THE PLAY REBOUNDER

Bachelor's Project in Industrial Design
Jonatan Schmidt
2018

THE PLAY REBOUNDER

Jonatan Schmidt

Degree Project for Bachelor of Fine Arts in Design
Main Field of Study Industrial Design

Lund University, School of Industrial Design
Department of Design Sciences

Examiner:
Prof. **Claus-Christian Eckhardt**

Supervisors:
Lec. **Anna Persson**
Prof. **Jasjit Singh**
Sen Lec. **Charlotte Sjödell**

2018[*]

[*]Year of printout of this documentation. However, the project itself was conducted in 2016/17

ABSTRACT

The purpose of this project was to create an object that improves the performances of football players, preferably on all levels, be it professionals or amateurs. The main theme was science and technology, to explore how they together can be used to accomplish this task.

The project consisted of doing research on site at amateur football clubs, which included observations of training sessions as well as interviews with managers and players. This was combined with market research and scientific journal texts, along with personal experience and knowledge of playing the game. The main focus point of the research was the science of practice and performance; to find out what abilities are relevant and how they might be practised more effectively through the use of technological aid. Either through effectivizing the practice routine itself or through measuring and assessing the performance retrospectively.

The brainstorming and idea generation were based on combining personal experience, research gathered from the internet as well as the observations and interviews at the football clubs. The ideation consisted mainly of sketching, as well as small scale test models.

The end result is a concept of a rebounder, a practise tool, which incorporates added interactivity and performance feedback in the form of an impact detection system and an accompanying microcontroller and display. The concept is based partly on feedback from the discussions with managers and players, as well as inspired by science highlighting the importance of mental functions for perfoming in the game.

A full scale model was built. The model showcases the physical mechanics, such as ball rebound, angling, folding and overall handling of the rebounder, while the technological side of the rebounder was illustrated through renderings.

TABLE OF CONTENTS

INTRODUCTION

Background & Motivation

Football is the biggest and most popular sport in the world, played by millions of people worldwide. Its simplistic and intuitive nature allows it to be played anywhere, whether it is organized playing or just spontaneous kicking about in a garden, street or park.

Today the game, above all on the professional level, is like almost every other major sport being increasingly subjected to scientific investigation. This is accompanied by a growing implementation of technological aid. Technology is used both by coaches and players themselves in order to retrieve valuable data on performance, as well as by an increasing number of companies, both within and outside the TV industry to collect and broadcast info to viewers during official games.

This ongoing fusion between science, technology and football, a consequence of the general evolution of technology and Internet Of Things, is what captured my attention in general. The main aspect to explore was the science of performance. Specifically, the factors that affect it and how those can be measured and practised more effectively by utilizing the power of technology.

BRIEF

To design an object/objects that *effectivizes* the practice, and consequently performances of football players. The design object/s should preferably be possible to use regardless of playing level, be it professional or amateur.

DEMARCATIONS

Due to my personal interest in football and because the relationship between football, science and technology in general fascinates me, I decided to not set any significant demarcations from the outset of the project. This in order to allow myself to explore as much as possible the quite complex question of performance and the many different factors that affect it.

However, one demarcation was that the focus should be only on designing something used when practising and not on match equipment. There was a clear reason for this. Even though it's during a match that performing ultimately matters, there are rules, or "laws of the game" stated by the main governing body FIFA, that dictate how the game is played. These rules must be strictly obeyed in order to not disrupt the function and natural flow of the game itself. Consequently, there are clear limits as to what's possible to do with the equipment used during matches, be it the wearable equipment of players, such as boots etc, or the components of the game itself, like the ball or the goals, etc.

Another important reason was that the game on the field is and should always be about the human ability, and it is in my own view essential that the human factor and simplicity of the game remains if the game is to be exciting for the players and viewers. Thus, designing something that is used for improving performance during matches ultimately felt both unrealistic and not very tempting, after all.

Primary goal/theme:

- Explore how *science & technology* can be utilized in order to improve the practice routine

Secondary goal:

- Design something that can be used by anyone playing the game, regardless of playing level or economy

I.
INITIAL RESEARCH

MARKET

The project began with doing a general research of the design, tools and technology being used in the world of football today. The aim with this was to get a general sense of what is done today in terms of performance monitoring/enhancing tech before finding potential gaps or specific subareas to explore.

It involved looking at what is used in training on both the professional level down to amateur, as well as some more conceptual equipment. Technology that is used during official matches was also briefly examined, although only for inspiration purposes as the focus of the project was not about improving the function or flow of the game itself, as previously mentioned.

An overview along with some brief explainations and evaluations of each example will be presented in the following pages.
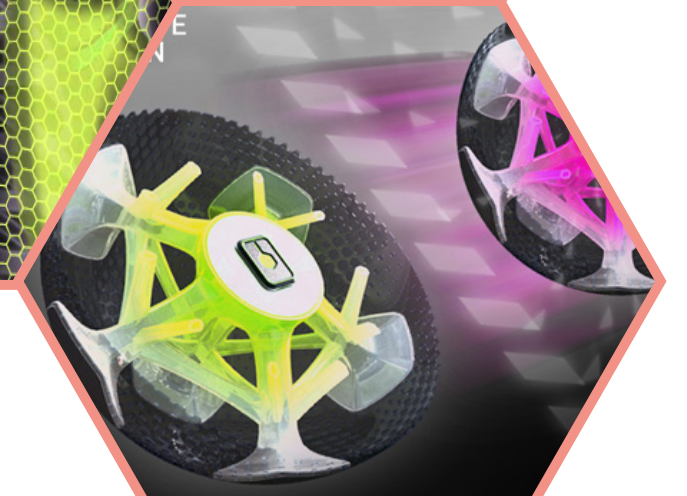
ELECTRONIC PERFORMANCE AND TRACKING SYSTEMS

Professional level clubs are today becoming increasingly interested in electronically tracking the performance of individual players in order to get real data as a basis for making accurate assessments.

This is made possible thanks to various wearable tracking devices, referred to as Electronic performance and tracking systems (EPTS)[1], that with the help of GPS, accelerometers and gyro sensors can map the physical performance of the players.

The trackers are normally placed in some kind of pocket and worn on the upper back in a vest-like apparel (above right).

What is measured?

The most prominently used performance measuring devices are ones that can measure certain important *physical* factors, such as speed, acceleration, number of sprints and distance covered. This information is stored on the devices and later viewed for analysis by coaches.

Availability

EPTS are essentially a professional level exclusivity. Only one example, the Adidas MiCoach speedcell (below right), that is commercially available or affordable to individuals on lower playing levels could be found in the initial research.
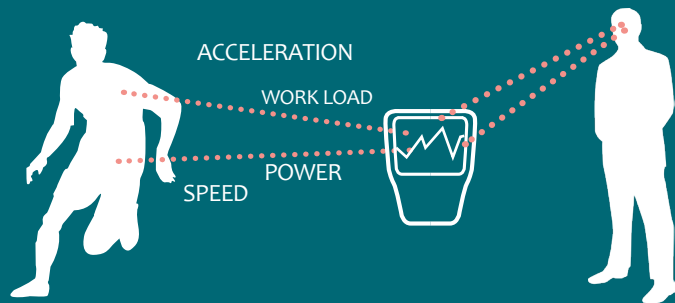
Market example - Adidas MiCoach (speedcell)

Adidas MiCoach[2] is a versatile tracking device that can measure various physical factors such as speed, number of sprints, distance, power and more that are collected for later viewing. One cool feature is also that it can showcase a heat map of where you've been positioned on the field during a match.

It has two unique selling points. One is that the sensor/data collector can be placed at the underside of the shoe, making it very non-intrusive. The other is that it is one of very few, if not the only affordable tracking device, which makes it a good solution to use also for amateur players.

TRAINING EQUIPMENT

Besides looking at what is done to monitor performance, a general research of the non-wearable (external) training equipment was done. This to explore if there is anything happening there regarding implementation of technology in the form of 'machines', electronic/digital functions or smart tech in order to monitor or effectivize practice.
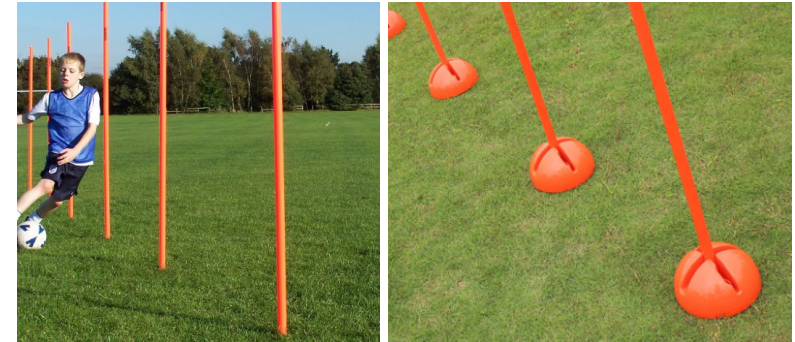
A brief overlook of how the equipment looks and works today is presented here.

Cones

Cones are simple but have various purposes; as markers for showing where playing areas end, as checkpoints in certain excercises or for obstacle courses and technical drills.

Stackable, lightweight and made of plastic make them both suitable and cheap.

Boundary poles

Similar to cones, although better for obstacle courses as they prevent cheating by forcing you to go around them. Plastic and lightweight. They are usually attached to the ground, although can be combined with certain cones (right picture)

Hurdles

Often used for physical excercises and drills, and practise jumping and quick feet (lower versions). Some models offer adjustable height.

Player mannequins

Player mannequins are used in the same way as boundary poles, but mimicking a real player in shape. Often combined and used as a wall for freekick training, replacing human players.

'SPECIAL' TRAINING EQUIPMENT

There are other types of equipment which is a bit more unusual, some of which are more advanced and for specific purposes, and therefore more common on higher levels.

Timing poles/gates

Probably exclusively used on professional level. As the name suggests, used for accurately measuring speed and times.

Ball launchers

Ball launcher machines are getting more common. They are very useful for speeding up excercises because of their quickness and the ability to aim more easily, making them more efficient overall than human shots. Especially useful for goalkeeper training, but its rapid launch rate makes it effective in almost any situation.

Rebounders

Rebounders are portable "walls" that practise essential skills such as passing and receiving. They are most often used as an individual training tool for younger kids needing to practise the basics, but is a very versatile and effective tool that is also used as an integrated excercise by teams on all playing levels. Come in many different sizes, shapes and versions.
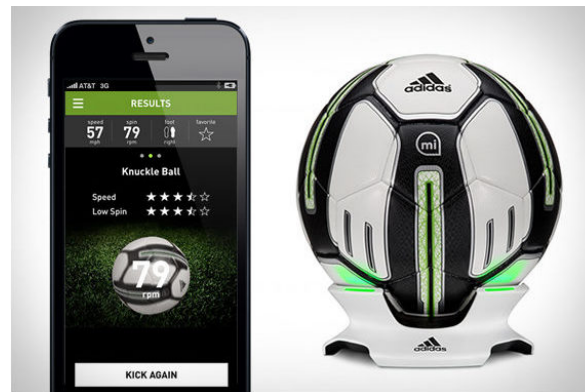
ADVANCED EQUIPMENT & TECHNOLOGY

MATCH TECHNOLOGY

Goal-line technology

In order to prevent the regularly ocurring incidents where goals are mistakenly allowed or disallowed due to the human errors of the referees, goal-line technology[5] has very recently been integrated to really determine if the ball crossed the line or not.

There are 2 kinds of GLT, camera-based and magnetic field-based. They both work by tracking the balls location and sending the information directly to the referee's watch when the situation demands it.

Footbonaut

The footbonaut[3] is a highly advanced, technological practice station. It consists of a square playing area enclosed by 4 walls and a roof. This creates a cage where footballs are launched with different speeds, heights and trajectories towards the player from openings in the walls and roof. The footbonaut practises several abilities simultaneously, such as spatial awareness, receiving the ball as well as passing/shooting accuracy as the player has to send the ball back to the opening indicated by lights. It's a perfect example of the fusion between football and technology, and likely a sign of where things are headed.

Adidas MiCoach SMART ball

The Adidas MiCoach Smart Ball[4] is another excellent example of an excellent use of technology for improving practice. It makes use of highly sensitive sensors that tells you everything you would want to know about your strike through an app on your phone, such as speed, power, where exactly you hit the ball with your feet and much more.

MARKET RESEARCH – ANALYSIS

After the initial web research, 3 standout conclusions were made:

1. Potential for exploring the implementation of interactive', intelligent or machine-driven objects

Thare a few examples of interesting new external training equipment that are being made, such as ball launchers and timing gates. Apart from that, the basic equipment is very rigid and undynamic in the way it functions. This gave inspiration for the following ideation of more dynamic equipment that might contain smart features and/or interactive elements that can tailor the challenge based on the player using it.
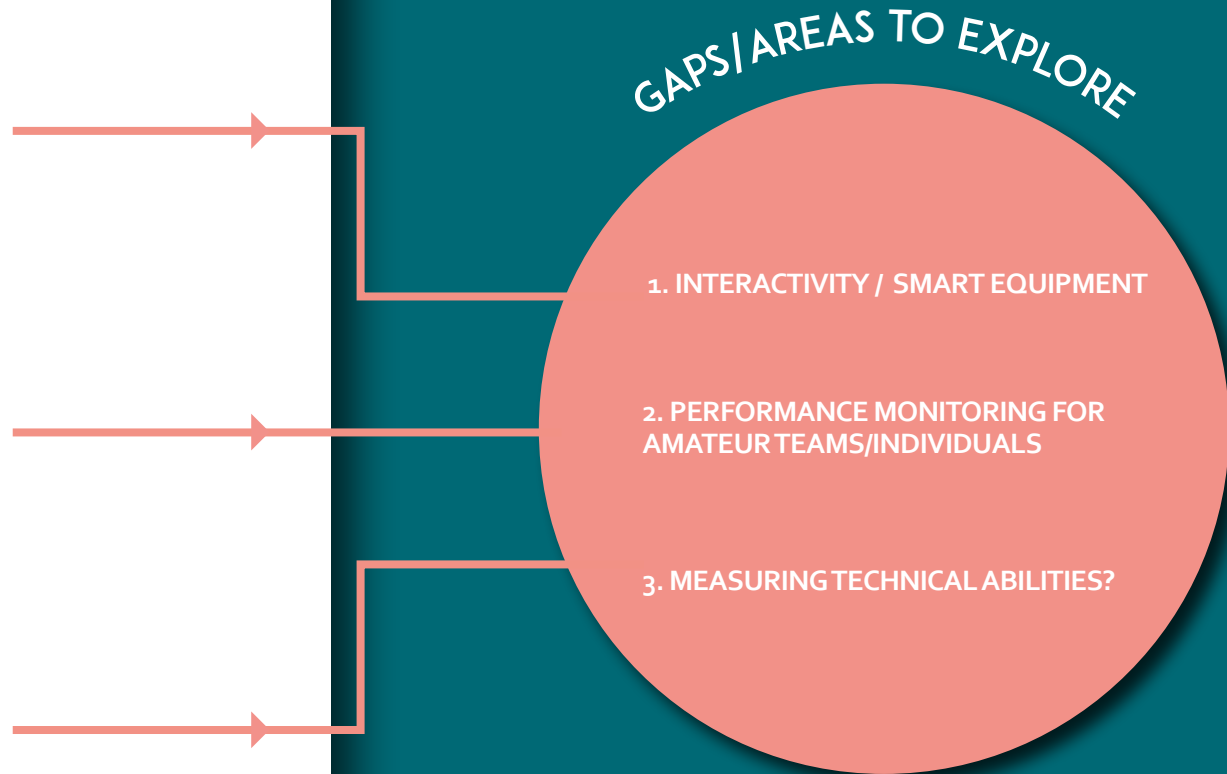
2. Lack of performance monitoring options for amateur teams and players

The options for teams and players on lower playing levels to monitor performance still does not exist. To find out if it would really be beneficial on this level, it was concluded that a visit to a football club might give some valuable information on this.

Exploring something that could be used individually and outside organized training sessions also came to mind.

3. Monitoring/analysis of technical abilities?

The electronic performance monitoring devices today are solely used for tracking physical performance. However, technical ability, such as passing, receiving, shooting and dribbling e.g., plays a huge role in the game, yet this is still left for the players and coaches to assess without any tangible data. Thus, it was decided to explore this area to see if there was any value or even possibillity of qualitatively measuring technique.

GAPS/AREAS TO EXPLORE

1. INTERACTIVITY / SMART EQUIPMENT

2. PERFORMANCE MONITORING FOR AMATEUR TEAMS/INDIVIDUALS

3. MEASURING TECHNICAL ABILITIES?
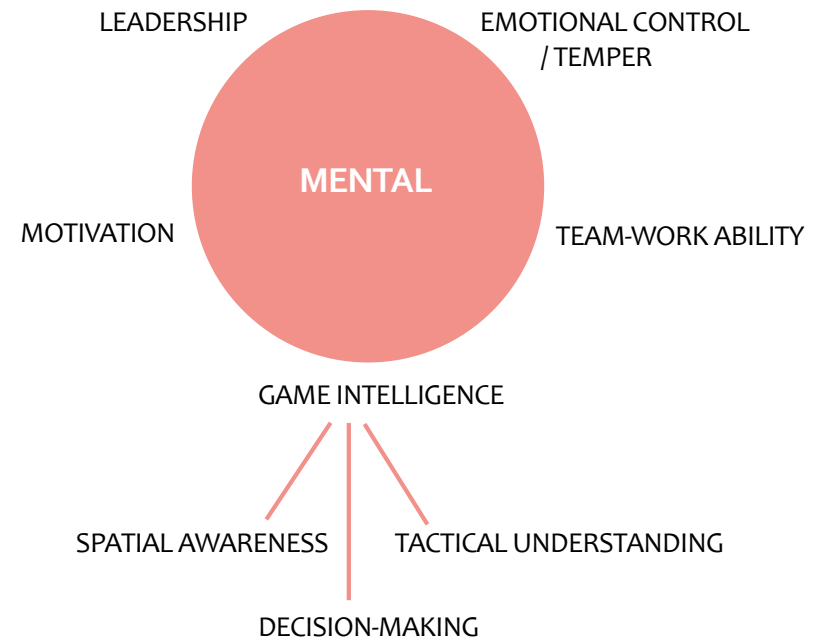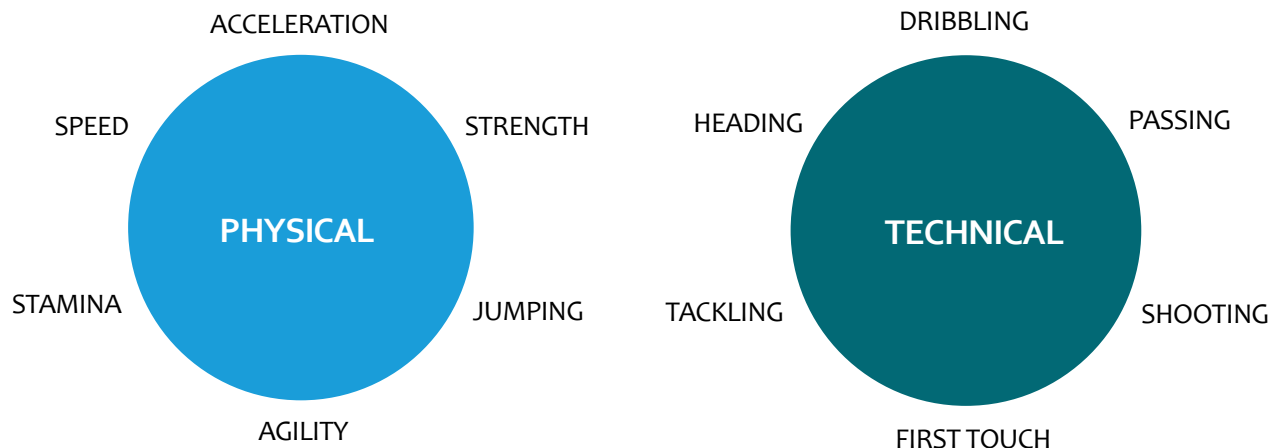
II.
INITIAL BRAINSTORMING & IDEATION

WHAT IS PERFORMANCE?

Before the initial brainstorming began, two questions raised were:

1. What exactly are the factors/abilities that define performance?
2. Additionally, which abilities are more relevant/less relevant?

Abilities in football - overview

A list was put together of abilities (factors) that are important for performance based on personal experience and on what is generally regarded as so by so called experts and football purists.

LEADERSHIP EMOTIONAL CONTROL / TEMPER

MENTAL

MOTIVATION TEAM-WORK ABILITY

GAME INTELLIGENCE

SPATIAL AWARENESS TACTICAL UNDERSTANDING

DECISION-MAKING

ACCELERATION

SPEED STRENGTH

PHYSICAL

STAMINA JUMPING

AGILITY

DRIBBLING

HEADING PASSING

TECHNICAL

TACKLING SHOOTING

FIRST TOUCH

What is the most relevant ability, or abilities?

If the goal is to design something that will be as effective as possible in making a player better, it seems logical to select the ability/abilities that most determine overall performance, and then start exploring how you can monitor or practise that/those abilities more effectively.

Having said that, the ranking between different skills/abilities is still quite arbitrary and not really scientifically established.

Importance of mental capacity in football

However, studies on the difference between higher and lower league players highlighted the importance of the mental part for performing well in the game, even suggesting that general cognitive capacity is the most decisive factor for becoming a successful player[6,7]. In the studies, the more successful players scored consistently higher in cognitive tests involving *executive functions*, compared to less successful players. Executive functions constitute abilities such as working memory, inhibition control, planning and decision-making, to name a few.

INITIAL SKETCHING

What can technology offer to practice and excercises?

When the process of ideation started, instead of focusing on something that would monitor/practise any specific ability, I decided to look at it from the perspective of technology. More specifically, what possibilities could it offer to practise and excercises that existing equipment cannot?

