

# Reinventing the shopping trolley for young adults: A user-centered design approach to improve the experience of urban, car-free grocery shopping

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Master's dissertation submitted in order to obtain the academic degree of  
Master of Science in de industriële wetenschappen: industrieel ontwerpen

Academic year 2022-2023





## Preface

First, I want to thank Marina Emmanouil, Ellen De Vos and Joris Ronsmans for their guidance throughout this thesis. They have provided me with excellent feedback, knowledge and assistance during the whole year. They offered support and understanding, even during difficult times.

Furthermore, I also want to thank Yves Peeters and Sander Zelck, two designers who also coached me at Achilles Design. Their opinions and feedback were essential to keep improving the product and its design. I also want to thank Erik Sijmons, senior design director at Samsonite, for providing me with feedback at critical milestones.

I also want to thank Guillaume Segaert for providing me with feedback on the styling and helping me improve the design. Additionally, I would like to thank Julian Adam for sharing his thesis insights with me and helping me to accelerate my research.

Next, thank all participants who participated in the user testing and all respondents who completed the survey. Without them, gaining a good understanding of the user would have been impossible.

I also want to thank my brother, Cédric, for assisting me in improving the grammar of this thesis. Lastly, I would like to thank my parents and friends for their endless support and patiently listening as I talked for hours about shopping trolleys.

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25/05/2023

## **Abstract**

As cities increasingly limit car usage and personal car ownership declines, car-free grocery shopping presents unique challenges. Often traditional shopping trolleys are associated with older people, excluding younger people from this market. This research aims to design a trolley that improves the car-free shopping experience of young people in the city. The user-centred 5-stage model of the Design Thinking methodology is employed where in-depth interviews and user testing are utilised to understand young adults' unique needs and preferences. The research recognises the evolving needs of users and proposes a modular trolley design that accommodates foot and bicycle use, ensuring flexible transportation options. Real-life user testing in a supermarket provided valuable insights into the effectiveness of the proposed design. This project offers a potential solution to the challenges that young adults encounter in urban settings and can serve as a foundation for creating a novel shopping tool.



# Reinventing the shopping trolley for young adults: a user-centred design approach to improve the experience of urban, car-free grocery shopping

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**Keywords** - Shopping trolley, urban mobility, user-centred design, ergonomics, design for user experience

## I. INTRODUCTION

Despite many customers living within a short distance from their most frequently visited store, a significant percentage still use cars [1]. The cargo-carrying capacity of cars and the desire to save time still make this the most popular mode of transport to do grocery shopping [2] [3]. Cities worldwide are trying to minimise the use of private cars in the city centre [4]. To change people's behaviour, they must have access to tools and services that support this behaviour [5]. Although shopping trolleys succeed in enabling users to carry a large number of groceries on foot, current shopping trolleys are not popular amongst young people. A survey conducted as part of this research (n = 171) revealed this is mainly due to the utilitarian appearance and the association with elderly people.

Carrying two-wheeled luggage is often considered a small task and, therefore, has not been thoroughly researched. Despite all the work on industrial carts, only a few studies have examined the ergonomics and requirements of personal carrying materials. Research has shown that pulling luggage has the most ergonomic flaws [3]. It requires more awkward postures from the user and puts more stress on the pulling arm. On the other hand, pushing instead of pulling eliminates the need for twisting the upper body. Larger wheel sizes have been shown to require less pulling force [4]. A single curved pole also allows for more space between the user and the trolley, resulting in a better user experience [4].

Suitable alternatives need to be provided to citizens to accommodate a shift in transportation methods [5]. There is a

need for an affordable, emission-free grocery shopping method, separate from expensive cargo bikes. A sleek and innovative shopping trolley with improved functionality is necessary to attract a younger audience. By focusing on the user's needs, creative solutions can be developed to enhance the overall user experience.

## II. STAKEHOLDERS

This research is carried out on behalf of Achilles Design, an innovation and design agency from Mechelen, founded in 1994. They have supervised this research from a technical point of view. A stakeholder map (Fig. 1) is used to create a more global image of the essential stakeholders for this project, with the end-users being the centre of the stakeholders, young adults.

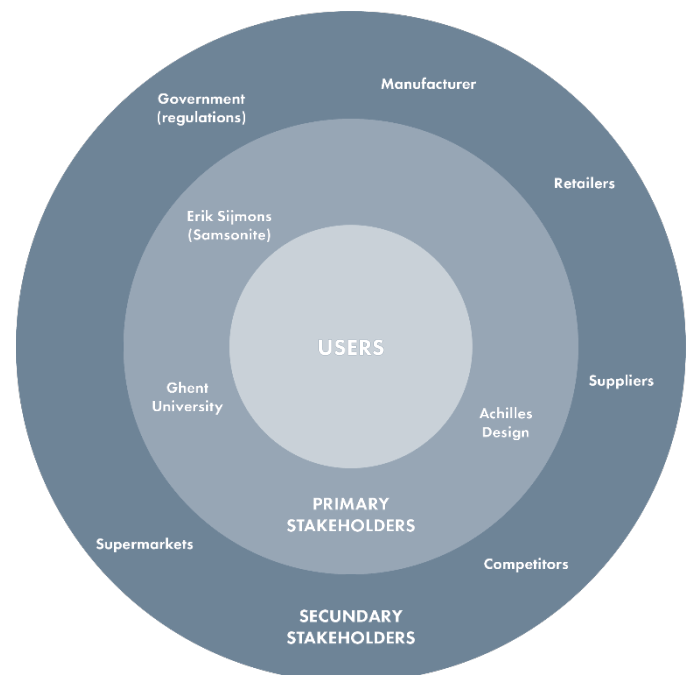


Figure 1 - Stakeholder map

The research question for this thesis is: 'How can we provide a new experience around car-free grocery shopping for young adults?'. The most critical parameters that will be investigated are based on a first benchmarking, revealing the aspects of current shopping trolleys where the most improvement can be made. These parameters are user experience, ergonomics, aesthetics and durability.

### III. METHODOLOGY

The methodology for this research project is based on and adapted from the five-stages model of the Design Thinking methodology proposed by the Hasso-Plattner Institute of Design at Stanford [6]. These stages are: empathise, define, ideate, prototype and test [7]. However, to better suit the needs of this project, additional stages were incorporated, including an analysis of existing products and detailed improvements of the product design. Figure 2 illustrates the design process that consists of three main spaces: problem, concept and solution.

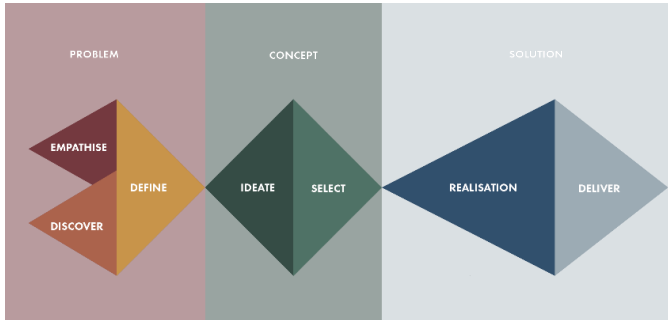


Figure 2 - Design process methodology adapted from the Design Thinking methodology by the Hasso-Plattner Institute of Design at Stanford [6].

#### A. Problem

The problem phase aims to understand and define the problem, establishing criteria for further development. This phase consists of three subphases: empathise, discover and define.

During the empathise subphase, the user's needs are thoroughly explored using techniques linked to user-centred design, such as questionnaires, interviews and observations [2]. Interviews ( $n = 11$ ) were conducted to understand the users' needs and habits. This included people that occasionally use a shopping trolley ( $n = 6$ ) and younger adults ( $n = 5$ ) who do not use trolleys. In addition, a survey was distributed among friends, family, acquaintances, and on social media platforms, collecting 173 responses from a diverse range of ages. After eliminating two incomplete answers, the analysis was conducted on 171 responses ( $n = 171$ ). This survey gathered insights on grocery shopping behaviour and respondents' views regarding shopping trolleys. Furthermore, customer journeys and user scenarios were used to understand the users' experiences.

The discover subphase aims to understand current products and technical needs. This was achieved through benchmarking, an interview with a salesman at a luggage and trolley store, and testing current products. Analysing the functionalities and reviews of existing products provided insights into technical possibilities. Examining concepts and previous student projects related to grocery transportation offered new perspectives. Furthermore, the author and two friends used three shopping trolleys over a few weeks to gain hands-on experience and better understand the user journey and needs.

In the define subphase, the findings of the previous subphases are brought together to create tools that can guide the design process. The conclusions of the survey and interviews were used to develop personas, representing generalised characters

that embody the target group. A list of needs and wishes for the product is drafted, with basic needs based on information from the benchmarking and additional needs and wishes derived from interviews, surveys and user scenarios, forming the product's Unique Selling Points (USPs). These requirements were translated into target product specifications. Furthermore, a list of design drivers was developed to guide the design process and allow hierarchy in the USPs.

#### B. Concept

The ideation phase started by brainstorming how the previously defined requirements could be implemented in a new shopping trolley design. Simultaneously the look and feel of the product were explored, using reference products from different categories. Different technical solutions were also investigated, exploring possible connections, wheels, handles, etc. Next, a morphological map was created based on the functions and USPs of the trolley. Combining different solutions for every function could create a wide range of concepts. The initial concepts were then analysed based on the requirements, but there was still a lot of room for improvement. The best concept that came out of this ideation was still leaning too much towards a basic shopping trolley. A new, more extensive morphological map and new concepts were developed in response. Next, the list of needs and wishes established during the previous phase was used to analyse the concepts and select the best concept.

#### C. Solution

The final stage focuses on transforming the concept into a tangible and feasible product through prototyping, testing and refinement. Prototyping was used to develop and improve critical aspects of the product design. User tests were performed to optimise the interactions between the product and the user, enhancing the overall user experience. Real-life scenarios, such as visiting a supermarket or a farmers' market with the new trolley, were simulated with the involvement of colleagues ( $n = 5$ ) and one external participant, providing valuable insights into user behaviour and identifying areas for improvement. The design drivers and feedback from users guided the refinement of the product. Many iterations were used to optimise the functionality and usability of the final product.

### IV. RESULTS

#### A. Empathize (Users)

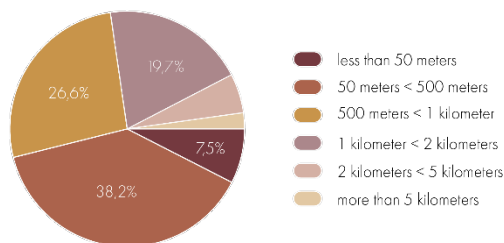
Interviews with people who occasionally use a shopping trolley ( $n = 6$ ) showed that they adapt their shopping routines to fill their trolley from the bottom, minimising the risk of damaging groceries. During interviews with young adults who do not use a trolley ( $n = 5$ ), many expressed difficulties shopping for groceries by foot or bike. However, they do not see a shopping trolley as an alternative. They prefer making multiple trips to the store than using trolleys, which they associate with older adults.

The analysis of customer journeys highlighted the introduction of bicycles as a means of transportation. A shopping trolley should be compatible with a bike to reach a wider audience beyond those near the store. This would

facilitate grocery shopping and make combining this with other activities like work or sports easier.

The survey results showed several findings. Firstly, 62.4% of the respondents belonged to the target age group of 18 to 40 years. Secondly, many participants who lived near a supermarket chose not to walk there, suggesting that walking may not be the preferred mode of transportation for grocery shopping, even for those nearby. Thirdly, 69.6% of the respondents reported occasionally using bicycles for grocery shopping (Fig. 3), indicating the popularity of cycling as an alternative transportation method. Finally, the survey found that 67% of the participants associated shopping trolleys with the elderly or senior citizens, suggesting a perception that older individuals primarily use trolleys. Further analysis, focusing on the target group (n = 106) of young adults aged 18 to 40, over two-thirds felt unable to carry enough groceries when walking to the store (n = 73). At the same time, only 6 percent used shopping trolleys occasionally (n = 6).

Proximity of respondent's homes to nearest supermarket



Transportation methods for grocery store visits

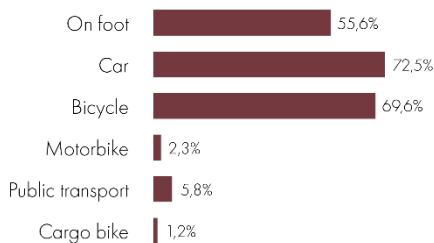


Figure 3 - A few interesting insights from a survey with 171 respondents

### B. Discover (Product)

After analysing the existing shopping trolleys, multiple aspects were discovered that could be enhanced in a new and improved design. The trolley should be easily cleanable and have an adjustable height. While the large capacity of the trolley bag allows for transporting numerous items, it also poses a risk of groceries colliding and getting damaged. The design should be suitable for supermarket usage. In conceptual work analysis, it was noticed that the most visually appealing products differed strongly from the traditional trolley design. According to a trolley salesman, elderly people sometimes place a shoebox at the bottom of their trolleys due to the excessive depth, which makes it challenging to retrieve items without bending.



Figure 4 – Pictures of two standard shopping trolleys [8] [9]

### C. Define

Based on the collected information from the previous phases, a list of needs and wishes for the new product could be drafted. Additionally, twelve design drivers were created to guide the ideation process. From these drivers, four were identified as the most important factors: ensuring compatibility with a bike, improved access to groceries, better ergonomics and avoiding collision of groceries.

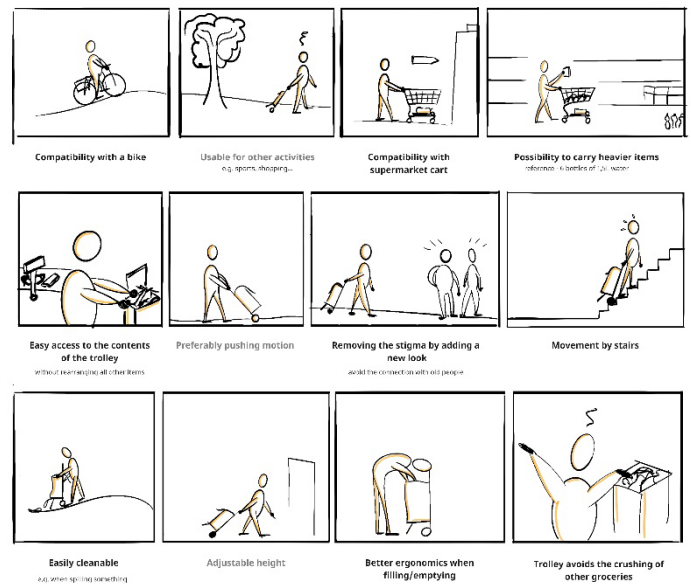


Figure 5 – Visualisation of the design drivers

### D. Ideation and selection

Creating a modular system is the only way to meet as many of the previously stated requirements as possible. The final concept, selected from the different ideas, involves modular bags and can be customised to meet the needs of various users.



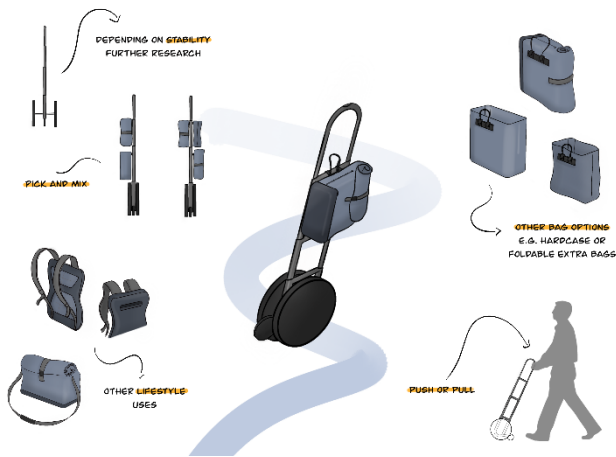


Figure 6 - Final concept from the ideation phase

## E. Realisation

### 1) General dimensions

A first mock-up of a bag (42cmx32cmx17cm) and a folded trolley (40cmx25cmx5cm) was constructed using cardboard and PVC tube. Although this does not conclude the final sizes, it provided a first guideline for further development. The sizing of standard bike bags from Ortlieb was used as a reference for the bag dimensions.

### 2) Development of structural elements

The critical elements of the trolley design are further developed and prototyped: the wheels, the bags and other general aspects like the handle and stand. Creating a stable wheelbase is crucial for the success of this concept. After some quick testing, it was clear that foldable wheels are necessary to provide enough stability for the loaded trolley. A feasible folding mechanism was created after a few iterations, using PVC pipes, 3D prints and many screws, showed in Figure 7.

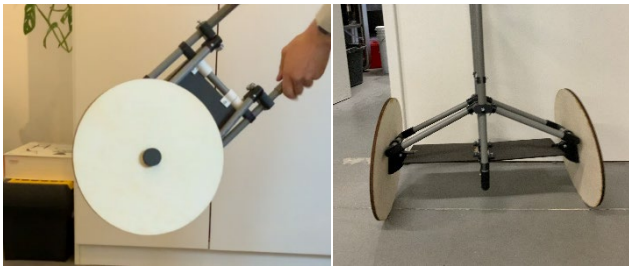


Figure 7 – Proof-of-concept of the folding mechanism

At the same time, the other parts of the shopping trolley were developed and prototyped. A handle was used from an old shopping trolley, and some interlocking tubes were used to build the frame. Various accessing methods were explored to design the bags using sketches and cardboard prototypes. Additionally, modifications were made to existing bags to test materials and storage capacities.

### 3) Exploration of key design drivers

The design drivers were further implemented to enhance the overall functionality and design of the shopping trolley. User testing was conducted to optimise handle ergonomics, including exploring different orientations and positioning in relation to the body. Furthermore, the height of the groceries was evaluated and adjusted to minimise the strain on the user.

Extensive exploration was conducted to guarantee compatibility with bicycles. The refined product design is presented through a sketch in Figure 8 and analysed based on the previously defined requirements. Additional optimisation is necessary and will be addressed in subsequent phases.

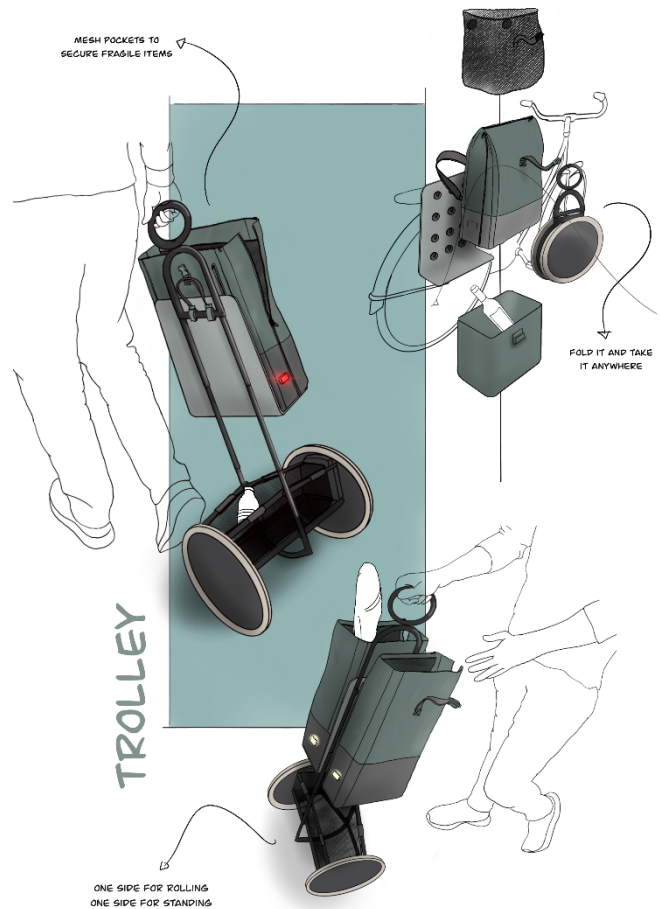


Figure 8 – Mid-term presentation sketch of the product design

### 4) Further improvement of the product design

The connection systems are redesigned to create a magnetic and secure ecosystem, elevating the user experience of the bags. The mechanism for unfolding the wheels is redesigned to ensure a functional and safe system. The new system is designed to support much weight without risking the folding system collapsing. Additionally, the overall styling of the product has been refined to enable seamless integration of different components, such as the stand.

### 5) Final prototype and user testing

To assess the product's interaction, the prototype must be robust enough to be walked around in a city. Not every aspect of the design can be incorporated, such as the folding mechanism, but all essential interaction points are present. The final Fidlock-system, used for the magnetic connections, is also integrated in the prototype to test user interactions thoroughly.

During the user testing (Fig. 9), most participants could identify the detachable bags, the handle, and the stand of the prototype. Some users assumed that larger items could be placed at the bottom of the trolley due to the available space. Many people found the Fidlock-connections to attach the bags to the trolley fascinating. Opinions on whether users would personally use the product varied, but most people recognised



the concept's potential. At first, some users felt that the small bag couldn't hold enough, but the issue was resolved with an update to a larger bag. Users found the option of a smaller second bag interesting for storing fragile items. The zipper improved bag accessibility, though users preferred only partially opening it to prevent things from falling out. Design adaptations from the user testing include adjusting the trolley's height and lowering the bags to minimise user effort, ensuring more space in the bags, and incorporating a handle with adjustable fixed positions.



Figure 9 – Two users during the user testing in a supermarket

#### F. Deliver

To answer the research question, 'How can we provide a new experience around car-free grocery shopping for young adults?' a new shopping tool has been developed, shown in Figure 10. This shopping tool is a modular system consisting of bags, a trolley and a bike mount. The bags are magnetically mountable onto the trolley, allowing for easy transportation of up to 40 litres of groceries. These same bags can also be attached to a bicycle using a magnetic connection. Moreover, the trolley can also be folded and attached to the bike.

The bags feature a solid back panel to maintain their shape when loaded with groceries. A zipper can remove this panel, allowing access to one or multiple shoulder straps. These bags can be used for daily activities such as commuting, going to the gym, or grocery shopping. Additionally, the bags can be customised to the user's needs by attaching inserts. For instance, an insert is designed to keep certain items cool for an extended period or securely store a laptop.

The trolley's height can be easily adapted to suit the user's preferences. Equipped with large wheels, the trolley is suitable for safely riding over obstacles or uneven surfaces. The handle is designed to rotate and securely lock into different positions, enabling effortless pushing or pulling. Furthermore, the two bags offer ample space for organising groceries, and the inner mesh pockets provide convenient sorting opportunities for bottles or other items.



Figure 10 - Render of the final product concept

#### V. CONCLUSION

This thesis aimed to create a new experience for young adults doing grocery shopping in an urban area. The survey results showed the reliance of the target age group on bicycles for grocery shopping and the association of shopping trolleys with the elderly, making them unattractive to young adults. This association can be avoided by giving the product a new look, as shown in the benchmarking of conceptual work.

The benchmarking of available products showed their limitations and highlighted aspects that can be improved. This includes improving the overall ergonomics of the product, making it easier to access the groceries and avoiding the groceries colliding. Through the ideation phase, it became clear that a modular design with customisable features was the most efficient way to meet the previously identified requirements. This approach allows users to adapt the trolley to their needs, making it versatile for daily activities beyond grocery shopping.

The prototyping provided valuable insights into critical aspects of the design, such as the folding mechanism. It allowed for user testing, making it possible to evaluate different aspects. This phase was crucial in identifying the design's positive aspects and flaws, allowing further iterations.

The user testing and interviews conducted with the participants suggest that the developed shopping tool has the potential to fulfil the needs of young adults who rely on car-free grocery shopping. However, it should be noted that due to the limitations of an eight-month, single-person project, the project could not be developed to a production-ready state. In addition, the limited time frame made it difficult to conduct multiple user tests and implement the necessary improvements.

Despite these limitations, this research project has progressed from a broad research question to a proof-of-concept of an innovative product. In conclusion, this study highlights the importance of user-centred design in addressing the challenges associated with car-free grocery shopping. The developed shopping tool provides a practical solution that enhances the user experience and promotes sustainable and convenient shopping practices. Further research and refinement of the product can lead to its successful implementation and widespread adoption in urban environments.

## VI. FUTURE WORK

The main objective of this thesis is to create a proof-of-concept for a new shopping tool. However, further steps are necessary to transform it into a production-ready product. The trolley's design is near completion and can now be adapted for manufacturing by adding required details like offsets and chamfers, depending on the production techniques. Additionally, thoroughly exploring materials is needed to optimise product properties while maintaining a reasonable price. Sewn prototypes and patterns can improve the bag's functionality, including features like pockets and zippers. Testing the redesigned handle for ergonomics can be done using foam models. Finally, the technical aspects of the trolley, such as buttons, folding mechanisms, and attachments, need further engineering to ensure a robust and functional design.

## VII. ACKNOWLEDGMENTS

First, I want to thank Marina Emmanouil, Ellen De Vos and Joris Ronsmans for their guidance throughout this thesis. They have provided me with excellent feedback, knowledge and assistance during the whole year. They offered support and understanding, even during difficult times.

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# De boodschappentrolley heruitvinden voor jongvolwassenen: Een gebruikersgerichte ontwerpbenadering om de ervaring van stedelijke, autovrije boodschappen te verbeteren

Miguel Deroo

Begeleiders: Prof. dr. Marina Emmanouil, Ellen De Vos, dhr. Joris Ronsmans (Achilles Design)

**Abstract** - Aangezien steden steeds meer het gebruik van auto's beperken en het bezit van een eigen auto afneemt, brengt autovrij boodschappen doen unieke uitdagingen met zich mee. Vaak worden traditionele trolleys geassocieerd met oudere mensen, waardoor jongere mensen worden buitengesloten van deze markt. Dit onderzoek heeft als doel een trolley te ontwerpen die de autovrije winkelervaring van jongvolwassenen in de stad verbetert. Het gebruikersgerichte 5-stappenmodel van de Design Thinking-methodologie wordt toegepast, waarbij diepgaande interviews en gebruikerstests worden gebruikt om de unieke behoeften en voorkeuren van jongvolwassenen te begrijpen. Het onderzoek erkent de veranderende behoeften van gebruikers en stelt een modulair trolleyontwerp voor dat geschikt is voor gebruik te voet en met de fiets, en zorgt voor flexibele transportmogelijkheden. Gebruikerstests in een supermarkt hebben waardevolle inzichten opgeleverd over de effectiviteit van het voorgestelde ontwerp. Dit project biedt een mogelijke oplossing voor de uitdagingen waarmee jongvolwassenen te maken krijgen in stedelijke omgevingen en kan dienen als basis voor het creëren van een nieuwe winkelrolley.

**Kernwoorden** – Boodschappentrolley, stedelijke mobiliteit, gebruikersgericht ontwerp, ergonomie, ontwerp voor gebruikerservaring

## I. INTRODUCTIE

Ondanks dat veel klanten op korte afstand van hun meest bezochte winkel wonen, gebruikt nog steeds een aanzienlijk percentage de auto [1]. De laadcapaciteit van auto's en de wens om tijd te besparen maken dit nog steeds de meest populaire vervoerswijze voor het doen van boodschappen [2] [3]. Wereldwijd proberen steden het gebruik van privéauto's in het stadscentrum tot een minimum te beperken [4]. Om het gedrag van mensen te veranderen, moeten ze steun krijgen [5]. Hoewel boodschappentrolleys gebruikers in staat stellen om een groot aantal boodschappen te voet te dragen, zijn de huidige boodschappentrolleys niet populair onder jongeren. Een enquête die als onderdeel van dit onderzoek is uitgevoerd (n = 171) heeft aangetoond dat dit voornamelijk te wijten is aan het utilitaire uiterlijk en de associatie met oudere mensen.

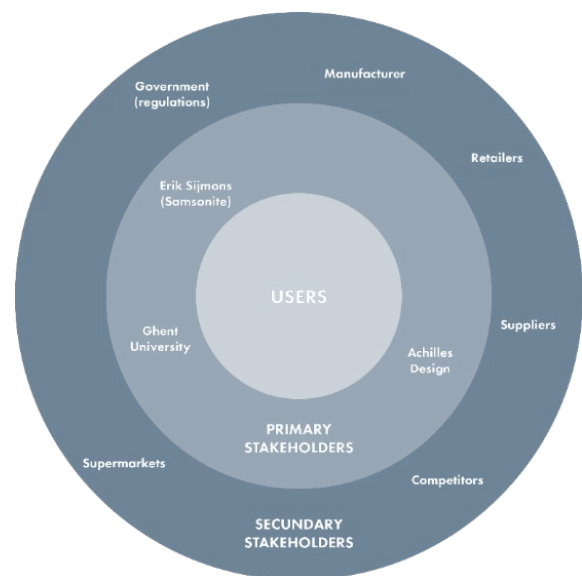
Het dragen van bagage wordt vaak als een gemakkelijke taak beschouwd en is daarom niet grondig onderzocht. Ondanks al het onderzoek over industriële karren, zijn er slechts enkele studies die de ergonomie en vereisten van persoonlijke draagmaterialen onderzoeken. Onderzoek heeft aangetoond dat het trekken van bagage de meeste ergonomische tekortkomingen heeft [3]. Het vereist ongemakkelijkere houdingen van de gebruiker en legt meer stress op de trekkende arm. Bovendien elimineert duwen in plaats van trekken de

behoefte om het bovenlichaam te draaien. Uit onderzoek is gebleken dat grotere wielen minder trekkracht vereisen [4]. Een enkele gebogen stang zorgt er ook voor dat er meer ruimte is tussen de gebruiker en de trolley, wat resulteert in een betere gebruikerservaring [4].

Er moeten geschikte alternatieven worden geboden aan burgers om een verandering in transportmethoden mogelijk te maken [5]. Er is behoefte aan een betaalbare, emissievrije methode voor het doen van boodschappen, los van dure cargofietsen. Een aantrekkelijke en innovatieve boodschappentrolley met verbeterde functionaliteit is nodig om een jonger publiek aan te trekken. Door te focussen op de behoeften van de gebruiker kunnen creatieve oplossingen worden ontwikkeld om de volledige gebruikerservaring te verbeteren.

## II. STAKEHOLDERS

Dit onderzoek wordt uitgevoerd namens Achilles Design, een innovatie- en ontwerp bureau uit Mechelen, opgericht in 1994. Zij hebben dit onderzoek vanuit een technisch oogpunt begeleid. Een stakeholdermap (Fig. 1) wordt gebruikt om een globaal beeld te creëren van de belangrijkste belanghebbenden voor dit project, waarbij de eindgebruikers, jongvolwassenen, in het middelpunt staan.



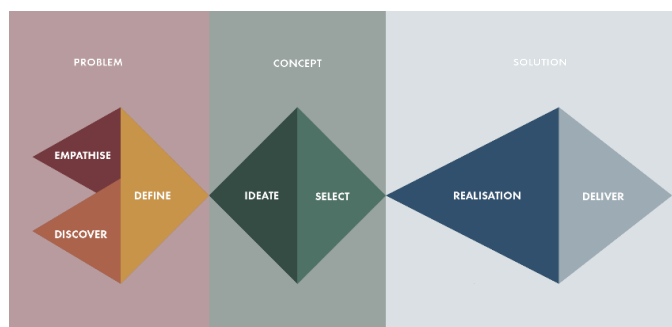
Figuur 1 - Stakeholder map



De onderzoeksvraag voor deze thesis is: "Hoe kunnen we een nieuwe ervaring bieden rond autovrij boodschappen doen voor jongvolwassenen?". De meest belangrijke parameters die zullen worden onderzocht, zijn gebaseerd op een eerste benchmarking, waarbij de aspecten van de huidige boodschappentrolleys waar de meeste verbetering mogelijk is worden geïdentificeerd. Deze parameters zijn onder andere gebruikerservaring, ergonomie, esthetiek en duurzaamheid.

### III. METHODOLOGIE

De methodologie voor dit onderzoeksproject is gebaseerd op en aangepast van het vijfstappenmodel van de Design Thinking-methodologie, voorgesteld door het Hasso-Plattner Institute of Design aan Stanford [6]. Deze stappen zijn: empathiseren, definiëren, ideeën genereren, prototypen en testen [7]. Om echter beter aan te sluiten bij de behoeften van dit project, zijn er aanvullende stappen toegevoegd, waaronder een analyse van bestaande producten en gedetailleerde verbeteringen van het productontwerp. Figuur 2 illustreert het ontwerpproces dat bestaat uit drie hoofdfases: probleem, concept en oplossing..



Figuur 2 - Methodologie aangepast van de Design Thinking-methodologie van het Hasso-Plattner Institute of Design aan Stanford [6].

#### A. Probleem

De probleemfase heeft als doel het begrijpen en definiëren van het probleem, waarbij criteria worden vastgesteld voor verdere ontwikkeling. Deze fase bestaat uit drie subfasen: 'empathize', 'ontdekken' en 'definiëren'.

Tijdens de subfase 'empathize' worden de behoeften van de gebruiker grondig onderzocht met behulp van technieken die verband houden met gebruikersgericht ontwerp, zoals vragenlijsten, interviews en observaties [2]. Er werden interviews afgenomen ( $n = 11$ ) om inzicht te krijgen in de behoeften en gewoonten van gebruikers. Dit omvatte mensen die af en toe een boodschappentrolley gebruiken ( $n = 6$ ) en jongvolwassenen ( $n = 5$ ) die geen gebruik maken van trolleys. Daarnaast werd er een enquête verspreid onder vrienden, familie, kennissen en op sociale media platforms, waarbij 173 reacties werden verzameld van verschillende leeftijden. Na het verwijderen van twee onvolledige antwoorden, werd de analyse uitgevoerd op 171 reacties ( $n = 171$ ). Deze enquête leverde inzichten op over het gedrag bij het boodschappen doen en de mening van respondenten over winkelwagens. Bovendien werden 'customer journeys' en gebruikersscenario's gebruikt om de ervaringen van de gebruikers te begrijpen.

De subfase 'ontdekken' heeft als doel om inzicht te krijgen in bestaande producten en technische behoeften. Dit werd bereikt door benchmarking, een interview met een verkoper in een bagage- en trolleywinkel, en het testen van bestaande producten. Het analyseren van de functionaliteiten en beoordelingen van bestaande producten leverde inzichten op over de technische mogelijkheden. Het onderzoeken van concepten en eerdere studentenprojecten met betrekking tot boodschappenvervoer bood nieuwe perspectieven. Bovendien hebben de auteur en twee vrienden gedurende enkele weken gebruik gemaakt van drie boodschappentrolleys om hands-on ervaring op te doen en een beter begrip te krijgen van de noden en behoeften tijdens het gebruik.

In de subfase 'definiëren' worden de bevindingen van de eerdere subfasen samengebracht om tools te creëren die het ontwerpproces kunnen begeleiden. De conclusies van de enquête en interviews werden gebruikt om personas te ontwikkelen, gegeneraliseerde karakters die de doelgroep voorstellen. Er werd een lijst van behoeften en wensen voor het product opgesteld, met basisbehoeften gebaseerd op informatie uit de benchmarking en aanvullende behoeften en wensen afgeleid van interviews, enquêtes en gebruikersscenario's, waarmee de Unique Selling Points (USP's) van het product worden gevormd. Deze vereisten werden vertaald naar productspecificaties. Bovendien werd er een lijst van ontwerpdrievouders ontwikkeld om het ideatieproces te sturen en hiërarchie aan te brengen in de USP's.

#### B. Concept

De ideefase begon met brainstormen over hoe de eerder gedefinieerde vereisten kunnen worden geïmplementeerd in een nieuw ontwerp van een boodschappentrolley. Tegelijkertijd werd gekeken naar de uitstraling en het gevoel van het product, met behulp van referentieproducten uit verschillende categorieën. Verschillende technische oplossingen werden ook onderzocht, waarbij mogelijke verbindingen, wielen, handvatten, enzovoort werden verkend. Vervolgens werd er een morfologische kaart gemaakt op basis van de functies en USP's van de trolley. Door verschillende oplossingen voor elke functie te combineren, konden er heel diverse concepten worden gecreëerd. De eerste concepten werden vervolgens geanalyseerd op basis van de vereisten, maar er was nog steeds veel ruimte voor verbetering. Het beste concept dat voortkwam uit deze ideefase neigde nog te veel naar een basis boodschappentrolley. Als reactie hierop werd er een nieuwe, uitgebreidere morfologische kaart en nieuwe concepten ontwikkeld. Vervolgens werd de lijst van behoeften en wensen die tijdens de vorige fase was opgesteld, gebruikt om de concepten te analyseren en het beste concept te selecteren.

#### C. Oplossing

De laatste fase richt zich op het omzetten van het concept in een tastbaar en haalbaar product door middel van prototyping, testen en iteraties. Prototyping werd gebruikt om kritieke aspecten van het productontwerp te ontwikkelen en te verbeteren. Gebruikerstests werden uitgevoerd om de interacties tussen het product en de gebruiker te optimaliseren en de algehele gebruikerservaring te verbeteren. Er werden realistische scenario's nagebootst, zoals het bezoeken van een supermarkt of een markt met de nieuwe boodschappentrolley, met de betrokkenheid van collega's ( $n = 5$ ) en één externe deelnemer, wat waardevolle inzichten bood in het

gebruikersgedrag en het identificeren van verbeterpunten. De ontwerpdrivers en feedback van gebruikers hebben geleid tot de verfijning van het product. Er werden veel iteraties gebruikt om de functionaliteit en gebruiksvriendelijkheid van het uiteindelijke product te optimaliseren.

#### IV. RESULTS

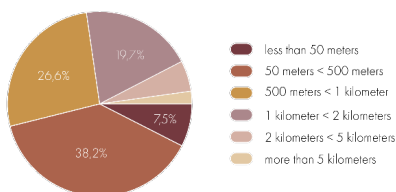
##### A. 'Empathize' (Gebruikers)

Uit interviews met mensen die af en toe een boodschappentrolley gebruiken (n = 6) bleek dat zij hun boodschappenkarretje van onderaf vullen om het risico op beschadiging van de boodschappen te minimaliseren. Tijdens interviews met jongvolwassenen die geen trolley gebruiken (n = 5), gaven velen aan moeite te hebben met boodschappen doen te voet of per fiets. Ze zien echter een boodschappentrolley niet als een alternatief. Ze verkiezen om meerdere keren naar de winkel te gaan dan trolleys te gebruiken, die ze associëren met ouderen.

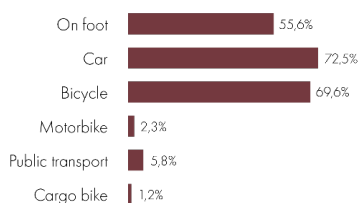
De analyse van de 'customer journey' benadrukte de introductie van fietsen. Een boodschappentrolley moet compatibel zijn met een fiets om een breder publiek te bereiken dan alleen degenen die dicht bij de winkel wonen. Dit zou het boodschappen doen vergemakkelijken en het combineren met andere activiteiten zoals werk of sport gemakkelijker maken.

De resultaten van de enquête toonden verschillende bevindingen. Ten eerste behoorde 62,4% van de respondenten tot de doelgroep van 18 tot 40 jaar. Ten tweede kiezen veel deelnemers die dicht bij een supermarkt wonen ervoor om niet te voet te gaan. Ten derde meldde 69,6% van de respondenten dat ze af en toe de fiets gebruiken voor boodschappen (Fig. 3), wat duidt op de populariteit van fietsen als alternatieve vervoersmethode. Tot slot bleek uit de enquête dat 67% van de deelnemers boodschappentrolleys associeert met ouderen of senioren, wat suggereert dat oudere mensen voornamelijk trolleys gebruiken. Verder onderzoek, gericht op de doelgroep (n = 106) van jongvolwassenen tussen de 18 en 40 jaar, wees uit dat meer dan twee derde van hen zich niet in staat voelde om voldoende boodschappen te dragen tijdens het lopen naar de winkel (n = 73). Tegelijkertijd gebruikte slechts 6 procent af en toe een boodschappentrolley (n = 6).

Proximity of respondent's homes to nearest supermarket



Transportation methods for grocery store visits



Figuur 3 - Enkele interessante inzichten uit een enquête met 171 respondenten

##### B. Ontdekken (Product)

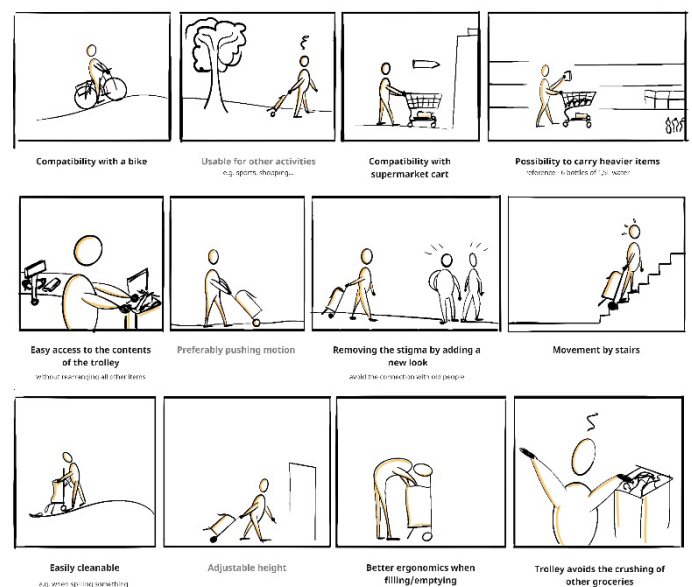
Na het analyseren van de bestaande trolleys zijn er meerdere aspecten ontdekt die verbeterd kunnen worden in een nieuw en verbeterd trolley-ontwerp. De trolley moet gemakkelijk schoon te maken zijn en een verstelbare hoogte hebben. Hoewel de grote capaciteit van de trolleytas het mogelijk maakt om talloze items te vervoeren, brengt het ook het risico met zich mee dat boodschappen met elkaar botsen en beschadigd raken. Het ontwerp moet geschikt zijn voor gebruik in supermarkten. Bij de analyse van conceptueel werk werd opgemerkt dat de meest visueel aantrekkelijke producten sterk verschilden van het traditionele trolley-ontwerp. Volgens een trolleyverkoper plaatsen ouderen soms een schoendoos onderin hun trolleys vanwege de overmatige diepte, wat het moeilijk maakt om items op te halen zonder te bukken.



Figuur 4 – Afbeeldingen van twee standard trolleys [8] [9]

##### C. Definieren

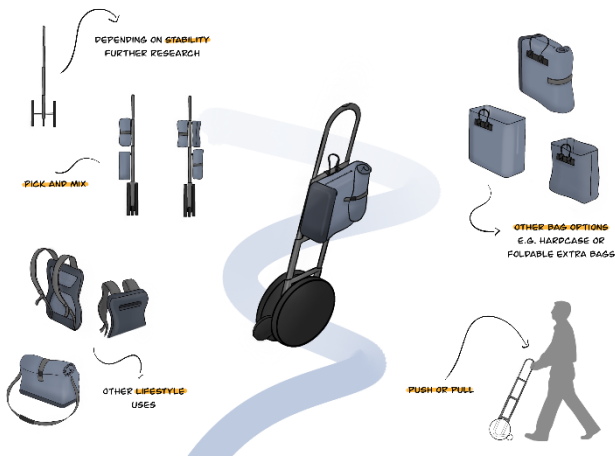
Op basis van de verzamelde informatie uit de eerdere fasen kon een lijst met eisen en wensen voor het nieuwe product worden opgesteld. Daarnaast werden twaalf ontwerpprincipes opgesteld om het ideeëngeneratieproces te begeleiden. Van deze principes werden er vier geïdentificeerd als de belangrijkste factoren: compatibiliteit met een fiets, verbeterde toegang tot boodschappen, betere ergonomie en voorkomen van botsingen tussen boodschappen.



Figuur 5 – Visualisatie van de ontwerpdrivers

#### D. Ideegeneratie en selectie

Het creëren van een modulair systeem is de enige manier om zoveel mogelijk aan de eerder genoemde eisen te voldoen. Het uiteindelijke concept, geselecteerd uit verschillende ideeën, heeft modulaire tassen en kan worden aangepast om te voldoen aan de behoeften van verschillende gebruikers.



