



LUND
UNIVERSITY

MASTER PROJECT INDUSTRIAL DESIGN

“STRAINING ISSUES”

Inflatable backrest vest

Jakob Lindstrand

STRAINING ISSUES

INFLATABLE PROTECTION PAD

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IDEM05

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Industrial Design, from Lund University, School of Industrial Design.

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ABSTRACT

This project is focusing on one of the underlying issues within the plumbing industry (called "Värme Ventilation Sanitet" in Sweden). Strain injuries was the focus of this project to find a solution and discover the reasons to why these injuries keeps happening. The project then goes into a suggestion of which direction the industry might need to take to become better. Getting a solution to the injury problem is very time consuming and needs more parties involved to make a change, which this project was not able to cover.

The project then focuses on a quite common area that service plumbers struggle more with regarding strain, working underneath the kitchen sink or cramped smaller compartments (suspended foundation). To combat this a vest / jacket with an implemented blow up open-cell-foam function was made, which would help people working on their back with bad uneven surfaces.

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INTRODUCTION

Knowing what project to do can be a daunting task, as having free reins can be ideal for some people while for others it is not as easy.

Choosing to focus on plumbing within this project came to mind while I was talking to a friend of mine that works in that area. As I was quite indecisive about what direction I wanted to take for my masters, did I want to do something and are within or outside of my comfort zone? I then decided to focus on Plumbing to see what the unexpected would lead towards.

Diving in to uncharted territory can be exiting sometimes while also scary, as you do not often know what to expect until you have went in to it.

My plan was to uncover what kind of issues there might be, hidden or plain to see. Then using design to combat the issues to try finding a suitable solution for the problem.

To find a good starting point a had to looking for some secondary research to find out more what the topic should be about within plumbing, and then to narrow the scope down and focus on what I believe to be the most important parts.



(Picture 1*)

DESIGN PERSPECTIVE

I believe that sometimes it is useful to engage with things you do not have a lot of experience in. It might enlighten yourself or others to a solution that might have been unexpected.

That is why I wanted for a change dive in to a topic that I do not have much prior information about. Making it also a bit harder for myself as I often tend to go for something that I enjoy. What might I learn and what might be created from this interaction?

Can my design make something that might aid the people that work in that field? What are the main issues to look for?

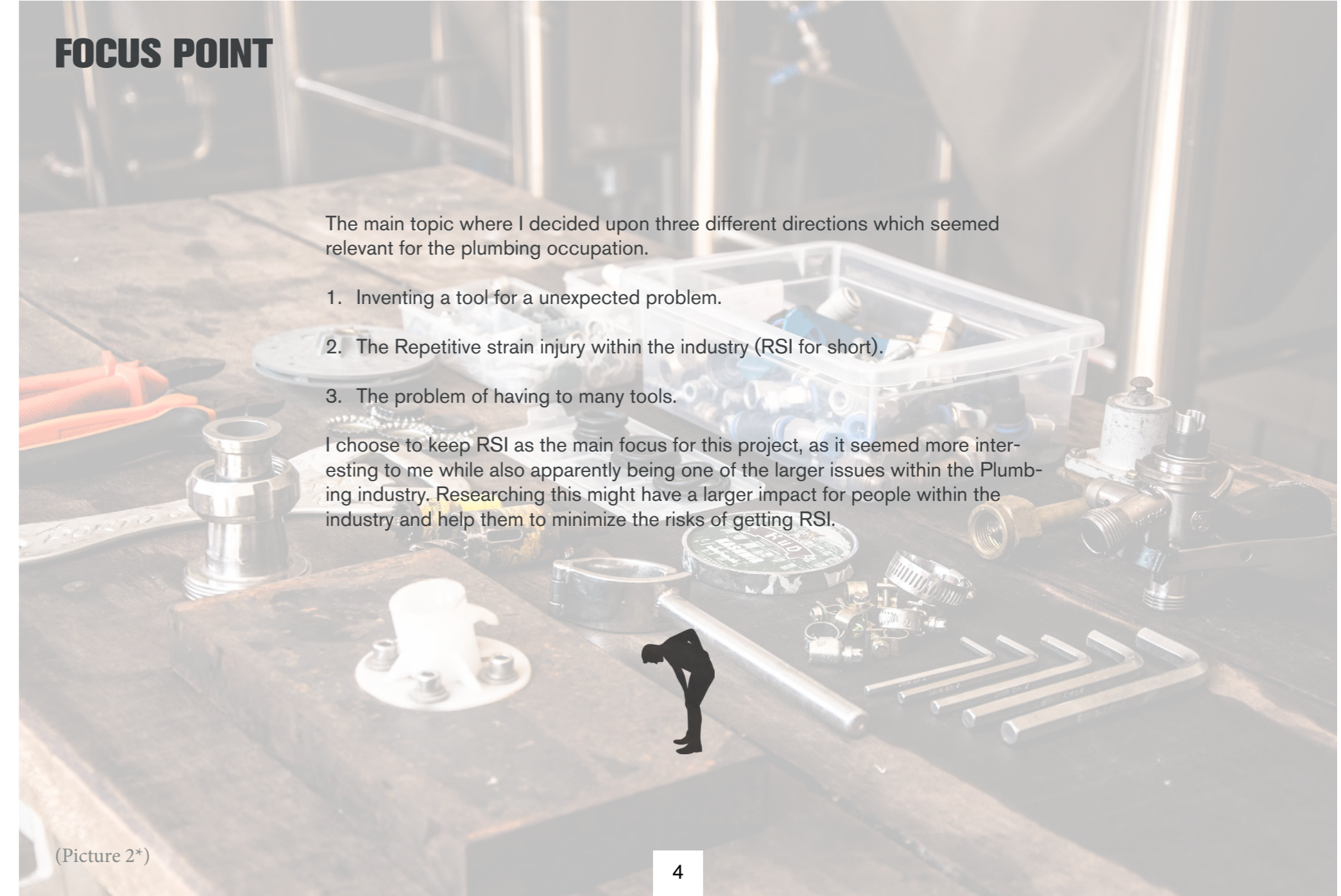
I will try to strive towards something I believe to be a useful solution that can easily be used and understood, which I believe to be the foundation of good design.

FOCUS POINT

The main topic where I decided upon three different directions which seemed relevant for the plumbing occupation.

1. Inventing a tool for a unexpected problem.
2. The Repetitive strain injury within the industry (RSI for short).
3. The problem of having to many tools.

I choose to keep RSI as the main focus for this project, as it seemed more interesting to me while also apparently being one of the larger issues within the Plumbing industry. Researching this might have a larger impact for people within the industry and help them to minimize the risks of getting RSI.



WHY IS IT RELEVANT

Strain injuries are one of the easiest things that people are prone to get within manual labour intensive workplaces, which is often caused from repetitive movements from joints like neck, shoulders/ arms, back etc.

One group that gets this problem from their work is plumbers as their occupation requires them to take many awkward positions, which in return will take its toll on their bodies. Around 70% of work related injuries in VVS is connected to RSI. This could be interesting as the research might help other people from similar fields that experience conditions that is the same for them. If its installing technical parts (like a technician) or maybe within construction as a carpenter.

While focusing on the work that gets exposed to it the most, I hope to find a way to mitigate the risks for the exposure to happen. Maybe there is some kind of aid (or maybe not) that is not used that might help a lot in a specific situation, which would help to lessen the stress on their body.

(Reference 1*, 2*)

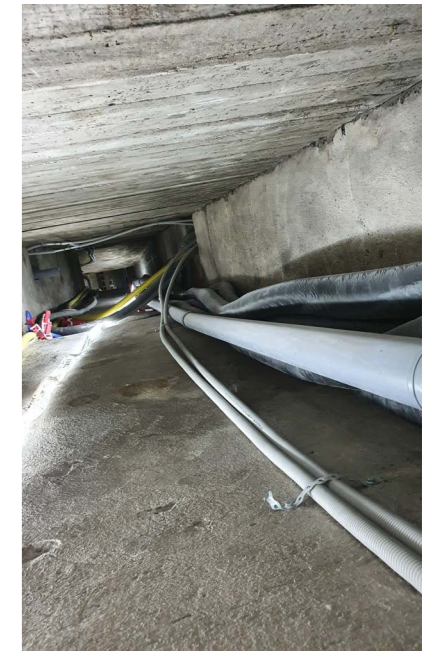
MOOD BOARD STRAIN FROM PLUMBING



(Picture 3*)



(Picture 4*)



RESEARCH GATHERING PROCESS

OCCUPATIONAL INJURY - REPETITIVE STRAIN INJURY (RSI)

MAIN CAUSES

Repetitive tasks, forceful exertions, vibrations, mechanical compression, sustained or awkward positions, or repetitive eccentric contractions. Working in cold weather increases the risk of getting a RSI.

Cold muscles are less flexible and therefore have a more easier time to susceptible to injury and strain from overuse. Low body temperatures also reduce blood circulation, this increases the build up of toxic by-products in the muscles that might put workers at greater risk.

There is three different grades of RSI that you normally get.

Grade 1 (mild strain): The muscle is overstretched and there are small tears in the fibres, mild pain and swelling may be present.

Grade 2 (moderate strain): The muscle or its tendon is overstretched and several of the fibres are torn. There is no complete tear in the muscle, but moderate pain and swelling may be accompanied by tenderness, bruising, and limited mobility.

Grade 3 (severe strain): Often a “pop” sensation occurs during injury. Most of the muscle fibres are torn or there is a complete tear in the muscle. Pain, bruising, tenderness, swelling, and limited mobility are typically present. There may be a “dent” or “gap”.

POSITION

When muscles contract they produce chemical by-products like lactic acid, which are then carried away by the blood. Holding a static or awkward body position requires muscles to stay contracted for long periods, which reduces blood flow and causes lactic acid build up in the muscles. This irritates the muscles, causing pain and putting you at increased risk of injury.

REPETITION

Repeating short, fast motions requires large amounts of energy in the form of glycogen. Using the same muscle group over and over depletes glycogen stores causing the muscles to fatigue. When tasks are continued despite this fatigue, they require greater effort. The forced action causes tiny tears in the fibrils (small muscle fibres) and if not rested, can result in injuries.

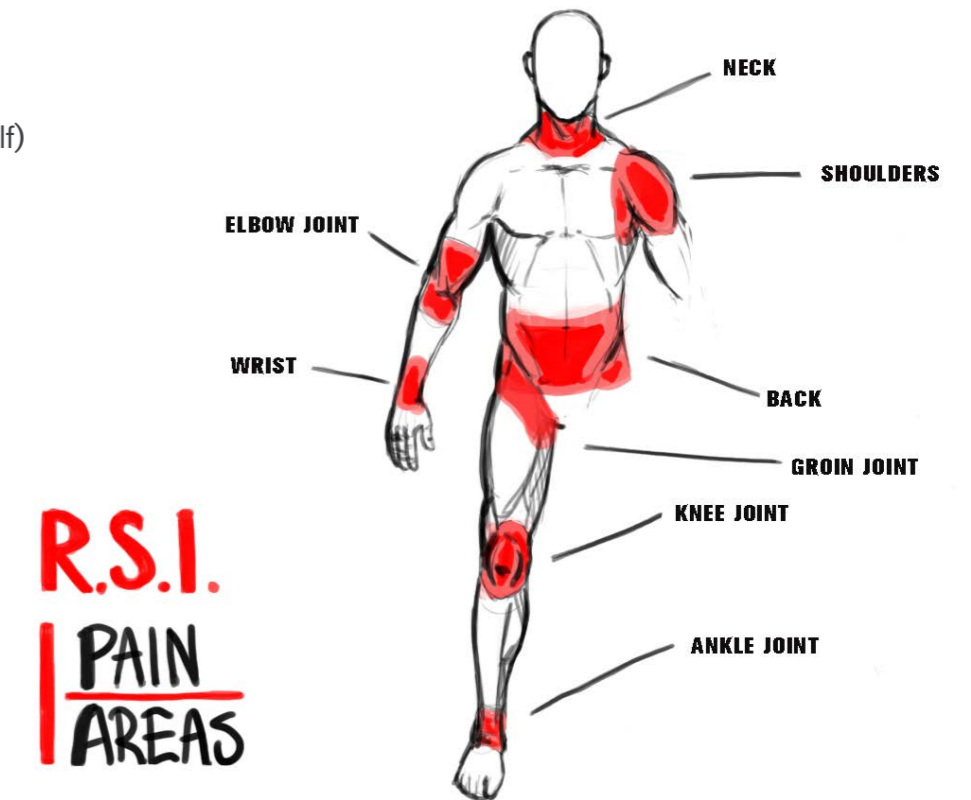
FORCE

Force is the amount of effort our bodies use to perform a task, such as lift a box, use a tool, or move an object. If the force used to perform a task requires excessive strain, injuries can result.

POPULAR AREAS FOR SPRAINS

Strains, as we mentioned, involve an injury to your tendons or muscles. Sprains, on the other hand, refer to an injury to your ligaments. Ligaments are thick, fibrous tissues that connect your bones to other bones in your body, differing from tendons. When a ligament is sprained, these tissues are stretched or torn.

- Back
- Legs (quadriceps and hamstrings)
- Elbow (Most present for those who play tennis or golf)
- Shoulders



DIFFERENT WORK SECTORS IN PLUMBING

CONSTRUCTION

Often done by younger people, working in big building complexes, does more heavy lifting.

SERVICE

Usually a one man job, going out to areas that needs help, which is not major problems that needs to be fixed as soon as possible. Can sometimes consist of older people within the occupation, as the tasks is not as heavy.

“PLUMBER ON CALL” SERVICE

Usually done by two people, fixing things that happens during the whole day, more emergency based than the other service part.

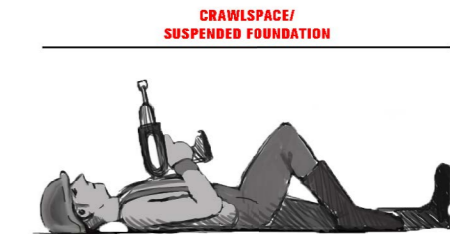
Most work related injuries are musculoskeletal disorders, and many of these are caused by cumulative trauma (repeated continuously) rather than a single event.

Women are more likely affected than men because of their smaller frame, lower muscle mass and strength, and due to endocrine influences

Load injuries are the most common occupational disease for plumbers. About 70 percent of occupational diseases are due to unsuitable working positions. In the kitchens, the mounting in the sink cabinets, a cramped space with work near the floor, are typical examples of uncomfortable areas.

