



HX-TRAIL

Ski Resort Emergency Response Vehicle

Industrial Design Thesis Report

James Maverick Alas

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HX-TRAIL

Ski Resort Emergency Response Vehicle

by

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Abstract

As winter sports continue to grow as a commodity and recreation in Canada, the amount of riders has grown exponentially over the years. With this rapid growth, comes the increased commonality of injury. This increase challenges the productivity and efficiency of emergency response and ski patrol teams. Ski resorts face almost an approximate 2 to 4 injuries per thousand snowboarders and skiers which can range anywhere from minor head injuries to major high degree fractures. Current solutions for emergency response in Canadian ski resorts are the traditional sleds muled down by a ski patrol or a fully operated snowmobile. However, external factors like weather conditions, the off-path location of the injured and security during transportation down the hill all counteract the current implementations of emergency response as difficult, unsafe, and inefficient. These factors can lead to further injury of the victim, other riders and even the patrol officer. How may we improve emergency response in Canadian ski resorts? At this rate, more injuries are bound to happen along with the number of casualties creeping up. It is evident that ski resorts are doing everything they can to increase ski patrol numbers and implement better tactics for their teams to mitigate these numbers. It is, however, compelling that the statistical number of injuries grow alongside these increased patrol volumes every year too. The success in mitigating these injuries lay in the hands of improving emergency response with goals of the process to be less difficult, safer and more efficient. Plans to conduct surveys, interviews and observational studies will provide adequate research to design and develop a safer, faster and more efficient response system to alleviate injuries while snowboarding/skiing. A deeper understanding of the possible users' injuries will help determine the ergonomics of the solution to overall mitigate the traumatic pain of the user to maintain their physical and mental needs. Significant consideration of the patrol officer will also need to take place as they are responsible for the whole process. Moreover, a solution will be designed to improve

emergency response for riders, enhancing the current method in which it is performed and improving the monitoring and detection of injured riders with one holistic goal to mitigate injury.

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1.1 Problem Definition

Injuries on the snowy hills of ski resorts are one of the leading areas of injury for winter sports in Canada; most commonly during skiing/snowboarding. More often, these injuries can occur at any given time and anywhere within or outside of the boundary lines of the mountain. Ski patrol teams must locate these accidents, provide on-site treatment and transport them safely to urgent care. These heroes frequently face external factors on the job while performing these duties that can further agonize the wounded rider. Current methods of locating, securing, and transporting patients are prone to these factors that can affect the safety, efficiency, and comfortability of the ride; with weighing responsibility on the skills of the ski patrol. The goal of this thesis project is to improve emergency response for ski patrol from the beginning of locating the patient to transportation to urgent care by developing a process that is faster, safer, and more comfortable for both the patient and the ski patrol.

1.2 Rationale & Significance

1.2.1 Key Information to be Determined

The current practices and uses of equipment of Canadian ski patrol must be studied to understand the actual process of emergency response to an injured rider from peak to bottom. Research into how a patient is treated when first discovered and how he/she is secured into a transportation system are key investigation areas; with close evaluation of current ski patrol methods of locating these accidents. This leads to the benchmarking of the ski patrol equipment and weighing out the assets and liabilities offered by different products. Moreover, research will need to be conducted on the patient's physical and mental shape during injury to allow for an understanding of their ergonomic and psychological state.

1.2.2 Key Questions to be Answered

Traditional methods and practices are often the go-to strategy and application of most ski resorts in Canada and have not ventured into the potential of enhancing these methods and

practices to improve emergency response. Some questions that need to be asked of current patrollers and riders are: What injuries does the average rider sustain? How often do ski patrols get called to service? In what areas do these accidents more often occur? Are the current methods of transportation physically/mentally tolling on the patrol officer? How safe does the rider feel when being transported?

1.3 Background/History/Social Context

Background

The amount of frequency of new-coming and returning riders continue to enlarge in Canadian ski resorts every winter season of the year. Snowboarding and skiing are winter sports that are growing exponentially over the past decade, most commonly in Canada due to its existing winter culture, access to multiple arrays of elevated mountainous regions, and home to many Canadian Olympic winter sports athletes. These trends become resonating reasons for newcomers to buy gear, hit the slopes, and try new things. Snowboarding and skiing are fun ways to exercise and be active but more than less, this wave of increased riders, however, comes with dare devilling individuals, outgoers, and often reckless young adults which leads to increased injury rates. The Canadian Ski Patrol organization oversees all operations in ski patrol teams on these ski resorts and teaches, helps, and guides every individual on the mountain. With social media fruition in the past decade, the excitement of learning to snowboard/ski is almost on every young adult's milestone list to impress others around them. With this, ski patrol is often tainted as the antagonists in most encounters with riders just solely for performing mandatory speed monitoring and off-boundary control. With the younger side of the demographic of riders being above the age of 12, they are more prone to exploration and curiosity which can lead to the breaking of rules and dangerous stunts and riding. Overall, the ski patrol monitors these trends and follows strict guidelines to make the slopes a safe place for riders of all levels.

2.1. Research

This chapter unveils an extensive presentation of data involving the user(s) demographics by a collection of research done through surveys, interviews, user observation, and video analysis. This will be accompanied by benchmarking current products used by ski patrol to relay the advantages, disadvantages, and technicalities of these products. All this information is to support the development of this thesis submission.

2.1.1 User Profile

The primary user group for this study will consist of the patient who is sustaining an injury and requires the emergency response of ski patrol for aid. This group may consist of snowboarders, cross-country skiers, alpine skiers, snowmobile drivers, snow snowshoers, or tobogganers. The task of these people is to ride ski lifts, get off at their desired hill, and go down the hill, more experienced people will perform tricks and jumps in the parkour area. More times than often, this group will wipe out from disbalance or loss of control for speed causing injury. The more serious injuries that can occur during these activities are mainly concussions, broken/fractured bones, and/or lacerations of any degree.

Demographic:

Age: 12yrs - 65yrs +

Gender: 61% M 39 % F (Snowboarders), 58% M 42% F (Skiers)

Household Income: Majority > \$100,000

Employment Profile: Full-time

Geographic Location: Southern Canada stretching far east and midwest

(Facts+stats ski and snowboard industry, 2015)

The secondary user group for this study will consist of the team of the ski patrol or people who are part of helping the injured patients. This group may consist of a ski patrol rescuer, a ski patrol manager, a lift operator, a snowmobile driver, and a first-aid operator.

The task that these people will perform is locating any injured riders, assessing the situation and degree of injury, calling for backup, treating the patient until backup arrives, securing the patient into the stretcher, and shredding down the mountain while operating the ski toboggan.

The tertiary user group for this study will consist of people treating the patient or anyone relative to the patient's accident. In this case, the group may consist of urgent care health workers, family and friends, and physiotherapy doctors. On the business-liability side of things, the resort's company and the patient's insurance company fall under this group as they deal with the aftermath of the accident. The client's insurance company may not meet with the agreement of the situation and cause a back and forth between the ski resort and him/herself. Members of this group are here to support the rider in any financial and emotional need possible.

User Persona:

Name: Miles Thompson

Age: 50+ years old

Sex: Male

Occupation: 40 years of serving as a Canadian Ski Patrol and volunteering at many posts around Canada

Method of Analysis: 1:1 Interview

This user was found in a local Facebook group dedicated to Blue Mountain ski patrol along with many other patrollers who were contacted.

2.1.2 Current User Practice

This area of research is owed to the ski patrol's day in life going over everything from how they start their day to the non-routine tasks, procedures, and attitudes that may occur during the process. By doing so, a greater empathic understanding of the ski patrol officer

will support the direction of this thesis focused not just on the patient but with enormous consideration of the patroller. Data is limited to video analysis and user interviews to achieve accurate results on the topic. In this thesis, a survey for snowboarders/skiers is created along with an interview with the user persona. This is accompanied by further video analysis to target any specifics missed by the ski patrol vet. Below are the interview and survey questions asked of participants:

Interview Questions:

1. As a ski patrol, what tasks do you take when first encountering an accident? Explain the process from locating, on-site treatment, and transporting down to urgent care.
2. How long have you been a ski patrol?
3. What training/skills/qualifications do you need to be one?
4. What equipment do you use on the job?
5. What are some challenges you face when on the job?
6. How do you think emergency response can improve for the injured and the worker?

Survey Questions:

1. How often do you go snowboarding
 - a. Once Every Month
 - b. Every Weekend
 - c. Occasionally every other week
 - d. One or two times
2. What ski resort do you go to?
 - a. Blue Mountain Ski Resort
 - b. Horseshoe Valley Ski Resort
 - c. Glenn Eden Ski Resort/Terrain Park
 - d. Mont-Tremblant Ski Resort

- e. Snow Vallet Ski Resort
3. What type of protective equipment do you wear while riding?
- a. Helmet
 - b. Gloves
 - c. Goggles
 - d. Knee Pads
 - e. Buttpads
4. Which level of the mountain do you usually ride?
- a. Green Circle - Easy slope
 - b. Blue Square - Intermediate slope, good pistes for the average skier
 - c. Black Diamond - Difficult slope, only for good skiers and snowboarders
 - d. Double Black Diamond - Very difficult slope, only for very good/expert skiers and snowboarders
5. Do you get injured while snowboarding?
- a. Yes
 - b. No
6. What type of injuries do you most often endure?
- a. Head Injury
 - b. Shoulder Injury
 - c. Ankle Injury
 - d. Leg Injury
 - e. Arm Injury
 - f. Back Injury
 - g. Neck Injury
 - h. Spinal Injury

- 7. Have you ever been treated by ski patrol? If so, please explain how the procedure went.
- 8. Have you ever gone to the hospital because of an injury during snowboarding/skiing?
 - a. Yes
 - b. No
- 9. Suggestions on how to improve emergency response in ski resorts?

The questions were then asked in a simple conversation with the interviewer and the interviewer, Miles Thompson. In some instances, the topic often expanded into different topics and more questions were asked to where more insights were obtained. The key takeaways which are of importance to this thesis design are listed below.

Key Takeaways - Miles Thompson
The ski patrol process is a tedious process that starts upwards from 6am or earlier.
Ski Patrol is the embodiment of safety in the ski mountains.
Analyzation of the situation is key in a patroller’s skillset
There are dozens of injuries that can occur and ski patrol needs knowledge on all of them
For a skilled skier, the process of transportation with a rescue sled is easy, it is the countless times it’s performed during the day
Communication is key to locating an injured rider

Table 1. Key Takeaways from 1:1 Interview

Provided are the survey results from 6 participants:

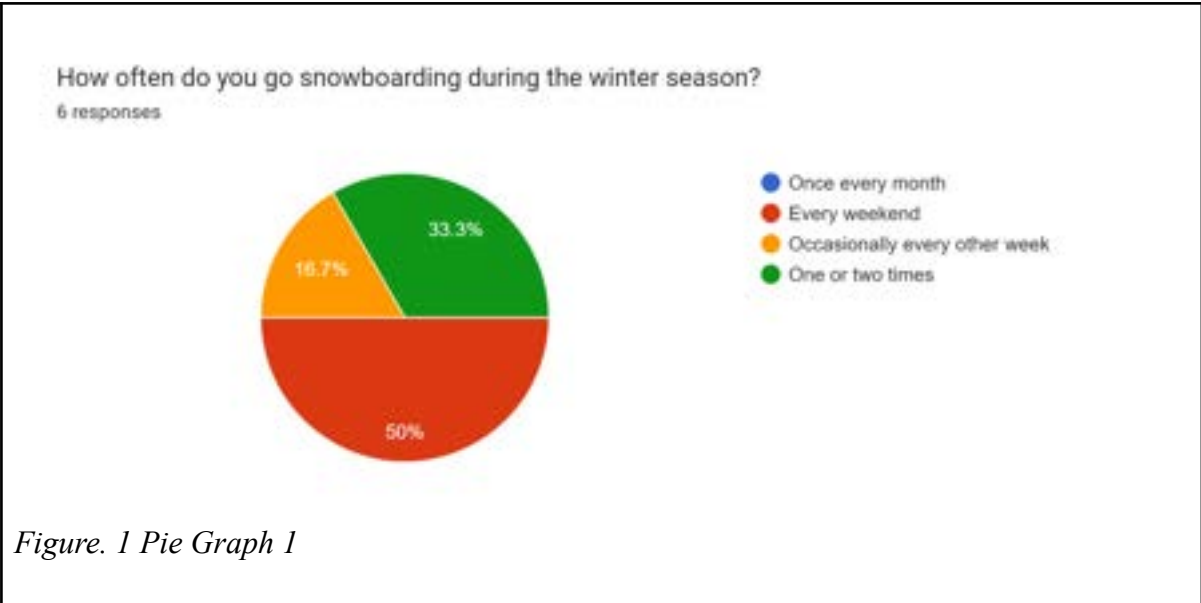


Figure. 1 Pie Graph 1

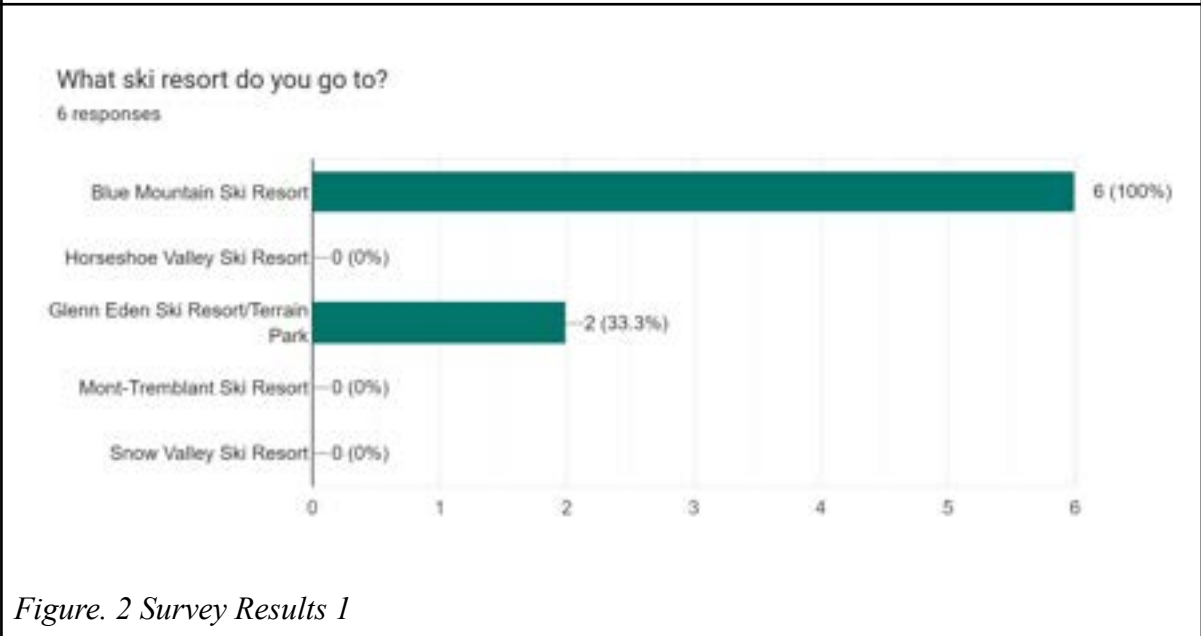


Figure. 2 Survey Results 1

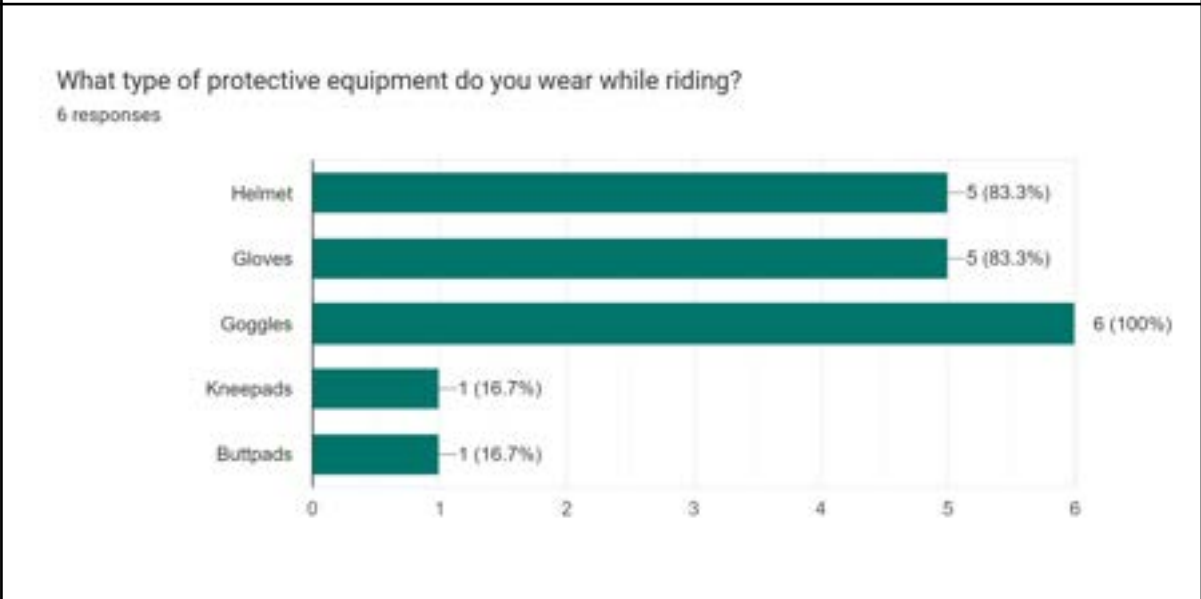


Figure. 3 Survey Results 2

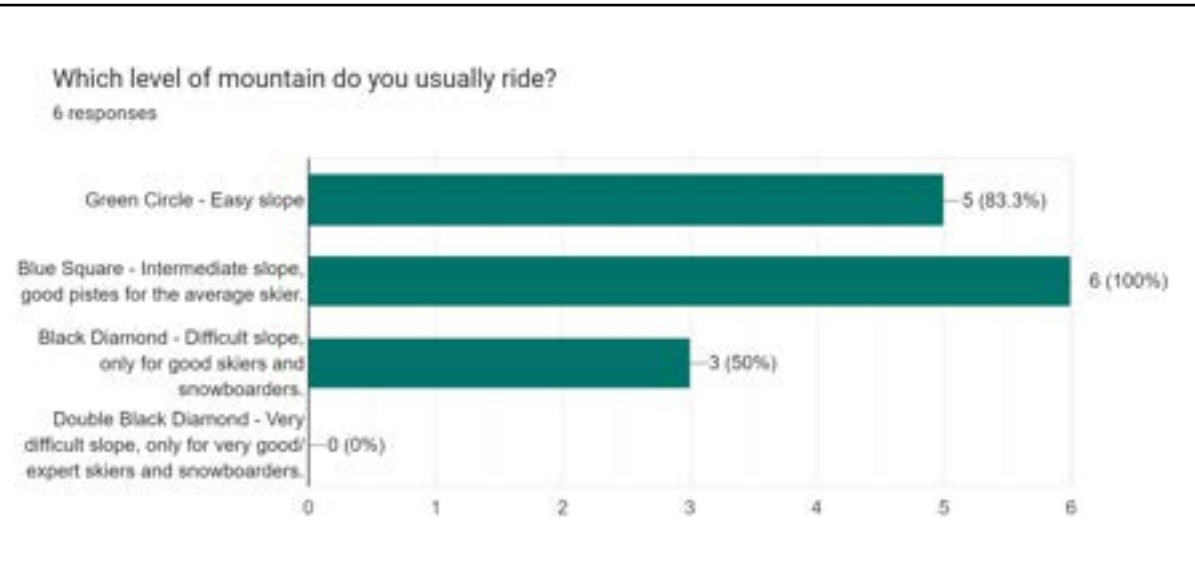


Figure. 4 Survey Results 3

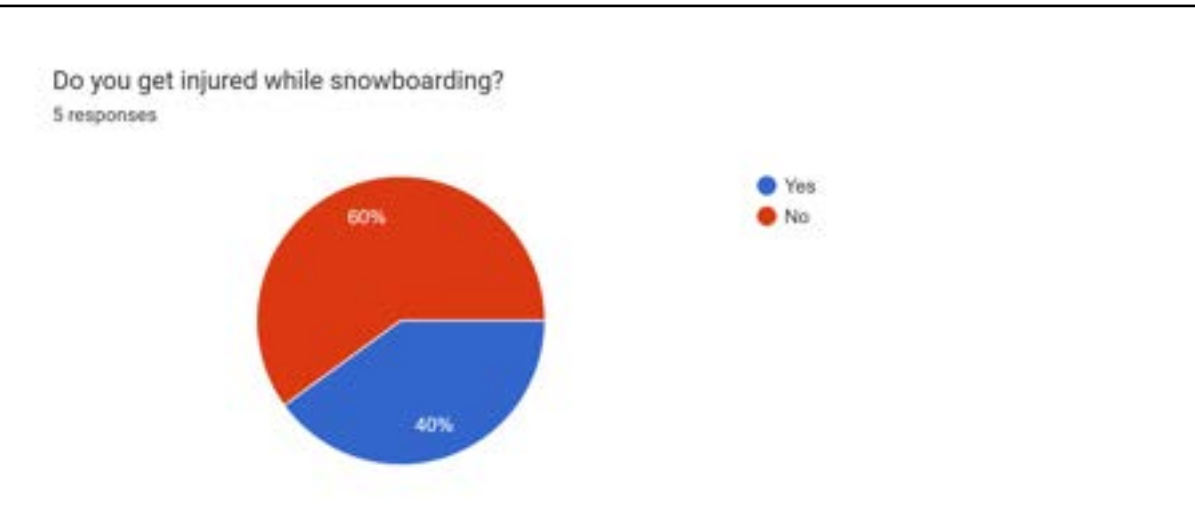


Figure. 5 Pie Graph Results 2

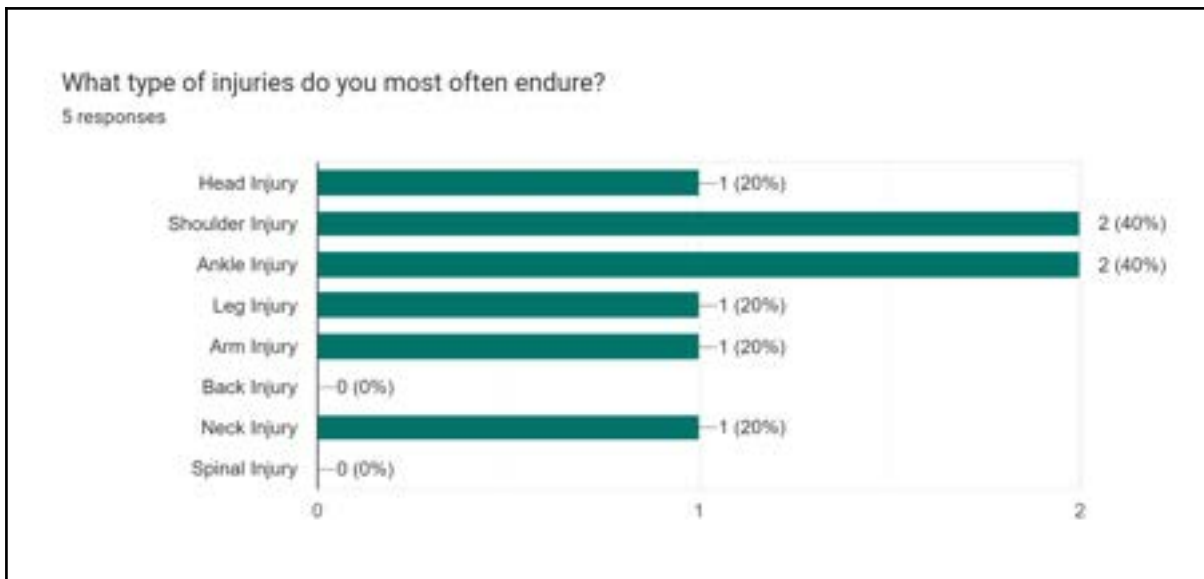


Figure. 6 Survey Results 4

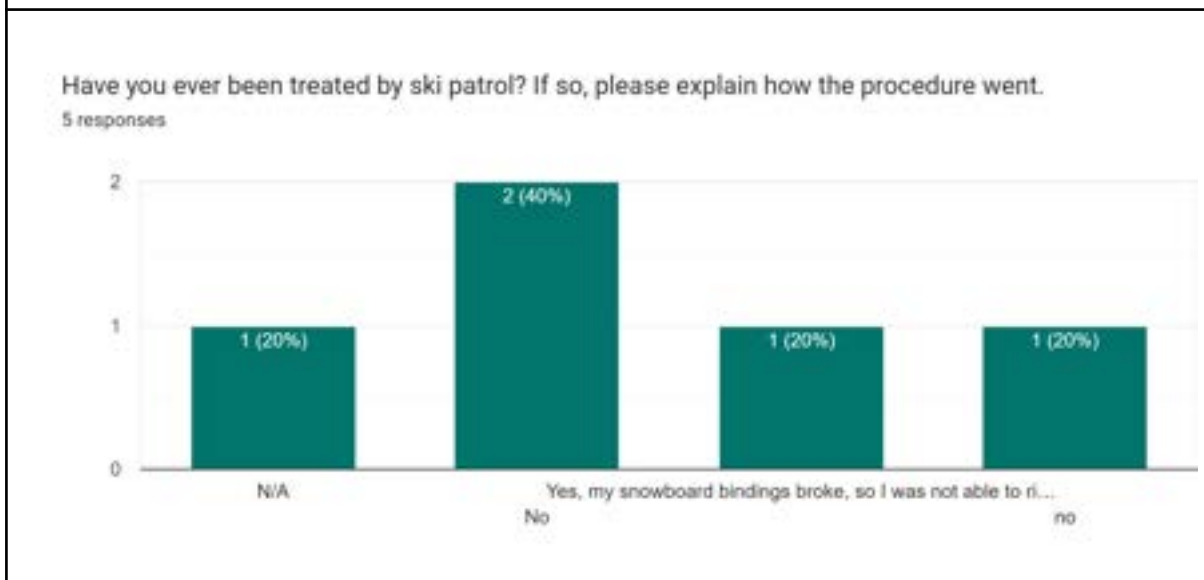


Figure. 7 Survey Results 5

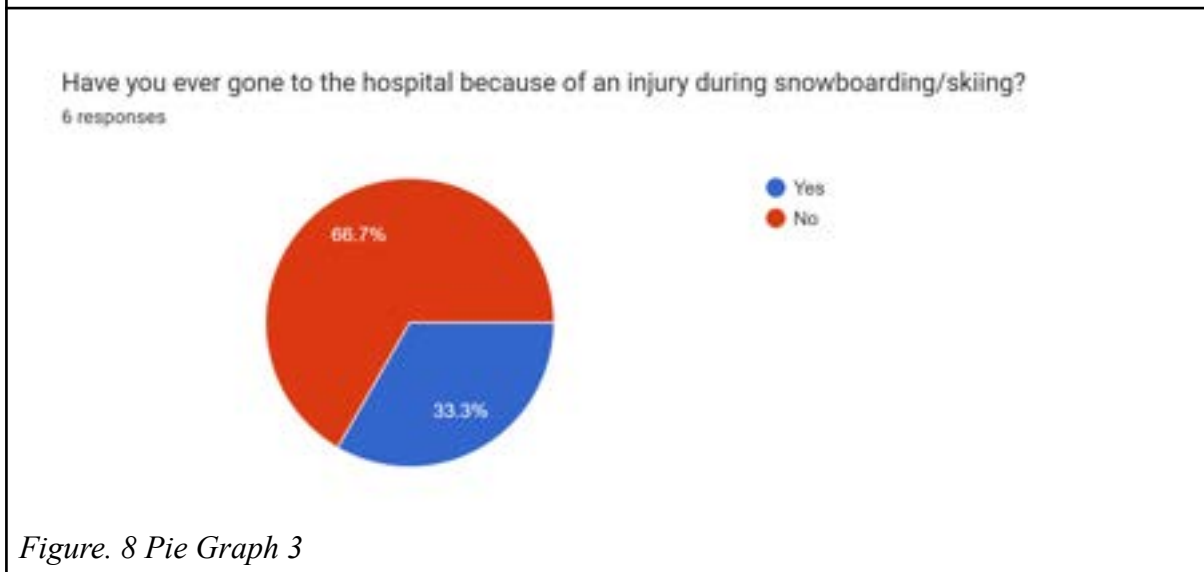


Figure. 8 Pie Graph 3

Suggestions on how to improve emergency response in ski resorts?:

- “Separate lanes to ensure people are clear of the way. A way of knowing ski patrol is going down the mountain (ex. Siren noise).”
- “Have a bigger response team readily available in different areas of the ski resort.”
- “So far they've done a great job from what I can see, one suggestion would maybe have a medic station somewhere in between the village and the top of the slopes to further increase the speed of help if there is any need of urgent help.”
- “More emergency stations, quick action from emergency personnel and more informative instructions/directions to and for emergencies.”
- “Wear a bright color for easier spotting from other skiers. Maybe have a siren or something noise related.”

