HORIZON

Enhanced Sleeper Semi-Truck

Bachelor of Industrial Design Thesis Report

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HORIZON – Enhanced Sleeper Semi-Truck

by

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Submitted in partial fulfillment of the requirements for the degree of

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Abstract

The long-haul truck transportation industry is a crucial part of the global economy, providing essential goods to consumers in every country and locale around the world. Moving cargo and goods by truck requires driver operators to spend days or weeks on the road at a time. The work environment and the driver's tasks can often have serious detrimental health effects on operators, which in turn results in very high turnover rates and high retraining costs across the industry. A lack of ergonomic innovation coupled with the repetitive nature of the job, lack of proper amenities and social isolation puts drivers at heightened risk of cardiometabolic diseases, musculoskeletal disorders, as well as anxiety and depression. How might we improve the livability and working conditions for long haul truck drivers? Research will be done to gain a general understanding of the topic, and user interviews and observations will be conducted to gain greater insight into the issues at hand. Research will be done on sleeper trucks and the findings will be used for a full ergonomic analysis. This analysis will greatly influence how the design is carried out. A solution will be designed to help the physical and mental well-being of long-haul truck drivers, and in turn help the overall trucking industry.

Acknowledgements

This thesis project would not have been possible without the support, guidance, and honest feedback from my professors in the industrial design program, my advisor, as well as my peers and my family.

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Special thank you to my advisor who has been so generous to help provide me with knowledge and insight into the world of long-haul truck driving. He volunteered his time to answer any questions I had, to talk about his experiences as a truck driver, and to explain the inner workings of the industry. This information was crucial in developing this thesis.

I would also like to say thank you to my fellow classmates. My classmates are a tough, hard-working, and friendly bunch that I have been so fortunate to have met and worked along-side during my time at Humber. They have pushed me to better myself and were also there to pick me up when I was down, so for that I owe them a great deal of thanks and appreciation.

And last but not least I would like to thank my family. Without them I probably would not have been able to attend any post-secondary institute. I am forever grateful they have afforded me the opportunity not just to attend a post-secondary school, but to attend a program that I am passionate about. I am thankful for their patience and for the emotional support they have given me, and the constant guidance and care they have given me throughout my life.

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CHAPTER 1 – PROBLEM DEFINITION

Figure 1 – Country Road - retrieved from Unsplash

1.1. Problem Definition

The long-haul truck transportation industry is a crucial part of the global economy, providing essential goods to consumers in every country and locale around the world. Moving cargo and goods by truck requires driver operators to spend days or weeks on the road at a time. The work environment and the drivers tasks can often have serious detrimental health effects on operators, which in turn results in very high turnover rates and high retraining costs across the industry. A lack of ergonomic innovation coupled with the repetitive nature of the job, lack of proper amenities and social isolation puts drivers at heightened risk of cardiometabolic diseases, musculoskeletal disorders, as well as anxiety and depression. How might we improve the livability and working conditions for long haul truck drivers?

Research will be done to gain a general understanding of the topic, and user interviews and observations will be conducted to gain greater insight into the issues at hand. Research will be done on sleeper trucks and the findings will be used for a full ergonomic analysis. This analysis will greatly influence how the design is carried out. A solution will be designed to help the physical and mental well-being of long-haul truck drivers, and in turn help the overall trucking industry.

1.2. Investigate Approach Taken

To understand a long-haul truck drivers experiences, as well as gain insight into the trucking industry, several research methods will be used to analyze the needs and wants of truck drivers currently working in the industry.

Research questions have been developed from basic scholarly research. These research questions will guide the research process and help discover and understand the experiences of long-haul truck drivers.

Questions addressed	Areas of study	Research methods
How might we improve the livability and working conditions for long haul truck drivers?	Current methods of compact living and mobile living.	Online and scholarly research.
What currently exists? Types of trucks?	Ergonomics and vehicle interior design strategies.	User interviews and user observation studies.
How can new transportation technologies be used to help drivers?	Electric vehicle specifications and emerging transportation technologies.	Video reviews.
How can a solution be handled in a sustainable fashion?	Current trucking standards and practices.	Ergonomic studies.
		Existing product research.

Table 1 - Investigate Approach Taken

1.3. Background / History / Social Context

Long-haul truck drivers are an essential part of global economy, providing goods and services to customers and locale all around the world. The trucking industry however has faced difficulties with high turnover rates, many drivers quit once they realize what the job entails. Long-haul truck drivers are required to be on the road for days or weeks at a time all alone. They drive about 11 hours per day which can lead to musculoskeletal issues, and when they are not driving they are living in the confined living quarters of their truck. Trucks are often not big enough to have facilities like a washroom or

cooking station, which makes drivers reliant on the facilities at truck stops, which makes living a healthy lifestyle difficult.

Studies show that fatigue is common issue among drivers. This can often be attributed to the monotonous nature of driving for extended periods of time, intense time pressures, noise from other trucks at truck stops and poor diets. Driver fatigue affects the driver's ability to focus, which can severely affect job performance. And when the drivers are driving, this can pose a safety risk to other people on the road.

Efforts have been made by industry leaders to improve driver retention by increasing pay. This has helped but it remains a large problem. The ergonomic issues, unhealthy lifestyle, fatigue, and the solitary nature of the job, all affect the driver's mental health and well-being, and that is a very significant reason why drivers are quitting so frequently. A fundamental shift in the way long-haul sleeper trucks are designed is necessary to make the job more bearable. If a solution can be developed that is ergonomically friendly and promotes a healthy lifestyle, this will improve the overall well-being of long-haul drivers and lessen the chances of quitting. Which in turn will help the trucking industry retain drivers and pose less of a financial burden.

CHAPTER 2 – RESEARCH

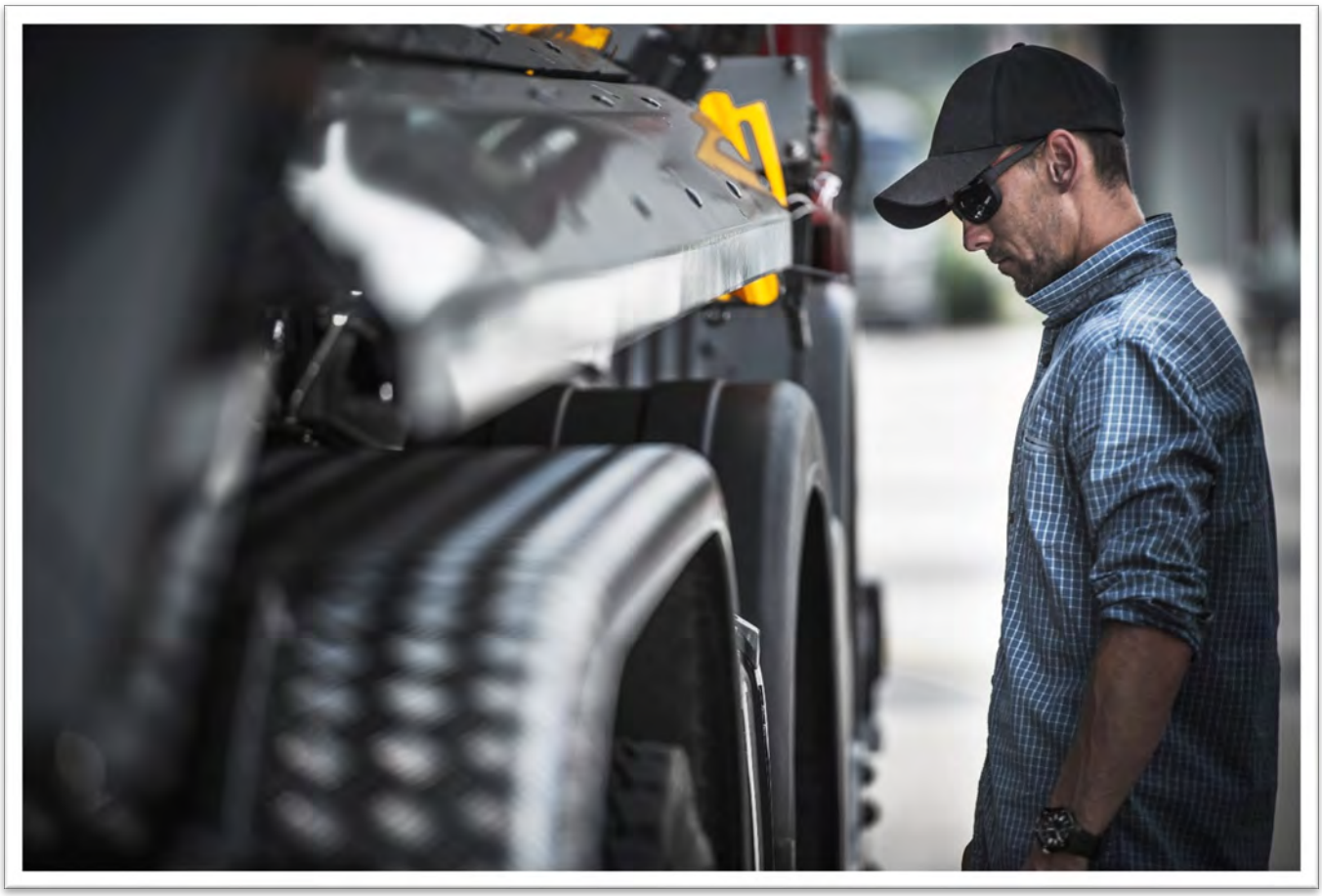


Figure 2 - Truck Driver - retrieved from Adobe Stock

2.1. User Research

The goal of this thesis study is to design a solution that will make sleeper trucks more livable for drivers, and thus encouraging them to stay working as a driver. In order to understand how to achieve this, user research has been done on truck drivers to determine who they are, what tasks they do, and what they feel while performing said tasks.

The research was done by means of online research through consumer search engines as well as scholarly articles and reports, user interviews, surveys and user observation studies. The data collected will be used to help determine who we are designing for. Criteria for a potential full-body interaction design solution will be assessed and analyzed during this process.

2.1.1. User Profile - Persona

Figure 3 - Portrait of man outdoors by truck. [Image] Retrieved from auremar on https://stock.adobe.com/ca/contributor/200863575/auremar?load_type=author&prev_url=detail

Name	Chris Daniels
Age	46
Occupation	Long-haul truck driver for a company
Income	$58,000/ year
Location	Lives in Toronto, travels to and from the U.S.A when delivering shipments
Education	Secondary school diploma, studied for a year in college for business before dropping out.

	Relationship status	Married with one child
	Years of service	8 years of trucking experience
	Social/Solitary	Work alone when on deliveries, enjoys time spent with family and chatting with friends
	Frequency of activity	Two overnight shipments per week. One night shipping to the U.S.A and another night taking shipment back to Canada

Table 2 - User Persona

A made-up user persona has been developed based solely on online research. Based on a series of demographic criteria, this persona was made to represent the average long-haul truck driver and the key demographic for this thesis study. A made-up user background is described below:

> *"Chris Daniels is a 46-year-old Caucasian male. He attended college to study business before dropping out to pursue a stable career as a long-haul truck driver. He earns a salary of $58,000/ year to support his wife and child. Chris always does his best to perform his job to the best of his abilities. He keeps to a schedule of 11 hours of driving a day followed by a 14 hour break period between shifts. He engages on social media between shifts to chat with friends, family and fellow truck drivers. He enjoys seeing the world as he travels in his truck on*

deliveries. Chris enjoys driving and operating his truck, in a way it feels like a second home to him and he takes pride in looking after it. He does sometimes feel the negative affects that the truck can have on his body and mind. 11 hours of driving per day has caused him to have aches and pains in his lower back and neck, and because of the lack proper household amenities he finds himself buying takeout at truck stops more often than he would like. This can sometimes take a toll on his mental health, causing to feel less motivated and even depressed a times. In times like this Chris does his best to push through so the job at hand can still be done well."

