APPENDIX

A mental model approach to design

The development of a new framework on design for behavioural change
Table of contents

A: Original project brief ........................................................................................................................................ 2

B: Recruitment flyer ........................................................................................................................................... 8

C: Interview protocol .......................................................................................................................................... 9

D: Interviews........................................................................................................................................................ 11
   D.1 Insights per participant ............................................................................................................................... 11
   D.2 MM maps per participant .......................................................................................................................... 14

E: Mental model clusters .................................................................................................................................... 19
   E.1 Cluster 1: ................................................................................................................................................... 19
   E.2 Cluster 2: ................................................................................................................................................... 20
   E3. Cluster 3A ................................................................................................................................................... 21
   E.4 Cluster 3B ................................................................................................................................................... 22
   E.5 Clustering #4 ............................................................................................................................................. 24

F: Embodiment examples for each strategy of *Refining the embodiment* .................................................... 25

G Shortlists for participants during toolkit test ................................................................................................... 26
   G.1 Persona ....................................................................................................................................................... 26
   G.2 Fact sheet, including mental models ......................................................................................................... 27

H: Moderator guide for toolkit test ..................................................................................................................... 28

I: Mental model explanation ............................................................................................................................... 31
IDE Master Graduation
Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student’s IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:
- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student’s registration and study progress.
- IDE’s Board of Examiners confirms if the student is allowed to start the Graduation Project.

** STUDENT DATA & MASTER PROGRAMME **
Save this form according to the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

Your master programme (only select the options that apply to you):
IDE master(s):  
- IPD  
- Dfi  
- SPD
2nd non-IDE master: 
individual programme:  
honours programme:  
specialisation / annotation:  
- - (give date of approval)

Your master programme (only select the options that apply to you):
IDE master(s):  
- IPD  
- Dfi  
- SPD
2nd non-IDE master: 
individual programme:  
honours programme:  
specialisation / annotation:  
- - (give date of approval)

** SUPERVISORY TEAM **
Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair
David Keyson
dept. / section: DCC

** mentor
Jeroen van Erp
dept. / section: DCC

2nd mentor
Danielle Timmermans or Ellen Uiters
organisation: RIVM
city: Bilthoven
country: The Netherlands

comments (optional)
David and Jeroen form a balanced mix. From David I expect to receive more supervision on the theoretical and abstract level. From Jeroen, his broad and practical design experience will be very helpful in this equally mixed project.

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v.

Second mentor only applies in case the assignment is hosted by an external organisation.

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.
Procedural Checks - IDE Master Graduation

APPROVAL PROJECT BRIEF
To be filled in by the chair of the supervisory team.

Chair: David Keyson
Date: __________
Signature: ____________________________

CHECK STUDY PROGRESS
To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair. The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: _______ EC
Of which, taking the conditional requirements into account, can be part of the exam programme: _______ EC
List of electives obtained before the third semester without approval of the BoE: ____________________________

YES all 1st year master courses passed
NO missing 1st year master courses are: ____________________________

Name: ____________________________ Date: __________ Signature: ____________________________

FORMAL APPROVAL GRADUATION PROJECT
To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **.
Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks?
- Does the composition of the supervisory team comply with the regulations and fit the assignment?

Content: [ ] APPROVED [ ] NOT APPROVED
Procedure: [ ] APPROVED [ ] NOT APPROVED

Name: ____________________________ Date: __________ Signature: ____________________________

IDE TU Delft - E&SA Department // Graduation project brief & study overview // 2018-01 v30
Initials & Name: WS van Hoeven Student number: 4602390
Title of Project: Design of a framework for embodying mental models
Design of a framework for embodying mental models

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 03 - 09 - 2018 end date 08 - 02 - 2019

INTRODUCTION

The proposed project in this draft is about mental models. A mental model is a conceptualization of something in the world. People use them to explain and predict the world around them. Although to designers mainly known in the field of usability, mental models can be about many things in life, ranging from cognitive to physical processes (see examples below). I believe that such mental models have a great impact on people and society and are therefore well-worth researching. For designers that aim to change behavior, mental models may become a valuable tool.

To give some examples: In voting, people's mental model can be crucial to get a high turn-out. An existing (advertisement) intervention in the Netherlands focussed on countering the mental model that one vote does not make a difference. This was done by offering a new mental model through providing a metaphor from physics (see image 1 on the next page). Helium balloons are added on a heavy weight. After a number of balloons, suddenly one balloons tips the balance and makes the weight become afloat. This metaphor explains that any vote can be the one that makes the difference.

