the relevance of abstraction and reduction. When analysing the models I have seen in practice, I concluded that ‘making a model = building’, which has to do with (2) choosing certain materials, techniques and scale. Which choices will be made in a specific design process depends on (3) the aim of the model. These three aspects will be discussed below, relating theory and practice: how one sees the relevance of the aspect and how one really deals with that aspect in practice.

3.2.1 Abstraction and reduction

A model is a composition of the designed reality and therefore there is a need for abstraction and reduction, as a model needs to be simple and plain. Simple and plain to be on the one hand not too complicated to make, and on the other hand to represent the essence of the design idea (notice the close relationship between making (skill) and thinking (idea)!): *“Better than that the models are not accurately finished, refined and highly decorated, but plain and simple so that they demonstrate the ingenuity of him who conceived the idea, and not the skill of the one who fabricated the model.”* (Alberti, 1485, p. 33-34). The model should be simple in scale, materials for making and vividness. The latter is specific for a physical model and not apply to a two dimensional drawing: *“The architectural model shares the mechanisms of abstraction and scale reduction with the drawing. Beyond this it offers the three-dimensional quality of its representation, which gives it its particular vividness, and the possibility of choosing the materials for making it freely – unlike samples and prototypes,* [...]*”* (Gänshirt, 2007, p. 151). There is not always a need to be exact, as a physical model also can be thematic, for example representing choreography or movement. As not everything can be shown in a model, it is especially important for a landscape architect to decide which moment in time (e.g. concerning season or age of trees) one wants to represent. (Amsterdam Academy of Architecture, 2015b; La Hausse, 2016)

“A physical model has to be relevant and summarizing the essence”, explains Peter Koorstra. This is something you have to think about first: ‘What aim has the model?’ – ‘What do I want to check?’ ‘What do I want to investigate?’ ‘What do I want to achieve with it?’. Then one can start thinking about how to represent that: ‘How to translate the materials?’ – ‘What elements do I want to show?’ ‘What should have attention and what can be reduced?’. In other words: ‘What is the input and what is the output?’. (Koorstra, 2016; Wingender, 2016) Models generally do not record all the attributes if the original they represent, but only those that seem relevant to the particular model-maker or model-user (Stachowiak, 1973)

“Seen as a design tool, the model makes it possible [...] *to work conceptually.”* (Gänshirt, 2007, p. 149) Although one has to be abstract in a physical model, it should also be realistic. Sometimes a detail of the design has to be tested with a physical model in the beginning phase of the design process, in order to check whether it works or not

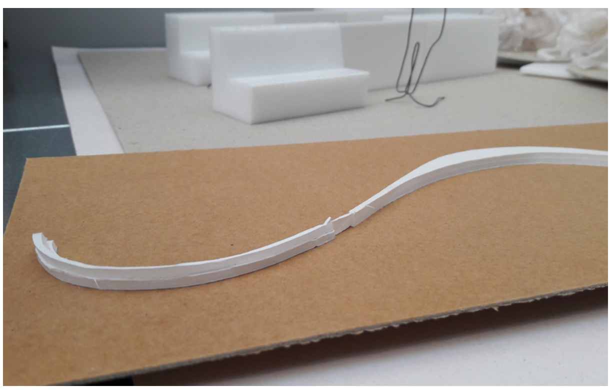
(e.g. concerning construction or aesthetics). The earlier in the design process you know, the better. Therefore, shifting scales – which is usually done with other design tools as well – is very important in physical modelling. While thinking about the design concept, one can already think about an essential (constructive) detail. As a good design is never designed by approaching it on only one scale, one should also design with different models on different scales. (Koorstra, 2016) And every scale has another abstraction level, which leads to another model. Because all models are not only made for a particular use, but also for a particular purpose (Stachowiak, 1973). This was clearly visible in the project of Warande by Bureau B+B where the designers shifted scale and meanwhile changed materials: started with cardboard and paper via sand and foamboard to white foam (**figure 3.29a,b,c,d**).

3.2.2 Materials, technique and scale

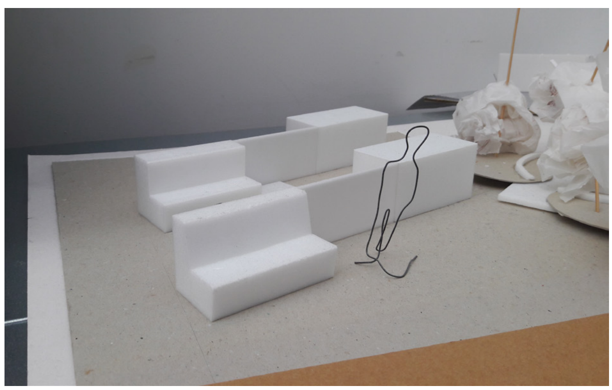
To reach abstraction and reduction three important choices must be made upon scale, materials and techniques, with respect to the above-mentioned question (paragraph 3.2.1)

3.29a Example of modelling on different scales in one project: sketch model to test mass-space (paper, cardboard);

3.29b Example of modelling on different scales in one project: more detailed model to test height of planting areas (sand, foam, cardboard);



3.29c Example of modelling on different scales in one project: more detailed model to test shape of water element (foamboard);

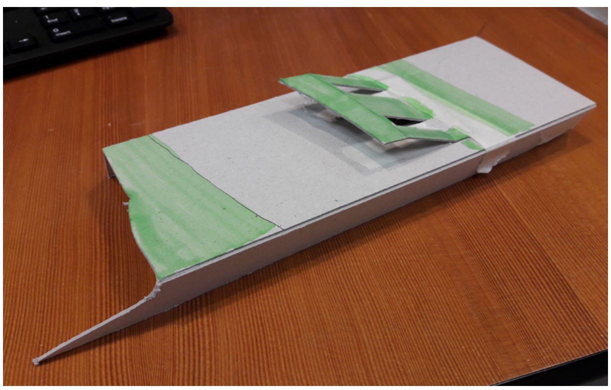


3.29d Example of modelling on different scales in one project: 1:20 model to test positioning of gate and benches (white foam); project Warande by Bureau B+B

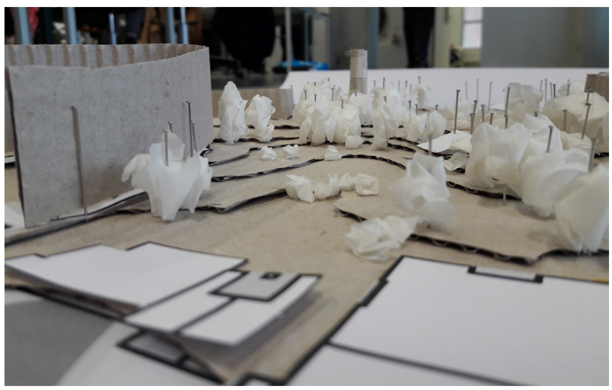
'What is the input and what is the output of my physical model?'. *"A model is a project in itself within the design process. The choice of materials says a lot about the underlying architectural idea."*, according to Wingender (Amsterdam Academy of Architecture, 2015b, p. 83) The choice for certain materials, techniques and scale, defines a model's content (association, level of detail (**figure 3.30a,b,c,d**)), its use ((de)formability, stability, durability, effect in the design process), its manufacturing time (required skills and tools) and there with its costs. (Behnisch, 1987; Gänshirt, 2007; Yaneva, 2009; Wingender, 2015; from practice). These aspects are related to the type of design (see paragraph 3.1.3), but the choice for scale, materials and technique is also depending on the wishes of the client (design process) and the repertoire of the designer (experience). The other way around, scale, materials and technique put limitations to what the physical model can or will represent: therefore *"the designer is guided by the physical model"*, thus Kinga Bachem. She means that physical models are small tests, in which the design process is steered by the materials; where the limitations of the materials play a role (Bron, 2016; Ganz, 2016; Bachem, 2016; from practice)

3.30a Example of physical models with a high abstraction level: containing a few simple materials;

3.30b Example of physical models with a high abstraction level: clay, sticks and paper;



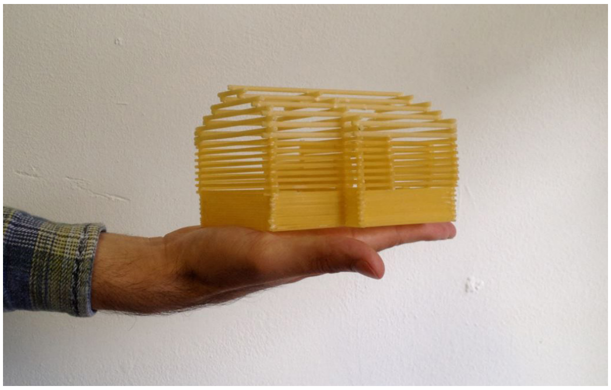
3.30c Example of physical models with a high abstraction level: cardboard and tape;



3.30d Example of physical models with a high abstraction level: cardboard, sticks and sketch paper; by landscape architecture students at Wageningen University

"Every planning step has its own materials and techniques", according to Behnish (1987, p. 40) Practitioners often say that you should 'just use what you need' for a physical model, whether it is an expanded model from a lot of different things (**figure 3.31**), or a model made from pasta (**figure 3.32**) – as long as it contains all ideas and its essence. However, there is no general theory about how to do that. As shown in paragraph 3.1.3, this is usually a result of the type of design, the design process and the (habit of the) designer. However, Arjan Karssen and Bernard Otte (2013) wrote a book about model making (Model making: conceive, create, convince) in which they distinguish and describe three types of models (draft scale model, design scale model and presentation model) and offer a step-by-step guide about how to create convincing architectural models. The book aims to be a 'manual for students of spatial disciplines, such as urban planning, architecture, public space or interior design, garden and landscape architecture, and those interested in the methods used to build scale models and the effect created by them' (Frame Publishers, n.y.). From practice I learned that this book is used by architecture students at TU/e and that offices in landscape architecture are also using techniques like those described in the book. This leads to the fact that landscape architects mostly make physical models the

3.31 Example of a physical model for the Floriade made from a lot of materials by Made by Mistake for MVRDV *(Made by Mistake, n.y.)*



3.32 Example of a physical model made from one simple material: pasta *(Wingender, 2016)*

3.33 Example of a physical model with flowing water by Made by Mistake for West8 *(Made by Mistake, n.y.)*

3.34 Example of a growing model of Sloterplas Amsterdam for the fourth IABR by Bureau B+B *(Bureau B+B, n.y.)*

way architects do. Logic, as both professions are of dealing with volumes, proportions (mass-space ratio), functions and people in their designs. However, these elements are for landscape architects far more dynamic (living and moving materials), than for architects (concrete materials). But although the professions differ considering the designer's way of thinking, acting and desired final product (mentioned in paragraph 3.1.3): architectural designs as 'static' and landscape architectural designs as 'dynamic' expressions are not represented in their use of physical models. Physical models in landscape architecture are overall very 'static' objects, barring some exceptions. Out of all models I saw and was told about, I only saw one physical model representing growth in a dynamic way and one where water could flow through. Another way in which dynamics are tried to involve in a physical model is when designer project a (changing) digital image on a physical (e.g. 3D-printed) model. Made by Mistake once made a dynamic model for West8 in which people could pour water to see the effect of the rising water at the site (**figure 3.33**). Bureau B+B once made a model for the International Architecture Biennale Rotterdam in which trees were growing during the exhibition (**figure 3.34** and **3.35**). Here the designers experienced with combining chemicals, which was seen as a very special happening and definitely not seen as the habit of a landscape architect to do things like that (**figure 3.36**). (Rooijmans, 2016; Van Campen, 2016; Sman, 2016)

Scale (size)

Scale depends mainly on the design and the design process. Sometimes several models on different scales are made for the same design, as at some moments in a design process there is need for more investigation or elaboration (**figure 3.29a,b,c,d**). In general, one works (for what I have seen in practice) on scales differing from 1:1 to 1:1000. In general goes: the smaller the scale, the more detail is included, the lower the abstraction level is. Scale 1:1 is normally used for prototypes, like Vogt LA made a foldable table (**figure 3.37**). Scale 1:100 and 1:200 are mostly used for landscape or urban designs. Scale 1:50 is preferred by Ganz LA and Vogt LA. *"1:50 is a nice scale to model on, but you can't do that for every design; often the model then becomes too big, which costs too much time to make"*, explains Nicole la Hausse. Solution for that is to make only a part of the design

3.35 The trees of the growing model (figure 3.34) for Sloterplas Amsterdam for the fourth IABR by Bureau B+B *(Bureau B+B, n.y.)*

3.36 A designer of Bureau B+B making the growing trees for the physical model for Sloterplas Amsterdam (figure 3.35) *(Bureau B+B, n.y.)*

which is essential for the design, or to make only that part that you want to use for a final representation. For that reason, Vogt LA is very selective in what they are modelling. Sometimes it is only a corner of a square, as this is (the basis of) what they want to represent in the end, because besides using the model as a design tool, a photo of the model is often functioning as a representation. Ganz LA also is also selective in what they model, so the designers sometimes only make a small model to investigate a particular part of the design. (La Hausse, 2016; Ganz, 2016) Nicole la Hausse does not think any scale is impossible, as you can reach a third dimension also just with paper. The model is than a hybrid between sketches and model making, like a student did at Wageningen University as well (**figure 3.38a,b**). Here, the model has a higher level of abstraction, as it is not possible to involve every detail.

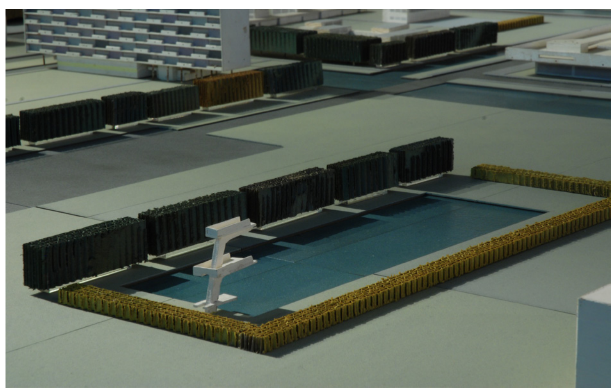
Materials can mean different things on different scales, which is very interesting. Nicole la Hausse showed me an example of 'jumping scales', by showing a small plate with pebbles and placing people of different scales in that model (like in **figure 3.39**). In that way, one can test how a certain material or object works on a certain scale. This can give new insights. (La Hausse, 2016) Similar to this is the fact that the size (e.g. thickness) of a certain material can exaggerate the scale. Wingender writes about the importance of letting go the connection of scale between second an third dimension: *"In the case of urban planning and landscape design, the third dimension can be a problem as a result of the larger scale of models. By letting go of the connection of scale between the second and third dimension, a model can actually examine the topography in a plan. The model is then no longer the 'true-to-life' representation of a plan, but thematises the essential characteristics and underlying concepts."* (Amsterdam Academy of Architecture, 2015b, p. 89) For example when making a sidewalk of thin cardboard on a scale where the sidewalk should actually be thinner than any paper can be. Although the thickness of the sidewalk in the model does not represent the actual and exact thickness of the sidewalk in reality, it does still represent the presence of a sidewalk. This is according to Peter Koorstra key in abstracting: to search for the relevance and to exaggerate when necessary to make the physical model 'workable'. He mentions that a model represents, not presents reality. In

3.37 Example of a foldable table where a 1:1 model was made of by Vogt Landscape architects *(Vogt LA, n.y.)*

3.38 Example of a simple three-dimensional paper model by a landscape architecture student at Wageningen University that way, vertical dimensions are often exaggerated in landscape models relative to the horizontal dimensions. There is no need for fear to loose reality, as the human mind is able to see the relevance of the object relative to the underlying structure. Exaggerating is therefore a very effective manner, as otherwise one would not see the object at all, or it would not be vivid and convincing enough. Exaggerating can be done not only in scale, also in colour. Example of doing both is a 1:200 model of the Alexanderpolder (**figure 3.40**) in which the aim was to show the essence of the design. As the trees should form a green structure throughout the residential area, chosen was to use autum-colours and to make the trees somewhat higher than reality "in order to keep the tree-effect". (Koorstra, 2016)

From what I have seen in practice I can conclude that more than often the question is not about scale, but about size. As Jan Peter Wingender questions: *"Do I hold it in my hand? Do I crawl through it?"* (Wingender, 2016). This adds up to the fact that most offices were saying that if a model would become too large, they found it not useful to make. The model would then need too much space, to build, to transport and to preserve. Because to be able to talk about a model (thus design (idea)) it is important to be able to transport the model easily (**figure 3.41**). However some offices did make large models (**figure 3.42a,b,c,d,** and **figure 3.43**) Most of these where seen an exceptional event at the office, for example specifically made for an exhibition. (a.o. Bron, 2016; Ganz, 2016) Nonetheless, some offices found solutions to deal with the fear of large models. ZUS recently choose to make models on a fixed paper format: A3. Started as a little joke, it turned out as very useful concerning transportation (Bachem, 2016). Ganz LA has also their own standard: the size of the model is depending on standard-door-size, as every model has to be moveable through (or out of) the office. If necessary the model is made out of two or three elements, all maximum door-size; *"In a way there is no limitation; even a very large project can be made in a model, even outside if necessary"*, explains Daniel when pointing through the window at an empty area downstairs. Although this also would be quite exceptional for Ganz LA as well. (Ganz, 2016) In addition to the practical aspects mentioned here, size is also influencing the effect of the physical model in the

3.39 Jumping scales, as explained by Nicole la Hausse *(Vogt landscape architects)*



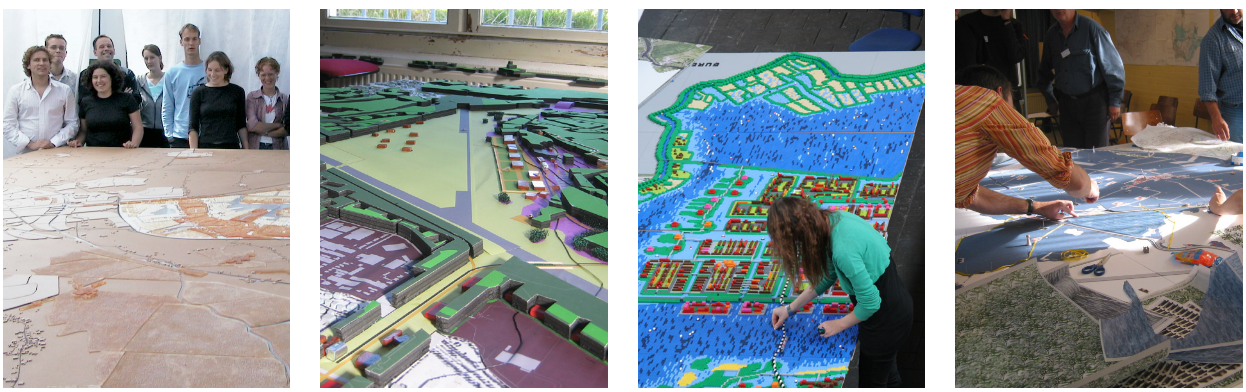
3.40 Example of a physical model of Alexanderpolder at scale 1:200 (horizontally) in which vertical scale and colours are exaggerated *(Koorstra, n.y.)*

design process: *"What is important is the question of how the observer can relate to the model; how large is the model and what can be achieved with it? Size does matter. Small models are often brought up in discussions. That breaks through the distance; someone can appropriate a design. For this reason, it is sometimes useful to present large buildings in small models. Conversely, a large-scale model of a small building can entice one into bending over backwards in order to gain a clear picture of the design. You can also make a model very sturdy, for example out of concrete, so that it, or the idea, cannot be easily set aside. A gossamer-thin, fragile model, on the other hand, which nobody dares to touch, or which slowly disappears, because it is made from ice for example, could give the design discussion a surprising twist"* (Amsterdam Academy of Architecture, 2015b, p. 84)

Materials

Every material raises a certain association: *"Cardboard models give rise to stodgy, flat, incorporeal buildings: wooden blocks produce wooden block architecture, and plasticine produces relatively free plastic structures."* (Behnisch, 1987, p. 40) (Karssen and Otte, 2013). As there is no general prescription of which material to choose for physical

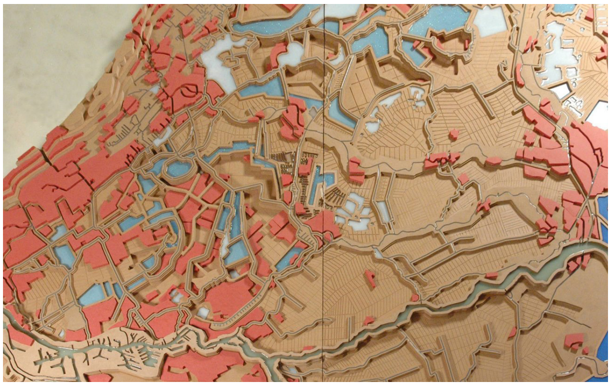
3.41 Size steers easiness to handle, steers transportability, steers the ability to talk, to develop (the design)



3.42 Examples of large models at HOSPER *(HOSPER, n.y.)*

models in landscape architecture, I will touch upon representation of the landscape base, vegetation in general and trees in specific, as these three aspects are most distinctive from the making of architectural models I have seen.

