2030: A future vision and concept for Vanmoof.

GRADUATION REPORT TEXTBOOK

Graduation thesis IDE Walt van der Veen
in collaboration with: VanMoof Amsterdam

2030: A future vision and concept for Vanmoof.

GRADUATION REPORT IMAGEBOOK

Graduation thesis IDE Walt van der Veen
in collaboration with: VanMoof Amsterdam

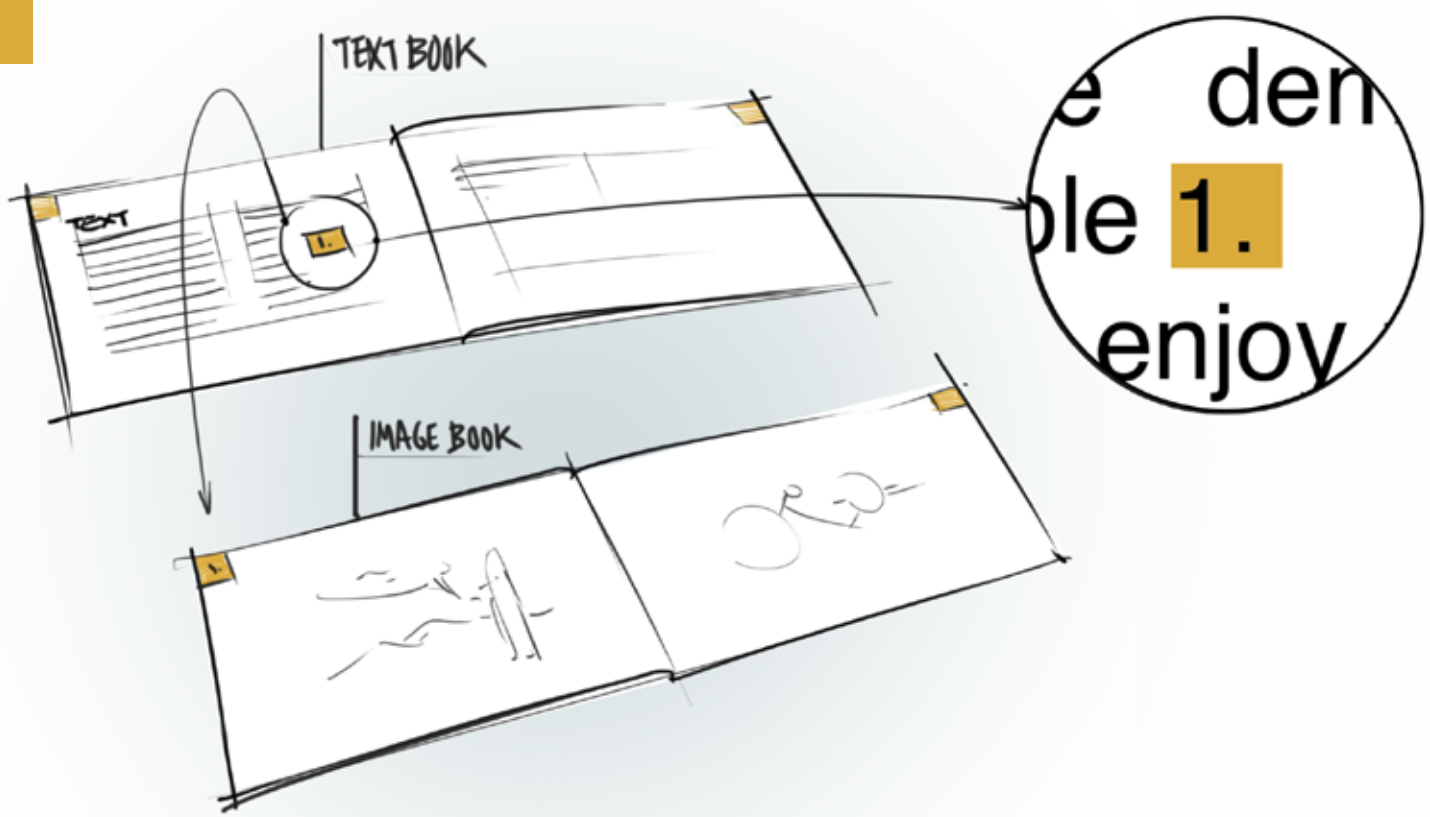
Welcome on the First Page!

Described and visualized in these documents in front of you is the process of the graduation thesis project for VanMoof bicycles. Within this thesis the choice is made to touch upon all phases of a design trajectory, a fuzzy orientation phase, creative idea and concept development and eventually followed by a detailing and prototyping phase. This might be ambitious, but it will surely deliver great variety in activities and elaboration on a wide set of personal learning objectives. One of which is the use of the Vision in Product design methodology.
Please note that two separate booklets contain the process in one: a written, and two: a visual manner. The documents are cross-linked, and whenever visual matter is considered a valuable addition to the written material, it will refer to the particular image. By doing so the reader is free to either read, observe, or do both at her/his own preference and speed.

This principle, which in itself is an experiment, will be demonstrated with the following example 1.

Each Chapter is marked with its own color. In this first example, it is yellow. Or orange?

Please enjoy reading (or watching)!



PLEASE NOTE:

That for the digital version, the written and visualized documents are joined together, as digitally this separated format will be a pain in the ass. Clearly this documentation layout is designed for a physical copy. Within this report, the upper half is the ‘textbook’, the lower half the ‘image book’. Whenever no written or visual material is present, the page is gray. Which, in fact, would mean the page would be absent in a printed copy.

Table of Contents

REFERENCE IMAGE

(Page absent in printed copy)

(Page absent in printed copy)

2030: A future vision and concept for Vanmoof.

REFERENCE IMAGE

(Page absent in printed copy)

Introduction

Over the last decades the mobility system has been coping with problems having to keep up with a rapidly changing society. As stated by Arup in 2018: ‘Driven by population growth, consumer expectations, fiscal constraints, and environmental and health concerns, the mobility ecosystem is in a state of flux. Combined with the effects of disruptive technologies, these changes are giving rise to an exciting set of opportunities as well as complex challenges.’ In urban areas that weren’t developed for car usage these opportunities and challenges are becoming increasingly apparent. Therefore, mobility is reconsidered and popularity of alternative mobility solutions is increasing (Martinez. L, 2017).

Directly related to this future mobility context is the Dutch company VanMoof. VanMoof designs and manufactures electric bicycles in Amsterdam. The company strives to innovate within the sector of urban mobility and commuting with the goal to replace the car for personal mobility. ‘That we’re different from the others is a fact’ (VanMoof, 2020). Although VanMoof proves to be successful in the current mobility sector, it is recognized by VanMoof that the changing future mobility landscape requires adaptation in order to maintain a distinguished position. Within this thesis it will be questioned what the future mobility context will be like, and how VanMoof can react to it.

As time will be a limiting factor throughout this thesis, it will be essential to define a domain in

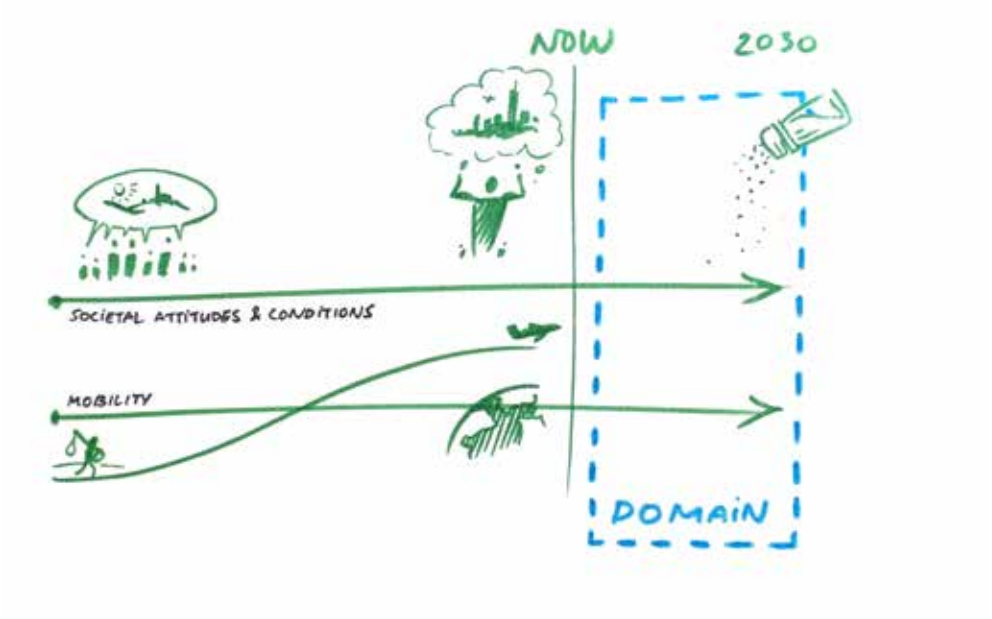
(Page absent in printed copy)

which it is desired to make a change. Rather than defining the design domain in a sentence, it is chosen to visually define it over a schematic time-line representing interdependent phenomena to be explored: developments in societal attitude and conditions in relation to Mobility 2.

Here, Societal attitude and conditions is the way in which people perceive and interact with their environments, and how their values are influenced by prevailing conditions. The Phenomenon 'development of societal attitude and conditions' is considered relevant as the current pandemic crisis (RIVM, 2020) will presumably accelerate the materialization of societal changes and alter the way in which people will interact with means of transportation. Due to this health crisis, new challenges and opportunities are revealed. History shows how a similar disruption led to innovation; modern day sewer systems were introduced only after global outbreaks of Cholera (Shenker, J. 2020).

'Mobility means and services' proved to be disruptive and of great influence on societal attitude in the past. In example: only a century ago, one would have limited access to mobility, increasing the importance of small communities. A century later, mobility around the globe became accessible for the masses, leading to an increase in urbanization and globalization.

It is a deliberate choice to maintain a 'distance' to VanMoof to ensure an outside perspective. In the Vision in Design process, which will be



the method of choice, this will mean a starting point at the beginning of the 'designing' phase. Later in the design process, the deconstruction (preparation) phase of the Vision in Product design process serves as a tool to better understand the VanMoof brand if necessary to create concepts suitable (enough) for the VanMoof company.

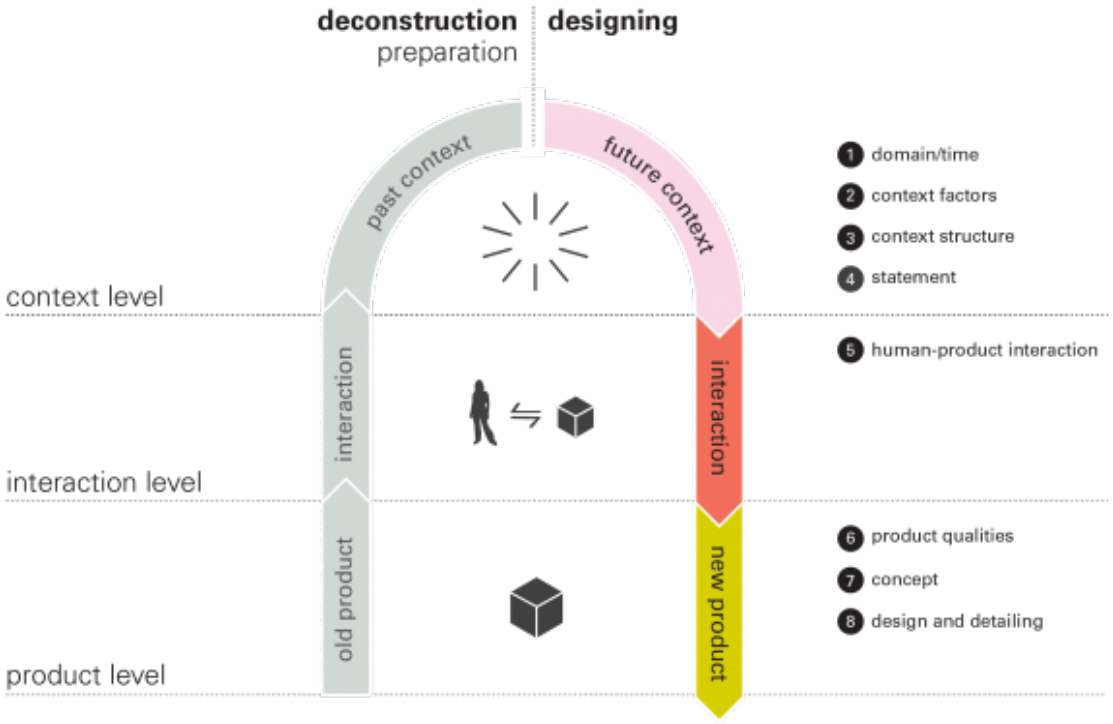
Problem Definition

VanMoof is a Dutch company changing and questioning the way we get from point A to B, building on and reinventing the bicycle as we know it today. Founded in 2009 they are currently present in 25 nations with more than 120.000 riders (VanMoof, n.d.). With a focus on urban environments, their product should make commuting increasingly efficient and comfortable, so that it will be given the preference over a car. Their combination of inventive implementation of electrical support and attention to design and detail, currently manifested in the S3 and X3 models 3., has led to a unique and successful product range. In 2018 VanMoof revenue was 10,7 million (Luimstra, J. 2019).

However, it is expected that competition will rise and VanMoof's distinguished position will decrease. Additionally, the current public health crisis will speed up the materialization of changes in social attitude and conditions with respect to mobility. How can VanMoof react to these changes, remain relevant and continue to distinguish themselves in the evolving mobility sector?

4 REFERENCE IMAGE

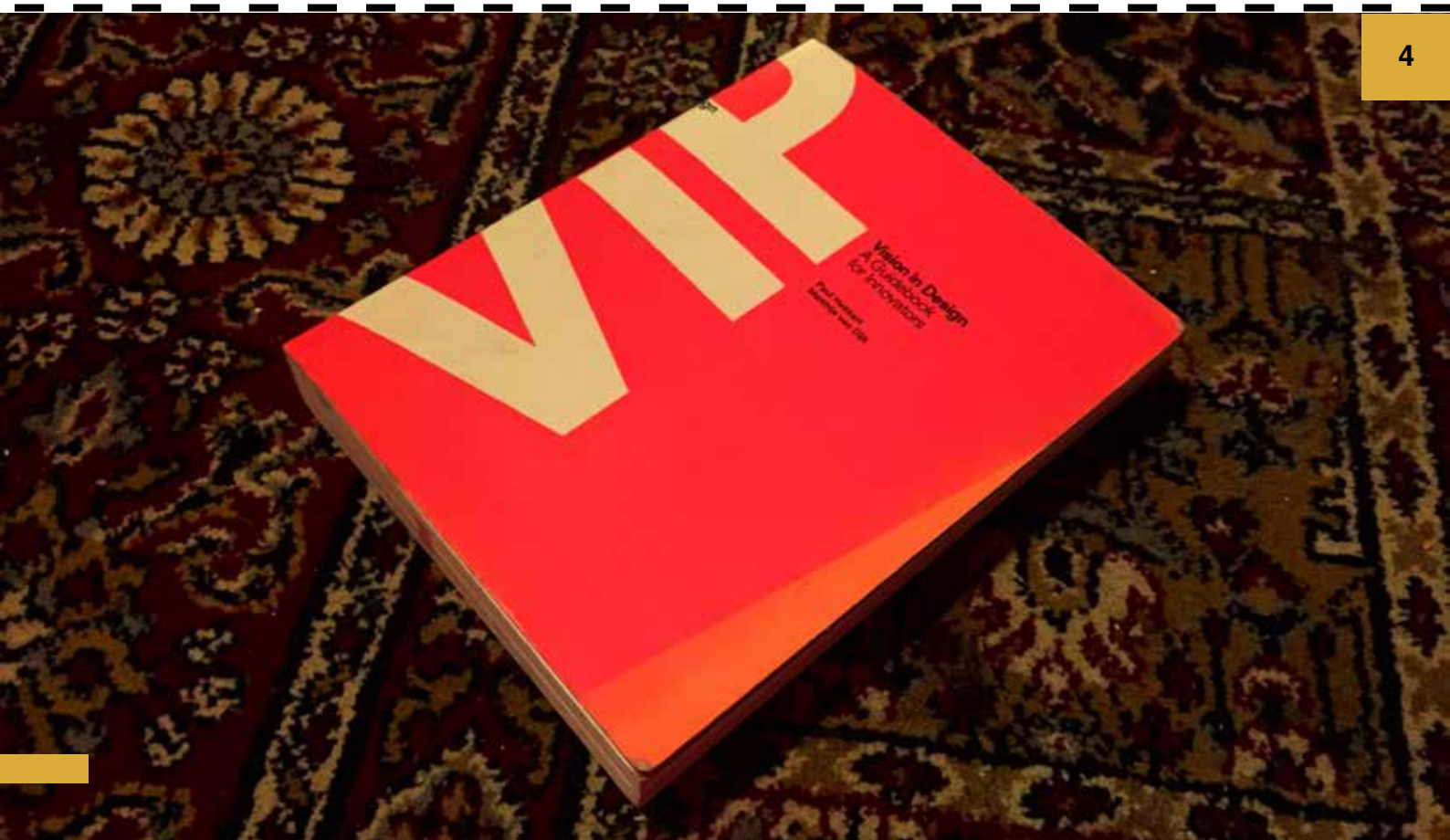
4



Assignment

How can VanMoof remain relevant and distinguished in the evolving world and mobility sector of 2030? Using the Vision in Product Design method a future context 4., world view and interaction vision will be developed and reacted upon with a concept that fulfills the desired effect. The project will be concluded with a physical prototype and/or functional model valuable for insights, testing and presentation.

After two months of research and exploration, I aim to specify how the conceptual product and/or service will interact with the future world, its inhabitants and what meaning it should fulfill. Within this design direction a phase of ideation will result in a number of concept ideas. Ultimately, a concept will be selected and developed into a physical prototype and/or functional model in order to gather further insights and for means of communication and presentation.



FUTURE CONTEXT

Graduation thesis IDE Walt van der Veen
in collaboration with: VanMoof Amsterdam

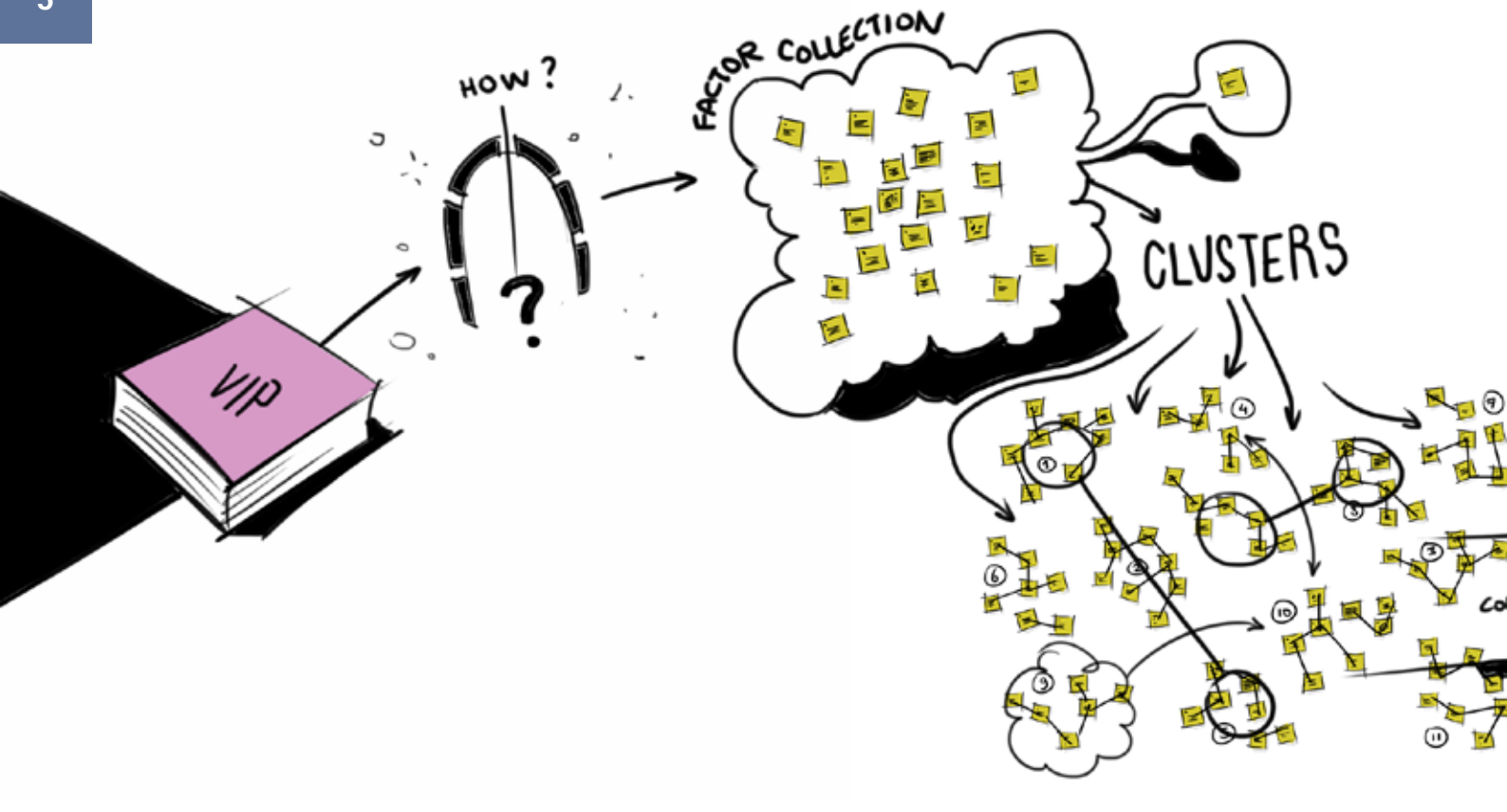
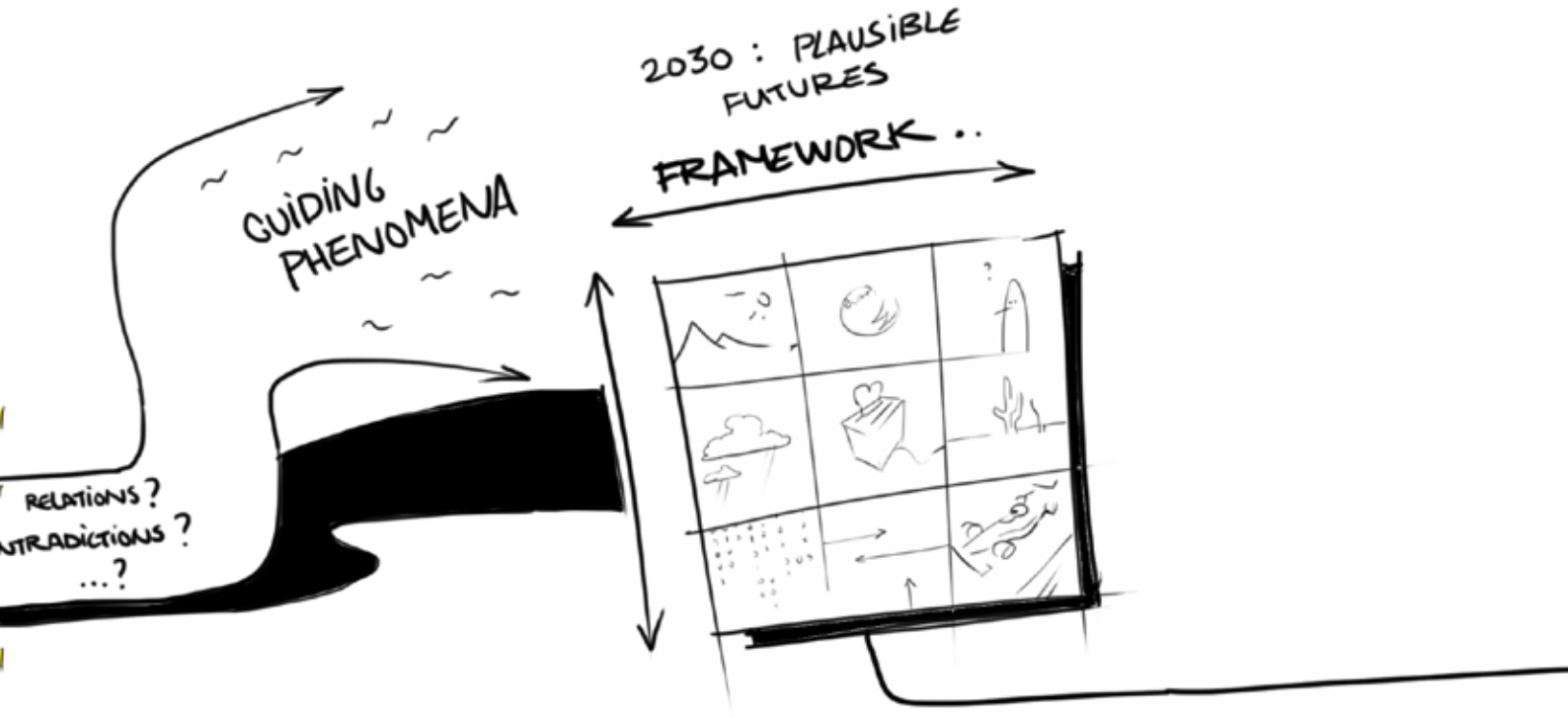


Table of Contents

5.



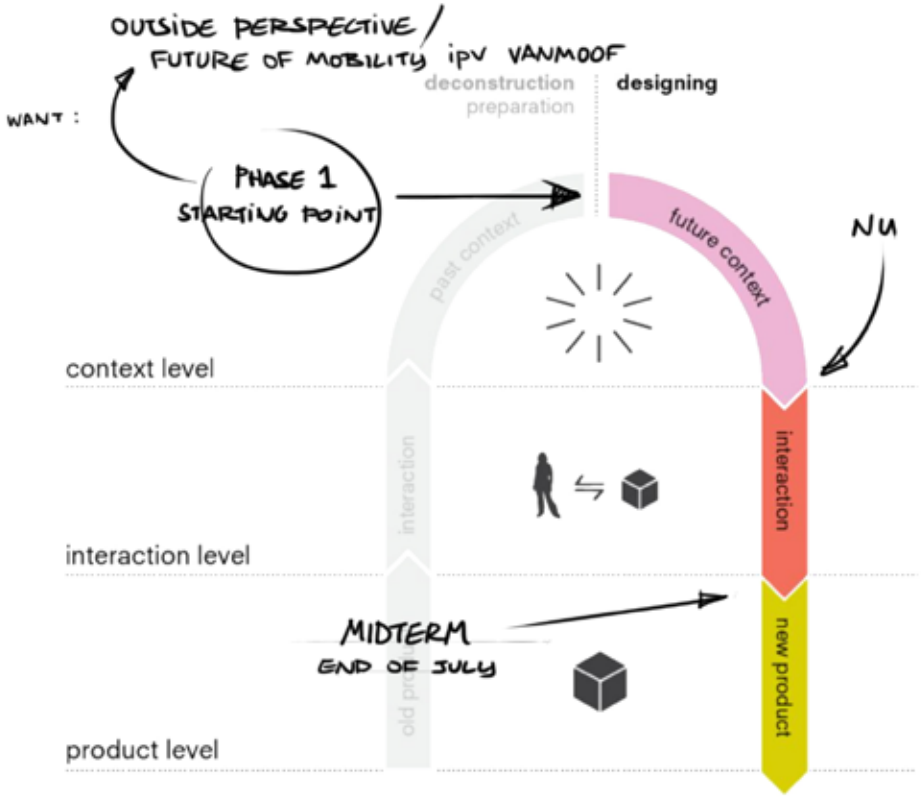
Vision in Product Design

'The ViP process contradicts the conventional Industrial Design Delft method in a way that it does involve the personal experience and motivation of the designer. Consequently the designer has to put in a piece of oneself, taking responsibility for the effects in the design.'

The Vision in Product design or in short, ViP method, forces the designer to look to the future context instead of responding to present day problems. It does so by providing a number of steps as presented in 6. The method consists of two main elements, wherein the first half is about deconstruction of the 'past'. The other half is about designing. In this phase the first level 'future context' presents the plausible circumstances surrounding the domain of the project. Within this future context a statement clarifies the goal of the project. The 'interaction level' follows to further elaborate on the goal and effect of the design, resulting in the qualities that will be the foundation of the next level. The final step is the 'new product' level wherein the qualities are transformed into ideas and eventually a conceptual design. Within this graduation project, the conceptual design will be further, partially, developed and detailed into a prototype.

In order to be able to maintain a certain distance to the current approach of VanMoof, it

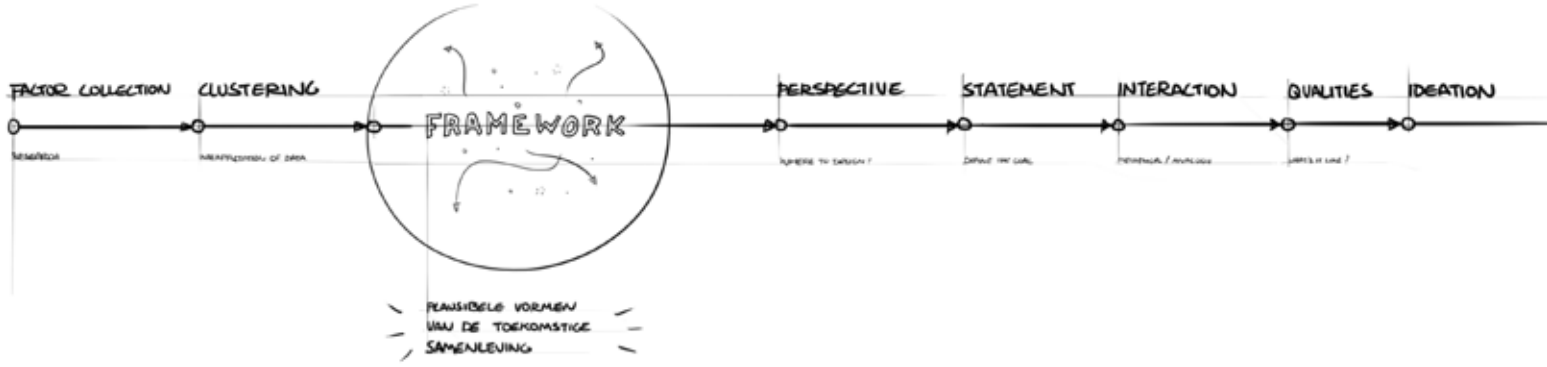
REFERENCE IMAGE 6/7



is deliberately chosen to start the project from the ‘designing level’ onwards. This means that there will be no deconstruction of the current product and context, only a construction of the expected future. The image 7. shows what steps in the ViP process in this project will lead to the final design.

Within the future context level, the first step is factor collection. It will be the first step that is elaborated upon. A ‘market analysis’ is not involved in this project in the ordinary sense. It will not be the development of the market that will guide the direction of this project as it is argued that the design of the ‘effect’ of the future design will be the crucial and decisive factor instead of an opportunity that follows out of the current market.

7



Factor Collection

The gathering of factors 8. is the foundation of the construction of clusters. The factors collected are of great variety and based on scientific research. As this project covers the domain 'societal attitude & mobility', the factors are all directly or indirectly related to this domain. Factors can be of four different kinds: *trends, developments, states and principles*. Without knowing or specifying a direction, the factors are categorized at first as to find out if they cover a range wide enough. Categories are: *Biological, Evolutionary, Cultural, Technological, Sociological, Demographic, Psychological and Economic*. This can be nerve-wrecking but it is essential to maintain a certain uncertainty. The full collection of factors can be found in ***Appendix 1.***

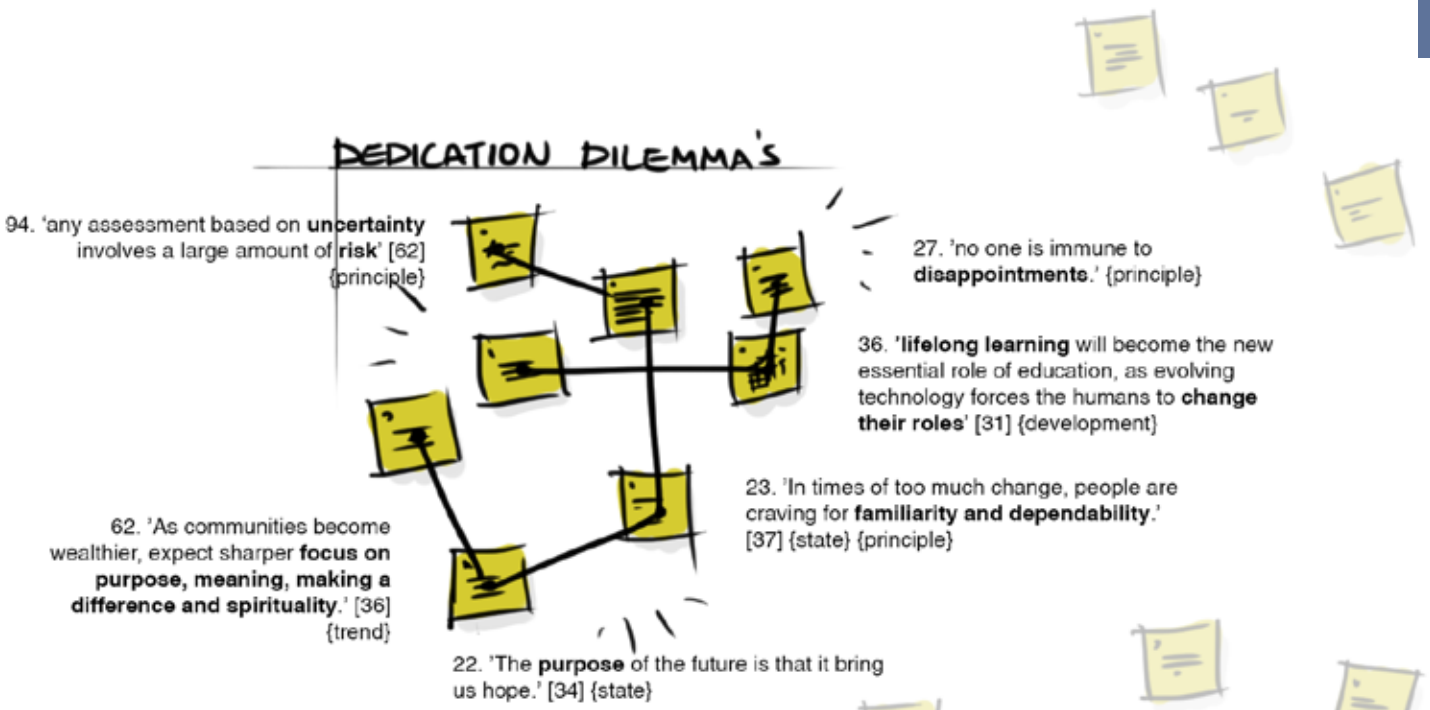
This step in the Vision in Product Design process will deliver the fuel for the next step: Clustering, wherein it will be assessed which factors strengthen each other, contradict each other, or together evolve into new directions beforehand invisible.

REFERENCE IMAGE 8/9/10

IMAGE 8

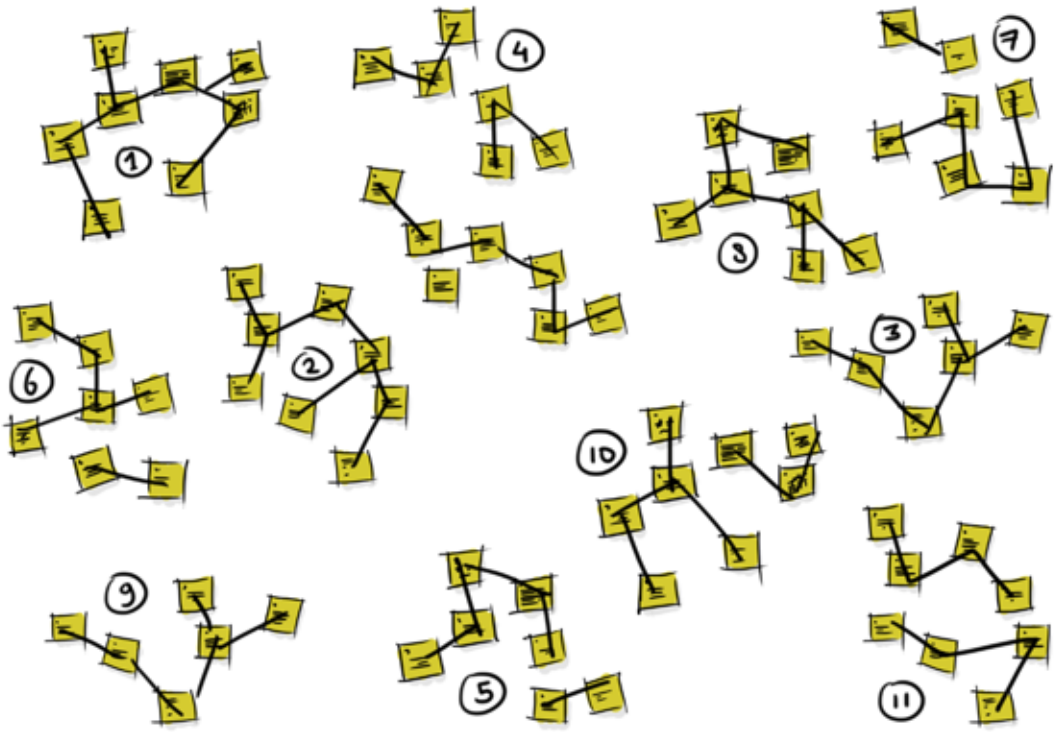
Clusters

With a sufficient amount of factors in a variety wide enough, clustering can begin. As mentioned earlier, this is where the interpretation of collected factors will give rise to overarching clusters. This can be a product of factors both strengthening or contradicting each other [9]. All collected factors are written out on post-its (3M, best quality) and positioned at random [10]. Thus the process of clustering becomes a physical and mental act of interpretation. Multiple sessions of clustering have led to eleven separate clusters. These clusters have been described in short summaries. They are provided with a title that evokes a feeling of interest, as that will be useful in the next step. Because the domain of the project is related to mobility and societal attitudes this is also what guided the research behind the collection of factors. As a result, the interpretation of these factors will lead to clusters that are relevant to this domain.



The process of clustering resulted in the following eleven clusters. These are provided with short descriptions that briefly state the essential meaning of each cluster. Within these descriptions of clusters it is crucial not to involve the effect on the human being just yet. This is essential to be sure no ideological view might influence the clusters just yet. What is looked for during clustering is a broad view on future phenomena.
The cluster is therefore a description of a phenomenon as expected to exist in the future of 2030. Later, the clusters will again be interpreted to find out in what way these phenomena may shape the future context.

It should be remembered that the clusters are presented in random order. No order yet.



Clusters, at random order

Time for Purpose / Motivation shift / Spirituality (Individual) human

A wealthier society gives room to become increasingly aware of the value of meaning, making a difference, spirituality and the connection between the mind and the body. It will become an expectation that consumers shift away from monetary motivation towards a more well-being orientated motivation.

Dedication Dilemma's / non-guidance

There is no certainty as to what might happen, or any stability in activities on the long term. It will be very hard to be sure about what to identify with, or what to dedicate to. The meaning of your existence might change overnight. Consequently, A steady purpose to ensure that they spent their lives in a good way will be harder to find, while one is expected to remain flexible as long as possible.

Establishment and Appreciation (within the group)

Self-expression and individuality are to be balanced within the we-mindset. New communities will evolve based on lifestyle sets rather than work. Creativity in other activities will lead to appreciation.

REFERENCE IMAGE

Into the Mystic.. Storytelling?

Mysticism (Storytelling? Legends?) Will help people to connect and feel involved with each other in times wherein little is left to coincidence. Uniqueness and strength of groups and tribes will be flattened out by globalization and fast changes, also involved in this demise are the mysteries/legends/'universal agreeable matter' currently so greatly valued by humans as they serve as a tool to have a bond and belonging to the community.

Nature and Ethics

The shift in energy resources will be inevitable but only happening if profitable. The need for petroleum decreases in the next decade. The necessity to reconsider models of consumption will lead to an economy 'entirely' based on demand instead of supply. The foundation of the consumption economy preferable lies in ethics over mere profit.

Inconsistency in Surroundings and Exploration (or Adaptability)

(Moving through) Surroundings in 2030 allow greater flexibility. The need to commute or perform similar journeys between (and in (car)) regulated and fixated surroundings will decrease. Remote work has enabled people to move out of cities. This sheds a new light on the relationship one has with its surroundings and how they interact with it. How to adapt to/ explore/feel comfortable in it? Or how does their

(Page absent in printed copy)

surroundings adapt to them? More impulse and change against the loss of personal(ized) stable environments (i.e. shared services vs. your own car?)

Availability Rises

Through the expansion of network everyone and everything will be available for everything at any time. A giant amount of people will join the global workforce due to developments in connection on a global level.

Efficiency Trade-off: Living Turbo? Or beauty of inefficiency?

Technological developments combined with the giant merge of powerful global organization, will answer humanity's intrinsic drive to make everything increasingly efficient and productive. There will be a trade-off between enhancing one's life with incredible efficiency and giving up independence further and further, or a deliberate choice to perform activities in a 'less' efficient as to counteract the 1984 phenomenon (being watched and monitored continuously).
Governance and political power will shift from institutions intended to do so towards organizations with commercial interest as only the latter can operate on global levels.

Work and Learning

There will be less work, for more people. Rapid innovation and reaction to innovation require

(Page absent in printed copy)

one to have a universal skill-set. Humans can take part in activities that demands their adaptability, creativity, imagination, social and emotional intelligence and passion. Not only work-related activities will define a human being. This shift gives the ability to connect over matter of greater variety on a shorter term.

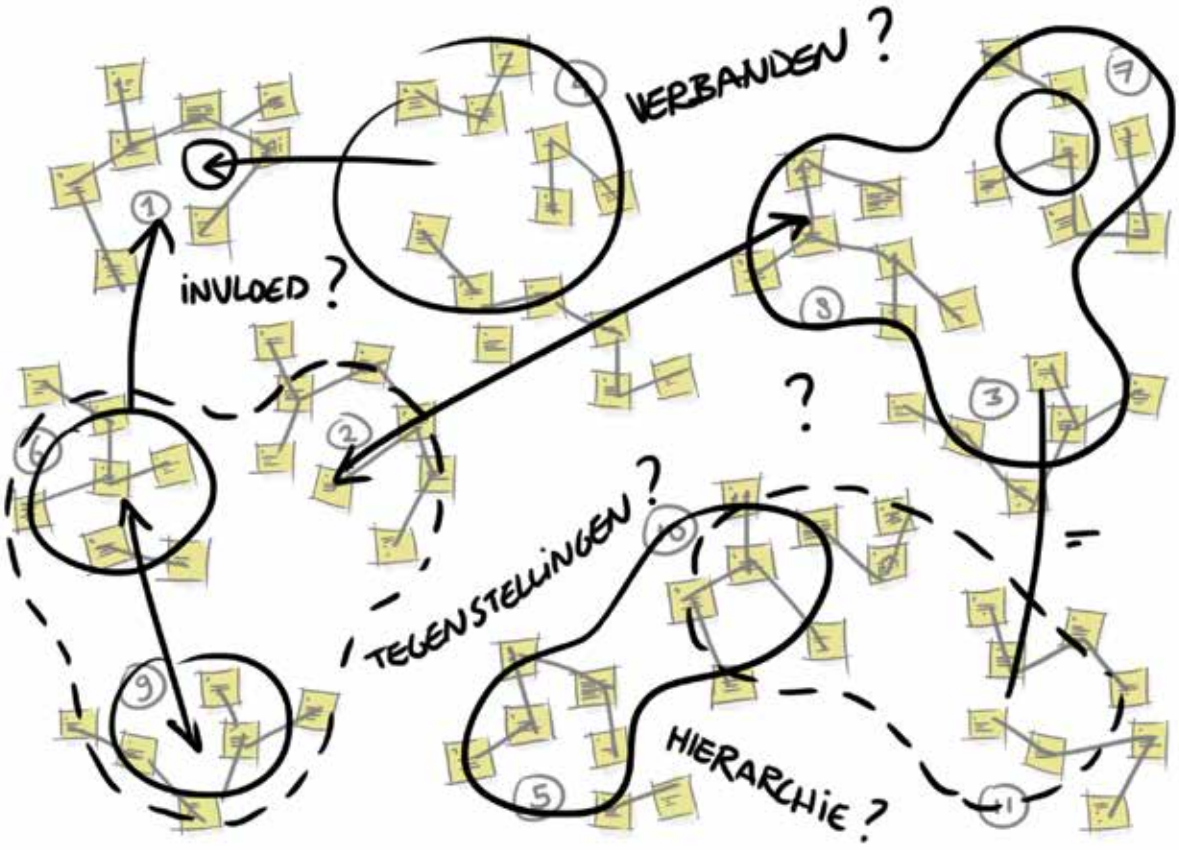
Blurred lines of Reality

What is real and what is not real? The dissolving boundaries between the physical and virtual world will blur the differences in surroundings.

Technology Love Affair / Origins of Bias (are robots also biased?)

Through the advance of AI technology, society is getting used to machines with great relative intelligence and consistency. The participation of machines in everyday work and activities gets society to get accustomed to the presence.

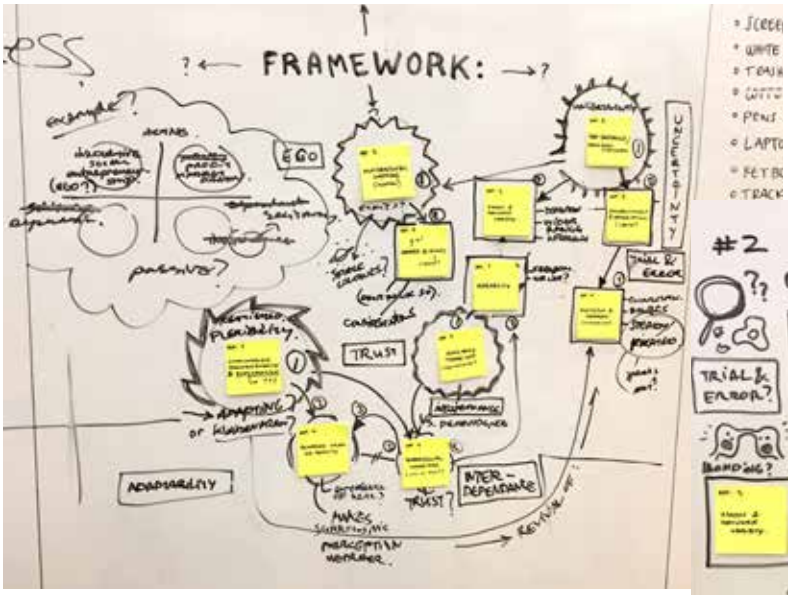
In order to lay bare overarching tendencies that can be derived from factors collected within the clusters, they are organized and interpreted to look for coherence and/or contradiction 11. This process clarifies what drivers will shape the future context. The essence of not taking any moral or ideological perspective during clustering creates the possibility for multiple standpoints concerning the overarching tendencies to vary. Within the next step, the creation of a framework, it will become more clear how the human relates oneself to the tendencies in the future context.

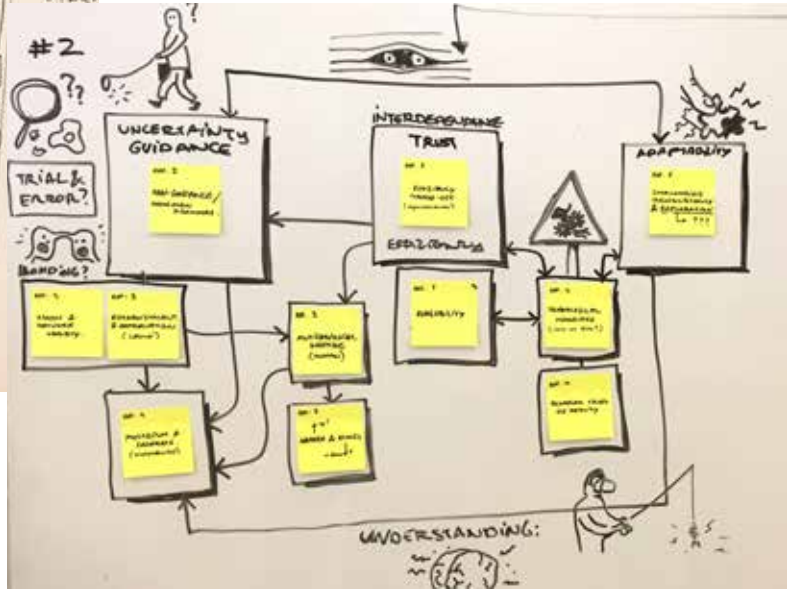


Clustering Towards Framework

From whitewall to paper, from paper to screen, the framework has taken shape. As the clusters were repositioned overarching tendencies appeared. This has been a process of trial and error, trying to find a hierarchy and structure in the collection of clustered data. The steps in the process are visually explained in image book 12. It has shown what main tendencies in human behavior are to be expected in the plausible world of 2030, in relation to the domain of societal attitude and mobility. During this process the goal is to define a way to construct a multitude of attitudes in a plausible future world 13. By doing so, it is taken into account that a future context, and how people act within it, is not one-dimensional.

It has resulted in two main tendencies, as briefly as possible described by a single word as follows: *Guidance & Dependence*. These tendencies provide us with the ability to define how one might behave within the spectrum of that specific tendency. These tendencies are positioned alongside an axis, representing the ability of a human to be able to vary in attitude regarding the tendency. Later these axis will be used to construct a matrix. Firstly, the two separate tendencies (or overarching mega clusters) are described and the possible attitudes of humans towards the latter are elaborated upon. They form the foundation of different behaviors in the future context.



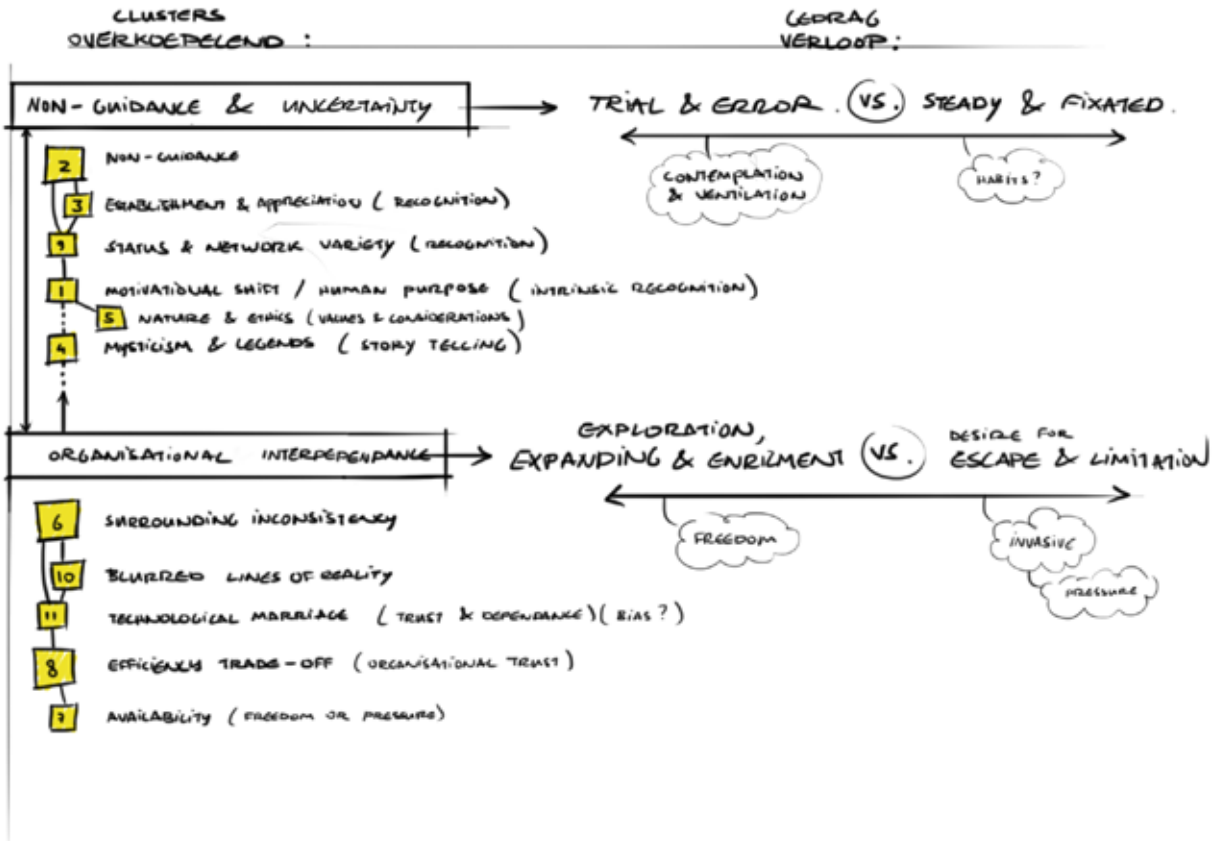


(Non)Guidance (Activity Orientation)

It will be harder to find out to what you will dedicate yourself. The shape of your activities, as well as the appreciation of it can change abruptly, and the meaning of it will thereby be in a state of flux. This is a result of rapid technological disruptions, the fact that humans need to belong and feel that they contribute, and the comfort of fixated matter and habits within times of rapid change. How do we deal with this kind of 'dissipation' and 'fluidity' of meaning, appreciation and fulfillment? As in: how do we prepare for and take part in activities?

Will one become extremely flexible and adaptable? Always open and ready to take part in a short learning sprint and open to the process of trial and error? These might be the ones who organize their life on the short term, and find that they can operate without permanence and thus with great variety. Will one bond over lifestyle sets, and matter of greater variety, instead of fixated work related activities? With trial comes error, and in order to prevent one from an overload of frustration, they look for ventilation.

Will they not care about it? One might be the 'in-between'. Those might be the ones who in the present work a different job every few years, and have greater appreciation for their social bonding and personal well-being instead of



pressure of pursuing a career and high hopes.

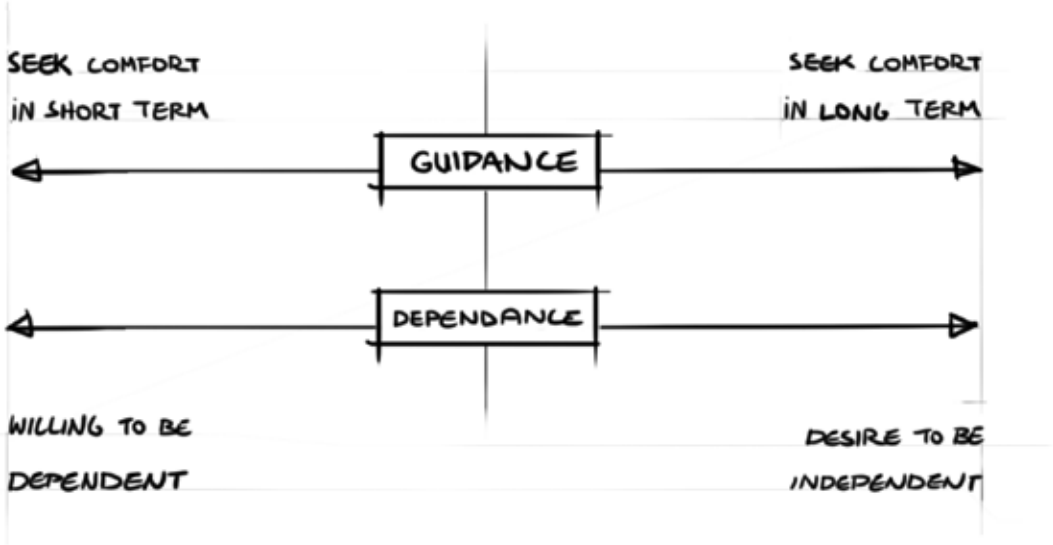
Will one become saturated with variety and hold on tight to the known? A desire for fixated habits, and finding within it, great comfort? Will this be the group that was schooled in an outdated system? These might be the ones who organize their life on the long term. Consequently, these might be the ones who find themselves running after their goals, as they slowly go up in smoke. They are forced to adapt, and need contemplation to find their new positions. As a result, they live in the past and look for steadiness in storytelling, mysticism and legends.

Dependence (Interventionism & Dirigism)

14.

As patterns of life become less fixated, moving through surroundings will provide more impulse and greater variety. Surroundings, objects and people around us become interconnected as it will be the tool to measure and regulate the ever increasing efficiency of interaction, society and infrastructure. Indoor and outdoor. Inside and outside. The great blend of the virtual augmented world and the physical 'real' world will rely on larger platforms controlled by larger organizations, as they merge to benefit unity in connection.

