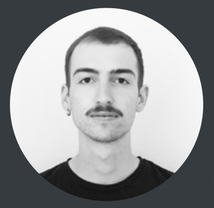
ASCENDER

ADAPTIVE TETHERING SYSTEM

MFA Advanced Product Design

Umeå Institute of Design

2021



STIJN VAN CUIJK

SYDNEY EILBACHER

Seamless Tool Handling for Workers at Height

Telecom technicians commonly work high up in telecom masts and towers. Bringing tools up in a tower and using them at height is a balancing act between safety and convenience. Unsecured tools can easily be dropped. This disrupts the technician's workflow, wasting valuable time and can cause serious injury. Sometimes fatal.

Tool handling safety can be greatly improved by tethering tools, securing them to the user with a safety line. As simple as this solution sounds, it brings several challenges. How will tethering affect freedom of movement, workflow and the handling of different tools?

In this project we aim to reduce injuries caused by falling tools at telecom tower sites by providing a tool tethering system that streamlines a telecom technician's workflow both on the ground and 60m above it, thus eliminating the daily struggle between safety and convenience and maintaining optimal performance. Organized, reliable and easy to use, this next generation tool tethering ecosystem offers a quick visual of all tools at hand and makes for an effortless workflow from the base of the mast to the top and back again.

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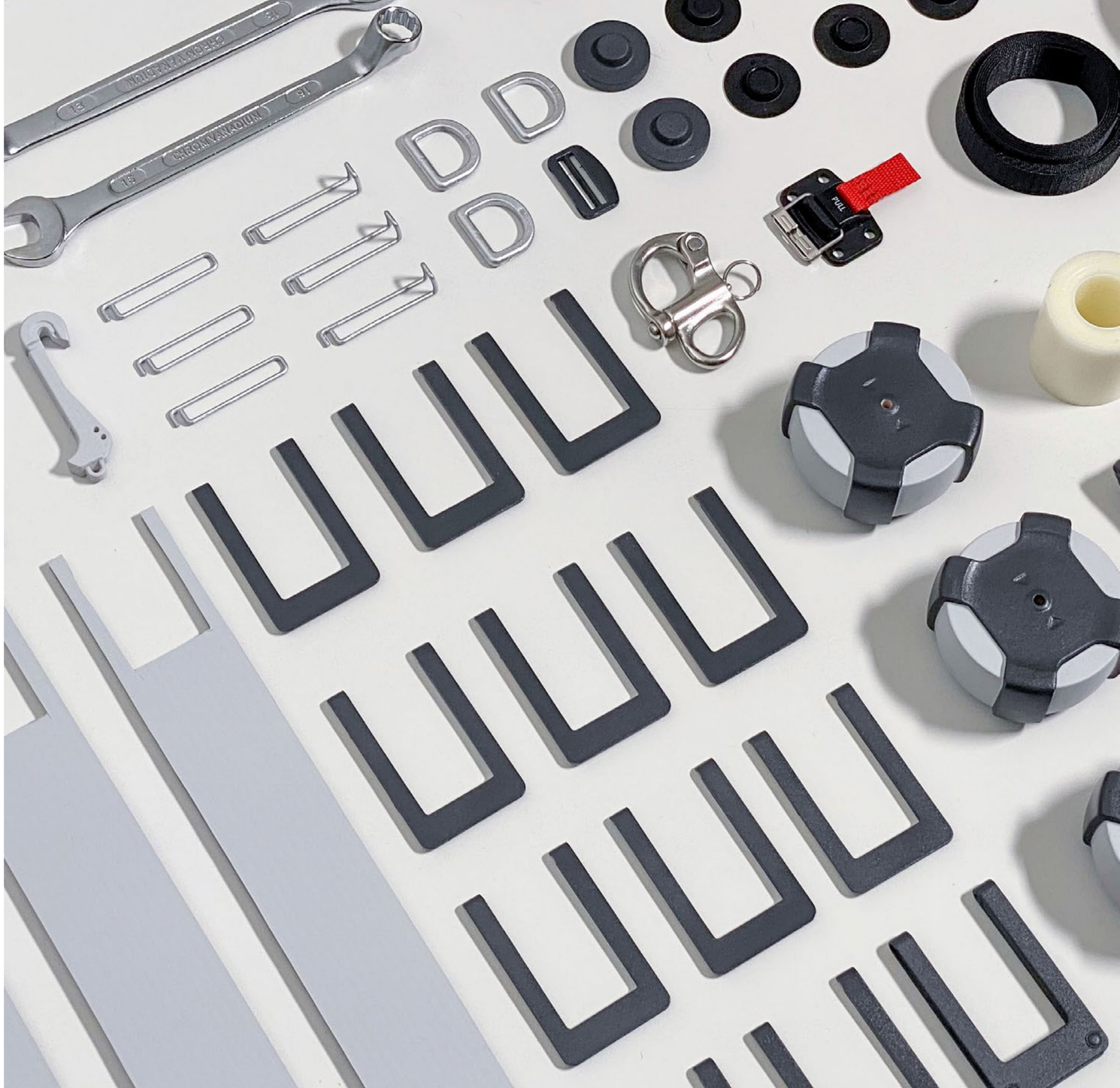


BACKGROUND & RESEARCH

Background

This project focuses on the daily challenges faced by telecom technicians at the worksite. We take a human-centered approach to identifying design opportunities based on their needs and pain points and explore new and relevant product solutions.

Collaborating Partner

This project is done in collaboration with Ericsson, a Swedish multinational networking and telecommunications company headquartered in Stockholm. Ericsson had a 27% market share in the 2G, 3G and 4G mobile network infrastructure market in 2018. They will support us in the design process by providing feedback and sharing their experiences and insights into telecom technologies and infrastructure.

Users

Telecom technicians are people who specialize in the installation, service, maintenance, and decommissioning of telecom masts and towers. They work with a variety of hardware, including coaxial cables, antennae, radios, and fiber-optic cables.

Telecom companies need telecom technicians to ensure that their networks remain operational. Without the services of telecom technicians, telecom providers would not be able to maintain network service or coverage for customers.[1]

Every telecom work site is different. Because of this, telecom technicians face different challenges every day. One day they will have to build a seventy-two meter tall mast, the next they might have to crawl through tight spaces to pull cables from one place to another. They need to be physically fit and have strong technical, analytical and problem solving skills.

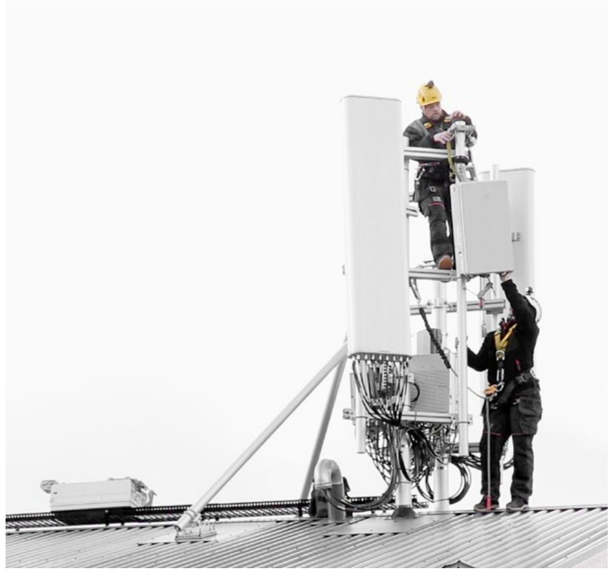
Research

In order to identify relevant design opportunities and pain points in the area of user centered telecom sites, ethnographic research was conducted in the form of observations, user studies and interviews. Two experienced telecom technicians were followed and observed while working at two different job sites over the span of six ten hour days.

Research data was captured using video, photo and notetaking. Video was captured from different angles, most importantly with point of view cameras from the technicians when they went places they could not be followed because of safety concerns. The resulting data was summarized for the two different jobs with visual timelines and research summary videos.

Gävle

The first job was at a build site in Gävle, where, over the span of four days, a small team of telecom technicians assembled and erected a new, seventy-two meter tall telecom mast with the help of a helicopter.



Sälen

The second job was the installation of new 5G antennas on an existing installation on a building in a ski resort near Sälen.

Problem Analysis

Multiple design opportunities were identified out of the research summary, most notably in the areas of safety, communication, hardware, measuring, wearables and tools. Tool safety was an immediately relevant pain point.

Telecom workers need many different tools to do their jobs, which vary depending on the task at hand. While they differ in size, weight, and frequency of use, they all have one thing in common: they are all affected by gravity. While on site, tools were filmed falling in both Gävle and Sälen.

In Gävle, a large wrench fell from a height of forty meters while a technician was climbing the mast. One can imagine how dangerous it would have been to be standing underneath.

In Sälen, a screwdriver fell out of a technician's hand while securing part of the antenna. He paused, frustrated, looked into his bag to see if he had a replacement (he didn't), and tried to continue working using his fingernail as a screwdriver before finally repelling down to retrieve his lost tool. Not only are falling tools a hazard to others, they are an inconvenience for the people who drop them.

So, why don't telecom technicians tether all their tools? The telecom technicians we observed, and presumably others as well, only tether the 'big tools' that promise to cause devastation when dropped.[4] They would of course like to secure all tools for convenience alone but the current solution's cumbersome workflow, tangle of safety lines and annoying nature prove to be major deterring factors.

