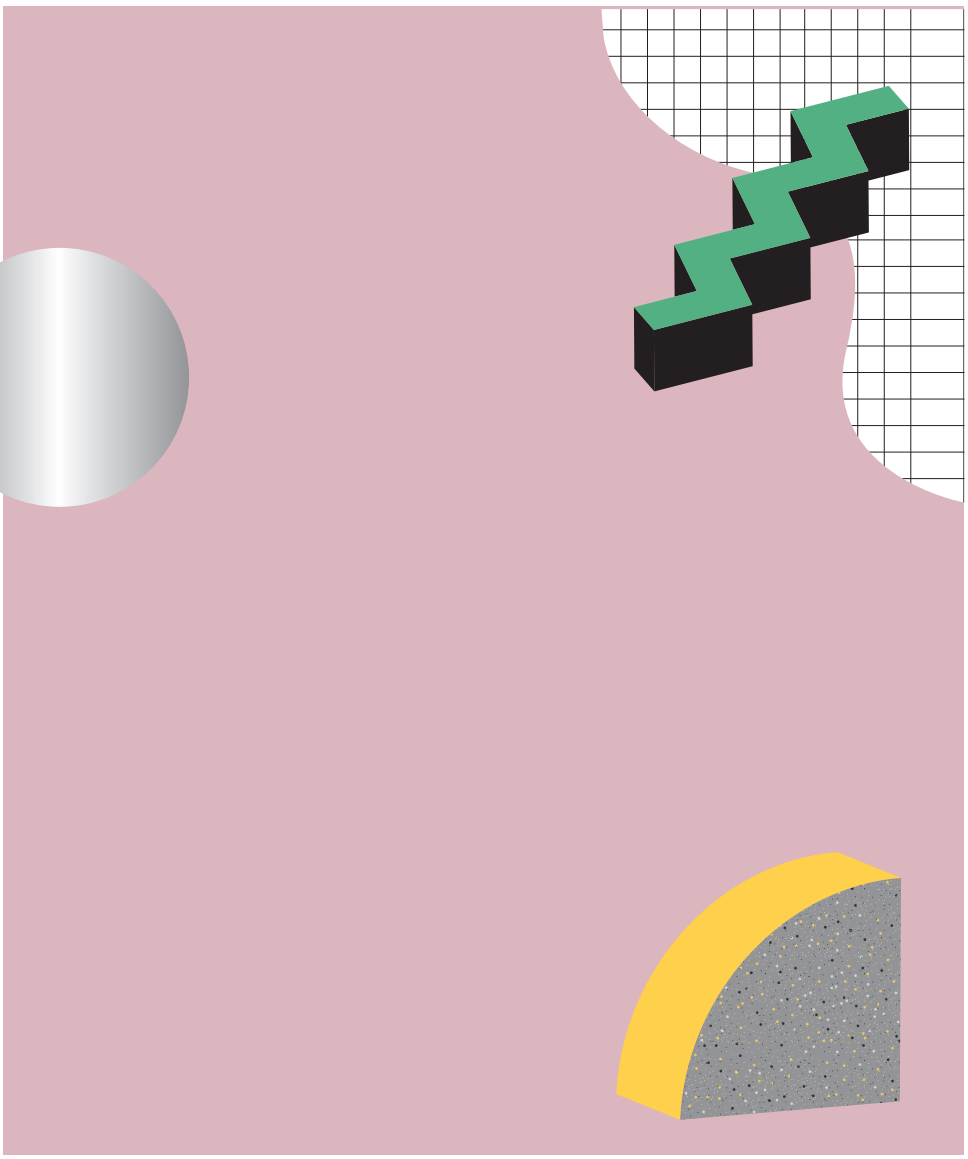
Freedom in creating families

A design speculation about the influences of technology on our reproductive futures and families in 2050.



Lievijn Hagenaars | Master Thesis - Design for Interaction, TU Delft

Project summary

Technologies related to reproduction and fertility follow each other in a rapid tempo as we stand at the start of the biotechnological revolution. How could these technologies which are able to radically alter our evolution alter our families and lives? Big questions with no direct answer.

Within this project speculation and exploration about possible futures within reproduction are constructed using Vision in Product design. A wide variety of information, from literature research to interviews is gathered and formed into clusters that aim to provide a future world-view. This future world-view is the basis that helps the designer create a statement which is a pivotal moment as the statement defines the designers response to the future world-view. Interaction characteristics help translate this response into actual experiences for the user and last but not least into the to be designed 'product',

In the case of this project the product is an speculative exhibit that aims to make the visitor aware of the impact of new reproductive technologies and add to the conversation about our reproductive futures. The focus within the exhibit lies on new types of families that reproductive technologies could create and asks the visitor to think about their personal limits around this new radical make-ability in reproduction.

In order to make the exhibit come to life, 3D drawings, prototypes and storyboards are created. A website allows all aspects of the exhibit to come together and is used as a tool to evaluate the design of the exhibit.

Master Thesis Freedom in creating families
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1. Introduction

1.1 Introduction and relevance

With many radical developments within the field of reproductive technology it seems like fertility medicine has entered the realm of what we once saw as something straight out of a science fiction movie. For example the culturing of embryo(s) in laboratory (International Review of Cell and Molecular Biology, 2018) the first illegally genetically altered 'designer' babies resistant to HIV that were born in 2018 using the CRISPR technology (Hsu PD, Lander ES, Zhang F., 2014) and experiments with 3D-printed ovaries (Laronda, 2017). Yes, 3D printed ovary tissue!

Technologies related to reproduction and fertility follow each other in a rapid tempo as we stand at the start of the biotechnological revolution. However we face more and more challenges around fertility and reproduction than ever before. Sperm counts have halved over the past 40 years which has doctors 'very worried' (BBC news, 2017) and women than ever before opt for motherhood later in life, facing the related health risks for both mother and child (The guardian, 2019).

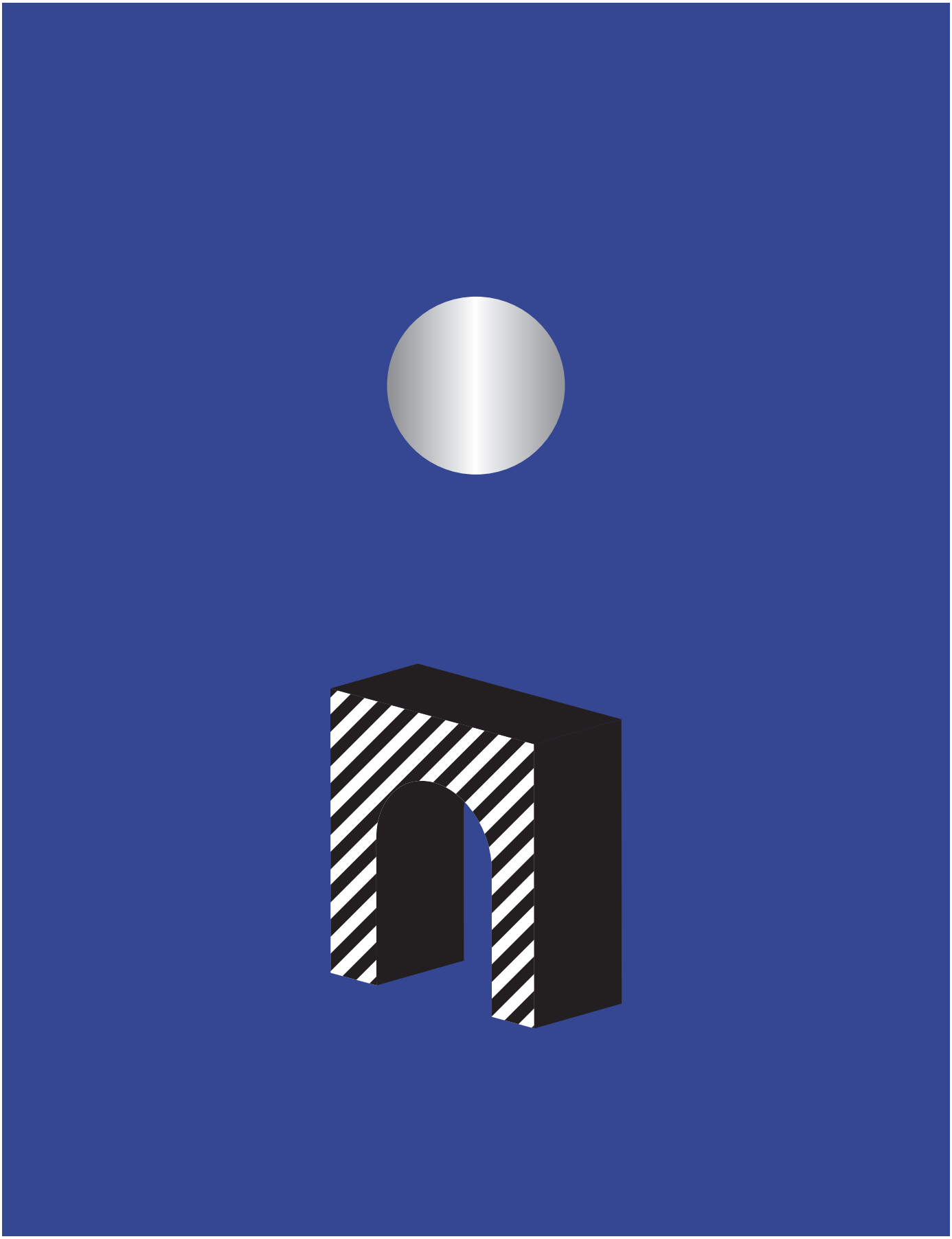
The time to make conversation about the role that reproductive technologies play within our future seems to be now!

In order to start a conversation about new reproductive technologies one has to be aware that, we are talking about the promises of biotechnology placing evolution under human direction and control. A sensitive and ethical conversation. For what is improvement in reproduction? Is control the ultimate goal in a process that for a part (used to) rely on coincidence, luck and intuition?

Technology in reproduction, a topic that most people avoid, not to mention the 'yucky' (= the messy) of it all. As philosopher Anna Smadjor from Oslo University (whose work focuses on ethical questions related to medicine, innovation and the life-sciences) mentions in a Next Nature interview, you have two things in one body, one of them has to come out. There is a bit of a taboo around that already. The whole process of reproduction and its connection to sex and gender, has become rigid in our ways of thinking about it. Yet, it is totally natural and totally necessary for us to exist. So we feel uneasy about questioning it too much. We prefer not to think about it too closely, we like to say it is this lovely natural thing and women say how amazing it is to give birth to their children. So there is a 'yuck-factor' for both natural as well as for artificial reproduction."

"The fact that you are engaging the general public is for me very interesting because the more people enter in the new paradigm the easier it will be 'to go' without rejection from the community and then people are more prepared for these scientific developments in reproduction"

Prof. Carlo Bulletti
Reproductive science
Yale University



1.2 The Design brief

The design brief sets the goal and scope of the graduation project.

Currently there is limited conversation about reproductive technology. While extreme situations and discoveries make the news, conversations about for example fertility or how we as species reproduce are not considered mainstream.

There are many taboo's surrounding reproduction and with new technologies like DNA editing and external wombs at our doorsteps the time to start a conversation within society seems to be now.

Next Nature Network aims to open up this conversation with their travelling exhibition Reprodutopia (*see figure 1*) this exhibition is designed as a fertility clinic set in 2050. In which the visitor experiences new radical reproductive technologies.

> *"The exhibition aims to start a conversation about the way technology radically alters our attitude towards reproduction, gender, relationships and love in the 21st century."*

The initial assignment was to contribute to the exhibition with a design fitting the overarching theme, and possibly filling a gap or touching upon a topic not included in the exhibition jet.

Due to the Covid-19 crisis and personal health issues the collaboration with Next Nature Network was discontinued. The first two months of my project I enjoyed working together and learned a lot about reproductive technologies. I continued working with the same goal in mind, the context of an exhibition with the theme of reproduction, be it a fictional one, with real exhibitions like Dutch Design week in mind.

The main design goal can be seen on page 14. The design goal states that the design should be discursive, discursive design is design that makes us us think, talk, and question *(MIT press)* and ultimately affect social thought.

Fig. 1 *A collage of pictures, media outlets and discursive designs for the Reprodutopia exhibit.*

1.3 Design goal & research questions

THE DESIGN GOAL:

"Design a concept/exhibit in order to start a conversation about the influence of reproductive technology on our futures."

MAIN RESEARCH QUESTIONS:

- **Q1:** What is reproductive technology?
  (focus in chapter 2: The contex)

- **Q2:** What is discursive design practice?
  (focus in chapter 3: Discursicve design practice)

- **Q3:** What could our reproductive futures look like when carefully constructed?
  (focus in chapter 4: Worldbuilding, ViP methodology)

1.4 The design approach

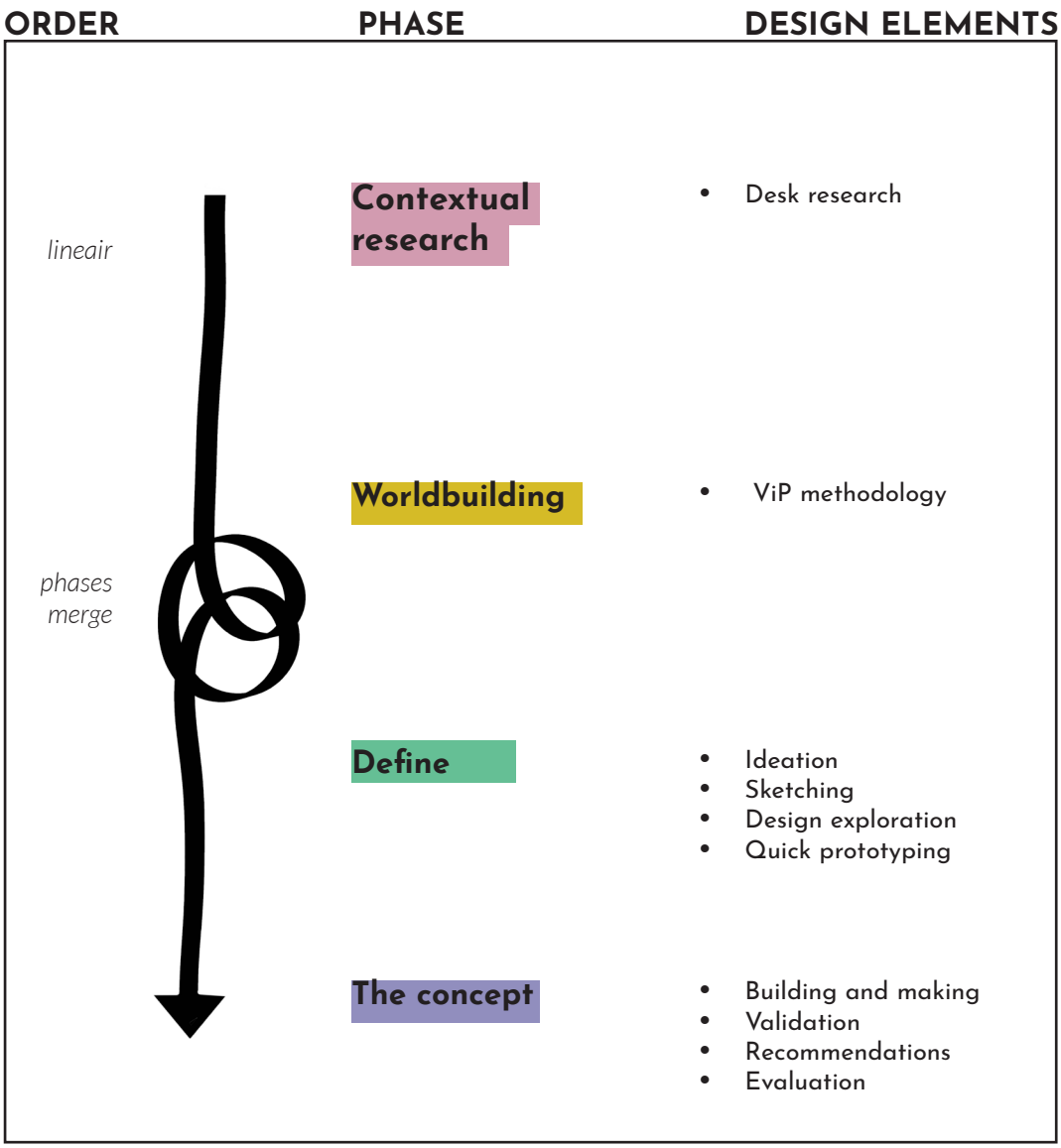


Fig. 2 *The design approach for the graduation project*

2. The context

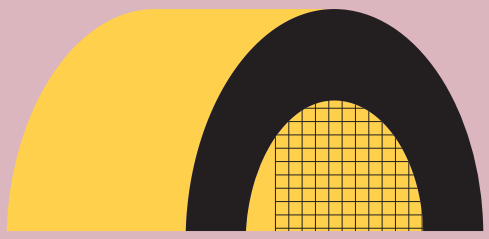
2.1 What is reproductive technology?

While our minds immediately jump to designer babies, reproductive technologies entails way more. Basically, reproductive technologies are **all** technologies involved in stimulating, altering or preventing human and animal reproduction.

For example woman can use birth control in order to plan or avoid pregnancy. An example of a more recent technology would be fertility treatments like in vitro fertilisation (IVF) (Sunderam, Kissin, Crawford, Folger, Boulet, Warner, Barfield, 2018), assisting couples whom find it challenging to receive. The list of reproductive technologies is long (the glossary on pages 125 - 126 includes all reproductive technologies mentioned in this report.) and spans multiple ages as humankind began trying to understand and manipulate reproduction centuries ago. The first use of condoms is found on cave paintings as early as 11000 before Christ! (Next Nature Network, exhibit booklet).
We have always been drawn to the mysteries around reproduction, and for centuries sexual intercourse, pregnancy and birth were seen as a mythical and even magical processes. Over the past decades discoveries enabled us understanding the biological workings of reproduction. Not only to understand, but also to advance and directly influence reproduction due to reproductive technologies.

The focus within this graduation project is on human reproduction and the lastest and even not jet excisting but predicted reproductive technologies. Appendix A shows a reproductive technology timeline which highlights developments and current predictions.

"While our minds immediately jump to designer babies, reproductive technology entails way more."



3. Discursive design pratices

3.1 A critical note on discursive design practices

Discursive design, critical design, speculative design or design fiction .. Ask an industrial designer about one of these terms and they will probably tell you they have heard of it. Ask for a distinction between the terms and most of them, me included, feel like Alice in Wonderland trying to make sense of an ever changing fantasy world.

Even designers that affiliate themselves with critical design practices have difficultly articulating the difference between them. The ambiguity and confusion are not that surprising for it is a relatively young field of practice. The term critical design was introduced in the mid nineties by Dunne & Raby. Before that the general term was "conceptual design", while "interrogative design" was introduced by Krzysztof Wodiczko at least by the early 1990s, and "anti-design" and "radical design" have been used to describe international movements in the 1960s and 70s (Core 77). Most recently speculative design and design fiction have been added to the design lexicon.

A lot of names for practices which serve the same goal: employing their design thinking to promote, and potentially affect, social thought (Core 77). A product is given form and function so that it can communicate and trigger ideas. It is still product design be it with somewhat different affordances.

This chapter dives into and tries to make sense of the differences within critical design practices. I use the terms that are introduced in Matt Malpass his book; *Critical Design in Context: History, Theory, and Practice*. Matt Malpass is the first to introduce critical design as a field. I will use the word 'discursive' as an overarching word for all practices affiliated, as the design website Core 77 mentions: "We feel that "discursive" represents the core of all of these forms, and operates most effectively as an organizing genus." Within my project I look at both speculative and critical design as well as design fiction for all seem fitting with the design goal of starting a conversation about the influence of technology on our reproductive futures . How I believe discursive design and the underlying practices fit the bigger field of industrial design is mapped in figure 3. This bigger field of Design is Masaki Iwabuchi's approach to the field of design.