Will it provide a personalized world, wherein technology helps the human to thrive and



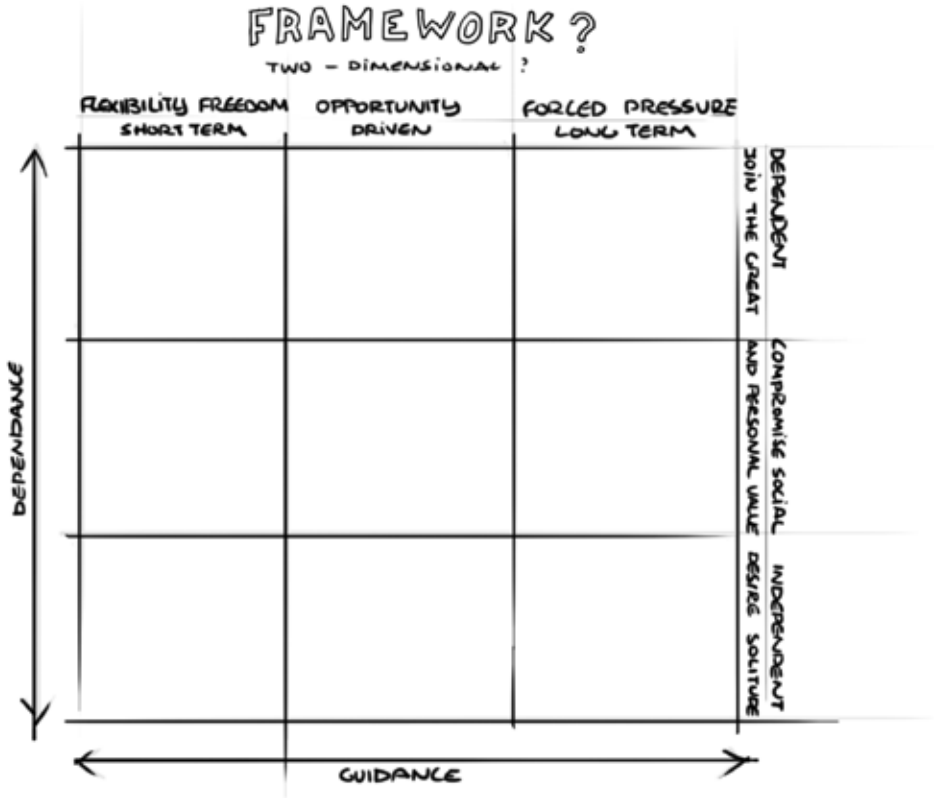
bond? Or a more distant world with less unique and stable environments? This presumably depends on the attitude and willingness towards the state of dependence. The range of three different states on the tendency of dependence is described as follows:

One will have no problems with dependence, as it provides them with the benefits that allow their modern lifestyle and attachment to communities to run smoothly. Their social circle is wider and global (not denser, but bigger) and for them, virtual and physical boundaries dissolve.

One will be dependent as their lifestyle demands them to be. It will be considered whether their involvement will be too much of a compromise between their dependence and independence. This group is expected to consider their personal values and privacy more than the before mentioned group. Suspicious minds?

One will have a desire to be independent, breaking bonds with and being skeptical towards phenomena that will, through involvement, make them dependent. Boundaries will be set by themselves. The distrust in overarching commercial organizations strengthens the desire to operate solitary, or in local, smaller and tighter social circles.

In other words: Either a willingness to join the great for enrichment. Or desire to operate solo for personal enrichment.



Framework

After the definition of the two axis that present the tendencies expected to exist in the world concerning mobility and societal attitudes in 2030, these axis are positioned and aligned in such a way that a matrix is created. This matrix 15. communicates the possibility for a multitude of behavioral typologies to exist. Thus, a multitude of plausible shapes of the future society. A behavioral typology arises from an attitude towards to two tendencies in the future. In this way it is taken into account that it would be naive to claim that merely one typology of behavior will exist in the future. By doing so, nine different behavioral typologies have been formulated. Although nine different typologies might seem like a large amount of variety, this is considered to be realistic as the domain of mobility and societal attitude is broad and therefore involves and applies to a great behavioral variety.

As to describe the behavioral typologies, these are all provided with a description of their concerns, beliefs and other relevant aspects concerning their attitude and behavior. Refer to the table in 16. to find the specific typology in its location within the matrix. Starting clockwise from upper left:

1. 'Loss of permanence & blend in global hyper-society'

They fully blend and are accustomed to changing the course of their life. To them, joining a new revolution has low threshold

	Flexibility and Freedom Short term	Opportunity Add-on to Wellbeing	Forced Pressure Long Term
Dependant and joining the great	'Loss of permanence & blend in global hypersociety'	'Reactively taking on opportunities'	'Looking for leadership in shared commitment and conformity'
Compromise personal/ social values	'Enthusiasm about environment variety'	'Comparing and belonging through lifestyle sets'	'Considering personal and social values and responsibility' Temporary aloneness
Desire for Solitude	'Exploring physical experience and variety in environment'	'Passive strive for consistency and state-of-mind'	'Retreat into save & personal environment'

IMAGE 16

for it is mostly digital. They are continuously in connection with their vast network which is not limited by physical boundaries. This too is their external platform of expression and recognition.

2. 'Reactively taking on opportunities'

They float around like jellyfish, following the current. If new activities rise within their reach, they take it if they will find appreciation for it from their surroundings. They consider the appreciation of their surroundings as a primary importance.

3. 'Looking for leadership in shared commitment and conformity'

They go for external grips, to cancel out unsafety and uncertainty. Thus they limit and fixate themselves by doing so. They rely more on communal value and beliefs. Storytelling could be one of them. So they depend more on approval of their surroundings.

4. 'Optimism about environment variety'

They have a positive attitude towards the refreshment of their surroundings superimposed on them through the fast pace of change. The dissolving boundaries between the physical and digital/virtual world allow them to re-explore and re-discover their context and themselves. They do not need to travel the world to find this satisfaction.

REFERENCE IMAGE

(Page absent in printed copy)

5. 'Comparing and belonging through lifestyle sets'

They are quite interested in an expansion of their opportunities. However, it should not be too much of an impact on their current standard of living and on the network evolved around it. They are in some way classic in their approach, more like we are now.

6. 'Considering personal and social values and responsibility'

They find that in the impermanence of their activities the right way to judge moral goodness is whether they contribute to both their inner needs as well as the community they live in. One does not stand without the other. This idea forces them to measure their activities and balance the values.

7. 'Exploring physical experience and variety in environment'

The impermanence of their activities in the world allow these people to become free to try multiple things. They intend to go out into the unknown and explore their surroundings in a physical and outstretched way. They are internally motivated to see, smell, feel and explore the world. In other words, they explore the world with all of their senses.

(Page absent in printed copy)

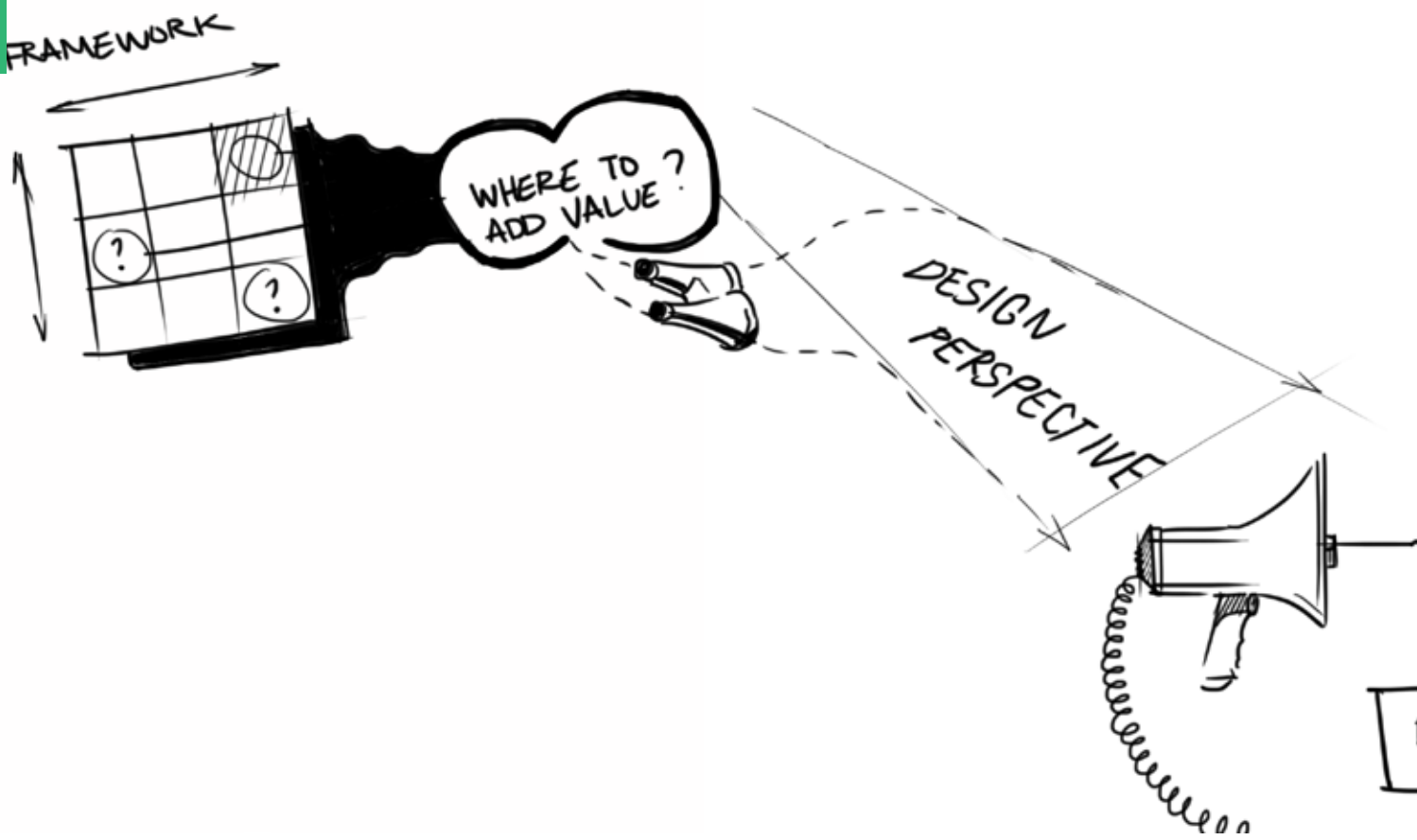
8. 'Passive strive for consistency and state-of-mind'

They follow the course of activity as it evolves around them and are not too afraid of changing their direction in life, if this is considered a valuable contribution to their personal wellbeing. They spend more time on a global state of mind that is peaceful and strong. They treat their work related activities as a secondary importance.

9. 'Retreat into save & personal environment'

They go back to the source of action within themselves, they find their comfort by drawing back to the personal level. They might withdraw in living in a small simple situation out in the fields. They distance themselves from the overflow of impulse and find their personal comfort in things that remain steady. They could be called control freaks. Being able to grasp their environment is a primary importance.

Now that the behavioral typologies have been formulated it is time to take a position. This is where I, as the designer, together with VanMoof will decide whether and how we want to have an effect on a certain typology. Alongside the company's brand values and outspoken desires, it is reasoned why and where it will be logical and desired to design. This too is the start of the next step in the ViP process: Vision on interaction. This will be further treated within the next chapter.



VISION ON INTERACTION

Graduation thesis IDE Walt van der Veen
in collaboration with: VanMoof Amsterdam

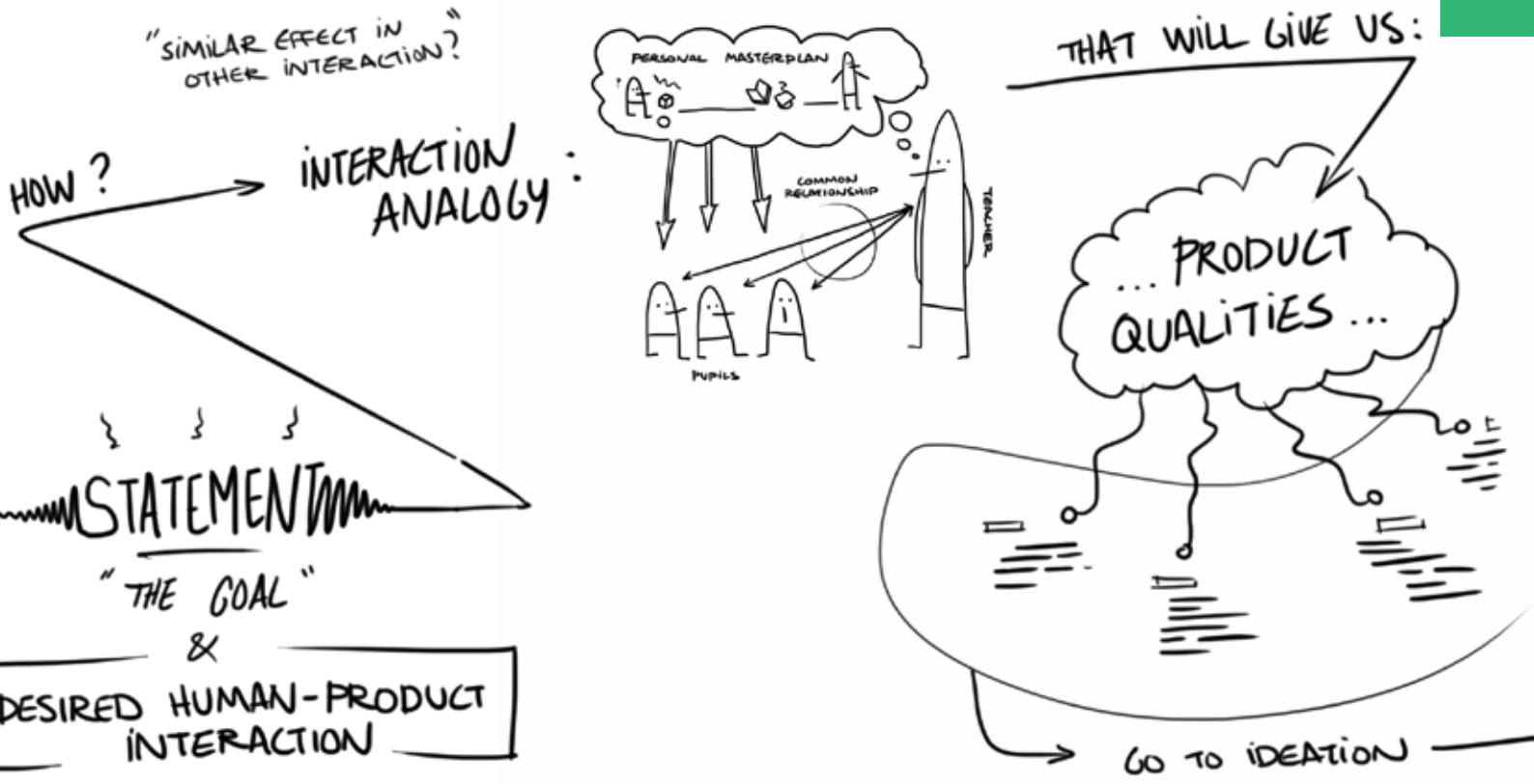
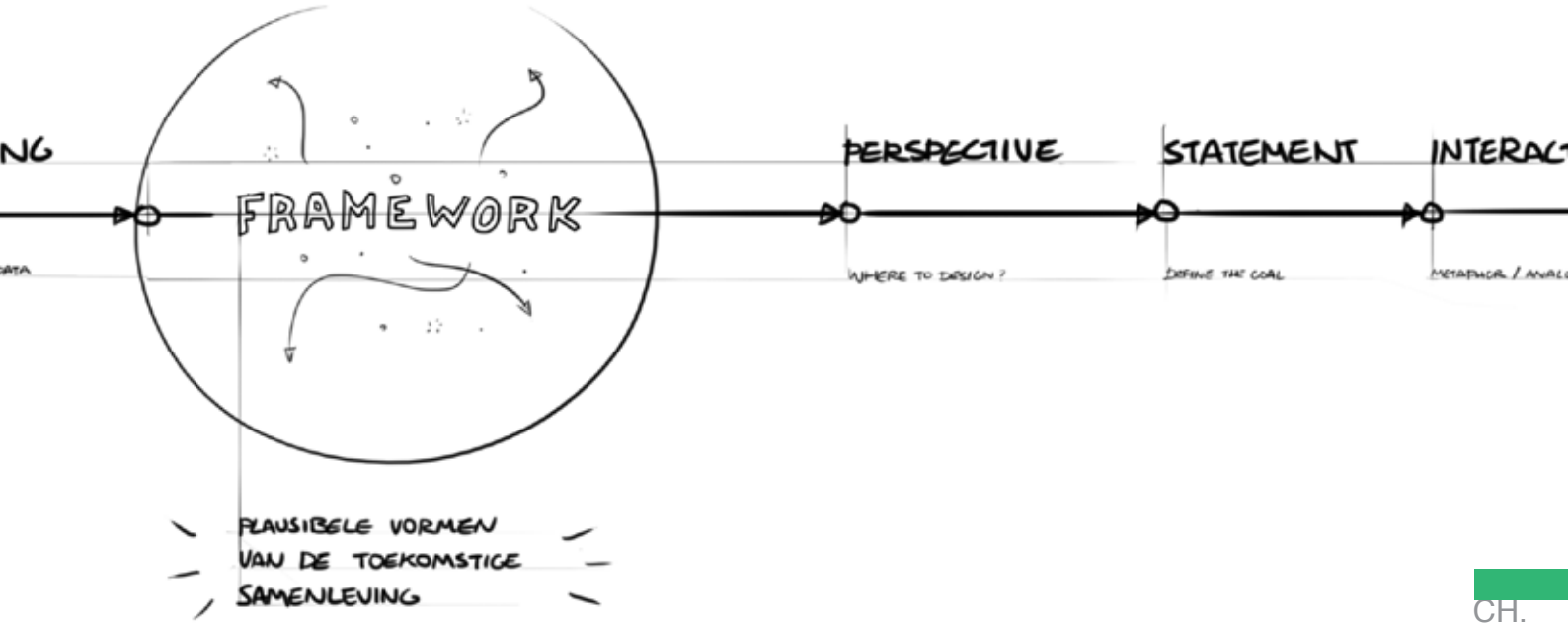


Table of Contents

17.

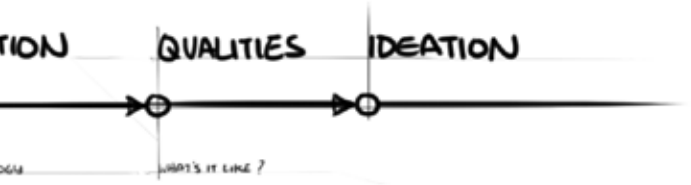
REFERENCE IMAGE



Vision on Interaction

Now that a concrete future context has been created, the next step in the ViP Process is the development of the 'Vision on interaction' 18. Within this development of the vision on interaction lie the first choices to be made regarding *where and how to design*. Hereby it is not meant that the choice will be made what kind of product will be appropriate. Instead, the aim of the next steps is to find out what kind of meaning preferably belongs to the future product, and what kind of interaction will lead to this desired perception of meaning. This design of the meaning is the backbone of the reason of being: *why the design should exist*. Without stating *what* the design will be, this vision has its focus on *how* the product will be used and experienced.

Firstly it is decided what perspective in the framework (see: Future context) is a suitable direction, by arguing where an intervention is relevant. Secondly, the definition of the statement. This statement describes the goal of what I, and VanMoof, want to achieve with the new design. Then, the goal as presented in the statement is looked for in an appropriate interaction metaphor or analogy. To be more specific, the relationship between the user and the product. What kind of interaction will lead to the goal as put forth in the statement and thus fit the future context as presented with the framework? Finally, the values of this interaction metaphor/analogy form the product qualities and foundation for ideation.

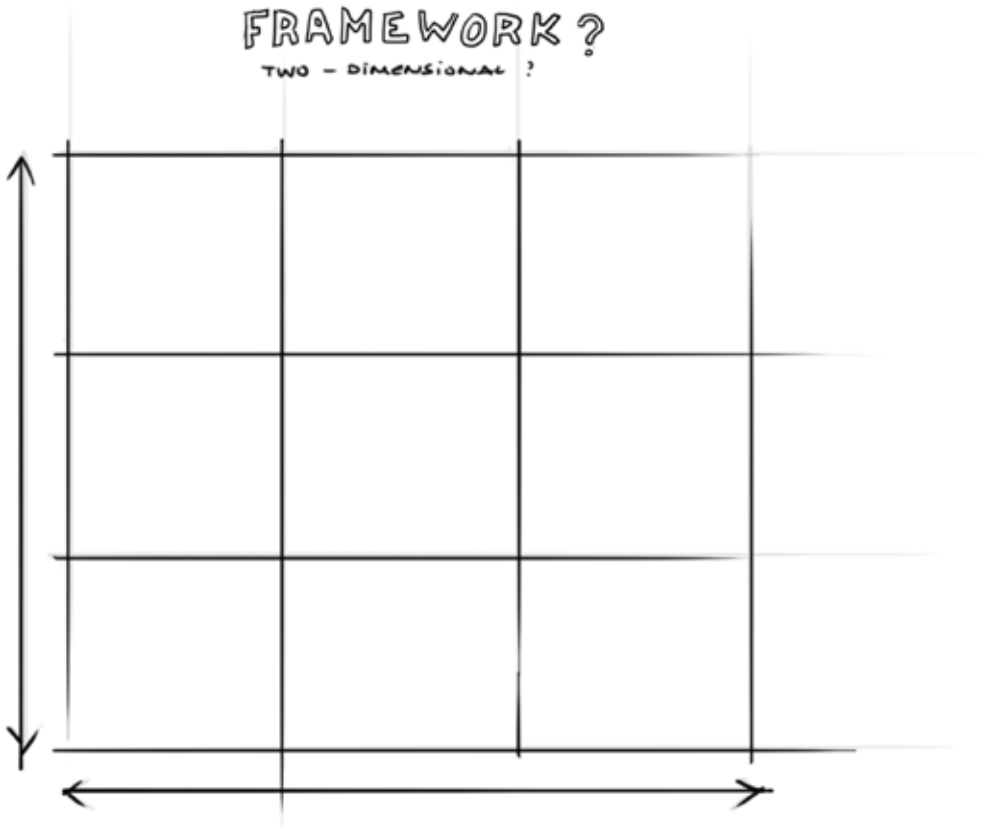


Design Perspective

It is important to figure out what will be an interesting field of operation for VanMoof in this future context of mobility. Their current mission statement and branding evolves around the keywords *smart, happy, urban* and *sleek design*. Their status is somewhat rebellious when compared to the status quo. Within the framework that would likely lead to a choice in field of design at the upper far left, as this is where the so-called early adapters are located. This being the case *if* they, and logic, insist on providing mobility for young, hip and flexible people. However, the VanMoof product, as well as the high-end aesthetics e-bike industry will normalize in the coming years. As a larger group of people of greater variety will become interested in a new approach of mobility, VanMoof would be smart to adapt to their motive accordingly.

We could say that in the future VanMoof will still be distinguished with good looks and design, but that probably will not persist. Cheaper brands will come, and they will look good if not better.

The choice in perspective is therefore influenced by logic (what is that? I don't know..). The framework shows how people might enjoy, or experience issues with the loss of guidance and permanence, together with them getting increasingly entangled in and dependent on the network as it over arches society more and more. If VanMoof desires to

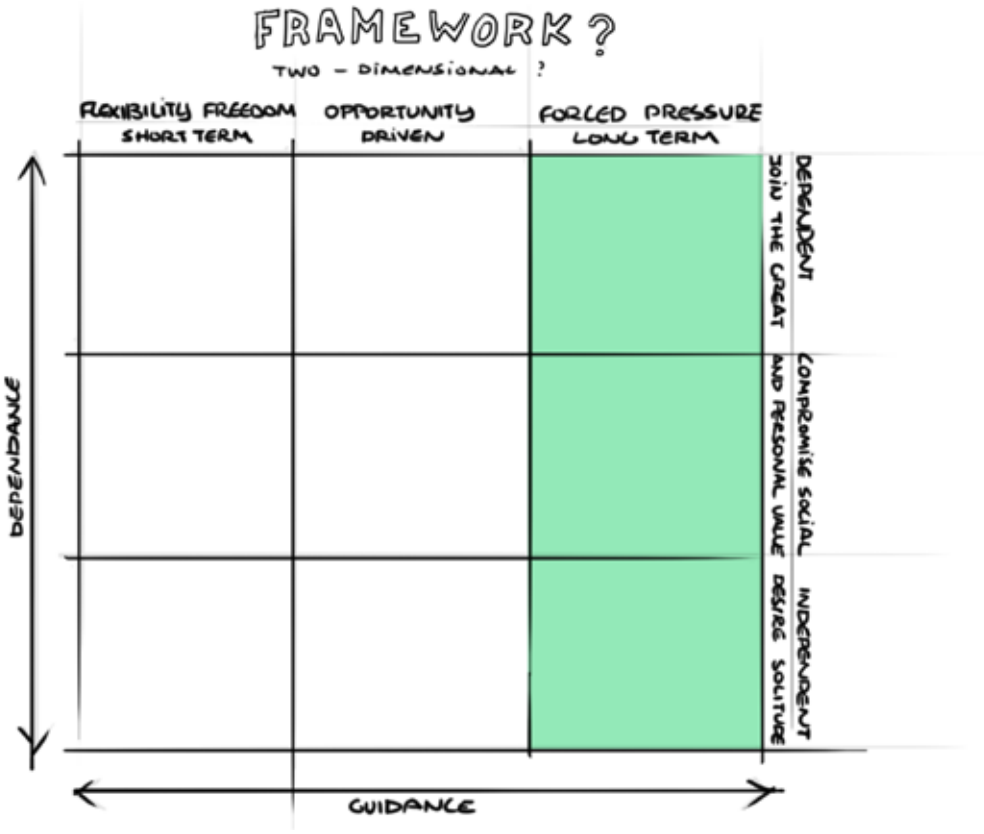


remain distinguished in this future context, it will be essential to respond to these tendencies.
An outspoken desire of the VanMoof product development team is to become more approachable as to appeal to a wider and more international audience.

How is that translated into a statement? This is both the preference of the brand, as well as the standpoint I have as the designer in this project. Personally, I should bear in mind that for what I propose, I have to take responsibility. So for example, I do not want to make a mobility medium armed with assault rifles because a framework might show that people will become afraid of strangers, as I personally do not believe that is the right solution considering a longer term. If the company would still desire such a choice, this would be something to discuss..

So what is it that I (and Vanmoof) want to address? And especially which behavioral typology is it? It is actually most interesting to take into account the group of people that will experience the somewhat negative effects of the future context. They come in great numbers and are likely to look for handles in a rapidly changing atmosphere. This typology -on the right in the future context matrix- 19. is a large entity, making it interesting and challenging to appeal to such a wide audience.

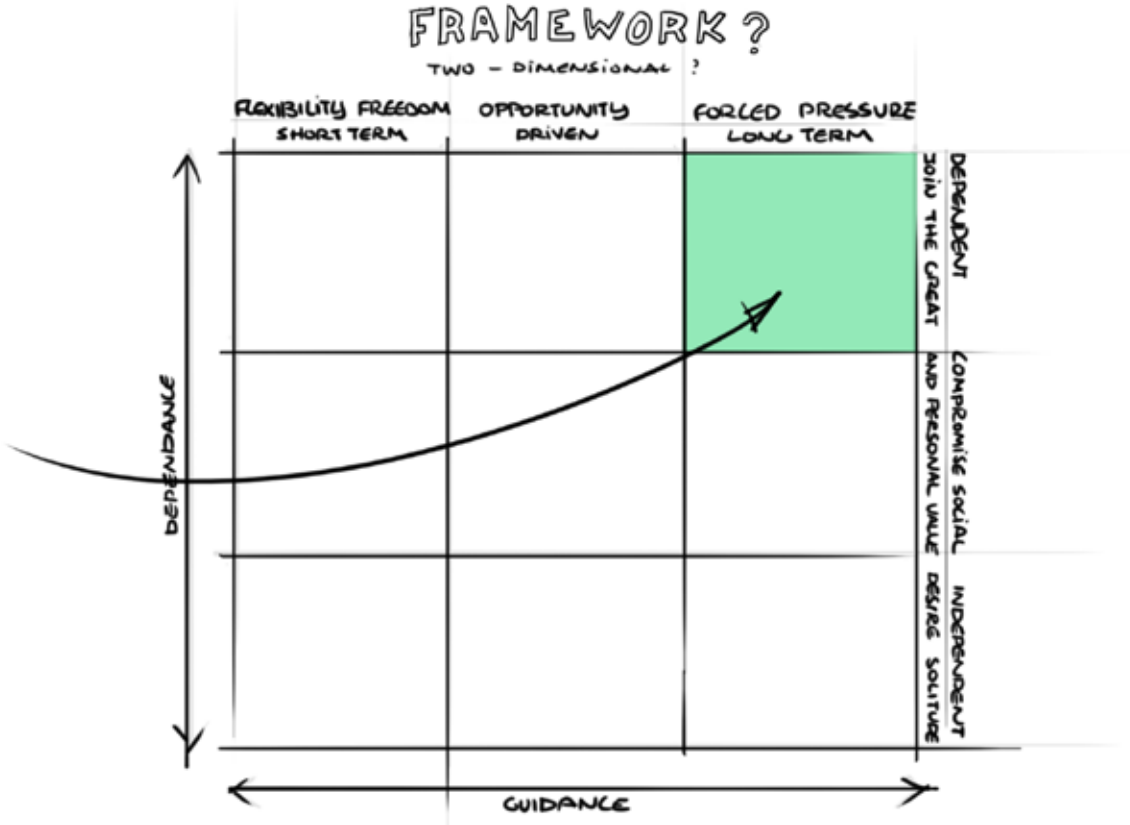
The before mentioned group on the right, who takes their comfort in security on the long term and thus find themselves increasingly stressed in a society wherein such patterns are



lacking, can be both looking for entanglement and dependence, while on the lower end they might prefer their solitude.

It is proposed to, through appropriate design, positively influence the behavioral typology located at the upper right corner 20. These people are craving for anchor points in life, they look for handles not in themselves, but in their surroundings. This too is the way in which they are different from the group who desires solitude.
Within the continuous flow of impulse they are confronted with, they aim to create a safe world wherein common sense is enough to grasp their surroundings. However, contradiction is greatly present in this way of life. They rely on their surroundings, but fail to grasp the fast pace of change that rules it. Thereby they limit themselves to thrive in the development of their capabilities and thereby their ability to absorb new information and keep up to date. Through their creation of a safe world, they become less and less prepared to deal with discomfort and difficulty.

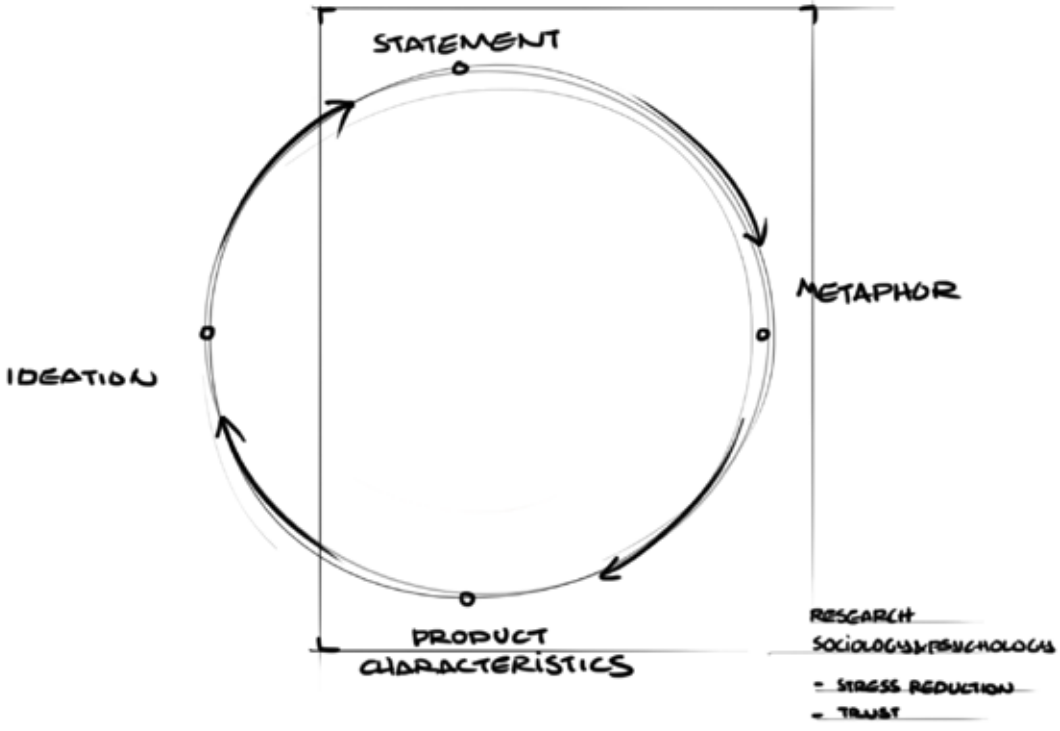
To be put in words, a statement will be formulated describing the goal. The desired effect for the behavioral typology as specified in the framework. This statement is the foundation on which the rest of the future vision will be built.



Statement

As proposed in the previous chapter (design perspective) it is desired to enrich the function of mobility for those people who experience the difficulties of a rapidly changing world. They stand still in a world in motion. And if they move, they run after their long term goals as they go up in smoke. They depend on their surroundings, but can not cope with the fast changes it comes with. This gives them stress, and that better not be the case. Why? Stress is unhealthy. Lower levels of stress are beneficial for one's physical and mental wellbeing (D. Umberson, 2018)(S. Baqutayan, 2019). Since the behavioral typology is the stressed out one, this is where an object with which they interact on a regular basis can truly help them and add value to their lives. To design a valuable meaning for the selected behavioral typology, it is argued that a 'trustworthy' aspect will contribute to the reduction of stress, and a facilitate a positive relationship. As is the desired effect of the to be designed service and/ or product. It is desired to cause the selected behavioral typology to have more trust in their future, which means that in 2030, one will have a positive attitude towards their coming years.

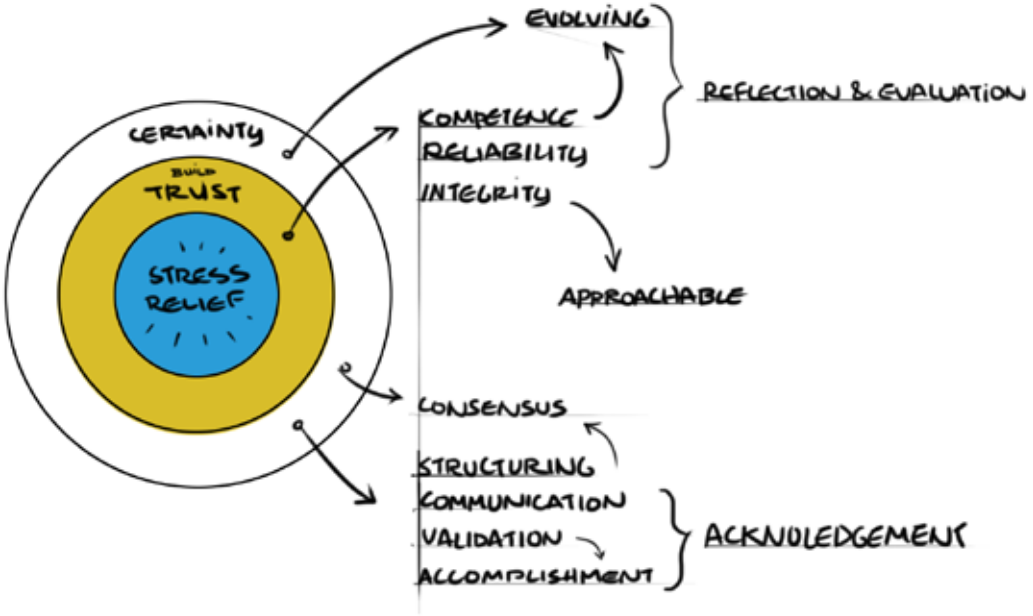
What is necessary to build trust in the future? How does 'trust' help to reduce the stress to which the selected behavioral typology is exposed? In order to better understand what fruitful aspects exist to build up trust in external relationships, sociological and psychological studies help to form an understanding and



to broaden the view on the term ‘trust’. As a result, the statement is a product of the ViP process philosophy combined with insights from literature studies in the field of psychology and sociology. Making the shaping of the vision a iterative process by continuously going back and forth 21. This is relevant as these fields of research are entangled in the societal focused domain of this project, and because the typology is externally dependent. It can be argued that certainty is the foundation of trust, and crucial for the perception of a better future. Certainty provides a sense of safety in the commitment which is asked from the stakeholders in a relationship. This sense of certainty is inherent in the reduction of stress. So if trustworthiness is achieved, then stress can be reduced.

Other than the value of trustworthiness, the statement should clarify by which means it is aimed to achieve the effect. The importance of understanding, reflecting on and evaluating the past and present is often mentioned as the most successful approach to build trust for the future. This ‘understanding’ allows one to be able to better predict meaning, and thereby build certainty. Acknowledgment and reflection are to be included in the statement as tools to achieve this trust in the future.

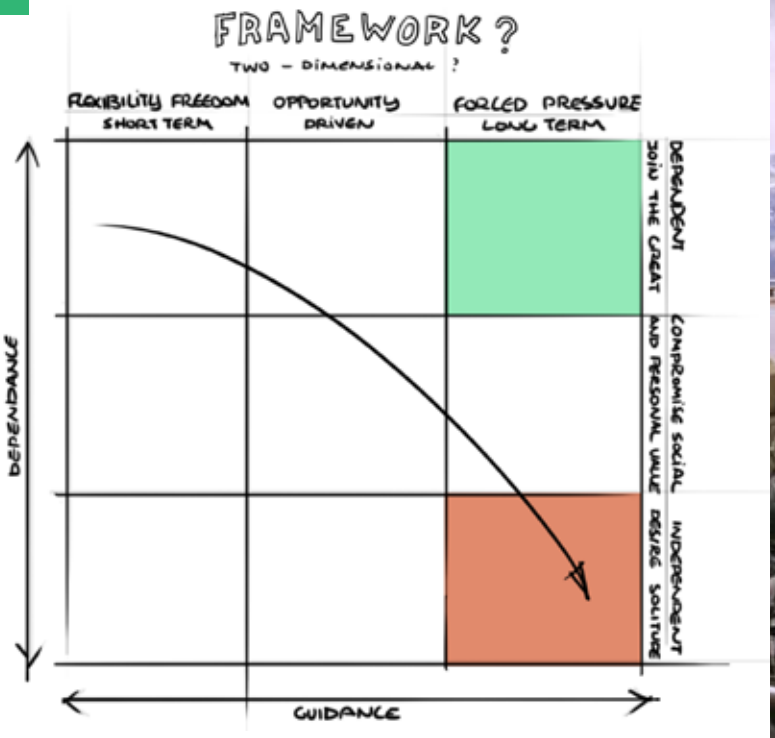
The way this trustworthiness is related to the formulation of the statement, and how they contribute as a fertile ground for further development of the vision on interaction, is communicated through 22.



“Within the domain of mobility in relation to societal attitudes, I want people to trust their moves into their future by enriching accessible and low-threshold mobility with personal acknowledgment and reflection.”

“Within the domain of mobility in relation to societal attitudes, I want people to trust their moves into their future by enriching accessible and low-threshold mobility with personal acknowledgment and reflection.”

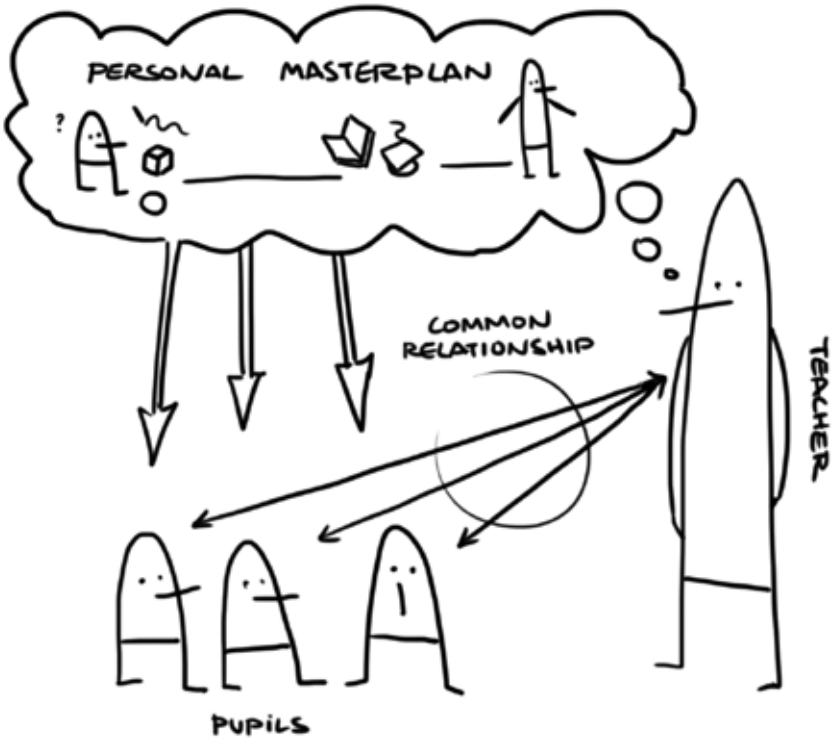
This statement also includes the more specific description of the form of mobility as it is most relevant to this typology: accessible, low-threshold mobility. For example: Whereas a behavior typology on the lower right 23. would ask for a form of mobility in the direction of exploring and adventure. This behavioral typology finds comfort in low-risk and giving away responsibilities. Mobility, or moving around, for them means their connection to their external factors. However, although they depend on mobility as their means to connect to their surroundings and social network, they are willing to commit only if it comes with little risk.



Interaction Analogy

It has been established what the goal of the choice to design will be in the Statement. Now the following steps towards the 'new product' design stage can be made: Interaction metaphor/analogy and definition of product qualities. To cross the bridge between the statement and defined product qualities, a suitable description of the desired human-product interaction is formulated. This description of the desired interaction clarifies how the experience results in the desired meaning. The interaction can be described making use of an analogy. The analogy allows us to better imagine what kind of experience leads to similar goals and meaning without being misguided by prejudice or influence of the domain of the project. The statement describes how it is desired that people trust their futures, and since they rely on external factors, a metaphorically defined interaction as follows seems most appropriate:

"A first grade teacher who oversees the future of pupils and provides each with a personal set of handles with which they can flourish in their futures."



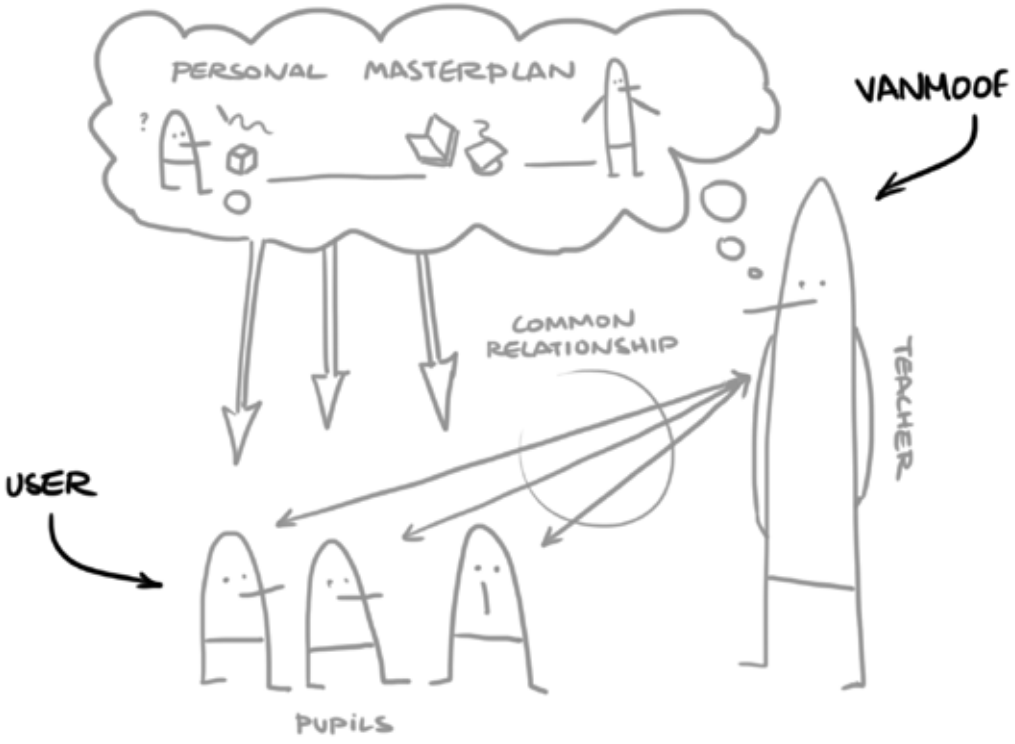
Putting an analogy in words makes it harder to interpret it in any other way then the sentence describes. For that reason it is conveyed better visually. The drawn interaction in the illustration 24. is the foundation for the definition of the qualities that are attached to this interaction. These qualities are to be transmitted by the product.

Product Qualities

I want people to build up trust in their future. So, as put forth in the interaction analogy, what they need is a 'teacher who oversees a group of pupils, teaching his/her pupil step by step in order to flourish in their personal future'. The teacher can see where it's headed, and the teacher's qualities hence follow 25. What is this teacher like? Or, what qualities should be embedded in the product to achieve the interaction as put forth by the metaphor? These, after extensive elaboration and a long process of association, are formulated as follows:

Personally Orientating,
Flexible, Adaptive, Competent,
Inspiring and approachable.

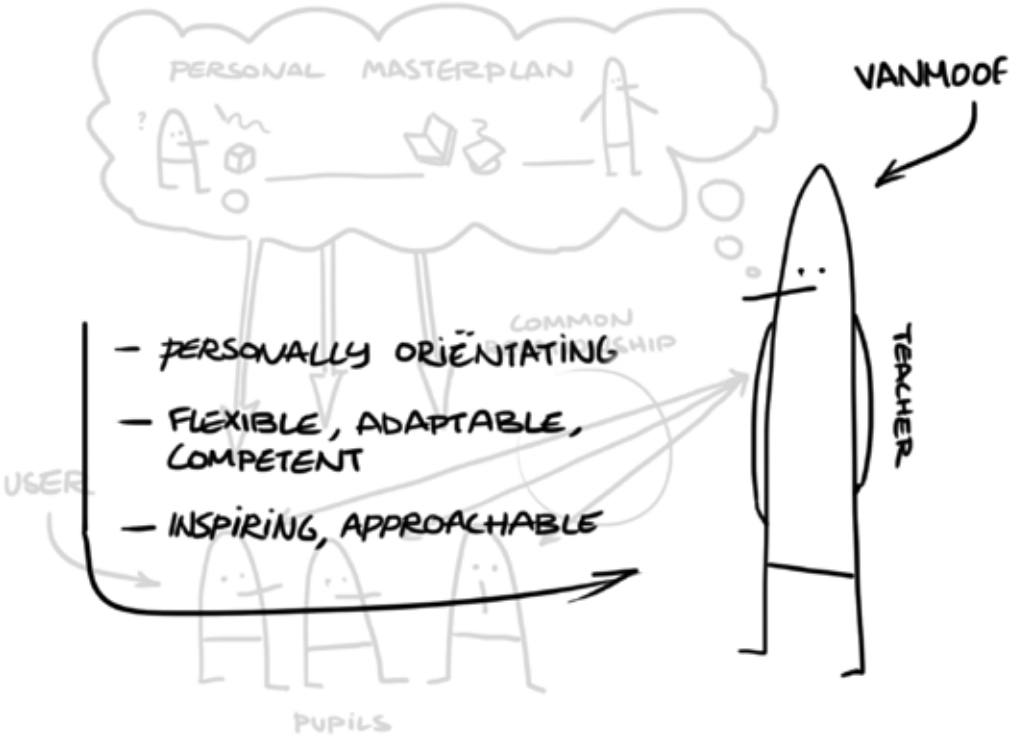
It could be stated that having a completely new set of qualities is the appropriate foundation to come up with fully original and all-new design. However, as to find a design solution that will suit VanMoof as the strong brand that they currently are, it is also desirable that there are dim similarities to the current brand values.



So how do the current and future qualities meet and where do they contradict? Whereas the current product is somewhat *rebellious, young, vivid, mysterious and.. not really flexible*, the future design should have product qualities that are *personally orientating, flexible and adaptive, inspiring and approachable*. But although most of this is quite different, a current intrinsic brand value -that is maintained within the new set of qualities- is the drive to reduce (perceived) complexity. However, the goal not being entirely aesthetic, but more a matter of easing the process of use.

Towards Ideation

These three steps in the ViP process might seem to be shallow and rather concise, however these steps are most crucial as they define the direction of the project from now on. The statement, analogy and product characteristics will be guiding during the phase of ideation and concept development.



IDEATION & CONCEPT

Graduation thesis IDE Walt van der Veen
in collaboration with: VanMoof Amsterdam

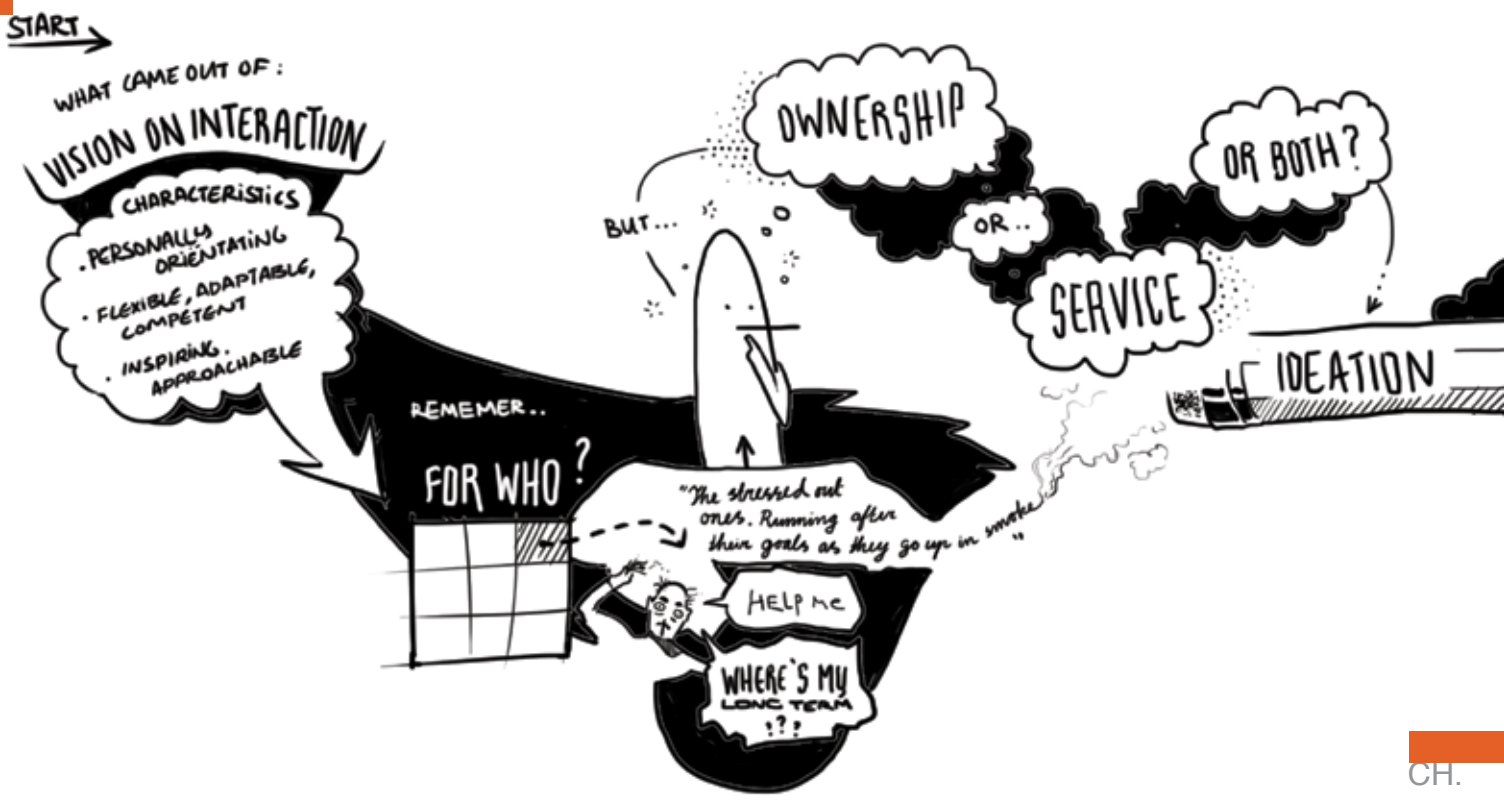
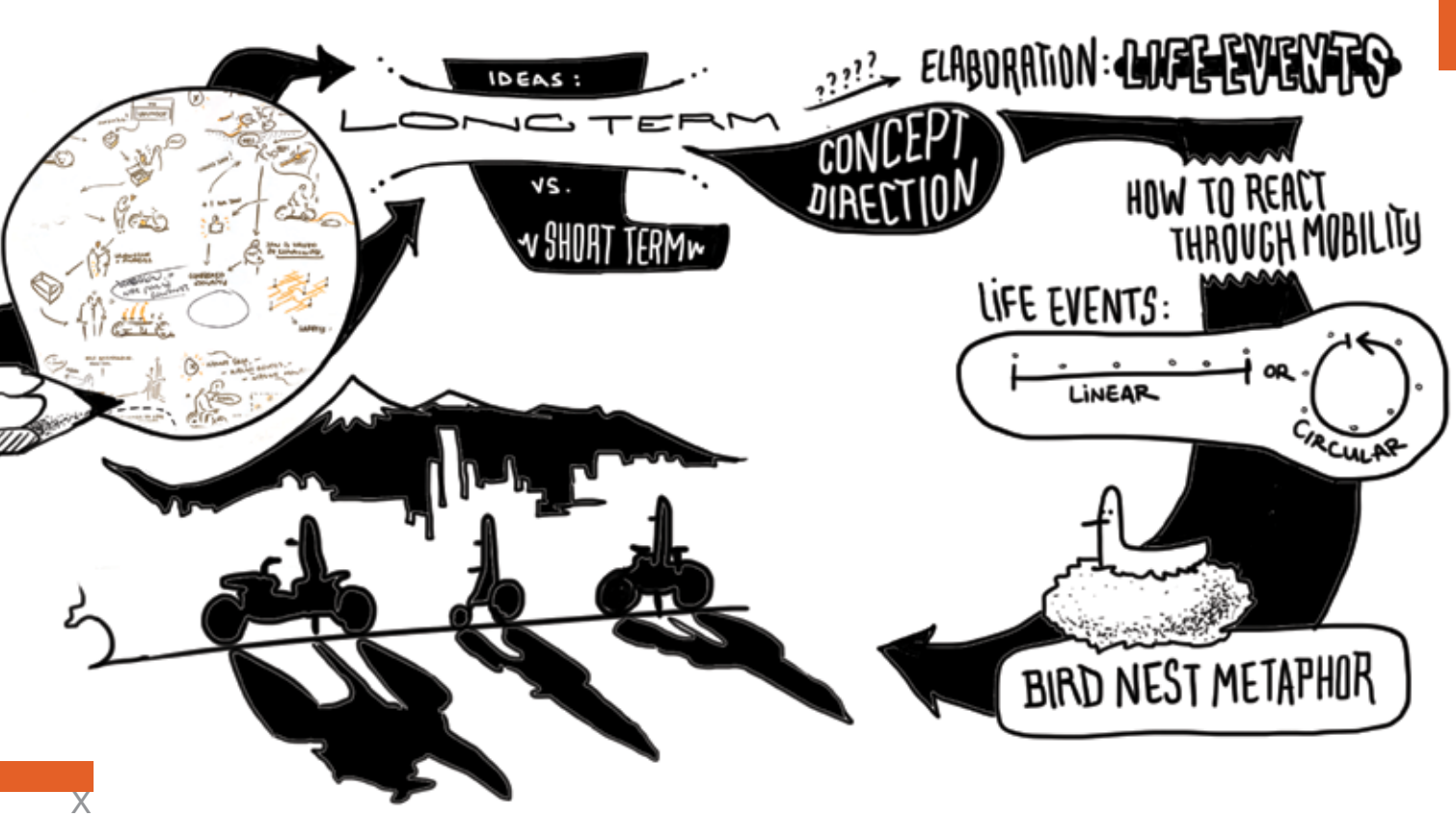


Table of Contents

26.