Another example is about recycling. In the Netherlands we have a separate stream of waste (PMD) that contains recyclable materials such as plastics and metals. However, for many people it is unclear what trash can go in there and what should be in the regular trash, with mistakes disrupting the recycling process. There are huge lists of allowed items, but these cannot realistically be memorized or consulted every time. Therefore, it would be helpful to improve the mental model about recycling this waste stream by communicating how the trash is separated (e.g. weight- and magneticity differences). This is something people will remember and can use to determine which trash should go where.

The main stakeholder is the RIVM (translated: Dutch National Institute for Public Health and the Environment). They do research into public and environmental health and communicate risks to policy-makers and the general public. The RIVM's current method is the Mental Models Approach to Risk Communication, which entails measuring the public's mental models and constructing textual communication to correct or complement them.

Currently, the RIVM is having trouble with the communication of risks to the public. The public thinks the provided information is irrelevant, too complex or not believable. Therefore, the RIVM is interested in different, more effective, ways of communicating mental models.

While working on a result that is useful for the RIVM, at the same time I want to make a contribution to design research. Within design, the concept of mental models is only used on the level of usability. I believe that there is a great potential for mental models to go well beyond that, into the field of persuasive design. Since mental models are central in cognition, changing these (e.g. the examples above) means a likely change in behavior as well. Designers could use mental models as a driver, or should at least be aware of its frequent emergence and effect.
introduction (continued): space for images

image / figure 1: Voting intervention through metaphor

image / figure 2:
PROBLEM DEFINITION **
Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

In this project I want to focus on the embodiment of mental models. Although I will start with a literature study about mental models, this is not a psychology project. It is about how the mental models can be embodied in a design, in such a way that the target group may (if they agree) adopt it. These different "hows" of embodiment will be collected in a framework.

To confine the project, it will be about mental models in the domain of food, which is a topic within the RIVM. A more specific topic within this domain will be chosen together with the RIVM (e.g. about pesticides or chemical additives). Besides mental models (and their embodiments) in the chosen topic, also a number of external examples will be analyzed to obtain a richer variety of embodiments.

ASSIGNMENT **
State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... . In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

I will research the potential of mental models for design. I will do this by composing a framework, which entails different ways to embody a mental model. In the framework I want to include different types of mental models and factors that are relevant for the user's adoption.

What I will do in my graduation is to explore this potential of design by collecting (and generating) examples of embodied mental models. By analyzing these, I want to gain insight on three levels. First, I want to map different ways of embodying a mental model. What I expect to find here are variables such as design medium, implicitness and locus of proof.

Secondly, I will map different types of mental models that can exist (which I also hope to find in the literature). For example, variables that I have thought of include the relation to one's current mental model (replacing it vs. existing in parallel) and its specificity (metaphor vs. specific fact).

Lastly, I will include factors that are of influence on the adoption of a new mental model. These should be taken into account while designing an embodiment for a mental model.
PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

In the literature study, I will review existing literature on mental models and related concepts to come to a clear definition. During the literature study, I am curious to find different types of mental models and how they may currently be applied.

Before being able to analyse any embodied mental models, I have to define what are current mental models within the chosen domain. I will do this by organising a generative session. It is not about finding an exhaustive list of validated mental models here. It is about finding a rich variety of existing mental models for the analysis. Furthermore, not only the mental models will be retrieved, also their embodiment (the perceptions that led to this mental model) will be applied for. Also any reason of the participant to (not) adopt a certain mental model will be noted since these may provide insight into adoption factors.

For most mental models I will likely not find existing embodiments, or at least not a rich variety of them. Therefore, I will collect embodiment ideas by generating them myself and by hosting short creative sessions with students. During the analysis I will categorize the different types of mental models, embodiments and adoption factors. This categorization will lead to the framework.

After the framework is complete, I will demonstrate it by designing a showcase within the chosen (food related) topic. Finally, to test its effectiveness, I will do an experiment with (one of) the designs as an intervention. Although this does not validate the entire framework, it should provide an indication of effectiveness and a start for potential further research.
MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, .... Stick to no more than five ambitions.

There are several reasons I set up this project. Firstly, I am interested in the intersection between psychology and design. In particular cognition and its implication for design fascinates me. It feels exciting to work on a rather unexplored subject and to discover new insights.

Secondly, I am interested in the impact design can have. The topic of mental models is, I believe, extremely suited for steering behavior and enhancing well-being. Especially since it is targeted on a high-level (how people see something, or how they believe it works) I believe it may have a sustained effect on a large number of behaviors.

Lastly, I want to try out how much a research-oriented type of project fits me.
Wat weet u over de "circulaire economie"?

Hoi, ik ben Ward! Ik studeer ontwerpen aan de TUDelft. Voor het afsluitende project van mijn studie doe ik onderzoek naar hoe mensen kijken naar duurzaamheid.

