FIXA*SPINE*

Improve your posture everyday

LUND
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Fixaspine - Improve your posture every day

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Abstract

The project started out with professor Fredrik Nilsson reaching out to the school on the behalf of a company called Fixaspine. They were developing a product that aims to improve the neck posture and were interested in collaborating on improving the current iteration of their prototype. I reached out and a collaboration was made.

An initial meeting was conducted where it was concluded that usability, aesthetics and better information about neck problems was the focus of the project.

Knowledge about the subject was obtained throught talking to physiotherapist Eva Ekesbo and conducting a literary research. Extensive user testing with the current prototype was done, including a phone interview with a patient and several in-person user testing sessions where observation and questions were asked.

With that information considerations to the design was made and a new shape was developed and 3d printed.

The result is a posture sensing necklace with improved ergonomics and usability. Accompanying the product is packaging that communicates the intent of the product, instructions that makes the product easy to use and the Fixaspine app that adds statistics and additional information about postural problems.

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4. Ideation

5. Realization

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7. Reflections

1.Introduction

1.1 What is Fixaspine?

Fixaspine is a product that helps the user to achieve a good body posture. By using it for 15-30 minutes every day your body starts to learn how to keep up a healthy posture.

The product is being developed by an upstart company called Fixaposture that is based in Ideon, Lund.

The device measures the distance between the chest and the chin as well as tilt. When you start slouching you will hear a signal and feel vibrations until you correct the posture.

The ability to both measure the distance as well as tilt has granted them with an european patent on the technology. This makes them quite unique on the market as most sensors only rely on tilt sensors.
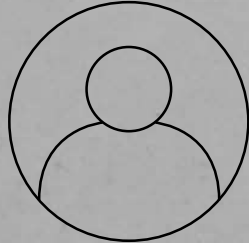
Göran Nybom
Engineer and electronics expert
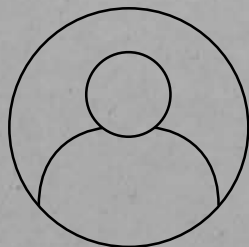
Eva Ekesbo
Physiotherapist and ergonomist
Specialist in back- and neck related issues
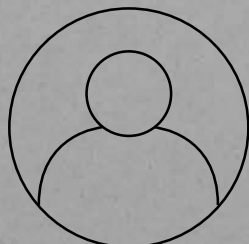
Per Harrie
CEO and project lead

15-30 min
/
day

1.2 My contribution

My role as a designer in this project was to look into the user experience. With a new type of product like this it is important that the first impression is positive so that they don't dismiss it. The goal is to utilize the medical and technical knowledge in the company and together with good design principles regarding user experience create a product that patients and other people want to use.

Initial meeting:
The project started out with a meeting with the Fixaspine team with a discussion discussion about the product and areas where it could be improved. The current Fixaspine is a functioning prototype with working sensors and a simple strap.
They had conducted some user testing with patients using the current prototype.
In regards to usability and the overall usability the consensus was that it was difficult to use. It was also pointed out in this meeting that Fixaspine is one tool among many in the treatment process. Hence it would be useful to the user to know where the device fits within a treatment method and provide some knowledge on the subject.

Make it more user friendly
First step would be to conduct new user testing, preferably in person where the user is observed and asked questions about aspects of the product. The next step would be to analyze the results and implement improvements to the usability in terms of ergonomics and make the device easy to understand.

Improve the aestestics
With the current Fixaspine being in a prototype stage it is understandable that the aesthetics has not been the focus. The next step would be to develop a new look for the device that makes it more approachable. This is important in order to attract both patients suffering from neck problems as well as finding a broader market of people that want better posture. This would involve making the product look more inviting and communicate its use better.

Provide accessible information about neck problems
By providing more information in an accessible way about neck pain the user will get a better understanding of the problem and where the Fixaspine can help.
This will increase the products integrity as people will know what it can and can't do.

Possibilities and
limitations

|

Components

|

How does it work?

Other desirable features

|

Ergonomics

|

Does the user understand
the product?

|

Does it work as intended?

Desirable

|

Shape in respect to
components and functionality

	Analyse current prototype			
	User testing		
	Form evolution		

Fixaspine 2.0

| Market research | | Idiation |

Who is the buyer?

|

Competition and position
on the market

How does it attach
to the body?

|

User interface

|

Additional features

1.3 Functionality

Fixaspine is used like a necklace. You put it around your neck and make sure that you have a good posture that feels comfortable.

A distance sensor is located on the top of the device. When the chin is within the distance of about 12-20 centimeters to the sensor it starts beeping. The device is shaped with an angle that makes sure that the distance sensor is angled parallel to the chin.
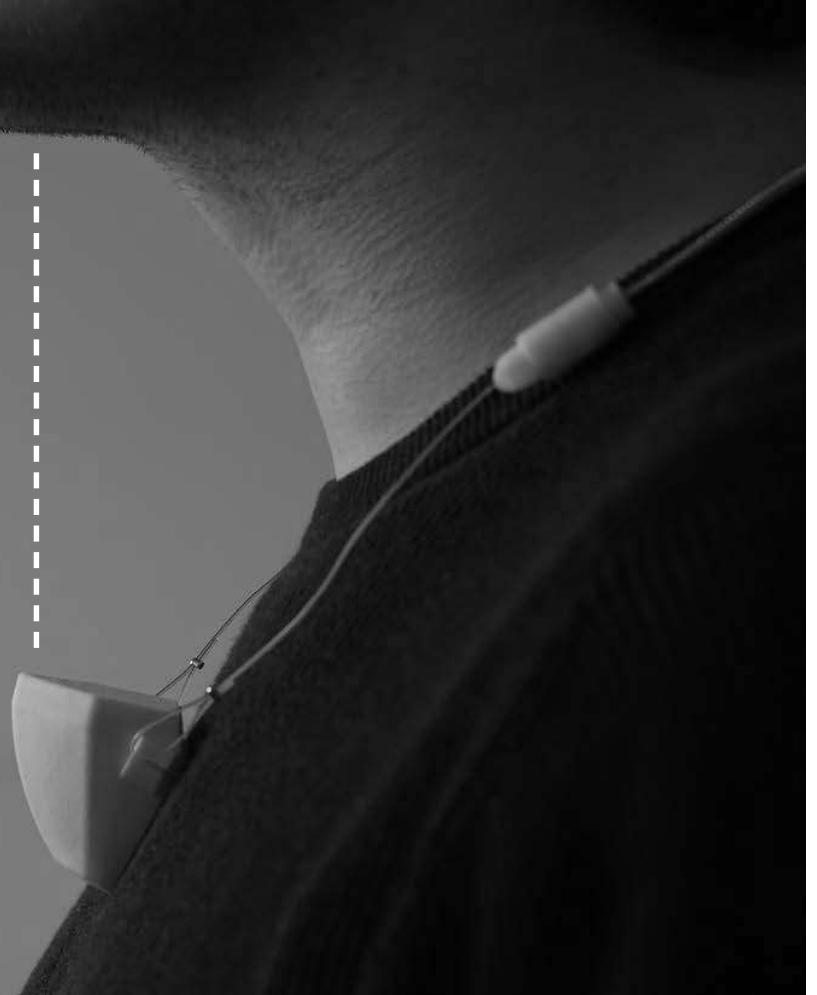
When the user starts slouching the distance sensor will register the distance difference and signal to the user with sound and vibration.
In addition there is also a tilt sensor that complements the distance sensor and together they cover the body motions well.
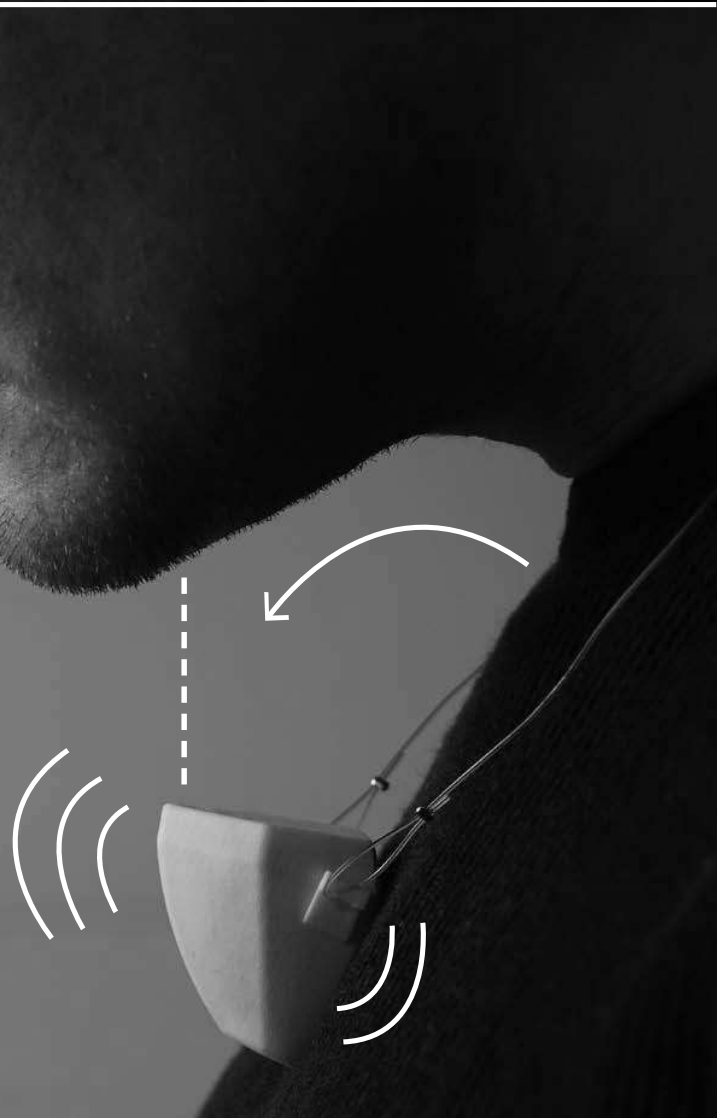
1. Adjust

The strap is adjusted by releasing the clamps on each side. This step is important in order to make sure that the sensor is at a distance that the user is comfortable with.

2. Power on

The magnet on the strap is attached to the main body. When connected the magnet acts like a switch and powers on the device.

3. Calibrate

Then the user takes on a healthy posture and covers the sensor. Fixaspine then signals to the user that it has started measuring.

1.4 Technical overview

A technical assessment was done in order to determine what components was inside the device. It was important to map out where everything was positioned, the respective size of each component as well as the core functionality of the product.

The main requirement was that the distance sensor had to be positioned a certain distance away from the chest in order to work properly with most body types.
In the current design the distance sensor was placed on the PCB which resulted in a overall design that had to bould around the shape of the board. The actual size of the components was rather insignificant compared to the overall size of the casing.

By separating the distance sensor from the PCB new design opportunities open up where one can mount the PCB board verticaly instead. This allows for more shape design.

Component list

Distance sensor: Measuring distance between unit and chin of patient, based on TOF(time of flight) echo measurement. It's like a radar but operating with light.
Also used for detecting input from users fingers, to change operating states between calibration, pause and running.

Inclination sensor: Measuring angle to the field of gravity. Actual three accelerometers measuring in three orthogonal axis.

MCU microcontroller: A complete computer on one single chip. With serial bus communication to sensor and digital output to vibration motor, LEDs and Buzzer. Second serial communication with Bluetooth modem. Volatile and not volatile memory. Analog measurement of battery voltage.

Bluetooth modem: A complete radio chip for communication intended for smart phones and apps. Intended future use will be adjusting function parameters for sensitivity, sound level etc and reading of logged data.

Magnetic switch: An on-off switch for the power, operated by the necklace magnet lock mechanism.

Vibration motor: Small motor spinning an eccentric balanced wheel producing vibrations which the patient may detect.

Buzzer: Small piezo electrical loudspeaker producing sound that the patient may detect.

LED: Small light sources indicating operation state on and charging of battery

USB port: Small contact providing +5 V for charging of the LI ion battery
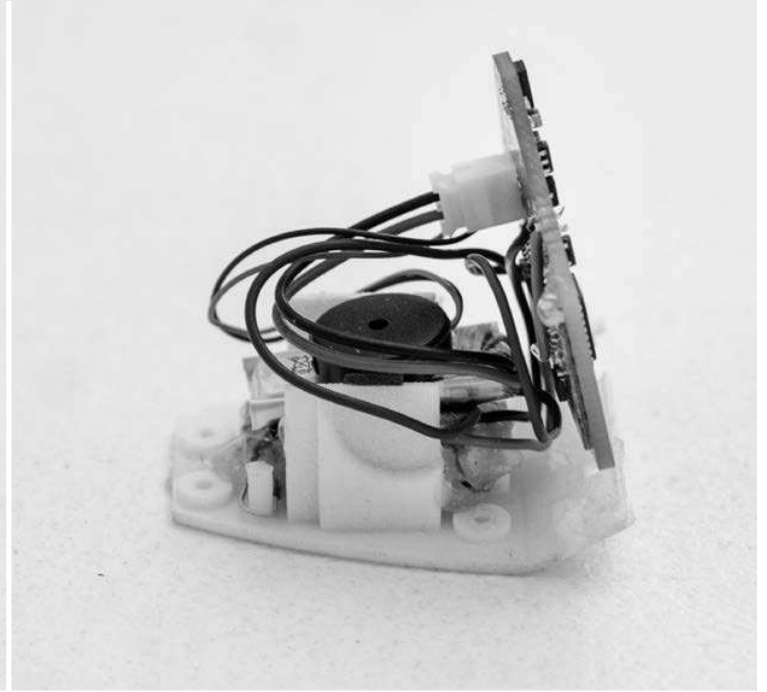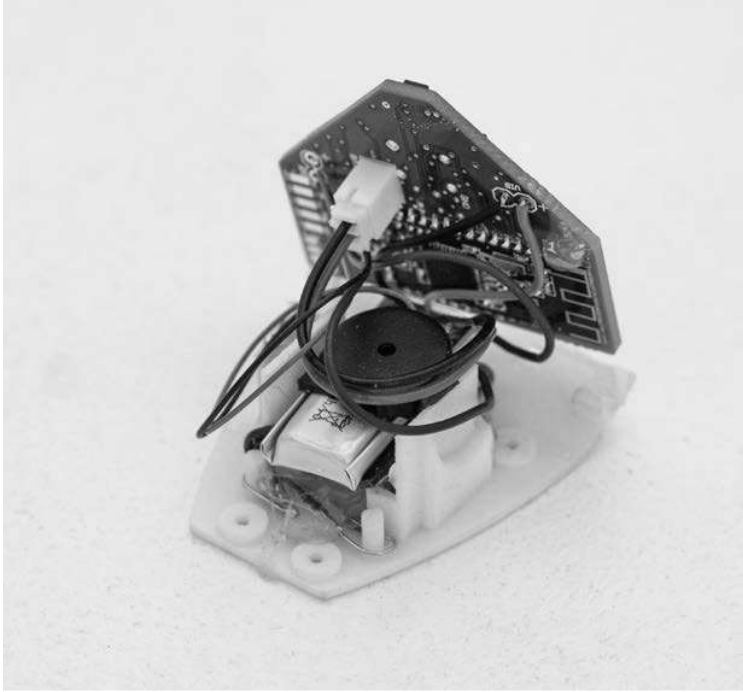
Blue tooth modem

Buzzer

Magnetic switch

PCB

LI-ion battery

Vibrator motor
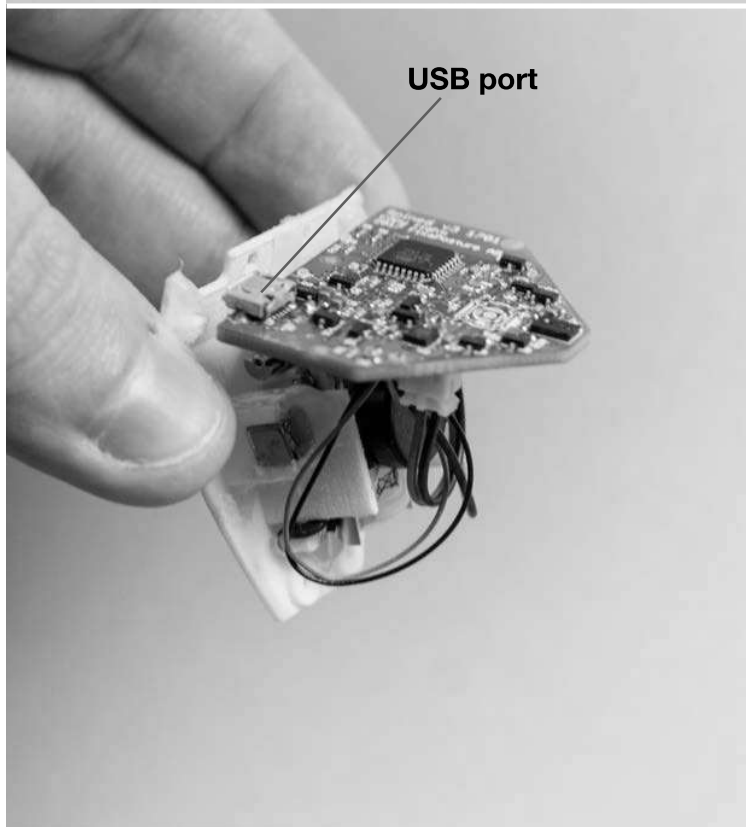
USB port

Distance sensor

Inclinaton sensor

MCU Micro controller

LED

As the project proceeded the Fixaposture company continued to evaluate the base design and how the components needed to be configured. Tests were conducted to determine if the distance sensor could be placed closer to the body. On the current prototype the sensor was placed 40 mm away from the chest which was believed to be excessive. A simple rig was made that made it possible to slide the PCB to different distances.
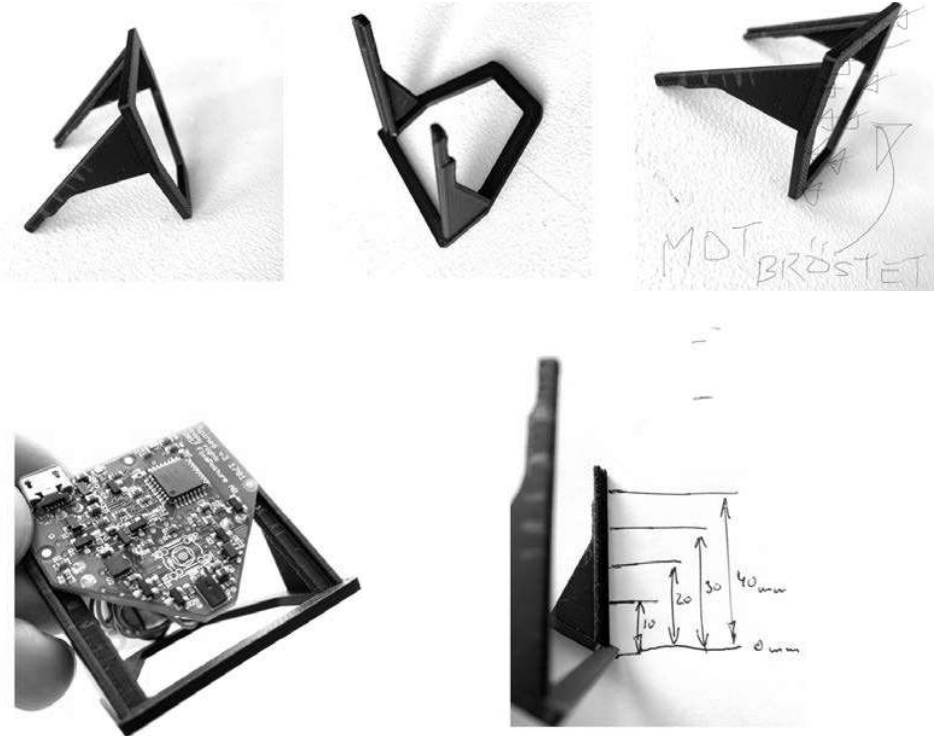
Distance:	Result:
40 mm	works
30 mm	works
20 mm	works
10 mm	does not work

The results from the test showed that the sensor could be moved as close as 20 mm to the chest while still functioning.

12-15 cm
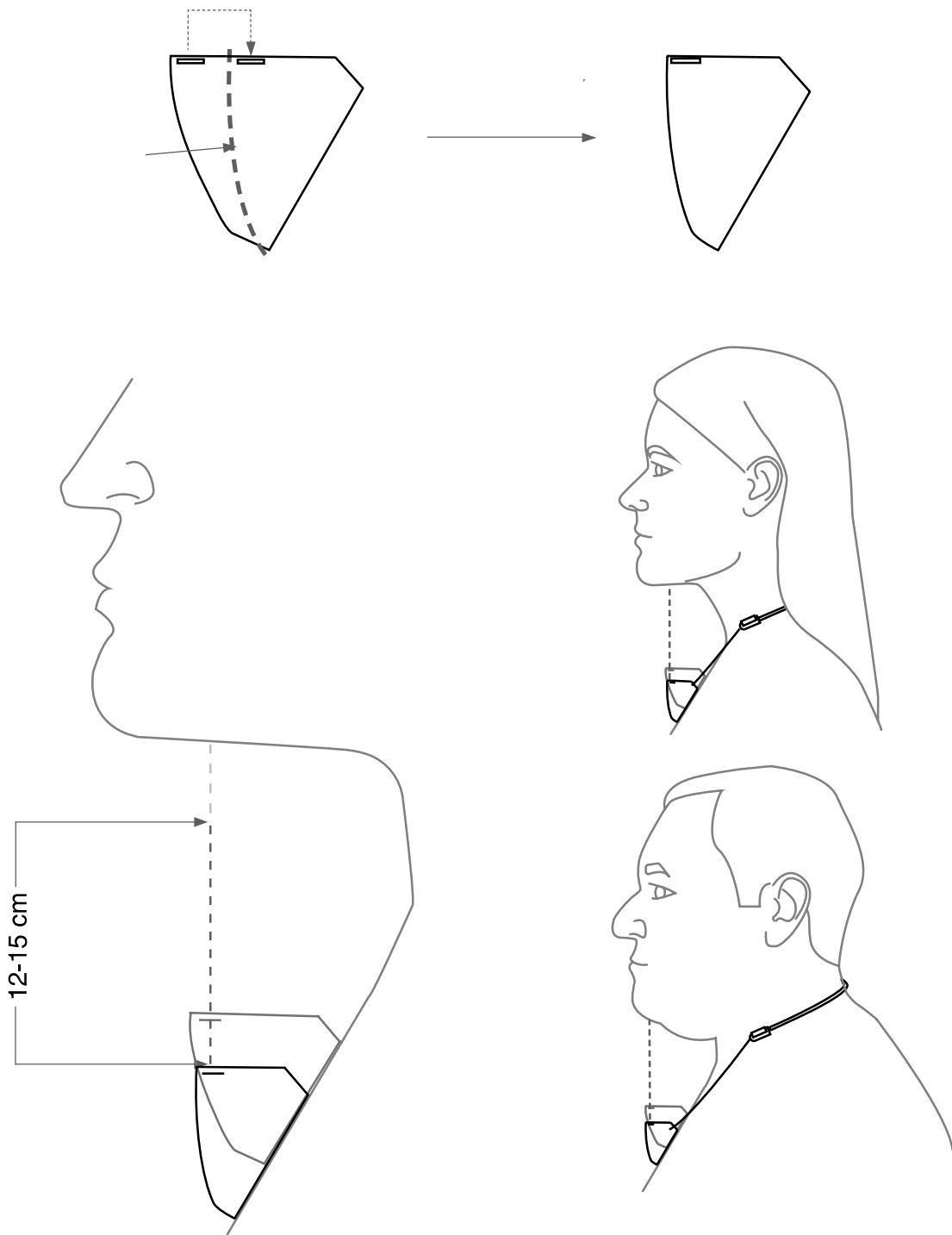
The reason behind the change was that in typical use no one used Fixaspine at the minimum distance from the sensor. Instead they positioned it lower down in order to allow for some head movement before the sensor was triggered. By moving the sensor closer to the chest it enabled the shape of Fixaspine to be more slim and opened up possibilities to make it look and feel more nimble.

2. Research

2.1 Market research

A market research was conducted in order to establish where Fixaspine is positioned on the market and how it compares to other products. The potential customers were also established and how they influence each other.

Physiotherapists and other health professionals are important customers. They meet with patients everyday and provide suggestions for treatment. Getting their approval and incorporating Fixaspine into the treatment process could help establish the product on the market.
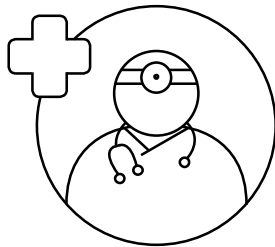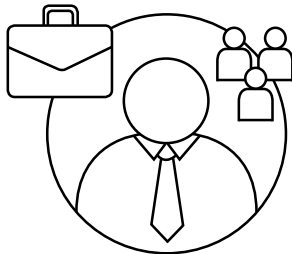
Businesses with offices full of people working in front of computers are a big costummer. Initiatives to keep personnel healthy is common to prevent sick leave and maintain productivity. A business often provides the employees with a physiotherapist to help them with the treatment.
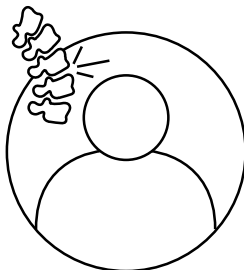
Patients are people suffering from symptoms from neck problems. They have seeked help from a professional and knowledge about the subject varies. Due to being directly affected means that they are likely to be the most interested in a product that provides a solution.
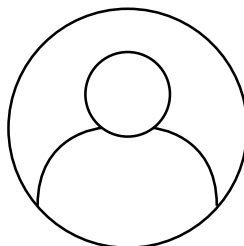
The average consumer is a potentially big customer base. They are health conscious and relate to having bad posture. They need accessible information about the product and the subject inorder to be convinced to buy the product. Pharmacys and online health shops could be places where they engage with Fixaspine.

Fig. 3 Lumo Lift

Fig. 4 Upright Go

Direct competition exists on the market. Products like Lumo Lift and Upright Go are two of many similar products that utilizes only simple tilt sensors, vibrates when the body tilts and have app integration. Their marketing communicates fitness and health with very general and vague terms. Lacking information on what neck problems are and how to properly treat them makes these products feel untrustful.

Fig. 1 Mckenzie Lombar roll

Fig. 2 HÅG, ergonomic offce chair

Fig. 3 Ergonomic laptop stand

There are other products that aim to prevent and treat posture related problems. Ergonomic chairs and cushions like the lumbar roll helps the person sitting to achieve a better posture. Laptop stand brings the screen closer to eye level to prevent slouching. FixaSpine should be a compelling complement to these products in order to provide a holistic solution to neck problems.

Fig. 5 Apple watch

Fig. 6 Google Fit bit

Wearables such as Apple watch and Google Fitbit are devices that monitor other aspects of the body such as pulse and blood sugar levels and track exercise metrics. They are made to be desirable, comfortable and useful which makes people want to use them every day.

Conclusion:
Fixaspine needs to cater to both health professionals like physiotherapists as well as the average consumer looking for a solution to their problems. This is achieved by creating a credible product that informs the costomer how and why it works. Additionally it has to be easy to use and look like something you want to use everyday. It will likely be used at workplaces as well at home and need to work well in these environments without being inconvenient to the user and the surroundings.

2.2 Meeting with physiotherapist
Eva Ekesbo

In the beginning of the project a meeting was arranged with physiotherapist
Eva Ekesbo. An overview of the neck related issues, the typical patient and some
examples of tools and training was provided.

The most common age group that comes to Eva for treatment for neck pains related to bad posture are between 40 and 55 years old.
That being said she has had patients from as young as 9 to as old as 85.

