

RAPTOR

A SAFER METHOD OF RURAL WINTER TRANSPORTATION



Sustainable Transportation In Rural Winter Environments

by

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Submitted in partial fulfillment of the requirements for the degree of

Bachelor of Industrial Design

Faculty of Applied Sciences & Technology
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Abstract

As winter months approach, problems in rural/small population communities arise. The winter environment poses challenges to people residing in rural areas susceptible to large snowfalls, regarding transportation and safety in these communities. For many reasons, adverse weather and road conditions are a highly considerable cause for elevated risks related to accidents and fatalities amongst drivers. Currently, individuals are forced to drive vehicles that are unfit for these winter conditions. Certain major risks for these rural communities are: lack of road maintenance, inadequate lighting conditions, and lack of transportation options as public transport services can hardly be efficient under such conditions. Overall the goal of this thesis proposal is to challenge the current transportation methods, through an in-depth study and analysis of the dangers and pain points, in order to enhance the safety for individuals driving in rural areas while dealing with harsh environmental factors. User research including interviews, observational studies, and analyses of statistical data, will give detail and justification for the design process in order to eliminate the current dangers from these environments. Additionally, with reference to current transportation methods such as cars, trucks, & snowmobiles, a one to one model will be developed in order to understand ergonomics and human scale as well as to evaluate the feasibility of the design. Results from this analysis will aid in developing a solution for transportation in small population communities. This solution will enhance the safety and overall lifestyle of individuals travelling through rural areas during the winter months.

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CHAPTER 1: Problem Definition

1. Problem Definition

1.1 Problem Definition

Transportation, completing daily tasks, driving to and from work, all of these activities are reasonably easy for most people to complete year round, although for individuals living in small population/rural communities these everyday responsibilities become very difficult and unsafe in the winter months. With many of these areas being susceptible to large snowfalls along with certain rural community characteristics, at times leaving your house for any reason would be considered challenging and dangerous. Within these rural communities, regular winter conditions that don't pose many issues in urban communities are amplified. These issues become more prominent due to: lack of road maintenance and road conditions, limited or no lights on highways/side streets, lack of driving discipline due to open roads along with less traffic, and large snowfalls causing road/visibility hazards.

Currently, individuals living in these communities are given no choice but to commute via car, truck, or snowmobile. Although each of these methods have their own risks and dangers that come along with use. As for cars and trucks, they are not specifically meant to handle the snow terrain and have proven to be unreliable when it comes to control on the icy roads, getting stuck in deep snow, and dangerous due to elongated breaking times. When it comes to snowmobiles, the issues arise with weather conditions, as the driver is exposed to the winter elements at all times. These machines have also been known to break down or malfunction which can pose serious danger in an open rural community during winter months.

Overall this problem encompasses the full body interaction and ergonomics to aid individuals living in rural communities susceptible to large snowfalls. By designing a vehicle that will allow for safer transportation, more control, better vision, and certain interior

ergonomic benefits, individuals will be able to commute and complete daily tasks throughout the winter months with ease and not need to worry about their safety.

1.2 Rational & Significance

Investigative Approach Taken

Coming up with a solution to any problem requires research along with gathering information to get a full understanding of what exactly needs to be addressed. In this case the problem lied within transportation during winter months. In order to get a better understanding on how the current methods of transportation could be enhanced, various methods of design research were conducted. These methods not only gave insights on the user, but also helped to enhance and progress the design solution. These methods are as follows:

- Literature Research
- Statistical Reviews
- Existing Product Benchmarking
- One on One Expert Interviews With Users And Automotive Professionals
- User Observations
- Ergonomic Studies
- Sustainability Studies
- User Activity Mapping

In order to understand the problem on a deeper level and the users that are affected by it, surveys were conducted to various people that are involved one way or another relating to the problem. Informal interviews were also conducted with the aid of pre thought out questions to act as a guide for the conversation topic. By conducting the interview as more conversation based, it allowed for the interviewee to speak freely and continue expressing their ideas and thoughts without being interrupted or stopped. This method was beneficial due to the nature of the conversation, ultimately allowing for the interviewee to bring up points and ideas that otherwise may not have been addressed.

1.3 Background / History / Social Context

Winter snowfalls have caused issues with travelling for as long as humans have existed. Due to the characteristics of the winter months, travelling becomes difficult at times, typically due to snow, ice and visibility conditions. Many inventions and revelations have aided humans in one way or another to attempt to overcome this ongoing issue. Specifically there are machines today that are great for snow, although they are not versatile and practical for everyday life situations, especially in rural communities. In general, transportation methods such as cars and trucks are improving vastly in their safety features as people have realized that it is vital to have in vehicles. Although there are still many downfalls when it comes to these methods of transportation in the winter months along with certain downfalls in snow specific vehicles as well.

When it comes to commuting via vehicles such as cars and trucks, there is a long list of dangers that come with it. Driving in rural communities in the winter exposes many of these

issues and also arises other challenges that majority of people in urban settings do not experience on a daily basis. Ultimately these winter rural environments can make travel and transportation extremely difficult. In Canada almost 30% of car accidents happen on icy or snowy road conditions (Admin, 2020). Along with two thirds of all “deadly accidents” in Canada happen on rural roads, where speed limits are faster and roads are not as well lit (Rural roads, 2020). As current trends show more safety features in vehicles today, none of the features are specific towards the issues the individuals in these rural communities face as these companies cannot afford to target specific safety features to one set population.

As it currently stands there are no other ways for people to get around due to the rural land mass and scattered population. Bus systems and other transportation options are extremely limited because it would hardly be possible for these vehicles to viably work under the land mass and disperse population. Not to mention the dangers that arise with these vehicles as well, as they would need to travel on small, unlit, snow and ice covered roads constantly. Overall the individuals living in these communities have a big disadvantage due to the current products on the market today, along with the characteristics of the population and land mass causing issues for transportation as a whole.

CHAPTER 2: Research

2.1 User Research

Introduction

The foundation to obtain a relevant design direction relating to any project in the field of design all begins with research. Research is vital to understanding the intended user demographics and their needs, wants, and current/future behavioural trends regarding the problem. Ultimately after completing the research related to the topic, the design focus and solution will become more evident and relatable for the end user. This section of the report will identify the intended user being researched and their behaviours/daily routines related to the issue being solved. This section of the design process is one of the most important and key parts to the overall process, simply due to the fact that the solution has to be able to improve the everyday lifestyle and experience of the user. With the aid of transportation and safety in rural environments susceptible to large snowfalls, the lives of these individuals will be impacted in a positive way, enhancing the overall experience of travelling.

Objectives

1. To determine the demographics, needs, wants, and behavioural trends of the intended user.
2. To generate a user profile.
3. To understand and identify the user of the potential product within regards to primary user, secondary user, and tertiary users.
4. To create a persona to represent the overall "typical" user.

Methods

Different research methods were used in order to collect the data on this specific topic. User observations and user interviews were also conducted to collect data, this further developed a deeper understanding of the problem from the targeted individuals. The data and insights collected were placed in the following results.

- User Profile/Persona
- Current user Practice
- Activity Mapping
- Research of Existing Products
- Safety and Health

2.1.1 User Profile

Introduction

Creating a fictional user persona in order to design a product is one method that is used when trying to solve a problem. By creating this persona it helps create empathy for the user, and it creates a bigger picture of who the end user will be and their specific needs and wants are. This topic will be based around a fictional persona profile, configured from the average user demographic. The profile will describe the users behaviour, needs, and their wants regarding current transportation issues in rural communities during winter months.

Objectives

- To determine the Primary, Secondary, & Tertiary users.
- To determine the demographics of the users.
- To create a fictional user persona that represents the average studied individual.

Method

While creating a fictional persona, information and data was gathered based on the average demographics and users of similar products. All of this information was taken into account due to the importance it had on furthering the design direction of the product solution.

Results

Primary User - Daily Drivers & Passengers Within Rural Communities

The primary user(s) are the individuals living in these rural communities susceptible to large snowfalls. With all of the dangers and challenges winter weather poses, these individuals are directly affected over the course of these months due to lack of safe, efficient transportation.

Secondary User - Recreational Users

The secondary user in this case are individuals also living in these rural communities who enjoy recreational sports during the winter months. These activities might include: Fishing, Hunting, Snowmobiling, Skiing/Snowboarding, etc... There are many downfalls to the current products on the market today. By allowing for these individuals to use a machine that

is not only safer but more efficient than the competition, it allows for a better more enjoyable lifestyle for anyone participating in these recreational events.

Tertiary User - Manufacturers & Sales Employees

These tertiary users are not only potential users of the product but also important to the production and overall experience prior to other individuals purchasing the machines. These manufacturers and sales employees are important to the product because they will be the only handling and making sure everything is in check before the product is passed on to the primary/secondary user. These individuals will be very knowledgeable about the product along with most likely deal with the product one way or another everyday.

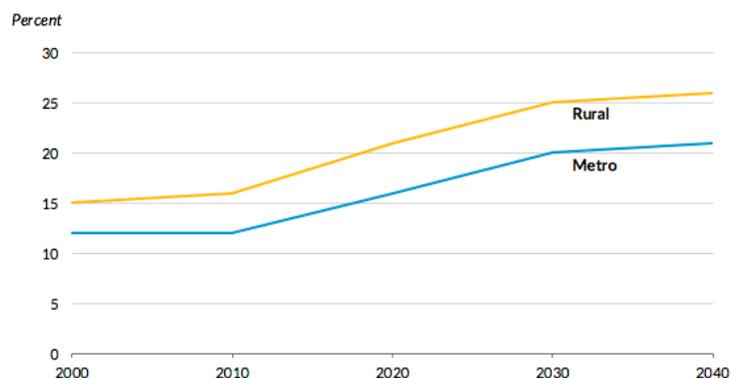
Demographics

Age

In Canada's rural areas, the age demographic is older compared to many other urban populations. Within these predominately rural regions, 15% of the population is seniors (age 65 & older). This trend is not only present in Canada, as statistically in the US, current numbers are rising regarding the elderly population in rural areas opposed to urban settings.

Pendall, R., Goodman, L., Zhu, J., & Gold, A. (2017, August 30)

Population Growth for Older Adults in Metro and Rural Areas

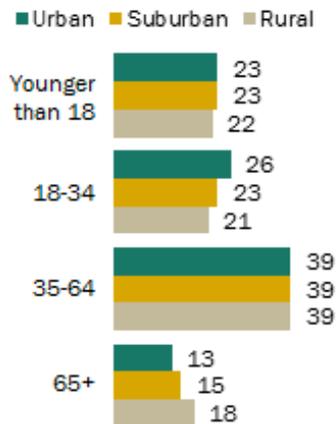


Source: US Census of Population and Housing.
Notes: Older adults are age 65 or older. Numbers for 2020–40 are Urban Institute projections.

URBAN INSTITUTE

Rural counties as a whole have a higher share of older Americans than cities or suburbs

% of total population in each county type



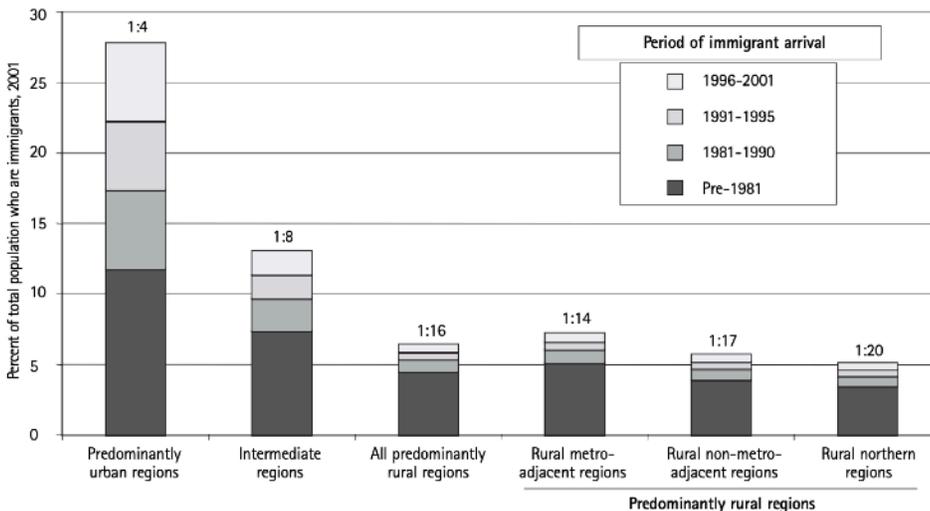
As it is evident that the population of elderly people is continuously rising in rural communities in Canada and the US, it is also known that other age demographics still live in these communities. This second chart shows the population percentage of age population percentage living in urban, suburban, and rural communities. Ages 35-64 is even at 39% population. Ages 18-34, rural is slightly less at 21% compared to 26% urban. Although with these population percentages in the US, it shows that there is a group of individuals that may be affected from large snowfalls in these rural settings.

Parker, K., Horowitz, J. M., Brown, A., Fry, R., Cohn, D. V., & Igielnik, R. (2020, May 30)

Ethnicity/Gender

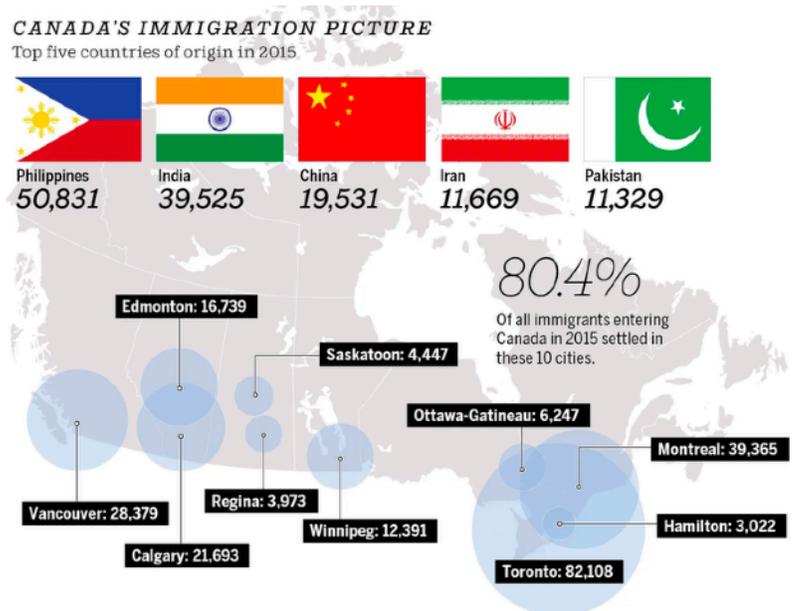
Again, as seen with the images the predominant ethnicity among people living in rural communities are not immigrants. In fact many immigrants who migrate to Canada end up in most major cities as shown on the map below.

Immigrants represent a low share of the predominantly rural population, but over one-quarter of the predominantly urban population



Source: Statistics Canada. Census of Population, 2001.

Typically rural communities are not as diverse and urban populations. This is due to the majority of immigration population migrating to major cities opposed to smaller rural settings. Because of this, in some rural areas, ethnicity is not strong. This trend tends to continue for these communities due to the lack of immigration and how current trends continue with less people willing to go outside the realm of “normal” and move to these smaller rural communities. This chart below shows how immigrants represent a low share of the rural population, and are more predominant in urban settings.



Dharssi, A. (2016, October 26).

Gender

Young men and boys outnumber young women and girls in rural, remote and urban areas between the ages of 0 and 24 years. In urban areas, this pattern is reversed, with women above 24 years outnumbering men. However, in rural areas, this is only true for women between the ages of 30 and 44, and those over 70. In remote areas, women are the majority only among those between the ages of 25 and 39 and 75 and older.

Fictional User Persona

Profile

Tyler Fleury is a 27-year-old caucasian male. He attended College to receive his bachelor's degree in Business. He earns a yearly salary of \$75,000 and has run his clothing and apparel company for 6 years in Muskoka, ON. Tyler began his business career at 21, a year after completing his school program. He prides himself on being successful with a start up company and is very happy with where he lives and his involvement in his community.

Persona

Name: Tyler Fleury

Age: 27

Occupation: Clothing & Apparel Founder

Income: \$75,000/ year

Education: Bachelor's Degree - Business

Relationship Status: Single

Location: Muskoka, Ontario

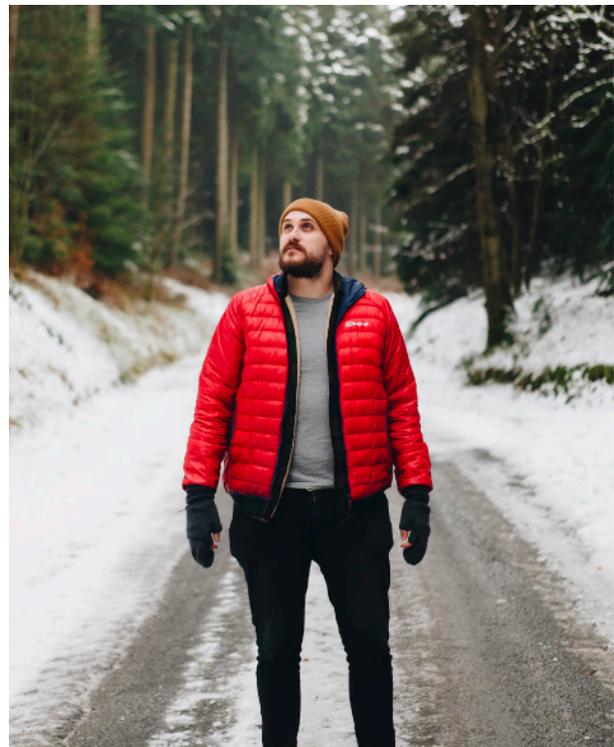
Career/ Volunteer: Career

Years of Work: 6 years in business

Social: Works with 12 other employees & is well known around the community

Frequency of Activity: Drives to work everyday in town, and around town for events and personal errands.

Hobbies: Hunting, Fishing, Snowboarding, Boating, Swimming.



User Behavior:

Tyler heads to work everyday and works reasonably long hours as it is required for his business to succeed. Despite not needing to head into the office everyday he finds it more productive to work. At his workplace the majority of the people are employees, they see each other very often and have built good friendships from their teamwork and success. Tyler enjoys surrounding himself with these people as they all have the same goal in mind, having success within the company. During the winter months, at times Tyler finds it hard to travel around the town he lives in due to the incimate weather.

2.1.2 - Current User Practices**Introduction**

The purpose of finding this data is to understand what the users current methods of transportation during winter months is. It is important to understand how they use it, how long they use it, what challenges specifically they have, and why they use it. By gathering this data, the finally design direction will be clearer and more specific to helping the individuals with their transportation problems.

Objectives

- To determine the frequency and duration of use from current transportation methods, and exactly where the individuals are travelling to. (where is the product being used).
- To determine the reason behind purchasing and using the current existing products.

Methods**Transportation Habits**

Currently most individuals who live in these rural communities have jobs in and around the

town they live in. In 2001, 2.8 million workers out of 14.7 million resided in rural and small town (RST) areas. Of the 2.8 million, about 2.3 million also worked in an RST area, but not necessarily in the municipality where they were living and approximately 0.4 million commuted to a municipality in a larger urban centre (LUC). (*Rural commuting*. Statistics Canada (2008, November 24))

Purchasing Decisions

Based on the land characteristics of rural communities, many individuals resort to trucks and SUV's as they are the most popular methods of transportation. Many drivers are looking for proven, and more importantly reliable/safe vehicles when they are inquiring to purchase. (11, J. P. | S. (2019, September 27)).