Figuur 6 – Finaal concept vanuit de ideegeneratie

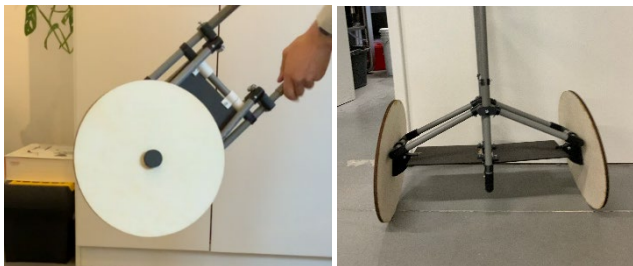
#### E. Realisatie

##### 1) Algemene afmetingen

Er werd een eerste mock-up gemaakt van een tas (42cmx32cmx17cm) en een opgevouwen trolley (40cmx25cmx5cm) met behulp van karton en PVC-buizen. Hoewel dit niet de definitieve maten zijn, bood het een eerste richtlijn voor verdere ontwikkeling. De afmetingen van standaard fietstassen van Ortlieb werden gebruikt als referentie voor de tasafmetingen.

##### 2) Ontwikkeling structurele elementen

De kritieke elementen van het trolley-ontwerp worden verder ontwikkeld en geprototyped: de wielen, de tassen en andere algemene aspecten zoals het handvat en de standaard. Het creëren van een stabiele wielbasis is cruciaal voor het succes van dit concept. Na enkele snelle tests werd duidelijk dat opvouwbare wielen noodzakelijk zijn om stabiliteit te garanderen voor een volle trolley. Na enkele iteraties werd een haalbaar mechanisme ontwikkeld, met behulp van PVC-buizen, 3D-prints en veel schroeven, zoals te zien in Figuur 7.

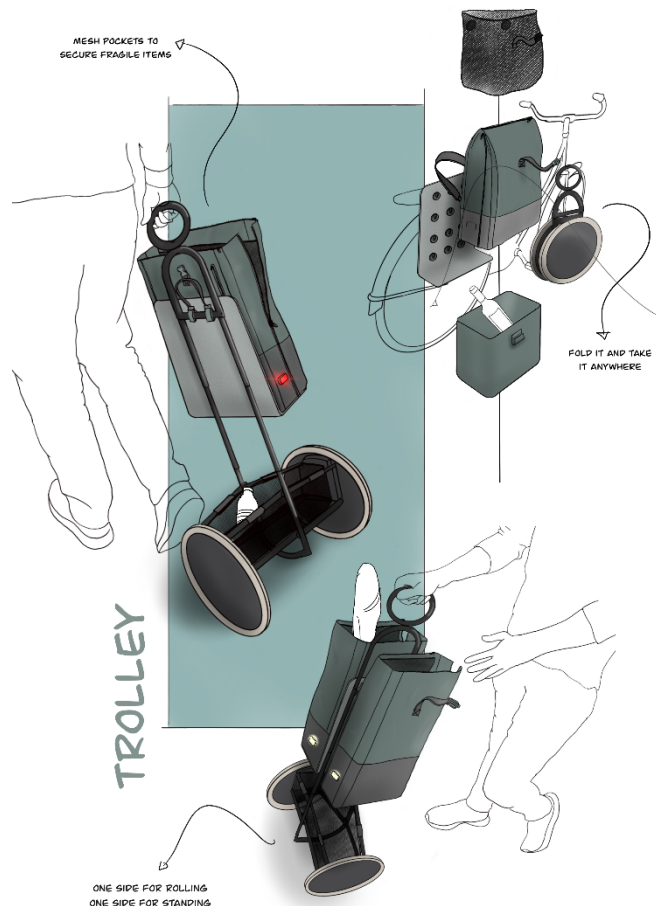


Figuur 7 – Proof-of-concept van het opvouwmecanisme

Tegelijkertijd werden ook de andere onderdelen van de boodschappentrolley ontwikkeld en geprototyped. Een handvat van een oude boodschappentrolley en enkele in elkaar passende buizen werden gebruikt om het frame te bouwen. Verschillende toegangsmethoden werden onderzocht om de tassen te ontwerpen met behulp van schetsen en kartonnen prototypes. Bovendien werden er aanpassingen gemaakt aan bestaande tassen om materialen en toegangsmethoden te testen.

##### 3) Exploratie belangrijkste ontwerpdrivers

De ontwerpdrivers werden verder geïmplementeerd om de functionaliteit en vormgeving van de boodschappentrolley te verbeteren. Gebruikerstests werden uitgevoerd om de ergonomie van het handvat te optimaliseren, waarbij verschillende oriëntaties en posities ten opzichte van het lichaam werden onderzocht. Bovendien werd de hoogte van de boodschappen geëvalueerd en aangepast om de belasting voor de gebruiker te minimaliseren. Er werd uitgebreid onderzoek gedaan om compatibiliteit met fietsen te garanderen. Het verfijnde productontwerp wordt gepresenteerd aan de hand van een schets in Figuur 8 en geanalyseerd op basis van de eerder gedefinieerde eisen en wensen. Verdere optimalisatie is noodzakelijk en zal worden aangepakt in de volgende fasen.



Figuur 8 – Tussentijdse presentatieschets van het product ontwerp

##### 4) Verdere verbetering productontwerp

De verbindingen worden opnieuw ontworpen om een magnetisch en veilig ecosysteem te creëren, wat de gebruikerservaring van de tassen verbetert. Het mechanisme voor het uitklappen van de wielen is herontworpen om een functioneel en veilig systeem te garanderen. Het nieuwe systeem is ontworpen om veel gewicht te ondersteunen zonder het risico dat het inklapsysteem instort. Daarnaast is de gehele stijl van het product verfijnd om naadloze integratie van verschillende componenten, zoals de standaard, mogelijk te maken.

##### 5) Finaal prototype en gebruikerstesten

Om de interactie met het product te evalueren, moet het prototype robuust genoeg zijn om ermee door een stad te kunnen lopen. Niet elk aspect van het ontwerp kan worden



geïntegreerd, zoals het inklapmechanisme, maar alle essentiële interactiepunten zijn aanwezig. Het uiteindelijke Fidlock-systeem, dat wordt gebruikt voor de magnetische verbindingen, is ook geïntegreerd in het prototype om de gebruikersinteractie grondig te testen.

Tijdens de gebruikerstest (Fig. 9) kon de meerderheid van de deelnemers de afneembare tassen, de handgreep en de standaard van het prototype herkennen. Sommige gebruikers dachten dat grotere items onderin de trolley konden worden geplaatst vanwege de beschikbare ruimte. Veel mensen vonden de Fidlock-verbindingen om de tassen aan de trolley te bevestigen interessant. De meningen over of gebruikers het product zelf zouden gebruiken verschilden, maar de meeste mensen erkenden het potentieel van het concept. In eerste instantie vonden sommige gebruikers dat de kleine tas niet genoeg kon bevatten, maar dit probleem werd opgelost door een update naar een grotere tas. Gebruikers vonden de optie van een kleinere tweede tas interessant voor het opbergen van fragiele items. De rits verbeterde de toegankelijkheid van de tas, hoewel gebruikers de voorkeur gaven aan gedeeltelijk openen om te voorkomen dat er iets uit zou vallen. Ontwerpaanpassingen op basis van de gebruikerstest omvatten het aanpassen van de hoogte van de trolley en het verlagen van de tassen om de inspanning van de gebruiker te verminderen, het zorgen voor meer ruimte in de tassen, en het opnemen van een handgreep met verstelbare vaste posities.



Figuur 9 – Twee gebruikers tijdens de gebruikerstest in een supermarkt

#### F. Finalisatie

Om de onderzoeksvraag 'Hoe kunnen we een nieuwe ervaring bieden rond het boodschappen doen zonder auto voor jongvolwassenen?' te beantwoorden, is een nieuw boodschappen hulpmiddel ontwikkeld, zoals te zien in Figuur 10. Dit product is een modulair systeem bestaande uit tassen, een trolley en een fietsbevestiging. De tassen kunnen magnetisch worden bevestigd aan de trolley, waardoor het gemakkelijk is om tot 40 liter aan boodschappen te vervoeren. Dezelfde tassen kunnen ook aan een fiets worden bevestigd met behulp van een magnetische verbinding. Bovendien kan de trolley worden opgevouwen en aan de fiets worden bevestigd.

De tassen hebben een stevig achterpaneel om hun vorm te behouden wanneer ze beladen zijn met boodschappen. Een rits kan dit paneel verwijderen, waardoor toegang mogelijk is tot één of meerdere schouderbanden. Deze tassen kunnen worden gebruikt voor dagelijkse activiteiten zoals pendelen, naar de sportschool gaan of boodschappen doen. Bovendien kunnen de

tassen worden aangepast aan de behoeften van de gebruiker door inserts te bevestigen. Bijvoorbeeld, een insert om bepaalde items gedurende een langere periode koel te houden of om veilig een laptop op te bergen.

De hoogte van de trolley kan eenvoudig worden aangepast aan de voorkeur van de gebruiker. Uitgerust met grote wielen is de trolley geschikt om veilig over obstakels of oneffen oppervlakken te rijden. De handgreep is ontworpen om te draaien en veilig in verschillende posities te vergrendelen, waardoor moeiteloos duwen of trekken mogelijk is. Bovendien bieden de twee tassen voldoende ruimte om boodschappen te organiseren, en de binnenste netjes bieden handige mogelijkheden voor flessen of andere items te sorteren.



Figuur 10 - Render finale productontwerp

#### V. CONCLUSIE

Deze thesis had als doel om een nieuwe ervaring te creëren voor jongvolwassenen die boodschappen doen in een stedelijke omgeving. De resultaten van de enquête toonden aan dat de doelgroep sterk afhankelijk is van fietsen voor het doen van boodschappen en dat winkelwagentjes geassocieerd worden met ouderen, waardoor ze onaantrekkelijk zijn voor jongvolwassenen. Deze associatie kan worden vermeden door het product een nieuwe uitstraling te geven, zoals blijkt uit de benchmarking van conceptueel werk.

De benchmarking van bestaande producten toonde hun beperkingen aan en benadrukte aspecten die verbeterd kunnen worden. Dit omvat het verbeteren van de algehele ergonomie van het product, waardoor het gemakkelijker wordt om toegang te krijgen tot de boodschappen en botsingen van de boodschappen te voorkomen. Door de ideegeneratie werd duidelijk dat een modulair ontwerp met aanpasbare functies de meest efficiënte manier was om aan de eerder geïdentificeerde eisen te voldoen. Deze aanpak stelt gebruikers in staat om de trolley aan te passen aan hun behoeften, waardoor het veelzijdig is voor dagelijkse activiteiten naast het doen van boodschappen.

Het prototypen leverde waardevolle inzichten op voor kritieke aspecten van het ontwerp, zoals het vouwmechanisme. Het maakte gebruikerstesten mogelijk, waardoor verschillende aspecten konden worden geëvalueerd. Deze fase was cruciaal om de positieve aspecten en tekortkomingen van het ontwerp te identificeren, waardoor verdere iteraties mogelijk werden.



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De gebruikerstesten en interviews die zijn uitgevoerd met de deelnemers suggereren dat het ontwikkelde boodschappen hulpmiddel het potentieel heeft om te voldoen aan de behoeften van jongvolwassenen die afhankelijk zijn van auto-vrij boodschappen doen. Het moet echter worden opgemerkt dat vanwege de beperkingen van een acht maanden durend, één-persoonsproject het project niet kon worden ontwikkeld tot een productieklaar product. Bovendien maakte het beperkte tijdsbestek het moeilijk om meerdere gebruikerstesten uit te voeren en de noodzakelijke verbeteringen door te voeren.

Ondanks deze beperkingen heeft dit onderzoeksproject zich ontwikkeld van een brede onderzoeksvraag tot een proof-of-concept van een innovatief product. Samengevat benadrukt deze studie het belang van gebruikersgericht ontwerp bij het aanpakken van de uitdagingen die gepaard gaan met auto-vrij boodschappen doen. Het ontwikkelde boodschappen hulpmiddel biedt een praktische oplossing die de gebruikerservaring verbetert en duurzaam en gemakkelijk winkelen bevordert. Verder onderzoek en verfijning van het product kunnen leiden tot een succesvolle implementatie en brede acceptatie van deze trolley in stedelijke omgevingen.

## VI. TOEKOMSTIG WERK

Het hoofddoel van dit onderzoek is om een proof-of-concept te creëren voor een nieuw winkelhulpmiddel. Er zijn echter nog verdere stappen nodig om dit concept om te zetten in een product dat klaar is voor productie. Het ontwerp van de trolley is bijna afgerond en kan nu aangepast worden voor productie door vereiste details toe te voegen, zoals offsets en afschuiningen, afhankelijk van de productietechnieken. Daarnaast is een grondig onderzoek van materialen nodig om de producteigenschappen te optimaliseren, terwijl een redelijke prijs behouden blijft. Gestikte prototypes en patronen kunnen de functionaliteit van de tas verbeteren, inclusief functies zoals zakken en ritsen. Het testen van het herontworpen handvat op ergonomie kan worden gedaan met behulp van schuimmodellen. Ten slotte vereisen de technische aspecten van de trolley, zoals knoppen, inklapmechanismen en bevestigingen, verder technisch ontwerp om een robuust en functioneel ontwerp te garanderen.

## VII. BEDANKINGEN

Ten eerste wil ik Marina Emmanouil, Ellen De Vos en Joris Ronsmans bedanken voor hun begeleiding gedurende deze scriptie. Ze hebben me uitstekend feedback, kennis en ondersteuning gegeven gedurende het hele jaar. Ze boden steun en begrip, zelfs tijdens moeilijke tijden.

Verder wil ik ook Yves Peeters en Sander Zelck bedanken, twee ontwerpers die me ook hebben begeleid bij Achilles Design. Ik wil ook Erik Sijmons, senior design director bij Samsonite, bedanken voor het geven van feedback op kritieke momenten.

Ik wil ook Guillaume Segart, Julian Adam en alle deelnemers bedanken die hebben deelgenomen aan de gebruikerstests en alle respondenten die de enquête hebben ingevuld. Tot slot wil ik mijn ouders en vrienden bedanken voor hun eindeloze steun en geduldig te luisteren terwijl ik urenlang praatte over boodschappentrolleys.

# **REINVENTING THE SHOPPING TROLLEY FOR YOUNG ADULTS**

A user-centered design approach to  
improve the experience of urban, car-free  
grocery shopping

Miguel Deroo



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# 01

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## introduction

# 1 Context and problem

## A. Shifting trends in grocery shopping transportation

People prefer to use a car to shop for groceries for the cargo-carrying capacity (Le Vine et al., 2014). Many people who work want to save time and money by minimising their trips to the grocery store. This often means relying on a car to transport their groceries (Bawa, 1999). A survey in Sweden showed that more than half of customers live less than two kilometres away from their most frequently visited store. Yet 70% of the customers occasionally use a car to shop for groceries. If the scope is narrowed down to large cities, only 45% of the customers use a car to shop for groceries (Hagberg & Holmberg, 2017).

City councils worldwide are working on plans to limit the use of private cars in the cities. This plan aims to reduce greenhouse gas emissions and helps in providing improved air quality for the citizens (Nieuwenhuijsen & Khreis, 2016). Furthermore, research shows a significant reduction in car ownership for young age cohorts (18-37 years) (Carrone, 2020). This implies that the people living in a city must start relying more on public transport, cycling, shared transport etc., to do their daily activities, such as getting groceries. Currently, the car is one of the only ways to transport large, unwieldy objects. To lower the use of personal cars in cities, an alternative should be provided to carry these items (Dautzenberg et al., 2021).

## B. Cargo bikes as an alternative transportation method

The popularity of cargo bikes (Fig. 1) has increased enormously in the last decade, with an annual growth of 60% in sales in Europe in 2020 (Cycling Industries Europe, 2021). The perceived safety in a city decreases when more cargo bikes are on the roads. Although this does not act as a barrier to the acceptance of cargo bikes, it is still crucial that other road users feel safe (Meerstra, 2021). Research from Heinrich et al. shows the failure of cargo bikes as an alternative vehicle for urban transport due to a few different causes (2016). Cargo bikes starting prices are pretty high due to the expensive components, including the batteries, and are expected to stay the same. The acceptance of cargo bikes is relatively low as users think this is bulky and uncomfortable (Heinrich, 2016).



Figure 1 - increasing popularity of cargo bikes

### C. The limitations of doing grocery shopping on foot

Reducing the need for driving will only bring drastic changes if the users have access to tools and services that support this transition (Laakso, 2017). Many shoppers attempt to minimise their use of extra bags but often overload their reusable ones. This can lead to serious health problems, including shoulder and back injuries (Hinchliffe, 2018). It is important to note that with age, the strength of muscles decreases (Trudelle-Jackson, 2011), which may explain why older people are more inclined to use a shopping trolley.



Figure 2 - older people often struggle more to carry their own groceries

### D. Health benefits of grocery shopping on foot

Incorporating lightweight exercises into one's routine is crucial, particularly as we age and experience natural declines in strength. Regularly carrying an appropriate weight a few times a week has been shown to provide positive health benefits, as shown by Hinchliffe in 2018. Furthermore, physical activity in any form, including walking, has been proven to have numerous benefits for overall health. Research has shown that consistent physical activity can help to reduce the risk of chronic diseases (Hinchliffe, 2018).

Walking is a very accessible method of physical activity as it does not require expensive equipment, special skills or facilities (Lee & Buchner, 2008). Combined with necessary travel, for instance, to the grocery store, walking can be a suited activity for people with busy work or family life. Other physical activities, such as riding a bicycle are also beneficial for health and more suitable for people who live further away from a supermarket.

## E. Current shopping bags and tools

Plastic grocery bags are highly convenient as the user does not have to bring anything to the store. Besides the fact that the ergonomics of carrying a lot of loaded bags are far from ideal, these plastic bags also have a significant environmental impact. There are three critical stages where plastic bags cause pollution: raw materials extraction, manufacturing process and end-of-life processing. Almost 96% of all plastic bags end up in landfill (B. Li et al., 2022). There is a need for a more sustainable alternative to the large number of plastic bags.

Shopping trolleys are made to carry larger amounts of groceries while saving energy and minimising the potential musculoskeletal injuries caused by manually handling heavy loads (Kwong, 2010). In European literature regarding shopping trolleys, the users are primarily elderly persons. They usually use a shopping trolley because they cannot carry heavy bags anymore (Brembeck et al., 2016). In research from Asia, there is a more diverse group of test users regarding their age (Kwong, 2010). There seems to be a stigma attached to using a shopping trolley in Europe: people associate a shopping trolley with older people (Fig 3). This hypothesis will be further investigated in this thesis.



Figure 3 - association of shopping trolley with elderly people

## 2 Problem definition

A few different factors contribute to the acceptance of a product, often referred to as DOL, Drivers Of Liking (Li et al., 2015). The most important DOL are perceived satiety, brand/labelling influence, price/WTP and emotional impact. Willingness to pay can be used to map the effect of other factors like the branding influence, emotional impact etc. (Li et al., 2015). The current prices of popular shopping trolleys are low compared to similar products like luggage or backpacks. This shows that the willingness to pay for a shopping trolley should be higher to succeed in the challenge of redesigning the shopping trolley.

Products that genuinely excite customers have higher chances of success. On top of the fundamental functions a product should have, like the ability to carry groceries, and the unique selling points (USPs) such as the compatibility with a bike, a product should also have excitement features. These are features the customer was surprised to discover and excite the customer (Desmet et al., 2007).

## 3 Stakeholders

This master's thesis is carried out on behalf of Achilles Design, an innovation and design agency from Mechelen founded in 1994. They have supervised this research from a technical point of view and gave plenty of feedback. Achilles Design also provided tools and resources for prototyping so concepts could easily be validated.

This research project is supported by a few people at Ghent University, specifically the Department of Industrial Systems Engineering and Product Design. They shared their insights and feedback on this project's methodology and academic approach.

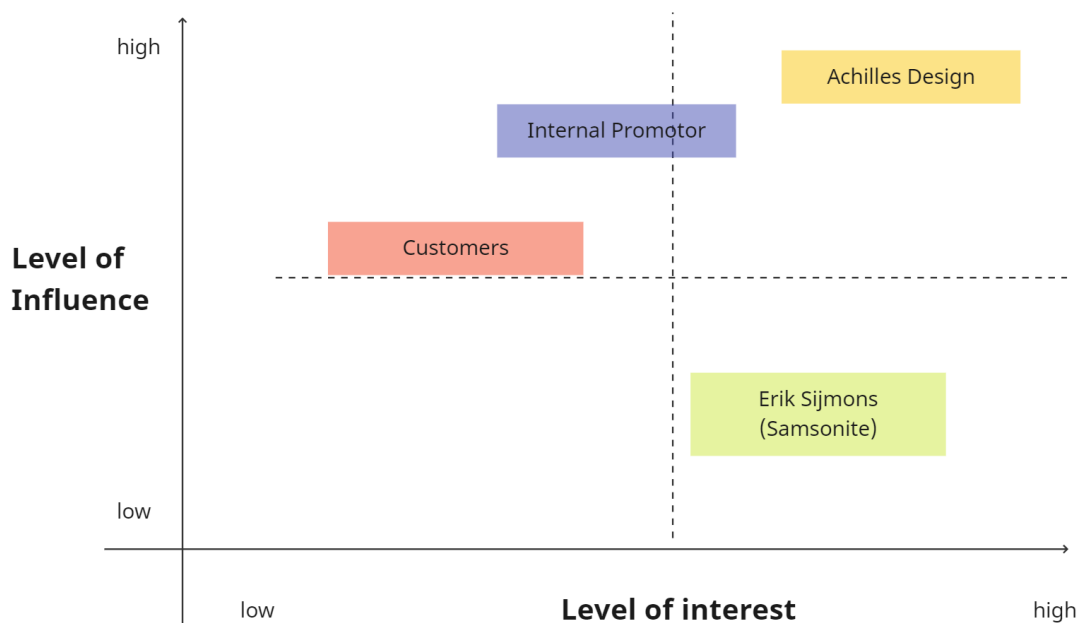


Figure 4 - stakeholder map



Visualising stakeholders' relationships to the project makes it easier to understand the stakeholder relationships and reduces the chances of project failure (Walker et al., 2008). Two common axes are often used for stakeholder mapping: the level of influence and interest (Murray-Webster & Simon, 2006). This power-to-interest matrix (Fig. 4) is used for a more detailed mapping of the primary stakeholders. A stakeholder circle (Fig. 5) is used to create a more global image of the critical stakeholders for this project, with the users being the centre of the stakeholders.

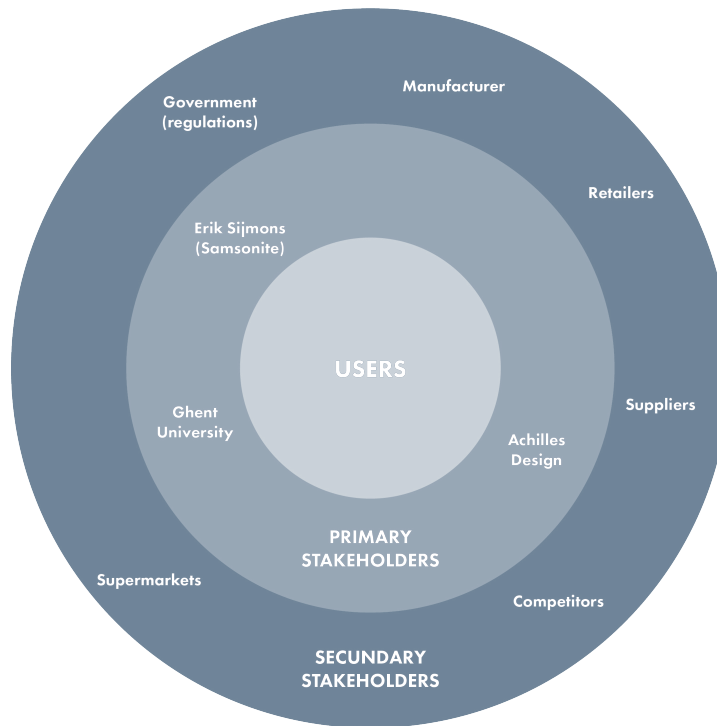


Figure 5 - stakeholder circle

Furthermore, it is essential to acknowledge the influence of power in the design process. Power Literacy highlights the importance of privilege and the possibility of excluding certain social groups that are further removed from our own (Goodwill, 2020). When designing this new shopping tool, it is important to consider the needs and experiences of a diverse range of users rather than focusing solely on a narrow target audience.

Awareness of the goal power present in a design process is essential. Not only the author but also the stakeholders will influence the process. So, it is important to check regularly that the process of the project is aligned with the goals drafted earlier. As experts and other professionals are participating in this project, the opinions of these people will be given more credibility. Although their views are very valuable, being cautious about their goals and checking their statements is crucial.

## 4 Research question

A shift to ban cars out of cities will not be possible without providing the proper tools to the citizens. There is a need for a lower-budget alternative to cargo bikes for doing emission-free grocery shopping. There are already many shopping trolleys on the market, with prices ranging from 15 euros to over 300 euros. These trolleys share a common feature: they are bags with wheels designed for carrying groceries on foot with a focus on functionality (Fig. 6).

According to a survey, despite their practicality, shopping trolleys have not always appealed to younger generations due to their often dated and utilitarian appearance. In recent years, some retailers have attempted to modernise the design of their trolleys to appeal to younger shoppers, but these attempts have not been successful in achieving their goal. Therefore, the research question emerges: "How can we provide a new experience around car-free grocery shopping for young adults?"

The shopping trolley should have a sleek and modern appearance to appeal to a younger audience. It should also be innovative on the level of functionality, bringing a new experience to the customers that shop in an urban setting. Focusing on the goal and experience of a product can help to generate innovative ideas that improve upon current, less attractive products. By considering the needs and wishes of the user, it is possible to come up with creative solutions that not only meet those needs but also enhance the overall product experience.



Figure 6 - picture of people with a shopping trolley by activeface photography

## 5 Methodology

The methodology for this research project is based on the five stages of the design thinking methodology proposed by the Hasso-Plattner Institute of Design at Stanford (Balcaitis, 2022). These stages are empathise, define, ideate, prototype and test (Wolniak, 2017). This model was adapted to fit this project's needs and align with the deliverables, as shown on Figure 7. In order to involve the end-user more closely, the methodology incorporated the principles of user-centred design (Abrás, 2004). This is achieved through questionnaires, interviews, and observations, with a strong emphasis on consistently considering the user's perspective throughout the different stages. The process can be divided into three main stages: problem, concept and solution.

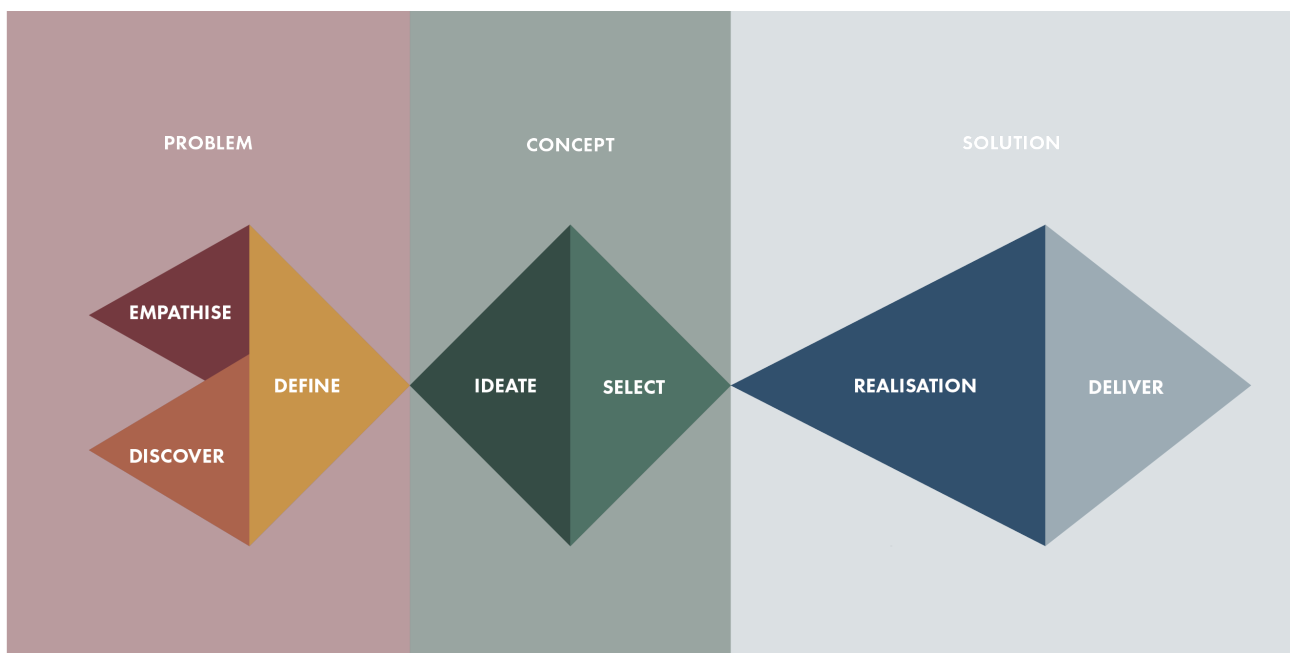


Figure 7 - methodology diagram

### A. Problem

The first phase aims to understand the problem and create a set of criteria for the further design process. The problem can be investigated on two levels: the user and the product. This is why this problem phase is split into two sub-phases: empathise and discover.

#### Empathise

In the empathise phase, a deeper understanding of the user is created. The users' habits and frustrations are explored using interviews, surveys, customer journeys, user scenarios and a literature review. The goal here is to collect a lot of information about all possible users. It is crucial to think not only about the possible users but also about other people that might be affected by the use of this product (Abrás, 2004).

#### Discover

At the same time, the product is explored to understand the current design and market. This

helps to understand the functionality and technical limitation involved in creating a shopping trolley. This phase primarily consists of research through benchmarking available products and conceptual work in this field. Furthermore, a trolley salesman was interviewed on his experiences, and the author and his flatmates used a few existing shopping trolleys. These methods helped to understand the product's issues and opportunities better.

### **Define**

All the information gathered during the empathise and discover phase is brought together and used to establish a clear starting point and create objectives for the solution. Some techniques summarize aspects from the empathise phase, such as personas and moodboards to represent umbrella users that can be used as a reference during the design. Additionally, techniques like product mapping summarise the information that was collected in the discover phase. Other methods used in this phase combine information from the empathise and discover phases: creating a list of needs and wishes, target specifications and a list of design drivers. These drivers are a few product specifications or functionalities used to identify the product's Unique Selling Points (USPs).

## **B. Concept**

In this second phase, the goal is to translate the needs and wishes of the product into a practical concept. Initially, the technical possibilities of creating various components such as handles, bags, and wheels are analysed through benchmarking, alongside exploring multiple styles. This analysis helps to explore various options. A morphological map brings together different possibilities and facilitates the creation of diverse concepts. After this ideating, the best concept is selected based on the criteria drafted in the 'problem phase'. Further iterations can refine the morphological map and concepts, resulting in one final concept.

## **C. Solution**

The final phase of the design process is creating a final product, which starts from the general concept. Through prototyping and testing, most key aspects of the design are explored and refined. During the realisation phase, potential users will test specific aspects of the product. Real-life scenario user tests will be performed with a prototype that embodies as many features of the design as possible. As the user experience is a significant aspect, the interactions between the user and the product must be thoroughly tested. This prototyping and testing will allow further refinement of the product and an understanding of potential gaps in the current product design. The final product will be presented at the end of the solution phase.





# 02

---

**empathise**

To design a user-centric shopping trolley, it is essential to identify the explicit needs of the users, such as durability, small storage space, and ease of manoeuvrability. However, there are also latent needs specific to shopping trolleys that may not be immediately apparent to users (Ulrich & Eppinger, 2019). These latent needs could include features like improved ergonomics to reduce strain on users' bodies or even smart sensors to assist with navigation and locating products. If these needs are fulfilled, greater customer satisfaction can be achieved.

The objective of this chapter is to collect a wide variety of information about the users, their context, and their needs. This diverging phase explores a wide range of possibilities before organising them in the next phase. Various techniques will be used, ranging from low-immersion methods like literature review to highly immersive techniques such as actively using a shopping trolley. Most techniques, such as interviews with current users, will fall somewhere in between these categories.

While some methods may not strictly align with the empathizing category, there are instances of overlap with the discovery and define phases, as depicted in Figure 8. For example, the author and their flatmates' testing of shopping trolleys falls under the discovery phase yet also encompasses empathizing and understanding the user. It is worth noting that the methods, although categorized, can include more than the specific aspects of their respective categories.

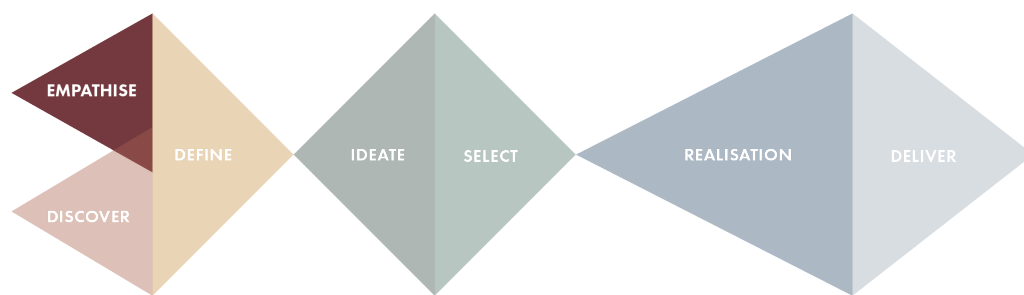


Figure 8 - empathise as part of the design process

## 1 Literature review on ergonomics

The movements performed by a user using a shopping trolley can be compared to those movements required by other wheeled luggage or carts. Existing literature primarily focuses on the ergonomics and handling of industrial four- and two-wheeled carts used for material transportation. Carrying two-wheeled luggage is often considered a small task and, as a result, is not thoroughly researched. Although much research has been conducted on industrial carts, only a few studies examine the ergonomics and specifications of personal carrying equipment.

### A. Pushing or pulling motion

In a comparative study by Rose et al. (2013) subjects were assigned to different carrying tasks while measuring the load on their spine (Fig. 9). Pulling luggage is an effective and low-risk method of carrying loads compared to backpacks or manually carrying items. This may be why most current grocery tools come in wheeled carts that users can push or pull.

Research has shown that pulling luggage has the most ergonomic flaws (Chitena et al., 2022). It requires more awkward postures from the user and puts more stress on the pulling arm. Although a push-trolley is rare in the luggage market, this seems to be a more ergonomic solution for carrying luggage. The pushing can be done using both hands, which results in a symmetrical position. By pushing instead of pulling, the user's upper body does not have to get twisted. Theoretically, a push-trolley would lead to less stress and fatigue and increase the carrying capacity, but no experimental studies on this topic could be found (Jung, 2005).

Furthermore, most luggage is designed for usage on flat surfaces, which can be found indoors or on decent streets. In urban areas, poorly maintained roads and pavements can pose a challenge for individuals transporting luggage.



Figure 9 - comparative study on the spine load in different carrying methods (Rose, 2013)

## B. Height of the handle

According to Jung's (2004) research on the ergonomics of pulling two-wheeled suitcases, a handle length of 110cm is more ergonomic than the 100cm length commonly found on luggage. Furthermore, this study tested two different wheel sizes: 8cm and 15cm. The larger wheels resulted in 31% less downward force, 14% less pulling force, 24% more sideward force and 6% less energy expenditure. This suggests that the human body requires 6% less energy to perform the same task with luggage that uses larger wheels. Additionally, by raising the point of gravity, the downward force was heightened by 44%, resulting in a 184% increase in the pulling force.

In 2006 Lee published a thesis study on the usability of two-wheeled luggage. Using mechanical models and usability tests, he found that the pulling force was minimised at an angle of  $65,56^\circ$ . During user testing with eight subjects with varying heights, the length of the handle was tested. The optimal length of the handle differed for each user, varying between 97,79cm and 125,73cm. The optimal height that was found by Jung, 110cm, aligns with the findings of Lee.

## C. Handle design

In a study by Jung et al. (2003), the differences between a single curved pole and a double pole in luggage design were investigated. The findings show that a single, curved pole creates more room between the luggage and the user's body. This aspect is essential for ensuring optimal comfort while rolling around luggage or using a shopping trolley.



## D. General recommendations

A survey published in 2012 by Farivar et al. investigated the ergonomic parameters of shopping trolleys. A list of design factors was created to minimise injuries in the arm, shoulders, and lower back muscles. The study also investigated which factors can reduce the amount of force required:

1. Use flexible tires for the wheels and add a spring mechanism for rough places; this reduces the vibrations
2. Using big wheels can make going up and down stairs easier. Front swivel wheels can lower the pushing force by 10% and increase the manoeuvrability.
3. A brake lever can fix the trolley on an inclined surface.
4. The body should be solid and stable to keep the load balanced.
5. The trolley should be as light as possible
6. An angled handle at 30-35 degrees from vertical is optimal for pushing.
7. Adjustable handle height
8. A handle with soft foam increases gripping and reduces pressure on the hand.
9. Foldability is essential for easy carrying and storage.
10. Special places are devoted to fragile and sensitive goods to prevent using several bags to gather (adjustment with type and amount of buying).

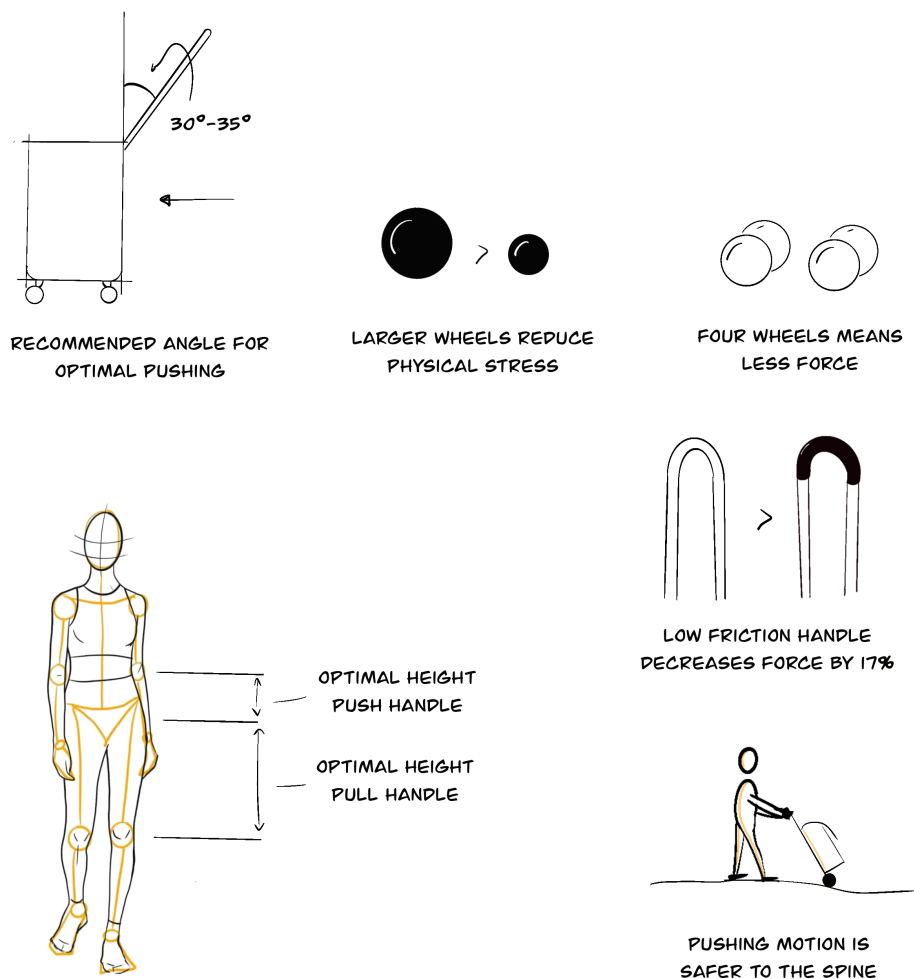


Figure 10 - visual overview of some key aspects found in literature on ergonomics



## 2 Interviews

### A. Interviews with current users at the farmers' market

Gathering user data is an essential aspect of collecting the needs and wishes of users. Understanding how a shopping trolley can be helpful for a new target audience starts with comprehending the problems and benefits that current users are experiencing. To achieve this, individuals using a shopping trolley at the weekly farmers market in Kortrijk were interviewed to gather insights on how and where they use their shopping trolleys and any positive or negative aspects they have experienced. There were six elderly ladies interviewed, who were the only demographic group observed at the market using a shopping trolley. Some of the women were accompanied by their husbands.

While a few participants mentioned that it is annoying that a trolley must be filled up starting from the bottom, most adjust their shopping routine to accommodate this requirement. They start by buying heavier items, like apples and potatoes, to end with light and fragile items, such as strawberries and a loaf of bread.

Almost all participants are very positive about their trolleys, especially on the ergonomic aspects. With this product, users can effortlessly pull their groceries instead of having to lift heavy bags. It helps to reduce pain in their back and shoulders.

Most participants use the trolley to go straight from their homes to the market, but some also use their cars. Most participants only use the trolley to go to the weekly market and do not use it for the supermarket. One respondent said that she finds it difficult in the supermarket to use it in combination with a supermarket cart.

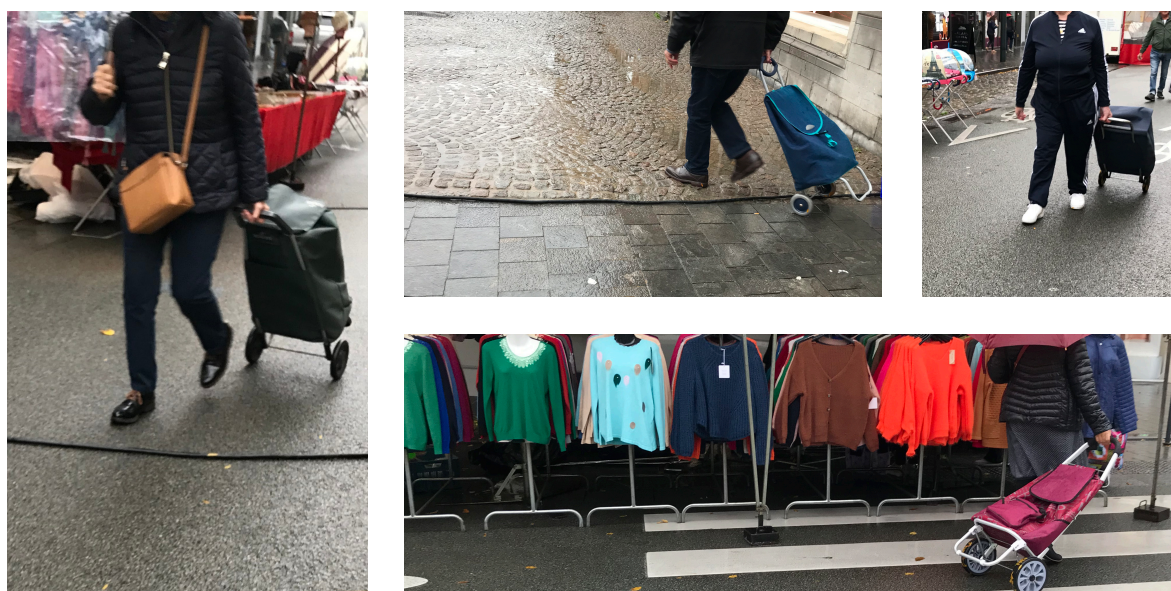


Figure 11 - pictures of people using a shopping trolley at the farmers' market

Overall, the participants expressed satisfaction with their shopping carts, prioritising practicality over aesthetics. According to a study conducted by Gutchess et al. in 2010, older adults can process information about themselves in a more normative manner. Younger adults tend to focus more on distinguishing themselves from others and care more about what others think.

## B. Interview with a current user in the supermarket

A middle-aged woman using a shopping trolley was observed at a grocery store. Upon questioning, the woman said she had started using the trolley after undergoing shoulder surgery. This is consistent with the information provided by the salesman at the luggage store: many individuals begin using a shopping trolley when it becomes necessary to avoid discomfort or pain.

