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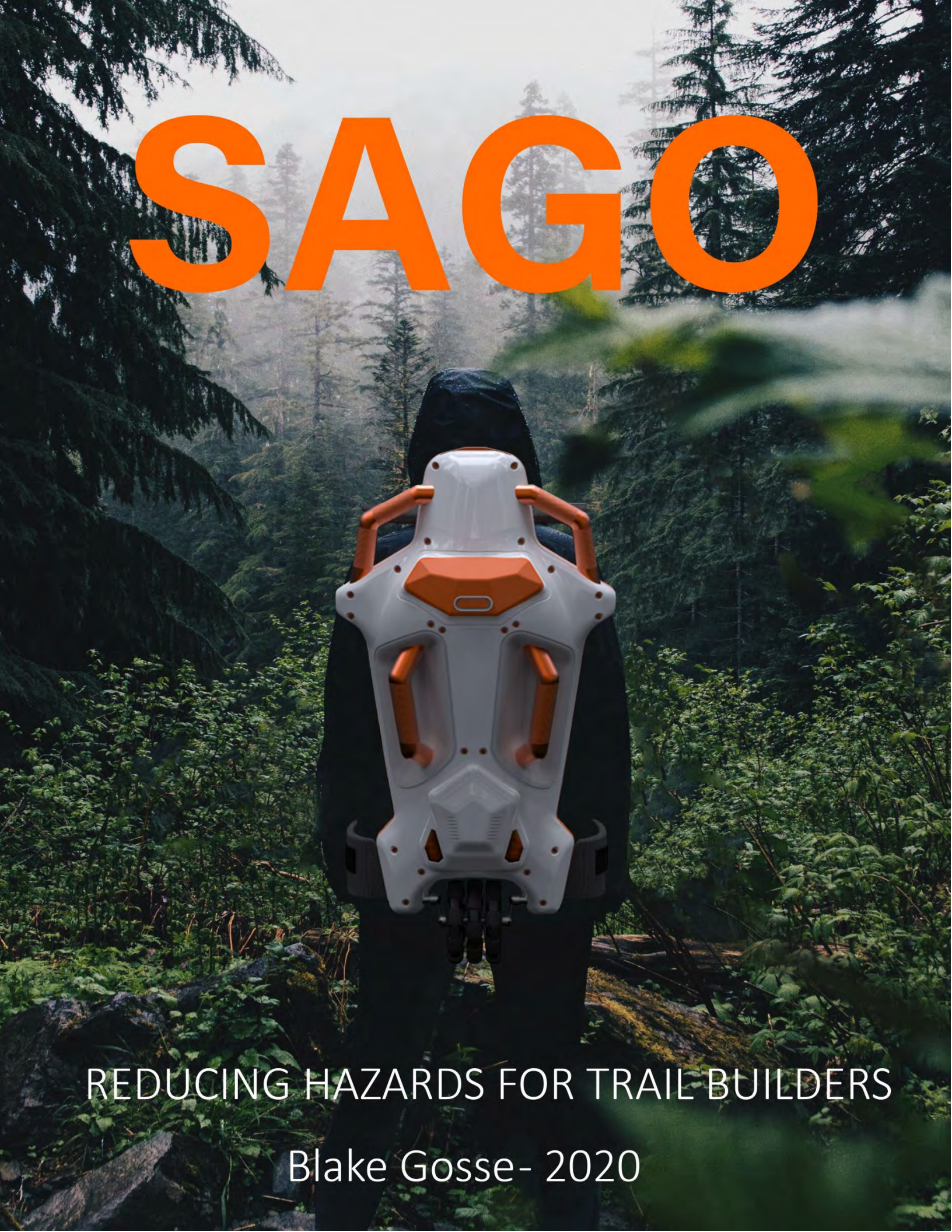

REDUCING HAZARDS FOR TRAIL BUILDERS

Blake Gosse- 2020

Reducing Hazards For Trail Builders

by

Blake Gosse

Submitted in partial fulfillment of the requirements for the degree of

Bachelor of Industrial Design

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HUMBER

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Abstract

As our society advances, we have become further and further removed from nature, and in this vastly connected world, we are more disconnected from one another more than ever. In recent years people have begun to realize this disconnect and have started to combat it through the use of interconnecting hiking trails. These hiking trails allow us to get in touch with nature and one another. Although this is a step in the right direction, we often overlook the people who work so hard to develop and maintain these intricate trails. How can we improve these physically demanding conditions of trail builders? The daily tasks of trail builders involve tremendous physical strain on the body, often using equipment that has been around and largely unmodified for decades. Some examples of this equipment that is used daily would be shovels, backpacks, chainsaws, and hiking boots. To fully understand the user experience, it will be necessary to develop a gamut of questions aimed specifically at what challenges and concerns the trail builders deal with on a daily, weekly, and monthly basis. Ultimately, the ideal design research method would be to conduct it through a qualitative ethnographic study. Once all relevant data is collected, a one-to-one scale ergonomic sketch model will be made to evaluate the overall ergonomics and full-bodied human interaction design adequately. Using actual people in these studies with the sketch model will prove a great deal of additional feedback, and will lead to further refinements. Overall the end-design will be a fully encompassed full-bodied interaction design that is well thought out design that addresses various challenges the trail builders face.

Keywords: nature, hiking, trails, builders, equipment, user experience, design, research method, ergonomics, end-design, full-bodied interaction.

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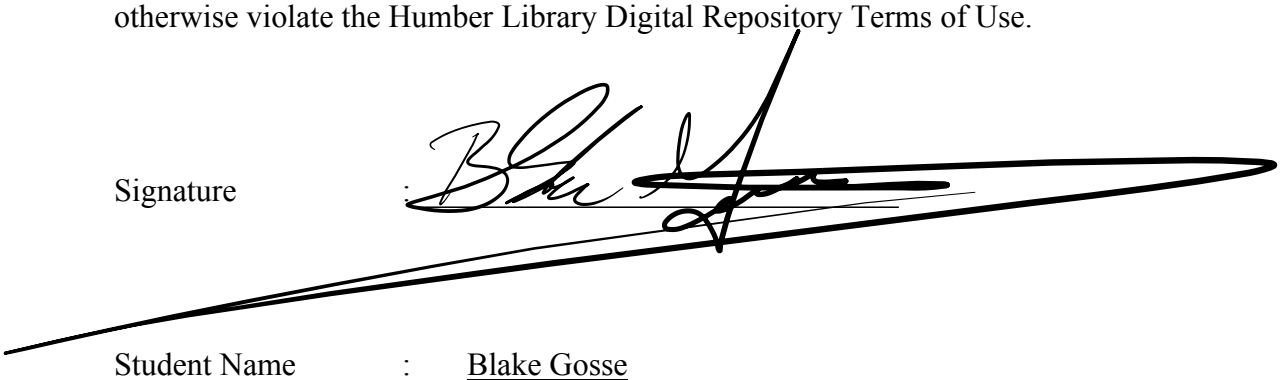
Signature : 

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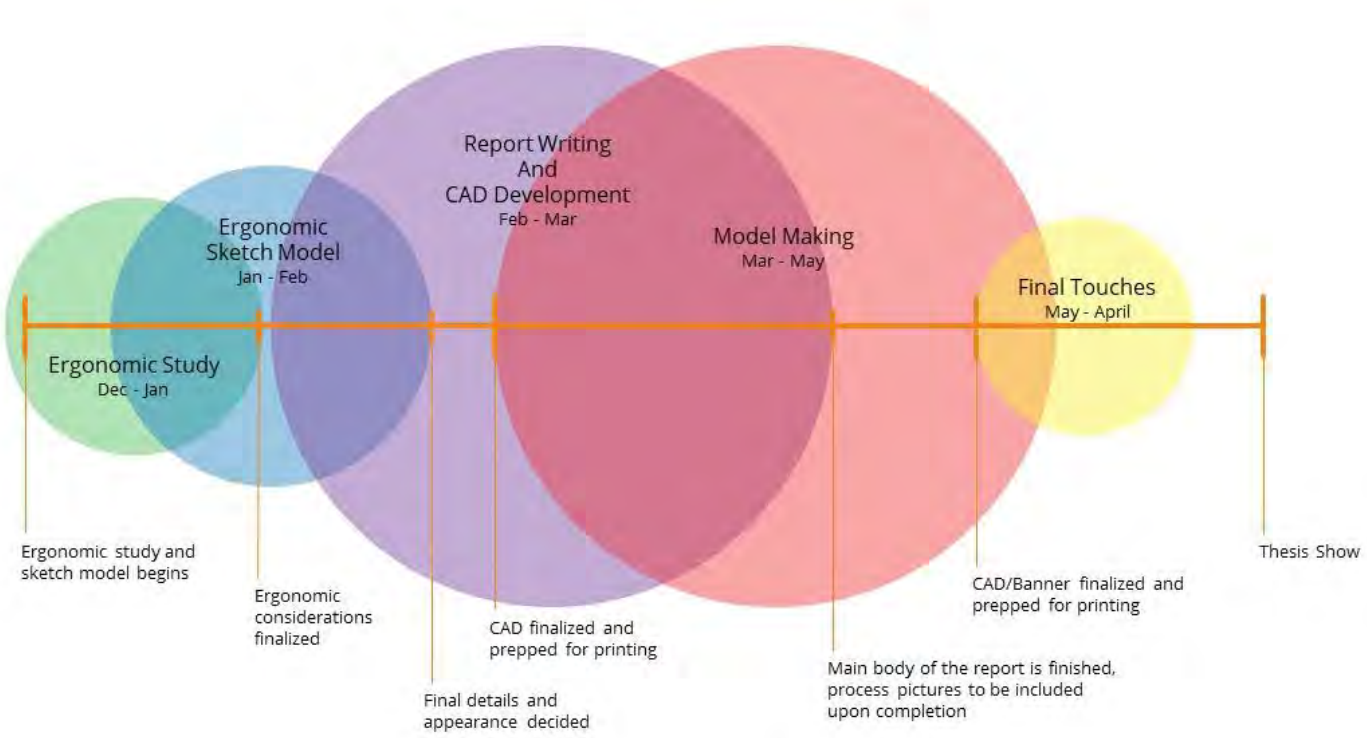
Project Timeline



1 – Problem Definition

1.1 Problem Definition

Figure 1.1 – Trail builders at work, by Routt County Riders.

With the increase in trail building comes an increase in injury and strains to workers building them. "… construction laborers and helpers typically work full time and do physically demanding work. Some work at great heights or outdoors in all weather conditions. Construction laborers have one of the highest rates of injuries and illnesses of all occupations." (Bureau of Labor Statistics, 2019) The goal is to reduce and potentially eliminate the chance for common strains and injuries to occur for trail builders. These strains and injuries stem from working in a wide variety of physical environments and weather conditions. In addition to these conditions, workers are often required to transport heavy and awkward tools need for the job.

1.2 Investigative Approach Taken

With the goal of improving the overall working conditions for trail builders, numerous methods of research will be conducted, which can be seen in Table 1. In addition to these research methods, there are various key questions which will be asked, such as:

- How can we improve the overall working conditions for trail builders?
- What types of environments are workers most often found in?
- What equipment is commonly used?
- What equipment is prohibited from use?
- How can a product be implemented without negatively impacting the overall workflow and efficiency already in place for workers?
- What are the most common types of strains and injuries for workers?
- What are the overall health and safety guidelines/practices?
- Are there special types of training involved in this type of work?
- What are some common fears or concerns workers have related to their work?
- What do workers enjoy the most about the work they do?

Design Methods	Thesis Development Research Methods
RESEARCH	• Product benchmarking • User Observation • User interviews/surveys • Video analysis • Literature reviews • Ergonomic study
ANALYSIS	• Material • Survey/interview overview • Overall research intake analysis • Empathize • Further, define the scope of problem definition
IDEATION	Rapid sketching, mind mapping
CONCEPT DEVELOPMENT	Final sketches, configuration layouts, styling variations
ERGONOMIC STUDY/REFINEMENT	Ergonomic sketch model to further define overall aesthetics and design
CONCEPT REFINEMENT	Ergonomic refinement, detail development, CAD development
MODEL DEVELOPMENT	Cad model, physical model
COMPLETED DESIGN	Formal Presentation

Table 1. Flow chart of thesis activities.

Ultimately, these research methods will lead to fully understanding and defining the problem definition while coming to a fully defined solution. The research methods will also aim to focus on solutions for the overall health and safety of trail builders while addressing environmental and economic restrictions due to working in protected wildlife areas.

1.3 Background, History, and Social Context

Trail building has been ongoing for thousands of years, and we have always built trails to make connections with each other and to enhance our daily lives. Whether it trails to connect villages to improve trade routes or leisurely walking paths through the forest - now more than ever, trail building has become a very important occupation as it allows people to connect with nature in an ever-increasing climate of technology. Not only does spending time in nature provide benefits like reduced stress and improved sleep, but it also greatly contributes to the overall global economy by improving the publics' mental health. (Buckley, 2019)

Trail builders are often working outside in all kinds of adverse weather conditions, working with dangerous tools that are heavy and cumbersome to operate and transport. Their goal is to preserve and protect the environment they are building trails while making a minimal impact on their surroundings with the maximum experience for people who hike the trails. The equipment and tools used are often archaic and outdated, with much of the equipment being repurposed or modified by the workers to suit their tasks. Current trends in technology show reduced user interaction with equipment through the use of remote devices or automation. Through these current trends, a design solution can be achieved for attaining a full-bodied interaction design that reduces overall stress and injury to the worker while creating a minimal environmental footprint.

2 – Research

This chapter showcases the overall research approach and methods used throughout the design process. It consists of both user and product research that will ultimately lead to a detailed understanding of current user experience that will aid in a final design solution.

2.1 User Research

2.1.1 User Profile

USER CATEGORY	DESCRIPTION
Primary User	**Trail Builder**
	The primary user for this product would be hiking trail builders primarily located in North America and Europe. This occupation exposes the users to a wide range of weather conditions and demands their bodies be put through regular physical strains like heavy lifting and long-distance hiking. They are also subject to being exposed to working with dangerous tools like chainsaws.
Secondary User	**Trail equipment sales and service person**
	The secondary users for this product would be those that work in similar professions that use tools like chainsaws for felling and trimming trees. These would be professions like forestry workers, firefighters, emergency first responders, and construction surveyors.
Tertiary User	**Hiking trail personnel**
	Tertiary users for this product would be the upper management and hiking trail personnel who are in charge of purchasing and storing the product. These people would typically conduct end of season inventory checks and maintenance, and they would have direct contact with the product.

Table 2.1 Three user categories.

The information that was used to assist in honing in on the key demographic information search is as follows.

Keywords used:

- trail builders
- hiking trail building
- hiking trail maintenance workers
- hiking trail workers

Nonprofit Hiking Trail Organization: Transcaucasian Trail Volunteers

Age: Uncertain
Gender: Mixed
Culture: Uncertain
Income: Middle to lower middle income (inferred due to typical nonprofit salary wages)
Educational background: Uncertain
Motivation: Fitness, Volunteer satisfaction, Social environment, Possible relationships, Travel experience

Figure 2.1- Transcaucasian Trail Volunteers (2018, Jan 4) Retrieved from https://i2.wp.com/transcaucasiantrail.org/wp-content/uploads/2017/11/20170613-104738-DilijanTrailbuildingWeek1-Tom-Nexus-6P-0060.jpg?resize=1160%2C665&ssl=1

Clubs: Vancouver Trails

Age: Uncertain
Gender: Male
Culture: Ethnicity appears to be predominately White
Income: Uncertain
Education: Uncertain
Motivation: Fitness, Volunteer satisfaction, Social environment, Possible relationships, Travel experience
Level of motivation: high

Figure 2.2 – Vancouver Trails Blog Photo- Building Demon Creek Bridge (2017, June 9) Retrieved from https://www.vancouvertrails.com/blog/wp-content/uploads/2017/06/watersprite-lake.jpg

Appalachian Trail Conservancy: Trail Volunteers

Age: 28-25
Gender: female
Income: lower (inferred due to young age)
EducationUncertain
Ethnicity: Mixed
Motivation: Fitness, Social environment, Volunteer satisfaction
Level of motivation: high

Figure 2.3 – Appalachian Trail Conservancy Volunteers (2019, Sept) Retrieved from http://www.appalachiantrail.org/images/default-source/Conservation/trail-management/trail-crews/14825898611_7e459f6b25_b.jpg?sfvrsn=3fdfb4a0_0

Appalachian Trail Conservancy: Trail Volunteers

Age: 20-50
Gender: Male
Income: Uncertain
Education: Uncertain
Ethnicity: Mixed
Motivation: Fitness, Social environment, Employment, Love of outdoors
Level of motivation: high

Figure 2.4 – Maintainence Team - Ouachita National Recreation Trail, photo by Loretta Melancon (2010, June 17) Retrieved from https://www.americantrails.org/images/_articleImage550/Maintenance-Teamwork-on-the-ONRT.jpg

Preliminary understanding for trail builder demographics was based on the study of literature search results. For this particular demographic, the following keywords were used.

Keywords used:

- trail builder demographics
- average income for nonprofit jobs
- construction laborer demographics

- hiker demographics
- laborer demographics
- non-profit salary

Demographic Summary

Age/Gender:

Due to the overwhelming lack of information, it was exceedingly difficult to produce a complete profile for trail builders. However, given the image research done previously for trial builder demographics, it can be inferred that the age range would be 20 to late 30's for trail builders, with a small number of older builders in their 40's and 50's. Additionally, gender would also have to be inferred from the image research. It would appear that it would be predominately male trail builders with a ratio of about 80% male to 20% female.

Despite the lack of information on trail builders, there was some information regarding hikers and laborers, which indirectly relates to the target user.

"The average (mean) age of hikers in the survey was 34 years old, plus or minus 13 years, with a median age of 29 years old." (Mariposa, 2018)

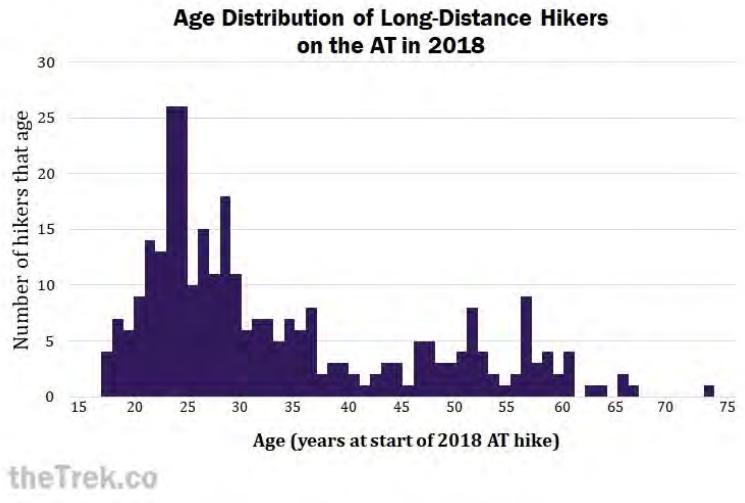


Table 2.2 – Age distribution of long-distance hikers on the Appalachian Trail. (Source: Mariposa, 2018).

"Fifty-five percent of hikers were biologically male, and forty-five percent were female. Regarding gender identity, 54 percent of hikers identified as men, 44 percent as women, and 1.6 percent identified as non-binary." (Mariposa, 2018)

Hiker gender of hikers on the Appalachian Trail	
Male:	55%
Female:	44%
Non-binary gender:	1.6%

Table 2.3 – Gender distribution of Long-Distance Hikers on the Appalachian Trail. (Source: Mariposa, 2018).

Ethnicity/Culture:

"The vast majority (95%, *n* = 286) of hikers in the survey were white non-Hispanic. Six hikers identified as Hispanic/Latino/Latina, three hikers as Asian, four as multiracial, one as Native American/Alaska native/Hawaii native, and one as black." (Mariposa, 2018)

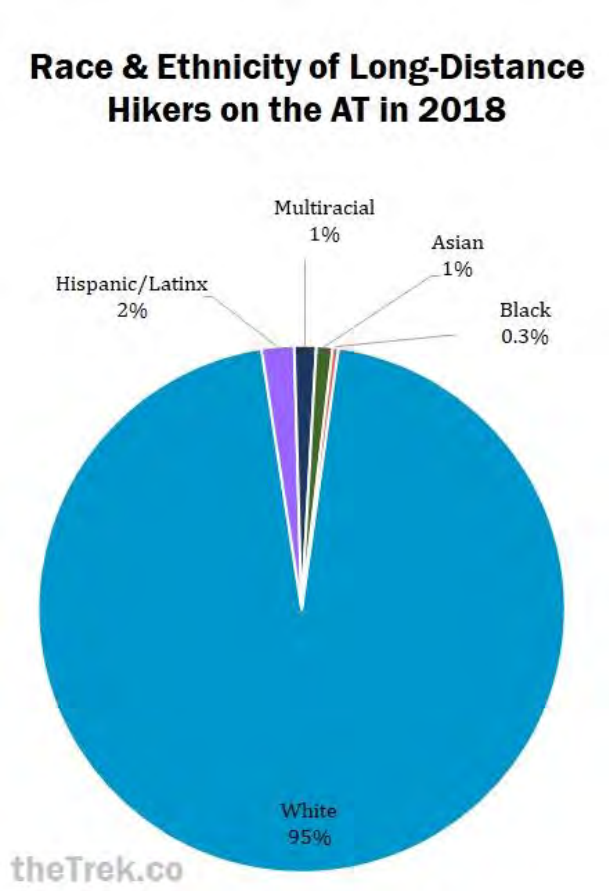


Table 2.4 – Race and ethnicity distribution of long-distance hikers on the Appalachian Trail. (Source: Mariposa, 2018).

Education and Income:

User demographics concerning education and income were no less difficult to find than it was for age and gender. To establish metrics for the income of trail builders, it was necessary to look into occupations that were similar to trail builders. The closest demographic to this was non-profit workers, and construction laborers/helpers.

"Nearly half of hikers in the survey (46%) had bachelor's degrees. One of the four hikers who had not yet finished high school was only 19 years old." (Mariposa, 2018)

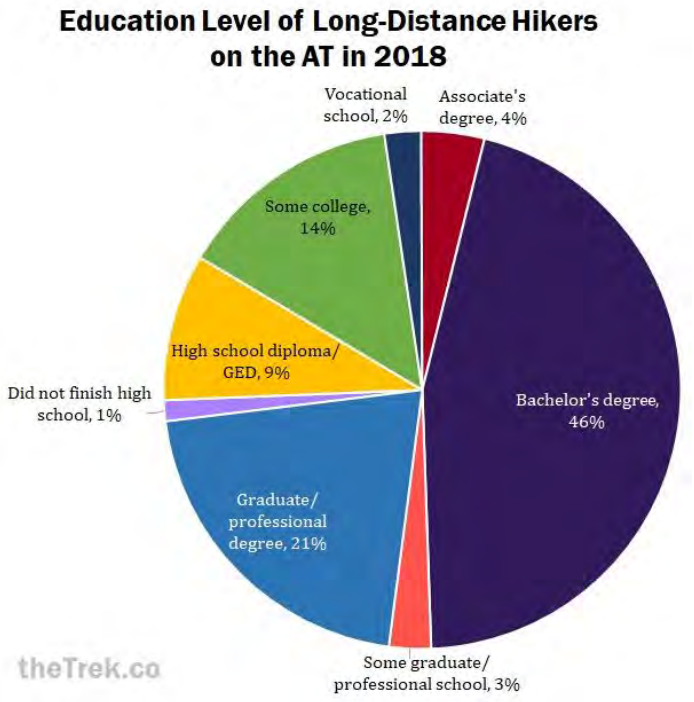


Table 2.5 – Education level of long-distance hikers on the Appalachian Trail. (Source: Mariposa, 2018).