Rural car buyers also need to consider a vehicle that has good highway fuel economy and a reliable engine that won't quit or fail. This is important as running errands simply takes more time to complete. Trips to the store are generally longer and take more mileage compared to individuals living in urban settings where stores are a lot more populated and closer in distance. On average, a Canadian living in a rural area will travel 33 kilometres more to a supermarket than their city counterpart. In addition, they will travel 54 kilometres more to a car dealership, 37 kilometres more to a local department store and 56 kilometres more to a discount store. (*Unhaggle*. Unhaggle Blog. (2014, October 14))

Another factor that rural car buyers need to take into consideration is the terrain they will be travelling on. Lack of road maintenance, rough roads, and rugged terrain are all issues that individuals living in rural communities will face on a daily basis. The further the road

system is from the main city core, the less attention that road will get. Resources are often limited and spread heavily where the population is dense. Often times individuals may deal with gravel roads filled with potholes and other hazards. These car buyers are aware of the road conditions and make their purchasing decisions largely based on how certain vehicles will handle the roads. (*Unhaggle*. Unhaggle Blog. (2014, October 14))

Within rural communities in Canada, the unpredictability of weather causes many car owners to consider the performance of their vehicle. People demand their cars to handle rain, snow and storm. Because of this mentality, some drivers choose to rely on trucks, SUVs and other vehicles with four-wheel drives as opposed to sports cars.

2.1.3 - Activity Mapping

Introduction

Commuting through rural environments at times can be very enjoyable and relaxing. Although throughout the winter months when there are large snowfalls constantly, driving can be extremely dangerous. There are many different areas to where certain risks are posed, and overall it leaves room for improvement with the current transportation methods. For the purpose of this thesis project and being able to fully understand the risks and dangers that drivers in these areas have, research was conducted to generate an activity log in regards to the overall experience. The areas that were concentrated on were individuals completing daily tasks. Throughout this experience of completing these tasks there were certain pros and cons that were evident and expressed from the user. These insights were vital in order to understand the user, and also develop a design solution that addresses the current methods of transportation.

Objectives

- To identify problem areas/risks that are evident during the driving activity.
- Highlight key actions.
- Identify various specific pain points the user is experiencing.
- Identify enjoyable experience the user experiences during the activity/task.

Method

Due to the pandemic, it was difficult to fully observe the user completing their daily tasks. Therefore, observational research was conducted with the use of reviewing similar experiences via video and recordings. This method was very effective due to the natural nature of the reviewing experience. The videos and recordings were based upon people in areas that were susceptible to large snowfalls, completing daily tasks the day of or day after a large snowfall.

Recording Techniques Used

The recording techniques used were the app called "Otter" and also the standard iPhone microphone app as well for a backup.

Person Of Interest/Interviewee

The individual that was interviewed was a 37 year old female living in a rural community where they are susceptible to lots of snow. Making an average income, and driving a recently new Mazda SUV during the winter months.

Results

User Background

User drives almost daily, whether that be getting groceries or a morning coffee. A 37 year old female with work that requires her to go into the office from time to time under the current pandemic situation. Prior to the pandemic, going to the office was an everyday occurrence. Based on an average salary, this user lives in a smaller house in a rural community, driving a Mazda SUV as their daily driver. This user also finds driving in winter challenging at times due to the large amounts of snow the area receives.

Results

Throughout this activity mapping there were a few main sections that were evident as major pain points. These pain points being: Shovelling drive way, losing control on the roads while driving in winter storms, no street lights in rural communities or highways, cold temperatures, and poor visibility as it snows harder usually in these areas.

2.1.4 - Human Factors (Research of Existing Products)

Introduction

Comparison of existing products on the market is very important. These other products would be something that the user potentially uses in the environment that this thesis topic is covering. By being able to break down and compare the existing products, it will provide benefits that they hold along with downfalls they have as well regarding the travel in rural winter environments. Relating to this thesis, these products will all be motorized transportation vehicles that the user will interact with when in use. In order to further the design of this thesis project, evaluating these benchmarked products along with ergonomic breakdowns for users, will allow for important insights and information to take into

consideration. Some other important factors that were examined were: the weight and size of these vehicles and how practical it was for the users, What materials the vehicle was made out of and if there could be improvements, and how versatile and rugged the vehicle was, posing the question “would it hold up and perform under rough winter terrain?”.

Objectives

- Identify ergonomic features of existing products
- Show configurations/product schematics of existing products
- Compare features, benefits/pros and cons
- Identify areas of innovation to implement into thesis design

Method

Using an internet search for product and vehicles that can be driven on snow and in winter conditions allowed for some interesting results that were comparable to this thesis topic. These products varied in many different areas when it comes to usability, size, styling, manufacturing, etc... All of these factors were noted and taken into consideration with the design of this thesis project.

Products & Results

1) Average Car (Honda Civic)



Name: Honda Civic (2019)

Size: 4518mm x 1799mm x 1434mm

Weight: 1290 - 1370 Kg

Construction: Aluminum, Steel, Copper, Glass, Rubber, Special Fibers, etc...

2) Average Truck (Ford F150)



Name: Ford F150 2018

Size: 5.89m x 2.03m x 1.92m

Weight: 4,069-4,653 lbs

Construction: Aluminum, Steel, Copper, Glass, Rubber, Special Fibers, etc...

3) Public Bus



Name: Public Bus

Size: 45ft x 9ft

Weight: 20,000 - 33,000 lbs

Construction: Aluminum, steel, glass, rubber, etc...

4) Snowmobile



Name: Yamaha Sidewinder SRX

Size: 2997mm x 1219mm x 1267mm

Weight: 215 Kgs

Construction: Kevlar composite construction, Aluminum, plastic.

5) Snow Plow



Name: Snow Plow

Size: (Varies)

Weight: 50,000 - 70,000 lbs

Construction: Polyethylene, Steel plows, Durable plastic, Aluminum, Glass, etc...

6) Ripsaw



Name: Ripsaw

Size: 185.95in x 99.50in x 73.47in

Weight: 7,750 lbs

Construction: Fully welded high strength exoskeleton, Military grade speed tracks,

High performance OEM truck parts.

7) Snowbike



Name: KTM Snowbike

Size: 120" x 12.5"

Weight: 300lbs

Construction: Aluminum or steel, Plastic Ski, Plastic track.

8) Snow Quad



Name: Bombardier Snow Quad

Size: 5.3ft x 4ft

Weight: 520lbs

Construction: Aluminum or steel, plastic track, rubber, etc...

9) Backcountry Vehicle



Name: Can-Am Apache Backcountry

Size: Size Varies

Weight: Unknown

Construction: Aluminum, Steel, Speed Tracks plastic, Rubber, OEM Parts

2.1.5 Safety & Research

Throughout all of these products, there are certain health and safety factors that need to be taken into consideration before production of any product. When a person get into or on one of these powerful machines it is vital that they are safe in the environment they are using the product. Some of the products listed above have more safety features and precautions based upon the use and general setting the product would be used in. Although with that being said, some of the products listed above have a larger risk factor when operating due to difficulty of operation.

As technology advances there are more safety features being implemented into standard vehicles such as cars, trucks, and busses. These certain safety features might include road guidance assistance, assisted breaking, reverse alert systems, additional air bags, etc... Besides these main road vehicles, other transportation options such as snowmobiles, snow bikes, and snow quads, are not equipped as equal with all of these safety features. Although there has recently been some improvement towards the current models on the market within regards to safety features, the industry still lacks majorly in that department. By understanding and implementing the major safety features along with integrating newer technology, there is opportunity within this thesis topic to produce the safest vehicle on the road/trail to date.

Another area that needs to be improved in the "standard" everyday vehicles majority of people use to drive around (cars, trucks) is the control on the road in rural communities which are susceptible to lots of snow. This is a major issue in these standard vehicles, as the safety precautions are not targeting these needs. Overall the relationship between traction, G Force and torque/speed of the vehicle on the snow/ice covered roads leads to higher risk of losing

control of the vehicle.

2.2 Product Research

Introduction

Research conducted on current products related to the proposed thesis topic is useful because it creates a deeper understanding along with reveals how the targeted user is using these products. This process will also generate an idea of the features and benefits of each product, along with the negatives or cons of the product as well. By completing this, the wants and needs of the targeted user will also be evident. Safety, performance, comfortability, space/storage, and how practical along with cost efficient a vehicle is will all be factors that the user considers when purchasing/using a product and need to be taken into consideration heavily when it comes to the design direction.

Objectives

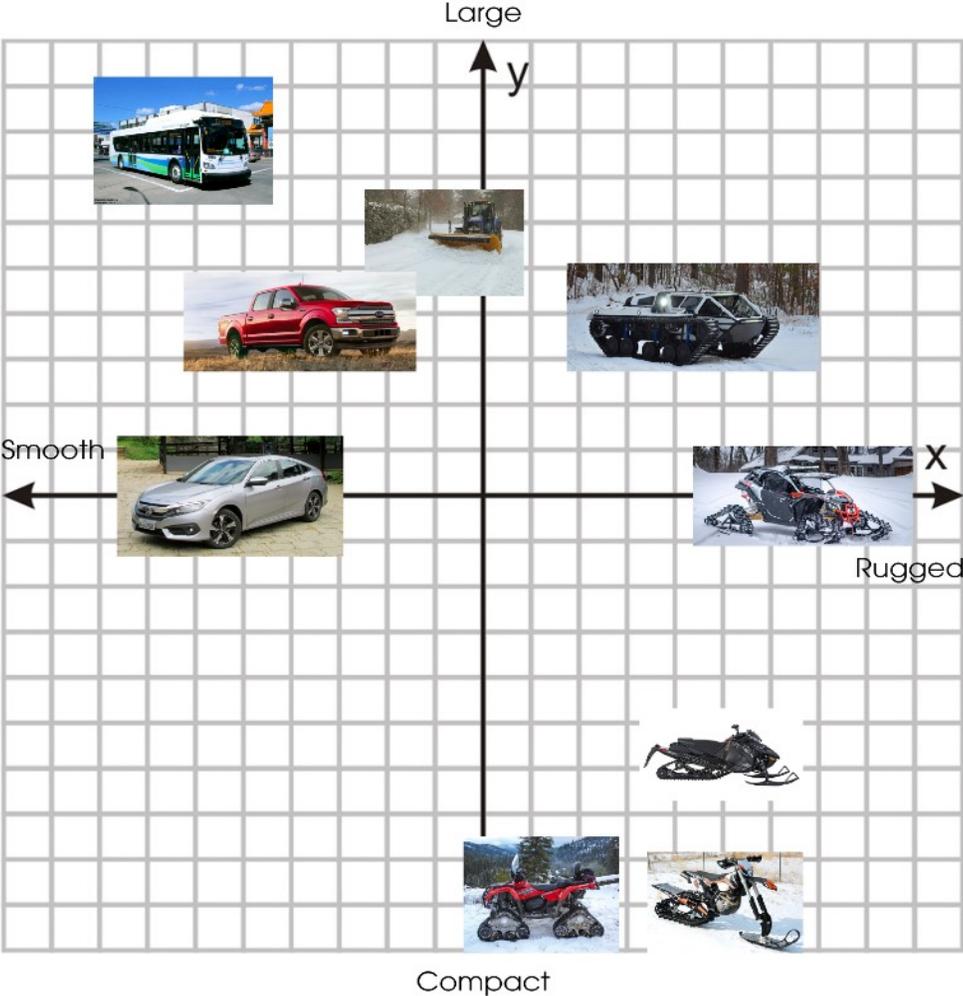
- Identifying benefits and features of the competing products on the market
- Benchmarking those benefits and features
- Evaluate the materials used in the competitive products
- Benchmark competition symbolic, aesthetic, semantic and functional profiles
- Look for areas with potential innovation (materials, safety features, usability, etc...)

Method

Data and information was gathered to generate a better understanding of the current products and their uses. This was done with google searches along with looking into reviews of each and every product from many different vehicle websites. This task was also done to gather information what products were more popular and why.

2.2.1 Current Products Profile

Two pairs of comparison features were selected to create an X,Y chart. These features were then assigned to either the X or Y axis, and the images of the benchmarked products were strategically placed on the chart within relation to their relating features. The chart features were simple in order to get an idea of the overall comparison between the products. On the X axis there was the comparison between “smooth” and “rugged” looking products. On the Y axis there was the comparison between “small” and “large” sized products. Comparing the products on this chart/graph was very important because it allows for an estimated target area where the thesis product should be placed. This is a very important insight on how the design aesthetically should be designed along with where the needs and wants lay within this correlation.



									
Size	4518 mm x 1799mm x 1434mm	5.89m x 2.03m x 1.92m	45ft x 9ft	2997mm x 1219mm x 1267mm	Varies	185 In x 99.5 In x 73.5 In	120 In x 12.5 In	5.3 ft x 4 ft	Varies
Weight	1290-1370 Kgs	4069-4653 Lbs	20,000-30,000 Lbs	215 Kgs	50,000 - 70,000 Lbs	7,750 Lbs	300 Lbs	520 Lbs	Unknown
Passengers	4 + Driver	4 + Driver	40-70 + Driver	1 + Driver	1	4 + Driver	1	1 + Driver	1-3 + Driver
Safety Features/ Rating	★★★★★	★★★★★	Unknown Rating * Safer than cars/trucks*	N/A	N/A	N/A	N/A	N/A	N/A
Power	180 HP	290-400 HP	450 HP	270 HP	Varies	600 HP	50 HP	50 HP	90 HP
Materials	Aluminum, Steel, Copper, Glass, Rubber, Special Fibers, etc...	Aluminum, Steel, Copper, Glass, Rubber, Special Fibers, etc...	Aluminum, steel, glass, rubber, etc...	Kevlar composite construction Aluminum, plastic.	Polyethylene, Steel plows, Durable plastic, Aluminum, Glass, etc...	high strength exoskeleton, tracks, High performance OEM truck parts.	Aluminum or steel, Plastic Ski, Plastic track.	Aluminum or steel, plastic track, rubber, etc...	Aluminum, Steel, Speed Tracks plastic, Rubber, OEM Parts
Shape	Soft edges, Smooth, Small	Bulky, Soft Edges, Tall	Bulky, Long, Boxy	Hard Edges, Sharp, Small	Large, Geometric, Hard Edges	Geometric, Rough, Rugged	Small, Sharp Edges	Small, Flowing edges,	Rugged, Sharp, Aggressive
Usability	Average storage, daily use	Lots of storage, daily use	Lots of passenger capacity, no personal storage	very small - no storage. Activity use	Work Related use	Unknown	No storage, activity use	small - no storage, activity use	Unknown
Protection From Elements	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes/No

Conclusion

- Overall everyday road vehicles are larger and aesthetically less rugged compared to snow specific machines
- Looking at the upper end of the graph (Large size) directly relates to the weight of these vehicles
 - These heavier vehicles are typically more commercialized products
- Most everyday vehicles lean toward the smooth pleasing aesthetic appeal
- Most smaller snow specific vehicles lean towards a more rugged rough terrain aesthetic appeal
- Majority of small - medium sized products are only 1 person machines
- Larger vehicles can seat multiple people
- Opportunity to integrate snow track technology into design
- Opportunity to integrate the 1 person machines aspect with a potential +1 option
- Targeted thesis product does not need as much power to drive compared to the larger vehicles on the graph

Opportunity to combine safety features from both larger and smaller vehicles into a “hybrid” machine

2.2.2 Benchmarking - Functionality

Introduction

Vehicles and machines that are designed to travel over snow currently are the product that occupy the market for people living in rural communities. These products have many different benefits and features for these people but also have many negatives or cons as well. This breakdown of the products functionality will aid the thesis design to enforce that the specific end user will have the best product available when it comes to usability along with functionality. As mentioned prior in the report, current vehicles on the market today have been updated with lots more safety features to ensure the well being of the users, although there is a gap between snow specific machines and these daily driven vehicles. This is a major issue as the individuals living in these rural areas are forced to choose between options that do not suit their specific needs in harsher winter weather conditions. Diving into the specific functionality of these current products will allow for a deeper understanding of exactly where these products lack when it comes to this thesis' targeted audience.

Objectives

- Compare vehicles and other transportation machines and their functionality
- Identify Ergonomics
- Identify Features

Methods

A comparison was conducted of the benchmarked products regarding transportation. Focusing on usability, functionality, ergonomics, touch points, and configuration of components associated with transportation vehicles. All of these products were examined to determine the most common and useful features and benefits they had to offer.

Results

A chart comparing the main features for the 9 comparable products was constructed.

The main features that were compared were:

- Size
- Weight
- Passenger seating
- Safety Features/rating
- Power / Engine
- Materials
- Shape
- Usability
- Protection from weather elements

Conclusion

There is a wide array of products currently on the market, although these products are in one way or another not suitable for the individuals living in rural communities susceptible to large snowfalls. This is due to many different reasons. For starters, the daily drivers such as:

cars, trucks, and buses do not handle well in the harsh winter snow environments. Due to the nature of the rural environments, these vehicles easily lose control if not driven with extreme caution. Secondly, the activity or hobby vehicles also have their downfalls in these winter environments for many different reasons. Although the most important downfall is the fact that majority of them are all exposed to the harsh winter environments in these scarce rural land masses. This poses many different risks and dangers to the driver if they are not very careful.

2.2.3 Benchmarking - Aesthetics & Semantic Profile

Introduction

Throughout our lives we see many of these transportation vehicles everyday, along with these snow specific transportation methods on various occasions depending on where you are located. As there is much competition throughout these products, it is very important that the aesthetic is appealing and the design of the product displays a certain expression that the user will want.

Objectives

- Determine aesthetics of various current vehicles and snow machines on the market today
- Identify the design language and who this is marketed to

Understand why users and buyers want to purchase these products, along with why they use them

Results

Overall throughout the various competition, there were a few areas where it was evident that improvement needed to be made. These areas were sustainability, reliability, and handling/control in the winter environments.

2.2.4 Benchmarking - Materials & Manufacturing

Introduction

The material consideration when designing for the individuals living in rural communities is very important because of the environment they deal with on a daily basis. It is vital that the design holds up against the winter climate, which includes colder temperatures than majority of urban locations and larger snowfalls. It is also important that the materials are able to be rugged enough to handle the rough terrain and unmaintained roads along with ice and snow conditions as they are less frequently plowed. By looking at the products on the market today, it will give a better understanding of what exactly goes into the manufacturing of these products and how they are made to last in the environments they are placed in. Once that is established, that information will lead to insights on what specific materials can be used to be most effective in a winter rural setting.

Objectives

- Identify materials used in existing products on the market today
- Identify best possible materials along with manufacturing process to accompany that material.

Method

Research was conducted regarding current products on the market today. These products were examined by looking at the material breakdown of the product along with the manufacturing method used to create these products. This method ultimately was used to

gain a deeper understanding of the development of transportation methods.

Results

Materials

Currently the vehicles on the market are taking advantage of strong light weight materials such as aluminum, and carbon fibre. Although a lot of these products are also using other strong durable materials such as steel, copper, types of rubbers etc... Some of the more specific snow vehicles are implementing extremely high quality performance materials into their products as well. For example some of the products are introducing military grade speed tracks that go on the bottom of the machine and are supplementary of the common wheel for most vehicles. There is also the use of high performance OEM parts, skis, and plastic integration. A lot of these materials allow for the machines/vehicles to perform better and more efficient. Although they come at a higher cost, it is worth the extra money for these companies to add them in because it also gives a higher appeal and aesthetic to the consumer.

There are also many different technologies across all of these products that go into the vehicles to add in different functions. Some of these functions may be safety features or potentially features to benefit the user and enhance the user experience.

Manufacturing

The manufacturing for all of these products are much like any other products (with the exception to the Ripsaw), where standardized components are made in bulk usually on a factory line, then sent out and assembled in a main warehouse. For products like cars and trucks, a lot of the main parts for the vehicle is manufactured all within the plant that certain

company has, although other parts may be shipped in and added to the vehicle along the assembly line process. With all of these products, the unit will be sold to the customer fully complete and ready to operate right off the lot. There is never any assembly needed or further work needed to be done to the vehicle prior to it being able to be used.