A lot of people start developing a problem at work from sitting down at the office for extended periods of time and exposing their neck stress. An adult head that is held up by the neck can weigh about 27 kilos in a slouching position. With proper posture the weight is centered around the spine and the rest of the body. When a person starts slouching the head and its weight is moved away from the rest off the body and is mostly held up by the spine. This causes tremendous strain on the neck and leads to damages in the long term. From this harmful habit people can develop a herniated disk where the nerve tissue in the disks in the spine gets damaged. The symptoms are pain or numbness.

Eva mentioned that it can be difficult for the patients to know the cause of the symptoms due to the fact that the nerves in the spine are connected to the whole body. When a patient feels pain in their arm or lower back it can actually be caused by a herniated disk in the neck due to bad posture.

Eva believed that this is an area where most people lack knowledge behind the problem which can lead to misdiagnosis. Finding a way for more information to reach out to the patients would be useful.

The key to treating neck problems and bad posture is to train the muscles in the neck and develop muscle memory. Eva views the Fixaspine as a potentially great tool that can be part of helping people with that.
For patients it can be part of the training program on their own and can work as a preventive measure for people in general with bad posture.

But it is important to understand that in order to treat these kinds of problems one has to take a holistic approach where training and healthy ergonomic work space is needed for a long term solution.

✓ ✗

Använd ALLTID laptopstöd!
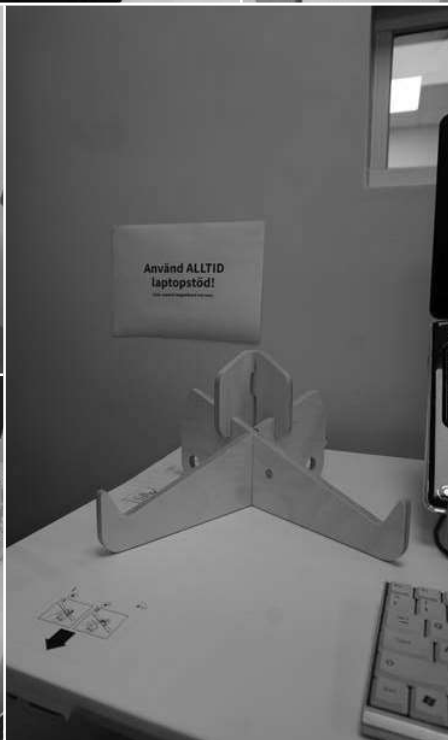
2.3 Literary research

A literary research was conducted with the goal of gathering more information around the neck and neck problems. The information found could later on be used together with the product to inform the customer on the subject.

Musculo-skeletal disorder:
Work related musculo-skeletal disorder, shortened WMSD, is the name for a collective of disorders related to physical factors in the workplace. The first signs can be light pain or numbness which is the body signaling that something is wrong. These initial warning signs are oftentimes ignored and people choose to work through it until the body can´t take it any more and the person in question has to go on sick leave.
At this point the symptoms have become more severe and also lead to limited movement and losing muscle power. The reason behind this can occur from heavy lifting, repetitive motions, static work and many other factors. In total WMSD is responsible for more than half of all reported sick leave in the EU. (Berlin, C and Adams, C 2017 p.17-18)

The physical load is put on the body's muscles, skeleton and the joints. Together they constitute the locomotive system which serves as structural support, protection and enables movement. The skeletal muscles are the type that attaches to the skeleton and can be actively controlled. Some of these skeletal muscles have specialized functions such as maintaining posture for the back and neck. Postural muscles can work on their own without active control from the brain and only lose control when we sleep or from severe fatigue due to bad posture. (Berlin, C and Adams, C 2017 p. 20-21)

Postural neck syndrom:
When a person gets tired and tilts the head forward the neck muscles are under static load. During static load the neck muscles neither contracts nor expands but instead tries to maintain the same position in order to stabilize the head. These types of static loads are very straining for the body and with around 50 percent muscle power a person will run out of stamina within 1 minute. Using just 5-10 percent muscle power the neck a person will still get tired within 1 hour and start slouching.
(Toomingas, AT., Mathiassen, SM., and Tornqvist, ET 2012 p. 204-205)

When the neck subsequently bends forward the joints get stretched. If the neck bends too much in one direction overstretching can occur. Overstretching is when a joint gets bent past its maximum position. Normally when we stretch we push a body part to a certain point until the body signals with pain that it is time to stop. If this signal is ignored and the person does not correct the posture the neck can gets damaged and treatment is needed. This is important to point out that it is a common misconception that the muscles are the ones being strained which is not the case. In reality it is the tissue around the joints and sometimes ligaments that gets damaged.
(Mckenzie, RM., 2011 p.19-21)

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Sitting down in front of a computer for long periods of time without taking any breaks will naturally result in bad posture. As time goes by the head moves forward and the neck gradually bends resulting in overstretching. This type of scenario is the most common cause of postural neck problems. The best way to prevent this is to develop a habit of regularly remind yourself to correct the posture. This method of regularly reminding yourself of the status of the posture is the basis behind the Fixapine device.

Sometimes it is not about fatigue or negligence but rather about working in a position that forces the person to bend the neck. Usually this occurs in professions where the a task requires some kind of precision through extended amount of time while the neck suffers.
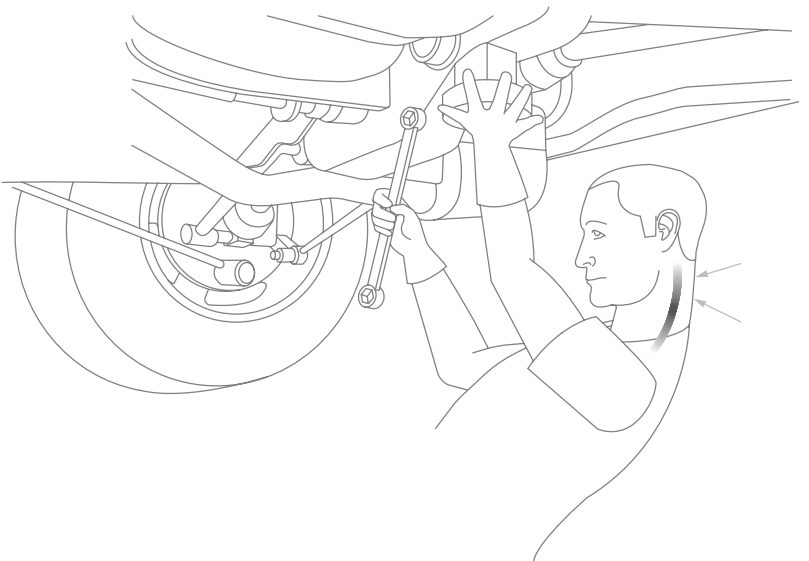
An other common source for postural neck problems happens when sleeping. Similar to previous example the overstretching happens from maintaining an awkward position where the neck stays bent for extended periods of time. It can be especially difficult to avoid this situation due to the fact that the a person loses consciousness when asleep and can't control the body's actions. Even if the person corrects the posture before going to sleep the body can return to a position that hurts the neck while asleep. (Mckenzie, RM., 2011 p.39,44)

The spine:

The spine consists of several bones called vertebrae that are stacked on top of each other forming a column. The spine is a vital part of the body that transfers load and provides stability to the rest of the body. It also serves as protection for the spinal cord. (Berlin, C and Adams, C 2017 p. 33-34) In each vertebra there is a hole and stacked together they form the spinal canal which is where the spinal cord runs. The nerves connect to the rest of the body through small gaps in each vertebra which can be seen in figure 8. The nerves are essential as they provide the muscles with power and communicate through sensitivity that some part of the body is being damaged.

Separating each vertebrae is a thin layer of cartilage that is referred to as a disc. The center of the disc consists of a fluid center called the nucleus which is surrounded by a cartilage ring called the annular ligament. The soft discs gives the spine flexibility and acts as shock absorbers. The vertebrae and the discs are connected with joints which are held together by ligaments. Surrounding the joints are muscles that have one of each ends connected through tendons to the bones. When these muscles contracts and expanded they move the spine. (Mckenzie, 2011 p.14-16)

The neck:

The neck consists of the top 7 vertebrae on the spinal column which are called cervical vertebrae.
The upper vertebra that connects to the head is extra flexible and allows for almost 180 degree movement.
To allow this movement there is less protective tissue around it which makes it extra vulnerable to damage from overstretching.
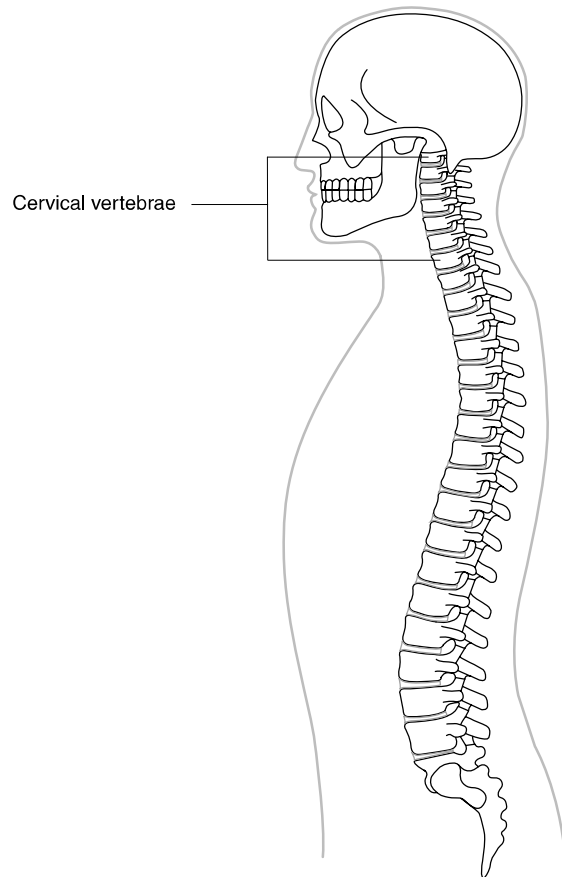(Mckenzie, 2011 p.17)

Cervical vertebrae

Fig. 7 Shows a picture of the spinal coloum.

Spinal cord

Anterior spinal artery
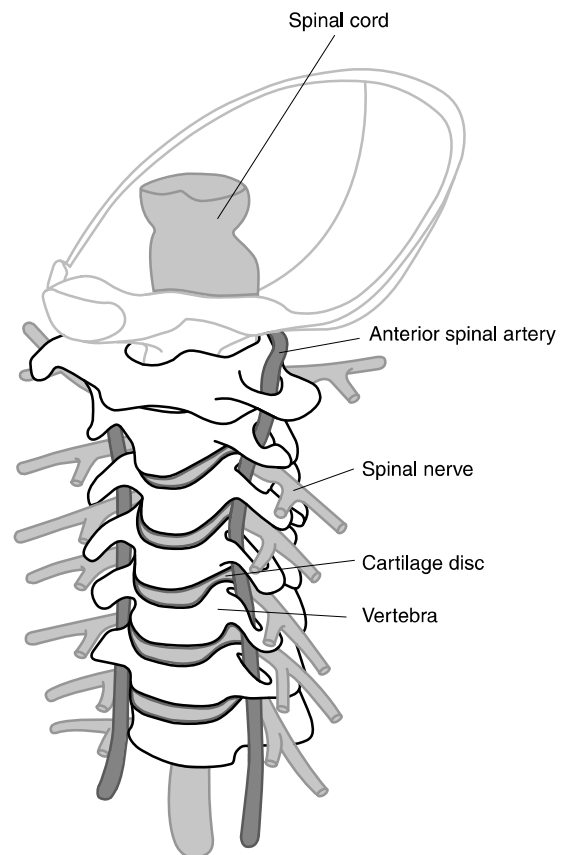
Spinal nerve

Cartilage disc

Vertebra
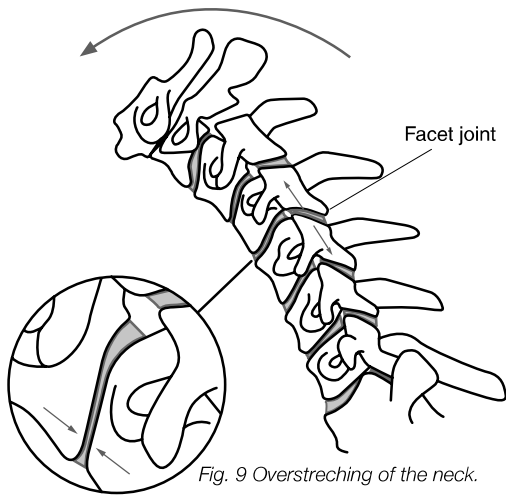
Fig. 8 Shows a picture of the cervical vertebra.
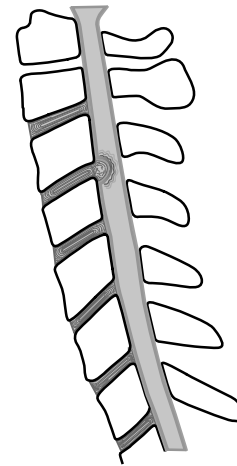
Fig. 9 Overstreching of the neck.

Fig. 10 Bulgeing disc putting pressure on the spinal nerves.

Overstreching and symptoms

In figure 9 the neck is being overstretched. The joints are being stretched past the body's capacity and are along with ligaments and surrounding tissue prone to damage. This forward bending of the neck is called hyperflexion. (Berlin, C and Adams, C 2017 p. 31)

As the stretching happens the joints are displaced a small distance from the normal position. This is called creep and is normal when stretching because the joints turn back to the original positions once the stretching is over. But if the stretching continues for a long period of time the creep will persist and the joints will keep being displaced. This results in an elongated tissue where the collagen fiber has been torn. This condition is permanent and can cause complications to the ligaments and discs disrupting the way they function and causing the neck to be more susceptible to injury in the future.
(Mckenzie, RM., May, SM., 2006 *p. 62)*

Another symptom that can occur from overstretching is that the outer ligaments of the discs suffer from injury causing the disc to lose its structural integrity making it unable to absorb the shocks from normal load. The disc might even bulge to the sides causing the displaced mass to put pressure on the spinal nerves.
(Mckenzie, RM., 2011 p.22)

Symptoms related to the neck can be difficult to diagnose due to the fact that the spinal nerves are connected with the rest of the body. The nerves in the neck are especially connected to the shoulders and arms. This means that damage to the nerves in the neck can lead to pain or loss of power in a completely different part of the body. This type of complication is called referred pain.
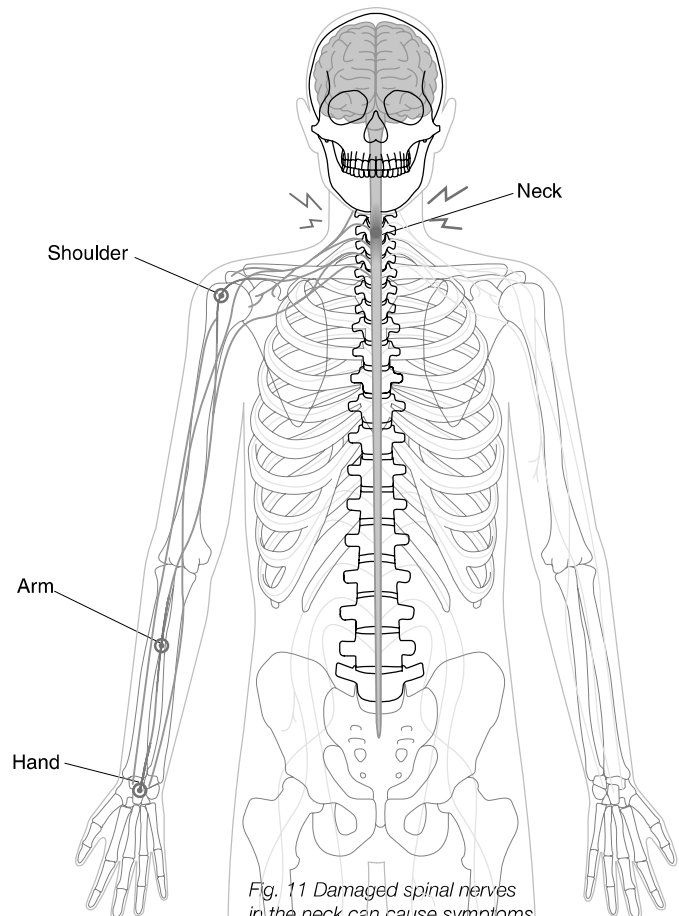(Hagberg, MH
.,1996 p. 17)

Fig. 11 Damaged spinal nerves in the neck can cause symptoms through out the body.

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Posture:

The position of the spine determines how good a person's posture is. When the body is in a good posture the spine is positioned in its natural s-shape that distributes the load evenly on the discs. When the spine is bent or is subjected to external load the balance shifts resulting in a uneven load on the discs. An adults head weight about 4.5 kilos which can cause severe damage by just being positioned forward of setting the from the s-shape.
(Berlin, C and Adams, C 2017 p. 34-37)

Bad posture:

Bad posture is in a sense natural for us humans. We are not made to sit down for long periods of time. After a while the body gets out of balance and eventually the neck muscles starts to relax leading to a protruded neck. Adding to this problem is that we often sit in chairs that are not designed well ergonomically which adds to the imbalance. The key to good neck posture is actually to have a supported lower back. It dictates the neck posture.(Mckenzie, 2011 p.30-31)As we slouch the lumbar area situated in the lower back start to fluxion causing the lower part of the cervical vertebra to push forward. (Mckenzie, RM., May, SM., 2006 p. 58)

It is also believed that age plays a big factor in this context. As we age the cervical mobility lowers limiting the range of motion . This degeneration start already in young adulthood and after age 50 the retracting motion gets especially limited.The reason behind it is that the cartilage discs in the spine loses some of its moisture and small lumps of bones called osteophytes start to grow impacting the joints. (Mckenzie, RM., May, SM., 2006 p. 56-57)

The head from a adult can way 4.5 kg or about 8 precent of the total body weight.
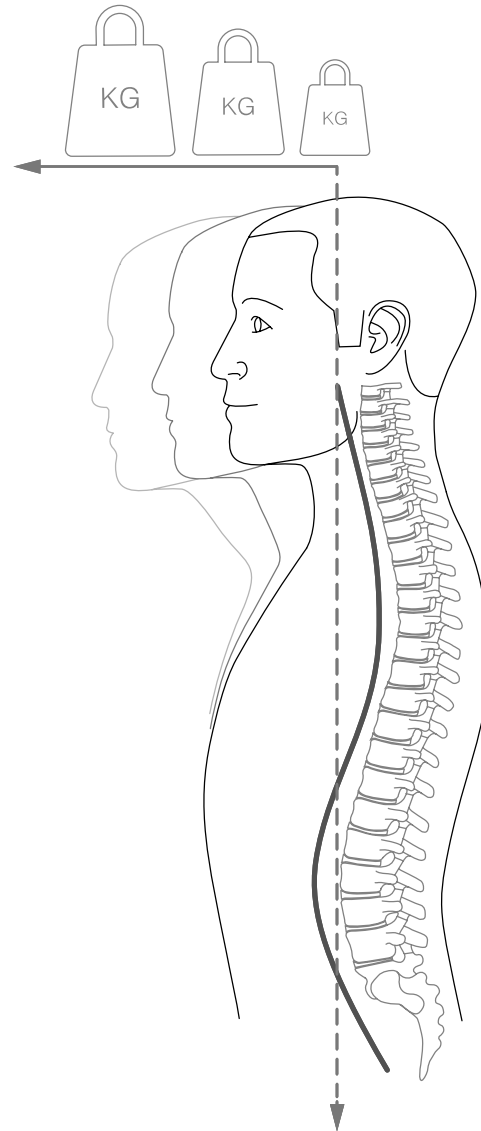
Fig. 12 Shifting the balance away from the spines s-shape increases the load on the discs.
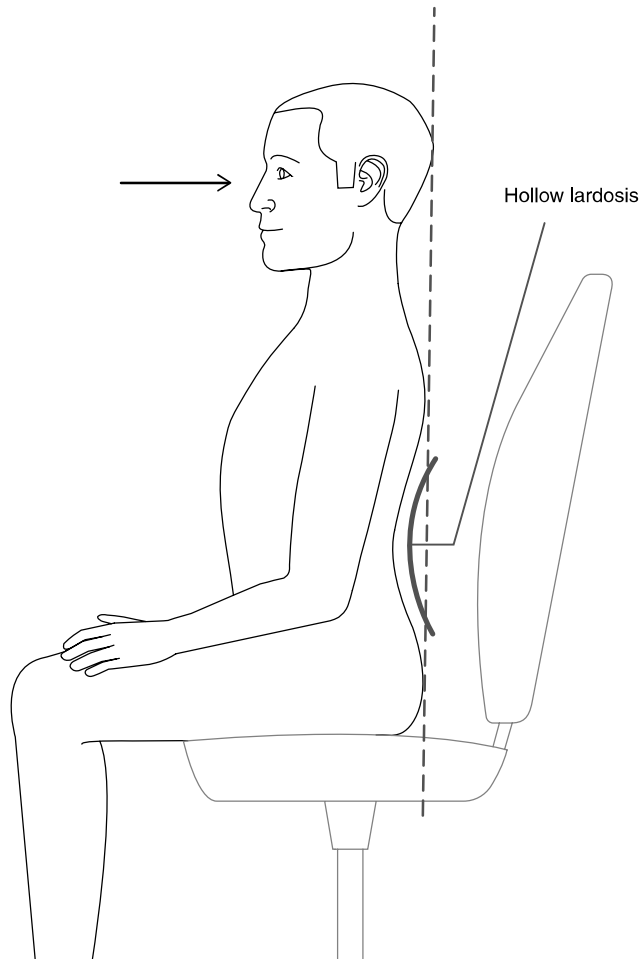
Hollow lardosis

Fig. 13 Achieving a hollow lardosis is the only way to rectify a protruding neck.
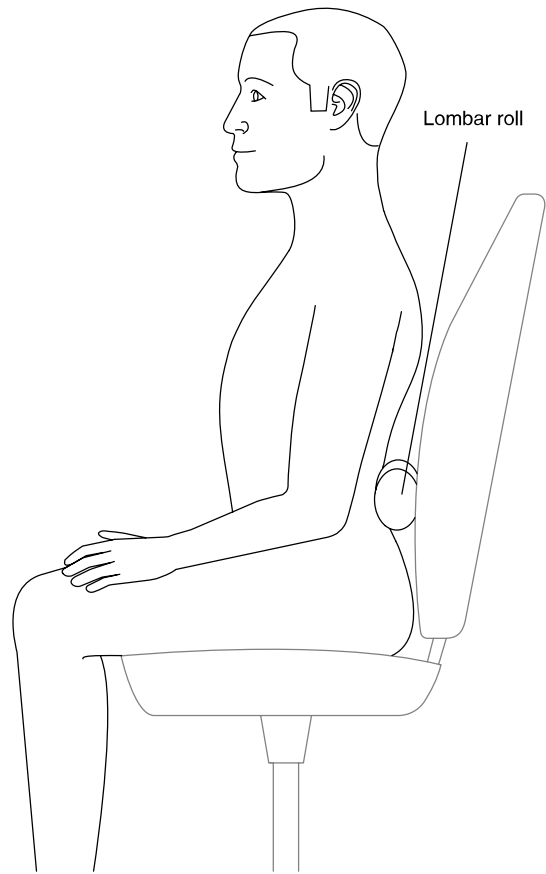
Lombar roll

Fig. 14 A lombar roll placed at the lower back helps maintaining the hollow lardosis.

Good posture:

In order to avoid protruding the neck there are things to keep in mind. Your have to sit in the right way and you have to be cognisant of your body by correct the posture periodically. The key to sitting correctly is to support the lower back. It is called maintaining a natural hollow lordosis and refers to the hollow shape created by the lower back then the posture is good. By using a lumbar roll placed between the lower back and the chair this can be achieved easier.

Next step is to retract the head back as far as possible while sitting. This motion should be done on a regular basis until the body regains mobility in the neck and can perform the motion perfectly. Then continue in order to develop a muscle memory where the retracted neck motion is part of how the person sits from then on. It is ok to adjust the neck back about 10 percent to reach a more natural sitting posture that a person can maintain for a longer time. (Mckenzie, RM., 2011 p.32, 33, 36)

The Mckenzie method:

The Mckenzie method is a series of popular treatment methods that are taught by physiotherapists world wide. The Mckenzie method of treating your neck is focusing on self treatment and designed so that most people can complete the treatment programme. (Mckenzie, 2011 p.3) These seven exercises are movements designed to stretch the ligaments in the neck to the maximum position of what the user can do or to the point of pain. The purpose is to remove the pain and regain mobility in the neck. If the user is mainly suffering from neck pain they should push to the point of pain and a little further. If the user wants to regain mobility they can apply additional pressure with their hands in some of these exercises. A sign of the treatment working is when the pain moves to a centralized point at the cervical spine in which case the pain gradually reduce. (Mckenzie, 2011 p.45-46)

The seven exercises:

Exercise 1:

The first exercise is about retracting your head while sitting down. Sit on a chair or a stool and keep your head straight pointing forward. Relax your body and your head will naturally protrude forward which is exactly what you want.
Now push your head backwards as far as you can in the same way as observed in fig. 15. It is important to keep the head parallel to the movement and refrain from tilting it up or down. Keep the body in this position for a few seconds and then let the body go back to the starting posture. If possible apply additional pressure with your hands by pushing the chin back further in the retracted position.
(Mckenzie, 2011 p.52)
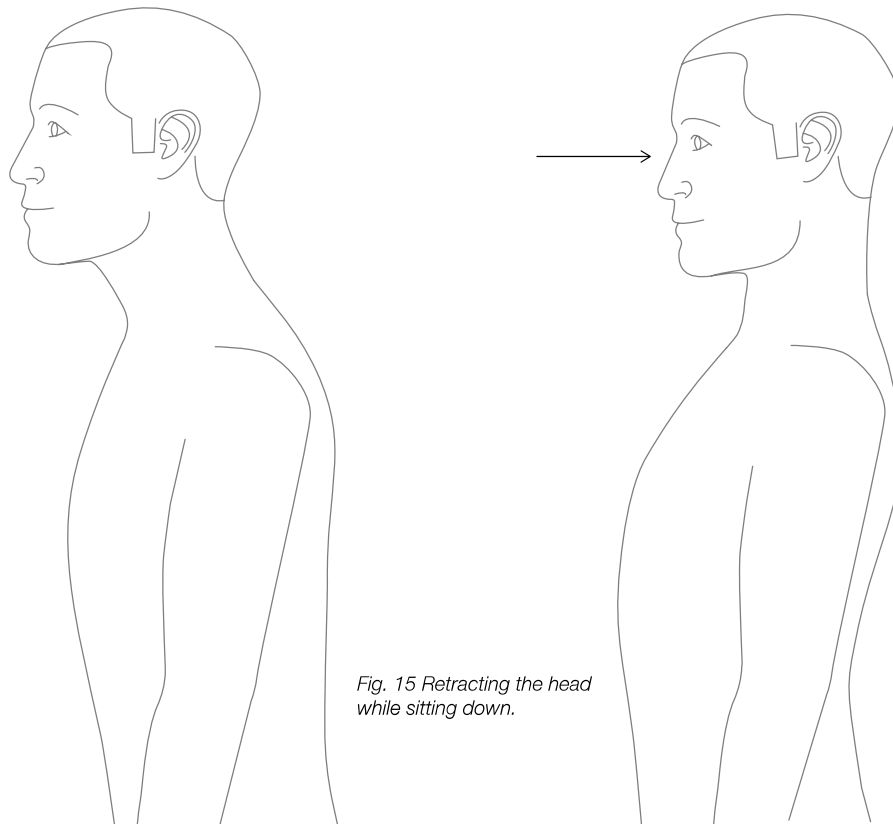
Fig. 15 Retracting the head while sitting down.

