mirrORCLE

WATCH AND LEARN.

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Project: Wearable Proprioception
Semester: B2.2

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INTRODUCTION

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Exercising is fashionable. Whether you have been given exercises by a physiotherapist, to help recover from low back pain, or are improving your fitness, there comes a time where you stand in front of the mirror, and exercise. But are you doing it right?

The Mirrorcle uses a motion tracker to capture the points of your back and visualize them as a line in your reflection. It can remind you of how to do you exercise, and predict how long it will take for you to achieve your recovery, or fitness goal.

It was developed for a clinical environment, but we see real potential in the fitness market. Personalized training and new technologies are much desired in this already booming industry.

This report explains and narrates the design process of Team Mirrorcle, which steps were taken, what conclusions were drawn and what was learned.

SEMESTER 1

SEMESTER 1

The previous team of the Mirrorcle looked somewhat different than it is now. It all started on the first day of the B2.1 semester. Four students: Emma Dhaeze, Anne Wil Burghoorn, Jelle Wories and Jasper Faber, who had a big interest in the healthcare subject, were put together in a project group. They were given the task to choose a subject for which they wanted to derive a design from. Luckily their noses all pointed in the same direction, so the subject was easily determined: Chronic nonspecific Low Back Pain. They also chose to dive into the wearable proprioception aspect of the theme. From this starting point, the Mirrorcle journey began.

The team started off rather quick. Mostly because their client: Annick Timmersmans. She started to support them from the first moment on. She provided the team with a fair amount of scientific papers to get them started with research on this problem. From this research the team found 3 approaches to go from: exercise therapy, posture correction and promoting a healthy lifestyle.

By use of different brainstorm techniques, a meeting with an actual physiotherapist and the feedback of Annick, the team eventually came to their final choice for the concept:

The Mirrorcle.

SEMESTER 1

After the first quartile the team managed to have a prototype ready to, on the first hand visualise the concept, and on the other hand demonstrate the functionality of the product. On the mid-term demoday, the team presented a pecha kucha with a demonstration included, which provided them with the title: best project presentation. This title meant that the team could exhibit on the exhibition 'Domotica & Slim Wonen' in the Evoluon.

For iteration 2, the team took the domotica exhibition as deadline. They wanted to incorporate as much feedback as possible to be ready to demonstrate the prototype to the big audience. Things that had been improved were: a more usable short-throw beamer, a stand for the mirror, adding a semi-transparent foil for better visibility and an improved interface. On the exhibition the team got a lot of very enthusiastic and useful comments on the concept. This also enhanced the motivation of the team to keep working, and further improve the prototype towards the final demoday.

With the feedback in mind, the team managed to create a new update of the prototype. This time with a working interactive program including the Kinect, a new interface for improved usability and even a soundscape. Eventually the Mirrorcle got tested on a real patient suffering from low back pain. Even though the test pointed out there were a significant amount of aspects to be improved, the final concept was very convincing. At the final demodays, Again, a lot of positive reactions from the audience. Even Annick came by and proposed if the team would like to write a scientific paper about the concept for IEEE EMBS.

When looking back, for the Mirrorcle this was a really fruitful semester. The concept was born, the societal value of it has been validated and a demonstrating prototype has been created. Because of this, and all the positive reactions, two students: Jelle Wories and Jasper Faber decided to continue this project their next semester. They both saw a real learning potential to see how to take a concept to the next level. So actually developing a working product that is ready for the market.

This is where the first semester ended. In the following chapters of this report, it will become clear how the new team arose and brought the concept to where it is right now.

OBJECTIVE

OBJECTIVE

The aim of this semester was to further develop the Mirrorcle, going into more depth than just a final prototype. This meant that a lot more had to be taken into account when looking at the design. It had to be possible to mass produce the product, making every detail important because a small scale iteration has a big impact if a lot of Mirrorcles will be produced. Design requirements specific to different markets had to be taken into account. Should it look clinical or trendy? How to make it lightweight, yet keep the feel of quality in it? How to use the best quality parts but still keep it cheap?

After having decided in roughly which direction to go, the process was divided into several segments. New hardware, new software, a business plan, and looking into intellectual property protection.

IDEATION

IDEATION

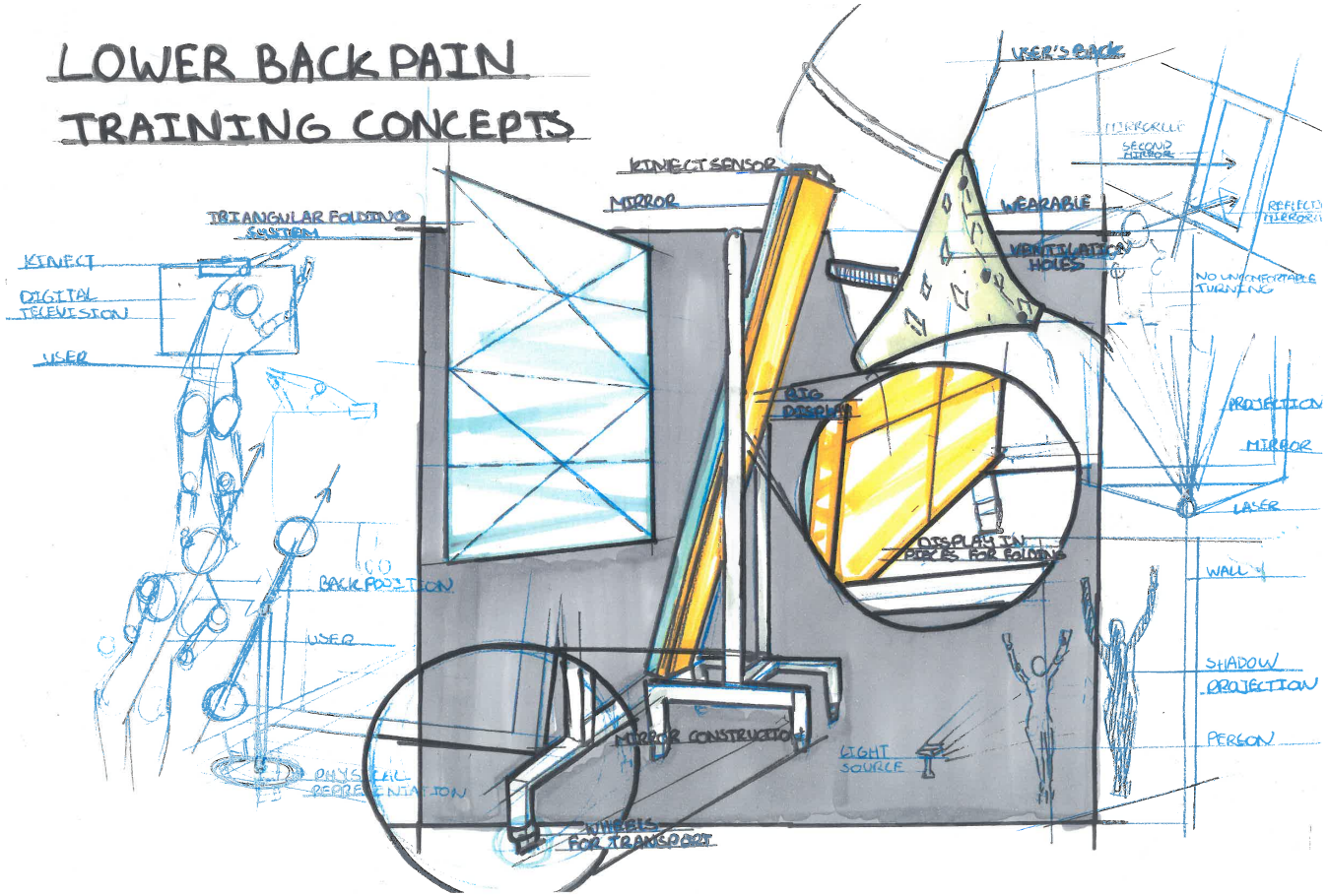
The first week of the project was about finding the direction to continue with. The new teammates Maarten and Daphne made themselves familiar with the topic of lower back pain and the previous prototype of the mirror by reading the previous project report and doing online research themselves.

After a discussion and question round, the idea generation started to diverge. Considering different options to achieve the same goal as the previous prototype did, was the goal. Some ideas were worked out more in detail by sketching.

The ideas and their positive and negative points were discussed. Feedback from the coach was the determining factor to choose for an idea close to the original prototype: a mirror with projection, this time using a display instead of a beamer.

The next step was to re-evaluate the feedback on the previous prototype, and to what sense this feedback was applicable to the new idea.

The most important critique that was also applicable to our new idea was about portability: patients with lower back pain had to carry an extremely big and heavy product with them to their homes.



PROTOTYPE

CONCEPT

In order to achieve our goals of discussing product production with (external) companies and experts, as well as reaching the finals of the TU/e contest it was necessary for the team to have a new prototype of the concept. The embodiment of a concept in physical form proves that the concept itself works, and can be used to capture data, do research and gain feedback.

The previous prototype was used in the same way, but was presented to different audiences for feedback. These audiences generated a good amount of feedback towards to the physical aspect of the prototype. The feedback was as follows:

• The prototype is too heavy to be carried by one person from a physiotherapists office to the parking lot outside. It is also too big, therefore not portable enough for its use in context.

• The projector that is placed behind the prototype is not portable enough

• The distance needed between the projector and the prototype is too long. The prototype takes 1,6m by 70cm by 2,0m in effective space because of this, instead of 1,6m by 70cm by 20cm.

• The projection on the screen is not bright enough for it to be visible in a normally lit room

• The prototype feels clunky, not clinical or clean.

This feedback was translated into the design criteria for the following iteration of the prototype.

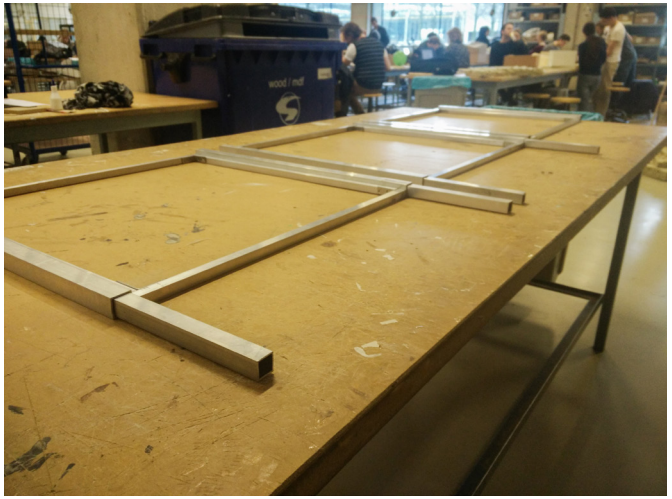
The first design choice that the team had to make was the method of displaying the visual feedback in the mirror. Research into different approaches yielded four main methods: An LED matrix, an O-LED screen, An lcd/led screen or a projector. An integrated LED-matrix would solve the visibility and portability issue, but raise another problem. The feedback would not be as accurate, and it would be more difficult to communicate a lot of information at once. The O-LED screen would solve all problems, as well as boost portability enormously, but the

source: iiyama.com

cost of the product would increase tenfold, making it a much less viable investment for the target market. The projector would need to be short-throw mini-projector with a high intensity. Due to the fact that these are not available for consumer consumption it was not possible to use of for the prototype. This type of project remains an interesting method for the future. An lcd or led screen would solve all issues, although the budget would only allow for a screen that was just large enough to display the visual feedback where necessary and not cover a whole mirror.

CONCEPT

The screen would allow for a very thin prototype, but it's necessity to be the size of a full mirror would still render it hard to maneuver. To make the prototype even more portable, an idea generation session was held in which many ideas for a portable frame were created. The resulting frame was one that would allow for easy manufacturing and better portability. 3 stackable sections of 60 by 60 centimeters would make the mirror easy to carry in pieces. Along with that, all three segments can be produced in the same way.



For the display, the team sought to place a maximum size screen in the available surface area.

A commercially available 24inch, 1920p by 1080p covers the inside of a 60 by 60 centimeter segment with only 2,5 cm to spare allowing for space to integrate the motion-tracking system. This setup also allows for the segment with the screen in it to be placed at the top or middle of the full mirror, so that every size customer can use the Mirrorcle.

To interpret the data coming from the motion tracker and visualize it in the reflection of the mirror, a computer would have to be part of the process. To make exercising in front of the Mirrorcle an easy experience, the user should not have to connect his own computer to the device at any point. Therefore, the process needed to be managed by an internal computer. The Raspberry Pi 2B is a powerful, small and light computer that is also inexpensive, and it seemed to suit the job perfectly. The Pi only has a HDMI (digital) output that would most likely need to be converted to an analog signal with a converter.

CONCEPT

This schematic (Figure 9) details the plan for all the components within the Mirrorcle. The screen was to be acquired from a computer monitor, which meant the modules could be detatched and placed strategically in the mirror. This operation was carried out very carefully, becuase CCFL cables are high voltage, and ribbon connectors are very delicate.