2.2.5 Benchmarking - Sustainability

Introduction

This section of research involved the interviewing of certain individuals living in rural communities that are susceptible to large snowfalls. Due to the pandemic during the time of the interview process, the interviews were conducted virtually using different online platforms such as Skype, phone call, email, etc... The nature of the interview was meant to be a guided conversation to allow the interviewee to speak freely on any points they felt was important. This method of interview was very important as it typically allows the interviewee to speak what is on their mind and usually giving more advice than simply answering base line questions. The interview process allowed for a deeper understanding of exactly what the users needs and wants were when it comes to travel in rural environments. It also allowed for a better understanding of areas where innovation and design could be implemented to allow for a better product for the end user.

Objectives

- Connect with users and individuals living in rural communities
- Understand pain points from these users within their daily actives
- Ask certain questions relating to the thesis topic

- Understand the users needs and wants
- Gain knowledge and insights on what the user experiences

Methods

Interviews were conducted with multiple people living in rural communities. These interviews were conducted via: Skype, phone call, zoom call, etc... The interviewees were asked questions based on their daily actives and what they struggle with throughout the winter months when it comes to transportation or driving in and around their town.

Results

Some of the main points brought up through the interviews can be shown as follows:

- Hard to control vehicle on snow and icy road conditions
- Poor visibility when sun goes down, makes it hard to see with not street lights
- Road are not maintained enough during winter
- Driveways are hard to get out of at times
- Rough terrain on back rural roads
- Lots of pot holes
- Animals can pose danger while driving (jumping in front of cars)
- Other vehicles aren't viable due to limited space and exposed to winter elements

Chapter 3

3.1 Needs Analysis

Transportation in rural communities that are susceptible to larger snowfalls is a big concern. Research in previous chapters has expressed the significant dangers of driving current vehicles and machines on the market today, under these extreme conditions. These methods all pose certain risk factors that individuals living in these communities are forced to deal with every time they leave their household in the winter months. Throughout the day these individuals may need to complete tasks or activities, in order to do this majority of the time they need some sort of motorized vehicle to travel from one location to another. One of the biggest factors is the fact that in these rural communities, a lot of the locations people travel to are very disperse and spread throughout the town. Most of the time in these situations, these individuals are not commuting very long distances. Although for the short commute time it takes them to reach a location and drive back home, it is very important that they are safe while completing their task.

Secondly, there are also a lot of individuals living in these rural communities that participate in recreational activities such as: snowmobiling, hunting, fishing, snowboarding etc... When it comes to safety with these individuals, they are also posed to a lot of dangers based upon the machines they use, as mentioned in prior chapters.

Therefor designing a new method of transportation that is versatile, nimble, handles extremely well in winter conditions, and protected from the winter weather elements, would be extremely beneficial for these individuals living in these small rural communities.

Ultimately allowing for people to complete daily tasks and recreational activities with ease, and peace of mind knowing they are safer from the dangers other motorized vehicles pose. This chapter will analyze and discuss the results of the research conducted concerning user needs.

3.1.1 Needs/Benefits Met By Current Products

Introduction

With a wide array of current products on the market, various levels of usability along with ergonomic aspects are present in many different ways. This section will aim to pin point the users needs and how current products meet them, along with suggest improvement, and innovation opportunities for the final design.

Objectives

- Identify the users needs
- Identify the needs that are met with current products on the market
- Identify areas for improvement/innovation

Method

This section will dive into the user profile, how they behave while using the product, and the products features and benefits, along with user interviews. A needs report was written to investigate the users needs of current products related to winter transportation. Research based on products was also conducted in order to gain information and insights on how users perceive current products on the market today. Finding from those reports are as follows.

Results

A lot of the products are marketed to a general audience and not specific to issues that are evident in rural communities. For the other products on the market that are more snow specific vehicles, there are certain uses that they are best suited for which doesn't always

appeal to the average person living in these towns. The following is a list of potential areas in which transportation in these rural communities can be improved on.

- Safety
- Handling
- Comfort
- Protection From Winter Elements
- Usability

Two products that were relatively close in relation to potential design opportunity for this thesis project, were evaluated and compared on how they met the users needs. The two products selected were:

- 1) Can-Am Apache Backcountry
- 2) Ripsaw

3.1.2 Latent Needs

Introduction

When looking into designing a product, the targeted user needs are the foundation for any design development. This is especially important when ergonomics, quality of life, and other human factors are in question. The final design solution proposed is a product that will enhance daily drivers through safety, comfort, and usability. This design solution must also be able to meet the fundamental needs of the targeted user. In this case the vehicle will enhance the user experience by allowing the individual to travel from point A-B in a safe environment and lessen the percentage of dangers posed on their journey. There are a few specific areas where this vehicle will need to out perform any competition, and that is what separates it from the rest of the products on the market. This section will focus on the latent needs of the user to understand what they are and what is not being met by the current products. There for allowing this thesis product to rise above and enhance human life.

Objectives

- Identify latent needs
- Understand needs being met
- Gain insights on how the product responds to the users fundamental needs
- Propose how a solution / innovation implemented in the thesis project will meet those needs

Method

This section reflects on the user, his/her behaviours, any features or benefits, and the user interview process. A needs report was written to investigate the users fundamental human needs of current products related to transportation in rural environments.

Results

The following shows the relationship between the product and fundamental human needs.

- **Safety** within this vehicle is critical. When the individual is completing daily tasks such as getting groceries, or driving to work and back home, they need have that feeling of safety and trust in the vehicle they drive. Without this safety, the individual is exposed to many dangers on and off the road.
- **Recreational Needs** are also a big factor within the lives of individuals who live in rural communities. There is a need for vehicles that can be useful during recreational sports, such as hunting, ice fishing, snowboarding back country etc... It is extremely important for these individuals who are participating in recreational events to have safety and security when it comes to the reliance of their machine. Without this reliance, these people can also be exposed to many dangers, as rural environments can be very unforgiving, especially during winter months.
- **Usability** is also very important, as the vehicle needs to be practical and suit the specific needs of the user. By understanding what exactly is needed from these individuals and their certain habits they perform on a daily basis, the design of the thesis project becomes enhanced. This is caused by the implication of certain features and benefits directly relating to the user. Overall enhancing the usability and the quality of life throughout this product.
- **Ease** in many ways is related to efficiency, although with this specific product the level of ease is important. With a vehicle that is difficult to drive and maneuver, people will not

connect and use the product to its full potential. With having a product that is easy to use, the users overall experience will be enhanced compared to other products.

- **Fun** and excitement is also important for a product with this ability. Individuals should be extremely excited when purchasing a product such as this one. It is a new experience for everyone as they try it for the first time, and also will change the way they commute and travel around on a daily basis.

Table 3.1.2.1

	Benefits	Corresponding Fundamental Human Needs (FHN)	Relationship Between Benefits & FHN
1	Safety	Control, visibility, sensors for oncoming dangers	Strong
2	Recreational Needs	Storage for hunting, fishing, snowboarding. Enclosed environments to protect against winter elements.	Strong
3	Usability	Space to complete daily tasks. Enough room to sit 2 adults. Operation cost.	Strong
4	Ease	Easy to operate, low learning curve.	Strong
5	Fun	Fun to drive. Exciting for the experience.	Moderate

Discussion

There are a lot of important factors that go into a well designed vehicle, especially one that is specific to snow travel in rural communities. Two areas that could vastly improve the

fundamental human needs is the safety and usability of this product. By creating a product that is safer to drive in the winter months within these rural communities, fundamentally these individuals needs will be met. With usability, fundamentally these individuals could use improvement from the current products on the market, as they do not suit many daily activities / tasks. Throughout the rest of the categories mentioned above, recreational needs and ease of use are also very important. There is a large need for improvement on recreational vehicles and their usability as they do not specifically suit the certain needs of individuals and their tasks while living in rural communities. Finally, the last category being fun, is also important as the user must feel a sense of excitement while they are using the product.

3.1.3 Categorization Of Needs

Introduction

Once the needs and how they are related to the user have been established, the information must be categorized into groups allowing for clear and direct understanding of the data and how it works. These groups will create a deeper understanding of which needs are higher priority compared to others, ultimately furthering the design of the final thesis solution.

Objectives

- Determine the user needs and how they differ from the users wishes
- Determine the needs that are most crucial to the design
- Determine latent needs
- Categorize needs

Method

Through interview process, user needs and wants were determined. Due to the pandemic, these interviews were conducted via Skype, Email, Phone Call, and Zoom meetings. This section also reflects on the user profile, current user behaviours and how they use the product, their thoughts and opinions on the related subject, along with features and benefits. This section also calls back to the initial needs report written in order to investigate the current products and how they are meeting the users needs/wants. These needs were then categorized into three separate groupings. These groups consisted of user wants/wishes, crucial needs, along with latent needs.

Results

The resolved design direction will focus on ergonomics, safety, and usability. With these areas being improved it will produce a dramatic effect on the user and their lifestyle. The following lists the user needs in categories.

User Wants/Wishes

- More control over the vehicle while driving over snow/icy roads
- Better visibility during night time driving (especially during winter months when the sun goes down earlier in the day)
- Compact vehicle that allows for usability and storage for completing small day trips or daily tasks

Crucial Needs

- Handling and control over vehicle, allow it to not slide out of control on the roads
- Handle the rugged terrain in rural communities

- Better visibility during night hours
- Sensor system to allow for alerts related to oncoming dangers (animals, deer, debris on the road)

Latent Needs

- Sensor system to display on coming dangers
- More compact area, while still offering generous storage
- Machine that can be used in both daily activities and recreational use
- Machine that offers better maneuverability

Discussion

The defined needs are categorized with each point listed below. Looking at what is most important, being the crucial needs, along with user wants/wishes and latent needs also taken into consideration while designing the final solution will allow for an overall better product for the end user.

3.1.4 Needs Analysis Diagram

Introduction

The section uses information taken from the categorization of needs in order to demonstrate how the final product will enhance the user experience and ultimately meet the users needs and wants. The usability, viability, and feasibility of the vehicle will be discussed in order to gain a deeper understanding and more knowledge of how the proposed product will affect the user. Overall by including this information into the final design direction, it will

set this product apart from the current existing products that these individuals are using in their daily lives.

Objectives

- Understand the desire individuals have for certain vehicles
- Provide feasible option for the user to enhance their lifestyle
- Innovate on current products

Method

This section reflects on all previous sections including the user profile, current user behaviours, features and benefits, the users interviews, and aesthetics/semantics. Reflecting on the categorization of needs will also be relevant in this section as it is needed to create a deeper understanding of innovation potential. To truly put this information together, a chart was made to display the successful human centered design following where the needs categorized were implemented into the following characteristics: Usability, viability, and feasibility.

Results

Usability

Usability is extremely important for these individuals daily lives because they are using the product almost every single day. It is a product that needs to be practical, where they are able to use it without any issues and their experience from using the product should be streamlined and positive. Looking at all the important features that are needed to achieve this, the usability boils down to the daily tasks that these people do everyday. Getting

groceries or recreational events that they might partake are all important to their living and equality of life, there for by implementing certain areas of the vehicle dedicated towards these data points, will ultimately enhance their usability experience with the proposed product.

Viability

The final design must be viable in many different areas in order for it to work in this market. The product must be able to perform ovetop of snow and ice as it is a winter specific vehicle. The product must also prove to be safer than other vehicles on the road by implementing certain specific safety features related to rural areas. Also the product must be ergonomically friendly for both 5% female to 95% male. By taking into consideration all these factors, this product will be viable specifically to the individuals living in these rural communities.

Feasibility

Feasibility is also very important for the people in these communities, as they do not want another product that is going to cause issues or be challenging to understand (especially as the demographic is predominately older). It is vital that the use of the product have an easy learning curve so that people who are using this product for the first time, or beginner drivers are able to understand fully how it works and be able to use the product to its full potential.

Discussion

Implementing all three of these characteristics into the proposed thesis product will fulfill the end users needs to a degree where it is ultimately benefiting their lifestyle in one

way or another. By taking into consideration all of the points made, along with iterating the design consistently, the final design solution will aim to please all three characteristic points.

3.2 Functionality

For this section, there was a survey conducted to allow for better insight on what needed to be solved in the eyes of individuals living in rural communities. For starters, questions were created in order to ask these individuals. The questions are as shown.

Questions For Empathy Mapping

Who are we empathizing with?

- 1) Can you tell me about yourself and what its like living in a rural community?
- 2) Can you tell me how often you travel within the community?
- 3) Can you explain to me the environment in winter months, and the challenges winter brings regarding daily travels?

What do they need to do?

- 4) What are some of the daily/weekly tasks you need to complete that involve you leaving the house?
- 5) What influences you to complete these tasks?
- 6) During winter months are there ever situations where you would not be able to complete these tasks and why?

What do they see?

- 7) Would I be able to see your transportation method
- 8) Do you ever have issues with this specific vehicle in winter months and what may those be?
- 9) What are the tell tell signs for you to not leave the house? What do you see to make those decisions?

What do they say/do?

- 10) Are there specific tasks you need to complete before you leave the house in the winter months?
- 11) What is going on in your head when you have to complete these tasks before going out?
- 12) Where are you usually travelling to? and are there any tasks that you need to complete when you get there?

Pains

- What is the most difficult part about going somewhere in the winter months?
- Are there every times where you were not able to get where you wanted to go due to the weather?
- What gives you the biggest frustration in the winter months and why?

Gains

- How do you feel about completing your tasks in these environments?
- Tell me about a time that was enjoyable where you had to go out?

What is your favourite part about the winter? do you have any favourite parts about travelling in the winter?

After completing these surveys, the main points being made for the users needs and wants are listed below.

Summary

- Living in rural community that is susceptible to large snowfalls.
- Travels or drives around almost everyday for one task or another
- Has hard time in winter to complete these tasks, due to the challenges and safety factors that winter poses.
- Hates to shovel and complete winter related tasks.
- Depends on weather channels and radio channels to know the weather conditions and future conditions.

- Sometimes doesn't feel safe on the roads due to winter conditions, but also other people driving in possibly unsafe vehicles.

3.4 Aesthetics & Semantic Profile

Introduction

Any vehicle is a very large item on the road, especially when it is a snow specific vehicle. These machines are recognizable due to their standout features such as tracks and other irregular parts. Many machines have changed over the course of time when it comes to their aesthetic appeal and functionality, along with manufacturability and technology. This section aims to, in conjunction with the previous sections, help decide the design direction of the proposed product for this thesis project.

Objectives

- Compare existing designs
- Understand the design language of existing products (interior/exterior)
- Decide design direction
- Discuss semantics of proposed product

Method

This section uses section in chapter 2 to look into ergonomics, aesthetics, and semantic features of current vehicles and machines that are in use today. In order to create an understanding of the design language involved in their design, a deeper look at the interior and exterior features will be done. Once completed this section will aid in a design direction for the end result of the thesis project.

Results

Interior and exterior features share certain aesthetics when it comes to the full experience of a vehicle. Each specific product has its own style and appeal which is targeted towards its user. Looking at ergonomics and component considerations, there are many factors that are relevant for the aesthetic of this design direction. These factors are as follows:

- Size of vehicle
- Storage capacity
- Product being stored on a daily basis
- Passenger Limit
- Interior ergonomics
- Driving style / type of transmission
- Person height/weight (5%-95%)
- Time product will be used
- Power Capacity / Storage for power unit
- Exterior materials
- Interior materials
- Vehicle weight

3.5 Sustainability - Safety, Health & Environment

Introduction

This section of research involves certain individuals living in rural communities that are susceptible to large snowfalls. By conducting research that dives into understanding the

current products on the market, insights and opportunities are presented for this thesis topic to enhance safety, health, lifestyle, and sustainability. When conducting this research, there are a few main areas that were targeted. These areas being the materials and manufacturing process' along with health, safety, and sustainability aspects that these products currently use. Once having completed that, there was also research conducted on new technologies and potential features that can be implemented into the proposed thesis design to further benefit the consumers. Safety, health and environment in any vehicle setting is very important, especially as this vehicle is aimed to create a safer transportation method for individuals living in rural environments. To be specific the choice of materials and features the vehicle has, plays a big role in creating that safe aspect for the driver. With all of the dangers posed from living in rural environments in the winter months, it is extremely important to implement as many features as possible to give the user a pleasant and positive driving experience. Throughout the design there are many different features that allow for not only sustainable benefits but also safe/health implications.

Literature Review

Currently on the market there are many vehicles that have different features related to off road driving/winter weather driving along with certain benefits depending on how these vehicles are used. Although there is much room for improvement within this industry as they can be enhanced in many different aspects such as safety, health, and sustainability. Some vehicles that are currently on the market would be: snowmobiles, winter quad vehicles, snow bikes, etc... For these vehicles, some leading companies in the industry today are constantly pushing to enhance their vehicle lineup to be new and innovative in our ever changing world. Snowmobile company Taiga Motors newest sled product lines are currently all switching to

electric power over combustion engines. This movement comes as electric is more eco friendly for the environment and with the new technology, along with more efficient than gas powered machines. Other leading competitors such as BRP are implementing new safety features along with top of the line technology to enhance the driving experience while using their products. Some of these new implementations include four wheel steering on some of their quad ATV's and cabin vehicles. Ultimately these are both examples of enhancement that companies are currently trying to implement as they are realizing that the winter vehicle industry is far behind in the sense of safety, health, and sustainability features.

Sustainability

Currently on the market when it comes to snow vehicles, there are limited actions taking place to ensure sustainability throughout these products. As trends are heading in the right direction and leading people to pursue more eco friendly/sustainable solutions for all of our products, unfortunately these so called luxury items are farther down on the list when it comes to that aspect. Only very recently are engineers and designers trying to implement these actions into their products. One of the companies mentioned above was Taiga Motors which has just launched a 2020 lineup of fully electric snowmobiles. This is one of the first initiatives to create a more sustainable and eco friendly product, as a lot of these smaller motorized vehicles are terrible for the environment due to combustion engine use. As Taiga Motors is one of the very first to finally implement electric options into their snowmobiles, it shows how far behind the competition is and how far behind the industry is as a whole when it comes to sustainable/eco friendly options.

Throughout the products on the market, there are certain health and safety factors that need to be taken into consideration before production of any product. When a person gets into or on one of these powerful machines it is vital that they are safe in that environment. Some of the products listed above have more safety features and precautions based upon the use and general setting the product would be used in. Although with that being said, some of the products listed above have a larger risk factor when operating due to difficulty of operation. From exploring all of the current benefits, this proposed thesis design is going to implement additional safety features to ensure rider safety no matter what environment. This design will take benefits from vehicles such as snowmobiles with track systems, and other common vehicles such as enclosed cars and trucks in order to protect against the elements of winter. In doing so the proposed product will be beneficial for an audience that lacks in transportation options during the winter months.

As technology advances there are more safety features being implemented into standard vehicles such as cars, trucks, and busses. These certain safety features might include road guidance assistance, assisted breaking, reverse alert systems, additional air bags, etc... Besides these main road vehicles, other transportation options such as snowmobiles, snow bikes, and snow quads, are not equipped equally with all of these safety features. With this thesis design, all of the safety features will be standard as the final proposed vehicle is enclosed and can host all of these features successfully. Although there has recently been some improvement towards the current small vehicle models on the market within regards to safety features, the industry still lacks majorly in that department. By understanding and implementing the major safety features along with integrating newer technology, there is opportunity within this thesis topic to produce the safest winter vehicle on

the road/trail to date.

Another area that needs to be improved in the “standard” everyday vehicle that majority of people use to drive around (cars, trucks) is the control on the road in rural communities which are susceptible to lots of snow. This is a major issue in these standard vehicles, as the safety precautions are not targeting these needs. Overall the relationship between traction, G Force and torque/speed of the vehicle on the snow/ice covered roads leads to higher risk of losing control of the vehicle. For this reason, this thesis design will implement a wheel based track system. This system will not only be able to hold better traction on the snow and ice, but it also hosts a motor in each wheel, allowing for real time data to enhance the driving experience through power supply to each track. By integrating this system into the proposed thesis design, the three wheel vehicle will be safer and more reliable than all other products on the market.