The woman used a Reisenthel Carrycruiser, which features a low basket, differing from the classic bag with two wheels. Additionally, she carried an extra bag inside the trolley to easily take out the groceries all at once. This resolves her issue with traditional trolleys that require unloading by hand, resulting in a lot of bending over. Furthermore, the Carrycruiser has an open design, allowing users to oversee all their groceries. The user indicated that she chose this trolley due to her perception that it prevents groceries from being damaged by each other.



Figure 12 - woman with a Reisenthel Carrycruiser (source: Connox)

## C. Interviews with potential users

To understand why most individuals between 20 and 40 are not utilising shopping trolleys, interviews were conducted outside a supermarket in Ghent's city centre (Fig. 13). To optimise the interview process and ensure the validity of the collected data, a pilot test was conducted beforehand with a colleague of the author. The interview involved five people between 20 and 30 years old, all carrying heavy bags by hand. The main objective was to better understand the participants' goals, needs and struggles when shopping for groceries. Additionally, the interviews aimed to investigate the participants' attitudes towards shopping trolleys and why they do not use this tool.

### Person 1

This participant says she tries to maximise the number of groceries she puts in her backpack. For extra items, she uses extra plastic bags that she attaches to her bike handlebars to ride home. She opts for grocery delivery services for larger items, such as a crate of beer or groceries for cooking with friends. The woman finds it a hassle to carry groceries on foot and primarily uses her bike to shop. However, she does not perceive a shopping trolley as a valuable tool, as she thinks the sidewalks in Ghent are not accessible enough. The participant associates shopping trolleys with the elderly or those with limited mobility.

### Person 2 & 3

These two participants, students living in Ghent, went to the grocery store together. They usually do their groceries on foot, using standard plastic grocery bags. When it comes to bigger items, they often struggle to drag them home. They separate the groceries over multiple days if they have too many items to purchase. They associate shopping trolleys with older people but would consider using them if they were more aesthetically pleasing. They find current trolleys old-fashioned and think there is some cliché surrounding their use.

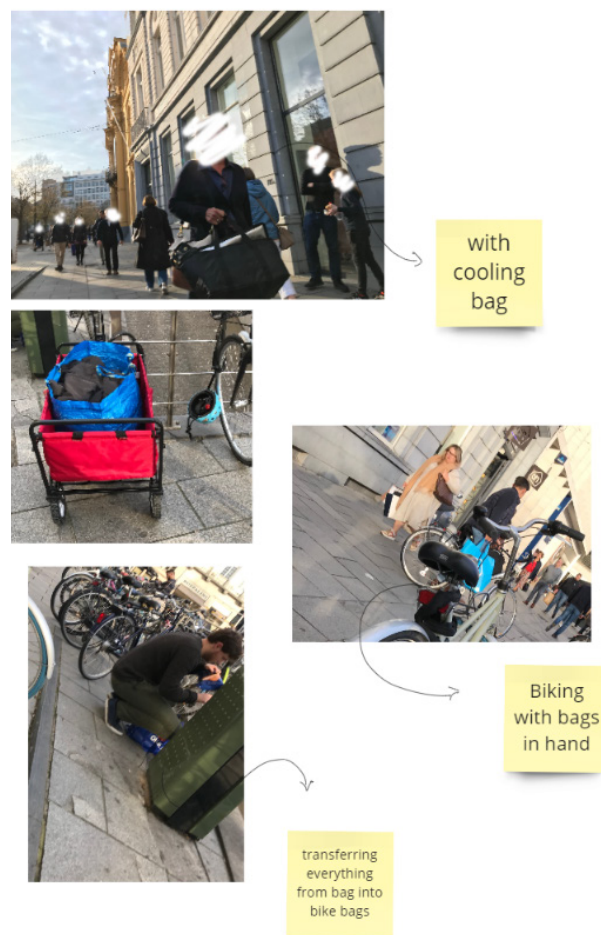


Figure 13 - observation of potential users

### Person 4

This person puts everything in plastic bags inside the store and then rearranges the groceries inside his bike bags. Despite using his bike to transport groceries, he mostly walks with his bike. His street is designated for pedestrian traffic only, so the bike acts as a trolley. Although this person associates the shopping trolley with elderly people, he finds it an interesting concept. Although he is uncertain of the cost or the exact location to purchase it, he believes this item could be beneficial.

### Person 5

This person puts his bags with groceries over his bike handlebars. He knows this is not so practical, but he chooses to do this because it is fast and easy. He does not think he would ever use a shopping trolley as long as he can carry his groceries. He believes that this is a product intended for individuals who are no longer able to carry their groceries.

### Conclusion

Most participants have difficulties shopping for groceries on foot or by bike but do not see a shopping trolley as a solution. Instead, they would rather go to the store multiple times than carry something associated with older adults. Most potential users use a combination of bike and foot to get around for groceries, which is an interesting aspect to explore.

### 3 Customer journey

Research shows that customer journeys are an effective way to understand the touchpoints where the user interacts with a product, allowing the designer to evaluate and improve the experience (Kuehl et al., 2019). One approach is to use customer journey mapping (CJM) to visualise the customer's overall experience, such as when using a shopping trolley. By mapping out the different aspects of the experience, CJM provides insight into the customer's concerns and feelings (Rosenbaum et al., 2017). This understanding of the good and bad aspects of the experience is a valuable starting point for the design process.

These two storyboards were created based on interviews with current and potential users. These storyboards capture the habits and assumptions of the user, translating them into real scenarios. The first storyboard is shown in Figure 14, with the according customer journey map in Figure 15. The second storyboard can be found in Appendix A. This enables accessible communication with potential users and provides valuable insights regarding the product's context. While this method narrows down the collected information to some extent, the primary purpose is to explore the interactions further and identify missing information needed to understand the user's needs.

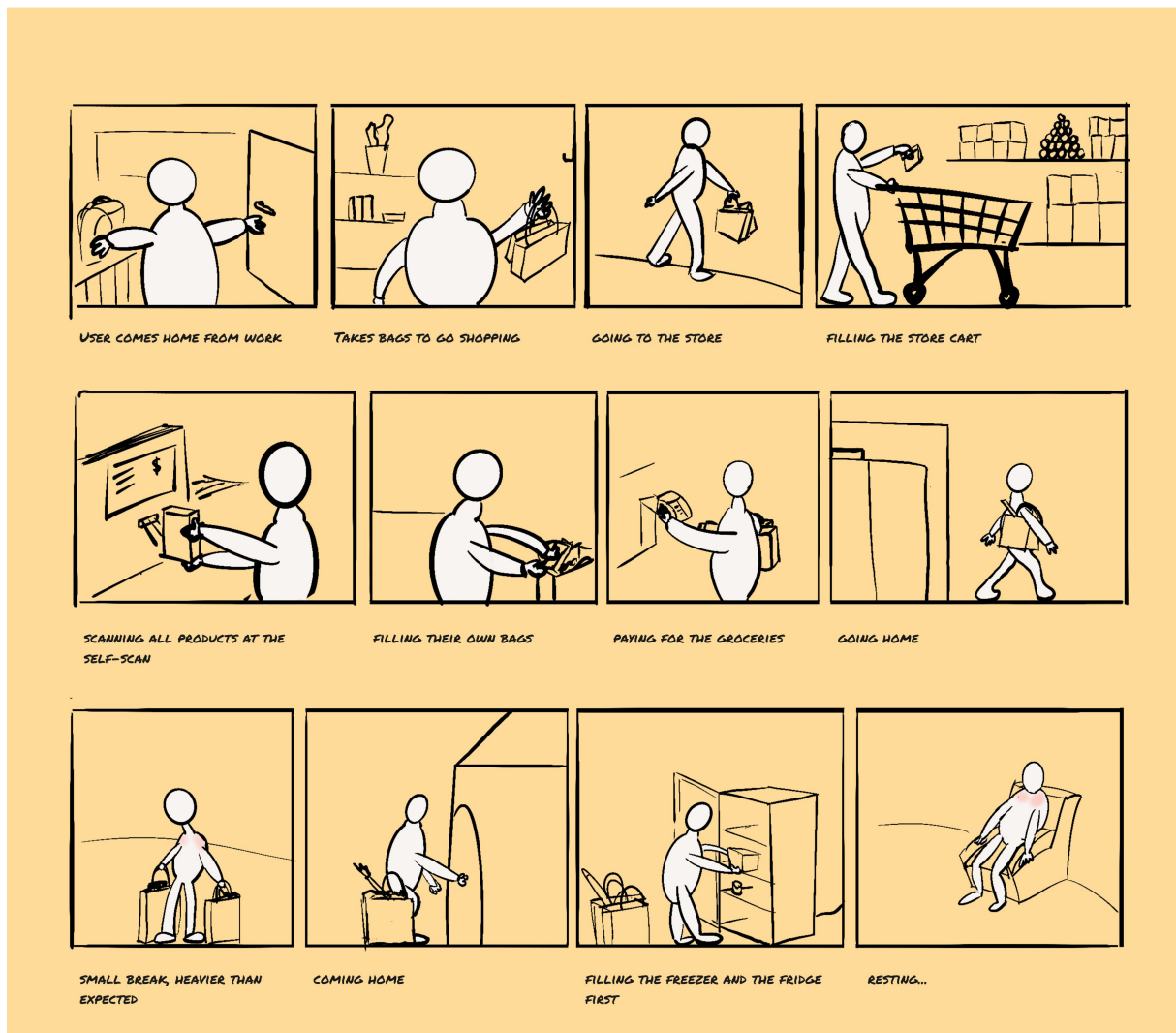


Figure 14 - customer journey 1



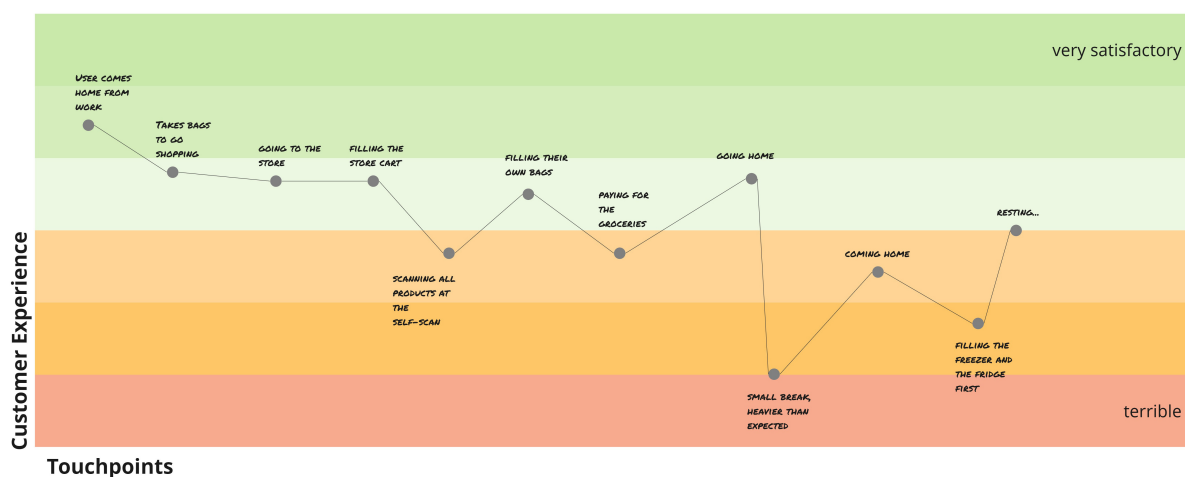


Figure 15 - customer journey map for customer journey 1

One important lesson that can be learned from making and analysing customer journeys is the need for more research on the transporting habits of customers doing groceries. Their ideal shopping trolley size and design may vary depending on their habits and transportation methods. If it is common for users to go to the supermarket straight from work or another location, then a foldable or renting solution would be necessary. Knowing whether most customers come from their homes when visiting the store can help to set constraints for these parameters.

Another pain point identified through these customer journeys is the storage of frozen and chilled products. Customers may find having a separate compartment for these items more convenient, making it easier to empty them when coming home. However, this also introduces a more considerable cost and can make it more difficult to quickly fill the trolley in the supermarket. A cooling compartment can be further explored in the next phases of the project.

Introducing the bike is also important to consider when analysing customer journeys. A shopping trolley compatible with a bicycle would be ideal for targeting a wider audience beyond those living close to the store. This also makes combining other activities like work or sports with grocery shopping easier. This way, people can use the bike to get to the store and use the trolley instead of a shopping cart, so they do not have to fill their bags at the checkout.



## 4 Survey

### A. Goal

The goal of the survey is to acquire a better understanding of the possible target groups and their requirements. Analysis of their current transportation modes, grocery shopping habits and shopping frequency can provide insights that help to improve the shopping trolley to meet the needs of its users better. Moreover, if sufficient responses are collected, this survey offers an opportunity to compile numerous frustrations and their respective significance. This information can all be used as a foundation for the design requirements further in the project.

### B. Methods

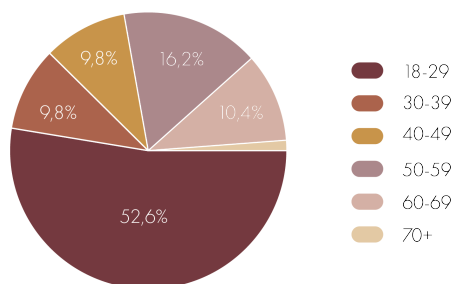
Initially, this survey was sent out to friends, family and acquaintances. Additionally, the survey was also shared on social media, including in several local groups on Facebook, like a community from people living in a specific neighbourhood in Ghent. This resulted in 173 responses, covering a wide age spectrum, starting from 18 years old. There were two responses eliminated from the further analysis, as their answers were incomplete.

### C. Results

#### General questions

The survey respondents represented a diverse range of ages based on age categories. Of the total respondents, 52,6% were between 18-29, and 9,8% were between 30-39 (Fig. 16). This means that 62,4% of the respondents are part of the target age group. More than 93% of these respondents have a grocery store within 2 kilometres of their home. Moreover, for 80% of the target group respondents, the grocery store is within 1 kilometre. According to previous studies, a one-kilometre distance is a general distance that people are willing to walk (Lee & Moudon, 2006). It also has to be noted that having a grocery store within this distance does not particularly mean that this is the preferred grocery store for these respondents. The preference for grocery stores is influenced mainly by distance but also by in-store characteristics and prices (Wei et al., 2022).

Age distribution of respondents



Proximity of respondent's homes to nearest supermarket

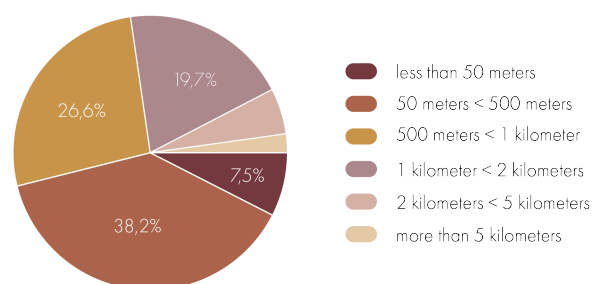
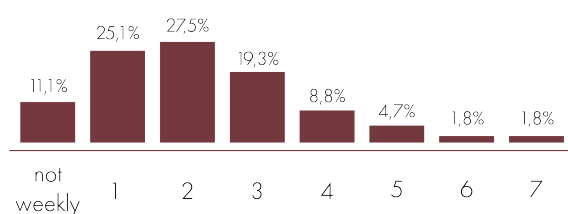


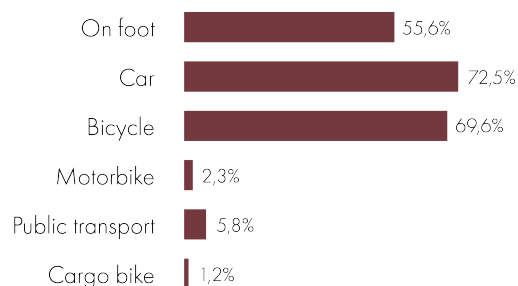
Figure 16 - charts showing the distribution of a few answers of the survey

## Questions related to shopping behaviour

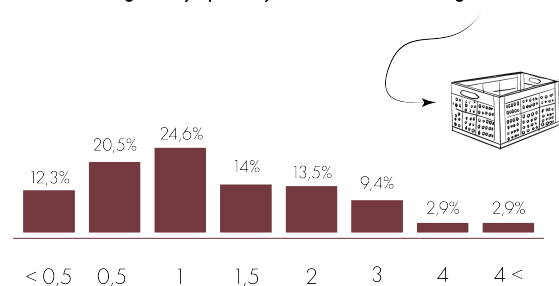
Frequency of grocery store visits per week



Transportation methods for grocery store visits



Estimation of grocery quantity in number of folding crates



Critical frustrations when grocery shopping on foot or by bike

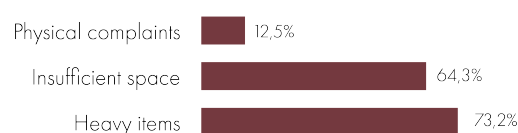


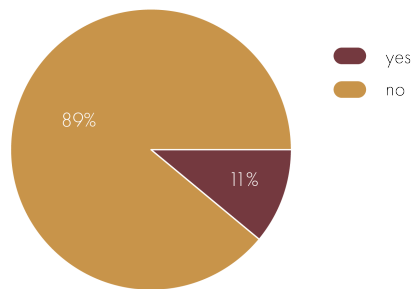
Figure 17 - a few important answers about the grocery behaviour of the participants

- × Twenty percent of the respondents living within 500 metres of a store never go to the grocery store on foot. Almost 70% of these respondents have indicated they cannot carry enough groceries or buy more oversized items.
- × More than 72 percent of the target audience uses their bike to go grocery shopping, and 62 percent do grocery shopping on foot. Almost 86 percent of the target audience respondents go on foot or by bicycle occasionally to do their grocery shopping.
- × 57% of the respondents' groceries fit within one foldable box of around 32 litres. For the target audience of people younger than 40, this is even 67%
- × More than 70% of the respondents first go home before doing groceries. This means that the user can leave their bags or trolley at home instead of bringing them to work.

Generally, it can be concluded that a bicycle is an essential part of grocery shopping in urban areas. With more than 70% of the target users using a bike to do groceries (Fig. 17), this shows many opportunities. The possibility of combining a shopping trolley with a bicycle is something that has to be investigated. In an ideal scenario, users can either walk or go by bike with this new shopping trolley.

## Questions related to a shopping trolley

Respondents who occasionally use a shopping trolley



Respondents that associate a shopping trolley with older people

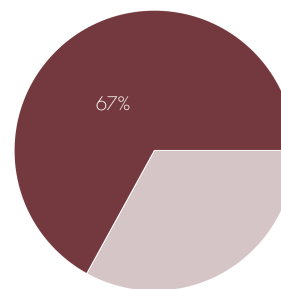


Figure 18 - results of a few questions related to a shopping trolley

To better understand why young people tend to avoid using shopping trolleys, the hypothesis that the aversion is linked to an association between shopping trolleys and older people is investigated. Participants in this survey were asked to describe their perceptions of who uses a shopping trolley. The results showed that 67% of the responses included references to elderly, aged or senior citizens. Furthermore, 13% of the answers mentioned individuals experiencing back pain or facing difficulties walking.

To gain better insights into what could motivate people to use a shopping trolley, the next question was: 'What would make you decide to use a shopping trolley?' 18% of the respondents said that the trolley's appearance was essential to them. Interestingly, this percentage was even higher at 23% within the target group. Furthermore, 10% of the participants said they would be more likely to use a shopping trolley if it could be used easily with a bicycle. Additionally, more than 6% of respondents stated they would be more interested in using a shopping trolley if it could be stored more compactly.

## 5 User scenarios

Building scenarios is a valuable tool for stimulating user-centred ideation and helps to place the product in a larger context (Suri & Marsh, 2000). Letting fictional characters go through specific scenarios helps discover new pain points that might have been overlooked in previous research. Every scenario is broken down into different steps, and for every step, an assumption is made about what the users are doing, thinking and feeling (Kuehnl et al., 2019). To enhance the user experience, it is beneficial to define the functional needs and incorporate the thoughts and emotions of the fictional user into the design. These scenarios go beyond a typical user journey, allowing the consideration of specific use cases that require attention in the design process. Two scenarios are shown in Figure 19; the other scenarios can be found in Appendix B.

After reviewing these scenarios, several crucial factors emerged that must be taken into account during the further development of the requirements:

- × People who do groceries on foot or by bike often worry about not having enough space to carry all their groceries. It is comforting to have expendable space or excess bags that can be used in case not everything fits inside the provided space.

- × The current shopping trolleys do not allow much organisation, which makes it hard for the user to protect fragile items. When the user has heavy items, they do not want to drop them on their other groceries.
- × As shopping trolleys have bags or baskets that start pretty low, the users have to bend over a lot to put away items carefully. When emptying the trolley at home, users can put it on a chair to make it easier to empty. This action is not ideal because the design is not suited for it.
- × The current shopping trolleys are challenging to manoeuvre through doors or on stairs. When designing a new trolley, it is essential to consider not only easily accessible areas but also places with uneven surfaces and small spaces such as escalators.
- × Removing and replacing items should be effortless in locations where customers must empty their entire purchase at the checkout. The order of the groceries gets reversed, but the users should still be able to arrange everything as they like. Just because a six-pack of Coca-Cola was at the bottom of the grocery bag, it does not mean it should be placed on top of all the other items after checking out.

#### Scenario - Doing groceries with a scanner and a trolley in a supermarket

| STEPS    | Buying groceries with a list                                   | Buying the items in the supermarket                                        | Buy a heavy item (e.g. bottle of cola)                                                  |
|----------|----------------------------------------------------------------|----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| DOING    | Making list and going to the supermarket                       | Take the items, scan them and put them in the trolley                      | Takes bottle of cola, tries to shove it down into trolley without damaging other things |
| THINKING | I got to think about the order of my groceries to be efficient | I have to make sure I have enough space for all my shopping, stacking well | I need to make sure my eggs don't break                                                 |
| FEELING  | At easy                                                        | Slightly concerned                                                         | Frustrated                                                                              |



+ Liesbeth does not find it frustrating that she has to bend over each time she wants to put an item in her trolley (yet). In a few years time this can result in more back- and neck pain.

#### Scenario - Emptying groceries with shopping trolley when coming home

| STEPS    | Taking trolley to kitchen                             | Emptying trolley                                | Trolley storage                 |
|----------|-------------------------------------------------------|-------------------------------------------------|---------------------------------|
| DOING    | Manoeuvring trolley through the house                 | Putting trolley on the table                    | Takes trolley upstairs          |
| THINKING | How to easily get this up the stairs/through the door | Otherwise I will have to bend over all the time | Lifts the trolley on the stairs |
| FEELING  | Frustrated                                            | Not very comfortable                            | Careful                         |



Figure 19 - example of a few user scenarios







# 03

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## discover

In addition to studying the needs and behaviours of users, this chapter analyses the current shopping products available on the market. The aim of this is to discover the functionalities and characteristics of the products that are currently available on the market. Additionally, exploring other conceptual works that aim to redesign the shopping trolley is valuable, as this can provide alternative perspectives and new approaches. Gaining a better understanding of the design of current shopping trolleys can help to develop a better view of the technical possibilities of this challenge.

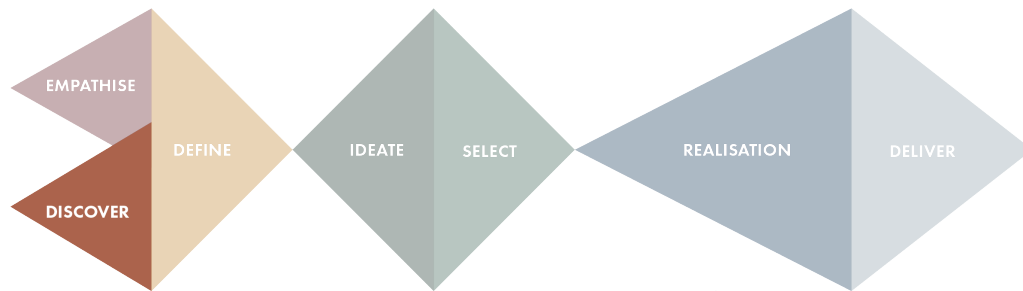


Figure 20 - discover as part of the design process

## 1 Interview with a trolley seller

An experienced salesman working at a luggage store was interviewed about his experiences with shopping trolleys. The interview's main focus was his past experiences with shopping trolleys, his customer demographics and the obstacles customers face when utilising these products.

When customers purchase a shopping trolley from a luggage store, they typically pay around 100 euros to start and can expect to use it for 10 to 20 years. According to the salesman, cheaper models that can be found at a discount or general store, costing less than 20 euros, have a short lifespan. The primary audience that buys shopping trolleys is still older people, but in the last few years, more and more younger people have bought trolleys. The salesman attributes this trend to the fact that moving around in a city by car is getting more challenging.

The conventional shopping trolleys, such as the red and black models shown in Figure 21, remain popular amongst the elderly. If the user wants to put items on the bottom of the trolley, they must stoop far down, which is physically demanding. To reduce this issue, users often put a shoebox at the bottom to diminish the depth of the shopping trolley. In the supermarket, they sometimes put the trolley inside their cart or fill it up during the shopping.

Thanks to its innovative design, young customers prefer the low-basket variant from Reisenethel (previously shown in Figure 12). The salesman has also mentioned selling some pink bags to ladies who want to use a big tote bag for daily activities but wish to attach it to a trolley when needed. According to the salesman, the non-traditional design of these shopping trolleys makes them more appealing to



Figure 21 - some of the shopping trolleys from this store

the younger demographic. Furthermore, younger customers visiting the luggage store are willing to spend more money on stylish products that have a long lifespan. Since people living in small urban spaces often use shopping trolleys, foldability is an essential feature.

The salesman strongly believes that utilising a shopping trolley is an excellent approach to shopping in a city. He finds it unfortunate that most people begin using trolleys only at a particular age. The salesman attributes this to the loss of pride that comes with using a shopping trolley for assistance during shopping, as some individuals feel they begin to belong to a different generation. Some people prefer to carry full bags rather than feel aged by using a trolley. It appears that not only younger people but also some older individuals have a negative perception of using a shopping trolley.

## 2 Benchmarking current products on the market

### A. Shopping trolley

An overview was created to evaluate the current popular shopping trolleys available. This evaluation was based on their popularity ranking on leading online retail platforms, such as Bol.com and Amazon. Table 1 provides some examples, while a complete benchmarking of twelve different products is available in Appendix C. Additionally, the reviews on these retail platforms were analysed to understand the frustrations and requirements of the users.



| Shopping trolley                                                                                                                                                                                    | Reisenthel Trolley M                                                                                                                                            | Carlett Urban Duo Lett430                                                                                                                                                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| €24                                                                                                                                                                                                 | €62                                                                                                                                                             | €128                                                                                                                                                                                                              |
| 40l                                                                                                                                                                                                 | 43l                                                                                                                                                             | 36l                                                                                                                                                                                                               |
| 2000g                                                                                                                                                                                               | 1485g                                                                                                                                                           | 4650g                                                                                                                                                                                                             |
| <ul style="list-style-type: none"> <li>× Big wheels</li> <li>× Small pocket for wallet etc.</li> <li>× Height not adjustable</li> <li>× Polyester bag</li> <li>× Foldable</li> <li>× Lid</li> </ul> | <ul style="list-style-type: none"> <li>× Pocket for wallet</li> <li>× Low wheels</li> <li>× Single handlebar</li> <li>× Folding handle can be hidden</li> </ul> | <ul style="list-style-type: none"> <li>× 4 wheels</li> <li>× Isothermal pocket 7,5l</li> <li>× Adjustable handlebar</li> <li>× Transformable to two wheels</li> <li>× Foldable</li> <li>× Safety brake</li> </ul> |

Table 1 - a few products from the benchmarking of current products



Taylor P.

★★★★★ **bag is not well made**

Reviewed in the United States on September 26, 2022

Color: Red | Design: Storage Carts | **Verified Purchase**

the bag rips very easily including the straps, the one that secures the bag to the cart ripped and i've only had it for 1 month. the cart itself is pretty good with large tires

Figure 22 - example of customer reviews on online retail platforms

According to reviews from shoppers (Fig. 22), a shopping trolley should be strong enough to handle heavy items and have a solid back to provide proper support. Waterproofing and the ability to close the trolley when needed are also important factors. Ergonomics are crucial for different situations, such as going downstairs and lifting the trolley into a shopping cart. Adjustable handle height is preferred, as it minimises the risk of bumping into the wheels with heels and provides better ergonomics. Additionally, shoppers appreciate features that allow for the organisation and protection of fragile items.

## B. Bike grocery transport

### Bags

There are already a lot of bags on the market that focus on easy attachment to a bike (Fig. 23). Ortlieb and other brands also have created unique models that focus on combining a backpack with a bike bag. This might be good for people who do not have a large amount of stuff to carry, but once the volume is too large, carrying by hand is no option.



Figure 23 - benchmarking current solutions of bike bags that incorporate alternative uses

### Trolleys

To solve this issue, a few brands have been making trolleys that can be attached to a bike. Trolleys are made to transport children and can be transformed into shopping carts or trolleys mounted behind the bicycle (Fig. 24). The popularity of this type of trolley is currently relatively low, potentially attributed to the looks and high price. Furthermore, the volume of these trolleys is quite large, making them unsuitable for small households.

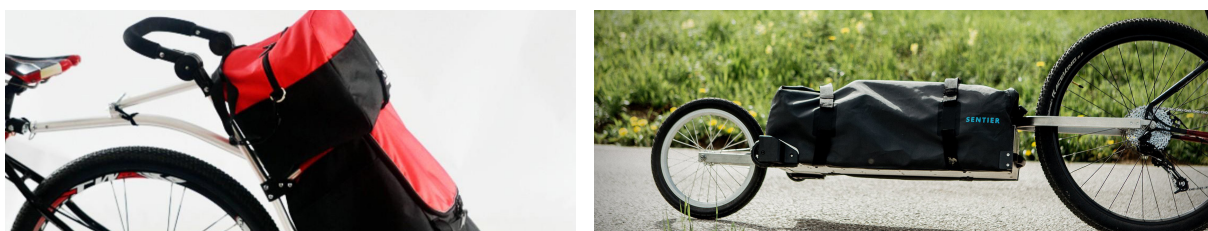


Figure 24 - benchmarking of current trolleys compatible with a bike



## C. Car grocery transport

As there is often a large space in the trunk of a car, efficient organisation is not necessary. This is why bags and crates are popular when grocery shopping by car (Fig. 25). These cheap tools allow users to organise their groceries easily. As there is no need to carry these boxes or bags for a long time comfortably, the ergonomic aspects do not have to be well-designed.



Figure 25 - benchmarking current products used for organising groceries in a car

## D. Luggage

In order to design an innovative new shopping tool, many different ways of accessing, storing and transporting goods are explored. As the shopping trolley market is relatively small, it is interesting to look at other product categories where similar needs are required. Luggage design is a good example, focusing on efficiently transporting items from one place to another. Furthermore, the luggage industry also focuses on innovation and incorporating new mechanisms, as shown in Figure 26.



Figure 26 - benchmarking of innovation in luggage design

### 3 Benchmarking conceptual work

The purpose of benchmarking conceptual work is to gather inspiration and ideas from existing designs and concepts created by others. Websites such as Behance and Yanko Design are explored to see how different designers have addressed the challenge of designing a new type of shopping trolley. This benchmarking of 11 projects brings together innovative concepts, creative solutions and unique approaches. Some interesting concepts are shown here; additional projects can be found in Appendix D.

#### Binderchart (Nixon, 2013)

- × A collapsible, lightweight grocery transporting tool with a small footprint
- × The result is very collapsible, but does not have a sturdy look

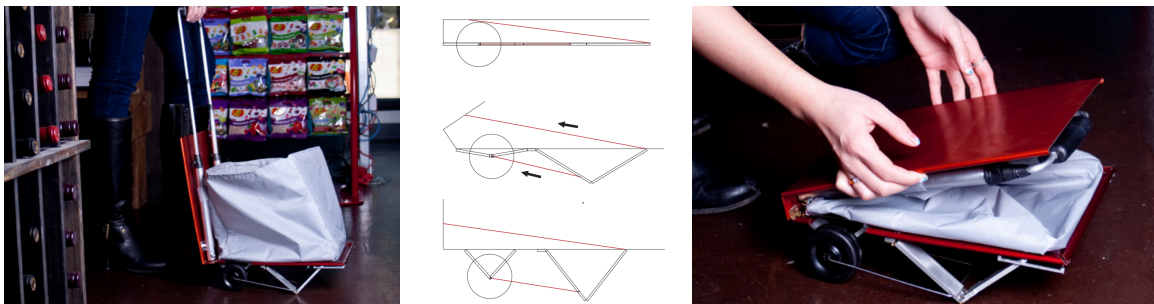


Figure 27 - Binderchart by Nixon

#### Accessory for urban bicycles to transport fresh products after grocery shopping (Rodriguez & Antonio, 2015)

- × A new way to carry fresh products around in cities on a bike
- × Convertible to a trolley
- × Insulated faces
- × Large lid that allows for easy access to the groceries
- × Makes it possible for fresh products to breathe, avoiding moisture concentration and humidity



Figure 28 - Fresh grocery shopping accessory by Rodriguez & Antonio

## Master's degree project at the Academy of Fine Arts (Kostecka, 2012)

- × Easy to access, orientation allows users to adapt the trolley to their own preferences
- × Pushing or pulling motion possible
- × Different compartments help to avoid the crushing of other groceries



Figure 29 - master's degree project by Kostecka

## Shoppingmate (Giesta, 2017)

- × New look through handlebar
- × Modular design
- × Restricted volume



Figure 30 - Shoppingmate by Giesta



## EVOO Shopping trolley (Samson, 2018)

- × A shopping trolley for young people with improved aesthetics and better functionality
- × Main drivers:
  - Avoid the bumping of wheels against the user's heels
  - One handed use, so the user can use their smartphone when needed
  - Compact storage
  - Better accessibility, mostly on the bottom of the trolley
  - Ability to go up and down stairs



Figure 31 - EVOO shopping trolley by Samson

## Brolley (Choi, 2021)

- × Cart to help you sort out the trash
- × Interesting look with the frame in the same orientation as the wheels



Figure 32 - Brolley by Choi



## Jumble (Delahaie, 2019)

- × Convertible design as bag, trolley and bike bag
- × All-in-one makes it hard to get the right volume. For a bike bag, this is too small, but for a daily work bag, this volume might be too large. The stability on the bike and the bag's access are aspects that could be improved further.



Figure 33 - Jumble by Delahaie

## Lévo (Pinto & Ximedes, 2012)

- × Modular system allows the user to adapt the trolley to their needs
- × The plastic bins have a large footprint to store



Figure 34 - Lévo by Pinto & Ximedes

## 4 Testing current products

In order to understand the current product, a few different types of shopping trolleys were tested. The main testing was done through personal use and with two friends who used the trolleys and were observed during this testing. The users were part of the target audience, aged between 20 and 22, and had no prior experience with shopping trolleys.

Testing these products can help to discover new flaws and areas of improvement. These insights can further be used to form the requirements and shape the goals of the product. On the other hand, testing current products can also help to understand the already good features. It is essential to focus on things that can be improved and avoid developing features where current alternatives already provide suitable solutions. The identified pain points and needs from earlier stages of the process became more apparent, and even new problems arose.

### Product 1

The first trolley is a very basic model, the fundamental archetype of a shopping trolley (Fig. 35). The bag hangs onto a frame, and the frame is collapsible. It fits many groceries, but the ergonomics of the trolley could be better. The user often bumps with their feet or heels against the wheels and has to bend over deeply to reach the bottom of the bag. The bag does not allow the user to arrange the groceries, so the user ends up with a scrambled bag of groceries.

When going to the grocery store, the user also tested putting a crate of beer on the trolley frame. A full crate provided more stability than an empty crate, but the crate still fell from the trolley during the testing. The general architecture of the trolley is suitable for carrying this crate, but there should be a fixture system so the user can safely attach the crate.

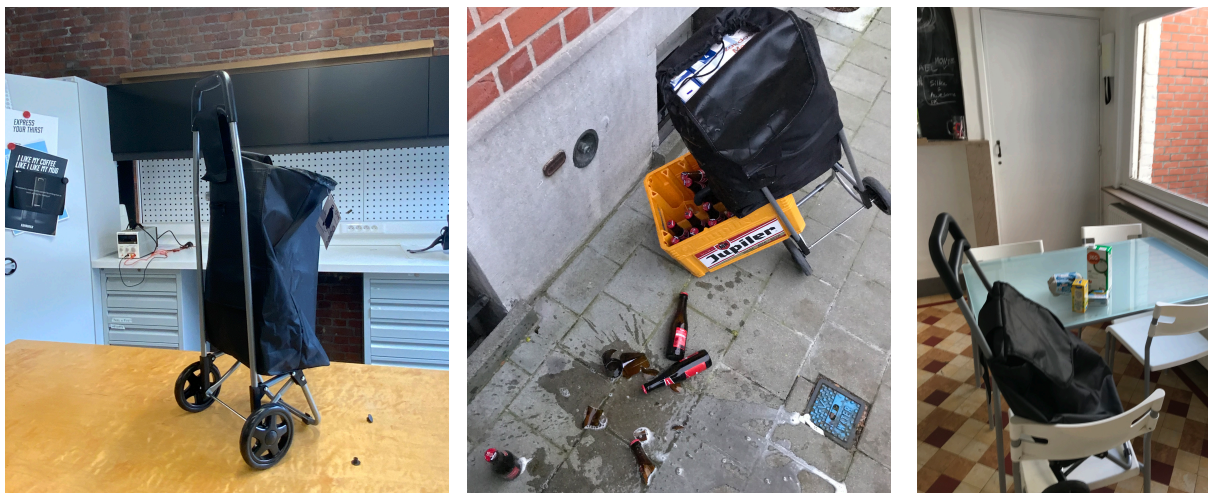


Figure 35 - tested benchmark 1



## Product 2

The second trolley is a compact and foldable shopping trolley, shown in figure 36. The unfolding process of the wheels is relatively straightforward due to the spring-loaded mechanism. There is no solid back inside the trolley, which means that the trolley falls over quickly when empty. However, even when filled with groceries, the trolley still often tips over. The trolley's height is lower than usual, causing discomfort for the user who has to bend down to use it properly.

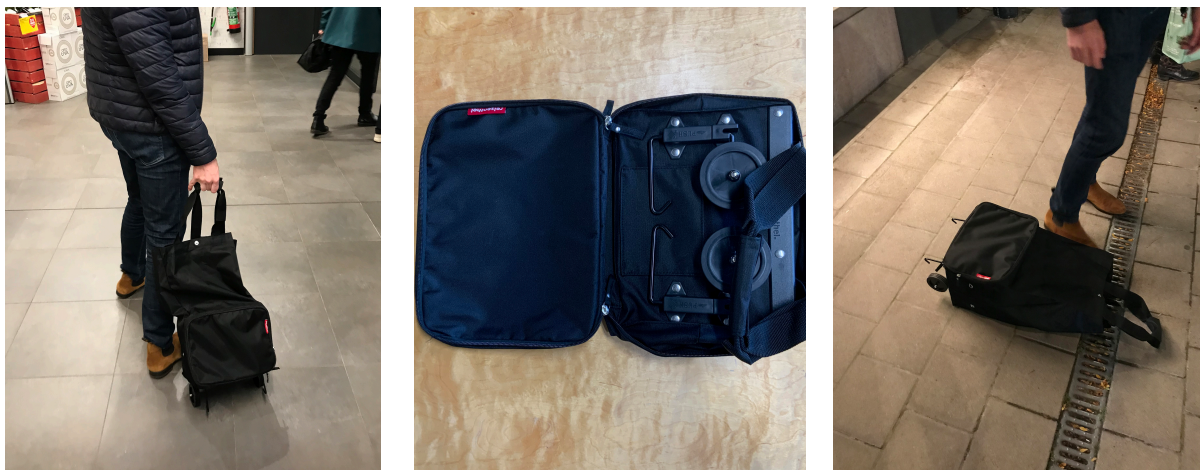


Figure 36 - tested benchmark 2

## Product 3

This modern trolley has a zipper (shown in Fig. 37) that prevents the user from overfilling the bag. The handle with one pole feels good to ride, but a little bump can cause instability, increasing the risk of the trolley flipping over. A lot of force comes on the user's wrist to prevent such accidents. The small pocket on the back is excellent for putting away keys or a wallet, but a bit too tiny to fit a smartphone.

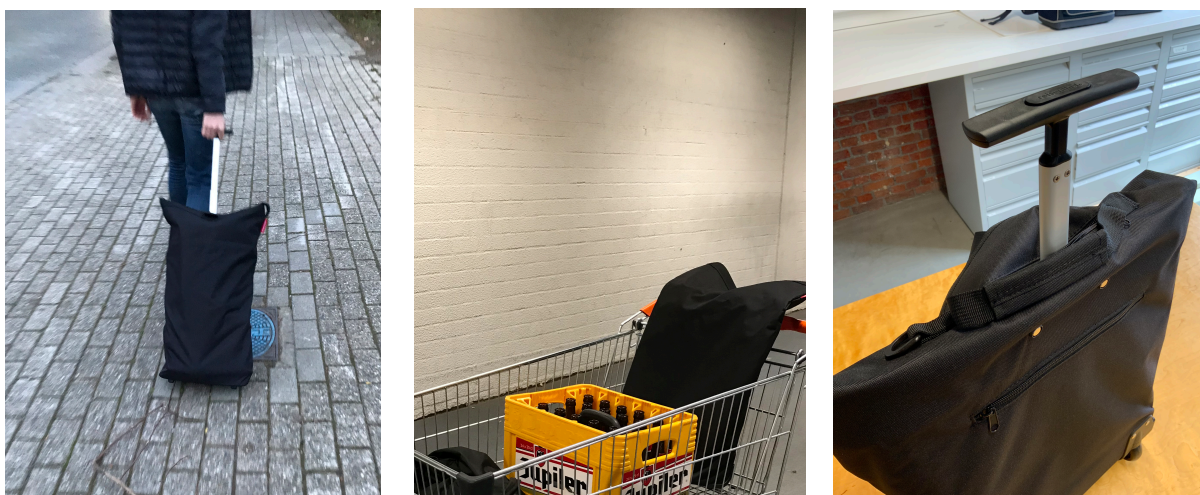


Figure 37 - tested benchmark 3





GREEN SQUASH  
\$ 1.99 LB

HOLLAND  
RED PEPPER  
4.99 LB

HOLLAND  
YELLOW PEPPER  
\$ 4.99 LB

YELLOW SQUASH  
\$ 4.99 LB

Drugs

CRISP LEEK  
TUBES  
\$ 1.99 EA



# 04

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## define

This chapter aims to summarise the research findings about the users and the product into concise overviews. These overviews serve as resources to guide the further development of the product. These tools assist in evaluating possible concepts and also ensure that the final product aligns with the research's findings. Organising all the information into overviews simplifies the use of the research and helps establish a framework for the following stages of the design process.

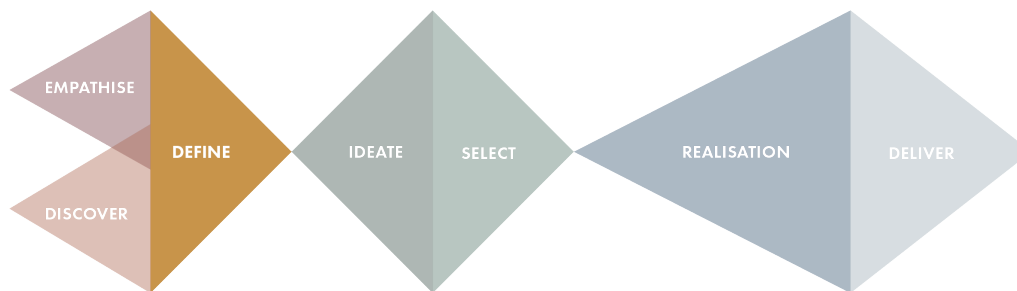


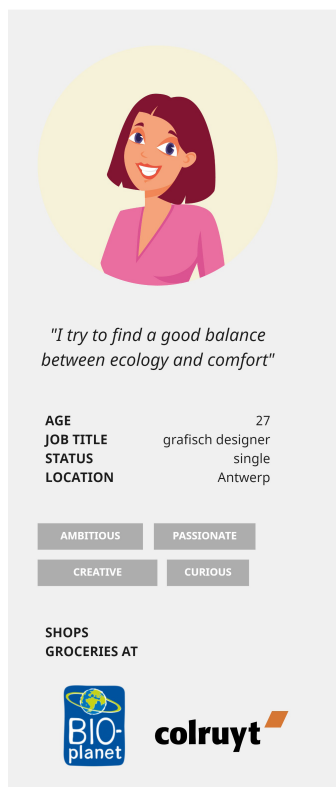
Figure 38 - define as part of the design process

## 1 Target audience

### A. Personas

Personas are fictional characters that represent a specific segment of the target audience. The creation of these personas starts with assumptions based on general and personal knowledge. To ensure accuracy, the characteristics of these individuals were confirmed through interviews and a previous survey with potential users. A reliable representation of different people was achieved by filtering the complete survey data ( $n = 171$ ) to the target group ( $n = 106$ ). Personas help focus on the target customers' goals, preventing self-referential design, where the designer thinks about their own needs (Miaskiewicz & Kozar, 2011). Research has shown that personas can help to overcome the disconnect between users and designers in a human-centred design process. During the design process, these personas can be used to check if the concept matches the lifestyle and needs of the user. Personas can also help to target the most significant customer segments and to narrow down the target audience.