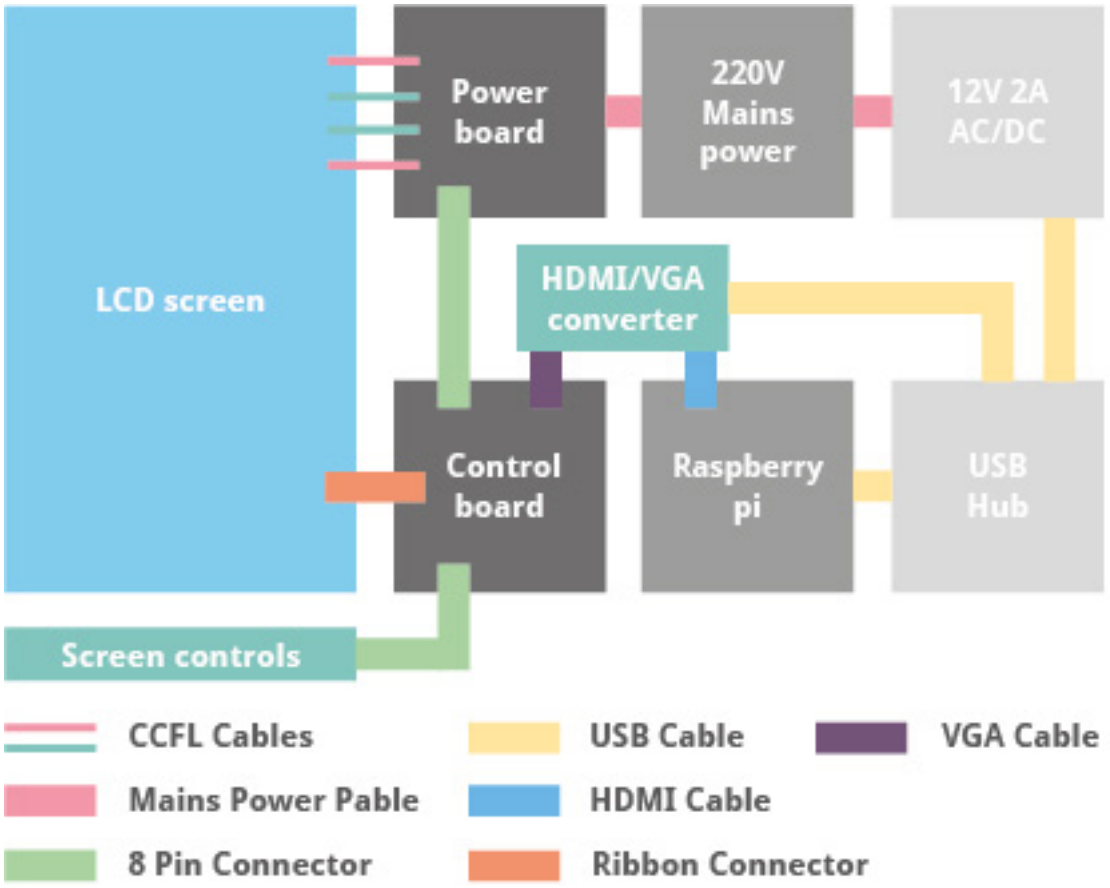


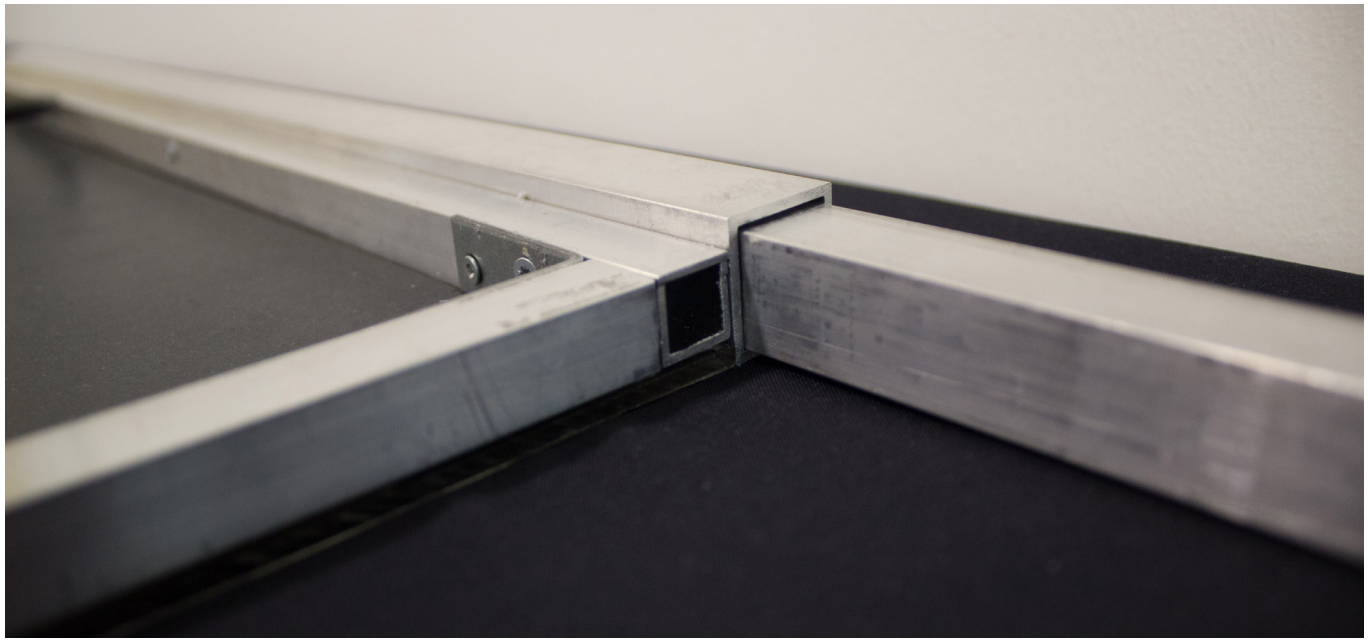
Figure 9

MATERIALS

Material Qualities
The first prototype was build out of wood, with a Perspex panel that served as the reflective surface. One-way mirror foil was used to give the Perspex a reflective quality, and diffusion foil was used to catch the light projected by the beamer behind the prototype.

The wood made the prototype heavy and unnecessarily large. Wood is also hard to work with in a manufacturing process. An alternative material needed to be used to make the prototype lighter, more durable, more workable and less flexible. A strong polymer would be ideal, but access to such a polymer was unrealistic. Another alternative was aluminum. It is commercially produced in ideal measurements, durable and light. The disadvantage to aluminum is its material expression.

Material Expression
Material expression contributes enormously to the interaction with the product as well as its look and feel. Haptics, but also weight, visual interpretation and material sound play a massive role in this. This expression should be tuned to the purpose of the design in its context.



In hindsight, home use of the Mirrorcle would most logically require a homely, friendly, warm look and feel, but during the design process, the team was convinced that it should reflect the clinical look and feel of a physiotherapists' therapy room. Aluminum expresses industrial strength, coldness and reliability.

Untreated, this material choice does not contribute to the interaction, even though there is no haptic interaction during use. In the future, it is critical to tailor material expression to suit product interaction in the right context.

ASSEMBLY

Each segment is built from two 2,5 by 2,5 by 60 cm, rectangular rods on which two 2,0 by 2,0 by 60cm rods are bolted, with 3mm left of the front side and 2mm on the back. Between these, two 1,5 by 1,5 by 55cm rods are bolted and joined with corner pieces.

To make the foil as reflective as possible, the light contrast ratio between both sides of the foil has to be high. Therefore, the areas of the segment that would not be covered by the screen were darkened with black material.
The screen is placed in the centre.

In the bottom of the figure, the CCFL wire are visibly exposed. The rasperry pi, including wi-fi-dongle is placed beside the screen, and a USB hub is placed at the top. This port supplies power to both the pi, and the HDMI to VGA adapter.

ASSEMBLY

Since the screen configurations do not have to be set, the buttons to control the screen can be placed inside the prototype. Along with the controller, the HDMI to VGA adapter is placedunder the USB hub. The pi is connected to the adapter, which sends a signal to the control board.

Next, the power board, which has been placed in a protective housing is placed on a plexiglass screen, which is then placed on all of the other components. It is connected to the CCFL wires, and the 8-pin cable is connected to the control board.

Finally, the container for the power board is closed, and the plexiglass plate is screwed onto the frame, keeping everything in place.

CRITICAL REFLECTION

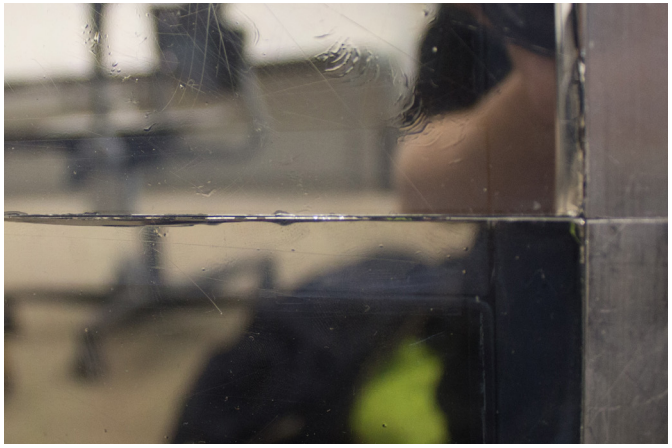
Because the mirror had to be modular, the placing of the screen was either in the middle segment or in the top segment, whilst the lower back often lies exactly in between. This was something that could have been calculated. Also, because the mirror was broken up into 3 pieces, a clear visible line could be seen in between the pieces, because of different light refraction, making people lose several limbs in their reflection.

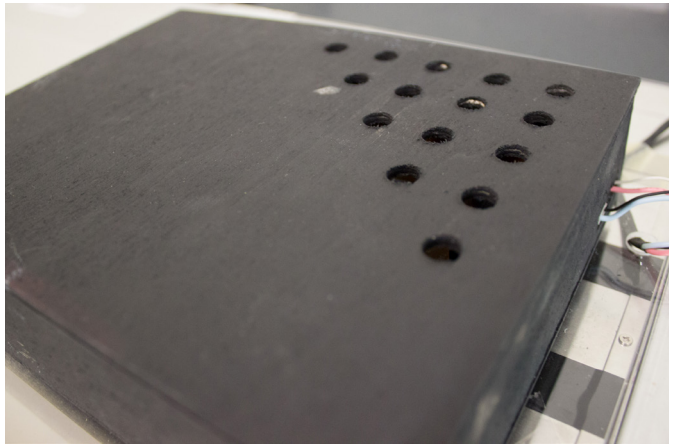
On top of this, a switch to fitness was made (see the section on business), so the mirror no longer had to be carried around, in a fitness centre it would have a fixed place meaning there would be no refractions, and a larger screen could be used. Ideally, all the hardware would be sealed behind a plexiglass panel to make the Mirrorcle flat and smooth. Due to the size of the capacitors in the power-board, this was not possible.
The solution was to build a compartment for the powerboard, to shield it and prevent short-circuits. This compartment was built out of wood, which absorbed too much of the paint, leaving a blemished finish.

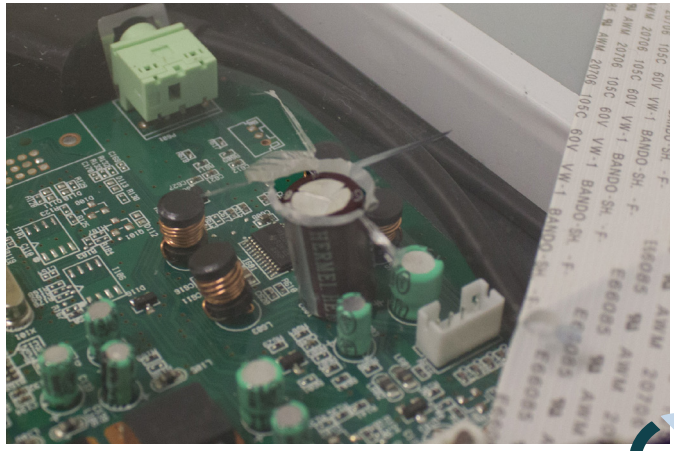
Because the aim was to create a product that was able to justify the concept in front of companies and experts, the time was invested in making it work. Less time was spent on finishing the concept. In the manufacturing process, machines will place the mirrorfoil on the plexiglass panels, and drill holes in the aluminium, allowing for more precision.

In this process it is also important to measure the stress points of the materials that are used. The plexiglass panel at the back cracked a number of times.

For the purpose of the prototype, the plexiglass panel was left transparent. The minimum viable product would have a black back-panel.

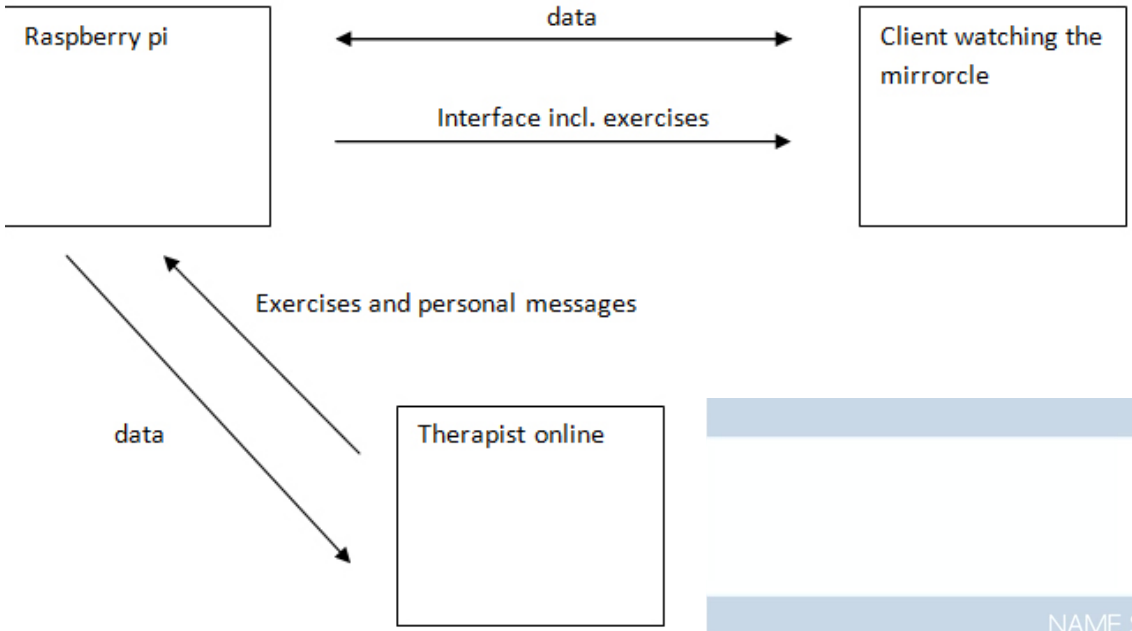






INTERFACE

INTERFACE



The client can receive the data from previous exercises to look through the development and the client can receive the exercises send by the therapist in order to start exercising.

Then, a first simple visualization of a possible interface both for the therapist and for the mirrorcle was made. The first interface can be found for the mirrorcle can be found in the Appendix [A1] .

The interface is designed in multiple iterations. The design started by making a clear model of how the system should work.

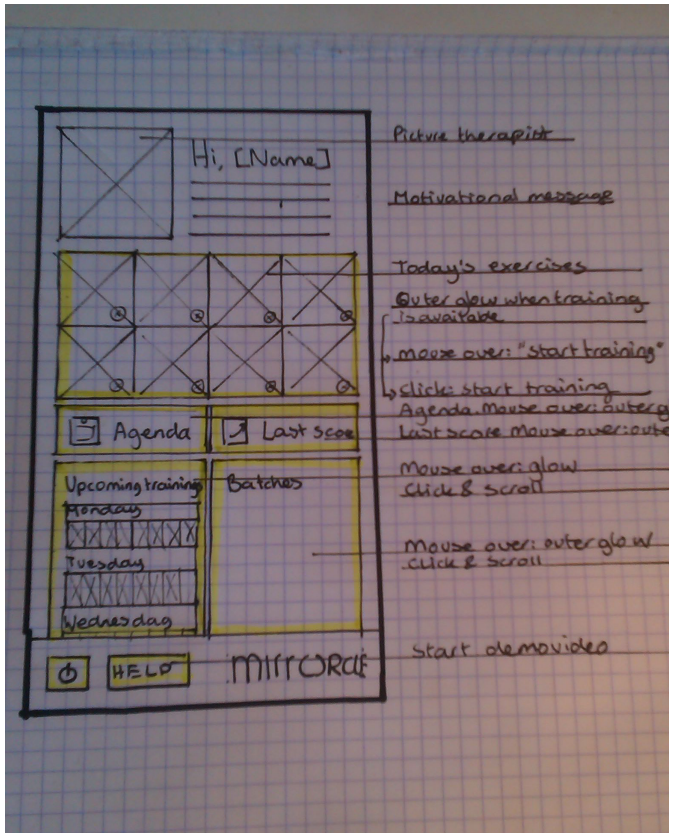
In short: the therapist adds exercises and is able to receive the data gathered by the mirrorcle, to see the progress of the client and to be able to send personal feedback in the form of a message to the mirrorcle.