There are 54,030 recorded nonfatal incidents with falling equipment annually in the US. That is 148 incidents per day.[2]

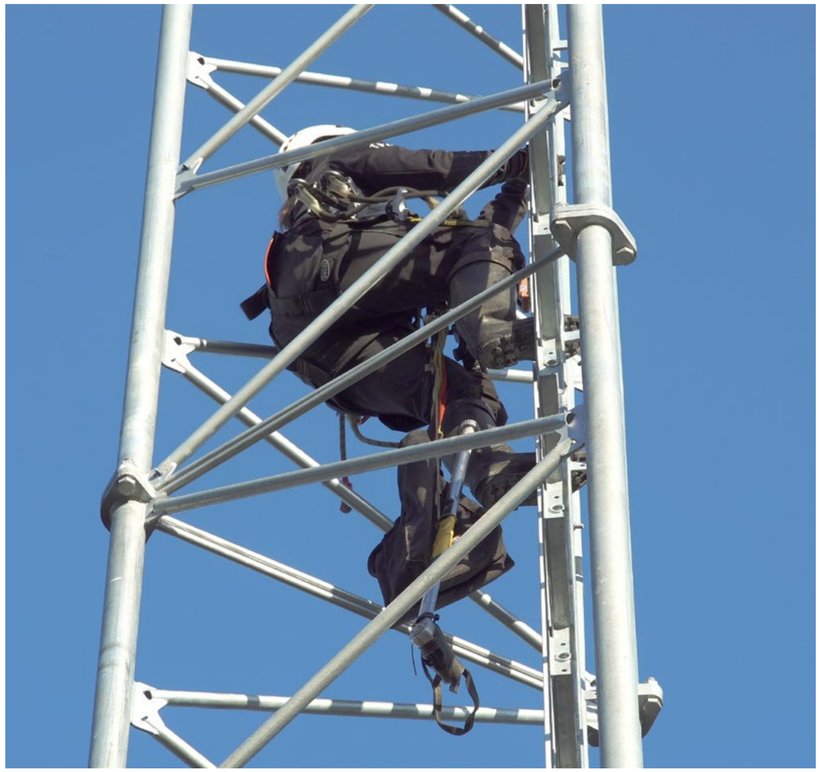
Additionally, 278 workers were fatally struck by falling equipment in one year.[3]

The main toolbox holds frequently used smaller tools like screwdrivers and wrenches within reach when working on the ground. These tools are some of the most commonly used when maintaining a mast. The necessary tools are transferred to a toolbag when working aloft.

Some of the most frequently used ‘Big Tools’.

Tool bags used for working aloft.

Climbing harness before tools and safety lines are attached.



Tools and tool bags hang between a technician's legs when climbing a mast.

A mess of safety lines, tool tethers, carabiners and rappelling gear restrict freedom of movement. The highlighted wrench is borrowed from someone else while still tethered to that person.

Nuts, bolts, and smaller tools are often stored in pockets.

Conclusion

Our research findings from Gävle and Sälen highlighted the fact that handling tools aloft is a daily struggle between safety and convenience. In order for this project to be successful, the new workflow should be the same as or better than their current workflow with untethered tools. Fast swapping. Easy sharing. Unhindered maneuvering. Minimal tangling. Flexible. Unobtrusive while climbing, crawling, hanging and rappelling.

Design Opportunity

How might we create a safer worksite environment by keeping tools from falling when working aloft while maintaining a smooth workflow?

Goals & Wishes: Design

Goals

A tethering system for the normally untethered/difficult to tether tools used by telecom technicians while aloft

Minimize risk of tools dropping while aloft

Single handed tool retrieval and replacement while aloft

Minimize entanglement of tethers and other safety lines

Preserve complete function of tool while connected to tethering system

Wishes

Create a universal tethering system for all tools (big and small) to be used by telecom technicians while aloft

No need to look at tool when retrieving or returning

Never have tools detached while aloft

Tools can be used as normal when detached from the tethering system

Universal tethering connector

Preserve fast retrieval and replacement of tool

User can move around freely while climbing

Goals & Wishes: Learning

Goals

Effective time planning and management

Storytelling

Visual narrative building

Wishes

Detailed CAD modeling

Soft goods prototyping if appropriate

Validation based design process

PROCESS

Taking an iterative, hands on approach throughout the entirety of this project enabled us to think about person-to-object interaction in a meaningful way. Going from sketches to rough, one to one prototypes and testing them in context gave us many insights to further push our concepts. We strapped ourselves into harnesses and dangled under stairwells with our prototypes to test the legitimacy of our ideas and used the resulting video footage to communicate our insights.

In addition to interaction, the materiality of the developed concept made it necessary to test physically, as it heavily depended on how certain materials would behave while bending and folding.

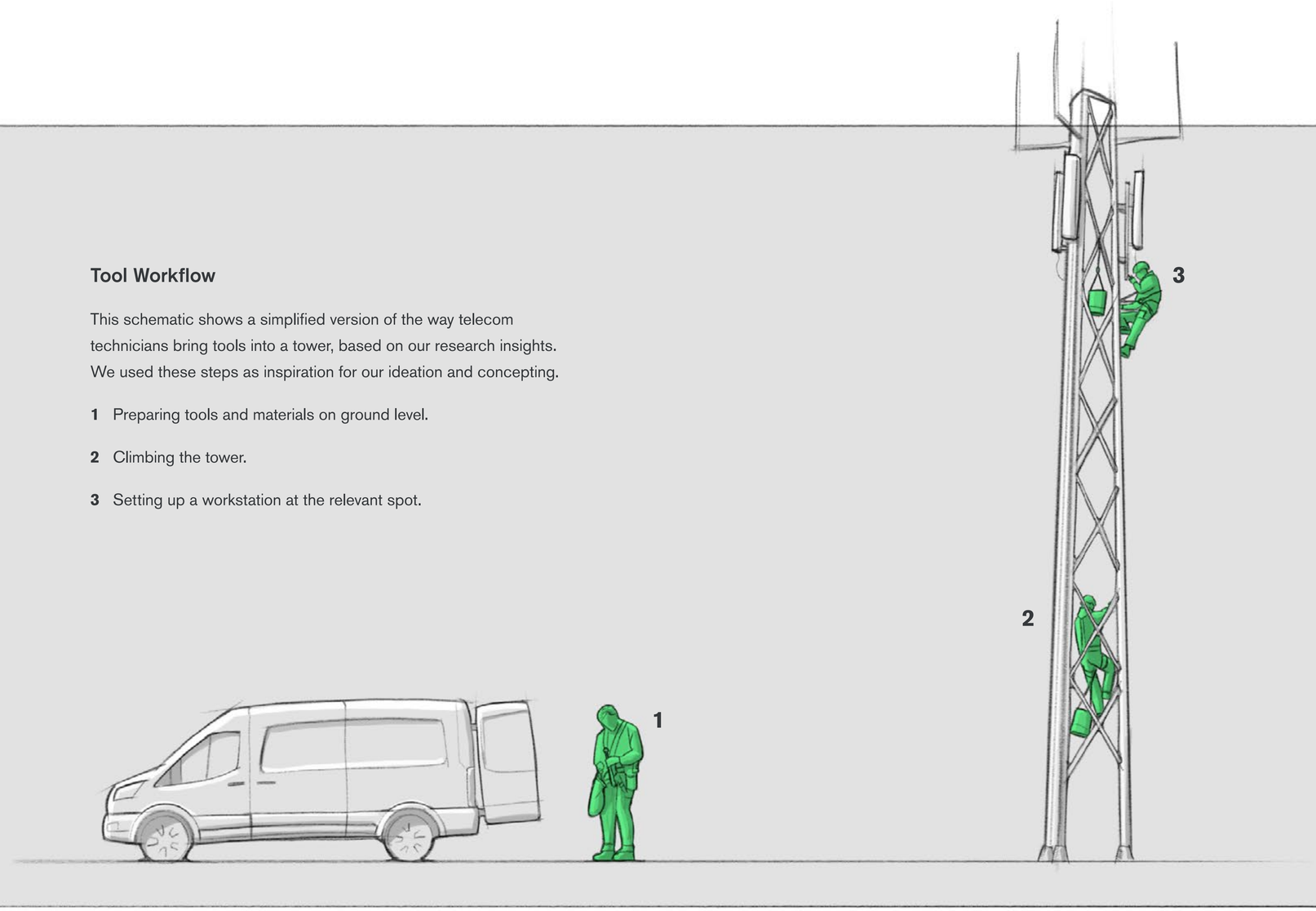
Tool Workflow

This schematic shows a simplified version of the way telecom technicians bring tools into a tower, based on our research insights. We used these steps as inspiration for our ideation and concepting.

1 Preparing tools and materials on ground level.

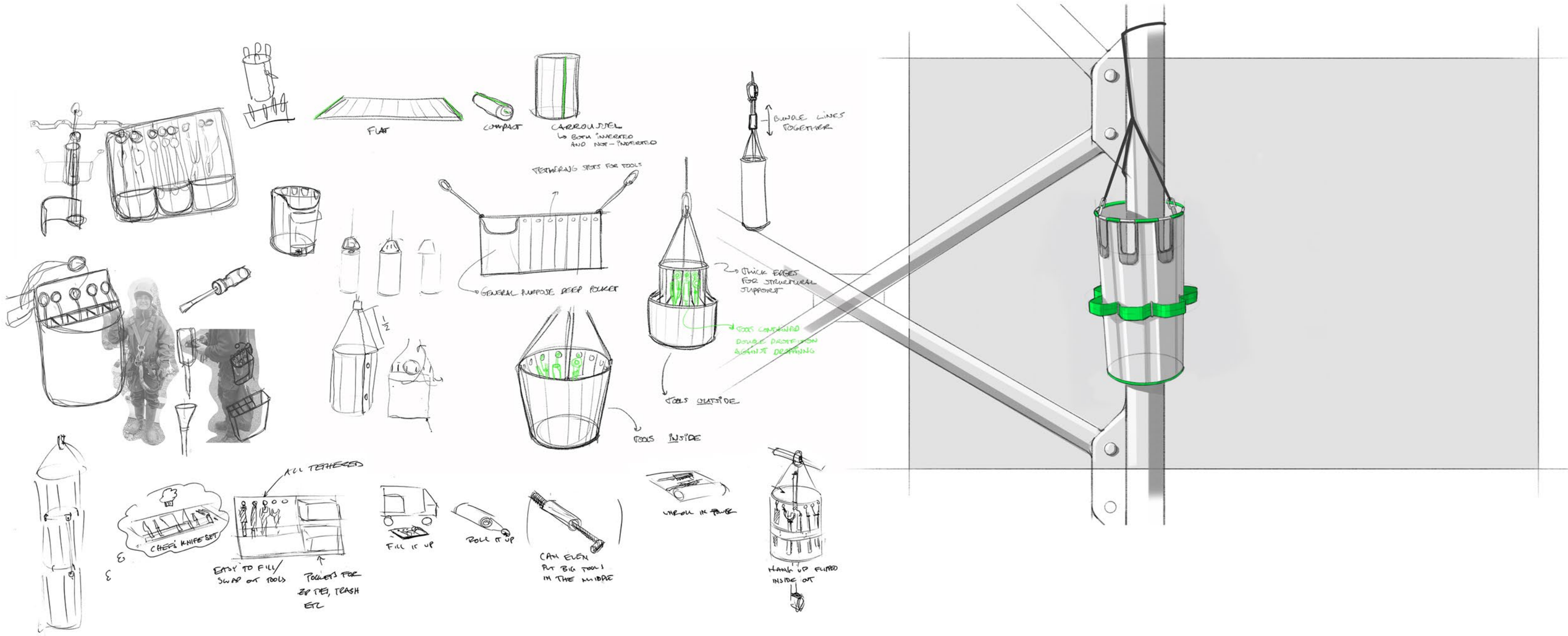
2 Climbing the tower.