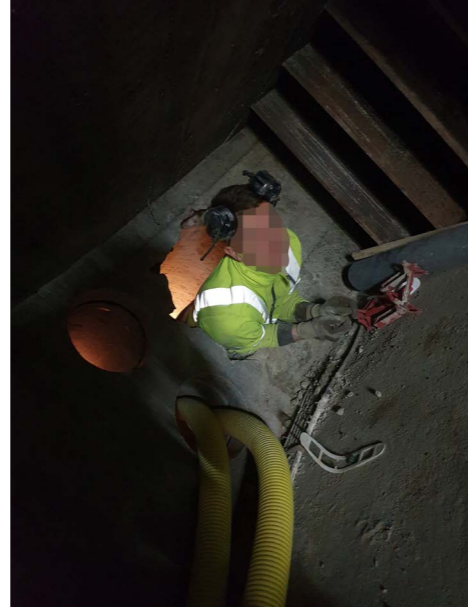
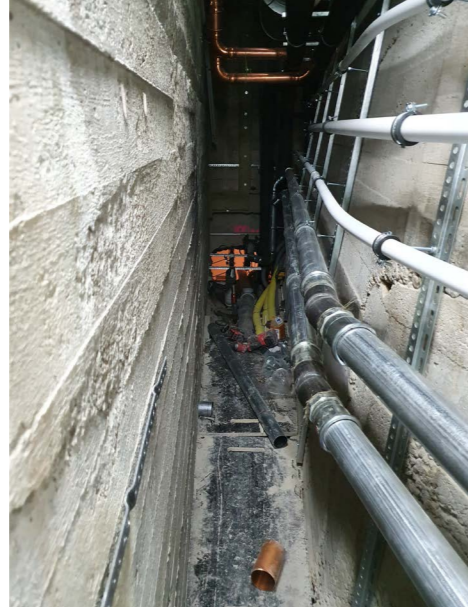
DIFFICULT WORKING AREAS

- **Working in high spaces:** At a high height anyone can slip and fall or be struck by a falling object above them. Slip and fall accidents are a leading cause of workplace injuries. Even when safety tools and tips are used, falls can still happen. Even being just a few feet off the ground is an accident risk. Relating to strain injuries, the plumbers could be doing work at a ceiling or close to it. Making you strain your arms, back and neck.
- **Confined spaces:** Crawlspace / Suspended foundation, installing sinks, Closed spaces that are not intended for safe oxygen levels, such as boilers, storage tanks, sewers, pipes, ducts and pits can all present unique challenges in terms of breathing. It also makes it hard for the plumbers to relax when they are working in a tight space as a crawlspace or underneath a sink.





CRAWLSPACE EXAMPLES



(Picture 5*)

(Reference 8*)

PLUMBER EXPOSURE

- **Repetitive Movement.** (Most related to strain injuries. Soft tissue damage to the shoulders, neck and wrists. Back injuries affecting ligaments, muscles and disks. Muscle strains and sprains)
- **Exposure to Asbestos.** (Harmful to breath in)
- **Extreme temperature Injuries.** (Happens often in confined spaces)
- **Mold.** (Bad to breath in)
- **Eye Injuries.**
- **Hearing loss.**
- **Hand-tool Injuries.** (Mostly caused by things like saws and knives)

TYPICAL UTILITY WITHIN PLUMBING

WORKWEAR

These are Work clothing that are used regularly.

- **Rubber boots or High boots.** (Safety shoes)
- **Work Gloves**
(The things above are using combined tarpaulin with water-repellent spray)
- **Warning Clothing/Jackets.**
- **Protective glasses.**
- **Breathing mask.**
- **Helmet.**
- **Ear protection.**

WHAT THINGS DO THEY HAVE TO PREVENT RSI?

KNEES AND BACK:

- Knee pads.
- Knee Braces.
- There are some information online.
- Mentions of “knee support chair”.
- Changing positions regularly.
- Work pallet with wheels.

NECK AND ARMS:

- Stretching and being active.
- Take small brakes, relax head.
- Neck-rest pillow.
- Staircase with railing.
- Drill stand.

HEAVY LIFTING:

- Stretching and being active.
- Take small brakes, relax arms.
- Material Lift.
- Stair cart.

METHODS TO HELP WITH RSI

THE R.I.C.E METHOD

“RICE” METHOD: (Rest, Ice, Compress, Elevate) is considered a first-aid treatment rather than a cure for soft-tissue injuries. The aim is to manage discomfort.

RICE is used immediately after an injury happens and for the first 24 to 48 hours after the injury. These modalities can help reduce the swelling and pain.

Low-grade RSIs can sometimes resolve themselves if treatments begin shortly after the onset of symptoms. However, some RSIs may require more aggressive intervention including surgery and can persist for years.

General exercise has been shown to decrease the risk of developing RSI.

If symptoms do not reduce when using the method, get in contact with a doctor. Consult with your doctor if you experience any of the following:

- Fever or chills.
- Pain and swelling do not reduce; they worsen.
- The affected area looks misshapen.
- Experiencing tingling or numbness in the area that is sprained.

The doctor will be able to perform a physical exam to determine how to treat your sprain and if surgery, in case if there was a complete tear.

RICE

Rest



Ice



Compress



Elevate



HOW TO PREVENT RSI IN THE WORKPLACE

RSI's can be prevented or at least the risk minimised by following some simple steps.

- Having good posture.
- Using correct lifting technique. (Lifting with the legs)
- Checking equipment is good enough and well fitted.
- Having regular breaks, when performing repetitive tasks.
- Working at a steady pace.
- Changing positions now and then / breaking from an activity as soon as you begin to experience pain or strain.
- Take regular breaks if not able to change your stance when working in awkward positions.
- Training in the safest way to complete the task.
- Educate yourself on stretching and strengthening techniques specific to the role.
- Use anti-vibration gloves when operating hand-held power tools.
- Using the latest power tool technology and ensuring equipment is well maintained.
- Using tools that are fit for purpose and using them in the way they were intended.
- Wearing proper clothing to protect from the cold, also having backup clothes if they are likely to become wet.
- Warming up prior to performing high risk activities, if temperatures are below 16 °C.

ERGONOMIC SBU RAPPORT

I got in contact with the ergonomic department in LTH and exchanged some words with Jane Ahlin, which referred me to contact the person in charge of Union for plumbers. She also gave me information of a report from the SBU ("Statens Beredning för medicinsk och social Utvärdering") which focus on RSI in the upper body ("Arbetsmiljöns betydelse för besvär och sjukdom i nacke, axlar, armar och händer", 2022).

It is a report that is a continuation from a earlier report from 2012 which is about systemic evaluated factors between work environment and discomfort or disease in the neck, shoulders, arms and hands. The evaluation includes physical, organic and psychological and more from all kinds of work environment factors.

The study was not that narrowed, in terms of gathering the information, making it very generalised. It does not take in consideration that some cases are quite different, some cases can be very personal in how they were affected.

The study also mentions a interesting fact that exposing the user to heavy loads of work often to similar areas of the body might heighten the risks of nerve pinches like "Ulnar nerve entrapment" (it is a nerve in the elbow region that gets pinched) this one is mostly focused on heavy loads towards neck and shoulders. You could also get exposed to "Carpal Tunnel syndrome" which also is nerve related, but focuses on the heavy loads that are put on hands and wrists while making repetitive movements. Apparently the latter is more prone to happen more often to female workers than men.

It is also mentioned in the comments part that there are reports from "Arbetsmiljöverket" which mentions that female workers are more prone to getting exposed to RSI in general than male workers.

It is also mentioned in comments of the report that to identify the risks and come up with solutions the future facts of the report needs to be more specific in what they want to know. As it seems to be very broad at the moment, which I also think. Although there were a few facts that I did not know about before reading.

WHERE DO THE PLUMBERS GET THE INFO

There is information for plumbers on how to minimize RSI that they have access to online, such as pan-flip PDFs like “Bra Arbetsmiljö för montörer och driftpersonal (Nov 2020)” from Plåt och Ventföretagen and “Belasta rätt (Jun 2019)” from AV which is the work environment agency in Sweden. There were more before that I found but it seems like they have been removed (like “Frisk i Jobbet” by Byggnads).

On “Byggnads” website (the union for plumbers and construction) there is information which is very accessible regarding ergonomics when working as a plumber. Showing several videos and giving tips and tricks to help people that is looking for answers, in the end of the page there is also some PDFs (from 2021) regarding work environment and risk assessment. They also had two more articles from 2021.

One of them is about highlighting the problem about RSI and talking about that reporting when you feel the symptoms starts to show, have a early medical examination and some tips what to think about when working regarding the body. The other one is about bad ergonomics and that is one of the leading factors to work injuries and then mentioning four “main issues” which is the leading cause within the construction business, the main topic is to make people that work in construction to be more aware of the problems by think before doing and to have higher demands on equipment to help the people that work in these conditions.

INTERVIEWS AND SURVEYS

INTERVIEW 1



CARL SANDBERG

- **APS Drift och Underhåll AB**
- **Plumber in Gothenburg**
- **9 Years of experience**

The first individual that I interviewed for this project is working as a on contract plumber, working with newly built structures most of the time, and is a friend of mine.

Carl describes his occupation:

It is a very strain inducing work and that is why there is a lot of younger people working within new construction as it puts quite the load on the body, but we do not tend to get strain injuries that often in my workplace (as it tends to happen to older workers). There are often stairs that we need to walk up and down a lot, heavy things to carry, a lot of toilets that needs to be installed (heavy). But when you get older you tend to change the branch direction to service instead as it is more about maintaining than installing new things, which tends to be tougher on the body. When working in service you tend to work by yourself very different from working on contract.

In the construction we can get around 20 – 30 porcelain (toilets, showers etc.) that must be installed the same day as it arrives and they are mostly carried by hand, otherwise we use trolley sometimes. If we get very big things that needs to be installed, that we cannot carry, we tend to use a crane on the outside to get it where it needs to go.

I tend to be aware how to lift things properly as you will learn it early why you need to do it. When we were new, we always had people that worked there longer than us always try to help us by telling us when we do not lift properly, example how you lift a toilet (describes a specific way). I also train on my spare time to be able to do my work and we get some help from our workplace (free gym access around the year / discount) as they notice themselves that we would not be able to do the

job otherwise. I do not usually tend to warm up before working and I do not see other people doing it either (no stretching/ warming up the muscles). If we need any help, we have work insurance if we feel that we need help, we also have health controls to see if we do not have any work-related injuries.

There is always work that needs to be done as a plumber, plumbers are very coveted now which means that we have a very booked schedule all the time.

We tend to work mostly standing and, on our knees, it varies a lot in which position we need to work with from high to low positions. Sometimes you need to be on your back as well when installing kitchen sinks/facets or even work in suspended foundation. I try to be aware of how I am working to get less stain on my body, like having a high ladder if I need to use a drill in an elevated position, which helps me not to stretch my arms to far (he gave more examples what he tends to do).

I tend to use knee protection all the time (used it in nine years), but not anything else specific.

Many people that work within this occupation can be tight lipped about the issues, do not talk about it, and mostly think that they can just keep going when issues happen," just keep working, it will be fine." (Macho personality)

Carl also mentioned an article about the company called "Kalmar Vatten" which might be a interesting read, as it relates to employees have to exercise or it will affect their potential increase in their pay.

I decided to dive in to it.

KALMAR VATTEN

In the article by “Byggnadsarbetaren” from 2021 they mention a company in Kalmar called “Kalmar Vatten”. They started a project during 2007 to encourage their workforce to train at least 2 hours a week. By doing the exercise you would get a potential salary increase while the people that do not exercise gets less. Apparently were there some people within the company were unsure and critical towards the project, but the interest has increased with time. Before starting the project the company had 25 of 60 people that had an high risk aptitude for bad health, but after implementing requirement there has apparently been less injuries relating to RSI within the company.

REFLECTION

It is a interesting way to making people motivated to work about which you could argue if it is a ethical way to do it, pushing people to exercise or there will be repercussions relating to their livelihood. Reading that they also include the training within work hours was also quite unexpected to me as I thought it was scheduled on their own personal time. That is great as it does not require more time outside of the schedule, making it a positive direction that seems to be mostly beneficial for the employees. This could be a good start to work towards some kind of industry standard potentially.

INTERVIEW 2



FREDRIK ALM

- **UNION (BYGGNADS) section; Plumbing industry**
- **Region SKÅNE**
- **Previously worked as a plumber with 20 years of experience**

After the interview together with Carl Sandberg I got in hold of the Plumber union and was able to get a hold of their representative for Skåne county, his name was Fredrik Alm.

He has previously worked as a plumber for 20 years. He has worked in many different areas within what a plumber gets to do, mostly big dimensions and a lot of welding. Now he educates plumbers, he is a representative, education officer for apprentices. One of the most important topics he usually works around is the work environment.

It is always a lot to do as a plumber Fredrik mentions, as he was continues scheduled 4 – 5 weeks ahead.

He confirms in the interview that contracting is one of the most heavy areas to work in within the industry and have the most risks.

There you put a heavy load on shoulders, knees (most probably). As an example, there is a lot of heavy-duty jobs as installing radiators, heavy materials, drainpipes, that makes it easy to get injured from if working with it incorrectly. The issue the Fredrik mentioned was “macho culture” mentality being one of the most common culprits towards making you prone to get injured while working. As he put it; “Work, no nagging” mentality, some people thinks that they are superman.

One of the ways he is trying to combat this issue is by talking about it with the younger generation, which is still in education, to trying to drive out this older mentality out of the industry. He is also trying to encourage people to use the aids that are provided to them, which is then up to them to use. The aids is then rejected by some plumbers as they do not

SURVEY

want an image of them looking as “weak” by using these.

Another thing that usually causes injuries within the field is lack of directions from people in charge of the workspace. This leads often towards a bad working environment. It needs to be properly planned as you work in both narrow (where you must wiggle through a tight space) and big spaces (bigger spaces might give you more static kind of work), like private homes or apartment complexes etc. In some places you might have to work in a very improper pose, which could then lead to harmful RSI injury’s. Temperature can also be an issue, especially in tight spaces where the temperature fluctuates, where you are prone to get burned easily.