Most offices start their landscape model with a base plate, with or without topography. Topography is mostly made from layers of grey cardboard (**figure 3.44**) or white foamboard (**figure 3.45**) Although this gives a nice impression of the height situation, this material is not easy to adjust during the design process. Therefore, some offices use 'deltasand' (also called 'moonsand'). This sticky sand forms a solid surface, but can be easily reformed or removed (**figure 3.46a,b**). At Ganz LA and Vogt LA this materials is largely part of their modelling habit, but H+N+S Landscape architects (Amersfoort) (**figure 3.47**) and recently karres+brands also started to use this kind of sand (**figure 3.48**). Ganz LA and Vogt LA however, developed their own way of shaping the deltasand according to the height lines. They use sticks (Vogt LA and Ganz LA) or vertical slices of cardboard (Ganz) to indicate the height lines first, after which they are able to model the sand according to the real situation (**figure 3.49**) Besides topography, several Dutch offices use satellite images

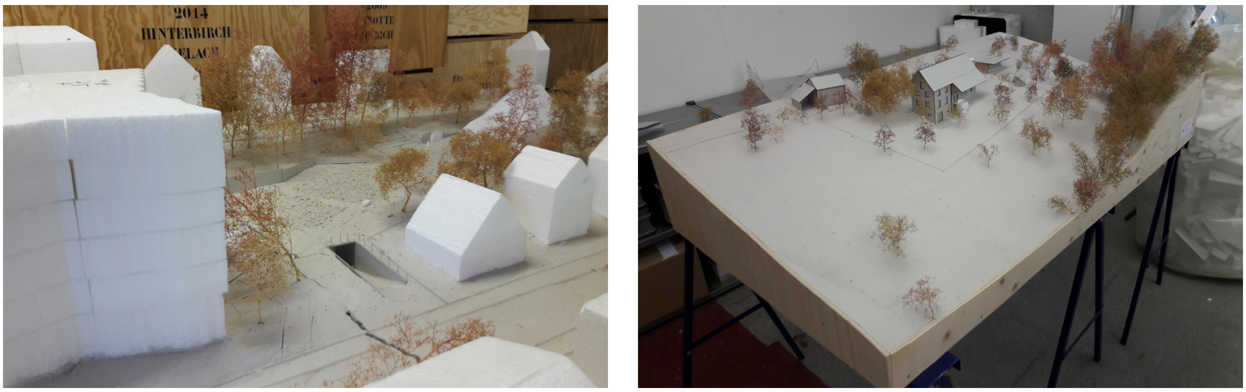


3.43 Example of a large presentation model by H+N+S Landscape architects for IABR 2005 *(H+N+S, n.y.)*

3.44 Example of a physical model with layered topography made of grey cardboard by H+N+S

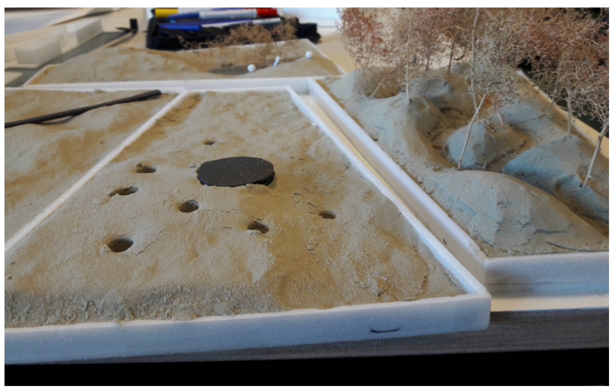
3.45 Example of a physical model with layered topography made of white foamboard by an architecture student at TU/e as basis for their landscape models (**figure 3.50**) The architectural intervention is then placed on top of it as an object, for example made from cardboard. Sometimes layers of cardboard are glued under the satellite image to indicate the height differences as well.

Most offices experiment with ways to represent vegetation. For example, designers at ZUS experimented to represent grass (**figure 3.51**). Ganz LA did the same, but then as a structure on mouldable sand (**figure 3.52**). During my internship at H+N+S we used pieces of carpet to represent different plantings (**figure 3.53**). For a park design, ZUS also struggled to find the right materials to represent reed. They ended up with pieces of real reed to represent the reed parts and with a grassy surface from the train hobby shop to represent the field of grass (**figure 3.54**). Also at other offices, when it comes to medium or low vegetation, hedges or planting areas are often included in the physical models, represented with 'the stuff from the train hobby shop'. Something which other landscape architects mentioned as well, is that these materials never give an attractive look to the models, while that characteristic is quite important for a useful physical model. An attractive model invites to talk about, which improves a design. *"It is more than to*



3.46 Examples of physical models with topography made of sand by Ganz LA

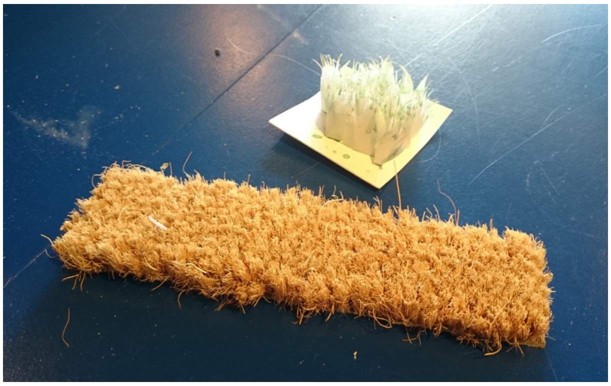
3.47 Example of a physical model in which topography is studied with delta/moonsand at H+N+S



3.48 Example of a physical model in which topography is studied with delta/moonsand by karres+brands *give a spatial impression, it is also the atmosphere you add to it"*, explains Kinga Bachem. In this case, for the park design of ZUS, it was the best solution to use the 'stuff from the train hobby shop', as other ways of representing lacked and the park design intended to

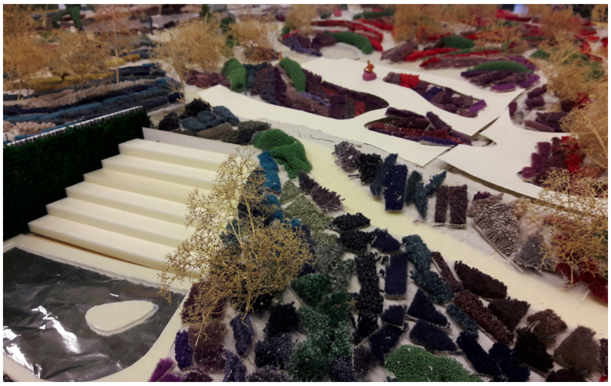
3.49 Landscape architects at Ganz LA use vertical slices of cardboard to indicate the height lines before filling the model with sand, sometimes also done with sticks

3.50 Example of a physical model with a landscape base of a satellite image by karres+brands



3.51 Example of a physical model with layered topography made of white foamboard by an architecture student at TU/e

3.52 Example of a physical model with layered topography made of white foamboard by an architecture student at TU/e



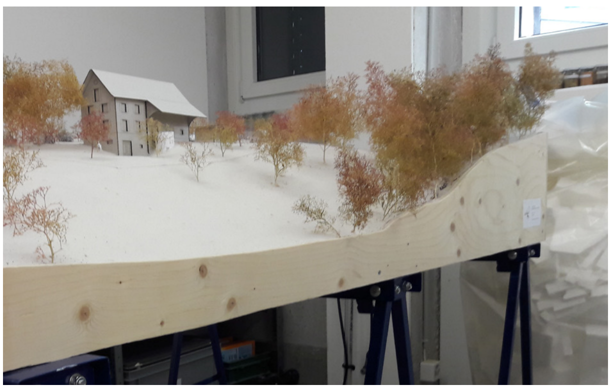
3.53 Landscape architects at H+N+S used carpet to represent different vegetation structures and types

3.54 Landscape architects at ZUS struggled to represente the vegetation of this park have a somewhat darker atmosphere. A better alternative seems to be 'reticulated foam', which is mainly applied for hedges or shrubs and for forests on a larger scale (**figure 3.55**). I recognized this struggle with representing vegetation at more offices. Even Made by Mistake, an office specialized in model making, often looks per project which way the design can be represented in the best way, depending on the wishes of the client and a bit of serendipity. Sometimes they discover new ways of representing, for example by merging two components and some water (**figure 3.56**).

Trees play an important role in landscape architectural models. An often used material is filigree (**figure 3.57**). As a good physical model needs abstraction and reduction, tree species are never distinguished in a model (**figure 3.60a,b,c,d**). *"For us, a tree is a tree in a physical model; we use a rendering to show which species we intend to have"*, thus Ronald Bron (**figure 3.58a,b**). Some offices only differ their trees is height and width (e.g. HOSPER, **figure 3.60**), others add volume to that (e.g. Vogt LA), and sometimes an office also includes logs and the height of branches (e.g. Ganz LA). Difference in park-tree and street-tree is sometimes made by spraying the trees in a different colour (e.g.

3.55 Example of a forest and solitary trees made from reticulated foam by H+N+S

3.56 Example of a model for which Made by Mistake found an original way to represent the vegetation patterns for the design of cemetry De Draai of karres+brands



3.57 Example of a physical model in which filigree trees are applied by Ganz LA

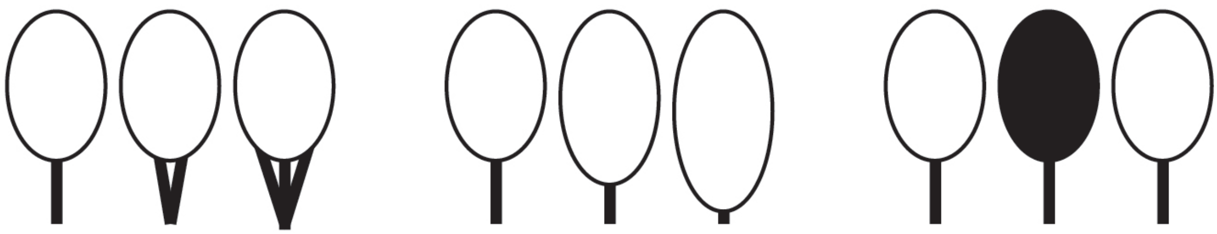
3.58 Example of showing vegetation species in (a) a rendering and not in (b) a physical model, by HOSPER *(HOSPER, n.y.)*

Vogt LA) (**figure 3.60**). In an early explorative phase of the design process, trees can also be represented with small wooden sticks to show the placement and density of a group of trees. When physical models are really used to design, trees are replaceable, for example by making the logs from sticks or wire. In a later phase, when a model is meant to represent and not change anymore, trees are fixed to a certain place.

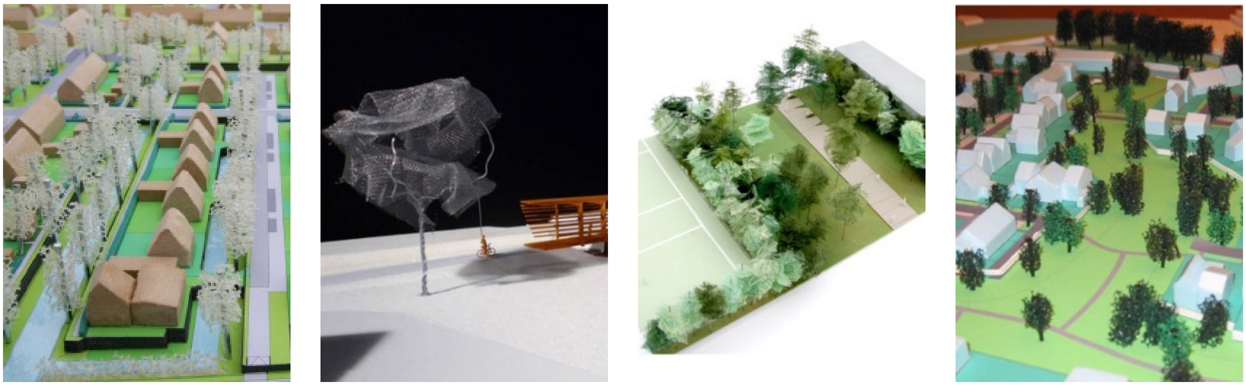
As I was curious to know if it would be possible to represent more differences within trees but still in an abstract way, and as literature and practice did not give me insight in this, I did a small intermezzo-experiment, shown in **figure 3.61**, in which I tried to reduce trees in a schematic way. However, it turned out that there are still too much possibilities to keep it doable, so no further research and design is done on this aspect.

Technique

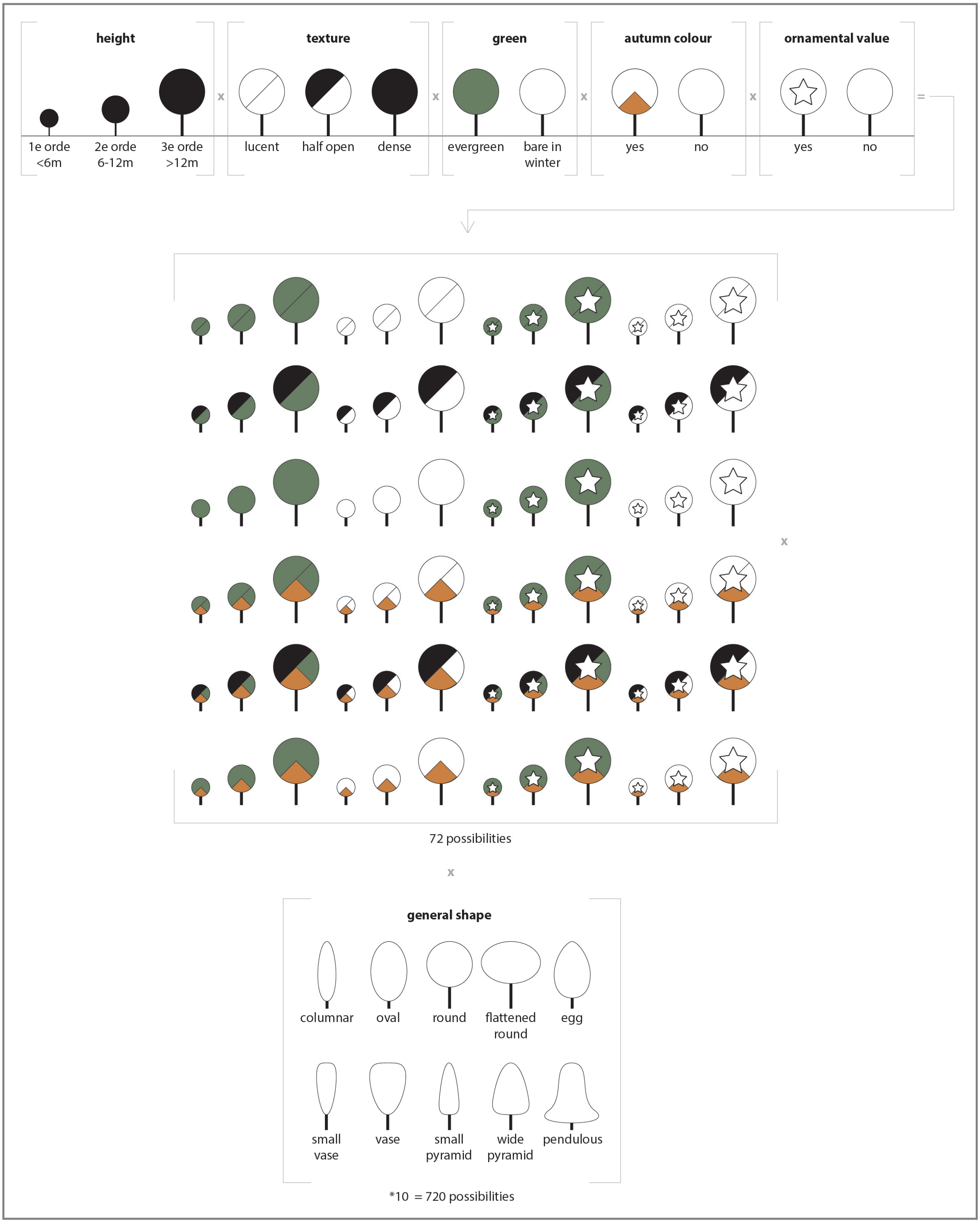
'Technique' is the skill to process the chosen materials. Which technique one uses for a physical model, influences the design. This is what Erez, architect at OMA (Rotterdam) explained in Alberta Yaneva's research on modelling at OMA *"The technique of modelling influences the design. If you build a square building, it's easier to build it out of foam.*



3.59 Ways how some landscape architects represent trees:
(a) difference in logs, (b) difference in branching height and volume and (c) highlighting special trees



3.60 Some examples of ways to represent trees by HOSPER, however in every model they only show height and width *(HOSPER, n.y.)*

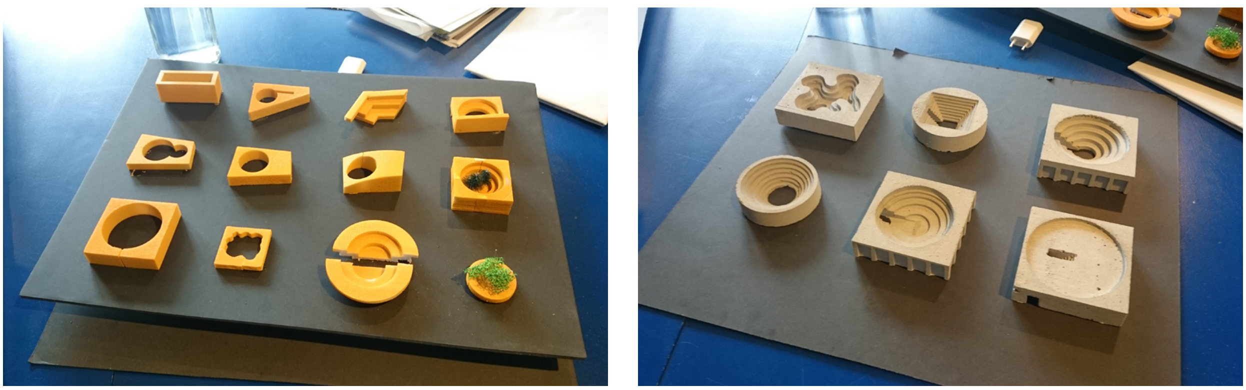


3.61 Intermezzo experiment to test how to reduce tree species; conclusion: still too much possibilities, so research and design is not continued on this aspect in this thesis

For example, the Guangzhou Opera House has a super-weird shape, it's a folding surface. Building this folding surface was really, really hard. So, when we develop the technique of building the model, it influences the design, because it never turns out the way you thought it would be. Then, if it's nicer it will influence the design. If it's not, you can abandon it and move on to another technique because you don't manage 'to establish beauty' as Rem says." (Yaneva, 2009, p. 77)

Kinga Bachem showed an example of using different techniques for different aims. At ZUS a model made of foam was used to test several types of house extension. These models lead to the final design, as no sketch was made at all. The final product however, was a multiplex model with a high level of detail, as it was made with a laser cutter. Another design process at ZUS started with foam models, which became concrete models in a later stage of the design process (**figure 3.62a,b**). (Bachem, 2016)

As mentioned at the start of this paragraph, a generally valid technique for physical modelling does not exist. However, Ganz LA and Vogt LA developed their own methods, which are quite similar to each other. Unfortunately, I can and will not elaborate on this any further, as (see also paragraph 3.1.3) this is the 'secret of the cook'. For what I have seen in practice, the Swiss offices were an exception to the Dutch offices, concerning the techniques they apply. Ganz LA and Vogt LA are focussing on models made of the materials and with the techniques they are so familiar with. Every model is made in more or less the same way and is mainly used as physical design tool in the design process. Some models find their way to the client as well, but the appearance of the model is in that case not different from the model as a design tool. One and the same model then functions as a tool for discussing and coordination between specialists, and as a tool to sell an idea (the design) to the public. Nicole la Hausse explains: *"We are never showing finished, exact, faultless things; not everything needs to be perfect: it needs to be open for change"*. Sometimes a sketchy model is made, which is a productive thing to help developing the design, not meant for taking stage in 'the outer world'.