Taken from Survey Results Question #9

2.1.3. User observation - Activity Mapping

This chart goes over everything in the process of a ski patroller, their attitudes and tasks:

<i>Specific Task-based</i>	USER TASK MAP			
TASK: SKI PATROL INJURY RESPONSE	Ergonomics	Efficiency	Interaction	Satisfaction
Locate injured		Skis right beside them to tend to their needs in out of boundary line area		User will not be in panic, help is here
Gather information on user and injury		Asks for name and details and what injury it is	Observes the body and injury	
Call for Assistance		Gets more help from team of ski patrol	Waits tally	Feelings of assurance
Tend to the injured	Lays them straight out, clothing and bands	Practice with cuts and movements	Cutting clothing, wrapping leg	
Transport down mountain	Needs to put injured in the rescue toboggan	Needs to be quick to not harm injured	Straps the person in hold	Feelings of safety
	Ergonomics – Safety	Efficiency	Interaction	Satisfaction
	Most common "risk" tasks	Most common efficient challenges	Indicators	How pleasant / fulfilling task is to do.
	1. Lifting injured in right position	1. Time	Arrows, instructions	
	2. Banding injured limb	2. Efficiency of doing first-aid		Feelings of control and mastery
	3. Hitting their head	3. Not following protocol	Controls	
	4. Putting heavy loads	4. Not fast enough skiing/snowboarding	Locks, ties, handles, skis	
	5. awkward body postures	5. lack of skill / training		
	6. Transportation injury			
	F. slips, trips and falls			

Table 2. Activity Map/User Task Map for User Observation

2.1.4. User observation - Human Factors of Existing Products





Figure. 9 User Observation of Emergency Response retrieved from

https://www.youtube.com/watch?v=im4vqIP4ESU&t=508s&ab_channel=WildGurm

User observation was done to see the usability of the current benchmarking product, the traditional ski toboggan, along with the processes of the ski patrol team.

Insights from User Observation
It took about 4-5 minutes for the ski patrol to come, not including before the user started filming. The patient was assumed to be stuck in the trees for 10-15 minutes.
Multiple patrol officers for one person.
Loading into the stretcher and then into the rescue toboggan took another 5 minutes.

Table. 3 Insights from User Observation

2.1.5 User Observation – Safety and Health of Existing Products

Rescue Toboggans are the most common form of emergency response for ski patrols in ski resorts. The safety and health common elements that are identifiable are as follows:

Product: Rescue Toboggan
<ul style="list-style-type: none"> ● Removable stretcher
<ul style="list-style-type: none"> ● Straps for legs, arms, and head

<ul style="list-style-type: none"> ● Body blanket
<ul style="list-style-type: none"> ● Handle brakes
<ul style="list-style-type: none"> ● Ski Patrol steering

Table. 4 User Observation of Safety and Health of Existing Products


2.2 Product Research

2.2.1. Benchmarking - Benefits and Features of Existing Products

The current equipment of ski patrol has a general benefit that every product on the market needs to perform for this task: transportation of a patient. Ski patrol equipment may also include first-aid equipment and other tools to enhance the safety of transporting a patient. Areas to consider when looking for ski patrol equipment is what is the form of transportation, how is it operated and how is the patient secured in place. These products can range from smaller-scale toboggans to more multi-functional ones to higher-scale snowmobiles. To understand these needs better and understand what the user expects out of their equipment, a comparison of benchmarked products will take place to contrast advantages and disadvantages, benefits and features.

Objectives

1. To identify the ergonomic benefits of each transportation mechanism,
2. To identify their features and benefits
3. To evaluate the cost, feasibility, and efficiency of each benchmarked product.

Product	Reference	Benefits & Features
<p>Cascade Rescue Toboggan Model 100 “The Legend”</p> 	<p>https://worknrescue.ca/product/cascade-rescue-toboggan-model-100-the-legend-w-bow-guard/</p>	<ul style="list-style-type: none"> ● Heavy Duty 6061 Aluminum Top Edging ● Internal Stainless Steel Perimeter Frame ● Non-Skid Interior ● Stainless Handles and Locks ● Removable Stainless Handle Mounts ● Three Patient Straps




		<ul style="list-style-type: none"> ● Quick-Detach Tail Rope ● Four Carry Handles ● Crossover Rope
<p>Ski-Doo Summit X</p> 	<p>https://www.ski-doo.com/ca/en/models/deep-snow/summit.html</p>	<ul style="list-style-type: none"> ● Track system and motor ● Best in-handle responsiveness ● Rider-centric design ● Deep-snow & Trail
<p>Subaru Mountain Rescue Vehicle</p> 	<p>https://www.stanleysubaru.com/blog/2012/october/25/what-vehicle-makes-for-a-good-rescue-vehicle.htm</p>	<ul style="list-style-type: none"> ● Four wheels ● Deep-snow terrain vehicle ● Multiple passengers ● Possible back sled attachment ● Can carry rescue toboggan ● Immense storage space
<p>Medical Rescue Skids</p> 	<p>https://www.kimtekresearch.com/products/medlite-transport-basic/</p>	<ul style="list-style-type: none"> ● Needs vehicle ● Back attachment ● Opportunity to perform medical care while transportation ● Enough space for sled ● Straps ● Aluminum Base

Table 5. Benchmarking Products

2.2.2 Benchmarking – Functionality of Existing Products

Toboggans provides ski resorts with a feasible, traditional product to operate emergency response on the hills. They offer the ski patrol an assisted transportation mechanism that can keep the injured rider secured going down the mountain. To understand the need for the ski patrol’s services, evaluation needs to focus on how a ski patrol uses existing products in their days performing tasks.

Objectives

1. How the patrollers use a toboggan/snowmobile/emergency response vehicle,
2. What features are essential of these products to the emergency response process?



Figure. 10 XY Functionality Graph

The following X-Y graph demonstrates the functionality needs for comfort and safety and agility in the current transportation of benchmarked products. The opportunity zone lies in the highest emphasis on comfort and safety for the patient and officer while still needing quick transportation but not to the extent of flying/hovering due to infeasibility.

2.2.3 Benchmarking – Aesthetics and Semantic Profile of Existing Products

Rescue toboggans have an ordinary shape to them whereas snowmobiles come in various kinds of shapes and sizes. Features between them are their apparent symbolization of security, transportation, and speed. Ski patrols that operate these products often look for relatable features between different benchmarked products which will be discovered in this section of the report.

Objectives

1. To determine the aesthetics of a transportation vehicle

2. To link the functionality features with aesthetic features
3. To understand the emotional need as to why ski patrol chooses one over the other.

Method

This will be achieved by comparison of benchmarked products based solely on their aesthetics and styling functions populated into a chart.

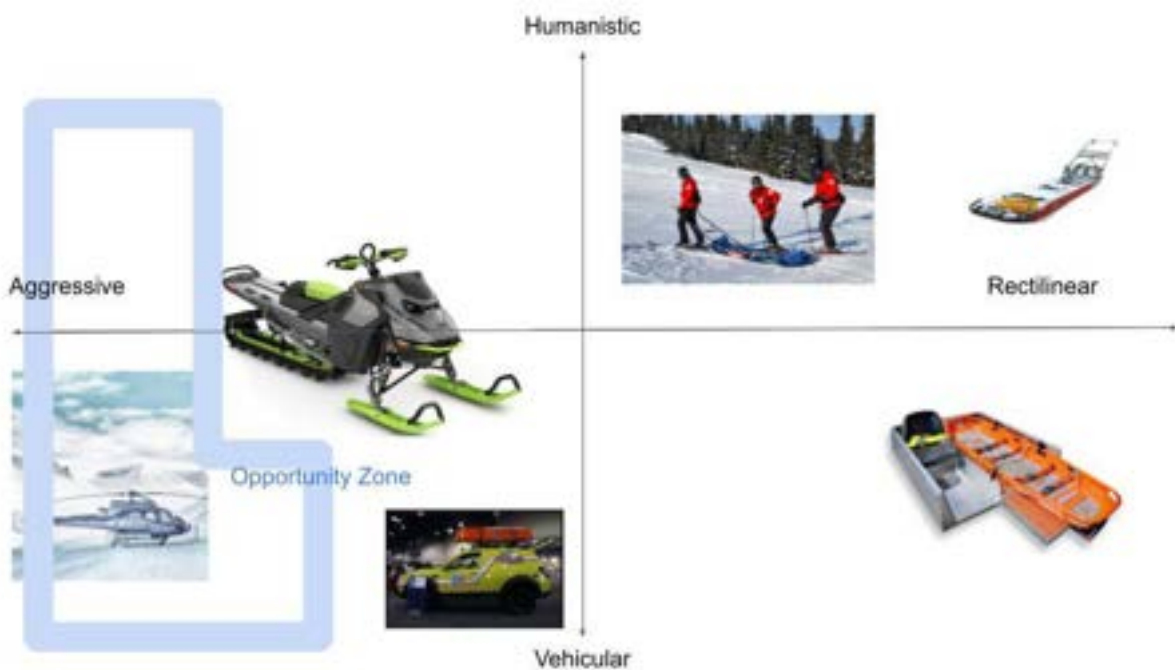


Figure 11. XY Aesthetics Graph

The following graph calls for a vehicular aggressive blue sky design similar to snowmobiles. The essence of a track and four wheels/tracks is of great aesthetic being in the snow. Based on benchmarking product aesthetics, the design should draw humanistic elements as well; being that the end users are both humans.

2.2.4 Benchmarking – Materials and Manufacturing of Existing Products

Following are materials that appear in current benchmarked products:

Material	Benefits	Reference
Hyfax	<ul style="list-style-type: none"> • Protects aluminum rails from wearing out the 	https://www.snowtec magazine.com/dup

	track	ont-vespel-hyfax/
Arctic Vinyl	<ul style="list-style-type: none"> • Waterproof, stain resistant, and scratch resistant • -50 degrees below zero cold crack 	https://rochfordsupply.com/shop/Outdoor-Vinyl/Snowmobile-Seating-Vinyl/Black_Snowmobile_Vinyl/index.html
HDPE	<ul style="list-style-type: none"> • “is often utilized in the structural materials [...] [to] enhance its stiffness, toughness, dimensional stability and electric-insulation properties” (Dai et, al., 2010) 	https://go-gale-com.ezproxy.humber.ca/ps/i.do?p=AONE&u=humber&id=GALE A226363655&v=2.1&it=r
UHMW	<ul style="list-style-type: none"> • Extremely tough • Highly abrasive • Wear resistance 	https://www.curbellplastics.com/Research-Solutions/Materials/UHMW
Polycarbonate	<ul style="list-style-type: none"> • Transparency • Durability • Weatherability • Flexibility 	https://www.acplasticsinc.com/informationcenter/r/what-is-polycarbonate
Desmopan (TPU)	<ul style="list-style-type: none"> • Durable • Flexible • Versatile • Intrinsically soft • Reduced carbon footprint 	https://solutions.covestro.com/en/brands/desmopan
6061 Aluminum Steel	<ul style="list-style-type: none"> • Heat treatable • Corrosion resistant • Machinable • Good for forming • Good for welding • High strength • Versatile 	https://www.stainlesswires.com/6061-aluminum
1000 Denier Cordura™ Nylon	<ul style="list-style-type: none"> • Extreme durability • Longevity • Water-repellant • Flame-resistant 	https://www.canwiltextiles.com/synthetic-coated-fabrics/1000-denier-nylon/

Table. 6 Benchmarking Materials

2.2.5 Benchmarking – Sustainability of Existing Products

A crucial area to consider in existing products is the direct impact on the powder-snowed environment in which they reside. Ski resorts are the concerned party at risk of environmental and sustainable effects by-products/systems used in the ski patrol industry; from emitting pollution or the rippling repercussions of the manufacturing processes used to create these products. With little discourse on the sustainability of the ski industry, a sole company, TAIGA, has taken action to create the first electric snowmobile to reach the snowmobile market on a widespread scale. Equipped with a permanent magnet AC and a 15kWh battery pack to power the sled, the TS2 opens the door to zero fuel emissions due to the absence of fuel burning for power (Lambert, 2018). This has a great effect on the sustainability of ecosystems around the ski resorts being encased in acres-wide forests.

2.3 Summary of Chapter 2

All in all, this chapter summarizes the qualitative and quantitative research conducted via 1:1 interviews, and surveys bringing in meaningful insights about the user feelings and a ski patrol's process. Further research explored the benchmarked functionality, aesthetics, and materials of benchmarked products to go along with already implemented sustainable actions provided by benchmarked products. All in all, these research insights will help to be the grounding evidence for this thesis project.

3.1 Analysis - Needs

Canadian ski resorts to continue to grow with “more than 355,000 skiers and boarders over the past year, despite the pandemic” (Stratton, 2022). Ski patrol teams operate in such congested areas dealing with chaotic skiing injuries amidst a chaotic setting. Ski patrol officers deal with the need of locating, treating, and transporting injured riders. Additionally, “For an individual to become a patroller, he/she must complete a course covering an extensive list of first aid skills and CPR. Additionally, other components such as accident

scene management, chair lift evacuation, rescue, communications, avalanche, and search and rescue” (CSP, 2023). The need for locating comes with experienced mapping and directions of all the trails within the ski mountain and a masterful amount of skill to get to the location in a meaningful time. Upon a burning time, the injured patient requires treatment based on the degree of their injury, ranging from first-aid to even CPR. Following treatment comes the need for transportation safely and quickly down the mountain into urgent care. These three challenges are essential to the emergency response practice of ski patrol. The need for assistance transporting an injured skier/snowboarder because waiting for off-road assistance is time-consuming and transporting down a patient in a toboggan is tiring. A transportation device is needed for an injured skier/snowboarder to allow the ski patrol flexibility to continue their tasks of first-aid and evaluation of the scene and injury. Further needs include ease of use, comfort, and prestige. Emergency response transportation is a purposeful activity based on ease of functioning based on control and mastery while providing comfort needed by the injured patient all in a timely manner.

3.1.1 Needs/Benefits Not Met By Current Products

Current methods of locating injured riders are through common communication via patroller to patroller and oftentimes through a radio device with directions from ski patrol headquarters. Oftentimes, these instructions face external factors like frequency and misunderstandings which leads to wasting crucial time intended for the injured rider. In these cases, the need not met is the efficiency of tracking injured riders.

The rescue toboggan serves as a versatile tool in securing and treating a patient with injuries. It is, however, limited to only a sit-down position where the patient may only be looking up. If in enormous pain, the restraint may lead to further mental trauma and injury. In this case, the need not met is the mental state of the patient.

Lastly, rescue toboggan comes with only one means of bodily protection for the patient: a strapped blanket and one method of operating: through the skills of the patrol officer. Having straps again may cause mental trauma because of restraint but more evidently, there is not any protection against the external factors of weather and collision. With the fate of the patient on the line, the skills of a ski patrol officer are the determining factor in travel time down the mountain which is a variable amongst officers.

3.1.2 Latent Needs

Latent Needs	Benefit Statement
Safety	Offers safety against external factors that can occur at all 3 stages of emergency response
Comfort	Physical comfortable position dependant on injury
Transportation	Maneuver the ambiguous ski mountain terrain with efficiency and agility along with hundreds of other skiers/snowboarders
Locating	Fast location method of injured riders in all areas of the mountain - between and outside boundary lines
Observation	To observe the mental state and comfortability of patient while transporting
Work/Productivity	From locating to transportation to urgent care in a timely manner

Table. 7 Latent Needs of injured skier/snowboarder and ski patrol

3.1.3 Categorization of Needs

Need	Benefit Statement	Relationship with Benefit
Aerial Bird’s Eye-View	Faster locating leads to faster treatment which leads to faster transportation	STRONG
Enclosure Pod	Protection from weather and collision	STRONG

Adjustable Bed	Different positions based on injury	STRONG
Full-Human Control	Skills are still of importance and the maneuvering of routes is dependant on a user's knowledge of terrain	STRONG
Safety-Mechanics	Collision prevention, driver's safety	STRONG
Easy Treatment Device	Faster treatment	STRONG
Latent Needs	Benefit Statement	Relationship with Benefit
Safety	Offers safety against external factors that can occur at all 3 stages of emergency response	STRONG
Comfort	Physical comfortable position dependant on injury	STRONG
Transportation	Maneuver the ambiguous ski mountain terrain with efficiency and agility along with hundreds of other skiers/snowboarders	STRONG
Locating	Fast location method of injured riders in all areas of the mountain - between and outside boundary lines	MODERATE
Observation	To observe the mental state and comfortability of patient while transporting	MODERATE
Work/Productivity	From locating to transportation to urgent care in a timely manner	STRONG
Wants	Benefit Statement	Relationship with Benefit
Fully Electric	Environment-friendly/Inspirational	STRONG
AI Features	Lessens work load of ski patrol	MODERATE

Table. 8 Categorization of Needs for thesis direction

3.2 Analysis - Usability

3.2.1 Journey Mapping

Ski patrol officers have multiple roles to perform on every ski day. Where shifts can last up to 12 hours long, these tasks often are on repeat at various intervals of the day.

Moreover, to design based on the tracking, treating, and transporting of injured riders, the analysis of a single emergency response call can be seen in *Figure 9*. The analysis, however, first starts with the planning and preparation of their initial daily morning tasks prior to getting an emergency response call.

	PLANNING	PREPARATION	TASK 1	TASK 2	TASK 3	GOAL	FINISH UP
USER GOALS	To find a more efficient process of ski patrol	Prepare slopes and boundary lines	Snow check	Ski Patrol Search and rescue	Ski Patrol transportati on down mountain	Treat and get injured down the mountain	Provide further medical care and information
USER ACTIONS	Go over team protocol and assignments	Ride up and down the mountain to make sure mountain meets regulations	Bombing and temperature checking	Asking everyone to make sure they are okay	Snowmobile or snow sled	Perform first aid	Talk to other medical staff with information on inured
USER THOUGHTS	My task is too hard, my task is too easy I won't have anything to do after	It snowed so much overnight, we need to carve out the tracks	This is satisfying	Is that person injured or did they just wipeout	This is heavy and hurts my legs	I love this job	I hope I provided you everything
USER FEELINGS	Tired but ready	Motivated	Loud	Focused on finding injured people	Stressed about the injured and their physical state	Satisfying	Content

Table. 9 Journey Mapping of Ski Patrol

3.2.2 User Experience

Leading from the journey analysis in section 3.2.1, a ski patrol officer’s experience is analyzed at each task again. This journey dives deep into the emotions during each task of the ski patrol officer’s journey.

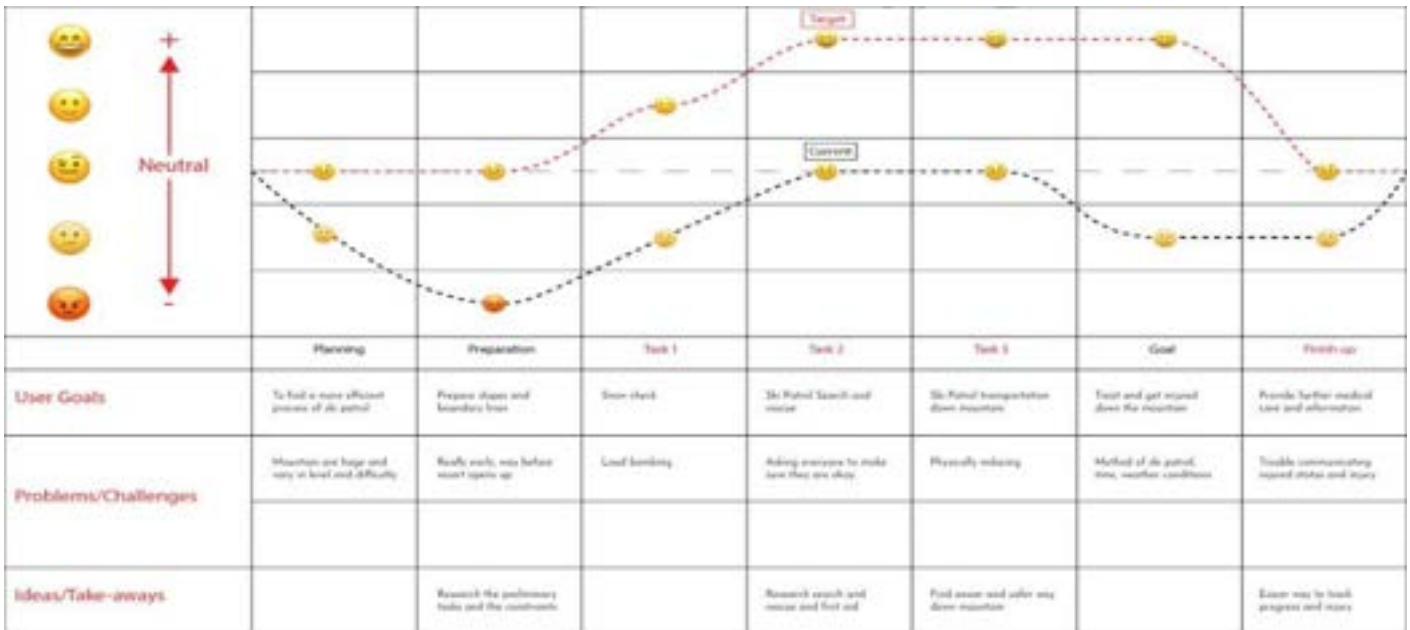


Table. 10 User Experience Mapping

As evident, the user starts the day feeling subpar and below neutral given the practicality of having to divide people into stations for ski patrol and prep across wide of snowy slope to have the mountain prepared, boundary lines visible and essentially all preliminary steps prior to opening the resort. “ Upon doing so, the tasks begin with snow bombing which are “explosives detonated at the ground-snow interface” (Perla & Everts, 2017) that cause avalanches before they occur naturally. This activity keeps the user under neutral feelings because of the loud noise and tedious calculations that come with the task. The user is most happy in his/her element of performing ski patrol tasks and although tired, the endorphins and adrenaline keep the mood up until having to transport down the mountain which is physically inducing. The mood relatively will go up again after completion due to relief, satisfaction, and pride.

3.3 Analysis - Human Factors

Human factors will always remain an essential topic of research to understand touch and feel points, ergonomics, and overall feel when using a product. These are things that will be explored and expanded on in this chapter.

3.3.1 Product Schematic- - Configuration Diagram

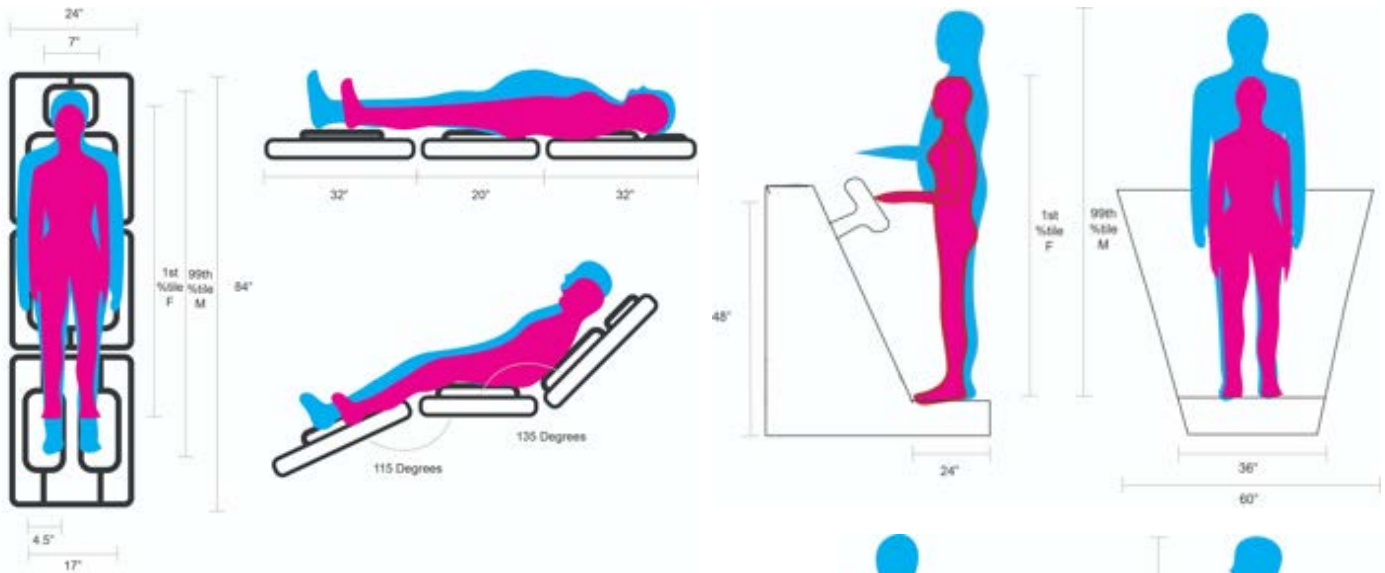
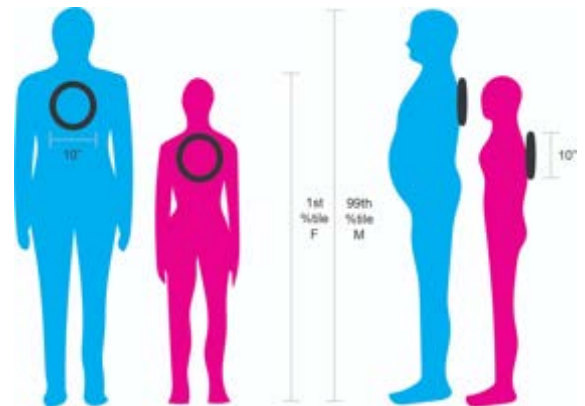


Figure. 12 Configuration Diagram: Stretcher

Figure. 13 Configuration Diagram: Operating Area

Figure. 14 Configuration Diagram: Drone



List of components (Stretcher):	List of components (Operating Area):	List of components (Drone):
Cushions	Steering wheel	Main body
Sidebars for lifting	Driver area	360 degree camera
Reclinable seat	Accelerator	Sensor

Straps	Brake	Propeller
Rail system for extrusion	Interface	Charging outlet

Table. 11 List of Components for Stretcher, Operating Area and Drone Schematics

3.3.2 Ergonomic - 1:1 Human Scale Study

This section will uncover the human to product interaction and functionality while investigating the requirements of ergonomic necessities required of an emergency response vehicle/product. Modern practices involve traditional uses of manpower mulling a rescue toboggan while other resorts may use off-road vehicles like snowmobiles or RTVs; options that both have their trivial flaws. The purpose of this evaluation process is to improve the efficiency of emergency response, enhancing on-site response and transporting the injured safely and quickly to further care. One-to-one scale models were designed to give greater detail and evaluation through human factors and user interaction. Results will show the adequate sizing for a stretcher system that can tuck into the vehicle and can sit upright or flat at any time and along with, a considerable amount of space for vehicle operators: the ski patrol. Redesigning the emergency response vehicle/product leads to faster, more efficient, and safer transportation and care of injured riders all because of the sought-out human factors and ergonomic considerations evaluated and tested.

LITERATURE REVIEW

The anthropometric data addressed in this study is taken from the book *The Measure of Man and Woman* (Tilley & Dreyfuss, 2002) with versatile emphasis on the 1st percentile of women all the way to the 99th percentile of men due to the diverse demographic of skiers and snowboarders of all ages, race, and sizes. Every dimension in this study of the product is precisely linked back to this literature to validate the product’s size and features.