3 Setting up a workstation at the relevant spot.

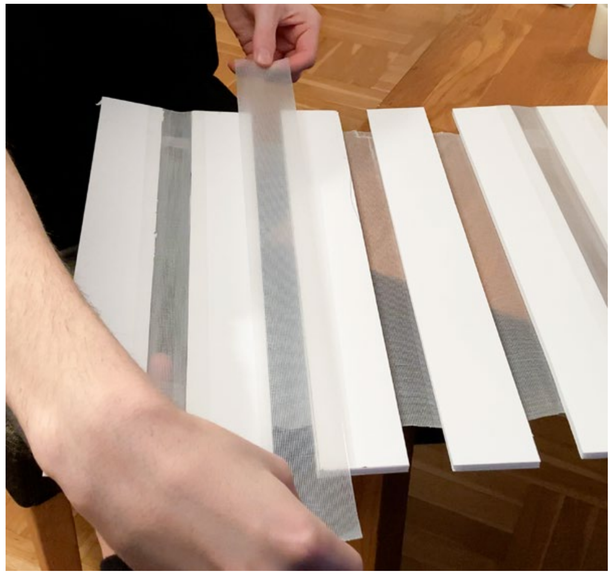


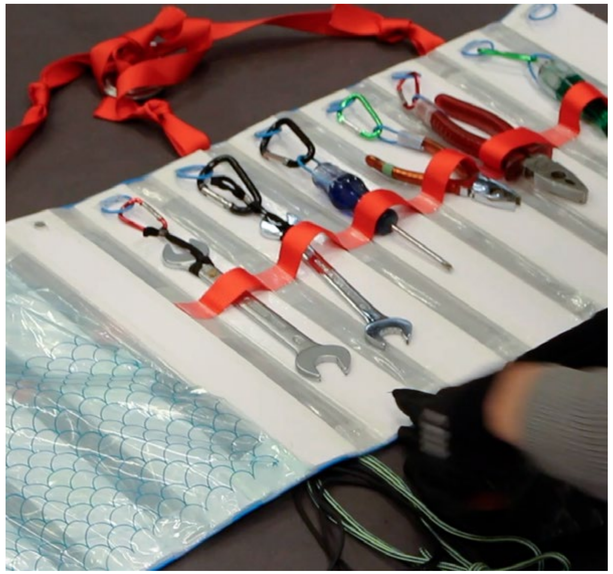
TOOLBAG

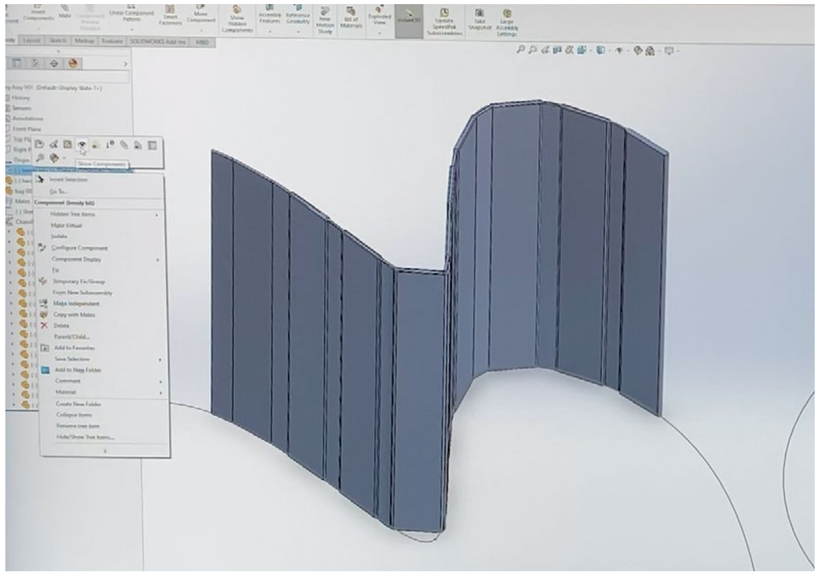
The first idea for the bag in this form factor, inspired by traditional tool rolls, became the starting point for the other parts in the tethering system.

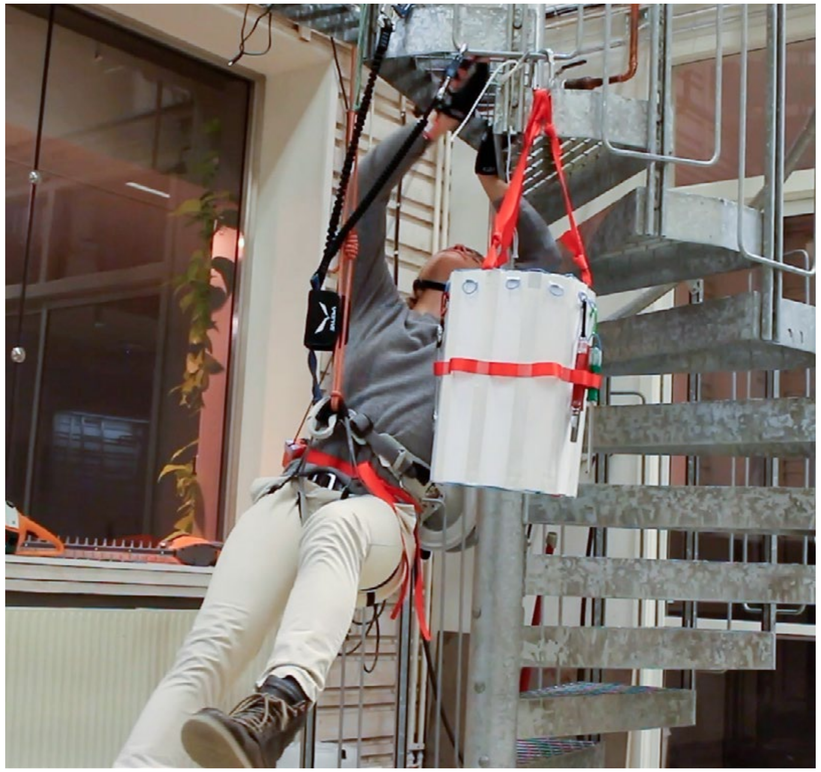



SLIDES
AROUND
ROPE?

