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## Design of a universal charging solution for shared electric mopeds

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Universal Wireless Charging Solution for Shared E-Mopeds project title

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

start date 21 - 11 - 2022 11 - 05 - 2023 end date

**INTRODUCTION \*\***

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

In the Netherlands, the use of electric mopeds has increased significantly. Already in 2022, e-mopeds will make up more than half of all new moped purchases (Correspondent, 2022). These e-mopeds are not only becoming more and more popular for private use, but also in the shared mobility sector. Sharing fleets are a fast-growing market in which user groups such as hotels, healthcare organizations, cities, and delivery services use light electric vehicles (LEVs). The term LEVs refers to electric-driven vehicles that travel relatively short distances, such as electric bikes, e-mopeds, electric scooters, and electric cargo bikes (Light electric vehicles (LEVs), 2021). Furthermore, with their shared e-bikes and e-mopeds, businesses like Felyx, GO share, and CHECK are reshaping urban areas (Pointer, 2021). However, one of the disadvantages of shared electric transportation is the time and effort that goes into charging. The providers of these shared transportation modes need to guarantee a fully charged battery, which can only be done by manually swapping the battery as the e-bikes and e-mopeds cannot be charged on the streets (felyx, 2021).

TILER has developed a new solution for charging e-bikes, without having to manually change the battery or be connected to a wire (figure 1). It all started with a patent from the TU Delft. This patent consisted of a technology that created a powerful, flexible and efficient way of inductive energy transfer. TILER developed this technology further to be integrated into the LEV market (The Green Village, 2021). The inductive energy transfer is integrated into the shape of an outdoor tile, which can be easily installed into the already existing pavement (Bowden, 2021). This tile is simply connected to the closest energy plug of a building. On the other side, the e-bike is equipped with a special kickstand, which is placed on the tile to enable the charging process (The Green Village, 2021). With their smart charging technology, they use inductive charging as efficiently as plugged charging. TILER's goal is, to be a part of a micro-mobility network to reduce the use of cars in cities and put people and nature back into the center (TILER, z.d.).

In the coming year, the prototype of the charging tile is further developed and tested to move it into the production phase. TILER is currently focussing on corporate bike fleet locations such as hotels and tourist spots. Simultaneously, TILER is looking for alternative areas in which to implement its unique technology. As the transition towards electric mobility is evolving, the mobility sector is attracting new attention from players from different sectors.

A future step for TILER is integrating their wireless charging solution into more LEVs such as shared e-mopeds to create publicly available charging tiles throughout the city. Currently, there are no wireless charging solutions on the market. The solutions for charging which are on the market are either bulky charging stations, battery swapping, or using a wired adaptor. In the future, TILER wants to integrate its already existing wireless charging solution with other light electric vehicles, including mopeds, to create a seamless mobility network.

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introduction (continued): space for images



image / figure 1: Wireless Charging Solution For Electric Bikes

**TO PLACE YOUR IMAGE IN THIS AREA:**

- **SAVE THIS DOCUMENT TO YOUR COMPUTER AND OPEN IT IN ADOBE READER**
- **CLICK AREA TO PLACE IMAGE / FIGURE**

**PLEASE NOTE:**

- **IMAGE WILL SCALE TO FIT AUTOMATICALLY**
- **NATIVE IMAGE RATIO IS 16:10**
- **IF YOU EXPERIENCE PROBLEMS IN UPLOADING, COVERT IMAGE TO PDF AND TRY AGAIN**

image / figure 2:

**PROBLEM DEFINITION \*\***

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

TILER wants to integrate its technology into other LEVs which can be used for shared mobility, such as e-mopeds. Therefore, research into the present and future of shared e-mopeds is needed to create a feasible design solution that can be integrated into a public environment. The main research questions that can be asked are: how are LEVs (especially electric mopeds) shaping the infrastructure in the future? What are the current (charging) solutions for sharing LEVs and their pros and cons?

The patented technology used in the wireless charging system for e-bikes can be implemented into the new design solution for e-mopeds, as their goal is to create one tile to charge them all (Coops, O., Personal Communication, 2022-10-10). However, designing a charging solution for e-mopeds brings along different ergonomic and mechanical requirements, as well as different usability than e-bikes. This also affects the user-product interaction as a different way of handling is needed to operate and park an e-moped. In addition, creating one universal solution for all types of e-mopeds can bring some challenges as they differ in size and construction. The main research questions that need to be explored are: what are the differences between brands of e-mopeds? How are users handling the different e-mopeds (e.g. putting them on the stand) and what ways are preferred?

Moreover, it is important to look at the customer journey while using e-mopeds. How can we make it understandable for the user how to connect the e-moped to the tile, e.g. with the use of distinct feedback? What is needed to create a seamless connection within the journey of the user? These are questions that also need to be explored during the research.

**ASSIGNMENT \*\***

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

The main aim of this graduation project is to redesign the TILER charging solution to be compatible and usable with e-mopeds in a public environment. The user-product interaction will be taken into account while considering the environment in which the tile should be placed. Furthermore, the production of the concept, with regard to material and manufacturing, will be integrated into the final concept and prototype.

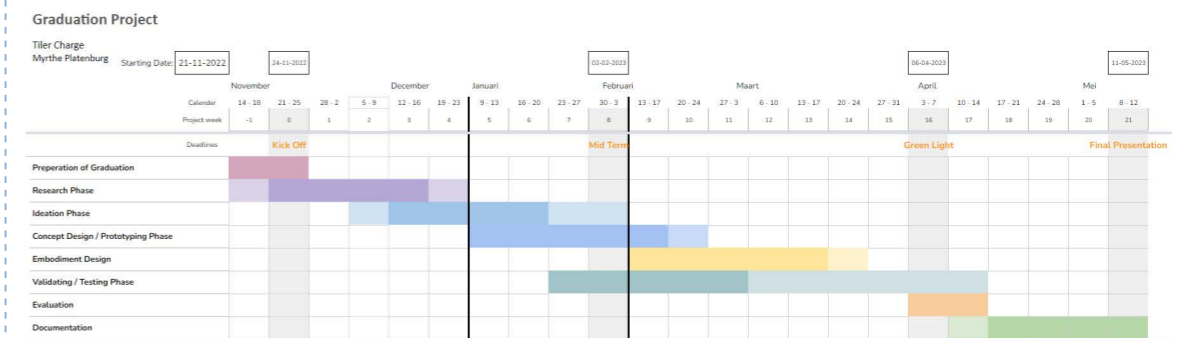
The end result of this project will be a prototype of the charging solution that combines the charging tile with the e-mopeds that can be implemented in the public environment to create a seamless travel experience.

- A (working) prototype or mock-up that charges the e-mopeds
- Tested user-product interaction to improve the usability
- Recommendations for further development of the charging solution
- Regular deliverables include a presentation, recommendations for TILER, and a poster/video.

**PLANNING AND APPROACH \*\***

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

start date 21 - 11 - 2022 end date 11 - 5 - 2023



In the figure, the planning for the next 20 weeks is shown. The black lines represent the holiday periods and the light grey columns show important meeting dates for the kick-off, mid-term, green light meeting, and final presentation. To create a feasible prototype at the end of this graduation project I will go through the design cycle. This cycle consists of a research phase, ideation phase, prototyping phase, testing, and assessment phase.

Firstly, an analysis will be made of the current situation. The technical aspects of the current charging tile for e-bikes will be researched and important advantages and limitations will be taken into account. Moreover, current charging solutions for e-mopeds and competitors of TILER will be analyzed. Research into the future of shared mobility, with a focus on shared e-mopeds, is also an important aspect of the research that will be conducted. Trend analysis and stakeholder mapping can be done to gather this kind of information. An analysis of the interaction of users with the e-mopeds will be done by interviewing and observing them to create a customer journey. Furthermore, requirements will be set which can be used to create a picture of how to integrate a new charging solution for e-mopeds into a public environment. Secondly, following the research phase, I will dive into the ideating phase. Within this phase, I will combine the gained knowledge with conceptualizing to create multiple concepts that meet the requirements set at the analysis phase. Tools like a Morphological Chart and Harris Profile can be used to create the most feasible ideas and concepts. Thirdly, the prototyping phase will start. The concepts will be developed further and will shift to embodiment design. Within this phase, materials and manufacturing will also be taken into account. One concept (or a combination of concepts) will be developed into a prototype that can be tested and validated. With this, I will move into the testing phase. After doing multiple tests to test the feasibility of the developed concept, adjustments can be made to match the user-product experience and final requirements.

**MOTIVATION AND PERSONAL AMBITIONS**

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

Mobility is becoming an important topic as LEVs take over the roads to provide a more sustainable and seamless transportation network. This is creating interesting design challenges on how to integrate this new network into the already existing infrastructure. Working on a project that can potentially contribute to this future network is one of the motivations why I wanted to work on this.

Moreover, this project reminds me of the course Advanced Embodiment Design (AED) during my master's Integrated Product Design at the TU Delft. I really enjoyed doing research into a new product and market, creating insights, and coming up with concepts using these insights. During this course, I gained a lot of skill sets to tackle a design project systematically and critically. I acquired more experience in using different tools to create prototypes, for example with 3D modeling and printing, which I am excited to apply during this project at TILER. Thus, I see a lot of similarities between this project and the course AED, and therefore it motivates me to tackle this project.

Finally, I envision myself working for a start-up company in my future profession. Therefore this project is giving me the opportunity to learn about their way of working, the environment, and the processes used at a start-up.

Below is a list of learning objectives I aim to improve:

- I aim to strengthen my capacity for performing scientific research, which then can be used for substantiated reasoning to create the best possible design solution.
- Applying design methods learned during the master Integrated Product Design to a new project in a new environment.
- During my previous internship, I learned more about the production process which I aim to integrate into and improve during this project.
- I want to improve my (3D) drawing and modeling skillset more to become an all-round industrial designer.
- After COVID some projects are done just to be done with. I want to learn to take time out to enjoy my project.

References:

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- TILER. (z.d.). TILER's Story. Geraadpleegd op 9 oktober 2022, van <https://www.TILERcharge.com/about>
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**FINAL COMMENTS**

In case your project brief needs final comments, please add any information you think is relevant.

