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AVALANCHE SURVIVAL UNIT

Bachelor of Industrial Design Thesis Report

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2023

Avalanche Survival Unit

by

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Submitted in partial fulfillment of the requirements for the degree of

Bachelor of Industrial Design

Faculty of Applied Sciences &Technology
Humber Institute of Technology and Advanced Learning

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April 18, 2023

HUMBER
Faculty of Applied Sciences & Technology

Avalanche Survival Unit

Abstract

Avalanches occur in many different conditions, whether it be steep slopes, warm temperatures, human interaction, or any other natural cause. Ultimately, most cases are induced by Mother Nature and it's a well-known fact that it is very unpredictable. Search and rescue is left to volunteer professional that must endure many different scenarios. Nevertheless, people still choose to enjoy winter activities regardless of the risk level and this becomes more worrisome especially as the climate changes and takes a toll on the frequency of avalanches. Since humans have started settling and enjoying mountain slopes, encountering avalanches of varying sizes and magnitudes has always been a serious issue. In response, structures have been established to disperse them as they fall or shelter people in their path, developed resources and equipment for search and rescue groups, and very minimal products for those entering avalanche prone areas. There is truly an excellent opportunity to perform an in-depth study about the length of time, procedures, and resources used by search and rescue personnel as well as investigating cases and scenarios of avalanche occurrences. There is the ability to provide potential victims with a product that allows them a higher chance of being found and plays on features that cater to the most dire needs. A 1:1 scale in a snowy environment will allow for testing multiple factors of any product direction focusing on grip, warmth, stability and overall ergonomic accommodation. By the end of this thesis study, a solution will be found for people in avalanche heavy regions that will allow for higher search and rescue efficiency and effectiveness.

Keywords: Avalanche, Safety, Search, Rescue

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Acknowledgements

The completion of this thesis project relied heavily on my instructors, interviewees, family and friends, and 3rd party services. Without their input on possible avenues to consider and think, this thesis project would have not met the required credentials. Without their answers, the following and deeper questions would never had been asked. Without the constant affirmation of possibly succeeding, the drive to finish would never had been applied. Without the multiple problems and obstacles that would have forced others to quit, there would not have been the opportunity to employ many other services to lift me closer to completion by picking up the troubles.

I would like to thank Catherine Chong, Frederic Matovu, and Michael Vander Velde, for their detrimental and critical critiquing of my early and foundational research and concepts. Their questions and proposed challenges forced, drove, and made me think vigorously about solutions in every angle possible.

Another enormous thank you to Cecilia of C.E Repairs & Alterations for being the only service from my google call list on undertaking the manufacturing of the final model. She was my saving grace in providing a stunning and awe-inspiring softshell model.

Lastly, I would like to thank my parents who supported me at every hardship, broken laptop, and broken 3D printer. They are the only reason I persevered to the very end after telling me they were prouder than ever when I admitted to them that I felt like quitting at every obstacle.

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Chapter 1 – Introduction

1.1 Problem Definition

Avalanches are still quite relevant even with today's technological advancements to preventing and stopping injuries entirely. However, the longer someone is stuck in an avalanche or is kept away from life saving medical support, it increases the likelihood that the victim may not survive much longer. Many avalanches happen in many parts of the world, and with each of them comes their own level of intensity as well as hold unknown consequences to anyone caught in them. Currently, surviving an avalanche can only be done in two main ways, save yourself or wait for others. Either it can be preventative or post-accidental procedures, only one of these offers a self-sufficient application to surviving an avalanche. The hope for this thesis project will be to show the development of a product that can provide both preventative and post-accident measures in order to allow the victim extra time for search and rescue personnel to arrive, or allow them to make the journey to a safe location away from the accident site.

1.2 Rational & Significance

Determining the rationale to proceed in this thesis topic as well as understanding the significance and importance of the problem at hand lie solely in the information found within research on the topic. When exploring the harsh consequences of being caught in an avalanche, as well as the events that must take place post-accident had to have been done in a methodic and extensive way. Some of which are derived from scholarly articles, expert and user interviews, and wide ranged generalized search engine exploration.

Research Methods

- Humber library – Peer-reviewed articles
- General health websites
- General statistic websites

- Specific avalanche statistic websites
- Product benchmarking
- 1:1 interview with avalanche safety experts
- 1:1 interview with users
- User observation
- Generalized sustainable materials research
- Ergonomic exploration

Coinciding with the research methods undertaken, certain checkpoints had to have been met in order to fully grasp the problem at hand that would justify the significance of this thesis topic. Primarily this involved asking hypothetical questions as people generally do not undertake dangerous tasks either without knowing the full implications of doing so or the complete disregard for the possibility of anything remotely dangerous happening.

Questions to be answered:

- What are the precursors to avalanches?
- What are the ways to surviving or avoiding an avalanche?
- How might a user of a potential product for avalanches understand the product components?
- In what circumstances, scenarios, and environments would a potential avalanche product be used?
- What products are currently available in relation to avalanches as well as their shortcomings?
- What injuries and health implications are sustained in avalanche accidents?
- What might be the procedures and methods used in search and rescue operations?
- What tools and equipment may be used in search and rescue operations?
- Who undertakes search and rescue operations and what skills/knowledge do they have?

1.3 Background, History, and Social Context

Avalanches are unstable masses of snow that break away from the mountain slope, where they pick up speed as it moves downhill, producing a river of snow, which in turn picks up even more snow as it rushes downhill. This produces a cloud of icy particles that rise high into the air where, once fully developed, it can weigh millions of tons and travel faster than 320 km/hr (Rutledge et al., 2022). These weather phenomena are unpredictable and can happen due to any number of circumstances, whether it is a temperature change, a loose layer of snow on the slope, external triggers, or just the general angle of the slope. Many points throughout history there has been numerous deadly avalanches that have taken hundreds to tens of thousands of lives. In preventing such tragedies many construction projects have gone underway to divert or hold back the resulting amount of snow. However, with new technologies and techniques, many avalanches are conducted in controlled measures where the surrounding communities are warned and cordoned off to the avalanche zone to allow monitored explosions of various methods. This allows for small, non-violent avalanches to occur before an unpredictable, large, and very violent avalanche can occur.

Avalanches are not discriminatory, they affect people of all ages, sexes, income levels and races. Although there is a general grouping of those who take part in activities residing in avalanche prone areas of mountain slopes. It can also be assumed that this general group is translated along all regions of the world in both areas of high human occupancy and low human occupancy. Looking largely into the personas of the many types of people caught in avalanches starting from individuals caught in a vehicle that was swept away on a mountainside road, an unsuspecting resident of an Appalachian town or village, all the way to the adrenaline seeking adventurist who traverses into dangerous terrain, one can understand that they are all very different. Some may be influencers on social media or free-willed nature lovers enjoying everything the planet offers to completely normal living, uneventful lives.

The purpose of this thesis is to add a better product to the market of life saving items for avalanche victims. As of right now the market is full of the same products that only cater to one or two dangers involved in avalanches in the preventative sense and other products cater to the finding of victims after they have already been consumed by an avalanche, by which snow has already compacted to a consistency of concrete. At this point in an avalanche there is currently no product that provides the victim with the most essential aspect of coming out of the avalanche alive as it is all resultant of available time before precursors of death set in.

Chapter 2 – Research

2.1 User Research

This chapter will link all the intricate variables that have been taken into context and consideration revolving around the specific user groups where one can understand the importance of multiple avenues of influence. This chapter will also include a look into existing products and what they offer, as well as how they fit in the daily activities of said users.

2.1.1 User Profile – Persona

Users

Primary users: Winter excursion enthusiasts

These users are typically categorised as winter sport athletes, winter adventure seekers, or day-to-day winter travelers. These are the people who typically are caught in various types of cold induced weather events leading to a harmful accident, more in line with avalanches and spontaneous crevice openings. Although each type of primary user is different in their own way, the dangers that they face in terms of weather are generally the same.

Secondary users: Search and rescue personnel

Search and rescue personnel as they partake in the search and the rescue of potential primary user victims are deemed the secondary users. These users would need a vast archive of knowledge and skills to carry out the operation through a numerous number of scenarios and environmental conditions. Many of which can be found on the spectrum of finding someone who has been missing for an extended amount of time to simply finding an injured primary user who cannot make it back to safety on their own but are not victims of a terrible weather related accident.

Tertiary users: Winter equipment retailer/repair worker

The tertiary user of this product has been determined to be retailers and repair workers as they are primarily tasked with having knowledge on vast amounts of winter equipment that range from sporting goods to “creature comforts” allowing for a more comfortable leisure experience. Many such locations are typically found within one another, and in doing so they provide attributes that would come in contact with any product in line with safety.

Demographics

Gender & Age

In relation to non motor sport winter athletic participation, the predominant group are males at 55.46% where females account for 44.54%. In terms of motor sport participation, 88% reside with males where the withstanding 12% reside with females. Each researched winter activity that yields dangerous outcomes are accompanied by there own variation of age group. Looking at the range of 12-43 years of age for the most avalanche inducing activities.

Education & Income

Excluding winter motor sport participation, only 43.43% currently have a university degree or other type of certificate in terms of their conclusive education. There is a nonrelated but highly inferred correlation to the income level of these participants where the general outcome is that primary users make greater than $75k a year. The variable used to mark the quantity in monetary value is USD.

Occupation, Language, and Ethnicity

Statistical analysis states that the percentage per job occupation resides with the category of “Other” where skiers make up 26.5% of the workforce in that category along with a majority English speaking participant at 62.5%, as snowboarders make up 33.1% of workers in that category along with a

majority English speaking participant at 65.7% (Ski Canada, 2014). Snowshoers are statistically ethnically majority Caucasian, accumulating for 75.3% (Snowsports Industries America, 2013).

Behaviour

Based on a collective average from multiple types of snow sport activities, there is a wide range of ages as well as a typical number of days that each age group participates in their desired activity throughout the year.

DAYS PARTICIPATING IN WINTER SPORTS / YEAR /AGE GROUP	
6-12	7.3
13-17	7.9
18-24	7.0
25-34	6.3
35-44	5.9
45-54	7.4
55+	6.5

Table 1 - Days participating in winter sports /year/age

The age group that has a higher frequency of participating belongs to gen. Z, who are individuals born after 1996. They are individuals who still may live with family or do not have much money to spend on trips and leisure. Subsequently they do have the most time and availability to participate as they do not have careers and continue to be enrolled in some type of educational institution. However, looking at the outlier age group that has a high frequency as well, it is reserved by the 45-54 age range. Generally speaking, these individuals reside in a career position that allows time to be taken off for leisure and in this position as well, have the money and means to participate in winter sports before getting to an age that induces fatigue, fragility, and lack of enthusiasm to participate.

User Persona

Name	Tyler Gill
Age	26 years old
Marital status	Single
Gender	Male
Education	High school GED
Income	$75k-$200k /year (Endorsements or contest winnings)
Location	Has residence in B.C, Canada but stays in hotels mainly
Family status	No wife and no kids
Frequency	Spends roughly 80% of year training and competing in Canada and New Zealand for approx. 7hrs/day
Likes	Snowboarding, mountain biking, meditating, being with friends
Fears	Mental health decline, broken bones, strained muscles, death by sport
Motivations	Feeling of doing it, love of outdoors, achieving something new, exercise

Table 2 - Fictitious user persona

Tyler is a 26 year-old professional snowboarder. He travels all over the world on company endorsements for his talent, participating in many different events and competitions. He only lives in hotels in whichever country he stays in or his house in British Columbia when he's back home. Tyler is a really down to earth guy who loves nature and everything in it. He has seen a fair share of injuries and mishaps on the slopes and because of this he likes to take care of himself in terms of safety, food, and

lifestyle choices. Tyler is no stranger to all types of snowboarding from regular mountain resort courses to back country off the grid.

User Behaviour

Tyler spends most of the year in the snowy mountains of either the Canadian Rockies or the New Zealand Alps as he switches between the two destinations when either country starts to experience their summer months. This will attest to approximately 80% of the year where he will be training or before competing. Typically, he will spend about 7 hours practicing various types of snowboard styles as to grow his repertoire of skills.

User Relationship with Avalanches

Tyler's relationship with avalanches is non-existent. He has heard stories, seen videos, and also seen in person what they are and what they can do. As a result, this is something he hopes to avoid and has taken the appropriate preclusions to survive or at least lighten the consequences if ever caught in an avalanche. The overall process has deprived precious resources from his snowboarding training and conditioning and wishes there may be an easier way to avoiding or lessening the dangerousness of being consumed in weather induced phenomena.

2.1.2 Current User Practices

Resultant of several expert interviews, key insights have been derived to understand aspects that can persuade the final design and outcome of this thesis project. It was mentioned that Canadian search and rescue response times can take on average, 8 hours. This however is different in European areas where search and rescue response times are much shorter as mountains and dangerous areas are closer to cities and towns, as well as having the availability to use cell phones as they are much closer to cell towers. It is said that affected individuals must take care of themselves until help can arrive if help is needed, although when allocating Canadian search and rescue volunteer personnel it can vary on the

availability due to a few factors that involve proximity to the launch base as well as time of day. However, experts and users say that avalanches can be predicted using such senses as sounds coming from the environment, the feeling of temperature increasing, and seeing “cartoon-ish” snowballs forming as they roll down the slope. Unfortunately, however if these signs are missed, it results in a very costly search and rescue mission and in terms of the types of people who become rescue personnel there has been a very big shift in the stereotypical big and burly individual to a mental health conscious individual. Experts and the seasoned users have noticed an increase in individuals partaking in winter mountain excursions, however, such people are not trained or skilled or have any knowledge in how to stay safe or survive if need be. In terms of products being seen on the slopes and in the backcountry, there is a higher use of technology and airbags although these products do not help if the user is not trained on how to properly use them as well as the lack of knowledge in basic survival skills that are very much needed post accident.

2.1.3 User Observation – Activity Mapping

There are multiple types of products currently on the market today in relation to finding, saving, or stopping an individual from being buried in an avalanche. Some are very rudimentary and mechanical where others are quite technologically advanced and some even being purely pneumatic with an invisible aesthetic which means that it is not noticed until activated.

Probe, shovel, and transceiver

- Individual gets swept away by avalanche
- Other party members stop and observe surrounding area
- Indications such as last point of reference of the individual, a search leader, and designated point of contact individual who interacts with professional search and rescue personnel
- An individual conducts a hasty search which is categorized as quick scanning of the area by proceeding down the avalanche zone with their transceiver on search

- Another individual conducts a fine search which is categorised as methodic zig-zagging down the avalanche zone with their transceiver on search
- Once either individual gets a reading they slowly move in on the pinpoint
- Once the victim is pinpointed, they mark out a $1m^2$ search area
- Probe the search area until the probe hits the victim
- Dig out the search area with a shovel
- Quickly clear out an airway for the victim and proceed to dig out the rest of them
- Keep the victim warm and if possible, treat any wounds allowing extra time for the victim until search and rescue personnel arrive

Beacon

- User peels off adhesive backing and attaches product to primary parts of body
- Individual gets swept away by avalanche
- Search and rescue obtain a missing/injured persons report
- Search and rescue send out a helicopter with a beacon transceiver hanging below on a cargo line
- Beacon transceiver receives location from user beacon
- Helicopter crew sends location to search and rescue personnel
- Search and rescue personnel carry out rescuing procedure using probe and shovel

Airbag

- User attaches airbag component to backpack or user purchases airbag integrated backpack
- User dawns backpack with airbag
- Individual gets swept away by avalanche
- User initiates airbag deployment

- User floats away on top of avalanche and becomes partially buried or not buried at all
- User walks away fine and continues on about their day or they proceed to call search and rescue for medical attention

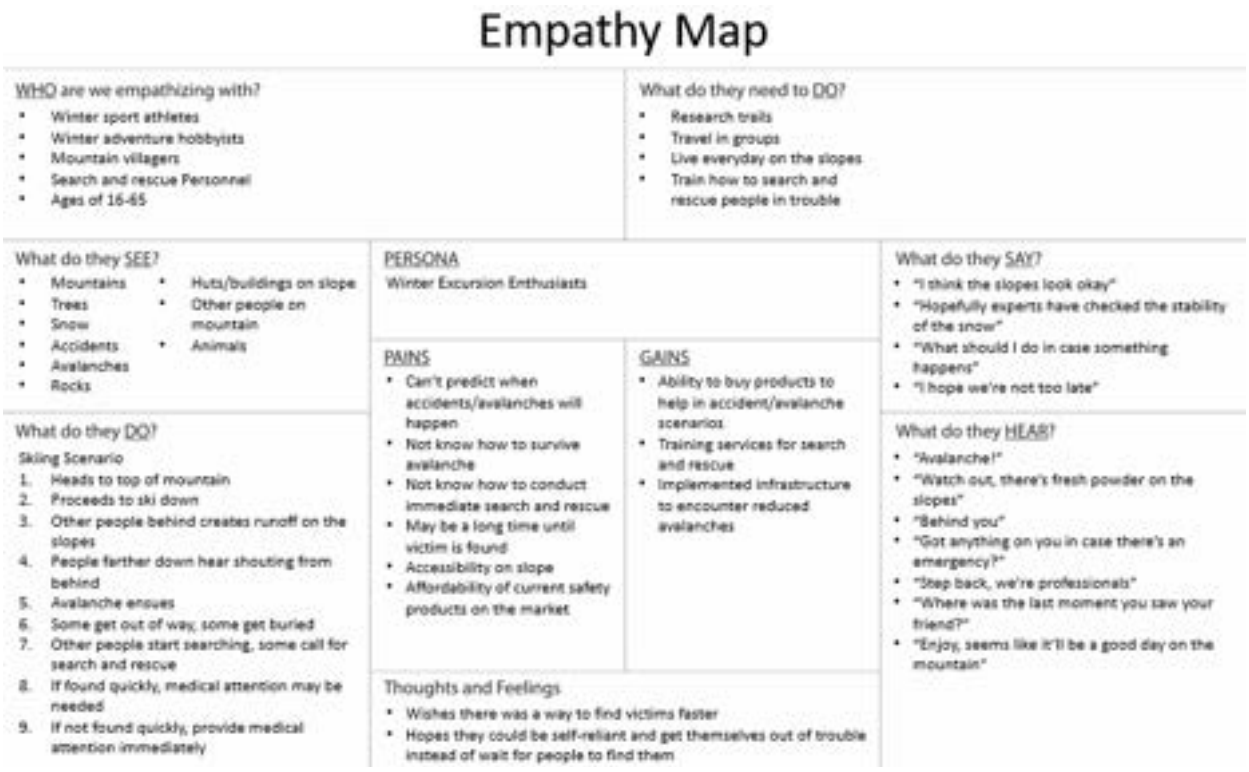


Figure 1 - Empathy map

This empathy map is derived from majority primary user empathy-based thinking and a small amount of secondary user empathy-based thinking.

User Journey Map

	PLANNING	PREPARATION	TASK 1	TASK 2	TASK 3	GOAL	FINISH UP
USER GOALS	Research new mountainous winter excursion destinations	Buy/collect all required items for trip	Deploy purchased avalanche product	Create suitable conditions to exit from avalanche	Get to a safe area	Make it back to safety	Replenish safety device if needed
USER ACTIONS	Look into reviews about destination	Research products that may be needed for said excursion	Determine best opportunity to activate device	Create airspace	Crawl/walk away from accident zone	Create conditions suitable to be found easily and alive	Go to nearest sporting store
	Research statements/ warnings on safety			Dig self out	Contact search and rescue		Purchase new or consumable item
USER THOUGHTS	I want to enjoy something I love doing but where	Will these items be enough for me to be comfy and safe	When and how	Don't suffocate, get hypothermia, am I okay	How long will it take for someone to find me	I'll be fine	This was a good investment
USER FEELINGS	Intrigued about what others have to say	Hopeful or happy about what's available	Worrisome about outcome	Stressed about panicking	Focused	Slightly worried	Happy and grateful
STORYBOARD PHOTOS							

Table 3 - User journey map

This user journey map is primarily based on the benchmarked airbag backpack product. Any and all steps would be typically found within a scenario involving an airbag backpack.

2.1.4 User Observation – Human Factors of Existing Products

Probe, Shovel, and Transceiver

Currently these products are only one size do too the nature that they can be used in all percentile groups. However, the shovel maybe telescopic to extend to different lengths as to a company different ergonomic proportions and comfortability.

Beacon

This product varies in shape which may also change its size but primarily is not sold in multiple sizes due to its nature of being adhered to another product being worn by the user.

Airbag

This product is currently the only avalanche prevention and safety product that is sold in multiple sizes depending on the percentile of the user. Many companies that make this product sell them in many different bag sizes but not airbag sizes if the two are integrated, there are many different sizes ranging from 15L capacity bags to 30L capacity bags.

These current products are sold in many ergonomic enhancing shapes and materials that include plastics, metals, and soft good materials such as a multitude of fabrics.

2.1.5 User Observation – Safety and Health of Existing Products

The currently available products on the market all hold the same level of health and safety standards. All of which need to assist the user in floating above the avalanche or perform in extreme conditions to find a victim. These products do not expand broader than these base levels of health and safety. However, smaller and not-so-specific products purchased to be used in avalanche scenarios such as fire starters and reflective blankets, hold a different use but also align with the primary benefit of protecting or sustaining the user.

2.2 Product Research

The following will be the benchmarking of existing avalanche safety and prevention products that involves a closer scrutinization of multiple aspects that are detrimental to determining what needs to follow along with the thesis product thinking as well as what needs to be added or improved to make this thesis product a viable solution to the problem at hand.

2.2.1 Benchmarking – Benefits and Features of Existing Products

This section will provide a comparative analysis of seven separate products that vary in their ability to protect and provide added features to the user allowing them to survive not only weather

induced phenomena but weather in general. The product's following along will include added mini products that can be used for all percentiles, airbag backpacks that are provided in a multitude of sizes for different percentiles, and generalized products that serve the user separately than avalanche safety.

Note that these products are readily available on the market for user purchase and only provide one or two specific or general services.

	TABLE: Interaction in Benchmarked Winter/Survival Products						
							
	1	2	3	4	5	6	7
	Emergency Winter Car Kit	Home-made Winter Car Survival Kit	The North Face Avalanche Airbag	BCA Float 2.0 Avalanche Backpack	Osprey Talon 26 Hiking Backpack	Dope Blizzard Snowboard Jacket	Montec Doom Snowboard Jacket
	Interaction						
Mechanical	x	x					
Pneumatic			x	x			
User	x	x	x	x	x	x	X
Environment						x	x

Table 4 - Interaction in benchmarked products

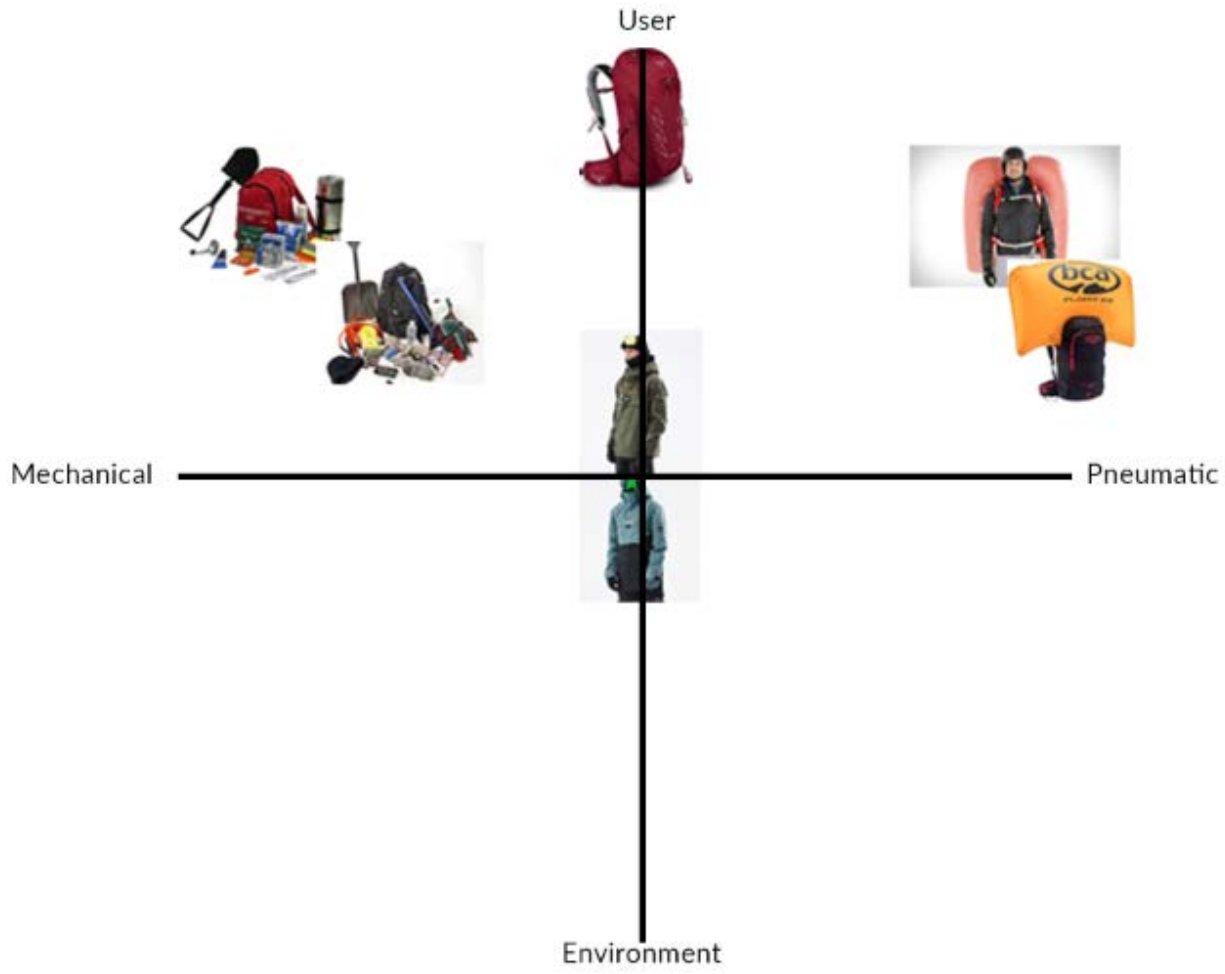


Figure 2 - Product Interaction Chart

There is an exponential opportunity to develop a product that does not heavily rely on mechanical intricacies or pneumatic complexities as well as not entirely being in contact with the users needs or protection from environmental implications. The center point of the axis represents a revolutionary product that will provide life saving opportunities to the user with the possibility of still looking fashionable.

Benefits

TABLE: Benchmarked Product Benefits						
						
1	2	3	4	5	6	7
Emergency Winter Car Kit	Home-made Winter Car Survival Kit	The North Face Avalanche Airbag	BCA Float 2.0 Avalanche Backpack	Osprey Talon 26 Hiking Backpack	Dope Blizzard Snowboard Jacket	Montec Doom Snowboard Jacket
Benefits						
Versatile Large variety of tools Medical items Shelter items	Comfort items Versatile Built for user needs	Easy to use Large airbags Large storage area Allows to hold items in bag	Easy to use Large airbags Large storage area Allows to hold items in bag	Large storage area Compartments to hold tools Compartments to hold gear	Easy wear Good coverage Large pockets insulated	Easy wear Good coverage Large pockets insulated

Table 5 - Benefits in benchmarked products

The product's being benchmarked carry a wide variety of benefits that do in fact carry over in one way or another from product to product. However, these are all products that deliver very different attributes to the user and by doing so provide a unique aspect to that user's comfortability and usability of said product.

Features

	TABLE: Benchmarked Product Features/Functionality						
							
	1	2	3	4	5	6	7
	Emergency Winter Car Kit	Home-made Winter Car Survival Kit	The North Face Avalanche Airbag	BCA Float 2.0 Avalanche Backpack	Osprey Talon 26 Hiking Backpack	Dope Blizzard Snowboard Jacket	Montec Doom Snowboard Jacket
	Features						
Weight	Varies	Varies	6.9 lbs	2.66 Kg	1.066 Kg		
Material	Varies	Varies		Nylon	Nylon		
Volume	Varies	Varies	24 Litres	42 Liter	26 L		
Size	Varies	Varies	20"x11"x5"	55x33x23cm	S-M,L-XL	XS,S,M,L,XL,2XL	XS,S,M,L,XL,2XL

Table 6 - Features/functionality in benchmarked products

The product's being benchmarked will carry a wide variety of features that do in fact mirror other products in one way or another. Many of which involve sizing where the product is offered in a multitude of different sizing's. These attributes allow the user to comfortably enjoy the product they have purchased as well as be able to be as safe as possible when entering dangerous areas or extreme weather.

2.2.2 Benchmarking – Functionality of Existing Products

Many products currently available in the market for avalanche safety or user accident prevention are either a wearable product or a handheld product that is stored away in a wearable accessary. These include backpacks or sleds, depending on the scenario that the user is currently in. These items tend to be very ergonomic in their sizing as well as the materials being used. Although some improvements can be made in terms of redesigning these products following a different layout or incorporating additional features.

This thesis project will not be about a redesign of these current products, but it will be derived from a multitude of them that allows for a never-before-seen product to which a user can ultimately feel like they can enter any dangerous scenario found on a snowy mountain slope. This is something that is publicized by current benchmarked products but unfortunately cannot truly deliver on that promise.

2.2.3 Benchmarking – Aesthetics and Semantic Profile of Existing Products

In a general sense given that this is a product that will revolve around safety, aesthetics and semantics will primarily need to revolve around helpful attributes such as being seen from distances, symbols being understood by all types of users without any sorts of physical, mental, or language barriers.

Traversing across multiple decades, one can notice the highly visible colours incorporated with winter excursion items. This also happens today in an attempt to subconsciously draw in a passerby's field of view.

	TABLE: Aesthetics in Benchmarked Winter/Survival Products						
							
	1	2	3	4	5	6	7
	Emergency Winter Car Kit	Home-made Winter Car Survival Kit	The North Face Avalanche Airbag	BCA Float 2.0 Avalanche Backpack	Osprey Talon 26 Hiking Backpack	Dope Blizzard Snowboard Jacket	Montec Doom Snowboard Jacket
	Aesthetics						
Shape	Geometrical/ organic	Geometrical/ organic	Organic	Organic	Organic	Organic	Organic
# of sub-items	Many	Many	Few	Few	None	none	None
Colour	bright	dark	bright	bright	bright	bright	Bright
Type of product	Wearable	Wearable	Wearable	Wearable	Wearable	Wearable	Wearable

Table 7 - Aesthetics in benchmarked products

Table 8 - Product aesthetics chart

Aesthetics

Primarily as you can see from figure 4 above, in terms of colours, they tend to be bright and highly visible. In terms of form development, there is a high dependency on external user perception, this would mean that depending on the user who would purchase these items they may feel it is nice to have something more organic or more geometric, but this would vary depending on each user. However, it may be beneficial to incorporate something that is organic as it would be easier to adhere and/ or incorporate closely to a user's body when developing this piece is product.

Semantics

Although semantics are not thoroughly examined or predominantly visible on any of these currently available products, there is the notion that anything involved with medical, or trauma care kits may contain a possible red or white cross depending on a red or white background that the cross is laid on. In relation to the airbag backpacks, there may also be the subconscious realization that a handle shape and form could perfectly coincide with the shape and form of a hand which would insinuate the notion to pull in order to deploy the airbag.

Derived from all attributes of all benchmark products, there is the current notion that the thesis product to be developed and created needs to transcend any and all barriers that would require extensive knowledge and/ or training on the product in order to use it. Aside from a couple products benchmarked, all other aspects of all other products can be freely used by any willingly purchasing user, this allows for a streamlined application of this product into that user's winter excursion lifestyle.

2.2.4 Benchmarking – Materials and Manufacturing of Existing Products

Items within the winter sport industry are striving to be as environmentally sustainable and obtain as many ethical standards as possible. However, companies developing ski and snowboard jackets, avalanche airbag backpacks and winter survival bags can only do so much.

Material/Manufacturing	Sustainable Aspects	Reference
RPET (Recycled Polyester)	Pre-/post- consumer plastic/polyester waste is used to create this material. PET bottles are the most common source.	https://www.g-star.com/en_ca/shop/men/premium-clothing/d22716-b958-d303
PrimaLoft Gold Insulation Eco with P.U.R.E	Range of recycled content percentages. P.U.R.E allows for 70% reduced CO2 emissions in manufacturing PrimaLoft Gold Insulation Eco	https://www.patagonia.ca/product/mens-nano-puff-jacket/84212.html?dwvar_84212_color=LTPG&cgid=mens-new-jackets-vests
PFC-free DWR	Perfluorinated compounds are non-biodegradable. PFC-free is the removal of these compounds.	https://www.mammut.com/int/en/products/1013-01620-50381/eigerjoch-advanced-in-hooded-jacket-men
Responsible Down	Down and feather production from well-treated animals, live-plucking and force-feeding practices are not included in this production method.	
Recycled Nylon	Pre-/post- consumer plastic/nylon waste is used to create this material.	https://www.outerknown.com/products/apex-jacket-by-kelly-slater-pitch-black
Kapok Insulation	Natural Kapok tree seed pod fibres	https://www.thokkthokkmarket.com/en/man/jackets/jackets/tt2025-kapok-jacket_5165_27822

Table 9 - Current sustainability efforts in market

These brief few materials used by companies in the market currently are the most common to incorporate within apparel and other products. Due to environmental push for companies to be more conscientious about their materials and manufacturing processes, it would inevitably revolve around recycling methods or naturally regenerative resources.

2.2.5 Benchmarking – Sustainability of Existing Products

Many companies along the luxury line of winter sport apparel introduce sustainable initiatives throughout their entire company or within a particular product. TenTree for example, commits their entire line of products to the sustainable approach of planting 10 trees per item sold. Alternatively, a large number of companies participate in sustainable initiatives through incorporating recycled materials to create their fabrics to which they manufacture their product lines. There are however, variances in the percentage number of recycled materials used to create these pieces. Many other

companies take part in ethical initiatives like free trade campaigns where their foreign manufacturing employees are paid premium wages to provide a livable income compared to many others. Additionally, some strive to incorporate animal rights ethics into their product lines and company structure as these companies do not want to change their insulation material. These companies use bird down and feathers rather than synthetic materials.

2.3 Summary of Chapter 2

Important factors to derive from this section of chapter 2 is that many products currently in the market are bright colours that bounce between organic and geometric form development. Generally, they have multiple sizes for multiple needs or possibly multiple percentile users, as well as allowing for an easy and uninterrupted step by step approach to incorporating a product into their lifestyle. Ultimately, this allows for a product to be developed that serves all possible interfaces including mechanical, pneumatic, user interaction, and environmental interaction.

Chapter 3 – Analysis

3.1 Analysis – Needs

The following pages of chapter 3 will overlook previous contributions to this thesis in determining what particular attributes must be taken into consideration above others when designing the solution for the problem at hand. Primarily analyzing the needs of the end user to inform design features that must be incorporated.

3.1.1 Needs & Benefits Not Met by Current Products

Users primarily need to feel safe; this can come in many different ways. The first way, being safe from the elements; winter, the cold, and all of its weather conditions can wreak havoc on the human condition known as mortality. Due to our ability to become hyperthermic, the user would need to be provided with a barrier between them and their surrounding environment although this is currently available in a variety of readily available products on the market which makes improvements on this aspect quite difficult. Further deliberation and design on aesthetics and materials may be a pathway to having a revolutionary product rather than a mere redesign. Following along, our innate inability to endure prolonged periods of time whilst holding an assortment of extra items is something that must also be looked after. Users currently participate in activities or hobbies that require an assortment of additional products that provide many different kinds of tasks or services. The opportunity to revolutionize the carrying system or apparatus would be key as long as it has the capability to carry an abundant number of extra items. Lastly, due to the human nature of curiosity, the user continuously tends to find themselves caught in strenuous circumstances and as such, these circumstances can only be found on mountains or winter weathered environments it may open the possibilities to life or death scenarios. Including safety features of multiple varieties is the most crucial aspect to creating a revolutionary product worthy of solving the problem definition. There is a multitude of safety features that can be added to a winter excursion product that provides a sense of security and invincibility when deciphering human presumptions on a particular attribute.

3.1.2 Latent Needs

The strategy used in this example was to look at two products separated along the cost spectrum. Aside from common benefits, other differentiated benefits would also become clear.

The current products examined were avalanche airbags.

Needs Statement for a New Product

Two Products: Airbags – dual bag vs. one bag

The North Face Avalanche Airbag

BCA Float 2.0 Avalanche Backpack

Benefits and Features- from Promotional Literature

Benefits	Features
Safe	Strong nylon materials
Easy to use Pull string	Backpack integration
Size Airbag volume	Many liters of compressed air availability
Storage capability	Large dimensions for lots of storage

Table 10 - Benefits and features of benchmarked airbag products

Table 9 below determines the level of importance correlated to a specific attribute of each category of Maslow's hierarchy of needs pyramid.