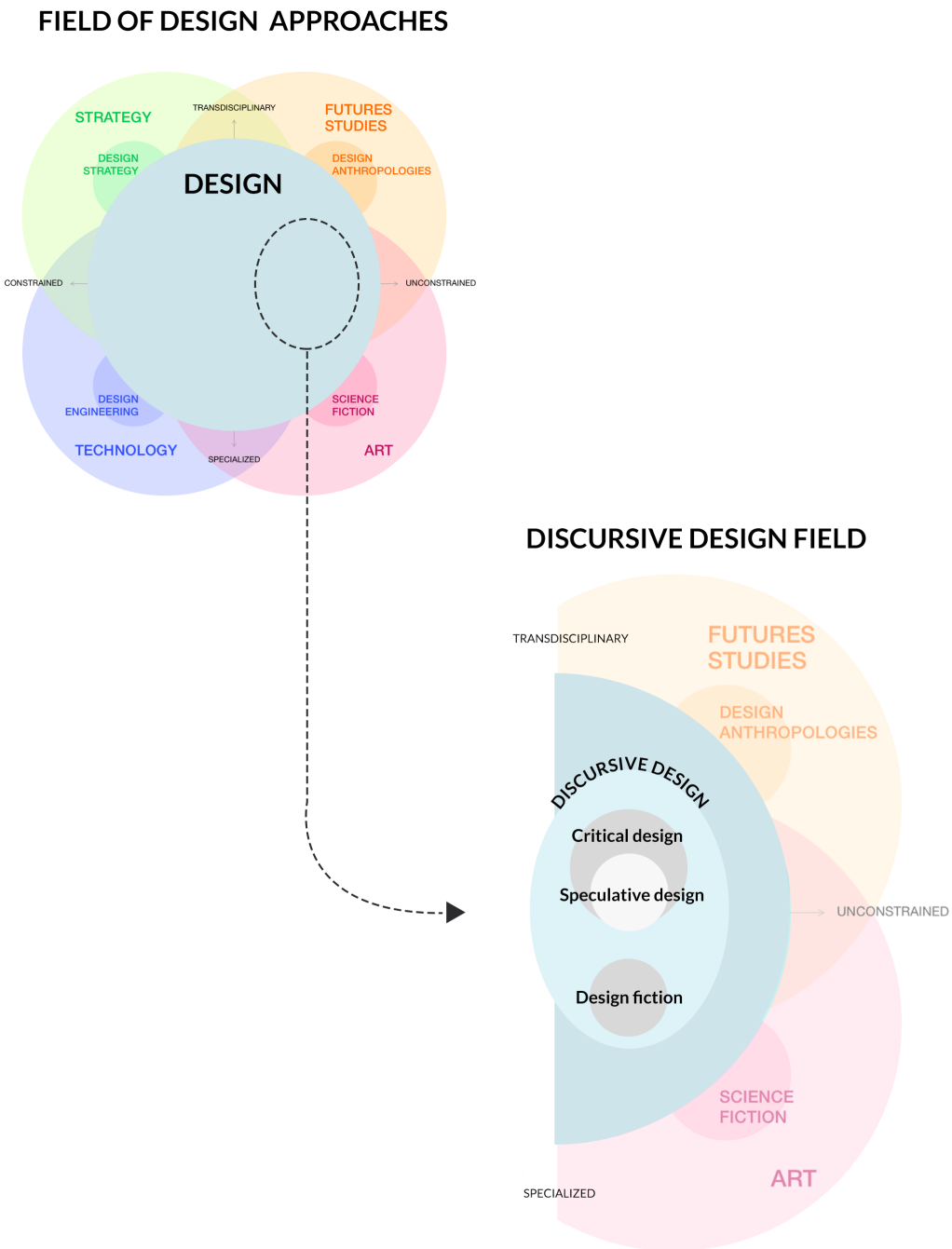


Fig. 3 *Mapping of current design approaches, created by Masaki Iwabuchi. I added the discursive design field in order to display how accroding to me it fits the field of design.*

3.1.1 Critical design practices

What can I take form discursive design practices?

What is critical design?

The main goal of ritical design is to share critical perspective and inspire debate.

Critical design bloomed after the full-scale capitalist embrace of the 1980s, while many designers were searching for alternatives outside the "service relationship" to market capital. A new generation of designers emerged, seeing beyond "form follows function" specific design. "Problem solving", designers started to contextualise their practice as part of a richer cultural milieu by focussing on social, cultural and ethical implications of design objects and practice. Ultimately the designers critiques what already exists by creating an object or installation which challenges the viewer (Malpass, 2019).

Critical design is different from classical industrial design as is it is not limited by production, fiscal gain or technological development, as these aspects are rejected altogether. It proposes design to inquire into matters of concern through the creative process of designing objects (Malpass, 2019) and services.

Critical design is as stated by the Modern Museum of Art (MoMA) New York:

> *"Critical Design is speculative, conceptual, provocative, and can be darkly satirical."*

CRITICAL DESIGN EXAMPLE

Fig. 4. *100% polluted water popsicles by Hong Yi-chen, Guo Yi-hui and Zheng Yu-di.*

Design students from the National Taiwan University of the Arts, Hong Yi-chen, Guo Yi-hui, and Zheng Yu-di created '100% polluted water popsicles". The popsicles seem attractive and appetizing, the colours and details draw you in. However on closer inspection, the popsicals contain industrial dye, bugs, dirt, dead fish, cigarette butts, nets, oil and plastic waste in various forms, such as wrappers, bottle caps and miscellaneous packaging.

The project has captured the attention of the media and has been featured in several exhibitions including the Taipei World Trade Center's Young Designers Exhibition 2017. This clearly is a critical design as it shares a critical perspective on water pollution and how we treat our waste, and does this by gaining public attention through the creative process of the design of objects.

What is speculative design?

Speculative design is a specific form of critical design that focusses on socio-scientific (= controversial social issues which relate to science) and socio-technical (= interrelatedness of social and technical aspects of an organization or the society as a whole) concerns (Malpass, 2019). It looks at how social, political and cultural values affect science and technology and how these in response affect society, politics and culture. It looks at implications of different technological futures before they happen.

As biotechnology and other advanced technologies move out of the laboratory into the marketplace there is a need now, more than ever, to explore the cultural, social and ethical implications of emerging technologies. 'What if...' scenarios are used -- not to predict or anticipate the future -- but serve as tools to help us understand and debate the kind of world we want to live in.

Speculative design functions in two ways, by creating tangible prototypes based on new futuristic developments in science and technology and by re-imagining the technological present. One can while creating a prototype thus choose to focus on a near future or on the present. Within this approach the designer draws intellectual concepts from scientific theories and practice and embeds them into artefacts and scenario's of use that tell stories.

"Speculative design thrives on imagination and aims to open up new perspectives on what are sometimes called wicked problems, to create spaces for discussion and debate about alternative ways of being, and to inspire and encourage people's imaginations to flow freely."

Tran, T. H.

The goal of these stories is to probe and identify the values of audiences in reaction to scientific and technological progression and start democratic discussion into how science and technology is developed and directed. It does not do this by presenting utopian or dystopian visions (which are often used within critical design) but by presenting challenging statements that attempt to explore ethical and societal implications. These forms of challenging statements are presented in exhibitions and public environments, where they issue public awareness, frame situations and problems and inform user audiences of details which they may not be aware of.

SPECULATIVE DESIGN EXAMPLE

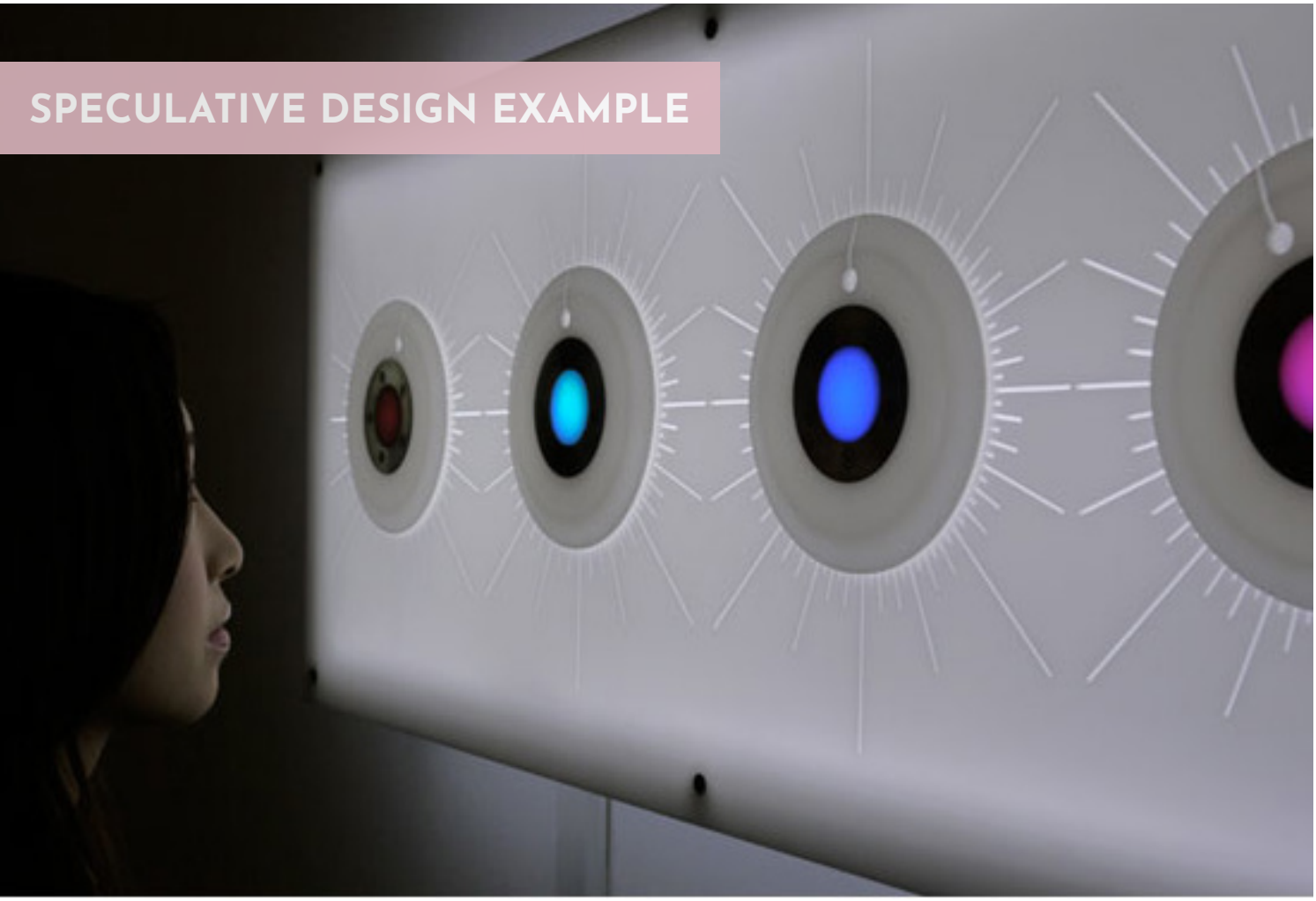


Fig. 5 *Happylife by Auger Loizeau.*

An example of a speculative design project is Auger Loizeau's happylife. Happylife is an electronic device that shows the human emotive states of members of a family within a household (context).
Happylife is the result of an ongoing collaboration between the designer Auger Loizeau and Reyer Zwiggelaar and Bashar Al-Rjoub of Aberystwyth University Computer Science Department, which shows that this project has a strong scientific basis as is often the case in speculative design.
Happylife sparks questions like, what if a device knows more about your partner's emotional state than you do? When does technology become too invasive?

The devices not presented as an utopian 'smart' home device that makes life more comfortable, it focusses on more complex human factors, the emotional interactions that take place between family members and friends.

What is design fiction?

Design fiction is especially different from the before-mentioned critical practices because of its main focus on the future , whereas speculative design uses the future as a backdrop to engage with social dilemma (Delft Design Guide, 2020) within design fiction, the design is all about the future.

> *"Design Fiction is the deliberate use of diegetic prototypes to suspend disbelief about a fictional future.*

Researchers Joseph Lindley and Paul Coulton propose that design fiction be defined as: "(1) something that creates a story world, (2) has something being prototyped within that story world, (3) does so in order to create a discursive space", where 'something' may mean 'anything'.

The elements of a design fiction cannot be looked at individually or simply viewed as a future story with technological gadgets. Rather, design fictions are about "creative provocations, raising questions, innovations, and exploration…[it] makes an effort to explore new kinds of social interaction rituals." (Bleecker, 2009, p.7)

Design fiction has the ability to resonate with an audience because of "possible world" theory, which states that a piece of fiction can be understood by an audience while exploring "possible worlds" that might not be so easy to grasp in their present reality (Markussen and Knutz, 2013, p. 233). These "possible worlds" are developed through "cognitive estrangement" (Raven and Elahi, 2015, p.52), or cues that communicate current time and place. The design fiction relies on the diegetic prototype along with the context to present these cues.

Design fiction presents future worlds which contain enough detail to encourage our imaginations but leave enough space to think about the experiences and rituals that might surround the designed object.

Design fiction is a combination of science fact, fiction and product design, it combines writing and storytelling with the material aspect of design. You could say that objects which tell stories are created to work in the space between the rigidness of science fact and playful imagery of science fiction presenting both things that are real and fake (Near future laboratory, 2009).

Design fiction does not present the design as an artwork, highlighted on a pedestal, it presents a context with a meaning, its is more of a story. Within this story the prototype is not fethisized but helps you empathise with the rituals and the drama that relate to the object.

DESIGN FICTION EXAMPLE

Fig. 6 *Minority report movie poster*

An example of a design fiction is one of the scene's in the movie Minority Report. Tom Cruise portrays inspector John Anderton whom in this scene interacts with a database of sound and images. He is interacting with this object clearly trying to solve a murder that will happen in the near future. While this scene is clearly is based on fiction rather than science fact, it does more than just demonstrate a future fiction, it relies on the prototype (object) and its context to create a story-world. A story-world we easily relate to and believe as it presents something far more timeless; a man trying to solve a murder looking for justice.

3.3 Conclusions

Critical design, design speculation, design fiction all forms of discursive design practice. They have one clear thing in common, they aim to explore, ignite imagination and raise questions through design. Which form of critical design best suits my project?

Critical, speculative and design fiction have a clear things in common, as the previous chapter shows, on a more detailed level they do differ. As critical design focusses on critiquing the now, speculative design focusses on the socio-scientific future whereas design fiction presents a future more as a story-world as it combines industrial design with storytelling.

The form a discursive practices best suited as a guide in my project is speculative design. It looks at implications of different technological futures, and does this by exploring cultural, social and ethical implications of emerging technologies. For me this means looking at implications of new/radical reproductive technologies, which I will do creating different reproductive futures using the ViP methodology.

Design speculation does not present fully utopian or dystopian visions but presents challenging statements that attempt to explore ethical and societal implications. I want my final concept thus not to present a one sided view of pro's or con's.

How to validate and determine the success of a design speculation? A design speculation aims to create:

"*spaces for discussion and debate and to inspire and encourage people's imaginations to flow freely.*" (Tran, T. H., 2019)

I thus aim to create debate and discussion among the visitors of the exhibition about our reproductive futures and want to inspire them to think about the topic.

4. Worldbuilding: ViP methodology

4.1 The Vision in Product design methodology

An overview of the most important steps in the ViP methodology.

In order to conduct research and create predictions about our reproductive futures the Vision in Product design methodology is used. This methodology focusses on what is possible tomorrow. It states that the designer is an individual with preference, believes and values and allows space for these values within the design process. This methodology focusses on the meaning of a design, as a design is often just a means to accomplish what you as a designer want to offer people.

This page explains all relevant terminology and steps taken in the ViP process. Figure 7 shows the overall structure.

Domain: The domain is the scope of the project context, what it entails and what not. It sets the boundaries and thus gives the designer direction.

Context factors: Context factors are snippets of information in any form, think news articles, scientific literature, interviews, snippets from podcasts etc. Context factors can either be described as states, trends, developments or principles. Trends and developments are things that change, be it in different speeds, states are more stable and principles can be seen as facts or truths. Factors should always be novel, unique, relevant and resonate with the designer. The goal of collecting context factors is to gain rich knowledge within the chosen domain.

Clusters: Each cluster is a group of context factors that either point in the same direction or together form a new emerging theme. Clusters are created by the designer by playing around with the context factors in order to discover coherent structure and storyline which is called 'clustering'.

Worldview: The clusters form a world-view of a future world. The clusters can be organised into a pattern a storyline or a framework that helps communicate a future world for the given domain.

Statement (What): Designing involves taking a position, with the statement the designer defines his/her/its response to the carefully constructed future world. Do you want to support or challenge certain aspects in this future world? The statement is essential as it represents the desired goal or effect the designer wants to evoke. It answers the 'what', what do you want to make happen? A statement should always be in-line with ones overall design goal or strategy.

Human product interaction (How) : This phase focussed on finding the interaction qualities; thus which human - product interaction will lead to the right effect (of the statement). The human product interaction focusses on the 'how': How do you want to deliver or evoke your statement?
This step is one of the harder and vaguer phases and thus often uses a fitting metaphor (in the form of words, images, movies, drawings etc.) that helps finding and communicating the desired interaction.

Product characteristics : Once the desired human- product interaction is defined, this interaction can be translated into product characteristics. These are the products (concept) qualitative characteristics. Just like a person has certain qualitative characteristics e.g. being friendly or stubborn, products have these as well. This steps helps the designer to decide what kind of product one is going to design. It helps one understand the personality of this to-be designed product.

Concept: Within this phase the designer translates the information from previous phases into a concept, a thing with feature and properties.It is decided what the final product should be; a service, product family etc. and what it should look like.

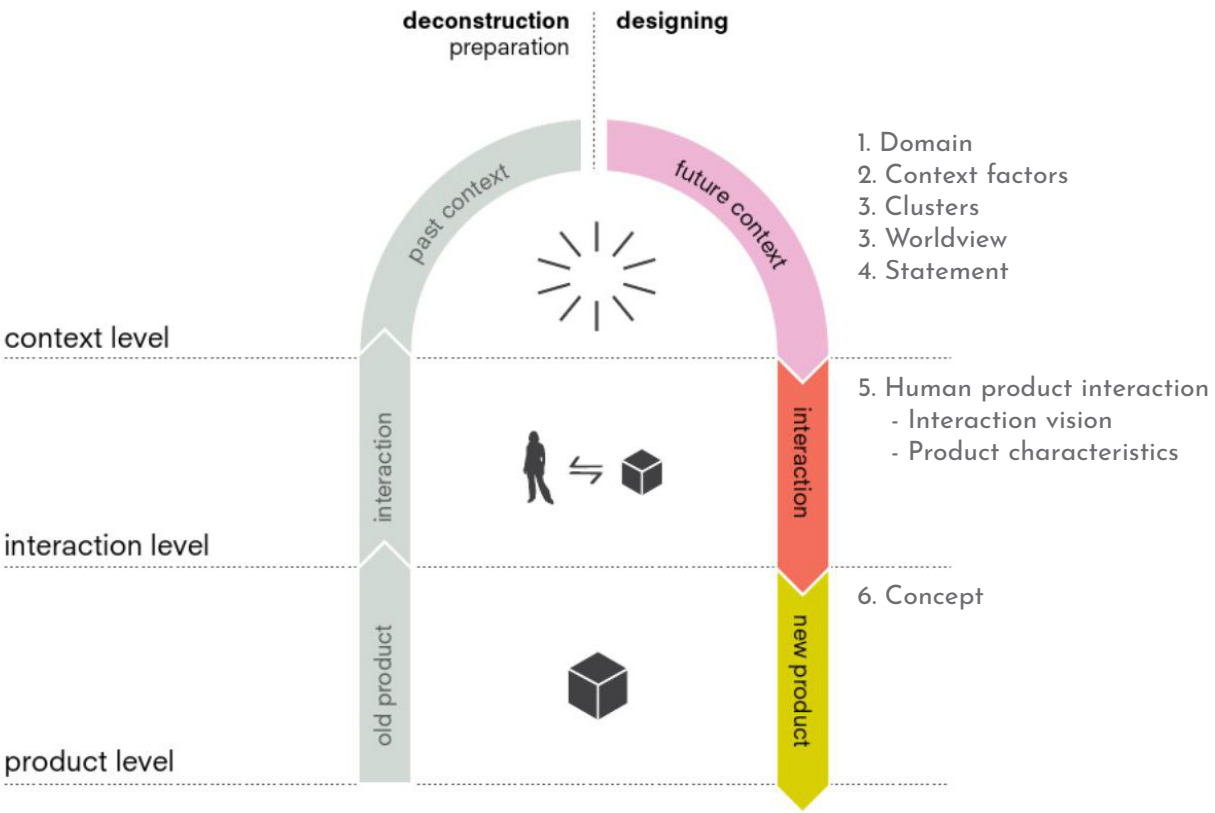


Fig. 7 *The ViP methodology structure, and the three levels of context, interaction and product.*

4.1.1 Gathering data

Collection of data in order to create a future world.

