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STANDING OUT TO FIT IN

By Karoline Müller

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ABSTRACT

Most women opt for so called cosmesis, a cover which mimics the look of a leg, on their prostheses in order to get real-looking legs. Their male counterparts usually choose to show the entire construction or parts of the raw prosthesis. However the cosmesis is in many cases lowering the functionality of the prosthetic leg.

In this project, 8 female and 2 male lower-leg amputees were interviewed in order to find out what might be the driving force to go for one or the other and find a common ground that works for most people. Additionally, a prosthesis engineer and a prosthesis technician were interviewed in order to understand the existing system.

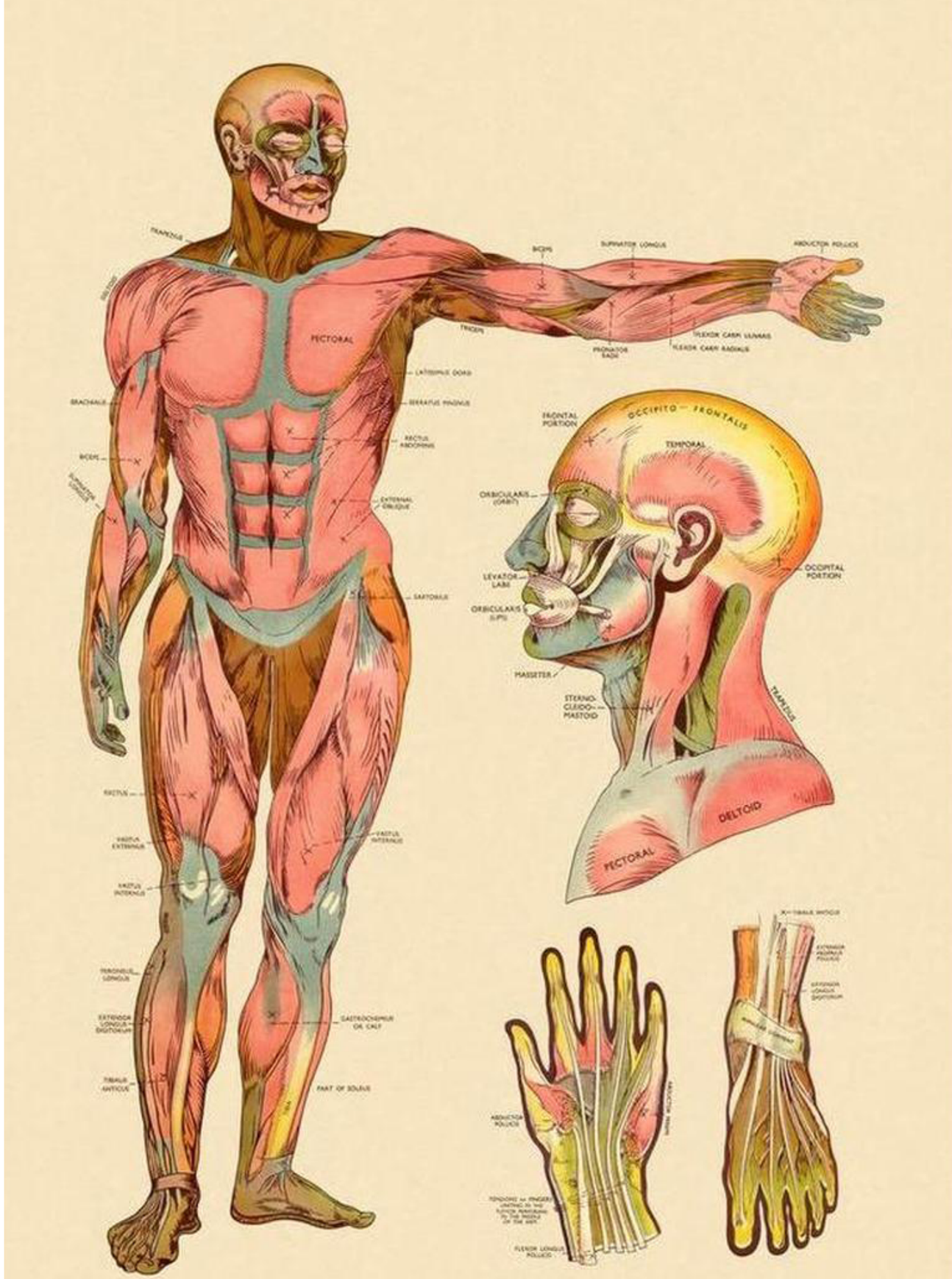
The findings resulted in a concept for an active lower-leg prosthesis which can be adapted to different shoes and heel heights - a titanium base with a 3D-knit sleeve which moves with the amputee.

1.0 **INTRO**

1.1 WOMEN & MEDCIAL DESIGN

The starting point for this project was the field of medical design with focus on inclusive design. It quickly became clear that, for a very long time, the female body had been excluded from the target group. Jackson writes about the history of medical bias in her article The Female Problem: How Male Bias in Medical Trials Ruined Women's Health (Jackson, 2019). She shows that women were excluded from many important medical studies (when included there was often no differentiation of sex in the results) and that "most of the advances we have seen in medicine have come from the study of male biology" (ibid.).

With this in mind, it can be assumed that, even though a lot has been done to change this already, there are still a lot of solutions which have not been developed to include women. We need to find these designs and recreate them to fit everyone who needs them. Additionally, in the long run, we need to go back and see what the actual needs and wants in medical design are today. On that base, we can design the next prosthesis, MRI-scanner or thermometer for everyone, regardless of factors like for example sex or ethnicity.



1.2 WOMEN & PROSTHETICS

During the research phase for this project, it quickly became clear that women to a much larger extent choose to cover up the raw prostheses with cosmesis, an aesthetic cover mimicking the appearance of the other leg (Grant, 2014). Men, however, seem to prefer showing the raw mechanics and materials by ”going commando”, as some amputees call it (ibid.). This might not seem like a big problem but if we take into account that the cosmesis actually makes the prosthesis less functional in several ways, such as having limited joint rotation, adding weight and being harder to repair, it gets problematic (Fact Sheet #07 - Prosthetic appearance and cosmetic covers, n.d.).

This distinction becomes even more clear when we look at the portrayal of female cyborgs in popular culture. Balsamo writes that ”femininity is culturally imagined as less compatible with technology” resulting in representations which either strictly conform to traditional female stereotypes or radically subverting them (2000, p. 151). It seems as though there only exist two types: the ones that hide their prostheses or have only very little showing (almost like jewellery), and the ones that show it openly and thereby somehow forfeit their other female attributes and adapt stereotypical male ones such as aggressiveness and impatience. For the first type we see for example Seven of Nine (left in the picture, from Star Trek) whose powers are typically female coded, such as superior visual acuity and eidetic memory. On the opposite side we see characters like Nebula (to the right in the picture, from Avengers), who clearly shows her machine-like parts and has the masculine temper to match.

1.3 CYBORG OR DISABLED?

The way we talk about things and how we picture them in our heads is usually directly linked to how our society depicts and brands these items. When we talk about someone as being 'disabled' we ascribe them the attributes of being different and, in one way or another, not able to do everything a 'normal' person can do.

With prosthetics we add another factor to the equation - the almost toy-like, manly man term 'cyborg'. This means that a person with the same amputation can be described as either being disabled or a cyborg, implying a broad range, from not being able to move at all to being the Terminator. With this in mind, it is clear that the choice of words in cases such as this can significantly shape how we view other people and, in the long run, how we interact with them, ascribe them abilities and personalities, and how society as a whole includes them.

If the only way to not be 'the disabled guy' is to wear a technically advanced looking prosthesis, people will try to conform to one or the other stereotype. In my opinion, we need to change the way we talk about prosthetics to terms which do not say 'cool toy' or 'disability' but rather what a prosthetic should be, namely a part of the amputee.

”How might I design a transtibial leg prosthesis with a less gendered aesthetic?”

1.4 PROJECT BRIEF

To this initial research, extra constraints were added due to the time limit of the project:
1. Working with a prosthetic leg instead of an arm is going to be time-saving and is therefore preferable.
2. The knee joint will take a lot of time, hence a transtibial (below-knee) prosthesis is preferred to a transfemoral (above-knee) one.

From this, the initial project brief was created:
”How might I design a transtibial leg prosthesis with a less gendered aesthetic?”

2.0 TARGET GROUPS

INTERVIEW WITH PROFESSIONALS

INTERVIEWS WITH AMPUTEES

MAIN TAKEAWAYS FROM INTERVIEWS

IDENTIFIED NEEDS

2.1 INTERVIEWS WITH PROFESSIONALS

As with most things in medical design, the final product needs to cater to two target groups: the professionals using/creating it and the patient receiving the product/treatment. Since this entire area was completely new to me I had to start with the basics. Hence, the first part of the research was conducted by spending a couple of half-days at the orthopaedic centre in Lund (Aktiv Ortopedklinik), together with Lina (Prosthetics Engineer), Zoran (Prosthetics Technician) and Gabriel (Prosthetics Technician). During this time, I learned a lot about the immense amount of work behind each and everyone of the prosthetics leaving their lab.

This lab works with Otto Bock as the supplier of the prostheses' parts. The socket, the part which is used to attach the prosthesis to the stump, is made either through a new method called direct socket or, in cases where the stump doesn't have the ideal form for that method, with a more time-consuming, older technique of layering weaves and coating them with plastic. Built into the socket, there is an adapter for the tube which is going to be the structure for the prosthesis and to which the ankle and foot will be connected.

When a patient gets referred to the lab, they first meet a prosthesis engineer who then makes an assessment of the stump and of the patients activity level. The patient then gets assigned a K-level (K0-K4) and if it is higher than a K0 the engineer and the amputee will proceed to making a prosthesis. Lina, one of the prosthesis engineers, thinks that when patients during this process decide for a cosmesis, they do it for their self-perception - they want to feel whole. She said that the cosmesis does not have any real function, other than filling out the pants, for the leg prosthesis and that it is more for those who want to hide the fact that they have a prosthesis. However, the cosmesis can affect the swing function in the joints which it covers.

2.2 INTERVIEWS WITH AMPUTEES

For this project, 8 women and 2 men were interviewed. The reason why not more men were included was because my initial assumption was that the regular tube-shaped prosthesis is made for men and therefore the gap which needed to be bridged was that to the female aesthetic and function. This was confirmed by an Australian study by Ruby Grant, in which it is repeatedly shown that the technical-looking prosthesis is the male coded one (2014). However, after a discussion with a friend, I realized how much this enforces stereotypes of men being these hard and cold 'machines' without emotions or the desire to just blend in. Therefore, I added two men to the study which was all that I could manage time-wise at that point. Both of them did, however, add valuable insights into the equation.

Each interview took between 30 to 60 minutes and consisted of 14 open-end questions which were tailored to spark a discussion.

All but one of the women wear cosmesis on a daily basis, while neither of the men did. One of the men does wear a custom 3D-printed cover which mimics the calf-size of his other leg and has a matte black finish with a pattern on it. All of the interviewees had at least two prostheses, one everyday-prosthesis plus one hygiene prosthesis, and most women (7 out of 8) had what some of them referred to as a "party-prosthesis", usually a leg suitable for heels, with an electrical ankle and cosmesis to cover it up.

