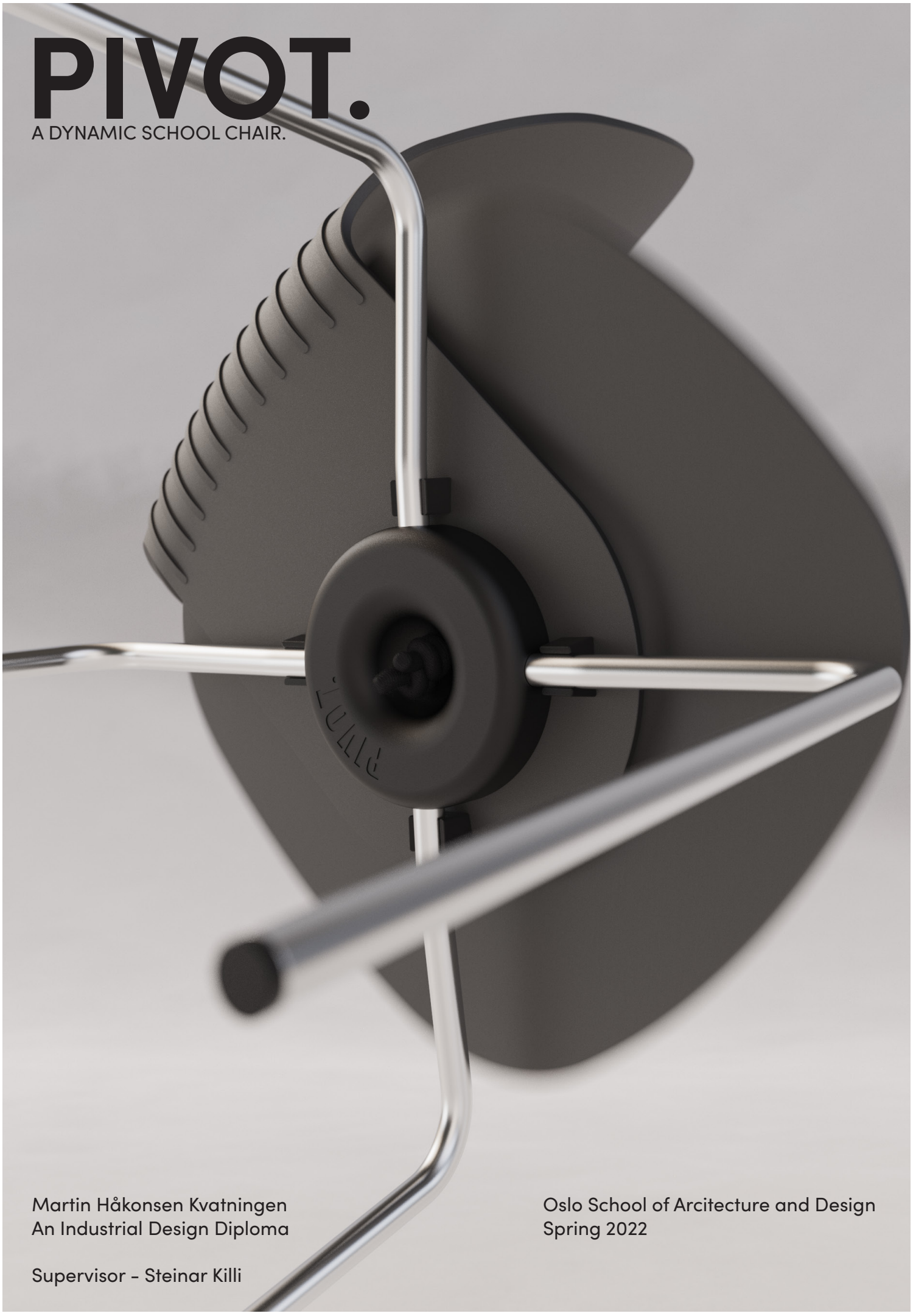
PIVOT.

A DYNAMIC SCHOOL CHAIR.



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An Industrial Design Diploma

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Oslo School of Arcitecture and Design
Spring 2022

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1.1 ABOUT

”Pivot”, a project that explores how to improve daily student life at school. Aims to design a chair with focus on active sitting.

Today, several students are struggling with poor sitting habits. This can negatively affect their personal health and school results. One reason for this is that schools often only offer regular static chairs. To improve students’ sitting habits, this project explores how, through introducing a new way of sitting.

Through a creative process of sketching, prototyping and user testing, this project concludes in a multifunctional dynamic chair, giving the users a whole new experience.

1.2 PERSONAL MOTIVATION

Furniture is all around us, we see them and use them every day. For me they are just not objects, but more than that. When I see a chair, I get curious about everything behind the chair. What is the idea behind or what production methods are used. Throughout my time at AHO, furniture design has really gotten my attention. After a few short projects designing chairs, i've been eagering to learn more about this universe.

Former project I did called "Corner" from the course Technoform.

1.3 GOAL

And as someone who wants to spend my time designing furniture in the future, I look at this diploma as an opportunity to expand my knowledge within furniture design, and showcase all the skills I've learned here at AHO. I know that designing a chair is a demanding task, but I want to challenge myself, proving that this is something for me.

Confidence is a big driver for me. With a good project in my portfolio, I get the drive to start new projects with new challenges. Hopefully this diploma will give me a good push. In the end, I want to finish my time here at AHO with a project that I'm proud of.

Going through this diploma, I'm showing an honest process. Going through each and every step, just the way it went down. Starting off with research, defining my scope, product development, final product proposal and in the end reflections.

2. BACKGROUND

2.1 INTRO

In this part of the report, I will explain the approach and context to my project. Taking you through desktop research, me talking to the users and finding the key insights forming my project.

2.2 SITUATION

An ordinary student spends hours in a chair daily. Studies show that we on average spend two-thirds of our study time while seated.[1] And a chair is considered as an important element when it comes to comfort and concentration in a study environment. This says alot about the important role of a chair in the student life.

There are a lot of factors that can influence your student life. Both, in positive and negative directions. A chair might not be the most noticeable, but it's there. Therefore it's important to not let an object affect aspects of your studies in a bad way.

From a personal perspective, my "school chair" is quite important to me. I sit on it for hours a day, if the chair does not cooperate, it will influence me. And we sit on quite normal static chairs. Maybe that's the issue? So I thought, how can I improve the daily student life through a more adapted school chair?

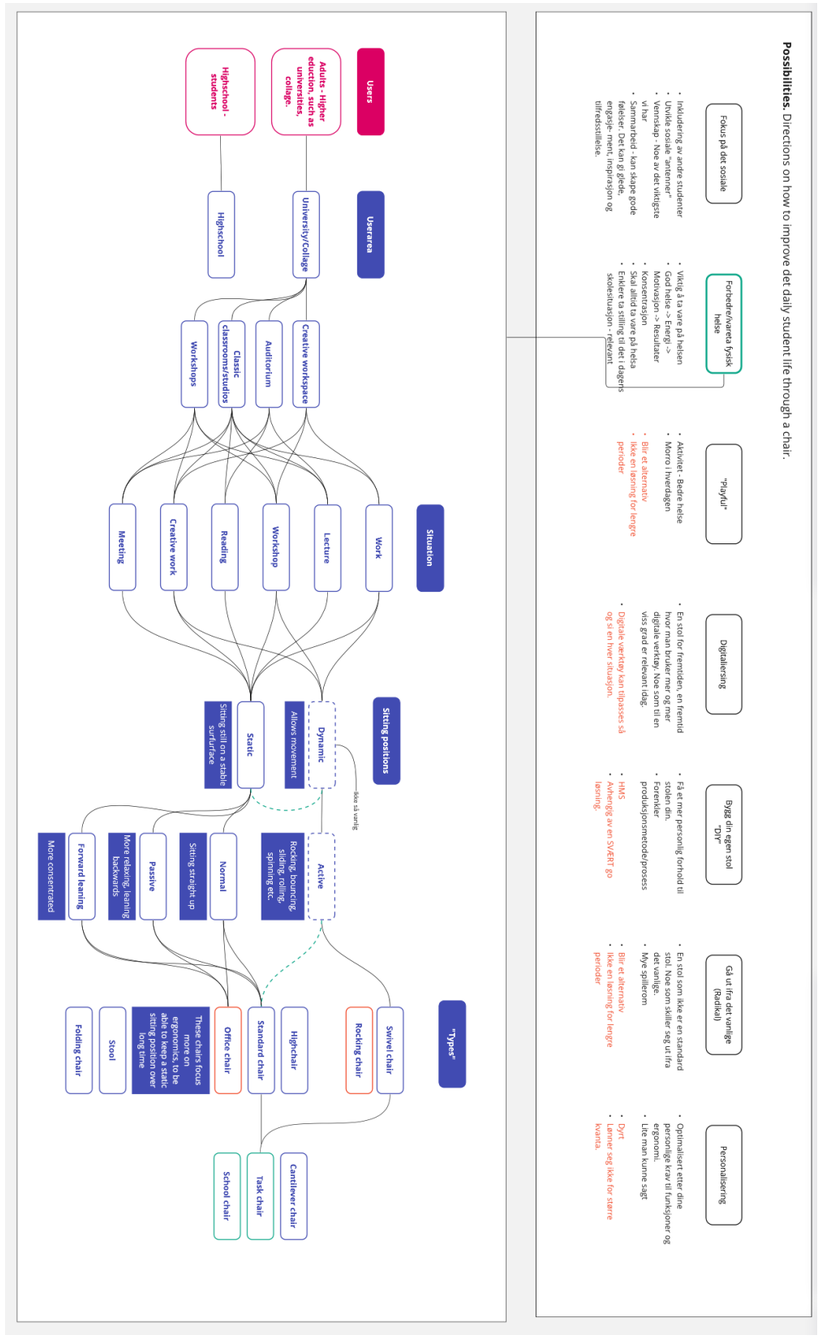
Photo: Zhuo Cheng - "Back to School" (2021)

2.3 POSSIBILITIES

As usual, this project started with "Desktop Research". At this point it was time to find an area to dive into. Therefore, it became very natural for me to start by mapping out different directions this chair can be aimed at. In each of these directions, I looked at both pros and cons. Weigh them against each other to find a direction that is relevant and has potential.

Many of these directions have a lot of potential in today's school situation. Such as the social aspect. In relation to fellow students, it is important for a student to feel safe and included in a school environment. And I think this can have positive effects on students' achievements. But the student's relation to its school chair becomes more of an individual thing and not necessarily something as general.

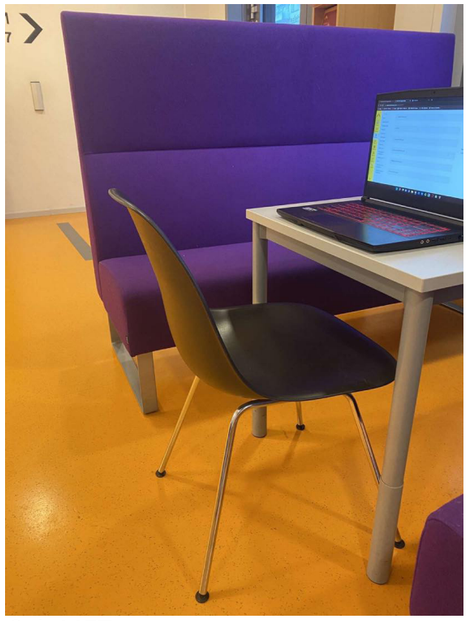
If there is one direction that always comes back to me, its health. We all have a personal relationship with our school chair. We sit in it for hours, and it has a greater impact on our health than what we think. This direction has a lot of focus in today's society. And with different "methods", the focus on health can do a lot with the student's quality of life and achievements.



2.4 CURRENT SITUATION

To get a better understanding of what the students actually sit on in today's situation. I visited different universities and colleges in Oslo. And mostly the students sit on quite basic chairs. At BI the typical chair is usually based on basic ergonomics, where the student sits more less in a static position. And the same goes to the chairs at Oslo MET. On the other hand, at AHO we have in my opinion better solutions. But what all these chairs have in common, is that over hours of sitting most students end up sitting in bad positions, which affects their posture and in worst case their studies.

Handelshøyskolen BI



OsloMET

Arkitektur- og Designhøyskolen i Oslo

2.5 GOOD POSTURE?

We all know that sitting with a good posture refers to a healthy spine. Studies show that sitting and standing with proper alignment improves blood flow, helps keep your nerves and blood vessels healthy, and supports your muscles, ligaments and tendons.[2] From my experience, I tend to not sit properly. That's because I've developed a bad habit, and there is nothing that reminds me of sitting healthy. And I'm sure I'm not alone.