LINKING BENEFITS WITH NEEDS – Airbag Backpack

Product- Airbag Backpack				
Needs	**Benefits and Underlying Needs**	**Level of importance**		
Basic Needs Physiological				
Food, water, shelter	Stores food and water in bag			High
Pleasure, gratification (sensory, compulsive responses)	Mentally **feels safe** with airbags Backpack alone doesn't provide covering from elements (**feels environment conditions)**		Moderate	
Security Safety, securing resources				
Safety	Increased avalanche survival chances			High
State, Group, Individual	Worn on individual level			
Securing resources Optimization of limited resources (cost effectiveness) • Value • Accumulation of resources (wealth)	Price is important to activity experience level		Moderate	
	Reliability			High
Control over environment (tasks)	Product (tool) that amplifies human abilities			
Convenience Ease of Use	Applying backpack to user Using the features and availabilities allotted per unit Pulling deployment cord		Moderate	 High
Speed (fast, less time)	Weight and size of bag limits speed			High
Control (precision, responsiveness, power)	General deployment quickly after initiation (no precision)			High
Long Term Security/Stability of Group Health/care/education of children	Caring for baby Is my baby warm enough? Comfortable? Feeling safe?			High
Environmental sustainability				
Insurance (car, house), pension, investments	Strollers are a form of security of the baby for parents	Slight		
Social Belonging Effort / resources to belong to a 'tribe'				
Fear of Abandonment				
Fear of the enemy				
Tribal Identity	Brand purchase	Slight		
Behavior cues for survival (copying behaviors… safe to eat, learned skills)	Survival skills/equipment knowledge		Moderate	
Behavior cues for social interaction of group (copying behaviors… Interaction cues, play, have fun)	Used in setting where everyone is enjoying themselves			
Peer Pressure				
Social Expectation (social covenant (gift))				
Esteem **Personal influence in 'tribe'**				
Social Status 'The elite have it…I want to be like them'	Deliberation on if safety is cool		Moderate	
Social Recognition				
Sexual attractiveness	Deliberation on if safety is sexy Deliberation on which styling is sexier		Moderate	
Self-Actualization 'Higher order' Functions/Needs **Needs that are pre-dominantly 'outer cortex'**				
Intrinsic pleasure	Aesthetically pleasing	Slight		
Creative endeavors				
Experiential (extrinsic)	New product feel	Slight		
Experiential (intrinsic)				
Emotional				

Table 11 - Maslow's hierarchy using benchmarked airbag backpack

Benefits of both

- Easy to use
- Large airbags
- Large storage area
- Allows to hold items in bag

Benefits of Each

Product A: Dual Airbag

- Easy to use
- Large airbags
- Large storage area
- Allows to hold items in bag

Product B: One Airbag

- Easy to use
- Large airbag
- Large storage area
- Allows to hold items in bag

3.1.3 Categorization of Needs

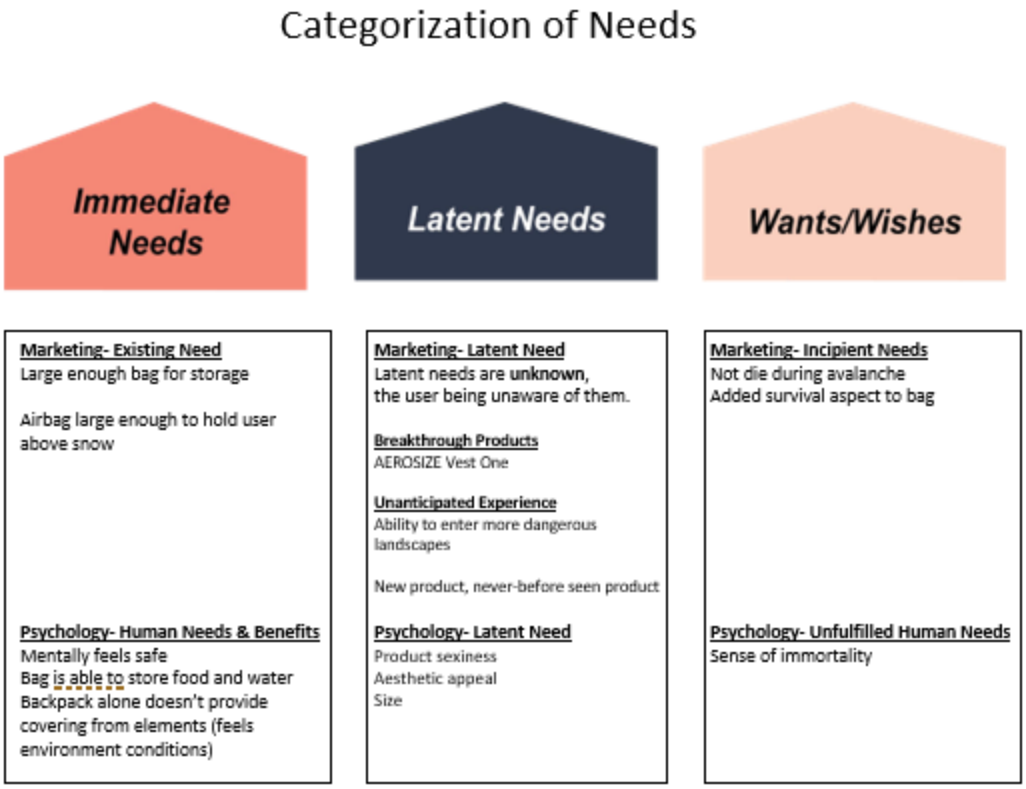


Figure 3 - Categorization of needs

3.2 Analysis – Usability

This part of the chapter will determine the overall user emotional experience when trying to complete a task in a predetermined environment. This would normally coincide with the chosen scenario that has dictated the journey and experience mapping outlines.

3.2.1 Journey Mapping

User Journey Map

	PLANNING	PREPARATION	TASK 1	TASK 2	TASK 3	GOAL	FINISH UP
USER GOALS	Research new mountainous winter excursion destinations	Buy/collect all required items for trip	Deploy purchased avalanche product	Create suitable conditions to exit from avalanche	Get to a safe area	Make it back to safety	Replenish safety device if needed
USER ACTIONS	Look into reviews about destination	Research products that may be needed for said excursion	Determine best opportunity to activate device	Create airspace	Crawl/walk away from accident zone	Create conditions suitable to be found easily and alive	Go to nearest sporting store
	Research statements/ warnings on safety			Dig self out	Contact search and rescue		Purchase new or consumable item
USER THOUGHTS	I want to enjoy something I love doing but where	Will these items be enough for me to be comfy and safe	When and how	Don't suffocate, get hypothermia, am I okay	How long will it take for someone to find me	I'll be fine	This was a good investment
USER FEELINGS	Intrigued about what others have to say	Hopeful or happy about what's available	Worrisome about outcome	Stressed about panicking	Focused	Slightly worried	Happy and grateful
STORYBOARD PHOTOS							

Table 12 - User journey map

This user journey map is primarily based on the benchmarked airbag backpack product. Any and all steps would be typically found within a scenario involving an airbag backpack.

3.2.2 User Experience

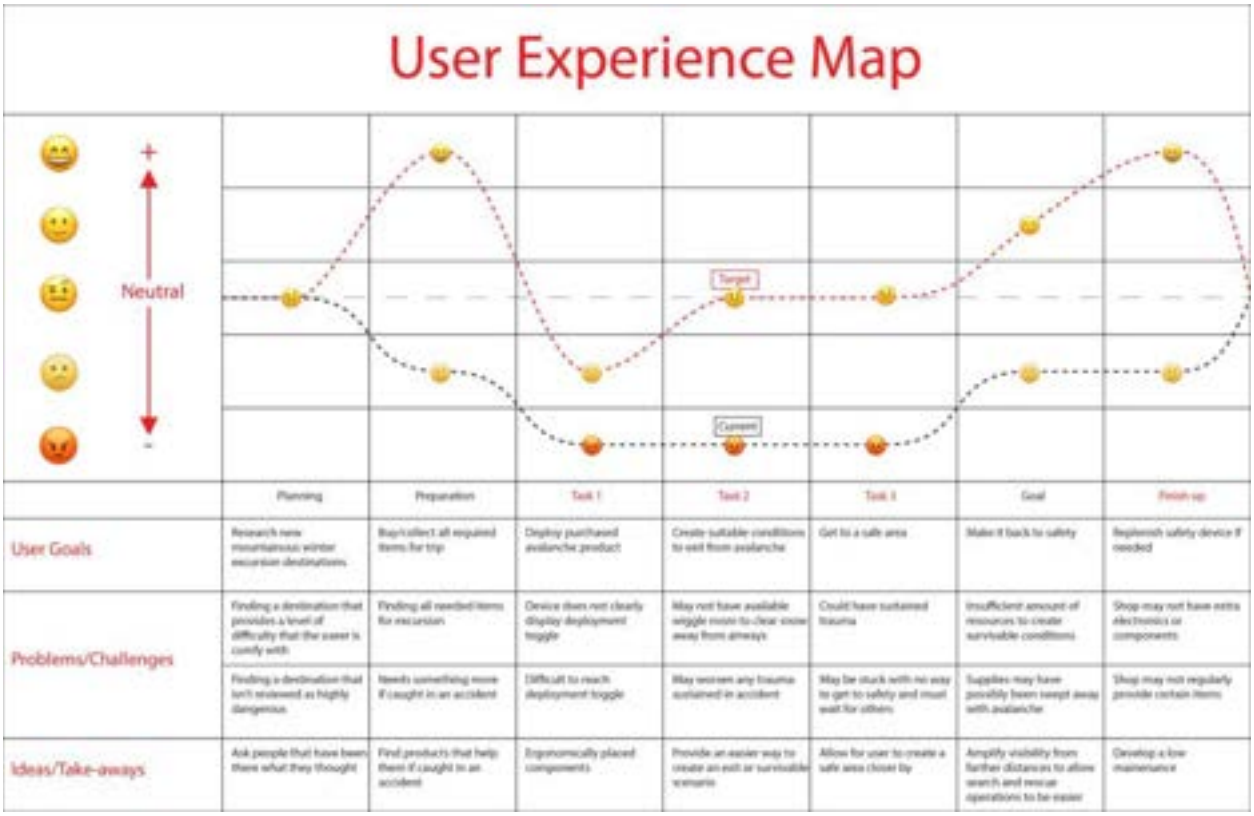


Table 13 - User experience map

This user experience map is primarily based on the benchmarked airbag backpack product. Any and all user goals would be typically found within a scenario involving an airbag backpack. The correlating experiential values exhibit a current airbag backpack and the targeted experiential values correlating to the proposed thesis product.

3.3 Analysis – Human Factors

This current section of the chapter shows a preliminary exploration of the proposed thesis product where its ergonomic considerations are viewed in full scale likeness. The following product schematic developed a thought process that influenced the ergonomic 1:1 human scale study based off the alignment of certain attributes of the preliminary design.

3.3.1 Product Schematic – Configuration Diagram

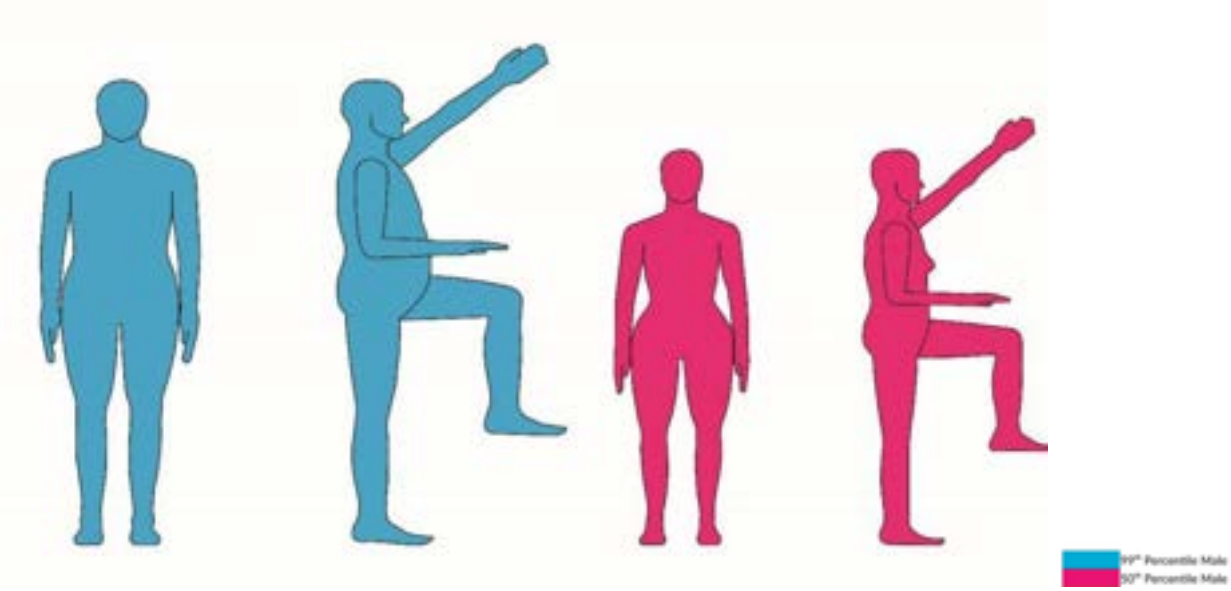


Figure 4 - User Schematics

Figure 6 goes on to show the 99th percentile male figure in blue along with all the attributes and subsystems correlating to the preliminary design. This also shows the 50th percentile female in pink with all the attributes and subsystems correlating to the preliminary design. These two percentiles were chosen based off the observed majority of users in winter excursion activities, where the male percentile is primarily 6 feet and 3 inches tall, and the female percentile is primarily 5 feet 4 inches tall. This allows for a 1 foot variation which can be accustomed by the proposed thesis product design, in ways that are linked to adjustable straps and malleable materials. However, this is a product that will be available in multiple sizes as it is part of the clothing industry where within that particular industry multiple sizes are made available for multiple body styles and heights.

3.3.2 Ergonomic – 1:1 Human Scale Study

An ergonomic evaluation was conducted to determine the user standpoint of the product interaction, comfortability, and overall product rational sizing. This was done in accordance to obtaining insight as to the manoeuvrability ergonomics of the user, the main functionality of the survival pack, And the overall make up of the survival pack and a jacket together. An observation was undertaken with

the priority of exposing dimensional flaws within the design of the product. Keeping in line with the key objective, a 1:1 scale model was created and worn in order to then self evaluate and document through photographs to illustrate flaws in the design or dimensions chosen. Not long after, the key objective was reached and a general finding was observed, where some dimensions within the jacket could be slightly bigger. Connecting to the big picture at hand, redesigning the jacket dimensions may work best for the overall scope of the thesis.

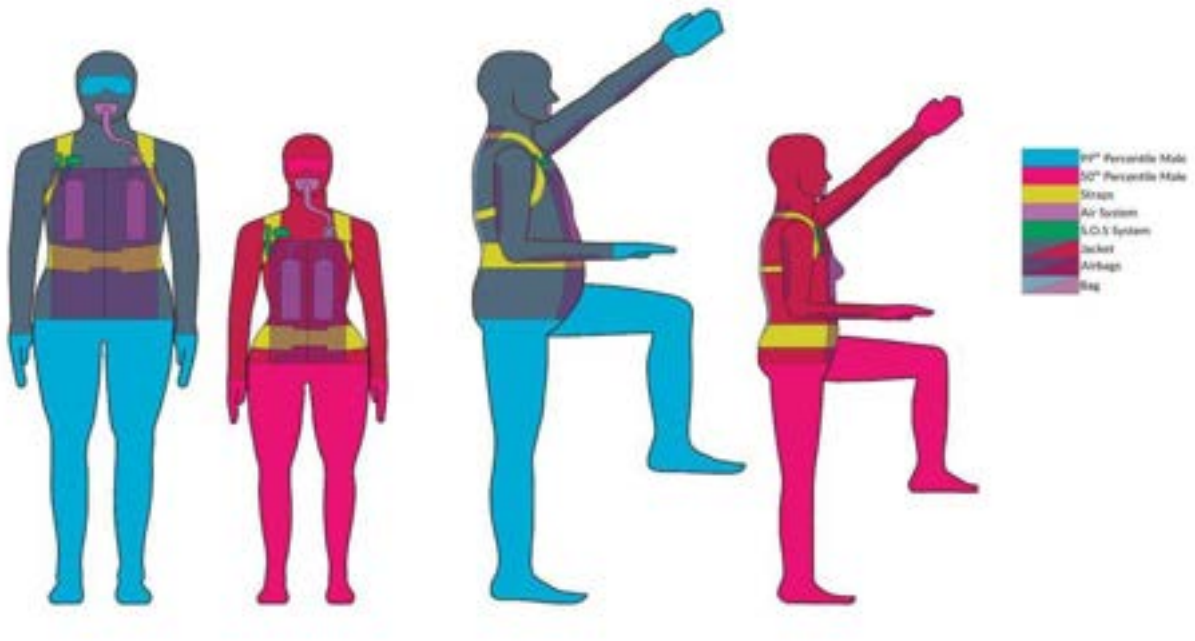


Figure 5 - Product Schematics

Literature review

The ergonomics and anatomic ratios or derived from Henry Dreyfus measure of man and woman. These images were then later used as templates to correctly size a 3-D model form in the appropriate sizing's of men and women within an app labelled MagicPoser. From these sources it was determined that the 99th percentile male and the 50th percentile female were to be chosen as primary users of this product. These measurements coincide with the projected target demographic.

Methodology

Abiding by the following concerns and conditions, an ergonomically evaluated and analyzed report of current avalanche prevention products was created. The main rationale for a 1:1 scale size mock up model is purely based on the 3-D form factors that revolve around comfortability when wearing the product. This entails making sure all dimensional properties are properly chosen and are specifically meant for the use in which the product will be enveloped in.

Results

Figure 6 - Fit of Jacket Generally

Figure 7 - Expression to Press Airbag Button

Figure 8 - Use of Side Zipper

Figure 9 - Maneuverability to Grab Bag Off Back

Figure 10 - Using Tent

Figure 11 - Using Tent

Analysis

Using images as well as user feedback of the 1:1 scale model, the dimensions within the jacket will more than likely be changed. As per the tent within the bag and the bag itself, there seems to be no problems with the current standing dimensions or anything else for that matter. Moving back to the jacket, it seems that the arm measurements as well as torso measurements are a bit off. Reviewing the tent and bag, the tent area seems to be just spacious enough for an injured or adrenaline filled avalanche victim to easily crawl in and rest without a claustrophobic feel. The bag neatly and nicely fits onto the back of the 99th percentile male and may be a tad large on the 50th percentile female. Other than this, the bag construction has adequate space to allow for a shovel head to fit under the storage compartments, an abundance of space for medical and trauma care kits as well as food and water rations. The 6 foot long tent is easily packed back into the bag and does not require any forcible adjustments to have it work otherwise.

Limitations and conclusion

Looking at the major areas of the body that come into contact with the avalanche survival unit, it would seem to include the torso, the arms, the back, and the head. For the torso region, the airbags

and air system apparatus seem to work well enough with the adequate space provided. The back in correlation to the bag, seems to comfortably support the survival bag. The arms and the head however, were not measured in their full capacity of ergonomic interaction with the product. The head did not interact with the jacket hoodie or respirator system, where the hands may have only touched the bag itself but did not touch its contents and survival tools.

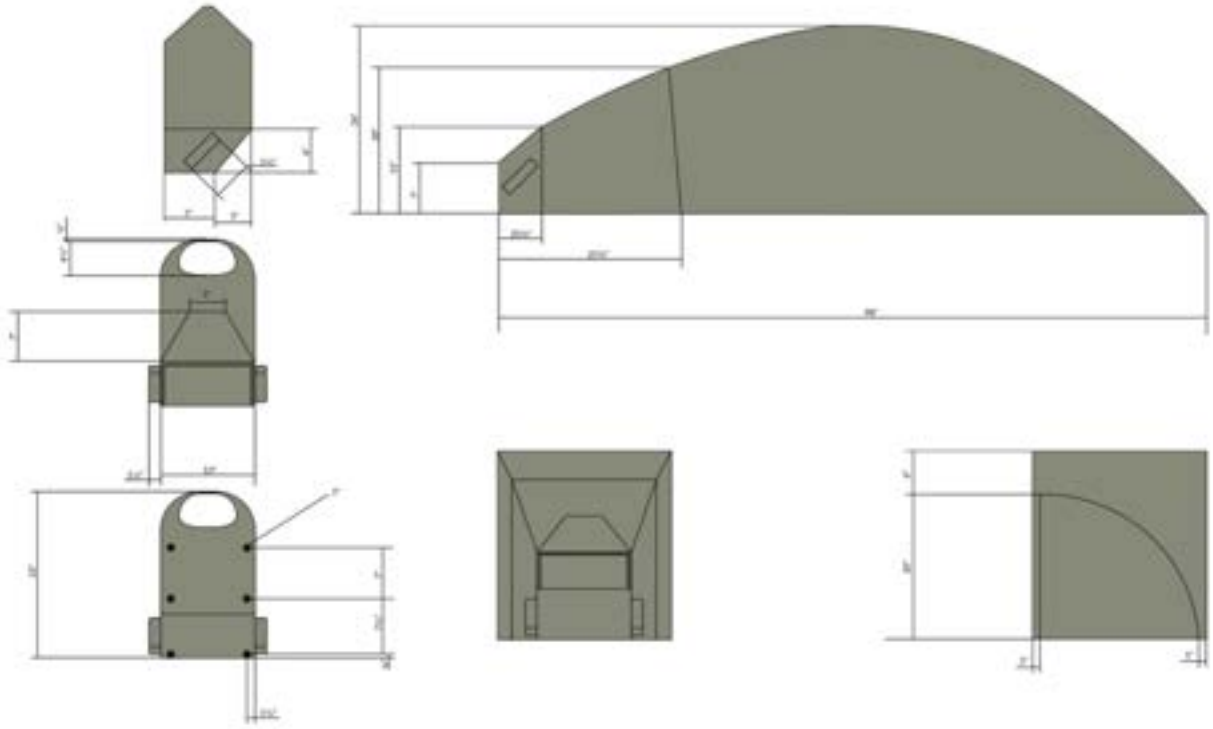


Figure 12 - Preliminary Avalanche Survival Bag Dimensions

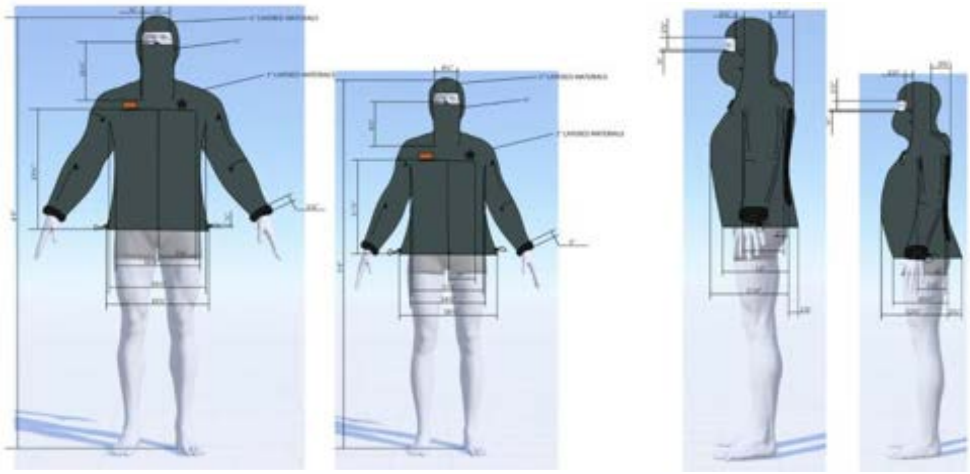


Figure 13 - Preliminary Jacket Dimensions

3.4 Analysis – Aesthetics & Semantic Profile

Currently at this point, aesthetic and semantic profiles are constantly changing as new and newer concepts are developing within the thesis timeline. There is a core underlying understanding that this product must be used by anybody and everybody from any walk of life without needing to read a manual or sit through training courses in order to use it. Given that this is supposed to be a safety product, “sex appeal” is very limited as it must provide the primary deliverables of protecting and saving the user's life when required. However, there is a preference of styling within clothing that the designer does enjoy, and this would have to be modelled after tapered and fitted clothing styles, and as one can see in figures 7 - 13 within subheading 3.3.2, the wearable product conforms to the curvature of the wearer's body in a more extreme fashion then current competitors available on the market currently.

3.5 Analysis – Sustainability: Safety, Health, and Environment

When it comes to the victim of an avalanche, their safety and health are at the forefront of the perceived scenario. However, the secondary stakeholder, the rescuer, also needs to be able to keep themselves safe and look after their own health. Sandra Riches, executive director of B.C AdventureSmart explains how on average it takes 8 hours for search and rescue personnel to reach and save an avalanche victim. Alternatively, Joe Obad, executive director of the Canadian Avalanche

Association claims that in Europe, it generally takes under half an hour. Two very different response times, for two very different geographical locations, and for two different levels of readiness within the local search and rescue teams; but no matter the response times as the saying goes, “weather always dictates”. In the event that a disaster occurs during inclement weather, the search and rescue personnel will not voyage into dangerous terrain to save one or multiple lives at the expense of their own. It was for this piece of knowledge that the decision to create a product with multiple features to prolong the survival chances of the victim in multiple different facets of the situation.

During the interviews conducted earlier on in the research both Sandra Riches and Joe Obad concur that during the avalanche, someone caught within one could sustain severe bodily harm if they were in the trajectory of rocks and trees. From this, they both mention that it is the due diligence of the victim to have gone through some sort of medical first aid training for this very reason or if they were in a group to at least administer it on another individual. One can only hope that the individual has packed a sufficient medical kit or has replenished used components to their kit from the last instance they had used it. This particular line of thought was the inspiration to the incorporation of features that combat many injuries in a variety of severities such as dangerously low core body temperature to broken bones.

When thinking about the environment of use for this product, it lends itself to be quite self explanatory that the slopes of snow covered mountains, all its ridged and dangerous terrains as well as the immediate surrounding area will be the primary use of this product. Within these realms many different circumstances dictate what features may be needed as well as the context of the survival scenario in relation to an individual getting caught in an avalanche. There is the possibility of being one of the lucky few that are part of a group capable of escaping the path of one but now must search for a companion that was swallowed by a wave of white. These circumstances and environmental variances demand an array of features to serve the user in more than one way.

After tantalizing scrutiny of all possible features and benefits to be incorporated into the design, the finalized rendition of its form and function stands to serve all possible scenarios that it and its user could face.

3.6 Analysis – Innovation Opportunity

Derived from the research that was accumulated amongst all benchmark products, as well as all user feedback on these products, and incorporating the interview feedback, there is not a clear direction on where to take this thesis. What is clear though, is that there are many products available to users in this lifestyle that they are able to use, however, these products only offer a limited amount of functions or services. The creation of one multi functional, all in one item is needed to accommodate the life sustaining needs of the user.

3.6.1 Needs Analysis Diagram

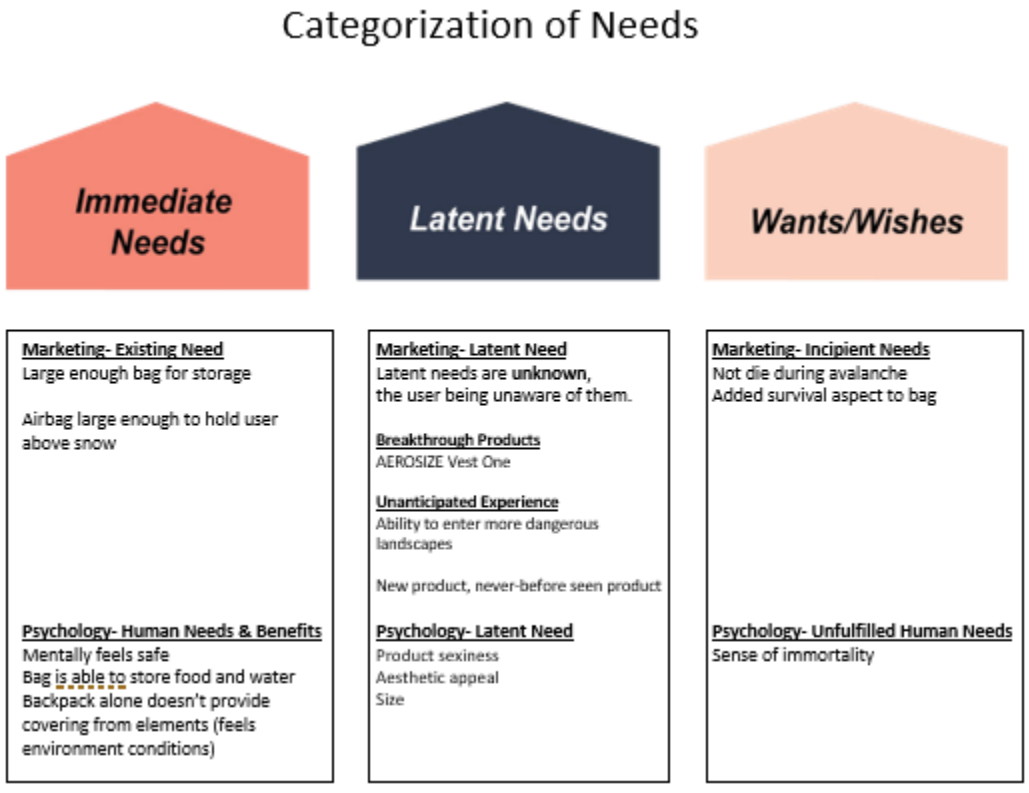


Figure 14 - Categorization of Needs

3.6.2 Desirability, Feasibility, and Viability

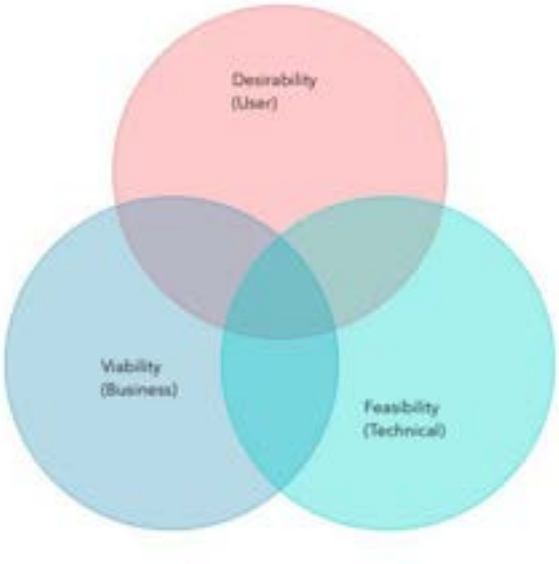


Table 14 - Human Centered Innovation Approach Diagram

The user may desire something lightweight and compact. This proposed concept may want to include the ability to not make their functions limited or hinder their ability to perform the activities they set out to do. Alternatively, they also may not want to sacrifice safety abilities and storage capabilities in the proposed concept. This then brings forth the challenge of creating a product that is generally bulky when imagining a product with safety features, while at the same time, making sure it is not bulky as to keep up with aesthetic appeal that users wish.

This design must turn out to be able to fit into a market gap that is clearly displayed, which would then prove its viability. Understanding that the closest products that serve the users needs would be that of airbag clothing and airbag backpack accessories along with multiple small products. Following along this path and exceeding it would allow for this product to fit comfortably at the centre of what the user would like to purchase. A favoured stream to pursue is a product that incorporates all other products in the market.

Understanding that with safety it may require a larger design, and then further understanding that the user does not want a large item means that technology and industry practises must be utilized

to its extent in delivering a feasible product. Materials would need to serve its intended purpose, as well as possibly administer a sustainability or ethical additive that is pleasing to the market. The technology may be crude and perform its intended function, or possibly outlandish and be held within theory. Technology would be the largest obstacle to overcome. In terms of manufacturing and development, the process could possibly succumb to a retrofitted manufacturing facility or may very well need to have the entire process reimagined to fulfil the concept.

The material that meets the elements must be strong, durable, as well as possibly waterproof, depending on the concept. Materials that fall under these credentials may also need to be scrutinized for ethical and sustainable standards to adhere to the needs and wants of the market.

The selection of materials and manufacturing processes will need to be researched further and looked at under the microscope of ethical standards and regulations as well as sustainable standards and regulations. Having to incorporate humanitarian standards and regulations within the manufacturing process may need to be undertaken as to combat corrupt and disastrous practices that many in the user market are against.

3.7 Summary of Chapter 3 – Defining Design Brief

Simply put the opportunity to innovate within the marketplace for avalanche safety equipment would be in developing a never before seen product that allows the user to seamlessly save themself from going under an avalanche and proceed to safety or allow them the time to be saved once they are affected by an avalanche. Tignes Spirit, an independent ski and snowboard company concluded from their research that 15 minutes trapped in an avalanche is all it takes for someone to pass away as a result of asphyxiation. In the book, High Altitude Medicine and Biology, it states that it takes under an hour for the human body to develop severe hypothermic symptoms post-avalanche. Avalanches are not 100% predictable and in that, they can happen at any time meaning that nobody knows if they are next.

To outline the criteria, most important to focus on when developing ideation for this thesis, it would be:

1. Provide safety equipment or tooling
2. Provide shelter or accessories to help in creating an improvised shelter
3. Features to combat hypothermia and cold winter conditions
4. Features to combat suffocation
5. Features to allow the user to not be trapped under an avalanche
6. Aspects revolving around search and rescue locating
7. Aspects revolving around search and rescue extraction
8. A design that fits into the lifestyle aesthetic
9. Materials that adhere to the moral standings of the proposed target market
10. The ability to use the product seamlessly without hindering on user activity performance

Chapter 4 – Design Development

4.1 initial Idea Generation

Starting this chapter will be the preliminary concept creation that started the thinking process. Following was the deliberation on where certain aspects were passed along into the final concept as well as where features and aesthetics along with semantics were taken into consideration to best serve the end-user.

4.1.1 Aesthetics Approach & Semantic Profile

Figure 15 - Preliminary Inspiration Board

The images portrayed has influenced and inspired the end result in concepts in areas such as performance wear the features were the main pillar on which to build the rest of the concept. These

attributes mainly pertain to safety as well as high visibility as to make sure that it followed in suit with view problem definition of creating a more efficient avalanche search and rescue effort.

After acquiring multiple sources of inspiration as well as deriving aesthetic or semantic influence, it mainly came from the more functional side of design rather than the glamorous and luxurious side of design given that a human life would generally be at stake when using this product.

4.1.2 Mind Mapping

Table 15 - Mind Map

4.1.3 Ideation Sketches

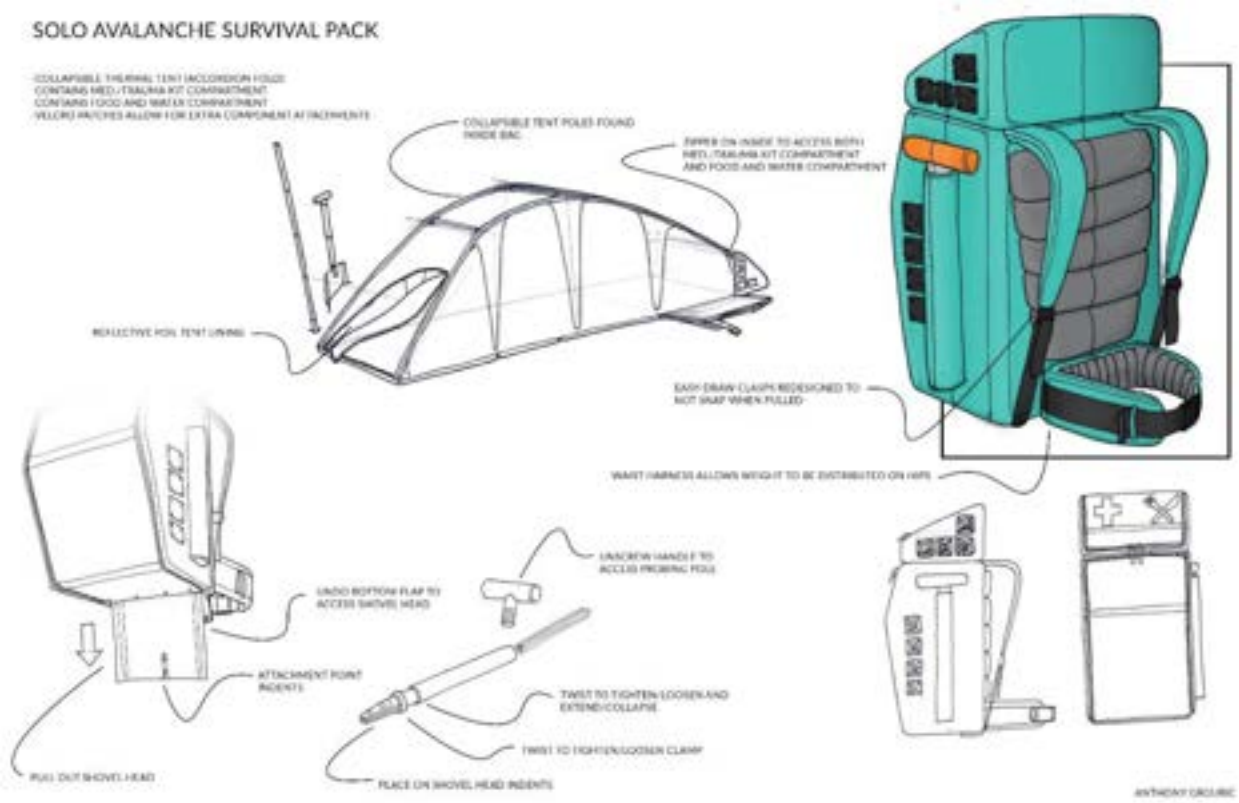


Figure 16 - Ideation Sketch

The solo avalanche survival pack claims precedence in inspiring the final design direction due to the attributes of self-sufficiency after an avalanche disaster. If a user is caught in an avalanche and is able to escape either injured or un-injured, it will generally take approximately eight hours for a search and rescue to reach them, at which point the user may need to endure the rugged elements surrounding them. At this point a survival aspect is needed to help create that efficient search and rescue environment. Using a collapsible thermal tent, medical and trauma kit, as well as food and water compartment. This concept leads the way for a major part in the final design along with the general aspects of the bag itself along with its accompanying tools.

