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Enhanced Sand Dune Riding Experience

Carlie Besser
Bachelor of Industrial Design

Enhancing the Sand Dune Riding Experience

by

Carlie Besser

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Supervisor: Catherine Chong

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Abstract

Sand dune riding is a sought-after and exhilarating recreational activity, yet aspects like safety, sustainability, and accessibility warrant improvement. According to the Council on Environmental Quality, over the course of three-years, there was a 27% increase in disturbed soil in one singular area due to off-road vehicle use. Minimizing this ecological impact through a sustainable approach is vital for preserving these fragile environments. Harsh climates and challenging terrains underline the need for enhanced safety measures. The North American, Middle Eastern, and Australian terrains pose accessibility challenges due to their location and characteristics. To enhance sand dune riding, multifaceted research, including observational studies, interviews, and surveys with tourists, professionals, and environmentalists, gathers diverse insights. Quantitative and qualitative data analysis aids in understanding unique challenges. Iterations, prototyping, and testing, guided by user feedback, explore solutions focusing on safety, ecosystem preservation, environmental harm reduction, and improved accessibility. The research aims to comprehensively enhance the sand dune riding experience, recognizing the need for an integrated, sustainable, and accessible approach.

Acknowledgments

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1.1 Problem Definition

Sand dune riding, a globally sought-after recreational experience, entices adventure enthusiast to destinations like the USA, Middle East, and Australia. The allure of this experience, however, is not without its challenges and considerations. This thesis delves into the multifaceted task of enhancing the sand dune riding experience, addressing three pivotal pillars: enhancing accessibility, environmental sustainability, and ensuring user safety. While the thrill of riding over sandy dunes is undeniable, logistical challenges in reaching these locations and the associated need for specialized equipment contribute intricately to the overall experience. Moreover, the environmental impact of sand dune riding on ecologically sensitive areas necessitates conservation efforts. Balancing the pursuit of adventure with the preservation of these habitats is crucial for the longevity of this riding experience. Additionally, prioritizing user safety becomes paramount, involving improvements in navigation, incorporation of advanced safety features in vehicles, and the promotion of safe riding practices. This thesis aims to provide innovative solutions to enhance accessibility, mitigate environmental impact, and ensure user safety. By delving into these critical aspects, the research seeks to contribute valuable insights to the realm of sustainable adventure tourism, enriching the sand dune riding experience for enthusiasts worldwide.

1.3 Background/History/Social Context

Sand dune riding, a captivating recreational activity, has a rich background intertwined with geographical features, cultural practices, and evolving social contexts. Historically, sand dunes have been sites of fascination and challenge, with communities in various parts of the world incorporating dunes into traditional festivities and rites of passage. In recent decades, the popularity of sand dune riding has surged, turning it into a global phenomenon with enthusiasts seeking the thrill of navigating sandy landscapes.

The rise of adventure tourism has significantly contributed to the growth of sand dune riding, transforming it from a niche activity to a sought-after experience. Destinations like the USA, Middle East, and Australia have become hotspots for sand dune riding, attracting tourists from diverse backgrounds. The social context of sand dune riding is evolving as well, with an increasing emphasis on sustainable and responsible adventure practices.

Statistics on the demographic trends of sand dune riders are limited, but the activity tends to draw a varied audience, ranging from thrill-seeking youths to families seeking unique recreational experiences. As this form of adventure gains momentum, understanding its historical roots and evolving social dynamics becomes crucial for shaping a sustainable and inclusive future for sand dune riding. This research delves into the historical, social, and cultural aspects of sand dune riding, providing a comprehensive foundation for addressing the contemporary challenges and opportunities within this dynamic recreational pursuit.

1.2 Rational & Significance

Existing research regarding the experience of sand dune riding predominantly centers on the experiential aspects and destination allure, often neglecting the nuanced challenges faced by those actively engaged in this recreational activity. After an initial exploration through qualitative research, it becomes apparent that a critical segment, being the individuals directly involved in this experience of the sand dune riding, remains understudied. By investigating user experiences, ergonomic-related problems, and the broader implications for enthusiasts, this research seeks to address these difficulties faced by the users.

CHAPTER 2
RESEARCH

2.1 User Research

The purpose of this chapter is to elaborate on the primary research methods which were used to develop a thorough and valuable understanding on the experience of sand dune riding. Benchmarking existing solutions, developing user profiles and environments of use allows for preliminary understanding of which areas to focus on to enhance the dune riding experience. Surveys and interviews were conducted to gain thorough understanding of what the riding experience can truly entail. Results from this qualitative research will aid in development of an innovative and strategic solution.

2.1.1 User Profile- Persona

The design solution will allow for use of various users. The target user for the design solution is adventure enthusiasts aged 18-55 years of age. The users are often tourists experiencing sand dune riding for the first time but it is desired to also suit the needs of experienced riders. Users seek the thrill of the open space and desire a vehicle which allows for connection with the environment.

Primary User: The Adventure Rider

Directly interacts with the product and participates in the sand dune riding experience.

Responsbilities

- Plan and execute their desired trip or journey
- To practice safe riding practices
- Ensure proper equipment
- Pack and transport belongings

50%
of users experienced dune riding 2-4 times.

87%
of users rode ATVs.

75%
of users booked a guided tour with a group.

100%
of users operated gas powered vehicles.

"A helmet was provided but no other safety equipment."
"I was worried about not having navigation- what if something happened..."
"I only sandboarded once, it was too exhausting to walk back up the dunes"
"Connecting with nature was the best part of the experience"

Secondary Users

Friends and Family
- Help plan dune riding experience
- Ensure user has knowledge and equipment necessary for a safe riding experience.
- Ensure user is safe and enjoying their experience without any unexpected challenges.

Touring Companies
- Responsible for providing a pre-planned and fully thought-out experience.
- Ensures users are aware of proper vehicle operation to ensure rider safety.
- Provides the user with proper equipment and any knowledge required to ensure safety

Tertiary Users

First Aid Workers
- Travel long distances and over difficult terrains to reach the patient.
- Provide proper care and aid for those injured during dune riding.

Environmentalists
- Desire to ensure environmental consciousness for primary users and those who are traveling on or across sand covered ecosystems

2.1.2 Current User Practice

The current user practice varies depending on multiple factors such as, where the user is traveling from to where the user is going, the user's skill and experience level and whether the user is renting equipment or using their own. To allow for more individuals to be able to experience sand dune riding, the focus was put on the user experience of traveling to a destination where users can rent equipment and participate in the experience within a group.

1 Plan & Research

Plan and execute plan without fail. Planning requires research into the area the user is traveling to, methods of transportation, locations to stay, essential belongings and more. The user should also complete research on the activity of sand dune riding to ensure their own safety throughout their journey.

2 Travel to Destination

Users travel to the desired destination. May have to transport belongings and equipment with them throughout the travel process. May also be required to switch or use multiple methods of transportation to arrive at the destination.

3 Tour Group Info

Upon arriving, users meet with their tour group and will be given a verbal explanation of the process. Tour group provides information on vehicle operation and safety. They then provide the user with essential safety equipment.

4 Vehicle Info & Practice

The users then get on their vehicle and familiarize themselves with operation. They will then follow the tour guide in a line, across flat, sand covered terrain to practice vehicle operation

5 Ride the Dunes

Upon arriving to larger dunes, users now have the essential practice required to effectively and safely drive on the dunes. The users can travel at their own freedom and have the ability to stop for breaks and to socialize. This is the chance for users to take advantage of the open space and enjoy the capabilities of the vehicle, as well as take photos and videos.

6 Sandboard & Relax

Often times, tour guides will provide opportunity to experience varying forms of dune riding such as sand boarding. This provides users with multiple unique experiences within one trip.

7 Head Back

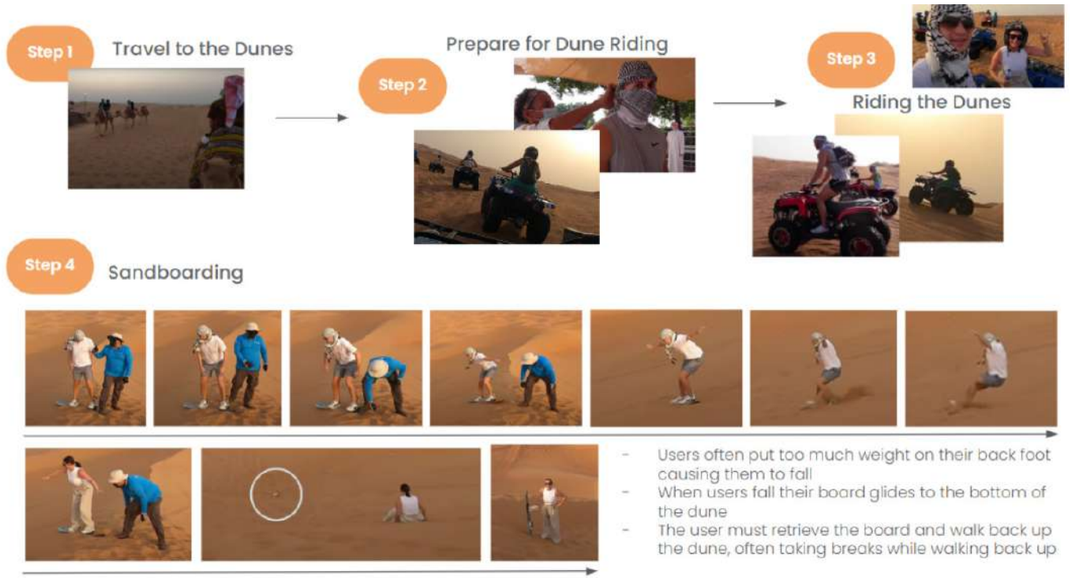
The users will follow the guide back to base when done. During this ride back, users should be able to take in the scenery one last time and reflect on the experience.

Challenges & Difficulties

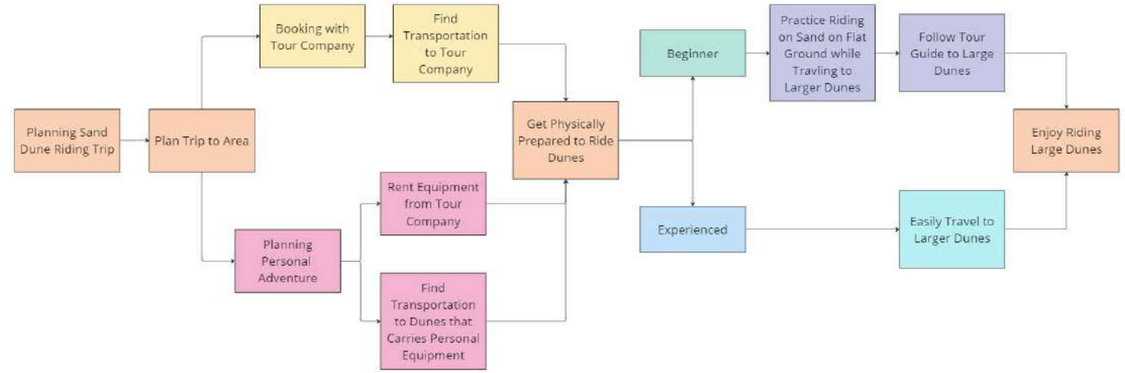
Difficulties may be regarding navigation issues to the base or on the dunes, lack of room for transportation of belongings, heat exhaustion or difficulties with travel.

2.1.3 User Observation- Activity Mapping

For further understanding and greater empathizing with the primary user, user observation was completed to enhance knowledge regarding the process the user goes through. The following diagram contains information and imagery featured in 'A Full Desert Day in Dubai' on YouTube (Hannah Isobel, 2022). To better understand possible journey tasks, a flow chart was also created.



Flow Chart of User Journey



Both the video observation and the flow chart diagram provide insight on the process of participating in sand dune riding. In the video observation, the user books a trip with a tour group, rents equipment from that company and follows instructions and safety guidelines provided from tour guides. Other users may book their own trip without a tour guide where it will be necessary to either transport their own equipment to the dunes or rent equipment from a tour company. Depending on the users experience level, the amount of time required to adjust to riding the vehicle on sandy terrain will also vary.

2.1.4 User Observation- Human Factors of Existing Products

Existing products currently used for sand dune riding are often vehicles which were not designed with the intention of sand dune riding, but rather, were optimized or altered to deal with sand. Therefore, challenges may rise when these existing products are utilized to travel on and to sand dunes.

2.1.5 User Observation- Safety & Health of Existing Products

Existing products have been designed to ensure user safety during operation but these products lack consideration when dealing with sand.

ATVs

All-Terrain Vehicles are multi-functional vehicles capable of handling various tasks on varying terrains. It is most common for ATVs to have a seat base without a backrest, where the user will be leaning forward to reach the handles. This leaning action is beneficial in improving center of gravity, allowing for users to use body weight to aid in steering the vehicle and provide more control over vehicle operation.

Some ATVs feature a roll cage whereas others do not. When riding on sand dunes it's not uncommon to flip and/or roll the vehicle over. The implementation of a roll cage is extremely beneficial in mitigating the risk of serious injury on sand dunes. ATVs should have both roll cages and seatbelts when being used on sandy environments

Sandboards

Sandboards feature a simple design where the intended way of riding is standing shoulder width apart on top of the board and keeping center of gravity aligned to mitigate the risk of falling off the board. Some Sandboards feature bindings where the user can strap their feet into the correct position, whereas other do not. Users should be using a sandboard that is of correct length to ensure optimal control while riding.

Sandboards do not require any safety equipment but helmets are often encouraged. Users should be using the correct size board to increase ease of operation, thus mitigating risk of falling.

Dirt Bikes

Dirt bikes are also commonly used for sand dune riding. Dirt bikes features a seat base without a backrest as the user needs to lean forward to control the bike. Users must use both their body weight and the bike handles to control the bike. It is essential that the user is in a position which allows for both body and arm movement for optimal control.

When operating a dirt bike protective gear such as helmets and safety gear should be worn. Dirt bikes are very powerful and therefore allow for users to reach high speeds and gain air when driving over dunes. Since the dirt bike itself does not feature safety features, the gear will allow for mitigation of injury if the user crashes.

2.2 Product Research

Conducting product research provided valuable insights into the existing landscape of sand dune riding vehicles. Analyzing product and vehicle information found online, this section will outline the benefits, features, functionality, and aesthetics of various types of current vehicles used for sand dune riding in the market.

2.2.1 Benchmarking- Benefits & Features of Existing Products

To benchmark existing products, various tables were created to further compare products with one another and to allow for understanding of which benefits and features are most common, which features could be implemented and to understand advantages and disadvantages of each product.

Tracker Off-Road 600

Cost
$8,000

Engine Type
Gas

Displacement
600cc / 45hp

Package Size
86.1" x 50.1" x 47.8"

Benefits
- Affordable
- Versatile
- Great for Beginners

BRP Can-Am Maverick R

Cost
$40,000

Engine Type
Gas

Displacement
999cc / 240hp

Package Size
138.7" x 78.1" x 70.4"

Benefits
- Powerful
- Versatile
- Thoughtful Ergonomics
- Enhanced Suspension
- Stylish

Yamaha YZ250

Cost
$10,000

Engine Type
Gas

Displacement
249cc / (25-40)hp

Package Size
86" x 32" x 50.8"

Benefits
- Lightweight
- Compact
- Freedom of Movement
- Precise Handling
- Versatile

Surron Light Bee X

Cost
$7,000

Engine Type
Electric

Displacement
6000W (≈35hp)

Package Size
74" x 30" x 40"

Benefits
- Environmentally Conscious
- Affordable
- Quiet
- Compact and Light
- Stylish

Polaris RZR XP

Cost
$30,000

Engine Type
Gas

Displacement
999cc / 114hp

Package Size
119.5" x 64" x 71.1"

Benefits
- Powerful
- Versatile
- Enhanced Suspension
- Thoughtful Ergonomics

Meyers Manx 2.0

Cost
$75,000

Engine Type
Electric

Displacement
202hp

Package Size
123.5" x 70.3" x 53.3"

Benefits
- Environmentally Conscious
- Quiet
- Stylish
- Powerful

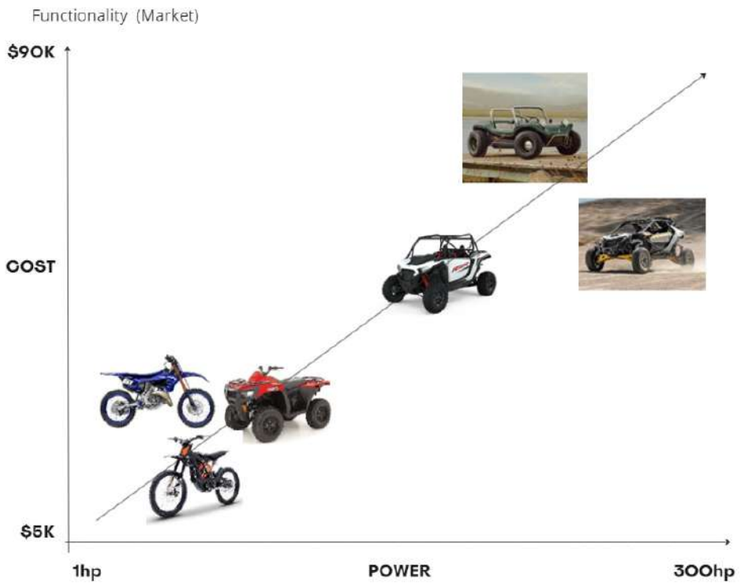
Insights- Benefits & Features of Existing Products

The main benefits of existing products would be the ergonomics and the comfort that the user experiences while operating the product or vehicle. This is crucial in mitigating injury and harm to the user. The power the vehicle can provide is also very important in allowing for effective ability to operate on sand. Vehicles that are environmentally conscious are sought after since the preservation of sandy terrain and environments is essential. It is also important for vehicle to be versatile as this allows for the product to serve multiple purposes and to travel over various terrains.

Both primary users and secondary users benefit from a cost-efficient vehicle and therefore a more affordable dune riding experience. Compact size and lightweight vehicles are also important for vehicle storage and transportation. Utilizing an electric or hybrid engine over a gas-powered engine is essential in mitigating harm on both the environment and ecosystem. Vehicles with ample horsepower will offer the power necessary for operation on sandy terrain. Vehicles that feature a large fuel capacity or range are important since users are far from any areas of fuel.

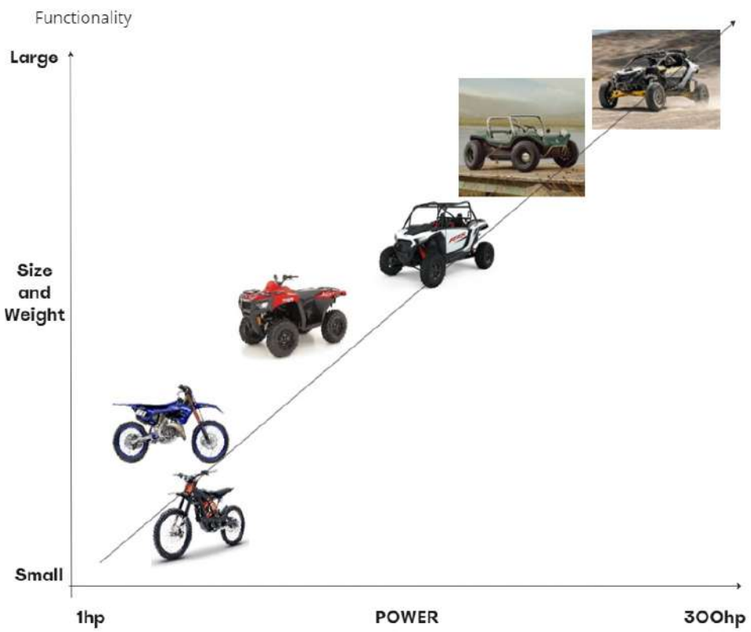
2.2.2 Benchmarking- Functionality of Existing Products

The charts below feature a visualization of the functionality of existing products. Chart one displays functionality of the product in the market, comparing the power with the available cost. Chart two shows the functionality of the product itself with a comparison of size and weight to the power of the vehicle.



There is a positive correlation between cost and power, as well as power and size and weight.

As one variable (cost, power, size, weight) increases, the others increase relatively proportionally.



Bikes and standard ATVs are most similar to one another. ATVs that double as dune buggies hold the most power.

As the size of the vehicle increases, the power must rise to compensate for added size and weight. However, power increases disproportionately more than necessary which also raises the cost slightly more.

2.2.3 Benchmarking- Aesthetics and Semantic Profiles of Existing

To further understand aesthetics and semantics of existing products, a comparison of form and color was completed. Analyzing these profiles allows for further comparison of aesthetic features on an x-y graph. Understanding existing products' aesthetic and semantic profiles will be of aid in determining trends in dune riding vehicles' design language

Tracker Off-Road 600

Bulky
Sharp
Gloss Finish
Red and Grey

BRP Can-Am Maverick R

Aggresive
Powerful
Gloss Finish
Yellow and Grey

Yamaha YZ250

Swift
Sharp
Gloss or Matte
Blue and Grey

Surron Light Bee X

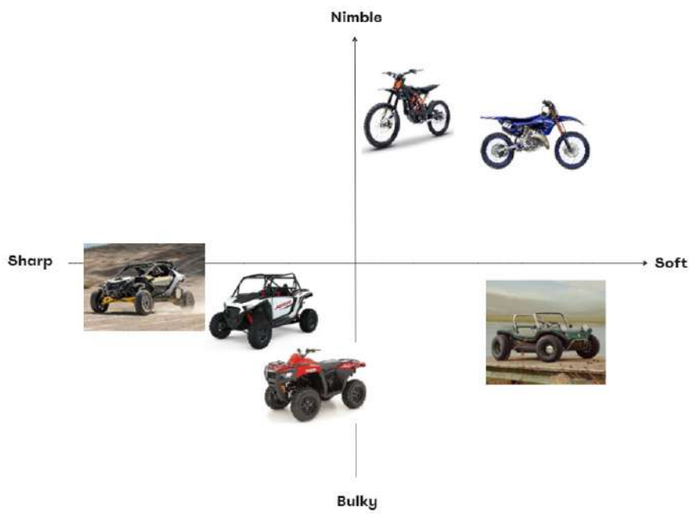
Sleek
Nimble
Gloss Finish
Orange and Grey

Polaris RZR XP

Sharp
Strong
Gloss or Matte
White, Grey, Red

Meyers Manx 2.0

Soft
Round
Retro
Dark Green



Takeaways

Retro aesthetics have been making a return, in particular in the color scheme

Vehicles may look more futuristic but still have these distinguishing retro features

Some companies have been gearing toward softer edges and contours

Other companies are remaining with their design language for off-road vehicles which has typically been a more aggressive, sharp form

2.2.4 Benchmarking- Materials & Manufacturering of Existing Products

Metals: Aluminum is a common choice for frames due to their lightweight, highstrength and durability. Common manufacturing methods include casting, extrusion and welding.

Plastics: Body panels and other components are often composed of plastics, more specifically polypropylene and polyethylene since both are lightweight and durable. One common manufacturing method would be injection molding, some alternatives being blow molding, rotational molding and extrusion.

Tires: Tires are composed of a variety of raw materials and include a rubber compound. Rims, spokes, or hubs are made up of steel, aluminum or alloys. The manufacturing process of rims typically includes casting, forging or flow forming.

Fabrics: One common material used for seats is vinyl due to its UV, weather, and temperature resistance as well as durability. Some alternatives are synthetics and leathers. Foam internals allow for cushioned seating. To manufacture seats, the selected casing material is often stapled or sewn around the foam cushion.

2.2.5 Benchmarking- Sustainability of Existing Products

Metals: Aluminum is 100% recyclable and it can be recycled repeatedly while maintaining properties. Aluminums light weight allows for less power required for operation. Aluminum and other metals such as steel are a limited resource and inefficient to produce. Aluminum has a higher corrosion resi tance than alternatives. Steel is also recyclable but the higher weight makes steel less desired.

Plastics: Both polyethylene and polypropylene are recyclable, however, the efficiency of the recycle process is poor. Some plastics such as High-Density Polyethylene (HDPE) can be recycled more than other plastics such as Low-Density Polyethylene (LDPE). HDPE can be recycled more than polypropylene. Polyethylene and polypropylene contain pollutants harmful on the environment. Polyurethane foams also contribute to these environmental issues.

Tires: Tires are a significant source of pollution. They do not decompose and therefore pile up in landfills. Tires could be recycled into other products but the majority of them are not. Natural rubber which is just one of the many materials in tires is a renewable source, but harvesting the rubber contributes to deforestation.

Fabrics: The production of vinyl and synthetics are harmful due to the use of crude oil in production. Crude oil must go through a lot of processing, creating pollution. Although crude oil is a natural resource, it is a non-renewable resource. Vinyl can be recycled but the recycling process can release toxic gas. Vinyl is not bio-degradable and is considered toxic. Some synthetic fibres such as polyester and nylon are also hazardous to the environment. Synthetic fibres are also non-biodegradable and are labelled as unsustainable.

Gas Vehicles: Gasoline vehicles have a significant negative impact on the environment. The combustion of gasoline releases carbon dioxide (CO2) and other greenhouse gases into the atmosphere, contributing to global warming and climate change.

2.3 Summary of Chapter 2

Chapter 2 explores user research methods and user profiles for sand dune riding, focusing on the primary user being the adventure rider and incorporating secondary users like friends, family, and touring companies, and tertiary users being first aid workers and environmentalists. The tasks associated with sand dune riding, from planning to returning home, are outlined, providing a comprehensive understanding of the user journey. Additionally, user observations and activity mapping enhance empathy with the primary user's experiences. The chapter also provides insights regarding product research, employing benchmarking to analyze existing sand dune riding vehicles. Key insights reveal the importance of ergonomics, affordability, power, and environmental consciousness in designing an effective and sustainable solution for an enhanced sand dune riding experience. Common materials and manufacturing methods for specific parts, such as frames, chassis, body, wheels, and seats, are discussed, along with a sustainability analysis of these materials.

CHAPTER 3
ANALYSIS

3.1 Analysis- Needs

The following section will further develop needs analysis on existing research. The analysis will be completed through a STEEPV analysis of benchmarked products and user feelings. This will provide a needs analysis which will offer insight into opportunities to enhance the users experience of sand dune riding. With insights from the needs analysis, further research into ergonomics can be completed. Ergonomic studies featuring schematic drawings as well as a 1:1 mockup provide insight into proper proportion, major touchpoints and human interaction.