INTERFACE

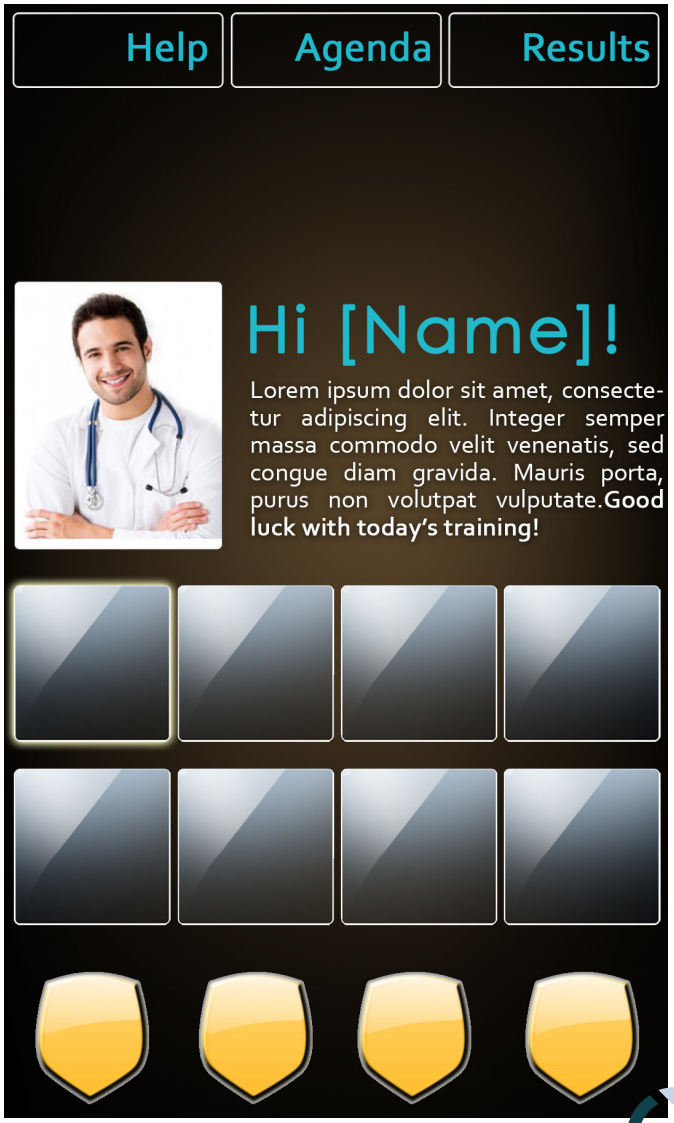
In the second quartile the team started working on improving this interface. A feedback session with Annick Timmermans was organized in order to discuss the points of improvement of the first interface and to discuss her vision on how the interface should be improved. The main developing point was to make the interface more personal and persuasive in order to improve the effectiveness of the trainings.

Even though the interface did not work fluently yet, the overall feedback of Annick Timmermans was positive. She liked the way of navigating through the menus, the idea of sending personal messages should be kept and adding persuasiveness within the interface is a good idea as long as the identity of the design stays clinical and professional. The agenda should be improved, as there should be more hierarchy in the exercises of today and the overall overview of exercises.

The project team decided to focus on the prototype of the mirrorcle and because of time reasons the interface of the therapist became second priority. Sketching and idea generating brought a sketch of a possible setup of the desktop.



Feedback from teammates was that the overall view was a bit too busy. This is why a few buttons and elements were eliminated for the final design of this second iteration.



INTERFACE

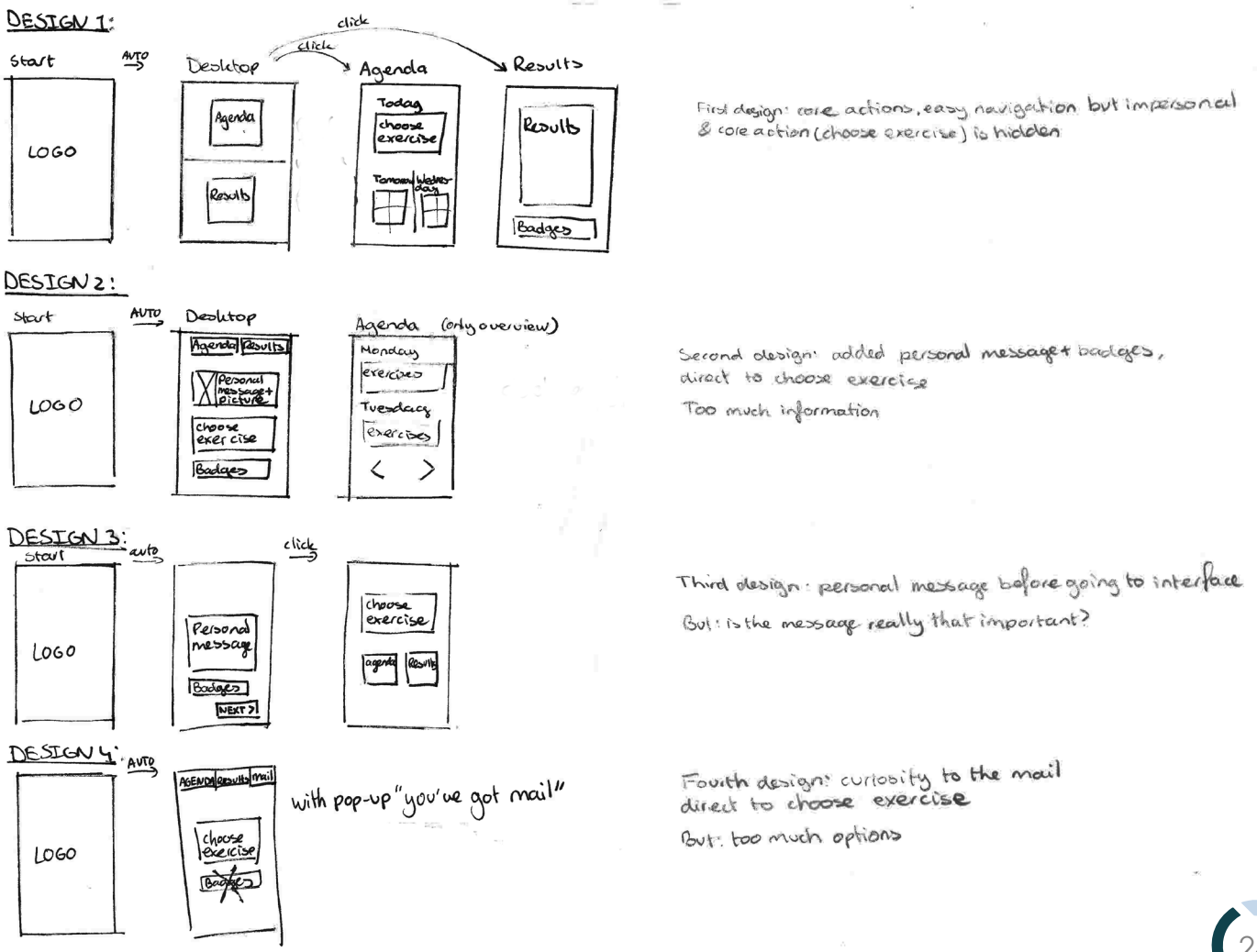
The feedback round based on this design was not very positive. The positive sides of the first design (extremely simple to use and a very structured amount of information per screen) seem to be gone. Also the added value of the persuasive elements were questioned. Another iteration was introduced.

An expert on the field of persuasiveness was introduced in the design process: Peter Ruijten. He gave access to valuable research material on the topic of persuasiveness. Reading and summarizing the following documents, , provided a list of possible ideas that could be added to the mirrorcle. Furthermore, an overview of all the ideas around the mapping of the interface was made.

- Influence: The Psychology of Persuasion by Robert B. Cialdini

- Nijland, N., van Gemert-Pijnen, J. E., Kelders, S. M., Brandenburg, B. J., & Seydel, E. R. (2011). Factors Influencing the Use of a Web-Based Application for Supporting the Self-Care of Patients with Type 2 Diabetes: A Longitudinal Study. Journal of Medical Internet Research, 13(3), e71. doi:10.2196/jmir.1603

- Persuasive Technology: Using Computers to Change What We Think and Do by B.J. Fogg



INTERFACE

In an expert meeting with Ruys Duindam, all the possible ideas were discussed and decisions were made about which ideas were relevant and should be continued in the final design. This resulted in the following design iteration 3. [Figure 25]

Feedback on this design was mostly about combining the visual design with the code. Since the navigation would be with arrows, the locations of the buttons changed a bit in order to make the navigation more logical. Furthermore, the program could only handle four exercises, so the amount of exercises in the interface was reduced. Last but not least, the gradients were deleted because that would give a more modern appearance. This resulted in the final design. [Figure 26]

Looking back, the user-tests and feedback show that the interaction with the design could be improved. The users should feel more connected to the mirror. This could be done by adjusting the house-style from clinical to something more sportive and user-friendly (which also fits better to the identity of the new market fitness), the visuals of the exercises could be designed more personal and further research to interface design and interaction is needed.

Figure 25

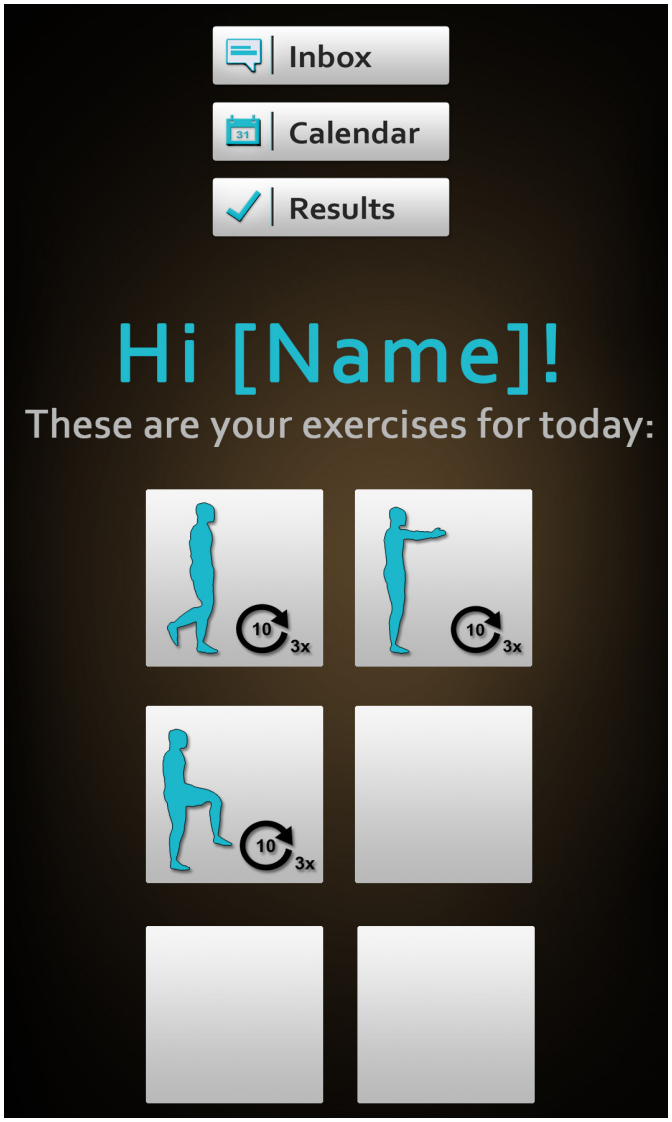
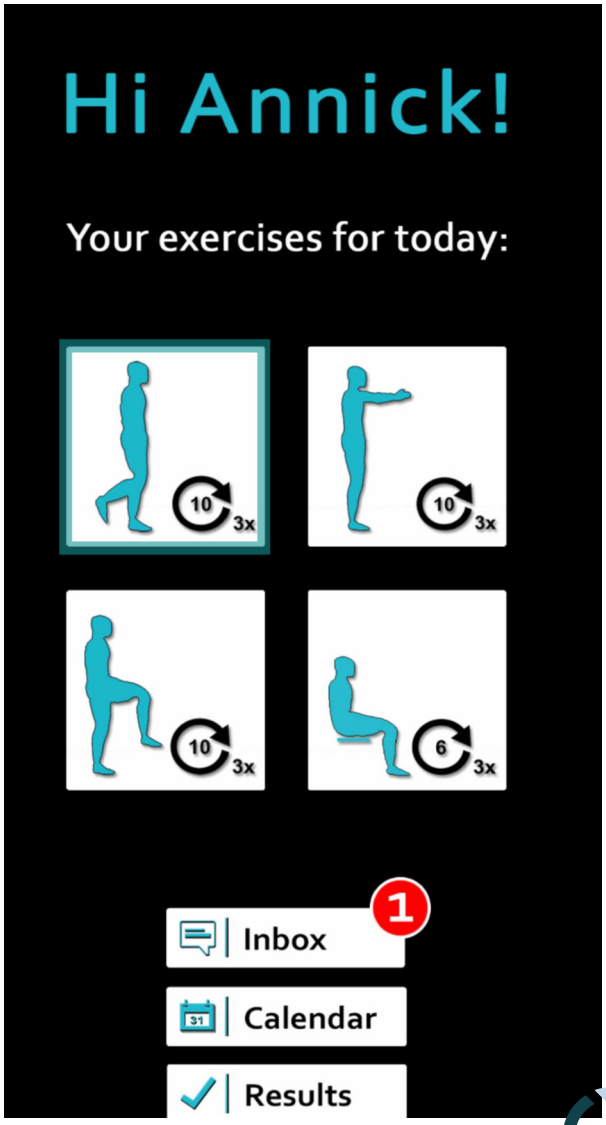


Figure 26

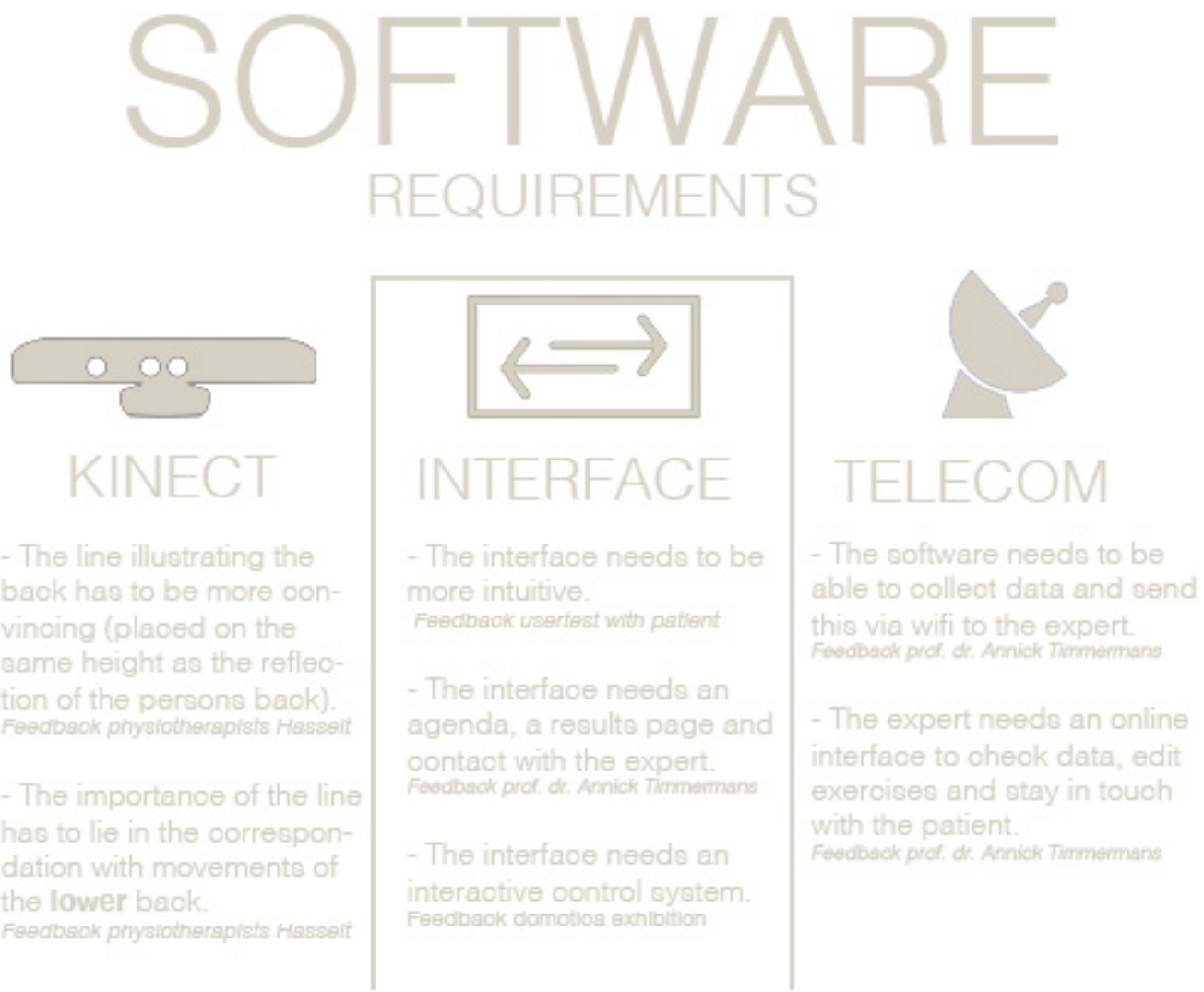


SOFTWARE

SOFTWARE

The software behind the mirrorcle was one of the biggest things that needed a change. Although the software of the first prototype succeeded quite well in explaining the idea behind the concept, There was a need for a prototype that could run on it's own. During the first semester the first Mirrorcle team collected a lot of feedback that needed to be taken into account before launching an actual product. From this feedback a list of requirements was derived:

This was an immense list of improvements, the one more challenging than the other. Taking the goal into account that the Mirrorcle had to be a stand-alone product that works on his own, and that interface had to be immediately clear and intuitive. The decision has been made that the focus should lie on creating a working interface. With a combination of user focussed interface design and logical programming the interface has been created. More information on the interface can be found on page 21.