The initial brainstorming was very open but circled mainly around the theme of technical excercises with moving elements and feedback on performance. This involved some quite unconstrained concepts to more affordable, and arguably realistic ideas.
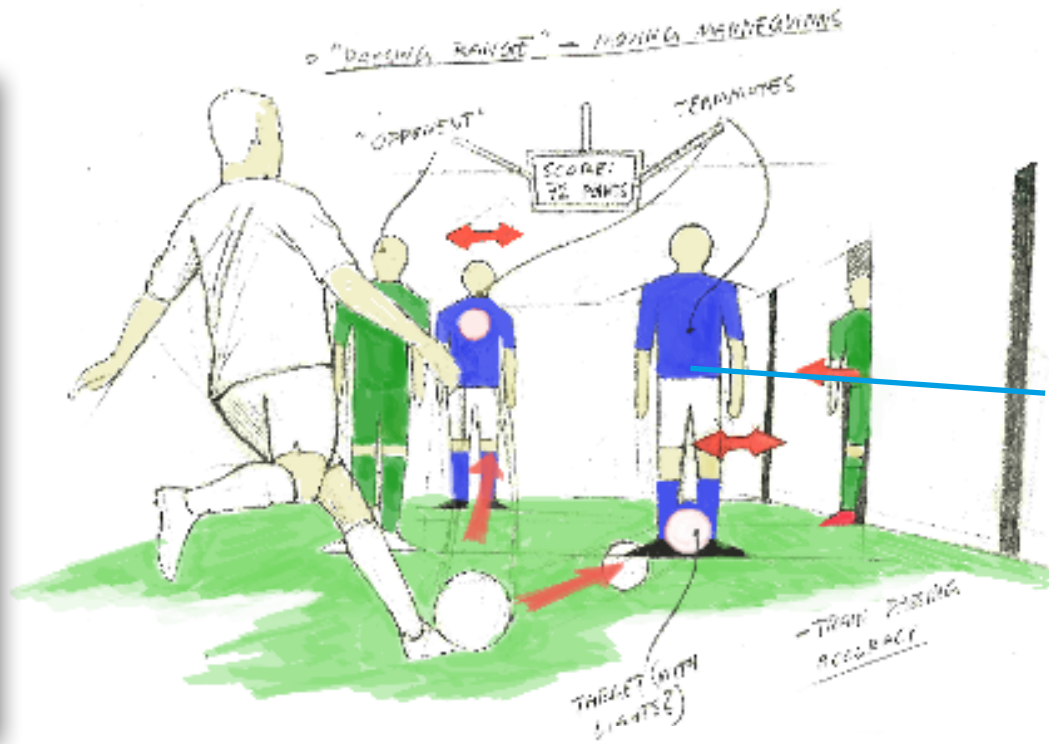
Shooting range

"Shooting range" with moving targets that practises passing, accuracy , reactioning and quick feet

Conceptual idea of obstacle course with obstacles that move in unpredictable ways, adding increased difficulty and practising of spatial awareness
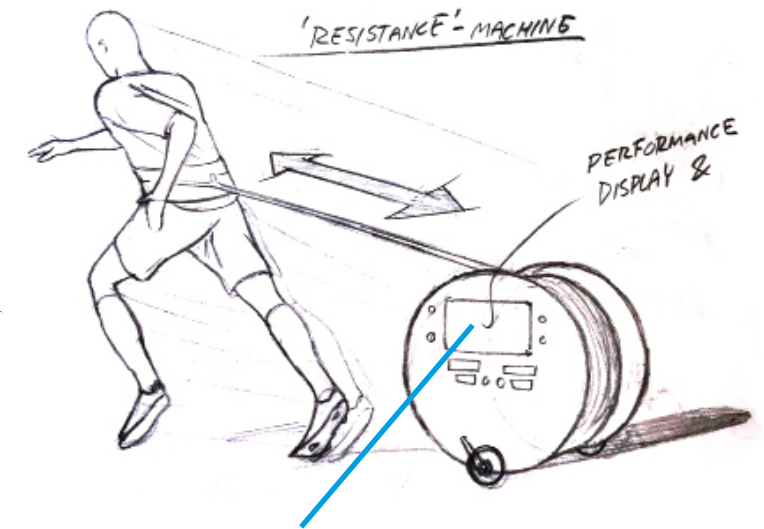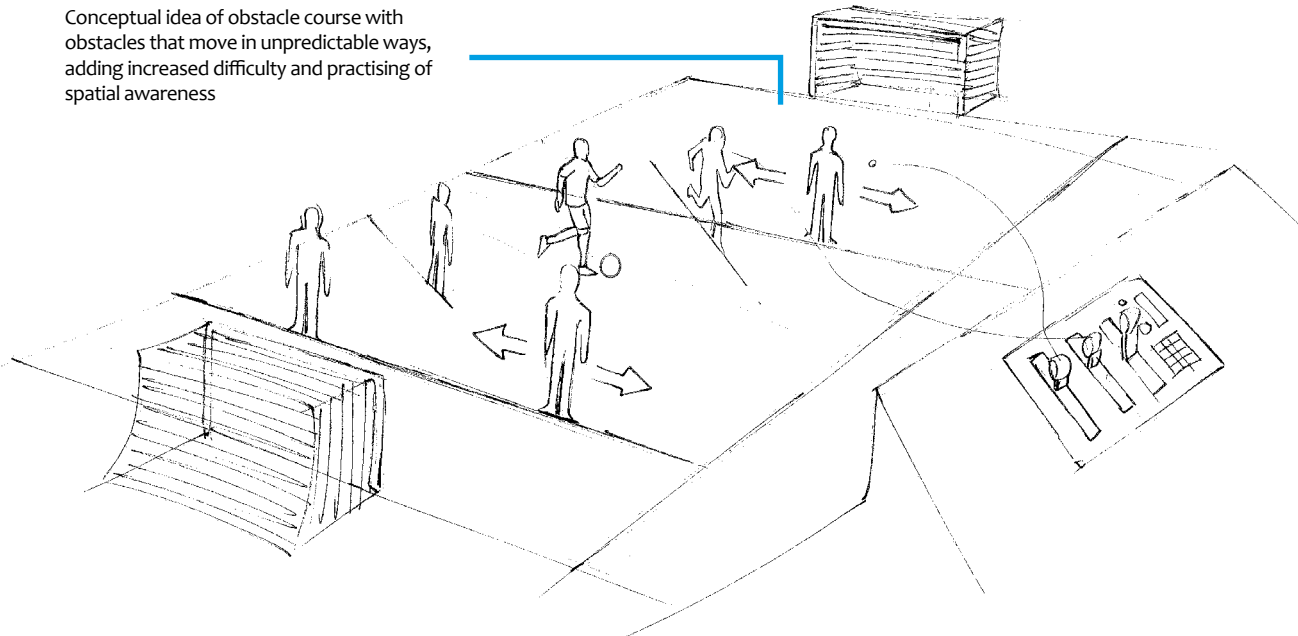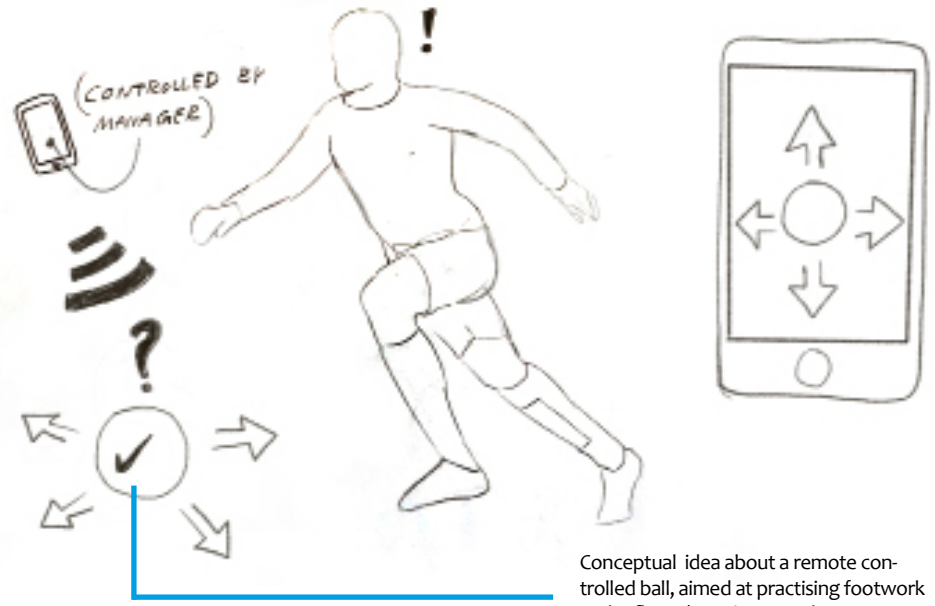
Strength/Power-monitoring

Strenght/power-training machine that adapts resistance to maximize the challenge for the player using it
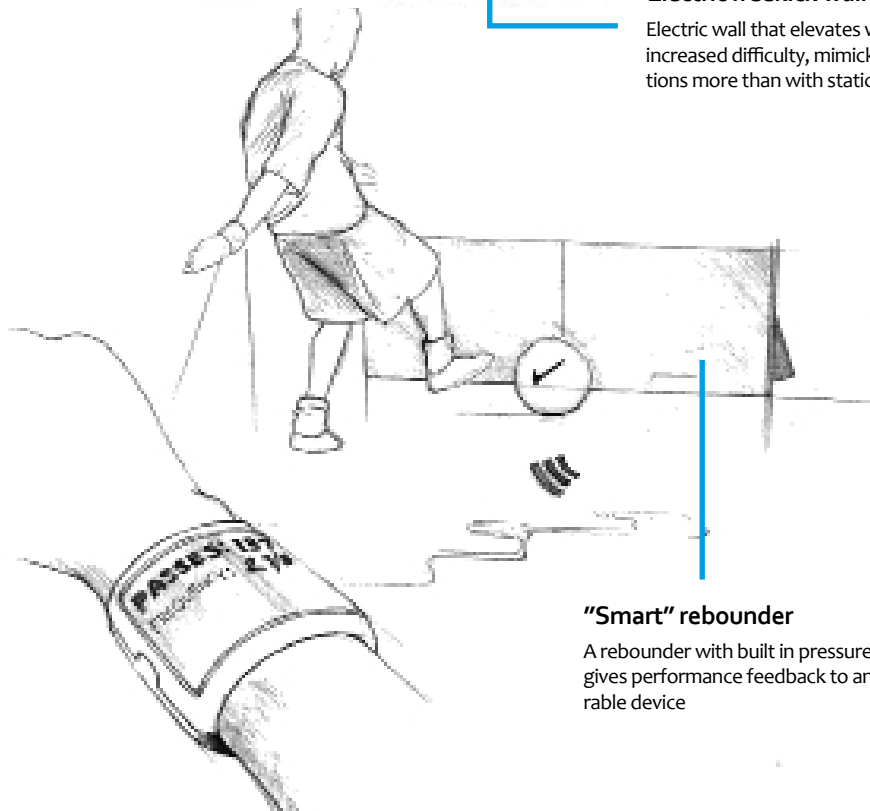
15
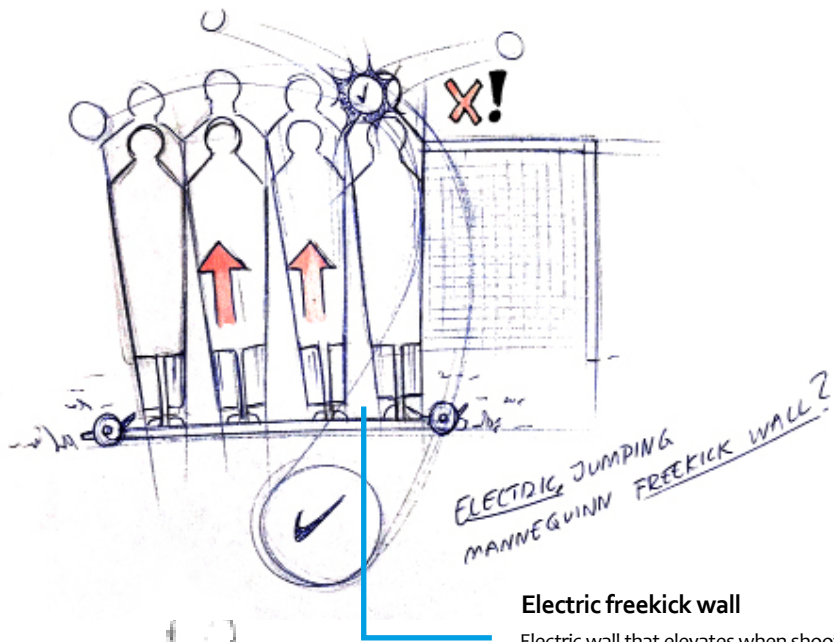
Electric freekick wall

Electric wall that elevates when shooting for increased difficulty, mimicking match situations more than with static mannequinns

Conceptual idea about a remote controlled ball, aimed at practising footwork and reflexes/reaction speed.
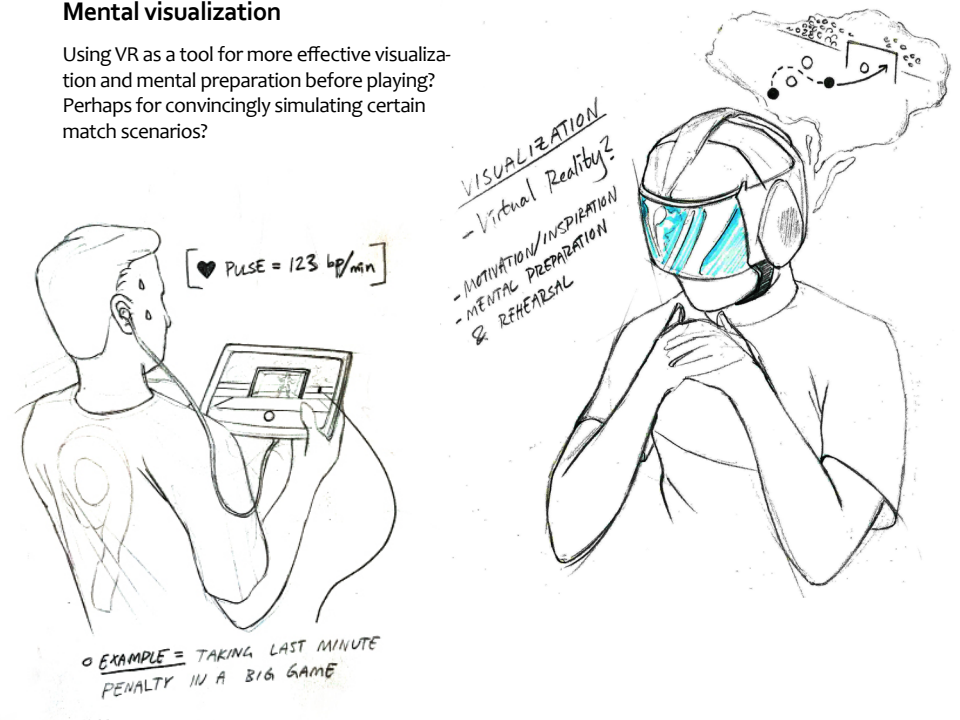
"Smart" rebounder

A rebounder with built in pressure sensors that gives performance feedback to an external wearable device

Mental visualization

Using VR as a tool for more effective visualization and mental preparation before playing? Perhaps for convincingly simulating certain match scenarios?

III.
RESEARCH & IDEATION

FIELD TRIP & INTERVIEWS - PART 1

What is necessary to measure?

A field trip along with interviews with managers was conducted in order to get some real world examples and insights about what equipment is being used. Another aim was to also find out what coaches themselves have to say about what is valuable to monitor or practice or what details might be improved with the existing equipment to make it more effective at improving players' abilities.

LUNDS BK - VISITS AND INTERVIEWS

The first two visits were to Lunds BK. Lunds BK is quite a successful club and the senior team is today playing in division 1, the third highest league in Sweden.

Interview with U19 manager

I managed to get in contact with the U19 team, which has players at or just under the age of 19. This team is actually an elite level team competing in Ungdomsallsvenskan. A training session was observed and afterwards an interview with the head coach, Sven Nilsson, was conducted.

What became clear was that there wasn't much equipment or tools being used, if any at all. Only the most basic equipment was used, such as cones for marking the playing field and certain spots/checkpoints in excercises. This was explained in the interview with Sven. The main focus is to use the ball as much as possible during training and to practice game intelligence mainly through open play. That is, to play regular matches with no particular emphasis on specific match situations. They do not use any complicated or advanced excercies with 'special' equipment.

The subject of technology on the professional level was brought up along with some pictures of market examples. He was aware of most of the performance measurig devices and technology and said that there are teams in the same division using them, such as Malmö FF's U19 team. However, he could not see it being particularly useful for his team. Based on his experience, observation alone usually provides enough information for him to make assessments and decisions. This is due to the fact that the weaknesses of players are still quite easy to spot, even on elite levels such as this.

Finally, when asked to single out a particular ability/abilities that he considered most determines performance or the overall quality of a player, he chose: "playing intelligence, the ability to read the game".

Interview - U17 Coach

I also interviewed the manager of the U17 team, Sergio Salinas. The discussion circled around the same points as in the first interview, i.e what would be beneficial to measure that is not possible right now as well as what tools are used and how they might be improved. We also went through more thoroughly the examples of technology and tools that measure performance in some way.

The interview was productive mostly concerning the latter subject, as the coach was very informative about what he thought about each particular example. However, regarding the need for performance enhancing/monitoring equipment, there were similar opinions as in the first interview.

SUMMARY & KEY INSIGHTS

The main impression was that neither of the managers could imagine anything that was missing or find a need for any additional equipment of the sort I was envisioning, at least not for their own teams.

- No technological/electric equipment was used. The amount of equipment was overall very sparse

- Making assessments with the naked eye is sufficient on this level, as differences between players and weaknesses are more obvious compared to the highest, professional level

- Money also plays a role in the decision to not implement more advanced equipment, as the economy of clubs on this level is normally quite limited

- According to both managers, the ability that most determines the quality of a player is playing intelligence - the ability to correctly read the game
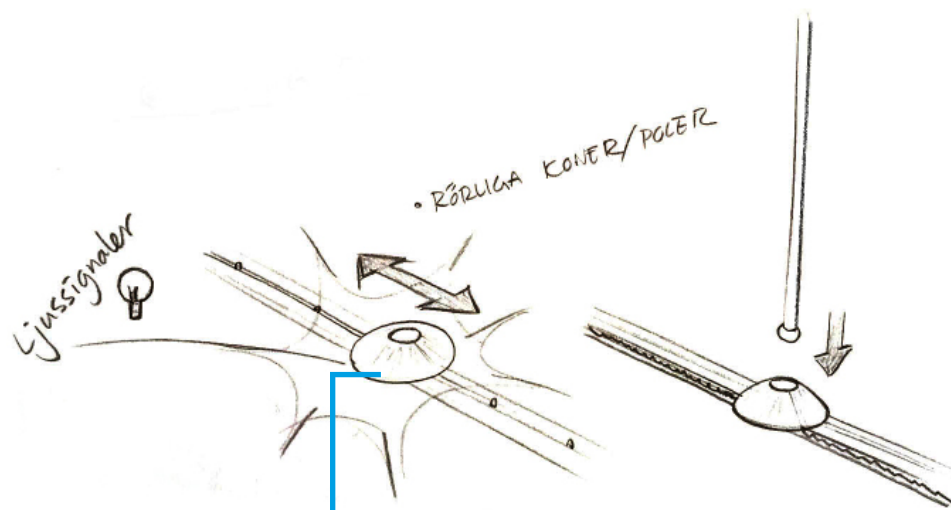
IDEATION -
TRAINING EQUIPMENT

Although the managers of Lunds BK were a bit sceptical about the use of equipment with intelligent/interactive elements or performance monitoring, the feeling was that this was also because there was a lack of specific ideas communicated.

The lasting impression was that there was still more exploration to be done as well as a need for additional visits to other teams for further investigation.

Further sketching/ideation

Some of the continued ideation was about adding smaller, more detailed improvements to the basic, existing equipment to amp up the effectiveness of it and the excercises it can create.
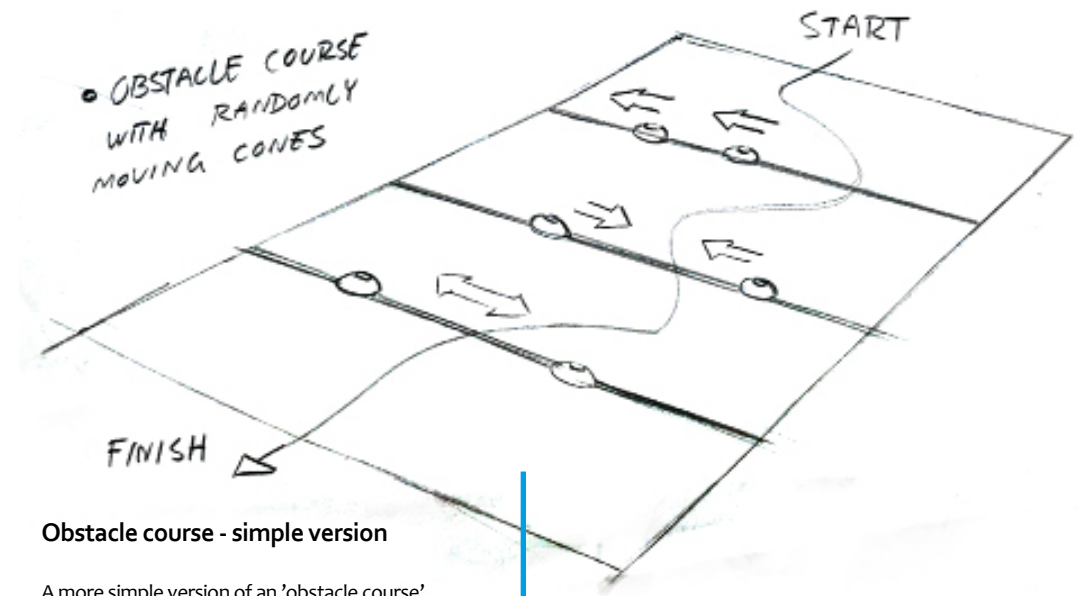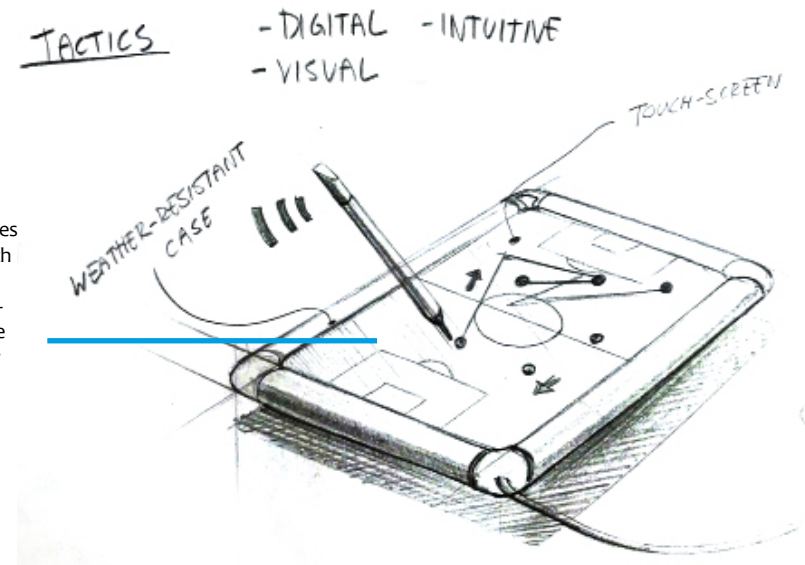
Tactics board/app

Most communication between coaches and players is still done verbally or with basic instructions drawn on paper. Ideas of a more intuitive, visual and instructive tactics board/app to improve the understanding between manager and player came to mind

TACTICS   - DIGITAL   - INTUITIVE
           - VISUAL
                              TOUCH-SCREEN
WEATHER-RESISTANT CASE

OBSTACLE COURSE WITH RANDOMLY MOVING CONES

START

FINISH

Obstacle course - simple version

A more simple version of an 'obstacle course' that would use randomly moving cones to increase the difficulty and immersiveness of technical excercises. In theory this would force the player to be more aware and react, thus allowing for more effective and 'unconscious' development of motor skills

Ljussignaler

RÖRLIGA KONER/POLER

Electrical, moving cones

Cones that emit light and move on rails/paths to make excercises more dynamic and engaging

FIELD TRIP & INTERVIEWS - PART 2

Lunds SK - interview with senior team manager

I visited another football club, this time Lunds SK. The senior team was playing in the 5th division.

I got in contact and did an interview with the manager of the senior team, Thomas Jernberg. The interview was again started with general questions about what could be improved with the existing training equipment, the potential of technological/machine-driven elements and monitoring/measuring performance. Some sketches of ideas were also shown and commented on by Thomas.

Input

The interview overall gave a bit more input than the previous visits. We talked about making small enhancements to the existing training equipment. Some sketches of ideas about improving and adding small details were shown as examples. The main impression was a curiosity towards the ideas, although we didn't reach a decision about a specific idea to continue developing.