3.62 Example of a design process at ZUS where different techniques are used for different aims:
(a) study models of foam, (b) the next design stage with concrete models

Jan Peter Wingender showed an example of choosing a specific technique for a specific aim: the application of porcelain for the thematic model Anouk Vogel made for the Prix de Rome competition in 2014 (**figure 3.21**). She used such an 'unusual' material to show that the design in its intention never was meant to be executed in real as well. (Amsterdam Academy of Architecture, 2015b, Wingender, 2016) This is a great example of technique supporting the model's aim.

Sometimes offices are cooperating with architects in their design process. Often, this is also visible in the way of modelling, which is then made together. For example, the landscape architects of Veenenbos en Bosch made the landscape base for the building of architect DoepelStrijkers (**figure 3.15**) and at Ganz LA the architect worked during the project at their office, ending up with a model of them together (**figure 3.63**). The model then functions as a tool for discussing and coordinating between specialists. (Ganz, 2016; La Hausse, 2016; Brouwers, 2016)

Another important aspect which has to do with physical modelling techniques, is the way how you present the model, as there is always a moment that 'your model has to go out'. Karssen and Otte (2013) mention the importance of the timing of that moment. For example one can think about hiding the model and suddenly opening up. How you present the model is not only important for final presentation models, but also for models used in the design process. Of course this has to do with a certain attractiveness of the model, but Jan Peter Wingender adds another important thing to this: seeing the model on eye-height; something which preferably should be taken into account when making the model. For example, a model that would be too low to look at on eye-height when it stands on a normal table, was extended with the foundation of pilars under the model to reach that eye-height (**figure 3.64**), because *"it had to be on that table"* (Wingender, 2016). In architecture one also puts emphasis on the fact that a physical model should be higher than the client (**figure 3.65**). In addition, plinths and base plates are part of the story: literally and metaphorically (**figure 3.66**). *"Plinths and base plates are a problem in themselves. A small model can benefit from a large plinth, even if it is merely to present*

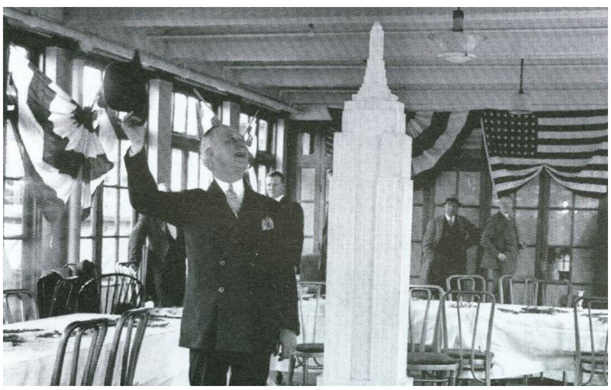
3.63 Landscape architects at Ganz LA made this design and physical model in cooperation with an architect

3.64 Example of the importance of eye-height when showing a model: by Bart van der Salm for Office Winhov *(Amsterdam Academy of Architecture, 2015, p. 85)* *the model at eye level and lend a sense of weight. The lack of a base plate is sometimes useful. The model is then more an object in itself that one can hold and turn around. A plinth must support the aim of the model and form an inseparable whole with the model. As a result of the choice of size and plinth, you steer the presentation of a model to a large extent. Does it form an aside, or is it actually the centre point of the presentation? Do we walk around it, do we have to stand on our toes or actually drop to our knees? The model is a seducer; good models move the observer both literally and metaphorically."* (Amsterdam Academy of Architecture, 2015b, p. 95)

On a regular basis, architects and landscape architects outsource their presentation models to specialized offices, like Made by Mistake, as they have the skills, tools and materials to make an attractive model. Like OMA outsources it's competition models to Vincent de Rijke: *"In Vincent's workshop, models can be made with materials that cannot be seen at the OMA. Those materials require heavy machines and special equipment, which could make the model-making process quite slow. And time is what designers at the OMA are often lacking.* [...] *The time a model spends in Vincent's workshop is precious as it allows the model to gain valuable new properties that cannot be acquired with the quick techniques of foam cutting at the OMA."* (Yaneva, 2009, p. 69-70). When the emphasis lies on visualization and not on developing the design by making the model itself, it is often more profitable to outsource it to the experts. (Bachem, 2016; Bron, 2016; Yaneva, 2009)

3.2.3 Aim of the model

How abstract a model should be and therefore which materials and techniques should be used, depends on the aim of the model. A model to check construction for example, is in general less abstract than a model to show a design concept. In addition, materials for working models (models a (landscape) architect is physically designing with) need to be adjustable, while materials for final presentation models should have a chic and attractive appearance. This has to do with the fact that materials, level of detail and colour are the ingredients for the atmosphere the model evokes; which is the result of



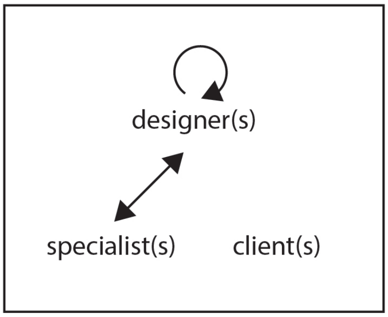
3.65 Example of a physical model which is higher than the client *(Wingender, 2016)*

3.66 Example of model with integrated baseplate for Office Winhov *(Amsterdam Academy of Architecture, 2015, p. 85)* the fact that materials and colours often are taken literally. (Karssen and Otte, 2013) In their book, Karssen and Otte give an overview of modelling materials, mentioning the appearance (association) of every material. Gänshirt (2007) writes comparable about that: *"[...] for working models we choose cheap, soft materials like wax, clay or plaster, and later cardboard, glue and balsa wood as well, all of which are easy to work with. Whereas abstract models illustrating ideas and imprecise working models restrict themselves to the essential lines of the design, presentation models are made with a great deal of time and effort from materials that are difficult to work like wood, plastic and metal, and worked out in detail."* (p. 152).

To be able to apply the right abstraction level and to use the right materials with the right technique at the right moment, one would need an overview of common model-aims (the 'causative' of all this) with a prescribed set of materials and techniques related to the aim; in order to apply the correct method for every type of design at every moment in the design process. However, this is more complicated than it seems.

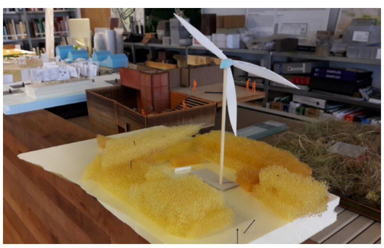
In literature, few writers touching upon the process of ((landscape) architectural) design have been specific about the role of physical scale models in designing. For example Lowry (1965) , Steinitz and Rogers (1970), Wade (1977), Zeisel (1981), Koberg and Bagnall (1981) and Clipson (1993) write about (scale) models as an important tool in landscape architecture, but do not elaborate further on it. (Most extensive literature can be found on digital modelling (e.g. Rowe, 1987; Perry, 2009; Costanza and Voinov, 2004)). Although using different frequently used databases (Scopus, Google Scholar, CAB-abstracts, WUR Library Catalogue), with different search terms, no peer-reviewed articles can be found on the aim or use of physical scale models in the design process. Only Karssen and Otte (2013) write in-depth about scale models as a design tool. They describe every model's aim, give examples from practice, and describe clear work instructions of how to make that particular model. But although it is a very practical guide, it does not always match with the landscape architectural practice (type of design, design process and (habit of) designer). By taking Karssen and Otte's distinction for scale models as a starting point, I started adding this up with general knowledge from others (Flusser, 1993; Berger, 2007; Pallasmaa, 2009; Gänshirt, 2007; Papenborg, 2010) and my findings from interviews and observations in practice. This led to definition of three model aims (**figure 3.67**): the model as a sketch tool, the model as a process instrument and the model as a presentation tool. Important to notice: models can shift meaning.

SKETCH TOOL



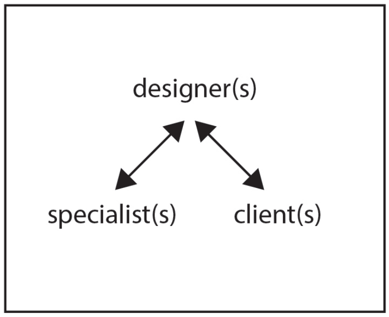
Used in the explorative phases of the design process; of greatest interest for the designer or design team itself to study forms, to analyse (existing situation and/or design idea), to sketch in three dimensions and to think with one's hands.
Sometimes, a specialist can be involved in this model making process, as for some specific decisions expert knowledge is needed. The model than helps to give insight in the designer's idea and can be changed right ahead where necessary.

AIM	
to understand	***
to think	***
to test	***
to communicate	*
MATERIALS	
adjustability	***
prize	*
TECHNIQUE	
skills	*
tools	*



Example of a physical model as sketch tool by H+N+S: windmill in relation to forest

PROCESS INSTRUMENT

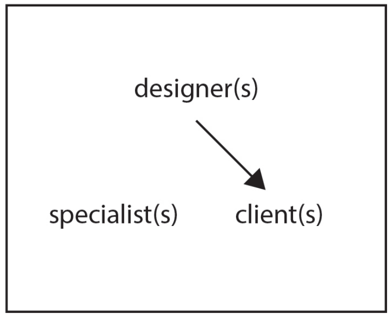


Used as a participation tool in the explorative phases of the design process as a means to communicate between designer(s), specialist(s) and client(s), to make alternatives clear and to be able to shift. One or more design options in one or more models, can be evaluated, discussed (and adjusted) together with the participants.
Sometimes, this happens more than once in one design process, while the physical model develops with the development of the design.

AIM	
to understand	***
to think	***
to test	**
to communicate	**
MATERIALS	
adjustability	**
prize	**(*)
TECHNIQUE	
skills	**
tools	**

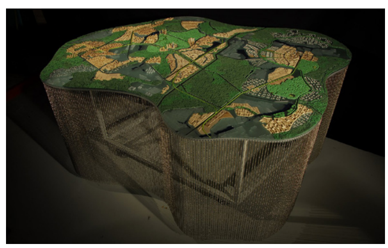
Example of a physical model as a process instrument by H+N+S for a workshop with children

PRESENTATION TOOL



Used to present the design (ideas). Meant to show the (often final) work to 'the outer world' in order to complete phases. Not meant to be adjusted after or during presentation. It is an attractive and 'precious' object, sometimes closely resembling an artwork. In this way, it implies to convince the public, and therefore may cost something. This type of model is therefore often outsourced, or made by the designers themselves by spending quite a lot of effort on it.

AIM	
to understand	*
to think	*
to test	*
to communicate	***
MATERIALS	
adjustability	
prize	**(*)
TECHNIQUE	
skills	***
tools	***

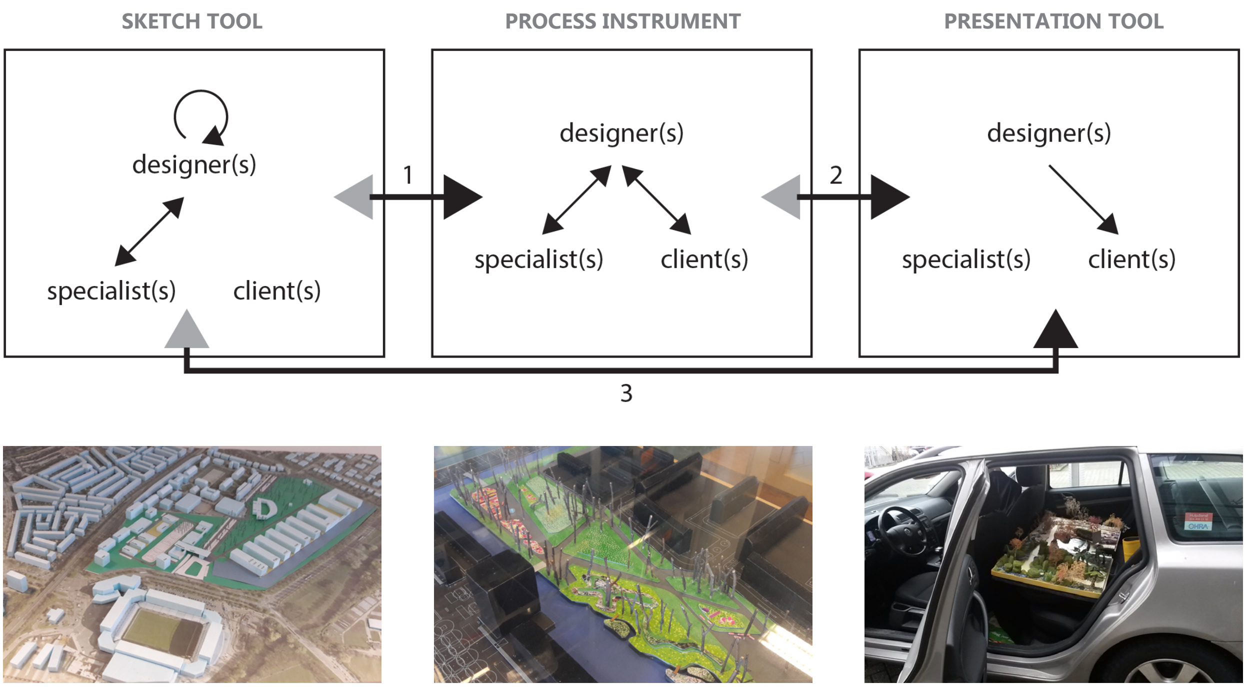


Example of a physical model as a presentation tool by Made by Mistake for MaxWan

3.67 Three model aims, based on all findings from literature and practice

Models shift meaning

In practice the three model types/model aims described above, could be found at all offices I visited. However, most designers I interviewed, could not arrange all their models in a certain category, as some models shift meaning throughout the design process. Some examples are showed in **figure 3.68**. Relating this observation to Gänshirt's theory, it seems a logical characteristic of the physical model: *"*[Models can be] *three-dimensional, simplified and reduced-scale representations of an object that both serve to develop its form, like a drawing, or objects as specimens which serve as a pattern for a piece of work that is to be produced* [...] *One and the same object can have two fundamentally different meanings: a representation of a mental image, or an example for something that is to be made. The possibility it contains of an arbitrary yet fleeting change of meaning* – [...] – *is a modus operandi common to all design tools."* (Gänshirt, 2007: 150) As a design tool, we can compare the physical model with a drawing. About the drawing Riedijk (2009) writes: *"The drawing transforms during the design process under the influence of all data and ideas stakeholders involved in the design process."* (p. 10). This is exactly what can happen to a physical model when used in the design process of a (landscape) architect: it can transform from sketch tool to process instrument, from process instrument to presentation tool, from sketch tool to presentation tool and all vice versa options.



1. Firstly meant to sketch with the designers at the office karres+brands used this model of the Kromhoutkazerne (Utrecht) also in communication with the client

2. Firstly meant as a participation tool, karres+brands 'upgraded' this model of the Botteskerkpark (Amsterdam-Osdorp) to a presentation tool

3. Firstly meant to sketch in 3D, H+N+S used this model of the museum garden of Naturalis (Leiden) as a presentation tool in a meeting with their client

3.68 A physical model can shift meaning throughout the design process: some examples from practice

Not everyone is always aware of this characteristic. But the shift of meaning makes it a particularly effective and explosive tool: *"The architectural model can be used for a large number of purposes, which makes it a highly effective, but also problematical design tool.* [...] *it is just as well suited to scientific experiments as it is to designing structures and buildings."* (Gänshirt, 2007, p. 149). On the one hand the transformative character of a physical model is an advantage, as it gives unlimited possibilities to apply; on the other hand it is a disadvantage, as you might have no idea about what is when and how exactly the best method.

3.3 Conclusions from literature and practice

In this chapter the use of physical models is explored. The value architects and landscape architects add to the physical model as a design tool is based on the fact that, firstly, it is a physical thing around which inspires as part of daily life; and secondly, that it bridges the gap between thinking and making, by offering the possibilities to understand, to think, to test and to communicate, within – and beyond – the design process. Whether or not (landscape) architects really use physical models in the design process, depends on the design itself (type of project), the design process (regarding stakeholders and availability of time, space and budget) and the designer(s) him/herself (their habit). How (landscape) architects are modelling when they do, is related to the degree of abstraction and reduction they (want to) reach by using certain materials, techniques and scale; based on the (desired) aim of the model. All aims of physical models can be distinguished in three model types (the model as a sketch tool, the model as a process instrument and the model as a presentation tool), however their real appearance can be transformative between different model types. This makes the physical model a very effective but also explosive design tool.