## 2 Results

# Questionnaire

Tijdstempel	Wat is jou leeftijd?	Wat is jou geslacht?	Als vervanging van welk vervoer?	Met wat voor reden gebruik je de deelscooter?	Voor wat voor afstanden gebruik je de deelscooter?	Wanneer je de deelscooter gebruikt, hoe vaak gebruik je de deelscooter?	Waarom heeft ze/man hij wel eens problemen met de deelscooter?	Ondervind jij wel eens problemen met de deelscooter?	Zijn er nog andere problemen die je ondervind tijdens het gebruik van een deelscooter?
6-12-2022 11:08:17	18 - 25 jaar	Vrouw	Lopen, Fietsen, Auto	Snelle jelle ff ergens heen	1 - 3 kilometer	Zijstandaard	Is makkelijker. Middelstandaard is te zwaar.	Soms loopt de app vast waardoor ik me rit niet op tijd kan annuleren	
6-12-2022 11:27:38	25-40 jaar	Vrouw	Lopen, Fietsen	Het is goedkoper dan het	> 5 kilometer	Zijstandaard	Omdat ik niet zo sterk ben	Nee	
6-12-2022 11:35:18	18 - 25 jaar	Vrouw	Lopen, Fietsen	Als ik geen fiets bij de hand heb	3 - 5 kilometer	Zijstandaard	Het is makkelijker en minder zwaar	Zelden, soms lukt het me niet	Soms is de app gecrasht, waardoor je de scooter niet uit kan zetten. Hierdoor betaal je extra kosten terwijl je helemaal niet meer aan het rijden bent.
6-12-2022 11:36:30	18 - 25 jaar	Man	Lopen, Fietsen, Auto	gemakkelijk in de stad als	1 - 3 kilometer	Middelstandaard	gemakkelijker	Ja soms is er weinig ruimte of valt de scooter om.	
6-12-2022 11:39:03	18 - 25 jaar	Vrouw	Lopen, Fietsen	Ik vind het soms makkelijk	1 - 3 kilometer	Middelstandaard	Ik heb het idee dat de scooter zwaar is	Ja, ik vind het soms lastig	Soms ontbreken er onderdelen, zoals de voetsteuntjes voor de bijrijder. Dit maakt het wel vervelend om met zijn tweeën te rijden.
6-12-2022 11:47:14	18 - 25 jaar	Vrouw	Lopen, Fietsen, Auto	Gemakkelijk	> 5 kilometer	Zijstandaard	Makkelijker	Het is best zwaar om een rit te maken	Nee
6-12-2022 11:58:44	18 - 25 jaar	Man	Fietsen	vooral snel en mobiel	ven 1 - 3 kilometer	Middelstandaard	voelt stabiel	nee eigenlijk niet	nee
6-12-2022 12:02:52	18 - 25 jaar	Vrouw	Lopen, Fietsen	Als ik snel van A naar B wil	3 - 5 kilometer	Zijstandaard	Die andere vind ik zwaarder	Alleen dat de scooter soms niet werkt	Nee ik ben echt fan van deelscooters. Het enige wat onhandig is, is dat ik de helm vaak niet uit dat achtervak krijg.
6-12-2022 12:12:23	25-40 jaar	Man	Fietsen	Doe ik niet	0 - 1 kilometer	Middelstandaard	Lijkt mij stabiel	Nooit	Nee
6-12-2022 12:14:06	18 - 25 jaar	Vrouw	Lopen, Fietsen	Praktisch en leuk	1 - 3 kilometer	Zijstandaard	Makkelijker	Heel vaak problemen met de app, niet kunnen stopzetten scooter	
6-12-2022 12:25:50	25-40 jaar	Vrouw	Lopen, Fietsen	In nood, maar dat is nog maar	1 - 3 kilometer	Zijstandaard	Ik heb geen voorkeur, maar het is wel makkelijk	Dat er geen plek is	Nee
6-12-2022 12:35:42	18 - 25 jaar	Man	Lopen, Fietsen, Auto	/	0 - 1 kilometer	Zijstandaard	Dit is makkelijker	Nee	/
6-12-2022 13:25:45	18 - 25 jaar	Man	Lopen	Als het lopend te ver is	> 5 kilometer	Zijstandaard	Makkelijker	Nee	
6-12-2022 14:09:09	18 - 25 jaar	Vrouw	Auto	Als ik bijv. 's avonds naar	> 5 kilometer	Zijstandaard	want ik heb geen kracht	Nee	Dat er bijv. staat dat er 2 helmen inzitten en dat er dan maar 1 inzit
6-12-2022 14:34:54	18 - 25 jaar	Vrouw	Fietsen	Om sneller en met minder moeite	1 - 3 kilometer	Zijstandaard	Met de middelstandaard is het zwaarder	Ja, wanneer het een middelstandaard is	In mijn stad mag je alleen nog maar met helm op de autoweg, dit vind ik niet fijn. Hierom pak ik liever de fiets.
6-12-2022 16:19:15	18 - 25 jaar	Vrouw	Fietsen	Snel, makkelijk, geen onderdelen	3 - 5 kilometer	Middelstandaard	Stabieler	Kan niet overal waar ik hem zou willen zetten	
6-12-2022 18:09:02	<18 jaar	Man	Niet	Niet	0 - 1 kilometer	Zijstandaard	Gemakkelijk	Nee	
6-12-2022 20:24:55	18 - 25 jaar	Vrouw	Auto	makkelijk manoevreren	er 3 - 5 kilometer	Zijstandaard	makkelijker	nee	nee
7-12-2022 10:58:49	25-40 jaar	Vrouw	Lopen, Fietsen	Gebruik geen deelscooter	0 - 1 kilometer	Zijstandaard	sneller/makkelijker	-	-
8-12-2022 16:20:14	18 - 25 jaar	Vrouw	niet	-	0 - 1 kilometer	Zijstandaard	-	-	-
8-12-2022 19:07:05	25-40 jaar	Vrouw	Lopen	Als er geen ander vervoer is	1 - 3 kilometer, 3 - 5 kilometer	Zijstandaard	Omdat ik de middelstandaard zwaarder vind	Zie vorige antw.	Het middelstandaard
12-12-2022 3:31:22	18 - 25 jaar	Man	Lopen	van a naar b	0 - 1 kilometer	Zijstandaard	sneller	nee	nee
14-12-2022 16:38:16	18 - 25 jaar	Man	Ik gebruik geen deelscooter	Gebruik ik niet	0 - 1 kilometer	Middelstandaard	Is makkelijker en staat steviger	Nee	
15-12-2022 0:30:32	18 - 25 jaar	Vrouw	Lopen	Snel ergens zijn	1 - 3 kilometer	Zijstandaard	Minder zwaar	Ja soms met de plek vind ik het zwaar	Niet echt
15-12-2022 15:41:45	<18 jaar	Vrouw	Lopen, Fietsen	nvt	0 - 1 kilometer	Middelstandaard	nvt	nvt	Nee
15-12-2022 17:55:58	<18 jaar	Man	Lopen	Snel op een plek komen	> 5 kilometer	Middelstandaard	Hierbij zal die minder snel	Een goede plek vinden	
22-12-2022 12:05:13	18 - 25 jaar	Vrouw	Lopen, Fietsen	Als ik ergens heen moet	3 - 5 kilometer	Middelstandaard	Makkelijker en veilig om op te rijden	Nee	Nee
23-12-2022 15:38:35	25-40 jaar	Man	Openbaar vervoer	Als het te lang duurt voor	3 - 5 kilometer	Zijstandaard	Is makkelijker	Nee	Het opstarten soms
3-1-2023 16:46:16	18 - 25 jaar	Vrouw	Lopen, Fietsen	Regen	1 - 3 kilometer	Middelstandaard	duidelijker	Neen	

## 3 Stakeholder Analysis

Stakeholders of TILER have been analyzed by asking three questions:

- Who are they?
- What are their interests?
- What is their influence?

### Users of Shared Mopeds

*Who are they?*

They use the shared moped for short first of last mile trips, to their destination in combination with public transport. Also, they also use shared mopeds for longer trips to a different city or destination.

*What are their interests?*

Accessible mopeds in a close proximity when they plan a trip and the convenience of the use of the mopeds.

*What is their influence?*

Users have a high influence as they have the first responsibility for connecting the electric mopeds to the wireless charging product. If they do not connect properly, the mopeds are not charged and ready for use by the next user.

### Providers of the Shared Mopeds

*Who are they?*

Companies that provide mopeds in a sharing vehicle system, such as Felyx, Gosharing and Check. They provide the mopeds and the service to their users.

*What are their interests?*

The providers want people to use their shared moped for first and last mile activities instead of cars to reduce pollution and the amount of cars on the road. Moreover, they want a safe and fast charging solution to make sure their mopeds are ready for use.

*What is their influence?*

They provide accessible and relatively cheap vehicles to people. They provide

the benefits of a light electric vehicle, such as an electric moped without users having to own them. Also, they can decide on which way of charging is most profitable and convenient for their business.

### Battery Swappers/e-Mechanics

*Who are they?*

Employees of the shared moped providers who make sure the mopeds are charged and maintained on a daily basis.

*What are their interests?*

Fast and easy way of loading the batteries and switching them in the mopeds. Equipment to be able to switch the batteries and maintain the mopeds. Easy accessible components within the mopeds for fast maintenance and battery switching (personal communication, January 17, 2023).

*What is their influence?*

Relatively low influence on the shared moped service, however their work contribute to a working system and therefore provide the shared moped providers with revenue.

### Electric Moped Manufacturers

*Who are they?*

Manufacturers that design and provide the shared services with electric mopeds, such as NIU, UNU and Super Soco.

*What are their interests?*

Providing electric mopeds that can be used in a shared mobility network. Integrated charging solution into the existing design of the electric moped which is profitable.

*What is their influence?*

Influence on how to integrate the

wireless charging solution in their design. E.g. wiring, frame, component designs.

### Municipalities

*Who are they?*

A residential area or group of residential areas with the associated area that are jointly governed by a political apparatus.

*What are their interests?*

Creating a sustainable, livable, and efficient infrastructure, with a focus on reducing pollution and congestion while also providing convenient and accessible transportation options for all residents.

*What is their influence?*

They design regulations and rules about new mobility systems and product, e.g. placement and needs.

### TILER

*Who are they?*

Provider and designer of a wireless charging solution for (light) electric vehicles.

*What are their interests?*

Designing a fast and profitable wireless charging solution for electric moped to create a charging network for all electric vehicles.

*What is their influence?*

Decisions on the design of the wireless charging solution.

### Rivals

*Who are they?*

Direct rivals to TILER who offer a wireless charging solution for electric mopeds.

*What are their interests?*

Having the leading innovation.

Designing a wireless charging solution for mopeds which is easier in use and more profitable.

*What is their influence?*

Designing a 'better' wireless charging solution that can be integrated in the city infrastructure and therefore taking the place of TILER.

### Residences

*Who are they?*

Residences of the city. Especially the residences that live in areas where there shared mopeds are in use and parked.

*What are their interests?*

A livable city without the nuisance of the shared electric mopeds. No obstruction on the streets and organized parking (no free-floating vehicles) for electric vehicles.

*What is their influence?*

Complain towards municipalities and providers of shared electric mopeds if they are not content with current solutions.

### Insurance

*Who are they?*

Companies that are paid to replace stolen or damaged vehicles. Also owners of buildings and areas that are used for charging electric mopeds.

*What are their interests?*

Safe and reliable charging solution with low risk of damage or vandalism.

*What is their influence?*

Forcing the providers of the shared electric mopeds to improve their way of charging.

## 4 Requirements

### Performance

- Parking = Charging
- Universal for all types of mopeds
- The two coils should align to connect the charger
- The maximum air gap between the two coils has a maximum of 15 to 22 [mm]
- Should not break when falling pavement, standing still and while going with a maximum of 45 [km/h] and height of 1 [m]
- Should be able to carry the weight of a moped (100kg) together with a person (100kg)

### Environment

- Internal temperature should not exceed 90 [C] in direct sunlight for over 8 hours
- Internal temperature should not go below 0 degrees with environmental temperatures of minimum 5 degrees.
- Dirt should not be able to infiltrate the insides of the product
- Water should not be able to infiltrate the insides of the product
- Product should have an IP68 rating

### Life in Service

- The product has to last at least 5 years
- Product should not be able to be opened without special tooling.

### Maintenance

- The electronics need to be accessible for maintenance
- Everything can be opened up only by screws
- The product should not damage the moped.
- Cleaning of connecting surfaces should be possible
- Product should not have edges that allow opening with force with simple tooling (e.g. prevent theft)
- Access to and replacing of electrical components should be possible without having to permanently break the embodiment.

### Size and Weight

- Should fit at designated spot on moped
- Use of product in public environment should be possible (i.e. installation in-ground should be possible)

### Aesthetics, appearance and finish

- Should fit in the product line of TILER
- Has to fit in the city environment
- Should match with mopeds
- Should be able to match with different sharing fleets
- No use of conductive materials in a way which can interfere with the charging process.