Sustainability Statement For Final Design

Overall these findings impact the thesis design majorly in the considerations for safety and health features along with maintaining a sustainable & eco friendly product. Being able to implement all of these safety features will allow for individuals: to be aware of oncoming dangers on the road, have more traction and control of their vehicle when driving on snow/ice covered roads, have more protection in the case of an accident, etc... Along with these safety features, being able to create a product that is also eco friendly and sustainable is very important and much needed within this industry. By designing and creating a vehicle that has solar panels, electric batteries/motors, and using materials that are sustainable, the proposed thesis design will allow for the product to be far ahead of any competition within the industry.

Conclusion

Throughout this process of comparing current products and the proposed thesis design, there was a big understanding of the lack of technology used in these smaller recreational/winter vehicles. As they are not the top priority when it comes to everyday use nor the most updated cutting edge technology, there is a big opportunity to implement these new technologies and safety features along with sustainable aspects in order to create something revolutionary in the winter vehicle industry. Conducting research on all of these current products gave insights into what was missing in the current vehicles on the market today. Ultimately allowing for this thesis design to take advantage of the lacking technology opportunity.

3.6 Feasibility & Viability

3.6.1) Material And Manufacturing

Vehicles on the market are taking advantage of small technology implementations, all of them are using strong light weight materials such as aluminum, and carbon fibre. A lot of these products are also using other strong durable materials such as steel, copper, types of rubbers etc... Some of the more specific snow vehicles are implementing extremely high quality performance materials into their products as well. For example some of the products are introducing military grade speed tracks that go on the bottom of the machine and are supplementary of the common wheel for most vehicles. There is also the use of high performance OEM parts, skis, and plastic integration. A lot of these materials allow for the machines/vehicles to perform better and more efficient. Although they come at a higher cost, it is worth the extra money for these companies to add them in because it also gives a higher appeal and aesthetic to the consumer.

3.6.2)

The manufacturing for all of these products are much like any other products, where standardized

components are made in bulk usually on a factory line, then sent out and assembled in a main warehouse. For products like cars and trucks, a lot of the main parts for the vehicle is manufactured all within the plant that certain company has, although other parts may be shipped in and added to the vehicle along the assembly line process. With all of these products, the unit will be sold to the customer fully complete and ready to operate right off the lot. There is never any assembly needed or further work needed to be done to the vehicle prior to it being able to be used.

3.7) Design Brief

The goal of this design is to create a safe transportation method for individuals living in rural environments that are susceptible to large snowfalls. Currently there are many different dangers that are posed on the roads within these communities. This thesis looks to design a solution that allows drivers to get from destination A - B safely while avoiding all those dangers. The following list guided the current design solution.

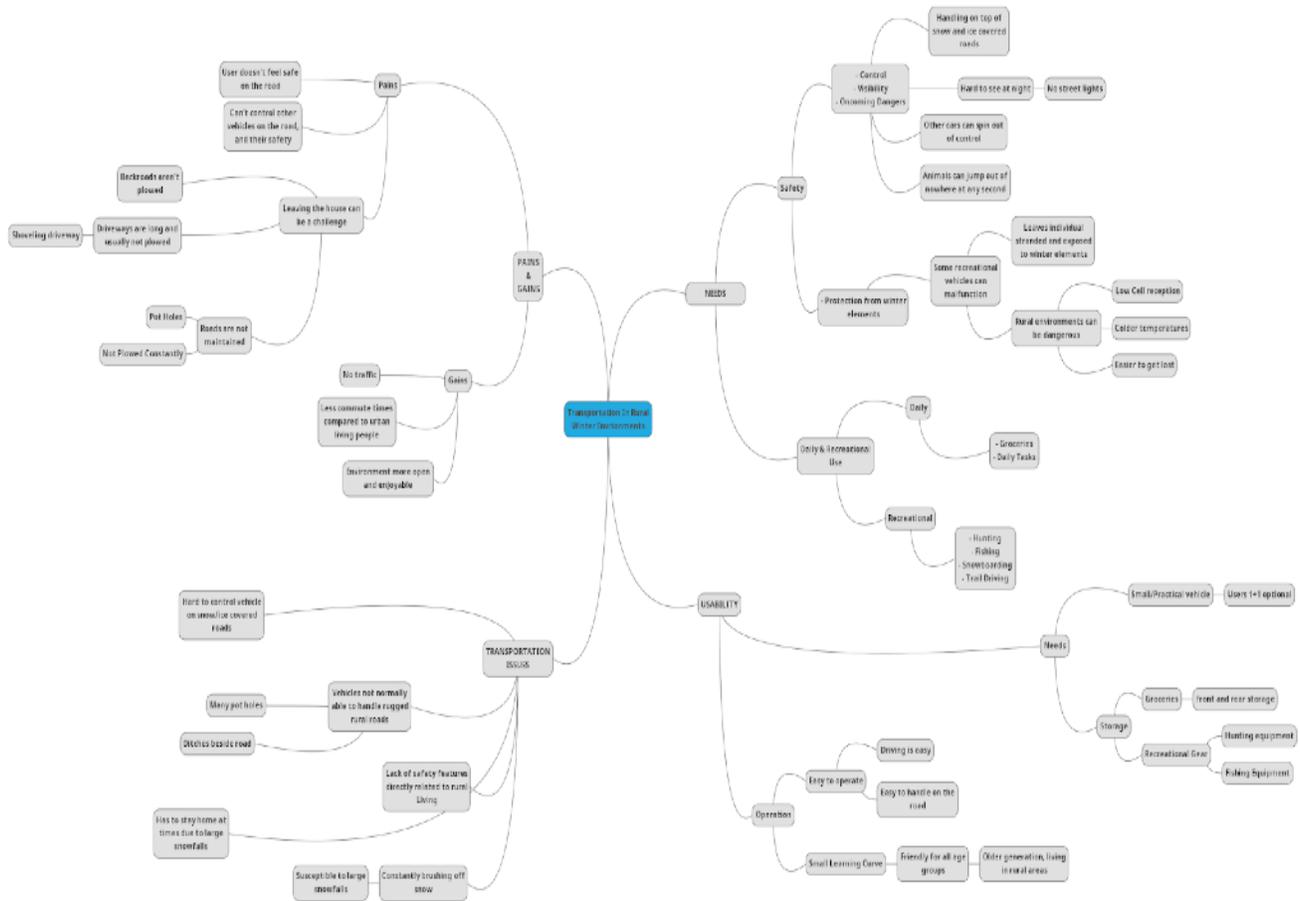
- Easy to use (easy learning curve)
- Easy to maneuver
- Create a solution for drivers to feel safe while driving over unplowed unmaintained roads
- Ergonomic interior
- Battery powered solution
- Solar panel solution
- Eco friendly LED headlights
- Tandem seating (1+1) design
- Advanced motors in wheel design for real time information / safety benefits
- Viable storage for everyday use

Chapter 4

4.1 IDEATION

4.1.1 Mind Map

The design process began with a mind map that was used to investigate and organize the main issues individuals have while driving in rural communities. It also investigates users needs and wants, ergonomics requirements, aesthetic looks, and the interaction and safety of the product.



4.1.2 Inspiration Board

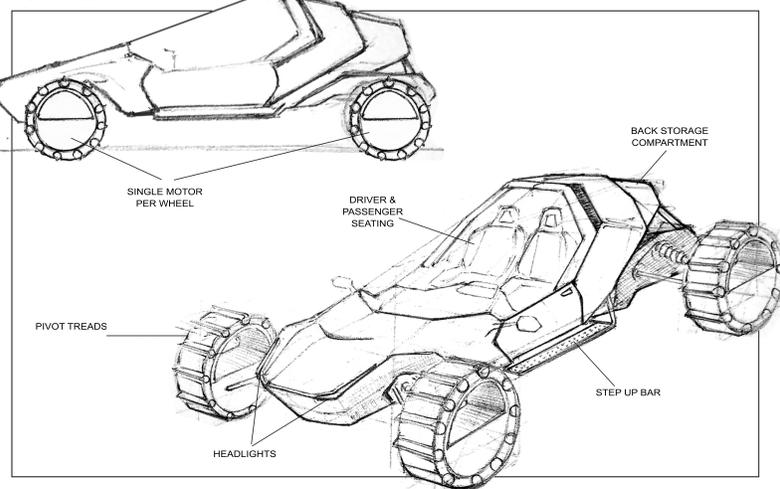
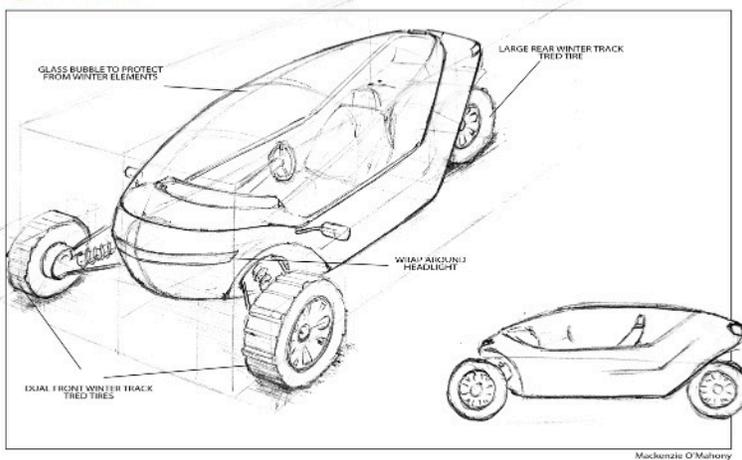
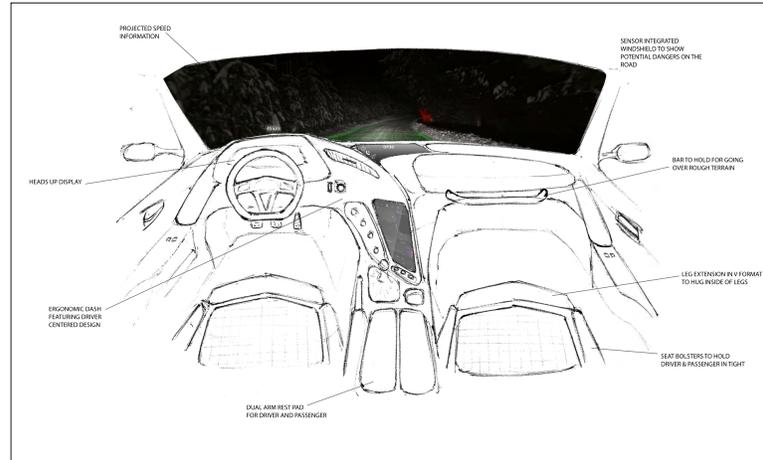
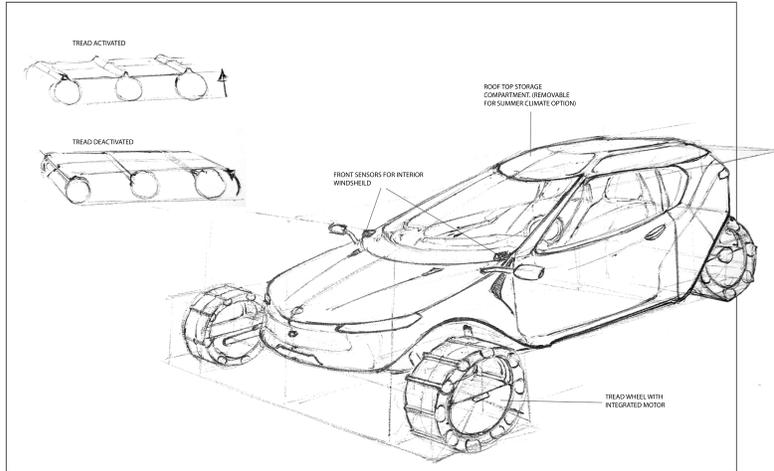
An inspiration board was created using Pinterest and Google searches. These images gave a design aesthetic guideline, branding, and colour scheme for the design solution.

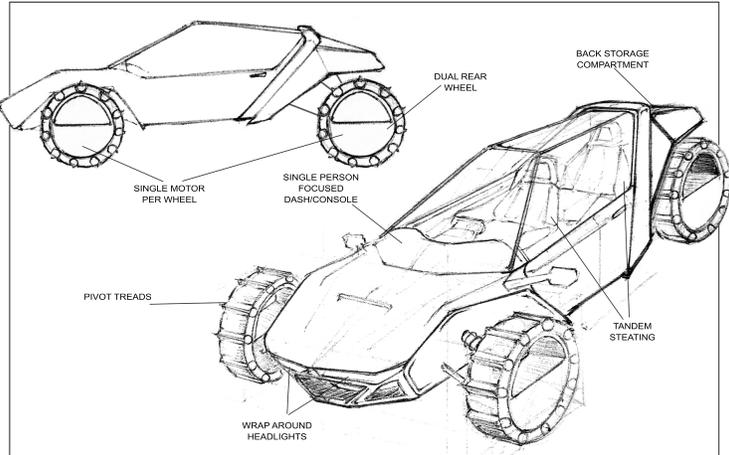


4.2 PRELIMINARY CONCEPT EXPLORATION

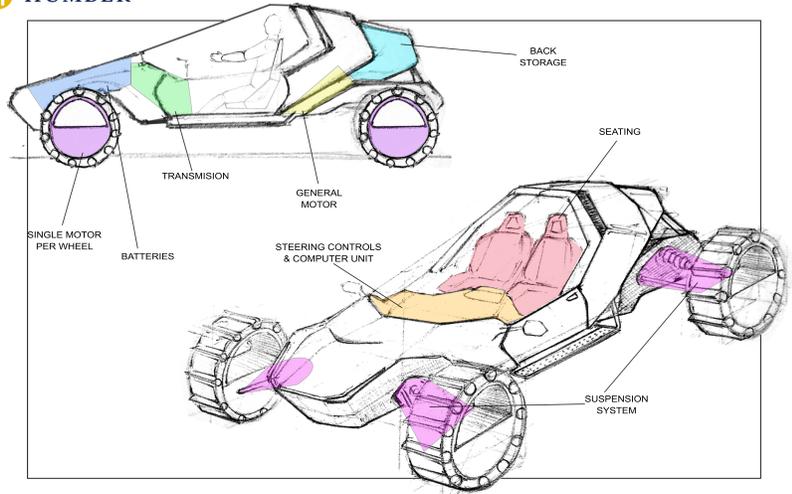
The initial stages of concepts sought to investigate as many design paths as possible.

They consisted of a variety of products that could ultimately aid in the transportation methods for individuals living in rural communities.

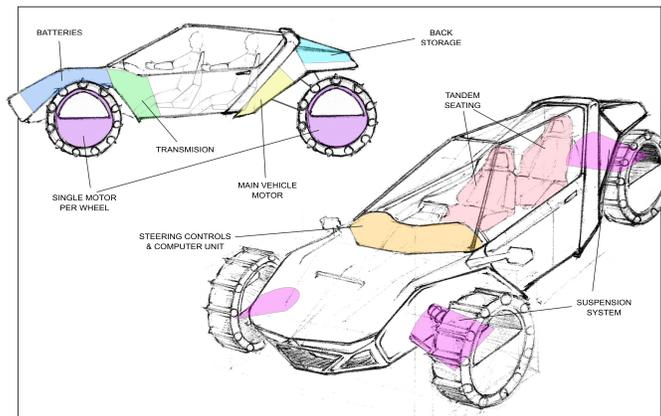




Mackenzie O'



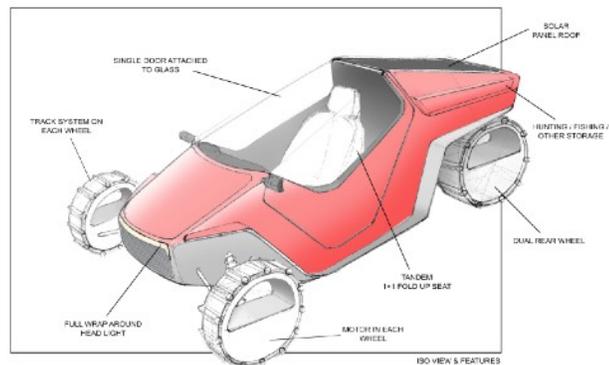
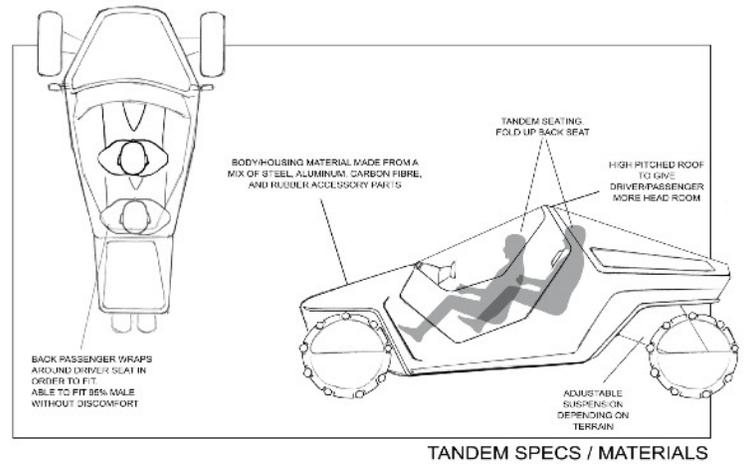
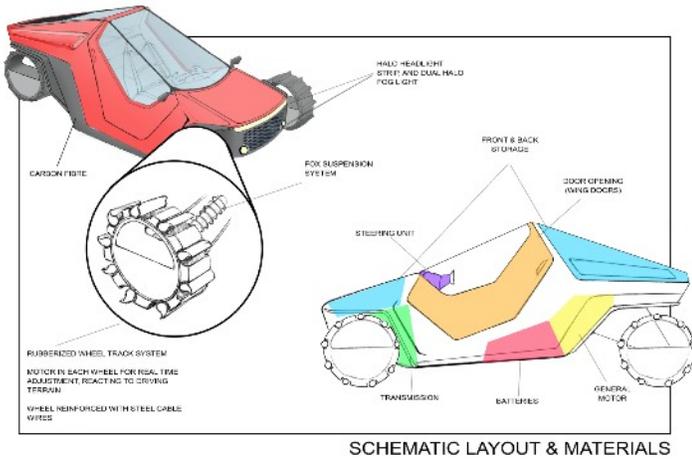
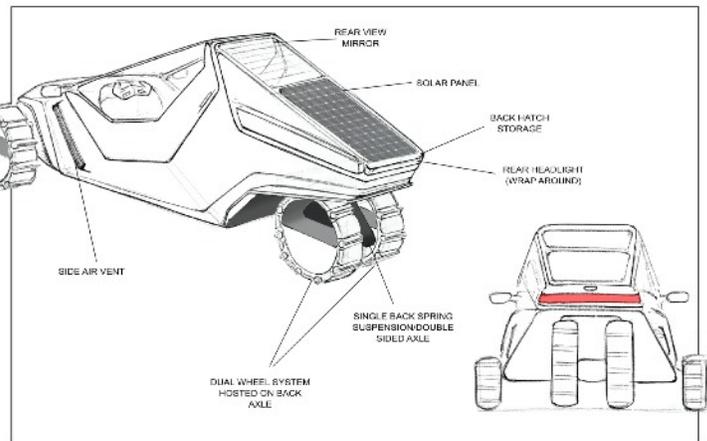
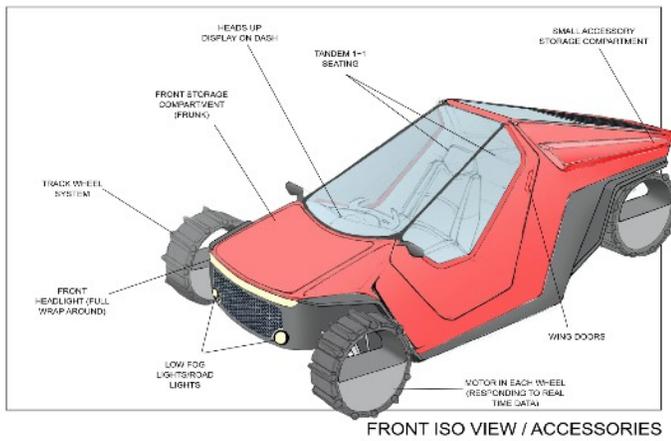
Mackenzie O'Mahony