From his own point of view, Thomas was interested in the idea of collecting data or info on individual players and their movement across the field during matches, more specifically, where they have *positioned* themselves. It would mean you could rely on real facts instead of feelings, allowing both the manager and player to really analyze what could be improved. This could also improve the communication between manager and player as there can often be different views and interpretations when discussing performance, he argued.

As mentioned before, the tracking devices that professional teams use are far too expensive to acquire by an amateur team, so a cheaper and probably less complex solution would be needed, we agreed.

Interview/discussion - senior team player of Lunds SK

I also got in contact with a player in the senior level team, who actually had previous experience of elite level playing.

Input

We walked through some market examples and some sketches. He was overall optimistic about the use of integrating technical aid in excercises/practice, having some experience of using some products, such as the Adidas monitoring shoe.

In terms of specific abilties that are most important to have or practise for performance, he ranked *spatial awareness* as the most important. That is, awareness about what is happening around you, i.e. where your team-mates and opponents are during game situations. Something that is achieved by keeping your head up while keeping good control of the ball, he argued.

MAIN INSIGHTS - SUMMARY

- A useful idea according to coach Thomas Jernberg was monitoring/capturing the movement (positioning) of players during a match.

- Spatial awareness is the most important ability to have according to the senior team player of Lunds SK

RESEARCH/IDEATION – TRACKING OF AMATEUR LEVEL PLAYERS

After the second round of visits, I started addressing the feedback of making something that could track the positioning of individual players during amateur level matches.

As mentioned earlier, the official laws of the game still do not accept the usage of wearable performance monitoring equipment during matches, and this applies to all levels of the game down to the lowest divisions. Even if it was allowed, one would also have to track the ball itself, since movement patterns are most often only relevant and possible to assess in relation to ball positions.

So it was concluded that the monitoring of movements of players during matches would have to use some other method that does not involve additional wearable equipment for each player.

Inspiration - tracking on professional matches

Some research was done to investigate exactly how the performance tracking of players during professional matches is done. This was for inspiration purposes and to try to find out if you could somehow do that in a cheaper and functional way for lower division teams.

Today, on professional level matches, tracking is being done with increasing fidelity, with big data companies that capture the movements and events of the game down to the smallest details, with every pass, tackle and much more being collected.

In short, the way it normally works on professional games is with the help of sophisticated camera technology that, without interfering with the game itself, can optically track the movements of the players from the stands. With the help of algorithms they calculate the locations of each player. The cameras used for tracking optically need to be deployed in the stadiums at precise locations in order for the calculations to work[8,9,10].

In terms of more detailed game events, such as passes, shots and tackles and so on, there are normally human "loggers" that view the broadcast and log these events in real time. The tracking data and the logged events are then combined to deliver the final statistics that is being broadcasted on TV and saved on databases for general purposes.[8,11]

Camera tracking on amateur level?

After having looked at how the movement tracking works on professional games and thinking how it can be applied to amateur level, the conclusion was that all of the most plausible solutions pointed towards using some version of camera tracking technology as the best option.

Such a solution depended on the camera itself and what it could do technically, which was considered to be too much of an engineering matter to be explored in this project.

# FINAL FOCUS POINT – INDIVIDUAL PRACTISE

The general feeling and conclusion after the visits to the football clubs, was that there was more potential with creating something that would be used *outside* of training sessions, i.e something more aimed at individual practice.

The implementation of technological elements and feedback on performance also seemed more valuable to younger kids, who might benefit more from stimulating elements and tangible analysis to make practising more engaging, motivating and ultimately effective.

FINAL TARGET GROUP:

Amateur individuals
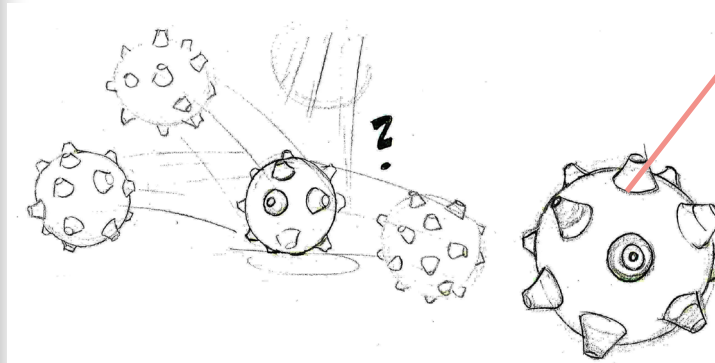
A football with 'pointy' surface giving it an unpredictable rebound, to practise quick feet, reactioning and ball control more effectively than regular ball.

Not something with technological or monitoring properties, but I still found it to be an interesting idea of how you might improve technical performance through simple means.

HEAT MAP OF TOUCHES/HITS OF BALL

SENSORS ALL OVER THE BOOTS

> 70 %
> 50 %
> 30 %
> 10 %

BALL DETECTION

Pressure sensitive boots

Boot with pressure sensors that detect ball contact and store the info and display it as a heat map. Might be useful for getting feedback on things like dribbling and shooting technique
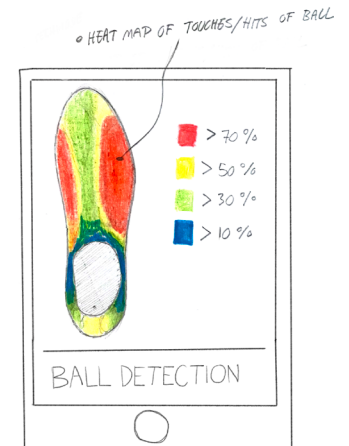
Ball control - monitoring and feedback

Dribbling and ball control ability is often dependent on how close you can keep the ball to your feet while running. What if the ball and boot could be connected via sensors that collect info on the distance between them?

SENSORS ?
- NFC
- RFID
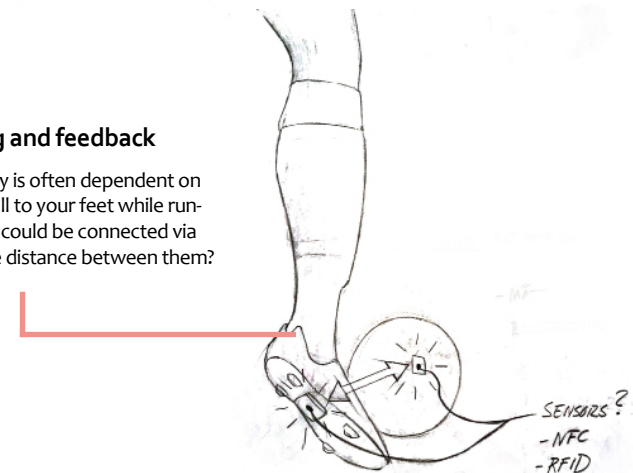
AREA OF FOCUS - REBOUNDERS

Rebounders - what, how and why?

A rebounder is a very common and effective individual (and sometimes group) practise tool for football, and many other ball sports for that matter. How they are used is quite simple. As the name suggests, they practise passing and receiving the ball back from a wall or net.

The reason rebounding is a very effective practice method is because it practises two of the most important abilities in the game; passing and receiving, the latter which is commonly referred to as *first touch*.

Passing is a huge and essential part of the game and very important for good performance. In addition, many or perhaps most experienced players, coaches and football analysts also argue that in terms of technical performance, the quality of the first touch is what separates good players from brilliant ones. With this in mind, it is not difficult to see why it can be an effective practise tool, if used with enough patience and determination.

Adressing lack of motivation - more variety and performance feedback?

However, despite its usefulness, practising with a rebounder alone for hours can become tedious and monotonous quickly, especially for younger players.

The feeling was that there were a lot of possibilities to integrate technology when it comes to rebounders, such as adding feedback on performance as well as increasing the variety and possibilities of use to make rebounding practise more fun and motivating. This while still keeping it effective and balanced, without unnecessary "gimmicks" that at best provide only temporary stimulation for the user.

As a result, the area of rebounders was chosen as the final focus point, with the main target being young, amateur individuals. The main question was how you can add more stimulation, variety and feedback to the practise to both make it more motivating and effective.

Implementation of intelligent/smart features, interactive elements and/or feedback on performance?

MARKET OVERVIEW & EXAMPLES - REBOUNDERS

Initially, some more extensive research on how existing rebounders work was done, mainly to see if there were any that offered feedback, 'smart' or interactive features.

The market of rebounders offers plenty of different models in varying price ranges. Here follows some of the most popular ones.

When examining one more closely and taking the science of football into account, several functional factors that all, to greater or lesser extent, affect the overall quality of the rebounder became evident.

That being said, one can argue that the rebound effect, i.e the power at which the rebounder sends the ball back to the player, is one of or perhaps *the* most important feature. Arguably, the end goal for the large majority of rebound users is to improve their performance in the collective game itself, and a more powerful rebound resembles more the pace of the passes that you receive when playing matches.

Overall, the examples were evaluated also based on aspects such as variety of usage, e.g. if they are possible to angle, if and how they are transportable, storage and pricing. These were all considered factors that determine the overall quality and effectiveness of a rebounder.
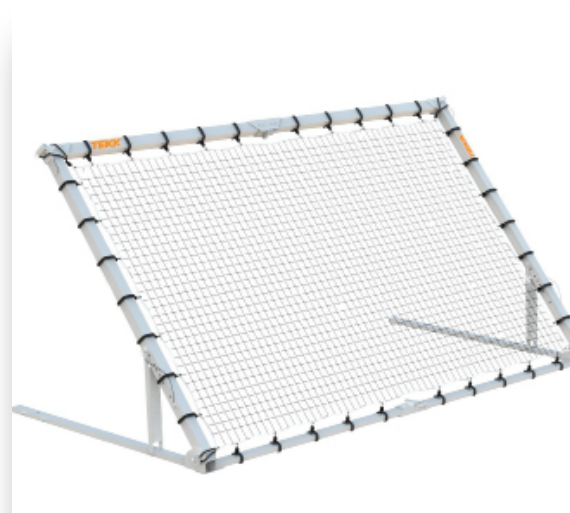
TEKK TRAINER (TEKK)

Price range: -
Size (area): 1,5 x 2.44 m
Weight: 15,9 kg
Material: Aluminum frame

Evaluation

+

+ Angling system
+ Good size
+ Very durable
+ Foldable for storing

–

- Transport?
  (No wheels = need to dissasemble to move longer distances?)
- Long assembly time
- Quality high, although the product is on the expensive side

Champro Sports rebounder

Size: 1.8 m x 1.3 m
Weight: -
Price range: 550 SEK

Evaluation

+

+ Target practice area
+ Robust frame and all-weather net
+ Adjustable angle
+ Cheap
+ Comes in various sizes

–

- Not easy to transport
- Fastens to ground with stakes = only grass = limits usability.
- Bungee chords = strong but eventually snap and need replacement

Quickster Trainer (SKLZ)

Size: Large side: 1,8 x 1,2   Small side: 1,8 x 0.5 m
Weight: Exact weight not found, but very lightweight
Price: From 1,000 SEK (US) to ~3,300 SEK (SWE)

Evaluation

+

+ 2 sides - play with a friend/s
+ High ball option (large side)
+ Easy set up & disassembly and transported with bag
+ Circle for target practise

–

- Rebounds slowly compared to other models = no long passes, less match-like
- Brackets to install in ground = only grass. Otherwise it needs weights to be stable enough.

Quickplay Pro (Quickplay)

Quickplay Pro is a high quality rebounder with very good rebound effect and is used by both individuals and teams at higher playing levels

Price range: ~ 4000 SEK
Size: 2x2 m
Weight: 22,2 kg
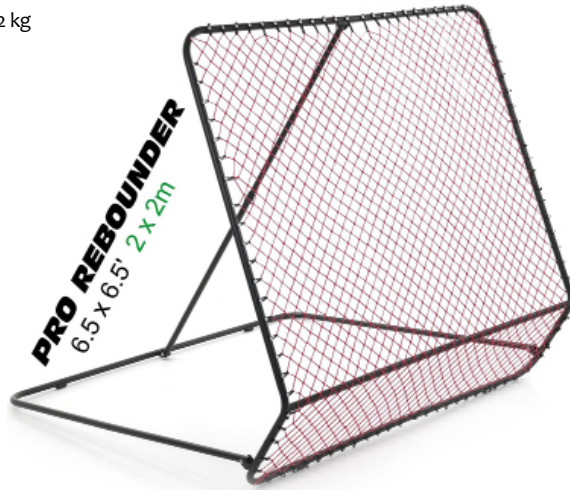
Spot Elite (Quickplay)

Another by Quickplay, meant for transporting and aimed at individual practise for younger kids or adults

Price: ~ 2400 SEK
Size: 2,4 x 1,8 m
Weight: 13, kg

Evaluation

+

+ Very good rebound effect thanks to quality, high-tension net = Long range practising very effective
+ Multiple angle system
+ You can vary between ground and high passes without having to adjust in between
+ Good size
+ Stable enough without ground stakes = can be used on many surfaces

–

- Quite expensive
- Transport is not very easy

Evaluation

+

+ Very quick set-up (2 min)
+ Lightweight & transportable to anywhere with accompanying bag
+ Sufficient rebound and size (can be used as a freekick wall)
+ Stands freely (no ground attachment) thanks to weighted base and rubber feet = all surfaces
+ Circle for aiming
+ Angling
+ Robust frame in galvanized steel = all weather usage

–

- Feedback?

PAL Rebounder (PAL-fotboll)

Swedish produced rebounder that is used by academies and clubs around Europe in organized training.

Price: ~ 4000 SEK
Size: ~1 x 1 m
Weight: 16 kg (1 set)
Material: High quality plywood

Evaluation

+

+ Angling
+ Can be combined and used in many ways for differwent purposes

–

- Rebound is adequate, but could be better
- Still quite expensive
- Transportable, but needs cart to do so (extra 1000 SEK)
- Best for grass, use on other surfaces
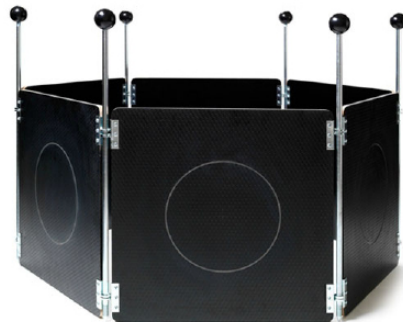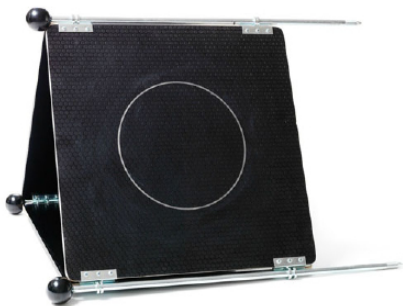
PAL for individual training

PAL also has this version more aimed towards individual training.

Price: ~3000 SEK
Material: High quality plywood
Size: ~1x1 m (x3)
Weight: 12 kg

Evaluation

+

+Simple: already set up, folded quickly and can be transported
+Weather resistant
+Tilt it to get high ball/volley option
+3 sides is also a plus if you want to practice dribbling around and passing while moving.

–

- Small area, needs good precision and longer range passing can be challenging, especially for beginners
- Transport is possible, but not optimal to move long distances?
- Quite expensive, not very affordable for younger children?

SOCCERWAVE JR. (SOCCERWAVE)

Size: 1.0 (W) x 0.7 m (H)
Weight: 12 kg
Price range: ca 1000 SEK

Evaluation

+

+ High ball option with varying curvature = many possible rebounds

+ 2 sides - play with a friend

+ Detachable and lightweight = transbortable.

+ Durable, galvanized steel frame with powder-coating along with UV-protected net = all weathers

+ Good, strong rebound

–

- Moves unless installed into ground with stakes

- Uses bungee chords for net attachment. Bungee chords are strong but may snap and need replacement

- Size is okay but ground pass area could be bigger

- Transportable but still cumbersome to carry for long or bring with bike. Best to use car for long distance transport

Quick Feet Coach rebounder (by Quick Feet)

Size: 6 sides of
Price: ca 2900 SEK
Weight: -

Quick feet has several different rebounder options. The most advanced one is the Coach version with implemented electronic elements. More specifically, it offers a few variants of 'modes' that involve hitting the correct side of the rebounder specified by audio cues and getting a resulting score, based on quickness and accuracy.

Evaluation

+

+ Unique rebounder with good variety: Practices not only first touch and passing but also turning, spatial awareness and reaction-times.
+ Assembly is quite easy. Package is transportable if you buy a standalone bag
+ Keep track of your score and performance through monitoring and stats collection with SD card
+ No need to anchor to ground
+ Price is relatively cheap. Even cheaper than other less advanced rebounders

–

- Rebound is quite weak
- No high ball option (no angling)

M STATION (Munin Sports)

Size: 1.4 x 1.4 m
Weight: ca 25 kg
Price: ca 5000 SEK

M Station by MuninSports is a unique rebounder with a very powerful rebound and accompanying app for performance feedback. The free app tracks your performance in real-time when you connect your phone to the frame behind the net. The app collects performance data such as hits, time played and more.

Evaluation

+

+ Excellent rebound speed (95 % energy conservation)
+ Adjustable angles for ground to high balls
+ Visually pleasing. Looks professional
+ Track your performance
+ Easy to move around locally when in use
+ High quality: durable, all weather-proof

–

- Transport is possible, but moving longer distances requires time-consuming dissassembly and reassembly.

- Excellent quality, but for those that can afford it. An investment.

MARKET - SUMMARY & ANALYSIS

Based on market research, some of the new rebounders are improving in terms of quality of rebound, creating more match-like conditions. The majority now also have angling options, and some offer longer distance transport and even feedback on performance.

However, the assumption that there was a lack of electronic or digital components within the majority of rebounders today was confirmed, to some extent. The majority are still 'unintelligent', with the exception of a very few which have begun to explore this possibility. This was regarded as a kind of gap or 'area of potential' that could be explored.

When it comes to mobility, it seems that almost all rebounder models offer short, 'local' transport, e.g. in a garden or likewise. However, not all are made to be transported longer distances. There are some models that focus heavily on that, although in some cases it seems to come at the expense of overall quality in that they limit some other important aspects, such as rebound power. Long distance transport was decided not to be a requirement, but was still deemed preferable as not all people or kids have a garden or likewise where they can practise, which might force them to move elsewhere.

From the market research, the properties decided as required as well as preferable were the following:

REQUIRED PROPERTIES

● Intelligent functions (interactivity/feedback on performance)

● Angling

● Weather resistance

DESIRABLE

● Mobility (i.e *longer distance* transport without complicated disassembly)

● Powerful rebound

IDEATION - REBOUNDER

After deciding the required and desirable properties of the rebounder, the following brainstorming started on the theme of implementing more interactive elements and performance feedback.

The mental factor

The study mentioned earlier about the importance of the mental capacity, or executive functions, for performing well was something that was considered very interesting.

Simulating complex game situations with a rebounder is obviously not realistic. However, the thought was that by adding these variables in individual practise, some aspects of executive abilities could be improved or at the very least stimulated, albeit in a more abstract way than during training/matches.

In addition, by engaging the mind more within practice, the physical/technical skills would in theory be more 'unconsciously' practised and consequently less monotone, as the attention is also focused on the mental part of the excercise. Lastly, adding these variables while providing feedback for tangible analysis could also make the practise more fun, engaging and motivating, perhaps making young players practise more and attracting the interest of kids that have not played yet.

The underlying idea was that the right technology could make it possible to practise some aspects of the executive functions, such as:

- **Decision-making**

- **Reacting to unpredictable events**

This to create a rebounder where *both* the mental and physical side are stimulated simultaneously, along with providing feedback on performance.

MENTAL + PHYSICAL

INSPIRATION
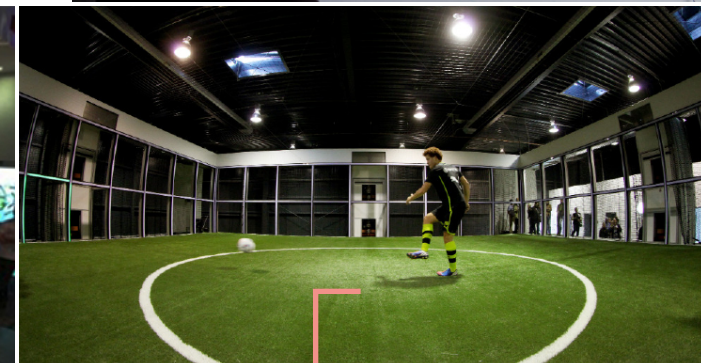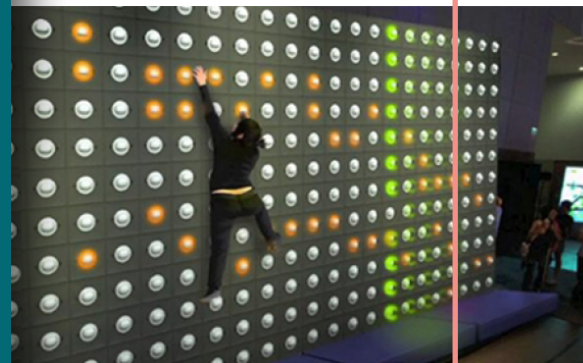
One idea was about building on the hit detection feature and performance feedback of the M-station, adding more variety, such as visual cues, targets, 'game modes?

Inspiration was also taken from 'The Footbonaut' (as shown previously) and its practise elements, e.g. visual indicators, unpredictability and target practice. The question was if you could make something that offers the same features but in a more convenient way in terms of size, transport and affordability?
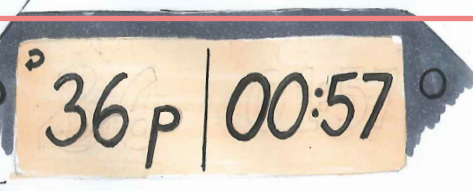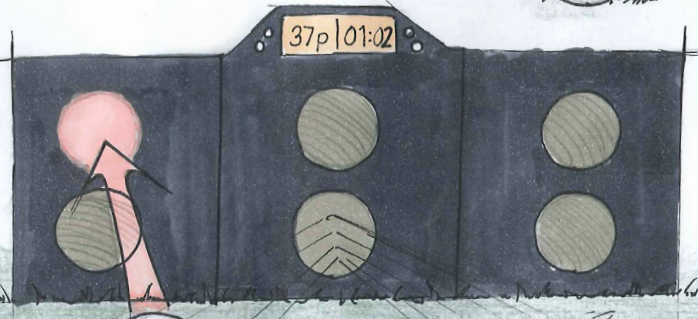
INITIAL CONCEPT

PRESSURE SENSORS WITH LIGHT SIGNALS

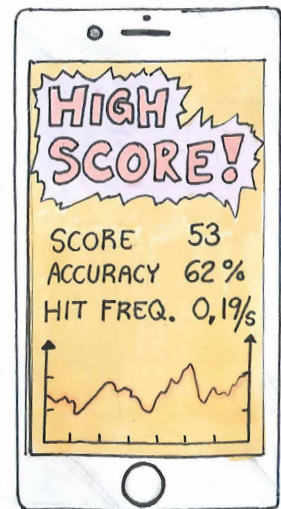1
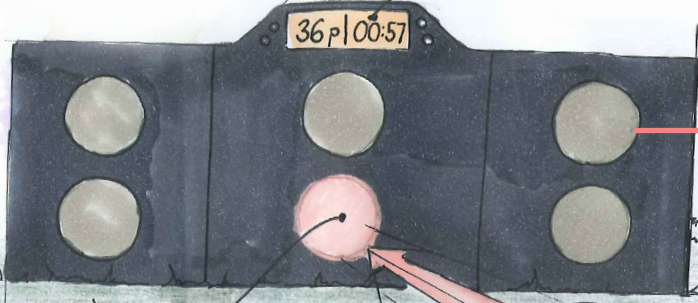
DISPLAY SHOWING SCORE, ETC
+ MENU WITH MODE SELECTION

36 P | 00:57

APP WITH REAL-TIME FEEDBACK ON SCORE, PERFORMANCE (E.G ACCURACY, POWER ETC)

2

3

HIGH SCORE!