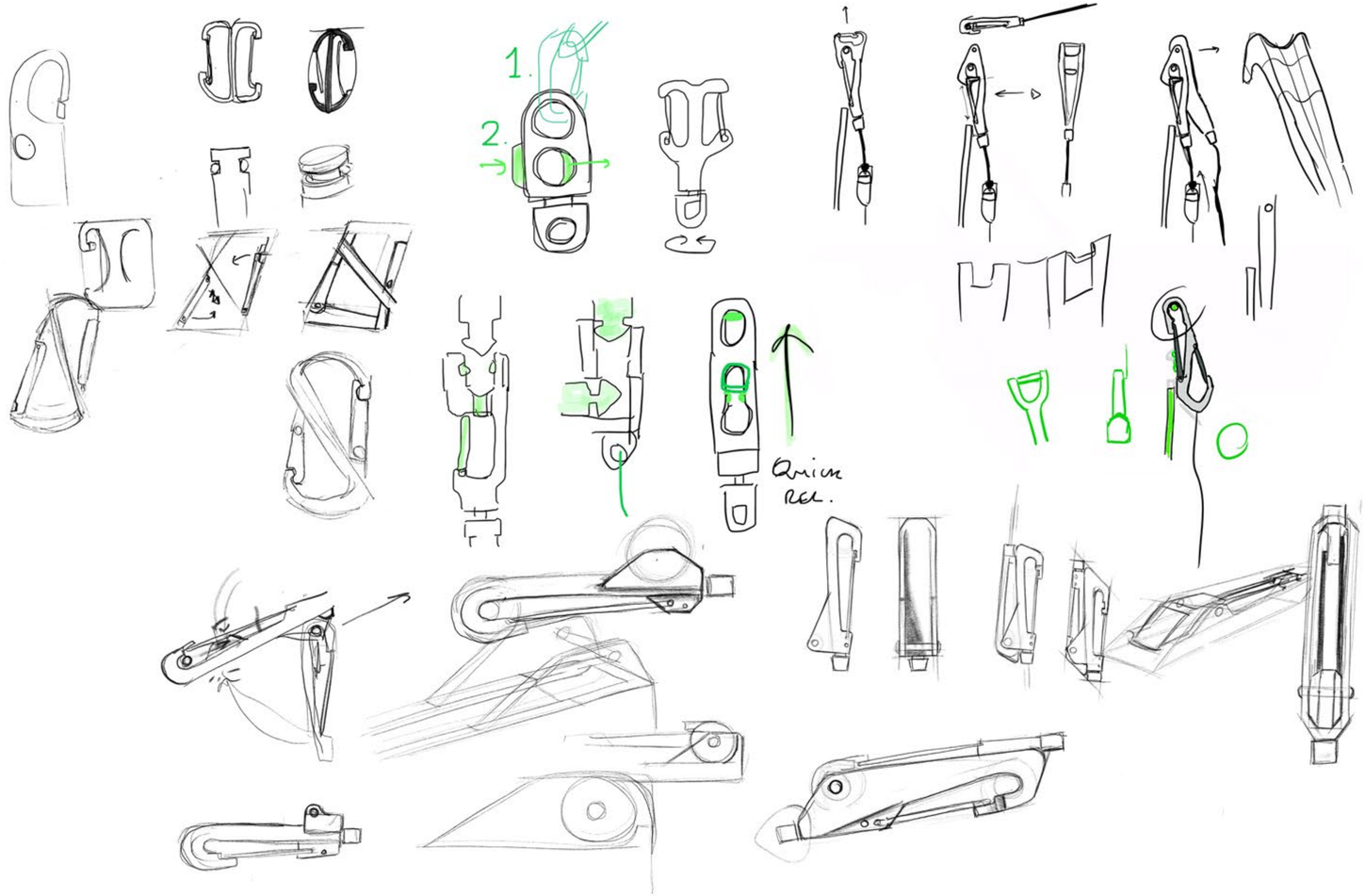


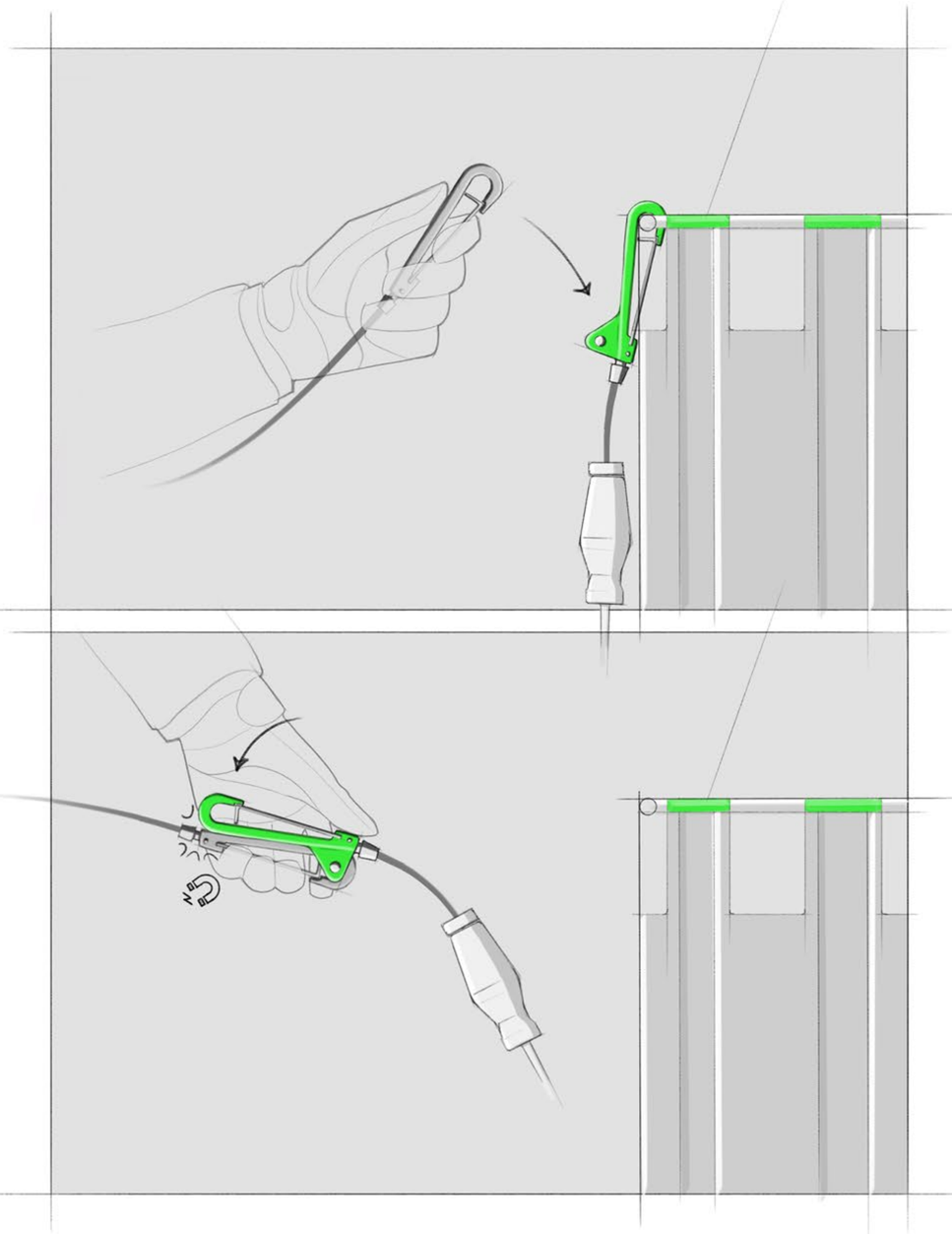


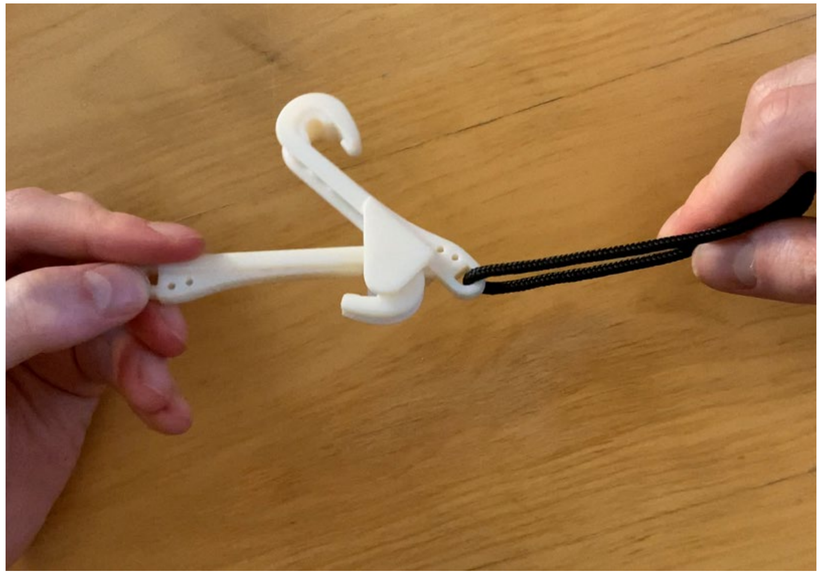


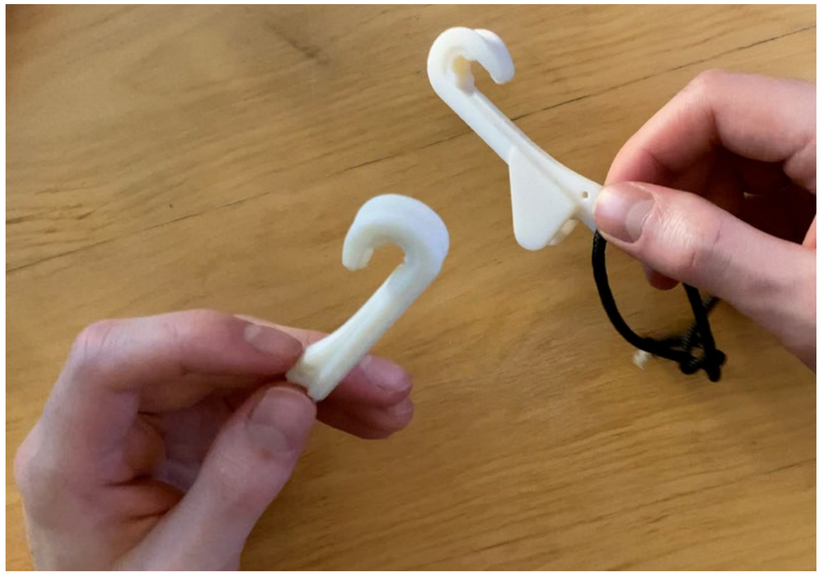


CARABINERS

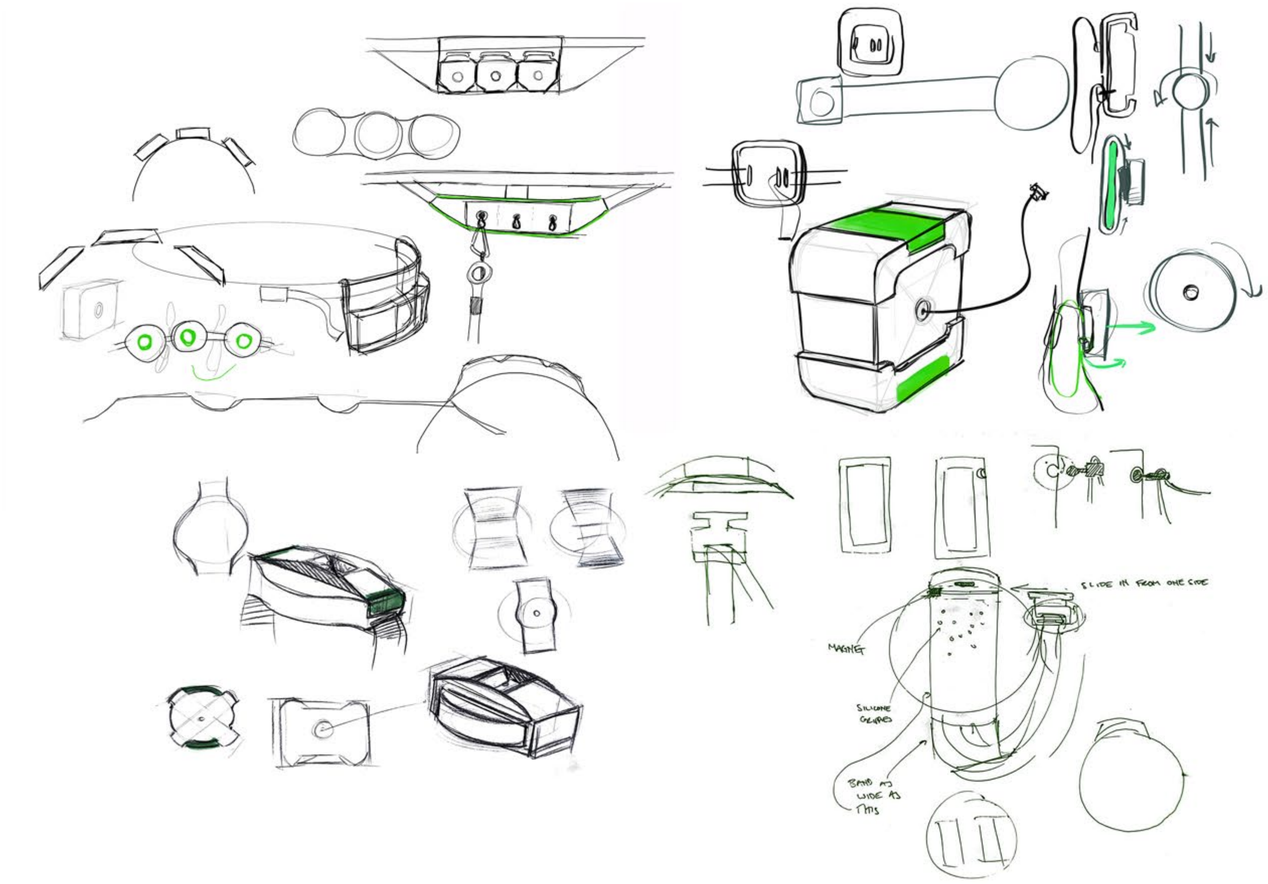


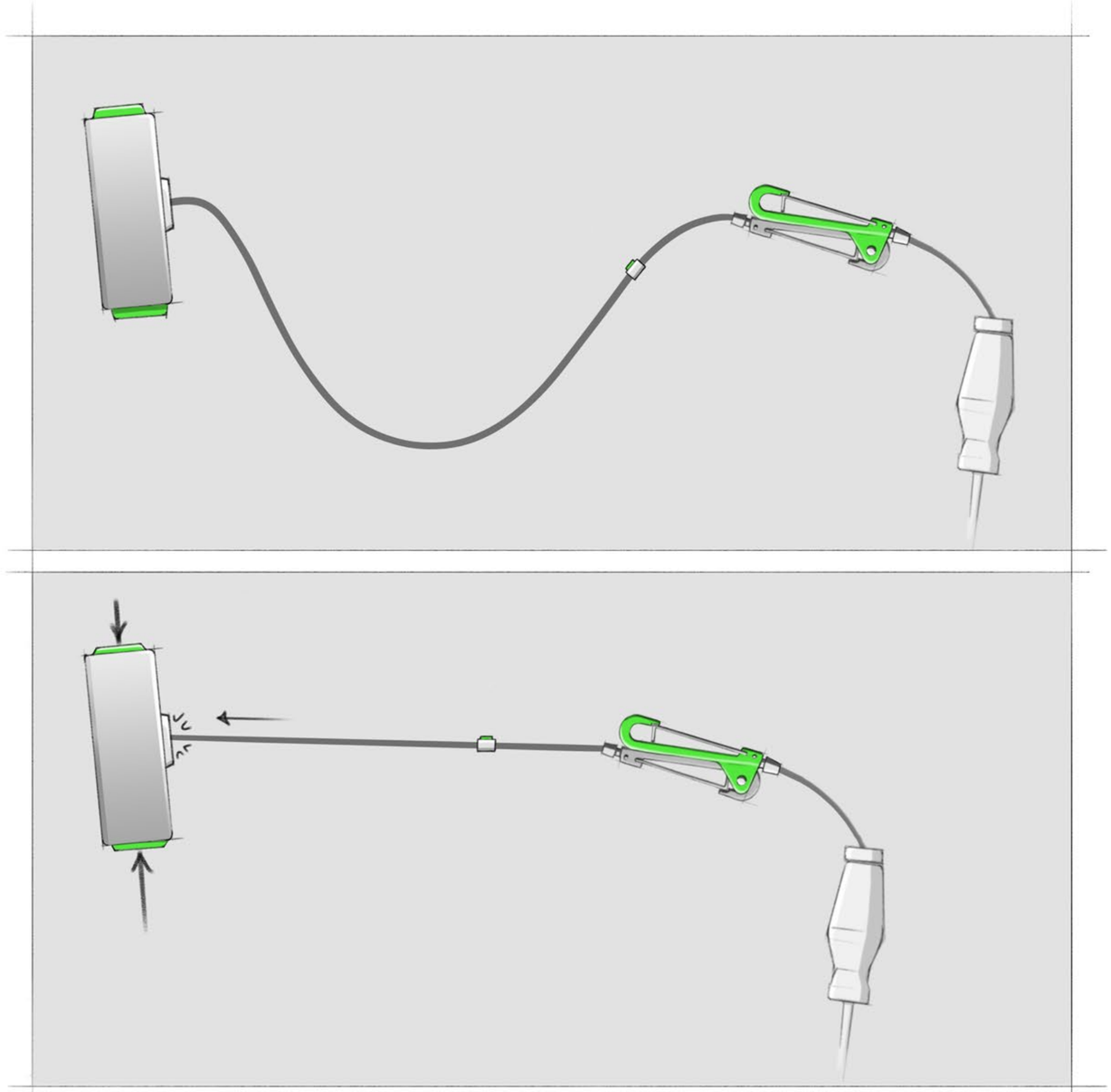


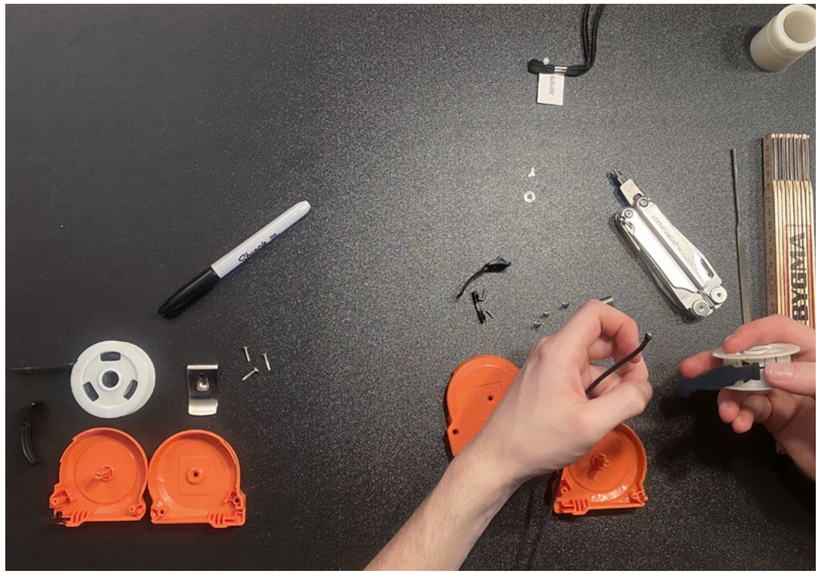




RETRACTOR


SLIDE IN FROM ONE SIDE
MAGNET
SILICONE COATED
BAND TO HOLD AS THIS



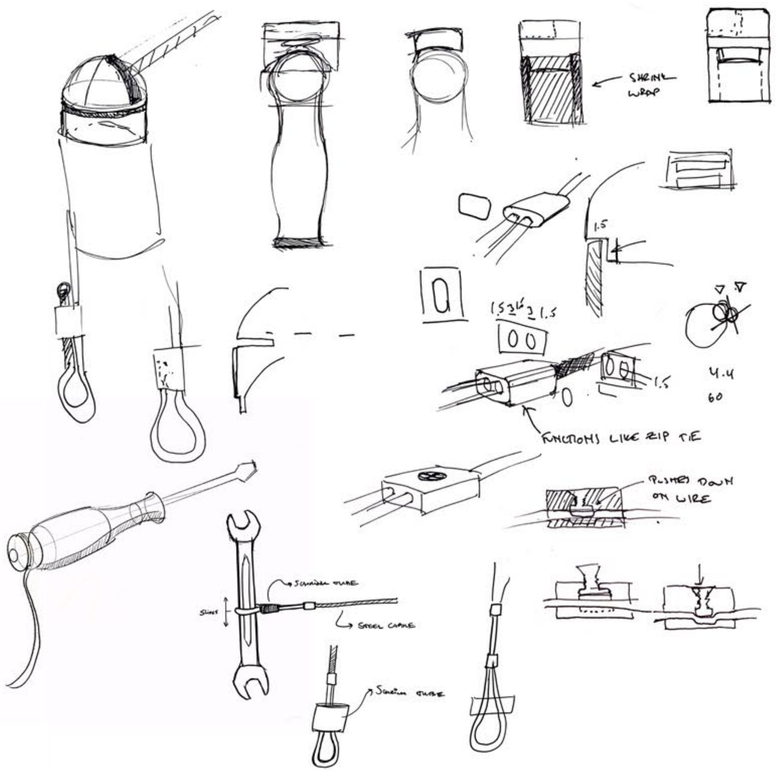


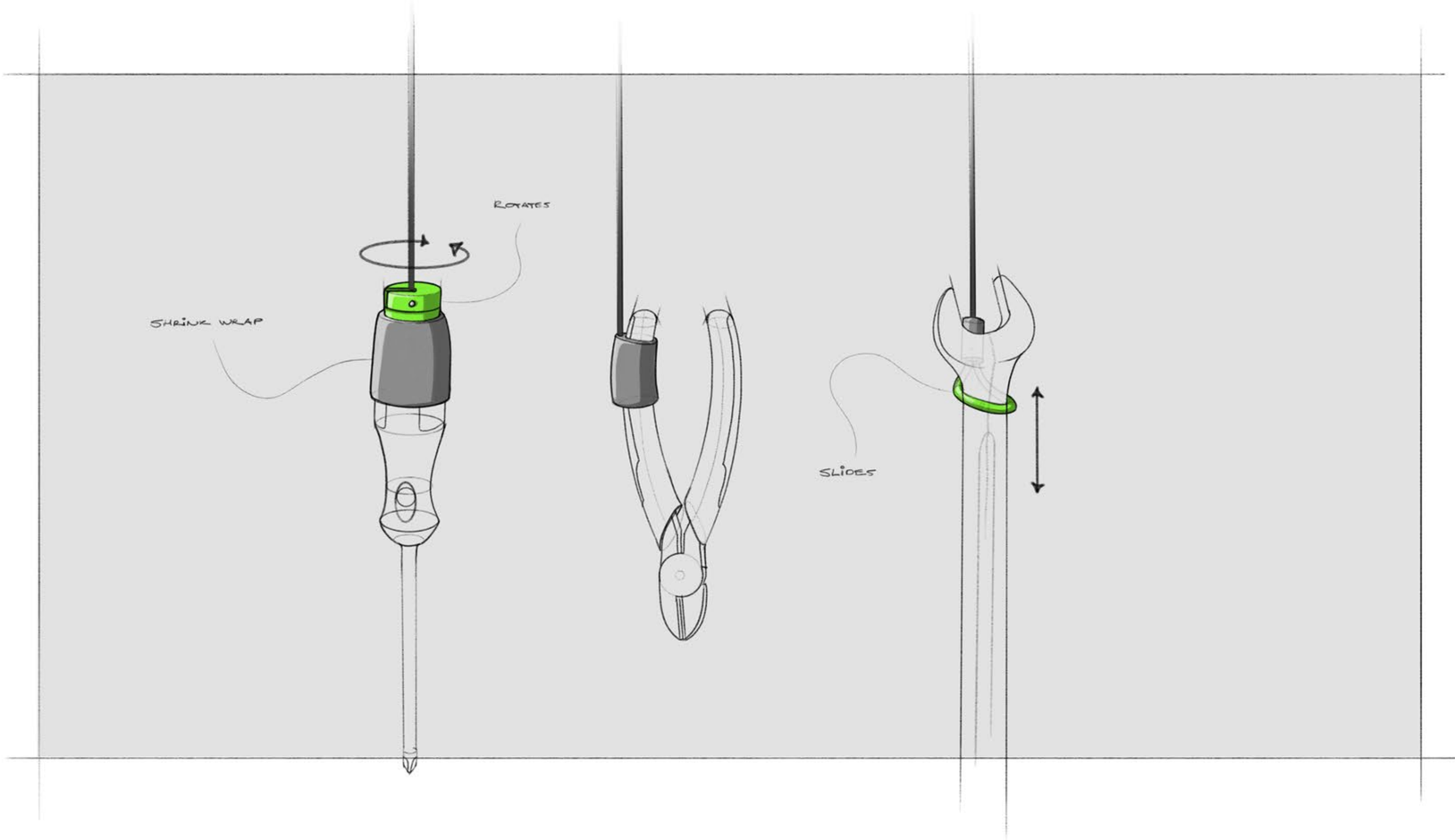

Tape
MEASURE
5M
Black Diamond


40-8741
Tape
MEASURE
5M


Black Diamond