The age range of truckers is quite vast for both men and women, the average age of truck drivers sits between approximately early 40's to mid-50's. It should be noted that the trucking industry has been looking to hire younger truck drivers who are strong and healthy. Truck driving is not a desirable job among a lot of young people, and as the current truck drivers get older, a severe shortage of drivers is starting to appear.

Studies show that there are significantly more male truck drivers than female truck drivers. In recent years however, there has been a recorded increase in female truck drivers. Moving forward with this thesis study, it will be important to design a solution to accommodate for both male and female demographics.

Demographic studies have shown that Caucasian people make up most of the long-haul truck drivers. Many ethnicities will be considered for the final design solution however because the job position is not restricted to only Caucasian people.

Most long-haul drivers have not completed any post-secondary school program, although a significant number have started post-secondary and dropped out. The most popular area of study in

post-secondary for future truck drivers is business studies, although very few truck drivers actually have a degree in anything.

The salary of which a long-haul truck driver is paid varies wildly depending on the type of work they are doing. Drivers under non-employer establishments are paid significantly more than drivers under employer establishments. But more drivers work for employer establishments than not, so the average salary of drivers is brought down.

The information found provides a strong insight into who truck drivers exactly are, which is crucial for understanding the potential users. Most truck drivers in the industry are middle aged and sit between 39 – 56 years of age. Most truck drivers are male, and most are Caucasian. Truck drivers typically have a high school diploma and some experience in college or university, though not even a high school diploma is always needed. The skills of a truck driver revolve around time management, problem solving, and equipment maintenance and operation, skills that do not necessarily require any post-secondary qualification.

Demographics		User Behaviour		Personality		Cognitive Aspects	
Age	39-55	Frequency of use	11 hours of driving per day	Locus of control	↑	Technical Skill	↑
Gender	Predominantly Male	Duration	Days or weeks at a time	Self-Efficacy	↑	Pre-requisite knowledge	↓
Culture	Caucasian	Social	Solitary				

Education	High school diploma	Level of focus	Middle				
Income	Middle class (Average $50,000)	Location	Highways, truck stops, truck cab				

Table 3 - Primary User Profile

2.1.1.1. Primary User

The primary users focused on in this study are long-haul truck drivers working either as independent owner operators or as a company employee.

2.1.1.2. Secondary User

Secondary users are mechanics, supervisors, and shunters. These are people who may be required to operate or handle the trucks for a short period of time.

2.1.1.3. Tertiary User

Tertiary users include warehouse workers and DOT inspectors. These are people will likely never be asked to operate a sleeper truck but may witness some of the effects the truck has on the driver.

2.1.2. User Observation – Current User Practice

2.1.2.1. Introduction

The purpose of collecting this data is to aid in the understanding of the different situations that long-haul drivers. Understanding how truck driver execute their tasks and the circumstances in which they are performing them will help in discovering the problem areas.

2.1.2.2. Method

User interview were conducted over the phone as well as over Zoom.

Long-haul truck drivers have certain, regular tasks that need to be completed with every shipment. A it of the difficulty with these tasks however, comes from the circumstances in which they are doing them. The underlying health issues associated with the job, and the unpredictable nature living and traveling on the road can make performing these tasks difficult. These regular tasks include planning the trip; receiving the load; conducting a pre-trip inspection; driving for 11 hours; stopping at a truck/rest stop for the night; a second pre-trip inspection; second day of driving to the destination; then dropping off the load.

Driving for 11 hours per day puts the driver at risk of getting aches and pains in the back, shoulders and arms, and also puts them at risk of more severe health problems like thrombosis. With health conditions like these, it can become difficult for the driver to drive for the allotted 11 hours, which can possibly affect the speed of the shipment. Constantly having to check the mirrors and spinning the wheel intensely when performing hard driving maneuvers like backing into a dock can also be made more difficult because of theses aches and pains.

The truck stops and rest stops are always an anomaly for drivers. Whenever a driver arrives at a truck stop for the night, there is no guarantee that there will be parking spots available. This can force drivers to either “make their own spot”, or continue driving to find another spot to sleep. A lot of the time at truck stops, drivers will park somewhere not in a parking space. Which means there is a risk of drivers being blocked into their spots, in which case they must knock on the blockers door and get them to move. The facilities at truck stops are not a guarantee either. Rest stops only have the bar minimum facilities, usually a washroom and a couple fast food restaurants. Truck stops generally have more facilities including washroom and showers, more fast-food places, the odd healthier sit-down restaurant, and even laundry facilities. These truck/rest stops however do have to close for the night. Which means drivers who arrive at truck stops late at night might not be able to grab dinner or even go

to the washroom before heading to bed. These factors make maintaining a healthy diet on the road quite difficult.

The aches and pains and dietary struggles take a toll on drivers mental health, which can make all of the regular tasks, even the simple ones, much more taxing and unenjoyable. The unpredictable nature of the job means these tasks can very enjoyable on some days, and dreadful on other days.

2.1.2.3. User interview and surveys

An interview was conducted with (anonymous name), who is currently working as a long-haul truck driver. Also, surveys were posted on trucking forums for other long-haul drivers to fill out. The questions in both the interview and the survey revolved around the experience of the job, the lifestyle, if the drivers experience any health issues, what they enjoy about living in a sleeper truck and what they would change. Below is some of the key takeaways from these user studies.

- General aches and pains are common from having to drive 11 hours per day. This can affect a drivers ability to perform tasks.

- Maintaining a healthy diet while on the road is difficult. Truck stops may not always have healthy food options, and if they do, they are expensive. And also, the truck does not have amenities that allow the driver to eat healthily (small fridge not big enough for healthier foods, and only a microwave available for cooking).

- Idling trucks are quite common even when the weather is nice. This causes other drivers to lose sleep because of the noise. If trucks have refrigerator units on them, they are often quite loud and disruptive as well.

- Mental health is often affected as a result of all of these issues.

2.1.3. User Observation – Activity Mapping

The objective of the user observation was to understand the steps involved with long-haul truck driving in order of operation, and get an experts take on the pains and gains of each step. The information gathered will provide an understanding of what areas of the job need improvement. The user observation was done in the form of a video review with an expert. Videos related to the topic of long-haul trucking were shown to the expert, where he gave his take on the videos and answered any additional questions.

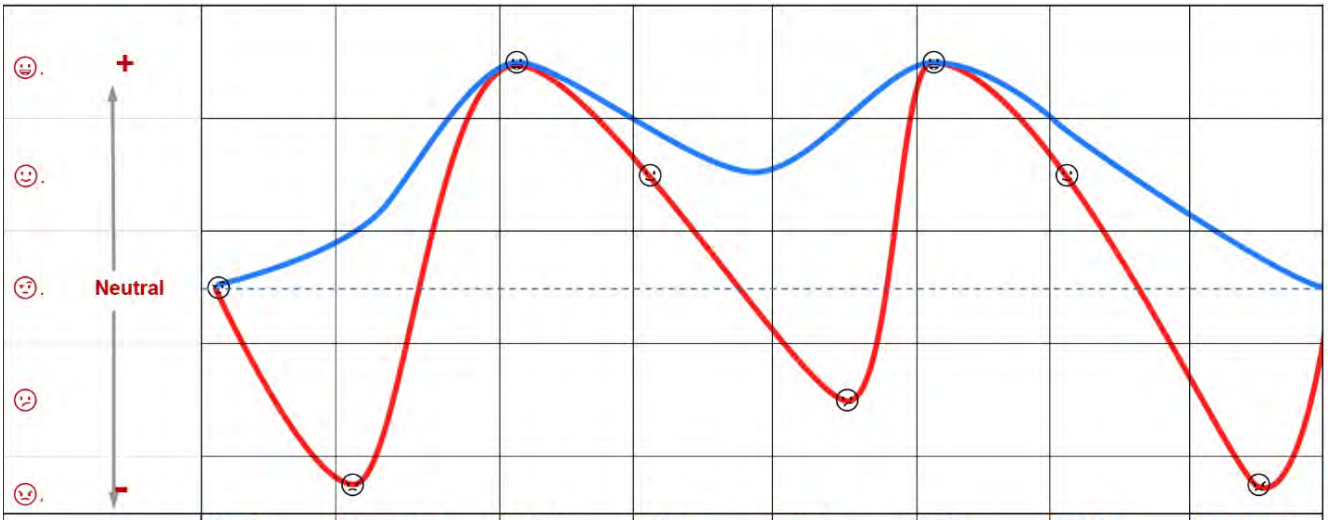
A Journey Map and a User Experience Map were constructed based on the data collected from the user observation video review. These maps illustrate the main tasks of a long-haul truck driver in order of operation, as well as the inherent challenges with those tasks, and how the user feels while performing them.

USER JOURNEY MAP

	Planning	Preparation	Task 1	Task 2	Task 3	Task 4	Task 5	Completion
User Goals	Plan trip	Receive shipment	Pre-trip inspection	Drive	Sleep	Pre-trip	Drive	Drop off shipment
User Actions	Use GPS to find route	Back into dock	Check truck systems	Drive for 11 hours per day	Find rest stop/truck stop	Check truck systems	Drive for 11 hours per day	Determine best way to get to the dock
	Determine best route to take	Receive paper work	Check brakes	Take mandatory 30 minute break	Park truck	Check brakes	Take mandatory 30 minute break	Back into dock
			Check tires	Cross border (sometimes)	Eat dinner	Check tires	Cross border (sometimes)	Give paper work to receiver
			Check fluids		Sleep	Check fluids		
User Thoughts	What are the best roads to take?	Is freight loaded properly?	Is everything in working order?	Are all systems okay on the truck?	Is there going to be spots available at this stop?	Is everything in working order?	Are all systems okay on the truck?	How do I get to the docks?
	What will get me there the fastest?	Do I have all the necessary documents?	Are there any major issues?	What's happening around me on the road?	What kind of facilities does it have?	Are there any major issues?	What's happening around me on the road?	What is the best way to approach the docks?
	Whats the most convenient rest/truck stop?		Is the truck safe to drive?	Is the GPS working? Is it taking me the right way?	What do I need to do before I sleep and in the morning?	Is the truck safe to drive?	Is the GPS working? Is it taking me the right way?	Is all my paperwork ready?
Storyboard / Photos								
User Experience								
+								
Neutral								
-								
Problems/Challenges	GPS may not always take on the best route	Locating docks and setting yourself up to back in is challenging		Can get shoulder tension and arm pain from driving	Available parking spots are not a gurantee		Can get shoulder tension and arm pain from driving	Locating docks and setting yourself up to back in is challenging
		Backing a large truck into a potentially tight dock		Pain can affect job performance	The stop might have minimal facilities and restaurants, or facilities might be closed		Pain can affect job performance	Backing a large truck into a potentially tight dock
					Idling trucks and reefers can be noisy when trying to sleep			
Ideas / Take-aways	The anticipation of a new trip can cause slight stress early on the job process	Backing in a large truck is difficult, especially when trying to navigate into a tight spot Can this be made easier?	No problems expressed	Excess driving, or driving in harsh conditions, can cause musculoskeletal issues Can the cockpit be adjusted to be more ergonomically friendly?	There is a high possibility that there will be no spots to park, and that the facilities at the truck stop, including bathrooms, will be closed. Is there a way to make drivers less reliant on truck stops?	No problems expressed	Excess driving, or driving in harsh conditions, can cause musculoskeletal issues Can the cockpit be adjusted to be more ergonomically friendly?	Backing in a large truck is difficult, especially when trying to navigate into a tight spot Can this be made easier?