"The average Non Profit salary in Canada is $31,200 per year or $16 per hour. Entry-level positions start at $27,300 per year, while most experienced workers make up to $53,040 per year." (Neuvoo, 2019)

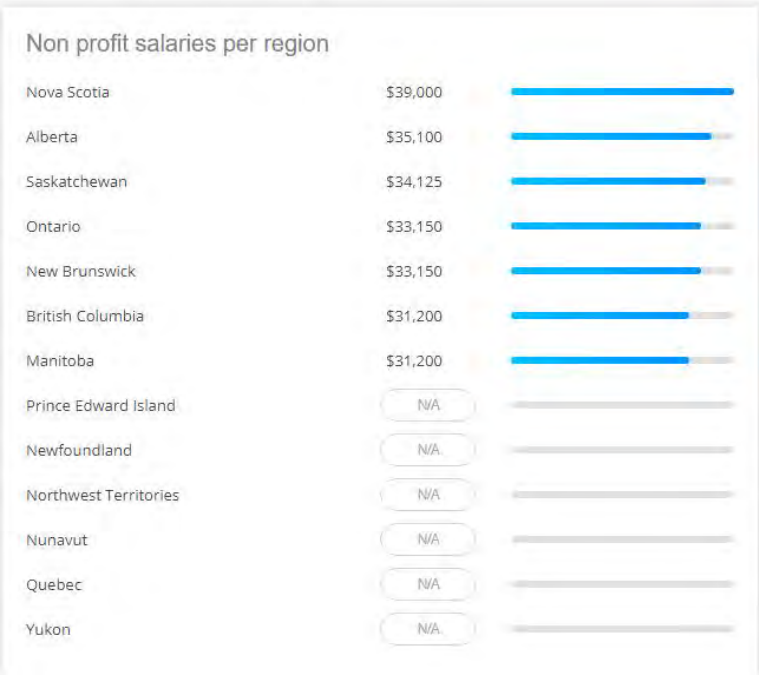


Table 2.6 – Level of income for non-profit workers in Canada (Source: Neuvoo, 2019).

Findings and Conclusion

Typically, the majority of trail builders reside in North America and Europe, 80% are white male, and have a high school education. Additionally, they earn around $32,000 a year and are in their late 20's to early 30's. Due to the harsh conditions of the job and the hard physical work required, there can tend to be a large turnover for trail building positions which in-turn keeps the age range relatively low as older people would have more difficulty with the physical requirements of the job.

User Persona

Name:	Eric Lawler
Age:	28
Job:	Trail Builder
Income:	$30,000 per year
Education:	High School
Family:	Single
Location:	St.John's, NL
Main Job:	Trail Crew Maintenance
Frequency:	Monday-Thursday
Duration:	40 hrs/week
Social/Solitary:	Works with a crew of 5 people, in a team of 15.
Other Activities:	Goes to the gym 3 times a week, socializes with friends at local bars, practices photography and takes in local art exhibits.

Table 2.8 - Trail Builder Eric Lawler User Persona.

User Profile

Eric Lawler is a semi-experienced trail builder, with almost four years of experience. He loves being outside, which results in a great deal of job satisfaction from his everyday work. Although he enjoys his job, he finds the physically demanding aspects to be tiring on his body, even for someone like him who would be considered in shape. When he's not working, he enjoys going indoor rock climbing at a local gym and spending time at local bars with friends. Additionally, he enjoys the arts and hopes to one day go back to school for adventure tourism.

User Behavior

When Eric is at work, he is very diligent with his safety procedures and in making sure his equipment is on him at all times. He does this as his job requires it, and he realizes it could save his life if anything goes wrong. The main pieces of equipment he wears would be a hard hat, safety glasses, gloves, high-vis vest, steel toe boots, and chainsaw pants. Although he can remove the chainsaw pants in the field when he's not using the chainsaw, he finds it to be tedious and tends to keep them on rather than having to take them on and off constantly.

Eric has never been injured on the job, although he knows people who have been and has seen some people he works with have some close calls. If he or anyone he works with see someone doing something potentially unsafe, they politely recommend an alternative way of doing it. There is a close working environment among trail builders, and they look out for one another when working in the field.

Eric's Relationship with his tools and equipment

Like most trail builders, Eric hates to have to wear the bulky chainsaw pants and uncomfortable hardhat and safety glasses. Although he finds a lot of his equipment uncomfortable, he realizes how important they are in keeping him safe and the fact his job has a zero-tolerance policy with anyone who doesn't comply with wearing the proper equipment. With excessive use, he has to replace his gloves frequently, while his boots usually last several seasons before needing to be replaced. Luckily his employer will replace his hard hat and chainsaw pants if they need replacing. As far as his tools are concerned, his employer supplies and maintains the major

power tools like drills and chainsaws. After work, Eric leaves the power tools and chainsaws with the employer at the depot and his equipment in his vehicle. Each morning he collects his equipment from his vehicle when he returns to the job site.

2.1.2 Current User Practice

User Behavior Summary

Frequency

Trail builders in North America and Europe frequently use chainsaws to clear debris and obstructions from trail paths. They typically hike with a group of people, from 2 - 15, and have three to four chainsaws. In addition to clearing paths, they also use the chainsaws to create crib ladders (steps), and boardwalks to span across wet marshy areas and steep slopes. (twinoakstrails, 2019) Sometimes the saws might not be used; however, they are almost always necessary to bring as anything could happen that might require tree clearing or cleanup. They always wear their protective equipment when on the trail and operating the chainsaws.

Duration

A typical workday for trail building is about 10 hours, the majority of that time is spent hiking on the trail with the tools and equipment to get to the job site that requires work. This being said, a large portion of time is spent handling the chainsaw and other tools in transporting alone. When the user reaches the job site on the trail, there can be several hours' worth. of work to be done with the chainsaw. Even if the saw happens not to be used that day, the user would still spend most of the day transporting the saw and storing it in various locations as he conducts other work.

Social or Solitary

Most trail building work is done in pairs as there is a lot of heavy lifting that requires two people. Although, when chainsaw work is involved, the best practice is to have the person operating the saw far away from other people in the crew. This prevents any accidental safety hazards to other members like falling trees or saw injuries. The chainsaw operators work in a solitary setting like this primarily because of the noise and the inability for them to hear other people around them. However, there are many times when they will be working with people in a group setting to get the finishing touches on a project. When they are working within a group setting, there is always a heightened sense of awareness with everyone in the group, and clear visual contact is made with all members of the group to ensure everyone knows what the operator is doing and that they stay out of the saw's way.

Motivation

The primary motivation for carrying a chainsaw and all the other support materials (gas, extra chain, maintenance kit, etc.) would be the ease in which it allows the user to cut down trees. When compared to felling a tree manually with an axe or hand saw, a chain saw saves the user valuable time and energy despite its heavy and cumbersome nature.

Lifestyle

Although the overall lifestyle can vary greatly among trail builders, they tend to share a common thread for the love of the outdoors and nature.

Focus and exertion

When operating a chainsaw, trail builders have to have a very high level of focus and a heightened sense of awareness of their surroundings.

Purchasing Behavior

Typically, employers pay more money for equipment that might be more expensive due to the higher quality and durability associated with the higher cost. Having tools and equipment that will last in the field is essential as anything that breaks in the field can bring work to a halt costing the employer a lot of money in tool repair and wages for workers that are unable to work with the broken equipment. Trail builders are mostly employed by non-profit organizations or companies that rely on government subsidies to operate. Due to the small budgets, many of these employers deal with, purchasing considerations are not taken lightly, and much consideration goes into the price and quantity of products acquired.

Location

Trail building takes place largely in protected parks and conservation areas; due to these locations, there are usually heavy restrictions on motorized vehicles and gasoline-powered tools. In addition to this, trails can be heavily isolated from large populations of people and city centers, which can add to the difficulties of transporting tools and equipment.

2.1.3 Activity Mapping

Activity Mapping Flow Chart Trail Building Example Routine – Building a bog bridge	
Step 1: Collect and inspect tools and equipment for the day's tasks.	
Step 2: Hike to the pre-planned work area.	
Step 3: Survey area for any changes and plan the fall zone for tree felling.	

Step 4: Unpack tools and begin making cuts to fell tree in the planned fall zone.	
Step 5: Once the final cut is made to fell tree, quickly exit the area to avoid any possible kickback when the tree falls.	
Step 6: When the tree has settled, begin cutting branches off.	

Step 7: After branch removal, start removing a strip of bark with a log debarker.	
Step 8: Take a long nail (spike) and start prying up and peeling the bark away.	
Step 9: Separate the log lengthways to form two planks. If necessary acquire additional logs for ground/plank supports	

Step 10: Secure plank supports firmly in-ground and prepare the top half by cutting grooves to accept the planks. Grooves can also be cut into planks for added traction.	
Step 11: Position planks onto plank supports.	
Step 12: Start nailing down, planks into plank supports. That's it; now, the bog bridge is complete.	

Table 2.9 - Activity Mapping Flow Chart - Trail Building Example Routine – Building a bog bridge

Conclusions from Observations

After reviewing the user observations from the trail building example routine (Table 2.9) and the process of using a chainsaw (appendix B), it was very clear that there was a lot of bending and twisting of the upper body. This type of interaction could lead to serious repetitive strain injuries, which would result in negative physical and emotional health for the user. To avoid these and other types of injuries, a newly designed product would greatly benefit from a variety of features such as:

- Lightweight
- Improved ergonomics
- Maintaining a high visibility appearance
- Improved comfort

2.1.4 Ergonomic Research (Existing Products)

Figure 2.5 Basic ergonomic features of a typical chainsaw

The majority of chainsaws have very basic ergonomic designs, there are many different types of manufactures for chainsaws, but their overall designs remain relatively the same. The typical features these chainsaws have would be: x.`

- Front handguard
- Top handle
- Bottom trigger handle
- Large pull chord

There are many other additional features in chainsaw design; however, these four are the primary focal points when human interaction and ergonomics are considered. One of the main components that changes are the bar length of the chainsaw, which can add additional weight and bulk to the saw. The main focus of this design thesis would be to incorporate a longer chain length into a smaller overall package while implementing automation to minimize user interaction and increase overall safety.

2.1.5 Safety & Health Research

Health and safety are a huge concern with trail building as many variables come into play with the safety and wellbeing of trail builders like weather, wildlife, and work environment.

“Most construction laborers and helpers typically work full time and do physically demanding work. Some work at great heights or outdoors in all weather conditions. Construction laborers have one of the highest rates of injuries and illnesses of all occupations.” (Bureau of Labor Statistics, 2019)

Typically, the most common hazards associated with trail building would be

- Strains and sprains from tripping and falling
- Overexposure to weather
- Repetitive strains from using tools like pruners and chainsaws
- Hearing loss due to increase decibels in chainsaw.
- Cuts and lacerations from chainsaw kickback
- Hit from falling branches and other objects caught up in trees.

2.1.6 Interview Results

The interviews were conducted via a survey through an online questionnaire. Trail builders were contacted through email, instant messaging platforms, and word of mouth in order to gain access to responses from multiple people.

Interview results proved valuable information in terms of feedback from users on tools and equipment they use daily. The results also showed how the users interact with the tools and what areas might allow for improvement. The transcripts for these interviews can be seen in Appendix C.

2.2 Product Research

This section will focus on researching products related to trail building and exploring the benchmarking for those products. A total of 8 different products will be evaluated to understand the effects of these products on the user and to better comprehend the needs, wants, and latent needs of the end-user. Additionally, there will be attention paid to any aspects of technology

integration within the eight selected products. For our purposes, technology integration will be defined as anything that gives the user feedback/input through electronic means.

2.2.1 Current Products Profile

Product Name	Benefits	Features	Technology Integration
Chain Saw	Reliable, durable, efficient	Provides job efficiency, durable	n/a
Chain Saw Boots	Durable, effective	Provides safety for the user, protection against elements	n/a
Trail Building Backpack	Comfortable, durable, efficient	Allows high tool portability,	n/a
Chainsaw Hard Hat and Visor	One size fits all,	Provides safety for the user, ear and face protection	n/a
Safety Glasses	Lightweight, compact	Foam gasket for added comfort/safety, anti-fog, UV protection	n/a
Chainsaw Pants	Lightweight, compact, efficient	Provides safety for the user	n/a
Chainsaw Gloves	Lightweight, compact, durable,	Provides safety for the user	n/a
Portable Chainsaw Mill	Semi-portable, lightweight, durable	Provides job efficiency, durable construction	n/a

Table 2.9.1 – Compared benchmarked products

2.2.1.1 Product Mapping

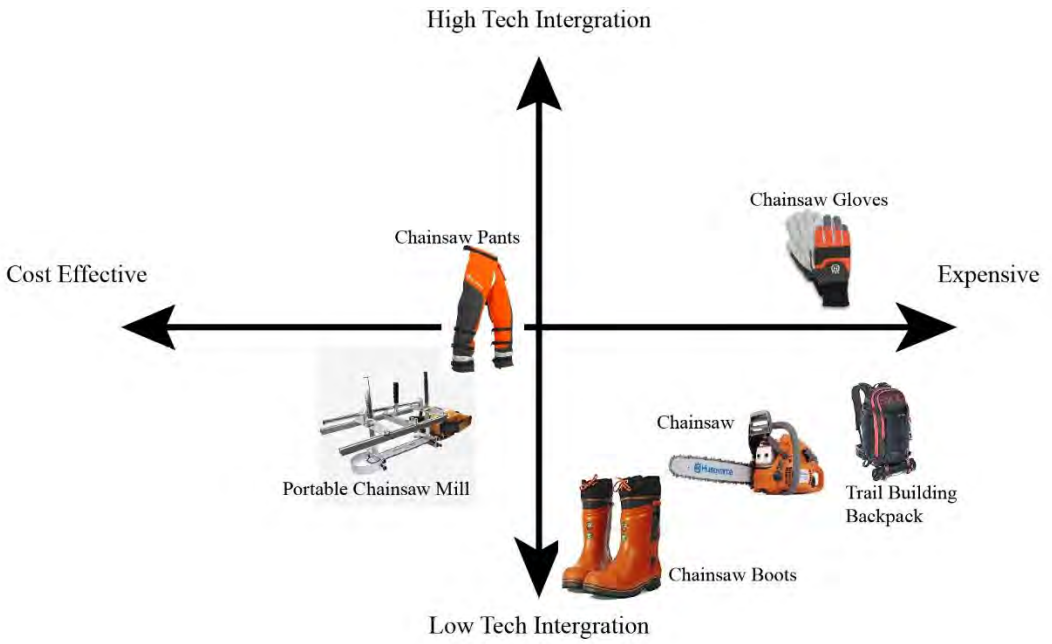


Figure 2.6 Product benchmarking showing product cost comparison with technology integration

2.2.2 Benchmarking – Functionality

When looking at the results from figure 2.6 we can see that there is a strong correlation between product cost and low technology integration. In terms of functionality, there appears to be a correlation between low cost and low technology integration when looking at low functionality products and negative user feedback/reviews. It shows there is potential for product development that is cost-effective with high technology integration.

Key Findings

- Improvement for portability
- Potential market for cost-effective/high tech integrated products
- Durability is paramount

- Rugged aesthetics
- Easily maintained by the user

2.2.3 Benchmarking – Aesthetics & Semantic Profile

Trail building products have never officially had their own category; instead, they have borrowed from multiple professions with similar job descriptions like construction, forestry, and carpentry. This section focuses on the current state of the aesthetics and semantics profiles of trail building equipment. Although the types of trail building equipment can vary with materials, features, and cost - their overall aesthetics and semantic profiles remain relatively the same.

Figure 2.6.1 Chainsaw hardhat with ear and face protection

Figure 2.6.2 Chainsaw boots

These two products incorporate subtle geometric aesthetics with an acute aggressive flair in the finer details. Although different materials are used in construction, they share a common thread with material durability as they are used in protecting the user from chainsaw debris and potential cuts and drops from heavy objects.

Sematic Profile

Shape

The shape of these products can be considered organic as they have to encapsulate specific parts of the human body like the head and foot. Although they have an overall general organic form, they also incorporate subtle geometric accents in the detailing. These geometric detailing shapes allow the user to associate the product with the protective aspects they lend themselves to as they are commonly used in aggressive and harsh environments. The overall organic base forms allow the user to connect with the protective qualities they offer.

Color

The colors associated with these two products share a commonality as they are used in settings that require highly visible colors. The bright orange color schemes with black accents associate the products with safety and a general sense of construction or industrial use.

Texture

Texture for the chainsaw boots and hard hat are generally very smooth and slick with high gloss finishes. These textures would allow any debris to easily wash off from their surfaces and would also aid in foreign matter deflecting effortlessly from the surface and reducing the chances of anything getting caught up.

Symbolism

The overall form of these products needs to invoke a sense of security and power in the user as they are meant to protect the user from very harsh elements and sometimes very hazardous conditions. In general, this sense of security is achieved through their organic base shapes, and their sense of power and stability is achieved through the geometric outer detailing. This symbolic connection is essential in instilling confidence in the user with the products they are using.

2.2.4 Benchmarking – Materials & Manufacturing

Depending on the manufacturer there can be a variety of different types of plastics used in the injection molded process of chainsaw shrouds, handles, toggle switches, etc. Materials like Nylon (Polyamide), Acetal resin (Polyoxymethylene), and Polycarbonate are some of the most common forms of plastics used in the injection molding process. (Rapid, 2018)

Figure 1.1 - Husqvarna 536Li XP with extended battery pack. Retrieved from. https://hqvcdn3.azureedge.net/qs_mh=920&mw=920&ver=ff3a83d51768e3a19e7d32057cc027ec&hcsh=BA0CCAB7A0A7D52A9898F888CF312705/_$$_/media/damroot/husqvarna/forest%20chain%20saws%20electric%20

2.2.5 Benchmarking – Sustainability

Sustainability varies with the products used for trail building as the textile elements are typically a variety of organic and composite materials that would be next to impossible to recycle at the end of the product lifecycle. Additionally, the more robust tools used like power tools and chainsaws incorporate stainless steel and aluminum, which are both highly recyclable with their outer shrouds typically composed of a durable polycarbonate that can also be recycled.

3 – Analysis

This chapter will cover the overall needs of the target user and categorize those needs in a way that allows for a clear vision of any potential gaps in the market. It is through this user need analysis that we will be able to further develop a concise design solution incorporating human-centered design, sustainability, and commercial viability. Additionally, there will be focus on overall sustainability for electric and gas-powered chainsaws. This focus primarily covers the current materials used in production, as well as the potential of more eco-friendly alternatives. The various fossil fuel alternatives are looked and their potential benefits being brought to light.

3.1 Needs Analysis

The variety of tools used for trail building are largely generic construction tools and trade-specific tools that are repurposed for specific tasks with trail building. Overall the tools are often bulky and have a lot of unnecessary added weight, which makes hiking with them tiring and even dangerous to the workers that use them. One of the most dangerous tools used on the job is the chainsaw, not only is it dangerous to operate, but it is also very expensive and time-consuming to train workers on how to safely and efficiently use them. In order the alleviate these

obstacles when working with chainsaws, it will be necessary to implement a comfortable, lightweight saw, with the ability to incorporate automation into the design to maximize user safety and proved a cost-effective solution for end-users.

3.1.1 Needs/Benefits Not met by Current Products

Current products on the market are cumbersome, heavy, and typically not meant to be traveled with on foot over long distances. Although chainsaws are highly effective, they have a large learning curve for users and are potentially very dangerous when used incorrectly or by inexperienced people. The table below is an overview of the potential areas of improvement in chainsaw design.

Needs	Benefits
Comfort	• Reduced muscle fatigue and repetitive strain from constant vibrations. • Light weight and more ergonomic to carry long distances
Safety	• Eliminated risk of kickback and binding from saw. • Lower noise, reducing risk of hearing loss.
Efficiency	• High capacity battery with quick recharge times • Easy access for maintenance
Aesthetics	• High visibility for enhanced safety • Boost in confidence and overall positive mindset from using a modern stylized tool

3.1.2 Latent Needs

The fundamental human needs of trail builders were analyzed concerning the benefits of an improved chainsaw design. The overall needs and benefits were cross-referenced with Maslow's Hierarchy of Needs chart. (Figure.3.1)

Benefit	Fundamental Human Needs	Relationship with Benefit
Comfort	• Psychological, safety, esteem	• Strong
Safety	• Psychological, safety, esteem	• Strong
Efficiency	• Self-actualization, esteem, safety	• Strong
Aesthetics	• Esteem, belonging, safety	• Medium-Strong

3.4 Aesthetics

Trail building equipment has never officially been in a category of its own as the tools used for this occupation have largely been repurposed from other similar professions like construction, forestry, and carpentry. In terms of aesthetics, this type of equipment has gone without much change for many years, keeping a very basic and utilitarian visual design. It has only been recently that companies have started to give slightly more focus on the overall aesthetics of these types of products. Even with the improvements to the overall appearance, there are still many products like the chainsaw that keep the utilitarian designs and have little to no visual improvements. The main focus for styling comes from the safety aspects of the job

sites these products are often found in. The majority of colorways these tools have are in bright, easily visible colors like orange, yellow, white, and green with black accents. For the most part, these tools are used for very specific tasks and have little to no considerations to how the end-user feels about the styling and appearance, so long as it works and does what they need it to do.

3.5 Sustainability – Safety, Health, & Environment

Although there have been little to no advancements in sustainability in plastics for the production of chainsaws, there have been improvements in the technology used to power them. Battery power chainsaws are becoming more and more popular as the technology gets better; they are becoming more commonplace, economical, and environmentally friendly alternatives to gasoline-powered chainsaws. (Fig 1.2)

Figure 1.2 - Husqvarna 40-Volt lithium-ion battery. Retrieved from. https://www.husqvarna.com/ca-en/products/homeowner-battery-series/

According to Husquarvana (2020):

> The 36V Li-ion battery back provides equally high power, reliable operation and long lifetime as gas-powered products – without any direct emissions. Also, you get as much done on a single charge, as you would manage on one tank of gas. (Despite the lack of current sustainable material manufacturing for these products, there have been

> recent advancements in bio and eco-plastics which look incredibly promising for electric chainsaw applications. (p.1)

As mentioned previously, there are several promising areas in bio and eco-plastics, which could potentially replace the more traditional fossil fuel plastics. A prime example of some of these fossil fuel alternative plastics would be hemp filled polymers that are offered by The Hemp Plastic Company. These hemp-based alternatives are meant as a drop-in replacement for the commonly used fossil fuel-based plastics used in injection molding. These drop-in alternatives cover a wide range of materials like Propylene, Ethelene, ABS, and PLA. (The Hemp Plastic Company, 2020)

The reasoning for using environmentally friendly alternatives for plastic injection molding of chainsaw components would be the substantial increase in environmentally friendly production while maintaining a cost-effective baseline for the overall product. There would be virtually little to no cost difference from switching over to the more eco-friendly option while doing so would further solidify many of the companies' environmental initiatives.

3.6 Commercial Viability

There is a large potential for success in terms of commercial viability despite the fact that this area could be considred a nitch market. As mentioned previously manufacturing processes could take advantage of injection molding and environmentally friendly materials. However for initial startups and lower quantity production runs, advanced thermoforming techniques could be

utilites for various body panels. This would in turn keep initial startup costs at a minimum until product sales increase.

3.7 Design Brief

The primary objective of this thesis is to develop a product that improves the overall working conditions of trail builders. This product would be something to replace the current tools used in felling and trimming trees such as de-barkers and chainsaws. By replacing the currently used tools, it would enhance the overall quality of life for trail builders while incorporating full-body interaction and enhancing overall user experience.