Daarom zou ik u graag interviewen over dit onderwerp. Of u er nou een sterke mening over heeft, of dat u er eigenlijk niet een duidelijk beeld bij heeft... Dit is allemaal belangrijke informatie voor mijn onderzoek.

Het interview duurt ongeveer 60 minuten en kan waar u het beste uitkomt. Bijvoorbeeld op de universiteit of als u dat liever heeft bij u thuis.

Vragen?
Telefoon: 06-58958379
Email: wardvhoeven@gmail.com
C: Interview protocol

This was the guide for interviews. It starts off with general questions, becoming more specific to inquire the interviewee's beliefs about certain concrete topics.

Protocol:

- “Ik zal mezelf even voorstellen. Ik ben Ward, ik ben 25 en ik ben aan het eind van mijn studie industrieel ontwerpen, en ben nu bezig met mijn afsluitende project. Daarvoor doen we ook dit interview.
- Ik ga zo wat vragen stellen, en dan wil ik graag jouw mening horen. Je hoeft dus niet te zeggen wat je denkt dat een “goed” antwoord is. In ben puur geïnteresseerd in hoe jij het ziet, hoe dat ook is. Als het helpt kan je dingen ook tekenen wanneer je iets uitlegt. Dat hoeft niet mooi te zijn, maar is om jouw te helpen om het voor mij duidelijk te maken. En als je iets niet weet, dan hoor ik dat ook graag.
  o OK to voice record for own reference?
- CE in general:
  o Tell me about CE...
    ▪ How can something be circulated in CE?
      • Biological vs. technical materials (composting vs. reuse, repair, remanufacture and recycle)
- Plastics within CE:
  o Tell me about plastics within CE...
  o Where does plastic come from? (100m years, petroleum, by-product of fossil fuel)
  o What happens when plastic packaging is no longer of use?
    ▪ How is it discarded
      • What happens to it over time? (landfill/incineration)
        o What is the effect of this?
        o What are biodegradable plastics and bioplastics?
      • How does recycling work?
        o How are different things separated in a recycling plant?
          ▪ Are there different types of plastics?
        o How are plastics eventually used again?
        o Do you think there will be an infinite reuse of resources?
- Participant's behaviour
  o Do you pay attention to behaving in a certain way with plastics? Green strategies concerning plastic packaging? Why? How?
    ▪ Do you (not) buy certain products? Why? How?
    ▪ Do you use plastic bags/bottles? Why? How?
    ▪ Do you re-use plastics? Why? How?
    ▪ How do you dispose of plastic packaging? Littering, PMD separating? ?
    ▪ How do you decide what should go in which bin? What can and what cannot go in PMD?
      • Are you always confident in deciding?
      • Do you clean packaging?
    ▪ Does your behaviour have an impact? Do others behave “good”?
      • Why? (on all questions above)
      • How does this work? (on all questions above)
- **Concerns**
  - “How concerned are you for the environment? (1 to 10)”
  - NL: “Hoe bewust ben je over het milieu? (1 tot 10)”
    - Why? What is the problem?
      - Global warming, too little resources, pollution, ...
    - How does this work?

- **Specific MMs of interest to check:**
  - Ocean plastics
    - How does it end up there?
    - What happens with it? How long?
    - Is it harmful? How?
  - Tell me what you know about microplastics
    - What is it? How is it formed? What are the effects?

- **Participant info:**
  - Age, education level
D. Interviews
The transcripts were analysed, leading to insights and a mental models map per participant.

D.1 Insights per participant

Participant #1
Motivations:
- Only wants recycle and act green if it’s not too much effort.
- Money is an incentive to act green.
- Acting green is done because she believes (MM) that others will copy her behaviour.
- She is unsure about whether recycling actually helps (because it takes a lot of energy). Therefore, she doesn’t want to spend a lot of effort.
- Concern: Future generation/her future kids
- Concern: Global warming