3.1.1 Needs and Benefits Not Met by Current Products

The benchmarked products previously researched in chapter 2, provided the following understanding regarding needs and benefits not met by current products:

Safety:

- Safety features and accessories not tailored to dune environment
- Lack of equipment and features designed specifically for sand dunes
- Lack of navigation and concerns regarding getting seperated from the group

Sustainability & Environment:

- Needs further consideration to mitigate harm on the ecosystem
- Tires are damaging on terrian and ecosystem
- Gas and fluid leaks are harmful
- Lack of connection between the user and the environment

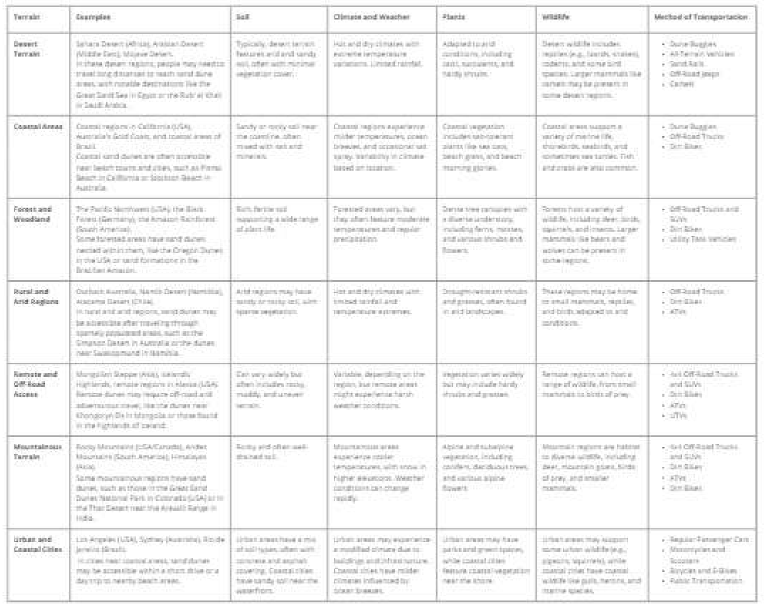
Experience & Enjoyment

- Customizability and adjustability would improve ergonomics and user-vehicle interaction
- Not able to communicate with others while riding
- Difficult to capture and share experience

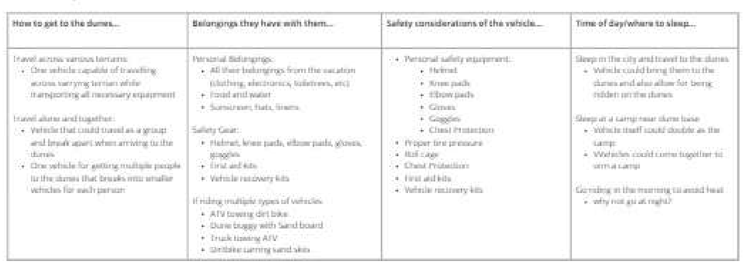
3.1.2 Latent Needs

To prioritize user needs, a STEEPV analysis was conducted. This analysis categorizes and effectively weighs user needs based on factors such as technological, emotional, social, ecological and environmental trends. The process of conducting the STEEPV analysis is to first develop user needs, weigh the needs in a matrix, develop prioritization, understand strategic prioritization and then synthesis the data and develop action strategies. Following this process all user needs were categorized into a prioritization grid to measure importance and feasibility of the needs.

Traveling to Dunes



Main Concept Considerations

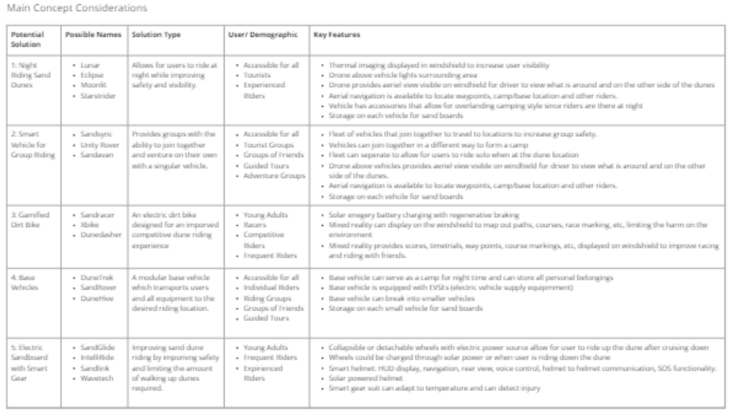


How to get to the dunes...	Belongings they have with them...	Safety considerations of the vehicle...	Time of day/where to sleep...

Travel across various terrains:
• One vehicle capable of travelling across varying terrain while transporting all necessary equipment
 	
Travel alone and together:
• Vehicle that could travel as a group and break apart when arriving to the dunes
• One vehicle for getting multiple people to the dunes that breaks into smaller vehicles for each person
	Personal Belongings:
	• All their belongings from the vacation (clothing, electronics, toiletries, etc)
	• Food and water
	• Sunscreen, hats, linens
	
	Safety Gear:
	• Helmet, knee pads, elbow pads, gloves, goggles
	• First aid kits
	• Vehicle recovery kits
	
	If riding multiple types of vehicles:
	• ATV towing dirt bike
	• Dune buggy with Sand board
	• Truck towing ATV
	• Dirt bike carrying sand skis
		• Personal safety equipment:
		  • Helmet
		  • Knee pads
		  • Elbow pads
		  • Gloves
		  • Goggles
		  • Chest Protection
		• Proper tire pressure
		• Roll cage
		• Chest Protection
		• First aid kits
		• Vehicle recovery kits
			Sleep in the city and travel to the dunes
			• Vehicle could bring them to the dunes and also allow for being ridden on the dunes
			
			Sleep at a camp near dune base
			• Vehicle itself could double as the camp
			• Vehicles could come together to orm a camp
			
			Go riding in the morning to avoid heat
			• why not go at night?

Strategy

Main Concept Considerations



Vehicle/Product Safety

Method of Transportation	Safety Concerns	Considerations	Preventatives	Navigation
Dune Buggies	Overturning on steep dunes, loose sand, and high-speed driving.	Ensure roll cages and seat belts are in place. Limit high-speed maneuvers.	Roll cages, helmets, goggles, gloves.	GPS systems for location tracking.
All-Terrain Vehicles	Rollovers, excessive speed, and loss of control.	Avoid steep dunes, follow recommended speed limits, and maintain proper tire pressure.	Helmets, protective gear (gloves, goggles, knee/elbow pads).	GPS or mobile apps.
Sand Rails	High-speed driving, stability, and rollovers.	Control speed on steep dunes and ensure the vehicle is well-maintained.	Roll cages, helmets, harnesses, gloves, and goggles.	GPS or mobile apps.
Off- Road Jeeps	Rollovers, high center of gravity, and tire punctures.	Maintain proper tire pressure and be cautious on steep dunes.	Seat belts, helmets (for open-top jeeps), gloves, and first-aid kits.	GPS or mobile apps.
Off-Road Trucks	Rollovers, tire punctures, and vehicle stability.	Maintain proper tire pressure, and follow safe driving practices.	Seat belts, helmets (for open-cabin trucks), gloves, and first-aid kits.	GPS systems for location tracking.
Dirt Bikes	Loss of control, high-speed crashes, and sand ingestion.	Control speed, especially on steep dunes, and practice proper riding techniques.	Helmets, gloves, goggles, knee/elbow pads, and chest protectors.	GPS or bike-mounted systems.
Utility Task Vehicles	Rollovers, speed, and vehicle stability.	Follow recommended speed limits and maintain proper tire pressure.	Helmets, gloves, goggles, and harnesses.	GPS or mobile apps.
Sand Boarding	Speed, control on downhill descents, and sand ingestion.	Start with small slopes, learn proper sandboarding techniques, and avoid high-speed descents.	Helmets, elbow and knee pads, gloves, and goggles for eye protection.	None needed; use trail markers or guides for orientation.
Sand Skiing	Speed, balance on skis, and sand ingestion.	Practice balance on skis and start on gentler slopes before progressing to steeper dunes.	Helmets, ski goggles, knee pads, and gloves.	None needed; use trail markers or guides for orientation.

Ranking Potential Solutions

3.1.3 Categorization of Needs

Previous research was compiled to develop and categorize needs into immediate and latent needs as well as the wishes and wants of the user. The categorization of needs allows for development of needs statements which will provide a point of focus to develop design solutions based on.

Immediate Needs

- Needs product with safety considerations and features
- Needs a comfortable riding experience
- Needs to have full control and enhanced maneuverability of the product
- Needs reliable performance
- Needs to consider ecosystem and environment

Latent Needs

- Needs customizable riding experience tailored to their preferences
- Needs terrain information display to access realtime information about landscape
- Needs environmental impact resolution

Wants and Wishes

- Wants a stress-free experience
- Wants to avoid walking up the dunes
- Wants enhanced social interaction and communication
- Wants adjustable seating and handles for comfort
- Wants cutting-edge safety technology
- Wants personalized aesthetics

The categorization and prioritization of needs allows for development of a needs statement. Needs statements are beneficial tools to foster a user-centric design process, guide decision-making, and ensure that the resulting product meets the genuine needs and expectations of its users. The needs statements are as follows:

Initial Needs Statements

- The outdoor enthusiast needs improved accessibility to arrive at the dunes because it is difficult to arrive at the sand dune riding location.
- The outdoor enthusiast needs enhanced safety features because they are at risk of injury operating vehicles/ products on sand dunes.
- The outdoor enthusiast needs environmentally friendly options because they are concerned with existing vehicles or products' harm on the ecosystem of sand dunes.

Revised Statement

- Sand dune riding is a purposeful activity based on ease of functioning (transport) and mastery of the terrain (control). Comfort during the ride caters to the fundamental need for security. Sand dune riding is also a social activity, involving interaction with fellow riders, addressing the need for social belonging.

Final Needs Statement

- The sand dune rider needs a vehicle that ensures safe and easy navigation across sand-based terrains because exploring challenging landscapes is a priority, and a vehicle that offers reliability and adaptability is crucial.

3.2 Analysis- Usability

The use of both a journey map and user experience map allow for improved analysis of the process, feelings, and emotions the user will go through. Both the journey and user experience maps focus on the process of experiencing sand dune riding, from the user planning the journey to when the user finishes the journey and heads back home. This analysis of the full process aids in considering all variables the user must go through and how they feel throughout the experience.

3.2.1 Journey Mapping

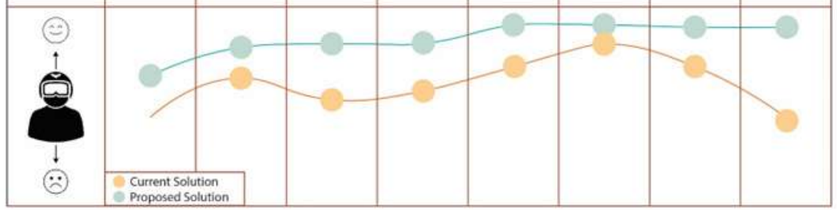
Below is a visual representation of the full journey process the primary user must go through.

	Planning/ Preparing	Travel to Destination	Physical Preparation	Safety and Practice	Travel to Large Dunes	Ride on Dunes	Play Around	Head "Home"
User Goals	Plan and prepare for a stress-free and fulfilling trip.	Get to the location of rental without getting lost, on time and with all equipment.	Be ready to face climate and conditions. Physically prepared for adventure.	Be informed about safety practices and learn how to operate vehicle properly and safely.	Safely travel to the larger dunes where they will be able to ride on their own.	Ride on the sand dunes and enjoy the experience.	Enjoy being on sand dunes. Explore and play around on the dunes.	Safely get back to base.
User Actions	Research where they are going, book tours ahead of time, pack all necesesary equipment.	Driving in rental car, or travel on camel. Secure all belongings for travel.	Put on linens, headscarf, sunscreen, helmet, and protective equipment.	Listen to guide, fimilairize themself with vehicle, practice riding slow on flat ground.	Follow the guide to the dunes. Continue to practice and familiarize with vehicle.	Ride on the dunes on their own. Take in the scenary. Get some speed and enjoy the open.	Try sandboarding, walk around, take photos and videos. Drink water and eat snacks.	Follow guide home, take in the scenery and the moment. Reflect on experience.
User Thoughts	Hope they considered and have everything they need	This is a long journey. Looking forward to being there. Enjoying the scenary.	I hope this will keep me safe and protected from the heat and sun.	I'm worried ill crash, I hope im doing this right. This isnt too hard. I think i'm getting the hang of this.	This is fun, the scenary is breathtaking. I can't beleive i'm doing this.	Wow, I can't beleive im doing this right now. Look where I am. This is beautiful and so much fun.	What a great experience. Fun trying sand-boarding. I am hot and thirsty.	That was a long day, but was incredible. I feel so fortunate.
User Feelings	Stressed, excited, nervous, enthusiastic	Tired, excited, surreal.	Nervous, excited.	Anxious, excited, nervous, adrenaline.	Enthusiatic, excited, surreal.	High adrenaline, surreal, excited.	Happy, content, euphoric.	Exhausted, happy, calm.
								

The journey map provides insights into the emotional journey, the user-vehicle interaction and the user-environment interaction.

3.2.2 User Experience

Below is a visualization of the user experience to further analyze the emotions and feelings the user goes through throughout the journey process. This user experience map also provides insight into what the desired level of user emotions should be achieved.

	Planning/ Preparing	Travel to Destination	Physical Preparation	Safety and Practice	Travel to Large Dunes	Ride on Dunes	Play Around	Head "Home"
User Goals	Plan and prepare for a stress-free and fulfilling trip.	Get to the location of rental without getting lost, on time and with all equipment.	Be ready to face climate and conditions. Physically prepared for adventure.	Be informed about safety practices and learn how to operate vehicle properly and safely.	Safely travel to the larger dunes where they will be able to ride on their own.	Ride on the sand dunes and enjoy the experience.	Enjoy being on sand dunes. Explore and play around on the dunes.	Safely get back to base.
User Actions	Research where they are going, book tours ahead of time, pack all necesesary equipment.	Driving in rental car, or travel on camel. Secure all belongings for travel.	Put on linens, headscarf, sunscreen, helmet, and protective equipment.	Listen to guide, fimilairize themself with vehicle, practice riding slow on flat ground.	Follow the guide to the dunes. Continue to practice and familiarize with vehicle.	Ride on the dunes on their own. Take in the scenary. Get some speed and enjoy the open.	Try sandboarding, walk around, take photos and videos. Drink water and eat snacks.	Follow guide home, take in the scenery and the moment. Reflect on experience.
User Thoughts	Hope they considered and have everything they need	This is a long journey. Looking forward to being there. Enjoying the scenary.	I hope this will keep me safe and protected from the heat and sun.	I'm worried ill crash, I hope im doing this right. This isnt too hard. I think i'm getting the hang of this.	This is fun, the scenary is breathtaking. I can't beleive i'm doing this.	Wow, I can't beleive im doing this right now. Look where I am. This is beautiful and so much fun.	What a great experience. Fun trying sand-boarding. I am hot and thirsty.	That was a long day, but was incredible. I feel so fortunate.
User Feelings	Stressed, excited, nervous, enthusiastic	Tired, excited, surreal.	Nervous, excited.	Anxious, excited, nervous, adrenaline.	Enthusiatic, excited, surreal.	High adrenaline, surreal, excited.	Happy, content, euphoric.	Exhausted, happy, calm.
								

Throughout the experience, the most common times for users to feel low are due to the stress of planning the trip, the long journey traveling to the dunes, walking back up dunes when sandboarding and exhaustion due to heat and exertion. Users generally have high adrenaline levels and high levels of excitement, overpowering some of the negative emotions. Users should also be able to take time to enjoy their surroundings and the scenery while at the dunes.

Emotional Journey

- Anticipation: Significance of maintaining excitement in the design
- High Points: Enhance the peaks of the user experience
- Challenges: Improve areas of difficulties and frustration

User-Vehicle Interaction

- Importance of responsive controls
- Quick to understand vehicle operation
- Vehicle allows for further appreciation of the environment
- User is both safe and comfortable

User-Vehicle Interaction

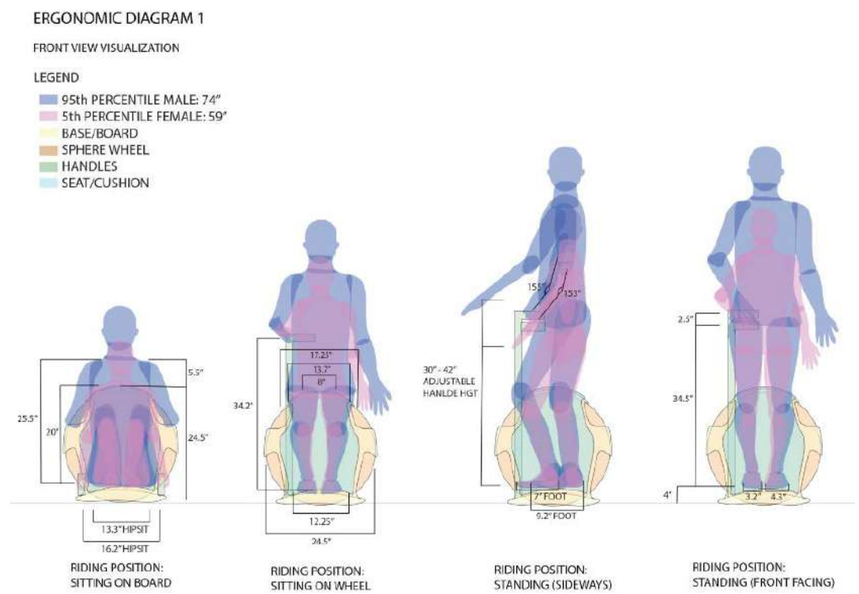
- Balance environmental conservation with user experience
- Users want to take time to enjoy their surroundings

3.3 Analysis- Human Factors

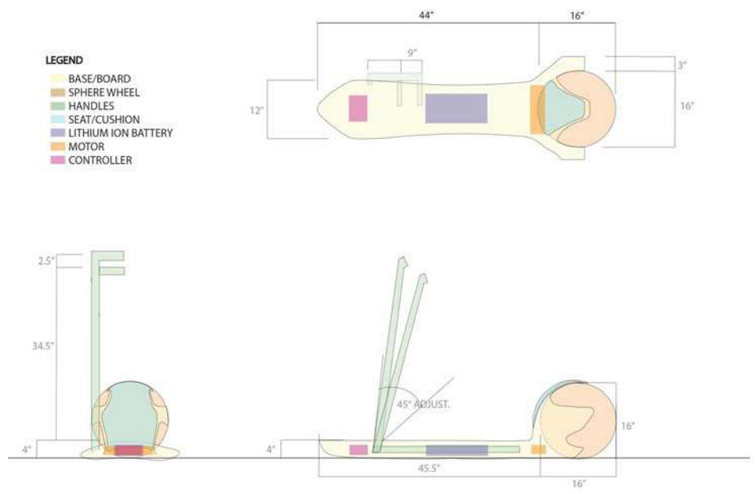
To provide user centered design, it is essential to understand the ergonomics and user interaction with the design solution. A one-to-one ergonomics study as well as a product schematic were developed to ensure proper proportion and interaction with the design solution. Further understanding of the significant touchpoints (the back and seat, arms and hands, and feet and legs) were focused on to ensure comfortability and ergonomic design. The development of the human factors study will aid in proving feasibility of the design solution.

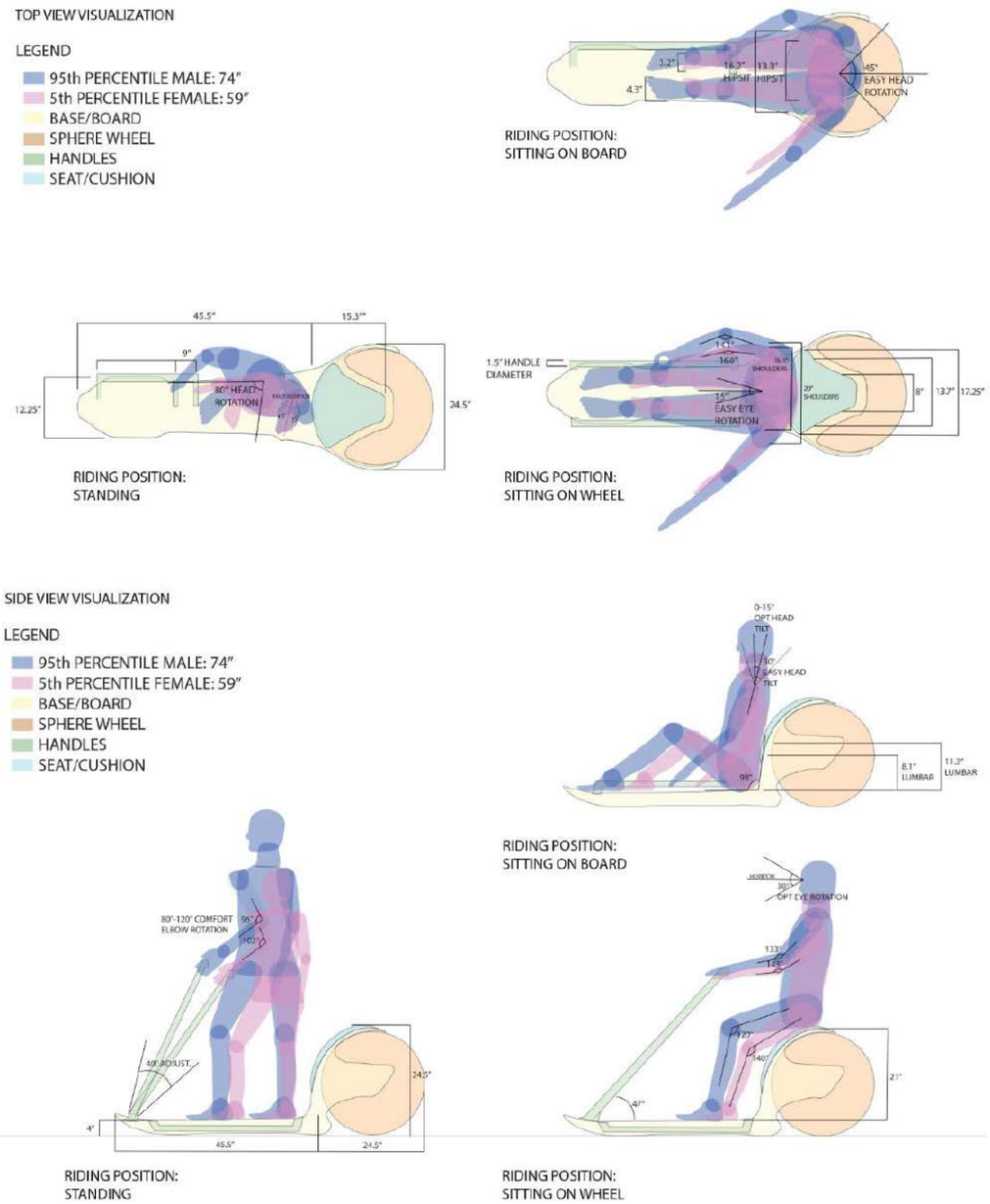
3.3.1 Product Schematic – Configuration Diagram

These product schematic diagrams show the proportion of the design relative to both a 5th percentile female and a 95th percentile male. Measurements taken from The Measure of Man and Woman (Tilley, 2022) provide insight into the user's ability to comfortability interact with the product in both standing and seated positions.



Product Schematic





Limitations and Conclusions

- The user requires an adjustable handlebar for maximum comfort and stability.
- A seat with proper ergonomic consideration would greatly improve back support.
- The rider will likely position between riding styles while operating the vehicle, need to ensure this movement is accounted for.

3.3.2 Ergonomic - 1:1 Human Scale Study

A 1:1 scale ergonomic buck was developed based on results from the schematic diagrams shown in section 3.3.1. This 1:1 scale buck allowed for further usability and interaction testing between the design solution and the user. Major touchpoints were further observed to establish any challenges faced by the user while interacting with the design.

This analysis was beneficial in further understanding the process and challenges faced while operating this sand dune riding vehicle. Users need to feel safe, secure, and comfortable all without fear of potential injury. The study aimed to identify the range of motion, eyesight, body rotation, and dimensional statistics which will allow for full ergonomic consideration throughout the design process. Analyzing the three major body areas will allow for continued adaptation of the design to benefit the users and their needs.

1:1 MOCKUP- FRONT VIEW
SEATED ON SPHERE WHEEL

5TH PERCENTILE MALE 90TH PERCENTI

1:1 MOCKUP- FRONT VIEW
SEATED ON BOARD

5TH PERCENTILE MALE 90TH PERCENTILE MALE

1:1 MOCKUP- FRONT VIEW
STANDING POSITION

5TH PERCENTILE MALE 90TH PERCENTILE MALE

1:1 MOCKUP- SIDEVIEW
SEATED ON BOARD

5TH PERCENTILE MALE

90TH PERCENTILE MALE

1:1 MOCKUP- SIDEVIEW
SEATED ON SPHERE WHEEL

5TH PERCENTILE MALE

90TH PERCENTILE MALE

1:1 MOCKUP- SIDEVIEW
STANDING POSITION

90TH PERCENTILE MALE

5TH PERCENTILE MALE

3.4 Analysis- Aesthetics & Semantic Profile

Based on previous analysis of aesthetics and trends as well as research into the history and social context of sand dune riding, the desired aesthetic is aimed to harmonize with the surrounding environment. Retro trends feature color schemes and forms which will be suiting of said environment. Aesthetic and semantic profile is further analyzed in section 4.1.1.

3.5 Analysis – Sustainability: Safety, Health and Environment

- **Material Selection:** Selecting materials with high recyclability and lower environmental impact is desired. This includes opting for recyclable plastics and considering alternatives that are more easily recyclable or biodegradable. Choosing materials that can be recycled or naturally degrade allows for reduction in environmental footprint.
- **Sustainable Sourcing:** Sourcing materials such as natural rubber from responsibly managed forests and prioritizing suppliers with environmentally friendly practices is desired. Sustainable sourcing ensures materials used have minimal negative impact on the environment.
- **Electric Power:** Electric vehicles produce fewer pollutants and less environmental harm compared to gasoline-powered vehicles.
- **Design for Disassembly and Recycling:** Components should be designed for easy disassembly and recycling at the end of their life cycle. This involves using standardized fasteners and avoiding materials that are difficult to separate. Designing for disassembly ensures that valuable materials can be recovered and reused.
- **Lifecycle Analysis:** Conducting a lifecycle analysis allows for understanding the environmental impact of the vehicle from raw material extraction to end-of-life disposal. This information allows for informed design decisions that minimize environmental harm throughout the vehicle's lifecycle.