Data was gathered by collecting context factors. As is explained previously, context factors are snippets of information relevant within the given domain.
Of course working on a graduation project it is a wise decision to make sure context factors are rooted in scientific fact.

Context factors were collected from :

- Next nature interviews with specialist's
- Scientific literature
- News articles
- Books (by experts in the field of reproduction and evolution).

The list of context factors and its sources can be seen in Appendix B.

These factors where collected for the specific domain of:

" Reproductive technologies for families in 2050."

4.1.2 Data analysis

A wide range of factors were collected. As 2050 is a big time gap, predictions become vaguer further into the future, therefore I chose to focus on a wide basis of knowledge. I dove into reproduction and related theme's, like ethics, family, pregnancy, genetic engineering etc.

As can be seen in the list of concext factors in Appendix B, I mapped the factors theme's in order to be able to evaluate wheter a rich collection was created.

The context factors were organized into bigger overarching themes by the process called 'clustering'. See Appendix C for pictures of the clustering process . One critcally looks at the factors and clusters that emerge and decides which ones are relevant and which can be left out. After a lot of shuffeling and editing I ended up with 6 main clusters. The clusters consist of sub clusters that each in their own way fit the main cluster and seem to point in the same direction. Sub clusters are thus never opposing eachother. For an overview of all clusters see pages 38-39.

4.2 Cluster overview

Overview of clusters and sub-clusters, for a summary of every cluster see the first page of the cluster, for the full cluster see the following pages. For a quick read quotes are provided for every sub cluster.

A.

Room for variety within families and gender

- Bye bye nucleair family
- Towards a gender spectrum

pages 40-47

B.

Pressure to be good, better, best..

- Pressure to buy a 'better' child
- Why hurry to start your own family

pages 48-53

C.

Ethics in reproduction, who is in control?

- Unity in diversity
- Power dynamics in sciene

pages 54-59

D.

Resistance to changes around gender

- Gender as a ritual

pages 60-63

E.

The whimsical aspects of reproduction

- The mysteries of attraction
- Primal instincts are here to stay

pages 64-69

F.

The makeable body

- The experiences of pregnancy
- Species intertwined

pages 70-75

A. Room for variety within families and gender

Sub - Clusters

- **Bye bye nucleair family**
- **Towards a gender spectrum**

Summary

Traditional family ties weaken, this means more room for new family structures and caretakers. With technologies like genetic engineering questions arise, what is and what connects family?

As family structure is traditionally connected to gender, dad works, mom takes care of the children, weakening of traditional family ties also means more freedom within (expectations around) gender. This is also supported by new technologies like ectogenesis, where gender does not define whom is able to have children. Will our society be free from the expectations around gender?

“Reproductive technologies like;
same sex reproduction, multi-parent reproduction enable a whole variety of couples to have children thus the types of families will become more varied.“

BYE BYE NUCLEAIR FAMILY

Technolgies involved:

MULTI PARENT REPRODUCTION | SAME SEX REPRODUCTION | ROBOTICA | LIFE EXTENSION | CLONING

Cluster story

The classic idea of the 'nuclear family'; a family with two parents, a man and a woman whom are married , and their children, will be less dominant. As reproductive technologies like ; same sex reproduction and multi-parent reproduction enable a whole variety of couples to have children, the types of families will become more varied.

Divorce rates are going up, there is a rise of single parents, an increased amount of re-marriages and more couples than ever before without children. These changes could mean weakening of the classical family ties we know nowadays *(The futures of families to 2030, 2011)*. These developments could lead to new and more democratic family structures.

The ability to create offspring from multiple parents (more than 2), raising these children might sound challenging. However within family structures that tend to be more complex or which differentiate from the norm children are stimulated to voice independent thought and often exposed to a richer range of social structures and contacts *(Dr Meg-John Barker, 2018)*. Take children from poly families (= a family consisting of parents in poly amorous relationships (relationships which involve multiple partners)) who even turn out to be pro's at establishing new relationships *(Dr Meg-John Barker, 2018)*.

In 2050 parents will still value key aspects of traditional family life without the traditional family structures. Activities like family meals or shared hobbies will be important, and families will seek to prioritize them in the face of pressure from technological change. A positive thing, as family structure is actually less important for children but more so the quality of relationships they have with caretakers and siblings according to Golombok.

As we as people become more connected due to technological developments we tend to share more. This increased sharing of information has lowered the need for secrets now more than ever before *(Church, 2014)*, this new-found honesty is expected to continue well into 2050. This means less hiding of for example sexual orientation, income, psychiatric status etc.

The way we share will not only change society but our families will also be subject to change. Due to the development of technologies like; connected brains, in which minds are melded with electrodes *(Pais-Vieira, et all., 2015)*, families can become connected on a whole other level! Imagine the influence on your relationships if you could share thoughts and senses with your family members 24 hours a day, perhaps literally dream together, all while being able to switch of when desired. As such the boundaries between families and ones personal identity will fade even more, and could as a result lead to more interconnected and intimate communities *(Dvorsky, 2015)*.

> "As such the boundaries between families and ones personal identity will fade even more, and could as a result lead to more interconnected and intimate communities."

In these mind-melded families one does do not necessarily have to be genetically related. One can select their 'own' family for being mind-melded is intense and not necessarily desirable with everyone whom you have genetic relatedness to. Families could become more about sharing life experiences and thoughts and less about sharing DNA as we curate whom to let into our mind-melded network.

"Families could become more about sharing life experiences and thoughts and less about sharing DNA as we curate whom to let into our mind-melded network."

Another technology that might be at the forefront in 2050 and which provokes the question: where do I end and you begin?' is cloning. As it is expected to become safe and reliable the public opinion of cloning being a dangerous and bad thing might change *(Dvorsky, 2015)*. But what kind of relationship do you have to the person whom is your clone, are you siblings, do you function as a parent or do you simply share DNA and live completely separate lives? One thing is for sure, if this technology finds a way into our lives it will shake up our idea of family and kinship completely. Even leading to questions like, what is family and how do we form family? Is family about shared connections and experiences or quite the opposite and merely about sharing the same DNA and thus having similar traits?

“If we look beyond binaries, when there is no category for you, you could just make one “

TOWARDS A GENDER SPECTRUM

Technolgies involved:

MULTI PARENT REPRODUCTION

IN VITRO GAMETONESIS

SAME SEX REPRODUCTION

ECTOGENESIS

Cluster story

We are currently in a transition from traditional gender roles towards more equal roles between different genders *(Heilman, Barker & Harrison, 2017)* . In western society traditional gender roles literally have been dominant for ages, the shift towards more equality and freedom is slow, for gender roles are embedded in all levels of our society and lives.

"If we want to value people to their full human capacity and desires we as society need to be responsive to the evolution and realities of peoples lives "

(Ipsos, 2020)

By 2050 we will be closer to this ideal and further away from traditional gender roles. With artificial eggs and sperm on the horizon *(Golombok, Next Nature interviews)* and with techniques like in vitro gametogenesis (=includes obtaining cells from a donor (such as skin cells), and differentiating the cells in a laboratory culture dish into gametes (eggs and sperm)) becoming more widely available, even being able to grown babies outside of females wombs (Ectogenesis) we no longer rely on gender in order to reproduce. This abolishes the need for gender categories even more and opens up space to discover.

By 2050 a part of western society might even question gender altogether and become more of a postgenderist society, which believes that gender in humans should be voluntary and that the abolishment of (traditional) gender is freeing us of expectations that are largely detrimental to our society *(The oxford eagle, 2018)*.
If there is no category for you, you could just make one *(Hamack P.L., Pacific standard, 2019)*.

B. Pressure to be good, better, best..

Sub - Clusters

- **Pressure to buy a ‘better’ child**
- **Why hurry to start your own family**

Summary

In a world under pressure due to among others climate change, parents feel pressure to raise succesfull children. Turning to genetic engineering makes sense, why not avoid illness and tweak some things to your childs advantage. However in a capitalist society, with free market principles genetic engineering in itself could create bigger unequality due to families being able to spend more.

Parents will take their time, getting theirselves and their careers in order, with life extension on the horizon, will the new normal be getting children in your sixties and seventies?



“We will rely on the power of genetic engineering to create benefits for family lines in which people are able and willing to spend more money, creating a world in which money indeed could buy you a ‘better’ child.“

PRESSURE TO 'BUY' A BETTER CHILD

Technolgies involved: GENETIC ENGINEERING EMBRYO SELECTION

Cluster story

With higher unemployment rates *(Futures Imapct, Daheim, Wintermann 2016)*, global environmental issues becoming more prominent and pressure on our resources our world will face many new challenges by 2050 *(NASA, 2020)*.

Parents feel pressured to prepare their children to become successful adults, for success guarantees a safer place amidst the change in a world in which we are fighting for a good position. In order to do this they 'better be a good parent', for its is up to parents to ensure their children's health, safety and future *(Kazdin, 2000)*. If higher chances of a successful child means selecting the most promise full embryo due to embryo selection, by 2050 a lot of parents will do this.

With children a rarer resource in the western world *(Church & Regis, 2012)*, while raising children in a demanding society all eyes are on you. Parents are expected to be specialised and highly trained *(Church & Regis, 2012)* which means the pressure is on. The lines between being a parent or a teacher might fade.

Genetic engineering that now seems pretty unethical, will become realistic. As Zhang mentioned in his Next Nature interview:

> *"If we tell parents this gene will increase the probability of mathematical intelligence, this gene may improve his/her athletic skills: they will do it! People don't realize that sending children to a private school and choosing the best genes are not that different and all serve the same goal. "*

Believing that technology has the power to fix all of our problems *(Pacala Solocow, 2004)*, why not use genetic engineering to design healthy children? While providing healthy genes seams ethical what are the boundaries around selecting favourable or specialised traits in a profit greedy industry.

In this future (2050) it is unfortunately unrealistic to picture equal opportunities. Which means that a more expensive or private clinic might offer more options of not only enabling people to get offspring, but also to engineer offspring than a cheaper or institutionalised one *(Zhang, 2018)*. This in itself will lead to higher inequality between people with higher or lower incomes.

Instead of changing lifestyle, habits and practices that might offer people equal chances we will rely on the power of technology to create benefits *(Pacala & Socolow, 2014)* for family lines in which people are able and willing to spend more money, creating a world in which money indeed could buy you a 'better' child.

What is interesting is that Koert van Mensvoort states, that if we all start engineering, life will probably stay little shape-able. While we feel pressure to engineer and expect DNA editing to give our children certain benefits, the question remains whether it really does as life is often remains unpredictable.

WHY HURRY TO START YOUR OWN FAMILY?

Technolgies involved: **LIFE EXTENSION**

Cluster story

We all age and there is a limit to how old we as humans can become. Life expectancy has gone up a lot over the last decade, and is now above 70 years, among others due to healthier lifestyle and better healthcare *(Roser, 2019)*. By 2050 new developments might drastically lengthen our life expectancy. Scientist could reverse or even be able to stop the processes we call aging by editing our DNA *(Peters, Joehannes , Pilling et all, 2015)*

A drastically higher life expectancy means, say comfortably living into your 100ths or even beyond. A shift this big means more time for education, to get yourself sorted, maybe even time for some space travel! Our life expectancy affects our future perspectives and all developments associated with it. *(Zhang, 2018)*; Why on earth (ghehe) would you hurry to reproduce and start a family? For:

> *"When people will be healthier and younger for a longer period of time, there is less pressure from our so called biological clocks to 'create a baby"*

We will see 'older' parents than ever before, having children in your 50's - 60' or 70's would not be an extremely rare phenomena anymore.

Even by 2050 we will probably still be at the forefront of eternal life and therefore the small changes mentioned here are just a grasp of how designing out aging might influence reproduction!



“Scientist might be able to reverse or stop the processes we call aging by editing our DNA. With a drastically higher life expectancy; Why hurry to reproduce and start a family?“

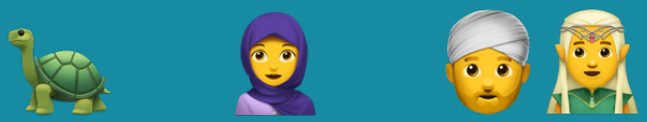
C. Ethics in reproduction, who is in control?

Sub - Clusters

- **Unity in diversity**
- **Power dynamics in science**

Summary

As powerful techniques for designing and redesign life are developing, whom determines the direction and sets the ethical boundaries? Neither science nor politics seem to have full blown answers nor is there a platform for people to speak their minds, while technology enabling us to alter DNA becomes more widespread and accessible by the day.



“Genetic engineering will allow us humans to become more diverse enhancing our prospects of survival, but in a society that favors certain traits over others will we really? “

UNITY IN DIVERSITY

Technolgies involved: GENETIC ENGINEERING

Cluster story

This cluster shows a contradiction, the development of genetic engineering will allow us humans to become more diverse enhancing our prospects of survival *(Church & Regis, 2012)*. But in a society that favors certain traits over others will we really?

In 2050 one will be able to engineer their offspring; it will start with a little bit of tweaking and might end up with a whole array of possibilities. This raises the question, as a society what do we believe is valuable and desirable? For we all desire to be more conscientious, friendly, organized and stable (*Vermeulen, Ondertussen in de kosmos, 2020)*. But if we all go for the same desirable traits or looks would we not become more the same than ever before? And is that healthy?

As you probably have heard the saying goes *'there is a fine line between genius and insanity"* by Oscar Levant or *"No great mind has ever existed without a touch of madness"* by Aristotle. By being able to design out whatever we prefer to, for example character traits or disorders that we do not consider 'normal' we run the risk to loose richness. We could lose 'other' perspectives and special traits which conform to the evolutionary rule that species that are more diverse have better chances of survival and success *(Church and Regis, 2012)*.

> "By being able to design out whatever we prefer to, for example character traits or disorders that we do not consider 'normal' we run the risk to loose richness."

Our power as species lies in unity in diversity, especially if we keep exploring new planets or while facing the challenges on our own planet. By 2050 we might experience the results of the current inequality by all favoring the same traits; we will hopefully realize that genetic engineering can make us more attuned and fitted to our environments .

We are able to create a more diverse society resilient to the changes to come! But unfortunately run the risk of all wanting the same and by that driving diversity into the ground.

POWER DYNAMICS IN SCIENCE

Technolgies involved: GENETIC ENGINEERING

Cluster story

Since we have found ways to edit the so called building blocks of life (= seeing DNA and new technologies being able to edit DNA as the building blocks (like Lego) of life in our universe.) and are able to redesign evolution and ourselves, the question is who holds the power? Will scientists who understand the complex matter have more power and take on priestly roles as they are able to rewrite the book of life ? *(Jasanoff, 2019)* Should governments create country specific policies to avoid this? Or are we already to late as free market principles enable anyone to start biohacking (= biological experimentation (as by gene editing or the use of drugs or implants) and science projects outside a traditional medical or scientific research environment conducted by individuals or groups) if they desire to do so.

The believe that science is self policing is a myth *(Jasanoff, 2019)*. Science starts to deal with important ethical questions around reproduction and evolution like: Will we allow multiple sources of DNA for reproduction? Is cloning of people with 'good' DNA acceptable? What do we consider healthy and natural? etc.

The direction science investigates and leans towards is not only driven by a desire or knowledge as we like to believe, but influenced by institutions with power. They are able to create laws, invest funds and private capital, and thus able to steer the direction science takes.

The ability to influence science can be seen as both good and bad, in a democratic society it is important science is guided by the peoples prerogative *(Taylor, 2004)*. Which means that complex ethical questions around reproductive technologies should be the public's concern and discussed in all levels of society, be it that people are well informed.

"ordering genetic parts required to tailor DNA seems to be headed in the direction of being as easy as ordering a new pair of sneakers online ."

As ordering genetic parts required to tailor DNA seems to be headed on the direction of being as easy as ordering a new pair of sneakers online (The New Yorker, 2015), the time to start talking ethics seems to be now. For the developments around reproduction and genetic engineering will not slow down as biohacking becomes more popular.

The question is, as powerful new techniques for designing and redesigning life are developing in a quick pace, who should be responsible for safeguarding life on this planet? Nowadays, science nor politics seem to have full blown awnsers to value laden questions like these *(Jasanoff, 2019.*

As Church and Regis predict, genome engineering has evolution on its side - not slow evolution but intelligently designed, fast evolution. As the process of creating policies and politics is slow and unpredictable, will the biohackers and private clinics of the future settle in political climates that offer the highest freedom?

“The question is, as powerfull new techniques for designing and redesigning life are developing in a quick pace, who should be responsible for safeguarding life on this planet?”

D. Resistance to changes around gender

Sub - Clusters

- **Gender as a ritual**

Summary

As society slowly moves away from traditional gender roles, this change is met with resistance. Gender is embedded in all layers of society and has been so for ages, it makes us feel comfortable and understand the world we know. New possibilities in reproductive technology could speed up this change but the discussion is not as inclusive as we like to think, some people feel left out and confused, possibly leading to polarisation.



“Gender is way more complex than just biologically being a man or woman. Gender is a type of script that society expects us to act out.”

GENDER AS A RITUAL

Technolgies involved: **IN VITRO GAMETONESIS** **ECTOGENESIS**

Cluster story

As is stated in the cluster 'towards a gender spectrum', society is slowly moving away from traditional gender roles. This cluster shows that by 2050 gender and the rituals around gender will still play a huge role in society and that moving away will be met with resistance. This is to be expected as traditional gender roles have been dominant in western society for ages and are embedded in all layers of our society.

We often feel comfortable in our current roles as man or woman because it helps us understand the world we know *(Barker in Time magazine, 2015)*. Take for example colour; blue for boys, pink for girls, it is still a thing because it has been so for ages, while colours are actually specific wavelengths of light totally unrelated to the biological differences between sexes. Seeing these colours on things like balloons, cakes or postcards while celebrating a new birth makes us understand without words.

As Judith Butler states, gender is way more complex than just biologically being a man or woman. Gender is a type of script that society expects us to act out and is performative, it produces a series of effects. Gender is not just an identity it is a ritual! A ritual which we all are able to recognize and perform without thinking about it too much.

We as humans have the desire to be unique individuals but more so need a sense of belonging and relatedness to others *(Adams,Berzonsky,Keating, 2006)* one is allowed to be unique, but not too unique or different for you run the risk of not being accepted.

Scientifically speaking it is hard to discover which behaviours have to do with biological sex and which with per-formative expectations.

For example across cultures woman on average are more sociable and men tend to be more risk prone *(Kaufman on personal blog, 2019)*, the question is; to what extend do genetics and biology and to what extend does society play a role in this? Do we raise our daughters to be more sociable and are female brains therefore better at social interaction, or do woman on average have more mirror neurons due to genetic predisposition?

> *"When it comes to gender there are a lot of questions and not a lot of scientific answers."*

As change is often met with resistance, and as gender is not an easy thing to discuss it seems that by 2050 a lot of rituals around gender will still be valued and performed. And the question is, will they become toxic as society and reproductive technology around them changes in a faster pace while a group of people are not ready to accept them. Studies show that the gender discussion is more uncomfortable for men. They mention feeling excluded and at times even afraid to speak up out of worry of being attacked *(Ipsos, 2020)* which means that the discussion is not as inclusive as we would like to think.

How we shape the discussion will influence whether we will accept gender to be more of a spectrum creating the bigger notion that everybody has the right to reproduce and technology could be an awnser to that, or whether we hold on to the rituals that surround gender that might prevent us to reach a situation of true equity *(Heilman, Barker & Harrison, 2017)*.

E. The whimsical aspects of reproduction

Sub - Cluster

- **The mysteries of attraction**
- **Primal insticts are here to stay**

Summary

As reproductive technologies enable us to have children with a bigger variety of people than ever before, however actual attraction cannot be fully explained by science . Mate selection seems to be guided by unseen matters of the heart.