### Product Life Span

- Should go 1 year without maintenance
- Components should be replaceable separately

### Ergonomics

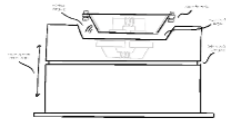
- The process of parking and charging should be intuitive and understandable for the user.
- People should not be able to fall or trip over the product
- Users should not have to exert more than 100 [N] force to use the product

# 5 Idea Generating

From the research that was conducted during this project, multiple ideas were explored. Using the 'How To' method from the Delft Design Guide, the main problem that needed to be solved was divided into subcategories. Questions on how to solve these subcategories were formulated. By answering these questions multiple solutions were written down. After this, these solutions were combined multiple times to eventually create a large set of ideas. The pros and cons of these ideas were then written out to create a comparison of all the ideas

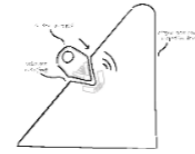
	<ul style="list-style-type: none"> <li>+ helps to park more neat</li> <li>+ no need for user to put on stand</li> <li>+ good alignment</li> <li>- extra object in city environment</li> <li>- expensive</li> <li>- low universal --&gt; different sizes mopeds</li> </ul>		<ul style="list-style-type: none"> <li>+ hides in the ground</li> <li>+ no need for user to put on stand</li> <li>+ fits in city environment</li> <li>+ good alignment</li> <li>- difficult to park</li> <li>- expensive</li> <li>- other objects can be parked on top</li> <li>- low universal --&gt; different sizes mopeds</li> </ul>
	<ul style="list-style-type: none"> <li>+ hides in the ground</li> <li>+ lower need for precise parking</li> <li>+ fits in city environment</li> <li>- expensive</li> <li>- not perfect alignment</li> <li>- other objects can be parked on top</li> <li>- mechanical issues</li> </ul>		<ul style="list-style-type: none"> <li>+ no need for specially made parking spot</li> <li>+ always charging when not in use</li> <li>- expensive</li> <li>- reduces comfort while riding</li> <li>- need to change the design of moped</li> <li>- low universal --&gt; different sizes mopeds</li> </ul>
	<ul style="list-style-type: none"> <li>+ gives user guidance</li> <li>+ fits in city environment</li> <li>+ good alignment</li> <li>- low universal --&gt; different sizes mopeds</li> <li>- extra objects in city environment</li> </ul>		<ul style="list-style-type: none"> <li>+ hides in the ground</li> <li>+ fits in city view</li> <li>+ user does not need to put on stand</li> <li>+ helps to park more neat</li> <li>+ good alignment</li> <li>- can have issues with water/dirt build up</li> <li>- low universal --&gt; different sizes mopeds</li> </ul>
	<ul style="list-style-type: none"> <li>+ Universal</li> <li>+ perfect alignment</li> <li>- uses an extra cable to charge</li> <li>- extra step while parking the moped</li> <li>- extra object in city environment</li> </ul>		<ul style="list-style-type: none"> <li>+ hides in ground</li> <li>+ fits in city environment</li> <li>+ medium universal</li> <li>+ good alignment</li> <li>- other objects can be parked on top</li> <li>- needs precise parking</li> </ul>
	<ul style="list-style-type: none"> <li>+ hides in ground</li> <li>+ fits in city environment</li> <li>+ medium universal</li> <li>+ good alignment</li> <li>- other objects can be parked on top</li> <li>- needs precise parking</li> <li>- new way of using a stand --&gt; confusing?</li> </ul>		<ul style="list-style-type: none"> <li>+ guide user to park correct</li> <li>+ good alignment</li> <li>- not universal --&gt; different design mopeds</li> <li>- extra object --&gt; trip over it</li> </ul>
	<ul style="list-style-type: none"> <li>+ helps to guide user where to park</li> <li>+ hides in ground</li> <li>+ fits in city environment</li> <li>- larger --&gt; more expensive</li> <li>- larger --&gt; needs more space on sidewalk</li> <li>- other objects can be parked on top</li> </ul>		<ul style="list-style-type: none"> <li>+ hides in ground</li> <li>+ fits in city environment</li> <li>+ medium universal</li> <li>+ no need for user to use stand</li> <li>- other objects can be parked on top</li> <li>- can be activated by other objects</li> <li>- mechanical issues</li> </ul>
	<ul style="list-style-type: none"> <li>+ hides in ground</li> <li>+ fits in city environment</li> <li>- precise parking needed</li> <li>- other objects can be parked on top</li> </ul>		<ul style="list-style-type: none"> <li>+ hides in ground</li> <li>+ fits in city environment</li> <li>- expensive --&gt; extra batteries needed</li> <li>- prone to stealing</li> <li>- extra step for user to charge moped</li> <li>- other objects can be parked on top</li> </ul>
	<ul style="list-style-type: none"> <li>+ helps to guide user where to park</li> <li>+ hides in ground</li> <li>+ fits in city environment</li> <li>- larger --&gt; more expensive</li> <li>- larger --&gt; needs more space on sidewalk</li> <li>- other objects can be parked on top</li> </ul>		<ul style="list-style-type: none"> <li>+ medium universal</li> <li>+ good alignment</li> <li>- extra object in city environment</li> <li>- could break easy while in use</li> </ul>

# 6 Weighted Objectives



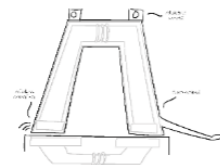
New table

W1	The design is easy in use as it helps to guide the user in the right direction. Moreover, the users does not need to precisely park the moped, thus will take less time to park	8	160
W2	The charging connector in the tile will move in the ground when not in use, thus will be flat with the ground. However, when in use, it will be an extra object in the environment	7	105
W3	This concept does work with a tile, however the kickstand is replaced by the attachment on the bottom of the moped	4	60
W4	The charging connector in the tile does move down in the ground when not in use. If you want to have this in a platform, the platform needs to be higher and bigger.	5	60
W5	The production cost for the tile will be higher as is is larger and has more components	4	48
W6	Breaking of the moped risk is low, however, the mechanism in the tile can have a higher risk in breaking as it has moving parts and electronics.	6	72
W7	Takes up little space when not parking as it moves in the ground (does need more space in the ground). When mopeds are parked, it takes up some space underneath the moped.	6	48
W8	Theft is of lower risk as all the important components are hidden when the product is not in use.	8	48
			<b>601</b>



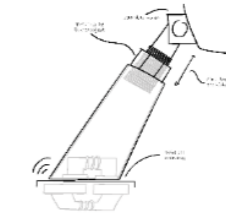
New table

W1	The design is easy in use as the only thing the user has to do is push the moped in the holder and there is no need to use the stand as it also helps to keep the moped up	9	180
W2	This will be a bigger object in the environment. People could trip over it when they are not watching where they are walking, thus can create an obstruction.	2	30
W3	No tile and no kickstand	1	15
W4	This can be installed on ground as it does not need to go in the ground and therefore also can be used indoors. Also, does not need a platform for installation.	9	108
W5	The production cost for the tile will be higher as is is larger and has more components	4	48
W6	The component on the moped can break as people need to push it in the charger. Therefore, the weight that people execute on this connector could make it break more easily	4	48
W7	Takes up more space in the environment as it is an permanent object in the environment.	2	16
W8	Can easier be vandalised as it is an permanent object in the environment. Also, the component can be stolen of the moped (what is connected to the wheels)	3	18
			<b>463</b>



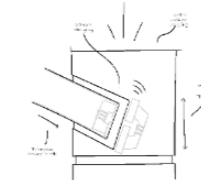
New table

W1	The design is less easy in use as people often experience trouble with the centerstand as the mopeds are heavy. Also precisely parking is less easy because of this	3	60
W2	This is a centerstand connected to the moped, thus does not create an obstruction. The tile is flat on the ground and therefore no obstruction. However, it does have slips in the tile to guide the user, thus created small height different people could 'achter blijven haken'	8	120
W3	It has a tile and a stand, however not a kickstand but a centerstand	8	120
W4	This can be installed into an platform and then moved inside as TILER is currently doing with their kickstand charger for their electric bikes.	7	84
W5	Production cost can be lower as all the components for the tile are already in house available. However the receiver coil in the stand is larger and therefore has a higher cost.	6	72
W6	The stand can be broken after a lot of use. Thus higher risk of breaking of the moped (as currently also happens)	3	36
W7	Takes up less space as it only is a tile flat in the ground.	9	72
W8	Components in the tile are harder to be stolen as it is hidden in the ground, however the stand can be taken of and stolen.	5	30
			<b>594</b>



New table

W1	The design is easy is use when parking as you only have to kick the kickstand down. However, precisely parking the kickstand can be a bit harder because maneuvering the moped (because of the weight) is also harder.	5	100
W2	This is a centerstand connected to the moped, thus does not create an obstruction. The tile is flat on the ground and therefore no obstruction.	9	135
W3	Kickstand and Tile	10	150
W4	This can be installed into an platform and then moved inside as TILER is currently doing with their kickstand charger for their electric bikes.	7	84
W5	Production cost can be lower as all the components for the tile are already in house available.	7	84
W6	The stand can be broken after a lot of use. Thus higher risk of breaking of the moped (as currently also happens)	3	36
W7	Takes up less space as it only is a tile flat in the ground.	9	72
W8	Components in the tile are harder to be stolen as it is hidden in the ground, however the stand can be taken of and stolen.	5	30
			<b>691</b>



New table

W1	The design is easier in use as the people only have to ride closely to the pole. However, they do need to presily put the handle bar in the hole, which can be harder. However, moving the steering wheel is easier then the whole moped.	7	140
W2	This will be a bigger object in the environment. However, it is more at eye level, thus less hard to bump into.	5	75
W3	No tile and no kickstand	1	15
W4	This can be installed inside, however it needs an extra platform to keep it sturdy. Because of the weight of the moped, this platform also needs extra reinforcement thus makes it harder to instal inside.	4	48
W5	The production cost for the tile will be higher as is is larger and has more components	4	48
W6	The handle bars are less prone to breaking and thus reduces the risk of breaking. However, the mechanism in the pole can have a higher risk in breaking as it has moving parts and electronics.	6	72
W7	Takes up more space in the environment as it is an permanent object in the environment.	3	24
W8	Can easier be vandalised as it is an permanent object in the environment. However, the component on the moped is hidden in the handle bars and thus less easier to be stolen.	6	36
			<b>458</b>

## 7 Analysis of Electric Moped

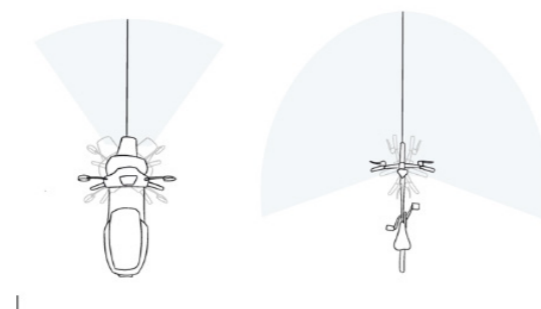
An electric moped typically has a more robust and heavy-duty design compared to an electric bike. It often features a larger shape, stronger frame, and a more powerful motor. This is because an electric moped is designed to be able to handle more weight and reach higher speeds than an electric bike.

Electric mopeds compared to electric bikes also have a different way of handling because of this. The bikes are lighter, easier to steer and have a smaller turning cycle (figure XX). The main reason why they have a smaller turning cycle is because the steering wheel can almost be turned into a full circle. The steering wheel of an electric moped can be turned with a maximum of 35 degrees left and right. The bigger turning cycle makes it therefore more difficult to precisely turn the moped. The weight of a moped is also different. A regular electric bike is on average between 20 and 40 kg (Cunningham, 2022) and that of an electric moped on average between 75 and 130 kg (Urban eBikes, n.d.). Therefore, making small adjustments, by for example lifting the vehicle, is possible with an e-bike and almost not with the moped.

When parking an electric moped, most of the time people will first drive to the spot they have to park at. When arriving at the parking spot, the moped is put on the preferred stand. With bikes, people often get off their bikes first and move to their wanted parking spot. Moreover, e-bikes only have one way of parking them: using the kickstand, which is also a big part of the design of the TILER wireless

charging solution. E-mopeds have two different types of stands: a kickstand and a side stand. These stands have to comply with a certain norm. This issue is covered in 'Council directive 2009/78/EC' (2009).

Overall, the design, weight and shape all influence the ergonomics, way of handling and parking of the moped. Mopeds are heavier and more robust than bikes and thus makes it harder to park precisely. This is an important factor of the wireless charging solution TILER offers and should therefore be taken into consideration. To further investigate how people handle and park the mopeds and what the motives of the users are during these actions, field research, interview and users tests have been conducted in the following chapters.



### Field Research

The mopeds have two different ways of parking: using the kickstand or using the center stand. By observing the shared mopeds on the streets, knowledge about which way of parking is preferred is collected.

57 mopeds were collected on the street, 40 of these mopeds were parked using the kickstand and 17

were parked using the center stand. However, 22 of these mopeds only had one of the two options to park. Looking at all the mopeds that had both the kick and center stand, 91% percent of the mopeds were parked on the kickstand. Almost half of the mopeds were missing one of the stands. K. Ruitter mentioned that kickstands are more prone to break off the moped. The main reason is that the mopeds are not designed for the shared mobility service. They are not intended to be used this many times, and therefore, components, such as the stands do break faster than when privately owning the same model of electric moped (personal communication, January 17, 2023).