METHODOLOGY

Three areas of the product were created and tested to find a solution to whether or not it would all tie in together or not: the stretcher mechanism, the operating area, and the ski patrol drone. The stretcher's skeleton was made to bend to show the angle at which is available to the injured, the operating area demonstrated the proper height of steering to allow for balance and the drone was made to show how it stores in the back storage of a ski patrol officer. The ergonomic evaluation and analysis of a current skid steer design were conducted with the following considerations:

Objective(s)

The goal of this process was to evaluate the full-bodied human interaction design and full-bodied ergonomic challenges for a stretcher, stand-up operating system, and drone backpack. This ergonomic evaluation report outlines the methods used to evaluate the three major body-part areas for assessment from human factors, ergonomics, and convenience of use challenges. The three major body-part areas for human factor assessing, ergonomics, and convenience of use challenges will be evaluated in this report through an ergonomic scope.

Decision(s) to be made

The following interactions relevant to three specific major body part areas (Chong et al., 2021) were investigated to minimize the negative experiences and maximize the positive experiences:

1. Ease of egress and regress of stretcher (Ski patrol's entire body)
2. Ergonomic bend of stretcher (Back, head, neck)
3. Interaction with operating controls specifically the steering wheel (Hand and Arms)
4. Ease of storage and carry for drone (Back)

Description of Users Targeted by Product

The target demographic was individuals on ski patrol. Their age ranged from 18 – 55 and varied in gender. They were also located outside of the GTA in ski resorts up north.

Evaluation process

The evaluation process consisted of designing a full-scale (1:1) ergonomic buck of the cabin (Badaraco, 2016; MacDonald, 2016; Pedulla, 2016) which allowed for critical observation of the following:

1. Observing how the user put an injured rider in their toboggan (Ingress/Egress)
2. Observing how the user straps the injured securely (Security)
3. Observing for pain points, slow reactions pauses in their procedure
4. Identifying critical human dimensions affecting product use

Description of User Observation Environment Used in this Study

For this study, a walk-through of the different levels of slopes and multiple ski patrol posts was essential in following the operations and procedures done.

Location and Timeframe

Date of Observation(s): 12/06/12 (Observation 1)

Location of Observation(s): Blue Mountain

RESULTS

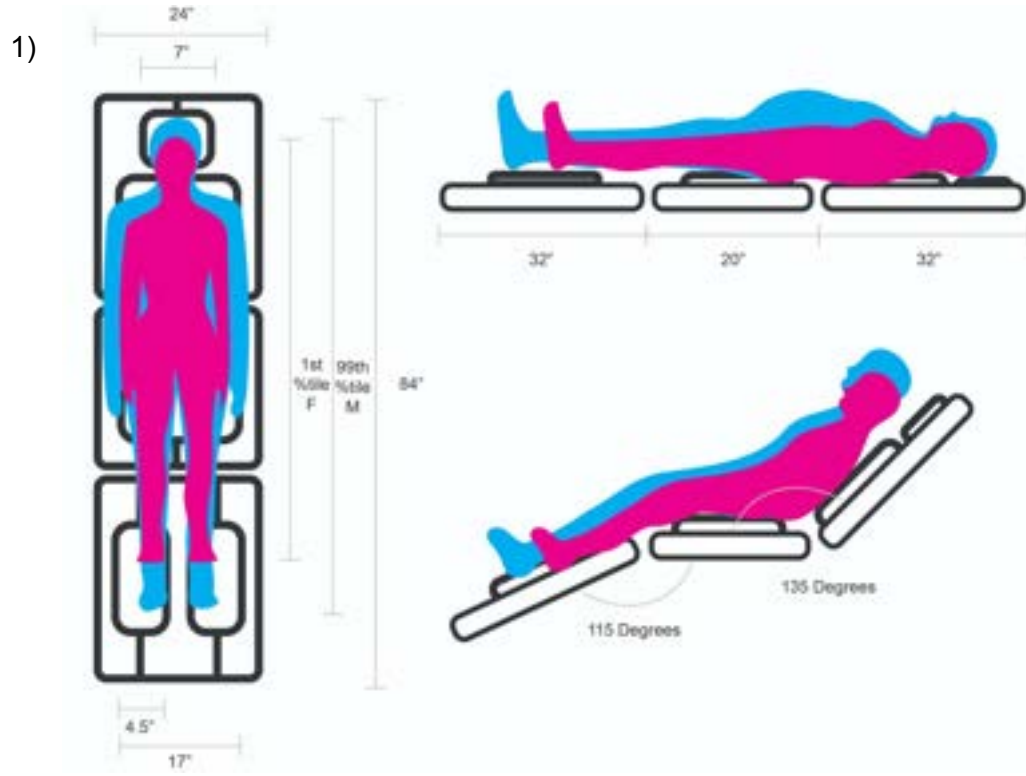


Figure. 12 Configuration Diagram: Stretcher

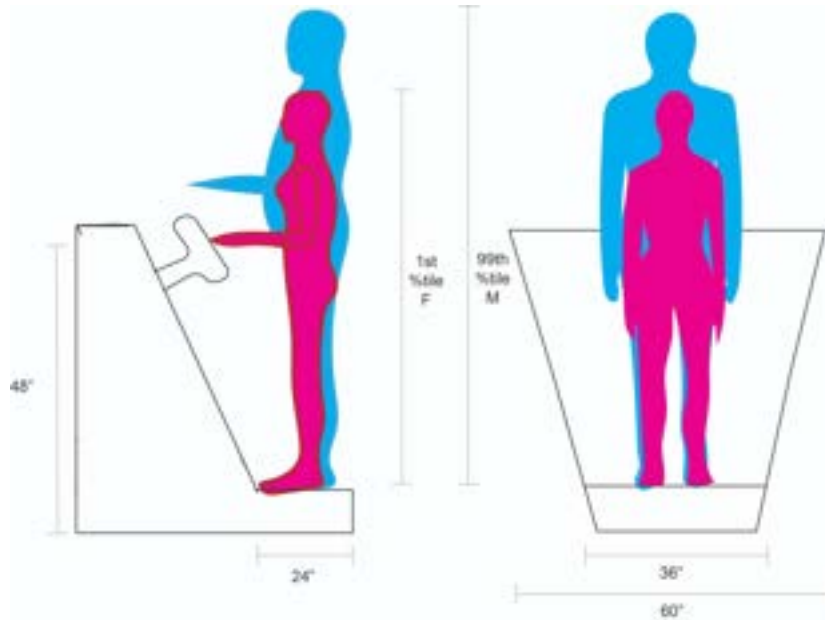


Figure. 13 Configuration Diagram: Operating Area

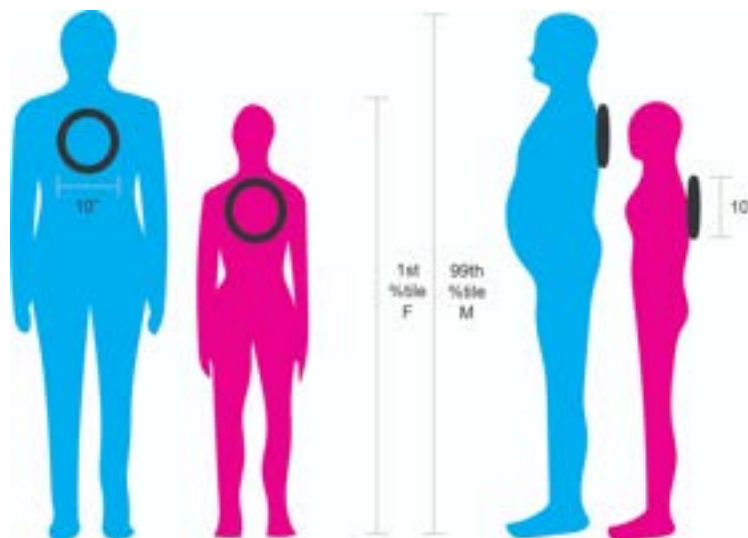


Figure. 14 Configuration Diagram: Drone

2) Below are pictures of a 1:1 physical model with 1th percentile female and 90th percentile male

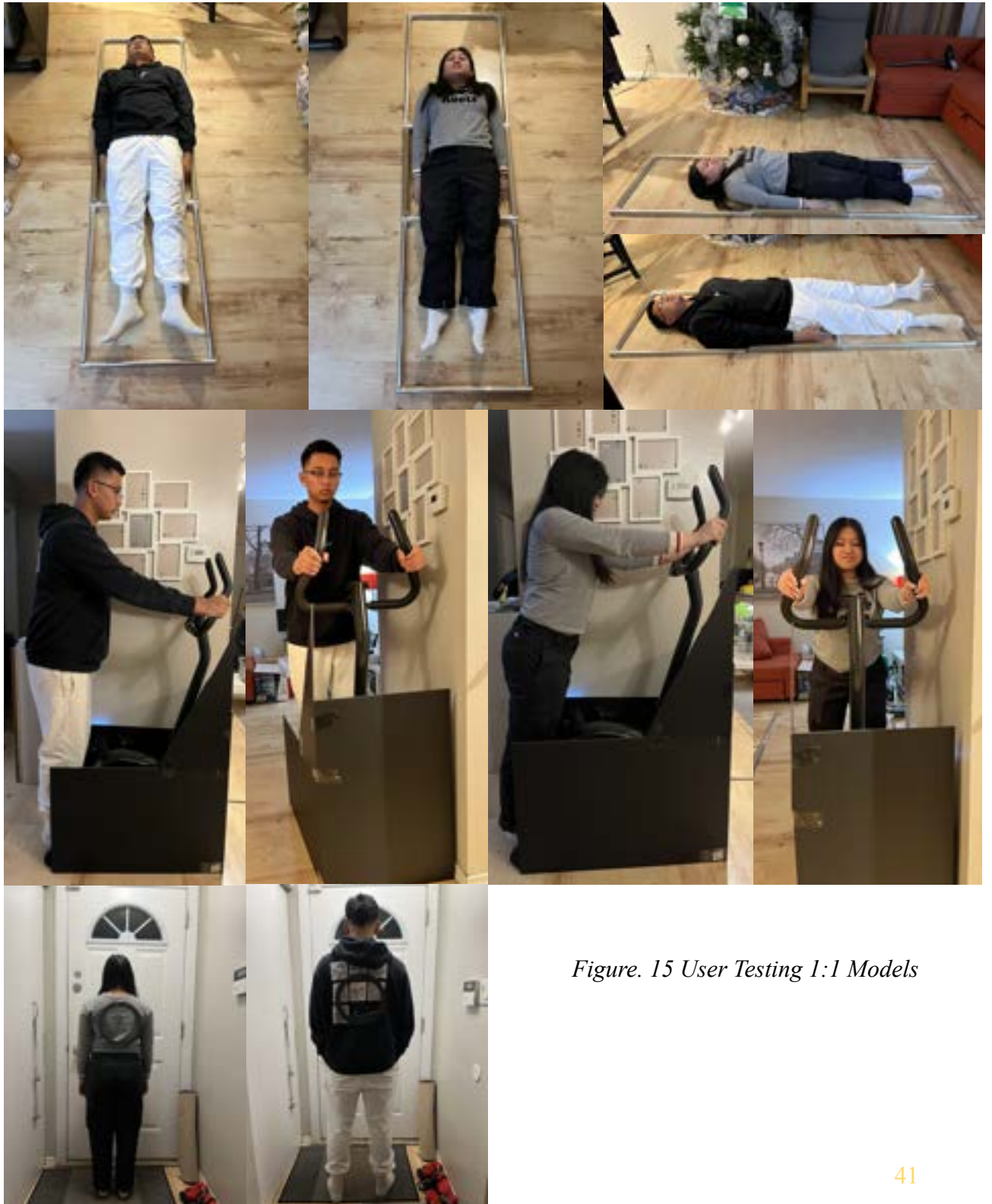


Figure. 15 User Testing 1:1 Models

3.4 Analysis - Aesthetics & Semantic Profile

The aesthetics and form of a product often overlooks the functionality and use of the product given it is the first and foremost thing the user observes with their very eyes. In the realm of transportation products, aesthetics serves just as much purpose as functionality. Moreover, the environment of use, Canadian Ski Resorts, calls for a solution that will provide the same values and feelings relative to its setting. Aesthetic approaches will match the rigidity and toughness that comes with the ski patrol process along with the agility and speed that the team works at. The function challenges the form in a way that will favor both the ski patrol as the driver and blend the need of a passenger: the injured patient.

Leaning more into a vehicular solution, a track system majorities over a wheel system which helps to establish the form of the base. Speed and quickness are of the essence so therefore the form will need to fight aerodynamics while being inspired by simple geometric shapes will serve to the rigidness, toughness, and symmetry that is intended to help “ground” the vehicle and all of its components. Inspirations from other winterized vehicles and winter sports will improve the exploration of form and function and enhance the creativity of the solution. The following mood board will encapsulate the purpose-driven and form-filling styling approach to the design solution.



Figure. 16 Moodboard for Aesthetics and Semantics

3.5 Analysis - Sustainability: Safety, Health, and Environment

In ski resorts, the injury toll is a constant daily number. Safety concerns on the number of injuries, the types of injuries, and even the safety during transportation must be accounted for to meet the basic needs of the user. The variety of injuries that can happen on the slope is a long list and is always situational on the skier/snowboarder. The design will address this ambiguity of injury by allowing for a retractable stretcher mechanism that extracts from the main body of the vehicle to treat the patient on-site. This stretcher can autonomously retract back inside onto an adjustable bed that can adjust the positioning from 180 degrees flat to any reclined position depending on the comfort and injury of the user. This patient area is then closed in by autonomous Makrolon polycarbonate panels that protect the user from the elements of winter and potential collisions. A mechanism that will help ensure the safety of the driver, the ski patrol, will also serve as an important feature of the solution.

The main purpose of being a ski patrol is to also maintain the health of patients by treating them with first-aid and transporting them fast down the mountain to urgent care. Traditional methods, however, are physically demanding of the patrol officer which becomes a health concern with older age groups of patrolling. This health concern is the driving factor that puts the needs of the user (ski patrol) at a sustainability risk. The way this design addresses this need is by making the vehicle motor operated by the patrol eliminating the physical need to drag a body down the slope. The operating area becomes a crucial part of maneuvering patients down the slope in a timely fashion which leads to faster healthcare.

Lastly, the environment in which emergency response takes place is the snow-capped mountains and trail-filled slopes. The ecosystem surrounding these ski resorts is acres wide of forests and other wildlife that not only become the surrounding barrier of trails but provide the skiers/snowboarders with masses of oxygen. Keeping these areas safe from pollution and toxins is a sustainable need that needs to be addressed to bring about an environmentally-friendly ski resort. This design addresses this by being fully electric with a rechargeable battery that nests on the bottom of the body of the vehicle. This vehicle will be able to recharge at charging stations posted in ski patrol team posts and allows for sustainable alpine rescue and the cut of gas emissions and pollution while still packing a punch in the category of speed. Overall, this design aims also to use sustainable materials that can be recycled/upcycled like Covestro plastics that are engineered to different functionalities and allows for more sustainable manufacturing processes.

3.6 Analysis - Innovation Opportunity

Having understood the benchmarked products in Section 3.1.1, it is evident that current ski patrol methods are outdated and have room for innovation. For tracking, the communication and interaction between riders and patrol officers can be explored in order to find the patient faster. For treatment, more consideration can be put into the importance of the mental and physical state of the patient. Lastly, transportation can be made safer, faster, and more reliable than the current means of transportation and with less stress on the patrol officer physically based on evidence from the user task map in Section 2.1.3 The figure below demonstrates the area of innovation in ski resort emergency response based on how these benchmarked products are mapped on a plot.

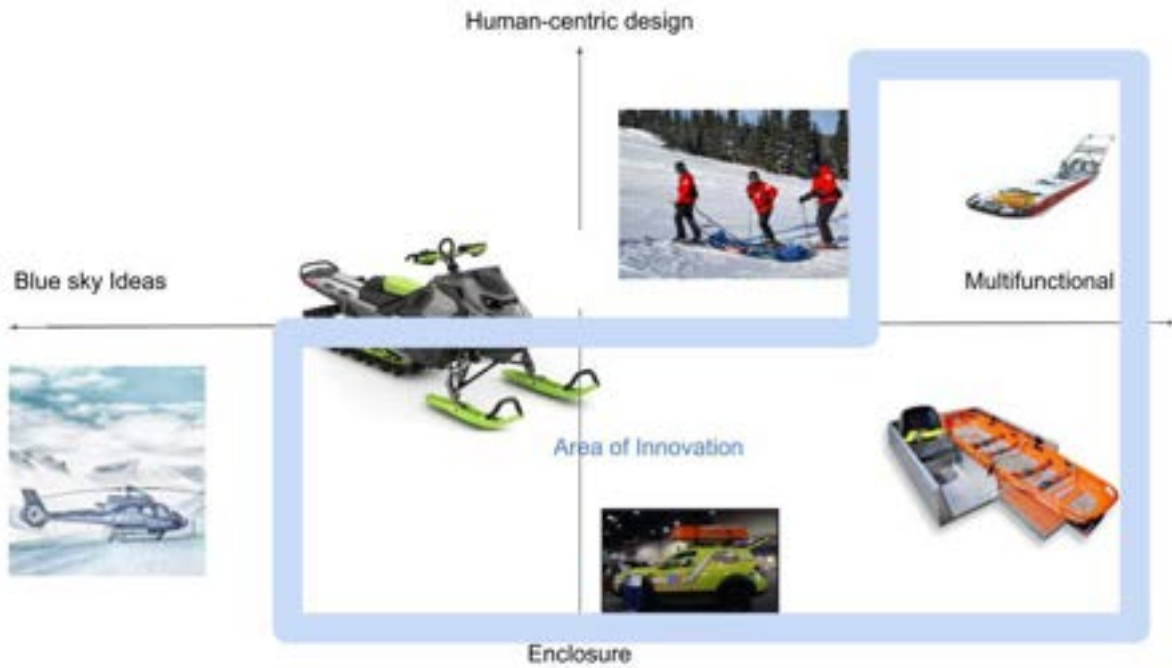


Figure. 17 XY Innovation Opportunity Graph

Based on the graph provided, the area of innovation allows the design to be multifunctional with the importance of an enclosure for a patient. This being said, there is open innovation to stretch out the functionalities to blue sky ideas with advanced technology and there is great emphasis on innovating it to be centered around the user; human-centric design. All in all, by using the benchmarked products, their aesthetics, functionality, and features, it is evident that there is an area of innovation for a transportation vehicle.

3.6.1 Needs Analysis Diagram

Product- Rescue Toboggan			
Needs	Benefits and Underlying Needs	Level of importance	
Basic Needs <i>Physiological</i>			
Food, water, shelter	Shelter as a means to hold injured person	Moderate	
Pleasure, gratification <i>(sensory, compulsive responses)</i>	Injured: Satisfaction that they are safe		High
	Ski Patrol: Handles do not feel uncomfortable, body of product is not too heavy		High
Security <i>Safety, securing resources</i>			
Safety	Protection of injured		High
State, Group, Individual			
Securing resources <i>Optimization of limited resources (cost effectiveness)</i> • Value • Accumulation of resources (wealth)	Price is important to ski resorts buying product		High
	Reliability	Moderate	
Control over environment (tasks) Convenience <i>Ease of Use</i> <i>Speed (fast, less time)</i> <i>Control (precision, responsiveness, power)</i>	<i>Product (tool) that amplifies human abilities</i>		
	Steering while using skis or snowboard		High
	MASTERY Waiting for a vehicle is slower		High
	Handles and skis	Moderate	
Long Term Security/Stability of Group <i>Health/care/education of children</i> <i>Environmental sustainability</i> <i>Insurance (car, house), pension, investments</i>	Caring for Injured <i>Is the injured okay? Is he/she going to make it down the mountain? Is he/she going to panic?</i>		High
	Rescue Toboggans are meant to transport them down safely		High
Social Belonging <i>Effort / resources to belong to a 'tribe'</i>			
Fear of Abandonment	Injured feels safe		High
Fear of the enemy			
Tribal Identity			
Behavior cues for survival <i>(copying behaviors... safe to eat, learned skills)</i>	Friends/relatives recommendations	Moderate	
Behavior cues for social interaction of group <i>(copying behaviors... interaction cues, play, have fun)</i>			
Peer Pressure		Moderate	
Social Expectation <i>(social covenant (gift))</i>			
Esteem <i>Personal influence in 'tribe'</i>			
Social Status <i>The elite have it...I want to be like them'</i>	All Ski Patrols use this product	Slight	
Social Recognition			
Sexual attractiveness			
Self-Actualization 'Higher order' Functions/Needs <i>Needs that are pre-dominantly 'outer cortex'</i>			
Intrinsic pleasure			
Creative endeavors			
Experiential (extrinsic)	Only professional skier/snowboarder can operate this		High
Experiential (intrinsic)			
Emotional	Empathy: <i>Is the injured okay? Is he/she going to make it down the mountain? Is he/she going to panic? Is he/she warm?</i>	Moderate	

Table. 12 Needs Analysis Table

3.6.2 Desirability, Feasibility & Viability

Desirability: Ski patrols are natural caregivers and selfless heroes that always put the needs of others first. They rely on their skills of the trade: skiing/snowboarding, to bring their passion to fruition by helping others as ski patrol officers. The goal of this thesis is to maintain and even encourage the need to help others by providing an enhanced process of tracking, treating, and transporting injured riders; which works in the favor of the ski patrol, making their jobs easier and releasing a bit of responsibility weighing on their shoulders.

Viability: The liability and insurance costs of Canadian ski resorts increase the more people get hurt on the slopes therefore ski resorts will be willing to discuss a way to mitigate these injuries in any way possible. The Canadian Ski Patrol Organization “provides advanced first aid and emergency response services at more than 230 ski resorts and Nordic centers, as well as hundreds of recreational and sporting events across Canada” (CSP, 2020). Based on their statement, funding, and donations will come from organizations like this to help improve their processes of emergency response on the slopes.

Feasibility: The creation of snowmobiles proves the manufacturability of this project with existing companies like Ski-Doo, Polaris, etc. The challenge and the risk of taking on a vehicle like this is the cost. The question also lies in the ability of ski resorts to fund a vehicle or two when paying around minimum wage to ski patrol officers is more feasible. It comes down to the need and purpose of this vehicle being the driving factor for production.

3.7 Summary of Chapter 3 - Defining Design Brief

This design brief solidifies the progression through the concept development stages with the goal of this thesis being, to design a vehicle that will improve emergency response in Canadian ski resorts. This vehicle should improve communication in tracking, make

treatment faster and allow transportation to be safer, faster, and more reliable. Below is a table that demonstrates the summary of this design brief:

Safety	Creating a safe vehicle that can operate in the parameters of the ski hill, can hold one patient safely within a pod, and have emergency features to protect the patient and driver from possible collisions.
Comfort	Ski resorts are cold and temperatures drop the higher up the mountain. During injury, the body starts to go into survival mode which can cause trauma. Implementing a pod for physical comfort against the cold and mental comfort from the injury.
Transportation	Maneuver the ambiguous ski mountain terrain with efficiency and agility along with hundreds of other skiers/snowboarders.
Locating	Fast location method of injured riders in all areas of the mountain - between and outside boundary lines with the possibility of aerial bird's eye view.
Ergonomics	Adaptability to different injuries, and all sizes and sexes and also allowing comfortability regardless of differences.
AI Integration	Can pre-determine injury before even arriving at the patient's location. Make the job faster, and life easier.
Sustainability	Possible EV implementation to keep the evergreen area's ecosystem fuel-emission-free.
Aesthetics	To be aerodynamic and use simple geometric shapes to bring unity to the design.
Versatility	4 track system allows for uphill and downhill transportation
Efficiency	Faster than a man-powered rescue toboggan and just as fast as a snowmobile. From locating to transportation to urgent care in a timely manner.

Table. 13 Summary of Design Brief Table

4.1 Initial Idea Generation

To begin the most anticipated part of this project, the design process, a mind map was developed with the main “How May We” question in the middle branching out to important areas touched over in this report: User, Products (Benchmarking), and Environments of Use. Although the ideation phase is filled with many styling, visual, and aesthetic directions, these areas are the spearhead of ideation and encourage this thesis to be a research-driven project. Idea generation will expand the research material into forms of shapes, patterns, and bodies solely on the insights and values obtained from the research.

4.1.1 Mind Mapping



Figure. 18 Mind Mapping

4.1.2 Aesthetics Approach & Semantic Profile

The aesthetic approach will be through loose lines, curves, and chamfers. The aim is to avoid any rectangular forms but chip away at them in ways that describe the insights

achieved from research. The approach will begin with the exploration of shapes to define a common theme and translate the value of those shapes into every feature of the product. Metaphorical imagery will play a role by grabbing the traits and values of the product's environment of use: the ski resort/mountain and will draw inspiration from winter sports like bobsledding and winter vehicles like snowmobiles.