As technology develops far into the realms of reproduction, this does not mean our primal instincs, the magical feelings surrounding reproduction are lost to us.

THE MYSTERIES OF ATTRACTION

Technolgies involved: **ECTOGENESIS**

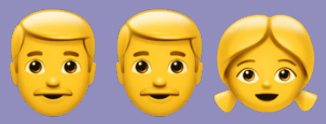
Cluster story

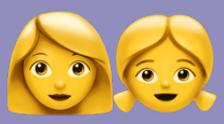
Our heart rate goes up, we feel sparks, our pupils dilate all examples of bodily effects of attraction. As science tries to explain what attracts us to others and how we decide with whom to start a relationship and possibly a family, it simply seems to complex and unpredictable to predict that romantic connection, that spark (Time, 2019).

With the developments of reproductive technologies enabling woman to have children later in life, or babies grown in external wombs (ectogenesis) cultural notions and ideas around what is seen as attractive will change as well. With woman stepping up and taking more power (Noam Spancer Ph.D. in Psychology today, 2014) woman in power will be seen as attractive. In males youth and stamina will become more important.

These cultural shifts will whether we want it or not, influence the complex 'system' that makes us select a mate. A big part of mate selection will however still be based on underlying evolutionary mechanisms (Alvarez & Jaffe, 2004) like markers of good genes (Gangestad, 2001). We will still feel the butterflies in our stomachs as our bodies tell us we are attracted or even falling in love with someone. As the philosopher Blaise Pascal so beautifully mentioned, the heart will have reasons the head will not understand.

“The couples and initially the families we form will still feel based on whimsical matters of the heart, but the complex system behind these choices will not be free from influences of new reproductive technology. “





“As reproductive technologies do not feel ‘natural’ or instinctual jet, by 2050 many people will still prefer the natural way of reproduction.“

PRIMAL INSTINCTS ARE HERE TO STAY

Technolgies involved: **BIRTH CONTROL**

Cluster story

Due to reproductive technologies, like in vitro fertilisation, one can easily have babies without having sex. With varying reliability, humans can also have sex without having babies. In terms of biological evolution, sexual activity is no longer directly related to a maternal instinct to have offspring.

However, sex in order to have offspring is still the main way of reproduction. As reproduction is a species-specific practice for life and survival, the desire to reproduce is part of pre-intellectual behaviour that is not based on any prior learning or experience (Taflinger,1996). The urge to naturally reproduce, experience pregnancy and become a parent are by many, even in 2050, experienced as primal instincts.

These urges make a lot of sense as people, according to evolutionary psychology, are beings inhabiting a thoroughly modern world of space exploration and virtual realities, with the ingrained mentality of Stone Age hunter-gatherers (Harvard business review, 1998). Our brains and related urges do not seem to keep up.

Take for example pregnancy, it is seen as on of the most special times in a woman her life in which she is forms close and loving bonds with her baby (Teman, 2018). Instinctually we want this desired to be met, and even though purely technological and preganancy might be widely available in 2050, a big group of people will still prefer the 'natural' way of reproduction.

Whereas the new reproductive technologies will target early adopters by presenting the benefits to people struggling to reproduce. Design of new reproductive technology plays a big role in reaching a bigger audience.

F. The makeable body

Sub - Cluster

- **Experiences of pregnancy**
- **Species intertwined**

Summary

Pregnancy takes a high toll on woman's bodies, technology, robots or other species offer new ways to manage and guide the process.
With new reproductive technologies we will start to see the body even more as a makable thing. The body becomes intertwined with technology and other species.

“Being pregnant is something that we nowadays see as something natural, visceral and highly emotional by 2050 we will view pregnancy more as something manageable we have technological solutions to“

‘NEW’ VIEWS ON PREGNANCY

Technolgies involved: ECTOGENESIS GENETIC ENGINEERING

Cluster story

Pregnancy consists of many phases in which a woman her body goes through many changes while it is putting a lot of energy into creating a tiny human. If we look at the process of child birth, it seems to have become more difficult for us humans to give birth compared to other species. As 40% of woman experience life-changing injuries, and childbirth is often distressingly painful and even possibly lethal *(BBC Earth)*.

Looking at modern medical intervention, we were able to change pregnancy and childbirth to be safer and lower the mortality rate in both newborns as well as mothers. From an evolutionary perspective this means that we apply selection, and thus over the years, we have evolved the process to what it is today *(Mitteroecker in BBC interview, 2016)*.

Being pregnant is something that we nowadays see as something natural, visceral and highly emotional *(Smadjor in Next Nature interviews, 2018)* . By 2050 our view will shift, as reproductive technologies will develop and become more effective. Ectogenesis is predicted to become a reality, pregnancy will become something manageable we have technological solutions to *(Smadjor in Next Nature interviews, 2018)* . Pregnancy will shift from a ‘natural’ something to more of a technological process, in which machines and biotechnology can take over. The impact and strain on woman bodies are taken seriously.

For couples whom struggle to reproduce, ectogenesis will definitely be an outcome that fulfils their desire to reproduce. In ectogenesis design plays a role in creating the experience, the rituals and bodily sensations around pregnancy and child birth, without actually (biologically) being pregnant. A future family might gather around an artificial womb to connect with the baby.

“We will start to see our bodies as something that is more make-able instead of something we simply inherit and live with“

SPECIES INTERTWINED

Technolgies involved: GENETIC ENGINEERING

Cluster story

As we take direct control of evolution due to genome engineering and start experimenting with 'the building blocks of life', the boundaries between species will fade as the interspecies barrier is falling fast and the global marketplace for genes is on the rise *(Church, 2012)*.

Nowadays we worry about losing species due to the effect we as people have on the planet. By 2050 we will be able to preserve, reintroduce and even adapt species *(Eriquez in Ted Talk, 2012)* to better withstand our ever changing world. (This comes with huge responsibilities and risks, see the cluster Power dynamics; science is not self policing).
The fact that we are now in the antropocene does thus not nececarilly mean the loss of species but could also mean there is room for new species to evolve *(van Mensvoort, 2019)*.

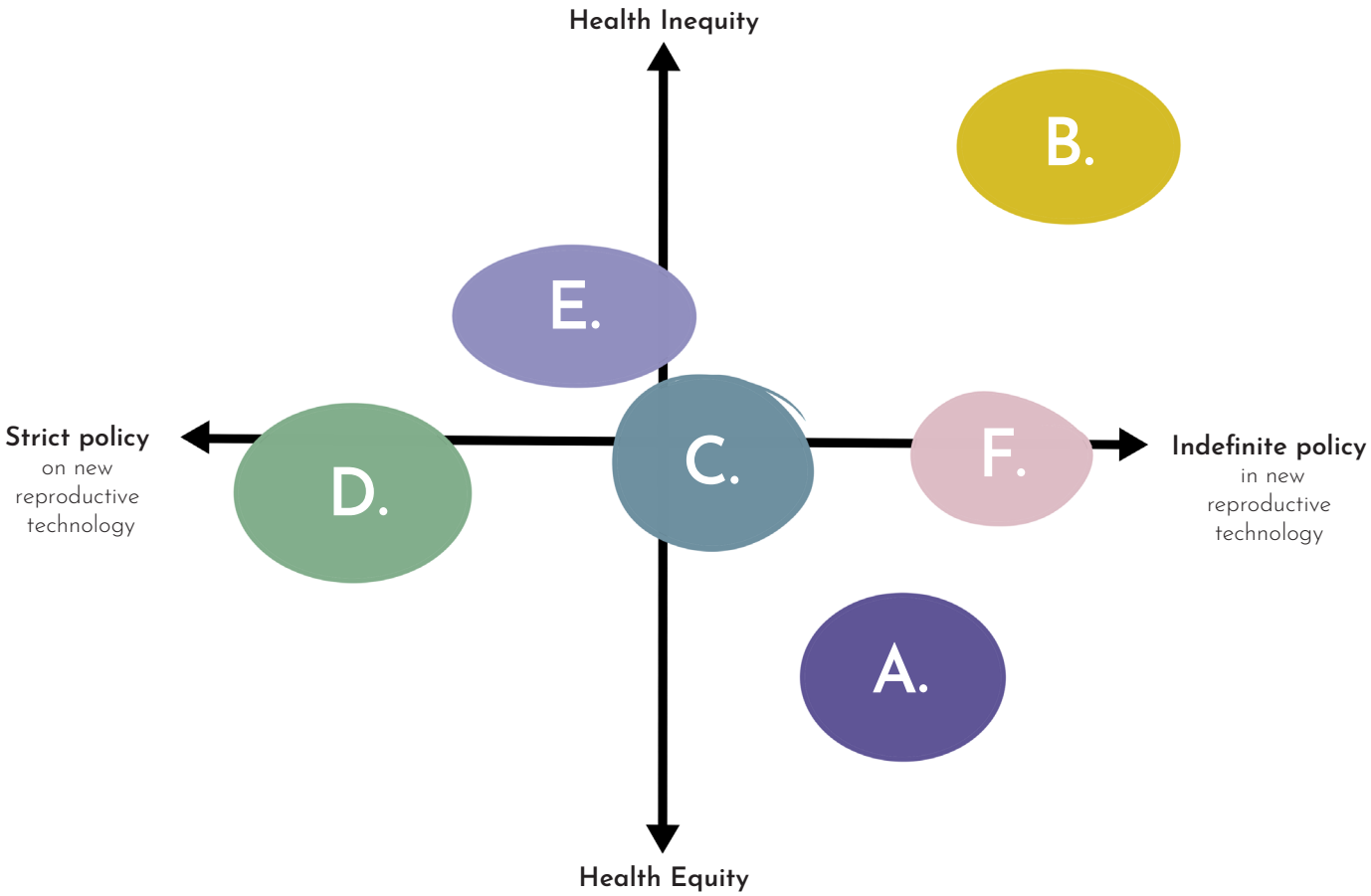
We will not only focus on saving other species, but by being able to mix certain traits of other species with our own, we can speed up and adjust our own evolution *(Greely in Next Nature interviews, 2018)*.

We will start to see our bodies as something that is make-able instead of something we simply inherit and live with, dealing with the quirks that come with our specific body. While the idea of lizard like fingertips might seem vague, the animal kingdom is full of inspiring and rich DNA codes that are adapted to very specific surroundings. By 2050 we might take the first steps towards turning ourselves into special purpose organisms *(Church & Regis, 2012)*. This would add a whole array of bodily experiences to our existence.

We are used to sharing certain traits and bodily features with our family, but this might fade as we start to alter our bodies and share more traits with other species and robots.

4.3 Framework

Looking for interesting directions by creating a framework.



A. Room for variety within families and gender
B. Pressure to be good, better, best..
C. Ethics in reproduction, who is in control?
D. Resistance to changes around gender
E. The whimsical aspects of reproduction
F. The makeable body

Fig. 8 *The clusters in the framework structure.*

The framework seeks to create clearer distinctions and lay bare different takes and directions based on the clusters. (Before the framework a storyline was explored, see Appendix D.) This is an essential step in order to clearly define a statement and thus a vision.

A framework is created to help reduce the variety and complexity of the clusters and discover interesting directions. For the steps creating the framework see Appendix E. Be aware that due to the framework the initial context factors and clusters are not forgotten, they still play a role in the concepting phase as the information is in the back of the designers mind.

The axis - vertical

As new reproductive technology develops in a quick pace, the question is, for whom will it become accessible? Will 2050 present a higher health equity or will the 'gap widen' and elitist group gain more access?

"Health equity is defined as the absence of unfair and avoidable or remediable differences in health among population groups defined socially, economically, demographically or geographically".

- World health organisation-

The development towards either one, represented on the vertical axis, depends on among other our political climate, the growth of economy, battling social injustice etc. Health equity will hugely influence how the new reproductive technologies will become present in society and families and is represented on the vertical axis.

- **Health Inequity** = a society with unequally distributed health equity and thus a wide gap between groups of people whom have access to radical reproductive technologies.

- **Health Equity** = a society with a equal distribution in health equity and thus radical reproductive technology that is accessible for all.

The axis - horizontal

As cluster C clearly describes, the direction new reproductive technology develops in depends heavily on policy, or the lack thereof. Will institutions in power create laws that guide, slow down or even stop radical reproductive technology, or will free market principles create freedom in experimentation as all tools needed are available for whom desires? This is the basis for the horizontal axis.

- **Strict pilocy** = governments and institutions in power make policy and laws that limit and could even stop development of radical reproductive technology leading to a society that holds on to more traditional beliefs.

- **Indefinite policy** = there is a freedom in experimentation and development of radical reproductive technologies as policy and laws are limited leading to a focus in society on experimentation.

Each clusters fits a certain space in this framework as can be seen on figure 8. For example the cluster "to be good, better, best.." fits a world with a high freedom in radical reproductive technology in which wealth and knowledge are not equally distributed.

Neither of the axis present a perfect world, this division helps create four distinc directions which are presented on the next page.

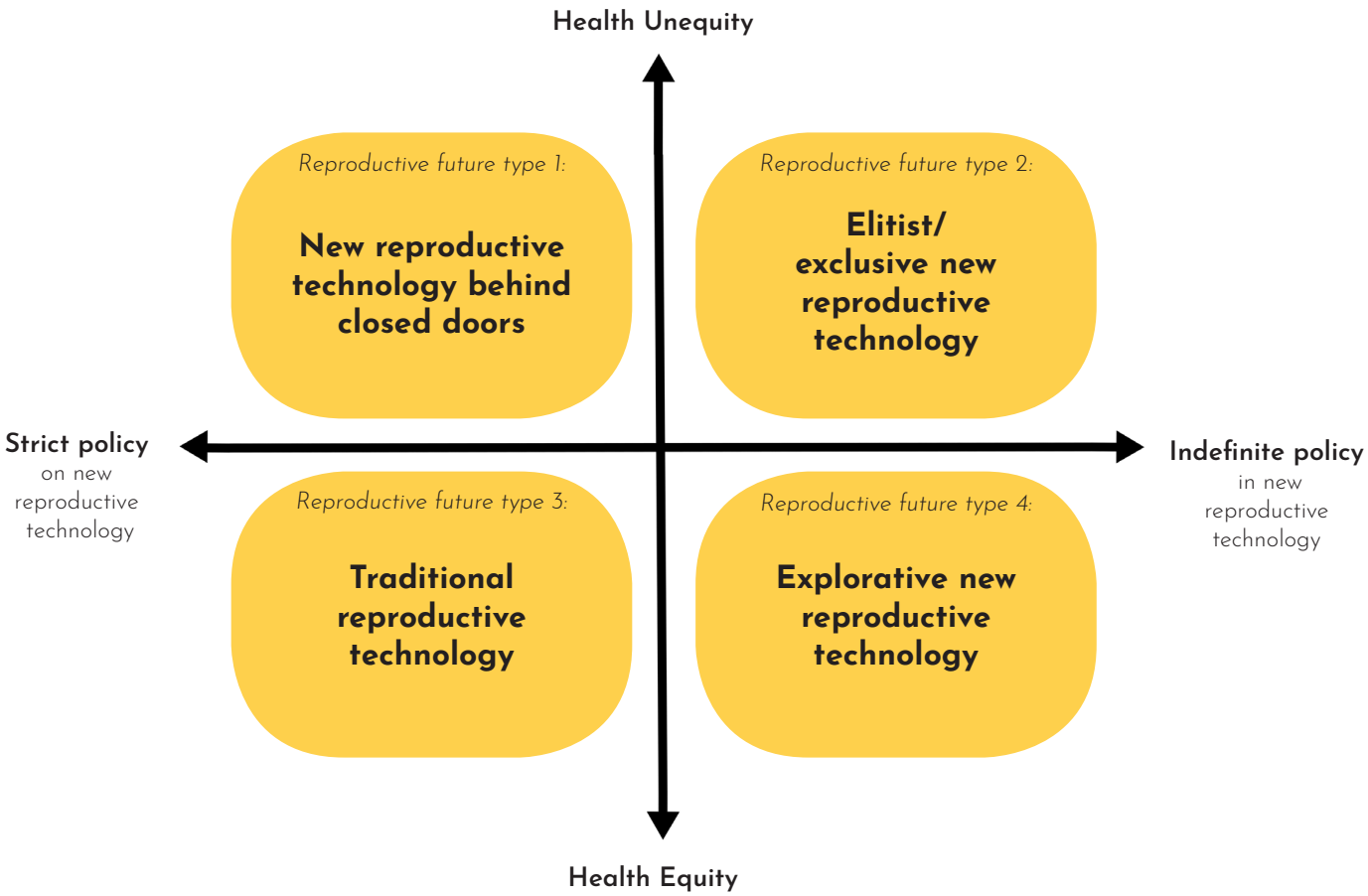


Fig. 9 *Reproductive futures framework : context structure*

Figure 9 presents 4 different reproductive future types. Each future type has different implications for society. What I consider pro's and con's which are described below.

1. New reproductive technology behind closed doors

- **Unequal health access**
- **Strict policy limits**

\+ Experimentation is guided and monitored by policy and can thus be considered safer/ less risky

\- As experimentation is guided by policy, this could lead to slow development, or risks of experiments being banned based on political climate.

\- Elitist groups have higher acces by overcoming policy limits with buying power. A few rich risk takers will look for ways to overcome strict policy limits, but not vent about this, thus keeping it behind closed doors.

2. Elitist/exclusive new reproductive technology

- **Unequal health access**
- **Indefinite/scattered policy**

\- Only elitist groups have access to pricy radical reproductive technology creating higher health inequity and thus even inequal chances in life

\- A select group guides the development of radical reproductive technology

3. Traditional reproductive technology

- **Equal health access**
- **Strict policy limits**

+- Most people will have equal access to reproductive technology, as long as they fit the stereotypical mold

\+ Experimentation is guided and monitored by in institutionalised hospitals and research centers /universities and can thus be considered safer

\- Experimentation is guided by policy, this could lead to slow development, or risks of experiments being banned based on political climate.

4. Explorative new reproductive technology

- **Equal health access**
- **Indefinite/scattered policy**

\+ All people will have equal access to reproductive technology, think all genders, forms of relationships, ages etc.

\- A lack of policily limits could lead to 'dangerous' experimentation and bio-hacking gone wrong

\+ Public debate and opensource structures guide the development of radical reproductive technology

4.4 Statement

What effect do I want my concept to have?

The statement is a personal response to the framework. It is essential as it represents the position the designer wants to take.

The framework presents four reproductive futures, reproductive future 4: Explorative new reproductive technology, is the future I base the statement on.

It is closest to what I believe is a desireable ans inspiring direction for reproductive technology. I want to present this future by highlighting the good and not leaving out the bad.

I want to challenge the audience to think about how far they are willing to go in relation to the make-ability in new reproductive technology. How far is th audience willing to go? Would they design certain traits or stay far away from DNA editing technology? Would they grow a baby in an external womb or stay far away from it? And what if the new reproductive technology is presented as mainstream and normal?

Other that challenging the audience I also want to create awareness that these new technologies also mean that genetic offspring is an option for a lot of people it is not now (same-sex relationships, older couples, multi-parental etc.) and that this could mean new forms of gender and families in our direct futures.

THE STATEMENT:

“I want the audience to become aware of new forms of gender and families

(due to developments in reproductive technology)

&

challenge them to think about their personal limits around the ‘radical makeability’ in reproduction.”

4.6 Interaction vision and product characteristics

The goal of the interaction vision and product characteristics is to create the desired human-product interaction.
These steps might seem vague but are essential in order to add a layer of meaning.

An interaction vision is a metaphor for the to be designed concept in order to find the essential characteristics, the product characteristics. An interaction vision can be expressed in words, images, movies and drawings etc. Your unconscious does the job of finding a fresh perspective.

The interaction vision I created is based on a personal experience, namely:

"How I felt when I saw a lecture by prof. Scherder on how to keep our brain healthy. The lecture was very inspiring, it presented information in a dynamic way, showed harsh fact, and was unforgettable as the man even brought a real pair of human brains which he showed! I could not stop talking about it to my friends and family . It created new insights and challenged my beliefs about health. This presentation even lead to newly formed opinions on health."

I want the audience/visistor to feel , how I felt when I saw this lecture. It is about a moment one is confronted with new information and believes in an interesting way. This challenges them to think and might even change their opinions.