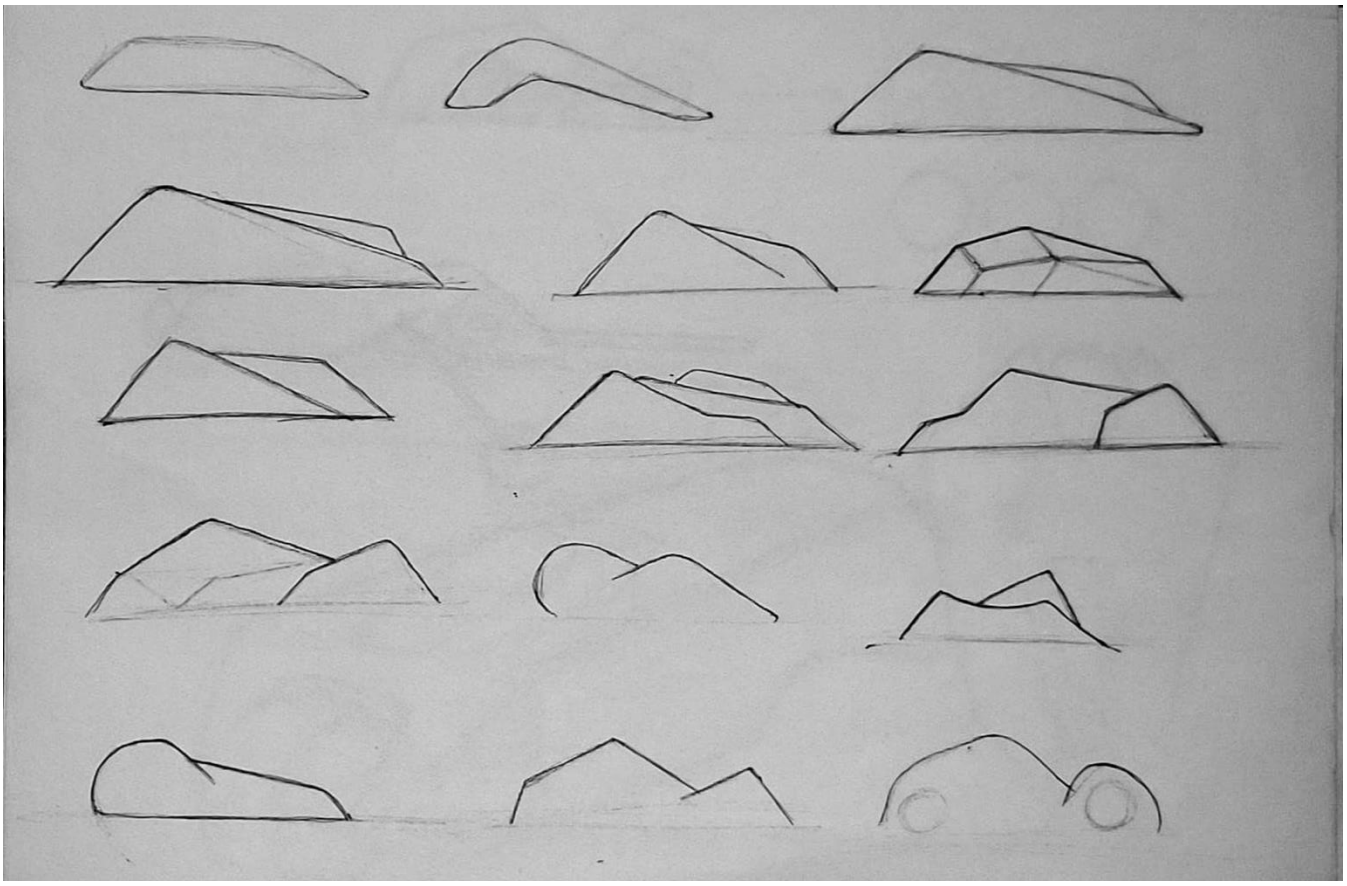
Key features for this product would be:

- Lightweight
- Portable
- Environmentally friendly
- Sustainable
- Modular and adaptable to work environment
- Cost-effective
- Interactive design utilizing current technologies
- Incorporating automation

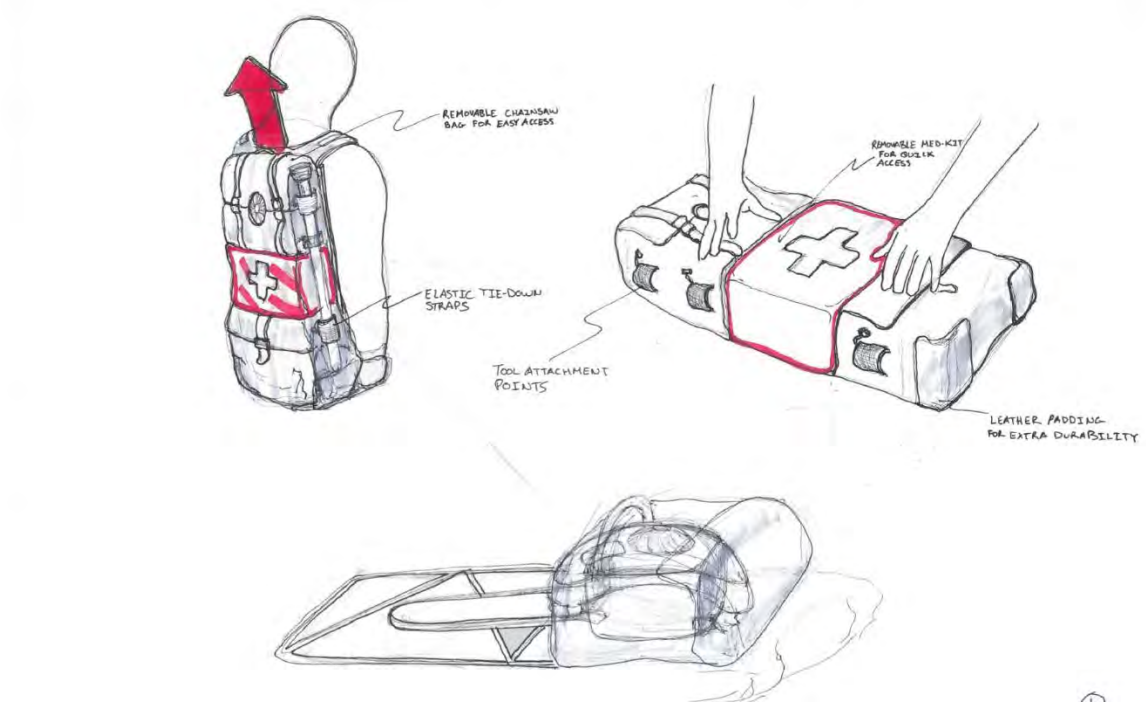
4 – Design Development

4.1 Ideation

4.2 Preliminary Concept Exploration

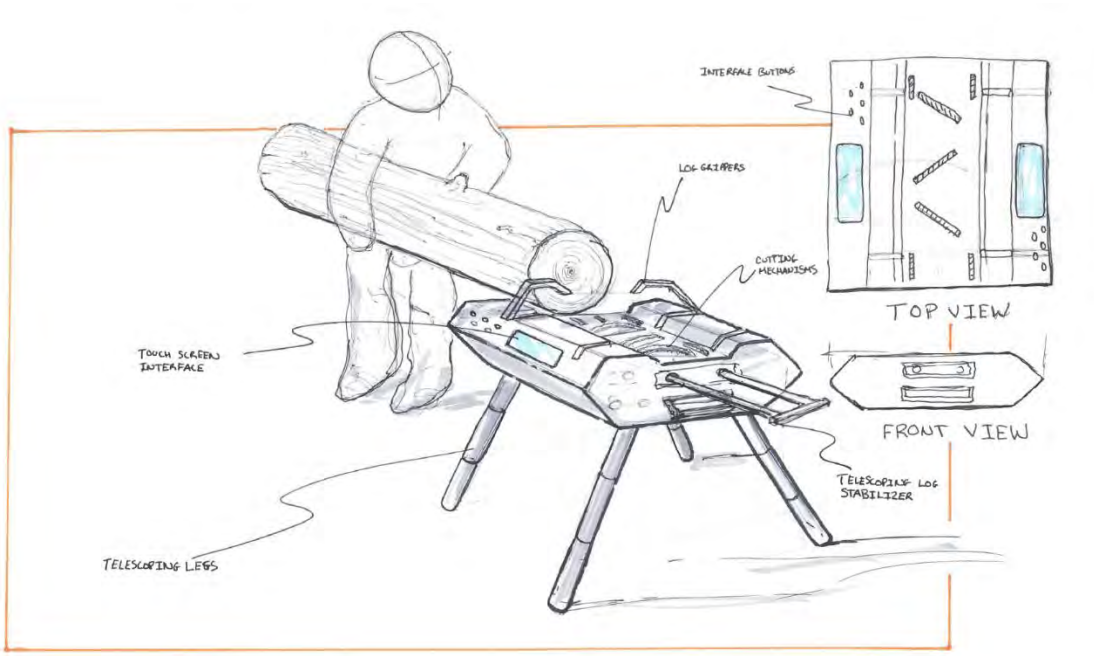


Concept 1 – Modular Chainsaw Backpack



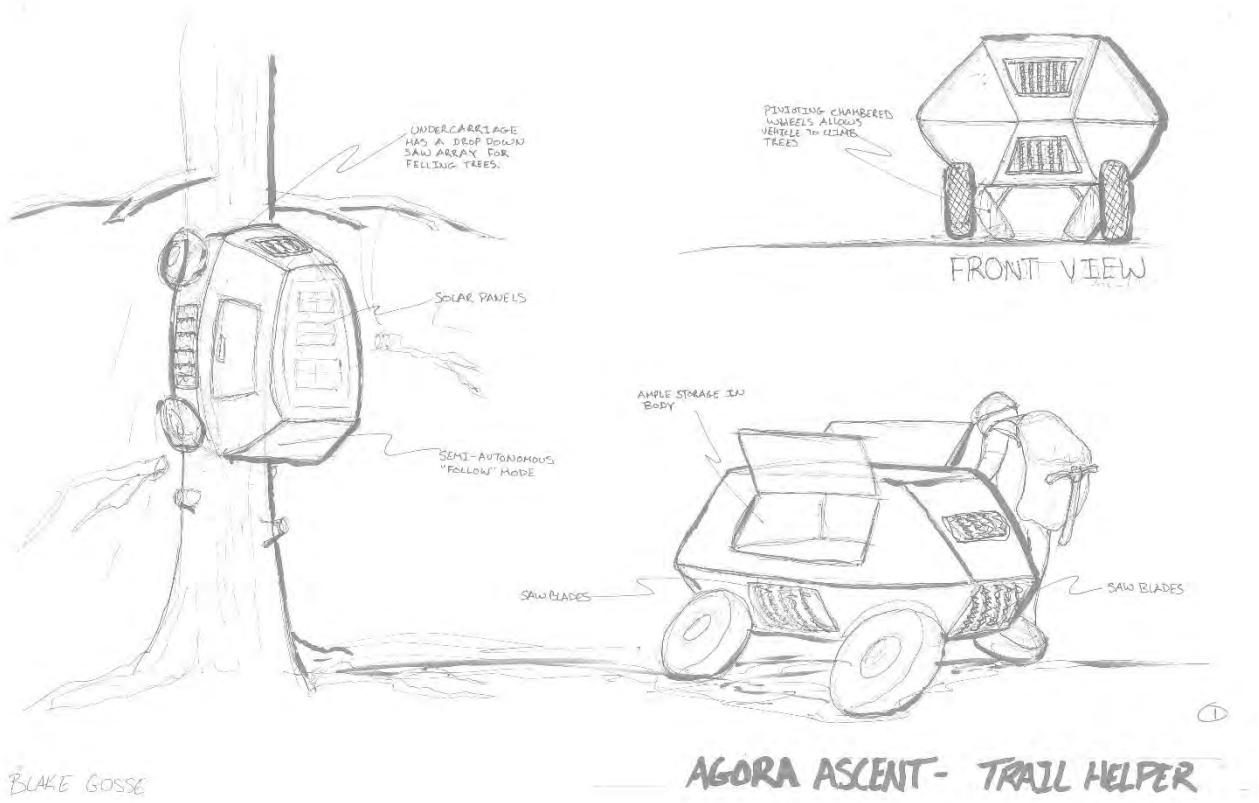
This concept allows the user to store all of the required tools for trail building. Heavier items are stored towards the lower portion of the back, which addresses user comfort which was a consideration taken into account from surveys and advisor feedback. This design also has opportunities for an integrated tool table frame built into the backpack frame.

Concept 2 – Modular Chainsaw Backpack



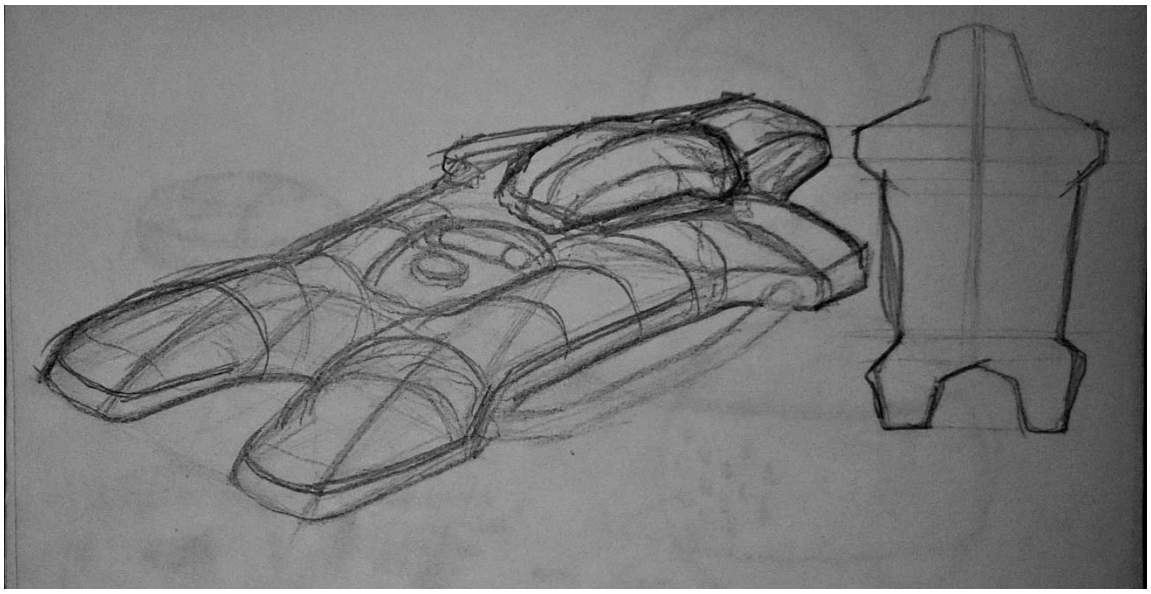
This concept allows the user to safely cut trees without having to be in direct contact with the tree itself. Automation is implemented when felling the tree, and the overall mill system is capable of creating planks from logs as well as adding finer details like cutting tread patterns and removing bark. The portable sawmill can be easily stored in a backpack and future stylings allow for an integrated carry/storage solution.

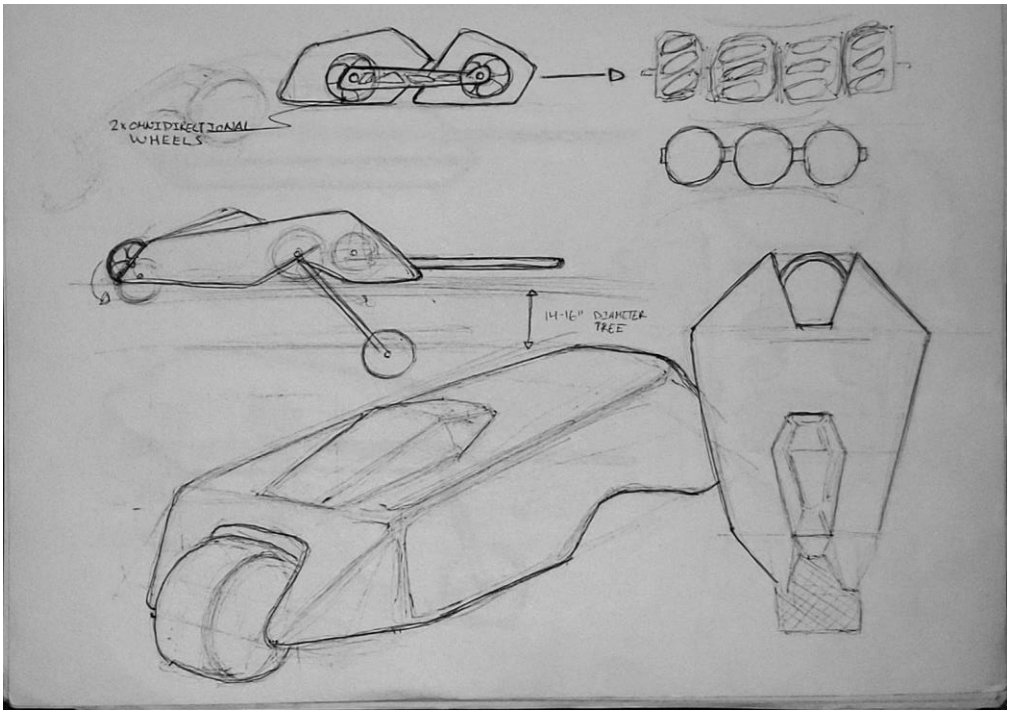
Concept 3 – Trail Helper



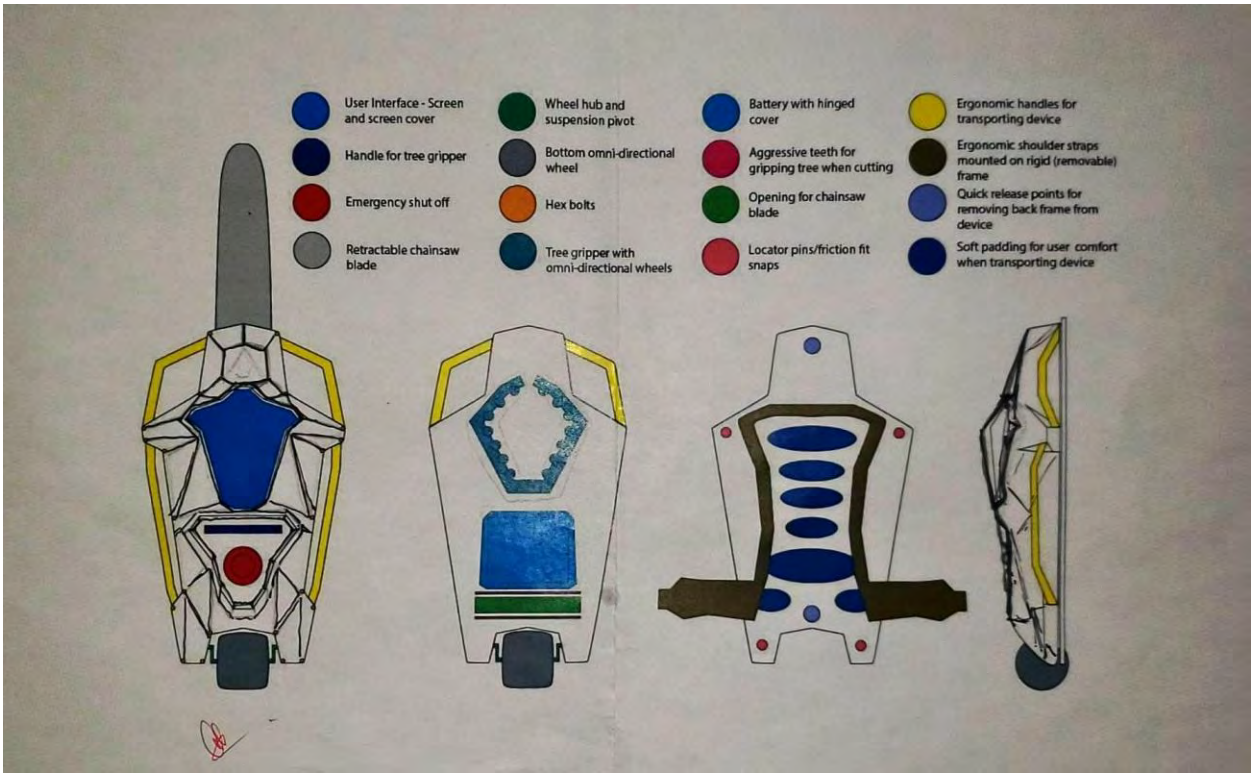
This concept helps the user transport heavy equipment and tools to the work site. In addition to this it aids in delimbing trees and reducing workplace hazards from falling debris.