The project's initial goal was to develop a new shopping tool for people living in an urban area. However, narrowing down the target audience is necessary to investigate the users' needs thoroughly. The demographic that is most likely to adopt a shopping trolley is individuals over the age of 50, particularly retired people. Therefore, the target audience for this project will be narrowed to young adults under 40. The reasoning behind this decision is that if this demographic can be successfully convinced of the utility and benefits of the shopping trolley, it will likely lead to greater adoption and acceptance among a broader range of individuals. Two fictional characters were constructed to serve as potential users of this new product (Fig. 39). The initial drafts of these personas were created earlier in the process and further refined based on new insights from the research. .



# Liesbeth Vermeulen

## ABOUT

I am a graphic designer, living in Antwerp and working in Brussels. I take the train daily to go to my work. I live together with 2 friends in a nice house in the city of Antwerp. I do not own a car and try to do as much as possible on foot or by bike. In my spare time I like to drink something with friends or go running in the park. At evening I love watching a good movie or read a book with a glass of wine.

## GOALS

- I try to pay attention to my ecological footprint, but due to my busy life this is not always possible.
- I want to do as much as possible by bike and by foot, but at the same time I don't want to lose too much time doing my groceries.

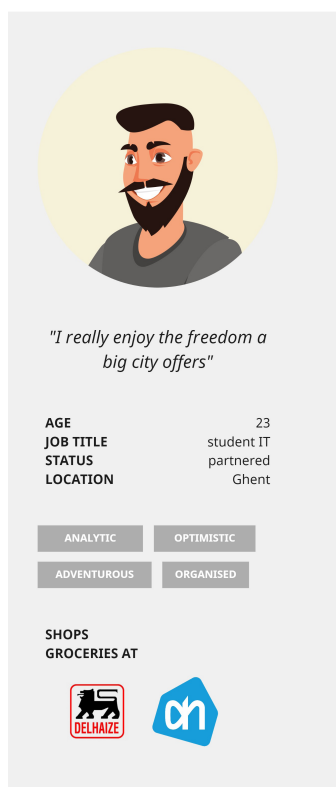
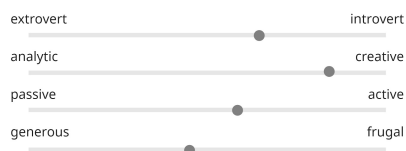
## NEEDS

- I try to do groceries twice a week. I like to buy enough at once so I don't have to run to the store every week.
- I sometimes want to invite friends over to have dinner and drinks, but this is sometimes hard to do last minute as I have to order the groceries or use a car from a friend.

## PAIN POINTS

- I want to do less groceries but due to the small amount that I can carry in one time, I have to go more often than desired.
- I try to rent a car from a friend when I need to get big packs of beer or milk. I don't really like being dependent on someone else. When I invite some friends, I have to plan these groceries way in advance.

## PERSONALITY



# Adam Patel

## ABOUT

I am an IT student, studying in Ghent and originally from Zedelgem. I cohouse with my girlfriend in Ghent. I do not own a car and try to do as much as possible on foot or by bike. I really enjoy the freedom of studying in a big city. In my spare time I like to drink something with friends or cook together with my girlfriend.

## GOALS

- I love the freedom of going to a supermarket regularly but at the same time I do not want to waste too much time.
- I want to go to a supermarket that matches my budget, as the closest supermarkets are often more expensive.

## NEEDS

- I want to take as much groceries home as possible, but due to the limited space of my bike, this is not always possible.
- I want to avoid using public transport to do my groceries.

## PAIN POINTS

- Although I live near the supermarket I always go by bike. This is because my bike allows me to carry more stuff at once. It is sometimes frustrating to load everything in the bike bags, than unload it again at home and then put everything away.
- When I buy bulky items, like a pack of milk, I put it on top of my bike rack and just walk with it.

## PERSONALITY

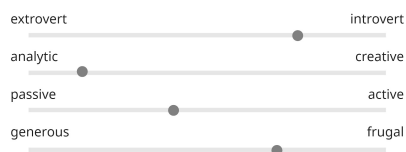


Figure 39 - visualisation of the personas

## B. Moodboard

Personas are a valuable tool to present possible target users and enhance the designer's understanding of the user's needs. However, they contain a lot of text, which can restrict quick immersion. To address this, a moodboard was made to provide the context of these target group users (Fig. 40). This visual tool quickly communicates the essence of the target audience to stakeholders but also makes it easier for the designer to empathise with the users.

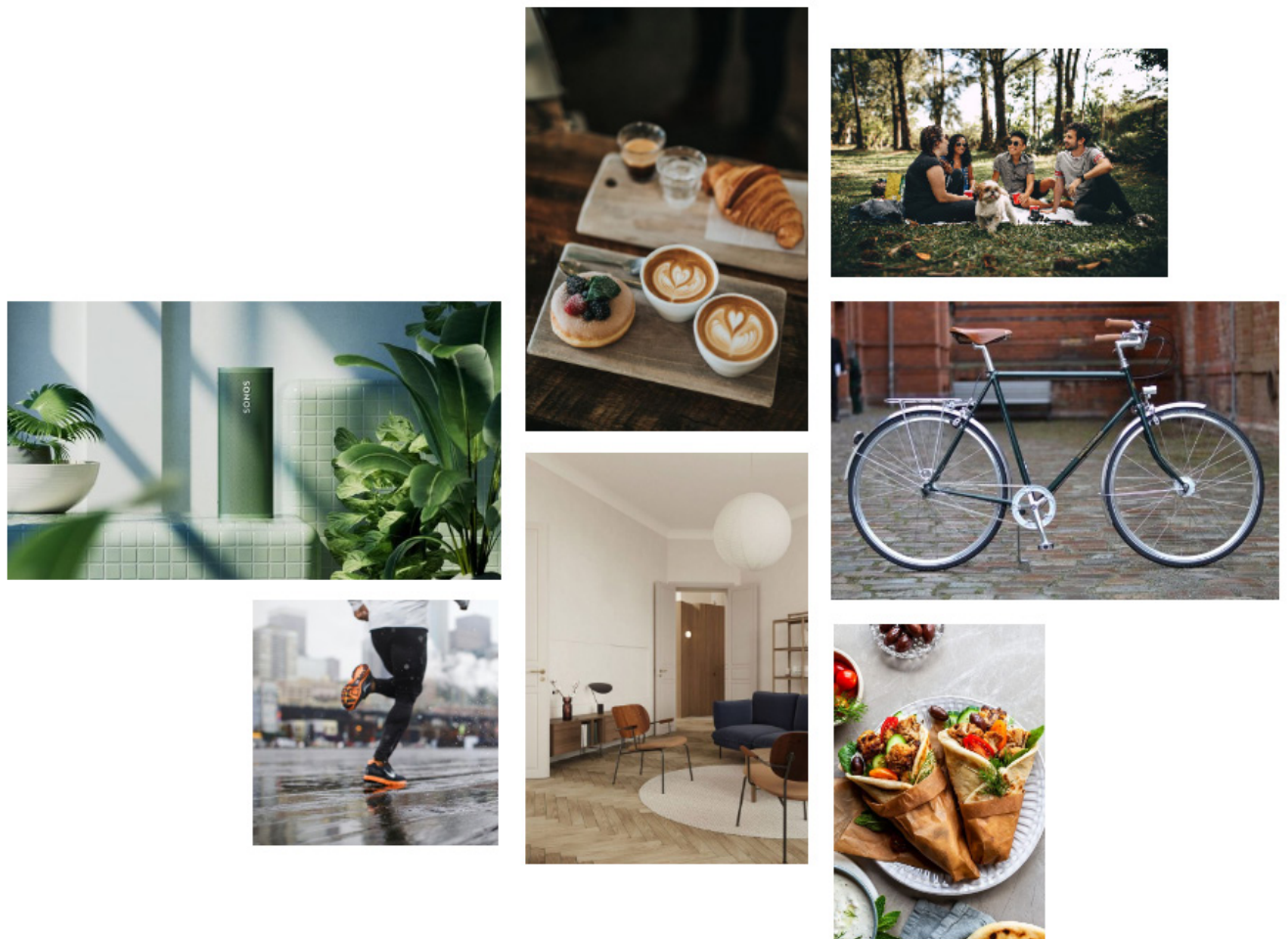


Figure 40 - moodboard target audience



## 2 Needs and wishes

A list of needs and wishes is drafted to provide clear goals for the product that will be developed. These statements should express what the product has to do, not how the product would do this (Ulrich & Eppinger, 2019). An overview of the shopping trolleys currently available can provide a starting point for these needs. The new shopping trolley should at least have the functionalities that basic shopping trolleys currently have. Figure 41 shows the ideal positioning of the new concept in comparison to the benchmarks.

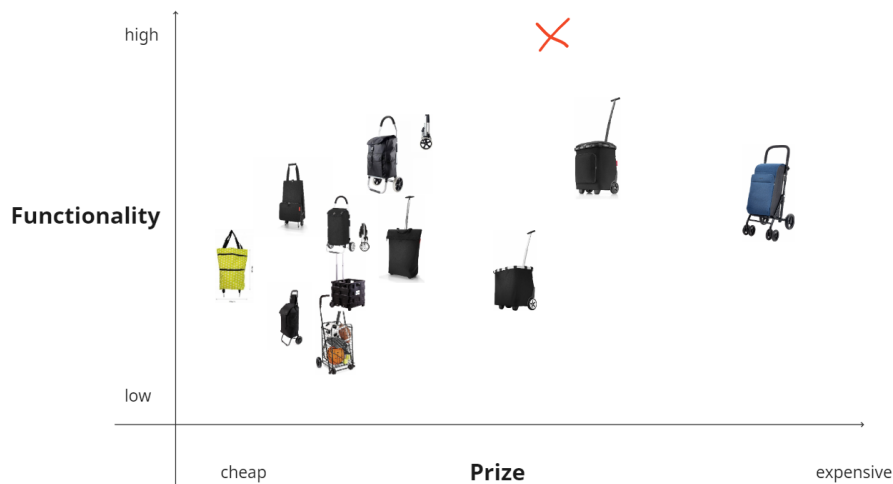


Figure 41 - target positioning of the product in comparison to benchmarks

After identifying the basic needs, a list of requirements that will distinguish this product from its competitors can be compiled. These requirements will further be referred to as Unique Selling Points or USPs. The USPs were determined through mixed research methods such as interviews, surveys, and benchmarking. The wishes are USPs that are not mandatory for the success of this product. Of course, incorporating as many wishes as possible will enhance the product's appeal and functionality.

| NEEDS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | WISHES                                                                                                                                                                                                                                                                        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>○ Easily foldable and unfoldable</li> <li>○ Self-standing</li> <li>○ Waterproof</li> <li>○ Carries a large amount of groceries</li> <li>○ Easy to operate</li> <li>○ Usable in a supermarket</li> <li>○ Compatible with a bike full and empty</li> <li>○ Possible to put items in different places</li> <li>○ New look</li> <li>○ Height is adjustable to the user</li> <li>○ Avoids groceries being crushed</li> <li>○ Provides a high-end user experience</li> </ul> | <ul style="list-style-type: none"> <li>○ Usable for other activities</li> <li>○ Usable as a backpack</li> <li>○ Different volume variations</li> <li>○ Affordable</li> <li>○ Fits into a backpack</li> <li>○ Optional lock</li> <li>○ Usable for less abled people</li> </ul> |

Table 2 - needs and wishes

### 3 Design drivers

A long list of needs and wishes can make it hard for the designer to focus on the essence of a new design. Design drivers are a way of setting goals for the project while maintaining focus on the most critical aspects of the new product (Driver, 2018). Initially, a list of 12 design drivers essential for the design was visualised and shown in Figure 42. Based on the information collected in the survey and the interviews, four design drivers that will be the focus of the design were chosen. These drivers will be the focus of the ideation and further development of the product.



Figure 42 - design drivers

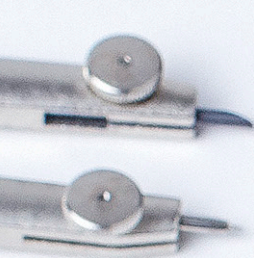
## 4 Target product specifications

Product specifications aim to turn the needs of the product into measurable goals (Ulrich & Eppinger, 2019). This makes it easier for designers to assess the effectiveness of certain design decisions and ensure that the identified needs are implemented correctly. The product specifications (Table 3) will serve as a guide for determining how well the product's design meets the requirements.

|       |                                                                 |                                                                                 |
|-------|-----------------------------------------------------------------|---------------------------------------------------------------------------------|
| NEEDS | <input type="radio"/> Easily foldable and unfoldable            | Assembly time is less than 30 seconds                                           |
|       | <input type="radio"/> Self-standing                             | Yes                                                                             |
|       | <input type="radio"/> Waterproof                                | Yes<br>Closing mechanism included                                               |
|       | <input type="radio"/> Carries a large amount of groceries       | Minimum volume: 34L                                                             |
|       | <input type="radio"/> Easy to operate                           | Maximum weight of 5kg<br>Needed force less than half of the full trolley weight |
|       | <input type="radio"/> Usable in a supermarket                   | Subjective                                                                      |
|       | <input type="radio"/> Compatible with a bike full and empty     | Yes<br>Mounting time is less than 1 minute                                      |
|       | <input type="radio"/> Possible to put items in different places | Yes                                                                             |
|       | <input type="radio"/> New look                                  | Subjective                                                                      |
|       | <input type="radio"/> Height is adjustable to the user          | Yes                                                                             |
|       | <input type="radio"/> Avoids groceries being crushed            | Yes                                                                             |
|       | <input type="radio"/> Provides a high-end user experience       | Subjective                                                                      |

Table 3 - target product specifications





DIFFERENT WHEEL SIZES

RISING  
COMPARTMENT

PUTTING TWO UNITS ON  
TOP OF EACH OTHER

BIKE TRAILER

LARGER FORMAT

BAG OR LARGER ITEMS

FIXATION

CARRY





# 05

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**ideate & select**

This chapter aims to turn the requirements for the product into a feasible concept, where the final concept meets all the needs stated in the previous chapter. The design drivers, mainly the four most important, will steer this ideating process. They are the most important characteristics that should be incorporated into the design.

The ideation phase starts with brainstorming, exploring potential opportunities and possibilities. At the same time, the look and feel are explored, as well as the technical possibilities. After these steps, a morphological map can be constructed, allowing the designer to combine solutions for each aspect of the new trolley design. Further iterations might be necessary to develop an innovative new shopping trolley concept that meets the previously outlined requirements. At the end of this phase, the most promising concept is selected.

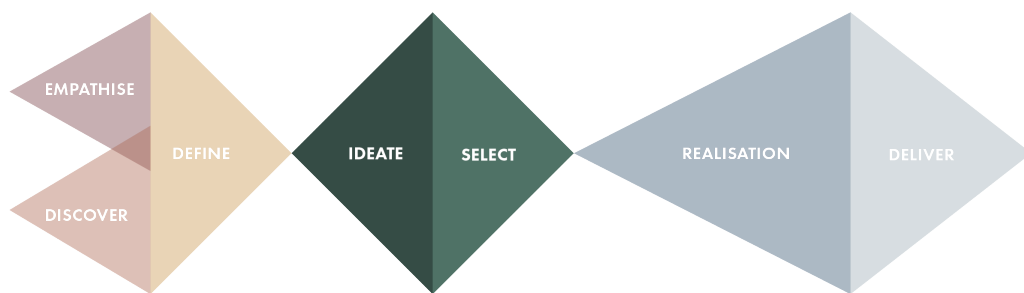


Figure 43 - ideate as part of the design process

## 1 Brainstorming

### A. Initial exploration

During the research phase of this project, some first ideas already came to mind. These are just some general concepts that can be considered during further ideation.

#### Idea 1

One possible solution is to create a hybrid system that incorporates various modes of transportation and ways of carrying bags (Fig. 44). This versatile trolley could be used for various activities, such as commuting to work or shopping for groceries.

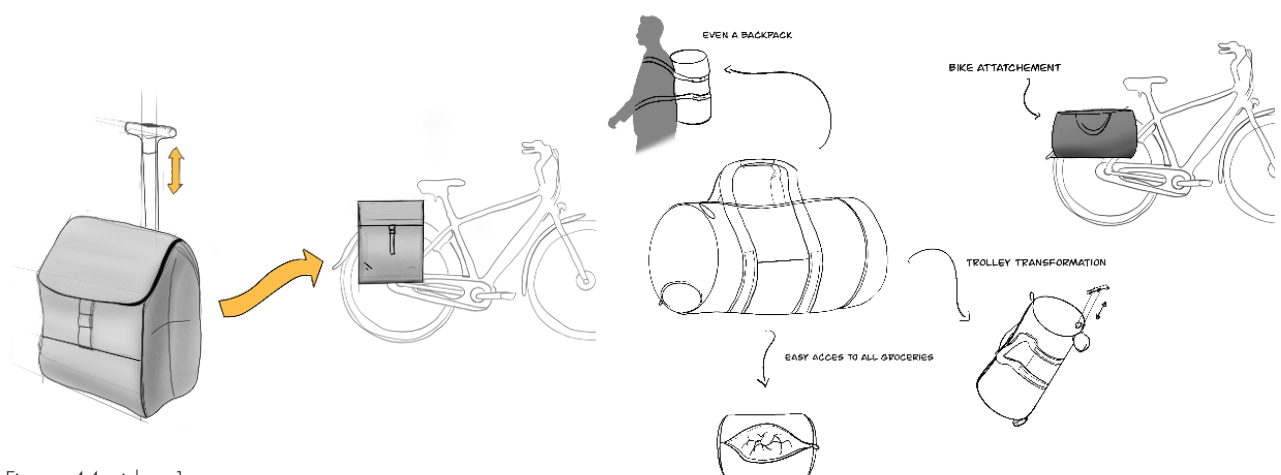


Figure 44 - idea 1

## Idea 2

The second idea is to create a modular system with components such as a trolley part, bags, crates, and other items. The user can then choose the components that match their needs. This allows a broader audience to have a product matching their lifestyle.

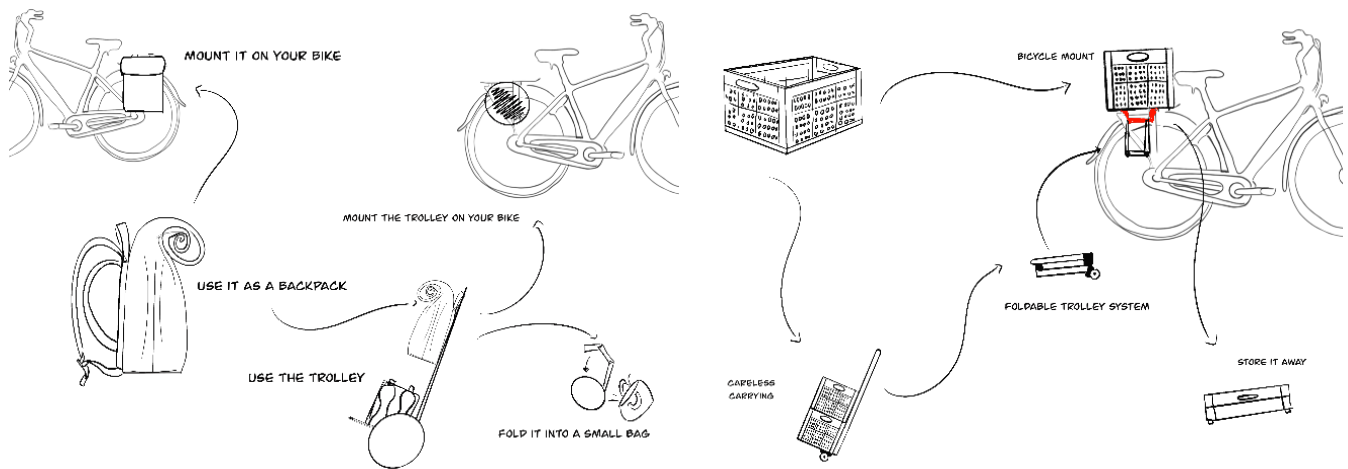


Figure 45 - idea 2

## Silhouettes

One way to change the look of a shopping trolley is by changing the general shape of the design. This can be achieved by creating a new archetype. Different silhouettes were created to explore new looks. Although some silhouettes look unique and original, the general outline of a wheel, storage place and handle are still the same.

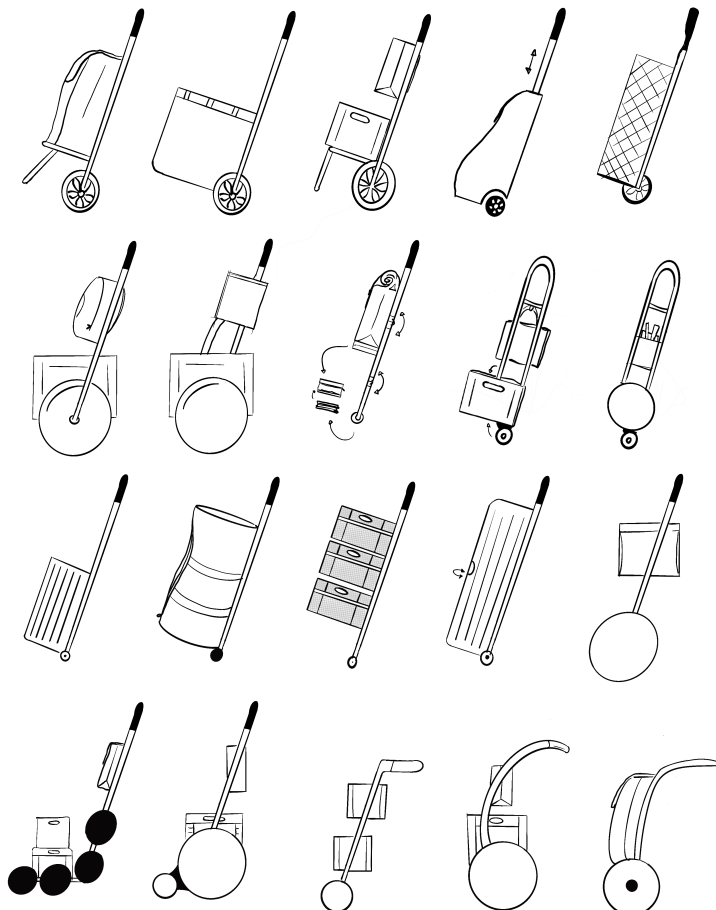


Figure 46 - silhouette brainstorming





## 2 Look and feel exploration

To begin the ideation phase, gathering product images that capture the desired essence and ambience is essential. These images can then be categorised to help with decision-making and to create moodboards for stakeholders (Fig. 49-52). Although diverse thinking is encouraged during this phase, it is also essential to integrate some defining methods. By adding structure and selection to this process, the idea generation can consider the overall look and feel.

### A. Outdoor classic

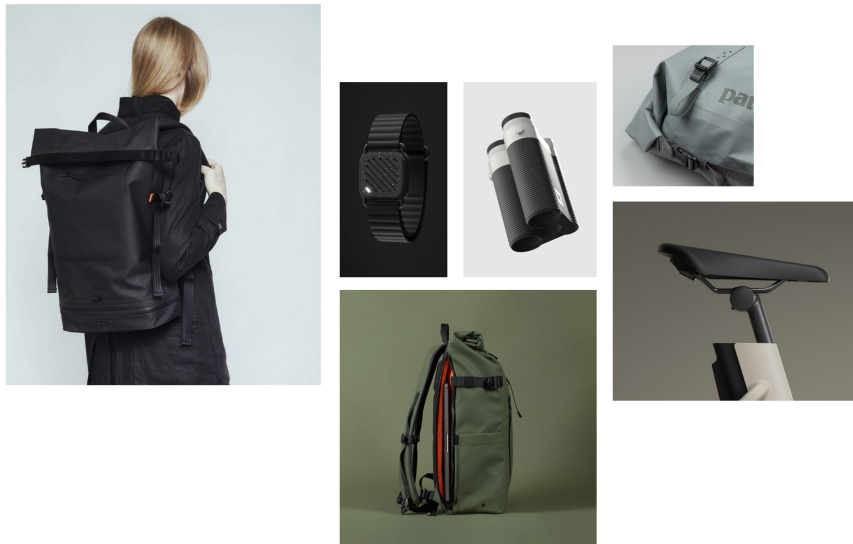


Figure 49 - moodboard outdoor classic styling

### B. Playful sleek

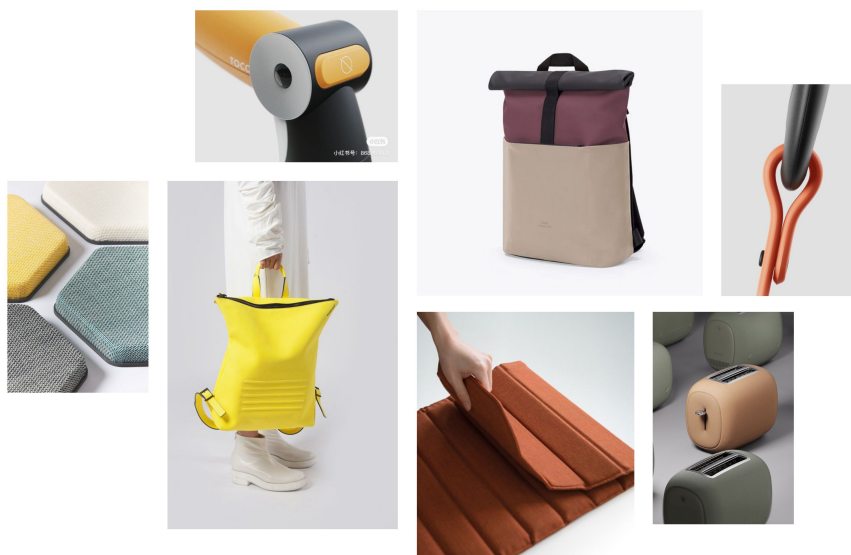


Figure 50 - moodboard playful sleek styling

## C. Scandinavian

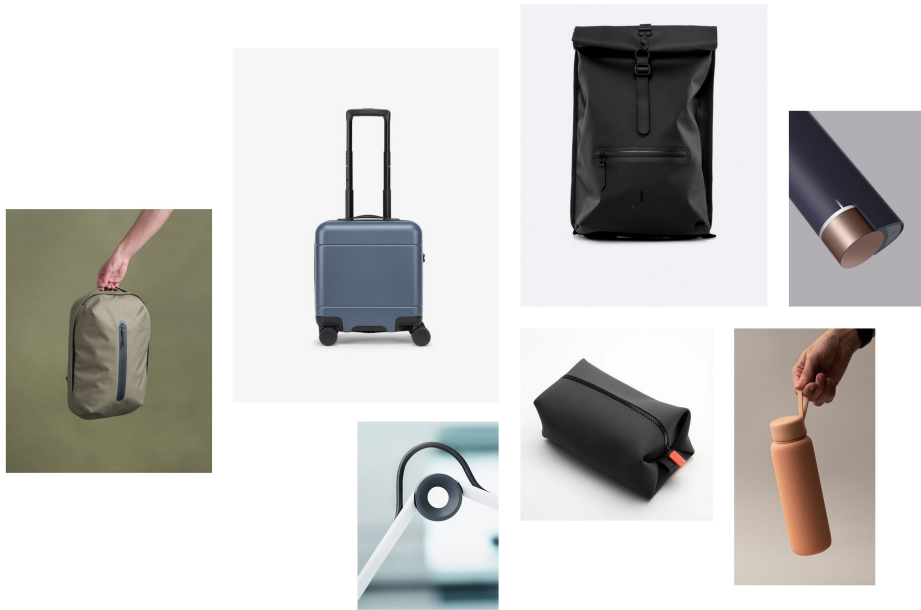


Figure 51 - moodboard scandinavian styling

## D. Technical



Figure 52 - moodboard technical styling

## E. Final styling moodboard

Since the stakeholders did not express a strong preference, the author chose a set of reference images and products for the final styling, shown in Figure 53. The goal is to create a clean and minimal design that incorporates a wide range of functionalities. The product should show its technical complexity while maintaining simplicity in the design. Using colours can enhance the overall appearance of a product by adding vibrancy.

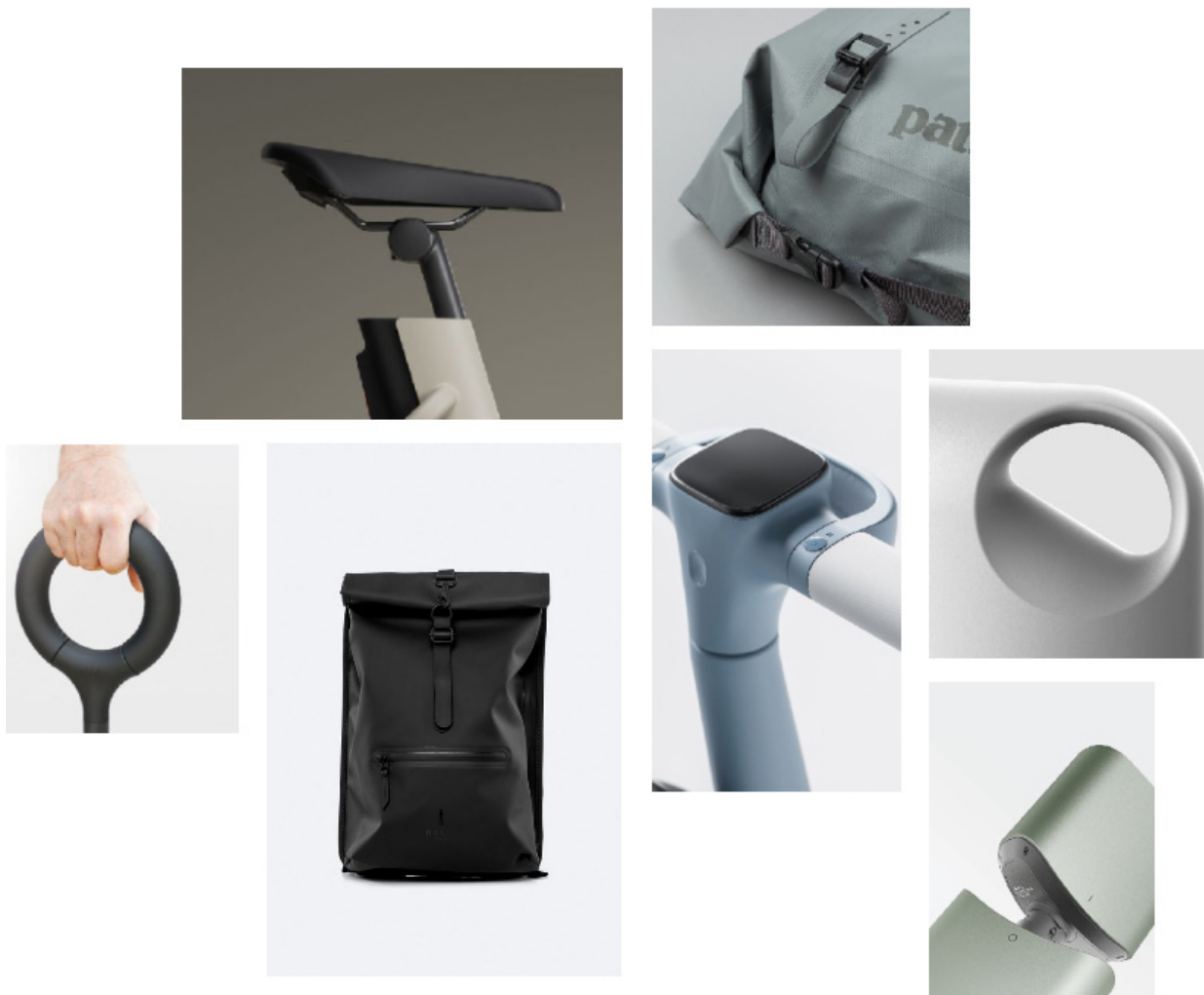


Figure 53 - final moodboard styling

### 3 Technical exploration

Further benchmarking on different technical solutions becomes interesting, considering the new shopping trolley design requirements. Exploring products beyond the trolley industry that showcase modularity, user-friendly transportation, effortless connections, bicycle compatibility, and more can offer valuable insights. Analysing these benchmarks can stimulate new concept ideation and enhance feasibility. This benchmarking is done by online research and visiting physical stores that sell these products (baby strollers, outdoor gear and more).

#### Baby strollers – one frame with different possibilities

A stroller for children is an example of a product that is only functional when it fits the user's needs. As children grow older, these needs change, which results in a short product lifespan. To resolve this issue, many manufacturers produce ecosystems that can adapt to the user's changing needs (Fig. 54). As the needs of an urban shopper can quickly change due to changing living conditions, it would be interesting if the product could adapt as well.

Baby strollers have some interesting aspects aside from the folding mechanisms as well. Many of these strollers have convenient storage compartments at the bottom, a great way to carry extra items while strolling with your toddler. The design of the wheels of the trolley and the use of brakes on the wheels are also interesting aspects that can be taken into account when designing concepts for the shopping trolley. Valuable insights can be gathered by examining the wheel design, including size and manoeuvrability.



Figure 54 - baby strollers

#### Sport wheelchair

This particular wheelchair is an excellent example of achieving a more significant distance between the touchpoints of the wheels with the ground without making the whole product look larger than necessary (Fig. 55). The increased distance between the wheels allows for maximal stability, a great design solution combining functionality and aesthetics to create a highly functional product.

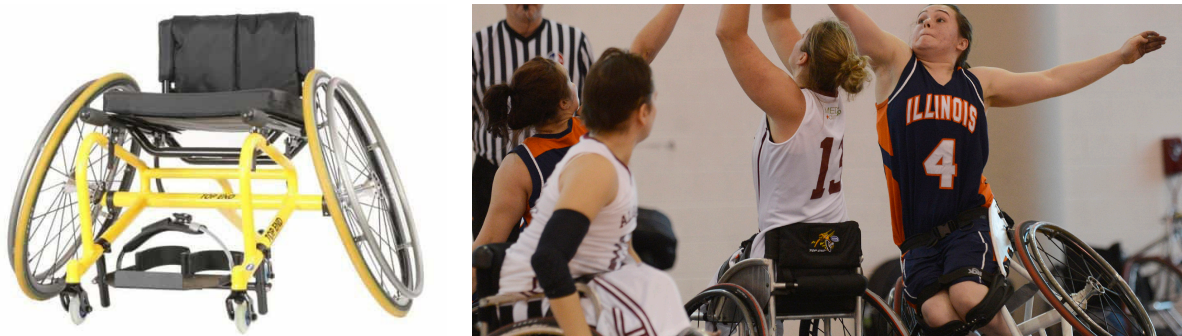


Figure 55 - sport wheelchairs



## Folding mechanism

Baby strollers have robust mechanisms that are key to maintaining strength and stability while still offering a compact and foldable design (Fig. 56). The use of bars and hinges allows for a seamless transformation from a fully extended position to a space-saving, folded configuration. The user experience and intuitiveness of the design are also impressive features that is incorporated into the design of these trolleys.



Figure 56 - folding mechanism in baby strollers

## Handles

The handle button is an interesting attribute in baby strollers and luggage (Fig. 57). These handles are ergonomically shaped and comfortable to grip, but they often also offer a button option. This button enables the handle's adjustable position, allowing users to customise it according to their preferred height or angle. However, it is crucial to guarantee that the button is not accidentally activated to avoid any undesired changes while using the handle.



Figure 57 - benchmark handles

## Bike attachment

As compatibility with a bike is one of the design drivers, it is crucial to look at how bags or other accessories can be securely attached to a bicycle. Current bike bag mechanisms generally offer user-friendly attachment systems that provide a reliable and sturdy connection (Fig. 58). However, some force is required when detaching the bags, indicating the potential for further improvements. Further exploring secure connections with easy detachment can be valuable to enhance usability and overall convenience further.

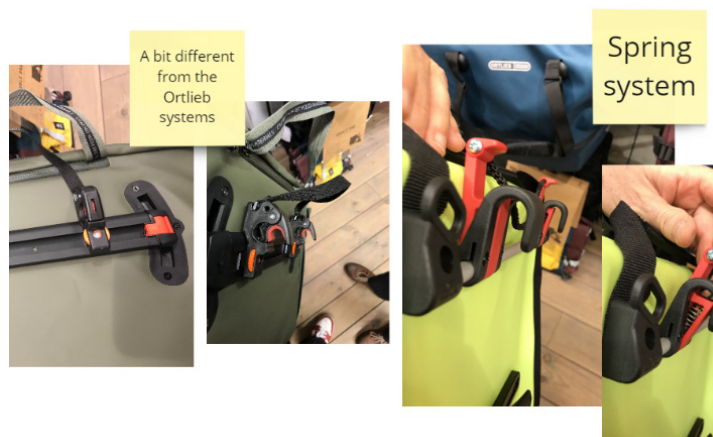


Figure 58 - bike attachment benchmarks

## 4 Morphological mapping

Morphological mapping is a valuable tool to convert the requirements of a product into product concepts. By breaking down the product into its essential functionalities, all possible solutions for this function can be explored. The designer can combine various solutions for every function to create product concepts. Morphological mapping provides a framework and encourages unique solutions while making informed decisions based on the requirements.

### A. By functionality

Based on three fundamental components of the shopping tool, a first morphological map was created (see Fig. 59). First, it should assist the movement on foot so the user does not have to carry all the weight. Secondly, it should have space to carry sufficient groceries. Thirdly the user should have a comfortable way of handling the trolley and be able to lift the trolley when needed.

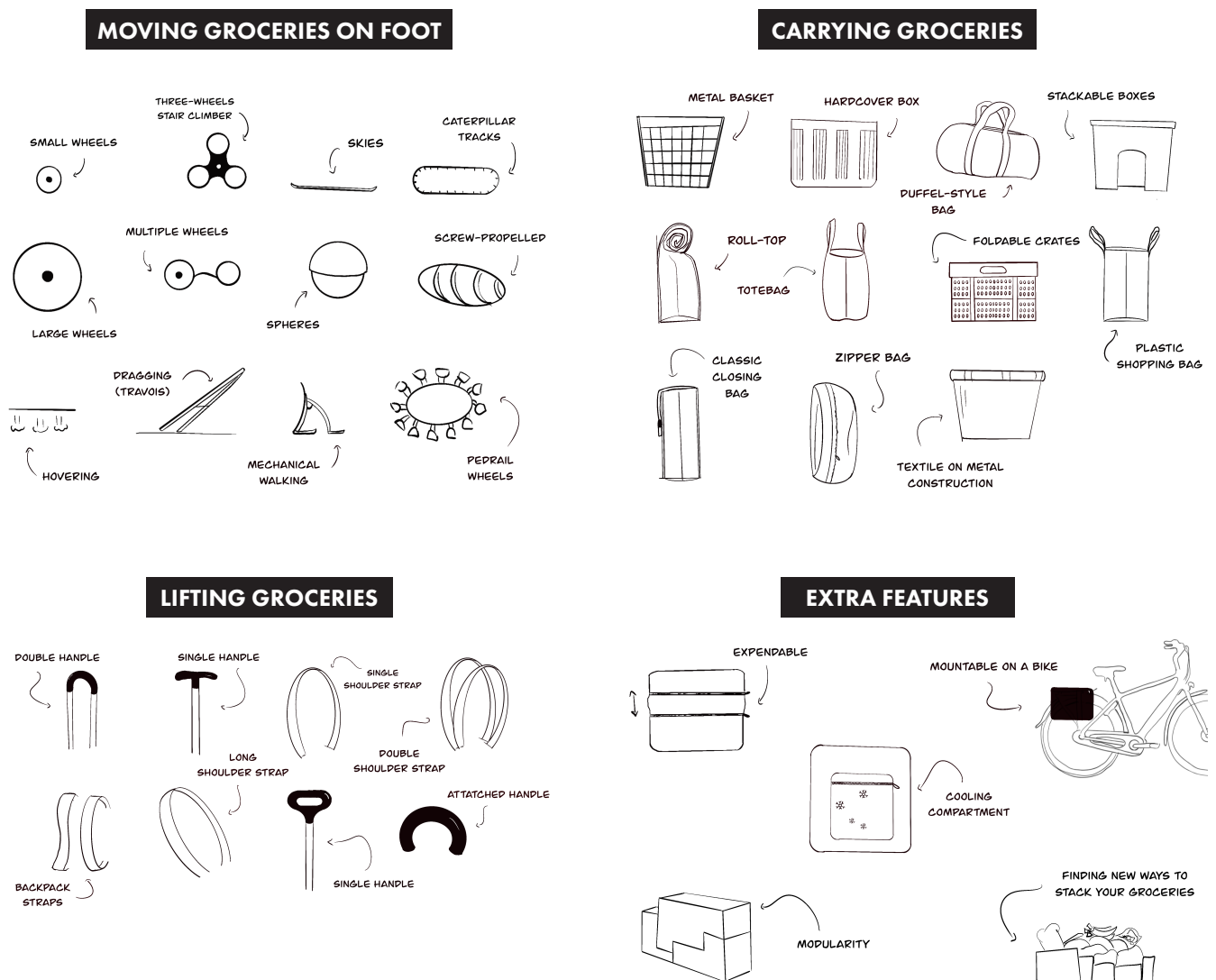


Figure 59 - morphological map based on functions

## B. By design driver

Although the morphological mapping provided a lot of original approaches, the feasibility of most partial solutions is limited. To find a new way to start the product's architecture, the design drivers were used to create a new morphological map (Fig. 60). This allows the designer to step away from the current structure and look at the functionality the product should provide.