Figure 10 captures the feel of the lecture and how the characteristics fit the interaction vision.

The interaction vision has specific characteristics I deem essential, which translate into the product characteristics, which are:

- **Believeable** = The concept is based on scientific fact and presented in a recognizable manner.
- **Captivating** = The concept attracts and holds attention and interest, by looking fascinating.
- **Mind-boggling** = The concept is intellectually and or emotionally overwhelming, like ones mind is blown.
- **Layered** = The concept consists of different layers and it might take time to fully understand and uncover all layers.
- **Challenging =** The concept offers a challenge and is thought-provoking.

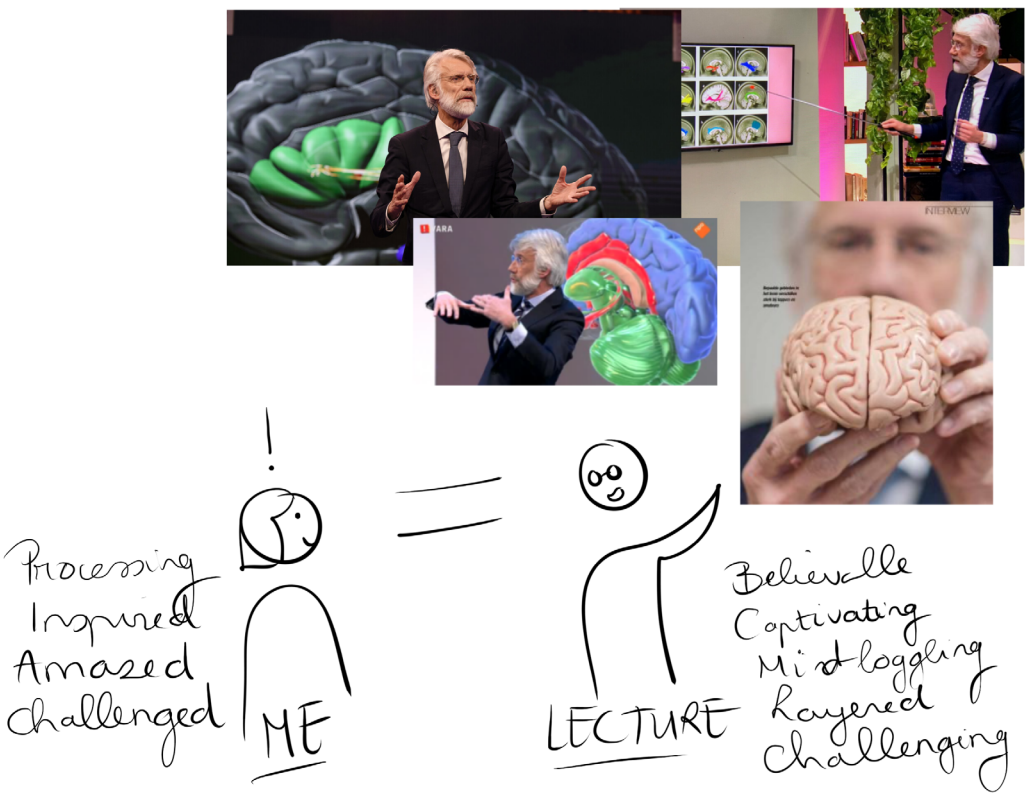


Fig. 10 *Sketch and images of the interaction vision and product characteristics*

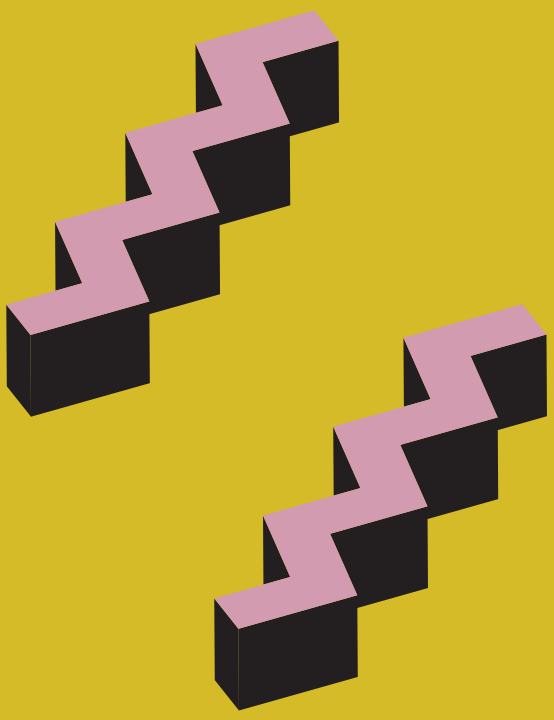
4.7 Conclusions

The ViP phase led to a framework with tension fields, a future worldview, a statement and product characteristics. Each of them serve the final concept and are the building blocks for the next phase: ideation and concepting.

The context of 2050 that serves as the backdrop of my concept is a world that is starting to figure out how much we are willing to use technology in reproduction in order to evolve evolution itself. A world that is coming to terms with both the opportunities and threats radical reproductive technology imposes on our society.

The specific world which my statement is based on is a world with health equity and none to limited policy and regulation. What my statement focusses on is what I want to highlight, namely the new types of families and genders that can now easily reproduce, but also the darker side of having little regulation, and thus little boundaries to the limits of 'makeability' of evolution.

On the interaction level product characteristics are defined which later will help evaluate the final concept. The concept will thus be considered a succes if interaction characteristics in the final concept can be identified, the audience is challenged to think about their personal opinions and limits and introduced to new family types.



5. Define

5.1 Ideation

The formation of multiple idea's

Ideation was conducted in steps. First a brainstorm was conducted about future reproductive technologies, later a session that specifically focussed on the exhibit. Within ViP idea's tend to come naturally so idea's also popped up randomly.

The brainstorm session about future reproductive technologies and possible services around these and was conducted with 2 fellow graduee's. The session followed the lines of a classic brainstorm. For the brainstorm setup and idea's see Appendix F. Other than coming up with ideas the brainstorm also aimed at creating open-mindedness after a deep dive with ViP, enabling me to let go of rigidness.

As working with Vip allowes the designer to actively work with the context, during the creation of the statement and while finding fitting characteristic, idea's tended to come naturally.

As for designing the details of the exhibit, conversations were conducted with people within my bubble.

5.2 The idea

Exploring and defining the idea in images and text

The idea is further explored and defined using different design methods.

The idea chosen as the basis of my concept is an external womb created by a company called Ostara. The company is part of the concept in order to really ground the concept and make it more believeable (product characteristic) .

The platform that presents the concept is an exhibit (as stated in the design goal). The exhibit will challenge the audience to think. While the womb is the center of the exhibit, the exhibit and information within the exhibit are part of the concept and thus carefully designed.

The look and feel of the womb is defined in 3D by collaging and sketching, see Appendix G.

In order to explore possible shapes and materials quick prototyping was conducted. I especially wanted to focus on this because of limited rescourses and materials available (due to financial limits and the current pandemic) I wanted to use materials easily availabe, see Appendix H for a selection of the quick prototypes and pictures of the making process.

5.3 Positioning the idea

Positioning the idea against other womb concepts

The idea of an artificial womb is not a new one. As there are more artficial womb concepts, why is there a need for another design? And how do I plan to differentiate?

The external womb is introduced and though about in many ways . However, awareness of its existence (yes, lambs have already been grown in external wombs, see the timeline in Appendix A) is not wide-spread, let alone a discussion or common opinion. The deeper layer we are discussing is radical make-ability in new reproductive technologies, evolution of evolution. Therefore I feel adding to the discussion cannot hurt!

The stance that repeats itself is an introduction of the womb as a purely medical device. An external environment that grows a baby, which is controlled and monitored. Often the context and people around the womb seem vague.

"An external womb, something that could save the lives of millions of babies who die due to premature births."

(Malewar, 2019)

How an external womb pregnancy opens up new possibilities for a wide variety of families and people is rarely mentioned. Or even approached negatively as the following quote shows how conservative views are not pro new family structures and freedom in gender.

"While social conservatives might be receptive about what an artificial uterus might bring, they'd probably not be happy that the technology also stands to make it much easier for male gay couples to have babies."

(Genetic literacy project, 2019)

I want people to become aware of new forms of families and gender (statement). A new point of view as my idea does not solely focus on the womb itself but also on the people and families surrounding it.

A project that also involves the people close to it is the 'Par-tu-ri-ent', a womb from a group of students from the ArtEZ school of Product Design (figure 16). What is interesting is that on their website the parents are followed in their daily lives. The interactions with the womb are highlighted and very clear. However looking at my desired goal of showing new families and genders, this womb shows a nucleair familiy consisting of a father and a mother. The Par-tu-ri-ent adds to the discussion about the use of a womb, exquisitely contructs daily life around it but does not touch upon opening up possibilities and freedom in gender and families.

Another womb is The Next Nature Networks womb (figure 13) it looks very realistic and is a beautifully designed medical speculation. As stated by Next Nature network it speculates about what an artificial womb may look like in the future and it is designed to mimic the natural environment of a womb. The direct social context around the womb however is left out.

Fig. 11 *Genetic Literacy's artificial womb concept*

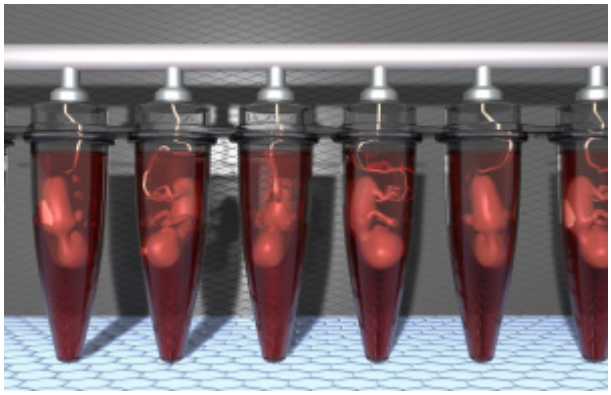


Fig. 12 *Center for bio-ethics and culture artificial womb concept*

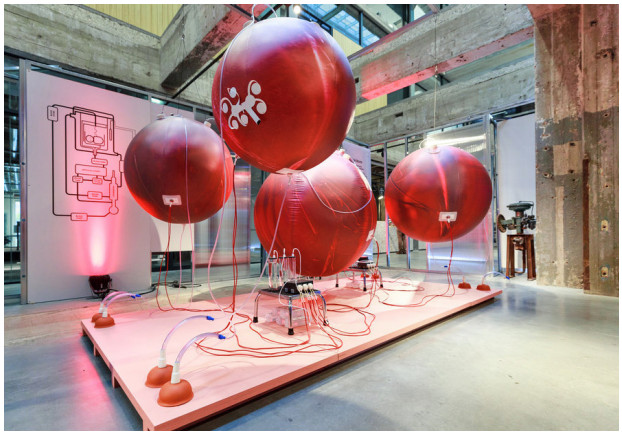


Fig. 13 *Next Nature Networks artificial womb concept*

Fig. 14 *Genetic Literacy's artificial womb concept*

Fig . 15 *Learn science.info artificial womb concept*

Fig. 16 *The ArtEZ school of Product Design artificial womb concept called the Par-tu-ri-ent*

Looking at the visual representation of external wombs, there is a look that seems to repeat itself, figures 11, 12, 14 and 15 clearly present this. These type of external wombs are cold looking technical machines. Bulbs or tubes with babies in them, often multiple in a row, presenting an en mass baby factory. While this view makes sense from a purely technological perspective and definitely highlights make-ability, they do not seem to resonate with ones personal life. Are you able to imagine yourself using them? They seem very futuristic and far from daily life. I intend to create a womb that will look look like a futuristic medical device without it looking to cold/harsh or distant. Added interactive elements will take the womb from a the level of a machine towards something that is closer to a living thing / a protective living baby carrier.

This is also where the exhibit plays a big role, the exhibit should make the audience relate more to the womb as certain aspects of the exhibit speak to them on a more personal level.

6. The Concept

6.1 The exhibit: We can ALL become parents.

The concept as an exhibition

The concept is presented in a fictional exhibit, this exhibit incorporates all desired interactions and different levels of information. The desired interactions being the product characteristics incorporated in the interaction scenario.

A fairly unknown concept, as an external womb is often harder to relate to or to place for people than products they already know. Further context around the actual design, a design speculation which combines science fact, fiction and product design thus makes sense as a whole concept for this project. A design speculation can have different forms, think for example documentaries, websites or an exhibit. For this project an exhibition is chosen as the format. This because it enables visitors to directly interact with the product design as well as experience 'actual' interactions and merely not through a screen as a website or a movie would. Engaging more real life senses creates a richer experience.

Think of this exhibition as something one comes across during events like the Dutch Design week, art biennales or design festivals. This means that the visitor is probably interested to explore, engage, learn new things and has an open minded approach.

6.1.1 The floorplan

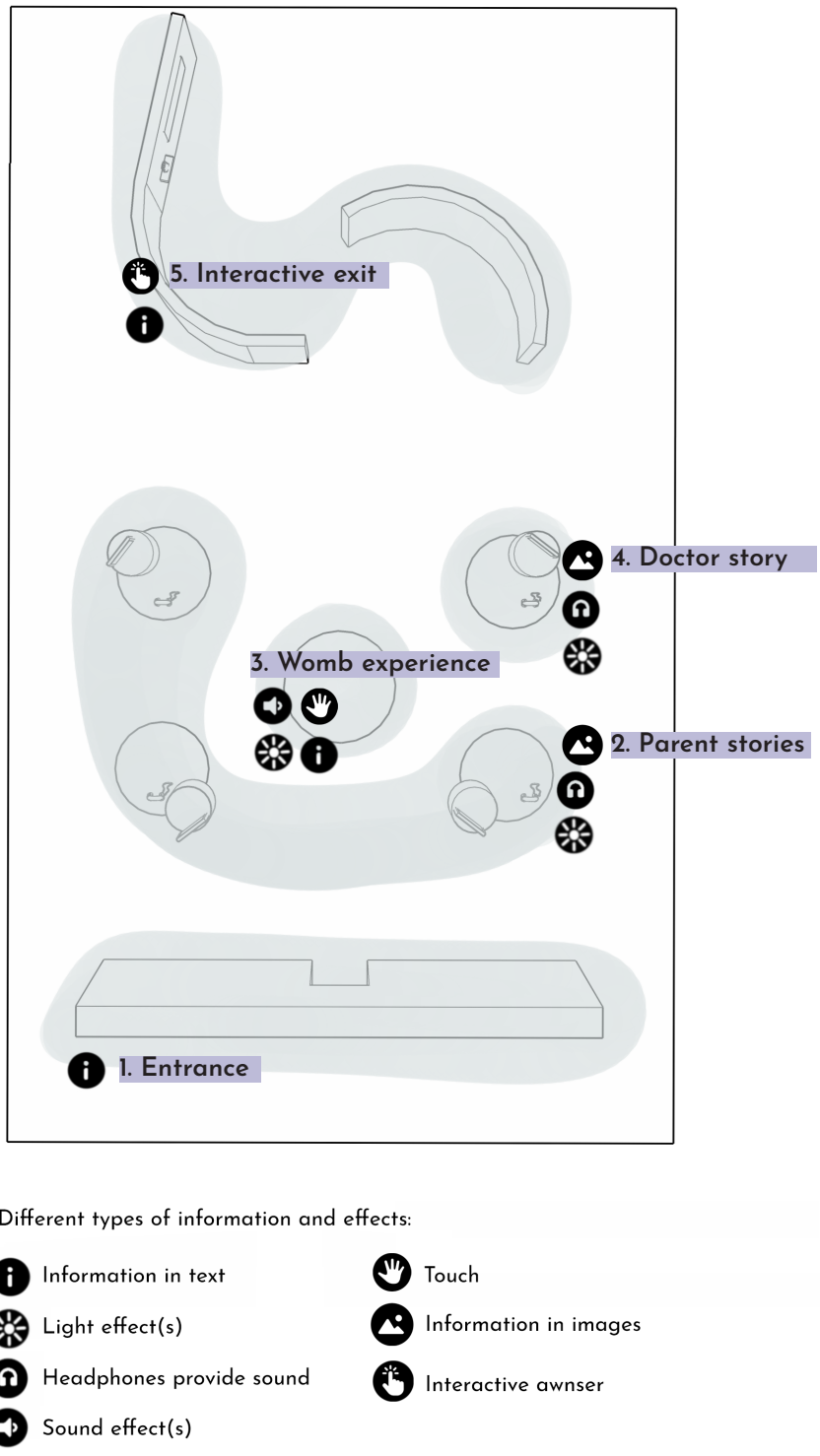


Fig. 17 *Floorplan of the Ostara exhibit*

6.1.2 Routing

As the exhibit does not enforce a certain route, the visitor is free to dwell, creating an experience to leaves room to explore. Examples of possible routes are drawn on figure 18, and show how certain elements can be skipped or visitited in different order. The green route serves as the basis for the interaction scenario and the online exhibit.

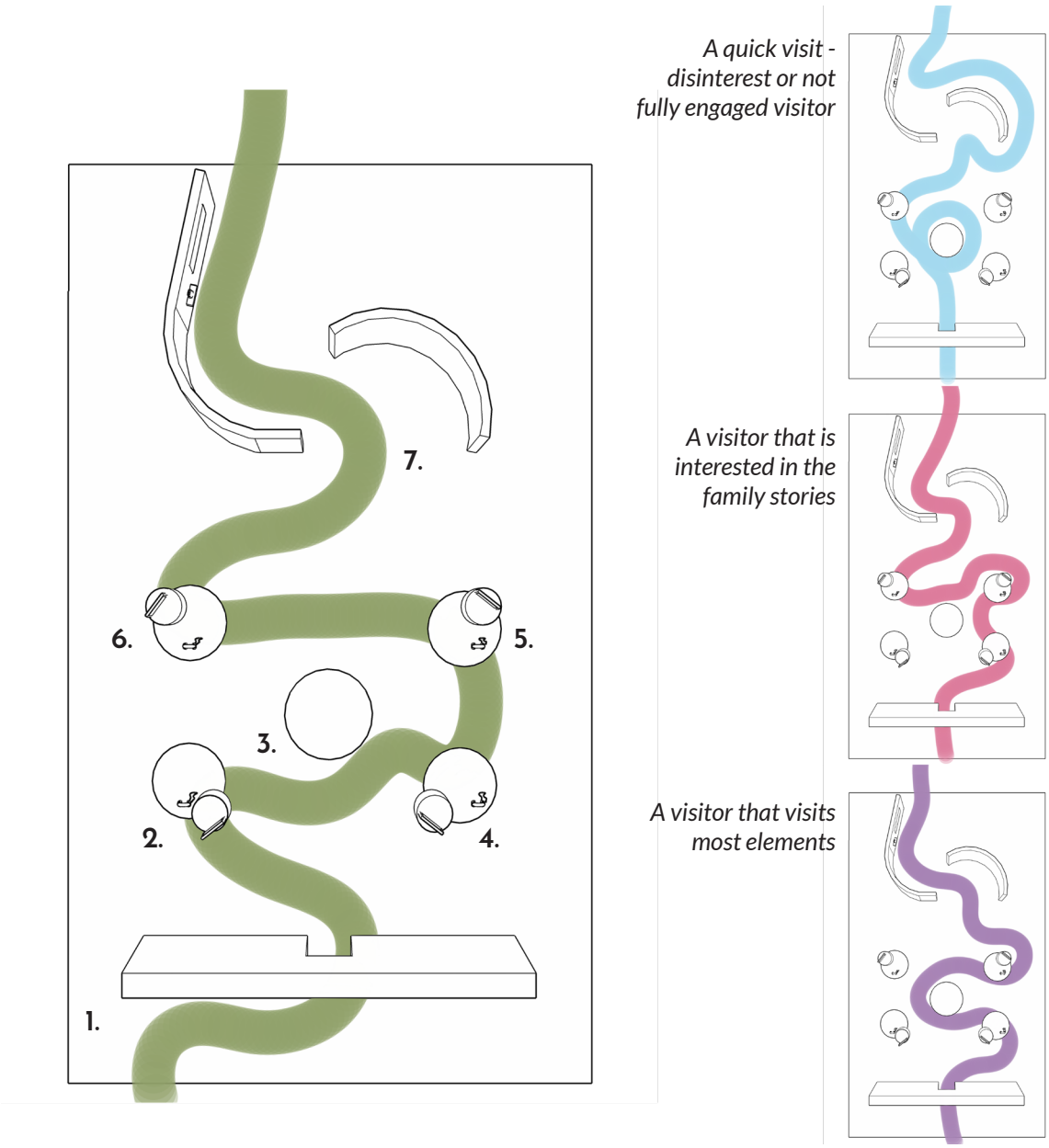


Fig. 18 *Examples of different routes visitors can take.*

6.2 The exhibit elements

Elements of the exhibit individually explained

The exhibit consist of different elements that togheter form a total concept.
The different elements are individually presented and discussed on the following pages.