2.6 INTERVIEWS

I've talked to the students at different schools in Oslo. I asked them about their relationship and experience with what they sit on. Most of the students that I talked to struggle with maintaining their posture. As one of the students said:

"I'm not conscious enough to sit properly. I can make myself sit up straight, but after 5 minutes I end up in a bad position. Without even notice It after 1 hour".

This seems to be a common thing. Because of this bad habit and the static chairs, It tends to affect daily life at school in one way or another.

"I have to take walks every now and then to take care of my back, because the chair doesn't"

"Sitting on a bad chair, affects my concentration"

That this issue is a common thing, is in my opinion critical. I'm sure there are students that are happy with what the school has provided them. But even if only a slight percentage of students have issues. The reason to do something about it is good enough.

To conclude, It seems like students need to be more conscious about their sitting posture. And to achieve this it is almost like we need a chair that "forces" us to actually develop a good sitting habit.

2.7 ACTIVE SITTING

How can you actually develop a good posture, or at least a healthy sitting habit? If you look at today's school chairs, there are almost just static ones. But where are the more dynamic chairs?

Active sitting is allowing the body to stay dynamic while seated and may consist of using modified chairs. Its goal is to engage some of your muscles like the back, abdominal, and legs. Instead of motionless sitting all day, active sitting lets you make minor movements to keep some of your muscle groups active.

And what are the benefits of this way of sitting:

- Improves posture
- It stabilizes blood flow and oxygen intake - This results in an energized and rejuvenated mind and body.
- Burns calories - Which signifies that energy is still being produced. [3]

2.8 SCIENCE

There have been several scientific tests to prove the benefits of active sitting. The Journal of Physical Therapy Science, did a study[4] on how working while sitting for long periods can cause lumbar pain, fatigue and reduced work efficiency. This article explains how a dynamic chair with a seat that moves three-dimensionally, has positive effects on pelvic mobility before and after work, work efficiency, and post-work fatigue.

For this, they tested and compared a static chair to a dynamic chair, by using healthy adults (mid 20s). They concluded that dynamic sitting maintained or increased pelvic flexibility and effectively helpt workers work continuously in seated postures with less fatigue.

With the scientific evidence of dynamic sitting benefits. It's weird that there is less focus on this in today's schools. But I'm sure there is a bigger reason behind this.

The Journal of Physical Therapy Science

Original Article

Effects of a dynamic chair on pelvic mobility, fatigue, and work efficiency during work performed while sitting: a comparison of dynamic sitting and static sitting

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Abstract. [Purpose] Working while sitting for long periods can cause lumbar pain, fatigue, and reduced work efficiency. How a dynamic chair with a seat that moves three-dimensionally affects pelvic mobility before and after work, work efficiency, and post-work fatigue were examined. [Subjects and Methods] Subjects were 17 healthy adults (10 males, 7 females, mean age 21.8 ± 2.7 years). Subjects performed a 30-min Kraepelin test under two conditions: sitting in a standard office chair and sitting in a dynamic sitting balance chair. Root mean square (RMS) values of pelvic movement measured by a triaxial accelerometer during 30 minutes of work, finger-floor distance before and after work, lumbar fatigue, and pelvic movement RMS values during finger-floor distance measurement were used as outcome measures. [Results] Pelvic movement RMS values collected every 5 minutes during 30 minutes of work were significantly higher while sitting in the dynamic balance chair. Changes in pelvic movement RMS values during finger-floor distance measurement after work and amount of work performed during 30 minutes were significantly higher and lumbar fatigue was significantly lower for the dynamic balance chair. [Conclusion] Dynamic sitting maintained or increased pelvic flexibility. The dynamic balance chair may effectively help workers work continuously in seated postures with little fatigue.
Key words: Pelvis, Sitting, Ergonomics

(This article was submitted Jan. 21, 2016, and was accepted Feb. 22, 2016)

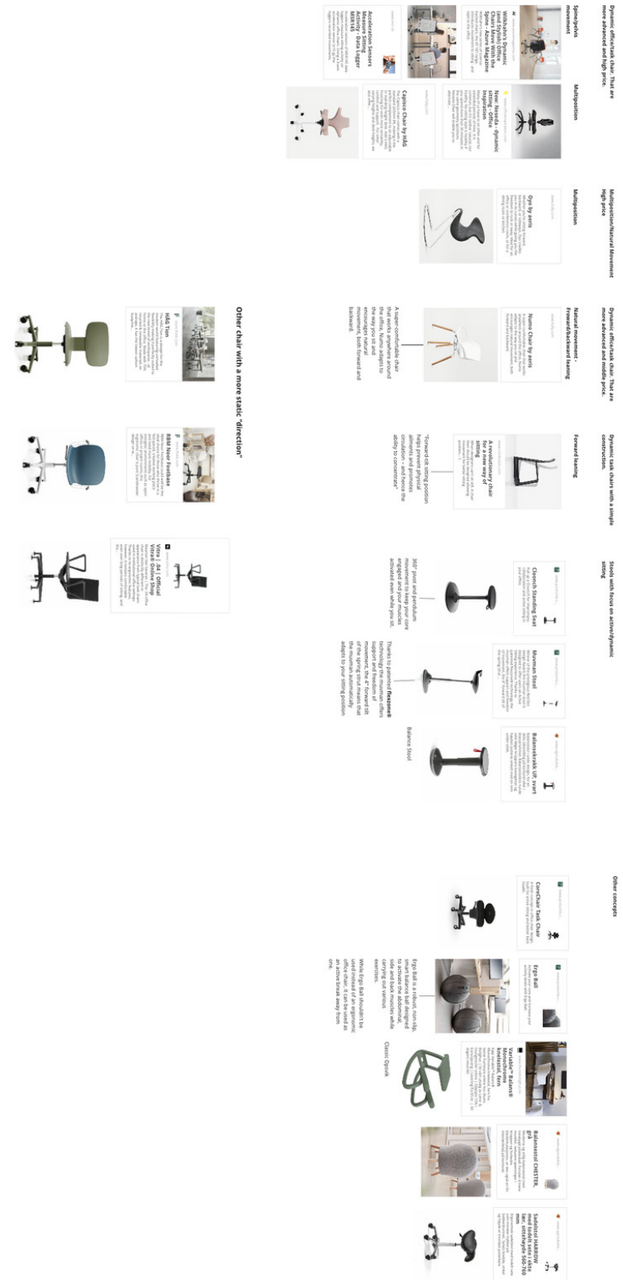
INTRODUCTION

Many office workers perform work while sitting in chairs[1)]. A previous study reported that workers in sedentary jobs spent an average of 10 h in a seated posture during a 24-h period[2)]. Prolonged sitting at sub-optimal workstations is associated with musculoskeletal dysfunction[3–5)]. While seated postures are less physically stressful overall than are standing postures, they place significant mechanical stress on the lumbar vertebrae. Thus, maintaining a static seated posture is a risk factor for low back pain[6, 7)]. In 2013, the Japanese government published guidelines for preventing low back pain at work. These recommend placing the lower back deep into the chair during work and supporting the trunk with a backrest[8, 9)]. The purpose of a backrest in an office chair is to support lumbar lordosis and to attenuate disc pressure that occurs as a result of gravity[10–13)]. Proper posture is a state of musculoskeletal balance that minimizes the stresses and strains acting on the body[14, 15)]. However,

2.9 THE MARKET

To get a good view of what today's market looks like, I mapped out and sorted the existing products.

Dynamic chairs come in many variations with different functions. There is a good range. But what makes these chairs "stand" out in the market is often price. Many of these chairs require complex components to enable specific functions. And that comes with a price. At least compared to a normal static chair based on a simple construction. And this may be one of the biggest drivers to why there's less focus on dynamic chairs in today's school picture. Schools often order chairs in large quantities, and that makes cheaper chairs more attractive and affordable.



3. SCOPE

3.1 PROBLEM STATEMENT

With the benefits of dynamic sitting, which should be more focused on within higher education schools. And students' lack of awareness on how to sit healthy. I see an opportunity to improve their everyday life at school, through a chair that promotes active and healthy sitting.

3.2 **3B**

User:
In this project I'm aiming to design for students in higher education. When these are students who spend more time seated, compared to for example students at primary or highschools.

Usersituation:
This chair will be an optional dynamic chair for the students to do their studies on.

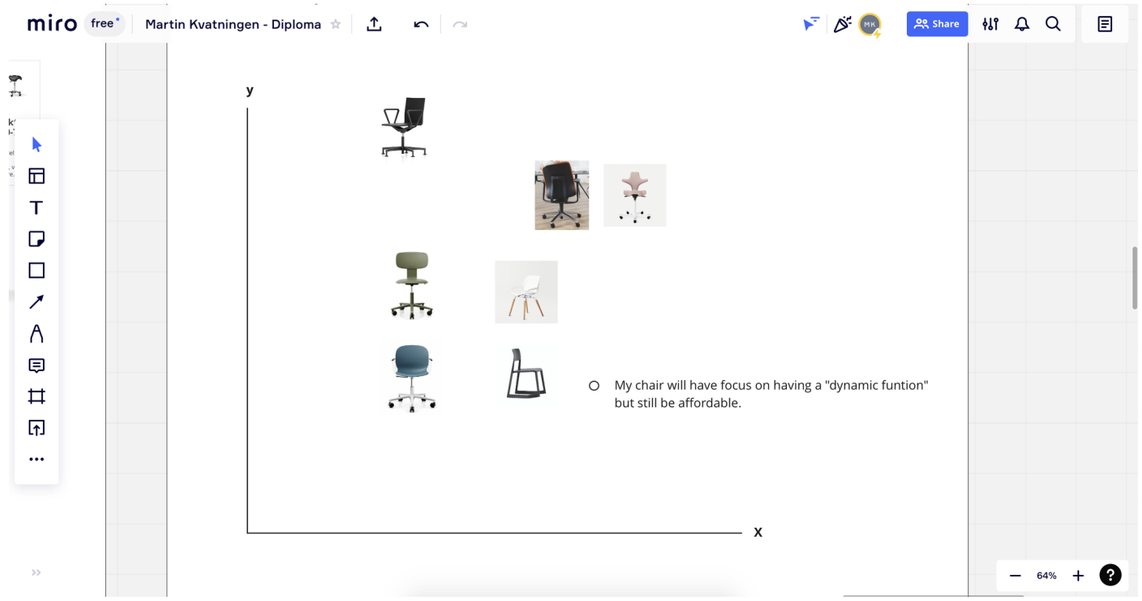
Userarea:
The main user area will be colleges and universities. But this can also be implemented in lower educational levels.

3.3 REQUIREMENTS

- Price is one of the most important factors. As these chairs are ordered in large quantities. The lower the price the better and more attractive. I'm not saying I'm going to design the cheapest chair, but try to keep it relatively cheap.
- To achieve this I need my solution to be as simple as possible, use as few components as possible, and to not use any complex mechanical solutions.
- The use of durable materials are necessary, since these chairs are going through rough use over years.
- I want to have a chair that gives the user a new sitting experience, with a function that promotes active sitting.
- Generic ergonomics and proportions.
- Some level of comfort.
- Possibility of stacking.
- DFM - Is quite important in the project. Where my design will be designed for specific production methods.

3.4 WHERE ON THE MARKET?

Compared to the market, I want this chair to focus on a dynamic function, and still be an affordable option.



3.5 SUSTAINABILITY

Sustainability has a lot to say in this project. Or in general, it is always important no matter what product you are designing today. To design a fairly sustainable chair. I'm following certain overarching "rules".

- Use of recycled materials.
- Chose materials that are durable.
- Use as less components as possible.
- Replace or fix worned out parts.

3.6 AESTHETIC MOODBOARD

- A color palette that blends the chair into a school environment.
- Soft lines and shapes that give a feeling of comfort.
- Functions that gives aesthetical values.