4.3 Concept Refinemen

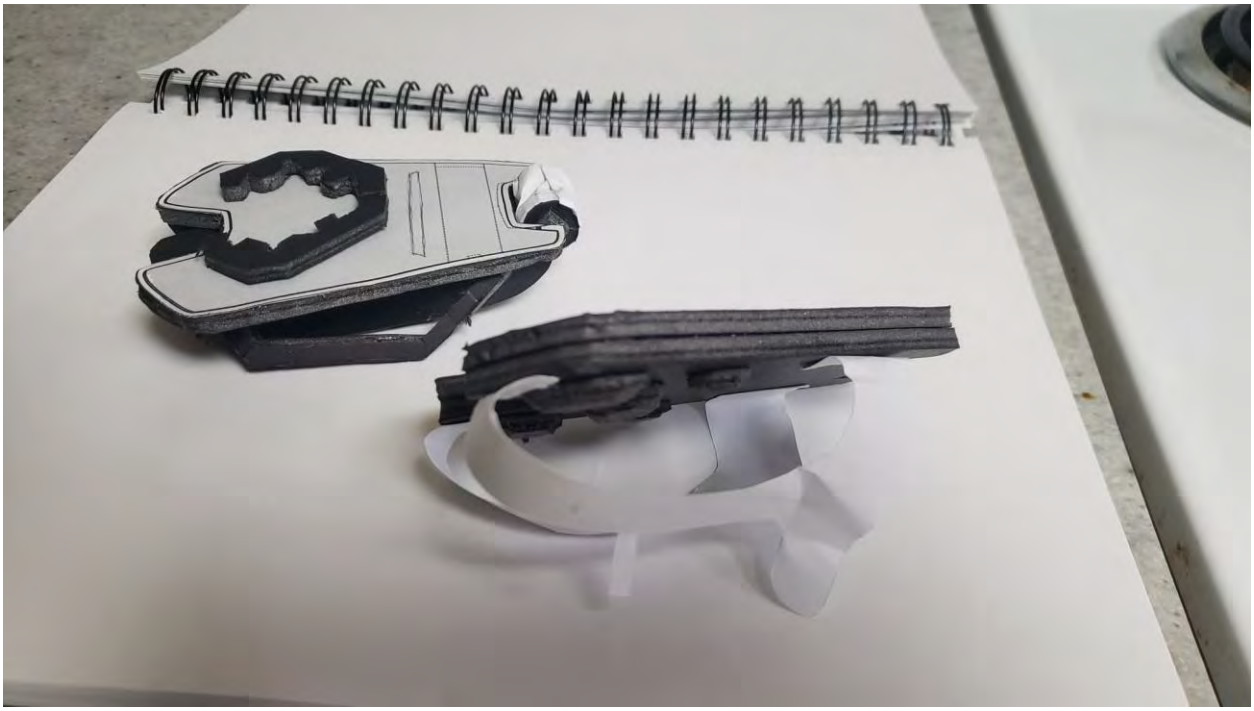


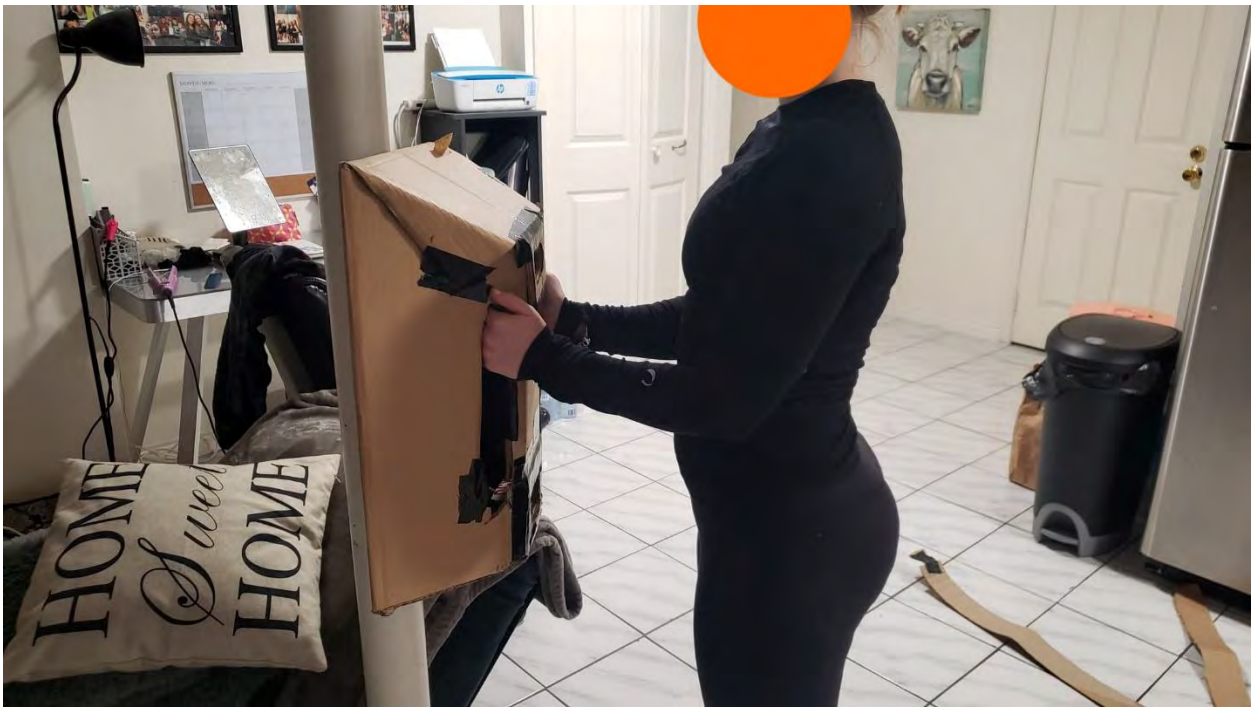


4.4 Detail Resolution



4.5 Sketch Models

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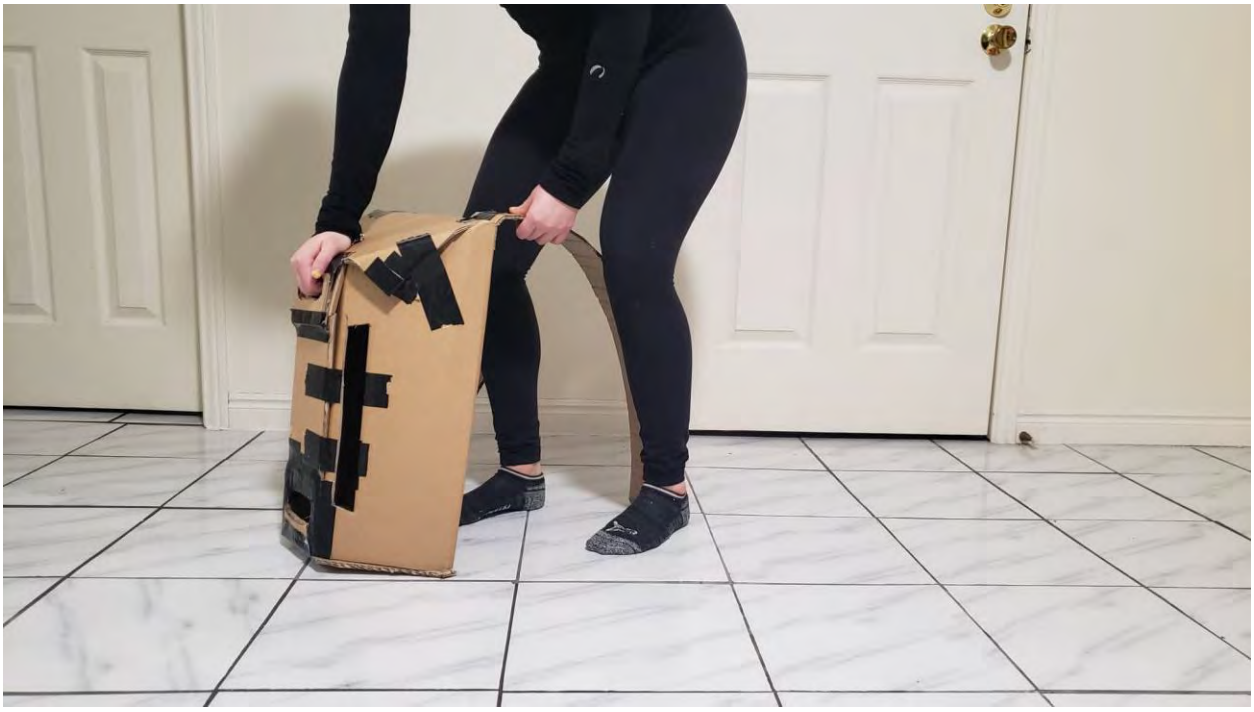
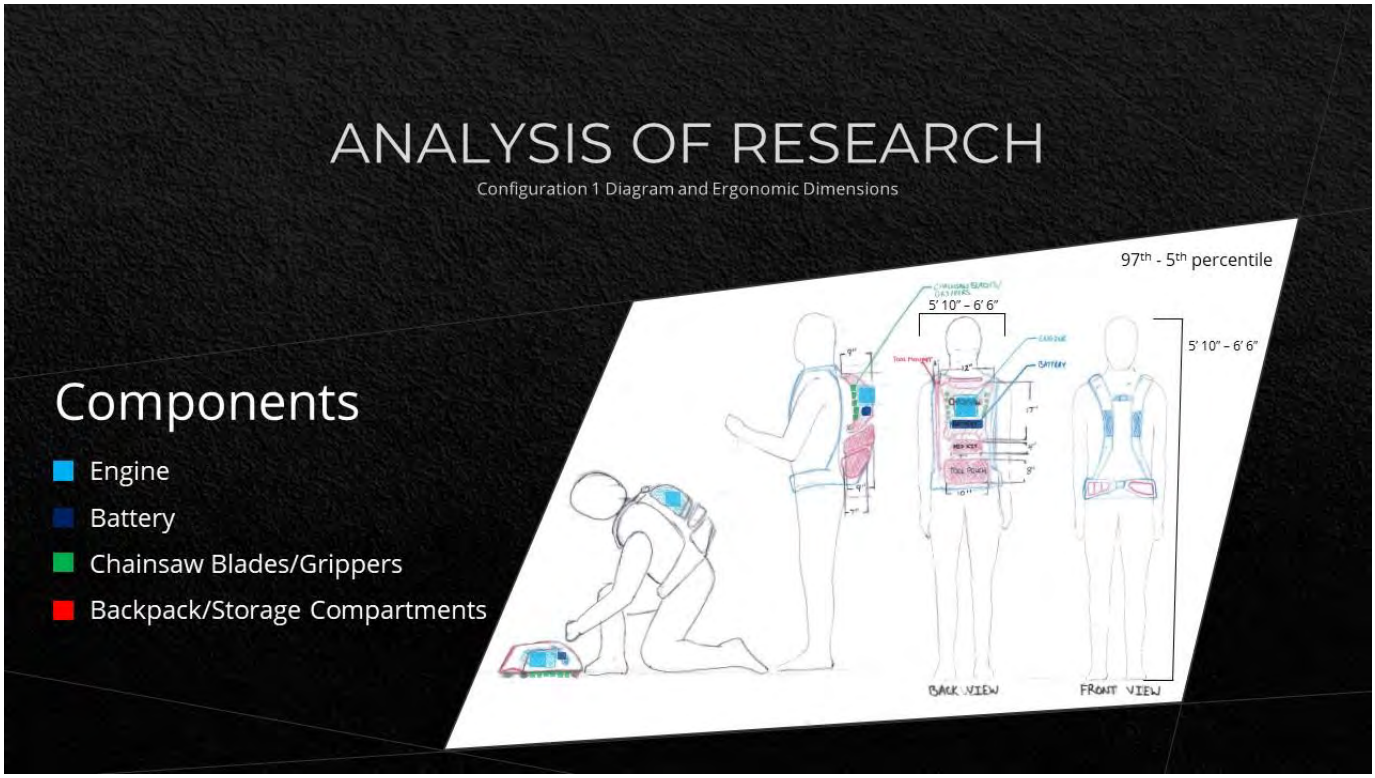
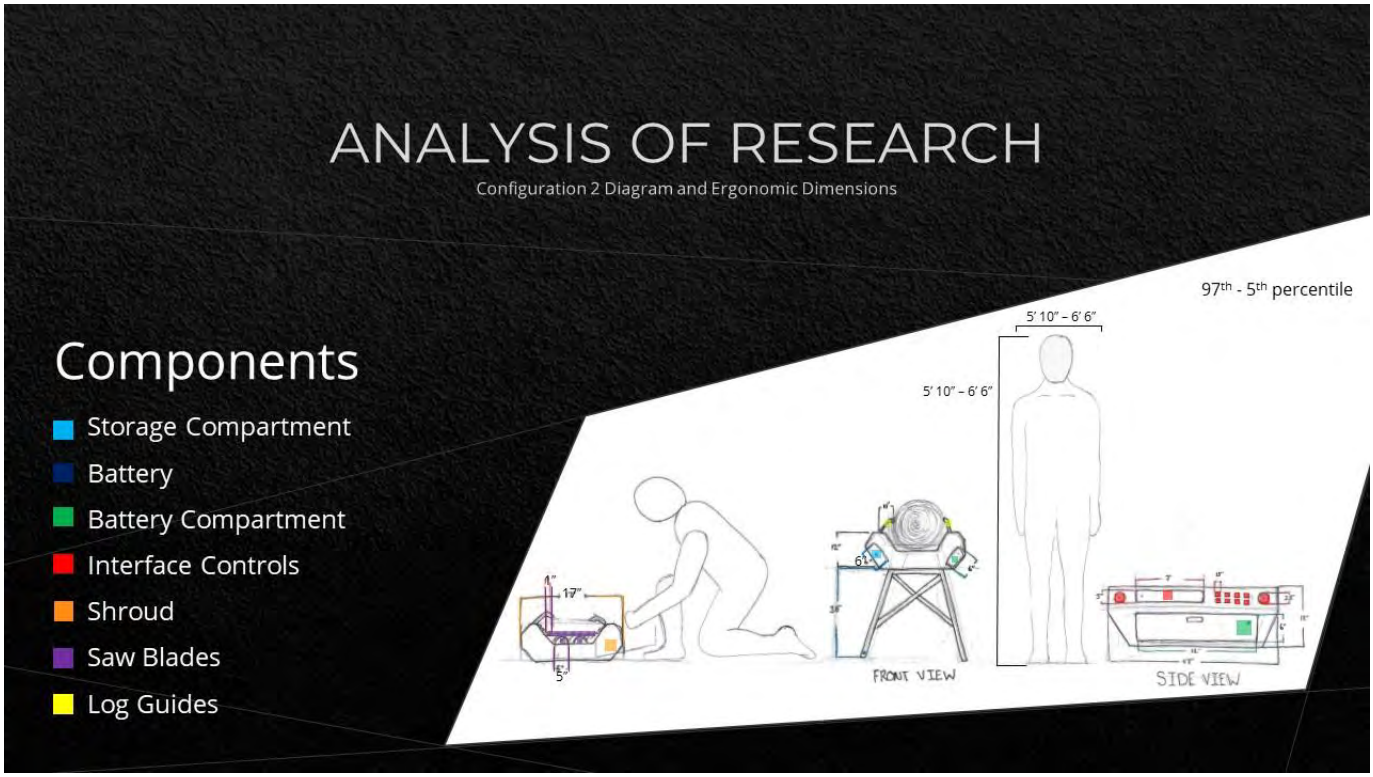
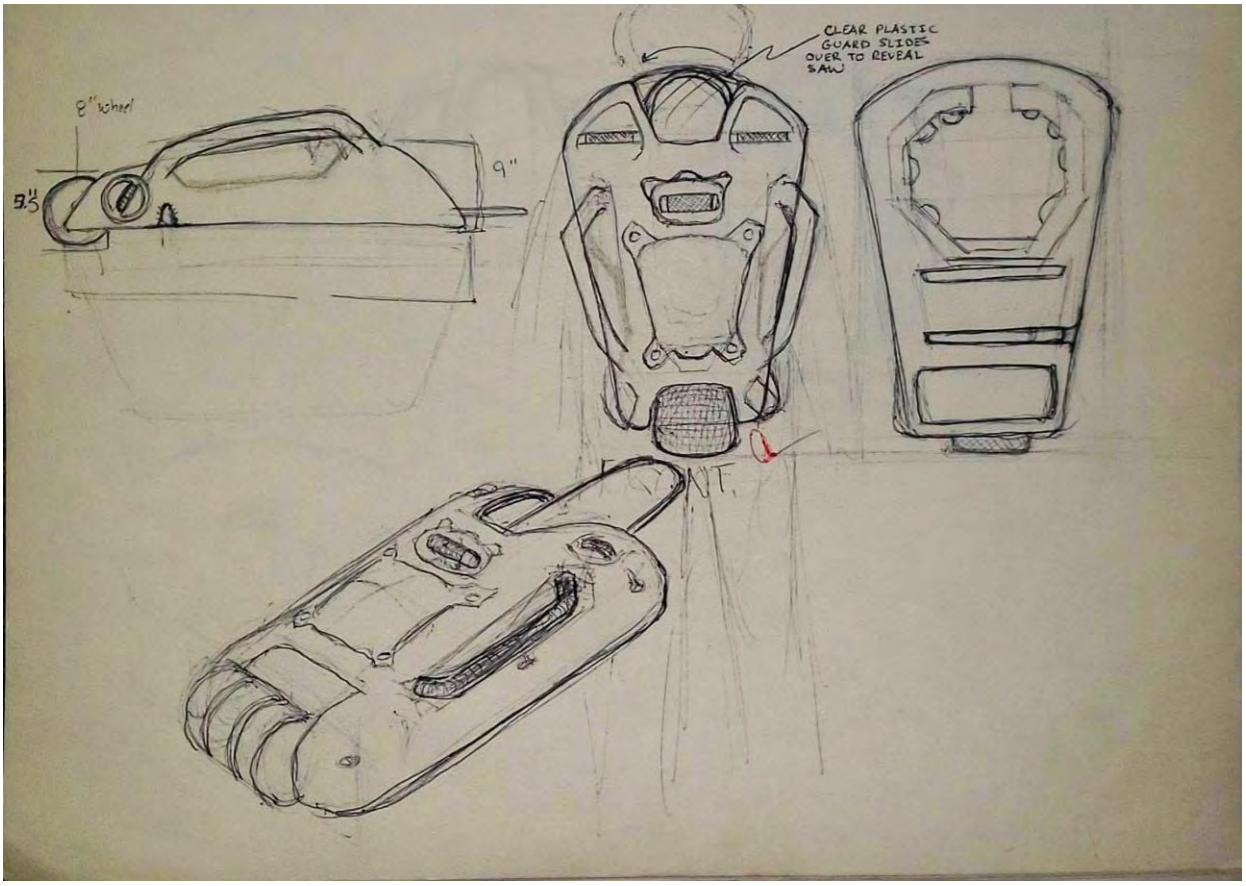


