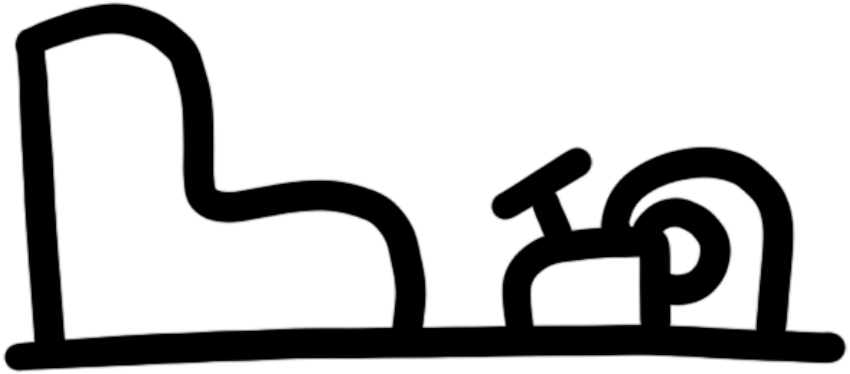


LEVO

THE VITALITY BENCH

Maxime Vallentin - 0956202

Coaches **Loes van Renswouw - Susen Lange**

Final Bachelor Project - Industrial Design - June 2021

Maxime Vallentin
0956202

Final Bachelor Project
Industrial Design
June 2021

Coaches
Loes van Renswouw
Susen Lange

Assesor
Aarnout Brombacher

Word count: 9875

INDEX

ABSTRACT

Sitting is the new smoking. Nowadays, people sit down way too much, even in the park, which is an overall healthy environment that stimulates activity. For an activity to be healthy for mind and body, one has to exercise for 20 minutes straight. Sitting down on a park bench mid-walk can obstruct this. That is why I designed LEVO. LEVO is a bench that stimulates users to still exercise while sitting down. By pedalling, the user makes the bench rise up to 2.20 metres, which provides a better view and their own cocoon feeling. This way, they are rewarded for exercising in an accessible way. High up in the sky, the distance creates a calmer environment, in which the user can enjoy the view, read a book or just relax. The interactive pedalling gives users control over the process, yet LEVO encourages the users to keep pedalling to stay at the top.

KEY WORDS Bench; pedalling; sitting; vitality; urban exercise

EXECUTIVE SUMMARY

This research targets the issue of people sitting down too much and not exercising enough. More specifically, it concerns the park bench, which often interrupts walks people take. For an activity to be healthy and beneficial for mind and body, it has to have a duration of at least 20 minutes straight (UW health, n.d.). Often, a walk that has the potential to last 20 minutes and thus improve vitality is obstructed because someone sits down on a park bench. To provide a solution to this issue and contribute to average health, LEVO lets a bench-sitter exercise while sitting down. This way, the 20 minutes-exercise-streak can be maintained while still taking a break from walking.

LEVO allows its users to integrate a simple and accessible exercise into their daily routine. All the regular activities of an average bench-sitter can still be executed. From the conducted user research, it turns out that the park bench is mainly used for two categories of activities. The first comprises activities for which the hands need to be still and free, such as eating, making a phone call or reading a book. These things cannot comfortably be done standing up or walking. The second category regards the privacy a park bench can provide. Because of the difference in height level and the unity and ownership of the bench, sitting down gives a sense of privacy. Moreover, if people sit down on a bench with two or more, it provides the opportunity to have a more private conversation. LEVO facilitates both sorts of activities. An additional effect that coincides with this is the calm environment LEVO offers. Up in the sky, the user can take their mind off things and relax for a moment. It even strengthens the second category since the height difference between the ground and the bench grows tremendously, which nourishes the feeling of privacy even more.

PROLOGUE

The past year, the COVID-19 pandemic made me realize the enormous relevance of sport, movement and vitality. On the 23th of February 2021, the Dutch government announced that adults of 26 years and under could start to play team sports again. Luckily for me, this meant I could start attending my weekly field hockey training again. This had an immediate impact on my life; My 'corona-downs' were less bad, I could look forward to something again and consequently, both my physical and mental health improved.

The word 'vitality' comes from Latin 'vita', which means life. This illustrates perfectly what vitality is: a precondition for a good life. I think vitality is greatly 'vital' for the world and every individual's life. Even though not all people are actively working on or even thinking about their vitality, it is constantly present, either in body or in mind. Consequently, a 'vitality-solution' has the most extensive impact on its users and the world in general.

Vitality and my design 'LEVO' fit well in my vision of design and identity as an industrial designer. It allowed me to incorporate my ability to identify everyday-problems many people struggle with. Moreover, the aforementioned value and importance of vitality stimulated me to create a design that would have the greatest impact possible. I did this by applying one of the most prominent aspects of my professional identity: designing a WOW-effect.

In accordance with the vision of the Vitality Squad Project (Vitality, n.d.), LEVO is an interactive device that motivates one to exercise more in a fun and appealing way and that is able to realize change with regard to one's vitality in the long term.

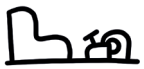
INTRODUCTION

In this society, a quarter of the world population does not exercise enough (Guthold et alii, 2018; Loket gezond leven, 2019). A possible solution to this is to redesign the public space so that people are stimulated or even forced to move more. With this, the goal should be to integrate activity into their daily routine since it will be more appealing to participate.

The problem identified for this project is the problem of sitting down. Nowadays, many people sit down for the majority of their day. This is greatly damaging for their physical health. (Bruin 2015). Apart from sitting down inside, the park bench gives people the opportunity to sit down even when they are outside. This way, the park bench contributes to the deteriorated vitality and health of the average person. For this project, the park bench is researched, this problem is analyzed and a solution is presented.

This solution presented is called LEVO, which is Latin for 'I elevate', 'I relieve' and 'I strengthen'. Moreover, it's an anagram for vélo, the French word for 'bike'. The design-approach was mostly vitality-oriented, namely to create a bench that stimulates its user to exercise while using the bench. This might seem paradoxical, but LEVO provides this opportunity by letting people only exercise with their legs, which is exactly the body part that they do not use enough when sitting. LEVO can be enjoyed for every regular bench activity yet provides an upgraded experience since only the legs have to be used for the exercise. This way, users can experience a private and calm environment up in the sky.

Research question: How can the concept of the park bench be redesigned for people from 12-99 who are not physically impaired, so that it stimulates the user to exercise in an accessible way and thus improves their vitality?



CONCEPT DESCRIPTION

In a public park, a passerby wants to take a break and sit down on one of the many park benches. They might want to have a chat with a friend, or read a book. Alternatively, they might want to have something to eat or enjoy the surroundings. The passerby sits down on a LEVO. They put their bag on the designated spot, under the chair. After adjusting the pedals to the distance that fits the length of their legs, they start pedalling. As soon as they start pedalling, the bench rises up to a maximum height of 2 metres and 20 centimeters. If the user stops pedalling, the bench lowers. At any time, the user can start pedalling again and the bench will rise. If the bench has reached its highest point, the user has to keep pedalling to stay there.

When the user is 2.20 metres up in the sky, they can do whatever they would want to do on a regular bench; read, make a phone call or enjoy the view. Nevertheless, due to the distance on the ground, their experience of these activities enhanced. They sit in a calm environment, far away from the busyness on the ground.

It's a great way to take their mind off of things without disrupting their routine. To enhance the sociability of this product, in accordance with risk ID 20 from the Design Risk assessment (Appendix H), multiple LEVO's can be placed next to each other to create an effect of interactivity, play and privacy. For example, two users on two separate LEVO's can have a fun competition on who is the fastest or collaboration with the purpose of staying on the same level and rising alongside each other. Once up, they can enjoy an exceptional private conversation or just each other's company.

LEVO might seem a paradoxical object. The affordance of a chair is to sit down, but the affordance of pedals is moving your legs or even transporting yourself. In general, affordances get people ready to act on them, which is called bodily action readiness (Tedx Talks, 2015, 01:40-02:38). With LEVO, the regular affordance of a chair is restructured and might cause a clash in the bodily action readiness which eventually, in the long term, will generate behavioural change.

Figure 1: LEVO

CONCEPT VALUE

Many working people have a sit-down job. This, together with the most common form of leisure, i.e. watching tv or Netflix which requires sitting down, causes many hours being in a sat-down state. Even if people want to go outdoors or exercise they often do not have enough time to fully carry this out. Moreover, a quick walk around the park does not always have the effect desired; A duration of at least 20 minutes is required for an effective walk. (UW health, n.d.; Hersenstichting, 2020). This means that it is not sufficient to walk to the park for e.g. 5 minutes, sit down on a park bench there for some time and walk back. Sitting down interrupts the period of movement and thus interferes with the improvement of health and vitality.

LEVO responds to this issue by allowing the user to continue their movement while sitting down and relaxing. The advantage is two-fold. On the one hand, users can complete their 20 minutes of movement. On the other hand, users can maximize their time of leisure by combining exercising and relaxing in their short amount of available time.

Another pain users deal with is the amount of work and trouble that has to be put into exercising (e.g. planning, preparing, travelling). LEVO provides a solution to this pain by presenting a product with a very low-threshold. The user can stop by whenever they want and the product is easy-to-use. Almost every user, definitely in the Netherlands, will immediately understand what to do: put your feet on the pedals and start pedalling. No special attire or even social interaction is necessary to use and fully experience LEVO.

A final, however greatly important, pain is the stress and busyness many working people experience. LEVO can relieve this by improving their existing relaxation experience with valuable additions. The fact that the bench heightens and thus lifts the user up is beneficial in two ways. It distracts the user of their daily life due to the feeling of an amusement ride and the excitement of rising up in the sky. Second, the calm environment provides the user with a higher level of relaxation.

For purchasers, the value is essentially the same as for users. Possible purchasers buy a LEVO for their own audience, clients or visitors to be used. This can vary from festival and their festival goers to municipalities and their inhabitants. In sum, the goal of these parties is to take care of the wellbeing of their target group and/or improve their experience. LEVO can assist with that using the aforementioned gain creators and pain relievers.

Next to the individualistic consequences of LEVO, it has a positive impact on its surroundings. Since it takes up quite a big space it has a great influence on the area it is in. It heightens the image of the location and creates a feeling of fascination and happiness for bystanders. In addition, this impact seamlessly fits the Dutch environment it's primarily placed in. The Dutch all know and like to cycle so will all understand the basic affordance of pedals. Moreover, since the Netherlands are so flat, LEVO can enrich the lives of the Dutch by offering them the opportunity to switch levels and see their landscape from a different perspective.

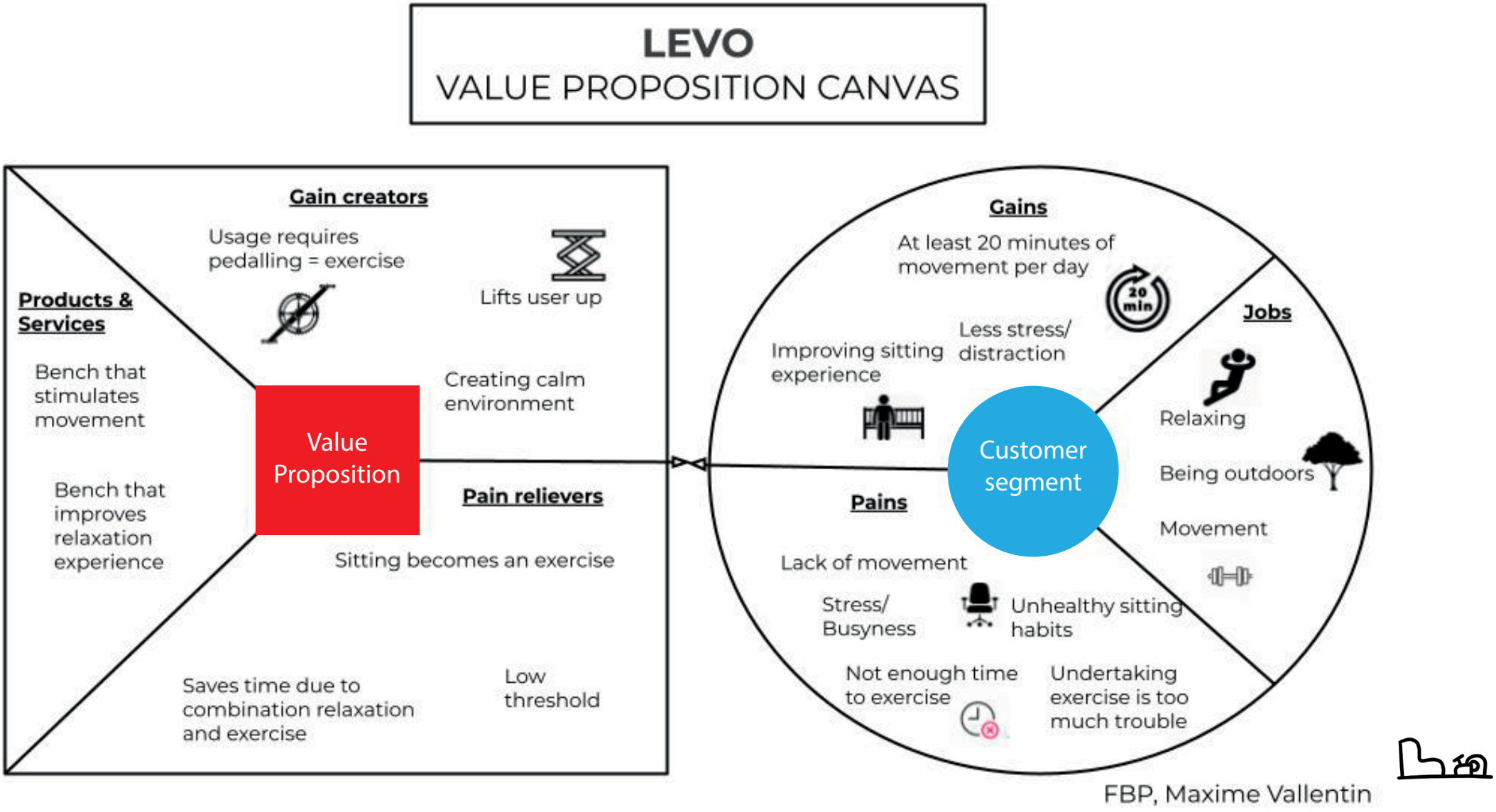


Figure 2: Value Proposition Canvas

PROTOTYPE

LEVO consists of a comfortable chair with two armrests and a seat that is slightly tilted backwards, which provides an extra feeling of safety. The pedalling set and wheel are placed on an adjustable guiding system for users with different lengths. The pedaling set is connected with the platform using conducting rails. These are attached to the platform on the one side and to the pedalling box on the other side. The chair is provided with a seatbelt for safety reasons. Directly beneath the chair, an open space is designed for the user to place their bags or coats. Moreover, the seat of the chair is designed with little planks that are slightly separate so that potential rain will fall through and the chair dries faster.