Table 4 - User Journey Map

User Experience Map



	Planning	Preparation	Task 1	Task 2	Task 3	Task 4	Task 5	Completion
User Goals	Plan trip	Receive shipment	Pre-trip inspection	Drive	Sleep	Pre-trip inspection	Drive	Drop off shipment
Problems/Challenges	Not knowing exactly where to go can cause stress early on	Struggling to back into a loading dock can be difficult and frustrating		Musculoskeletal pain from driving can affect the overall well-being of the driver	Lack of sleep can occur from the noise from other trucks, stress about the route ahead, and also potential lack of sustanence due to facilites being closed		Musculoskeletal pain from driving can affect the overall well-being of the driver	Struggling to back into a loading dock can be difficult and frustrating
				Can affect how well other tasks are performed	Maintaining a healthy diet is difficult		Can affect how well other tasks are performed	
Ideas / Take-aways	Can this stress be minimized in some way? App?	Can the truck be modified to make this task easier?		Can the cockpit be made more ergonomically friendly? More ergonomic steering mechanism? Seat?	How can the sleeper be adjusted to be more livable? Toilet? Cooking station?		Can the cockpit be made more ergonomically friendly? More ergonomic steering mechanism? Seat?	Can the truck be modified to make this task easier?

Table 5 - User Experience Map

With the data collected from the video review, a Journey Map and User Experience Map were able to be made. These maps show that the most challenging parts of the job are maneuvering the truck in tight spots, particularly when backing in, and getting adequate rest at rest/truck stops. It is during both these tasks when the driver expresses the most frustration. The process of driving can be enjoyable, although after long periods of time or during harsh weather conditions, it can cause muscular strain. This can take a toll on the driver's job performance, well-being, and the overall

experience of the job. Ergonomic driving mechanisms, compact living, and semi-truck anatomy will be analyzed to form a solution that will meet the target user experience.

2.1.4. Human Factors – Research of Existing Products

Long-haul truck driving poses many musculoskeletal risks to drivers due to the current equipment being used for the job. Though efforts have been made by industry to help remedy these ergonomic problems, aches and pains and even more serious conditions like thrombosis can still occur. Sleeper truck drivers' seats are often equipped with air-ride suspension mechanisms, which allow for a smoother ride. Even though the ride might be smoother, it does little to help the underlying issues of sitting for 11 hours per day. And by the very nature of the job, they are given little opportunities for extra exercise, which is essential for physical and mental well-being for any human-being.

Trucks usually come with a bed, but it has been reported that drivers usually bring extra padding for more comfort and support like memory foam. Colin Van Duzen described it as 'sleeping on the sidewalk'. He brings his own memory foam into his truck to sleep on, which means if the company asks him to switch trucks, he has to move the bedding as well.

2.1.5. Safety and Health - Research of Existing Products

Commercial trucks have to follow certain safety standards in order to be owned and operated. And operators have to perform pre-trip inspections daily to make sure the truck is safe to drive. Pre-trips include checking the oil and fluid levels; checking the headlights and taillights, making sure the brakes are functioning correctly; checking the tire pressure; battery level; and cargo security. If there are any major issues with the truck that could threaten the safety of others, that truck has to be fixed before it can be driven.

Safety measures on the interior need to be taken as well, including adequate seat belts and airbags. Sleepers contain other living amenities as well however so cargo security must be considered

on the inside as well. This means there needs to be latches on all the doors and hinges to prevent personal belongings from moving around the cabin. And because drivers are sleeping in their trucks at truck stops, black out blinds are provided for the windshield for the driver's convenience and to ensure that no one can peek inside.

2.2. Product Research

This section of the thesis study analyzes existing products that are currently being used by long-haul drivers. At this point in the thesis study the cockpit of the truck was being analyzed from an ergonomic standpoint, and a new solution for seating was being considered. So the chosen products for benchmarking was car seats. The seats will be analyzed based on their key benefits and features, functionality, and aesthetics. This is being done to find opportunities for innovation.

Eight different car/truck seats were selected to be analyzed for this study. These specific seats were chosen because they all serve the same general purpose but have slight differences between them. Promotional material was reviewed for each of these seats and the core features and benefits were extracted and organized into separate tables. The organized features and benefits were reviewed to determine the most common features and benefits across all eight seats. Promotional material and descriptions can be found in Appendix A.

2.2.1. Features and Benefits

Benefits		
Name	Image	Benefits

Recaro Pole Position N.G. Series Seat	 *Figure 4 - Recaro Pole Position N.G. Series Seat. Image received from https://www.carid.com/recaro/pole-position-n-g-series-*	- Sporty - High quality - Structured support - Preventing fatigue - Comfortable - Functionality - Safety - Premium Quality - Contemporary
Bestop Trailmax Pro II Seats	 *Figure 5 - Bestop Trailmax Pro II Seats. Image received from https://www.autoanything.com/seats/61A7506A0A0.aspx*	- Elite - Coziness - Comfy - Sitting pleasure - Luxury - Soothe - Soft - Firm - Support
Edirb 110	 *Figure 6 - Edirb 110. Image received from https://bride-jp.com/en/seat/edirb/110_redleather.html*	- Medical comfort - High functionality - Higher grade - Increased comfort - Reduction of fatigue - Solid hold - Comfortable - Smooth touch - Breathable - Quality - High fashion - High end - Excellent quality

Wide Ride + Serta	 *Figure 7 - Wide Ride + Serta. Image received from https://www.bostromseating.com/en-us/product/seat/wide-ride-serta*	- Premium - Most comfortable - 2x the support - Comfortable - Reduce back pain - Prevent stiffness and pain - Reduces vibration - Smooth - Stable
Minimizer – Long-haul Series Suspension Seat	 *Figure 8 - Minimizer – Long-haul Series Suspension Seat. Image received from https://www.truckid.com/minimizer/long-haul-series-suspension-seat.html#features*	- Safety - Comfort - Support - Safety - Durability - First-rate quality - High quality
Bostrom Seating Lopro 910 Sc Manual Lumbar Mid-Back Truck Seat	 *Figure 9 - Bostrom Seating Lopro 910 Sc Manual Lumbar Mid-Back Truck Seat. Image received from https://www.truckid.com/bostrom-seating/bostrom-seating-lopro-910-sc-manual-lumbar-mid-back-333649203.html*	- Affordable - High quality - Budget friendly - Great quality

MasterCraft Safety Baja RS Premium Reclining Suspension Seat	 *Figure 10 - MasterCraft Safety Baja RS Premium Reclining Suspension Seat. Image received from https://www.carid.com/mastercraft-safety/baja-rs-premium-reclining-suspension-seat.htmllumbar-mid-back-333649203.html*	- Safety - Comfort - Fatigue Fighting - Attenuation - Superior energy - Superior performance - Precision crafted - Durable - Trouble-free comfort
Distinctive Industries Deluxe Touring II Front Bucket Seats	 *Figure 11 - Distinctive Industries Deluxe Touring II Front Bucket Seats. Image received from https://www.carid.com/distinctive-industries/deluxe-touring-ii-front-bucket-seats.html*	- High Quality - Strength - Durability - Comfortable - Supportive

Table 6 - Benefits Analysis

Feature	**Frequency**
Support	14
Extras	11
Seat	10
Material	10
Benefit	**Frequency**

Design	14
Quality	12
Comfort	10
Ergonomics	9

Table 7 - Key Benefits and Features

The most prominent benefits being convey are comfort and quality. This makes sense because a seat must be comfortable if you're going to be sitting in it for possibly long periods of time, and it has to be good quality to ensure the longevity of the seat. And it appears that the most prominent features are all geared toward ergonomics. The promotional material often made a point of highlighting the seats ergonomic construction, its adjustability and/or its lumbar support. The sporty seats often boasted the benefits of their elegant designs, while the more practical seats often spoke about the many features they had. Seats in sleeper trucks often have air suspension and focus more on the adjustability of the seat rather than the looks. This is an important angle to take considering long-haul drivers drive for upwards of 10 hours per day, but this chart shows there are stylistic opportunities for truck seats.

One of the key benefits determined by this analysis was the design, and the key feature was support. This seems to suggest that there is a desire in the marketplace for seats that have an aesthetically pleasing design, as well as proper ergonomic support. This makes sense from a consumer's standpoint because it is often frustrating to have to pick one or the other. A seat that has the best of both worlds is going to be more desirable than seats that do not. Truck seats often focus more on functionality, there is room to make air-ride truck seat more aesthetically pleasing.

2.2.1. Features and Functionality

The purpose of these X-Y graphs is to discover trends in the designs of the seats. The Adjustability vs. Purpose graph was made to see if there is a correlation between the level of adjustability and what the intended use of the seat is. And the Bulky/Thin vs. Honest/Sculptural chart is meant illustrate aesthetic trends in seats. The information gathered from these two charts will determine the best type of seat for long-haul drivers, as well as discover any styles of seats that have not been explored.

Figure 12 - Functionality XY Plot

2.2.2. Aesthetics

Figure 13 - Aesthetics XY Plot

The Adjustability vs. Purpose chart shows that there is a clear correlation between the level of adjustability vs the intended purpose. Seats designed for long distance driving often have more adjustable features, while racing seats are more likely to have less adjustability or even be completely fixed. For long-haul truck drivers, seats with air-ride suspension are the best option available. The Bulky/ Thin vs. Honest/Sculptural chart shows common trends in seat aesthetics. There are seats in every section but there is a lack of thin, sculptural designs. It appears that car seats often use a lot of foam padding as way to create more comfort for the user, thus making it more common for them to be bulky. These charts show an opportunity for an ergonomically designed, thin and sculptural seat for long distance use. This design direction will be considered moving forward.

2.2.2. Materials and Manufacturing

The seats from the analysis above all share a common aspect about their marketing. That being that none of them prominently highlight the specific materials that each seat uses. There are some that use

vague-sounding phrases to try and influence the buyer that the materials are good quality, without making any mention of the materials themselves. Phrases like “Expertly crafted from premium materials”. Others will mention the materials but they never go into detail about the materials are processed or treated. Simply saying “leather” gives no indication to the reader what type of leather it is. The fact that car seats on the market do not boast the specific materials they are made from, indicates that the materials are not particularly special or unique such that it could be a selling feature. Some of the materials found were synthetic leathers, PVC, polyester fibres and upholstery foam. A new material that is becoming more and more common place especially in the fashion industry is vegan leather. Leather that does not come from cows but rather other innovative and sustainable sources like pineapple leaves, cork, and apple peels. Incorporating this material into the automotive industry would provide an eco friendly way to reduce the number of harsh chemicals used to create synthetic leathers, and it would also be a more sustainable way to obtain real leather. Rather killing animals for their leather, we can gather it from other organic sources.

The various parts of car and truck seats are often manufactured separately then shipped to an assembly plant. The frame of the seat is made of steel, and is manufactured using many different methods including stamping, folding and casting. The upholstery is often injection molded. This is done to achieve a perfected ergonomic shape. The fabric and/or leather used is sewn by machine. Once these pieces are manufactured, they are sent to the assembly plant to be put together. Some of these manufacturing methods are quite harmful to the environment because of the fossil fuel energy that powers the operations. The use of different materials may influence the method in which these seats are manufactured. In 2013 designer Eric Klarenbeek constructed a seat by 3D printing with mycelium. The 3D printer used was simply powered with electricity meaning it emitted no harsh chemicals into the atmosphere. As more renewable

and natural materials are employed, the methods in which we manufacture products will change as well.