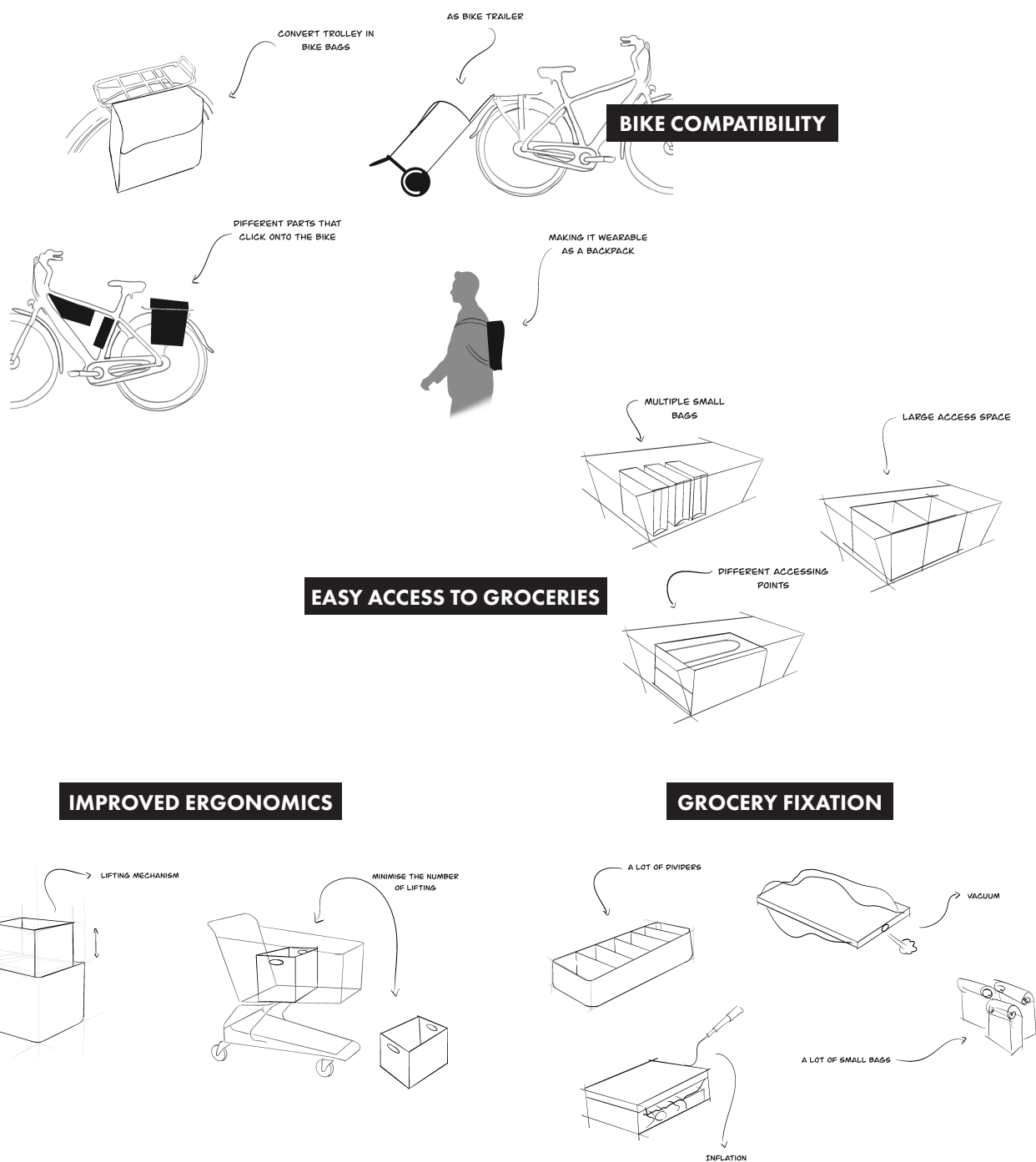


Figure 60 - morphological map based on design drivers

## 5 Concept development

These concepts aim to bring together different aspects of working principles and forms. These sketches are not the final product but embody some aspects allowing the designer to make choices. Visualising these concepts helps to think about aspects that might have been overlooked during the brainstorming. This chapter will present several concepts; the remaining variations can be found in Appendix E.

### A. Concept 1A

This hardshell spinner trolley uses a four-wheeled configuration to ride comfortably (Fig. 61). Modular bags can be mounted on a railing system, allowing users to structure their groceries. The trolley can also be expanded or mounted on a bicycle when needed. While this concept clearly sets itself apart from current shopping trolleys, the price of this trolley would probably be too high because of the cost-intensive production of the outer shell.

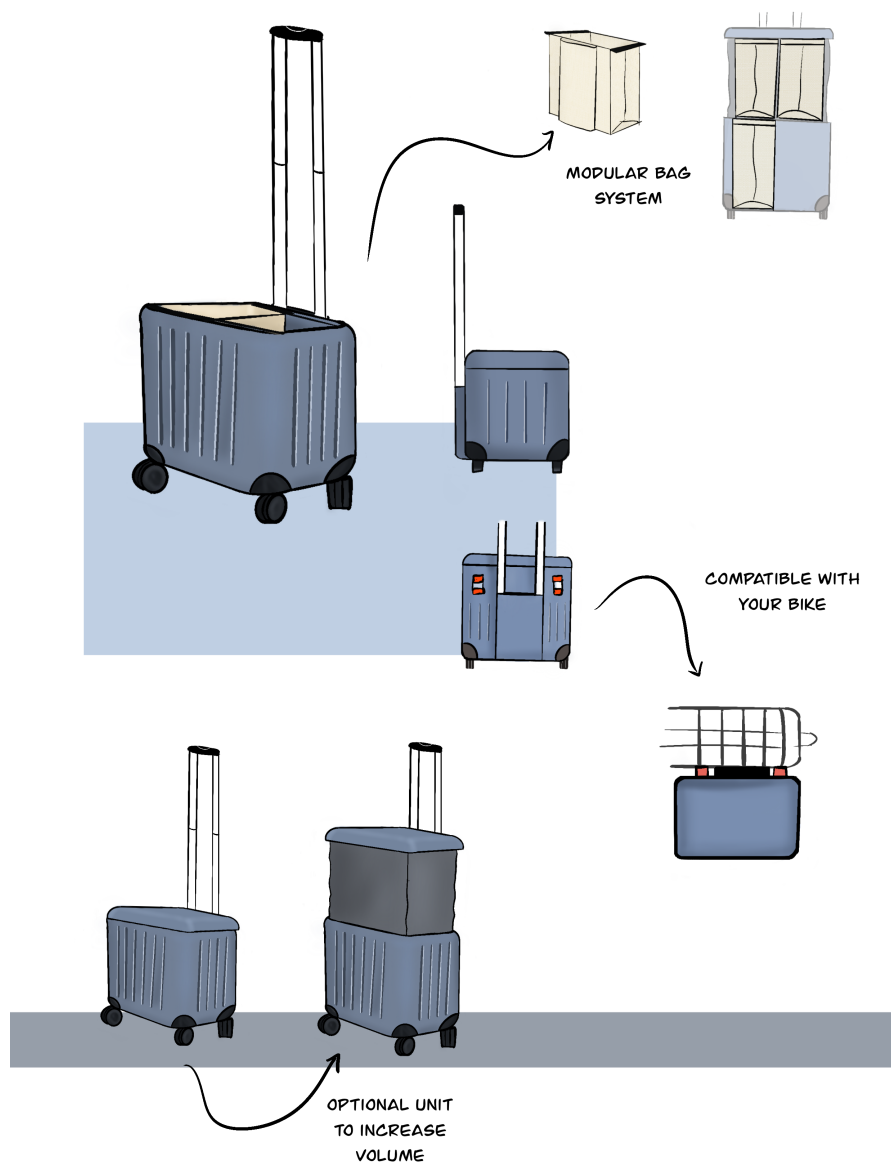


Figure 61 - concept 1A



## B. Concept 1B

It may be challenging to determine the appropriate size for the initial concept, as it must be large enough to fit a shopping cart but still easy to attach to a bicycle. This variation of the first concept can separate into two parts to make it easy to mount the trolley onto the bicycle and provide more stability (Fig. 62).

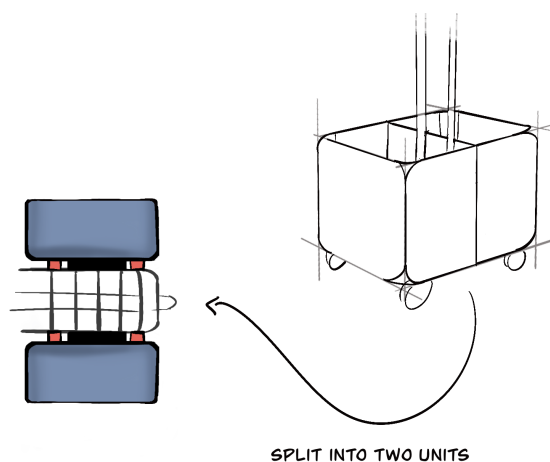


Figure 62 - concept 1B

## C. Concept 1C

This concept is a variation of the first concept but uses foldable crates (Fig. 63). This allows the user to compactly store the trolley but will make it harder to mount these crates on a bicycle.

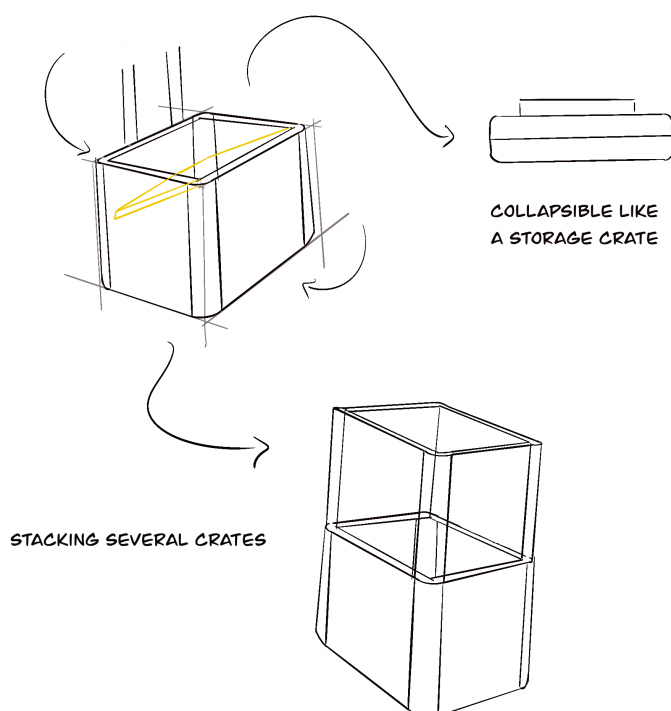


Figure 63 - concept 1C

## D. Concept 2

In this concept, the bike bags are used as bags on a trolley (Fig. 64). The bags could then be used separately as bike bags, backpack bags or even sports bags. The trolley part should be telescopic and can be put away in one of the bags.

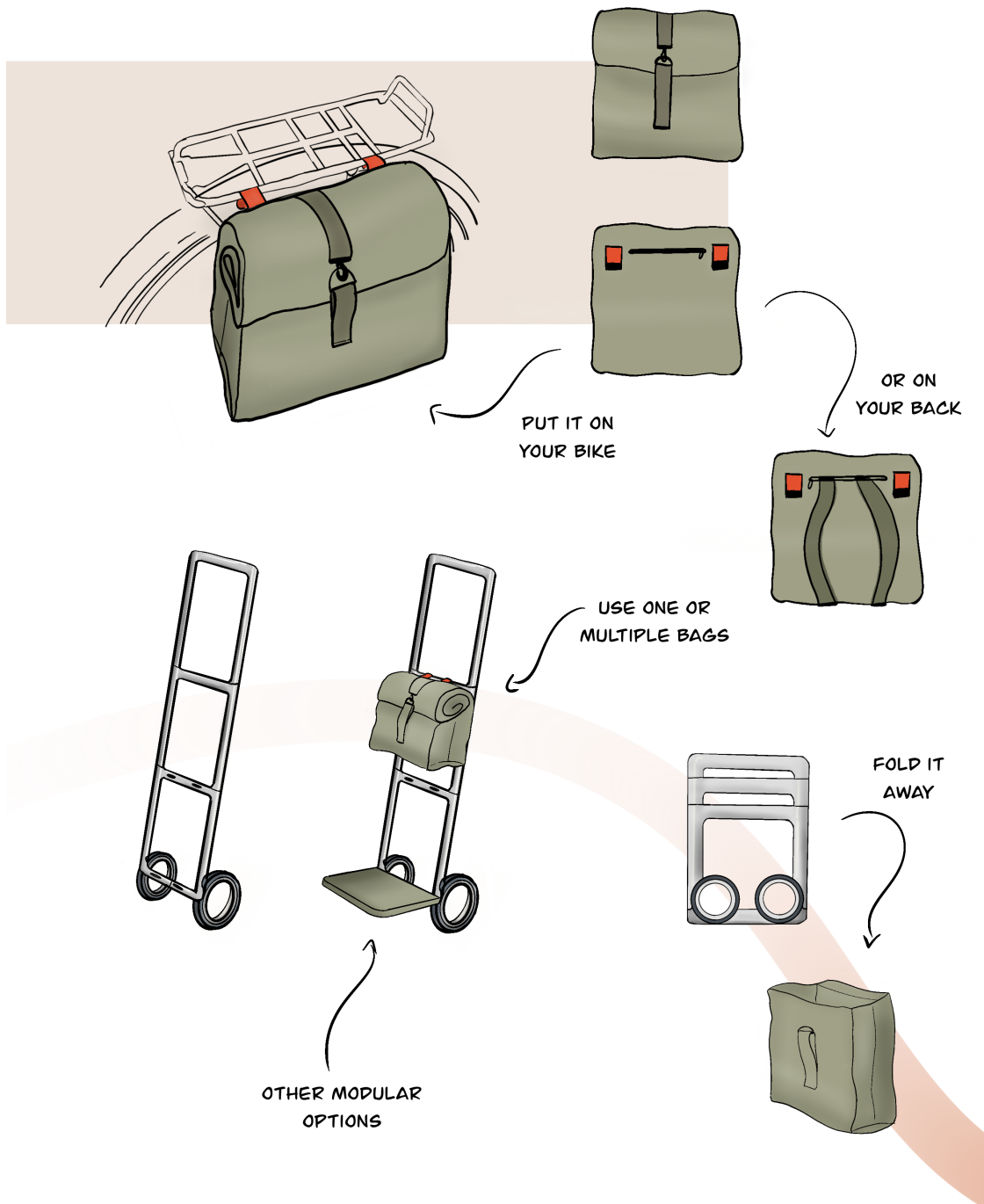


Figure 64 - concept 2

### E. Concept 3

The backpack is the central item in this concept (Fig. 65). Modular elements can turn this backpack into a shopping trolley. Volumes can be added if more space is needed.

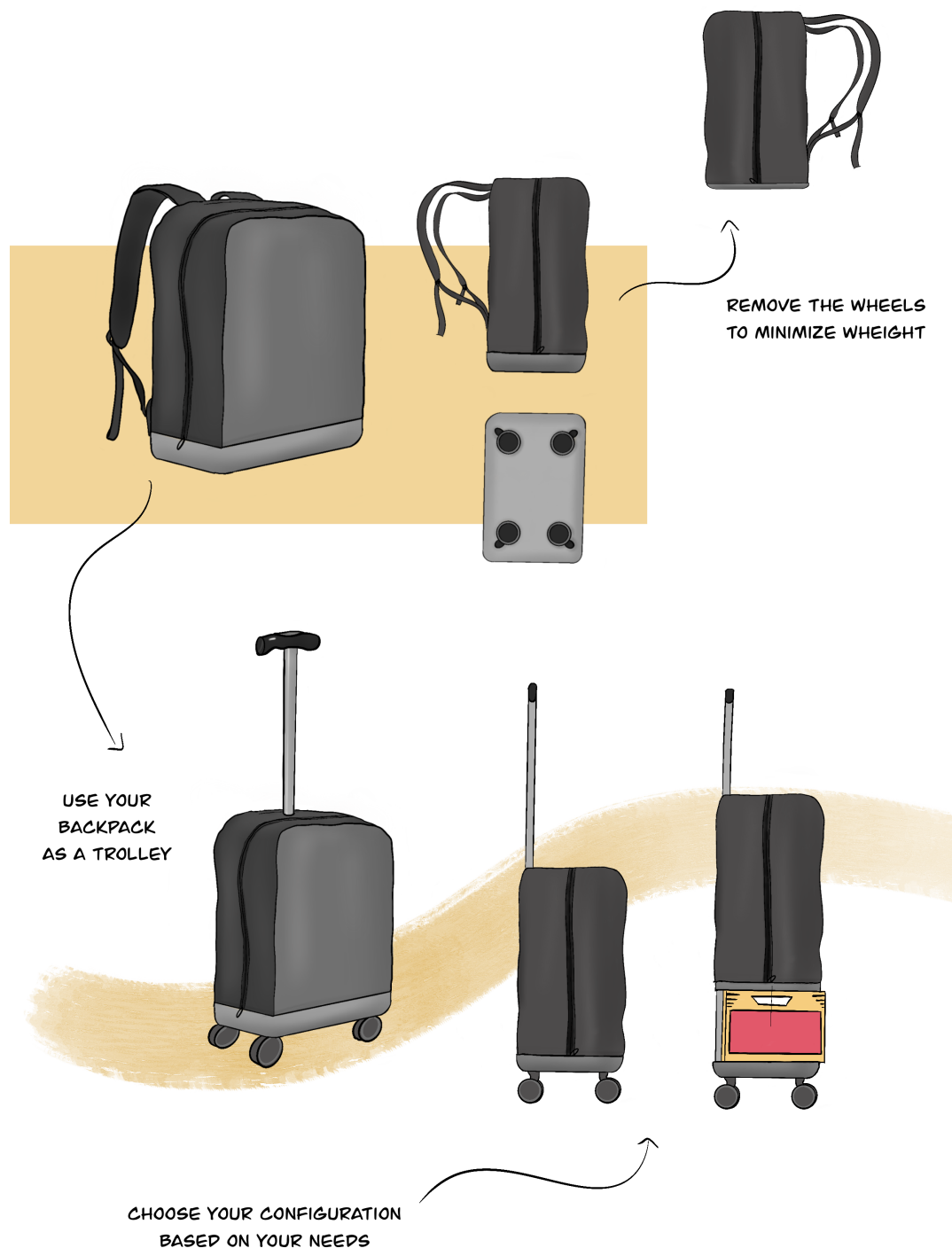


Figure 65 - concept 3

## 6 Concept evaluation

Concept screening is a method to evaluate concepts described by Ulrich & Eppinger based on the Pugh concept selection. This method helps to narrow down the number of concepts quickly. A list of criteria is used to evaluate every idea against a reference concept. The concepts are compared to a basic shopping trolley (+ means 'better than', 0 is 'same as' and – means 'worse as'). The criteria used are the extended list of the 12 design drivers (Table 4).

|                                                | Concept 1A | Concept 1B | Concept 1C | Concept 2 | Concept 3 |
|------------------------------------------------|------------|------------|------------|-----------|-----------|
| Compatibility with a bike                      | -          | +          | -          | +         | 0         |
| Compatibility with a supermarket cart          | 0          | 0          | +          | +         | -         |
| Possibility to carry heavier items             | 0          | 0          | 0          | +         | 0         |
| Easy access to the contents of the trolley     | 0          | 0          | 0          | 0         | 0         |
| Removing the stigma by adding a new look       | 0          | +          | -          | 0         | -         |
| Movement by stairs                             | +          | 0          | 0          | +         | 0         |
| Easily cleanable                               | 0          | 0          | +          | 0         | -         |
| Better ergonomics when filling/emptying        | 0          | 0          | 0          | +         | 0         |
| Trolley avoids the crushing of other groceries | 0          | 0          | 0          | +         | 0         |
| Usable for other activities                    | -          | +          | -          | +         | +         |
| Preferable pushing motion                      | +          | +          | +          | 0         | +         |
| <b>+</b>                                       | 2          | 4          | 3          | 7         | 3         |
| <b>-</b>                                       | 2          | 0          | 3          | 0         | 3         |
|                                                | 0          | 4          | 3          | 7         | 0         |

Table 4 - concept screening

The concept that stands out from the rest in the matrix is concept 2. There are still some critical points where the concept could be improved, like making it easier to access groceries and creating a new look. Concept 2 shows progress in the desired direction but lacks the innovative character needed for this challenge. The concept still leans too much towards a basic shopping trolley. We take a few steps back to develop new ideas and start by constructing a new morphological map.



## 7 Improved morphological mapping

A new morphological map is created to help identify different possibilities to incorporate all design drivers in the new concepts. This process involves collecting solutions from current products on the market and conceptual work, and developing new solutions. This forms a comprehensive overview that helps create unique concepts by combining different elements from each section of the map. This approach makes it easier for the designer to consider all design drivers while exploring all possibilities. Two examples of exploration around a design driver are shown in detail below (Fig. 66); the entire morphological map can be found on the next page (Fig. 67).

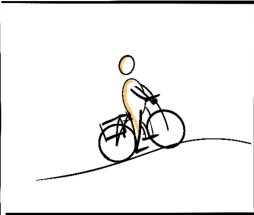
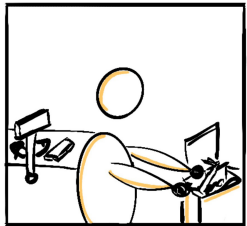
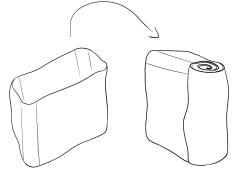
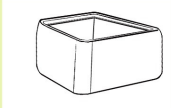
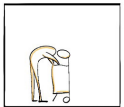
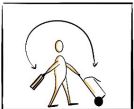
|                                                                                                                                         |                                                                                                                      |                                                                                                                       |                                                                                                                                              |
|-----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
|  <p>Compatibility with a bike</p>                      |  <p>Click-system</p>                |  <p>One-part</p>                    |  <p>Different parts - modular</p>                         |
|  <p>Click on system on other parts of the bicycle</p> |  <p>As a backpack</p>              |  <p>Bike trolley on rear wheel</p> |  <p>Connection bar to the bike frame</p>                 |
|  <p>Easy access to the contents of the trolley</p>   |  <p>Multiple accessing points</p> |  <p>Small bags as inserts</p>     |  <p>Multiple small bags</p>                             |
|  <p>Vertical accessing</p>                           |  <p>Sideways accessing</p>        |  <p>Full opening - zip</p>        |  <p>Different orientation when filling/transporting</p> |

Figure 66 - improved morphological map compatibility with a bike and easy access to groceries

# MORPHOLOGICAL MAP

| Design Drivers                                                                      |                                                                                   |                                                                                                                                                                                                                                      |                                                                                                                                      |
|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
|    | Compatibility with a bike                                                         | <br>Click-system                                                                                                                                    | <br>One-part                                      |
|    | Compatibility with supermarket cart                                               | <br>Front attachment                                                                                                                                | <br>Most flexible<br>Bags for in supermarket cart |
|    | Possibility to carry heavier items<br>reference : 6 bottles of 1,5L water         | <br>Dedicated unit for bottles                                                                                                                      | <br>Removable bags                                |
|    | Easy access to the contents of the trolley<br>without rearranging all other items | <br>Multiple accessing points                                                                                                                       | <br>Small bags as inserts                         |
|    | Removing the stigma by adding a new look<br>avoid the connection with old people  | <br>Using polyester                                                                                                                                 | <br>Matte finishes                                |
|  | Movement by stairs                                                                | <br>Passage d'obstacles<br>Les roues déformables en TPU complètent la solution à trois roues et permettent le passage d'obstacles et d'escaliers. | <br>3 wheels                                    |
|  | Easily cleanable<br>e.g. when spilling something                                  | <br>Detachable bag and frame                                                                                                                      | <br>Inner bag with zipper                       |
|  | Better ergonomics when filling/emptying                                           | <br>Possible to put inside cart / on table                                                                                                        | <br>Integrated scissor lift system              |
|  | Trolley avoids the crushing of other groceries                                    | <br>Small bags as inserts                                                                                                                         | <br>Cord that can be tightened                  |
|  | Usable for other activities<br>e.g. sports, shopping...                           | <br>Cover for bike hanger                                                                                                                         | <br>Multiple sides - convertible                |
|  | Easily foldable and unfoldable                                                    | <br>One movement                                                                                                                                  | <br>Telescopic                                  |
|                                                                                     |                                                                                   |                                                                                                                                                                                                                                      | <br>Hidden steering bar                         |

| Possible Solutions                                                                                                                                                                   |                                                                                                                                                |                                                                                                                                                              |                                                                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Depends on specific bike</p>  <p>Click-on system on other parts of the bike (e.g. handlebar)</p> | <p>Less ergonomic</p>  <p>As a backpack</p>                   | <p>Too much responsive for the users</p>  <p>Bike trolley on rear wheel</p> | <p>more bulky design</p>  <p>Using a connection bar to the bike frame</p> |
|  <p>Modular space</p>                                                                               |                                                                                                                                                |                                                                                                                                                              |                                                                                                                                                             |
|  <p>Vertical accessing</p>                                                                          |  <p>Sideways accessing</p>                                    |  <p>Full opening - zip from back</p>                                        |  <p>Different orientation when filling / transporting</p>                 |
|  <p>Rugged and outdoor look showing the durability and quality</p>                                  |  <p>Large wheels</p>                                          |                                                                                                                                                              |                                                                                                                                                             |
|  <p>Single shoulder bag</p>                                                                       |  <p>Switching from pushing to pulling two larger wheels</p> |                                                                                                                                                              |                                                                                                                                                             |
|  <p>Hard plastic</p>                                                                              |                                                                                                                                                |                                                                                                                                                              |                                                                                                                                                             |
|                                                                                                                                                                                      |                                                                                                                                                |                                                                                                                                                              |                                                                                                                                                             |
|  <p>Vacuum fixation</p>                                                                           |  <p>Inflation fixation</p>                                  |  <p>Flexible sections</p>                                                 |                                                                                                                                                             |
|  <p>Carrying system</p>                                                                           |                                                                                                                                                |                                                                                                                                                              |                                                                                                                                                             |
|                                                                                                                                                                                      |                                                                                                                                                |                                                                                                                                                              |                                                                                                                                                             |

Figure 67 - improved morphological map

## 8 Iteration on concept design

Implementing an enhanced morphological map has resulted in the creation of some new concepts that explore a wide range of possibilities. While these unique ideas emphasise different elements, they all integrate the four fundamental design drivers highlighted in the accompanying drawings (Fig 68-70). Appendix F shows the prior concepts to these ideas.

### Concept 1 - modular bags with a telescopic trolley

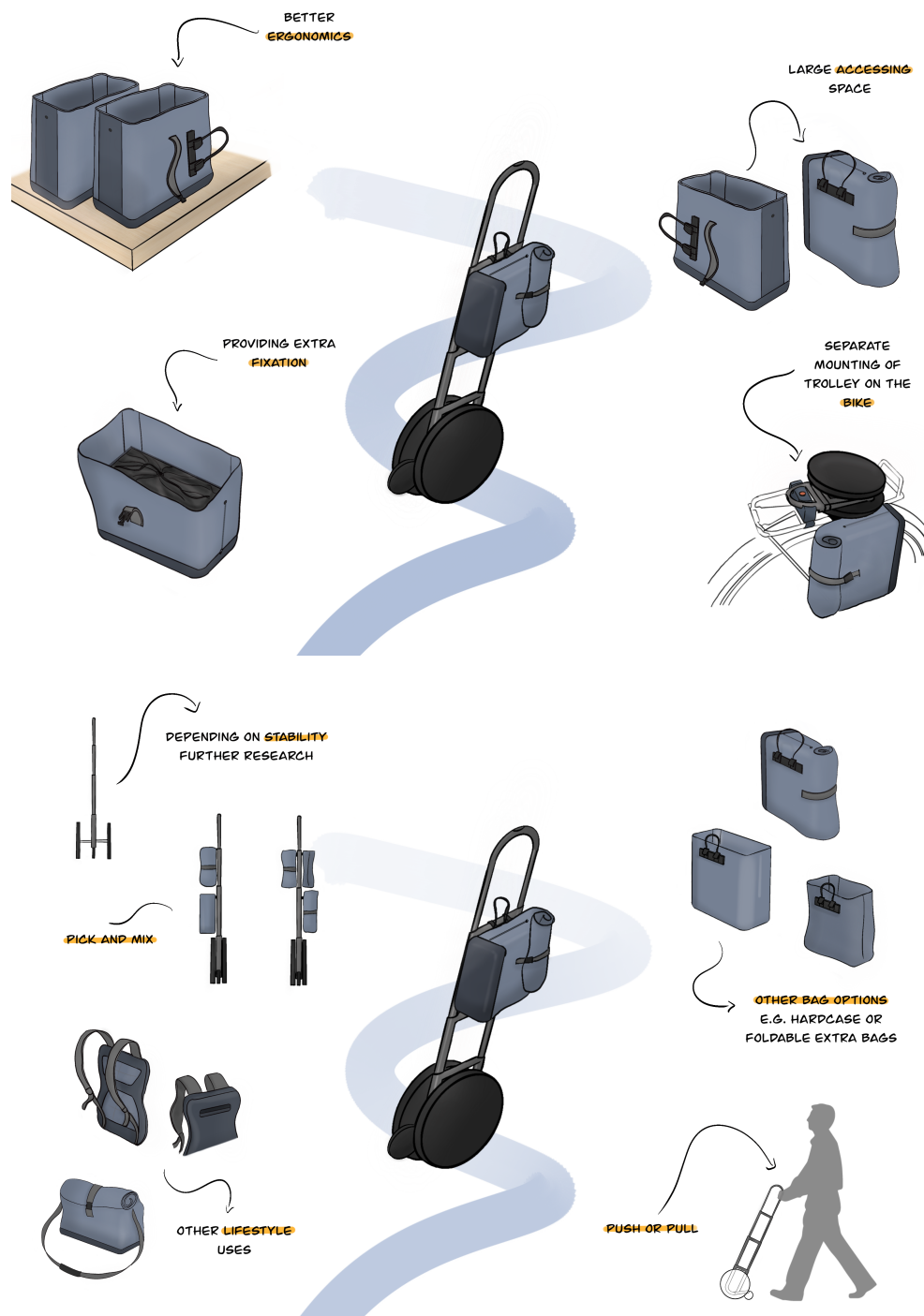


Figure 68 - concept 1



## Concept 2 - Spinner trolley



Figure 69 - concept 2

## Concept 3 - Bike trailer

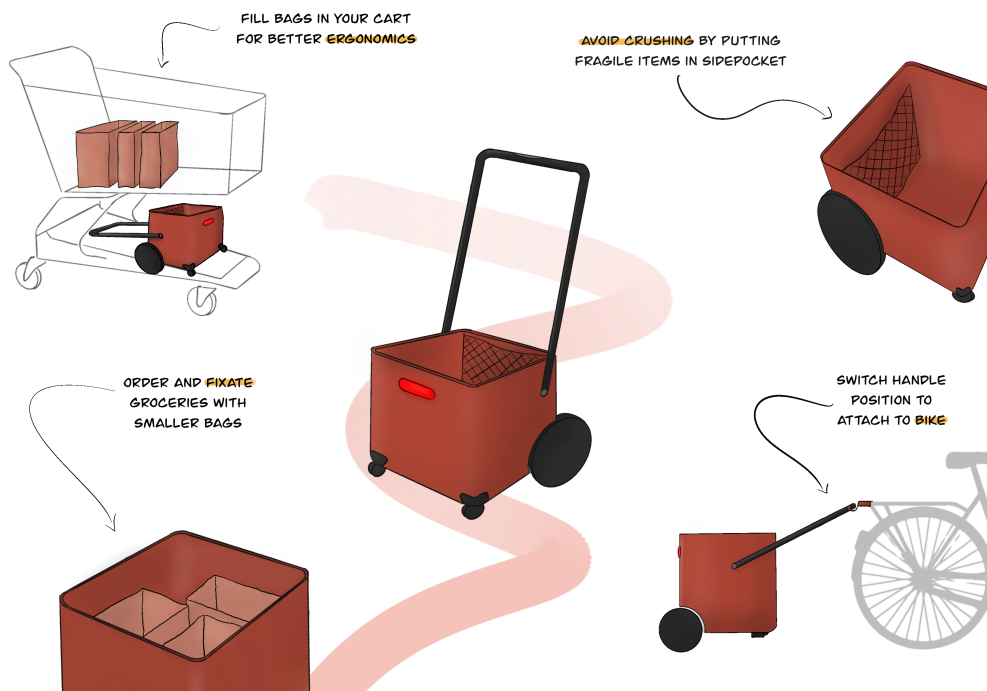


Figure 70 - concept 3

## 9 Concept selection

The final three concepts were presented to the coaches from Achilles Design and to Erik Sijmons from Samsonite. The reviewers concluded that the first concept was most captivating due to its flexibility and innovative character. On the other hand, the second concept showed better ergonomics when used on foot, thanks to its four-wheel configuration. However, mounting this product on a bike will be a significant challenge, as the large volume on top of the bike rack will seriously impact the bike's stability. The third and last concept shows a lot of opportunities and puts the product into a different category. The price of this product will be much higher than standard trolleys, there are many regulations when attaching a cart to a bike, and it takes up much more space.



Figure 71 - concepts overview

Considering the modularity of the first concept (left in Fig. 71), it shows the most significant potential for customisation to meet the needs of a diverse range of possible users. This enables users to buy specific accessories or components depending on their evolving requirements. This concept will be further investigated in the realisation phase, where practical implementation will be explored in detail.

The needs and wishes are used to analyse the alignment of the concept with the project’s goals. This concept checks almost all boxes of the list that was defined earlier. The successful integration of these requirements will depend on their feasibility during the realisation phase.

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |                                                                                                                                                                                                                                                                               |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NEEDS | <ul style="list-style-type: none"> <li>✓ Easily foldable and unfoldable</li> <li>✓ Self-standing</li> <li>✓ Waterproof</li> <li>✓ Carries a large amount of groceries</li> <li>✓ Easy to operate</li> <li>✓ Usable in a supermarket</li> <li>✓ Compatible with a bike full and empty</li> <li>✓ Possible to put items in different places</li> <li>✓ New look</li> <li>✓ Height is adjustable to the user</li> <li>✓ Avoids groceries being crushed</li> <li>✓ Provides a high-end user experience</li> </ul> | WISHES | <ul style="list-style-type: none"> <li>✓ Usable for other activities</li> <li>✓ Usable as a backpack</li> <li>✓ Different volume variations</li> <li>✓ Affordable</li> <li>✓ Fits into a backpack</li> <li>✓ Optional lock</li> <li>○ Usable for less abled people</li> </ul> |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Table 5 - needs and wishes

With this new concept in mind, a few extra criteria can be added to validate the success of the final product:

|       |                                                                                                                                                                                                                                                                                  |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| EXTRA | <ul style="list-style-type: none"> <li>○ Reliable and secure folding mechanism</li> <li>○ Maintains a stable wheelbase even in the presence of uneven weight distribution on both sides</li> <li>○ Minimal physical strain on the user’s arm during trolley operation</li> </ul> |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

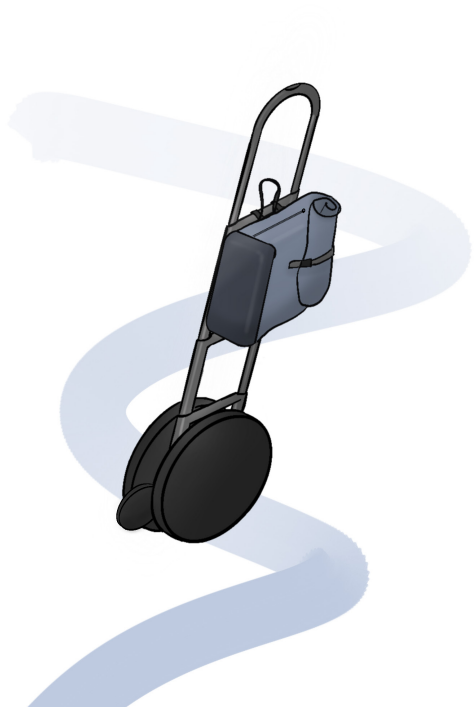
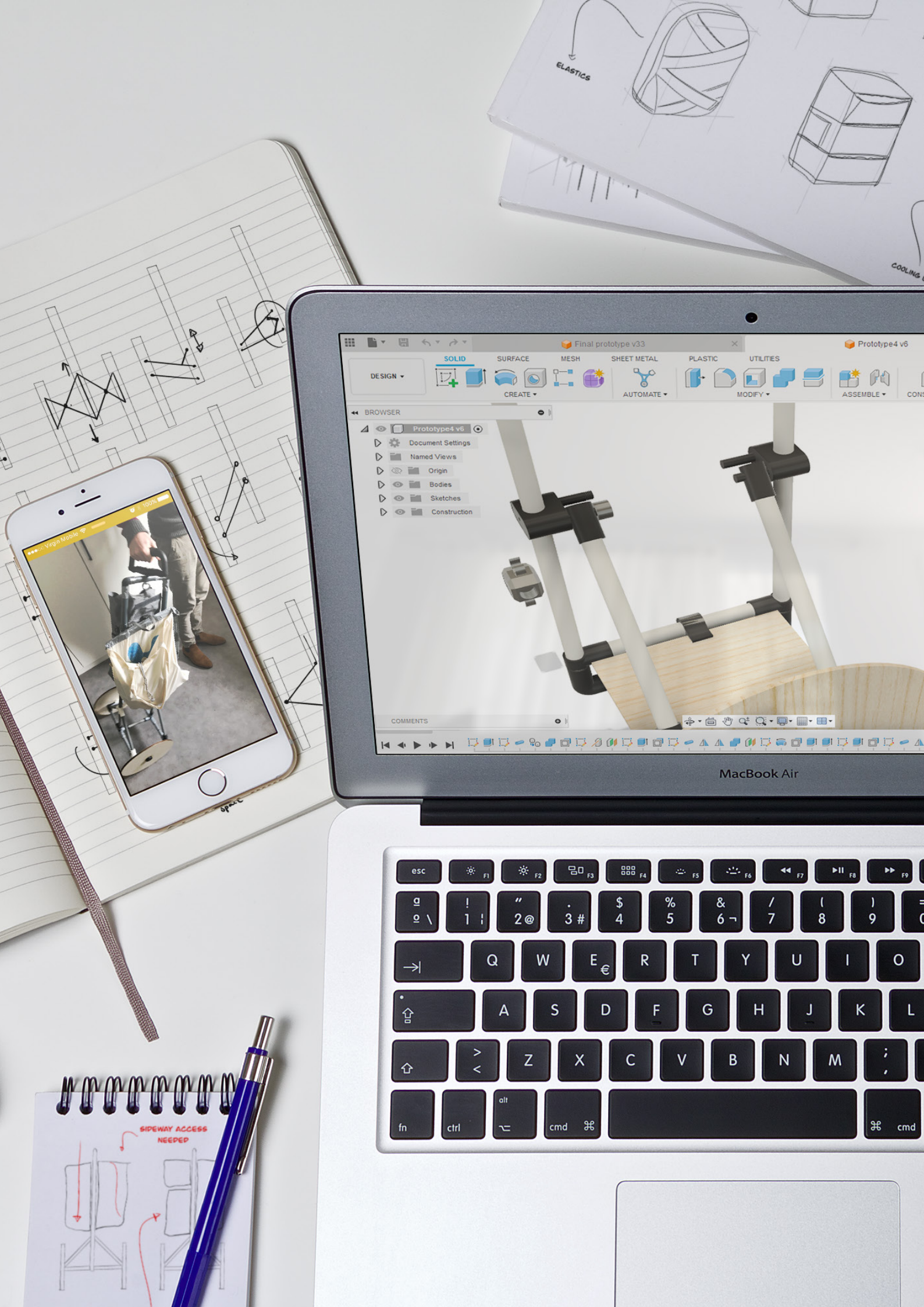


Figure 72 - selected concept







06



**realisation**

This phase focuses on turning the new shopping trolley concept into an actual product. Prototyping is an ideal method to connect the dots between the theoretical design and the practical implementation. This allows the concept to be tested on mechanical functionality, ease of use and user experience. Prototyping and testing will help refine the design, troubleshoot possible problems and ensure the product idea is technically feasible. While the realisation stage is primarily divergent and focuses on exploring various solutions, it also includes decision-making and selection methods.

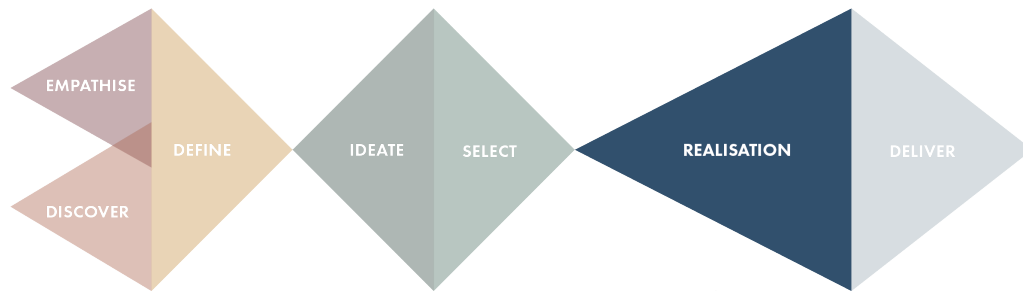


Figure 73 - realisation as part of the design process

## 1 General dimensions

Some constraints must be determined to develop the trolley system and the bags. The most important constraint for this concept is the sizing of the bags and trolley, as they have to fit on a bicycle. Using some cardboard and PVC tubes, a first mock-up of a bag (42cmx32cmx17cm) and a folded trolley (40cmx25cmx5cm) was created (Fig. 74). Although this does not conclude the final sizes, it provides a first guideline for further development. Standard bike bags from Ortlieb were used as a reference for the bag sizing.



Figure 74 - exploring the general dimensions with quick and dirty prototypes

## 2 Development of structural elements

To bring this concept design to life, the initial phase involves developing the different components of the product. In the case of this trolley design, there are three crucial parts: the wheels, the bags and other general aspects like the handle and stand. The product can be further refined once these essential elements are functional and efficient. Through this systematic approach, the product can evolve from an abstract idea to a tangible and user-friendly product.

### A. Design of a stable wheelbase

The concept of this shopping trolley heavily relies on the functionality of the wheels. If the wheels cannot provide the user with a comfortable ride with groceries, the shopping trolley does not work. If the wheels cannot be folded compactly, the trolley will not be able to fit on a bicycle. This means that developing a solid wheel system is crucial for the success of this shopping trolley.

#### Fixed wheels

The easiest option from a mechanical point of view would be to have wheels that do not have to unfold. This way, the wheels can have a sturdy connection with the frame, and the frame only must be telescopic. If there is almost no distance between the wheels, this can be compared with only having one wheel, as shown in the illustration in Figure 75. A quick and dirty prototype showed that once some weight is added to the frame, the trolley does not provide an ergonomic solution (Fig. 75), as the user must absorb a lot of force.

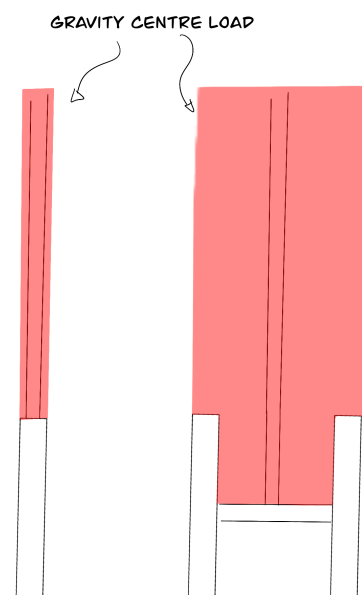


Figure 75 - prototype with one wheel (left) and schematic explanation stability wheelbase (right)

To have a stable trolley system, the centre of gravity must be within the base of the wheels. With only one wheel, this base is reduced to a single point. This means a slight addition of weight can cause the centre to shift, leading to the trolley tipping over. A two-wheeled base provides a larger area within which the centre of gravity can be located, resulting in a more stable product.

## Foldable wheels

The goal of the folding mechanism is to have the wheels parallel to the frame and as close as possible when folded. On the other hand, the wheels should be parallel to the frame and further away from the frame when unfolded. Using some cardboard and pins, the motions and rotations of the folding mechanism were explored (Fig. 76). The wheels and connections should be able to carry a trolley full of groceries. When the wheels are folded, they should also be locked to prevent unwanted unfolding.