SOFTWARE

Figure 28

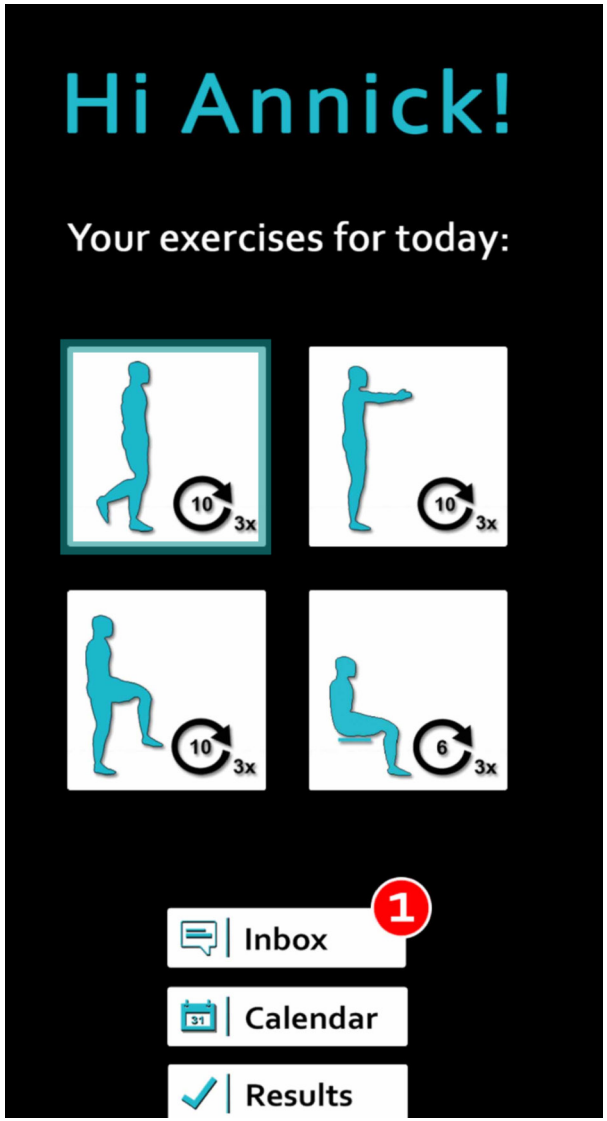


Figure 28 shows the desktop page of the interface. Also see appendix [A2] for a scheme explaining the logics, and also an important part of the code. The idea behind the interface is, when a button is pressed on the keyboard, the program recognises this key and sends a signal that determines whether the blue rectangle should move to another spot. In this way the user easily sees which button has been selected. With a simple press on the spacebar, the user enters the selected button. Right now the interface is controlled by the computer keyboard. Nevertheless this can easily be exchanged to other input devices read (page ... interaction).

This interface also works together with the Kinect software. When the spacebar is pressed while an exercise is selected, the program automatically runs the corresponding Kinect program.

This program was created in the previous semester of the mirrorcle. With special thanks to Emma Dhaeze, who worked very hard to develop this program.

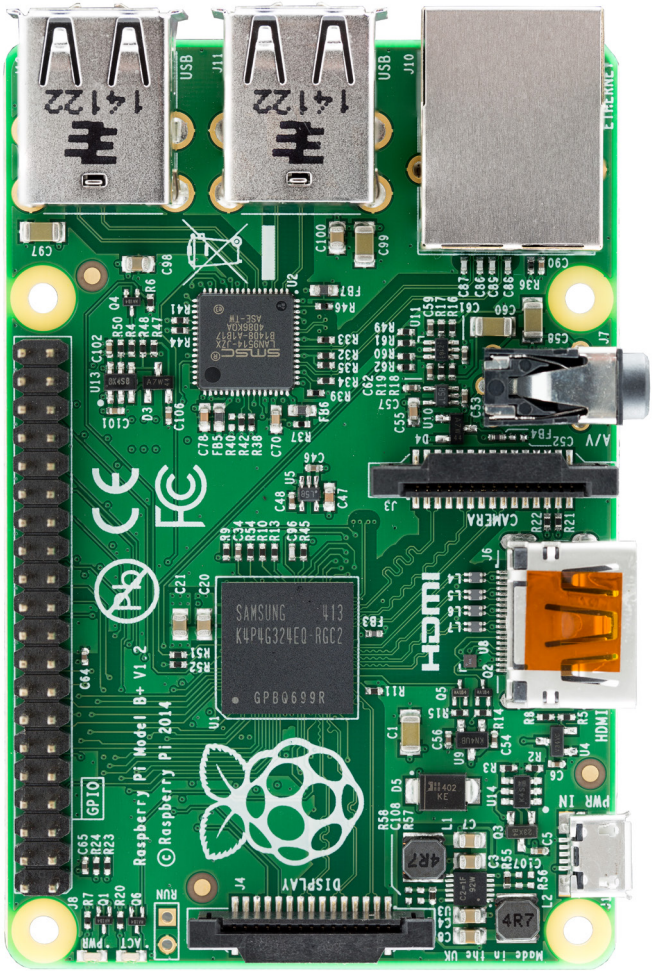
Part from the previous mirrorcle report:

We've managed to set up an animation which tracks the angle between torso and bottom. Around this animation we've set up a square that illustrates the boundaries of the maximum angle. Together creating the feedback model. Besides this, we also created a mistake counter, adding up the times you cross a boundary. And a demonstration animation which first demonstrates the exercise several times, and then moves to the right bottom of the screen.

SOFTWARE

One of the hardware requirements stated that the prototype should run without a laptop connected. Therefore the decision has been made to load the interface made in processing on a Raspberry Pi. For more information about the Raspberry Pi and hardware read16.

In the last week before the demodays, it seemed that the Raspberry wasn't powerful enough to execute the code via processing. It took the interface more then 5 minutes to boot up the program. Attaching and running the Kinect seemed even more impossible for the Raspberry. Before making the choice for the Raspberry, research has been done from which could be derived that a Raspberry was able handle programs in processing and receiving data from a Kinect. Unfortunately this was just to some extend.



For future development a more powerful micro computer has to be bought in order to run the program and the Kinect.

Reflecting on this part of the project, we could say that we wanted to improve more on the area of software. Because none of us is an expert on the area of programming, the whole process developed quite slowly. For this reason only one of the 3 requirements pillars: Interface is improved. Now the team has developed more knowledge about coding and programming, future software changes won't take as much time as it did now. For future development of the Mirrorcle it would be the task for the team to work on the other aspects of the software requirement.

INTERACTION

INTERACTION

One of the main feedback points from previous semester tells that the Mirrorcle needs a way to interact with it. This put the team for a choice: delivering an extra device like a remote or a brace from which you can control the mirror? Create a close user-product bonding by creating touch sensitivity on the screen of the mirror? Or wanting to use the kinect as a device to track different gestures and from this control the interface.

From technical perspective, the gesture control was out of doubt. The Kinect isn't accurate enough to provide a smooth gesture recognition. This results in a laggy interface which works as a negative force on the intuitiveness of the interface.

From business perspective, the focus lies on keeping the production costs down. Therefore implementing a touch screen would be a bad choice, because touchscreens are still quite expensive. A thing to take into account are cheaper alternatives of a touch screen. Like the amazing technology provided by Leapmotion, Inc.

This technology makes it possible to track hand movements very accurately on short distances. Eventually the decision has been made to choose for the VNC (Virtual Network Computing) technology of the Raspberry Pi. This technology allows to remotely control the desktop interface of one device from another. It transmits the keyboard and mouse events from the controller, and receives updates to the screen over the network from the remote host. To gain access to this technology, apps exist that turn your mobile device into a Raspberry Pi controller. Because a working interactive interface was necessary, and the focus lied on creating the actual interface, the choice was to use the VNC technology.

For future development of the mirrorcle, the Leapmotion technology should be considered.This because it's more intuitive and it creates a stronger bonding with the user.

IPR

INTELLECTUAL PROPERTY

When it comes to doing business with new products or inventions, it becomes of crucial importance to analyse intellectual property protection possibilities. Registered intellectual ownership of an invention gives the owner the right to exclude others from materializing the owners 'idea(s) commercially. These monopoly rights have evolved to be one of the largest assets to businesses developed around products.

It is vitally important for business to determine whether the Mirrorcle concept is infringing any patents. Patent holders could ask for license fees or in the worst-case stop production entirely. It is also beneficial to know whom the key players, inventors, and patents are in the technology field. None of the components are new inventions, what is novel in the concept is the combination of motion tracking with direct visual feedback in a reflective surface.

To define a patent landscape for the Mirrorcle is to analyse data related back-position measuring devices with feedback systems. The search query must reach at least all patents in the same technology area, and as little as possible unrelated patents. To stay within the relevant technology areas, IPC Codes are used.

Search Query
The search query will be limited to codes:

A61B-005 Measuring for diagnostic purposes
A61H Physical therapy apparatus

The database that we used for this search was Derwent Innovations Index. We will analyze such existing devices or technologies to find answers to the following:

• What does the IP publication trend for these devices look like and how have the filings evolved?

• Who are the top assignees or key players in this technology?

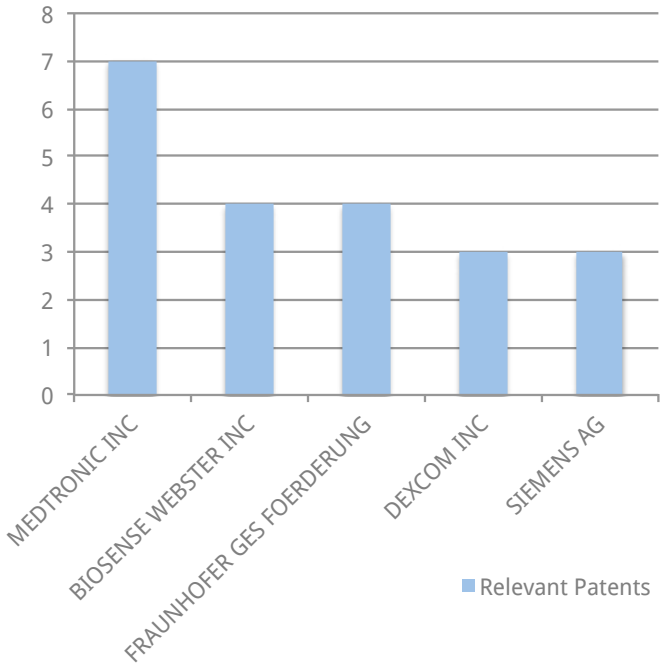
The database search query can be found in the appendix [A6], it yielded 222 patent results.

Search Query
The patent publication trend for this technology area spiked is shown in the graph. It started growing enourmously around the year 2000, indicating that patents are high value assets for the technology area.

INTELLECTUAL PROPERTY

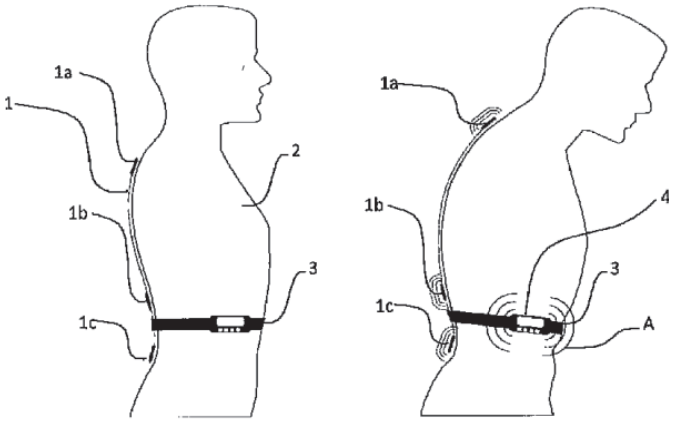
Top assignees
The Top assignees in the technology area, measured by portfolio size as Medtronic, Biosense Webster, Fraunhofer, Dexcom and Siemens. These companies should be considered when it comes to striking up partnerships, gaining new information and doing research.

They may also pose competition for the mirrorcle.



Key patents
Most patents in the query, that are relevant to the technology area function the same way as the Mirrorcle does.

For example, patent US2015065919-A1 uses sesnors and an accelorometer to measure the position of the back and give feedback through sound.



Although the results in terms of functionality may be similar, the Mirrorcle does not infringe this (or these types of) patents.

As for discussing an investiment in patent protection for the Mirrorcle, there are two problems. The first is that the invention was made in assignment for the TU/e, which means ownership rights would have to be discussed further. The second problem is that the Mirrorcle and its workings were publically exposed in an exposition in November. This means that it cannot be patented or claimed by anyone anymore, and incidentally solves the first problem.

Alternative IRP protection methods include design rights, copyright and trademarks. Unfortunately, design rights would also be hard to get, because of the exposition.

The answer lies in trademarking and copyrights. The Mirrorcle would only give value to fitness firms or physiotherapists if its interaction would cause users to willingly return to the Mirrorcle. Therefore, a viable business lies in the perfection of the service and interface of the Mirrorcle and establishing brand identity as the best service on the market.

Strategic trademarking and copyrighting would cover the protection of such a service and give a huge asset to the business as a whole. Next to that, novel processes within the service could also be inspected for patentability.