To research why people would prefer this way of charging, a questionnaire is done (n=29). People prefer to use the kickstand because it is easier and because of the weight of the moped. "I had to be helped twice when I tried putting the moped on the centerstand." - questionnaire [2]

Using the center stand requires more strength because you have to pull the weight of the moped over a tipping point. Putting the moped on a kickstand requires no to little strength because the moped will fall into place. However, some people do feel like the moped is more stable when parked on the center stand (Appendix 1: Results Questionnaire). When a moped is designed it has to comply with certain norm. The more elaborate norms on a center stand may be the reason why some people feel that this kind of parking is more reliable. This is untrue, though, as the kickstand

is made to make it difficult for the moped to tip over. (J. Koudijs, personal communication, December 13, 2022). In conclusion, people most of the time prefer to use the kickstand of the moped to park, because it requires less energy and effort. However, people do get the feeling that when the moped is parked on the center stand it feels more stable, however this is not the case as the both the kick- and center stand are designed to satisfy strict norms.

Maneuvering and parking an E-Moped Electric mopeds are more difficult to maneuver than electric bikes. The wireless charging solution of TILER requires relatively precise parking because the user has to park the kickstand in a square.

### User Tests

To test the precision in which way people can park an electric moped, a few tests will be done. Firstly, testing the positioning and maneuver of the moped. For this test, two main questions are asked:

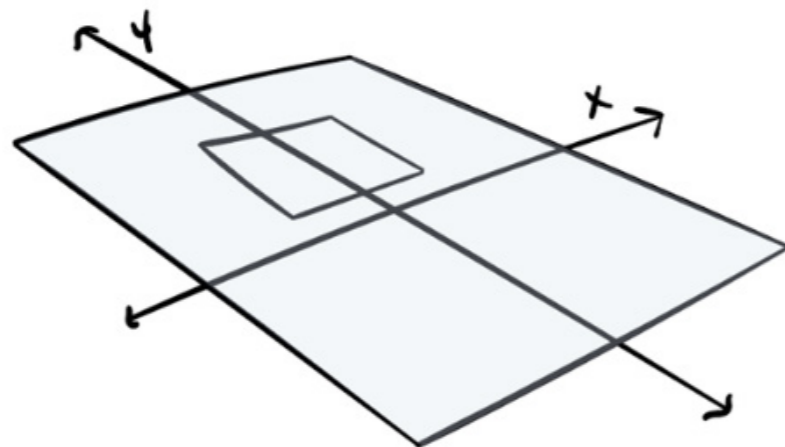
1. How straight can people park while having to turn 90 degrees?
2. How many times do they need to adjust their position?

Secondly, testing the precision of using the kickstand. TILERs current product uses a square space of XX mm by XX mm in which users have to park the kickstand of the electric bike. With this test, it is tested if this concept can also be applied to mopeds, and if not, how precise the kickstand can be parked. For this test, two main questions are asked:

1. How precise can people park the kickstand on a square?
2. How many times do they need to adjust their position?

### Results

A common issue the participants experienced was that it was hard to estimate where the kickstand would touch the ground. All participants steered in to close and thus overshot the square on the ground. They could easily adjust their position in the x-direction (figure xx) by moving the moped forward and backwards. However, they needed to adjust their position in the y-direction to be able to park in the square. They managed to do this by moving the moped backwards, steering to the left, and then moving forwards again. This required more effort, however it was manageable.

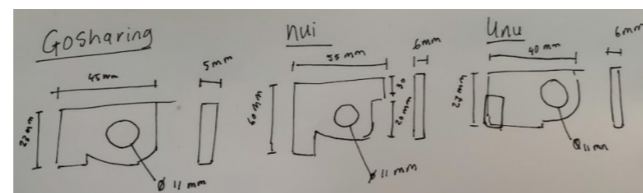


## 8 Analysis of Moped Connection

To get a better understanding of the differences between mopeds, field research was performed. I went to WvM-Mobility in Delfgauw to look at different models of electric mopeds. He told me about the most popular models and brands of mopeds in The Netherlands. Also, by going outside and coming across mopeds, I learned about the differences.

The main difference that kickstand mopeds have is the length. Mopeds differ in size and weight; therefore, the kickstand is also specifically designed for these dimensions. I saw that the length of the kickstand differs quite a lot (table XX).

Furthermore, the mounting piece of the moped also differs, however way less than the difference in length. The most important factors are the thickness of the mounting piece and the diameter. As seen on the next page, the thickness is fairly the same - only one mm difference - and the diameter for the pivot connection point is the same on these models.



### Moped Brand/model Length Kickstand

Nui NQi	170 mm
Segway	170 mm
Super Soco	150 mm
Nui	145 mm
Unu	170 mm



## 9 LowFi and HiFi Prototyping

The final design has gone through multiple prototyping phases. Starting with low fidelity prototypes out of cardboard to determine the main shape of the product. Further in the process, 3D printed models were made to go in more detail of the product.

### Iteration 1: First low fidelity prototype

The initial prototyping phase started off with developing multiple low-fidelity prototypes made out of cardboard to test the first shape of the kickstand. The dimensions of the coil were set to be 60 x 30 mm. However the high of the coil is reducing in future development of the technology. The current height of the coil is 25mm, however it is said to be reduced by two thirds. The new coil will thus be 8 mm. These dimensions were the starting point of the dimensions of the kickstand. A few cardboard models were made with these dimensions. With this cardboard model, I could get the first look and feel of the kickstand underneath the moped. Also, the folding in and out of the kickstand was tested.

### Iteration 2: First 3D printed prototype

After using cardboard as a prototyping tool, I went on to use 3D printing. 3D printing gave me more freedom in designing the shape of the kickstand. At first, a rough outline of the kickstand was created in

Solidworks. While holding this 3D print next to the moped, it became visible that the kickstand was quite bulky and large in size. This could cause problems when the kickstand is folded in. Users can scrape along the kickstand and then, for example, damage their own clothes or the kickstand itself.

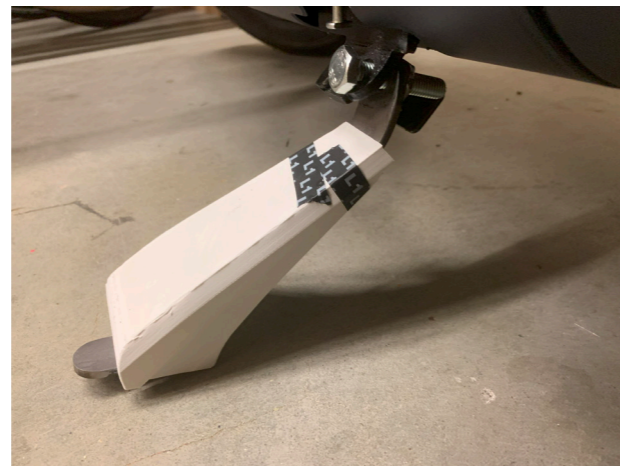
Thus in the next iteration unnecessary space is reduced to reduce the overall size of the kickstand. Also, harder lines were replaced by more softer lines and curves to make it less easy to damage the user if they scaped along the kickstand.



### Iteration 3: 3D printed prototype ready for the moped

With the reduced kickstand size, I wanted to be able to put the prototype underneath the moped. Because the prototype is made out of 3D printed plastic, it would not be able to hold the weight of the moped. Therefore, I decided to add a steel frame to put underneath the moped. Around this steel frame, the 3D printed model could be secured to be able to get a look and feel of the kickstand.

After creating a steel frame, I was ready to attach it to the moped. However, after putting the full weight of the moped on the steel frame, it bent immediately. The reason for this was the flat shape of this frame. It did give me a good image of what happens when adding the large weight of the moped on the kickstand and which place it will most likely bend first. With this knowledge in mind, I decided to order an existing kickstand to use as the frame for the prototype.



After reducing the size of the kickstand, the kickstand still was sticking out too much. As seen on the picture on the left, when folding in the kickstand, it will stick out because of the angle in which it needs to rotate. One solution could be to change the connection of the moped, however I aim to not change anything on the moped for easy integration of the product into the sharing moped sector.

Looking at the picture on the right, if the kickstand could be folded in and

out at a different angle, it would not stick out too much. However, for the coil of the tile and kickstand to align, this position of the kickstand is not possible. One other solution could be to change the dimensions and shape of the coil. I brainstormed on how I could change the shape of the kickstand, however it became clear by doing so, the alignment of the kickstand with the tile became even harder. It is already more difficult to maneuver the moped than a bike and thus I did not want to make this any harder to prevent misalignment of the mopeds.



#### Iteration 4: Separate attachment of the Moped

After brainstorming on multiple different solutions, I decided to try to solve it by changing the shape and outline of the kickstand. Moreover, more unused weight of the kickstand was reduced by this next iteration. By adding a curve at the location where the kickstand was sticking out too much, I wanted to reduce the size on that location. Also, to make the kickstand universal, I decided, after brainstorming and iterating, to add a separate attachment. This attachment is designed to fit specific models of moped. The rest of the kickstand is secured on this attachment. This is done by screwing the fin of this attachment to the moped.

However, after securing this iteration to the moped, the issue of sticking out too much was still present. Therefore, I needed to brainstorm on another solution as I could not reduce the size of the kickstand anymore. While looking at the 3D printed model and the round axis of the attachment piece, one solution came to mind. If the body of the kickstand could rotate around the attachment, it could have different positions when folded in and out. If the kickstand is folded out, the kickstand would rotate so that the coils align perfectly. And if the kickstand is folded in, the kickstand could rotate approximately 90 degrees, and be more flush with the moped itself.



### Iteration 5: Rotating Kickstand

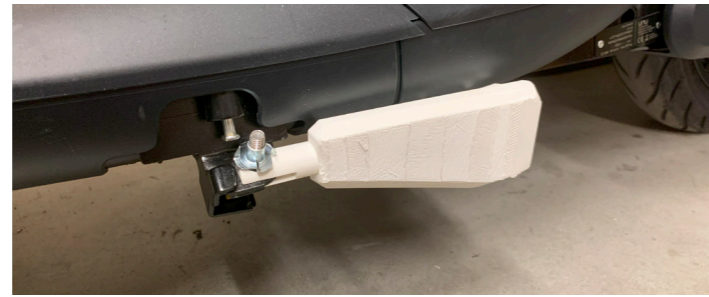
After brainstorming on how to add the rotating mechanism I decided on a few requirements for the kickstand. I did not want to make the rotating mechanism more difficult by for example adding a motor to rotate the kickstand. This not only adds an extra step for the user, it also makes the kickstand more expensive. Therefore, I tried to add existing parts of the current kickstand to help the mechanism.

The existing kickstand uses a spring to keep the kickstand upwards when riding the moped. This spring was also a part that needed to be integrated into the kickstand. Because the spring would already be present on the kickstand, I tried to use this to also rotate the kickstand. The idea was to place the spring not centered with the attachment point on the moped, but to place it more to the side of the kickstand. I wanted to use the tension of the spring to be able to rotate the kickstand over the axis.



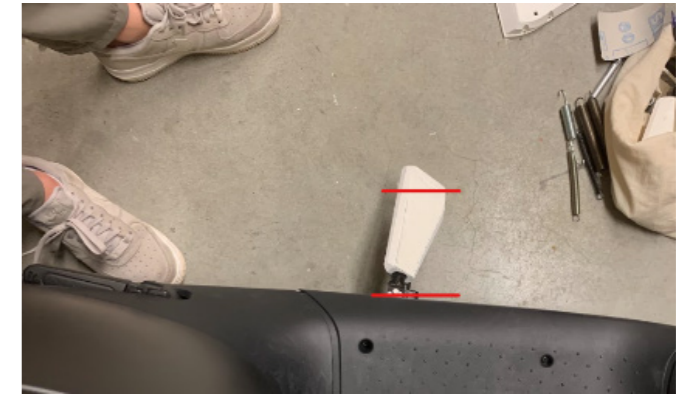
**Iteration 6: Adding a frame to hold the weight of the moped**

Multiple iterations and 3D printed models were made to test the mechanism. Also, the location of the spring on the body of the kickstand was determined by testing multiple 3D printed models. After testing I realized that the spring was not able to rotate the kickstand completely to align perfectly with the coil in the tile. However, after testing the kickstand, I noticed that when lowering the moped and adding weight on the kickstand, it automatically wants to rotate the kickstand. This is because the kickstand will rotate to its flattest position. To see if this is understandable for the user, testing is required with participants who do not know about this rotating mechanism. Therefore, a test model is created. I adjusted an existing kickstand to be able to fit in the body of the kickstand. Because of this, for the first time, the kickstand held the weight of the moped without having to support the moped, as seen in the picture on the next page.