The Process of Ideation

The process of idea generation starts by taking into account the product qualities as they resulted from the interaction analogy. And in what way they contribute to achieve the desired effect of the human-product interaction. This is an iterative process of going back and forth to sketching and detours into the world of literature, museums, art and minds of fellow designers and thinkers. By doing so, things that are overlooked by my narrowed down mind can be pulled out of oblivion and contribute to a set of original ideas and/or combinations. As once stated by Frank Zappa:

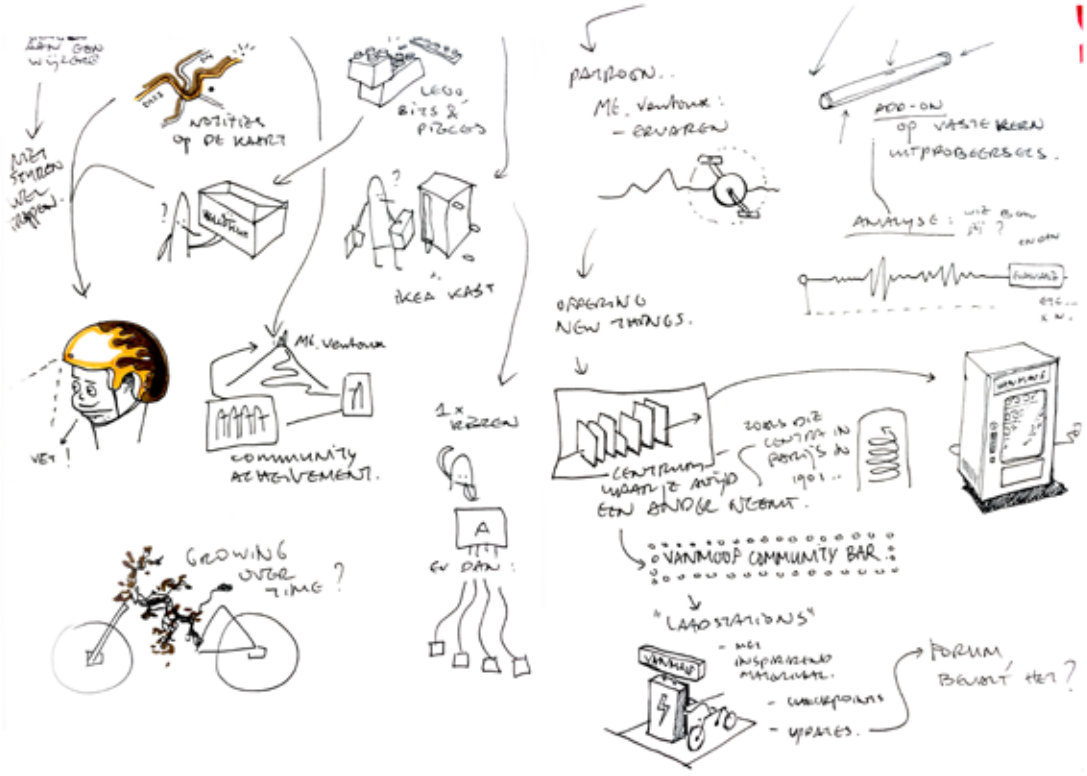
'your mind is like a parachute, it doesn't work if it doesn't open'.

The full process of thought and sketches is visible within ***Appendix 2 & Sketchbooks***. The most crucial steps and decisions are explained in the next paragraphs.

It is important to note that, as a Dutch person, I consciously aim to look further than the Dutch mobility climate. New means of mobility, especially cycling, will emerge around the globe. For cycling is already widely accepted in the Netherlands, the Dutch mobility climate is not representative for the mobility climate as it appears in most cities around the world.

The Typology

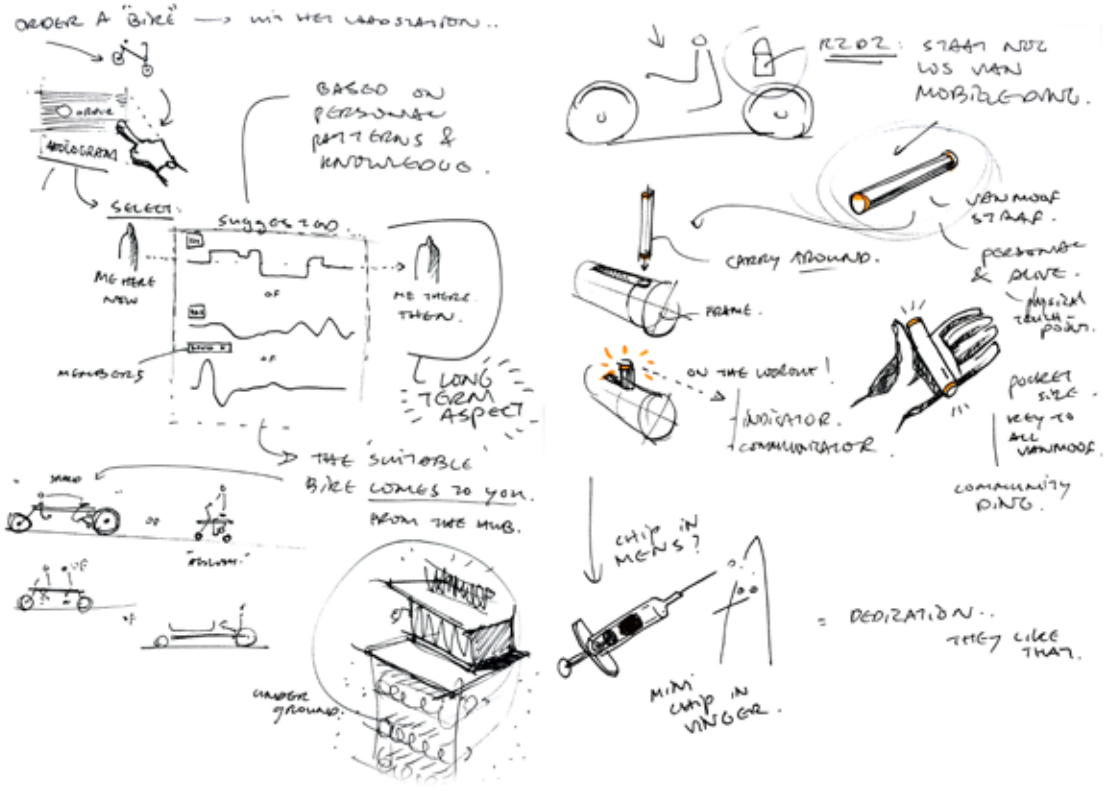
The typology to be designed for finds comfort in aspects that are secure on the long term,



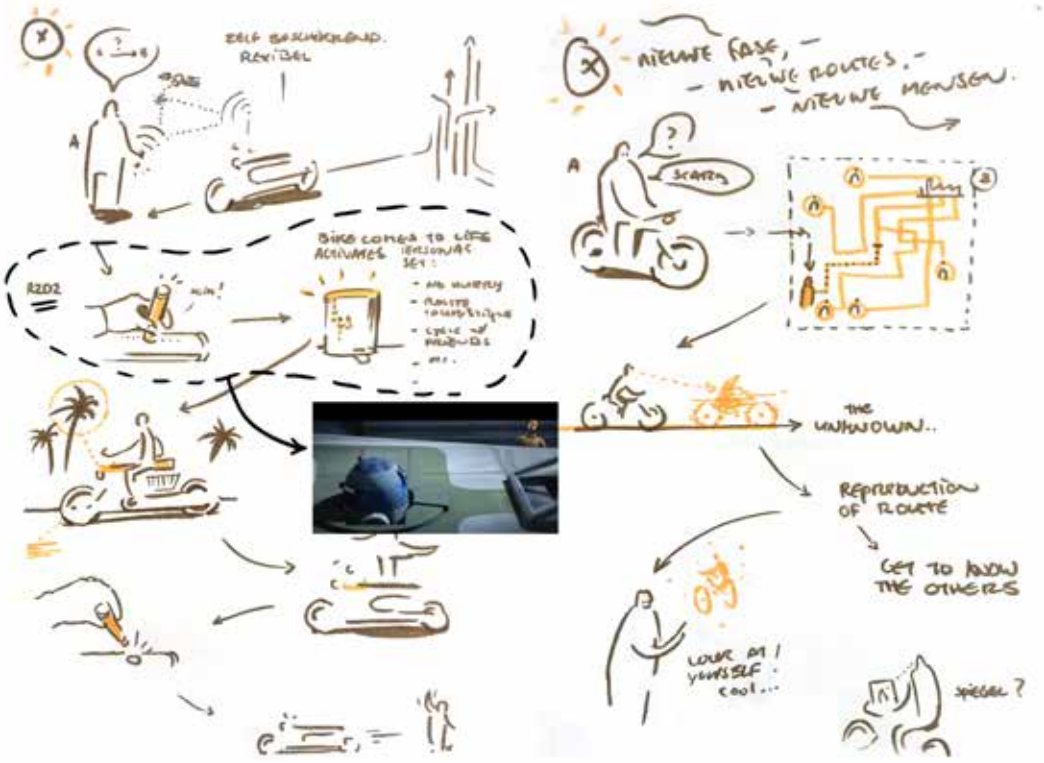
while orientating and depending on external aspects. They desire long term guarantee to make commitment worthwhile, and tend to rely on an external party to provide them with this guarantee. By doing so, they try to minimize the risk of making a decision that ends up being ‘wrong’ or ‘harmful’, and thereby strive to create safety. These safety concerns -in effect- are among the most general long term concerns people have. Safety is, in a multitude of different aspects: i.e. physical, social, financial, a concern that stretches out over an entire lifespan. A logical conclusion would be to provide them with a full mobility service, so they do not have to commit to something. In other words: they do not have to take the risk.

Ownership and/or Service?

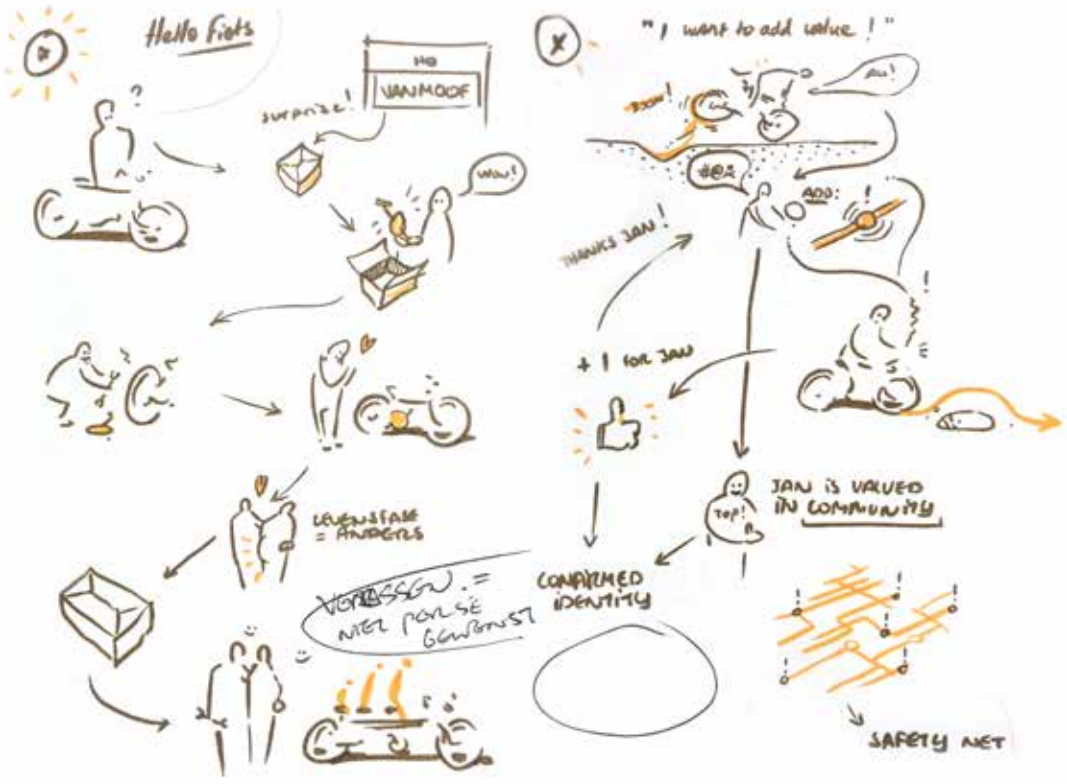
Throughout the process of gathering inspiration and ideation, a number of ideas for mobility services emerged 27. As put forth in the statement, the desired effect is to increase trust in one’s own future. Research into human psychology showed that increased trust results from risk reduction, which can be achieved by providing a product instead of selling a product. Ownership is decreasing and as more and more services emerge, for some it might be attractive to detach themselves from the burden of owning an object entirely. However, I do not expect this specific typology to feel comfortable with the complete loss of personal belongings and ownership. Ownership also means consistency when it comes to availability,



(Page absent in printed copy)



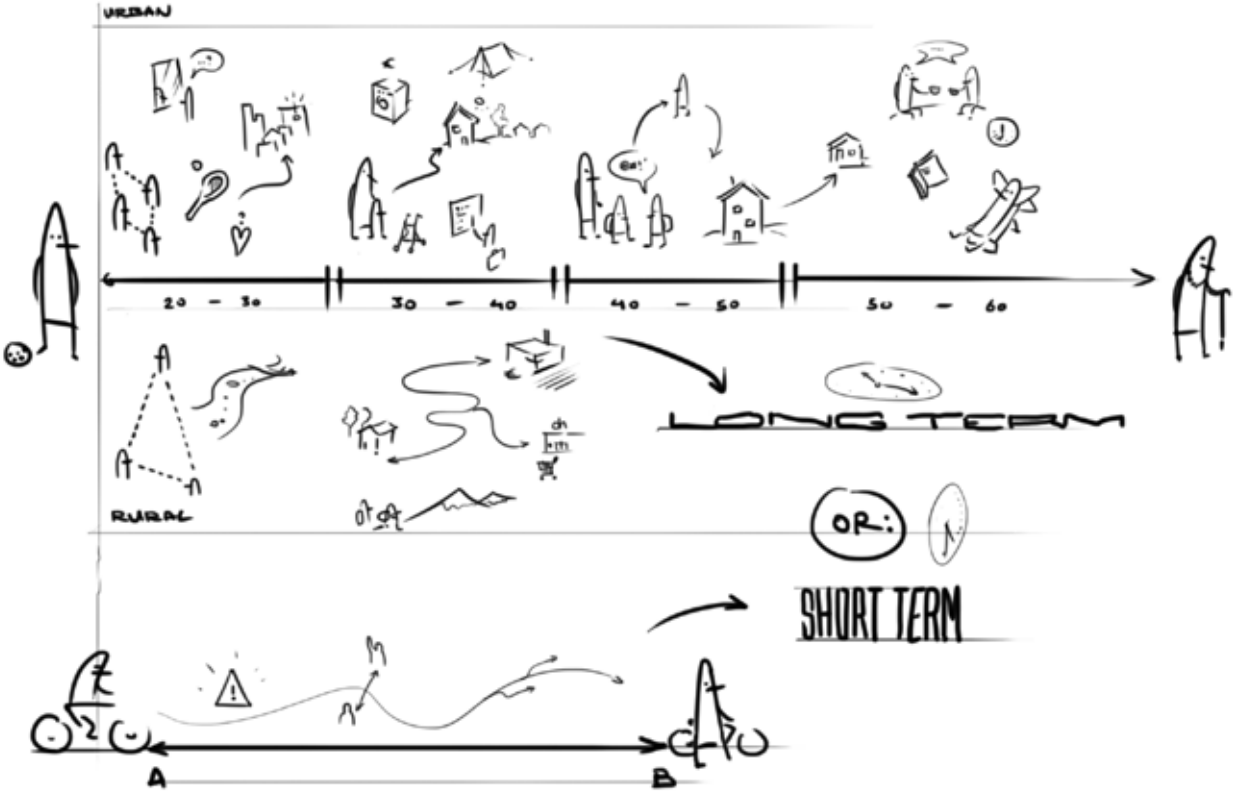
(Page absent in printed copy)



personal bonding and feelings of control (and power). People in the future society of 2030, within the typology as clarified, will presumably treasure a factor that remains consequent, and their own. By knowing what to expect from an object, perceived risk will decrease and thus it becomes easier and less scary to commit to using it. When it comes to ideation, this results in the quest to find an interesting combination of personal ownership and a service. Logically, most services go hand in hand with a physical product. The challenge in this case lies within finding a service/system that provides long term 'safety' en thus creating trust in eventual future events, while one still has its own 'thing' to build a relationship with.

Short-Term and Long-Term Ideas

Many a service or system concept that emerged from this process of ideation went into the direction of guiding the user during the act of being mobile. As the future world will force them more often in irregular routes and trips, this could be something in which a service might help them be prepared for unexpected events underway, or to share their experiences with other riders within the VanMoof community. Nevertheless, such ride-enhancing-systems have already emerged in the present world of cycling, and systems of many kinds are currently available through smartphone applications. Inevitably, instead of smartphones today, the future appearance and function of the medium of communication will

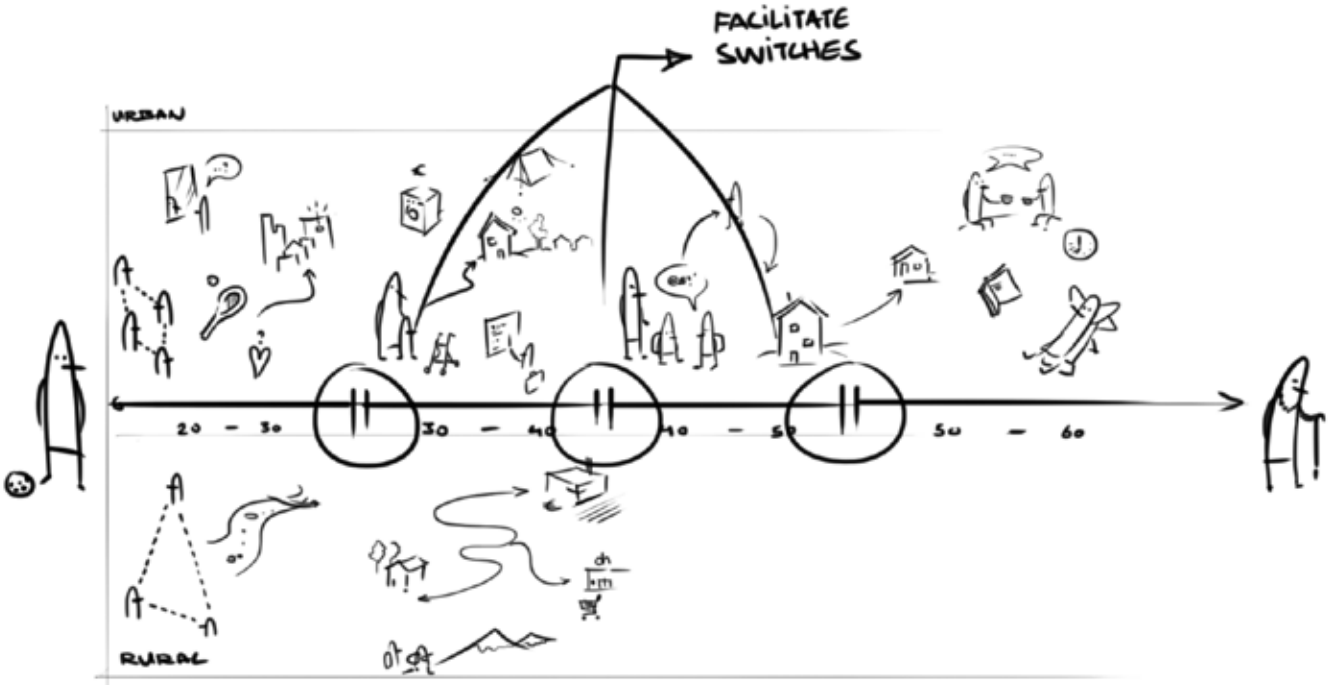


change. I do not expect that people will even have a physical mobile phone object like we know them today. For this reason, a number of ideas ranged from different kinds of media and modes of communication (holograms/ projection) between the mobility device and the person and/or community using it 28. Although I sincerely believe these kind of systems will be of great importance in line with the growing international popularity of cycling, I think these systems especially deal with the guarantee of safety on a shorter term: *the trip itself.*

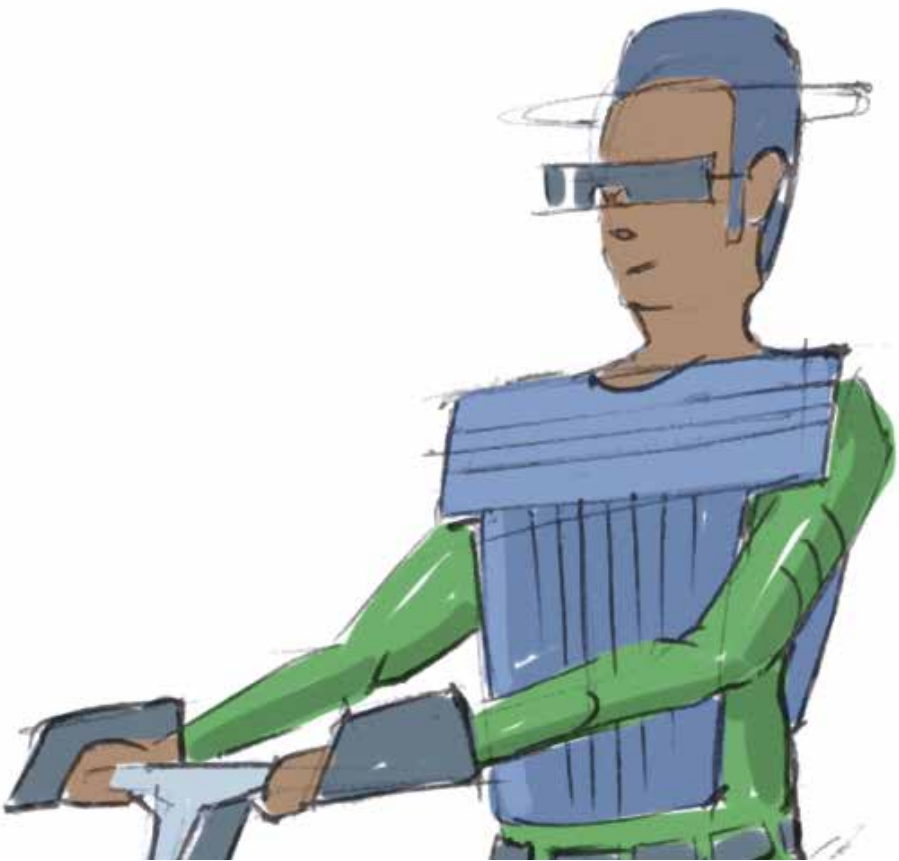
Aside these 'short-term'-based ideas, many ideas were found that focus more on the long term facilitation of mobility. One of many example ideas would be the VanMoof 'stick' containing personal information for optimal use, used as an insert to operate autonomous mobility devices in the most personal and accustomed way. This stick would be your personal touch point that you may form a relationship with. Roughly equal to the role of R2D2 who submerges itself in the starship 29.

Concept Direction

This clarified that two directions emerged during ideation: solutions for risk reduction over the timespan of one trip, and solutions that reduce risk for larger amounts of time 30. Looking again at the behavioral typology selected to design for it is clear that what stresses them is the fact that they have to change the course of their life, without being able to properly anticipate on the abrupt changes.



This is the direction of thought in which the concept idea is starting to take shape. After all, if VanMoof would successfully manage to facilitate -not force- their changes in life, they could become of great value on a longer term. In order to properly design a concept to create the desired effect, the most universal changes -so-called life-events in psychology- are to be looked into to better understand how they occur, and what they might mean when it comes to mobility aspects.

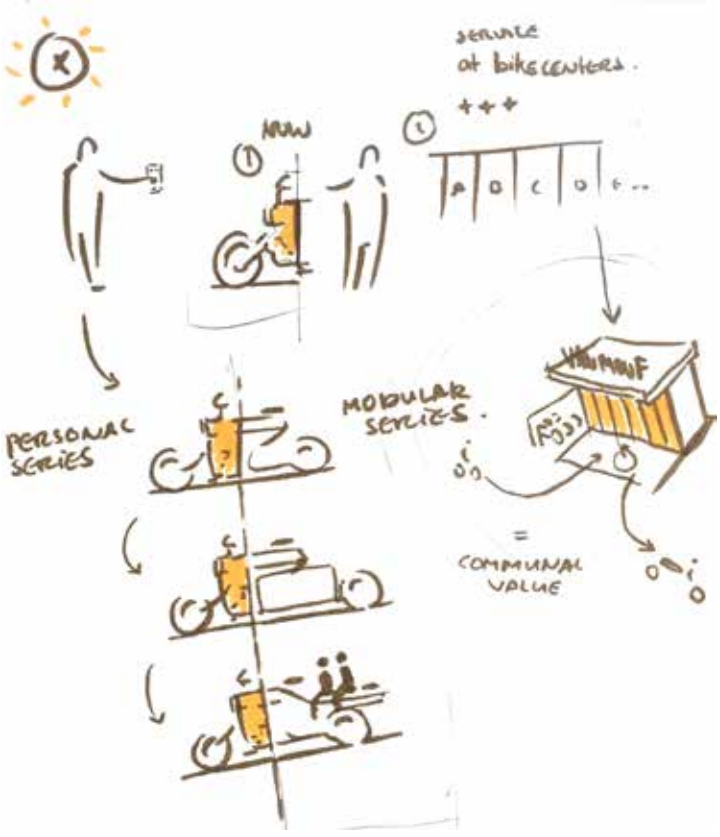


Elaboration: Life-Events

In order to better understand what crucial changes occur in life, it has been researched what incentives normally lead to changes in life and mobility medium selection. In literature there can be found several descriptions of what most common causes induce changes. *'Clark et al. in 2016: Regard life events as major factors for mobility behavior change. The authors found residential relocation, change of employer and gaining a driving license as most effective life events in terms of mode switch.'* Here, the life-event is mentioned as the factor forcing a person to change and adjust. Life events, as even better put forth by Yuri Jang William E. Haley in 2020, are considered as follows: *'Life events are defined as discrete experiences that disrupt an individual's usual activities, causing a substantial change and readjustment. Examples of life events include marriage, divorce, illness or injury, and changing or losing a job.'* 31.

A simple example of influence of residential relocation might be as follows: *If you would live in an urban congested environment, a move into a different spatial context would require a rather different set of features that comply with the needs that occur from such a change; trips become longer and less diverse, or infrastructural differences could allow you to have a larger physical footprint.*

The moments wherein a person switches from one mobility device to another thus largely rely



on both internal and external factors which change at the time life-events take place. It is important to note that these are almost all, with exception of minor injury, changes with effects on the long term. It is for this reason that an effort is made to create a mobility solution that facilitates adjustment necessary to cope with life-events and resulting changes.

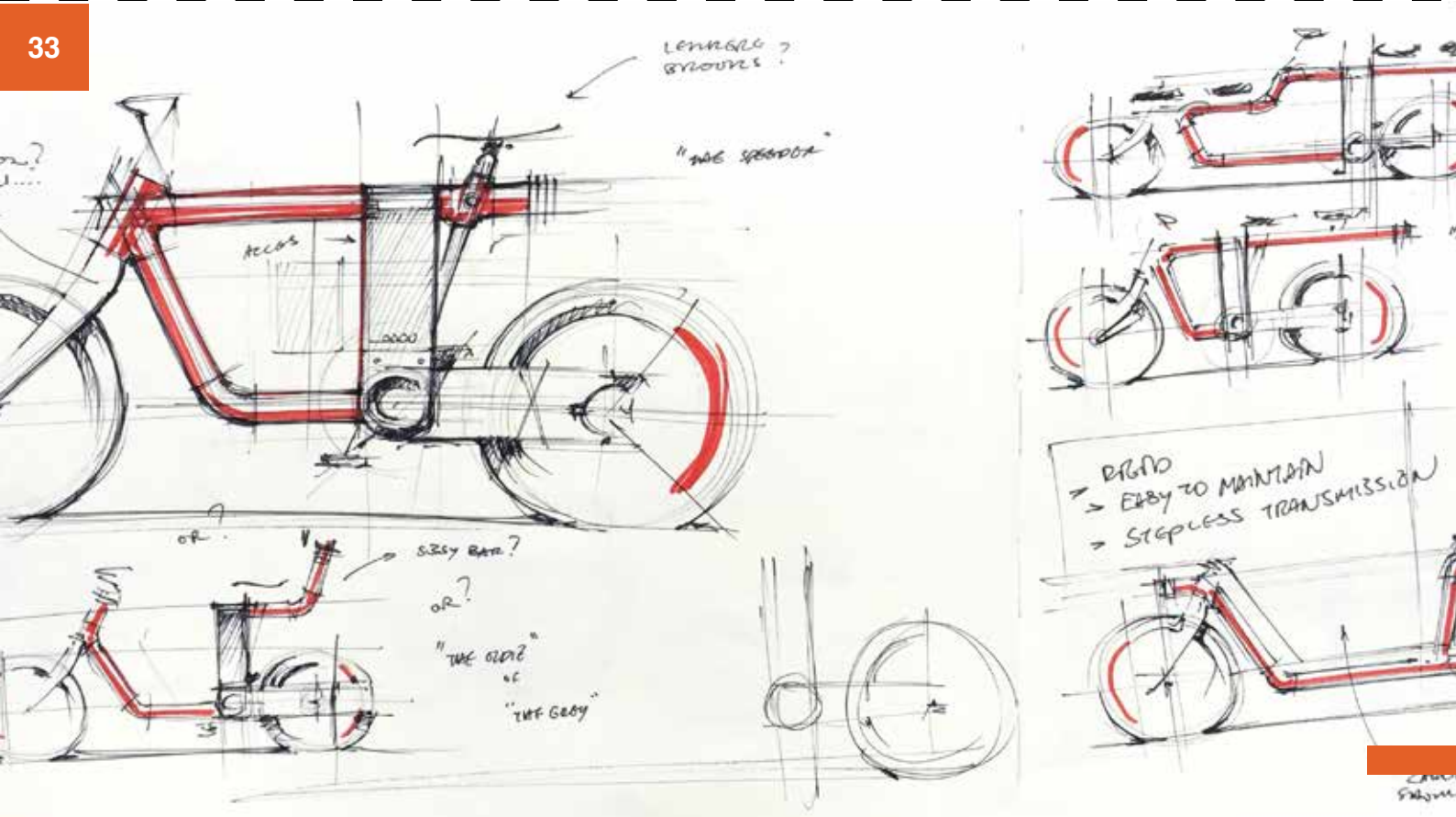
How to React Through Mobility?

A simple sketch formed the foundation of the service/product idea that seems appropriate to achieve the desired effect 32. The basic idea here is to create a service that provides specific mobility needs with add-on systems, in combination with a technical 'part' that would be purchased 33.

Selected Idea

Through intensive iteration and discussion with both the VanMoof design team and Chair and Mentor, the rough idea is shaped into the following conceptual idea:

A service providing a crucial technical set of components combined with a personally owned mobility outcome which is suitable for ones state of being and fulfills the concerns attached to it. Thus: the technical core is provided to you by VanMoof on a leasing basis. Upon that you select, through purchase, the mobility shape that facilitates the life-event that is taking place.

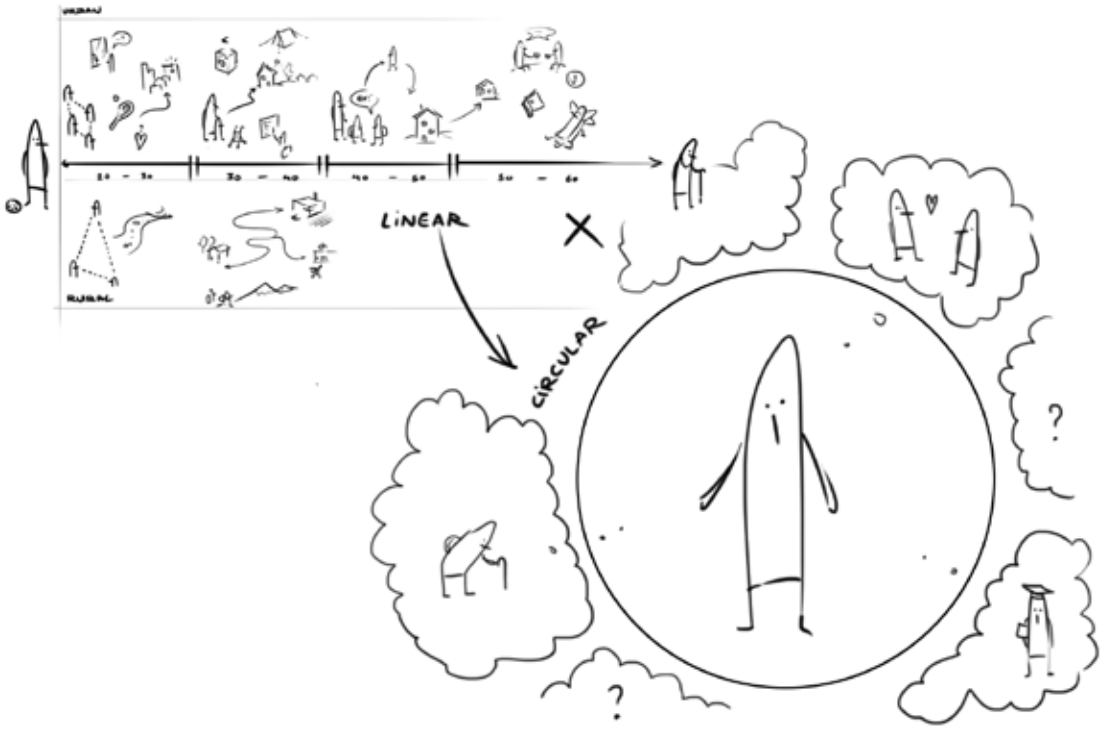


Life-Events: Linear or Circular?

2030 will be a time wherein major life-events take place far more rapidly and sporadically. It is exactly that phenomenon which causes stress through a feeling of non-guidance within the typology selected to design for.

Furthermore, life-events are not similarly or simultaneously experienced by everyone, a phenomena that strengthens even more when taking a cross-cultural perspective. In example: *care-taking of the elderly differs greatly between The Netherlands and Italy, where in the latter they are being taken care of by family members, whereas in the Netherlands they are put away in elderly homes.*
So, taking into account this life-event irregularity, it would be wrong to anticipate on a linear set 34. of life-events implying a regular conservative life-line (marriage, children, growing old etc.).
Therefore it should be emphasized that one can move from one mobility shape to another without any logical order. The service's ability to switch between any shape at any given moment is crucial to facilitate the adjustment. It is for this reason that the life-events should be depicted in a circular pattern to make sure these are not interpreted as a linear pattern.

But then the question remains: Which life events can be defined in an universal way? And how would mobility shapes and features change accordingly?

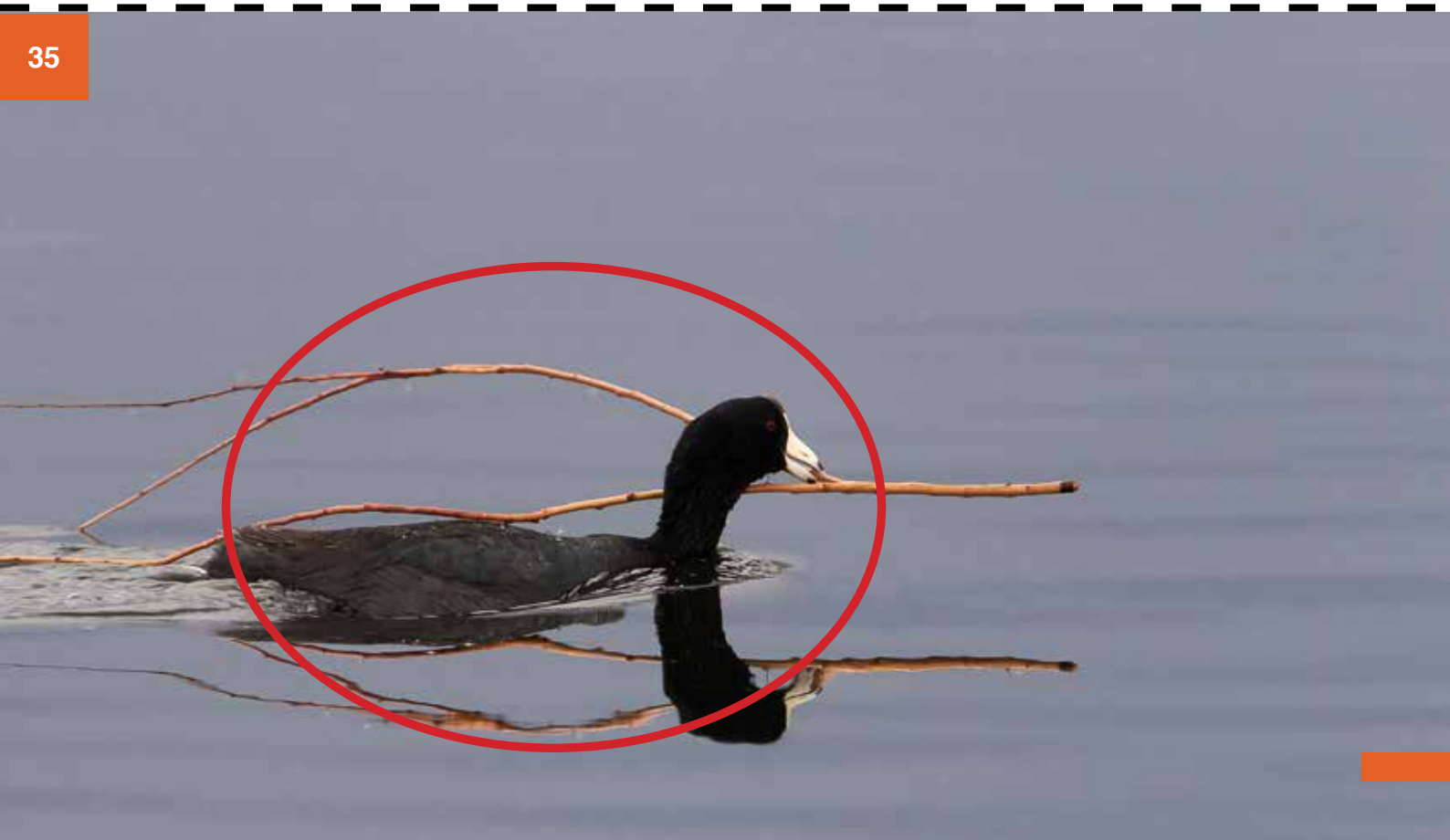


The Birds Nest

Making an effort to approach the set of life-events as universally applicable as possible: a metaphor of a bird's process of nesting 35. is used to clarify the different life-events, and what kind of concerns are attached to that 36. What do I mean by that? And why is this metaphor useful? A bird establishing new territory by preparing its nest has its specific concerns: *attachment to its chosen location, large numbers of short trips, gathering attributes and the need to be quick and agile.*

This can be projected onto human activity, without implying that the human is building a dedicated room for the birth of the first child. It might as well be a food-delivery service, delivering a warm freshly baked bread to addresses nearby.
By doing so, the essence of the life-events is shaped because of the universal concerns attached to it. Using the concerns that follow from the metaphor, a number of key-features are defined. These key-features form the foundation of a specific mobility shape.

Each described life-event resulting from the bird nest metaphor is provided with an example of how it might project onto human life, and a number of key-features that are essential for appropriate mobility.

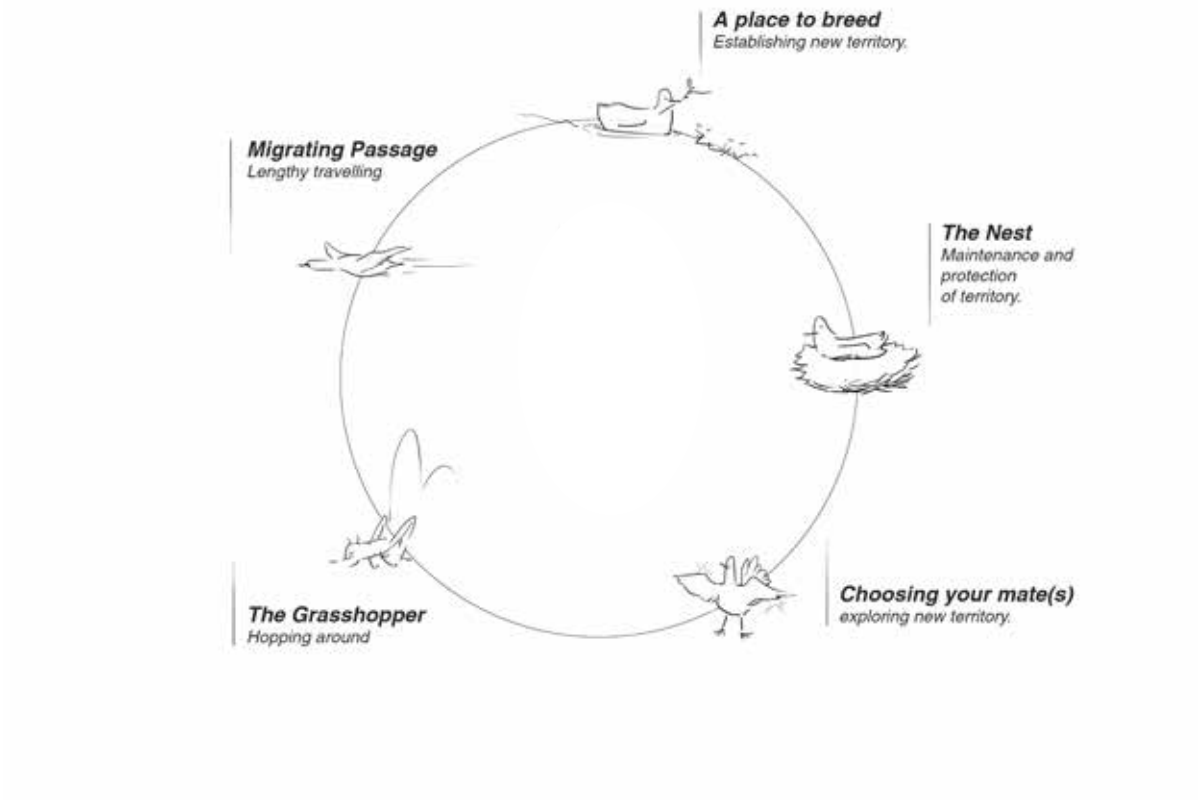


Choosing Your Mate(s): *exploring new territory.*

Exploring around to find friends, mates and new opportunities. With this 'flight out of the nest' comes great change. The environment in which one felt secure is being expanded and has to be explored. Consequently, concerns evolve around insecurity, questions of meaning and the need to explore unknown fields of existence. Self-exploration and the quest for identity and belonging are also part of this state. An example of what the quest for identity and belonging could lead to: Receiving a pink Vespa scooter with panther print upholstery for a 16th birthday, a quite common sight in the present world. This scooter is selected because of its appearance and attached values, instead of rational thinking about usability.

Key-Features: Personally expressive yet conforming to the mass, idiot-proof, agile, space for 1.5 (may a mate be attracted). Look cool at arrival.

Example: These could be teenagers, as you might logically conclude. However, they might as well be 45-year olds losing/finding a job, relationships or other changes to fixated pattern and habits. Nevertheless, it could also be someone consciously choosing to move into a new environment.



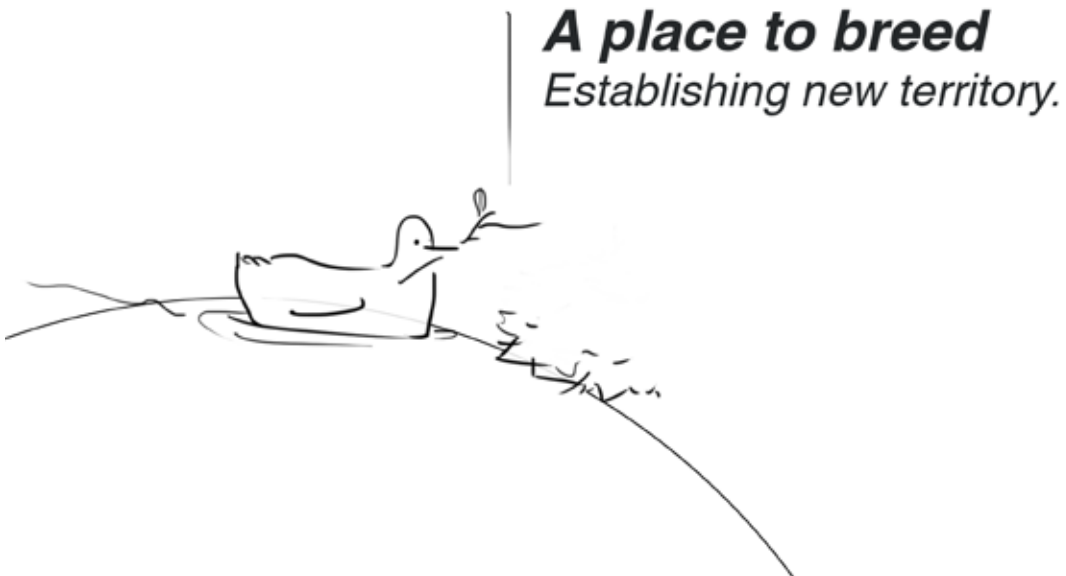
A Place to Breed: *establishing new territory.*

37.

Birds have to put in work whenever they desire the expansion of their family. A bird establishing new territory chooses a place it considers suitable, and starts building a nest. The bird now has its new set of concerns: *attachment to its chosen location, large numbers of short trips, gathering attributes and the need to be quick and agile.* Moving around very often involves small attributes essential for the territory. What attributes pile up can be unpredictable, and for that reason it is desirable to be able to adjust accordingly.

Key Features: Agile yet Stable, Speedy, long range, multi-purpose use of compartments or 1 + 1 seating.

Example: This could be the parent bringer a child to school, or getting groceries. However, it could also be the appropriate set of features for someone expanding ones business. Or for someone who discovered the tremendous pleasures of maintaining a tiny vegetable garden, bringing home some highly biological carrots.



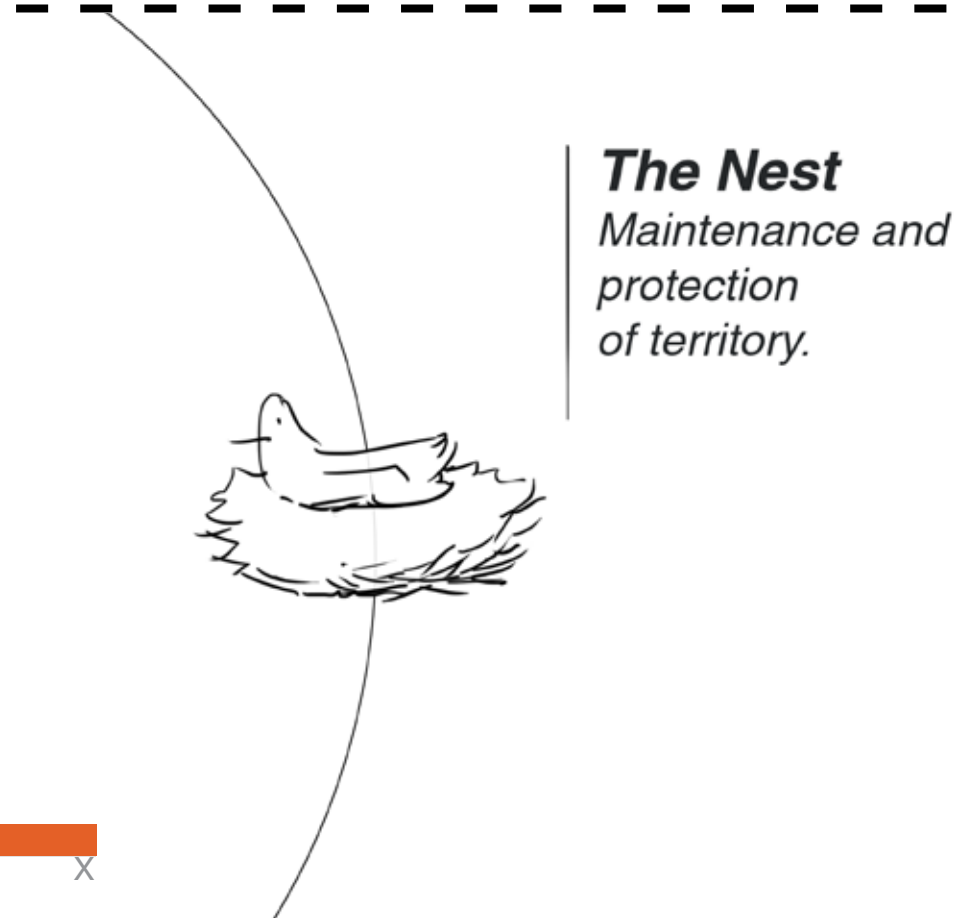
The Nest: *Maintenance and protection of territory*

38.

Now that the new territory and badge have been achieved, it should be maintained and kept safe. Concerns evolve around protection: *keeping the badge safe and keeping it warm.* The sturdy nest provides the cocoon of safety. But what does the nest consist of? Apart from being a number of young humans (also known as infants, or children), this nest could be a multitude of things: deliveries, medicine or the freshly baked food. Reliability is key, combined with balance and safety. One protects it, that's why one is upright in the front. Not in the back.

Key Features: Balance, Safety, Overview, Spacious.

Example: Logically, this is interpreted as the ultimate set of features for a parent with small children. But why not a lumberjack? Carrying around the freshly chopped wood. Or that delivery guy bringing that warm dish to some elderly person? Or even that creep who is selling ice-cream late November? They need their attributes, and these need to be safe.



The Grasshopper: *Hopping around territory, and long jumps*

39.

Whenever one is not expanding, but narrowing down. Or who is certainly solo, not carrying large amounts of attributes around. Mobility is a matter of exploring small distances, and the ability to cover great distance unhindered. A Grasshopper can go literally anyplace. Therefore, you need not to claim more space than you really need. Free and smart moving around in a total agility.

Concern evolve around maximum agility, when in one territory, and the ability to move fast to other territories in straight lines.

Key Features: Small footprint, Light, Super Agile, lower speeds ask for balance, Portable?

Example: for those who have to switch mobility modes for their trip, this is ideal. A lightweight and tiny mobile device that can be brought on the long trips and that fulfills your need to cross small distances in an easy and flexible way when in a new territory.

The Passage: *Migration between territories*

40.

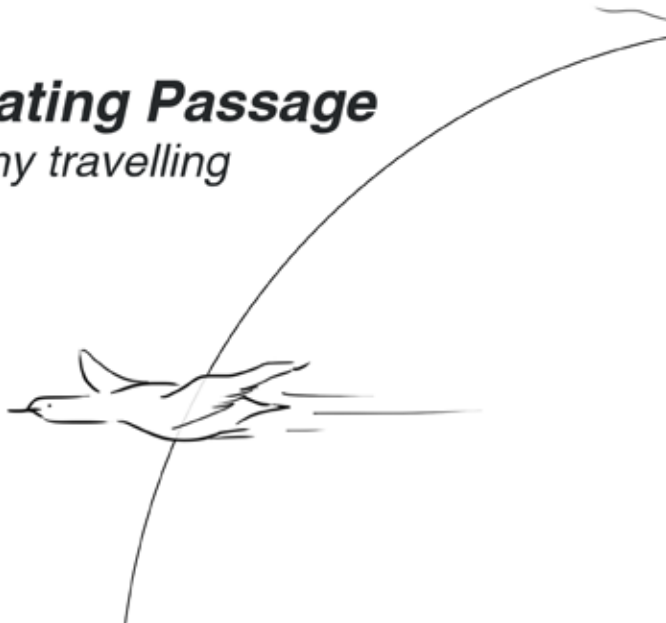
This too is a solo traveler, but different from the grasshopper. As the bird moves to the warmer climates it has to cover great distances, and be sure not to get tackled by the dangers during the flight. Concerns evolve around protection and certainty to cover these longer distances in a peaceful and comfortable way.

Key Features: Larger footprint (for balance), Cover, Higher Speed, Long Range, Aerodynamic shape.

Example: This could be a person who moves further away from the daily activities, thus having to cover larger distances. However, trips are significantly fewer. More space is available for them to drive, as well as to store their mobility device.

Migrating Passage

Lengthy travelling



Concept: Icon Silhouettes

The Bird Nest metaphor helps to derive the key-features necessary to best facilitate ones changing life due to life-events taking place. Through a long process of searching the right shapes, these key-features are translated into mobility solutions 41. These mobility solutions are detailed no further than a simple drawing each, in order not to imply to far an elaboration. Far more important at this stage are the key-features that lie at the foundation of each mobility solution. The silhouettes become a symbol or icon for the phase of life one is living in.

Based on the goal of overcoming whatever holds you back in properly adjusting yourself after the impact of a life-event, the key-features are transformed into mobility solutions (the silhouettes). How life-events result in changes in the field of mobility is elaborated upon in Chapter 3: *Ideation & Concept*. Whenever one changes course, the mobility solution will be able to move accordingly and facilitate these necessities crucial for optimal adaptation. VanMoof facilitates this change by answering the changing concerns by simple switches in mobility function. Narrowed down to a set of five different mobility solutions; the before mentioned icon silhouettes.

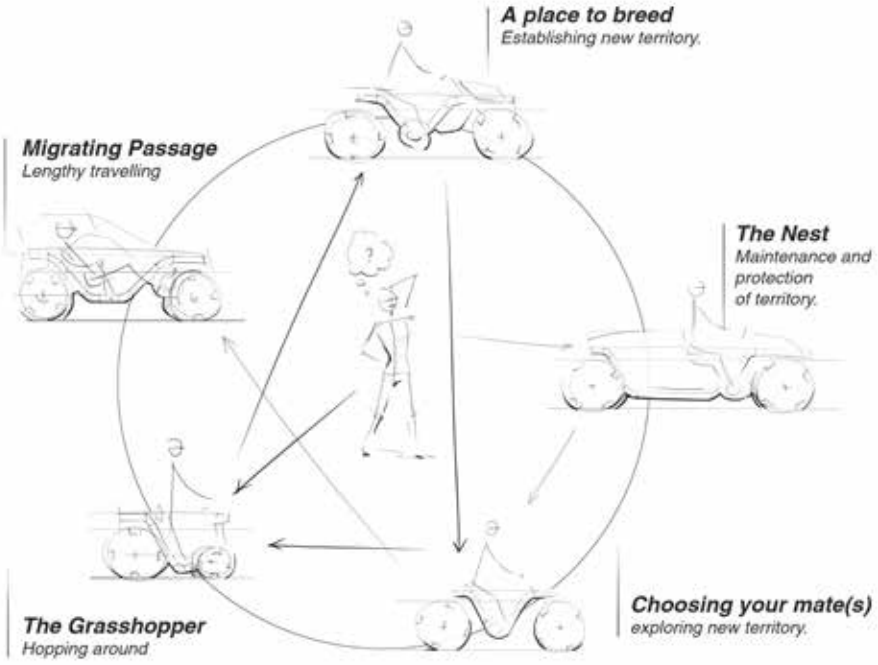
Consequently, VanMoof becomes a provider of a mobility service. But how does that service function? This service is based on the separation of a technical core, in combination

REFERENCE IMAGE 41

with a ‘unintelligent’ frame joined together. (Please note that this does not mean visual integration is abolished). This separation is essential as it allows VanMoof to design a simple set of five mobility solution that are driven by the same technical core. VanMoof provides the technical core, which consists of most of the parts subject to wear, on a leasing basis. One then purchases a frame suitable for one’s needs at that very phase of life. Whenever life changes, a frame can be brought back and a different frame can be obtained with a discount. By doing so, VanMoof manages to recollect its materials and parts useful for the construction or refurbishment of frames.