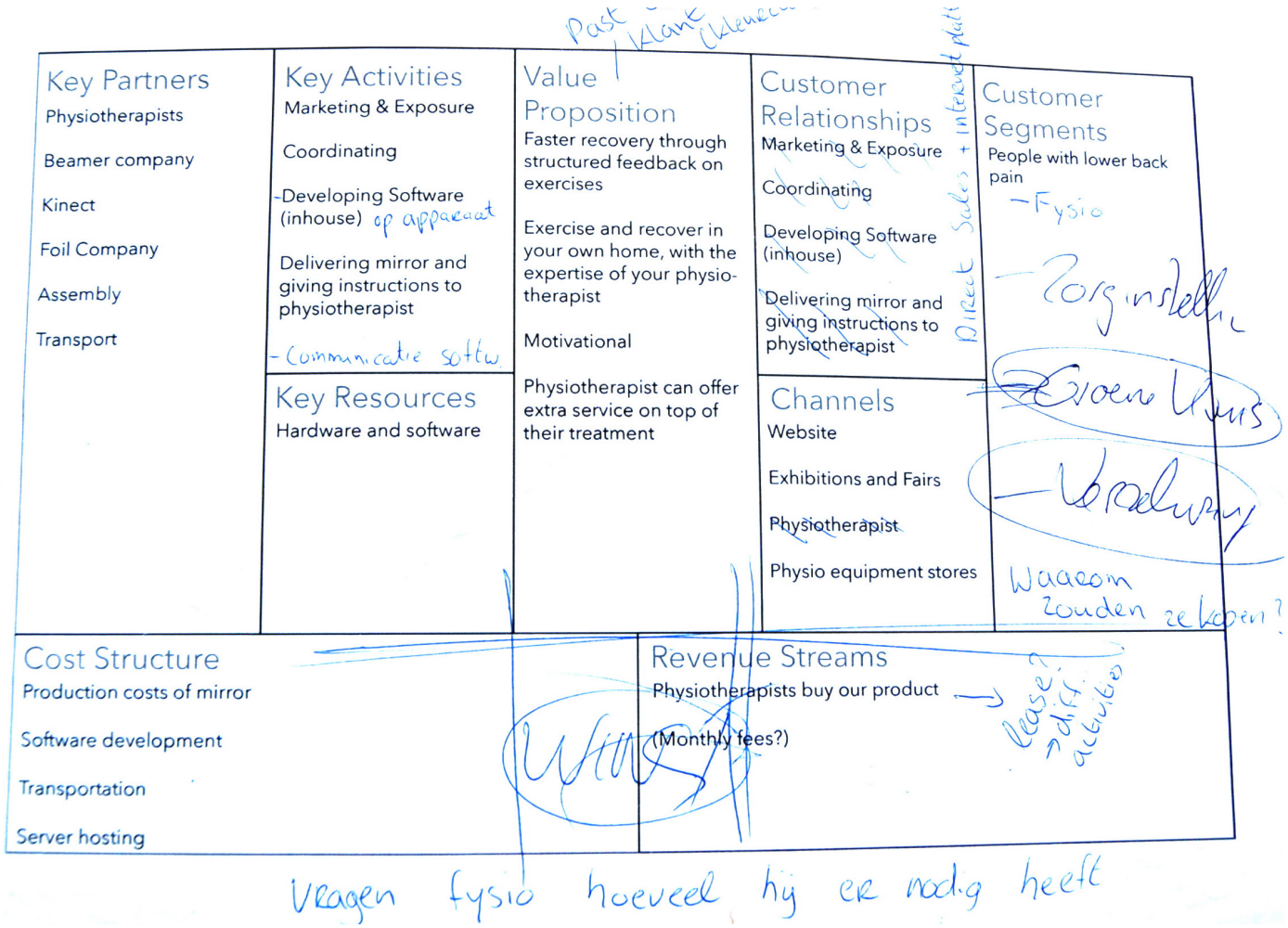
BUSINESS

BUSINESS MODEL 1.0

This semester has been a lot more business-focussed than previous semester, because a lot of the design decisions needed to be grounded on validated business claims, to be able to start producing the product and bringing it to the market. As indicated before, the first business aim was to create a device for physiotherapy.

First Business Model Canvas

Shown on the right is the very first business model canvas made for physiotherapy, where everything was still very abstract. No key partners were defined, a lot of resources and activities were missing, the customer segment was incorrect (Customer: people with low back pain. Who buys the product: physiotherapy. Incorrect), and thus the value proposition was also misinterpreted. Herman Wories (Vice President Global Business Incubator at DSM, also father of Jelle) helped immensely with the business side of the project, giving continuous input, arranging contact with experts, and making time for extensive feedback sessions. He was the first to give feedback on the initial business model , as shown in figure ?.? and a new one was made.



BUSINESS MODEL 2.0

Business Model Canvas Version 2.0
Back to the drawing board, a new canvas was made [figure 44] , with the feedback from Herman included. He talked about creating market insight, how large is the market, how many can be sold, what is exactly the value proposition, etc. He gave a lot of suggestions about how to create this market insight (doing value perception analyses, looking at figures from CBS, products that resemble Mirrorcle, ask physiotherapists about how exactly their sessions work), and gave a structure for a business case. Sadly, because of DSM confidentiality this cannot be shown here.

In the first business model canvas, there was still a question whether leasing the product could also be leased to physiotherapists, but Herman argued that this would mean to much capital (stock) for the Mirrorcle company, and that this would mean investing more time into setting up a lease structure than developing the product.

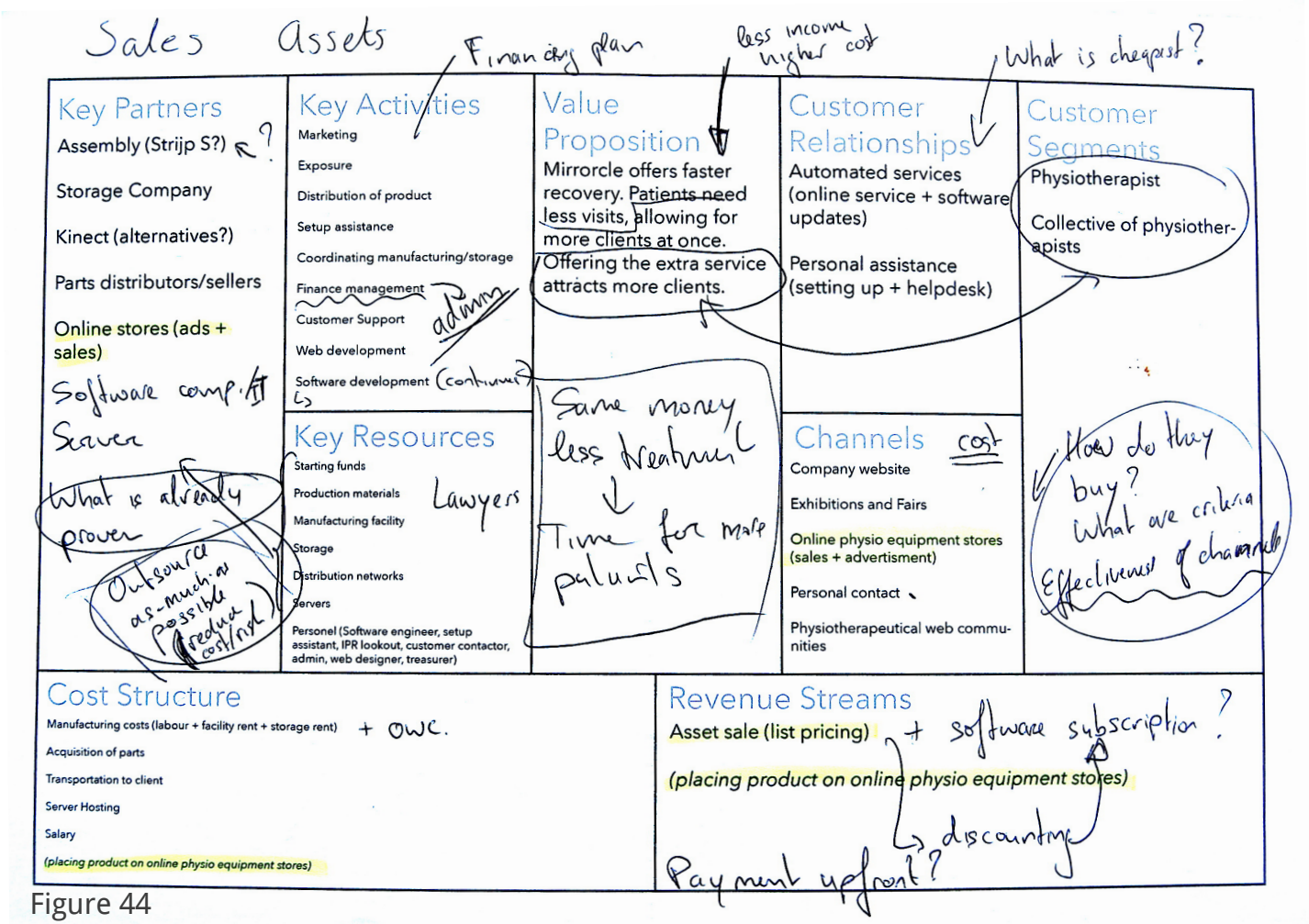


Figure 44

He also mentioned that investors search for opportunities to expand to more markets than just the starting one, the term King Pin Bowling Alley was applied. This basically means that the front pin (the starting market) in a bowling alley has been hit, the others (other markets) should follow. This encouraged the search for other markets than physiotherapy, which had not yet been thought of. This was when switching to fitness was mentioned for the first time.

EXPERTS

Meeting Christian Kling

A meeting with one of Herman's colleagues, Christian Kling (Business Analyst at DSM Innovation), was held. When the concept had been explained, and fitness as a alternative market was mentioned, Christian almost immediately stated that a switch to fitness would be preferable. There is more money, possibilities, growth and less regulations in the fitness business compared to physiotherapy. He also confirmed that leasing would not be a great idea.

He talked about how the market of fitness is enormous and still growing. Not only are more people starting to practise fitness, hotels and sport complexes need fitness centres to gain extra facilities and keep people coming. Even bigger companies install fitness apparatus to keep their employees healthy.

It was becoming more and more clear that a switch to fitness might be a very viable option.

Meeting Koen Klokgieters

Koen Klokgieters (CEO Business Innovation & Entrepreneurship) was contacted for input on how to analyse the market, and take the next steps towards this. He happened to have worked in the physiotherapy business, so he could helped a lot with valuable information.

Physiotherapists are paid per session, and there are strict rules and regulations regarding the price of these sessions. The value proposition was up till now to make the treatment more efficient so patients need less visits to the physiotherapist, who can therefore treat more clients. This would only be beneficial for the physiotherapist if he could ask more money per session because of his extra added service, which would not be the case if regulations are applied. Health insurance companies will benefit from this because patients claim the costs of their visits, less visits means less claims. Therefore, if physiotherapy was the one to go for, contact needed to be made with health insurance companies so that they can exert pressure on physiotherapists to buy the Mirrorcle. (by for instance stating that they will no longer insure them if they don't)

Koen stressed that the fitness market is a lot easier to enter because there is more money to be spend on innovations like this. Also, for a medical aid, we need to validate the claims, which can easily take more than a year. In fitness, this is not necessary.

An online community will be of great value. People can share their own results and rank with others. Fitness is very much a result-driven activity, a focus on this would be beneficial. He suggested to implement showing comparisons, show them how they will look like if they continue to work hard/harder. Connecting to smartphone app so they can get motivated at home (push notifications etc.) and can show people their progress, would add another layer of depth to the concept.

He also gave a lot of advice for the TU/e Contest finals and how to tackle the presentation in front of the dragon's den setting (he had been an investing dragon several times), but more on that in the section about TU/e Contest.

After the meeting with Koen, a team meeting was held and the decision was made to keep developing software for Lower Back Pain to show the concept to the investors, but to focus the business on fitness, this also to show the investors that some serious market consideration had been done.

MARKET RESEARCH

Market Research
It was time for some market research. Below, there are some facts and figures about fitness.

Facts and Figures
Fitness has become one of the most practised sports in our society. Fitness centres can be found in hotels, companies, sport complexes, as individual employers, etc.

There are around 1.600 fitness centres in the Netherlands, with an average of 1.600 members each. 20% of the dutch population practices fitness, concerning around 3 million people. Around 75% of visitors does so at least once a week, and an average visit lasts for 1,5 hours. A visitor is on average 30 years old.

The average turnover of a fitness centre is over 400.000 euros. The total turnover of the entire branche is estimated at 1 billion euros.

Trends
• Growing demand for personal coaching

• 24/7 coaching via mobile apps

• The market will become more and more dominated by lowbudget centres like Basic-Fit

• Consumers are only willing to pay more for concepts with a unique experience or concepts with great added value. Fitness centres can distinguish with new, innovative concepts.

Source: Rabobank Cijfers & Trends - Fitnesscentra, 30 April 2015, Appendix ?.?

COSTS

Production costs
To get a clear picture of how much the Mirrorcle would cost, a list of necessary parts was made, and an internet search was conducted to scavenge for the cheapest suppliers. On the right [Figure 45] is the list of components with pricing and supplier. Green parts have been validated, yellow parts have been calculated with unvalidated estimations.

	What?	Cost?	Where?
1100	**Parts**		
1110	LCD screen	110,00	Hangzhou Leehon Technology Co., Ltd.
1120	Aluminium Frame	50,00	
1130	Raspberri Pi 2	40,00	
1131	*Raspberri Pi 2 Model B*	32,00	Shenzhen Plus Color Technology Co., Ltd.
1132	*Wi-Fi Module*	3,00	
1133	*SD-card*	5,00	
1140	Kinect	149,99	Microsoft Xbox
1150	Plexiglass Covers	65,00	
1150	*Plexiglass (60cmx60cm) x 6*	50,00	
1160	*RS-20 Foil*	15,00	
1170	Cabling	10,00	
1200	**Assembly**	50,00	**AP Nederland or AMS**
1300	**Transport**	25,00	
1400	**Total**	499,99	

Figure 45

COSTS

Overhead costs
Also, an overview of the overhead costs has been made [figure 46].
There was not enough time to research how many would be sold each month, so a consumer cost price has not yet been calculated.

	What?	Cost pppm	Amount	Total Cost per month
2100	**Personnel**			**8.000,00**
2110	Distr. + Setting up	2.000,00	2	4.000,00
2120	Finance + marketing	2.000,00	1	2.000,00
2130	Customer Support	2.000,00	1	2.000,00
2200	**Office**	**1.150,00**		**1.150,00**
2210	Rent	600,00		
2220	Internet + Telephone	50,00		
2230	Insurance	500,00		
2300	**Warehouse**	**1.000,00**		**1.000,00**
2400	**Advertisement**	**300,00**		**300,00**
2500	**Minivan**	**1.000,00**		**1.000,00**
2600	**Server Hosting**	**10,00**		**10,00**
	Total			11.460,00

Figure 46

BUSINESS

Business Model Canvas Version 3.0

With all the necessary parts, companies and resources listed, a last (mind you, not final, there is never a final) business model canvas was made.

Key Partners

Microsoft Xbox

Server Company

AMS or AP nederland

Key Activities

Marketing

Exposure

Distribution + setup of product

Setup assistance

Coordinating manufacturing/storage

Admin (finance management)

Customer Support

Continuous Software development

Key Resources

Starting funds

Production materials

Manufacturing facility

Storage

Distribution networks

Servers

Personel

Minivan

Value Proposition

With our product, fitness centres can satisfy the growing demand for personal coaching in fitness, and therefore attract more customers.