A striking thing discovered, is the fact that time (and therewith costs) is an important factor in the decision making process of any (landscape) architect to use physical models or not. Besides, I noticed a lack of know-how and skills in the field of landscape architecture to design with and make physical models. No general guidance was appointed by the experts in practice: they do not use the same standards or step-by-step guides, they 'just do what they do'. Although Ganz LA and Vogt LA have developed their own way of applying physical models in their design processes, this is (firstly) not an accessible and (secondly) not a for everyone understandable method, as experience and habit play a very important role for applying these methods. Offering an extended overview of what is done in practice (and why!) might be an ideal start to unravel the mystery of model making. One should collect all available data on existing models (scale/size, technique, materials, aim, moment of application – in relation to the specific design process), after which (hopefully) an overview could be given of what works when and what not. However, the aim of this thesis is not to do that.

Far more interesting (expected to lead to a far more interesting attempt) is the conclusion that landscape architects seem to model the way architects do, while their profession differs regarding their way of thinking, their way of acting and their desired final product: architect's assignments are very static, while landscape architect's assignments are often very dynamic. However, we do not see that in the practical application of physical models. Dynamic assignments are often approached (in combination) with other tools. For example, a digital projection is made on a 3D-printed model, to show the change of landscape. It seems not to be a landscape architect's habit to approach dynamic assignments by using dynamic physical models, as all models I have seen are static representations, except for two models. However, these 'dynamic models' were both designed as a presentation tool, and not for the landscape architects themselves to use during their design process by physically designing with it. These models were not used to develop the design, but for communication – not to understand, to think or to test, while the latter are amazing features of the physical model, which somehow are acknowledged by the landscape architects as important values of a physical model. By visiting practice I noticed that landscape architects struggle (or just don't, as they don't know how) with representing landscape dynamics, for example growth of vegetation over time, seasonality or flowing water, while everyone knows how to represent buildings and streets. Something Wingender (Amsterdam Academy of Architecture, 2015b) also noticed: *"The model offers the opportunity to thematise and imagine phenomena. For example, the phenomenon 'time' can be examined in a model in a totally unique manner. Can a model literally 'grow' or actually develop its own transformation as a result of disintegration and erosion?"* (p. 89). So far, my study into literature and practice did not give an answer to this question.

4 EVALUATING PART I *Challenges for landscape architecture*

From chapter 3 it has become clear that landscape architects are lacking a habit (know-how, skills and experience) to make and use dynamic landscape models to the fullest. Although landscape architects assign a high value to the use of physical models at different moments in their design process (described in section 3.1), they do not use it (or exceptionally) for the characterizing landscape architectural assignments concerning the dynamic landscape (described in section 3.2). If a dynamic landscape model is made, it is used to present and not implemented in the explorative phases of the design process. Concluding that, the next step in this research is to explore the physical model as a design tool for the explorative phases in dynamic landscape design: to use a physical model as sketch tool and/or process instrument; not only to communicate, but also to understand, to think, to test and therewith to develop the design process and its design outcome. In order to do that, there is a need to develop modelling standards, or at least a need to make those specific landscape models more accessible by increasing know-how, skills and experience. The way in which this thesis deals with that mission, is by offering insight in involving landscape dynamics in a physical model – taking into account the factors that influence the general making and use of physical models in the design process.

'Offering insight' can be done by showing an example of a dynamic physical model, including the way(s) in which this model can be made and used in the design process. Even better (more valuable and interesting for practice) would be to also show the real effect and result of using that dynamic model for the design process and the design itself. As not all dynamics can be explored for physical modelling within the timeframe of this thesis, choices should be made.

'Taking into account the factors that influence the general making and use of physical models in the design process' focusses the explorative study on the effect of materials, techniques and size (not scale). Materials, as the main modelling ingredients, need to be adjustable (as being used as explorative sketch tool and/or process instrument), cheap (to save costs), adaptive (to be dynamic) and surprising (as that is what landscape architects love: to be unexpectedly surprised). Technique should be quick and easy (to save time and costs). Size should be taken into account (as scale is minor to this) to make the model easy to handle and therewith transportable (to be able to talk about it, as talking = developing). Technique in this sense however, has the lowest priority for the explorative study, as I believe that experience and improved skills can catalyse the technique – and therefore saves times and costs.

To fill the lack of knowledge, to improve skills and to develop experience, an explorative study is needed as literature and a solid study-background are lacking and no general habit concerning dynamic physical modelling exists: there is need for explorative thoughts. As *"Making is thinking"* (Foxley, 2010, p. 28) there is need for explorative making as well: need for trials and errors, need for ordering those trials and errors and need for arranging them, in order to give insight in (thoughts upon) how people can deal with this. Which might lead to a standard, or at least an example of a useful design tool.


ASUS

PART II

a dynamic landscape model

5 EXPLORING PHYSICAL MODELS FOR DYNAMIC LANDSCAPE DESIGN

This chapter describes the process of the explorative study to find a physical model for dynamic landscape modelling in the explorative phases of the design process. Based on specific landscape architectural design elements, materials and techniques should be selected that fit landscape architectural design – scale is related to that. A focus within landscape dynamics on flowing water and growing vegetation is expected to be a good kick-off for the exploration of dynamic landscape models. As *"Making is thinking"* (Foxley, 2010, p. 28), there is a need for me to 'make': I cannot think without making – I cannot think about a design tool, without making it myself. Making and thinking, as an iterative and parallel process, full of experiments and a case-study.

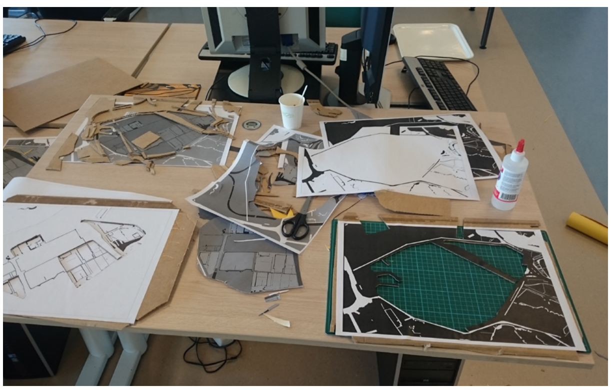
5.1 Experiments

As evaluated in PART I, the importance of materials, technique and size should be taken into account in exploring possibilities for physical dynamic landscape models. Summarizing and prioritizing the points of attention per aspect:

Materials	:	adjustable, cheap, adaptive, surprising
Size	:	easy to handle, transportable
Technique	:	quick, easy

Yet, a first search for suitable materials still leads to a lot of possibilities. For the sake of this thesis' timeframe, there is a need to focus and make quick choices. Some choices for experiments are made after consistent discussion of former findings (as well from literature as from practice and previous experiments) and some are executed in hope for serendipity. If the results of an experiment offered valuable opportunities for physical dynamic landscape modelling, the results were taken into account in a next or parallel experiment. If an experiment turned out into full failure, offering no valuable opportunities for further research, a follow-up was dismissed. Rating the results of an experiment as valuable or not was for every experiment a specific choice.

Overall, three types of experiments can be distinguished: (a) experiments to find suitable basic materials and techniques for an explorative landscape model, (b) experiments to find



suitable materials and techniques for physically modelling the dynamics of flowing water and (c) experiments to find suitable materials and techniques for physically modelling the dynamics of growing vegetation. In every series of experiments the above mentioned priority for model making aspects is taken into account. As the type of materials is the leading factor in exploring dynamic landscape models, the points of attention of this aspect (adjustability, cheapness, adaptiveness and surprise factor) are also prioritized for every type of experiment. In **appendix 5** the raw-notes (notes + more photos) of the experiments can be found, including filmstills and/or movies.

5.1.1 Basic materials and techniques for an explorative landscape model

As the objective of this thesis is to explore the physical model as a design tool for the explorative phases in dynamic landscape design, the physical model need to be of use to understand, to think and to test design ideas; as these things are happening in the explorative design phase. From PART I of this thesis is concluded that materials therefore need to have a high degree of adjustability. The material-priorities are thus the following:

Points of attention for materials:

1. Adjustability

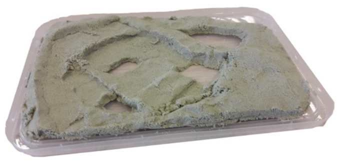
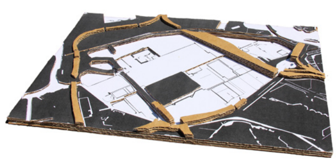
2. Costs

3. Adaptiveness

4. Surprise factor

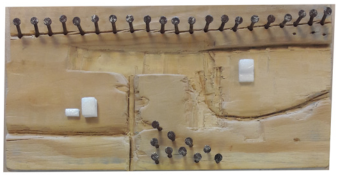
In this series of experiments cardboard, plaster, play clay, magic sand, wood and peas are investigated. As water somehow would be involved (later) in the development of the landscape model, I executed some parallel experiments as well, to test the reaction of the materials on contact with (stagnant) water. (**see next four pages**)

Water resistency

RANKING	IMAGE	DESCRIPTION
1 MAGIC SAND (1)		AIM: making a model (scale does not matter to test this material's workability and adjustability MATERIALS: plastic box, magic sand, 'stuff' (foam + plastic tree-things) TOOLS: -
2 PLAY CLAY (1)		AIM: making a model (scale does not matter) to test this material's workability and adjustability MATERIALS: plastic box, play clay TOOLS: -
3 MAGIC SAND (2)		AIM: making a magic sand model on scale 1:25.000 MATERIALS: plastic tray (cover of food box), magic sand TOOLS: plastic clay-tools
4 PLAY CLAY (2)		AIM: making a play clay model on scale 1:25.000 MATERIALS: plastic tray (cover of food box), play clay TOOLS: plastic clay-tools
5 CARDBOARD		AIM: making a model (1:10.000) which shows the water system of polder Watergraafsmeer on A3 format MATERIALS: 'stuff': cardboard and printed paper TOOLS: stanley knife, cutting mat, scissors, normal glue, computer (to make basic maps (Illustrator))

ASSESSMENT

					**NOTES**
++	+	-	--	++	*"Magic sand is easy to shape; The little box and round shape makes it special, especially in combination with the play clay model"*
++	+	-	--	+-	*"Play clay is very easy to shape; The little box and round shape give something extras to this model: 'a precious thing'; Next time think about using tools."*
+	+	-	--	++	*"Using the clay-tools was more difficult than with play clay; Height was not possible to scale, as it was very flat; Stacking the sand made it hard to relate to the basic map and therefore to shape reality; The end result was very ugly and felt apart very quickly as it was such a thin model on a flat cover"*
+	+	-	--	+-	*"Using the clay-tools made it easier to meet reality; Height was not possible to scale, as it is difficult to make thin homogenous flat pieces of clay; Making different height layers first on basis of the height map costs come time arrange; The end result was not that attractive."*
+-	++	--	--	+-	*"Thickness of cardboard led to exaggerating of the vertical scale; Printed paper was used as cutting these shapes was not possible in cardboard; Water levels are not exact according to height: water levels sometimes should be the same while the surface levels raised, I choose to print two levels in two ways (black-white and white-black), might be understood wrongly"*

RANKING	IMAGE	DESCRIPTION
6 WOOD		AIM: making a wooden model (scale does not matter) to test this material's workability and adjustability MATERIALS: wood, nails, foam, glue TOOLS: Stanleyknife, cutting mat, scissors, normal glue, computer to make basic maps using Illustrator
7 PLASTER (1)		AIM: making a model (1:10.000) which shows the water system of polder Watergraafsmeer on A3 format MATERIALS: 'stuff': cardboard and printed paper TOOLS: hammer, chisel
7 PLASTER (2)		AIM: making a better plaster mixture for a model to test this material's workability and adjustability MATERIALS: magic sand (for mall), plaster and water TOOLS: mall (cardboard cup), cup, swizzle stick
7 PEAS		AIM: making a simple model with peas to test mass-space effects of vegetation MATERIALS: peas, basic map (printed paper 1:10.000) TOOLS: -

ASSESSMENT					NOTES
--	+	--	--	+-	*“Magic sand is easy to shape; The little box and round shape makes it special, especially in combination with the play clay model”*
--	+	--	--	--	*“Making the landscape in the wood couldn’t be that much detailed and precise (quite wide chisel); Chiselling was easier in one direction than the other; When hammering the nails, I had to take care the wood was not splitting.”*
--	+	--	--	--	*“Sand was easy to shape; Plaster did not clump this time; Sand was a useful material for the mall; Some sand sticked to the plaster model after drying, which had to be swept of.”*
--	+	--	--		*“The peas did not remain on the paper, they rolled everywhere; The peas were not scale-related to the map, so no relevant conclusions could be made”*

5.1.2 Physically modelling the dynamics of flowing water

When physically modelling the dynamics of flowing water two things matter: having a liquid (water) flowing through a certain material (the basic material of the landscape model). To represent the interaction of water with the landscape, in the form of erosion and sedimentation, the basic material in the physical model should be ideally adapting to what happens (when the water flows). Therefore, the material-priorities are the following:


1. Adaptiveness


2. Adjustability


3. Costs


4. Surprise factor

From the first series of experiments (5.1.1) (Magic) sand turned out to be most valuable material for an explorative landscape model dealing with water. Therefore, this material forms the basis for new experiments. But, to be open minded, some other experiments

RANKING	IMAGE	DESCRIPTION	
1 SAND AND WATER		AIM MATERIALS TOOLS	to test a qualitative sand and flowing water setup plastic box, bucket, small bowl, sand, water, tube video camera, tripod
2 MELTING CHOCOLATE		AIM MATERIALS TOOLS	to test if/how melting chocolate might have possibilities for physical modelling plastic box, white and dark chocolate, hot red lemonade, hot milk video camera (smartphone)
2 DISSOLUTING SALT		AIM MATERIALS TOOLS	to test if/how dissolving salt might have possibilities for physical modelling plastic cover, salt, water video camera (smartphone)

were executed as well. All meant for explorative study, in which it is about quality over quantity. Starting point is to develop a simple and easy ‘do-try-this-at-home/the office’-situation, which means involving simple tools and skills (**see below**).

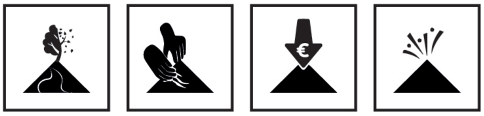
Follow-up experiments for Sand and water

AIM	To make a smaller experiment set up of Sand and water	
MATERIALS	plastic box, sand, small bowl, water, thin tube	✔

AIM	To test magic sand for Sand and water	
MATERIALS	plastic box, bucket, magic sand, water, tube	✘

From these follow-up experiments the conclusion is that a very small set up is not working properly when using for explorative study. However, magic sand is as suitable as normal sand (which was used for the larger experimental setup). The experiments with melting chocolate and the dissolution of salt did have the largest surprise factor, but concerning the other criteria valued as not valuable enough for further research.

ASSESSMENT



				NOTES
++	++	++	-	*“Qualitative testing on a small scale (A3) is possible; One has to take into account the output of such a model (water flows everywhere); Sand is very easy to adjust and simple objects can already give an impression of small intervention”*
+	-	++	+-	*“Dark and milk far more attractive than white and red; Patterns not as visible and clear as I expected; Video analysis might give results for erosion patterns; Flow should be constant; Chocolate milk was disgusting”*
+	-	++	+-	*“It just dissolved; Dissolving pattern might be influenced by greasiness of the plastic cover; Material not valuable enough for further research; Video should be made from a fixed point”*

5.1.3 Physically modelling the dynamics of growing vegetation

Usually vegetation is modelled in a static way, by testing the mass-space effect of trees, shrubs and eventually undergrowth. When considering the effect of growing vegetation in a design, one can think about the development over time and the effect of the vegetation for every single moment in time; which might lead to an unexpected situation. Materials for physically modelling growing vegetation therefore need to have a surprising effect, besides a certain adaptiveness to what happens in the rest of the model. The material-priorities thus are these:


1. Surprise factor


2. Adaptiveness

3. Costs


4. Adjustability

To come close to the reality of the effect of growing materials in reality, living materials are chosen for this series of experiments. Two types of growing vegetation are explored: cress (*Lepidum sativum*) and moss (**see below**).

RANKING	IMAGE	DESCRIPTION	
1 CRESS		AIM	making a model (1:25.000 which shows the green structures around Watergraafsmeer on A3 format
		MATERIALS	plastic tray, cotton wool, cardboard, sketch paper, cress, water
		TOOLS	stanley knife, cutting mat, markers, tape, computer (map),spray bottle, photocamera (smartphone)
2 MOSS		AIM	exploring a growing and flowing medium (source + surface + slope)
		MATERIALS	plastic box (old food box), pebbles, cup with moss + beer + yoghurt + water, water
		TOOLS	blender, funnel (paper), photo + video camera (smartphone), spray bottle

Follow-up experiments

As cress had a higher score on adaptivity, it seemed the most suitable material for the dynamics of growing vegetation. So extra know-how on this type of material was necessary to be able to generate knowledge on how to apply this material as a modelling material for explorative study. The speed of growth was studied, as well as the scale effect it could create, and the culture media on which the cress could grow. As the Moss-experiment failed, I tried another one, to test its growing speed as well. (**see below and next page**)

AIM
capturing the growing speed of moss paint

MATERIALS
tile, cup with moss + beer + yoghurt + water, water

TOOLS
blender, brush, photocamera, spray bottle

RESULT ✗

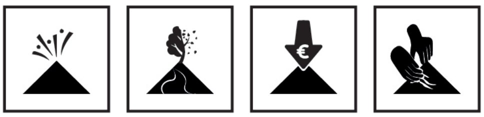
AIM
capturing the growing speed of cress

MATERIALS
plastic tray (cover), cotton wool, cress, water

TOOLS
spray bottle, photocamera

RESULT ✓

ASSESSMENT

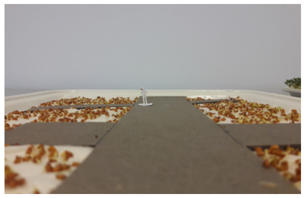


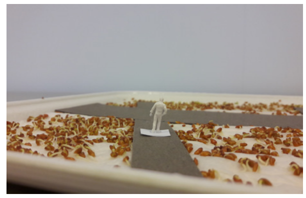
				NOTES
++	-	++	--	*"As there is no reference on the basic map, it is difficult to orientate; The cress grew very fast and in a very easy way: few maintenance was needed; The further the cress grows, the less visible the green structure becomes; The cress has no relation in scale with the basic map, this makes it less understandable; However, everyone found it a very attractive and surprising model"*
++	--	++	--	*"Difficult to make the right mixture; The paint was expected to flow over the slope of pebbles, but it did not; Too much uncertain factors: unknown mixture + slow expected growth; Amazing surprise after some days: rated as failure, but the model got surprisingly moldy, which created an unexpected appearance"*

AIM	MATERIALS	TOOLS
exploring the effect of cress on different scales	plastic tray (cover), cotton wool, cress, water, scale figures on different scales (1:50, 1:100, 1:200)	spray bottle, photocamera (smartphone)