2.3 INTERVIEWS WITH AMPUTEES: SELECTED COMMENTS

SPARKING CONVERSATION

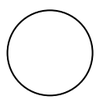
”I have got a customised hygiene prosthesis with a print of fish on it (...) that is a positive way to spark conversations with people who want to ask anyway.”
-Emma 29

COVERING THE DISABILITY

”For me it is a question of finding myself (...) it is not always easy to know who you are if a disability is the main thing people notice right away. That is why I have this kind of cool cover (...) then I think that people will think about me as that cool disabled guy at least.”
-Tim 28

ADJUSTABLE HEEL HIGHT

”My ’party’-prosthesis only works with shoes with heels (...) If I am wearing heels and go to a party where they tell me to take off my shoes it’s over. Then I have to bring my other prosthesis (...) go to the bathroom, spend half an hour there.. I think that is pretty annoying.”
-Katalin 46

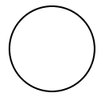


NOT A ROBOT

”I don’t want to feel like a robot.”
-Katalin 46

NOT A ROBOT

”I don’t want to look like a robot.”
-Mattias 55

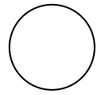


NO ROOM FOR BEING SPONTANEOUS

”Usually I have to plan my day exactly, there is little room for spontaneous stuff (...) if I want to be active and am wearing my prosthesis for heels, well tough luck!”
-Elin 27

LIKE A NICE DRESS

”If I had a prosthesis which was nice in the same way as for example a nice lace dress, I’d definitely wear that instead [of the cosmesis].”
-Emma 29

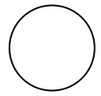


BEING ACTIVE IS IMPORTANT

”The most important thing for me is that I can be fully active (...) I dance salsa and am doing aerobics about 8-9 times a week.”
-Inger 56

IT WILL NEVER LOOK LIKE A REAL LEG

”How ever much they’re trying to make it look like a real leg, it will always be visible (...) and then it’s almost better to not go for a cosmesis or choose a 3D-printed cosmesis with fun patterns.”
-Emma 29



1 ENERGY RETURN

2 NOT TOO MUCH LIKE A ROBOT

3 DIFFERENT SHOES + HEELS

4 EASY TO REPAIR

2.4 IDENTIFIED NEEDS

From the interviews with professionals and amputees, I gathered four main needs. I focused mainly on the amputees need because they are in contact with the product for a much longer time than the professionals.

Energy return was repeatedly mentioned by almost all amputees interviewed. It was also the most mentioned property which they valued the most in their prostheses (or missed it in those which did not have it).

”I don’t want to look like a robot.” That sentence was mentioned several times during interviews, in one form or another. To create an aesthetic which is as far removed from that of a machine does therefore seem like an important need.

Many of the women are wearing heels with prostheses adapted for it but these prostheses usually lack other properties like energy return or being light-weight, hence, including an adjustable heel seemed like a desirable need.

Last but not least, the repair-ability was essential to some of the amputees and the professionals. The cosmesis hides all the parts which can be adjusted and repaired and is therefore not optimal for this.

2.5 IDENTIFIED GOALS

Basic Goals

- full function
- fully adjustable to different stumps
- some energy return

Necessary Goals

- honest to being a prosthesis
- ”blending in”-feeling
- aesthetically pleasing
- little compromise in function vs looks

Desired Goals

- working for all types of leg amputations
- ”a part of me”-feeling
- gender-neutral in color and material
- high energy return, for lighter sports etc.

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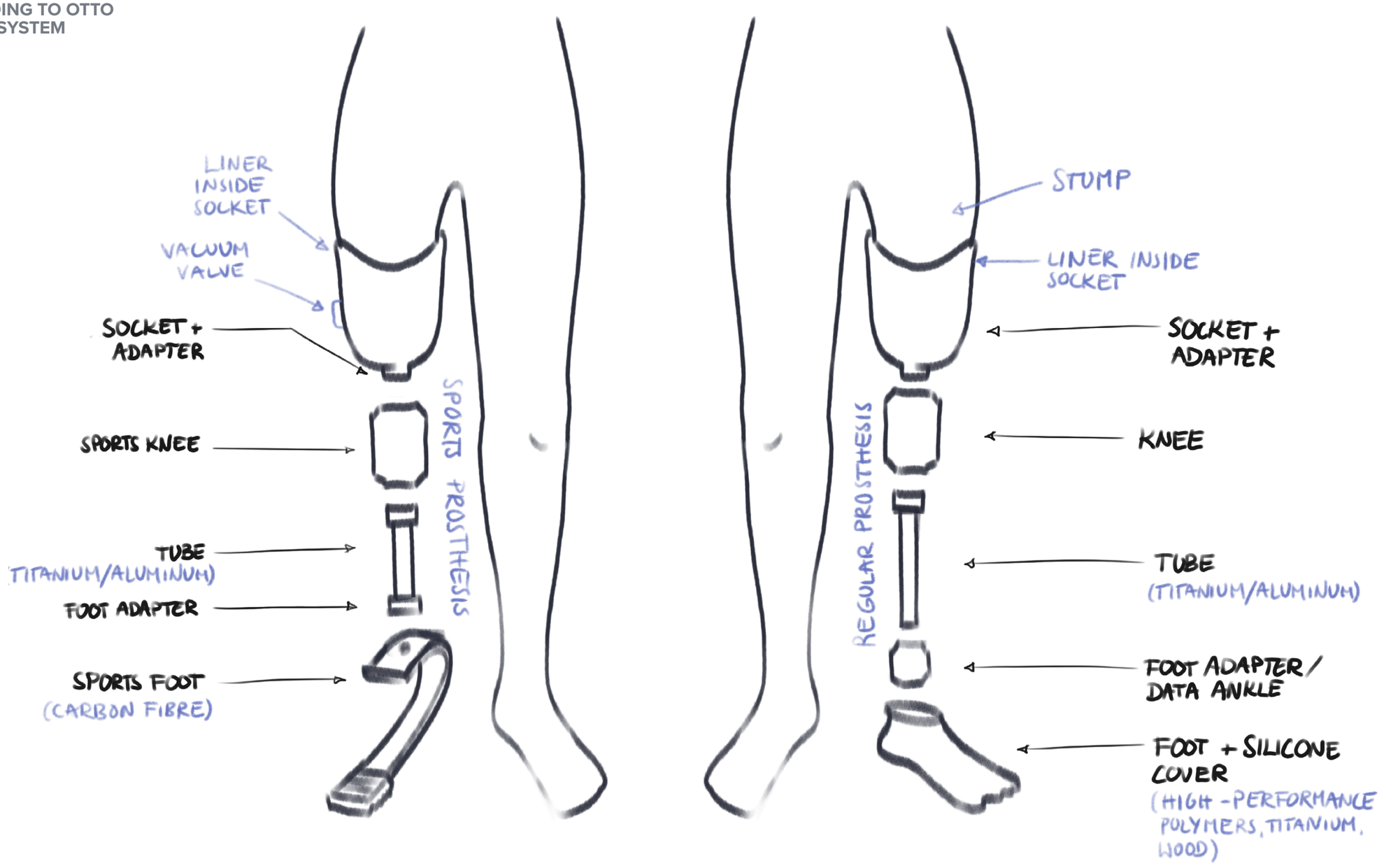
3.0 **MARKET RESEARCH**

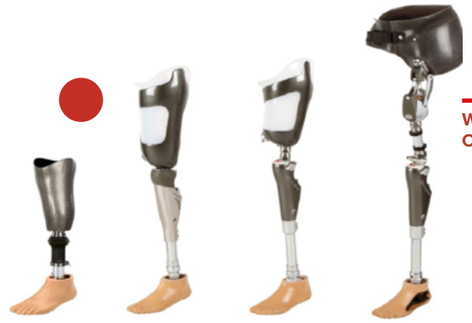
3.1 EXISTING SYSTEM

ACCORDING TO OTTO BOCK'S SYSTEM



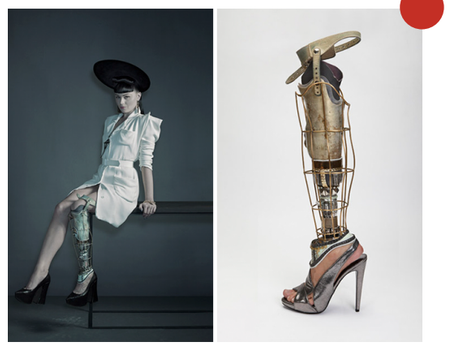
3.2 MARKET ANALYSIS

When looking at the market, there are clearly a lot of options. I chose a few of them to illustrate where this project will be trying to position itself. To begin with, we got the well-established Jaipur Foot, an Indian prosthetic leg which has proven to be very effective and is extremely inexpensive. Next we got the Circleg, an affordable 3D-printed prosthesis adapted to fit poorer regions. OttoBock's prostheses are widely used and, while being rather expensive, they are high quality and cover many different types of prostheses. With cosmesis and in particular their functional cosmesis, they even cover the functionality-focused customers as well as the more emotionally-focused. Last but not least, we find the Alternative Limb Project, prostheses that are about as expensive and emotionally coded as they come. All of the studio's prostheses are custom-made for each client and feature extravagant and imaginative designs.



OTTO BOCK

WITH ADDED COSMESIS



THE ALTERNATIVE LIMB PROJECT

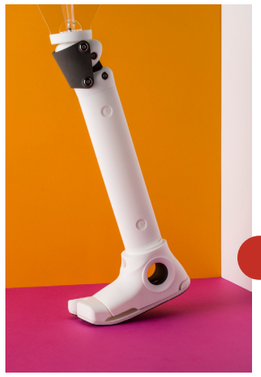
PRICE HIGH

FUNCTIONAL

MY PROJECT

EMOTIONAL

JAIPUR FOOT



THE CIRCLEG

PRICE LOW

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3.3 EXISTING COVERS

An overview of the existing covers which are applied on standard prostheses.

UNYQ -
Prosthesis Covers

LINDH EXTEND -
Prosthesis Covers

3.4 **EXISTING FEET**

A quick look into what types of feet are out there to solve the problem of an extra angle for different shoes and heels in particular.

FREEDOM INNOVATION -
Runway Foot
Hight-adjustable for different heel heights. Carbon fibre.

COLLEGE PARK -
Accent Foot
Hight-adjustable for different heel heights. Adjusted with a button. Includes only low heel heights up to 51 mm.

STUDENTS FROM JOHNS HOPKINS UNIVERSITY -
Adjustable Prosthetic Foot for High Heels
Unfortunately, there is not a lot of information about this one out there but it seems to work like the one from Freedom Innovation.

SCOTT SUMMIT (SUMMITID) -
Transfemoral Monocoque Polyaxial Study
Not just a foot but a good example of how laser sintering can be used to create biophelic structures.

”What might a gender-neutral leg prosthesis for all occasions, including different shoe types and everyday-sports, look like?”

3.5 FINAL BRIEF

For the final brief, I decided to narrow down some of the terms from the previous brief. A huge focus during the interviews was on the ability to wear different types of shoes as well as energy return in everyday activities and more demanding sports.