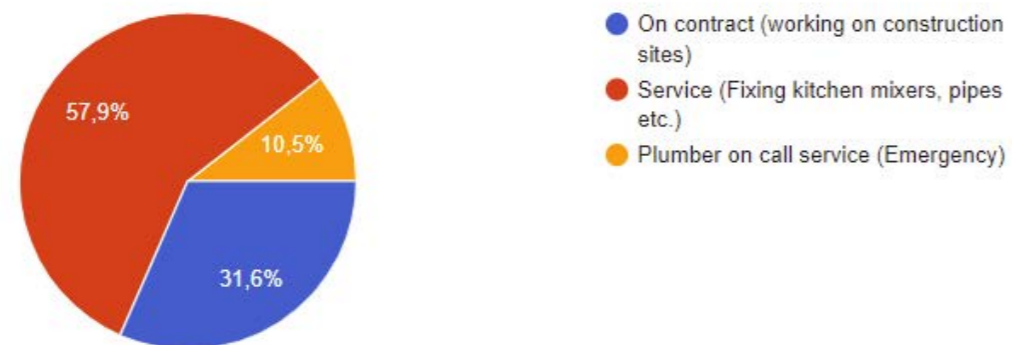
He also talked about there could be many different things that you might do within service work, which many older people transitions in to after working in construction. There they Install toilets, facets, boilers or being on the back while installing mixers. These can contribute to many weird working angles. “You have to be half acrobat and half plumber”.

Fredrik also told me about a company that is based in Ystad, which has done a exercise project similar to “Kalmar vatten” but without focusing on a punishment system towards the wage increase and more towards helping everyone in the company. This seemed very interesting, so I got in contact with them for an interview later in the report.

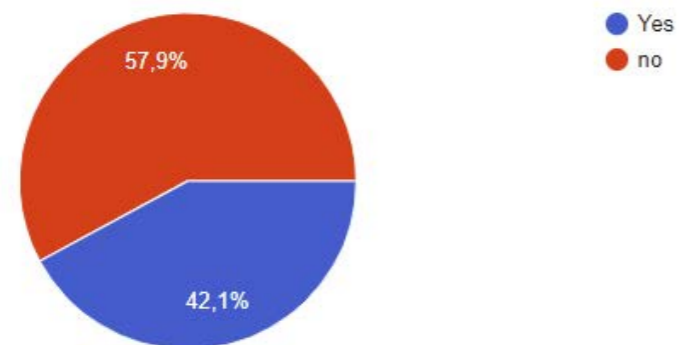
After having the interviews I tried to get in contact with more people on several different locations, either people that educate and or work as plumbers, some did not seem interested while a lot of them seemed to busy to participate in a interview.

I then decided to continue with a survey, which I sent to four different websites/forums, to get answers faster and from more people. Hopefully this would be easier than getting interviews.

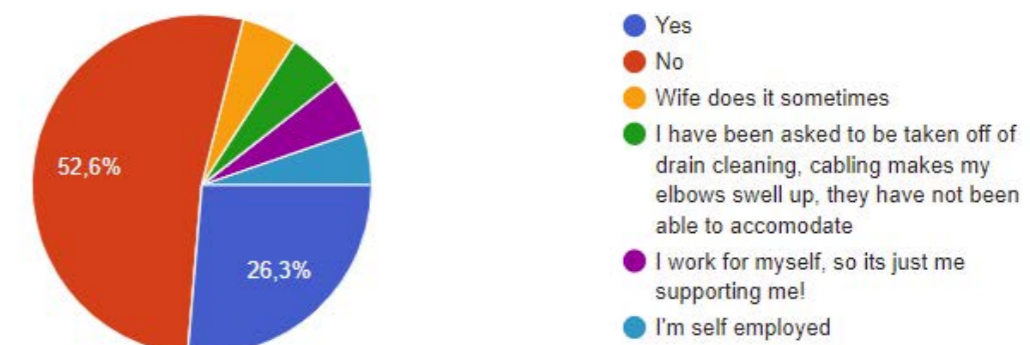
What area within the Plumbing do you tend to work in the most?



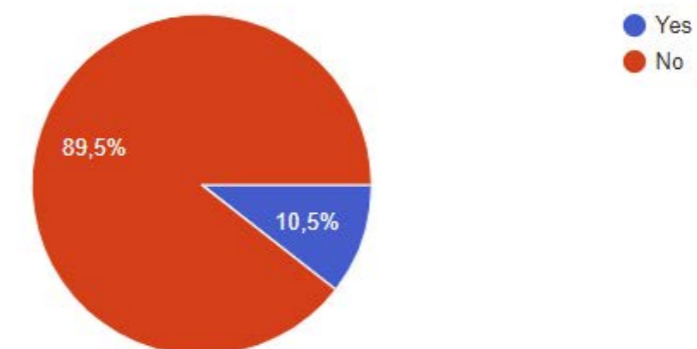
Do you warm up, stretching, before doing heavy lifting work and before working in awkward positions?



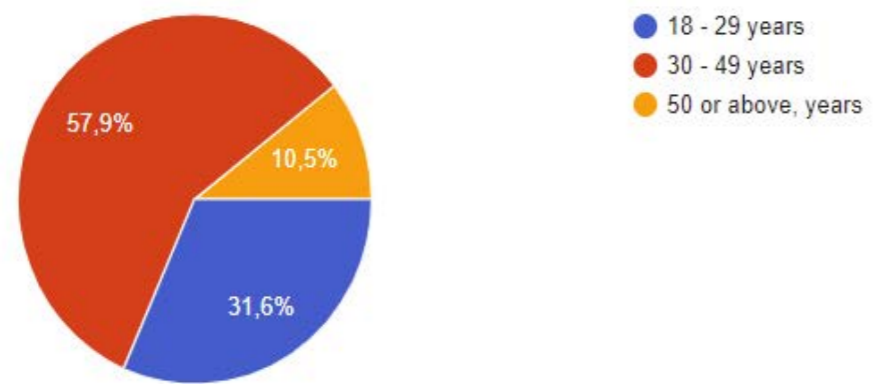
Do you feel that you get all the help that you need to help against RSI? (Equipment and company support)



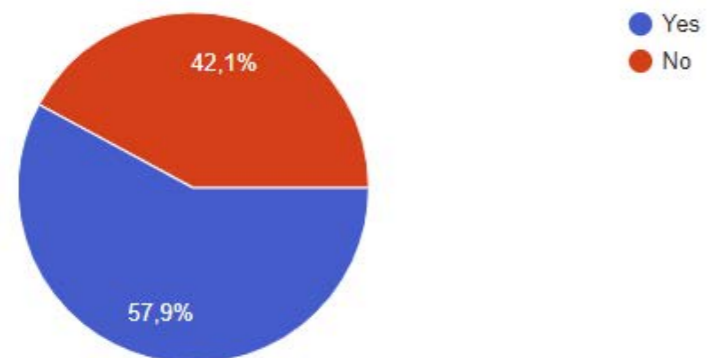
Do you use equipment for your upper body to minimize the risk of getting RSI? (in the upper body area)



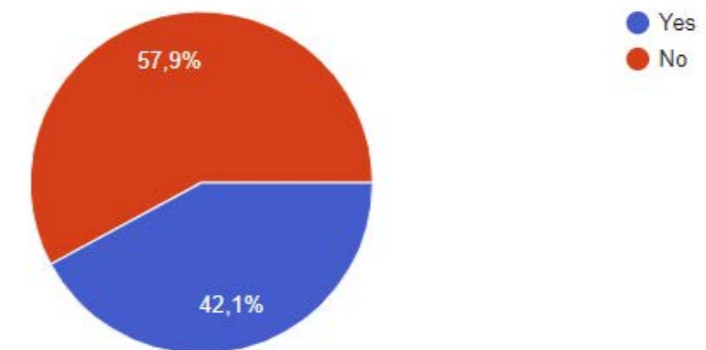
How old are you?



Do you suffer from RSI within your workplace? (Repetitive Strain Injury)



Do you feel you have good equipment to work in crawl space areas? Regarding RSI.



If you answered yes, what kind of equipment?

Knee pads

Being small. Rickets

Lights, ventilation, a buddy who is not going into the crawl space

Pants with kneepads sewn in

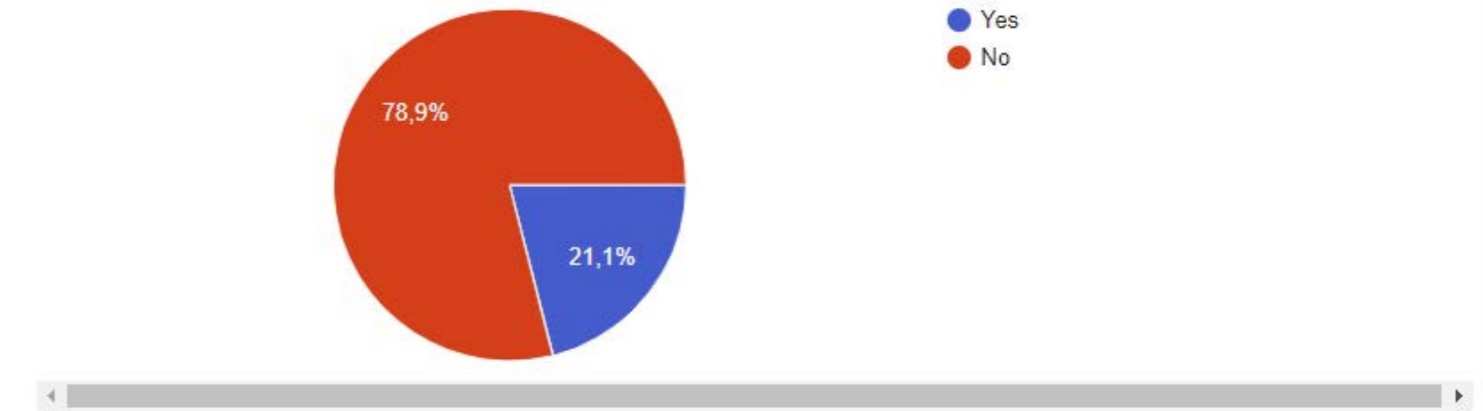
My current company is able to supply any safety equipment needed. Knee pads, dust masks, lights, fans

My body

If you are suffering from RSI, which/what areas are strained the most?

- Side of Neck most used...dominant sides on most RSI...shoulders....tennis elbow....knees
- Legs and abdominals
- Knees, shoulders and lower back
- Lower back/ SI joint, shoulders,
- Wrists
- My elbows have terrible tendonitis
- Shoulder
- Shoulder/ back
- Shoulders wrists and knees

Have you ever heard of RICE method? (To help with early stage of RSI)



SURVEY SUMMERY

I think it was very interesting results from the survey were you could see if people that work within that industry has the knowledge and resources to treat the injury, which in this case seemed to lack by a large majority. Almost 60% seemed to work in service. There was a age distribution in the survey, but a larger part was between the ages of 30 - 49 years, could be an age group that are more prone to get RSI. A lot of them do not seem to do exercising / stretching to minimize the risk either, were 59% users said that they did not. The most common areas for injury's where shoulders, back, legs and wrists, but primarily shoulders. The RICE method did not seem to be that well known, but at least 20% knew about it, which was honestly more than I thought it would have been.

AB STURE ANDERSSON VVS, YSTAD

INTERVIEW 3



ULRIKA GÖTEBY

- **AB STURE ANDERSSON VVS**
- **Economic assistant**
- **Switchboard operator**

I got in contact with the company that was suggested to me by Fredrik Alm from Byggnads. A company that uses progressive means to help people be more active, which makes it easier to minimize the risks to get RSI.

The person I got to talk to was Ulrika Göteby, which is one of the contributors to the making a exercise routine that is implemented to the daily schedule of the plumbers in the company and also other people that wants to get involved.

The exercise consist of a 15 minute workout every morning where they either do gymnastic stretches or yoga. They use recorded exercise programs from Byggnads that they play on the TV. The project started with them talking about work injury's and together they started a training session at work, during work hours. The management agreed to it as long they were more than ten individuals, which they were able to get to participate. It is still going on today and have not had a significant negative impact on the working hours. At the current moment they are going between 4-10 participants for each session.

The plumbers and the other colleges that does the exercise feel a positive difference compared to before.

The people that do not participate are either younger workers that feel that it is a bit silly and other people are to stressed to get involved.

REFLECTION

Overall I feel that this is a very ethical and positive way of minimizing the risks of RSI. Taking a little bit of a different direction that "Kalmar Vatten" did while looking for a similar result.

Including it in work hours and structuring it to not impact the work or their economic standpoint, something that could be a good framework for the industry as a whole.

TOPIC REFLECTION



THE MAIN PROBLEM

The Repetitive Strain Injuries is a very big issue within the plumbing industry and also a big culprit in many other labour intensive works. The issues to why it still happening is because of several different factors. How companies is driven by the owners, how willing the employees are to participate in ways to reduce the chances of getting RSI (macho culture), sometimes it even seems to be question about getting the information of how to prevent it, as can be seen in the survey. Although it is still a big issue there exist means that they try to put in place to help. Some people try to educate the younger generation about the problem so they can know what to do before RSI happens to them.

There are also company's, like I mentioned before "Kalmar Vatten" and " AB Sture Andersson VVS", that have taken action against the problem with similar but a bit different methods. Those projects should be considered as good framework if it could be implemented as a mandatory way of working within the plumbing industry. Instead many rely on that employees should workout on their on free time, while working already long days, which seems to me like a temporary bandage. If it is required to be fit and strong to be capable to work there, then I think the structure of the industry needs to adapt in a way that helps the plumbers more. As it is a very demanding on your body because of heavy lifts, long periods of working in the same positions and even weird positions that the body is not used to.

As a example, firemen is a occupation that have exercise as part of their work structure because of the labour insensitivity that there field brings. Firemen is also prone to do very heavy lifting and using a lot of heavy equipment when working, similar to plumbers. They are demanded to exercise within their work hours so that will not be any issues happening while they have to move out in a intense situation. Mentioned from "SverigesViktigaste-Jobb" (Reference 21*, 2024). They have to stay fit to be able to do their job, which I think plumbing also could benefit from. Becoming a part of the job-description. Having a similar framework for the plumbers as the firemen would probably make RSI issues appear less often.