The use of sand dune riding vehicles presents health and safety challenges. The ergonomic design is crucial to users' comfort, safety, and efficiency. Materials selected for seating, handles, and control interfaces should prioritize ergonomics while also considering sustainability initiatives. The materials used in the design solution must meet safety standards to protect users from physical harm. This includes selecting materials with high impact resistance to ensure they can withstand rugged terrain and collisions. Materials with good shock absorption properties can reduce the impact of vibrations and shocks on riders. The durability of chosen materials is crucial since vehicle breakdowns in remote deserts can be dangerous. Choosing materials with high durability and resistance to wear and tear can enhance the reliability and longevity of the vehicle, thus reducing the risk of mechanical failures. The harsh environments also include exposure to moisture, salt and other corrosive elements therefore, corrosion resistance in material selection is crucial. Selecting materials with inherent corrosion resistance or applying protective coatings can extend the lifespan of components and ensure the structural integrity of the vehicle over time. Opting for environmentally friendly materials that are recyclable or biodegradable can reduce the vehicle's ecological footprint. Electric vehicles contribute to pollution reduction, offering a cleaner alternative to traditional gasoline-powered vehicles.

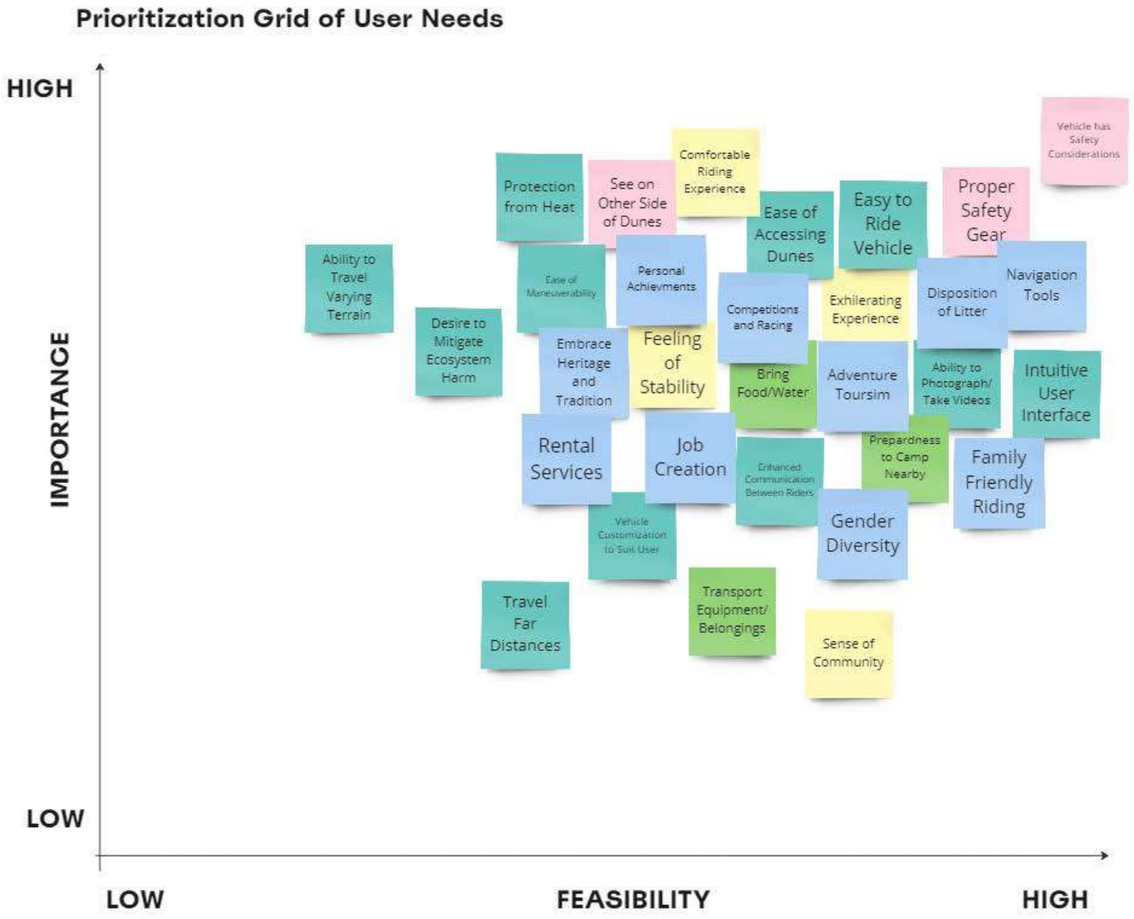
3.6 Analysis – Innovation Opportunity

To further understand and address opportunities of innovation various data collection and organization methods were utilized. Analyzing user needs allows for developing solutions which provide innovative design elements to enhance the dune riding experience.

3.6.1 Needs Analysis Diagram

An analysis of latent user needs was linked with Mazlow's Hierarchy of Human Needs to gain insight into the importance of individual needs, as seen on the right. The development of a prioritization grid, as seen on the following page, provides insight into areas of focus which address various needs.

Product- a) Sand Board and b) ATV				
Needs	**Benefits and Underlying Needs**		**Level of importance**	
Basic Needs *Physiological*				
Food, water, shelter	Storage for water and food.			*High*
Pleasure, gratification *(sensory, compulsive responses)*	a. Sensory pleasure of gliding down the sand dunes. b. Gratification through powerful and responsive off-road experiences.			*High*
Security *Safety, securing resources*				
Safety	a. Non-slip surfaces and secure bindings b. Rollbars and reliable breaking systems			*High*
State, Group, Individual				
Securing resources *Optimization of limited resources (cost effectiveness)* *· Value* *· Accumulation of resources (wealth)*	a. Cost effective and low-maintenance b. Efficient on fuel and resources			*High*
	a. Affordable and accessible, allows for broader audience b. Caters to range of budgets, offers various models and varying costs.		*Moderate*	
Control over environment (tasks)				
Convenience *Ease of Use* *Speed (fast, less time)* *Control (precision, responsiveness, power)*	a. Easy to use, promoting control and precision during descent on dunes. b. Provide speed, responsiveness and control for navigating diverse terrains			*High*
Long Term Security/Stability of Group *Health/care/education of children*	a. Affordable recreational activity, promotes healthy lifestyle b. Support family adventures.		*Moderate*	
Environmental sustainability	a. Environmentally friendly, minimal impact on surroundings. b. Eco-friendly options with electric or low emissions models		*Moderate*	
Insurance (car, house), pension, investments	a. Low cost recreational option, reduces need for insurance b. Insurance available for riders provides sense of security	*Slight*		
Social Belonging *Effort / resources to belong to a 'tribe'*				
Fear of Abandonment	a. Inclusive and accessible, fosters sense of community b. Social experiences in off-road communities		Moderate	*High*
Fear of the enemy	a. Promote shared experiences, diminishing fear of isolation b. Group rides and off-road events create supportive community		Moderate	
Tribal Identity				
Behavior cues for survival *(copying behaviors... safe to eat, learned skills)*	a. Learning and sharing safe riding practices within community b. Enhancing off-road skills and safety tips, contributing to a knowledge base.		Moderate	*High*
Behavior cues for social interaction of group *(copying behaviors... Interaction cues, play, have fun)*	a. Encourage playful interactions, promotes joy and fun b. Group activities and playful off-road experiences strengthen social bonds.			*High*
Peer Pressure	a. Positive peer influence in adopting safety measures and responsible riding b. Social pressure to adhere to responsible off-road practices		Moderate	
Social Expectation *(social covenant (gift))*	a. Shared gifts of knowledge and expertise b. Exchange of information and support		Moderate	
Esteem *Personal influence in 'tribe'*				
Social Status The elite have it...I want to be like them'	a. Unique status through skillful sand riding b. ATV models may have a sense of status		Moderate	*High*
Social Recognition	a. Recognition for mastering the rt of sand dune riding within the community b. Acknowledgement for participating in challenging off-road activity		Moderate	*High*
Sexual attractiveness	a. Physical Fitness		Moderate	
Self-Actualization ***'Higher order' Functions/Needs*** *Needs that are pre-dominantly 'outer cortex'*				
Intrinsic pleasure	a. Inherent joy from conquering sand dunes using "natural" mode of transportation b. Intrinsic pleasure in navigating challenging terrain.		Moderate	
Creative endeavors	a. Creative expression in mastering different techniques and styles of riding b. Creativity in navigating diverse landscapes and overcoming obstacles		Moderate	*High*
Experiential (extrinsic)	a. External experiences of freedom and exhilaration b. Experiencing the thrill of off-road adventures		Moderate	*High*
Experiential (intrinsic)	a. Internal satisfaction for accomplishment b. Experiences the thrill of off-road adventures and conquering varied terrain.		Moderate	
Emotional	a. Emotional satisfaction and a sense of liberation while gliding down sandy slopes b. Emotional fulfillment in conquering off-road challenges and exploring new territory		Moderate	*High*



The STEEPV analysis developed in section 3.1.2, provides insights and allows for categorizing all user needs into a prioritization grid to measure importance and feasibility of each need.

Highest Priority Needs:
- Safety Considerations
- Proper Safety Gear
- Navigation Tools
- Negative Waste Production
- Ease of Riding
- Exhilarating Experience
- Intuitive User Interface
- Ability to Capture Experience

3.6.2 Desirability, Feasibility & Viability

When designing a sand dune riding vehicle, the focus on innovative features that enhance the user experience and push the boundaries of design are favored. Considering IDEO's desirability, feasibility, and viability framework from a design perspective aids in the development of an innovative design solution:

Desirability:
- Explore new ways to make the vehicle more appealing and exciting, such as incorporating safety features, customizable options, or interactive elements.
- Insights from user research inform the design process and create a solution that resonates with users on a deeper level.
- Aim to create a vehicle that not only meets but exceeds user expectations, offering features and functionalities that are unique and captivating.

Feasibility:
- Focus on designing features that are technically feasible and can be implemented using existing technology.
- Prototype and test the design to ensure that it can be manufactured and operated safely and effectively in a sand dune environment.
- Balance innovation with practicality, ensuring that the design is both innovative and functional, providing a seamless and enjoyable riding experience.

Viability:
- While the focus is on innovation, it's important to consider the long-term viability of the design. Evaluate the cost-effectiveness of implementing new features and technologies, and consider how these innovations could impact the overall marketability of the product.
- Consider scaling and adapting for different markets or applications, ensuring potential of being successful in a variety of contexts.
- Push the boundaries of innovation while balancing potential to be successful in the market.

3.7 Summary of Chapter 3

Chapter 3 delves into a comprehensive analysis of user needs, usability, human factors, aesthetics, and sustainability for enhancing the sand dune riding experience. The needs analysis emphasizes the gaps in current products, unveiling a lack of connection with the environment, limited sand dune specific features, and insufficient consideration for ecosystem impact. Latent needs are identified through STEEPV analysis, categorizing them into immediate, latent, wishes, and wants. The chapter presents needs statements that will guide the user-centric design process. Usability is assessed through journey mapping and user experience maps, capturing the emotional and interactive facets of the sand dune riding journey. The analysis also encompasses human factors, employing ergonomic studies and product schematics to ensure optimal user interaction. Aesthetics are explored with a focus on harmonizing with the sand dune environment. This chapter lays the foundation for informed design decisions and innovation in sand dune riding vehicles. An analysis of latent user needs linked with Maslow's Hierarchy of Human Needs provides insight into the importance of individual needs, while the development of a prioritization grid offers insight into areas of focus addressing various needs. The focus on innovative features that enhance the user experience and push the boundaries of design is emphasized, guided by IDEO's desirability, feasibility, and viability framework. This approach aims to create a vehicle that exceeds user expectations, offering unique and captivating features and functionalities.

CHAPTER 4
DESIGN DEVELOPMENT

4.1 Initial Idea Generation

Analyzing the data collected from user research, initial idea generation was developed. The understanding of the user experience gained in Chapters 2 and 3, served as a starting point to ensure the design solutions features and functionality would be of aid to the user. Analyzing the initial ideations, justification was developed to ensure which solutions would be most beneficial to meet and exceed the user's needs. This initial idea generation would later serve as a starting point for ideation sketches and eventually concept development.

4.1.2 Aesthetics Approach & Semantic Profile

The desired aesthetic approach for a dune riding vehicle is to ensure the vehicle itself has an aesthetically pleasing contrast with the surrounding environment. A color scheme of dark greys and vibrant green complement the natural environment. The design solutions aesthetic is intentionally aggressive and exciting while seamlessly blending with the timeless beauty of dunes and paying homage to the history of sand dune riding.

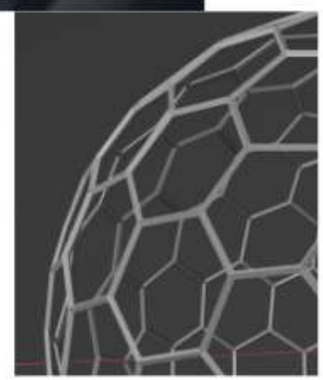






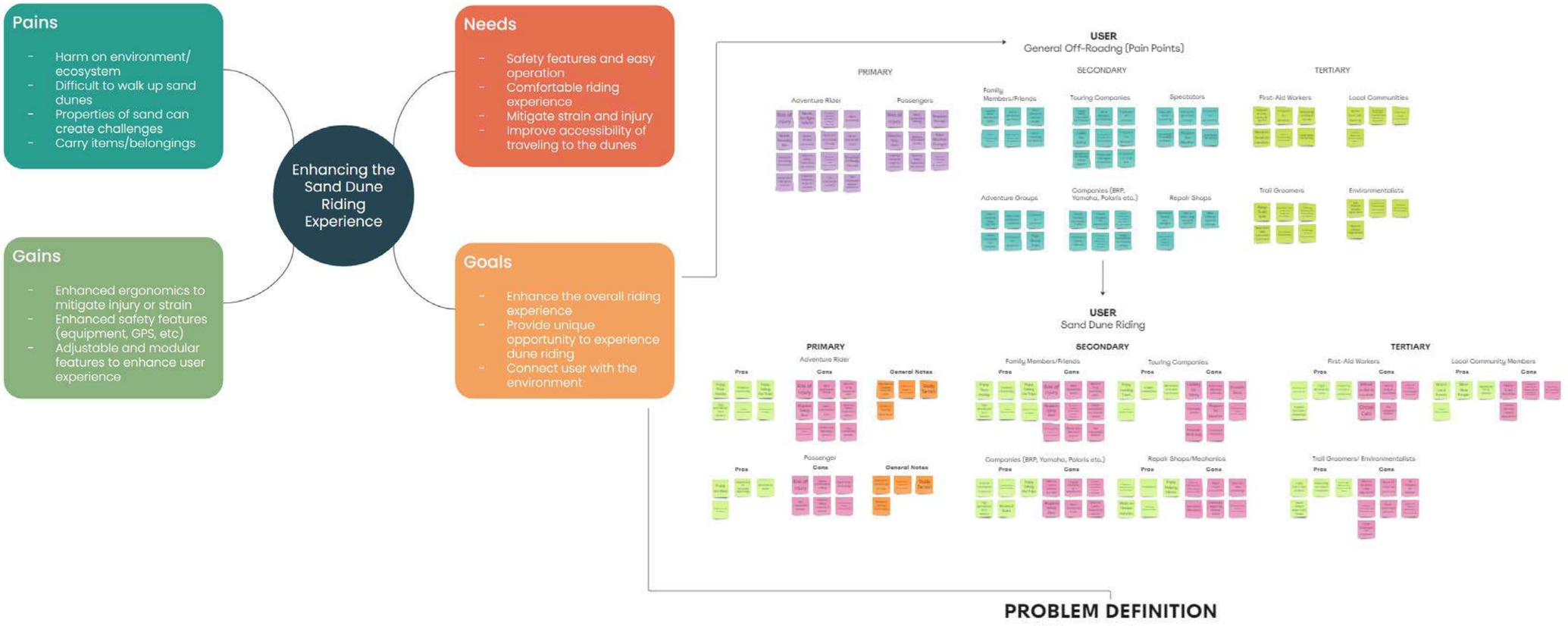






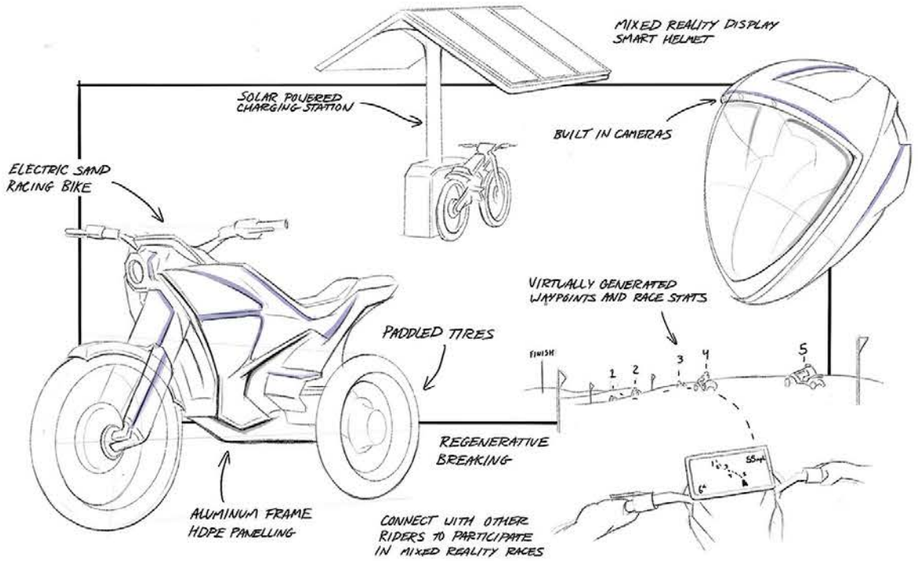

4.1.2 Mind Mapping

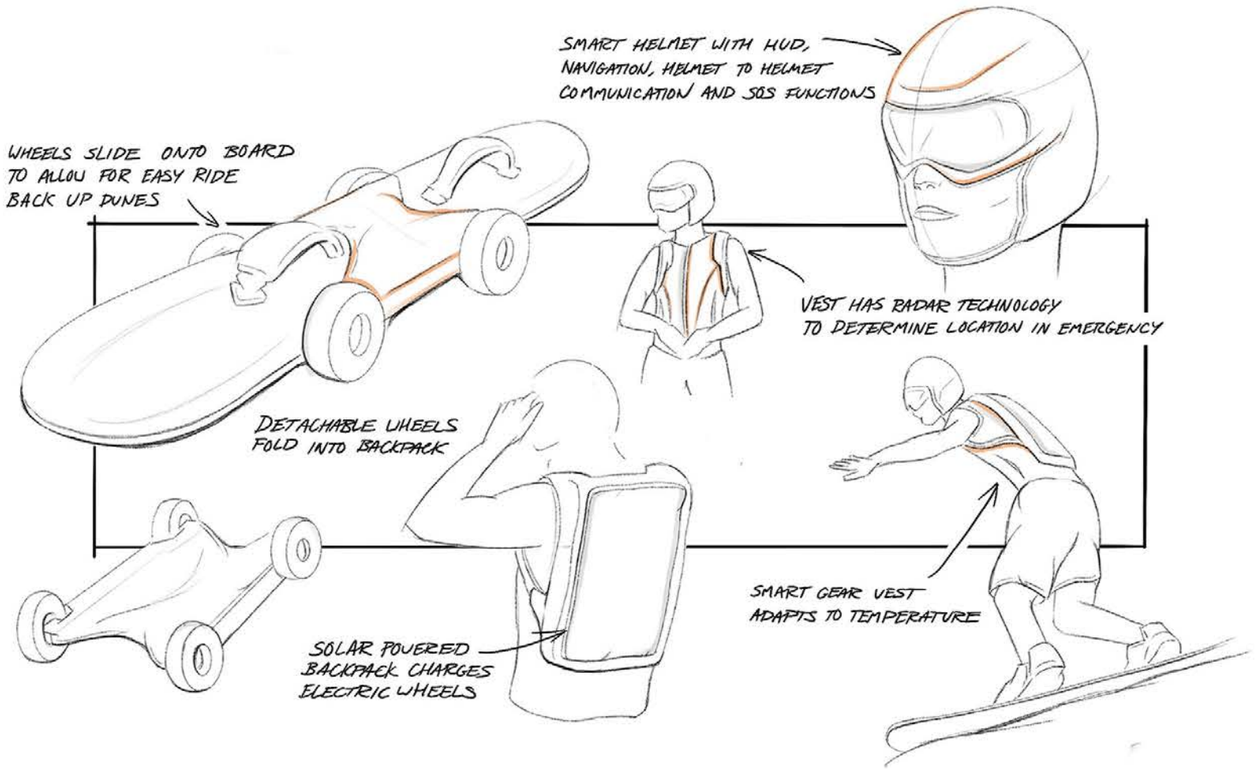
Developing mind mapping from research findings allows for a visualization featuring the pains, gains, needs and goals of the users who are participating in sand dune riding. The mind map is effective in serving as a key diagram featuring essential aspects to be met which ensure user satisfaction from the design solution.

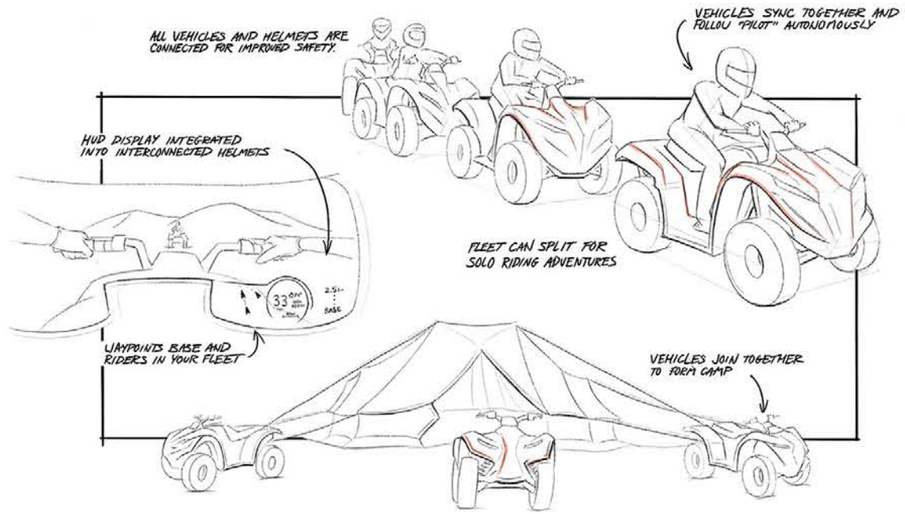


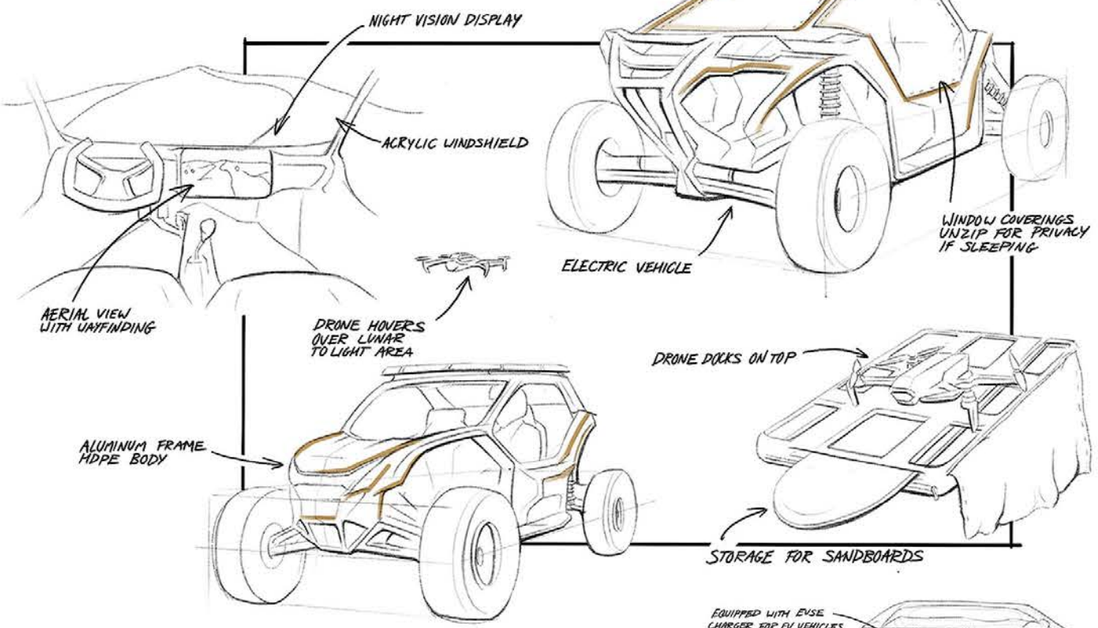
4.1.3 Ideation Sketches

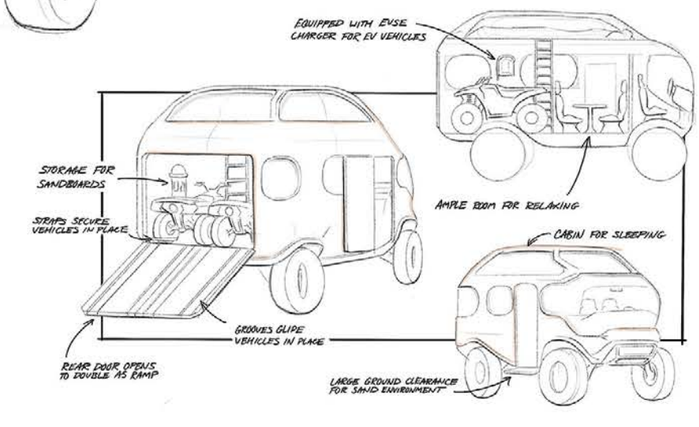
Idea generation consisted of various solutions containing unique features which would be of aid to those who experience sand dune riding. These ideas served as starting points to further develop unique solutions. The initial idea generation was very focused on features of the design solution rather than the aesthetic or ability of the design itself.