What might a gender-neutral leg prosthesis for all occasions, including different shoe types and everyday-sports, look like?

4.0 **PROCESS**

INITIAL
SKETCHES

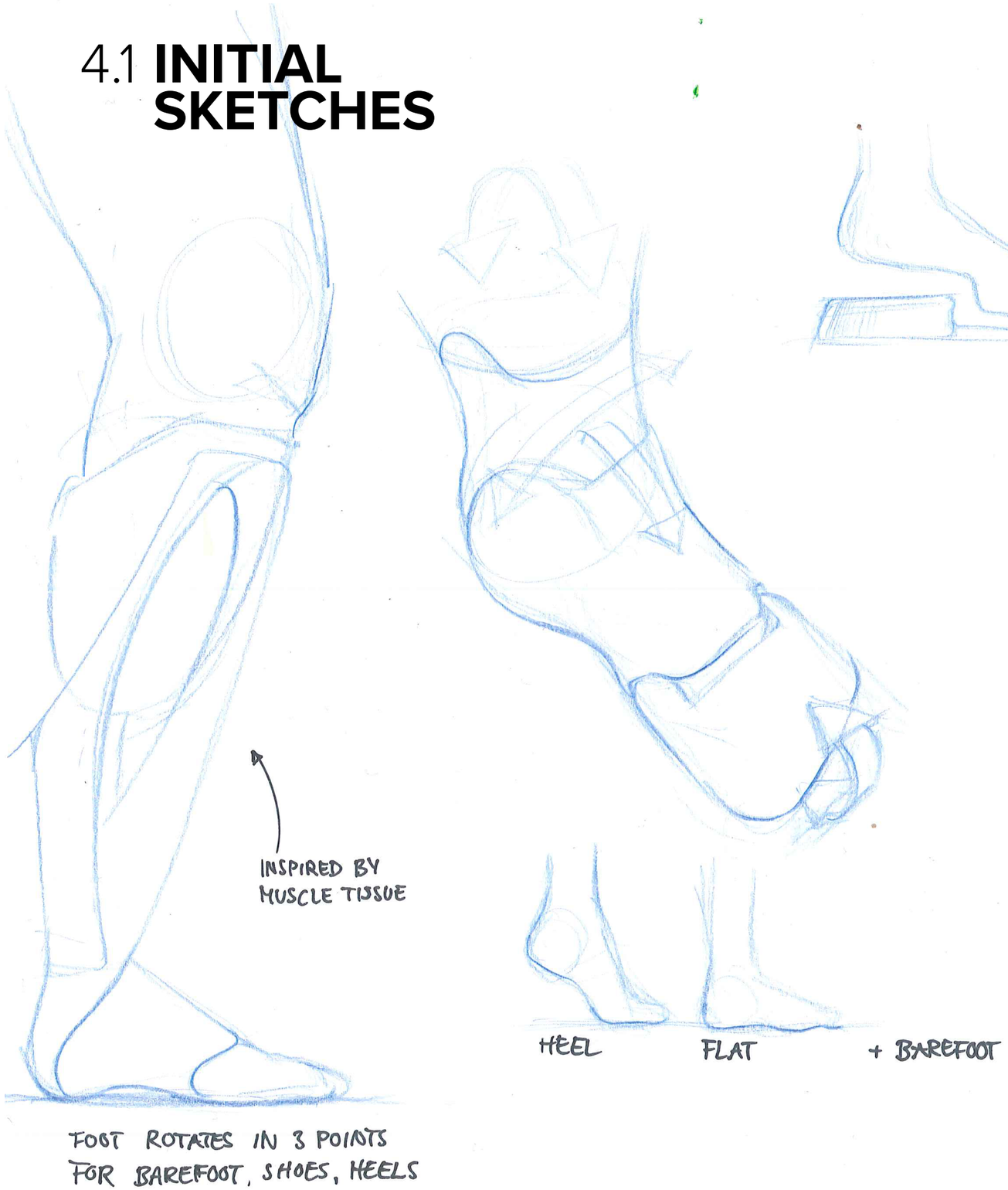
INITIAL
PROTOTYPES

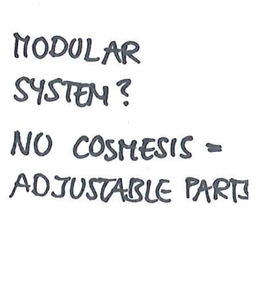
TURNING
POINT

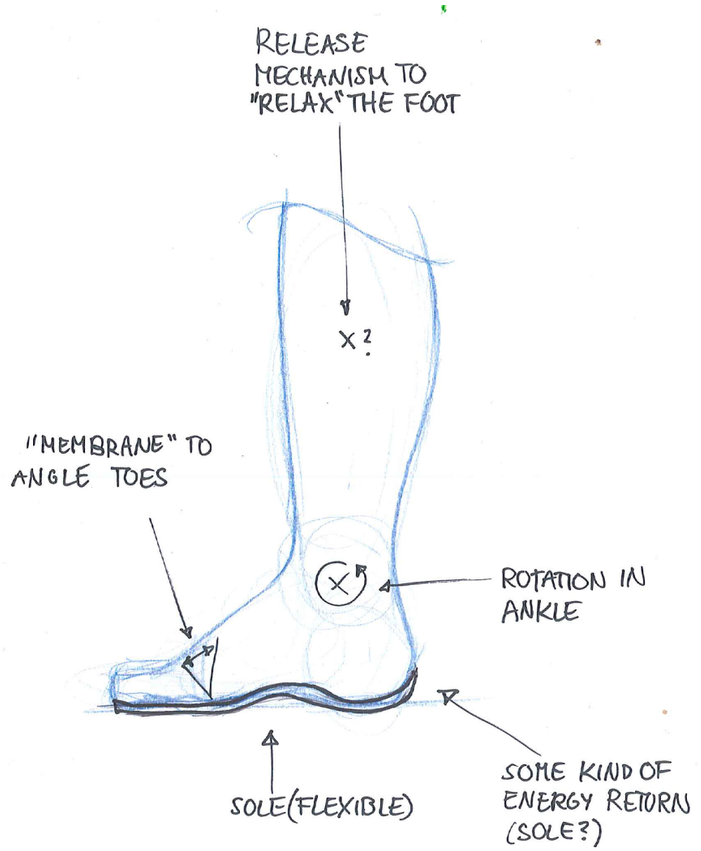
MOOD
BOARDS

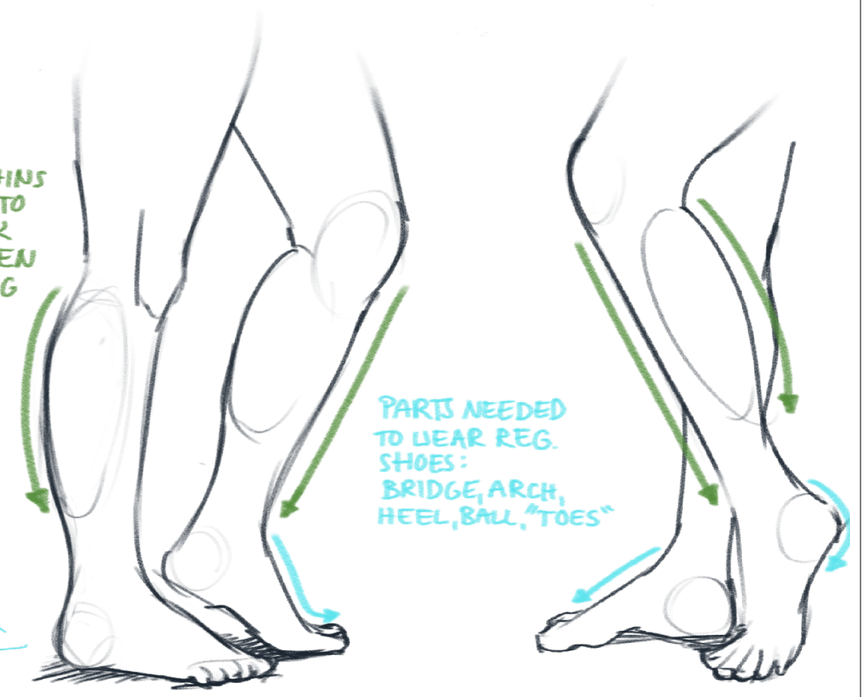
CONCEPTING
MIXED MEDIA

4.1 INITIAL SKETCHES









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COPIC sketch
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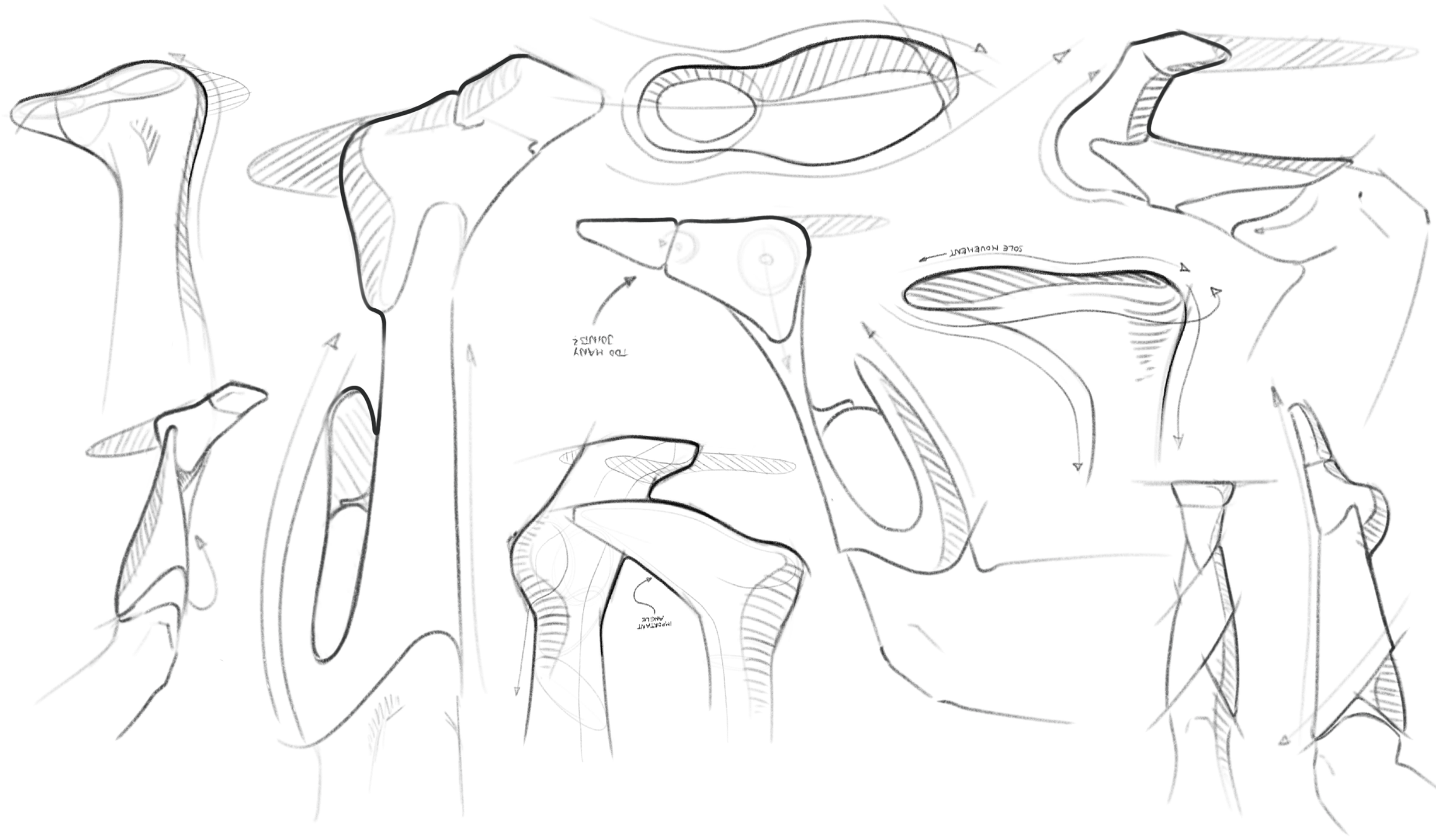
BIC


TOO HAIRY
JOINTS
SOLE MOVEMENT
IMPORTANT ANGLE

4.2 **PROTOTYPES**

While I had been told all the details about how leg prostheses work and what works and what does not, it was still very hard to grasp how I would implement my goals into the product. Simple carton prototypes helped me to understand what level of complexity was needed to achieve certain functions and with that how 'mechanical' they would look.