Customer Relationships

Automated services (online service + software updates)

Personal assistance (setting up + helpdesk)

Channels

Company website

Exhibitions and Fairs

Fitness Community (online)

Personal contact

Exposure

Customer Segments

Fitness Centre Chains

Individual Fitness Centre

Hotels

Sport Complexes

Cost Structure

Manufacturing (parts + assembly)

Transport

Minivan

Salary

Advertising

Revenue Streams

Asset sale (list pricing)

Software Subscription

MARKET RESEARCH

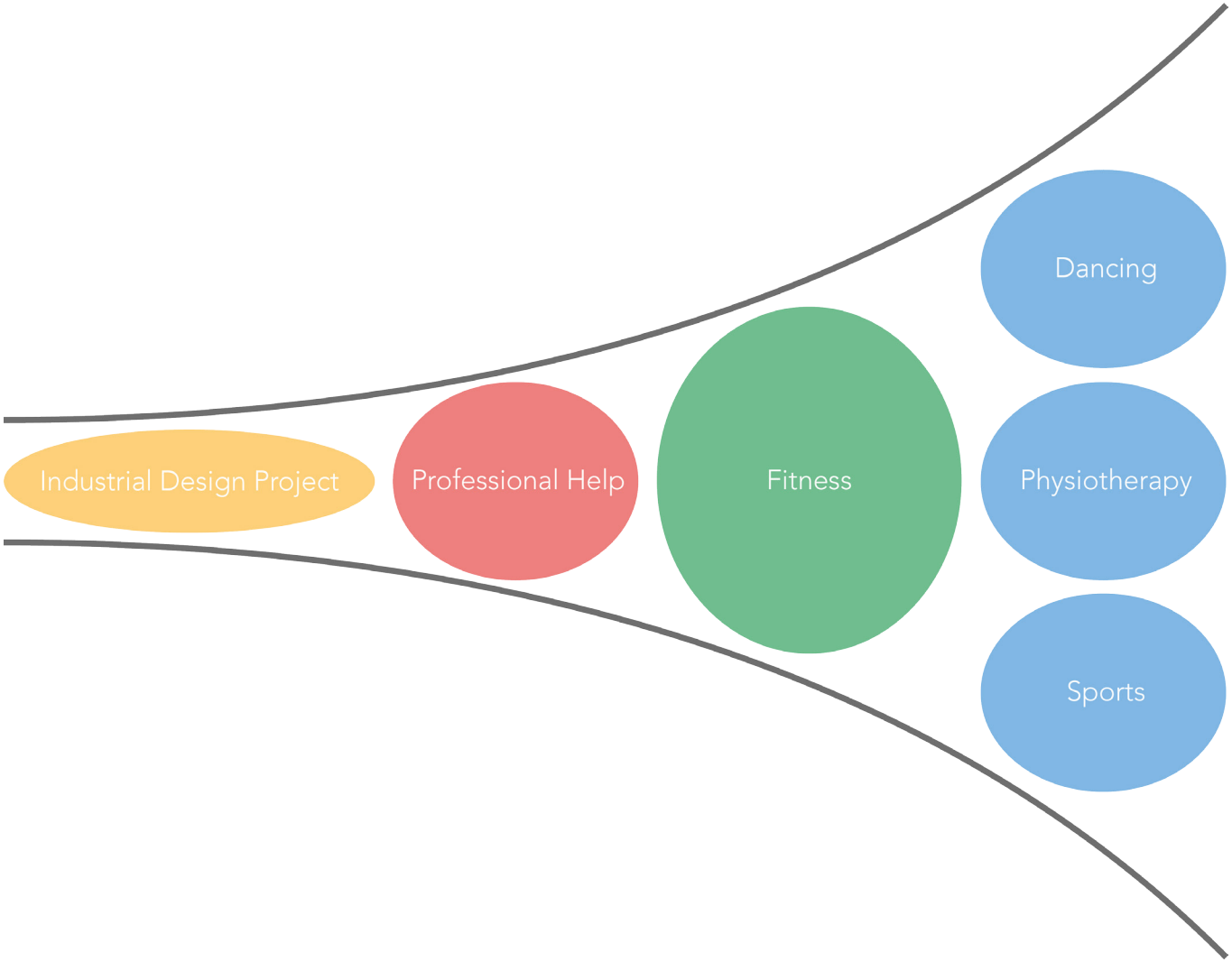
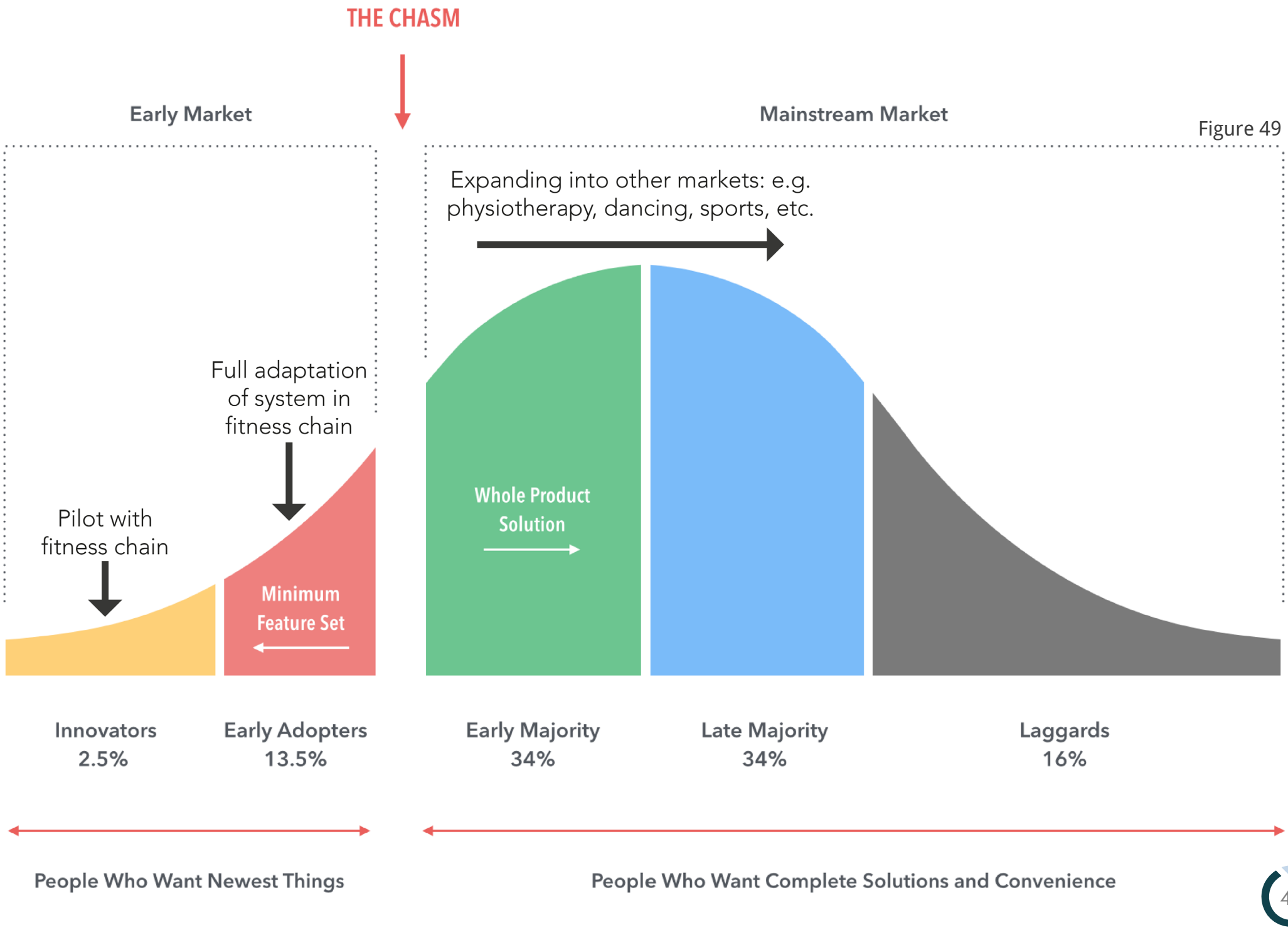


Figure 48

Market Strategy

The figure to the left [figure 48] shows the plan how the product will be developed. Professional help from experts and companies (see section about TU/e Contest) will take the project to the next step. Firstly, the concept will enter the fitness market, and afterwards expand into other markets like dancing, sports, and maybe even an implementation back into fitness.

Expanding into other markets will not only interest investors, it will also ensure future and growth in the company. It will help crossing the chasm (Moore's Chasm) between early adopters and the mass markets. As shown in figure 49, on the next page a pilot with a single fitness centre/chain shall be conducted, providing precious input and user feedback. After this, there will be a focus on implementing the concept on large scale in a fitness chain like Basic Fit, after which other fitness centres/hotels/sport complexes will follow and the concept will be iterated towards different markets.


THE CHASM
Early Market
Mainstream Market
Figure 49
Expanding into other markets: e.g. physiotherapy, dancing, sports, etc.
Full adaptation of system in fitness chain
Pilot with fitness chain
Minimum Feature Set
Whole Product Solution
Innovators 2.5%
Early Adopters 13.5%
Early Majority 34%
Late Majority 34%
Laggards 16%
People Who Want Newest Things
People Who Want Complete Solutions and Convenience

TU/E CONTEST

TU/E CONTEST

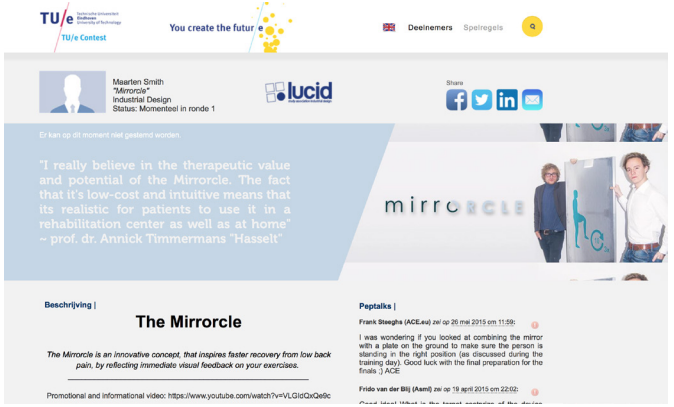
Team Mirrorcle also entered the TU/e Contest, a contest where all students could participate in showing others that their concept/idea was best. The focus of the contest was very much on innovative, technological and feasible ideas. Around 140 projects registered.

Motivation
The motivation to enter the contest was mainly because the project fitted very well in focus of the contest, Mirrorcle is innovative, it has never been done before, technological, it uses new technologies, and feasible, a working prototype had already been made.

On top of this, the TU/e Contest also served as an excellent motivational factor, giving the team extra responsibilities and deadlines, keeping up the work pace, not only at the end of the semester when ID deadlines were coming, but also during the semester.

Promotion (Campaign)
Each project needed to recruit votes, because the top 20 projects with the highest amount of votes would continue to the semi-finals. When the team entered the contest, a Facebook page was set up almost immediately, making sure there was a main medium to gain exposure.

After having shot some basic photo's for the Facebook page, the promotion began, inviting people to like the page and posting messages that they needed to vote for Mirrorcle. Within a few days, the team had created a huge peak of likes and votes, but this impulse attenuated as time progressed.



TU/E CONTEST

The team decided to create another peak of likes and votes, by making a promotional video and distributing this. For this, the prototype needed to be presentable, so the team focussed on making the outside of the prototype. After extensive research into how Kickstarter promotional videos were setup, a thoroughly thought out script was made. An interview with Annick Timmermans, our client, at the University of Hasselt was arranged, the needed shots were filmed, and a couple of weeks later, the promotional video was finished. [Figure 52]

To reach other people than from Facebook, the team shared the video on other media, such as Twitter, Linkedin, etc. The team even managed to promote the Mirrorcle at the Society of the Eindhoven Studenten Corps. To gain even more votes, a more personal approach was used, sending emails to colleagues and friends of parents, family, and many more. This resulted in another huge peak of incoming votes, making sure the team recruited the most votes of all projects.

Semi Final: Training day

Continuing into the next round, the team was invited for a so-called Training Day, where all 20 teams would have the opportunity to talk to the companies involved in the contest ([igure 53], the team with guys from ACE), along with the possibility of participating in a workshop by Startup Bootcamp XL about business models, and a pitching workshop.

A lot of information and input was collected to implement before the finals, what the companies wanted to hear in the pitch, what last steps needed to be taken to convince investors, but it was also a great network opportunity with officials from these companies.

Figure 53

TU/E CONTEST

Cursor

The Cursor is the newspaper from the University of Technology Eindhoven, they wanted to write an article about several projects in the TU/e Contest, one of which was the Mirrorcle.


Mirrorcle: Zeker winst halen uit de contest

"De Mirrorcle is een spiegel voor als je van je fysiotherapeut oefeningen moet doen om lage rugpijn te verminderen. Je mag hem mee naar huis nemen en kunt zelfstandig oefenen. De spiegel gebruikt motion-tracking om de positie van je rug te meten, en projecteert vervolgens directe visuele feedback in de reflectie van het spiegeloppervlak", zegt ID-student Maarten Smith. Zijn projectgroep, die nu bestaat uit hemzelf en Jelle Wories, Jasper Faber en Daphne Muller, bedacht de Mirrorcle al in september 2014. Er is begeleiding van revalidatiewetenschapper Annick Timmermans van de Universiteit Hasselt en hoogleraar Loe Feijs van faculteit Industrial Design. Bij de workshop op 19 mei hadden ze contact met Medtronic, ACE, ASML en AOMB. Een eerste prototype is in november 2014 naar de Domotica Beurs geweest.

"De lijn die Mirrorcle projecteert, beweegt precies mee met je rug, zodat je kunt zien of je rug recht staat tijdens het oefenen. De spiegel slaat ook alle data op van de oefening zodat je terug kunt kijken op je vooruitgang, en een voorspelling op de toekomst kunt krijgen. De fysiotherapeut kan vanuit zijn computer alle data bekijken en analyseren, om een zo efficiënt mogelijke behandeling te geven."

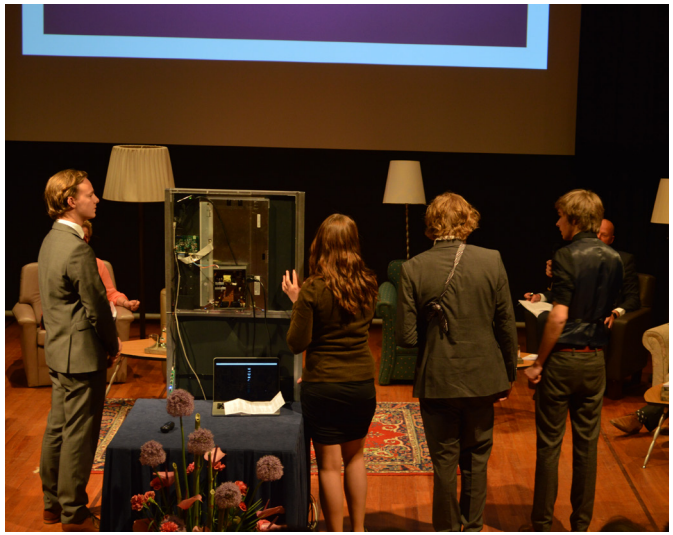
Meedoen aan de wedstrijd beschouwen de vier studenten als een leerproces. Maarten: "We beoefenen niet alleen onze technische kundigheid en professionele skills, maar ook onze kennis van business, productieprocessen en zelfs marketing in een real-life scenario. Het mooie is dat we hierdoor hoe dan ook winst gaan halen uit deze contest. Voor de rest zien we het allemaal als een mooie kans om ons idee nog verder te ontwikkelen en het markt-klaar te maken." De kosten die ze tot nu hebben gemaakt zijn voornamelijk materiaalkosten voor prototypes en een klein beetje aan promotie. "Deze driehonderd euro kosten hebben we uit eigen zak betaald."

Mirrorcle even appeared on the front page!

Final

During the (semi) finals, which took place in the Blauwe Zaal in the Auditorium of the TU/e, all 20 projects had the chance to do a 1 minute pitch to the Grand Jury. The best 6 pitches/projects were selected to continue, one of which was team Mirrorcle, and were allowed to give a 3 minute pitch to the grand Jury.

The 1 minute pitch focussed on getting the jury's attention, explaining the basis of our concept, and very briefly mentioned our business case. The 3 minute pitch went into more detail about why Mirrorcle wanted to switch to fitness, showed a bit more of the concept, introducing the team, and the future plans.



Although the first minute pitch went very well, the prototype failed during the second pitch, which resulted in time shortage, so some important parts of the pitch had to be left out. The feedback hence focussed on for instance future plans and business case, which could not be covered in the pitch.

Nevertheless, team Mirrorcle came third in the contest (figure ?.?), out of 140 projects, granting the team a sum of money. Although only the first place would receive professional help from companies, the team has already received numerous invitations by these companies to have a talk about the future.