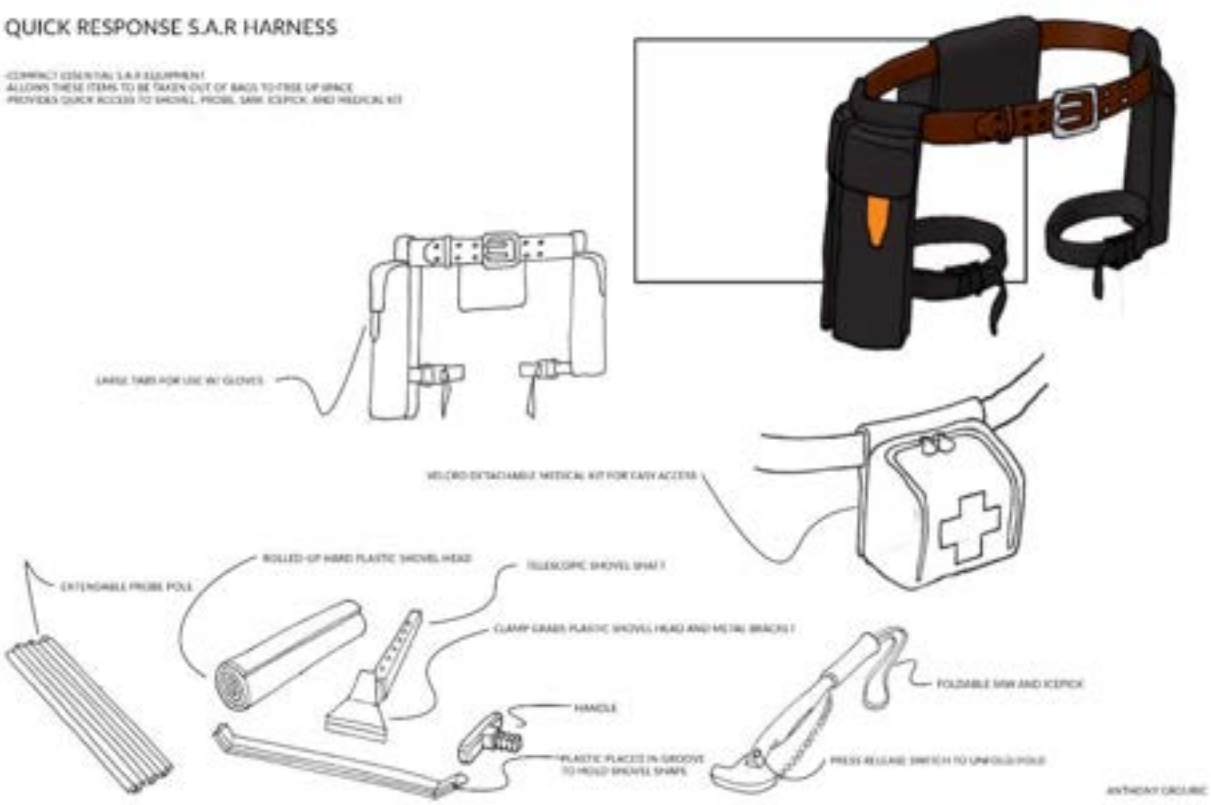


Figure 17 - Ideation Sketch

The quick response search and rescue harness includes inspiring aspects such as ease-of-use, easy accessibility, as well as out of the box thinking in terms of its tools and components. Although the general design of this ideation is lost in the final concept its components and attributes are quite prevalent in the final design.

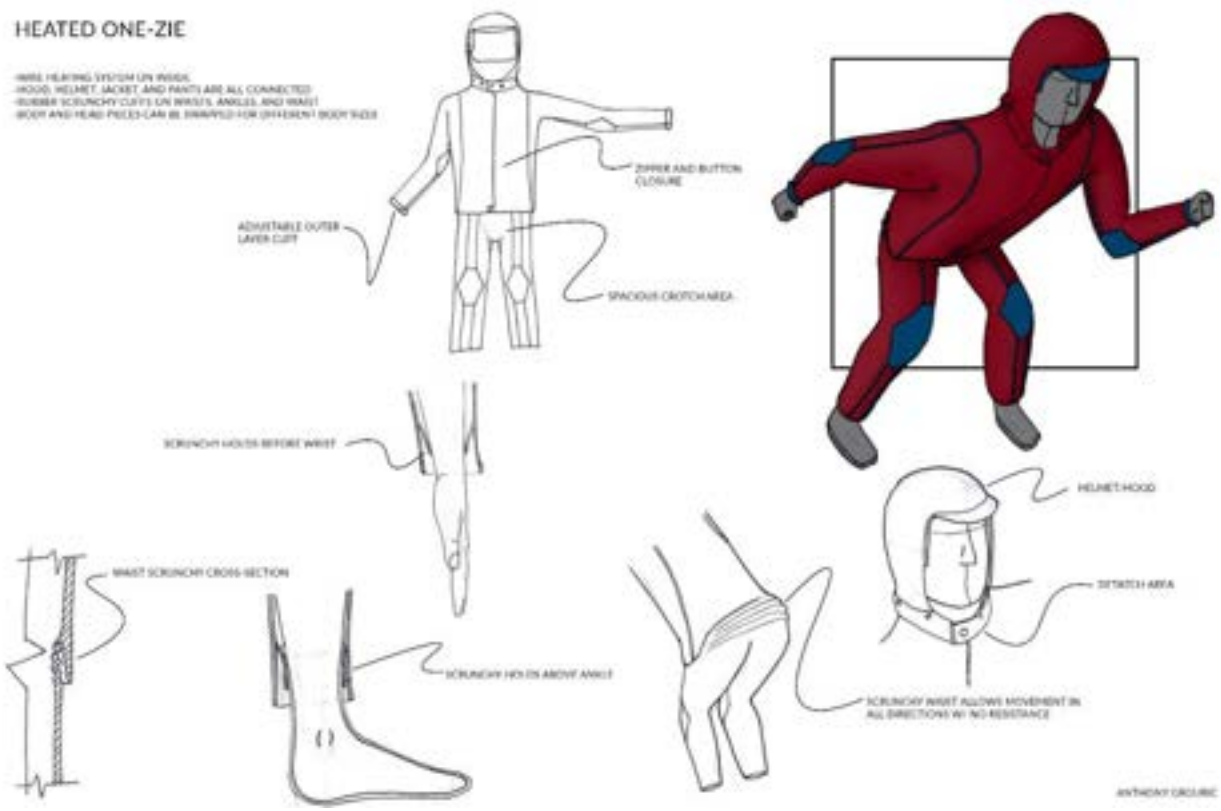


Figure 18 - Ideation Sketch

The heated onesie inspired a detrimental aspect to the final concept which was the elasticated cuffing and ribbing of the wrists, ankles and waist. Although in the final design these are spread in other areas, it was this idea that sparked the continued utilization of this attribute.

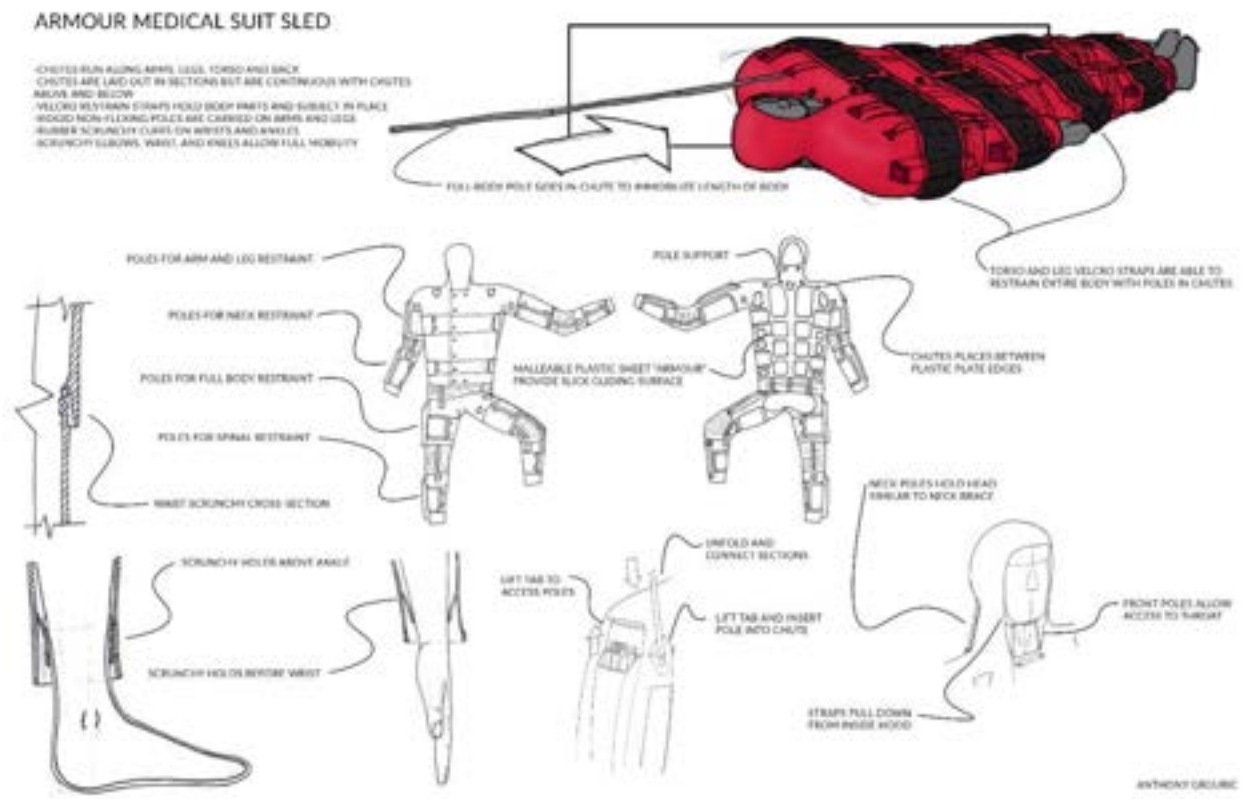


Figure 19 - Ideation Sketch

The armour medical suit sled paved the way for a revolutionary avalanche victim preventative and post-accident product. With its use of elasticated bands, hook and loop fastening, and medical harness integration, this concept allowed for an undisputed competitor for the final design and how it would influence the current state of this thesis project.

Figure 20 - Ideation Sketch

The eight-hour burial jacket is yet another integral and major aspect of the current thesis solution. With its air tank integration, S.O.S satellite transmitter, and respirator layout, this design is used to create the foundation of what the final design is currently. This design also allows for the use of a facemask that covers the nose of the user which holds the respirator to their mouth in the event of an avalanche in which if buried, they would have an extraordinarily long amount of breathable air to wait for search and rescue personnel to come to their aid. This jacket alone provoked many out of the box thinking in terms of secure, fashionable, and unorthodox closing formats to the jacket where the user can stay warm and allow the integral parts of the jacket to perform with ease.

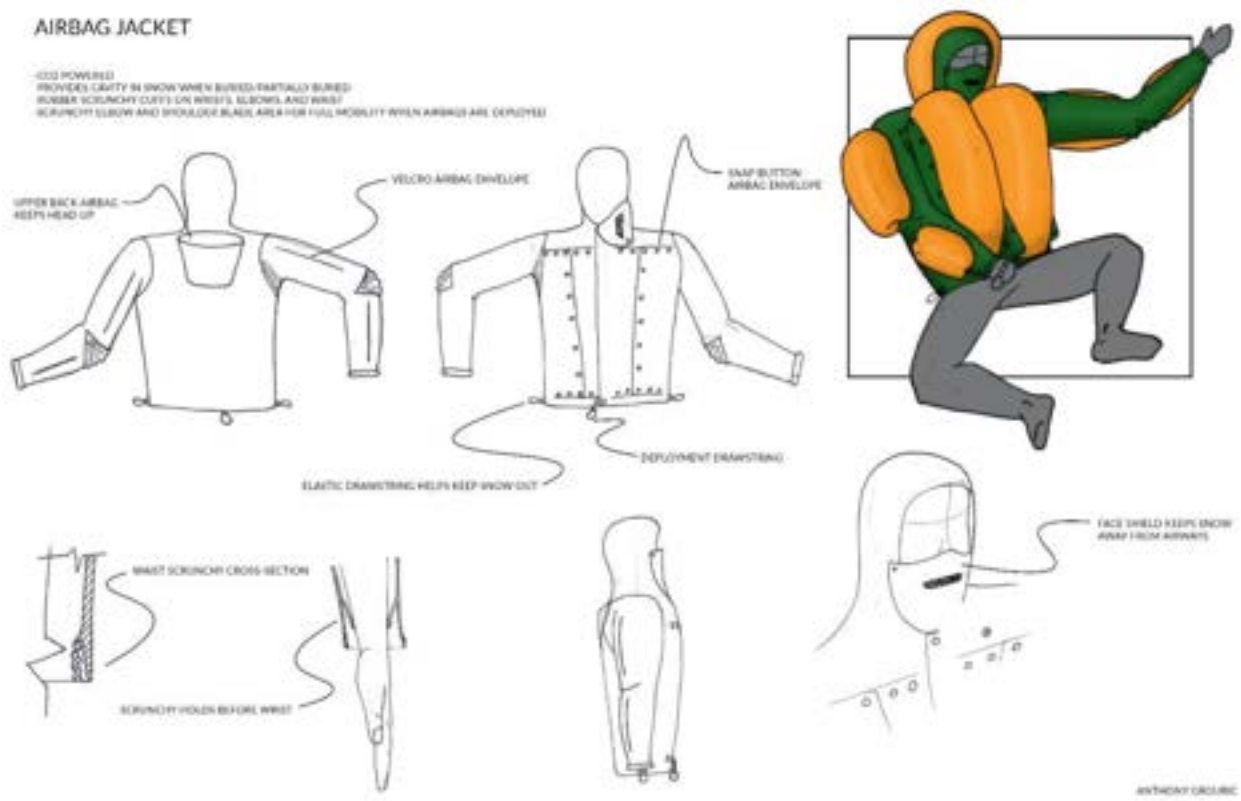


Figure 21 - Ideation Sketch

The airbag jacket, although not entirely original from current products on the market when it comes to avalanche survival, does however incorporate the airbag aspect in a new and inventive way that does not hinder the user's ability to wear whatever backpack however. Aspects of this design such as elastic drawstrings, elasticated cuffs as well as elasticated joints were aspects that once again followed through to the very end of the design process.

4.2 Concepts Exploration

Moving from initial idea generation and incorporating ideas from across all six concepts to create three top contending concepts is where this part of the chapter will take precedent.

4.2.1 Concept One

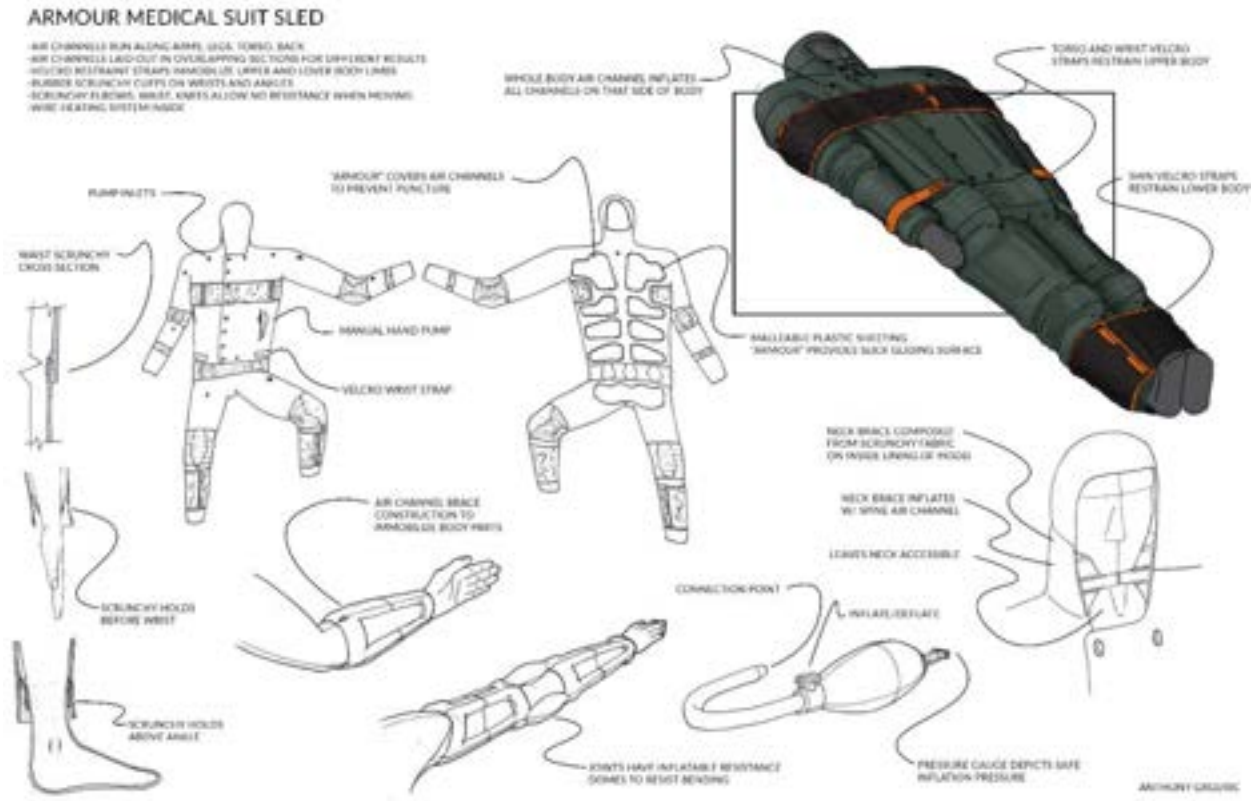


Figure 22 - Concept Sketch

The armour medical suit sled incorporates air channels that run along the arms, legs, torso, and back that help immobilize the user in the event of a injuring scenario. The way these air channels are laid out are in an overlapping section format so that the user can also immobilize particular areas of their body if only a certain area has been injured. This allows for hurt but yet functional users to find their way to safety and not rely on a companion to help them. Along with the air channel system a hook and loop fastener restraint strap immobilizes aspects of the body such as limbs, in an effort to make sure that total immobility is achieved. In normal use situation‘s, where the user is enjoying their time on the slopes, rubber scrunchy cuffs on the wrists and ankles as well as rubber scrunchy joints on elbows, knees, and waist allow no resistance and allow complete uninterrupted mobility for the user. This concept also includes a wire heating system inside the suit sled as to allow an injured victim who may be going through stages of shock to stay warm and endure their injury until proper medical attention is

provided. This concept comes with air channels that also render the neck and head immobilized to help aid head and neck injuries sustained by avalanches. All of these air channels can be achieved by a medical grade hand pump that many people can see being used in a doctor's office along with blood pressure gauges. The steps of use for this concept would generally be the user accesses a single pocket that contains this pump, connecting it to an air channel inlet, and pumping until the gauge signals the user to stop. The stopping feature allows the user to not cut off blood circulation but also have a stiff enough brace that does not allow the limb or area of the body to move. In the event that the user must be fully immobilized and slid away by companions, the back of this concept incorporates malleable plastic sheeting or in other terms called armour, that provide a slick gliding surface to which they can be easily manoeuvred to a safe area. This design incorporates a neutral colour scheme for the suit itself but high viz. colours along its safety features to attract attention and be able for others to notice its purpose and understand how to use this suit properly.

4.2.2 Concept Two

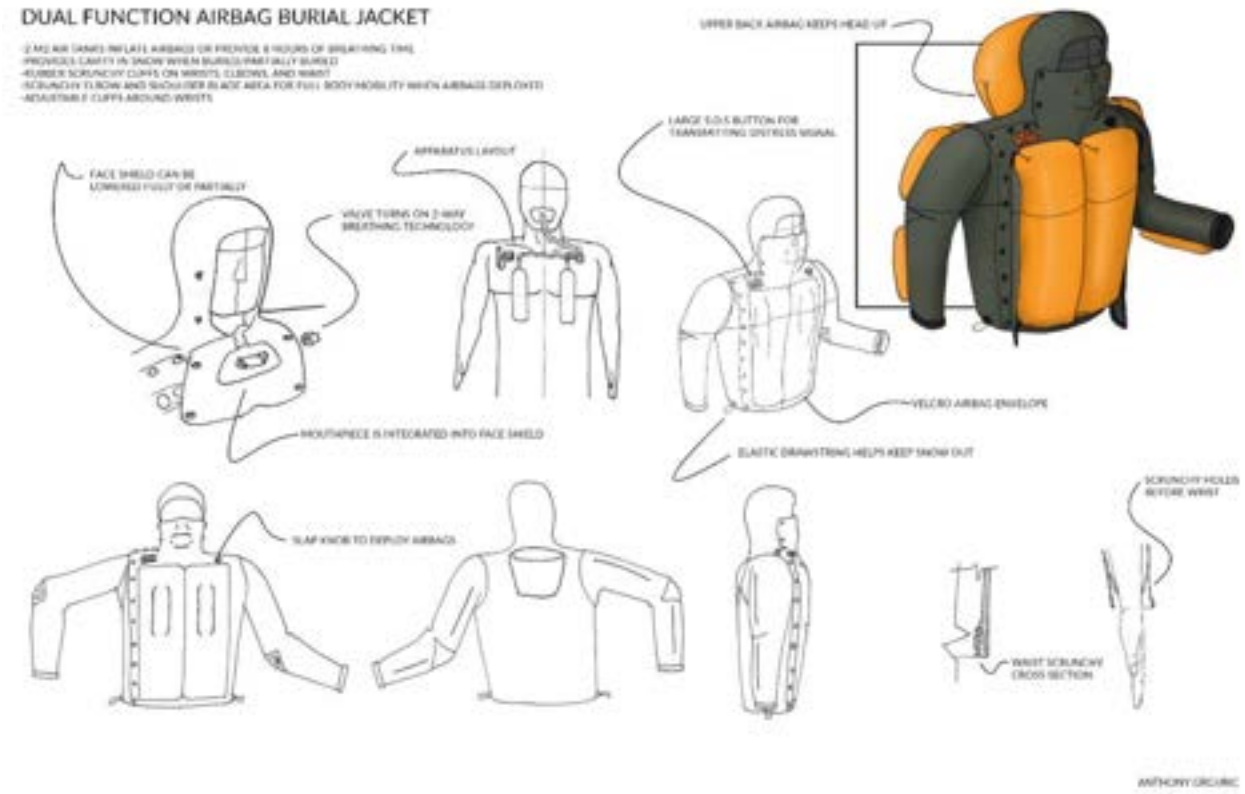


Figure 23 - Concept Sketch

The dual function airbag burial jacket contains 2 M2 air tanks that are used to inflate the airbags or provide the user with eight hours of breathable time. These airbags, if the user were to be buried, provide a cavity within the snow to which the user would not succumb to asphyxiation as a result of severe pressure on the abdominal cavity. If partially buried or fully buried the user would still have the option to inhale the air from the air bags itself or from the air tanks if the user was unable to deploy the airbags. This design also incorporates rubber scrunchy cuffs on the wrists as well as rubber scrunchy joints on the elbows and the waist. These elasticated aspects allow for complete cut off for the inside of the jacket to the outside environment which would allow the user to retain body heat in an avalanche scenario. The valve in which this air tank system is achievable is a two-way breathing technology valve where when the user breathes in, air is taken from the tanks, but when the user breathes out, the tanks are sealed. This allows for approximately eight hours worth of breathable air. A large S.O.S button is also

featured on this design to allow transmission of distress signals as well. The valve on this apparatus can also be used as the ignition point to inflate the airbags as the user would only have to slap the knob to inflate their jacket. As to allow the jacket to perform its main functions and also not hinder on the possibility of the jacket opening when needed, the user would dawn the jacket and then a series of buttons and zippers are used to create a strong secure closure.

4.2.3 Concept Three

Figure 24 - Concept Sketch

The solo avalanche jacket survival pack is a combination of a jacket with an integrated and wearable backpack. This backpack is dry bag inspired due to its popularity in the outdoor adventure world. Shoulder straps and waist harness along with necessary padding on each is integrated into the jacket to which the user must dawn appropriately like any other mountaineering knapsack. This design incorporates traditional methods to dawn the jacket as well. This backpack incorporates a rail and knib system that resembles teeth running down a track which lock in at the bottom. This knapsack includes

the tools necessary for survival as well as includes an expandible thermal tent, medical and trauma kit, food and water ration storage, tent pole and air pump storage. It also includes a collapsible avalanche shovel and a foldable ice pick and saw tool. The jacket incorporates elasticated wrist cuffs and an elasticated waist band to allow maximum heat retention and to keep out snow and other debris from the environment. This concept would be used after the event of an avalanche where the user or group of users may need to survive overnight or over a length of hours to wait upon search and rescue personnel. An easy expandible thermal tent that comes out the top of the dry bag and inner access to medical treatments and sustenance allows the user to comfortably wait for help away from elements and further environmental exposure. The air pump that belongs with this concept is meant to inflate a single layer of material at the base of the tent which will create an air chamber thermal pocket allowing for maximum heat retention inside the tent to which the ground floor cannot absorb body heat through the material from the user.

4.3 Concept Strategy

This part of the chapter defining the concept strategy to which a final deliberation of which direction to take the final concepts design is carefully conducted through two different concepts that provide the same end function in very drastically different ways, provide an improvement in the efficiency of avalanche search and rescue efforts.

4.3.1 Concept Direction & Product Schematic One

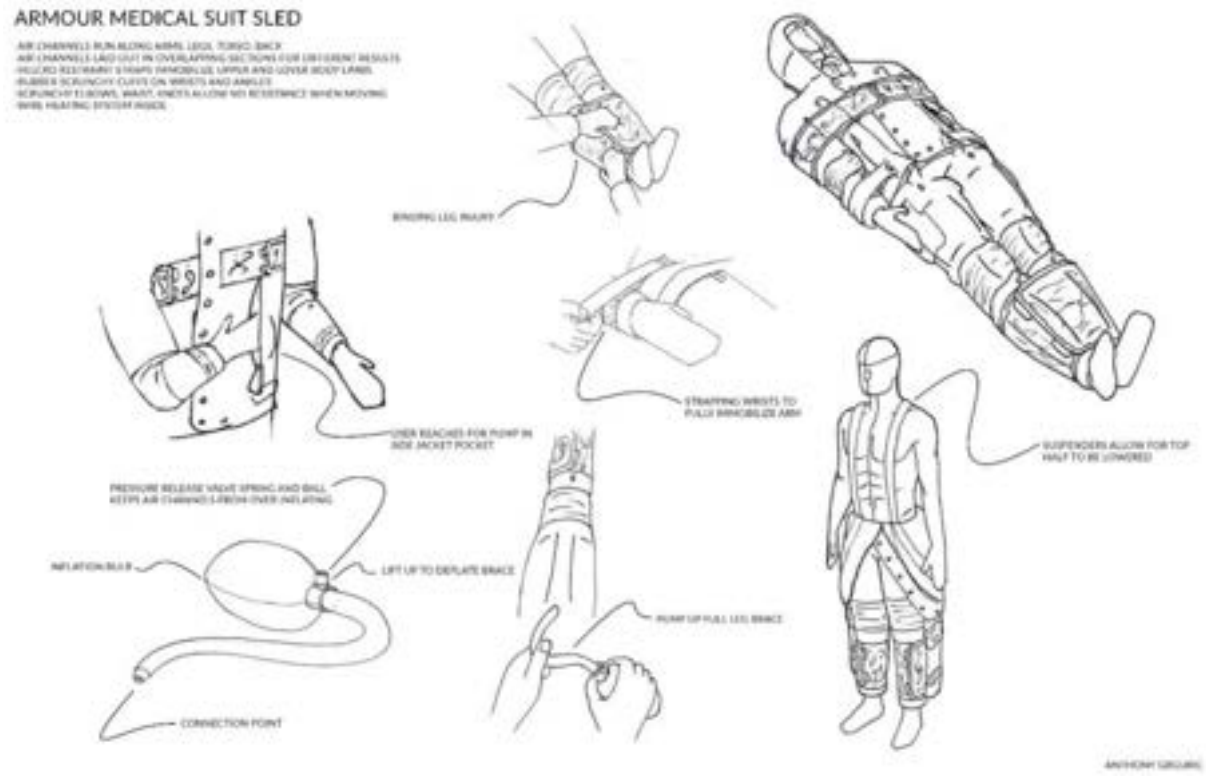


Figure 25 - Refined Concept Sketch

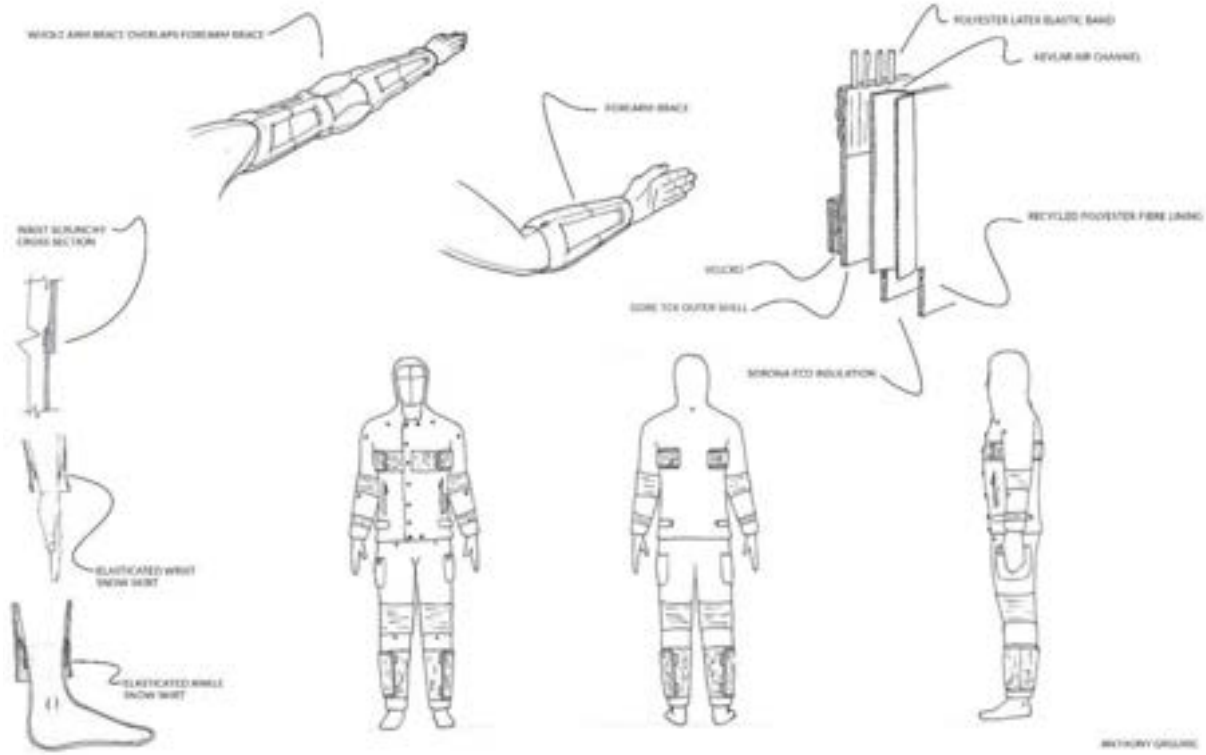


Figure 26 - Refined Concept Sketch Development

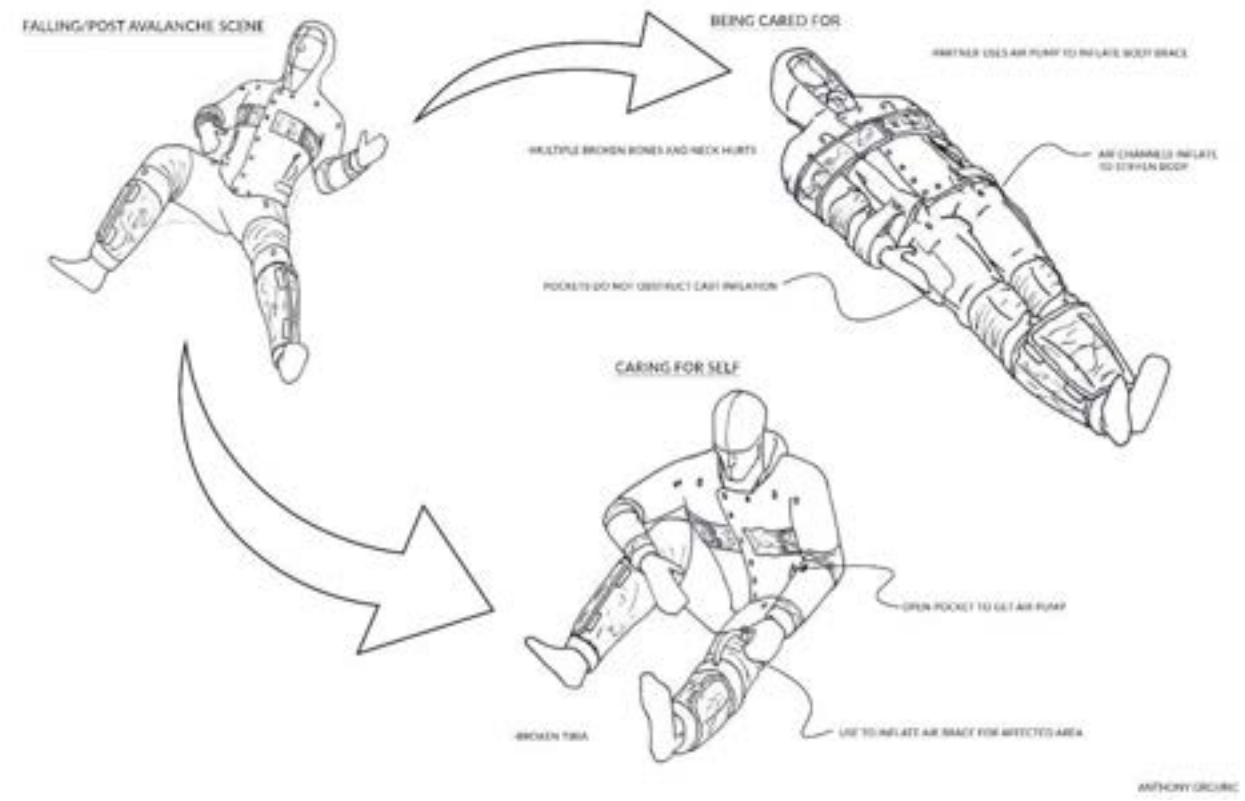


Figure 27 - Refined Concept Sketch Development

The armour medical suit sled as previously stated contains air channels that run along the arms, legs torso, and back as well as a supportive brace to secure the neck and head. These air channels are laid out in an overlapping fashion as to allow the user to inflate and immobilize specific areas of their body. Loop and hook fastener restraints help in this immobilizing factor between the limbs and the upper and lower body areas. An added feature of straps or suspenders has been added to this concept in an effort to allow the user to undress halfway when not in a dangerous scenario. The hand pump on this rendition of this concept has also changed as it now has a pressure release valve. A spring and ball allows for the mechanical gauge to be removed. This still provides the same service as to allow the air channels to not overinflate, also it provides the added aspect of being able to lift up in an to deflate a brace when reaching a medical station. The system of use would be the same as this previous rendition, in a caring for self fashion or a care by others fashion. This concept endured a revamp design to the air channel system that now allows for extending features. This means that this concept can be rolled up or

rolled down to address multiple sizes of users. Rolling the sleeve up and securing with the button strap also creates a new endpoint to the air. Elasticated wrist cuffs, ankle cuffs and elasticated joints and waist areas provide a full range of movement and a fully encapsulated perimeter allowing no body heat to escape and preventing external elements from entering the suit.