4.1.3 Ideation Sketches

Even with the emphasis on vehicle/transportation design, ideations will feature subcomponents of that vehicle to complement the job of the ski patrol officer. Ideation sketches are as follows:

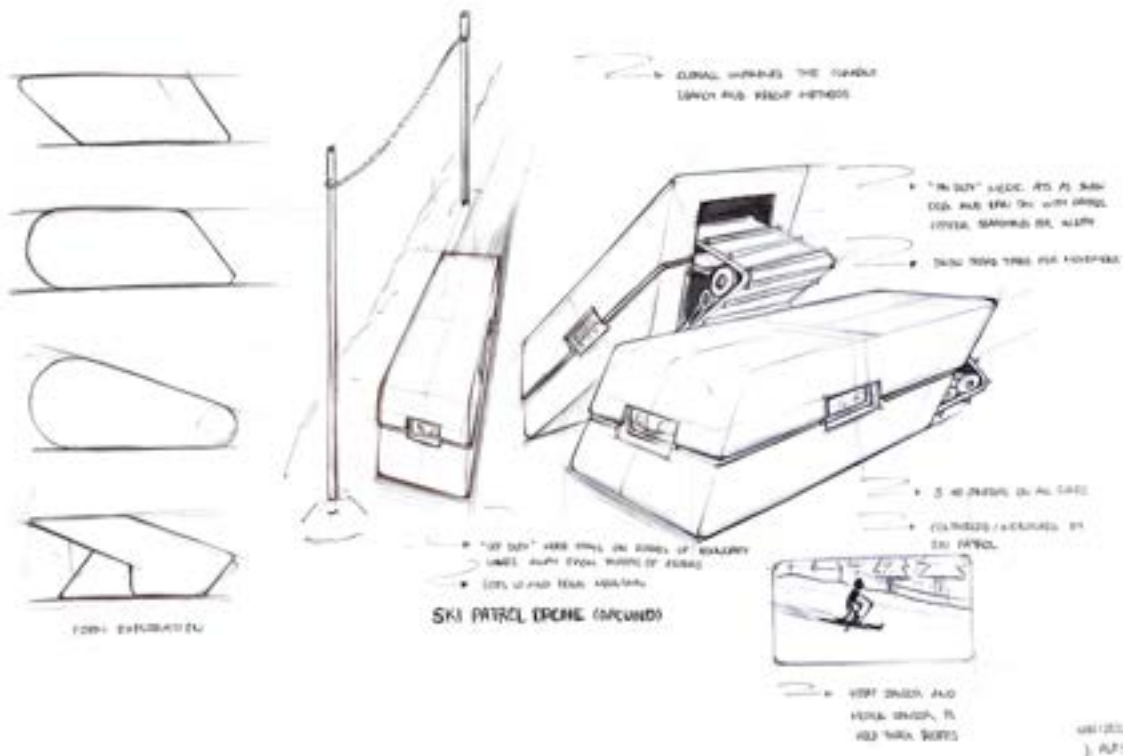


Figure. 19 Ski Patrol Drone (Ground)

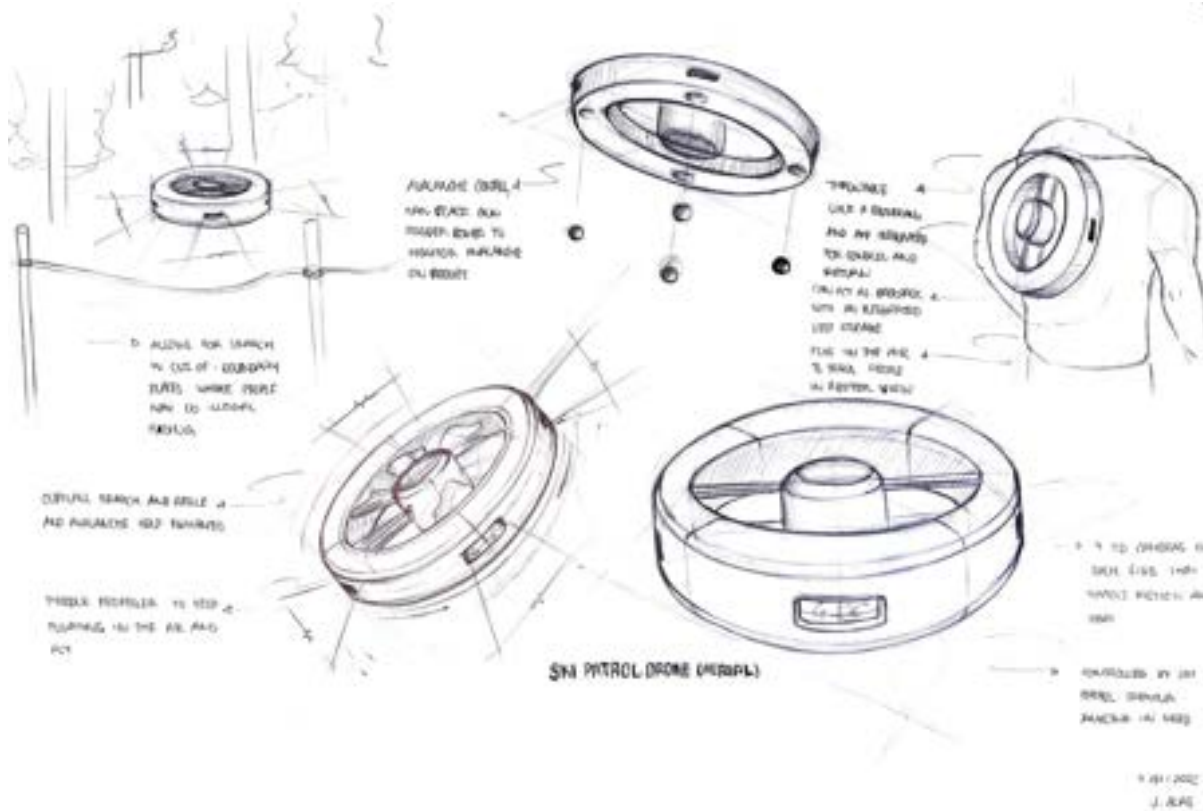


Figure. 20 Ski Patrol Drone (Aerial)

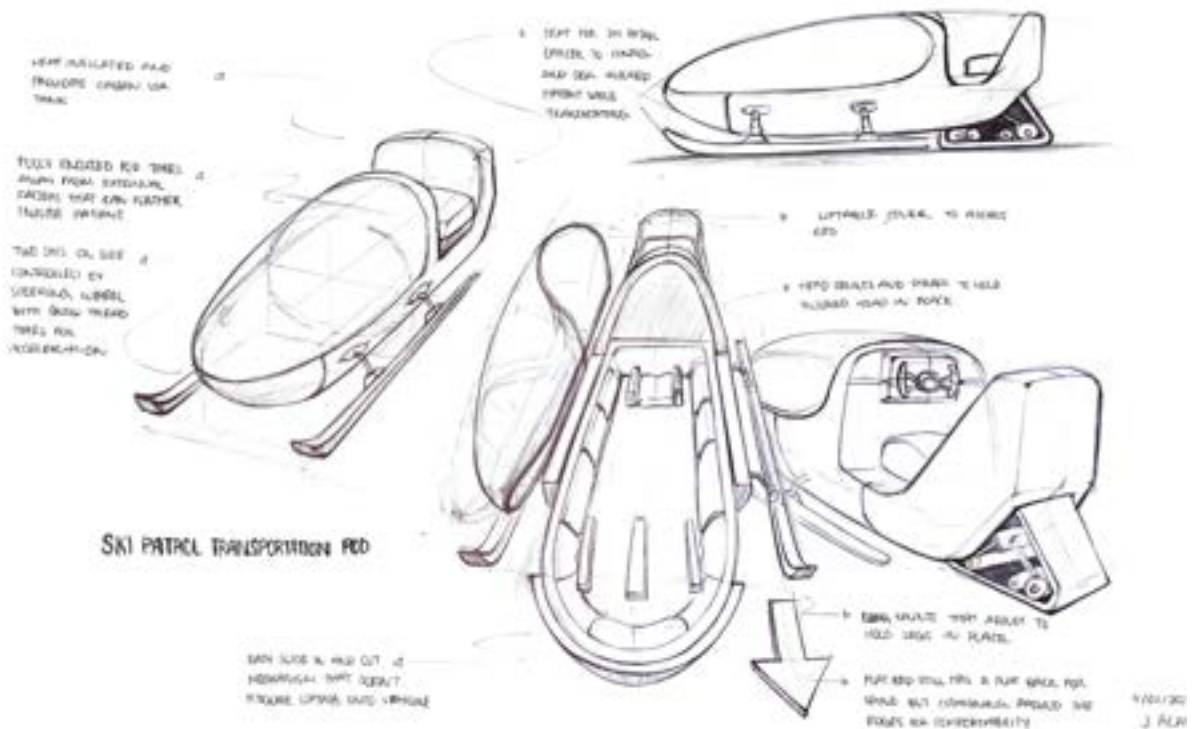


Figure. 21 Ski Patrol Transportation Pod

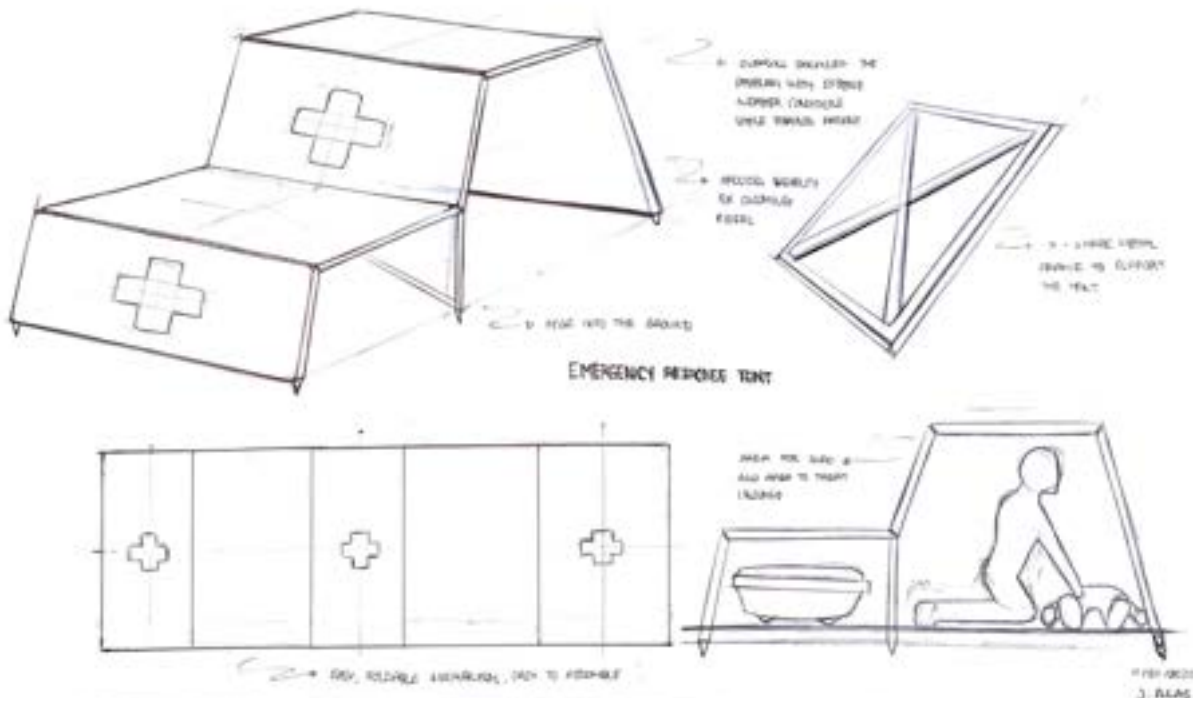


Figure.22 Emergency Response Tent

SKI PATROL MEDICAL HELMET

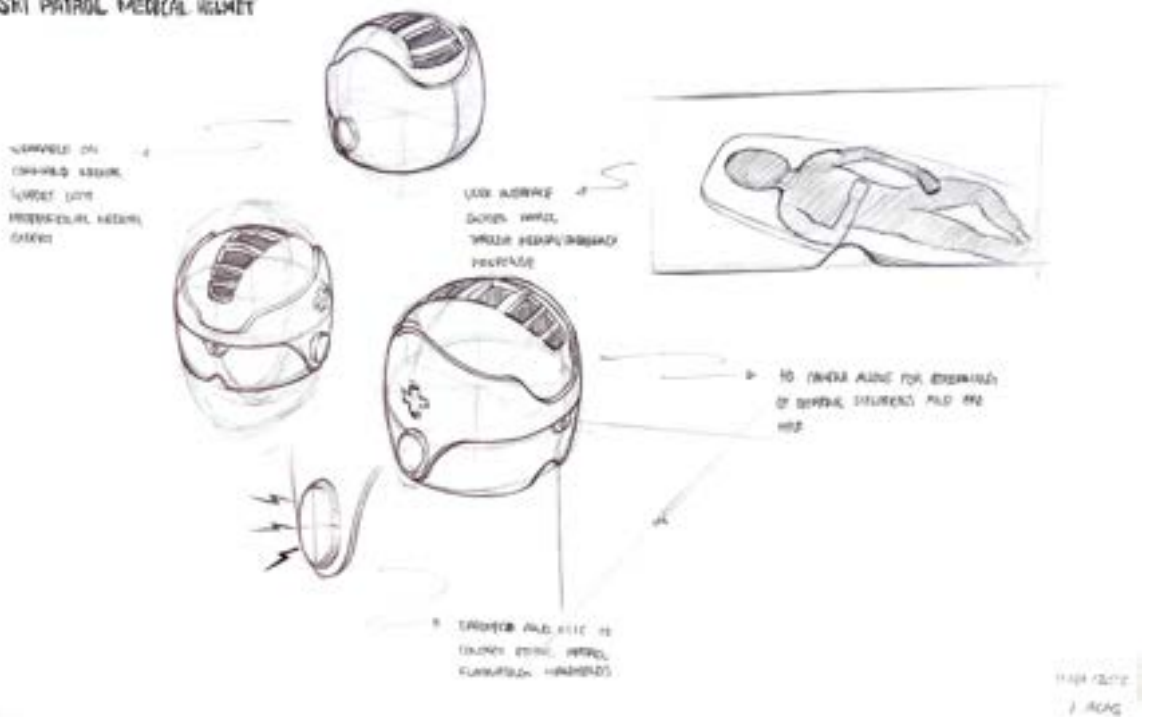


Figure. 23 Ski Patrol Medical Helmet

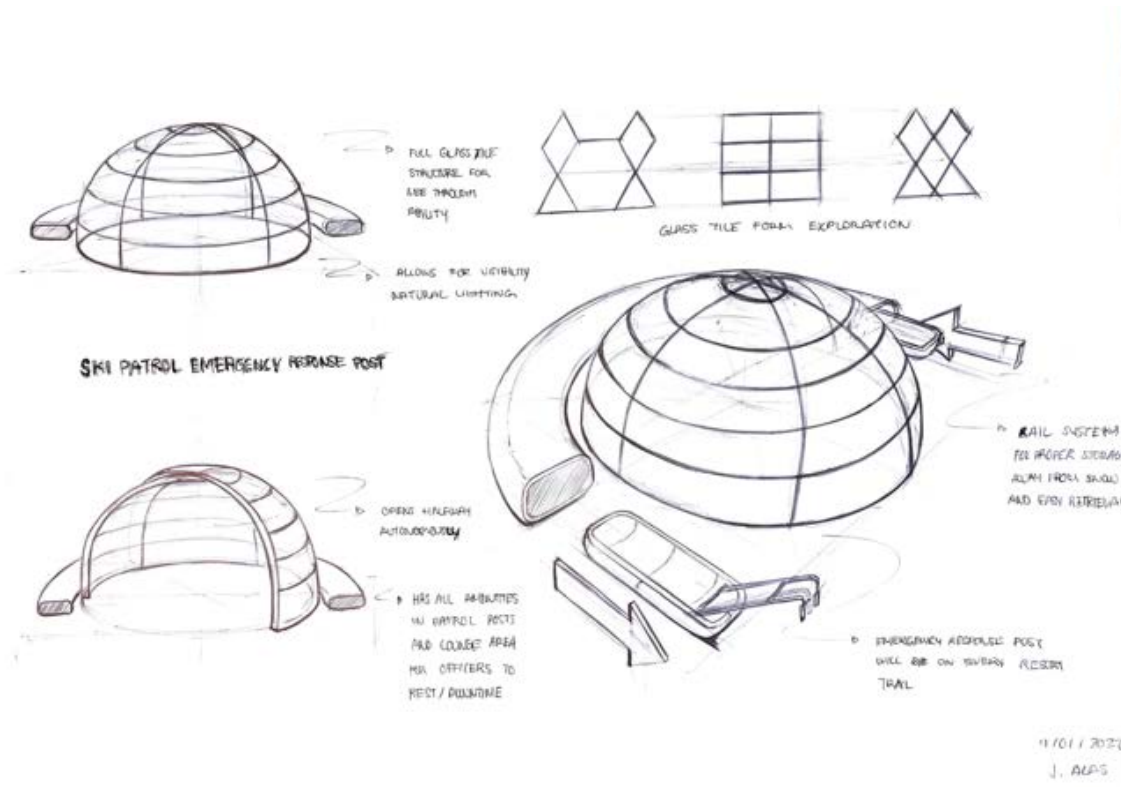


Figure. 24 Ski Patrol Emergency Response Post

4.2 Concepts Exploration

Following the idea generation stage came the Concepts Exploration stage where 6 ideas had to be rounded down to 3 and ideas came to consolidation and/or combination. This is shown by eliminating ideas that did not feed the requirements of expanding beyond its scope to be worthy to be a thesis project. The difficult part of this stage is trying not to find a solution to the problem so early but with the project being almost predetermined based on the derived research, the strategy of creating a vehicle and making sub-components is the direction concept exploration is following.

The following concepts deal with early-form development, a drone & helmet, and a ski patrol emergency response post.

4.2.1 Concept One

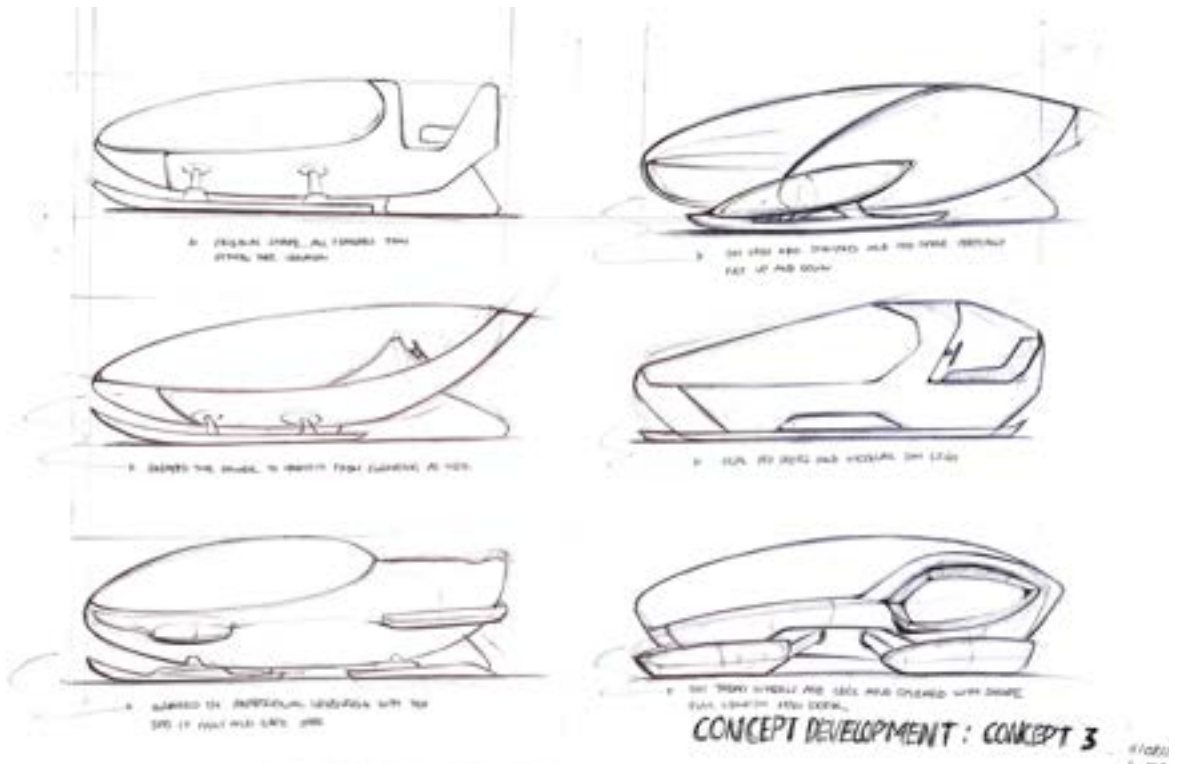


Figure. 25 Ski Patrol Transportation Pod Form Development

4.2.2 Concept Two

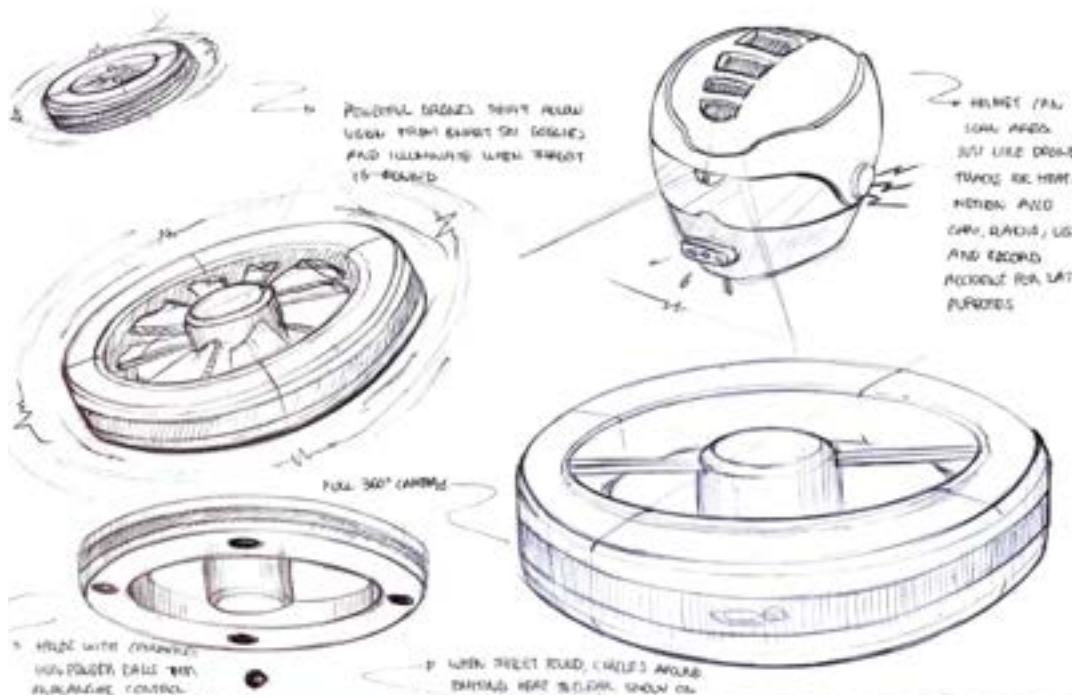


Figure. 26 Ski Patrol Drone and Medical Helmet

4.2.3 Concept Three

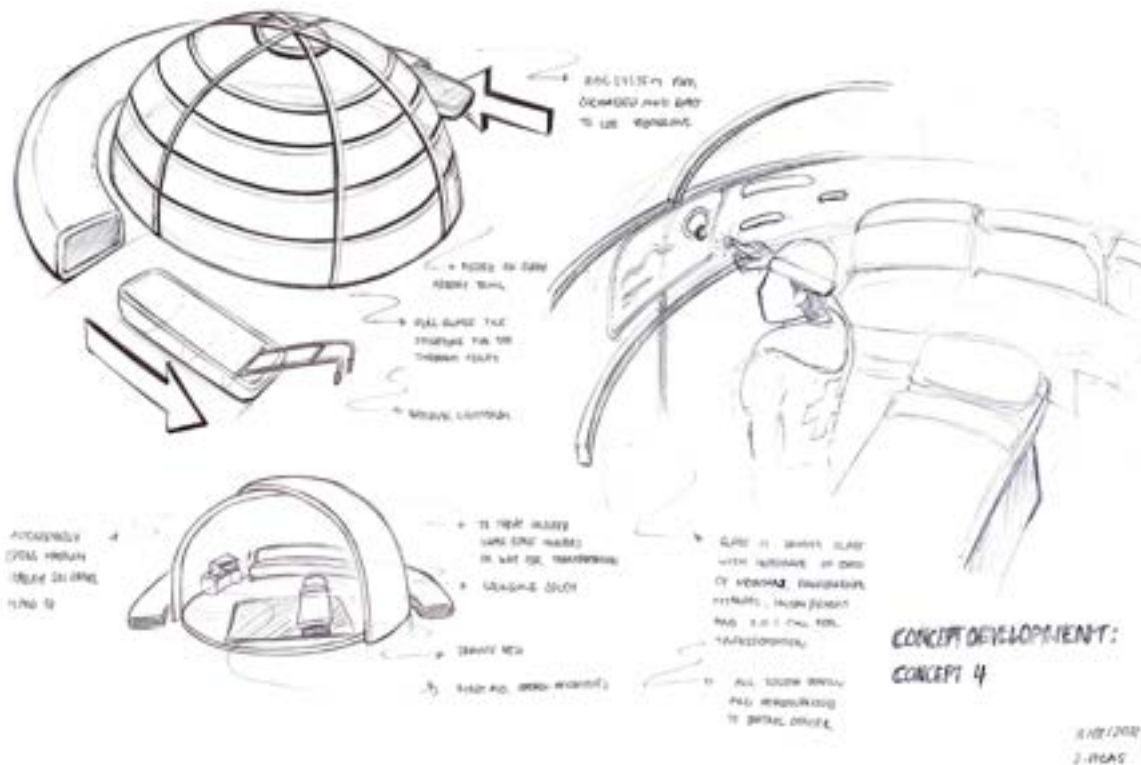


Figure. 27 Ski Patrol Emergency Response Post

4.3 Concept Strategy

Two designs stood out with their potential for styling, development, and improvement of human well-being. Concept Direction One being at the forefront of the main design direction explores the use of a pod enclosure that can hold an injured skier/snowboarder and is maneuvered by the ski patrol driving it from behind. Concept Direction Two will combine the health and safety aspects of the pod with a drone advanced tech helmet that will enhance the experience of the ski patrol from predetermining the state of injury to locating the injured patient. By evaluating the needs of both users, the solution was clear: to combine the transportation pod work with the drone in unison. To add to this, a flat bed stretcher fits the transportation pod mechanism perfectly and could extrude from the pod itself to give way to easier treatment.

4.3.1 Concept Direction & Product Schematic One



Figure. 28 Ski Helmet & Drone Concept



300 GRAMS



SMALL BUT TACTILE



SIMPLE AND SLEEK



EASY TO CARRY

HEAT EMISSION

AIRLANCE BARRETT

TECH INTEGRATION

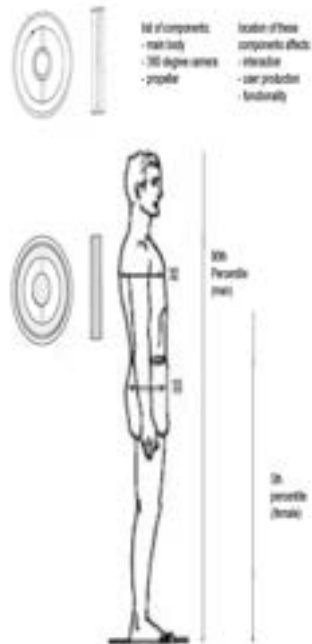


Figure. 29 Drone Concept Schematic One

4.3.2 Concept Direction & Product Schematic Two

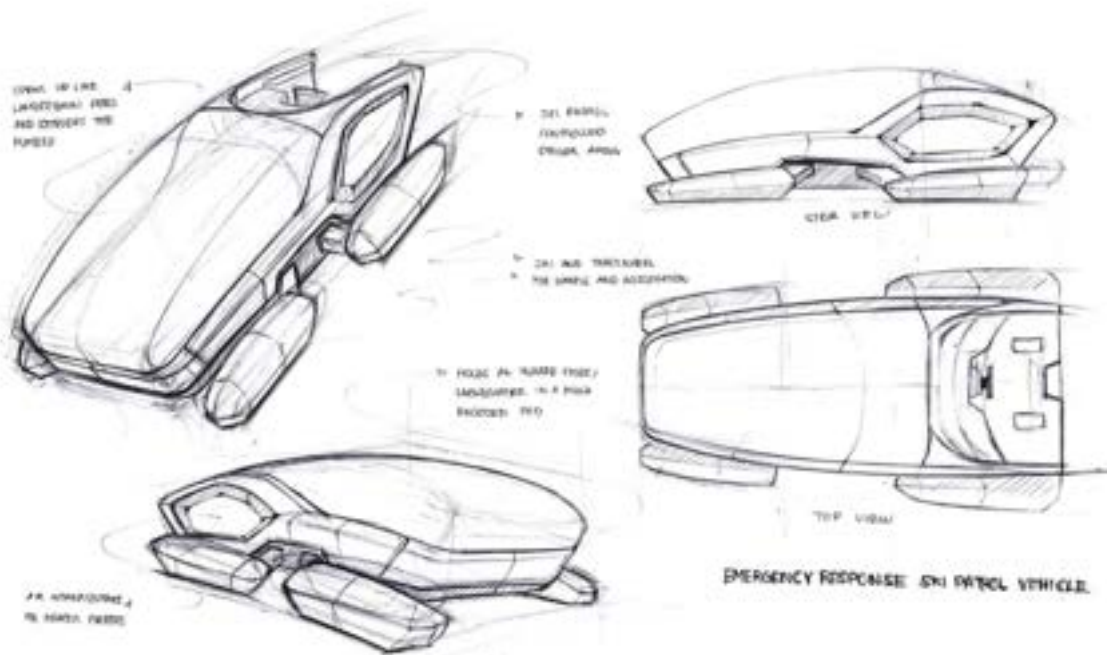


Figure. 30 Emergency Response Ski Patrol Vehicle Concept Direction

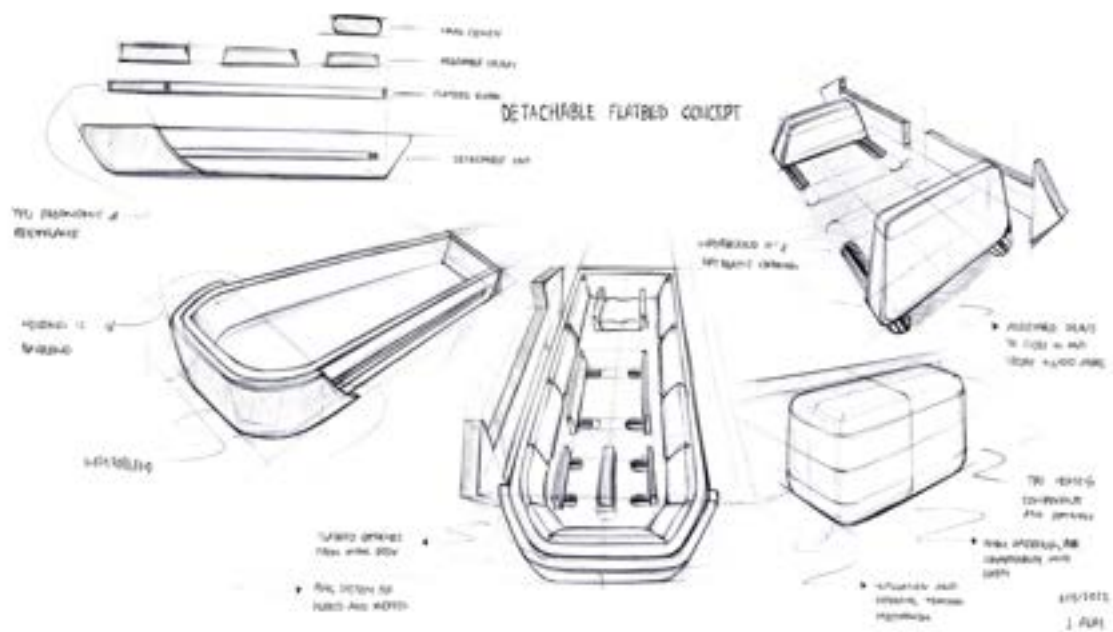


Figure. 31 Emergency Response Ski Patrol Vehicle Concept Direction: Detachable Bed