Scale 1: 50

Like a corn field





Scale 1:200 | second day after seeding

Scale 1: 100

Like the edge of a park

Scale 1:200 | fourth day after seeding

Scale 1: 200

Like an old forest

Scale 1:200 | sixth day after seeding

"Important to take every photo on the same moment of the day; Important to take every photo from the same spot: could be better by using some kind of tripod"

"As those three trays were seeded two days after one another, these pictures could be taken all on the same day, which made it easier to take the photos all from the same spot"

✔

✖

✔

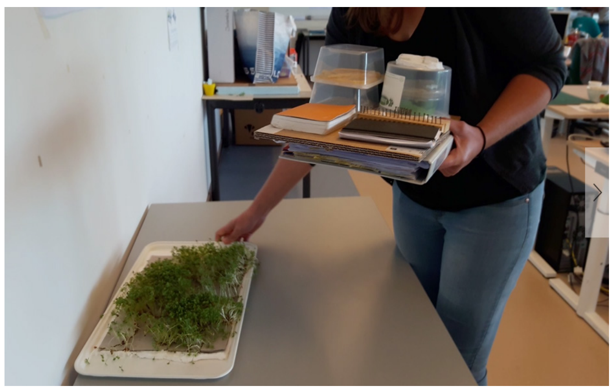
AIM	MATERIALS	TOOLS
exploring culture media for cress	glass pots, cotton wool, play clay, magic sand, cress, water	spray bottle, photocamera (smartphone)

"Water remained on top of the play clay; More water was needed for the sand to moisture in comparison to the cotton wool; Cress on the sand grew somewhat slower than on the cotton wool"

5.2 Conclusions from experiments

While experimenting I made decisions for follow-up experiments: selecting materials and techniques suitable for dynamic landscape modelling. As described above, (1) Magic sand turned out to be the best basic material for an explorative landscape model. In the next series of experiments on physically modelling the dynamics of flowing water, (2) a simple and easy 'do-try-this-at-home/the office'-situation was developed, for which Magic sand also was a suitable material. In the series of experiments on physically modelling the dynamics of growing vegetation, (3) Cress was a very striking, interesting and attractive material to use. Therefore, this material was explored more in-depth in some follow-up experiments, resulting in a refined overview of more exact possibilities of this material for physically modelling growing vegetation. So magic sand, a simple flowing water set up, and cress are independently of each other valuable aspects for a dynamic landscape model for explorative study. The know-how that these aspects do not interfere with each other (magic sand can be used in a simple flowing water set up and cress can grow on magic sand) offers great opportunities for combining these aspects into a dynamic landscape model. Besides finding suitable materials for a dynamic landscape model, another point of attention (set at the start of paragraph 5.1) is 'size'. After experimenting, some important notions can be made on this aspect as well. In all experiments I limited myself to a maximum size of paper format A3 (**figure 5.1**). This choice was made based on the fact that the model should be easy to handle and transportable. During the execution of the experiments, this format was most suitable for me to carry the experiments with me: it was easy to handle while biking (and driving by car) between university and home. In addition, this size made it possible to carry all experiments to the meetings I had with my supervisors (**appendix 6**, **figure 5.2**). Last but not least, during experimenting I also tested some ways of tracking the design process. The use of a video camera on tripod offered some extra possibilities in afterwards analysis. Making photos during time offered the possibility to capture the development of the situation. However, this should be executed more precise to make the result more valuable: making photos from fixed points in a more consequent matter offers a better possibility to compare, relate and conclude.

5.1 In all experiments I limited myself to maximum size of paper format A3: makes it easy to carry



5.2 The importance of the ability to carry experiments to for example meetings: makes it easy to talk about; see also **appendix 6**

6 TESTING A PHYSICAL DYNAMIC LANDSCAPE MODEL

The results from the experiments are translated into a case-study in which a dynamic landscape model is made and tested for a specific explorative design process. As I generated know-how on modelling in general (PART I) and on materials and techniques for dynamic landscape modelling in specific (Chapter 5), I developed a physical model which I expected to serve as a helpful design tool in a explorative design process for dynamic landscape design. By testing this tool in a currently executed design process, the value of using the model could be 'tracked', analysed and concluded upon.

6.1 Case-study

To be able to test the use of a dynamic landscape model for the explorative phases in landscape design, the model firstly should be made, and secondly the model should be involved in a design process that fits to the focus on flowing water and growing vegetation. As briefly described in paragraph 2.2.3 of the INTRO, the design process of fellow landscape architecture master thesis student Carlo Leonardi is suitable to explore the use of a dynamic landscape model. For the sake of time (of as well Carlo's as my thesis process), I will build the model myself, although we prepar the model together. After the model is built, the model can be involved into the design process of Carlo by offering Carlo the opportunity to test and reflect upon the model himself (**figure 6.1**). This process will be filmed, transcribed and analysed afterwards, in order to study and show the effect of using this dynamic landscape model in Carlo's design process.

As an almost new experiment, the case-study has its own limitations and constraints. These points should be taken into account when evaluating the case-study and making conclusions from that. First of all, Carlo is also supervised by Paul Roncken, which means that we have had meetings together before, so Carlo knows already things about my research and design. Secondly, I will be modelling and not Carlo (the designer) himself. Thirdly, for the sake of time only a small part of Carlo's design will be modelled. The results might be different if another part is modelled.

6.1 Overview of case-study: preparation, construction, transportation and testing & reflecting

About Carlo’s design process

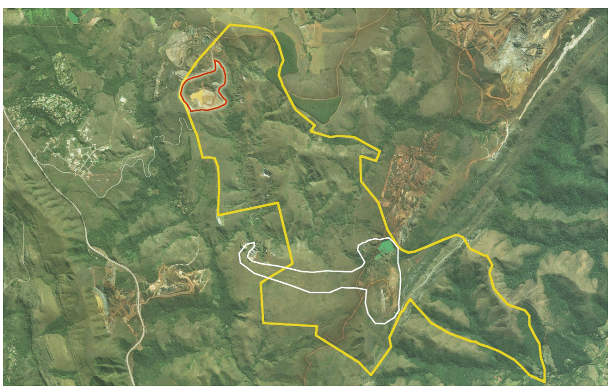
Carlo Leonardi’s research and design concerned the reclamation of a post-mining landscape in Quadrilaterero Ferrifero, MInas Gerais, Brazil. Here, a mining waste dam (*Lagoa de Rejeito*) was built by a company called Herculano Mineraçao (**figure 6.3**). Carlo approached this design assignment from a phenomenological point of view, with the aim to create a landscape for research and educational purposes.

When preparing the physical model, Carlo had already designed a masterplan for the site (**figure 6.4**). This masterplan includes soil movements, path structures, water runoff (conceptually) and desired flora and fauna. Carlo did some reference studies on parking area, entrance area, terraces, stairs and bridges, water garden, pavilions, the incident’s site, floating pier and materials. The assignment for Carlo was to design this masterplan further into detail, but he struggled with scale and topography of the site. Of course, (see PART I) a physical model is able to give insight in scale and to be able to think and understand topography better. But in addition, a dynamic physical landscape model is expected to help in finding answer on the following design questions, which Carlo has to deal with (see **figure 6.2**):

- How to deal with a growing forest?
- How to deal with rainwater runoff and soil erosion?
- How to deal with phenomenology in the design?

GROWING VEGETATION RAIN WATER RUNOFF PHENOMENOLOGY

6.2 The issues Carlo has to deal with: growing vegetation, rain water runoff and designing with phenomenology



6.3 Location case-study (red) within the ecological station of Aredes (yellow) *(Leonardi, 2016)*

6.4 Masterplan Carlo (this map has no legend) *(Leonardi, 2016)*

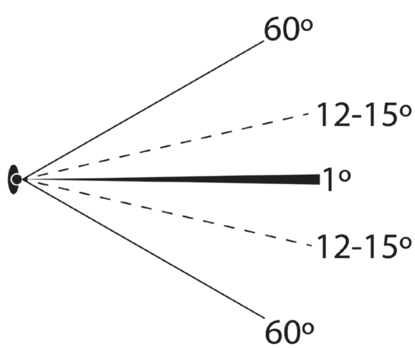
For the sake of time, a part of the masterplan would be modelled in a dynamic physical landscape model. Starting point is a visual Carlo made in addition to his masterplan (**figure 6.5**). This visual shows a viewpoint in the forest area of the design. From this viewpoint, a dense and diverse forest can be experienced. In addition, water runs off through a labyrinth of paths and bridges. Inspiration for the character of this area found Carlo in a painting of Rousseau (**figure 6.6**). At some points in Carlo's masterplan one can have an open view through the forest, looking to the desert area below, while experiencing water runoff after a heavy rainfall.

6.1.1 Preparation

The construction of the model, its transportation to Carlo and the creation of a certain set-up are part of the preparation before the testing and reflecting with Carlo could begin.

6.5 Starting point for the dynamic landscape model: Carlo's visual representing the experience of a dense and diverse forest in combination with water runoff through a labyrinth of paths and bridges *(Leonardi, 2016)*

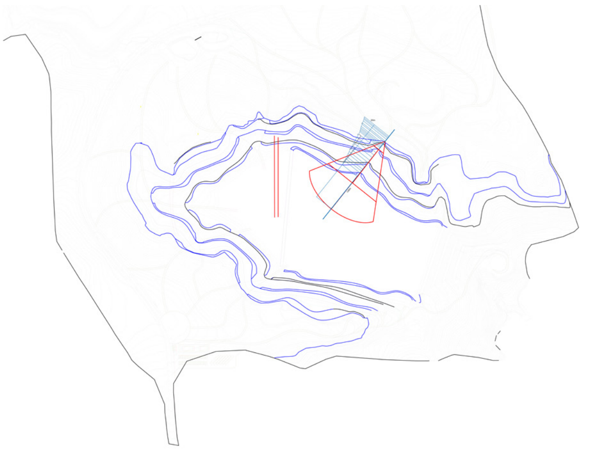
6.7 Insipration for Carlo's visual: a painting of Rousseau (Il sogno) showing a dense diverse forest (SOURCE)



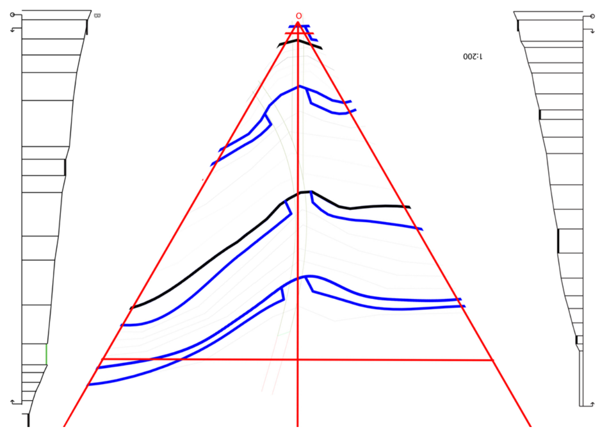
6.6 The angle of the human view forms the basis frame for the physical dynamic landscape model *(Based on Loidl and Bernard, 2014, p. 70)*

Model construction

In order to translate Carlo's visual into a physical model, a basic map is prepared. The angle of human view forms the basic frame (**figure 6.7**). As the model should be easy to handle and transportable (evaluated in PART I), maximum size is door size. In addition (as concluded from the experiments of Chapter 5), cress will represent a dense forest on 1:200. Combining this with Carlo's masterplan, a part of the plan can be selected (**figure 6.8**). On the basis of the height map of Carlo's masterplan the model base map and two side-sections could be made (**figure 6.9**). Then, the construction could begin, resulting in a finished dynamic landscape model (**figure 6.10**). The construction process is captured in photos and movies and summarized in the folder 'Physical modelling a dynamic landscape for dummies' added to this thesis (**figure 6.11** see also **appendix 10**). In order to be able to look at the model without being worried about the input for the water flow, I developed a closed water system (**figure 6.12** and **6.14a,b**). However, this water

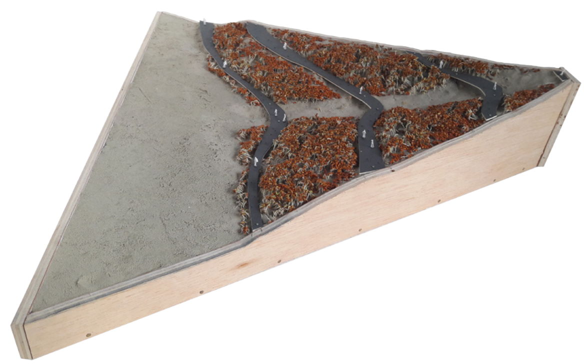


6.8 Choosing the model size (Illustrator) on the height map of Carlo's masterplan (AutoCAD-file)

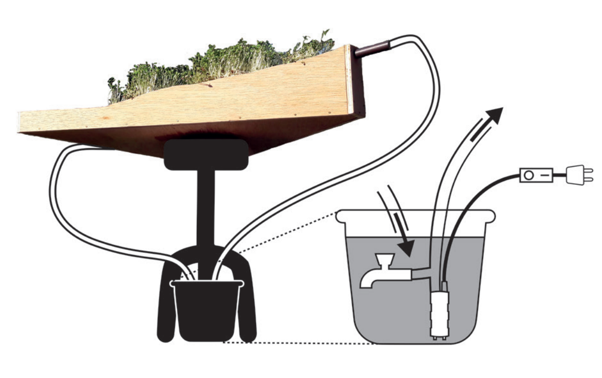


6.9 Preparing a basic map and sections, originally scale 1:200 (Illustrator)

6.10 The construction of the physical dynamic landscape model: for the making off movie, see also appendix 10

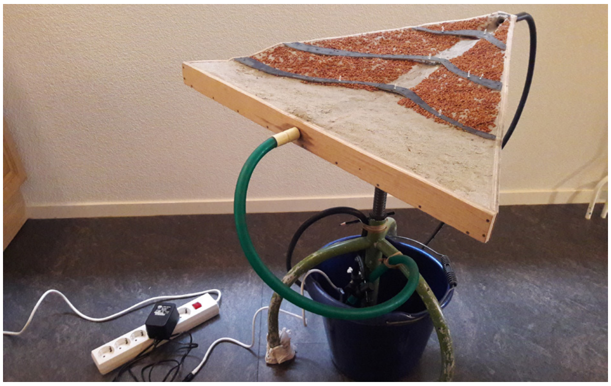


6.11 The finished physical dynamic landscape model



6.12 Water system of the model: this was how it was meant to be, however during the experiments it was broken

6.13 Alternative water system as the pump system from figure 6.12 and 6.14a,b



6.14 a,b Water system of the model in reality, like shown in figure 6.12

6.15 Model and additional stuff transported by car

6.17 Model was quite easy to carry (about five kilo)

6.16 Set up: model at eye-heigth on turning stool; video camera set on tripod to film everything system is not used during the case-study, as on the first morning I broke an essential part of it, which could not be fixed within that week. Therefore, I pour in water myself during the case study (**figure 6.13**).

Model transportation

After the model was finished (built in Papendrecht) it was transported to Wageningen University, where Carlo was working on his design (**figure 6.15** and **figure 6.16**). Also during the case-study, which took five days, the model was taken back to Papendrecht every day to be able to water it on time.

Model set-up

At the university, a testing set up was prepared: the model was set on eye-height and a video camera was set to film everything that was happening to the model (**figure 6.17**).

6.1.2 Testing and reflecting

Three things are part of the testing and reflecting phase: (1) a logbook Carlo kept, (2) the process when Carlo had the model physically around and (3) tracking the model's development. The aim is to explore Carlo's design process influenced by the use of the dynamic landscape model, in order to study its effect on the design process and the design itself. Below these three aspects are described, including the results of each aspect.

Logbook

Carlo kept a half-day logbook in which he also captured his mood about his design progress during the case study (**appendix 7**). Although the logbook does not give a very comprehensive and detailed overview of Carlo's design progress and process, it gives the impression that Carlo had a good feeling about his design progress when he had the model around (summary in **figure 6.18**). Carlo valued his design progress as 'good' for 47% (7/15) of the moments that Carlo had no physical model around. Looking at the

DAY	CARLO'S MOOD	MODEL AROUND?
Tue MO	GOOD	NO
Tue AF	GOOD	NO
Wed MO	BAD	NO
Wed AF	BAD	NO
Thu MO	DON'T KNOW	NO
Thu AF	DON'T KNOW	NO
Fri MO	DON'T KNOW	NO
Fri AF	GOOD	NO
Weekend -	GOOD	NO
Mon MO	DON'T KNOW	NO
Mon AF	GOOD	YES
Tue MO	DON'T KNOW	NO
Tue AF	GOOD	YES
Wed MO	DON'T KNOW	NO
Wed AF	DON'T KNOW	YES
Thu MO	GOOD	NO
Thu AF	GOOD	YES
Fri MO	GOOD	YES
Fri AF	GOOD	NO
Weekend -	GOOD	NO

EXCELLENT GOOD DON'T KNOW BAD TERRIBLE

6.18 Summary of Carlo's logbook concerning his mood about his design progress when he had the model around or not; question asked: *'Give today's mood concerning your design progress a value: Ask yourself at the end of the day: how do I feel about my design progress?'*

6.19a Testing and reflecting the model with Carlo during three days: Carlo thinks out loud, I watch and listen

6.19b Testing and reflecting the model with Carlo during three days: while Carlo talks, I ask some specific questions

6.20a Dynamic model in action: rainfall with spray bottle and water

6.20b Dynamic model in action: rain water runoff by pouring water

6.20c Dynamic model in action: sunshine with flashlight

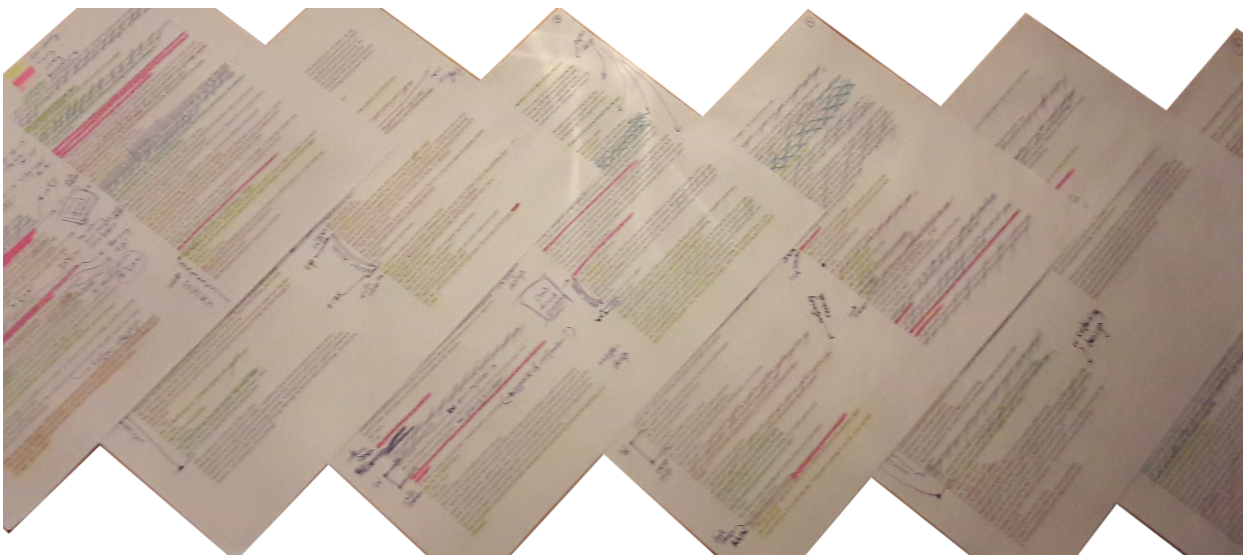
6.21 Fourth day: Carlo explains Sander his design (ideas) with the model: Carlo talks, Sander asks

6.22 Fifth day: I ask Carlo to think back of the previous days and to summarize moments Carlo did have the physical model around, he valued his design progress for 80% (4/5) of the time as 'good', and never as 'bad' or 'terrible'. Carlo valued the moments directly after when Carlo had the model around (e.g. Tuesday morning after Monday afternoon) for 50% (2/4) positively: twice 'good' and twice 'don't know'.