2.2.3. Sustainability

In the materials and manufacturing section, it was highlighted that the materials of car seats were not the selling feature. Manufacturers are often using very conventional seating materials and manufacturing methods to create these seats, and are not considering the impact their seats have on the environment. The current push to go green has spawned many sustainable material innovations that are becoming more commonplace in the realm of product design and society at large. Being able to support the environment by purchasing eco-friendly products is more appealing to consumers now than in the past. And as the automotive industry is going green with EV technology, there is an opportunity to incorporate these new materials into vehicles. This will lower the carbon footprint of vehicles and make them more appealing for future consumers.

2.3. Summary

Currently there are many car and truck seats on the market that are designed for a wide range of purposes. There are some that are meant for style and racing and others that are more utilitarian and meant for longer road trips. Across the analyzed designs however, there is a clear function vs. form issue. The more utilitarian seats are rarely aesthetically pleasing are often quite bulky, while the less utilitarian seats have much nicer designs, often appearing more sculptural. None of the analyzed seats promote the materials as a selling point. All of them use generic materials that often use environmentally harmful processing methods to produce. And because of the lack of material innovations, the harmful manufacturing methods have remained the same over the years. This analysis has shown that there is an opportunity to innovate on current truck seat designs. Making a seat that is

simultaneously stylish and ergonomically friendly will mean consumers will not have to sacrifice one over the other. And achieving this while using renewable materials and eco friendly manufacturing methods will lower the carbon footprint of individual vehicle and make vehicles more appealing for the next generation of consumers.

CHAPTER 3 – ANALYSIS

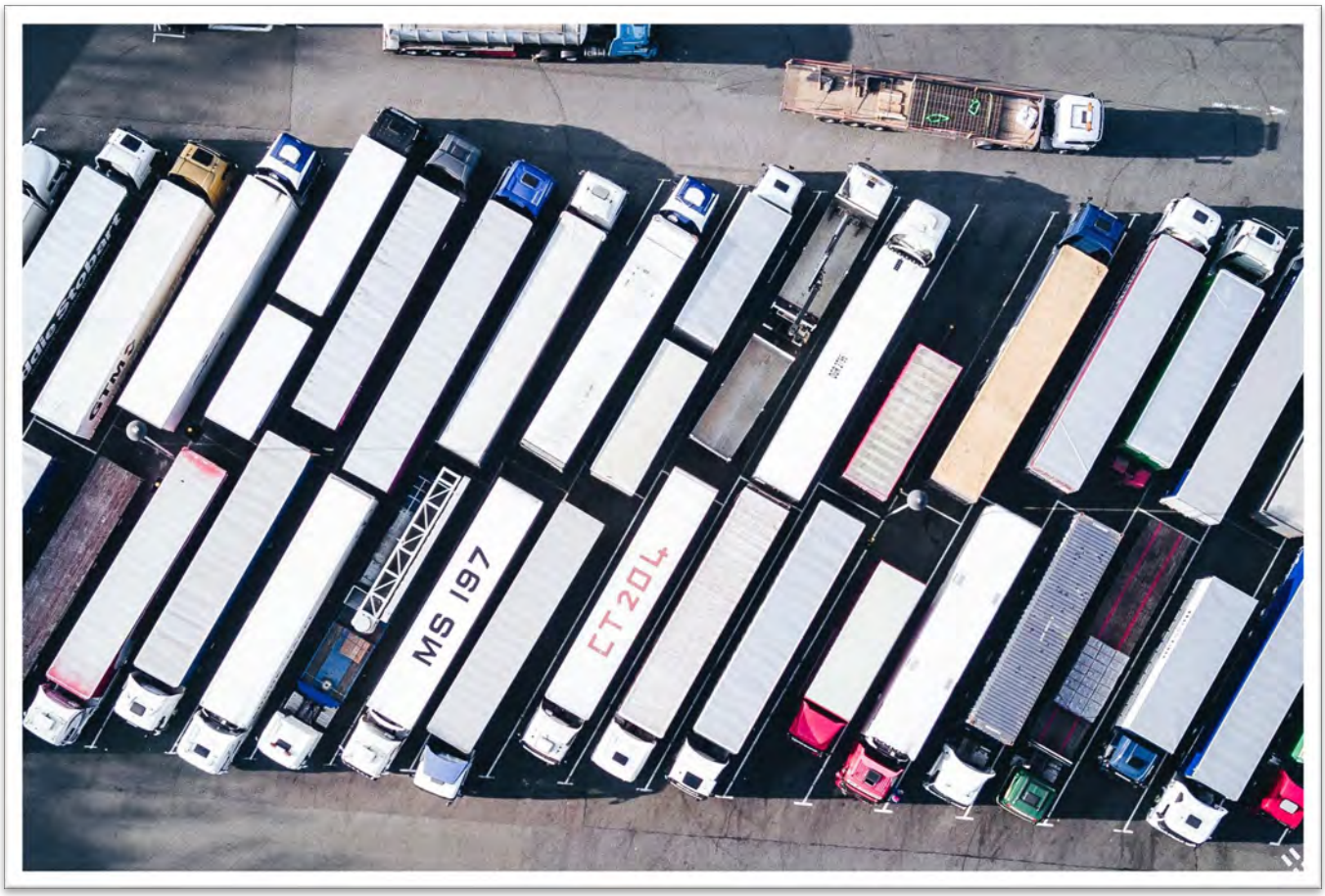


Figure 14 - Truck Parking - Retrieved from Unsplash

3.1. Analysis – Needs

The trucking industry is responsible for providing goods to businesses across the globe. The people that drive these large trucks and make shipments daily, provide an essential service to the economy. The trucking industry however faces low driver retention rates and high turnover rates, meaning drivers are getting hired a lot, but are also quitting a lot. Those poses a huge financial burden on trucking companies who must pay train new drivers. These turnover rates are often attributed to the work conditions involved with the job, like being on the road for days or weeks at a time; being away from family and friends; and the unhealthy lifestyle that is associated with trucking.

Long-haul drivers are prone to health risks that affect their job performance and mental health. Drivers need to be physically and mentally healthy to perform their jobs better, avoid chronic fatigue, and to improve general well-being. The need for a more livable sleeper truck is crucial for the trucking industry as well. Developing a solution that will meet mental and physical needs of truck drivers will encourage new drivers to continue working instead of quitting, because they will have the means of keeping themselves healthy without having to go out of their way to do so.

3.1.1. Needs/Benefits Not being Met by Current Products

Research was done on car seats to try and discover an area for ergonomic and aesthetic innovation. From an aesthetics standpoint, there was little to no car seats that were thin and sculptural. And in terms of ergonomic support, air ride seats are the best. The key features and benefits that were found in the benchmarking study were, respectively, support and design. This show us that there is a desire and an opportunity to create a aesthetically pleasing, thin seat that has adequate ergonomic support. As the scope of this thesis project has gotten broader, more research is to be done on related products to find more areas for innovation.

3.1.2. Latent Needs

Latent Needs	Benefits Statement
Comfort	Comfort allows the truck to be driven for allotted 11 hours per day easily, and to be slept in soundly with proper support.
Storage	Adequate storage for personal belongings, tools, and food provides convenience, cleanliness, and proper organization
Shelter	Environment gives a homey feel that is secure and protects from the elements and intruders.

Table 8 - Latent Needs

3.1.3. Categorization of Needs

Needs	**Benefits Statement**	Relationship With Benefit
Ease of Travel	Allows the driver to drive for extended periods of time with a low risk of musculoskeletal issues and other health problems	STRONG
Adequate Living Environment	Provides an environment that promotes a healthy lifestyle, and allows the driver to be more self sufficient	STRONG
Latent Needs	**Benefits Statement**	
Comfort	Comfort allows the truck to be driven for allotted 11 hours per day easily, and to be slept in soundly with proper support.	STRONG
Storage	Adequate storage for personal belongings, tools, and food provides convenience, cleanliness, and proper organization	STRONG
Shelter	Environment gives a homey feel that is secure and protects	STRONG

	from the elements and intruders.	
Food preparation	Allows the driver to eat healthily on the road with ease	STRONG
Exercise	Reduces the risk of health problems and will ensure the driver remains fit enough for the job.	MODERATE
Wants/Wishes	**Benefit Statement**	
Cost Effective	Affordable/Lower cost for repairs	MODERATE
Aesthetics	Stepping away from the utilitarian feel will make the truck feel more unique and homier	STRONG

Table 9 - Categorization of Needs

3.1.4. Needs Analysis Diagram

Desirability

Long haul drivers find satisfaction in maintaining their trucks and enjoy the freedom and travel aspects of the job. Making sleeper trucks more livable, and providing opportunities for a better trucking lifestyle, will make the job even more enjoyable for those currently working, and for new drivers entering the industry.

Viability

As transportation technology keeps developing, there has been a massive amount of innovation in the transportation and vehicle design industries. Applying these new technologies, in particular new EV technologies, to a sleeper truck is achievable. And doing that will open up many opportunities for innovation on the interior of the sleeper that will meet the unique needs of long-haul truck drivers.

Feasibility

The technology needed to meet the needs of long-haul drivers exists and can be implemented in the present day. Because of that, this concept has the potential to built rather quickly and start improving the lives of truck drivers.

3.2. Analysis – Usability

3.2.1. Activity – Workflow Mapping

The table below explains what the main activities of a long-haul truck driver are, what performing those activities is like based on scholarly research and user interviews, and ideas for potential improvement.

Activity 1	Steps / Process	Base Experience	Potential for Improvement
Plan Trip	Receive shipment job Determine best route via GPS/smart device Locate convenient truck stop	Non-strenuous Requires thought and careful consideration of efficiency Can be stressful when the driver is unfamiliar with the route	Improve onboard GPS and dash to avoid the need for external devices Create a trucker driver specific GPS system that informs the driver of the best route for semi trucks

Table 10 - Workflow Map Activity 1

Activity 2	Steps / Process	Base Experience	Potential for Improvement
Receive Shipment/Dropoff Shipment	Drive to pickup/drop off point Locate loading docks Back into dock Receive/ hand off load paper work	Locating docks can be frustrating (GPS takes you to the front door) Setting the truck up to be backed in properly can be challenging	Altered truck design to make truck easier to maneuver Autonomous driving system that backs in automatically (beacon system)

		Maneuvering large truck can be stressful Risk damaging truck and or other peoples property	

Table 11- Workflow Map Activity 2

Activity 3	Steps / Process	Base Experience	Potential for Improvement
Pre-trip Inspection (Day one and two)	Check truck systems Check fluids Check brakes Check tires	Generally non-strenuous Requires knowledge of truck operations and maintenance Can be satisfying Can become slightly strenuous when suffering from aches and pains	Provide easier means of checking the underside of the truck

Table 12- Workflow Map Activity 3

Activity 4	Steps / Process	Base Experience	Potential for Improvement
Drive (Day one and two)	Drive for ~11 hours per day Take mandatory 30 minute break	Generally easy Requires driver to be cognitively aware of who else is around and the condition of the truck Can become strenuous after long periods of time Health risks associated with repetitive motions and prolonged sitting	Improve seat ergonomics to be more supportive Provide different steering mechanism for better ergonomic handling