Together the elements form a whole that present the visitor a design speculation, a story, that both challenges and helps them emphasize. The exhibit tells the story of a biotech company called Ostara that celebrates the successful implementation of one of their recent reproductive technologies in the year 2050.
The reproductive technology is that of the womb 4.0 an external womb machine. In order to share their success story an exhibit is created that displays the womb and allows the public to interact with it. Other than that the exhibit shows he variety of families and their experiences with this technology thus creating a wider context around the womb 4.0. The goal is to present new possibilities and variety in starting families.

Last but not least the exhibit invites the visitor for their first 'screening' on what this womb technology could mean for them in terms of tweaking what they pass on to their future children. It tries to draw them in and test how willing they would be to become a user of genetic modification.

6.2.1 The entrance

Fig. 19 *the exhibit entrance*

The entrance, the start of the exhibit presents the visitor with an introduction in text. The yellow text balloon is designed to challenge the visitor, and make them think about what they know about reproduction to begin with. Can they come up with radically new reproduction or are they at a loss? It primes them to think about their current level of knowledge and think about the theme of reproduction. Do they feel weird thinking about reproduction it or does their mind immediately jump to multiple technologies?

Information in text: the information on the entrance is presented in text:

"Open your mind and travel to 2050! Ostara, a top reproductive clinic would like to present their most successful innovation, the womb 4.0, an extra-corporeal gestational system that grows babies, yes .. you heard it correctly, babies. Welcome to a world were we ALL can become parents, no matter our gender, age, biological fitness or relationship status.

Could future you possibly be one of Ostara's new clients?

6.2.2 The womb display

The womb display is designed to present the womb prototype. The goal is to get the visitor acquainted with the concept of the womb and it invites them for closer inspection and even touch. This getting acquinted is important because the womb 4.0 is not a product that excists jet, the visitor has to be persuaded to believe (product characteristic) the fiction. Involving different senses, sound and touch, invite the visitor to go with the makebelieve, it gives them experiences a real product would give them.

Light: The womb is highlighted by a red flashing light (in line with the sound of the heartbeat) in order to attract attention and make the womb display even more captivating (product characteristic).

Sound: The sound of a heartbeat is played that represents the heartbeat of the mother the baby is supposed to hear, this adds to the experience of the womb holding a living thing.

Touch: The visitor is encouraged to touch to womb, on which a 'touch me' pad is placed, upon touching the visitor notices that the womb is warm (around skin temperature), apart from making the womb more believable this also instills that a living embryo is inside.

Information in text: The information in text is presented on a small card that in short explains the features of the womb in order to give the visitor more detailed information about the workings and the context.

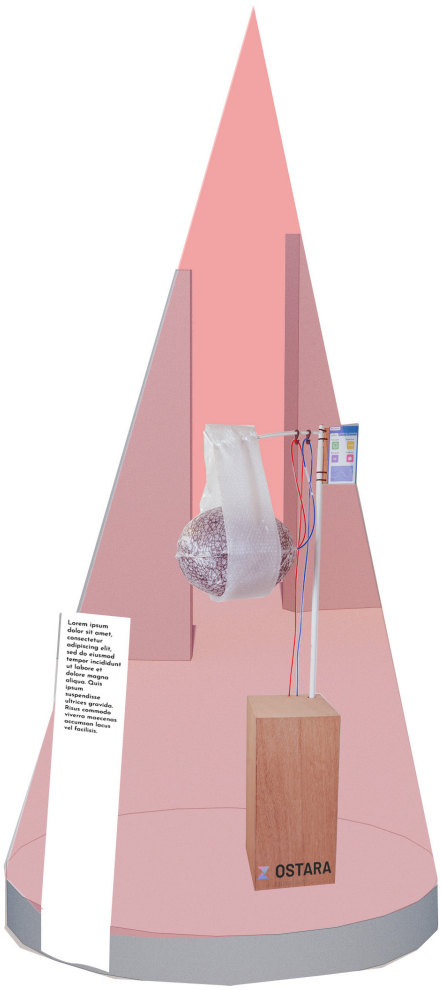


Fig. 20 *the womb display*

The text:
Ostara's - Womb 4.0

The womb 4.0 is Ostara's latest external womb version. It includes all basic elements that can be expected from an extra-corporeal gestational system (technology that supports the development of a fetus outside the womb). What makes our external womb 4.0 unique are customisable soundscapes that mimic the sounds surrounding the parents in their natural environments, which promotes healthy development of the auditory cortex in the fetus. However, the biggest upgrade we have to say are the new laws around gene editing technologies approved by the European court! These not only let us design out heritable disease but also help parents decide on the favourable traits they want to pass on to the next generation.

Take a closer look to inspect our womb 4.0 and feel free to touch.

6.2.3 The parent & doctor displays

The parent and doctor stories goal is to present different types of new families and perspectives (in line with the statement).The stories in spoken text and the family photo's help the visitor relate to human experiences around the womb.
The doctor story presents the scientific standpoint and discusses some of the effects on society, challenging the visitor to think about the bigger picture.

Light: The light turns on once a visitor steps into the circle in order to let them know the 'object' is activated and to encourage other visitors to also visit the objects.

Images: Pictures of the specific family in a frame present the different types of families and genders visually.

Sound: Short stories and quotes from the family represented on the image can be heard by putting on the headphones.

The scripts for the spoken text can be found in Appendix I , certain quotes are highlighted on this page.

"The remarkable thing is, I did consider an external womb, even though there is no medical reason for me to do so. I feel absolutely no shame when I say I wanted to avoid the process of pregnancy. I have a fulfilling and demanding career as a dancer, pregnancy and the implications that come with it were not things I looked forward to."
- Ellis

"Ah, I remember you did not opt for genetic preferences and by just combining your DNA randomly wanted to be surprised. I guess about half of our clients choose for this option nowadays, it is so heart-warming to see parents discover their children abilities as they grow."
- Dr Menuri

"I am glad we decided that since we look pretty different from each other, for Ralf not to resemble any of us, we are truly unique and as a family our strength lies in being there for each-other, spending time together."
-Marc

"Yes, my grandparents still think we are mad for doing this, but they love Ralf anyway. It kind of makes sense that their generation needs more time to adjust, babies in machines, people in pressure tanks to heal, designing out heritable disease, biotechnology is developing so fast, sometimes it feels like we live in a real time experiment, new things are never without risks."
- Jonathan

Fig. 21 *Dr. Menuri on display*

Fig. 22 *Max, Ellis and the doctor on display.*

Fig. 23 *The Ostara doctor/scientist, Dr. Menuri*

Fig. 24 *Max, Ellis and the doctor*

Fig. 25 *Jonathan, Marc & Drew on display.*

Fig. 26 *Jules & Joanna on display*

Fig. 27 *Jonathan, Marc & Drew*

Fig. 28 *Jules & Joanna*

6.2.4 The interactive exit

The goal of the interactive exit is to challenge to visitor to think about their personal limits around the new make-ability in reproduction (in line with the statement). are they open to genetic engineering, and babies in external wombs, or does it make them feel uneasy?

By asking them a personal question: 'which traits would you pass on to your future child?' the aspect of make-ability becomes more personal and relatable.

Information in text: The exit literally asks the visitor in text which traits they would pass on to their future child.

Information in graphs: Graphs and text will present the visitor with Ostara's advice on which traits they think the visitor should pass on. Ofcourse the technology to give personalised advice based on a hand scan does not exist jet, therefore randomised advice is given. This means that each visitor gets different advice, which enables people who visit together or simply wish to interact to compare and it gives one the feeling of getting unique advice. It also means that there is not any personal information that is shared or filled in public, which could be a concern.

The advice given by Ostara is mixture between general and some specific information, enough to be believable if one wishes so, like a horoscope, there is always something about yourself you can find in it.

The interaction scenario goes into more detail about the specific steps and interactions.

Fig. 29 *The exhibit exit*

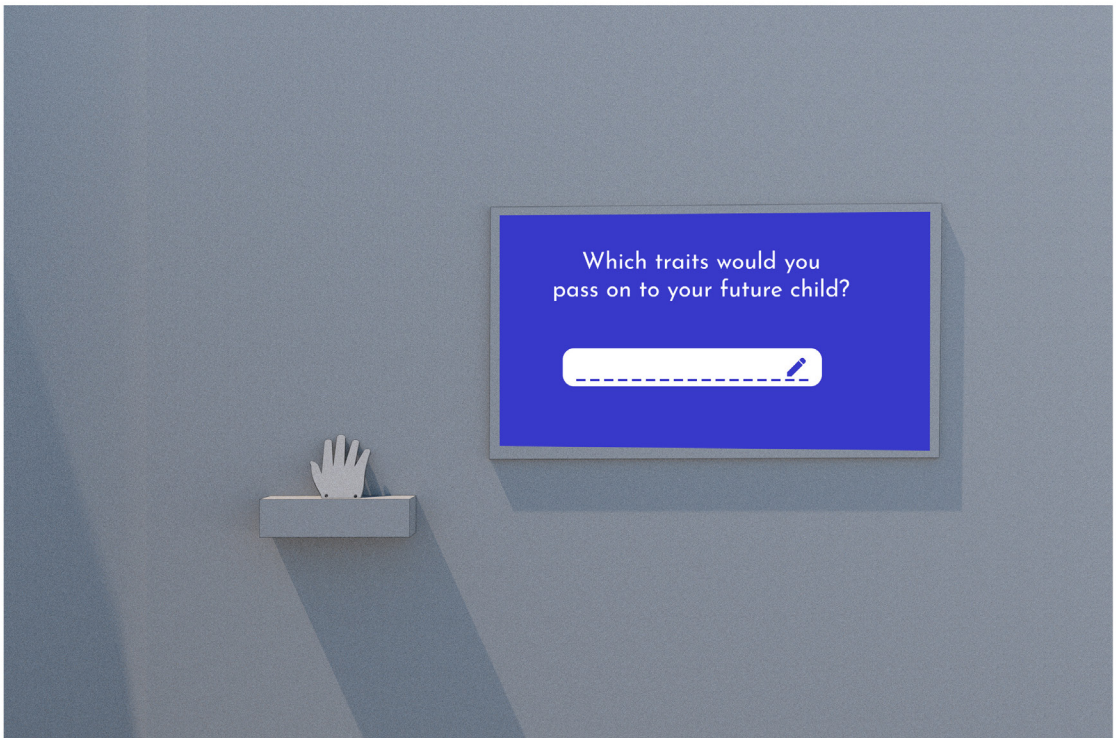


Fig. 30 *The touch screen*

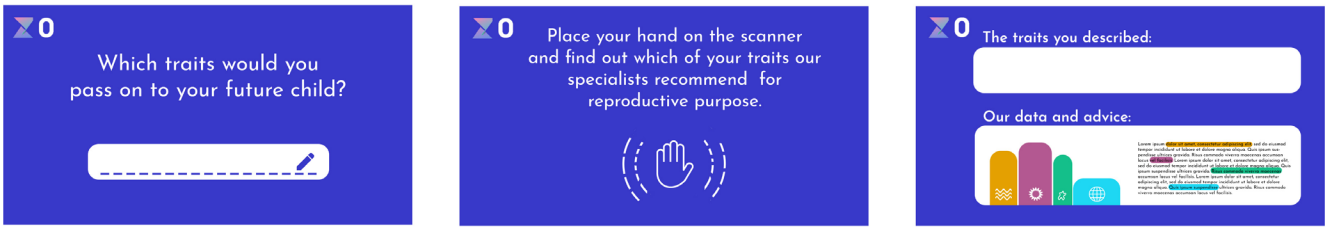


Fig. 31 *The touch screens interfaces*

6.3 The womb 4.0 prototype

The womb 4.0 is the speculative product design at the center of the exhibit, and actual prototype is created in order to make the speculation more believable (product characteristic). The womb consists of a console with a screen, a frame, the womb, and tubing.

The console shows an information about the baby growing inside of the womb and statistics that show the babies vitals. Oxygen levels, the babies mood, the current soundscape and the sleep quality are present on the home screen, whereas more complex information is hidden for professionals only.

The womb is the part that holds the baby and designed to look like a crossover between a machine and something more life like resembling tissue. Therefore the 'egg/shell' that holds the baby resembles tissue/arteries.

Tubes are added that feeds the womb the necessary nutrients and enables the control of the fluids, more complex machinery is hidden in the wooden box, allowing the womb to look friendlier.

Fig. 32 *The womb prototype*

Fig. 33 *The womb prototype*

6.4 Interaction scenario

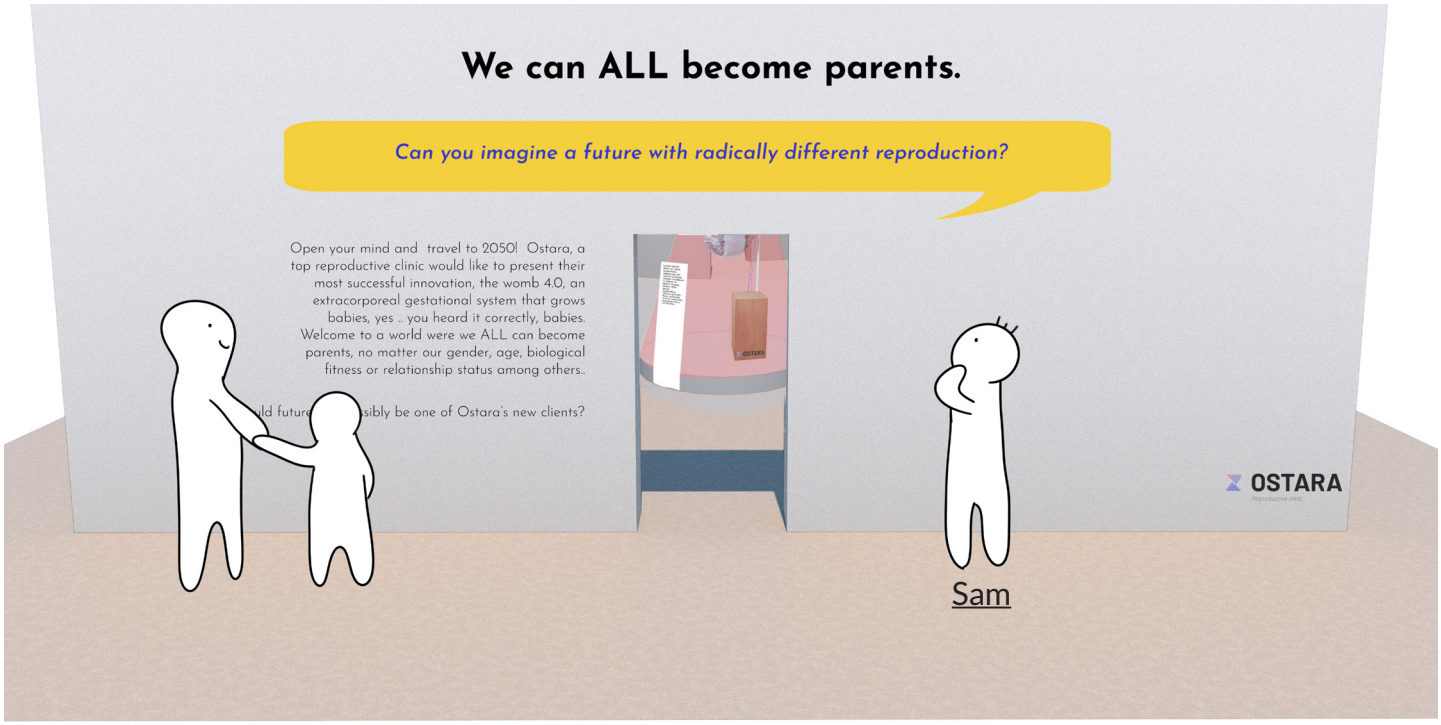
The interaction scenario presents the interactions and the different elements of the exhibit. We follow a visitor named Sam its experiences.

As the route a visitor takes and the amount of elements a visitors decides to inspect or interact with will differ per visitor, different routes are mapped on figure 18. The green route is represented within this interaction scenario, a route in which the visitor visits each element once.

We follow Sams experiences while exploring the exhibition, The product characteristics related to the interactions are mentioned in the scenario.

The entrance

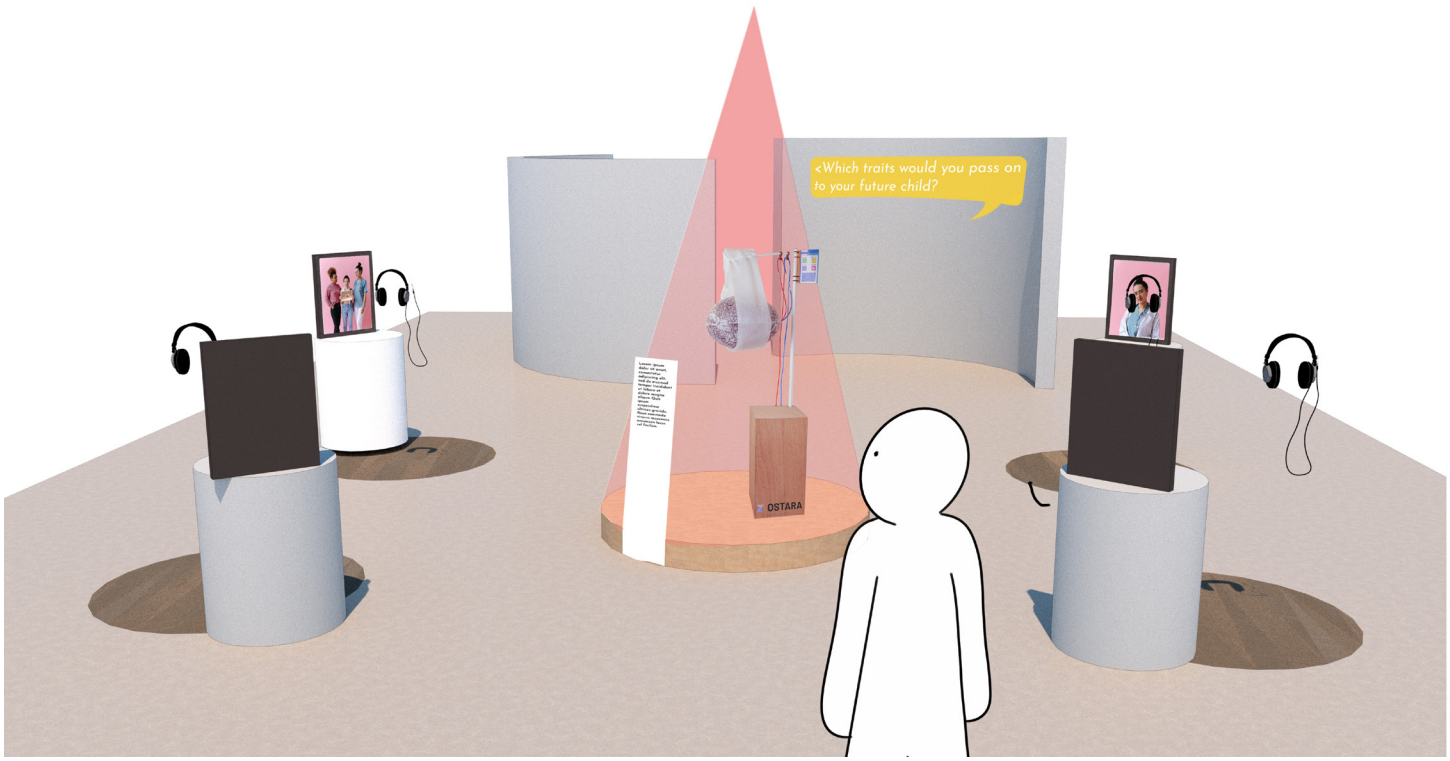
Sam is visiting the yearly design festival in his hometown, he does this every year and is very excited to explore and be amazed on his day out. While exploring the main hall his eye lands on one specific exhibit. Sam approaches the entrance. A red pulsing lights and sounds in the distance captures his attention. However Sam stops and reads the title of the exhibit and the information on the wall. * thinks: "reproductive technology, is that DNA stuff? by a company called Ostara?"* The information clearly states the year 2050, Sams interest is sparked. *thinks: this must be pretty futuristic!*