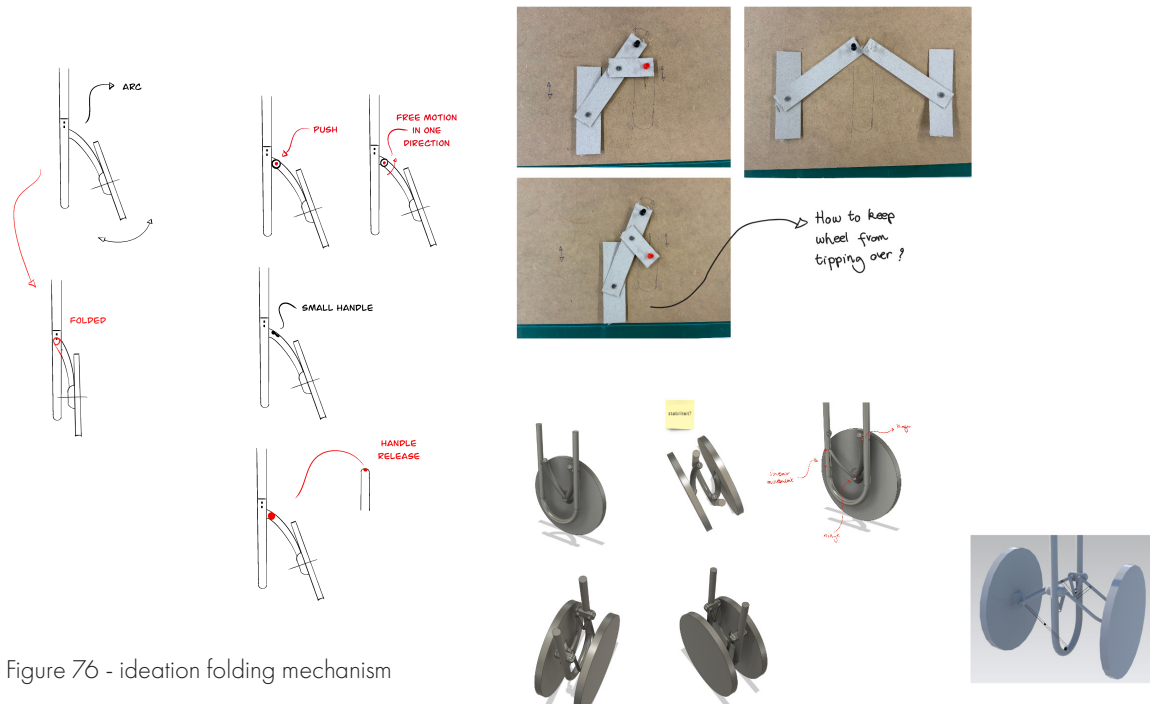


Figure 76 - ideation folding mechanism

Once a feasible mechanism was developed in CAD, it was translated into a model that uses standard PVC pipes, 3D printed parts and some laser-cutted wood. Many iterations were made to create a working prototype; the whole process can be found in Appendix G. This prototype is a functional tool that provides a way of validating the general concept idea (Fig. 77). It shows that it is possible to create a trolley with folding wheels and a telescopic design. This prototype also helps further validate the sizing of the wheels and the height of the expanded trolley. It is still far from being a working shopping trolley, but it shows a few of the fundamental features of this concept.

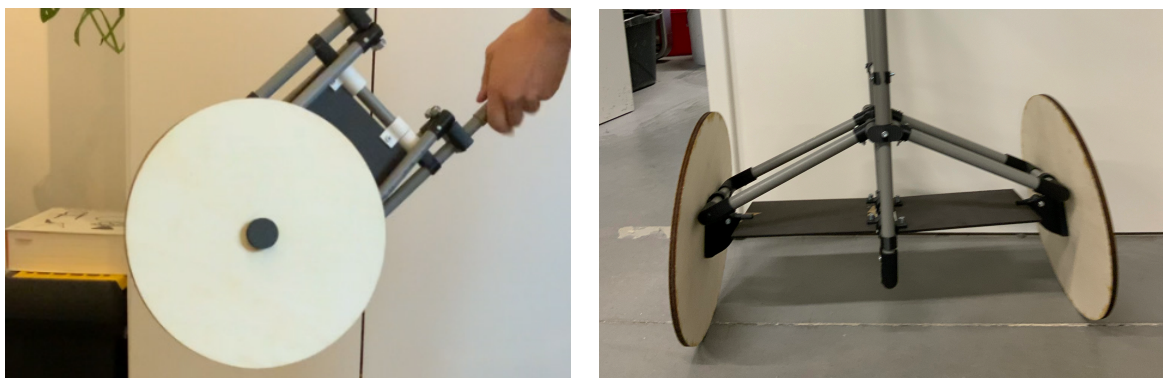


Figure 77 - proof of concept folding mechanism



## B. Development of other aspects of the trolley part

Once the feasibility of the folding system is demonstrated, the other aspects of the design can be considered as well. Bags could be added, the handle can be explored, and the stability of the product can be improved (Fig. 78). Although a few of these elements can be prototyped with this prototype, the folding mechanism is still a weak point in this design. As the prototype is made with many 3D-printed parts, it will not be able to hold a lot of weight.

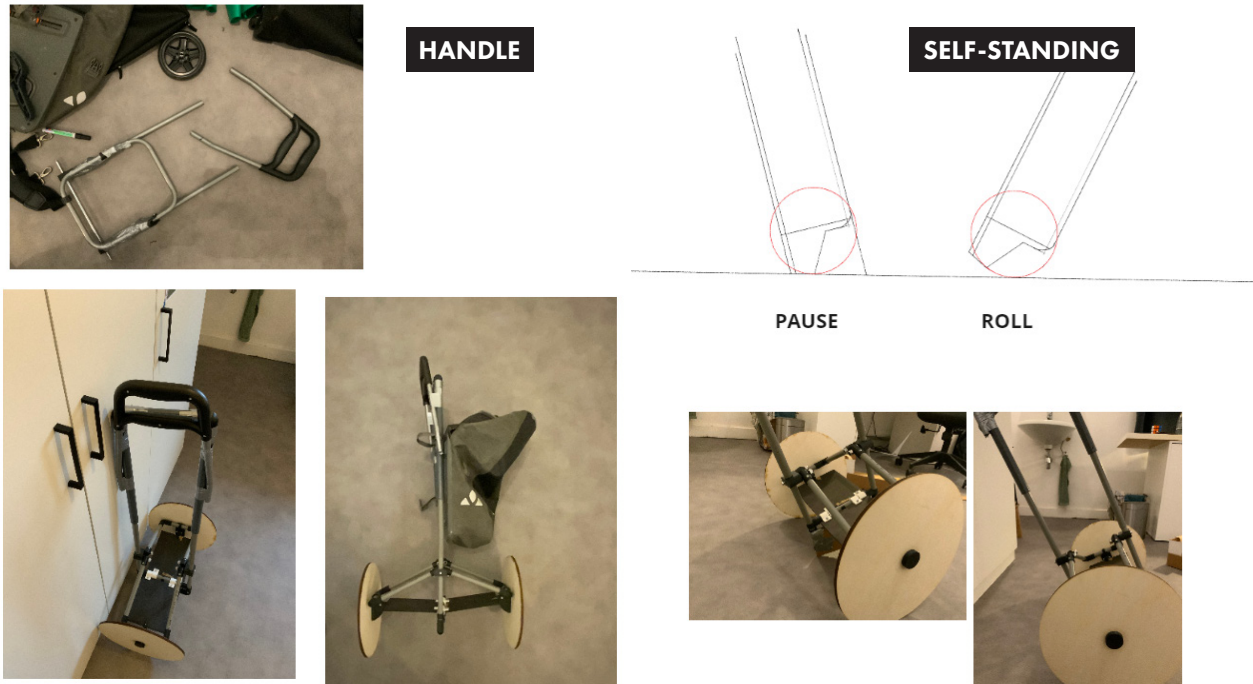


Figure 78 - development of handle (left) and self-standing mechanism (right)

A solid prototype will be used to develop other aspects of the trolley further, removing the folding mechanism. This prototype is made from 3D printed parts, tubes, lasercutted wheels and many screws (Fig. 79). The angles at the base simulate the architecture of the unfolded mechanism. This construction will help to prototype and test other aspects of the trolley quickly without relying on the folding mechanism. The handle of an existing shopping trolley was used as the first handle for the prototypes. By adding a screw, the handle can rotate and be secured when necessary.



Figure 79 - prototype without folding mechanism

## C. Bag design

### Exploration from benchmarks

Many bags in the outdoor sector already use clever organising systems to make travelling easier. This can form some good inspiration for applying these techniques to organise groceries. Although some good modular backpacks are available, they may not be practical for carrying groceries. It is interesting to look at this inspiration and think about how these techniques could be helpful for sorting fresh produce, boxes, bottles, and more (Fig. 80).



Figure 80 - benchmarking bags

A visit to a local outdoor shop showed what kind of materials, connections and aesthetics is employed for current backpacks and bike bags (Fig. 81). Many bag manufacturers try to make the contents of the bags easy to access, which is an interesting aspect for the shopping trolley as well. In general, this visit gave some concrete and valuable information about how current bags are designed, which can inform the further development of the trolley bags.



Figure 81 - observations at a local outdoor shop

## Exploration through sketching

The first ideas that came up during the benchmarking and store observation were turned into quick concepts that embody several possibilities of connecting, accessing and closing the bags. Figure 82 shows these sketches that helped transform these abstract ideas into tangible concepts by integrating various components.

A few interesting ideas include space to attach bike lights so the user feels safe walking around with the trolley at night. Incorporating reflective zones can enhance visibility. Exploring options for attaching extra bags on the inside and the outside provides two approaches for achieving modularity.

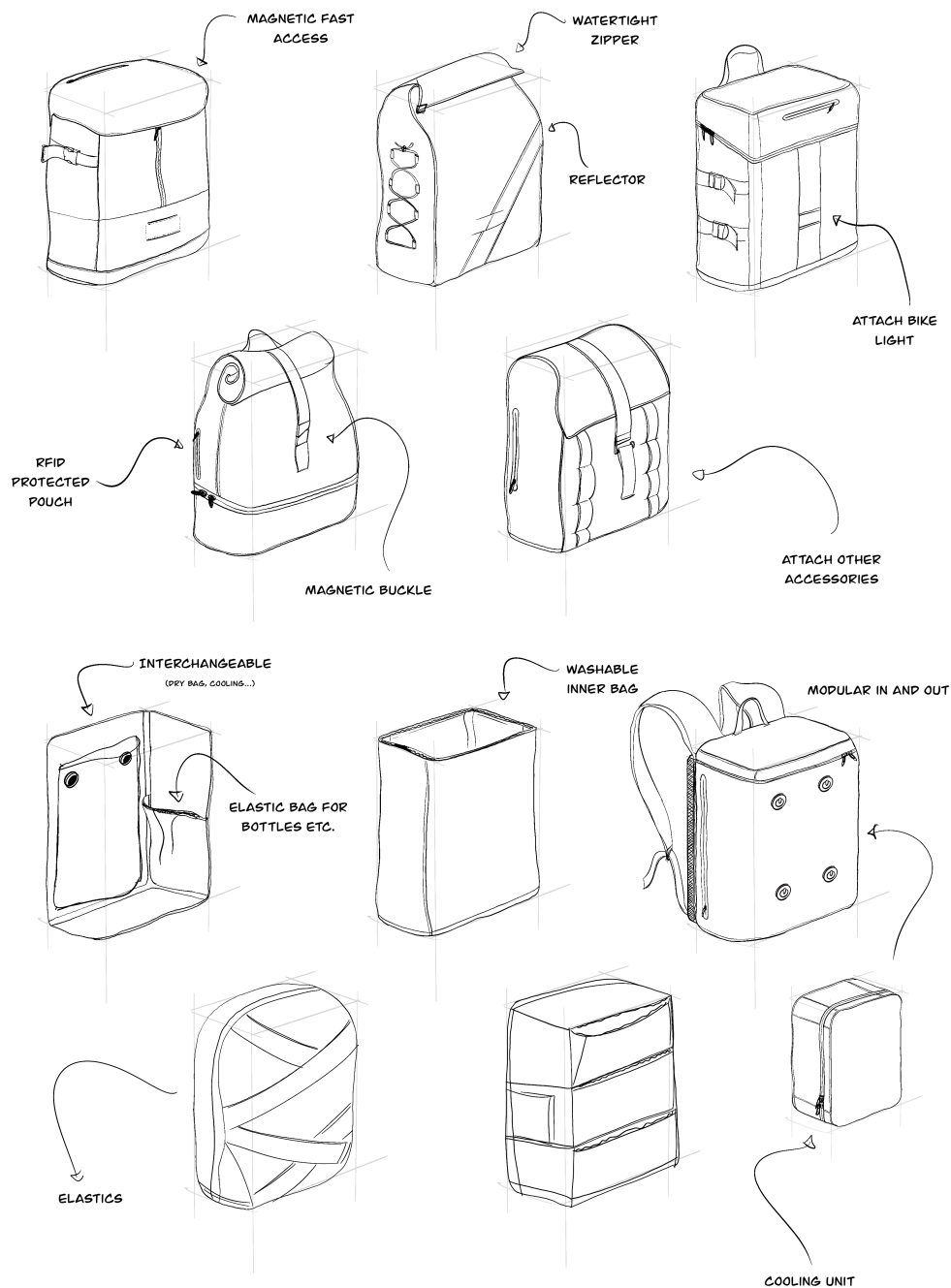


Figure 82 - explorative sketches for the design of the bags



### Cardboard prototypes

The development of the bags started with a cardboard prototype, as this allows for quick iterations and adaptations without requiring a lot of tools and material. The first bag was too small to fit enough groceries or personal items (Fig. 83). Compared to a fabric bag, cardboard provides a firmer structure, allowing less flexibility. A magnetic connection from an old bag was used as a closing mechanism.



Figure 83 - cardboard bag with magnetic closing

The second prototype features a larger bag with a rolltop (Fig. 84). A zipper down the middle allows the user to quickly fill and organise the bag. Some inner pockets were made with elastics and fabric, providing more space for organisation. The trolley will often be filled while riding, causing the bag to lean towards one side; shifting the zipper position towards the opposite of the leaning side would be better. The rolltop closure now uses two straps with snap buckles, requiring some force and precision from the user. However, when this bag is opened, these straps hang around the back, which is impractical. The bag also has straps to wear as a backpack, but these straps get in the way when not in use.



Figure 84 - cardboard bag with zipper

### Hacked prototypes

A prototype bag (Fig. 85) was created using the shopping trolley bag from an existing model previously used to test the current product. This was a first test to see if the vertical opening on one side of the bag would be effective for quickly filling the bag. Although there was no zipper, some magnets that allowed easy opening and closing gave a good indication of the effectiveness of this design. The vertical opening helps to gain full control over the groceries' arrangement without digging deep inside a bag. However, a sturdier closing mechanism should be used for further testing, as the groceries would fall out when this bag is filled with heavier items.



Figure 85 - modified trolley bag

A bike bag was modified for a second fabric prototype (Fig. 86). The plastic and bag parts were separated, and magnets were attached to allow these two components to snap together. The snapping action is a user-friendly and easy action that would be interesting to implement in the product, but it does not allow for a sturdy connection in this prototype.



Figure 86 - modified bike bag

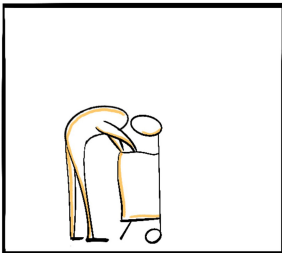


### 3 Further exploration of key design drivers

The first essential aspects of the trolley have been explored and prototyped. To enhance the design of this shopping trolley, the previously formed criteria are brought back to evaluate the concept. This chapter aims to improve the product further while prioritising the design drivers and effectively integrating these USPs. This approach allows the product development process to shift towards the most critical design aspects.

In order to focus more on the design drivers, these were transformed into specific goals. For each design driver, at least one scenario is created, describing an activity that the user should be able to accomplish easily (Fig. 87). The design of the shopping trolley should facilitate these activities. As these aspects are the main focus of this design, the user experience during these scenarios is also an important aspect to consider.

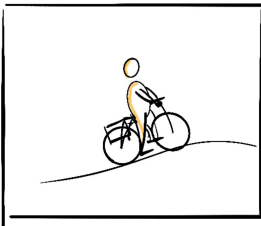
**A**



Better ergonomics when filling/emptying

- × user is in a comfortable position when filling and emptying the trolley
- × user is in a comfortable position when riding and manoeuvring around

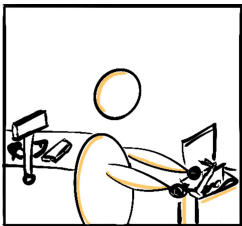
**B**



Compatibility with a bike

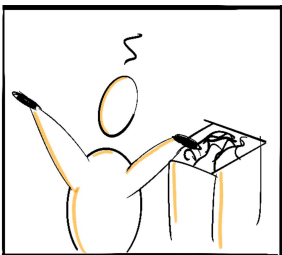
- × user can easily put a full and empty shopping trolley on their bike within a minute
- × user can ride their bike with a full shopping trolley

**C**



Easy access to the contents of the trolley

- × user is able to easily store and remove items in different sections
- × user can arrange items, in any order, depending on their fragility,



Trolley avoids the crushing of other groceries

Figure 87 - key design drivers

## A. Ergonomics

### Handle and position

The design should be adapted to the user's needs and not the other way around. A prototype with a turning handle was made to understand the optimal positioning for the user while riding the trolley (Fig. 88). This handle allowed the user to orientate the handle to their liking. Five colleagues at Achilles Design were asked to ride with the trolley as if they were doing grocery shopping. During this test, they also performed the actions they would do when riding the trolley to their homes.

When shopping, most people found the pushing motion more comfortable, as filling up their bags this way is more accessible. On the contrary, when walking home, people preferred to pull the trolley behind them. The preferred handle orientation is linked to the position related to the body. When pushing, the participants preferred the vertical position for the handle, but the horizontal position was preferred for a pulling motion. Although the rotating handle was mainly designed for testing, this is an excellent way for users to adapt the product to their liking. This is why the rotating handle will be implemented further into the product design.



Figure 88 - prototyping and testing different ergonomics of the handle (left) and positioning (right)

A study by Bylund et al. (2006) investigated the impact of handle size and anthropometric measures on the performance of a precision task (Fig. 89). They tested different diameters of handles (30, 38 and 46mm) but found that the preference was dependent from user to user. There was no general preference for the size of the diameter of the handle; instead, it is more important to have a good grip and a large surface area.

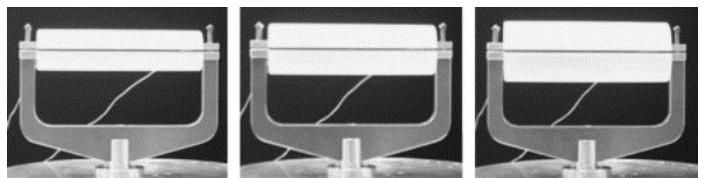
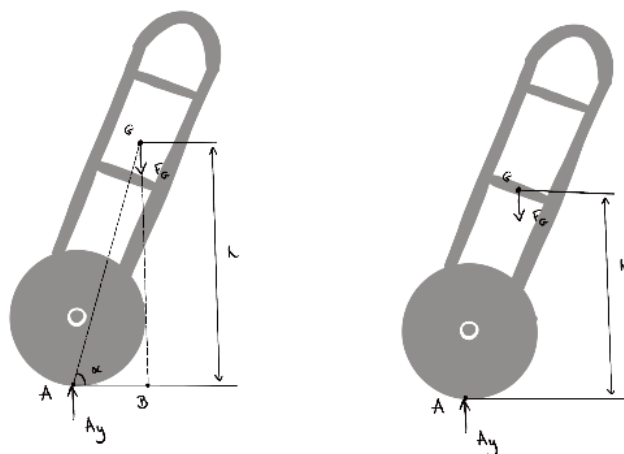


Figure 89 - different size handle testing by Bylund et al. (2006)

## Stability

The height of the load is a crucial factor for the ergonomics while riding with the shopping trolley. The lower the bag with groceries is attached to the frame, the smaller the moment around the wheels (Fig. 90). The higher the centre of mass of the attached bag, the more significant the moment and the heavier the weight the user has to carry on their own.

From a mechanical point of view, trying to get the weight as low as possible is essential, which is also visible in existing shopping trolleys. On the other hand, lowering the bags' position means that people have to bend over more. This was also mentioned in the interviews and survey: a shopping trolley is designed to provide a more ergonomic experience, but constantly bending over compromises this purpose.



Suppose the angle alpha stays the same

$$\tan \alpha = \frac{h}{AB}$$

$$AB = \frac{h}{\tan \alpha}$$

$$M_A = m \cdot g \cdot \frac{h}{\tan \alpha}$$

How closer the weight to the wheel, how lower the height, resulting in a smaller moment

Figure 90 - impact of the height of the weight on the stability.

While riding the trolley, the weight should be as low as possible. However, during the process of filling or emptying, it is better if the bag is positioned higher. Switching the position of the groceries would be too time-consuming for the user, so a 'happy medium' should be found for the height of the groceries. To decide on this height, a prototype was adapted with three different bars for attaching bags (Fig. 91). Then, a small crate of groceries was divided into two bags and attached at different heights. Unfortunately, the wheels of the prototype broke during the first pilot test, limiting the number of participants to only one user, apart from the author, who could test this weight distribution.



Figure 91 - testing different heights of weights

Although there was not much testing, it was clear from one test that the lowest position was uncomfortable to fill for the user. On top of that, the wheels would also get in the way when trying to fill the bottom section, making it unusable. The highest position was comfortable to fill, but as expected, it put a lot of strain on the user. The middle position was comfortable enough to fill, where the user had to bend slightly to reach some areas. At the same time, this position was also easier to ride around without too much effort from the user. This is why the middle position will be used as the height of the grocery bags for further development.

### Self-standing

The most stable position of the trolley is achieved when it is slightly angled towards the support. If the trolley stands fully vertical, even a slight shift in weight towards the wheel side could make it flip over. Therefore, it is crucial to have a large distance between the wheel axis and the end of the support to maximise stability. The trolley will not fall over if the centre of mass is located between these two boundaries (Fig. 92).

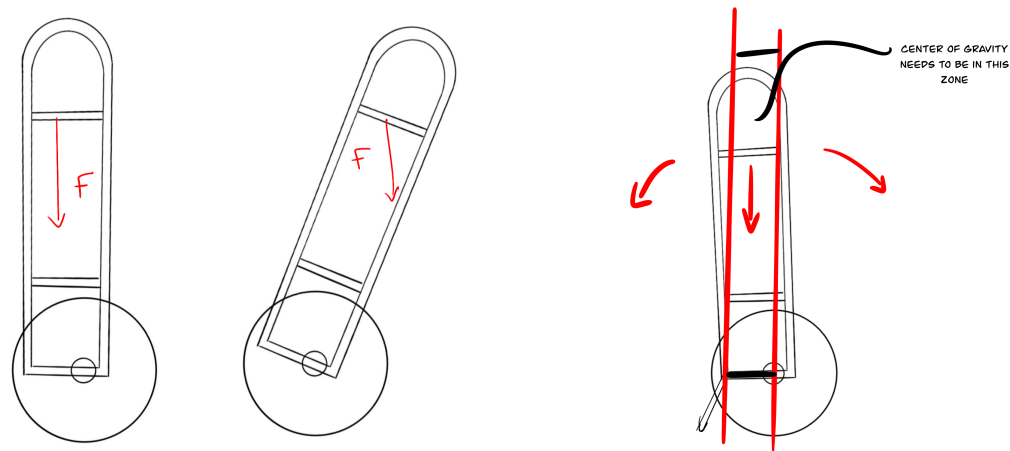


Figure 92 - schematic placement of the stand (left) and impact of the centre of gravity (right)

A previous prototype was hacked using a 3D-printed piece that was then sanded to the correct size to test the right angle (Fig. 93). Although this was a good indication of the working principle, this prototype was not solid enough for further testing. A more robust prototype of the stand should be developed in the next stage to be tested with actual groceries.



Figure 93 - quick and dirty prototype stand



## B. Bike compatibility

### Integration

The trolley part of the shopping trolley could either be a stand-alone part or integrated into one of the bags. To determine the optimal approach, input was gathered from a few friends and family ( $n = 5$ ) who were presented with these two scenarios (Fig. 94); the complete answers can be found in Appendix H. Most preferred the first option with a stand-alone trolley part, as it allows more flexibility. This also aligns with the goal of maximising the product's modularity, allowing the users only to buy what they need.

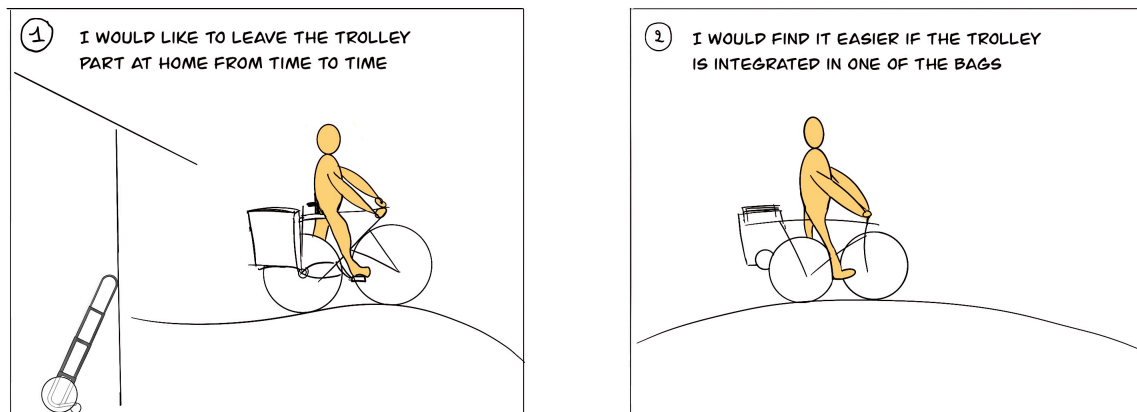


Figure 94 - scenarios around the integration of the trolley part

### Attachment

There are many places on a bike where bags could be attached, but for this product, the attachment should be as universal as possible. The most common available spot on most city bikes is the luggage carrier. While there is also some space available at the bike's handlebars, there is a lot of variation here, depending on the type of bike. Different bikes feature various handlebar designs, cable management configurations, bike lights, and more.



Figure 95 - a few of the possible attachments of the trolley on the bike

In addition to the attachment of the bags, it is crucial to ensure easy attachment of the trolley part to the bike frame. To explore the possibilities, a mock-up of the folded trolley was used, along with some tape, to attach to the bicycle (Fig. 95). Hanging the trolley part somewhere on the luggage carrier is the most feasible option. Hanging it onto the outside of a bag seems like the best option at first, as it still allows the user to use two bags and a trolley part. However, when there are fragile things inside the bag, these will probably be damaged by the frame's weight. Ideally, the frame would be mounted between the bike and an extra bag.

### C. Easy access and avoid crushing of the groceries

During the previous prototyping of the bags, the first fundamentals of designing a bag that is easily accessible were investigated. A large opening on the side combined with smaller pockets can allow easy access to the different parts of the bags. Since groceries come in various sizes and weights, individuals often want organised and protected storage for specific items. To address these needs, a modular grid is designed where different bags can be combined on top of each other, as shown in Figure 96. An L-shaped structure can be used as a hub to hold the various elements together and attach to the bike or trolley. A connecting system is used to attach the bags magnetically, providing a convenient and reliable connection.

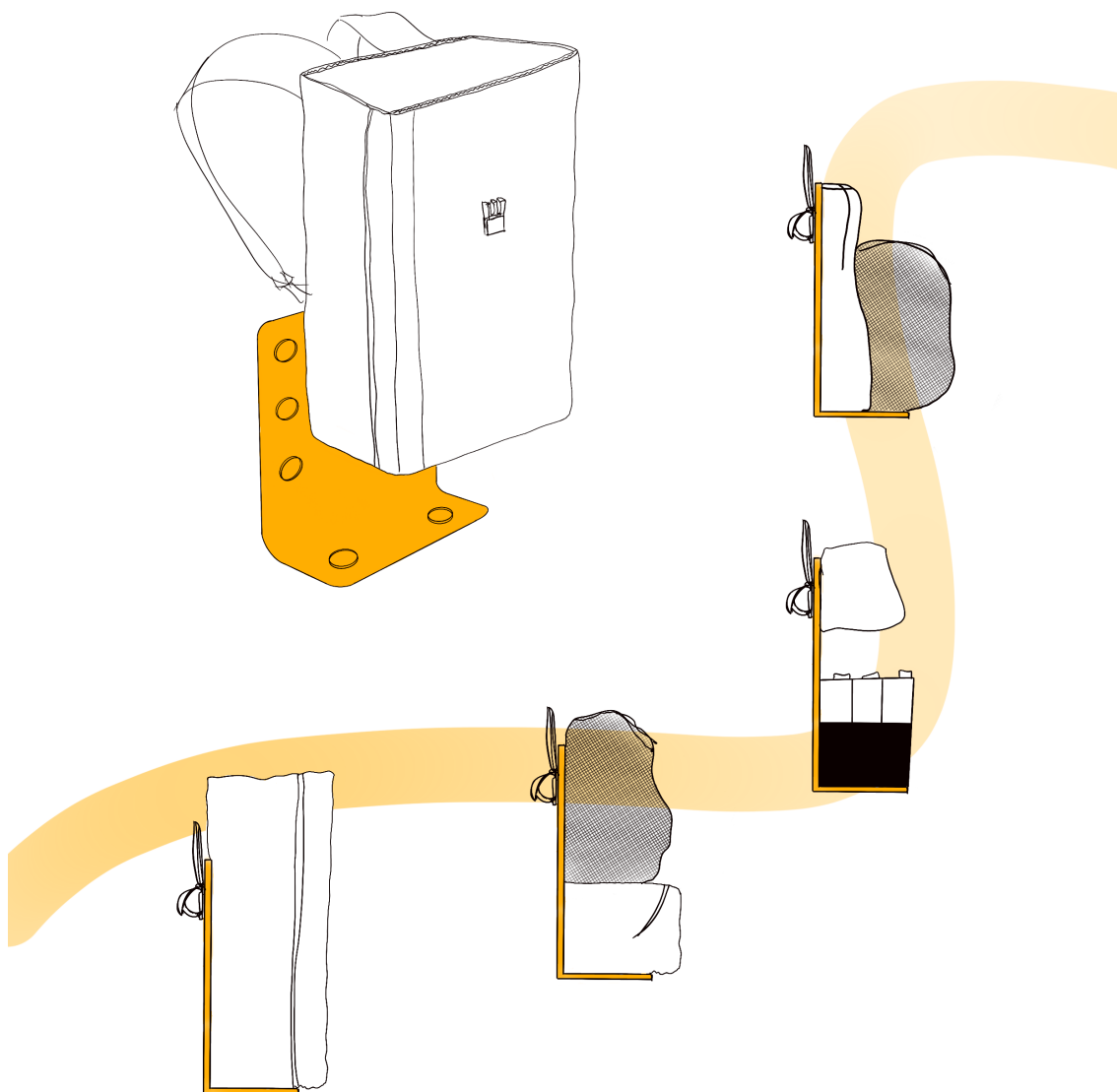


Figure 96 - modularity sketch

## 4 Mid-term review of the product

The realisation phase so far has allowed the design to shift from a concept towards a feasible product. As almost every part of the design has changed throughout the prototyping and development, it is crucial to bring all these aspects back together. Moreover, the sketch in Figure 97 combines the different parts of the user journey, giving a more holistic view of the product. Additionally, as incorporating styling into rough prototypes is challenging, this presentation sketch is an opportunity to show those aspects in more detail.

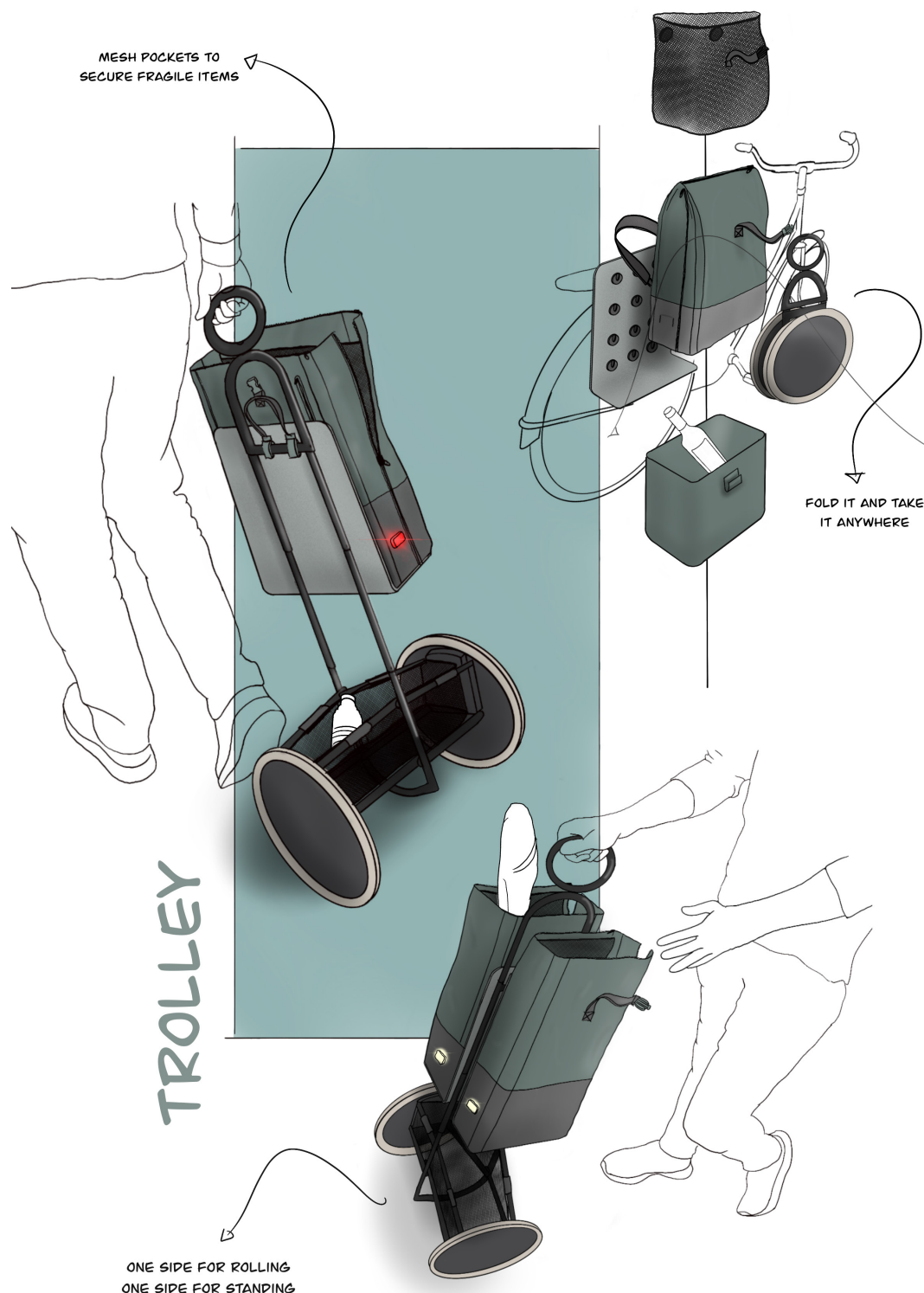


Figure 97 - mid-term presentation of the concept

The previously created checklist can now be used to assess the new design's effectiveness in fulfilling the user's needs (Table 6). This analysis can then act as a tool to identify areas where improvements can be made.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <div>NEEDS</div> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Easily foldable and unfoldable</li> <li><input checked="" type="checkbox"/> Self-standing</li> <li><input checked="" type="checkbox"/> Waterproof</li> <li><input checked="" type="checkbox"/> Carries a large amount of groceries</li> <li><input type="checkbox"/> Easy to operate</li> <li><input checked="" type="checkbox"/> Usable in a supermarket</li> <li><input checked="" type="checkbox"/> Compatible with a bike full and empty</li> <li><input checked="" type="checkbox"/> Possible to put items in different places</li> <li><input checked="" type="checkbox"/> New look</li> <li><input checked="" type="checkbox"/> Height is adjustable to the user</li> <li><input type="checkbox"/> Avoids groceries being crushed</li> <li><input type="checkbox"/> Provides a high-end user experience</li> </ul> | <div>WISHES</div> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Usable for other activities</li> <li><input checked="" type="checkbox"/> Usable as a backpack</li> <li><input checked="" type="checkbox"/> Different volume variations</li> <li><input checked="" type="checkbox"/> Affordable</li> <li><input checked="" type="checkbox"/> Fits into a backpack</li> <li><input type="checkbox"/> Optional lock</li> <li><input type="checkbox"/> Usable for less abled people</li> </ul> |
| <div>EXTRA</div> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Reliable and secure folding mechanism</li> <li><input checked="" type="checkbox"/> Maintains a stable wheelbase even in the presence of uneven weight distribution on both sides</li> <li><input type="checkbox"/> Minimal physical strain on the user's arm during trolley operation</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

Table 6 - assessment of the needs and wishes of the mid-term product design

There are several aspects where this design can be further enhanced:

- × The aspects of self-standing and easy-to-operate have yet to be thoroughly tested. Similarly, the minimal physical strain on the user's arm should also be checked by performing user tests.
- × The compatibility with a bike presents a challenge when protecting groceries from getting crushed. Attaching the trolley part to a soft bag that contains groceries puts pressure on these items, potentially damaging these groceries.
- × The high-end user experience could be improved by refining the connection of the bags to either the bike or the trolley. While using the standard bike connections provides a secure connection, it may not offer the most refined user experience.
- × Further steps are required to develop a reliable and secure folding mechanism. A proof of concept for this mechanism is essential to come to a more realistic and functional design.



## 5 Further improvements of the product design

### A. Redesigning the connection systems

To create a more streamlined ecosystem, every aspect of the product must have the same high-end feeling. The current solution of attaching the bags to the trolley and the bike works well but does not offer a premium feeling. Using a new system where the user actions are more accessible and enjoyable would create a more high-end product. Fidlock offers a range of components that snap in place magnetically but are mechanically fixed (Fig. 98). This technology allows for easy assembly while maintaining good strength.

The first step in redesigning the trolley with this new mechanism is determining where the female and male connectors would be attached. Ideally, the trolley could snap between the shell and the bike. However, this would result in an asymmetric design with two different shells on each side of the trolley. To maintain modularity and avoid this, the trolley part should have two connections above each other, enabling it to connect to the bike frame and using a single shell design (Fig. 99).

As the bike mounting must be very sturdy, a SNAP pull would be a good option. This specific Fidlock connection snaps into place, just like all the other connectors, but a pulling mechanism needs to be activated to release the attachment.

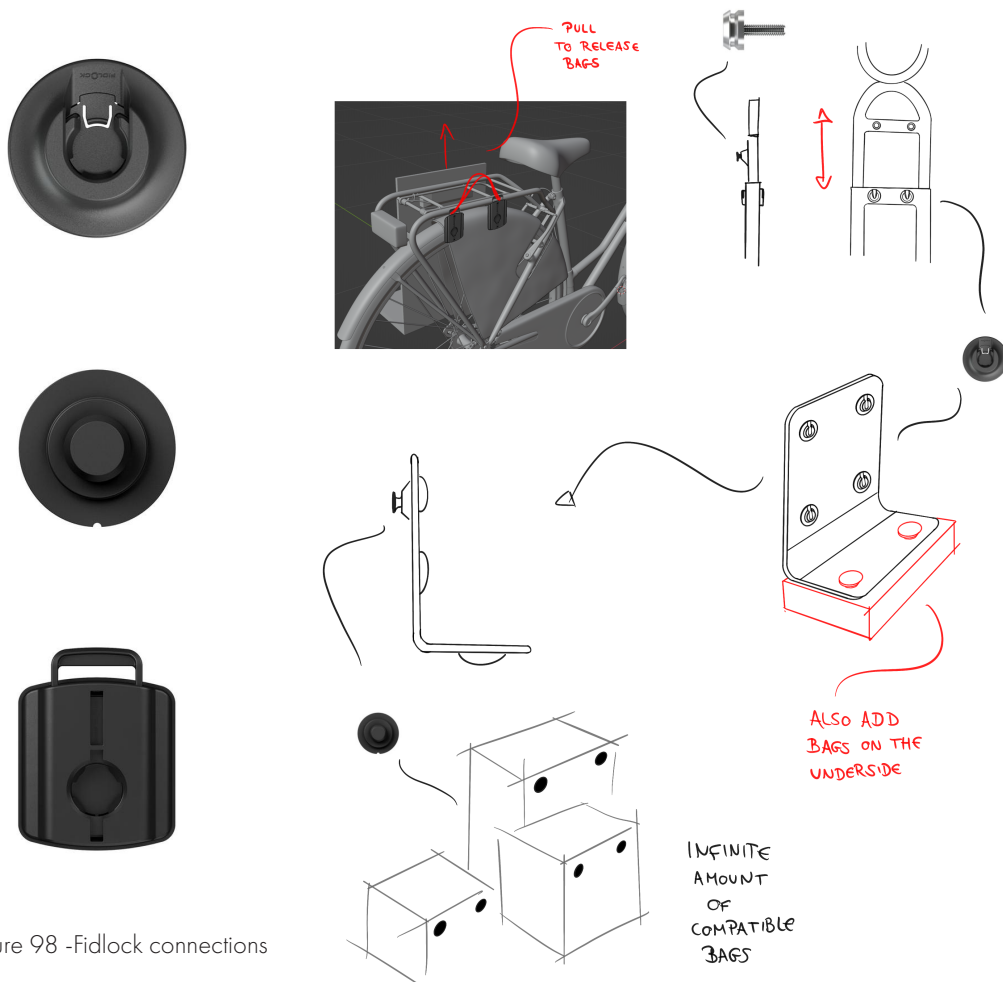


Figure 98 -Fidlock connections

Figure 99 -Fidlock integration rough idea

### Improving compatibility with a bike

The trolley part that attaches to the bike differs from the part where the shell with the bags will be attached. In Figure 100, the yellow part is attached to the bicycle, while the bags are connected to the red part. This means that the whole weight of the bottom part of the trolley, including the wheels and the bags, relies on the performance of the telescopic mechanism. Although this might work, the system would be more secure if all connections with the bike and bags were one solid part.

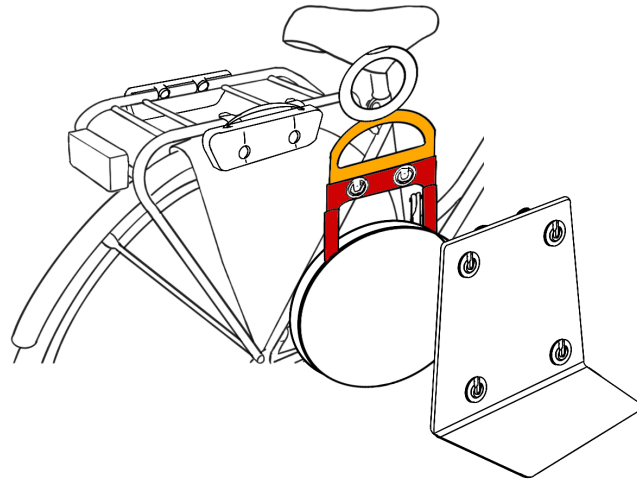


Figure 100 - risks of the current bike connection design

The system is redesigned to allow all essential connections between the bags and the bike to form one solid part. Additional spacing must be provided to accommodate space for the unfolded wheels and avoid pressure on the connections. The previous configuration can be seen on the left in Figure 101, and the right sketch shows the redesign.

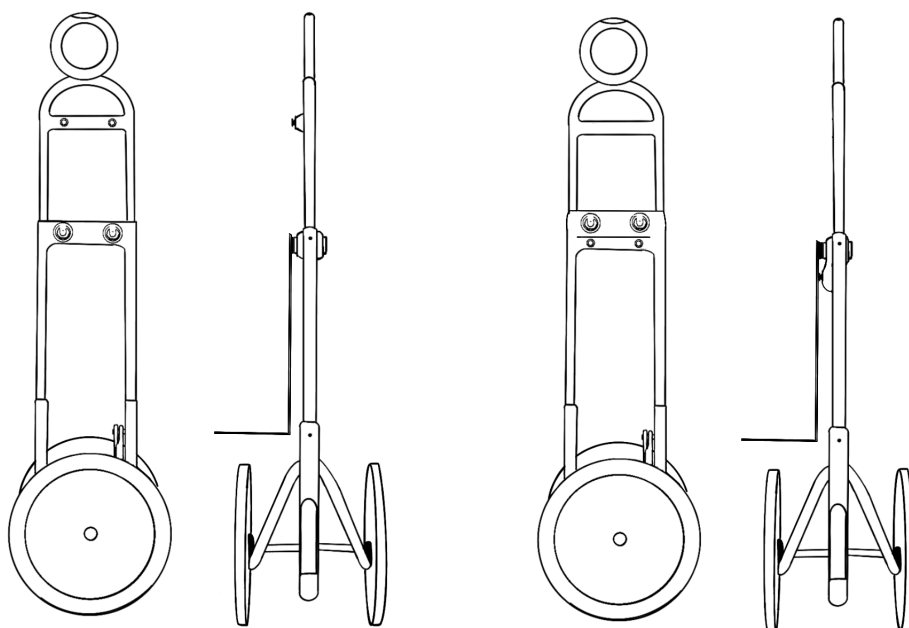


Figure 101 - previous design (left) and redesigned connections (right)

## B. Redesign of the base mechanism

For now, the mesh at the bottom of the trolley will be left out to focus on developing a stable wheelbase. This redesign aims to create a feasible mechanism that quickly unfolds its wheels and visually showcases its stability. Considering some fragile components in the previous folding mechanism, the whole folding mechanism will be redesigned.