Exercise 2:

Second exercise is about extending the neck while sitting down. Warm up with exercise 1 first . Then start off with the head retracted and slowly lean the head backwards as far as possible until a large part of the ceiling is visible. Stay in this position for a couple of seconds and then rotate slightly to the left and back to the middle and then the same to the right. (Mckenzie, 2011 p.54)
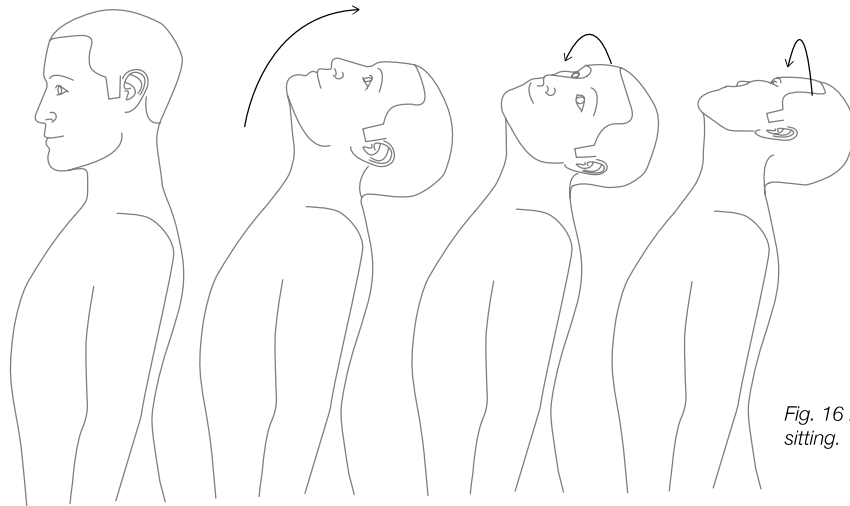
Fig. 16 Neck extension while sitting.

Exercise 3:

This exercise is about retracting the head whilst lying down. Lye down on a flat part of a bed without using a pillow. Your head should be facing the ceiling and rest along with the shoulders against the mattress. Then push the back of the head against the mattress while keeping the chin tucked in. Keep the pressure for a couple of seconds and then relax and let the body go back to the starting position.(Mckenzie, 2011 p.56)

Fig. 17 Head retraction while lying down.

Exercise 4:

This exercise involves extending the neck whilst lying down. Start off by doing exercise 3 first. Continue exercise 4 in the bed. Start by placing your hand under your head as support. Then move to a position where the head, neck and upper shoulders stick out of the mattress. Keep the hand as support as you slowly lower your he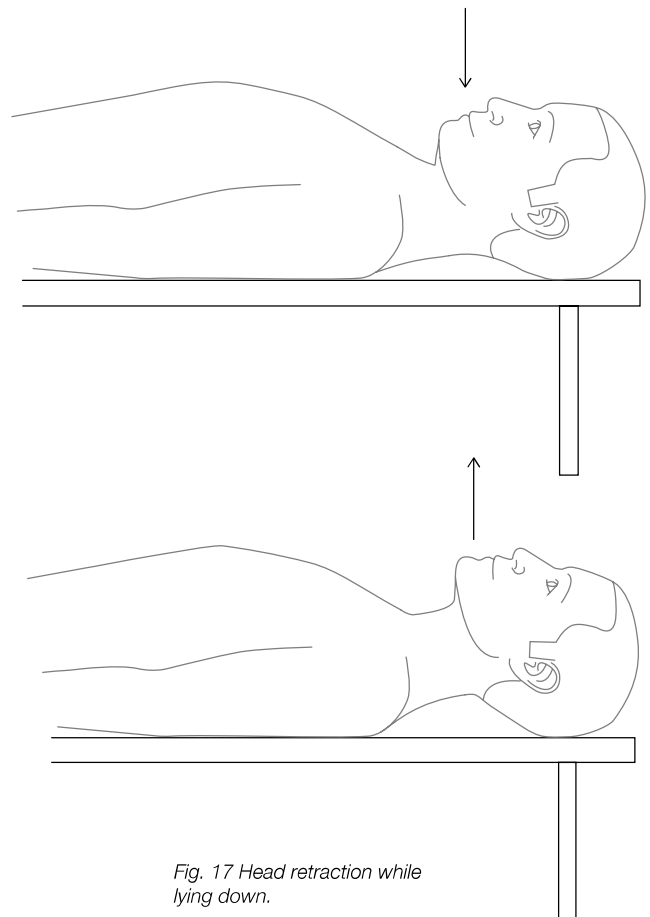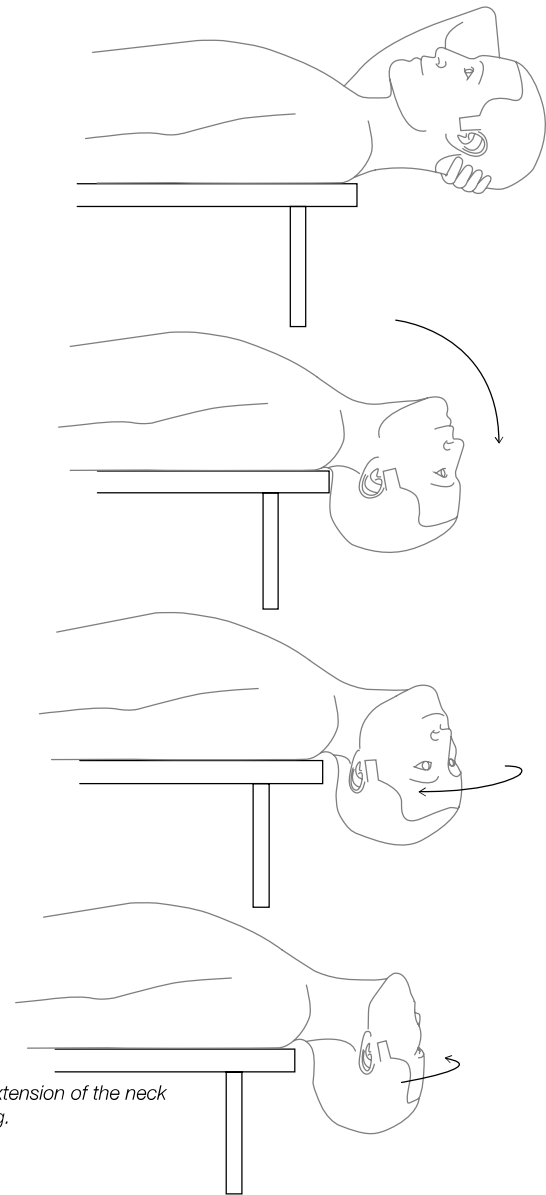ad. Let the head bend backwards as far as you can and the goal is to try to see as much of the floor as possible. Whilst in this position rotate the head from side to side. Then try to relax in this posture for 30 seconds and then use your hand as support to move the head back . (Mckenzie, 2011 p.58)

Fig. 18 Extension of the neck while lying.

Exercise 5:

This exercise consists of bending the neck from side to side. Use exercise 1 as warm up. With this exercise we go back to the chair. Start out by bending the head to one side of your body and try to push your ear as close to the shoulder as possible. Prioritize the side where the pain is located and place your hand on top of the head to apply more pressure if possible. (Mckenzie, 2011 p. 60)

Fig. 19 Bending the the neck to the sides while standing.
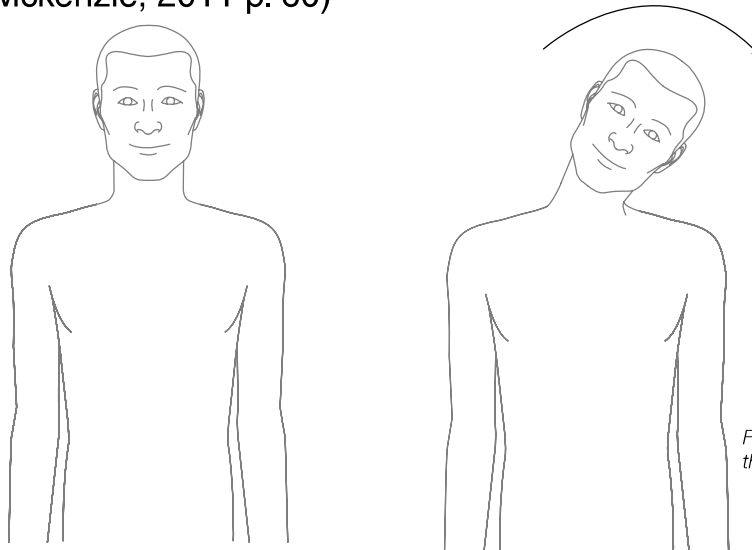
Exercise 6:

In this exercise the user rotates the neck. Use exercise 1 as warmup and keep the head in the retracted position. Then rotate the head as long as you can from left to right while keeping the posture the same. Prioritize the direction where you feel the most pain. Use your hands to help rotate the neck to the maximum. If the pain keeps getting worse through the training method you can rotate to the other side instead. (Mckenzie, 2011 p.62)

Fig. 20 Neck rotation while standing.
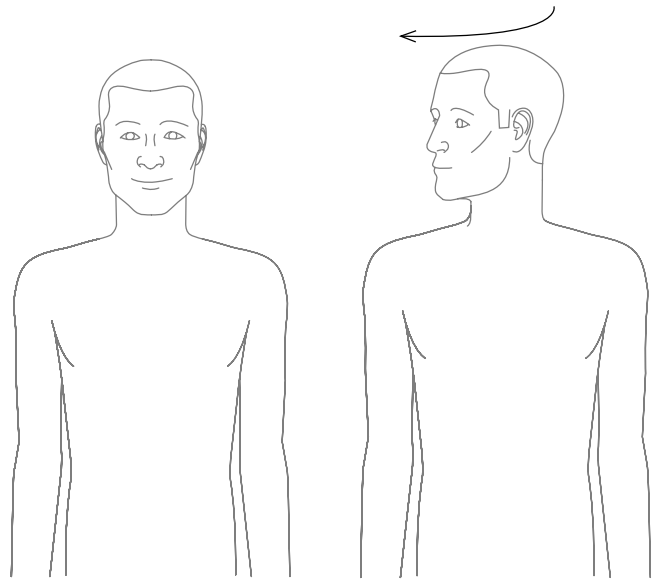
Exercise 7:

Last exercise consists of flexion of the neck. Start by taking a seat in a chair and relax the body while looking straight forward. Move the head forward and let it drop down towards the chest. When ready apply additional pressure by placing the hands on top of the head and let the weight of the arms pull the head further down. Maintain this position for a couple of seconds and return to the starting position. (Mckenzie, 2011 p.64)
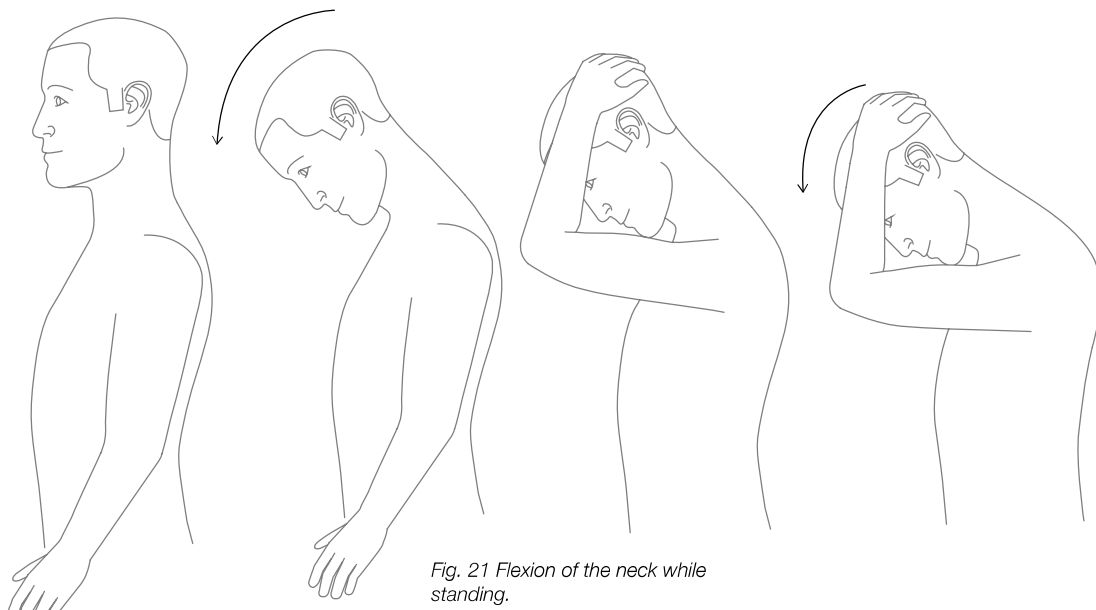
Fig. 21 Flexion of the neck while standing.

3. Product evaluation

3.1 Interview with a patient
A phone interview was conducted with Claire who is a patient suffering from neck related disorder. She has been part of user testing the Fixaspine prototype and was lent the device for 1 week.

---

1. Name: Claire

2. Age: 42

3. Gender: Woman

4. What were your first impressions of Fixaspine before you tried it?
- I thought it looked bulky

5. Was it difficult to put the device around your neck?
- No it was easy

6. Was it difficult to adjust the length of the strap?
- We adjusted it before I used it at home and I did not change it. I don`t think I know where to adjust it.

7. Was the calibration process easy?
- It was ok but sometimes it did not seem to work and it started beeping for no reason. It felt too sensitive maybe and I would like it to have more of a gradual signal when it responds to movement.

8. How were the the feedback/signals of the device?
- The signals were clear but it was overall too much beeping and I dont always know why.

9. Did you need instructions to use the product?
- I got some verbal instructions from Eva but I would definitely need instructions.

10. How would you like to have these instructions to be provided?
- I would like an app that shows me how to use the device and my statistics. I do not want to read instructions. Instead have it visualised so it is clear what I need to do to get started.

11. Do you think you have a need for a product like this?
- Yes, I suffer from a herniated disk that I am going to have to deal with for the rest of my life. Being able to help me with my own treatment is something I am very interested in.

12. Where would you use it and would you use it in public?
- I would not use it as it is now. It is too loud for the work environment. I am in video conferences every day at work and this would disturb to much with the sound signals. I would also like to use it for the whole 8 hour work day.

13. What other attributes would you change or add to the current prototype?
- Be able to lower the sound or only use vibrations, make it less eye-catching and smaller. Have it more attached to the body so I can move around or event exercise with it.

Conclusion:

Interviewing Clair provided a great insight into how a person with chronic neck injury functions on a daily basis. She described the pain as being very oppressive at times and puts limits on what she can do. That is why she is very interested in solutions that can help her alleviate the symptoms and improve her condition.

She expressed that the current prototype was hard to understand, bulky, loud and got in the way in daily life. Instead she wanted something discrete and that attached better on her so she could move around to up to 8 hours on the days she was in better condition.

The main takeaway from this interview was that there was a desire to wear the device for longer periods and be more active while using it. To accommodate that Fixaspine needs to feel more seamless to use and needs to attach better to the user so that they can feel confident using it. Related to that is that Fixaspine needs to be easier to understand with better instructions. This is especially important when you are in pain and are doing treatment.

Additionally Clair lives with this condition everyday, sometimes it's better and sometimes worse. A way for people like her to be able to track the condition would be useful.

3.2 User testing

User testing was conducted in order to find out how other users perceived the prototype. Fixaspine had previously been tested exclusively by patients with neck problems.
They were shown briefly how the device worked and received some printed instructions. For approximately a week they tested Fixaspine on their own.

In order to reach a broader user base and help prevent neck problems it was important to talk to non patients who have yet to seek out treatment. These people might have a different perspective on the subject and have needs and requirements that differ from patients. The age of the users ranged from 14 to 60 years old and in total 18 people tested Fixaspine.

Having tested the prototype myself and concluded that it was difficult to use, the decision was made to conduct interviews and testing in person.
This method made sure that the user could receive instruction when needed and guarantee that all the aspects of the prototype were experienced.

The first impression and initial test was done without instructions which were documented. Then they received a printed user manual along with verbal instructions. This made it possible to see how well the product by itself is perceived and what can be improved in order to make it easier to use.

Fixaspine

Fixaspine is a product that helps the user to achieve a good posture. By using it for 15-30 minutes everyday your body starts to learn how to maintain a healthy posture.

Fixaspine measures the distance between the chest and the chin aswell as tilt. When you start slouching you will hear a signal and feel vibrations until you correct your posture.

12-20 cm
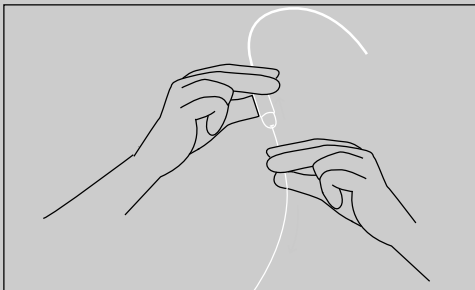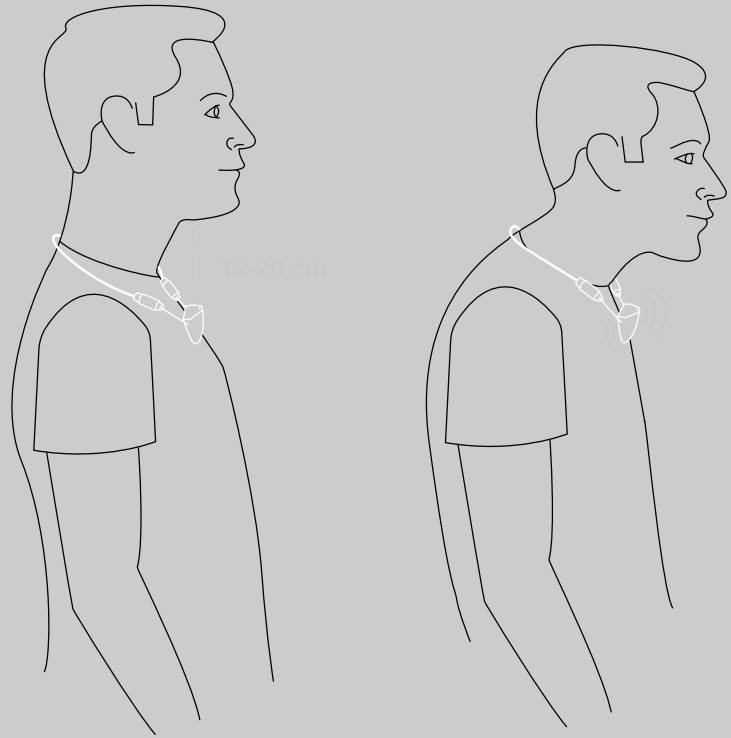
1. Adjust the straps to the correct lenght
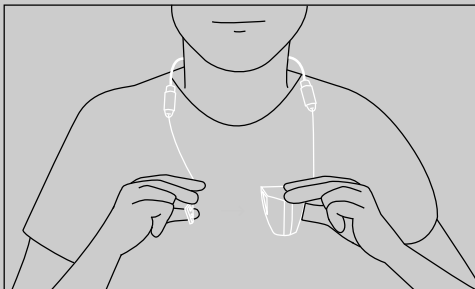
2. Activate Fixaspine by attaching the magnet to the main body.
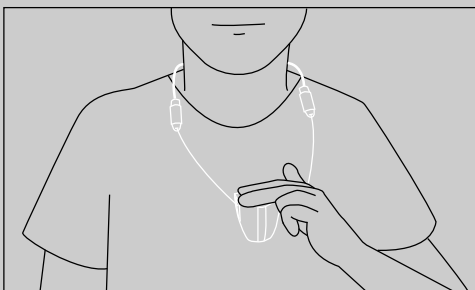
3. Place your hand on top of the Fixaspine until you hear a ticking sound. Remove the hand after 3 seconds. Wait for 4 signals to buzz and then it is calibrated.

33

3.3 Test results

**What were your first impressions
of Fixaspine before you tried it?**
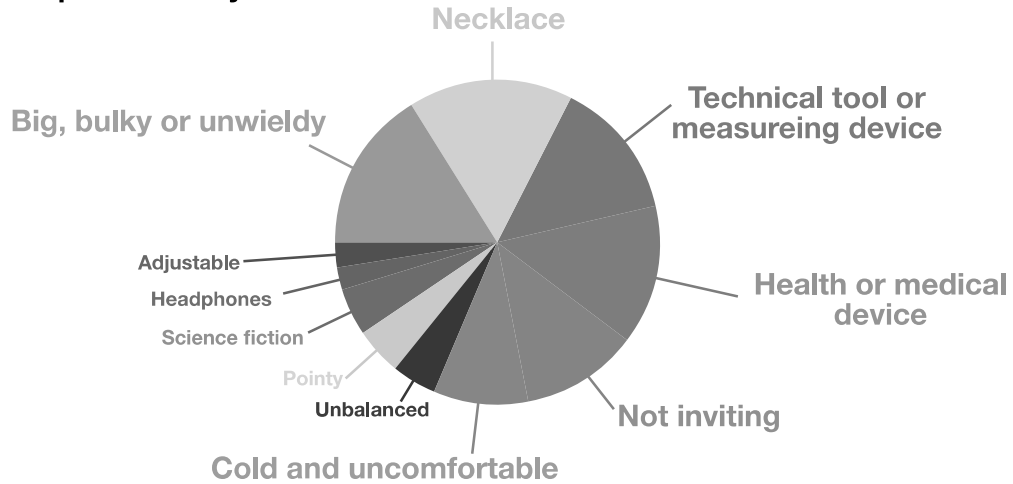
Necklace

Technical tool or
measureing device

Big, bulky or unwieldy

Adjustable

Headphones

Science fiction

Pointy

Unbalanced

Cold and uncomfortable

Health or medical
device

Not inviting

**Was it difficult to put the device
around your neck?**

Easy   Ok   Difficult
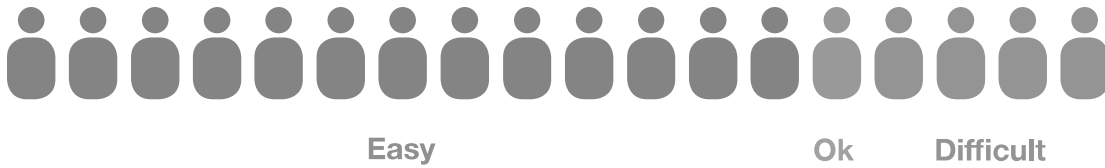
**Was it difficult to adjust the length
of the strap?**

Ok   Difficult

What were the difficulties with adjusting the strap?

Hidden feature

Difficult to judge the
distance

Unbalanced and
flimsy

Small and fraglile

Was the calibration process easy?

Easy   Ok   Difficult
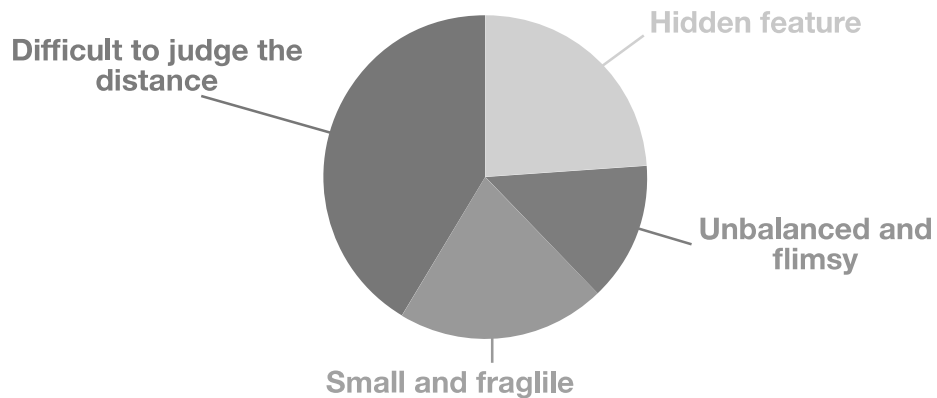
What were the difficulties with the calibration process?

No tactile feedback when covering the sensor

The beeping sound confused me
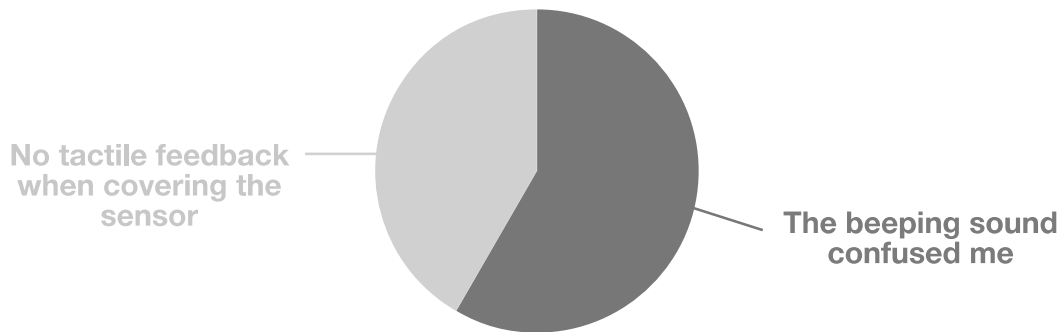
How were the the signals of the device?

Too loud

Difficult to understand what each beeping means

Not pleasant sound
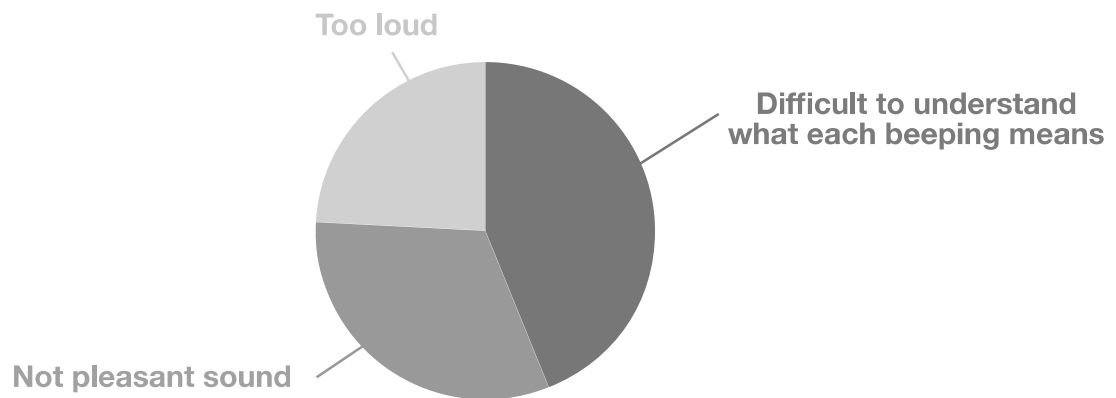
Did you need instructions to use the product?

Yes

How would you like to have these instructions to be provided?