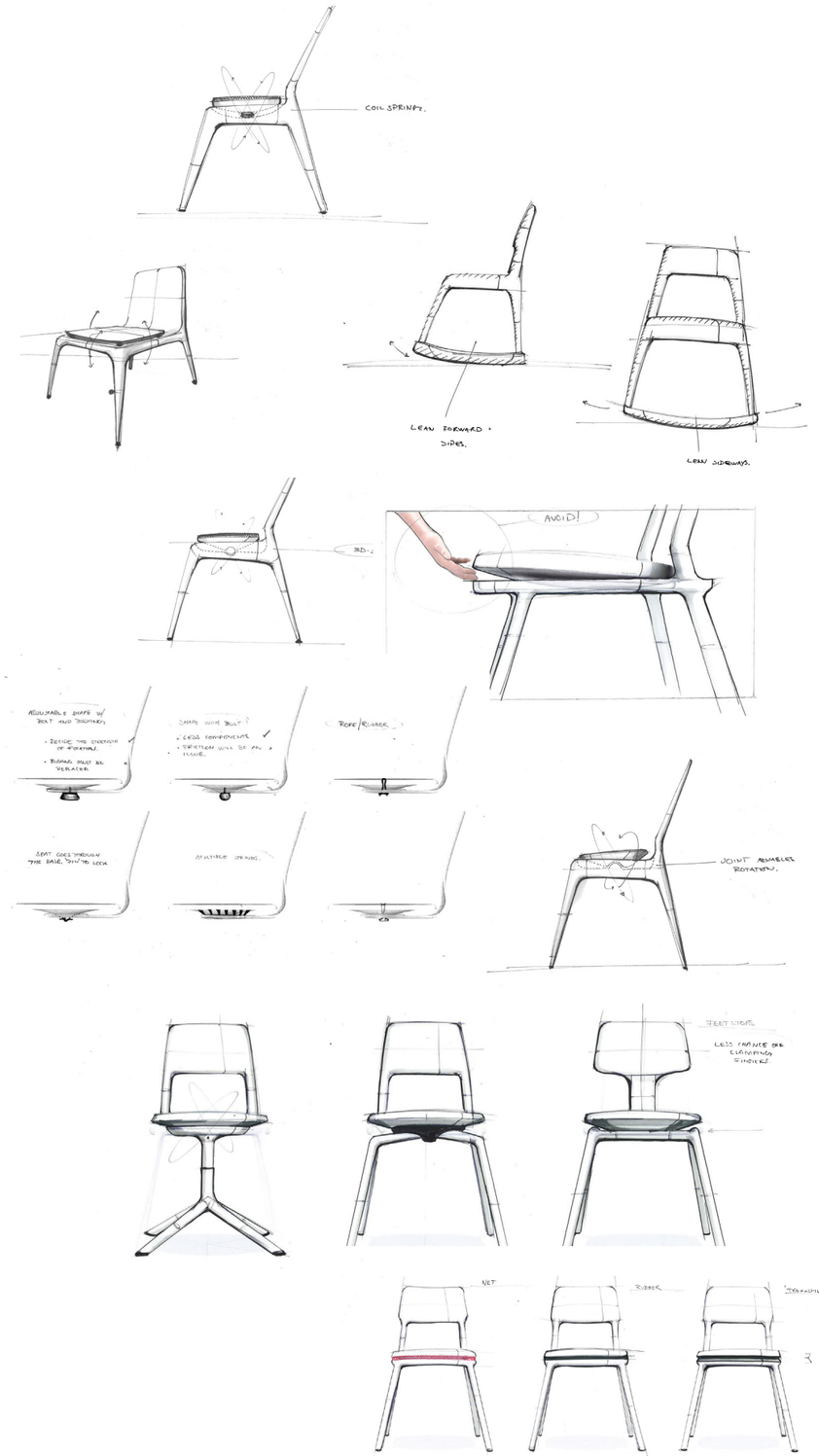
Vitra - "EVO-C" (2020)
Antony Richards - "Pendant Light Hook" (2015)
FRITZ HANSEN N02

4. PRODUCT DEVELPOMENT

4.1 INTRO

Now, with my scope ready, It is time for the fun part of the process. In this chapter I will take you through a creative and problem solving process. Showing the early sketches transforming into physical mockups and prototypes.

4.2 IDEATION



Some sketches from the process.

Sketching with pen and paper is a fantastic tool. It's a nice way of getting ideas onto paper rapidly. I have sketched a lot along the way, as new ideas/concepts popped up in my head. Looking at existing solutions out there, I sketched down similar concepts and tried to find something new and interesting.

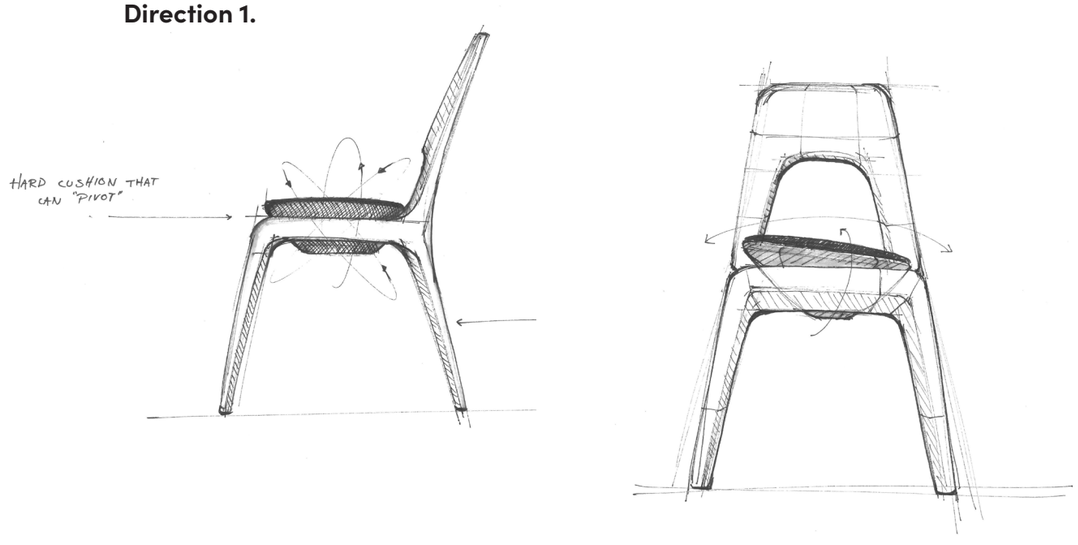
After analyzing all these sketches, I've managed to go further with two main directions.

Direction 1: Where the first direction is to have a static frame and a separate seat that promotes movement.

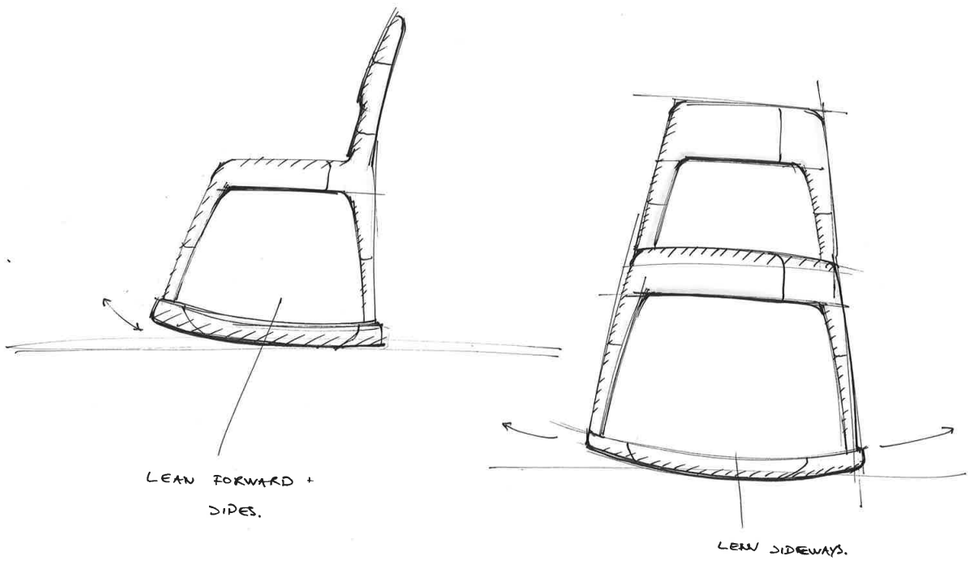
Direction 2: The idea is to have a 100% solid structure that promotes movement though its legs.

Weighing these two directions up to each other, I found direction one the most interesting. This was a hard choice to make. Because I see potential in both of them. Direction two has a big advantage when it comes to the number of components. Since there only would be one. But with this direction, I found it hard to be original. Looking at the market, I sew similar concepts and I was scared this would limit my solution. When direction two had more room to play with.

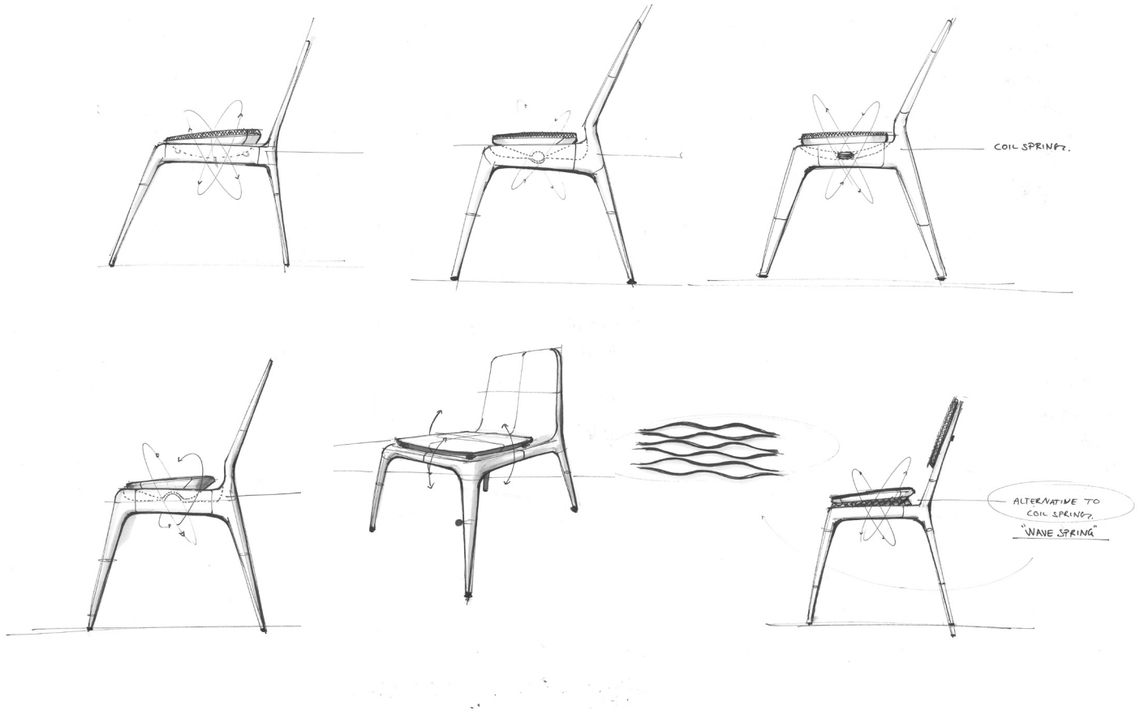
Direction 1.



Direction 2.



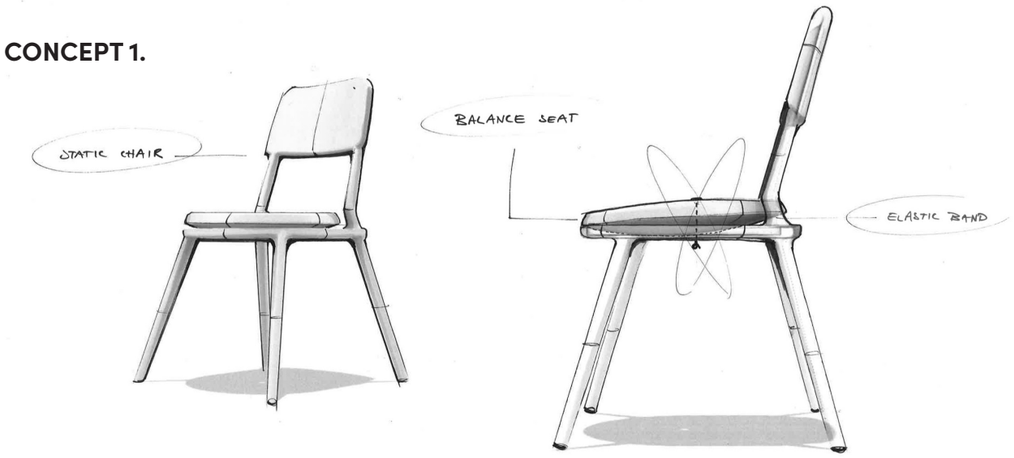
4.3 CONCEPT



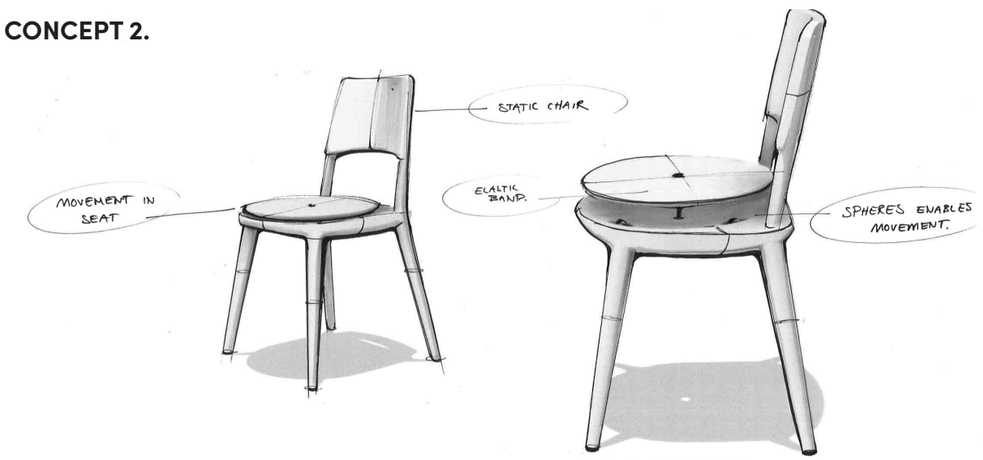
Sketching further on my chosen direction, I noticed some issues. Some of these concepts require some kind of technical solution or that friction could be a tearing problem. Knowing that my requirements want a simple solution, I found two concepts more adaptive.