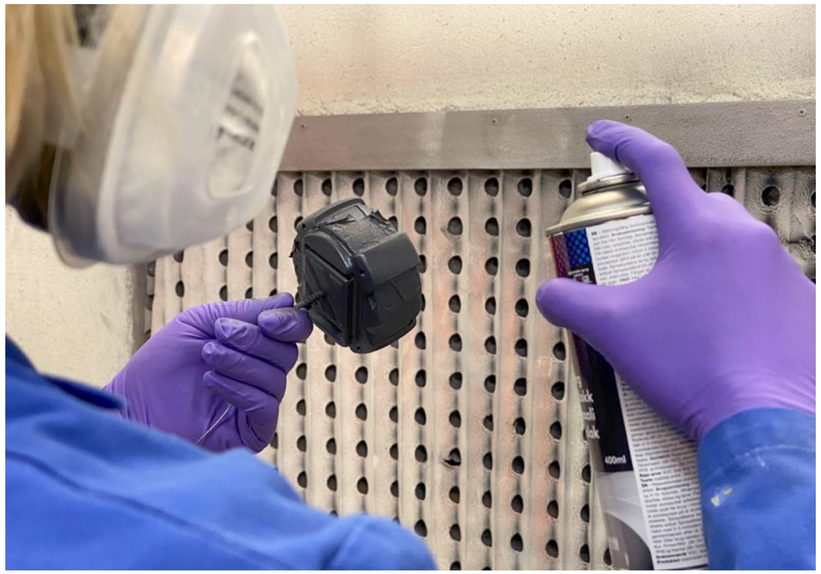
TOOL CONNECTIONS

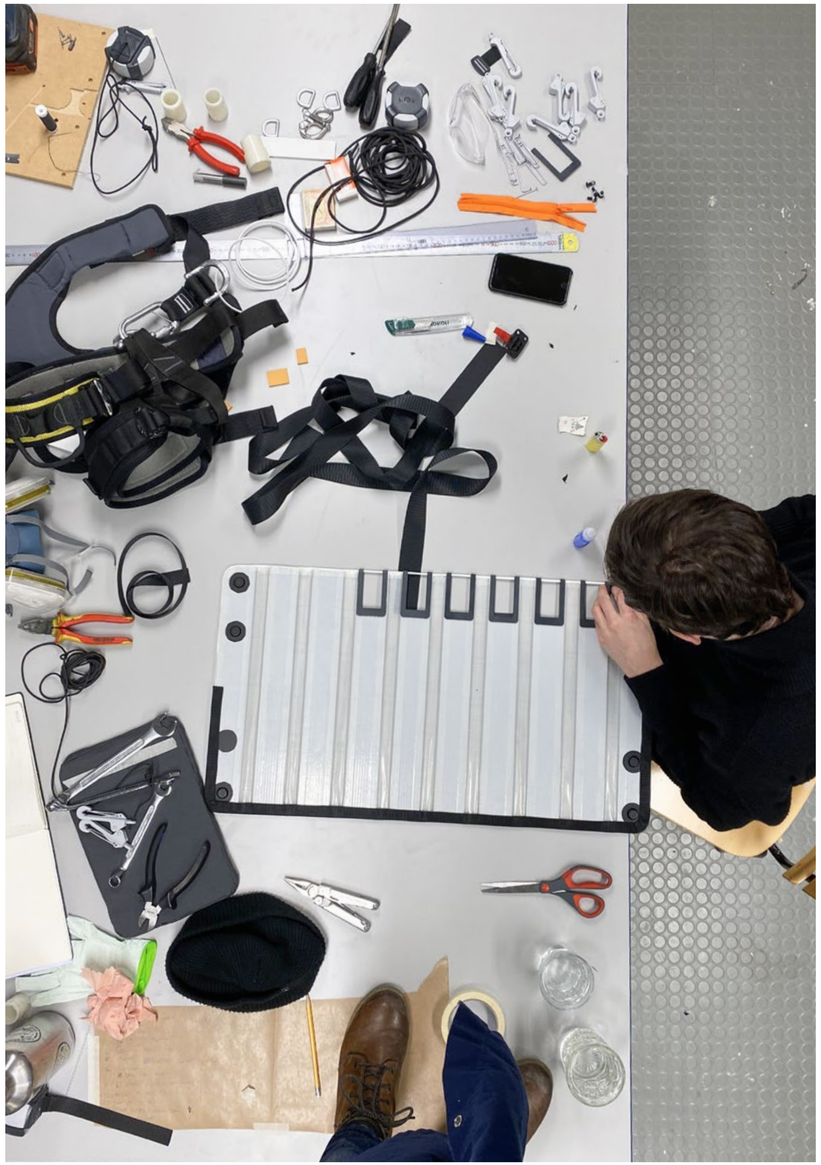




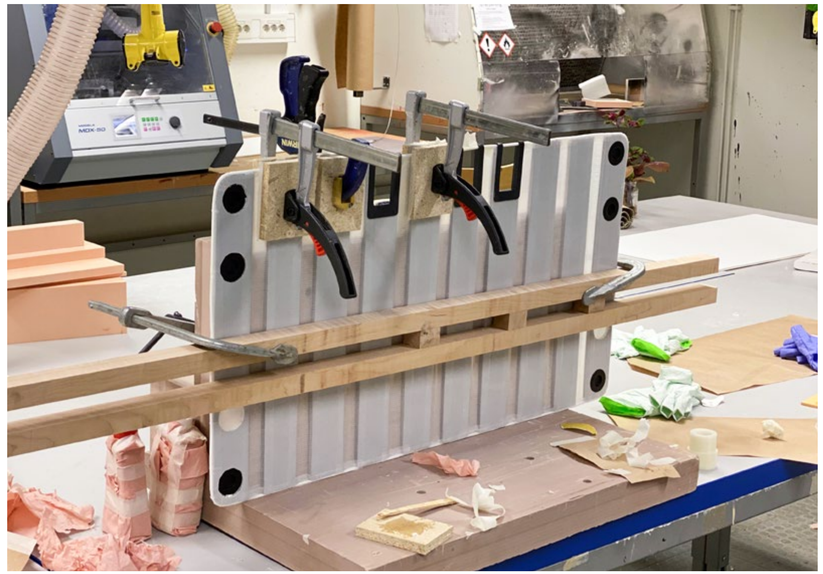
FINAL MODEL

We set out to create a model with the right balance between being functional and visually true to the developed CMF, with the goal to both validate the concept and demonstrate its use.





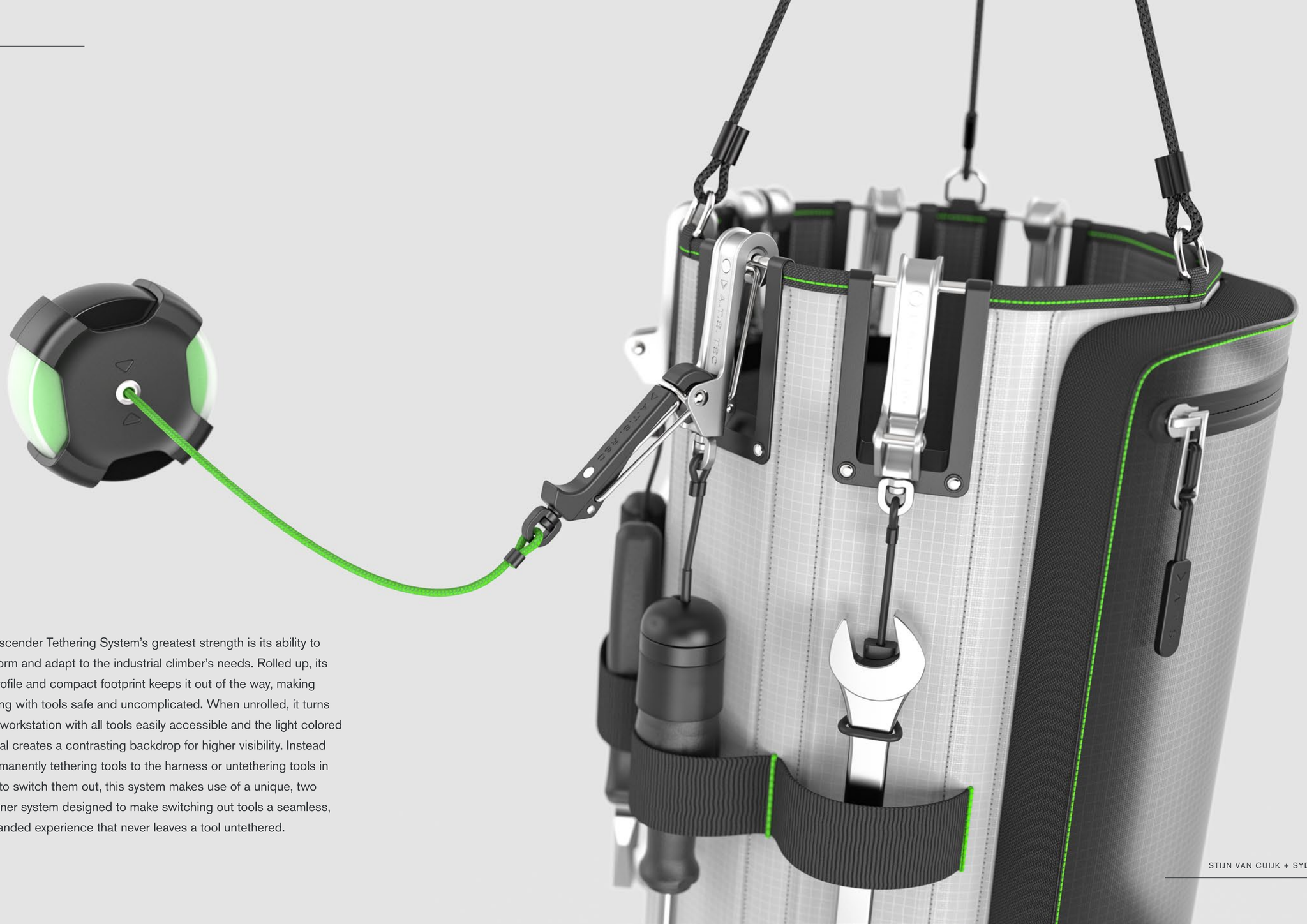

WORLD
SURF
LEAGUE



CONCEPT

ASCENDER

ADAPTIVE TETHERING SYSTEM



The Ascender Tethering System's greatest strength is its ability to transform and adapt to the industrial climber's needs. Rolled up, its low profile and compact footprint keeps it out of the way, making climbing with tools safe and uncomplicated. When unrolled, it turns into a workstation with all tools easily accessible and the light colored material creates a contrasting backdrop for higher visibility. Instead of permanently tethering tools to the harness or untethering tools in order to switch them out, this system makes use of a unique, two carabiner system designed to make switching out tools a seamless, one handed experience that never leaves a tool untethered.