For this purpose, I made three different life-sized prototypes, including all the joints. For each prototype, I learned a bit more about the way the flexible parts and the joints would behave. In the end, however, the design as it was here was discarded due to the fact that it would look too robot-like.

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VERSION 1

Initial Prototype with 2 joints (heel and forefoot)

Main Insights:
•Only the joint in the ankle needs to be adjustable.
•Not a clear calf for filling out pants.

VERSION 2

Second Prototype with one rotating joint (heel) and a bendable sole (forefoot)

Main Insight:
•Needs a way of returning energy.
•The foot looks very mechanical with the gap to the forefoot.

VERSION 3

Third prototype with a rotating heel joint and a semi-rotating forefoot joint plus bendable sole and multi-directional energy return in the heel.

Main Insight:
•Avoiding to over-complicate things (less mechanical).
•Needs a reliable two-way axis in the ankle.

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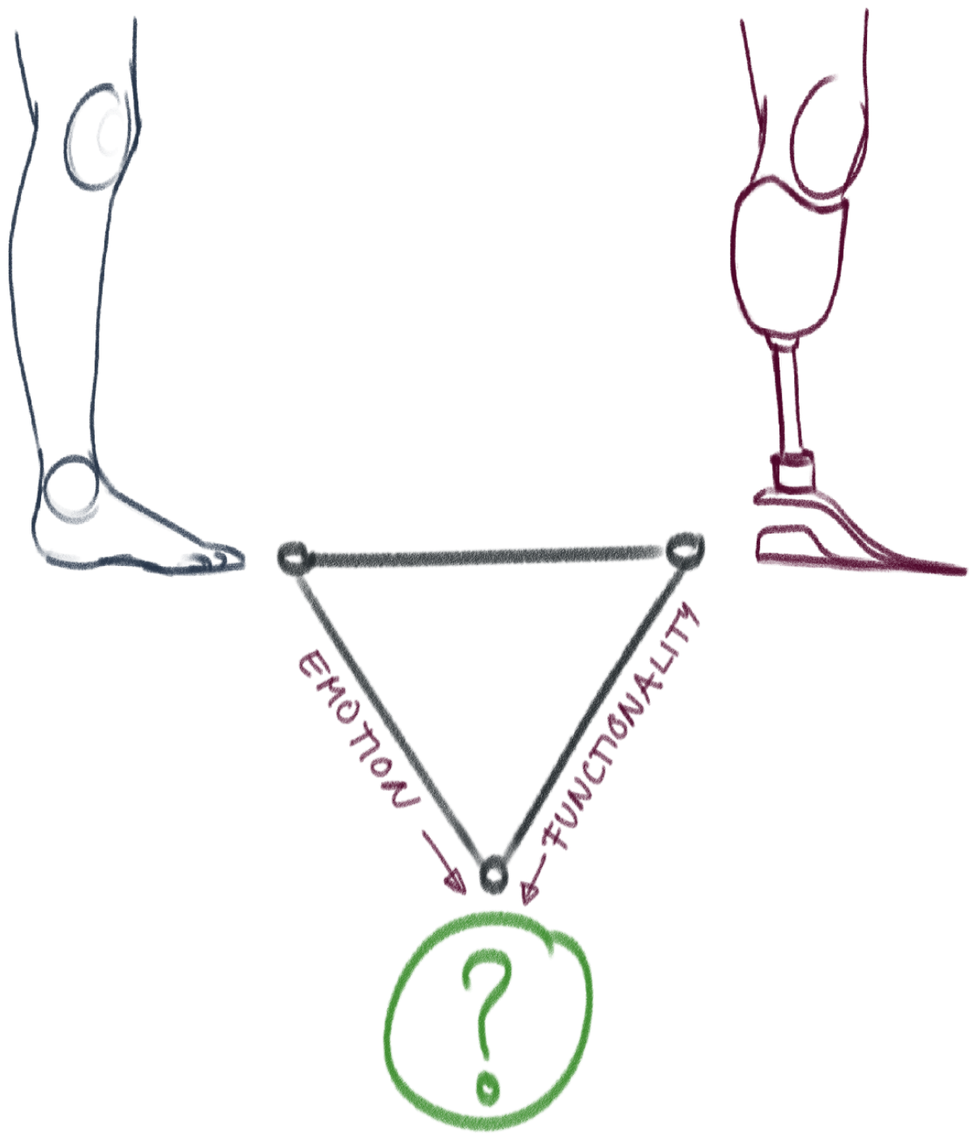
4.3 TURNING POINT

(figure 1)

”It’s not just about the right shape and looks, it’s about the right feeling and movement.”

In the beginning I was looking for ”the middle” (see figure 1) - this zone between the hard, male-coded, raw prosthesis and the cosmesis, the imitation of a real leg. However, when talking to the interviewees, I realized that both the male and female amputees in my study wanted something very different - something that was more a part of themselves and didn’t make for assumptions.

From there I came to the realisation that it needs to be something new, something that does not try to mimic real legs but also does not leave the prosthesis in a sheer functional state (see figure 2).

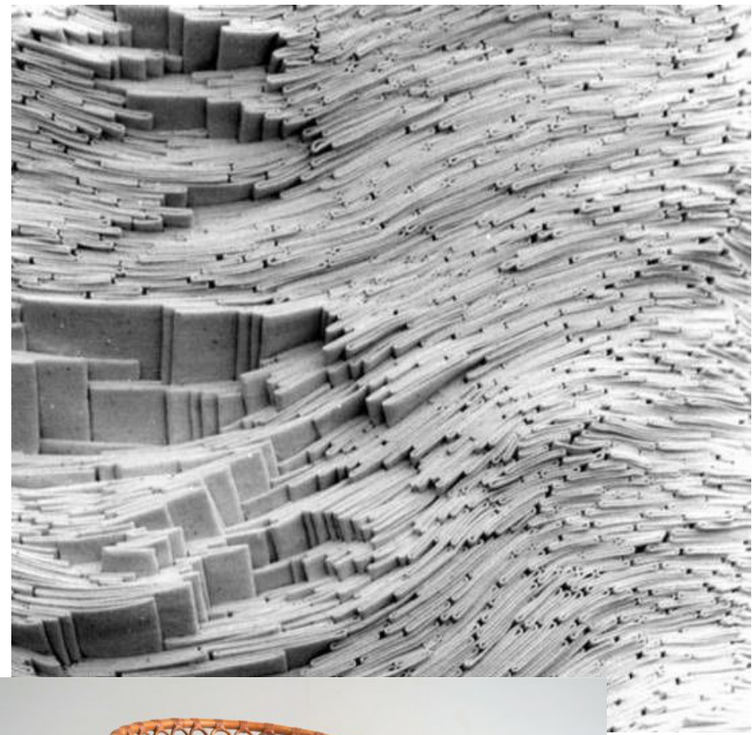


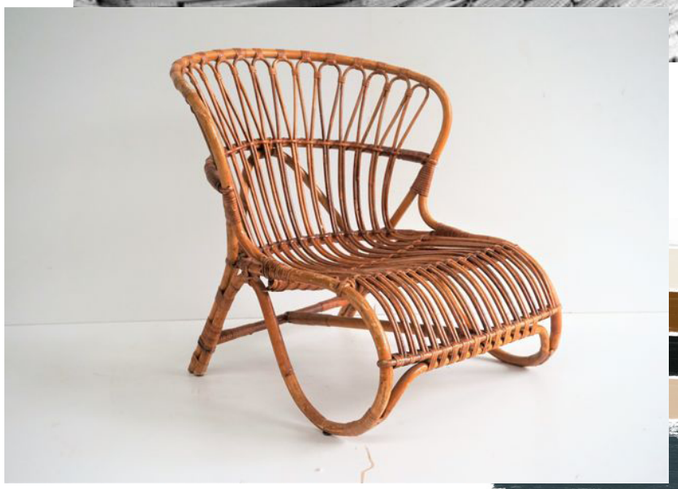
(figure 2)

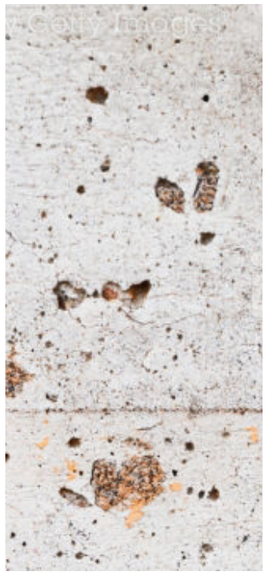
4.4 MOOD BOARD
A) COLOUR & TEXTURES

I looked at the home-y, more structural feeling of rattan, mixed with the randomness of naturally occurring speckles. The intention was to create something that looks stable and structured but keeps the biophelic feeling through a natural flow of the pattern.

On the side of colour, I went with neutral earthy tones that are used in gender-neutral clothing and give a natural feeling.







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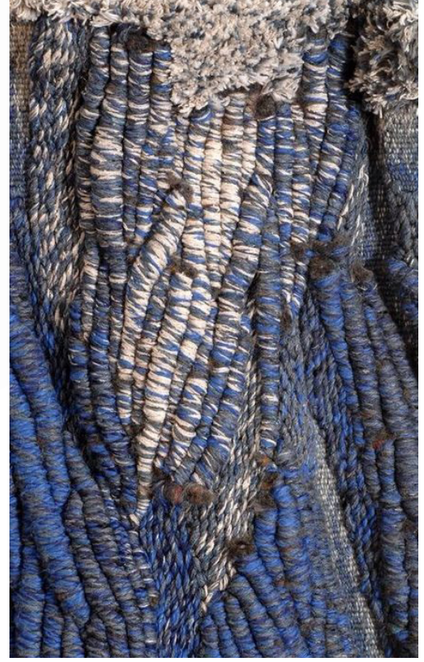
4.4 MOOD BOARD
B) KNITS



From the structured elements I found my way to 3D-knits. The patterns which are created by simply adjusting the fabric density where it needs to be stronger, were very appealing to me. On top of this, the 3D-knit can be water-repellant and easy to clean if the right threads a re used.