Product characteristics: Captivating & Believable

Taking in the exhibit

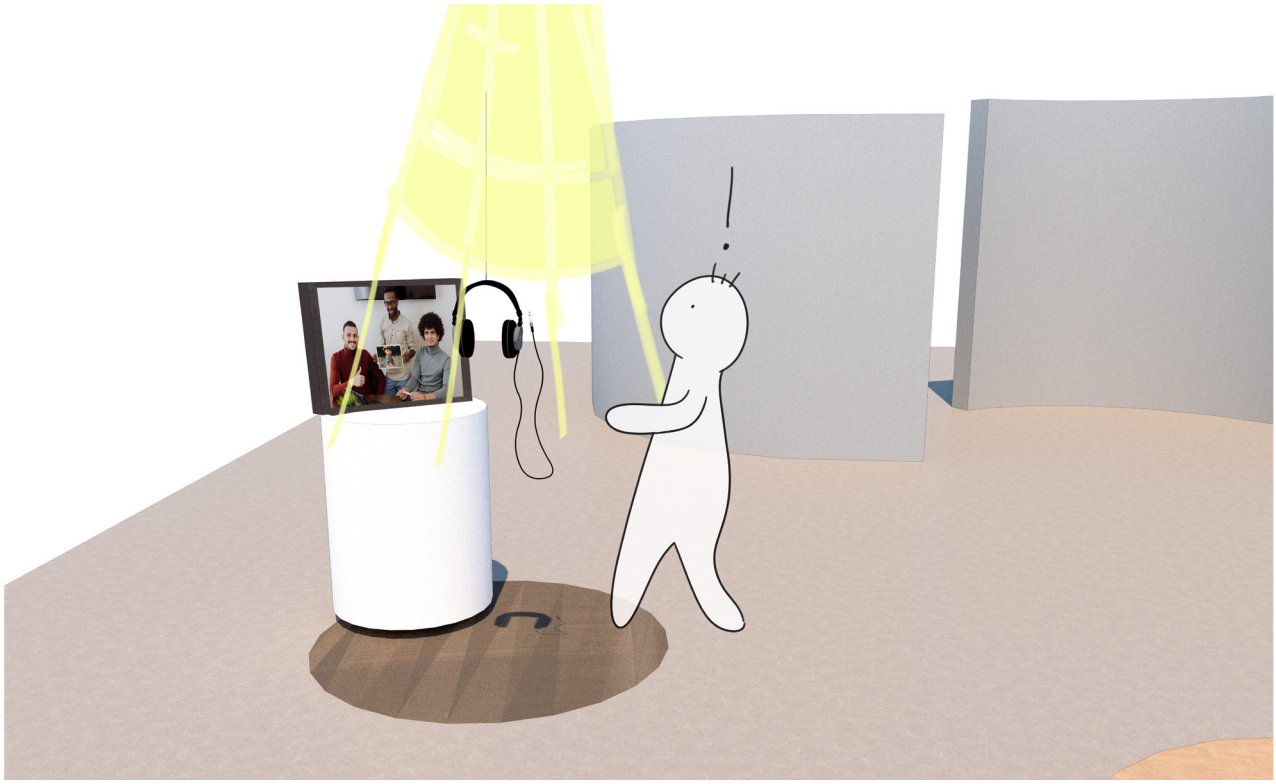
Upon entering the exhibit becomes visible. Sam is amazed by the light and hears the sound of and actual heartbeat coming from the direction of what looks like a machine. Sams gaze then crosses the elements which display pictures and headphones. Sam does not fully understand their intent but as they are closest by he decides to approach one.



Product characteristics: Captivating & Layered

Parent story

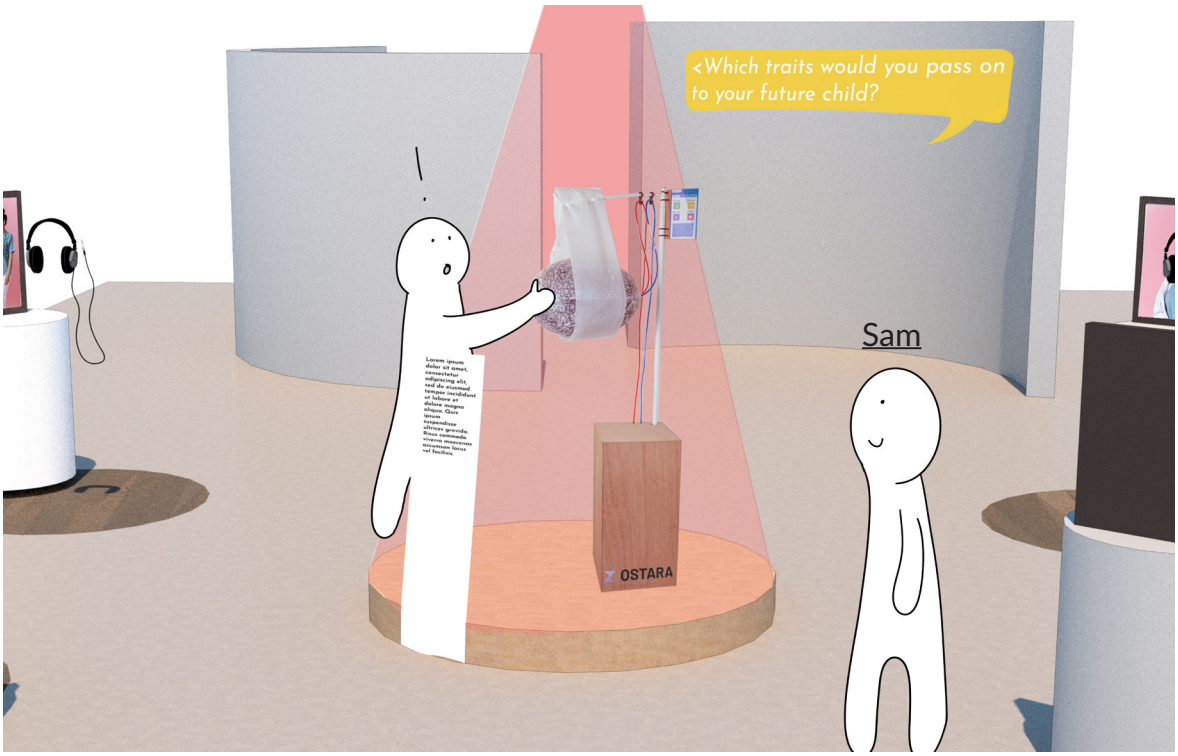
Sam approaches the element that is closest by. While stepping into the circle a spotlight turns on as if the installation is now activated. *Sam is surprised* Sam puts on the headphones and hears three men talking about their experiences with an external womb. Sam realises the men in the picture frame are all genetic fathers of the baby in the frame. *thinks: wait, what, 3 fathers that is .. weird, or isn't it". The story the men challenges Sam to think, but it is also a lot to take in, Sams mind needs time to process. Actually hearing their voices makes the new information believable and Sam is able to empathise.



Product characteristics: Mind-boggling & Challenging & Believable

Womb experience

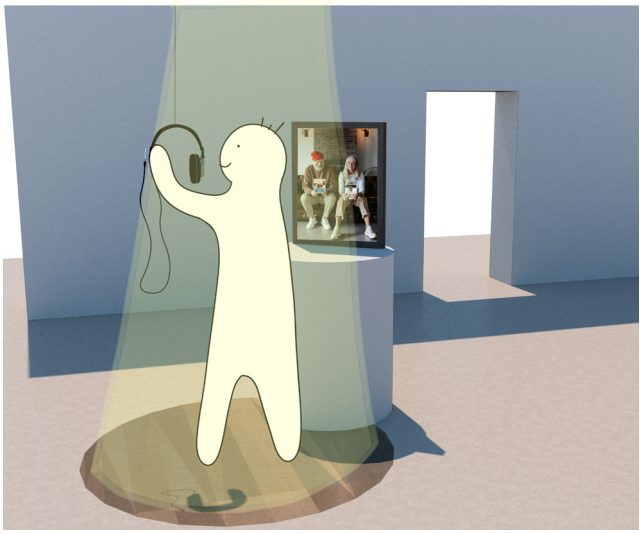
After hearing the 3 fathers, Sam is curious to inspect this womb they were talking about. He is not the only one inspecting the womb, another visitor is closely listening to the sound of a heartbeat and sounds that seem to mimic daily life. Sam decides to step closer an he notices a blinking light on the machine, does that mean it is on? Upon closer inspection Sam is allowed to touch the womb. Sam puts its hand on the womb.. , it is warm to the touch! Sam is fully captivated by the machine, he notices the screen and the fetus its vitals. Especially the mood of the fetus attracts his attention, the fetus seems content, this makes Sam smile.

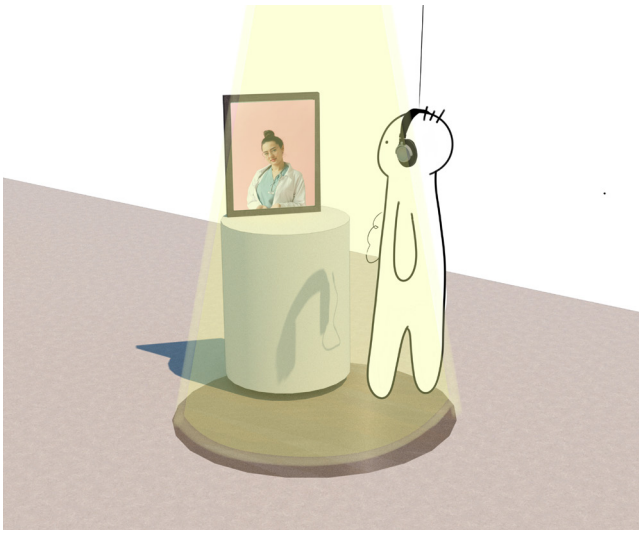


Product characteristics: Mind-boggling & Captivating

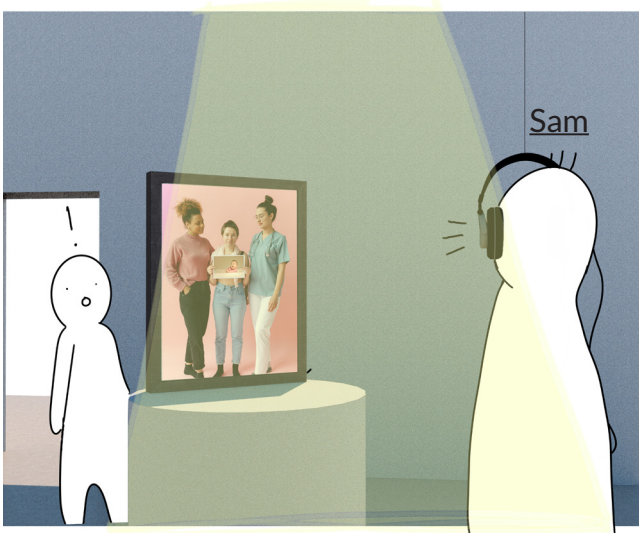
Parent story and scientist story

This time Sam knows what to expect while approaching the elements. Sam decides to hear out the elderly couple first. Sam approaches the element of the picture with the three woman, one is clearly a doctor. Sam likes the story but listens for a short while. Sam is more interested in what this doctor has to say and approaches the last element. *thinks: Could this scientist help me get my thoughts in order?* The scientist talks about health equality, safety of the technology, and how it shifts and creates new roles in society. Sam is inspired but also slightly creaped out.., and a bit overwhelmed. Could this technology really become possible? It clearly has a lot of benefits.



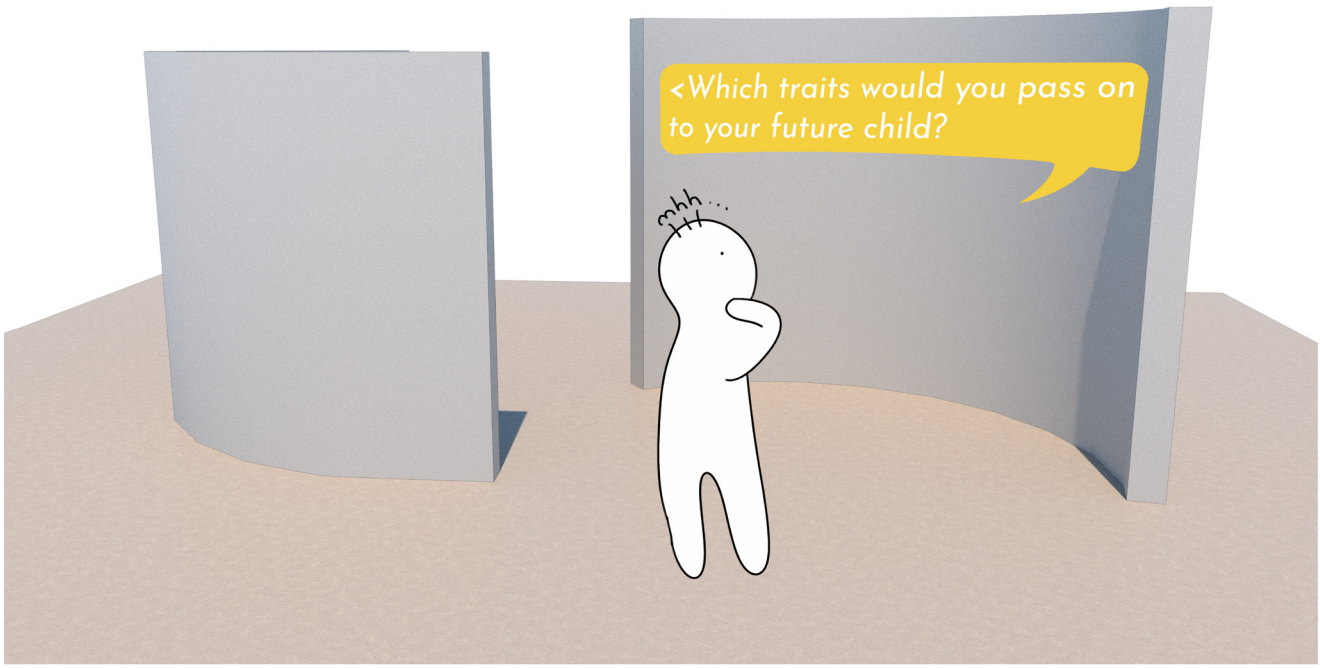


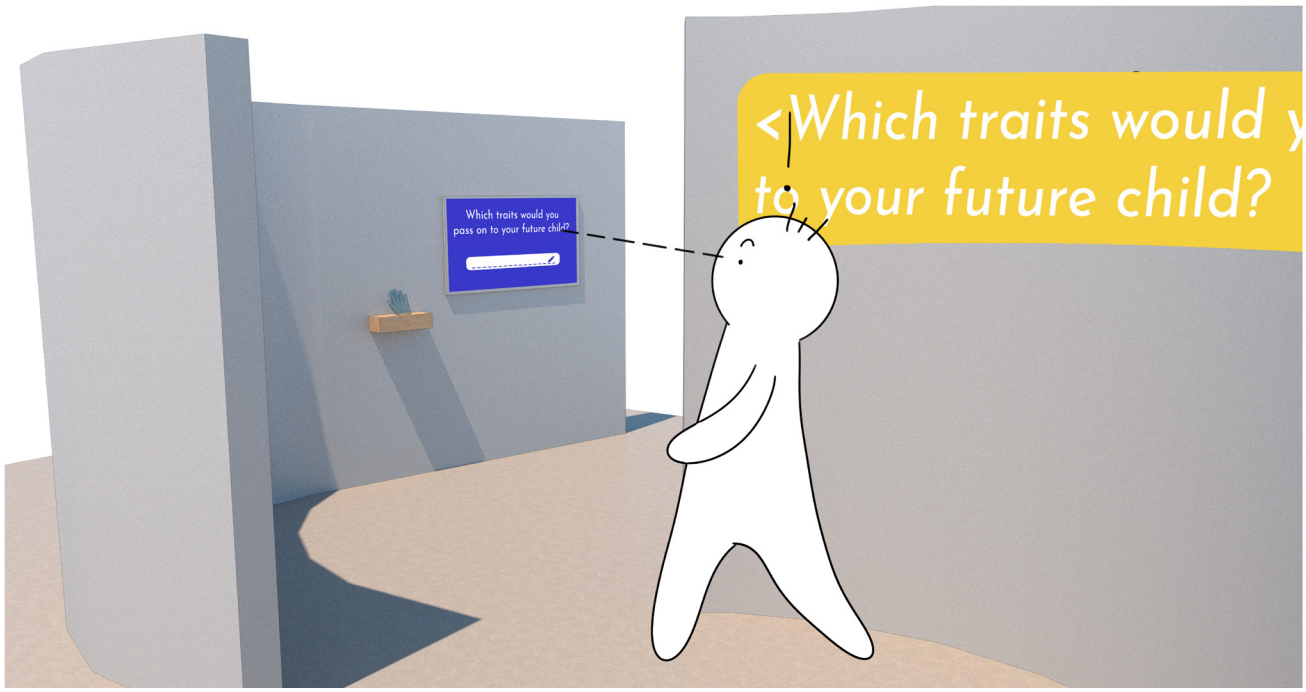
Product characteristics: Mind-boggling & Captivating



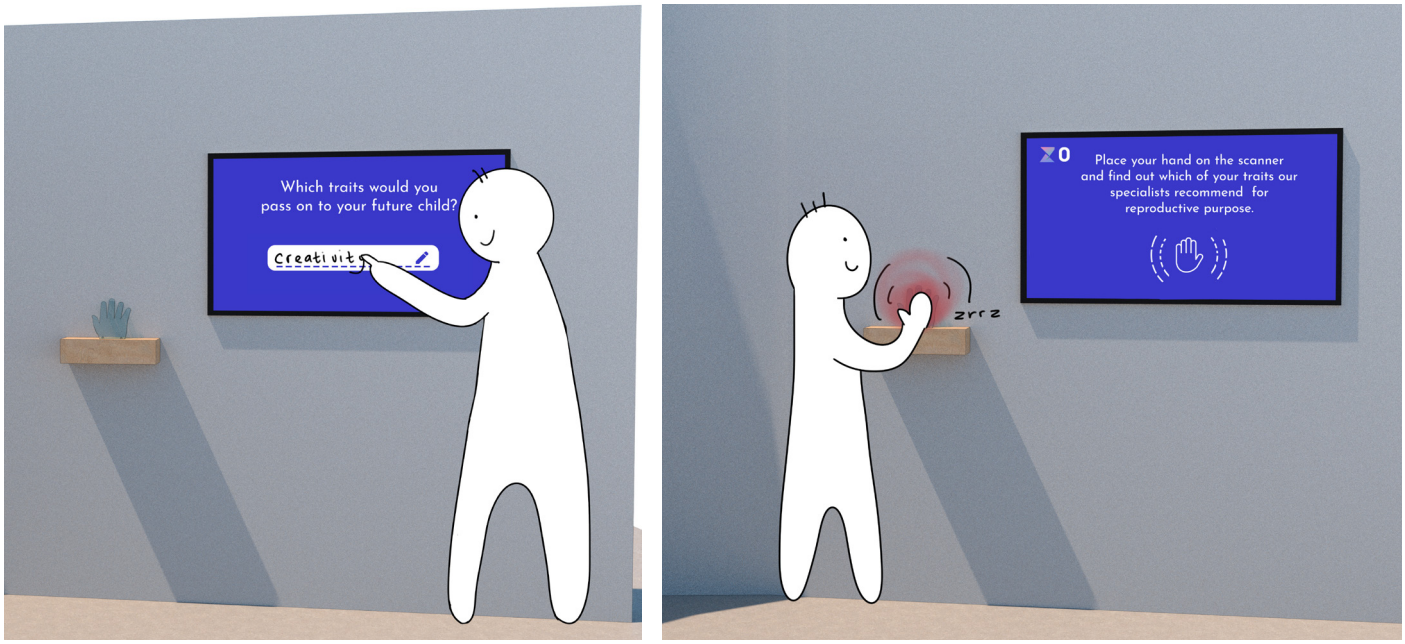
Interactive exit

Sam walks around the exhibit for a short while, in order to give his head some room to process and het casually observes the reactions of other visitors. After a while he decides to approach the exit, the question on the wall draws attention, but does not initiate direct thinking. Around the corner a screen appears, the exit is quiet and shielded