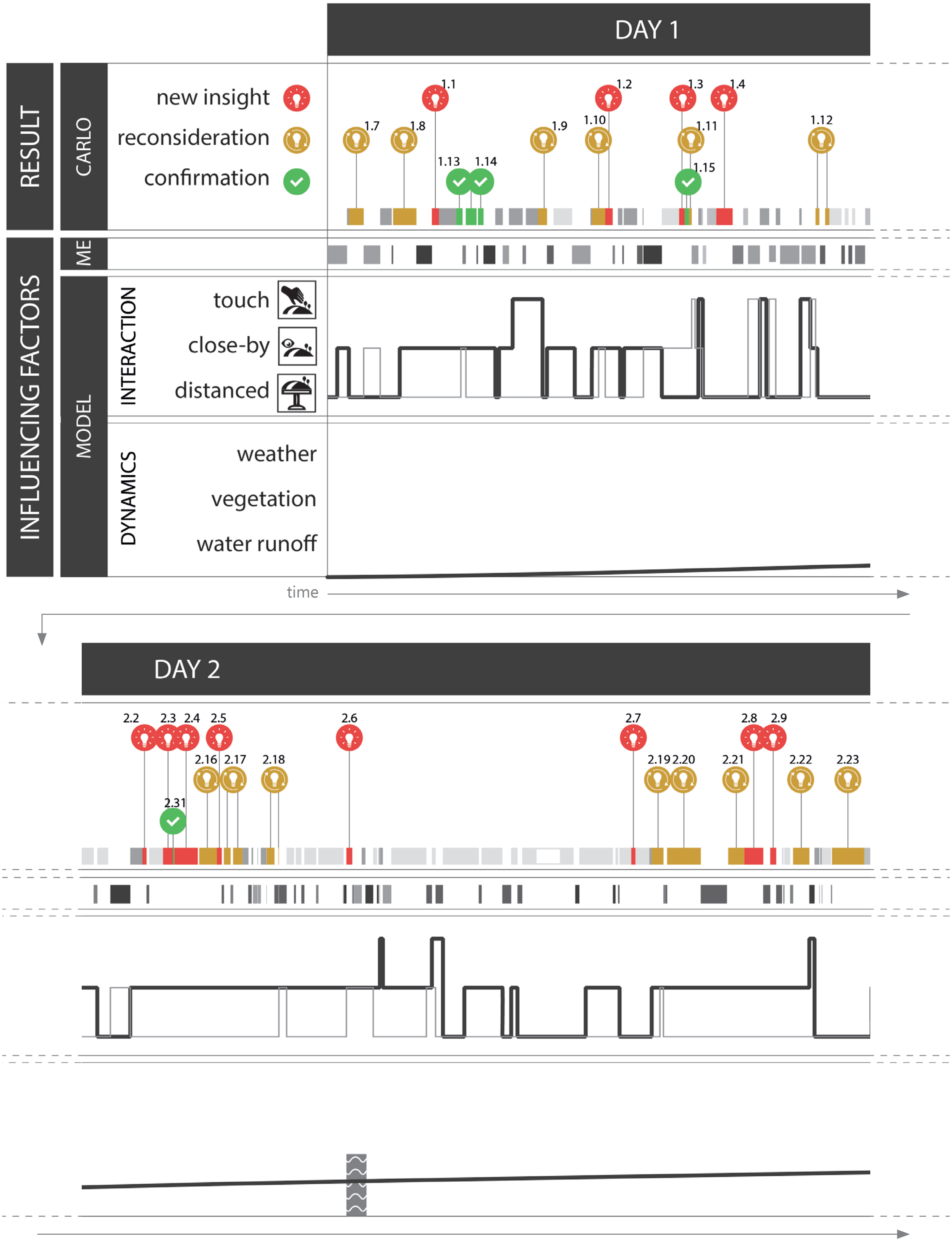
Having the model physically around

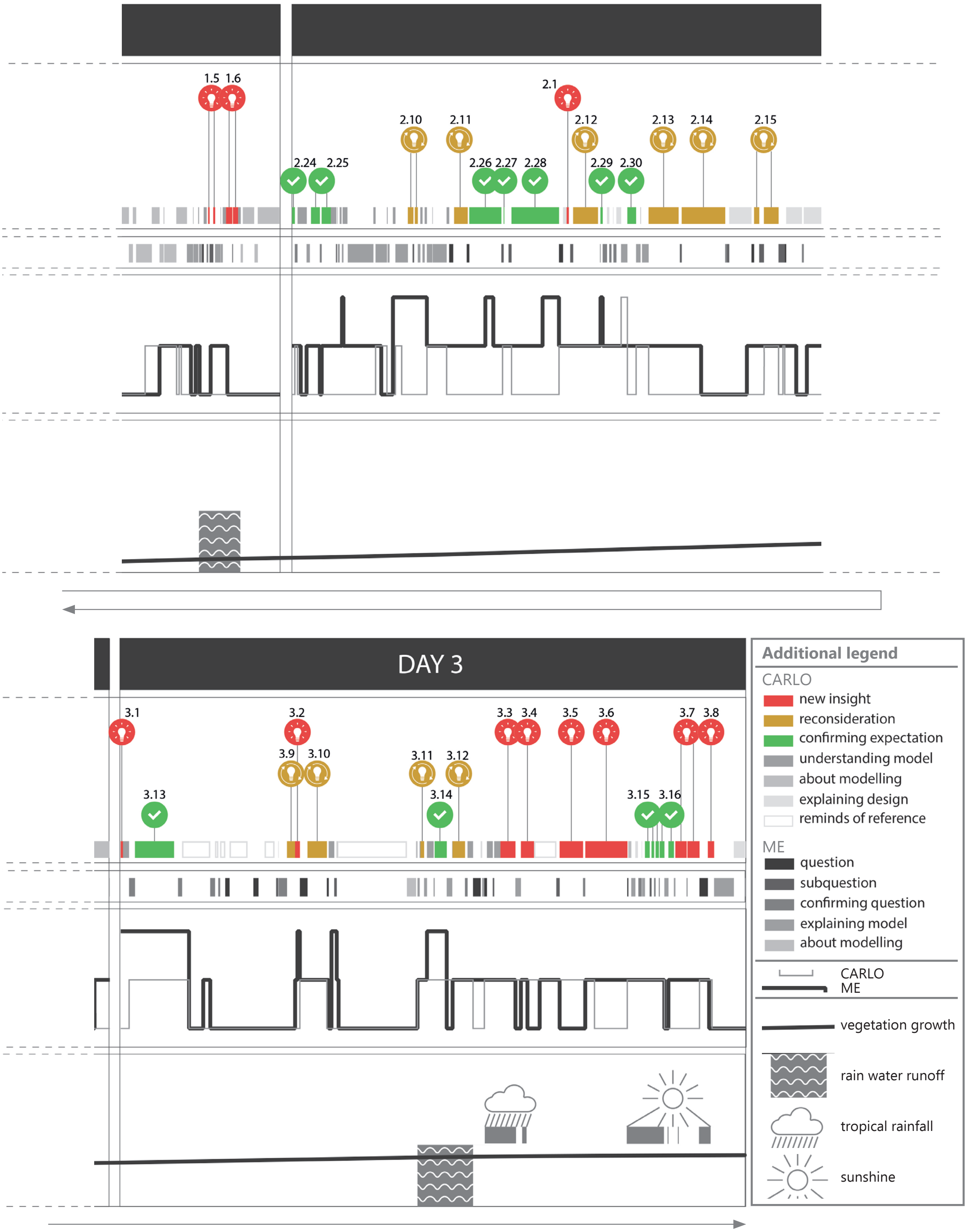
During three days Carlo had the model around for about one and a half hour every day. At those moments, Carlo was able to take a look at the model and he was asked to think out loud. I only asked some steering questions to test whether and how this model could help him. As the pumping system I developed was accidentally broken, I put in the water myself. In addition, I let it rain (using a spray bottle with water) and let the sun shine on the site (using a mobile phone) (**figure 6.19a,b** and **6.20a,b,c**). The latter I only did on the third day. However, the first two days are comparable to the third day. At the fourth day, Carlo explained his design (ideas) to another master thesis student (Sander) by explain ing it with the model, which was also caught on video (**figure 6.21**). At this day, Carlo talked and did, while Sander was asking him things and threw questions about his design.The day after (the fifth day) the model did not change that much concerning its vegetation growth, so I asked Carlo to look back at the previous days and to summarize (**figure 6.22**).

When analysing, the video-materials of the first three days were transcribed and coded to find the effect of the physical dynamic landscape model on Carlo's design process and design (ideas) (**figure 6.23**, **appendix 8**: raw video transcript and coding). A visualisation of this videotranscript, is shown in **figure 6.24** (see also **appendix 9**). When reading the video transcript in combination with watching the movies, it becomes clear that the (A) content of the talk around the model ('Carlo's thoughts') is influenced by (B) the appearance of the model, (C) the interaction with the model and (D) dynamics of the model .



6.23 Raw video transcript and codign; see also **appendix 8**

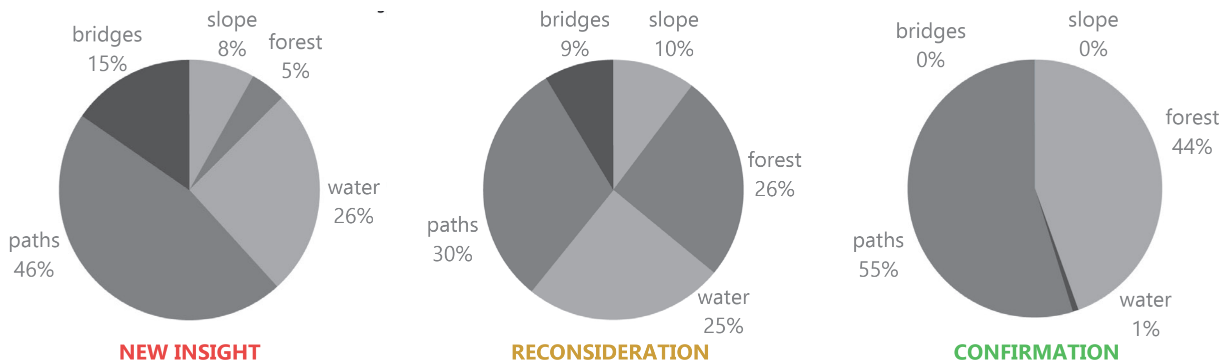

DAY 1
RESULT
CARLO
new insight
reconsideration
confirmation
1.1
1.2
1.3
1.4
1.7
1.8
1.9
1.10
1.11
1.12
1.13
1.14
1.15
INFLUENCING FACTORS
ME
MODEL
INTERACTION
touch
close-by
distanced
DYNAMICS
weather
vegetation
water runoff
time
DAY 2
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
2.16
2.17
2.18
2.19
2.20
2.21
2.22
2.23
2.31



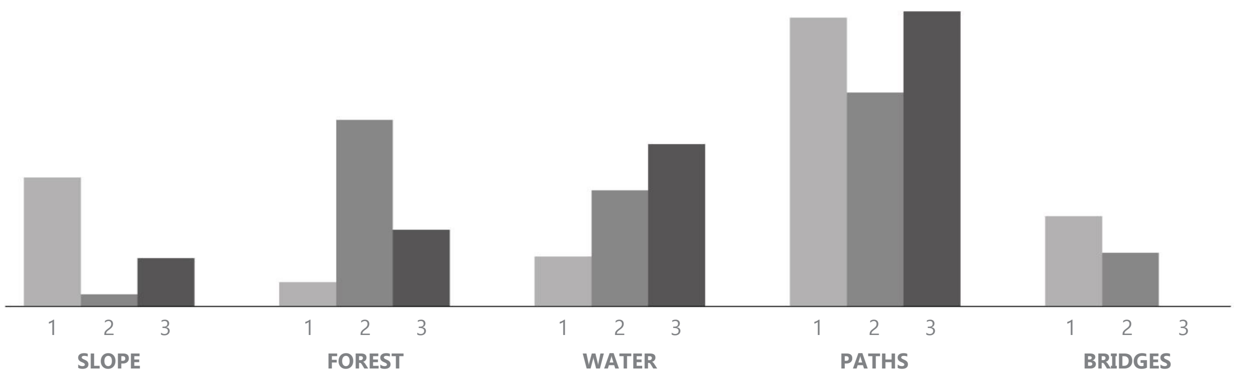
6.24 Visualisation of video transcript in which the content of Carlo's thoughts is related to my talk, the interaction with the model and the dynamics of the model; the length of every coloured block represents the amount of words

(A) CARLO'S THOUGHTS
Overall, Carlo had three types of reflection upon his design when having the model physically around: new insights, things that he reconsidered and things that confirmed his expectations (**figure 6.27**). These reflections are arranged around five topics: 'slope', 'forest', 'water', 'paths', and 'bridges'. **Figure 6.25** shows the overall content of the talk in relation to the three types of reflections by showing the percentages of spoken words by Carlo concerning a certain topic during the three days. **Figure 6.26** shows the relative amount of words concerning the topics, distributed over the three days.

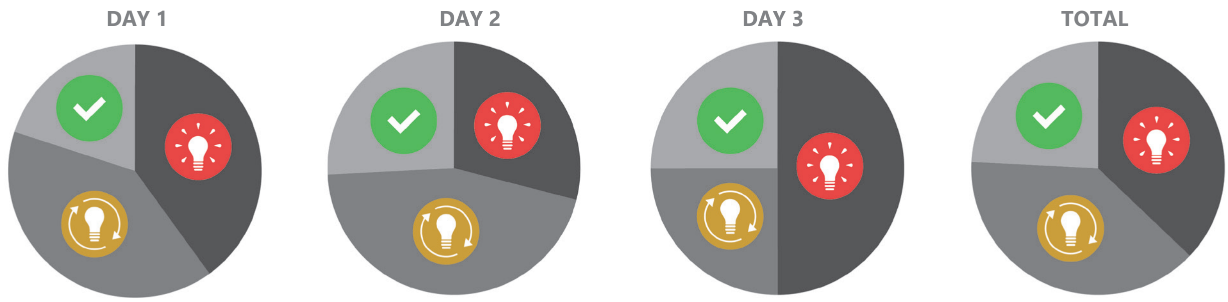
(B) MODEL APPEARANCE
The model appearance is mainly based on the construction: materials/techniques (wood, sand, cardboard and cress) and size/scale (1:200, +/- 1m2) (**figure 6.29**). As living materials are used, the models appearance changed over time. **Figure 6.28** shows the vegetation growth of the model during the three days that Carlo had the model around and the level of moisture of the sand caused by the modelled rainwater runoff and rainfall on day 2 and 3.



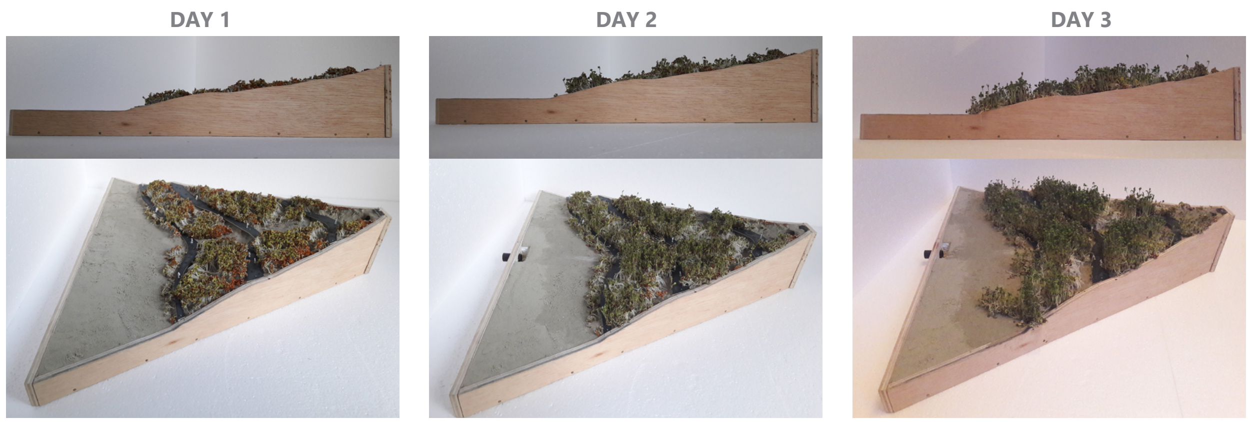
6.25 Three types of reflections concerning five topics: the relative amount of words spoken by Carlo over three days



6.26 Distribution of topics over the three days: the relative amount of words spoken by Carlo about these topics



6.29 The relative amount of words concerning the three types of reflection Carlo had when having the model physically around: new insights, reconsiderations and confirmations of expectations: shown per day and in total



vegetation height	± 1.5 cm	± 2.0 cm	± 3.5 cm
vegetation effect	open	closed on paths and mainview	more closed
sand moist	low	medium	high

6.28 Visualisation of the video transcript: Carlo's talk (thoughts) about the model, influenced by the appearance of the model the interaction with the model and the dynamics of the model

6.27 Model appearance concerning construction: a wooden base, sand topography, cardboard paths and cress vegetation

(C) MODEL INTERACTION

Interaction with the model took place in three main ways: touching and shifting in the model, looking close-by or at eye-height and being distanced from the model (**figure 6.30**). **Figure 6.31** shows the overall ratio of these three model interaction-modes, as well for Carlo as for my own interaction. In general I was most of the time distanced from the model to not influence Carlo's behaviour too much. However, I sometimes also touched the model, to inspire and stimulate Carlo to do so as well. This was mainly on the first day when explaining about the model (**figure 6.32**). By looking at the graph of **figure 6.30** the

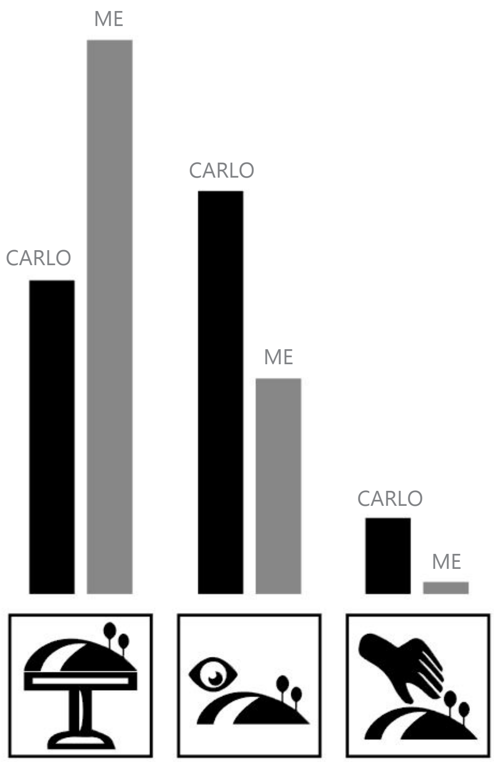
Touch

Close-by

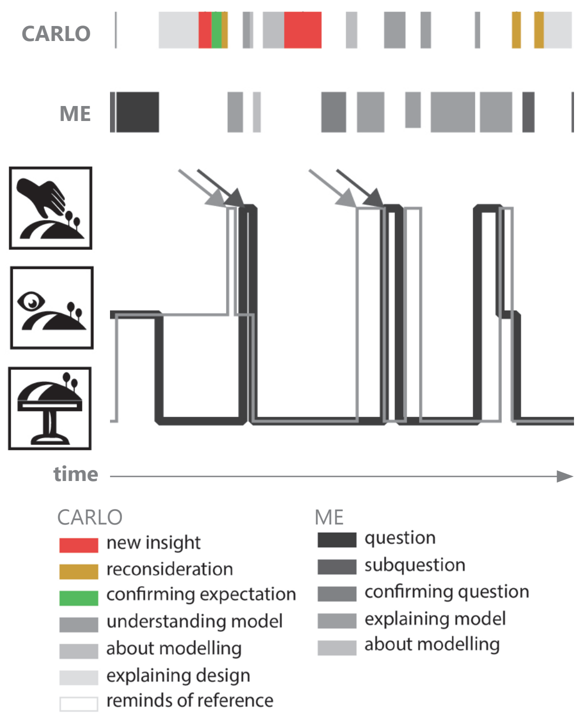
Distanced

6.30 Three main ways of model interaction: ouching and shifting in the model, looking close-by or at eye-height and being distanced from the model conclusion can be made that relatively little is touched or moved in the model and that often the model is seen close-by or at eye-height.