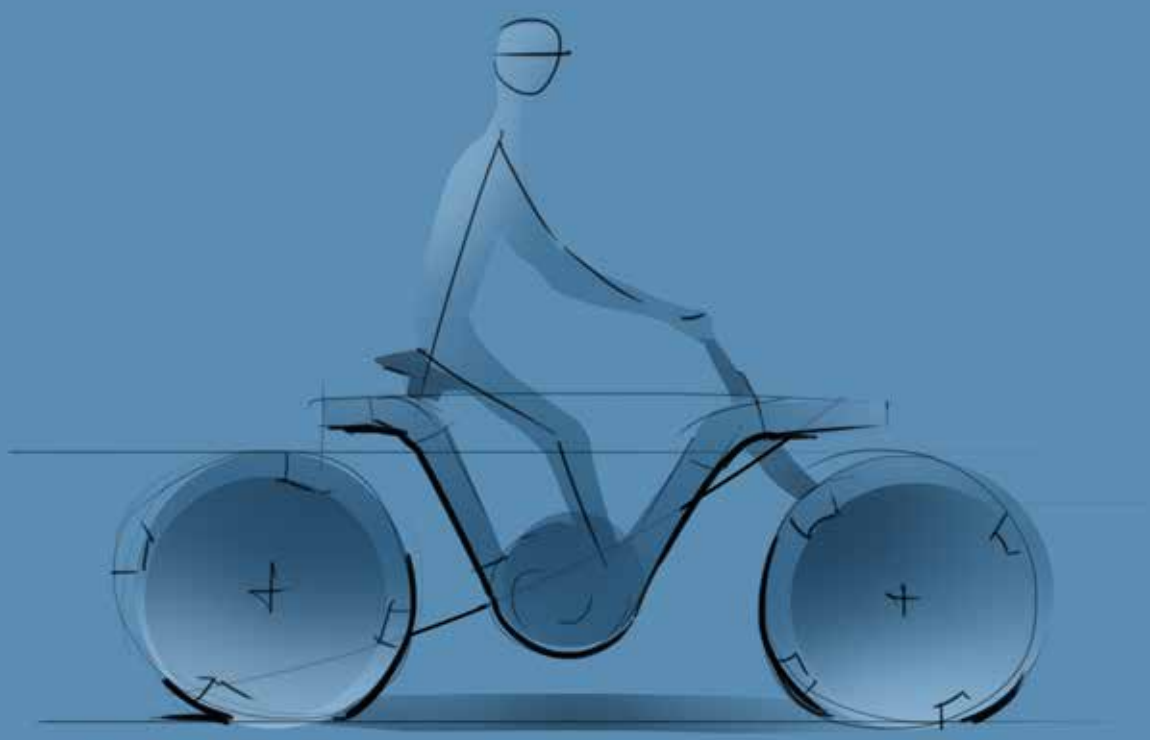
Earlier in this graduation thesis it has been made clear that reduction of risk is of great importance to the selected behavioral typology. Lower risk increases the willingness to commit, and the service function as described in the paragraph above is crucial for each of the icon silhouettes concepts to succeed.

For the further elaboration in the graduation project, a selection will be made to detail one specific icon silhouette. This because of the limited amount of time available.

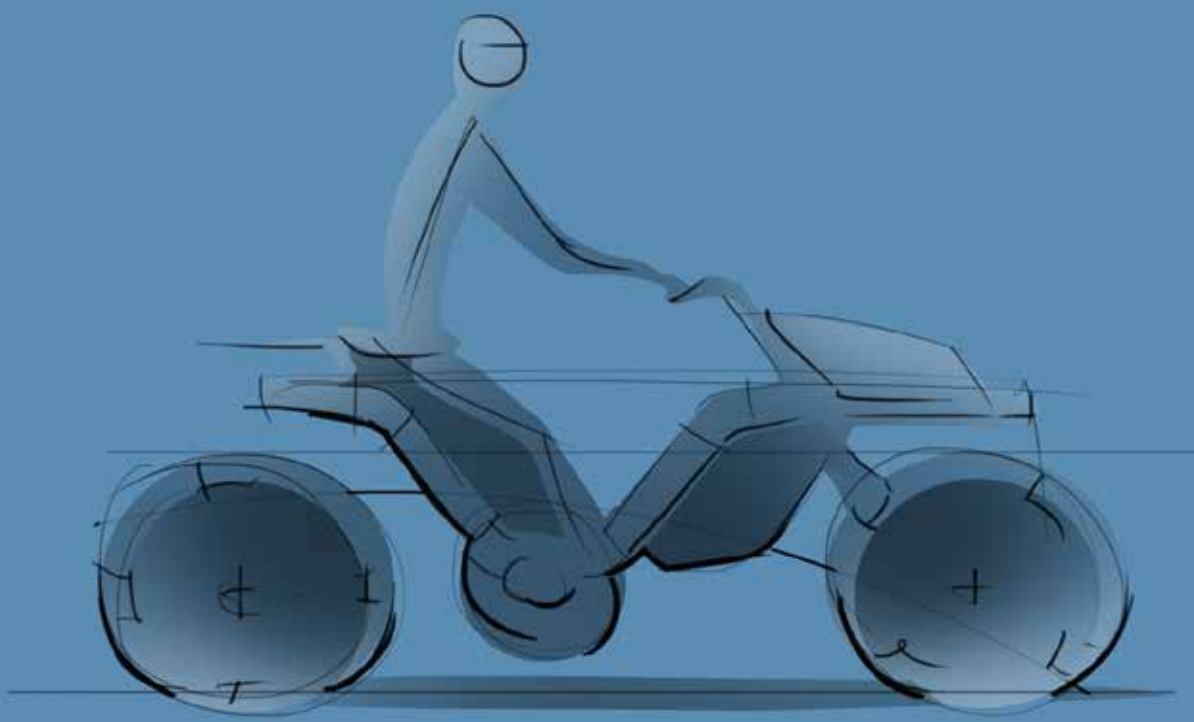


REFERENCE IMAGE

(Page absent in printed copy)

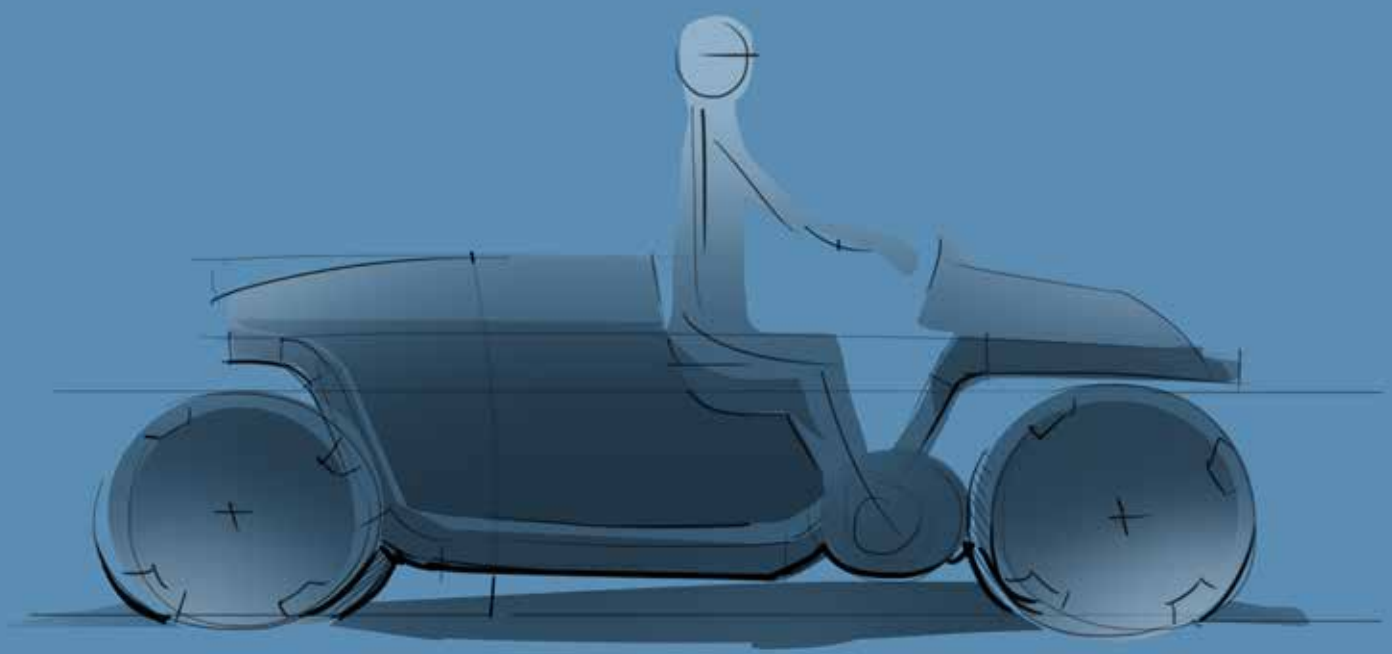


(Page absent in printed copy)

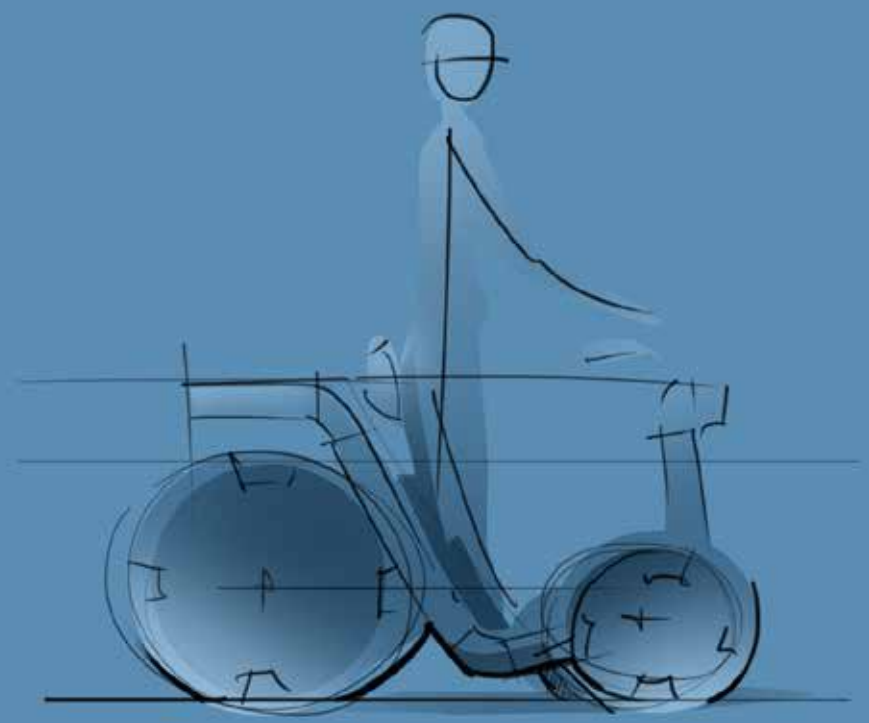


REFERENCE IMAGE

(Page absent in printed copy)

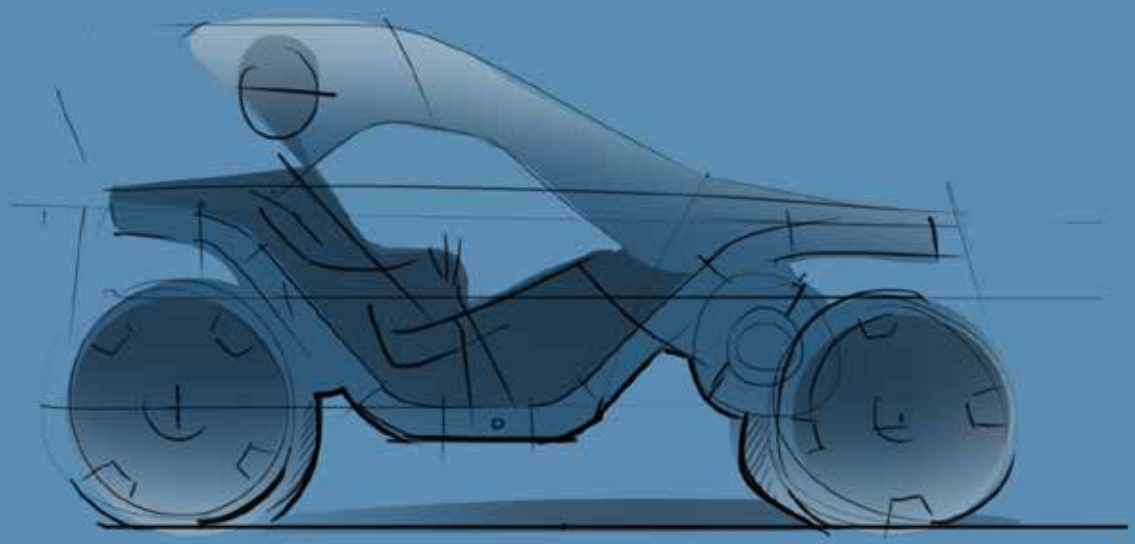


(Page absent in printed copy)

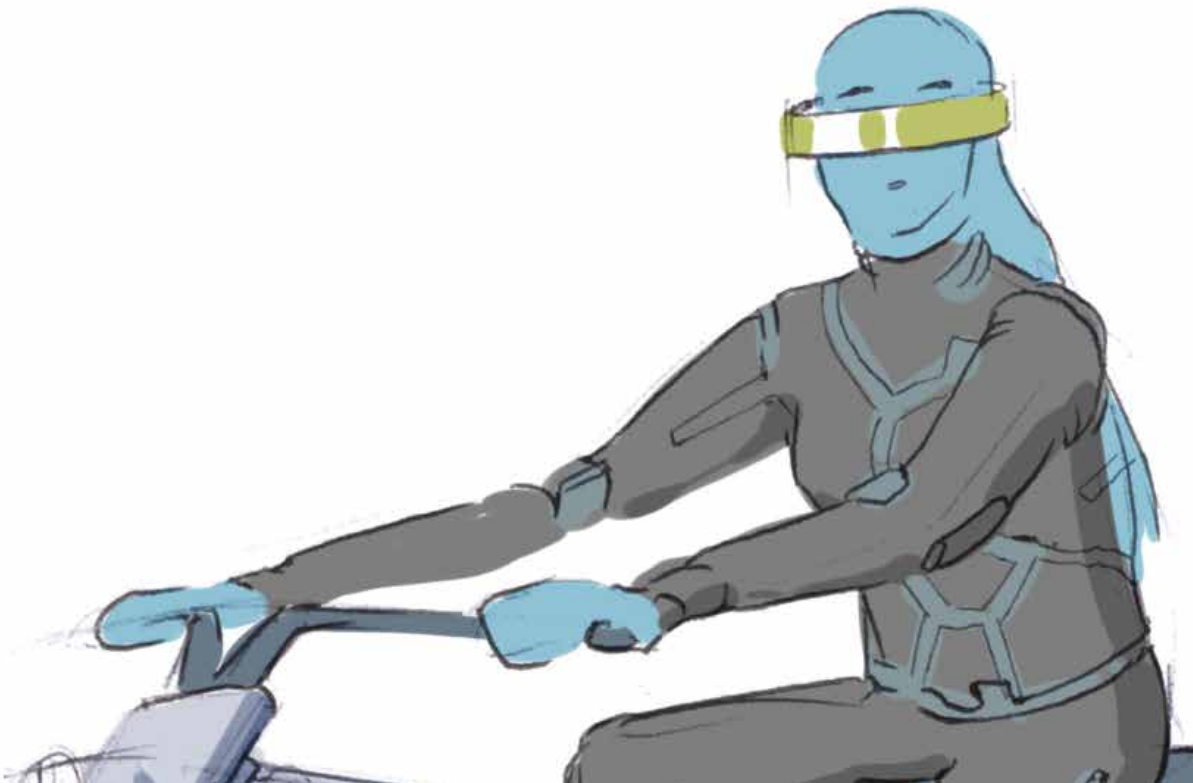


REFERENCE IMAGE

(Page absent in printed copy)

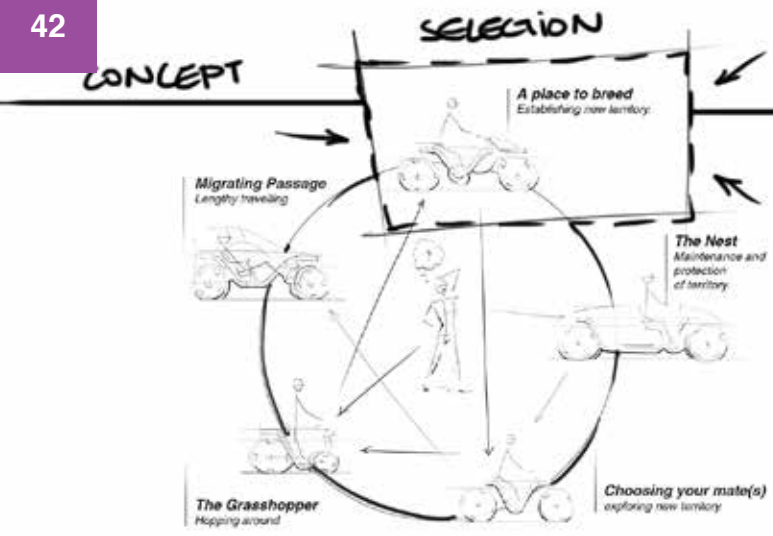


(Page absent in printed copy)



CONCEPT DETAILING

Graduation thesis IDE Walt van der Veen
in collaboration with: VanMoof Amsterdam



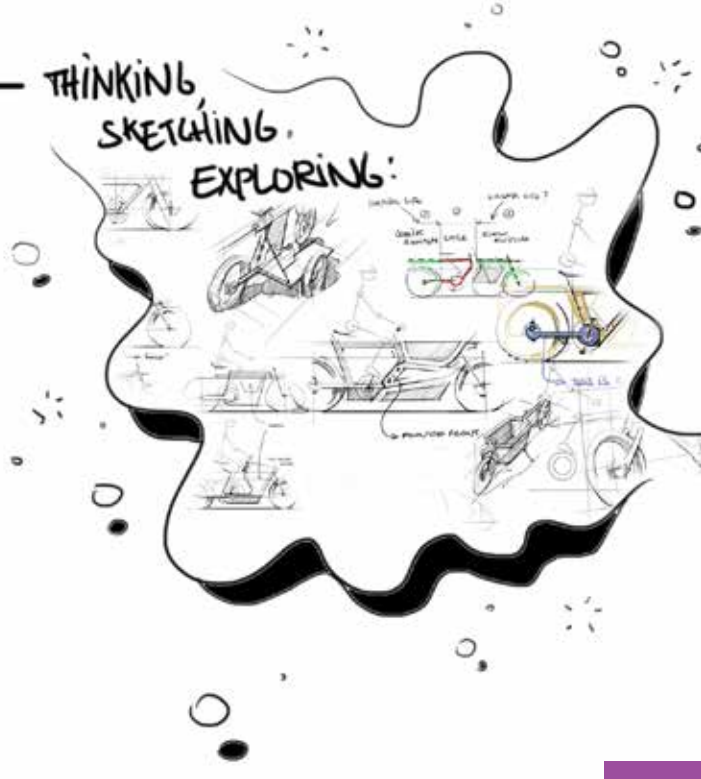
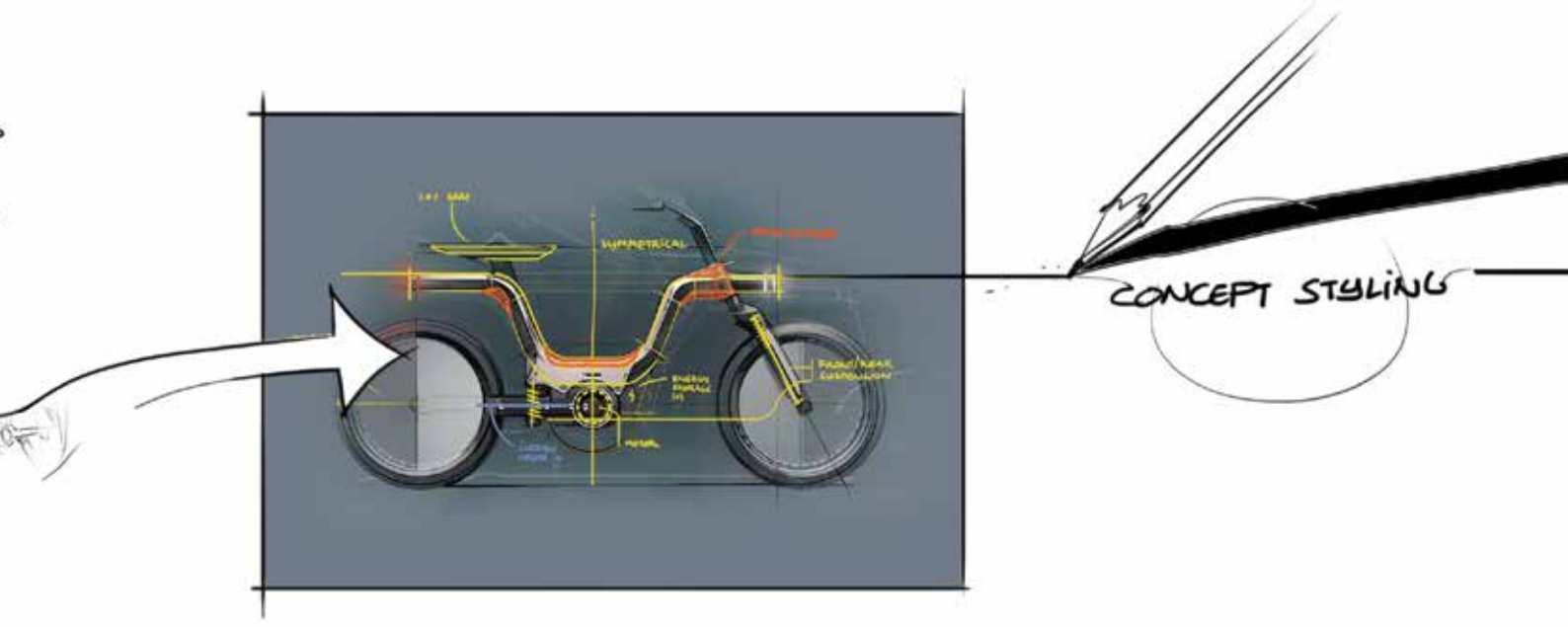
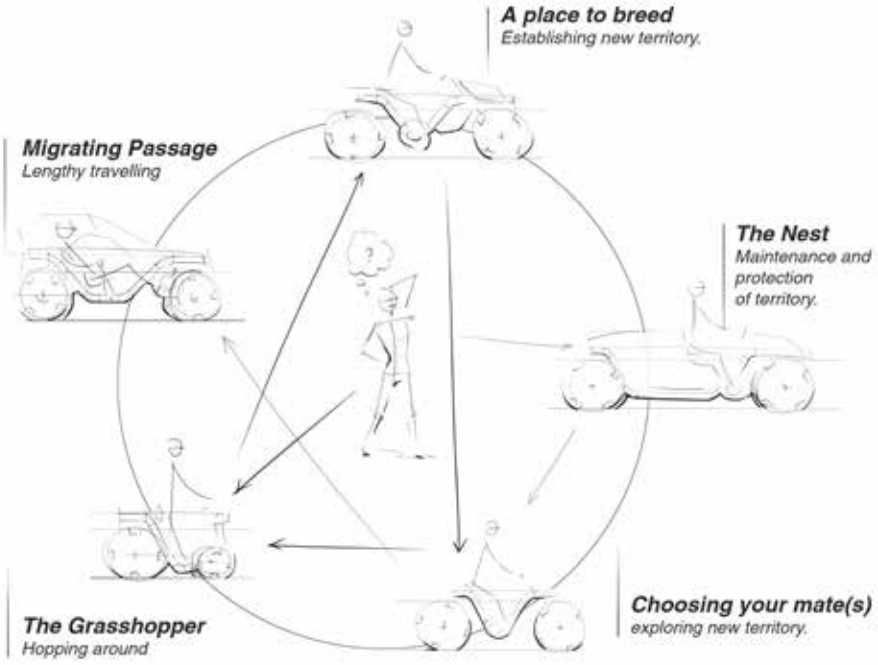


Table of Contents

42.



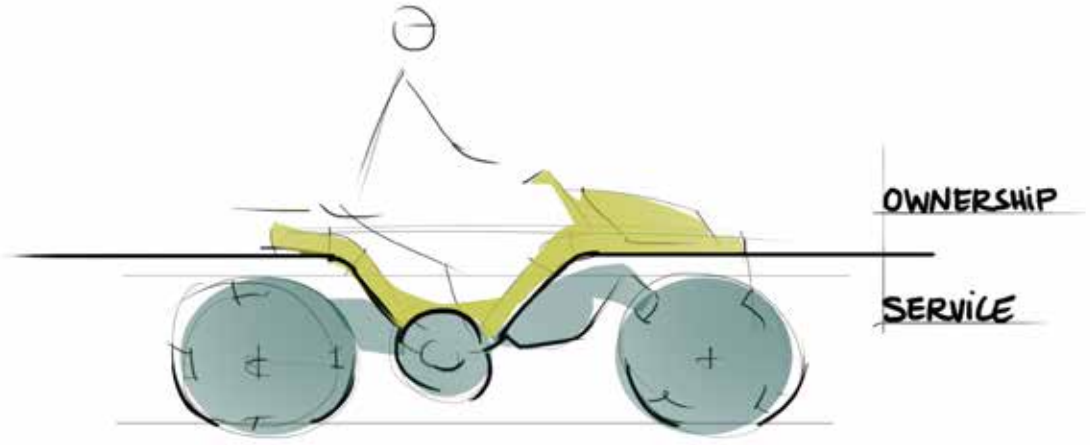

A place to breed
Establishing new territory.
Migrating Passage
Lengthy travelling
The Nest
Maintenance and
protection
of territory.
Choosing your mate(s)
exploring new territory.
The Grasshopper
Hopping around

Concept Selection

As the graduation thesis has a time limit it is at this stage necessary to make a choice which specific model of the conceptual idea of mobility icon silhouettes I will select to further define and detail. After all, it was the objective from the start to arrive at a stage of detailing and prototyping. At this point, a selection can be made out of five different mobility silhouettes 43. Together with the VanMoof design team it was discussed which specific model is feasible to build, and would still be a surprising mobility icon silhouette. The preference goes out to the 'A Place to Breed' icon silhouette, as it is quite different from what people are used to today, but would still be a believable mobility solution. Most advanced, yet acceptable. It should be remembered once again that this concept is not meant to be a 'stand-alone' object. It is part of a larger system which is described in Chapter 3: *Ideation & Concept*, which is essential for it to fulfill the envisioned desired human-product interaction.

Separation: Service & Ownership

As stated in the description of the silhouette concept range, this mobility facilitating system demands the separation of the silhouettes into two main components: *a personal frame, based on purchase, and a provided technical core* 44.The use of a separate and cross-model applicable technical core is crucial in order to facilitate a range of different models. Different models will require only the slightest



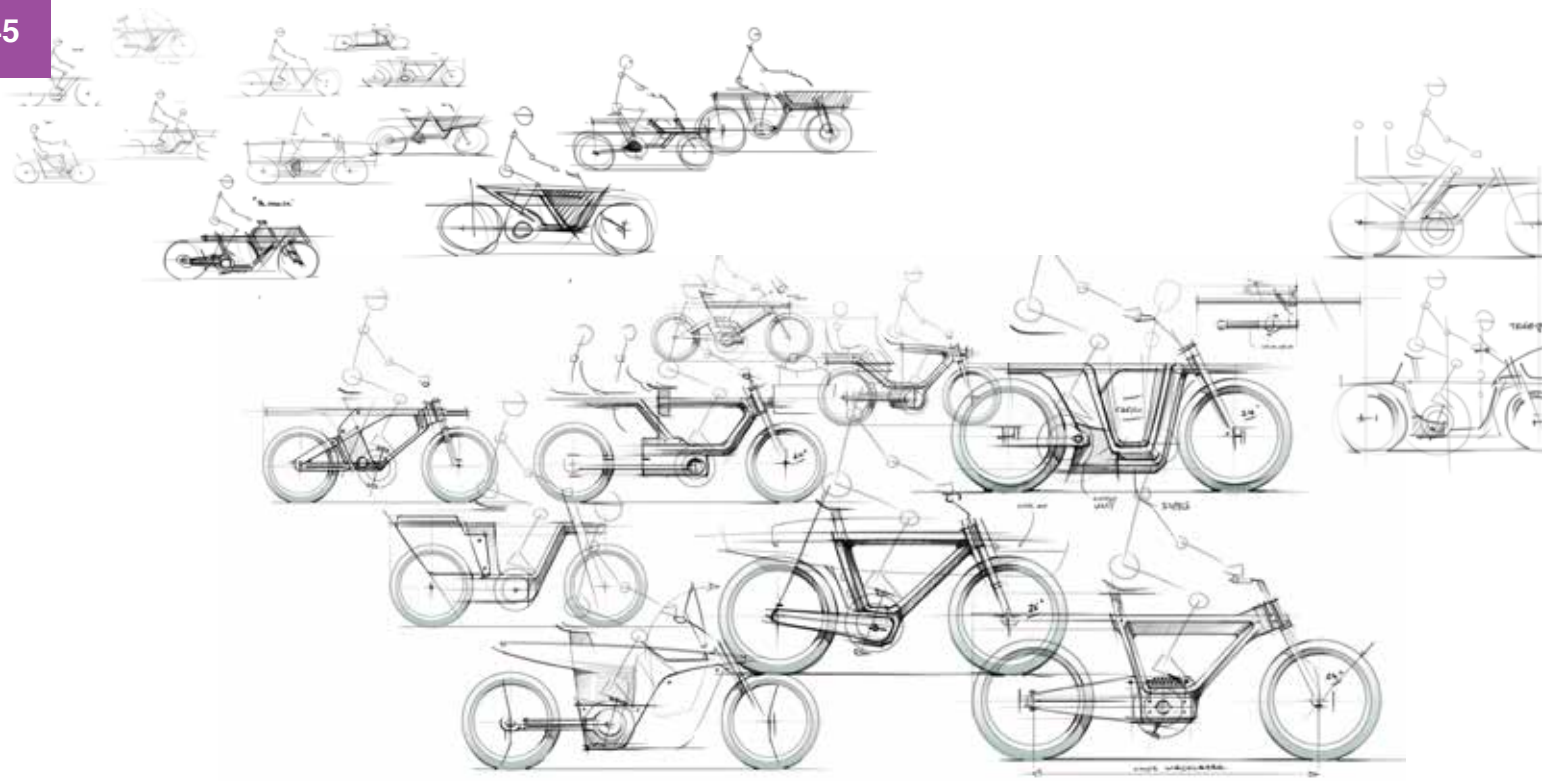
alterations in i.e. drive-train or suspension, thereby enabling easy maintenance. And as the technical core will be provided by VanMoof -thus bearing the responsibility-, easy maintenance is an important aspect.

Thinking, Sketching, Exploring

Up to this point, the selected silhouette has not been defined any further than a sketch with a few lines. At this point in the process it is necessary to dive deeper into the specific shape of the selected silhouette. The most effective method is to explore all different possibilities through sketching, especially side-views 45. The sketch as included in the bird nest metaphor concept is used as a starting point. And more important, the characteristics and key-features as put forth by the nesting-bird metaphor. It could be stated that the aesthetics do not guide, they follow. Thus, the shape will be mostly dictated by the key-features and the characteristics:

Agile yet Stable, Speedy, long range, multi-purpose use of compartments or 1 + 1 seating.

Upon all of these key-features further elaboration is necessary to translate them into physical solutions. This process of designing the physical object involves large amounts of sketches, thoughts and discussion with VanMoof and fellow designers. Especially within the VanMoof design team, discussing concrete sketches and design choices is clearly something about which enthusiasm was vivid.

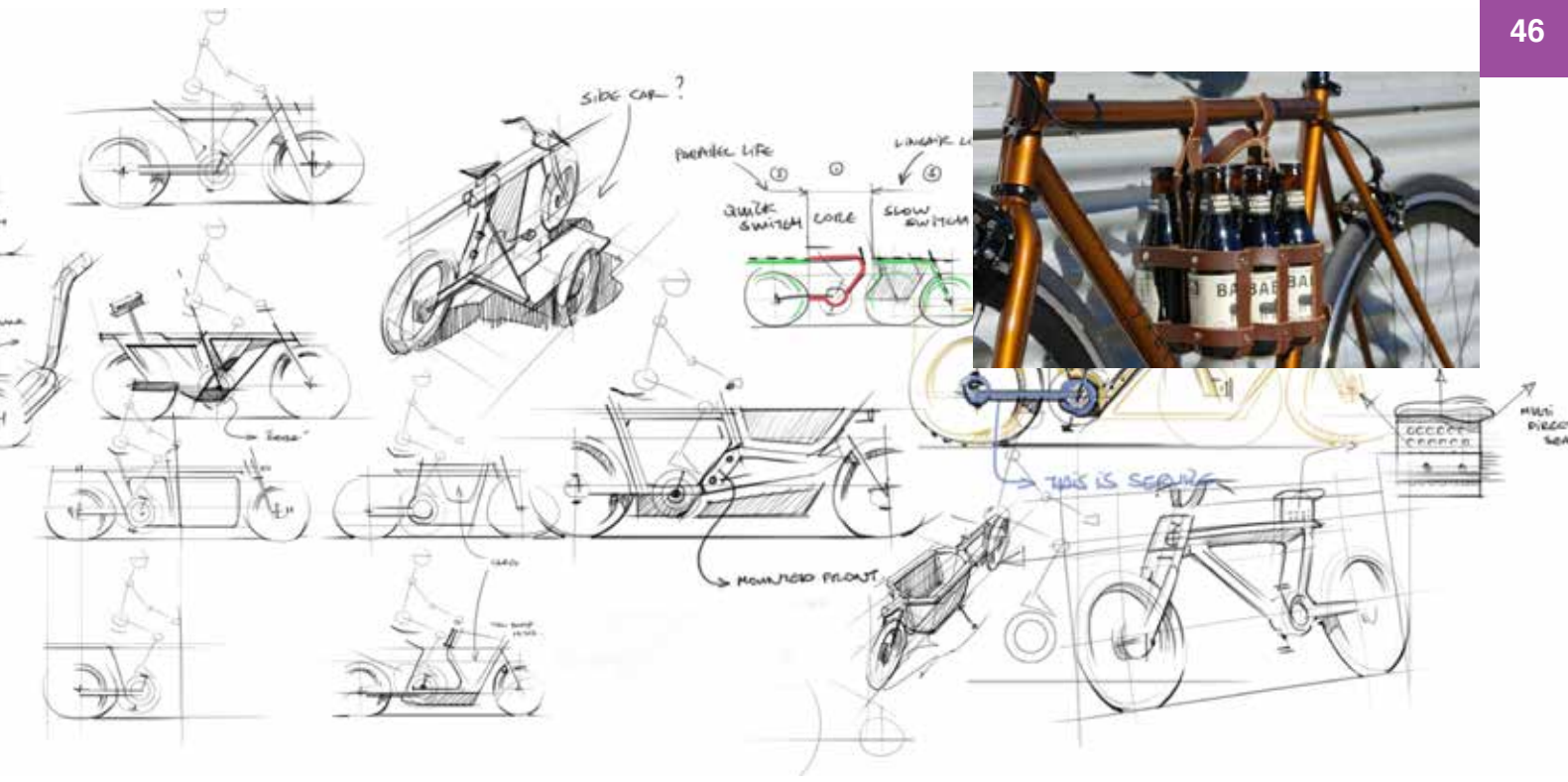


There was a lot of knowledge and know-how shared, accompanied with the repeated wish to have a more approachable shape.

Like the other desired key-features, the multi-purpose use of compartments needs further elaboration. After all, even with the silhouette sketch as inspiration, there could be numerous iterations and variations on its shape and functionality. A selection of sketches made throughout this process of thought are included 46/47/48., as to provide insight in the way of working.

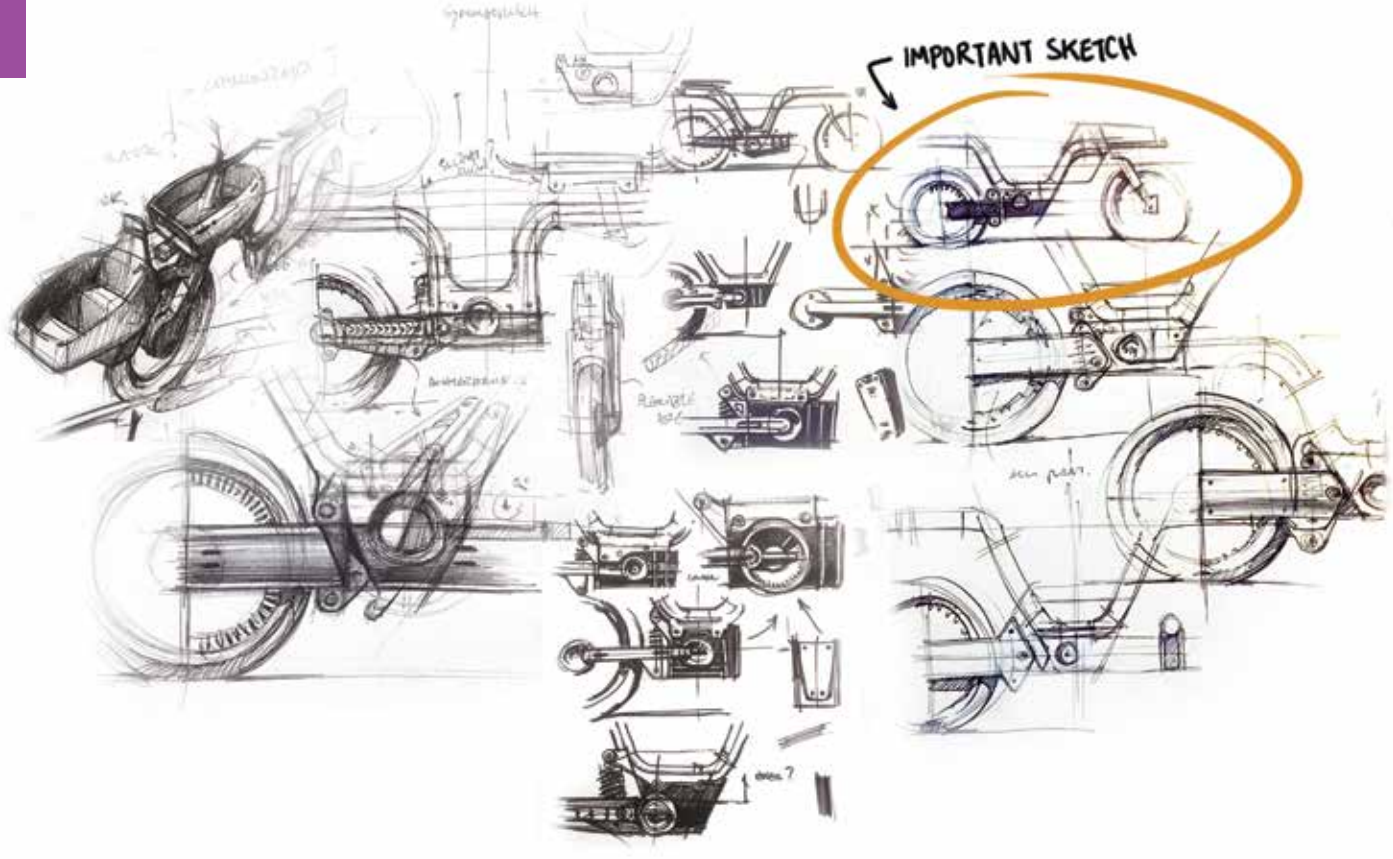
International Focus

At this point in the process, it should be emphasized again that the concept is not merely focused to fulfill its function in the Dutch mobility climate, since the Dutch mobility climate is not representative for most of the worlds infrastructure. It is therefore taken into account that different mobility climates often tend to be more rough, demanding more from i.e. suspension systems. Furthermore, it should not be forgotten that Dutch people are among the tallest on earth (BBC News, 2020). The current S3 model proves to be simple too tall for other nationalities. This too relates to the wish to produce a more approachable model.

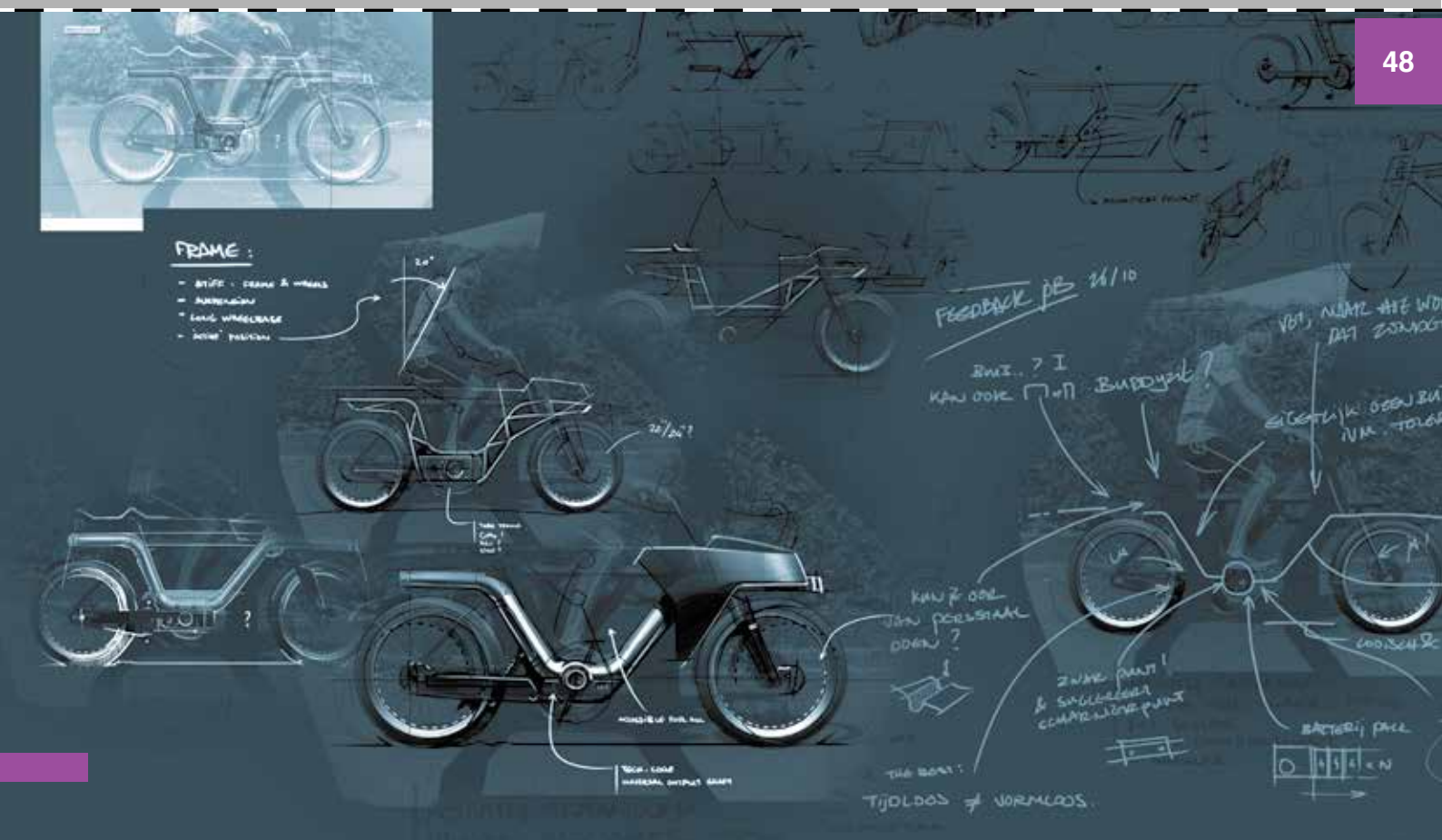


REFERENCE IMAGE

(Page absent in printed copy)



(Page absent in printed copy)



Concept Embodiment

Remember, as put forth by the metaphor in the Chapter describing the Vision on Interaction, the characteristics were defined as follows: *Personally Orientating, Flexible, Adaptable, Competent, Inspiring and Approachable.* Most of these characteristics have led especially to the founding of the service as described in Chapter 3: *Ideation & Concept*. However, when it comes to the design of the selected 'a place to breed'-icon silhouette, there are still these characteristics to be taken into account on a product-level design process, combined with the key-features derived from the metaphor: *Agile yet Stable, Speedy, long range, multi-purpose use of compartments or 1 + 1 seating.*

Consequently, a number of embodiment choices have been made along the way, each with its own reasons. The Concept design has been frozen at this stage so further steps can be taken 49. Here, the most important choices are explained from large to small.

Symmetrical Frame & Compartments

50.

The Multi-purpose use of compartments, together with the characteristics *Flexible and Adaptable* results in the design of a frame which is symmetrical. This allows the desired compartments to be used both on the front and the rear of the frame, resulting in optimal flexibility in use. Cargo compartments extend over a greater distance over the frame, passing the head tube or seat post. In this

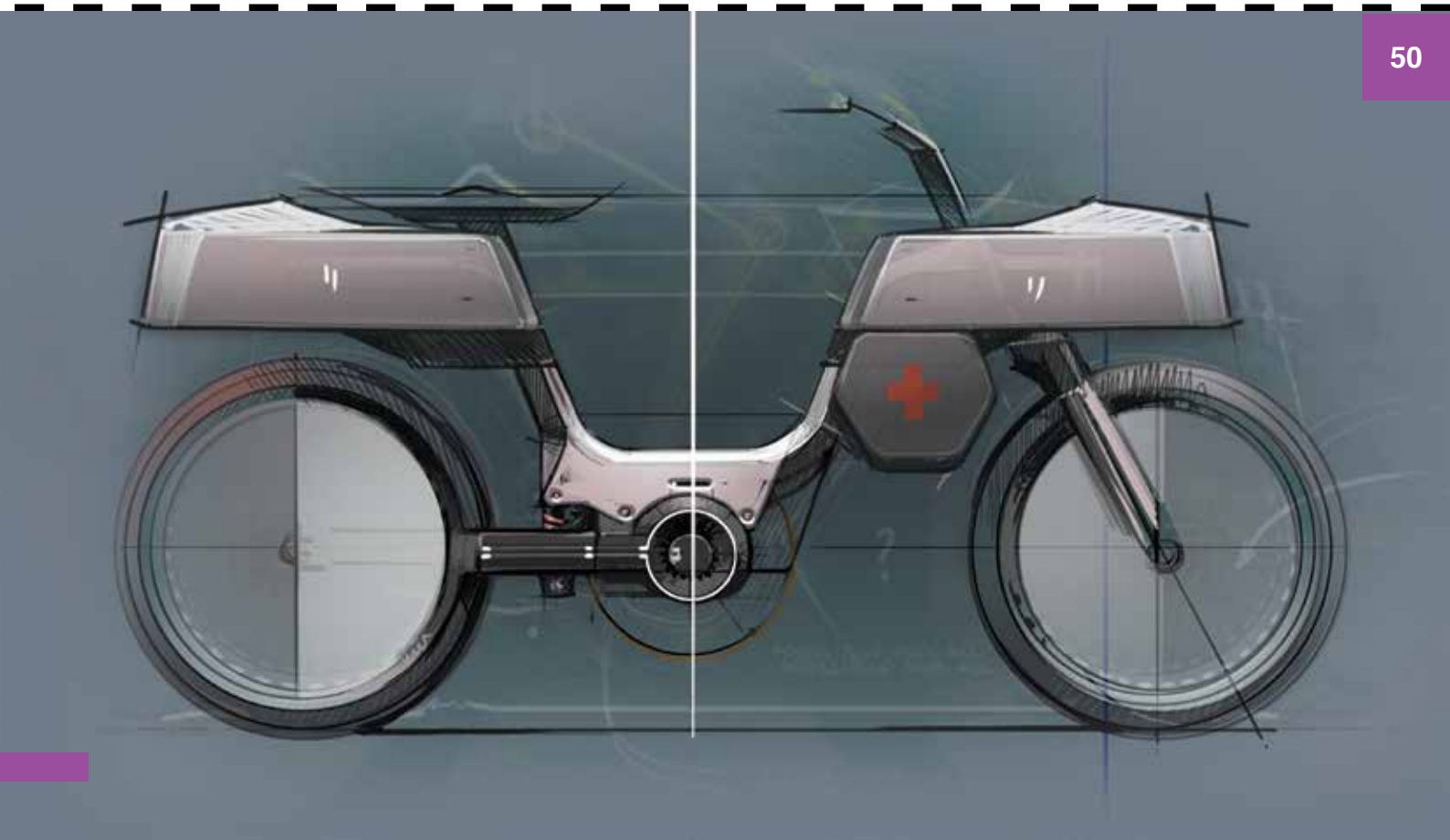
way, the footprint of the concept remains small while making optimal use of available space. Although it might seem that this would obstruct the legs during cycling, this is not the case 51.

Entrance

No longer will VanMoof implement the straight top-tube in their bicycle frames. In order to achieve optimal approachability in a literal sense, this choice for an 'inclusive' frame is made. By doing so, the bicycle is approachable for young and old, female or male or in-between. This removal of the continuous top tube also adds to the *Agile yet Stable* feature since getting on and off the bike when loaded does not require one's leg to be thrown over the frame.

Seating Position

For the concept the choice is made to put the rider in an active seating position. 20 degrees forward (trunk angle) is considered an active seating position: This active seating position adds to the key-feature of Agility inherent to this icon silhouette. In order to adapt to different body shapes and sizes, the seat should be able to move up and down, as well as back and forth. In this way a most optimal seating position can be found. This is essential for comfort and to avoid aching muscles after longer of frequent use (PhysioPedia, 2020).

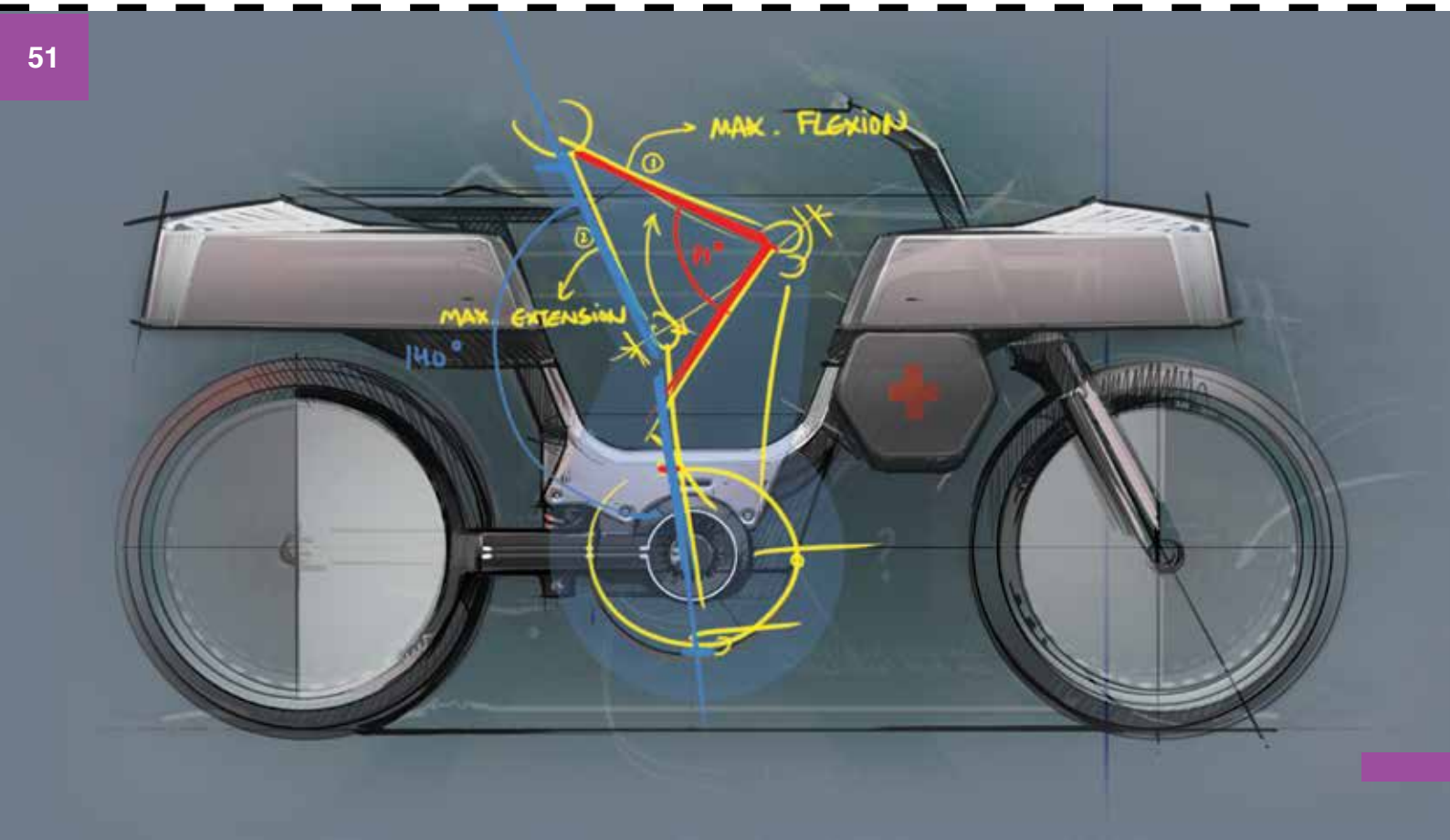


Wheelbase and Wheel Diameter

Also adding to the *Agile yet Stable* feature are the 24“ wheels 52. Agility is increased due to the maneuverability of a smaller wheel, Stability is maintained due to the long (1300 mm) wheelbase. Plus, this slightly smaller wheel diameter allows the frame ‘entrance’ to be lower without the abysmal looks of a bicycle for the elderly. Also resulting in a more approachable design for people of different sizes. Furthermore, smaller wheels are structurally stronger and are more resistant to impact when compared to a 28” rims (Shaddy, W. 2020) , thus contributing to proper functionality in environments less suitable for cycling. Also, the use of a smaller wheel diameter allows the cargo compartments to be positioned lower on the bicycle, which is beneficial for balance and handling (Heine, J. 2009)

Suspension

This finds its reason of being in suitability for non-cycling-friendly environments at higher speeds. While the key-features demand the concept to be quick and speedy, suspension enhances a more tranquil ride with greater control. After all: ‘Bumpy terrain increases jarring and compression to the spine, which can lead to back pain’ (PhysioPedia, 2020) It could be argued that the desired ‘active riding position’ contradicts the choice to include a suspension system, However, this silhouette involves place for attributes, thus weight. Weight bouncing up and down without being sprung or damped causes severe disadvantages when it



comes to vehicle dynamics. The characteristics '*competent*' and '*flexible*' would require proper vehicle handling, thus emphasizing the need for suspension.

The Technical Core

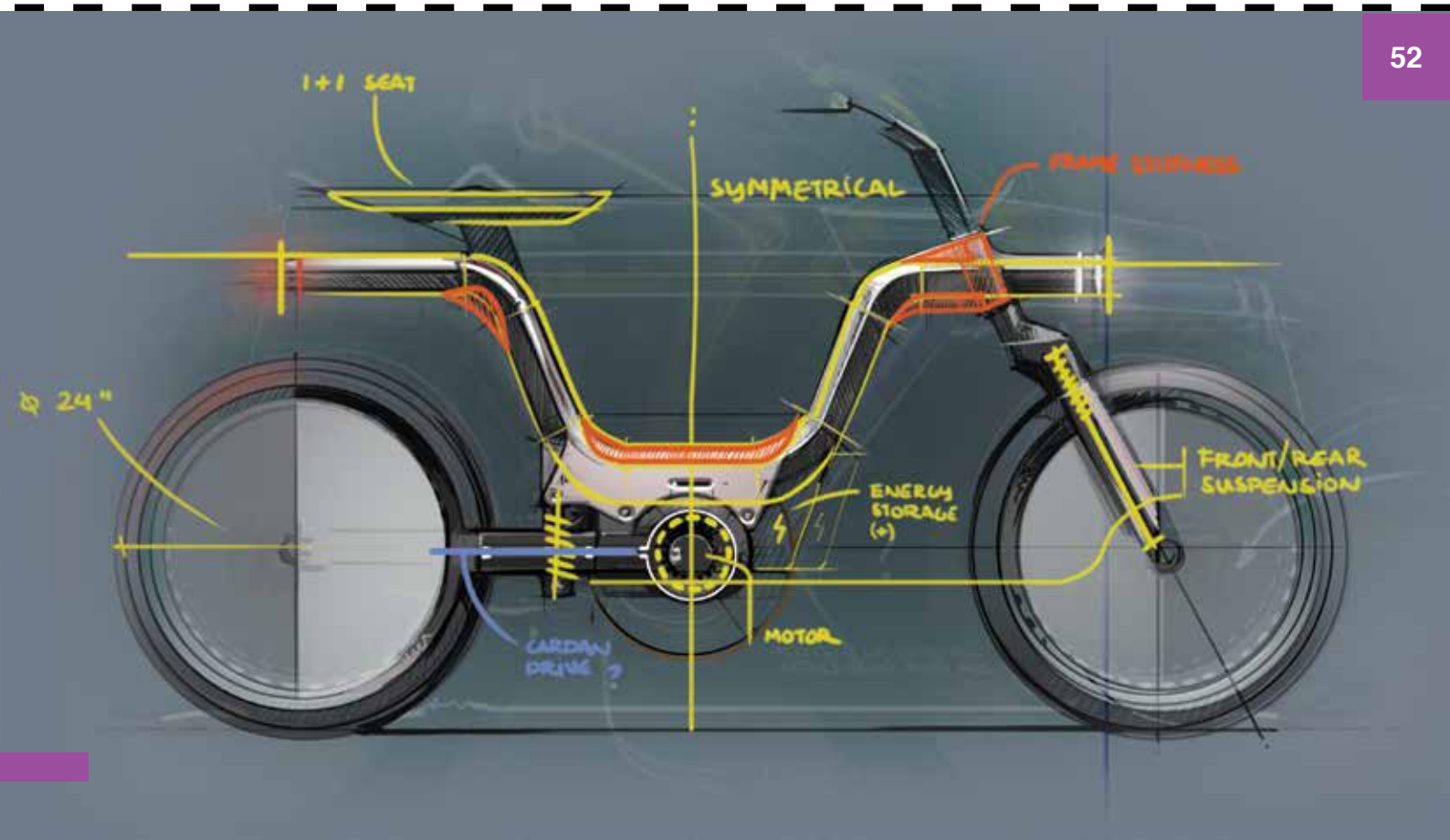
It is considered essential to have a solid, idiot-proof, technical core that can be removed and maintained easily. In order to achieve this, a number of technical choices are made and motivated as follows.