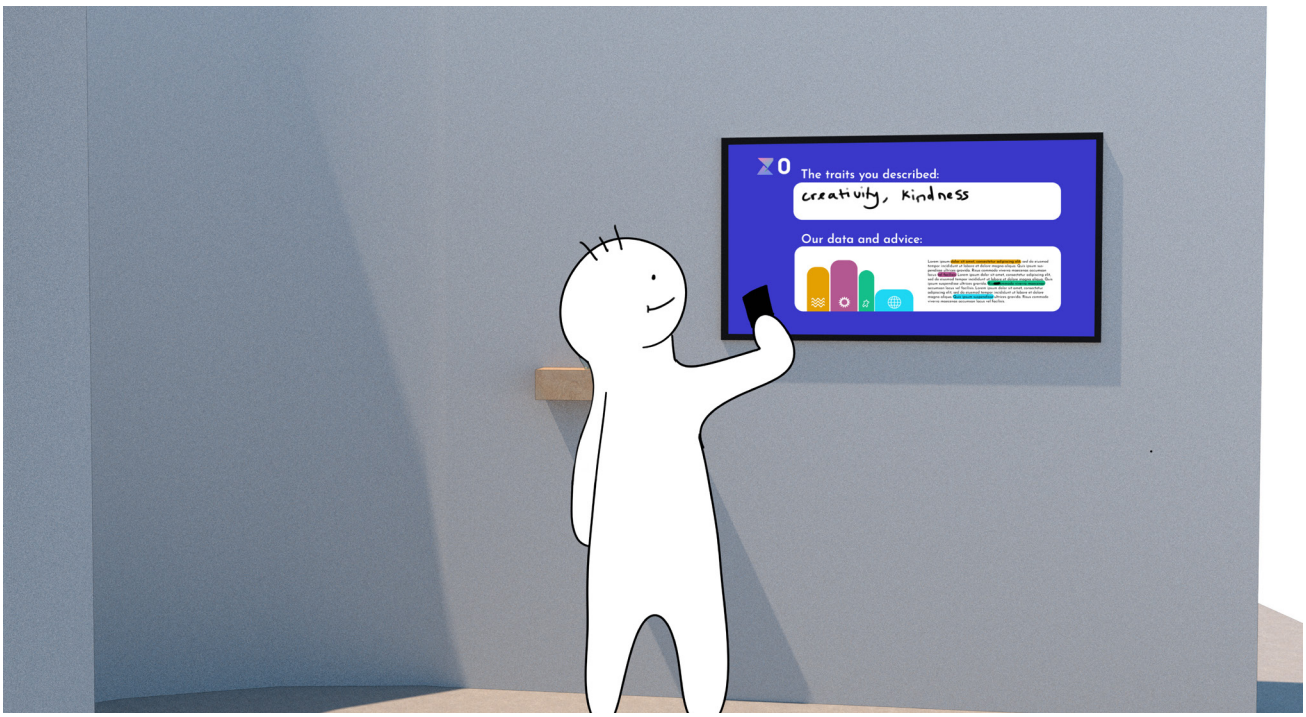




Screen: Which trait would you pass on to your future child? *Sam thinks: If I could decide what would I value most?* Sam enters creativity and kindness. The screen tells Sam to scan his hand if he wants advice on what Ostara's specialists would recommend based on his/her genes. Sam is intrigued, * thinks: would their advice make sense?* Sam puts his/her hand on the scanner and it buzzes and blinks.



The screen shows the results, which look proffesional and detailed and suggest things Sam has never thought about. Apparently he carries genes with a predisposition for athletics and there are as he expected some aspects that talk about creativity. It is interesting but also a bit creepy, *thinks: this is not real right? But could it be? Would I want it to be?* Sam scans the code in the screen to later access the outcomes, he wants to share it with a friend whom would definitely love this. Sam walks away from the exhibit mind buzzing and excited.



Product characteristics: Challenging & Believable

6.5 Validation

In order to evaluate the concept formal validation is conducted. It is tested wheter the desired product characteristics and interactions are recognised and present, validation the 'succes' of the concept according to the ViP method. Validation is also important in order to recognise what to improve and possibly change based on particpants feedback.

As stated in the statement I want the visitor to be aware of new types of families and gender and challenge them to think about their own opinions and limitations around the new 'make-ability' in reproduction.

In order to evaluate this qualitative interviews (3 participants) and a short questionnaire (5 participants) are conducted.

Research questions

1. Does the participant notice and talk about the new types of families presented in the exhibit? (Interview)

2. Does the participant form an opinion about the technology of the womb and their own limits around make-ability? (interview)

3. Does the participant mention both positive and negative implications about the technology of the womb? (Interview)

4. Are the participants able to identify the product characteristics? (Questionnaire)

Qualitative interviews

For the setup of the interviews see appendix J.

As the exhibit is a concept, not a real exhibit the participants are presented the floor plan which is made click-able (a website) in order to explore the exhibit digitally. For print-screens of the website see appendix K.

Does the participant notice and talk about the new types of families presented in the exhibit?

All participants talked about the new types of families and recognised them as something that is more uncommon now, but could very well be possible due to new reproductive technology. The level of thinking and reflection differed per participant, where one went as far as questioning what family could be altogether:

"*those 3 men especially got me thinking.. I mean, first I honestly was a little appalled, three men, how are they going to organise a household haha! But who defines what a family is anyway? Taking care of someone and having a bond is key right." (Participant 3)*

whereas others just mentioned noticing it:

"Getting a child at 65 would definitely be new, but it could make sense in 30 years you know." (Participant 1)

And one participants expected to see more and even weirder families:

"I would have loved to have seen even more families, even weirder ones, three grandmothers, a father and his clones, to me these families were nice, but not very shocking." (Participant 4)

Does the participant form an opinion about the technology of the womb and their own limits around make-ability?

All participants discussed the technology of the womb and it inflicted a wide range of reactions which all where either an opinion or the participant trying to form one. The exhibit and the prototype thus seem to spark participants to think about forming or exploring their opinion both about the womb but also themes related to the womb. It was also interesting to see that details of the womb prototype where mentioned and could influence their opinions. Some participants went into whether they would use this technology and what their own limits where whereas with others I had specifically ask.

"This womb machine thing is crazy, I get that some aspects might be safer. As a mother myself I don't think I would have wanted to miss out on pregnancy even though not all aspects were nice." (Participant 2)

"Where can I sing up? haha! I very much believe technology and biology together are going to really change human experience this century, it gets me very excited, so seeing and external womb excites me as well." (Participant 4).

"The fact that the womb is warm to the touch, I would love to experience that, that would make it so real and approachable" (participant 4)

Does the participant mention both positive and negative implications about the technology of the womb?

Some participants were very excited about the technology, and mainly stated positives whereas others had more doubts, however all of the participants mentioned that technology like the womb or gene editing (mentioned at the exit) could have both positive and negative aspects, whereas one participant mentioned not to worry too much about implications at all. The exhibit seems to highlight more neutral and positive aspects but this does not keep the participants from thinking about negative implications.

"will governments regulate or is there more of a free market? Will investments be made? People wanting to change their biology is nothing new, we will just have new more effective tools at hand. " (Participant 4)

"When I think about it for too long things like this, and gen technology and stuff scare me. It can solve a lot of problems but what about new problems, what if power goes out, stuff like that? The exhibit does not really seem scary however" (participant 5)

"developments happen anyway and can be so unpredictable, I do not really worry or think about what might happen and what not, we will see . (participants 1)

Overall feel of the exhibit

Participants overall were positive about the feel of the exhibit and as was to be expected mentioned that the website could differ from what they would think where it a real exhibit.

Entrance

- A participant mentioned liking the text at the entrance and getting excited to explore more.

Family & doctor displays

- It was mentioned the families could be more extreme, and more families to choose from being presented.
- Hearing the families talk felt personal and helped participants relate.

  "I liked hearing the people from the frames talk, that made it feel real. I understood what this womb was able to offer them" (participant 5)

- The pictures of the families were mentioned to look very polished an perfect.

  "The families did look a little too perfect in a way, not the girls in front of the pink, I liked that, maybe one format could have been used." (participant 1)

Womb display

- Particicpants were positive about the womb display, and mentioned this as the display they would really had loved to see in real life.

  "I would have liked to be able to really touch this womb in real life, it looks awesome" (participant 4)

- The womb really seemed to not only make participants thinks but also feel differently, more open minded towards technology and biology merging,

  "The heartbeat definitely made me feel protective of the machine. haha I just mentioned that I would never use it, maybe I do not know what I want " (Participant 2)

Interactive exit

- The interactive exit was desribed as surprising and seemingly innocent, until you realise what it really means, which seems to really test the visitors limits around make-ability.

  "The exit really got me, first I though mhh interesting, cool, but them I was like ho wait, am I now choosing what my child will excel in? That is very unethical stuff" (particpant 2)

- One participant however did not really get it, which points out that real interaction with the screens might be needed to fully understand.

  "The exit was a little confusing to me, I think I got the point but I am not sure ... passing on a trait is that DNA editing." (participant 1)

Questionnaire

Within the questionnaire participants (5) were asked after viewing the website whether they recognised and how they scored the characteristics on a scale from 1-5.

The characteristics mentioned in the questionnaire are: Believable, weird, captivating, mind-boggling, layered, challenging and dull.

Two of the above-mentioned characteristics are not desired interaction characteristics but are added in order to keep participants focussed and thinking instead of just giving high ranks to every characteristic.

Below the results per characteristic are discussed, for the data in graphs see appendix L , the percentages are shown in the table below.

	1 (not at all)	2	3	4	5 (very much so)
Believable	0%	20%	0%	60%	20%
Weird	20%	20%	40%	20%	0%
Captivating	0%	20%	0%	80%	0%
Mind-boggling	0%	0%	20%	0%	80%
Layered	0%	0%	0%	80%	20%
Challenging	0%	0%	20%	40%	40%
Dull	40%	40%	20%	0%	0%

Table 1 *Percentages of the scored characteristics.*

As the group of participants is low (5) this data is not for drawing hard conclusions, but a general check whether these participants thought the characteristics were represented in the exhibit, and wheter one of the characteristics did not come across at all.

In all characteristics the majority scored them as being recognised. One participant thought the exhibit was not that believable, which is not that weird it being very futuristic and an online exhibit. One participant thought that the exhibit was not that captivating, this also could have to do with the format of a website and something to take into account in the recommendations.

What is great to notice that 80% of the participants thought it was very mind-boggling and the majority also thought it was challenging, which could point at them having to think about it and process the content.

Answering the research question one could say that the participants were able to recognise the interaction characteristics.

6.6 Recommendations & limitations

Website & Validation

- Validating an exhibit through a click-able map has it obvious limits, the participant does not really experience the exhibit and has to use its imagination, therefore results have to be carefully interpret. 3D technologies like virtual reality or something more dynamic like film (not do-able due to time limits) could help the participants imagine their experience better.

- The exhibit consists of a lot of different elements which were not tested separately, main conclusions can be made about the overall feel certain elements that were mentioned, for recommendations per element more detailed testing would have to be conducted.

Exhibit

Family and doctor displays

- As was mentioned by a participant, if the main focus is on the families and social aspects of new technology in evolution, more and even extremer families could have been shown in the exhibit. I would propose a more interactive installation showing the different type of families, for example a whole wall full of possible and more extreme families with each their own story where the visitor is free to choose which family to listen to, or to take a look in their lives.

- The pictures used for the families were stock photo's, even though they ware carefully chosen to seem real and relaxed I would recommend making 'real' pictures where an exhibit like this to be created.

The womb prototype

- Participants seemed to react strongly to the womb, the sounds, the idea of heat, it could be very interesting to see how these aspects influence visitors by actually testing them. Based on this the design of the womb could become a lot more experimentaland interactive. It could become a machine you actually carry around, and not necessarily on your abdomen. Or partly integrated in your body, but you can also take it out for short times so it does not become to taxing. What if multiple family members carry the external womb, lots to explore.

- As was remarked the heartbeat of the sound-scape could be confused as being the heartbeat of the baby itself, instead of the parent, additional information about the sound-scape or visitors being able to alter or interact with the sound-scape could clear this confusion up.

The exit

- Real interaction with the screen will probably make the point the exit tries to make (test peoples limits around make-ability) more clear. Also having a real doctor on the screen telling you your results would be even more personal and convincing.

Making the exhibit a reality

- Creating an exhibit like this is something that would take time and needs funding. Therefore I think that making the whole exhibit, with al its components come to life would only be possible if a company or specific funding is involved. What would make more sense that specific parts are worked out further and developed in a stand alone thing.

- More important I believe than making this exhibit or parts of it an actuality, is continuing the conversation about what new reproductive technologies can offer us in relation to our families and social lives. This could be possible by using this project as a basis/ inspiration for the creation of prototypes/simple artefacts. Maybe a family tree in 2050, maybe planned parenthood for people whom spent at least 50 years on this earth. These artefacts could serve as the basis for an online/ printed article or be part of larger exhibits and are far simpler to realise the exhibit as a whole.

6.7 Conclusions

The exhibition 'we can ALL become parents' using the fictional company Ostara in order to speculate about a future in which external wombs are part of our lives seems to be able to get the visitor acquainted with new forms of families and questions their limits around the new make-ability this technology brings. It is able to challenge the visitor to not only think about this new womb but also opens up conversation about related theme's. It fits the goal of a design speculation in that it opens up a space for discussion and debate and inspires and encourages peoples imaginations to flow freely (Tran, T. H., 2019).

Different elements and layers of information together form the exhibit including the desired interaction characteristics. Validation shows that the desired interaction characteristics and the goal of the statement are being met, albeit there being recommendations that could improve certain elements and thus the whole experience.
In order to get to a statement and product characteristics gathering data and clustering using the ViP method where essential and I believe form a strong basis. The translation from this deep dive into the context into an actual concept was challanging to say the least.
Working on an exhibit with so many layers of the design was refreshing , storyboards, floor-plans, 3d renders, drawings, prototyping a lot of variety. This variety proved daring in validation and a website was created to be able to offer the participants a glimpse/experience of the exhibit.

Working with a theme this futuristic has really opened my eyes towards the possibilities revolutionary developments in biotechnology can offer us! I even have to admit to have become somewhat of a futurist, diving deep into literature, scrolling through forums about longevity and getting weekly updates on my in-box on recent breakthroughs in biotechnology. I think it is very interesting to see which role the field of interaction design can play in the biotechnological innovations to come, we might not be the scientists tinkering the biological processes but we can add by stirring conversation, by envisioning new technology in line with humand needs and desires (and ofcourse by creating user experiences for the healthcare and biotechnology to be).

Glossary

- **Abortion =** the ending of a pregnancy by removal or expulsion of an embryo or fetus. (Lippincott Williams & Wilkins. 2012)
- **AI: Artificial Intelligence** = the simulation of human intelligence processes by machines, especially computer systems.
- **Anthropocene** = s a proposed geological epoch dating from the commencement of significant human impact on Earth's geology and ecosystems, including, but not limited to, anthropogenic climate change.
- **Bio-hacking** = biological experimentation (as by gene editing or the use of drugs or implants) done to improve the qualities or capabilities of living organisms especially by individuals and groups working outside a traditional medical or scientific research environment.
- **Building blocks of life** = seeing DNA and new technologies being able to edit DNA as the building blocks (like Lego) of life in our universe.
- **Cloning -** the process of creating clones of organisms or copies of cells or DNA fragments. In essence cloning is an **asexual method of reproduction** (=** Asexual reproduction is a naturally occurring phenomenon in many species, including most plants and some insects (Horticulture).
- **Gender binary** = the classification of gender into two distinct, opposite forms of masculine and feminine, whether by social system or cultural belief.
- **Gender spectrum** = the agreement that gender is a spectrum of identities rather than the binary of male or female. *Ipsos - The future of gender is increasingly nonbinary*
- **Genetic engineering -** Techniques used to cut up and join together genetic material. For example **CRISPR-CAS 9** raises the possibility, more realistically than ever before, that scientists will be able to rewrite the fundamental code of life, DNA.
- **Health equity** = "the conditions, resources, opportunities and power that allow one to achieve optimal health." according to Dr. Aletha Maybank Chief health equity officer, VP American Medical Association in the Januaty issue of WTF Gender by Ipsos)
- **Information overload** = an over-exposure to information or data.
- **Life extension -** the concept of extending the human lifespan, either modestly through improvements in medicine or dramatically by increasing the maximum lifespan beyond its generally-settled limit of 125 years.
- **Mind melded families** = a family in which the minds of the members are interconnected and thus able to communicate ..
- **Mirror neurons** = a neuron that fires both when an animal acts and when the animal observes the same action performed by another. Thus, the neuron "mirrors" the behavior of the other. They are essential brain cells for social interactions. Scientific American - The Mirror Neuron Revolution: Explaining What Makes Humans Social
- **Nuclear family** = also known as elementary family; a nuclear family is a household consisting of a father and a mother, whom are usually married, and their children.
- **Poly family** = a family consisting of parents in poly amorous relationships (relationships which involve multiple partners) and their children.
- **Postgenderism** = a social, political and cultural movement that believes that gender in humans should be voluntary and that the abolishment of (traditional) gender is freeing us of expectations that are largely detrimental to society.

- **Reproductive technologies** = all current and anticipated technologies involved in human and animal reproduction.

- **Togheter-alone time** = when children are at the same location as their parents, but do not report being copresent with them. (Mullan, K., & Chatzitheochari, S. (2019). Changing Times Together? A Time-Diary Analysis of Family Time in Digital Age in the United Kingdom. Journal of Marriage and Family, 81(4), 795-811. doi:10.1111/jomf.12564)

- **Traditional gender roles** = the traditional behaviors, values, and attitudes that are considered appropriate in a society that views men as the provider for the family and women as the caretakers of both the home and the family.

- **Trans-humanism =** a philosophical movement that advocates for the transformation of the human condition by developing and making widely available sophisticated technologies to greatly enhance human intellect and physiology. Bostrom, Nick (2005). "A history of transhumanist thought" (PDF). Journal of Evolution and Technology. Retrieved February 21, 2006.

Assisted reproductive technology - medical procedures which address infertility.

- Artificial Insemination = (AI), sperm are collected from a man and placed into the female's uterus by a reproductive specialist.

- Cryopreservation
  a technique in which tissues, cells and organs ****are preserved by cooling to very low temperatures, in the case of reproduction often embryo's and gametes (= an organisms reproductive cell)

- Germline gene therapy
  therapy that allows for the correction of disease-causing gene variants that are certain to be passed down from generation to generation.

- In vitro fertilisation
  often known as IVF, a process of fertilisation where an egg is combined with sperm outside the body, in vitro ("in glass").

- Preimplantation genetic diagnosis
  is the genetic profiling of embryos prior to implantation (as a form of embryo profiling) and sometimes even of oocytes prior to fertilization.

Predicted - reproductive technologies in development or predicted by specialists in the field

- **Artificial womb =**a device that would allow for extracorporeal pregnancy by growing a fetus outside the body of an organism that would normally carry the fetus to term (Bulletti et all. 2011)

- **In vitro gametonesis =** includes obtaining cells from a donor (such as skin cells), and differentiating the cells in a laboratory culture dish into gametes (eggs and sperm), which enables same sex reproduction.

- **Multi parent reproduction =** Reproduction in which offspring has DNA from multiple parents (more than 2 as is the case in classic reproduction).

- **Uterine transplant=** surgical procedure whereby a healthy uterus is transplanted into an organism of which the uterus is absent or diseased. Enabling transsexual (male to female) pregnancy or even male pregnancy.

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