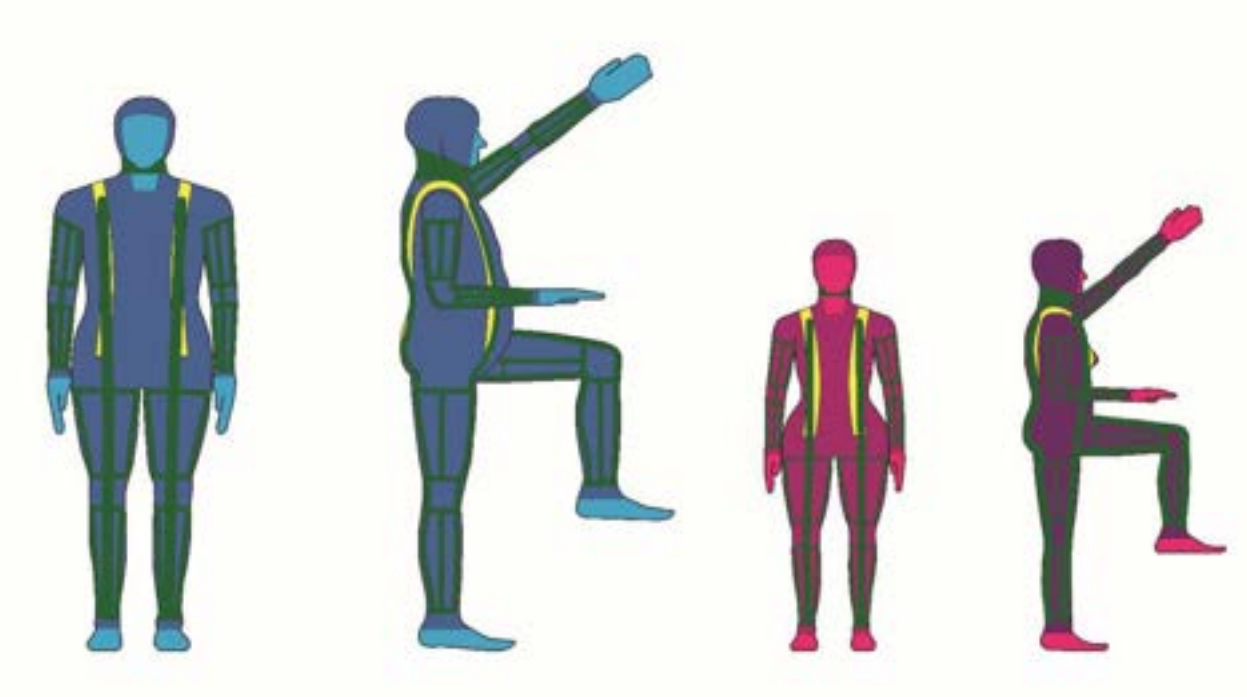


Figure 28 - Concept Schematic Reference

The schematic layout for this concept depicts the multiple chambers that would inflate as well as the areas of the body that would come in contact with material and the straps where the user would be able to undress halfway. The schematic is also available to be viewed in a smaller proportion to show the difference in sizing. The percentiles used are 99th percentile male and 50th percentile female.

The study of product schematic influenced by this concept can be suggested in a way that it is very feasible to create and to become the end result for this thesis.

4.3.2 Concept Direction & Product Schematic Two

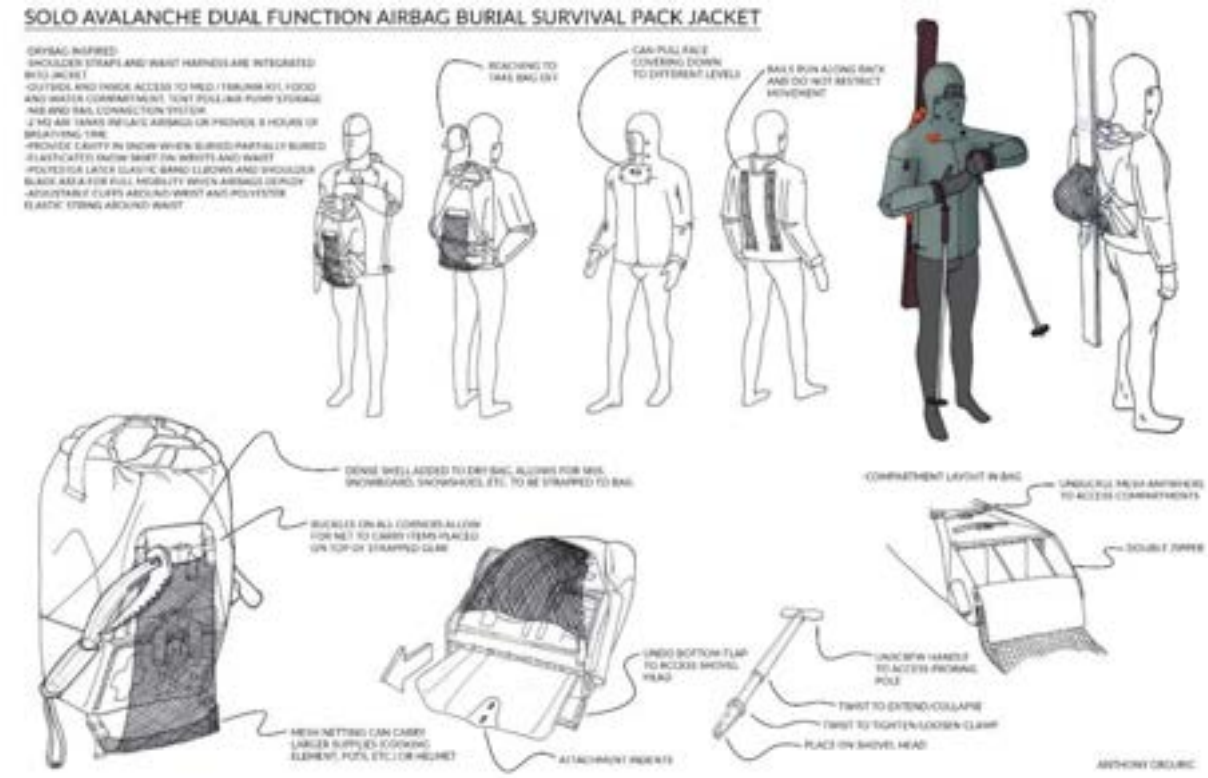


Figure 29 - Refined Concept Sketch

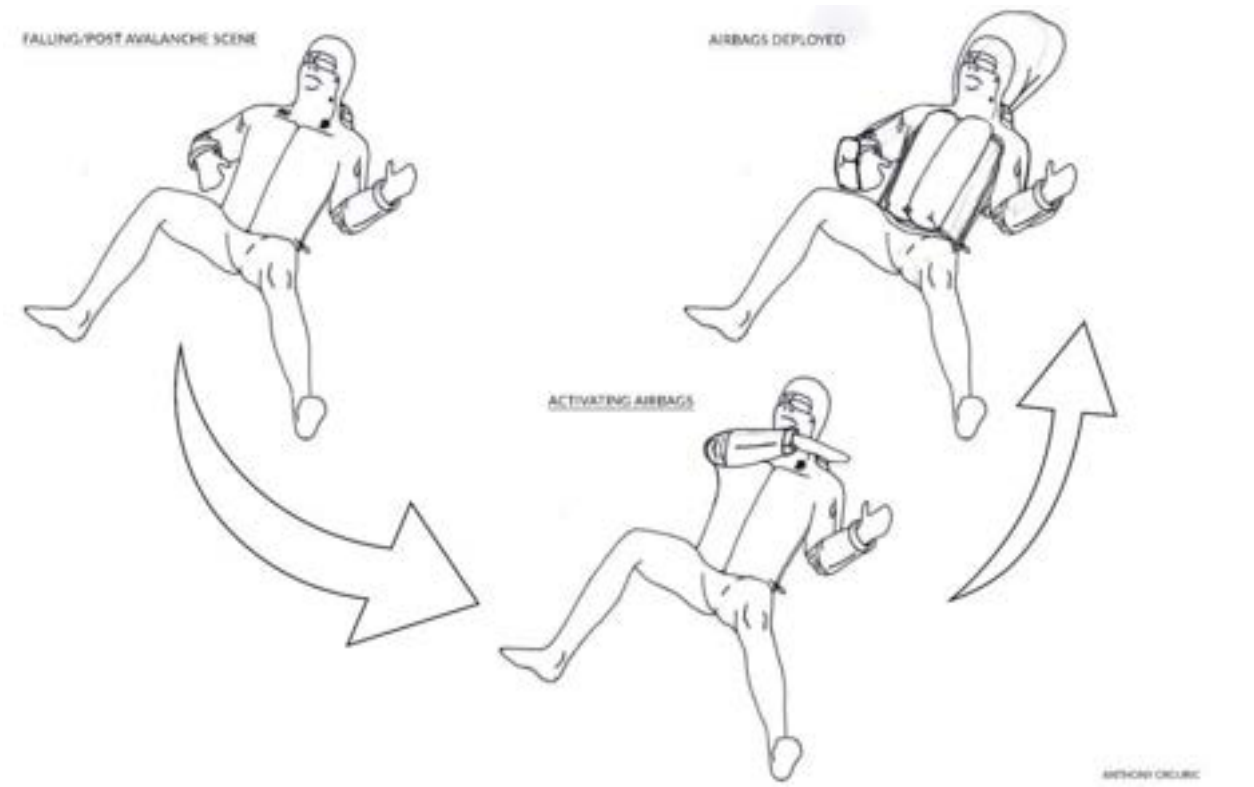


Figure 30 - Refined Concept Sketch Development

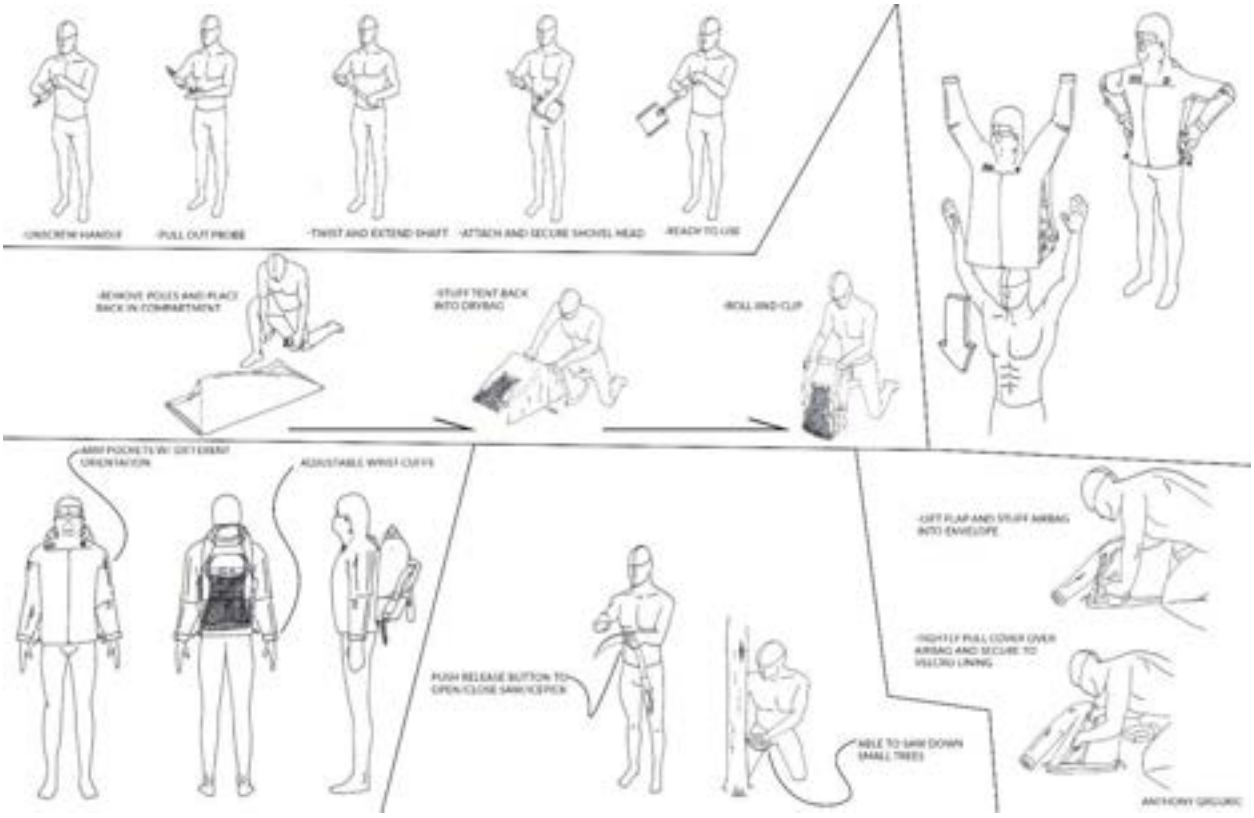


Figure 31 - Refined Concept Sketch Development

The solo avalanche dual function airbag burial survival pack jacket is the second concept to be chosen to determine whether or not it would be pursued in a for the end result of this thesis project. This includes a dry bag inspired backpack design that now has a few new features such as straps and buckles to allow the user to attach skis or snowboards or possibly even snowshoes as well as ski poles. It also includes a strap and buckle netting to allow the user to hold onto a helmet or possibly even extra survival gear such as pots or containers of some sort. This rendition of the jacket involves a front breast plate that is completely adorned with the breathing and airbag apparatus components that the user would zip up onto the rest of the jacket, secure with hook and look fasteners, and then button up. After that the user would then adorn the dry bag backpack along with all of its components. This concept has many variations of use due to its many subcomponents, first being the shovel, twist and extend the shaft to get it to a desired length, attach and secure the shovel head with a torque nut at the end of the shaft. The user would have to unscrew the handle to use the avalanche probe stick. In terms of the ice pick and saw tool, the user can keep it closed to have it function in the saw rendition or press a spring-loaded trigger mechanism which would allow it to open to the ice pick formation where they can then use that tool for its many various purposes. When setting up the tent, the user can open the bag and extend the tent lining outside the confines of the dry bag, grab the tent poles and proceed to insert them into the shoots, inflate the air mattress and follow these steps in reverse order to pack up the tent. When repackaging the airbags of the jacket the user would have to lift up any jacket flap material and stuff the airbag liner into the envelope area. From here the user would have to tightly pull the cover or envelope area together and secure using the hook and loop fastener lining. There is also an example of activating the airbags in an avalanche scenario where the user smacks the air system knob and instantly afterwards the airbags were deployed with pressurized air inside.

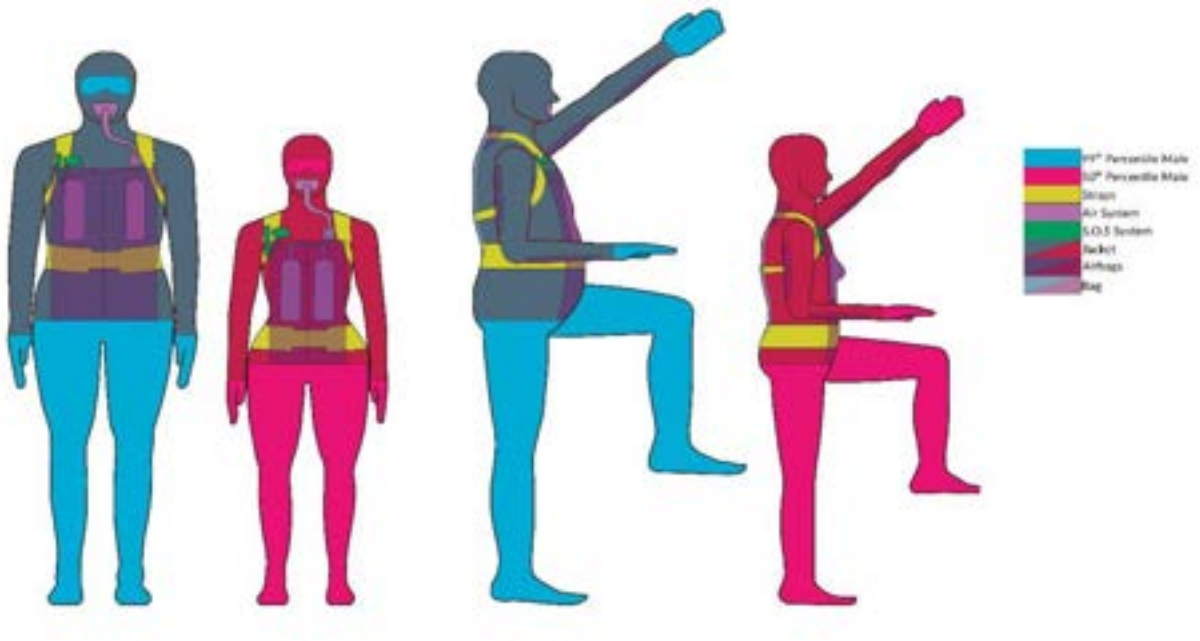


Figure 32 - Concept Schematic Reference

The schematic layout for this concept provides a look at all aspects of this concept from the tubing of the air system along with its air tanks, regulator, and the respirator. And then also displaying the survival pack harness that is integrated inside the jacket along with the area of the jacket that the bag comes in contact with, and finally all areas of the user that come in contact with the jacket itself. It is offered in another view using the same 50th percentile female and also on the 99th percentile mail.

The study of products schematic influenced this concept strategy by providing a very strong possibility to improving the general well-being of the end-user not only in avalanche scenarios but also could be possibly adapted for other natural disaster events.

4.4 Concept Refinement and Validation

The concept refinement includes further development pertaining to one concept derived from the previous section of this chapter.

4.4.1 Design Refinement

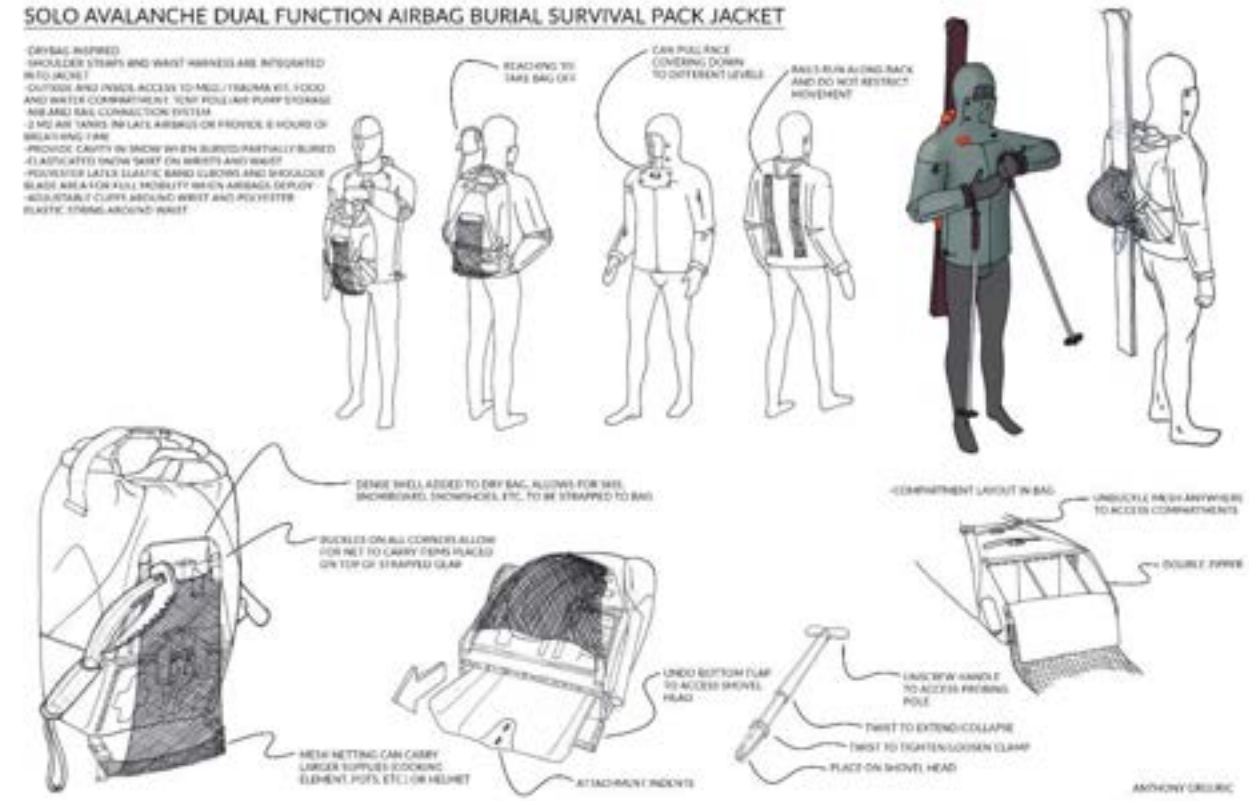


Figure 33 - Refined Concept Sketch

4.4.2 Detail Development

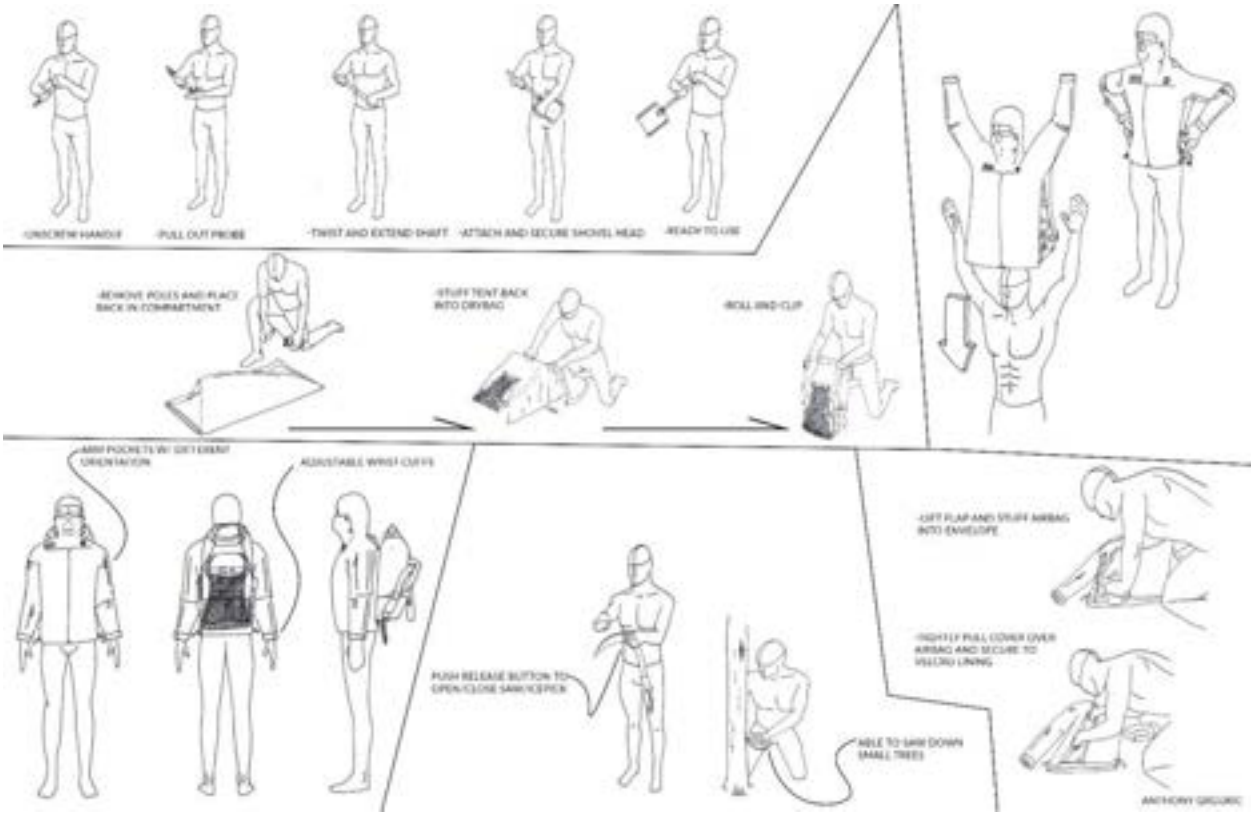


Figure 34 - Refined Concept Sketch Development

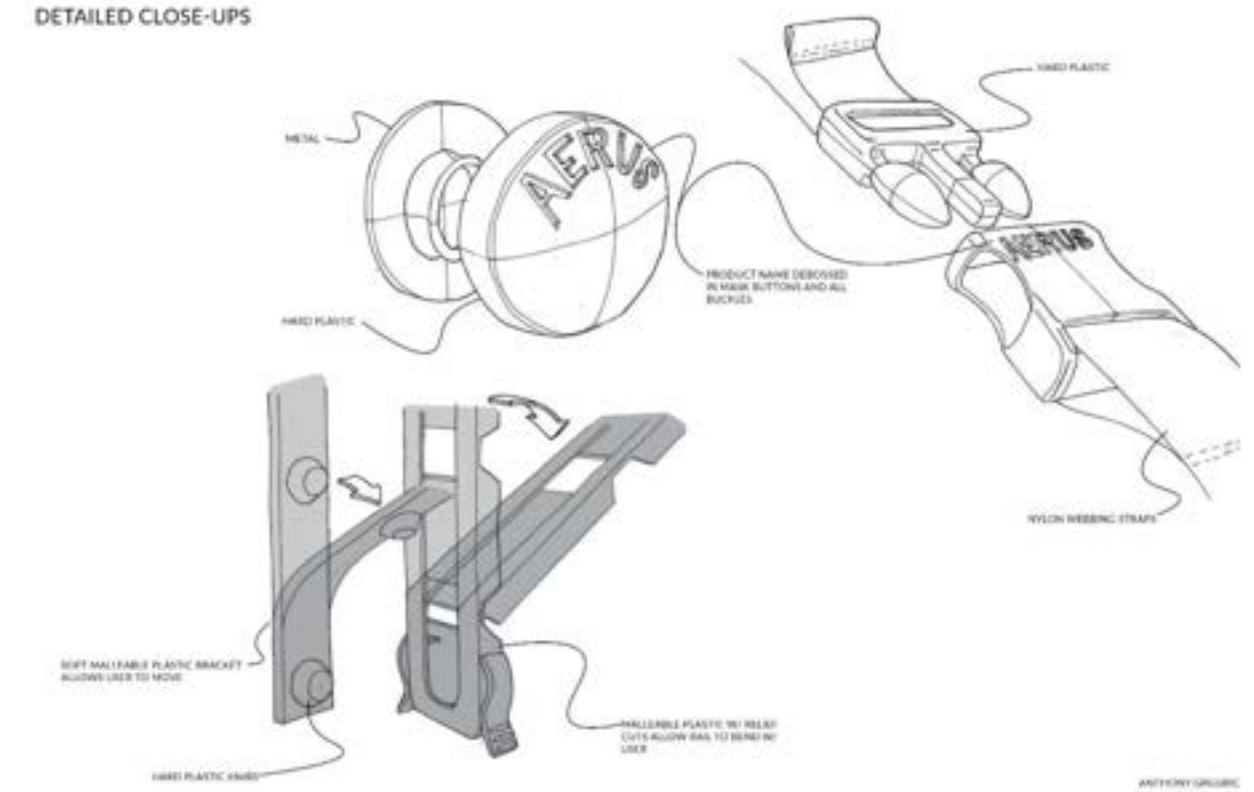


Figure 35 - Refined Concept Sketch Development

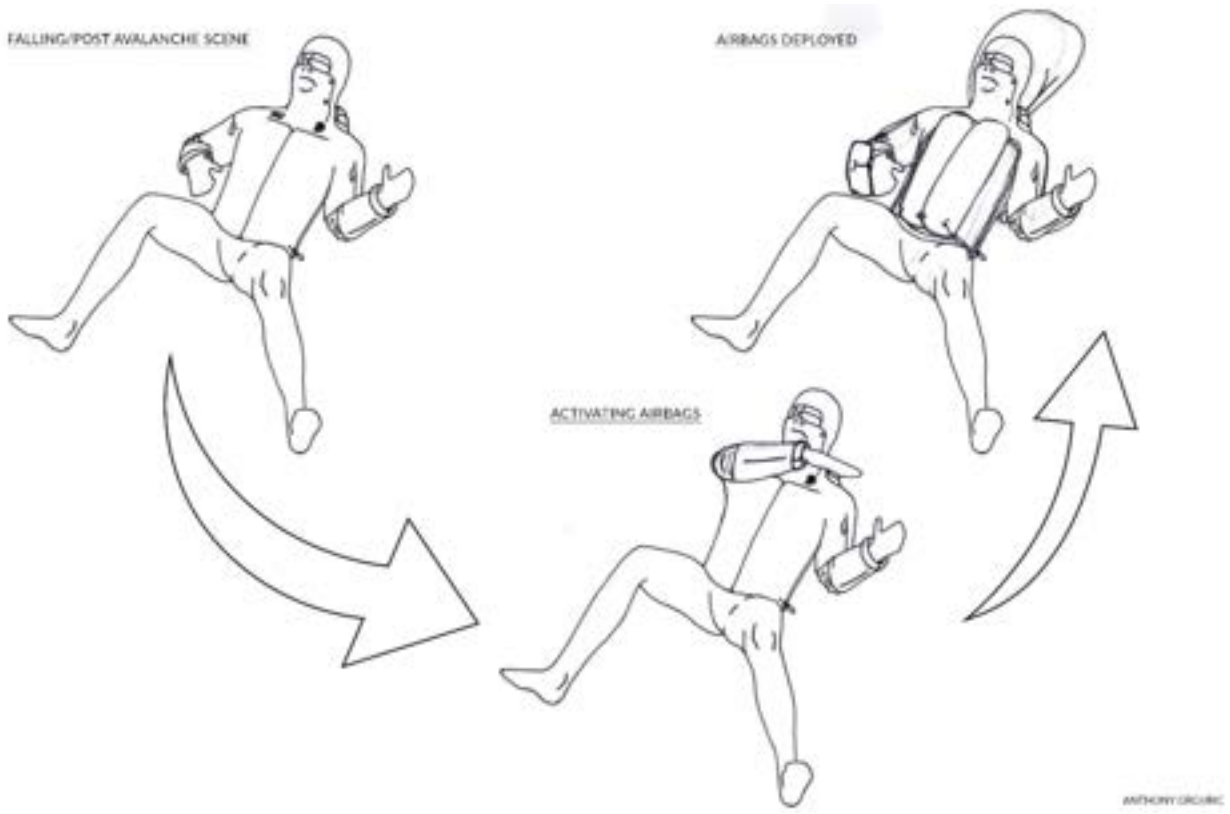


Figure 36 - Refined Concept Sketch Development

The now proclaimed avalanche survival unit has been chosen based off its possible avenues of succession in other natural disaster events. It also allows for not only all aspects of the thesis project to be met but also the aspect of further developing this concept more so than the other concept. This thesis topic is explained as how may we improve efficiency in avalanche search and rescue efforts and with this concept it not only looks at the users side of improving survival during an avalanche but it improves the chance of being found easier and faster by search and rescue personnel with its survival aspects. This is including but not limited to the survival pack. The airbags and breathing apparatus allow time for search and rescue personnel to arrive on scene and be given the time needed to find an endangered victim.