SCORE   53
ACCURACY   62%
HIT FREQ. 0,19/s
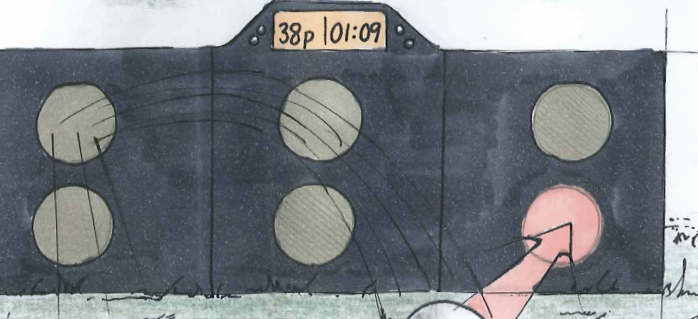
Interactive rebounder with 'game modes' and performance feedback

Concept of an interactive rebounder with blinking light targets and built-in microcontroller with customizable 'game modes'. This to practise the executive functions, making the practice both more engaging and effective.

Pressure sensors integrated in the targets sense if a target has been hit and send info to microcontroller, which in turn displays score and time, etc.

'Modes' - examples

Example of a playing mode could be to hit as many blinking targets as possible within a certain time limit. Another could be to hit a specific color (light) shown on the integrated display or specified through sound. Other lights could be used as 'distractions' for increased difficulty.

The main concept of a rebounder with interactive targets and customizable game modes + feedback was decided to go forward with.

MATERIAL, REBOUND, ANGLING & MOBILITY

Building on the target-practice rebounder idea, sketching continued on what material to use, the impact detection technology, angling and mobility options.

"HANDLE" WHEN STRETCHING

STRETCH TO TENSION?

ELASTIC MATERIAL? RUBBER?

SPIKES/SCREWS FOR GRASS ATTACHMENT
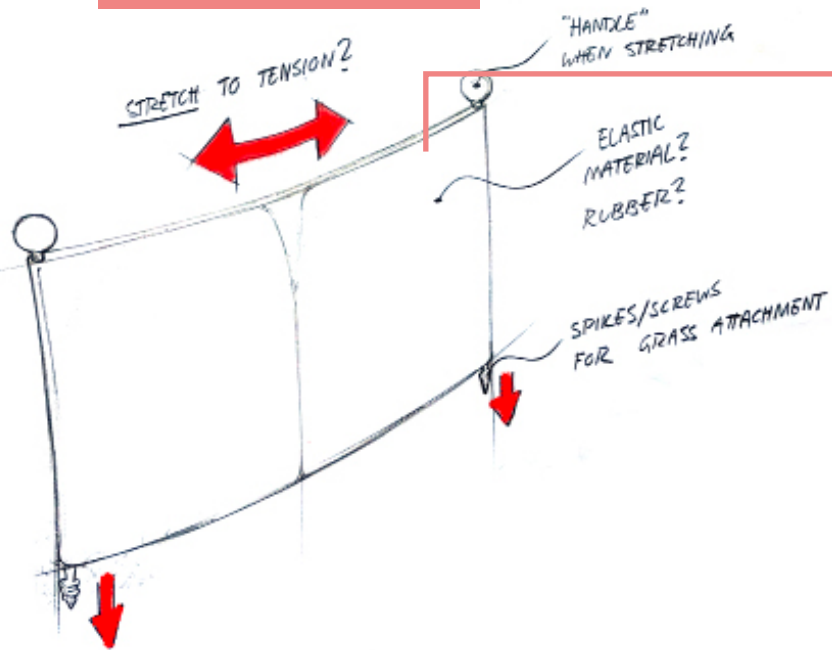
Elastic material for stronger rebound

Elastic material that tensions by stretching and attaching to grass.
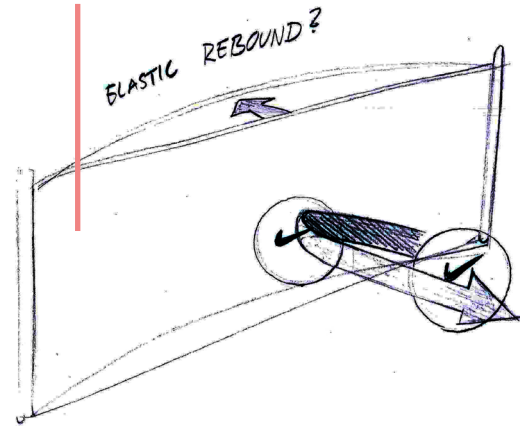
ELASTIC REBOUND?

Only the targets in elastic material to create more variety of rebounds, and a 'feedback' sensation when hitting right.

BETTER REBOUND?

Elastic what?

SCORE 62
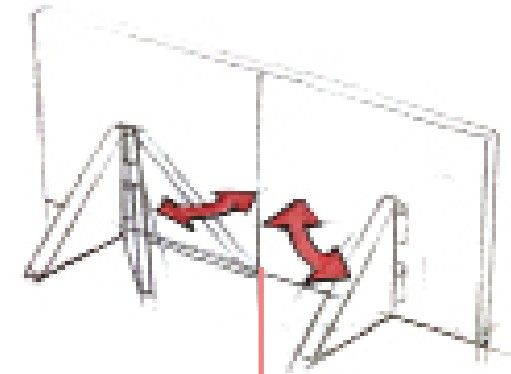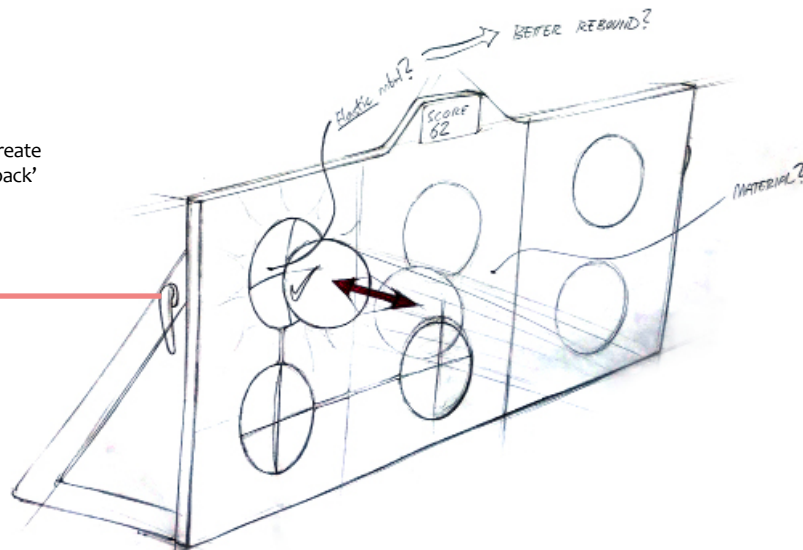
MATERIAL?

Foldable for mobility

Foldable stand and surfaces to allow for easier transport. Wheel and handle attached to the backside to make it rollable.

FOLDABLE

MOBI

FOLDABLE/TRANSPORTABLE REBOUNDER

CUSTOMIZATION?

NET ADD-ON

TENSIONING NET
(PULL & TIGHTEN)
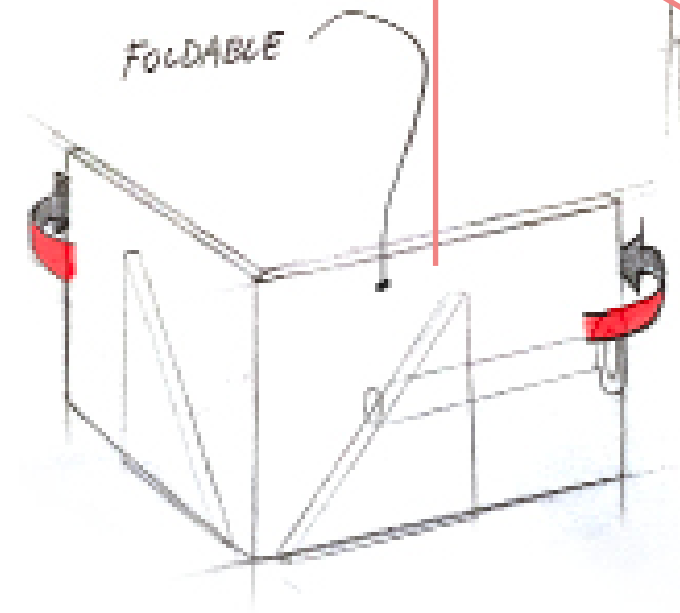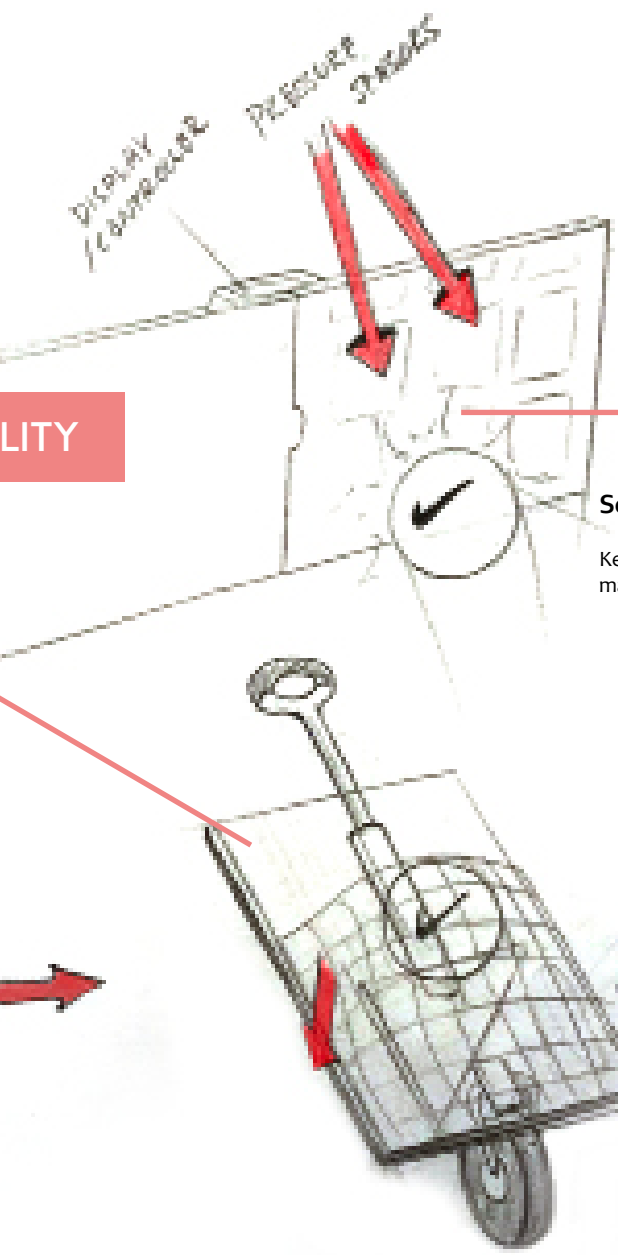
Solid material

Keeping the rebounder made of 'solid' material to
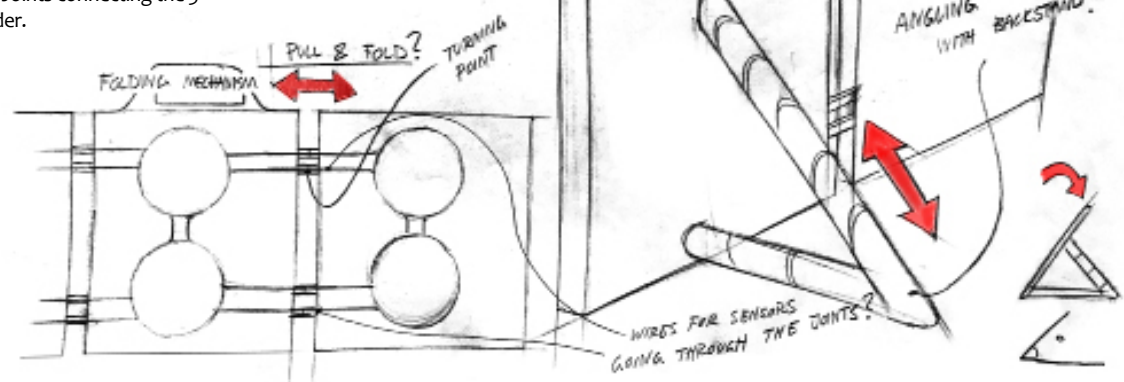make it foldable + easier to install pressure sensors

DISPLAY / ILLUSTRATOR

PRESSURE SENSORS
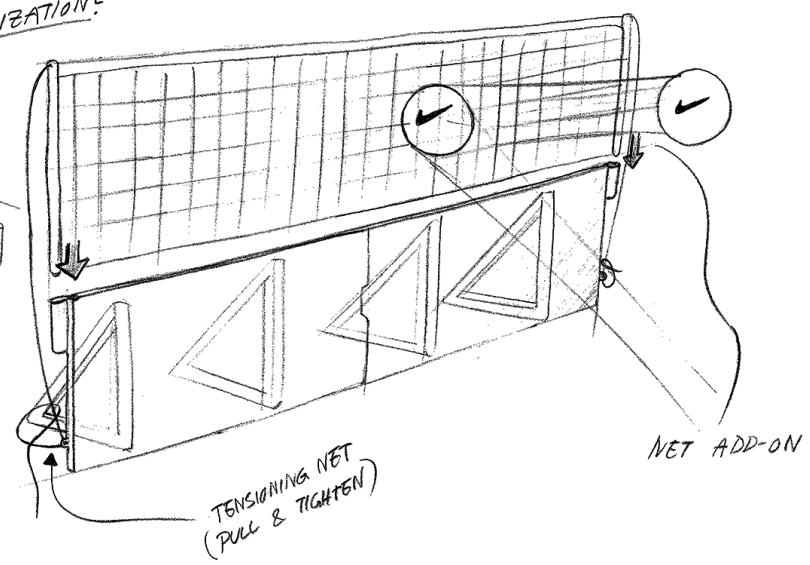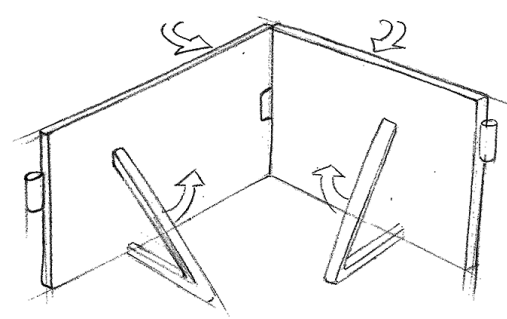
ANGLING

Telescopic backstand for angling of
the rebounder.

Folding mechanism. Joints connecting the 3
parts of the rebounder.

FOLDING MECHANISM

PULL & FOLD?

TURNING POINT

ANGLING WITH BACKSTAND?

WIRES FOR SENSORS
GOING THROUGH THE JOINTS?

TEST MODEL - TARGET PRACTICE

Axel, a former football player with experience from higher playing levels (swedish division 1), acted as a test person for a basic model of the target practise concept, i.e. a striking area with targets of different colors.

He was subjected to a short performance test in which he had to hit randomly selected colors in order to get points in a 1 minute time interval. The main idea was to hit the intended target color until you could get a point and move on to the next one, and so on.

Feedback

Axel agreed to some extent of having the experience of not thinking consciously as much about his own body movements as he might do when rebounding against an 'empty' wall without targets.

When asked what he thought and felt about the experience and general concept, his response was that he thought it is a relevant and useful idea for younger players or kids who are starting out.

We agreed that the final model and the target themselves should be bigger in size for a more forgiving, slightly less challenging practise, and ultimately more effective performance improvement.

SUMMARY

- *Target practice idea seemed promising and would be ideal for young kids, according to Axel*

- *Both rebounder and targets need to be bigger*

34
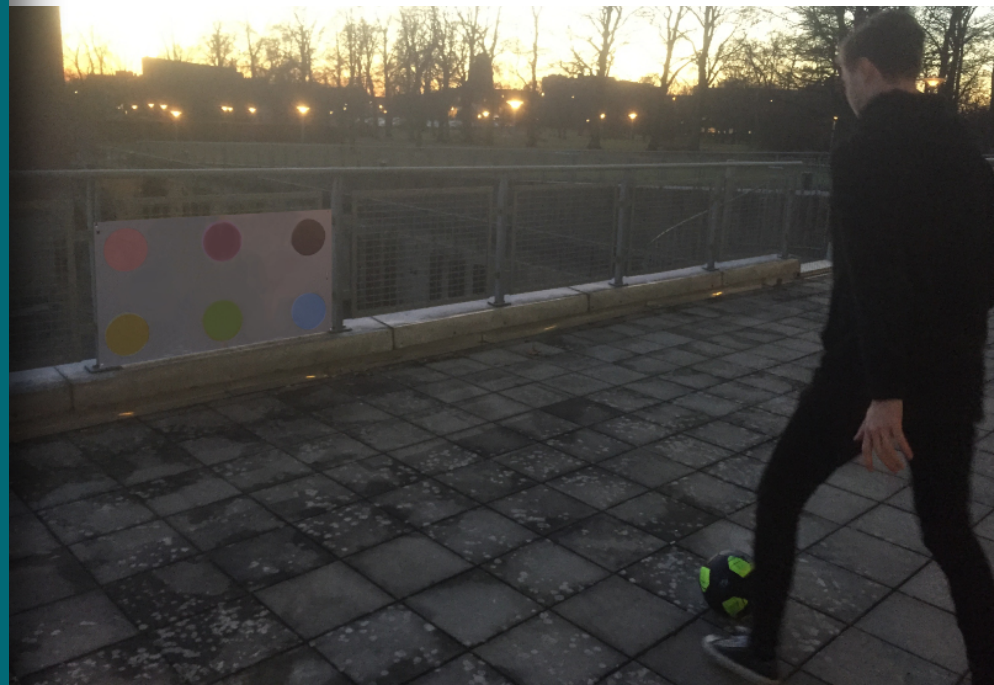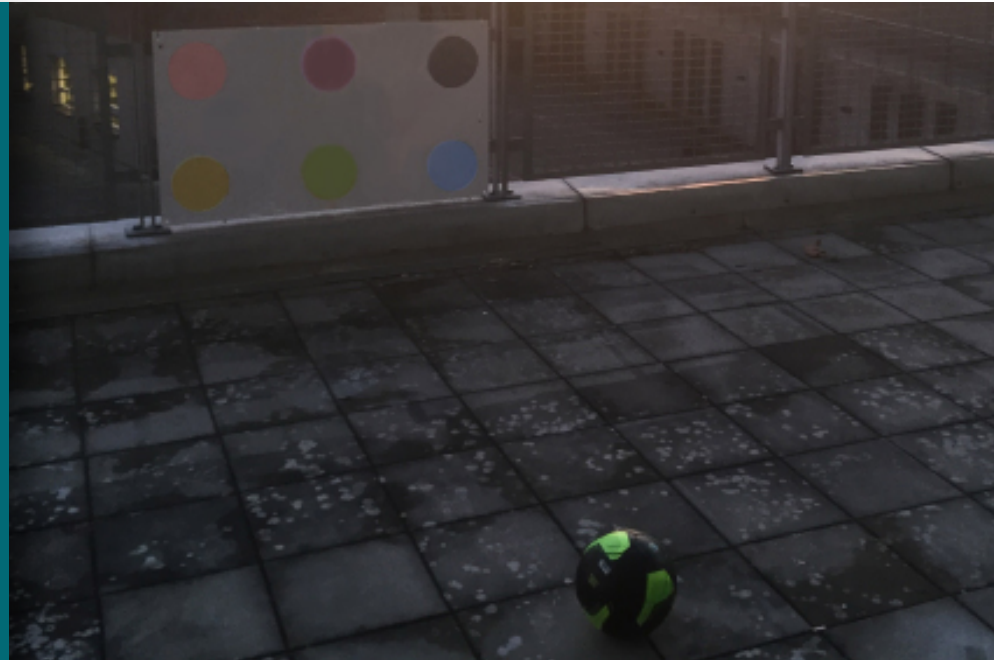
INTERVIEWS - PART 3

A third round of interviews/discussions were carried out, this time focusing only on the rebounder concept, in order to get feedback from coaches and players on its potential value.

Lunds SK - coach of P11

A brief discussion was had with the coach of the P11 team at Lunds SK. The main insight gained was that he thought there would be more value discussing the concept with real 'researchers' focusing on the science of football and effective practice, and suggested contacting the Swedish Football Association.

However, there was brief positive feedback on the concept of target practise as a practise method to 'spicen up' a training session for young players. The coach mentioned that a very similiar excercise was sometimes used in his team sessions for this very reason.

Lunds BK - P13 players

I managed to get some short discussion time with some younger players of Lunds BK, aged 13. This was just to get a general response from the main target group itself that I was aiming for.

The feedback was not very detailed nor extensive, as was to be expected, but the impression was that the idea of a rebounder with interactive target practice and customization was met with enthusiasm from the majority of young players spoken with.

SUMMARY

- *A target practise rebounder with modes and score system could be effective also in group sessions to encourage competitiveness among players, and make the practice more fun and engaging.*

- *The response from players aged 13 on the rebounder concept was overall positive*

SPECIFYING THE PROPERTIES (SIZE, MATERIAL, REBOUND & IMPACT DETECTION)

1. Size specification

Area/size of the striking area/frame was the first property to specify. It is arguably better to have more space to hit for a more engaging practise and variety in terms of ball rebound. It also has to be sufficiently big so that it is easy enough to hit also from longer distances to avoid making the practice too difficult and frustrating, especially for beginners.

A size of 1.6 x 1.5 meters was set as a standpoint, initially. It was estimated to be an appropriate size for both effective close and long range passing practise.

INITIAL SIZE SPECIFICATION:

1.6 x 1.5 m (W x H)
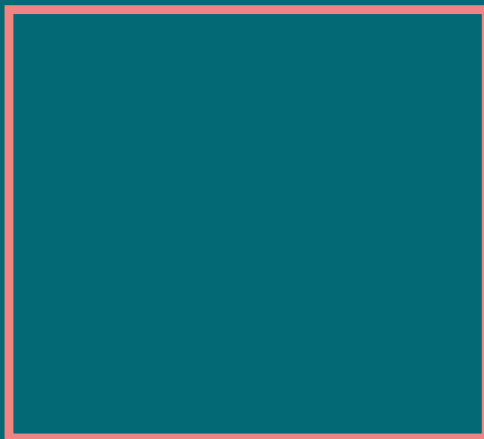
2. Material of 'striking area'

Due to the difficulty of finding a 'solid' material that seemed able to provide a strong rebound effect, it was decided that a change of material seemed necessary.

In addition, to allow for the possibility of transporting the rebounder, the size specified of 1.6 x 1.5 m seemed to be a bit on the heavy and cumbersome side if the rebounder was in solid material.