Figure 3: Chair

The product has been assembled in such a way, using bolts, that it is easily deconstructed. This way, LEVO can be easily transported and built up somewhere else. The chair, bike and platform are all loose components, which are designed to be put together and taken out with ease.

The device consists of two separate electrical systems. The first system is the scissor lift which has its own security system, a hydraulic pump and two foot pedals for control. The second system is an arduino with a current sensor, dynamo, two relays and a push switch. Both systems operate separately but are connected through the foot pedals of LEVO. The two relays are connected to the two foot pedals. One is for up, one is for down. This way, the system can control the lift but the other system, inherent to the scissor lift, can be used to overrule the first system. Moreover, the emergency button from the scissor lift stays active.

Figure 4: Distance setter

Onto the wheel, a dynamo is attached. As soon as the pedals are moving, the wheel starts turning and activates the dynamo. This provides power which is measured by a INA-219 current sensor. The sensor is calibrated to 30 rotations per minute. There are two relays. If the sensor measures enough rotations, the relay for rising gets activated. This relay is connected to the hydrologic pump of the scissor lift the bench is placed on. Thus, the pump gets activated if the rising-relay does. If the pedalling stops and consequently the current sensor does not measure any significant movement any more, the rising-relay deactivates and the lowering-relay starts up. Accordingly, the bench lowers if the user stops pedalling. If the user does keep pedalling and the bench reaches a height of 2 meters and 20 centimetres, a bar under the platform presses against a push switch that prevents the bench from rising even more. See figure 8-11. If the pedalling continues, the bench stays at this height and both relays are inactive.

Figure 5: Dynamo

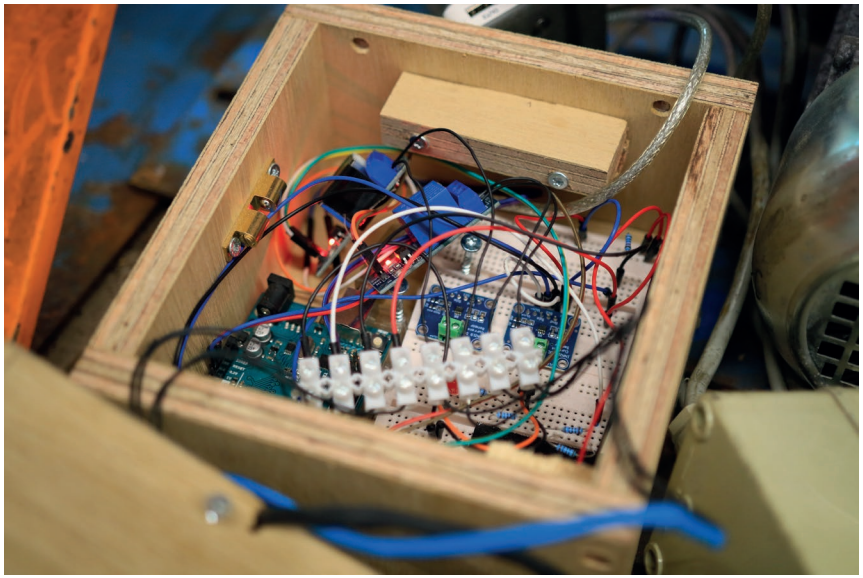


Figure 6: Computer set

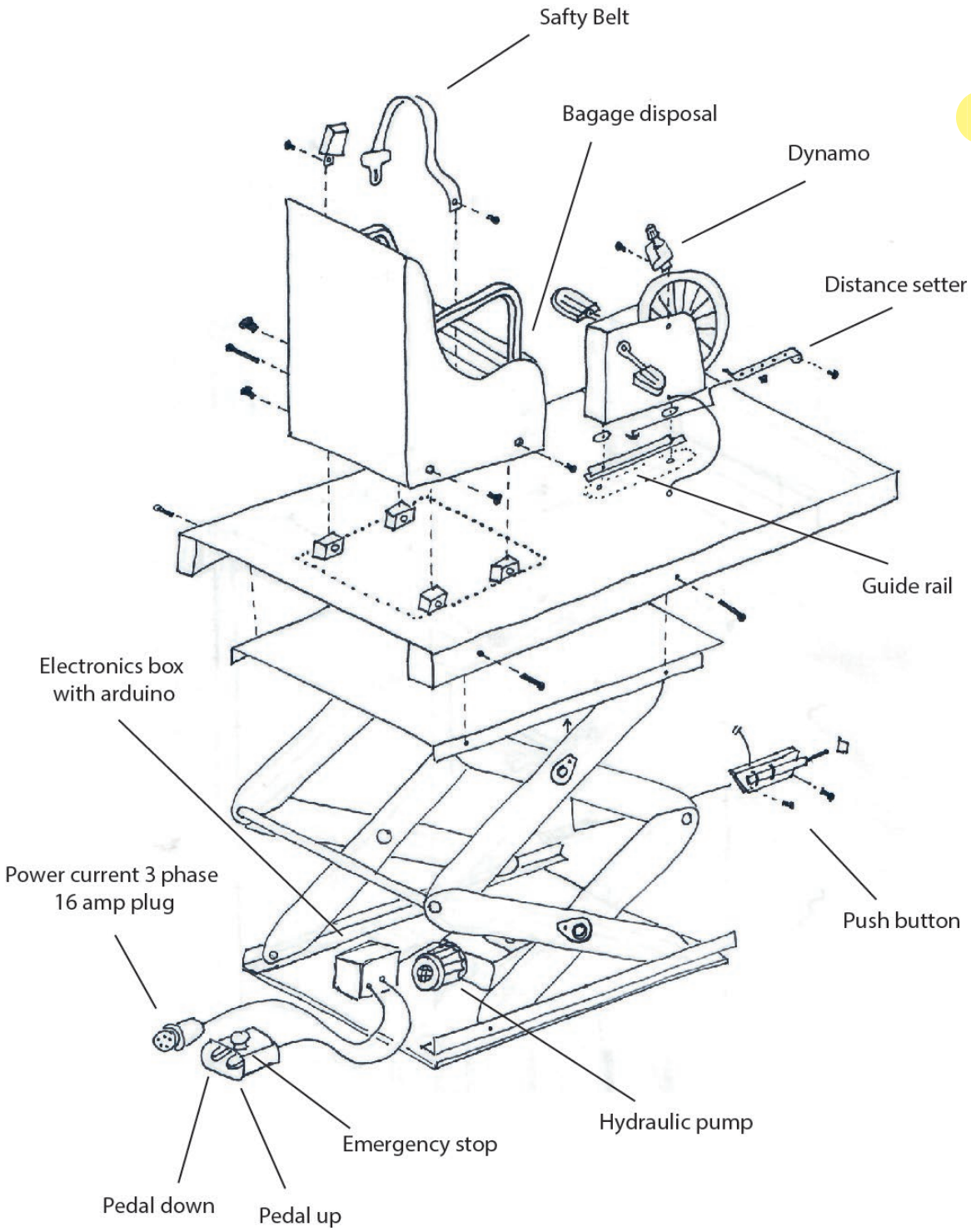


Figure 7: Technical drawing

PUSH BUTTON

To make sure that the hydraulic pump stops when the platform reaches the right height, a pushbutton is installed under the platform. The affirmed element is welded onto the metal and on top of that, the button is secured. The button consists of a copper tube with a cap with a small hole in it. On the other side, the tube is open. Through the entire tube, a metal rod is pulled through, including a conductive cap on the top and a spring on the other end. In state of inactivity, the metal cap is pushed onto two isolated electrodes by the spring, so that a closed circuit is created between the electrodes and the metal cap. Both electrodes are connected to the Arduino. If the back of the rod hits the approaching plate from the rising scissor system , the circuit is breached because the conductive cap gets pushed on by two electrodes. This way, the pump gets deactivated at the proper height.

Figure 8: Pushbutton inactive

Figure 9: Pushbutton active

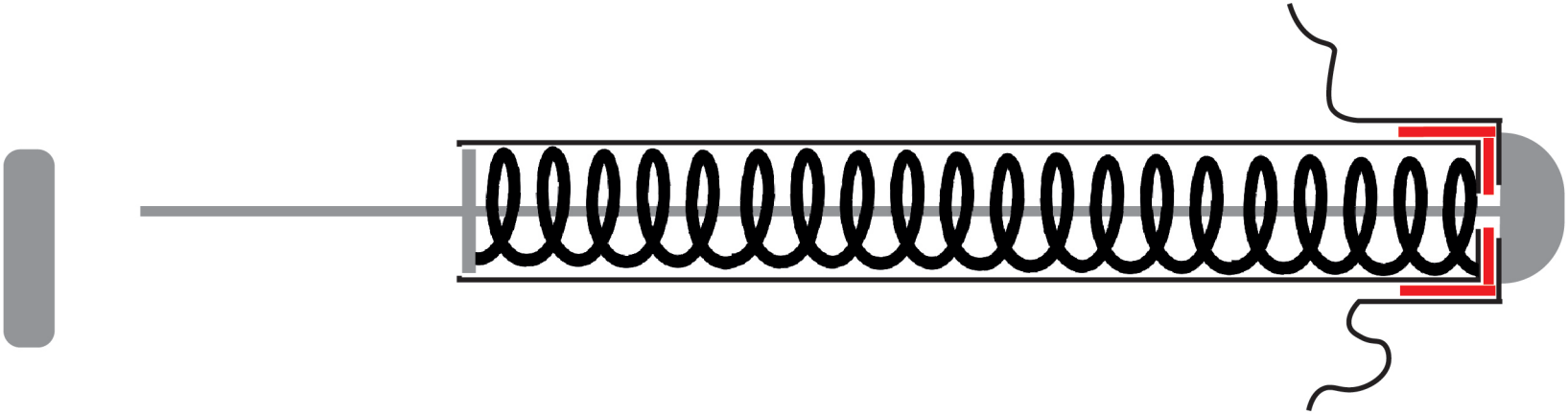


Figure 10: Schematic drawing of pushbutton inactive

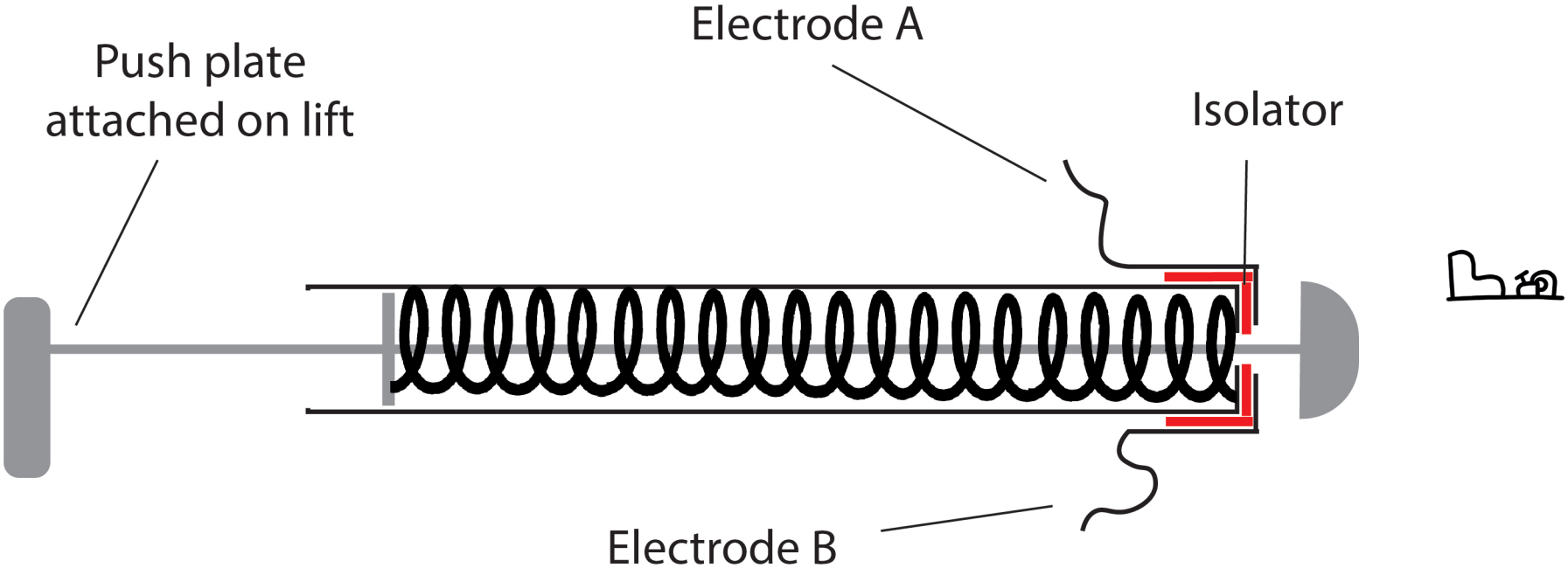


Figure 11: Schematic drawing of pushbutton active

CODING

The Arduino is connected to two devices, namely the Ampère meter (INA219) and the pushbutton. The used code is programmed as an 'if, else' statement (code is included in Appendix D). It is partly based on an example code from Adafruit (Arduino Adafruit INA219 getcurrent, n.d.).