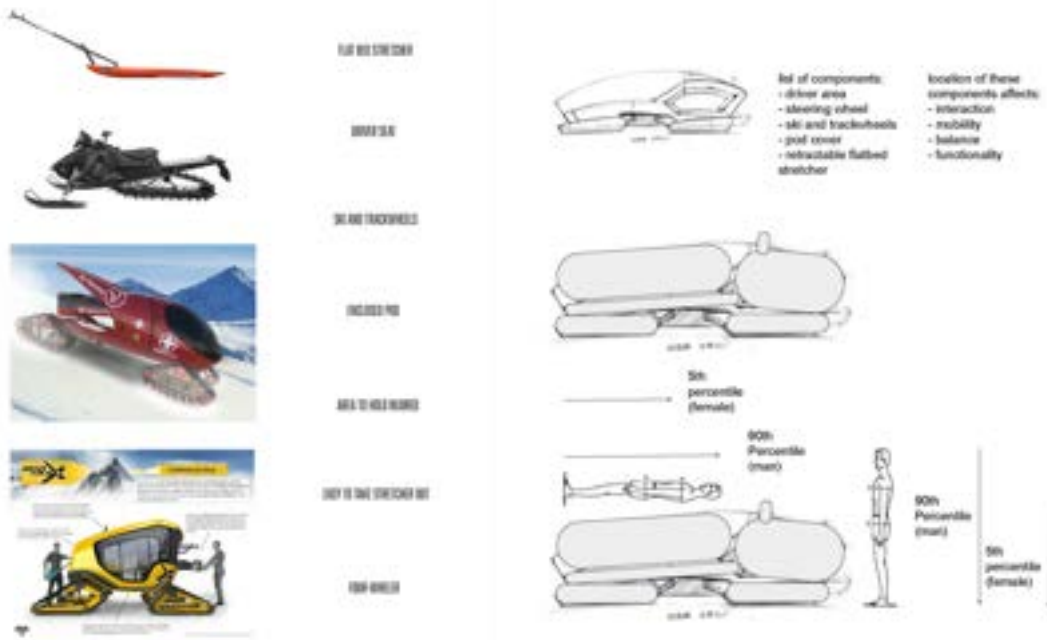


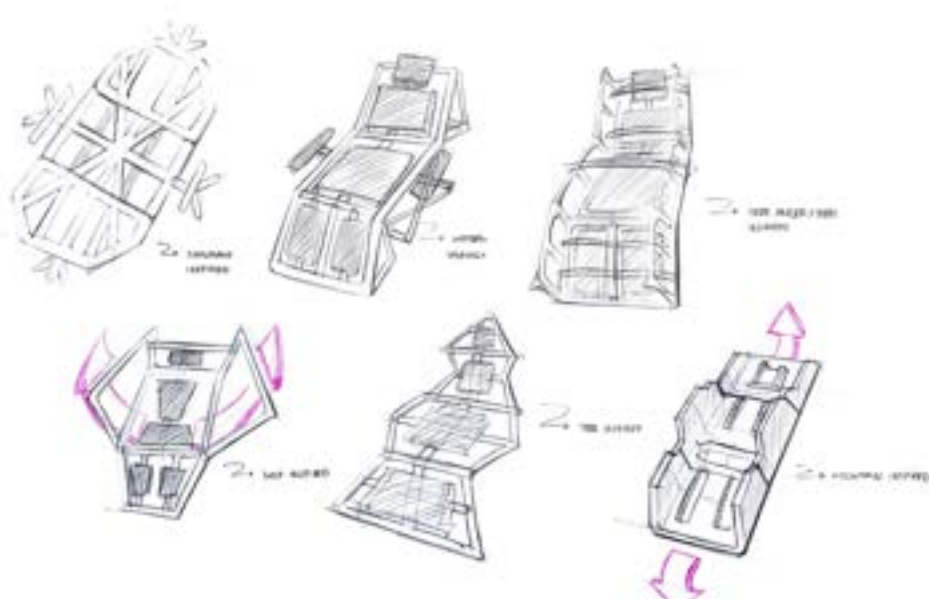
Figure. 32 Vehicle Concept Schematic Two

4.4 Concept Refinement & Validation

Both Concept Directions were used to further develop the project. Furthermore, this allowed for the development and ideation of the stretcher mechanisms, styling, functionality and meaning as well as the operating area of the vehicle.

4.4.1 Design Refinement

Figure. 33 Stretcher Ideation 1



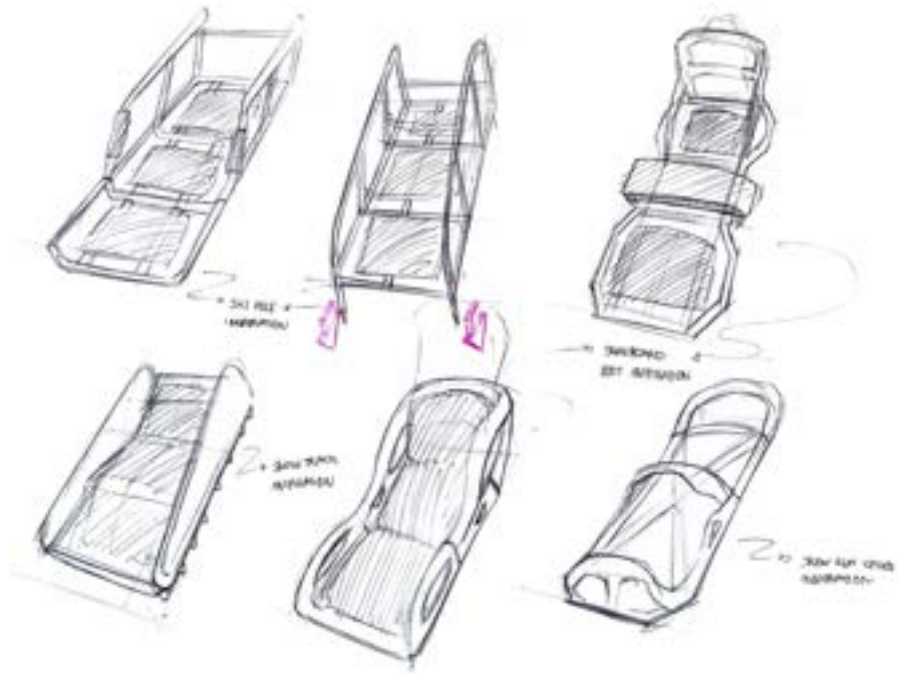


Figure. 34 Stretcher Ideation 2

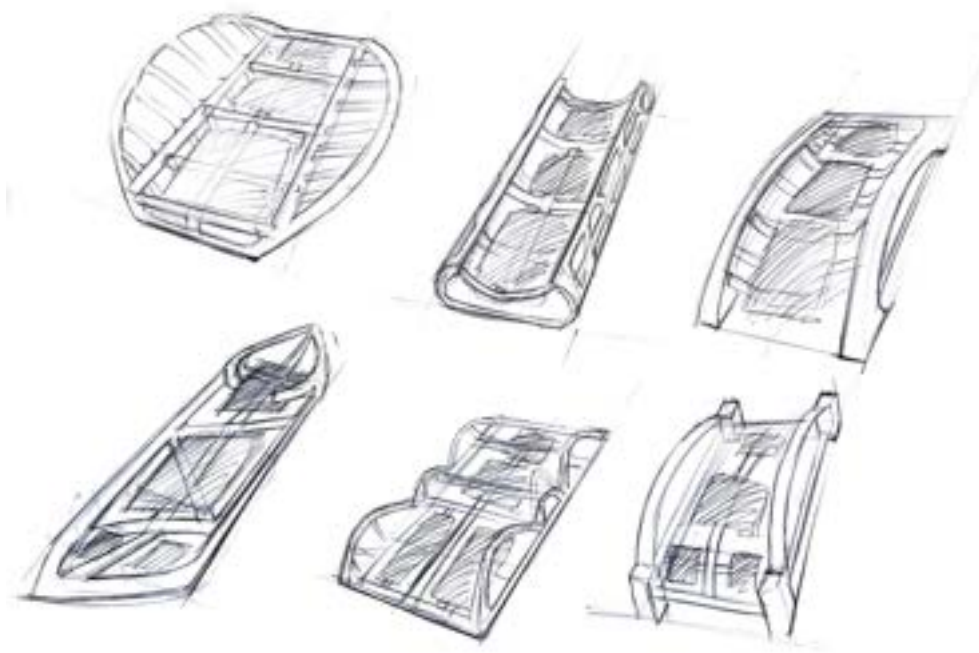


Figure. 35 Stretcher Ideation 3

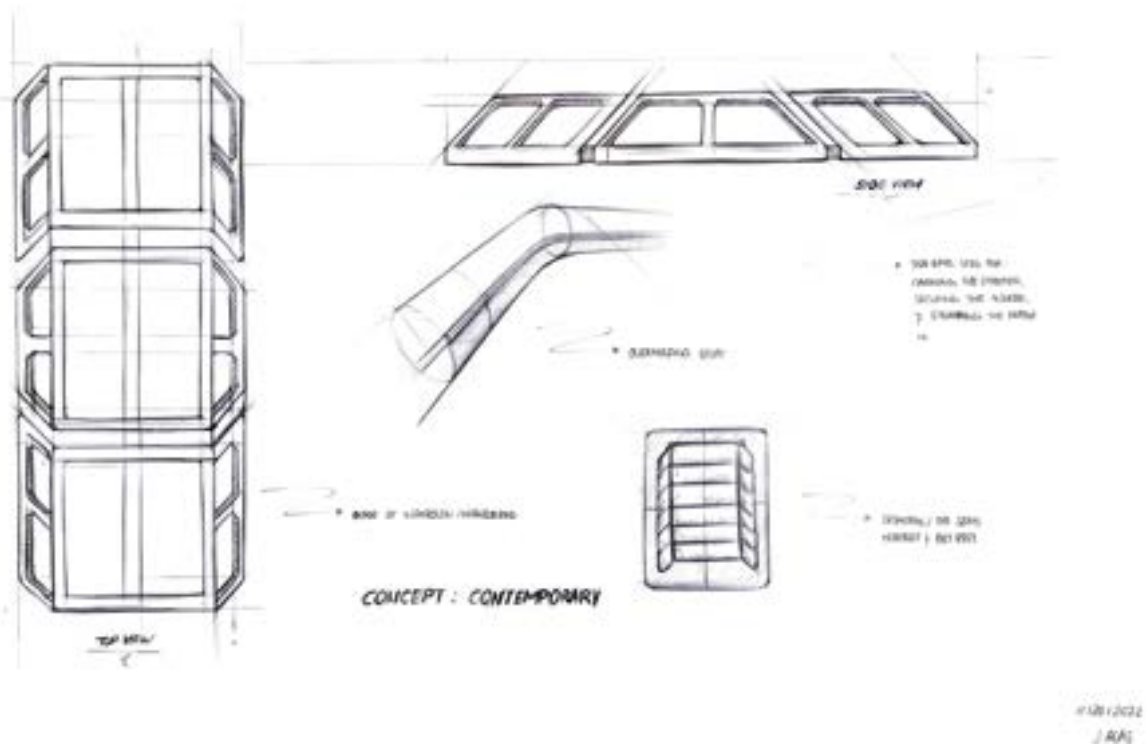


Figure. 36 Stretcher Concept Development 1

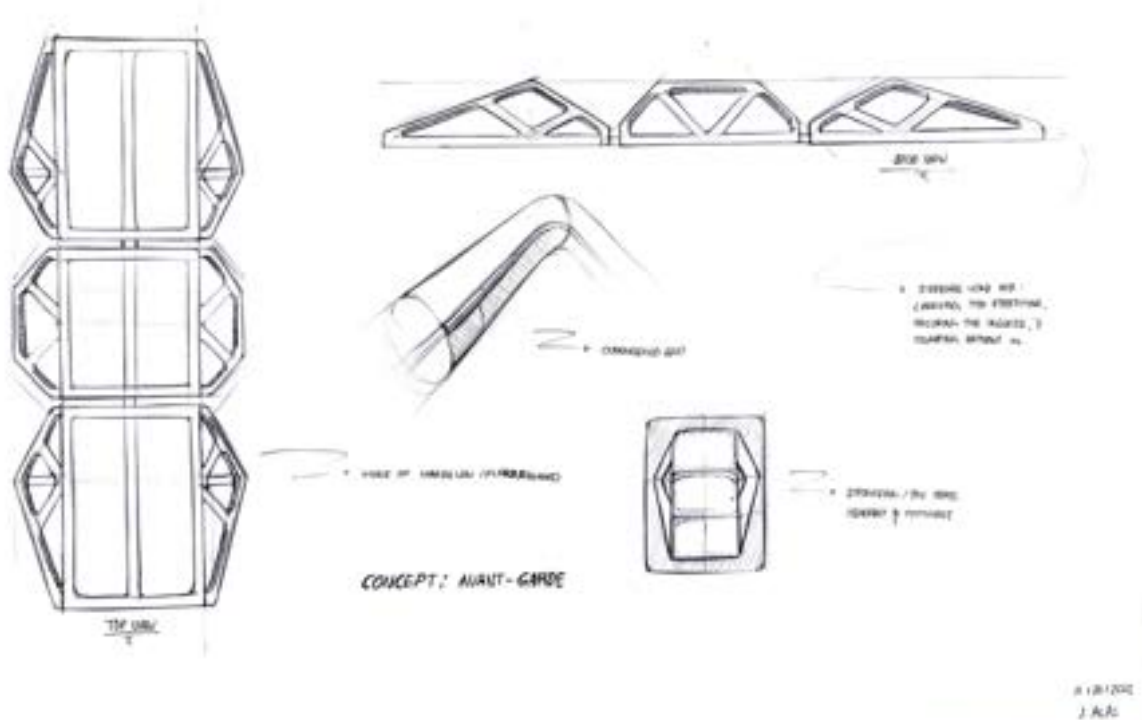


Figure. 37 Stretcher Concept Development 2

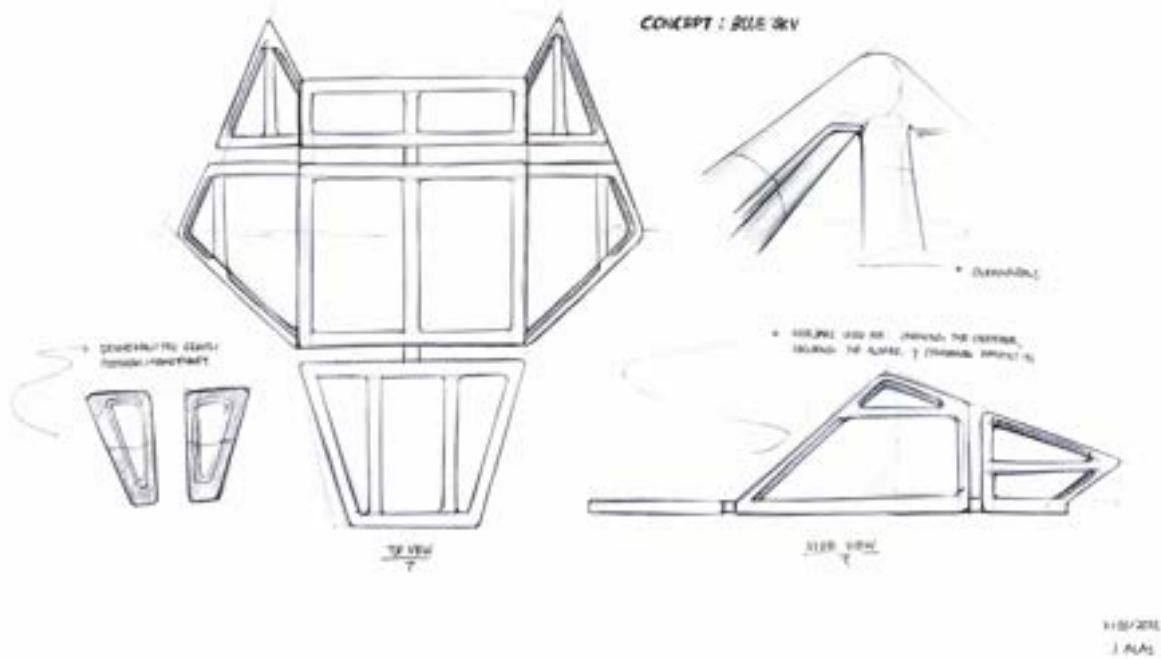


Figure. 38 Stretcher Concept Development 3

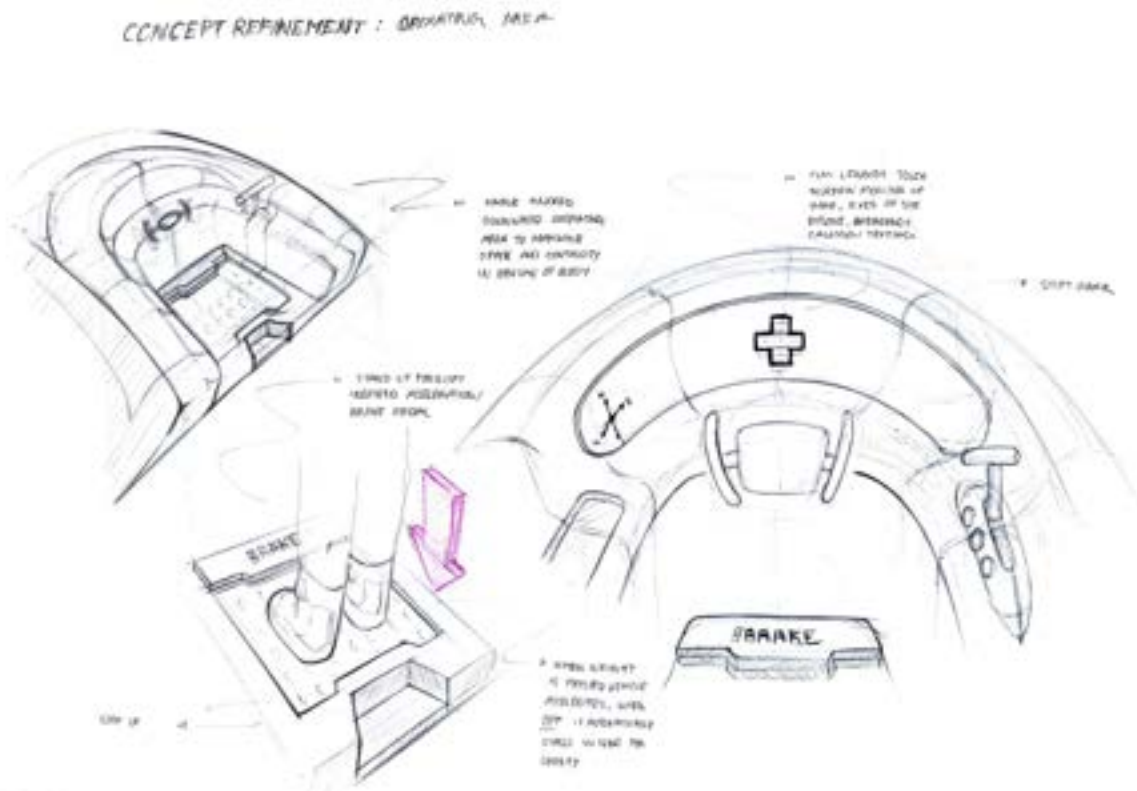


Figure. 40 Concept Refinement: Operating Area

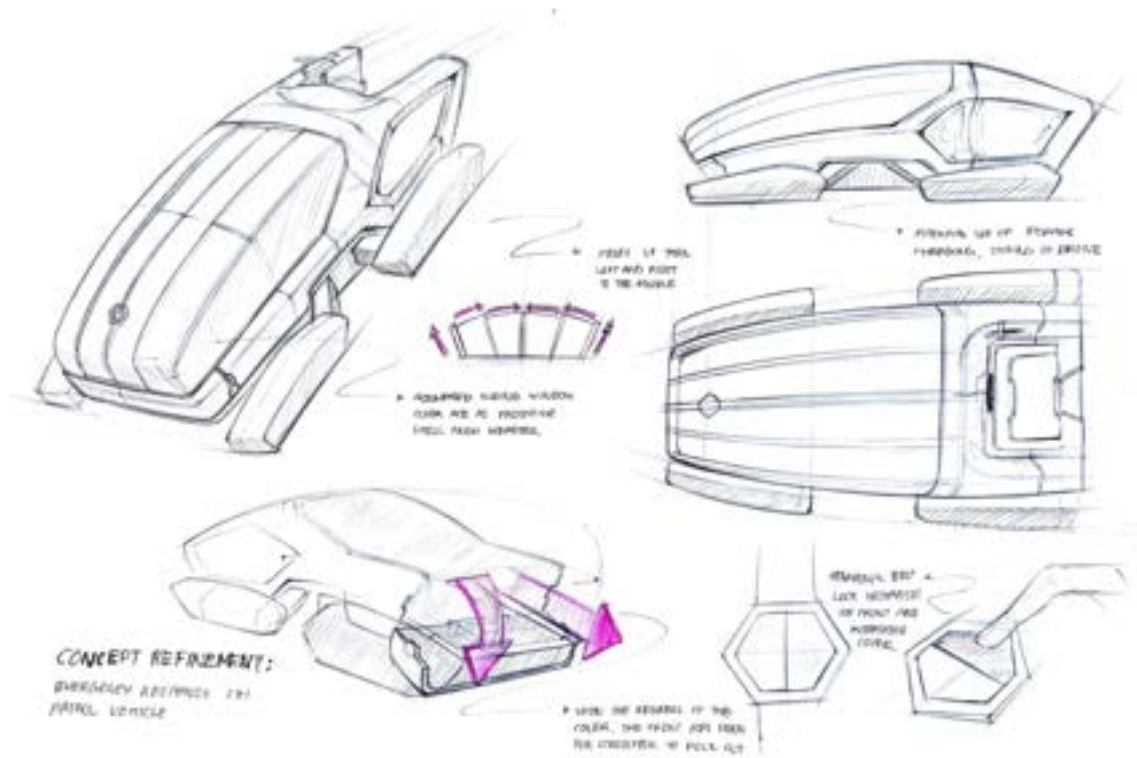


Figure. 41 Concept Refinement: Vehicle Aesthetic

4.4.2 Detail Development

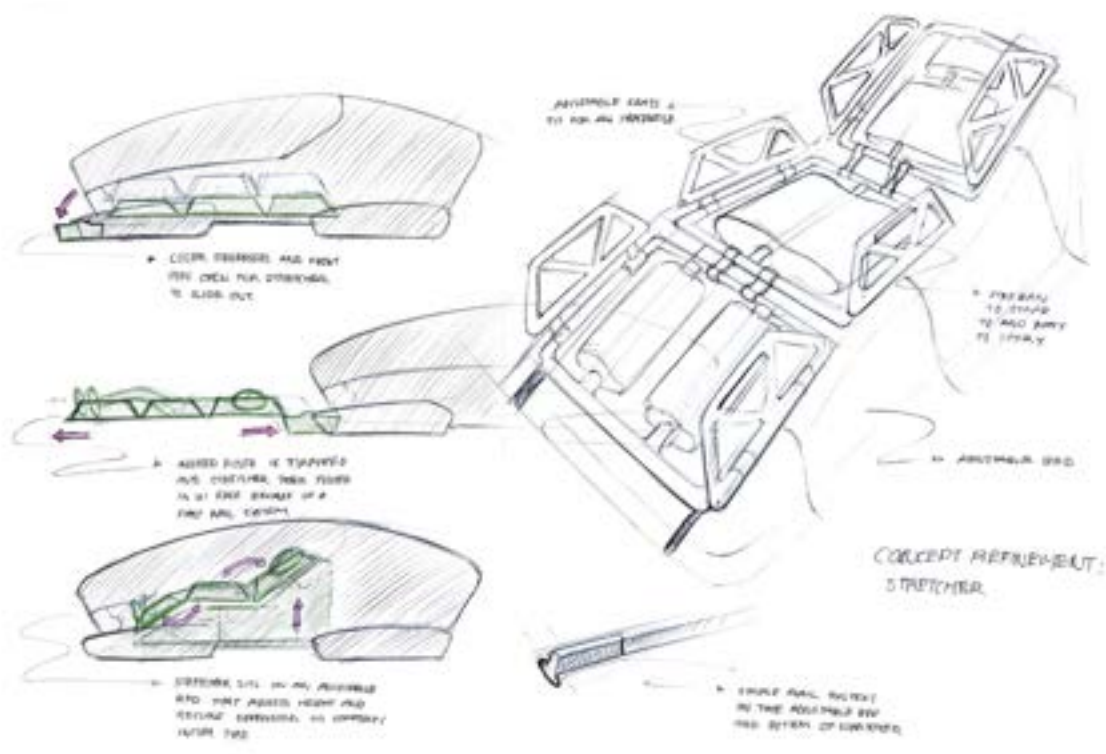


Figure. 42 Detail Development: Stretcher Mechanism

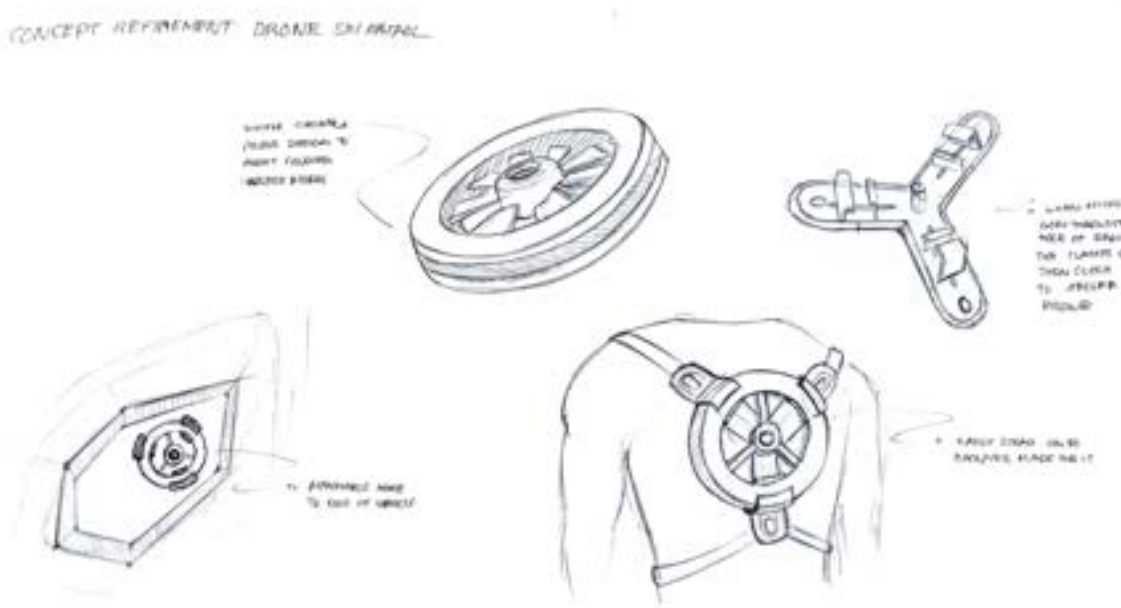


Figure. 43 Detail Development: Drone Attachment

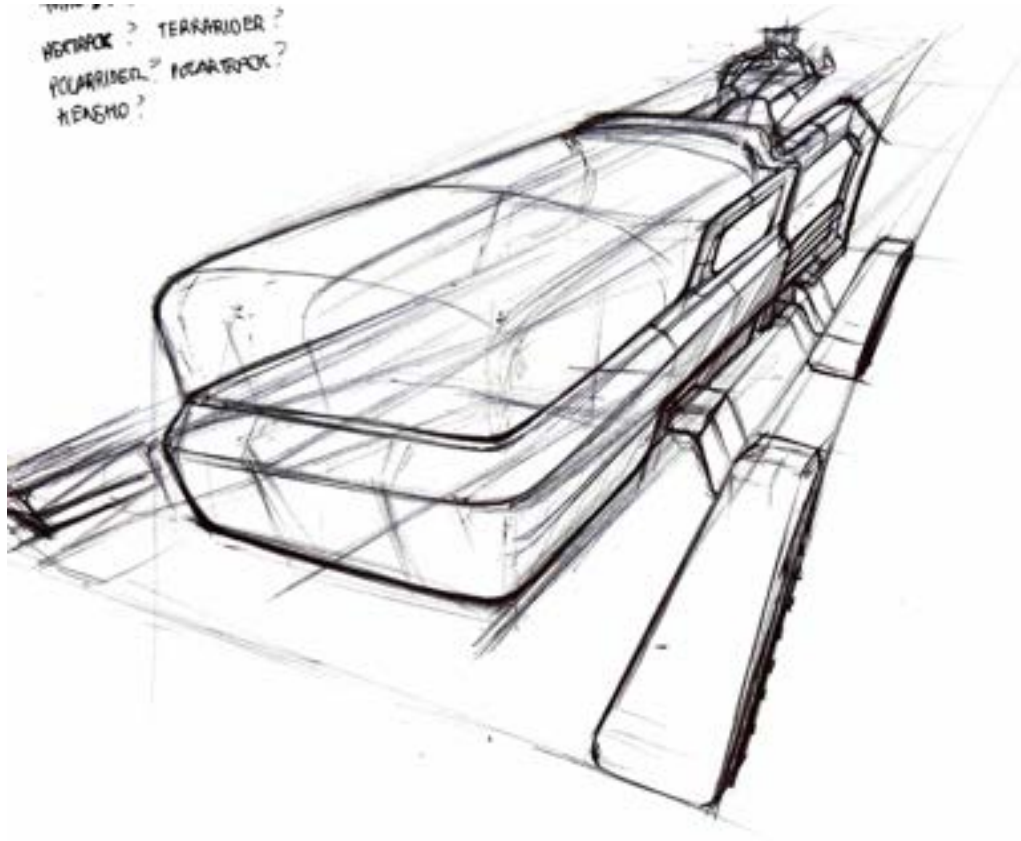


Figure. 44 Detail Development: Vehicle Aesthetic

4.4.3 Refined Product Schematic & Key Ergonomic

Minor Adjustments were made to the measurements of the stretcher and the operating area to fit the developed body aesthetic that was created.