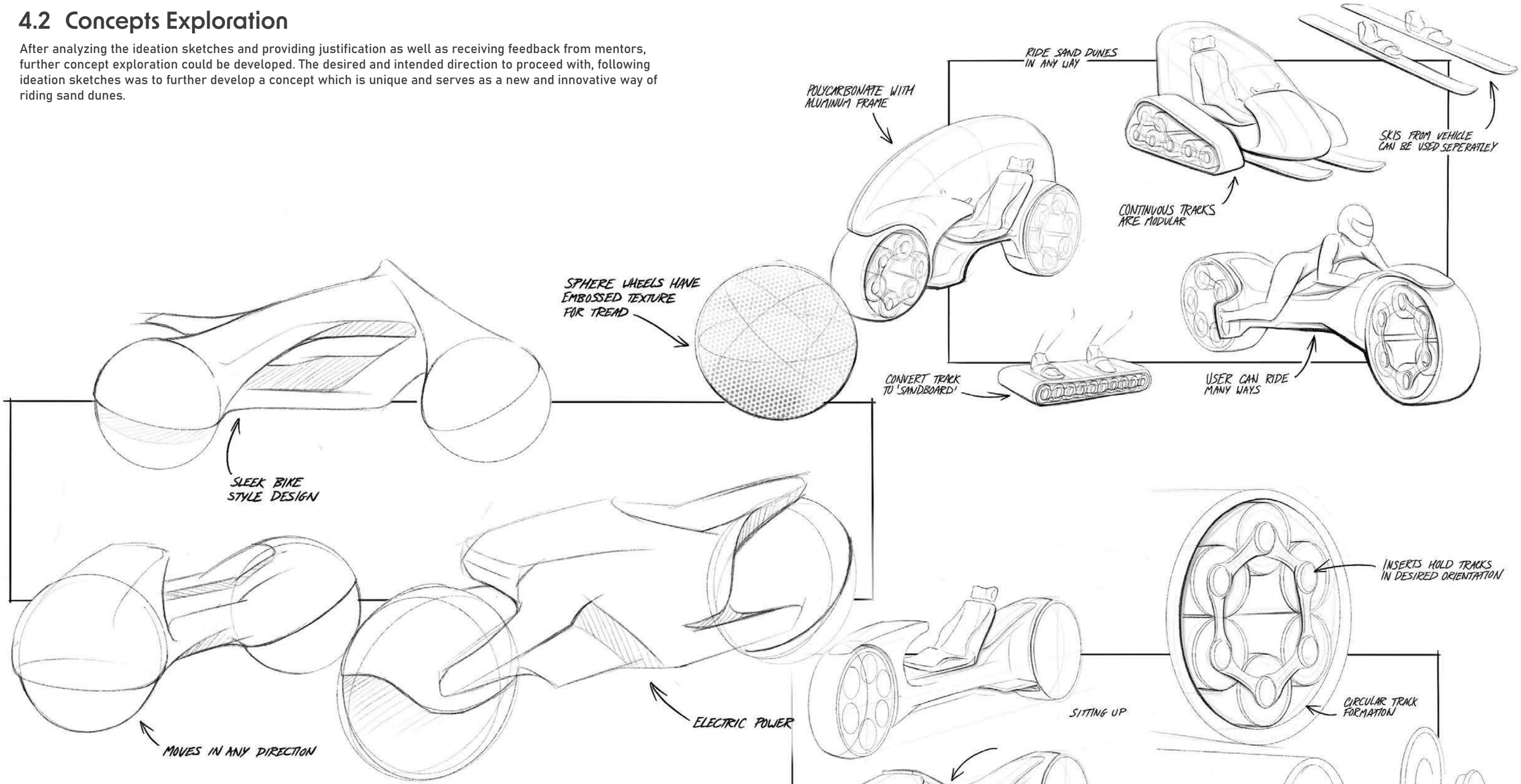






4.2 Concepts Exploration

After analyzing the ideation sketches and providing justification as well as receiving feedback from mentors, further concept exploration could be developed. The desired and intended direction to proceed with, following ideation sketches was to further develop a concept which is unique and serves as a new and innovative way of riding sand dunes.

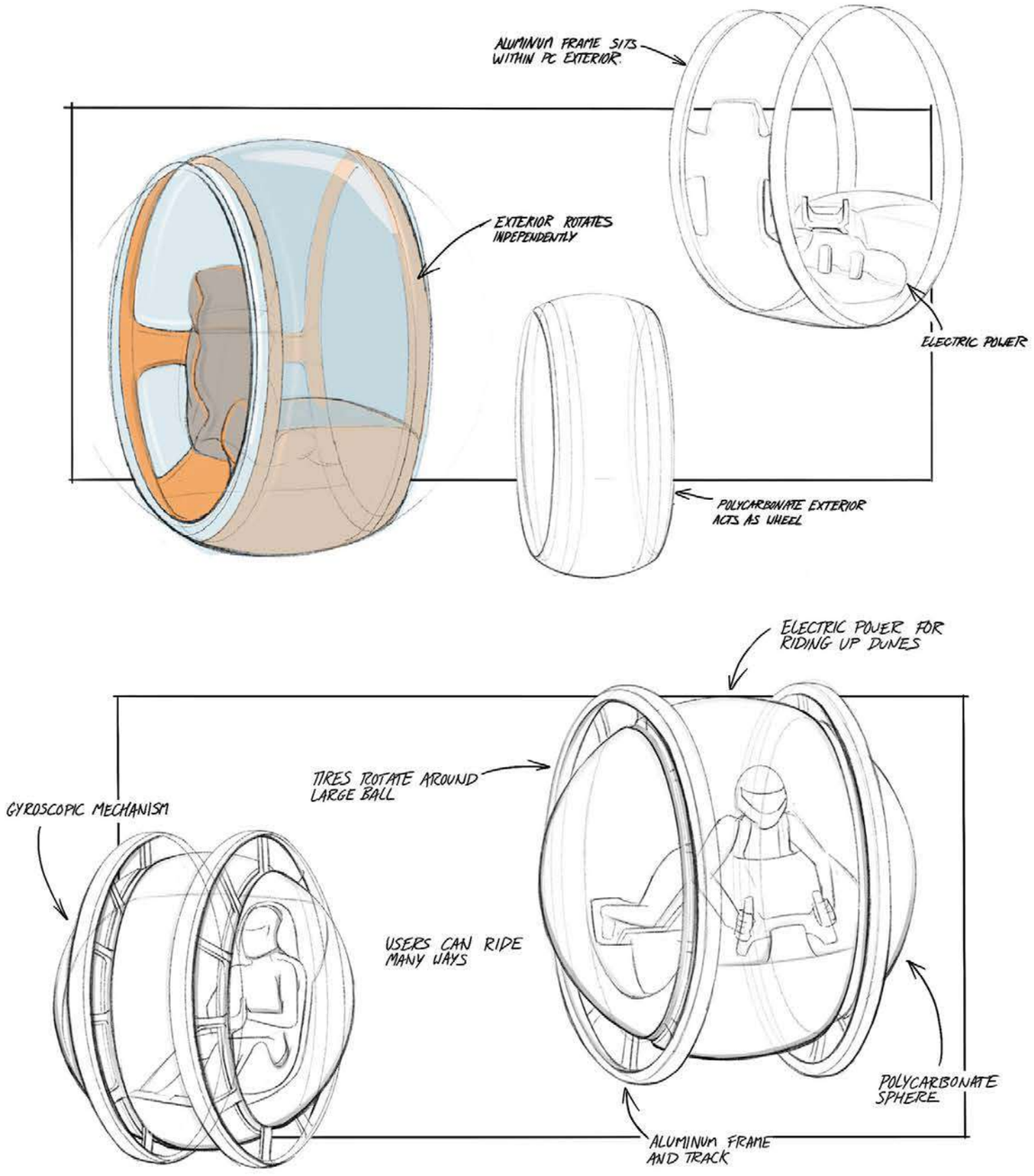


4.2.1 Concept One

The intention of concept one is to develop a modular vehicle featuring a continuous track. The continuous track would allow for modularity, where the user can manipulate the size and orientation of the track to be used in varying ways. After further justification, it was understood that a continuous track which is modular would have too many components and these components could malfunction due to sand entering the parts. From here, the concept was developed to maintain the form of the vehicle previously developed but instead have omnidirectional textured wheels which would effectively interact and excel when functioning on sand.

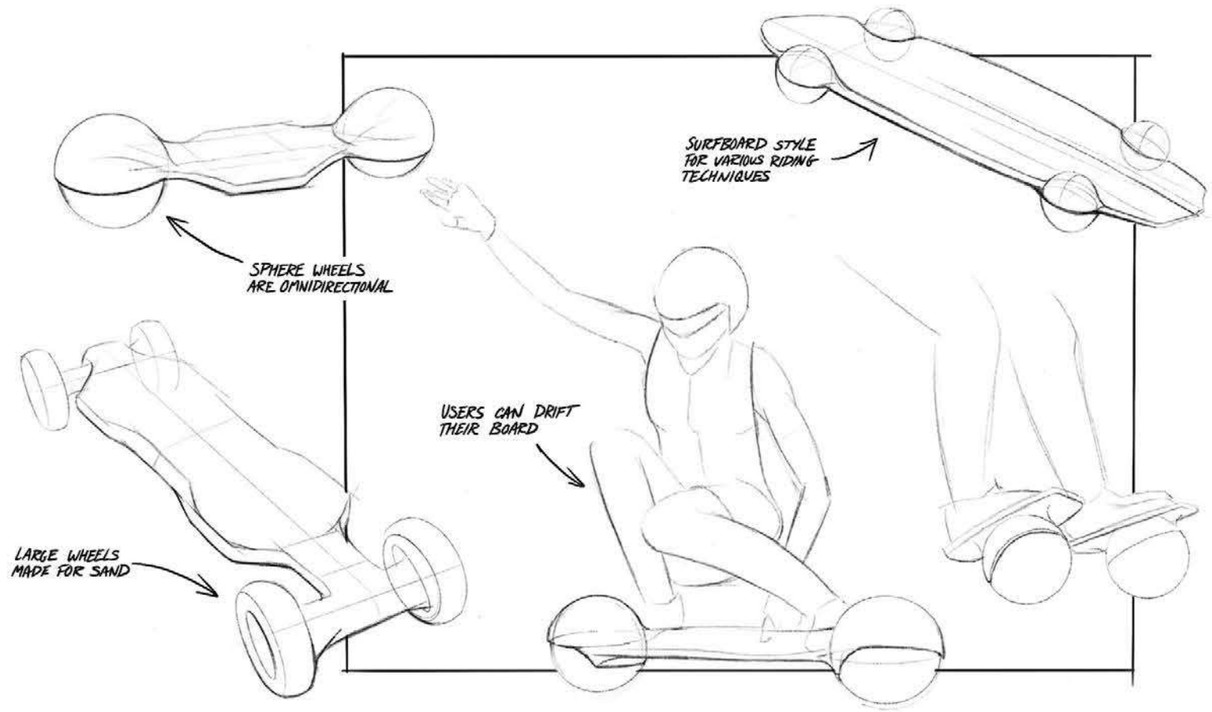
4.2.2 Concept Two

The purpose of concept two is to increase the user's ability to connect with the surrounding environment. The concept features a circular track with gyroscopic technology where the user can be seated inside the product and ride up and down the sand dunes. A polycarbonate enclosure allows for users to have a clear view of their surroundings while also protecting the user from obstruction of vision due to sand. After further consideration, this concept may not be beneficial in that the polycarbonate enclosure in hot climates would increase heat inside the unit which could be harmful to the health of the user.



4.2.3 Concept Three

Concept three was developed after further consideration of the current sandboarding experience. When sandboarding, if a user falls- which is common for beginners- their board will travel to the bottom of the sand dune. The user will then have to walk to the bottom of the dune to retrieve the board and then walk back up the dune to be able to go down again. Even if the user doesn't fall, they will still need to walk back to the top of the dune. Having an electric powered board would allow for the user to ride on the board both up and down the dunes, thus enhancing the sandboarding experience for users.

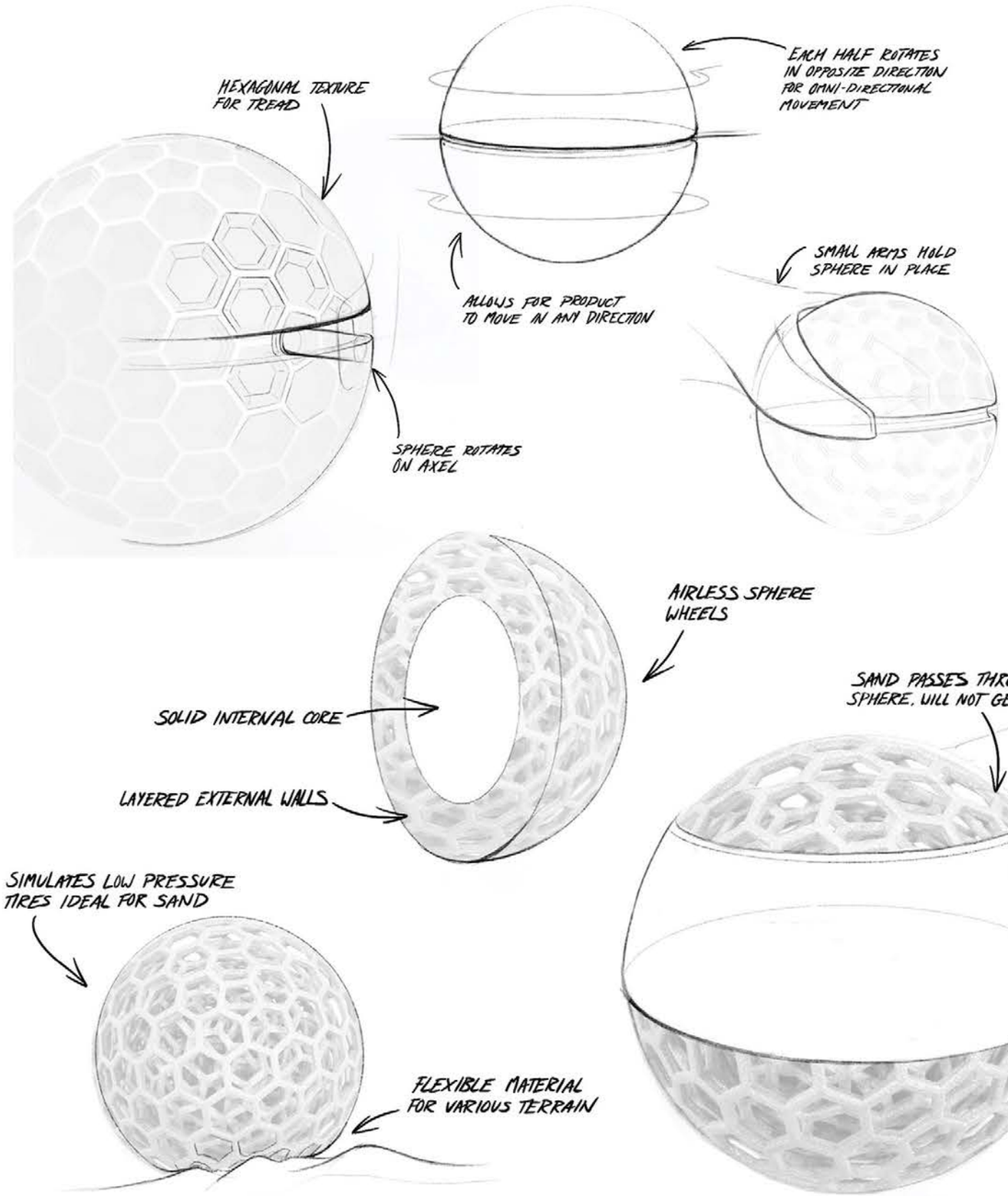


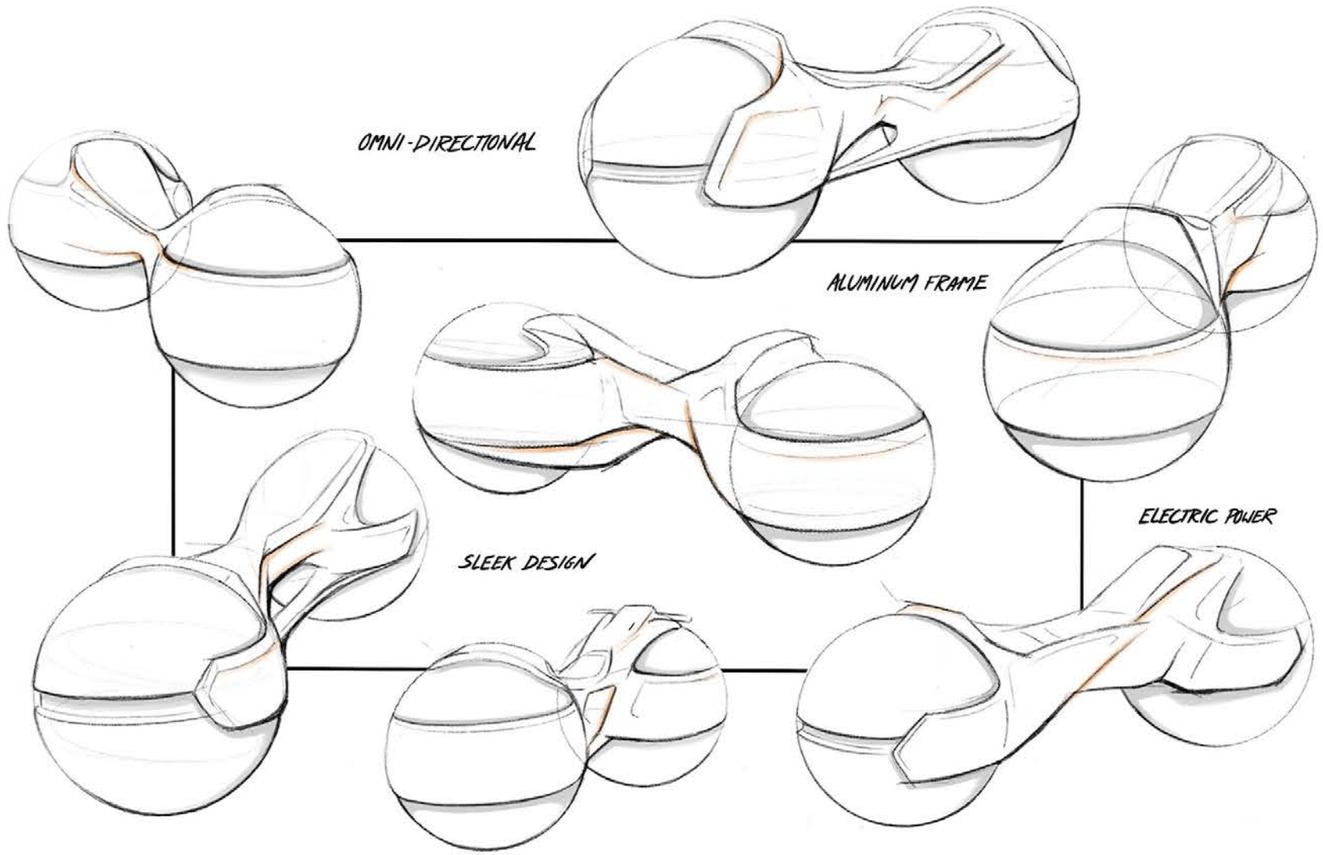
4.3 Concept Strategy

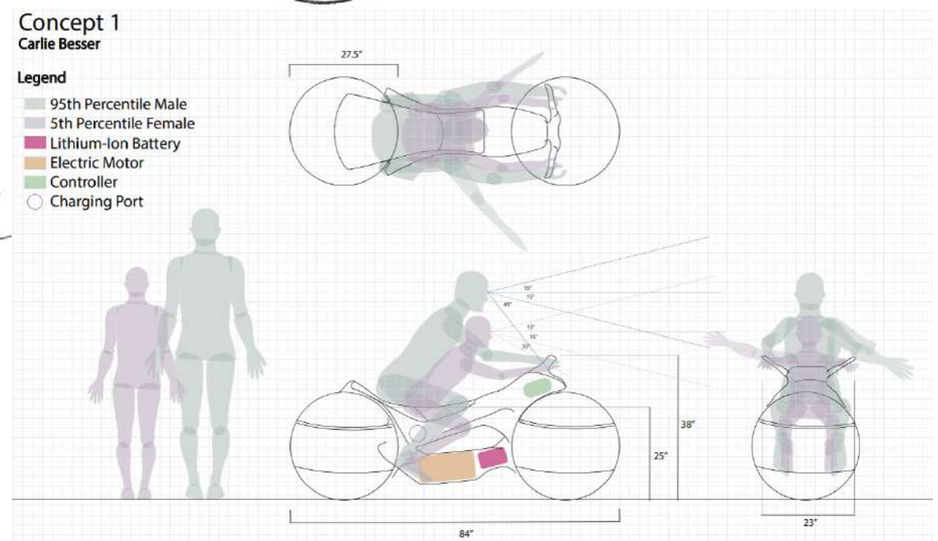
From the previous three concepts, two concepts were further developed. Concept one was chosen due to its opportunity of developing an innovative, omnidirectional wheel ideal for sand. Concept three was also developed due to its strong improvement on existing sandboarding practices and opportunity to reinvent the sand dune riding experience.

4.3.1 Concept Direction & Product Schematic One

This concept direction was developed from concept one. The use of omnidirectional wheels in partner with a two wheeled type 'bike' creates an exhilarating vehicle with substantial power to ride around on sand dunes. The innovative development of the omnidirectional wheel allowed for an airless sphere wheel with texture ideal for sandy environments. This allows for users to travel in any direction, not worry about tire inflation and to use a wheel ideal for the properties of sand.



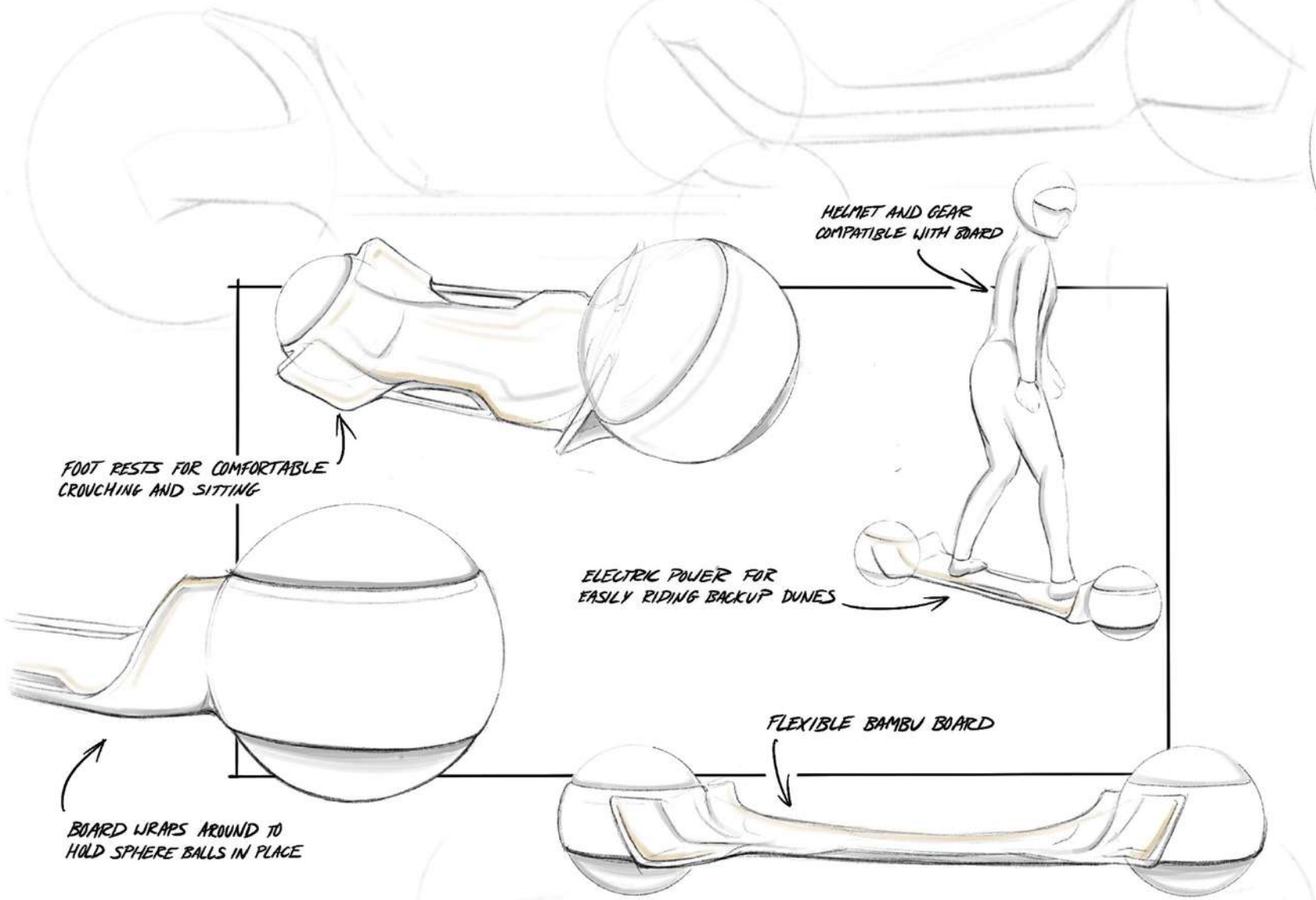


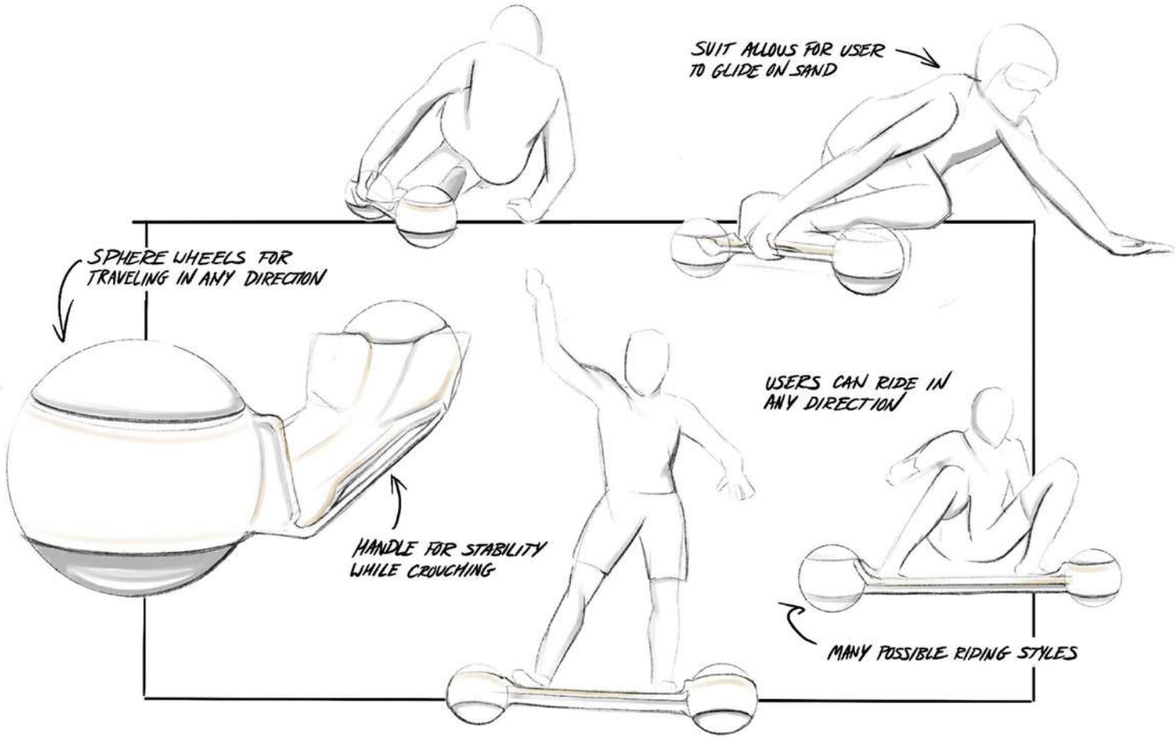


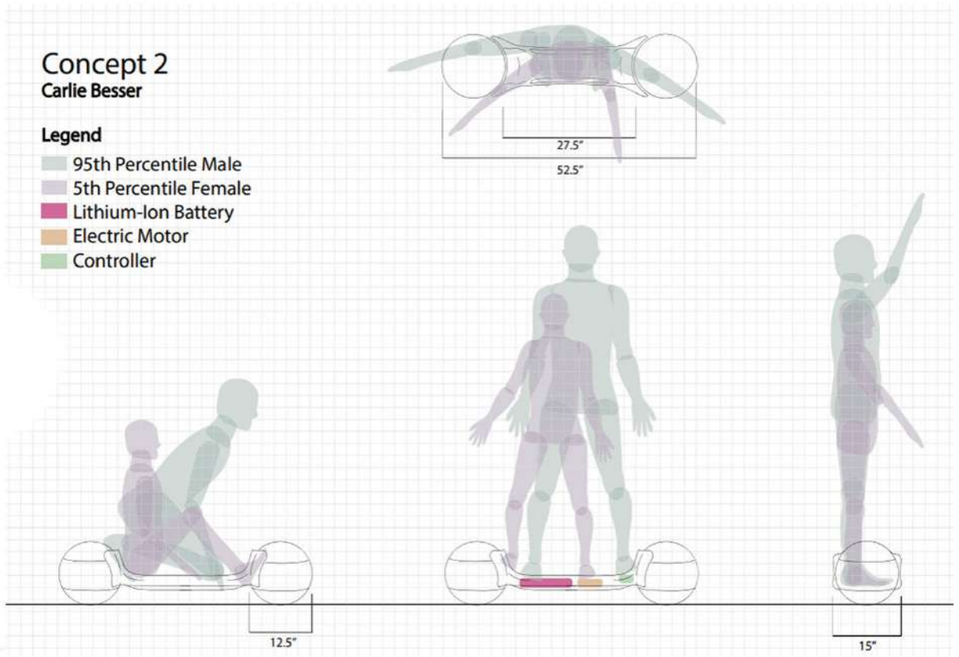
The developed schematic was of aid in determining the correct vehicle sizing as well as a comfortable position both 5th percentile females as well as 95th percentile males. After further consideration, it was determined that a vehicle this large is further disconnecting the user from the environment which is not desirable as this connection is something that should be enhanced.