The code is programmed in such a way that the system cannot rise any further if the push button is pressed.

The current sensor is merely capable of measuring flat signals (DC), yet a dynamo never offers a nice straight signal. In the graphic below, the output of a standard dynamo is depicted. For this reason, I took the average number of values to obtain the average voltage. As soon as that transcends a value of 2A, the lift rises.

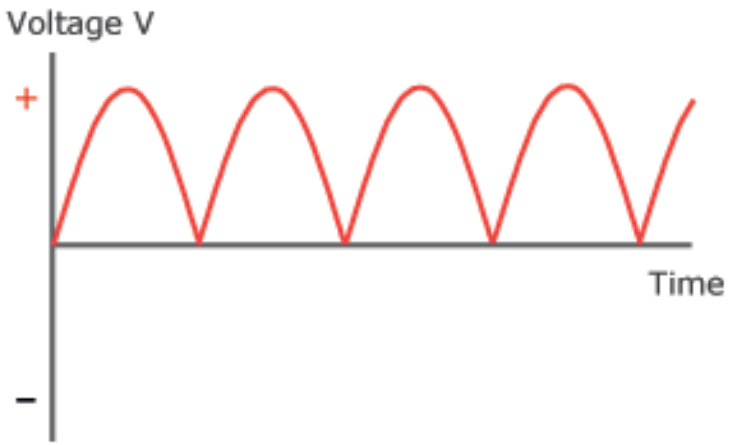


Figure 12: Graphic output dynamo (Rectified voltage, n.d.)

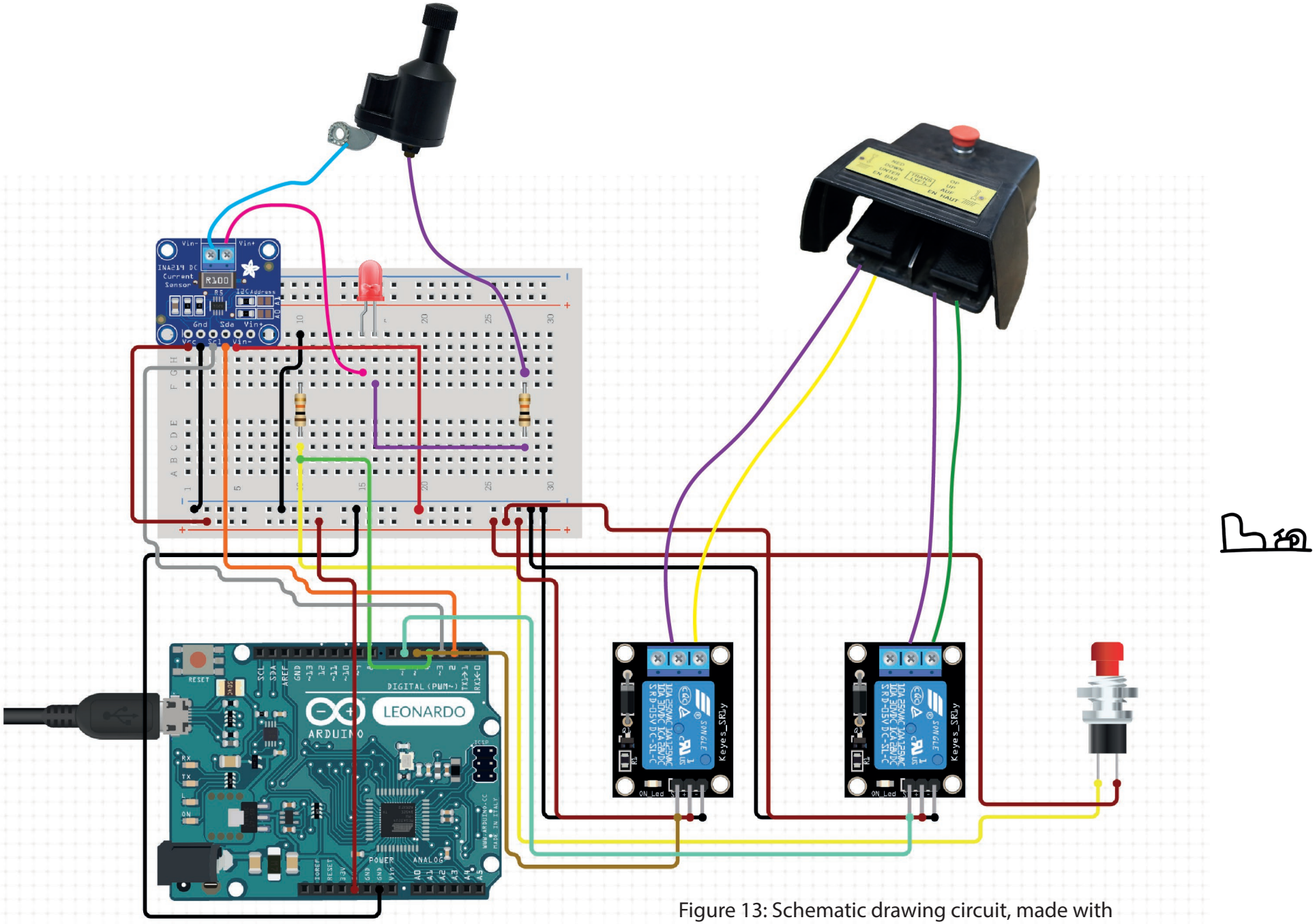


Figure 13: Schematic drawing circuit, made with circuito.io

DESIGN PROCESS

DESIGN METHODOLOGY

The methodology used for this project is the Triple Diamond, which is an adaptation by Zendesk of the original Double Diamond (Chen, 2020). This design process consists of iteration of two phases; the first is a discovery phase in which a broad perspective is applied. The second is a phase of definition in which the options are narrowed and eventually a selection is made. The third iteration is most extensive since it comprises the development of the final product.

This method fits this project best since it provides the opportunity to scan all options and consequently make a well-thought-through decision.

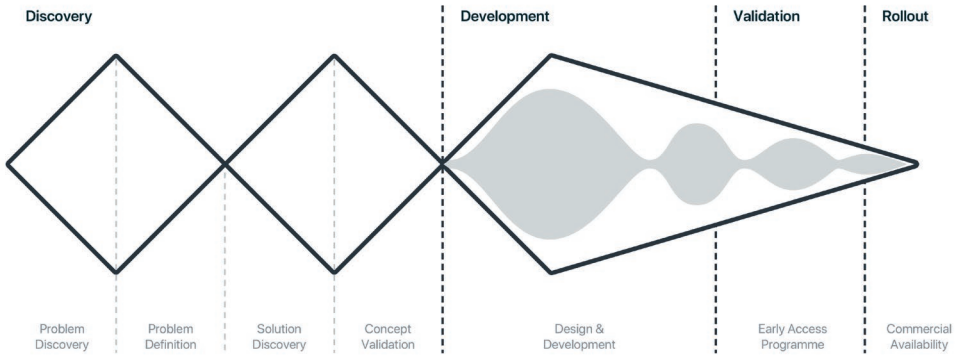


Figure 14: Graphical representation of the Triple Diamond (Chen, 2020)

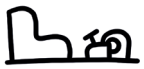
Lorem ipsum

PROBLEM DISCOVERY

I started with a broad concept definition; an installation that improves the vitality of the user in the public space. In this phase, I went outside to observe what people's routines were and whether there were any issues or possibilities. When doing so, I quickly found that almost all the people on the streets were going somewhere and did not have time to pause their travel easily. This was true for all except the people in my local park. The people there seemed to be relaxed and have time. I found it of great importance that I would place my design somewhere where people had the time to use it, since the effect of my design would be greater if people had more time to experience the design.

Because of this, I decided I wanted to design something for the people in the park. When walking around the park, I wrote down all the sports and physical activities people were undertaking. Moreover, I researched existing general literature on urban vitality, movement and parks. With this, I identified the first goals and preconditions I wanted to pursue. Figure 15 shows the first 'who, how and why'.

After I set these guidelines for myself (who, how, why), I started sketching to come up with as many design possibilities that would stimulate the user to get more active. In total, I made 55 sketches. See Appendix A for an overview.



People who are already outdoors but not with the goal of exercising/ improving their health/.

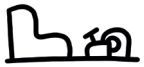
By creating a WOW-effect:
- Details
- Well thought-through

Raising a heartbeat
Taking care of people through design or unifying people

Figure 15: first identified 'who, how, why'

PROBLEM DEFINITION

Figure 16: Activities in the park.



I kept observing in the park and eventually found out that almost everyone in the park was already being active. They were either walking, running, cycling or exercising. See figure 16.

The only group that was definitely not being active was the group of people that sat on benches. This group was the most interesting and challenging for me because they had the most room for improvement.

When combining the observations I did outside and the sketches I made, I decided the bench was the object I wanted to work on.

Following that, my problem statement became: How can the concept of the park bench be redesigned so that it stimulates the user to exercise and thus improve their vitality?

SOLUTION DISCOVERY

After I identified the problem statement, I made another 25 sketches of different sorts of benches to come up with the most creative ideas possible without going in a certain direction (See appendix B). Moreover, I did a benchmark in which I researched existing benches with a twist and a literature research on benches and sitting down. Then, I did a qualitative as well as a quantitative research on bench-users and processed the results. The insights gained are explained in the paragraph 'User Research'. The most important results of this research were the reasons why people sat down on benches namely:
- Creating a private bubble.
- Focussing on each other.
- Having their hands free, e.g. to eat or call.

The literature I researched provided me with insights on the societal relevance of park benches and on the preconditions for a good bench-design. With these, i.e. the aesthetic, ergonomic and environmental elements (Please see the paragraph 'Literature Review',) in mind, I had a base for designing the bench. Moreover, the performed benchmark, as described in the heading 'Benchmark', helped me to identify strong aspects and weaknessess of existing products.

CONCEPT VALIDATION

Next, I used the collected information to reassess my sketches and ideas to identify the desired characteristics of the product. I did this by prioritizing my sketches in order of value for the identified problem. Examples of sketches that inspired me most were sketch 4, 9, 14 and 19. (See Figure 17)
From this, I arrived at the first concept of LEVO. Immediately I started building the first low-fidelity prototype. (See Figure 19) My strategy was to come up with the details of my design through realising the prototype.

This way, I came up with the idea to make the pedals on my bike adjustable so users with all lengths could use the design. With this, I started the proper validation process by user testing the prototype. The most important aspects I wanted to validate were:
- What effect does the going up have?
- How high should LEVO rise to be most effective?
- Which side effects does LEVO cause?

The user test is elaborately processed in the paragraph 'User test'.

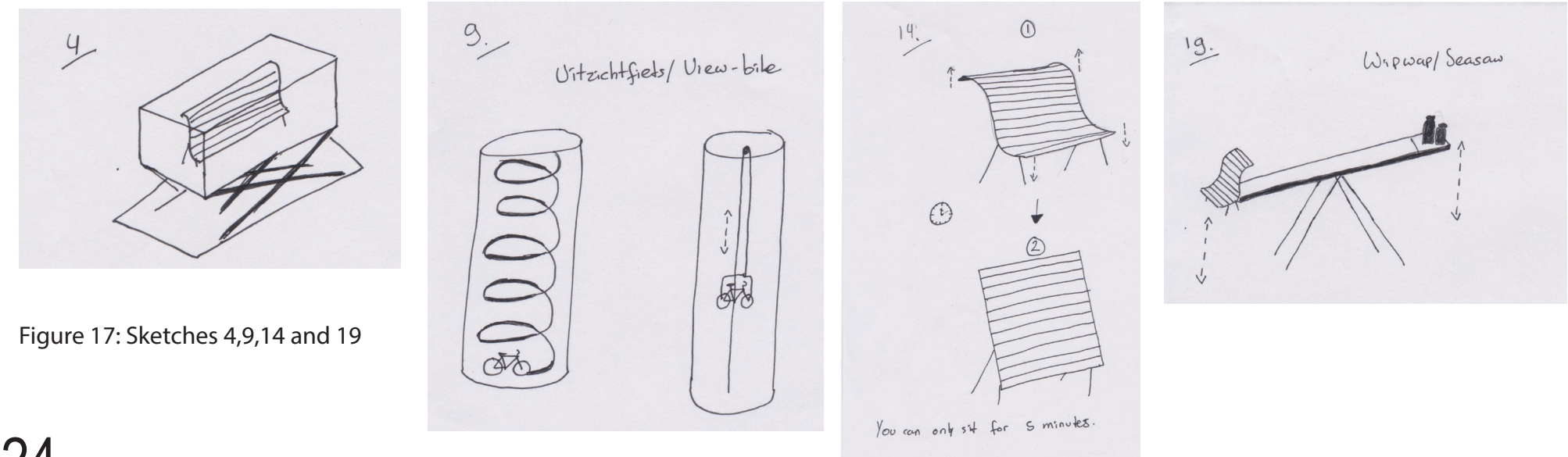


Figure 17: Sketches 4,9,14 and 19

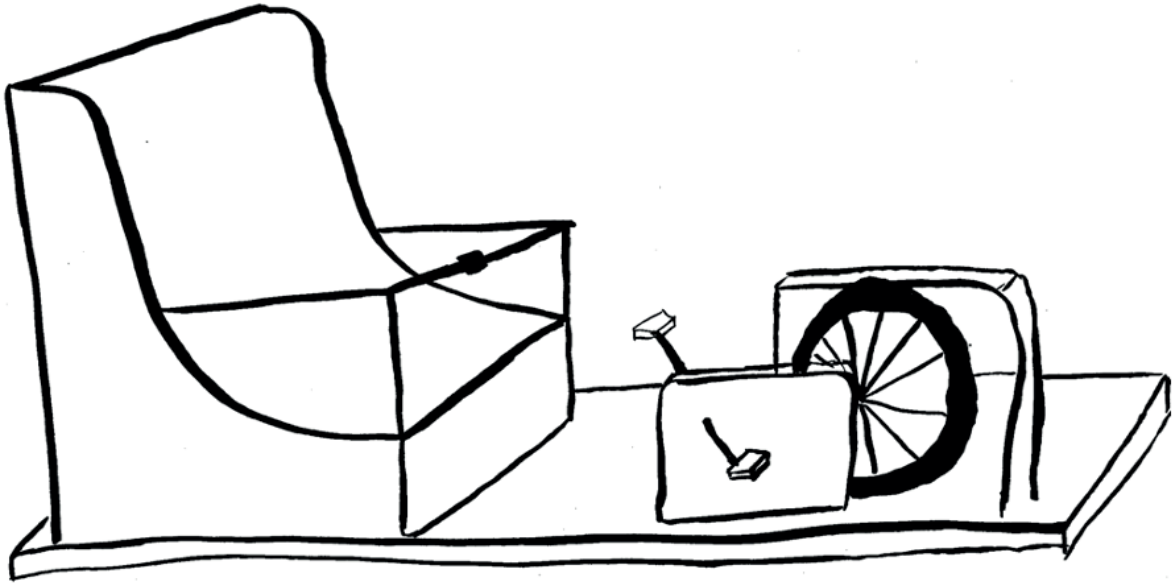


Figure 18: First concept sketch

Figure 19: Creating the first prototype

DEVELOPMENT PHASE

I directed my focus on the safety of LEVO. This was one of the main pointers of feedback I rightfully received. For this, I met up with Jan Rouvroye, risk and security expert at the TU/e, and his team to discuss the risks and opportunities with regard to safety. This was greatly valuable for the following step of technological development I was going to undertake since we discussed the safety measures that I had to undertake and they referred me to Henk Apeldoorn, electronics expert at the TU/e. He checked the electronics of LEVO to guarantee safety concerning the high voltage power. At the same time, I requested the NEN-norms applicable to this product and created a risk analysis, which I kept altering during the further progress of this phase. This Design Risk Assessment is included in Appendix H.