Written on the packaging

Video

Printed manual

App in my phone
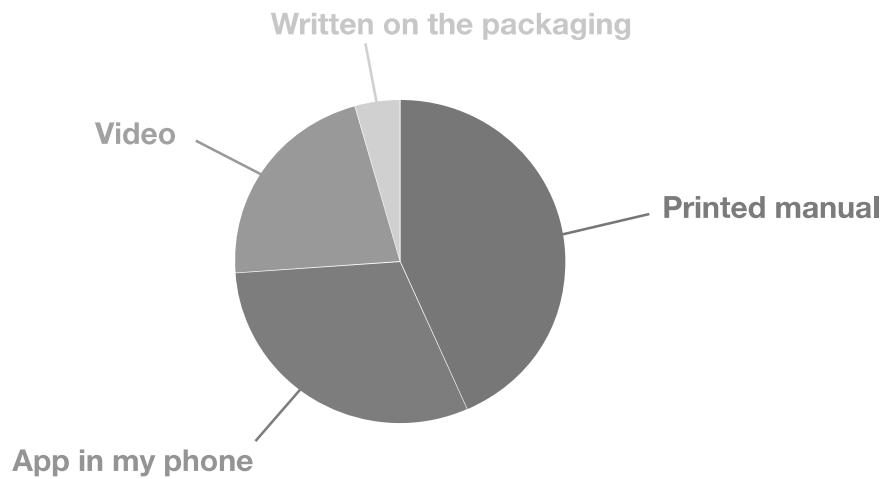
Do you think you have a need for a product like this?

Yes   No

Would you consider using it in public?

Yes — Yes if it sounded less and looked more pleasing — No

Where would you use it?

Work / school — Home — Both home and work

What other attributes would you change or add to the current prototype?
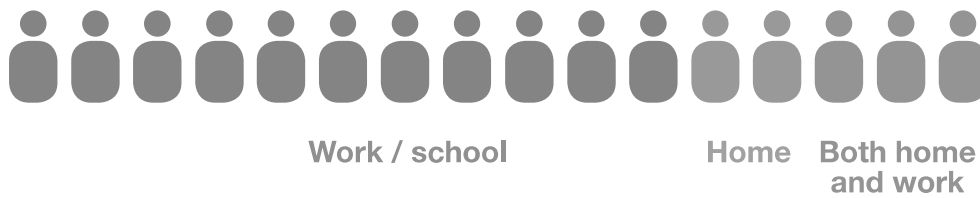
Positive sounds and feedback
A bag or case for storage
Softer materials
Have access to more information, statistics and usage
Other type of strap
More descrete appearance
Couple with headphones
Simplify the signals
Smaller or more sleak shape
Tactile buttons
Vibration only
Have it rest or attach better on to your body
Adjust the sound volume
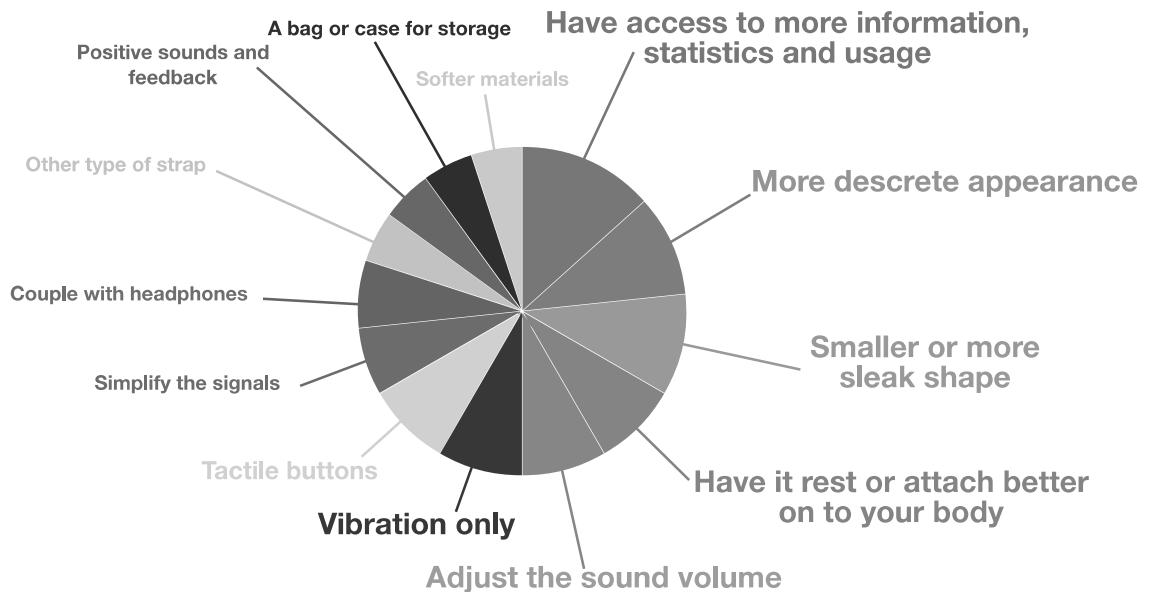
3.4 Observations

The user tests were documented with photographs in order to get additional information about the user experience. By observing an action it was easier to see what people struggled with and to what capacity.

The general observation was that the testers viewed the prototype as a delicate technical device rather than a necklace or a tool that they were comfortable with.

The prototype was perceived as fiddly and unbalanced which made the interaction awkward when handling it.

With that said one of the core functions that worked well for nearly all the users was the magnetic lock. Given the challenge of consistently attaching the necklace in a blind spot right underneath, this implementation was done well.
This action of taking it on and off is a very important action to execute well as it is something the user is expected to do at least once per day.
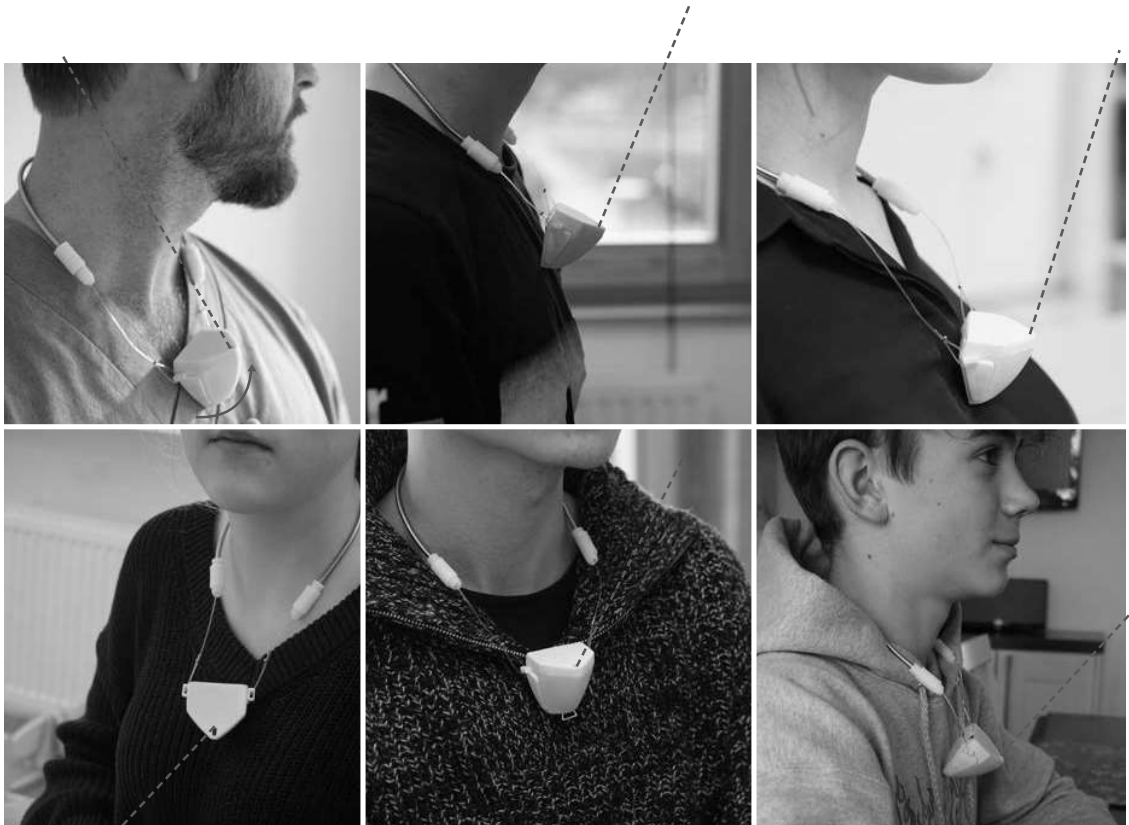
Another recurring thing that happened was that the devices did not rest that well on the body of the testers. Naturally this caused the sensors to be misplaced and the device started beeping. Some of the reasons behind this were that people tended to have the strap slightly too long, the device was front heavy and the stiff metal neck rest together with the thin line resulted in the device tipping forward.

Adjusting the length of the strap was something everybody was struggling with. There was no clear indication that the feature existed which meant that only the people who read the instruction paper found the feature later on. None of the testers could adjust the strap while wearing the device.

3.5 Conclusions

Through an extensive interview process and by observing the user testers conclusions could be made about what the product needed to offer.

Input: Tactile, physical botton

By nature the device will always be positioned in a blind spot underneath the chin. This requires the product to have tactile inputs.
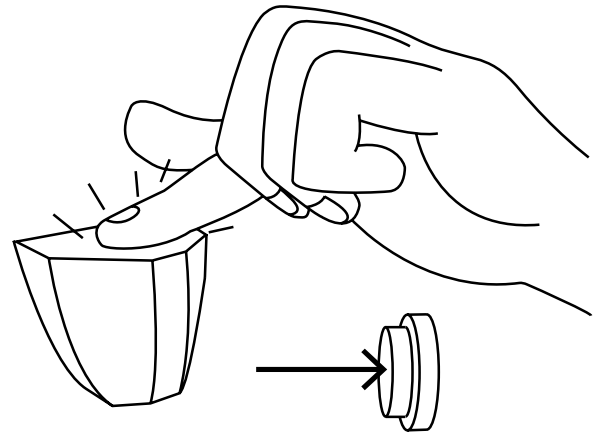
Attachment: Secure, connected, balanced

In order to get the sensor to read correctly the device needs to stray in place.
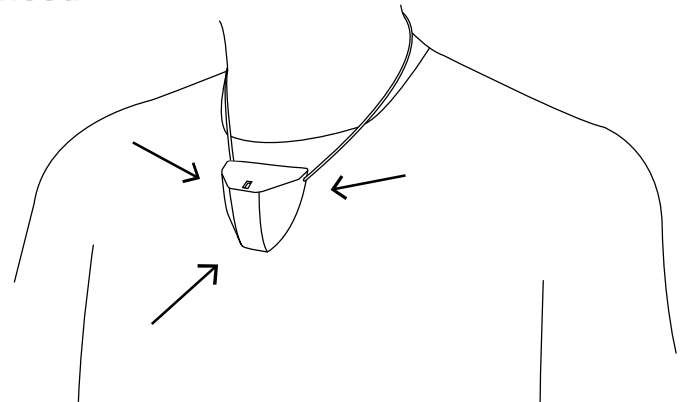
Strap: Simple, soft and adjustable

The strap was something people understood and explained the use of the product well but it needs to be easier ro adjust. With its mix of metal and string gave it a mechanical look that was not inviting and was awkward to handle. A more conventional soft strap was desired.
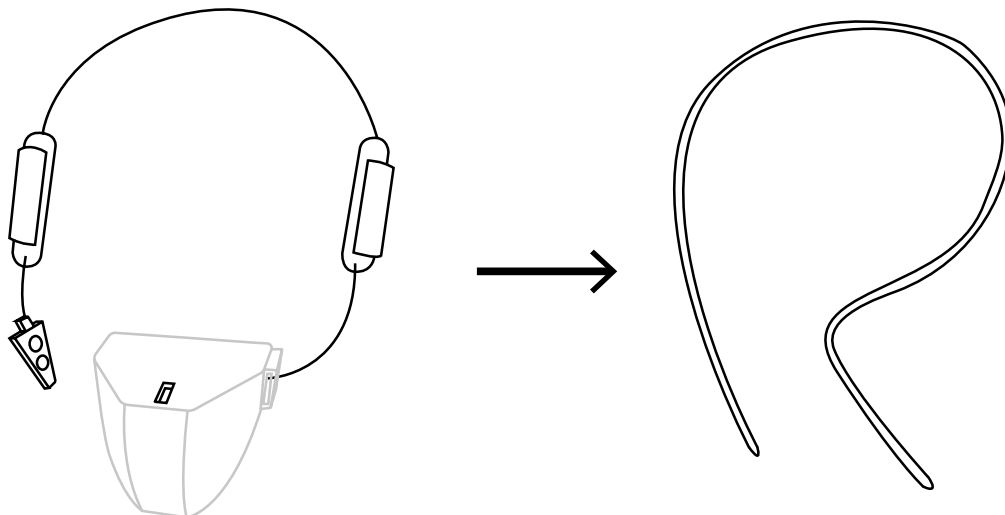
Shape: Smaller, descrete, smooth

The shape was described as big , pointy and not thar aesthetically pleasing. The device needs to appear smaller, smoother and more discrete.
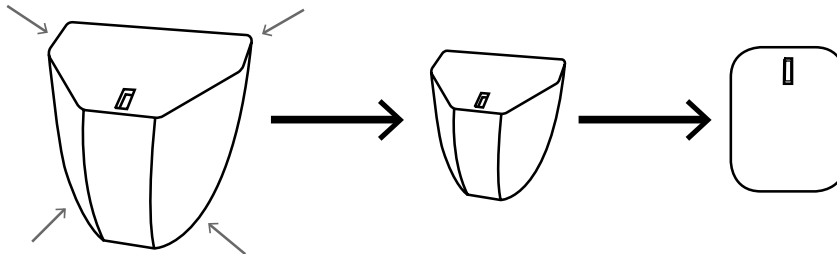
Signals: Too loud, adjustable, positive

The device was considered too loud to be used in public. An adjustable sound that can switch to being only vibration would ensure that the user and the surrounding are not bothered.

BEEP!
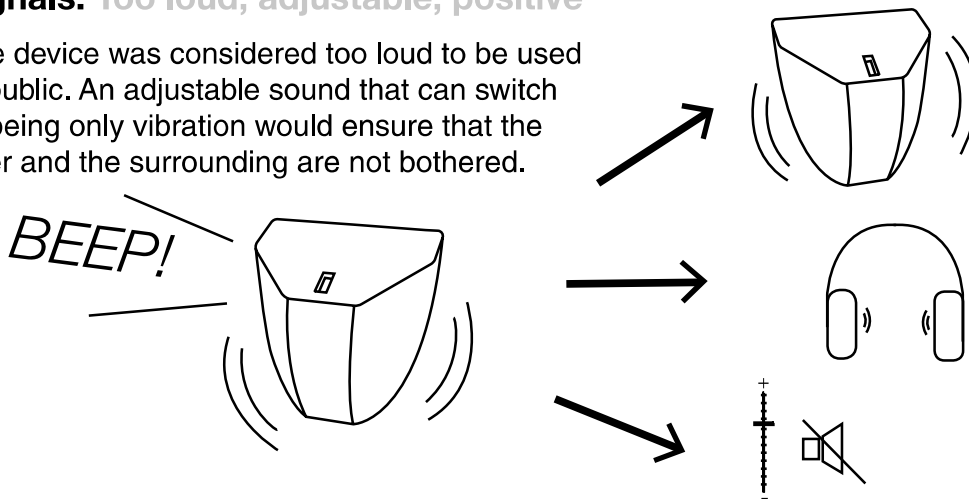
Instructions and info: Both a printed manual and an app

Some people wanted a simple manual to get started while others wanted a way to access more information about their usage, training and instructions.

Profile

Statistics

Training

Information

Basic instructions
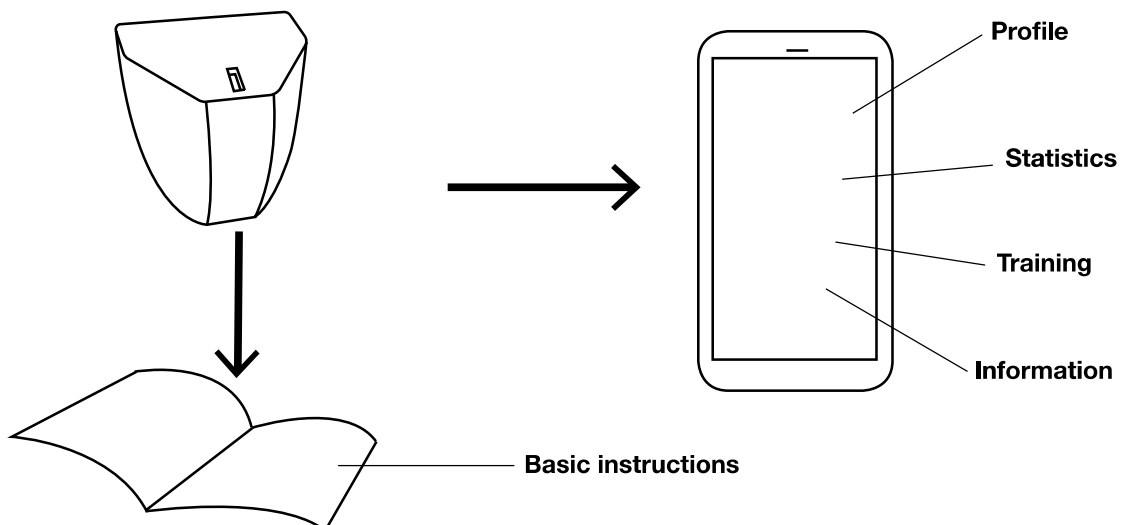
4. Ideation

4.1 Attachment method

The first step to improve the ergonomics of the product was to develop the way Fixaspine attached to the body. The strap as a necklace worked well as a way to reliably set the distance to the sensor and the users are familiar with the mechanism. The strap needs to be able to open and close easily as it is something the user is expected to do at least once per day. It also needs to be able to adjust its length which is something that is done to accommodate different clothing or when the user's posture is changing. Both these functions need to be convenient and easy to use so that the user wants to include it in the daily routine.

When designing the new strap the goal was to center all actions to the device and use the main body as the only contact point. This way the user can adjust the length of the strap and still keep the device centered on the chest. It was also important to aim for having a symmetrical design with a balanced weight distribution.

All this needed to be considered while also reducing the complexity and making it more inviting to use.

In order to replicate the feeling of the current prototype simple cardboard models were made filled with clay to achieve the same weight. The body including the shell and the electrical components weighs 23 gram.

A simple strap made out of fabric was used throughout the explorations.

Fixaspine main body with

components = 23g
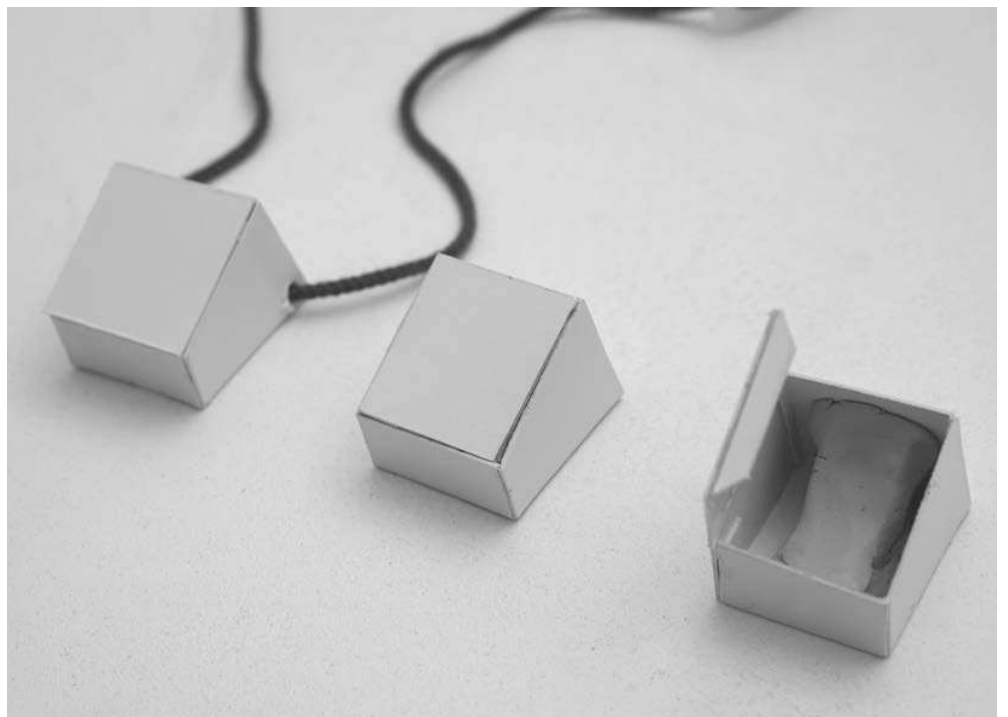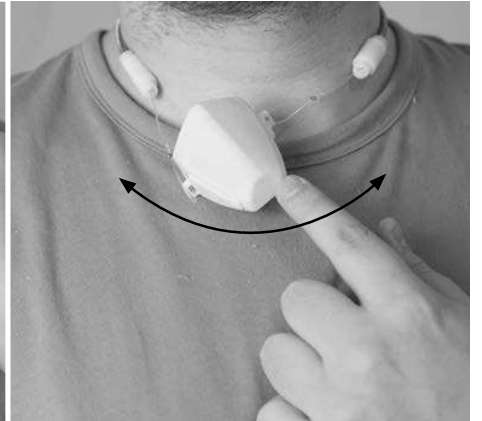
The current prototype has a magnetic lock that works well as it is easy to take on and off with minimal effort. The connection works as an on and off switch. While it reduces the amount of actions required to get started it also makes it impossible to wear the device without the user always being measured. This feature also makes it difficult to store as the magnet often attaches to the device and drains the battery.

The metal strap around the neck can be shaped to attach tighter to the neck and prevent movement. Despite this the main body is still prone to move around.

The adjustment of the length of the strap is difficult and requires both sides to align.
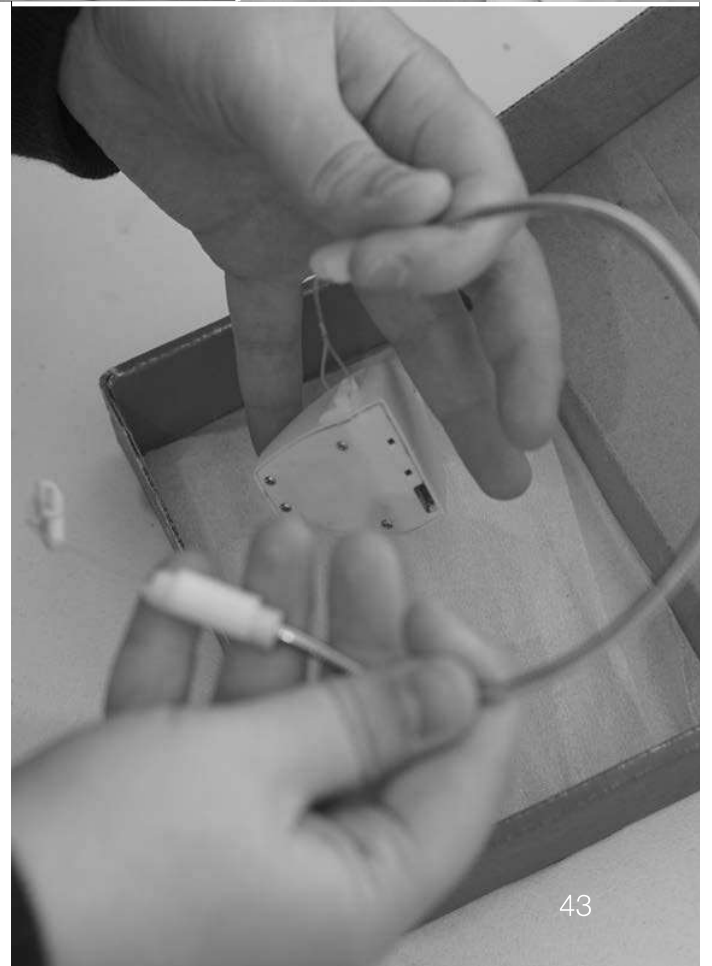
1.

This solution uses a carabiner lock which is a familiar mechanism used in jewelry and necklaces.
It attaches securely but requires too much precision to use in this case and introduces an asymmetrical strap that makes it more difficult to center. The strap runs through the main body which allows the user to adjust the strap in the center of the device.
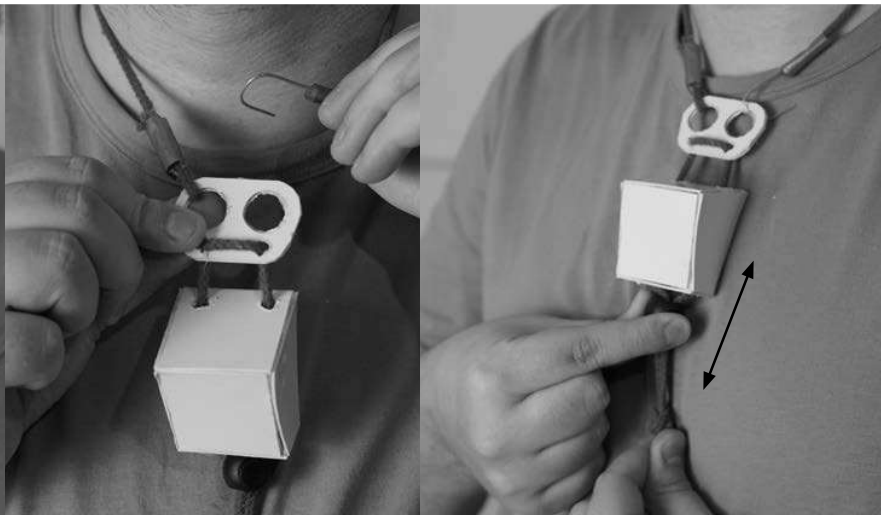
2.

The second concept uses a separate loop for the neck and the device. A simple hook is used for attachment. The overall construction ended up being too complex and fiddly.

3.

This concept consists of a strap in a closed loop. It is a simple and symmetrical solution but requires a long strap to fit around the head especially if the user has longer hair.
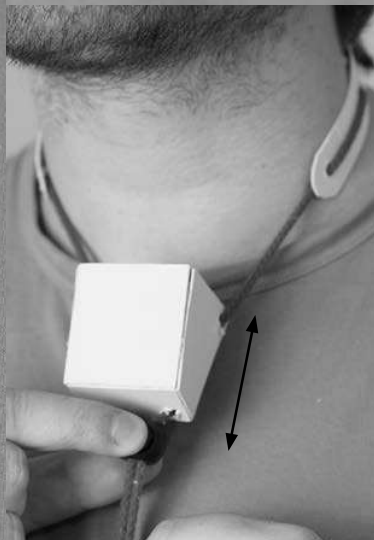
4.

A additional neckstrap was used in this concept as a simpler version of the current prototype design. Moving the lock to the back did not feel as user friendly as the other propositions.