4.3.2 Concept Direction & Product Schematic Two

This concept was further developed from concept three. The inclusion of omnidirectional wheels onto a board style product would allow for users to travel up and down dunes while also traveling in any desired direction. This would allow for users to carve both up and down sand dunes, providing an experience not yet possible and allowing for users to further connect with the surrounding environment.



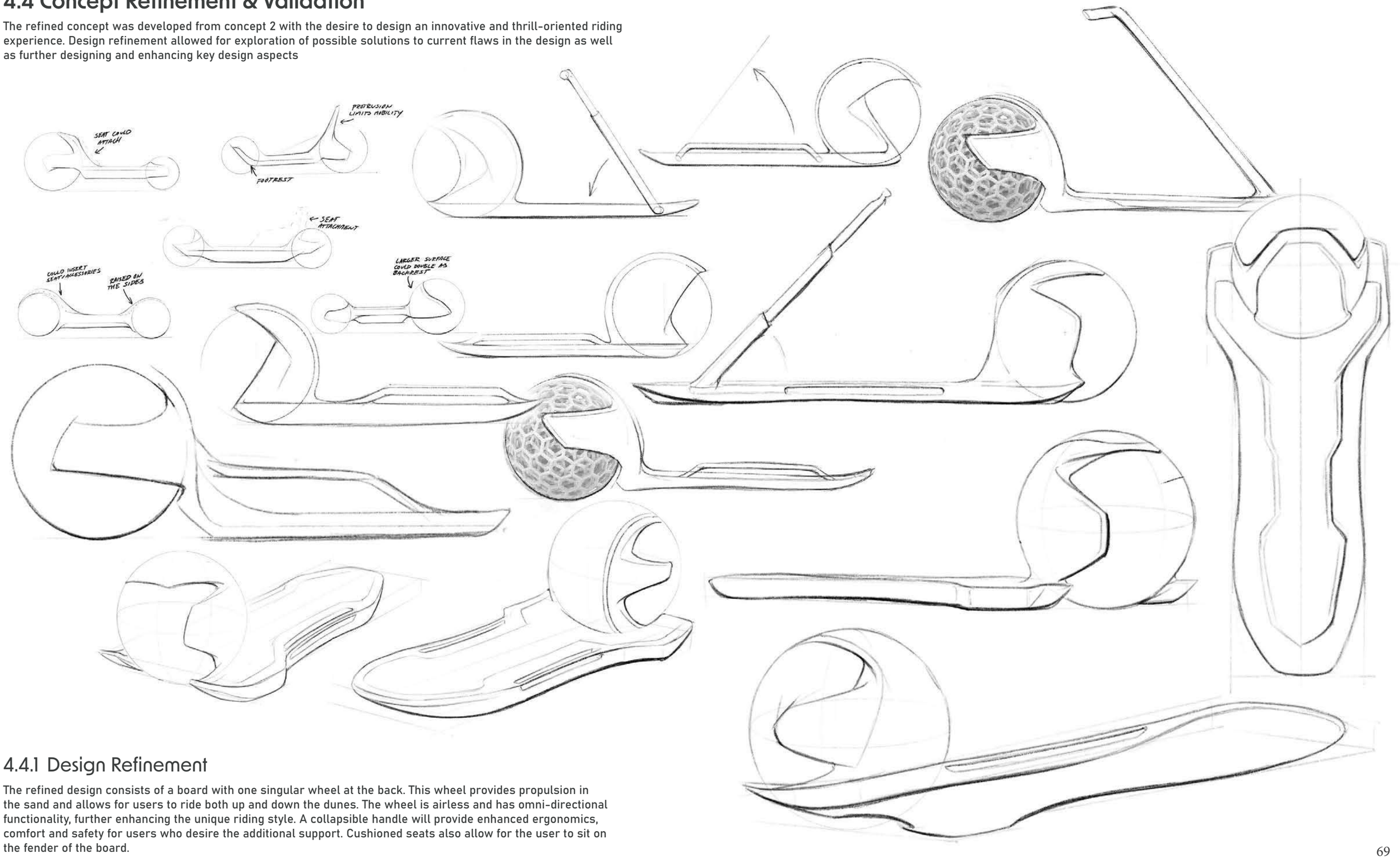




A schematic was developed to ensure necessary components of the product would ft inside the housing and to ensure both 95th percentile males and 5th percentile females would be able to ride the board in various ways and in any position desired by the user. Users would be able to crouch, sit and stand on the board as desired.

4.4 Concept Refinement & Validation

The refined concept was developed from concept 2 with the desire to design an innovative and thrill-oriented riding experience. Design refinement allowed for exploration of possible solutions to current flaws in the design as well as further designing and enhancing key design aspects

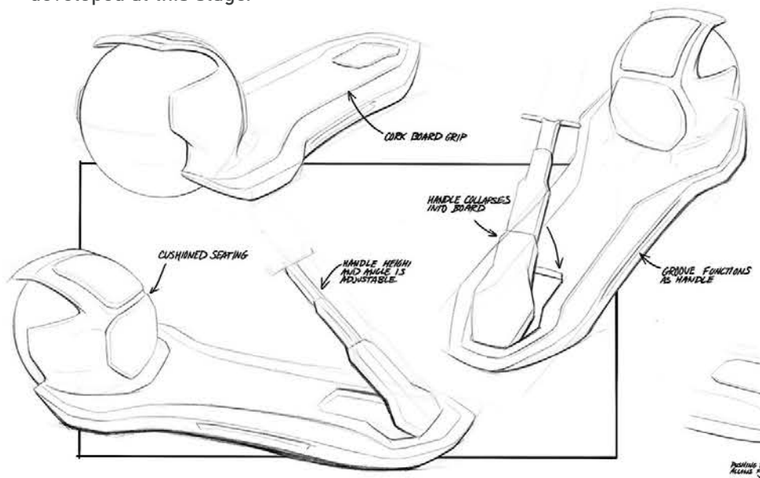


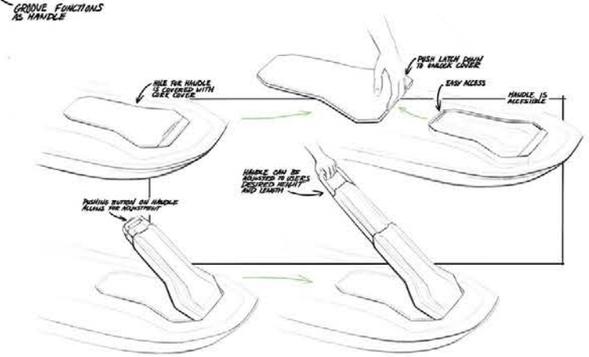
4.4.1 Design Refinement

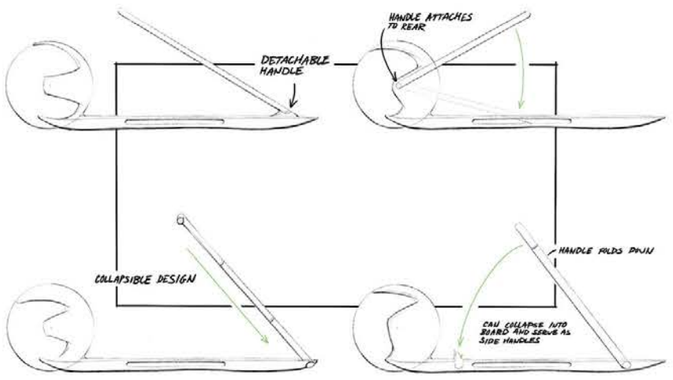
The refined design consists of a board with one singular wheel at the back. This wheel provides propulsion in the sand and allows for users to ride both up and down the dunes. The wheel is airless and has omni-directional functionality, further enhancing the unique riding style. A collapsible handle will provide enhanced ergonomics, comfort and safety for users who desire the additional support. Cushioned seats also allow for the user to sit on the fender of the board.

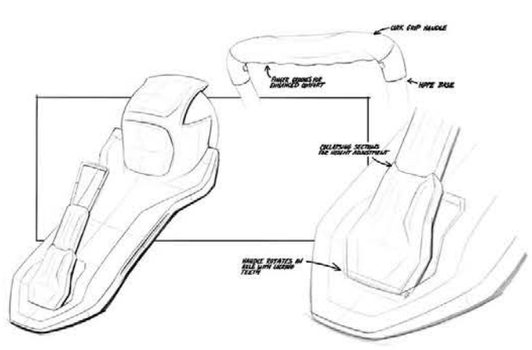
4.4.2 Detail Development

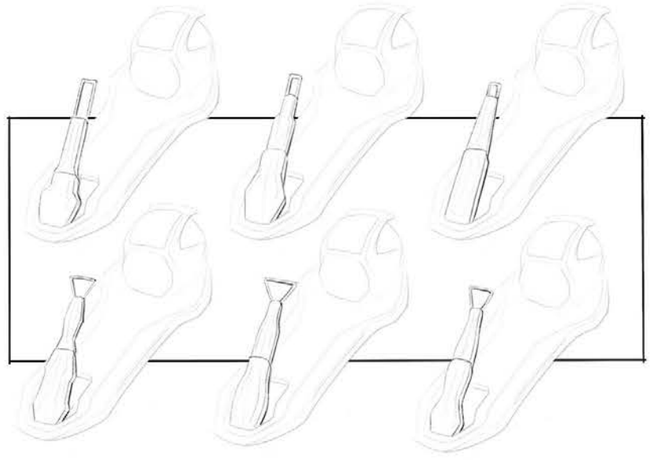
Detail development consisted of designing the mechanics and functionality of the collapsible handle. Further detailing was also necessary for the aesthetics of the board. The AR visor integrated helmet was aesthetically developed at this stage.

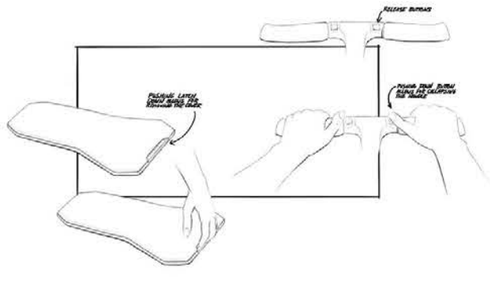


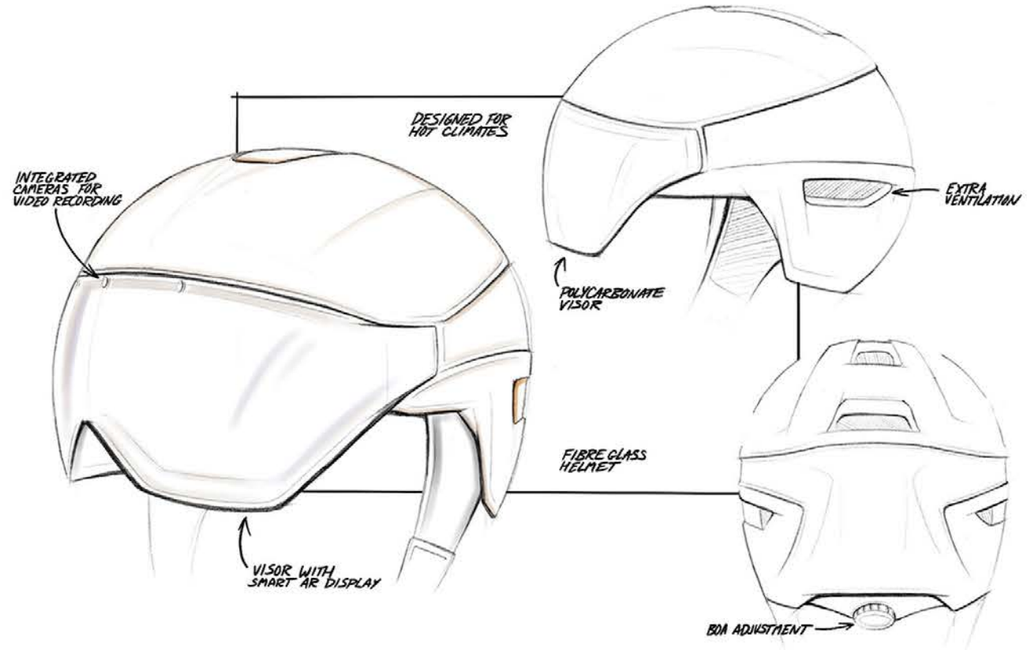


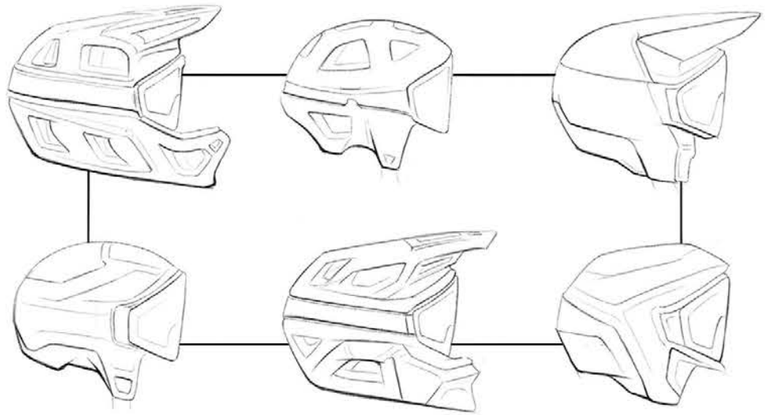


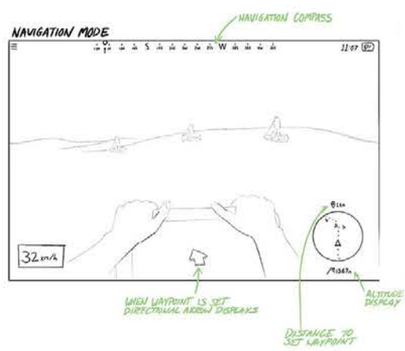


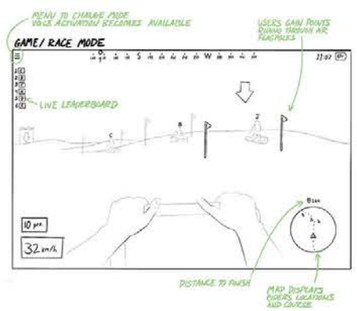


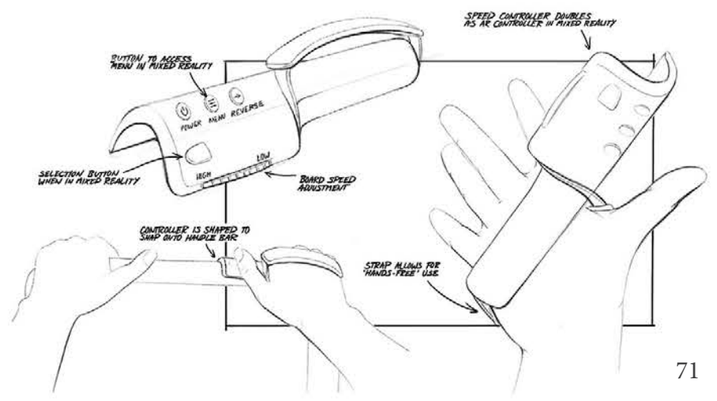






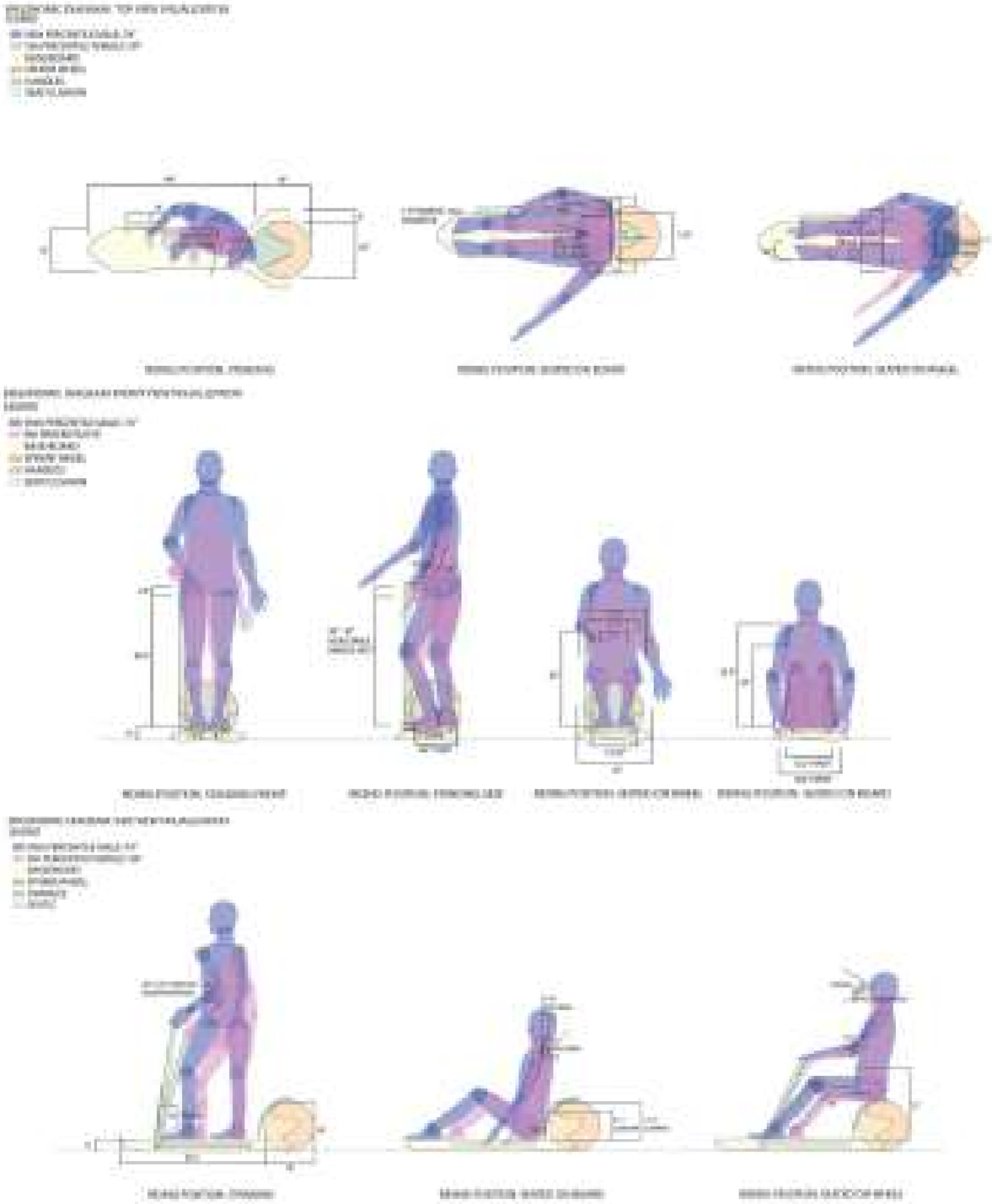






4.4.3 Refined Product Schematic & Key Ergonomic

Presented below are schematics which aid in the ergonomic analysis of the design solution.



4.5 Concept Realization

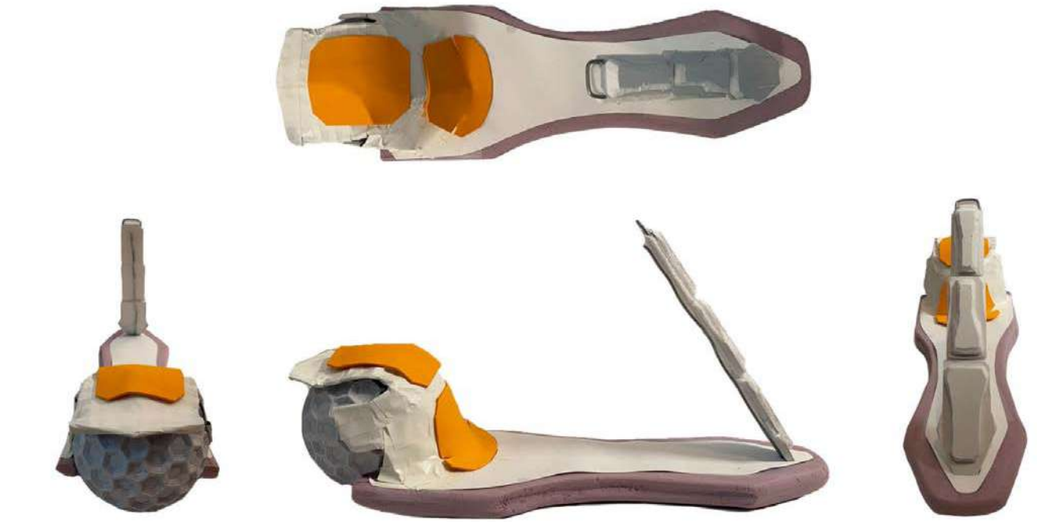
The realization of the concept ensures the design solution has been refined and serves its unique purpose effectively. The concept addresses three main goals, safety, accessibility and sustainability.

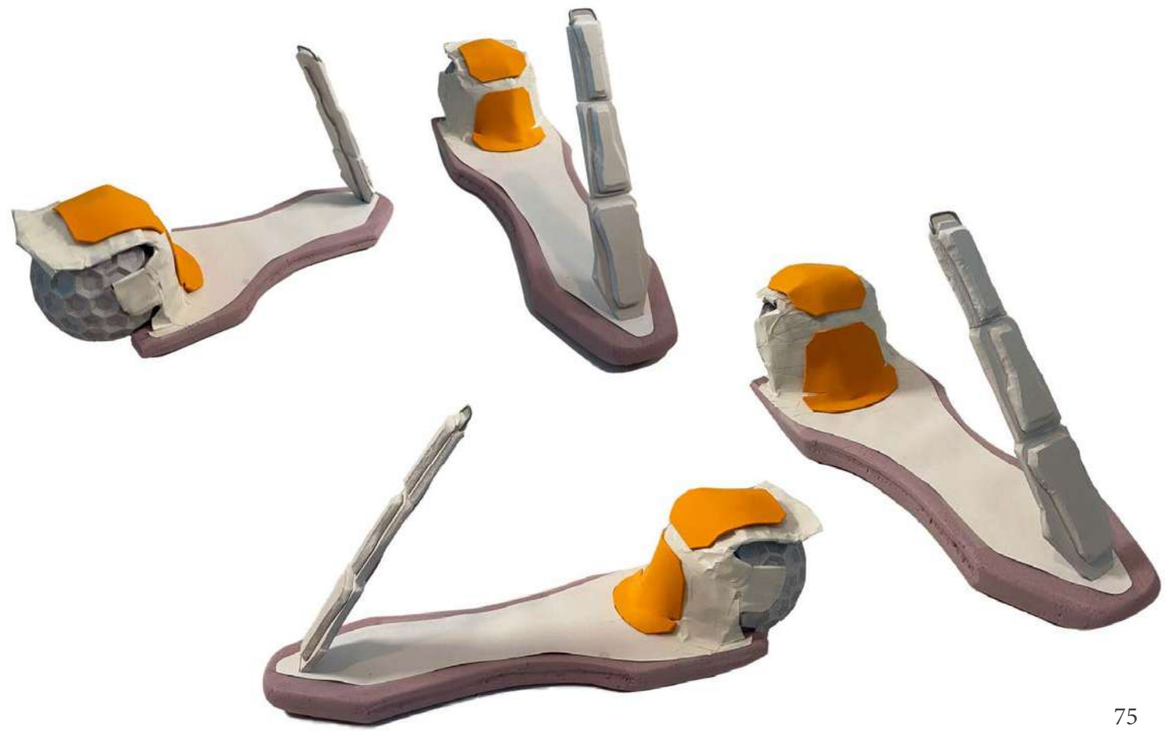
4.5.1 Design Refinement

The final design consists of three products, the main board with the wheel, helmet with AR visor and speed controller. To further understand and ensure design functionality, revision of product and ergonomic schematics were utilized. A physical study model of the main body was developed to better consider and determine physical dimension and form.