4.4.3 Refined Product Schematic & Key Ergonomic

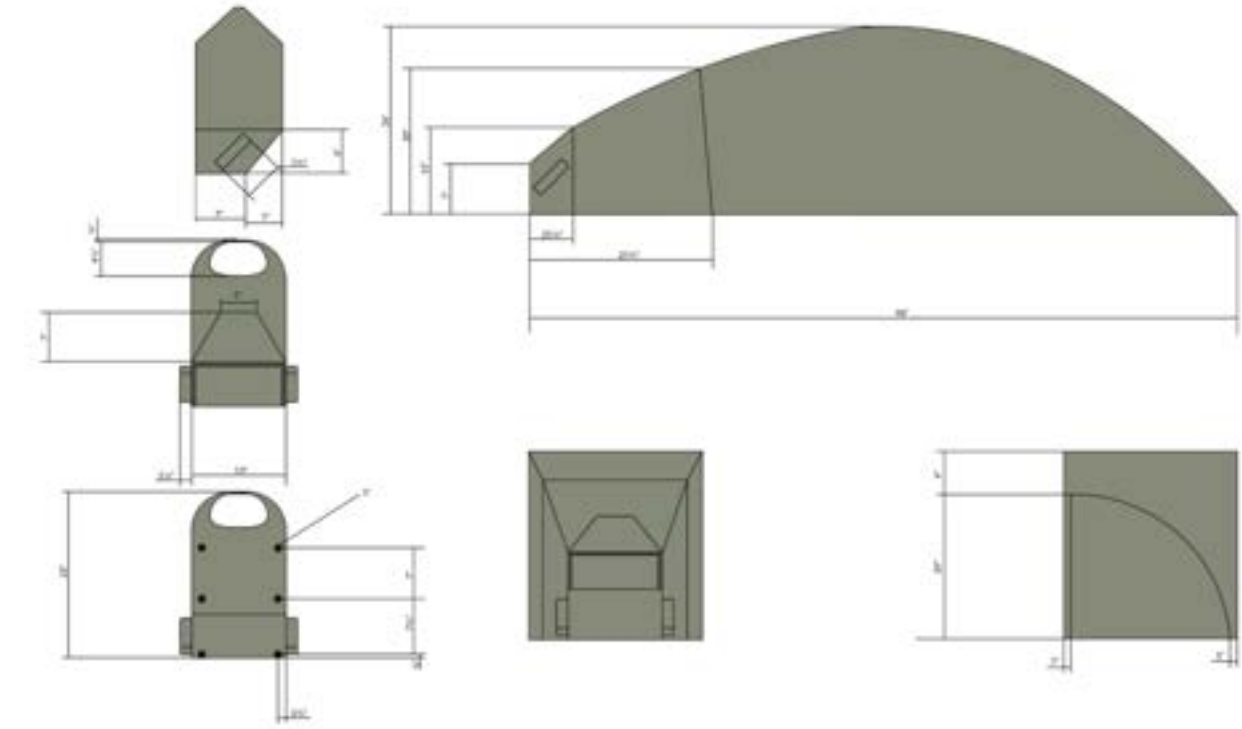


Figure 37 - Avalanche Survival Bag Dimensions

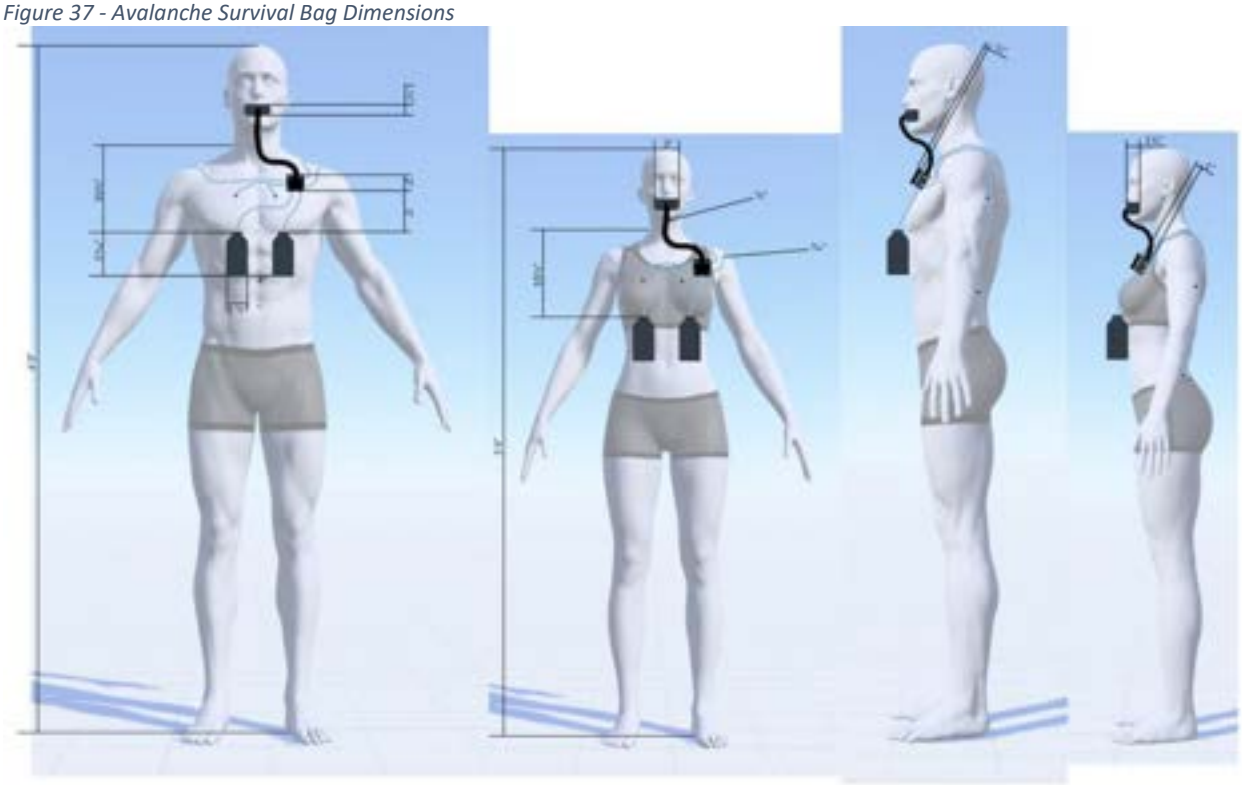


Figure 38 - Breathing Apparatus Dimensions

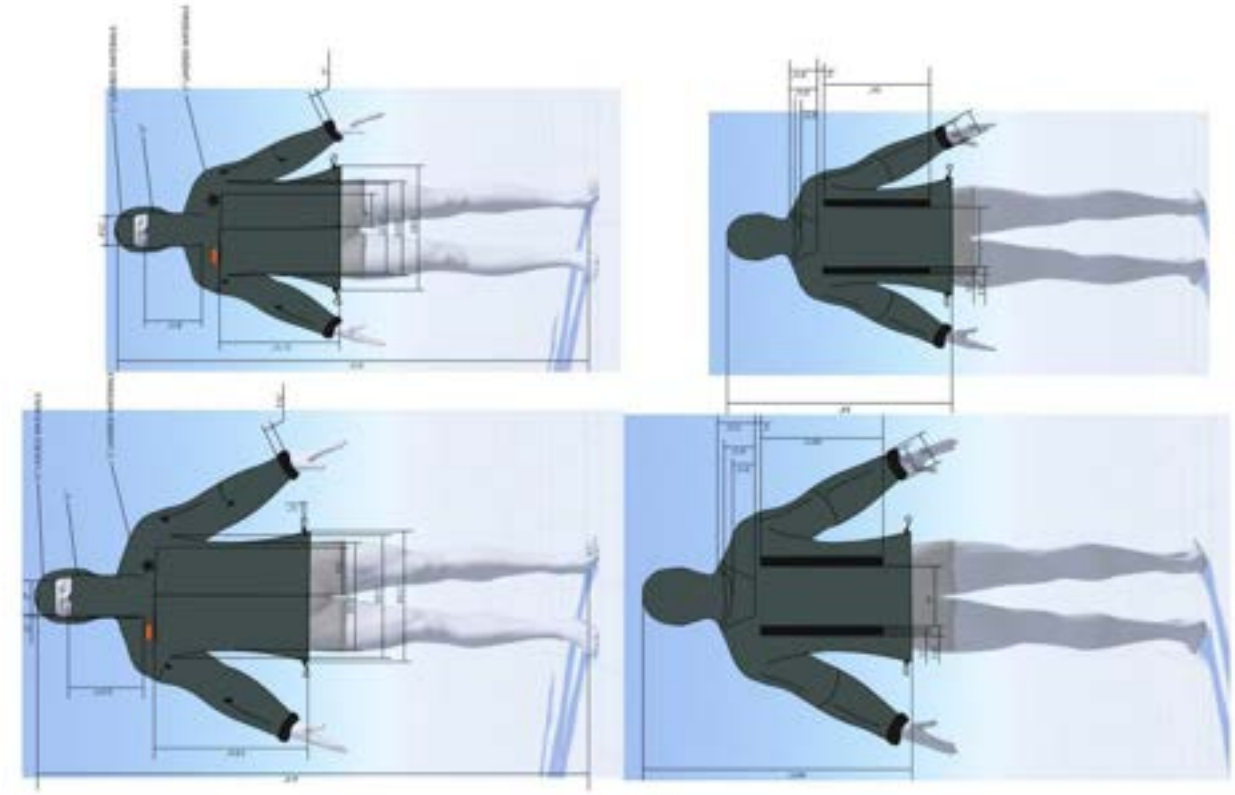


Figure 39 - Jacket Dimensions

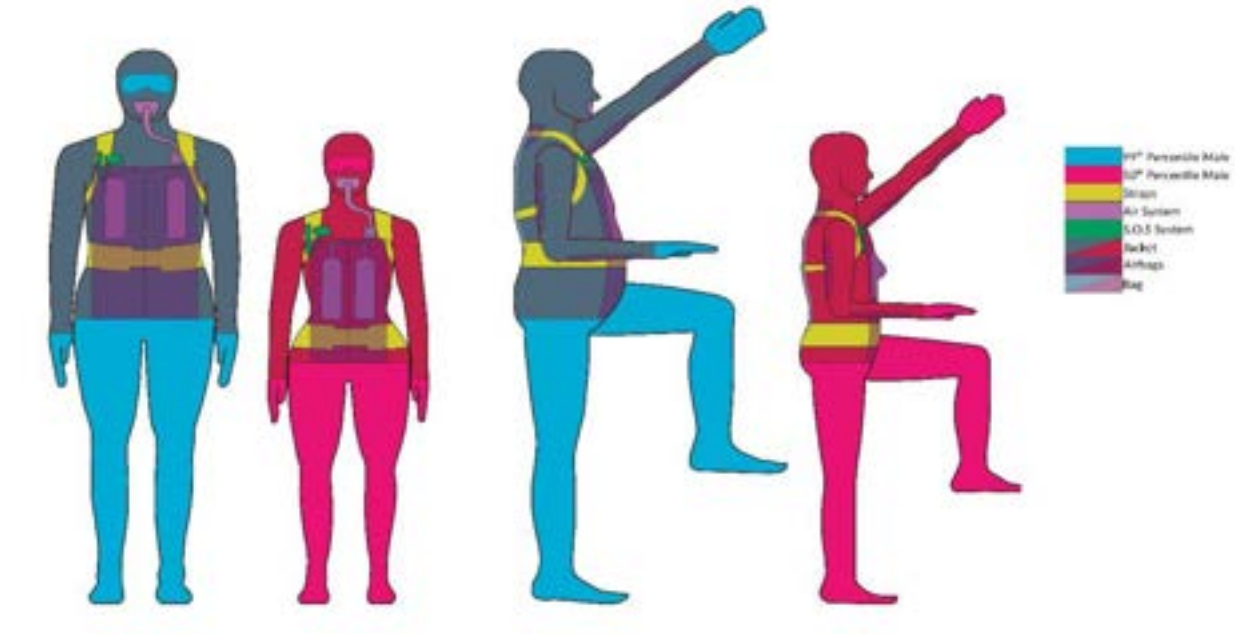


Figure 40 - Concept Schematics Reference

After further deliberation it has been acknowledged that calculations were miss interpreted and incorrectly executed resulting in an improper 1:1 ergonomic dimensioned model. It is now the understanding that these dimensions are feasible and work and will be pursued within the concepts moving forward.

4.5 Concept Realization

The concept realization occurred after many 1:1 interactions with the professor, assisting professors and teaching assistant, family, friends, and overall thought within the realm of winter safety equipment currently on the market. Thought was also placed on what this project could achieve as a new product on the market. From that finalized design concept, a physical model study was conducted with the major aspects of the design being created for a proportional view and adjusting the final proportions.

4.5.1 Design Finalization

The final overall concept, in terms of semantics, aesthetics, benefits, and human factors is thoroughly represented in the design process. Within the final development, small attributes and features were created with the intention of adding comfort, providing safety and security for the user

and easing the motions of use within the overall design.

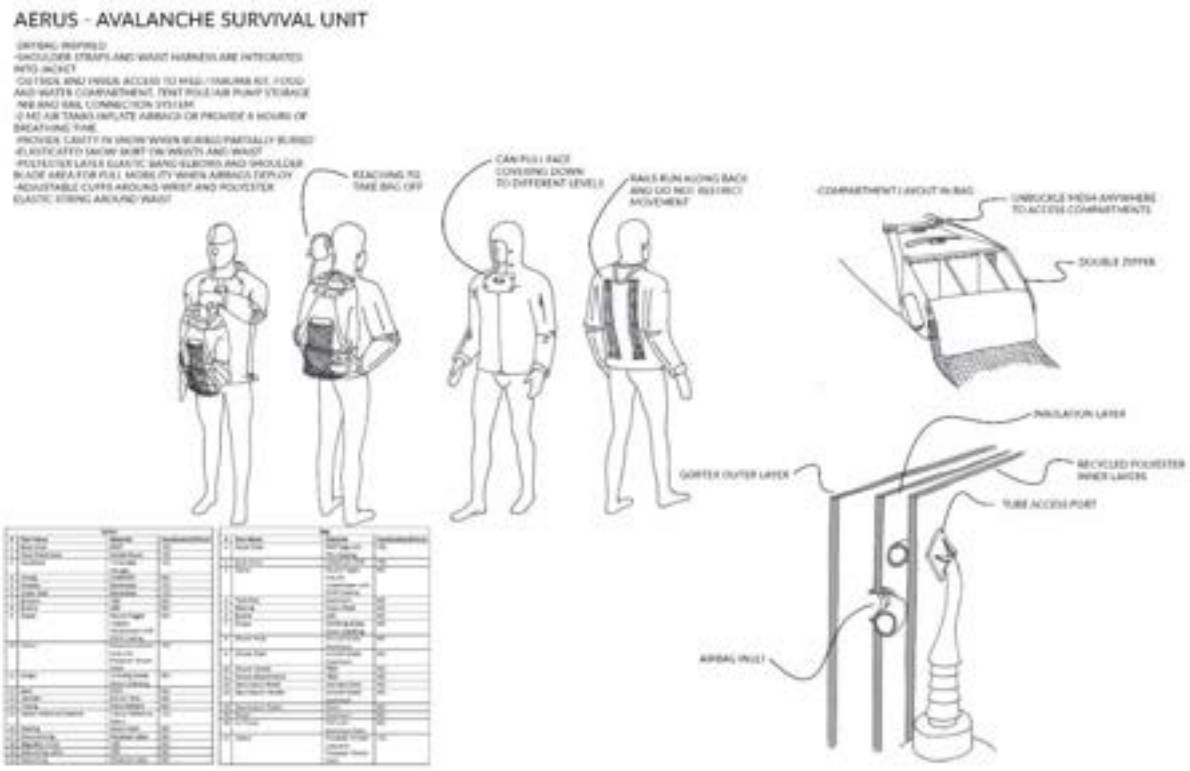


Figure 41 - Final Concept Sketch

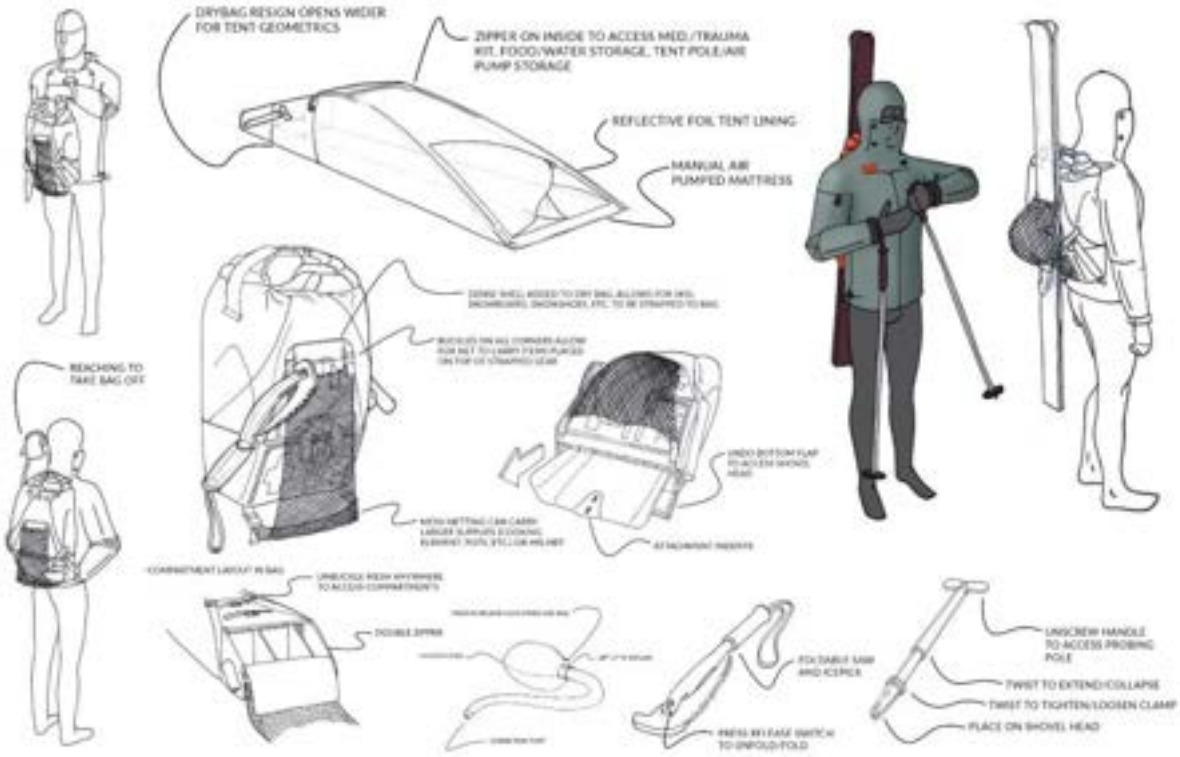


Figure 42 - Final Concept Sketch

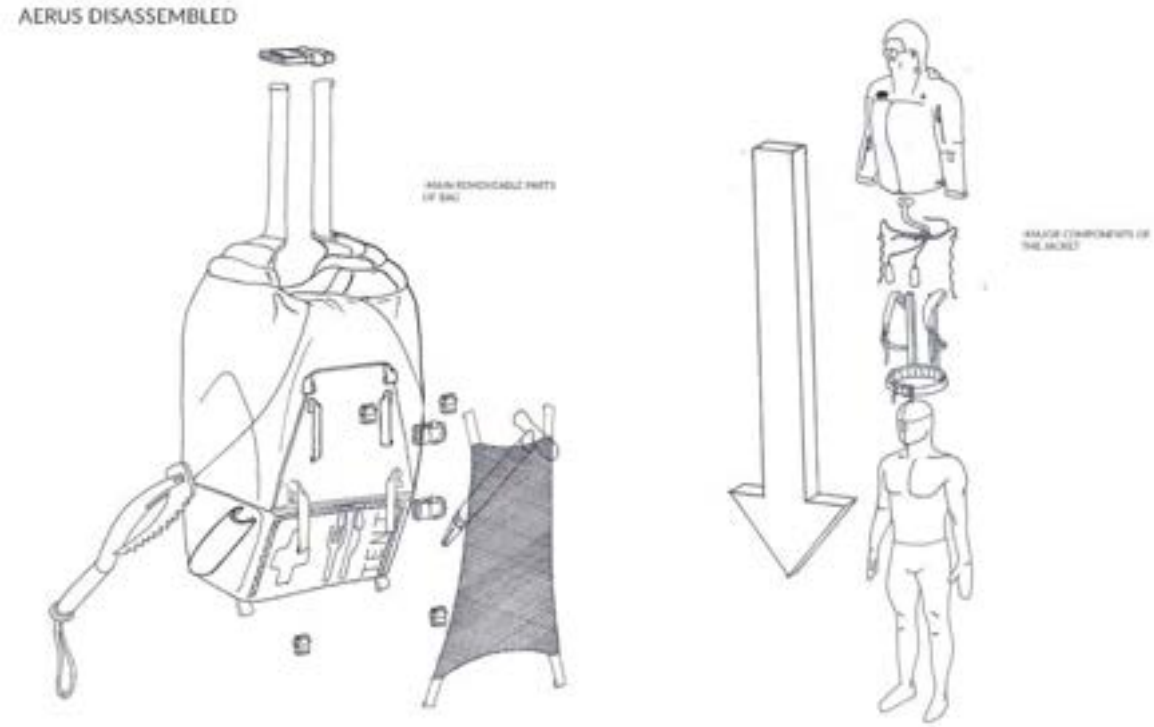


Figure 43 – Final Concept Exploded View

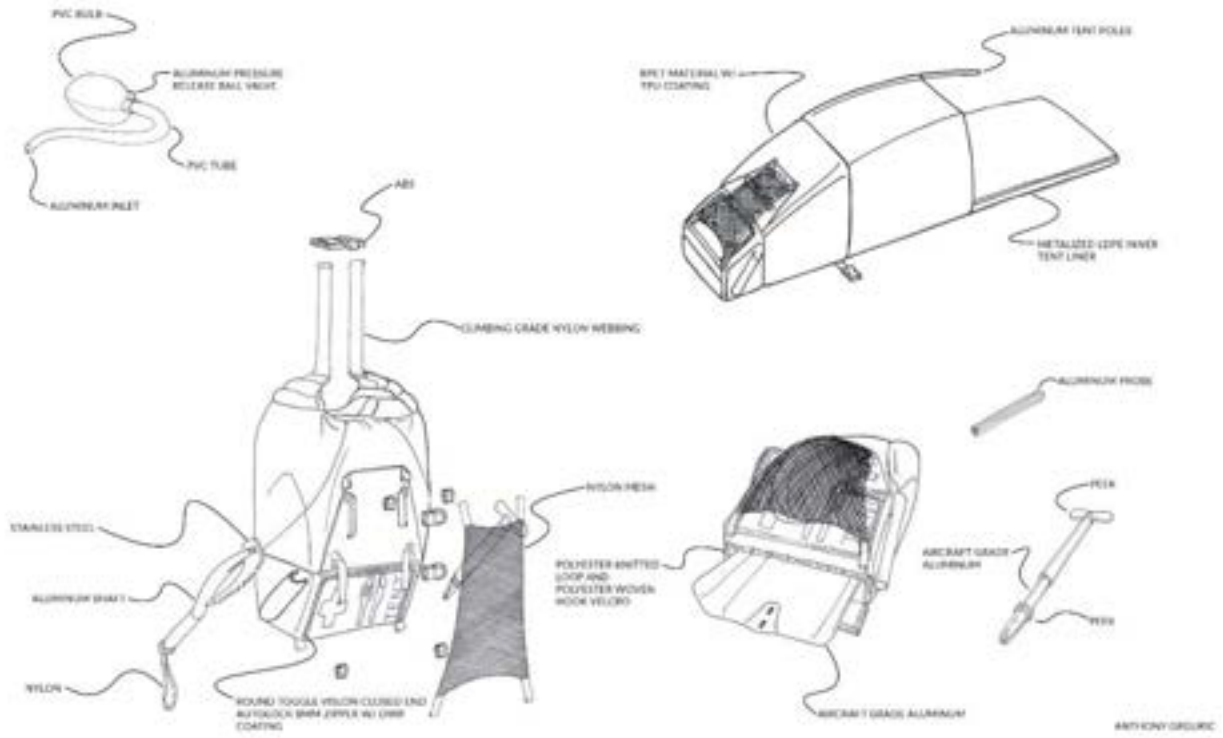


Figure 44 - Final Concept Detailed Sketch

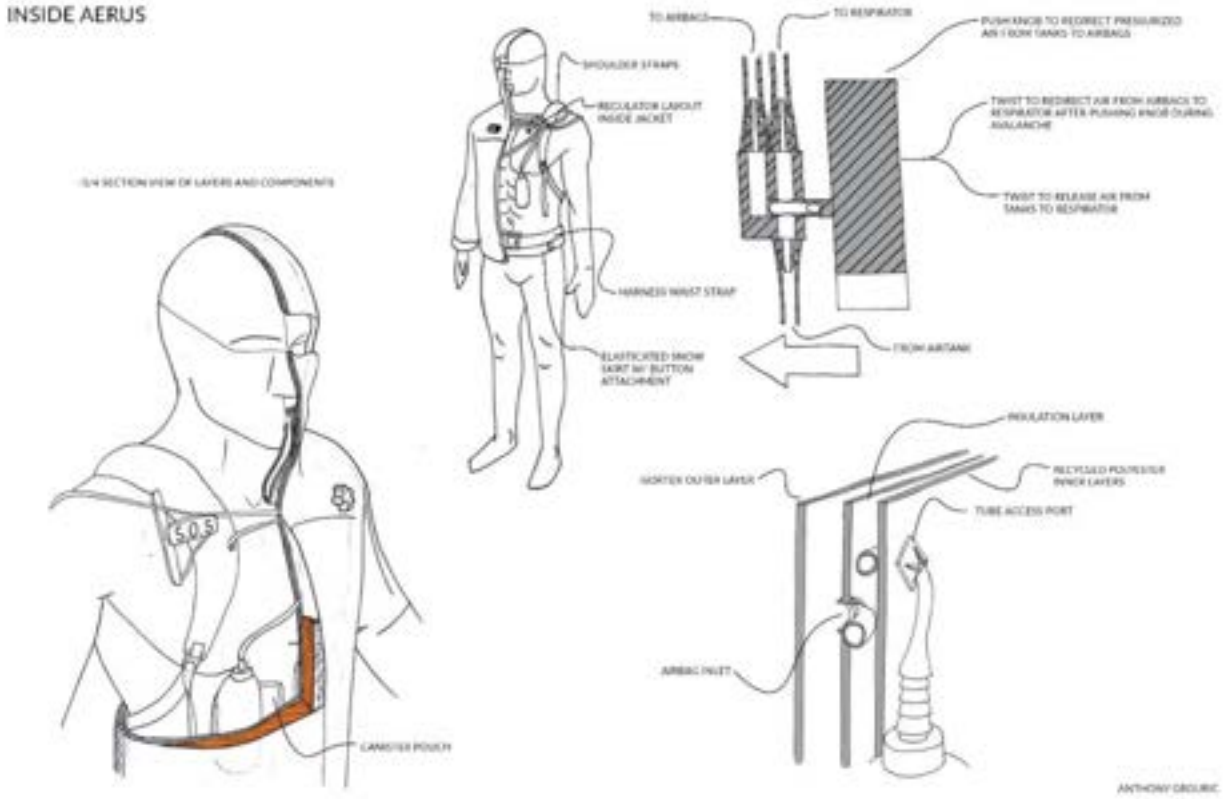


Figure 45 - Final Concept Detailed Views

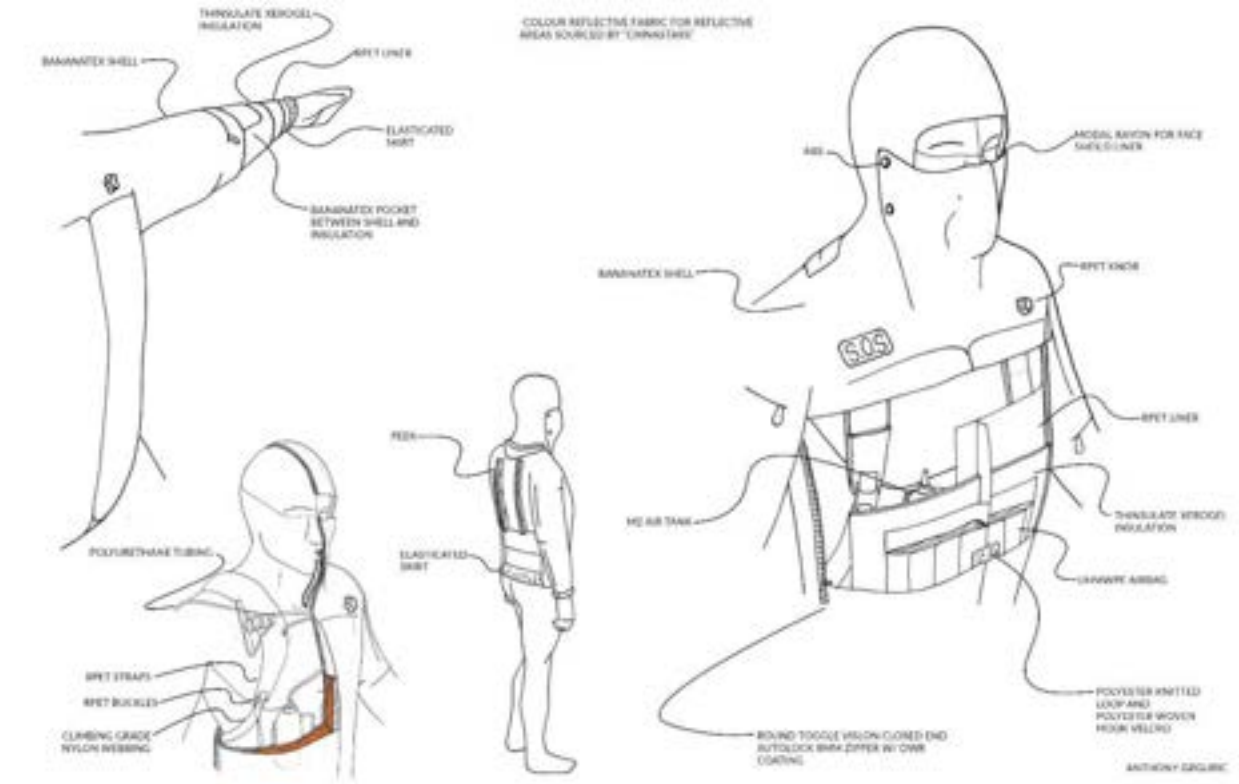


Figure 46 - Final Concept Detailed Views

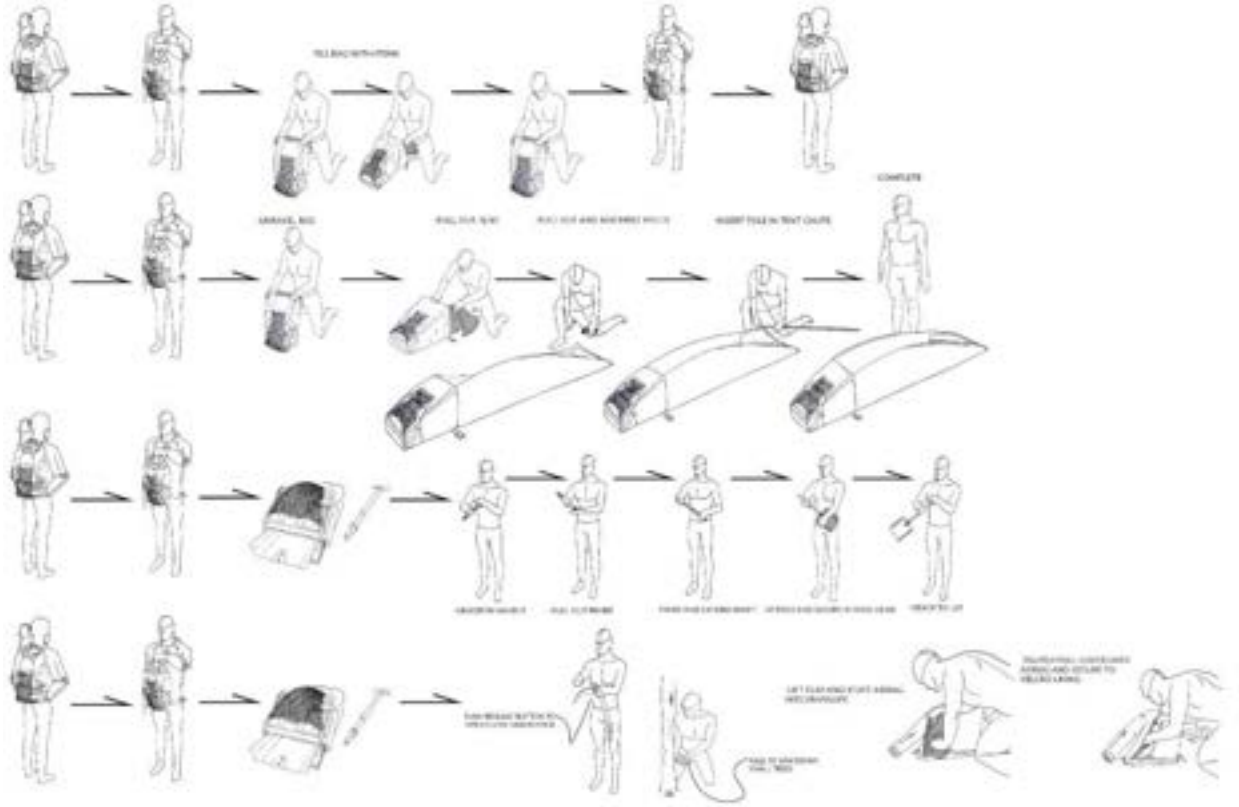


Figure 47 - Final Concept Steps of Use

Depicted in the figures above are design choices to help benefit the aesthetic appeal. There were multiple renditions of the final aesthetic, collaborated in a multi tiered, refinement solution. In the end, the required benefits would have been to make sure the aesthetics does not hold back from the safety applications. Meaning that reflective areas would need to be seen easily as well as not hinder on the attractiveness of the overall product.

Within AERUS, the latest and final chosen features were incorporated in the analogue design, which would've included the bag and all of its apparatuses and holders, as well as any fasteners and enclosures. In regard to the jacket, the final design of AERUS would have included the safety features for the regulator and airbag systems, along with any pockets, enclosures, and fasteners as well.

Given that in the most dire situations when these features would have needed to be used, there would have needed to have been an easy and uncomplicated approach to any visuals or writing that would be needed anywhere on AERUS. Here, many symbols as well as abbreviations that are common within the field or activity stream is incorporated along the final design.

At this point through to the sketch model phase, the need to weed out any improper specifications was required, and all adjustments had been made prior to the final design and would not have changed. The measurements were perfect for a 99th percentile male and 50th percentile female. Note that the final model was created for a less than 99th percentile male solely based on the parameters of the purchased mannequin. It was only at this point that final measurements had to be manipulated and changed in order to scale the model for a different sized body. However, the model would still have been a 1:1 scale.

4.5.2 Physical Study Models

The final physical model study was skewed to say the least. Given that the model is less than the 99th percentile male as the measurements were taken for, the mannequin, being the tallest mannequin

able to be purchased, was only 5’11”. After developing the measurements for the 99th percentile male on that size of mannequin, small adjustments were made to scale down the parameters to fit the size post process. All final tweaks and symmetry was then developed in CAD.

Figure 48 - Ice pick and saw closed

Figure 49 - Ice pick and saw open

Figure 50 - Shovel compacted

Figure 51 - Shovel expanded

Figure 52 - Avalanche survival bag structure

Figure 53 - Shoulder straps

Figure 54 - Breathing apparatus

Figure 55 - Waist strap

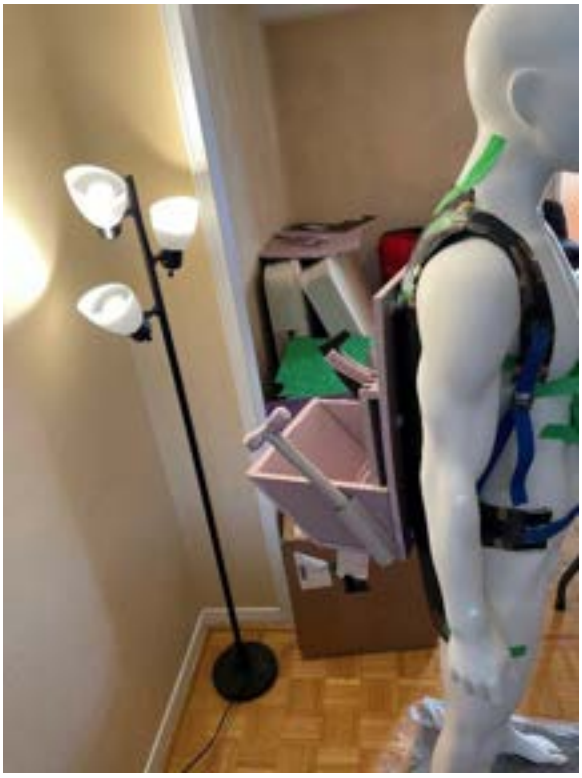


Figure 56 - Bag position on back

Figure 57 - Bag position on back top view

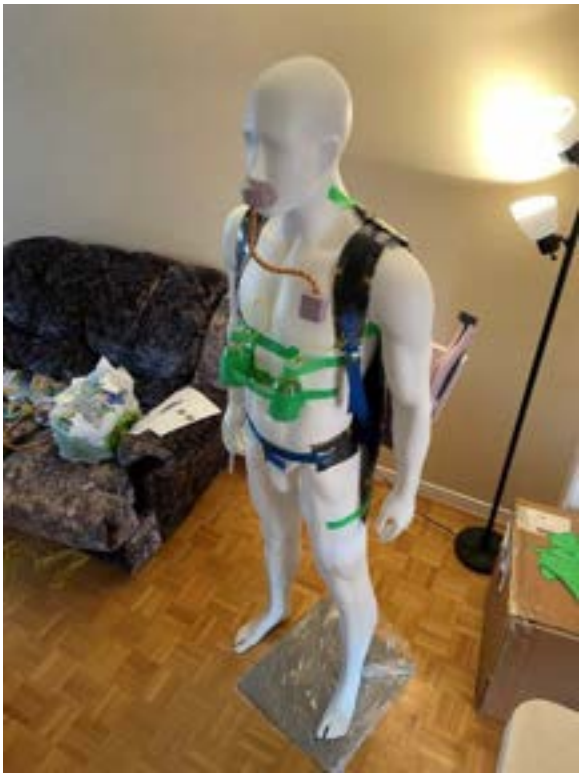


Figure 58 - Internal components layout

Figure 59 - Bag position on back 3/4 view

Figure 60 - Completed sketch model back view

Figure 61 - Completed sketch model 3/4 view

Figure 62 - Completed sketch model face shield

Figure 64 - Completed sketch model side view

Figure 63 - Completed sketch model front view

Figure 65 - Completed sketch model low angle view

4.6 Design Resolution

The interaction between the user and AERUS needed to be seamless, so with this in mind, very few mechanical aspects were involved in the final design resolution making sure that it is fool proof. Functionality is also encapsulated within the human interaction aspect, primarily for aspects such as tools, shelter, and pressurized air release. These factors all need to be ergonomic resulting in the easiest and least burdening movements that the user could make. Final adjustments to the design were made in the form of the fabric pattern seam lines which would then give a final view of what the final physical model would look like, along aesthetic, approach, and use of semantics.