The first one was the simplest one, where the seat uses FORM to enable movement. The idea is to have a "half-sphered"-shape underneath the seat that balances with a pivot point on top of a surface. This gives the user the possibility to tilt back and forth in every direction, balance your core and rotate while seated. The other concept. Gives you the same movement, but its four small "balls" to rotate on.

CONCEPT 1.



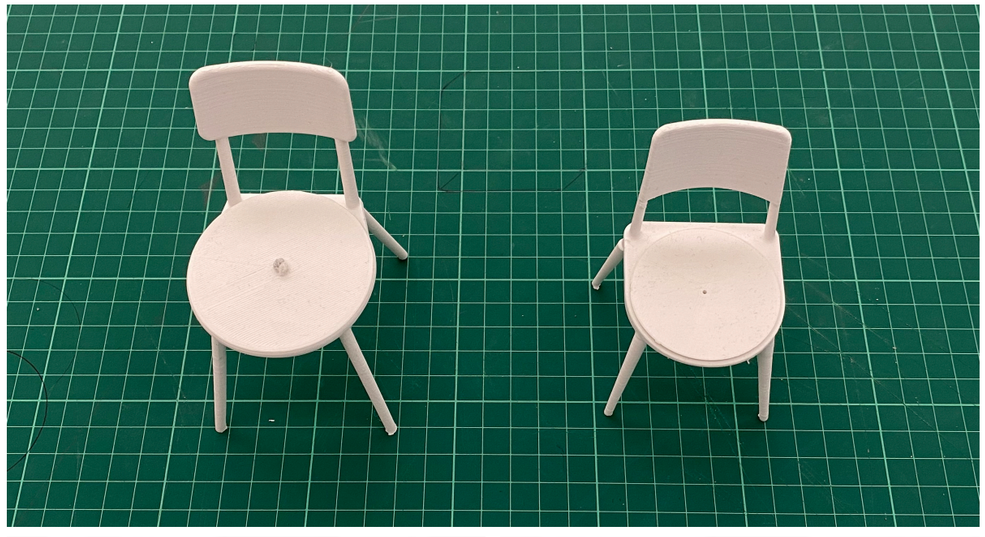
CONCEPT 2.



4.4 CONCEPT MOCKUPS

To get a better eye on these two concepts I decided to take them into physical form, and made 3D-printed scale models. Concept nr 1 turned out to be as I imagined, but concept two had some issues.

The four balls made the seat rotate, but it "moved" the seat out of the chair's frame. Which would be critical in terms of use. This was something I didn't imagine, and that shows how important it is to physically test something, instead of looking and thinking at a 2D-drawing. I had a good feeling about concept 1, and maybe the saying "the simplest solution is almost always the best" is true?



When you are designing a chair, it's important to test out the concept in 1:1 scale. To actually understand this concept, I took it one step further. I wanted to see If this concept actually worked and had potential. By making a quick physical model for testing. I tested this principle with multiple students, and got approving feedback.

- **This was something interesting and new for the students**
- **It was fun and playful.**
- **But it also gave the students a feeling of sitting "free", you could sit however you want, tilting forward, backwards or even balancing.**

This feedback gave me a green light, so I started diving more into it.

To have good reflections on how this concept actually works. I Imagined long time testing is necessary. Therefore I used this mockup as my chair for a longer period, and summed up my reflections at the end of this report.

5. PRODUCT DEVELPOMENT, SOLVING FUNCTIONS

5.1 INTRO

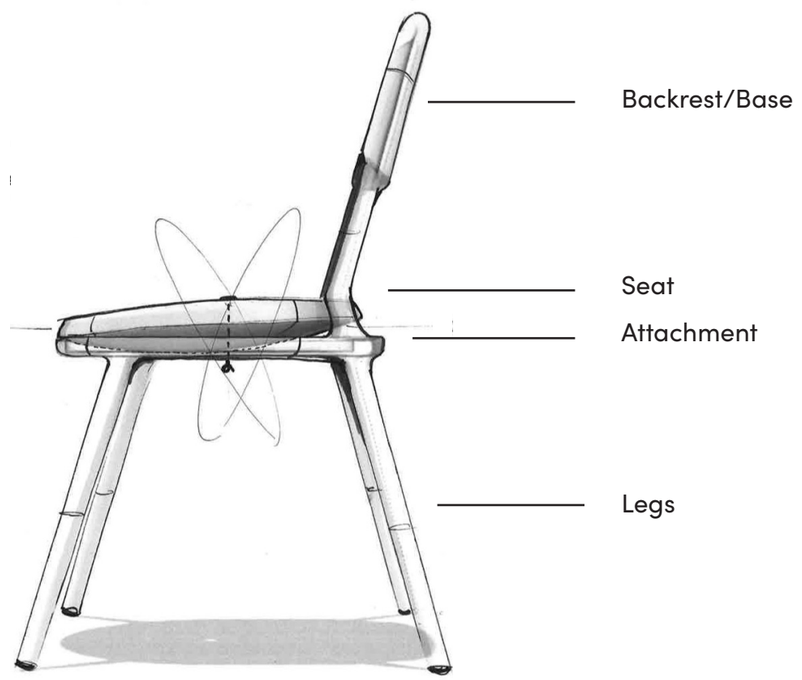
Throughout this problem solving process, I've done constant testing along the way with both users and myself. After all these problems are solved. I built a functional prototype which I in the end took into a final usertest.

5.2 **ONE BY ONE**

Designing a chair is not the easiest task, there are a lot of components, functions and proportions you need to be aware of, and in the end all these need to communicate to each other.

To make this process easier for myself, I split the chair into the different components needed. Started with the main component, used that as a base, and designed everything around it. Taking each component, one at a time.

Throughout this problem solving process, I've done constant testing along the way with both users and myself.

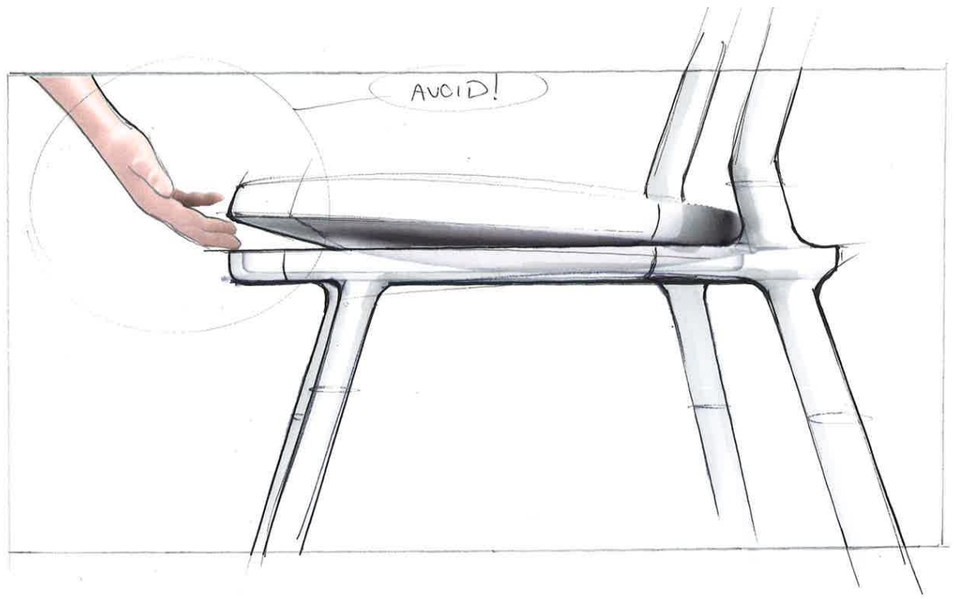


5.3 **BACKREST/BASE**

I started with the backrest in combination with what I call the “base”, which is where the seat will be balancing on. As this is one component.

Already after doing the first physical model test, there was an issue. Where there’s a possibility to clamp your fingers in between the seat and base. This could occur if you were to adjust your position while seated. Even though this doesn’t sound that harmful, the possibility of injuries is always a “No go”.

I did some sketching on my own, where I looked at how I could use material in between the two parts or even change the shape of the base itself. But did not seem to solve this without changing the concept drastically or adding unnecessary components.

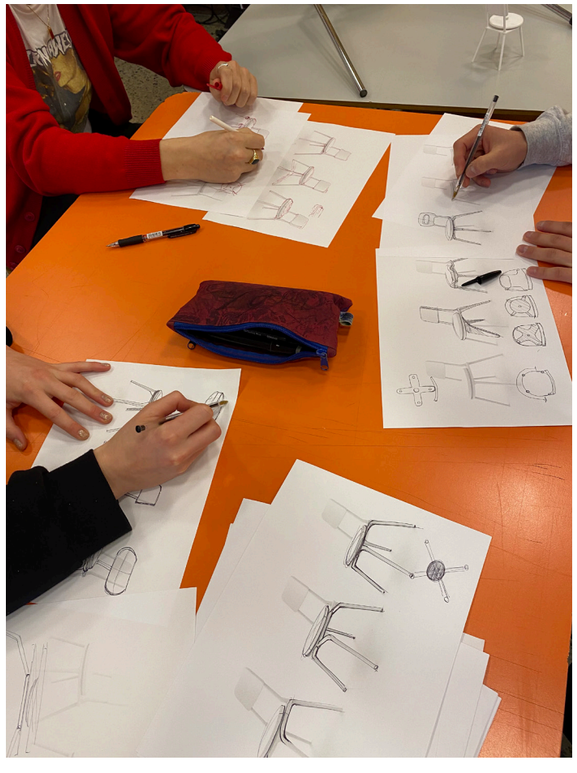


5.4 **BACKREST/BASE WORKSHOP**

To solve this I sought some help from my fellow students. Arranged a workshop to get more “designer-brains” onto this issue. After a discussion and some sketching, we ended up with a conclusion that, to keep the original concept, we needed to reduce the possibility of actually clamping your fingers. To do so, the user needs to actively do it on purpose.

This was solved by reducing the width of the base itself. The user needs to stick their hands all the way underneath the seat. This way the user is most unlikely to clamp their fingers with natural behaviors of use.

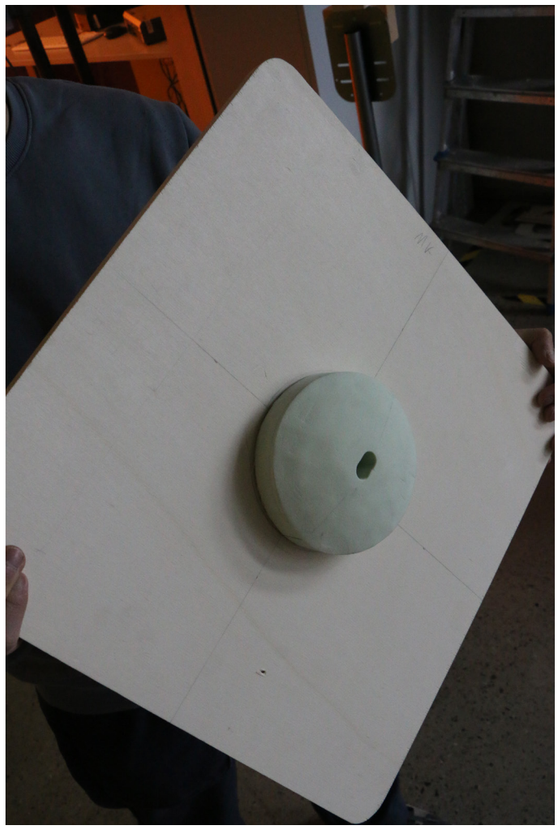
Even though there is a slight possibility to clamp your fingers, I feel like this solution lies within the limits of security.