It seemed that using a tradtional net would be the best option after all, both in terms of the rebound and its lightness. What exact material the net should be made of was yet to be specified.

STRIKING AREA (MATERIAL):

SOLID ➜ NET

## REBOUND POWER & IMPACT DETECTION - INSPIRATION

M-Station

The rebound power of the M-station rebounder by Munin Sports, was a source of inspiration.

Upon inspection, the M-station uses a net made out of nylon that is strung in a way very similiar to the strings on a tennis racket. The net consists of 2 continuous threads in vertical and horizontal direction, which go above and below eachother alternately, as shown (top, following page). This creates a net without knots , although not really a uniform one, which makes disassembly and longer distance transport more complicated[11].

However, the absence of knots between the horizontal and vertical threads, means the net can be tensioned more strongly than other, knotted rebound nets, giving it its unique rebound power.
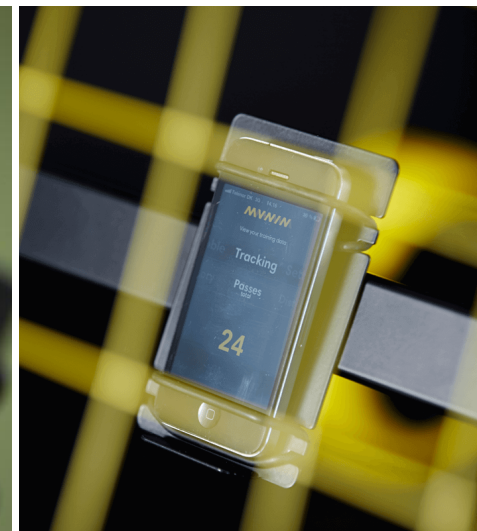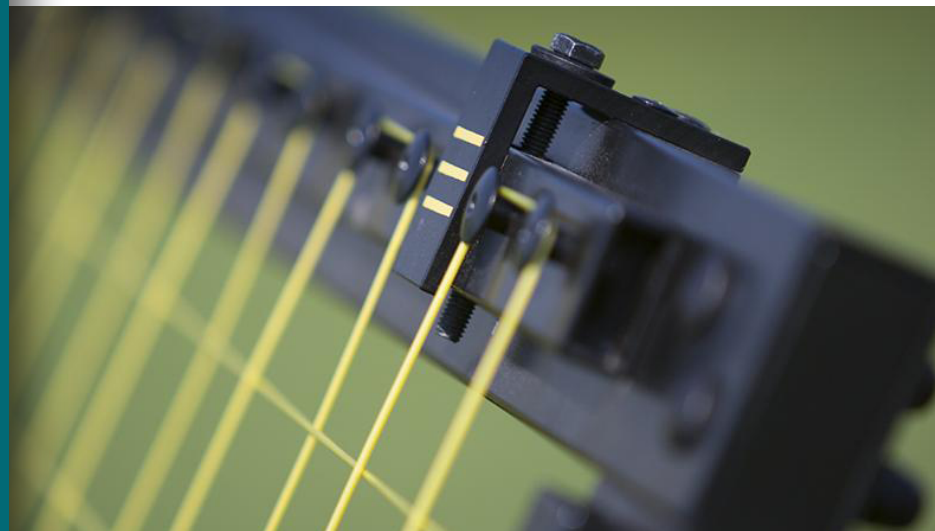
(How the net is 'woven')
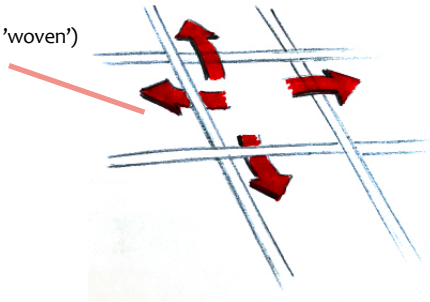
Impact detection - vibrations + smartphone

The hit detection works with the help of a smartphone which is attached to part of the stand behind the net, receiving and analyzing the vibrations that propagate through the frame and stand after impact (right picture, previous page).

Tensioning method

2 sides of the frame have 'inner' parts that can be screwed 'outwards' from the center with a handle. This tensions the net horizontally and vertically.
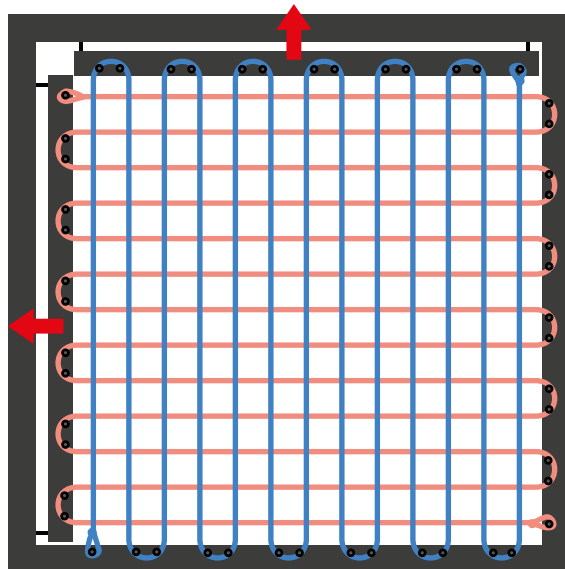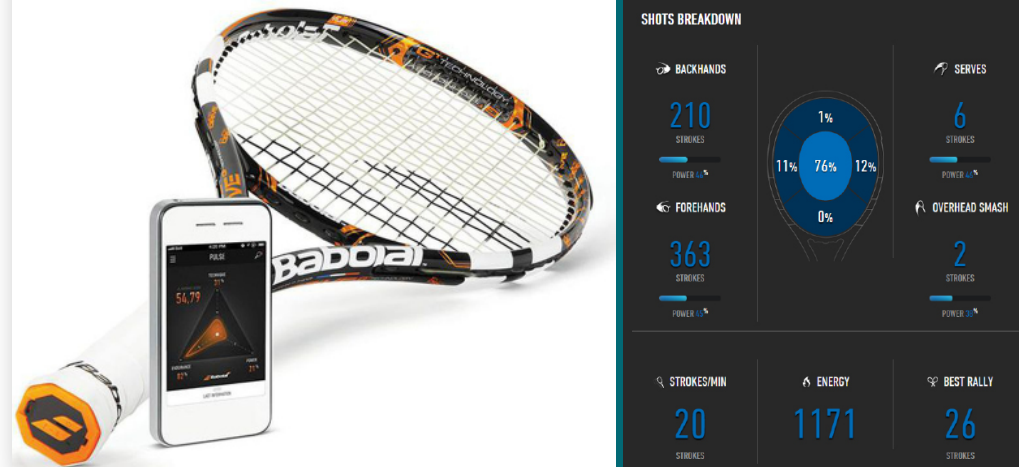

SMART TENNIS RACKETS

In the world of tennis, smart technology has found its way into tennis rackets in the form of integrated or standalone sensors that can tell you all kinds of details about your technical performance, such as number of shots during a session, swing speed, ball impact location and much more[12,13].

Impact detection & location - piezoelectric sensors

The way in which these sensors can sense ball impact is, similarly to the M-station, through vibration analysis.

However, the majority of sensors can also pinpoint exactly *where* you strike the ball on the racket. In the rackets examined, this is achieved with a *piezoelectric* vibration sensor[13].

FINAL CONCEPT

Combining M-station net stringing + smart racket tech?

Sketch overview of the final concept. The main idea was to combine both the net stringing of the M-station and the impact location technology from tennis rackets.

How the *angling* was going to work was decided to be explored later on through test models. The concept was more focused on the target practice and the technology that would make it work.

TENSIONING

Tensioning vertically and horizontally, (like M-station). The main goal was to have a 'quick-tensioning' system with 'levers' on the frame that move outwards to tension the net. The details were left to be explored and solved when building the prototype/model.

HANDLE FOR ROTATION

NET IS TENSIONED
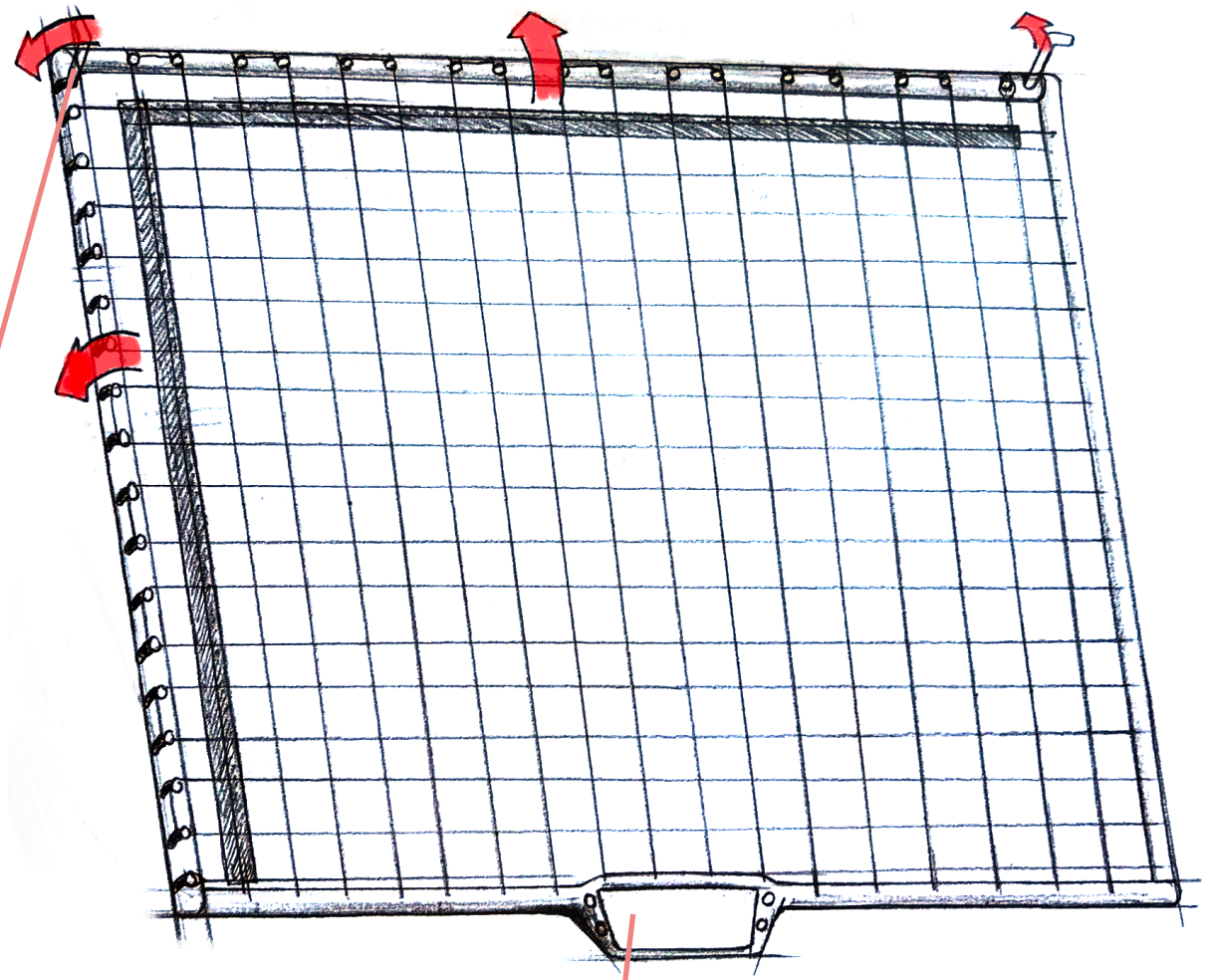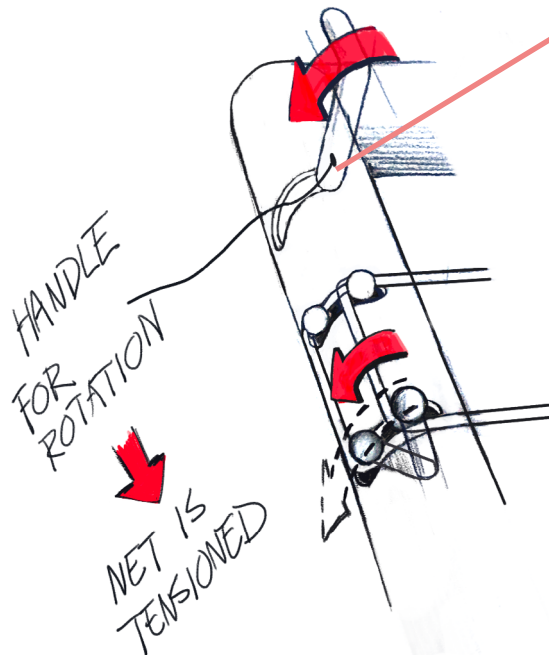
IMPACT DETECTION + LOCATION

Microcontroller + Piezosensor

Regarding ball impact detection & location, the initial idea was about using a piezoelectric sensor and microcontroller integrated in the frame itself. These would handle all the data and provide the *feedback* and *customization* of game modes through a user interface on a display.
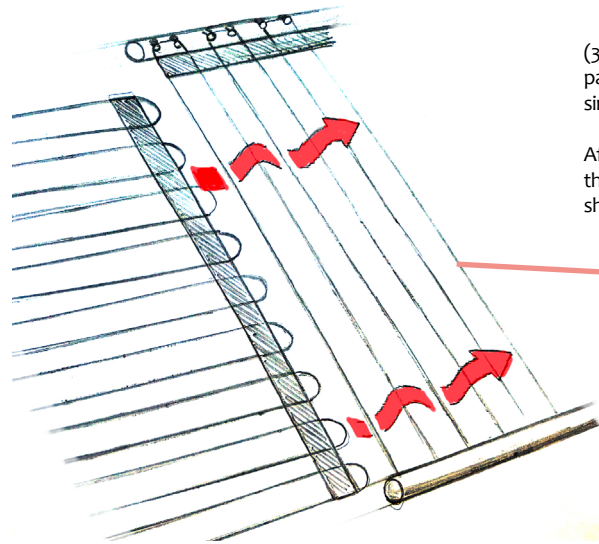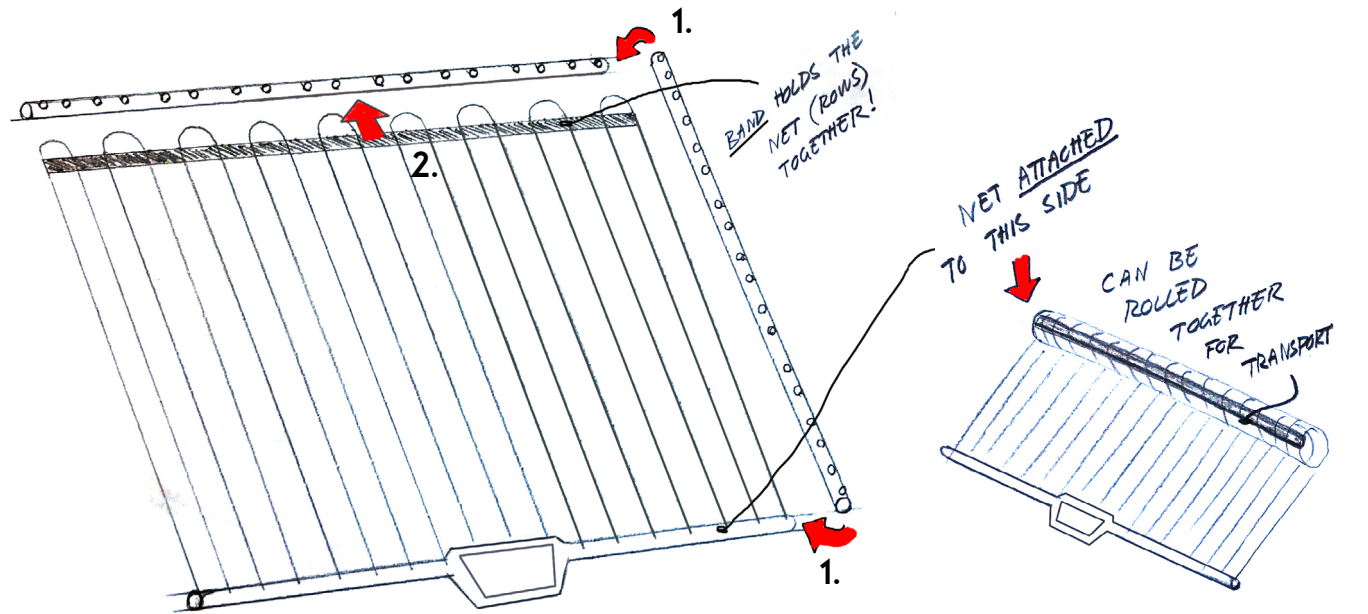
ASSEMBLY & MOBILITY

Detachable frame + net in 2 'parts'

The idea was to have the frame easily detachable at each corner (1), and to have the net divided into 2 'parts', one with vertical 'rows' and one with horizontal.

The rows are attached to one side of the frame and held together by a band at the other end, in order for the net to be 'rolled' around the frame to make transport a bit easier.

The 'free' ends of the rows are hooked onto the tensioning 'bolts' at the opposing side of the frame (2).

1.

2.

BAND HOLDS THE NET (ROWS) TOGETHER!

NET ATTACHED TO THIS SIDE

CAN BE ROLLED TOGETHER FOR TRANSPORT

1.

(3) Attaching the horizontal net part to the vertical. The two parts are 'strung' above and below eachother, creating a net similiar to a tennis racket/the M-station.

After the 2 net parts are hooked onto the tensioning bolts, the net is finally tensioned and the rebounder is set up as shown on previous page.

3.
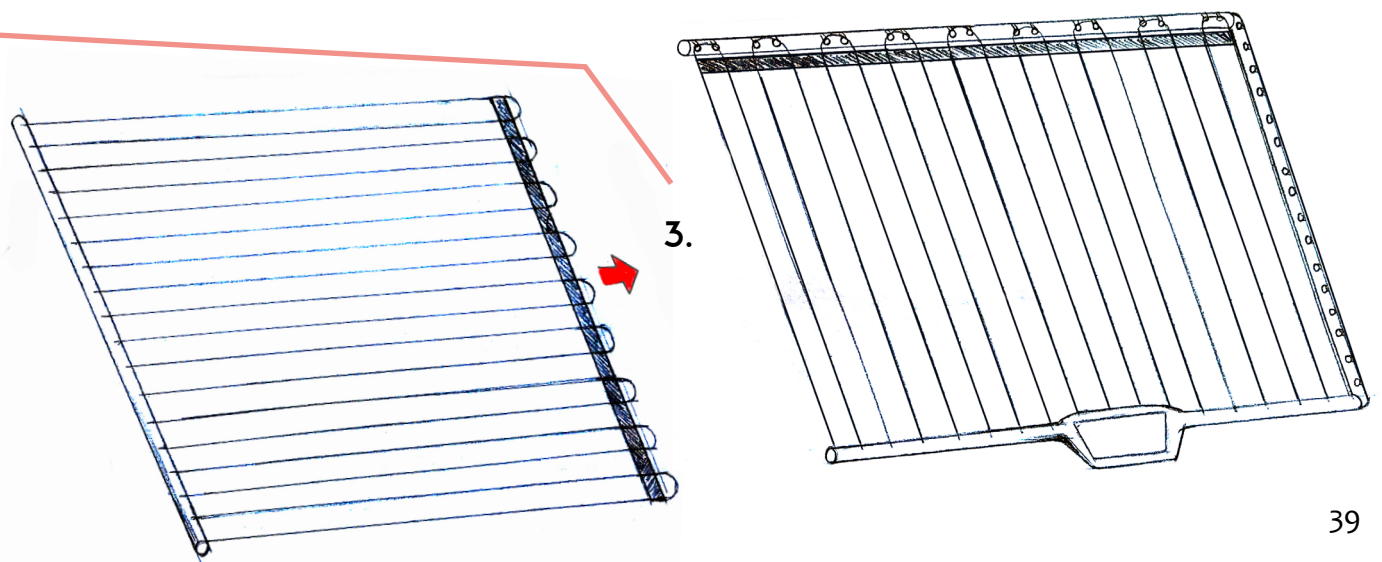
# THE TECHNOLOGY –
INSPIRATION & FINAL IDEAS

Inspiration

When it came to making the light targets work, the inspiration came from fiber optic technology and glowing textiles. Fiber optic cables are usually made from nylon or similar material, which means they are flexible and slightly elastic, theoretically making them also ideal for withstanding ball impact and delivering a good rebound.

There are now fiber optic cables which can emit light not only along its own axis, but in all directions, making the entire cable glow[14]. One example of such a 'side emitting' fiber optic cable is *Fibrance*, displayed below.

Final concept - the light targets

The final concept for the interactive light targets was to have *side emitting* optical fibers as a net, attached to 2 sides of the frame, as shown previously. And for the light source, having LEDs integrated in the frame, feeding the optical fibers.
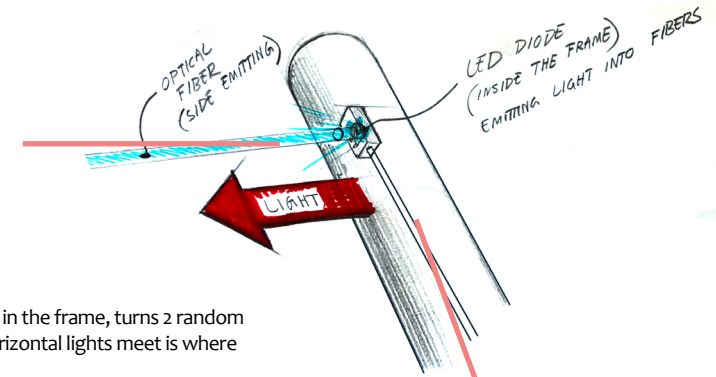
Function - overview

1. The microcontroller, which controls the LED lights in the frame, turns 2 random LED lights on. The point at which the vertical and horizontal lights meet is where the ball has to hit in order to receive a point.

2. Ball hits the net. The piezosensor, located at the same location as the microcontroller, detects the vibrations propagating through the net and frame, and calculates the location.