Subsequently, I decided the best way to proceed was to work out the business opportunities and the design at the same time. These two subjects, I believe, are essentially intertwined and interdependent since it is not feasible to contact potential business partners and elaborate on the business plan without having a worked out design. Moreover, it is impractical to continue designing without knowing in what kind of market the product would be placed and which purchasers and users it would have.

BUSINESS

For business development, I started by filling in a SWOT analysis, a Value Proposition Canvas and a Business Model Canvas (Please see the heading 'Business plan' below). This gave me insights on what elements of LEVO still had to be improved concerning the design and on who it's buyers would be. Moreover, I contacted multiple companies, institutions and organizations that might have been interested in supporting the development of LEVO in various ways or even starting a collaboration. I did receive responses from several companies but none unfortunately had the offer I was looking for. This made me decide, holding the timespan and deadlines into account, that I had to purchase the needed material myself. Moreover, I realized that I liked the idea of being independent better, since I would still be able to collaborate with everyone I wanted and to alter the lift the way I needed to.

DESIGN

Using the SWOT analysis, user test, the mid-term feedback and sketching, I worked out the design. The first issue was the lift system. The forklift I used for my first prototype was not the initial solution, so I did some research on the existing registered patents with similar mechanics. During this, I discovered the scissor lift, which is apt for LEVO since it can handle a lot of weight and has the lift mechanism stowed away under the platform. After determining the elements of the mechanism, I came up with the final design. See figure 21.

Figure 21: LEVO from the front

Figure 20: LEVO with 'levo' letters

As visible in figure, the final design was inspired by the letters of the word LEVO.

Figure 22.1: Creating the second prototype

Figure 22.2: Creating the second prototype

PROTOTYPE

Since the prototype includes a heavy scissor lift (350 kilos) which needs high voltage power, it requires a location with high power voltage and a forklift. For transportation, I arranged a suitable workshop with the requirements to work on the prototype. To limit the elavation height to 2.20 metres, I installed a stud that the lift would hit and consequently stop. Please see the heading 'Operation' for further information. After creating the woodwork and welding the stud under the platform, the chair could be assembled (Figure 22). After two weeks of challenging and intense building LEVO was ready to be used.

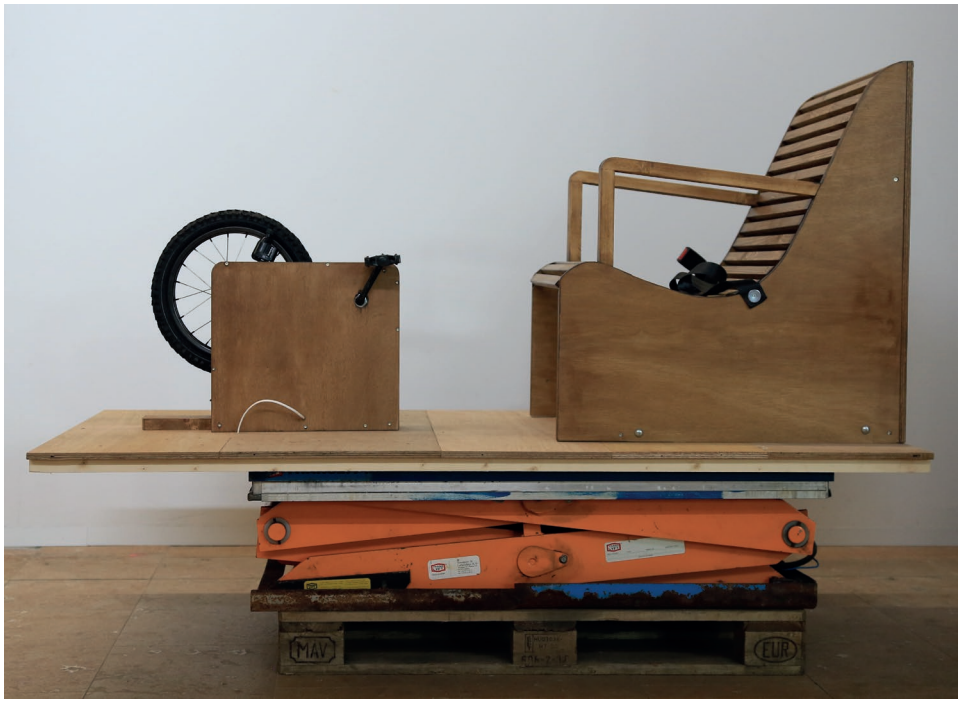


Figure 23: Final prototype

USER TESTS

My primary goal with these tests was to test whether the final, ideal design should be a bench for two or more separate chairs that could interact with each other. The tests are elaborately discussed in the heading 'User tests'.

I processed the insights I gained and created the final design. Please see also the heading 'Future Work and Final Design'.

Figure 24: User testing

USER RESEARCH

I wanted to find out what kind of people sit on benches and why they sit down by applying guerilla testing in the public park. To obtain this information, I did qualitative and quantitative research.

With this user research, I also determined the target audience for this project. It comprises people from an age of 12 onwards that walk through the park and sit on the park benches. Since this group is rather big and general, the diversity within is great. LEVO is not fit for small children and people who are physically impaired with respect to their legs.

QUANTITATIVE

First, I observed how long people sat on their bench. It turned out that the average time for sitting was fifteen minutes. However, one extreme case was ninety minutes. Second, everyone I interviewed had not taken more than 15 minutes to reach the bench. This meant they did not move actively for at least 20 minutes, which is the minimum for gaining physical benefit from movement (Hersenstichting, 2020). Moreover, this meant that the users would exceed this limit if they would have been active while sitting on the bench and would have walked back and forth the park without resting.

QUALITATIVE

I interviewed 9 people on benches after they stood up. Please see Appendix E for the questionnaire. They had various reasons for sitting down, but those reasons can be put in two categories. They either sat down to focus on each other in a more private environment or have their hands free to use their phone or eat. Their reason to stand up again was not onefold; they were just done with sitting down or had to be somewhere.

It has to be mentioned that the observed benches were in a rather quiet part of the park where people for example did not sit down while their kids were playing on the playground.

USER TESTS

FIRST USER TEST

GOAL

During the concept validation phase, I wanted to find out whether the product worked through a contextual inquiry; Whether it was scary, what the perfect height was, whether it was too much effort etcetera. My product anticipates the feeling of the user and I could only find out what emotions LEVO would call by testing. To gather the wanted information, I approached the test both in a quantitative as in a qualitative way. The quantitative test consisted of me gathering information on the duration users sat on the bench and the height on which they stopped pedalling and thus rising. The quantitative approach comprised a questionnaire. Please see Appendix F for this questionnaire.

SET UP

The first prototype was a pallet with a wooden platform. On top, a comfortable chair and sawed through children bicycle were placed. The bike was positioned on a stretched out plank with a groove in the middle. Through this groove, the bike could be shifted back and forth and be secured with a rotary knob on two bolts. This way, the pedals could be placed further or closer from the chair and were thus accessible for people from different lengths. The method was Wizard of Oz since the bench and the bicycle were not actually attached to the lifting system. As soon as a user started pedalling, I activated the fork lift. This way, for the user, it seemed like they were properly controlling the lift by pedalling and experienced an interaction. Please see figure 25.

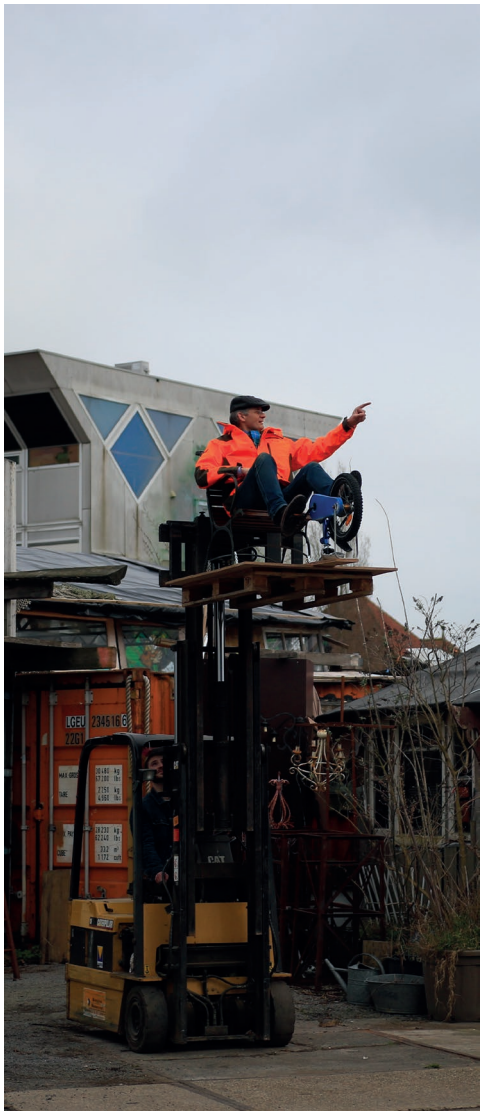


Figure 25: First user test 1

INSIGHTS

For this test, I had eleven people test out my first prototype using a forklift. Please see Appendix F for the questionnaire. The first thing I found out is that it's interesting for a view to be different from the view on the ground. An example is the difference of view in a forest and a meadow since height does not give you a new perspective in a meadow. When the view does change, someone really gets themself in a new environment. Second, the best height turns out to be 2.20 up to 2.50 metres. Lower was not impressive enough and higher, up to 4 metres, was too scary. Interesting enough, all users roughly had the same individual answer to the question of their preferred height. Third, the users stayed on the bench for about 10 minutes. This is similar to the duration people normally sit on a bench in the park, according to my research. Fourth, the people enjoyed the shape of the chair because this gave them the opportunity to relax their body and the handels gave them a feeling of safety. Finally but most importantly, every user stated that they felt like they had more privacy and that they entered a bubble of sorts when they were up in the sky. This gave them a feeling of happiness and even euphoria, which was shared with the passersby who were surprised by the product.

Figure 26: First user test 2

SECOND USER TEST

GOAL

This user test was to discover the usability of LEVO and what the interaction should be between multiple LEVO's placed next to each other.

SET UP

The second user test included the second and final prototype. The setup was the same as with the first prototype. However, the adjustable system of the pedals differed slightly, as explained in the heading 'Operation'. LEVO was placed just outside the workshop, still using the high power voltage from there. For the interactivity test, I used two prototypes placed next to each other, namely the first low-fidelity prototype and the final prototype. Users both sat on their own prototype and were in advance unaware of what was going to happen. Two scenarios were tested. With the first one, both platforms rose at the same time if the two users pedalled simultaneously. The second scenario consisted of the two platforms being controlled by their user, separately from each other. During this test, I primarily observed and consequently asked questions to the participants.

Figure 27: Second user test 1

INSIGHTS

Concerning usability, the users had some issues with the adjustable pedalbox. The conductive system has to be more robust and more clearly indicated. It might be helpful to place some arrows next to the pedalling box so people understand its moveability. The outcome of the issue of interactivity was clear since the participants agreed unanimously. They all preferred the situation in which the two LEVO's moved independently. This way, they were motivated more to pedal since they had the opportunity to compete and 'win' by reaching the top first. Moreover, they liked trying to stay at the same height by collaborating.

Figure 28: Second user test 2

FEAR OF HEIGHTS

Some people, during all three tests, indicated that they had a fear of heights. First, they were somewhat reserved but as soon as they started and the bench rose a bit, their fright seemed to wash away. They indicated that this was probably the case because they had control over the proces; anytime, they could come down. Moreover, the leaned back backrest of the chair and the fact that they could not look down directly gave them a safe feeling.

BUSINESS PLAN

The company LEVO will sell and rent LEVO's to companies. The company that organizes this and will keep improving the design is based in the Netherlands. The production of the LEVO will be outsourced to companies, preferably in Europe due to the lesser influence on the environment, that can make the LEVO's in a sustainable way for the cheapest price. Moreover, LEVO will own a warehouse where to be sold LEVO's can be stored and some LEVO's can be placed that can be rented. All the sold or rented LEVO's will stay under supervision of the company; at least once every 6 months, maintenance will be carried out. For this business model, the team will ideally start out with a CEO, a designer and a sales person. Moreover, with at least two technicians on board, LEVO can keep up with the maintenance and repair of their own products. The targeted buyer group consists of companies and institutions in the entertainment or societal industry. LEVO will not be sold or rented to individuals. Please see the heading 'Partnerships' for an elaboration. From the start, the publicity will be focused on having several LEVO's in one place by emphasizing the fun interactivity of multiple LEVO's.