5.5 **SEAT**

Now the seat is one of the straightforward components, I knew I needed a half sphere as a balance-point and an ergonomic surface on top.

Pivot
After testing with the existing 1:1 mockup. The half sphere is well balanced. The size feels good, it's not too "sensitive" and you get a good degree of tilt and rotation. Considering this, I used these dimensions at a base throughout the process.



Ergonomics
Following my requirements, my chair will be as generic as possible. I used existing proportions and ergonomic shapes. As this chair has a movable seat, the feeling of sitting "tight", was necessary. The last thing I wanted is to have the user sliding off the chair.

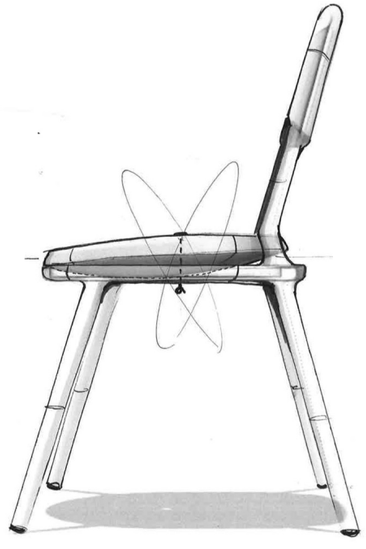
Static seat?
I also thought of the idea to somehow lock the seat for a static sitting position. But the question is, is there a need? After doing testing around the first mockup. The movement is relying on your core and the positioning of your legs. This way you are able to hold a steady position while seated. For a more body-resting position, you are also able to tilt back and forth, resting the seat on the base. So even if this is a dynamic chair, the possibility to sit statically is also possible. Without any necessary lock-mechanism.

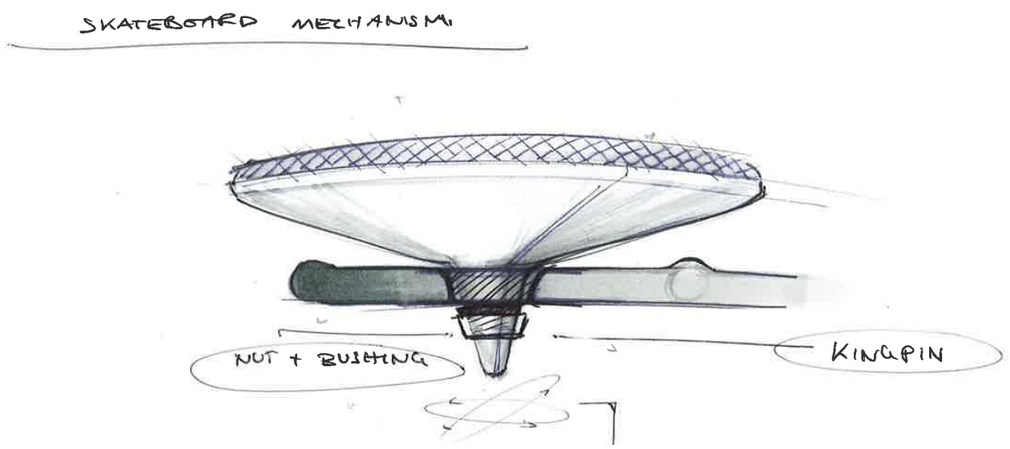
5.6 **ATTACHMENT**

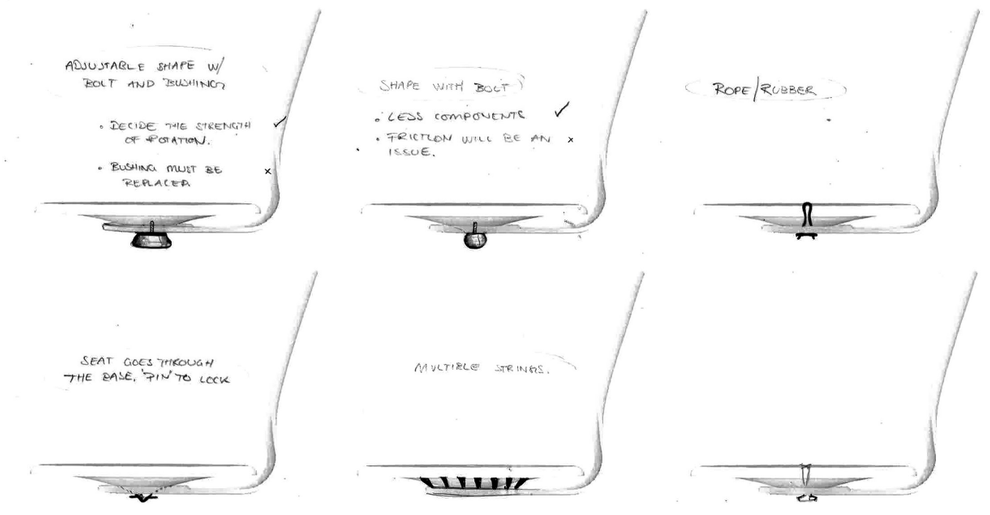
The seat does not go anywhere when you sit on it. Because the pressure from your bodyweight holds it in tackt. Unless you have more radical movements. But for example: you need to be able to move the chair and still have the seat mounted. Basically there can't be any loose parts. Again, I wanted my chair to be as simple as possible, by not using any complex components. And this function can influence the design in the opposite direction. That's why I had to think about simplicity.

The main idea was to have an elastic string/band that attaches the seat to the base. But my concern was if this was enough in terms of wearing of the material.

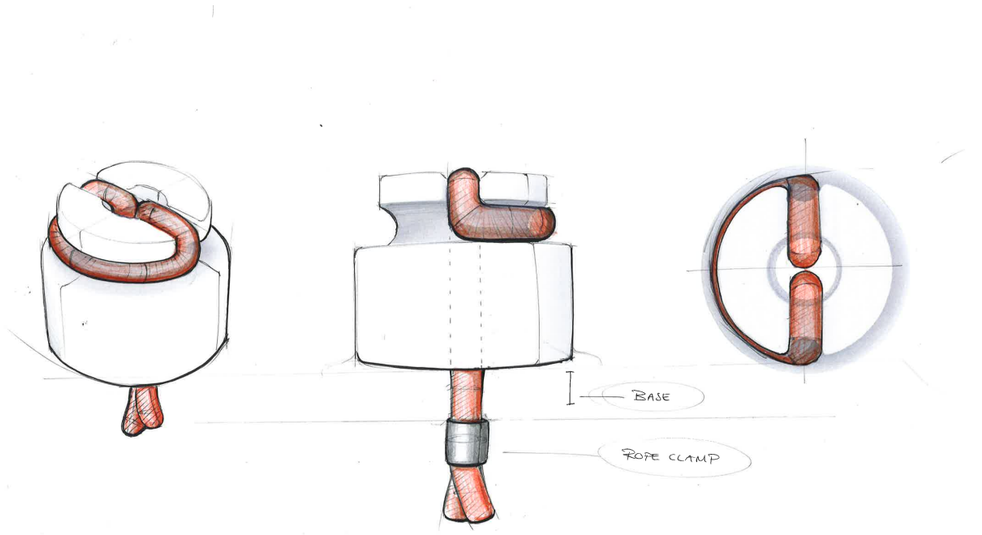
I went back to the drawing table, made up several ideas on how this could be solved. The best would be if I solved this only using form and no extra components. But all I ended up with was something similar to the rope or something that's totally against my requirements. So I thought, let's just try the rope again. Because I wont know if this works before I actually try it.

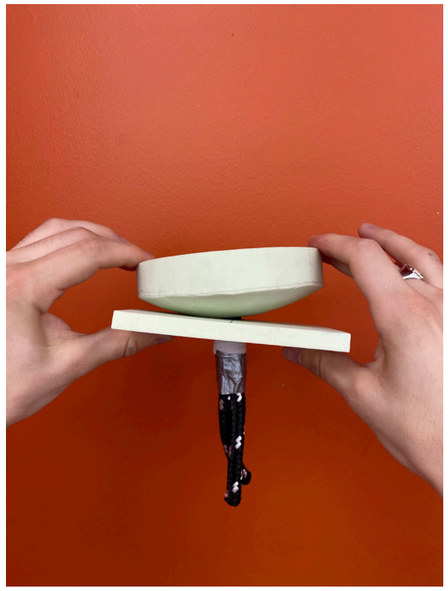






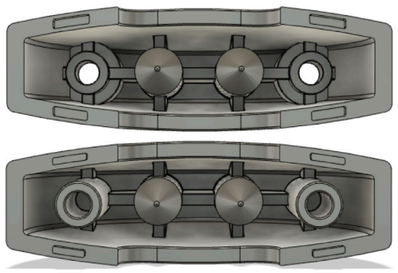
Hook
The idea behind this solution is to use the rope as a hook, feed the rope from under the base, and then hook it on the “cut-out” on top of the seat. After some testing, the mockup turned out to be a success. The rope held the “seat” intact with the base, and did not affect any movement.

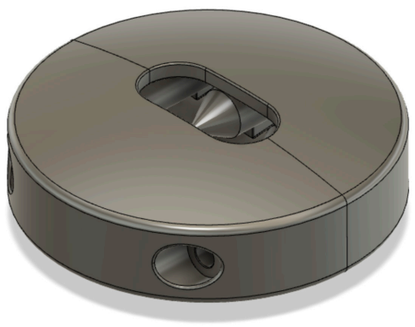


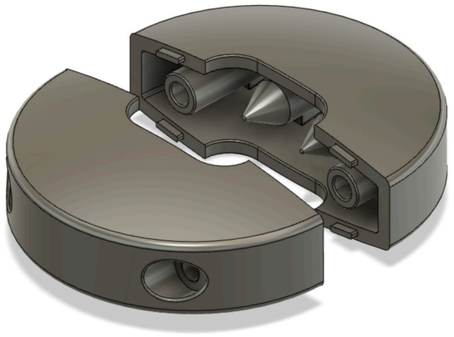


Clamp
Next thing was to figure out how to clamp the rope on the bottom. To prevent it from unhooking. Based on a classic rope-clamp. I “cadded” and 3D-printed one.

I tried it on the mockup, but the spikes seem to wear on the rope. Making it loose. This is not Ideal, I needed something stronger than the both rope and the clamp. I took one step back, and tried to come up with something even simpler.







Elastic band - Cup
Inspired by ball bungees, I bought a stronger elastic rope and made a similar solution, which holds up really strong and there is less wear on the rope.

5.7 **LEGS**

Since my “base” had a slimmer surface compared to normal chairs. There will be a smaller anchor point. Inspired by “Syveren” designed by Arne Jacobsen, I quickly knew I needed a crossed-leg structure. This way I could attach the legs to the base. This structure gives the strength needed underneath the center of gravity.

Now taking all these functions into a total conclusion. It was time to create a functional prototype.

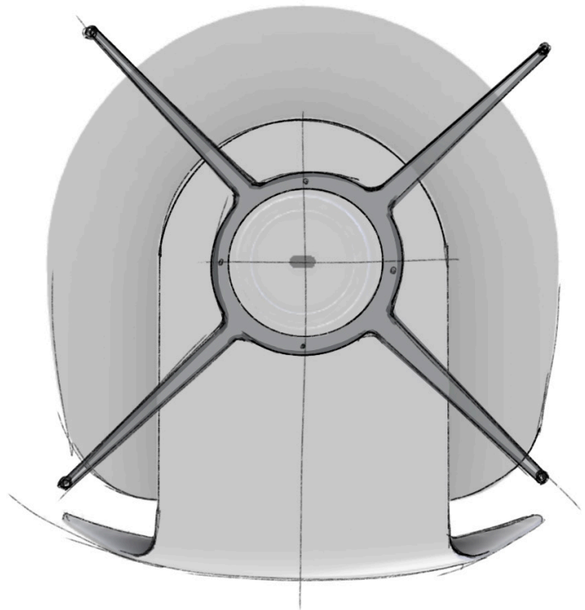


Photo: Brian Burchard - Berlin x Republic of Fritz Hansen (2017)

6. **FUNCTIONAL PROTOTYPE**

Creating a functional prototype was necessary for this project. I think this gives you a good picture of how the different functions really work and how the product feels. It is at this point you will find out what's working or not.