Figure 66 - AERUS aesthetic render

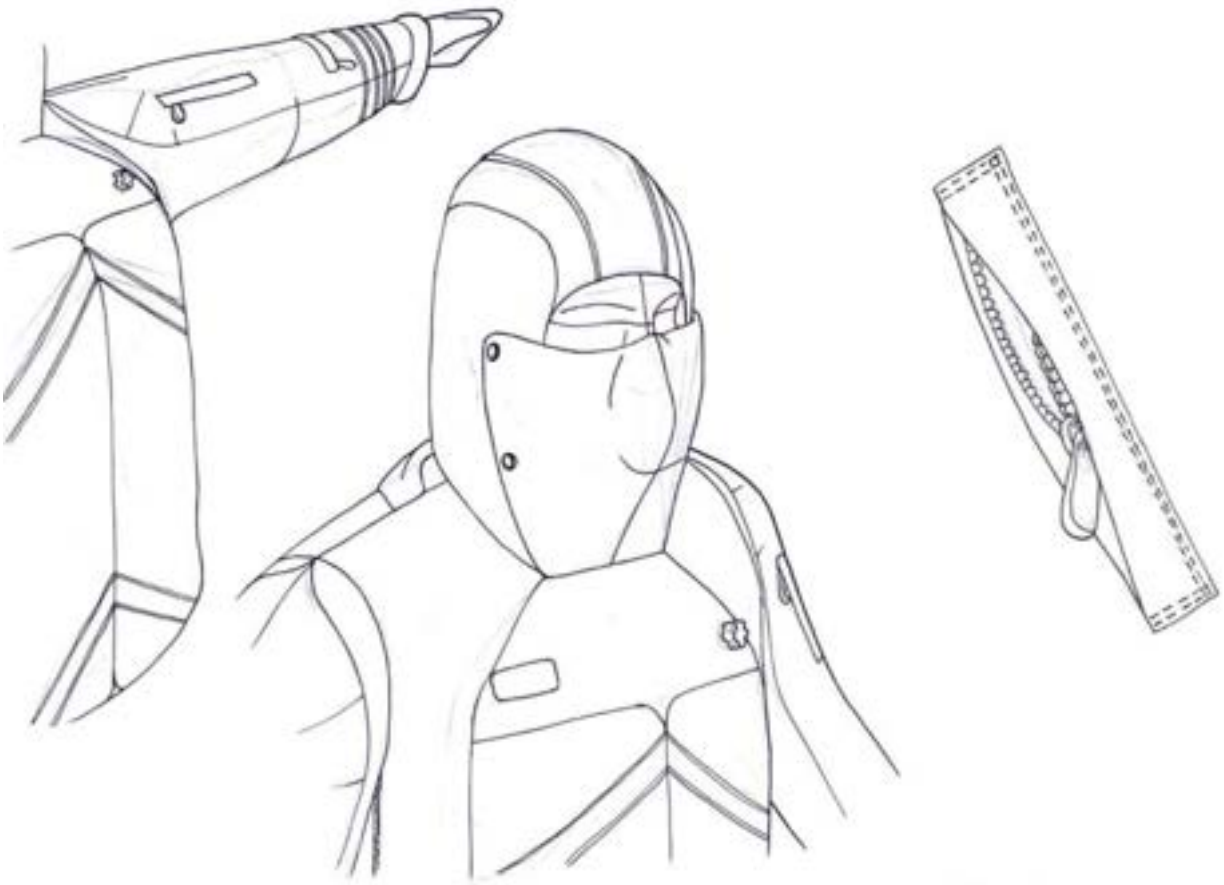


Figure 67 - AERUS final design development

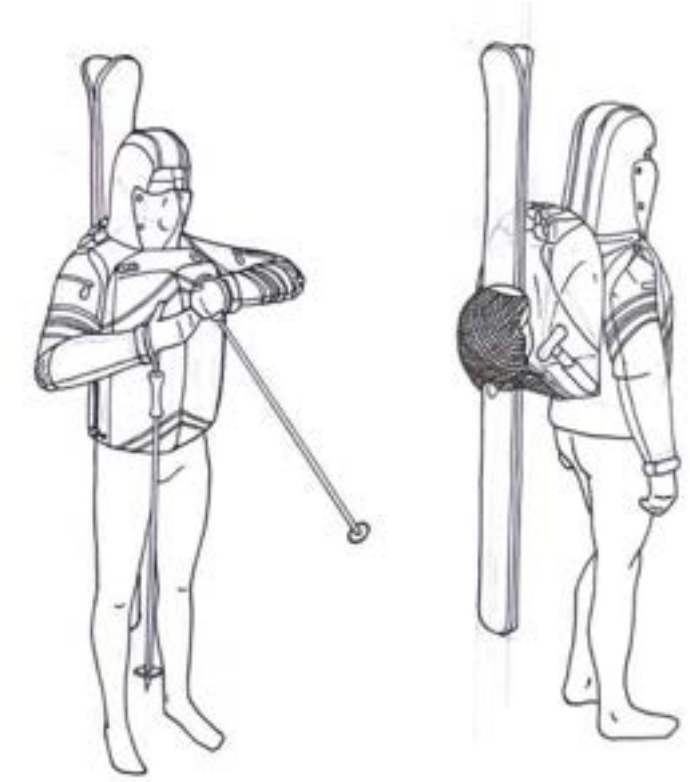


Figure 68 - AERUS final design development

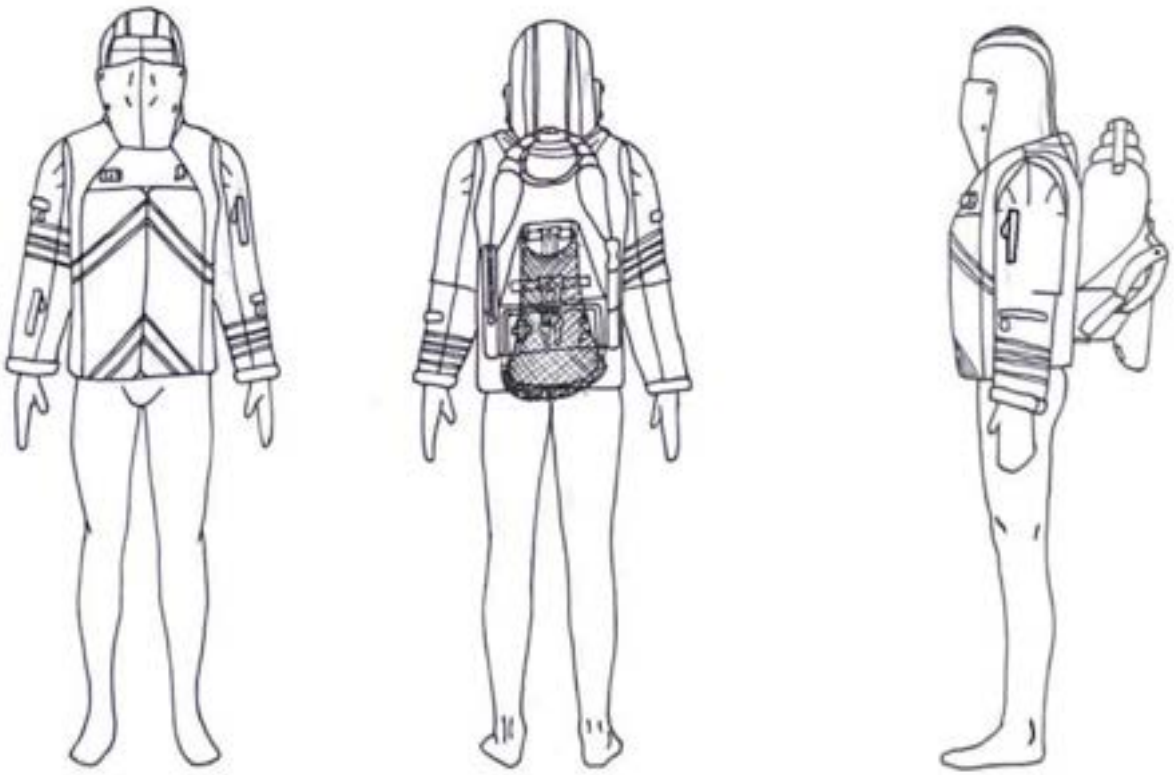


Figure 69 - AERUS final design front, back, side view

4.7 CAD Development

Well, within the CAD development, a couple different design software's were used, CLO 3D and SolidWorks. CLO 3D was primarily used to design all soft-shell aspects to AERUS along the lines of fabric. This software provided a very functional and very computer-generated physics, specific simulation of how the projected fabric upon the avatar model would drape, react to pulling an adjustment, and overall manufacturing in the line of sewing. SolidWorks was primarily used for all hard-shell aspects to AERUS. These hard-shell pieces would mainly perform the function of the hardware sewn into and fitted into the fabric pieces, as well as serve towards providing proportional and visual support in creating and understanding the tools accompanying the avalanche survival bag.

Resulting from these CAD software's was a final, manufacturable outline, that would serve as tracers or STL files to them later, be 3-D printed.

CLO 3D was a new software that I had to learn on a very short notice and with this, they were many learning curves to overcome, and many tutorials were needed to be watched in order to succeed in creating a final CAD model. Sizing, however, led to be the greatest challenge as, taking the pictures of the templates created in the physical model study, being translated into an adobe, illustrator design, and then imported into the software, many measurements at sewing lines did not add up due to the unknowledgeable and unskilled practises that were used. This later, then resulted in setbacks where small measurements needed to be adjusted and angles, along with curves needed to be improvised to form the final model.

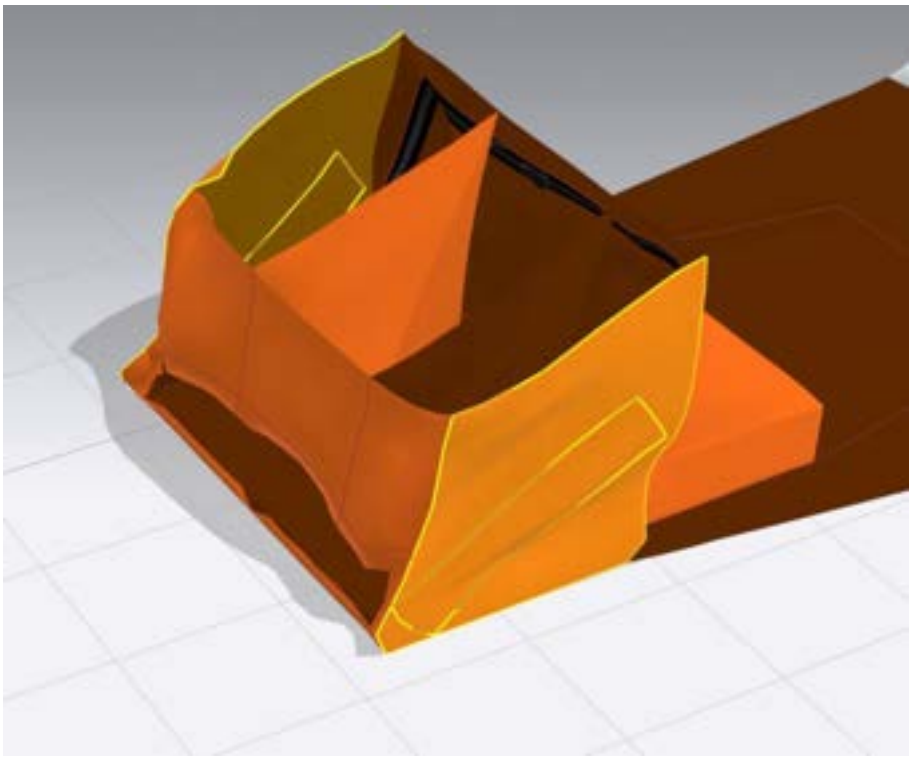


Figure 70 - AERUS bag storage

Figure 71 - AERUS jacket sleeve

Figure 72 - AERUS jacket development

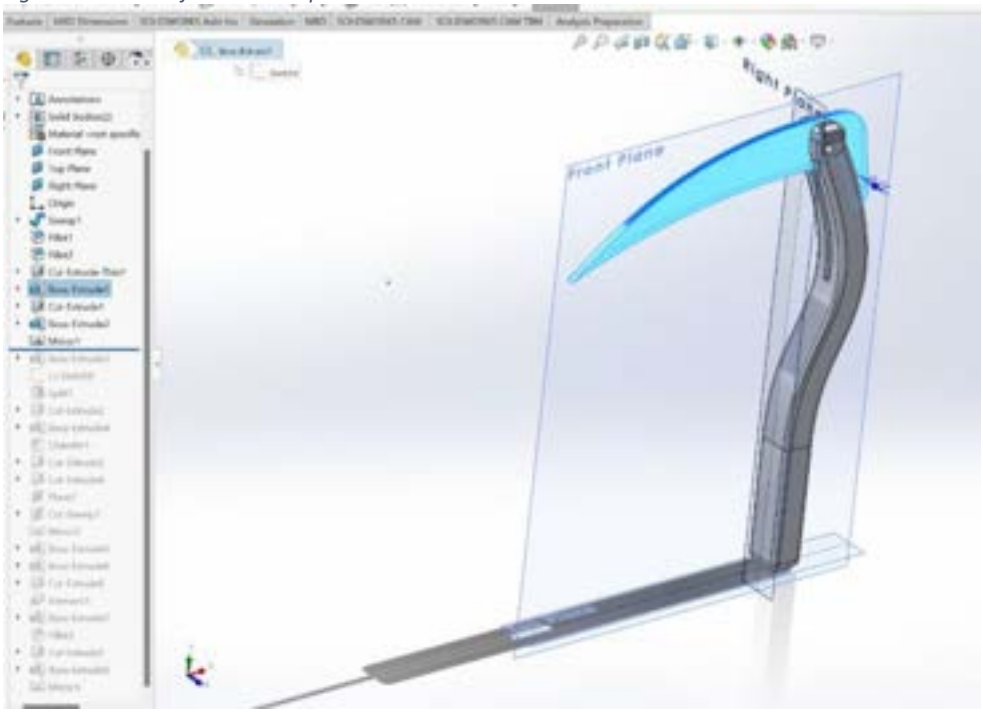


Figure 73 - Survival tool development

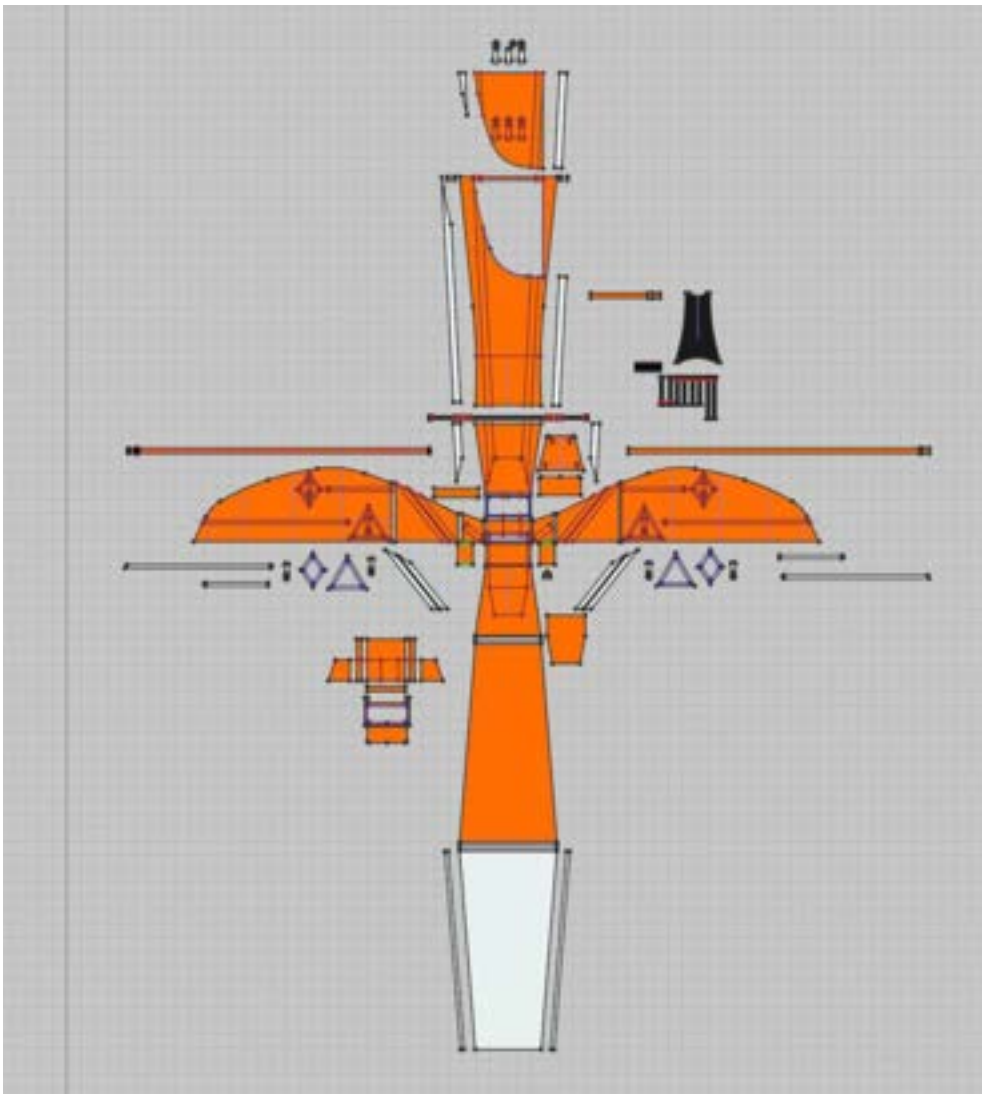


Figure 74 - All bag pattern pieces

4.8 Physical Model Fabrication

Figure 75 - Final model fabrication tool lanyard

Figure 76 - Final model fabrication jacket straps

Figure 77 - Final model fabrication adhering rails

Figure 78 - Final model fabrication rail alignment

Figure 79 - Final model fabrication airbag adjustment

Figure 80 - Final model fabrication arm airbag

Figure 81 - Final model fabrication final check

Figure 82 - Final model fabrication adhering button caps

Chapter 5 – Final Design

5.1 Design Summary

AERUS has been developed for the need of winter mountain excursion activity safety equipment. There is a large gap in the market for an all-in-one product that helps individuals who find themselves at the mercy of Mother Nature. Avalanche survival equipment is complicated, there's many items to choose from, and often times these items require training to use them, rendering it to not be so easy to implement in life. AERUS is a series of products that work fluidly with each other. A simple jacket formatted with the most cutting-edge insulation that reflects close to 100% of the user's body heat but is still breathable. Incorporated within the jacket however is the breathing and airbag deployment apparatus. A series of connected tubes and pressurized air tanks that allow for the user to float on top of the avalanche or breathe for a prolonged period of time if buried. Additionally, there is an S.O.S transmission beacon button built into the jacket. The avalanche survival bag is a dry bag inspired survival bag that is also a reflective tent that allows the user to wait in a secure and warm structure for search and rescue personnel. Additionally, the survival tools are common items already found in the market. They include a collapsible avalanche shovel, a probe, and a 2-in1 ice pick saw tool. AERUS would allow for the user to overcome the top 3 causes of death accompanied with avalanches. The air system would prohibit asphyxiation in multiple ways, the survival pack would provide a quick shelter and life sustaining material to wait for help in harsh weather, and the multiple assets incorporated for body heat retention and reflection throughout the products allow the user to push past hypothermia.

5.2 Design Criteria Met

Following is the final stages of the thesis process with eh creation of a final model, its proposed material and manufacturing, as well as the ergonomic considerations.

5.2.1 Full Bodied Interaction Design

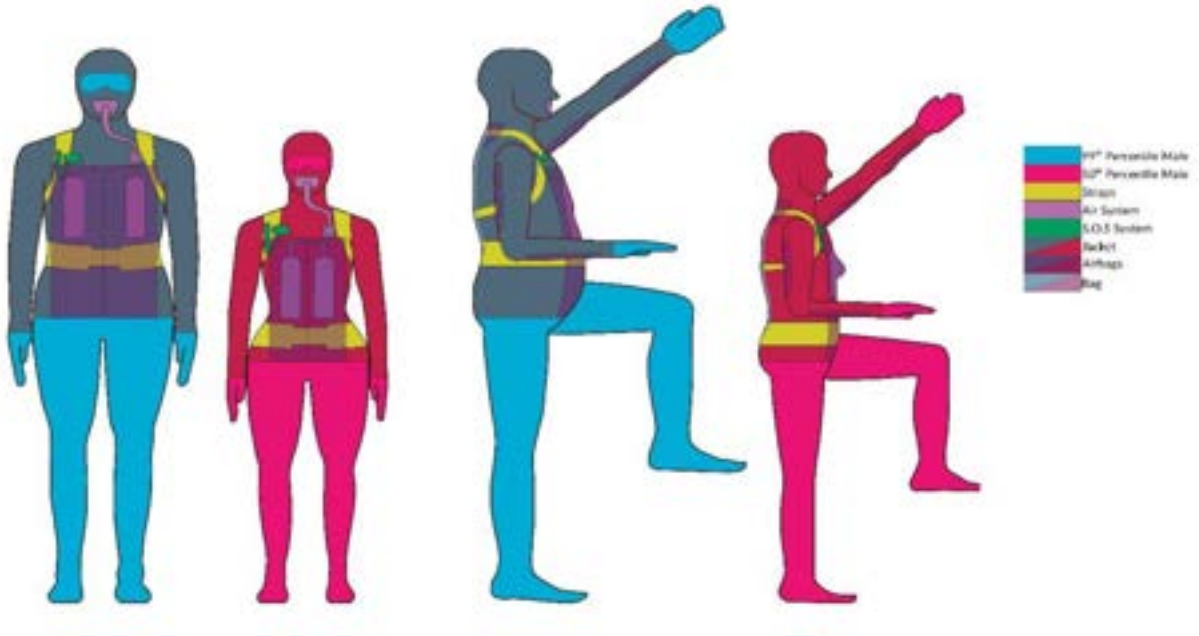


Figure 83 - AERUS final schematic

5.2.2 Materials, Processes, and Technology

In production, AERUS would be comprised of premium materials that hold above all else. The face shield for example, will be in contact with a humid environment and most likely condensation. This requires a fabric that is moisture wicking and breathable, modal bamboo rayon serves as the answer nicely. The natural properties of this fabric keeps the users face dry and doesn't hinder airflow.

A strong and durable material would be needed for the outer shell, the layer that faces the winter elements and environment. BananaTex is a fabric derived from banana stalk fibers that allow the production of the material to be sustainable. Banana stalks otherwise go to waste in landfills, this process allows the organic material a chance at serving a purpose. It can also be coated with a TPU coating for waterproof and repellent properties. The inner liner of the jacket would be a smooth, recycled polyester fabric. This fabric would combat land and ocean pollution as the plastic harvesting can be in cooperation with activist and volunteer groups that collect the material. Synthetic insulation is

a more ethical choice than down and feather filled options. Xerogel is so porous that it is practically air. The make up of this insulation does not allow for the user's body heat to transfer through while simultaneously allowing for cooler air to pass through. This aspect provides an aerating feature to the make up of the jacket, ultimately adding to the comfortability of the user.

Smaller parts to AERUS would be manufactured in traditional ways but also add the incorporation of ethical treatment of workers. This aspect alone combats many big name brand manufacturing practices that users wish were addressed. By providing an alternative, it would attract a large portion of their markets.

5.2.3 Design Implementations

Jacket					
#	**Part Name**	**Material**	**Sustainable/Ethical**	**Quantity**	**Man. Method**
1	Body Liner	RPET	YES	3 yrds	Die cut/sew
2	Face Shield Liner	Modal Rayon	YES	½ yrd	Die cut/sew
3	Insulation	Thinsulate Xerogel	YES	5 yrds	Die cut/sew
4	Airbag	UHMWPE	NO	4 yrds	Die cut/sew
5	Pockets	Bananatex	YES	1 yrd	Die cut/sew
6	Outer Shell	Bananatex	YES	3 yrds	Die cut/sew
7	Buttons	ABS	NO	8	Injection molding
8	Buckle	ABS	NO	1	Injection molding
9	Zipper	Round Toggle VISLON closed/open with DWR Coating	NO	6	Casting
10	Velcro	Polyester Knitted Loop and Polyester Woven Hook	YES	1 yd	Weaving/injection molding
11	Straps	Climbing Grade Nylon Webbing	NO	10 ft.	Weaving
12	Rails	PEEK	NO	2	Injection molding
13	Canister	M2 Air Tank	NO	2	Die press
14	Tubing	Polyurethane	NO	10 ft.	Extrusion
15	Safety reflective Material	Colour Reflective Fabric	YES	2 yrds	Die cut/sew
16	Netting	Nylon Mesh	NO	½ yrd	Weaving

17	Snow-skirting	Polyester Latex	NO	½ yrd	Die cut/sew
18	Regulator Knob	ABS	NO	1	Injection molding
19	Drawstring Latch	ABS	NO	2	Injection molding
20	Drawstring	Polyester Latex	NO	5 ft.	Weaving
Bag					
#	**Part Name**	**Material**	**Sustainable/Ethical**	**Quantity**	**Man. Method**
1	Outer Shell	RPET Bag with TPU Coating	YES	10 yrds	Die cut/sew
2	Inner Liner	Metalized LDPE	YES	5 yrds	Die cut/ultrasonic welding
3	Zipper	Round Toggle VISLON closed/open with DWR Coating	NO	2	Casting
4	Tent Pole	Aluminum	NO	3	Extrusion
5	Netting	Nylon Mesh	NO	½ yrd	Weaving
6	Buckle	ABS	NO	7	Injection molding
7	Straps	Climbing Grade Nylon Webbing	NO	3 ft.	Weaving
8	Shovel Head	Aircraft Grade Aluminum	NO	1	Stamp press
9	Shovel Shaft	Aircraft Grade Aluminum	NO	2	Extrusion
10	Shovel Handle	PEEK	NO	1	Injection molding
11	Shovel Tightener	PEEK	NO	1	Injection molding
12	Saw/Icepick Blade	Stainless Steel	NO	1	Stamp press/grinder
13	Saw/Icepick Handle	PEEK	NO	1	Injection molding
14	Saw/Icepick Tether	Nylon	NO	1	Weaving
15	Probe	Aluminum	NO	1	Extrusion
16	Air Pump	PVC with Aluminum Parts	NO	1	Blow molding
17	Velcro	Polyester Knitted Loop and Polyester Woven Hook	YES	½ yrd	Weaving/injection molding

Table 16 - AERUS bill of materials

5.3 Final CAD Rendering

Figure 84 - AERUS CAD avalanche snow shovel

Figure 85 - AERUS CAD ice pick/saw

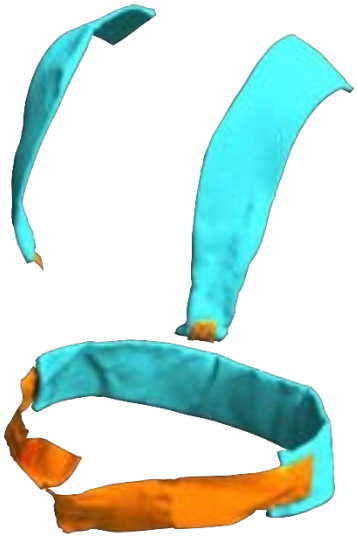


Figure 86 - AERUS CAD integrated bag harness

Figure 87 - AERUS CAD airbag deployment

Figure 88 - AERUS CAD jacket and bag view

Figure 89 - AERUS CAD exploded view

Figure 90 – AERUS CAD bag in tent form

Figure 91 - AERUS bag scale

Figure 92 - AERUS avalanche survival bag exploded view

5.4 Physical Model

Figure 93 - Airtank representation

Figure 95 - AERUS avalanche survival shovel disassembled

Figure 94 - AERUS avalanche survival shovel

Figure 96 - AERUS icepick/saw closed

Figure 97 - AERUS icepick/saw close up

Figure 98 - AERUS icepick/saw open

Figure 99 - AERUS visual of multiple layers

Figure 100 - AERUS pocket capacity

Figure 101 - AERUS layers of closing jacket

Figure 102 - AERUS opened snowskirt

Figure 103 - AERUS harness

Figure 104 - AERUS facemask

Figure 105 - AERUS rail clips

Figure 106 - AERUS all together

Figure 107 - AERUS avalanche survival bag storage

Figure 108 - AERUS avalanche survival tent

5.5 Technical Drawings

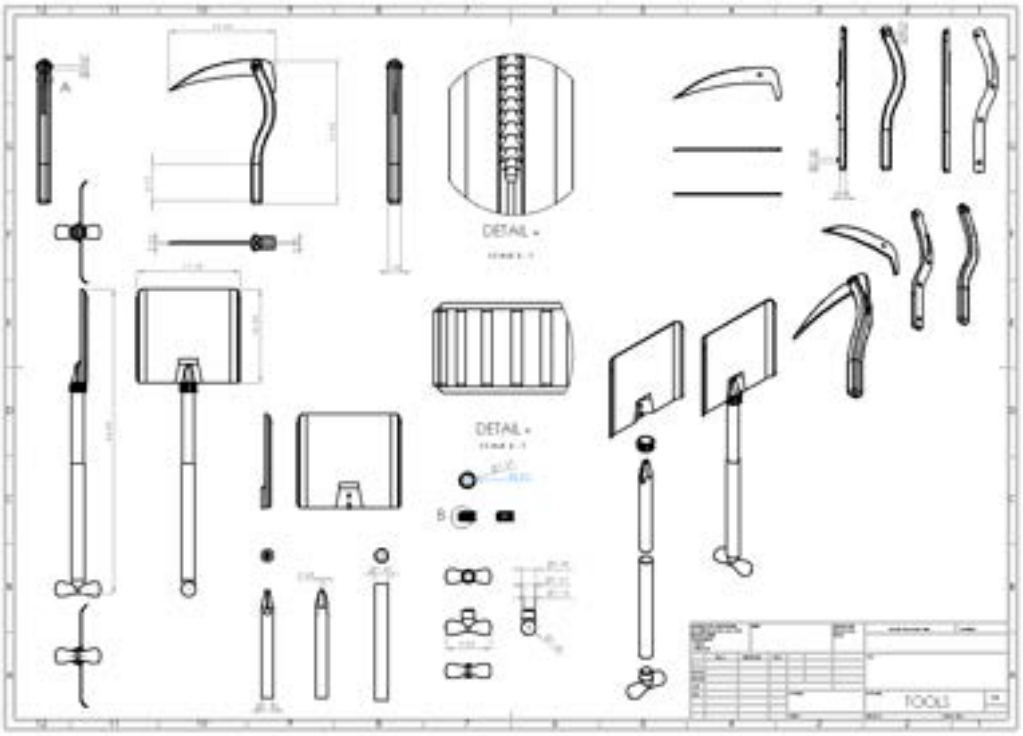


Figure 109 - Tool technical drawings

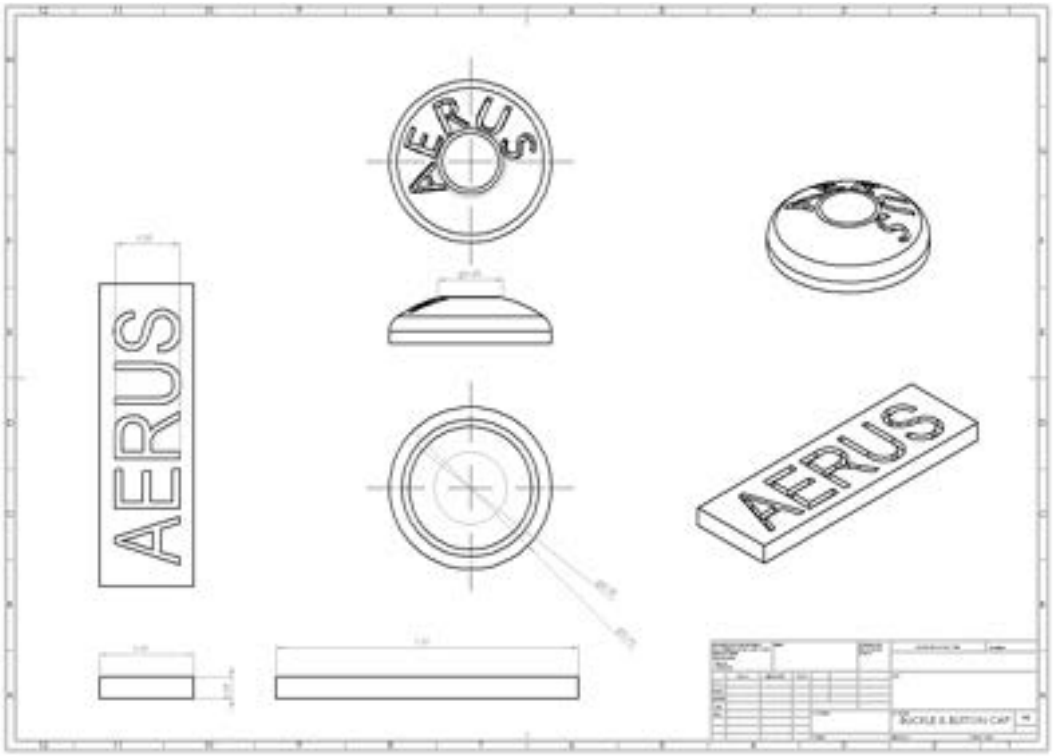


Figure 110 - Button and buckle name cap technical drawings

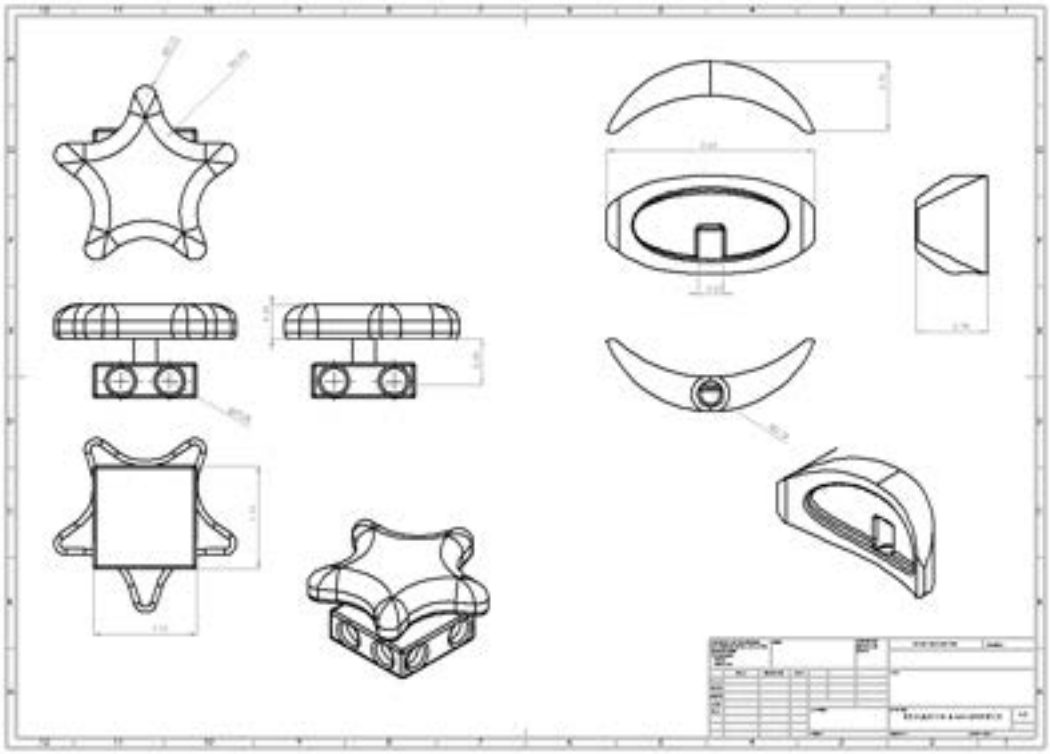


Figure 111 - Regulator and mouthpiece technical drawings

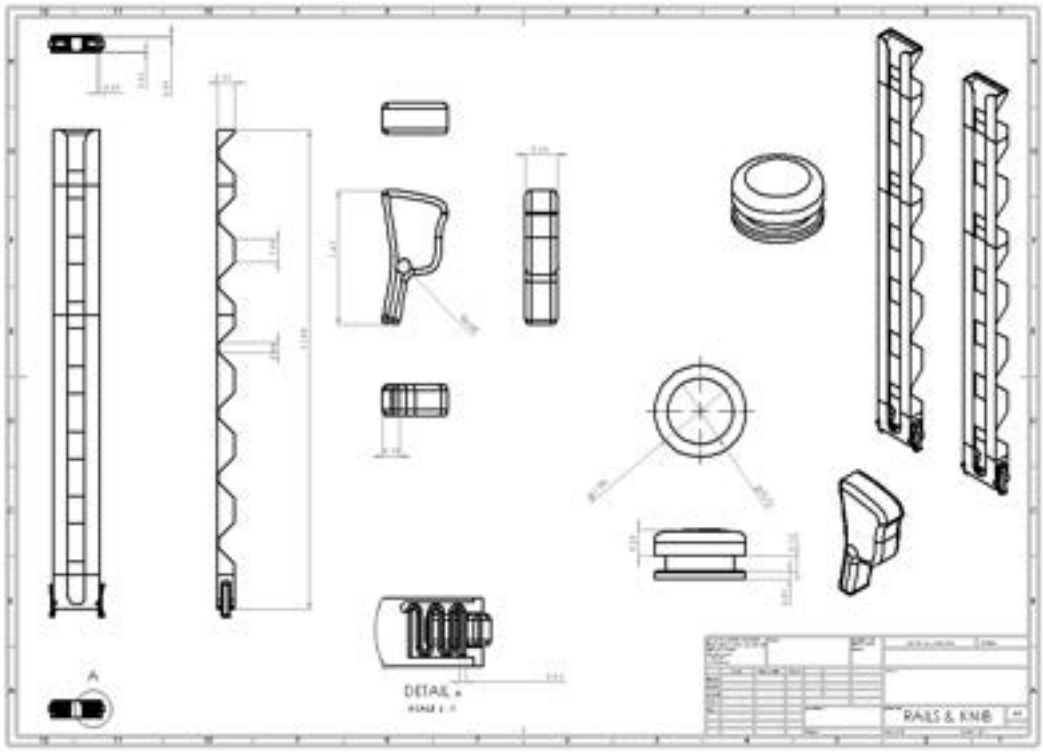


Figure 112 - Rail system technical drawings

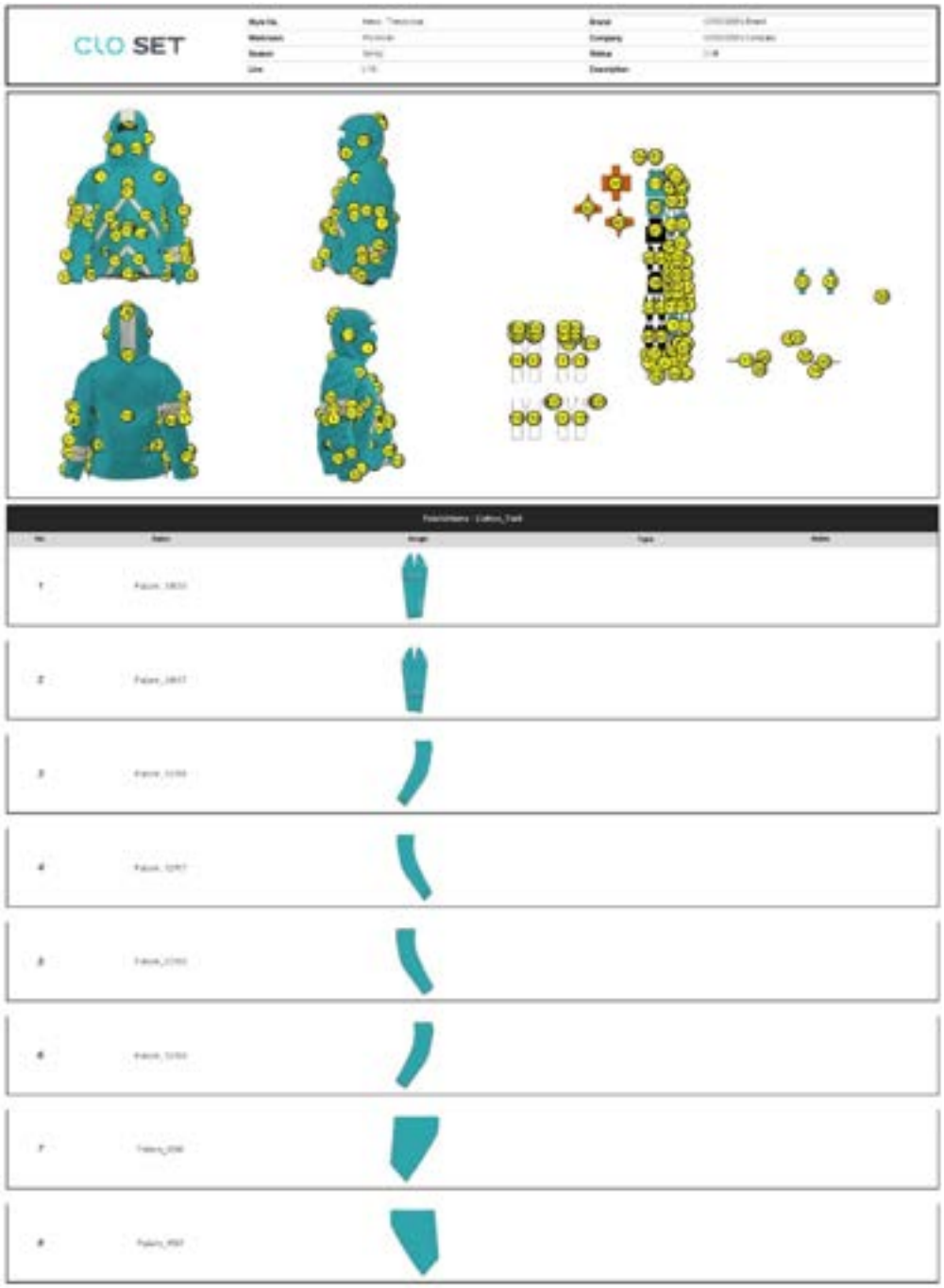


Figure 113 - AERUS jacket tech. pack

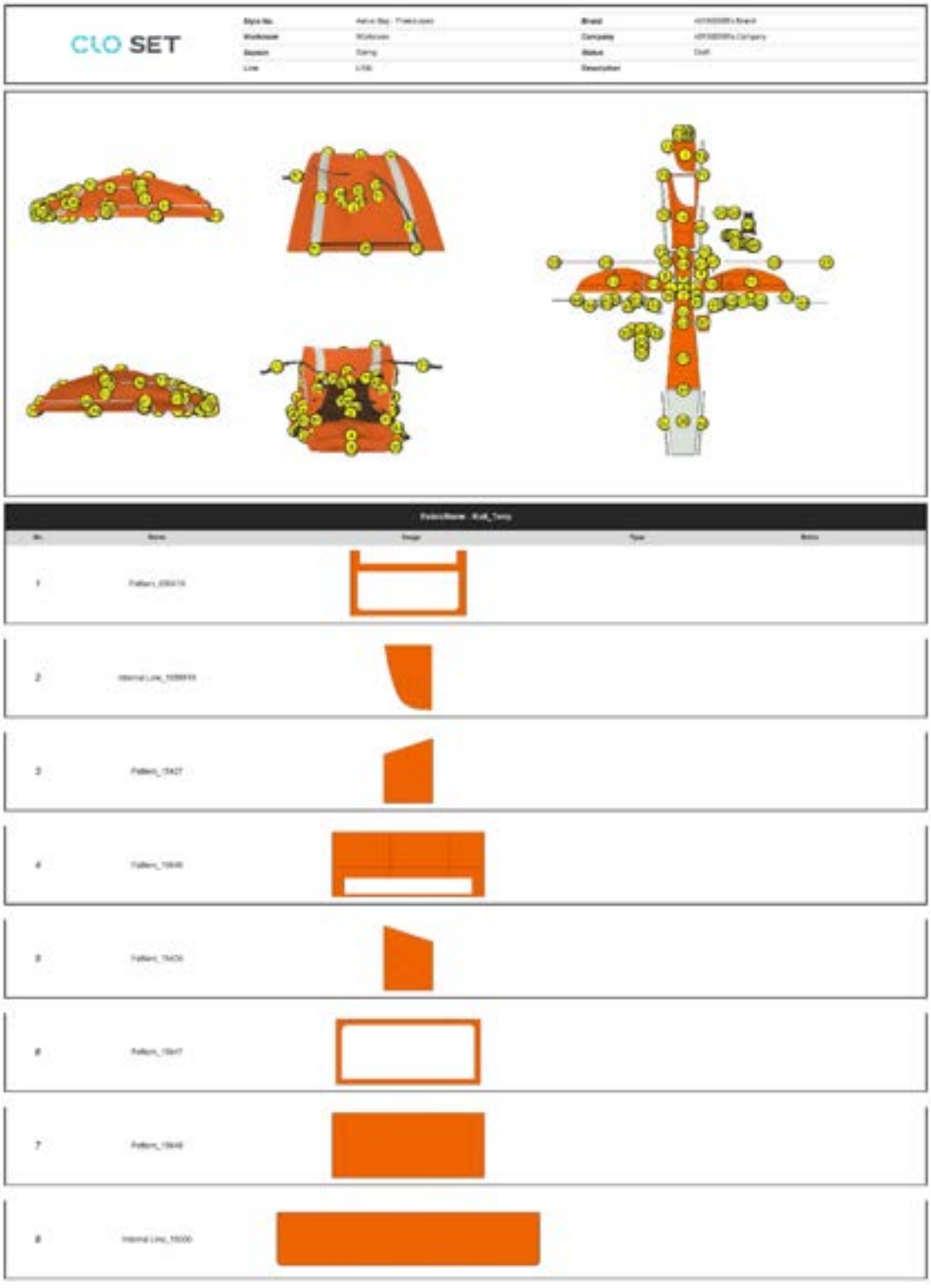


Figure 114 - AERUS avalanche survival tent tech. pack

5.6 Sustainability

Incorporated within AERUS are a multitude of facets that pertain to the pillars of upholding sustainability for all.