4.5 Concept Realization

Upon review after review from professors, industry advisors, and local lovers of the winter sport, a concept direction has been finalized. This vehicle had now three main components to it: the enclosed pod, the operating area, and the drone. With the help from the Refined Product Schematic & Key Ergonomic stage, a sketch model was created to resolve the design and its components.

4.5.1 Design Finalization

This stage took into consideration, the functionality of mechanisms, finalized form development, and hexagonal aesthetic to finalize the design.

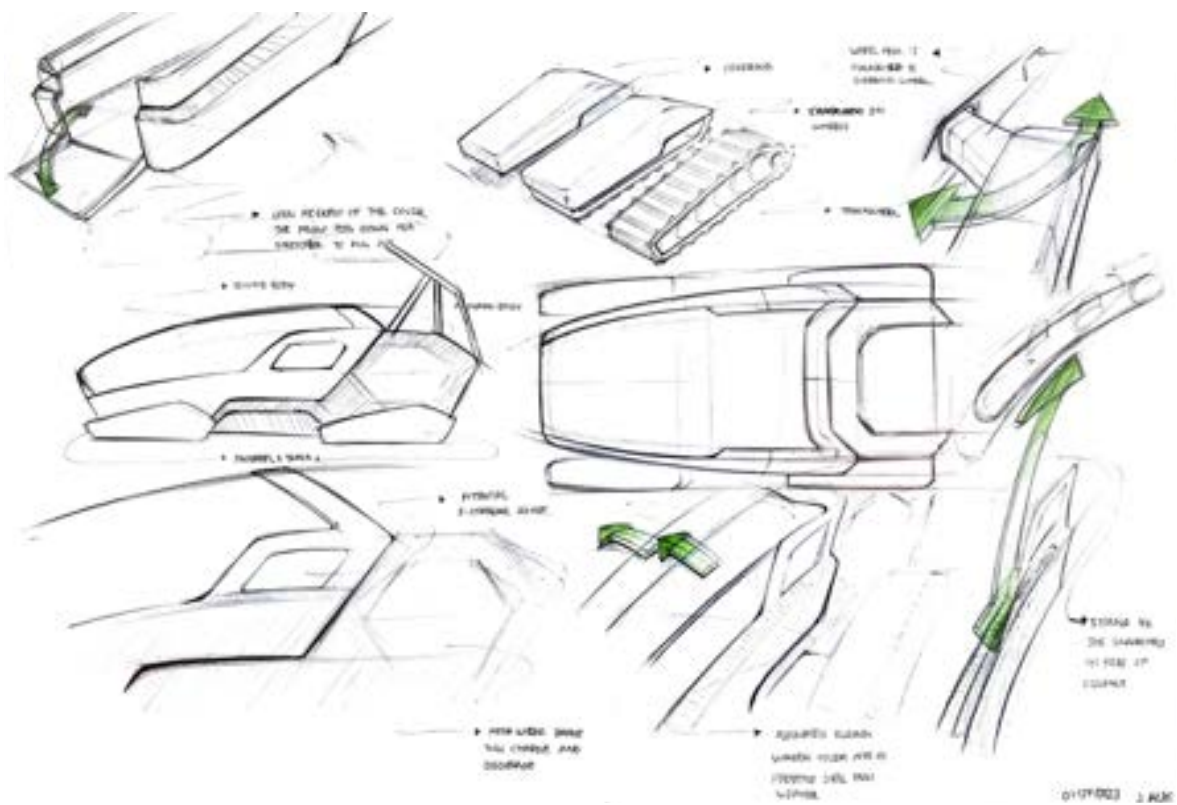


Figure. 45 Design Finalization: Vehicle Aesthetic

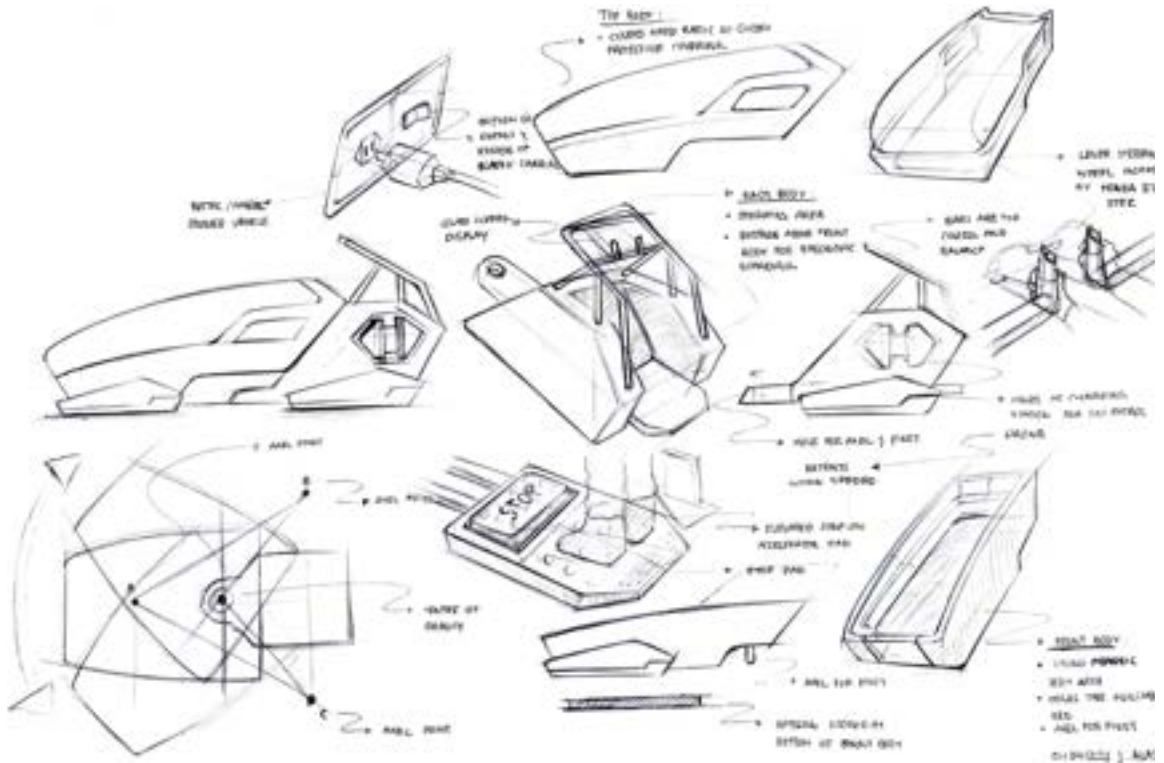


Figure. 46 Design Finalization: Vehicle Aesthetic

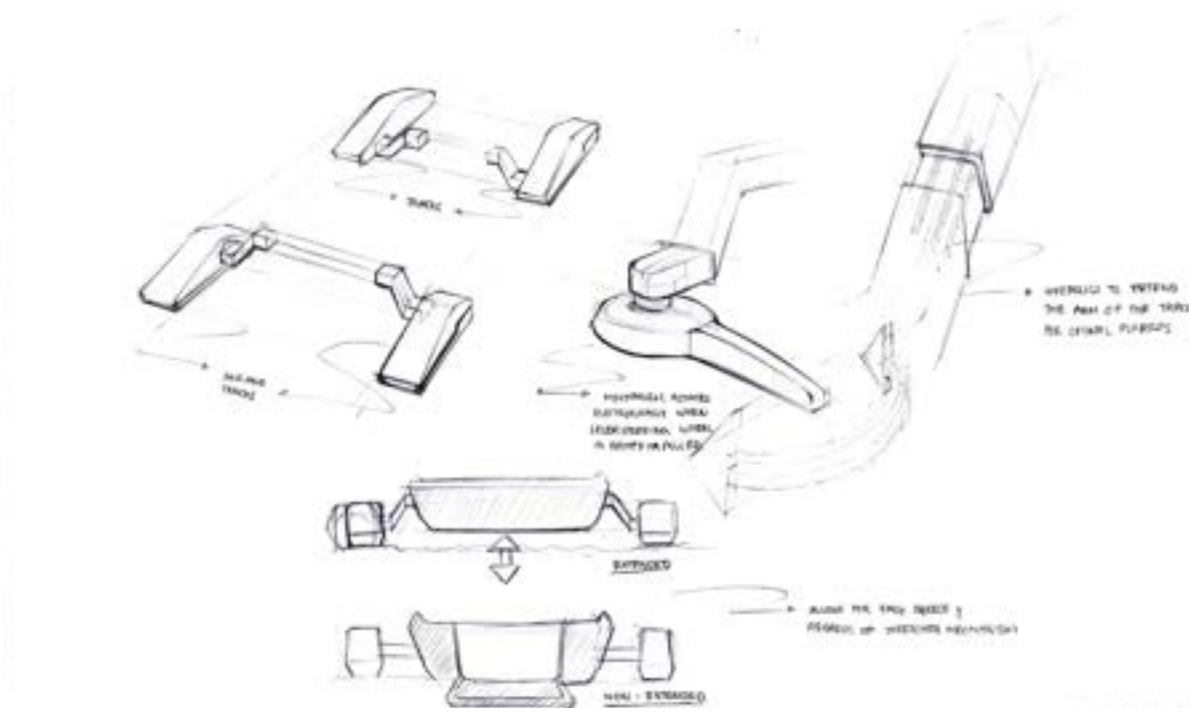


Figure. 47 Design Finalization: Track Mechanism

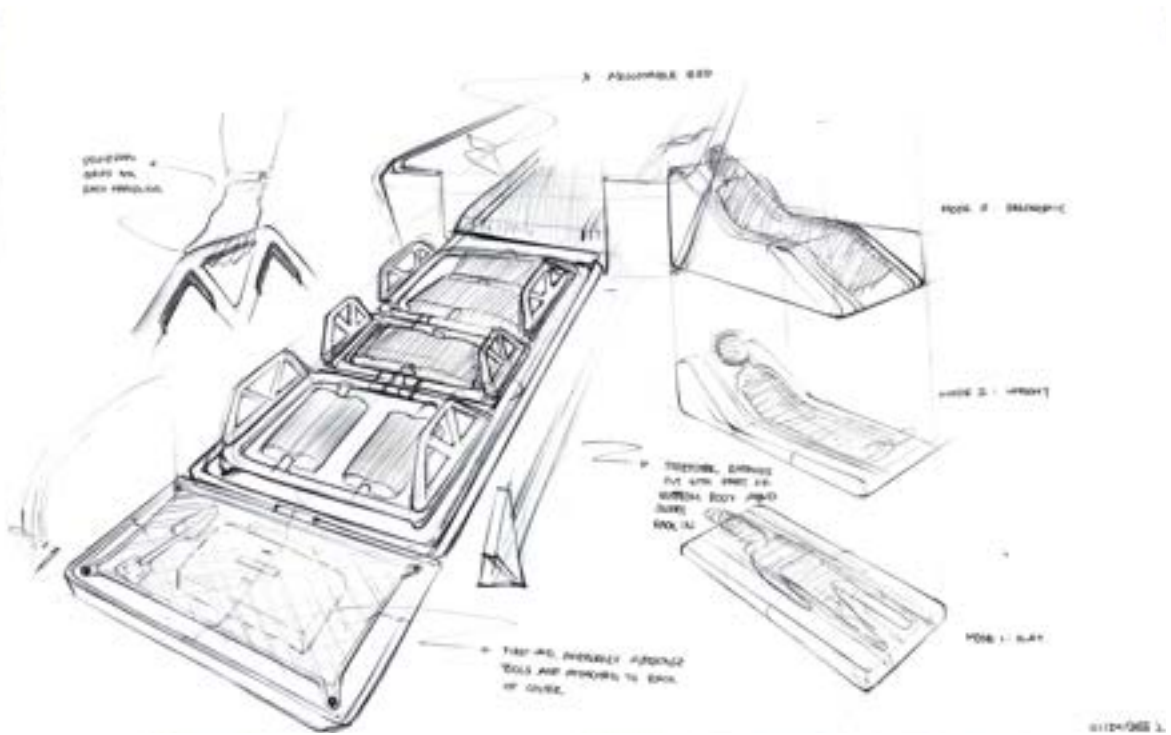


Figure. 48 Design Finalization: Stretcher

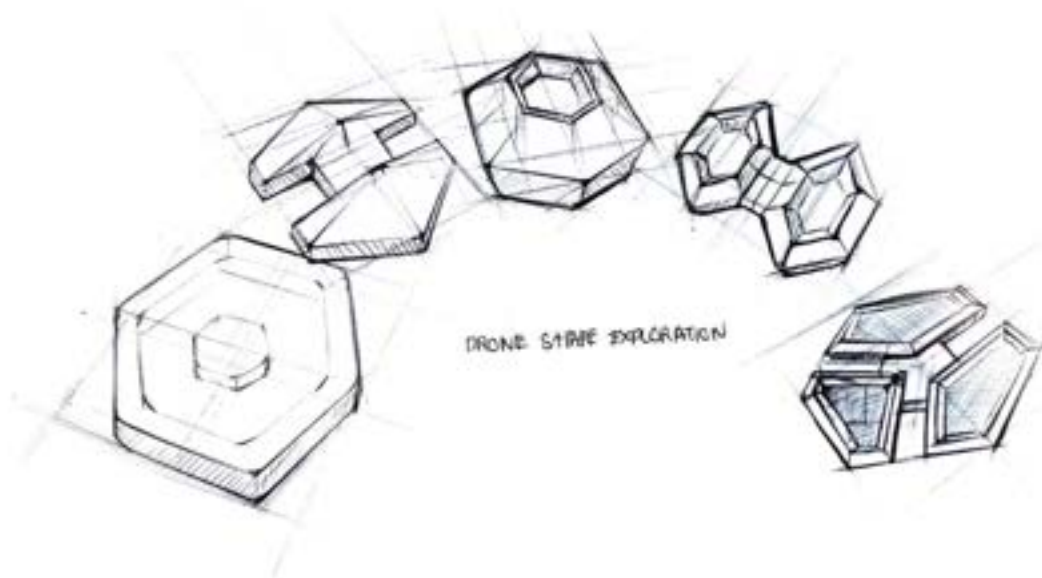


Figure. 49 Design Finalization: Drone

4.5.2 Physical Study Models

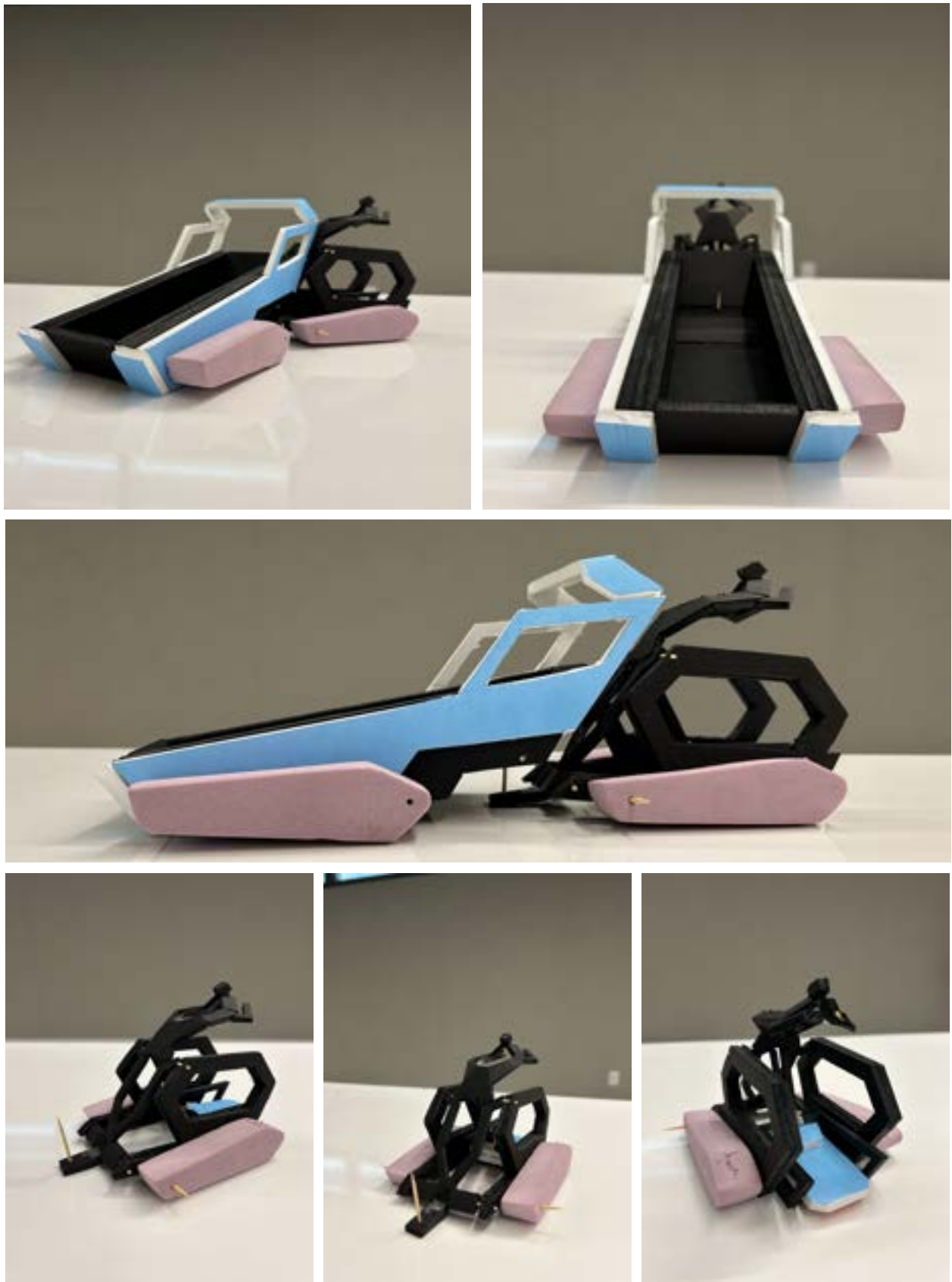


Figure. 50 Sketch Models

4.6 Design Resolution

The completion of the sketch model stage helped enormously in generalizing the measurements and testing if the proportions between the components and the overall vehicle were correct or not. Moreover, the model holds a collapsible enclosed front pod with a retractable stretcher, four-track wheels with a pivot turn in the center of the vehicle for quick turns and stops, and a hexagon-shaped back operating area. Constant reviews with the thesis professor and teaching assistant lead to the operating area shape being undesirable and of need to change form. The challenge of this back piece was the compromise of measurements from the operating area needing some sort of protection on the sides for the upright driver while also considering the length of the vehicle; the higher the back piece was made, the further back the operating stand. If either were compromised, the angle meeting the back piece from the front piece won't have continuity. Finally, after more ideation, a solution is as follows:

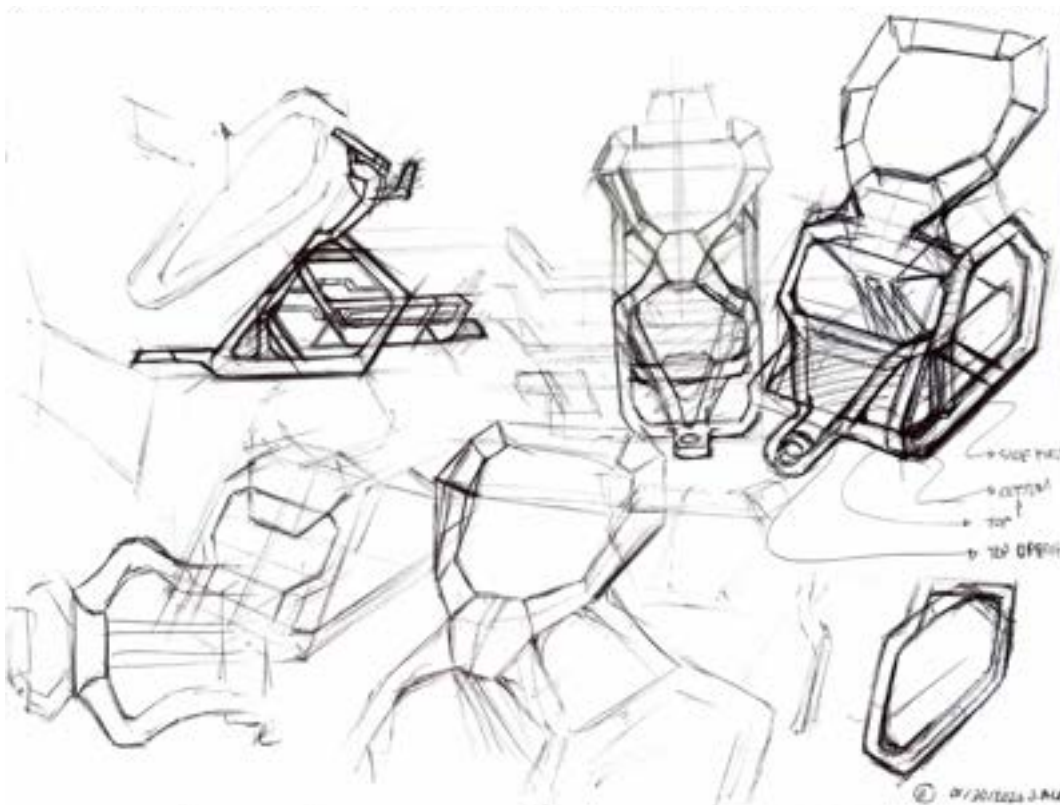


Figure. 51 Design Resolution: Back Portion Aesthetic

4.8 Physical Model Fabrication

3D-printed SLA parts are used for the physical model fabrication of these then primed and painted to resemble the CAD model. Steps of assembly will come as follows:



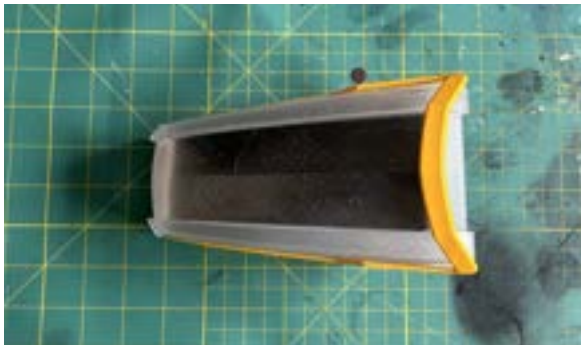


Figure. 52 3D Physical Model Development

5.1 Design Summary

5.1.1 Description

HX-TRAIL is a Ski Resort Emergency Response Vehicle that aids in the tracking, treatment and transportation of injured skiers/snowboarders in Canadian ski resorts. This vehicle aims to make the ski patrol emergency response process faster, safer and more efficient with emphasis on the health and safety of the patient and usability of the ski patrol officer.

5.1.2 Explanation

Current solutions for emergency response in Canadian ski resorts are the traditional sleds pulled down by a ski patrol or a fully operated snowmobile which are either too slow or not feasible. Moreover, these solutions often face external factors like weather conditions, transportation collisions and overall the fight against time. These factors can lead to further injury of the victim, other riders and even the patrol officer. How may we improve emergency response in Canadian ski resorts? At this rate, more injuries are bound to happen along with the number of casualties creeping up. It is evident that ski resorts are doing everything they can to increase ski patrol numbers and implement better tactics for their teams to mitigate these numbers. It is, however, compelling that the statistical number of injuries grow alongside these increased patrol volumes every year too. The goal of this thesis is to improve ski patrol practices through the use of a vehicle and mitigate the challenges faced in every stage of the emergency response process.

HX-TRAIL addresses these issues by providing a transportation, treatment and tracking solution for the necessary jobs of the ski patrol of ski resorts. This vehicle will tackle the physical and psychological needs of both users and fit them within parameters ergonomic to any shape and size for maximum comfortability. The implementation of AI technology will

help make the job of the ski patrol officer easier and not as physically-tolling. All features in the HX-TRAIL will make the emergency response process smoother, more user-friendly and more efficient.

5.1.3 Benefit Statement

HX-TRAIL is a multi-functional vehicle that benefits the ski patrol and the injured patient in ways that will improve the needs of well-being, usability, comfort, injury prevention and more. The HX-TRAIL has sub-components like the drone, retractable-stretcher, enclosed pod, step-on acceleration pad, joystick steering and AI integration to improve these needed areas. HX-TRAIL will eliminate broken communication of injury sightings, create a faster process from injury spotting to transportation down the mountain and will mitigate collisions during treatment and/or transportation.