Drive Train

For optimal weight distribution and maintenance concerns the engine should be located at the crank. Since the engine usually is a heavy component placing it in the lower middle improves handling. The power should be translated to the rear wheel making use of a step-less transmission combined with a cardan drive. Seamless peddling is preferable. The transmission unit should be integrated in the technical core itself instead of being located in the rear hub. In this way, the wheel is kept most simple, and the unsprung weight will be decreased.

Cardan

Although a cardan drive has some minor disadvantages such as slightly higher loss of energy, higher weight and complexity, a cardan drive-shaft requires very little maintenance and is easily adjusted in length when necessary to implement the technical core into a different frame silhouette (Sutton, M. 2017). The cardan



drive-shaft also proves to be a cleaner solution when compared to a chain or belt, since the system is closed.

Fun fact: Some say that bike riders used to wear only black shirts because of the dirty oil and grease on the chain. And that the motor-scooters and other 'enclosed' drive train systems result in drivers wearing lighter and neater outfits..

REFERENCE IMAGE

Energy storage

As this concept should have the key-feature of agility and adaptability the battery capacity should be adjustable by adding or removing series of cells. Not only does this provide flexibility in action radius, it also allows the phenomenon of charging separate cells to be approached differently. That however, would entail a whole new project.

(Page absent in printed copy)

Durability

Now it might seem that this technical core will become an object far too complex. However, it should be remembered that this technical core should be designed to withstand a long lifespan, serving a number of different mobility silhouettes. Not having to redesign a new technical core every two years means that a larger investment can be made to build a technical core strong enough to last longer. Also, it is beneficial as VanMoof is taking the risk for failure as a result of bad designed core to propel the service.

(Page absent in printed copy)

Concept Styling

Having clarified and fixed the technical and functional choices, the aesthetic choices follow. As the concept is designed for 2030 it is desired to 'visually' move into the future as well. It is undesirable should it appear to be the next model to be introduced. Instead, it should evoke surprise and discussion. Therefore, it is a conscious decision to preserve only a number of Vanmoof details while taking the freedom to come up with a fresh and surprising styling. Although the technical core and the frame are separate entities, the combination is crucial to form an integrated aesthetics when looking at the concept in its entirety.

Notable in the concept's styling is the long wheelbase of 1300 mm combined with a relatively small wheel diameter. This makes the concept look like a rather long object. However, it is only slightly longer than the average 28 inch bicycle so common today 53. This unusual shape is considered a unique and surprising styling feature that finds it's origin in the importance of optimal space for cargo and attributes.

It could be argued that the continuous top frame tube with integrated lighting units is most notable in the VanMoof styling as it has occurred over the past ten years. Although this continuous top frame tube is physically no longer present in the concept design, the visual continuity is maintained 54. Also maintained

will be the integrated lighting units. The lighting units will be extended with a ring near the end of the frame tube, allowing the rider to be perceived more clearly from the side.

The aluminum frame, sanded with a fine grain, has a hexagonal profile. Due to this profile a sharp leitmotiv along the frame is created. This emphasizes the light and fresh top part of the concept, contrasting to the darker lower part housing the technical components. Thus, the sharp edge emphasizes the line between ownership and service.

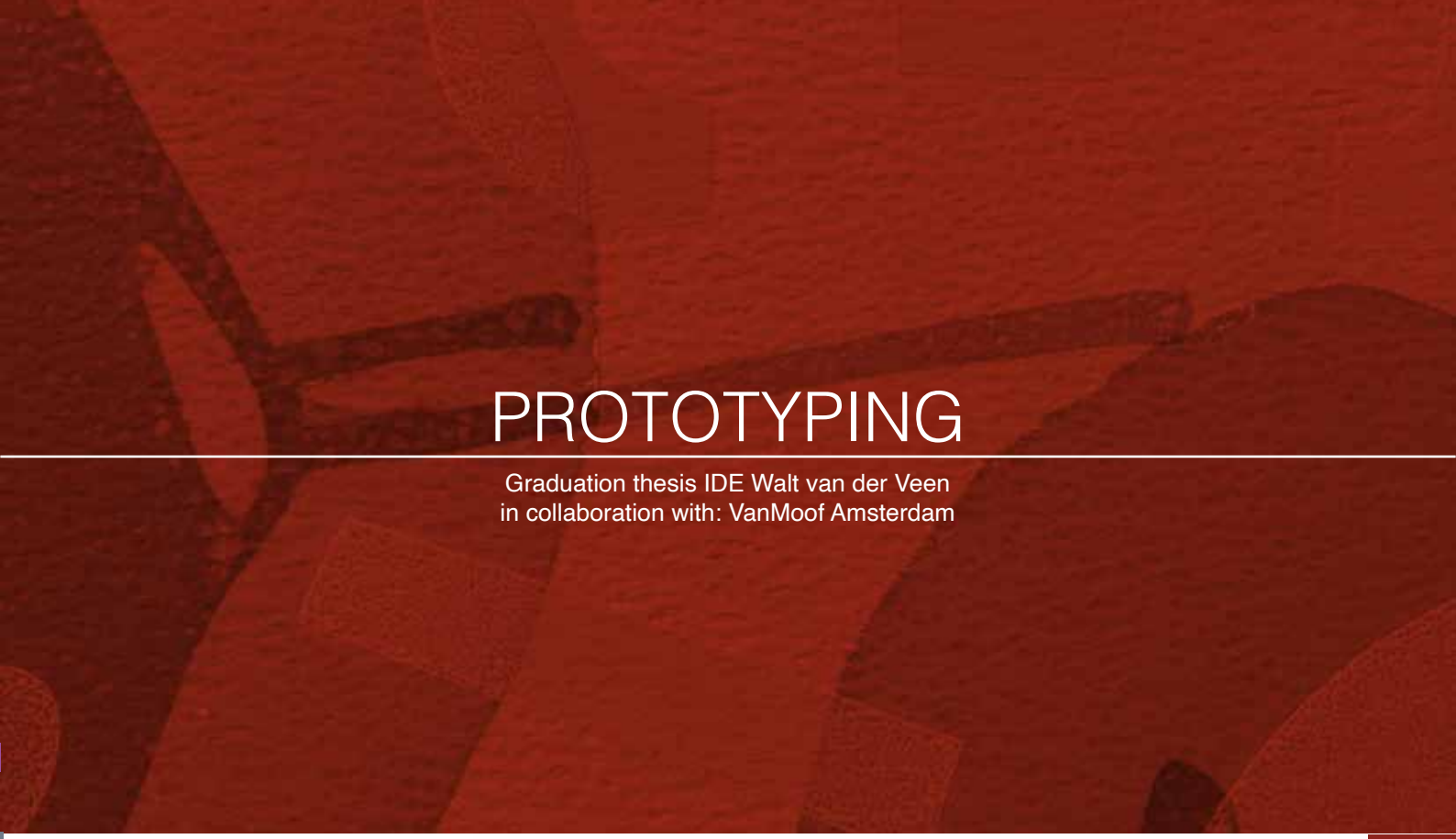
This lower technical core is housed by a simple design on each side, this to decrease the perceived technical sophistication. This is considered to be important as it is the goal to have people trust the mobility concept to be durable and lasting for a longer term. The circular white circle relates to the peddling motion and the location of the engine.

The front and rear cargo compartments are identical and fit onto the symmetrical frame. And where a cargo compartment is installed, a wheel hubcap can be installed to avoid objects from being trapped in the spoked wheel.

Towards Prototyping

The Concept has been frozen after being presented to Vanmoof 55. By doing so it became clear that they are enthusiastic about the final concept. At this time it was also put forward that it would be interesting to build a full scale functional model. As mentioned earlier, for a number of reason it is considered useful to fabricate a prototype. These will be explained in the next Chapter which describes in further detail the goal and process of building a prototype.

REFERENCE IMAGE 55



PROTOTYPING

Graduation thesis IDE Walt van der Veen
in collaboration with: VanMoof Amsterdam

Table of Contents

56.

56

REFERENCE IMAGE

56

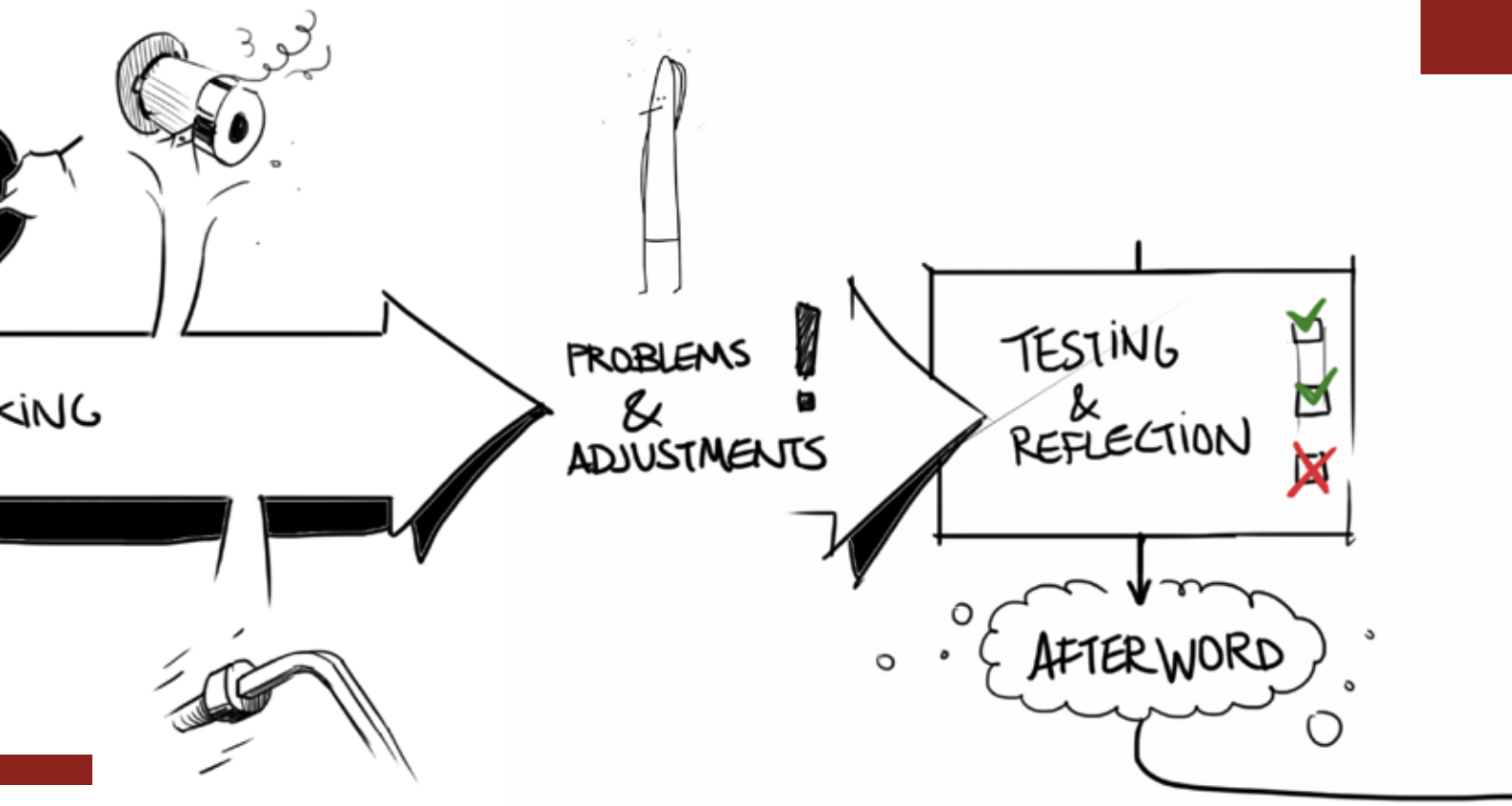
Table of Contents
56.
Importance of Making 85
Prototype Goal 87
Process of Making 88
Ultimate Problems and Adjustments 132
Testing & Reflection 144
Afterword 152
References 155

Importance of Making

As was the goal from the very beginning of this graduation thesis, the building of a prototype is to be included. The choice to deliver a physical prototype finds its motivation in three different aspects. The concept has a shape which is quite novice and uncommon. In order to fully test and experience the human-product interaction as put forth in the vision, which has been of great importance all along the process, a physical prototype is considered essential.

Furthermore, a physical prototype is considered highly valuable for means of presentation and conveying the concept idea as best as possible. While for a trained designer an idea can be imagined, for many this is not at all easy. Therefore, a physical representation of an object that itself represents a greater idea is highly useful to clarify the story and to depict the goal towards a new course can be set out. Especially for those who are not designers or in possession of the quality to imagine visually. At the same time, it should be realized that the effectiveness of a physical prototype can lead to misconception of the use of a prototype: to function as a communication tool and a starting point for further development and inspiration. The prototype should therefore not be interpreted as a final design.

And on a personal level, for the sake of learning more from the actual process of building and material knowledge and processing skills. It is becoming increasingly



uncommon for designers to have the ability to have both knowledge of conceptual design stages as well as the concrete knowledge inherent to physical shaping of materials and methods of production, while this combination contributes greatly to making quality design. As the graduation thesis allows one to define the learning objectives and goals, this is one of the most important learning goals I planned to deepen throughout this project.

And also very important:

The vision developed earlier during this project clarifies how the desired product effects take shape in a solution that guarantees a long term mobility fulfillment. This solution is based on a partial service facilitated by VanMoof, which consequently means that VanMoof will have to stand for the quality of their product for a long term. A prototype clarifies better than anything else the points at which further iteration and development is necessary. This first prototype as developed during the graduation thesis sets out the foundation for further development crucial to ultimately reach the best design possible and necessary to fulfill the long term goal as put forth in the vision.

The challenge lies in managing the planning, as the production of a number of parts will take a delivery time ranging from 1 to 3 weeks. Furthermore, the current situation and lock-down measures following the Covid-19 pandemic continuously forces the planning to be adjusted and re-planned.

Prototype Goal

The goal of making the first prototype lies in communication and presentation. The plan is to translate the concept design in a full-scale functional model. The prototype will be as close as possible to the original concept design as presented in Chapter 4: *Concept Detailing*. So that, if one would make a sci-fi movie about 2030, it would fit in nicely. In order to actually make the concept functional, it is chosen to base it on a selection of components currently embedded in the X3 model 57/58., which shares most similarities to the concept design when it comes to dimensions.

Process of Making

The search for the concept has taken slightly more time than initially planned. Therefore it is highly essential to properly plan out the process of building the prototype. As it was decided at the concept presentation and discussion, the goal is to build a full-scale functional model of one selected icon silhouette from the conceptual icon silhouette range. The following description of the manufacturing of the prototype consists of a number of chapters describing the shaping of essential components. In reality, the process involves countless small parts crucial for fittings, hinges etc. In an effort to present this story as logical as possible, these most significant steps are briefly described in chronological order.

Please note that during the real process of building the prototype numerous iterations and jumping between different steps took place. The following steps in the process will be described:

Orientate Feasibility of Aluminum Welding:

This is considered a crucial component of the early prototyping process, as the selected material will be aluminum. Aside updating the written graduation report continuously, some time will be used to learn the basics of aluminum welding to evaluate the feasibility of using the technique 59. If I would be able, which I think is possible, to learn the basics of Aluminum welding through building a prototype bicycle, then I dare to say I acquired

REFERENCE IMAGE 59/60/61

a significant amount of knowledge and skills during the graduation project. By doing so, I force myself to learn more about the material and the very difficult process of welding the material using TIG-welding techniques. To me, as an experienced MIG-welder, this would be the ultimate challenge.

In order to know whether the plan to build a prototype out of Aluminum is at all plausible, the most uncertain factor must be scrutinized beforehand. In this case: the welding of Aluminum using the TIG-welding technique. While the concept design is reaching its last stages, a start is made with learning the technique at the PMB (prototype lab). Here, a number of very skillful employees are ready to provide the necessary knowledge and feedback to optimize the learning curve 60. Welding Aluminum proves to be very difficult, but not impossible. Looking at the progress made, it is considered an achievable result to weld the frame together 61.
This then formed the starting point to model the frame parts in CAD.

CAD-Modeling of Frame,

In order to make a full-scale model of the frame design, it has to be modeled in CAD software. The model will then be, as decided together with the product design team at VanMoof, sent off to be CNC-milled and delivered in pieces to be welded together. Some of the model dimensions are based on the CAD-model of the current X3 model, as a number of components


60

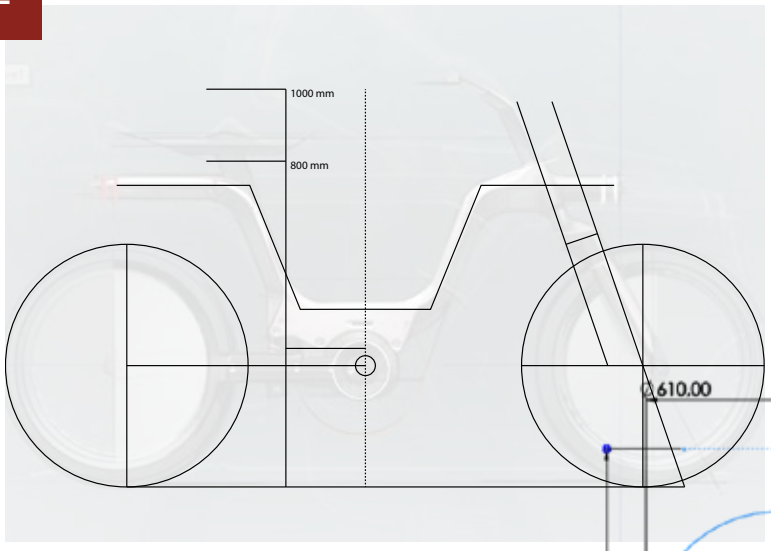

61

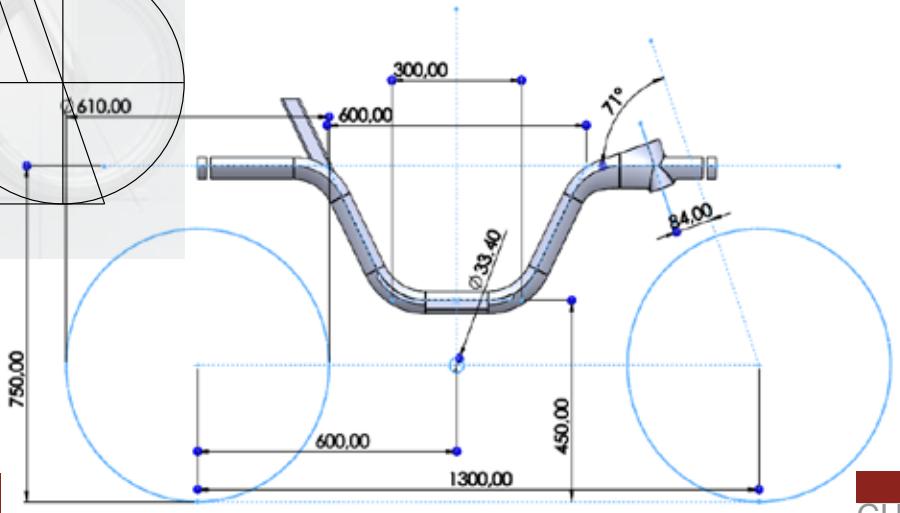
of the X3 bicycle will be used as donor parts to save time. The average delivery time for parts to be CNC-milled by the trusted supplier of VanMoof is three weeks. Therefore it is crucial to send the models as soon as possible.

The first objective, as mentioned in the build-plan, is to finalize the CAD-model of the frame. As clarified by the VanMoof team of designers it would be the ultimate goal to actually produce the frame. This would mean sending off CAD-models to CNC-milling suppliers, and having to wait until the parts are finished and delivered. Therefore, this CAD-model should be finished as soon as possible to be able to send it off for estimated costs and delivery time.

Furthermore, a concrete CAD-model provides a clear set of dimensions that will be used for constructing the other parts. By doing so, the prototype can be fit together without (too many) problems when the separate parts are finished. Based on essential dimensions of the X3 24 inch model, the original concept sketch is translated into a simple line sketch which can be transported to Solidworks 62. The essential dimensions are considered: Wheel size, rake angle and trail (crucial for proper handling), possible positions of the saddle and the central location of the crankshaft 63.

62





63

Material Selection

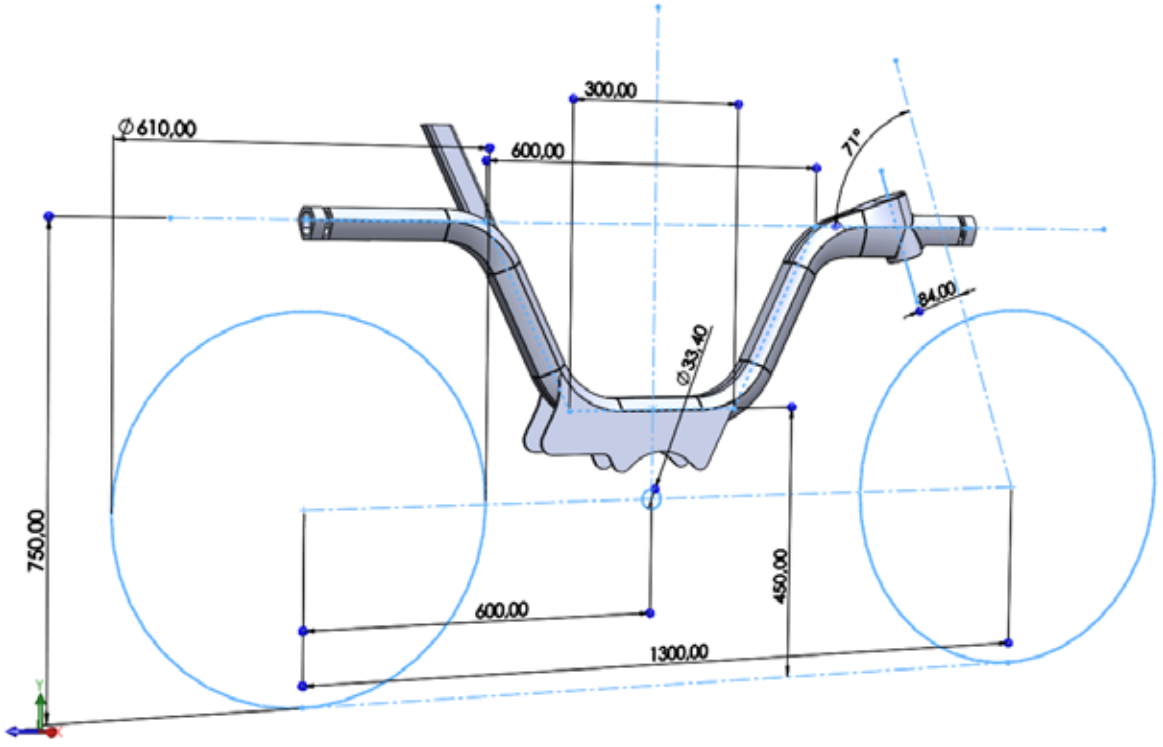
The selected material for the frame is the 6061 Alloy Aluminum. The selection for this material is made because of its mechanical properties in relation to strength and machining and welding. As 6061 Alloy performs well with respect to these aspects, it is commonly used for constructions and frame-like applications. It weight is 2,7 g/cm3, making it equal in weight to the weaker 1060 Alloy (ASM, n.d). Although the criteria for making a prototype do not necessarily involve a weight limit, it is preferred that it can still be transported.

Is it a Puzzle?

No! It is a frame. In order to actually produce the concept frame, parts have to be CNC-Milled out of 6061 Alloy. As it would be impossible to produce the frame in one piece, it has been divided in multiple pieces that fit together like a puzzle 64. After the parts are delivered, the frame has to be welded together. As to facilitate easier fitting of the parts, each fitting can be positioned into the next and welded together without the use of a frame building jig 65. It fits together like a puzzle.

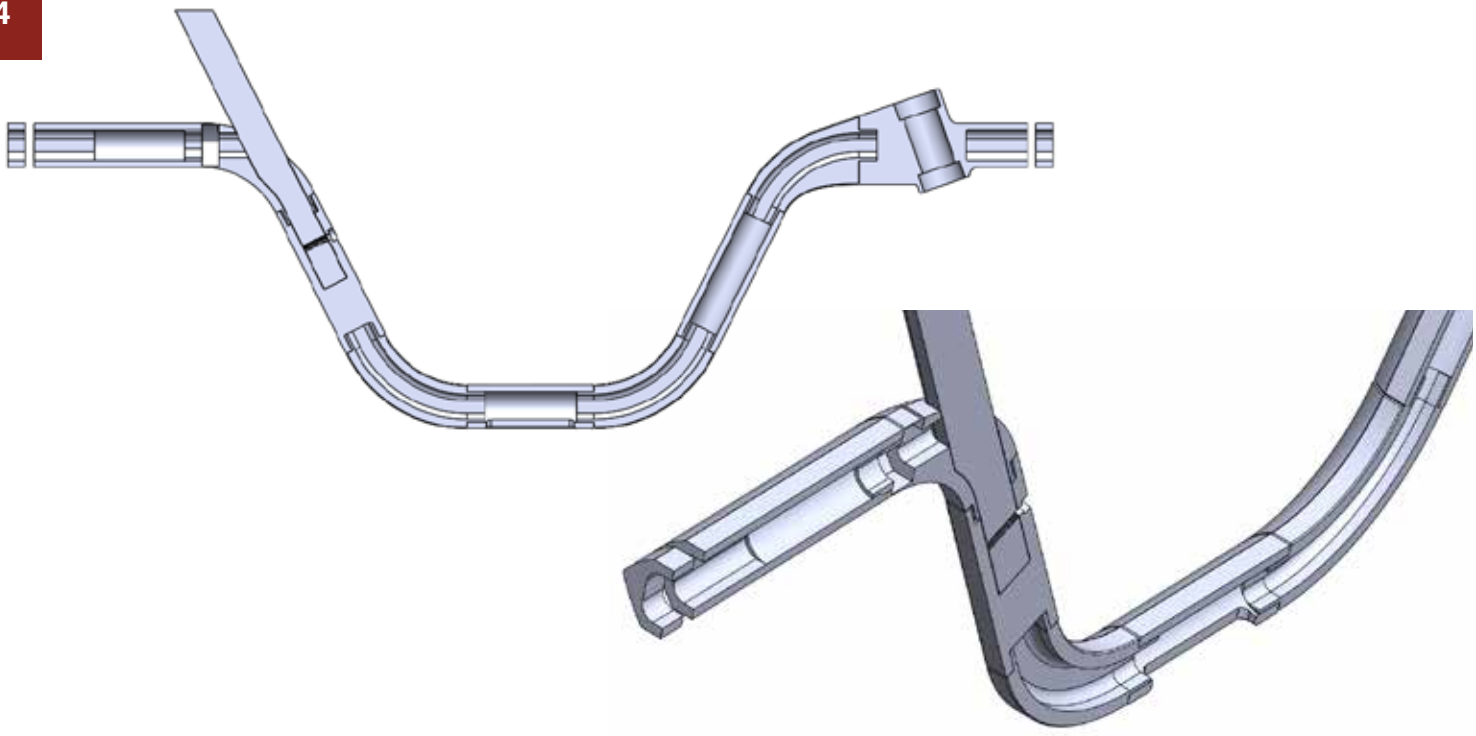
TIG-Welding the Frame

After the delivery of the separate frame parts 66. the process of welding together the parts began 67. At this point in the process, my acquired experience with aluminum welding gave me the confidence to face the task

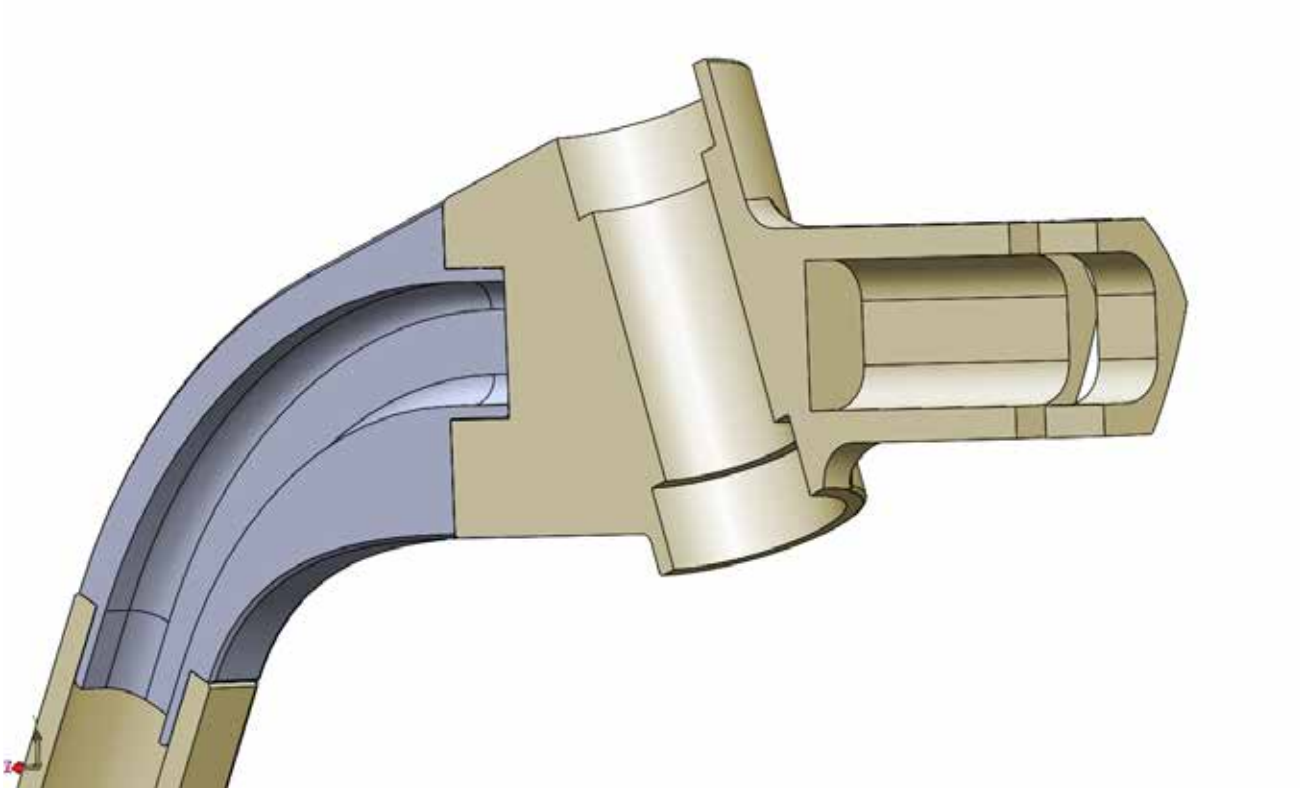


REFERENCE IMAGE

(Page absent in printed copy)

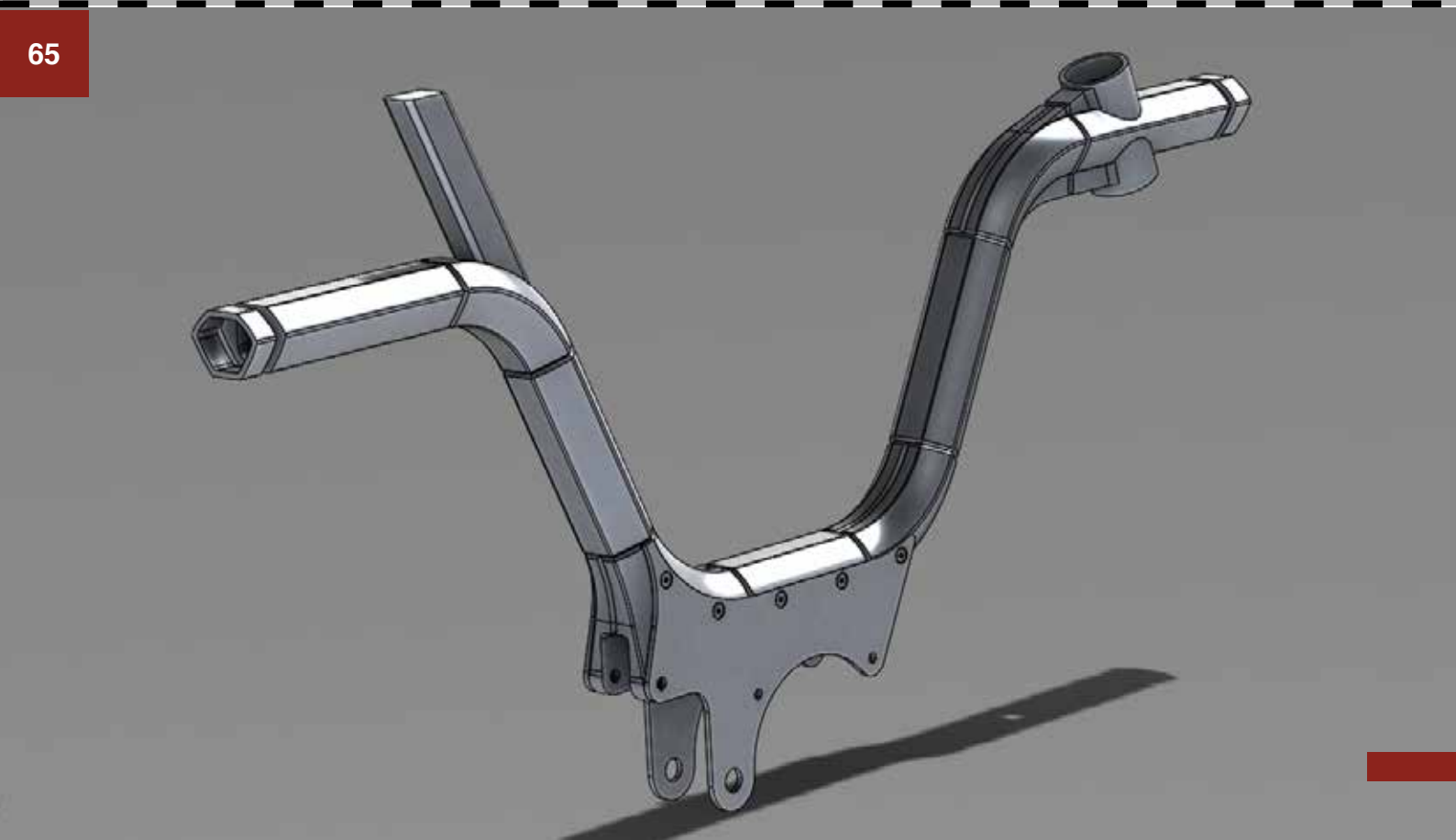


(Page absent in printed copy)

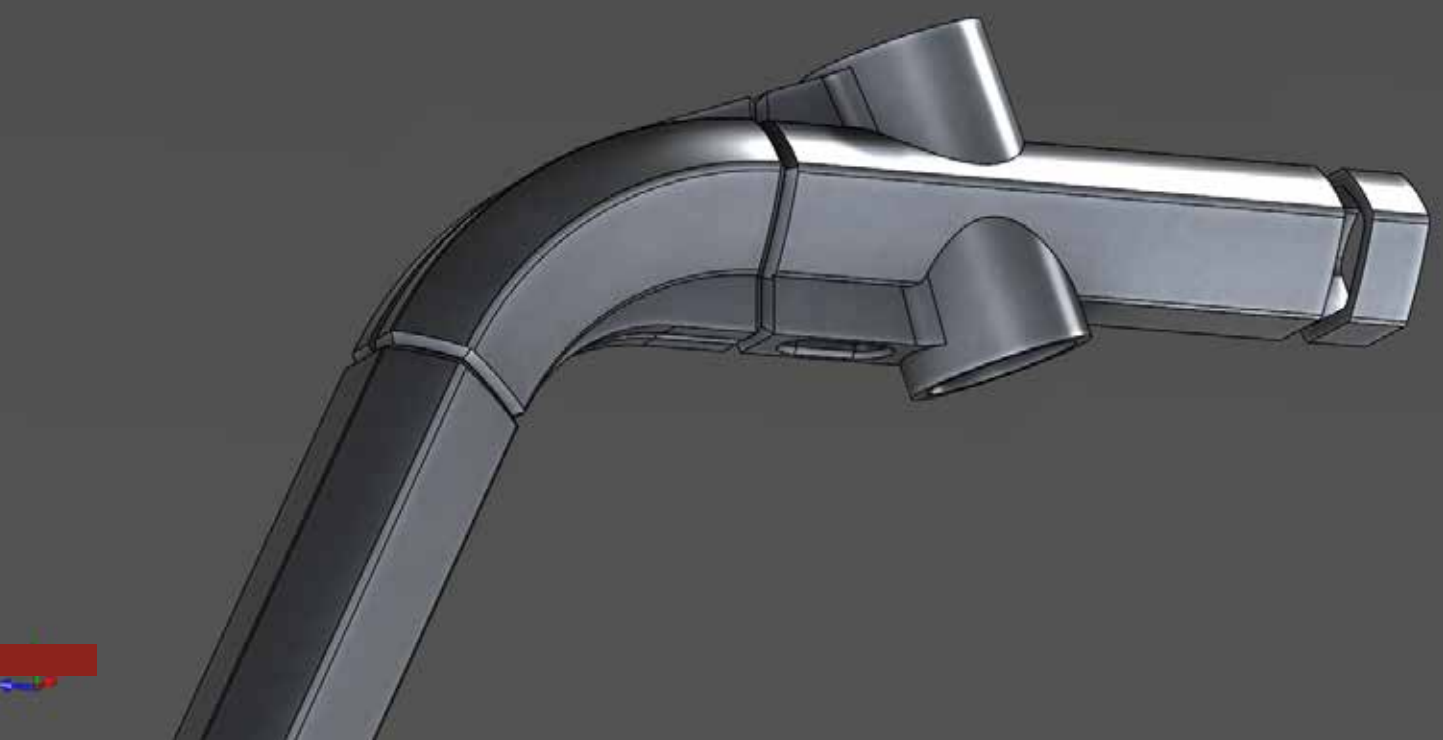


REFERENCE IMAGE

(Page absent in printed copy)



(Page absent in printed copy)



REFERENCE IMAGE

(Page absent in printed copy)

(Page absent in printed copy)

of risking quite some serious investment. As the parts were CNC-milled out of solid aluminum, there was quite some material to be heated before welding. As aluminum is highly conductive, most heat added with welding would escape into the colder areas of the material, counteracting the ability to melt a proper pond to start joining the parts. This preheating was done through using a gas torch and patience 68. When heated to the right temperature, welding could begin 69. This method was used to weld together the entire frame 70.

CAD-Modeling of Other Components

Also to be modeled for production or size references are the mounts for the technical core, the rear swing arm, the side covers, the transparent lighting housing. A number of these parts are significantly smaller and can therefore be produced at the PMB workshop at the faculty of IDE in Delft or at the 3DMZ workshop in Haarlem, where they have the possibility to print larger scale objects as well as a broad range of other ADM techniques such as transparent SLA printing, which will be needed to print transparent lighting units with high quality surface finish 71.

Disassemble X3 for Components:

While the frame was being CNC-milled, the rest of the prototype can be build in-house. In

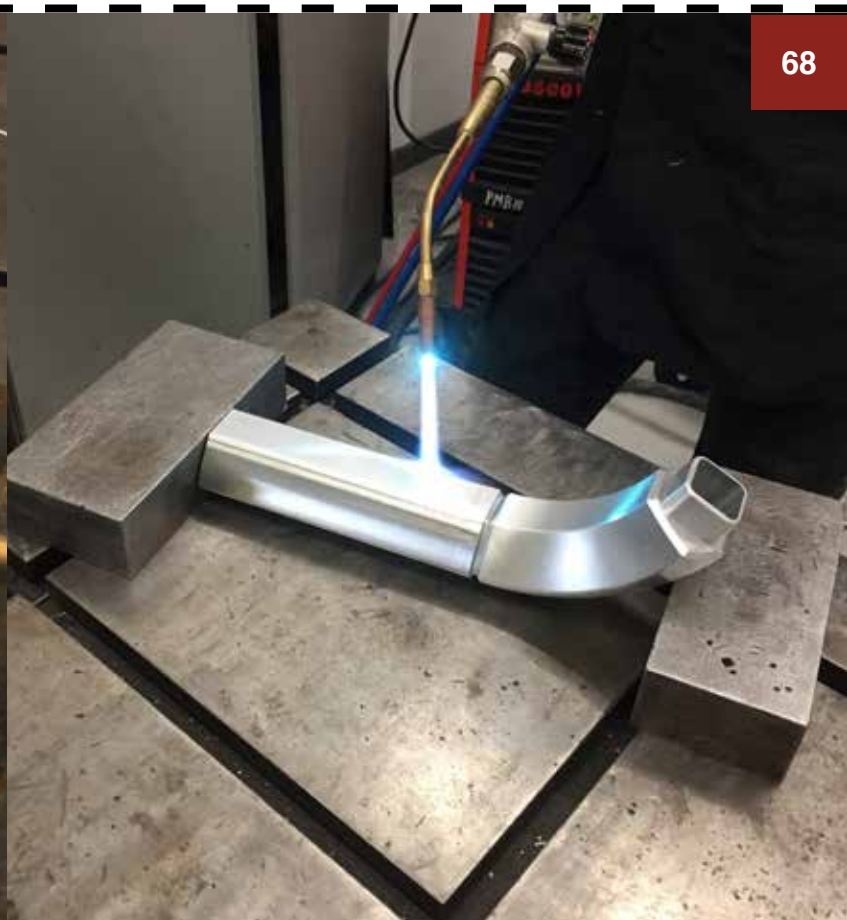
order to save time in the process of prototyping, all parts that can be possibly used of the current X3 model will be disassembled. As the concept bicycle shares a number of technical similarities to the X3. The components will be taken out of a donor bike.

Taken out of the X3 will be the crucial set of components to make an actual rolling prototype. This means: the front wheel with hub motor, the cardridge with the motor control unit, the battery, the crankshaft with RPM-sensor 72. Furthermore a set of components have been adjusted and/or rebuild in order to make the prototype fully functional, such as: the steer and rear dropouts for the rear wheel and shifting and lock mechanism.

Rearrange Technical setup

The disassembled parts of the X3 will be rearranged to fit inside the technical core prototype 73., which will eventually be assembled onto the frame as an external unit.

In order to locate the electrical components in the correct place, and to test whether these components can be connected with the existing wiring harness, a wooden approach of the frame is constructed 74/75 The wheelbase of 1300 mm is fixed with rigid long steel beams, and a wooden frame constructed. This clarifies how the length of the cables should be adjusted or not. Furthermore, it can be tested whether the cardridge and battery pack would fit together with the crank between the two



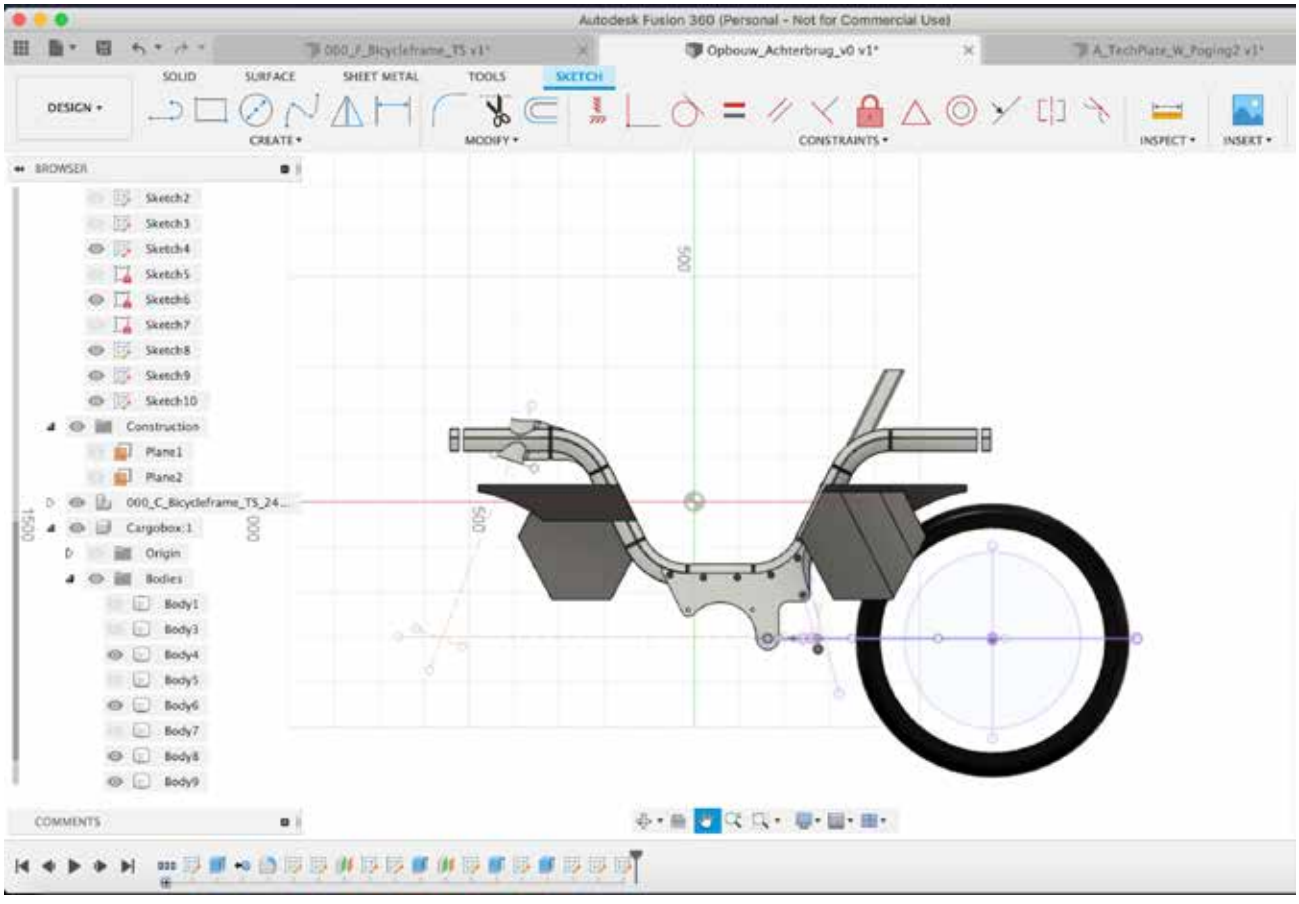
REFERENCE IMAGE

(Page absent in printed copy)

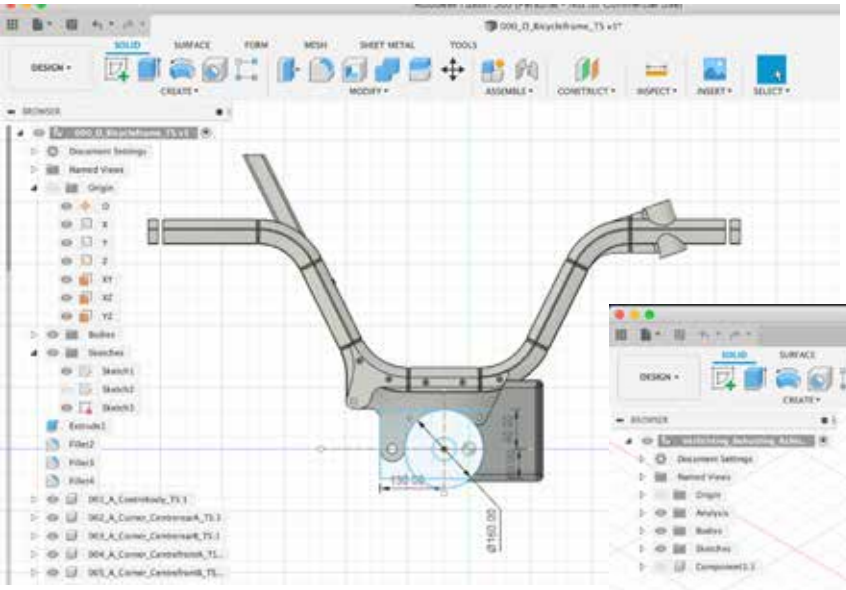
(Page absent in printed copy)

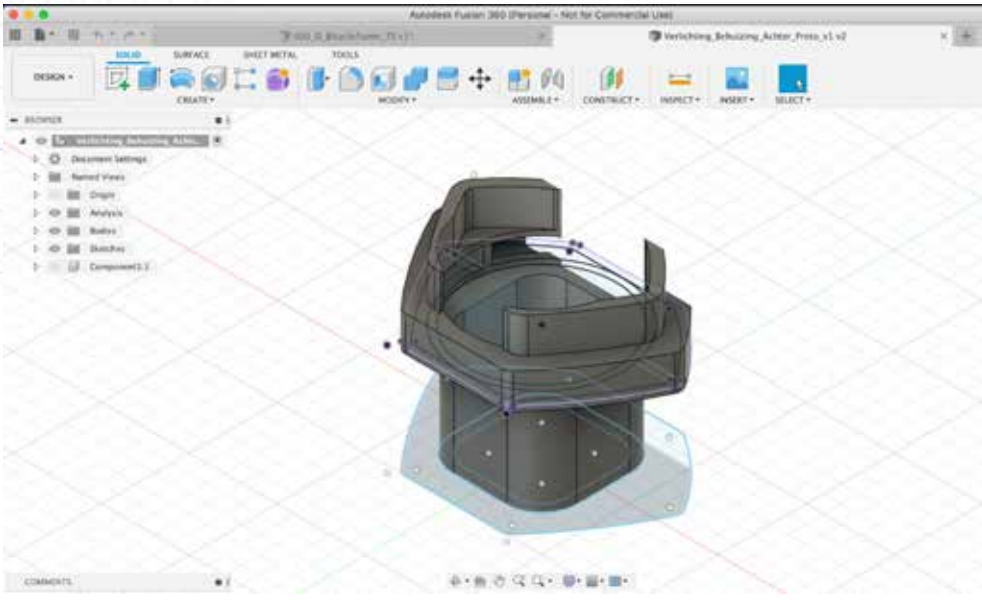
REFERENCE IMAGE

(Page absent in printed copy)



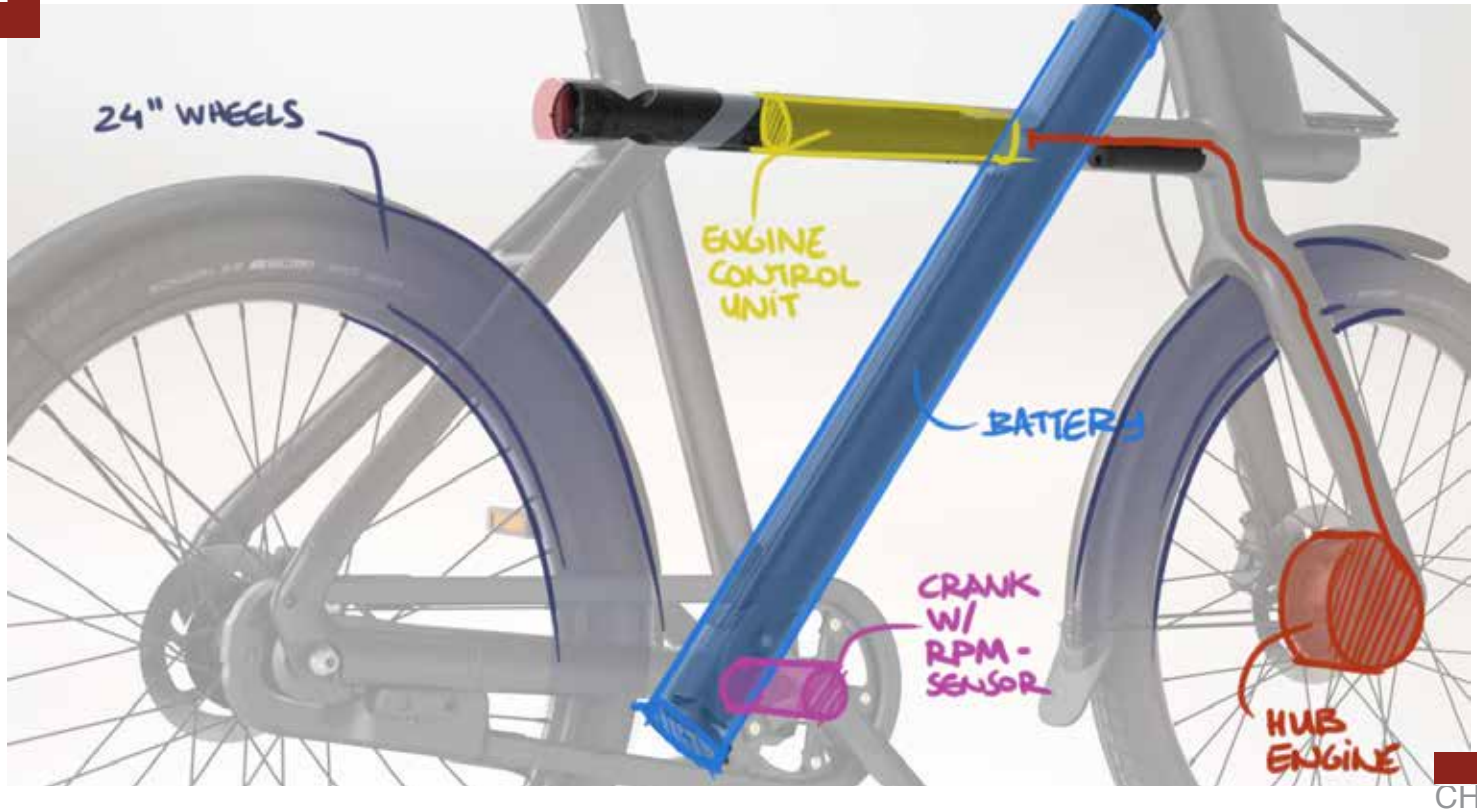
(Page absent in printed copy)



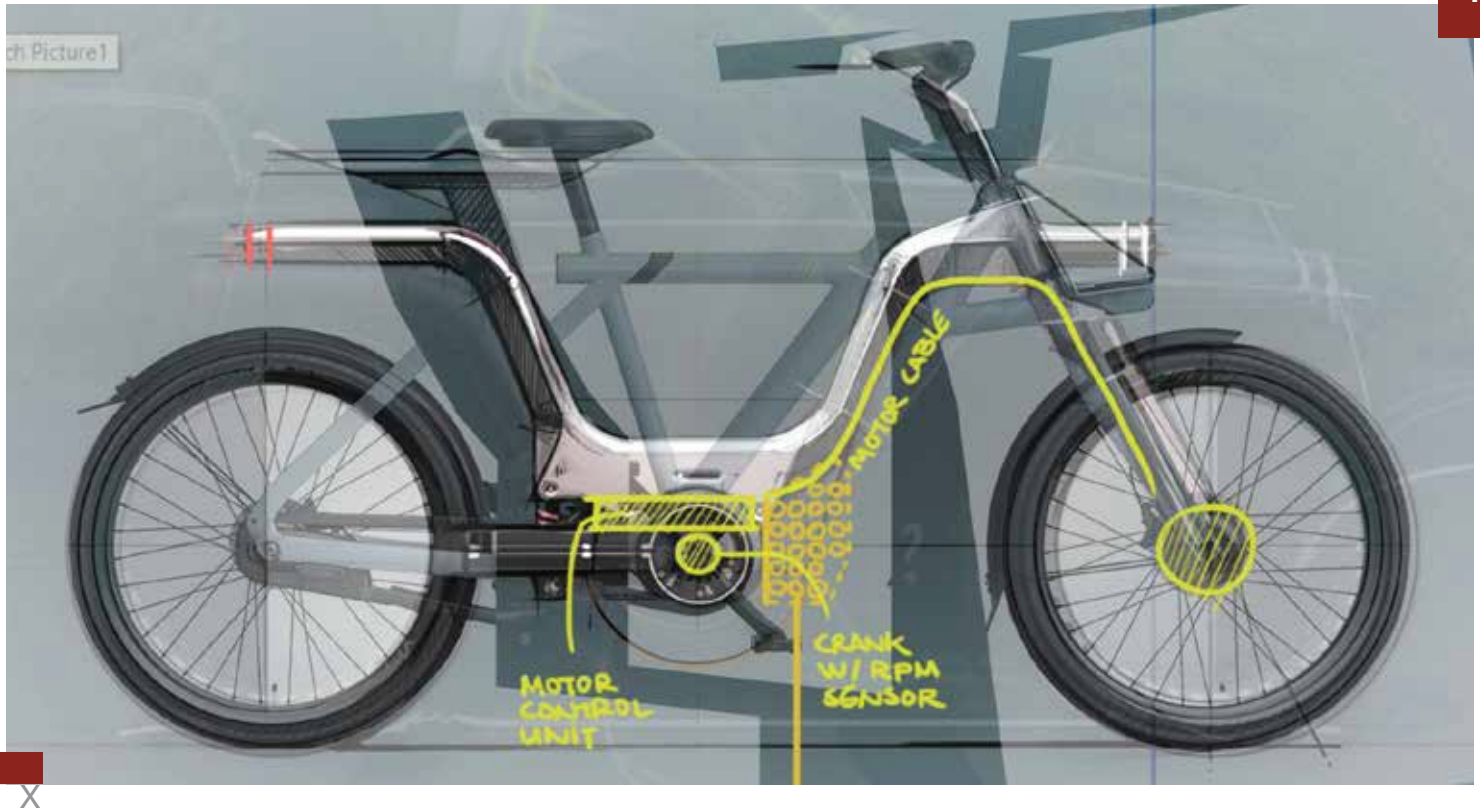


REFERENCE IMAGE

(Page absent in printed copy)



(Page absent in printed copy)



aluminum plates 76.
The battery pack as embedded in the X3 bike is very long, as it is currently hidden in the lower frame tube. For the prototype it will not be possible to hide the battery in the frame due to differences in dimensions. At first it was considered acceptable to disguise the battery as a piece of cargo 77. However, due to the shape of the battery being hard to disguise as anything logical, this option was eventually dismissed. Therefore it has been looked into to rearrange the battery cells into a more compact shape. Gathering knowledge from engineers at VanMoof R&D it became possible to dissect a battery, which can be quite dangerous. Cells shorting out could mean a severe meltdown. The battery pack consist of 40 different cells, bound together in packs of 4 cells 78, interlinked with point-welded steel plates 79. It is possible to 'fold' the battery in three locations. After soldering some connections that had to be disconnected to fold the cells into a new shape, the battery fits into the small space reserved in the prototype. It can be concluded that the theoretical plan to fit all technical components in the lower middle compartment is feasible 80.
Thus, the aluminum housing for the technical core can be produced. Two aluminum plates have been cut out and holes for the crank housing were drilled 81. These are welded together with the crank in between 82, and can be attached to the frame using m8 bolts 83.