Mackenzie O'Mahony

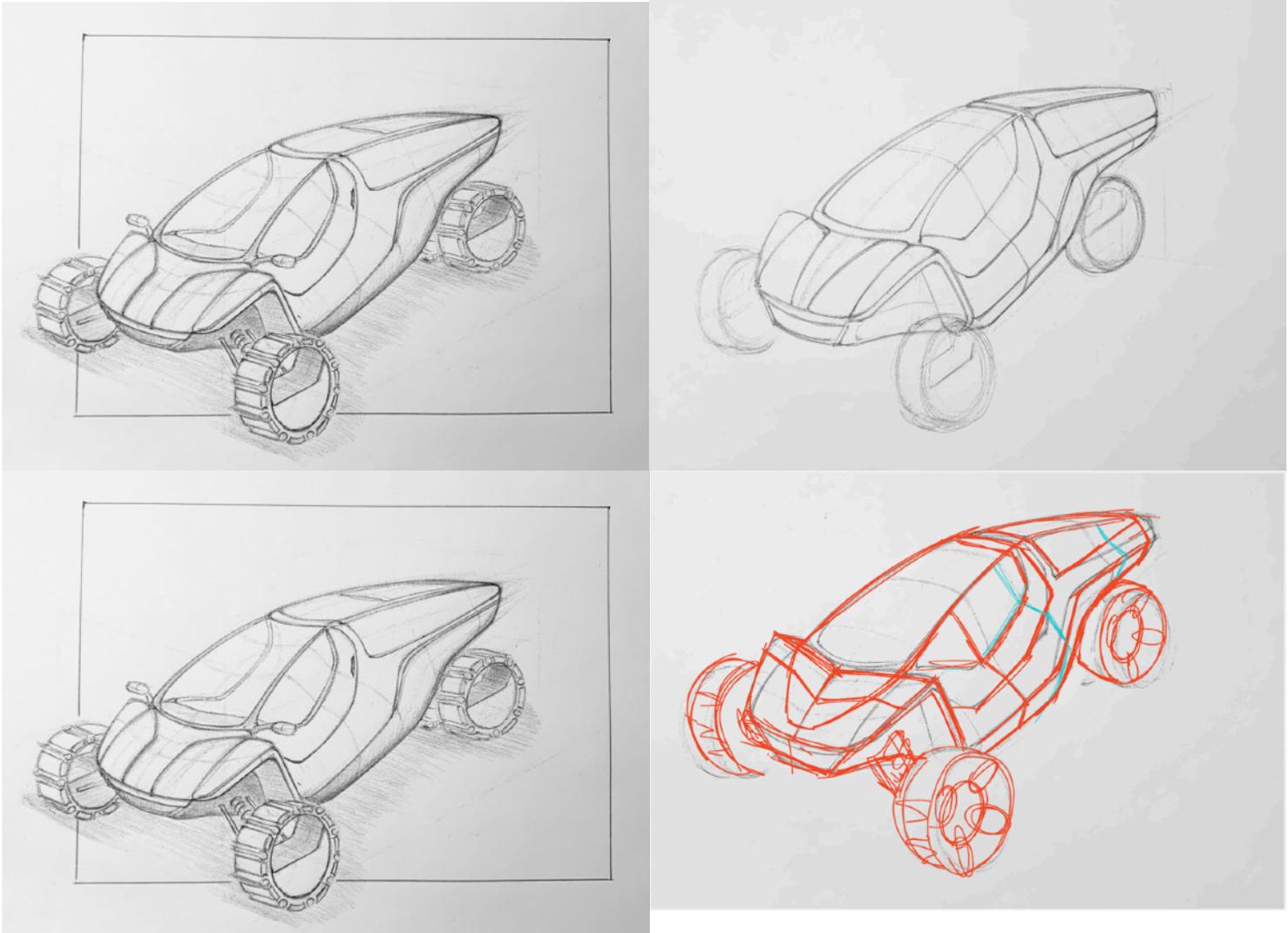
The preliminary concepts involved different styles / types of winter vehicles that would be used in a rural setting. Eventually the design was further developed as shown in the concept refinement stage.

4.3 CONCEPT REFINEMENT



Once the design was slightly more fleshed out, a lot of the schematics was important factors were implemented into the design.

4.4 DETAIL RESOLUTION

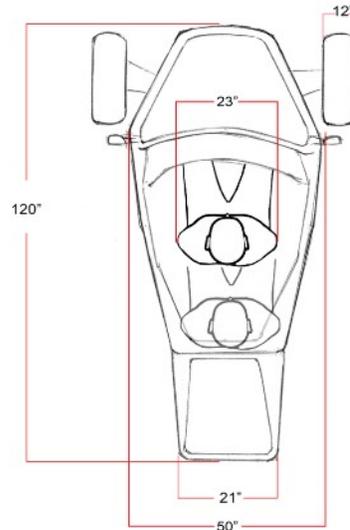


The detail resolution was beneficial in resolving some of the smaller details and aesthetic looks of the overall design. This ultimately led the design into CAD (Solidworks), where the rest of the small features and design aesthetic would be resolved fully to completion.

4.5 SKETCH MODEL

4.5.1 & 4.5.2) Functionality & Ergonomics

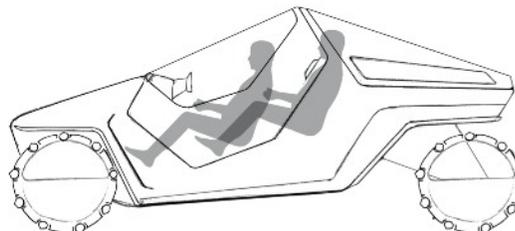
A scale model was created in order to aid the final design direction. This model was extremely helpful in getting the dimensions of the final design resolved along with the overall layout and how each section was going to work in conclusion with one another.



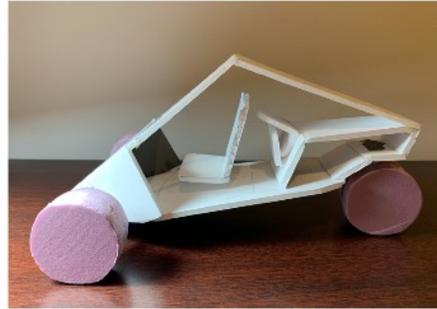
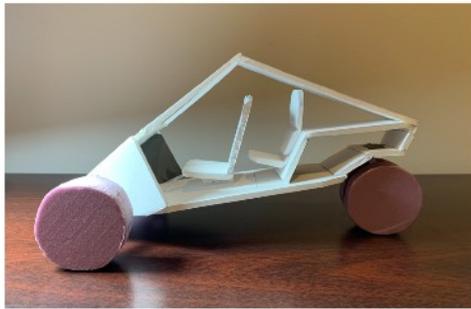
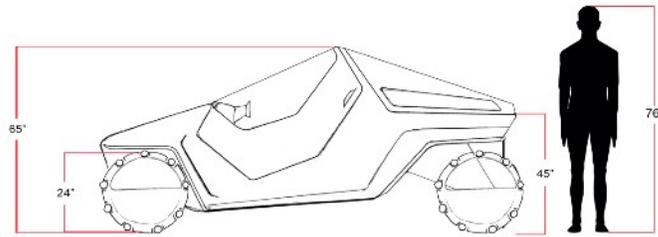
FRONT/BACK/TOP VIEW



INTERIOR DETAIL



SIDE VIEW



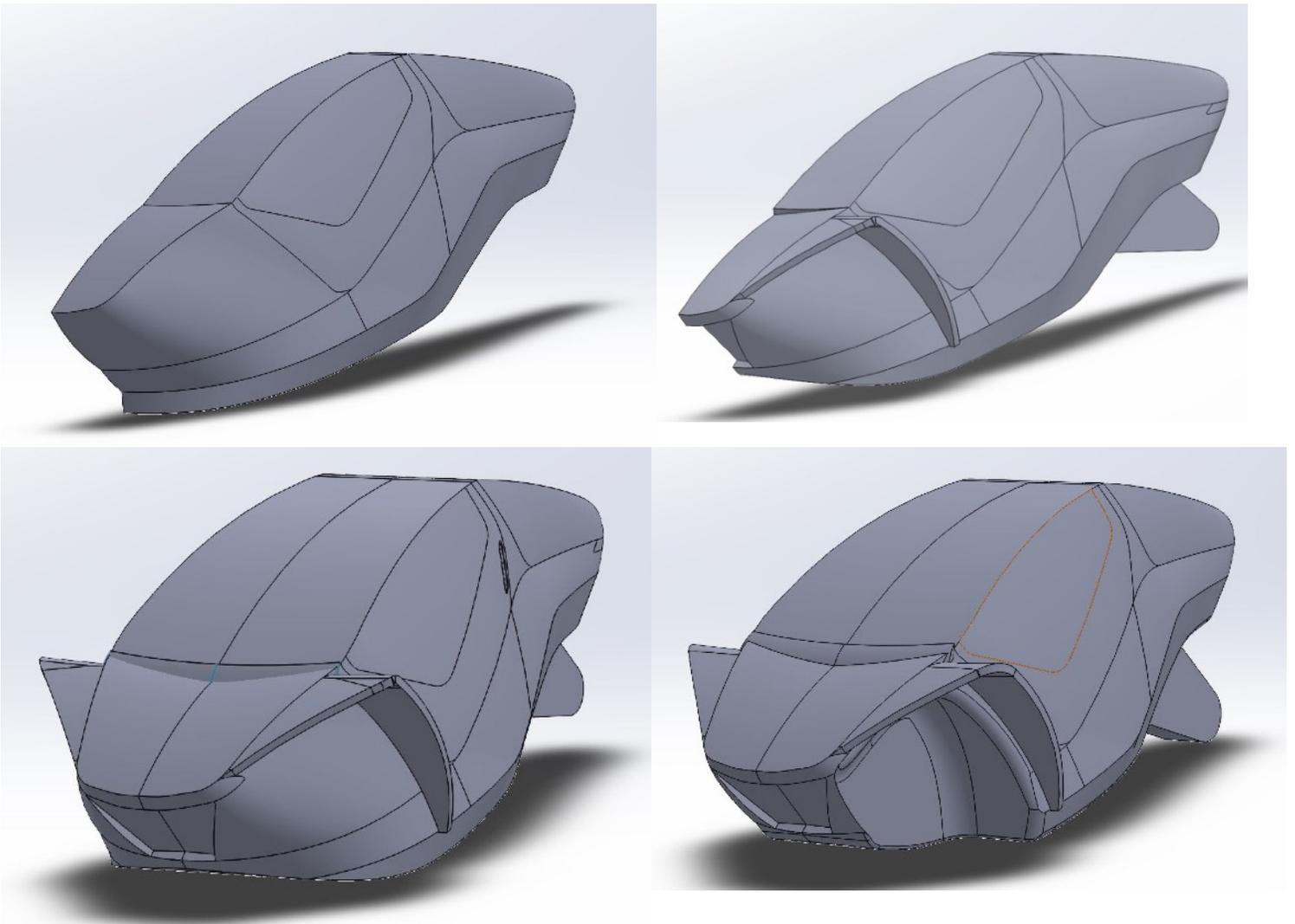
ISO VIEW

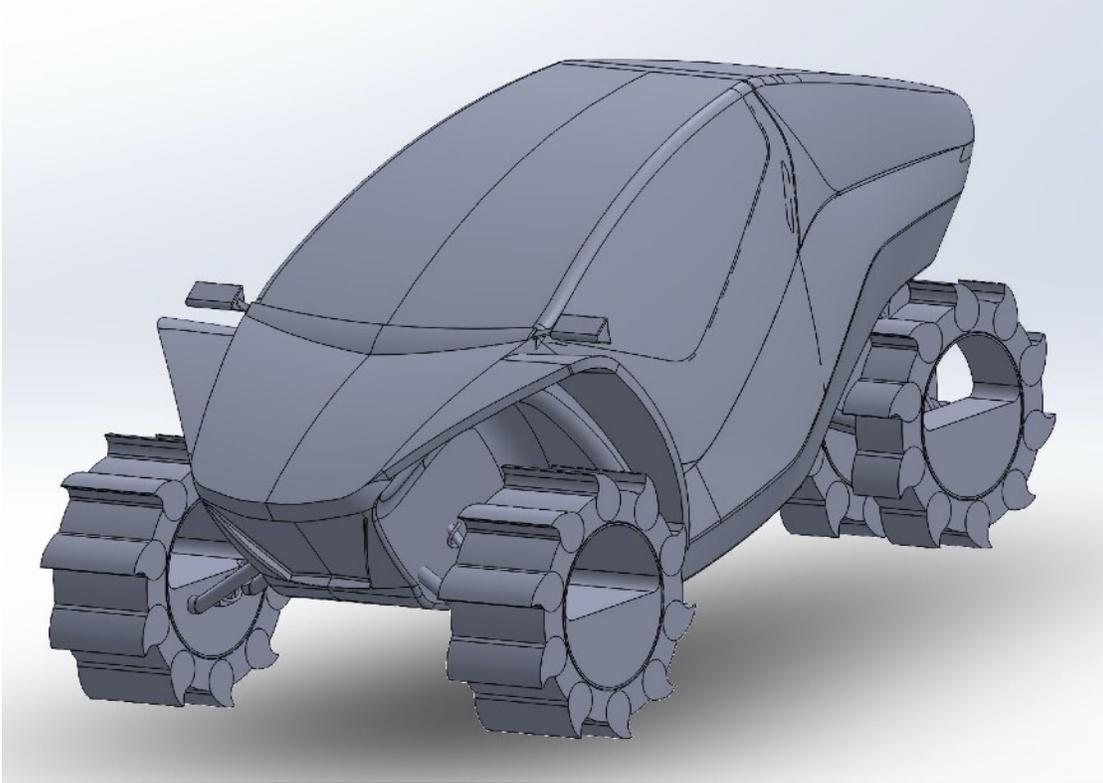
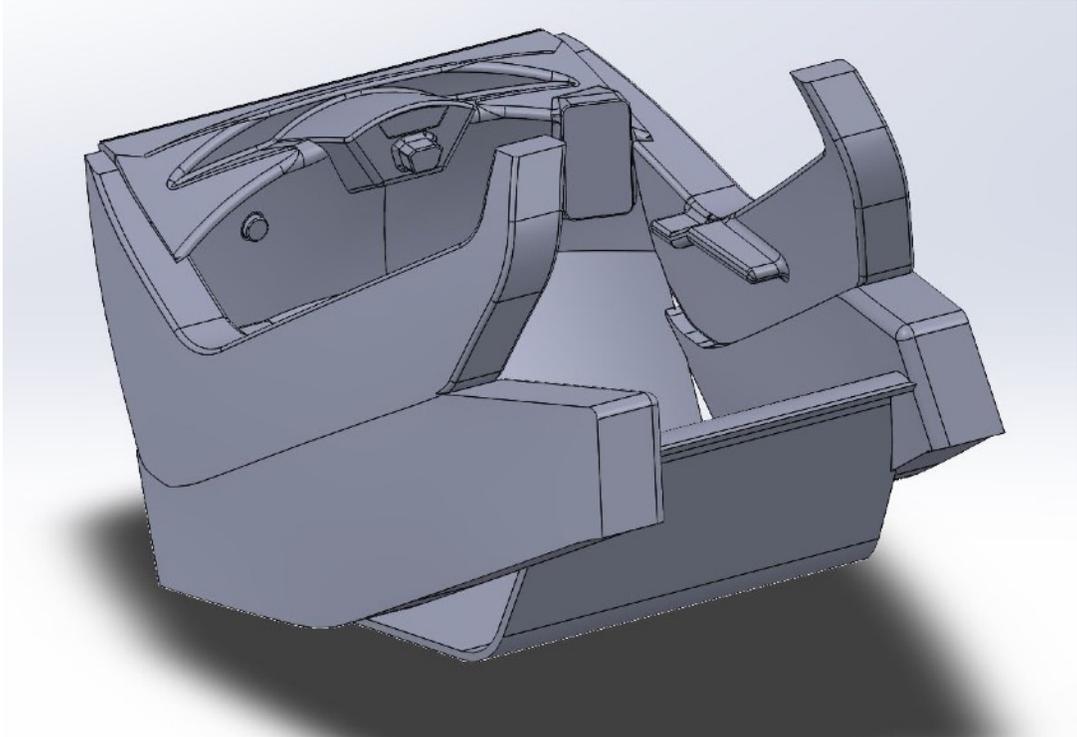
Ergonomic factors were also resolved within the building of the initial sketch model. The model was built to model around the 95% male as that is the largest human that would need to interact with the rather small vehicle. 5% female considerations were also made throughout the design to make sure that the vehicle would be functional for all humans no matter size or weight.

4.6 FINAL DESIGN

The final design for this thesis was created and modelled within Solidworks. As the design was already mainly worked out, it was crucial at this place in time to start the CAD work and resolve any other issues with specific dimensions in Solidworks. This was beneficial to the design because it allowed for any smaller details to be worked out and resolved without any hesitation on whether it was be viable in the overall design.

4.7 CAD DEVELOPMENT





4.8 PHYSICAL MODEL FABRICATION

This one to one scale buck was created to get a better idea of what the overall design would look like and feel. By creating this one to one scale model, insights were given on certain dimensioning and the final overall design.



CHAPTER 5

5.1 SUMMARY

5.1.1 Description

Raptor is a winter vehicle specializing in winter transportation methods in rural communities. This product will solve some of the major issues that come with living in these communities and the dangers that arise with winter weather conditions.