3. If the targeted area is hit, the microcontroller proceeds to register a point and light up a new area of the net.
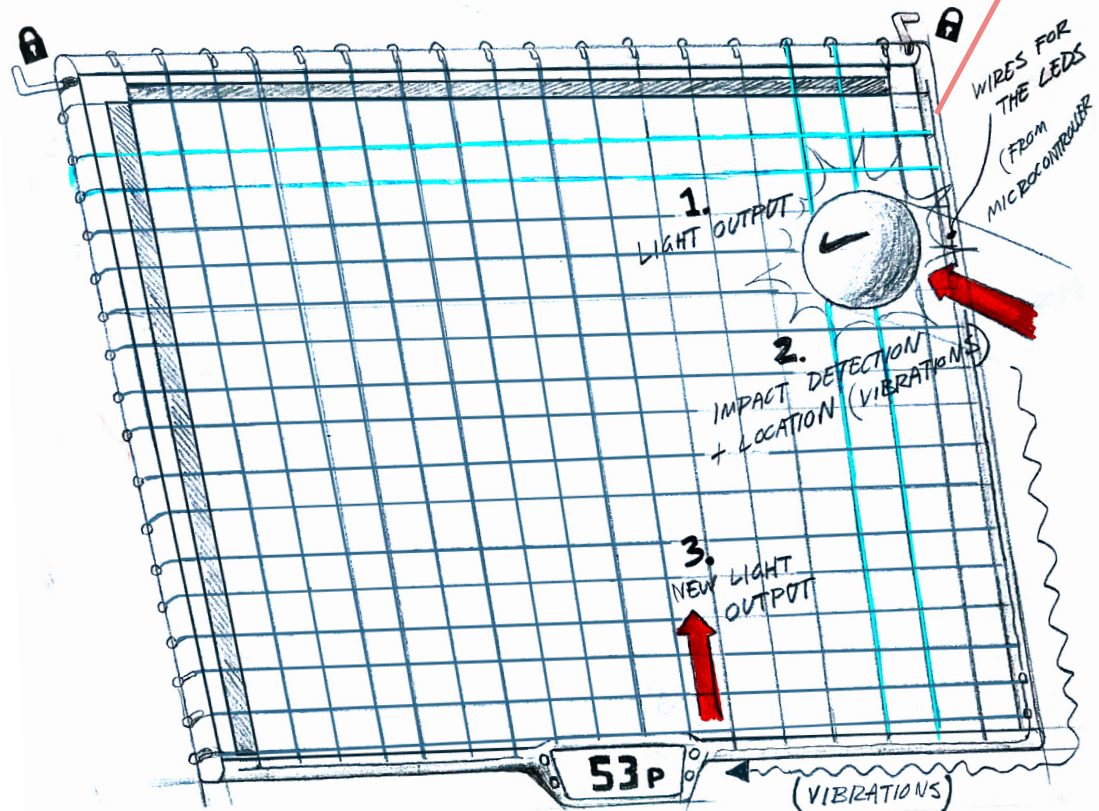
IV.
DEVELOPMENT

PROTOTYPE MODEL

To get a better sense of things, a 1:1 scale prototype model was started. The decision to make it the correct scale was because it seemed advantageous to be able to try it out physically with a ball, e.g. to get a sense if the size was adequate and what material to use that would both be lightweight yet strong enough to withstand the force from the net tensioning.

Main goal(s)

- Prototyping the *physical/mechanical properties*, such as the net material, tensioning, angling mechanism as well as mobility.

- Testing the size and rebound power

Secondary goal(s)

If possible, to prototype the impact sensing functions and interactive light targets

The net and implementation of lights

As shown previously in the 'final concept', optical fibers were assumed to be ideal to use when making the net, potentially providing both good rebound and making the glowing targets work. However, the optical fibers found were all shown to be much too thin to be strong enough for ball impacts or for delivering a clearly visible light output.

The idea of having a transparent net and ultimately testing out with LEDs, was eventually discarded in the physical model, as it proved very difficult to find a suitable material.

The net was instead made from ~4 mm thick *paracord*, a very strong and slightly elastic thread that is similar to nylon. It was winded in the same way as the M-station net, i.e. with the vertical and horizontal 'threads' going above and below eachother respectively.

Wood was chosen as the material to start testing with due to its user-friendliness.

The frame was made detachable into 4 pieces. They were connected with L-shaped steel joints at the edges.

Screws were used as bolts/posts on which to wind the net around.
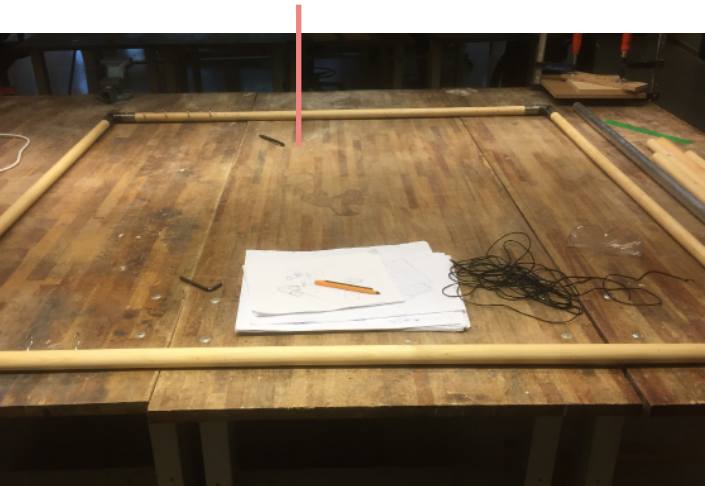
TEST - TENSIONING & FRAME MATERIAL

The net was first tensioned by twisting the wooden frame outwards and locking it in place with a screw. However, it was quickly concluded that the wood would be too weak for this type of tensioning method, at least in the long run.

It was replaced with 2 mm thick aluminum pipes instead. Aluminum was chosen because of its lightness, which would be ideal for transport.

A ratchet strap was used to get a general sense of the strenght of the aluminum frame.

A slight curvature was shown on the pipes, but it they were estimated to be strong enough to hold.

For making the 'posts' on which to wind the net around, holes were drilled and bolts inserted through the pipes. The bolts were locked in place with a nut on each side.
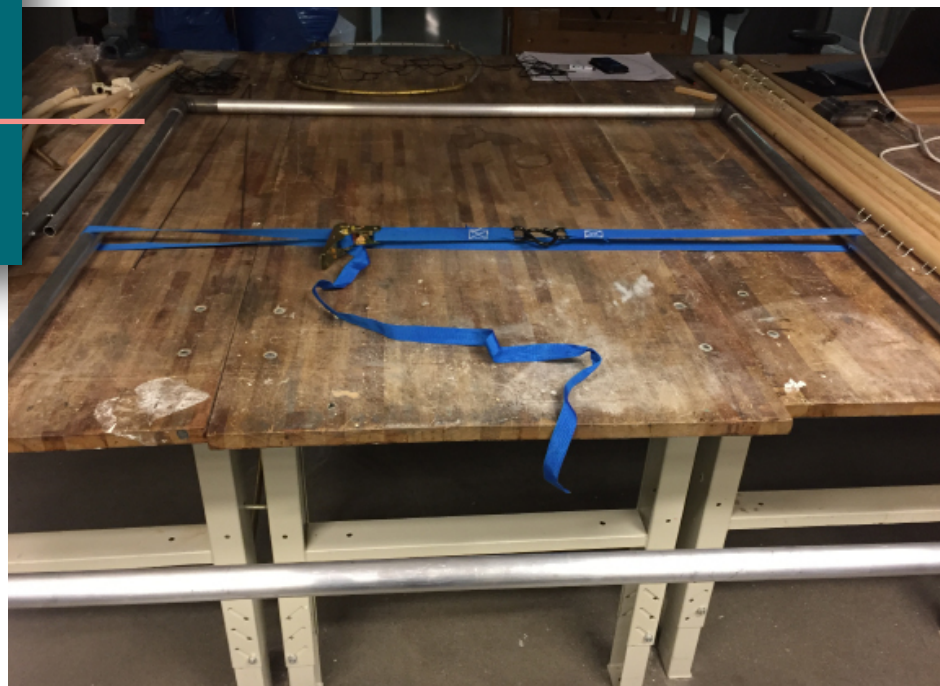
'QUICK' TENSIONING & LOCKING - IDEATION & TESTING

The primary idea was to have the net tensioned by twisting the 'pipes' of the frame outwards and locking it in place.

LOCKING

Handle with a spring-powered locking button, similar to a telescopic pipe.

QUICK TENSIONING

Initially, the idea was to have an inner, solid cylinder', on which the screws would be more easily attached, and which would be rotated outwards independently of the outer pipe/tube, with the screws moving along cutouts.
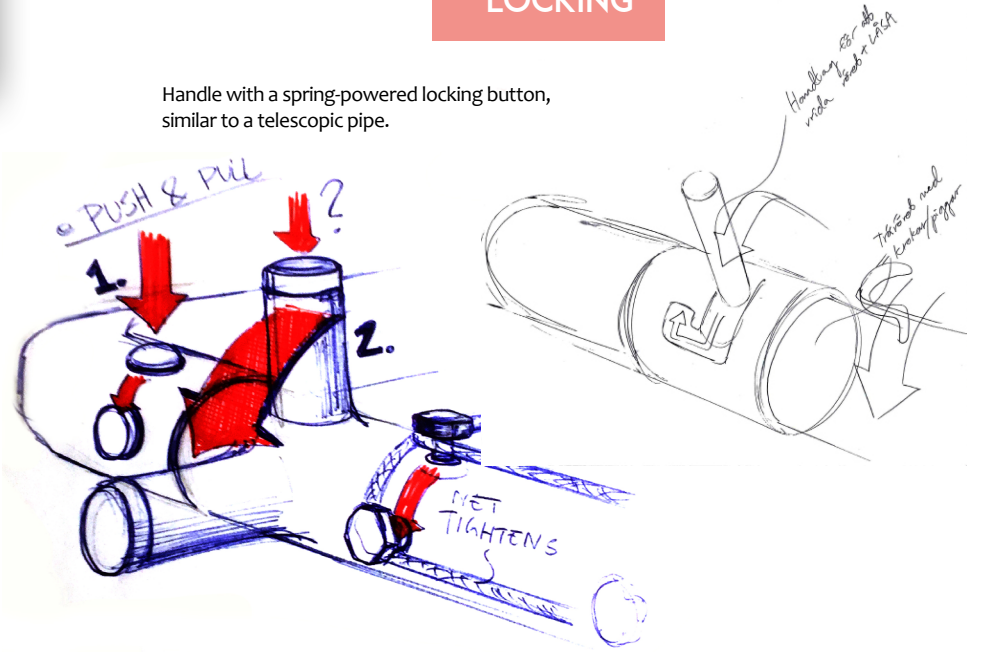
However, because of convenience the tensioning was tested with just the aluminum tubes first, to see if the method worked well.
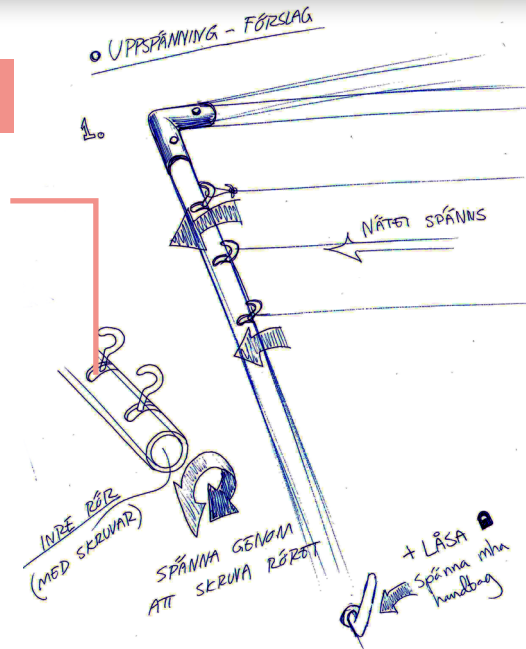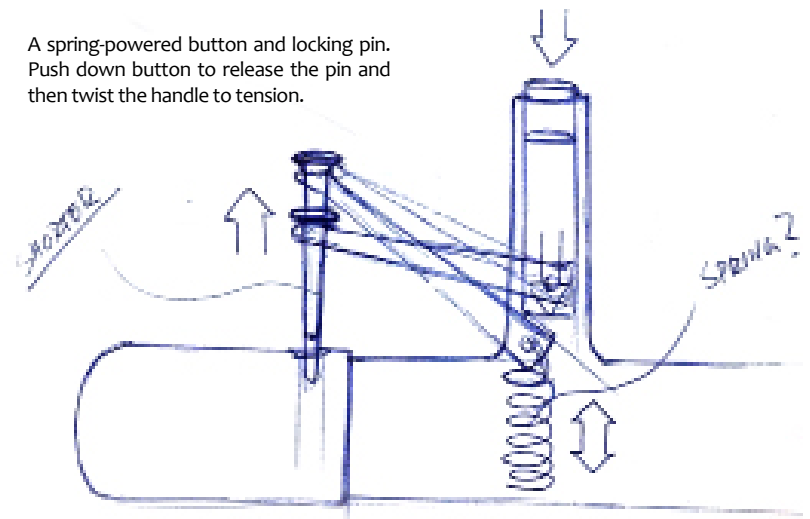

Testing the 'quick' tensioning method. The aluminum pipe was rotated outwards with a large nipper as a makeshift 'handle'. When tensioned, the pipe was locked in place with a screw at the joints at the edges of the frame.

A spring-powered button and locking pin. Push down button to release the pin and then twist the handle to tension.

THE NET – SMALL SCALE HANDLING TEST

A small scale test model of the divided 'optical fiber'-net partly attached to the frame was made, focusing on the handling, storing and 'mobility' aspects.

Test 1 - Net divided into 2 parts (with separate rows)

The net was divided into separate vertical (and horizontal) rows. Each row was attached to one side of the frame (1). All of the rows were then connected with bands at both ends to try to keep the net together (2).

This divided the net into 2 main parts - one part with vertical rows and one with horizontal. The 2 parts were meant to be rolled around the side of the frame it was attached to for facilitated transport and storage, as shown previously in the final concept sketches.

Evaluation

However, the net still tended to quite easily get tangled into itself, (as shown below right) when trying to roll it around the frame, as was intended when storing the rebounder.

Additionally, the optical fiber net would also require cables for the LEDs to run through 2 sides of the frame to be connected to the microcontroller. This would make detaching the frame into pieces for transport complicated, as the connection between the LEDs and microcontroller would have to be 'cut' somehow

As mobility and keeping the rebounder relatively easy to 'handle' when setting it up and storing it was considered important, this type of net was eventually discarded.

### Separated net & changing how the targets work

The decision was made to keep the M-station/tennis racket style net as it provided such powerful rebound, but trying to make it *separated* from the frame and easier to fold or roll together.

This meant that the light targets had to be made some other way, as the optical fiber net required some kind of light source feeding it from one end of the threads.

45
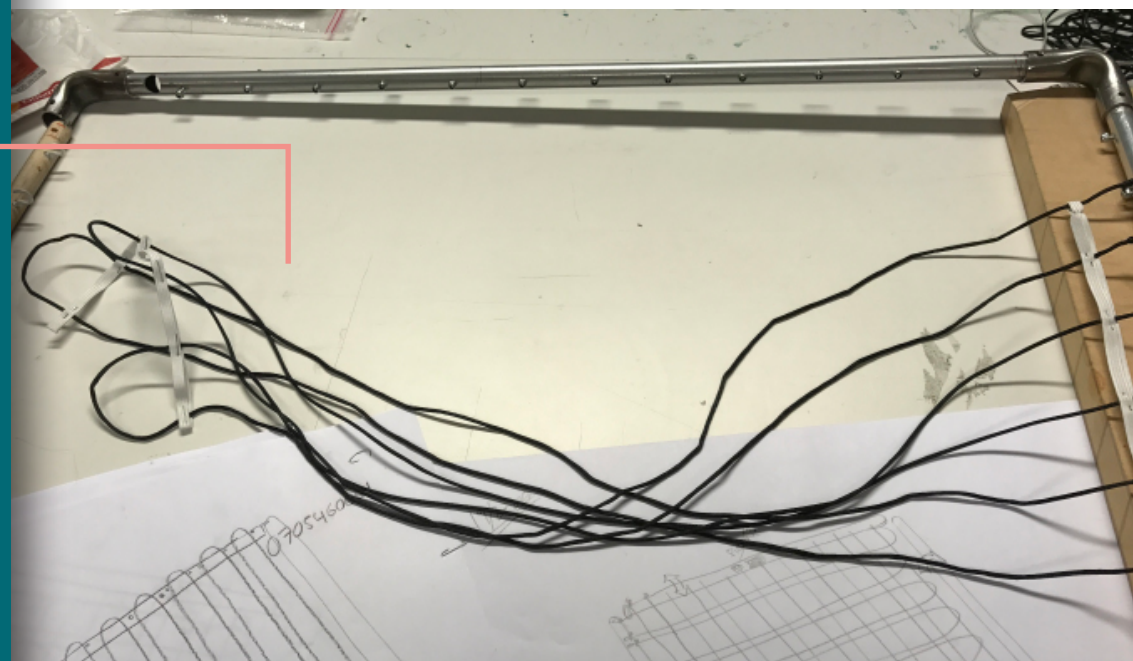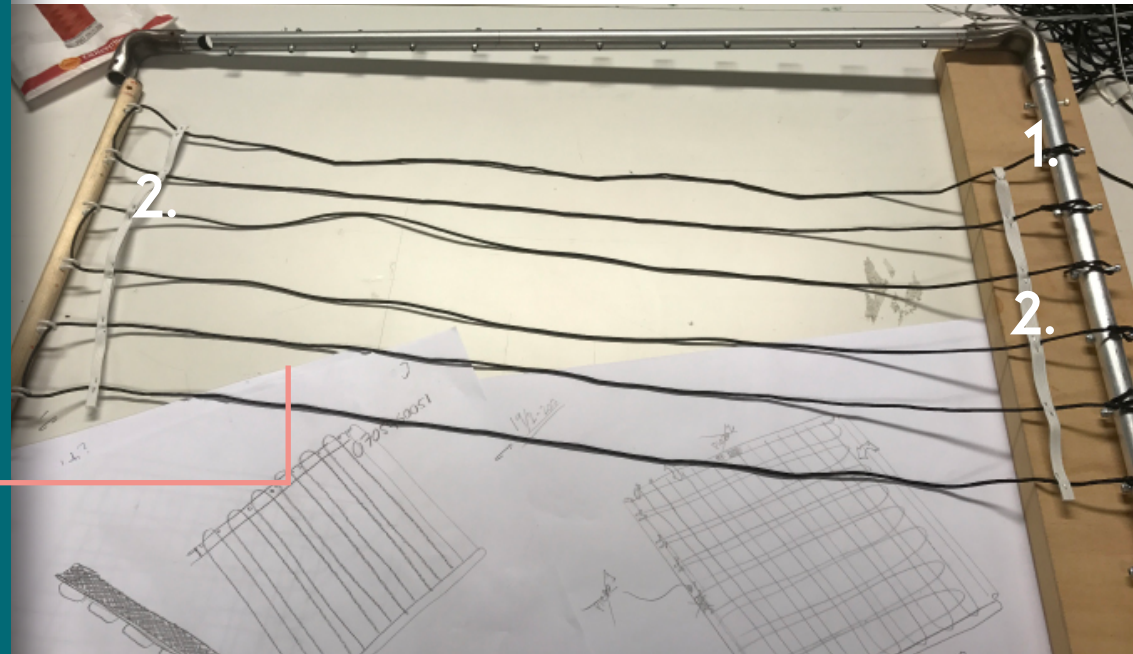
Test 2 - Making the net separated and 'uniform'

The second test was to have the same type of net without knots, but separated from the frame and with a connecting 'band' making it into 1 uniform part instead. This in order to make it possible to remove it from the frame more easily, minimizing the hassle of handling and transporting it.
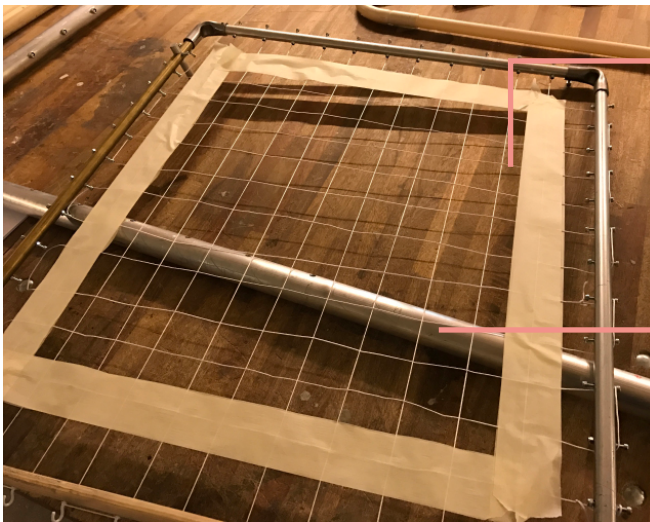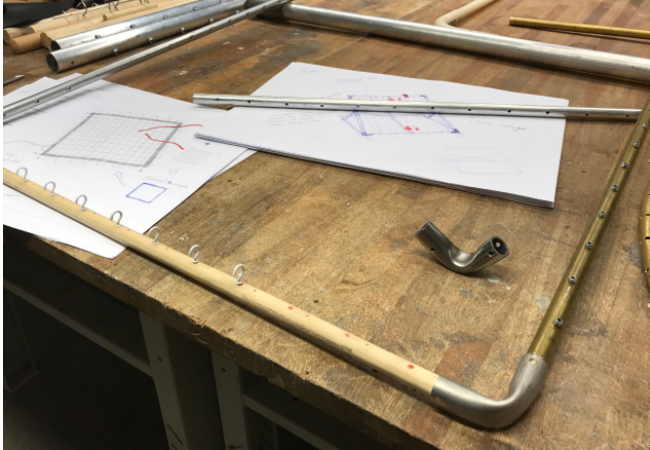

First test of a net separated from the frame, and connected together with tape where the two horizontal and vertical threads meet.

Evaluation

The net proved to be a little bit easier to handle in this way, although the part inside the connecting 'band' (tape) still got tangled up easily when the net was removed from the frame.

In addition, hooking the loose ends of the net onto the frame posts was a bit frustrating.
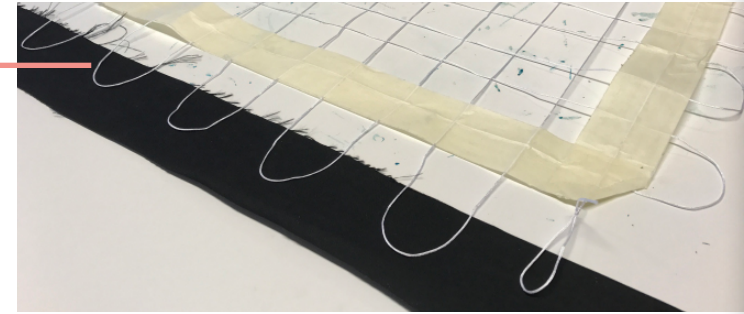
An attempt to make the outer edges of the net connected with a textile 'frame' to make it easier to hook the net onto the rebounder frame.
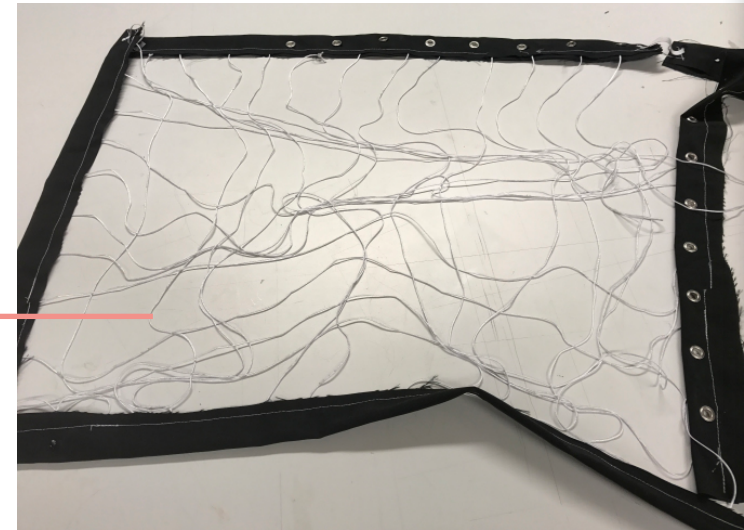
Evaluation

However, result were unsatisfying as the net still was very easily tangled and difficult to maneuver.