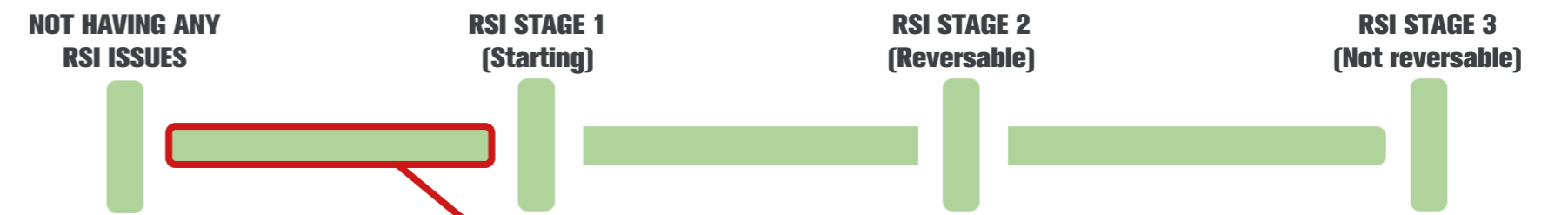
One idea could be using the union "Byggnads" or perhaps "ArbetsMiljöVerket" (2024, ref 37*) to inspect how management of the VVS-companies handles the work environment from a plumber perspective, in a similar way to "Kalmar Vatten" project (VVSforum 2021, ref 36*). Instead of doing that you could also employ an inspection company with a similar direction in mind, with the goal of trying maintain the same working standard for as many companies in VVS as possible. Having a top priority on training and positively motivate the working force towards that goal. This is of course a tough subject as there is very easy to get people discouraged from the idea, if not done correctly. That is why using already working projects that show good results should be more encouraged upon.

These inspections should make sure that both the workers and the employers work together to achieve better working conditions, regarding health and their heavy work schedule, to minimize RSI.

As I mentioned before, there are some cases that actually accomplishes this scenario in some kind of way. I can only hope that other companies within the plumbing industry can see the benefits to follow in their footsteps.

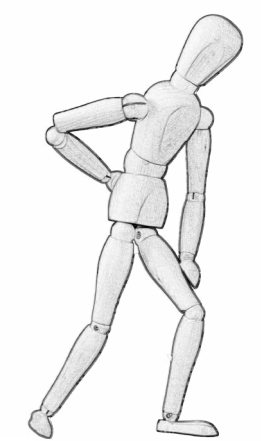
The solution to this is not simple to accomplish as it requires more than what I can accomplish by myself in this project. There are probably more things you have to considered before this "solution" would be able to begin. Rather than that being the answer I hope what I previously discussed can be more of a consideration, as it probably will take long time before mayor change will happen. So instead I decided to pivot and continue with this project on a smaller scale, to see what I could make by helping in the early stages or before you get RSI.

PROJECT FOCUS



What I will focus this project on.

As i feel that minimizing the risks before it happens is always better than waiting for the problem to happen first, making countermeasures.



MORE RESEARCH PROCESS

EXOSKELETON

Works very well to minimize the risks of RSI as it will help the user to distribute the force in to the EXO parts making it easier for the user.

Vest 1: EksoVest

“FORD” tried out exoskeleton gear to combat RSI in their production line.

The employees that work in assembling car details in production had the possibility to test Exoskeleton gear and says that they feel like they have more energy later during the day and do not feel as soar as before using it. The exoskeleton they used was made by "EksoVest" for the upper part of the body, who collaborates with ford during the end of 2017. It seemes to have been a great success and which has boosted moral and the health of the users.

Vest 2: HA EXO-01

Minimalistic and low weight Exo, Made for the upper-body, no need for power, uses cable-based mechanical technology.

Takes some time to calibrate and put on, 10-15 min, may be considered a personal tool, you don't have to recalibrate every time. Helps with heavy work most. 20,000 sek price tag makes it more prone to renting.

USER INTERVIEW:

A guy called Johnny Brandborg from Sweden and got interviewed by “Målarnas-facktidning” (2020/11/11). He works in painting service and tried the exoskeleton (EXO-01) and had apparently only good things to say about it.

He seemed to like it a lot as it does not feel like you have something heavy on he had already painted a lot of roof area while having one on and still felt like he could keep going. It helped especially with heavy things like using the grinding machine.

EKSOVEST

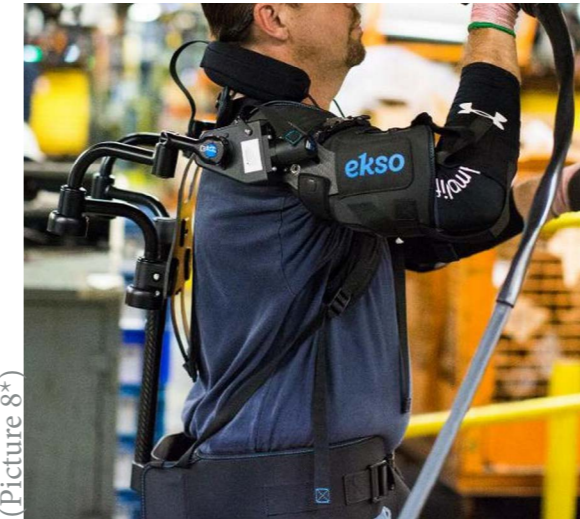
It seemed to be most useful when working high up as he tended to take it off while working in a lower position, where it did not help and was mostly in the way. An other issue that he noticed was the wraps around the biceps was quite loose and he needed to put on extra clothing to fill in the gap.

If it was a personal one it helps with time as it is ready to go right as you put it on, however while sharing it you have to adjust it every time someone else has used it. That would have the opposite effect. Overall it seemed to benefit people within his line of work as force towards shoulders and arms is a big issue, as they tend to work in a high position.

PROBLEMS WITH EXO PROTOTYPE FOR “VVS”

- Cost is high which makes this a less probable solution for small time company’s working in “VVS”, as the minimalistic one was about 2000 Euro per person, which was mentioned, more prone to rent than buy.
- The EXO might be in the way as it takes a some extra space, while the plumbers might change working positions on a whim.
- There are several situations where it can become a hindrance instead of a aid, as it takes up more space around you, won’t be able to have it on while crawling in tight spaces or if you need to change position often.
- Might be hard to connect with a jacket. (Idea about implementing two things in to one)

I think that EXO can be great, but there are too many issues with it. The calibration time for each user (if you share one), the cost of the product is quite steep and it might get in the way if you have to work in other positions than working high up were the sweet-spot for it seems to be. Those are the reasons that made me think of not using it for the project.



(Picture 8*)



(Picture 9*)

HA EXO-01

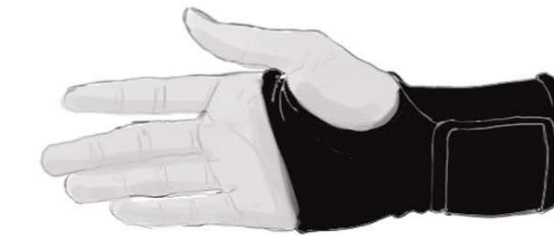
OTHER PRODUCTS TO COMBAT RSI

- **Roll Kinesiology Sports Tape** - Strain injury support. It is elastic, waterproof, adhesive, cheap, more like a bandage to compress, prevention product, not a medical product. Quite commonly used by athletes.
- There is also several variations of “**Supporting Braces**” that is for multiple areas. For the groin, back, elbows, shoulders, wrists, ankles and knees.

Overall cheap solutions, which helps with supporting the limbs while you started to feel symptoms of RSI that is meant to lessen the stress on the limbs that is weaker.

I decided to focus more on the tape as it seems being applicable to different areas on the body while taking less space.

(SUPPORT BRACE EXAMPLES)



ROLL KINESIOLOGY SPORTS TAPE

It is meant to be applied to the body to provide the user support to lessen pain, reduce swelling, and improve performance.

The tape is a blend of cotton and nylon. It's designed to mimic the skin's elasticity so you can use your full range of motion. The tape has a medical-grade adhesive which is also water-resistant and have enough durability to stay on for up to five days. This means you can both shower and work with it on you.

The tape recoils slightly when it is applied to your body while gently lifting your skin. It is supposed to help you by creating a microscopic space between your skin and the tissues underneath it, relieving pressure.

Kinesiology tape is meant to make you move normally without restrictions. Some studies even show that it possibly can enhance movement and endurance. The performance has also improved, according to studies where athletes have shown that when the tape is used on muscles that was fatigued.



(Picture 10*)



(Picture 11*)



(Picture 12*)

[KINESIOLOGY SPORTS TAPE IN USE PICTURES]

To apply the tape, remember these steps:

(Written by Rebecca Joy Stanborough, 2019)

- Clean and dry the area first. Lotions and oils can prevent the tape from sticking.
- Trim excess hair. Fine hair shouldn't be a problem, but dense hair could keep the tape from getting a good grip on your skin.
- For most treatments, you'll start by tearing the backing paper in the centre.
- Cut rounded corners at the ends of each strip if they don't already have them. The rounded corners are less likely to get snagged against clothing; and helps to keep the tape on longer.
- When you apply the first tab to anchor the strip, let the end recoil slightly after you take off the backing paper. You don't want any stretch in the last two inches at either end, because those tabs are just to hold the tape in place. If you stretch the ends, the tape will pull your skin, which could cause irritation or make the tape detach sooner.
- Keep your fingers on the packing paper to hold the tape. Touching the adhesive part will make it less sticky.
- Your therapist can let you know how much stretch to use in the treatment area. To get a 75 percent stretch, extend the tape as far as it will go and then release it about a quarter of its length.
- When you stretch the tape, use the whole length of your thumb across the tape to get an even stretch.
- After you apply the tape, rub the strip vigorously for several seconds. Heat activates the glue. Full adhesion usually takes around 20 minutes.



THE COLD-PACK

A cold compress is an cold material, sometimes frozen. Like a ice pack or a cool wet wash-cloth. When used correctly, they can help to relieve pain and swelling or cool a fever.

IT WILL HELP TO TREAT:

- **Minor injuries**
- **Fevers**
- **Headaches**
- **Eye pain or allergies**

There are also chemical packs that you have to break for the freezing reaction to activate.

Apparently Ice is most effective in the immediate aftermath of an injury. The user should not constantly have it on, instead use it in intervals as long as it is needed. Get in contact with a doctor if the symptoms do not improve.

Can sometimes be found in first-aid kits, but depends on the size of the kit. Usually not inside the smaller ones.

REFLECTION

Already exist in FIRST-AID kits, might not be necessary to implement in the final product.

(Reference 26*)

(Picture 15*)

CONCEPT 1

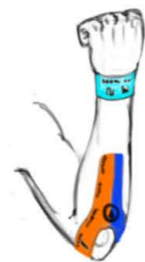
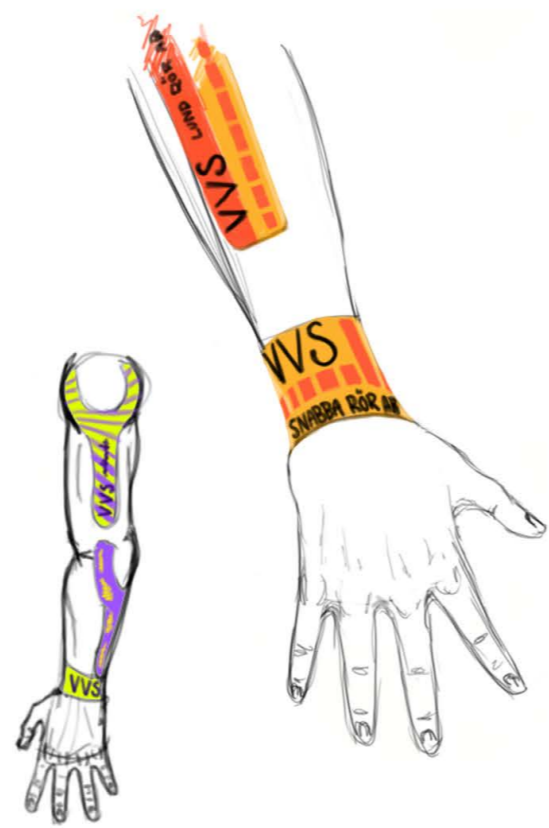
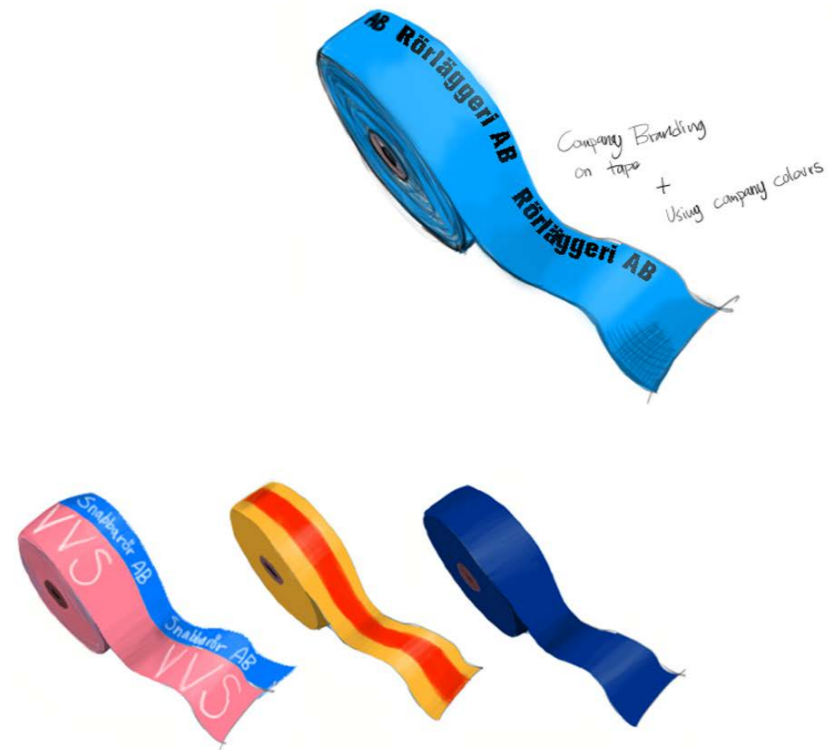
R.S.I KIT WITH R.I.C.E METHOD

Small book guide to prevent RSI + Jacket equipped with some situational prevention towards RSI.

Why:

As shown from my research there seems to be a lot of people that does not know what to do to prevent getting RSI symptoms or knowing about methods that help to minimize the risks.