45
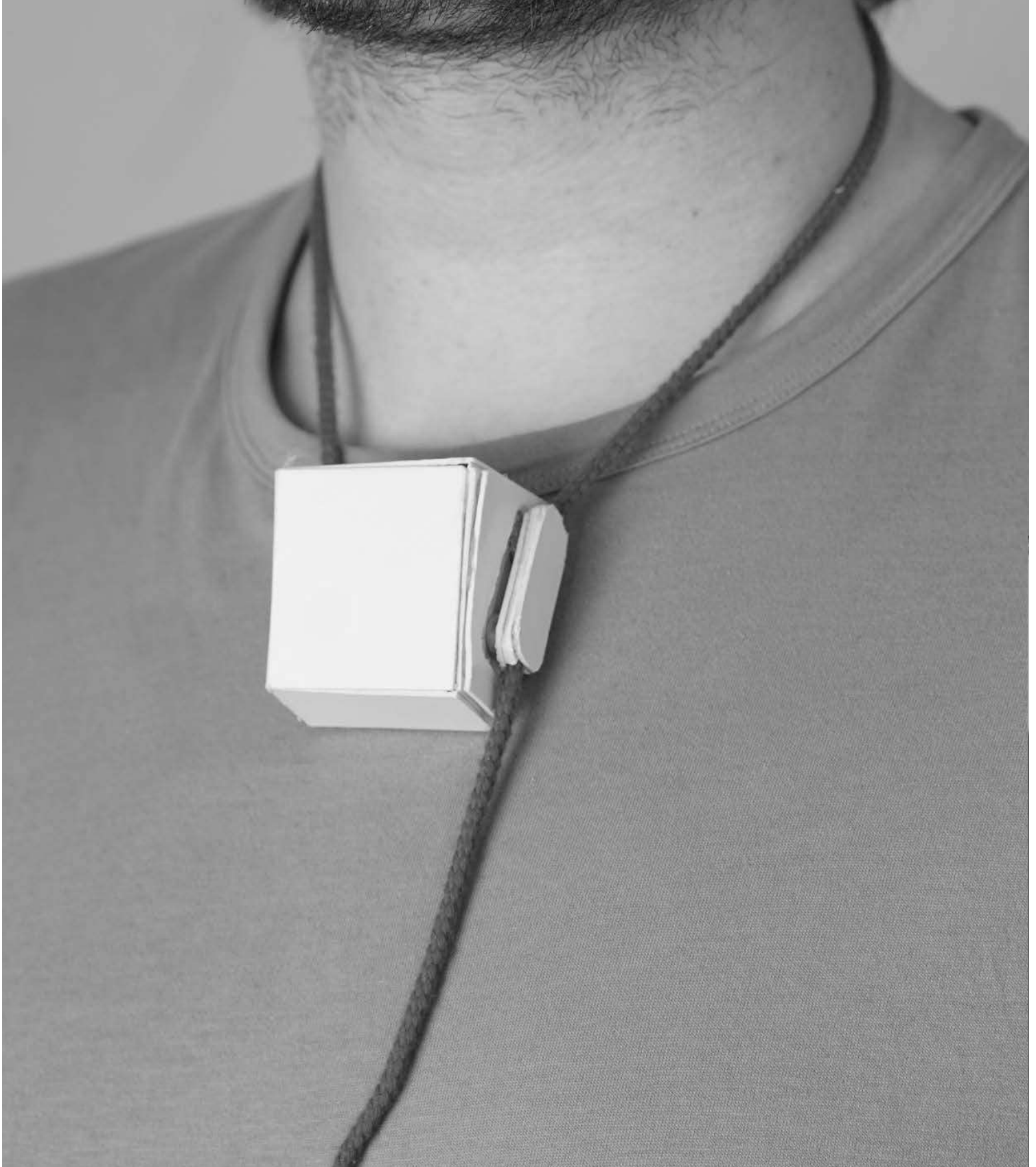
Final.
This was the chosen strap design. It has a magnet lock on the side of the device that requires minimal level of precision to attach. The strap runs through the magnet lock and can be adjusted by sliding the lock along the strap.
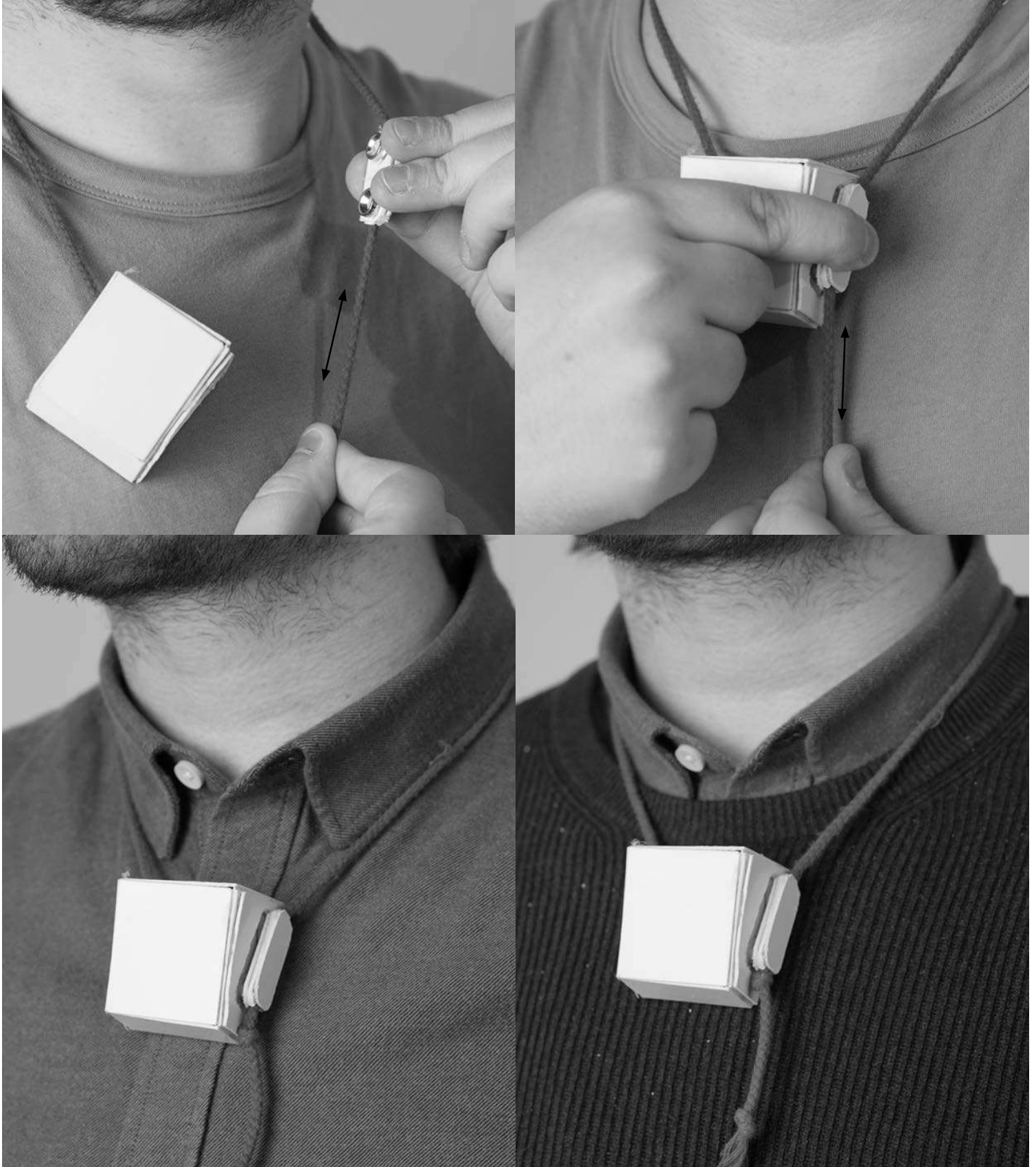
The advantage of this design is that the user can adjust the strap while keeping the device centered on the chest. The friction from the magnetic lock ensures that the strap stays in place and maintains the same length for next use.

To ensure that the device was attached securely and to allow for a little bit more movement when in use a secondary attachment was considered. This could be useful for when the user wants to change position to vary the posture or to make sure that when the user leaves the office chair for a break it stays in place on the body.

Clamps were considered as a way of securing the device to the body. It was deemed to require too much effort by the user and obstructed the movement of the strap too much.

In this concept a safety needle is put directly on the device. While it attached securely it required too much effort to perform this action.

The chosen solution was a rear magnet that is put under the clothes that attaches to the back side of Fixaspine. It can stay on the device and never be used without getting in the way or be used frequently where it is always available.

4.2 Design considerations

To start off the design process it was important to map out the design considerations related to Fixaspine. This would influence the way it was constructed, how it informed the user and aesthetics.
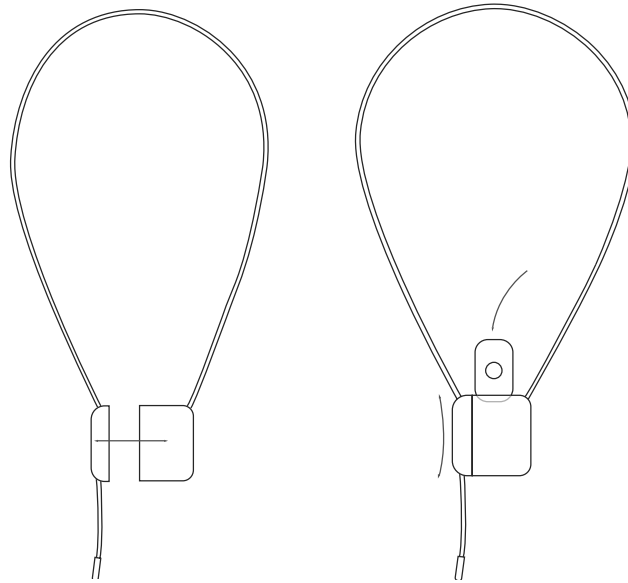
The opening and closing of the strap needs to feel good and the back magnet needs to be incorporated in a way that creates a smooth back side to ensure stability and also to avoid disrupting the vibration signal to the chest.
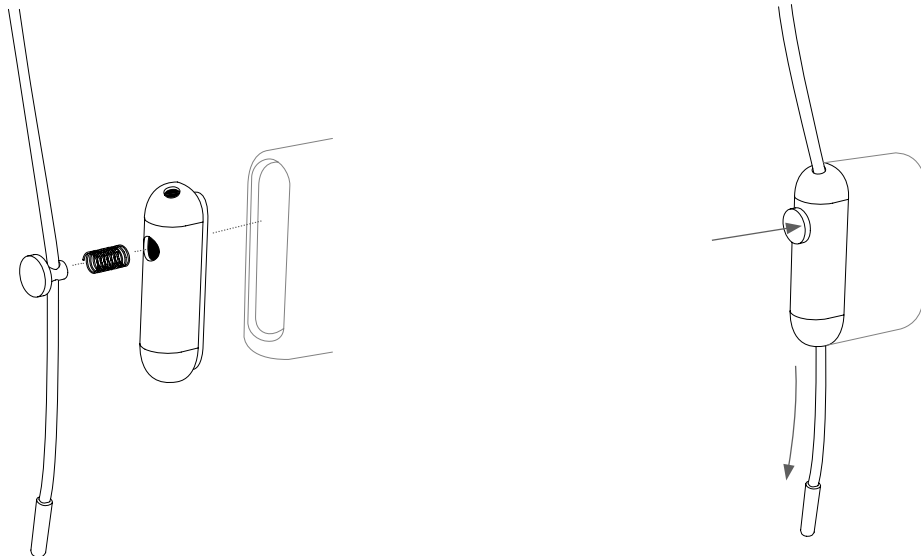
When developing the magnetic lock it was decided that it needed a spring loaded mechanism in order to ensure that the strap would stay in place while still being convenient to use.

Activate /Pause

On / Off
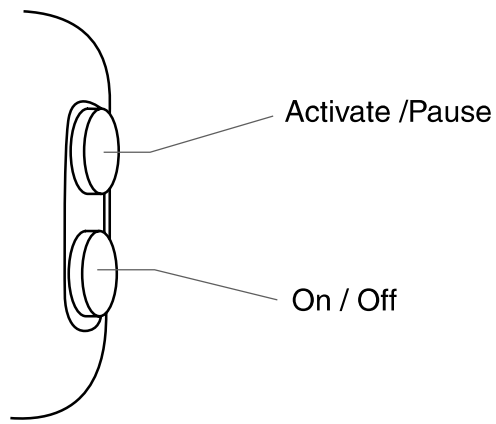
Physical buttons needed to be incorporated into the new design. There needed to be one button for power it on and off and one button that doubled as activating the sensors and pause. The user won't be looking at the buttons when they are using Fixaspine and therefore they need to be tactile and placed in a spot that is convenient.
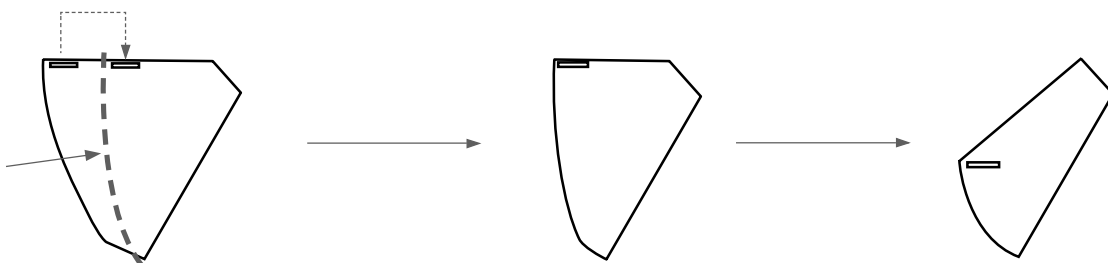
In addition to slimming down of the body by moving the sensor there was also a possibility to further reduce the profile by adjusting the angle of the top plane. Due to the buttons replacing the way the user interacted with the product it was no longer vital to have the top plane where the sensor is positioned to be perpendicular to the direction of the sensor.
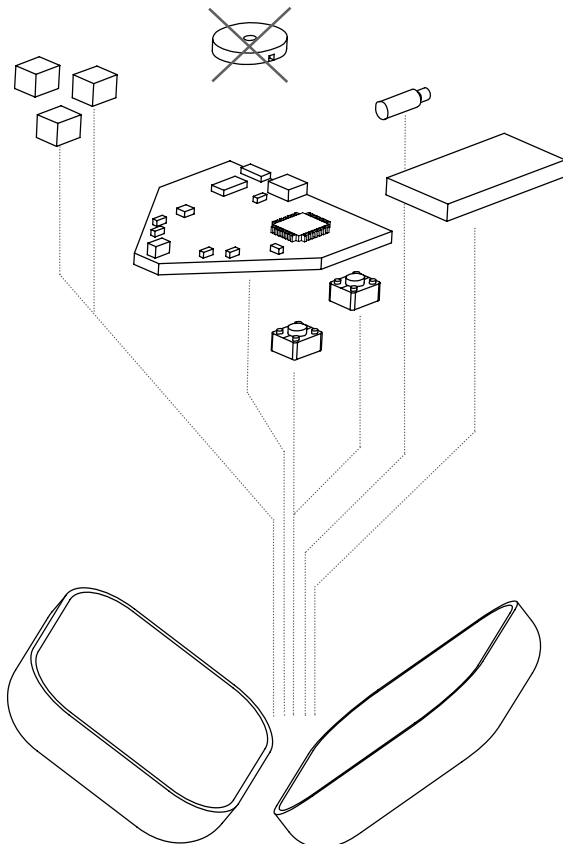
Lastly the components have to fit the new shape of the main body.
This includes a Pcb with the area of 1100 mm2, the battery, the vibrator motor, 2 buttons and magnets.
The buzzer that produces sound was removed to make Fixaspine purely rely on vibrations for signals.

4.3 Sketches
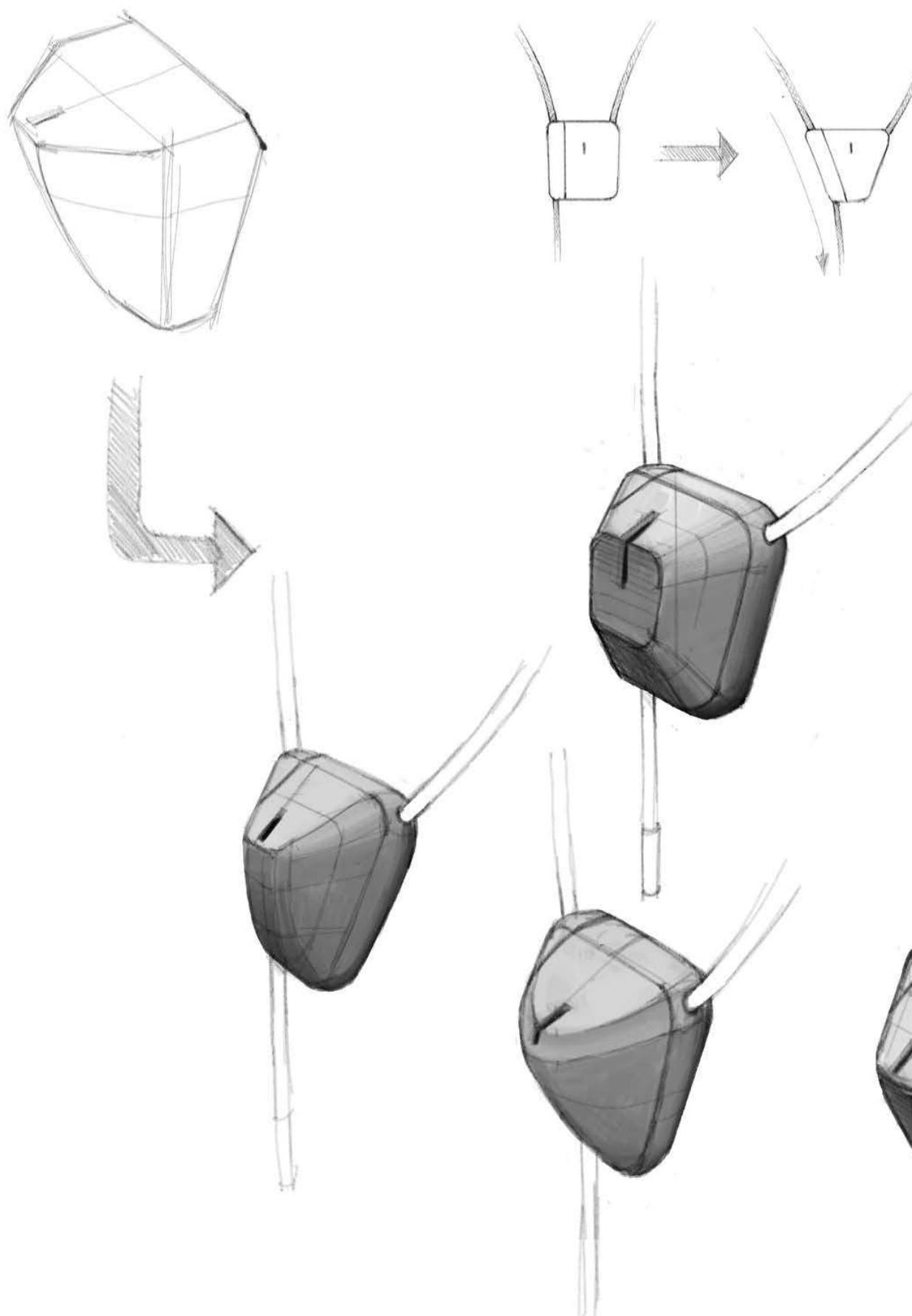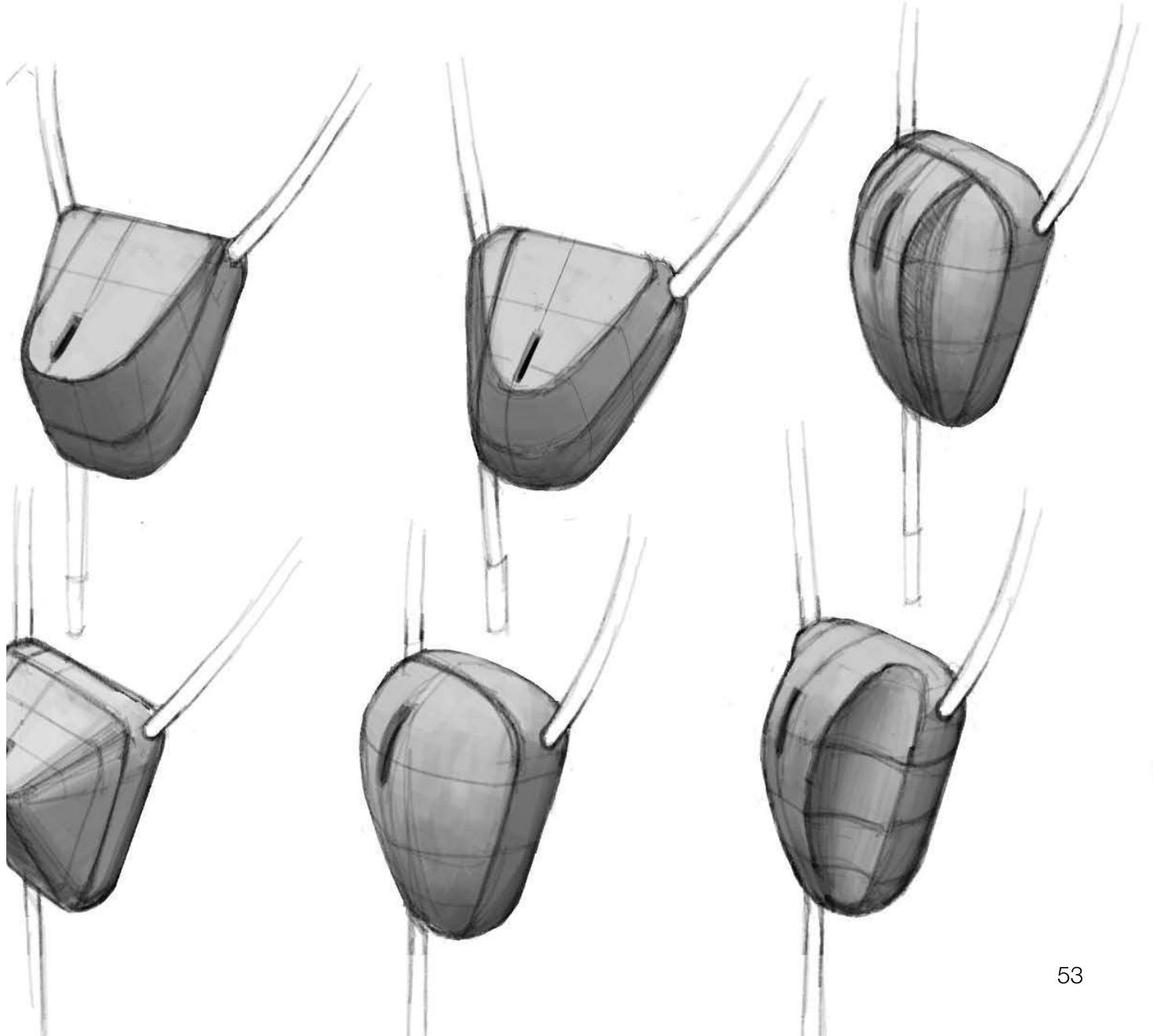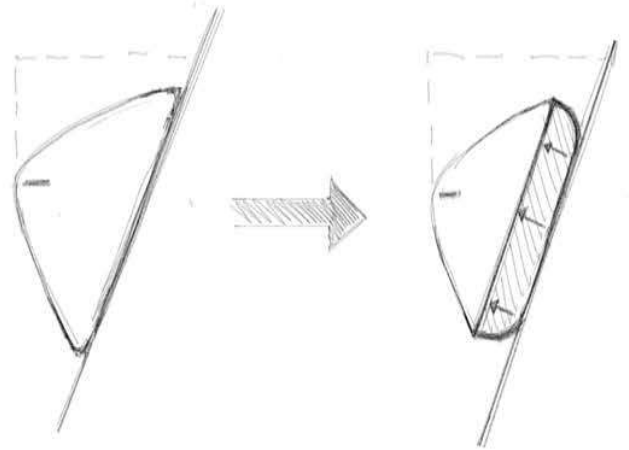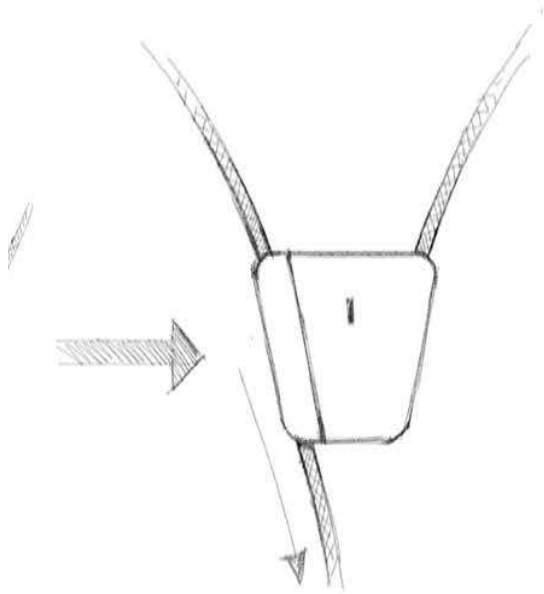
4.4 Clay

After the sketch phase the chosen shapes were evaluated further in clay.
This was a fast way of iterating on different shapes and exploring size and proportion.
With each shape the goal was to smooth out the edges and continue to explore ways
of making it feel like part of your body while still maintaining 20-30 mm of distance
between the chest and sensor.
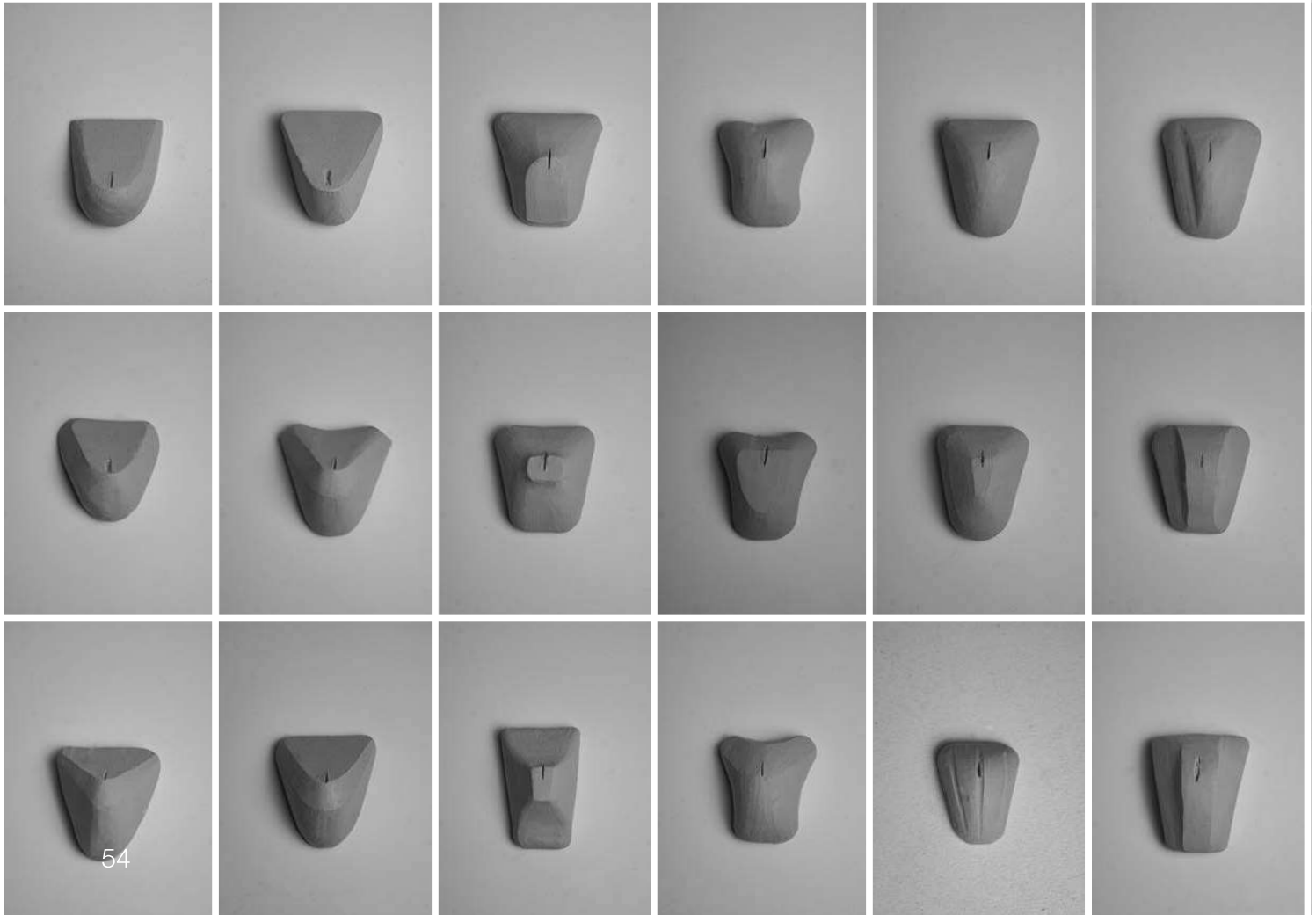
Here we can see the chosen shape. It has a simple base profile with a slight taper that can comfortably contain the components and at the same time provide a large contact point to the chest. The front has an organic wave shape that helps the shape to blend between the thin sides and the protruding point where the sensor is positioned.