Main good/bad/missing MMs:
- She puts most responsibility for environmental action (against global warming) at businesses and the government. The government should regulate businesses and the population by providing incentives and restrictions.
  - She should be made aware of the responsibility and influence consumers can have
    ▪ Cars, heating, etc. (consumers) also have an impact on global warming
    ▪ Laws from the government take very long to come through and will not be extreme enough, because there are a lot of counter-motives (economic, lobbies, ...)= complexity of sustainable policy (should be shown)
    ▪ Monetary incentives can be circumvented. E.g. tax on trash makes people dump it in nature. “Selling” trash to be processed in other countries, make them dump it in the ocean. Tax on unsustainable practices will lead companies to move elsewhere.
- Plastics is seen as being bad for global warming. She is not sure how, but this is because it is related to oil.
  - Explaining that plastics is a by-product of gasoline, can enforce this negative association.
- She is concerned for global warming. But she is not aware of the loss of resources.
- She thinks poor countries will get in trouble first. There should be a MM that shows that effects also happen close to them (psychologically proximal).
- She is unaware of waste incineration, and the accompanying CO2. Furthermore, she is unaware of how CO2 is the input for plant remains that get formed to oil.
  - Communicating the circle of CO2, back to CO2 and the timescale of both sides could be beneficial.
- She feels like recycling is not effective, since it also takes a lot of energy.
  - A new MM could explain that this is just the start of recycling, and that it may become more efficient once the system is optimized and the scale is enlarged. Then, participating now is an investment in a more efficient recycling future.
Participant #2
Motivations:
- The effect of an environmental action should be worth the sacrifice. If it's a lot of work (like eating vegan, or going to the "milieustraat"), she rather contributes by something else (eating vegetarian).

Main good/bad/missing MMs:
- She thinks that businesses have a bigger impact, and that they put it all on the consumer.
  - New MM: political consumption, that consumers have an influence on businesses.
- She thinks that the actions of an individual have very little impact.
  - New MM: butterfly effect
- She thinks that PMD is often put together with general trash in municipalities because recycling is too expensive or there is not enough capacity (plants).
  - New MM: Businesses pay a fee for every package to recycling plants

Participant #3
Motivations:
- Wil gerecyclede dingen, maar alleen als ze niet veel duurder zijn
- Het is een balans tussen effort en effect. Als hij denkt dat het veel oplevert dan wil hij ook relatief veel moeite doen.

Main good/bad/missing MMs:
- Missing: How plastic is made from Oil
- Hij weet niet dat verschillende soorten plastic worden gescheiden in de recycling plant.
  - Daarom heeft hij niet de juiste redenering waarom chipszakken er niet in mogen
- Hoeveel moeite recyclen kost bepaald of mensen het doen
- Hij doet wel groen, omdat "als iedereen er zoveel denkt, dan werkt het"
- Alle beetjes helpen, als iedereen dat doet
- Goed: CO2 uitstoot bij productie van stoffen, en dat is minder bij recyclen
- Goed: Kost veel energie om grondstoffen van ver weg te halen
- Plastic vergaat in 50 jaar in oceaan → veel langzamer
- Missing: Algen produceren veel zuurstof en die worden aangetast.
- Goed: Hij denkt dat plastics ook op het strand in NL aanspoelen. (proximate)

Participant #4
Motivations
- It's wasteful to throw goods things away. Other people have less and would like it.
- Doesn't know what and how to recycle
- Does not know about the consequences of not recycling
- Recycling is a hassle, and she has too little space for a separate bin
- Concern: Doesn't care much for emissions, mainly financial motivations to save gas.
- Concern: Health is important to her

Bag/good/missing MMs:
- Animal feed uses the same things that vegans eat
- Disbelief of global warming by humans → should explain MM of greenhouse effect
- Good: Better quality affords longer use and less waste
- Bad: Plastic garbage collection trucks drive around half empty
- Bad: Only fleece sweaters can be made from recycled plastic because the mix cannot be separated
- Missing: Recycling plastic saves resources and energy (and thus potentially money)
- Wrong: Plastic stream is only plastic bottles
- Electric cars may not be very good yet, but there is a transitional phase. Now, electricity is mainly from fossil fuels (which is generated more efficiently than in a car's engine), but will be from sustainable sources.
- Missing: Plastic is bad for algae → oxygen
- Missing: Microplastics are formed by disintegrating plastics in the sea.

Participant #5
Motivations:
- People make money and have a job because of recycling. That's mainly why he participates. Otherwise, these people won't have anything to pick up
  - Environmental benefit is just an extra
- It is possible to recycle... Then why not do it? That would just be lazy.
- Saving money is a motivator (to prolong use). If it then is better for the environment, he likes it. But also, he is willing to pay a little extra if it is better for the environment.
- He does not want to be controlled by the consumption culture.

Good/bad/missing MMs:
- He does not have a correct CE definition. He thinks it is about the economy in general.
- He is aware that energy is lost if things are built (and this energy is lost when it is broken down)
- He does not know that plastics decompose into microplastics
- He does not know that the RIVM also communicate to citizens
- He is aware of how the consumption culture happens
- He does not know how oil is formed
- He thinks that a lot of smart people are working on recycling, and he has quite some trust that they will improve recycling in the future.
- He does not know what exactly should go in PMD.
- He thinks the main issue is not running out of resources, but that using it has a negative impact now.
- The proximity of the impact of climate change is high: In 3rd world countries mainly. But also close, e.g. health risks like eczema.
- There is a (political) balance. Some parties are pro-environmental action, but this costs money. Other parties are contra, and they make sure there is enough money. Also, some people don't participate in the consumption culture, and some do. Then, the economy will function.