5.1.2 Explanation

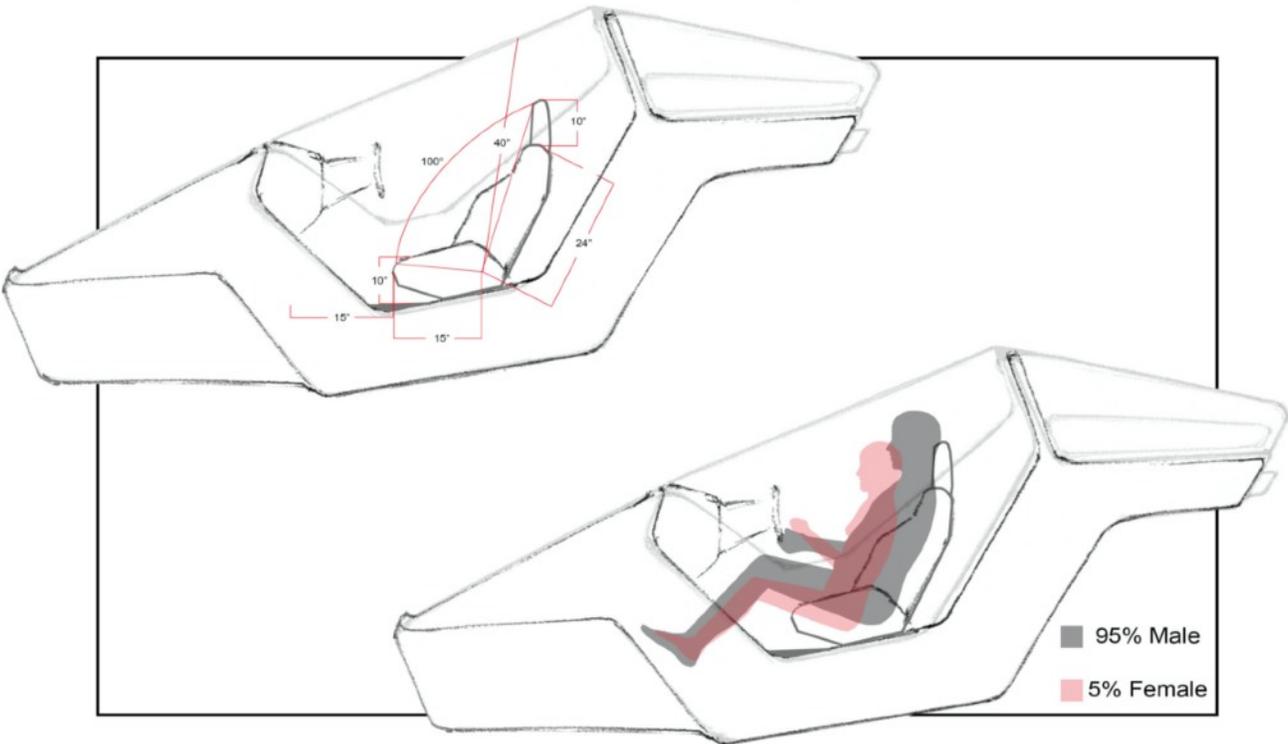
Currently on the market today there are many different vehicles that individuals can use in the winter months. Although there are many different downfalls throughout this wide array of vehicles that make them in one way or another dangerous in the winter months for these specific geographical locations. Transportation, completing daily tasks, driving to and from work, all of these activities are reasonably easy for most people to complete year round, although for individuals living in small population/rural communities these everyday responsibilities become very difficult and unsafe in the winter months. With many of these areas being susceptible to large snowfalls along with certain rural community characteristics, at times leaving your house for any reason would be considered challenging and dangerous. Within these rural communities, regular winter conditions that don't pose many issues in urban communities are amplified. These issues become more prominent due to: lack of road maintenance and road conditions, limited or no lights on highways/side streets, lack of driving discipline due to open roads along with less traffic, and large snowfalls causing road/visibility hazards.

Currently, individuals living in these communities are given no choice but to commute via car, truck, or snowmobile. Although each of these methods have their own risks and

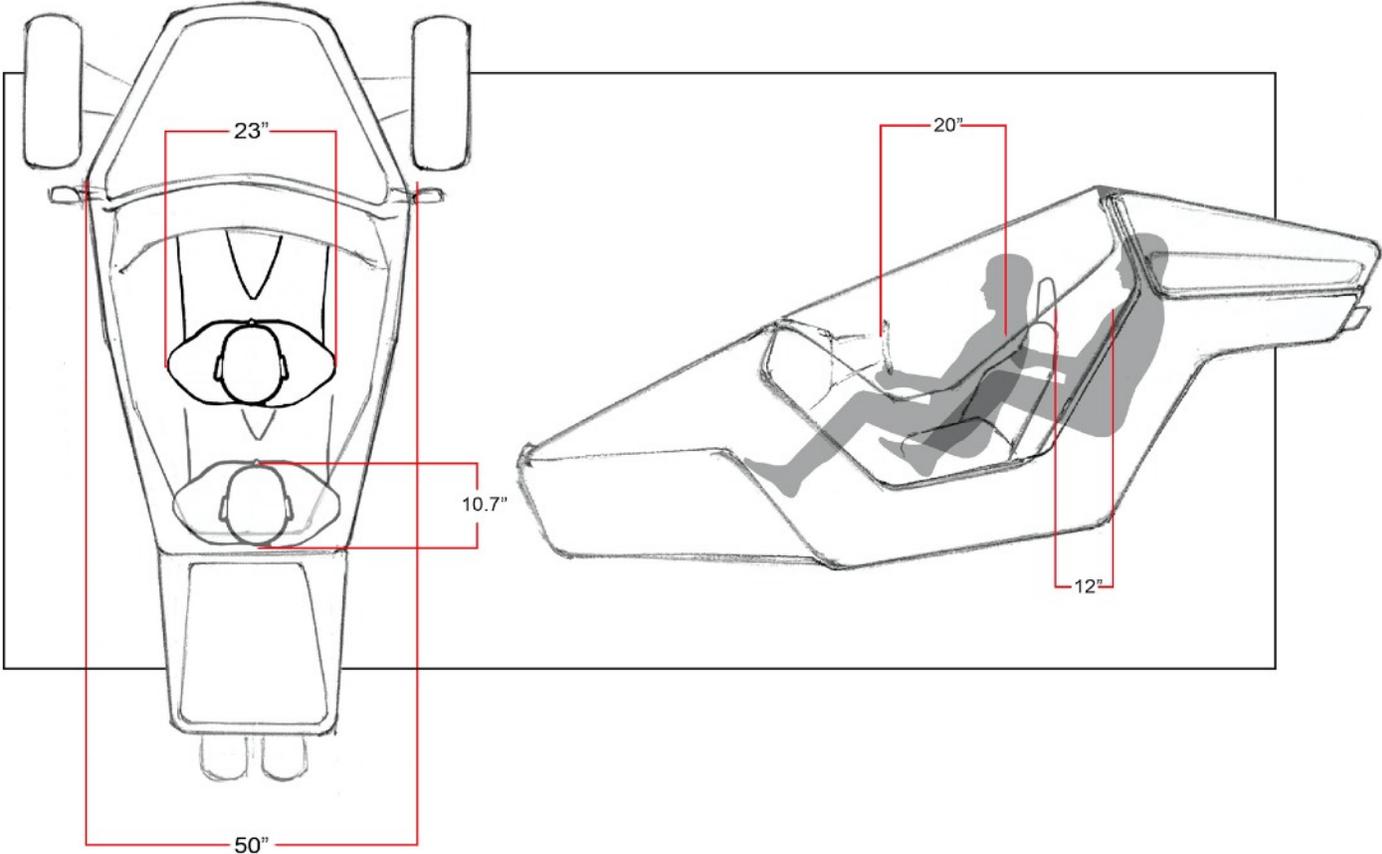
dangers that come along with use. As for cars and trucks, they are not specifically meant to handle the snow terrain and have proven to be unreliable when it comes to control on the icy roads, getting stuck in deep snow, and dangerous due to elongated breaking times. When it comes to snowmobiles, the issues arise with weather conditions, as the driver is exposed to the winter elements at all times. These machines have also been known to break down or malfunction which can pose serious danger in an open rural community during winter months.

Throughout the design there are many different aspects that allow for this specific vehicle to handle more efficiently in the snow and ice conditions. For example there are high performance track treads that wrap around a motorized wheel for a snowmobile like traction on the snow and ice. This allows for the vehicle to gain traction and plow through snow at a much better and easier rate, ultimately enhancing the handling performance overall. There are four wheels in total that all utilize this track system and are mounted on a wheel system that has its own motor in each base hub. The motors in the wheel are constantly collecting real time data and relaying it back to the overall vehicle handling system. This real time data allows for the vehicle to make adjustments to certain wheels depending on the road situation. For instance if one wheel is slipping or sliding out of control, the vehicle can sense the change in road condition and adjust the wheel settings (speed, rotation, suspension) in order to gain back control. Ultimately this handling system with having a motor in each wheel base, allows for the vehicle to use AI technology to keep the vehicle safe and the user safe as well.

This vehicle also allows for two individuals to fit inside the cabin. With the integrated and fold out tandem seating, the driver has the main focus and control of the vehicle with the controls wrapping fully around, and the secondary passenger sits directly behind the driver wrapping their legs around the front seat. This is an added benefit because it allows the



sustainable and eco friendly factors implemented into the design. The whole vehicle is



powered by electric energy through a main battery system. It also has a separate solar panel attachment which will help to charge the vehicle when needed. The vehicle also supports eco friendly head lights and tail lights which are all LED based, along with eco friendly sourced materials throughout the vehicle to additionally make the lowest footprint as possible.

5.1.3 Benefits Statement

The Raptor provides exceptional handling benefits, sustainable benefits, ergonomic profiles allowing for human interaction design, and small key features that overall allow for this vehicle to be deemed more safe in these winter environments. Through the wheel / track system, the vehicle produced much better handling than other vehicles on the market today with better traction. Sustainably this vehicle allows for a much smaller carbon footprint compared to all other transportation methods that are available today. Other small features that allow for this design to be more beneficial and safe are evident as well. There are integrated full wrap around head lights and tail lights to allow for better visibility and many more features... And overall the full design allows for any individual no matter size, weight, height, etc... to be able to use this vehicle with no issues ergonomically.

5.2 DESIGN CRITERIA MET

5.2.1 Ergonomics Introduction

Based on the characteristics of the vehicle being created for winter environments in rural communities, there were a lot of different ergonomic/human factors that needed to be

addressed in order to successfully and accurately create a product all individuals can use. Looking at the vehicle there were a few main points of interaction that the individual driving would come in contact with frequently. In order to figure out precise measurements that would be needed to ergonomically suit both the 95% male and 5% female, the Henry Dreyfus book "The Measure of Man"(The Measure of Man, Dreyfus) was used to configure these measurements. Some of the main points of contact that were evaluated were, the steering wheel length between passenger and console, along with size and diameter for grip. The height of arm rests off the ground along with width for comfortable resting positions was also measured. Along with the distance between passenger and the touch screen / media unit within the vehicle. Other important factors that were taken into consideration were the view point over the dash for the driver to be able to see all surroundings outside of the vehicle, and the foot well within the vehicle as the pedals need to be within reach for all percentiles.

Methodology

The ergonomic evaluation and analysis of the posed transportation method for rural communities in winter months was conducted with the following considerations:

Objective(s)

The aim of this process was the evaluate the full bodied human interaction design and full bodied ergonomic challenges that are posed for winter transportation in rural communities. Based on the proposed solution design, there are many body parts that are relevant to the ergonomics involved with the vehicle. This evaluation report outlines the methods used to figure out what major body parts are coming in contact with the vehicle and the ergonomic

measurements needed to allow for both 5% female and 95% male to comfortably be able to use the product. In order to complete this evaluation, a 1:1 size mock up model/buck was created in order to get a better sense of the correct measurements and specific factors that needed to be considered while finalizing the design for this thesis project.

Decision(s) to be made

The following interactions relevant to three specific major body part areas were investigated to minimize the negative experiences and maximize the positive experiences of:

1. The driving experience within the vehicle as a tandem cabin. (Body Position/Seating)
2. Operating visibility (Road Visibility) (Head neck and Shoulders)
3. Interaction with operating controls (Hand and Arms)

Description of Users Targeted by Product

The target demographic were individuals who operate vehicles within rural communities during winter months. Their age ranged from 19 – 70 and a mix between male and female. They were located within and around rural communities with large snowfalls and harsh winter environments. For this user observation report a specific individuals that suited the target demographic profile was observed and studied.

Evaluation process

The evaluation process consisted of designing a full scale (1:1) ergonomic buck of the cabin which allowed for critical observation of the following:

1. Observing how the user interacts with the features of the machine. (Ingress/Egress)

2. Observing how the user visually sees the road/trail ahead of them along with checks their rear blind spots.
3. Documenting the inside of the cab. (Position of steering wheel, arm rests, touch screen/touch points.)
4. Identifying critical human dimensions affecting product use

Description of User Observation Environment Used in this Study

For this study, due to covid restrictions, a virtual one on one meeting with individuals was set in order to better understand their daily activities and pros/cons of commuting throughout the winter months in their towns.

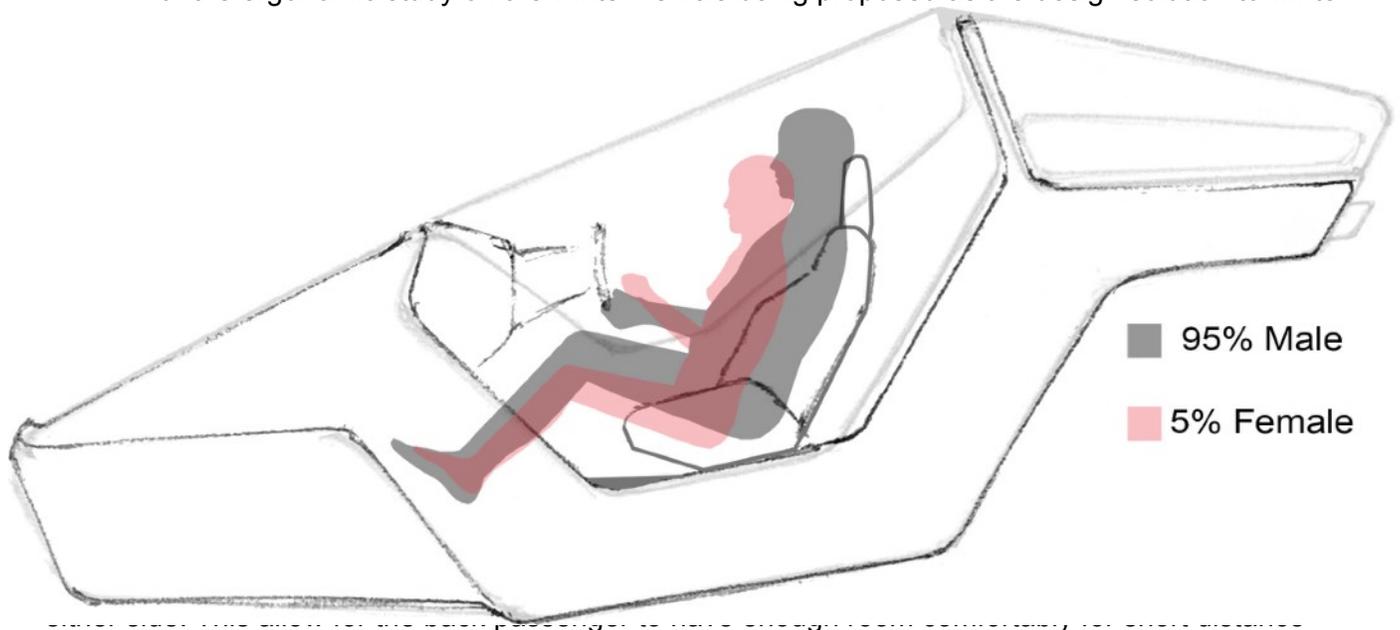
Location and Timeframe

Location of Observation(s): Online Via Skype

Timeframe: 45 Min study

RESULTS

For the ergonomic study on the winter vehicle being proposed as the design solution to winter



drives.

Secondly, the measurements between the passenger and steering wheel were analyzed. Based on the research conducted, it was established that the measurements being used should suit the 95% male. This decision was made due to the fact that would be the maximum distance the seat and steering wheel would need to adjust to in order to suit the largest human interacting with the vehicle. All humans that are smaller would be able to adjust seat height off ground, length from steering wheel, steering wheel pitch, etc... Ergonomic studies from "The Measure of Man" were key in this observation as it was projected that the distance from the steering wheel to the seat backing would need to be at least 28" in order to comfortably fit a 95% male. This took into consideration the chest size of a 95% male and the distance of arm length while sitting back in the vehicle seat in order to reach the steering wheel. Pitch of seat angle would also be adjustable in order to suit driving preferences for any driver, along with adjusting the arm distance and angle the driver prefers to drive at.

One of the final ergonomic studies completed with this model was the range of motion from the users arms and the different touch points they would come in contact with. This was especially important because to access a lot of the vehicles features, the individual needs to comfortably be able to reach the touch points. Research was conducted on arm length and distance from driving positions

to touch points. The main areas that were targeted were: steering wheel, media touch screen, and other features that would sit on the front dash. All of these measurements were set at a main perspective point, being the back rest of the seat. This was to ensure that the distance would be correct size based upon the seating length for the 95% male driving position. This was decided as this would be the maximum distance between seat distance and touch points, as the seat can adjust forward to allow for touch points to be closer to driver.

Two of the main touch points that needed to be addressed were the touch screen on the right side of the driver, and the other features on the left (transmission dial, car start button). Sitting at 24" from the middle back of the seat

allows for optimal reach from the driver (95% male). The driver would be able

to reach these touch points

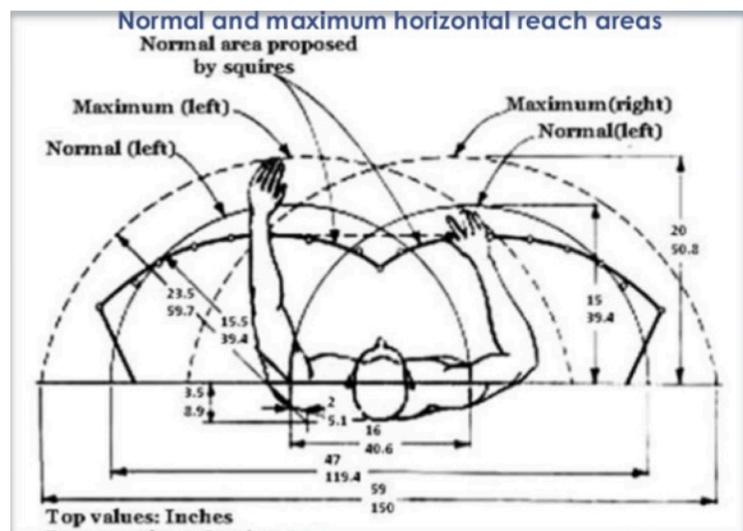
comfortably without compromising

their driving position. As shown in the

diagram all of the touch points would

be comfortably within reach for the

driver on both left and right sides.



5.2.2 Materials, Processes and Technology

When in production this vehicle has many different parts that will need to be assembled in order for completion. Although with that being said there are main parts that has certain importance to the overall design. For starters the track system is built with a military grade plastic that will last without breaking down unless specifically sent for

repurposing. This allows for a track wheel that will never need to be changed to thrown away in the entirety of the products life cycle.

Secondly, the main body is built from a combination of steel and carbon fibre. This allows for the vehicle to be light but also durable which enhances structure but also allows for good mileage when it comes to battery km limit.

There is also solar panel technology that is mounted on the back hatch of the vehicle. This allows for more sustainable benefits along with a better km range in milage for the electric battery.

Throughout the vehicle there are also many different technologies implemented in order for the best user experience and safest vehicle as possible. As mentioned before the wheel hubs have motors that relay real time data for safety purposes. There is a full touch screen system integration as well to control the whole vehicle that sits at the front of the vehicle on the dash.