4.5 Foam

The shape was recreated in foam where the strap was also integrated into the design. Edges were refined and placement for the three buttons were decided.

4 mm

Calibrate

Power button

6 mm

Split line

Spring loaded button for the strap
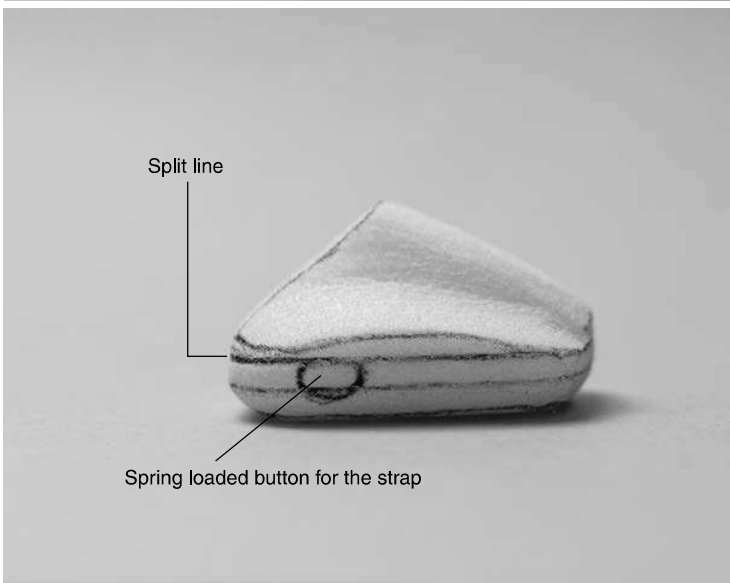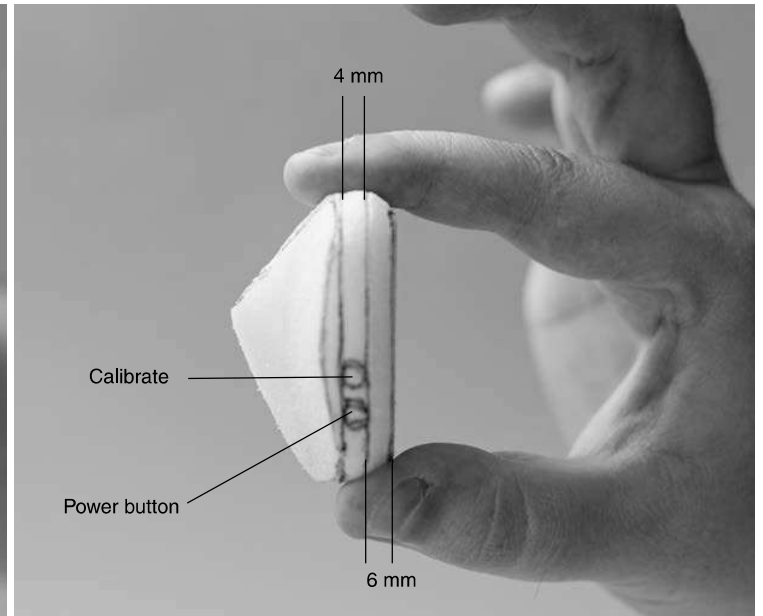
In the foam model the back side and the front side were further defined. The back side received a more pronounced radius while still maintaining a consistent flat surface along the sides where the buttons were placed.

The connection between the magnetic lock and the main body felt natural and the added stop at the end of the strap further communicates how the product is used. The picture at the bottom right shows how the buttons are mapped in a way so that the user can adjust the strap without interfering with the other buttons.

5. Realization

5.1 3d modeling

In this phase the model was refined and finalized. This involved both the aesthetic of the overall shape as well as designing the housing for all the components on the inside. The new model was designed to be made in a two part mold which would enable the product to be injection molded when reaching production.
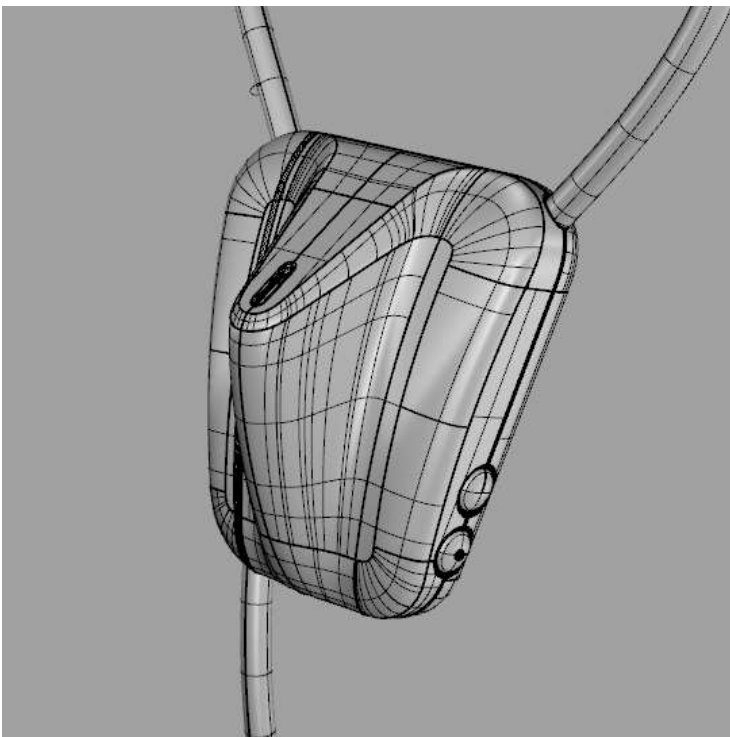
The front part received a rounder overall shape with a radius that runs along the contour and transitions into a chamfer that highlights the sensor.
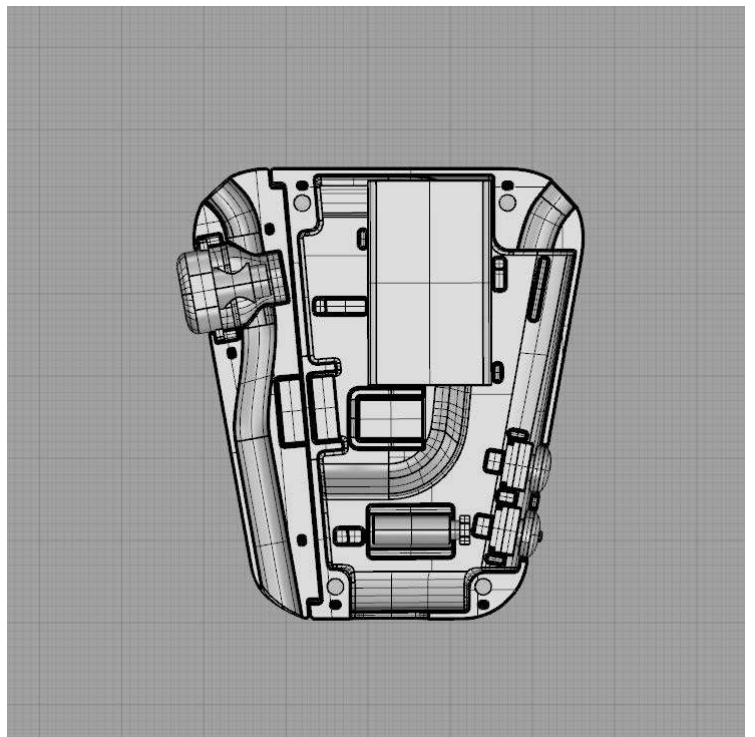
The components were implemented into the new model and made to fit securely. The components used in the new model were the same as in the previous Fixaspine.
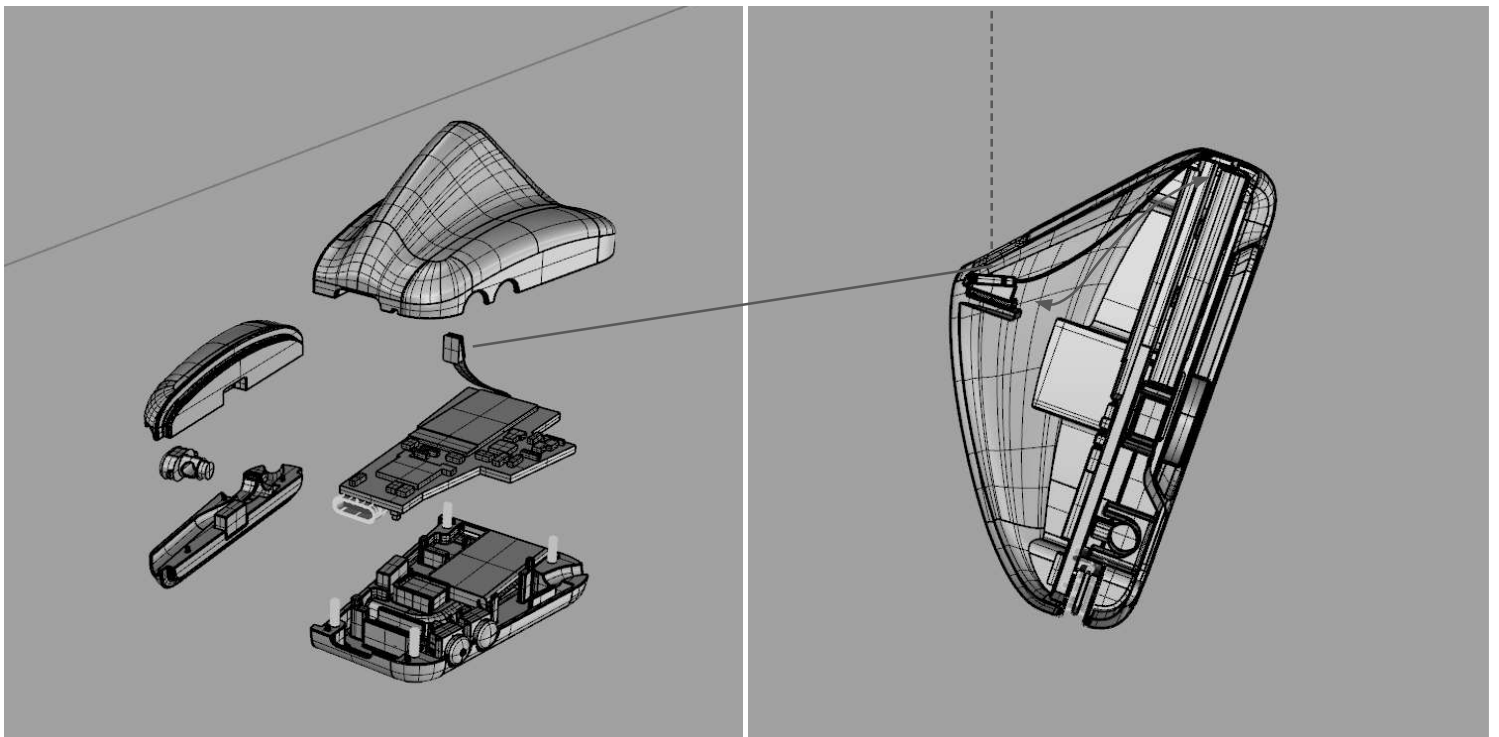
A new Pcb was made to fit the new housing and kept the same area as the previous one. The distance sensor was connected with the Pcb with a flexi cable and placed in a socket at the very front of the model.

5.2 3d print and components

The final design was 3d printed in PLA. In this step it was important to make sure that the components fit into their respective place. The main body has two layers of components. The bottom layer consists of the vibration motor and the bottom magnet which needs to be attached to the back side in order to function. The battery and the strap is also mounted on this layer. The Pcb is placed on top of these components. Having all the components except from the distance sensor at the bottom increases the balance of the product.

Spring loaded button

Distance sensor

Battery

3x Magnets

2x Push buttons

Vibration motor

Pcb, 1100 mm2

Usb C, power

Tactile buttons
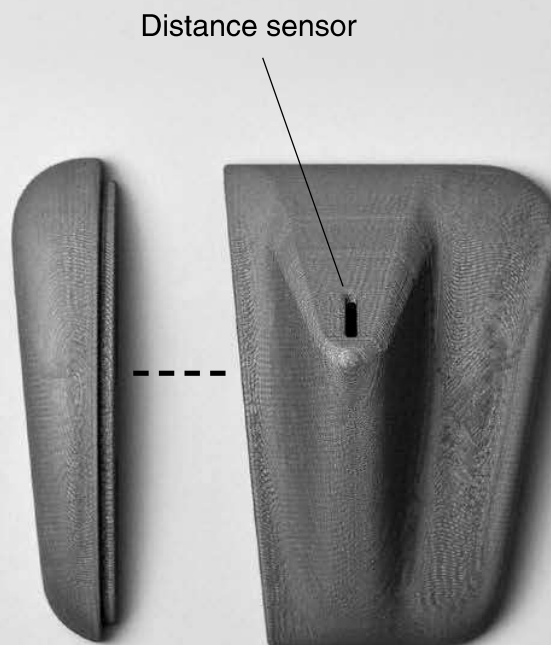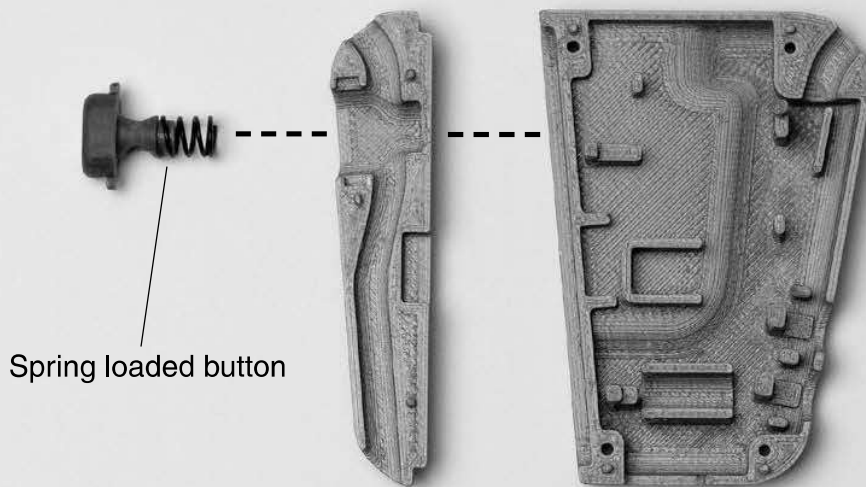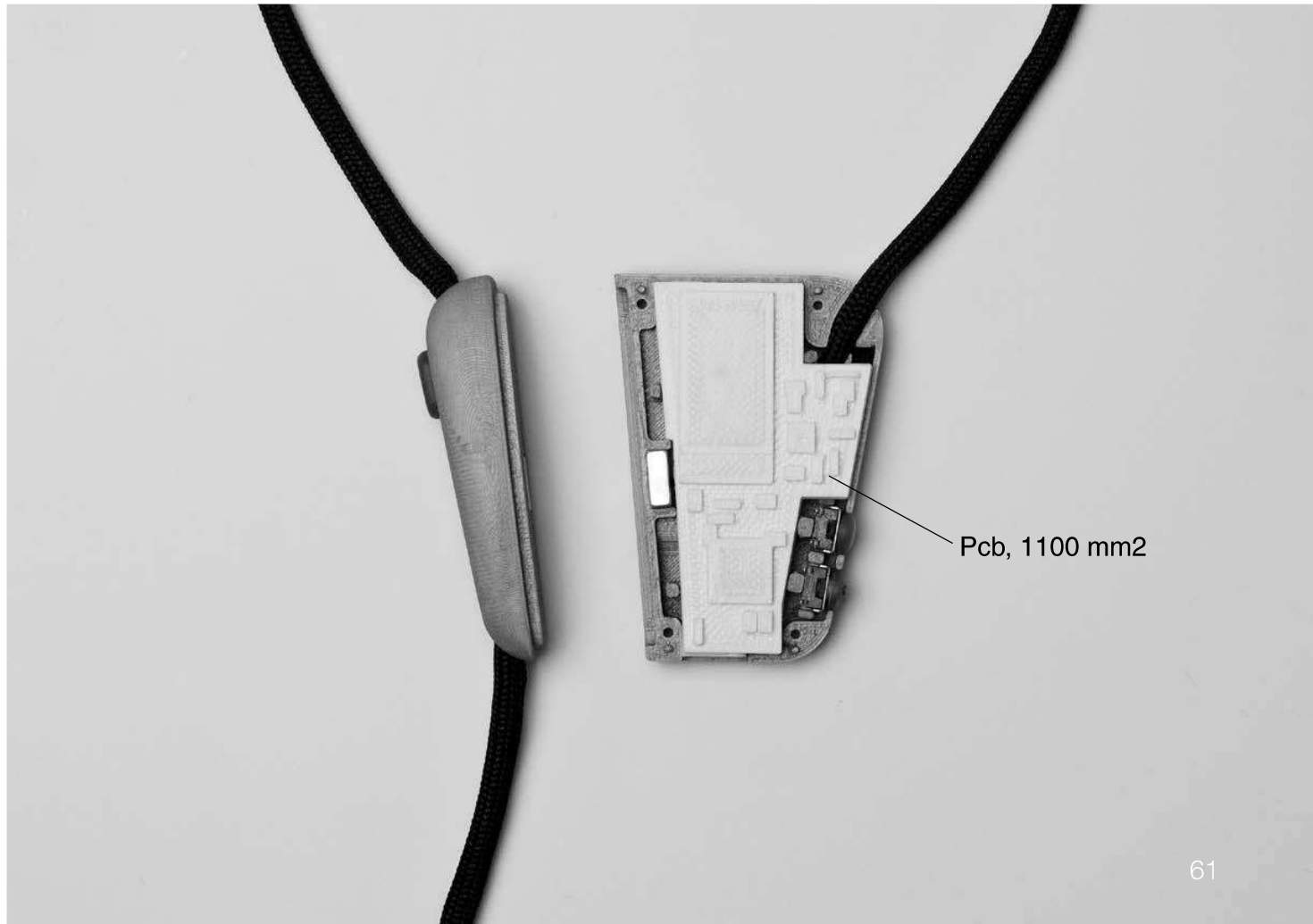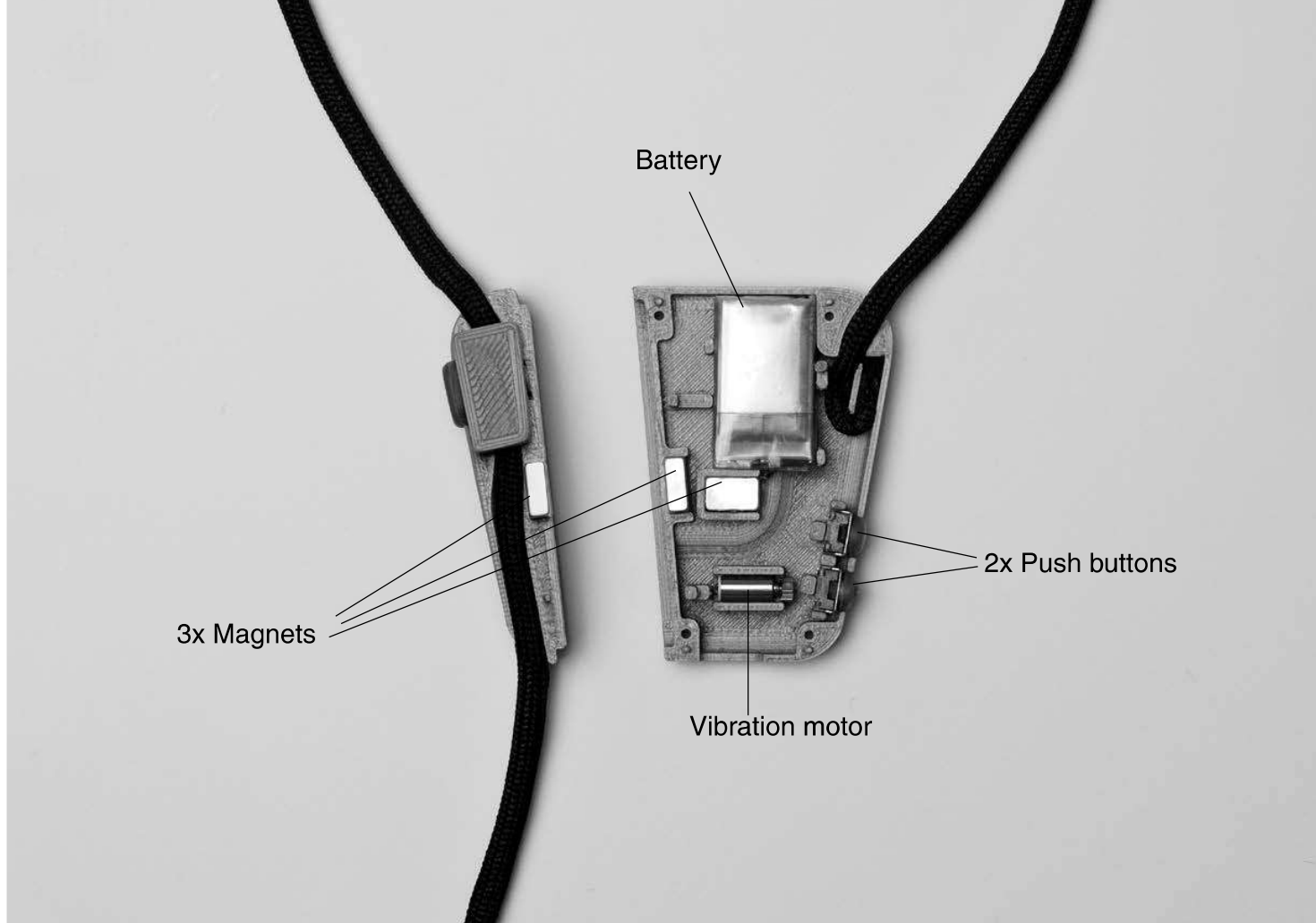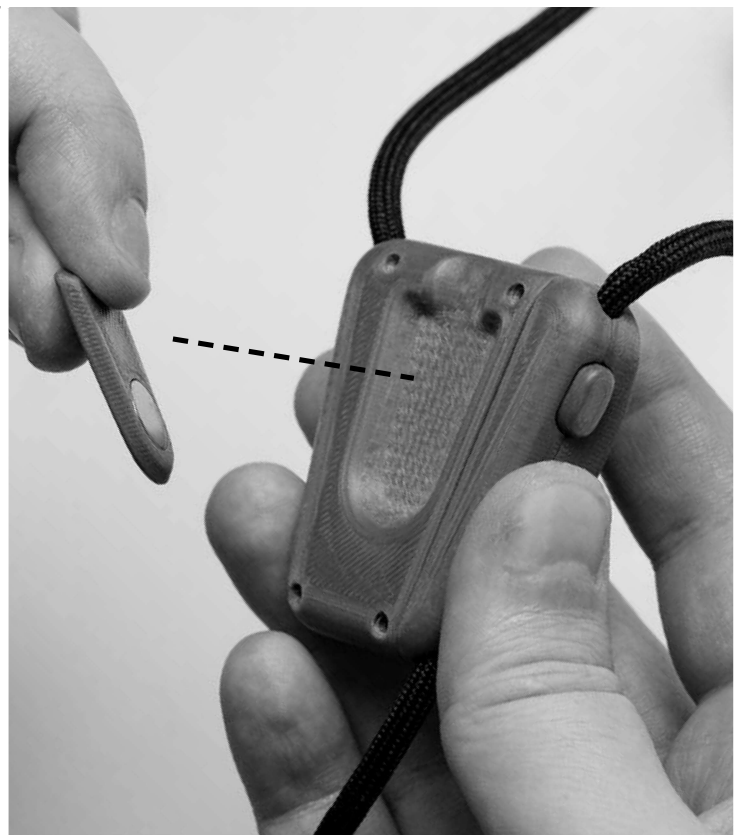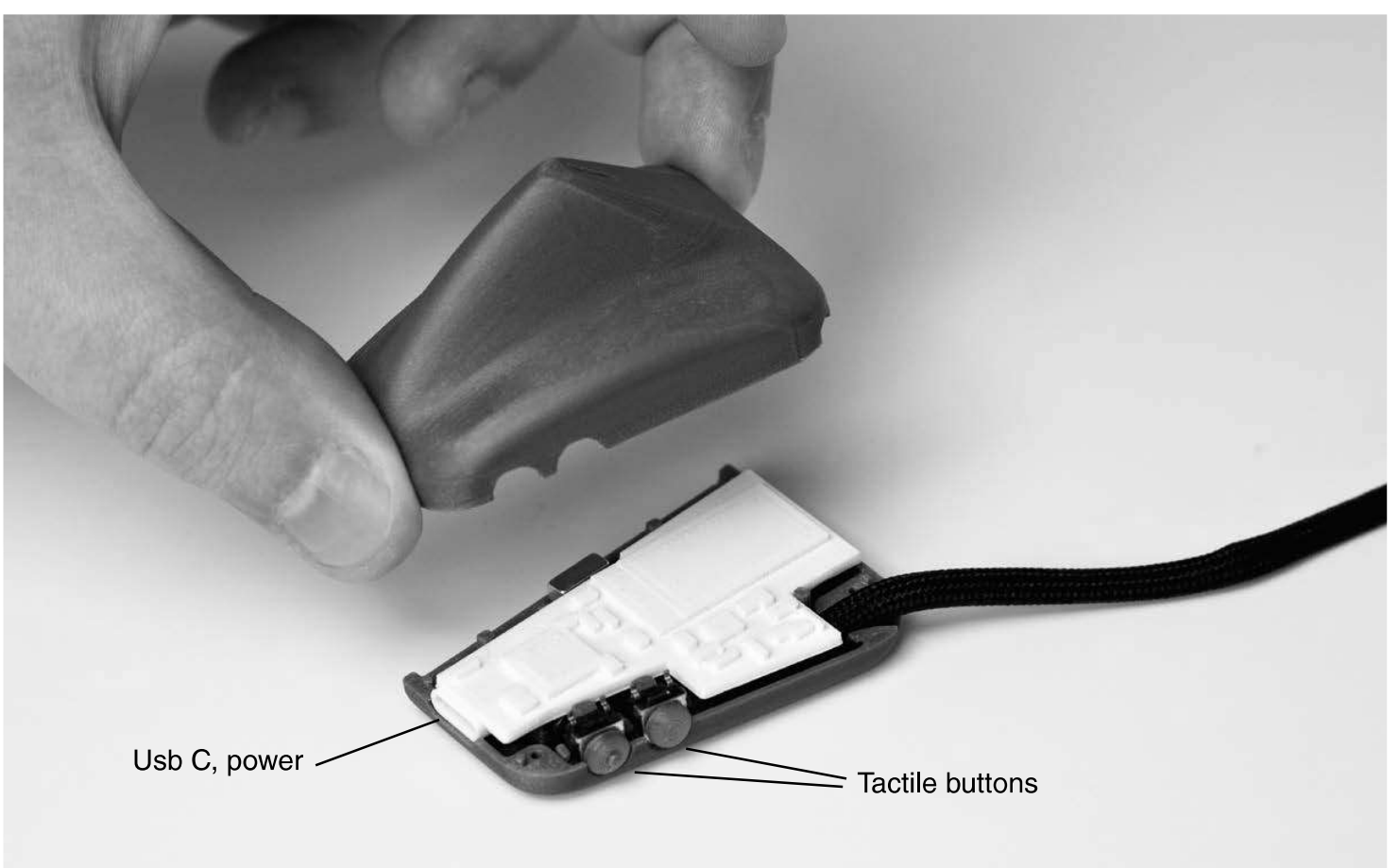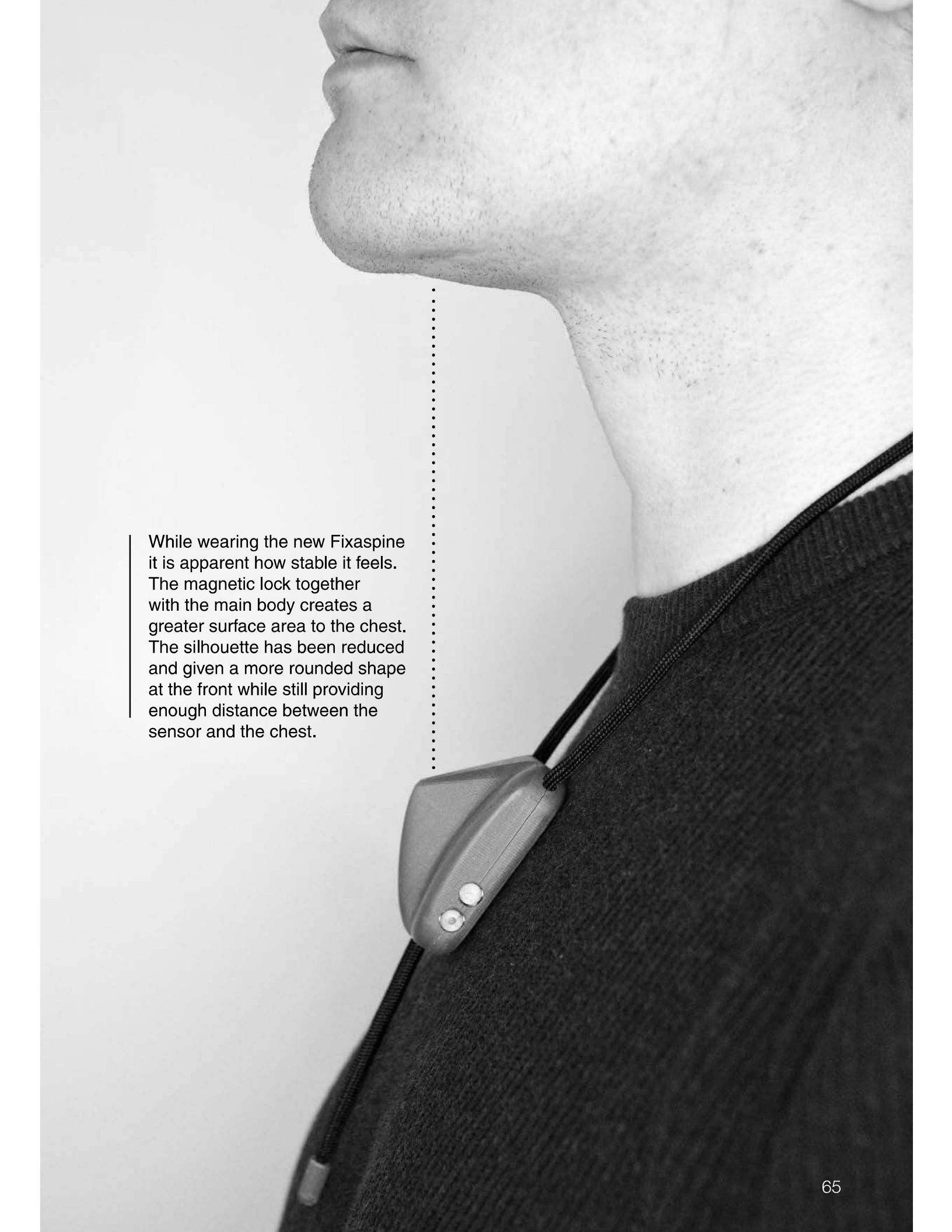
The magnet on the backside is positioned in a groove that enables the magnet to
be flush to the surface. This is important in order to ensure that the device rests in a
stable manner on the chest and to not affect the angle of the sensor.