REFLECTION

REFLECTION DESIGN PROCESS

1: Idea generation

2: Deciding on direction

3: Research to display

4: Deciding on display

5: Making the frame

6: Deciding on continuing with TU/e contest

7: Research to the judge, facebook promotion

8: Deciding on how to make the movie

9: Making the movie

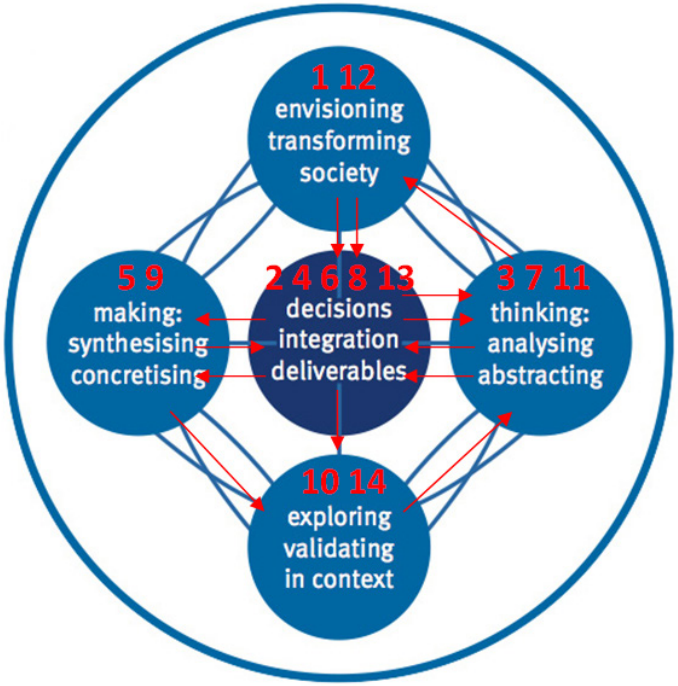
10: Midterm demo day presentation

11: Reflecting

12: Envisioning what to achieve in the second quartile

13: Setting goals
--individual design processes--

14: Demo day and TU/e contest



Reflection
Analyzing the visual of the design process, shows that some improvements could be made in the future. First of all, we could start making earlier in the process. The project started with a lot of thinking and decision making where making became of a less priority. Furthermore, the amount of exploring and validating in context could be improved. Validating could help to find improvements earlier in the design process which could save time.

The amount of envisioning was less of a priority, since the direction of the project was already decided at the beginning. However, when looking at the individual design process envisioning still played an important role. In the future, discussing a vision could be done more frequently with the whole team in order to avoid communication problems.

REFLECTION JELLE

I believe that continuing with Mirrorcle has been a great learning opportunity. I have been focussing on the business aspect of the project, and I believe that I have immensely increased my marketing insights by using different business model techniques, reading books on business innovation (Lean Startup by Eric Ries, Business Model Generation by Osterwalder), and getting inspired by a lot of business experts. I notice that, whenever I hear someone talk about their concept, I immediately start to think about business opportunities and feasibility.

I have also learned a lot about intellectual property. I have learned that patents can be great (sometimes indispensable) assets when you're planning on selling the idea/concept to investors, because they need a reason to buy it instead of just copying it themselves. Because we presented our concept before, patenting was no longer possible, but I learned that there are alternatives to protect your intellectual property, like design rights, trademarks and creating brand identity.

Entering the TU/e Contest helped greatly in realising that things were becoming more and more serious, and there was true potential in the Mirrorcle. This contributed to me handling the project with a more professional attitude. It also allowed me to create contacts within several companies, so it was a great networking opportunity too.

I think that the semester has been very fruitful, especially because it has been different from the standard Industrial Design project. I now understand the importance of business insight, and next projects I will start from this perspective, instead of adding it to the project in a later stage.

REFLECTION JASPER

Extraordinary, is how I would call my past year at Industrial Design.

The reason why I call this year extraordinary is because I managed to find a theme where I feel I belong. When starting with the project, we immediately were provided with a clear problem statement, supporting research and a helpful client. I think I could speak on behalf of the first team when I say this really helped us getting to the concept very early in the design process. This created the ability to deliver 3 iterations of a prototype, which was something that felt very satisfying. On top of that, the approach of designing for a world problem is something I really liked.

That I felt myself comfortable within the theme was not the only reason I chose for this extra semester. Also because I really wanted to explore a design process from another dimension. In the first year I saw how to get from nothing to a thought trough concept and a low-fi prototype. Now I wanted to explore the area that lied behind this phase. I wanted to see how it is to take prototyping to a next level: product designing. Also when looking at the area of market, promotion and branding I saw many opportunities to dig out.

The first quartile for was a rather strange quartile. Continuing in the same theme meant two new team members. This was kind of exiting. You can never predict if they want to join you on your design journey. Fortunately, the two new members were ready and willing to continue the project together with us. After the first quartile, the team was on the same line, a new goal and vision were set, a part of the new prototype was developed, the interface started to take shape and the first roots of the TU/e contest were formed. In advance, I had hoped the blending of the team and the constitution of the new vision would develop a lot faster. But now I noticed that, when working on the same project for half a year, it takes a lot of care to get two totally fresh persons on the same line as you are. They will come with new idea's and concepts which are completely different. Of course this is a very good thing, and for us it was to task to incorporate these new ideas but make sure not to derive too much from the existing concept. In my opinion this worked out really well, mostly because of the use of a list of requirements.

In the second quartile we diverged the team into different subjects which needed to be researched or developed. I engaged myself on programming the logics behind the interface.

Next to this, I followed the assignment Creative Electronics. Applying the acquired knowledge into practical use in the project, resulted in a substantial growth regarding my skills in programming. Together with Daphne, who was responsible for delivering the graphical images, we worked towards developing a working interface. Within this collaboration, communication had of high importance. Eventually the teamwork went quite well. One thing I would like to improve next time is to be more clear about what I need and when. This time the graphical interface images were delivered too tardily. Which resulted in some time pressure at the final stages. Next time I know, when your work depends on the work of someone else, make sure you are clear about which resources you need and when.

REFLECTION JASPER

Next to this the TU/e contest also played a big part in the second quartile. Getting advice from big companies like ASML, ACE, Metronik etc. was really inspiring. They gave me insight in the world of a startup. I feel I grew some substantial awareness on the area of getting a product into the real world. Right now the concept is starting to change from physiotherapy to fitness. Which is something I see as fruitful direction for the project. Nevertheless for me as a designer this means I'm not designing for a world problem anymore. We would be creating a commercial product. Unfortunately this will not contribute to my personal growth as a designer, therefore I would like to take this on as a part-time activity next year. This because the Mirrorcle is a project with a lot of potential, it would be a waste to throw it away.

REFLECTION DAPHNE

At the beginning of this semester I decided to work on an existing and validated design, and see how my design directions end up differently than when I start from scratch. Furthermore, I expected to be able to focus on developing the look, feel and interaction of the product. While looking over the shoulders of my teammates I expected to learn about business and technique: I wanted to learn which tools exist and become important in this part of the design process and how I can use them in other projects.

We ended up developing a new prototype and working on promotion during the TU/e contest.

Prototype development
The idea generation in the beginning of the semester was an interesting start to get introduced in the design decisions of the previous project. It was interesting to see that diverging our ideas lead to the initial concept.
In making the hardware I learned about the existence of different techniques to project light, I learned about the possibilities of one-way mirror foil, technology like the raspberry pi and the Kinect sensor. During the workshop Electronics for Health I learned about the existence of different sensors and microcontrollers. I found the possibilities around the raspberry pi so promising that I need to develop this further in future projects.

In the topic of business I learned about the Porter five forces, how to iterate on a business model canvas and some practical insights: you should not try to bring a perfectly working product on the market, but a product that is just good enough for your goal to make sure that you do not use valuable feedback and money. Furthermore, it is sometimes necessary to switch from market if you want to reach your initial goal.

I personally worked a lot on the house-style and designing the interface. I learned the steps of finding a house-style that reflects what the project stands for in an abstract way. I found graphic elements that define my style as a designer. In designing the interface I made the fault to do not plan clear iterations which I can improve in the future. Also keeping the amount of information per screen limited was a good learning point: not only in the amount of buttons but also in the amount of information I place on the screen.

Furthermore, I worked on the persuasiveness of the mirrorcle, to combine my knowledge with my USE-learning line Human in Technology. The biggest learning point was to not overdo it. It was clearly not only about adding an extra load of information, but about strategically trying to find out in which steps your users need extra persuasive factors and adding it on those spots in the interface. I learned that overdoing the persuasiveness have negative effects on the usability.
Reflecting on this process, I received the feedback that the whole setup of the interface should be slightly more persuasive and personal, and especially in the way of interacting with the mirror. I need to learn to find a balance between the identity of a market (in our case the impersonal clinical environment) and the needs of the user. In future projects, I can avoid mistake this by planning more time for user tests, and also by testing the interface in different environments.

TU/e contest
During the TU/e contest I learned about setting up a promotion and pitching your ideas. I found that it is really important to set clear priorities, since I had the feeling in this project that developing the prototype became less important than competition in the contest, which was not our initial goal of the project.

REFLECTION DAPHNE

During the promotion I found that facebook is a very powerful tool, especially when you are in a team. Making a movie is a very powerful tool to get shared along different networks of people, but I need to ask myself if it is really necessary to achieve this for my final goal.
During the pitches in the finals I was able to do valuable observations. I created a list of tips and inspiration I can use for preparing future pitches.

Teamwork
I reflected extensively on the teamwork this semester, since in my opinion this was a pity exercise. The main conclusion was that the combination of dividing tasks and working at home made me lose overview of the continuation of the planning. I learned that in the role as a team leader it is really important to keep this overview and to keep tracking each other's development. In future projects I will avoid this working attitude by making clear agreements with the team at the start of the semester about what we expect from each other.

Vision development
During this project, I found out that I got very enthusiastic about the technical background of the concept. Adding technology in a creative way makes the product interesting for me to explain to others, and it adds an extra challenge to get it working. I also loved the setup of health and helping people, but during the business model development I found out that these sectors are not always very designer-friendly. Last but not least, this project was very much focused on business and promotion. I enjoyed this part of the project but for my feeling it was a bit out of balance with prototyping and designing. In the future, I will try to balance going to contests or exhibitions with having a priority on prototyping and concept development.

REFLECTION MAARTEN

The requirements for the 2nd and 3rd year of Industrial Design are to achieve depth in all competency areas. This is done by applying gained knowledge, skills and attitude in these competencies, and applying them at a professional level.

As the B2.1 semester came to a close, I set my overall growth learning goals for my next project:

• To gain depth in Social-Cultural Awareness, by experiencing the role of an industrial designer as design approaches mass production.

• To develop a business attitude and apply this attitude where necessary in the design process

•To gain more understanding for my place in a design team, my identity.

•To professionally apply a user-centered design process

•To apply my understanding of technology, IPR and descriptive and mathematical modeling to communicate with experts on a professional level.

• To apply my pitching and communicative skills and strengths at a high level.

I realized the challenge, as these experiences usually happen deeper into a design process than one semester will allow. Ideally I would work on an existing project, and go into greater depth of learning, involving experts along the way. This ideal wish was realized when I was invited to join the team that was going to take the Mirrorcle to the next level. Because of this, I have a achieved nearly all these learning goals this semester.

Working together with Jelle catalyzed my growth in developing a business attitude enormously.

Being placed between Jasper, who is by nature a real designer, and Jelle who is by nature a real designer gave me new insight into understanding my place in the team. I feel comfortable in business and in design, but mostly, being the link in between.

I wasn't able to achieve my goal for professionally applying the user-centered design process; so I developed this in my RSDL activities.

I was able to practice communicating my knowledge to experts in production processes and IPR through communicating with experts during the TU/e contest. This was really the next step in my development of Integrating Technology. I practice my understanding for descriptive and mathematical modeling, but I did not develop it further.

In the campaign for the TU/e contest I experienced starting a campaign to create awareness about a product. I also used my pitching strengths in the high-pressure final.

REFLECTION MAARTEN

Your one-minute-pitch was top.
~ Jan Mengelers (Voorzitter College van Bestuur TU/e.

The feedback I got on my pitching was very encouraging, and I am going to take this strength to a very high level in the future.

I also developed a new vision on the clinical health sector. Although design plays a vital role in the sector, limitations, clinical credibility and testing create a spider-web that provides many limitations. Because of this (and other factors) I have tuned my vision towards becoming a designer for reinstatement or improvement of mental wellbeing through intelligent design, storytelling and creation of empathy.

FUTURE

FUTURE CONCEPT IMPROVEMENTS

One piece
Because it was necessary to create a portable product that could be taken home from the physiotherapist, the new prototype got a modular design. This would make it easy to dismantle, transport and construct the product. The disadvantage of this, came to surface while developing the prototype. When the Mirror is split up into 3 different modules. You cut down the possibilites to place the screen. Right now the biggest screen that could be implemented is 22". Also the positioning of this screen isn't very convenient.

Another problem that occurred is, when dividing a mirror in 3 different modules, even the smallest irregularity causes an optical distortion.

When the Mirror's destiny would switch to fitness, the product doesn't have to be portable anymore. This means that in the future, the Mirror should consist of just one piece of glass.

Material
Feedback told that the Mirrorcle gives the user a 'distant' feeling. Mostly because the material that is used: aluminium, feels very cold and industrial. At the beginning of this semester, this was a very logical choice. The Mirrorcle had to be sturdy, clean and light-weighted. Here the same principle occurs as before. When the switch is made, portability isn't top priority anymore. Therefore the material can be adapted to be more user friendly. Possible material considerations could be wood or plastic.

Also the use plexiglas with half-way mirror foil should be changed. Placing the foil over the plexiglas most of the time results in an irregular surface. Nowadays companies exists that can create custom made glass against low prices. Using hardened half-way mirror glass means better looks and feel for the user.

Interaction
Emotional connection triggered before, during and after the interaction with the Mirrorcle is of vital importance to the viability of the business model that was created for the Mirrorcle. We create value for fitness centers or physiotherapists by providing a product and service that will attract new customers and keep customers coming. If customers are to keep coming they need to fall in love with the interaction with the Mirrorcle, and see the benefit of returning to it.

However, if the interaction gets too intimate, it might frighten customers, or create a barrier for users. This means that new steps have to be taken to provide a nuance in the interaction, so that the Mirrorcle fulfills both these criteria.

FUTURE SOFTWARE IMPROVEMENTS

More Power
Unfortunately the raspberry wasn't strong enough to handle the software. To solve this problem, the next version of the Mirrorcle needs a stronger device. Specific research is needed to find out what would be the optimal choice considering processing power, price and integration within the other hardware.

Connectivity
The Mirrorcle still has to be able to send and receive data from over the internet. This enhances the connection with the user and functionality. This is quite a challenging subject to tackle, because expert knowledge on the area of programming is needed to develop this kind of system. In the future the team could look for a new team member with the right knowledge and skill to develop the connectivity of the mirror.

Kinect
Right now, the kinect software does what it does. But it still looks like a prototype. If the Mirrorcle has to be market ready, big changes have to be made considering the looks and running of the kinect program. On top of that, the program has to switch to fitness exercises. For this research has to be done about the ins and outs of these kind of exercises. The same counts for the look of the interface.

TASK DIVISION

TASK DIVISION

Introduction	Jelle
Semester 1	Jasper
Objective	Jelle
Ideation	Daphne
Prototype	Maarten
Interface	Daphne
Software	Jasper
Interaction	Jasper + Maarten
IPR	Maarten
Business	Jelle
TU/e Contest	Jelle
Design Process Reflection	Daphne
Future	Jelle + Jasper + Maarten
Compilation	Maarten

During the design process Daphne was responsible for the interface design, Jelle for business, Jasper for software and Maarten for IPR and the electronics. The frame was built by Jasper, Jelle and Maarten.

ACKNOWLEDGEMENTS

ACKNOWLEDGEMENTS

We would like to thank several people who helped us, inspired us, or made us realise whether we were doing good and when we were going in a false direction.

prof. dr. A.A.A. (Annick) Timmermans
Annick was our client for this project and helped us a lot with all the different questions we had regarding Low Back Pain.

prof. dr. ir. L.M.G. (Loe) Feijs
He was our coach during this project. Every week he helped us going through the design process asking critical questions and giving us advice.