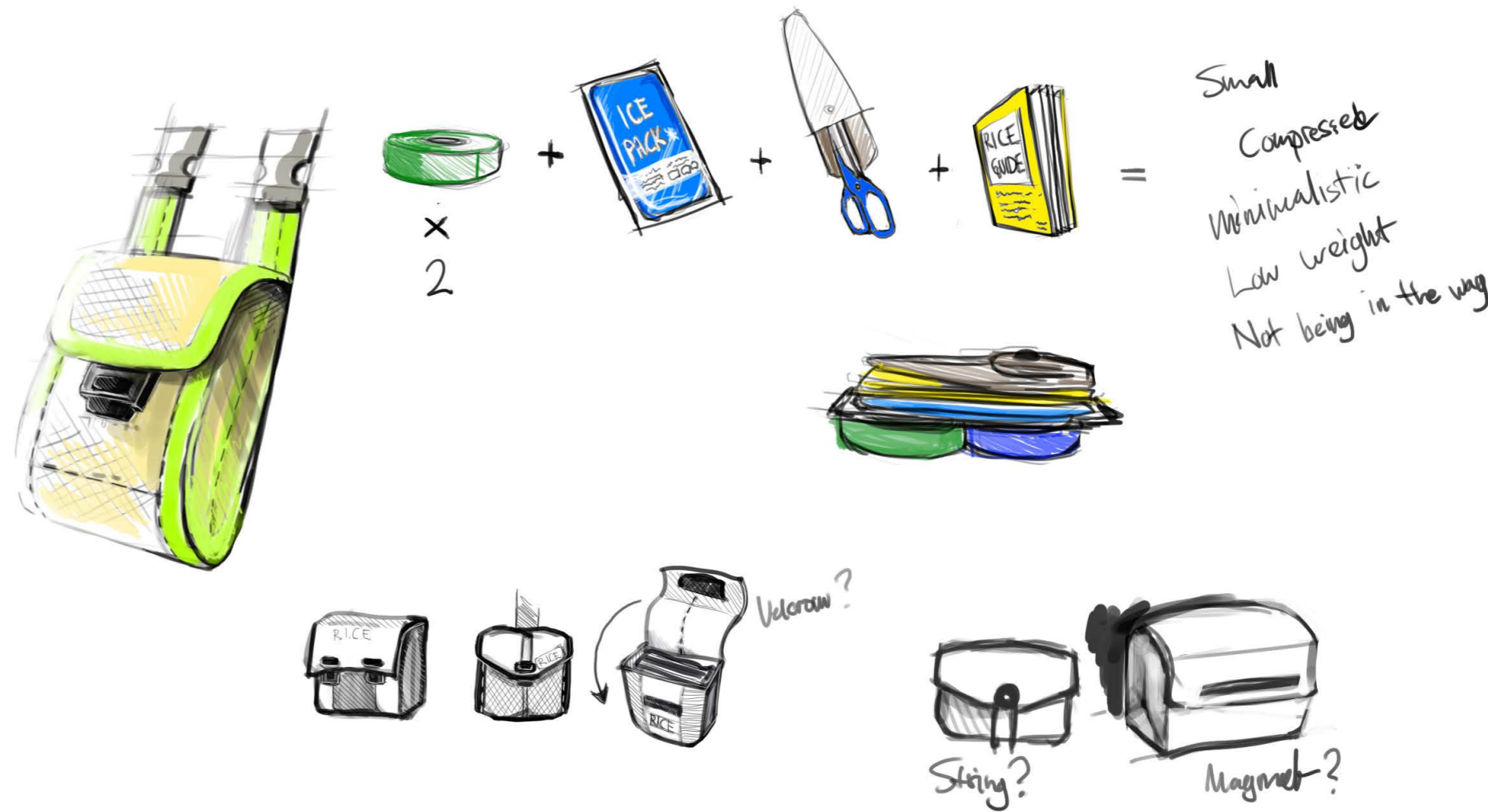
A kit for R.I.C.E. method treatment, containing a lightweight cheap solution which is easy to work with. Similar to a first-aid kit.



COMPANY BRANDED THERAPEUTIC TAPE

Might be an interesting idea to arrange the tape to become part of the branding of their company. Being less about just being hurt which might make people want to use it less, as they might be assumed to be weak for wearing it. Hopefully that might make people use more and make them proud of wearing it as it seems more Professional.

R.I.C.E method kit.



CONCEPT 2

AFTER FEEDBACK AND REFLECTION

Small book guide to prevent RSI: R.I.C.E Method Kit

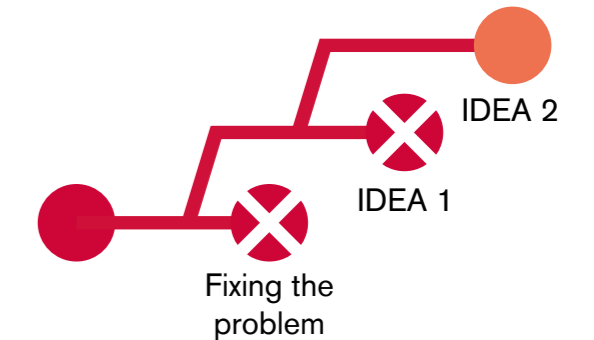
After having a meetings with my supervisor and exterminator and reflecting on my direction, I decided to change my focus away from the R.I.C.E kit. There is already first-aids that are similar which exist, which will make my product have less of a impact for the users.

Instead I decided to focus on protection from a ground position (lying down, on stomach or back) as it seems like it is one area that is underutilised from previous research.

RSI BACK PROTECTION PAD

Moving away from the kit idea I decided to focus on protection for the back in a laying position. For work in service and places where you have to do work on your back or stomach on the ground, which might be very uneven and puts a lot of pressure on your back while working.

It would also be quite interesting to try minimize by implementing it in to the back of the work jacket. Making less stuff to carry around with you during work, as you usually already have a lot of tools to bring with you as a plumber.



CONCEPT 2 RESEARCH INSPIRATION

(Picture 16*)



(Picture 17*)

BIKER/SKIER BACK PROTECTION

Perhaps it could work as pads that you put in the back similar to what bikers and skiers use, to help them if they fall off their bikes while driving or falling while skiing down the mountain.

This might work, but seems still quite uncomfortable when you are supposed to have a longer working session while laying down and having your back on a hard pad/board.

Maybe there is a way to make a softer pad with less weight, which helps to put less pressure on your back by being more comfortable as well?

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AIRPLANE INFLATABLE LIFE-JACKET

I also looked at airplane inflatable life-jackets as they seemed to have a fast expansion, they use a cartridge of carbon dioxide sewn in to them which will activate when you pull the strings filling the jacket with gas. Some jackets will expand by just being in the water.

As good as that seems, the bad thing about it is that you can only use it once. After that you have to open it up and take out the old cartridge to replace it with a new one. Making this not that suitable to use often, which is something I would want for my product. Less of a hassle to use.

POSITIVE

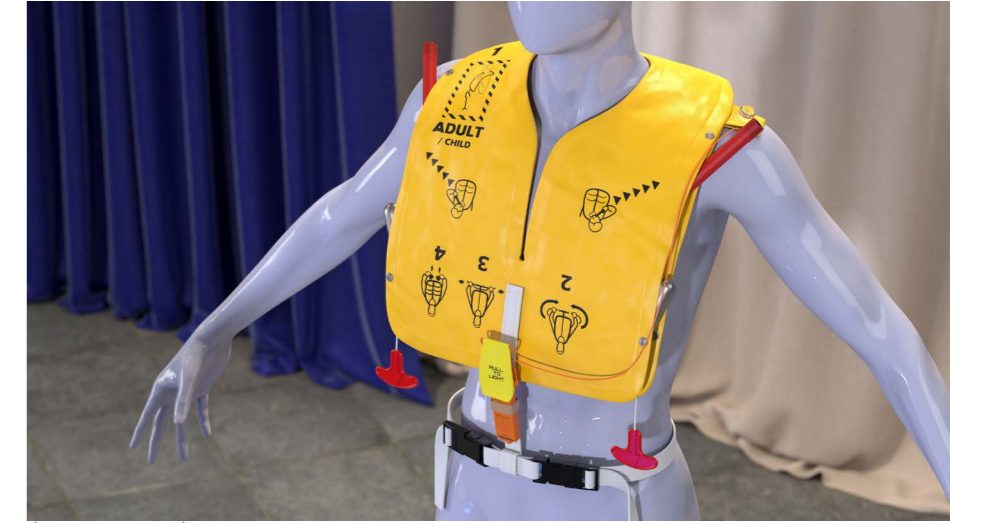
- **Rapid Expansion.**
- **Very light weight.**

NEGATIVE

- **One use only.**
- **Complicated to exchange cartridges.**
- **Might expand when being in contact with water.**
- **Can get punctured.**

After noticing this, it was not what I was looking for.

(Reference 27*)



(Picture 18*)



(Picture 19*)

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(Picture 20*)

(Reference 28*)

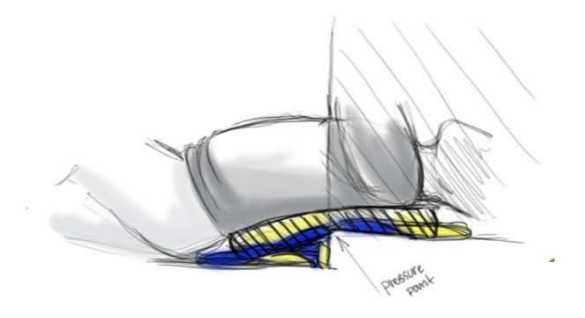
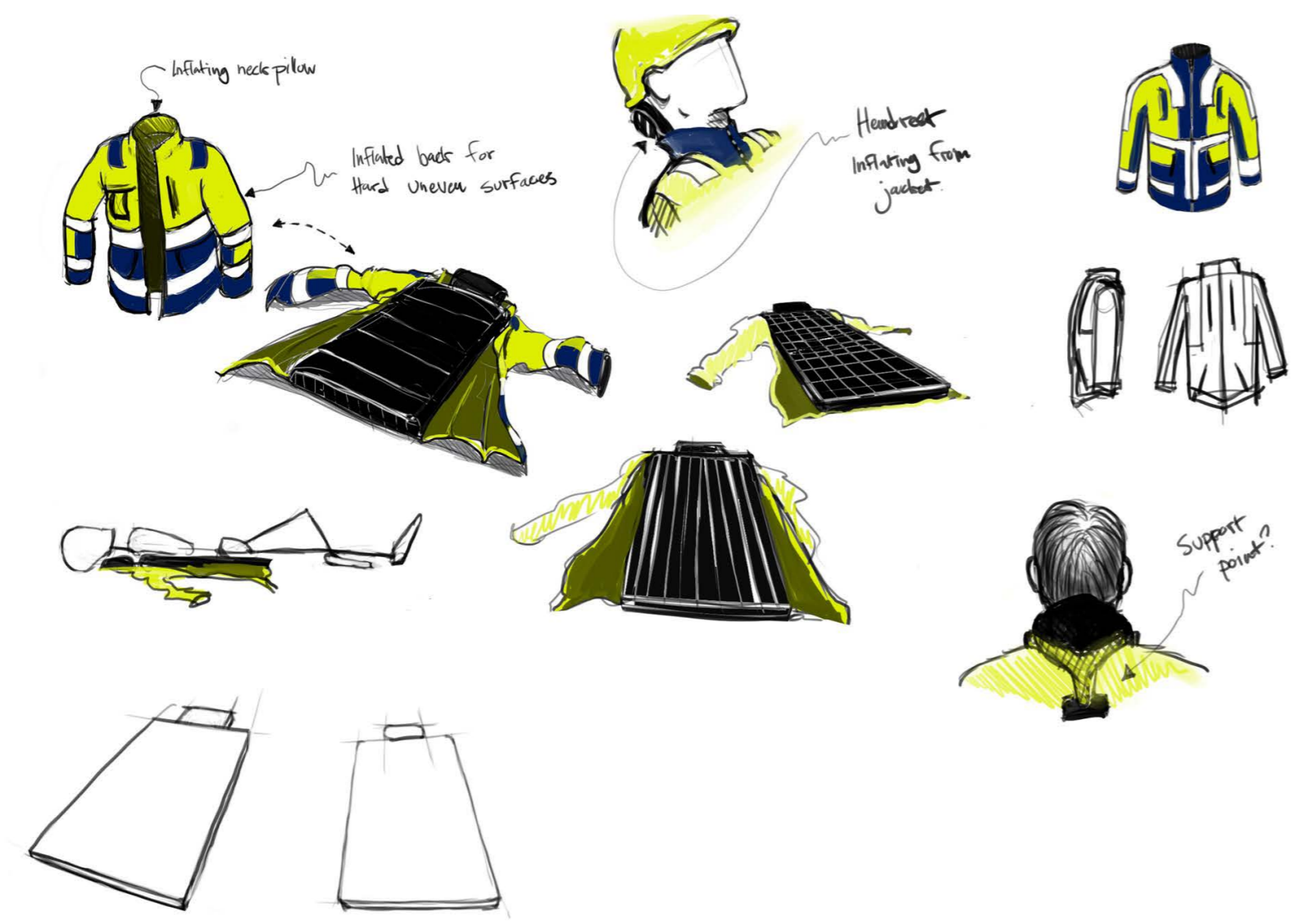
BALLOON ARTICLE FROM NEW YORK

After having a meeting with my supervisor she referred me to an article that might be interesting to look in to, as it focuses on how to make something withstand great force. This might help to minimize risks of my product getting punctured (if it was supposed to be inflated).

The article is about a gigantic balloon that was fitted to stop flood water from a massive storm that was causing havoc in New York City. It was made to be inside a 16 foot-diameter tunnel blocking the water. It needed to be strong and light weight in its requirements. The balloon was made with 3 different strong textile layers of material and one of the inner layer was woven with "vectran armour", which should help with the massive force that it was supposed to stop.

Having a woven protection layer would be a very ideal to have in my product as well. To minimize puncture and destruction of the product during use. Especially if it is supposed to be inflated later on.