AERUS tackles boundaries to which others have stopped at in terms of the environmental impact as to which they conduct the bare minimum. Providing the largest chance possible to flawlessly incorporate environmentally sustainable acts is pivotal in setting this product aside from the rest. However, this cannot come at the cost of the people and within this statement it must be made clear that if this thesis project holds promise to become a manufactured item, there will be people responsible to manufacture all its features, forms, and components. Part of being truly sustainable is to hold the people in the minds of the developers and incorporate initiatives to provide an everlasting and fruitful future for them as well. Ultimately, there is no future to AERUS without the much-needed economic face to sustainability that will create the opportunities to continue providing for the other two faces to sustainability. Although, it does not mean to put this facet first and foremost, in other words, greed. This would be the pillar on which integrity to give back to charities and foundations to embitter the planet and the resources for which AERUS is created.

Touching upon the tangible aspects of this products eco-friendly fabrics and materials along with possibilities for sustainable ethical initiatives to bring this product to the forefront of the industry and to proclaim a standard and goal as to what is achievable by all other companies will include a brief rundown of integral parts to AERUS' design.

Pointing to the exterior of the jacket, its make-up is that of a fabric called Bananatex, a banana stalk comprised fabric that is durable and offers the ability to be covered in a durable water-resistant coating, allowing for a similarly comparable alternative to current market standard jacket shell materials. Another important material that is incorporated along the jacket as well as the survival bag is that of the reflective strip material. Even though it may not be made from an environmentally

sustainable material, it is however certified by OEKO TEX® STANDARD 100 that informs users that it is free of regulated and unregulated harmful materials beyond an internationally appointed threshold that indicates the material is undoubtedly safe for contact with humans. Not many companies, if none, have this certification on their products. Lastly, the common conception of sustainability enveloping longevity as an aspect revolves around a few components within AERUS, such as the aircraft grade aluminum shafts of the icepick/saw and shovel and shovel head. These subcomponents will last until time has taken their toll on them and wear and tear has rendered them useless, this however may take many, many years where the possibility of the subcomponent tools lasting longer than AERUS as a whole.

Looking at the larger picture, a model of the envisioned full circle approach to developing AERUS and keeping this product on the market for many years to come presents itself to be quite simple. Starting with the sourcing and development of the fabrics and materials both sustainable and not, initiatives to collect the reusable materials would be the first step. Following, the production of this product may need to take place in a nation where the average hourly wage is much more feasible than manufacturing within North America or Europe, however, it would be the responsible action on the development side of this approach to provide a higher-than-average wage that coincides with what the projected livable wage of that nation would be. Once units have been developed, a marketing approach of multiple initiatives, a list of incorporated materials that hold certification standards, and sustainability labels will draw in a niche consumer group where these values match with theirs. The collection of profit will first go to paying the workers their wages along with the added ethical initiative to support the facilities where which the raw materials are being harvested and produces, this may entail planting of certain crops and the expansion of workforces for collecting plastics used in recycling processes. That is where this proposed model comes back full circle where the growth of the means of production for AERUS take precedence over corporate greed and unfair treatment of foreign workers.

Chapter 6 – Conclusion

References

11 facts about avalanches. DoSomething.org. (n.d.). Retrieved April 19, 2023, from https://www.dosomething.org/us/facts/11-facts-about-avalanches#:~:text=Each%20year%20avalanches%20kill%20more,then%20punch%20your%20hand%20skyward.

16 March 2022 • Giada Nizzoli. (n.d.). *Polyester vs recycled polyester: Is the latter eco-friendly?: Sustainable fashion blog: Project CECE*. Sustainable Fashion Blog | Project Cece. Retrieved April 19, 2023, from https://www.projectcece.com/blog/500/virgin-polyester-vs-recycled-polyester-clothing/

3M™ thinsulate™ insulation. 3M in the United States. (n.d.). Retrieved April 19, 2023, from https://www.3m.com/3M/en_US/thinsulate-us/

Adventure Medical Kits. (2013, February 26). *What's the difference between Space® Blankets & Survive Outdoors longer® emergency blankets?* Adventure medical kits. Retrieved April 19, 2023, from https://www.adventuremedicalkits.com/blog/2013/02/space-blanket-versus-emergency-blankets/

Avalanche awareness. Avalanche Awareness | In-Depth | Services | Tignes Spirit. (n.d.). Retrieved April 19, 2023, from https://www.tignes-spirit.com/services/indepth/article/2#:~:text=Most%20people%20suffocate%20within%2015,to%20make%20an%20air%2Dpocket.

Avalanche Deaths in British Columbia, 2011-2022. BCCS Avalanche Web Report 2011-2022. (2023). Retrieved from https://www2.gov.bc.ca/assets/gov/birth-adoption-death-marriage-and-divorce/deaths/coroners-service/statistical/bccs_avalanche_web_report_2011-2022.pdf

Avalanche victim resuscitation. Sierra Avalanche Center. (2017, February 23). Retrieved April 19, 2023, from https://www.sierraavalanchecenter.org/avalanche-victim-resuscitation#:~:text=The%20American%20Avalanche%20Association%20(AAA,15%20minutes%20of%20burial%20time.

BANANATEX®. (n.d.). Retrieved April 19, 2023, from https://bananatex.info/

BioPuff. saltyco®. (n.d.). Retrieved April 19, 2023, from https://www.saltyco.uk/

Blumhardt, M. (2023, January 23). *Colorado's four avalanche deaths of the season are eerily similar. here's why.* Fort Collins Coloradoan. Retrieved April 19, 2023, from https://www.coloradoan.com/story/news/2023/01/20/colorado-avalanches-why-people-die-survival-times-if-buried-safety-tips/69816022007/

Canada, P. S. (2018, February 22). *Avalanches*. Public Safety Canada. Retrieved April 19, 2023, from https://www.getprepared.gc.ca/cnt/hzd/vlchs-en.aspx

CBC/Radio Canada. (2023, March 3). *'saddest day ever': 3 dead, 4 injured after Avalanche Hits Heli-Skiing Group in B.C. Interior | CBC News*. CBCnews. Retrieved April 19, 2023, from https://www.cbc.ca/news/canada/british-columbia/invermere-avalanche-british-columbia-1.6764948#:~:text=There%20have%20now%20been%2012,trip%20in%20B.C.'s%20Interior.

Custom polyurethane molding services. Gallagher Custom Polyurethane Molding. (n.d.). Retrieved April 19, 2023, from https://gallaghercorp.com/

D;, S. A. W. D. L. S. A. (n.d.). *Causes of death among avalanche fatalities in Colorado: A 21-Year review*. Wilderness & environmental medicine. Retrieved April 19, 2023, from https://pubmed.ncbi.nlm.nih.gov/29960854/#:~:text=Asphyxia%20was%20the%20cause%20of,%25%20(6%2F32).

Environmental equipment: Air Quality: Water Monitoring. Field Environmental Instruments, Inc. (2017, December 4). Retrieved April 19, 2023, from https://www.fieldenvironmental.com/

Fabric Online Store: Fabric by the Yard Online. Mood Fabrics. (n.d.). Retrieved April 19, 2023, from https://www.moodfabrics.com/

Fashion design clothing manufacturers for your brand. Sewport. (n.d.). Retrieved April 19, 2023, from https://sewport.com/

Home. YKK Americas. (2023, April 18). Retrieved April 19, 2023, from https://ykkamericas.com/

Made for Tomorrow. Home - Cradle to Cradle Products Innovation Institute. (n.d.). Retrieved April 19, 2023, from https://c2ccertified.org/

Materialdistrict. MaterialDistrict. (n.d.). Retrieved April 19, 2023, from https://materialdistrict.com/

McIntosh, S., Grissom, C., Olivares, C., Kim, H., & Tremper, B. (2010, February 23). *Cause of death in avalanche fatalities*. Wilderness & Environmental Medicine. Retrieved April 19, 2023, from https://www.sciencedirect.com/science/article/abs/pii/S1080603207702582#:~:text=Asphyxia%20is%20the%20main%20cause,trauma%20will%20kill%20fewer%20victims.

PolyAlto, G. (n.d.). *Groupe Polyalto*. Blogue. Retrieved April 19, 2023, from https://blogue.polyalto.com/

Rauch, S., Strapazzon, G., & Brugger, H. (2021, September 29). *On-site medical management of Avalanche Victims-A Narrative Review*. International journal of environmental research and public health. Retrieved April 19, 2023, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8507645/

Sayed, M. A. (n.d.). *Textile apex*. Textile Apex. Retrieved April 19, 2023, from https://textileapex.blogspot.com/

sewing.org. (2008). Elastics - Types, Characteristics and Uses .

Shop camping, biking, skiing, hiking and+. Altitude Sports. (n.d.). Retrieved April 19, 2023, from https://www.altitude-sports.com/

A single-source partner. Nordson MEDICAL. (n.d.). Retrieved April 19, 2023, from https://www.nordsonmedical.com/

Sustainable fashion at your fingertips 🌱. SustainYourStyle. (n.d.). Retrieved April 19, 2023, from https://www.sustainyourstyle.org/

A timeline of avalanche deaths in B.C. for the 2022-2023 season. (2023). *Toronto Star*.

UHMW. Curbell Plastics. (n.d.). Retrieved April 19, 2023, from https://curbellplastics.com/research-solutions/materials/uhmw

Urethane, P. (n.d.). *Engineering solutions for high wear applications*. Custom Molded & Cast Polyurethane Manufacturers | Precision Urethane. Retrieved April 19, 2023, from https://www.precisionurethane.com/

Velcro® brand FASTENING SOLUTIONS: Velcro Companies. Velcro. (2023, March 7). Retrieved April 19, 2023, from https://www.velcro.com/

World's leading manufacturer of reflective material and safety clothing. Reflective Fabric And Safety Vest Manufacturer In China. (n.d.). Retrieved April 19, 2023, from https://www.chinareflective.com/

Zipper guide. Trican. (n.d.). Retrieved April 19, 2023, from https://www.tricancorp.ca/zipper-guide

Appendix A - Discovery

Observation

To truly understand the devastation of avalanches, video review was conducted. Observing the affect that avalanches have on the body and the procedures in place currently to find a victim.

Youtube: https://www.youtube.com/watch?v=dH9v4Js1YKY&ab_channel=ForecastSkiMagazine

Following this video a search and rescue explanation was observed.

Youtube: https://www.youtube.com/watch?v=zb3gaW8Lz0s&ab_channel=SalomonTV

An excerpt of the transcription *(or notes)* is below, along with preliminary coding.

The full transcription *(notes)* is available in the Appendix.

…we see an avalanche break around them the first thing we're going to do is yell avalanche you yell avalanche because johnny's skiing down and he might not know what's happening behind him and when he hears avalanche, he'll look back he'll see it and ideally he'll just ski away from it also gets the grip around making sure they get eyes on him and get that last seen point because that eliminates a lot of terrain right off the bat… if you can aim at a 45 degree angle to ski out of it that might help if that doesn't work and you're actually starting to get moved by the avalanche and you're wearing an airbag you can pull your airbag and that'll float you up on top and ideally save you… once the avalanche starts to slow down you really want to focus on creating an airspace because that's going to give you valuable air time while your friends are searching for you just move your hands push the snow away try to get your head in by your arm here and pushing it away just trying to really create some space for you to breathe during the minutes your friends are searching for you before we get into rescuing johnny we want to make sure that we as rescuers are safe and that there's nothing left above that could come down and hit us while we're rescuing them so the next step kind of changes with scenario with group size but ideally you want to establish a group leader doesn't necessarily have to be the most experienced person but maybe the most calm person in that moment this is also a great time if you have enough people to call in the rescue call that local emergency number or get on a radio get help out there as soon as possible so we've established that the scene is safe we know johnny's last seen point and we've made Greg the leader yep so let's uh ski down to where johnny disappeared we've skied down to the last seen point the next thing we want to do is we want to pull out our beacons and put them on search and you want to visually do it so that you can check each other because if you're stressed you might not have done what you think you did perfect now that we're both on search and we're not picking up johnny's beacon we have to figure out how we're going to search this avalanche path and find Johnny as quick as possible the first thing I want to do is I want to send Chris off on a hasty search where he's looking for pulls skis gloves or an ideally Johnny and I'm making sure that I pick up those poles pick up those skis because Johnny might be attached to it and that in that case I don't need a probe I can just start shoveling right away really important to eliminate the terrain as I go down so I sent Chris off on his hasty search meanwhile I want to do a more thorough search in case he misses something so I'm going to look at the avalanche and I'm going to figure out how to strategically zig and zag my way down it to cover the whole area and the distance between my zigs and zags I don't want to be bigger than 40 meters that way I will efficiently eliminate all the terrain working my way down the slope… okay so now we're into the fine search and this becomes very important that the orientation of your beacon does not change so no turning it this way no turning it that way just keeping it nice and steady the… so while Chris is doing the fine search I'm

going to get the rest of my equipment ready I'm going to get out my probe and shovel which are easily accessed and quick to get to probes are great they're just like tent poles you grab onto one end you throw them out you shake them and that's ready once it's ready I'll throw it over to Chris and I'll get my shovel up okay so we got our lowest point we reached on our beacon mark with my goggles and that's the first place I'm gonna probe now probing technique is super important chances are you're not going to get a hit on the first thing is a methodical approach to probing is super important I personally like a cinnamon bun approach it's about 20 centimeters apart each time and you just kind of work your way outta lot of people these days are using the square whatever it is whatever you like the best you need to practice with that the other thing that's really important about a probe is making sure it goes into the slope perpendicular every time we don't want the probe going this way and this way because by the time we're two meters down that's a huge area that we're missing… once you get a probe strike you leave it in because that's where you know to dig to I'll go about a meter downhill and I'll start shoveling and shoveling is not like this shoveling is you get own on your knees you chop it up like this and you kind of paddle it back… get to the airway Greg you're gonna get tired dig it Chris I need a break can you go front yeah here he goes looking for his face here got his face open wearing his airway he's got to get some snow off his chest here hey johnny all right buddy we got you man… three so now that we've got johnny out we're gonna make sure that he's as warm as possible and then we gotta figure out his injuries and then how we're gonna save him and extract them and get him to medical help because of that kind of conveyor belt we've got a nice big flat area we can get him warm we can get him that first aid and it's kind of our chance to take a breath and hopefully johnny's all right… Greg Johnny and myself would really like to thank you guys for taking the time to watch that was a relatively simple avalanche scenario but you can tell it's quite complicated and the only way to gain these skills is by practice yeah and take a course with an avalanche professional so you know how to react in the right way when it happens and then keep practicing those skills because you can never be as good as you want to be…

Figure 2.1.4a. Transcription of the User Observation (internet video)

More in-depth coding was then conducted.

Survival steps	yell avalanche
	ski away
	pull your airbag
	creating an airspace
	valuable air time
	create some space for you to breathe
	make sure that he's as warm as possible and then we gotta figure out his injuries and then how we're gonna save him and extract them and get him to medical help
S.A.R tasks	make sure that we as rescuers are safe
	establish a group leader
	call in the rescue call that local emergency number or get on a radio get help out there as soon as possible
	pull out our beacons and put them on search
	hasty search where he's looking for pulls skis gloves or an ideally Johnny
	more thorough search in case he misses something
	zigs and zags
	fine search
	cinnamon bun approach it's about 20 centimeters apart each time and you just kind of work your way outta
	people these days are using the square
	probe is making sure it goes into the slope perpendicular every time

	probe strike you leave it
	meter downhill and I'll start shoveling
	looking for his face here got his face open
Equipment used	get out my probe and shovel
	lowest point we reached on our beacon
	first place I'm gonna probe

Interviews were conducted with credited individuals within the avalanche research field. Answers are derived from the executive director of B.C AdventureSmart, Sandra Riches, executive director of the Canadian Avalanche Association, Joe Obad, professional and national champion skiers Noah Morrison and Chris Rubens.

- **Joe Obad interview answers**
- **Sandra Riches interview answers**
- **Noah Morrison interview answers**

Interview Answers combined

What would you say are the most dire avalanche induced injuries?

- Suffocation
- Trauma (due from trees, impact)
- Data driven
- Bc – 1900 calls yearly
- Top 3 for SAR (backcountry, snow adventures, avalanches) – injury (avalanches, snowmobile, snowshoeing, etc), getting lost, exceeding abilities (training and safety knowledge level
- Terrain features cause injury – trees, rocks, cliffs
- Broken femurs
- Collapsed lungs
- Internal bleeding

Where might someone find stats on individuals caught in avalanches and their outcome?

- Most countries have databases
- Avalanche Canada
- Avalanche Canada – community outreach and events, forecasting, learning opportunities, resources, blogs, avalanche ratings/scales
- Bc keeps incident summary tally/data – bc gov website (incident summary)
- Bc search and rescue association has own stats
- Avalanche Canada has own nation wide records

What would you say are the most common scenarios causing avalanches?

- Refer to stats for quotable types of scenarios
- Snowmobile accidents
- Neglect – Leaving structure and safety rules behind and going wild
- Avalanche Canada has stats on scenarios

What would you say are the average response times for a S.A.R team to get on scene?

- Europe – helicopters can get on scene in 15 min
- Companion rescue has not limit on time to conduct rescue
- Variety very high – no stats for non death situations – skews final results
- 8 hrs length of entire call
- Call 911 for SAR (police/RCMP task SAR)

- Calls often come late in day
- Affected individuals on average have to take care of themselves for 8hrs before SAR can get you individuals or get them back or even longer before SAR can get them back
- Time to reach those in trouble may vary on SAR personnel availability (having to be paged, get to base, get gear, assess risk management, extra vehicles to be brought in)

Where would someone trying to improve the efficiency of S.A.R efforts look for data regarding victims and the scenarios they were facing?

- Avalanche Canada
- Emergency management BC
- Parks Canada
- Refer to question 3

When might someone on a mountain notice an impending avalanche or at least see signs of one?

- Depends on type of problem
- Cracking in snow pack
- Hearing “wumph”
- Hear avalanches but not see them
- Increase in heat
- Seeing snowballs rolling down slope
- Perform snowpack test
- Avalanche Canada has detailed info
- First step signs – snow can change based off temperature change, stick a pole down through snow and feel the levels to see strength
- Dig snow pit to self assess

What would you say are the top 3 challenges amongst S.A.R individuals?

- Information if one challenge – call comes in and transferred to rescue party – info needs to be properly collected from those in trouble and transferred to rescuers
- Ensure safety of rescuers at scene – possible remaining instability – is it safe for rescuers to save individuals in trouble
- Funding – helicopter time ($3600/hr) – training – professional level (BC relies on unpaid volunteers)
- 20 years with adventure smart
- 30 years in outdoor rec
- 78 SAR groups in bc – 3000 SAR volunteers

What might’ve been the top 3 trends you noticed in the last 5-10 years about S.A.R personnel, their training and equipment as well as the people they’re trying to save?

- Canada doesn’t make hard distinction between SAR and prevention – “the unawares” risen in accidents as not aware of entering danger areas
- PTSD in rescue community
- Big shift from burly rescue hero to someone who sustains mental trauma
- A lot more tech. entering backcountry
- Recreationists invest more in equipment than training
- Airbags are on the rise – effectiveness increases 11-22% if used during same risk management if going into backcountry without airbag (TRAINING)
- Skills training increased
- Pandemic forced more people out into outdoors – mixture of the trained and untrained
- Many enthusiasts belonged to an organized group or club that was a family member or friend and was mentored into the skills and training
- Less do this now and more casually just head outdoors not apart of group or club
- More people are trying to go outdoors lately
- Lately the encouragement to go outside was prompted by covid
- 30% increase in SAR calls due to this
- sees larger change in the type of enthusiasts that go out
- severity of call reduces as subjects have more training and equipment – SAR personnel are faster to save them

- very informal, social meet up hikes/groups and 30 people show up and not able to trust others have their 3T's

What are the most important pieces of equipment in S.A.R that are not exclusive to just avalanches?

- Helicopters
- Radios
- Sat. phones
- Training and experience of SAR personnel
- Transceiver, shovel, poles
- Training in shelter building, fire starting, first aid, etc

What might you say about opportunities to improve life saving equipment on the victims' side of the scenario?

- Prevention and rescue – ensuring people have training
- Did not answer

How would you describe the impact of new technology and their impact on rescue efforts specifically imaging and beacon advancements and anything else you may have seen in your profession?

- Using tech. to make false calls diverts resources
    - Example – accelerometers in phone or gadget could read a fall as an avalanche
- Transceivers becoming more sensitive to find other signals – easier to intercept interference
- Tech plays a huge role
- Communication devices
- Advancements in transceiver tech

Who would you suggest might be another very insightful person on avalanche crises and S.A.R?

- Didn't answer
- Avalanche Canada

Do you think there are other sports in the industry that are prone to avalanches?

- Snowmobiling
- Anything to do with snow and mountains

What would be the most avalanche or accident inducing form of skiing?

- Backcountry – depends, such as alpine (steep/higher up)

Do you know anybody who is S.A.R or been in contact with S.A.R personnel?

- No

If yes, what scenario(s) were they involved in?

- Answered no

When might someone on a mountain notice an impending avalanche or at least see signs of one?

- Temperature plays role
- Impact test

What might be the feelings one gets when entering an avalanche?

- Life flash before eyes (family thoughts)
- Don't know how big it is or where its coming from
- Thoughts of death

What might be the feelings one gets when being found after an avalanche?

- Saw blue sky and was smiling and happy
- Overwhelming
- Appreciative of life a bit more

What might you say are the varieties of equipment you use or see others using when exploring the backcountry?

- Shovel
- Probe
- Beacon
- Airbag

How difficult is it to carry and store typical mountain recreation equipment?

- Smaller back pack is needed
- Not difficult to carry these items
- Anything that can be easier is helpful

What might've been the top 3 trends you noticed in the last 5-10 years about individuals in the backcountry skiing and winter sport community?

- Equipment is evolving – makes it easier for lower level skiers to get in backcountry
- Years ago there wasn't amazing backcountry skis so individuals had to be very good at skiing to get into the backcountry
- Now making bigger (wider) skis and skis that make it easier (different shapes) to get into the backcountry – allows for more novice skiers to enter

Have you noticed any other types of winter natural disasters on the mountains or in the lower parts at the mountains base?

- Has seen rock slides (on resorts as well)
- Mini avalanches on smaller hills (climate change?)

What might you say about opportunities to improve S.A.R equipment?

- Can't think of anything

How would you describe the impact of new technology and their impact on rescue efforts specifically imaging and beacon advancements and anything else you may have seen in your profession?

- Has come a long way – room for improvement
- Mentions beacons are good but wonders if there's an easier way to use – more universal tracking device
- something that can be incorporated on a phone

Who would you suggest might be another very insightful person on avalanche crises and S.A.R?

- Chris rubbens – knows everything about backcountry safety – pro skier

<u>Additional information</u>

- Joseph Obad
- Executive director of CAA
- Europeans keep phones on hand cause close to cell service to call SAR
- Bruce Jameson has website for risk management and snow stability
- Tend to be worried about upper layers of snow pack – upper 2 meters
- Personal responsibility of subjects to be adventure smart
- Responsibility of them to take control of scene after accident, etc
- Rely on training, NEED training on certain aspects to survive before SAR get there
- Don't rely on phone
- 3 T's – trip planning (equipment, gear, etc also leave it with someone trusted), training, take essentials
- Bunch of friends head out into backcountry – transceiver is not godsend tool, need to know how to use it, need skills training,
- Fills pack with everything, don't know how to use it, pointless if no knowledge on use
- In bc access to wilderness is very accessible and gives false sense of security to those who don't know what to expect on a fun time out with family/friends, don't let easy access fool you
- National champ 3x
- Compete in x-games
- Over 40 world cups
- His avalanche experience was induced by a 4 degrees increase
- His avalanche was his first
- Watched someone go down mountain before him and they were fine before going down
- Went down and skis instantly ejected and he was flipping before feeling wall of snow encase him
- Partially buried in snow except for face and hand
- Felt like he was encased in concrete – couldn't move anything except for 1 hand
- Says people freeze with the beacon, would be easier with just an app or a tracking chip
- Thinks having something more user friendly that doesn't require training would definitely be a lot better

SAYS IM ONTO SOMETHING WITH MAKING A PRODUCT NOT NEED TRAINING TO USE

Appendix B – Contextual Research

Search and Rescue Task Map				
Task: Search and Rescue	**Ergonomics**	**Efficiency**	**Interaction**	**Satisfaction**
Check surroundings: make sure area is safe	Looking and listen - Look for signs - Listen for signs	Adrenaline may cause distorted senses		
Get organized: establish group leader	Communicate with others	Emotional may limit communication ability		
Get professionals: call local rescue team		Emotional may limit communication ability		
Search	Body contorts while skiing/snowboarding to look for victim	Avalanche zone could be hundreds of meters downhill		
Locate victim	Moving arms to probe	Know how to conduct locating procedure properly		
Find	Moving arms and torso to dig out victim	Unfortunate chance of finding injured/dead victim		
			Not applicable in this case	Nerves and emotions make this a strenuous task

Ergonomics – Safety	**Efficiency**	**Interaction**	**Satisfaction**
Most common “risk” tasks	Most common efficient challenges	**Indicators**	Nervous and emotional
1. Not triggering another avalanche	1.Accuracy of tech.	Sight, sound, temperature	Outcome can be relieving or saddening
2.Bending	2.Skills and knowledge of tools	**Controls**	
3.Lifting		Buttons on tech	
4.Dragging			

Needs Statement 1

The user needs an added chance of surviving an avalanche because they happen spontaneously without warning and kill many people.

Needs Statement 2

An avalanche airbag product allowing the user to have a higher chance of survival allows for the continued enjoyment of conducting dangerous winter activities. Further needs may entail ease of use, comfort, and maneuverability.

Needs Statement 3

Search and rescue is a strenuous and stressful task based on the ability to find the individual endangered in a timely manner as well as the aftermath effects (broken bones, etc).

Winter activities can be conducted alone or in group settings and with this, it comes down to the level of comfortability on the skills and knowledge to stay safe, prevent and treat injuries.

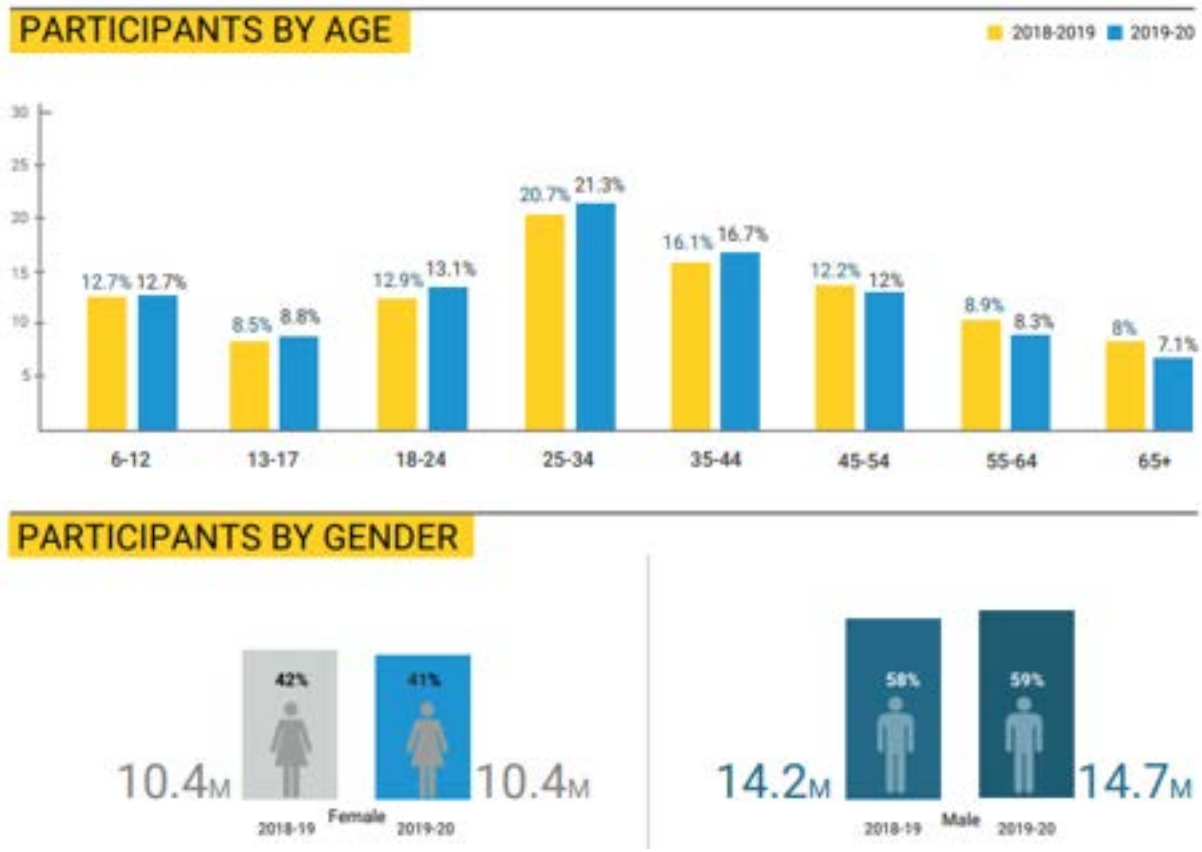
Esteem can be afforded by social acceptance of the stance on if safety is cool.

Control of the device is related to the ease of operability for the airbag deployment.

Incorporated at this section of Appendix B is the demographical analysis of the potential user base.