ANGLING - THE STAND & BASE
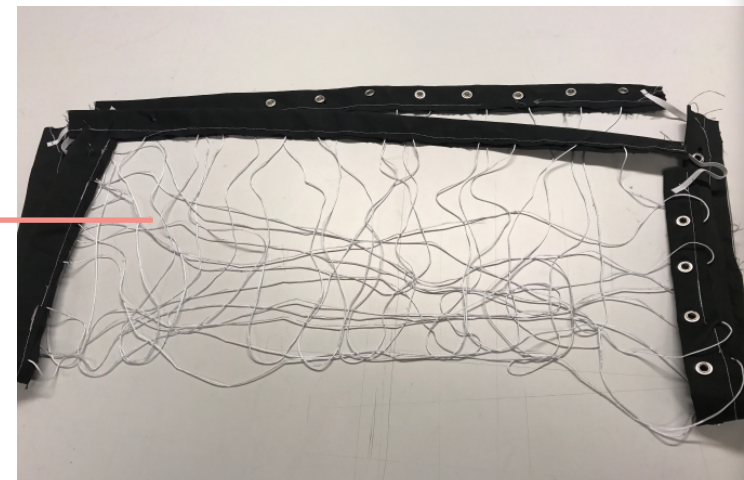
The solutiuon for the net was left aside temporarily and focus turned to how the rest of the rebounder should work and look.

The next step was making angling possible. The requirements set up were:

A Angling should be *intuitive*. Switching between positions should be quick and uncomplicated, as users might want to change back and forth during sessions.

B Angling of at least 30 degrees. This was arbitrary, but estimated to be the minimum angle for effective practice of higher ball rebounds and volleys.

C Stability. The stand must be positioned so the rebounder is stable enough in all angles and does not fall over. The stand must also be locked securely enough to handle powerful passes or even shots.

D Ergonomy. The changing of angles should be kind to the body and not force complicated and/or unergonomic movements.

Test models

The 'learning by doing'-approach seemed most appropriate when it came to solving the stand and the base. Thus, instead of sketching, test models of a stand and base began to be constructed.

First off, an adjustable/rotatable wooden stand was made, connected to the frame and resting on a wooden, ground base (1). The stand was simply 'locked' in place on the base with a stopping screw (2). Initially, the purpose of the stand was just to make the rebounder stand up and be used as intended to get an accurate sense of the ball rebound. The rebound proved to be very satisfying using the M-station style net.

After the first test at 90 degrees, the stand was shortened a bit so that lower angles could be tested (3). The stand was locked in different positons by slots that prevented both backwads movement and a recoil effect from ball impacts.

1.

2.

3.

4.
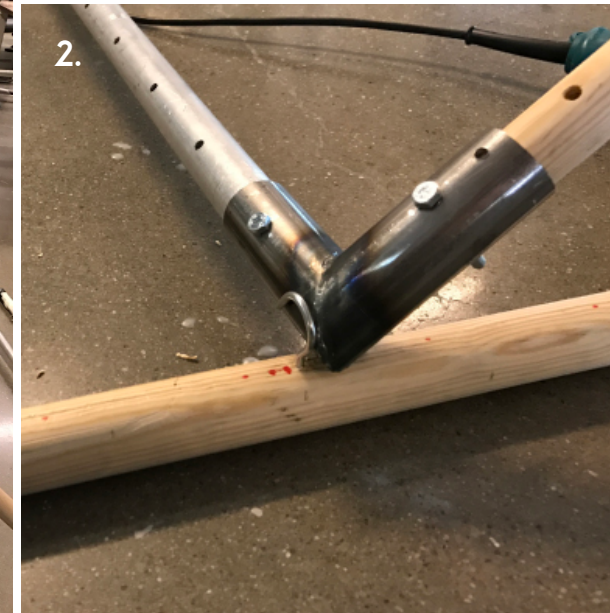
The frame was first tied to the base with a rope so that it could be angled/rotated around that point to allow for different angles (4).

REMAKING THE NET

After the difficulties of finding a way to make the initial, M-station/tennis racket-style net into a single 'uniform' net that could be detached from the frame and easily handled, the final decision was to use a traditional, knotted net tensioned with regular bungee chords.

The reason was mainly in order to make the net much easier to handle and fold when *transporting*. It was also due to not finding a satisfying solution to 'quick tension' the net. Having a uniform net that doesn't get tangled when removed seemed a better solution, even if it might sacrifice a bit of rebound power.

'Ready-made' standalone nets were very difficult to come by, so the new net eventually had to be tied from scratch.

ANGLING, CONTINUED

Functional analysis - ergonomy and stability

Functional analysis concerning ergonomy when changing the angle was conducted.

As mentioned, the aim was that changing the angle should be as un-complicated as possible and not force unwanted body movements.

METHOD 1 - TEST

Standing upright and changing angle.

METHOD 2 - TEST

Sitting down. This gave more control when putting the stand in the desired slot, but needed a bit more physical effort and felt more risky as there was less control of the frame.
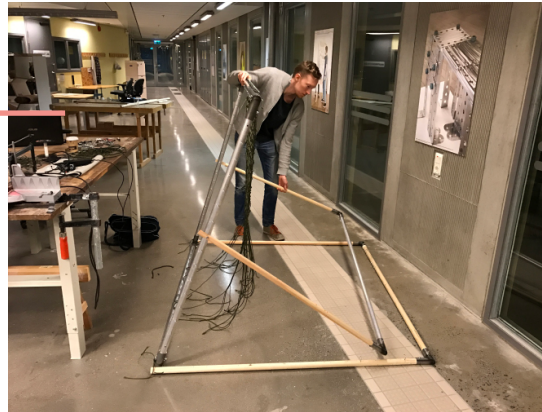
FOLDING & STORING

Storing

To allow for convenient storage and mobility, the aim was to make the rebounder as *compact* as possible.

To prevent having to disassemble the rebounder when storing it, the decision was to made to have the rebounder foldable/collapsible.

For the construction to fold together to take as little space as possible, the solutions that seemed most suitable was to have the base, frame and stand folded and connected into one, uniform part.

Clamp/joint to rotate stand

Taking inspiration from a bike saddle clamp, a lockable clamp connecting the stand to the frame was printed out. It was believed advantageous to be able to adjust where the stand connects to the frame to get the best angle for the stand and consequently stability for the entire construction.

The stand was simply rotated up and down around the screw in the middle.

Frame & base - joint

A cylindrical joint was made to connect the frame to the base and allow it to rotate/fold on top of it.

(90° ANGLE)

CAN'T FOLD INWARDS/DOWNWARDS UNLESS STAND IS "TELESCOPIC" (RETRACTABLE)
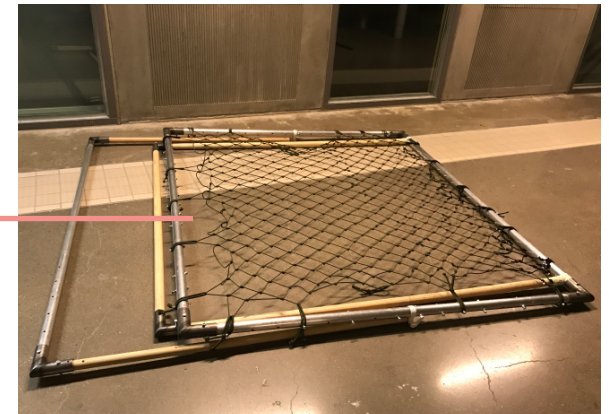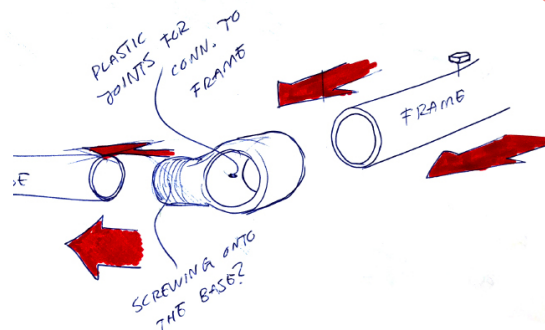
The most suitable solution was to have the stand rotate upwards to connect to the frame, and then fold the rebounder down on top of the base.

PLASTIC FOR JOINTS FOR CONN. TO FRAME

FRAME

SCREWING ONTO THE BASE?

Test of folding together. The stand was shown to be too long and sticking out too much.

50
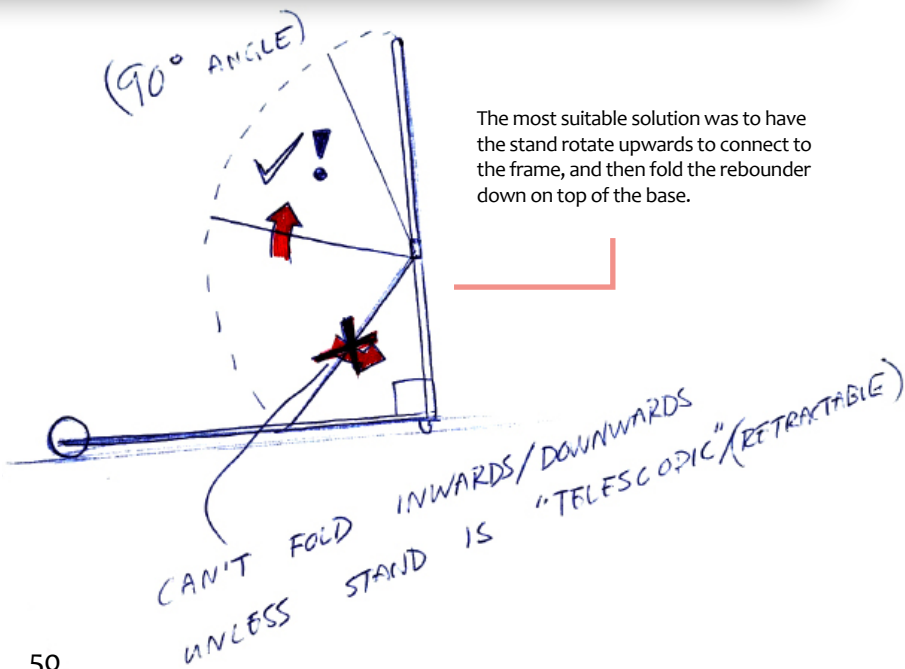
Test 2 - folding together (shorter stand)

A test of having the stand a little bit shorter to have it match the top of the frame.

The shorter stand was shown to provide enough stability when hitting the rebounder with a ball.

SHORT DISTANCE TRANSPORT - IDEATION

2 means of short distance transport were needed:

1. Moving the rebounder around locally when it is *in use* (folded out), during a practise session.

2. Moving the rebounder when it is *folded* together, from where it is stored to the practise area.
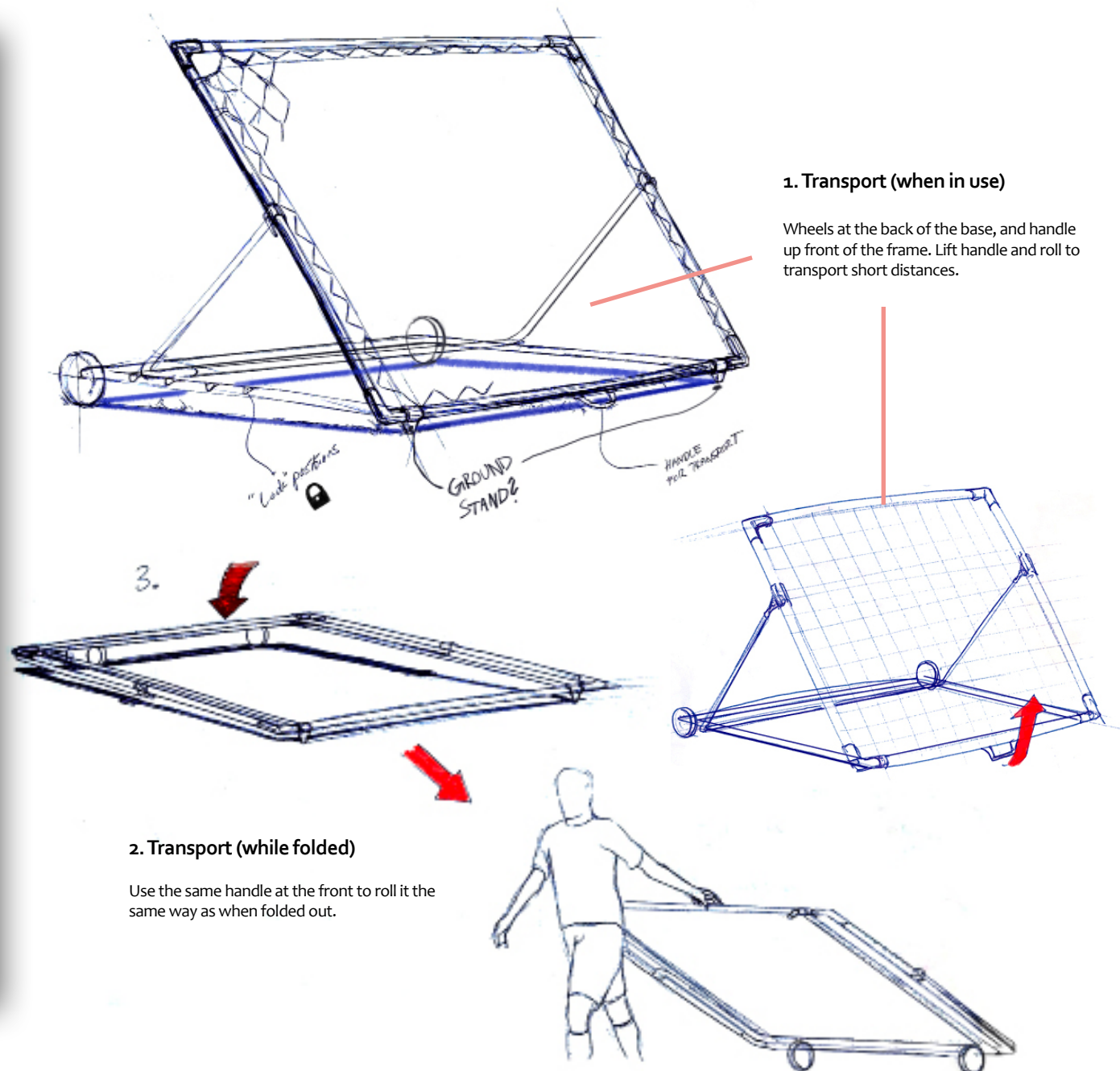
Wheels

Adding wheels to the rebounder seemed the most obvious solution.

The proposed solution was to have the wheels at the back, to not be in the way of the striking area. It would also provide better balance when moving the rebound when it is in use, as opposed to having wheels at the front.

Feet

Adding wheels meant that the height of the rebounder would be altered. In this case, the model would lean forward with the wheels at the back.

To balance this out, the solution was to add feet at the front. This to make it easier to get a hold of the transport handle at the front, and protect the frame from scratches and likewise, if playing on asphalt and similar surfaces.

"Lock positions"

GROUND STAND?

HANDLE FOR TRANSPORT

3.

1. Transport (when in use)

Wheels at the back of the base, and handle up front of the frame. Lift handle and roll to transport short distances.

2. Transport (while folded)

Use the same handle at the front to roll it the same way as when folded out.

STAND & LOCKING MECHANISM – IDEATION

When creating the mechanism for the locking and changing of angles for the stand, the 2 aspects taken into consideration were:

1. Quick and easy removal and changing of positions

2. Secure locking to prevent the stand from releasing, causing damage to the rebounder.

The solutions circled mainly around using some kind of *slots* on the base in which the stand could be quickly and securely locked in place, while also having it easily removed for quick changing between positions.
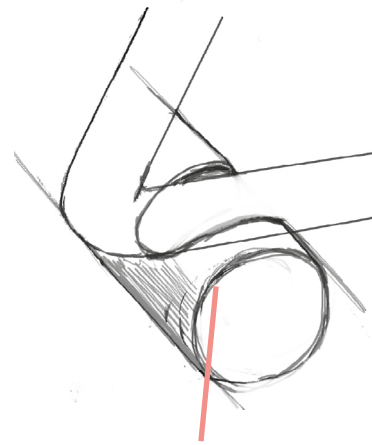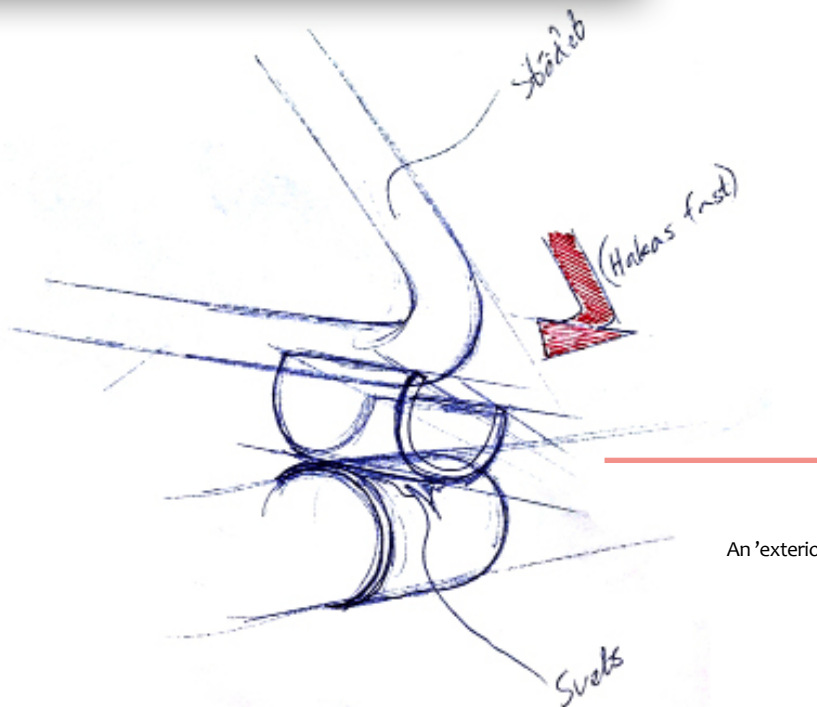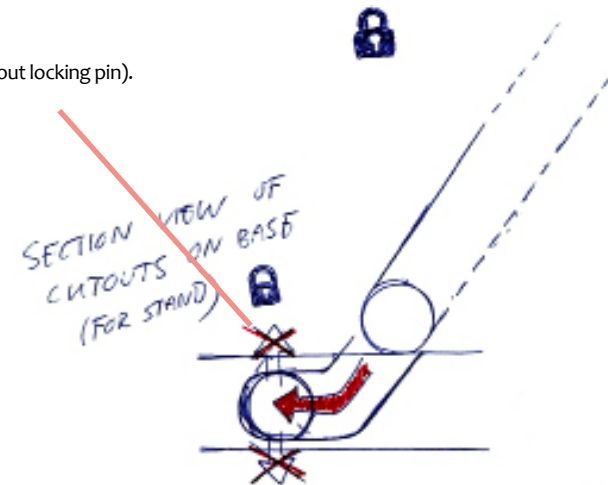
Cylindrical, cutout slots on the base in which the stand can rest.

Section-view of cutout(s) with a spring-powered locking 'pin' to keep stand securely in place.
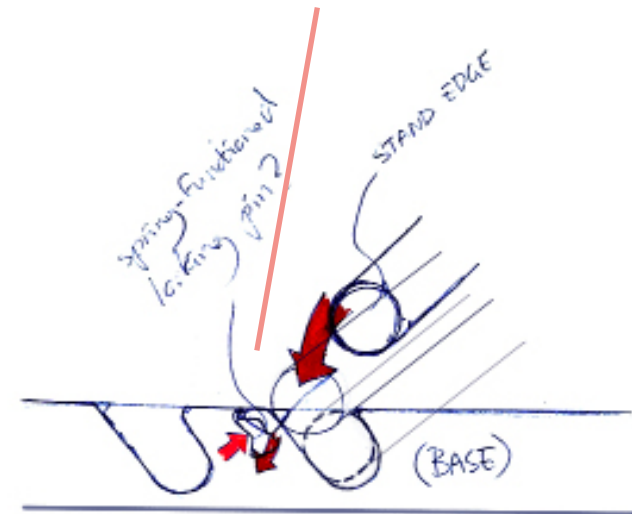
A 'deeper' cutout (without locking pin).

An 'exterior' slot added onto the base

CREATING THE BASE & STAND – MATERIAL & SHAPE

Considerations

When making the final models of the base and stand, the things to be considered were:

1. The base had to have a certain weight so that the rebounder is stable and doesn't fall over.

2. The stand must be light enough to lift with *one* hand when changing the angle and when folding the rebounder.

3. Lastly, the total weight must be light enough so it can be lifted and rolled (when folded and not folded) with relative ease.

In the 2 latter cases, the lower strength of young kids was also considered.

Choice of material - steel

After some weight estimation was done, it was decided that the final models of the base and stand were to be made out of *steel tubes.*

Steel was chosen to provide a bit more 'backweight' for the rebounder. Tubes with a bit smaller dimensions were used for the base and stand compared to the aluminum frame, in order to keep the weight down a little to take transport into account.

The total weight of the base amounted to around 4,5 kg, while the stand was around 2,5 kg. This meant a total weight of around 7 kg.

1, 2 & 3

The base and stand were also made in *parts,* so that no part was longer than 1,6 m to also make transport by car more convenient.

The idea was also to have the base, stand and the frame align smoothly when folding together the rebounder, so they could be wrapped together with a band, to not have them fold out when storing the rebounder vertically. (2, 3).

4 & 5:

Testing how much the frame should be elevated with 3d printed 'feet' joints at the front. It was important also for the ball to be able to return along the ground and not be lifted due to the cylindrical shape of the lower part of the frame. The final height was decided through trial and error by testing the rebound out with a ball.

WHEELS - ATTACHMENT

Ready-made, lockable wheels were chosen for the final model. Lockable wheels were chosen to prevent the rebounder from potentially rolling when using it.

Attaching the wheels

Joints that connected the wheel to the frame were 3d modeled and printed out.
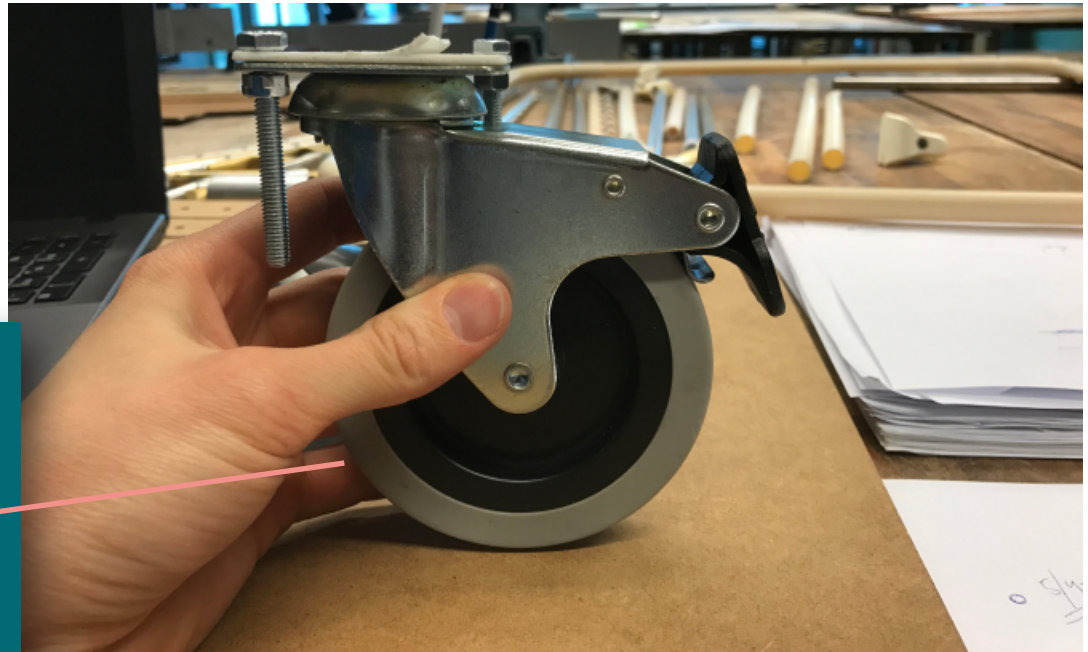
CREATING THE CUTOUTS/SLOTS FOR ANGLING OF THE STAND

Test model

Testing of the slots for the stand was first done on wood to see if it worked as desired.