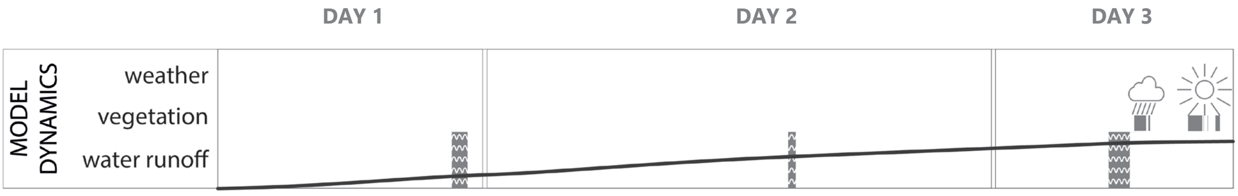
(D) MODEL DYNAMICS
The dynamics of the model consists of four elements: growing vegetation (**figure 6.27**), rainwater runoff (**figure 6.20b**), rain (**figure 6.20a**) and sunshine (**figure 6.20c**). The vegetation growth is a constant dynamic factor, while the others are temporally dynamic events added to the model by myself at certain moments (**figure 6.33**). Rain and sunshine only happened on the third day.



6.31 Three types of model interaction, relative over the three days



6.32 Example of me stimulating Carlo to touch the model when explaining about the model



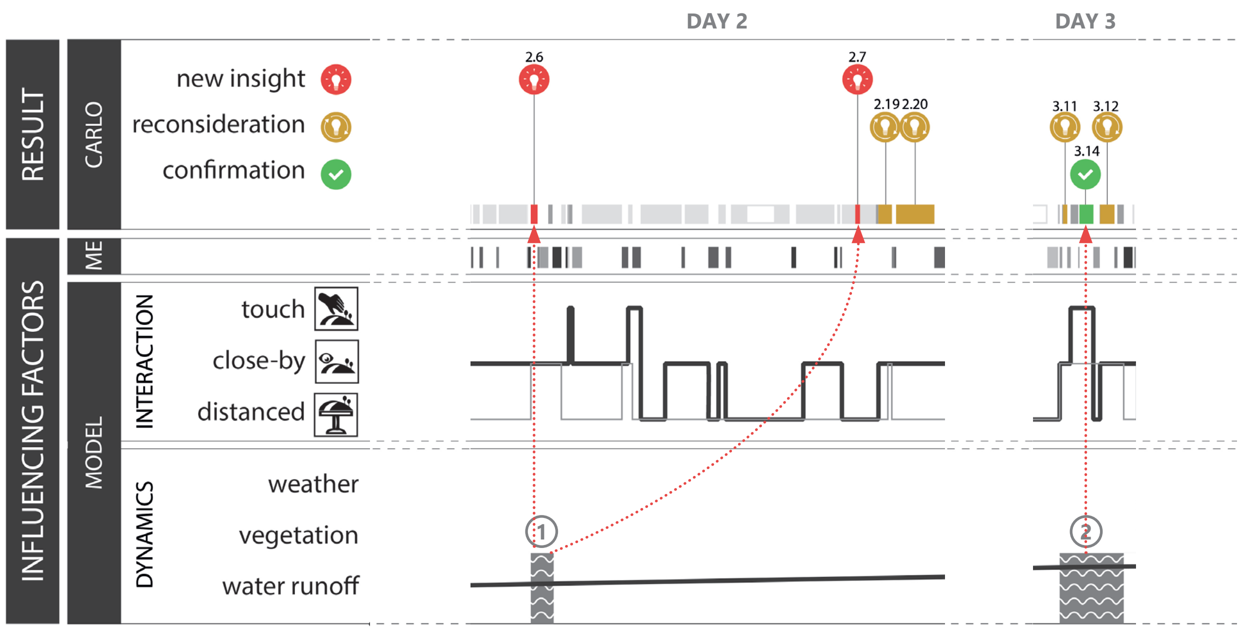
6.33 Model dynamics: constant vegetation growth (1) and temporally dynamic events like rainwater runoff (2), rainfall (3) and sunshine (4)

'Carlo's thoughts' in relation to 'Model appearance'
The conclusion that Carlo's thoughts existed of five main topics, is mainly related to the model's appearance. During the three days, most of which was talked about is 'paths' (**figure 6.26**). The way in which the paths were represented in the model was apparently different than Carlo's thoughts on forehand. This lead to a lot of new insights (*path width, elevation, continuity*), reconsiderations (*path geometry, visibility, colour, maintenance)* but also confirmations *(path proportion, visibility*). The topic 'slope' came up most on the first day. Carlo was surprised to see how the slope worked out in 'reality'. The presence of model made him grasp the scale, also concerning the bridge construction (*following topography, larger bridges*). On the second day the topic 'forest' stands out. This is also relatable to the appearance of the model. Between the first and second day more difference was found in the vegetation effect (density) than between the second and third day (**figure 6.28**). Besides, Carlo's attention turned on the second day to the edge of the forest, near the desert area. Carlo reconsidered vegetation on two sides of the lowest path by making and looking at two different situations. He put away some vegetation at one side of the model and could turn the model to see the difference of experience on the path (**figure 6.34**). From the results of **figure 6.25** the fact that no confirmation of expectations was on the topics of 'bridges' and 'slope, and very few on 'water'. No confirmation on slope is logical, as Carlo expected the slope to be much steeper. No confirmation on 'bridge' and 'water' can be explained by the fact that Carlo did not design that much on these topics himself yet. For him this were only lines and shapes on a map, not yet visualized or designed ideas in three dimensions. Therefore it also makes sense that there were quite much new insights and reconsiderations about 'bridge' and 'water', as the model appearance made them visible in three dimensions, open for perception and judgement.

'Carlo's thoughts' in relation to 'Model interaction' (and 'Model appearance')
The conclusion that relatively little is touched or moved in the model (**figure 6.31**) is striking. Likely this has to do with the Model's appearance as well. Magic sand was chosen from the experiments as the best basic material for an explorative physical landscape model

6.34 By adjusting one side of the vegetation near the lowest path and turning the model Carlo compared two types of situations on the lowest path because of its high adjustability. But the cress covered a large part of the topography which made it (almost) not possible to adjust the sand. Where the sand could be adjusted (mainly along the desert part) it was done. However, the fact that a thin layer of sand was put on top of a white foam filling, made only small adjustments of topography possible. As well Carlo as me did not know what the effect would be on the longer term if we would shift the cress. We did not know what would happen if we would move (parts of) the forest for example. However, at the second day some of the lowest vegetation parts (on the desert side of the lowest path) was shifted 'into the desert' to be able to look at the effect of (1) having vegetation on both sides of the path and (2) having an open side to the desert (**figure 6.34**). Although the cress was quite roughly moved aside, the next day it was already growing further on the place we had put it.

'Carlo's thoughts' in relation to 'Model dynamics' (and 'Model interaction')
On the first day, Carlo thought the slope was *less steep than expected* and he reconsidered making the slope steeper. However, the second day he realized – due to the simulation of the rain water runoff (point 1 in **figure 6.35**) – that the *slope helped to steer water* (thought 2.6) and that he should be *careful with making the slope steeper for water runoff* (thought 2.7). On the third day he reconsidered that the *slope was ok like this* (thought 3.12), also when seeing the rain water runoff (point 2 in **figure 6.35**). In general, the model with simulated rain water runoff helped Carlo to imagine and test how it really would work out concerning water design, as Carlo had only designed this from a two-dimensional map. He had no idea what effect the water flow would have. The model came closer to reality.

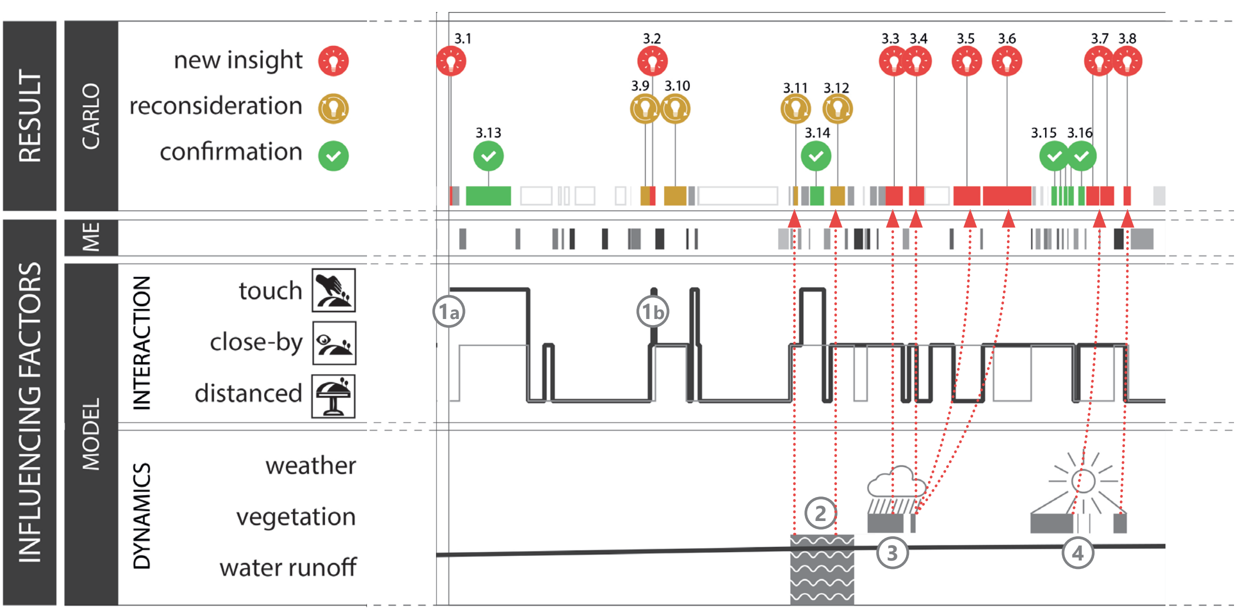


6.35 Example of 'Carlo's thoughts' about the 'slope' in relation to 'Model dynamics' on Day 2 and Day 3

Another striking thing is that on the third day a lot of new insights are gained (**figure 6.27**). When looking at the video transcript, one can recognize a relation to the 'Model dynamics'. On that day 75% of the new insights is gained at the moment the model is highly dynamically active. The other 25% of new insights can be linked to a high degree of 'Model interaction' (point 1a,b in **figure 6.36**). When the rainwater runoff was simulated (point 2 in **figure 6.36**) Carlo started reconsidering the construction of the lowest bridge (thought 3.11) and realized the *steepness of the slope was ok* (thought 3.12). When a tropical rainfall was simulated (point 3 in **figure 6.65**) Carlo had a new insight that the *paths should maintain easy to walk on* (thought 3.4). When the rain stopped the whole model was wet. This made Carlo think that *the paths and water system should stay for quite some time* (thought 3.5), as the design should not wash away; and about how the *water distribution* should be *in relation to other parts of the plan* (thought 3.6). When sunshine was simulated on the model (point 4 in **figure 6.36**) the wet paths were reflecting, what Carlo appointed as *a cool contrast with the dark forest* (thought 3.7). Directly after concluding that, Carlo thought that the material of *the paths should be robust and not slippery, but still reflecting* (thought 3.8), as the dynamics of the model made him think of a muddy situation he experienced himself as unpleasant. New insights are not only gained about the design, but also about design representation. When Carlo sees the tropical rainfall (point 3), he thinks about *adding rainbows to his visual* (thought 3.3), as that was something he saw during his site-visit in Brazil. The model made him remind of this situation; simulating a specific weather situation brought these memories back.

Tracking the model's development

Besides keeping a logbook and having the model physically around, the case-study



6.36 On Day 3 the 'Model dynamics' had a large link with 'Carlo's thoughts' concerning gaining new insights and reconsiderations: 75% of new insight was gained when the model was highly dynamically active (point 2, 3 and 4); the other 25% of new insights was gained while having a high mode of interaction with the model (point 1a and 1b) concerned keeping track of the model's development. Therefore I made a photo booth (**figure 6.37a,b,c**) to be able to take seven pictures each day from the same viewpoints, in order to keep track of the model's growing process (**figure 6.38**). From these photos time lapses could be made (.gif-documents). In addition, I made some photos of the model itself. (**figure 6.38a,b,c,d**) and a movie (**appendix 12**, filmstills are shown in **figure 6.39**).

6.37 Tracking the model's development by taking every dag seven pictures from the same spot: white (foam) background and a standard   to be sure the pictures are always taken from the same angle

6.38 Some photos taken from the model (a) right after seeding, (pure photograph) (b) at the morning of Day 1 with some sunlight in the living room (pure photograph) (c) in the afternoon of Day 1 (pure photograph) and (d) on day 3 (slightly blurred by computer) after simulated rainfall in the classroom

6.39 The model's development over seven days from seven angles

DAY 3 DAY 4 DAY 5 DAY 6

6.40 Filmstills of the movie of the model; natural sounds of animals, wind and rain recorded on the project site are part of this movie

6.1.3 Discussing the case-study

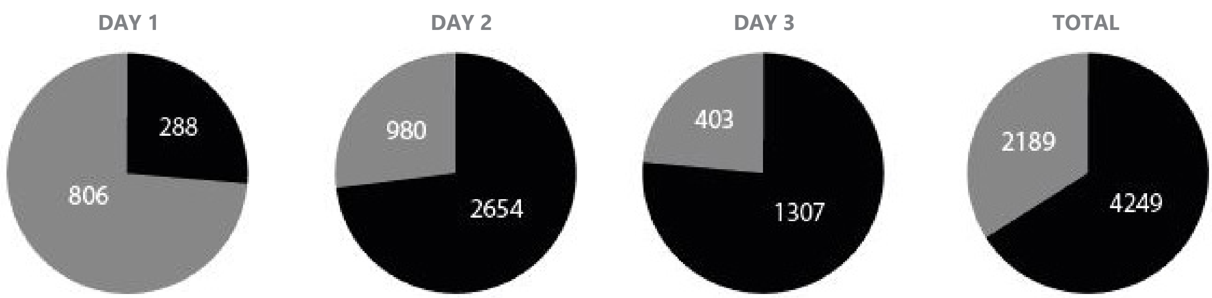
All three aspects of the case-study have their own limitations and constraints. Below these things are discussed, concerning the set up and results of every aspect.

Logbook

Although Carlo valued his design progress for 80% as ‘good’ while having the model around, and only for 47% as ‘good’ when he had the model not around, not much value must be attached to these results. Firstly, there are a lot of external factors of influence on keeping this logbook. Some of them cannot be controlled, for example the influence of Carlo’s private mood to his feeling about his design progress. Secondly, one cannot conclude about the effect of the model on Carlo’s design process. The logbook gives the impression that Carlo felt good about the moments he had the model around, but the effect of these moments on the next phases in his design process cannot be seen from only this logbook. A more extended (quantitative) in-depth study is at least needed for that, for example using consistent surveys with more questions.

Having the model physically around

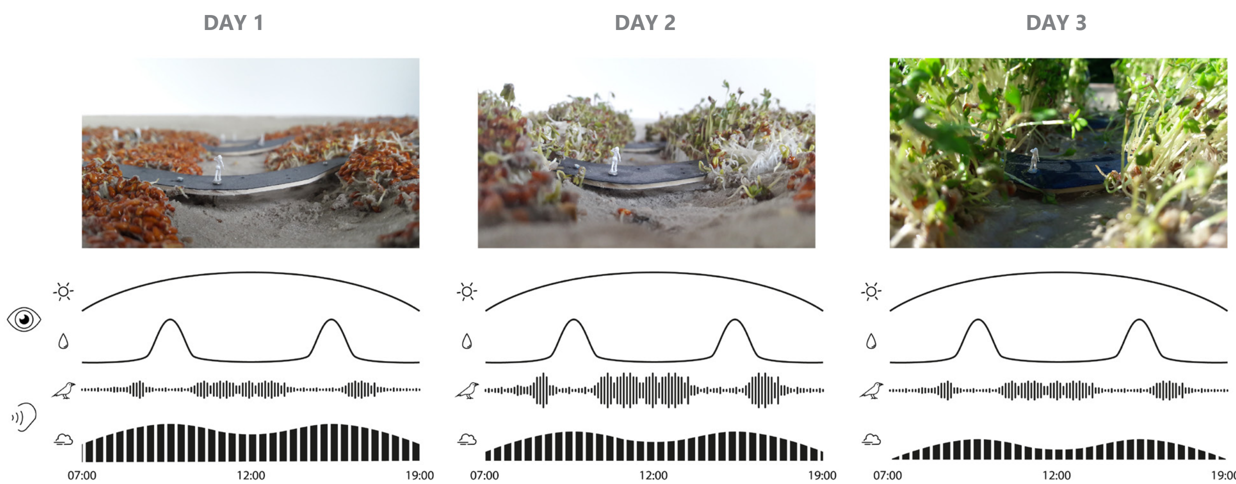
Important to notice is that the process of the case-study was also a process of trial and error in its set up. At the end of the first day I watched the movie of that day and transcribed it. Then I realized that I was interrupting Carlo quite often. I heard myself talking a lot (enthusiastic about the model and willing to explain how I made it) while it was the aim that Carlo could think out loud freely. So on the second day I put effort to let Carlo talk more. The same goes for the third day; resulting in the balance of **figure 6.41**.
At the fourth day, Sander influenced the case-study more or less, however it was helpful that he asked things and that Carlo had the opportunity to talk from himself about the model and his design ideas about it. Carlo started to think and reflect some more, which again made him look a little bit different at the model. In addition, this moment gave some extra evidence that the model could be really of value for landscape architecture, as two landscape architects (in training) were talking about a design, using the model. Sander got really enthusiastic from it and actually mentioned, without asking him, those things were the model was meant for. While explaining his design to Sander, Carlo looked



6.41 The amount of words spoken on every day: as on the first day I heard myself talking a lot, I put effort on the second and third day to enable Carlo to speak his thoughts out loud even more, without interrupting him very happy and motivated to talk about the situation in the model. As at the fifth day I asked Carlo to reflect on the previous days, the last two days were supplementary to the first three days.