Since the average start-up employee earns roughly 34.000 euros per year (Computable, n.d.), the minimal profit of the company will have to be that times five, which is 170.000 euros. The fixed overheads contain about € 107.000 per year, see figure. By researching renting fees of similar products per day, like carousels or seesaws, a reasonable starting price per LEVO will roughly be € 3.000 (Nostalgische attracties, n.d.). The selling price will be around € 60.000, based on prices of similar products (1limburg, 2015). This way, if at least three LEVO's are sold each year and 15 are rented, the required profit will be made. The total income of the company will be €225.000 per year. Roughly €40.000 of this will be extra profit. The first year, € 100.000 will have to be invested in materials, tools and marketing etcetera. This will be recouped back in 2.5 years.

SWOT ANALYSIS

The base for the business development of LEVO is the SWOT as included below. The most insightful segment was the one on opportunities. The described weaknesses are inherent to LEVO; the product simply is meant for one person at a time so it will reach a relatively small number of users per bench by definition. Moreover, because of the mechanics and safety risks, supervision and frequent maintenance will always be a necessity. The same holds for the threats; both the economic situation and the always existing urge of certain people to vandalize objects in the public space are beyond control of the responsible company. The described opportunities, however, comprised relevant pointers. After creating this SWOT, I focused mainly on the last four items: interaction, aesthetics, business and technology. For an elaboration on sustainability, please see 'Future work and Final design'.

The described strengths fit the preconditions that the Technical University of Mara in Malaysia has identified as elements for a successful park bench. The size and looks of LEVO make sure the aesthetic factor is met and the ergonomic factor is filled in with the comfort of the chair (Perumal & Rahman, 2016). Please see the heading 'Literature review' for more information on this research.

SWOT

Strenghts
Brings happiness
Improves health and vitality
Impressive looks
Height inclusive
Pedalling fits Netherlands as cycling country
Comfortable

Weaknesses
Limited reach amount users
High maintenance
Constant supervision needed

Opportunities
Sustainability
Interaction with users
Aesthetic details
Solid business plan
Technological elaboration

Threats
Prone to be misused/ vandalized
Customers might not want to invest due to economic situation

Figure 30: SWOT analysis

BUSINESS MODEL CANVAS

The stakeholders for LEVO are stated within the segment 'Key Partners'. Next to the obvious relevant party of buyers and users, some advisatory and assisting stakeholders are essential. Experts in the field of movement and safety will help to keep improving the design. Moreover, an important role is the one of supervisor, which relates to the issue of responsibility. In multiple contexts, it is not completely clear who the responsible party is for the safety of such a product. Evidently, the designer and the company behind LEVO are primarily responsible for taking measures for safety risks that can be anticipated. Nevertheless, even with safety belts, undergrounds and more, there always will be the possibility of a user climbing out on purpose. In this case, the question of responsibility is not conclusive. Signs with 'Do not climb out' and/or 'Children under 12 have to be supervised by an adult', should definitely be placed, but will not guarantee any misuse. This is why it might be necessary to encompass supervisors with every LEVO. Please see the heading 'Further Work' for an elaboration on this subject matter.

LEVO Business Model Canvas

Key Partners

Manufacturers
Movement experts
Safety experts
Buyers:
- Municipalities
- Festivals
- Insurance companies

Supervisors

Key Activities

Design
Production
Maintenance
Marketing
Interaction with investors and users for improvement

Key Resources

Materials for LEVO
Software
Patents
Publicity

Value Propositions

Products & Services
- Stimulates movement
- Improves relaxation experience

Pain relievers
- Sitting = exercise
- Low threshold
- Saves time due to combination relaxation and exercise

Gain creators
- Pedalling = exercise
- Lifts user up
- Creating calm environment

Customer Relationships

Surveys on user experience
Surveys on buyer experience

Channels

Online feedback platforms
Attendance at fairs
Partner's channels
Instagram

Customer Segments

Customer jobs
- Relaxing
- Being outdoors
- Movement

Customer pains
- Lack of movement
- Stress
- Unhealthy sitting habits
- Lack of time
- Exercise = much trouble

Customer gains
- 20 min movement
- Less stress
- Better sitting experience

Cost Structure

Expenses
Materials
Rent workspace
Personnel

Revenue
Sale products
Advertisement
Funding

Revenue Streams

Selling products to municipalities
Selling products to festivals
Selling products to insurance companies
Government fundings

Maxime Vallentin for Levo 2021 16/04/2021

Figure 31: Business Model Canvas

PARTNERSHIPS

For LEVO, as for many other similar designs, the user will most likely differ from the purchaser. In some cases, this means that the purchaser will buy LEVO for their own commercial purposes, audience or clients, such as festivals or museums. In other cases, organisations such as municipalities can buy a LEVO from a societal point of view. In that case, LEVO can contribute to creating an urban sports landscape, which is three fold beneficial, as described by Zhang and Kazerooni (2016) in the heading 'Literature review'.

I reached out to a great variety of possible partners, such as insurance companies, institutions for entrepreneurial support, festivals and the municipality of Amsterdam. Unfortunately, none of the contacted parties viewed LEVO as the perfect fit for their intentions. Some were only able to offer purely financial support and some did not have an opening in their programme, many times because of COVID-19 and its implications. Even though I did keep trying and had several meetings with somewhat interested parties, like PIM academy (Online Academy, n.d.), I did realize at the same time that merely financial support would not be helpful enough and that maybe I was not at the right stage to engage in such collaborations.

However, during the user test of the prototype, I ran into someone with an interesting background. He turned out to have a useful position at NEMO, a science and technology museum in Amsterdam. He told me about an exhibition about energy he was putting together and showed interest in LEVO. After some contact back and forth, he had pitched LEVO both within and outside NEMO. An adjacent company called 'La Bolleur' also showed interest. This possible collaboration is currently still in progress.

This showed me that for cases like this, it is way more effective to have face-to-face contact with possible partners and investors. Parties can understand better what LEVO is when they see it with their own eyes and experience it. This way, I added valuable knowledge to my understanding of business and entrepreneurship.

MARKET VALIDATION

The market validation for LEVO will still have to be researched further might it come to realization. However, multiple indicators point at probable success and room for LEVO in the current market. First, the fact that all participants of the user test were enthusiastic, did not have many pointers of feedback and that unplanned passersby were also interested and fascinated by the product indicates that individuals are vacant for the product. Second, two companies, namely NEMO and Design studio La Bolleur, have already shown interest in using LEVO, for example for the opening of a new exhibition. Third, some of the parties that were contacted unfortunately did not have the means to collaborate at this moment but did have a positive response to the concept. These testimonials of both possible users and buyers indicated the room there is in the market.

RENAMING

For reasons of intellectual property, the name of this product will eventually have to be altered, might it come to realization and launch on the market. A swiss company that produces, amongst others, lifts for the disabled holds the name 'LEVO' (levo, n.d.). Moreover, an European wide bicycle company is called 'LEVO' as well. It would be untenable to launch this product with its current name since these companies will most likely undertake action. Consequently, this product will be renamed 'LEVAS'. This derives from the same stem as the previous name, i.e. 'levare' in Latin. In this second person singular declension, it means 'You elevate'. This is a sustainable name since this brand is not indicated in the EU trademark register, thus to date available for usage.

LITERATURE REVIEW

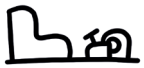
A healthy urban environment is of great importance for a city and its inhabitants. Zhang and Kazerooni (2016) have distinguished three reasons to create an urban landscape that provides the people with the opportunity to be active. First and foremost, the activity is healthy for the users. Second, individual projects, objects and initiatives strengthen the sports culture in the urban environment. This improves the image and cultural power of the city. Finally, every sports-stimulating concept inspires other designers to create for the sports culture. Another valuable point that these researchers make is that every city is its people's city. Designs that stimulate activity are able to contribute to this concept by letting the city, the people, and in some cases even nature, harmonize. Amongst others, this can be done by taking already existing objects in the urban environment and upgrading them. In this research, this focus lays on one of these objects, namely the park bench.

In the scientific discourse, the bench has been an important object of research in several fields. Furthermore, the more general topic of sitting down has been even more present, in scientific publications as well as in non-scientific media. An important example is the dutch book 'Zitten is het nieuwe roken' ('Sitting down is the new smoking'). Written by a magazine-editor, it portrays her personal standing-up story during which she researched the consequences of sitting-down all day. To a great extent, she describes why sitting down is such a bad habit by quoting dozens of scientific researches. For example, extensive research of Dutch vitality shows that the existing standard of sitting-down starts at a very young age. On average, dutch children between the age of four and seventeen sit 8.5 hours a day (Kenniscentrum Sport en Bewegen, 2019). Another research has shown that those same children are not meeting the vitality standard of the WHO (Bruin, 2015).

The bench as an accessory in public parks has also been researched, for example by the Technical University MARA in Malaysia. Their research on ten different benches in a Malaysian park shows that two factors play a vital role in the user-friendliness of a bench. On the one hand, the bench should be comfortable, safe and easy-to-use. This is the ergonomic factor. On the other hand, the bench should look pleasing, beautiful and exciting; the aesthetic factor. (Perumal & Rahman, 2016) These are premises on which every bench design should be based. According to my research, this design model lacks one important precondition of a bench, which comprises the environment. This is elaborately discussed in the user research paragraph.

Priandika et alii (2021) agree with this aspect of environment and moreover define harmonizing with the environment as an important element in the park bench, which most designers or municipalities have not taken into account for many years. Their research aims to create a design model that makes benches sustainable. They identified three issues regarding the sustainability of existing bench models. First, many benches are damaged quickly because the wrong material or structure was used. Second, benches made with iron are uncomfortable because of the sturdiness and the heat intake.

Third, many benches have not been designed for the specific location they will be placed in. This results in an unharmonized object which is not appealing to use. As a solution for these problems, Prindika et alii designed a bench and chair that is functional as well as valuable in their specific environment. As the main material, HDPE plastic from a waste bank was used, which is very strong compared to other common plastics. To make sure the benches could take a natural place in their environment, they turned some of their stools into planters so the nature of the park could keep growing between the benches.



This bench was designed for a different problem than the one I identified for this research. My problem statement reads: Benches are not functional since they only require people sitting. My approach to this problem is twofold: Benches should stimulate activity while still maintaining the essence of the bench. The essence of a bench, as my user research demonstrated, is that it gives people the opportunity to be in their own world for some time. A few existing benches I researched identified a similar problem and used a similar approach. Examples are the Bench Go Round, the Hidden DIY Hydraulics (Figure 33) and the WeWatt bench (Figure 32). Please see appendix C for all references to the benchmark products. All of these designs are based on the fact that benches are unhealthy since they promote sitting and not moving. They provide a solution for this problem by stimulating the user to get active. In the case of the Hydraulics and the WeWatt , this activity rewards the user for exercising. Another important example in the benchmark is the waterbike. This is essentially the same concept as LEVO, since it lets people be together, create their own world and exercise through pedalling. However, the main difference is an important one. With the waterbike, one gets rewarded for pedalling by moving forward, on the pond. This is the standard for pedalling; namely transporting your moving forward. LEVO provides this reward in a new, innovative and fun way namely moving directly up.

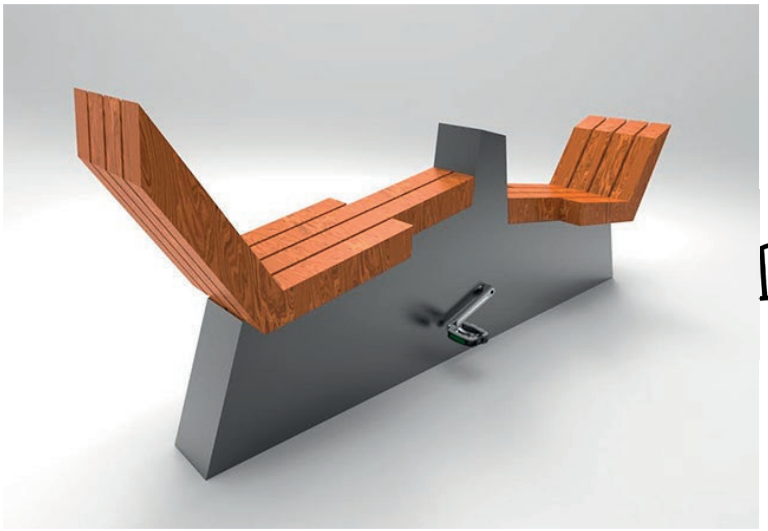


Figure 32: WeWatt (wewatt-outdoor, n.d.)

Figure 33: Hidden DIY Hydraulics, n.d.

Next to these products that used a similar approach to the LEVO, namely to stimulate activity, there are products that answer the same problem but provide a solution with a different approach. The main examples in the benchmark are the Community Wall (Figure 34), the Shape Changing Bench (Figure 35) and the seesaw. All of these aim to reevaluate the concept of the bench and create a valuable and fun addition to the seating-function. However, the designers did not choose to do this by an addition that stimulates movement. Instead, they focused on digital interaction (Community Wall) or on bringing people together by creating an 'odd' bench (Shape Changing Bench).

Finally, some designs used a similar approach to find a solution to a different issue. For example, the Recumbent Bike (Figure 36) identified the problem of senior citizens not exercising enough. They created chairs, suitable for elderly, with pedals on them to make them move their legs. Next, some office workers place the DeskCycle (Figure 37) under their desk to make sure they move more during their office hours. Both designs had a different starting point when coming up with the pedals for exercising.

Figure 34: Community Wall (Image, n.d.)