### Slanting

To create more stability, sports wheelchairs have slanted wheels. Slanting the wheels allows more contact with the ground and helps to distribute the weight over a more significant distance. This practice is also used in the design of all-terrain vehicles, dune buggies and recumbent bicycles. As there is no need for extra space at the bottom of the trolley, this is a design choice that would benefit the overall sturdiness of the design. The wheels can have a more solid attachment and are easier to (un)fold (Fig. 102).

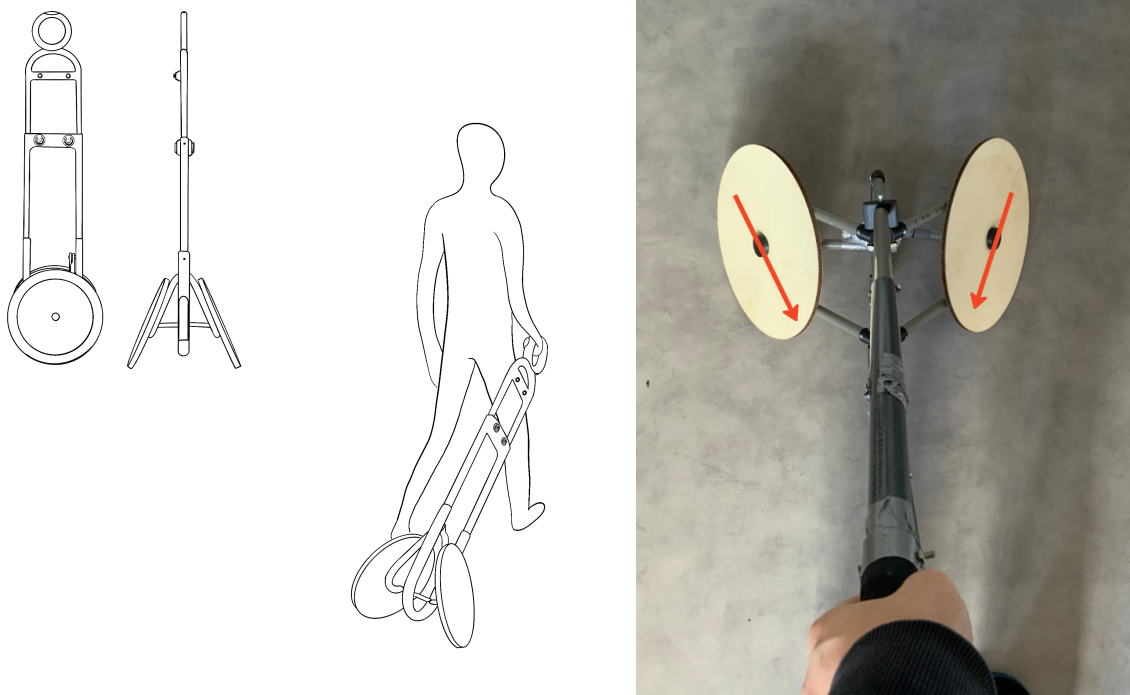


Figure 102 - slanting base mechanism design (left) and prototype (right)

Some hacking of an earlier prototype demonstrated this mechanism and allowed for some testing (Fig. 102). The slanted wheels are perfectly working and stable when the trolley is upright. However, the wheels do not function properly when the trolley is tilted at an angle, which is how the trolley is used most of the time. The wheels are then both rolling inwards, which causes a lot of friction. The wheels should be redesigned to roll parallel to the trolley frame.

## Straight

The wheels must be parallel to the frame in both the folded and unfolded positions. On top of that, the wheels must be very sturdy when unfolded and able to carry the frame and some full grocery bags. The only way to avoid having a lot of extra clicking mechanisms and weak points is to use two parallel bars to mount the wheels. To explain the different options, motion simulations were made in CAD using Fusion360.



Figure 103 - upwards folding mechanism

This unfolding system was also prototyped using a pen and 3D-prints, but this needed to be smoother to provide a good visualisation of the mechanism. The result is relatively simple: a linear motion guides the unfolding of the wheels that are mounted onto the frame using two parallel rods (Fig. 103).

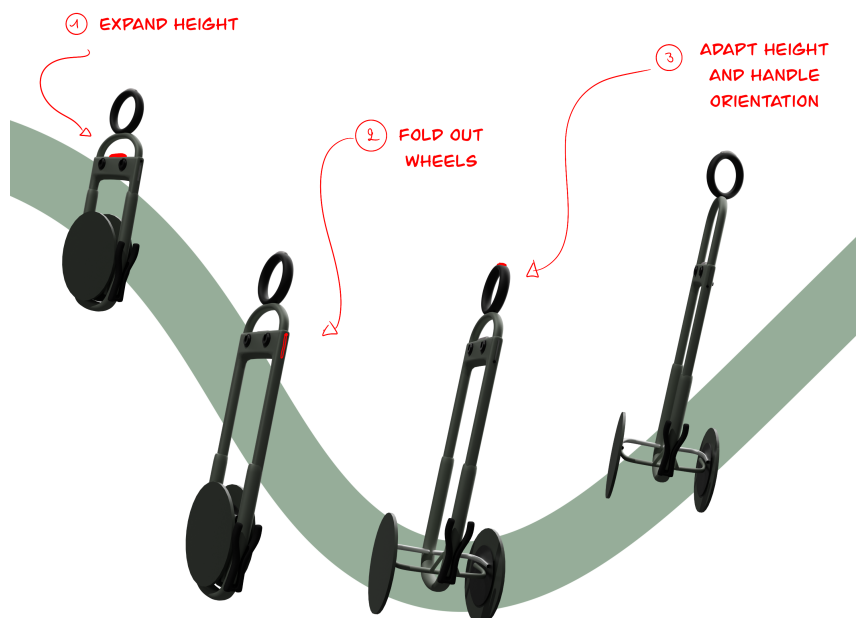


Figure 104 - visualisation of the unfolding user actions (right)



When folding and unfolding the trolley, the number of actions should be minimised to provide an optimal user experience. In this design, the wheels must be folded by an extra step, as the linear motion is the reverse direction of extending the telescopic frame. Furthermore, an additional bar should be provided so the user can quickly grasp the frame to expand this. The buttons that should operate the different actions are further explored and adapted during this process (Fig. 104).

In the previous mechanism, the whole weight of the bags and the trolley were putting pressure on the rod that would fixate the mechanism in position. This means the wheel's functionality depends on the fixation rod's effectiveness. The folding wheel mechanism is further redesigned to overcome this issue (Fig. 105). Putting force on the new version of the trolley does not create any risks for the mechanism to fold together or fail.



Figure 105 - downwards folding mechanism

Moreover, in this new design, the linear motion has been reversed. Expanding the wheels is now integrated into the pulling motion used to expand the frame (Fig. 106). By performing a single action, users can expand the frame, and once it reaches a sufficient distance, the wheels will also automatically expand.

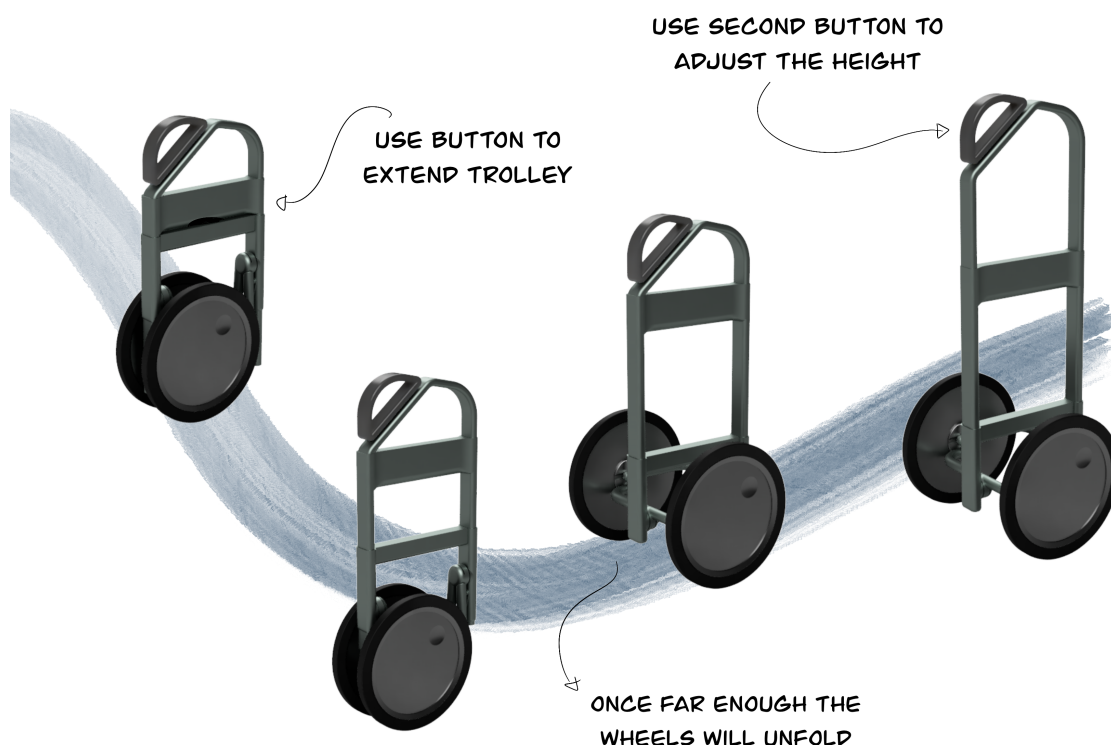


Figure 106 - final design wheel unfolding user actions

## C. Styling

Seamlessly integrating all different components into the shopping trolley gives the end product a sense of coherence. This further enhancement of the design will not only improve the overall maturity but also gives it a higher sense of realism. The moodboard in Figure 107 shows the desired style for the final product.

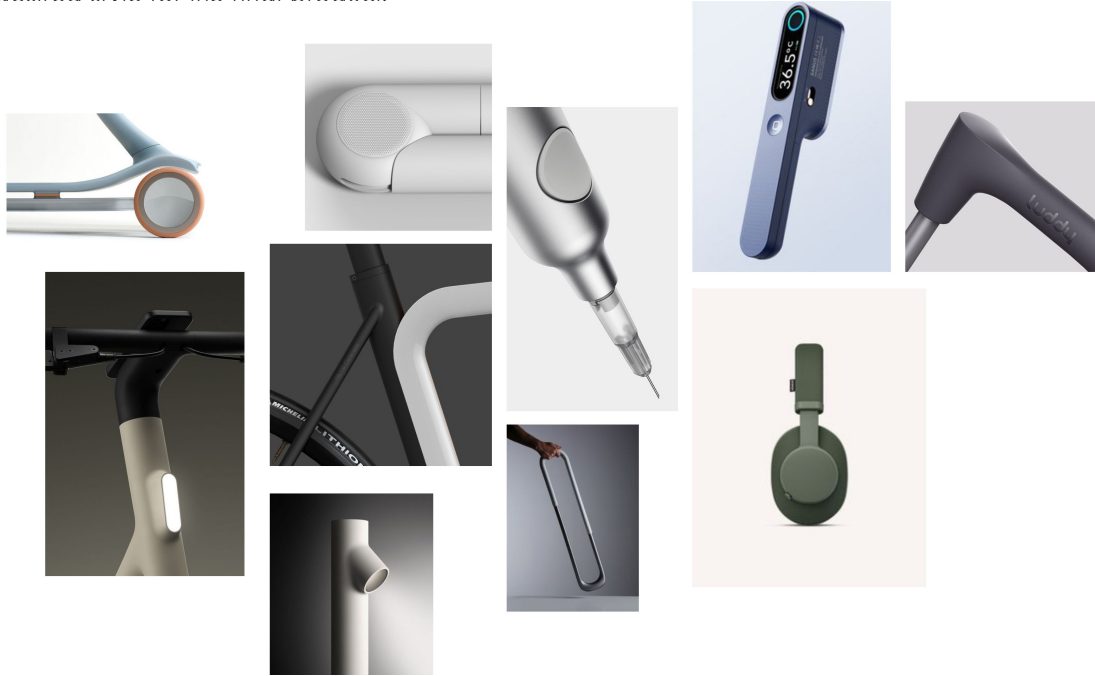


Figure 107 - moodboard styling

A few sketches were created to refine the styling of the shopping trolley (Fig. 108). This approach helps to transform initial concepts into more tangible designs, without the need to modify the CAD design. Once the desired styling has been determined, it can be incorporated into the final product design of the trolley.



Figure 108 - explorative sketches on the styling of the trolley

Throughout the design process, the styling of the trolley underwent a series of transformative changes, leading to a more sophisticated and polished final product (Fig. 109). Each component gets more refined as the development progresses, ultimately contributing to the trolley's overall appeal and functionality. Notably, the wheels significantly improved, transitioning from plain flat discs to realistic wheels with a rubber border. This alteration also enhanced the trolley's traction and manoeuvrability. Similarly, the stand gradually integrated into the overall design, seamlessly blending with the trolley's structure. This integration improved the trolley's aesthetics and contributed to its stability and ease of use.

Moreover, the folding system underwent a substantial transformation, evolving from a rudimentary system with bars and connectors to an integrated hinge mechanism. Overall, these design iterations brought about a more refined and mature product, where improved functionality defined the trolley's styling.

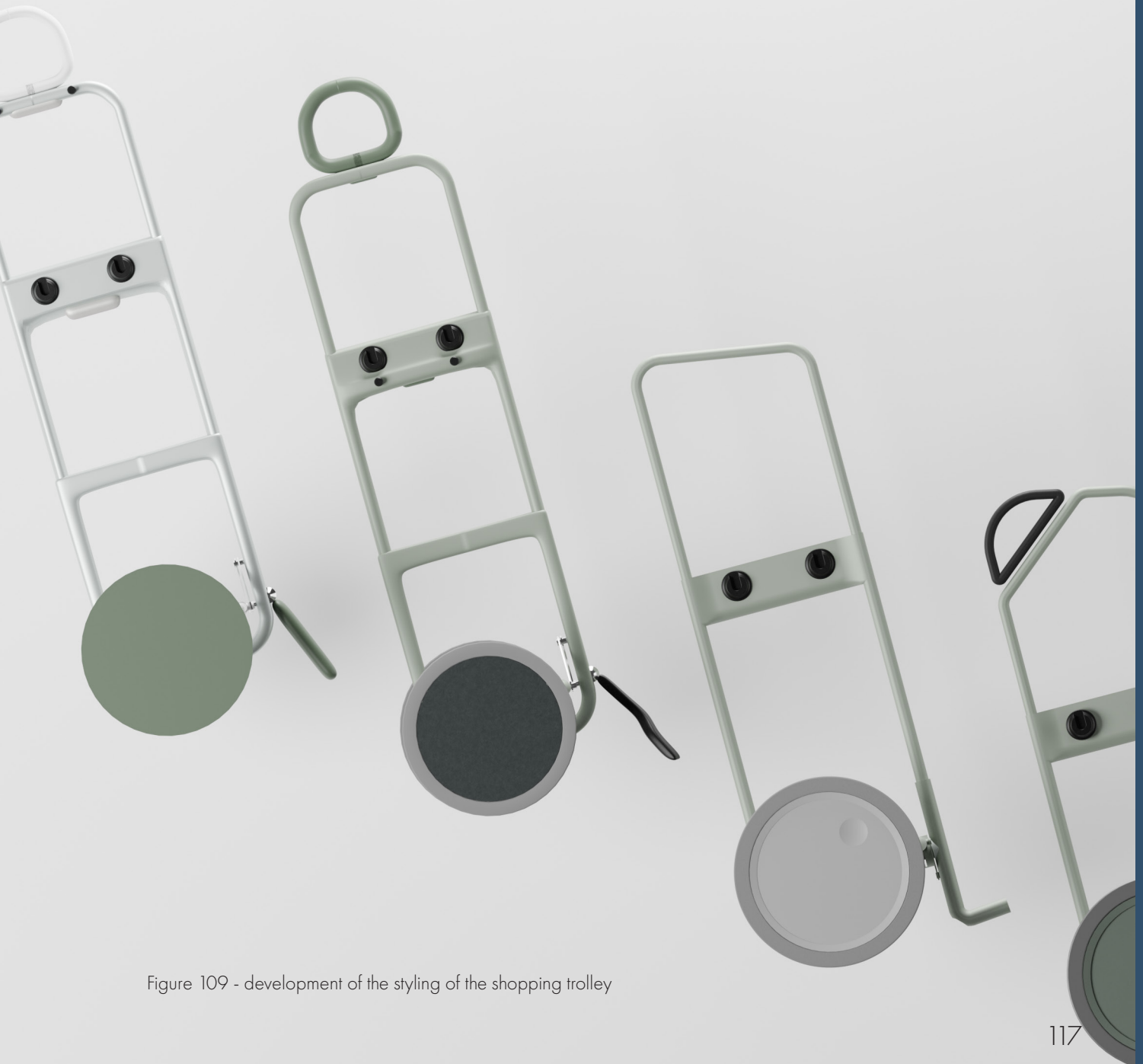


Figure 109 - development of the styling of the shopping trolley

## 6 Final prototype

The goal of this final prototype is to test the interactions with the product in a real-life scenario. This means that the prototype is solid enough to be walked around in a city. Although not every aspect of the design can be implemented into this prototype, all interaction points should be present. As many connections as possible will embed the final Fidlock-system, to test these interactions properly.

The base of this prototype will not be foldable, as this would compromise the amount of weight that this prototype can carry. The construction is made using aluminium profiles in combination with 3D-printed parts and screws (Fig. 110). The 3D-printed parts are made out of PLA, but made with more shells and infill than usual, allowing for higher strength.

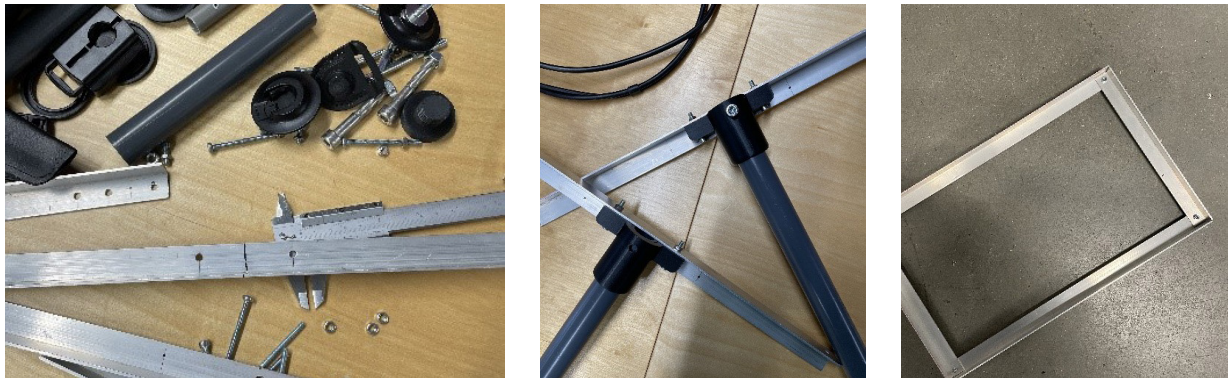


Figure 110 - solid base to facilitate proper testing

To test the stand of the trolley properly, an existing bike stand was used and mounted onto the prototype (Fig. 111). A strong 3D printed part holds together the PVC tube with the stand, combined with a few bolts. There is only one bolt that attaches to the PVC tube, making it easy to adapt the stand and fit the height to the trolley.

Interlocking PVC-pipes in combination with 3D-printed parts is used to create the structural architecture of the trolley. This makes the prototype foldable when the screws are removed, giving a good general idea of the folded dimensions (Fig. 111). The Fidlock components are then integrated into the 3D-prints to represent the final product better. The handle is also 3D-printed, allowing for quick iterations and adaptations.



Figure 111 - construction stand and telescopic frame



A first pilot test was done, going to the store with a friend, while he uses the prototype to do some grocery shopping (Fig. 112). A few aspects of the prototype clearly had to be improved. The wheels on one side of the trolley came loose while riding. This is not unexpected, as the rotation of the wheel turns the nut loose from the bolt. To counteract this, a second nut was added later on, to secure the nut on its place. A second aspect that was not working right, was the attachment of the larger bag. The bag came loose and started hanging around one pivoting point. This not only made the whole trolley harder to carry around but also did not feel safe to the user. For the tests, a smaller bag was used, to simulate the modular architecture and make sure the bag is better secured to the trolley.

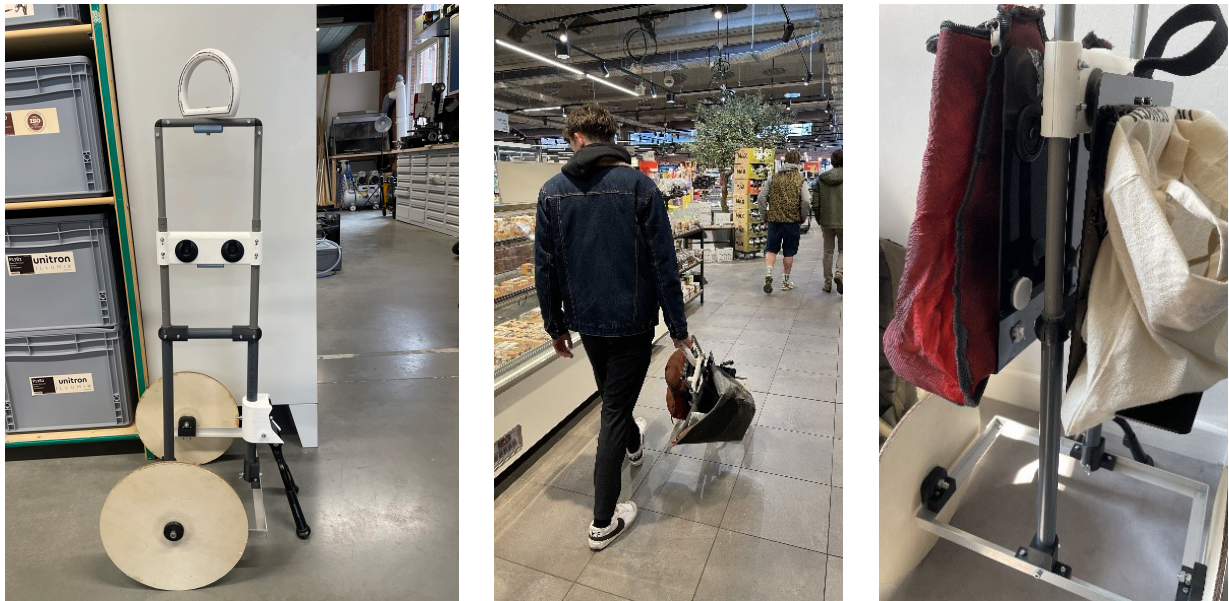


Figure 112 - prototype and first pilot test

In the last few user tests, a new larger bag was used, featuring a zipper along the side (Fig. 113). The users found this zipper useful to open up the top of the bag more, allowing easy access. Users have some safety concerns about a full zipper and zipping it all the way down would not have many advantages.



Figure 113 - improved bags after first pilot test

## 7 User testing

To extract as much qualitative information from the user testing as possible, a protocol was created to structure the tests (Appendix I). An interview was conducted before the testing and afterwards to capture additional feedback. The tests were performed with six persons, five colleagues at Achilles Design and one other external person. A supermarket store was visited with four test participants, and a local farmers market was visited with one test participant.

A rough prototype can be used for user trials but must be robust enough not to degrade over the testing process (Milton, 2013). This prototype can be a tool to observe how well the design communicates its function to the user. Furthermore, renders or sketches can show the product's look and other aspects that might not be incorporated into the prototype.

The objective of conducting these tests is to evaluate and analyse the user experience that this new shopping trolley will provide. The goal is to gain insights into the intuitiveness of the design, the user's opinions on the ergonomics and whether they perceive this product as suitable for their own lifestyle. This user feedback will provide valuable information that can be used to further enhance the product.

### A. Testing procedure

If the test person had no prior knowledge about the project, a few extra questions were asked about what they think this prototype would represent. As most of the users knew that the project was about a shopping trolley, they were asked to describe the USPs of this project, based on the prototype.

The second step in the testing was asking a few standard questions to understand the context of the participants: their age, living situation, what kind of transportation they use to do groceries etc. The participants were also asked if they had ever used a standard shopping trolley before and if they had any prior back or neck problems.

Next up, the prototype was shown to participants, and they were asked to identify the different parts and their functionalities. The next step was to go to a (super)market with the test person. Only with one participant this was not possible due to limited time. Four users used the prototype to shop in a supermarket, and one participant used it at the farmer's market.

As part of the user tests, certain design aspects were modified to be tested with subsequent users. Three individuals tested each bag design, and for the final test, adjustments were made to the height of the bag and the handle. These modifications were implemented to gather feedback on the revised design.

### B. Test results

The individuals chosen for user testing have diverse characteristics, representing various demographics and perspectives. Gender representation includes a mix of males and females, ensuring a balanced perspective. The age distribution spans from young adults in their early twenties to individuals in their late thirties, providing insights from different life stages. The participants' living situations encompass various arrangements, such as those with partners and children, single individuals, and students. Additionally, they reside in various cities such as

Leuven, Antwerp, Ghent, and Brussels, which offers unique perspectives from people living in diverse urban settings. The most used grocery transportation methods, including biking, walking, and car usage, differ among the participants. The full overview of their demographics and a few of the user's opinions are listed in Appendix J. Having a variety of participants in user testing enhances its effectiveness and provides a more comprehensive understanding.

## C. Conclusion user testing

None of the participants had ever used a standard shopping trolley before. On the other hand, half of them had already had some back or neck issues. The pictures of the user tests can be found on the next page (Fig. 114).

### Intuitiveness of the design

Most test persons identified the detachable bags, the handle and the stand. Some of the users assumed that there was a possibility to put larger items at the bottom because of the available space. The attachment of the shells with the bag, using the Fidlock-connections, was something all participants found interesting.

### Perceived usefulness

Whether the participants would use this product, was answered differently from user to user, but generally, most saw potential in this concept. In the two first user tests, with a small bag, users found the volume that the trolley could carry too small. 'If you buy a trolley, you want to carry a lot of items' one of the test subjects said. With the update to a larger bag, from the third test, the rest of the users felt like they could carry a lot of groceries. Moreover, some said they liked the option of a smaller second bag, as it allowed them to put away fragile items.

The zipper definitely improved the accessibility of the bag, but most users only felt the need to open it slightly. A test person also said that opening the zipper further would make them fear things might start falling out. Other alternatives that just allow more opening at the top of the bag, without causing any risk that items might fall can also be explored further.

Most participants claimed that they want to quickly fill up their bags when they are at the register, making it more convenient to have large bags. Inserts and other sorting systems can still be added on the inside, but when needed a large space should be available.

### Ergonomics

Generally the users were very positive about the ergonomics of the trolley, except when the trolley was getting heavier. The current height causes a small angle with the ground when rolling, resulting in a larger force required by the user. The bags of the trolley should also be lower, minimising the force needed by the user to move the trolley. Moreover the combination with the rotating handle caused some issues. The handle of the trolley should click into a few positions, making it easier to rotate or turn the trolley.

The most important aspects of the shopping trolley design that will be adapted after this user testing are:

- × The height of the trolley
- × The design of the bags and shell system
- × The handle





Figure 114 - user testing in a supermarket and at the farmers' market



## 8 Bag redesign

Based on the observations and feedback from the user testing, a new bag was designed. This bag enables users to easily and efficiently pack a large quantity of groceries, while maintaining the option to sort them as needed. A zipper could close the bag down the middle, allowing extra organisation.

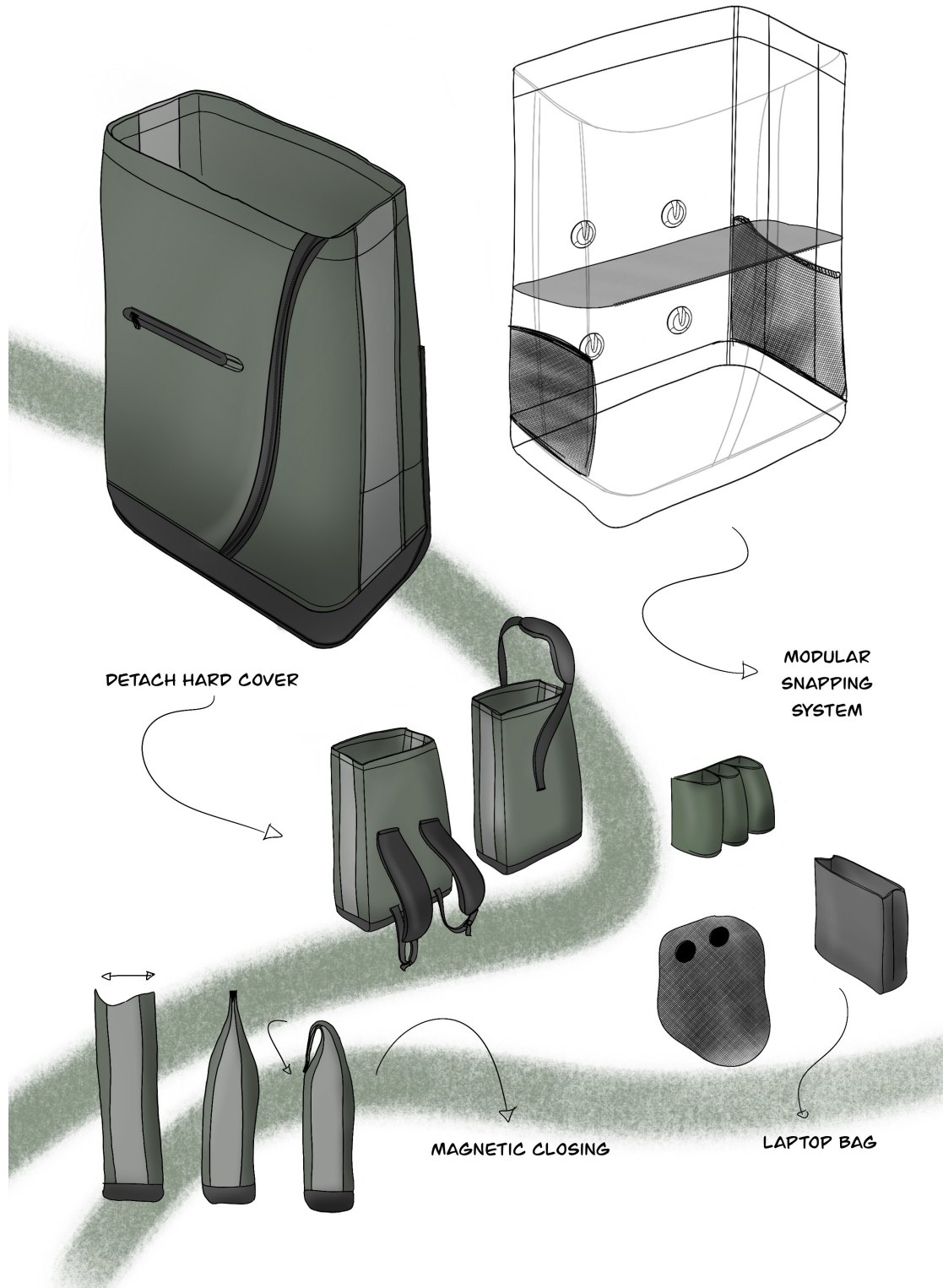


Figure 115 - bag redesign



# 07

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**deliver**

# 1 Product presentation

Answering the research question, “How can we provide a new experience around car-free grocery shopping for young adults?”. Developing a new shopping tool resulted in a modular system consisting of bags, a trolley and a bike mount. These bags can be magnetically mounted onto the trolley to easily accommodate the transport of up to 40 litres of groceries. The same magnetic connection can be used to attach these bags to a bicycle. Furthermore, the trolley part can be folded to be attached to the bicycle as well.

There would be a few inserts are available to be attached to the inside of these bags to customise them to the user’s needs. There could, for example, an insert to keep certain items cooler for longer or safely store your laptop. The bags feature a solid back panel to maintain the bag’s shape when loaded with groceries. A zipper can remove this panel, allowing access to (a) shoulder strap(s). This way, these bags can be used for all kinds of daily activities, like going to work, to the gym or to the grocery store.

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |                                                                                                                                                                                                                                                                       |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NEEDS | <ul style="list-style-type: none"><li>✓ Easily foldable and unfoldable</li><li>✓ Self-standing</li><li>✓ Waterproof</li><li>✓ Carries a large amount of groceries</li><li>✓ Easy to operate</li><li>✓ Usable in a supermarket</li><li>✓ Compatible with a bike full and empty</li><li>✓ Possible to put items in different places</li><li>✓ New look</li><li>✓ Height is adjustable to the user</li><li>✓ Avoids groceries being crushed</li><li>✓ Provides a high-end user experience</li></ul> | WISHES | <ul style="list-style-type: none"><li>✓ Usable for other activities</li><li>✓ Usable as a backpack</li><li>○ Different volume variations</li><li>✓ Affordable</li><li>✗ Fits into a backpack</li><li>○ Optional lock</li><li>○ Usable for less abled people</li></ul> |
| EXTRA | <ul style="list-style-type: none"><li>✓ Reliable and secure folding mechanism</li><li>✓ Maintains a stable wheelbase even in the presence of uneven weight distribution on both sides</li><li>✓ Minimal physical strain on the user’s arm during trolley operation</li></ul>                                                                                                                                                                                                                     |        |                                                                                                                                                                                                                                                                       |

Table 7 - assessment of the needs and wishes of the final product design





Large wheels make the trolley suitable for safely riding over obstacles or uneven surfaces. Moreover, these large wheels significantly reduce the force exercised by the user to push or pull the trolley forward. Additionally, the trolley features an integrated stand that ensures its stability and upright position, even when fully loaded.



Two bags offer a lot of space for organising groceries, and the inner mesh pockets provide convenient sorting opportunities for bottles or other items. Two zippers on the sides allow easy access for the user. A few Fidlock connectors on the inside will allow future inserts to be attached.



The trolley has a button on the handle that allows users to adjust the trolley to their personal needs. The trolley's height can be easily adapted to fit the user's preferences. The handle is designed to rotate and securely lock into various positions, enabling effortless pushing or pulling.





The folding system is designed to prevent accidental folding during use. It consists of two parallel rods that keep the wheels straight and unfolded, ensuring stability and usability.



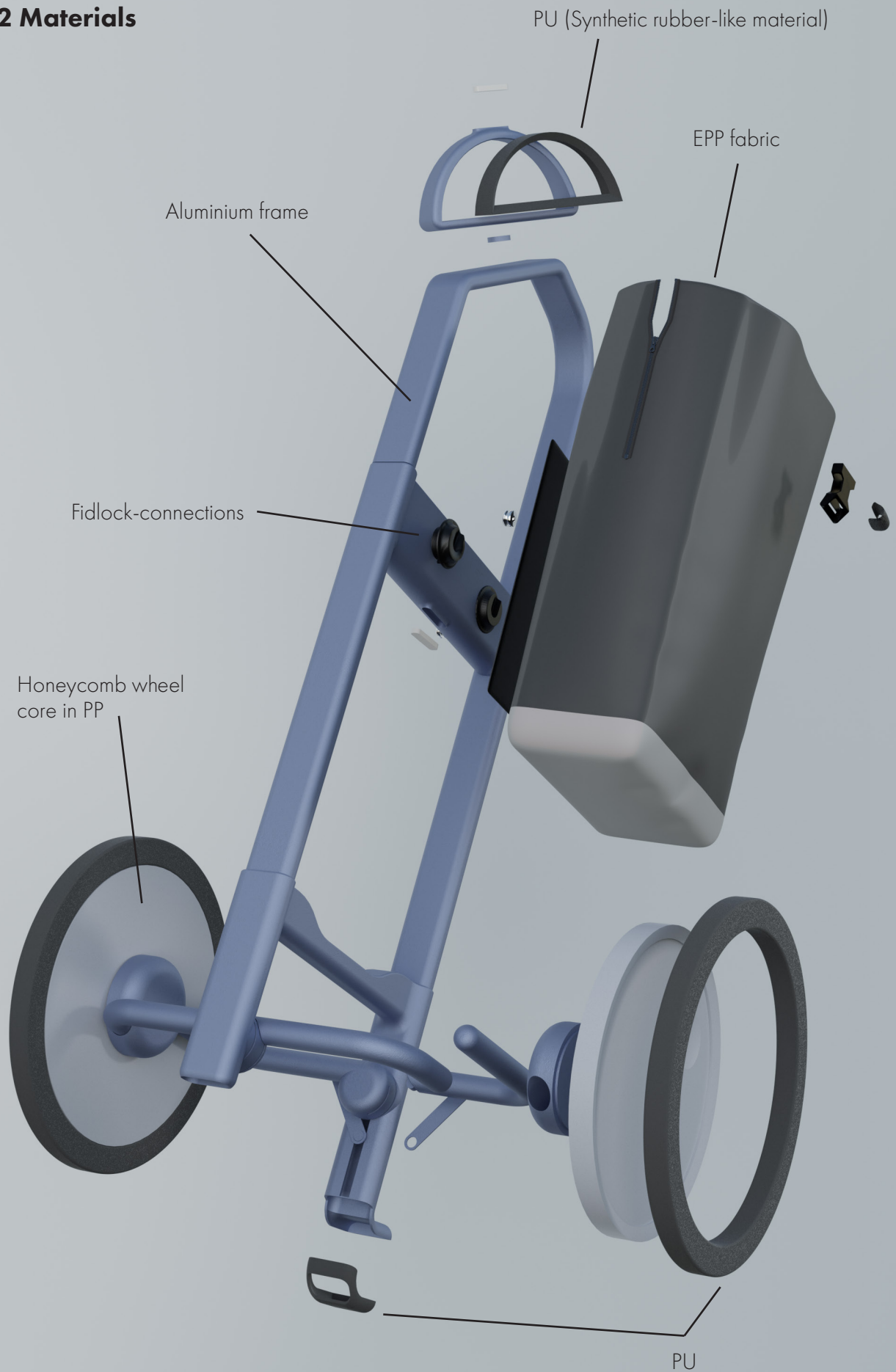
The user can easily unfold the trolley by holding down a button located beneath the magnetic connections. This unfolding process can be done even if one bag is still attached. As the wheels slide down, they will automatically start unfolding once they have reached a sufficient distance.



The bags can be securely attached to both the bike and the trolley using magnetic snaps. Additionally, the trolley can be snapped onto the bike holder while still holding one of the bags. Users simply need to press a button to detach the bags or the trolley from the bike, providing a convenient and effortless release mechanism.



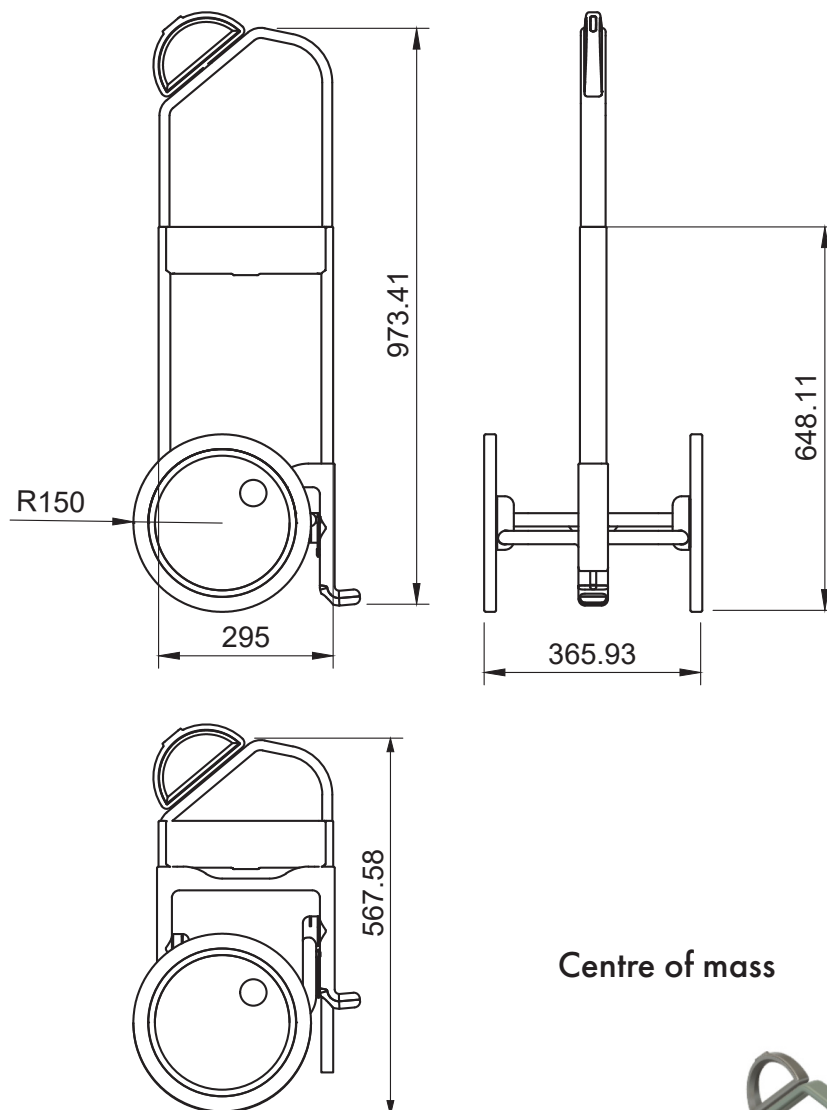
## 2 Materials





### 3 Technical information

#### Dimensions (in mm)



Centre of mass

#### Estimated weight - 5,86 kg

This is the calculated weight based on the CAD-drawing, but this is far removed from the actual weight. A lot of the parts in this drawing are solid, while in reality they will be hollow. The actual weight should be under 5 kg.







## 5 Sustainability

### A. Sustainability current product

Research from Belgian consumer association 'Test Aankoop' has shown that a standard Asian-fabricated shopping trolley is currently the least sustainable way to transport groceries (Test Aankoop, 2021). The ecological footprint of a reusable LDPE-bag is much smaller than the ecological footprint of a shopping trolley. Using an LDPE-bag once or twice compensates for its impact, while a shopping trolley should be used at least 709 times.

This LCA analyses and compares the products based on materials and production. Due to the use of metal and injection-moulded plastic parts, the impact of the shopping trolley is much higher. On the other hand, people who use a shopping trolley are more likely to go to the store on foot instead of using a car. This switch in transporting modes has a high impact on the total ecological footprint of these customers.

### B. Sustainability end product

The materials in this shopping trolley are carefully chosen based on the health and the energy used during the process, from material extraction to disposal. There is no glue or other adhesive components used in this product, making it perfect for repairing or upgrading. If this product would enter the market, a maintenance and repair service would be provided. Unfortunately, it is impossible to create a complex product as a shopping trolley with a smaller ecological footprint on materials and production than a basic plastic bag. The sustainability of this product has to come from its use and durability. The shopping trolley clearly has the potential to be a product that can replace the need for plastic bags.

Due to the modular design, the user only buys the bags they really need, avoiding any unnecessary materials and production. Using a top that can be closed by flipping it over, more groceries can be carried when necessary and the top can just be left open. This minimizes the need for extra plastic bags and lets the users carry their groceries, even when they buy too much.

The removable bags in the design of this shopping trolley allow the user to use these bags for other activities. These bags can perfectly be used as a bike bag, shoulder bag or backpack. The more these bags are used, the faster they compensate for the ecological footprint of their production and material extraction.