5.2 Design Criteria Met

5.2.1 Full Bodied Interaction Design

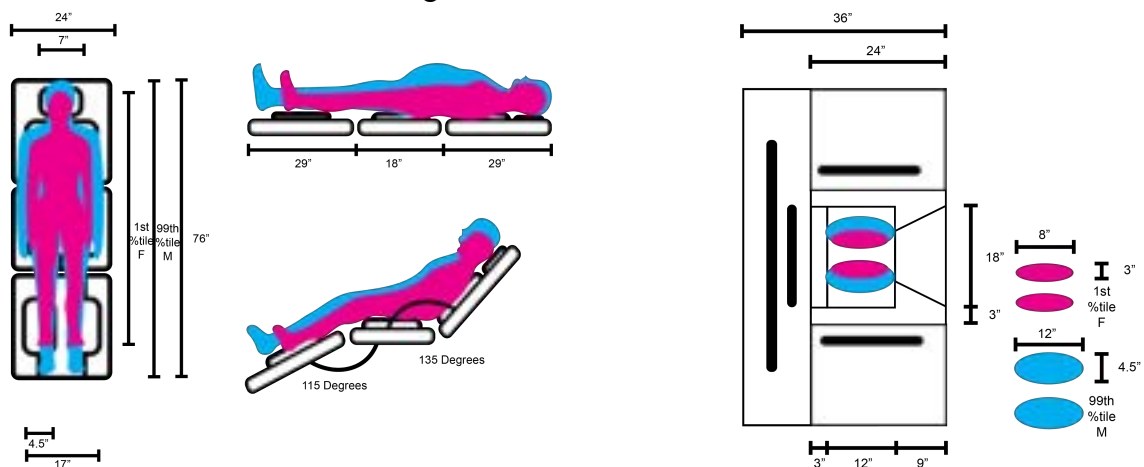
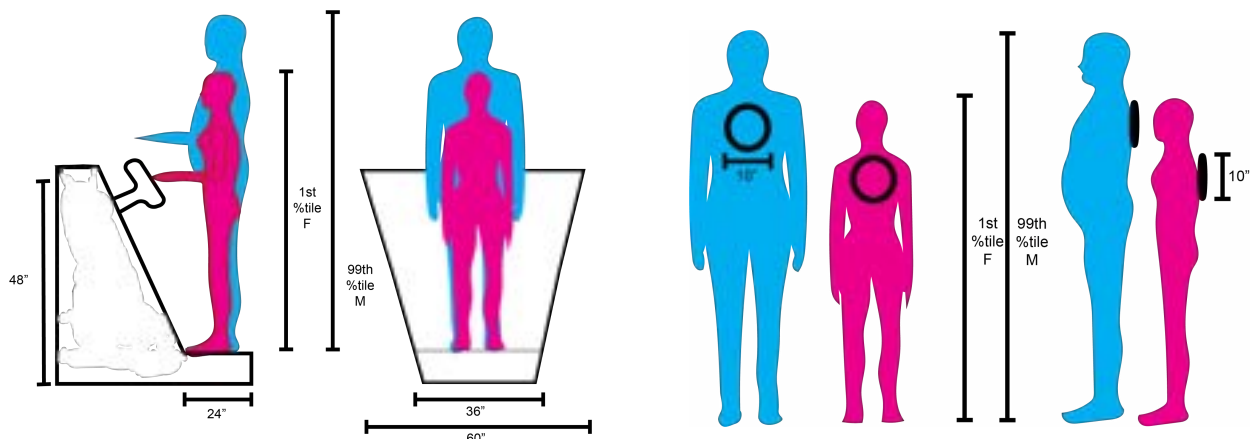


Figure. 53 Finalized Configuration Diagrams



Ergonomics

HX-TRAIL achieves all aspects of full-bodied human interaction design by creating human touchpoints features on devices like: the stretcher and the stand-on acceleration pad and joysticks.



Figure. 54 HX-TRAIL Final Render: Stretcher Extrusion

These aspects of HX-TRAIL allow for enhancing comfortability and safety of both the patient and the patrol officer through various safety features like stretcher straps, emergency stop brakes. To steer, the officer pushes to turn left and pulls to turn right while standing on the pad to accelerate. HX-TRAIL upholds a human-centered design approach by incorporating ergonomics in every device. The stretcher allows for flat laying and upright sitting dependent on the patient's injury.

Figure. 55 HX-TRAIL Final Render: Back View



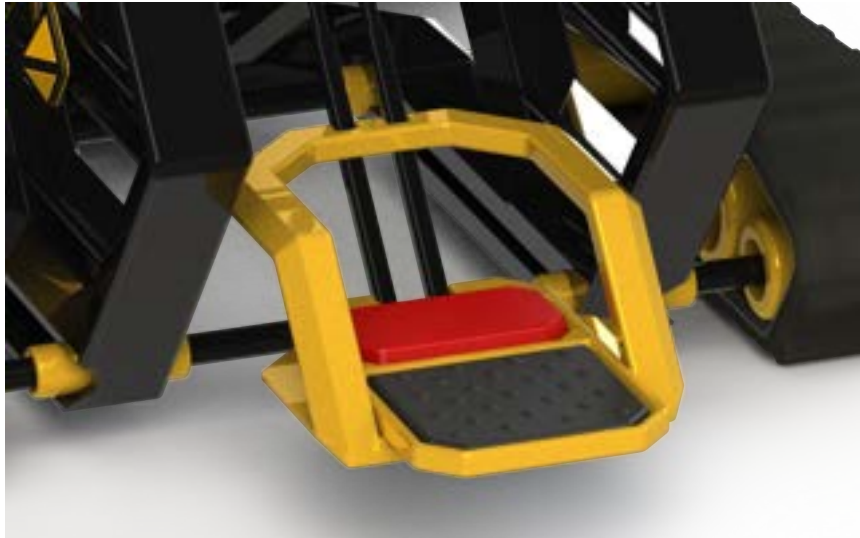


Figure. 56 HX-TRAIL Final Render: Acceleration Step-on Pad



Figure. 57 HX-TRAIL Final Render: Stretcher Modes

The stretcher also allows for adjustability from the 1st percentile woman to the 99th percentile man sizing. The cushions are made to hug the areas of common injury and the enclosed pod fits within the parameters of a patient but allows for arms width of space to eliminate claustrophobia.



Figure. 58 HX-TRAIL Final Render: Stretcher Fitting



Figure. 59 HX-TRAIL Final Render: Interior view of Outside

5.2.2 Materials, Processes, and Technology

Research done on benchmarked materials can be viewed in section 2.2.4, which gives a full breakdown of their benefits and purposes in benchmarking products in the industry. The final design of HX-TRAIL takes full consideration of the list of materials and applies their specialties where applicable. The main body of the vehicle will consist of upcycled Covestro plastics merged with synthetic materials to increase the overall rigidity and strength against the cold weather and snow. The enclosed pod collapsing glass will be made of UHMW clear glass to also resist the precipitation and provide impact resistance in the case of collision. The inner pod and cushions of the stretcher will be laced with biodegradable felt that will help maintain warmth inside the pod to go alongside sustainable rubber materials for the tracks. With hopes of the vehicle being fully-electric, it calls for a lithium-ion battery to sit on the bottom half of the body of the vehicle and the ability to charge and recharge with an outlet. Therefore, this vehicle will contain a 15kWh lithium-ion battery that will not just provide the vehicle with the speed it needs but provide the environment with a no-fuel-emission initiative. All in all, these materials will be sourced from third-party suppliers within Canada with the essence of sustainability when producing the products.

Ski patrol processes are traditional but have room for innovation, especially with the rise of injured riders every year. As a result, HX-TRAIL will implement current and new technologies that are within the scope of 2030; where testing and implementation should be at its highest. A list of technologies (current and new) implemented into the final design are as listed:

- Lithium-ion Battery
- Drone 360 camera motion and heat sensor tracking and automated pre-screening of the patient using radiant heat screening
- Holographic display screen for directions given by drone
- Step-on acceleration pad and emergency brake pad
- Monitored AC/Cooling system
- Autonomous extrusion of stretcher
- Autonomous collapsing of front pod door and glass enclosure
- EV charging ports for vehicle and drone

5.2.3 Design Implementation

Manufacturing costs are often the deal breaker in design and usually at the forefront of every business decision made in design. As this solution provides many features, amenities, and positive outcomes, a cost report will determine how much these important features cost. Conceptually, costs will be based on products already in the snow-terrain vehicle market but with inflated prices due to the difference in size.

The table below demonstrates a rough assumption of multiple components within HX-TRAIL. The information will go as follows: description, estimated material cost, estimated production costs, and quantity:

Part Description	Quantity	Material	Manufacturing Method	Price
Tracks	4	Hyfax and Sustainable Rubber	Press Molding	\$1200
Pod Bed	1	HDPE Biodegradable felt	Blow Molding	\$1500
Pod Bed Overmold	1	HDPE	Blow Molding	\$2000
Collapsing Glass Cover Left	1	UHMW	Compression Molding Ram Extrusion	\$500
Collapsing Glass Cover Right	1	UHMW	Compression Molding Ram Extrusion	\$500
Collapsing Glass Cover Main	1	UHMW	Compression Molding Ram Extrusion	\$1000
Main Back Piece	1	HDPE	Blow Molding	\$1000
Step-On Acceleration Pad	1	HDPE	Blow Molding	\$150
Joysticks	2	HDPE Desmopan	Blow Molding	\$100
Stretcher	1	Desmopan Biodegradable felt	Blow Molding	1000
Drone	1	HDPE	Blow Molding	\$200

Table. 14 Material Pricing Table

5.3 Final CAD Rendering



Figure. 60 HX-TRAIL Final Render: Outside Post



Figure. 61 HX-TRAIL Final Render: Down Mountain



Figure. 62 HX-TRAIL Final Render: In-situ with drone



Figure. 63 HX-TRAIL Final Render: Drone Tracking

5.4 Physical Model



Figure. 64 HX-TRAIL Final Render: Final 3D-Printed Physical Model

5.5 Technical Drawings

These drawings are made to 1/12th scale given that is the size of the model. To obtain relative dimensional information, multiply the given value by 12 for a 1:1 scale dimension.

HX-TRAIL: Full body without collapsible glass

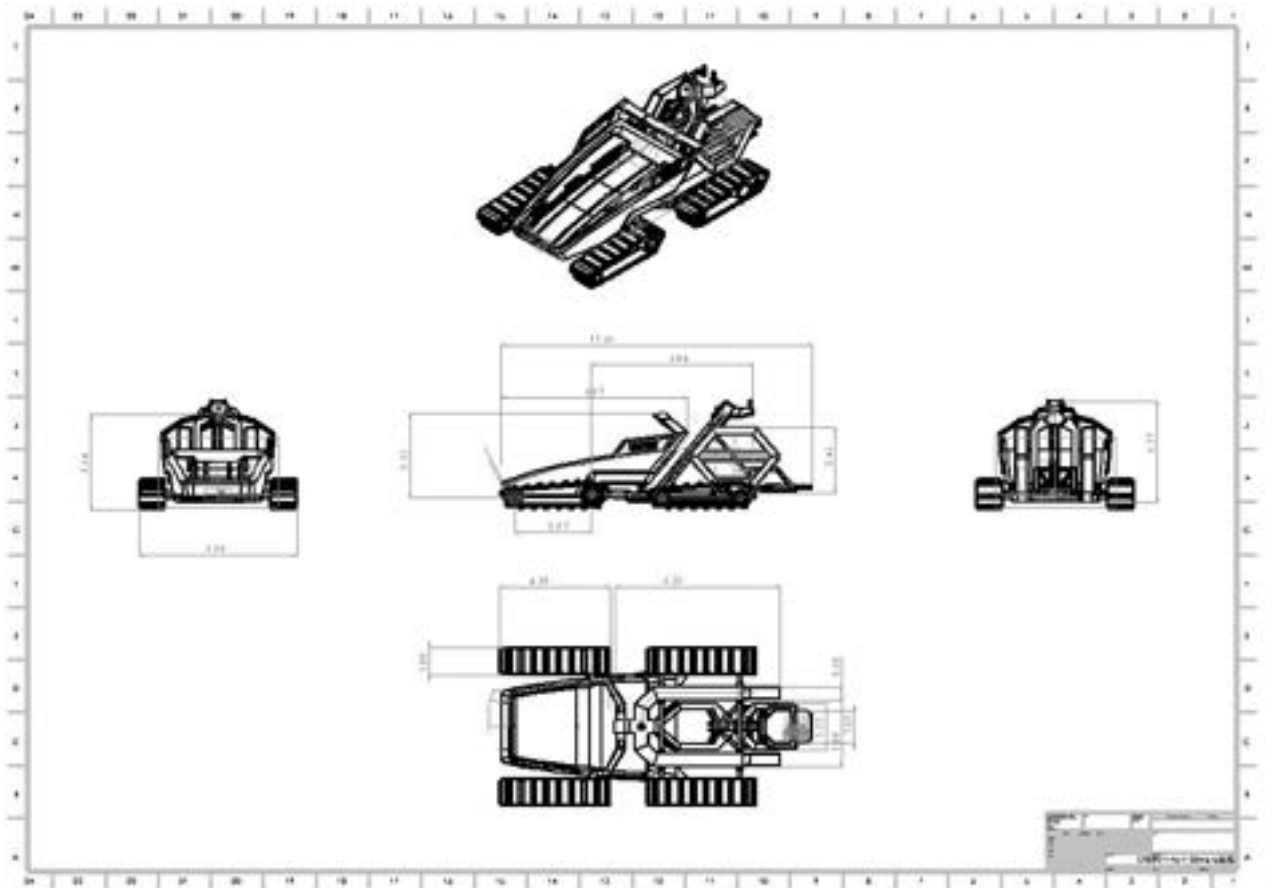


Figure. 65 Technical Drawing: Vehicle

HX-TRAIL: Enclosed Pod

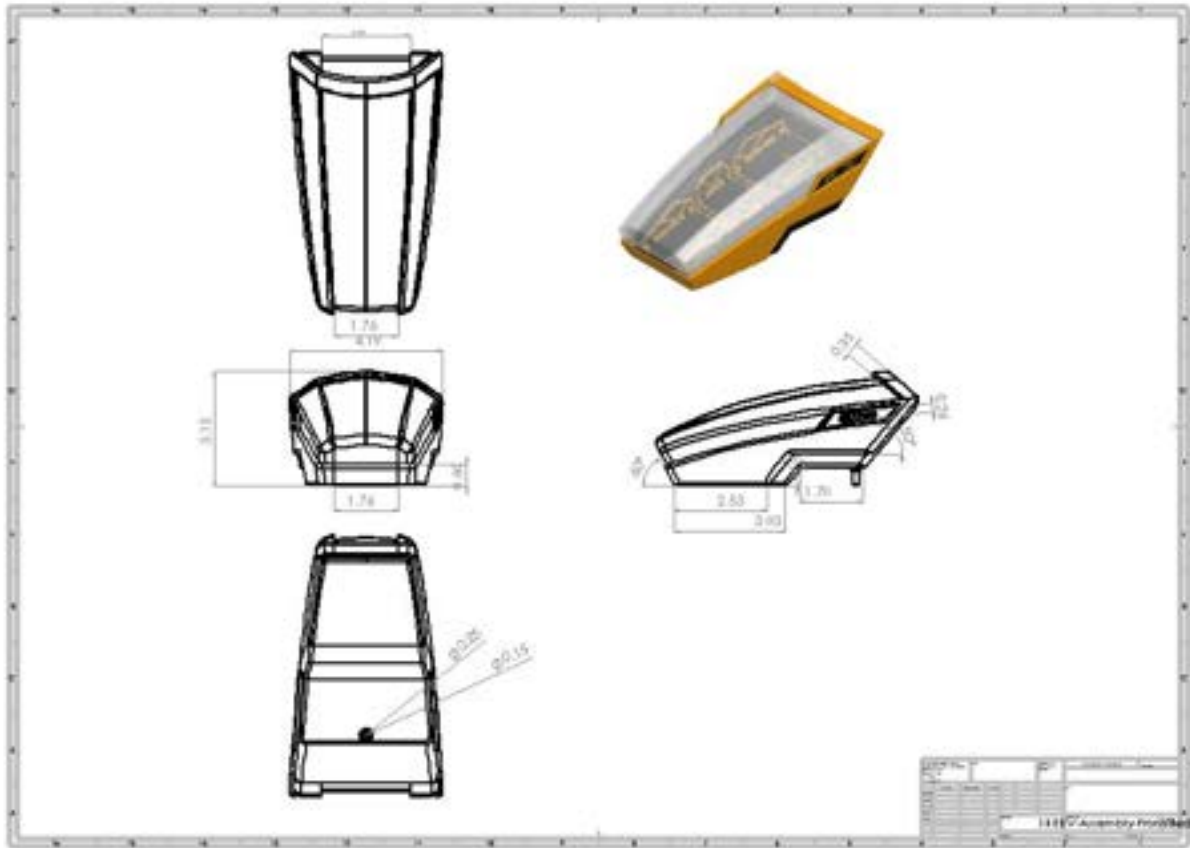


Figure. 66 Technical Drawing: Front Pod

HX-TRAIL: Stretcher

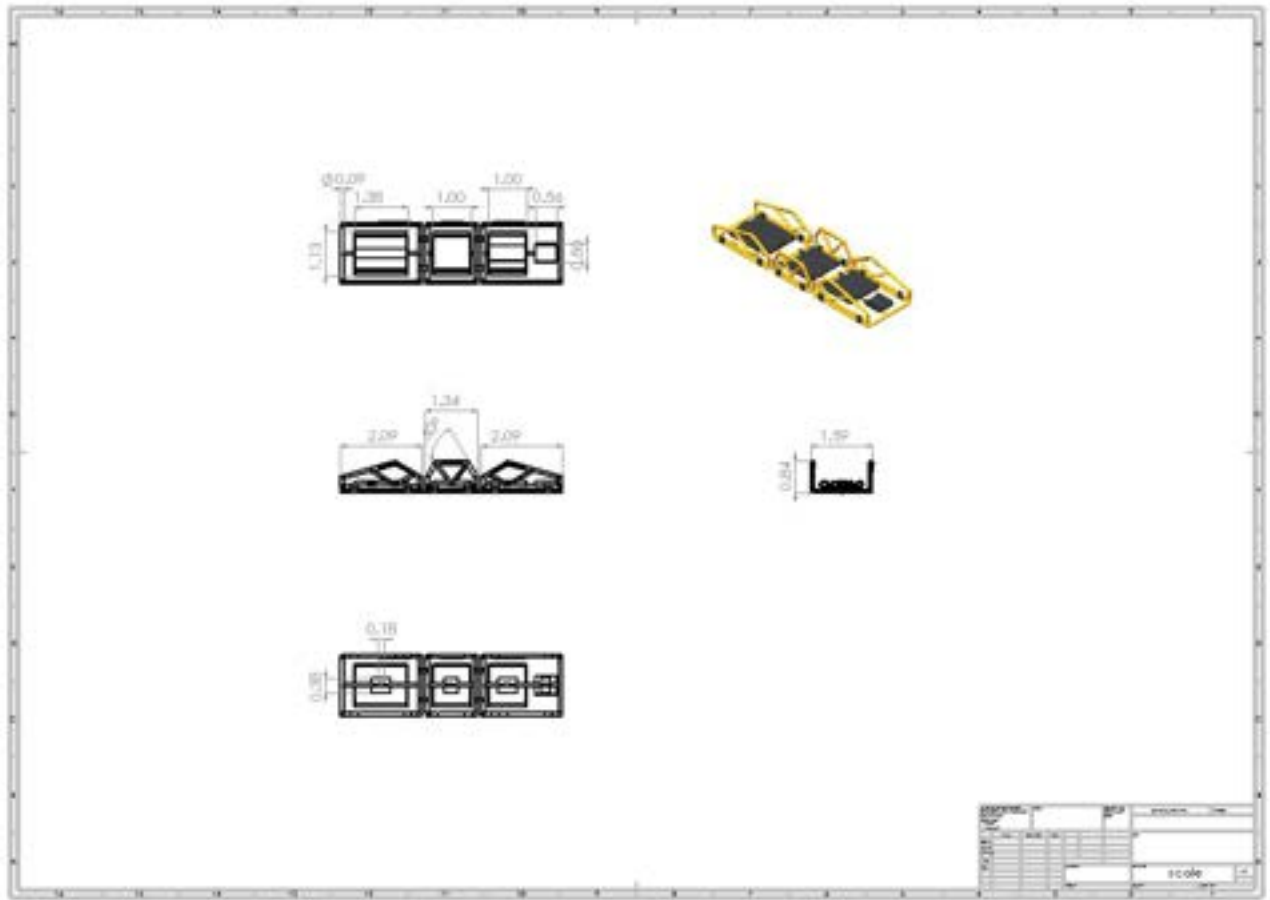


Figure. 67 Technical Drawing: Stretcher

HX-TRAIL: Drone

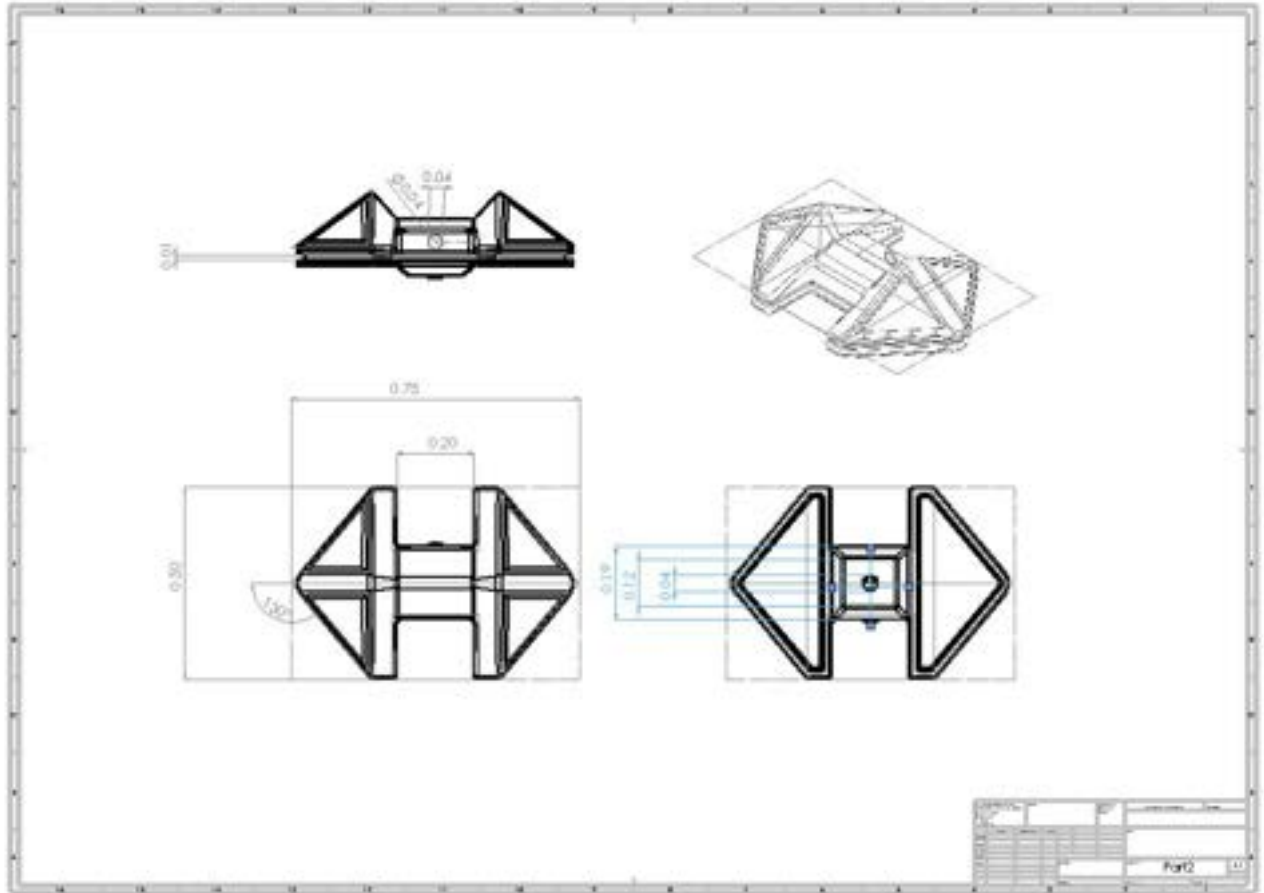


Figure. 68 Technical Drawing: Drone

HX-TRAIL: Tracks

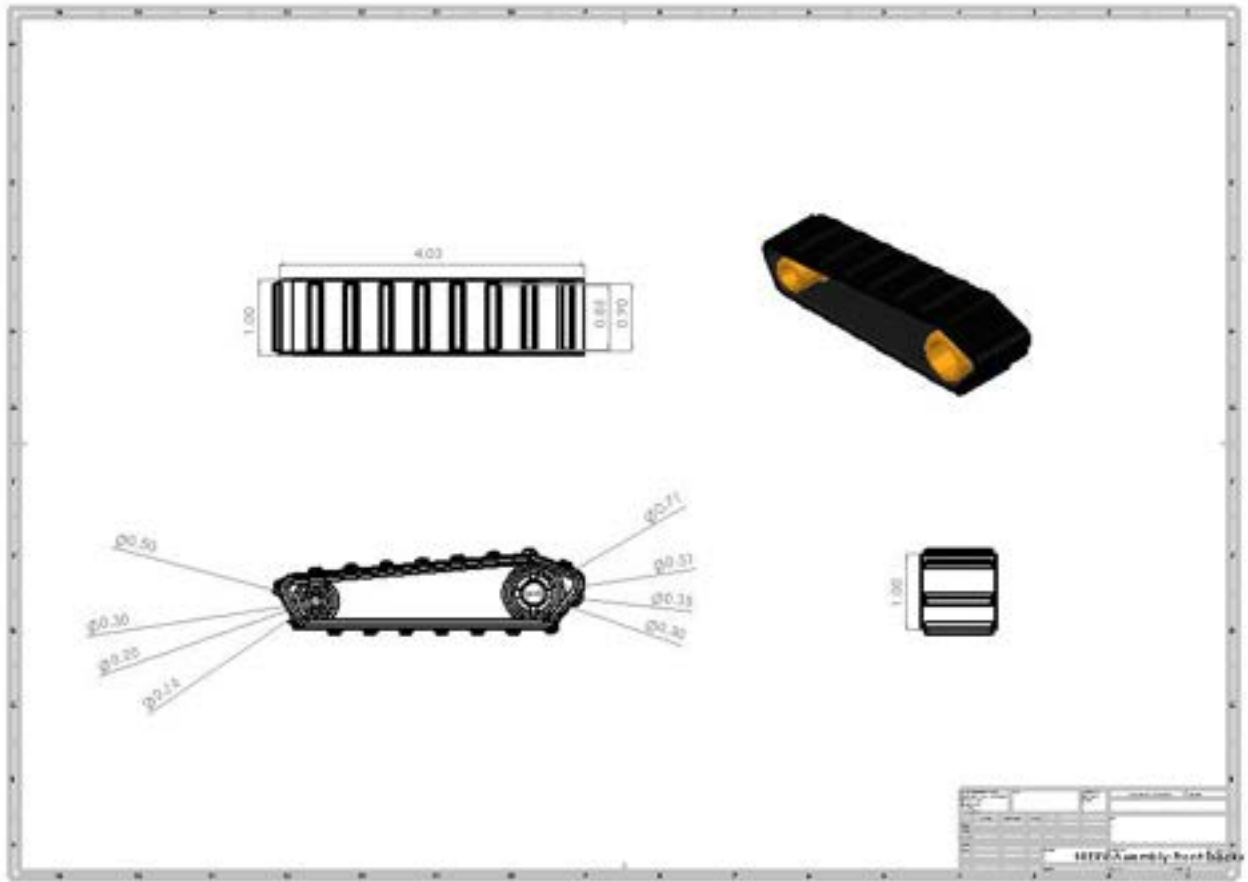


Figure. 69 Technical Drawing: Tracks

5.6 Sustainability

In ski resorts, the injury toll is a constant daily. Safety concerns on the number of injuries, the types of injuries, and even the safety during transportation must be accounted for to meet the basic needs of the user. The variety of injuries that can happen on the slope is a long list and is always situational on the skier/snowboarder. This design addresses this ambiguity of injury by allowing for a retractable stretcher mechanism that extracts from the main body of the vehicle to treat the patient on-site. This stretcher can autonomously retract back inside onto an adjustable bed covered in biodegradable felt that can adjust the positioning from 180 degrees flat to any reclined position depending on the comfort and injury of the user. This patient area is then closed in by autonomous Makrolon polycarbonate panels that protect the user from the elements of winter and potential collisions.

The main purpose of being a ski patrol is to also maintain the health of patients by treating them with first-aid and transporting them fast down the mountain to urgent care. Traditional methods, however, are physically demanding of the patrol officer which becomes a health concern with older age groups of patrolling. This health concern is the driving factor that puts the needs of the user (ski patrol) at a sustainability risk. The way this design addresses this need is by making the vehicle motor operated by the patrol eliminating the physical need to drag a body down the slope. The operating area becomes a crucial part of maneuvering patients down the slope in a timely fashion which leads to faster healthcare.

Lastly, the environment in which emergency response takes place is the snow-capped mountains and trail-filled slopes. The ecosystem surrounding these ski resorts is acres wide of forests and other wildlife that not only become the surrounding barrier of trails but provide the skiers/snowboarders with masses of oxygen. Keeping these areas safe from pollution and toxins is a sustainable need that needs to be addressed to bring about an

environmentally-friendly ski resort. The way this design addresses sustainability is through the vehicle's ability to be fully electric with a rechargeable battery that nests on the bottom of the body of the vehicle. This vehicle will be able to recharge at charging stations posted in ski patrol team posts and allows for sustainable alpine rescue and the cut of gas emissions and pollution while still packing a punch in the category of speed. Overall, this design aims also to use sustainable materials that can be recycled/upcycled like Covestro plastics that are engineered to different functionalities and allows for more sustainable manufacturing processes.