Source of information:
- He uses his own (or stories of) perceptions to make conclusions. E.g. he sees less flies on his headlights, which connects to bad chemicals in the air. He goes on a holiday to the same beach often. Lately, there is way worse weather and more plastic on the beaches.
**Participant #1: Mn (student, 23)**

**Concern:** Afraid that global warming will have a negative effect on future generations (her children)
- She is not aware that waste is incinerated (→ CO2)

**Attitude towards recycling:**
- Unsure whether it actually has a positive effect
- Thinks her behaviour is copied by others (an osmotic effect)

**Attitude to sustainable behaviour:**
- Thinks that environmental action should be initiated from government, not consumers. She is not aware of the complexity of creating sustainable policy
Some contamination cannot be separated 500 years. Washed and separated (by magnetism, floating/sinking, color scanning, weight).

No waste; saved costs for society.

Ocean plastics: Unrecyclable plastics (e.g., thermoplastics, alloys). Incineration: lower quality plastic resource. Not 100%, so it’s better to use less instead of recycling.

Chopped up and used as filler.

Plastic packaging combined with regular trash in some municipalities.

Plastic in nature:

Recycling/reusing plastic has a small impact. Put it all on the consumer.

Business/individual impact:


Business toward recycling:
- Believes PMD is combined with general waste due to lack of economical and physical capacity.
- Denoted: too much effort for the effect.

Attitude toward green behavior:
- Believes businesses have a larger impact and should initiate green behavior more.
- Believes individual action has little impact.
Participant #3: D (student, 19)

Attitude towards recycling:
- Is keen on recycling, unless it takes much extra effort.
- Believes the effect also occur on the NL (plastic on beaches).

Is not aware of PMD being separated.

Attitude towards green behaviour:
- Believes in the snowball effect.
Participant #5: P (Part-time construction worker, 52)

Attitude towards recycling:
- "Why not?" He thinks that if it is possible and not too much extra effort, it would be a good idea.
- He thinks many smart people work on recycling, so it must be well thought out.
- He does not want to be controlled by the consumption culture.
- He is aware of the energy loss of recycling.

Attitude towards green behavior:
- He has seen climate change himself.
E. Mental model clusters

A selection of the collected mental models is clustered to find underlying types and dimensions. The initial clusters are found below.

E.1 Cluster 1:

- This clustering is on the link between a MM and behaviour.
  - Main distinction: Enabling vs. motivating vs. make barriers visible (first two from literature: TPB).
    - About barriers cluster: The MMs in here are not best characterised by being motivating, but more by communicating how people’s beliefs and behaviours are influenced/biased.
    - About consequence cluster: Proximity is relevant (from literature).
    - About enabling and perceived control clusters: These are related: Enabling someone will likely also increase their perceived control and vice versa. They are placed in the cluster their emphasis is on.
  - Relevance: A MM can be aimed at one of the different strategies. It differs per situation which is best: Perhaps the cluster that is lacking should be targeted (e.g. consequences if people don’t know/belief them), or the one people are most sensitive to (e.g. extrinsic benefit like money, if that’s a big concern for someone).
This clustering is on what the MM is about. This nicely shows how broad the structure of MMs about plastic within the CE is.
Some MMs are more generalizable than others. For example the one that explains how plastic is made from petroleum together with gasoline is very specific and cannot be transferred to any other system. On the other hand, the “snowball effect” is generic: It can be about any physical or social system.

- However, the one axis doesn’t seem to cover it all... It is not only about how easily a MM can be transferred to another domain, it is also (or even mainly) about for how many relevant (green) behaviours it is beneficial.

- On to cluster 3B →
While clustering, two dimensions of generalizability emerge:

- **Domain specific/generic**: Is the MM applicable in another domain?
  - Specific instance vs. abstract MM. An abstract MM is a generalization of an instance: One situation in which the rules of the abstract MM are applied.

- **Specific/open behaviour**: For how many relevant (=green) behaviours is the MM applicable?
  - Logically, there is a correlation between domain and behaviour specificity. If a MM is applicable to many domains it is likely to affect more behaviours. However, this is not always the case.
- Both dimensions combined form overall generalizability.