Adidas

The North Face

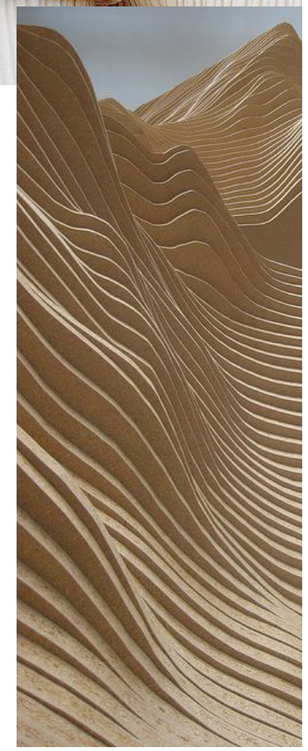
Nike

Nike

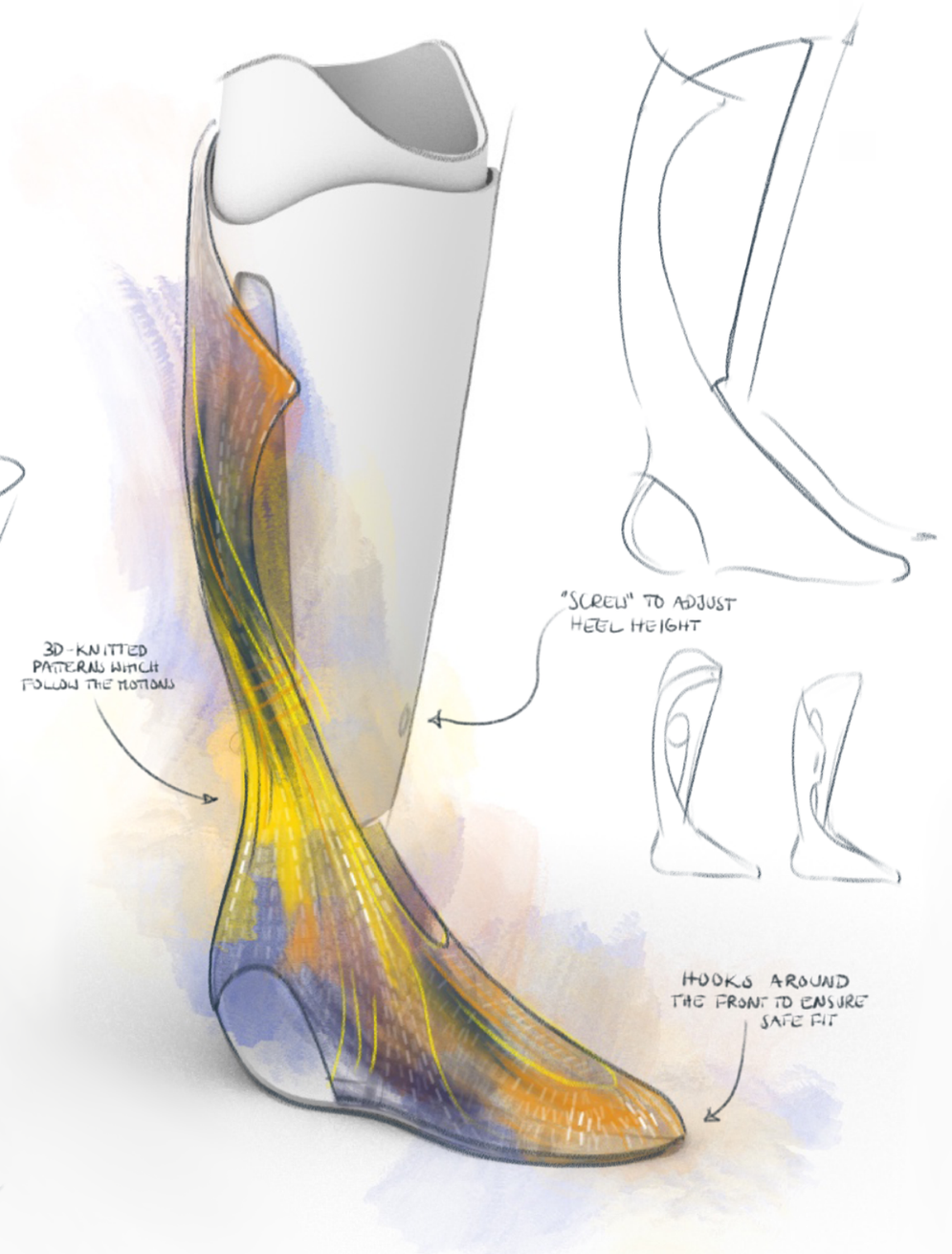
4.4 MOOD BOARD
C) LAYERS

Since prostheses are usually made up by many different parts, I was drawn toward an honest approach with layers showing the materials interact with each other.

The idea was that all the parts would follow a directionality and create the illusion of movement even when static.



4.5 CONCEPTING: MIXED MEDIA



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5.0 **FINAL DESIGN**

ADJUSTABLE HEEL HEIGHT

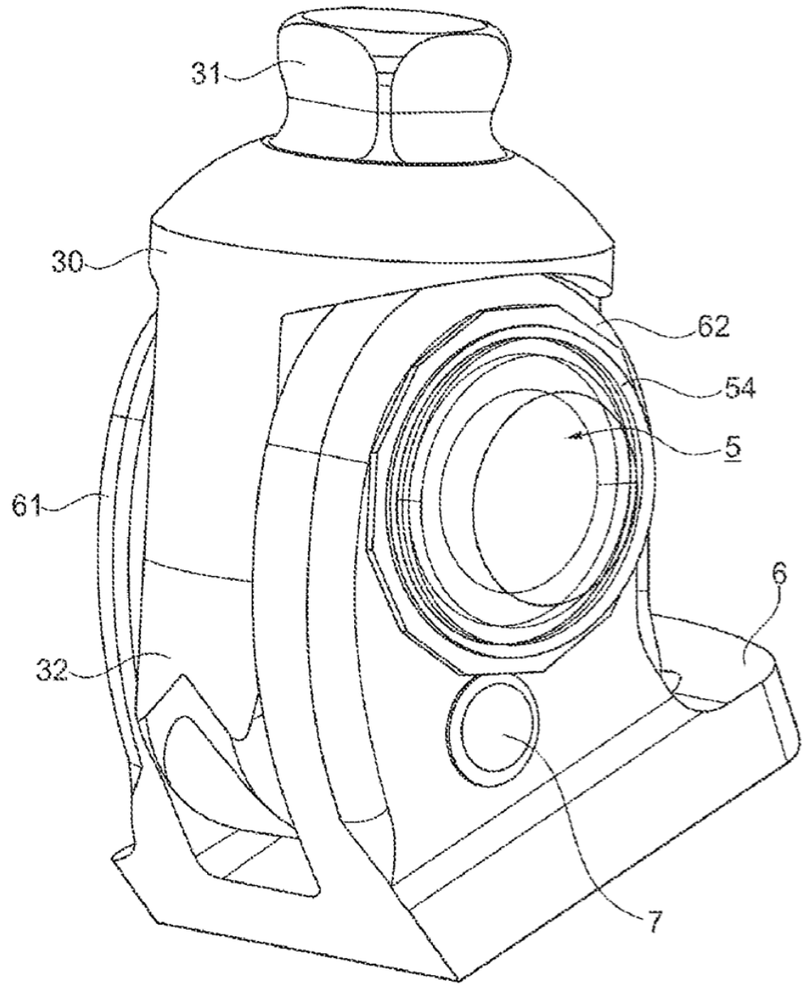
MATERIAL CHOICES

THE SYSTEM

FINAL IMAGES

5.1 ADJUSTABLE HEEL HEIGHT

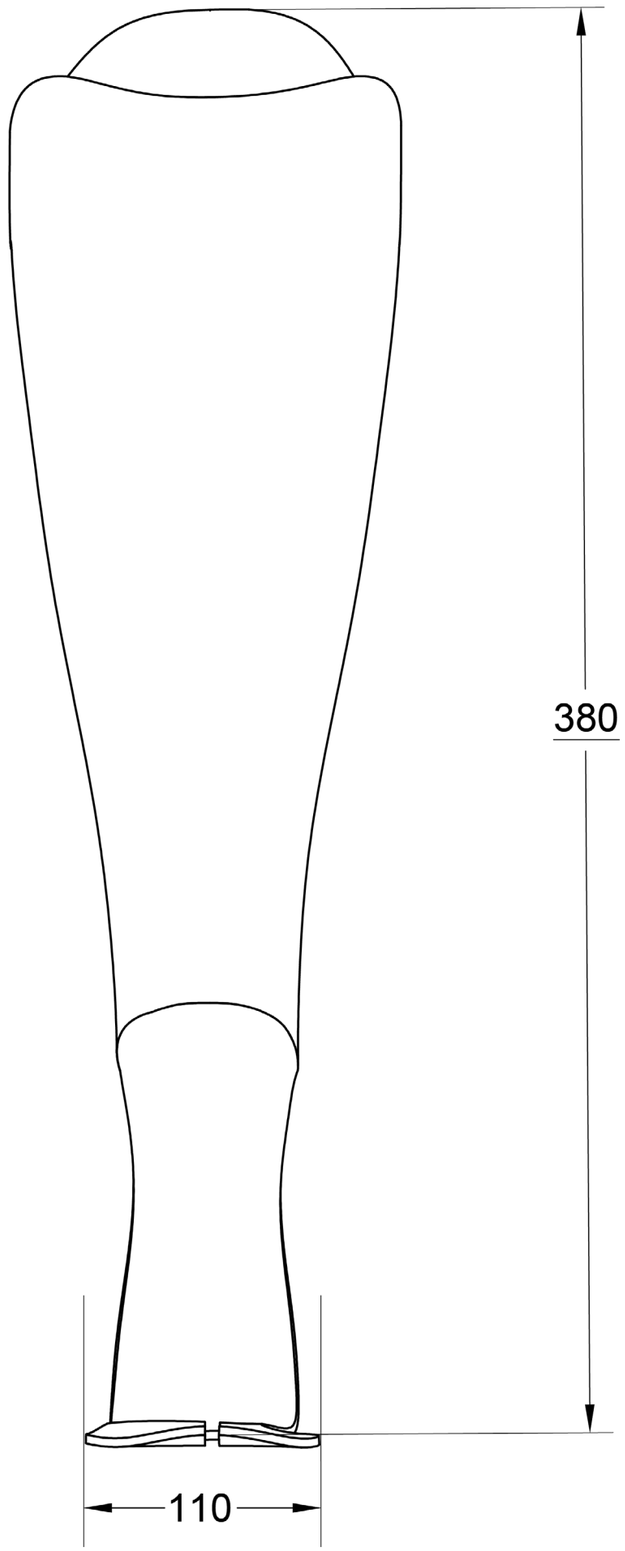
The ankle is adjustable to fit different heel heights such as hiking boots, and high heels. The mechanism for this is taken from an existing patent by OttoBock (2020). It is a push-button to release and adjust according to your heel height. The patent includes automatic adjustments which are not considered for this project but might be valuable if the amputee wants to include an automatic ankle.