Tracking the model's development

Making and using the photo booth was of great improvement concerning capturing moments over time in comparison to the experiments. As the photos were taken from the same angles and with an (almost) white background, the pictures were very comparable and resulted in a uniform range of images. In addition, taking pictures from the model on the level of the human eye offers possibilities for representing to present and test design ideas and dynamic (and atmospheric) effects. When I showed Carlo the photo of figure 6.38d, he said: *"This is wonderful. I should skip the visualisation in that part, and just use your photos"*. The time lapses (.gif-documents) made from the photo booth pictures showed the growth over time and helped, according to Carlo, *"to realize"*, *"to see the differences and to remember them"*. Carlo himself acknowledged the importance of capturing the moments in time in this dynamic model: *"[...] you are capturing a moment, so you can see it back. Since the model is changing all the time, you cannot compare a moment that had already passed by another. So it is important to keep record of this thing, so you can go back in this sense."* The video of the dynamic model, shown to Carlo before editing (so raw material, no sounds), did not add that much for him: *"I already saw it. Well, what is nice of this, is the sun; not because you made a video of it, but because I saw it with the light of the sun, which makes it different and creates this nice atmosphere in here [pointing at the shadows]."* . However, making a movie enables the designer to show his design (ideas) in a more extended way than a Photoshop, as sounds and movements can be included. It would be even better to include time even more. An example is shown in **figure 6.42**. Here, three movie(still)s are shown, including the dynamics of sunshine, rain, natural (animal) sounds and wind during the days.



6.42 Example of making and using movies of a physical dynamic landscape model including change over time

6.2 Conclusions from case-study

According to the designer himself, Carlo would have been less conscious and less secure about his design when not having the physical model around. He would have taken different decisions. At the start of this chapter it was stated that Carlo had to deal with three design questions. The making and using of the dynamic landscape model aimed to help to deal with answering these questions. Now we can conclude that it did work out:

Having the growing dynamic landscape model around helped Carlo to understand and study the **growth of the forest**. In addition, the photos from the photo booth and the time lapses were a means to capture the change through time and to represent certain situations in order to test and present the atmospheric effects of the different stages of vegetation height.

The dynamics that could be simulated in the model helped Carlo to understand and study the **rain water runoff** as water could flow through the model. The interaction with the angle of the slope surprised Carlo and also the fact that the water flow eroded the sandy topography helped Carlo to think of these effects in reality. Although no quantitative value can be attached to what is seen in this physical model, it offers great opportunities to think about it in a qualitative way.

Concerning **phenomenology in the design** (process) Carlo gained some new insights due to the model dynamics, for example about the atmospheric effects of weather on the materiality of the design. In addition, the ability to take photos and movies from the model is a very simple and fast way to visualize the design in a way that comes close to reality and has a multisensory appearance.

Within the design process of the case-study the features of a physical model to understand, to think, to test and to communicate (concluded from Chapter 3 in the first part of this thesis) are recognizable. In addition to that, the added value of a dynamic physical model over a static physical model is visible in this case-study.

To understand

The physical dynamic landscape model helped Carlo to understand the situation he had designed in his masterplan. The appearance of the model helped him to grasp the scale of the slope and the path and bridge construction. Due to the model dynamics Carlo understood the effect of rain water flow and became aware of the consequences for soil erosion and design interventions he had to take into account. These were things he had not yet studied with other design tools.

To think

During the time Carlo had the physical dynamic landscape model around he gained new insights, started reconsidering things and saw some of his expectations confirmed. The model stimulated Carlo's creativity and enlarged his imagination. The fact that the model was highly dynamically active on the third day caused a huge effect on his thoughts and provoked a lot of new insights which improved his design (process).

To test

The physical model as a way to test design (ideas) can be recognized in the presence of reconsiderations and confirmations in combination with model appearance and model dynamics. Carlo could test in a static and a dynamic way. Statically, the model offered the possibility to test topography and construction of paths and bridges. This is closely related to 'understand', as Carlo did not change these elements in order to test alternatives. But as the vegetation changed over time, Carlo could still test the shapes and proportions of paths in relation to the different stages of vegetation density. Shifting vegetation in the model only took place when Carlo compared the situations of vegetation along the lowest path. Here, Carlo really did *"point, stoop, pick, shift, look, test and judge"*, like landscape architect Raf Rooijmans mentioned. Although it seemed that shifting the cress was (almost) not possible, it can have more potential than we think. The cress that was roughly moved aside still grew further and just attached already the next day on the other spot: cress might be more adjustable than we think. New experiments should be carried out to find out how far the adjustability of cress reaches, also concerning cutting it and growing further. Although the effect of a certain material could not literally be tested in the model, it happened indirectly as the model made Carlo think about the reaction of materials on different weather conditions.

To communicate

Explanatory communication took place when having the model physically around. Carlo explaining his model to Sander, which was what Gänshirt (2007) described as *"bridging the gap between laymen and experts"* (p. 149). Here, Sander is the 'layman' and Carlo the 'expert' about Carlo's design. The appearance of the model contributed to this, as the model as a physical object offered the ability to point at things which are explained. The model dynamics helped about seeing the water flow and explaining about what is happening and how Carlo want to reacts on that with his design.
Steering communication concerning manipulation can be recognized in the case-study in manipulating perception and decision making. The 'moving Photoshop' created by filming the model when it was dynamically active and adding natural sounds to that, is a way of showing the phenomenological effect of the design. Here the added value of a dynamic physical model is very present as more senses come in: not only sounds, but also movement, which makes it come closer to reality. A dynamic physical model offers more opportunities for this than a static model. As I visualized Carlo's design from his

height map and masterplan, I accidentally seduced him to make elevated and continuous paths by choosing a certain material to represent that in the model (cardboard). This is an example of Peter Koorstra's term *"the good accident"*.

As written above (between the lines), the dynamic physical landscape model has an added value over a static physical model. The moment that the model was highly dynamically active, Carlo's design process got "surprising twists", as architect Jan Peter Wingender mentioned. The water flew over the lowest bridge, which was unexpected, and the effects of rainfall and sunshine surprised Carlo and stimulated him to think even more about his design and its materiality. The model dynamics also provoked Carlo to think of references (e.g. rainy and muddy situations and a walk in a park with closing vegetation). This makes the model even more a stimulator of creativity, thus landscape architect Daniel Ganz.

7 EVALUATING PART II *The dynamic landscape model*

From Chapter 5 it has become clear that magic sand and cress are suitable materials for dynamic landscape design, combined with a simple and easy 'do-try-this-at-home/the office'-situation to model the dynamics of flowing water. In addition, during the series of experiments the importance of size was addressed, as well as the way to track a design process.

The case-study described in Chapter 6 translated these findings to an actual design process and even improved the techniques. However, although a water pumping system was developed (example of an improved technique), it did not work during the case-study. This might have influenced the use of the dynamic landscape model, as at that moment there had to be found and alternative to let the water flow. The importance of size and tracking the design process was taken into account as a kind of 'background process' to positively influence the making and use of the physical dynamic landscape model itself.

OUTRO

8 EVALUATION OF THE RESULTS

In PART I of this thesis the use of physical models was explored. The conclusion is that a physical model is seen as a valuable tool in many ways. As it is an inspiring physical thing around which also bridges the gap between thinking and making, the physical model is a valuable tool within (and beyond) the design process. Under influence of the type of design, the design process and the designer(s) him/herself, it is decided whether or not to model. When using physical models for designing, the aim of the model depends how physical modelling takes place, concerning the model's abstraction and reduction and its materials, techniques and size (related to scale). Although one can distinct all aims of landscape architectural physical models in three types, the physical model appears to be a transformative tool, which has the ability to shift meaning. This makes the physical model a very effective but also explosive design tool. The fact that time is an important causer of costs, makes it an important factor in deciding to use physical models or not. The existing lack of know-how and skills concerning the use of physical models for landscape design appears to be a very related issue. This adds up to the fact that landscape architects seem to model the way architects do (static), while their profession differs (static architecture versus dynamic landscape architecture). It seems that landscape architecture therefore passes over the full possibilities that a physical model can offer for their design process (and thus design outcome), mainly relating to the explorative phases in dynamic landscape design. Here, the challenge for this thesis is formulated: to give new insights on the use of physical models for the explorative phases in dynamic landscape design; so to give new insights in involving landscape dynamics in a physical model – by taking into account the factors that influence the general use of physical models in the design process: the choice of materials, technique and size. This is done in the second PART.

PART II described and evaluated the explorative study to find a design tool for physical dynamic landscape modelling. Focussed within landscape dynamics on flowing water and growing vegetation, three series of experiments and a subsequent case-study were executed. The experiments led to a substantiated choice for materials and techniques suitable for dynamic landscape modelling. Three aspects stood out: the use of Magic sand for an explorative landscape study, the use of a simple and easy 'do-try-this-at-home/the office'-situation for physically modelling the dynamics of flowing water (for which Magic sand is suitable), and the use of cress (*Lepidum sativum*) for physically modelling the dynamics of growing vegetation (which can grow on Magic sand). These aspects were implemented into a case-study, taken into account the importance of physical model size for the use of the model in the design process (the model should not exceed door size). From the case-study two things came out: an example of how to build a dynamic landscape model for exploring the dynamics of flowing water and growing vegetation, and an example of how this model exactly could be used in and influenced a specific phenomenological design process (and its design outcome).

9 DISCUSSION

For the sake of good research and design it is important to look critically at the results and conclusions made.

I expect both parts of this thesis to be independently and in conjunction with one another useful in terms of scientific research and the practice of design. PART I offers an overview of the current use of physical modelling in architecture and landscape architecture, with special attention to the field of landscape architecture. This overview based on literature and practice is based on and complementary to the existing knowledge on physical modelling and offers a lot of examples from practice. PART II goes into depth within the explorative phases of dynamic landscape design by offering a specific case-study in which a physical dynamic landscape model is applied.

PART I offers no complete overview, as some literature sources might be overlooked and only a part of all students and professionals in (landscape) architecture were interviewed. However, I think I reached a certain point of saturation in my in-depth interviews, as the last two interviews were very repetitive of what I heard before. PART I largely came to being by interpreting and analysing what I myself saw, heard and understood. Although I have tried to be open minded throughout the process, some preconceptions or expectations might have influenced the conclusions. Some assumptions were taken for granted, for example when a professional made a statement, which I assumed as 'truth', based on the fact that I experienced this (sometimes not even literally heard or seen) at other offices as well; while not first comprehensively criticizing that statement or finding. However, the answers of the professionals on my questions might be assumed as valid for the rest of his/her office.

PART II has some other things that can (and should) be criticized. Firstly, the experiments were led by trial and error and therefore are not exhaustive. I have based my decisions on my findings from literature and practice, on discussions with professionals, but also on discussions with my supervisors and fellow students throughout my thesis process; in order to value the outcomes of the experiments as valuable or not, as relevant for a follow-up experiment or not. The case-study besides, is limited in the sense that it offers one example of one case for one designer, carried out in one week. This makes the dynamic landscape model not yet proved in the wider field of landscape architects, as it might be (will be) different with other designers, design processes and design assignments. However, it was a process of trial and error in its set up, which makes it also a starting point for further research, as everything that took place in the case-study is described and transcribed.

10 CONCLUSION

This thesis has brought me to the conclusion that physical models are indeed valuable design tools; even for dynamic landscape design. Useful in many different ways, on different moments and for different aims, a physical model inspires and helps a designer to understand, to think, to test and to communicate. Although the criticism of Chapter 9 should be taken into account concerning the in-depth study in the current use of models and the explorative study to the use of a physical dynamic landscape model, this thesis shows a way in which physical models can contribute to the landscape architectural design process for dynamic landscape design. As shown in the case-study, a model with Magic sand, cress and water as main ingredients, can be used to improve the explorative design process and therewith the design of a dynamic landscape, concerning flowing water and growing vegetation.

Because the design process (of building the model and using it to design) is tracked, transcribed and analysed, this thesis offers a comprehensive example. Designers (landscape architects and others) can read and see how this type of model was made, and why and how this model helped Carlo. I hope this inspires them [you] to start modelling, to experience and apply this (or preferable an even better) way of physical modelling, in order to develop knowledge, skills and experience on physically modelling dynamic landscapes. In addition, I hope not only this thesis, but also the conversations I had

throughout the thesis process, create awareness of the value and meaning of physical models, which even goes beyond design processes themselves.

As one of the influencing factors to decide whether or not to implement physical models in the design process is the study-background of the designer(s) him/herself, attention should be paid to landscape architectural education. Studies should nurture know-how about the different design tools and their application, of which the physical model is one. Students (who become professionals) should learn about the possibilities created by physical models for the design process and the development of the design. As one cannot think without making, students themselves should be involved in experiencing and testing with physical models themselves. Besides creating a proper physical environment with sufficient space and materials (which does not need to be complicated or advanced), a good basis of know-how will help them to start choosing the right design tool for the right design tool and to use that to the fullest.

Sharing knowledge on the use of physical models is a start of improvement and perfection of skills and experience in dynamic landscape modelling. I hope applying this knowledge in study and practice leads to better design processes, ending up in better design solutions. Together we can identify, recognize and widen the habit of the landscape architect.

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‘n.d.’ stands for ‘no date’ meaning the date of publication was unknown

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APPENDICES

All appendices can be found online: please scan the QR-code below,
or copy the following URL in your internet browser:

https://drive.google.com/open?id=0ByMH6ibU58gOaEJDSnZoc1Vacmc

Overview of appendices:

1 Interview questions
2 Raw notes + photos Interviews and Observations

3 My daily logbook on thesis progress
4 Mood diagram of my thesis process

5 Raw notes + photos + movies of Experiments
6 Importance of carrying experiments

7 Case-study logbook Carlo Leonardi
8 Raw video transcript + coding Case-study
9 Visualisation of video transcript (extended version)
10 Constructing the physical dynamic landscape model
11 Testing and reflecting the physical dynamic landscape model
12 Movie of the physical dynamic landscape model

DANKWOORD

In mijn zoektocht door literatuur, praktijk, experimenten en de case-study werd ik geleid door mijn nieuwsgierigheid naar het gebruik van fysieke modellen (maquettes). Vanaf begin tot eind groeide mijn nieuwsgierigheid naarmate ik meer te weten kwam. Dat zou nooit zijn gebeurd als ik daarin niet was ondersteund. Doorlopend gestimuleerd in het doorzetten van mijn geklooi, wat vooral in de beginfase maar zeker ook in het latere proces heeft bijgedragen aan het blijven vertrouwen in en het navolgen van mijn fascinatie. Een groot deel hiervan heeft Paul voor zijn rekening genomen, wie ik hiervoor ook zwart-op-wit nogmaals hartelijk wil bedanken. De Serious-Landscaping-bijeenkomsten met medestudenten hielpen om te focussen en door te zetten. Daarom ook dank aan hen, en de andere studenten die ik op de derde (en soms tweede) verdieping van het Gaia om me heen had. Ik ben blij dat jullie mijn geschreeuw om hulp en aandacht, en de zooi (inclusief stank- en geluidoverlast) die ik maakte in het lokaal, hebben overleefd. Dezelfde dank gaat uit naar mijn familie thuis, waar ik een vergelijkbare (of ietwat ergere) situatie heb gecreëerd, maar waar mentale en praktische hulp nooit ver weg was. Vanaf thuis ben naar allerlei plekken in Nederland en zelfs Zwitserland gereisd om al die inspirerende mensen te ontmoeten: Peter Koorstra, Kinga Bachem, Dick Sman, Ronald Bron, Willem Brouwers (via email), Daniel Ganz, Nicole la Hausse, Claudia Moll, Raf Rooijmans, Jan Peter Wingender, Lieneke van Campen, Arjen Meeuwsen. Hartelijk dank aan jullie allen, de gesprekken die we hadden waren stuk voor stuk van grote waarde voor mijn onderzoek en ontwerp. Vaak ging dat gepaard met een bak goede koffie, soms een zelfgestookt likeurtje, of na het vier keer passeren van een landsgrens met verlopen paspoort; overal werd ik vriendelijk ontvangen en ging ik weer met een goed gevoel naar huis. In het speciaal ook nog dank aan Andrea, Pascal en Marlen, die een meer dan goed verzorgde locatie boden in de voor mij toen nog onbekende stad Zürich. Tot slot dank aan Carlo voor zijn enthousiasme en betrokkenheid bij de case-study, Rudi voor zijn bereidheid om Paul te vervangen tijdens de laatste weken van mijn thesis proces en dank aan Adri voor zijn uitdagende maar stimulerende feedback na afloop van mijn Proposal en Groenlicht-presentaties.

ACKNOWLEDGMENTS

My curiosity to the use of physical models has guided me through literature and practice, through experiments and case-study. From creation to completion of this thesis, my curiosity grew the more I found out. This would never have happened if I was not supported. Particularly in the beginning phase of the thesis process, but certainly also further in the process, this has contributed to keep trust in the relevance of and to follow my fascination. A large proportion of support throughout 'this process of me fooling around' was taken by Paul, who I gratefully thank hereby black-on-white as well. The Serious Landscaping-meetings with fellow students have helped me to focus and continue. Therefore also thanks to them, and those students surrounding me on the third (and sometimes second) floor of the Gaia building. I appreciate your patience in accepting my screams for help and attention, and the mess (including unpleasant smells and sounds) I created through the whole room. The same acknowledgements for my family at home, where I created a similar (or even worse) situation in the living room, kitchen, shed and garden; but where mental and practical help was never far away. From there I have travelled throughout the Netherlands and even Switzerland to meet all those inspiring people: Peter Koorstra, Kinga Bachem, Dick Sman, Ronald Bron, Willem Brouwers (via email), Daniel Ganz, Nicole la Hausse, Claudia Moll, Raf Rooijmans, Jan Peter Wingender, Lieneke van Campen, Arjen Meeuwsen. A big thanks to all of you, as the conversations we had were great input for my research and design. Often concomitant with a cup of good coffee, sometimes a home-distilled liquor, or after four times crossing a land border with expired passport; every time I was kindly received and went home in a good mood. Special thanks to Andrea, Pascal and Marlen, who offered a more than all-inclusive stay in a city I never expected to appreciate as much as I do right now. Last but not least, I want to thank Carlo for his great enthusiasm and involvement in the case-study, Rudi for his willingness to substitute Paul during the last weeks of my thesis process, and Adri for his challenging but stimulating feedback after Proposal and Greenlight presentation.

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