CONCEPT 2 SKETCHES





MOVING FORWARD

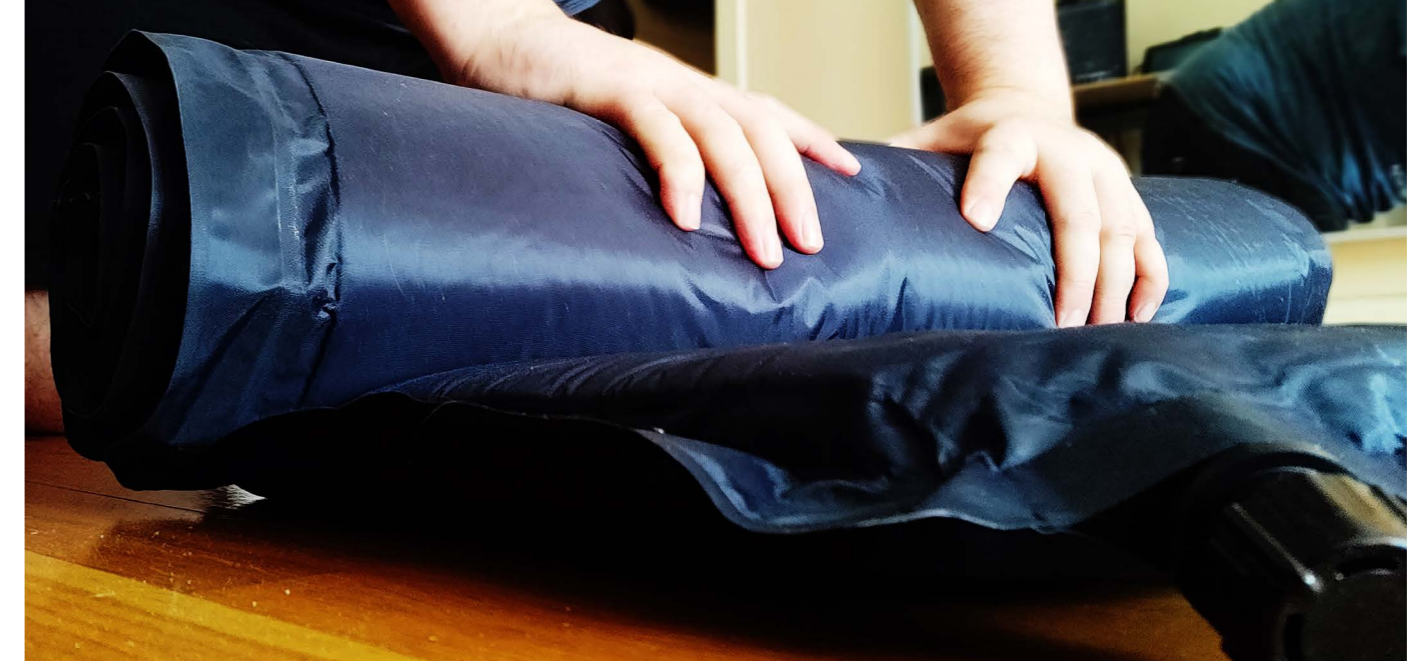
After making some sketches I decided to try some rough mock-ups at home to see how it would feel and to make me more accustomed to the idea in general.

How thick does the pad need to be? Is a harder pad better than a softer one? If it is inflatable where should the vent be placed?



MOCK-UP TESTING



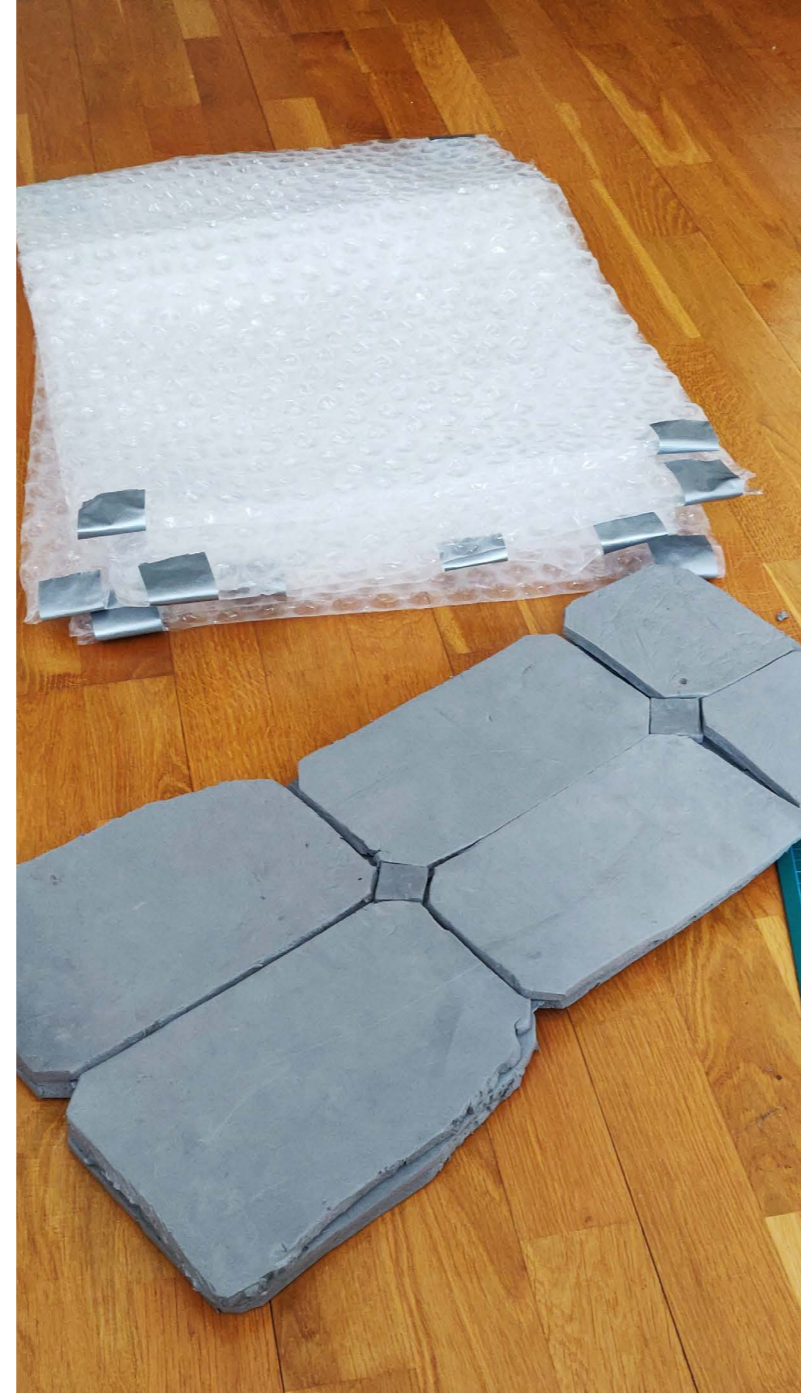


SELF-INFLATING MATTRESS

This is a self-inflating mat which uses a layer of compressible foam, inside an airtight envelope of fabric with a valve to control the airflow. By opening the valve up it will expand on its own, but you can also make the process a bit faster by blowing air in to it (which I tried during the tests) which requires less effort compared to a regular inflatable mat.



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THREE PROTOTYPES

I tried out three different variants of prototypes.

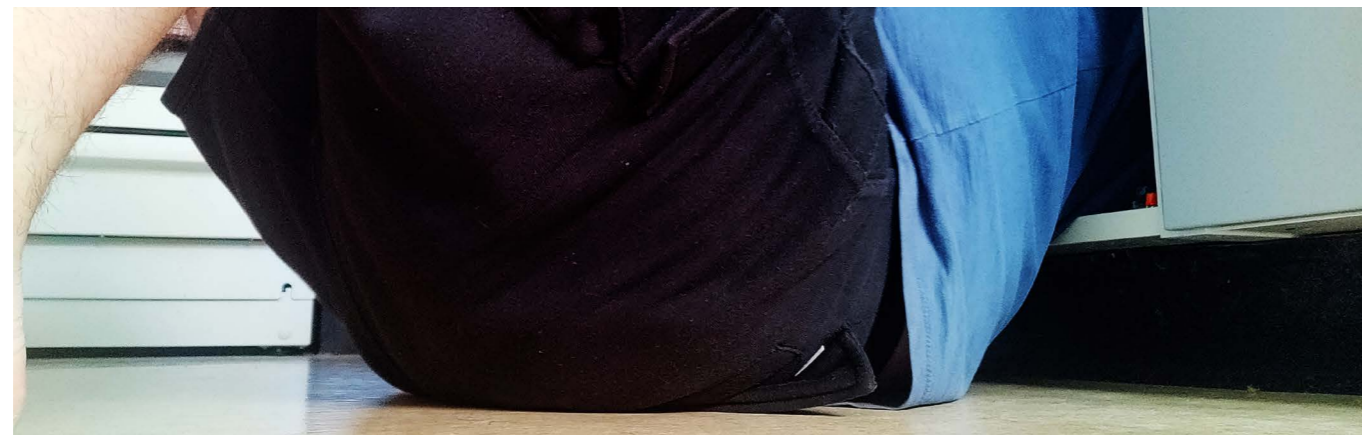
1. One with bubble-wrap, to try the thickness (putting one more or less layers). How thick did the back need to be to not feel discomfort.
2. A foam backrest to try out shape or size of the prototype.
3. A open-cell foam mattress to compare it to the harder pad.

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UNDER KITCHEN SINK



VENT PLACEMENT

I tried placing the vent in different areas on my mock-up to see where the best placement might be, while laying down on it, blowing air in to it etc.

The best area was the corner of the mat, as it was not in the way when having your back on it.

The airflow seems to be a lot better distributed if having it there as well as the air will travel along the long and short side inside the mat.

This result can also be seen on other mats using open cell-foam. (Including the one that I had bought for testing)



MOCK-UP RESULTS

When trying the difference in the hardness of the material against a uneven surface, I noticed that the foam mattress worked a lot better than the hard pad. I would still feel a pressure towards my back area where the sharp uneven part from the cupboard edge were. The cell-foam mattress distrusted the pressure a lot better, as it is soft, and I could barely notice the pressure while laying down on top of it.

The pad could also be annoying to have as you need to remove it or have it on you all the time and it takes more space. The cell-foam mat is easy to inflate as it will not need a lot of effort from the user. It can inflate by itself or you could help it by blowing air in to it (takes around 5 min). While a regular air-mattress needs more energy from the user. It was also easy to deflate as you only need roll it up to get the air out, taking less space than the pad.

Using the bubble wrap sheets I tried to notice at which thickness that the pressure from a hard edge would no longer be noticeable on my back. Around 30mm was the sweet spot where it started to not be as noticeable any longer.

Overall I feel that the cell-foam preformed best in the testing and will be what I will continue with for the product.

MATERIALS

JACKET BASE MATERIAL

“PROFI 265” Work wear Fabric

The textile is made from 51% polyester and 49% cotton. It is a very common use as a work-wear textile as it is very thick and tear resistant. Clothes made from it tend to be very warm and durable.

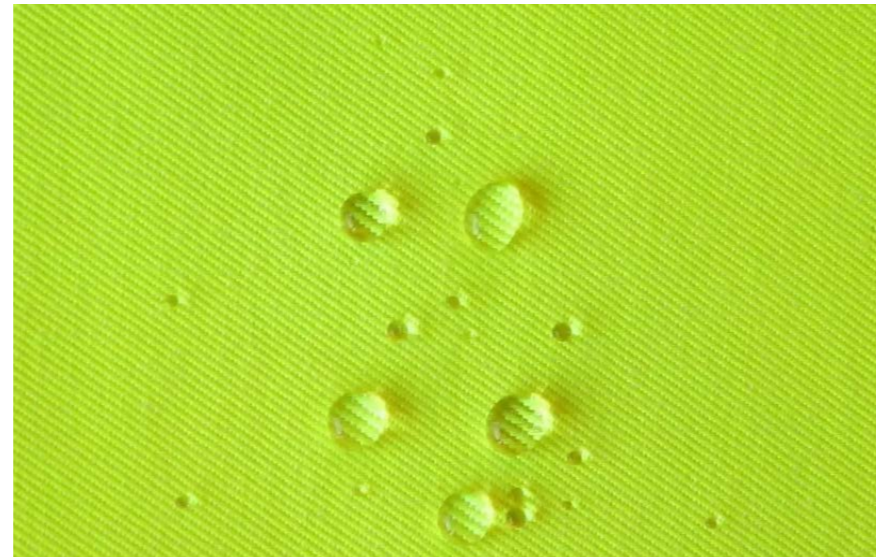
You can also attach a finishing of water repellent which it usually is when it is meant for use during winter.

It also is certified to EN 20471 (High Visibility Clothing) in yellow and orange colours.

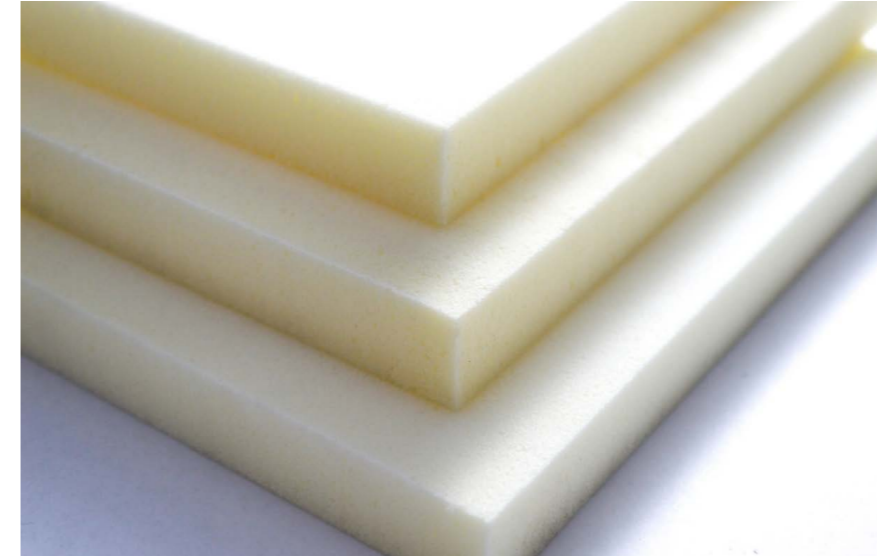
(Reference 29*)



(Picture 21*)



(Picture 22*)



(Picture 23*)



(Picture 24*)

OPEN CELL FOAM

Polyurethane Flexible Foam

Polyurethane flexible foams are open-cell foams, which is a high resilient foam sponge that absorbs air.

When creating the foam, gas is released in the material to create the empty spaces/open cells.

Being a open-cell foam it lets air pass in and out of each cell, when putting pressure on to the foam the air gets pushed/forced out from it.

The foam would expand faster if blown air in to it rather than letting it self inflate (which you can also do), and uses less effort by the user compared to regular air-mattresses.

(Reference 30*)

BACK PAD OUTSIDE LAYER TAFFETA-190T

As for the outside layer for the foam pad a Taffeta-190T would be useful. This can be seen to similar products on the market which uses a variant of the 190T (Even the one I used in mock-ups, page 67).