- Relevance: A MM that is applicable to many green behaviours may be desirable: It's an efficient way to increase impact. However, a MM being less coupled to a specific behaviour has the potential downfall of not being recognized to be used (or being easily disregarded -it is likely incongruent with other motivations such as ease).
E.5 Clustering #4

**INTERNAL SYSTEM**
e.g. about ones cognition/behaviour

- Invisible algae
  - Algae are visible (under water) so it’s often forgotten
- Eyegirl helps
  - Every bit of good behaviour helps, not only if you do it at the time.
- Black plastic: Manipulation
  - People are aware of recyclability, yet do it because of consumer manipulation: License

**EXTERNAL SYSTEM**

- Black plastic: Manipulation
  - People are aware of recyclability, yet do it because of consumer manipulation: License
- Ocean plastic > food
  - Ocean plastic is present everywhere
- Media hype
  - Some manipulations increased some PAM waste because of press hype - “trash not stable”
- Political power of oil
  - Dependence of oil = need for oil everywhere and its only at desert locations

**APPLICATION TO BOTH**

- Oil nations biased info
- Start up phase
  - Initial low efficiency still become more efficient when backed anyway
- Link plastic oil
- Wear and tear
  - Plastic wears in use, creating microplastics, e.g. Styx
- Snowball effect

**Applicable to both:** These MMs are more generalizable/abstract, and could be applied to both external and internal systems.

- This clustering distinguishes between MMs that are internal or external to the individual:
  - Internal: About ones own cognition or behaviour.
  - External: About a system separate from the individual.

Applicable to both: These MMs are more generalizable/abstract, and could be applied to both external and internal systems.
REFINING THE EMBODIMENT: 3 LEVELS OF STIMULATION - INCLUDING EXAMPLES

1. how to stimulate interaction
   - make it automatic: put embodiment on existing touchpoint
   - activate using emotion: e.g. curiosity

2. how to stimulate internalization
   - facilitate repetition of exposure
   - make more believable: show credible source
   - make it relevant for the target group: use personal data for explaining the target-MM
   - let the target group apply the found mental model to strengthen the internalization
     - encorporate tips for mental model congruent behaviour
     - let people interact with demo-feature, increasing perceived ability to have an influence

3. how to stimulate application
   - make memorable: provide visuals to enable a mental representation
   - decrease distance between embodiment and target behaviour (the ‘just in time’ principle)

E.g. Supermarket receipt: Stating for which products a recycling fee has been paid by producers on the receipt. Or perhaps even on the price tags in the shop.

E.g. Optical illusion on PMD container: The recycling container has a visual on it which, if you stand at the right spot, gives the illusion of looking into it, and seeing a recycling plant.

E.g. A trash bin on the street with multiple compartments: The fact that there are compartments for different waste streams triggers a mental model of the recycling process. Seeing and interacting with it daily increases the chance of internalization.

E.g. Glass facade on recycling plant: Seeing the system with their own eyes is a highly credible source.

E.g. Follow your trash: After scanning a QR code on the PMD container, one’s own trash can be followed through a set of camera’s in the recycling plant. One sees why some things can(not) be recycled.

E.g. Plastic bags and circularity: A print on supermarket plastic bags states “40% material, 60% energy”, communicating the mental model that while materials can be recycled, energy cannot. To increase both internalization and application, the tip “put me in your backpack, so you don’t forget me” is printed on it as well.

E.g. SimCity Edu: A game in which users try to build a sustainable city. In doing so, they start to see that the sustainability can actually be tangible and therefore also malleable.

E.g. Melting polar cap shower mat: A shower mat that depicts a polar cap with a polar bear in the middle. The longer the shower is on, the more it soaks up with water, becoming smaller and smaller. The intervention is at the same time as the target behaviour (showering shorter) can be displayed.
G Shortlists for participants during toolkit test

To circumvent the need for the participants to emerge themselves in the domain of plastics within the circular economy, two shortlists were provided: One to get to know the target group and one to get familiar with some mental models within the domain.

G.1 Persona

Meet Peter. He is 31 and works in facility maintenance. If you’d ask him what he knows about recycling, he would tell you it’s not much. He doubts whether recycling has any effect, since he heard that plastic is often combined with the regular trash and incinerated. And even if it is recycled, he thinks that the output material would not be of much use.

In general, he believes that as an individual consumer, has little effect with his behaviour and that businesses and the government should take action first. Peter is not very committed to making an environmental impact (the fact that he does not have that much money to spend on greener products doesn’t help). However, he is concerned for his future children. He wants them to have a safe and prosperous world to grow up in.
Recycling info-sheet

Each year, the Dutch produce 490 kilograms of waste per person. Only about 50% of this is recycled. Around 80% of it could be.

Non recycled trash in the Netherlands is incinerated. This leads to green-house gasses that contribute to climate change.

If recyclable materials are incinerated, their resources are lost for good. This is not in line with the concept of the circular economy, in which the same (finite) resources are kept in the circulation infinitely.

Consumers can exert influence on green products and services by boycotting or buying/using them. This “Political Consumption” is often forgotten in the context of recycling and buying (un)recyclable products.