As the aluminum housing for the technical and electronic components interferes with the

74

75

76

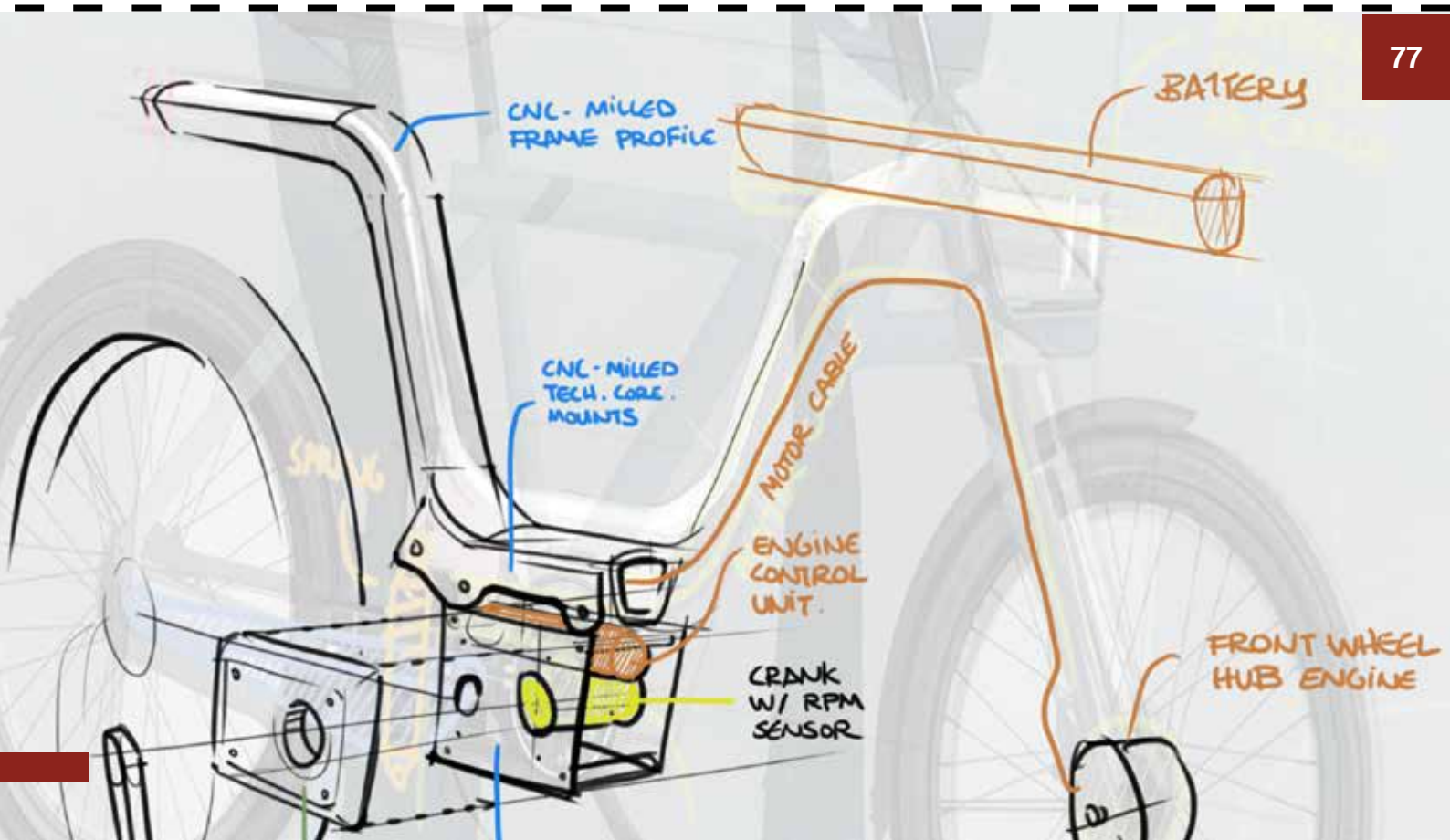
swing arm and suspension construction, this part is next in line for further development.

Rear Swing arm/Suspension Construction

In the original concept design it was decided to use a rear wheel cardan drive. While the goal is to produce a model as close as possible to the appearance, the development of an actual cardan drive embedded in a suspension rear swing arm would become overly time consuming in this project. Instead, the Aluminum cast dropouts as used in the current X3 model are used and modified to fit and function within a self constructed aluminum swing arm 84. As the model is based on 24 inch wheels as currently used in the X3 model, using the dedicated dropouts proves to be a useful solution.

The construction of the rear swing arm is one of the most complex welding challenges due to the required strength, quality of the weld and welding positions 85. As aluminum tends to deform significantly due to applied heat the swing arm construction requires post outlining multiple times to properly outline with the frame. In order to attach the dropouts to the swing arm, cardboard cutouts indicated the layout for cutting aluminum profile 86. This asked for some patience and trial and error, but in the end the dropouts are properly and firmly baked into the swing arm construction 87.

In order to attach the swing arm to the frame



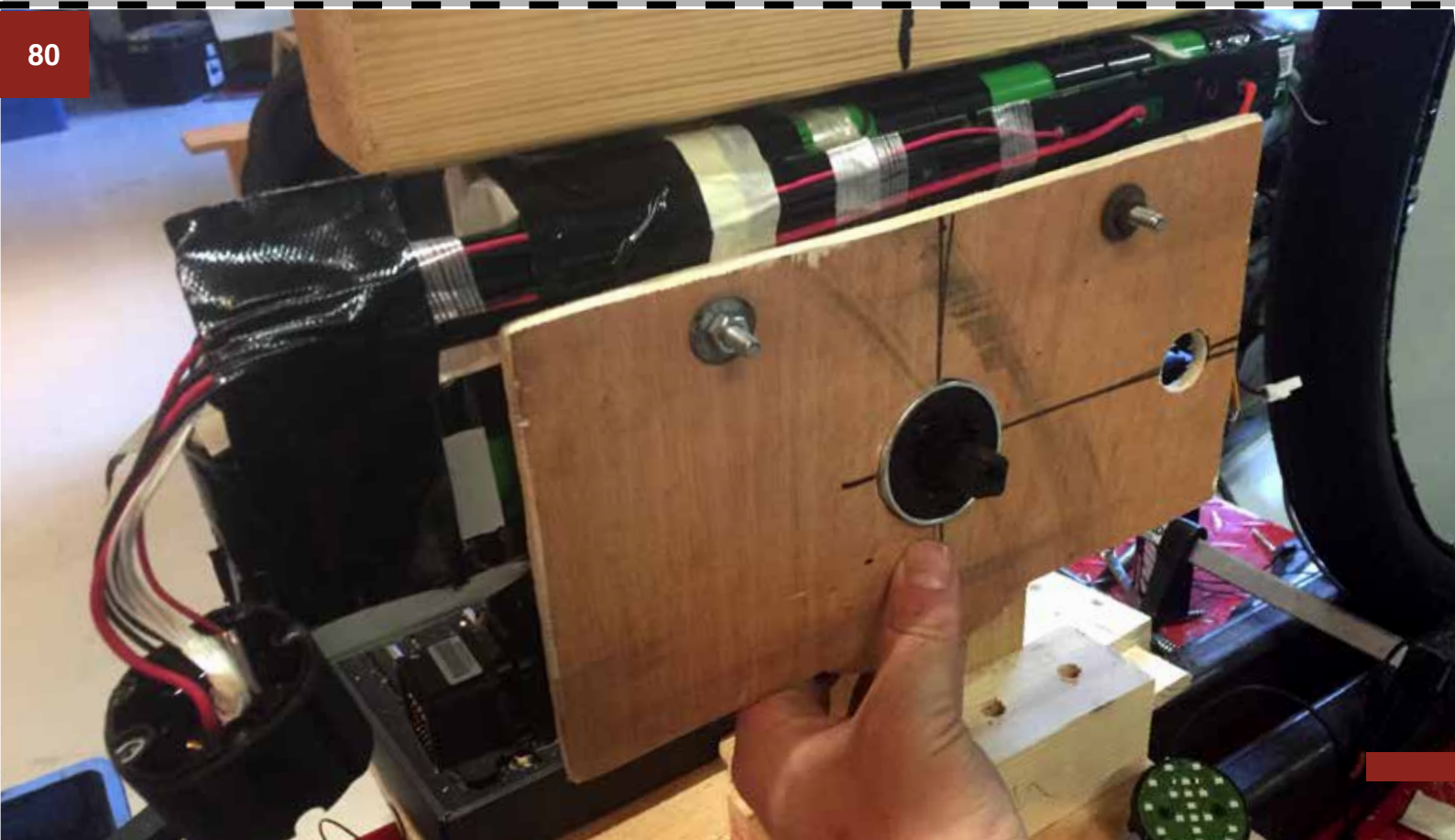
REFERENCE IMAGE

(Page absent in printed copy)

(Page absent in printed copy)

REFERENCE IMAGE

(Page absent in printed copy)



(Page absent in printed copy)

81

82

REFERENCE IMAGE

(Page absent in printed copy)

(Page absent in printed copy)

84

85

a pivot point must be built. This is done by turning Aluminum tube and rod in combination with self-lubricating polymer rod often used for gliding bearings 88. Attached to the frame with a M12 bolt with appropriate spacers 89, the swing arm can be mounted into the frame with negligible free play, as is desired due to it being the only point of connection 90. Please note that it would be a more adequate solution to provide conical roller bearings for long term use under heavier circumstances, which could be expected if further development is desired. A simple calculation led to the selection of a 1200 LBS spring of 125 mm length bought at AliExpress, with a beautiful description 91. When unloaded, the suspension lifts up the bike ever so slightly, so that when loaded with a 75 kg person, it balances out until it is in a horizontal line.

The spring damper for the suspension mechanism should be placed into the swing arm construction, preferably without removing material if adding material would be possible. For example: drilling large holes where stress in the material is high is not desired to ensure maximum strength. For this reason a separate spring mount is constructed onto the swing arm construction 92. This separate spring mount can be bolted onto the swing arm due to a thicker piece of aluminum strip with M6 thread tapped into it is welded onto the swing arm.

The swing arm and spring-mount constructions were sandblasted to remove any imperfections

on the surface and to prepare both parts for primer and coating later in the process 93.

Steer and Front Fork Assembly

At this point in the process it is necessary to construct and adjust the steer and front fork to fit in the head tube. By doing so, the actual rolling of the frame can be tested and evaluated. This is quite an important step in the process, as failure of a constructed component would lead to serious issues.
The steer is constructed making use of an old aluminum steer. It has to be elongated and adjusted in order to fit the rider position according to the concept. Cutting the appropriate parts (top tube and lower clamp) and clearing off the anodized surface layer makes it possible to weld it together 94. A piece of regular aluminum tube is used to bridge the gap and achieve the height needed for the correct shape 95. Using the milling machine, a 30 mm fitting is milled out to fit the top tube 96. The parts are then welded together 97 and sandblasted to remove imperfections on the surface, and to prepare it for primer and coating.

REFERENCE IMAGE

(Page absent in printed copy)

88

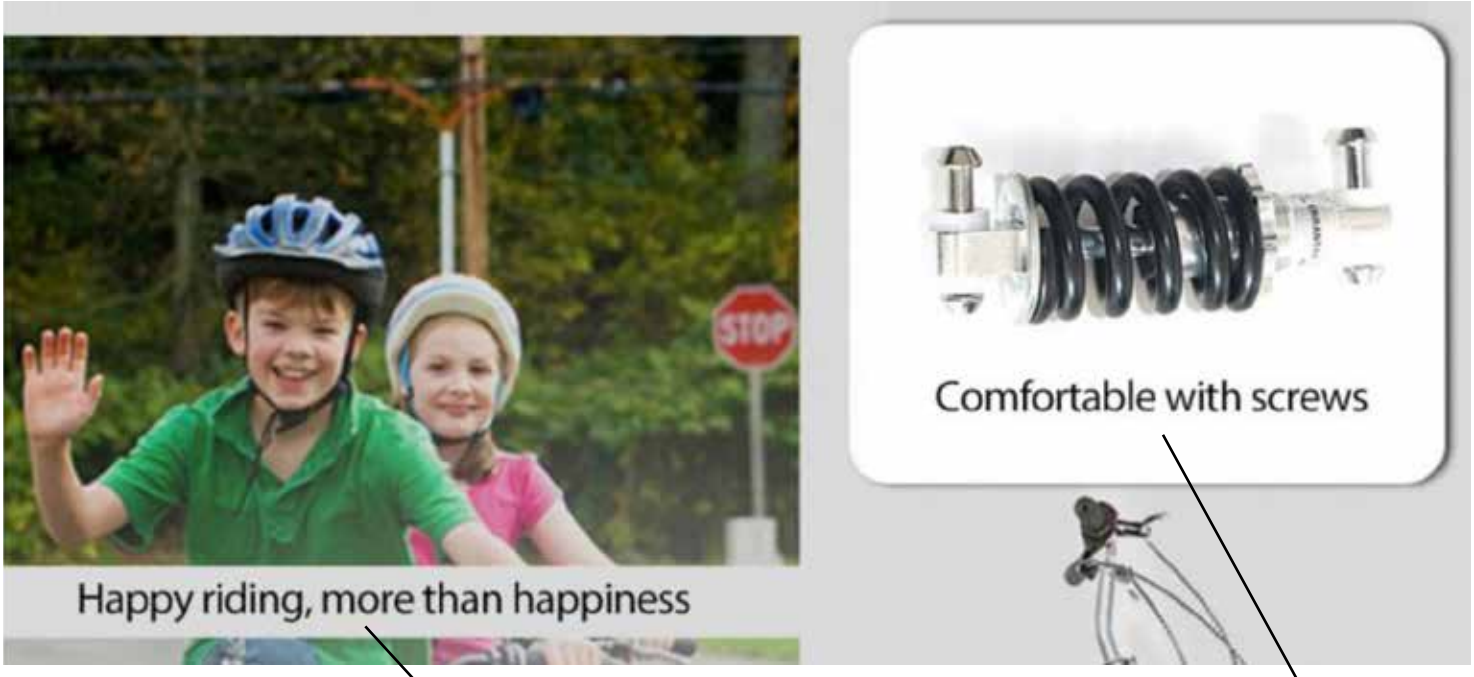
89

(Page absent in printed copy)

90

REFERENCE IMAGE

(Page absent in printed copy)



(Page absent in printed copy)


92


93

REFERENCE IMAGE

(Page absent in printed copy)

(Page absent in printed copy)

98/99/100/101/102

REFERENCE IMAGE

Finding an appropriate suspension 24 inch front fork proves to be very difficult due to the Covid-19 induced lock-down. For this reason, a set of temporary adapter units are turned on a lathe in order to install a front fork as currently used in the X3 model 98. This allows the frame to roll and be tested without having a suspension fork just yet 99. With this temporary setup it was concluded that no parts failed under load!

At last, a long quest finally led to the acquisition of a suitable second hand front fork: 1.1/8 inch steer tube, 100 mm dropout distance, disk brake mounts and O.K. appearance. Some minor machining is necessary to fit in the slightly wider front wheel hub (due to the motor). New adapter units are turned on the lathe holding the conical bearings for the front fork in place 100. This had to be redone as the first ones prove to have excessive play, making the front fork assembly rather wobbly. Having put together the front fork and steering assembly allowed the next test to take place. The front and rear suspension systems operate nicely together as a stable system, making the ride quite comfortable and most important of all: suitable for a rough infrastructure 101.

103/104/105/106/107

At this point in time the one part left to be produced to properly test the bike is the saddle.

96

97

Saddle, Saddle-Mount & Upholstery

As the concept design has a rectangular seating tube, this too is to be adopted in the model. The seat post is CNC-milled within the badge of parts ordered for the frame. A square seat post has the one major advantage of having just one possibility to fit in the frame, thus avoiding rotation of the seat post.

Onto the rectangular seat post a custom seat is produced. For this specific part, I use a method I have often used to build seats for motorcycles. This is a simple yet effective method. A base of PVC plate is cut out into the desired shape 102, after heating in the oven at 200 C it is formed in the desired curve 103. The now finished base is provided with M8 bolts for assembly later on, and sanded to prepare the gluing of foam 104. All glued together the foam can now be further shaped using a knife and a veil 105.

The saddle was then provided with upholstery by my mom 106.

3D-Printing Details

The method of ADM manufacturing came in handy for the making of details essential to achieve a realistic appearance. Here the 3DMZ facility in Haarlem 107 offered great help and flexibility in printing the parts needed.

REFERENCE IMAGE

(Page absent in printed copy)

(Page absent in printed copy)

100

REFERENCE IMAGE

(Page absent in printed copy)

(Page absent in printed copy)

REFERENCE IMAGE

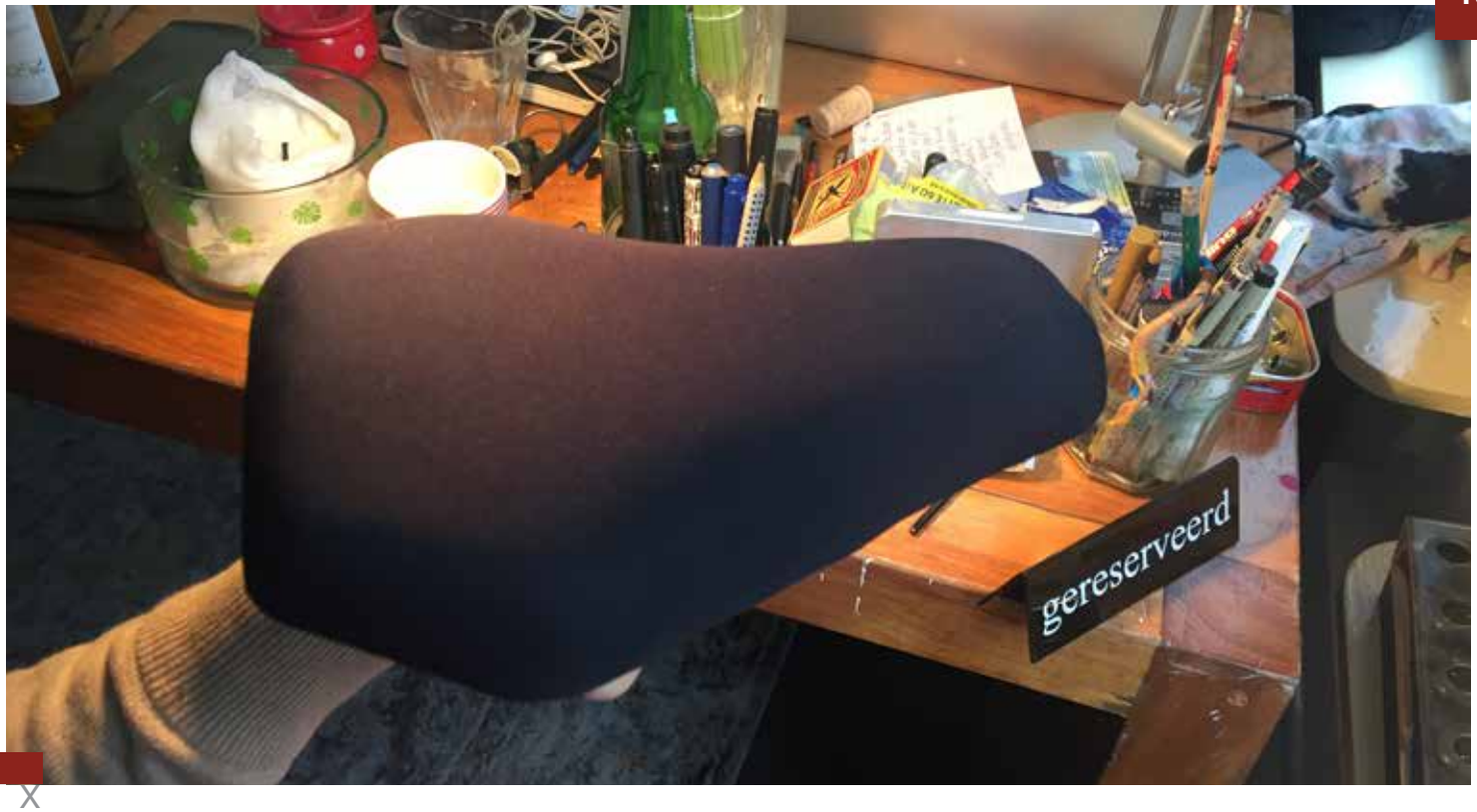
(Page absent in printed copy)

(Page absent in printed copy)

REFERENCE IMAGE

(Page absent in printed copy)

(Page absent in printed copy)



The concept design included a rather special lighting housing unit, with a ring of light around the frame tube's end for optimal visibility from the side 108. A set of lighting housing units were printed first in regular PLA enveloping the current LED lights and PCB's as used in the current X3 model 109. These lighting units were printed in SLA to achieve a smooth surface transparent print as needed for a diffuse lighting effect 110. These were then installed into the frame, with the dedicated aluminum 'ring' around it to produce the diffuse ring of light at the end of the frame-tube 111.

Furthermore, the housing to 'hide' the actual aluminum housing for the electronic components is printed in PLA at the 3DMZ facility.

Ultimate Problems and Adjustments

The full model can now be assembled and the dummy components were replaced by the functional electronic components 112. On the test board these fully functioned together successfully when tested earlier in the prototyping process 113. As the concept model requires the motor cable to be longer than it currently is, it has been lengthened using an extension cable and a piece of another motor cable. Here, the PMB employee Wiebe helped me greatly by soldering and measuring the cable and connectors as neat as possible. The frame had been modeled to be hollow and thus allow the motor cable and other wires to be pulled through 114. However, a minor mistake with the fitting has to be solved as a sharp

edge will do damage to the motor cable [115], the prototype has to be disassembled to get rid of the sharp edge on the milling machine [116]. Furthermore, a number of problems occurred with the swing-arm as weld beads hindered parts such as the chain tensioner to be assembled and outlined properly straight. This requires the swing-arm to be adjusted multiple times and tested to confirm that no parts are obstructing others.

Unfortunately a communication problem appears causing most of the system to be dysfunctional. This is quite a deception, however it could have been expected and therefore it is not necessarily a major setback. Times like these require an optimistic and flexible mindset. After some long hours of investigation and thinking it is clarified that the problem simply lies within the choice to use the wiring harness of the 28 inch model. This wiring harness has a number of slight differences in its connectors, causing the components not to function. An appropriate wiring harness is obtained out of the donor X3 frame. It certainly is extremely difficult to disassemble the wiring harness without damaging it or getting annoyed. The X3 wiring harness proves to be the solution for the earlier problems, which is highly comfortable to conclude just before the weekend starts [117]. It works, thats great, now finish it. Having the prototype to fully function is euphoric. It can now be tested and evaluated, which will be discussed in the next chapter [118].

REFERENCE IMAGE

(Page absent in printed copy)

(Page absent in printed copy)

REFERENCE IMAGE

(Page absent in printed copy)

(Page absent in printed copy)

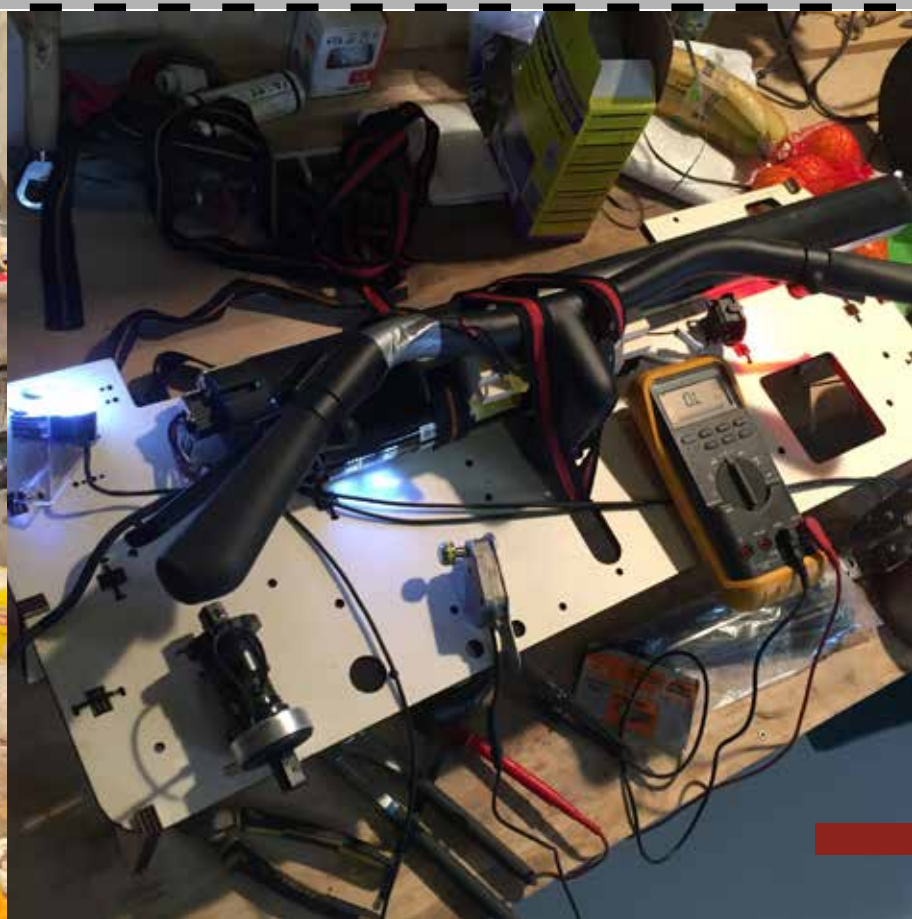
Hopefully it looks nice when installed.. REF 111

(Page absent in printed copy)

(Page absent in printed copy)

REFERENCE IMAGE

(Page absent in printed copy)



(Page absent in printed copy)

(Page absent in printed copy)

(Page absent in printed copy)

Testing & Reflection

What else is a good way to end this once and for all? Over the last 6 months this project came a long way, but it is far from done. The prototype is considered to be a wonderful starting point (for another graduate student?) to further detail and develop. The manufacturing and testing of the prototype has clarified points of improvements on the design as well as the design process.
I have decided to reflect on the goals as stated in the beginning of the prototyping chapter: 1. Vision and Design 2. Presentation and Communication, 3. Personal Learning Objectives.

REFERENCE IMAGE

1. Vision and Design

The Vision development, which formed the foundation for further unraveling of this project, resulted in the quest for a durable and concentrated technical core combined with a multitude of frames. When put together, these form a component of a the mobility system facilitated by VanMoof in 2030. Now that the first prototype has been finished and is being tested a number of conclusions can be drawn whether the embodiment of the design actually helps to fulfill the goal as put forth in the statement in the Vision chapter.

In order to make this reflection somehow structured, the key-features, as derived from the metaphor in the Vision chapter, will be

reflected upon as to conclude whether the design fulfills its function successfully, or if it needs further elaboration:

Agile yet Stable, Speedy, long range, multi-purpose use of compartments or 1 + 1 seating.

Agile yet Stable?
When riding the prototype, it can be noted how the smaller wheel diameter increases maneuverability. This proves to function well in combination with the long wheelbase that ensures stability when riding at higher speeds. Furthermore, entering the bicycle -getting on and off the bicycle- is comfortable and simple. There is no need to swing one's leg over the saddle, making it a more stable maneuver especially when loaded with attributes. This is currently simulated because of the prototype being rather heavy due to being CNC-milled out of solid aluminum. This too is a lesson for whenever this method of CNC-milling a prototype frame is repeated: it could have been a lot less heavy if I would have modeled the separate parts to be lighter.
The current absence of a kickstand can be considered annoying. Since this concept is supposed to be stable at all times, a center stand would be a must to avoid tipping over when at standstill or being loaded with attributes. Also adding to the stability of this model is the cargo compartments being located on the frame instead of attached to the steer.

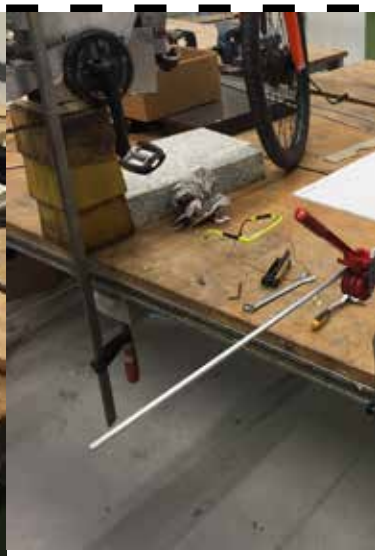
Speedy and Long Range?
As stated before, the long wheelbase ensures

stability at higher speeds and the concept includes the idea to involve an energy storage that can be expanded by adding units. However, these key-features can not be properly be reflected upon as the specific characteristics of the powertrain and energy storage system have not been detailed just yet. The current prototype is supplied with the propulsion as currently embedded in the X3 model, and this allows the prototype to run at speeds up to 27 km/h. It can be concluded that the concept's handling can be considered stable and easy to control which is desired in any speedy object.

Multi-purpose use of Compartments?

Especially the space reserved for compartments raised quite some question marks. Would it fit with the movement of the knee? Luckily it can be confirmed that it does indeed function well. The cargo space does not obstruct the movement of one's body in any way. Furthermore, since the steer originates from a long straight up tube, it is able to move freely even when attributes are placed onto the bicycle. As the cargo compartments 119 and weight are attached to the frame instead of the steer, it proves to be easy to handle.

Nevertheless, the rear suspension has a tendency to start bouncing at certain frequencies of peddling. The springs/damper's behavior changes when the mass applied is changed (carrying cargo or passenger), thus it is desired to make this system adjustable in accordance with the weight applied.

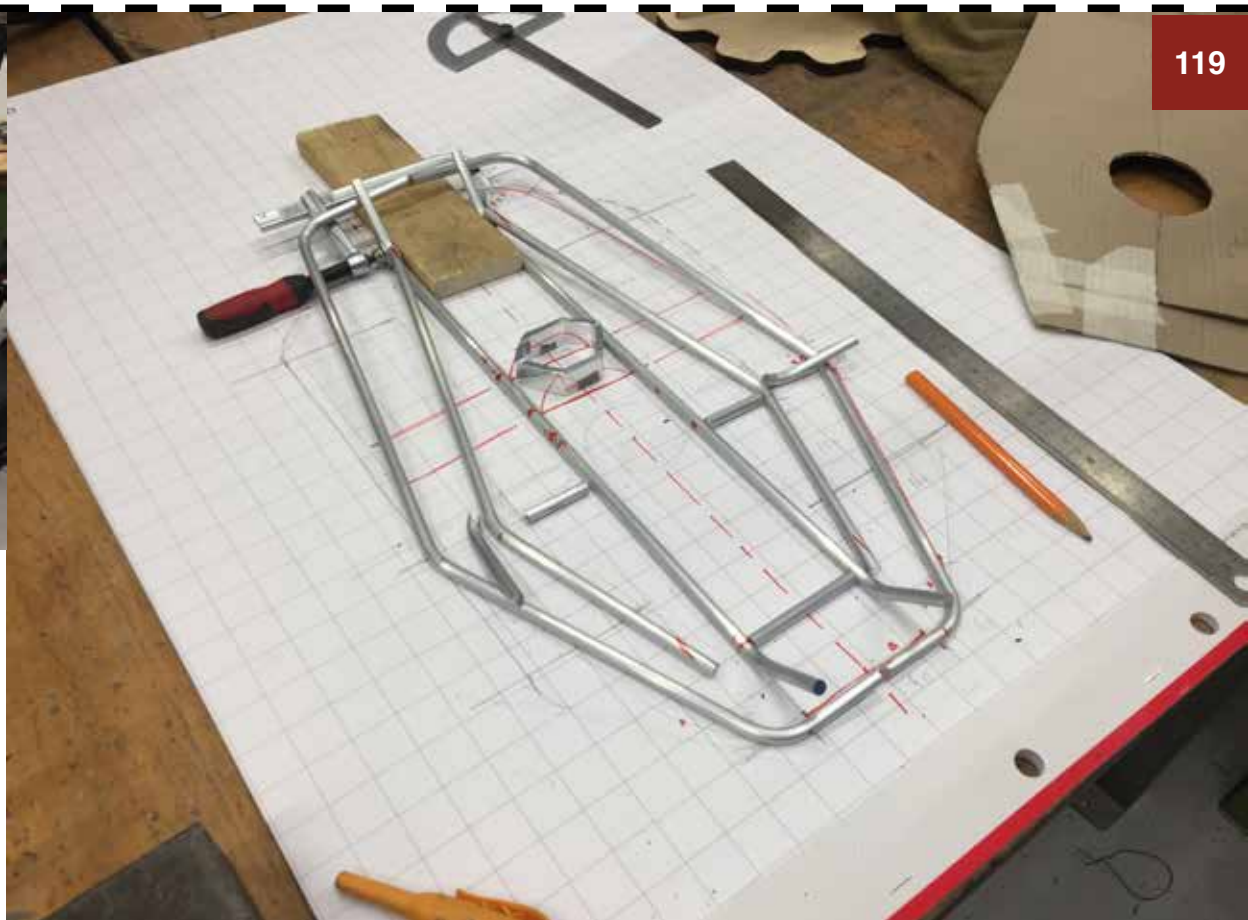


Furthermore?
When it comes to the overall design, it proves to be indeed comfortable and easy to work on the physical object due to it being split in two separate parts. This is essential since the switching of frame should be a most simple act. It should be noted however that in the current prototype the swing arm is connected to the technical core which is not always comfortable. Preferably the swing arm would be attached merely to the frame so that the technical core can be removed as a whole, while leaving the frame as an easy to handle rolling object.

2. Presentation & Communication

Another important reason to build a prototype was to have an physical object for presentation and communication. As it is difficult for many to visualize an idea or even a drawing or a 3D-Model, a physical object helps greatly to transmit the idea. However, due to the Covid-19 induced lock-down the presentation of the graduation thesis will take place in an online format. Sadly, it will therefore not be possible to asses enthusiasm and to have spectators actually ride, feel and interact with the prototype. However, the prototype will not dissolve abruptly, and hopefully it will be able to be presented later in life.

For communication however, even the manufacturing of the prototype was highly effective. Almost every single person passing by the project at the faculty in Delft stopped to ask and talk about it. This allowed me to show



them and explain what the goal of the concept was, and how that contributed to the physical shape at hand. People often need to see and feel an object in real life to relate to it. For this reason it was considered to be valuable to deliver a physical prototype, and up to now I am convinced it successfully contributes to the purpose of communication.

3. Personal Learning Objectives

This entire graduation thesis has been a highly educational and enjoyable project from the very start. Using the Vision in Product design method has opened new directions of thought and the way in which I will and hope to approach product design in the future. The fabrication process of the prototype has been one of the learning goals as defined in the very beginning. VanMoof has been greatly flexible, supporting and motivating throughout this prototyping process and that has helped me to make most of it.

However, during prototyping the concept I have once again been confronted with my weakest point: the desire to 'do it all'. Looking back it can be concluded that the plan to manufacture a full scale functional prototype bicycle in two months, while beforehand having to master the skills of working with aluminum still, was quite (or too) ambitious. Although I am not disappointed with the results, there was a very short time left to correct and adjust all problems that came up during the process, and problems will always come. Initially I had planned one week for delay in the end which

REFERENCE IMAGE

(Page absent in printed copy)

appeared to be extremely limited. The full prototype assembly should have been done at least two weeks before the deadline in order to have enough time to set things straight. Plus, it should be remembered that the prototype is not the only deliverable. A report, a presentation and other formalities had to be produced as well, leaving me very little time to sleep. To conclude, in my opinion I have not managed to plan out the manufacturing process well enough. Unfortunately, I overlooked the essence of thoroughly thinking through technical necessities and details beforehand. Consequently, I was facing new matter to be designed and solved at each step in the process, and while this a amusing activity, it was consuming large amounts of time that should have been spent on other activities. Examples of these were: prototyping the wiring harness design, implementation of a braking system, the quest for appropriate suspension systems and overall problems with failing components and necessary adjustments in the final stages of assembly.

Not very helpful either was the Covid-19 induced lock-down and closed hardware and bicycle stores. This once again asked for flexibility in a phase wherein the dependence on workshop availability and material suppliers is largest, making planning even more complex. Personally, when designing I usually find great inspiration and reflection in minds of fellow designers and others with which can be talked and discussed. These times of isolation strengthened and emphasized the fact that

(Page absent in printed copy)

graduation is an ‘alone’ project. That made it difficult at times to keep an overview on the project.

Nonetheless, my skills as a designer have been expanded into exactly those directions I had hoped at the start of the project. I had not expected to be able to TIG-weld aluminum well enough to use the technique to manufacture a prototype consisting of difficult shapes and curves, yet this has worked out very well. It has opened new opportunities in use of aluminum for prototyping for later design projects. Additionally, numerous parts were produced using the lathe and milling machine. Especially challenging were the parts that required fine to middle tolerances for tight fittings. Furthermore, during the prototyping process I have enjoying working with before unknown CAD-Software and methods of ADM & Printing. All considered, I dare to say that the acquired experience during the prototyping stage has made me confident that the next prototype will be five times better.

REFERENCE IMAGE

(Page absent in printed copy)

(Page absent in printed copy)

Afterword

A soon as it went by, the graduation thesis is now finished. Over the past months I have had the wonderful experience of learning those things I still wanted to learn in my career as a student the IDE faculty at the TUDelft. The project has been highly enjoyable and this would not have been possible without the wonderful team surrounding and supporting my graduation thesis.

Therefore I want to thank my Chair Matthijs van Dijk for being a great sparring partner about not only the ViP process, but also during our conversation related to random other subjects such as: *how did they produce machines with high precision, while for that you need machines with high precision?* A major thanks for hosting my graduation thesis and for all the fine discussions and help whenever I got stuck or needed some ventilation in the frustrating process of design.

Furthermore I would like to thank Wouter Kets for the guidance throughout the process! Without Wouter's help on the formal process of graduation and all the constructive meetings it would not have been to remain confident about what on earth I was doing. Also greatly interesting were the discussions on product styling since Wouter is an expert in this field. In this graduation thesis the process of styling has been rather short, and hopefully Wouter would be willing to discuss and explain more about this after graduation!

Obviously, I want to thank Job Stehmann and Jean-Paul Niellissen for having me as

REFERENCE IMAGE

(Page absent in printed copy)

a graduate student at the Vanmoof design team. It has been a wonderful opportunity and experience from the very start. They have been very open to the vague nature of the project which has helped to make most out of it. When the project became more concrete they offered me highly useful feedback and advice, and they have even proved to be willing to invest some serious money to help me build a full scale functional model. I consider this to be very unique opportunity and I am grateful for it!

Last but not least, there have been quite some others who have helped me throughout this project. I would there fore like to thank: Anke Kempen, for being the one advising me to consider Matthijs van Dijk as a Chair, and to contact Jean-Paul for a graduation opportunity that eventually led to this great experience, and for helping me throughout the process of ideation. The team at the PMB prototyping lab at the IDE faculty, for offering me a space to work in these strange times, for helping me learning how to TIG-weld and explain to me all other processes needed, and for the coffee and friendliness. Timothy Somers, for helping me out with CAD-modeling multiple times. Herman van Bolhuis and Nick Visser at the 3DMZ facility in Haarlem, for offering me a fantastic place to work and think, and for helping me to 3D-Print parts for the prototype using unique techniques. Thijs Faber, Marjolein Deun and Geert at Vanmoof, who supported my project through thinking along and helping me to get the parts needed for prototyping. Nino Rubinstein, for all the support and good discussions and thoughts along the way.

(Page absent in printed copy)

REFERENCE IMAGE

(Page absent in printed copy)

CH.

References: Project Brief

(1) COVID-19 (nieuwe coronavirus). (n.d.). Retrieved April 14, 2020, from https://www.rivm.nl/coronavirus-covid-19

(2) Goulding, L., & Butler, T. (2018). Rethinking Urban Mobility, 6–7.

(3) Kamargianni, M., MATYAS, M., Li, W., & Muscat, J. (2018). Londoners' attitudes towards car-ownership and Mobility-as-a-Service: impact assessment and opportunities that lie ahead. TRID, 51. Retrieved from https://trid.trb.org/View/1502485

(4) Hekkert, P., & Van Dijk, M. (2011). Vision in Product Design. Amsterdam: BIS Publishers.

(5) Martinez, L., & Viegas, J. M. (2017). Assessing the impacts of deploying a shared self-driving urban mobility system: An agent-based model applied to the city of Lisbon, Portugal. International Journal of Transportation Science and Technology, 6(1), 13–27. Retrieved from https://www.sciencedirect.com/science/article/pii/S2046043016300442

(6) About - Van Moof. (n.d.). Retrieved April 14, 2020, from https://www.vanmoof.com/nl_nl/about

(7) Kamargianni, M., Li, W., Matyas, M., & Schafer, A. (2016). A Critical Review of New Mobility Services for Urban Transport. Transportation Research Procedia, 14,

(Page absent in printed copy)

3294–3303. Retrieved from https://www.sciencedirect.com/science/article/pii/S2352146516302836

(8) Shenker, J. (2020, March 26). Cities after coronavirus: how Covid-19 could radically alter urban life. Retrieved April 15, 2020, from https://www.theguardian.com/world/2020/mar/26/life-after-coronavirus-pandemic-change-world

(9) Harris, K., & Schwedel, A. (2016, February 10). Spatial Economics: The Declining Cost of Distance. Retrieved April 15, 2020, from https://www.bain.com/insights/spatial-economics-the-declining-cost-of-distance/

REFERENCE IMAGE

References:

5 Ways the Sun Impacts Your Mental and Physical Health: Tri-City Medical Center. (2018, December 29). Retrieved May 04, 2020, from https://www.tricitymed.org/2018/08/5-ways-the-sun-impacts-your-mental-and-physical-health/

Accenture. (2020, May 4). COVID-19 Increasing Consumers' Focus on 'Ethical Consumption,' Accenture Survey Finds. Retrieved May 7, 2020, from https://newsroom.accenture.com/news/covid-19-increasing-consumers-focus-on-ethical-consumption-accenture-survey-finds.htm

Acemoğlu, D., Coyle, D., & Stiglitz,

(Page absent in printed copy)

J. (2020, August 04). GovAI Webinar #1 COVID-19 and the Economics of AI. Retrieved May 29, 2020, from https://www.fhi.ox.ac.uk/webinar1/

Aluminum 6061-T6; 6061-T651. (n.d.). Retrieved November 20, 2020, from http://asm.matweb.com/search/SpecificMaterial.asp?bassnum=MA6061T6

Amos, J. (2016, July 25). Dutch men revealed as world's tallest. Retrieved December 10, 2020, from https://www.bbc.com/news/science-environment-36888541

Baqutayan, S. (2011). Stress and social support. Indian Journal of Psychological Medicine, 33(1), 29. doi:10.4103/0253-7176.85392

Barrett, R. (2020, January 09). Understanding people's 'New World' brand expectations. Retrieved June 03, 2020, from https://www.thedrum.com/opinion/2020/01/09/understanding-people-s-new-world-brand-expectations

BBCHARDTALK. (2020, May 05). Coronavirus: Yuval Noah Harari, philosopher and historian, on the legacy of Covid-19 - BBC HARDtalk. Retrieved May 11, 2020, from https://www.youtube.com/watch?v=gfVrin7Ybp8

Bienvenu, E. (2020, April 14). 7 Predictions for a Post-Coronavirus World. Retrieved May 7, 2020, from https://marker.medium.com/7-

(Page absent in printed copy)

predictions-for-a-post-coronavirus-world-aaac052c8514

Big Think. (2017, November 20). Your Life in 2027: A Look at the Future | Vivek Wadhwa (Full Video) | Big Think. Retrieved May 21, 2020, from https://www.youtube.com/watch?v=m0wy0YYzU0s

Black, O. (2016, February 01). Are you one of us? What behavioural science reveals on inclusion | Octavius Black | TEDxSquareMile. Retrieved May 11, 2020, from https://www.youtube.com/watch?v=mOlynlKPR-8

Boffer, D. (2020, April 8). Amsterdam to embrace 'doughnut' model to mend post-coronavirus economy. Retrieved May 4, 2020, from De donut van Kate Raworth: hét kompas voor de betekeniseconomie

Brotherthon, J. (2020, April 15). Coronavirus Will Change the World Permanently. Here's How. Retrieved May 05, 2020, from https://www.politico.com/news/magazine/2020/03/19/coronavirus-effect-economy-life-society-analysis-covid-135579

C. (n.d.). Nederland in 2030 en 2050: Twee referentiescenario's. Retrieved May 29, 2020, from https://www.cpb.nl/sites/default/files/publicaties/download/cpb-pbl-boek-19-wlo-2015-nederland-2030-en-2050.pdf

Caprino, K. (2016, September 21). Let's Face It -- We're Deathly Afraid Of Authenticity.

REFERENCE IMAGE

(Page absent in printed copy)

Retrieved May 7, 2020, from https://www.forbes.com/sites/kathycaprino/2016/09/18/lets-face-it-were-completely-afraid-of-authenticity/#b5a82716b689

Centraal Bureau voor de Statistiek. (2017, November 07). Veel jonge gezinnen verlaten de grote stad. Retrieved May 19, 2020, from https://www.cbs.nl/nl-nl/nieuws/2017/45/veel-jonge-gezinnen-verlaten-de-grote-stad

Chillot, R. (2013, March 11). The Power of Touch. Retrieved May 04, 2020, from https://www.psychologytoday.com/us/articles/201303/the-power-touch

Clark, B., Chatterjee, K., & Melia, S. (2016). Changes to commute mode: The role of life events, spatial context and environmental attitude. Transportation Research Part A: Policy and Practice, 89, 89-105. doi:10.1016/j.tra.2016.05.005

Covid-19: How it will change the world | The Economist. (2020, May 08). Retrieved May 11, 2020, from https://www.youtube.com/watch?v=XsArdIXgRTU

Cyclist's Back. (n.d.). Retrieved November 20, 2020, from https://www.physio-pedia.com/Cyclist%27s_Back

Darwin, C., & Rachman, S. (1983). The expression of emotions in man and animals. London: F. Pinter.

(Page absent in printed copy)

Dixon, P. (n.d.). 10 trends that will really DOMINATE our future - all predictable, changing slowly with huge future impact - based on new book The Future of Almost Everything. Retrieved May 29, 2020, from https://www.globalchange.com/10-trends-that-will-dominate-our-future-all-predictable-changing-slowly-with-huge-impact.htm

Ellis, D. (2018, July 12). Is technology really ruining your life? | David Ellis | TEDxLancasterU. Retrieved May 12, 2020, from https://www.youtube.com/watch?v=mNKN4dHGQKg

Futures of Manufacturing, Processing and Supply Chain Management [Personal interview]. (2020, May 12).

Heine, J. (2009, June). Where to Carry a Load. Retrieved November 21, 2020, from http://www.adventurecycling.org/default/assets/resources/200906_MechanicalAdvantage_Heine.pdf

Holzwarth, A. (2020, October 18). The Three Laws of Human Behavior. Retrieved June 2, 2020, from https://www.behavioraleconomics.com/the-three-laws-of-human-behavior/

Horst, L. V. (2020, May 04). Corona en mobiliteit: Dit zijn de drivers achter innovatie en verandering. Retrieved May 04, 2020, from https://www.emerce.nl/achtergrond/corona-en-mobiliteit-dit-zijn-de-drivers-achter-innovatie-en-verandering

REFERENCE IMAGE

(Page absent in printed copy)

Kelly, K. (2015, September 11). What's next for AI - Kevin Kelly. Retrieved June 11, 2020, from https://www.ibm.com/watson/advantage-reports/future-of-artificial-intelligence/kevin-kelly.html

Kjaer, A. (n.d.). Imagining the Future: Consumer trends for the Future. Retrieved January 10, 2021, from https://www.bbvaopenmind.com/en/articles/imagining-the-future-leading-the-way-in-a-changing-world-consumer-trends-for-the-future/

Lichfield, G. (2020, April 02). Predictions for 2030 by people shaping the world. Retrieved May 29, 2020, from https://www.technologyreview.com/2020/02/26/905686/predictions-2030-people-shaping-the-world-davos/

Lichfield, G. (2020, April 10). We're not going back to normal. Retrieved May 04, 2020, from https://www.technologyreview.com/2020/03/17/905264/coronavirus-pandemic-social-distancing-18-months/

Life Events and Stress - Life Events Research, Life Events In Old Age, Future Directions. (2020, January 14). Retrieved September 23, 2020, from https://medicine.jrank.org/pages/988/Life-Events-Stress.html

Marder, L. (2019, July 14). Important Features That Separate Humans From Other Species. Retrieved June 2, 2020, from https://www.thoughtco.com/what-makes-us-

(Page absent in printed copy)

human-4150529

Marr, B. (2019, July 15). The Future Of Work: 5 Important Ways Jobs Will Change In The 4th Industrial Revolution. Retrieved May 19, 2020, from https://www.forbes.com/sites/bernardmarr/2019/07/15/the-future-of-work-5-important-ways-jobs-will-change-in-the-4th-industrial-revolution/#250f1f7b54c7

McGlone, F., Wessberg, J., & Olausson, H. (2014, May 21). Discriminative and Affective Touch: Sensing and Feeling. Retrieved May 07, 2020, from https://www.sciencedirect.com/science/article/pii/S0896627314003870

Montessori, M. (n.d.). Tendencies of Humans. Retrieved June 2, 2020, from https://montessoriforeveryone.com/Tendencies-of-Humans_ep_73-1.html

Moore, K. A., Lipsitch, M., Barry, J. M., & Osterholm, M. T. (2020, April 30). Part 1: The Future of the COVID-19 Pandemic: Lessons Learned from Pandemic Influenza. Retrieved May 7, 2020, from https://www.cidrap.umn.edu/sites/default/files/public/downloads/cidrap-covid19-viewpoint-part1_0.pdf

Nichols, T. (2020, April 15). Coronavirus Will Change the World Permanently. Here's How. Retrieved May 05, 2020, from https://www.politico.com/news/magazine/2020/03/19/coronavirus-effect-economy-life-society-analysis-covid-135579

REFERENCE IMAGE

(Page absent in printed copy)

Once Upon A Future ...Hoe deze crisistijd bij kan dragen aan een betere toekomst. (2020, March 31). Retrieved May 25, 2020, from https://www.youtube.com/watch?v=yS7hG0h4QPU

Pereira, H. (2017, June 12). These are the 6 biggest things to happen to mobility before 2030. Retrieved January 10, 2021, from https://blog.evbox.com/6-biggest-things-mobility-2030

Ramirez, V. B. (2019, March 24). 7 Non-Obvious Trends Shaping the Future. Retrieved May 29, 2020, from https://singularityhub.com/2019/03/21/these-trends-arent-obvious-but-theyre-helping-shape-the-future/

Rauch, J. (2020, April 15). Coronavirus Will Change the World Permanently. Here's How. Retrieved May 5, 2020, from https://www.politico.com/news/magazine/2020/03/19/coronavirus-effect-economy-life-society-analysis-covid-135579

Schrad, M. L. (2020, April 15). Coronavirus Will Change the World Permanently. Here's How. Retrieved May 5, 2020, from https://www.politico.com/news/magazine/2020/03/19/coronavirus-effect-economy-life-society-analysis-covid-135579

Sergey Makhno I 25 March 2020 Leave a comment. (2020, March 26). Life after coronavirus: How will the pandemic affect our homes? Retrieved May 04, 2020, from https://www.dezeen.com/2020/03/25/life-

(Page absent in printed copy)

after-coronavirus-impact-homes-design-architecture

Shaddy, W. (2019, October 15). Small Bike Wheels Vs. Large Bike Wheels. Retrieved November 20, 2020, from https://www.sportsrec.com/5438446/small-bike-wheels-vs-large-bike-wheels

Simonite, T. (2020, May 18). As Machines Get Smarter, How Will We Relate to Them? Retrieved June 2, 2020, from https://www.wired.com/story/as-machines-get-smarter-how-will-we-relate-to-them/

SkyNews. (2020, January 6). Ten tech predictions for the decade ahead: What will happen by 2030? Retrieved June 11, 2020, from https://news.sky.com/story/ten-tech-predictions-for-the-decade-ahead-what-will-happen-by-2030-11884641

Some Things Will Never Change. (n.d.). Retrieved June 2, 2020, from http://www.lifecoachingcourses.ie/2014/02/things-will-never-change/

Sutton, M. (2017, May 02). Bafang debuts first motorized E-shaft drive system for public bikes. Retrieved November 22, 2020, from https://cyclingindustry.news/bafang-debuts-first-motorized-e-shaft-drive-system-for-public-bikes/

TEDxTalks (Ed.). (2020, March 11). Coronavirus Is Our Future | Alanna Shaikh | TEDxSMU.