Slots roughly matching the shape of the stand were cut out. It was easy to set the stand in the desired slot and they also kept the stand well in place when rebounding.

'Add-on' clamp

After consideration, it was believed that the hollow, steel base would be weakened too much by making such cutouts. There were also technical as well as time constraints.

The decision was to go for an 'add-on' clamp instead, which could be moved along the tubes of the base, without the need for cutouts. Another reason was also that this would likely offer more angling options than specific slots could do.
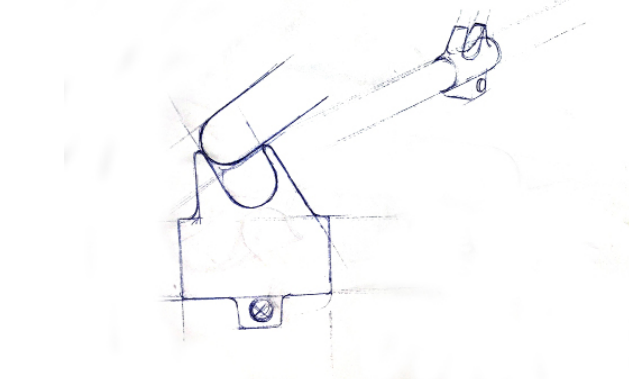
An add-on clamp was modeled after the stand and printed out, one on each side. The clamps were tightened and released with a wing nut to lock it or to slide them along the base.

Mobility - folded transport

The rolling of the rebounder worked as intended, except for one minor issue.

Due to the wheels being rotatable, (since 'static' wheels that were lockable were not found), the rebounder naturally became very difficult to steer.

However, they worked well enough to be able to test the mobility out in terms of weight & ergonomy.
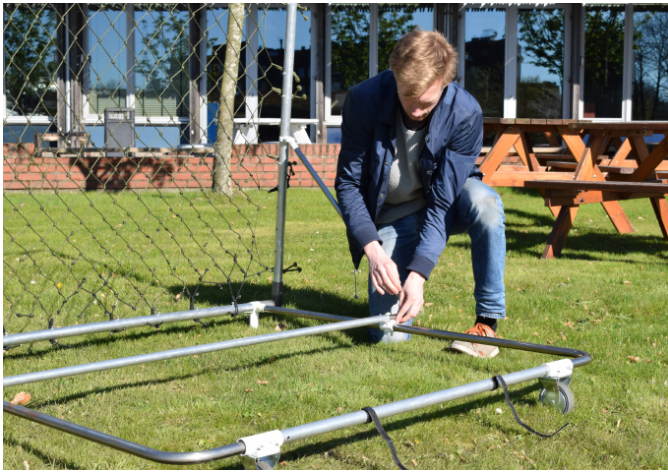
Angling - step by step

1 - Loosen the wing nut on the clamps

2 & 3 - Slide the frame to the desired position/angle

4. Lock the clamps by tightening the wing nuts.

Vertical storage

Final details

2 velcro bands were added at the base to wrap the rebounder together when folded.

FINAL DETAILS, CONTINUED

Powder-coating & weather-resistance
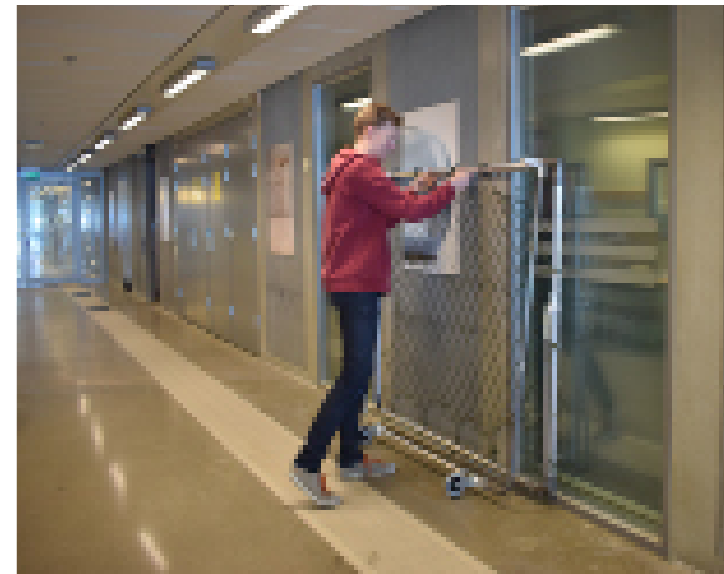
The model was poweder-coated in dark grey and black, which made the entire model weather resistant.

Change of material - feet and wheel joints

The 3d printed front 'feet-joints' were replaced by ones made from steel to provide the needed strength.

The new joints and the ends of the base were threaded so they could be screwed onto eachother.

The joints connecting the base and the wheels were also remade from steel material.

● FINAL MODEL

The final, physical model. The implementation of the technology for target practice; lights, sensors and display etc, was not made due to the technical complexity.

However, some different ways in which this technology could be integrated was explored. Some examples are explained in more detail and visualised to some extent in the following section.

V.
REALIZATION

THE TECHNOLOGY - FINAL SOLUTION & VISUALIZATION

When arriving at a final solution for how the targets on the net could work, the 2 main options considered were:

1. Optical fiber net and LEDs integrated in the frame.

2. Using painted numbers/symbols instead of lights, and having the microcontroller either display what target to hit or use sound output.

Lights vs colored targets

The most interesting and perhaps overall most effective method would be to have blinking lights as targets. However, the solution found that involved using optical fibers with LED lights would require the net to be attached to the frame, making transport more complicated and the set up of the rebounder more time-consuming, as shown.

Another downside with lights is that it might be difficult to see them during daytime practice, perhaps requiring the rebounder to be in the shadows, which drastically limits the usability.

### Final solution - painted targets

The most optimal solution was eventually considered to be a net with painted numbers as targets, and to tell the player what target to hit either *visually* on the display or through *sound* commands.

Using the display on top of the rebounder as the indicator would be similiar to having light targets, as it would also force the player to keep his head up at all times while controlling the ball, which as mentioned is a very important ability in the game.

Other reasons for going with painted targets were that it would allow for the target practise to be possible during any time of day, as well as not requiring the net to be attached to the frame, making the process of setting up, storing and transporting the rebounder slightly easier.

THE 'PLAY' REBOUNDER

Rendering of final concept with a microcontroller, display and net with painted numbers
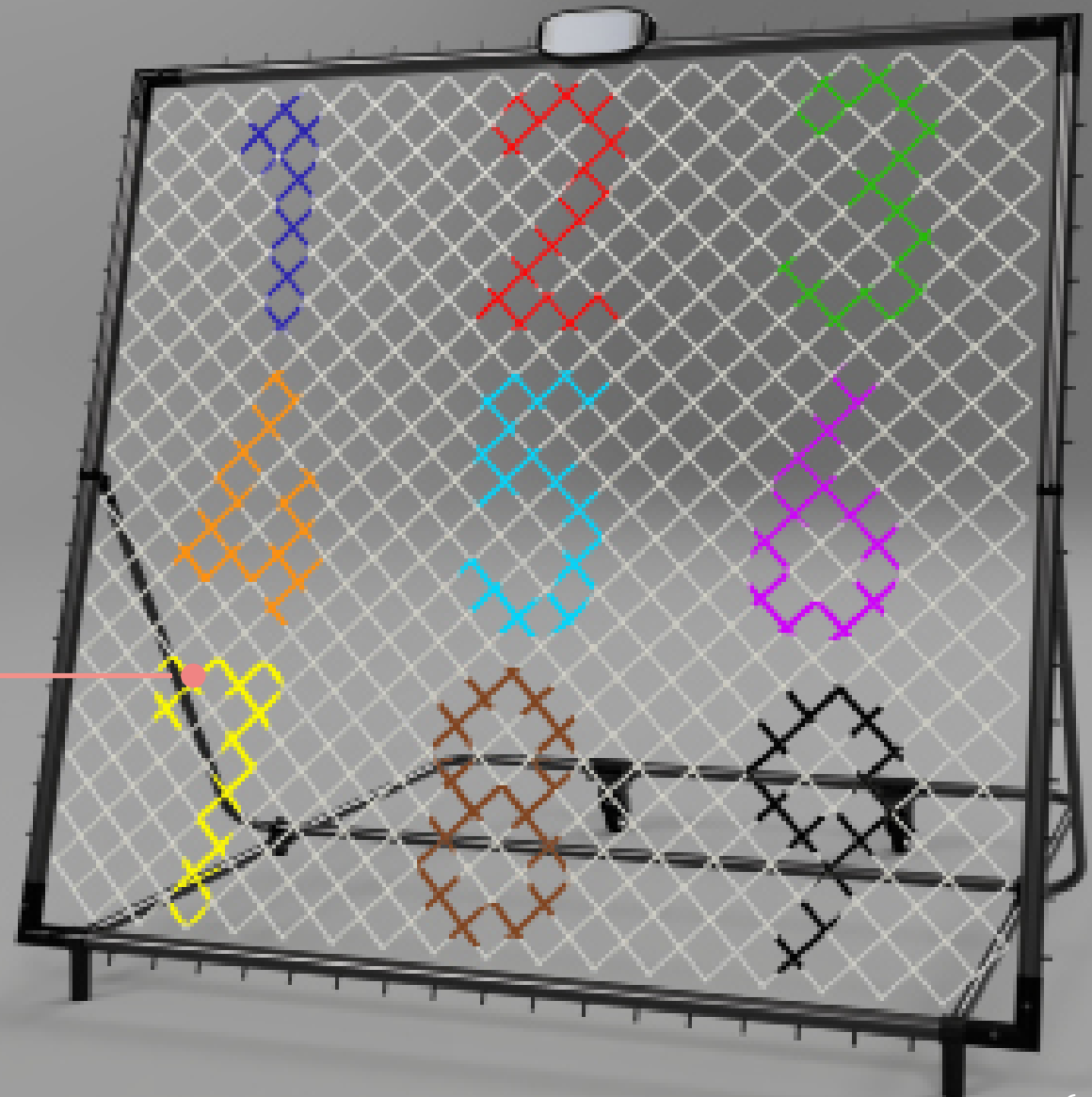
DETAILS

Microcontroller and display

Customization

The microcontroller has a user interface in which the player can choose between different game 'modes' and levels of difficulty.

Visual and audial commands

The player is told which target to hit through sound commands, or for increased challenge, visually on the display.
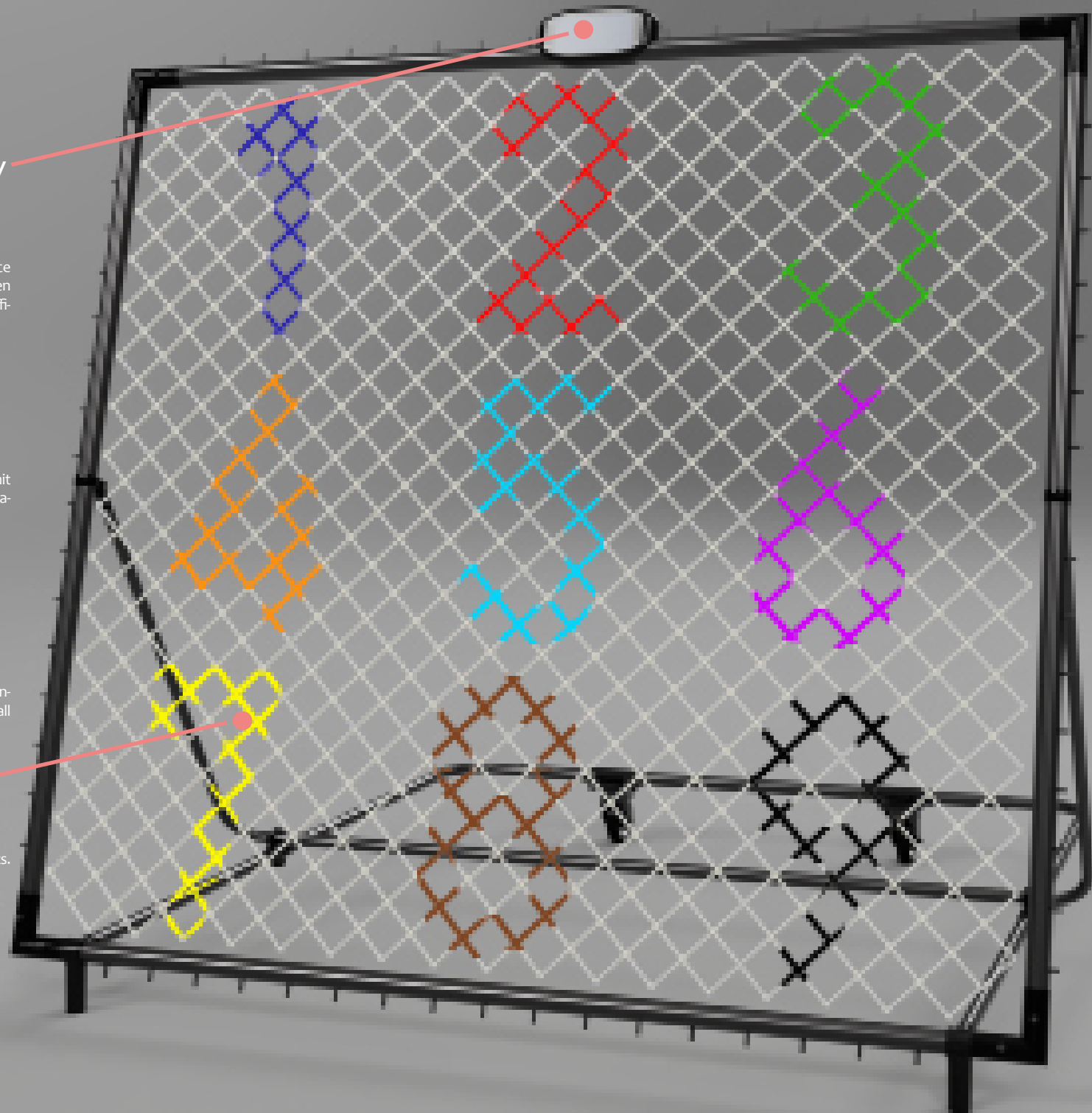
Piezoelectric vibration sensor

The piezosensor sits within the microcontroller. It receives the vibrations from ball impacts and calculates the location.

The net

Standard, nylon net with painted targets. Attached to frame with bungee chords

MICROCONTROLLER & DISPLAY
- DETAILS

The microcontroller sits at the top of the rebounder, and can be taken off when it needs to be charged.

Powerbank (inside)

Built-in powerbank as power source, with USB-charging port

Rugged case and LCD/LED display

Rugged, weather and impact resistant case and reinforced touchscreen display with sunlight readability[15], such as the rugged computers/tablets used in industrial environments[16].
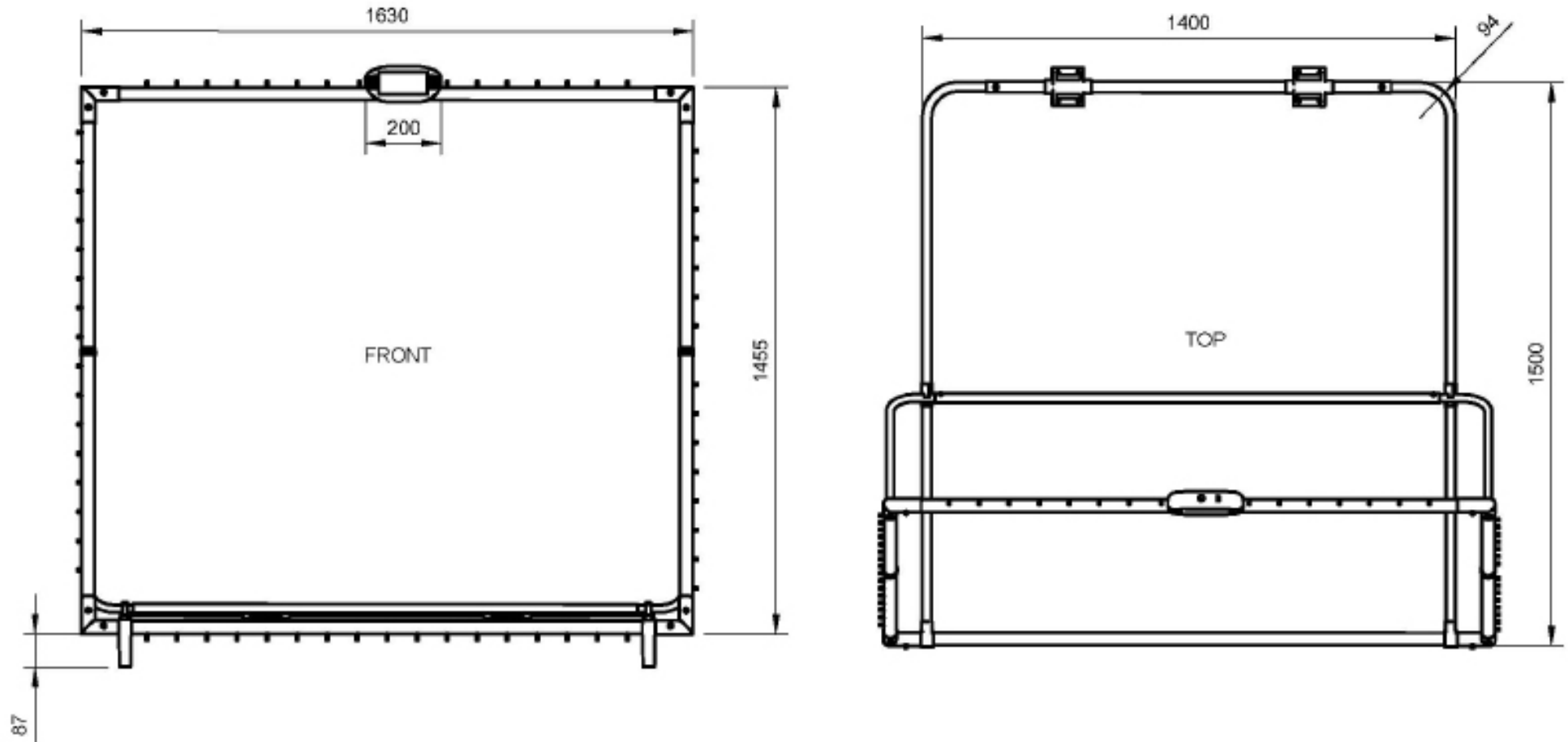
On/off-button

Speakers

For the sound commands

SCORE

58

START GAME

5

TECHNICAL DRAWING & MAIN DIMENSIONS

(Units: mm)

FRONT

1630

200

1455

87

TOP

1400

94

1500

REFLECTION

When reflecting on the project as a whole, the conclusion is that the inability for long periods of choosing a specific ability to measure and/or practise with the aid of technology, resulted in the project taking far too much time than intended.

The brief and 'focus' was very open, which I still don't think was a bad thing necessarily, as I think it is valuable to not paint oneself into a corner and instead try to consider and explore a subject from different angles and viewpoints. Both in order to come up with a good solution to a problem and for one's own creative learning process.

Visiting amateur clubs to try to find out if there was some potential for improving parts of the general training equipment, was not as successful as I had hoped. Although my initial ideas felt a bit abstract and conceptual, the discussions could probably have benefitted from a more driven approach on my part, using the coaches and players more for feedback on the ideas I had from the start, rather than trying to draw out ideas from them. All in all, this has served as a valuable learning experience.

Even though the idea of making measuring technology available for amateur teams and players felt relevant and interesting, it eventually seemed like too big of a challenge to do it in a way that would realistically work. At least when it came to measuring things that the managers mentioned could be beneficial, such as positioning of players during matches.

After the research and ideation on improving or creating new team training equipment, the decision to scale it down and focus more on an individual practice tool was made because, in the latter context, the implementation of technology seemed more relevant and possible to realize. The decision to focus on a rebounder was because it is a proven effective individual practice tool, but that also seemed to have a lot of potential for being improved through the addition of elements such as performance feedback and more interactivity.

The idea of combining physical and, to some extent, mental practice was more or less the idea behind the final product. Reflecting on the result, even though interactivity and feedback on performance was the main focus, it eventually played a smaller role due to the difficulties of prototyping the ideas generated, and because it became clear that there were many other important aspects needed to be considered when making a rebounder.

REFERENCES

1.   https://football-technology.fifa.com/en/media-tiles/epts/ (EPTS, sida 9)

2.   https://www.techradar.com/news/world-of-tech/adidas-unveils-micoach-speed-cell-tracker-1036849

3.   https://www.bundesliga.com/en/news/Bundesliga/borussia-dortmund-and-hoffenheim-use-footbonaut-to-hone-their-passing-skills-464313.jsp

4.   https://www.nordicsemi.com/node_206/node_305/Product-Related-News/adidas-miCoach-Smart-Ball-coaches-soccer-players-to-improve-their-kick-techni-que-using-Nordic-Semiconductor-Bluetooth-Smart-wireless-technology

5.   https://football-technology.fifa.com/en/media-tiles/about-goal-line-technology/

6.   https://sports.vice.com/en_us/article/wn3vwz/faster-in-the-head-can-video-games-make-soccer-players-better

7.   http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0034731

8.   https://motherboard.vice.com/en_us/article/gvyy4q/this-system-turns-the-beautiful-game-into-big-data,

9.   https://www.stats.com/player-tracking/

10.   https://www.sporttechie.com/fifa-will-provide-teams-with-in-match-tracking-video-during-world-cup-soccer-football/

11.   chrome-extension://oemmndcbldboiebfnladdacbdfmadadm/https://muninsports.com/tools/net_manual.pdf

12.   https://www.marketwatch.com/story/what-its-like-to-play-with-a-smart-tennis-racket-2015-09-03

13.   https://www.forbes.com/sites/amadoudiallo/2014/08/28/can-babolats-smart-racket-improve-your-tennis-game/#2809271d5fd6

14.   https://www.researchgate.net/publication/249341297_Side-Emitting_Fibers_Brighten_Our_World

15.   http://nauticomp.com/sunlight-readable-displays-monitors-overview/

16.   https://en.wikipedia.org/wiki/Rugged_computer

PICTURE REFERENCES

1.   https://www.stats.com/player-tracking/   (Optical tracking cameras, p. 21),

2.   https://fitness-gaming.com/news/fitness-and-sports/pavigym-vertical-3.0-brings-highly-interactive-zones-to-fitness-clubs.html   (Interactive gym, p. 30)

3.   http://flowtechgym.com/jukerock-interactive-climbing-wall/   (Interactive climbing wall, p.30)

4.   https://www.marketwatch.com/story/what-its-like-to-play-with-a-smart-tennis-racket-2015-09-03   (Babolat app - interace example, p. 38)

5.   https://www.forbes.com/sites/amadoudiallo/2014/08/28/can-babolats-smart-racket-improve-your-tennis-game/#2809271d5fd6   (Babolat racket, p. 38)

LUNDS
UNIVERSITET

Jonatan Schmidt

2018