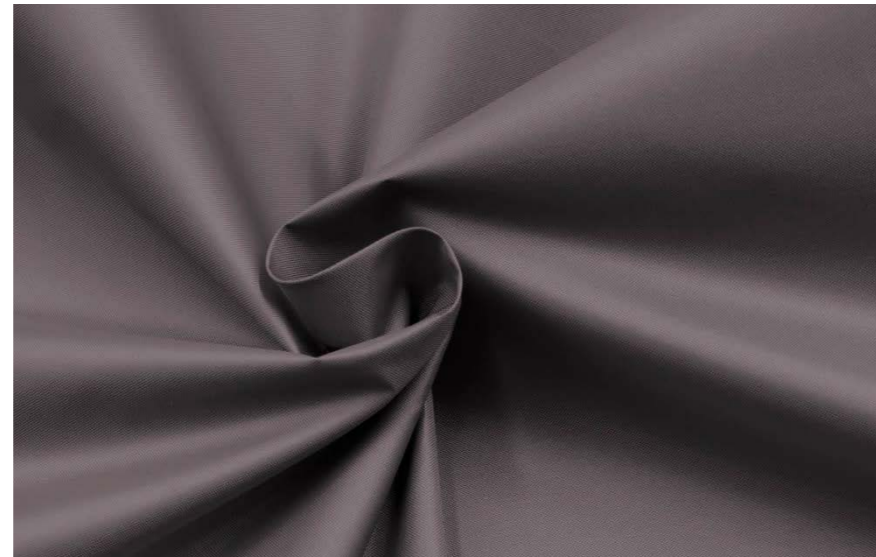
It is a elastic polyester fabric which is resistant towards water and wind (tear resistant), as it is PU coated.

Used quite commonly as lining of work-wear clothes.

(Reference 31*)



(Picture 25*)



(Picture 26*)



(Picture 27*)



(Picture 28*)

INSIDE LAYER Elastic PVC sheet

An elastic PVC sheet behind the outside fabric/layer for extra protection against puncturing the mat, minimizing the risks of opening up the mat from use. Tear and puncture resistant.

It is also water resistant, flame-proof and has several other properties.

Using the weaved layer similar to what was used in the Balloon article (page 59).

(Reference 32*)

RESTING SIDE

Polyester 30D elastic fabric

It is a 100% knitted polyester fabric which is very soft, waterproof and tear resistant. This is thanks to a coated layer which is called TPU (Thermoplastic Polyurethanes), which is on one side of the fabric.

On the “top side“ of the mat, where you rest your back on or stomach. For a more comfortable surface to place your body on.

It could also be a replacement for the PVC layer as it is stated that it might be a more environmental friendly replacement to it.

(Reference 33*)



(Picture 29*)



(Picture 30*)

REMAINING METHOD AND MATERIALS

The remaining material is Plastic moulded valve for opening and closing the air in and out of the pad.

There is also meant to be a double-faced glue between the foam and the fabric in the pad while having heat welded seams on the sides to keep it airtight.

VERIFYING DIRECTION



Åsa Elvstrand

Product Developer /Designer
Procurator AB

As to verify that the jacket with a implemented expanding back-protection would be a good idea, I decided to get in contact with someone which works with construction clothing / work-wear.

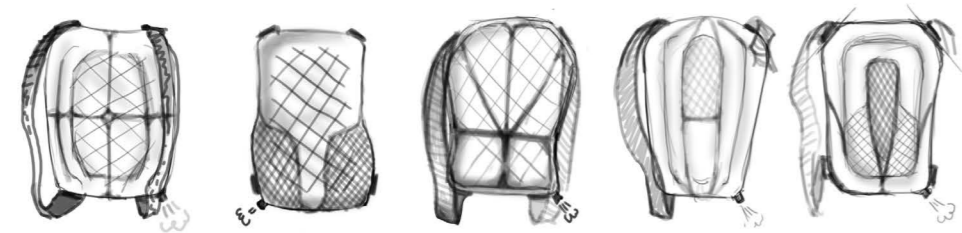
I emailed a product developer / designer by the name Åsa Elvstrand. She was quite busy at the moment that we decided to keep the communication through email, where I could describe some about the product and get some valuable feedback.

After describing the product I was developing she mentioned a issue that she was most concerned about. Having the product being a jacket might make it more expensive to produce as you would make brand new jackets with the implemented function. Focusing on something that could be adaptable with the old work-wear might be more suitable, as it would make it less expansive to produce and more adaptable to different situations.

I felt that this made sense, and why I wanted the jacket to be a part of it in the first place was to minimize the amount of “stuff” that you need to be concerned about, making it a part of the uniform. This was something I decided to move away from.

After reflecting on the mater I then decided on moving more towards a vest version, as it seemed more viable.

SKETCHES OF IDEA 2.1

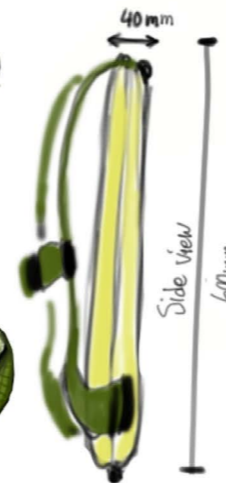


Maybe a vest instead of a workjacket (?)

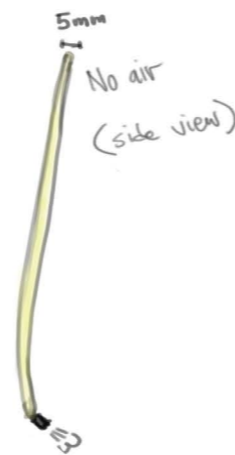
Vest version



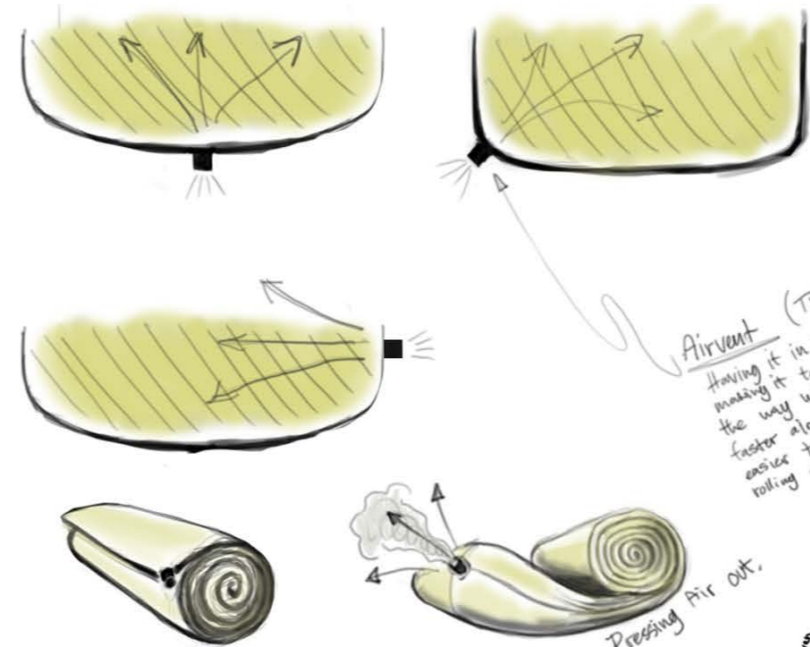
Self inflating vest version



Based on a person that is 180cm in height (Average for men)

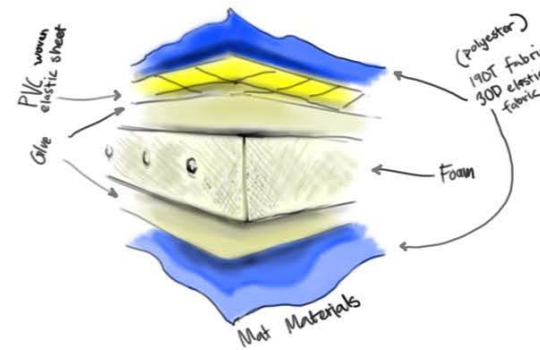


No air (side view)



Airvent (Two way)
Having it in the corner making it to be less in the way when using it. faster air dispersion and easier to empty when rolling out the air.

Pressing Air out.



Vest/Back Version



SECOND MEETING SKETCH FEEDBACK

After developing some sketches of the prototype I got in contact with Ulrika Göteby again through "Teams" and she brought two plumbers with her to the call, a senior and a apprentice.

They both seemed to like my prototype idea a lot as they agreed to having to lay on their back on very uncomfortable areas often. The older plumber mention that he has had problems previously but feel a lot better now that they are doing the exercises at their work. He seemed very enthusiastic towards the back protection idea.

I showed them my previous idea and the new vest version, and they seemed to like the vest a lot more. They even were willing to try out a working prototype if I had one in my possession (which I do not).

I also got to hear from the apprentice that during their education, the teachers gives them a lot of information about repetitive strain injury's and even brings in people that has this issue and talks about it. Something I had a hard time to get a hold of when I was looking for interviews, was that the teachers I tried to get in contact with did not respond.

Overall I felt that there was a good validation about the product and I even got some questions answered which I did not previously got.

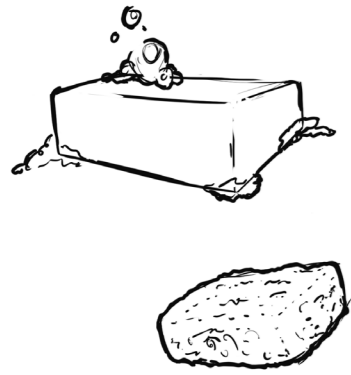


CLEANING PAD

Regarding the cleaning factor. It uses material which is supposed to be water proof, because of its impregnation coating. Usually made from polyurethane or polyvinyl chloride. That means that is made to not let moisture penetrate the material surface. Taffeta-190T material (as mentioned on page 81) is a material commonly used for outside camping gear as well as outside furniture pads as it easily maintained and does not require a lot of effort from the user.

How to cleaning a self inflated is described from an article from the team from “puffy.com” (2024, ref. 35). Regarding self inflating pads you need to be gentle with the vent area, ensure that it is closed and water will not leak inside when washing. Keep the mat inflated as it will help with cleaning the entire surface and identifying the more dirty spots. Using lukewarm water and mild rather than a harsh detergent, as the more harsh versions might damage the material/coating of the mat. When trying to clean textured surfaces it is recommended to either wipe it gently or use a soft-bristled brush as it will get rid of the dirt in the though spots while not damaging the material. After wiping or scrubbing rinse the pad with water. When drying it let it be in a shaded area and make sure it is completely dry to prevent mold growth.

Ultimately it comes down to when the user wants to use this pad and it using already materials that is quite commonly used within that occupation. Adding some rubberised areas in the vent to minimize exposure to moisture might be considered for future development. There might be issues that could still happen with the current prototype, as the mat is not tested yet within the right circumstances. The design needs to be adjusted regarding the faults that might eventually happen.



(Reference 31*, 34*, 35*)

DESIGN CHOICES

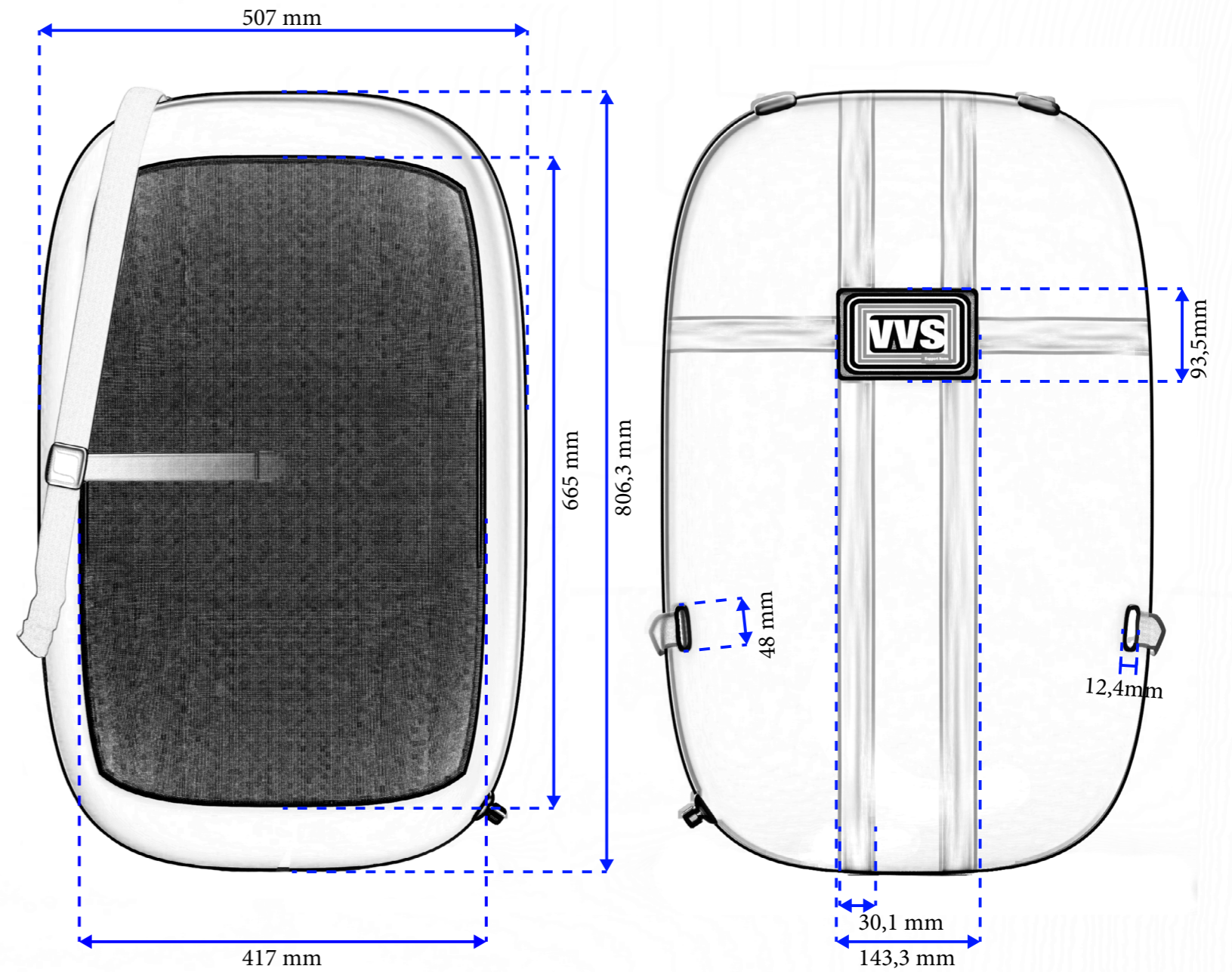
The design of the pad would be considered a early face prototype as it has only has had a visual feedback which went very positively, but there could always be things that might not work as successfully in practice. Making the mat as a flat-piece, instead of adding curvature, was a design choice by me as I think it will absorb the distribution of uneven/sharp surfaces a lot better. Being inflatable together with a foam inside will naturally shape it self somewhat around your body. As the pad being flat will also make it more flexible to use for several other positions then only just your back, like kneeling, stomach etc. I also added the reflective stripes and the visual yellow colour to ensure the safety and visibility during both day and night for the workers. To minimize dangerous situations that could happen otherwise. Which is quite common to see in construction based occupations.