Creating this prototype, I've used the resources this school has to provide. With a fantastic workshop I managed to build a prototype with the thought functions, ready for testing.

FUNCTIONAL PROTOTYPE

68.

69.

6.1 **USER TESTING**

Again, we students sit on chairs over long periods. And I believe that to properly test this dynamic chair. It has to be done over a “longer period”, rather than just a fast test-sit. This way I asked four students to use the chair for a whole day each.

I handed the students the chair, and told them to not be scared of being too hard with it. After a day of use, we had a chat. I asked them about what they thought of the dynamic function, and the impact on their body.

- How is the sensitivity of the seat?
- Are you able to move around/ do you feel comfortable moving around?
- How is it to hold a static position?
- How is it in combination with work?
- Does it have an impact on your body (negative or positive) after a day of use?

When It comes to the feedback I got from the students, there are a few things I found interesting.

“It is good, not too much. Does not feel like I am falling off the chair or anything.”

“It is comfortable to move both front to back and side to side. Nice to be able to turn to the sides when sitting, it creates less strain on my neck.”

“I feel like I sit in a more active and dynamic way, especially since I can tilt a bit more forward. The tilt forward is also helpful for me to reach the floor with my feet since I am a bit short.”

“Good when working, activating the core.”

When It comes to sensitivity, the students feel there’s not too much or too little movement. The most important thing is that the students don’t feel like they’re falling off the chair. After tons of usertesting, this function can of course be optimized, finding a perfect sensitivity. But I think I’ve gotten quite close to that.

What I want with this chair. Is to give the user the possibility to move freely on the chair, adjusting the position for different working situations. And also be able to pivot and keep your core active. And this seems to be “achieved”.

“After sitting it and working for a day, I got used to this mechanism, but I found myself sitting still at one angle. This causes some problems, like it puts too much pressure on one side of my butt compared to sitting flat, so if I sit still too long, this means one side of my butt will feel hurt and tired. But this might be good, as it reminds people to move. In my case, because I have only used it for one day, I found this most annoying.”

The seat also made me use the backrest very rarely as I felt like being more forward while doing designwork and communicating with my partner. It made me sit and feel more active in the creative space.

We students are quite used to sitting on normal chairs. And most of us haven’t tried some of the existing dynamic chairs. That makes sitting on this chair a whole new experience, giving it an interesting and positive first impression. But after some time, your body can react to the mechanism. But I think that this has something to do with that you are not used to it. So over time these issues can be overcome.

The testing was done at AHO. Where most of our work is done in a creative workspace. Making the user more forward leaning and engaged. So I should have tested this chair in a more “relaxing” environment. Where the user sits more backward-leaning using the backrest.

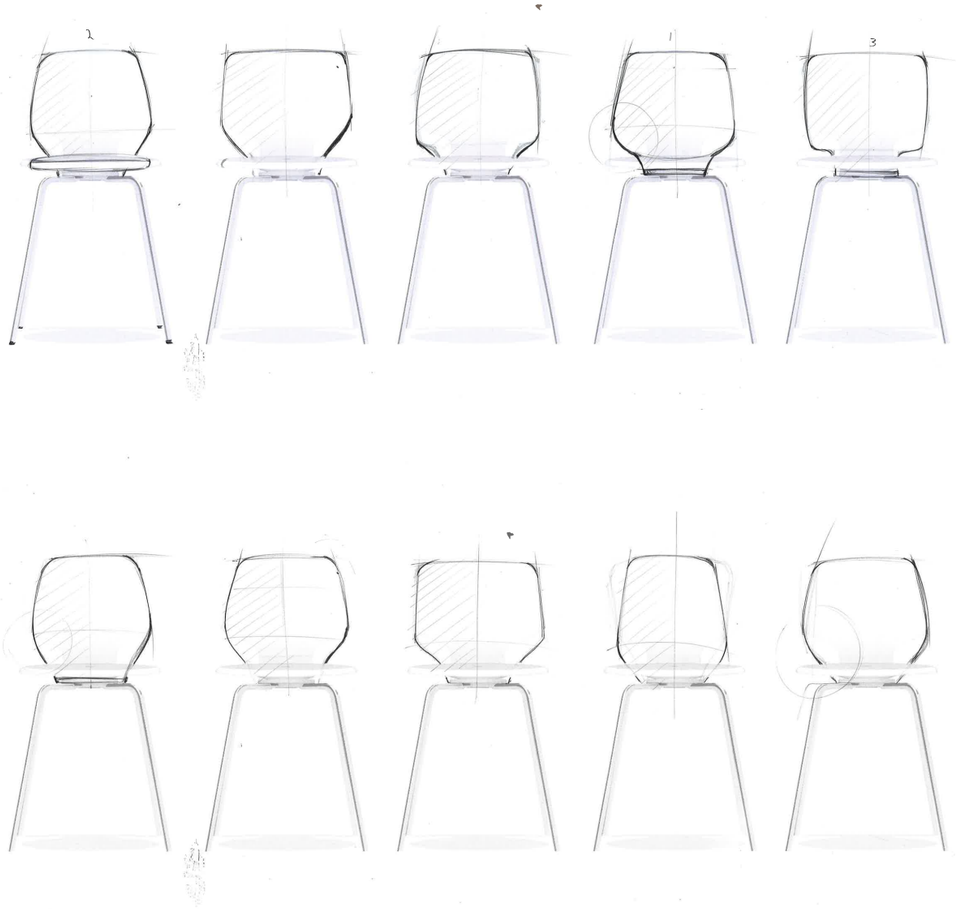
But I assume this chair would fit more into a creative work area, rather than a relaxing environment. But, all in all, I think this chair has something new and interesting to offer. And has the potential to be something positive for students’ sitting habits.

When It comes to changes in the chair itself, there was some issues with the proportions. The backrest was a bit too far back. And for one of the students the chair was too short. Now these are things I could optimize for the final product proposal.

7. **Shape**

Following my early aesthetical requirements, I wanted soft lines and shapes that give a feeling of comfort. And functions that give aesthetic values. I've had this in mind throughout the whole process. Now that my process has been more functional-focused, I've spent less time on this part. And I believed that aesthetics always comes after function. The current functions did limit me from doing whatever I want with form. But I think this was a good thing. Giving my functions aesthetic values. But there was still some room for me to work with the total expression.

To achieve the soft lines, I sketched on top an early "CAD" I made, which is a rough result of earlier function-testing. This way I had a starting point to work from.

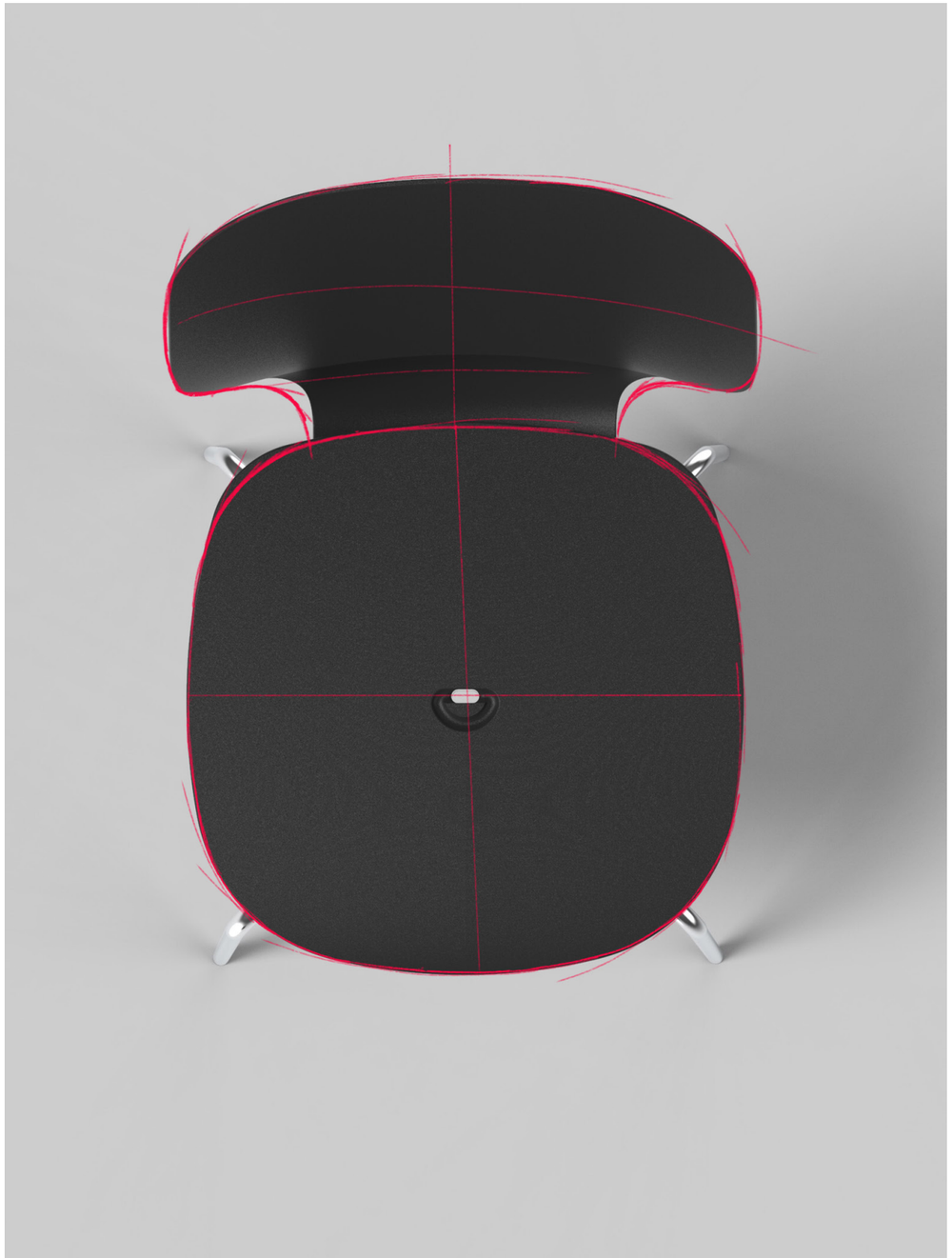


The smooth lines slowly got together. But to get a better feeling of how the lines really look, I made quick rendings. This is an effective method to look for improvements. Now I have a more refined design, which I again can use as a new starting point.

But what do we associate with “comfort”? From a personal perspective, I think of smooth and soft lines. To bring this into this chair, I gave every corner a smooth transition and lines that speak the same from language. For comfortable ergonomic sitting I gave the chair shapes that are suitable for the body. I chose to not keep these ergonomic shapes too radical, to open up for more sitting positions.

I also had to keep in mind that strength also will be influenced during formgiving. So I can’t strip off too much material. On the other hand, it’s better to add material.

I could always give this more iterations, but you also have to say stop. In the end I believe I have achieved what I wanted.



8. **PROPORTIONS**

“Syveren’’ came in handy finding the correct proportions, using it as a reference. As I said, I want my dynamic chair to be as generic as possible when it comes to proportions. But after the user testing. Some changes had to be done. The legs needed more height, and the backrest needed to be more forward leaning. In collaboration with the pivoting function, these changes would make the function feel more comfortable in use.