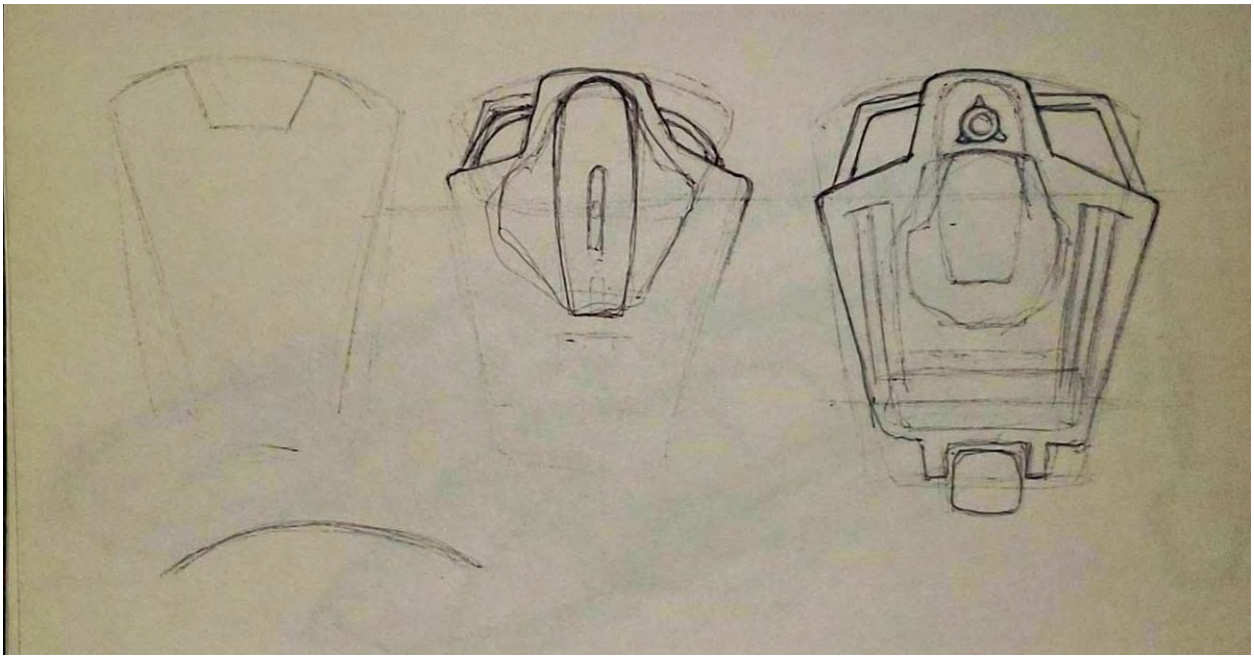
Configuration Diagrams



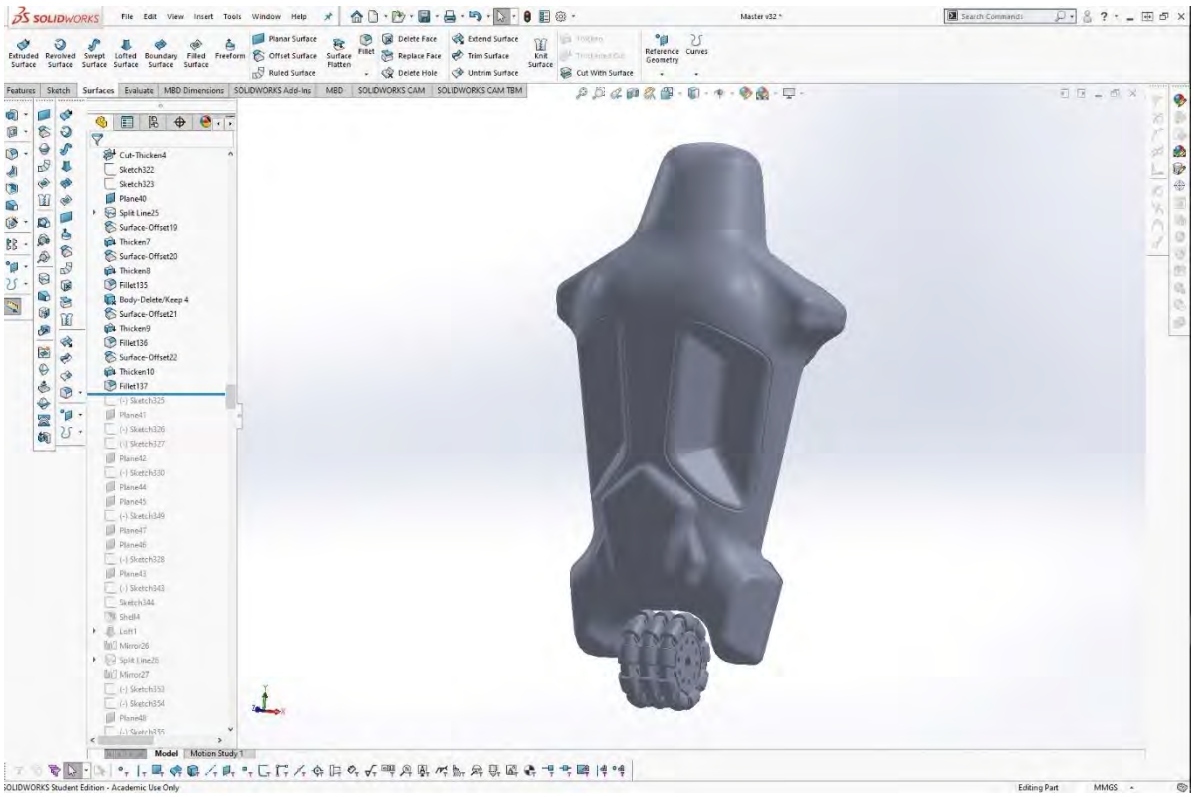


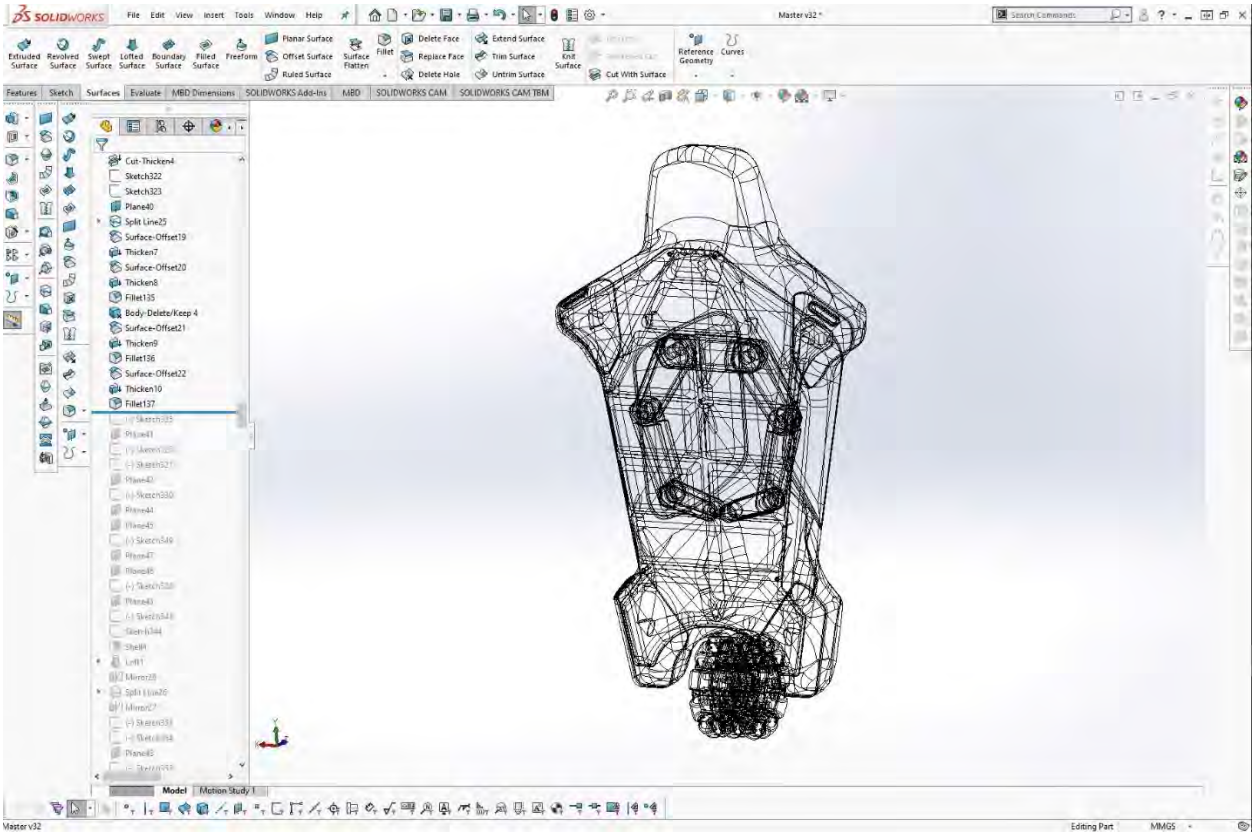
4.6 Final Design

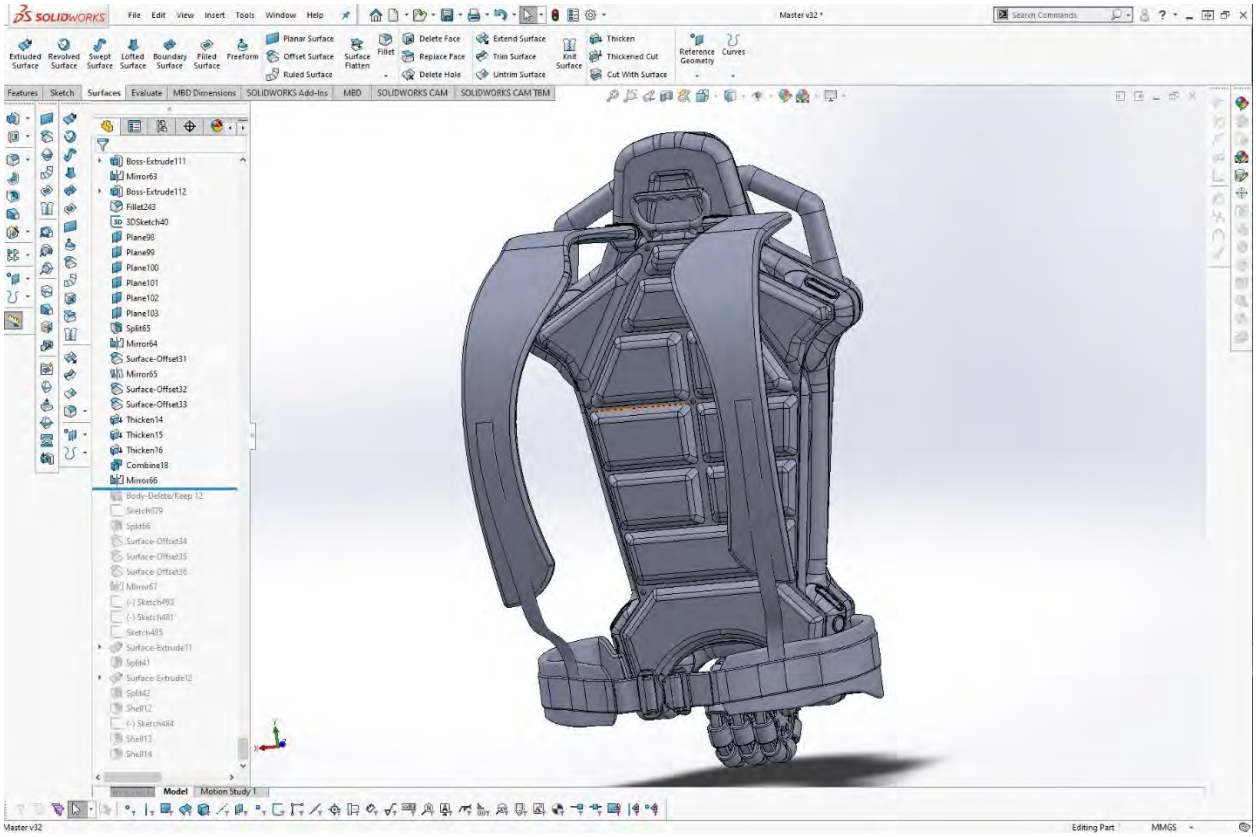




4.7 CAD Models



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Extend Surface
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Untrim Surface
Knit Surface
Thicken
Thickened Cut
Cut With Surface
Reference Geometry
Curves
Features Sketch Surfaces Evaluate MBD Dimensions SOLIDWORKS Add-Ins MBD SOLIDWORKS CAM SOLIDWORKS CAM TBM
Boss-Extrude111
Mirror63
Boss-Extrude112
Fillet243
3DSketch40
Plane98
Plane99
Plane100
Plane101
Plane102
Plane103
Split65
Mirror64
Surface-Offset31
Mirror65
Surface-Offset32
Surface-Offset33
Thicken14
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Thicken16
Combine18
Mirror66
Model
Motion Study 1
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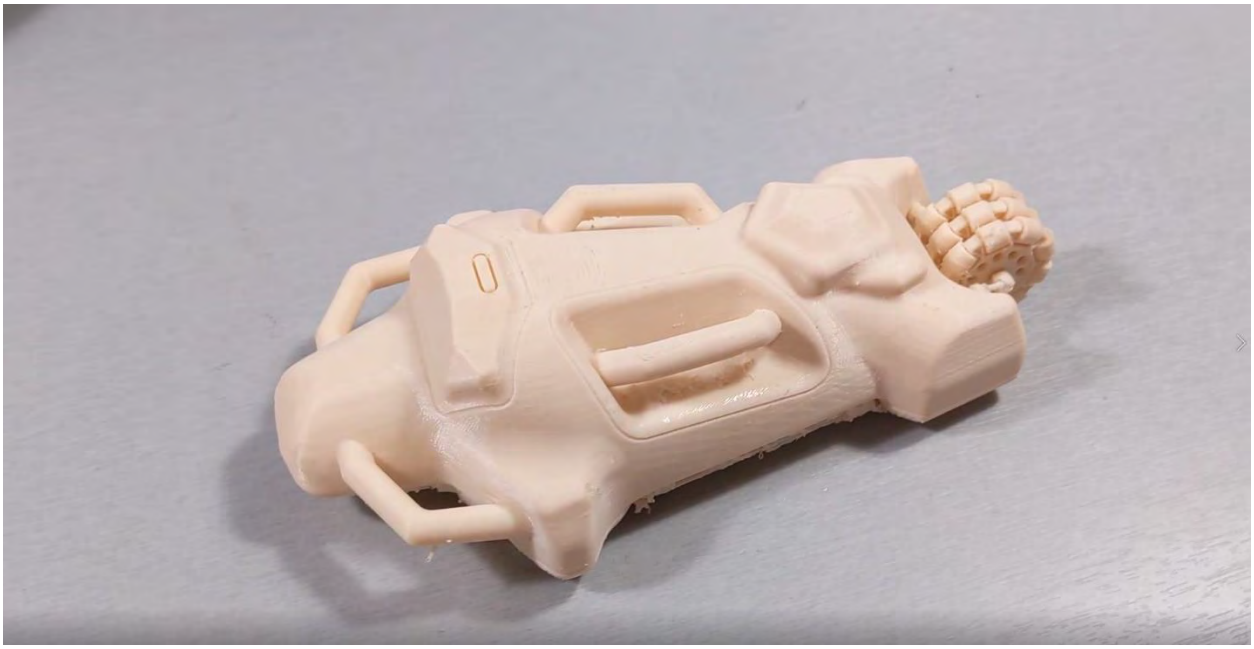
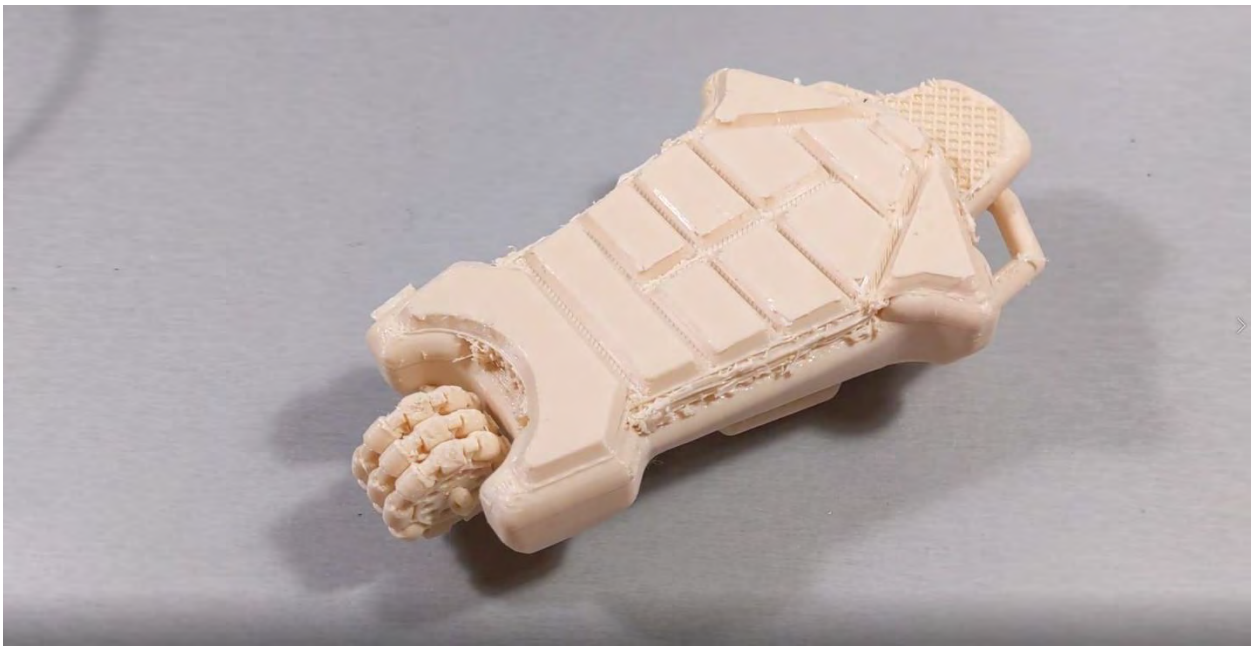
4.8 Hard Model Fabrication History





5 – Final Design

This chapter will give an overview of the data collected from the previous chapterts and showcase the final design results through model photos, ergonomics, material and manufacturing processes, technical drawings, and sustainability.

5.1 Summary

Description

Sago, is a unique solution for trail builders that helps them with their daily tasks on the jobsite. Through advancements in technology the Sago device greatly reduces occupational hazards that trail builders encure on an everyday basis like hazards from falling debris, repetitive strain injurie, and working in close proximity to cutting tools.

Explination

Sago takes inspiration from the invasive insect named the Sago Palm Weevil, as this beetle can quickly destroy trees bringing them to the ground. “Weevil larvae can excavate holes in the trunk of a palm trees up to a metre long”. (North American Plant Protection Organization, 2020)

Sago is a portable tree de-limbing devce that allows trail builders to work remotely from the tree being delimbed. This is possible through a unique clamp integrated into the device, in conjunction with omni-directional wheels. In additiona to this there is an integrated backpack system that allows the user to safely and comfortably transport the unit to the job site.

Through research conducted it showed that the distances traveled by trail builders can be very long and as through the need to carry heavy cumbersome tools it increases the chances of repetitive strains and accidential falls. In addition to this, the workers encounter falling hazards from debris caught up in tree branches. The only way for them to remove this debris is through standing in close proximity to the tree and physically cutting it down, or using a chainsaw on a pole to remove the branches. The current work pratices in place for conducting such tasks can be highly dangerous.

Benefit Statement

Sago allows users to remotely delimb a tree which enables them to stand at a safe distance from any subsequent fallout material. In addition to this, there are tremendous benefits in terms of repetitive strains and potentially life threatening injuries. The user is not required to directly interact with the device while it is operating, thus eliminating any possible repetitive strains from vibrations and interaction with the moving chainsaw blade. In addition to this, there is comfortable straps and back cushions integrated into the device that allows the user to safely transport the device, further eliminating any potential for injuries.

5.2 Design Criteria Met

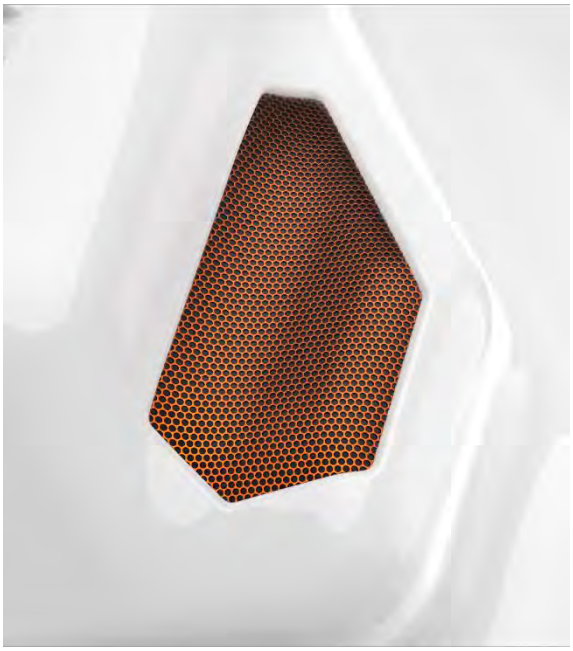
This section will discuss the design creteria and how it was achieved through the overall concept design.

5.2.1 Ergonomics

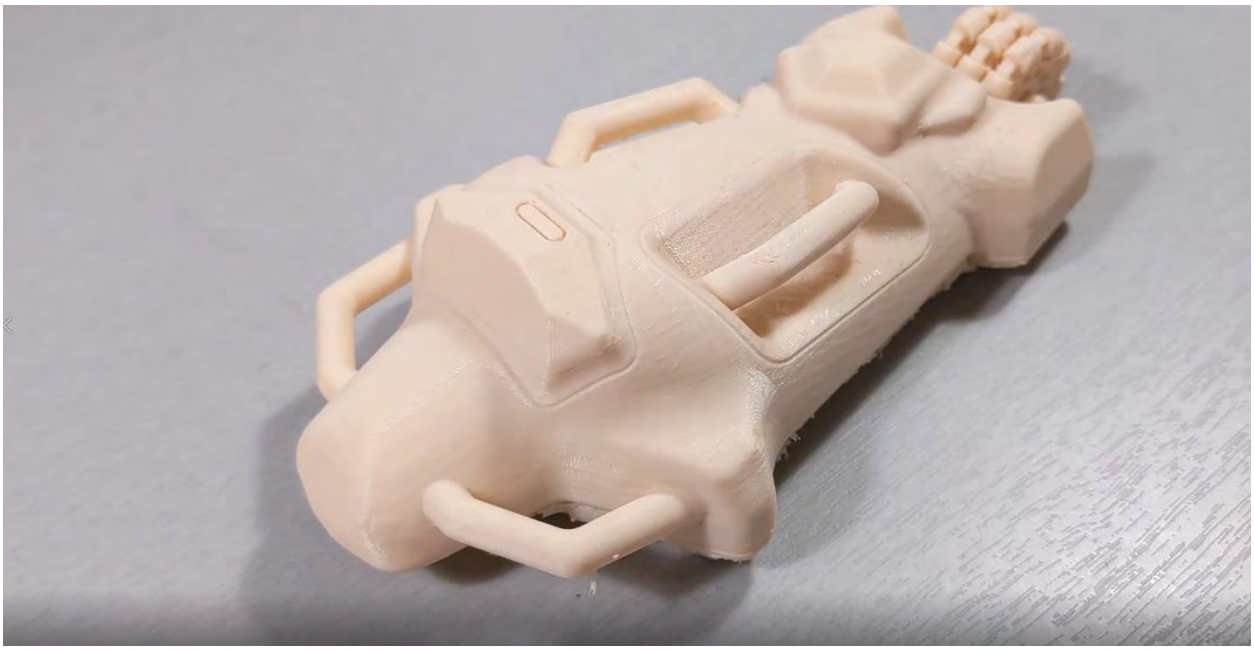
The Sago design takes body size considerations from the 5th percentile all the way to the 95th percentile. Ths is achievd through multiple grip points and and user adjustability and modulariaty for shoulder and waist straps. The display cover/power access panel is positioned in such a way to allow any potential debris to deflect off, and it hinges upward to shield the interface from the elements thus increasing user visibility.

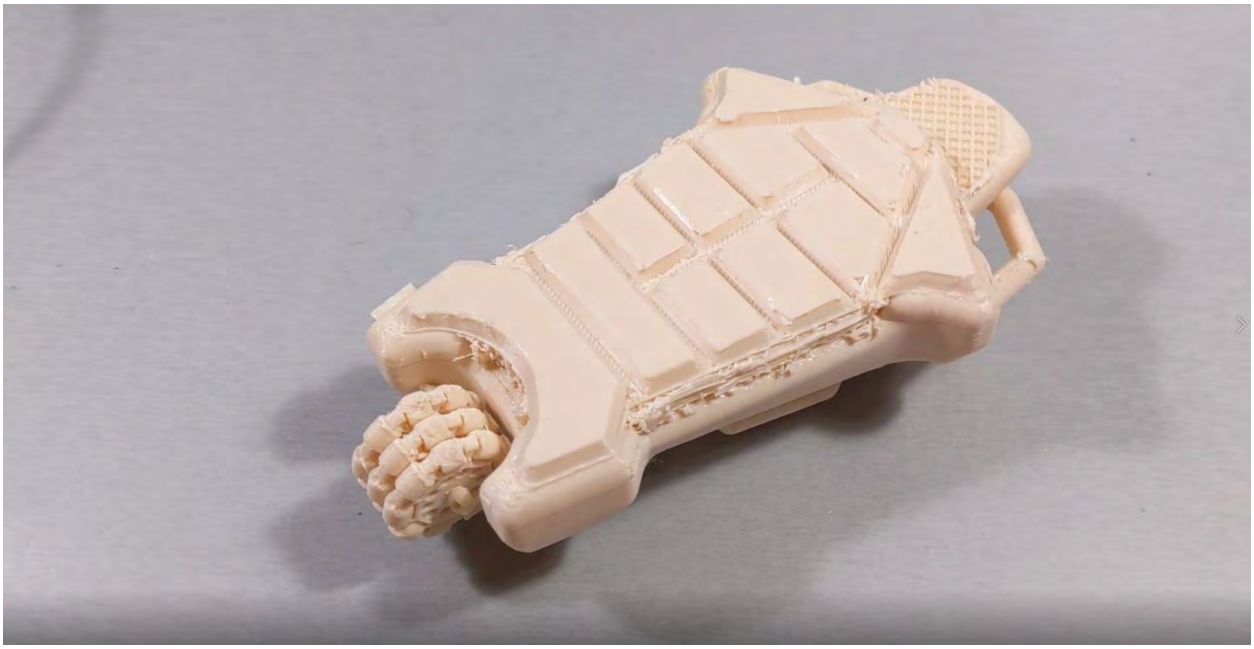
The buttons used to disengage the backpack frame from the device are large and easily accomidate a user wearing gloves. The button for the waist strap is also positioned in such a way that it would not be engaged by accident. There is also an optional telescoping handle with a large opening to accomidate work gloves, in addition to this there is a cutout behind this handle to further increase the opening for the users hand.

5.3 Final CAD Renderings

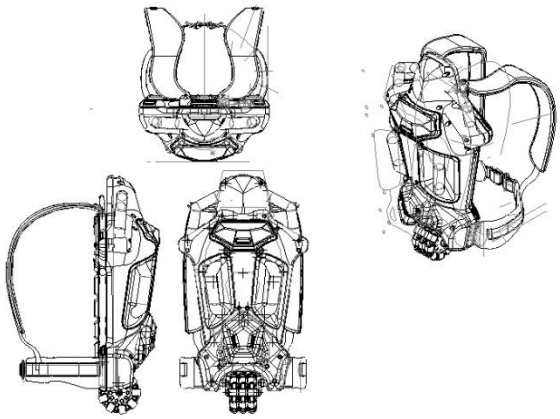


5.4 Hard Model Renderings





5.5 Technical Drawings



5.6 Sustainability

As mentioned previously, there are several promising areas in bio and eco-plastics, which could potentially replace the more traditional fossil fuel plastics. A prime example of some of these fossil fuel alternative plastics would be hemp filled polymers that are offered by The Hemp Plastic Company. These hemp-based alternatives are meant as a drop-in replacement for the commonly used fossil fuel-based plastics used in injection molding. These drop-in alternatives

cover a wide range of materials like Propylene, Ethelene, ABS, and PLA. (The Hemp Plastic Company, 2020)

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There is a large potential for success in terms of commercial viability despite the fact that this area could be considred a nitch market. As mentioned previously manufacturing processes could take advantage of injection molding and environmentally friendly materials. However for initial startups and lower quantity production runs, advanced thermoforming techniques could be

utilites for various body panels. This would in turn keep initial startup costs at a minimum until product sales increase.

6 – Conclusion

Overall I am pretty amazed at what I managed to achieve given I had to pack up and move everything I owned for the last four years due to the circumstances of the COVID-19 outbreak and the subsequental pandemic. There are definitely things I would fix when returning to this to polish it for my portfolio. I was very much like to do some exploded view videos and address the issues I encoutnred with trying to separate the various body panels on the shell of the device. Due to time restraints I wasn't able to cut these panels in to the pieces I wanted that would have showcased the manufacturing process. I believe there would be a very high visual impact if I could show this in renders and exploded views. Overall I am happy with what I achieved and I look forward to what the future may bring.

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Unknown (2020). Husqvarna 40-Volt lithium-ion battery. Husqvarna 40-Volt lithium-ion battery. Retrieved from. https://www.husqvarna.com/ca-en/products/homeowner-battery-series/

Tables

Table 2.7

Level of income for laborers and helpers (Source: Bureau of Labor Statistics, 2019).

Quick Facts: Construction Laborers and Helpers	
2018 Median Pay	$34,810 per year $16.74 per hour
Typical Entry-Level Education	See How to Become One
Work Experience in a Related Occupation	None
On-the-job Training	Short-term on-the-job training
Number of Jobs, 2018	1,645,700
Job Outlook, 2018-28	11% (Much faster than average)
Employment Change, 2018-28	173,400

Note: Income statistics on Construction Laborers and Helps, retrieved from the Bureau of Labor Statistics (2019).