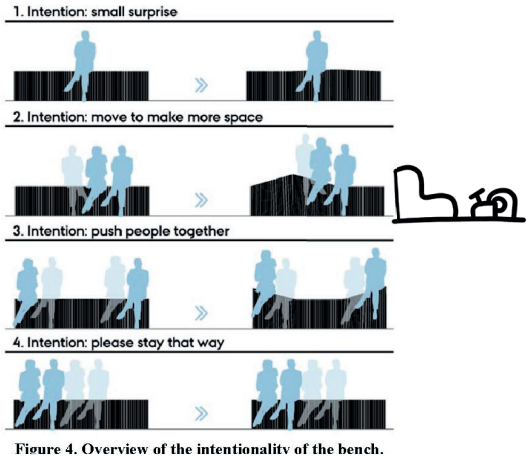


Figure 35: Shape changing bench (Figure 4, n.d.)

Figure 36: Double Recumbent Bike, n.d.

Figure 37: DeskCycle (Bureaufiets, n.d.)

BENCHmark

An interesting category of similar products is the one in which sitting is merely the secondary function and the first function is pragmatic or entertainment. This includes the seesaw, a swing and the bike. Even though the goals ranking is switched around in comparison to the functions of LEVO, this category is still relevant since it creates an experience by letting people exercise while sitting down. This shows that sitting and moving do not exclude each other. An example is the musicality swing. A swing in itself is already something that requires sitting and moving. By adding the musical aspect, the designers have created an experience. Another relevant example, with a focus on pragmatics, is the leaning rails at bus stops. This is used for a combination of sitting and standing, i.e. leaning.

In the Benchmark visual, it is clearly visible that the best category is the aesthetic aspect of the designs. The reason for this is probably that most designs are made for inside a park and that even if one will not use the design, they will still see it. See figure 38 for examples of described products that excel in the aesthetics.

Another interesting point is that only one design scores five points on the comfortability aspect, namely the Curve Seats. I consider this as a huge missed opportunity for the remaining designs since, as my personal research and the one of MARA university in Malaysia, show, the comfort of a bench is a crucial precondition of its success. See figure 39 for the Curve Seat.

The accessibility of existing products is a relevant element. The observed products were not made with the intention of accessibility, mostly because the included products are not designed for intuitive usability, but with the intention of creating a fun and exciting experience. I view this as a missed opportunity since the product can reach way more users and create more effect if the threshold to utilize it is low, especially when it concerns a product for sports. The operation should not be so complicated that users have to figure out how to work it.

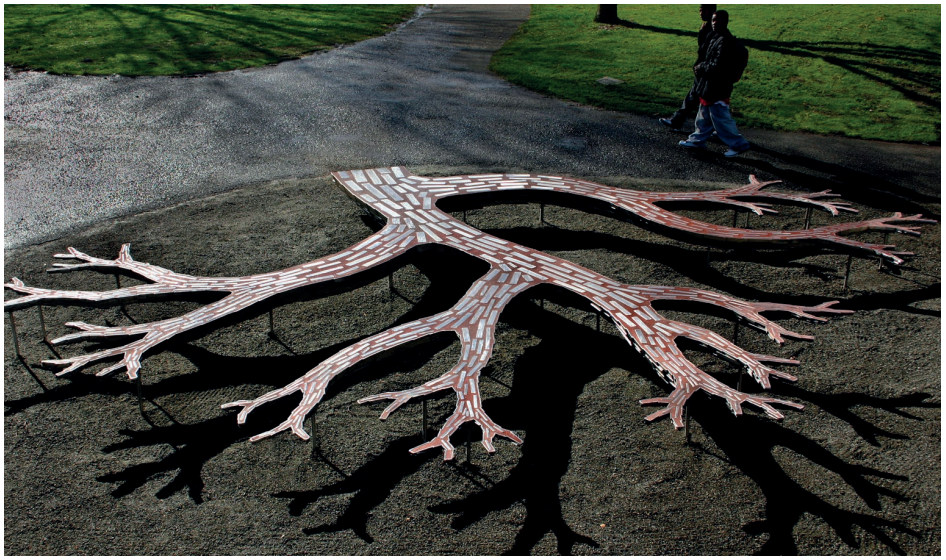


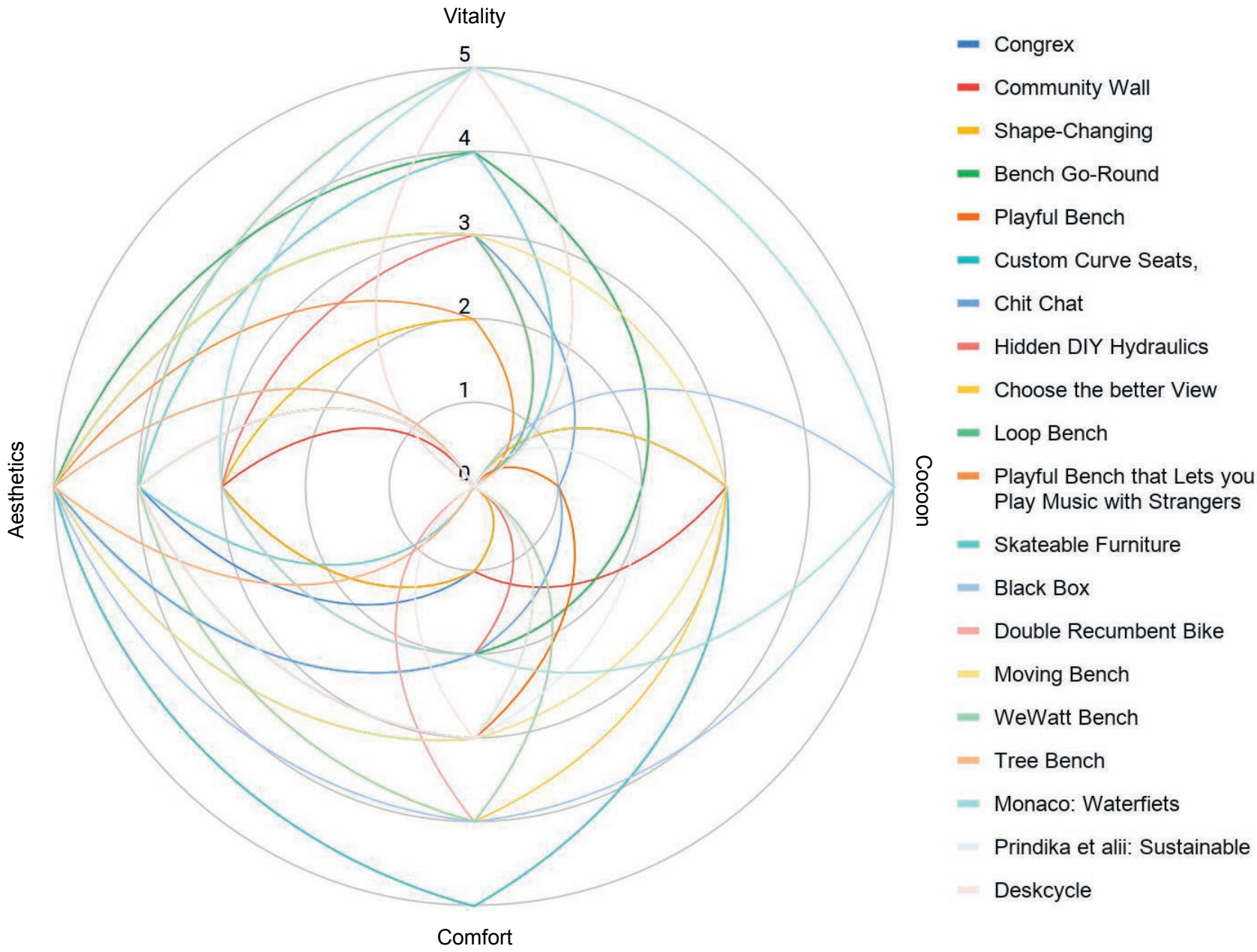
Figure 38.1: Tree bench, 2013

Figure 38.1: Chit Chat, n.d.

Figure 38.3: Bench-go-round, 2015

Figure 39: Custom Curve Seat, 2010

BENCH mark


Vitality
5
4
3
2
1
0
Cocoon
Comfort
Aesthetics
Congrex
Community Wall
Shape-Changing
Bench Go-Round
Playful Bench
Custom Curve Seats,
Chit Chat
Hidden DIY Hydraulics
Choose the better View
Loop Bench
Playful Bench that Lets you Play Music with Strangers
Skateable Furniture
Black Box
Double Recumbent Bike
Moving Bench
WeWatt Bench
Tree Bench
Monaco: Waterfiets
Prindika et alii: Sustainable
Deskcycle

ARTIST IMPRESSIONS

Figure 40: Artist impression - enclosure imprints

To portray the ambience and environments LEVO could be placed in, three artist impressions are included. The one above depicts possible imprints on the enclosure under the platform (Figure 40). The second impression shows multiple LEVO's in a park (Figure 41) and the third a single LEVO in the dunes (Figure 42).

 Figure 41: Artist impression - park

 Figure 42: Artist impression - dunes

FUTURE WORK & FINAL DESIGN

In the current design, there is still valuable space for sustainability and durability, as described in risks number ID 16 and 17 (Appendix H). For example, the high voltage power could potentially be replaced with a different energy source, such as actual strengthened power of the dynamo. This way, LEVO will not need any external power at all and will be better for the environment. A supplementary advantage of the first consequence is that LEVO can be placed in remote locations where there is no power available, such as nature reserves. Moreover, further research should be conducted on the possibility of using sustainable materials for the production of LEVO. When regarding the three issues Priandiika et allii have identified, as described in the heading 'Literature review', two are relevant for LEVO. Since the current design does not contain any iron, the third issue is not of importance (Priandiika et alli, 2021). The first relevant pointer is to use materials that will last long. Currently, the used wood and mechanics might be too fragile. To make sure LEVO can last as long as possible, further research has to be done. Moreover, in case of official realization, the element of location will have to be observed more elaborately. As described before, a LEVO fits in various locations, from festivals to parks. More thought has to be put in whether there have to be different executions of LEVO to fit different locations.

As stated in the heading 'Business Model Canvas', it still has to be researched whether it would be necessary to place a supervisor with every LEVO. This research can only be done by checking in with relevant testing bodies such as the dutch Voedsel en Warenautoriteit (Home - NVWA, n.d.) and DEKRA product testing and certification (Consumer Electronics & Electrical, 2020). Moreover, as explained in the Business section further research on the market validation has to be conducted.

As explained in the heading 'Renaming', the name of LEVO will have to be altered in case of an official launch. I propose the name 'LEVAS'. In the future, LEVO will have to be finetuned with regard to the safety measurements. The current belt might have to be replaced by something more secure, like a metal bar. When LEVO rises, a metal enclosure will rise directly below it, so that no one can be under the bench and be entrapped. This answers risk number ID 8 and 14 (Appendix H). Moreover, the wheel will be closed off with an enclosing box of perspex (risk ID 6) and the ground below and around LEVO has to be of a soft material that can somewhat intercept a possible falling user if necessary (risk ID 9). The platform LEVO is placed on will be of anti-slip materials (risk ID 11) and will contain a sensor that measures whether something or someone else is standing on the platform (risk ID 10). In that case, LEVO will not rise and will lower if the rising has already begun. Finally, a low fence has to be placed around the platform with a gate that children cannot open (risk ID 5) and signs have to be placed that state that children under the age of 12 cannot use LEVO and that this is the responsibility of the adult or supervisor.

All specifics and measurements have to be checked by comparing them to the proper European NEN norms, including the applicable requirements for such a device. I suggest consulting both norm NEN-EN 1176-1, Playground equipment and surfacing - Part 1: General safety requirements and test methods (NEN-EN 1176–1:2017, n.d.), and NEN-EN 13814-1, Safety of amusement rides and amusement devices - Part 1: Design and manufacture (NEN-EN 13814–1:2019 en, n.d.). These norms have to be examined and interpreted by experienced parties.

The system of LEVO will have to be altered. Currently, the security is installed in such a way that the lift stays put if the power goes out. Instead, the lift will have to lower slowly if this happens so people can always get off. Moreover, an emergency button will have to be installed next to the chair that switches off in case of the power malfunctioning (risk ID 3, 4).

In the future, it could be researched whether different kinds of LEVO's would be successful. Exemplary options are to create a LEVO for kids or for people with a disability. There also lie opportunities in the area of interaction. For example, LEVO could be programmed in such a way that the pedals give more resistance as the user pedals longer.

Finally, as stated in the DRA (Appendix H), more small or bigger adjustments have to be made such as a more clear indication that the pedalbox is adjustable by putting arrows along the side.

DISCUSSION & ETHICAL CONSIDERATIONS

COVID-19

As I started my Final Bachelor Project, the COVID-19 virus and the corresponding safety regulations were in full effect. This had some prominent influences on my process and thus eventually my design. First of all, I design and explore by prototyping a lot. Not being able to use all the facilities on the campus had a big impact on this. Moreover, not being in face-to-face contact with other students was hard and going through a creative process was not as smooth as possible. Second, I think the whole process was slowed down because of the constraints. I could not reach stakeholders and users as easily since many people were preoccupied with the regulations and their consequences. They did not respond as fast as they would have in a normal situation or they did not respond at all.

Safety

The safety risks of LEVO are an important discussion pointer and the most important ethical consideration. The current prototype does not suffice and cannot guarantee safety for every possible user. The installation will have to be checked by the required authorities and will definitely have to be altered in such a way that it meets the requirements from the corresponding national, European or even universal norms.

Please see the heading 'Future Work' for elaboration on this matter. With the current design, it is always possible that an accident happens or that due to various reasons, a malfunction occurs and endangers the user.

Limited test options

Because LEVO requires high voltage power and a lift of some sort to fully operate, the possible locations for it to function are limited. This resulted in LEVO only being tested in one location. This led to an unilateral test and improper results. However, since the participants mostly did agree I still believe the current concept is apt for the market. Might it come to full realization of LEVO, it will first have to be tested on various locations. Moreover, LEVO has not been tested yet outside of the context of a usertest. This means that I, as researcher, was always present and coördinated the whole process. It will be insightful to test LEVO without this influence, to find out what people intuitively do when they encounter LEVO. This way, it can also be researched for how long people use LEVO if there is no external party present. In sum, an unmoderated remote usability test will have to be executed.