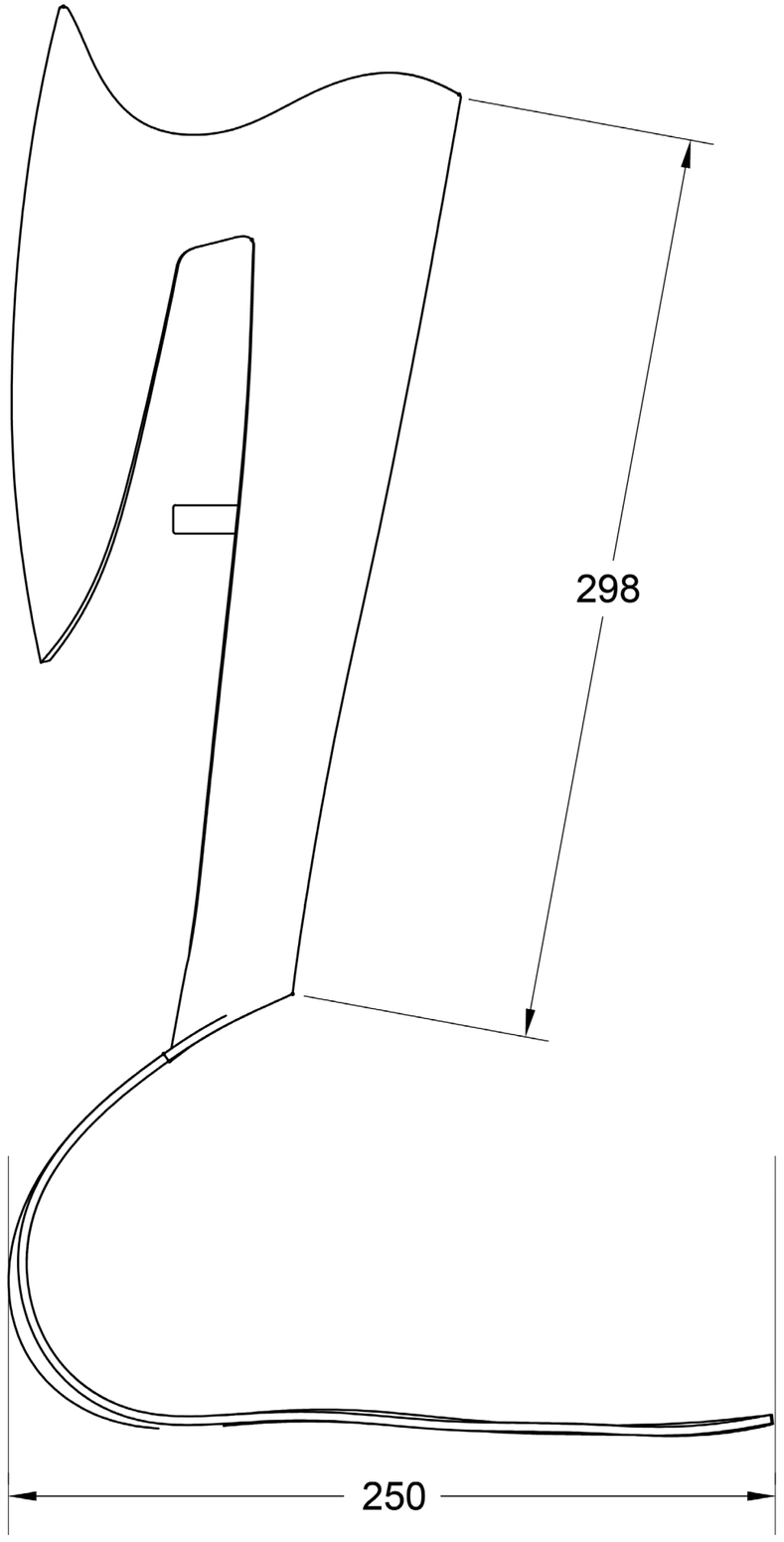


Pub. No.: US 2020/0170808 A1
Pub. Date: Jun. 4, 2020

5.2 TECHNICAL DRAWING

The measurements in this drawing are oriented around the average measurements for a human leg. Since the final product is 3D-printed and customised for every new user, measurements will differ according to the size of their other or previous leg.





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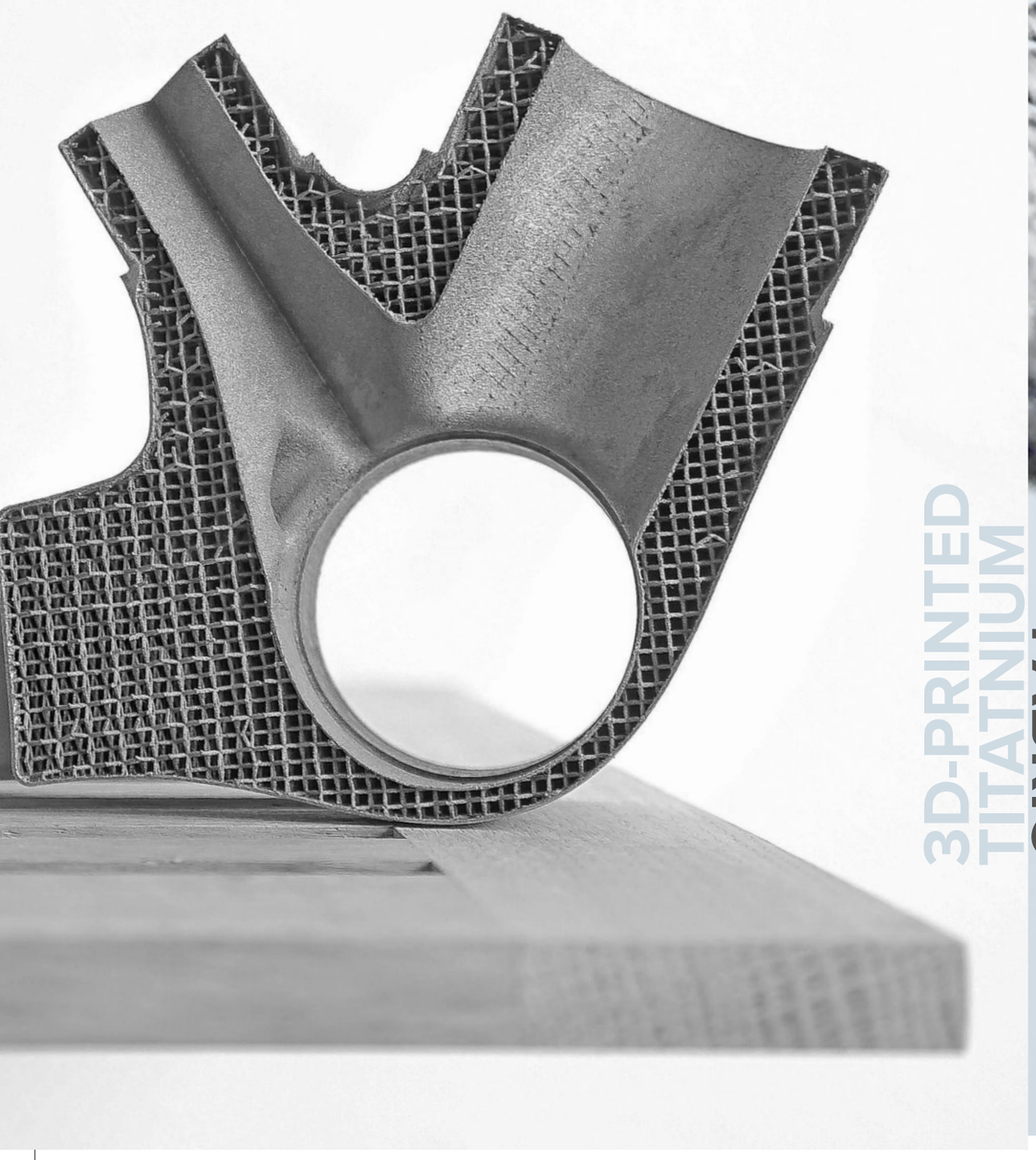
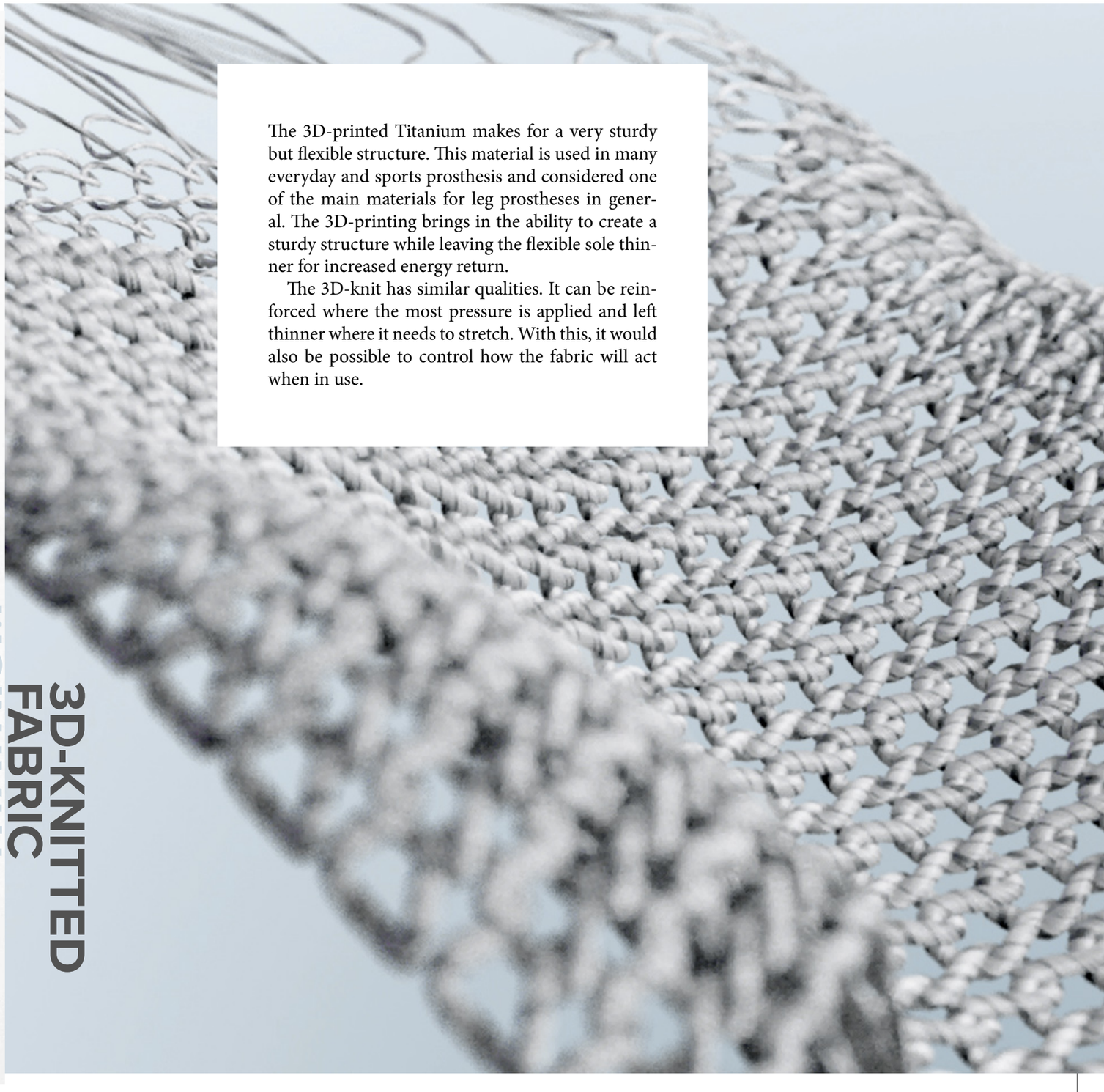
5.3 MATERIAL CHOICES