Table 13- Workflow Map Activity 4

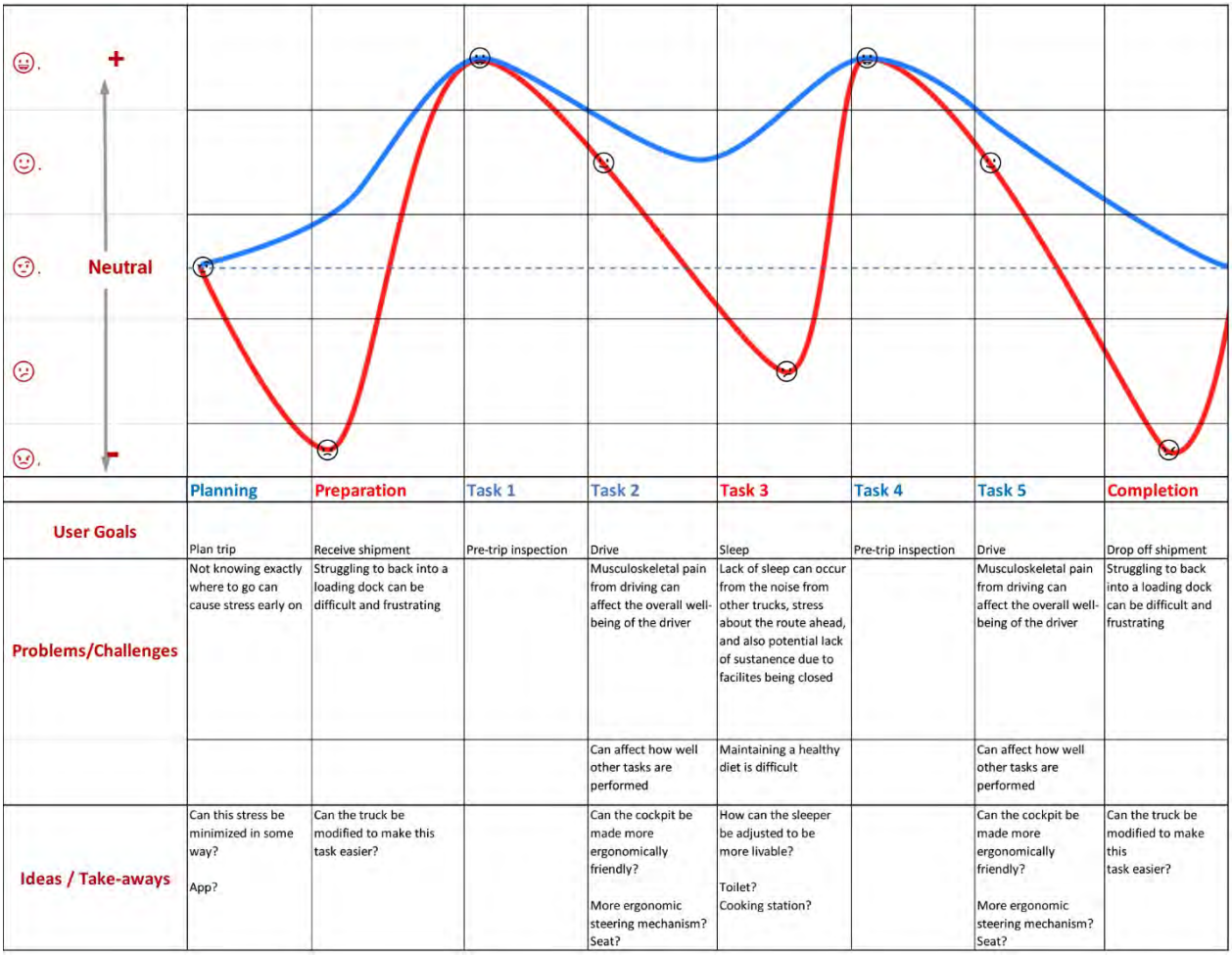
Activity 5	Steps / Process	Base Experience	
Rest at Truck/Rest Stop	Locate truck/rest stop Find parking spot Eat, wash up, do necessary paperwork, sleep	Somewhat relaxing Can use microwave to cook meals. Locating a parking spot can sometimes be stressful Truck stop facilities may not be open upon arrival. Noise from idling trucks can affect sleep	Provide the means for a healthy lifestyle on the truck, rather than driver being reliant on truck stop facilities Give truck an electric powertrain to eliminate idling engine noise

Table 14- Workflow Map Activity 5

The user/tool combination between the driver and their truck does not meet the needs of drivers efficiently. The activities themselves are not overly difficult, and thus can be completed, but the truck is not very well suited to accommodate the drivers' basic human needs. Drivers spend most of their time either at truck stops or on the road, in both cases the truck the truck can cause detrimental health effects on the driver. If the driver sits for too long without adequate ergonomic support, the driver may experience back and shoulder pain, and occasionally something more serious like thrombosis. And stopping at truck stops can prove to be quite difficult as well. If the truck stop facilities are closed upon arrival, the driver may have to go without a washroom break, shower and dinner that night. And because of the lack of adequate food storage and preparation space in sleeper trucks, it makes it difficult for drivers to remain healthy on their own without relying on truck stops. To make the user/tool combination more efficiently meet the needs of drivers, sleeper trucks must include the means and amenities needed for drivers to live healthily and mitigate risks of injury.

3.2.2. Activity – Experience Mapping

The figure below is an experience map based on a user observation study. In this study the driver described the experience of each of the main tasks of a long-haul truck driver, and provided detail on why things were fun or challenging. The drivers experience is represented by the red line, and the targeted user experience is represented by the blue line.



	Planning	Preparation	Task 1	Task 2	Task 3	Task 4	Task 5	Completion
User Goals	Plan trip	Receive shipment	Pre-trip inspection	Drive	Sleep	Pre-trip inspection	Drive	Drop off shipment
Problems/Challenges	Not knowing exactly where to go can cause stress early on	Struggling to back into a loading dock can be difficult and frustrating		Musculoskeletal pain from driving can affect the overall well-being of the driver	Lack of sleep can occur from the noise from other trucks, stress about the route ahead, and also potential lack of sustanence due to facilites being closed		Musculoskeletal pain from driving can affect the overall well-being of the driver	Struggling to back into a loading dock can be difficult and frustrating
				Can affect how well other tasks are performed	Maintaining a healthy diet is difficult		Can affect how well other tasks are performed	
Ideas / Take-aways	Can this stress be minimized in some way? App?	Can the truck be modified to make this task easier?		Can the cockpit be made more ergonomically friendly? More ergonomic steering mechanism? Seat?	How can the sleeper be adjusted to be more livable? Toilet? Cooking station?		Can the cockpit be made more ergonomically friendly? More ergonomic steering mechanism? Seat?	Can the truck be modified to make this task easier?

Figure 15 - Activity Experience Mapping

The activity experience map shows that the long-haul truck driving experience fluctuates quite drastically from activity to activity. The activity that makes the driver the happiest is the pre-trip inspection. During this task the driver is actively moving around the truck checking the various truck systems to ensure the truck is safe to be driven. This task is the most stimulating task on the job. The driver is on their feet, actively moving around and inspecting the truck, determining if everything is in order and

making an informed decision on if the truck is safe to drive or not. There is a lot of physical and mental activity involved with this task and the driver is in control the entire time. Backing into a loading dock is the most frustrating part of the job. The task requires complex driving maneuvers which are difficult in their own, but often times the loading docks are in awkward and/or tight positions. There is a high risk of damaging the truck and someone else's property whilst performing this task, meaning that the driver often feels stressed while backing in. A drivers day often starts with the pre-trip inspection, meaning that there is a steady decline in positive experiences as the day goes on. The projected target user experience vastly reduces that decline, and illustrates a more positive long-haul truck driving experience. A solution will be designed that helps improve the long-haul truck driving experience and reach the target goal.

3.3. Human Factors

3.3.1. Introduction

Long-haul truck drivers are required to drive approximately 11 hours per day when. The prolonged time spent sitting and performing repetitive and monotonous movements can often cause musculoskeletal health issues. General aches and pains are often reported from long periods of driving, often in the neck, shoulders and arms, and lower back. And in more serious cases, prolonged sitting can lead to deadly health conditions like thrombosis. To mitigate these health problems, a thorough ergonomic study is necessary to determine the proper sizing, arrangements and orientations of the features of the cockpit. If done successfully, the final solution will significantly lower, or even eliminate, the musculoskeletal health risks associated with prolong driving.

3.3.2. Literature Review

Various scholarly articles, reports and literature were reviewed before conducting the ergonomic study. These sources provided information about specific human measurements, ergonomics relating people to products, and delve into more specific studies regarding human centred

design and full-body interaction design. The more specific studies spoke about the idea of using bodily movement as a medium to create more meaningful user experiences. Rather than using movement as a means to use a product, how can the movement itself lend to the product experience? The social and environmental aspects of product use were studied as well, the idea that using products can connect us to other people and the physical environments around us. The topics discussed in these resources were considered when performing this ergonomic study.

3.3.3. Methodology

It was decided that for this thesis study that a 1:1 scale model of the dashboard and drivers' seat would be the best way to analyze ergonomics. This is because most of the musculoskeletal issues related to the job, are caused from the motions (or lack of motions) of driving for long periods of time. The model will be built out of cardboard, taking into consideration accurate dimensions. Once built, photos will be taken of someone interacting with the model to demonstrate how specific features work, and show how the body moves to interact with those features.

3.3.4. Results

The results of the ergonomic study are displayed below in the form ergonomic diagrams. The diagrams are elevation few illustrations that depict key the key dimensions of the most important features. The diagrams also include scale human figures of the 99th percentile male and 5th percentile woman, this is to show how people of different sizes interact with the features of the truck.