The recycling process is financed by the businesses that produce packages. For each package they pay a fee which covers the costs made in collecting and recycling it.
Introduction on MMs and TK

- For graduation I've developed a framework on how mental models can be used by designers to influence behaviour. This may sound a bit confusing, so I'll break it down:
  - First of all, it is about influencing behaviour. Behaviour change is the goal of this framework.
  - Secondly, “Mental model” (MM) entails a model people have in their head about anything in the world. This model describes how this “something” works.
    - For example, a MM could be about the green-house effect. It could entail how the sun's rays reflect on the earth's surface, heat up the earth, reflect back from the ozone layer, etcetera.
    - Another example of a MM could be a psychological bias; the bandwagon effect. This MM entails that people tend to follow what other people do, in order to avoid risky behaviour and standing out. Knowing this, means having the MM.
  - Now, you may wonder why it is interesting to influence people's MMs. Well, if someone does not believe that global warming is real it may help to explain them how it works instead of simply telling them it is real. Furthermore, being aware of the bandwagon effect bias may help people to recognize and prevent it instead of being a mindless sheep.
    - There are 2 advantages of changing behaviour through MMs. First, it's much more convincing to explain why something is a certain way, than to simply state that it is (think about the green-house effect, for example). It allows people to form their own conclusions, yielding a higher autonomy and less resistance. Secondly, MMs can be about something abstract, which is applicable to many situations (the bandwagon effect, for example) and can therefore have a large combined effect.
  - Thirdly, it is a framework that I developed. This means that I executed research to come up with a theoretical framework. However, this is not directly applicable by designers. Therefore, I translated it into a toolkit with hands-on tips to work with MMs. I want to emphasize that this is the first iteration of the toolkit, so it might have some sharp edges. And it is not yet clear which parts of it are useful. So please feel free to criticize, and say what works for you and what does not; that is the purpose of this test. Furthermore, to safe the time of writing a full guide for you that helps you through the whole process, I decided to be the guide. I am live and can adapt to your questions, so feel free to consult me as your guide.
- In order for MMs to be a useful for designers, they need to know which MM to use and how they create an embodiment of it. An embodiment (EMB) means a design in which a MM is embodied, in any way, so that the person who interacts with the design is likely to adopt the MM.
  - So, there are two aspects of the toolkit: A mental model part and an embodiment part. Both are subdivided into a collect and evaluate phase and a refinement phase.
- Therefore, the first step is to collect potential MMs and to evaluate them. Next, one chosen MM will be refined in part 1B. Then it will translated into design ideas for embodiments in phase 2A. Finally, in phase 2B one concept will be refined a bit further.
- To help designers do this, the toolkit consists of possible strategies to, for example, generate embodiments and dimensions to keep in mind while tweaking the MM.

**Plan for today**
- Today we are going to test the toolkit.
- You will work on a real case, using the toolkit. We will go through all 4 phases of the toolkit, and we will do so relatively quickly. The case is about sustainability and your goal for today is to increase the desired behaviour of consumers: Recycling of plastic. Although there are many ways to do this (e.g. paying people to do so, put a fee on not doing it or making it easier by increasing the number of collection containers) today we will only focus on solutions that are driven by MMs. This may be tricky, so keep an eye on this (I will as well).
- The schedule for today is: We will go through the toolkit, discuss your experience and end with a lunch.

**Phase 1A (MM collection and evaluation)**
- First, you will get acquainted with the target group. I composed a persona (Peter) which is based on actual people from Delft which I interviewed.
- Now, to get familiar with the process of recycling and the MMs about recycling, I composed a small information sheet. You can use this to come up with 2-3 MMs which you think have potential, based on what you now know about the target group. But also feel free to come up with your own.
- Write down the 2-3 chosen MMs on the evaluation cards. We will include the system on the evaluation card. The system is the thing that the MM is about. If the MM is the greenhouse effect, then the system is the sun, earth and ozone layer. If the system is the bandwagon effect bias, the system is people and their brain.
- That was the first part of phase 1A, now we will evaluate them. You can see the evaluation card as a checklist, with questions that relate to the theory parts of the toolkit. Go through the checklist, and consult the corresponding A3s on the wall (the ones marked 1A).
- After filling in the entire checklist, add up the points. Now, it's time to make a decision on a MM to design for. You don't have make a decision based on the total points, it is just an indication.

**Phase 1B (MM refinement)**
- Now that you've chosen a MM, it is time to go into phase 1B: Refining the MM. Again, use the checklist to go through the theory parts of the toolkit.
- But before doing that, there is one extra step: See whether you can find any additional effects for the chosen MM. An additional effect is an extra effect on behaviour which can be accomplished by the same MM.
- After going through the checklist, write down the refined MM.