CHAPTER 6 – CONCLUSION

Current ski resort ski patrol teams offer very traditional, often slow, and inefficient means of emergency response. External factors like weather and collisions can be guilty of further hurting the injured person. This is variable to the skills of a patrol officer which may pose as risky due to the handling of injured patients. An effective emergency response comes with effective tracking of an injured person(s), adequate treatment of their injuries, and fast transportation of the patient to further urgent care. HX-TRAIL is the long-overdue solution to these challenges by taking in a human-centered vehicular design approach with sustainable aspects in the mix.

HX-TRAIL is a multi-functional vehicle that benefits the ski patrol and the injured patient in ways that will improve the needs of well-being, usability, comfort, injury prevention, and more. The HX-TRAIL has sub-components like the drone, retractable stretcher, enclosed pod, step-on acceleration pad, joystick steering, and AI integration to improve these needed areas. HX-TRAIL will eliminate broken communication of injury sightings, create a faster process from injury spotting to transportation down the mountain, and will mitigate collisions during treatment and/or transportation.

HX-TRAIL has design initiatives that address sustainability at its highest point by being powered by a 15kWh lithium-ion battery making it an all-electric, zero fuel emission, eco-friendly vehicle. This will help sustain the evergreen environment that the vehicle will work in.

HX-TRAIL aims to ease the weight on the ski-patrol shoulders and bring a safer, faster, and more reliable means of emergency response for injured riders.

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Approval Form

CRITICAL MILESTONES: APPROVAL FOR CAD DEVELOPMENT & MODEL FABRICATION

Student Name:	James Alas
Approved Thesis Title:	Ski Resort Emergency Response Vehicle

THESIS PROJECT – DESIGN APPROVAL FORM

Design is reviewed and approved to proceed for the following:	<input checked="" type="checkbox"/> CAD Design and Development Phase
<p>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.</p>	

Design is reviewed and approved to proceed for the following:	<input checked="" type="checkbox"/> Model Fabrication Including Rapid Prototyping / 3D Printing and Model Building Phase
<p>Comment: Waiting for CAD development review (as of Feb-21).</p> <p>CAD development reviewed, design satisfied, some features still to iron out, continue to clean up detailing. Good to go and start model fabrication as soon as possible.</p>	

Instructor Signature(s):	
	
Date:	04 April 2023



Appendix B - User Research

2.1 User Research

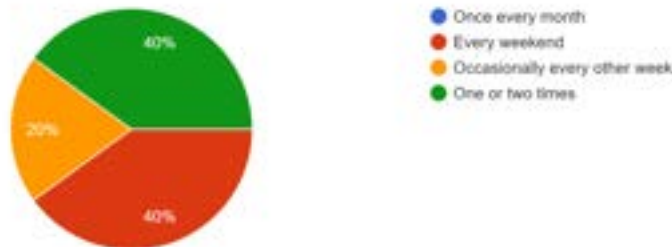
2.1.1 User Survey

In-depth user feedback was conducted to determine why users are doing this task (snowboarding/skiing), and what they like and dislike about it. A survey (Google Forms) was handed out via social media platforms (facebook and Instagram) between Oct 9-15, 2022.

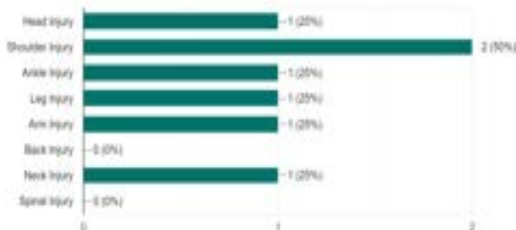
Results

Results are displayed as bar graphs/pie charts/tables in Figure (table) below)

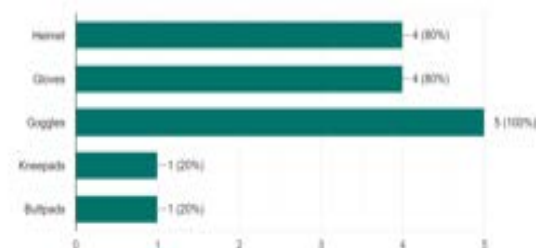
How often do you go snowboarding during the winter season?
5 responses



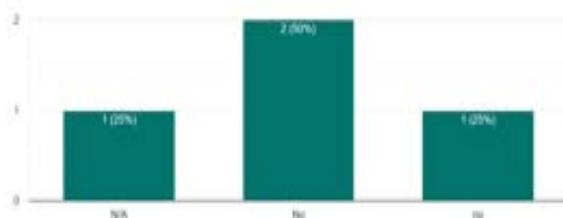
What type of injuries do you most often endure?
4 responses



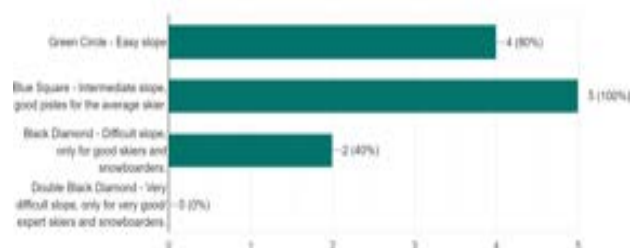
What type of protective equipment do you wear while riding?
5 responses



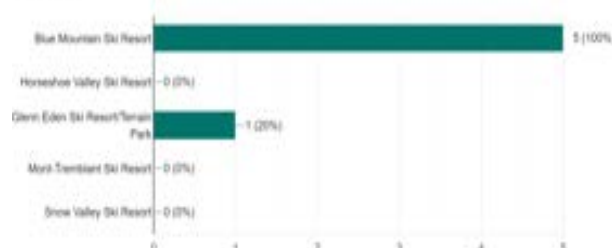
Have you ever been treated by ski patrol? If so, please explain how the procedure went.
4 responses



Which level of mountain do you usually ride?
5 responses



What ski resort do you go to?
5 responses



Summary: How this may inform design

- Snowboarding and skiing are very popular and people usually start on beginner to moderate slopes
- The amount of injuries are very common even while using the correct protective gear
- Injury is common within the sport

2.1.2 User Interview

In-depth user feedback conducted to determine why users are doing this task (swimming), and what they like and dislike about it. A 1:1 interview was conducted with I.M. Fish by phone on Oct. 8, 2022. The interview was recorded with permission and transcribed

Results

Preliminary questions were created (see Figure below).

An excerpt from the interview is in the Figure below (the full interview is in the Appendices)



Summary: How this may inform design

- Ski patrol controls the usability of all slopes
- Ski patrol is the reason why people are safe
- Traditional methods may be outdated and physically tolling
- There are many other things that go into emergency response rather than just treatment and transportation

User Observation- Focused

This User Observation was focused on specific key activities.

These specific key activities were ski patrol treating an injured rider. These specific key activities were determined by an interview with an expert

Objective

To determine the usability (ergonomic and ease of use issues) as well as effectiveness (time and optimization of steps) of key activities.

Method

The type of User Observation selected was (select from the following)

1. User(s) in-situ doing key activities

2. Master-Apprentice (User/Investigator)

User (the master) performs key activities and tells the investigator (apprentice) how to do the job.

3. Expert critique of video showing key activities being done, accompanied by the investigator. Simultaneous viewing (expert and investigator) allows for interaction (question & answer) between the two.

The user observation occurred in December 2013, in Snowbird, Utah in which a ski patrol treated a snowboarder with an injured tibia and fibula.

Consent forms were obtained.

This actual observation was recorded with photos, note-taking, video, etc. Conversations were recorded by note-taking/transcription.

Results

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

Time	Say	Physical Space	Do- Duties/Other	Do- Socialize	Attitude: Positive	Attitude: Negative
0:08	hurry	Ski Resort				
0:14	i think his leg is like in two					
0:17	752 on scene		Calls for assistance			
0:22	yesh my legs in two right now dude					Panic
0:24	what's here that leg is in two okay		Protocol - Injury Identification			
0:26	what's your name daniel nlike and what's		Protocol - User identity			
0:23	your name					
0:34	okay					
0:37	daniel yez sir so what happened i see		Protocol - Injury Identification			
0:40	your skis up there he was jumping and he		Protocol - Injury Identification			
0:44	um didn't land it fully and so he was		Protocol - Injury Identification			
0:46	crashing and he got wrapped around that		Protocol - Injury Identification			
0:48	tree that is huge directly below		Protocol - Injury Identification			
0:50	yesh					
0:51	yep					
1:01	uh no it's just holding on till you got					
1:03	here					
1:04	okay		Protocol - Injury Identification			
1:06	right leg		Pain Point			
1:17	okay					
1:19	no pain in your hips		Protocol - Injury Identification			
1:20	we're gonns roll you over		Procedure			
1:21	okay					
1:35	big breath				Assurance	
1:37	one two three				Assurance	
1:40	your right foot on my knee		Procedure			
1:42	over to the side		Procedure			
1:44	right there		Procedure			
1:48	straighten out your leg		Procedure			
1:51	how old are you					
1:54	so i didn't peek i'm with uh					
1:56	18 year old daniel		Protocol - User identity			
1:58	took a good spill		Calls for assistance			
2:00	through the trees		Calls for assistance			
2:02	uh apparent injury right now is a tip		Calls for assistance			
2:05	bib		Calls for assistance			
2:06	you get a right coming this way		Calls for assistance			
2:10	you'll have to come		Calls for assistance			
2:12	um		Calls for assistance			
2:13	to the mid ball on the mid baldy		Calls for assistance			
2:15	traverse and drop down		Calls for assistance			
2:17	or below shot five		Calls for assistance			
2:19	in the other end downhill		Calls for assistance			
2:23	and bring a couple sets of hands		Calls for assistance			
2:36	not at this time					
2:40	daniel		Procedure			
2:41	lay back i want you to do me a favor		Procedure			
2:45	can you boot yourself up above him		Procedure			
2:47	and kind of put a leg on each side of		Procedure			
2:49	him		Procedure			
2:50	and have him support his head for me		Procedure			
2:54	um		Procedure			
3:16	yesh a leg on either side of him so that		Procedure			
3:18	he can kind of		Procedure			
3:20	slide down put his head in your crotch		Procedure			
3:23	you know what i mean i just want you to		Procedure			
3:24	protect him from when they come down		Procedure			
3:27	and just keep him warm wrsp your hands		Procedure			
3:30	around him keep him warm dsn you put		Procedure			
3:32	your other glove on		Procedure			
3:38	how about up here					In a lot of pain - screaming
3:53	relax muscles relax your muscles				Assurance	In a lot of pain - screaming
4:02	slow deep breath				Assurance	In a lot of pain - screaming

Appendix.

Coding

More in-depth coding was then conducted.

Time	Location	Do	Say	Social Interaction	Positive	Negative
Morning	Ski Resort Mountain	Address the scene	What's your name? How old are you?	Ski Patrol needs medical info	Reduces panic	
		Address the injury	What happened? How's your leg feeling? Why leg is broken	Ski Patrol needs medical info		Worried
		Procedure - Backup	I need a couple set of hands I got a TSI on scene	Calls for backup	Assurance	
		Procedure - Treating Injury	Need you to hold both legs Keep both wrists Make your shoulder	Wants to hold legs		Worried about situation

User Task Map for Focused Observation

A User Task Map for specific task (s) was generated, looking at design parameters of ergonomics, efficiency, interaction, and satisfaction. This is shown in the table below, with the keys used for these design parameters shown in the table underneath.

Specific Task-based	USER TASK MAP			
TASK: SKI PATROL INJURY RESPONSE	Ergonomics	Efficiency	Interaction	Satisfaction
Locate injured		Ski right beside them to tend to their needs in out-of-boundary line area		User will not be in panic, help is here
Gather information on User and injury		Asks for name and details and what injury it is Gets more help from team of ski patrol	Obstructs the body and injury Worries family	Feelings of assurance
Call for Assistance		Prepares with cuts and movements	Cutting clothing, wrapping leg	
Tend to the injured	Lays them straight cuts clothing and tends	Needs to be quick to not harm injured	Straps the person in hold	Feelings of safety
Transport down mountain	Needs to put injured in the rescue toboggan			

Ergonomics – Safety	Efficiency	Interaction	Satisfaction
Most common 'vibe' tasks	Most common efficient challenges	Indicators	How pleasant / fulfilling task is to do
1. Lifting injured in right position	1. Time	Arrows, instructions	
2. bending injured limbs	2. Efficiency of doing first-aid		Feelings of control and mastery
3. Holding their head	3. Not following protocol	Controls	
4. Pulling heavy loads,	4. Not fast enough skiing/snowboarding	Locks, ties, handles, skis	
5. awkward body postures	5. Lack of skill / training		
6. Transportation injury			
7. trips, trips and falls			

2.1.4. User observation - Human Factors of Existing Products

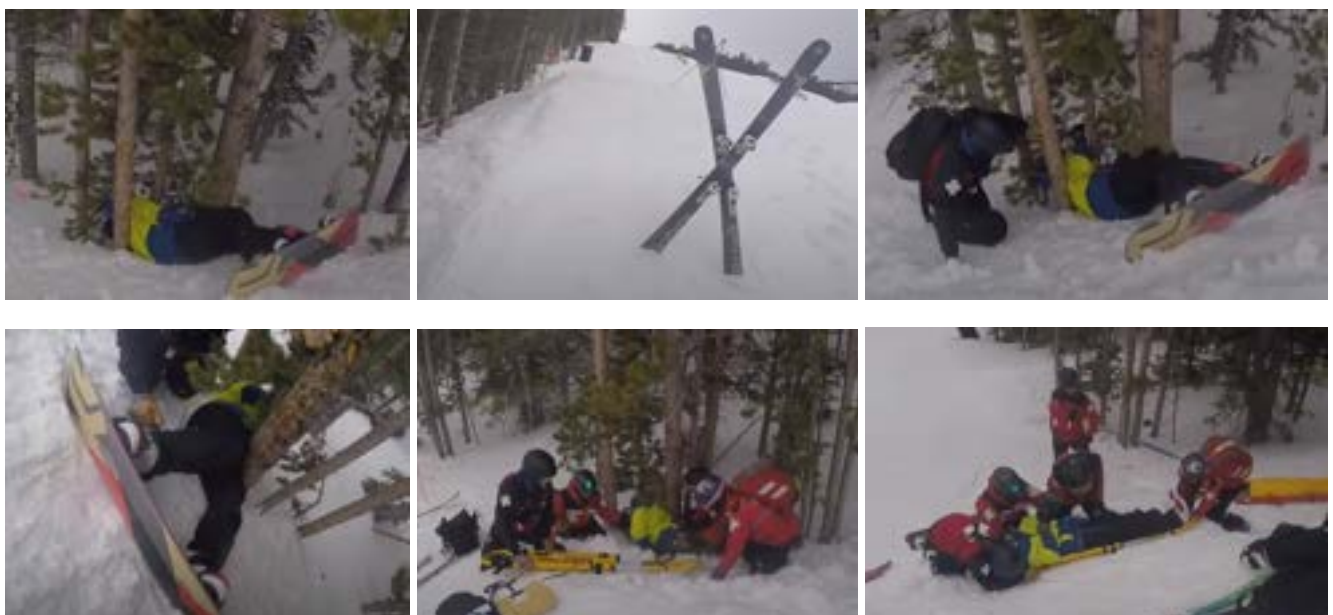




Figure. 9 User Observation of Emergency Response retrieved from

https://www.youtube.com/watch?v=im4vqlP4ESU&t=508s&ab_channel=WildGurm

User observation was done to see the usability of the current benchmarking product, the traditional ski toboggan, along with the processes of the ski patrol team.

Insights from User Observation
It took about 4-5 minutes for the ski patrol to come, not including before the user started filming. The patient was assumed to be stuck in the trees for 10-15 minutes.
Multiple patrol officers for one person.
Loading into the stretcher and then into the rescue toboggan took another 5 minutes.

Summary: How this may inform design

- Gains: Reinforces Ski Patrol officers and their teams to follow protocol, practice their skills and value the injured
- Pains:
 - Frustration of not being fast enough
 - Frustration of getting hurt through transportation
 - Frustration of physical toll on pulling down a body
- Usability & Ergonomics
 - Awkward skiing position when pulling down a toboggan
- Efficiency
 - Preparation and organization for the task at hand inefficient
- Interaction
 - Strapping person securely, performing proper first aid, keeping injured in injury-prevention position

- Satisfaction
 - o Mastery and Control- describes the overall user experience involved in the specific task, not individual steps (pain points)

Maps

Empathy Mapping

WHO are we empathizing with? <ul style="list-style-type: none"> • People of the ski patrol team • Age between the age of 19-45 		What do they need to DO? <ul style="list-style-type: none"> • Trained to perform mountain duties • Work as a team to check snow and set boundary lines and grip mountain • Perform first aid as required and transport people down mountain with skis/board or sled 	
What do they SEE? <ul style="list-style-type: none"> • People snowboarding/skiing • People going over the boundary lines • Injured people 	PERSONA Ski Patrol 	What do they SAY? <ul style="list-style-type: none"> • "It's cold today" • "Time to check the snow" • "You need to jump the mountain for the sake of all riders" • "I have an emergency" • "I can't seem to perform first aid on you correctly" • "Are you injured? Where does it hurt?" 	
What do they DO? <ol style="list-style-type: none"> 1. Ski/snowboard down the mountain in intervals to see for injuries 2. Locate the injured 3. Attempt to assess the severity of the situation 4. Contact other patrol team 5. Perform first aid 6. Strap the injured in the sled comfortably 7. Arrive down the mountain 8. Rushes injured to emergency care for further treatment 9. Drive back up the Mt. 	PAINS <ul style="list-style-type: none"> • I can't feel my legs and arms after hours pushing down the sled • I always feel the need to help when there's an injury • The sled is hard to maneuver • It's such a pain bringing the sled back up • Why don't these people just follow the rules? 	GAINS <ul style="list-style-type: none"> • I love to help people • I am able to help people in need and stop further pain • It is satisfying knowing/ making people safe 	What do they HEAR? <ul style="list-style-type: none"> • "I need help" • "My leg hurts" • "Leave me alone" • "Someone crossed the boundary line" • "You know pulling down a heavy sled on a sled"
Thoughts and Feelings <ul style="list-style-type: none"> • Would there could be a more physically demanding method of transportation of injured down the Mt. • Questioning performing sled rescue had to be by legs and arms and bringing it up the Mt. causes a problem or stoppage of the lift 			

User Journey Mapping

	PLANNING	PREPARATION	TASK 1	TASK 2	TASK 3	GOAL	FINISH UP
USER GOALS	To find a more efficient process of ski patrol	Prepare slopes and boundary lines	Snow check	Do Patrol Search and rescue	Do Patrol transportation down mountain	First aid and get injured down the mountain	Provide further medical care and information
USER ACTIONS	Go over team protocol and assignments	Build up and down the mountain to make sure mountain meets regulations	Banking and temperature checking	Asking everyone to make sure they are okay	Responsible on snow sled	Perform first aid	Talk to other medical staff with information on injured
USER THOUGHTS	My tool is too hard, my tool is too slow I can't figure anything to do after	It seemed so much easier, we need to come out the tracks	This is satisfying	Is that person injured or did they just appear?	This is heavy and hurts my leg	I love this job	I hope I provided you everything
USER FEELINGS	Tired but ready	Motivated	Good	Focused on looking around people	Stressed about the injured and they appeared state	Satisfying	Calm

User Experience Mapping



Summary: How this may inform design

· Empathy MAP

- o Pains
 - I can't feel my legs and arms after hours mulling down the sled
 - I always feel the need to help even when tired
 - The sled is hard to maneuver
 - It's such a pain bringing the sled back up
 - Why don't these people just follow the rules?
- o Gains
 - I love to help people
 - I am able to help people in need and stop further pain
 - It is satisfying knowing I make people's day
- o Thoughts & Feelings
 - Maybe there could be a less physically restraining method of transportation of injured down the hill
 - Overtime, performing sled rescue hurts my legs and arms and bringing it up the ski lift causes a problem or stoppage of the lift

· Journey MAP / Experience MAP

- o Major problems and challenges
 - Transportation, keeping injured person secure and safe
- o Major points of delight
 - Enjoys to snowboard and help people
- o Major takeaways / Possible avenues for focus (solutions)
 - As enjoying as it is, it may become too physically tolling

User Profile

The primary user group for this study will consist of the patient who is sustaining the injury and requires the emergency response of ski patrol for aid. This group may consist of snowboarders, cross-country skiers, alpine skiers, snowmobile drivers, snow snowshoers, or tobogganers. The task of these people is to ride ski lifts, get off at their desired hill, and go down the hill, more experienced people will perform tricks and jumps in the parkour area. More times than often, this group will wipe out from disbalance or loss of control for speed causing injury. The more serious injuries that can occur during these activities are mainly concussions, broken/fractured bones, and/or lacerations of any degree.

Demographic:

Age: 12yrs - 65yrs +

Gender: 61% M 39 % F (Snowboarders),

58% M 42% F (Skiers) Household Income:

Majority > \$100,000

Employment Profile: Full-time

Geographic Location: Southern Canada stretching far east and midwest

The secondary user group for this study will consist of the team of the ski patrol or people who are part of helping the injured patients. This group may consist of a ski patrol rescuer, the ski patrol manager, the lift operator, the snowmobile driver, and the first-aid operator. The task that these people will perform is locating any injured riders, assessing the situation and degree of injury, calling for backup, treating the patient until backup arrives, securing the patient into the stretcher, and shredding down the mountain while operating the ski toboggan.

The tertiary user group for this study will consist of people treating the patient or anyone relative to the patient's accident. In this case, the group may consist of urgent care health workers, family and friends, and physiotherapy doctors. On the business-liability side of things, the resort's company and the patient's insurance company fall under this group as they deal

with the aftermath of the accident. The client's insurance company may not meet with the agreement of the situation and cause a back and forth between the ski resort and him/herself.

Members of this group are here to support the rider in any financial and emotional need possible.

User Persona:

Name: Miles

Thompson Age:

50+ years old



Sex: Male

Occupation: 40 years of serving as a Canadian Ski Patrol and volunteering at many posts around Canada Method of Analysis: 1:1 Interview

This user was found in a local Facebook group dedicated to Blue Mountain ski patrol along with many other patrollers who were contacted.

Appendix C - Product Research

4.

Product	Reference	Benefits & Features
<p>Cascade Rescue Toboggan Model 100 “The Legend”</p>	<p>https://worknrescue.ca/product/cascade-rescue-toboggan-model-100-the-legend-w-bow-guard/</p>	<ul style="list-style-type: none"> ● Heavy Duty 6061 Aluminum Top Edging ● Internal Stainless Steel Perimeter Frame ● Non-Skid Interior ● Stainless Handles and Locks ● Removable Stainless Handle Mounts ● Three Patient Straps ● Quick-Detach Tail Rope ● Four Carry Handles ● Crossover Rope
<p>Ski-Doo Summit X</p> 	<p>https://www.ski-doo.com/ca/en/models/deep-snow/summit.html</p>	<ul style="list-style-type: none"> ● Track system and motor ● Best in-handle responsiveness ● Rider-centric design ● Deep-snow & Trail
<p>Subaru Mountain Rescue Vehicle</p> 	<p>https://www.stanleysubaru.com/blog/2012/october/25/what-vehicle-makes-for-a-good-rescue-vehicle.htm</p>	<ul style="list-style-type: none"> ● Four wheels ● Deep-snow terrain vehicle ● Multiple passengers ● Possible back sled attachment ● Can carry rescue toboggan ● Immense storage space

<p>Medical Rescue Skids</p> 	<p>https://www.kimtekresearch.com/products/medlite-transport-basic/</p>	<ul style="list-style-type: none"> ● Needs vehicle ● Back attachment ● Opportunity to perform medical care while transportation ● Enough space for sled ● Straps ● Aluminum Base
---------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Table 5. Benchmarking Products

Appendix D- Needs Analysis

Product- Rescue Toboggan		
Needs	Benefits and Underlying Needs	Level of importance
Basic Needs <i>Physiological</i>		
Food, water, shelter	Shelter as a means to hold injured person	Moderate
Pleasure, gratification <i>(sensory, compulsive responses)</i>	Injured: Satisfaction that they are safe	High
	Ski Patrol: Handles do not feel uncomfortable, body of product is not too heavy	High
Security <i>Safety, securing resources</i>		
Safety	Protection of injured	High
State, Group, Individual		
Securing resources <i>Optimization of limited resources (cost effectiveness)</i> • Value • Accumulation of resources (wealth)	Price is important to ski resorts buying product	High
	Reliability	Moderate
Control over environment (tasks)	<i>Product (tool) that amplifies human abilities</i>	
Convenience	Steering while using skis or snowboard	High
Ease of Use	MASTERY	
Speed (fast, less time)	Waiting for a vehicle is slower	High
Control (precision, responsiveness, power)	Handles and skis	Moderate
Long Term Security/Stability of Group <i>Health/care/education of children</i>	Caring for Injured <i>Is the injured okay? Is he/she going to make it down the mountain? Is he/she going to panic?</i>	High
<i>Environmental sustainability</i>		
<i>Insurance (car, house), pension, investments</i>	Rescue Toboggans are meant to transport them down safely	High
Social Belonging <i>Effort / resources to belong to a 'tribe'</i>		
Fear of Abandonment	Injured feels safe	High
Fear of the enemy		
Tribal Identity		
Behavior cues for survival <i>(copying behaviors... safe to eat, learned skills)</i>	Friends/relatives recommendations	Moderate
Behavior cues for social interaction of group <i>(copying behaviors... interaction cues, play, have fun)</i>		
Peer Pressure		Moderate
Social Expectation <i>(social covenant (gift))</i>		
Esteem <i>Personal influence in 'tribe'</i>		
Social Status <i>The elite have it...I want to be like them'</i>	All Ski Patrols use this product	Slight
Social Recognition		
Sexual attractiveness		
Self-Actualization 'Higher order' Functions/Needs <i>Needs that are pre-dominantly 'outer cortex'</i>		
Intrinsic pleasure		
Creative endeavors		
Experiential (extrinsic)	Only professional skier/snowboarder can operate this	High
Experiential (intrinsic)		
Emotional	Empathy: <i>Is the injured okay? Is he/she going to make it down the mountain? Is he/she going to panic? Is he/she warm?</i>	Moderate

Table. 12 Needs Analysis Table

Latent Needs

Latent Needs	Benefit Statement
Safety	Offers safety against external factors that can occur at all 3 stages of emergency response
Comfort	Physical comfortable position dependant on injury
Transportation	Maneuver the ambiguous ski mountain terrain with efficiency and agility along with hundreds of other skiers/snowboarders
Locating	Fast location method of injured riders in all areas of the mountain - between and outside boundary lines
Observation	To observe the mental state and comfortability of patient while transporting
Work/Productivity	From locating to transportation to urgent care in a timely manner

Table. 7 Latent Needs of injured skier/snowboarder and ski patrol

Categorization of Needs to Benefits

Need	Benefit Statement	Relationship with Benefit
Aerial Bird’s Eye-View	Faster locating leads to faster treatment which leads to faster transportation	STRONG
Enclosure Pod	Protection from weather and collision	STRONG
Adjustable Bed	Different positions based on injury	STRONG
Full-Human Control	Skills are still of importance and the maneuvering of routes is dependant on a user’s knowledge of terrain	STRONG

Safety-Mechanics	Collision prevention, driver’s safety	STRONG
Easy Treatment Device	Faster treatment	STRONG
Latent Needs	Benefit Statement	Relationship with Benefit
Safety	Offers safety against external factors that can occur at all 3 stages of emergency response	STRONG
Comfort	Physical comfortable position dependant on injury	STRONG
Transportation	Maneuver the ambiguous ski mountain terrain with efficiency and agility along with hundreds of other skiers/snowboarders	STRONG
Locating	Fast location method of injured riders in all areas of the mountain - between and outside boundary lines	MODERATE
Observation	To observe the mental state and comfortability of patient while transporting	MODERATE
Work/Productivity	From locating to transportation to urgent care in a timely manner	STRONG
Wants	Benefit Statement	Relationship with Benefit
Fully Electric	Environment-friendly/Inspirational	STRONG
AI Features	Lessens work load of ski patrol	MODERATE

Table. 8 Categorization of Needs for thesis direction