**Iteration 7: Adding visual design clues**

After finalizing the mechanism and testing it if it would work I could focus more on the aesthetics of the kickstand. The prototype is still quite bulky and way larger than a normal moped kickstand. Also, the prototype has a lot of flat walls which also makes the kickstand look more bulky. Therefore, I wanted to add more curvature, not only to make the kickstand more stiff, also for aesthetic purposes. Also, the size of the backside is reduced. It still fits all the components and electronics. Also, I wanted to add lines to help the user understand the rotating mechanism. If the user looks down on the kickstand, the lines will guide them to think that the kickstand is in the right position as they are perpendicular to the ground and parallel with the moped. When parking the moped, the kickstand will rotate to its final location.

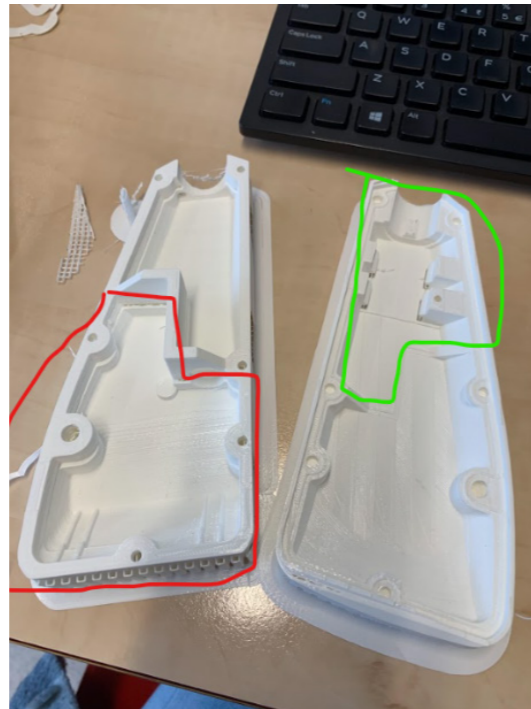


### Iteration 8: Inside of the kickstand

This is not the last iteration, but an ongoing iteration during the prototyping phase. While designing the outside of the kickstand to make it possible to hold the moped, the inside also needed attention. The components and electronics needed to fit inside, as well as the rotating mechanism. The electronics needed to be protected from water and rain. I did this by adding a seal around the part when the electronics are located. By adding a packing and fastening the two parts together, a watertight seal is created.

However, after adding the rotating mechanism, this watertight seal was not possible as it would interfere with the rotating of the rod because it causes friction. After brainstorming and iterating I decided to add two separate compartments: one for the electronics (red part), one for the mechanism (green part). With this, I could still add the watertight seal.

The rotating mechanism also needed attention. With the chosen production method of the aluminum housing I could not add a hole for the rod. I decided to add an aluminum profile to hold the rod that rotated after consulting with experts. This also helps with the assembly process. However, because the compartment with the mechanism is not sealed off, it could let in water and dirt. Therefore, I added holes on the aluminum housing as well as the plastic housing. The holes on the aluminum housing have two purposes, letting out water and dirt, and creating hooks inside the housing to hold the aluminum profile.



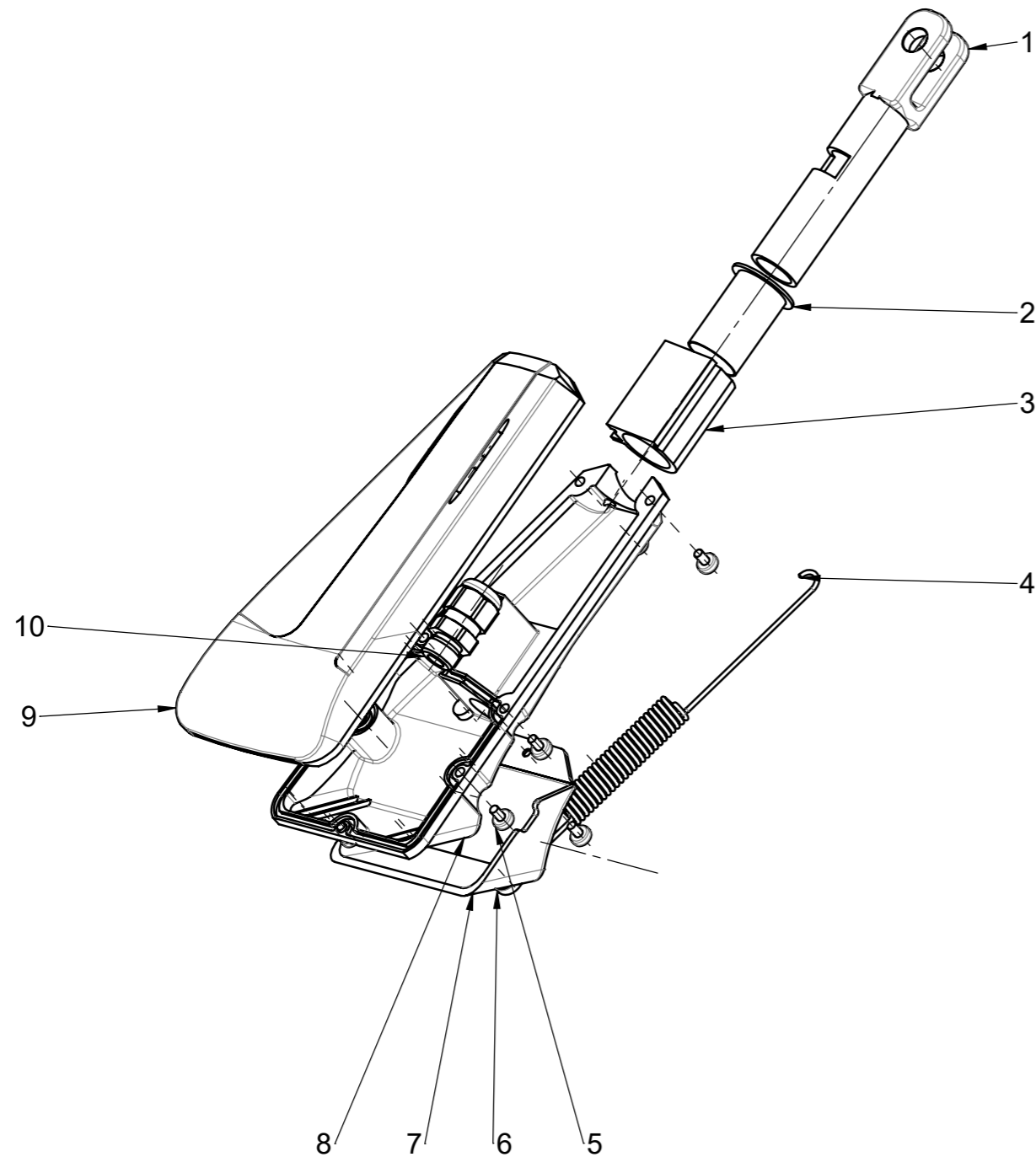
### Iteration 9: Visual Prototype

After developing the shape and insights of the product, a visual prototype was made. This prototype is closely made to look like the final prototype. By painting 3D printed models, a clear visual representation of the product is made. Also, this prototype is a working model with the right mechanism inside. Moreover, after putting this prototype underneath the moped, it was also able to hold the weight of the moped, even though it was fully made out of plastic.

After testing this prototype, the final prototype could be made. The black paint on the aluminum housing was too shiny and thus needed to be replaced for the final prototype. This was the only issue this prototype had, and thus no big changes needed to be made. The only thing that also needed to be adjusted was the spring holder bolt. This needs to be shorter so it does not touch the ground when parked.



# 10 Technical Data Packidg

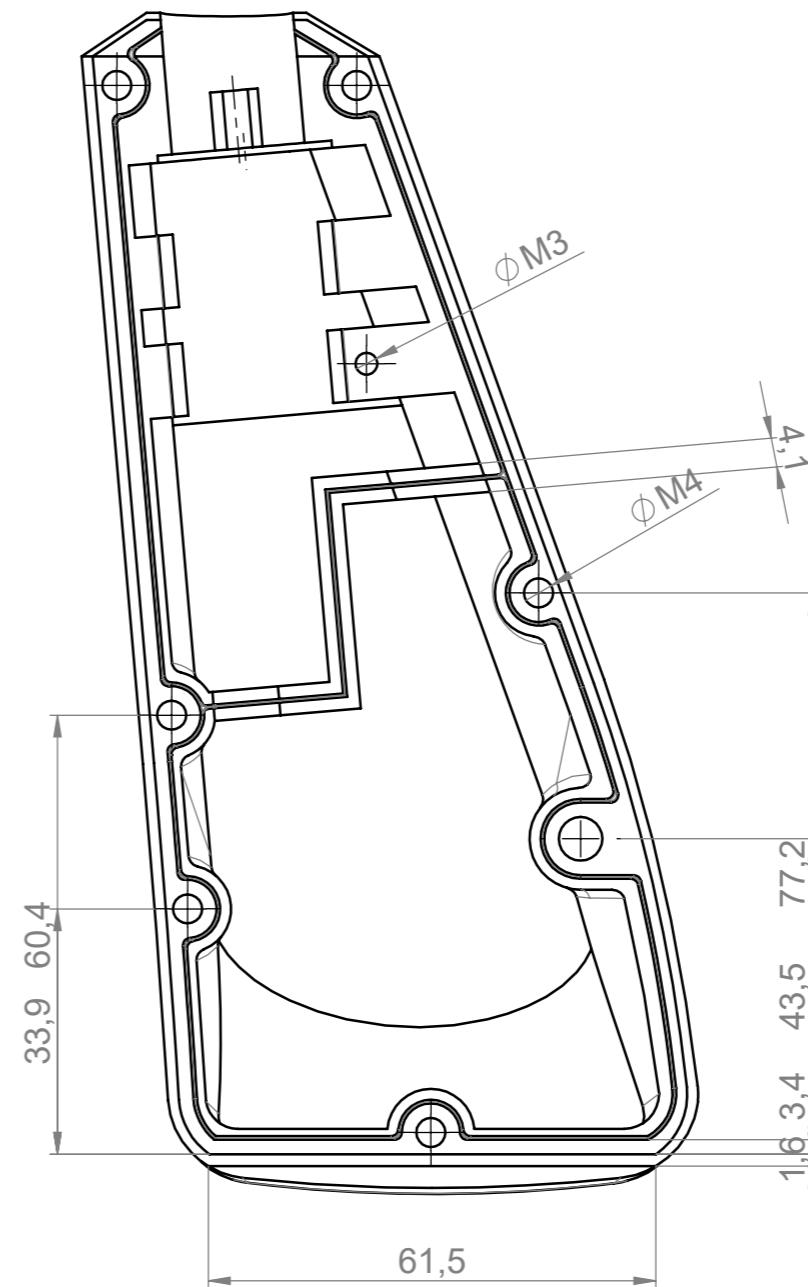
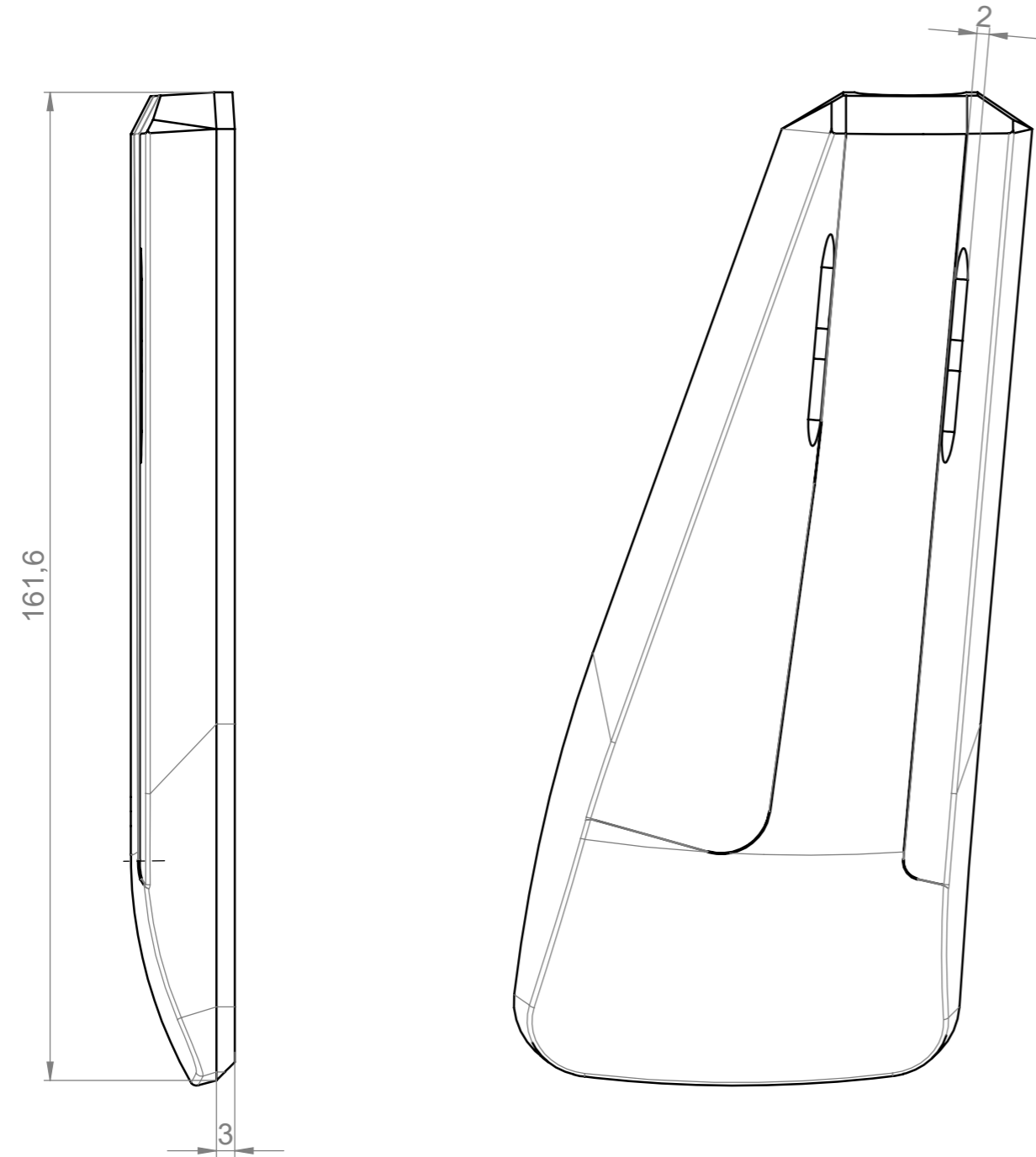