4.5.2 Physical Study Model

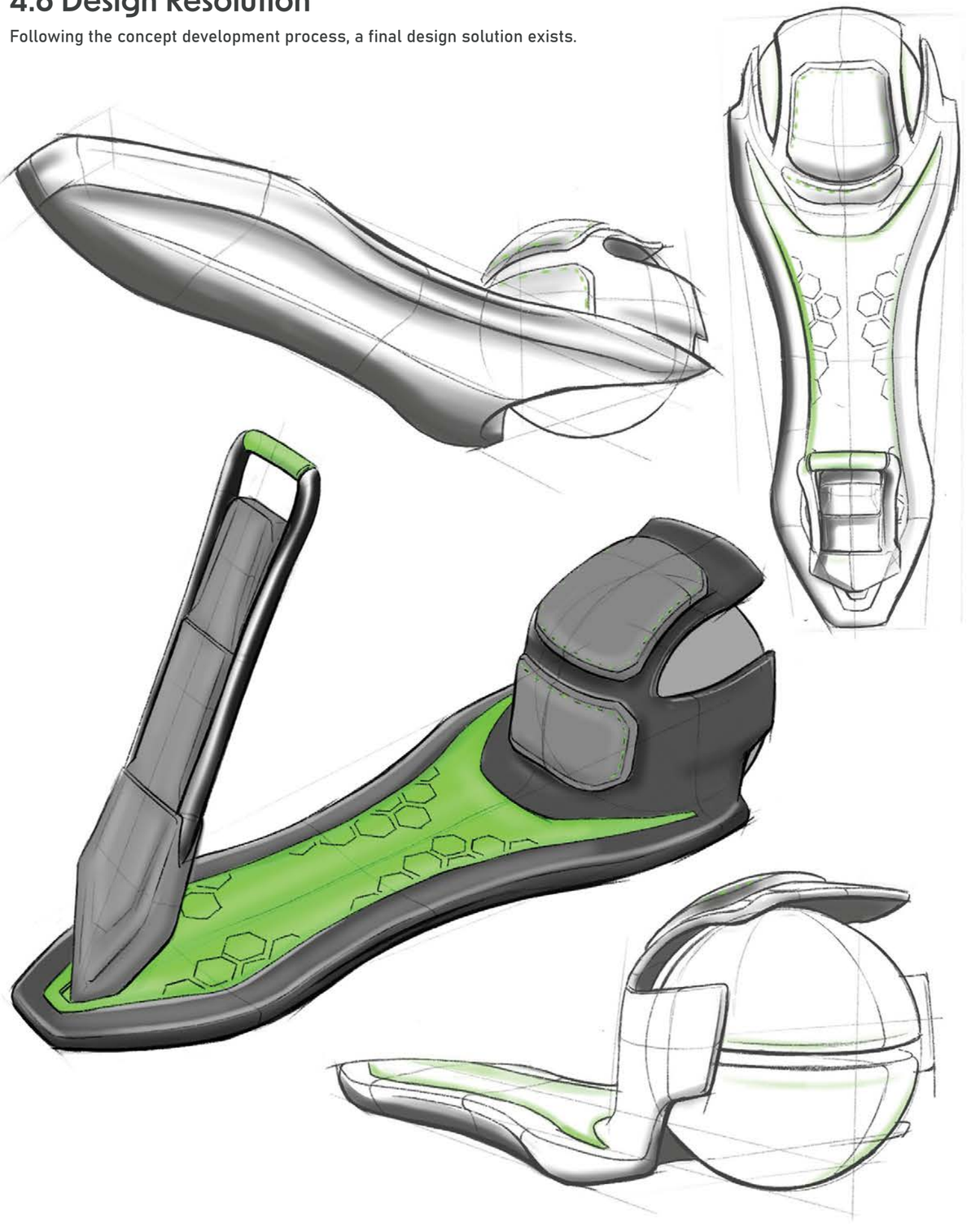
Following refined ergonomic studies, physical study models were utilized to visualize the design solution and further refine design dimensions and aesthetics.

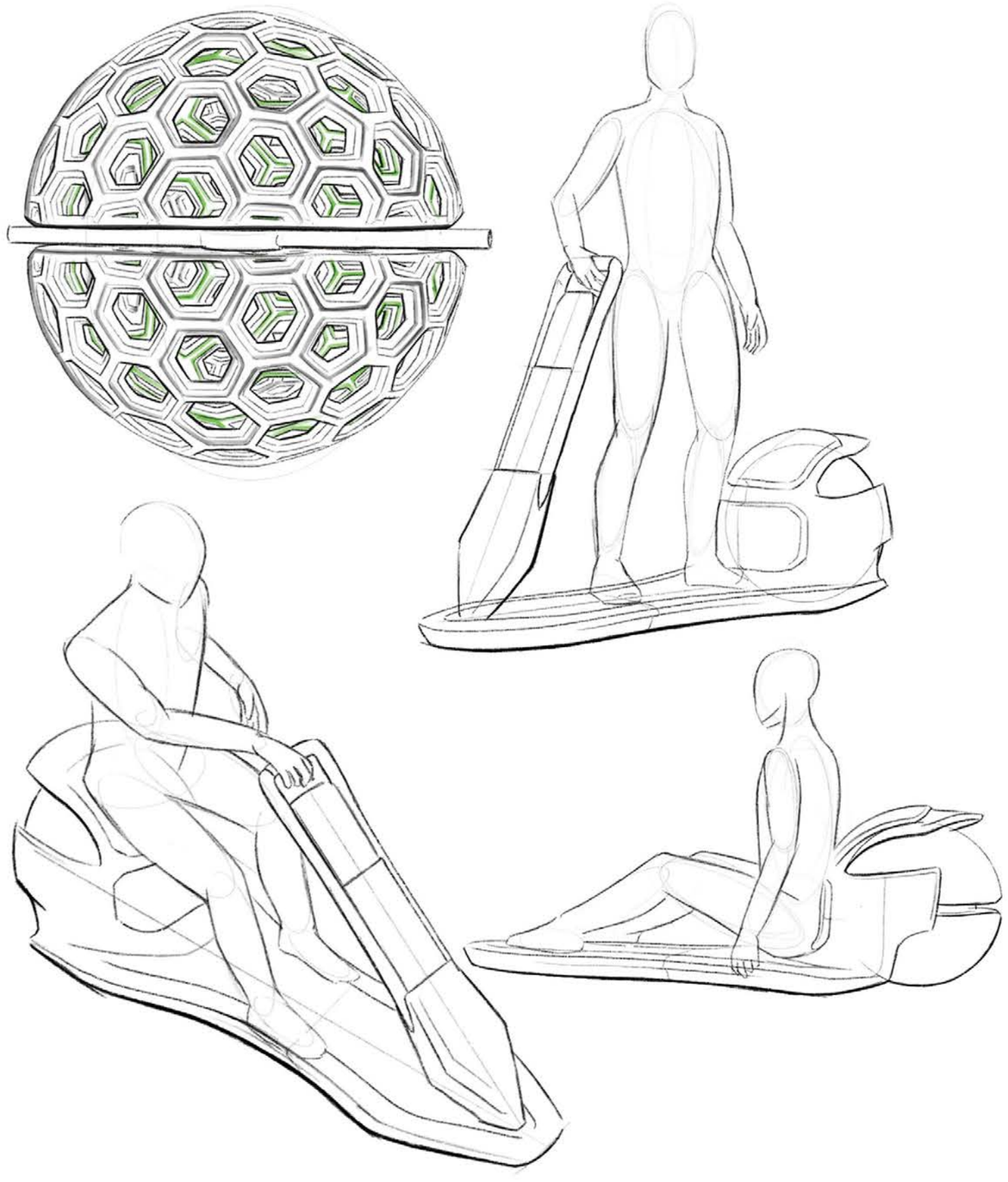




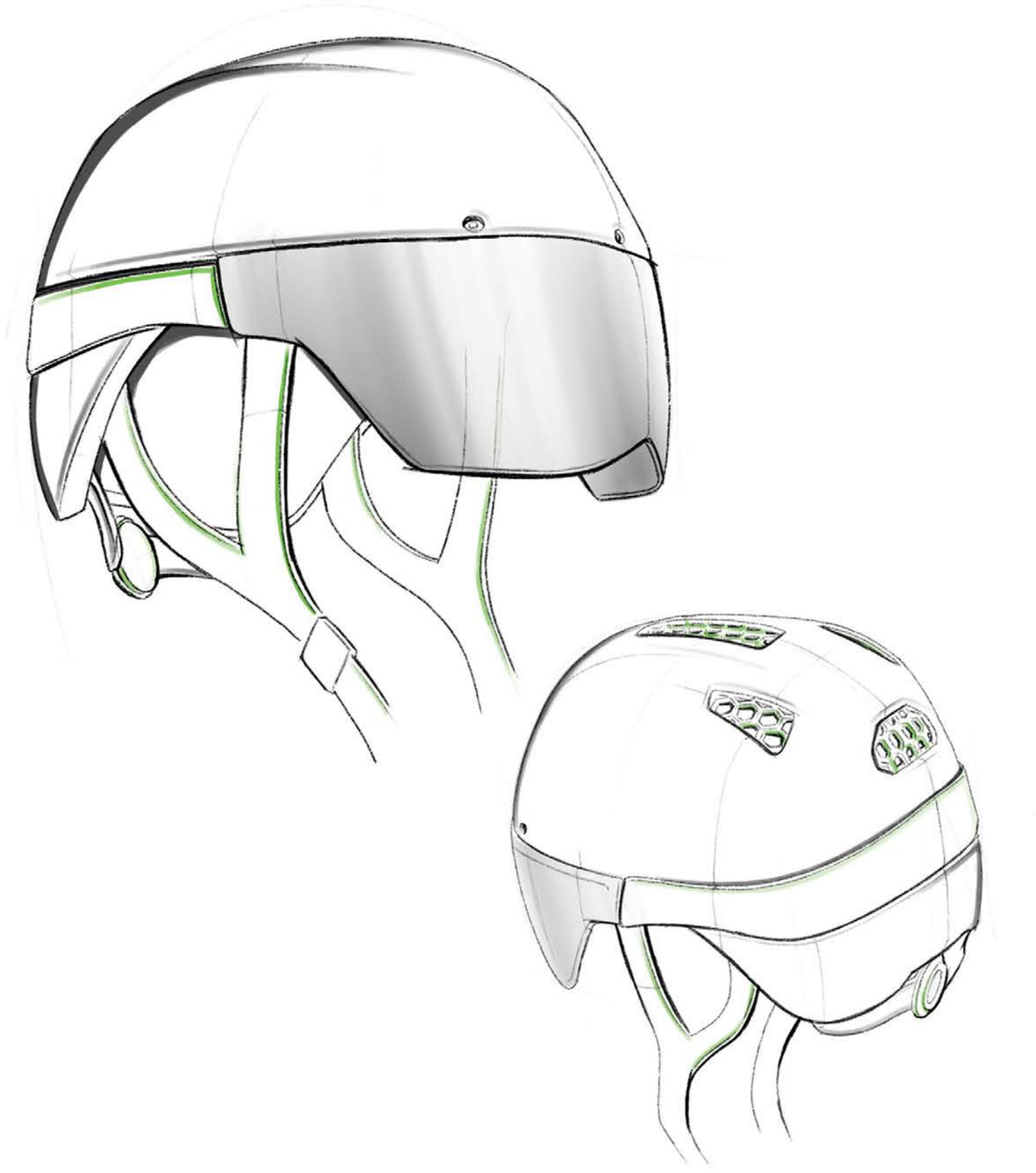
4.6 Design Resolution

Following the concept development process, a final design solution exists.

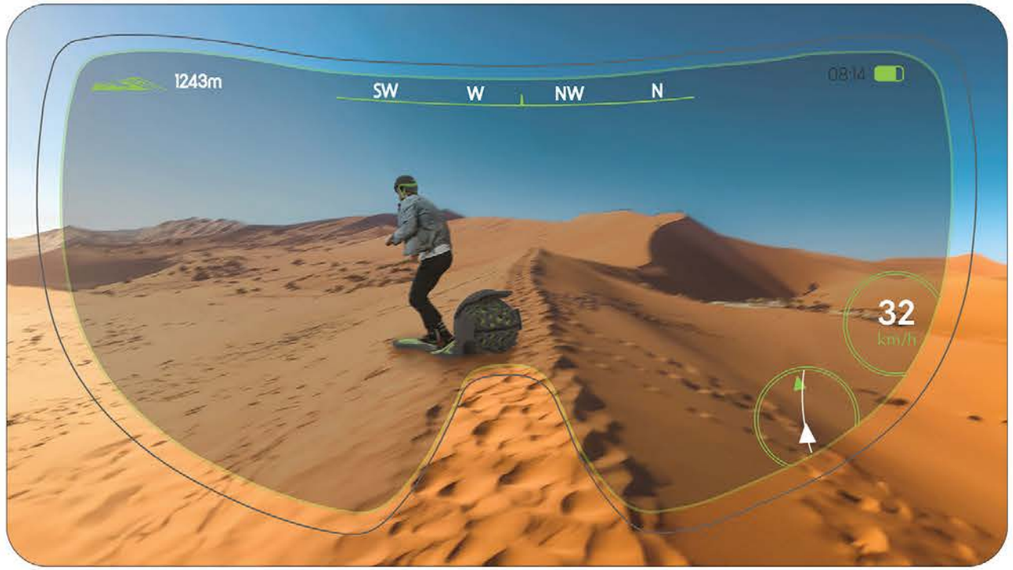


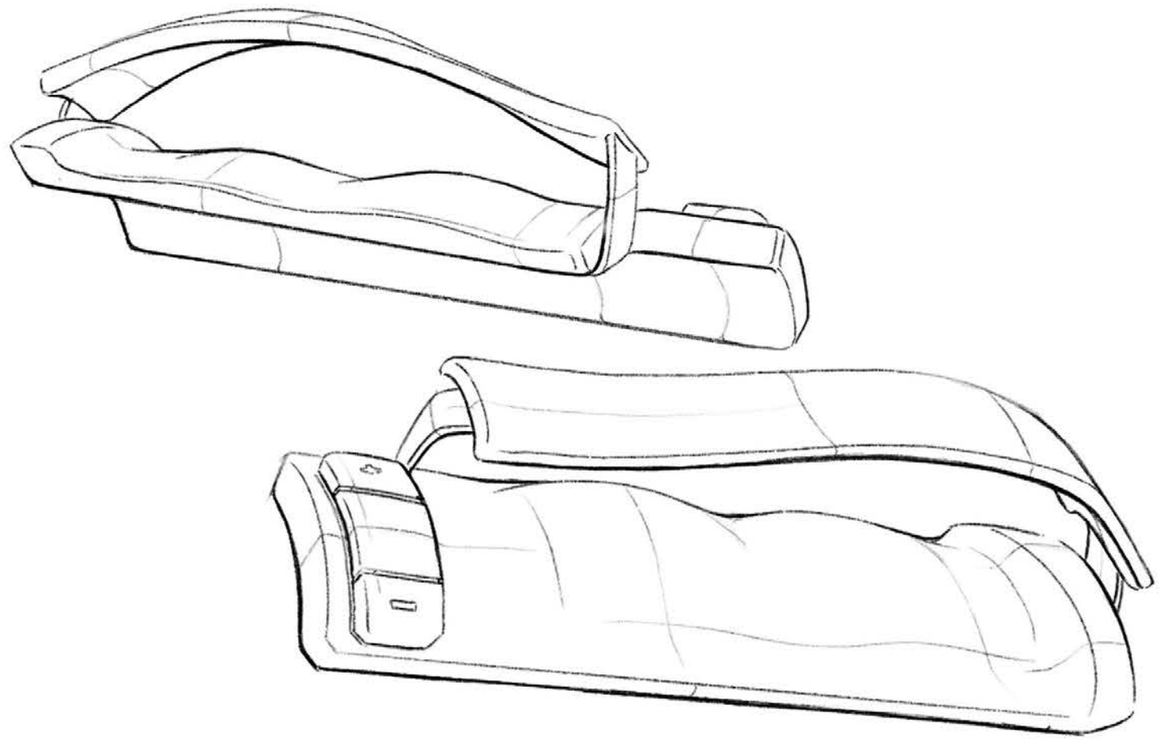


The final design is a board with one rear, airless, omni-directional sphere wheel. A collapsible handle allows for additional support and comfort. Users can also sit on the fender or sit on the board and lean against the cushioned fender. A groove on the side of the board features as an additional handle when carving or sitting. Users utilize their body weight and foot position for steering and carving. For enhanced speed and propulsion users are advised to sit on the cushioned fender to enhance the wheel's traction in the sand. When surfing down the dunes, users have the ability to ride in any way imaginable.



A helmet featuring an AR integrated visor allows for enhanced safety, communication and offers the ability to share the experience. Riders are able to view the location of others in their group as well as make calls via voice command to emergency services or other riders. The visor displays information such as speed, altitude, time, remaining board charge, and navigation. The helmet is breathable and utilizes BOA adjustment. Three hi-fidelity cameras allow for capturing video to record the experience.





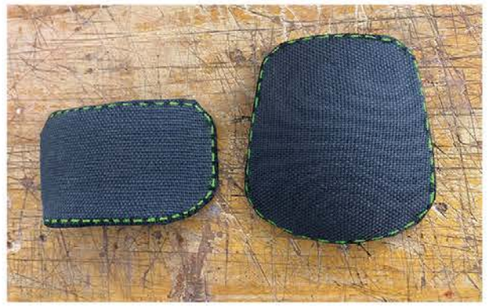
A speed controller allows for users to adjust speed while riding. The controller is “hands-free”. A strap fits around the back of the hand and the controller rests in the palm area of the hand. If a user wishes to use the handle, the controller features a concaved back where it rests on the handlebar.

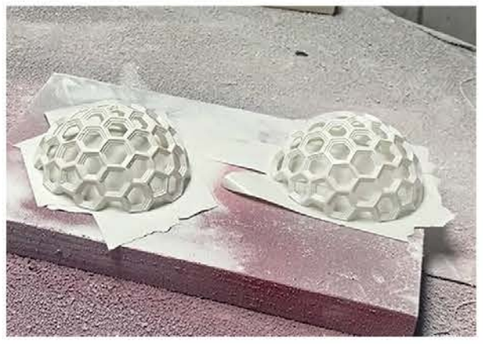
4.7 CAD Development

Images of the CAD modeling process are featured on the following pages.

4.8 Physical Model Fabrication

Images of model fabrication are featured on the following pages.

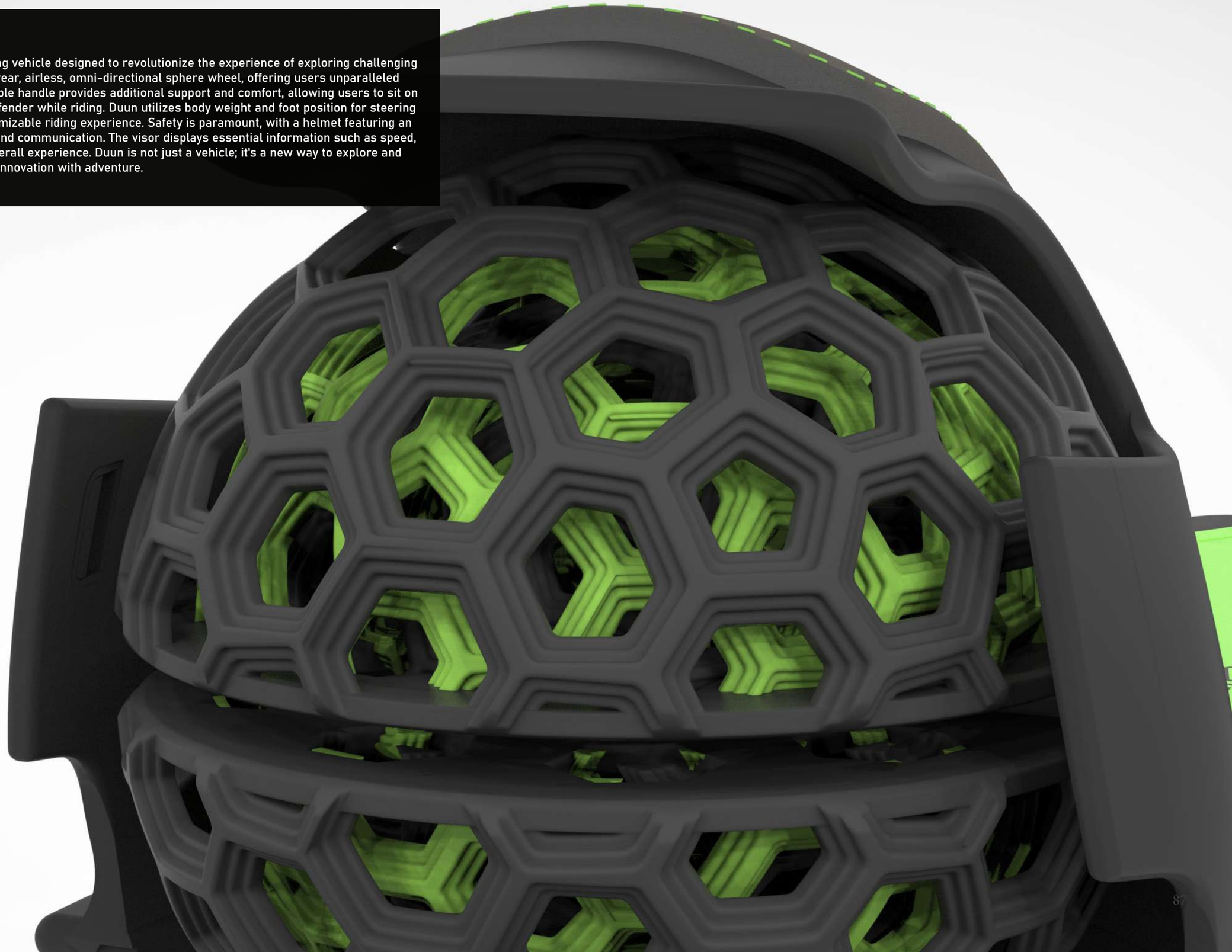




CHAPTER 5
FINAL DESIGN

5.1 Design Summary

Duun is a groundbreaking sand dune riding vehicle designed to revolutionize the experience of exploring challenging landscapes. It features a board with one rear, airless, omni-directional sphere wheel, offering users unparalleled maneuverability and control. The collapsible handle provides additional support and comfort, allowing users to sit on the fender or lean against the cushioned fender while riding. Duun utilizes body weight and foot position for steering and carving, offering a thrilling and customizable riding experience. Safety is paramount, with a helmet featuring an AR integrated visor for enhanced safety and communication. The visor displays essential information such as speed, altitude, and navigation, enhancing the overall experience. Duun is not just a vehicle; it's a new way to explore and enjoy sand dune environments, blending innovation with adventure.



5.2 Design Summary

This section will explore how Duun meets all design criteria for this thesis project, including its status as a full-bodied interaction design and its alignment with all four essential pillars. Additionally, it will assess the feasibility of the design based on its materials and manufacturing methods.

5.2.1 Full-Bodied Interaction Design

Duun is designed as a full-bodied interaction experience, catering to the comfort and engagement of its users. The vehicle features multiple touchpoints that support the body in various positions, ensuring a comfortable and secure ride.

The collapsable handlebar allows for additional support and safety as needed. Cushioned seating ensures users can ride comfortably in a wide-variety of ways. The hexagonal pattern on the base of the board is intentionally placed in areas where users should stand for optimal steering and control. The helmet ensures safety and is adjustable and designed specifically for use on sand dunes. The controller is countered to fit comfortably in the palm of the rider's hand, ensuring ergonomics and mitigating strain while using.

These design elements aim to enhance the overall riding experience, allowing users to focus on enjoying the sand dunes while feeling supported and in control.

5.2.2 Materials, Processes, and Technology

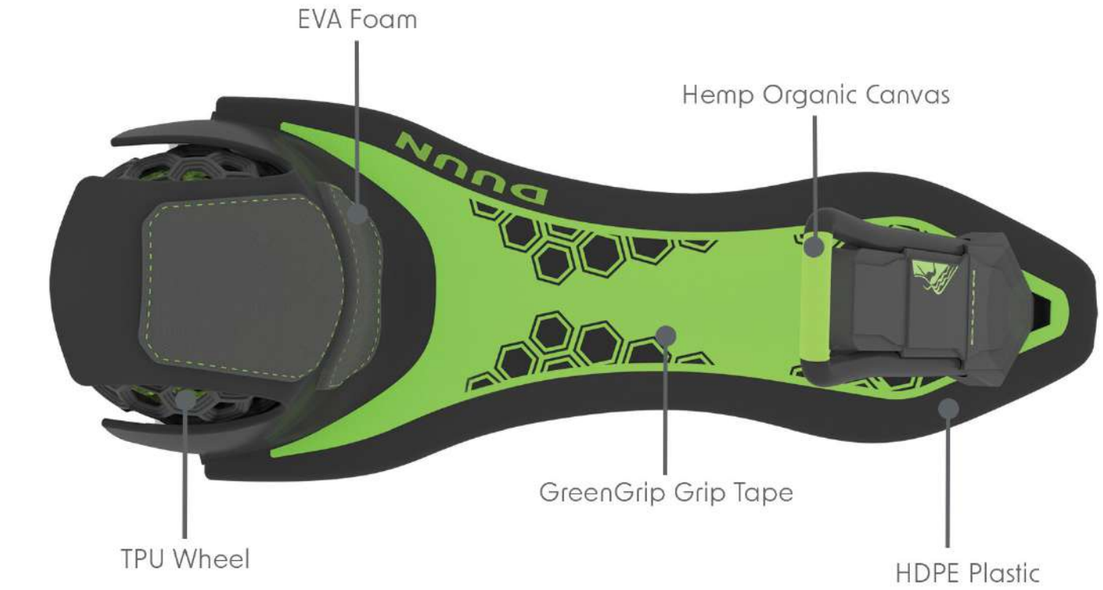
Materials

Plastics: High-density polyethylene will be a desirable choice for the main bodies. It will be essential that the product functions well in sand dune environments. HDPE glides effectively on sand, has UV and temperature resistance, it is also durable, flexible and recyclable. To allow for recyclability, the HDPE body will be easily disassembled from other components.