CONCLUSION

LEVO is a redesigned park bench that stimulates its user to exercise in an accessible way by requiring them to pedal to reach great heights. It addresses the pressing challenge of over-sitting, which has damaging effects on the mind and body. In current society, the majority of people sit down many hours per day, which can cause serious and long-lasting health issues. To answer this challenge, the taken approach consists of creating a bench that honours people's wishes with regard to benches but makes them move their bodies at the same time. The provided solution comprises leg exercises, which are the main body parts that directly suffer from sitting down too much. During this research, user tests and observations gave insights on the essential concept of the bench and the needs of its users. Sitting down means relaxation and having your hands available for other activities such as eating or making a phone call. Moreover, it provides the opportunity to enter a somewhat private environment which is especially valuable for conversations between multiple people sitting on a bench. LEVO can contribute greatly to various environments, such as the public urban landscape, since it provides users a way to get more exercise done. It is preferable over other similar solutions due to the low threshold and the possibility to utilize LEVO without disrupting your routine. Next to this individualistic purpose, LEVO as an object in itself and as the provided activity pose a valuable addition to the landscape it is in. This way, it also has a positive impact on the area it's placed in and on the surroundings and bystanders. LEVO upgrades the space around it.

ACKNOWLEDGEMENTS

Loes van Renswouw (L) and me (R)

First and foremost, I would like to thank Loes van Renswouw, Susen de Lange and my assessor Aarnout Brombacher for their valuable support, advice and tips throughout the process. Moreover, Carine Lallemand and Rhys Duindam helped me greatly by offering feedback and being prepared to think along. Next, I would like to thank Jan Rouvroye and Henk Apeldoorn for their valuable help.

For the assembling and creating of my prototype, and the user testing, I needed space and materials. For this, I would firstly like to thank Sven Jonkers and 'De Ruimte' in Amsterdam Noord for giving me the opportunity to use their space and forklift. Next, I am grateful to Maloney Amsterdam, Bike store Beter Fietsen and Brewery Homeland for providing essential materials.

For the transportation and placing on the TU/e terrain, I'd like to thank Hendri Vliegen, Twan Aarts and student association Lucid.

Finally, big thanks to Midas Meester, who performed as a great actor in the final concept video, to all the user-testers and to Fenna Visser, who helped me throughout the process to optimize LEVO.

REFERENCES

1limburg. (2015, September 2). Zweefmolen Toverland te koop voor 85.000 euro. Retrieved 8 June 2021, from https://www.1limburg.nl/zweefmolen-toverland-te-koop-voor-85000-euro

Arduino Adafruit INA219 getcurrent. (n.d.) Adafruit. https://learn.adafruit.com/adafruit-ina219-current-sensor-breakout/arduino-code

Bruin, K. (2015). Zitten is het nieuwe roken (1st ed). de Geus.

Chen, M. (2020, August 29). The Zendesk Triple Diamond - Zendesk Creative. Retrieved from https://medium.com/zendesk-creative-blog/the-zendesk-triple-diamond-process-fd857a11c179

Loket gezond leven. (2019). Cijfers en feiten sport en bewegen. Retrieved from https://www.loketgezondleven.nl/gezondheidsthema/sport-en-bewegen/cijfers-en-feiten-sport-en-bewegen

Computable. (n.d.). Startup-scene groeit sneller dan arbeidsmarkt. Retrieved 8 June 2021, from https://www.computable.nl/artikel/nieuws/computable-next/6239873/250449/startup-scene-groeit-sneller-dan-arbeidsmarkt.html

Consumer Electronics & Electrical. (2020, 16 juli). DEKRA Product Testing & Certification. https://www.dekra-product-safety.com/nl/sectoren/consumenten-producten

Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2018). Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1·9 million participants. The Lancet Global Health, 6(10), e1077–e1086. https://doi.org/10.1016/s2214-109x(18)30357-7

Hersenstichting. (2020, 4 juni). Hersenen gezond houden tijdens corona crisis. https://www.hersenstichting.nl/hersenen-gezond-houden-tijdens-corona-crisis/

Home - NVWA. (n.d.). Nederlandse Voedsel en Warenautoriteit. https://www.nvwa.nl/

Kenniscentrum Sport en Bewegen. (2019, November 27). Trendrapport bewegen en gezondheid 2000/2014 (2015). Retrieved from https://www.kenniscentrumsportenbewegen.nl/kennisbank/publicaties/?kb_id=16038

levo. (n.d.). Welcome at LEVO, the experts in standing. Retrieved 9 June 2021, from https://www.levo.ch

NEN-EN 1176–1:2017 nl. (n.d.). nen. Geraadpleegd op 6 juni 2021, van https://www.nen.nl/nen-en-1176-1-2017-nl-240626

NEN-EN 13814–1:2019 en. (z.d.). nen. Geraadpleegd op 6 juni 2021, van https://www.nen.nl/nen-en-13814-1-2019-en-259878

Nostalgische attracties. (n.d.). Nostalgische Attracties. Retrieved from https://nostalgische-attracties.nl/nostalgische-attracties/

Online Academy. (n.d.). PIM Noord-Holland. Geraadpleegd op 6 juni 2021, van https://www.pimnh.nl/academy

Perumal V., Rahman K.A.A. (2016) Analysis of Ergo-Aesthetics Assessment: A Case Study of Public Park Benches. In: Abidin S., Legino R., Noor H., Vermol V., Anwar R., Kamaruzaman M. (eds) Proceedings of the 2nd International Colloquium of Art and Design Education Research (i-CADER 2015). Springer, Singapore. https://doi.org/10.1007/978-981-10-0237-3_46

Priandika, B. S., Kuswanto, D., & Zulaikha, E. (2021). Sturdy and modular concept of 2 in 1 public furniture design by recycling massive plastic waste. IOP Conference Series: Earth and Environmental Science, 649(1), 012039. https://doi.org/10.1088/1755-1315/649/1/012039

Rectified voltage. (z.d.). [Illustration]. Bigshot camera. http://cdn.bigshotcamera.com/images/learn/Section01_Figure06b_voltage_graph.png

TEDx Talks. (2015, August 18). Sitting kills, support standing | Erik Rietveld | TEDxGhent [Video file]. Retrieved from https://www.youtube.com/watch?v=vf7sPS6Q2A0

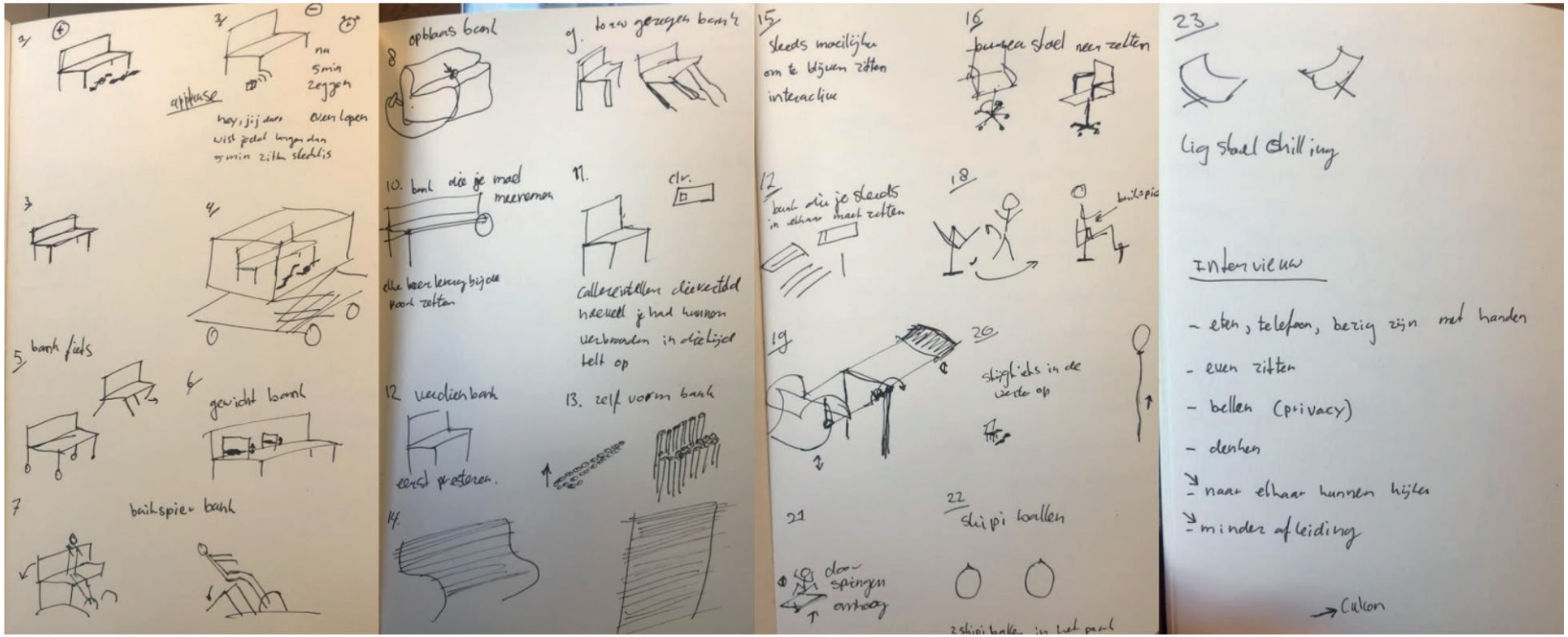
UW health - Is 20 Minutes of Exercise Enough? (n.d.). Retrieved 6 June 2021, from https://www.uwhealth.org/news/is-20-minutes-of-exercise-enough

Vitality. (n.d.). TU/e. Retrieved 7 June 2021, from https://www.tue.nl/universiteit/faculteiten/industrial-design/innoveren/collaboration/squad-projects/vitality/

Zhang, J., & Kazerooni, H. (2016). Consideration on the Building of Urban Landscape Sports Culture. Journal of Mechanical Engineering Research and Developments, 39(1), 83–87. http://jmerd.net/Paper/-vol.%2039%2C%20no.%201%20%282016%29/83-87.pdf

Appendix A: Iterations Problem discovery

Appendix B: Iterations Solution discovery



Appendix C: References Benchmark products

Bench Go Round.(2015). [Photo] Retrieved from https://images.squarespace-cdn.com/content/v1/521956b8e4b07c5692c64be2/1450764349530-CVRC38LRDD7LDIPLBIAY/ke17ZwdGBToddI8pDm48kOouuPCRmzCdud9lOgByk8N7gQa3H78H3Y0txjaiv_0fDoOvxcdMmMKkDsyUqMSsMWxHk725yiiHCCLfrh8O1z4YTzHvnKhyp6Da-NYroOW3ZGjoBKy3azqku80C789l0hHMyhIh2kKzuOL3ydJCryACqlPbMiCiqRl7BxVOzFKv0F_GypTTLNm4da0xhhGDGA/image-asset.jpeg?format=750w

Bench Go Round. (2015). Retrieved from http://www.georgezisiadis.com/-bench-go-round

Boano, T. (2015, September 23). Just a black box transforms from street furniture into kiosk. Retrieved from https://www.designboom.com/architecture/just-black-box-kiosk-london-09-23-2015/

Bureaufiets. (z.d.). [Photo]. Deskcycle 2. https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.bol.-com%2Fnl%2Fp%2Fdeskcycle2-bureaufiets%2F9200000084120864%2F&psig=AOvVaw0ksnLKAy05X9S-ypRbwQzk&ust=1623322232640000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCKCPvdqwivECFQAAAAAdAAAAABAF

Chit Chat. (n.d.). [Photo] Retrieved from https://www.horabarneveld.com/uploads/products/albums/chit-chat-1/compression/ChitChat-Swinging_seat-7-RiZZ_teunFleskens.jpg

Chit Chat. (2016). Retrieved from https://www.horabarneveld.com/nl/chit-chat-1

Congrex: Rashman, A., Rizal, A., & Hamidah, F. (2012). Congrex (Public Benches For Park). Sustainable Tropical Environmental Design Exhibition, 4, 216–217. Retrieved from http://stedex.upm.edu.my/306/

Creative, I. B., True, M. A. I. (2005, October 10). Skateable Furniture. Retrieved from https://we-make-money-not-art.com/the_project_cam/

Custom Curve Seat. (2009). [Photo] Retrieved from https://streetfurniture.-com/wp-content/uploads/2015/02/IMG_5303_1-700x500.jpg

Designed by Tina Roth Eisenberg (swiss-miss.com) and built by John Ford (aldenta.com). (2009, June 14). Art Basel | Jeppe Hein. Retrieved from https://www.swiss-miss.com/2009/06/art-basel-jeppe-hein.html

DesignRulz. (2012, June 22). Choose the Better View with This Interactive Outdoor Bench. Retrieved from https://www.designrulz.com/outdoor-design/public-spaces-outdoor-design/2012/06/choose-the-better-view-with-this-interactive-outdoor-bench/

Double Recumbent Bike. (z.d.). [Illustration]. Industrias Agapito. https://www.industriasagapito.com/en/double-recumbent-bike-r7135/

Figure 4. (z.d.). [Illustration]. Semantic scholars. https://www.google.-com/url?sa=i&url=https%3A%2F%2Fwww.semanticscholar.org%2Fpaper%2FEncounters-on-a-shape-changing-bench%253A-exploring-and-Kinch-Gr%25C3%25B6nvall%2Fb6820e815c2e83e4284f80bee80b6a9274cc4d5d&psig=AOvVaw1aYnx5q3J1_2WNe5H9S4nN&ust=1623322527729000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCMiTmuqxivECFQAAAAAdAAAAABAD

Grasso, A., Karsenty, A., & Snowdon, D. (2000). A bench for all moods. CHI '00 Extended Abstracts on Human Factors in Computing Systems - CHI '00, 197–198. https://doi.org/10.1145/633292.633400