10	1	Cable Gland	PA Type 6	4.73		
9	1	Aluminium Housing	Aluminium	121.69		2
8	1	Plastic Housing	ABS	28.38		3
7	1	Foot	PE High Density	10.67		4
6	1	Spring Bolt	Alloy Steel	14.59		
5	7	Screw	Alloy Steel	1.08		
4	1	Spring	Alloy Steel	17.03		
3	1	Aluminum Profile	Aluminium	19.19		5
2	1	Sliding Bearing	PTFE (general)	2.48		
1	1	Shaft	Alloy Steel	95.77		6
Item No.	Qty.	Name	Material	Weight [grams]	Standard	Remarks / Drawing No.

schaal 1:1		datum 16-5-2023	opmerkingen <<opmerkingen>>
maateenheid mm	gewicht 316.93 gram		
getekend <<(achter)namen & studienummers>>	groep <<dagdeel groep>>		

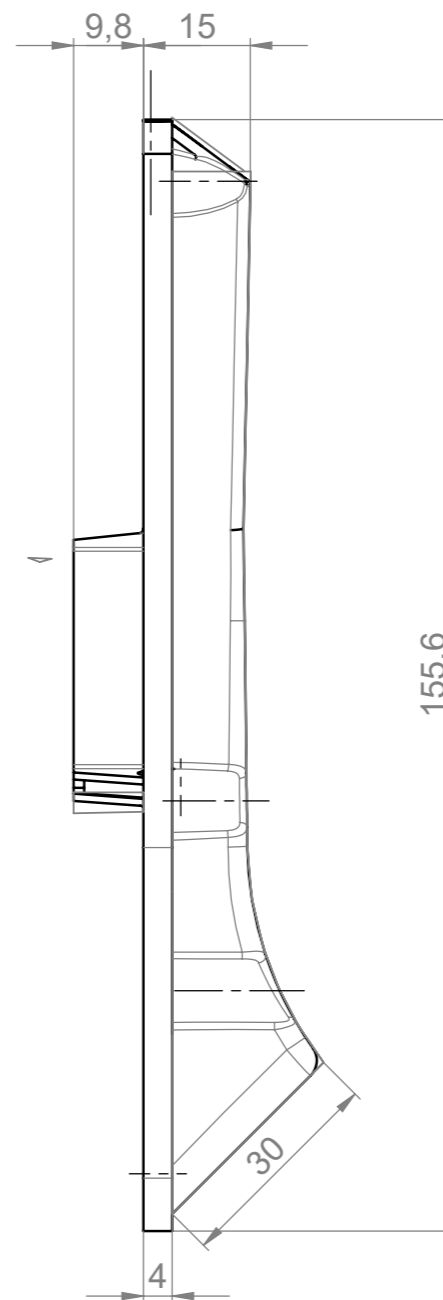
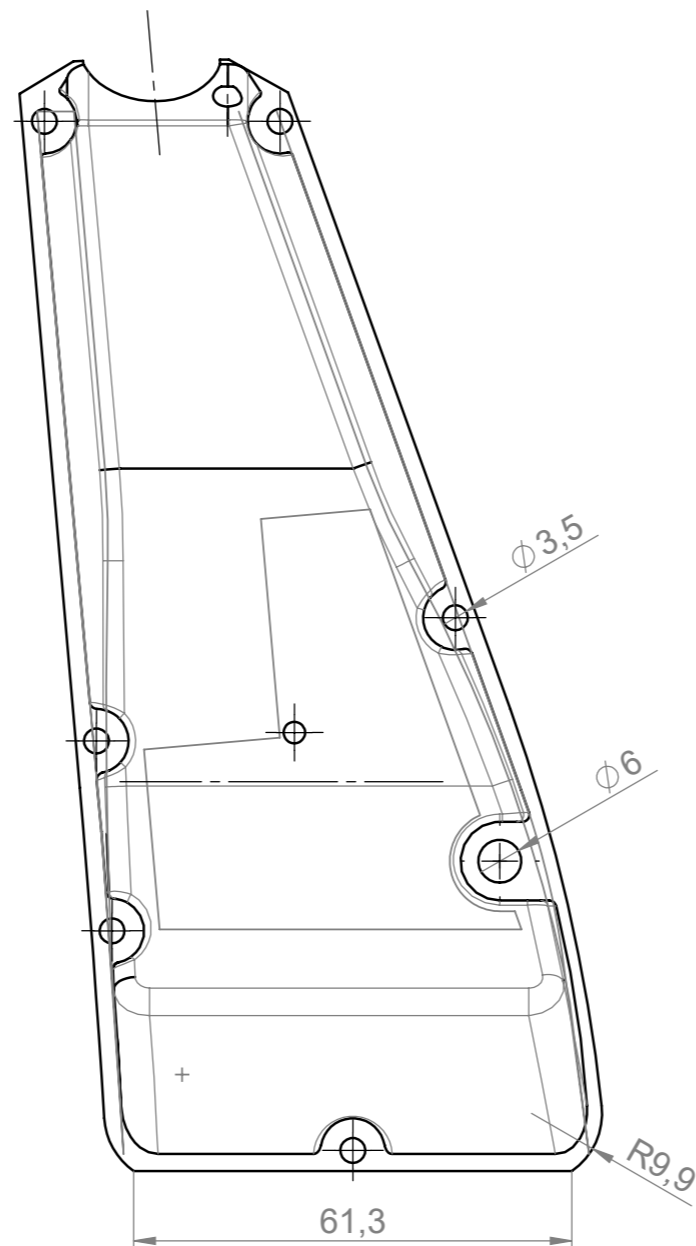
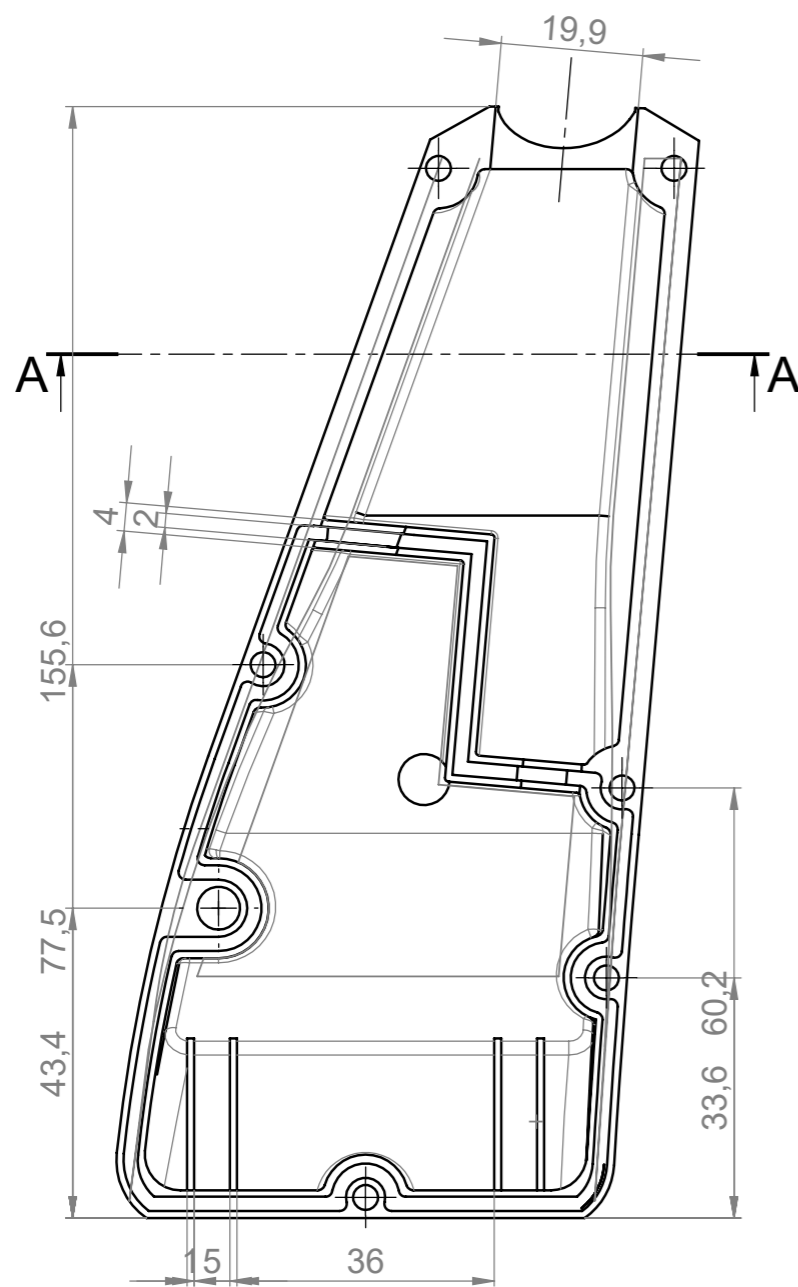
benaming **Assembly Mick**

<b>TU Delft</b> Industrial Design Engineering	formaat <b>A3</b>	tekeningnummer 1
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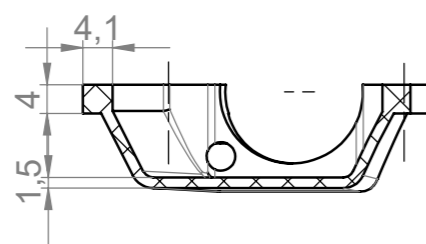


Mat.: Aluminium  
Tolerance: DIN 1688 GTA 13

schaal 1:1 maateenheid mm getekend Myrthe Platenburg	 datum 15-5-2023 gewicht 121.69 gram	opmerkingen
benaming <b>Aluminum Housing</b>		
<b>TU Delft</b> Industrial Design Engineering	formaat <b>A3</b>	tekeningnummer 2