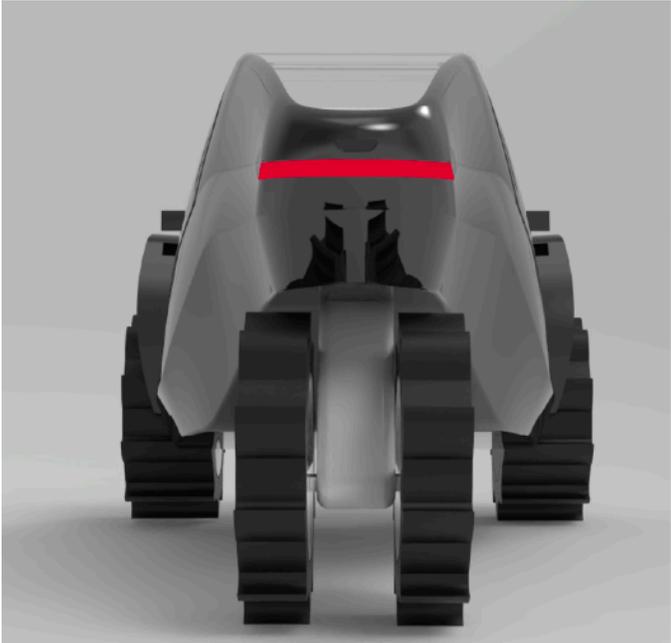
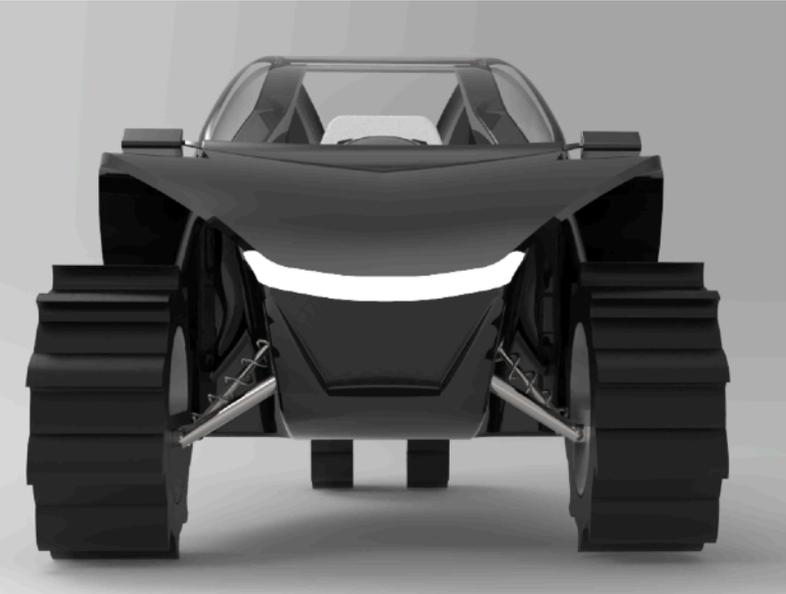
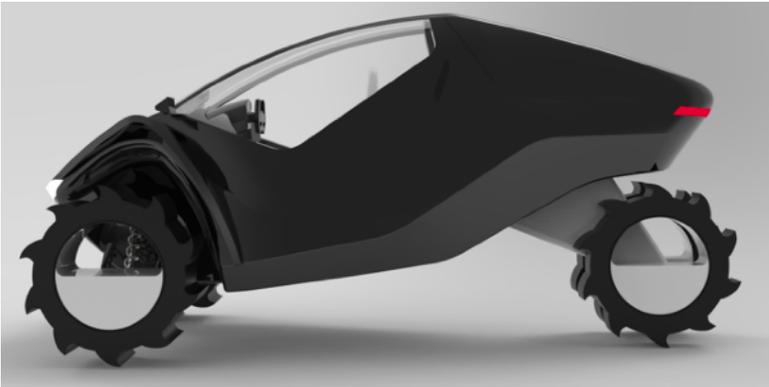
5.2.3 Manufacturing Cost Report

For the manufacturing cost, there was a breakdown of the main sections the vehicle would need.

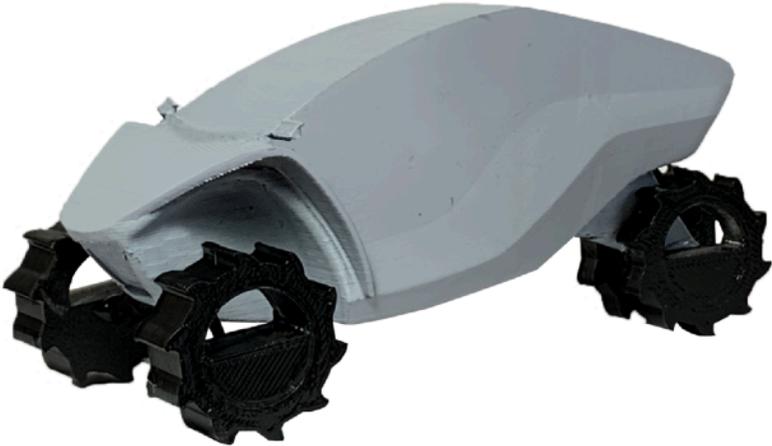
Materials Cost

PARTS	UNITS	COST
Wheel Tracks	4	\$800.00
Wheel Motor	4	\$1600.00
Main Body	1	\$3000.00
Chassis	1	\$4000.00
Interior Seating	2	\$500.00
Batteries	3	\$1500.00
Suspension	1	\$1000.00
Miscellaneous		\$4000.00
Total		\$27,000.00

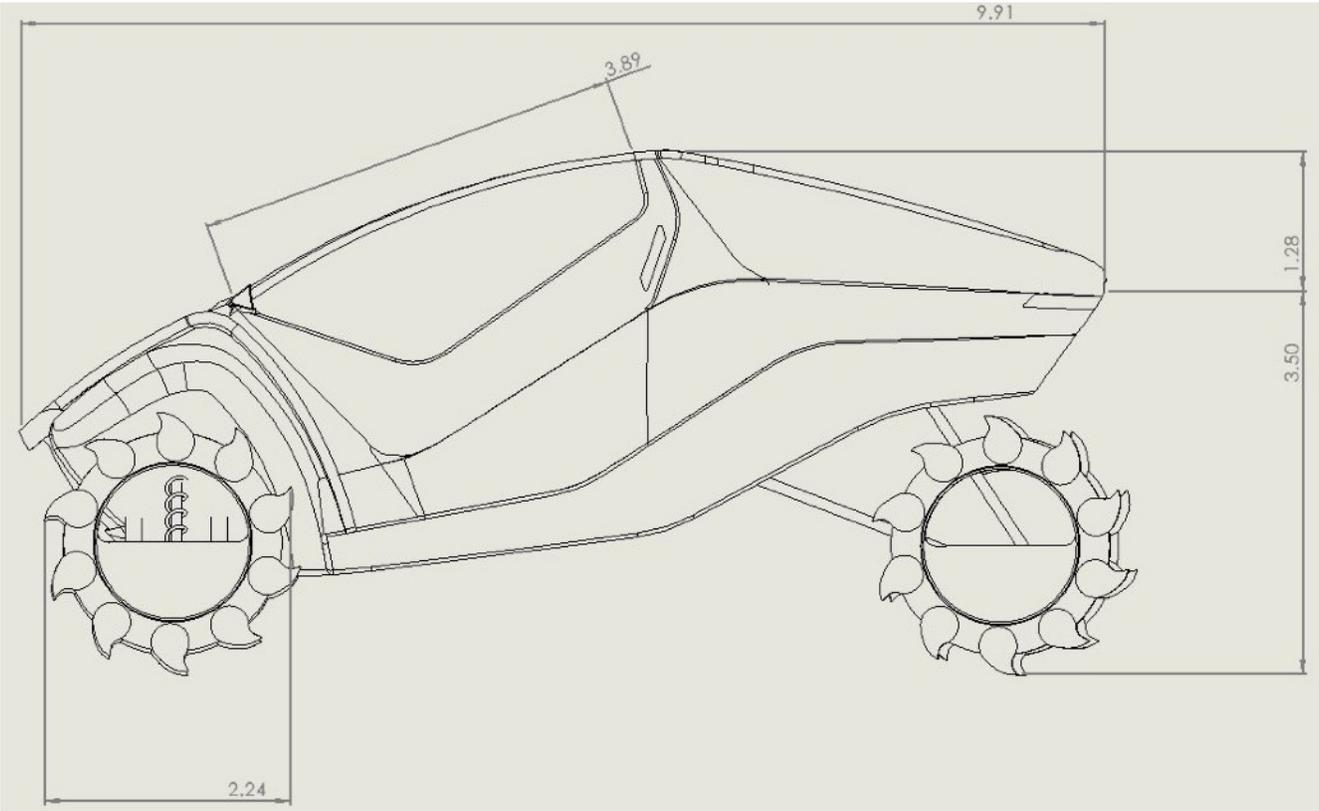
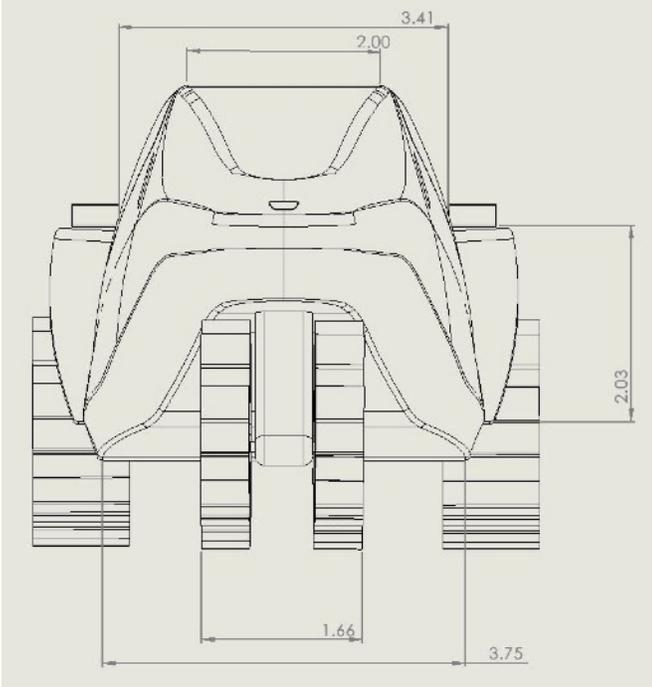
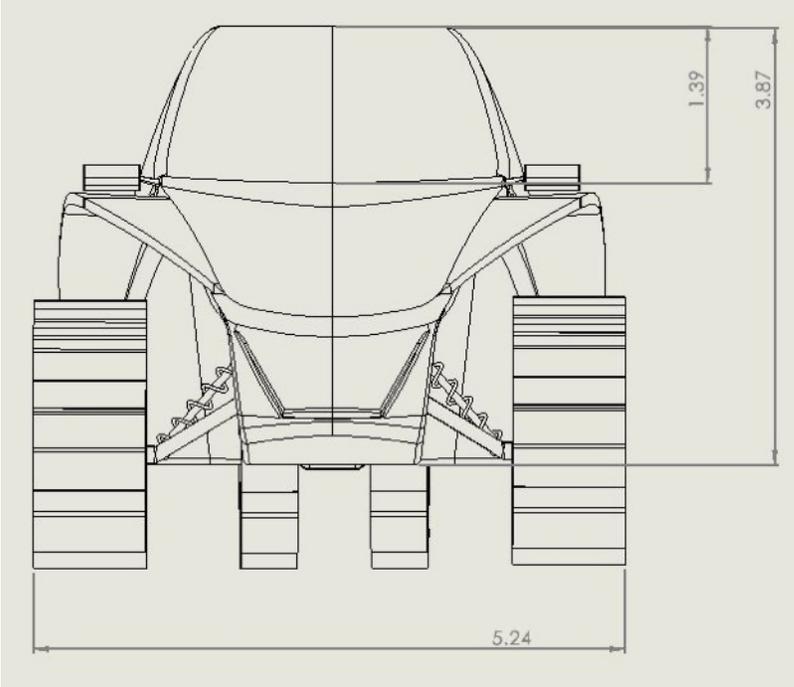
5.3 Final CAD Renderings



5.4 Final Model



5.5 Technical Drawings



5.6 Sustainability

The final design solution for this thesis is a human centered vehicle that is meant for winter transportation in rural communities that are susceptible to large snowfalls. The full vehicle has sustainable sections and aspects towards it in all different areas. For starters it has an electric powered motor that gives it an advantage over any gas powered vehicle on the market for sustainability. It also allows for solar power as it has an attachable solar panel on the back hatch. All the lighting systems throughout the vehicle are eco friendly LED's and the materials throughout are also recycled plastics, and cloth fibres. Overall these aspects lead to a design that is not only eco friendly for the environment but also sustainable for the products life cycle.

CHAPTER 6

6) Conclusion

The Raptor is a device that allows for individuals living in rural communities to travel safely during winter months without having to worry about all of the dangers that the weather and geographical location poses. Through the technology, features and benefits of the design, and ergonomic studies, this vehicle will serve as a method of transportation that allows for peace of mind while travelling. Overall based on the location and factors, this vehicle will provide a safe method of transportation for everyday use from all different kinds of individuals.

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CHAPTER 8

8 APPENDIX

A) Discovery

Background / History / Social Context

Winter snowfalls have caused issues with travelling for as long as humans have existed. Due to the characteristics of the winter months, travelling becomes difficult at times, typically due to snow, ice and visibility conditions. Many inventions and revelations have aided humans in one way or another to attempt to overcome this ongoing issue. Specifically there are machines today that are great for snow, although they are not versatile and practical for everyday life situations, especially in rural communities. In general, transportation methods such as cars and trucks are improving vastly in their safety features as people have realized that it is vital to have in vehicles. Although there are still many downfalls when it comes to these methods of transportation in the winter months along with certain downfalls in snow specific vehicles as well.

When it comes to commuting via vehicles such as cars and trucks, there is a long list of dangers that come with it. Driving in rural communities in the winter exposes many of these issues and also arises other challenges that majority of people in urban settings do not experience on a daily basis. Ultimately these winter rural environments can make travel and transportation extremely difficult. In Canada almost 30% of car accidents happen on icy or snowy road conditions (Admin, 2020). Along with two thirds of all “deadly accidents” in Canada happen on rural roads, where speed limits are faster and roads are not as well lit (Rural roads, 2020). As current trends show more safety features in vehicles today, none of the features are specific towards the issues the individuals in these rural communities face as these companies cannot afford to target specific safety features to one set population.

As it currently stands there are no other ways for people to get around due to the rural land mass and scattered population. Bus systems and other transportation options are extremely limited because it would hardly be possible for these vehicles to viably work under the land mass and disperse population. Not to mention the dangers that arise with these vehicles as well, as they would need to travel on small, unlit, snow and ice covered roads constantly. Overall the individuals living in these communities have a big disadvantage due to the current products on the market today, along with the characteristics of the population and

Analysis

Empathy Map Canvas

<p>1 WHO are we empathizing with?</p> <ul style="list-style-type: none"> - 30 year old female who lives in a rural community. - Commutes within the town to work everyday pre Covid - sometimes during Covid. - Earns an average salary. - Drives Mazda SUV year round. - Lives in small house (single). - Leaves the house almost everyday for one reason or another. 	<p>2 What do they need to DO?</p> <ul style="list-style-type: none"> - Travel to work year round. - Leaves house daily to complete daily tasks. - Be able to travel from day to day and commute in any environments. 	
<p>3 What do they SEE ? </p> <ul style="list-style-type: none"> - Checks the weather almost everyday in the winter months. - Sometimes ice and snow will influence her not to leave the house. (not feeling safe) - Lots of trees and open areas when travelling. - Larger snowfalls due to location. 	<p>PERSONA</p> <p>PAINS <i>Fears, frustrations, anxieties</i></p> <ul style="list-style-type: none"> - School teacher assistant. - Loves skiing and ski trips with friends. - Hates shovelling, although loves the winter months because in her area the scenic views look amazing. - Sometimes doesn't feel safe on the road. - May feel safe in own vehicle although concerned with other drivers and their control on the road. <p>GAINS <i>Goals achieved; experiences enjoyed</i></p> <ul style="list-style-type: none"> - Loves the views when snowfalls come. - Loves going skiing and on trips with friends. 	<p>5 What do they SAY ? </p> <ul style="list-style-type: none"> - Hates shovelling snow when there are large snowfalls. - Does not own snow blower, so she has to shovel manually. - Usually has to scrape and brush off snow everytime getting into the car and going anywhere.
<p>4 What do they DO ? </p> <ul style="list-style-type: none"> - Has to shovel snow when there are large snowfalls. - Does not own snow blower, so she has to shovel manually. - Usually has to scrape and brush off snow everytime getting into the car and going anywhere. - Salt the driveway when it is icy or snow is coming. 	<p>What might make this easier, more productive, more enjoyable?</p> <ul style="list-style-type: none"> - If there was a way to make travel safer and allow for winter to not influence the driving aspect. - Possibly an easier way to complete the tasks that winter brings (shovelling, scraping, etc...) 	<p>6 What do they HEAR ? </p> <ul style="list-style-type: none"> - Always listens to the TV or radio to hear about the weather conditions for that day or the day after. - Sometimes may be contacted by school or colleagues about the weather conditions and ask what their situation is regarding getting to school/work.

land mass causing issues for transportation as a whole.

B) User Research

Additional research was also conducted with interviews to gain further insight as to what individuals feel when they live in these rural areas.

Who are we empathizing with?

Q - "Can you tell me about yourself and what it's like living in a rural community?"

A - " yeah for sure. Living in a rural community has its benefits and downsides although I like it here. For the time being I work as a school teacher assistant and am hoping to work my way into the school system soon. I'm not sure exactly where i'll end up due to my career although I came here because I felt there was more opportunity. Living in a rural community definitely is a different experience opposed to the city life. A lot of things are different, like the sense of community, along with just the environment is less busy and more open obviously."

Q - "Can you tell me how often you travel within the community?"

A - " Well as of right now I don't travel as much as I use to due to the pandemic, although I usually am still driving out or around town everyday. When Covid was not an issue I would be driving to work everyday and then add on personal trips such as groceries or whatever else I might need. Although back to the question, I drive my Mazda around to travel."

Q - "Can you explain to me the environment in winter months, and the challenges winter brings regarding daily travels?"

A - " The winter months are definitely a challenge. out here we get a lot of snow and it makes it hard sometimes to travel around the town. some of the biggest challenges sometimes are getting out from the driveway and our road leading into our subdivision onto the main roads. Id say the biggest challenge is just driving around town when you know that it's not necessarily safe to be doing so."

What do they need to do?

Q - "What are some of the daily/weekly tasks you need to complete that involve you leaving the house?"

A - "Um yeah so as mentioned before I have to go to work sometimes although a lot less now. I also go get groceries and stuff like that, maybe a coffee in the morning if I feel like one."

Q - "What influences you to complete these tasks?"

A - "Usually simply because I need to or else I won't be able to eat or get paid for working. other than that i don't know, sometimes just to get out of the house at times."

Q - "During winter months are there ever situations where you would not be able to complete these tasks and why?"

A - "Yeah definitely, sometimes it snows really bad here that I don't feel it is safe to really go out and do anything. Although with that being said I always try my best to make it to the school because other people depend on me to be there. Although sometimes it definitely isn't safe to leave the house in some winter conditions."

What do they see?

Q - "Would I be able to see your transportation method? How do you like it? (in the snow)"

A - "Yeah i'll show you after the meeting if you would like, its just a Mazda cx-30. I love the car, i think its really good for the price point. It gets me where I need to go safe. The car handles well in snow although at times no matter what car you drive the conditions can be dangerous."

Q - "Do you ever have issues with this specific vehicle in winter months and what may those be?"

A - "As I said before I do at times have some issues with driving around if the roads are really bad, or maybe if the plows aren't able to clear the road fully due to the constant snow fall. Although for the most part driving isn't too bad in these winter months."

Q - "What are the tell tell signs for you to not leave the house? What do you see to make those decisions?"

A - "I will always check the weather in the morning or the night before to see what the next day is going to be like. If the weather says that the roads are going to be really bad then I will make a judgement call and see what I think. One of the main benefits from living in a rural community is that I don't have to travel very far to work like others that may be working in the city. Which i guess in turn makes my commute a little bit less dangerous as I am not on the road as much or for as long, although I mean sometimes that doesn't matter as an accident can happen anywhere at anytime. When it comes to visuals, if the roads look to be really bad then that may influence my decision wether I drive or not."

What do they say/do?

Q - "Are there specific tasks you need to complete before you leave the house in the winter months?"

A - "the only thing I can think about is maybe shovel the driveway or salt it if there is going to be icy conditions."

Q - "What is going on in your head when you have to complete these tasks before going out?"

A - "Yeah i hate shovelling, and I don't have one of those push snow blowers, so at times it can be a bit exhausting and frustrating, especially when I have to get to the school early."

Q - "Where are you usually travelling to? and are there any tasks that you need to complete when you get there?"

A - "Most of my travelling is when I go to the school, although as I said before a lot of it is just personal trips for the time being due to the pandemic. Um there is nothing really that I need to do for tasks when I get to work, although if it continues to snow I may need to scrape my windows before I head back home."