3D-PRINTED TITATNIUM

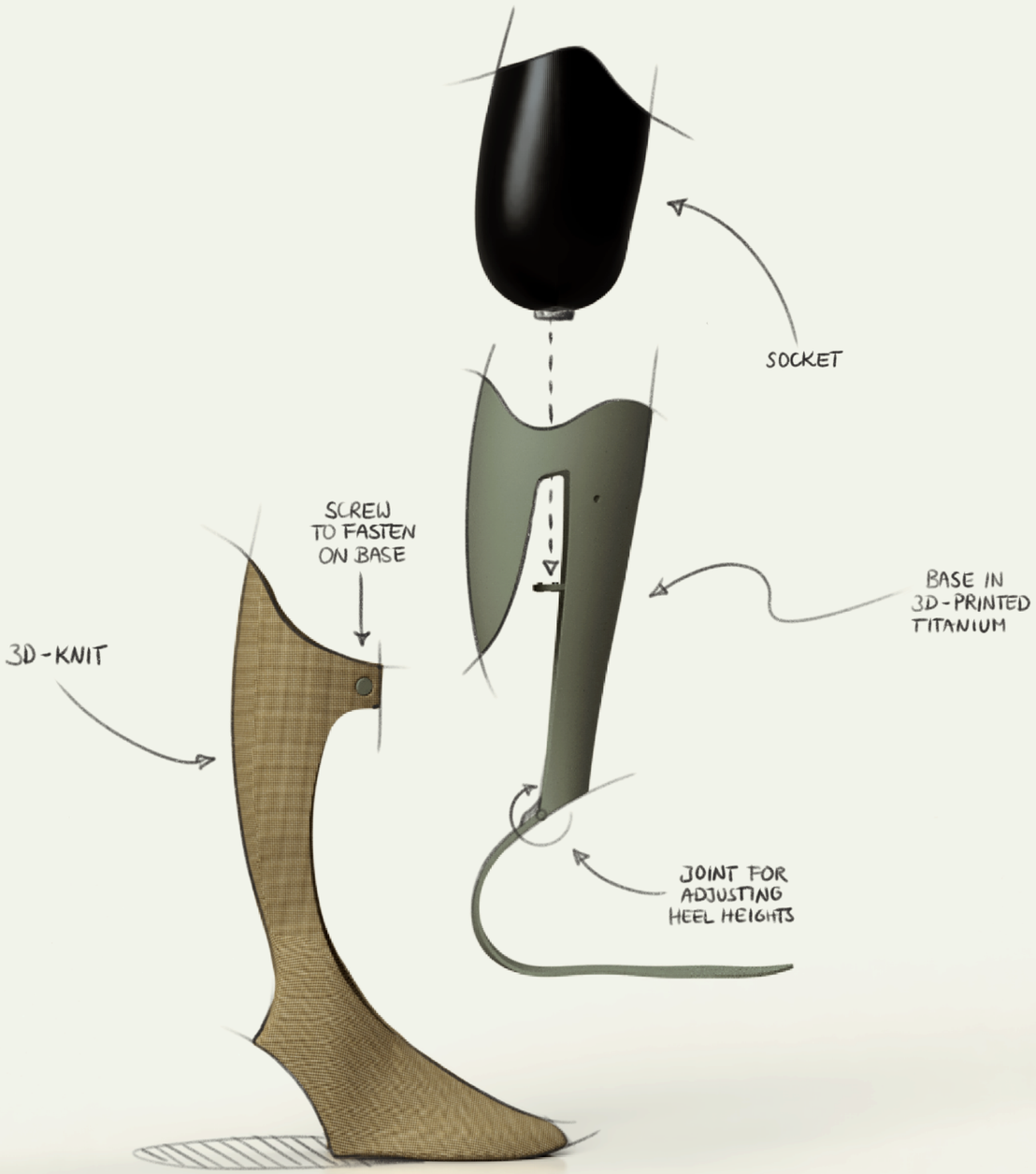


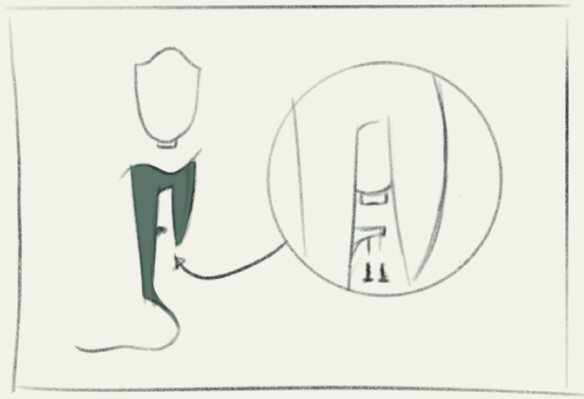
3D-KNITTED FABRIC

The 3D-printed Titanium makes for a very sturdy but flexible structure. This material is used in many everyday and sports prosthesis and considered one of the main materials for leg prostheses in general. The 3D-printing brings in the ability to create a sturdy structure while leaving the flexible sole thinner for increased energy return.

The 3D-knit has similar qualities. It can be reinforced where the most pressure is applied and left thinner where it needs to stretch. With this, it would also be possible to control how the fabric will act when in use.

5.4 THE SYSTEM





1. Attach the socket to the base

2. Put the socket + liner over the stump

3. Slide in the 3D-knit in the slit on the ”toes”

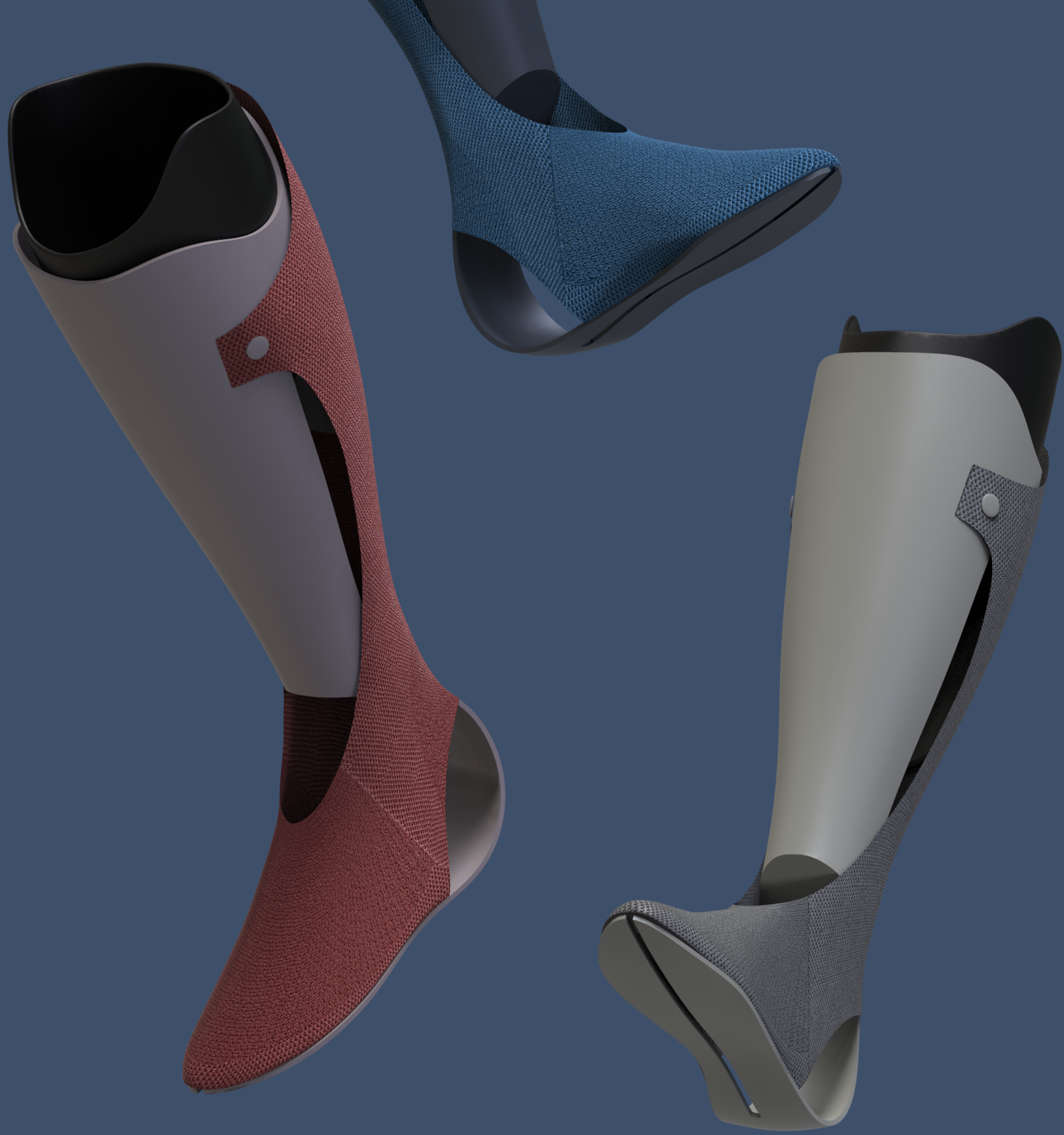
4. Stretch knit over the heel

5. Press the screws into place

6. Screw the knit into place

5.5 FINAL IMAGES

Some images showing the final concept - a 3D-printed titanium base with a 3D-knit sleeve and a screw button to attach the sleeve. This concept is for both everyday wear and lighter sports as well as different heel heights.