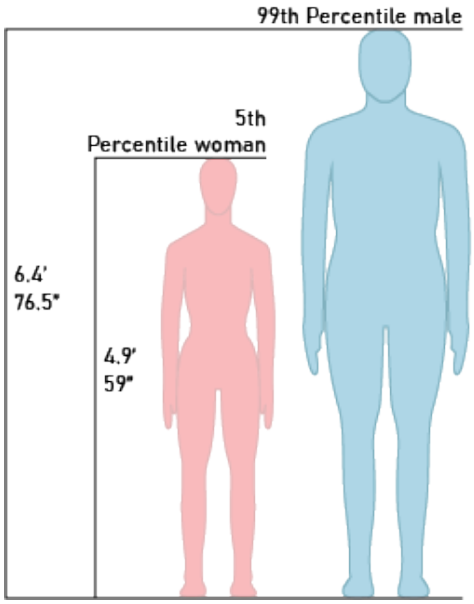


Figure 16 - Percentile Person Diagram

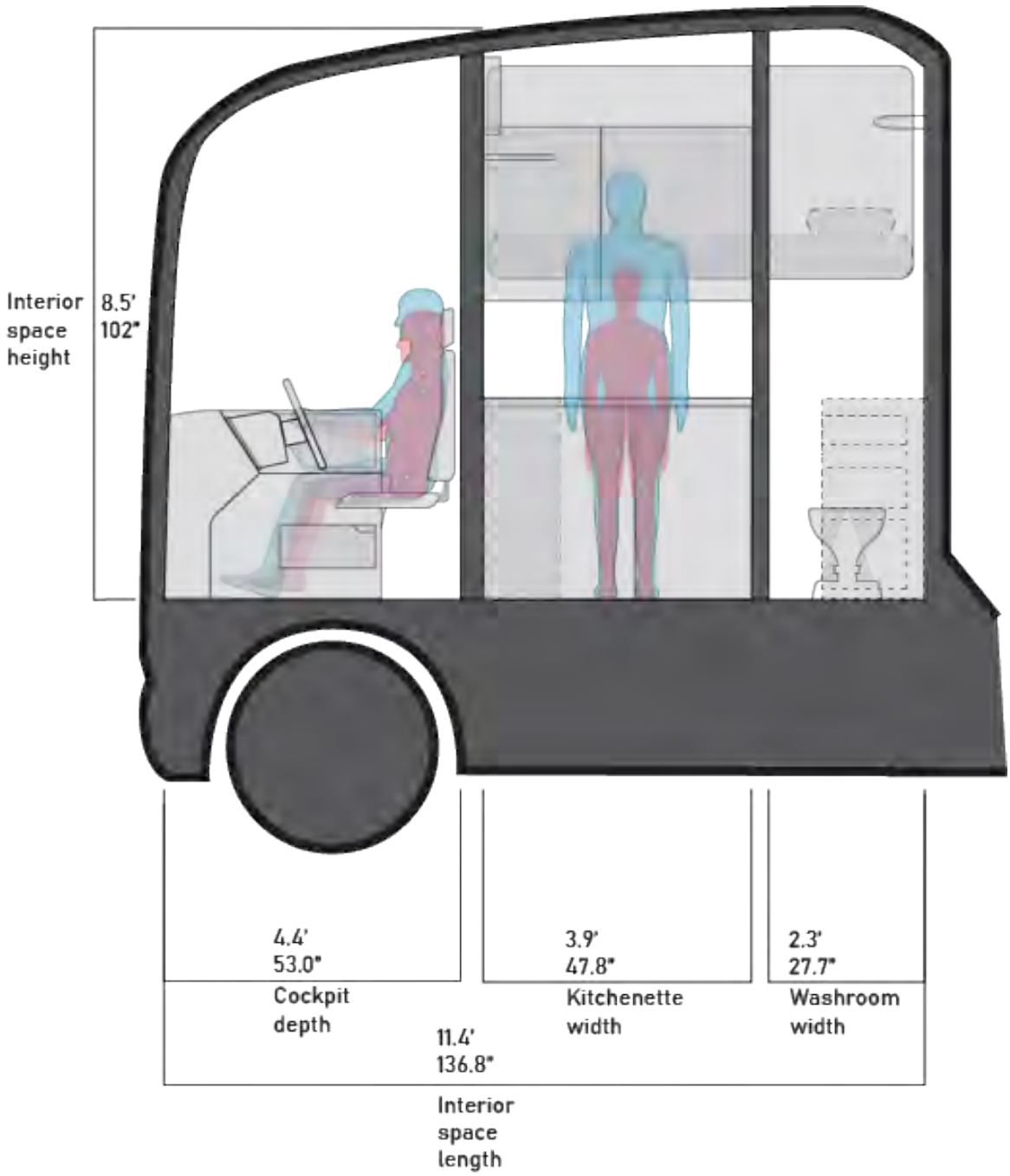


Figure 17 - Side View of Cabin

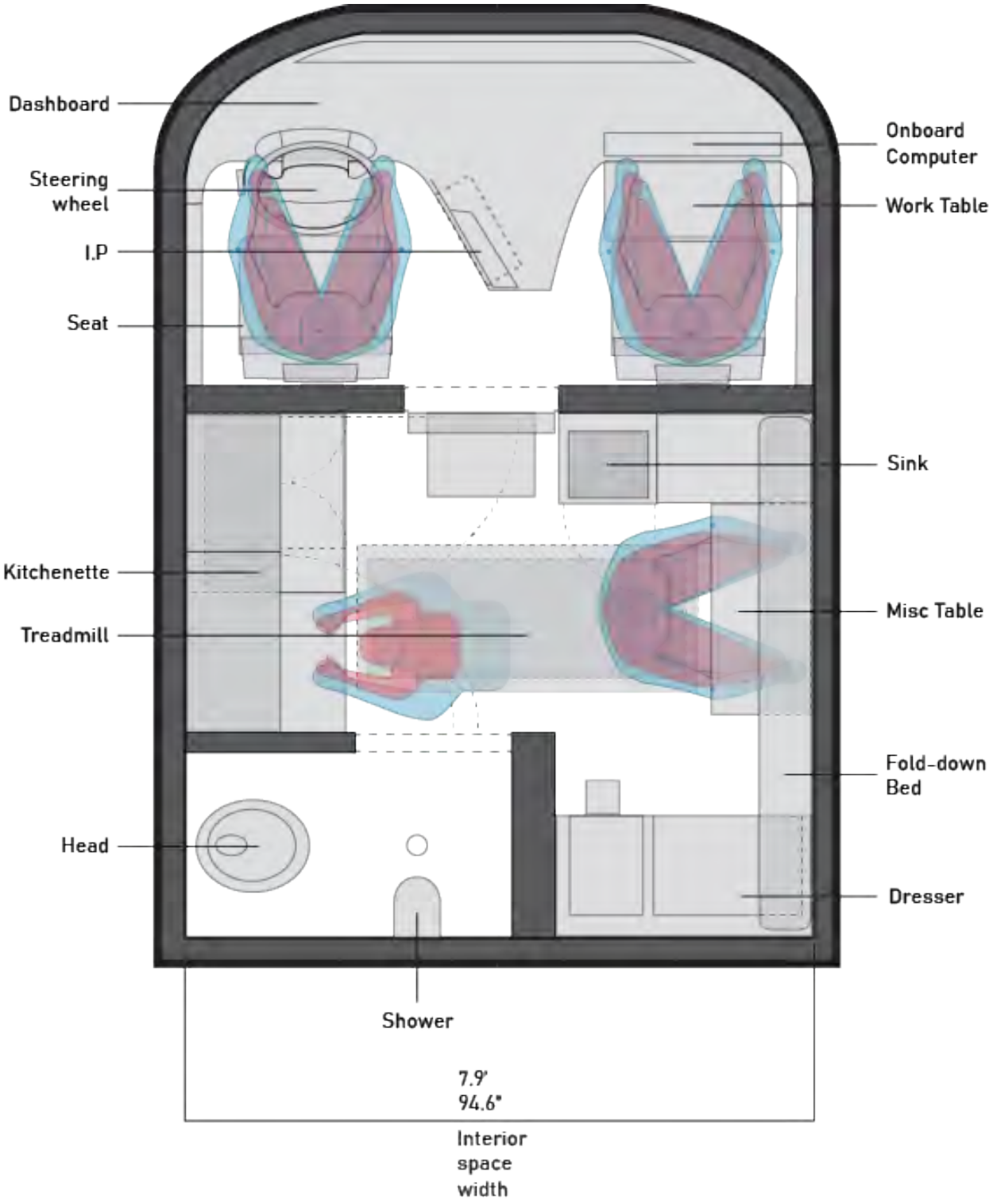


Figure 18 - Top View of Cabin

The side view and top view drawings show the overall layout of the vehicle. Every dimension is critical when trying to combine a living and working space into a very confined space. The overall size of the truck was decided upon because it represents a truck that is only slightly above average in size. Today, if someone wanted all these features in a semi truck, they would have to get a custom truck built. Custom trucks are often much longer than normal standard semi trucks, which can cause problems with maneuverability and parking. Fitting all the features shown into a standard size truck will provide the driver the benefits of a custom truck with the convenience of a standard truck. The dimensions of each interior room and feature were determined based on the ergonomics of the 99th percentile male and the 5th percentile female, as well as the minimum sizes needed to make the features easily usable.

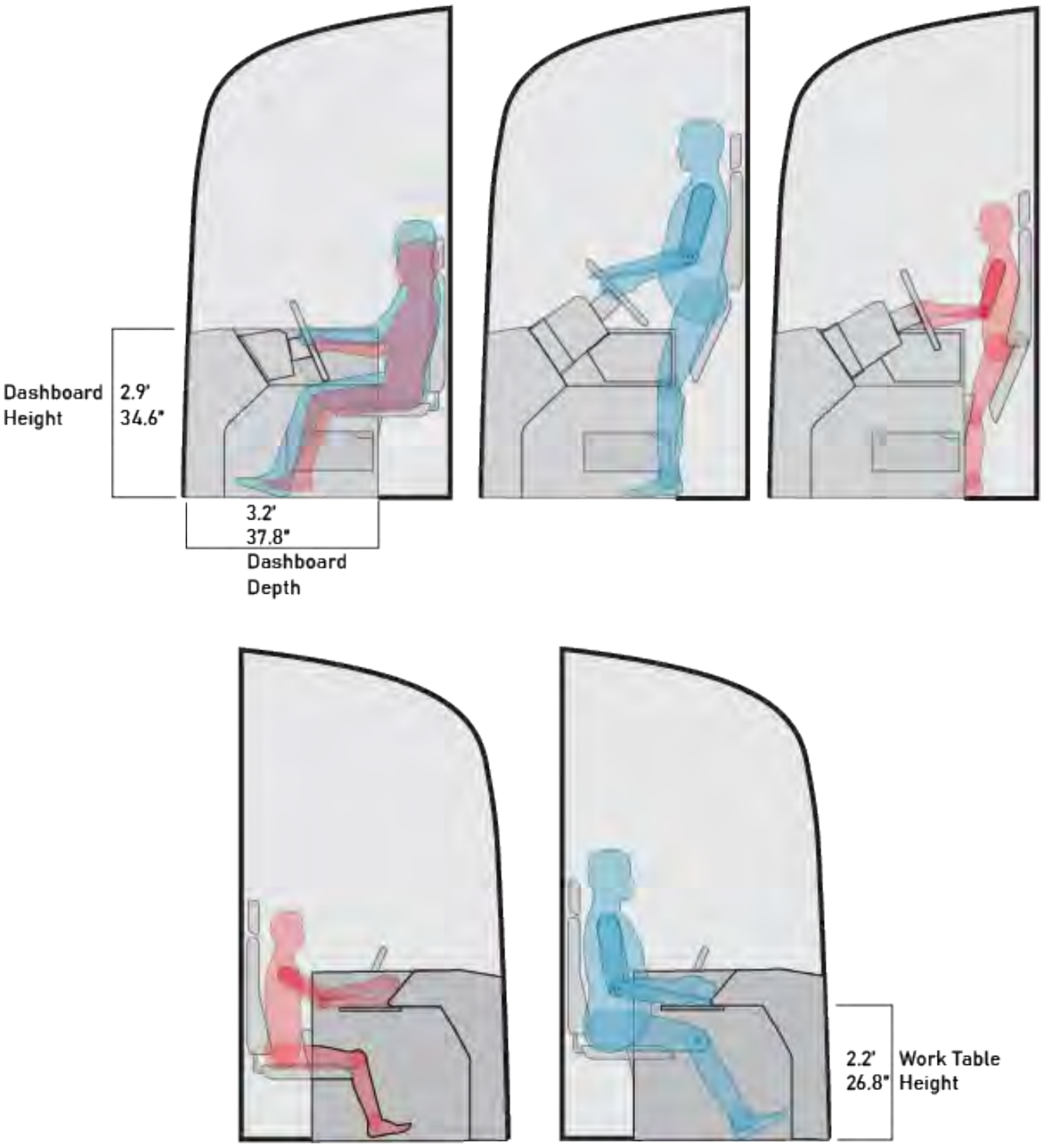


Figure 19 - Drivers Seat and Work Station Diagrams

The dashboard diagrams illustrate how the drivers seat, steering column and workstation would work. The steering column and steering wheel will be adjustable in several different ways to ensure

that wheel can be easily reached from any sitting or standing position, by anyone of any size. Refinement will need to be done on the steering column to determine how the tilting and telescoping mechanisms would work. The workstation includes a pullout table and onboard computer designed for filling out paperwork and planning routes. The most critical dimensions for the workstation are the height of the table as well as the length of the table. Finding the most suitable dimensions will ensure comfort for the 99th percentile male and 5th percentile female.