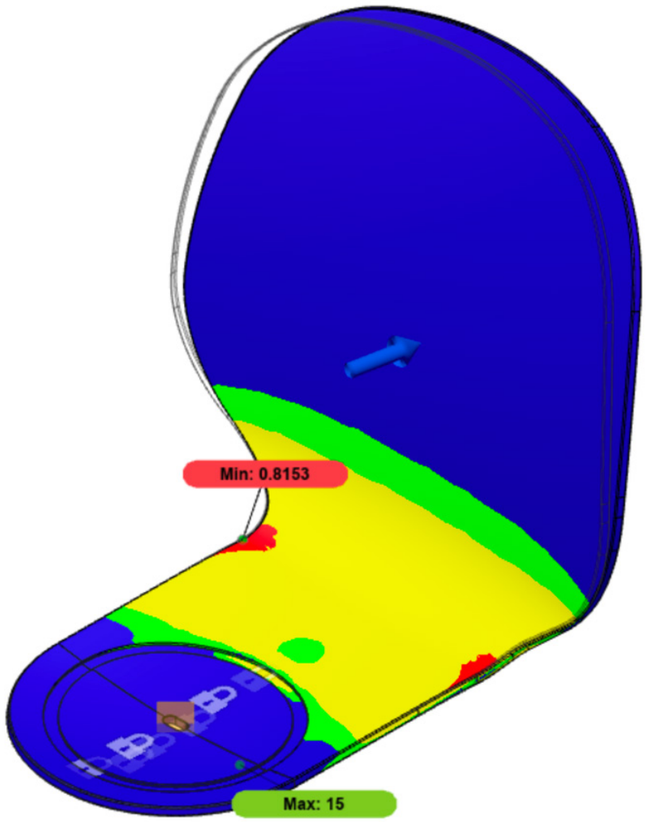
To make the chair most suitable for the majority of the users. I got some help from a fellow student of average height (172cm). The final proportions ended up with an increase in the legs length, decrease in the backrest-angle, wider backrest/seat and a higher lumbar support to give more room for your lower back.

Proportions needed for final product.

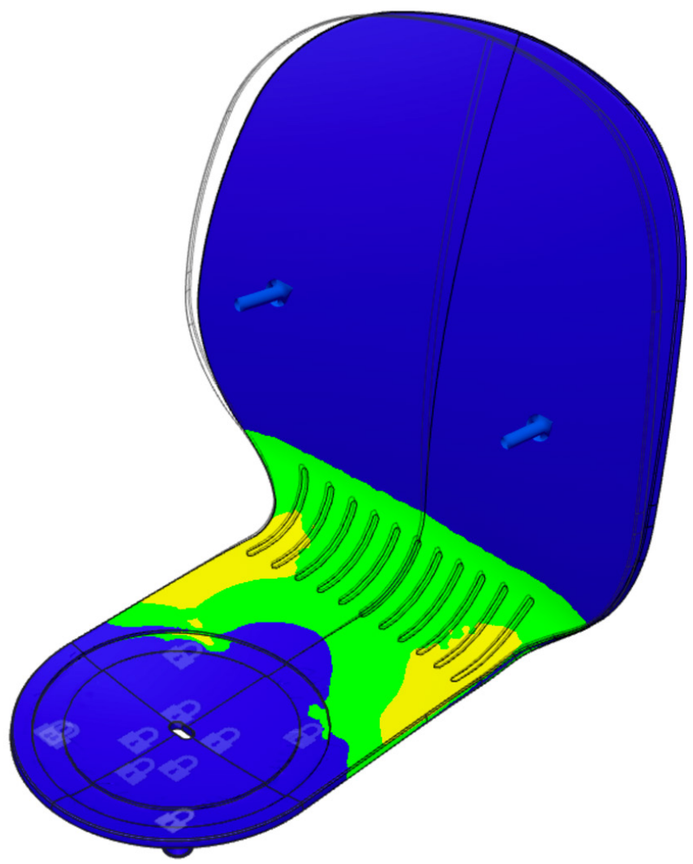
9. **STRESSTEST**

Doing strength is important in finalizing a chair design. It lets you know if the chair can handle the weight and use of a human. To do so, I used a simulator provided by a CAD-software called Fusion360.

Test 1: With a 50 kg force centered on the backrest, my first iteration can cause some damage in the structure. Meaning that the component will either deform or brake.



Test 2: To give the structure more strength I've decided to add supportribs in the back. With the same amount of force, the structure held up stronger. I find the second test improving. Meaning I decided to go further with this solution. In my opinion I think the supportribs also improves the aesthetic values.



10. PRODUCT PROPOSAL

10.1 **PIVOT**

Through all the insights I've gathered, in everything from desktop research, user interviews, mockup testing, user testing, etc. I have concluded a final product proposal, called "**Pivot**".

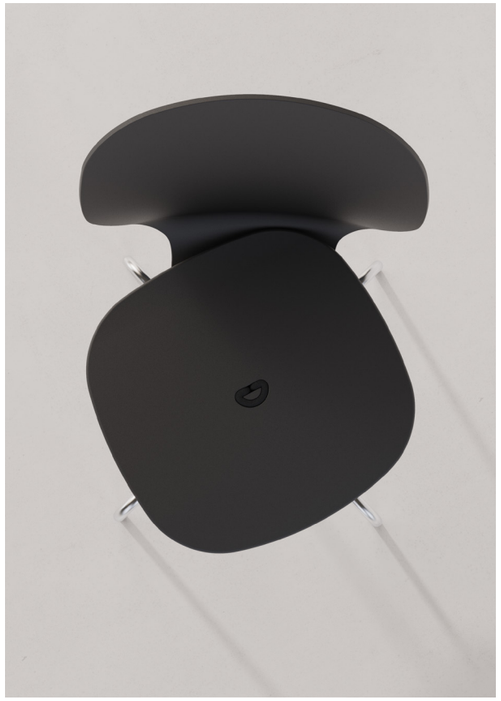
"Pivot", is a dynamic school chair. Based on the health benefits of active sitting, Pivot aims to positively change students' sitting habits through a function that provides movement. The chair is designed with the idea of simplicity. To keep the production costs down and be a more attractive alternative for Universities and Colleges.

With a static frame and a movable seat, the user is able to pivot and change in between positions depending on the given working situation. This means the user can tilt forward, side to side, lean backwards, rotate or balance to keep their core muscles active.

10.2 **POSITIONS AND MOVEMENTS**

Tilt forward.

Lean back for a relaxed position.



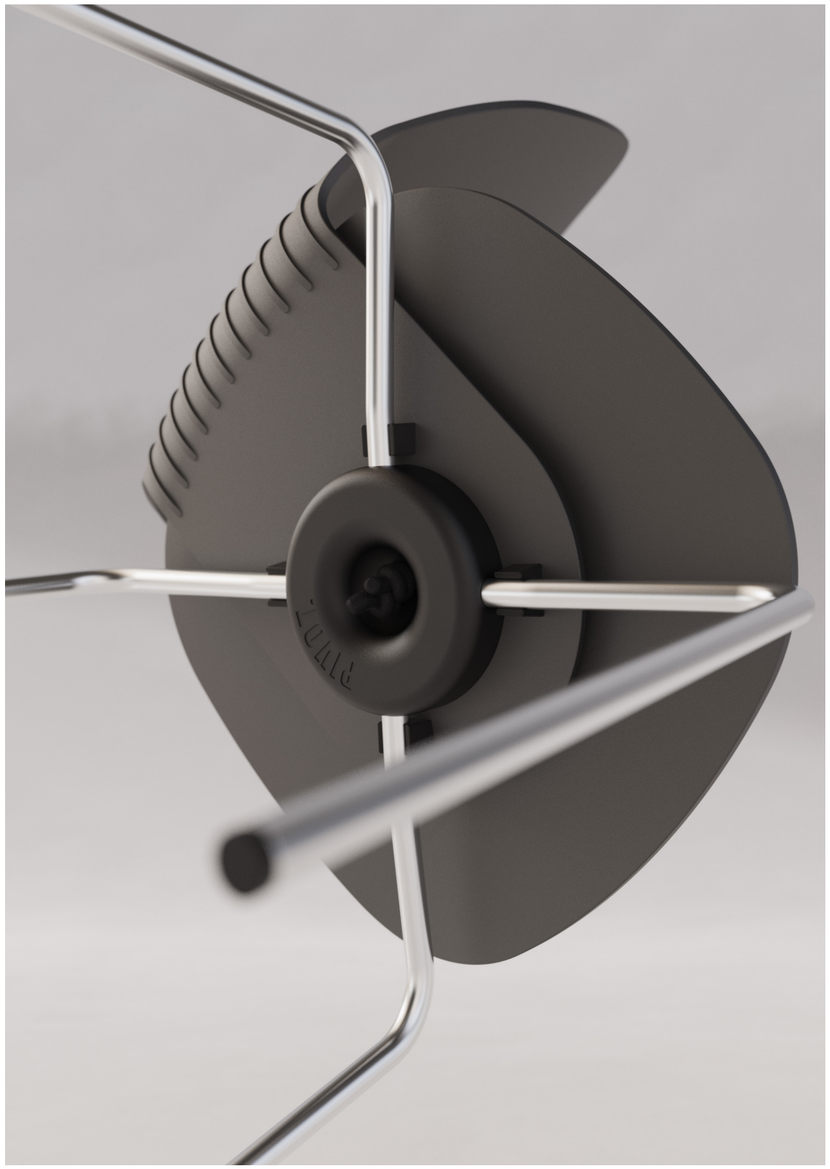
Rotate the seat side to side.

(After I finished the final design, I noticed that in a certain angle, the seat will touch and rub against the backrest. This can be fixed by increasing the corner radius.)

Balance to activate your core mucsles.

10.3 **DETAILS**

With a simple **elastic rope** the seat is attached to the chair. This way it's easy to attach or detach for cleaning and replacement. To simply attach, you push the rope up from underneath, hook it onto the seat and then you tie.



The **cover** is used to act as a cup for the elastic band and to hide the construction of the legs.

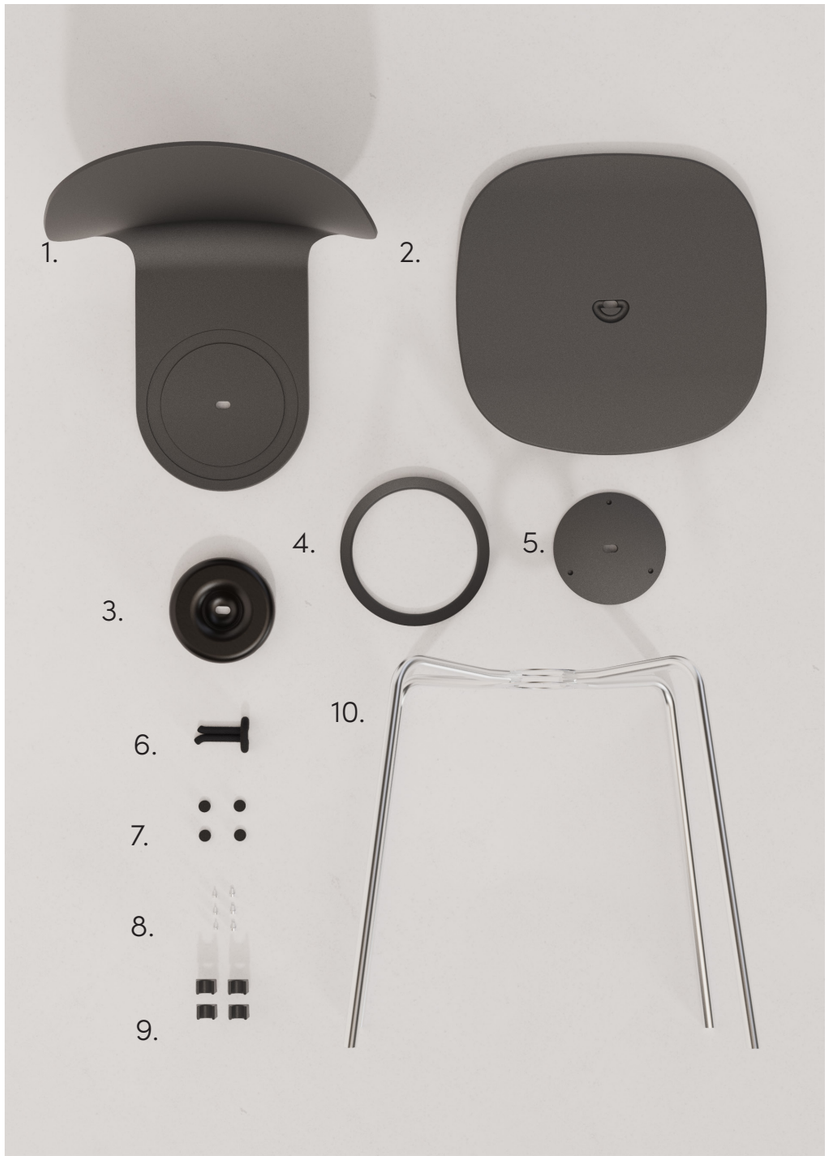
To make all these different movements possible, the seat has a **half sphered** form underneath.

Using a **soft rubber ring**, the pivoting movement will feel softer for the user. This ring also stops the seat from tilting too far.

The chair has **supportribs** in the back to give extra strength. This also comes as an aesthetic feature.

To fit into most school environments, Pivot comes in different **color choices**. The color choices are based on being able to fit into both neutral and colorful environments.