Figures

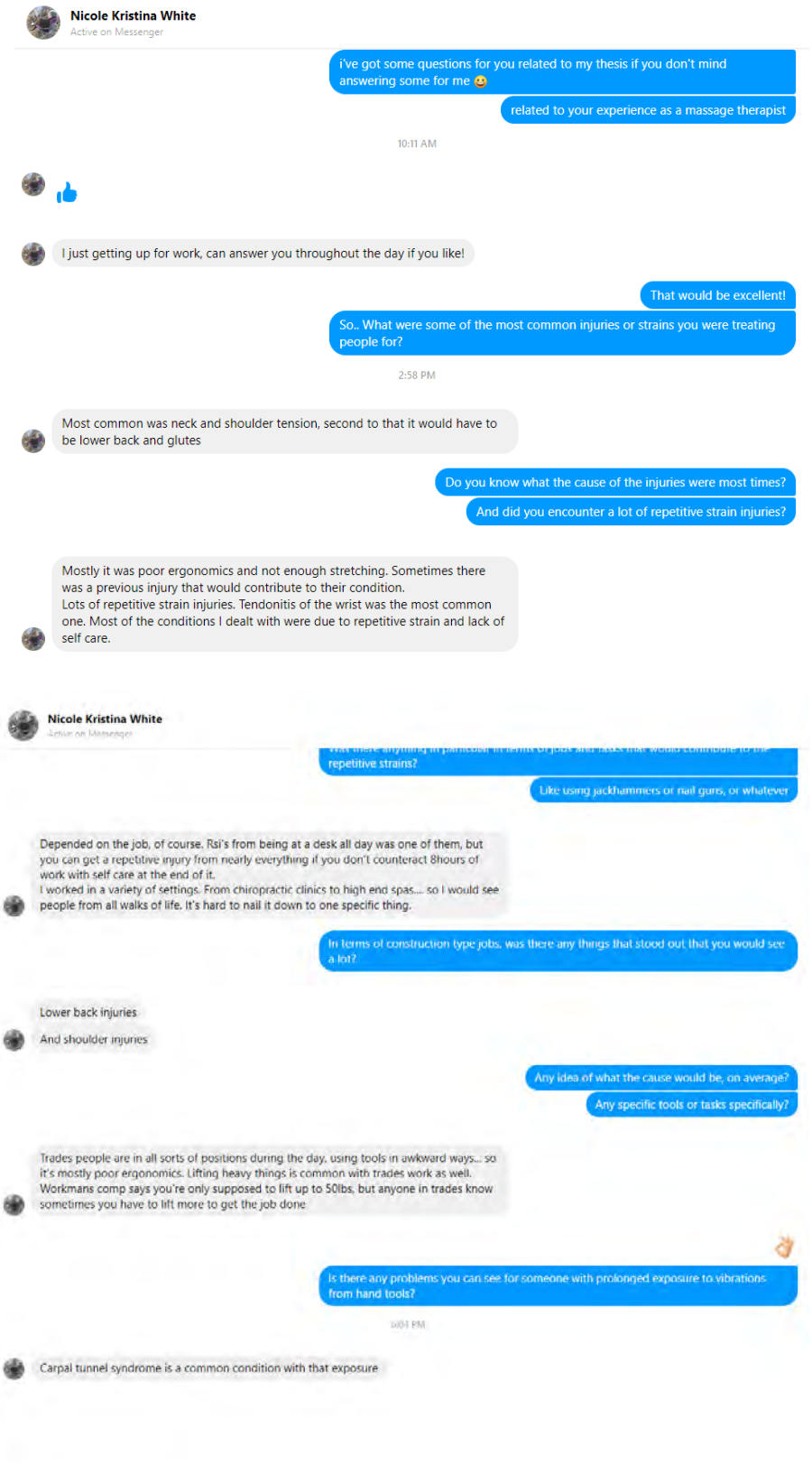
Figure 3.1. Maslow's Hierachy of Needs chart. Retrieved from. https://cloverbites.com/2019/06/05/organizational-values-that-employees-really-seek-career-community-cause/

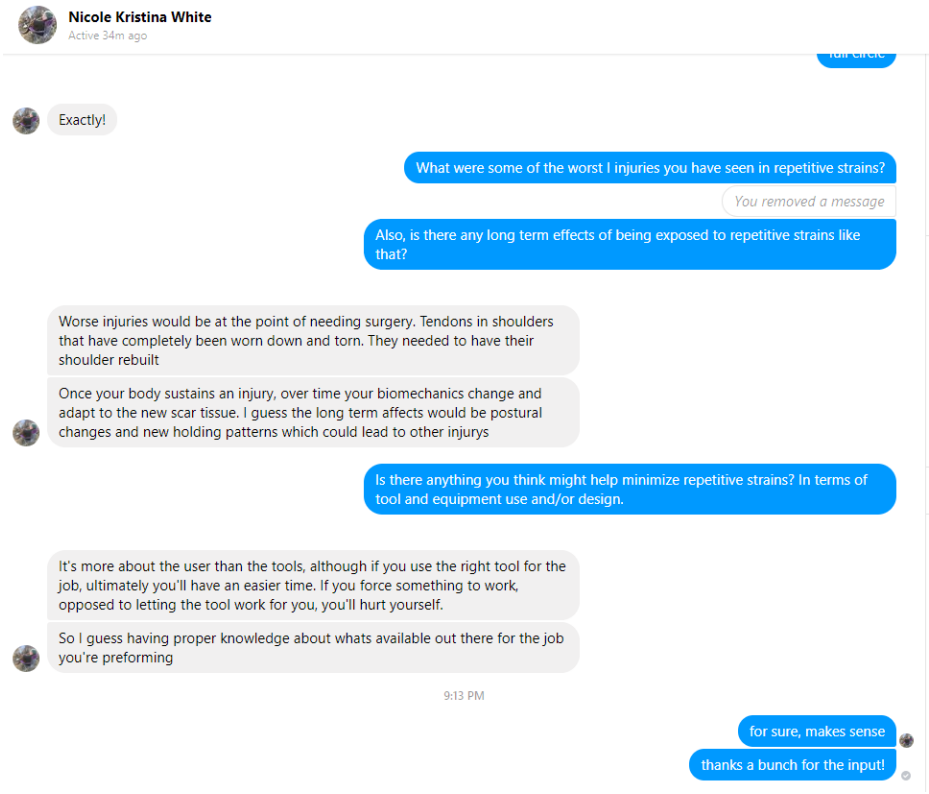
Appendices

Appendix i – Discovery

Expert Interviews

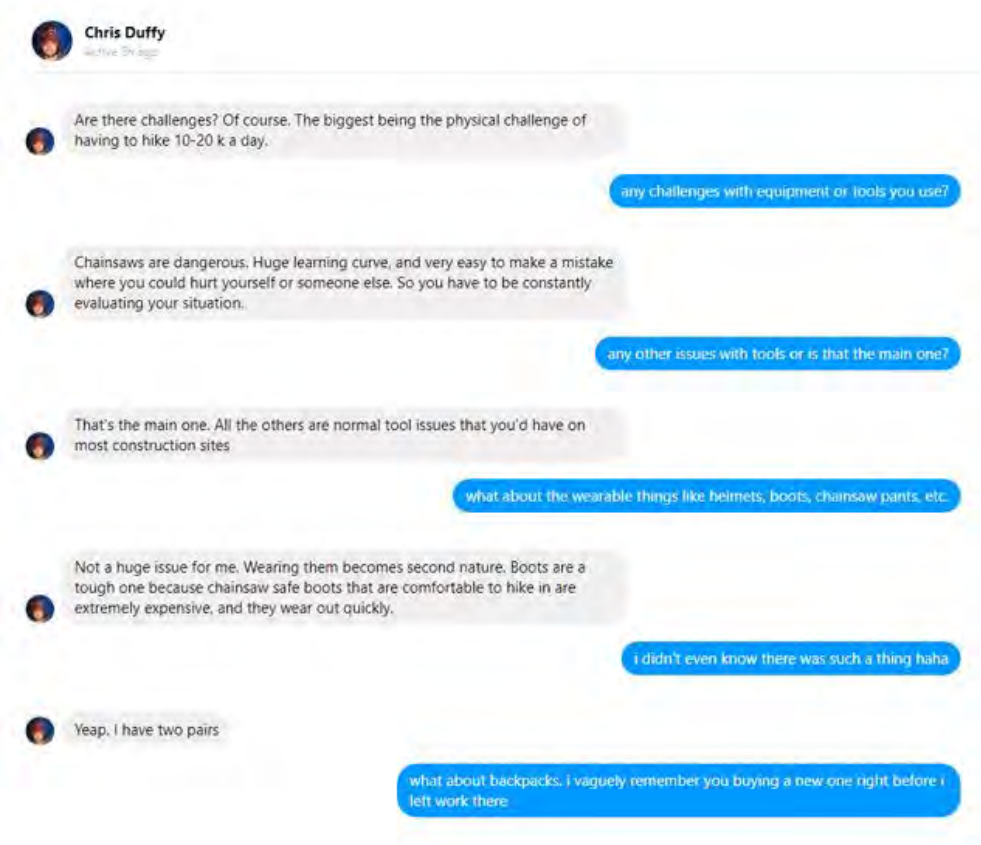
Nicole White – Physiotherapist





Expert Interviews

Chris Duffy – Trail Crew Supervisor



Chris Duffy
Active 3h ago

I bought another one since then. I rotate back and forth between the two depending on what size I need. I bought the 35l pack when you were here and bought a 55l later

I mostly use the 35 though

any issues with those?

in terms of using them at work

Nope

you mentioned how hiking long distances was a physical challenge, is there anything you'd do to try to make it easier?

https://www.google.com/search?q=haix+protector+prime+Orange&client=ms-unknown&prmd=sivn&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjtspqZj97kAhURr54KHVoPCIwQ_AUoAnoECA0QAg&biw=455&bih=782

haix protector prime Orange - Google Search

google.com

i literally just went to the haix website right before you posted that lol

I've been rotating through 4 different pairs of boots for hiking. That allows them time to dry properly and reduces chafing on your feet. I've also been using body glide to help with chafing as well.

Starting in decent shape is important as well. Fortunately when you hike everyday for work, you're getting paid to stay in shape

i forgot about that body glide stuff, i used to use that for running all the time

alright, that's all i've got for now... hopefully i can narrow something down soon hah

Haha right on

Chris Duffy
Active 3h ago

is Ed still working there? How's he doing now?

SEP 16, 2019, 8:16 AM

Yeah, he's still there. He seems to be good. Not a whole lot of change in him

SEP 16, 2019, 8:05 AM

That's good

SEP 19, 2019, 7:15 PM

hey, i've gotta couple informal questions about trail building for you if you don't mind answering them... i'm still in the process of choosing between two different thesis topics

Sure

are there any challenges you face on the trail in a typical work day?

if so, what are they

this is assuming you're doing trail building type stuff too btw : P

I don't do much actual work on the trail anymore. I'm doing more planning these days.

yeah i figured

but when you did do trail building

Q1

Can you tell me your name, age, location and briefly describe what it is you do and what a typical workday is like for you.

My name is Brett, I am 29 years old and I live in northern Saskatchewan.

Q2

What kind of work schedule do you have, do you work all year round?

As far as trail building goes it's usually only a couple of weeks in the late summer or early fall

Q3

What kind of special training have you had for this job? Can you explain in detail what that training was?

No special training just experience and knowledge of the tools I use

Q4

What are the different types of tools, equipment, and field gear you use? (for example: backpacks, shovels, saws, helmets, etc)

Atv, backpack, chainsaw, small hand saws, axe, whipper snipper and a pull behind roughcut mower.

Q5

What are some of the biggest obstacles you have with the work you do?

When I want to build a new trail on my trap line it is in a provincial park so I have to get special permits from the government to build a new trail. I can clear existing trails with out a permit.

Q6

Has there ever been a time when you were injured or encountered an injury at work? If so, what happened?

Just small cuts and scrapes nothing major.

Q7

What is your favorite and/or least favorite thing about the work you do?

It gets me outside in the deep forest I get to enjoy the beauty of fall. All the smells, Colors and sounds. The least favourite thing is that it's hard work and time consuming.

Q8

You mentioned obstacles you have to work with, is there anything you would change about the tools or equipment you use to help you with those obstacles?

If I had to choose a tool upgrade. They are really expensive but I would love to get a skid steer with a mulcher attachment.

Q9

Is there anything you encounter at work that makes you uncomfortable or uneasy?

No not really. But sometimes you are alone a long ways from anyone with no cell service and running a chain saw. There is a possibility of getting hurt badly and no one to help.

Q10

In an ideal scenario, what tools, equipment, or field gear options would you like to have?

Heavy equipment, a bulldozer.

Q1

Can you tell me your name, age, location and briefly describe what it is you do and what a typical workday is like for you.

I work for trailcrew at Pukaskwa National Park. We maintain the entire backcountry which is approximately 100 km of hiking trails and many campsites. Each day we take a boat and travel to a different section of the trail and run a trail sweep. We've also built several bridges. All of which the material is carried by hand. We've also built a whole new trail, Madabii Mikana.

Q2

What kind of work schedule do you have, do you work all year round?

Summer seasonal position- April to end of August. 8-430 Monday to Friday

Q3

What kind of special training have you had for this job? Can you explain in detail what that training was?

Chainsaw courses- the first year I completed basic chainsaw training. Then also learned special felling techniques. I also completed Advanced Wilderness First Responder training.

Q4

What are the different types of tools, equipment, and field gear you use? (for example: backpacks, shovels, saws, helmets, etc)

Backpack, helmet, chainsaw, polaski, extra bar and chain, first aid kit. When building bridges we had all battery powered tools, desalt drills, impacts, Makita rock drill.

Q5

What are some of the biggest obstacles you have with the work you do?

It's physically exhausting work- especially when hauling the wood for the bridges, by the end of the day you're body is so physically exhausted you cant do any work at home. Also working in the backcountry, there is no cell services. You rely completely on radios that often don't work. If there was ever an injury there's no first responders. Your crew and the boat operator are responsible for getting that person out.

Q6

Has there ever been a time when you were injured or encountered an injury at work? If so, what happened?

In a rush to get off the boat to meet a helicopter I hit my head off a latch on the boat. I didn't realize anything was wrong at first until someone else noticed I was completely drenched in blood. The boat driver took me back to the campground. And I had a severe concussion and needed 5 stitches.

Q7

What is your favorite and/or least favorite thing about the work you do?

Favourite is being out in the bush everyday and being out on the water. The entire back country is beautiful and I feel so proud of the work I get to do. Worst part is the bugs. For about 3 months of the summer they are insatiable.

Q8

You mentioned obstacles you have to work with, is there anything you would change about the tools or equipment you use to help you with those obstacles?

We have top of the line tools however longer lasting batteries for our power tools would be beneficial. Since we have to carry all of our gear into and out of a worksite having an entire backpack just of batteries so we can get the work done is annoying. We were using 60volt dewalt battery packs each costing several hundred dollars and they didn't last very long for the work we were doing.

Q9

Is there anything you encounter at work that makes you uncomfortable or uneasy?

Being the only female working in an all male crew definitely had its difficulties. My first season I was definitely looked at differently and treated differently. I had to prove myself. The following seasons did not have this problem

Q10

In an ideal scenario, what tools, equipment, or field gear options would you like to have?

Ideally, I would like to have a fully equipped first aid kit with a way to treat heavy bleeding or limb loss. Also lighter tools, in general.

Q1

Can you tell me your name, age, location and briefly describe what it is you do and what a typical workday is like for you.

My job is to perform trail maintenance, which includes brushing and clearing trail but also building up trail infrastructure like bridges and stairs, etc. A typical workday involves a meeting to establish a plan for the day, then heading out on a boat to the section of trail we will be working on. Once the job or day is done, we radio to be picked up.

Q2

What kind of work schedule do you have, do you work all year round?

I work 5 Mon-Fri 8-430 from May til the fall

Q3

What kind of special training have you had for this job? Can you explain in detail what that training was?

I haven't really had any special training other than chainsaw training

Q4

What are the different types of tools, equipment, and field gear you use? (for example: backpacks, shovels, saws, helmets, etc)

Backpacks helmets shovels chainsaws hammers drills Pulaskis ladders hiking boots work pants radios maps and gps

Q5

What are some of the biggest obstacles you have with the work you do?

Weather is the biggest issue. On days that the lake is bad or if it's rainy/stormy we won't go out on the trail. Fitness can also be a barrier.

Q6

Has there ever been a time when you were injured or encountered an injury at work? If so, what happened?

The only injury I've encountered was a rolled ankle. Luckily it was near the end of the trail section for the day so it wasn't a big deal

Q7

What is your favorite and/or least favorite thing about the work you do?

My favorite part of my job is being outside and doing physical work. My least favorite part is doing unnecessarily long or arduous sections of trail in one shot.

Q8

You mentioned obstacles you have to work with, is there anything you would change about the tools or equipment you use to help you with those obstacles?

It would be a huge help if chainsaws were lighter, and batteries for drills/saws lasted longer. Drills running out of batteries is a constant problem.

Q9

Is there anything you encounter at work that makes you uncomfortable or uneasy?

Sometimes the rough lake conditions can make me uneasy

Q10

In an ideal scenario, what tools, equipment, or field gear options would you like to have?

Better and lighter drills and chainsaws, helmets that weren't just normal construction helmets with earmuffs,

Q1

Can you tell me your name, age, location and briefly describe what it is you do and what a typical workday is like for you.

Chris Duffy. 37. St. John's, Newfoundland, Canada. I am the Assistant Trail Manager for the East Coast Trail Association. I help plan and prepare the work season by assessing worksites along the trail and figuring out the structures needed to protect the ground from erosion. I don't have a typical work day. I usually have to be prepared to go anywhere and do anything.

Q2

What kind of work schedule do you have, do you work all year round?

This is a new position that is all year round, but in the past I'd normally work from April to November/December, Monday to Friday, 40 hours a week.

Q3

What kind of special training have you had for this job? Can you explain in detail what that training was?

Chainsaw training. How to safely use a chainsaw in a professional environment. Safe felling of trees, bucking, and hazardous tree assessment. How to build structures with a chainsaw, ripping logs to make steps and boardwalk. Also maintenance of saws.

Q4

What are the different types of tools, equipment, and field gear you use? (for example: backpacks, shovels, saws, helmets, etc)

Backpacks, chainsaws, Sledge hammers, digging bars, drills, grinders, rock nets, picks, shovels, hard hats, chainsaw chaps

Q5

What are some of the biggest obstacles you have with the work you do?

Keeping employees and getting material to remote locations.

Q6

Has there ever been a time when you were injured or encountered an injury at work? If so, what happened?

I injured my back setting up the Depot and was off for two months. And I also twisted my ankle hiking to a job site and sprained it and missed a few days from that.

Q7

What is your favorite and/or least favorite thing about the work you do?

Being outside on the coastline, watching whales, seabirds, and ice begs. Running a chainsaw and building structures, even though I don't do that much anymore.

Q8

You mentioned obstacles you have to work with, is there anything you would change about the tools or equipment you use to help you with those obstacles?

We've recently started using helicopters to move material into remote locations, couldn't get anything easier really.

Q9

Is there anything you encounter at work that makes you uncomfortable or uneasy?

Having to deal with employees who are being problematic.

Q10

In an ideal scenario, what tools, equipment, or field gear options would you like to have?

I'd like to move away from generators and use gas powered drills.

Q1

Can you tell me your name, age, location and briefly describe what it is you do and what a typical workday is like for you.

Kieran, 34, Takaka New Zealand. My role is Great walk supervisor, i look after anything visitor related for The Northern Abel Tasman Great Walk and the Eastern Heaphy Great Walk. This includes huts, trails, campsites, structures and about 7 staff (Hut wardens). A typical day can vary hugely. It can be in the office organising a monthly work plan to in the field upgrading a trail, cleaning a toilet to Cutting windfall off trails, Servicing Great Walk huts with a helicopter to brush cutting a trail. Everything and anything!

Q2

What kind of work schedule do you have, do you work all year round?

I am employed all year round, summer is the busy time for staff and visitor numbers. Winter is more of a skeleton crew. Most of our back country work is done over summer with winter being front country or day visitor sites as well as planning for the coming summer.

Q3

What kind of special training have you had for this job? Can you explain in detail what that training was?

Any training has been on the job stuff to gain national qualifications for the various skills needed for the work. For example; blasting ticket a 4 day course with renewal every 5 years. Chainsaw has different levels, From Basic to dangerous tree work, and we are assessed every 3 years to make sure we operate at high levels. I have no high school or university qualifications.

Q4

What are the different types of tools, equipment, and field gear you use? (for example: backpacks, shovels, saws, helmets, etc)

Shovels and all kinds of hand tools, small excavators, rock drills, chainsaws, tirfor winches, motorbikes, helicopters, boats, track barrows (a big wheelbarrow that operates with self laying tracks and carrys up to 5ookg), Brush cutters.

Q5

What are some of the biggest obstacles you have with the work you do?

Red tape! lots of safety related forms to work through before we start most jobs.

Q6

Has there ever been a time when you were injured or encountered an injury at work? If so, what happened?

So far only minor stuff like crushed fingers or rolled ankles.

Q7

What is your favorite and/or least favorite thing about the work you do?

Being in the field doing the actually work is good. Sitting in the office organising staff, work planning and general paperwork would be the lest favourite.

Q8

You mentioned obstacles you have to work with, is there anything you would change about the tools or equipment you use to help you with those obstacles?

Red tape is unavoidable in this game. Tool and equipment are fine.

Q9

Is there anything you encounter at work that makes you uncomfortable or uneasy?

Compliance and Dealing with public can be uncomfortable at times.

Q10

In an ideal scenario, what tools, equipment, or field gear options would you like to have?

Give me an excavator, chainsaw and some explosives and tell me where you want the new trail to start and finish, and ill go off happily building it!

Q1

Can you tell me your name, age, location and briefly describe what it is you do and what a typical workday is like for you.

My names Brian Gionet I am the the marine operator for Pukaskwa National Park. I facilitate the travel of the trail crew into the backcountry. A typical day is maintenance of the marine vessels and transporting the crew.

Q2

What kind of work schedule do you have, do you work all year round?

6 months of the year is dedicated for marine operations. The other half for maintenance, contracts and procurement. Typical workday is 8-4 with additional hours on call in basis

Q3

What kind of special training have you had for this job? Can you explain in detail what that training was?

I have captains licence for 60 ton vessel. Navigation, night operations, search and rescue etc.

Q4

What are the different types of tools, equipment, and field gear you use? (for example: backpacks, shovels, saws, helmets, etc)

First aid kit, flares, life jackets, marine vessel electronics.

Q5

What are some of the biggest obstacles you have with the work you do?

Weather is the biggest obstacle. Weather dictates where and when we can travel to the backcountry.

Q6

Has there ever been a time when you were injured or encountered an injury at work? If so, what happened?

There has been many medical evacuation as well as body recoveries.

Q7

What is your favorite and/or least favorite thing about the work you do?

Favourite thing is the marine operations aspect, being on the boat and on Lake Superior. Least favourite is unsuccessful medical evacuation recovery

Q8

You mentioned obstacles you have to work with, is there anything you would change about the tools or equipment you use to help you with those obstacles?

The marine workplace is always evolving, keeping up with the technological advancements related to night ops, navigation and SAR. Cost of the new equipment is a big hurdle for government employees

Q9

Is there anything you encounter at work that makes you uncomfortable or uneasy?

Inter employee relations can sometimes get in the way of accomplishing what we need to do. As well as internal politics

Q10

In an ideal scenario, what tools, equipment, or field gear options would you like to have?

Have the newest navigation equipment, a larger boat and better equipped vessel, that wouldn't restrict

adverse weather operations

Appendix ii – User Research

Name:	Eric Lawler
Age:	28
Job:	Trail Builder
Income:	$30,000 per year
Education:	High School
Family:	Single
Location:	St.John's, NL
Main Job:	Trail Crew Maintenance
Frequency:	Monday-Thursday
Duration:	40 hrs/week
Social/Solitary:	Works with a crew of 5 people, in a team of 15.
Other Activities:	Goes to the gym 3 times a week, socializes with friends at local bars, practices photography and takes in local art exhibits.