Primary	Winter activity enthusiast
Secondary	Repair/Service shop
Tertiary	S.A.R/Park ranger

Age and Gender



Retrieved from https://industry.traveloregon.com/wp-content/uploads/2021/04/SIA_Participation_Study_2019-2020_Nov.pdf

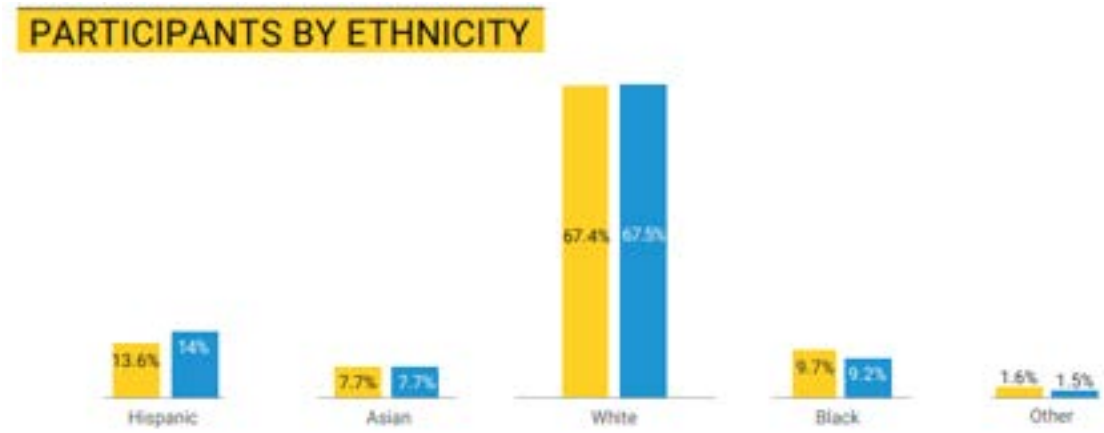
Demographic data skiing (ski Canada – 2014)	
Gender	M 57.1% | F 42.9%
Age: majority	25 – 34
Language	Eng 62.5% | Fr 26.3%
Income: majority	< $100k
Education: majority	University grad/other certificate 38.5%
Occupation: majority	Other 26.5%

Demographic data snowboarding (ski Canada – 2014)	
Gender	M 55.3% | F 44.7%
Age: majority	12 – 17
Language	Eng 65.7% | Fr 23.6%
Income: majority	< $100k
Education: majority	University grad/other certificate 34.8%
Occupation: majority	Other 33.1%

Demographic data snowshoeing (Snowsports Industries America – 2013)	
Gender	M 54% | F 46%
Age: majority	18 – 34
Income: majority	> $75k
Education: majority	University grad/other certificate 57%
Ethnicity: majority	White 75.3%

Demographic data snowmobiling (International Snowmobile Manufacturers Association – 2009)	
Gender	M 88% | F 12%
Age: average	43

Ethnicity/Culture



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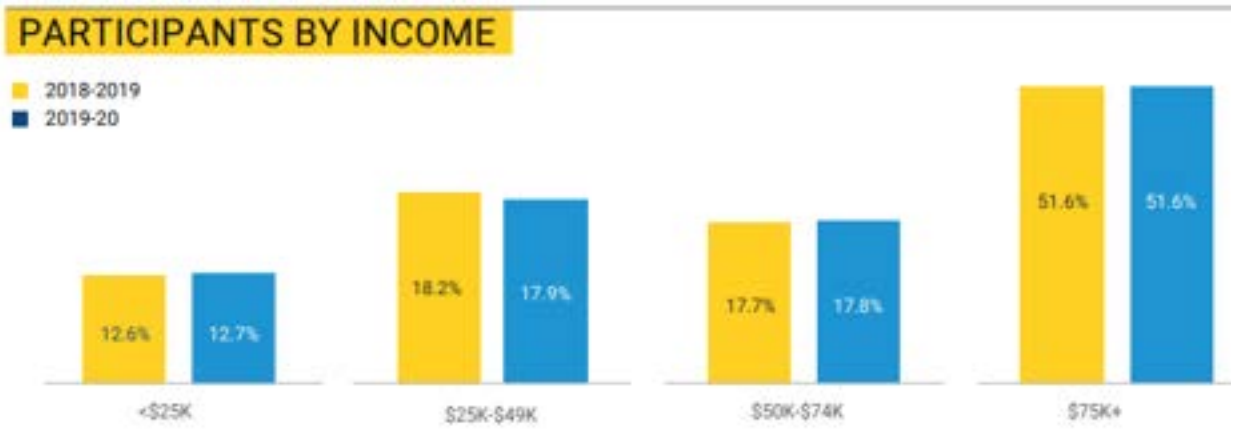
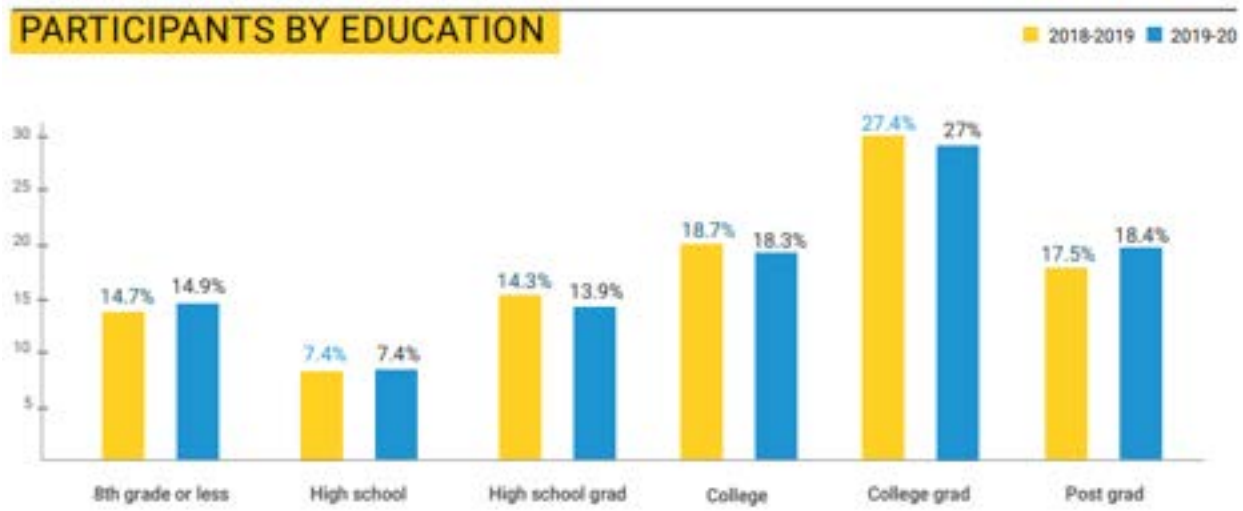
Education and Income





Retrieved from https://industry.traveloregon.com/wp-content/uploads/2021/04/SIA_Participation_Study_2019-2020_Nov.pdf

Summary of Demographics

Demographic data	
Gender	Mostly male (59% - 2020)
Age: largest group	25 – 34 (2020)
Income: majority	> $75k
Education	College/University (63.7% - 2020)
Ethnicity: majority	White 67.5% (2020)

The main age group that participates in winter sports more frequently throughout the year reside with gen. Z. Many in this age range have not yet entered a career and still participate in educational institutions.

The second most avid participants in winter sports are those aged 45-54. Many within this age group hold high positions within their careers and retain the ability to take time away from work as well as have the funds to enjoy the sport which they partake in.

Motivation and Lifestyle

Benefits	Rating (1 – 7)
Enjoying nature	4.98
Achievement	4.26
Family togetherness	4.54
Socialization	4.33
Physical fitness	4.50
Risk	4.25
Escape	4.44

Retrieved from https://www.researchgate.net/publication/342553648_Push_and_Pull_Factors_Influencing_the_Winter_Sport_Tourists_in_China_The_Case_of_Leisure_Skiers

Income Level and Purchasing Behaviour

The buying habits revolving around the means by which winter sport enthusiasts are obtaining their gear and accessories are as stated: 51% from online sources, either mass merchant (28%) or specialty retailer (23%). At the same time 77% of winter sport enthusiasts said they had shopped at a brick-and-mortar store in the last 12 months.

Appendix C – Field Research

These products served as benchmarks to allocate appropriate features and capabilities to incorporate in AERUS. These products displayed the cons that offer a gap in the market for this project to hold a standing.

BCA Tracker 3 T3 Avalanche Rescue Package
Approx. $499.99

- Most common product package sold
- Transceiver
- Shovel
- Probes

- Expensive
- Must be knowledgeable on search and rescue
- Learn to properly use transceiver
- Takes time to find victim
- Usually used in a methodic and systematic way
- **Person must first be consumed by avalanche to use product**

Kong Avalanche Rescue Package
Approx. $942.49

- Systematic portable grid search package

- Expensive
- **Person must first be consumed by avalanche to use product**

Mammut Barryvox Transceiver
Approx. $474.95

- Commonly used item
- Easy to use

- Expensive
- Must have knowledge of how to use
- **Person must first be consumed by avalanche to use product**

BCA Shaxe Teck Avalanche Shovel
Approx. $199.99

- Commonly used items in search and rescue
- Easy to use
- Axe used more in icy/slippery areas

- **Person must first be consumed by avalanche to use product**

CRELFOS 10/18 Teeth Ice Crampons Pro. Anti-Skid Spikes Cleats Winter Snow Boot Gripper For Hiking Climbing Walking Shoes
Approx. $115.24

- Mainly used for S.A.R
- Ice climbers use regularly
- Winter mountain hikers us on icy slopes

- Not worn all the time
- Takes up space when stored

Skedco Basic Rescue System
Approx. $1090.00

- Mainly used by S.A.R
- Only brought out in serious injury cases
- Easy to transport

- Expensive
- Can only be brought in by S.A.R personnel
- Takes time to acquire one, victim may not have time
- **Person must first be hurt to use product**

CMC Harness Rescue
Approx. $139.97

- Primarily used by S.A.R

BCA Float Mtn Pro Vest Av. Airbag 2.0
Approx. $1099.99

- Snowmobile safety product
- Hydration system compatible
- Lamination of materials for protection

- Expensive
- Can only be refilled at certain locations
- Reduces the depth of being buried
- **Person must first be consumed by avalanche to use product**

RECCO Rescue Reflector
Approx. $83.79

- Adaptive to all equipment

- Only transmits a signal
- No search function
- Need extra equipment with this device

Mammut Removable Airbag System
Approx. $499.99

- Common

- Expensive
- Only compatible with Mammut 3.0 backpacks
- Reduces the depth of being buried
- **Person must first be consumed by avalanche to use product**

AeroSize Vest One
Approx. $870.35

- Compact and slim
- Deploys with backpack on also

- Expensive
- Single use cartridges
- Reduces the depth of being buried
- **Person must first be consumed by avalanche to use product**

Prep Store Emergency Pack

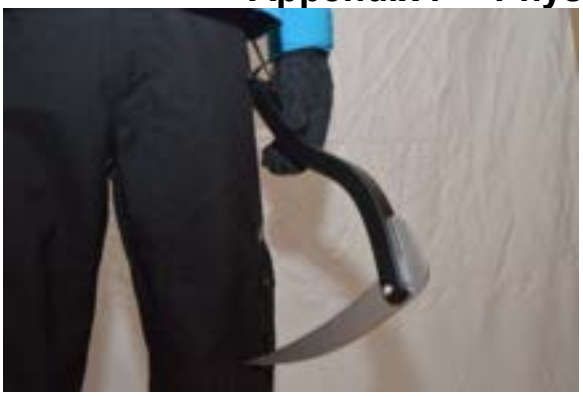
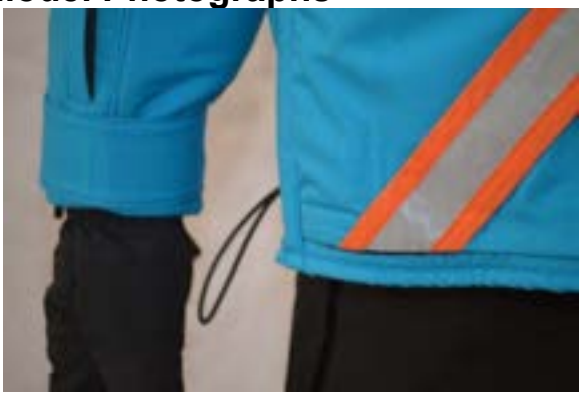
1. High-capacity backpack made of ultra light and durable nylon fabric
2. It is contoured and adjustable
3. An attached rain cover for additional protection from the elements

MONTEC Doom 2021

1. Extra deep storm proof hood with rear drawstring adjustment
2. Large underarm vents are perfect for quick cooling
3. Easy access media pocket specifically for phones with internal headphone cord outlet
4. Non-slip elasticated snow skirt with adjustable button closure to keep you dry in the deepest powder
5. Lift pass pocket perfectly located for on the left sleeve for easy access
6. Wrist gaiters are stretchy and comfortable, perfect for keeping the snow out
7. Oversized sleeve openings are ideal for use with cuffed or larger gloves

Appendix E – CAD Development

Appendix F – Physical Model Photographs

















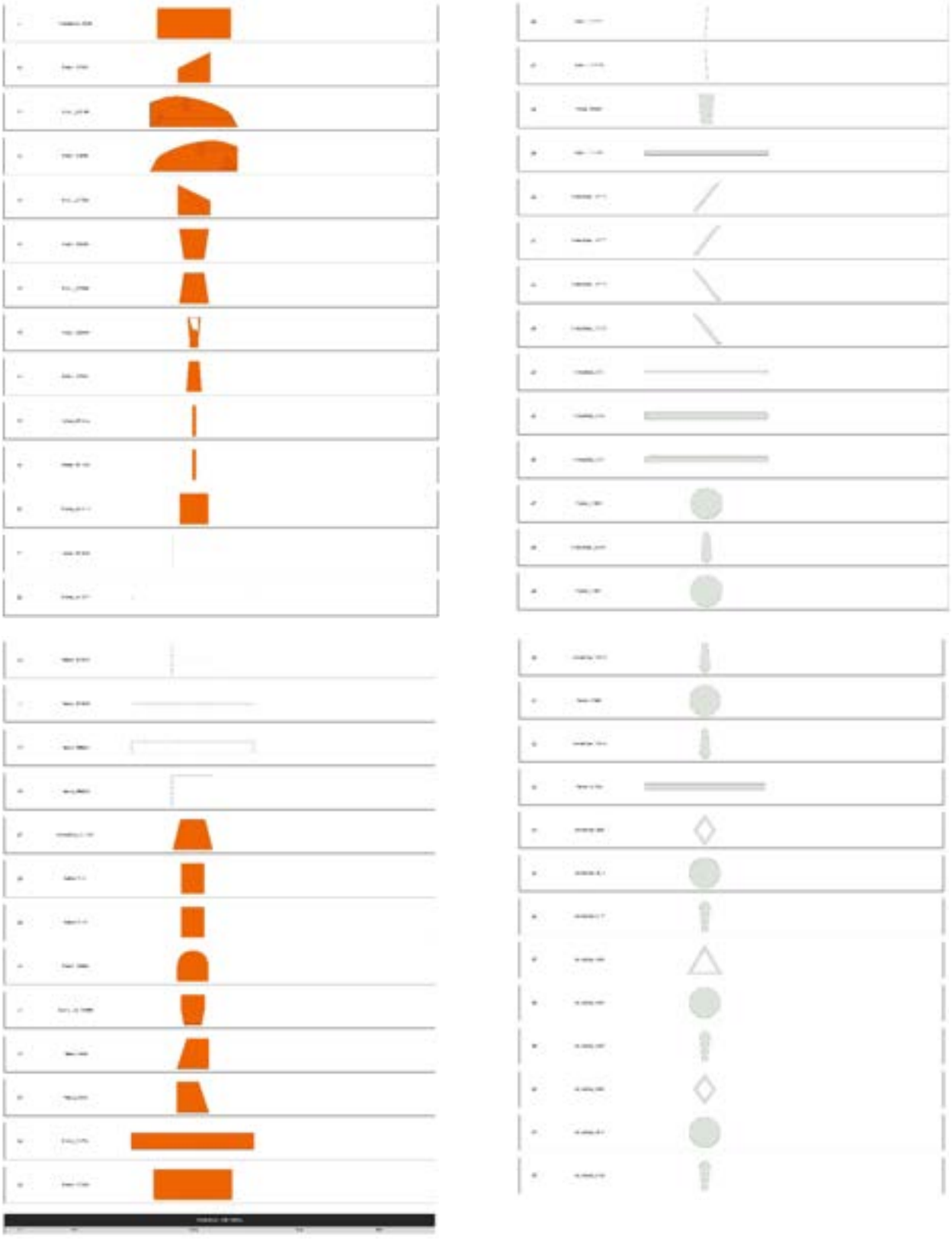


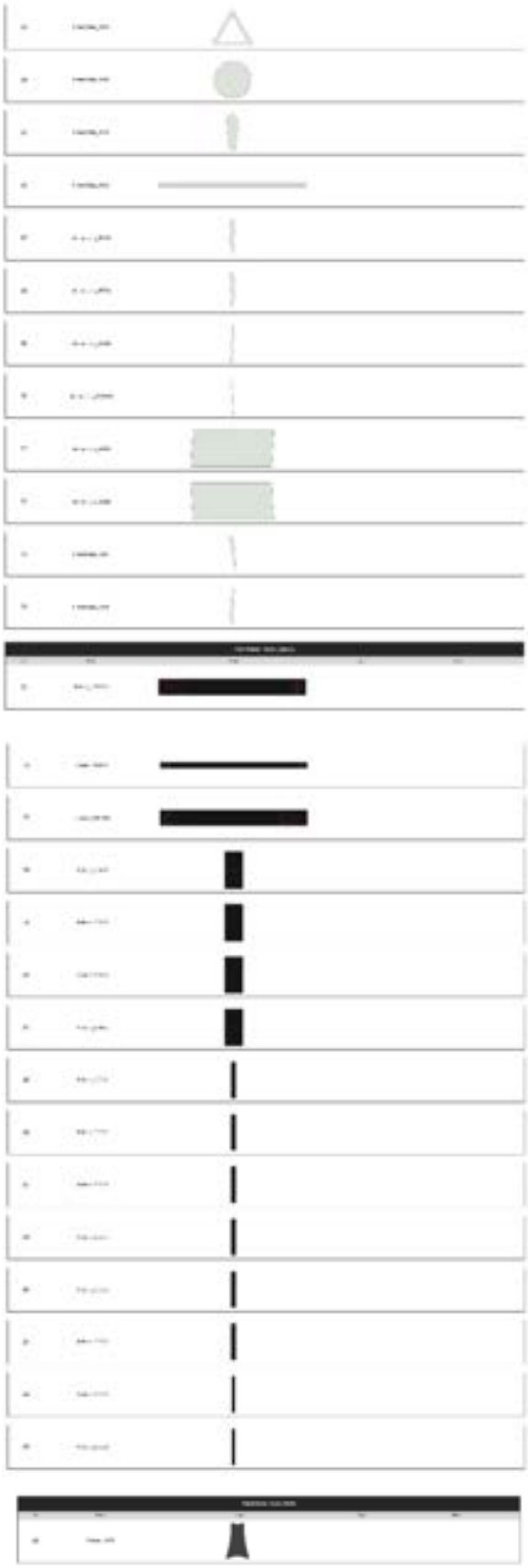


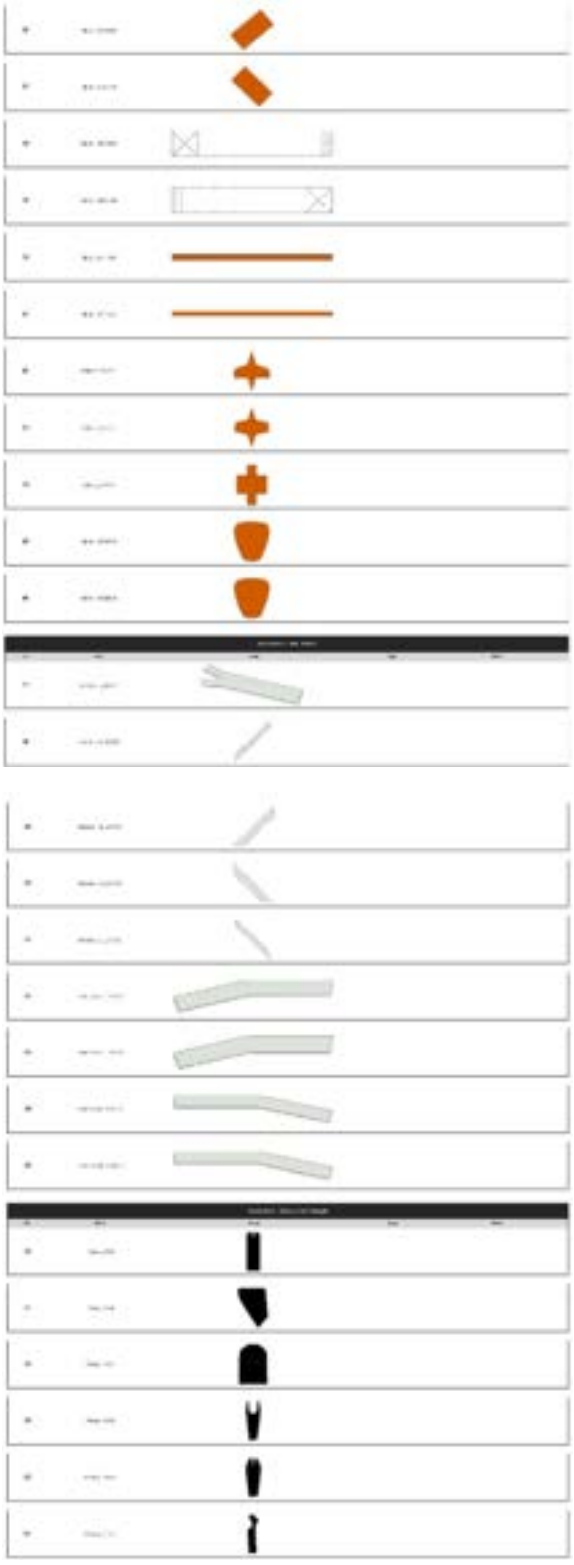


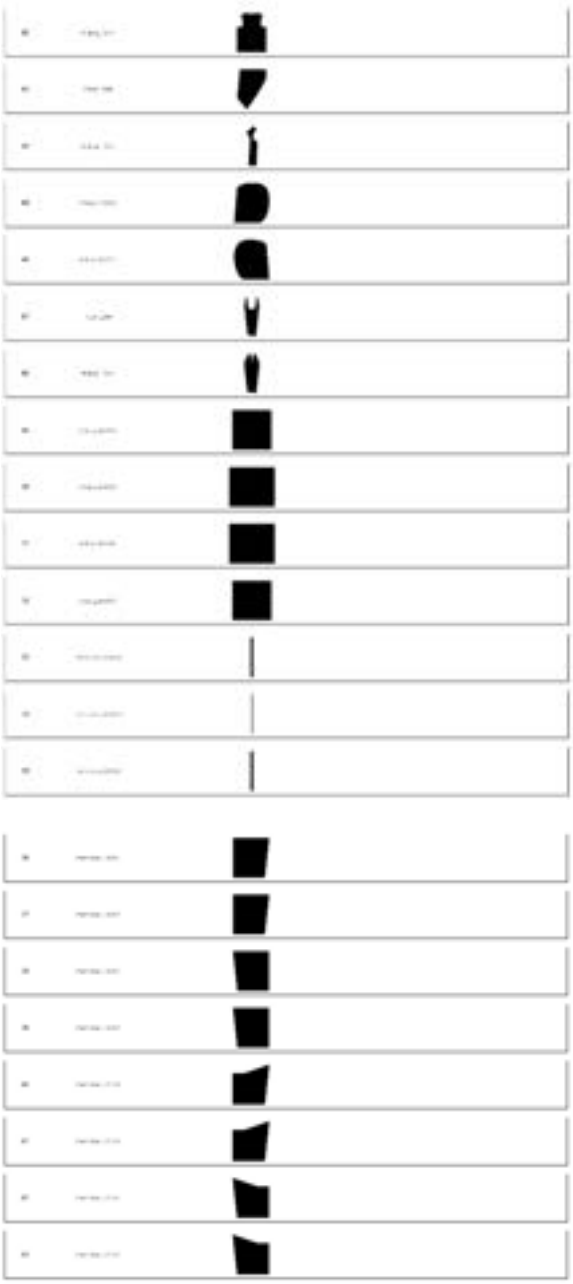



Appendix G – Technical Drawings









Appendix I – Sustainability Info/ Data

Product Name	Credentials
BananaTex	Cradle to Cradle – Gold Green product award 2019 Certified biodegradable in industrial composts Certified biodegradable in marine water German sustainability award design 2021
RPET (Recycled Polyester)	Primarily made from plastic bottle and products that use the same plastic as bottles
Modal Bamboo Rayon	Water efficient Bamboo rapidly regenerates Carbon neutral fiber Much less chemical use in manufacturing than other materials
Thinsulate Xerogel	60% recycled material

Appendix J – Approval Forms & Plans

IDSN 4002
SENIOR LEVEL THESIS ONE

Humber ITAL / Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2022
Catherine Chong / Frederic Matovu

THESIS TOPIC APPROVAL:

Student Name:	Anthony Grguric
Topic Title:	How May We Improve Efficiency in Avalanche Search and Rescue Efforts

TOPIC DESCRIPTIVE SUMMARY (PRELIMINARY ABSTRACT)

Avalanches occur in many ways, whether it be steep slopes, warm temperatures, human interaction, or any other natural cause. Ultimately, most cases are induced by mother nature and it's a well known fact that it is very unpredictable and leaves search and rescue to the task of finding victims. Nevertheless, people still choose to enjoy winter activities regardless and this becomes more worrisome for their health as climate change takes a toll in causing more frequent avalanches. Since humans have started settling and enjoying mountain slopes, encountering avalanches of varying sizes and magnitudes. In response, structures have been established to disperse them as they fall or shelter people in their way, developed resources and equipment for search and rescue groups, and very minimal products for those entering avalanche prone areas. There is truly an excellent opportunity to perform an in-depth study about the lengths, procedures, and resources used by search and rescue personnel as well as investigating cases and scenarios of avalanche occurrences. Alternatively, there is an area to look into that discusses preemptive signs to recognizing avalanches. There is the ability to provide potential victims with a product that allows them a higher chance of being found. A 1:1 scale in a snowy environment will allow for testing multiple factors of any product direction focusing on grip, warmth, stability and overall ergonomic fit and feel. By the end of this thesis study, a solution will be found for people in avalanche heavy regions that will allow for higher search and rescue efficiency and effectiveness.

Student Signature(s): Anthony Grguric	**Instructor Signature(s):** Catherine Chong
Date: 26/09/2022	**Date:** 6 October 2022

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Chong, Kappen, Thomson, Zaccolo

IDSN 4502
SENIOR LEVEL THESIS TWO

Humber ITAL / Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / WINTER 2023
Catherine Chong / Fredric Matovu

CRITICAL MILESTONES: APPROVAL FOR CAD DEVELOPMENT & MODEL FABRICATION

Student Name:	Anthony Grguric
Approved Thesis Title	Avalanche Survival Unit

THESIS PROJECT – DESIGN APPROVAL FORM

Design is reviewed and approved to proceed for the following:	X	**CAD Design and Development Phase**

Comment: Continue design refinement in CAD development, need to iron out detailing and product's features, pay attention to surfacing, components and assembly methods for design feasibility. Viable holistic design thinking in conjunction with considerations into sustainability aspects. CAD development must be at least 75% complete for review before approval for fabrication.

Design is reviewed and approved to proceed for the following:	X	**Model Fabrication Including Rapid Prototyping / 3D Printing and Model Building Phase**

Comment: Waiting for CAD development review (as of Feb-21).

Good progress with CAD, design completed, continue detail refinement, once refined, fabrication of model can begin.

Instructor Signature(s):

Date:	14 March 2023

PANEL ON RESEARCH ETHICS

TCPS 2: CORE 2022

Certificate of Completion

This document certifies that

Anthony Grguric

successfully completed the Course on Research Ethics based on the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2: CORE 2022)

Certificate # 0000864282 **4 October, 2022**

Research Plan/Advisor Initiatives

Purpose

The purpose of creating the research plan and advisor initiative is to formulate a step by step and methodical way of researching all the important and necessary aspects involved with my thesis as well as helping to create an informed design decision. A properly thought out correspondence between myself and possible advisors can also provide me with much insight into the practicality of avalanche survival as well as avalanche search and rescue efforts; fortunately two things that I have never come to experience but unfortunate for the purpose of truly understanding the implications I am trying to help with.

Research Elements

- How avalanches occur
- What are avalanches
- How many people are affected by avalanches
- What are the injuries sustained by avalanches
    - How long would it take for the injuries to claim the victim
- What products are currently on the market
- What are the experiences and feelings of people caught in avalanches
- What is the procedure and timing of search and rescue efforts

Research Sources

- Humber library
- Google
- Associations and Organizations

Research Methods

- 1:1 interviews
- Surveys
- Peer-reviewed resources

Interview/Survey Questions

Interview:

- When did you first take an interest in avalanches?
- What would you say are the most dire avalanche induced injuries?
- Where might someone find stats on individuals caught in avalanches and their outcome?
- What would you say are the most common scenarios causing avalanches?
- What would you say are the average response times for a S.A.R team to get on scene?

- Where would someone trying to improve the efficiency of S.A.R efforts look for data regarding victims and the scenarios they were facing?
- When might someone on a mountain notice an impending avalanche or at least see signs of one?
- What would you say are the top 3 challenges amongst S.A.R individuals?
- What might've been the top 3 trends you noticed in the last 5-10 years about S.A.R personnel, their training and equipment as well as the people they're trying to save?
- What are the most important pieces of equipment in S.A.R that are not exclusive to just avalanches?
- What might you say about opportunities to improve life saving equipment on the victims' side of the scenario?
- How would you describe the impact of new technology and their impact on rescue efforts specifically imaging and beacon advancements and anything else you may have seen in your profession?
- Who would you suggest might be another very insightful person on avalanche crises and S.A.R?

Survey:

- Have you ever seen an avalanche firsthand? If so, how did you feel seeing it.
    - Yes
    - No
- Have you ever been caught in an avalanche? (fully buried – not buried)
    - Yes
    - No
- Do you know of anyone caught in an avalanche?
    - Yes
    - No
- Do you know of anyone that participates in avalanche search and rescue efforts?
    - Yes
    - No
- Are you aware of the equipment used by search and rescue efforts?
    - Yes
    - No

- Are you aware of avalanche safety products for people in danger of being trapped by one?
    - Yes
    - No
- Given the risks of partaking in winter mountain excursions, what allows you to continue to pursue these activities?
- If a new safety product were to be developed, what category would you like to see one be developed?
    - Clothing
    - Portable shelters
    - Handheld devices/products
    - Other

What country were you in when encountering an avalanche or search and rescue efforts?

Research Schedule

1. Conduct 1:1 interviews with experienced/professional individuals in the fields of search and rescue/winter mountain activities/organizations dedicated to avalanche awareness.
2. Conduct general survey about experiences with avalanches/search and rescue.
3. Collect peer-reviewed articles on the understanding and signs of avalanches
4. Collect peer-reviewed articles on what mitigations are currently being put in place to prevent avalanches
5. Collect statistics on avalanche occurrences involving a victim
6. Collect anatomical data on specific injuries in relation to being caught in an avalanche
7. Observe current products and their shortcomings
8. Collect visual data from videos on avalanche occurrences involving a victim and the events leading to search and rescue

All must be completed by December to make final design decisions

Appendix K - Advisor Meetings & Agreement Forms

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2022 & WINTER 2023

IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

INFORMATION LETTER

Research Study Topic: How May We Improve Efficiency in Avalanche Search and Rescue Efforts
Investigator: Anthony Grguric | (905) 515-4063 | anthonygrguric@gmail.com
Sponsor: Humber ITAL, Faculty of Applied Sciences & Technology (IDSN 4002 & IDSN 4502)

Introduction
My name is Anthony Grguric, I am an industrial design student at Humber ITAL, and I am inviting your participation in a research study on various problems that affect people who enjoy mountainous winter activities or live in mountainous regions facing multi-scale avalanches. These problems include hypothermia, physical injury, suffocation, little to no safety equipment and lack of search and rescue skills. The results will be contributed to my Senior Level Thesis project.

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Participation and Withdrawal
Your participation in this study is completely voluntary and you may interrupt or end the study and the session at any time without giving a reason or fear of being penalized.

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Humber Research Ethics Board
This research project /course has been approved by the Humber Research Ethics Board. If you have any questions about your rights as a research participant, please contact Dr. Lydia Boyko, REB Chair, 416-675-6622 ext. 79322, **Lydia.Boyko@humber.ca**

1

IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2022 & WINTER 2023

INFORMATION LETTER

Conditions of Participation

- ✓ I understand that I am free to withdraw from the study at any time without any consequences.
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- ✓ My identity will be masked.
- ✓ I understand that the data from this study may be published.

☑ **I have read the information presented above and I understand this agreement. I voluntarily agree to take part in this study.**

Click or tap here to enter text.		Click to enter a date
Joe Obad , CAA Executive Director	Joe Obad	Oct 27, 2022
Participant's Name	Participant's Signature	Date

Project Information

Thank you very much for your time and help in making this study possible. If you have any queries or wish to know more about this Senior Level Thesis project, please contact me at the followings:

Phone: (905) 515-4063

Email: anthonygrguric@gmail.com

My supervisor is:

Prof. Catherine Chong, **catherine.chong@humber.ca**

2

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2022 & WINTER 2023

IDSN 4002 / 4502

SENIOR LEVEL THESIS ONE & THESIS TWO

PARTICIPANT INFORMED CONSENT FORM

Research Study Topic: How May We Improve Efficiency in Avalanche Search and Rescue Efforts
Investigator: Anthony Grguric | (905) 515-4063 | anthonygrguric@gmail.com
Courses: IDSN 4002 & IDSN 4502 Senior Level Thesis One & Two

I, Joe Obad *(First Name/Last Name)*, have carefully read the Information Letter for the project How May We Improve Efficiency in Avalanche Search and Rescue Efforts, led by Anthony Grguric. A member of the research team has explained the project to me and has answered all of my questions about it. I understand that if I have additional questions about the project, I can contact Anthony Grguric at any time during the project.

I understand that my participation is voluntary and give my consent freely in voice recording, photography and/or videotaping; with the proviso that my identity will be blurred in reports and publications.

Consent for Publication: Add a (X) mark in one of the columns for each activity

ACTIVITY		YES	NO
Publication	I give consent for publication in the Humber Library Digital Repository which is an open access portal available to the public	☒	☐
Review	I give consent for review by the Professor	☒	☐

Privacy

All data gathered is stored anonymously and kept confidential. Only the principle investigator /researcher, Anthony Grguric and Prof. Catherine Chong or Prof. Frederick Matovu may access and analyze the data. All published data will be coded, so that visual data is not identifiable. Pseudonyms will be used to quote a participant (subject) and data would be aggregated.

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☑ I have read the Informed Consent Form.

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Click or tap here to enter text.		Click to enter a date.
Joe Obad		Oct 27, 2022
Participant's Name	Participant's Signature	Date

3

✓

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2022 & WINTER 2023

IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

INFORMATION LETTER

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1

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2022 & WINTER 2023

IDSN 4002 / 4502

SENIOR LEVEL THESIS ONE & THESIS TWO

INFORMATION LETTER

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Click or tap here to enter text.		Click to enter a date
Chris Rubens		**Nov 22/22**
Participant's Name	Participant's Signature	Date

Project Information

Thank you very much for your time and help in making this study possible. If you have any queries or wish to know more about this Senior Level Thesis project, please contact me at the followings:

Phone: (905) 515-4063

Email: anthonygrguric@gmail.com

My supervisor is:

Prof. Catherine Chong, **catherine.chong@humber.ca**

2

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2022 & WINTER 2023

IDSN 4002 / 4502

SENIOR LEVEL THESIS ONE & THESIS TWO

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Research Study Topic: How May We Improve Efficiency in Avalanche Search and Rescue Efforts
Investigator: Anthony Grguric | (905) 515-4063 | anthonygrguric@gmail.com
Courses: IDSN 4002 & IDSN 4502 Senior Level Thesis One & Two

I, **Chris Rubens** *(First Name/Last Name)*, have carefully read the Information Letter for the project How May We Improve Efficiency in Avalanche Search and Rescue Efforts, led by Anthony Grguric. A member of the research team has explained the project to me and has answered all of my questions about it. I understand that if I have additional questions about the project, I can contact Anthony Grguric at any time during the project.

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Click or tap here to enter text. **Chris Rubens**		Click to enter a date. **Nov 22/22**
Participant's Name	Participant's Signature	Date

3

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2022 & WINTER 2023

IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

INFORMATION LETTER

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Investigator: Anthony Grguric | (905) 515-4063 | anthonygrguric@gmail.com

Sponsor: Humber ITAL, Faculty of Applied Sciences & Technology (IDSN 4002 & IDSN 4502)

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IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2022 & WINTER 2023

INFORMATION LETTER

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Sandra Riches		2022-10-20
Participant's Name	Participant's Signature	Date

Project Information

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Phone: (905) 515-4063

Email: anthonygrguric@gmail.com

My supervisor is:

Prof. Catherine Chong, **catherine.chong@humber.ca**

2

IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2022 & WINTER 2023

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Investigator: Anthony Grguric | (905) 515-4063 | anthonygrguric@gmail.com
Courses: IDSN 4002 & IDSN 4502 Senior Level Thesis One & Two

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Sandra Riches		2022-10-20
Participant's Name	Participant's Signature	Date

3

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Faculty of Applied Sciences & Technology
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HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2022 & WINTER 2023

IDSN 4002 / 4502

SENIOR LEVEL THESIS ONE & THESIS TWO

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Click or tap here to enter text.		Click to enter a date
Noah Morrison		11/8/2022
Participant's Name	Participant's Signature	Date

Project Information

Thank you very much for your time and help in making this study possible. If you have any queries or wish to know more about this Senior Level Thesis project, please contact me at the followings:

Phone: (905) 515-4063

Email: anthonygrguric@gmail.com

My supervisor is:

Prof. Catherine Chong, **catherine.chong@humber.ca**

2

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2022 & WINTER 2023

IDSN 4002 / 4502

SENIOR LEVEL THESIS ONE & THESIS TWO

PARTICIPANT INFORMED CONSENT FORM

Research Study Topic: How May We Improve Efficiency in Avalanche Search and Rescue Efforts
Investigator: Anthony Grguric | (905) 515-4063 | anthonygrguric@gmail.com
Courses: IDSN 4002 & IDSN 4502 Senior Level Thesis One & Two

I, Noah Morrison *(First Name/Last Name)*, have carefully read the Information Letter for the project How May We Improve Efficiency in Avalanche Search and Rescue Efforts, led by Anthony Grguric. A member of the research team has explained the project to me and has answered all of my questions about it. I understand that if I have additional questions about the project, I can contact Anthony Grguric at any time during the project.

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Participant's Name	Participant's Signature	Date

3


AERUS
AVALANCHE SURVIVAL UNIT