While wearing the new Fixaspine it is apparent how stable it feels. The magnetic lock together with the main body creates a greater surface area to the chest. The silhouette has been reduced and given a more rounded shape at the front while still providing enough distance between the sensor and the chest.
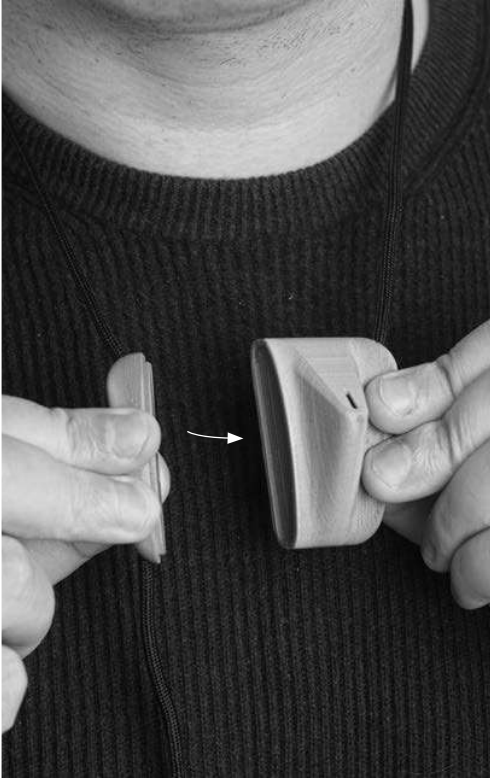
Put the Fixaspine around the neck.

The necklace is locked with a simple magnetic connection.

Adjust the strap to the desired length.

As an additional option the user can use the magnet on the backside to further attach Fixaspine to the chest.

By placing the magnet underneath the shirt it attaches through the clothing to a magnet on the fixaspine.

Press the activate button to start the measuring process.

6. Result

6.1 Product rendering

Fixaspine is an all black device that is made to fit in with other electronic devices and pair discreetly with most clothing. The strap connects seamlessly to the device creating a symmetrical and balanced shape.

6.2 CMF

Casing	
Color	RAL 9005 Jet black, spray painted
Material	Acrylonitrile butadiene styrene (ABS) Injection Molded
Finish	Matte lacker spray coated

Strap	
Color	RAL 9005 Jet black
Material	Polyester fiber, woven

6.3 Mapping

Activate/pause
- When pressed triggers one quick vibration.

Power on/off
- When pressed triggers two quick vibration.

Charging indicator LED

Usb-C charging

6.4 Attachment

Fixaspine is designed to be comfortable to wear. The magnetic lock makes it easy to take on and off for quick daily training sessions. When the user wants to wear Fixaspine through out the day the back magnet can be used to further ensure that the device stays in place.

6.5 Sensors and feedback

✕ Fixaspine starts vibrating right as the body starts to slouch. A vibration is sent to the chest to signal to the user that it is time to correct the posture.

Fixaspine will stop vibrating when a healthy posture is achieved. The user can maintain this posture knowing that it is not straining the neck.

6.6 Instructions

What is Fixaspine?

Fixaspine is a posture sensing wearable that helps the user to achieve a good posture with daily use. By using it for 15-30 minutes everyday your body starts to learn how to maintain a healthy posture.

Fixaspine measures the distance between the chest and the chin aswell as tilt. When you start slouching you will feel vibrations on your chest until the posture is correctected.

Distance sensor

Tilt sensor

12-15 cm

It was concluded from the user testing that clear instructions were instrumental for the user to understand and start using Fixaspine.

People were confused about what the product was and how to use it. The instruction manual therefore comprised two parts. The first part explained what Fixaspine is, how it works and the way it is meant to be used.

The second part explained in four steps how to use the core functionality of the product. Pictures were more zoomed in and with improved detail compared to the previous user guide.

The instruction was intended to be printed with a scale of 1:1 seen above where each page is 150 mm by 63 mm.

1.

Put Fixaspine around the neck

2.

Adjust the strap to a desired length

3.

Keep Fixaspine in place by applying the back magnet through the clouthing.

4.

Activate

Power button

Press the lower button to power on/off the device.
Press the upper button to activate/pause the sensors.
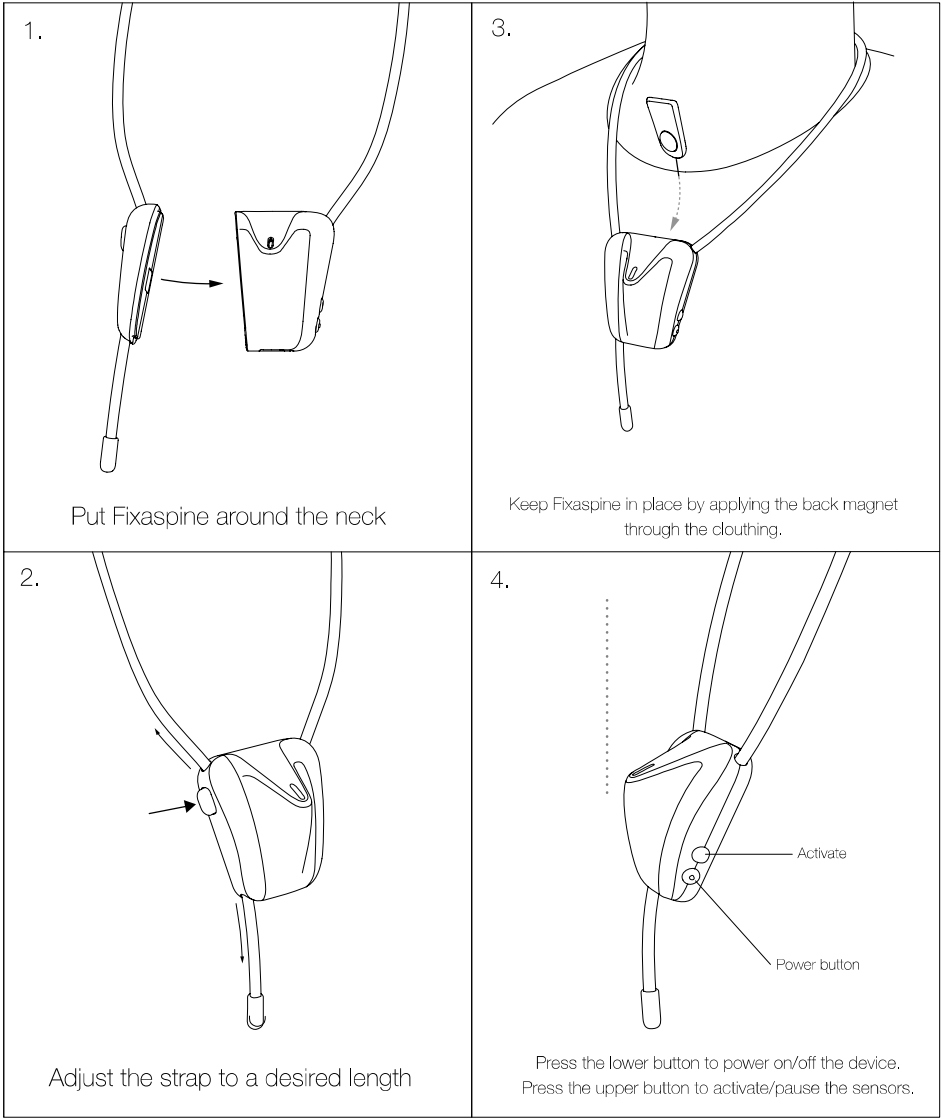
6.7 Packaging and accessories

The visual language of the packaging was meant to match the new look of the product. Additional inspirations were taken from packaging of consumer electronics such as heads phones and wearables in order to appeal to a wider audience.
At the same time it was important to convey a credible impression to the more knowledgeable consumer such as physicians and other ergonomic experts that might recommend the product to patients and companies.

The front side displays the new logotype along with the slogan that explains the product well. Posture sensing wearable is highlighted so the customer knows exactly what they are buying.

On the back side the 30 minutes per day is emphasized to show the potential buyer how much time you need to commit. Below that is information about neck problems where the customer and determine if they identify with the same problem. Finally there is a call to action to download the Fixaspine app with a QR code. This could be a way to engage with the customer before they buy and build up credibility.

FIXASPINE
Improve your posture everyday

Posture sensing wearable

Fixaspine

USB-C charging

Carrying case

App
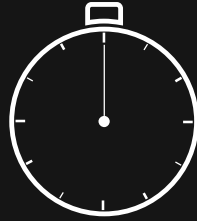
30 min
per day

Improve your posture by training with Fixaspine once a day for 30 minutes.

Suffering from neck pain or just want to improve your posture?

Neck problems has become increasingly common as people are spending more time hunched over a computer or phone. This puts a lot of stress on the neck and can lead to neck pains aswell as affecting other part of the body. Training regularly with Fixaspine helps the body to develop a muscle memory that improves the posture longterm.

Download the *Fixaspine App* to learn more about the product and its functionalities. Here you can also find information and exercises that work well together with Fixaspine.
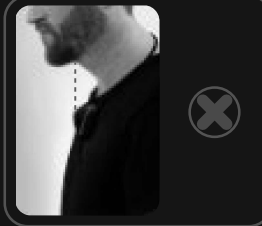
When the body is slouching Fixaspine will start to vibrate until a health posture is acheived.

Fixaspine is the first product to utilize sensors that measures both distance and tilt in order to gather an accurate read on the body.

Included in the packaging is a carrying case in a clam shell design that matches the device in terms of material and colour.

FIXASPINE
Improve your posture everyday

Fixaspine

USB-C charging

Carrying case

App

Posture sensing wearable

6.8 Fixaspine App

An app was developed as an interactive concept in Figma and would work together with Fixaspine as a compelling add-on to the default use case. The purpose of the app was to build a stronger connection between device and user. This type of product is rather new to many people and therefore communicating how it works and in which context was important.

The app includes the main functionality which is the training programme. The user is timed and the posture is visualized in real time using the data from the tilt- and distance sensor. Statistics of the user's performance and pain level is tracked after every use.

Integration with the phone allows for better signals in the form of vibrations and sound. In the settings one can enable additional vibration from the phone as well as activating the speakers which defaults to the phones current alarm sound.

Log in:

Training programme:

Statistics:

Instructions:

What is Fixaspine?

Fixaspine is a posture sensing wearable that helps the user to achieve a good posture with daily use. By using it for 30 minutes everyday your body will start to learn how to maintain a healthy posture.

Introduction >

Distance sensor

Tilt sensor

Fixaspine measures the distance between the chest and the chin as well as tilt.

< Sensors >

When the body starts to slouch you will feel the device vibrating until the posture is corrected.

< How it works >

Information about postural neck problems:

Why do I have neck pain?

Dr. Mckenzies 7 exercises

Achieve good posture

Information, tips and exercises >

Why do I have neck pain?

First it is important to establish what kind of neck problem you have. Fixaspine and the Mckenzie method focuses on preventing and treating postural neck problems which accur when spending extended periods of time in a bad posture for the neck.

Important!
If you suffer from a neck injury due to a sudden impact such as a car accident or sport injury you need different kinds of treatment and should seek out medical assistance immediately.

Introduction >

The spine constists of bones called vertebrae and discs made out of cartilage. Together they form a strong yet flexible structure that enables upperbody movement and protects the spinal cord.

< The spine >

C1

C7

The neck is called the cervical vertebrea which include the 7 upper vertebrae. It is flexible which makes it possible for the head to move around freely. Unfortunally it is also less protected than the rest of the spine which makes it prone to injury.

< The neck >

Put Fixaspine around your neck

< 1. >

Adjust the strap to the desired length

< 2. >

Keep Fixaspine in place by applying the magnet through the clothing.

< 3. >

Lower button powers on the device. Upper button activates the sensors.Press the same button again to pause.

< 4. >

The vulnerable parts of the spine are soft tissue such as cartilage discs and surrounding ligaments. Inflammation in these areas can in turn affect the spinal nerves.

< A closer look >

Having a protruded neck posture will eventually lead to overstreching. It is when the ligaments are streched beyond its maximum position for a extended period of time.
This can damage the ligaments.

< Oversteching >

The damaged ligaments can get displaced and push on sourrounding tissues and can cause inflamation on the nerves. Unlike muscles ligament does not heal as evenly which can lead to shorter ligaments that effects nerves and mobility.

< Tissue damage >

The nerves in the neck are connected with the shoulder, arm and hand. Damage in the neck can subsequently lead to symptoms in these other areas.

< Symptoms >

Mckenzies 7 exercises:

Mckenzies 7 exercises

These 7 exercises are part of the Mckenzie method of treating your neck. They are movements that are designed to stretch the ligaments in neck to its maximum position or pain point. Performing these exercercises on a regular basis will help your regain mobility and alleviate pain in the neck.

< Introduction >

Sit on a chairand relax. Then retract your head back as far as possible. Keep it in this position for a few seconds, relax and then move back. If this exercise gives you too much pain replace it with **exercise 3**.

< 1. Head retraction while sitting >

Warm up by doing **exercise 1** a couple of times. Then start off with the head retracted and tilt the head backwards. Stay in this position and rotate your head slightly from center to the sides. If this exercise gives you too much pain replace it with exercise 3.

< 2. Neck extension while sitting >

Lie down on a bed or something similar. Make sure that your head and shoulders are at similar level. Push the head down by pulling the chin down towards the mattress.

< 3. Head retraction while lying >

Posture:
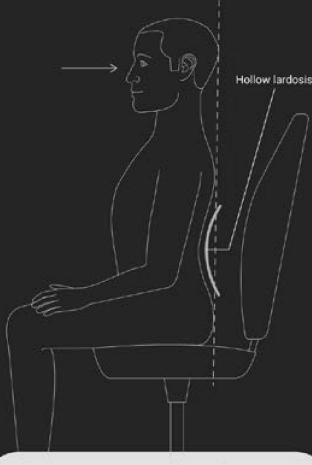
The spine is the strongest when it forms a s-shape. An adult head weights abut 4.5 kg and by moveing it forward away from the balance point results in exponentially heavier load on the neck.

Spinal load >
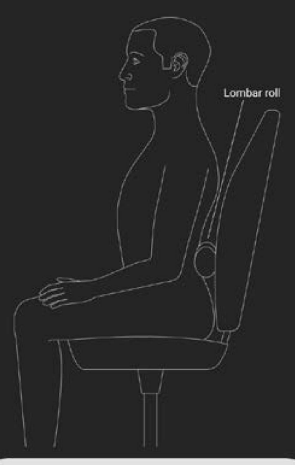
Hollow lardosis

To prevent a protruding neck posture one most achieve a natural hollow lardosis. It is a posture where the lower back curves inwards. Focus on maintaing this posture and the neck will stay in a balanced postion.

< Good posture >

Lombar roll

You should train to acheive a good posture anywhere. But if you neck assistance there are lombar rolls that can be place on your lower back for support.

< Lombar support >

84

Warm up by performing **exercice 3**. Move part of the shoulders, neck and head over the edge. Support the head with a hand and proceed to lower the head. down and keep it there for 30 seconds.Remove the hand and rotate your head from middle to the sides.

< 4. Neck extension while lying >

Sit on a chair and repeat **exercise 1**. Then start out this exercise in the retracted neck position. Keep your head facing forwards and tilt start to tilt to the sides as far as you can.

< 5. Side bending of the neck >

Sit on a chair and relax with your head looking straight forward. Move your head forward and let it drop down towards the chest. Continue by putting your hands on top of the head and let the weight of the arms pull down the head even further.

< 7. Neck flexion while sitting >

Sit on a chair and repeat **exercise 1**. Then start out this exercise in the retracted neck position. Proceed to rotate the head .Try to focus on the side that hurt the most and gradually strech until mobility is regain or the pain is gone.

< 6. Neck rotation >

Settings:

Sound

Vibration

Track statistics

Yes   No

Settings

7. Reflections

Process

Looking back at the project it is clear that working with the Fixaspine company affected the process greatly. This was the first time that I started out the design process with an existing prototype already made. I did not have to question the core functionality and purpose of the device to the same extent as before which in return gave me more opportunity to focus on improvement and push the project further along in the product development. This also meant that there was more pressure to provide tangible improvements to the project that had to be considered objective improvements due to the fact that there was already something to compare with.

In terms of research, having access to experts like Göran Nybom and Eva Ekesbo gave me a head start and learning what and how to use the information in the design process was a good learning experience.

Conducting the user testing was at times a challenge due to the current pandemic. Having the tests be in person was very important which was at times difficult to facilitate with everybody working from home.

One skill that evolved throughout the project was working with more complex 3d shapes. This made it possible to translate the form process into the final model with good surfaces and incorporate the components properly.

Result

I think that the result from the project turned out great overall.
The Fixaspine vision was developed and expanded in a way that puts it a couple of steps further to becoming a product. The hardware was revamped in a way that greatly improved the usability and the Fixaspine app added functionality that improves the user experience.

The next natural step for Fixaspine would be to conduct a second user test where the new changes can be evaluated and refined further.
Finally I would like to see a second technical evaluation where components in terms of size and performance are optimized. This would allow Fixaspine to become even smaller which would be beneficial.

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Hagberg, MH., (1996) *Nacke och skuldra: Att förebygga arbetsrealterad sjuklighet*, Stockholm. Rådet för arbetslivsforskning

Mckenzie, RM., May, SM. (2006) *The cervical and thoracic spine: Mechanical diagnosis and therapy*, 2nd edition, Spinal publications New Zealand Ltd

Internet sources:

Berlin, C and Adams C 2017 *Production Ergonomics: Designing Work Systems to Support Optimal Human Performance*. London: Ubiquity Press.
DOI: https://doi.org/10.5334/bbe.

Appendix

1. Name: Kasia

2. Age: 26

3. Gender: Woman

4. What were your first impressions of Fixaspine before you tried it?
-Looks like a nose, looks like you put it around your neck, and it feels technical and measures something.

5. Was it difficult to put the device around your neck?
-It was easy.

6. Was it difficult to adjust the length of the strap?
-Yes especially when you have it on, it was a hidden feature for me to adjust the straps, the fact that it was so unbalanced weight wise made it more tricky.

7. Was the calibration process easy?
-The magnet was easy to understand as a on/off button, the rest was quite difficult, the device needs something more tactile when you don't see what you are interacting with. I want my finger to be guided to the button or switch with a indentation or a different texture that you can feel.

8. How was the feedback/signals of the device?
-All the beeping was confusing and it was hard to understand what sound communicated what, the sound of the calibration sound and error sound was not pleasant.

9. Did you need instructions to use the product?
-Yes

10. How would you like to have these instructions to be provided?
-I would prefer an instruction video, instructions where you see body parts like hand length in order to determine the distance of the sensor and chin.

11. Do you think you have a need for a product like this?
- Yes as a reminder for bad posture would be useful.

12. Where would you use it and would you use it in public?
- Yes I would use it at work and at university but I would have to be smaller and different sounds.

13. What other attributes would you change or add to the current prototype?
-Maybe an alternative to the necklace/strap, more positive sounds and vibrations rather than error sounds, would be nice with different texture or colours so you know what side should rest against your body.

1. Name: Georgious

2. Age: 27

3. Gender: Man

4. What were your first impressions of Fixaspine before you tried it?
-I looked at the magnetic connection and wondered what it was for. It looked like something health related, like it is measuring heart beat.

5. Was it difficult to put the device around your neck?
-Very easy.

6. Was it difficult to adjust the length of the strap?
-Difficult.

7. Was the calibration process easy?
-Difficult without instructions but if I used it for a while I think it would be easy.

8. How was the feedback/signals of the device?
-Unclear start up sound when it is ticking, and I felt stressed by the sounds and reminded me of an alarm clock.

9. Did you need instructions to use the product?
-Yes.

10. How would you like to have these instructions to be provided?
-It needs a manual, something that is easy to understand that shows the process.

11. Do you think you have a need for a product like this?
- Yes, when I spend a lot of time in front of the computer I get bad posture.

12. Where would you use it and would you use it in public?
- I would use it at home, not in public.

13. What other attributes would you change or add to the current prototype?
-It feels a bit too big, and I would like it to be more sturdy, make it easier to adjust the strap or other method to attach to the body, it should be as easy as my headphones to put on. From an aesthetic standpoint I want it to be more discrete. Also I would simplify the signals. I would also like an app or something to show my progress or something to make it more fun.

1. Name: Sara

2. Age: 29

3. Gender: Woman

4. What were your first impressions of Fixaspine before you tried it?
-It looked like something you have around your neck, reminds me of headphones, it looks medical and something that measures something.

5. Was it difficult to put the device around your neck?
-Easy

6. Was it difficult to adjust the length of the strap?
- It was hard because there was no clear indication that you could adjust the strap, and it felt fiddly and it was light but still unbalanced which made it hard.

7. Was the calibration process easy?
-Difficult to judge the right distance to calibrate because I can not see it, the magnet as a start up felt natural, would like a button instead to clearly indicate that I am calibrating.

8. How was the feedback/signals of the device?
-The sounds in the beginning was first confusing and you don't know what the different sounds mean or if you are doing something wrong, it would be easier if sound was for calibration and only vibration for use when training

9. Did you need instructions to use the product?
-Yes

10. How would you like to have these instructions to be provided?
-Something simple like a brochure in the packaging to show how it works.

11. Do you think you have a need for a product like this?
- Yes, I would use it at school where I sit in front of the desk the most and where I have the most problem with posture when you are tired.

12. Where would you use it and would you use it in public?
- Yes at school or work, but it would have to be more quiet.

13. What other attributes would you change or add to the current prototype?
-Make it smaller if possible and another shape that is more calm, would be nice with soft fabric for friction against chest so it stays put, other attachment method because I sometimes use thicker clothing or jackets indoors during winter, clear signals between the different functions of the device. It would be nice if I could pick the colour of the device and match with clothing for a more discreet look.

1. Name: Jinglin

2. Age: 24

3. Gender: Man

4. What were your first impressions of Fixaspine before you tried it?
-You understood that it was a necklace of sorts, it looks flexible, adjustable and light and slim. But it does not look that inviting.

5. Was it difficult to put the device around your neck?
-Difficult with one hand, tricky to center it in the body. Did not work with my sweater so I had to use a t-shirt.

6. Was it difficult to adjust the length of the strap?
- Felt like a hidden feature to retract the string but the flexible metal part was easy to understand and adjust.

7. Was the calibration process easy?
-Without instructions it was impossible, but once I was shown how it works I think it was pretty easy. Still the right distance will be hard to know and remember each time.

8. How was the feedback/signals of the device?
-The feedback was not very clear, and when you have it on and want it to be quite it continues beeping and you don't know why. The sound is very negative like an error sound.

9. Did you need instructions to use the product?
-Yes

10. How would you like to have these instructions to be provided?
-Would like it on packaging and phone. Phone is good because I always have it with me but I might not keep packaging.

11. Do you think you have a need for a product like this?
- Yes I have this problem

12. Where would you use it and would you use it in public?
- I would use it at school or at work if it was more inviting, soft and less technical looking. And it needs to be customizable so I can adjust signal level to where I work and also how I attach it to my outfit each day. I would also use it for sport and exercise if it measures other things.