Grönvall, E., Kinch, S., Petersen, M. G., & Rasmussen, M. K. (2014). Causing commotion with a shape-changing bench. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 2559–2568. https://doi.org/10.1145/2556288.2557360

Hidden DIY Hydraulics. (z.d.). [Photo]. dornob. http://dornob.-com/wp-content/uploads/2010/05/diy-interactive-art-bench.jpg

Image (jpeg). (z.d.). [Photo]. STEdex. http://stedex.up-m.edu.my/306/6/Congrex_(Public_Benches_For_Park)_5.jpg

Playful Bench that Lets You Play Music with Strangers – Why Sit When You Can Play - The Great Inspiration for Your Building Design - Home, Building, Furniture and Interior Design Ideas. (2012). Retrieved from http://www.-marvelbuilding.com/playful-bench-lets-play-mu-sic-strangers-sit-play.html

Tree bench. (2013). [Photo] Retrieved from http://cosartbeat-wpengi-ne.netdna-ssl.com/wp-content/uploads/2013/12/Sorey-PR06.064.01.jpg

Staff, D. (2011, May 8). Hidden DIY Hydraulics: Convertible Custom-Height Benches. Retrieved from https://dornob.com/hidden-diy-hydraulics-con-vertible-custom-height-benches/

The Playful Bench. (2013, July 24). Retrieved from https://architizer.com/-projects/the-playful-bench/

WeWatt. (2021, April 6). WeWatt | Products. Retrieved 9 June 2021, from https://wewatt.com/nl/products/

wewatt-outdoor. (z.d.). [Photo]. wewatt. https://www.google.-com/url?sa=i&url=https%3A%2F%2Fwewatt.-com%2Fproducts%2Fwewatt-outdoor%2F&psig=AOvVaw3mVTYV3U3f_Bq5VCMPRQ05&ust=1623410625119000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCLCgs__5jPECFQAAAAAdAAAAABAD

Appendix D: Code

```
#include <Wire.h>
#include <Adafruit_INA219.h>

Adafruit_INA219 ina219;

int pushButton = 2;

void setup(void)
{
  Serial.begin(115200);

pinMode(pushButton, INPUT);

 pinMode(7, OUTPUT);// connected to S terminal of Relay
 pinMode(8, OUTPUT);// connected to S terminal of Relay


  while (!Serial) {
      delay(1);
  }

  uint32_t currentFrequency;

  Serial.println("Hello!");

 // Initialize the INA219.
    if (! ina219.begin()) {
    Serial.println("Failed to find INA219 chip");
    while (1) { delay(10); }
  }
  // To use a slightly lower 32V, 1A range (higher precision on amps):
  ina219.setCalibration_32V_1A();
  // Or to use a lower 16V, 400mA range (higher precision on volts and
amps):
  //ina219.setCalibration_16V_400mA();

  Serial.println("Measuring voltage and current with INA219 ...");
}

int i = 0;
float mean = 0;
float meanmA = 0;

void loop(void)
{
  float shuntvoltage = 0;
  float busvoltage = 0;
  float current_mA = 0;
  float loadvoltage = 0;
```

```
  float power_mW = 0;
//  float meanmA;

  shuntvoltage = ina219.getShuntVoltage_mV();
  busvoltage = ina219.getBusVoltage_V();
  current_mA = ina219.getCurrent_mA();
  power_mW = ina219.getPower_mW();
  loadvoltage = busvoltage + (shuntvoltage / 1000);


// read the input pin:
  int buttonState = digitalRead(pushButton);
  // print out the state of the button:
//  Serial.println(buttonState);
  delay(1);        // delay in between reads for stability


 if (buttonState == 1 && meanmA >= 2)
{
   digitalWrite(8,LOW);// Down
//   delay(500);
   digitalWrite(7,HIGH);// Up

}


 else if (buttonState == 0 && meanmA >= 2)
{
  digitalWrite(7, LOW);// up
  digitalWrite(8,LOW);// Down
}


else  // if buttonState == 1 && current_mA <= 2
{
  digitalWrite(7, LOW);// Up
//  delay(500);
  digitalWrite(8,HIGH);// Down
}

  mean += current_mA;
  i++;
  if (i == 100){
    meanmA = mean/100;
    Serial.print("Mean Current:      "); Serial.print(meanmA);
Serial.print(" mA");
    i = 0;
    mean = 0;
  }
  delay(1); //1/2 sec
}
```

Appendix E: Questionnaire User research

Nummer:

Geslacht: _____

Leeftijd(scategorie): _____

Alleen of samen? (met wie?)_____

_____

Waar kom je nu vandaan (voordat je ging zitten)?

_____

Waarom ben je nu hier?_____

_____

Waarom ging je zitten? **Tijd:**_____

_____

Waarom wilde je dat zittend doen?_____

_____

Zou je dat ook op een andere manier kunnen? (Niet zittend bijv.)_____

_____

Waarom ging je op **dit** bankje zitten?_____

_____

Vervoersmiddel:_____

_____

Hoelang duurde het voordat je hier kwam?_____

_____

Waarom ben je net opgestaan? **Tijd:**_____

_____

Waar ga je nu heen?_____

_____

Hoelang op het bankje?_____

_____

Appendix F: Questionnaire First user test

User test Prototype 1

Geslacht: Leeftijd:

Hoe lang op het bankje?_____

Wat voelde je bij 1 meter? _____

_____

Wat voelde je bij 2 meter?_____

_____

Wat voelde je bij 3 meter?_____

_____

Wat voelde je bij 4 meter?_____

_____

Beschrijf dit design in drie woorden. _____

Wat dacht je toen je aankwam lopen?_____

_____

Wat voelde je toen je omhoog ging?_____

_____

Hoe voelde je je toen je 'boven' was?_____

_____

Waarom stopte je met trappen?_____

_____

In welke context zou je op dit bankje gaan zitten?_____

_____

Wat had je zin in om op het bankje te doen?_____

_____

Wat voelde je toen je boven was?_____

_____

Waar dacht je aan toen je boven was?_____

_____

Appendix G: Consent form user tests

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

CONSENT FORM

User test 'LEVO'

Thank you for agreeing to take part in this study. Before beginning, please complete the following consent form. Afterward, you will be taken through the questions.

Aim: The aim of this research is to observe and evaluate users' experience of LEVO, aimed at creating a combined exercise and relaxation opportunity.

Potential risks and benefits: In this user test, a scissor lift with hydraulic pump is used. Supervisors will constantly be present. Do not stand up when LEVO is up in the air. Only get off when the object has fully reached the ground.

Confidentiality:

- Confidentiality will be maintained throughout the study. The entire process and data will be anonymized. Data will only be presented in the aggregate and any individual user comments will be anonymized prior to presentation or publication.
- Only the researcher will have access to the data to ensure that you confidentiality is protected.
- Storage of data: Data will be stored until one year after the end of the research and then destroyed.

Data Usage: The data collected in this study will be used as part of an academic research on the design of exercise devices/ park benches. You will not be identifiable from the data. If you agree with this consent form, you give permission that pictures will be taken. These will only be used for the study.

Right to Withdraw: You are free to withdraw from the study at any point without consequences. To do so, simply email the researcher. Your data will be removed from the study.

Contact information: This study is being run by researchers at the Industrial Design Department from the Eindhoven University of Technology. If you would like additional information *about the* study or wish to remove your data after the study has ended, please contact Maxime Vallentin.

Maxime Vallentin

m.vallentin@student.tue.nl

NAME:

DATE:

SIGNATURE:

Appendix H: Design Risk Assessment (DRA)

ID	Category	Risk Item	Effect	Cause	Likelihood (0-5)	Importance (0-5)	Action to minimize	Remarks
1	Resource	Too expensive to build	Cannot be completed	Unexpected expenses	1	5	Monitor costs + utilize budget tools	
2	Resource	No available workspace	Cannot be completed	Too demanding	2	5	Request space in time	
3	Resource	Electricity unavailable	Does not operate	Various	2	1	Emergency battery	
4	Resource	Short circuit	User cannot come down	Various	2	1	LEVO lowers if power runs out, potential emergency battery, ladder available	Firefighters can safely take user out
5	Safety	Utilized by incapable people, e.g. children	One of the safety hazards occurs, as described below	Too accesible	4	5	Fence with gate, unopenable for children, placed on the ground, surrounding the object	
6	Safety	Hands getting stuck between wheel and box	Injury to user	No protection	3	5	Protective perplex box around wheel	
7	Safety	Hands/Fingers getting stuck in between wooden planks of chair	Injury to user	Improper distance between planks	3	5	Distance where no fingers fit in	
8	Safety	Getting stuck between bars of lift	Injury to user	No protection	3	5	Metal enclosing between lift system	
9	Safety	User falls/jumps out	Injury to user	Various	1	5	Soft ground to intercept fall + belt	
10	Safety	Multiple users on one LEVO	Risk of falling	Various	4	3	Sensor on platform that measures whether something is on the platform	
11	Safety	User slips	Injury to user	Slippery	3	3	Anti-slip material	
12	Technical	System malfunction	Possible injury to user	Various	1	5	Emergency button next to chair that lowers object	
13	Technical	Guiding rails could break	Pedal box not adjustable	Various	3	2	Make more robust	
14	Technical	Animal gets stuck in system	Does not operate	Animal	2	5	Metal enclosing	
15	Technical	Hydraulic system could break	Lift comes down extremely fast --> Injury to user	Various + gravity	1	5	Potentially springs that will prevent the lift from falling	
16	Environmental	Uses unsustainable materials	Climate change	Cheap materials used	4	3	Research sustainable materials	
17	Environmental	Uses high-power voltage	Climate change	Electricity needed	4	3	Research on alternative electrity sources, e.g. dynamo	
18	Environmental	Rain	Not comfortable + endangers mechanics	Weather	4	3	Space in between planks, platform runs down, computer is secured	
19	Environmental	Flood	Malfunction in system	Weather	1	3	LEVO should be placed somewhere where water does not come together	
20	Social	Groups cannot use LEVO together	Not used by individuals in groups or unsocial	Product is for one	4	2	Multiple LEVO's placed together	
21	Social	Vandalism	Does not operate	People	3	5	Robust materials used + supervision	

Appendix I: Reflection

For me, the Final Bachelor Project was a valuable educational experience that provided insights on both my identity and position in the world and that helped me develop my skills and deepen my knowledge on designing.

First and foremost, there was an ethical issue in my process. I had not filled in the Ethical Review Form properly and had not noticed that it is not allowed to test with children without consulting the ERB first. I did do this once, in an informal and unplanned setting. Fortunately, everything went well. This, however, has been a very valuable learning pointer for me. I now understand better the relevance and urgence of every element of the Ethical Review Form and will from now on always read and thus comply with the requirements. Moreover, I will be more wary when working with children or other vulnerable groups.

The most challenging aspect of this project, from the start, was the individualistic aspect. Never before had I gone through such an elaborate design process without having fellow designers by my side. Moreover, the global pandemic and its restrictions strengthened this challenge since I was not able to meet with fellow students and exchange creativity and excitement with them. The fact that I had to do everything on my own also caused a clash with my own perfectionism: On multiple moments, there were so many small things I had to do that I felt stagnated. This was probably caused by the fact that I sometimes have a hard time distinguishing main subjects and details from each other, since I value details so much. I solved these stagnations by drafting actions plans and to-do lists. In the future, I will try to stagnate less by creating roadmaps and restructuring after every phase in the process.

During the phases of problem discovery and definition, I realized that I can generate insights and designs the best in the wild. Behind my laptop or sketching paper, I did not have the imagination I did outside. In the future, I will consequently go out and visit relevant locations for the design problem and concept.

I am very positive about the design process I have gone through. Before starting the process, I already defined my design methodology very strictly. This caused me to include some fixed moments of reflection and summarizing. I feel like the process went smoother and faster than ever before because of the very clear criteria and focus the methodology posed. From now on, I will always start with choosing a clear methodology that will provide me with guidance and support during the process.

It was quite difficult to always perform in the area of Business and Entrepreneurship to my full potential due to the COVID-19 regulations. Normally, I try to have as much face-to-face contact with stakeholders as possible. The importance of this was once again stressed during this process. I could not reach as many people as I wanted to through digital contact, probably because they were preoccupied with the COVID-19 regulations. As soon people actually observed and experienced LEVO themselves, they became quite interested and fascinated by the concept. From this, I experienced and learned that, even though it might be more difficult in some cases, it is most of the time more effective to reach people face-to-face and give them the full experience.

The least effective way is to send an email to a general mail account because you most likely will hit a wall of employees and bureaucracy. (Business & Entrepreneurship)

With regard to the realization of the design concept, I have developed myself greatly. I had to buy a very expensive and unmanageable lift and arrange all sorts of material and space. At first, I was somewhat hesitant but eventually I had to make decisions. Fortunately, everything worked out properly and I now feel more confident about arranging and realizing such a big product. Moreover, I've learned or improved a great variety of new skills. Since I had to work with metal and the hydraulic system, I developed my ability to weld and my understanding of such a system. (Technology & Realization)

In the expertise area of Math, Data and Computing, I developed my coding skills. I am now able to program a state machine. Moreover, I strengthened my understanding of coding a full program since I had to do this on my own for the first time. (Math, Data & Computing)

During the process, I have performed multiple user tests and a user research with specific goals. This way, I could strictly distinguish insights and combine these to perfectionate my product. I feel like this is more effective than having lesser but broader tests, which is why I will define narrow goals for user tests in the future. (User & Society)

The aesthetics of my project were very relevant since, according to consulted literature, one of the main preconditions for a bench to be a hit is pleasing aesthetics. I think one great aspect of LEVO is the fact that it was designed based on the actual shape of the word, which adds a layer to the product. (Aesthetics & Interaction)

I feel like I have gained the most relevant insights concerning my professional identity and vision. By thinking about and tweaking my PI&V during every stage of the process, I have discovered my true characteristics and wishes for design. I feel like this has given me a great base for the future since I now understand better who I am, both as a designer and as a person, and what I want to do. Because of this project and process, I feel like a proper designer who is ready for the future.