Direct User Observation

The pictures were taken of someone with experience in using a chainsaw, although the chainsaw shown is an electric one – the user demonstrates how they would go through the motions in using a gas-powered chainsaw. The reason for this is that they would normally use a gas-powered one for more heavy-duty tasks like trail building, so to accurately the ergonomics they acted as if it were gas-powered. There were essentially seven key positions involved in carrying out the assigned tasks of transporting and operating the saw.

The first position starts as a neutral position, with the user upright and the saw lying at their feet.

The second position has the user crouching to pick up the chainsaw by the handle. This motion involves bending at the knees with some twisting of the upper body.

The third position shows the user standing upright with the chainsaw blade pointing behind them. I was told this was to have added safety when hiking with the saw, in the event they trip or fall, the blade remains behind them and not between them and the ground.

The fourth step shows the user placing their dominant right foot in the handguard to secure it to the ground while their left-hand hold the saw by the handle. While the saw is being held in two separate points, their dominant right-hand reaches for the pull cord to start the engine. The user's body is bent mostly at the waist to achieve a maximum torque angle in preparation for pulling the cord to start the engine.

In the fifth position, the user's right dominant hand jolts upward and away from the saw pulling the cord to start the engine.

The sixth position has the user bend fully at the knees and picks up the idling chainsaw.

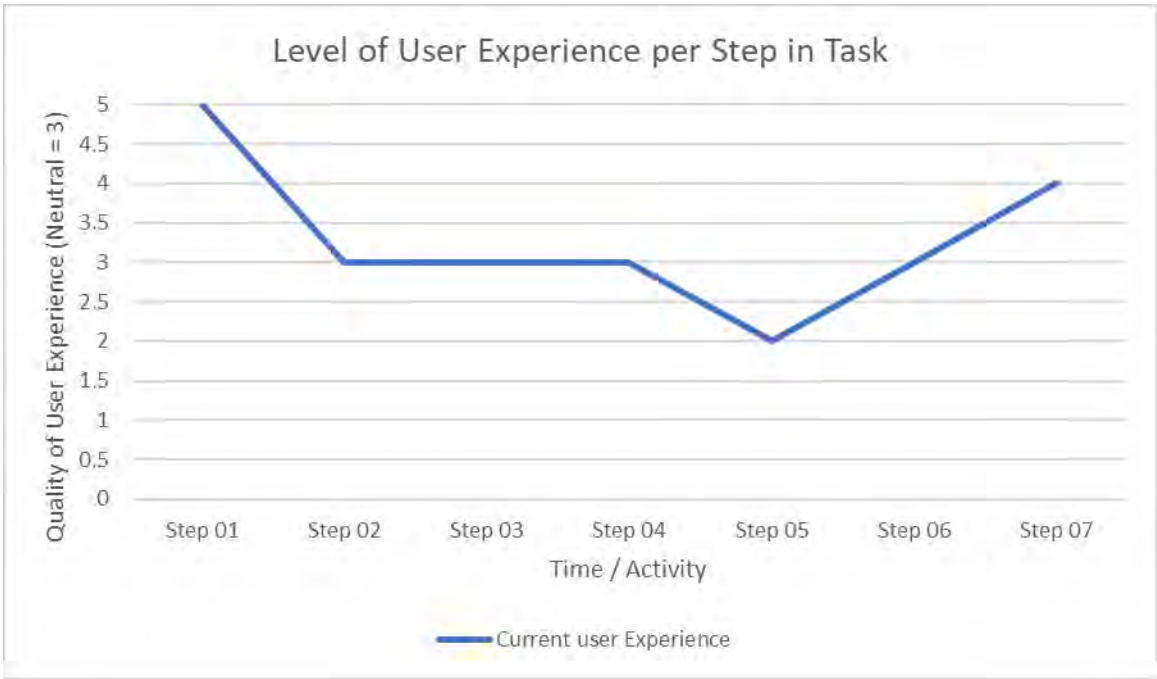
The final position shows the user standing upright with the chainsaw at a resting waist position.

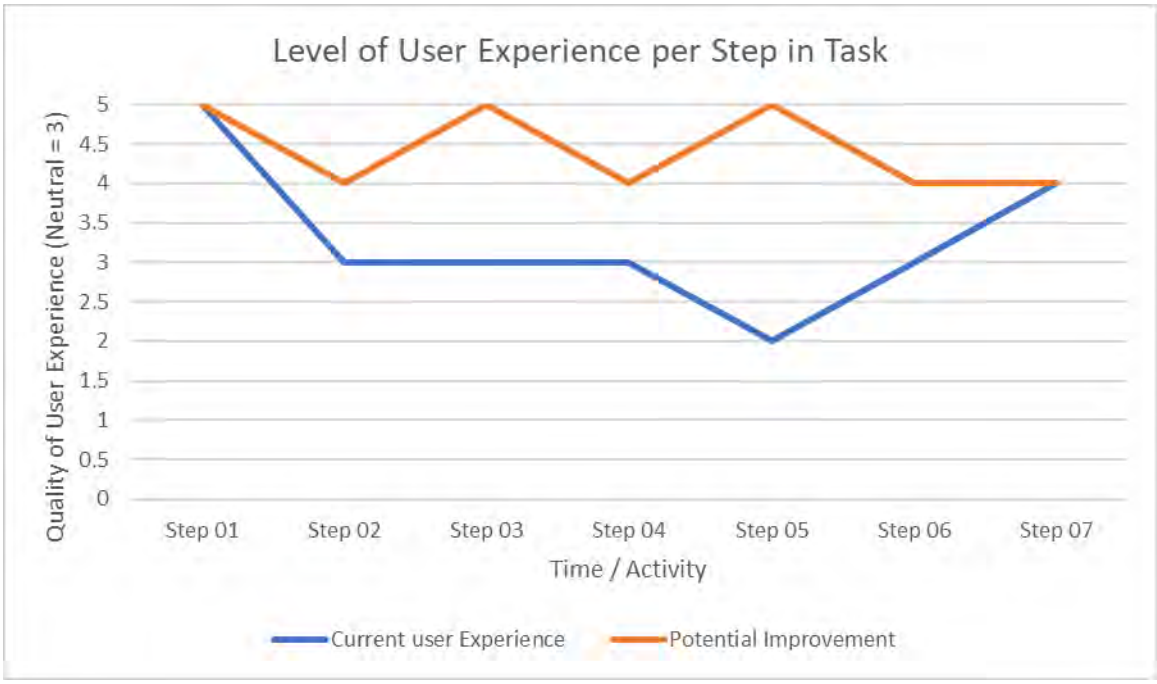
User Experience

User Experience Map

Task: Transporting a chainsaw and starting it to begin cutting.

Step #	Description	Gradient Scale of Pain – Pleasure Points Negative = 1; Neutral = 3; Positive = 5				
		1	**2**	**3**	**4**	**5**
01	Neutral pre-pickup position.	○	○	○	○	●
02	Picking up the saw.	○	○	●	○	○
03	Carrying and transporting the saw.	○	○	●	○	○
04	Securing saw to ground with arm and leg.	○	○	●	○	○
05	Pulling cord to start saw engine.	○	●	○	○	○
06	Bending to pick up idling chainsaw.	○	○	●	○	○
07	Standing holding idling chainsaw.	○	○	○	●	○


Level of User Experience per Step in Task
Quality of User Experience (Neutral = 3)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Step 01
Step 02
Step 03
Step 04
Step 05
Step 06
Step 07
Time / Activity
Current user Experience


Level of User Experience per Step in Task
Quality of User Experience (Neutral = 3)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Step 01
Step 02
Step 03
Step 04
Step 05
Step 06
Step 07
Time / Activity
Current user Experience
Potential Improvement

Overall Analysis

Over the course of observing and speaking with the chainsaw user I discovered there were a lot of specific and deliberate actions required in order to fully complete the tasks required. A lot of these tasks require repetitive motions that have tremendous potential for repetitive strain injuries. The user also voiced their concerns with transporting the saw and the difficulties surrounding starting the engine. Additionally, there were other obstacles the user mentioned involving maintenance and uncomfortable operating conditions due to extreme vibrations from the chainsaw. After looking at the Potential User Experience Improvement Chart it is clear that there is room for improvement with this specific tool and the interactions required to run it.

Appendix iii – Product Research

Chainsaw Hardhat with Face Shield & Ear Protection	
	Newly designed, sturdy yet lightweight protective helmet with ear protection. The helmet can be adjusted in several ways to suit your particular needs. A new, innovative ventilation system generates a comfortable temperature for your head. The visor has been re-designed for better protection of your face and, above all, give you perfect visibility both when folded up or down. • Comfortable and lightweight helmet designed specifically for loggers • One-handed ratchet system which allows for easy size adjustment (personal fit) • Adjustable 6 point suspension • Free-view visor for optimal visibility • Mesh ventilation provides comfort for long hour
https://www.husqvarna.com/ca-en/accessories/helmets/forest-helmet-technical/588646001/	
https://www.amazon.ca/Husqvarna-585058401-Technical-Forest-Helmet/dp/B00PQD8TZY/ref=sr_1_5?crid=3NZNHTX89O564&keywords=chainsaw+hard+hat+visor&qid=1576474591&sprefix=chainsaw+hard+hat%2Caps%2C214&sr=8-5	

Chainsaw Gloves	
	A comfortable saw protection glove made with a goat leather double palm with foam laminated spandex on the back and with nylon neoprene knuckles. Goat leather has a good protection against moisture since it contains natural fat and is therefore suitable for demanding jobs. Knitted wrist makes it easy to put on and gives a soft comfort. • Cut resistant in left hand • Spandex fabric back • Goatskin palm • High visibility colors • Reflective Crown H logo
https://www.husqvarna.com/uk/parts-accessories/gloves/gloves-functional-with-saw-protection/579380207/	

https://www.amazon.ca/Husqvarna-579380210-Functional-Protection-Gloves/dp/B009E82SEK/ref=sr_1_6?keywords=chainsaw+gloves&qid=1576474102&sr=8-6

Chainsaw Boots

Rubber logging boots that are chainsaw resistant, waterproof and have a steel toe. Chain saw resistant, meets OSHA Regulation 1910.266. Natural rubber with cotton pile lining, 4 layer insole, ankle-guard and heel grip. Steel toe meets ANSI and CSA standards. ANSI Z41-1999 I/75 C/75. Waterproof. oil resistant sole. Optional liners and caulks available.

- Available in US sizes ranging from 8.5 to 15.5 and European sizes ranging from 41 to 50
- Chain saw cut resistant which meets OSHA regulation 1910.266
- Steel toe meets ANSI and CSA standards - ANSI Z41-1999 I/75 C/77
- Waterproof - Made of natural rubber with cotton pile lining, 4 layer insole, ankle guard, heel grip and oil resistant sole
- Optional liners and caulks available

https://www.husqvarna.com/us/accessories/boots/rubber-logger-boots/596298041/

https://www.amazon.ca/Husqvarna-544027942-Rubber-Loggers-European/dp/B00UAD4B3O/ref=sr_1_7?keywords=chainsaw+boots&qid=1576474214&sr=8-7

Chainsaw Gloves

CARMYRA MADE PORTABLE CHAINSAW MILL 36"
SUITABLE FOR CHAINSAW BAR 14" TO 36"
HIGH QUALITY,30 DAYS MONEY BACK WARRANTY
Fast & Easy Installation 7.5KGS Portable ChainSaw Mill

- High Quality Steel and Aluminum Construction
- Cut Cedar, Walnut and Oak into High Quality Lumber
- High-Quality Mill Cuts Beams or Lumber from 0.5“ ”To 13“ Thick and 36” Wide
- Attaches to saw without drilling bar
- Lower price

https://www.amazon.ca/Carmyra-Portable-Chainsaw-Planking-Milling/dp/B071W1BW64/ref=sr_1_1_sspa?keywords=chainsaw&qid=1576473166&sr=8-1-spons&psc=1&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUFXU1dUWlI5RkJCSlMmZW5jcnlwdGVkSWQ9QTA3MDQ3NzQyMzlQVExITUFVVUVTJmVuY3J5cHRlZEFkSWQ9QTA3MjE4MTZTMVlUWE5RSTkzSkEmd2lkZ2V0TmFtZT1zcF9hdGYmYWN0aW9uPWNsaWNrUmVkaXJlY3QmZG9Ob3RMb2dDbGljaz10cnVl

Chainsaw	
	Conquer your workload with a great all-round chainsaw. Thanks to an X-Torq® engine, the Husqvarna 445e delivers powerful, efficient and eco-friendly performance. Meanwhile, the bar is robust enough to cut through the most demanding workloads. Smart Start® technology and a built-in fuel pump ensure reliable start-ups time after time. Spend less time pulling a starter cord, and more time getting the job done. Best of all, the 445e comes equipped with Husqvarna's powerful new X-Cut® chain. • 445 18-Inch Gas Powered Chain Saw, 45 7CC 2.8HP • Two cycle engine • Quick and easy chain adjustment • Air purge removes air from carburetor and fuel system for easy starting • Provides fewer air filter cleanings and improved engine life
https://www.husqvarna.com/ca-en/products/chainsaws/445-ii-e-series/967651003/	
https://www.amazon.ca/Husqvarna-18-Inch-Stroke-Powered-Chain/dp/B008AJLKB6/ref=sr_1_5?keywords=chainsaw&qid=1576473166&sr=8-5	

Chainsaw Pants

	Apron wrap chap made in 1000 Denier Polyester with PVC coating. It contains 5 layers of TEK WARP protective material. Felling wedge and gear pocket. Acetal delrin buckles. Adjustable waist size up to 42" (overall length is from waist to ankle). Wash in cold water mild detergent and hang to dry. Never use chlorine bleach. Meets ASTM F1897, ANSI Z133.1. UL® certified. Meets OSHA regulation 1910-266. • 1000 Denier Polyester with PVC coating with Tek Warp Protective Layers • Adjustable Waist Size to 42 Inches • Felling Wedge/Gear Pocket and Acetal Delrin Buckles • Meets ASTM F1897, ANSI Z133.1 and OSHA Regulation 1910-266 • UL Certified
https://www.husqvarna.com/us/accessories/protective-clothing/technical-apron-wrap-chainsaw-chaps/587160704/	
https://www.amazon.ca/Husqvarna-Technical-Apron-Wrap-42-Inch/dp/B00TZXUG9I/ref=sr_1_4?keywords=chainsaw+pants&qid=1576473323&sr=8-4	

Trail Building Backpack	
	With the EVOC TRAIL BUILDER you can carry your trail building workshop on your back. Designed together with and for trail builders, the backpack offers a carrying system that provides balanced load distribution, making it ideal for comfortable transporting of heavy loads. Just the perfect pack for carrying your tools on and next to trails with your mountain bike. • Complete portable trail building workshop for your back • Exceptionally durable backpack • Designed and developed by and for trail builders who need to be able to go to remote places on their bike with heavy equipment • Sophisticated carrying system helps to distribute heavy loads symmetrically and as close to the body's centre of gravity as possible. • Attachment system for: axe, hammer, hedge clipper, chain saw, protectors (storable)
https://www.evocsports.com/products/backpacks/trail-builder	
https://www.amazon.ca/EVOC-Builder-Technical-Performance-Backpack/dp/B00NNRDPHM/ref=sr_1_1?gclid=EAIaIQobChMIwNyYmbi55gIVCBgMCh2kwQ2fEAAYASAAEgKsdPD_BwE&hvadid=336906092057&hvdev=c&hvlocphy=9000154&hvnetw=g&hvpos=1t1&hvqmt=b&hvrand=9479682827680062684&hvtargid=kwd-299345473333&hydadcr=26030_9772388&keywords=evoc+trail+builder&qid=1576474243&sr=8-1	

Protective Eyewear	
	3M™ Virtua Protective Eyewear lends an athletic-inspired image in a premium line of safety glasses that offers both protection and affordability. Clear anti-fog lens features a +2.0 reading diopter to help workers who have difficulty reading small print or who are engaged in small detail work. The optional foam gasket attachment helps limit eye exposure to nuisance dust while providing additional cushioning. The large wraparound lens keeps eyes more fully protected and provides a wide viewing area. Contoured temples fit comfortably and snugly without pressure points but also without any looseness that causes shifting. The impact-resistant polycarbonate lens absorbs 99.9% UV rays. Meets the requirements of CSA Z94.3-2007. Effective in both hot and cold weather. • Foam gasket helps limit eye exposure to nuisance dust while providing additional cushioning • Anti-Fog polycarbonate lens absorb 99.9-Percent UV • Meets the requirements of CSA Z94.3-07 and is Impact Rated to ANSI Z87.1-2010
https://www.3mcanada.ca/3M/en_CA/company-ca/all-3m-products/~/3M-Virtua-Cord-Control-System-Protective-Eyewear-VC215AF-clear-anti-fog-lens-1-5-dioptre/?N=5002385+8720549+3293229990&preselect=8720539+8729628+3293786499+3294529206&rt=rud	
https://www.amazon.ca/3M-Virtua-Protective-Eyewear-11872-00000-20/dp/B00AEXKR4C/ref=sr_1_6?keywords=safety+glasses&qid=1576474336&sr=8-6	

Appendix iv – Needs Analysis

1 Preliminary Needs Assessment

What the product does

Helps trail builders do their job with less injuries.

360 initial inquiry

Who are your target market group?	Hiking trail builders
What does it do?	Helps workers avoid injury and complete tasks with more ease
Where will it be done?	Outside in the wilderness, typically forested areas.
When is it done/used/needed?	During daylight hours
Why is it needed?	Lowers chances of fatigue and makes working conditions safer

Why would someone buy this product?

- Helps to avoid injury while working
- Makes their job easier
- Durable, holds up to repeated use and harsh weather conditions
- Cost effective

2 Linking Benefits to Human Needs

Products with similar benefits were determined, and promotional media for them gathered.
A more in-depth look at the benefits listed in the promotional literature was carried out.
These benefits were related to Human Needs using:

1) Hierarchy of Human Needs *(Mazlow)* and
2) Fundamental Human Needs *(Max-Neef)*

Determining Products which Bracket Key Benefits for the Thesis Topic

A key element to a unique and original design is to start with thinking about the user and their needs, rather than current products.

The point of this exercise is not to design a product, but to understand the user and what their key needs are.

Starting design with current products can seriously bias the development of a unique solution.

Thesis Topic

How can we improve the overall physically demanding and dangerous conditions of trail maintenance workers?

Benefits that bracket topic

1. Less stress on the body for user
2. Safer operation of daily tasks for user
3. More cost effective for employer

Benefit #1: Products that offer ease of carrying for user:

- Hiking backpack
- Chainsaw backpack

Benefit #2: Products that help prevent injury to user:

- Hiking/Chainsaw Boots
- Hiking pants
- Hard hat
- Safety gloves

Based on this, two Tables for **Linking Benefits with Needs** are generated, one for easy carrying, and the other for infant comfort

Benefit #1: Ease of carrying

Product: Chainsaw backpack

True North Chainsaw Pack – Low profile wildland chainsaw pack

155 lb Carrying Capacity (approximately) (hard to find Canadian suppliers, sourced from supplycache.com)

Price: CDN$ 364.83 + $145.14 taxes & shipping **TOTAL: $509.97**

Product Description

- Patented SCS Suspension System
- 3 drawstring pockets for fuel, water, and other essentials
- Fire shelter case attaches to belt with ALICE clips
- Axe scabbard
- Size: Standard (28"- 48") waist belt
- Lightweight: 5.5lbs
- Holds loads of approximately 155lbs

Specifications

Brand Name	True North
Color	Black
EAN	763-97001
Material Type	1000 Cordura, Nylon Webbing, Leather, Reflective Tape, Nylon hardware
Model Number	N/A
Weight	5.5lbs

Benefits	Features
Outdoor use	Suspension System
Fire shelter case attaches to belt	3 drawstring pockets
Secures chainsaw when hiking	Waist belt

https://www.supplycache.com/products/nomad-chain-saw-pack-true-

High quality materials 1000 Cordura material, leather, etc	Reflective tape
Lightweight at 5.5 lbs	Holds loads of 155lbs

TABLE: Linking Benefits with Needs (Benefit #1 Ease of Carrying)

Product- Chainsaw Backpack				
Needs	**Benefits and Underlying Needs**	**Level of importance**		
		Slight	Moderate	High
Basic Needs *Physiological*				
Food, water, shelter				
Pleasure, gratification *(sensory, compulsive responses)*	Comfortable and easy to carry			High
Security *Safety, securing resources*				
Safety	Loads secured and balanced Doesn't leave your back sore			High High
State, Group, Individual				
Securing resources • *Value* • *Accumulation of resources (wealth)*	*Optimization of limited resources (cost effectiveness)*			
	Price ($509.97)			High
	Reliability			High
Control over environment (tasks)	*Product (tool) that amplifies human abilities*			
Convenience *Ease of Use*	Easy while using *(doesn't leave your back sore)* Easy to Store Comfortable to touch (handle)		Moderate	High High
Flexibility	Travel use- (portable, flexibility)			High
Speed (fast, less time)				
Control (precision, responsiveness, power)				
Long Term Security/Stability of Group *Health/care/education of children*				
Environmental sustainability				
Insurance (car, house), pension, investments				
Social Belonging *Effort / resources to belong to a 'tribe'*				
Fear of Abandonment				
Fear of the enemy				
Tribal Identity		Slight		
Behavior cues for survival *(copying behaviors… safe to eat, learned skills)*				
Behavior cues for social interaction of group *(copying behaviors… Interaction cues, play, have fun)*				
Peer Pressure				
Social Expectation *(social covenant (gift))*				
Esteem *Personal influence in 'tribe'*				
Social Status *'The elite have it…I want to be like them'*		Slight		
Social Recognition		Slight		
Sexual attractiveness				
'Higher Order' Functions/Needs *Needs that differentiate humans from non-primates*				
Intrinsic pleasure		Slight		
Creativndeavors				
Experiential (extrinsic)				
Experiential (intrinsic)				
Emotional				

Summary Table: Benefit #1

Product:	**Chainsaw Backpack**	
Linking Benefit:	***Avoids injury, helps transport***	
Needs – *long term*	**Needs –** *short term*	**Benefits**
Safety	Transport	Loads secured and balanced Protects user from carrying awkward and heavy loads while hiking
Durability	Securing resources	Value (safety,convienence) Reliability
	Control over environment (tasks)	Convenience: Ease of use • Easy while using *(can easily access tools and equipment)* • High quality mateirals used • Comfortable to wear (lightweight)
	Convenience: Flexibility (holds multiple tools) Portability	Convenience: Lightweight • Reduces injury lowering costs to employer

Statement of Need *(transport and safety)*

Specialized equipment for outdoor chainsaw users which affords:

1) security for the user and
2) control over the transport of expensive equipment, and heavy/bulky equipment.