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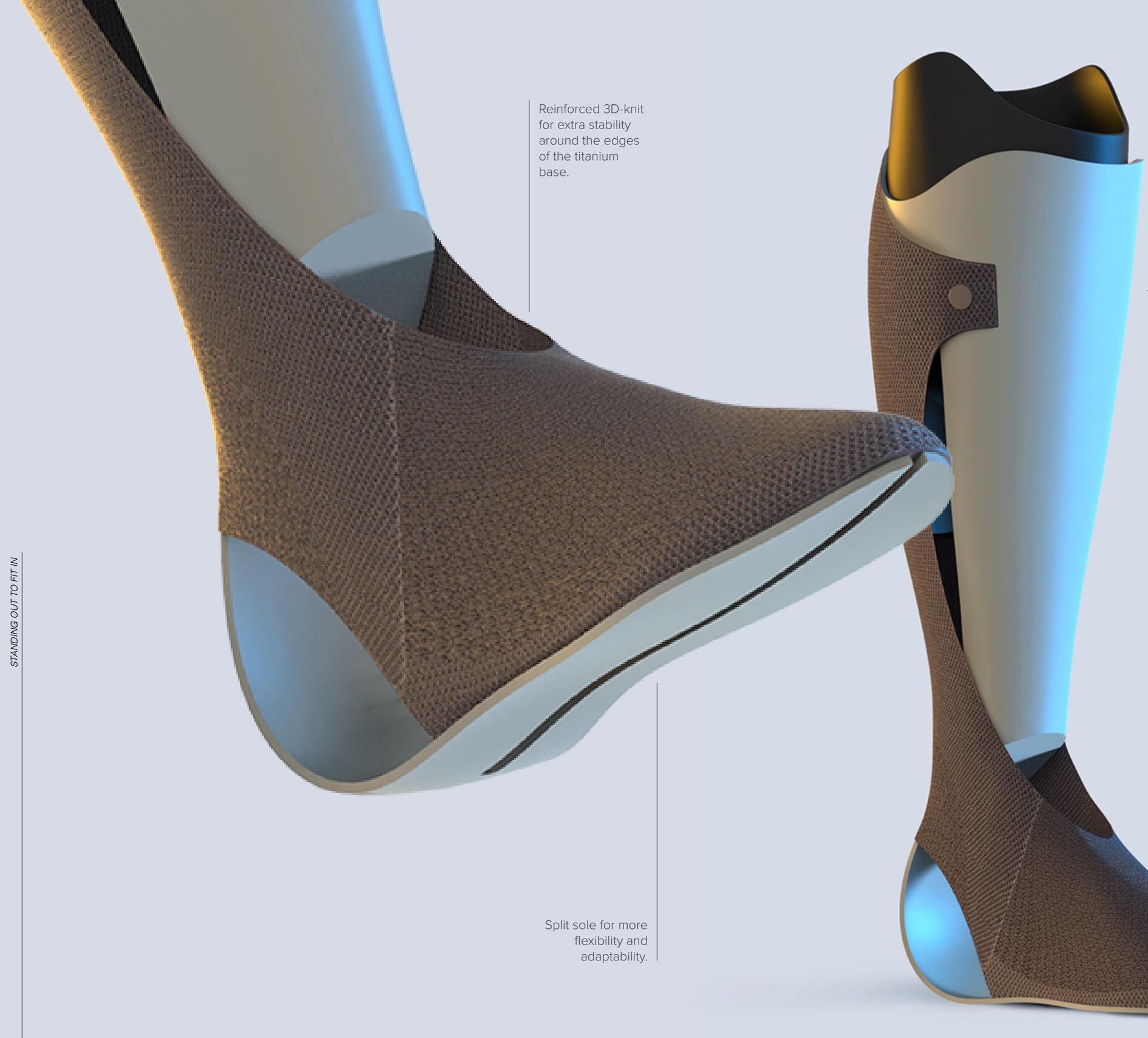

Reinforced 3D-knit for extra stability around the edges of the titanium base.

Split sole for more flexibility and adaptability.

Big screw-head for easy assembly.

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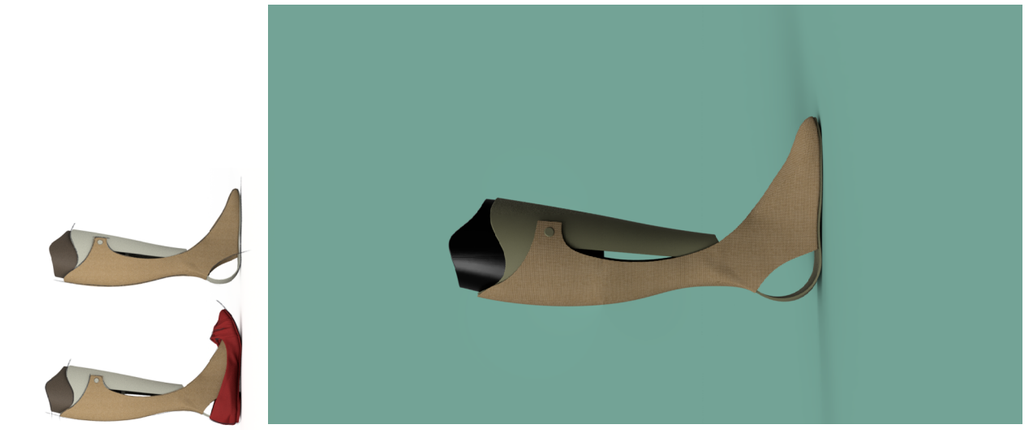

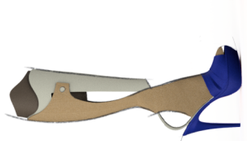

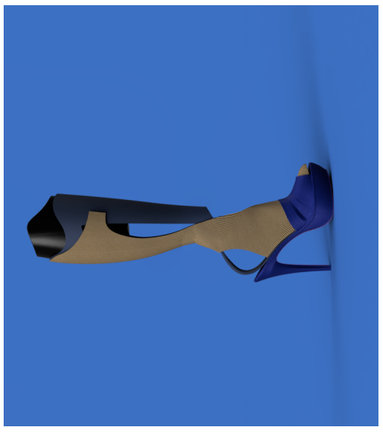

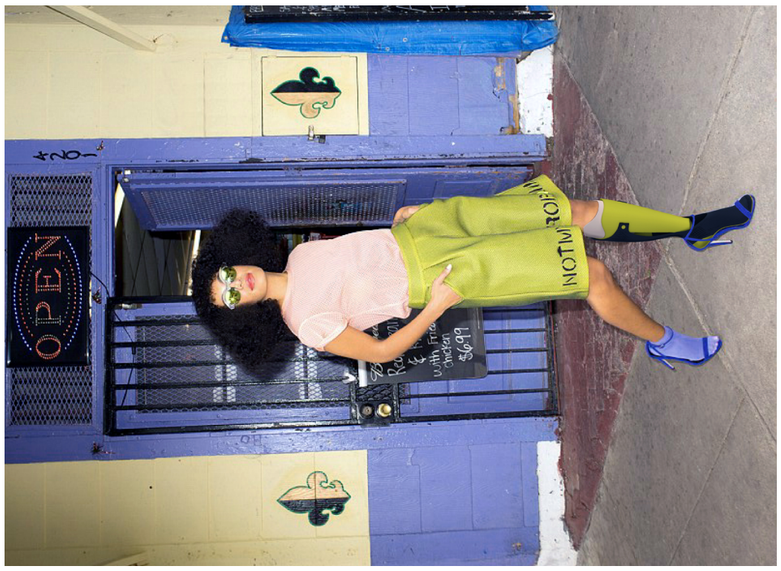

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6.0 FURTHER RESEARCH

3.5 PROTOTYPE TESTING

Because of COVID-19, the testing phase for this project was cancelled. This turned the outcome into a concept rather than a final design. When things clear up, a testing phase could be made with the actual materials and lower-leg amputees testing it.

Some of the major things that need to be tested to legitimize the project idea are user interaction (which has only be storyboarded so far), material testing (3D-printing of the titanium and test-knitting the fabric), and stress-testing the materials.

3.5 SOLE & ANKLE

The sole is split into two in the front. This because it was the standard for most high-mobility prostheses. How deep this split is needs to be revised according to testing results.

Currently, the ankle is an existing patent from Ottobock. Realizing that the ankle in itself would be a whole other project (due to stress-testing), I took it out of the scope and replaced it by an existing patent. This would of-course have to be adjusted in further research of this project. The ankle needs to be adjusted to the prosthesis base and the material types.

3.5 GENDER LABELS & STEREOTYPES

Finally, a word needs to be said on gender-labels and stereotypes. These are concepts deeply rooted in our society and hence even those, who do not generally benefit from these norms, will act on and choose those things that represent our society's values. This project aimed at finding the "third option" to a somewhat binary system of options and this option often lies outside the norms making it hard to access.

While this project most likely will not change how society sees this issue, it does shed some light on the problem that designers are biased as well and that we, even when actively trying, are still somewhat biased as long as society is. Which is why it is so important that we keep trying to change it.

Citations

Balsamo, A. (2000) Reading Cyborgs, Writing Feminism in G. Kirkup, L. James, K. Woodward & F.

Hovenden (Eds.) Te Gendered Cyborg: A Reader. (pp. 148-158). London, UK: Routledge.

Grant, R. (2014). Going Commando: Prosthetics and the Politics of Gender. University of Tasmania, Australia.

Fact Sheet #07 - Prosthetic appearance and cosmetic covers, (n.d.). Retrieved March 15, 2020, from https://www.limbs4life.org.au/uploads/resources/Fact-Sheet-7.pdf

Jackson, G. (2019, November 13). The female problem: how male bias in medical trials ruined women's health. Retrieved March 15, 2020, from https://www.theguardian.com/lifeandstyle/2019/nov/13/ the-female-problem-male-bias-in-medical-trials

Meyer, Bertolt, and Frank Asbrock. "Disabled or Cyborg? How Bionics Affect Stereotypes Toward People With Physical Disabilities." Frontiers, Frontiers, 29 Oct. 2018, www.frontiersin.org/articles/10.3389/fpsyg.2018.02251/full.

Summit, Scott. "Summit ID." Summit ID, www.summitid.com/#/3d-printed-prosthetic-leg/.

Patents

5.1 Adjustable Heel Height:
Meyer, et al. (2020). Retrieved June 15, 2020, from: http://www.freepatentsonline.com/20200170808.pdf

Pictures

Abstract:
https://imagebox.cz.osobnosti.cz/foto/viktoria-modesta-moskalova/N608646-68949.jpg

1.1 Women and Medical Design:
https://posterfoundry.com/diagram-of-front-muscles-of-human-body-vintage-anatomy-chart-framed-poster-by-proframes-14x20-inch/

1.2 Women and Prosthetics:
https://www.deviantart.com/alanmac95/art/Nebula-Avengers-End-Game-Render-2-796616178
http://germundandersson.blogspot.com/2019/05/seven-of-nine_13.html

1.3 Disabled or Cyborg:
https://techthelead.com/this-scientist-sports-a-metal-gear-solid-inspired-prosthetic-arm-that-carries-a-drone/

3.3 Existing Covers:
http://unyq.com
https://www.lindhextend.com/sv/

3.4 Existing Feet:
https://www.freedom-innovations.com/runway-2/
https://www.college-park.com/accent
https://releases.jhu.edu/2016/05/25/johns-hopkins-students-design-prosthetic-fit-for-high-heels/
http://www.summitid.com/3d-printed-prosthetic-leg

5.2 Material Choices:
https://bastion-cycles.com/process/photo-8-9-16-3-27-49-pm-2/
https://www.aixsponza.com/assets/Uploads/AM1-knit3b.jpg?

THANK YOU
FOR READING.