H.J. (Herman) Wories
Herman helped immensely with the business side of the project, giving continuous input, arranging contact with experts, making time for extensive feedback sessions, and devoting his time to helping us.

Koen Klokgieters
Koen gave us a lot of input on how to analyse the market, add extra value to the concept, and take the next steps towards realising this.

Christian Kling
Christian gave us a lot of insight and knowledge about how to choose your market and helped us in realising that we should switch to fitness.

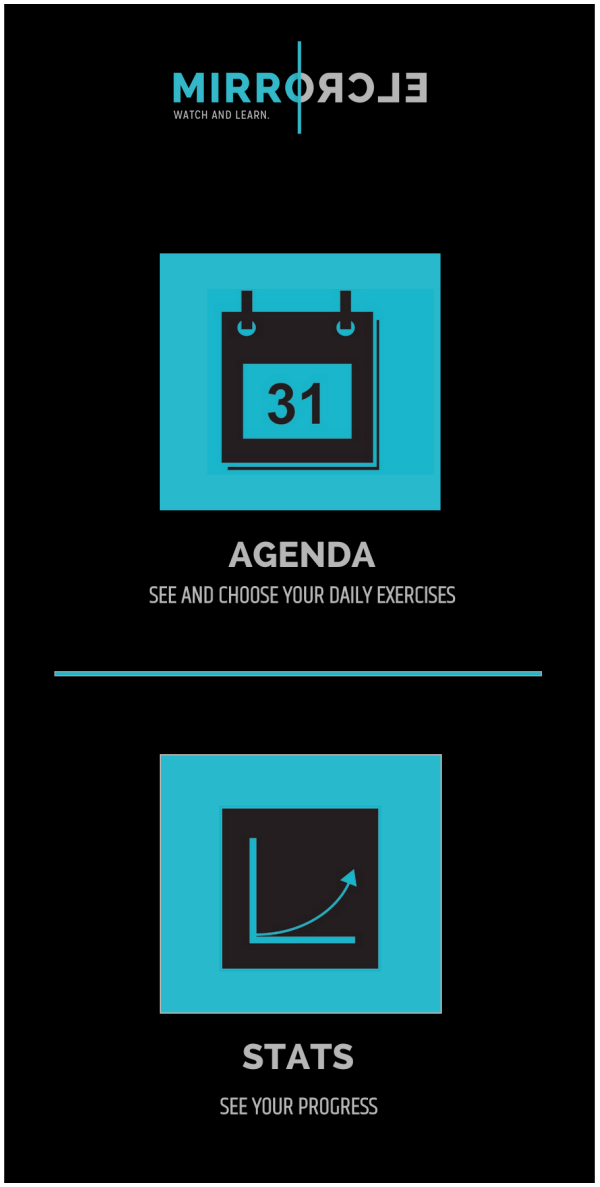
Rhys Duindam

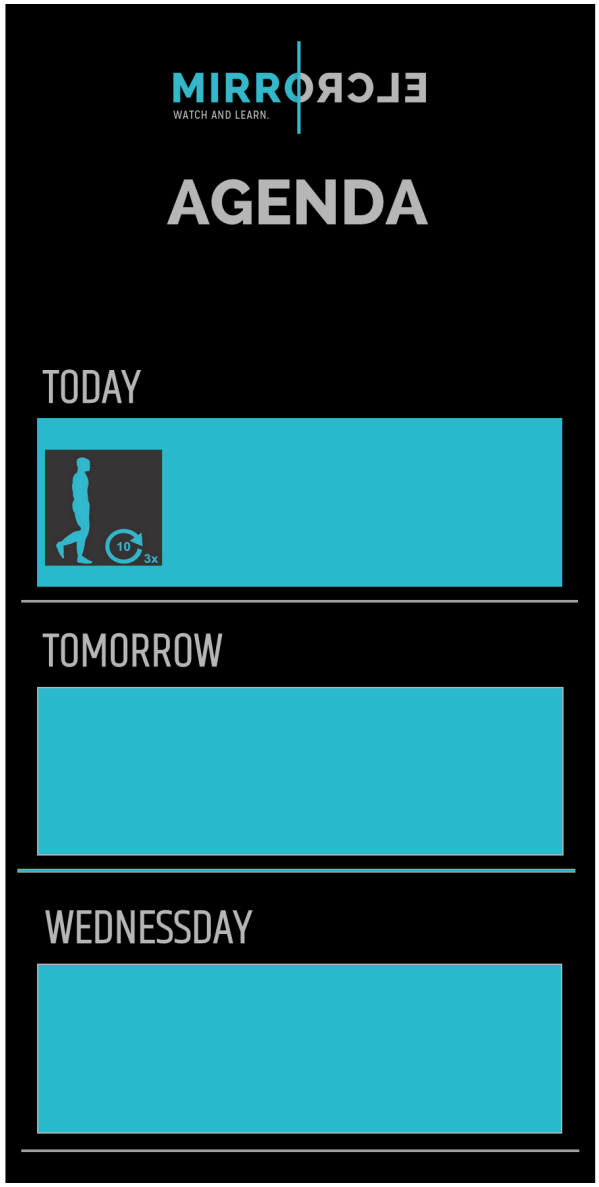
Peter Ruijten

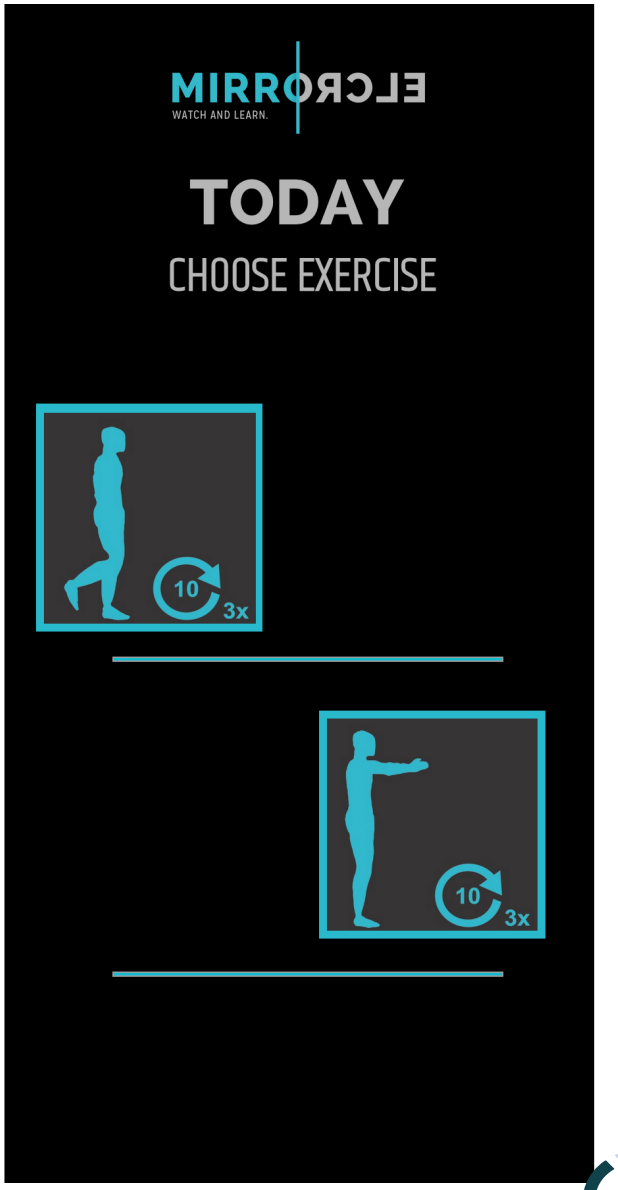
The guys from Vertigo
They helped us with construction techniques for the aluminium frame, enduring the terrible racket we made, supplying tools and knowledge.

APPENDIX

A1 FIRST INTERFACE







A2 SOFTWARE

```
// converts the keypressed function into a variable which can be used for controlling the interface.
void keyPressed() {
  if (keyPressed) {
    if (key == 'w') {
      keyVar = 1;
    }
    if (key == 'a') {
      keyVar = 2;
    }
  if (key == 's') {
      keyVar = 3;
    }
    if (key == 'd') {
      keyVar = 4;
    }
    if (key == ' ') {
      keyVar = 5;
    }
  }
}
```

In this picture the piece of code is shown that tranlates the keys that are pressed to a veriable called keyVar. Appendix 2.2 shows how this keyVar controls the switch between different frames.

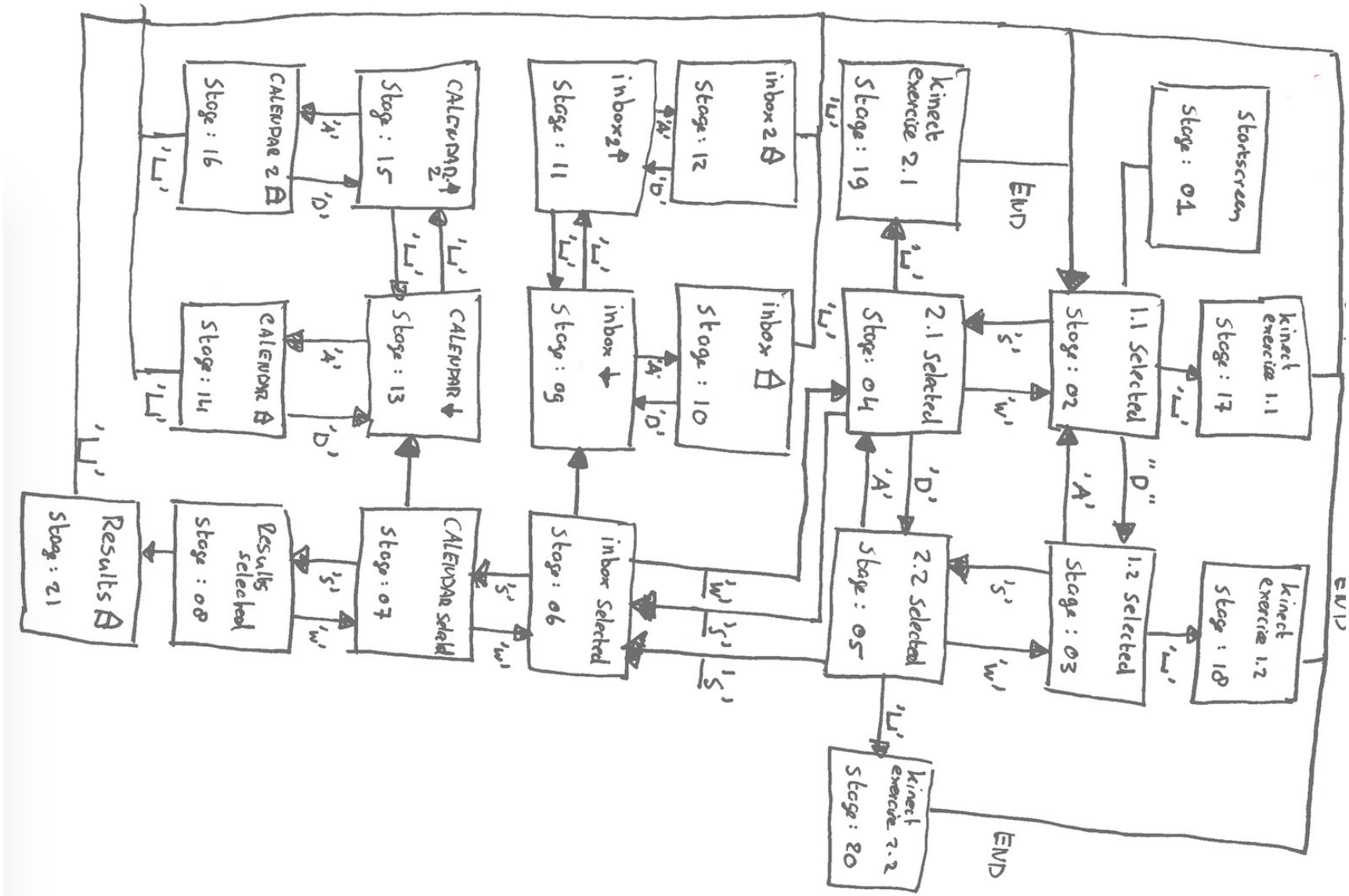
A3 SOFTWARE

```
//exercise 1.1 selected
void stage02() {
  background(0);
  image(homescreen, 0, 0, 1920, 1080);
    initializeOutline();
  rect(515, 530, 305, 308);

  if (keyVar == 4) {
    keyVar = 0;
    stage = 3;
  }
  if (keyVar == 3) {
    keyVar = 0;
    stage = 4;
  }
  if (keyVar == 5) {
    keyVar = 0;
    stage = 18;
  }
}
```

Every different screen is build from this ground code. The only differences are the available keys, the background image and the placing of the rectangle cursor.

A4 SOFTWARE



This diagram shows the logistics behind the the program. The diagram shows every accessible frame and which keys lead from there.

A4 ONE MINUTE - PITCH

Exercising is fashionable. Whether you have been given exercises by a physiotherapist, to help recover from low back pain, or are improving your fitness, there comes a time where you stand in front of the mirror, and exercise.

But are you doing it right?

The Mirrorcle uses a motion tracker to capture the points of your back and visualize them as a line in your reflection. It can remind you of how to do you exercise, and predict how long it will take for you to achieve your recovery, or fitness goal.

It was developed for a clinical environment, but we see real potential in the fitness market. Personalized training and new technologies are much desired in this already booming industry. The effortlessness and absolute lack of intimate contact with technology make the Mirrorcle a perfect investment for fitness centers. Sadly, we only have 1 minute, so we cannot show it NOW.

With your help, we can take the Mirrorcle a step further by developing the service to go with it, the intelligent algorithms and bringing it to the market.

Thank you very much for listening

A5 THREE MINUTE - PITCH

The Recap
Let's just give a quick recap of our previous pitch. The Mirrorcle uses a motion tracker to capture the points of your back and visualize them as a line in your reflection. It was developed for a clinical environment, but we see real potential in the fitness market.

The Target Market
Why? Approximately 3 million people in the Netherlands practise fitness, and this number is rising continuously [...] The market will become more and more dominated by low-budget concerns, such as Basic-fit. These concerns need to distinguish themselves to keep people coming and attract new customers [...] Personal coaching and new technologies are much desired in this already booming industry, which is EXACTLY where our concept kicks in!

The Concept
Let's go into more detail. This is the motion tracking system, it sends data about the position of your body to the built-in computer, which displays visual feedback on the screen. As you can see, the line, which represents your back, moves along with you. If your back is not in the right position, Mirrorcle will indicate this. The device will also store all the data and make a prediction about the achievement of your fitness goal or recovery time.

Now, Jelle has been in touch with several Chinese suppliers, we estimate that all the components together will cost a bit more than 400 euros. Adding up assembly and transport, we estimate our production costs to be around 500 euros per Mirrorcle.

The Team
We'll quickly introduce the team as well! We are working with 4 industrial design students, though we all have our specific areas of interest and expertise. Jasper, who is in the audience, has been programming the Mirrorcle like there's no tomorrow, Daphne, also in the audience, has been designing the interface, Maarten has been looking into Intellectual Property Protection and making the hardware look sexy and Jelle has been playing our business man.

The Future
So, what will happen if we get your support? First of all we will be able to design and test a service to manage Mirrorcle. The user will be able to manage all their data from an application on their phone. We will also be able to invest in some significant hardware updates and make deals with industrial prototyping companies.

A6 SEARCH QUERY

The Search query used for the Derwent Innovations Index patent database is as follows:

TS=((back OR backbone OR spine OR spinal OR vertibr* OR rachis) AND (measur* OR meter* OR track*) AND (rota* OR angle OR position* OR placement OR placing) AND (physi* OR therap* OR clinic* OR fitness)) AND IP=(A61B-005* OR A61H*)