R12 TOOLBAG

Adapts to the situation

Open
easy access to all tools

Rolled Up
climbing without obstruction

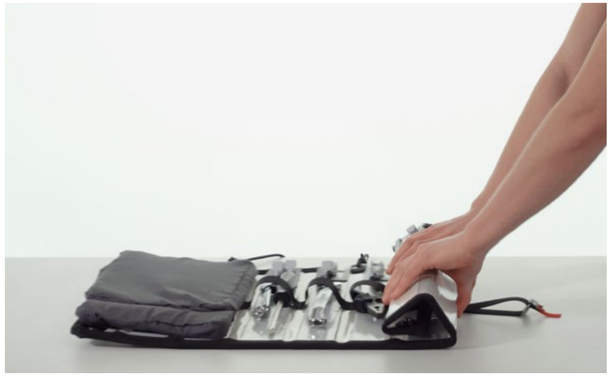
Open Inverted
protect the tools while moving around

Flat
loading & preparing on ground level

Clipping in and Rolling Up

Clip the desired tools onto the bag and roll it up to prepare for work aloft.

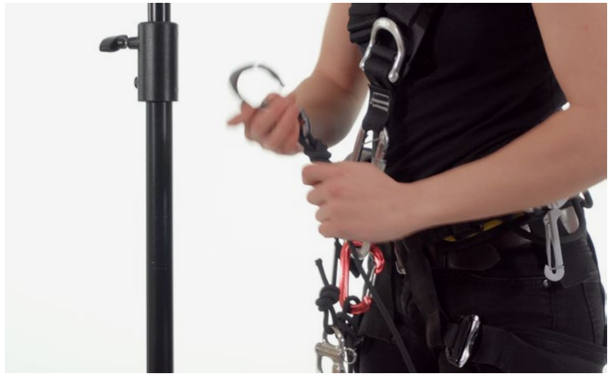


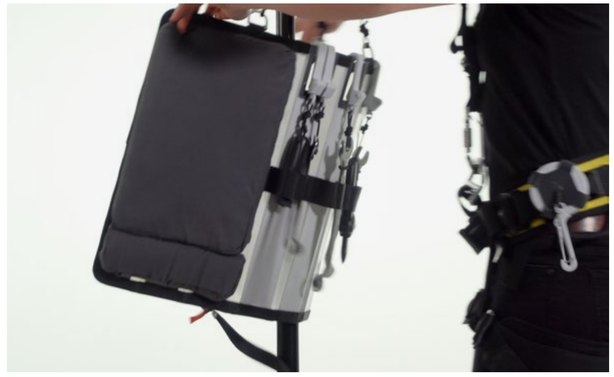


Transport to and Setting Up Work Station

Clip both of the bag's carabiners into harness and climb to workstation. Attach bag to workstation structure using first the main carabiner followed by the safety carabiner. This ensures that the bag is never untethered.

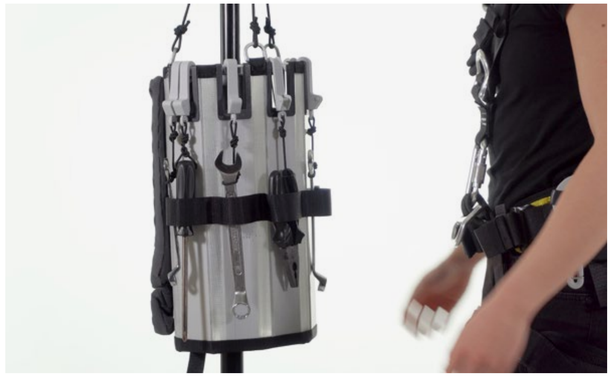






Moving to a Different Workstation

When it is time to move to a new task in a different spot, invert the bag to ensure a smooth location transfer.



Climbing Down

When finished working and ready to climb down, roll the bag back up, tighten the straps and attach to harness.







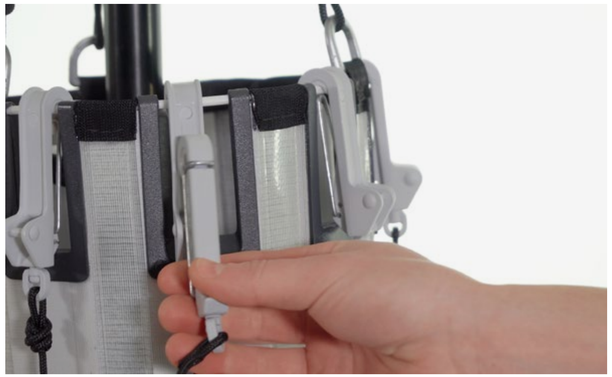

CARABINERS

The carabiners enable the quick and easy switching out of tools between the bag and the user. One is always connected to a retractor, the other to a tool. Together they make sure no tool ever has to be untethered.

Swapping Tools








RETRACTOR

When not using tools, dangling tethers can obstruct freedom of movement and create a risk of getting caught behind things. When using the retractor, the tether is only there when necessary. Just pull out the tool to extend the tether.

Only when the buttons on both the top and bottom are pressed will the tether retract. This prevents the tether from being accidentally retracted and allows for working with the tool without the tether pulling on it. The adjustable buckle enables it to be attached anywhere on the climbing harness.

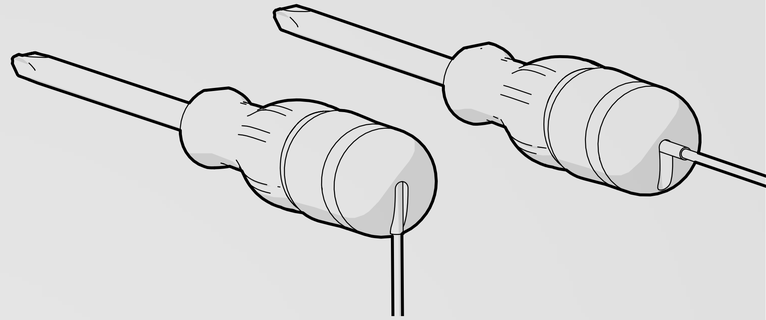
Attaching the Retractor

TOOL CONNECTORS

To make sure tools retain optimal ergonomics while tethered, different ways of connecting them to a tether are required. We developed tool connectors for the three most commonly used tools by telecom technicians. This way they can be used without the tether getting in the way.

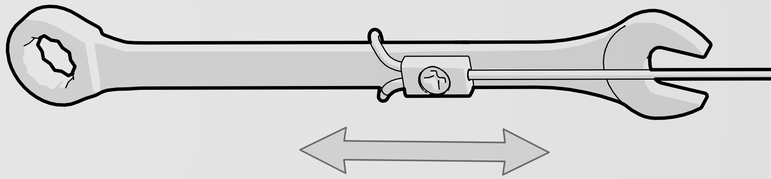
Screwdrivers

The screwdriver connector is fixed to the screwdriver with shrink wrapping. It can rotate along the longitudinal axis to accommodate the turning of the screwdriver without tangling up the tether. The tether is connected via a 90 degree hinge, which can be used to angle the tether down when resting the back of the screwdriver in the hand palm while using it.



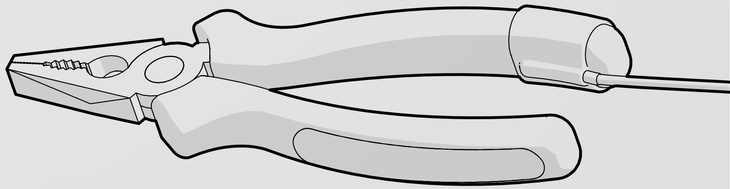
Wrenches

The wrench connector holds the wrench using a loop that can be tightened at fastened with the setting screw. The loop allows the connector to slide around the base of the wrench, making it possible to use both sides of the wrench. Additionally it supports wrenches of varying thicknesses.



Pliers & More

For tools like pliers, the tether is simply connected with shrink wrap at the end of the handle.