REFERENCE IMAGE

(Page absent in printed copy)

Retrieved May 11, 2020, from https://www.youtube.com/watch?v=Fqw-9yMV0sI

TEDxTalks. (2013, June 06). The purpose of the future: Ruud Veltenaar at TEDxBrainport. Retrieved May 25, 2020, from https://www.youtube.com/watch?v=z7PQRGXKSyI

TEDxTalks. (2017, January 17). Imagining the Future: The Transformation of Humanity | Peter Diamandis | TEDxLA. Retrieved May 25, 2020, from https://www.youtube.com/watch?v=7XrbzlR9QmI

Timis, D. (2019, July 31). The future of skills in the age of AI | David Timis | TEDxLuxembourgCity. Retrieved May 11, 2020, from https://www.youtube.com/watch?v=fBDIAA0GEes

Townsend, S. (2018, November 21). 88% Of Consumers Want You To Help Them Make A Difference. Retrieved May 04, 2020, from https://www.forbes.com/sites/solitairetownsend/2018/11/21/consumers-want-you-to-help-them-make-a-difference/#3c9feed26954

Umberson, D., & Montez, J. K. (2010). Social Relationships and Health: A Flashpoint for Health Policy. Journal of Health and Social Behavior, 51(S54–S66). doi:10.1177/0022146510383501

Waude, A. (2017, July 20). Social Influence: Why We Conform In Groups. Retrieved May 5, 2020, from https://www.psychologistworld.com/influence/social-influence

(Page absent in printed copy)

Winston, A. S. (2019, May 07). The World in 2030: Nine Megatrends to Watch: Andrew S. Winston. Retrieved May 19, 2020, from https://sloanreview.mit.edu/article/the-world-in-2030-nine-megatrends-to-watch/

Winston, A. S. (2019, May 07). The World in 2030: Nine Megatrends to Watch: Andrew S. Winston. Retrieved May 29, 2020, from https://sloanreview.mit.edu/article/the-world-in-2030-nine-megatrends-to-watch/

Wired Staff. (2020, January 01). Here's What the World Will Look Like in 2030 ... Right? Retrieved May 29, 2020, from https://www.wired.com/story/heres-what-the-world-will-look-like-in-2030-right/

REFERENCE IMAGE

(Page absent in printed copy)

(Page absent in printed copy)

APPENDIX TEXT

Graduation thesis IDE Walt van der Veen
in collaboration with: VanMoof Amsterdam

APPENDIX IMAGES

Graduation thesis IDE Walt van der Veen
in collaboration with: VanMoof Amsterdam

Appendix 1: Factor Collection

BIOLOGICAL

1. 'Physical interaction with plants and nature is proven to be beneficial for one's health' [bron?] {principle}

2. 'Fresh air and light have positive effects on physical and mental health' [6] {principle}

3. 'Touch is the first and strongest sense a human acquires' [8] {principle}

4. 'Touch generates endorphins that makes people feel warm and positive' [21] {principle}

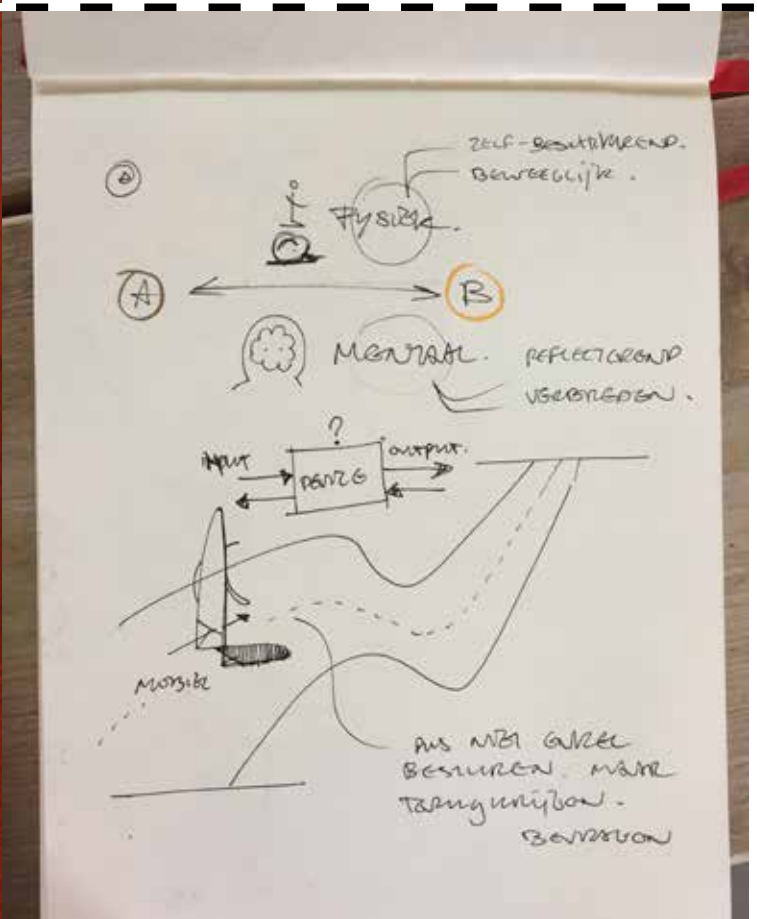
5. 'Interacting with another human being is both a mental and a physical act' [bron?] {principle -> state?}

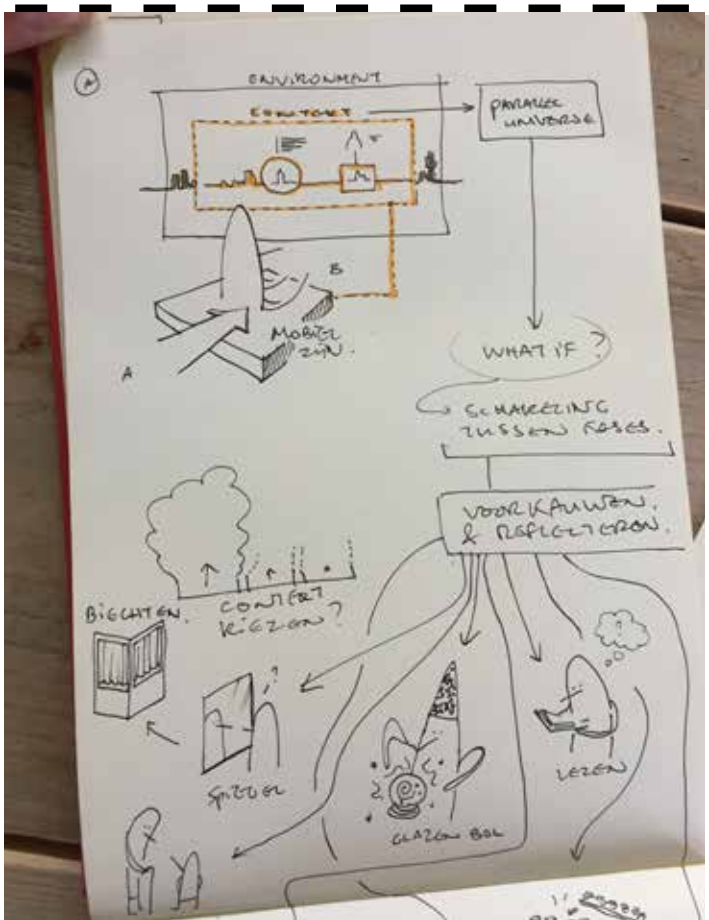
6. 'Life ends at some point.' {principle}

7. '"Blushing is the most peculiar and the most human of all expressions."' [46] {principle}

8. 'We largely rely on language to inform each other about what is on our minds.' [47] {principle}

9. 'Knowing we are going to die not only places an acknowledged limit upon our lives, it also gives a special intensity and poignancy to the time we are given to live and love.' [48] {principle}





REFERENCE IMAGE

EVOLUTIONARY

10. 'People do not want to rely on other people for basic needs' [bron?] {principle}

11. 'Humans are social animals' [22] {principle}

12. 'People are addicted to social interaction' says the psychologist [28] {principle}

13. 'Human beings want to know their relationship to the environment around them.' [50] {principle}

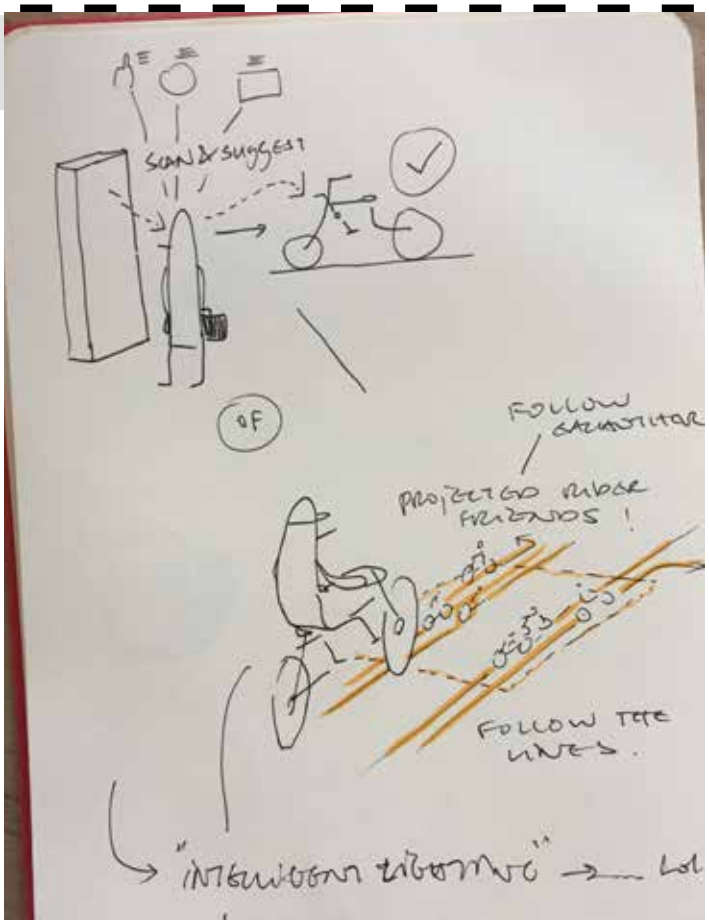
14. 'Humans are creatures of least resistance. We take the road most traveled, or the road best paved.' [51] {principle}

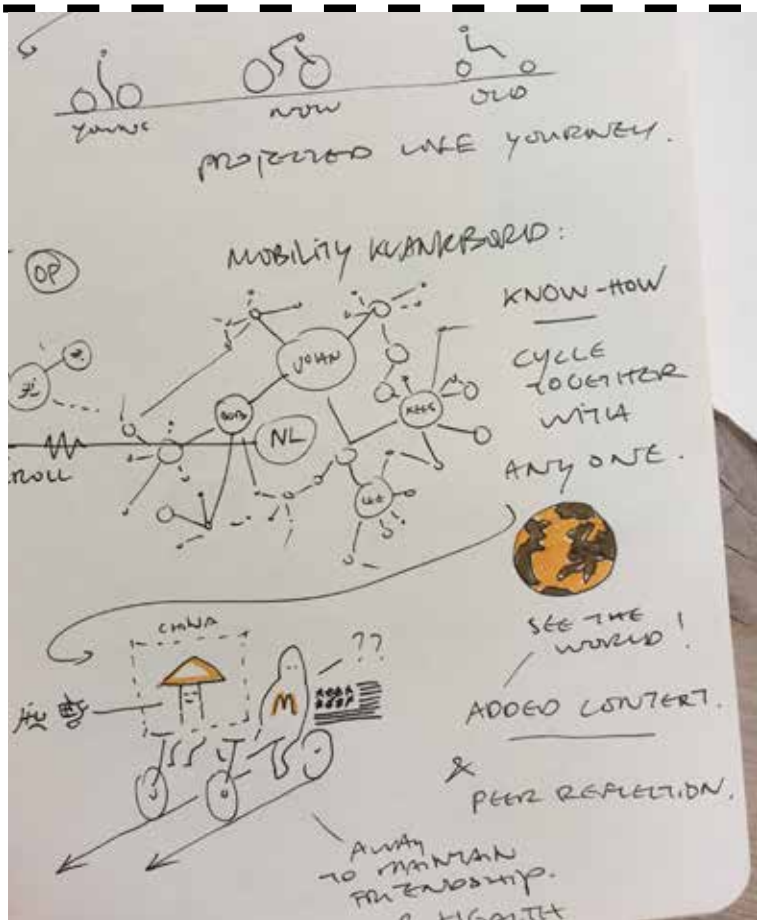
15. 'Humans need to take hold of their environment to understand it.' [50] {principle}

94. 'Any assessment based on uncertainty involves a large amount of risk' [62] {principle}

106. Certainty really matters when people make decisions, it can give them a sense of security and it earns trust. Nobody would like to invest time and money on an uncertain thing. [70] {principle}

107. It's well known that people naturally follow the crowd. Our research reveals that in the context of certainty, people become more confident of their opinions when they think that others share them. [71] {principle}





108. All life forms move, even if only to orient daily towards the sun while remaining rooted in the earth. Animal life typically requires movement for sustenance, shelter and mate selection to enhance individual and species survival. [72] {principle}

PSYCHOLOGICAL

16. 'There is an increasing importance of health and hygiene being considered' [3] ?????? {development]???

17. 'People are spending more time on self-care and mental well-being' [19] {development}

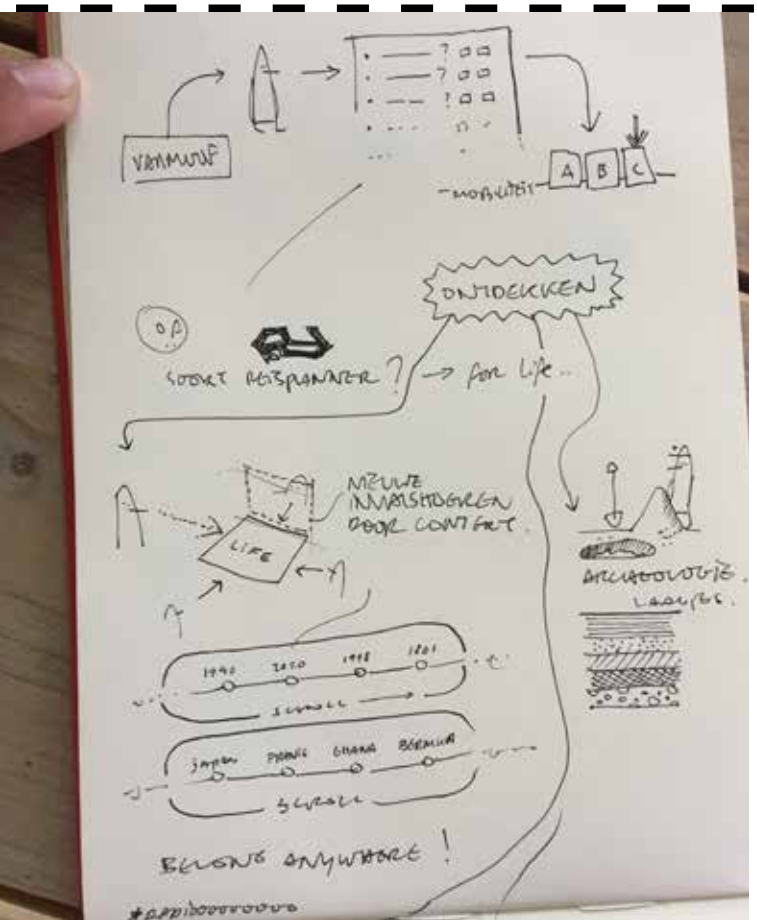
18. 'People will need something more than a paycheck as a motivation to work. Many want to work for an organization with a mission and purpose they believe in.' [31] {development}

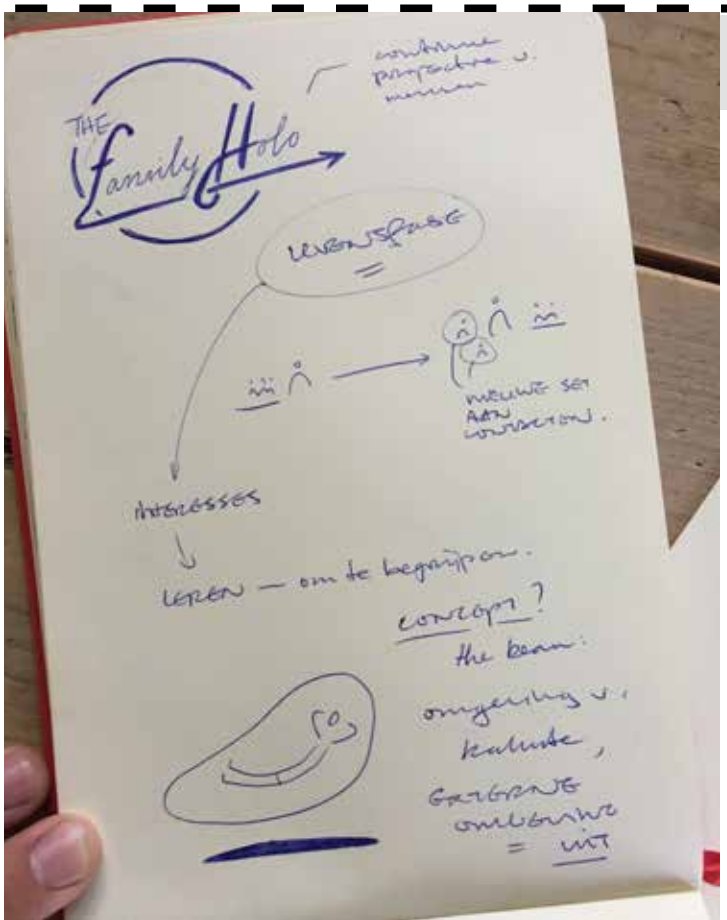
People are always looking for purpose as to motivate life. -> principle?

19. 'Rather than succumb to the doomsday predictions that "robots will take over all the jobs," a more optimistic outlook is one where humans get the opportunity to do work that demands their creativity, imagination, social and emotional intelligence, and passion.' [31] {development}

20. 'We're defined by our jobs, we take pride in creativity in our work, our lives evolve around our work' [32] {state} (sociological?)

21. 'Technological disruption causes the loss





of autonomy, think of autonomous driving' [32] {state}

22. 'The purpose of the future is that it bring us hope.' [34] {state}

23. 'In times of too much change, people are craving for familiarity and dependability.' [37] {state} (principle?)

24. 'People have difficulties with thinking of the long term future' {principle}

25. 'People like nostalgic experiences' [37] {principle}

26. 'Stories give us meaning, and meaning is what we need in order to be able to put the pieces together. Stories give us a way of understanding the world' [37] {principle}

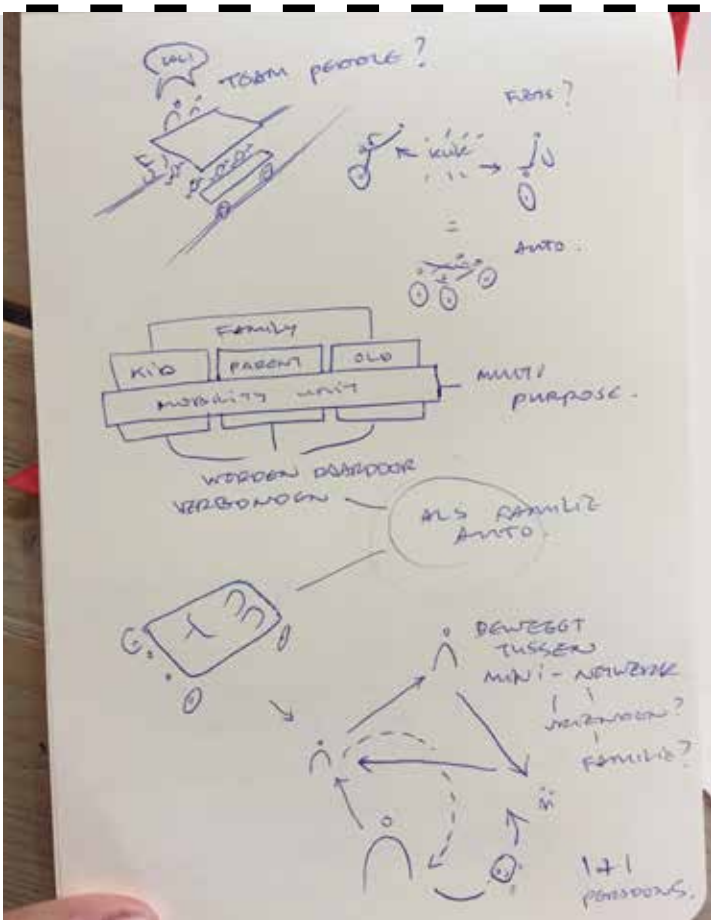
27. 'no one is immune to disappointments.' {principle}

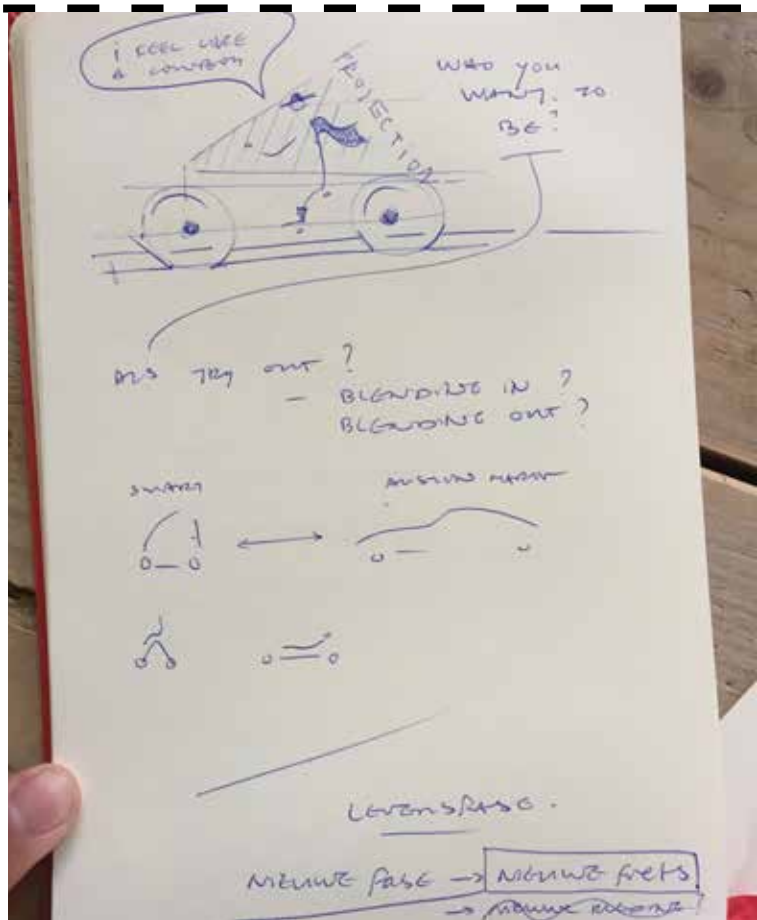
28. 'People do not like or desire sudden change' [bron?] {principle}

91. 'As we become willing to step away from insisting that our opinions are right by recognizing they are actually subjective interpretations based on personal biases and world-views, we are able to consider opinions from a broader and therefore more accurate perspective. [60]

92. It increases uncertainty when we cannot

REFERENCE IMAGE





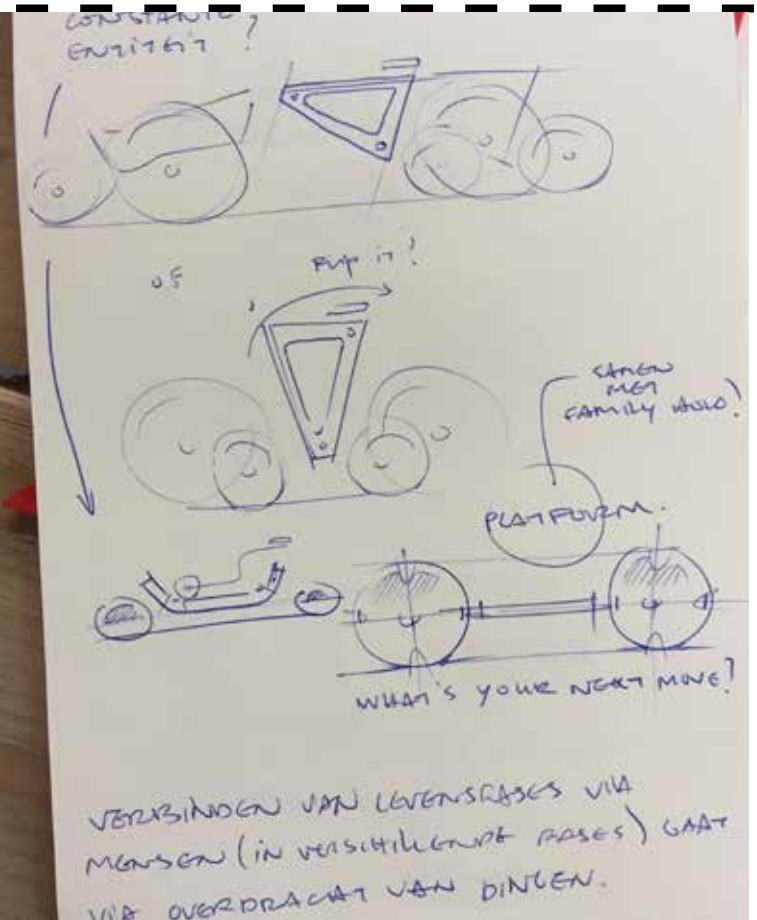
actually see, touch or feel what they are building. The assets are literally all around us, yet invisible. One implication for learning is the need to train more coders and software engineers — and fast. The result will be an even more invisible world. [61]

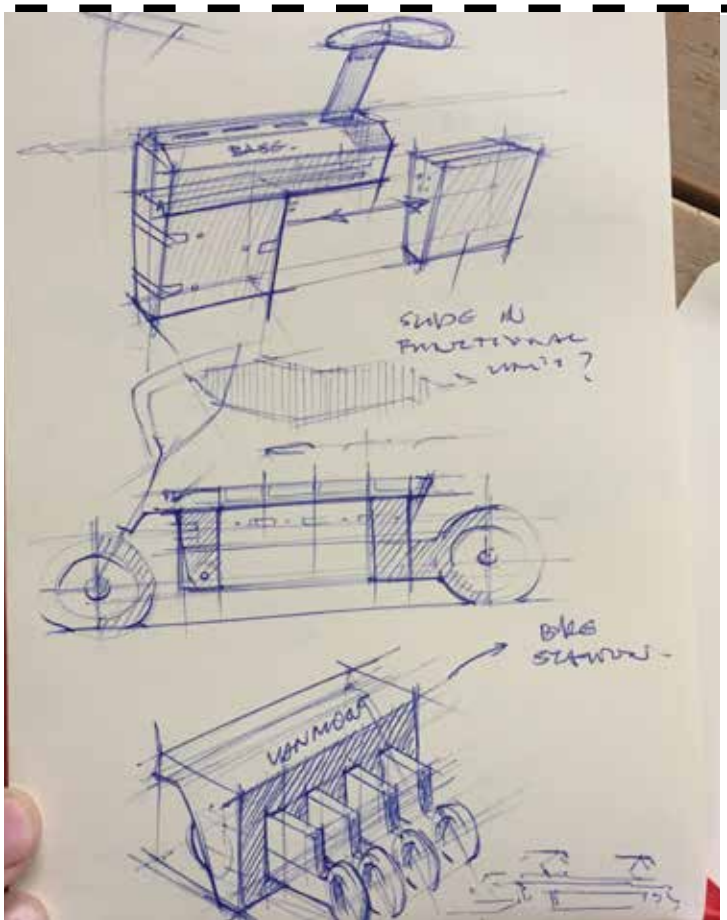
95. 'We demand certainty of others. We ask our bankers, doctors, and political leaders (among others) to give it to us. What they deliver, however, is the illusion of certainty. We feel comfortable with this.' [63] {principle}

101. 'As a high-school student I'm constantly being reminded to figure out what to do with my life, what career I would like to have and so on. I definitely feel huge amounts of pressure when my teachers and parents tell me to figure out something now. I'm young and I don't want to make a mistake and ruin my future. I know what I like and what my interests are but when I read about a job related to those interests I always feel as if I wouldn't enjoy it and I don't know why.' [66] {trend}

103. Values refer to stable life goals that people have, reflecting what is most important to them. Values are established throughout one's life as a result of accumulating life experiences and tend to be relatively stable. The values that are important to people tend to affect the types of decisions they make, how they perceive their environment, and their actual behaviors. [68] {principle}

104. You know your history better than any





other person alive today. You are the world's foremost expert in the subject of You. [69] {principle}

105. 'Living more in the here and now — or, as the popular term goes, more mindfully — helps us appreciate what to do next. Our history can provide us some general guidance, but changing our behavior requires using history as a source of wisdom, not as a source of change itself.' [69]

CULTURAL

29. 'Enough is enough? Good life of Goods life?' [38] {trend}
People are slowly moving away from mass consumption towards smaller amounts with greater meaning.

30. 'There is a great lack of trust' [39] {trend}
People are increasingly losing trust in organizations and governments

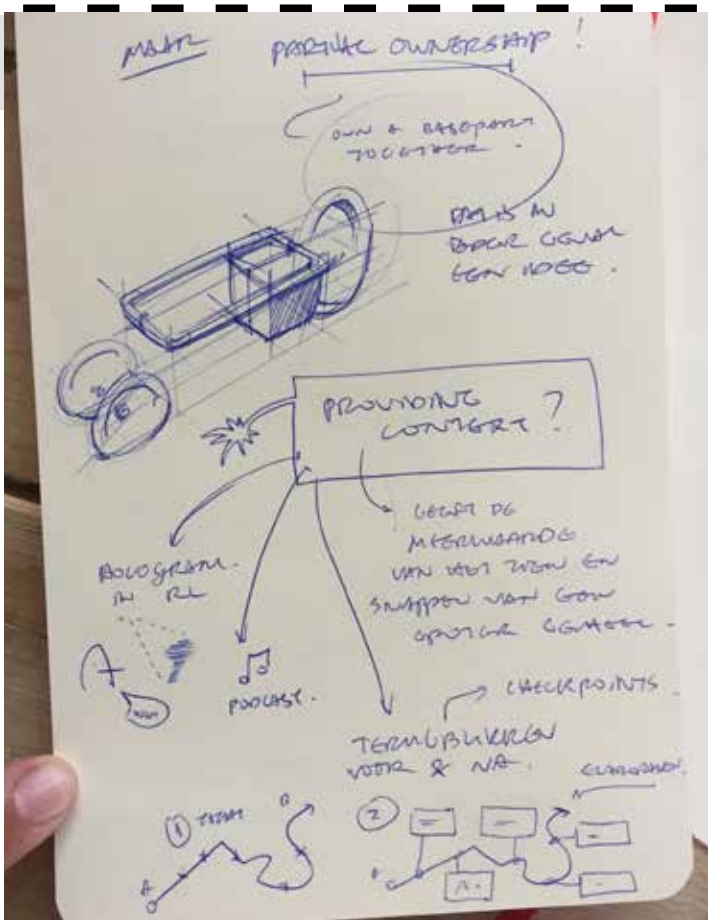
31. 'The love for community will (hopefully) increase over shooting up someone else's/ a new kind of patriotism' [11] {development}

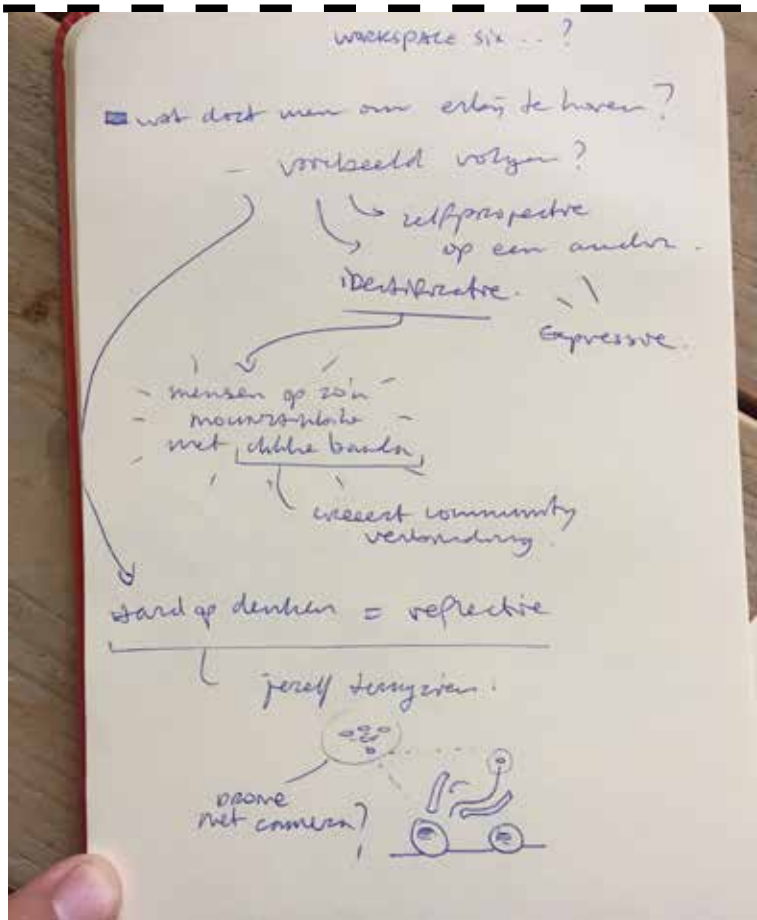
32. 'People will be newly aware of community and interdependence' [13] {development}

33. 'Expertise matters' [12] {development}
A greater positive attitude towards expertise

34. 'There will be greater value connected to

REFERENCE IMAGE





health' [bron?] {development}

35. 'Places where people have to gather in close proximity will be rearranged and its activities accordingly' [14] {development}

People dislike being too proximate to one another, people desire personal space

36. 'Lifelong learning will become the new essential role of education, as evolving technology forces the humans to change their roles' [31] {development}

37. 'Greater female participation and higher positions (as they do better)' [38] {development}

38. 'Globalization is a treat to 'tribes' and will presumably lead to more activism and even terror.' [bron?] {development}

39. 'People's expectations of brands have risen' [52] {development}

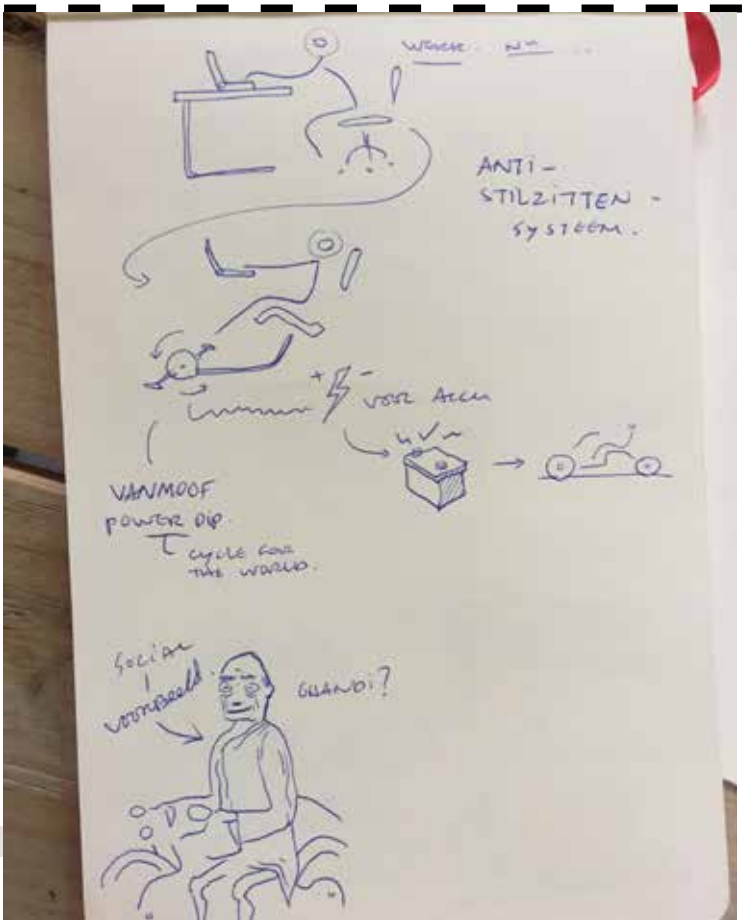
40. 'Surveillance as technological tool will become normal' [26] {development}

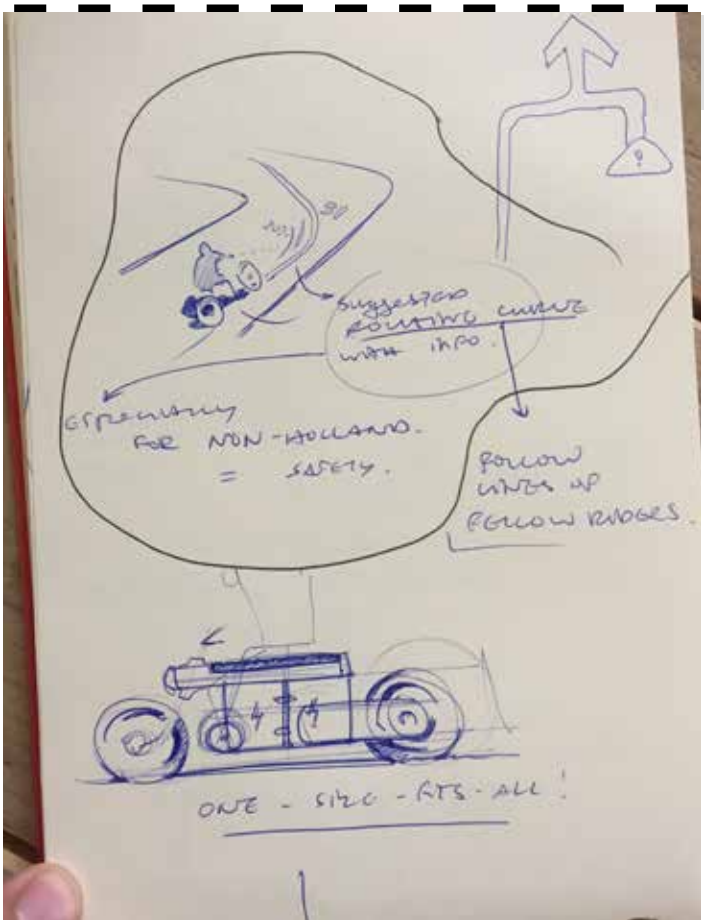
41. 'Happiness is not something ready made, it comes from our own action' [Dalai Lama]

42. 'All humans are equal, but some are more equal than others' {principle?}

43. 'Rory Gallagher is a great musician' {principle}

44. 'Storytelling remains integral to being





human and to human culture.' [47] {principle}

98. Meditation, sleep and off-grid industries are all booming. In a world where social connection is always on and commodified to the point of parody by influencers, solitude is becoming a new luxury. [65] {trend}

DEMOGRAPHIC

45. ''No more office coffee my friend' [bron?] {trend}
Work is no longer an activity connected to a physical place.

46. 'Things and people will move less' [18] {trend}

47. 'The world should reach 8.5 billion people by 2030, up from 7.3 billion in 2015. The fastest growing demographic will be the elderly, with the population of people over 65 years old at 1 billion by 2030' [43] {trend}

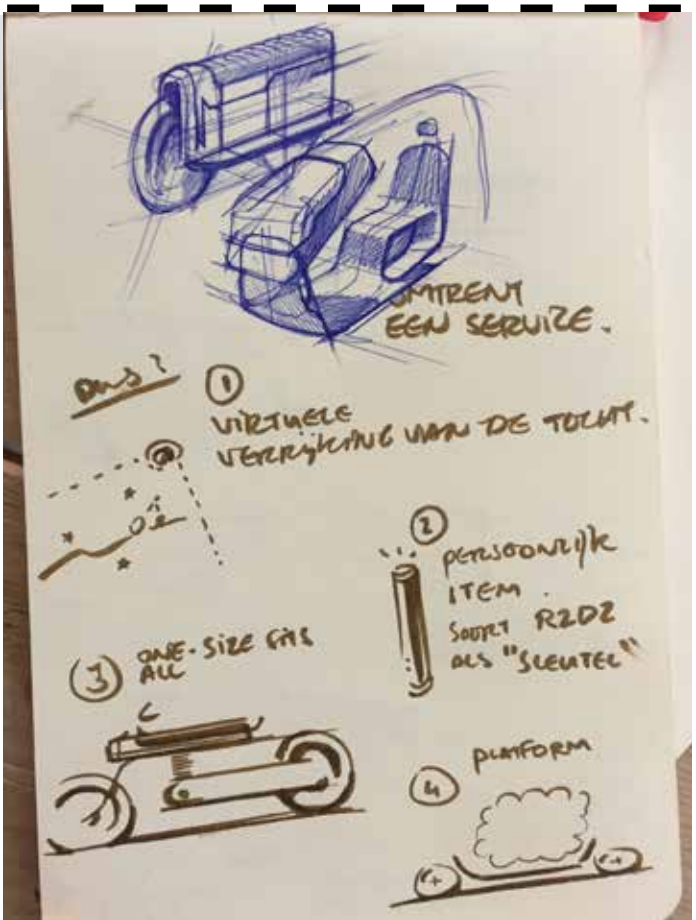
48. 'Remote work will become the new standard' [16] {development}

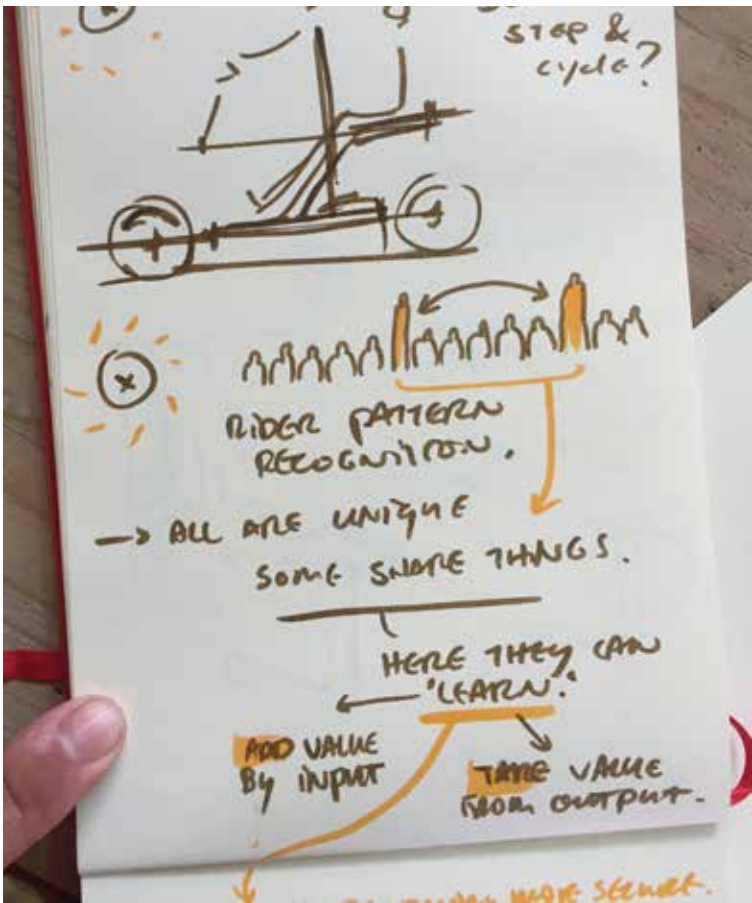
49. 'Young families often move out of the cities after the birth of a child' [29] {development}

50. 'Rising inequality between the developed countries and the third/2nd world.' [bron?] {development} (economic?)

51. 'In 2030, the most part of the worlds population will be connected to the Internet,

REFERENCE IMAGE





bringing tremendous numbers of new thinkers, workers, creators around the globe.' [35] {development}

52. 'The use of a car is becomes less and less in 2030' [40] {development}

People are turning to a wider range of tools to enhance themselves with mobility.

TECHNOLOGICAL

53. 'The costs of technology and connectivity will fall' [36] {trend?}

54. 'More merging and consolidation of manufacturing, distribution and retail.' [36] {trend}

Greater power will lie in fewer organizations. -> People are capable of working together and become stronger when joining forces.

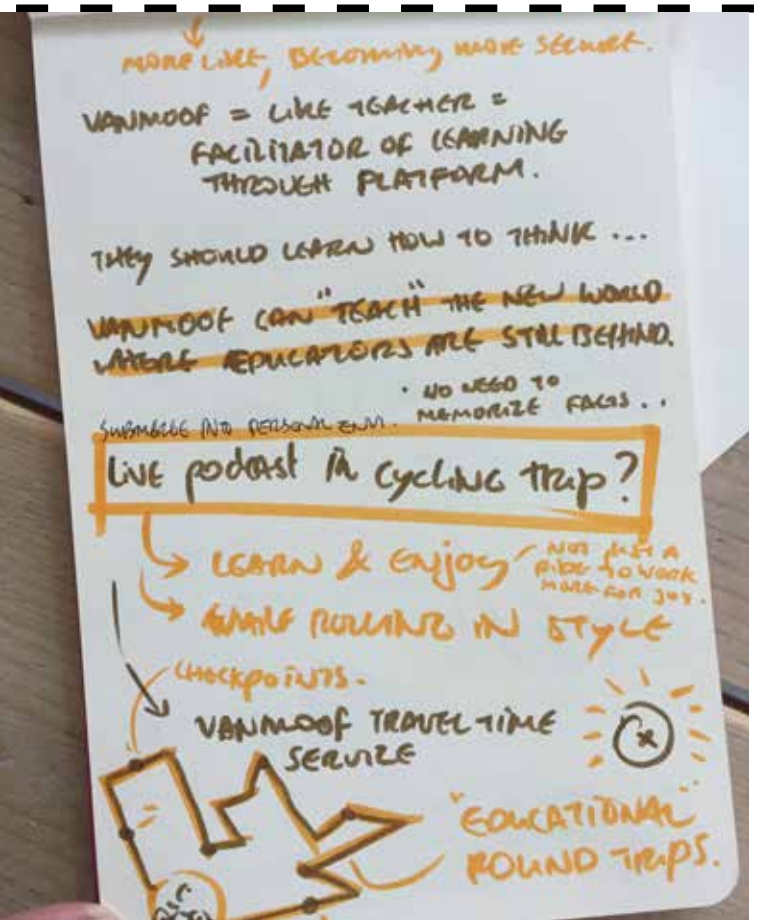
55. 'Municipalities are turning and adapting to models promoting sustainable decisions for public policy' [1] {development?}

56. 'People are increasingly willing to digitally communicate instead of direct verbal contact' [2] {development}

57. 'Sped up increase of diversification of supply chains' [25]

People do not want to rely on others for basic needs.

58. 'Affordable AI will achieve human levels of



intelligence. AI and machine learning will plan much of our lives and make us more efficient, well beyond choosing driving routes to optimize traffic' [30] {developments}

People are always looking for a way to make life more efficient and productive with least effort.

59. 'We're heading for a future of perfect knowledge, all is known, all is measured' [35] {development}

60. 'Genetically engineering plants to synthesize chemical compounds opens up a design space exponentially larger than petroleum, to create new materials that will let us live more sustainable and propel the economy forward.' [44] {development}

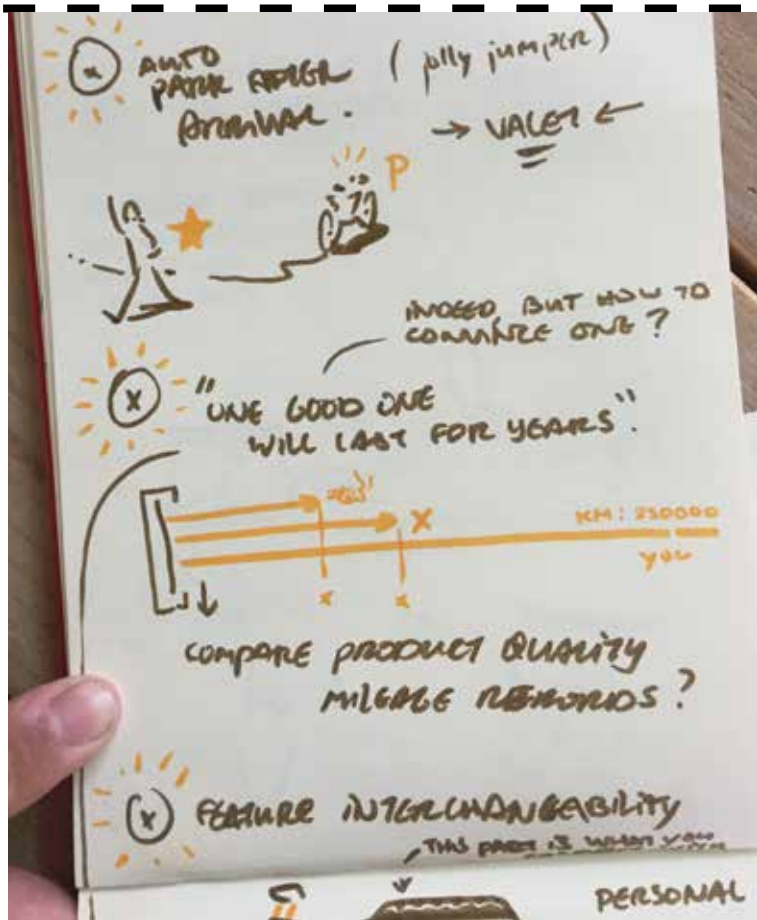
61. 'Our tendency is to assume, perhaps without realizing it, that AI systems have minds somewhat like ours.' [49] {state}

85. "Augmented Intelligence, where humans and machines exploit each other's strengths, is likely to become an increasingly common way of working. [54]

86. "But by 2030 we'll also start to see AI taking a much more sophisticated shape as humans will start to trust machines to fly planes, diagnose illnesses and manage financial affairs unsupervised. [55]

87. "We'll also have pivotal fights against state and corporate uses of facial recognition, social media monitoring, encryption back-doors, automated decision making and predictive

REFERENCE IMAGE



analytics. [56]

88. ”The love affair with big data will have soured. Good, accurate, authoritative data will be the hot desire. [57]

89. “We will become more attuned to the misuse of behavioral data about us. Privacy will continue to matter but it won’t be a one size fits all. Concepts of ownership of data will persist amongst the few, but the majority will act collectively to challenge organizations who are unethical. [57]

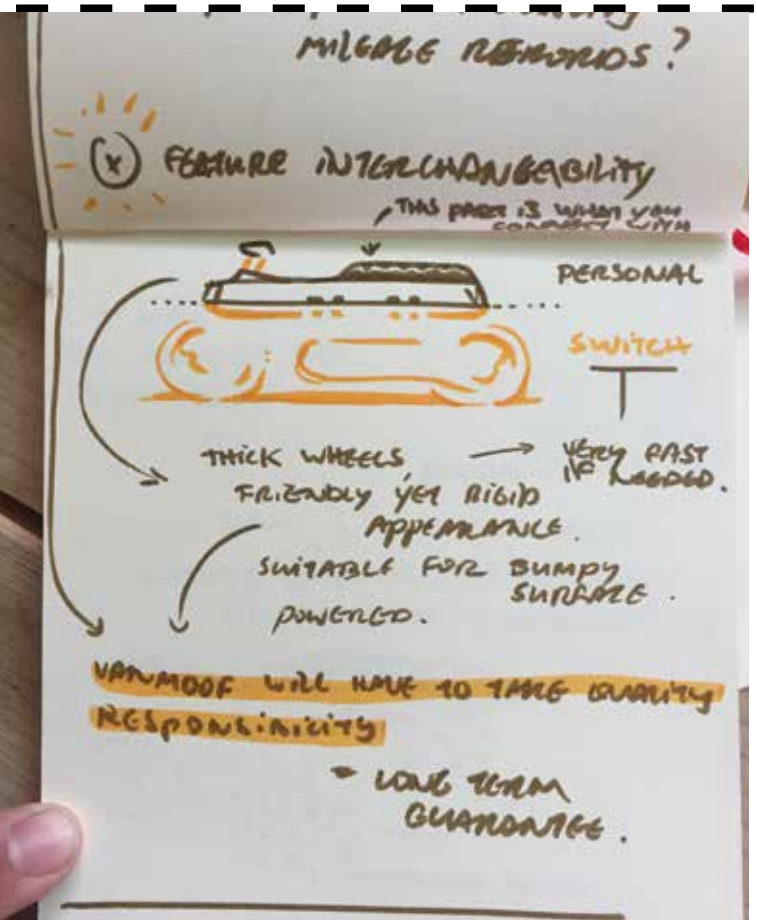
90. And so, similarly, through AI, we’re going to invent many new types of thinking that don’t exist biologically and that are not like human thinking. Therefore, this intelligence does not replace human thinking, but augments it. [59]

100. “Gen Z is unstoppable,” [65]

SOCIOLOGICAL

62. ’As communities become wealthier, expect sharper focus on purpose, meaning, making a difference and spirituality.’ [36] {trend}

63. ’A reaction to the fast pace of change these days - and the fast pace of life, for that matter - is that empathy is regaining value and even becoming a driver of innovation. [37] {trend}



64. 'As physical and virtual borders dissolve, seamless transitions and self-defined boundaries in all areas of life will be the norm.' [38] {trend}

65. 'New communities or "tribes" will be formed based on shared values and lifestyle sets and there will be a growing emphasis on balancing the need for self-expression and individuality against the WE mindset of the future.' [38] {trend}

66. 'The architecture surrounding us in private spaces will become increasingly flexible' [bron?]
{development}

67. 'Discrimination against people who are a disease-risk will rise' [7] {development}

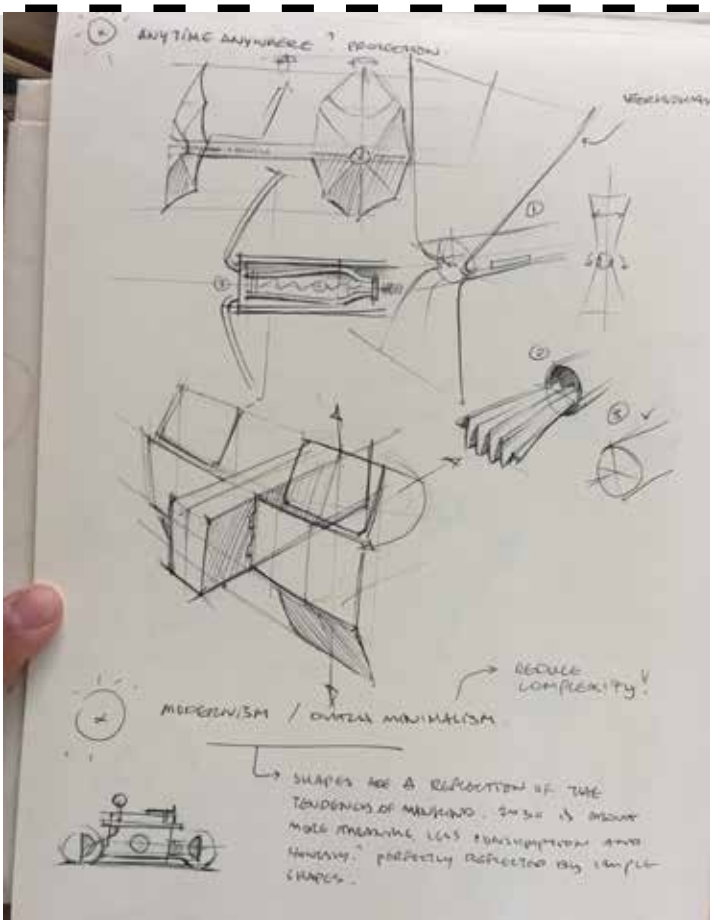
68. 'People tend to conform with values of a group' [9] {principle}

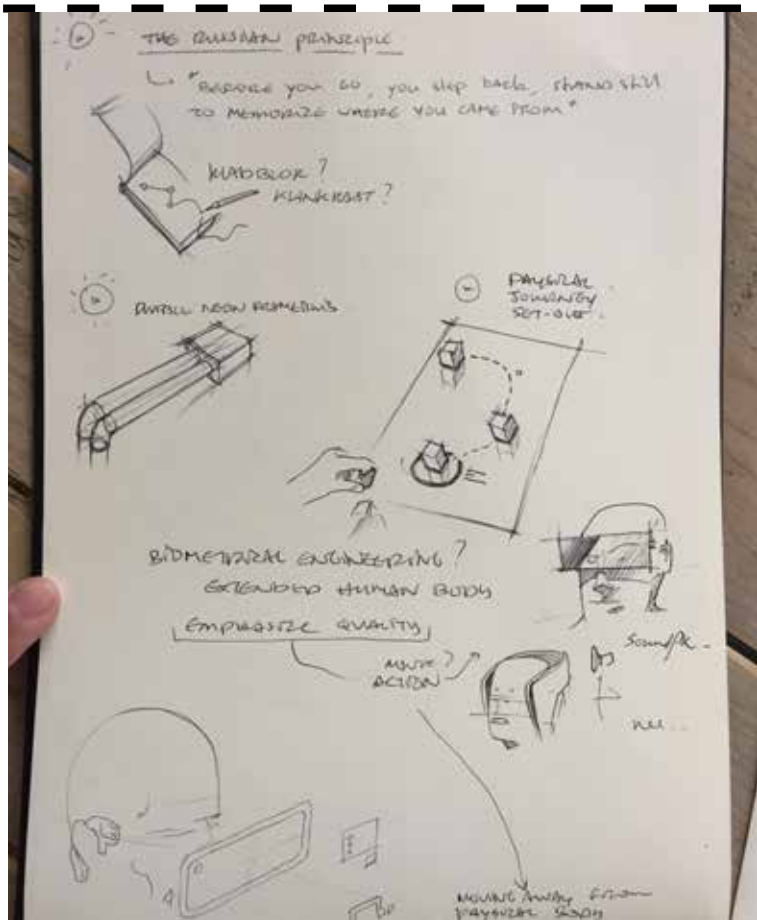
69. 'Conformity levels are found to be lower in countries where individualism is valued.' [10] {principle}

70. 'People are afraid of authenticity' [20] from a societal perspective it isn't safe {principle}

71. 'People have an intrinsic drive to belong and connect with others over simple things' Please reuse your towels -> 50% does it. OR 83% of people in this hotel reuse the towel -> great increase. BECAUSE: you will belong to that 83%! [24] {principle}

REFERENCE IMAGE





72. 'People want to add value and feel included within a group.' [45] {principle}

93. There are critically important universal skills needed for both innovation and the reaction to innovation. Critical thinking and problem-solving are enduring capabilities, more so now than ever in this world of rapid change and uncertainty. However, I would argue we do not currently have a very good strategy for developing these critically important capabilities. [61]