Pains

Q - "What is the most difficult part about going somewhere in the winter months?"

A - "definitely the uncertainty to be safe on the roads. It's one thing to feel safe in your own car and feel like you have control, but then there is always the factor of someone else who may not be in the same situation or lose control of their own vehicle."

Q - "Are there every times where you were not able to get where you wanted to go due to the weather?"

A - " There are many times where snow has convinced me to stay inside and not go do what I needed to get done and maybe push it to the next day or something."

Q - "What gives you the biggest frustration in the winter months and why?"

A - "The biggest frustration is defiantly the cold weather haha, although I'm not sure, I do hate shovelling the driveway."

Gains

Q - "How do you feel about completing your tasks in these environments?"

A - " sometimes it can definitely suck, although I do love the winter for the most part."

Q - "Tell me about a time that was enjoyable where you had to go out?"

A - " hmm that's a tough question, i guess id have to say its always enjoyable when the trees are fully covered in snow after a big snowfall and everything looks so pretty. That always seems to get me in a good mood, especially because there are so many trees around here."

Q - "What is your favourite part about the winter? do you have any favourite parts about travelling in the winter?"

A - "my favourite part about winter is definitely skiing! I love to ski as much as I possibly can. When it comes to travelling, me and my friends sometimes go on ski trips to Mount Tremblant for either a weekend or a few days. I always look forward to those kinds of things."

C) Product Research

Some user research was completed on other vehicles on the market today. This gave more insight onto the specs that go into these vehicles and other important factors.

FEATURES			
From Promotional Material	Re-order: NOUN first	Sort #1 DATA [On Menu Bar] →	Sort #2 Group like categories
1.5 litre four cylinder	Car - Automatic	Design - Aggressive look	Power & Engine- 7
151 hp	Car - Big engine	Design - Bulky design	Car - 158
158 hp	Car - Hatchback	Design - Larger Design	Car - 151
2.0 litre four cylinder	Car - Hybrid	Design - Light weight	Car - 306
306 hp	Car - Light weight	Design - Heavy	Truck - 280
Adaptive Cruise Control	Car - Sedan	Design - Low Luxury	Car - 1.5 litre four cylinder
Aerodynamics	Car - Stylish	Drivetrain - FWD	Car - 2.0 litre four cylinder
Aggressive Design	Car FWD	Drivetrain - FWD	Truck - V6 powertrain
Emergency Braking	Car- Automatic w paddle shifters	Drivetrain - AWD	
Five Passengers	Car- FWD	Drivetrain - FWD	
Four door hatchback	Car- Safety features	Gearbox - Automatic	
Hatchback	Car- Small engine	Gearbox - Automatic	
Hybrid	Car- Standard	Gearbox - Standard	Gearbox : 4
Lane Keeping assist	Car- medium weight	Gearbox - Paddleshifters	Car - Automatic
Less or no gas consumed	Car-FWD	Suspension - Dampers & Road	Car - Standard
Paddle shifters	Truck - AWD	Power & Engine - 158 hp	Car - Paddle Shifters
Sedan	Truck - Automatic	Power & Engine - 151 hp	Truck - Automatic
Three trim levels	Truck - Big engine	Power & Engine- 306 hp	
automatic gear box	Truck - Crew Cab	Power & Engine-280 hp	suspension
front wheel drive	Truck - Rugged	Power & Engine - 1.5 litre 4 cylinder	suspension: dampens road vibrations
fuel efficient	Truck - Tailgate	Power & Engine- 2.0 litre 4 cylinder	
in bed trunk	Truck - Towing	Power & Engine - v6 powertrain	Design, Styling
light weight aluminum		Other - Safety - lane assist	Car- Aggressive
			Car - Low luxury
multifunctional tailgate		Other - Doors - 4	Truck - Bulky
standard gear box		Other - Towing Cap - 5000lbs	
towing more than 5000 lbs		Other - Tailgate - Multifunction	
turbo charged four cylinder		Other - Driving - Cruise control	Drivetrain: 4
v6 powertrain			Car - FWD
			Car - FWD
			Car - FWD
			Truck - AWD
			Other
			Doors - 4
			Driving - Cruise control
			Safety - Lane Assist
			Tailgate - multifunctional
			Towing capacity - 5000lbs

BENEFITS	Sort #1	Sort #2
From Promotional Material	DATA [On Menu Bar] →	Groups like categories
3 trim packages	Accelerate fast	comfort 10
Compact Car	Back roads	comfort
Fun to drive	Comfort	comfort
Higher ride	Fast	Comfort
Lots of truck room	adventurous spirit	comfort
Plenty of driver assistance features	automatic	comfortable
accelerates quick	comfort	comfortable
agility and refinement	comfort	comfortable body position
comfortable	comfort	comfort-oriented
comfortable interior	comfort-oriented	soak up any bumps
comparable to other cars	comfortable	soaks up the bumps
cornering grip	comfortable	
entertaining	comfortable body position	style 10
good sizes back seats	efficient,	lighter
good suspension	keeps things simple	look.
lots of room	lighter	looks
low price point	look.	stylish look
low ride	looks	style
lower price point compared to other trucks	paddle shifting	style.
mid sized pickup	quick rip	styling
no torque steer	quick rip	stylish look
one size fits all cargo bed	sleeker look	sleeker look
plenty of interior storage space	smooth, flowing lines	smooth, flowing lines
rides smooth	style	
satisfying drive	style.	efficiency 3
small item storage	styling	efficient,
standard crew cab	stylish look	Fast
stylish bodywork	stylish look	Accelerate fast
subdued styling	switch gears	
touch screen	versatile	
Lots of truck room	Accelerate fast	
plenty of interior storage space	Back roads	ease 6
		paddle shifting
		automatic
		keeps things simple
		versatile
		switch gears
		switch gears
		plain having fun 4
		quick rip
		Back roads
		adventurous spirit
		quick rip

Additional Product Benchmarking

Part 2

Features and Benefits of Comparable Products

Product 1 - Honda Civic (https://www.honda.ca/civic_sedan)
Honda Lifestyle

Promotional Piece: (Highlight the **Benefits** and **Features**)

Once mere basic transportation, the humble Honda Civic has blossomed into a desirable and **fun-to-drive compact car**. Available as either a **sedan or a practical hatchback**, the Civic is powered by your choice of a **158-hp 2.0-liter four-cylinder or a turbocharged 1.5-liter that makes 174 or 180 horsepower**, depending on the model. Honda loads up its **smallest car with plenty of standard driver-assistance features**, including **automated emergency braking, adaptive cruise control, and lane-keeping assist**. Oddly, modern infotainment features aren't standard; the base LX model comes with a tiny touchscreen that offers radio tuning and not much else. The base model notwithstanding, the Civic is a **compact car** that should satisfy most buyers and one we're happy to recommend



Top 5 Features

- 1) **Sedan or Hatchback**
- 2) **158-hp 2.0 litre four cylinder**
- 3) **Automated Emergency Braking**
- 4) **Adaptive cruise control**
- 5) **Lane keeping assist**

Top 5 Benefits

- 1) **Fun to drive**
- 2) **compact car**
- 3) **plenty of driver assistance features**
- 4) **Touch screen**
- 5) **Lower price point**

Product 1 - Honda Car (<https://www.edmunds.com/honda/insight/>)
Honda Insight Hybrid

Promotional Piece: (Highlight the **Benefits** and **Features**)

Honda's Insight favours more **subdued styling**. This more traditional approach can be found inside, too. The Insight's cabin is **familiar and comfortable**, and the driving experience is **more refined and satisfying than what you typically get from other mainstream hybrids**. Because the Insight is a sedan, you give up a bit of cargo-carrying versatility compared to a hatchback, but the Insight compensates with **excellent small-item storage**. The 2020 Honda Insight is a **five-passenger hybrid sedan** that comes in **three trim levels: LX, EX and Touring**. All are driven by a **1.5-liter four-cylinder engine** that primarily acts as a generator to supply power to an electric motor that drives the front wheels (and takes over powering the wheels at freeway speeds). **Combined system output is 151 horsepower**.



Top 5 Features

- 1) **Five Passengers Sedan**
- 2) **Hybrid = No or less gas**
- 3) **Three Trim Levels**
- 4) **1.5 Litre four cylinder engine**
- 5) **Combined system outputs 151 hp**

Top 5 Benefits

- 1) **Subdued Styling**
- 2) **Comfortable**
- 3) **More satisfying compared to other hybrid cars**
- 4) **small item storage**
- 5) **3 Trim packages**

Product 1 - Honda Car (<https://www.caranddriver.com/honda/civic-type-r>)
Honda Sport Performance

Promotional Piece: (Highlight the **Benefits** and **Features**)

Despite its **gloriously juvenile bodywork**, the 2021 Honda Civic Type R is a **hugely entertaining** and **entirely practical four-door hatchback**. With a **306-hp turbocharged four-cylinder** and a **standard six-speed manual transmission** (the only gearbox available) **feeding the front wheels**, the Type R is not only the quickest Honda Civic, it's one of the quickest sport compacts. Honda has managed to **virtually eliminate the dreaded torque steer that plagues powerful front-drive cars** and provide talkative steering, **tremendous cornering grip, and a ride that's surprisingly smooth**. Its interior isn't the fanciest, and its red accents make the cabin look like a crime scene, but the reasonably-sized back seat and ample cargo area give it every-day practicality. Apart from a subdued exhaust note and noisy highway **behavior**, the 2021 Civic Type R ranks among the most entertaining cars to drive right now.



Top 5 Features

- 1) **Four Door Hatchback**
- 2) **306 hp**
- 3) **Turbo charged four cylinder**
- 4) **Standard gear box**
- 5) **Front wheel drive**

Top 5 Benefits

- 1) **Stylish bodywork**
- 2) **Entertaining**
- 3) **No torque steer**
- 4) **Cornering Grip**
- 5) **Rides smooth**
- 6) **Good sized back seats**

Product 1 - Honda Truck (<https://www.caranddriver.com/honda/ridgeline>)
Honda Offroad

Promotional Piece: (Highlight the **Benefits** and **Features**)

Despite a testosterone-fueled facelift, the 2021 Honda Ridgeline is neither as rugged nor as capable as other mid-size pickup trucks—but that's OK. Instead, the only Honda with a **cargo bed is a one-size-fits-all alternative to traditional pickup trucks**. While the Ridgeline lineup doesn't include an off-road-ready model or an optional diesel engine, it does have a **standard crew cab** that's **roomier and more comfortable** than any of its competitors'. Its minivan-based underpinnings and **V-6 powertrain** don't **allow it to tow more than 5000 pounds**, but they do enable the Ridgeline to **accelerate quickly**, consume **fuel efficiently**, and **drive with unrivaled agility and refinement**. Its host of **standard driver assists** and innovative features—including an **in-bed trunk** and a **multifunction tailgate**—further bolster the 2021 Ridgeline's status as the truck equivalent of a Swiss Army knife.



Top 5 Features

- 1) **V6 Powertrain**
- 2) **Tow more than 5000 pounds**
- 3) **Fuel Efficient**
- 4) **In bed trunk**
- 5) **multifunction tailgate**

Top 5 Benefits

- 1) **Mid sized pickup**
- 2) **One size fits all cargo bed**
- 3) **Standard Crew Cab**
- 4) **Comfortable**
- 5) **Lots of room**
- 6) **Accelerates quickly**
- 7) **Agility & Refinement**

D) Analysis

A user analysis empathy mapping chart was produced in order to get a better understanding of the pains, gains, wants, and needs, that individuals living in rural communities have.

Summary

- Living in rural community that is susceptible to large snowfalls.
- Travels or drives around almost everyday for one task or another
- Has hard time in winter to complete these tasks, due to the challenges and safety factors that winter poses.
- Hates to shovel and complete winter related tasks.
- Depends on weather channels and radio channels to know the weather conditions and future conditions.
- Sometimes doesn't feel safe on the roads due to winter conditions, but also other people driving in possibly unsafe vehicles.

E) CAD DEVELOPMENT

All CAD development files and photographs are in section 4.7

F) Physical Model Photographs





J) Approval Forms

IDSN 4002

SENIOR LEVEL THESIS ONE

Humber ITAL / Faculty of Applied Sciences & Applied Technology

Bachelor of Industrial Design / FALL 2020

Catherine Chong / Sandro Zaccolo

FTA-4 THESIS TOPIC APPROVAL (TEMPLATE)

Start: Week #4 / Sep-28

This project/assignment constitutes 5% of total mark for the course

Due: **Week #5 / Oct-05**

THESIS TOPIC APPROVAL:

Student Name:	Mackenzie O'Mahony
Topic Title:	How may we enhance sustainable transportation in harsh rural winter environments?

Abstract

As winter months approach, problems in rural/small population communities arise. The winter environment poses challenges to people residing in rural areas susceptible to large snowfalls, regarding transportation and safety in these communities. For many reasons, adverse weather and road conditions are a highly considerable cause for elevated risks related to accidents and fatalities amongst drivers. Currently, individuals are forced to drive vehicles that are unfit for these winter conditions. Certain major risks for these rural communities are: lack of road maintenance, inadequate lighting conditions, and lack of transportation options as public transport services can hardly be efficient under such conditions. Overall the goal of this thesis proposal is to challenge the current transportation methods, through an in-depth study and analysis of the dangers and pain points, in order to enhance the safety for individuals driving in rural areas while dealing with harsh environmental factors. User research including interviews, observational studies, and analyses of statistical data, will give detail and justification for the design process in order to eliminate the current dangers from these environments. Additionally, with reference to current transportation methods such as cars, trucks, & snowmobiles, a one to one model will be developed in order to understand ergonomics and human scale as well as to evaluate the feasibility of the design. Results from this analysis will aid in developing a solution for transportation in small population communities. This solution will enhance the safety and overall lifestyle of individuals travelling through rural areas during the harsh winter months.

Student Signature(s):	
Date:	05 / 10 / 2020

Instructor Signature(s):	
Date:	28 / 10 / 2020

Chong, Kappen, Thomson, Zaccolo

IDSN 4502
SENIOR LEVEL THESIS TWO

Humber ITAL / Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / WINTER 2021
Catherine Chong / Sandro Zaccolo

CRITICAL MILESTONES: APPROVAL FOR CAD DEVELOPMENT & MODEL FABRICATION

Student Name:	Mackenzie O'Mahony
Topic / Thesis Title:	Enhancing Rural Winter Transportation

THESIS DESIGN APPROVAL FORM

Thesis design is approved to proceed for the following: CAD Design and Development Phase

Comment: Initial CAD progress reasonably as of week #12 / April 12th, continue with detailing and refinement. CAD must complete before model fabrication.

Thesis design is approved to proceed for the following: Model Fabrication Including Rapid Prototyping and Model Building Phase

Comment: Design development progress reasonably as of week #12 / April 12th, once CAD is completed, can move forward to model fabrication from week #12 onward.

Instructor Signature(s):



Date: 12th April 2021

PANEL ON
RESEARCH ETHICS

Navigating the ethics of human research

TCPS 2: CORE



Certificate of Completion

This document certifies that

Mackenzie O'Mahony

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

Date of Issue: **3 October, 2020**

K) Advisor Meeting Messages

Advisor: Stefan Djerkic

Hello Stefan,

I just wanted to say thank you for agreeing to assist me throughout this thesis project! I think that your expertise will be a great help with my concept.

As Catherine mentioned in the previous email my thesis topic is "**How may we enhance sustainable transportation in rural winter environments?**". Currently we are in the initial ideation stage, producing rough concepts and ideas. I also do have a list of questions that I would like to send you if you don't mind, although I am just going to tweak them to not be so general as I now know your relationship to design and expertise in transportation. I will get the revised questions to you as soon as possible.

Thank you again for taking the time to do this, I really appreciate it.

If you have any questions for me or want to know more about the thesis project, feel free to send me an email or I can give you my number to connect.

Mack

Hi Mack,

I would be glad to help.

Send me the questions and maybe we can arrange a skype call if that works for you.

Stefan

....

Stefan Djerkic
Industrial Designer
514-546-6114
[LinkedIn](#) [profile](#)

 Thesis Questions.pdf

20 KB



Hey Stefan,

Here are the questions that I have come up with to try and get a better sense of my direction for this thesis topic. Answer at your earliest convenience.

I tried to make the questions a bit more specific to you and not as general. With that being said if there is any question you feel you cannot answer that is perfectly fine as some of the questions understandably may not be related to your expertise.

We can also definitely set up a skype call. What days/times work best for you?

Thanks again for all your help!

Mack

....

Perfect, thank you for your answers!

I will be in touch when there is more progress in the design.

Cheers,
Mack

....

Hi Mack,

See my answers below:

1- In my field of work, I have a working and recreational relationship. I commute to work in winter time and I design/develop products and snowmobile parts for Ski-Doo.

2- Pot holes and deer crossings are a main concern especially at night when visibility is low while driving my car to work. Unpredictable weather patterns related to climate change also make the roads/trails more dangerous. Icy and wet conditions are really the worst. For snowmobile trail riding, oncoming traffic can be extremely dangerous especially on sharp turns or hilly sections when you can't see oncoming traffic. It is much easier to spot oncoming traffic at night because you can spot the headlights from afar. During the day it's much more difficult to see. The trails are narrow and if you don't keep to your right, you can easily collide with traffic coming the other way at very high speeds (100km-150km/hr). Experienced riders tend to drift at high speeds in their turns which make it really difficult to avoid. For backcountry and mountain snowmobile riding getting lost can be a major concern. The risk of avalanche is another big concern for mountain snowmobilers. Getting stuck is a general problem for snowmobiling. You always need a shovel and minimum 2 people to get your sled out of the snow. Getting unstuck alone is possible but generally very difficult due to the weight of the sled and snow accumulation in the track. Falling through ice on a frozen lake happens every year as well. Smartphone freezing in our pocket is no fun either especially when riding at night during a snowstorm. Getting lost or left behind by your group is also something that already happened to me in the middle of the night. Keeping track of your riding partners can be challenging. A panic button could be an interesting feature..

3- Depends of what type of riding style and what the needs of the user are. Look at current infrastructures available and the laws around them (trails vs on road) in different parts of the world. That should define your overall vehicle package (refer to what is already existing out there)

4- Look up Taiga Motors (electric snowmobile startup based in Montreal).

5- Both are essential for the success of a product. You need to seduce your audience with an attractive design that communicates its function clearly. It must evoke an emotion at first glance. The functional aspect of the design will also create connection with the user and reinforce the brand.

6- There are all types of snowmobile riders. From young to old and of all social and economical classes. You have recreational, mountain, backcountry, racing, utility, adventure and trail riders just to name a few. A lot of the time vehicles are designed to be upgraded just like cars. They use the same chassis and give it a facelift (eg: Kia vs Hyundai) depending on which audience they are targeting.

7- Running out of gas in the middle of a snowstorm at night in the middle of nowhere...

8- For cars, mainly not built to last or answer the current needs related to climate change and generally speaking our harsh Nordic winters. For snowmobiling, getting stuck is the main common issue amongst all types of snowmobile segments I would say.

9- General control over the vehicle. It's not easy to operate especially for beginners. Each riding style has its' challenges. The sleds are so powerful that the skis tend to lift when accelerating which forces your weight backwards and make it very hard to control. Experienced riders get used to it but it could get tricky. Drifting is trick that riders use in turns but the sleds are not intended to do so per say.

10- No

11- It depends again in what context, weather conditions and type of riding. Too general of a question to be answered in a relevant way.

12- Speak with experienced snowmobile riders. Go test the sleds yourself if you want to improve their design and remember that your opinion does not necessarily reflect the opinion of experienced riders who ride thousands of kms a year.

As for a skype call, I'm really busy with work these days.

Maybe when you have a more clear direction I can help guide your design if you have some interesting sketches to show me.

Good luck

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Thank You!

Mackenzie O'Mahony