Specific needs to be considered include:

- Safety for the user
- Ease of use the user (packing and unpacking)
- Flexibility (allows user to pack multiple items)
- Affordable
- Durable

Benefit #2: Injury Prevention

Product: Chainsaw Hiking Boots

HAIX Protector Ultra Signal Red Chainsaw Boot

Price: C$524.50 inc taxes & shipping

https://www.haixca.com/haix-protector-ultra-signal-red

Product Description

- HAIX® Secura Liner® – never a loose liner
- GORE-TEX® waterproof inner liner
- HAIX® Climate System for temperature balance
- HAIX® Two-Zone Lacing System
- European Class 2 cut protection
- Steel toe cap
- Non-metallic puncture protection
- Vibram® sole for extra grip and slip resistance
- Rubber toe and heel protection for prolonged service life
- Waterproof/breathable leather

Specifications

Brand Name	HAIX
Color	Red/Black
Pkg Dimensions (in)	24.2 x 16.1 x 6.3
Model Number	603111
Item Weight (lb)	5 lbs (approximate)

Benefits	Features
Cut protection	Secure never loose liner
Steel toe cap	Waterproof inner liner
Slip resistance	Climate control fabrics
Rubber toe	Puncture protection
	Durable and rugged Vibram sole
	Heel protection
	Waterproof/breathable

TABLE: Linking Benefits with Needs (Benefit #2 Comfort for Infant)

Product- Chainsaw Boot				
Needs	**Benefits and Underlying Needs**	**Level of importance**		
		Slight	Moderate	High
Basic Needs ***Physiological***				
Food, water, shelter				
Pleasure, gratification *(sensory, compulsive responses)*	comfort for user			High
Security ***Safety, securing resources***				High
Safety	breathability of fabric (infant safety) visibility of sides and CSA approval tag (steel toe)			
State, Group, Individual	Injury prevention			High
Securing resources	*Optimization of limited resources (cost effectiveness)*			
• *Value* • *Accumulation of resources (wealth)*	Price C$524.50			High
Control over environment (tasks)	*Product (tool) that amplifies human abilities*			
Convenience				
Ease of Use	Adjustable lacing system		Moderate	High
Flexibility	Easily take boots on and off	Slight		
Speed (fast, less time)				
Control (precision, responsiveness, power)				
Long Term Security/Stability of Group				
Health/care/education of children				
Environmental sustainability				
Insurance (car, house), pension, investments				
Social Belonging ***Effort / resources to belong to a 'tribe'***				
Fear of Abandonment				
Fear of the enemy				
Tribal Identity				
Behavior cues for survival *(copying behaviors… safe to eat, learned skills)*				
Behavior cues for social interaction of group *(copying behaviors… Interaction cues, play, have fun)*				
Peer Pressure				
Social Expectation *(social covenant (gift))*				
Esteem ***Personal influence in 'tribe'***				
Social Status *'The elite have it…I want to be like them'*		Slight		
Social Recognition		Slight		
Sexual attractiveness				
'Higher Order' Functions/Needs ***Needs that differentiate humans from non-primates***				
Intrinsic pleasure				
Creative endeavors				
Experiential (extrinsic)				
Experiential (intrinsic)				
Emotional				

Summary: Benefit #2

Product:	**Bassinet**	
Linking Benefit:	***Comfort of infant***	
Needs – *long term*	**Needs- *short term***	**Benefits**
Basic Needs	Pleasure, gratification	comfort for mother (side panel, adjustable height) comfort for infant (sturdy mattress)
Security	Safety	breathability of mesh sides (infant safety) visibility of mesh sides (infant safety)
	Securing resources	Value (price)
	Control over environment (tasks)	***Convenience*** ***Ease of Use*** : quickly & easily attend baby any hour of night move bassinet to bedside (portability) ***Flexibility:*** switches from sleeper to bassinet range of baby sizes to allow for growth folds up for travelling and storage
Social Belonging	Fear of Abandonment	baby sleeps knowing mother is beside

Statement of Need *(comfort only)*

Specialized footwear that will protect the user when using a chainsaw which affords:

1) security and comfort for the user and
2) instills confidence in the user when hiking and operating dangerous equipment (chainsaws).

Specific needs to be considered include:

- comfort for the user
- safety for the user when hiking and operating dangerous equipment
- allows user to easily adjust lacing system
- various additional safety features like reflective material and steel toe cap
- durable

Combined Statement of Need for Benefit #1 and #2

Statement of Need *(transport and comfort)*

A protective device for a trail builder that affords the user flexibility to continue their tasks with comfort and peace of mind in terms of safety.

Specific needs include:

- ease of use, lightweight, comfortable, and
- durable, with a variety of safety features

Fundamental Human Needs

Linking the product benefits with fundamental human needs will utilize two models: Maslow's 'Hierarchy of Human Needs', and 'Fundamental Human Needs' (according to the school of "Human Scale Development" and Manfred Max-Neef).

The 'Fundamental Human Needs' is similar to Maslow's model, but with some important additional categories. For example, in the 'leisure' category, one has 'games, parties'. Games are fun and often highly addictive.

Below is a table summarizing these categories.

Need	Being *(qualities)*	Having *(things)*	Doing *(actions)*	Interacting *(settings)*
subsistence	physical and mental health	food, **shelter**, work	feed, clothe, **rest, work**	living environment, social setting
protection	**care, adaptability,** autonomy	social security, health systems, **work**	**co-operate, plan, take care of, help**	social environment, dwelling
affection	respect, sense of humour, generosity, sensuality	friendships, family, **relationships with nature**	share, take care of, make love, express emotions	**privacy**, intimate spaces of togetherness
understanding	critical capacity, curiosity, **intuition**	literature, teachers, policies, educational	analyze, study, **meditate**, investigate,	schools, families, universities, communities,
participation	receptiveness, **dedication**, sense of humour	responsibilities, **duties**, **work**, rights	**cooperate**, dissent, express opinions	associations, parties, churches, neighborhoods
leisure	imagination, **tranquility**, spontaneity	games, parties, **peace of mind**	day-dream, remember, relax, **have fun**	**landscapes, intimate spaces, places to be alone**
creation	imagination, **boldness, inventiveness**, curiosity	**abilities, skills, work, techniques**	**invent, build, design, work, compose, interpret**	spaces for expression, workshops, audiences
identity	sense of belonging, **self-esteem, consistency**	language, religions, **work**, customs, **values**, norms	get to know oneself, **grow**, commit oneself	**places one belongs to**, everyday settings
freedom	autonomy, **passion**, self-esteem, **open-mindedness**	equal rights	dissent, **choose**, run risks, **develop awareness**	anywhere

Common benefits and the correlating fundamental human need

Commonly cited product benefits are the following: ***easy, efficient, convenient, comfort***
These are related to **control over one's environment**. Correlating needs are (Max-Neef model):

Protection: **autonomy**, adaptability, work, planning, take care of
Freedom: **autonomy**, self-esteem

Another group of benefits are **experiential,** e.g. ***exciting, stimulating, exhilarating***
These are related to experiences. Correlating needs are (Max-Neef model) are:

Leisure: **spontaneity,** games, have fun, imagination
Freedom: **autonomy**, self-esteem, risk-taking

Beauty and style are important categories not specifically addressed by either the Maslow or Max-Neef models. "Beauty is the quality of being pleasing, especially to look at, or someone or something that gives great pleasure, especially when looking at it." *Wikipedia.* What is pleasing is either innately or culturally derived.
R

For purposes of this exercise of associating benefits with fundamental human needs, **style and beauty** will be associated with the term **aesthetics** or higher order activities such as **self-fulfillment** and **creativity**.

Benefits and Corresponding Fundamental Human Needs

The fundamental human needs corresponding to the product benefits *(reference Product Research REPORT)* was determined and displayed in the Table below. The relative strength of relationship (strong/moderate/weak) was also indicated.

Table: Benefits and Corresponding Fundamental Human Needs

Trail Builder Safety

	Benefit	***Possible Corresponding Fundamental Human Needs (FHN)***	***Relationship between Benefits and FHN***
1	Comfort	Control, security, safety	strong
2	Style	Esteem, belonging, aesthetically pleasing	moderate
3	Efficiency	Accomplishment, autonomy, self-esteem	moderate/strong
4	Ease	Accomplishment, autonomy, protection, security, control, self-esteem (mastery)	strong
5	Fun	Leisure (excitement), Participation, Belonging (shared fun)	moderate

Comfort in this context is increasing the sensory experience for the infant of being protected, connected with the caregiver and the outside environment, with some freedom to move safely)
Comfort also includes the harshness of the ride (ride harshness would contribute to a feeling of a *loss of control*, increasing possibility of injury (risk), both of which decrease one's sense of protection)

Security is the major fundamental human need met.

Style is an important expression of individuality. What is considered by the group as stylish increases **self esteem**.

Efficiency is defined as the effort required to perform at a particular level. This is related to **control** the user has during the activity (**autonomy**)

Ease is in many ways related to efficiency in terms for fundamental human needs (i.e. **control, autonomy**).

Fun related to **work interaction** (having fun while hiking with coworkers) and **belonging** (**shared fun, participation** trail builders).

Statement of Need

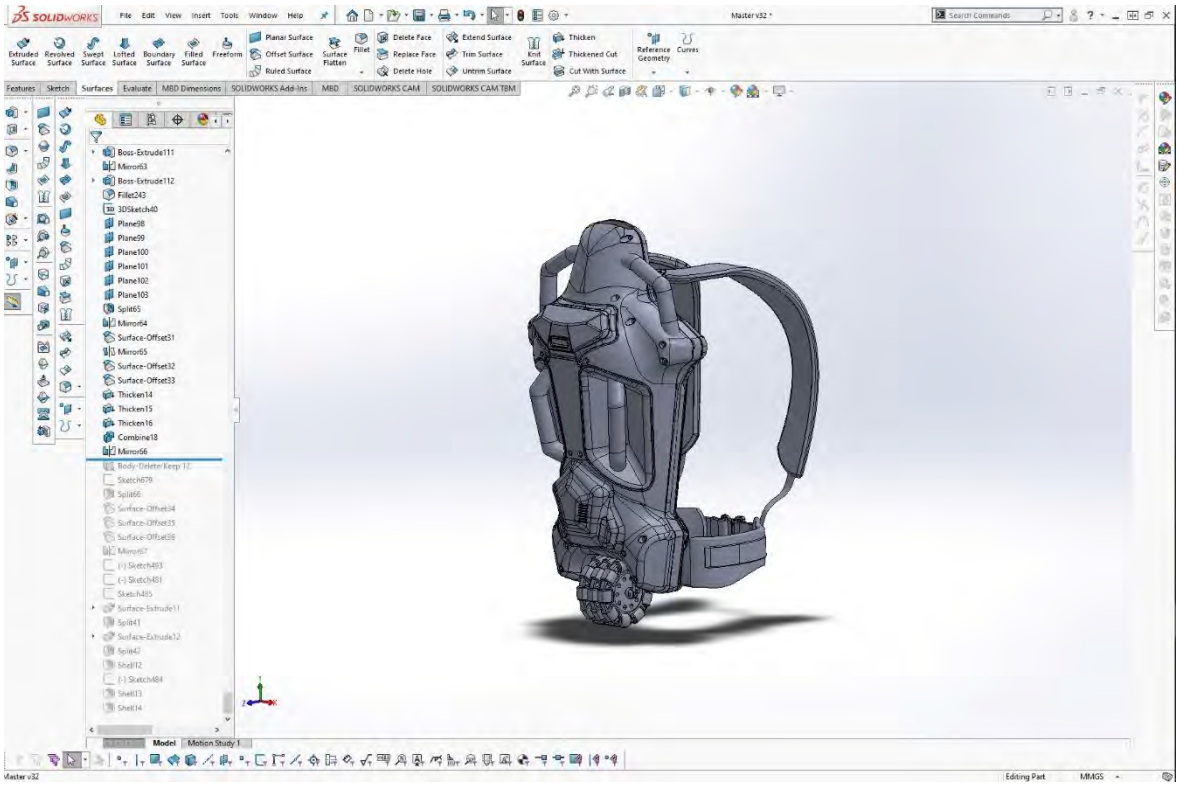
Trail building is a purposeful activity based on ease of functioning (equipment and transport) (**control, mastery**), and comfort afforded the worker (**comfort and security**).

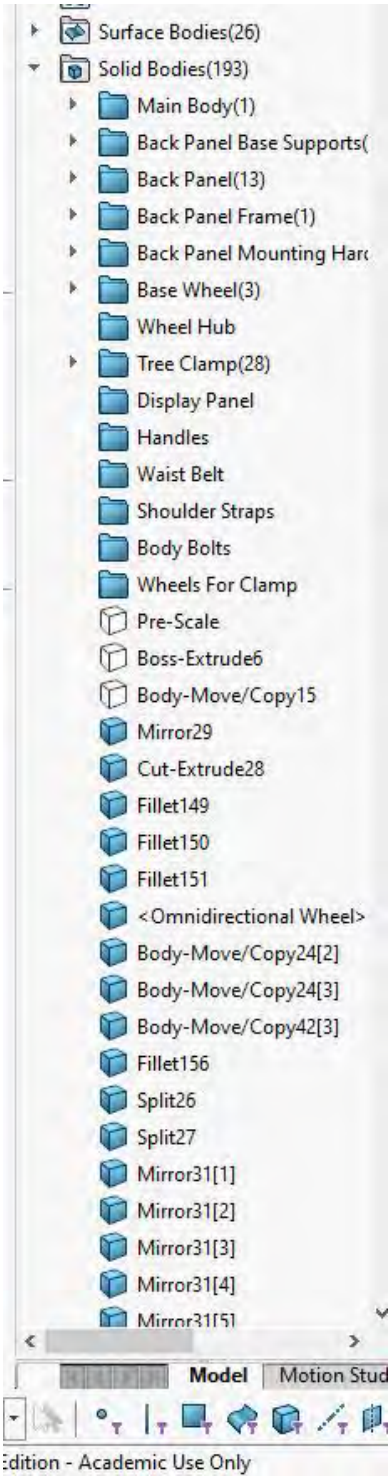
Trail Builder work is also a **social** activity, since most work involves interaction between other workers throughout the day.

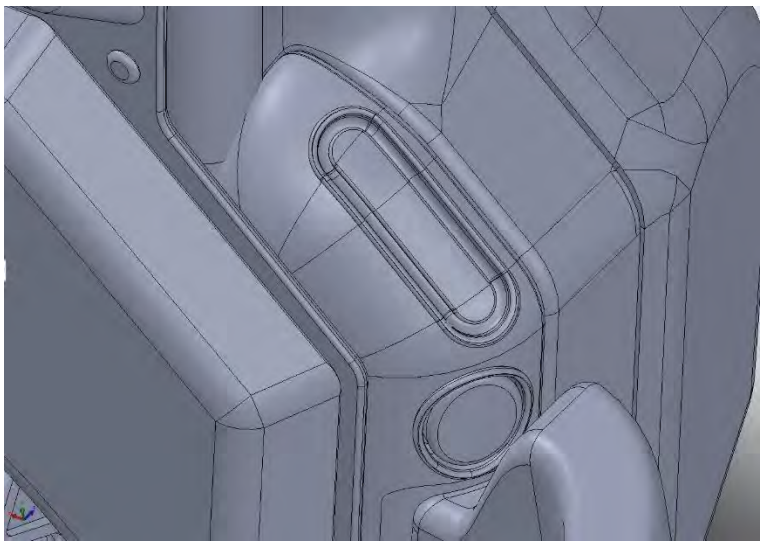
Esteem can be afforded by good styling/quality cues of the equipment used by the workers.

Control and **mastery** of the device is related to the performance of the equipment (**effectiveness, ease of use** and **comfort)**.

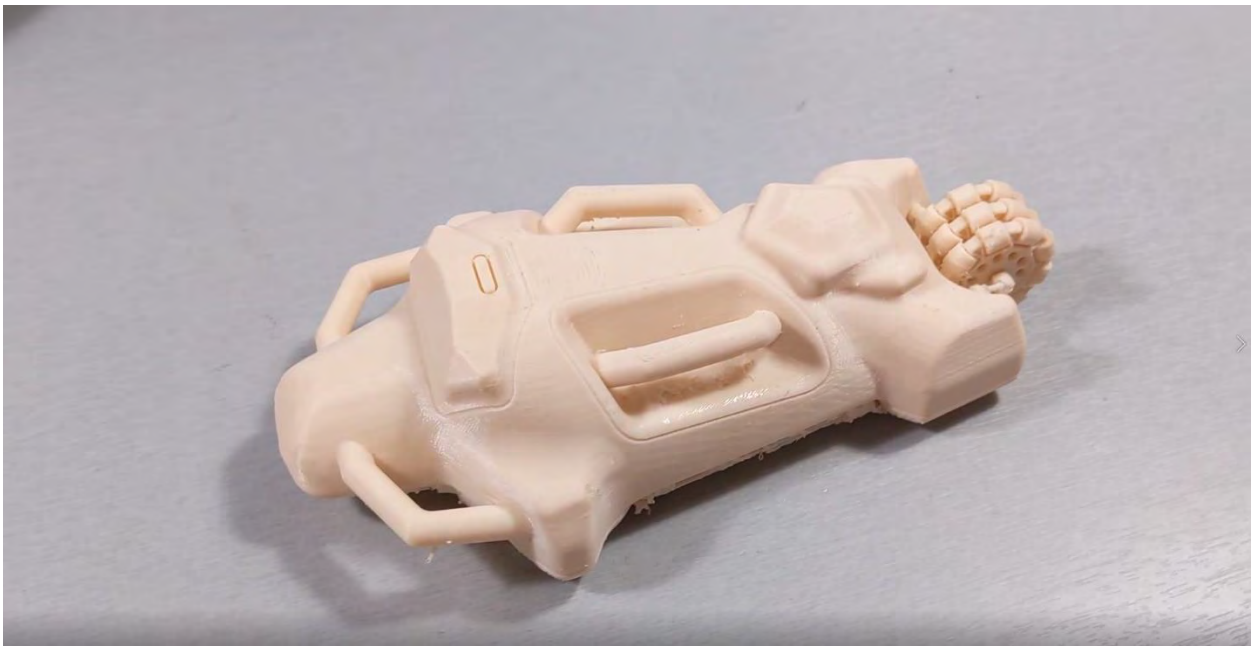
Appendix vii - CAD Models



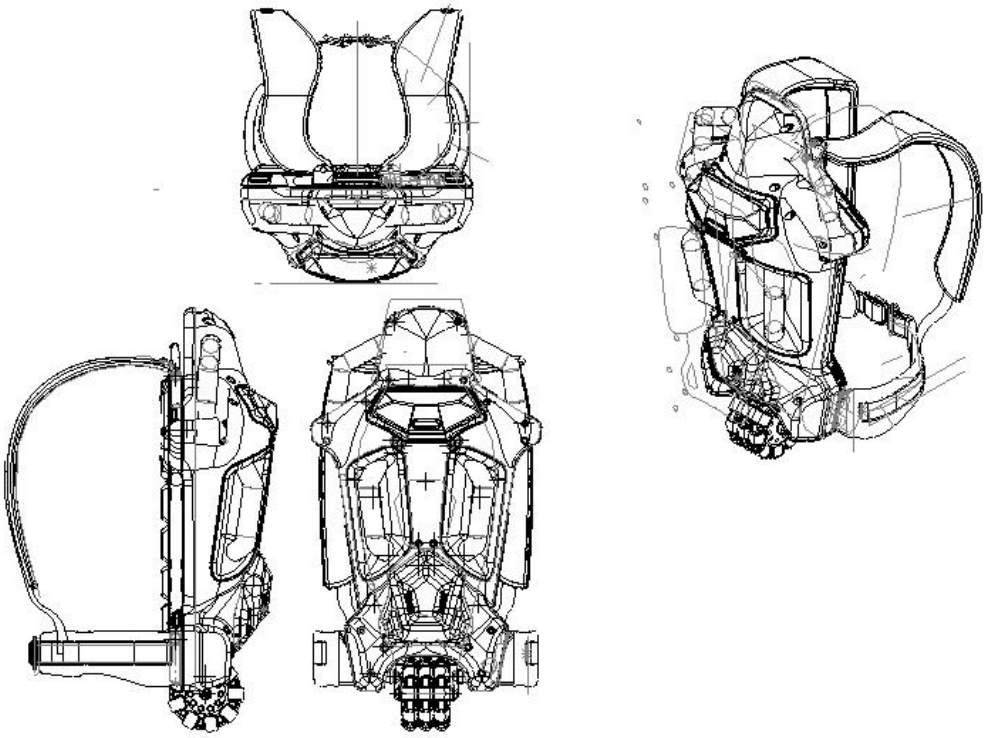

Surface Bodies(26)
Solid Bodies(193)
Main Body(1)
Back Panel Base Supports(
Back Panel(13)
Back Panel Frame(1)
Back Panel Mounting Harc
Base Wheel(3)
Wheel Hub
Tree Clamp(28)
Display Panel
Handles
Waist Belt
Shoulder Straps
Body Bolts
Wheels For Clamp
Pre-Scale
Boss-Extrude6
Body-Move/Copy15
Mirror29
Cut-Extrude28
Fillet149
Fillet150
Fillet151
<Omnidirectional Wheel>
Body-Move/Copy24[2]
Body-Move/Copy24[3]
Body-Move/Copy42[3]
Fillet156
Split26
Split27
Mirror31[1]
Mirror31[2]
Mirror31[3]
Mirror31[4]
Model
Motion Stud
dition - Academic Use Only



Appendix viii – Hard Model Photgraphs



Appendix vii – Technical Drawings



Appendix ix – Maufacturing Cost Report

Appendix x – Sustainability Report

Although there have been little to no advancements in sustainability in plastics for the production of chainsaws, there have been improvements in the technology used to power them. Battery power chainsaws are becoming more and more popular as the technology gets better; they are becoming more commonplace, economical, and environmentally friendly alternatives to gasoline-powered chainsaws. (Fig 1.2)

Figure 1.2 - Husqvarna 40-Volt lithium-ion battery. Retrieved from. https://www.husqvarna.com/ca-en/products/homeowner-battery-series/

According to Husquarvana (2020):

> The 36V Li-ion battery back provides equally high power, reliable operation and long lifetime as gas-powered products – without any direct emissions. Also, you get as much done on a single charge, as you would manage on one tank of gas. (Despite the lack of current sustainable material manufacturing for these products, there have been recent advancements in bio and eco-plastics which look incredibly promising for electric chainsaw applications. (p.1)

As mentioned previously, there are several promising areas in bio and eco-plastics, which could potentially replace the more traditional fossil fuel plastics. A prime example of some of these fossil fuel alternative plastics would be hemp filled polymers that are offered by The Hemp Plastic Company. These hemp-based alternatives are meant as a drop-in replacement for the commonly used fossil fuel-based plastics used in injection molding. These drop-in alternatives cover a wide range of materials like Propylene, Ethelene, ABS, and PLA. (The Hemp Plastic Company, 2020)

The reasoning for using environmentally friendly alternatives for plastic injection molding of chainsaw components would be the substantial increase in environmentally friendly production while maintaining a cost-effective baseline for the overall product. There would be virtually little to no cost difference from switching over to the more eco-friendly option while doing so would further solidify many of the companies' environmental initiatives.

Appendix xi – Topic Approval Form

Humber Institute of Technology & Advanced Learning
School of Applied Technology
Bachelor of Applied Technology – Industrial Design
Winter 2020
IDSN 4502 Senior Level Thesis Project II
Dennis L. Kappen/Catherine Chong/Sandro Zaccolo

THESIS DESIGN APPROVAL FORM

NAME
BLAKE GOSSE

TOPIC TITLE (Brand)
Husqvarna sem-automated de-limber and tree felling device

PS: Ensure that the visualization of the final design, side views and front views in Illustrator or Photoshop are required to be shown to us for securing an approval

Thesis design is approved to proceed for the following:

CAD Design Phase

Rapid Prototyping and model building phase

COMMENTS:

Signed

Catherine Chong / Dennis L. Kappen

Appendix xii – Advisor Meetings & Agreement Forms

Appendix xiii – Other Supportive Raw Data

Appendix xiv – Topic Specific Data, papers, publications

CAD Omni-directional wheels and quick-release buckle retrieved from Gabcad.

https://grabcad.com/

Omni Wheels. https://grabcad.com/library/100mm-heavy-duty-omnidirectional-wheel-1

Cobra Clip Buckle. https://grabcad.com/library/cobra-style-webbing-buckle-1