Main Body
polyester ripstop with TPU-film laminate
polypropylene inserts
nylon

Suspender Carabiner

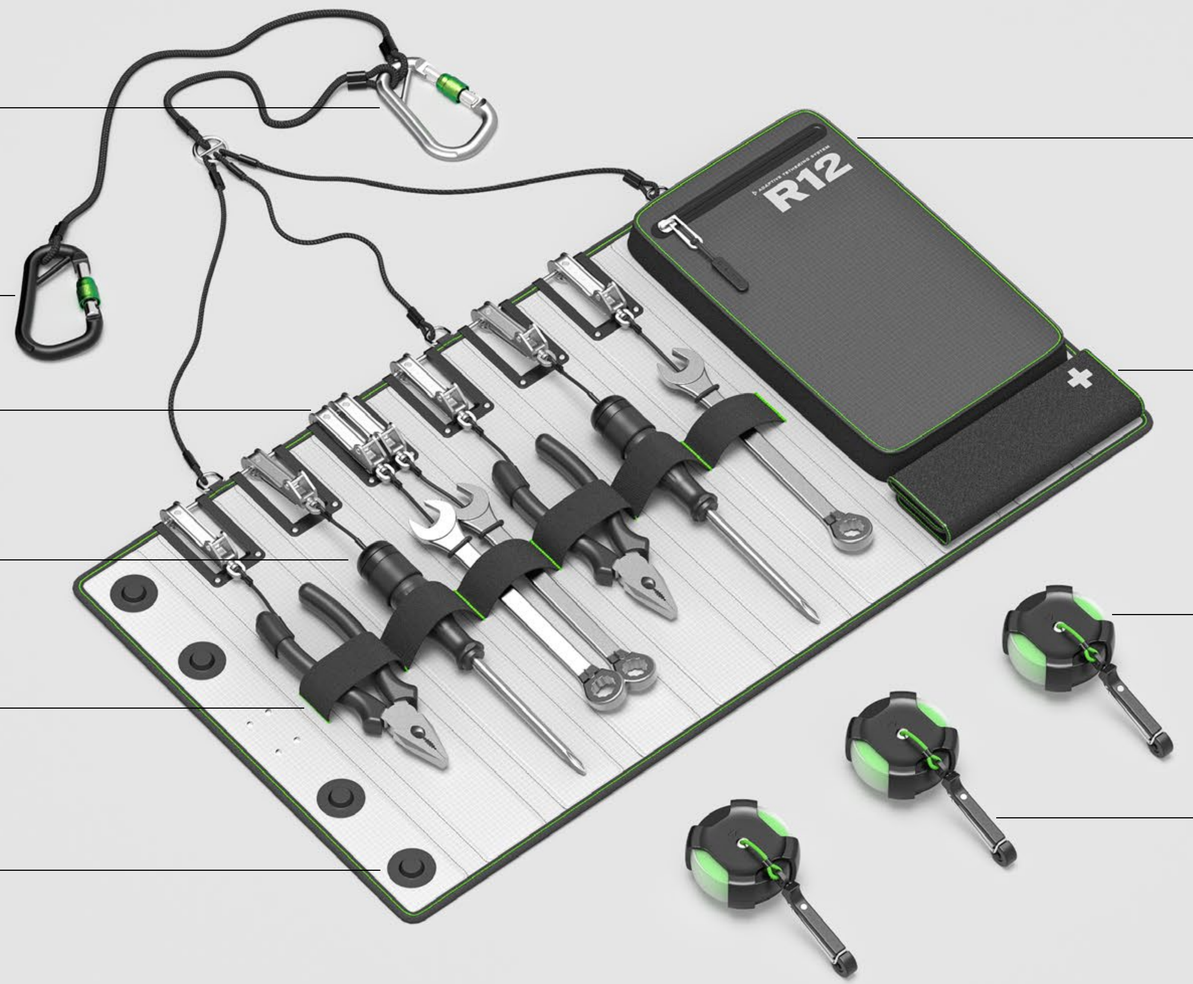
Safety Carabiner

Tool Side Carabiner
anodized aluminum
spring steel
stainless steel
neodymium magnet

Tool Connectors
polymer
steel
shrink wrap

Tool Holders
elastic webbing

Magnet Closures
polymer
neodymium magnets



Pocket
elastic textile
translucent vinyl

First Aid Kit

Retractor
polymers
stainless steel
spring steel

Retractor Side Carabiner
anodized aluminum
spring steel
neodymium magnet

REFLECTION & CONCLUSION

Reflection: Team

In this project we had a pragmatic approach to problem solving. If we were stuck, we made time to sit down and think about it or discuss it. If we were unsure of something, we tested it. If we still didn't know then we asked for help. This way of working generally took care of most the problems we ran in to.

After a while, say, three weeks where the idea doesn't change, insecurities start bubbling up. Here we had to remind ourselves of our solid process that backs up our solution, so we just continued. This validation based, iterative process worked for us.

Our main frustrations were due to things that were just out of our control. We had plans, we made a model, we did everything in our power to climb the tower with our model and in the end it just didn't work due to the weather conditions. We would have liked to be in the workshop even more and tested things even more but the ongoing pandemic made that difficult. We delt with it in a creative way, and are satisfied with the process and resulting design.

STIJN VAN CUIJK + SYDNEY EILBACHER — 2021

Reflection: Stijn

This project once again exemplified the importance of collaboration for me. Working together with Syd these last few months had been an absolute blast. It was a balance between fun and serious hard work and I think it shows in the end result. For me, working together gives the necessary validation to be able to move a project forward at a steady pace. It makes it easier to personally distance myself from the design, seeing the bigger picture, and concentrate on making the project stronger instead of getting lost in realising my own vision.

I think Syd and I complemented each other very well. Syd is a joyful, resilient and positive person, always pushing for improvement. We both put the project before ourselves and helped the other out whenever possible. A true team spirit. It made me happy to work on the project every day, even if it meant working into the late hours.

On a skills level I'm happy with what I have been able to produce during this project. It is still a struggle whenever my idea of a nice image doesn't necessarily coincide with what needs to be communicated. I sometimes can lose track of what is important during a project and will often misjudge how people outside the project might perceive it. Syd has a strong sense of this and has put a lot of things into perspective for me.

I think an important contributing factor to the pace of this project has been how we went about the planning and decision making. Syd and I both believe in reason and having healthy discussions. If we would get stuck, we would figure out a way to resolve it by doing more research, testing with sketch models or some creative exploration. I think this is what created a healthy and productive atmosphere in the project and made it pleasant to work on.

STIJN VAN CUIJK + SYDNEY EILBACHER — 2020

Reflection: Syd

My personal goals for this project were textbook: get better at effective time planning and management, become more confident in CAD, explore a validation based design process, learn to trust said design process, you can probably guess the rest. What you might not guess, though, is that this is the first term project where I have managed to NOT pull any all nighters. Where I have learned the value of saying 'no' to certain, often frivolous, things and instead to keep coming back and focus on the heart of the project and what the central goals for it actually are. That this focus and deliberate execution allowed for deeper, more detailed and more satisfying work. I've even learned the importance of a consistent, dedicated work schedule and sticking to decisions and that these things are, for me, the keys to moving forward. Don't get me wrong, I did see vast improvements in my planning skills. My confidence in CAD has yet to turn into love but I'm getting there. My love for a validation based design process has only gotten stronger and anxiety within the design process is s l o w l y getting better. But the biggest take away for me is that I have never experienced such visceral personal growth in a project as I have over these last three months. I fell asleep most nights with what felt like muscle soreness, only it was in my brain. I am proud of what we have achieved; this has been my favorite project to date.

I have also learned the true value of team work and collaboration. I must admit, I was nervous to voluntarily partner up for a three month term project. I've never done such a long two person project, and I was intimidated by the idea of having to run all my ideas by someone else before they could be made a reality. I was afraid this project wouldn't reflect what I had intended it to be. *What if our opinions clashed so hard we couldn't move forward? What if we ended up wanting vastly different things? What if? What if? What if?* But something told me to just go for it anyways, and I'm so happy I did. I could not have asked for a better partner.

We have a range of skill sets and skill levels between the two of us - I've learned so much and have also had a spotlight shined on my actual capabilities and what areas need immediate attention and improvement. I thought I knew my stuff, but Stijn blew me out of the water in every digital competence. I have been severely humbled and have learned so, so much. I am grateful for his patience.

What has surprised me the most, however, is how effortless everything felt. Never any major disputes. Differences in opinion were solved quickly and with logical reasoning. Ideas bounced back and forth like a tennis ball, a never ending game of catch, and validations were made quickly through discussion, models and the occasional scribble. The entire design process became a metaphorical dance that flowed so smoothly I felt like I was cheating. Maybe Stijn has other opinions about being stuck with me for three months but, for me, this project was magic.

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APPENDICES

References

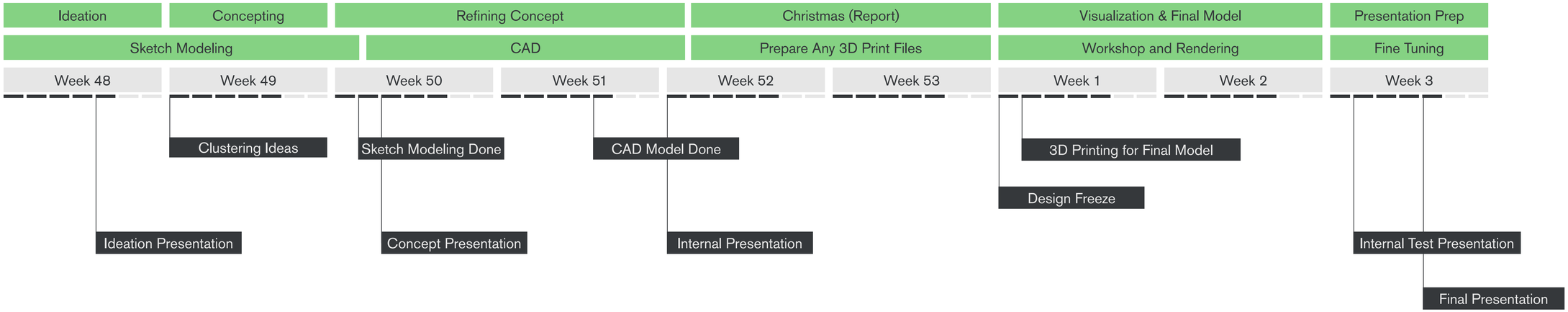
[1] “Ericsson: Telecom Tower Technician: Career, Skills & Salary: FE.” Ericsson | Telecom Tower Technician | Career, Skills & Salary | FE, www.fieldengineer.com/skills/telecom-tower-technician-ericson.

[2] “Charts Related to the Latest ‘Census of Fatal Occupational Injuries’ News Release.” U.S. Bureau of Labor Statistics, U.S. Bureau of Labor Statistics, 2018, www.bls.gov/charts/census-of-fatal-occupational-injuries/fatal-occupational-injuries-by-event-drilldown.htm.

[3] “R64. Number of Nonfatal Occupational Injuries and Illnesses Involving Days Away from Work by Event or Exposure Leading to Injury or Illness and Industry Sector, Private Industry, 2019.” U.S. Bureau of Labor Statistics, U.S. Bureau of Labor Statistics, 4 Nov. 2020, www.bls.gov/iif/oshwc/osh/case/cd_r64_2019.htm.

4 Zugravu, Andrei, director. Installing 5G Antenna on Cell Tower. YouTube, 2020, www.youtube.com/watch?v=dCOgbcpBW94.

Planning


Ideation
Concepting
Refining Concept
Christmas (Report)
Visualization & Final Model
Presentation Prep
Sketch Modeling
CAD
Prepare Any 3D Print Files
Workshop and Rendering
Fine Tuning
Week 48
Week 49
Week 50
Week 51
Week 52
Week 53
Week 1
Week 2
Week 3
Clustering Ideas
Sketch Modeling Done
CAD Model Done
3D Printing for Final Model
Design Freeze
Ideation Presentation
Concept Presentation
Internal Presentation
Internal Test Presentation
Final Presentation