Fabrics: Touchpoints, such as handles, grips, straps, where the user directly interacts with the product will be made of hemp organic canvas. Hemp organic canvas is a natural material. It is comfortable, soft, and provides an effective grip texture where users will interact with the product. The production of hemp utilizes less water and provides more material than alternatives. Hemp is also biodegradable, renewable and has great UV resistance making it a superior choice for dune riding environments.

Cushioning: The cushioning of the seat and other straps, can be composed of sugarcane-based EVA (ethylene vinyl acetate copolymer) foam. Sugarcane is a natural and renewable material. This bio-based EVA foam is recyclable and compostable making it a great alternative to existing plastic-based foams.

Wheel: The desired material for the wheel will be bio-based thermoplastic polyurethane (TPU). TPU is a tough but flexible material with properties such as UV, weather and tear resistance, and high durability, which will function effectively on sand. This sustainable TPU features bio-based materials with low carbon and sustainable sources resulting in an environmentally friendly material



Processes

The desired manufacturing approach will emphasize energy efficiency and waste reduction. Manufacturing processes that minimize energy consumption and emissions, such as using renewable energy sources in production facilities and optimizing production processes to reduce material waste, will be prioritized.

The main HDPE body will be manufactured through injection molding as it is effective for larger hollow, flexible parts. It is one of the more environmentally friendly methods since it is more material efficient and therefore, produces less waste. The bio-based TPU wheel will be manufactured through the process of injection molding. Injection molding TPU can allow for the high-performance properties of TPU to be exhibited.

Technology

Electric Powered Wheel Rotation: The wheel features an innovative design with an axle that allows each half of the wheel to rotate independently. This design enables better maneuverability and control, especially on challenging terrains like sand dunes. The electric-powered rotation mechanism ensures a smooth and efficient operation, providing users with a seamless riding experience.

AR Visor: The helmet is equipped with an integrated augmented reality (AR) visor that enhances the safety and user experience. The AR technology overlays digital information onto the real-world environment, providing users with real-time data such as speed, altitude, time, remaining board charge, and navigation.

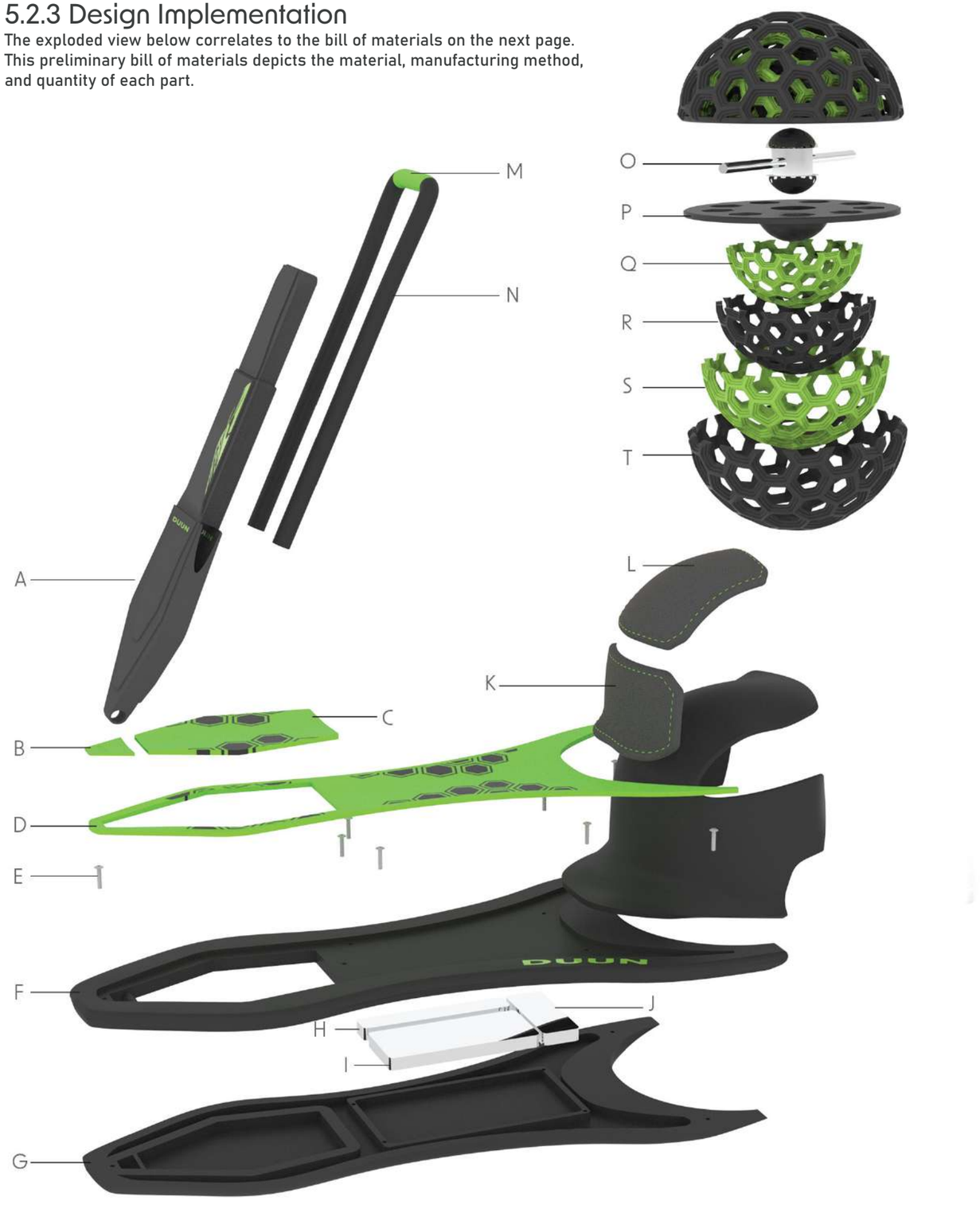
Hi-Fidelity Cameras: The helmet is equipped with three hi-fidelity cameras that allow users to capture their riding experience in high-quality video. These cameras are strategically placed to provide different perspectives, capturing the thrill and excitement of riding down sand dunes. The video footage can be used for personal enjoyment or shared with others to showcase the adventure.

Voice-Activated Calling: The helmet features built-in speakers and a microphone that enable voice-activated calling for emergency services or other riders. In case of an emergency, users can use voice commands to call for help, ensuring a quick and efficient response. This feature adds an extra layer of safety and peace of mind for riders, especially when exploring remote areas.

Adjustable Speed Settings: The speed controller wirelessly allows users to adjust the speed of the wheel rotation to suit their preferences and riding conditions. This allows users to customize their riding experience, whether they prefer a leisurely ride or a more adrenaline-pumping adventure.

5.2.3 Design Implementation

The exploded view below correlates to the bill of materials on the next page. This preliminary bill of materials depicts the material, manufacturing method, and quantity of each part.

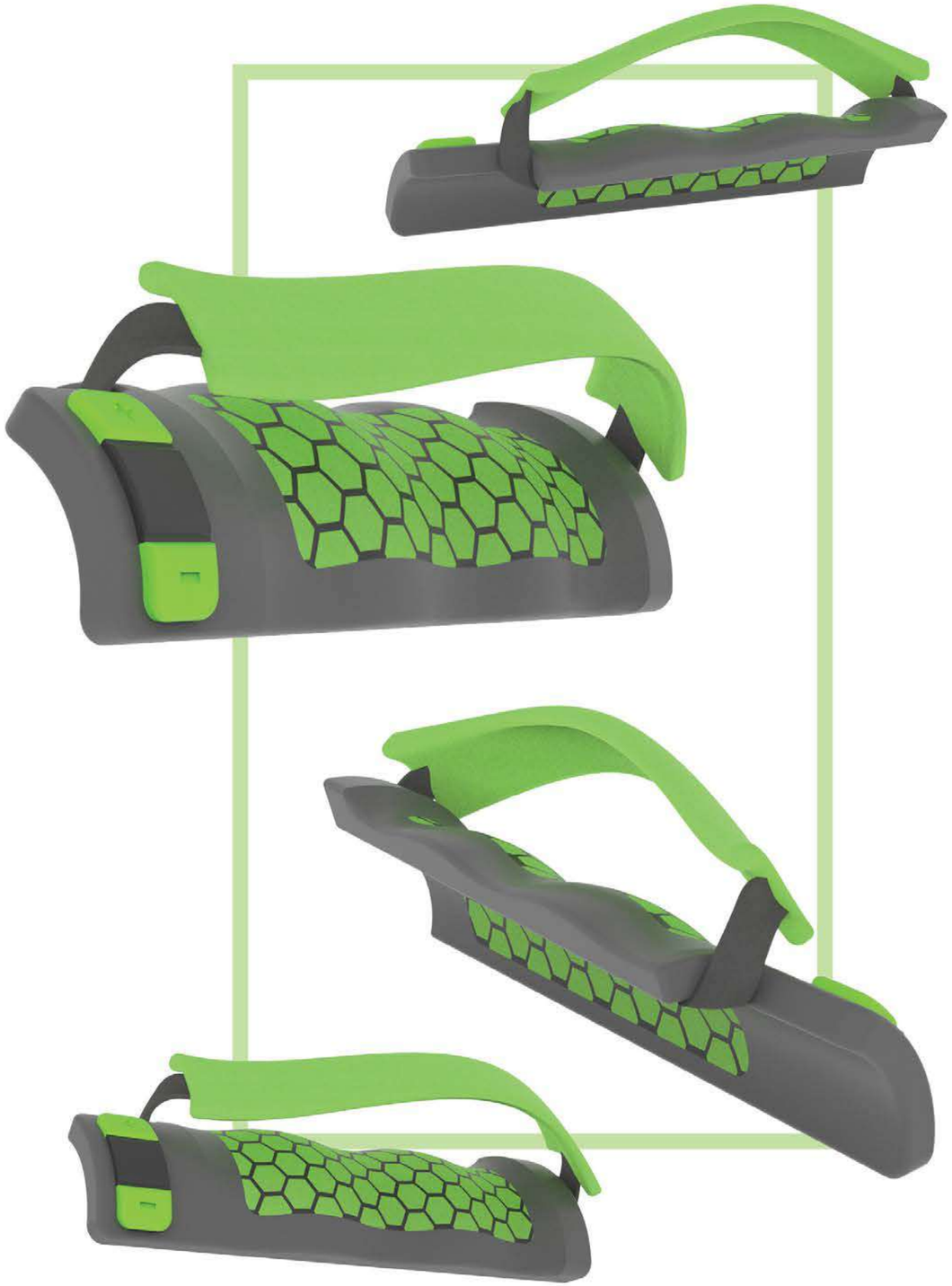


Letter	Part Name	Material	Manufacturing Method	Quantity
A	Handle Body	HDPE	Injection Molding	1
B	Handle Cover, Moveable	HDPE w/ GreenGrip Grip Tape	Injection Molding, Die Cut	1
C	Handle Cover	HDPE w/ GreenGrip Grip Tape	Injection Molding, Die Cut	1
D	Board Grip	HDPE w/ GreenGrip Grip Tape	Injection Molding, Die Cut	1
E	Screws	Stainless Steel	Thread Rolling	8
F	Upper Housing	HDPE	Injection Molding	1
G	Lower Housing	HDPE	Injection Molding	1
H	Controller	ABS	Injection Molding	1
I	Battery	Aluminum, Lithium-Ion	Stamping/Machining	1
J	Motor	Aluminum, Neodymium	Aluminum Die Casting	1
K	Lumbar Cushion	EVA Foam, Hemp Organic Canvas	Compression Molding, Weaving	1
L	Top Cushion	EVA Foam, Hemp Organic Canvas	Compression Molding, Weaving	1
M	Handle Bar Grip	Hemp Organic Canvas	Weaving	1
N	Handle Bar	HDPE	Injection Molding	1
O	Axle	Stainless Steel	Machining	1
P	Wheel Base	TPU	Injection Molded	2
Q	Innermost Hex Layer	TPU	Injection Molded	2
R	Third Hex Layer	TPU	Injection Molded	2
S	Second Hex Layer	TPU	Injection Molded	2
T	Outtermost Hex Layer	TPU	Injection Molded	2

5.3 Final CAD Renderings

Below are final renderings of Duun, the helmet and the speed controller.


DUUN
DUUN
DUUN

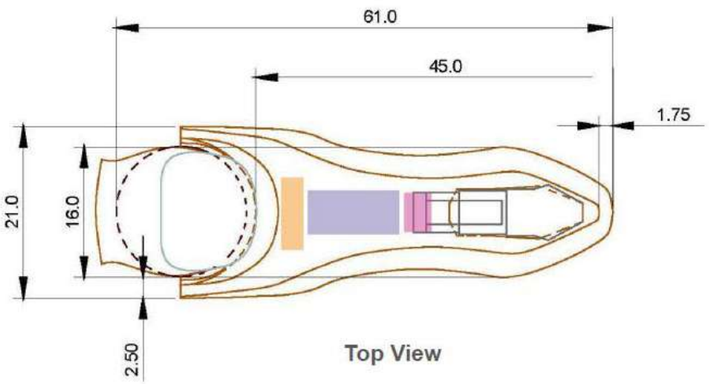


5.4 Physical Model

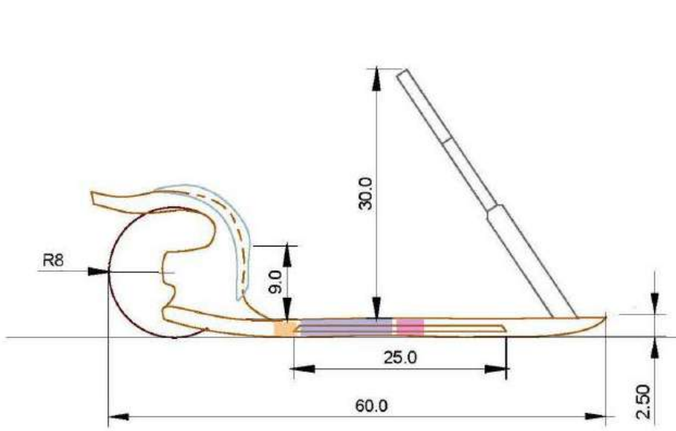
Below are images of the 1:5 scale model of Duun.

5.5 Technical Drawings

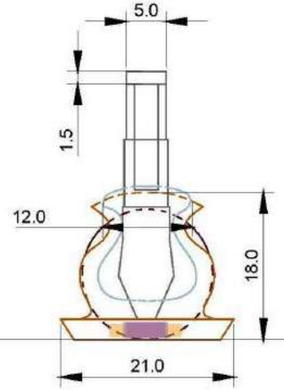
Below is the technical drawing of Duun.



Top View



Side View



Front View

5.6 Sustainability

The design solution prioritizes sustainability through material selection and manufacturing methods. Key sustainable materials include High-Density Polyethylene (HDPE) for the main body, chosen for its recyclability, UV resistance, and durability on sand. Hemp organic canvas is used for user touchpoints due to its comfortable grip texture as well as biodegradability and renewable nature. The wheel uses bio-based TPU for its UV, weather, and tear resistance, as well as its low carbon footprint and sustainable sources. Manufacturing methods focus on energy efficiency and waste reduction, with rotational molding chosen for the main HDPE body and injection molding for the bio-based TPU wheel. Sustainable initiatives include selecting materials with high recyclability and lower environmental impact, opting for electric power, designing for disassembly and recycling, and conducting lifecycle analysis. Health and safety considerations encompass ergonomic design, selecting materials with high impact resistance and shock absorption properties, and prioritizing durability. The design aims to provide a safe, comfortable, and environmentally sustainable sand dune riding experience

CHAPTER 6
CONCLUSION

DUUN

Duun represents a groundbreaking approach to sand dune riding, addressing the needs and desires of outdoor enthusiasts in a comprehensive and innovative manner. By focusing on key aspects such as accessibility, safety, and environmental impact, Duun offers a solution that not only enhances the riding experience but also promotes sustainability and user well-being.

Through extensive research and development, Duun has been designed to provide a seamless and enjoyable riding experience. The incorporation of an electric power source, along with advanced technologies such as the AR integrated helmet and adjustable speed controller, demonstrates Duun's commitment to blending cutting-edge design with practical functionality.

Furthermore, Duun's emphasis on sustainability sets it apart as a responsible and eco-conscious product. The use of durable and environmentally friendly materials ensures that Duun not only meets the needs of riders but also minimizes its impact on the surrounding ecosystem.

In conclusion, Duun represents a new era in sand dune riding, offering a holistic and forward-thinking approach to outdoor recreation. With its blend of innovative design, advanced technology, and environmental consciousness, Duun is poised to revolutionize the way people experience and interact with sand dunes.

APPENDIX

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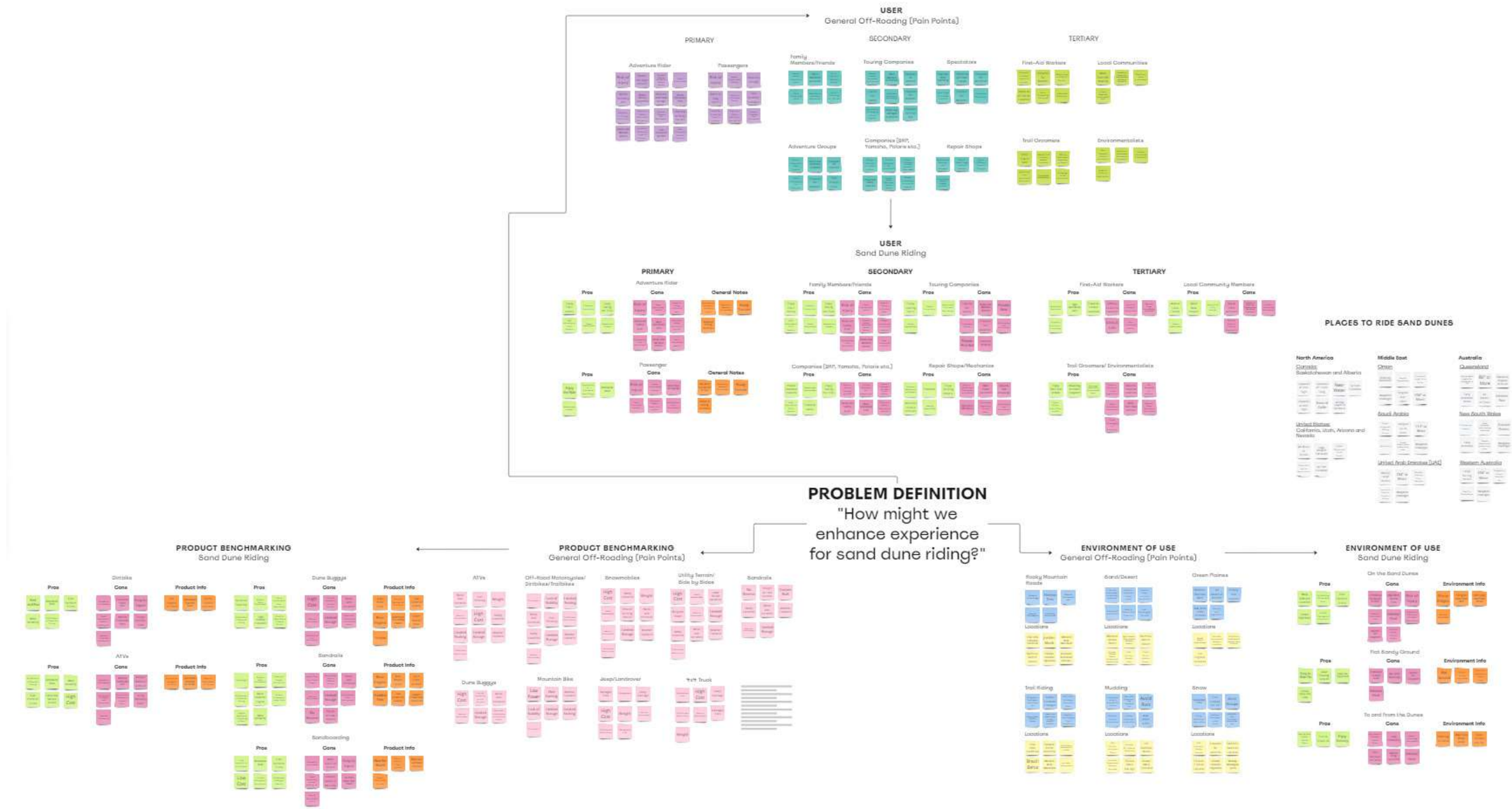

USER
General Off-Roading (Pain Points)
PRIMARY
SECONDARY
TERTIARY
Adventure Rider
Passengers
Family Members/Friends
Touring Companies
Spectators
First-Aid Workers
Local Communities
Adventure Groups
Companies (Bilt, Yamaha, Polaris etc.)
Repair Shops
Trail Groomers
Environmentalists
USER
Sand Dune Riding
PRIMARY
SECONDARY
TERTIARY
Adventure Rider
Pros
Cons
General Notes
Passenger
Family Members/Friends
Touring Companies
Companies (Bilt, Yamaha, Polaris etc.)
Repair Shops/Mechanics
First-Aid Workers
Local Community Members
Trail Groomers/ Environmentalists
PLACES TO RIDE SAND DUNES
North America
Canada:
Saskatchewan and Alberta
United States:
California, Utah, Arizona and Nevada
Middle East
Oman
Saudi Arabia
United Arab Emirates (UAE)
Australia
Queensland
New South Wales
Western Australia
PROBLEM DEFINITION
"How might we enhance experience for sand dune riding?"
PRODUCT BENCHMARKING
Sand Dune Riding
Dirtbike
ATVs
Dune Buggys
Sandrails
Sandboarding
Pros
Cons
Product Info
PRODUCT BENCHMARKING
General Off-Roading (Pain Points)
ATVs
Off-Road Motorcycles/ Dirtbikes/ Trailbikes
Snowmobiles
Utility Terrain/ Side by Sides
Sandrails
Dune Buggys
Mountain Bike
Jeep/Landrover
Yeti Truck
ENVIRONMENT OF USE
General Off-Roading (Pain Points)
Rocky Mountain Roads
Sand/Desert
Open Plateau
Trail Riding
Mudding
Snow
Locations
ENVIRONMENT OF USE
Sand Dune Riding
On the Sand Dunes
Flat Sandy Ground
To and From the Dunes
Pros
Cons
Environment Info

Appendix B - Contextual Research (User)

FULL DESERT DAY IN DUBAI | Quad biking, Sand boarding,

Beginners Sand Boarding

Instructor Holds Board In Place

Putting too Much Weight on Backfoot

Too Square with Board

Sand Filled Shoes

Get Wrapped In Headscarf

Beginner Riding

Using Body Weights to Turn

Sitting in Dune Buggy

Sharp turns and donuts

Getting air

Landing from air

Wax the Board

Foot Positioning

Weight on Backfoot

Carving on dunes

Sharp Carves

2:38
it's definitely challenging as far as
2:40
not having a stiff boot or a binding so
2:43
give you leverage in the turns so it's
2:45
kind of linking and maybe related a
2:47
little bit to surfing where you relying
2:49
more on your leg strength to achieve the
2:52
length turns down the slope of the sand

Appendix B - Contextual Research (User)

Overall, did you enjoy the dune riding experience? (Was it thrilling? Is there anything you would change? Did anything make you feel unsafe? Would you do it differently if you were to do it again?)

8 responses

thrilling only cause unsafe. It was super fun to just ride an ATV in a sea of sand. Would i do it differently? NAH, prolly just like a more powerful ATV if anything

It was very thrilling. I did not feel unsafe.

It was thrilling. Also riding in the sand dunes during a sunrise is an incredible experience. I would do it again. One thing I would change is the fuel type of the ATV. Electric, hybrid, or hydrogen. Preferably electric for faster acceleration response.

It was one of the best experiences of my life.

One thing that would definitely be useful would be to have a gos system that lets you know were other riders are at the same time. Similarly to a mini map in video games so you don't go flying over a dune jump into another rider.

Yes, I wouldn't change anything about it. It was extremely thrilling and I felt safe the whole time. If I were to do it again, I wouldn't do anything differently.

I want to learn more about your personal dune riding experience. Share any funny stories or thoughts about your experience. Maybe your ATV got stuck somewhere, or you forgot your water and you were really thirsty? Any wicked sunburns while on the dunes or maybe some brutal falls when sand surfing? You probably slept pretty well when you got home that day. Tell me more!

7 responses

Got stuck at the bottom of a dune and we had to go find rocks to make it unstuck lol. Sandboarding falls didnt really hurt that much but I did tumble for a while lol.

We took a camel ride and went from our resort tents to like a deeper part of the desert for bigger dunes. Started sand boarding ffor a bit but climbing the dune again was a pain so we switched to ATVs pretty quick. After that it was just doughnuts and zoomin around, was super super fun 11/10 would do again

I flipped a buggy after taking a sharp turn on top of a hill. Nobody was hurt, so it was a funny experience overall.

Dune riding in the morning before/during a sunrise in the Sahara is quite a beautiful experience. Also some other riders flipped their ATVs which was pretty entertaining (they were fine)! Bringing water is essential even without direct sun. As the sun starts rising it can quickly become intense, so sun protection is a must-have. I would never do it mid day without a headscarf, sunglasses, linens, and sunscreen. Also you have to be careful about the operating temperature of the vehicle. For example a battery powered ATV probably should not be used in full sun in the desert.

What was your experience getting to the sand dunes and overall, how hard was it for you to physically access the dunes? (e.g. did you have to walk to a location where you could rent the vehicles? did you ride a vehicle to the dunes? how far of a distance did you travel to ride the dunes?)

8 responses

We rode a camel from our tent to the bigger dunes for Sandboarding, like a 10-15 minute camel ride not too bad

Drove a vehicle to the rental location and short ride (2 mins) to the dunes

We drove from Marrakesh to the Merzouga which is a 9 hour drive with no stops. Upon arrival we rode Dromedaries into the desert and stayed the night in permanent camp. At 5 am we hopped on ATVs and rode into the dunes. It required minimal walking.

Drove a vehicle to the base of the dunes.