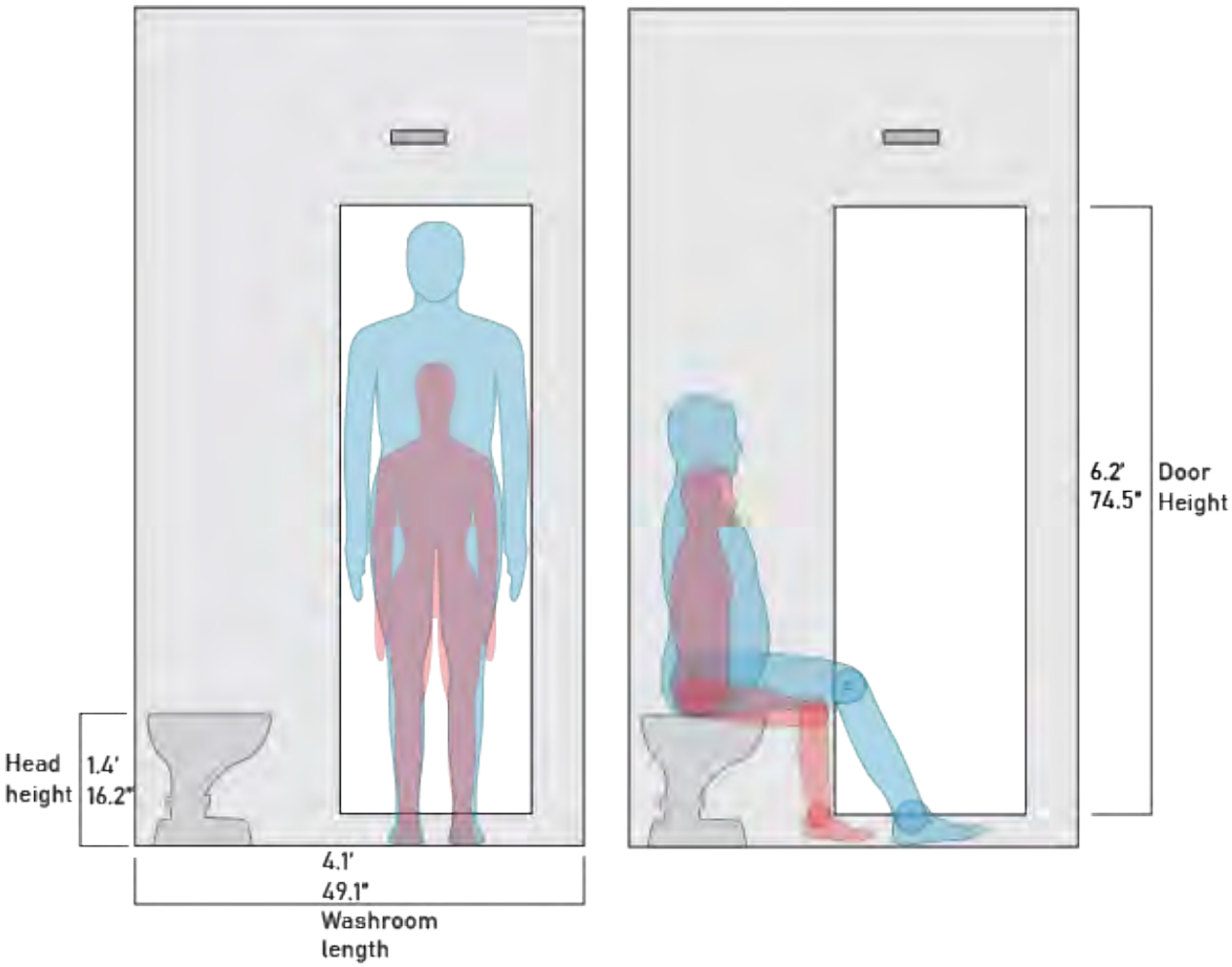


Figure 20 - Washroom Diagram

The washroom diagram illustrates the size of the washroom in relation to the 99th percentile male, 5th percentile female, the door, head, and shower head. Because of the limited space available on the truck, the washroom has been organized as a two-in-one washroom, meaning a toilet and shower in the same space. The dimensions of the room were determined mostly by examining the 95th percentile male and using his dimensions to determine the smallest possible area while still being functional. The washroom does not include a sink, as there is already a sink in the main living space. This decision will ultimately leave more space in the shower and save on costs.

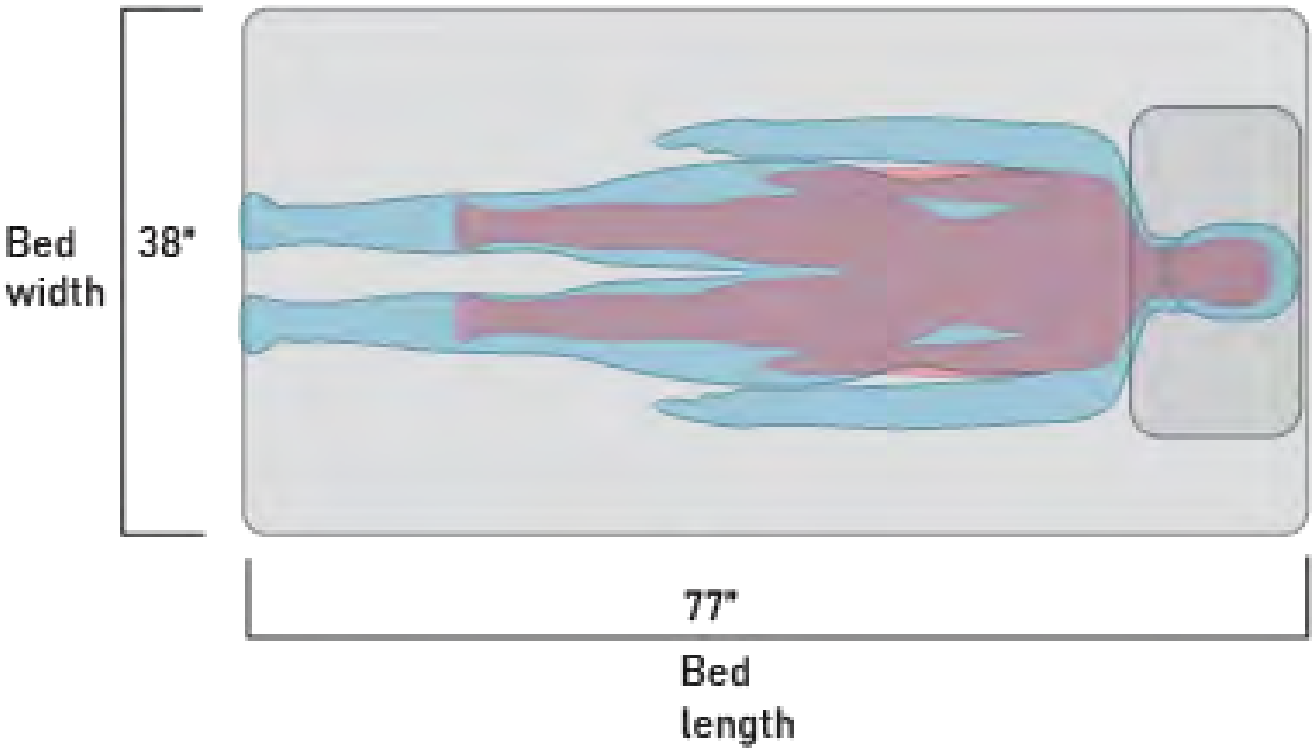


Figure 21 - Bed Diagram

The bed size was determined by looking at current sleeper trucks. Sleeper trucks are often equipped with twin size beds. This is appropriate to keep for the new design because of the limited space. And there were no drivers found that complained about bed size when conducting user research and interviews.

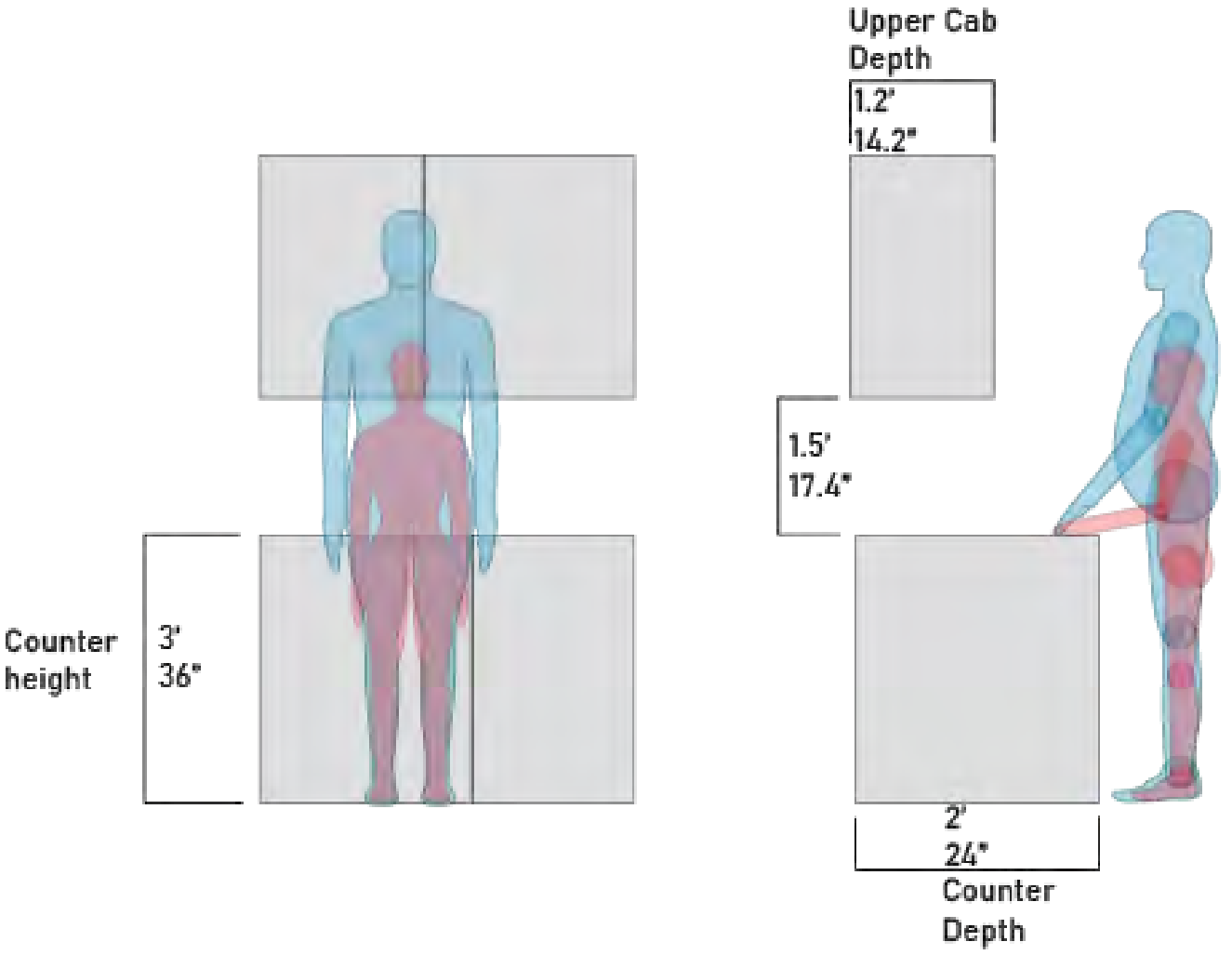


Figure 22 - Kitchenette Diagram

The kitchenette diagram shows the size of the lower and upper cabinets compared to the 99th percentile male and the 5th percentile female. The sizing of the cabinets was determined by looking at standard kitchen counter sizes in houses. Using household kitchen dimensions ensures that the cooking space is usable and will provide an adequate cooking experience. The width of the kitchenette was centered around the size of an average bar fridge. Once an adequate bar fridge size was determined, the amount of extra storage space for pots, cooking utensils and dry food was considered while keeping

track of how much countertop space these sizes would allow. Consideration needs to be put into how the 5th percentile woman can reach the upper cabinets easier.