For more effective storage, the chair can be **stacked** to a certain number of chairs. The movable seat can cause instability if you stack too many chairs.



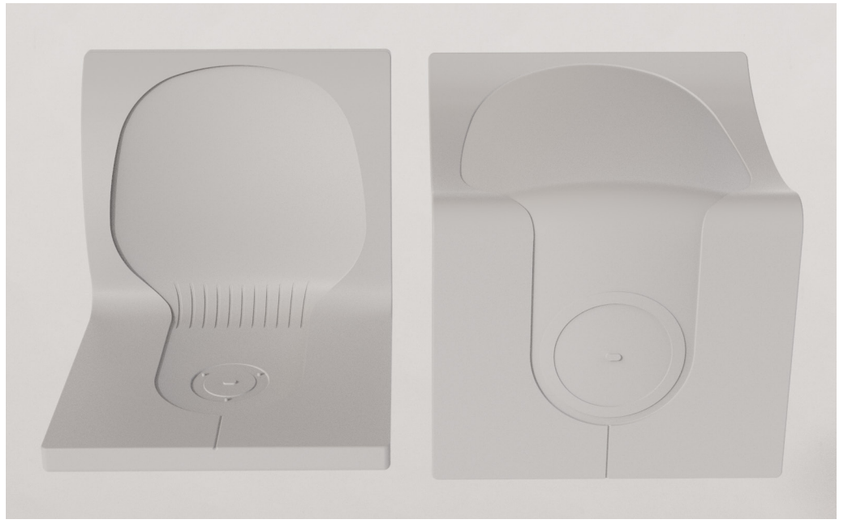
1. Backrest/Base **2.** Seat **3.** Cover **4.** "Suspension" **5.** Pivot **6.** Elastic Rope **7.** Floorprotectors **8.** Bolts **9.** Support **10.** Legs

An exploded view showing the assembly. Using the base/ backrest as a baselayer, where every main component is held together by bolts and the elastic rope.

Choice of materials.
Considering my requirements, I want to use durable materials. With my given dynamic function, there will be wear. But also, the price aspect has a lot to say. To keep the production price lower. That's why I have chosen to work with plastics. More specifically polypropylene. There are several reasons why I chose this material.

- It is a relatively inexpensive material
- Recycle - A sustainable option.
- It possesses good fatigue resistance, It has good impact strength
- It's known for being a very "moldable" material.[5]

Injection molding.
When it comes to production methods. Ive designed the chair with injection-molding in mind. Thinking about draft angles and mold-directions. You can not be 100% sure if tools work before they are actually taken into production. Usually, "in real life" the final product goes through several stages of manufacturing tool-changes. That's why I haven't concluded this. But I made a "tool" to illustrate and give an example on how this could be done with one of the parts.



Replacing components.
Throughout years of use. Parts will be worn out. And that is something that comes with every chair, especially school-chairs. When it comes to Pivot, I assume the part that will get most beaten up will be the seat. But since this part is "separate" from the chair, it will be replaceable. That way the buyers only need to buy a new seat, instead of a whole chair. And that also goes for the elastic rope. Where that is a relatively cheap component.

From a sustainable perspective, I really think this way of replacing worn out components is the way to go.

Price
In order for a chair to be attractive for schools, it is important to keep production prices down. To achieve this to a certain extent. I have focused on using relatively cheap and durable materials, solutions based on simplicity, use of few components (in relation to the function) and cheap productions methods. It is difficult for me to solve this, since you can not set a price for the product until it is 100 percent ready for the market. But with the use of some of the crucial factors for keeping a low production price, you can aim at a relatively lower price.

In comparison to the market, I wrote "I want this chair to have focus on a dynamic function, and still be an affordable option." It's difficult to estimate a price now, but if I were to do so I would put the chair in a medium price group. Where prices vary around 3000 kr.

I reached out to Øystein Austad, an industrial designer with tons of experience with chair design. I asked him if he could give a rough estimate on the price of this chair on the market. This chair needs two big molding-tools (seat and backrest/base) as the bigger expense. The rest of the components will be relatively cheap. In that case the estimate could be around 1500kr for production + other expenses like for example transport + 40-50% in sale price earnings. In total around 2500 to 3000kr. Considering this, Pivot has a retail price that should be reasonable for universities and colleges.

10.4 **VISUAL MODEL**

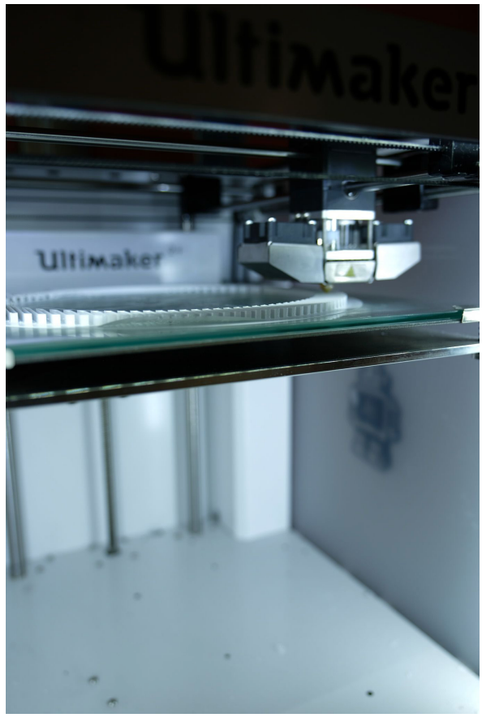
10.5 **BEHIND THE MODEL**

I've alway loved building physical models. I have more experience building smaller products, but this was on a different level.

This process took me 3-4 weeks. Starting with the CAD-file itself. I drew the chair in Fusion360, an intuitive, skybased software for industrial design and mechanical construction. Throughout my time here at AHO, I've spent many hours in this software. And I have gotten quite familiar with it. After a few iterations and 50+ hours drawing, I sent the file for 3D-printing. Printing it with a bigger 3D-printer called BigRep.

For the legs, I bent steel-tubes and welded them together. For the smaller parts I used the smaller 3D-printers called Ultimaker. When all the 3D-printed parts were ready, it was time for the final finishing. After many layers of sparkling and sanding, the chair was ready for assembly.

This model is a visual model, showing how the functions work with optional materials, and how it's assembled. If I sit on it, it will most likely break. And I'm not risking that chance. I really wish I could make a functional model that I could sit on. But that would require more time and better model making skills. At least I have the functional prototype to test and prove the concept.



11. **REFLECTIONS**

Have I answered the problem statement?
Following usertesting, I have designed a dynamic chair with a function that makes students sit more actively during school work. I do not know if this will have long-term benefits for students' health, because it has not been tested by others (except me) over a long period of time(months). Based on my experience with the mockup and prototype. After two months of sitting on them. I do not know if there is a huge improvement in personal health and sitting habits. But I find myself sitting more actively and freely. And I think that is a good starting point. Imporvement in health and changing in habits, usually takes time.

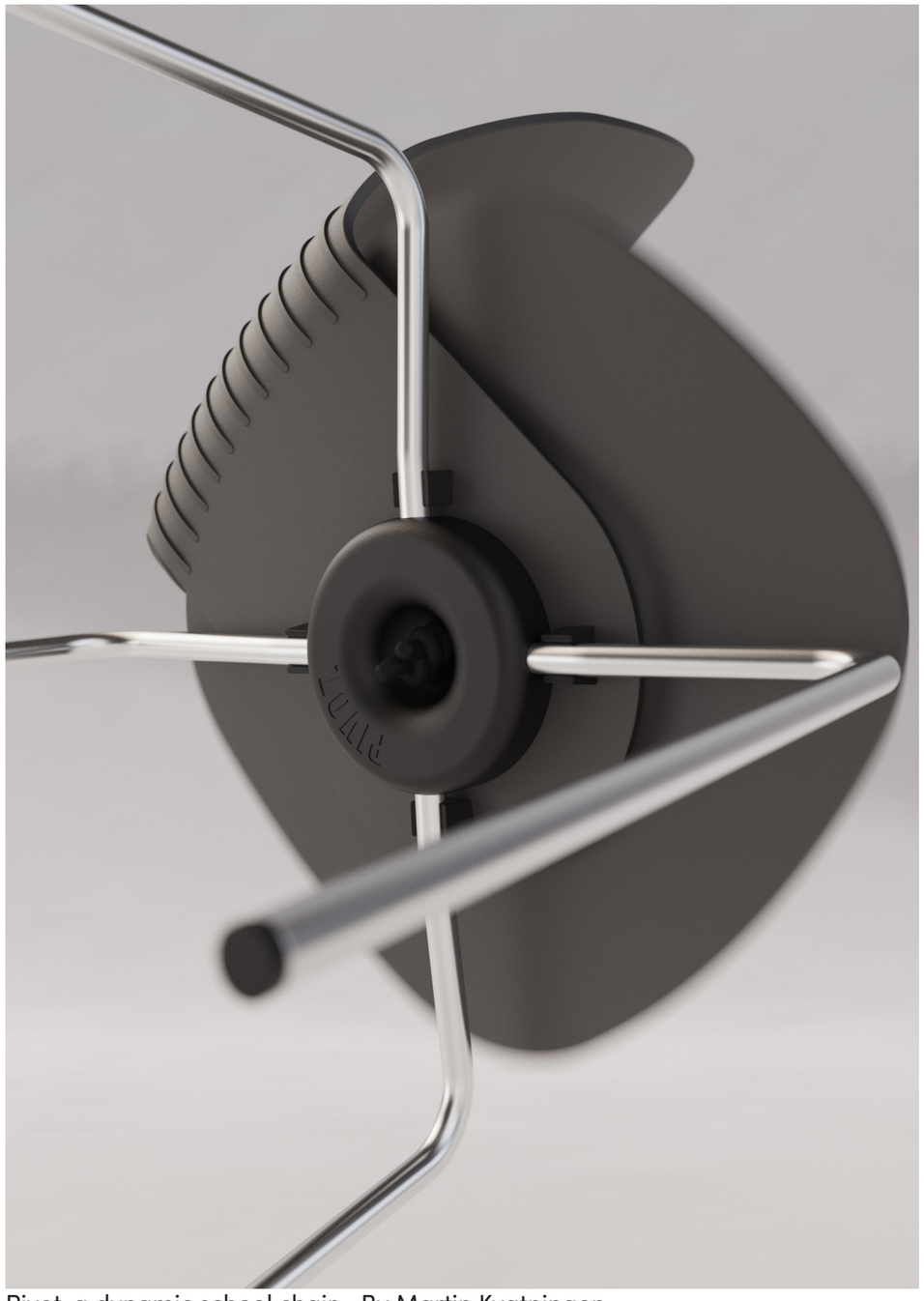
Based on research on active sitting and today's existing products, this chair contains many arguments that should indicate that this function can have a positive impact on students' everyday lives. Through testing my on prototypes/ mockups, I see that this is something completely new for the students. And a curiosity for the dynamic function emerges. And they seem very positive about the concept. Summing all these insights, I believe that this chair can be something positive for the students. Therefore, I think Pivot is a result that answers the problem statement.

Reading this I assume it's hard to fully understand this concept. To do so, you actually have to try the chair(functional prototype) before you can say something about it.

Whats next?
Looking back at my final dynamic chair, I'm quite pleased with the result. But there is one thing I've learned throughout this process, a chair needs more than two iterations. Now, even though I've given my all and I didn't have time to do more iterations. I feel like this chair has potential for further development. To take this concept a step further, I would look for other ways to strip down the chair. Making it an even cheaper option on the market. I would also look for optimizations in many aspects of the solution, such as strength, ergonomics, use of material, dimensions and the dynamic function itself, giving it a better user experience. Lastly I see an opportunity to add additional features to the existing solution, like for example armrests or even upholstered cushions on the seat.

Last words.
Designing a chair from scratch has not been an easy task. From the start, to be honest, I was a little scared, and I had no idea how this was going to end. But as soon as I started, I quickly got into it and the weeks went by. As a personal goal, I wanted to expand my knowledge in furniture design. And I definitely did. I have also proven to myself that this is something I might like to do in the future.

In the end, I would like to thank everyone who has been involved in this project. First of all, thank you to Steinar Killi for supervising this diploma. Mikkel Jøraandstad and Øystein Austad for taking time to discuss my diploma. Fellow students that have given me advice. The guys at the workshop, everyone that I interviewed, tested and talked to. And, last but not least, friends and family that have supported me through this journey.



Pivot, a dynamic school chair - By Martin Kvatningen

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