The most important aspect of sustainability for this product is the impact it can have on the behaviour of people. This approach is called 'Design for sustainable behaviour (DfBs)' (Ceschin & Gaziulusoy, 2019) and it involves designing products and systems in a way that encourages and enables sustainable behaviour. Although there is not yet a unified model of DfSB, most approaches are based on four principles:

- × Making it easier for people to adopt the desired behaviour
- × Making it harder for people to perform the undesired behaviour
- × Making people want to perform the desired behaviour
- × Making people not want to perform the undesired behaviour

Applied to grocery shopping in a city, the second and fourth principles are mainly handled by



regulations and campaigns done by the city. Banning cars from their centres and making parking more difficult can convince people to look for other transportation methods to do grocery shopping. That's where the first and third principles play an important role: making it easier for people to do groceries without a car and making people want to do groceries without a car. As the development of the shopping trolley has strongly focused on high functionality and great user experience, this product has the potential to convince a lot of people that shopping trolleys can be a very useful tool to do grocery shopping in a city.

## Sustainable Development Goals

Furthermore, this new shopping trolley design addresses several challenges indicated in the Sustainable Development Goals (SDGs). This trolley design encourages responsible consumption and production by minimising the number of different materials and components and making everything easy to separate. Furthermore, the modular design allows the users only to buy the items they need, avoiding overproduction and consumption. These aspects all relate to SDG 12, 'Responsible Consumption and Production', which aims to ensure sustainable patterns in consumption and production.

Promoting the adoption of alternative transportation methods can strongly impact the sustainability of cities. By reducing the reliance on personal cars, cities can drive a change towards more sustainable behaviours. Providing citizens with the necessary tools and infrastructure to embrace alternative transportation options marks the start towards a greener city that does not depend on fossil fuel-powered transport. The goals of this new shopping trolley align with the objectives of SDG 11, 'Sustainable Cities and Communities', which seeks to create more inclusive, safe, resilient and sustainable cities.



Figure 116 - SDG 11 and SDG 12 from The Danish Institute for Human Rights

## 6 Personal reflection

This year has been a wild ride. I worked hard throughout the year because I was excited about this challenge. I learned a lot from this project, like how to make better sketches, build prototypes of different parts, and create 3D models of fabrics. I enjoyed working on my thesis at Achilles Design in Mechelen. I met many lovely colleagues and learned a lot from their expertise.

I wanted to base my ideas on the research data, but I think I waited too long to start building prototypes. When I finally did, I should have focused more on how people would use the product and how it would generally work. I spent a lot of time developing and testing the folding mechanism. Still, the interactions with the user are even more important.

The project started with a big question, sometimes making it hard to know how far I should take it. In the end, I'm really happy with the result. It's not a finished product, but it's a solid proof-of-concept, thanks to real-life testing with users.

I want to thank everyone who helped me with this project in some way. I feel like I've grown a lot this year, both as a designer and as a person. I learned to explain my ideas better, ask for help when I needed it, and take charge of the project.

## 7 Limitations

The thesis project had some limitations along the way. One important point to note is that being an eight-month, single-person project, the product could not be fully developed into a production-ready state. This means that certain aspects, like scalability and robustness, could not be thoroughly addressed. Additionally, the limited timeframe made it difficult to conduct multiple user tests and implement necessary improvements. However, despite these challenges, the project progressed from a broad research question to a proof-of-concept of an innovative product. It emphasized the importance of user-centred design in tackling the unique challenges young adults who rely on car-free grocery shopping face. The developed shopping tool provides a practical solution that enhances the user experience and promotes sustainable and convenient shopping practices.

## 8 Future work

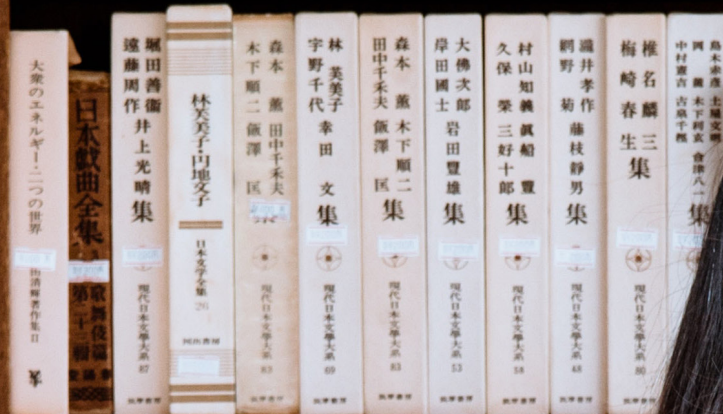
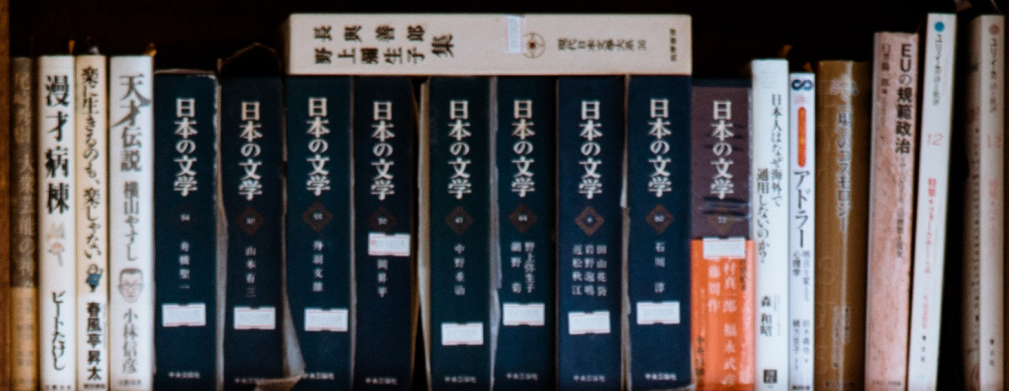
The main objective of this thesis is to develop a proof-of-concept of a new shopping tool. However, several steps must be taken to transform this product into a production-ready one. As the general design of the trolley is completed, this can now be translated into a manufacturable design. This process requires more detailing, including offsets and chamfers, to adapt the design to the specific manufacturing techniques.

Furthermore, a more extensive exploration of materials used for the trolley and the bags is necessary to achieve optimal product properties at the right price point. This involves creating a detailed bill of materials and estimations of the production costs, serving as a starting point for further analysis of the retail price.

To improve the functionality of the bag, sewn prototypes can be developed, along with sewing patterns. The attachment to the shell and the inserts can be designed in more detail, allowing for further testing of the integration of shoulder straps. Additional elements, such as small pockets and zippers, can also be developed. A mesh attachment can also be created for the bottom of the trolley part, allowing the user to place heavy items at the bottom. The redesigned handle should be thoroughly tested on ergonomics. Foam models can be used to compare different possibilities.

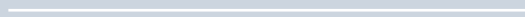
The technical aspects of the trolley also require additional engineering to transform this proof-of-concept into a fully functional, manufacturable product. This involves further developing the buttons, folding mechanisms and attachments to ensure a robust and functional design.







# 08



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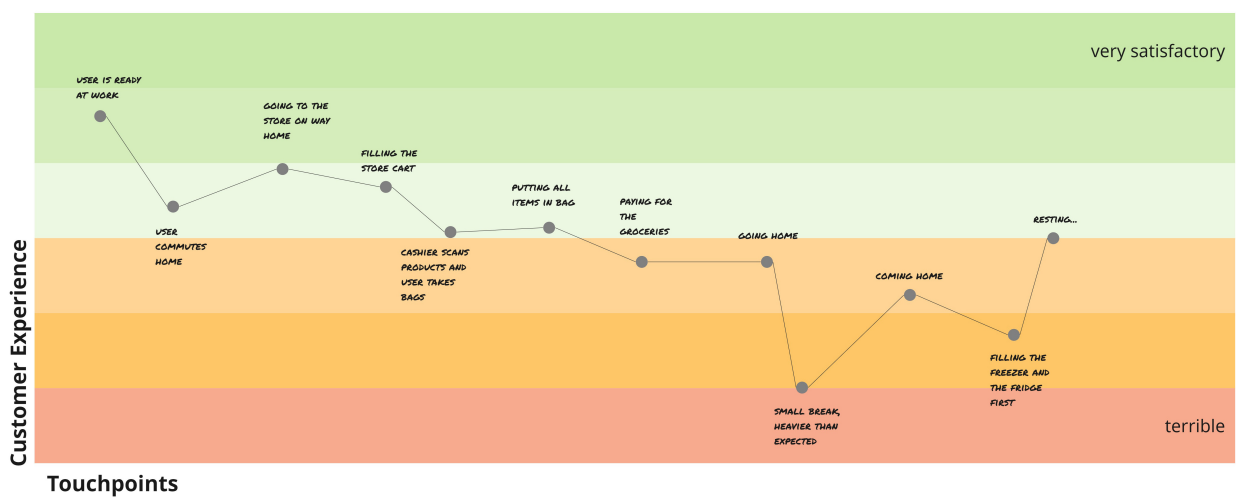
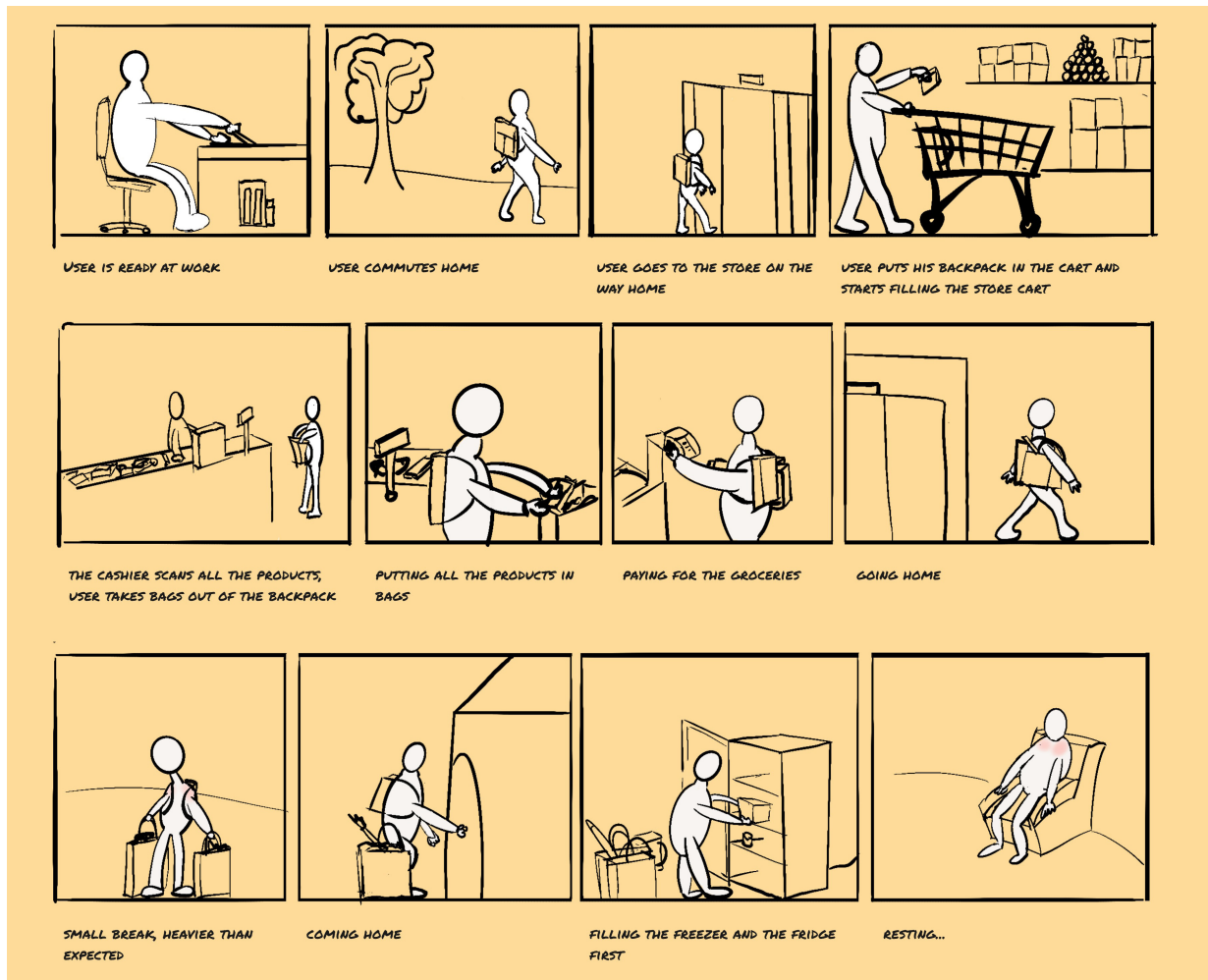
# 09

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## appendix



## Appendix A - Customer journey map 2





## Appendix B - User scenarios

### Scenario - Selfscanning

| STEPS    | Producten scannen in de winkel                   | Zak vullen                                         | Controle                       |
|----------|--------------------------------------------------|----------------------------------------------------|--------------------------------|
| DOING    | Trolley direct vullen met producten              | Producten kunnen direct in de trolley              | Alles uit trolley halen        |
| THINKING | Ah nu moet ik straks niet meer alles verplaatsen | Telkens bukken en producten goed proberen stapelen | Komt gelukkig niet zoveel voor |
| FEELING  | Opgelucht                                        | Niet heel comfortabel                              | Gefrustreerd                   |



### Scenario - Buying a carton of milk

| STEPS    | De pakken melk passen niet met de glas in de trolley               | De pakken melk worden apart in de trolley gestoken                                |
|----------|--------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| DOING    | Maakt lijst op en gaat naar supermarkt                             | Neemt items, scant deze en legt ze in de trolley                                  |
| THINKING | Ik moet mijn lijstje ordenen zodat ik snel door de winkel kan gaan | Ik moet zorgen dat ik voldoende plak heb voor al mijn boodschappen, goed stapelen |
| FEELING  | Gerust                                                             | Licht bezorgd                                                                     |



### Scenario - Using a trolley with a shopping cart in a supermarket

| STEPS    | Trolley in winkelkar zetten                   | Boodschappen scannen                                      | Naar buiten gaan                         |
|----------|-----------------------------------------------|-----------------------------------------------------------|------------------------------------------|
| DOING    | Trolley in mand leggen of onderaan kar        | Boodschappen op band / Personeel zet over                 | Kar wegzetten, trolley eruit             |
| THINKING | Toch jammer dat ik het niet kan vullen direct | Trolley vullen in de kar, niet heel handig qua oriëntatie | Wel handig dat mijn trolley nu is gevuld |
| FEELING  | Ok                                            | Niet heel comfortabel                                     | Ok                                       |



## Appendix C - Benchmarking current products



**Utility cart**  
€40

foldable  
sturdy



**Magna cart**  
€40

foldable  
sturdy



**Boodschappentrolley**  
€30

big wheels  
small pocket for wallet etc.



**ShoppingCruiser**  
€45

foldable  
integrated cooling  
compartment  
removable bag  
water repellent

€50



**Reisenthel - foldable trolley**  
€35

foldable

30€



**Achaté - boodschappentrolley**  
€53

detachable bag  
(not clear how you would carry this)

45€



**Opvouwbare Boodschappentrolley 3-in-1**  
€20

also usable as bag  
**expendable in size**

really flimsy



**Reisenthel Trolley**  
€54

pocket for wallet

40€



**Reisenthel - carrycruiser**  
€109

40€



**Reisenthel - carrycruiser plus**  
€119

closed with thermal insulation

43€ + 3€



**Andersen Tura Shopper Ortlieb**  
€335

reflective details for at night  
solid design  
waterproof

43€



**Carlett URBAN Duc**  
€200

isothermal pocket 7  
handlebar adjustabl

36€

## Appendix D - Additional benchmarks conceptual work

Daniela Stockenhuber - Shop'n'roll

idea - 3 wheel trolley



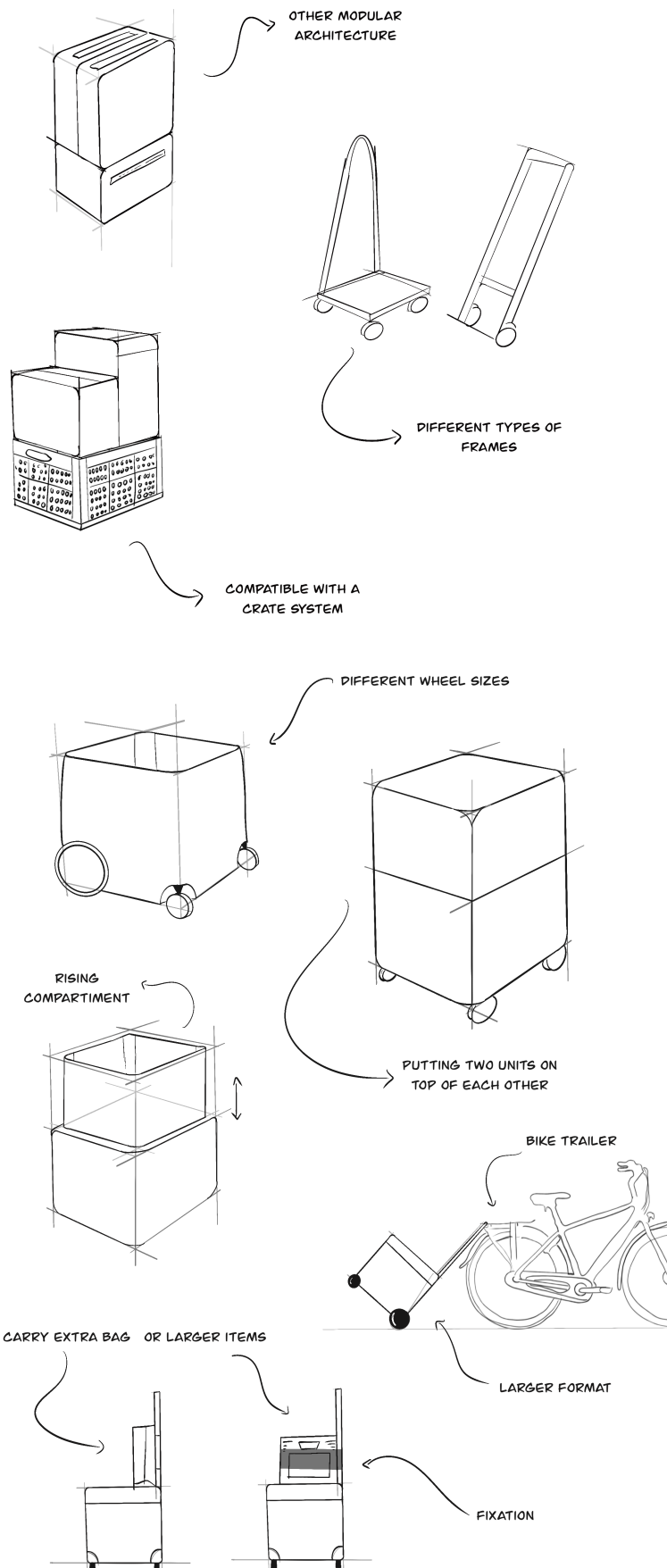
Tadek Ciechanowski - Hej Trolley



Romarc Delahaie - Shopping trolley concept

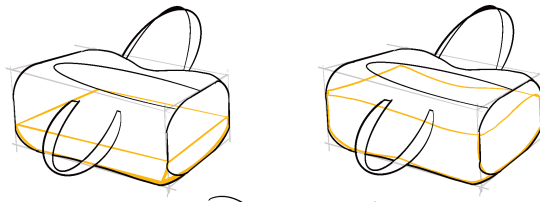


## Appendix E - Additional concepts

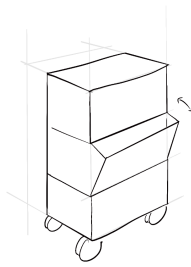








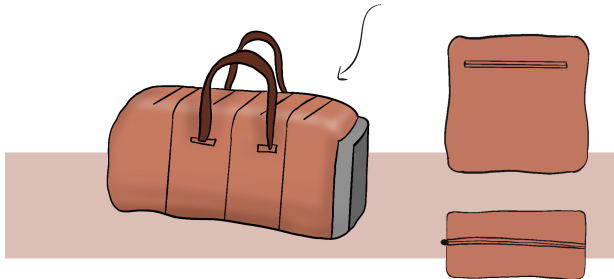
INFLATABLE TO FIXATE  
ALL THE GROCERIES



OTHER ACCESSING METHODS

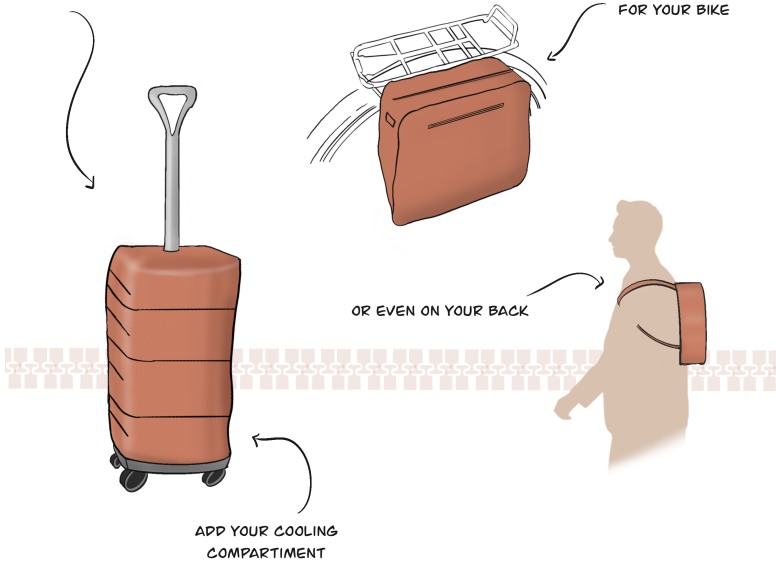
#### CONCEPT 04

FILL DIFFERENT BAGS AND  
ZIP THEM TOGETHER



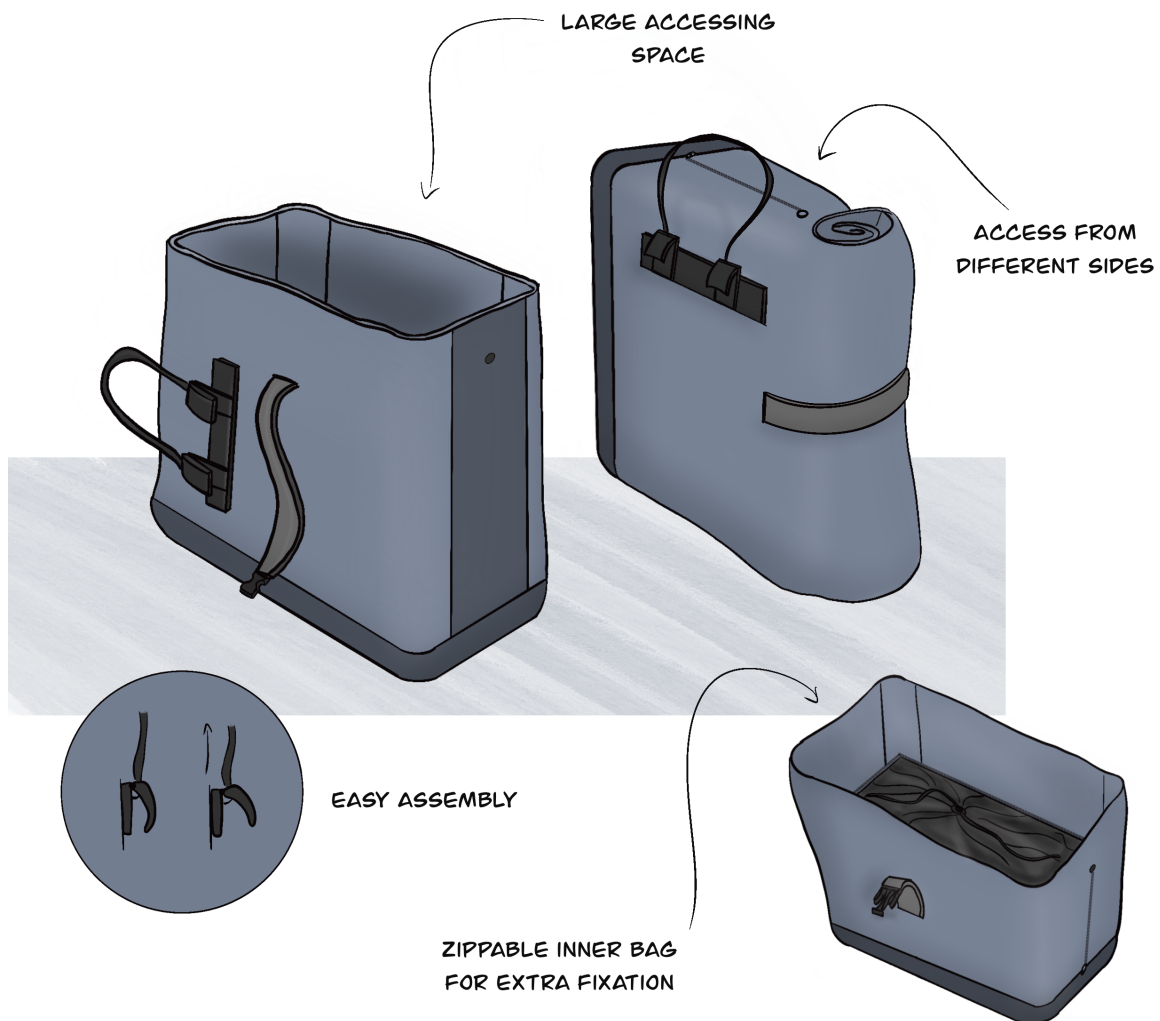
USE THE TROLLEY MODULE  
TO TRANSPORT MORE GROCERIES

USE SOME BAGS  
FOR YOUR BIKE

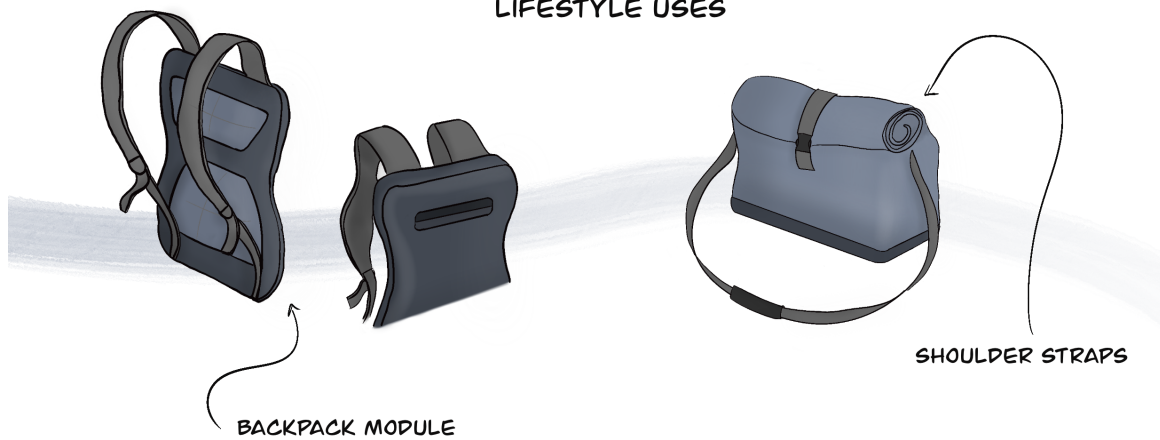


## Appendix F - Prior concepts

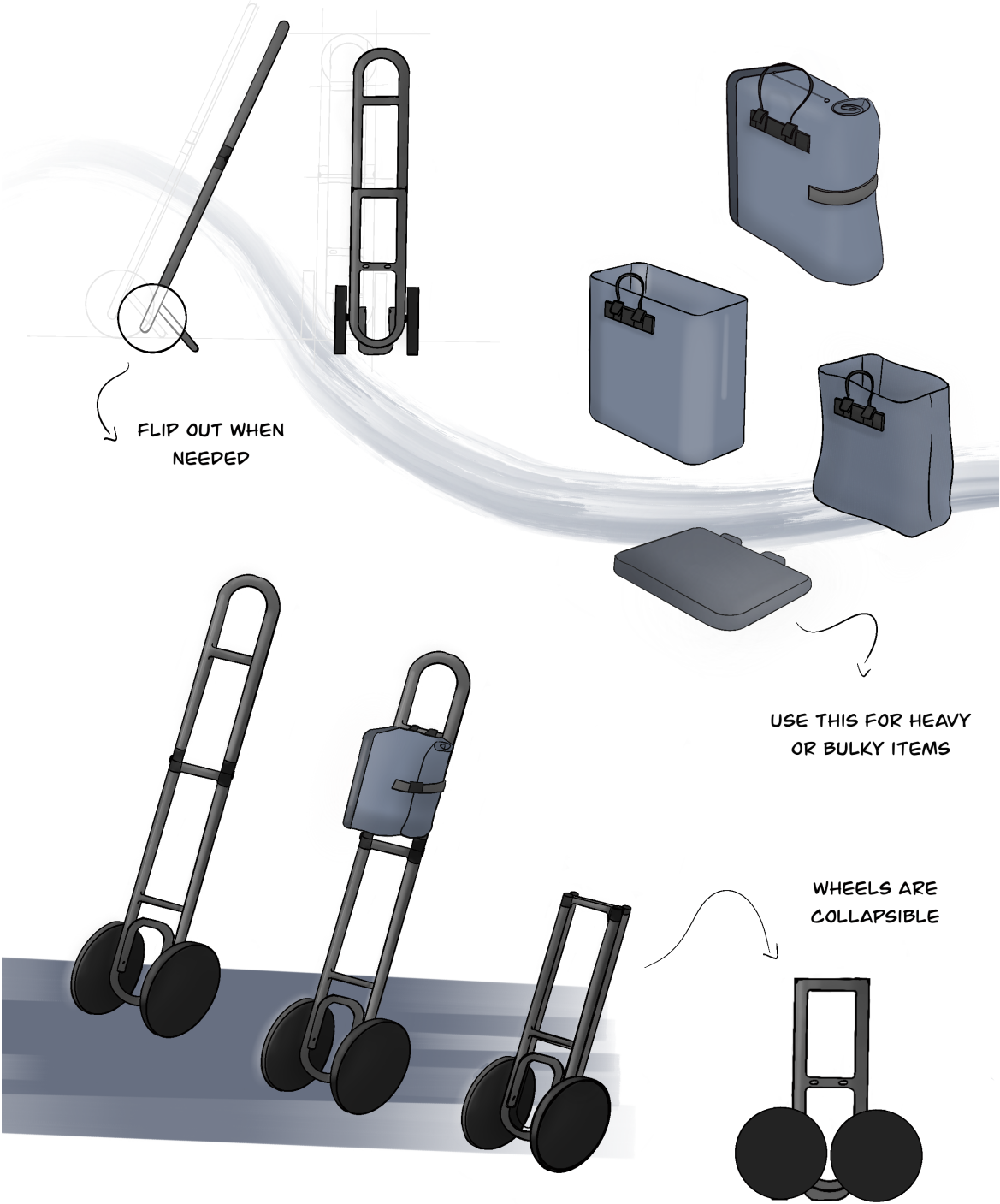
### BAG CONCEPT



### LIFESTYLE USES

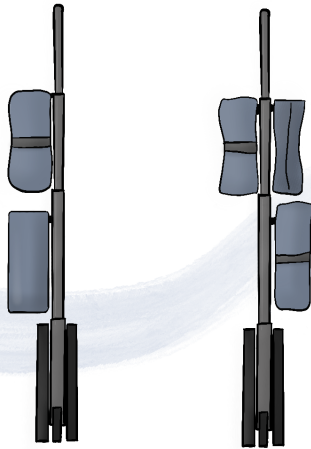


FOLDABLE TROLLEY

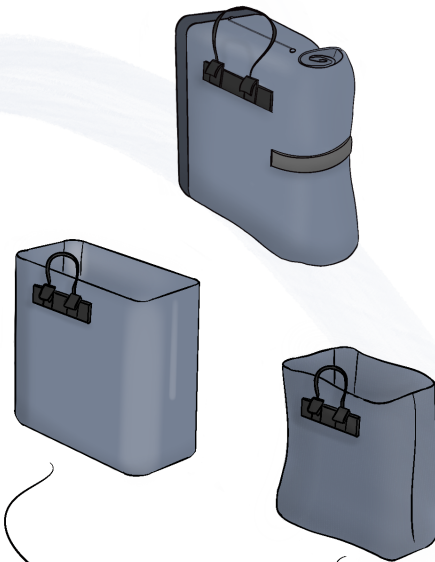




## TELESCOPIC TROLLEY

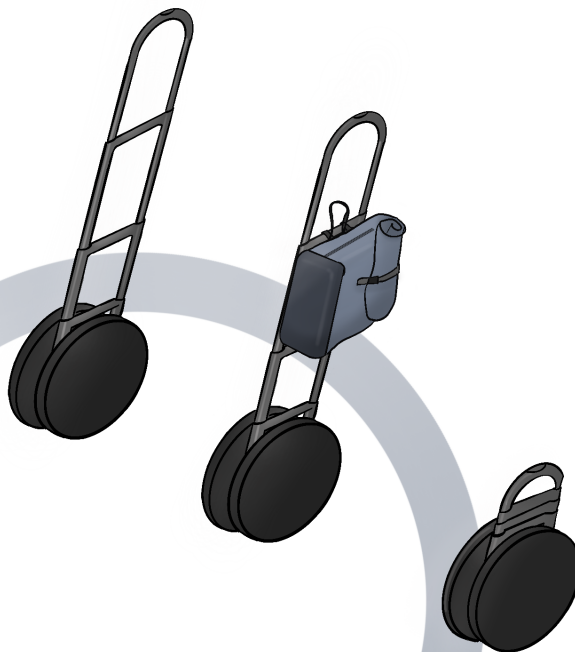


PICK AND COMBINE

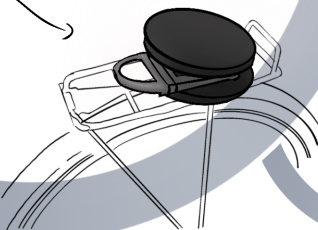


HARDCASE  
E.G. FOR BOTTLES

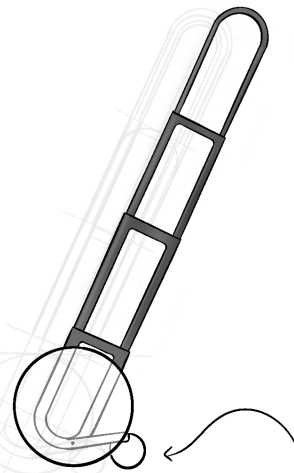
FOLDABLE BAG FOR  
EXTRA SPACE



MOUNT IT ON  
YOUR BIKE



FOLD-OUT WHEEL  
FOR EXTRA  
STABILISATION

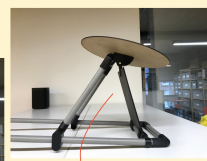


## Appendix G - Prototyping process folding mechanism

V1



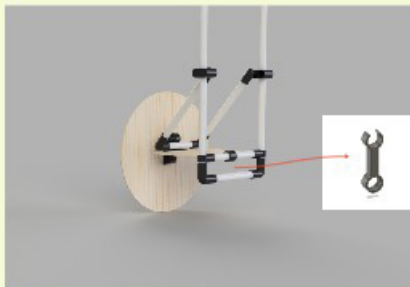
Stability



Forms a constraint for the foldability

Need of extra constraints to hold wheel in place when used

V2



Click on place when wheels are folded out



Combining 3D prints with screws and tape to make the prototype modular and adaptable to changes



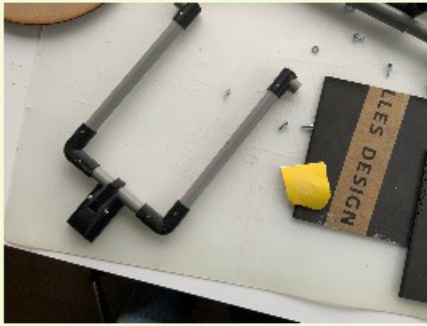
Hinges block each other, forming a constraint to make it fully foldable



Using fitting tubes that can slide into each other



Start of fixing the platform to the base, but there is a more solid connection needed



Adding nails to fix the angles, mimicking the use of a bended tube



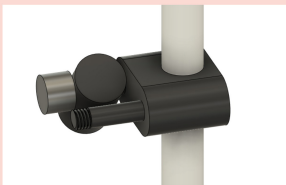
This hinge comes loose very easily, as it is made with PVC pipes



Wheels still flip outside when trying to ride. There is a click mechanism needed so the wheels snaps in place

Better constraints for connections needed so everything fits well

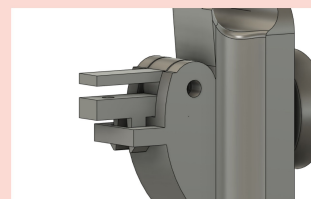
### V3



New hinge, using 3D printed threads and screws



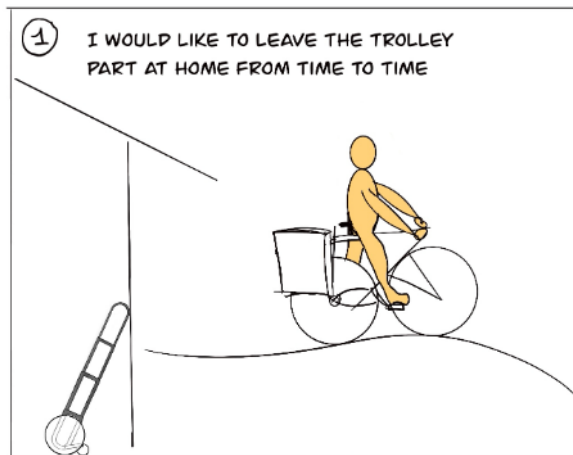
Symmetric connection with bottom plates, the screws are now on the outside



Snap wheels on place, but too small and fragile, change mechanism



## Appendix H - Bike integration



Nr 1 omdat je dan niet altijd het gewicht mee moet nemen wanneer je bvb in de winkel bent (Rural area, 21)

I chose the first; as you can leave it on when you want to however it's much handier to have the option (Rural area, 21)

Het is extra en volume dat ik niet wil meesleuren (Urban area, 52)

Waarom zou je meer meenemen dan je nodig hebt? Als ik met de fiets naar de winkel ga, dan zijn er winkelkarren in de winkel. Als ik te voet ga neem ik de kar. (Urban area, 21)



Voor snel boodschappen te doen en denk anders dat je het bijna nooit gaat mee hebben. Kijk naar hoeveel mensen hun zakjes van de Colruyt vergeten, en mensen dat tassen hebben, maar toch nieuwe zakjes kopen. (Someone living in a rural area, 21)



## Appendix I - Guidelines user testing

### USER TESTING protocol – shopping trolley

user -

#### BIASED / NON-BIASED

##### If non-biased

|                                                                 |       |       |
|-----------------------------------------------------------------|-------|-------|
| Do you have any idea what this prototype might be representing? | A bit | No    |
| What do you think the different parts are for?                  | Right | Wrong |

#### CONTEXT

|                                                         |                                 |                 |                   |
|---------------------------------------------------------|---------------------------------|-----------------|-------------------|
| Age                                                     |                                 | Family          |                   |
| Urban/rural                                             |                                 | Groceries means | Car – Walk – Bike |
| Have you ever used a shopping trolley for personal use? | Any prior back / neck problems? |                 |                   |

#### INTUITIVENESS OF THE DESIGN

|                                                                                                      |                                             |
|------------------------------------------------------------------------------------------------------|---------------------------------------------|
| What do you think the different parts of the trolley are for?                                        | Shells<br>Bags<br>Different buttons<br>Pins |
| Installing bag(s) onto the prototype                                                                 |                                             |
| Showing renders<br>What kind of bags would you want to use?                                          | First thoughts                              |
| Showing the user journey – Is this something you would see into your own lifestyle?<br>Why? Why not? |                                             |

## SUPERMARKET VISIT

|                                                                          |          |               |
|--------------------------------------------------------------------------|----------|---------------|
| Pulling/pushing the trolley during the walk                              | Pull     | Push          |
| Pulling/pushing the trolley in store                                     | Pull     | Push          |
| User has to bend over in order to access groceries                       | Yes      | No            |
| User acts like they are afraid the trolley might fall over when standing | Yes      | No            |
| User puts the groceries carefully into the bags                          | Yes      | No            |
| User lifts up the trolley when going over sidewalks or obstacles         | Yes      | No            |
| Orientation of handle while pulling                                      | Parallel | Perpendicular |
| Orientation of handle while pushing                                      | Parallel | Perpendicular |
| User lifts the trolley up when going down stairs                         | Yes      | No            |
| User lifts the trolley up when going up stairs                           | Yes      | No            |
| User takes of the bags in order to empty the trolley                     | Yes      | No            |

## REFLECTION

|                                                                                                                                 |  |
|---------------------------------------------------------------------------------------------------------------------------------|--|
| How do you feel about the ergonomics of the shopping trolley?<br>Do you have to bent less than with a regular shopping trolley? |  |
| What positioning did you prefer? Pushing pulling?<br><br>What do you think about the handle?                                    |  |
| Do you feel like this design allows you to better arrange your groceries than with other shopping tools (e.g. crates or bags)   |  |
| How do you feel with putting a fresh pack of strawberries into the shopping trolley?                                            |  |
| Do you feel like you could easily take out an item that you put in the trolley at the beginning of your groceries?              |  |
| How did you find the experience of unloading and loading the groceries when buying them in the store?                           |  |
| How do you feel about the compatibility with a bike?<br>Do you think that this is something you would use?                      |  |
| Asking again – would you use this shopping trolley?                                                                             |  |
| What features do you feel are missing or are not necessary?                                                                     |  |

## Appendix J - Test results

| Person 1                                                                                                                                                                                                                                                                                           | Person 2                                                                                                                                                                                                              | Person 3                                                                                                                                                                                                                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Female                                                                                                                                                                                                                                                                                             | Male                                                                                                                                                                                                                  | Male                                                                                                                                                                                                                    |
| 35                                                                                                                                                                                                                                                                                                 | 22                                                                                                                                                                                                                    | 34                                                                                                                                                                                                                      |
| One child + partner                                                                                                                                                                                                                                                                                | Student housing                                                                                                                                                                                                       | Two children + partner                                                                                                                                                                                                  |
| Leuven                                                                                                                                                                                                                                                                                             | Antwerp                                                                                                                                                                                                               | Antwerp                                                                                                                                                                                                                 |
| <p>"It is easier to fill a higher bag but at the same time the height increases the force that comes on your wrist."</p> <p>"I feel like the total volume is too large for the amount of groceries I can put inside this trolley. I would rather buy a cheap normal trolley."</p>                  | <p>"The modularity should not be in the way of quickly loading a large number of groceries or larger items. Organisation looks nice but is often not possible during the stress of the shopping."</p>                 | <p>"I would not want to pick out my own bags, I just want general bags that I can use for all my shopping needs."</p> <p>"The bags need to be a lot bigger; this is the reason why I would buy a shopping trolley".</p> |
| Person 4                                                                                                                                                                                                                                                                                           | Person 5                                                                                                                                                                                                              | Person 6                                                                                                                                                                                                                |
| Male                                                                                                                                                                                                                                                                                               | Male                                                                                                                                                                                                                  | Female                                                                                                                                                                                                                  |
| 38                                                                                                                                                                                                                                                                                                 | 27                                                                                                                                                                                                                    | 28                                                                                                                                                                                                                      |
| Two children + partner                                                                                                                                                                                                                                                                             | Single                                                                                                                                                                                                                | Partner                                                                                                                                                                                                                 |
| Ghent                                                                                                                                                                                                                                                                                              | Antwerp                                                                                                                                                                                                               | Brussels                                                                                                                                                                                                                |
| <p>"I need large bags to put everything in quickly when needed."</p> <p>"I would invest in this if it is usable in different scenarios. Once a year, for example, I would want to jump on a train with this and travel with it. The modularity should allow for a lot of different scenarios."</p> | <p>"The option with bicycle makes it less stigmatising."</p> <p>"I will only use a shopping trolley if it has a modern and cool look. It has to be ergonomic and practical, but styling is most important to me."</p> | <p>"I would dare to walk in the street with this."</p> <p>"Would depend on the price if I would buy this."</p>                                                                                                          |







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Master's dissertation submitted in order to obtain the academic degree of Master  
of Science in de industriële wetenschappen: industrieel ontwerpen

Academic year 2022-2023