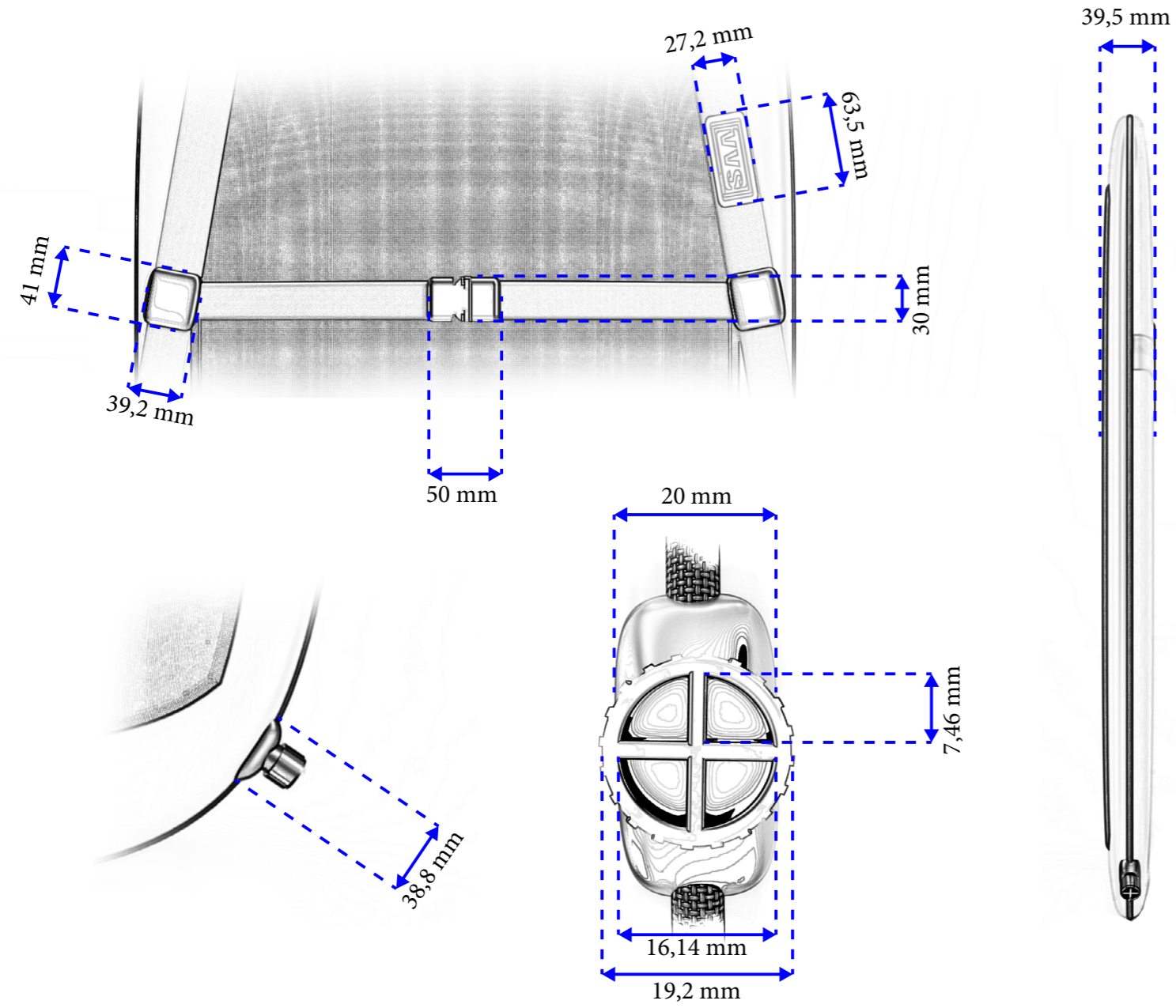
Having the straps would help letting your hands to be used for other things while also be able to carry it around, or you could keep it rolled up until you take it to the area where you want to use the pad. Giving the user some more versatility. I also considered that the straps could be more like an add-on to the product and you would be able to remove them if necessary.

Something that I did not previously think about, before focusing a little bit more on cleaning, was the importance of making the vent more secured regarding moisture. This would be a very important thing to focus on if continuing the project, as it will in high probability be used in situations where it will get exposed to water. Might consider designing the vent to use some rubber parts on the inside to make it more airtight.



TECHNICAL SKETCH





Inflated the mattress is 39,5 mm and when is deflated it is around 10 mm in thickness.

RENDERINGS

BLACK STRAPS VERSION



AIR VENT





YELLOW STRAPS VERSION



BACKSIDE





PROJECT REFLECTION

The project has had very unexpected events, which might happen a lot in areas you are new to. I have never had any issue getting people to interview before this project as most have shown mostly interest and excitement. In this project however, it was quite a struggle in the beginning at least. It is easy to take such things for granted and I should make more plans/methods to prevent this issue from happening in new projects.

It is so easy to get stuck at the big picture sometimes rather than to narrow yourself down to a more specified focus, that is something I personally need to get better at.

I also feel that getting to know more about the repetitive strain injuries has impacted my way of thinking, making me more aware about labour intensive work and involving this knowledge in some way into future projects might be beneficial. Like how force and time impacts the users when using products.

By the project being quite information and research heavy, as I was kind of new to the subject, I did not have as much time to perform tests to develop the design. This makes this prototype most likely subjected to change regarding future outcomes.

If the project would continue, I think making a functioning prototype will be the next step and make the vent more moisture-proof. The pad needs to be tested with the intended user in mind and in the right environment to understand what was done correctly and what might need be adjusted. Is it useful in practice or will there possibly be some unknown faults/issues with the current design.

REFERENCES AND LINKS

PICTURES

1. <https://pxhere.com/sv/photo/1623010>
2. <https://pxhere.com/sv/photo/607232>
3. <https://www.elinstallatoren.se/app/uploads/sites/2/imported/koksjobb-970x546.jpg>
4. <https://pxhere.com/sv/photo/1379600>
5. https://upload.wikimedia.org/wikipedia/commons/d/d8/Crawlspac_under_house.jpg
6. https://upload.wikimedia.org/wikipedia/commons/thumb/3/35/RICE_medicine.svg/1200px-RICE_medicine.svg.png
7. <https://pxhere.com/sv/photo/477173>
8. <https://www.nyteknik.se/fordon/fords-fabriksarbetare-far-exoskelett-6883232>
9. <https://byggkatalogen.byggjtjanst.se/nyheter/exoskelett-for-byggarbetare/22913>
10. https://upload.wikimedia.org/wikipedia/commons/c/c8/Tommy_Robredo_Swedish_Open_2008.jpg
11. https://upload.wikimedia.org/wikipedia/commons/f/f9/Grand_Slam_Moscow_2011%2C_Set_1_-_083.jpg
12. https://cdn.pixabay.com/photo/2017/03/30/22/42/kinesiologi-2189905_1280.jpg
13. https://m.media-amazon.com/images/I/61IFUksxLnL._AC_SX679_.jpg
14. https://img.joomcdn.net/9fd76589edc77667e231a-912b801ec9bc7d606e6_original.jpeg
15. <https://www.medicalnewstoday.com/articles/321950#how-to-make-a-cold-compress-for-injuries>
16. https://www.revzilla.com/product_images/0027/8145/5074-400_750x750.jpg
17. <https://images.motoaction.se/guard-d30-wm-viper-2-back--748016-2.jpg?w=640&h=640&q=81&version=100>
18. <https://i.pinimg.com/originals/0b/0b/d8/0b0bd8ee176d-fb49b87c27b913f956c9.jpg>
19. https://img.aeroexpo.online/images_ar/photo-g/174588-13080775.jpg
20. <https://static01.nyt.com/images/2012/11/19/science/video-tc-media-tech-121119-tun/video-tc-media-tech-121119-tun-articleLarge.jpg>
21. https://www.xmtextiles.com/wp-content/uploads/2000/06/80022_Profi-265_Navy-2_foto3-350x350.jpg
22. https://www.xmtextiles.com/wp-content/uploads/2023/02/profi-265-yellowhv-2_foto-jpg.webp
23. https://www.generalplastics.com/wp-content/uploads/2016/11/DSC_0558_edited.jpg
24. <https://technicalfoamservices.co.uk/wp-content/uploads/2017/09/20PPI-TFS-091118-0014.jpg>
25. <https://www.xmtextiles.com/wp-content/uploads/2023/02/taffeta-navy-2-350x350.jpg>
26. https://www.xmtextiles.com/wp-content/uploads/2000/01/94002_Taffeta-190T_Black-1_foto3-350x350.jpg
27. <https://image.made-in-china.com/2f0j00pFETVqfPqyrg/Elastic-Mesh-PVC-Vinyl-Fabric-for-Event-Tents-Manufacturer.webp>
28. <https://image.made-in-china.com/202f0j00zytQWGUmsnup/Elastic-Mesh-PVC-Vinyl-Fabric-for-Event-Tents-Manufacturer.webp>
29. <https://s.alicdn.com/@sc04/kf/H9ef18b892ace46f0bb-60d02206178569t.jpg>
30. <https://s.alicdn.com/@sc04/kf/Hb2033660cb774b5eace2606789d71cd1c.jpg>

REFERENCES:

1. <https://www.av.se/globalassets/filer/arbetsmiljoarbete-och-inspektioner/upphandling/branschen-vvs.pdf>
2. <https://www.vvsforum.se/nyheter/2020/november/har-ar-de-vanligaste-arbetskadorna/>
3. <https://orthoinfo.aaos.org/en/diseases--conditions/sprains-strains-and-other-soft-tissue-injuries/>
4. <https://www.prochoicesafetygear.com/ppe/blog/work-place-safety/preventing-repetitive-strain-injury-on-industrial-work-sites/>
5. <https://osgpc.com/what-is-a-strain-injury/>
6. <https://www.vvsforum.se/nyheter/2020/januari/jobbet-som-sliter-pa-kroppen/>
7. https://en.wikipedia.org/wiki/Repetitive_strain_injury
8. <https://www.bizcover.com.au/plumbers-hazards-guide/>
9. <https://www.vvsforum.se/2016/02/nya-eu-krav-pa-skyddsutrustning/>
10. <https://www.av.se/halsa-och-sakerhet/personlig-skyddsutrustning/>
11. https://drive.google.com/file/d/1jH5uXoRFPQ6FWflf_t0nKjkcIGsmfslz/view?usp=drive_link
12. https://en.wikipedia.org/wiki/RICE_%28medicine%29
13. <https://www.sbu.se/sv/publikationer/SBU-utvarderar-arbetsmiljons-betydelse-for-besvar-och-sjukdom-i-nacke-axlar-armor-och-hander/?lang=sv>
14. https://www.pvforetagen.se/globalassets/dokument-op-pna/branschfakta/ventilation/bra-am-for-montorer-o-driftpers_2020-11-09.pdf
15. <https://www.av.se/globalassets/filer/publikationer/broschyror/belasta-ratt-arbeta-ergonomiskt-smartare-i-byggbranschen-broschyr-adi616.pdf>
16. <https://www.byggnads.se/medlem/arbetsmiljo/omraden/ergonomi/>
17. <https://www.byggnads.se/regioner/vast/aktuellt/2021/ergonomi/>
18. <https://www.byggnads.se/regioner/vast/aktuellt/2021/belastningsskador/>
19. <https://www.byggnadsarbetaren.se/lagre-lon-om-du-inte-tranar-styrketraning-ingar-i-arbetsuppgifterna/>
20. <https://www.sverigesviktigastejobb.se/brandman/>
21. <https://www.gastrikeraddningstjanst.se/jobba-hos-oss/brandman/>
22. <https://www.nyteknik.se/fordon/fords-fabriksarbetare-far-exoskelett-6883232>
23. <https://byggkatalogen.byggjtjanst.se/nyheter/exoskelett-for-byggarbetare/22913>
24. <https://malarnasfacktidning.se/2020/11/johnny-testar-exoskelettet-jag-har-nog-aldrig-kunnat-kora-pa-sa/>
25. <https://www.healthline.com/health/kinesiology-tape>
26. <https://www.medicalnewstoday.com/articles/321950#how-to-make-a-cold-compress-for-injuries>
27. <https://www.mapquest.com/travel/outdoor-activities/water-sports/life-jacket.htm>
28. <https://www.nytimes.com/2012/11/20/science/creating-a-balloonlike-plug-to-hold-back-floodwaters.html>
29. <https://www.xmtextiles.com/products/xm-textiles/beaver-type-workwear-fabrics/profi-265/>
30. <https://technicalfoamservices.co.uk/blog/open-cell-vs-closed-cell-foam/>
31. <https://www.xmtextiles.com/products/xm-textiles/polyester-fabrics/taffeta-190t/>
32. <https://derflex.en.made-in-china.com/product/vKxmzByGJIRf/China-Elastic-Mesh-PVC-Vinyl-Fabric-for-Event-Tents-Manufacturer.html>

33. https://xinlun-yarn.en.made-in-china.com/product/uXKQtq-zlbChU/China-30d-Elastic-Waterproof-TPU-Laminate-Woven-Polyester-Fabric-for-Garment.html?pv_id=1htrn8c-7c7fe&faw_id=1htrn8s6iaee
34. <https://www.amazon.com/Inflating-Sleeping-Lightweight-Inflatable-Backpacking/dp/B08VN39DZC?th=1>
35. <https://puffy.com/blogs/best-sleep/how-to-clean-sleeping-pad>
36. <https://www.vvsforum.se/2021/01/vi-har-inte-haft-belastningsskador-hos-personalen-pa-manga-ar/>
37. <https://www.av.se/arbetsmiljoarbete-och-inspektioner/inspektioner-utredningar-och-kontroller/inspektion/>



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