13. What other attributes would you change or add to the current prototype?
- I do not mind the size of it if I use it like the test but it looks ugly, I want it to look more neutral, also I would prefer rewards and positive feedback rather than just negative error sounds. I would like to be able to fold it or wrap the strap so I can store it on a desk or put it in my bag easily.

1. Name: Moa

2. Age: 23

3. Gender: Woman

4. What were your first impressions of Fixaspine before you tried it?
-It reminds me of science fiction a bit but like a necklace, looks pointy and unbalanced.

5. Was it difficult to put the device around your neck?
-Easy

6. Was it difficult to adjust the length of the strap?
- Yes, adjusting the length was a hidden feature and would be easier with a normal strap.

7. Was the calibration process easy?
-It was difficult to understand for me. Because of the start up beep and calibration beeps being too similar.

8. How was the feedback/signals of the device?
-The signals were easy to hear but confusing at first to understand. It would be nice if you could adjust it.

9. Did you need instructions to use the product?
-Yes you need to be told how it works, but the magnet button was easy to understand.

10. How would you like to have these instructions to be provided?
-Video

11. Do you think you have a need for a product like this?
- Yes

12. Where would you use it and would you use it in public?
- I would use it if it didn't sound so much or I could adjust it, and if I could use it with a headset. I would use it here at school

13. What other attributes would you change or add to the current prototype?
-Couple with headphones, distribute the weight better because now the strap is too thin and would be uncomfortable for 30 min training, and I would like it to look more like other wearable products and more normal.

1. Name: Felix

2. Age: 30

3. Gender: Man

4. What were your first impressions of Fixaspine before you tried it?
-Feels flimsy, not so inviting with the plastic and metal combination, the sensor part looks big in relation to the strap, the color gives it a medical feel. It is probably something that measures something on your body.

5. Was it difficult to put the device around your neck?
-Was a bit difficult and felt weird, I also had the wrong sweater for this test.

6. Was it difficult to adjust the length of the strap?
- Not that hard once you know but could be easier, the thin strap made it require more precision and having two point of adjustments on the sides added to the difficulty. Judging the length would be easier once you use it more I think.

7. Was the calibration process easy?
- Quite difficult because there is no indication of how it works on the product itself. I don't know what the beeping sounds are representing. It is impossible to know the appropriate length of the strap. I would personally like a button to give it a more tactile feeling so I know that I am calibrating.

8. How was the feedback/signals of the device?
-I would like the feedback to separate the functions and steps of the product more clearly, as it is now it is confusing.

9. Did you need instructions to use the product?
- Yes

10. How would you like to have these instructions to be provided?
-A video would be nice for the steps and other useful information.

11. Do you think you have a need for a product like this?
-Yes, long sessions in front of the computer at school is when my posture becomes worse.

12. Where would you use it and would you use it in public?
- I would use it if it was less egdy shape and more smooth and neutral shape that mixes in better with the clothes. I would use it at home or at work if it could be silent.

13. What other attributes would you change or add to the current prototype?
- A dedicated button for start up and calibration so you could have it on and do other things before or in between training without the device is on beeping. I would like a magnet or something else to attach it without being limited by the strap.

1. Name: Feng Xue

2. Age: 26

3. Gender: Woman

4. What were your first impressions of Fixaspine before you tried it?
-I was wondering which direction to put it on. When I look at it on the table the main shape has no clear direction for me. I understand that you put it around the neck like a necklace.

5. Was it difficult to put the device around your neck?
-Easy to put on, hard to stay in place.

6. Was it difficult to adjust the length of the strap?
- Would not have noticed the feature of adjusting the strap if it was not told to me. It was difficult to adjust when you have it on and hard to judge when I adjust it on the table.

7. Was the calibration process easy?
-Difficult without instructions, quite easy once you know. Some of the sounds are confusing to me.

8. How was the feedback/signals of the device?
-Confusing if you don't know what they mean, I would like the calibration sounds to be more different than the normal beeping sound.

9. Did you need instructions to use the product?
-Yes

10. How would you like to have these instructions to be provided?
-I would like a introduction video so you can see and hear the different sounds and what they refer to. Could be on a website or app in my phone.

11. Do you think you have a need for a product like this?
- No, I have had this problem before when I was younger and tried straps for upper body. Now I would use training and take breaks from sitting.

12. Where would you use it and would you use it in public?
- ---

13. What other attributes would you change or add to the current prototype?
-I would make it look less fragile and more balanced shape so I can easily throw it in a bag without worrying or hang it somewhere accessible. I want the backside of the device to be more connected with the chest with a soft material, the shape needs to be more smooth and not pop out so much, and also more interesting color.

1. Name: Tommaso

2. Age: 24

3. Gender: Man

4. What were your first impressions of Fixaspine before you tried it?
-It looks cold with the metal and something I would not want to wear. I get that it is electronic and goes around the neck. Looks like something you wear at the hospital.

5. Was it difficult to put the device around your neck?
-Yes easy.

6. Was it difficult to adjust the length of the strap?
-Yes, I understood directly that I could shape the metal part of the strap but I would not have noticed how I could adjust the strap part without instructions.

7. Was the calibration process easy?
- Difficult to judge distance when it is directly under my chin. I would need to do it in front of a mirror for the first few times. It would be nice to be able to measure with something. I did not know what each of the sounds did so it was confusing. I would like one button so I know for sure that I initiate the calibration instead of waiting for a sound.

8. How was the feedback/signals of the device?
-I would remove the sound and only use vibration, and have more tactile feedback like a button that you press when calibrating. It is also too loud for me in this room.

9. Did you need instructions to use the product?
- Yes

10. How would you like to have these instructions to be provided?
-I would like to have instructions that show the distance between the sensor and chin with a hand or something else that I can relate to. I would like it printed and in my phone.

11. Do you think you have a need for a product like this?
-Yes I am always slouching my neck when I look at my phone.

12. Where would you use it and would you use it in public?
- I would use it at home and in public if it looked different, I would like it to look more like a jewel or accessory that represents me rather than looking like a health product.

13. What other attributes would you change or add to the current prototype?
- A physical button, bluetooth calibration and I want the device to store the calibration settings.

User interviews
Age 31-65

1. Name: Josefin

2. Age: 45

3. Gender: Woman

4. What were your first impressions of Fixaspine before you tried it?
-It looks technical but not in a bad way and a bit clumsy.

5. Was it difficult to put the device around your neck?
-Yes easy with the magnet.

6. Was it difficult to adjust the length of the strap?
-The strap made it difficult and we had to adjust it on the table multiple times with a trial and error method. I would need a mirror the first times like this as the product is not giving me any hints.

7. Was the calibration process easy?
-The steps were simple when I was shown how to do it but making the strap the right length was still hard.

8. How was the feedback/signals of the device?
- I was stressed out by the sounds and would prefer only vibration. At Least no sound when I am doing the posture training.

9. Did you need instructions to use the product?
-Yes

10. How would you like to have these instructions to be provided?
- I would prefer a video.

11. Do you think you have a need for a product like this?
- Yes I get bad posture all the time when I sit in front of the computer at work. I try to move around and have a mental clock to tell me that I need to stretch and adjust my body. We also have a standing desk at work which helps during certain tasks.

12. Where would you use it and would you use it in public?
- At work when sitting down in front of the desk. At home I am sure I also have bad posture when I sit on the sofa but I would not use it there anyway.

13. What other attributes would you change or add to the current prototype?
-I would like it to be more sleek looking and easier to handle, it should rest nicely on the body. I would like it to be something you can forget that you have on like a jewelry, maybe with straps that I can match to my shirt so I only see the sensor part. I would store it in my handbag in a case, I am thinking of a case similar to the ones for my glasses if it is possible.

1. Name: Richard

2. Age: 43

3. Gender: Man

4. What were your first impressions of Fixaspine before you tried it?
-It looks big.

5. Was it difficult to put the device around your neck?
-No but first I put it on backwards. Otherwise I like that it is lightweight.

6. Was it difficult to adjust the length of the strap?
-Difficult to adjust because of the blind spot. Impossible with accuracy to judge the distance.

7. Was the calibration process easy?
-I would like a button and something analog to adjust the distance.

8. How was the feedback/signals of the device?
- The sound was clear but way too loud for the office and workspace. For me the vibration would be enough. I am unsure of when it is measuring.

9. Did you need instructions to use the product?
-Yes I need it for the calibration process at least.

10. How would you like to have these instructions to be provided?
- A paper with the packing maybe so I can get started with the basics. Then have info on my performance in the device.

11. Do you think you have a need for a product like this?
- No, I solve the problem with training.

12. Where would you use it and would you use it in public?
- ---

13. What other attributes would you change or add to the current prototype?
-I would like it to measure my stats always and when I have bad posture during the day, I also want the product to show me that I am doing the training correctly, maybe it can see when it has been us and when I am slacking. Looks wise I would like it to be black with a black leather strap.

1. Name: Juan

2. Age: 40

3. Gender: Man

4. What were your first impressions of Fixaspine before you tried it?
-It looks big with a lot of corners. It looks cold and hygienic. I understand that it is a necklace of sorts and that the magnet fits into the socket on the sensor.

5. Was it difficult to put the device around your neck?
-It was ok once I adjusted my sweater that was in the way.

6. Was it difficult to adjust the length of the strap?
-Yes everything is too small on the strap for me and the unbalanced weight distribution between the light strap and the big sensor part made it more tricky. I would need a mirror or something to see the correct distance.

7. Was the calibration process easy?
-Difficult with the distance and it does not tell me clearly that I am doing it the right way.

8. How was the feedback/signals of the device?
-The sound signal is too low for this cafe room we are in. Especially the ticking sound as I calibrated it was hard to pick up. I would like to have something more pleasant than the error sound that feels more positive.

9. Did you need instructions to use the product?
-Yes

10. How would you like to have these instructions to be provided?
-A instruction manual with illustrations with less text the better.

11. Do you think you have a need for a product like this?
- Yes

12. Where would you use it and would you use it in public?
- I would use it at work if the company I work for was providing it. Buying ergonomic furniture and other tools is quite common so something simple like this would be good. I try to solve bad posture and sitting down too much by switching workspace during the day.

13. What other attributes would you change or add to the current prototype?
- For it to be used at my work I need to be able to adjust the sound or only use vibrations. It was too quiet during the test but could be too loud in an open workspace. Another feature could be to use headphones. I would store it in a small fabric bag or a charging etui like air pods. An app or something that tracks improvement or makes it more fun with challenges.

1. Name: Sara

2. Age: 48

3. Gender: Woman

4. What were your first impressions of Fixaspine before you tried it?
-It looks like something you have around your neck and I can see that it measures something.

5. Was it difficult to put the device around your neck?
-Not that difficult but it was hard to keep the sensor from sliding around.

6. Was it difficult to adjust the length of the strap?
-Difficult when you have it on.

7. Was the calibration process easy?
-Easy once you know it but getting the right distance can still be tricky.

8. How was the feedback/signals of the device?
-The sound was clear but a bit annoying, but it depends on how it is used and how frequent it beeps.

9. Did you need instructions to use the product?
-Yes

10. How would you like to have these instructions to be provided?
-A manual in the packaging

11. Do you think you have a need for a product like this?
- If I had bad posture I think it is a good and simple alternative compared to other solutions.

12. Where would you use it and would you use it in public?
- I would use it at work because it is here that I would have the problem of sitting down too much.

13. What other attributes would you change or add to the current prototype?
- I would like to see a version of the prototype where it is more attached to me. I would also like instructions and examples of exercises I can do to improve my health. I like statistics and a clear goal and stuff like that rewards me instead of reminding me that I have a problem. I would store it in a little bag with a zipper.

1. Name: Marie

2. Age: 32

3. Gender: Woman

4. What were your first impressions of Fixaspine before you tried it?
-It is not beautiful, reminds me of hospitals.

5. Was it difficult to put the device around your neck?
-It was easy and I liked the magnet because it is fast to take on and off.

6. Was it difficult to adjust the length of the strap?
-Yes. I wish I could see it better or that the device showed me how to do it and the distance. If I am going to use it every day I want it to be easy.

7. Was the calibration process easy?
-It worked well for me. Its a hidden feature but once I knew how it works it felt natural.

8. How was the feedback/signals of the device?
- It worked well for me.

9. Did you need instructions to use the product?
-Yes, the instructions I got were easy to follow.

10. How would you like to have these instructions to be provided?
- A manual like the one in the test.

11. Do you think you have a need for a product like this?
-Not now but if I had a problem with my neck and I could not move around well it could be useful.

12. Where would you use it and would you use it in public?
- I would use it at work, that's where my routines are and it would be easier to fit in.

13. What other attributes would you change or add to the current prototype?
-I think the manual should have some additional information to remind me why the training is important. I would also like a nice box for the device.

1. Name: Eva

2. Age: 60

3. Gender: Woman

4. What were your first impressions of Fixaspine before you tried it?
-Looks clunky

5. Was it difficult to put the device around your neck?
-Easy.

6. Was it difficult to adjust the length of the strap?
-Yes it was hard.

7. Was the calibration process easy?
- Not at first but I can see it being easy if you are used to it. For me it was confusing that I had to cover the sensor and then wait for it to start beeping.

8. How was the feedback/signals of the device?
- I would like to adjust the sound levels or use only vibration. It is too loud for workplace.

9. Did you need instructions to use the product?
-Yes

10. How would you like to have these instructions to be provided?
-A manual like this and not an App because it is complicated.

11. Do you think you have a need for a product like this?
- Yes

12. Where would you use it and would you use it in public?
- Both at work and home.

13. What other attributes would you change or add to the current prototype?
- Adjust signals to fit the situation, charge in a box. I would also like to wear it without it beeping all the time.

1. Name: Hanna

2. Age: 32

3. Gender: Woman

4. What were your first impressions of Fixaspine before you tried it?
-Looks industrial and medical. I was a little concerned that my hair would get stuck in the strap. It does not look like something I would buy.

5. Was it difficult to put the device around your neck?
-I think it was difficult actually. Did not see where the magnet would go and I think about if the magnet will come loose. I like however that the startup happens as you attach the magnet so I get started right away with the task.

6. Was it difficult to adjust the length of the strap?
- Yes it was difficult to put it on the table to adjust the straps.

7. Was the calibration process easy?
-A button would be better for me so I know that I have pressed the button instead of waiting for the beep to change. I would like a more positive sound when the calibration is completed. Otherwise I don't mind the sounds when I am alone.

8. How was the feedback/signals of the device?
- I would like a more positive sound when the calibration is completed. Otherwise I don't mind the sounds when I am alone and for work I need it to be silent so vibration would work.

9. Did you need instructions to use the product?
-Yes impossible otherwise.

10. How would you like to have these instructions to be provided?
- I would need a video. If it had printed manual it would have clearer illustrations and more close ups of the device.

11. Do you think you have a need for a product like this?
- Yes I always lean my back forward.

12. Where would you use it and would you use it in public?
- I would hesitate to use it in public like it is now. It might be ok to use if the a company introduced them to the office. To blend in easier it could be integrated into something else like part of the key card or attached to the same strap.

13. What other attributes would you change or add to the current prototype?
- I would like a softer material on the strap, more like a normal strap and a softer shape. A custom made strap that makes it easy for me to know my measurements. It should be non assuming shape, I don't need to make a statement, something that matches my clothings. More simplistic shape like an Apple product. I would like an app where you can fill in questions about your condition and it will choose the duration and other exercises. The app should keep me motivated and remind me of the exercises and help create a routine.

1. Name: Lena

2. Age: 68

3. Gender: Woman

4. What were your first impressions of Fixaspine before you tried it?
- Looks like a health device such as a medical tool. It is not that good looking, the shapes are hard and look uncomfortable.

5. Was it difficult to put the device around your neck?
- Not that hard but the strap came loose causing it to almost fall down.

6. Was it difficult to adjust the length of the strap?
- Yes, I could not do it.

7. Was the calibration process easy?
- Yes it worked ok

8. How was the feedback/signals of the device?
- I heard the signal well. In a normal work setting it is probably too loud.

9. Did you need instructions to use the product?
- Yes

10. How would you like to have these instructions to be provided?
- I liked the printed instructions so similar to the one I got.

11. Do you think you have a need for a product like this?
- Yes, but only if you had a good storage to put it in and if it was less loud.

12. Where would you use it and would you use it in public?
- I would use it at work or at home and use it at the same time as I am sitting down anyway. So in front of the computer at work and when I am reading a book at home.

13. What other attributes would you change or add to the current prototype?
- A bag or case to store it in.

User interviews
Age 13-18

1. Name: Louise

2. Age: 15

3. Gender: Woman

4. What were your first impressions of Fixaspine before you tried it?
-Looks like something you could get from the school nurse probably because of the color. The shape of the sensor feels a little bit science fiction.

5. Was it difficult to put the device around your neck?
-Yes and no. I got that it is a necklace but I thought the magnet could attach everywhere which was not the case. For me it was not obvious which side faces where.

6. Was it difficult to adjust the length of the strap?
-Yes it was. Adjusting it while wearing it was difficult because the magnet connector came loose. Once it is open it is easy to drop.

7. Was the calibration process easy?
-Hard when I can't see where to cover the sensor but once I put my palm over the whole top part it was easy to make it work every time. Just had to make sure that the magnet stays on.

8. How was the feedback/signals of the device?
-I was fine with the sound. It is not annoying to me if I use it for 30 minutes by myself. I would like the sounds to be more different though so I know what does what.

9. Did you need instructions to use the product?
-Yes.

10. How would you like to have these instructions to be provided?
- I would like both a simple printed manual and a video for the sounds especially.

11. Do you think you have a need for a product like this?
- Yes, sometimes I do my homework in bed which is not good for my posture.

12. Where would you use it and would you use it in public?
- I would use it at home because that is where I do my homework. I think it would be too noisy in the classroom.

13. What other attributes would you change or add to the current prototype?
-I would like it to look more neutral and normal. The appearance of this product does not look like anything it is related to. I bring my phone and other stuff to school and they are normal for me because you recognize what they are used for. Being able to make it less loud or vibrate only would be nice. I would store it in my room on a shelf where it is accessible, otherwise I would probably forget to use it daily.

1. Name: Elias

2. Age: 14

3. Gender: Man

4. What were your first impressions of Fixaspine before you tried it?
-Looks like a technical device and fragile.

5. Was it difficult to put the device around your neck?
-No, but when I tried it first without instructions I thought that the device should be underneath my shirt. Once I knew how it worked it was easy. It did not work too well with my hoodie.

6. Was it difficult to adjust the length of the strap?
-Yes because the strap is so thin and the clamps require some force to adjust the length and I was worried I would break it.

7. Was the calibration process easy?
-Once I tried it a couple of times and was shown how it was used it was easy and if I kept the strap the same all again next time when I know my measurement it would be easy to use.

8. How was the feedback/signals of the device?
-It took some time to understand what sound did what. I would get tired of the sound if I heard it too much.

9. Did you need instructions to use the product?
-Yes.

10. How would you like to have these instructions to be provided?
-An app would be great. I would probably not keep the packing or printed manual.

11. Do you think you have a need for a product like this?
-Yes, I don't have a problem but I have a bad habit of using my phone a lot and then I slouch my neck.

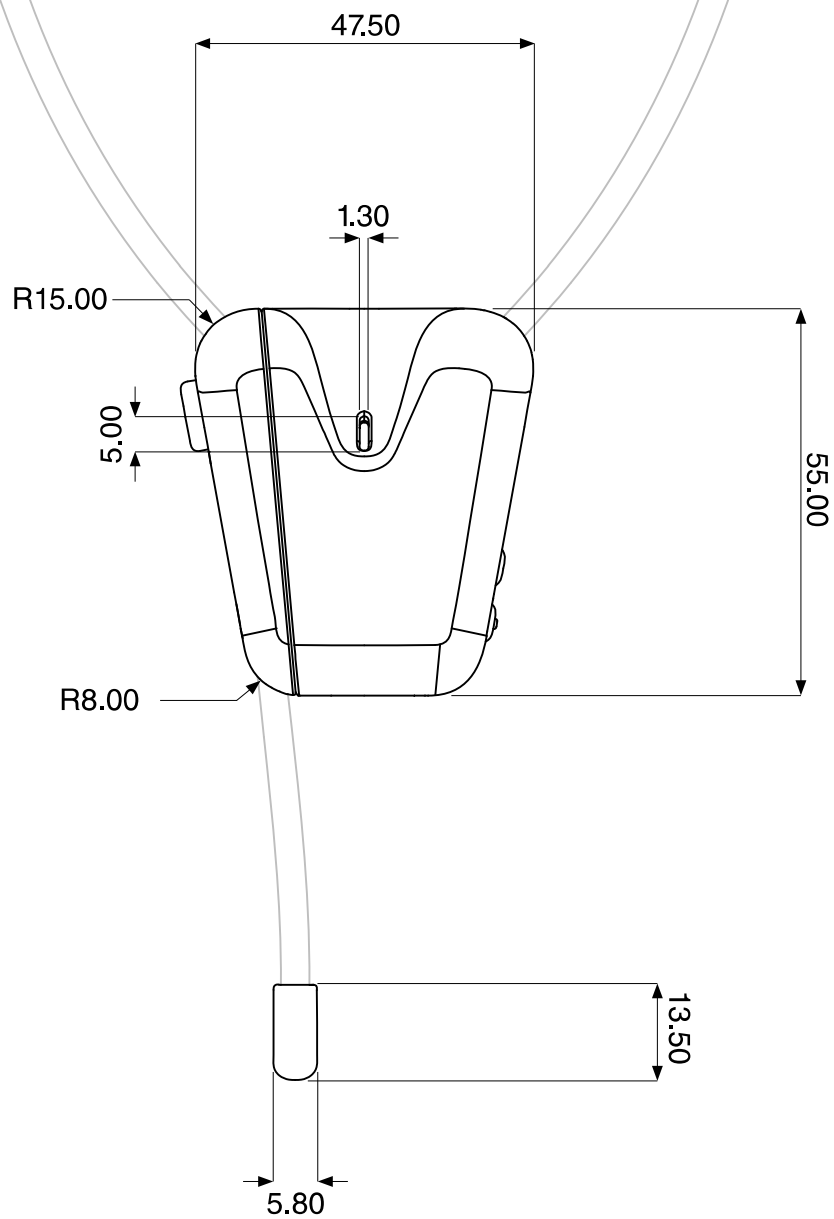**12. Where would you use it and would you use it in public?**
- I would not use it like it is now at school. The beeping sound would be annoying in school if everyone had one. If I had a problem I would be ok with using it at home if the shape was smaller.

13. What other attributes would you change or add to the current prototype?
- It would be nice if the device worked together with my phone and headphones. Instructions in the app on the phone in case I forget how it works and sound in headphones so I don't bother anyone
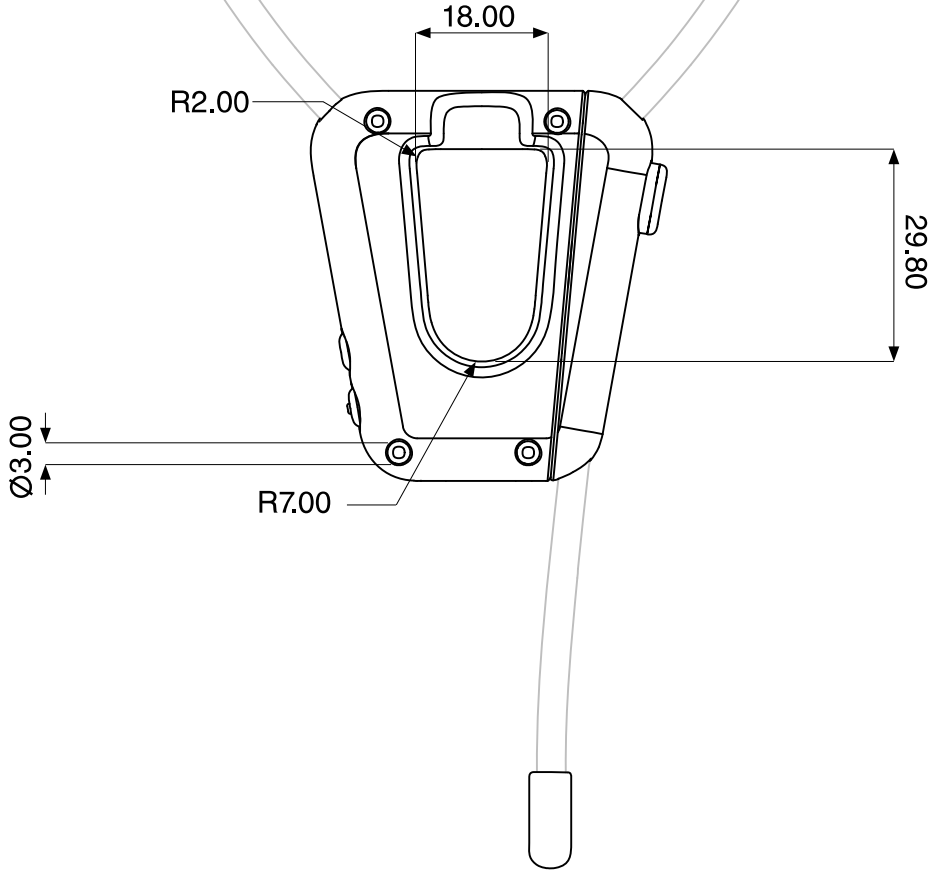
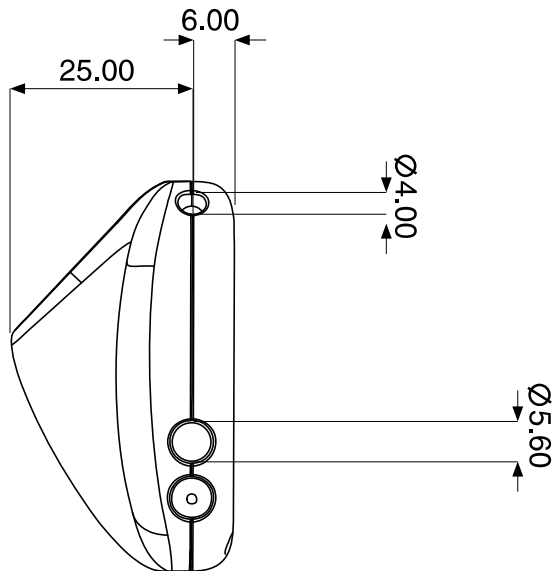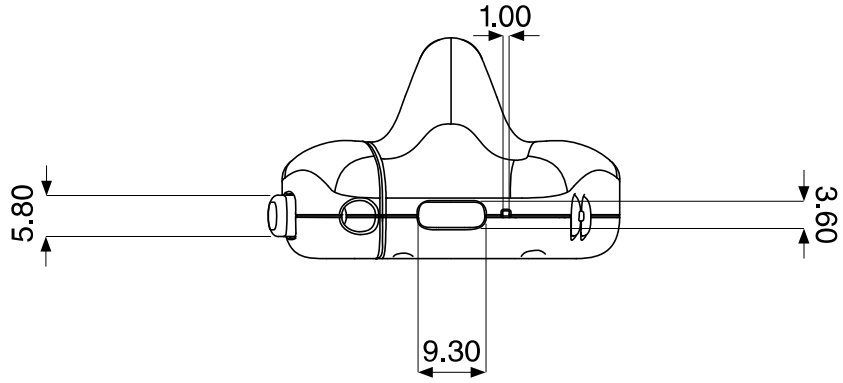# Technical
drawing

Scale 1:1
(mm)

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1.30

R15.00

5.00

55.00

R8.00

13.50

5.80

Scale 1:1
(mm)

18.00

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29.80

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R7.00

Scale 1:1
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1.00

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Scale 1:1
(mm)

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1.00

10.60

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Ø5.00

10.00

13.00

6.20

R1.00

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3.20

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