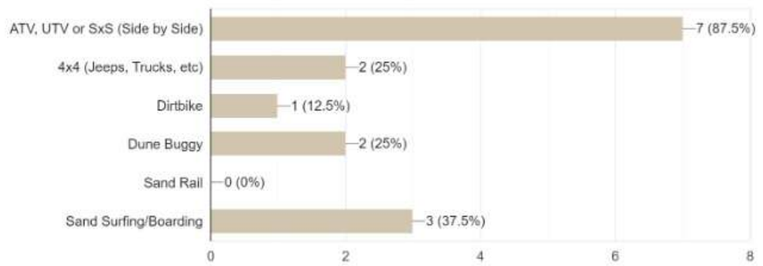
We drive about a half hour into the desert from the city after spending about an hour loading up all our gear and bikes onto a trailer.

Rode a vehicle from the city into the desert, there was a camp, and they drove us to the dunes

go a ride to the dunes, it was about 10 min from the rental place

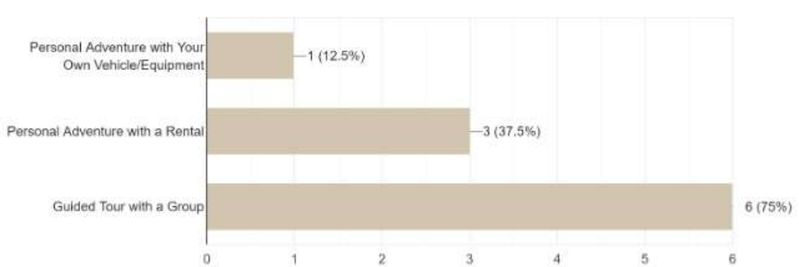
What type(s) of dune riding have you done? (Select all that apply)

8 responses



Which of the following most accurately describes your experience(s)? (Select all that apply)

8 responses



PRODUCT BENCHMARKING
Sand Dune Riding

Dirtbike

Pros

Fast and Fun

Adrenaline Rush

Can Perform Tricks

More Versatility

Extension of Open-Air Driving

Cons

Exposed to Sun/Weather

Sand Gets Inside Bike

Easy to Injure

Need equipment: helmet, padding, etc.

Need to Clean Bike Often

Tough to Ride Slow

Light and Comfy Bike Maintenance

Product Info

Put Paddle on Tires

Specialized Bikes for Sand

Some Electric Options

ATVs

Pros

Extension of Open-Air Driving

Adrenaline Rush

More Versatility

Can Perform Tricks

Can Cross Various Terrain

High Cost

Cons

Exposed to Sun/Weather

Need to Sandproof ATV

Weight Makes it Difficult

Disturbed on Engine and Transmission

Correct Tire Pressure or Paddle Tires

Bring Recovery Gear

Require Maintenance

Product Info

Accessories Available for ATVs

Specialized Versions for Dunes

Require Safety Gear for Dunes

Dune Buggys

Pros

Superior Stability

More Comfortable than Alternatives

Extension of Open-Air Driving

High Ground Clearance

Good for Steep Slopes / Uneven Terrain

Cons

High Cost

Limited Versatility across Terrains

Noise and Vibration

Harm on Environment

Limited Storage

Restricted Visibility due to Protective Frame

No Protection from Environment

Product Info

Large, Wide Tires

Complex Mechanical Structure

Low Center of Gravity

Rear Engine

Assembled on Existing Chassis

Short Wheel Base

Fiberglass

Sandrails

Pros

Lightweight

Harm on Energy Environment

Balanced Weight Distribution

Extension of Open-Air Driving

More Powerful Engine

Robust Suspension, Larger Sizes

Greater Agility due to Less Drag on Sand

More Versatility

Cons

Higher Cost than Dune Buggy

No Versatility across Different Terrains

Noise and Vibration

Harm on Environment

Limited Storage

No Protection from Environment

No Reverse

Rough at Low Speeds

Product Info

Rear Engine

Rear Wheel Drive

Built From Scratch

Paddled Tires

Low Center of Gravity

Smaller, Fixed-Low Front Tires

Sandboarding

Pros

Less Harmful on Ecosystem

Adrenaline Rush

Can Perform Tricks

Low Cost

Limited Damage on Equipment

Extension of Going in Open-Air

Cons

Exposed to Sun/Weather

Walk Back Up Dunes

Easy to Injure

Need equipment: helmet, padding, etc.

Should Avoid in Mid-Day

Far from Water and Shade

Cannot Ride Within 24hrs

Product Info

Wax the Board

Can Be Hard to Find Rentals

Materials: Laminate/ Formica

Board Doesn't Get You Far

PRODUCT BENCHMARKING
General Off-Roading (Pain Points)

ATVs

Noise and Vibration

Fuel Efficiency

Weight

Harm on Environment

High Cost

Safety Concerns

Limited Seating

Limited Storage

Weather Exposure

Trail Access Restrictions

Off-Road Motorcycles/ Dirtbikes/Trailbikes

Discomfort

Lack of Stability

Limited Seating

Noise and Vibration

Fuel Efficiency

Trail Access Restrictions

Safety Concerns

Limited Storage

Weather Exposure

Harm on Environment

Snowmobiles

High Cost

Safety Concerns

Weight

Lack of Maneuverability

Smaller Turning Radius

Noise and Vibration

Harm on Environment

Limited Storage

Weather Exposure

Trail Access Restrictions

Utility Terrain/ Side by Sides

High Cost

Lack of Maneuverability

Lower Terrain Variability

Weighed Down

Harm on Environment

Limited Storage

Safety Concerns

Noise and Vibration

Weather Exposure

Trail Access Restrictions

Dune Buggys

High Cost

Limited Versatility across Terrains

Noise and Vibration

Harm on Environment

Limited Storage

Restricted Visibility due to Protective Frame

Mountain Bike

Low Power

Over Exerting

Weather Exposure

Lack of Stability

Limited Storage

Limited Seating

Discomfort

Jeep/Landrover

Damaged Tires

Maintenance Cost

Body Damage

High Cost

Weight

Harm on Environment

Trail Access Restrictions

Maintenance Cost

4x4 Truck

Maintenance Cost

High Cost

Body Damage

Trail Access Restrictions

Harm on Environment

Damaged Tires

Weight

Appendix D - Result Analysis

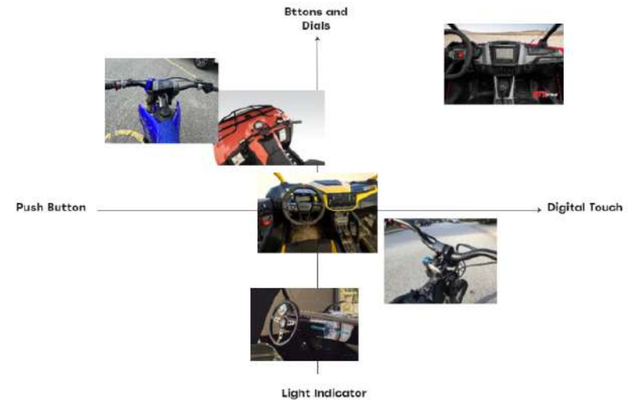
					
1	2	3	4	5	6
Tracker Off-Road 600	BRP Can-Am Maverick R	Yamaha YZ250	SURRON Light Bee X	Polaris RZR XP	Meyers Manx 2.0
Affordable Versatile Great for Beginners	Very Powerful Versatile Thoughtful Ergonomic Great Suspension Stylish	Lightweight Compact Ergonomics for movement freedom Precise Handling Versatile	Environmentally Conscious Affordable Quiet Compact Lightweight Versatile	Powerful Versatile Good Suspension Ergonomic	Environmentally Conscious Quiet Stylish Powerful

						
	1	2	3	4	5	6
	Tracker Off-Road 600	BRP Can-Am Maverick R	Yamaha YZ250	SURRON Light Bee X	Polaris RZR XP	Meyers Manx 2.0
Cost	$8000	$40,000	$10,000	$7000	$30,000	$75,000
Type	ATV	ATV/Dune Buggy	Dirtbike	Dirtbike	ATV/Dune Buggy	Dune Buggy
Engine Type	Gas	Gas	Gas	Electric	Gas	Electric
Dimensions (in.) (L x W x H)	86.1" x 50.1" x 47.8"	138.7 x 78.1 x 70.4 in	86" x 32.5" x 50.8"	74" x 30" x 40"	119.5 x 64 x71.1 in	123.5" x 70.3"x 53.3"
Weight	748lbs	2150lbs	227lbs	123lbs	1900lbs	1550lbs
Displacement (cc) / hp	600cc / 45hp	999cc / 240 hp	249 cc / (25-40hp)	6000W (approx. 35hp)	999cc / 114 hp	202 hp
Tires	- Powder Coated Steel - 25 x 10-12	- 15 in. Aluminum Flow Formed - 30 x 10 x 15 in	-110/90-19 Geomax MX33	Front/Rear 70/100-19 CST	Trail Master X/T, 29 x 11-14 Radial Tire	-
Material	HSLA Steel Frame	High strength steel (Dual phase) steel tubing and stampings	Aluminum Frame	Aluminum Frame	Roofs available in lightweight poly or durable steel	-
Fuel Capacity	5.7 gal	13.2 gal	8L	Range: 75 km at 40 km/h	9.5 gal	300 miles
Other	-300lbs cargo capacity	17" ground clearance	14" Ground Clearance	-20-60 miles per charge	14" Ground clearance	Not Yet Released

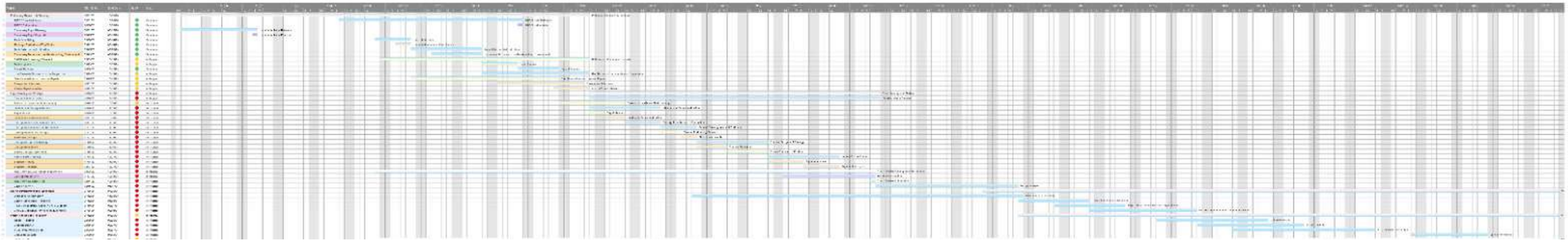
						
	1	2	3	4	5	6
	Tracker Off-Road 600	BRP Can-Am Maverick R	Yamaha YZ250	SURRON Light Bee X	Polaris RZR XP	Meyers Manx 2.0
						
Buttons / Dials	x	x	x	x	x	
Light indicators		x		x	x	x
Touch interface		x		x	x	
Other (voice, gesture etc)		x				x

						
	1	2	3	4	5	6
	Tracker Off-Road 600	BRP Can-Am Maverick R	Yamaha YZ250	SURRON Light Bee X	Polaris RZR XP	Meyers Manx 2.0
Form	Bulky	Aggressive Powerful	Sharp Swift	Sleek Nimble Light	Sharp	Soft Gentle Round
Colour	Red	Grey Yellow	Blue Grey	Orange	White Red Grey	Dark Green

Interface



Appendix E - Approvals & Plans



IDSN 4002 /4502
SENIOR LEVEL THESIS ONE & THESIS TWO

HUMBER
Bachelor of Industrial Design / FALL 2023 & WINTER 2024

INFORMATION LETTER

Research Study Topic: Enhancing the Expirience of Sand Dune Riding
Investigator: Carlie Besser / 905-962-1859 / carlie.besser11@gmail.com
Sponsor: Humber ITAL, Faculty of Media & Creative Arts (IDSN 4002 & IDSN 4502)

Introduction
My name is Carlie Besser, I am an industrial design student at Humber ITAL, and I am inviting your participation in a research study on various problems that are involved in the experience of sand dune riding. These problems include both environmental harm and damage to ecosystems, as well as accessibility and safety aspects and features of riding sand dunes. The results will be contributed to my Senior Level Thesis project.

Purpose of the Study
This study is being conducted as an aid in designing a solution which enhances the experience of sand dune riding. With a focus on sustainability, the solution is capable of mitigating harm to the environment and ecosystem. It will be designed to increase both the opportunity and accessibility of sand dune riding as well as keeping users safe with the implementation of proper safety features and gear while ensuring proper riding practices. With your assistance, I plan to enhance these aspects of dune riding, providing users with a guilt-free, accessible and safe sand dune riding experience. This study is primarily based on understanding ergonomics, human interaction design activities, and user experience aspects of the research area.

Procedures
If you volunteer to participate in this study, your experience and knowledge of sand dune riding will be documented. During interview sessions, your answers will be audio and/or video recorded and notes regarding your interview will be taken. You will be asked questions regarding your knowledge on this topic as well as your thoughts and personal experience of sand dune riding.

Confidentiality
Every effort will be made to ensure confidentiality of any identifying information that is obtained during the study. In the case of being recorded visually, your face will be masked /blurred or hidden. The information and documentations (photographs) gathered are all subject to being used in the final presentation of the study.

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

If at any point during the session, you feel uncomfortable and wish to end your participation, please let the moderator know and they will end your participation immediately.

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

1

IDSN 4002 /4502
SENIOR LEVEL THESIS ONE & THESIS TWO

HUMBER
Bachelor of Industrial Design / FALL 2023 & WINTER 2024

INFORMATION LETTER

Conditions of Participation

- ✓ I understand that I am free to withdraw from the study at any time without any consequences.
- ✓ I understand that my participation in this study is confidential. (i.e. the researcher will know but will not disclose my identity)
- ✓ My identity will be masked.
- ✓ I understand that the data from this study may be published.

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

Click or tap here to enter text.		Click to enter a date.
Eric Fournier		16 OCTOBRE 2023
Participant's Name	Participant's Signature	Date

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

Phone: 905-962-1859
Email: carlie.besser11@gmail.com

My supervisors are:
Prof. Catherine Chong, **catherine.chong@humber.ca**

IDSN 4002/4502
SENIOR LEVEL THESIS ONE AND TWO

Humber ITAL / Faculty of Media & Creative Arts
Bachelor of Industrial Design / FALL 2023
Catherine Chong

FTA-2 (B) THESIS TOPIC APPROVAL (Preliminary Abstract)

THESIS TOPIC APPROVAL:

Student Name:	Carlie Besser
Topic / Problem Definition:	How might we enhance experience for sand dune riders?

TOPIC DESCRIPTIVE SUMMARY (PRELIMINARY ABSTRACT)

Sand dune riding is an experience sought after by many and is an extremely exhilarating recreational activity. Although desirable, some aspects of the experience of sand dune riding such as safety, sustainability, and accessibility could be further enhanced. According to the Council on Environmental Quality, over the course of three years, there was a 27% increase of disturbed soil in one singular area due to the use of off-road vehicles. Minimizing ecological impact by facilitating a sustainable approach is necessary to preserve these ecologically fragile environments. The scorching temperatures and unforgiving terrain also necessitate a need for added safety measures for all users. These terrains, located in North America, the Middle East and Australia are difficult to access due to their location and environmental characteristics, thus decreasing the accessibility and ease of participating in dune riding. With the intention of enhancing the experience of sand dune riding, multifaceted research approaches involving observational studies, interviews and surveys with tourists, professionals and environmentalists allow for gathering insights from various perspectives. Both quantitative and qualitative data will be analyzed to allow for greater understanding of the unique challenges of dune riding. Iterations, prototyping and testing with user feedback will allow for exploration of a solution. This process will further develop solutions which foster safety implementation, preservation of fragile ecosystems, reduction in harm of environment and improve accessibility for adventure seekers. Thus, overall enhancing the experience for sand dune riders.

Student Signature:	Carlie Besser
Date:	09 / 10 / 2023

Instructor Signature:	Catherine Chong
Date:	12 October 2023

Chong, Kappen

PANEL ON RESEARCH ETHICS
Navigating the ethics of human research

TCPS 2: CORE 2022

Certificate of Completion

This document certifies that

Carlie Besser

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

Certificate # 0000953079 **8 September, 2023**

Appendix F - Advisor Meetings & Agreement Forms

IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

HUMBER
Bachelor of Industrial Design / FALL 2023 & WINTER 2024

PARTICIPANT INFORMED CONSENT FORM

Research Study Topic: Enhancing the Expirience of Sand Dune Riding
Investigator: Carlie Besser / 905-962-1859 / carlie.besser11@gmail.com
Courses: IDSN 4002 & IDSN 4502 Senior Level Thesis One & Two

I, « Participant's Name » Eric Fournier *(First Name/Last Name)*, have carefully read the Information Letter for the project 'Enhancing the Expirience of Sand Dune Riding', led by Carlie Besser. A member of the research team has explained the project to me and has answered all of my questions about it. I understand that if I have additional questions about the project, I can contact Carlie Besser at any time during the project.

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

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

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

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

I also understand that I may decline or withdraw from participation at any time, without negative consequences.

I understand that I can verify the ethical approval of this study, or raise any concerns I may have by contacting the Humber Research Ethics Board, Dr. Lydia Boyko, REB Chair, 416-675-6622 ext. 79322, **Lydia.Boyko@humber.ca** or Carlie Besser / 905-962-1859 / carlie.besser11@gmail.com .

Verification of having read the Informed Consent Form:

☑ I have read the Informed Consent Form.

My signature below verifies that I have read this document and give consent to the use of the data from questionnaires and interviews in research report, publications (if any) and presentations with the proviso that my identity will not be disclosed. I have received a copy of the Information Letter, and that I agree to participate in the research project as it has been described in the Information Letter.

Click or tap here to enter text:		Click to enter a date.
ERIC FOURNIER		16 OCTOBRE 2023
Participant's Name	Participant's Signature	Date

Questions

1. **Do you personally have any experience exploring or off-roading on sand dunes?**
   Yes
2. **Can you elaborate on the specific terrain and environmental factors that influence vehicle designs for sand dunes?**
   - Dunes could hide anything behind. The vehicle must be visible as soon as possible.
   - Vehicles could stock in the send. Vehicle design must allow to deal with the sand nature.
   - Conditions could be very warm in the desert.
3. **What safety features and considerations are necessary when designing these vehicles for such challenging conditions?**
   - Some features to face conditions previously mention.
4. **What strategies could be employed to strike a balance between vehicle performance and its impact on the environment within a design?**
   - This should be answered by the designer.
5. **Can you share any insights on the durability and maintenance requirements of vehicles used for sand dune off-roading?**
   - I am not so familiar with this aspect for sand usage.
6. **In targeting diverse customer segments, what demographic insights have driven the customization of marketing approaches for these vehicles?**
   - Today, this type of vehicle is mainly used by men. But it could be very interesting to imagine what could be a dune riding vehicle that meet women expectations…
7. **What are some of the most valuable vehicle accessories for sand dune riding?**
   - Cooler
   - Jerry can
   - Additional light bar
   - Sound system

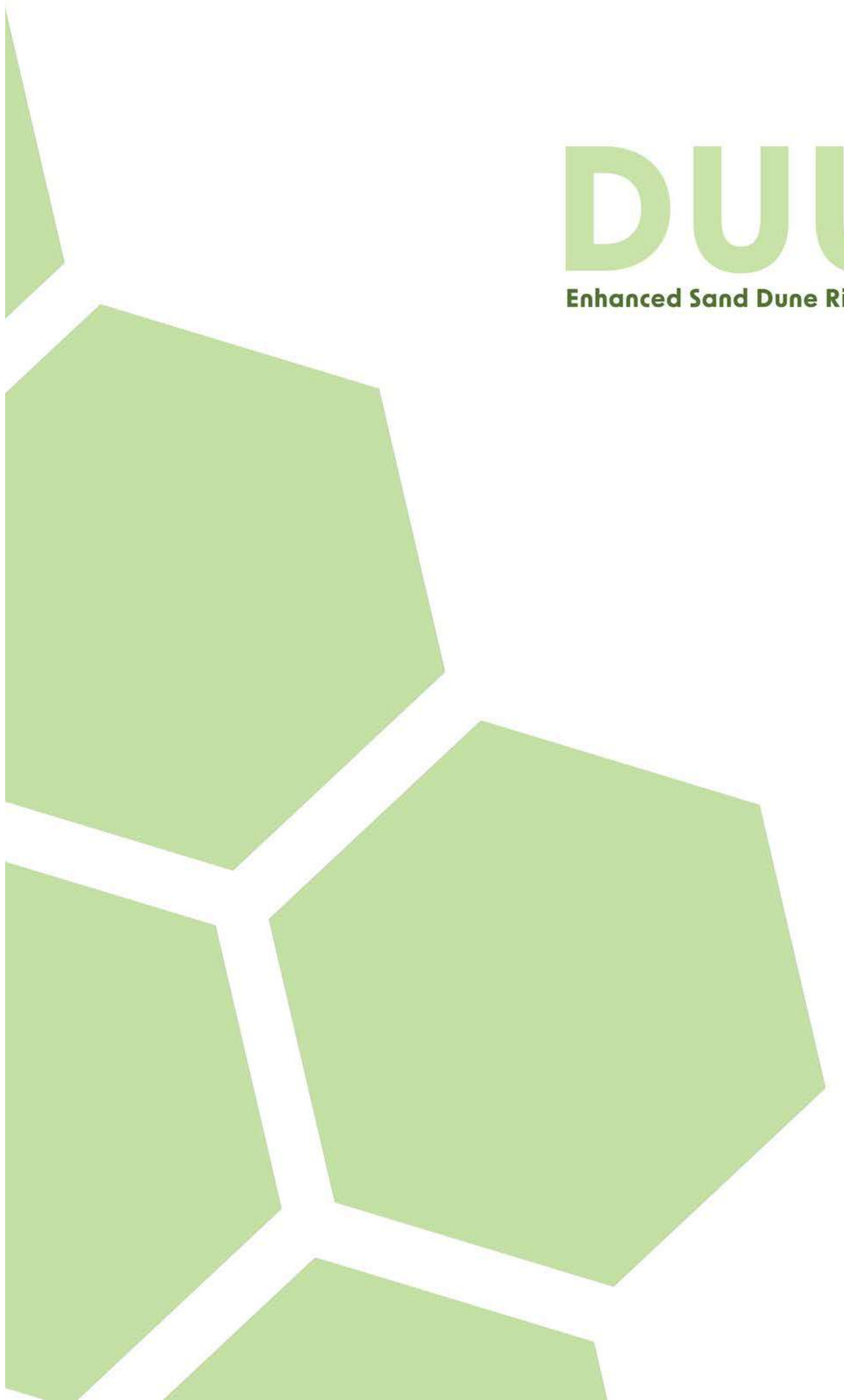
Carlie Besser

8. **Can you describe some of the unexpected challenges that have risen in your vehicle design projects for sand dune environments, and how you addressed them?**
   No
9. **How do you envision the ideal sand dune off-roading experience, and how does your design work contribute to achieving that vision?**
   We have just launched the Maverick R. This is the best vehicle to deal in this type of terrain.
10. **When considering the feedback and experiences of riders, what aspects of the sand dune off-roading adventure do you find most intriguing and inspiring as a designer?**
    Our current users enjoy a lot the open space dunes riding is offering as opportunity. Then, the speed is key for them.

C: How many times have you experienced sand dune riding sand dune riding?
P: Unfortunately, only once.
C: Where did you go dune riding? Was it with a tour group or individually? Did you use rented equipment or personal equipment?
P: I went while on vacation with some of my close friends in Africa. We visited Egypt and went to the Sahara Desert for this dune riding adventure. We booked the dune riding trip with a local tour group before our vacation.
C: What vehicle did you use to ride the sand dunes?
P: We used gas powered ATVs for our ride. They are the only vehicle that the tour group provided. We were also provided with sand boards so when on the actual dunes we were able to take a break and try boarding down the sand dunes.
C: What challenges have you faced when planning sand dune riding trips?
P: Booking the guided tour was easy however actually getting to Merzouga, which is a small village in southeastern Morocco, was difficult. We drove from Marrakesh to the Merzouga which is a 9 hour drive with a rental car and with no stops. Upon arrival we rode Dromedaries (one humped camels) into the desert and stayed the night in permanent camp. At 5 am we hopped on ATVs and rode into the dunes. It required minimal walking.
C: Was the vehicle equipped with any safety features or navigation? Did you encounter any safety issues?
P: We didn't encounter any issues but there was no advanced safety gear or equipment and no navigation available on the vehicles. I assume that the guide had safety and first-aid equipment with them. They did provide helmets for the riders which is pretty standard. We left early in the morning to watch the sunrise so there was no risk of extreme sun exposure. The ATV slide around a lot which was part of the fun and going up the dune on the ATV was difficult at times because it didn't get too much traction on the sad.
C: What gear did you wear or bring for this experience?
P: I was able to bring a small backpack with water. If we went midday, it would have been necessary to wear a headscarf, sunglasses and linens. Sunscreen is also a must.
C: Was the experience easily accessible in your opinion?
P: Yeah I would say that access was relatively easy but the long drive into the desert was tiring. The tour began where we parked our rental car and the tour group had the Dromedaries ready for us to ride to the base camp which made getting to the base much easier. I'm not sure what we would have done if they didn't offer that service. Riding the Dromedaries was a very cool experience but it was kind of scary. You're pretty high off the ground and riding on wild animals.
C: Are you aware of the environmental impact sand dune riding activities?
P: I know a bit about the impact on the environment from my personal knowledge but no one had shared any information regarding the environment with us. I'm sure it is hard on terrain and the vibrations and noise and as well as the pollutants from gas powered vehicles would negatively impact the ecosystem. Changing the fuel type of the vehicles to electric would be a beneficial improvement to the environment.
C: Tell me more about your favorite dune riding experience or any memorable stories.
P: Dune riding in the morning before/during a sunrise in the Sahara is quite a beautiful experience. We got up under the stars and drove to the top of a dune for half an hour while we watched the sunrise over the dunes. It was magical. Also, some other riders flipped their ATVs which was pretty entertaining (they were fine)! It was absolutely beautiful to just ride around in the sea of sand. Bringing water is essential even without direct sun. As the sun starts rising it can quickly become intense, so sun protection is a must-have. Sand boarding was a super fun and I am very glad we got to experience that as well, but it was extremely exhausting walking back up the dunes. It took a while to get used to riding the sandboards, I tumbled for a while but falling on the sandboard didn't really hurt too much. We switched back to the ATVs pretty quick since sandboarding was pretty exhausting. All in all it was an incredible experience.

DUUN

Enhanced Sand Dune Riding Experience



Carlie Besser