**Phase 2A (EMB generation and evaluation)**
- This part of the toolkit (2A) makes the transition from the MM to the embodiment, which has to give people the MM.
- These embodiments have to find a place in the world. For example, the embodiment could be a redesign of a PMD container or something in the supermarket or on a garbage truck. We are going to map these potential touchpoints people could have with the MM.

- Next, grab some post-its and the sheet "Ways to embody". This part of the toolkit provides many strategies to embody a MM.

- No idea is too crazy. Remember, we can get quality from quantity. And an unrealistic idea may be the inspiration for a more feasible one.

- When you need some inspiration, take a look at the touchpoints to get some input on where the embodiment may exist. However, don't get pinned down on this. Embodiments could exist anywhere, in any form.

- (If the participants come up with a lot of explicit embodiment ideas, tell them: There is a distinction between explicit and implicit embodiment ideas. Explicit embodiments simply state what the MM is, usually through text (for example a poster or website). An implicit embodiment on the other hand, does not explicitly state the MM, but shows it to people in a way that they see it themselves or are able to infer it (for example by showing the system itself or its output).)

- Now you have a lot of ideas, you are going to evaluate them using the last checklist (phase 2A). However, we cannot evaluate all, so we will pick a few intuitively. But first, let's have a look at the checklist. And we will do so by picking one idea and put it through the checklist. So pick your favourite idea.

- Now that you have a feel for what makes an embodiment effective, please choose two more ideas. You can do so intuitively, but keep in mind the checklist.

- Now, also for these two additional ideas fill in the checklist.

- Now we have 3 ideas to choose from. Which one do you like best? Why?

**Phase 2B (EMB refinement)**

- We are going into the final phase of the process. We now have one idea, which we are going to tweak into a more refined concept. For this, have a look at the final sheet; “Refining the embodiment”.

- Make a concept poster to that communicates the design, including the MM and how it affects behaviour.

**Post-test questions**

- Open: What did you think?

- Can you talk me through your experience of the process (from beginning to end)?
  - Were the dimensions helpful to evaluate and refine the MM?
  - Were the strategies helpful to come up with ideas?

- Do you see this method being applicable to your design practice? Which parts? In what way?

- Was my explanation about what MMs and embodiments are, and why they can be useful clear?
I: Mental model explanation
The following two pages were composed and tested to communicate the concept of mental models for design for behaviour change.

What is a Mental Model and why is it useful?

A practical example: A Mental Model about the green-house effect
You can tell someone that driving leads to climate change, but because of people's wishful thinking (wanting that driving is not a terrible thing) and contradicting information (provided by oil beneficiaries) they may not believe it.

If we try to impose this belief on them, it may lead them to discard it even more since they don't like to be told what to think and do (they desire autonomy).

This group of people should be enabled to form their own conclusions by more fully understanding the situation. Instead of being told that climate change happens, they should understand why it does. They should understand how it works. In this example that would be through understanding how the green-house effect works.

Mental model definition
The green-house effect is a phenomenon in the world. People can have a Mental Model about this phenomenon.

- A Mental Model is a *model* of reality. Therefore, it can be wrong and/or incomplete. Also, people can have different Mental Models about the same phenomenon.

- A Mental Model is *in the mind* of people, in contrast to the thing it describes which is *in the world*.

<table>
<thead>
<tr>
<th>Reality</th>
<th>Model (of reality)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the world</td>
<td>In the mind</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How the phenomenon actually works

Correct MM  Incomplete MM  Wrong MM  Missing MM

Summarizing: How a phenomenon in the world works (e.g. the green-house effect) can be communicated to people with incomplete or wrong Mental Models.

A Mental Model can be seen as describing a *chain of discourse*, describing the relationships between different elements. Someone’s Mental Model about the green-house effect can look like this:
Another example: A Mental Model about giving a good example

Besides physical phenomena (such as the green-house effect), people can also have Mental Models about psychological phenomena.

Many people are demotivated to act green because they feel like the impact they make, as just one person, is negligible. There is one phenomenon which, if they internalize a Mental Model about it, may remove this demotivation: The ripple-effect. This phenomenon entails that good behaviour spreads like a ripple in the water. People perceive each other’s green behaviour and follow the example. In this way the behaviour spreads exponentially. Therefore, the behaviour of one person is much more influential than only its direct individual impact.

Especially with things such as recycling or using more sustainable products people are often demotivated by a perceived lack of impact. In that case, this Mental Model could provide a much more positive attitude towards the behaviour. And one big advantage is that this Mental Model is applicable to many behaviours. So once people have this Mental Model, it will have a large cumulative impact.