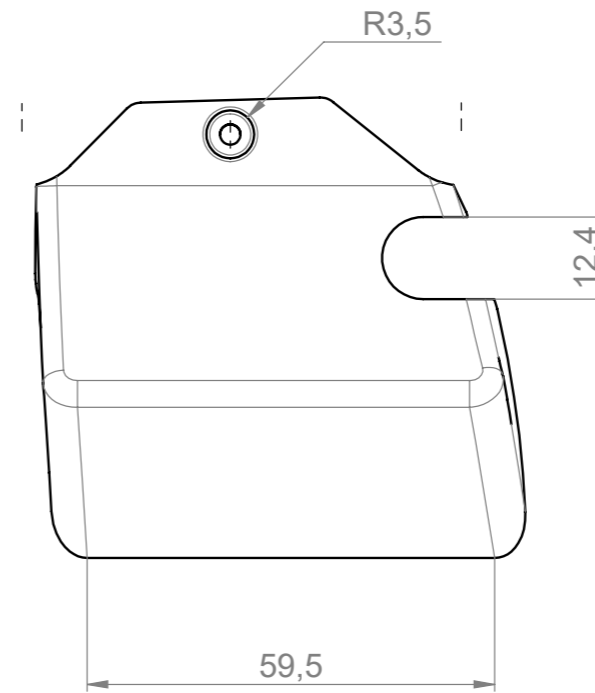
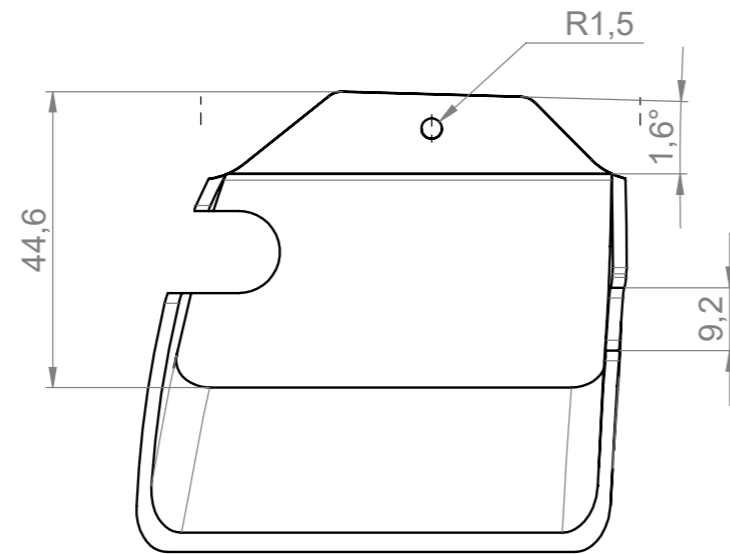
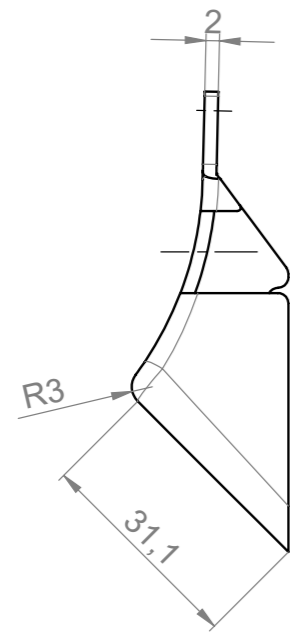
Mat.: ABS  
Aantal: 1



A-A

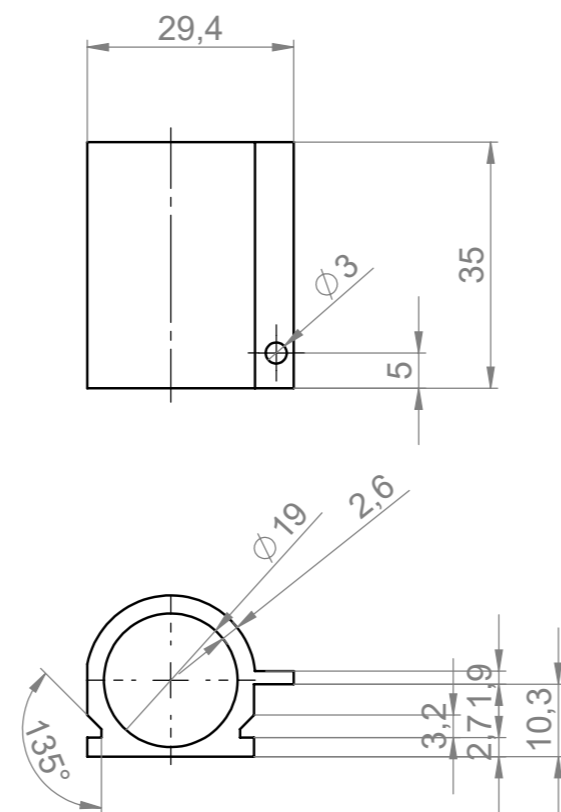
schaal 1:1		datum 15-5-2023	opmerkingen
maateenheid mm	gewicht 28.38 gram		
getekend Myrthe Platenburg			
benaming Plastic Housing			
<b>TU Delft</b> Industrial Design Engineering	formaat <b>A3</b>	tekeningnummer 3	

Mat.: PE High Density  
 Aantal: << >>



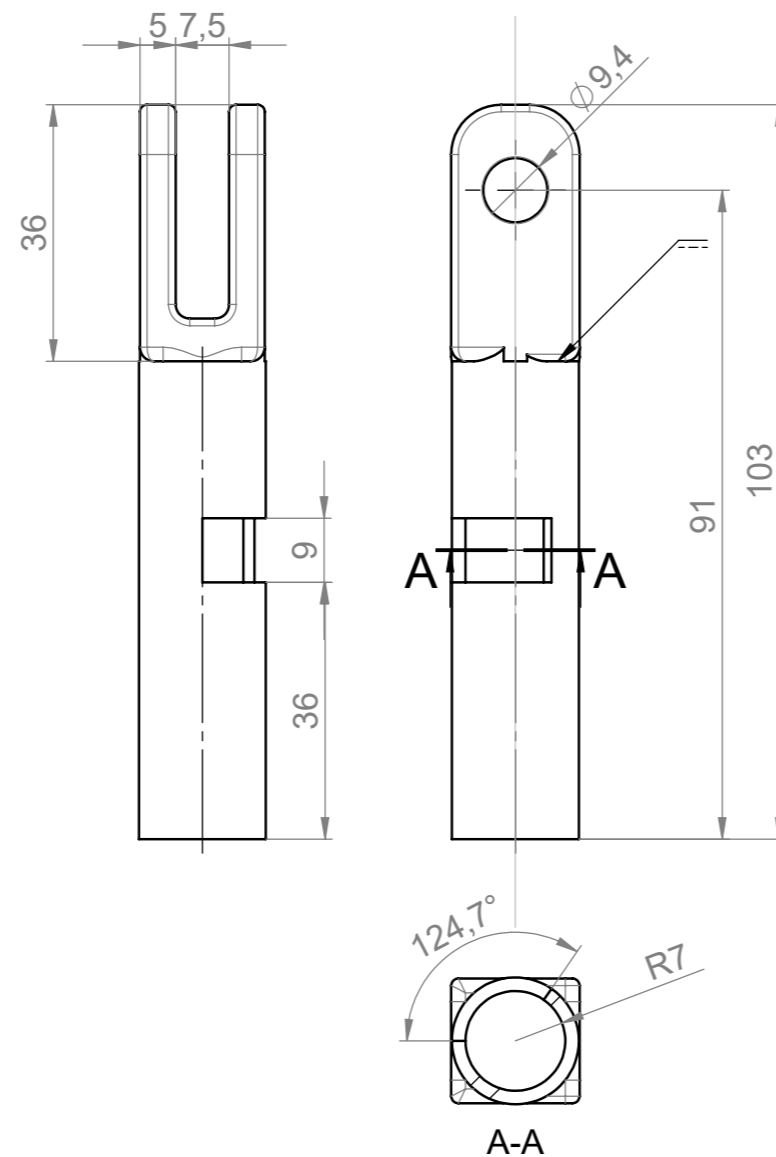
schaal 1:1		datum 15-5-2023	opmerkingen
maateenheid mm	gewicht 10.67 gram		
getekend Myrthe Platenburg			
benaming <b>Foot</b>			
<b>TU Delft</b> Industrial Design Engineering		formaat <b>A3</b>	tekeningnummer 4

Mat.: Aluminium  
 Aantal: << >>



schaal 1:1 maateenheid mm getekend Myrthe Platenburg	 gewicht 19.19 gram	datum 15-5-2023 opmerkingen
benaming <b>Profile</b>		
<b>TU Delft</b> Industrial Design Engineering	formaat <b>A3</b>	tekeningnummer 5

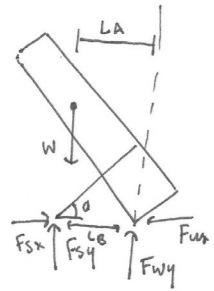
Mat.: Alloy Steel  
 Aantal: << >>



schaal 1:1		datum 15-5-2023	opmerkingen - Steel bended piece welded on tube
maateenheid mm	gewicht 95.77 gram		
getekend Myrthe Platenburg			
benaming <b>Shaft</b>			
<b>TU Delft</b> Industrial Design Engineering			formaat <b>A3</b>
			tekeningnummer 6

# 11 Calculations

## Forces on kickstand Moped



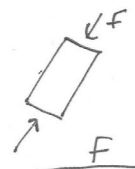
- $F_{sy} = W \cdot \frac{L_B}{L_A}$
- $F_s = F_{sy} / \sin(\alpha)$
- $\alpha = 45^\circ$
- $W = \text{mass scooter} \cdot 9,81$
- $\text{mass} = 100 \text{ kg} + 100 \text{ kg (human)} = 200 \text{ kg}$
- $L_B = 150 \text{ mm}$
- $L_A = 50 \text{ mm}$

$$F_{sy} = (200 \cdot 9,81) \cdot \frac{L_B (150)}{L_A (50)} = 5886$$

$$F_s = \frac{5886}{\sin(45)} = \boxed{8408 \text{ N}}$$

## Buis

- important compression



$$\sigma = \frac{F}{A} = \frac{F}{\pi/4 (D_2^2 - D_1^2)}$$

$$SF \cdot \sigma_{\text{yield}} = \frac{F}{\pi/4 (D_2^2 - D_1^2)}$$

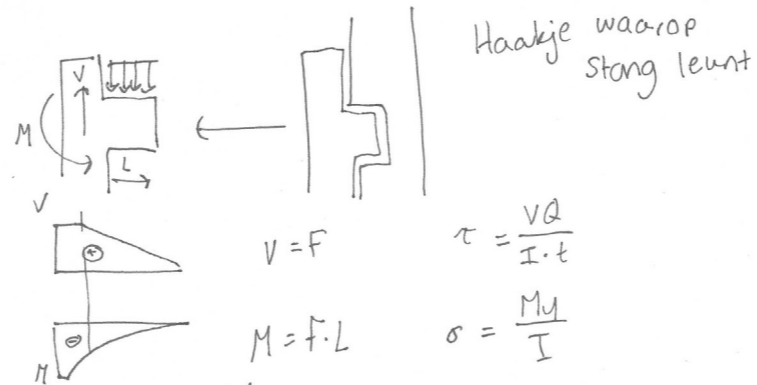
$$D_2^2 - D_1^2 = \frac{F}{\pi/4 \cdot SF \cdot \sigma_{\text{yield}}}$$

$$D_1 = \sqrt{D_2^2 - \frac{F}{\pi/4 \cdot SF \cdot \sigma_{\text{yield}}}}$$

$$D_1 = \sqrt{0,018^2 - \frac{8408}{\pi/4 \cdot 1,5 \cdot 250 \cdot 10^6}}$$

$$D_1 = \frac{0,00384 \text{ m}}{0,017} \rightarrow 0,384 \text{ mm} \rightarrow 17 \text{ mm}$$

Dus met een 18 mm stalen stang moet de binnen diameter minimaal 17 mm zijn



Haakje waarop stang leunt

$$\tau = \frac{VQ}{I \cdot t}$$

$$\sigma = \frac{My}{I}$$

$$\tau = \frac{VQ}{I \cdot t}$$

$$I = \frac{bh^3}{12}$$

$$Q = b \cdot \frac{h}{2} \cdot \frac{h}{4} = \frac{b}{8} \cdot h^2$$

$$\tau = \frac{V \cdot \frac{b}{8} h^2}{\frac{bh^3}{12} \cdot b} = \frac{V/8}{\frac{hb}{12}} = \frac{12V}{8hb}$$