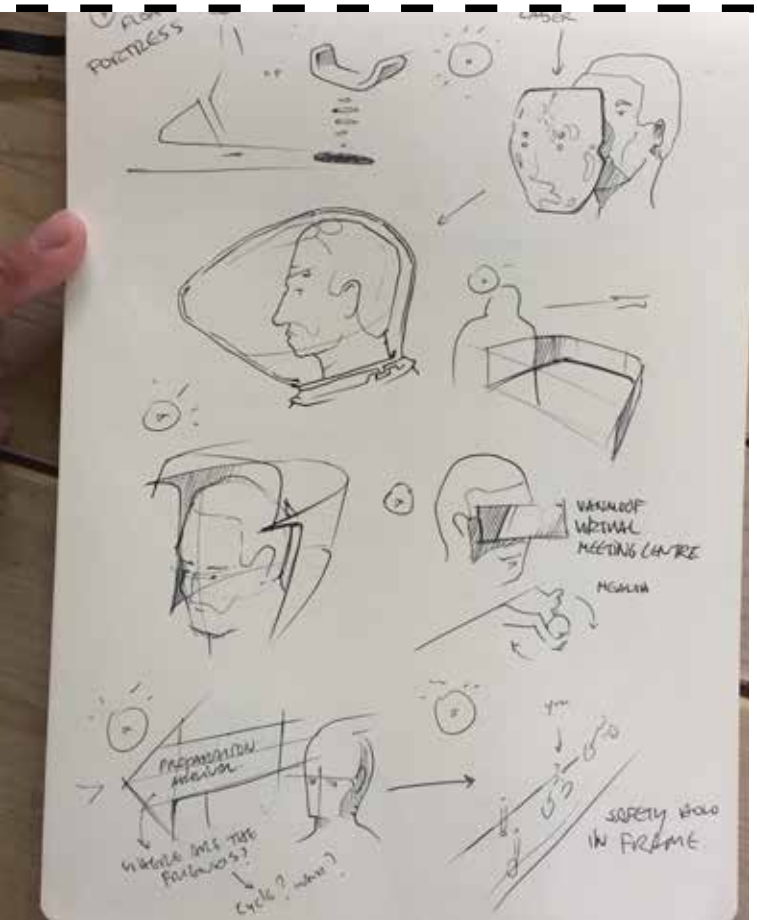
96. 'People with a high need for certainty are more prone to stereotypes than others and are less inclined to remember information that contradicts their stereotypes. They find ambiguity confusing and have a desire to plan out their lives rationally.' [63]

97. The rise of local community groups, communal living and work space and rent-a-person services, revives opportunities for human companionship eroded by modern realities. [64]

ECONOMIC

73. 'The cost and use of energy will presumably have greater influence on economic value' [bron?] {trend}

74. 'More people are willing in ethical buying and believe they can positively contribute, but want to be helped to do so, and involved by the brand' [5] {trend}



75. 'Online sales and home-delivery is increasing' {trend}

76. 'Over 85% of people live in emerging markets. America and Europe will decline as global players' [36] {trend}

77. 'Consumers and citizens demand, on the one hand, transparency and ethics, and on the other, more choice and discounts.' [38] {trend} 'Organizations must shape up to meet consumers' and society's demands for radical transparency. Adapting to an open and approachable model now — disclosing the good as well as the bad of the organization's "value ecosystem" — will earn trust from people and consumers in the future.' [38] {trend}

78. 'A resistance grows towards the market-based pharmaceutical and healthcare industries and shift towards a public sector' {development}

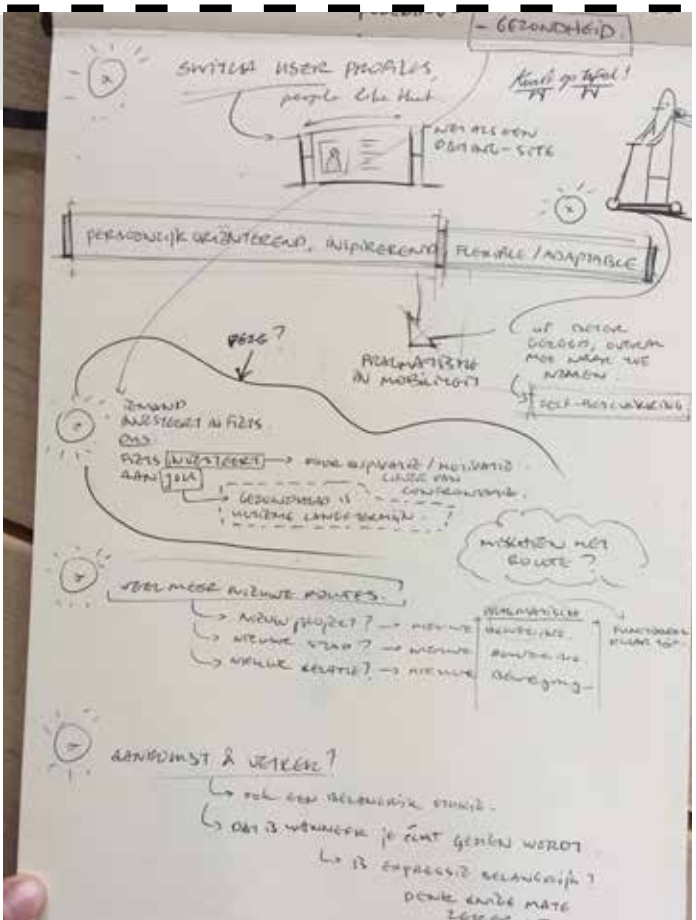
79. 'As machines outperform humans in repetitive work, skills become more important' [23] {development}

80. 'The "gig" economy will continue to expand where professionals sign on as contractors or freelancers and then move on to the next gig.' Work on demand [31] {development}

83. The shift from a supply-driven towards a demand-driven economy. [53] {development}

99. 'Successful brand communities are built

REFERENCE IMAGE



around a shared passion between users, facilitated by the brand. The ones that are dominating the culture right now respond to our need for deeper, real-life, person-to-person connection.' [64]

102. Being able to accommodate the new will come in handy. As the world progresses, it will bring with it new technologies and ideas. Constant learning is the key to being prepared for any changes that the future may bring. [67] {development}

OTHER

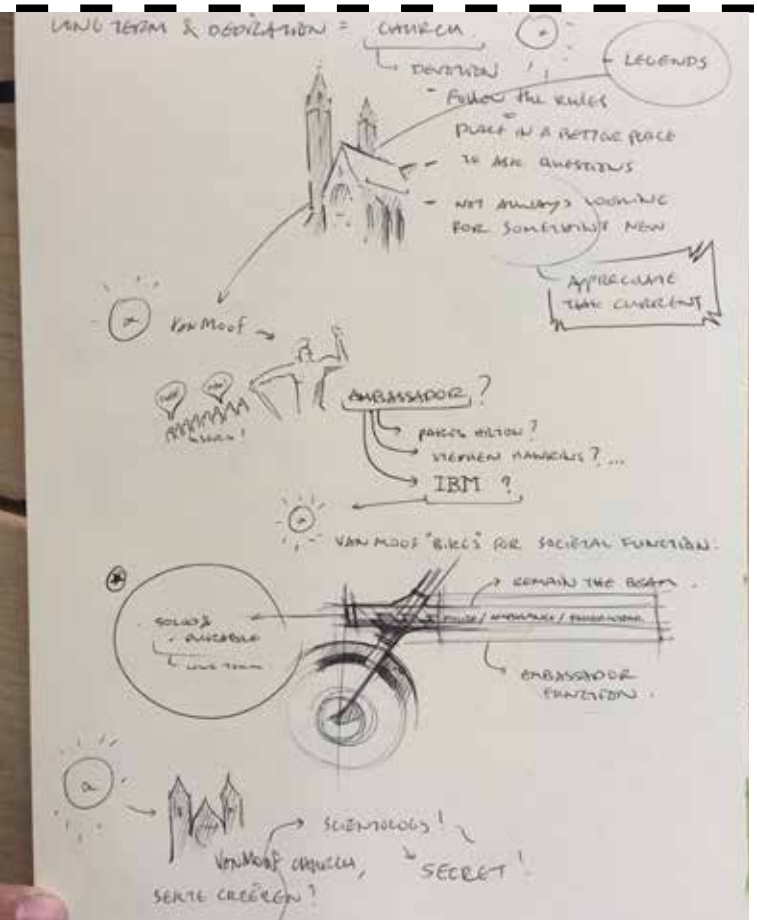
'The popularity of open (in house) architecture will decrease and make place for separated area's due to hygienic reasons' [4] {trend}

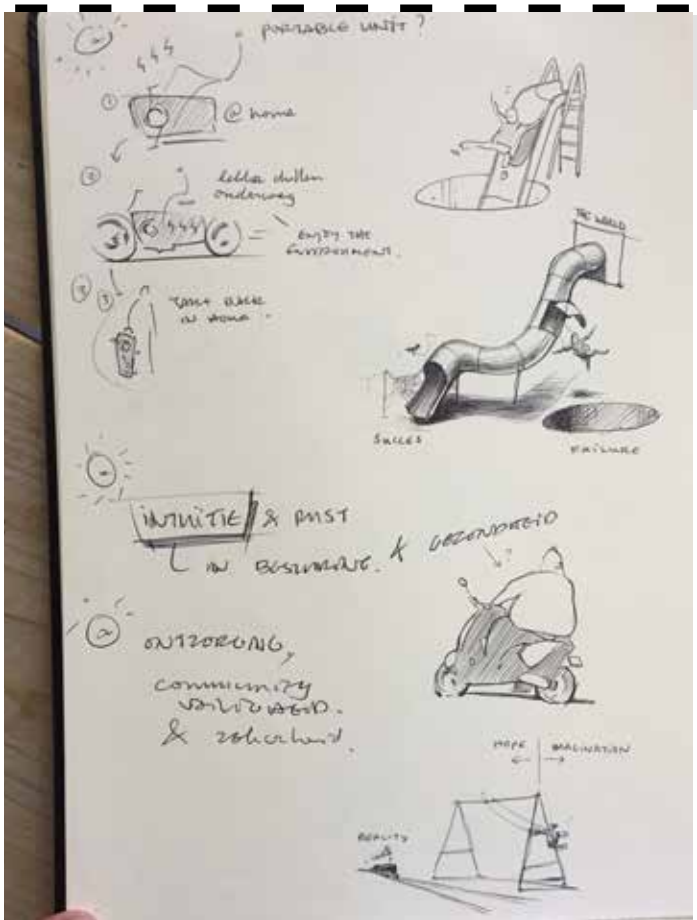
84. 'Job automation everywhere possible' [17] {development}

83. 'We will also see an explosion of data-driven technologies that make buildings, the grid, roadways, and water systems substantially more efficient.' [30] {development}

81. 'Stronger storms, rising seas, fiercer wildfires' [41] {development}

'But the gains are unevenly distributed, and climate change now threatens to undo much of the progress, pushing millions back into destitution and creating a "climate apartheid."' [42] {development}

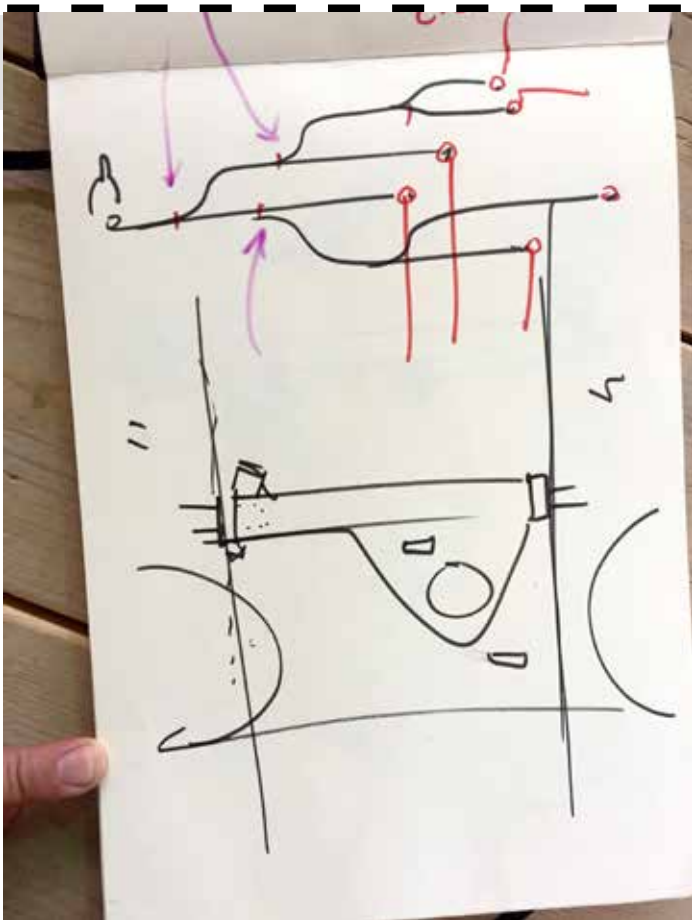


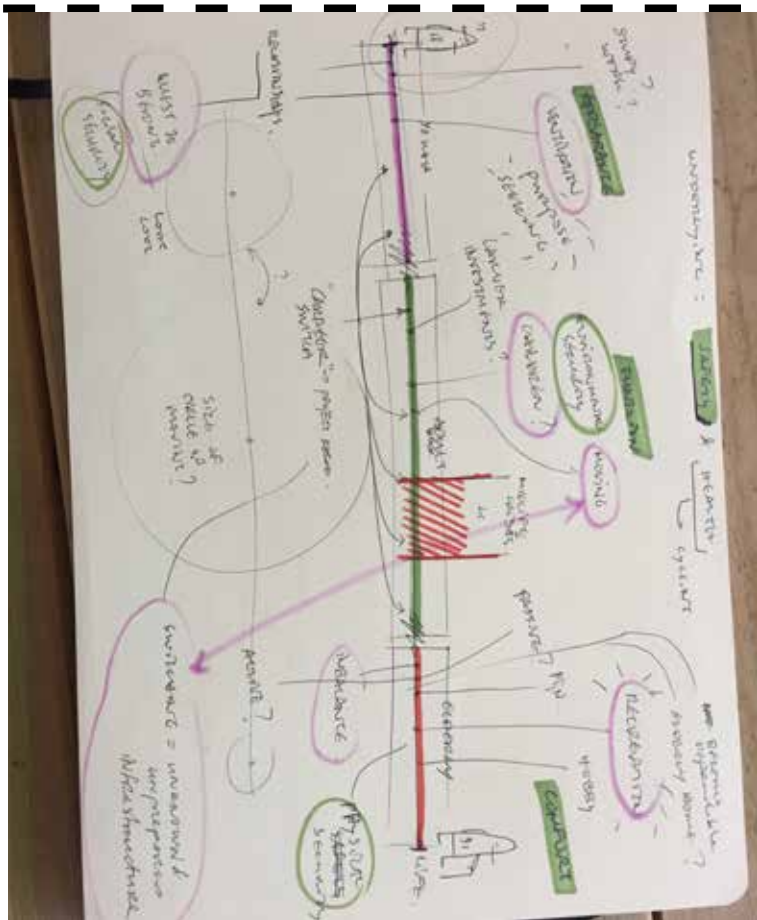


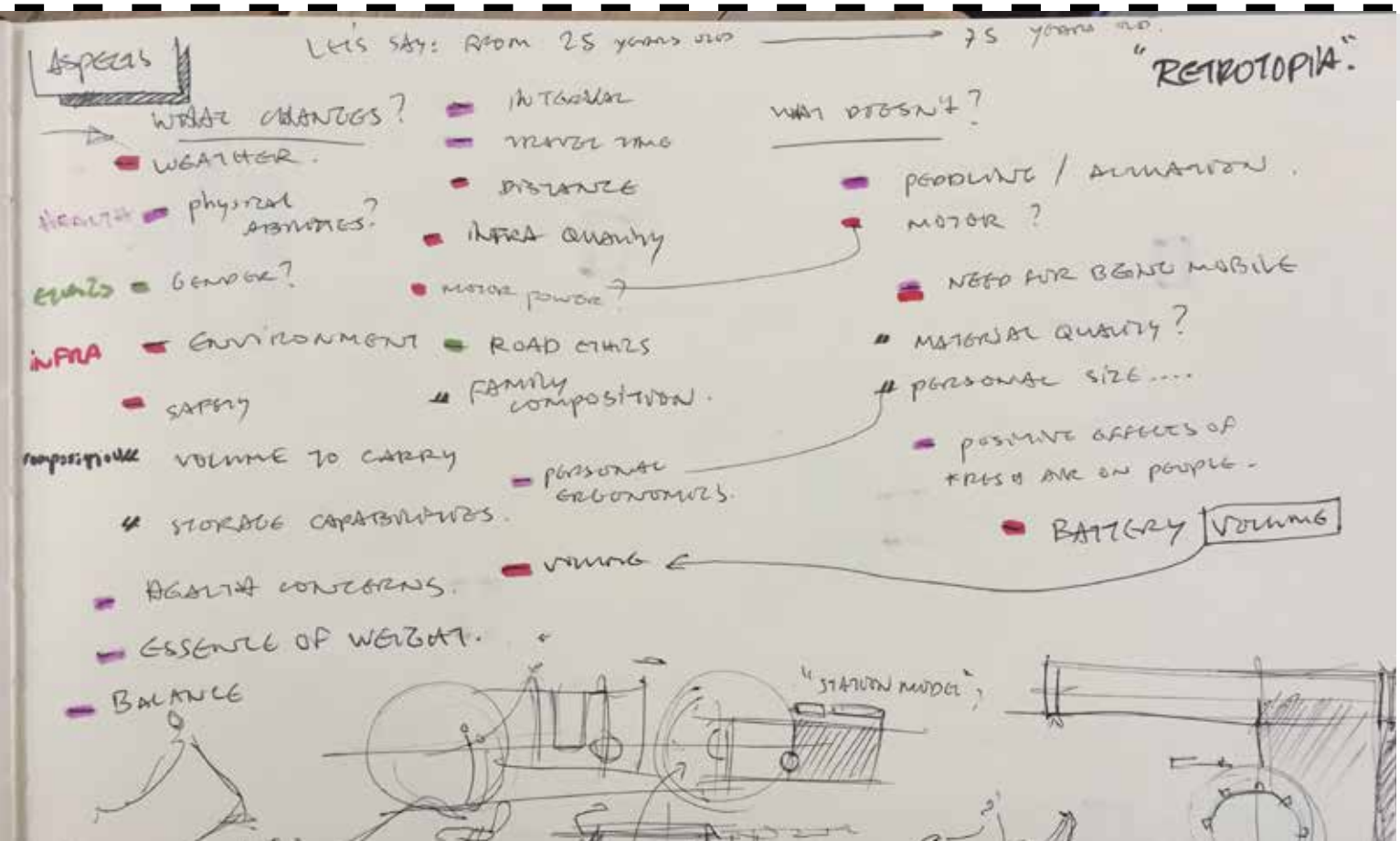
82. 'We're heading for an ecological crisis' [34] {development}

'Mother nature is on a comeback' [33] {principle}

REFERENCE IMAGE

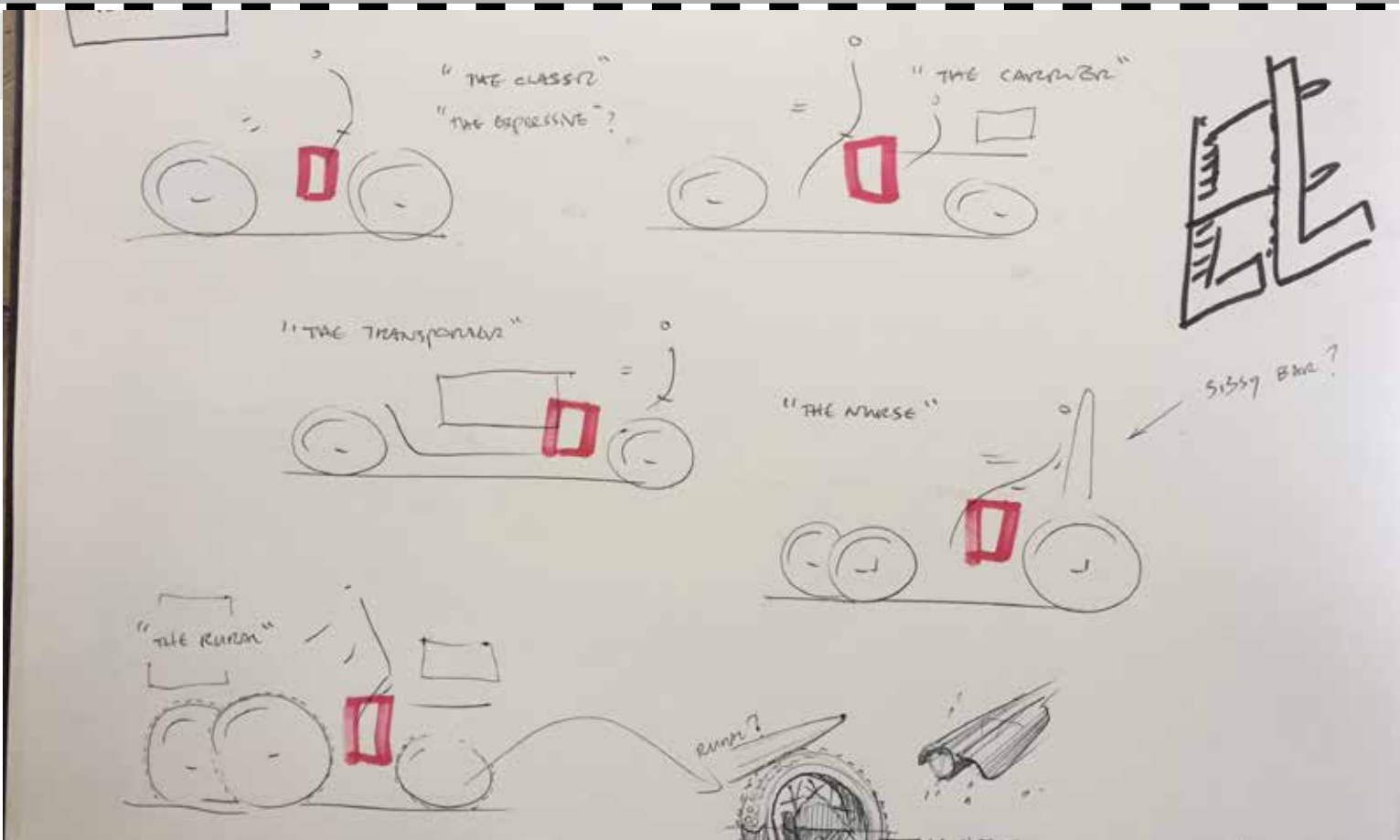




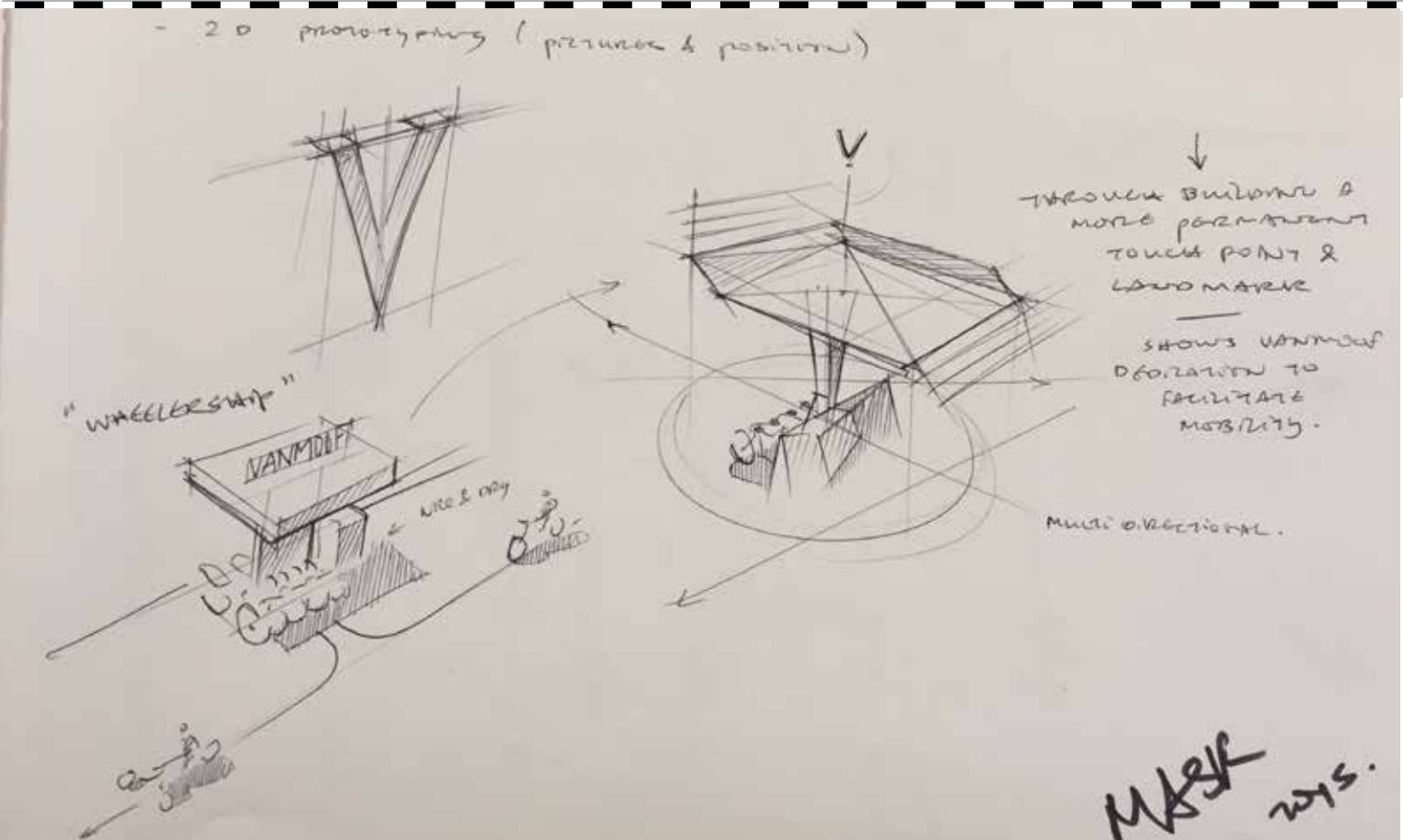

Aspects
Let's say: From 25 years old
75 years old.
"RETROTOPIA".
WHAT CHANGES?
WEATHER.
physical abilities?
GENDER?
ENVIRONMENT
SAFETY
VOLUME TO CARRY
STORAGE CAPABILITIES.
HEALTH CONCERNS.
ESSENCE OF WEIGHT.
BALANCE
INTERNET
TRAVEL TIME
DISTANCE
INFRA QUALITY
MOTOR POWER?
ROAD CHIEFS
FAMILY COMPOSITION.
PERSONAL ERGONOMICS.
VOLUME
WHAT DOESN'T?
PEDELEC / ALIMENTION.
MOTOR?
NEED FOR BIKE MOBILE
MATERIAL QUALITY?
PERSONAL SIZE....
POSITIVE EFFECTS OF TREES ARE ON PEOPLE.
BATTERY
VOLUME
"STATION MODEL"

REFERENCE IMAGE

(Page absent in printed copy)

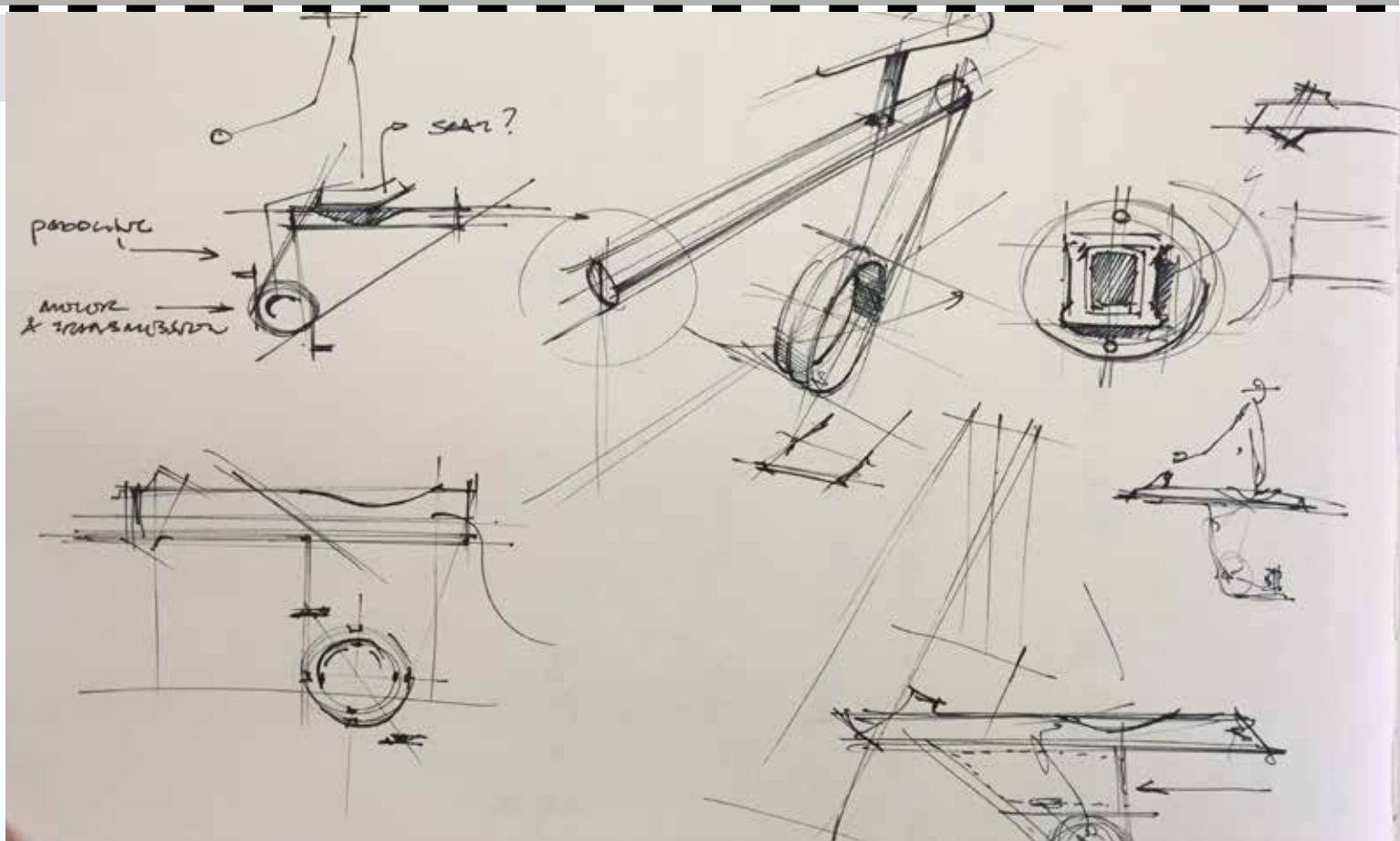


(Page absent in printed copy)

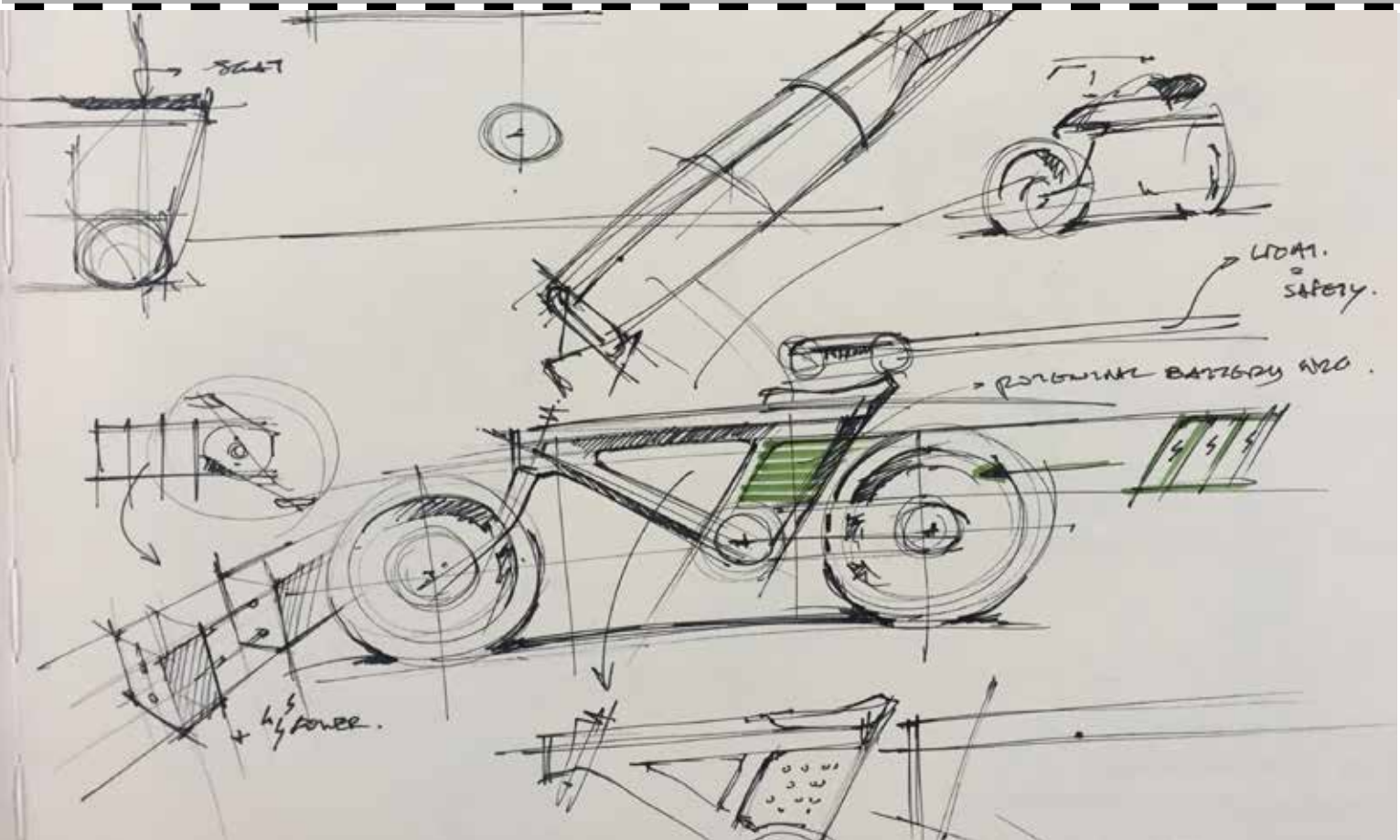


REFERENCE IMAGE

(Page absent in printed copy)

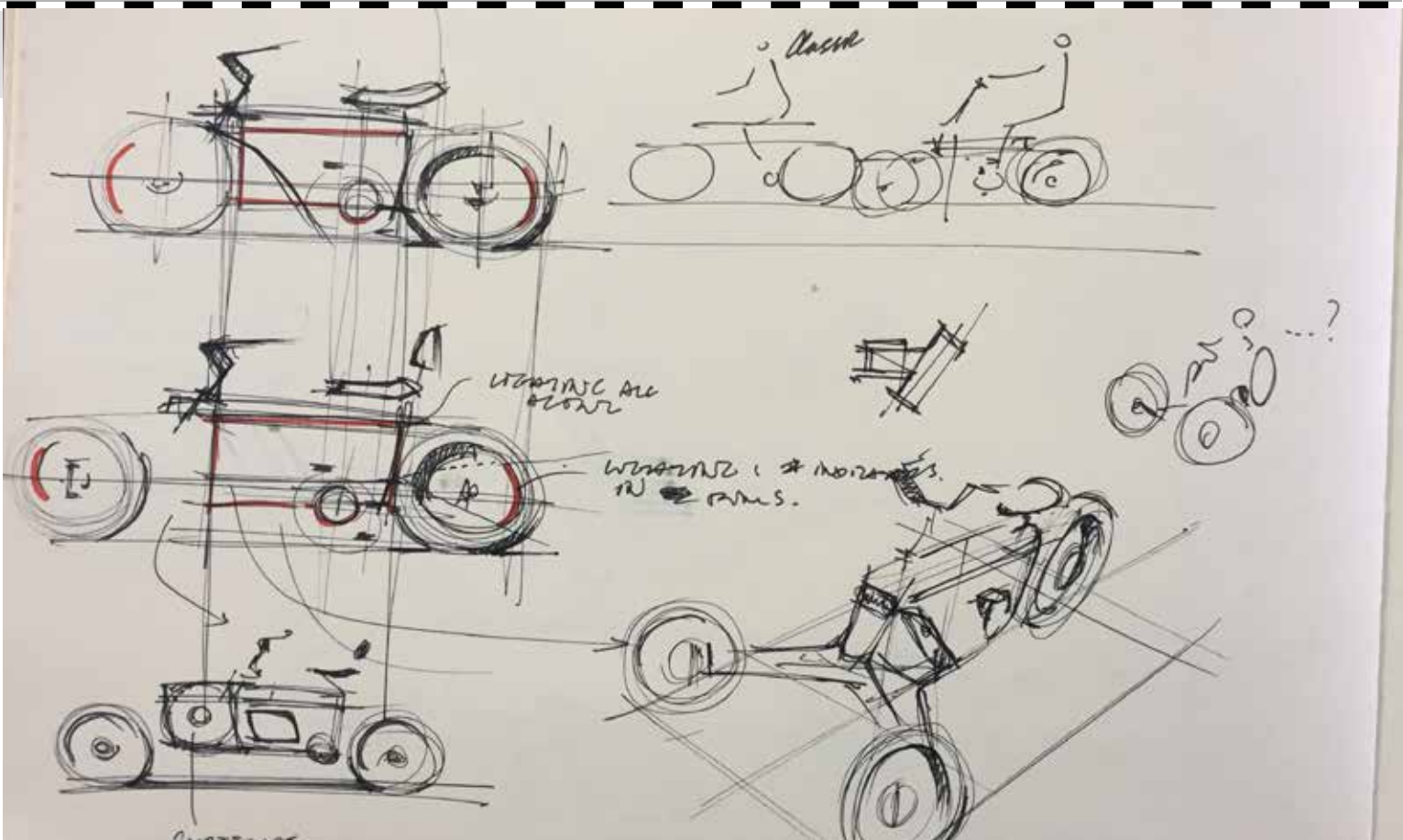


(Page absent in printed copy)

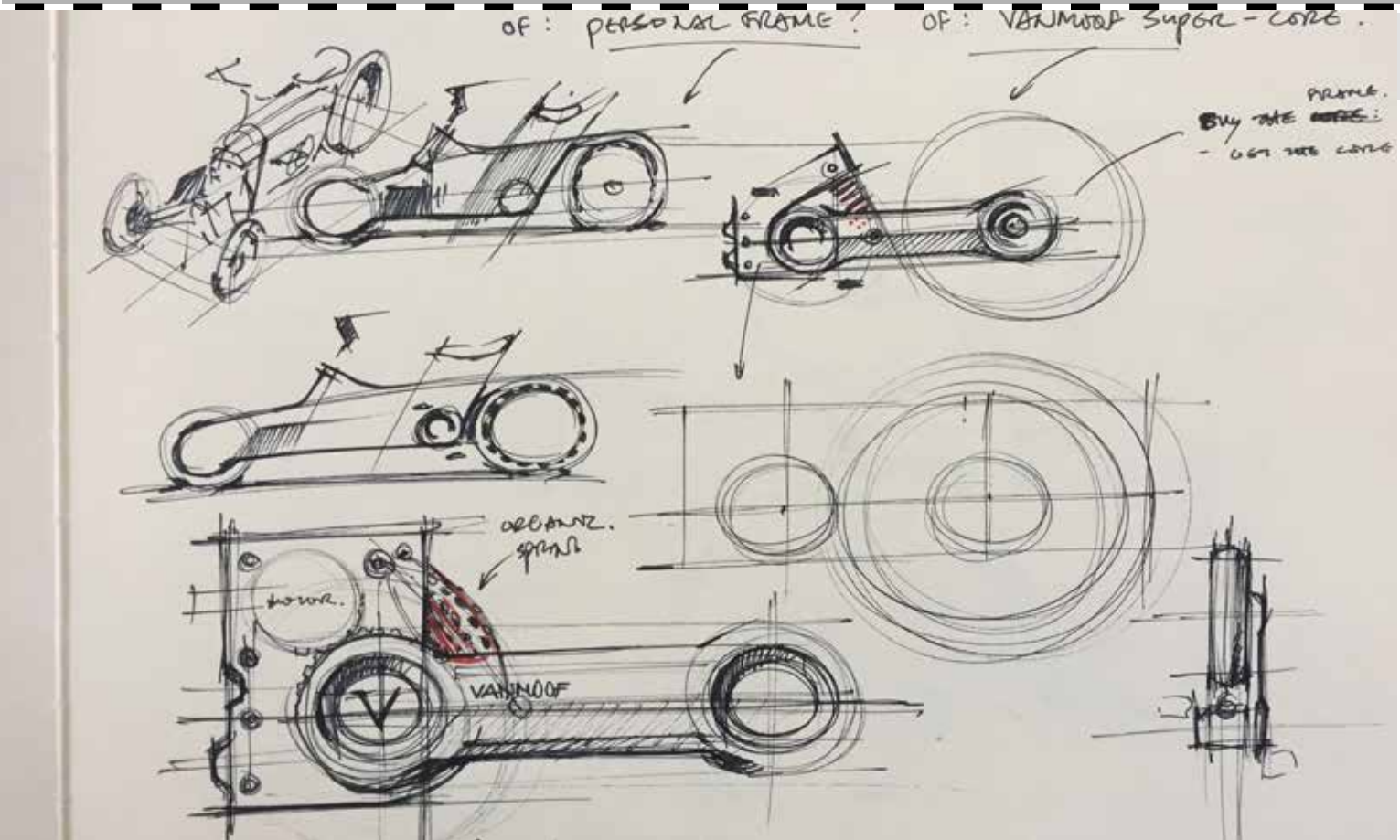


REFERENCE IMAGE

(Page absent in printed copy)

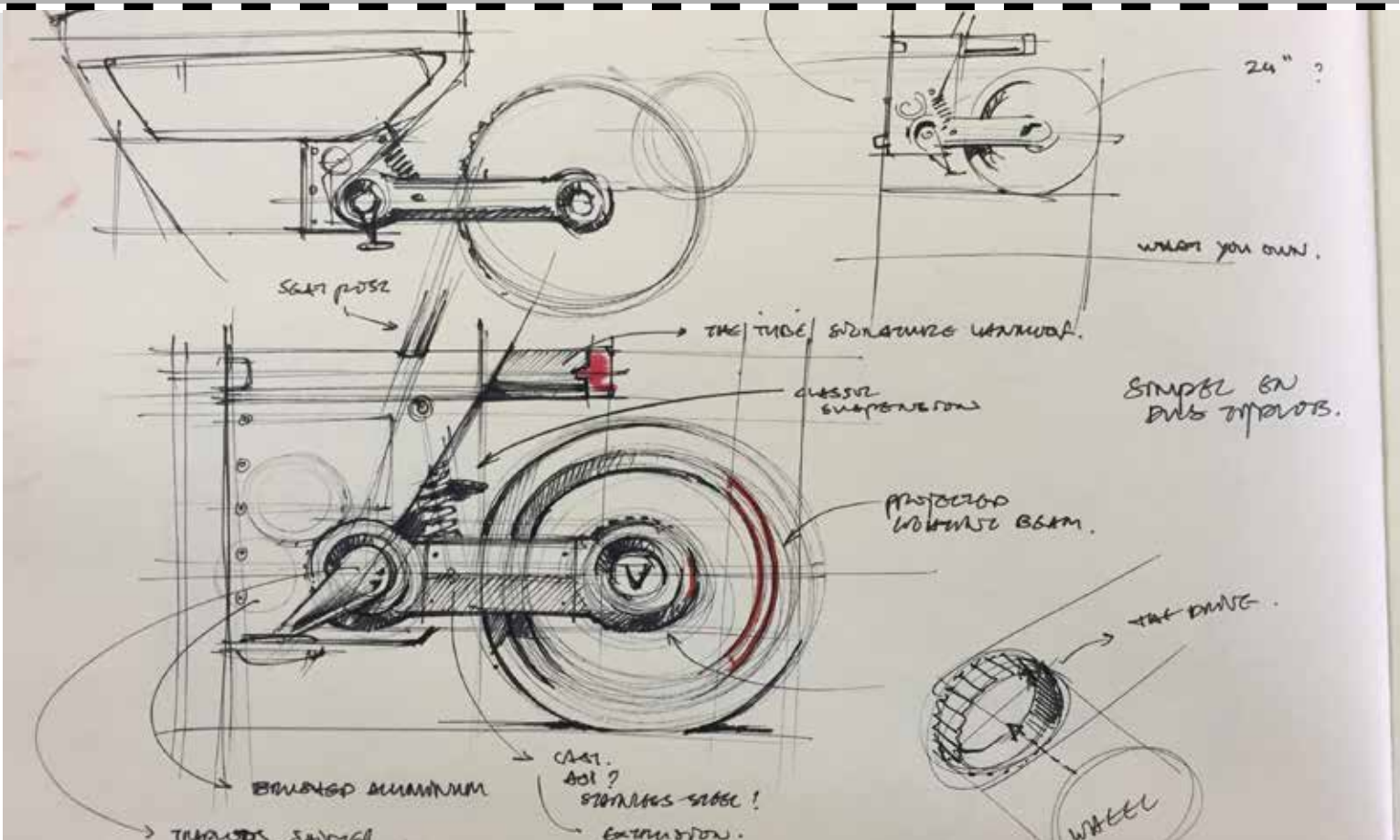


(Page absent in printed copy)

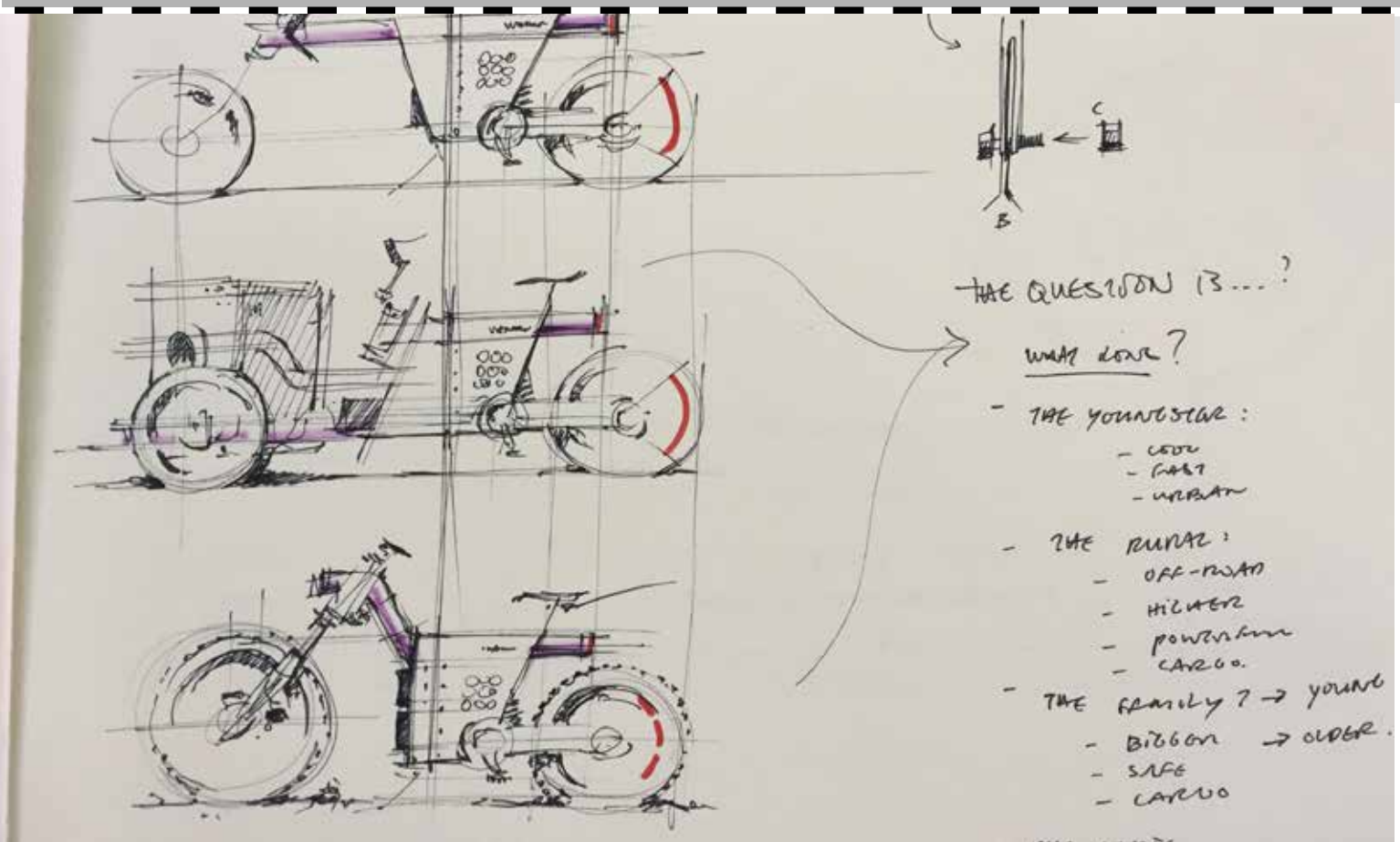


REFERENCE IMAGE

(Page absent in printed copy)

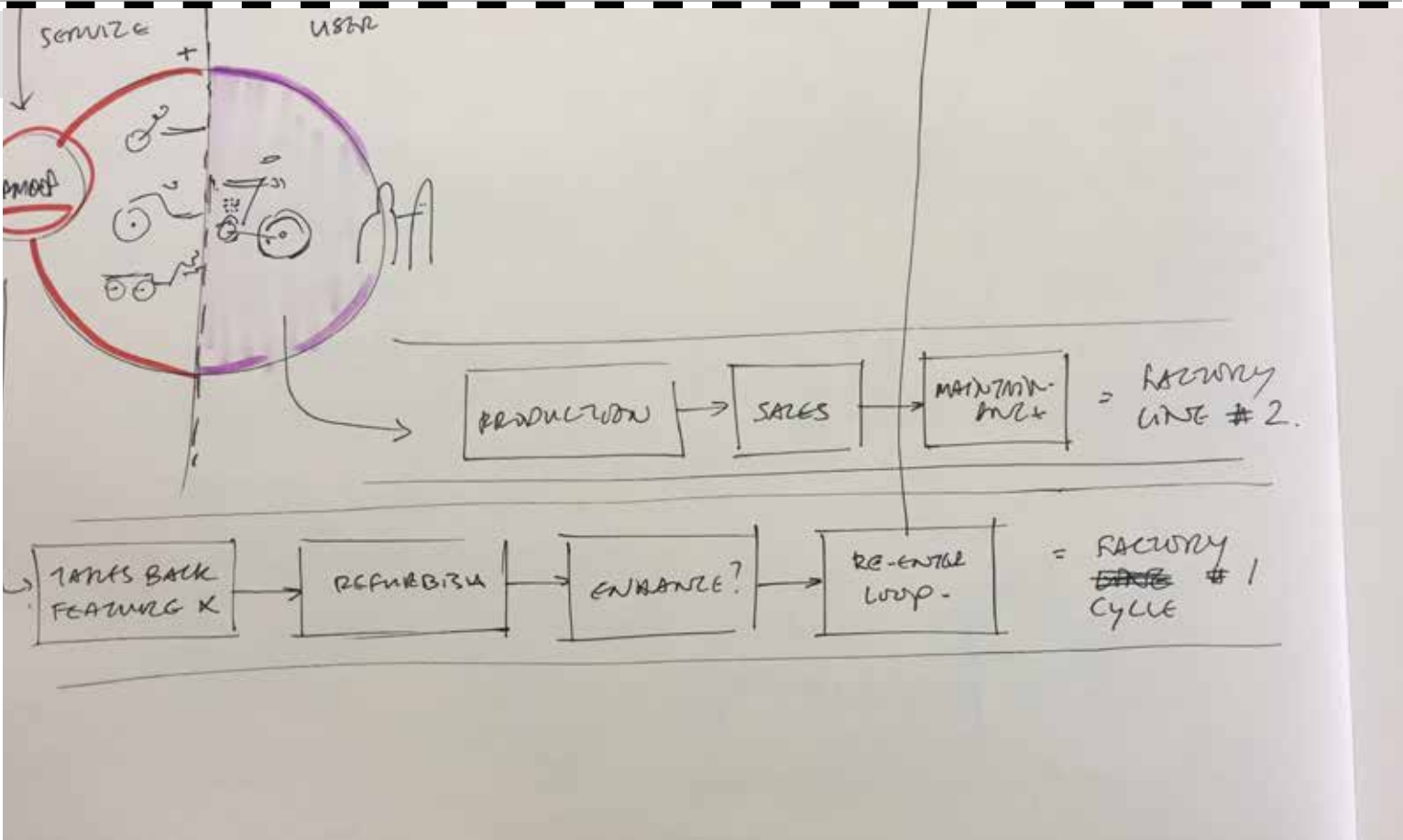


(Page absent in printed copy)



REFERENCE IMAGE

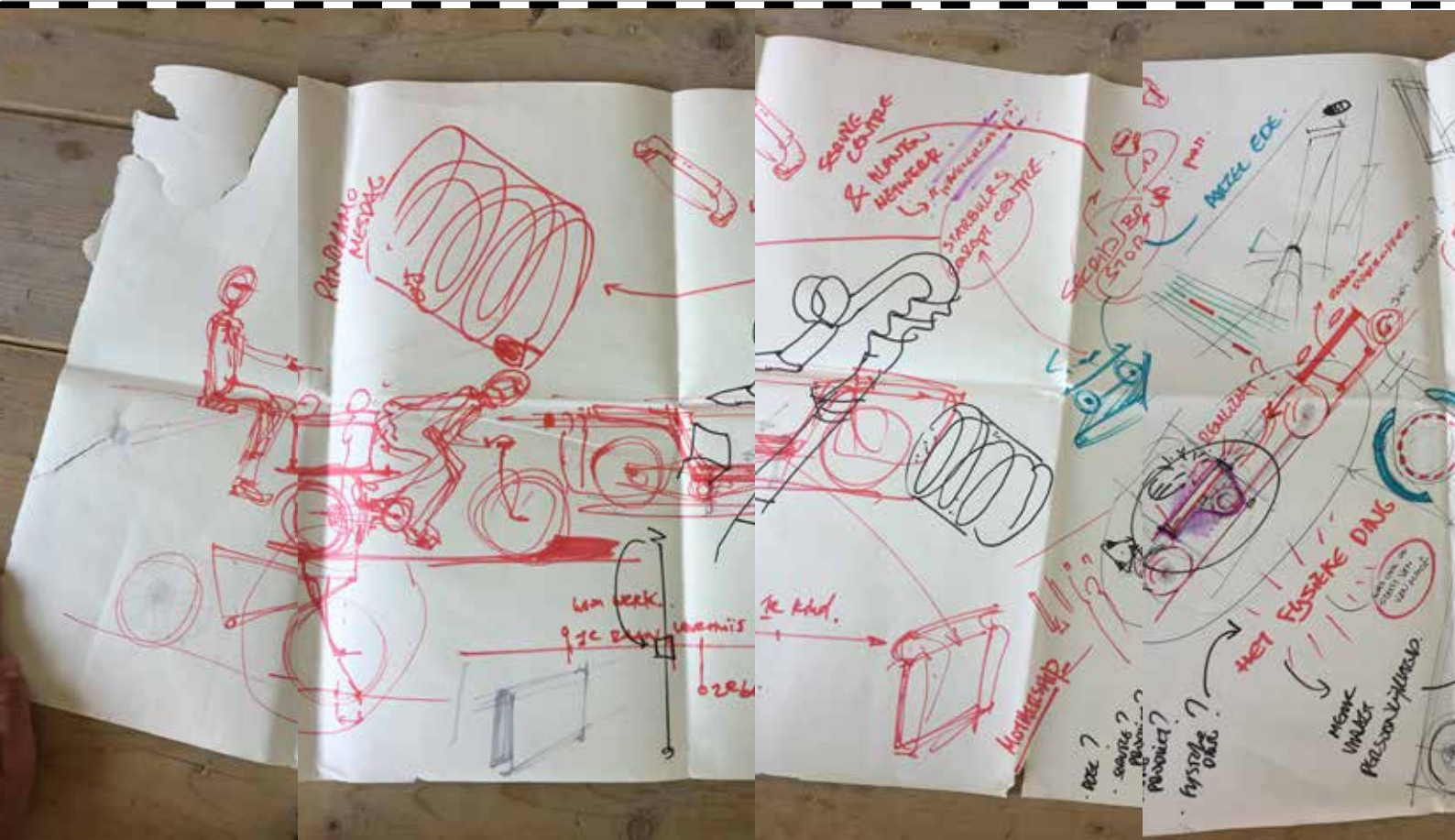
(Page absent in printed copy)



(Page absent in printed copy)

REFERENCE IMAGE

(Page absent in printed copy)



(Page absent in printed copy)