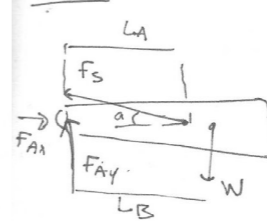
$$hb = \frac{12V}{8 \cdot SF \cdot \tau_{\text{Alu}}}$$

$V = 8408$   
 $SF = 1,5$   
 $\tau = 207 \cdot 10^6 \text{ Pa}$

$$hb = 0,0004062 \text{ m}^2$$

Dus stel  $b = 6 \text{ mm} \rightarrow 0,006 \text{ m}$  dan moet  
h dus  $\frac{0,0004062}{0,006} = 0,0677 \text{ m}$  dus afgerond 7 mm zijn

## Veer



$$F_s = \frac{8,829 \cdot 140}{120 \cdot \sin(\alpha)}$$

$$= \frac{1236,06}{41,24}$$

$$= 30,12 \text{ N}$$

(Dit is alleen om hem omhoog te houden)

$$F_f = M_s \cdot N$$

$$F_s = k \cdot x$$

$$x = L_2 - L_1$$

$$k = \frac{F_s}{x}$$

$$k = \frac{30}{0,010} = 3000$$

Dus, veer nodig met minimale veer constante van 3000

$$F_{sy} \cdot L_A = W \cdot L_B$$

$$F_{sy} = W \cdot \frac{L_B}{L_A}$$

$$F_s = \frac{F_{sy}}{\sin \alpha} = \frac{W \cdot L_B}{L_A \cdot \sin \alpha}$$

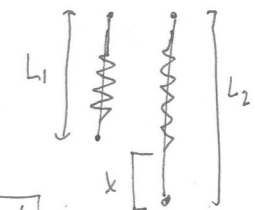
$$W = \text{massa kickstand} \cdot 9,81$$

$$= 0,9 \cdot 9,81 = 8,829$$

$$L_A = 120 \text{ mm}$$

$$L_B = 140 \text{ mm}$$

$$\alpha = 20^\circ$$



$$F_s = 30 \text{ N}$$

$$L_2 = 130 \text{ mm}$$

$$L_1 = 120 \text{ mm}$$

$$x = 130 - 120 = 10 \rightarrow 0,010 \text{ m}$$



Kostprijsopbouw: K Steel Shaft, pagina 1 van 1

Opbouw van de kosten per onderdeel

Maak alvorens wijzigingen aan te brengen duplicaten van dit tabblad aan voor elk *in house* te produceren onderdeel van je product. RMK op tabblad K Onderdeel > Move or copy > Create a copy.

Benaming Aluminium Profile		Productieserie	5.000	stuks	per onderdeel
<b>Materiaalkosten</b>		<b>bruto hoeveelheid/product</b>	<b>eenheid</b>	<b>prijs/eenheid</b>	<b>bedrag</b>
halffabrikaat	0,2	kg	1,17	€ 0,23	
				<b>totaal materiaalkosten</b>	<b>€ 0,23</b>
<b>Bewerkingskosten</b>		<b>capaciteit [stuks/u]</b>	<b>machine- uurtarief</b>	<b>machine- kosten</b>	
machine 1	80	62,50	€ 15,00	€ 937,50	
machine 2	1000	5,00	€ 0,00	€ 0,00	
etc.	1000	5,00	€ 0,00	€ 0,00	
nabewerking	1000	5,00	€ 0,00	€ 0,00	
				<b>totaal machinekosten</b>	<b>€ 937,50</b>
machines als bovenstaand		<b>mens/machine-bezetting</b>	<b>arbeidsuren</b>	<b>mensuurtarief</b>	<b>arbeidskosten</b>
machine 1	1	62,50	€ 18,00	€ 1.125,00	
machine 2	1	5,00	€ 0,00	€ 0,00	
etc.	1	5,00	€ 0,00	€ 0,00	
nabewerking	1	5,00	€ 0,00	€ 0,00	
				<b>totaal arbeidskosten</b>	<b>€ 1.125,00</b>
				<b>totaal bewerkingskosten</b>	<b>€ 2.062,50</b>
<b>Instelkosten serie</b>		<b>insteltijd [u]</b>	<b>uurtarief insteller</b>	<b>mach.uurtarief</b>	<b>kosten</b>
machine 1	10	€ 24,00	€ 15,00	€ 390,00	
				<b>per product</b>	<b>€ 0,08</b>
<b>Gereedchapskosten</b>		<b>aanschafprijs</b>	<b>standtijd [stuks]</b>	<b>restwaarde</b>	<b>prijs/eenheid</b>
matrijs A	€ 1.500	10.000	€ 0,00	€ 0,15	
montagemal B		25.000	€ 0,00	€ 0,00	
subtotalen	€ 1.500		€ 0,00		
gemiddelde waarde	€ 750				
kapitaalrente	0,0%	rentekosten	€ 0,00	€ 0,00	
				<b>totaal gereedchapskosten</b>	<b>€ 0,15</b>
<b>Algemene toeslagen</b>					
uitval-factor*	1,0%	*afgekeurde producten, zie Kals voor percentages		<b>subtotaal</b>	<b>€ 0,87</b>
overheadfactor**	15,0%	** algemene toeslag voor productiefaciliteiten			
<b>totaal</b>	<b>16,0%</b>				<b>€ 0,14</b>
K <sub>F</sub> voor interne calculatie:		<b>Productiekostprijs Aluminium Profile</b>			<b>€ 1,01</b>

# 13 Cost estimation Qocreators



Customer name: Fabrique Invent B.V.  
Supplier: QoCreators Limited  
Attention: Mr. Mike de Jong  
C.C. : Mr. Raymond Gui  
Referentie: Myrthe Scooter Standard  
Date: April 12<sup>th</sup> 2023  
Total pages: 2 pages

## Proposal Myrthe Scooter Standard

Dear Mr de Jong, dear Mike,

Please find below our quotation based on the files received April 7<sup>th</sup> 2023.

### Tooling:

Item	Description	Cavity	Mouldlife	Leadtime	Price
1	Myrthe_AluminiumHousing	1*1	50k shots	8 wks	€ 6.800,00
2	Myrthe_HDPE_HousingBackside	1*1	50k shots	8 wks	€ 7.700,00
					<b>€ 14.500,00</b>

### Parts:

Item	Description	Material	Weight	MOQ	Price (ea)
1	Myrthe_AluminiumHousing	ADC12	121 gr	5000	€ 2,77
2	Myrthe_AluminiumHousing	ADC12	121 gr	1000	€ 2,95
3	Myrthe_HDPE_HousingBBackside	HDPE	27 gr	5000	€ 0,86
4	Myrthe_HDPE_HousingBBackside	HDPE	27 gr	1000	€ 0,95

- Leadtime first productionbatch: 6 wks plus transport
- The price for the aluminium housing includes powdercoating

— Shanghai Office Room 853 | No.1189 Wuzhong Rd. | Dobe E Manor of Hongqiao | Minhang | Shanghai | 201103 | China  
T +86 (0)21 64 06 05 28 | E info@qocreators.com

— Holland Office Tappersweg 35 | 2031 ET | Haarlem | Nederland | KvK nr: 34225025  
T +31 (0)23 73 70 224 | E holland@qocreators.com

## 14 Interaction Prototyping

To test and validate the design multiple prototypes have been made. The first prototype has been made to test the interaction with the users and the reactions of the users when folding in and out the kickstand. To create a test prototype, a hole has been made into the two 3D printed houses. A regular kickstand has been modified to fit in between these two houses.

### Test set-up Interaction Prototyping 1

To test the interaction with this first prototype a test setup has been made. The current tile of the TILER charger for e-bikes has been printed out and taped onto the ground to simulate this tile laying somewhere in the ground. This tile has been used to test if there also need to be adjustments on the tile to make parking the moped easier. Furthermore, the interaction between the kickstand and the rotating mechanism needs to be tested. It is important to know how potential users will react when the kickstand rotates. The tests have been done with six participants. 3 of the participants have more experience with riding mopeds as they owned them themselves, and the 3 other participants have little experience with mopeds as they have driven them a hand full of times in their lives.



### Insights and Results

Participants with little experience with mopeds needed one time to readjust the position of the moped.

Estimating when to turn to be able to park the moped currently can be difficult as the moped has a large turning circle.

The participants with experience riding on a moped did not need to adjust their position when parking.

One participant tried to rotate the kickstand himself.

The participants mentioned that the design of the kickstand looks like it belongs on the moped.

It was very understandable how to use the new kickstand mainly because it is a familiar mechanism.

An indication - for instance on the tile - where the moped needs to align would be preferred by 4 out of six participants.



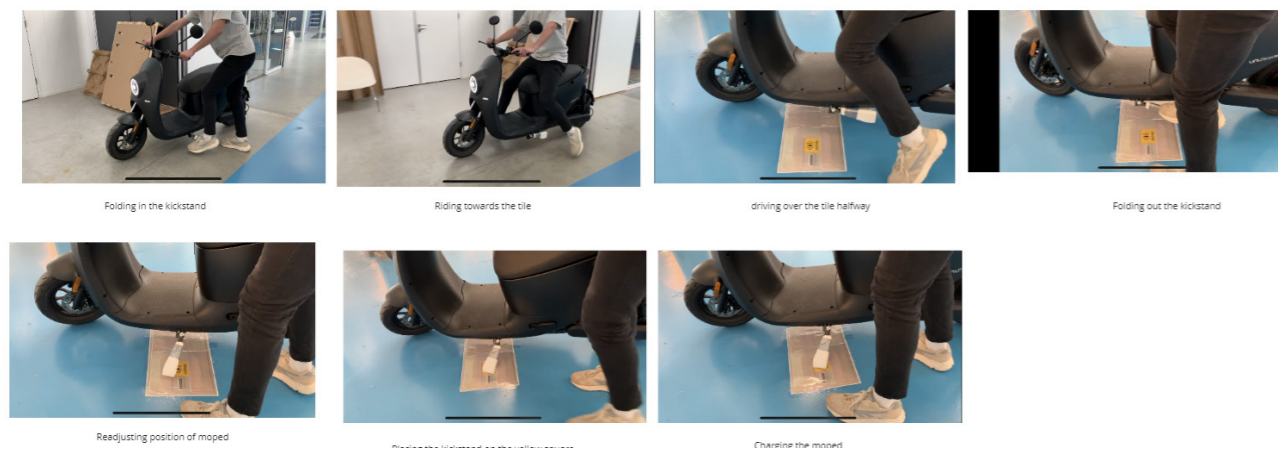
## Participate 1



## Participate 2



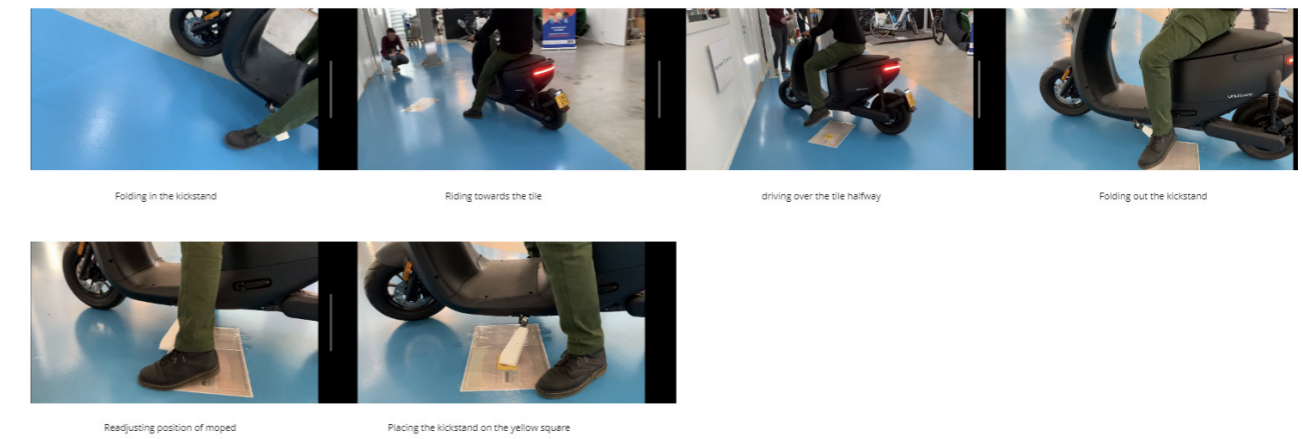
## Participate 3



## Participate 4



## Participate 5



## Participate 6