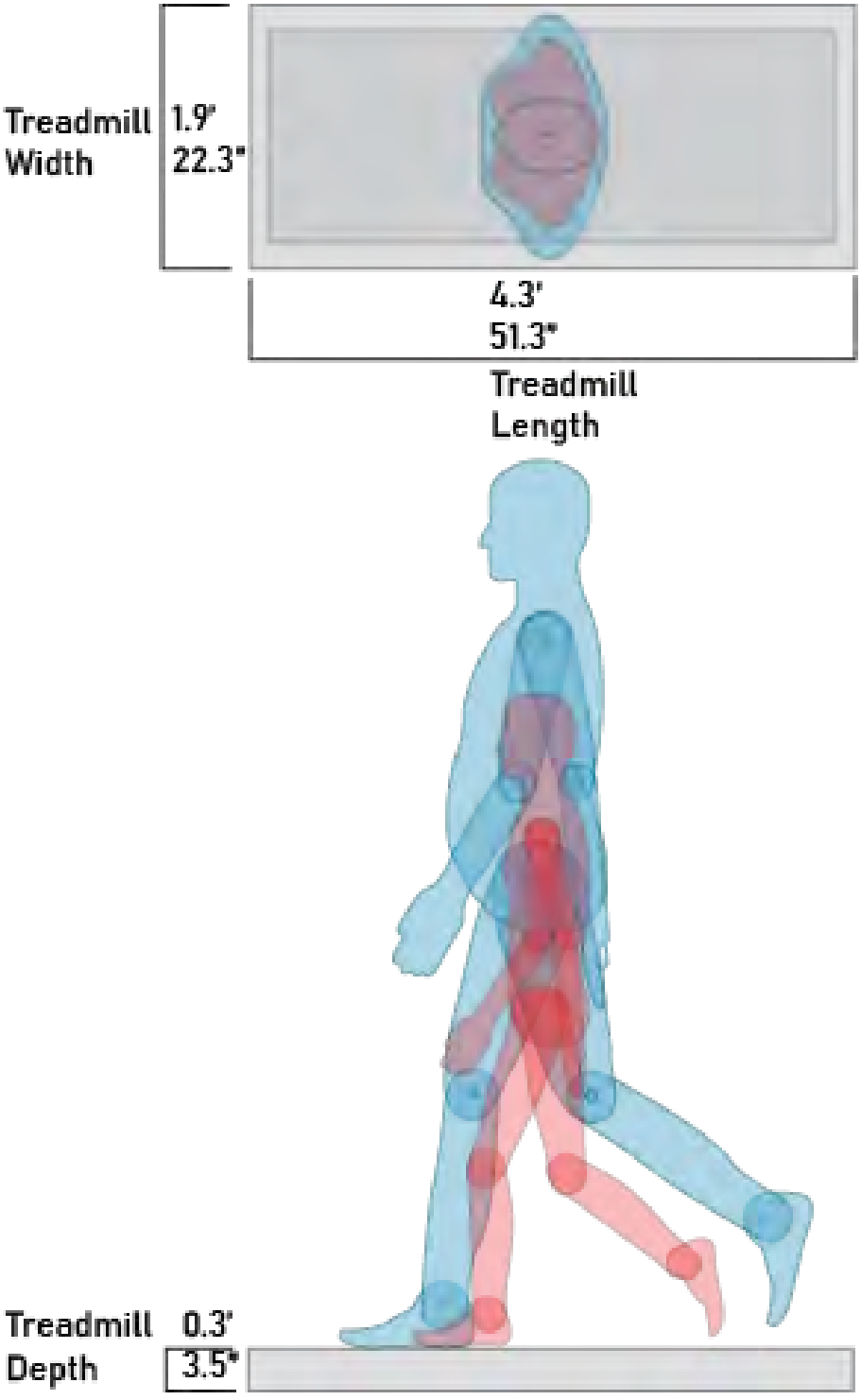


Figure 23 - Treadmill Diagram

The treadmill diagram shows the 99th percentile man and the 5th percentile woman using the treadmill that's hidden in the floor of the main living space. The size of the treadmill was determined solely on the smallest treadmill that is currently available to buy. This was done because of the limited space the truck allows.

3.3.5. 1:1 Physical Model

Below are images of the 1:1 scale mock-up with an 85th percentile male interacting with it. Paired with each photo is a short description and some takeaways to note for when producing the final design.

Figure 24 - 1:1 Model Photo 1

Photo of 85th percentile male interacting with the steering wheel as if he was driving.

The position of the feet and legs will be noted as there are no pedals. The legs aren't stretch forward like they normally are.

Figure 25 - 1:1 Model Photo 2

85th Percentile male using the steering wheel in the standing orientation.

Note the position of the steering wheel. It has been raised up slightly and angled upward from the sitting position, but its still not in an ideal ergonomic position. A design solution will need to be thought of to make sure the steering wheel can be extended closer to the driver.

Figure 26 - 1:1 Model Photo 3

85th Percentile male using the instrument panel while driving.

The lateral angle and distance the I.P is away from the driver is critical, and these dimensions will need to be solved. This will determine how far the driver has to look away from the road to use the I.P.

Figure 27 - 1:1 Model Photo 4

85th Percentile Male using the hand controls with his left hand.

How close the hand controls are to the steering wheel and the dashboard will need to be considered. It will need to be close enough to the steering wheel to grab easily, and far enough away from the dashboard so when the driver brakes, his/her hand will not touch the dashboard.

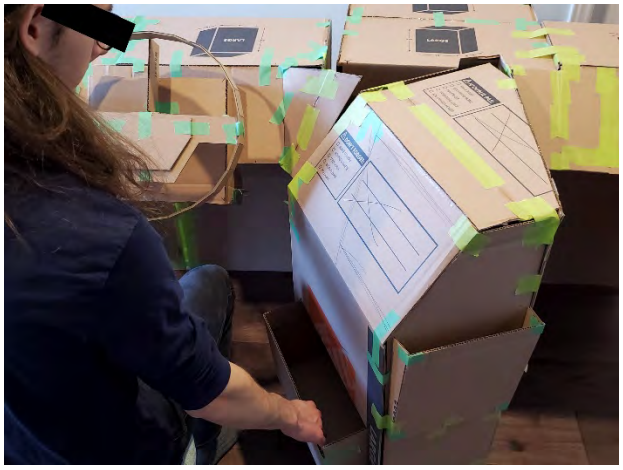


Figure 28 - 1:1 Model Photo 5

85th Percentile male using the drawer next to the driver seat.

More smaller storage solutions should be considered along side the drawer. The drawer can not be accessed safely while driving. So if the driver needs to grab something essential, he/she should not have to look away from the road to do so.

Figure 29 - 1:1 Model Photo 6

85th Percentile male grabbing paperwork from paper holder from drivers seat.

Paperwork will likely not need to be accessed while the truck is moving. The current position of the paper holder seems comfortable and easy to access.

Figure 30 - 1:1 Model Photo 7

85th Percentile male using the work station on the passengers side.

The size of the table will have to be considered further, and also if more paper storage is necessary.

3.3.6. 1:1 Model Analysis

Long-haul truck drivers are essential for delivering goods to consumers everywhere. Today however, the physical and mental needs to of truck drivers are not being met by the trucking industry, causing a low retention rate. Meeting drivers' physical needs through ergonomic support will promote a healthier lifestyle on the road, and will in turn help the drivers mental health.

Since the nature of long-haul trucking requires a lot of driving, ergonomic innovations were sought after to provide a unique, comfortable driving experience that mitigated the health risks associated with prolonged sitting. The most notable feature shown in the 1:1 model is the standing seat. This feature is a direct, ergonomic solution to prolonged sitting. Being able to drive while standing will promote healthier habits, lower the risk of back and neck pain from slouching, and even prevent more serious health conditions like thrombosis. The 1:1 model has shown that careful consideration to how the seat is shaped, and the steering column mechanism are both critical in making this idea feasible. Further work will be done to develop a design solution that allows this idea to work easily and safely.

Another feature necessary to make the standing seat possible is hand controls. Since the driver's legs and feet will shift positions when transitioning from sitting to standing, pedals cannot be used. A single lever was built into the dash of the 1:1 model just to the left of the steering wheel. It was positioned close to the steering wheel that way the driver can simultaneously hold the lever with his/her fingers and use their thumb to help keep the steering wheel steady. Hand sizes will be critical in determining the appropriate size for the lever, and well as its position in relation to the steering wheel and dashboard.

Semi trucks are much more complicated machines than normal cars. They have a lot of very specific controls and features that can be activated from the instrument panel. Current instrument panels use primarily physical switches, buttons, and dials as a means for activating these features. A new I.P was constructed in the 1:1 model that consists of one angled touch screen. The touch screen will provide a clear display that will make it easy to locate specific controls and features. The angles on both the vertical and horizontal axis will ensure that the driver can easily access the instrument panel without needing to turn their heads away from the road. The angles will also ensure that the I.P can be used from the sitting and standing positions.

Long-haul drivers spend most of their time driving, sitting at the drivers' seat. When driving on the job for extended periods of time, it is important for the driver to have everything he/she will need for the trip ahead. This often includes shipment documentation, logbooks, identification, as well as essentials like food and water. All of these things need to be easily accessible from the driver's seat, thus storage solutions for these items that are situated close to the drivers seat is a necessity. The 1:1 model shows how these storage solutions could be implemented. Moving the glove box from the passenger's side to beneath the instrument panel will make storing identification and truck documents easier and much more convenient. The 1:1 also shows a potential spot for a paperwork holder that can

be easily reached from the driver's seat. Further thought into storage solutions will need to be done to accommodate items like food and water.

With more space free on the passengers side, the passengers side of the dashboard has been converted into a work station. An area appropriate for handling paperwork and planning routes. The ability to do paperwork at the dashboard means that all the essential tasks of the long-haul truck driver can be done outside of the living area of the cabin. This will assist in improving the mental health of drivers because in their living space will not longer be correlated with work in their heads, even though they are still on the truck, making the living area a much more relaxing space. Since the dashboard is asymmetrical, the passengers side is tighter than the drivers side, and this was demonstrated in the 1:1 model. Careful consideration to the table size and computer size will need to be considered to attain the most ergonomic comfort and also maximize the effectiveness of the space. More storage solutions will need to be considered to accommodate for writing utensils and other documents.

3.3.7. Limitations and Conclusion

This study has shown what critical dimensions need to be determined to provide the best ergonomic experience for long-haul truck drivers.

- The mechanism and sizing of the extendable steering column needs to be resolved so the steering wheel can be positioned closer to the driver.
- How the hand controls are attached the dashboard and the position of the hand controls needs to be determined for the most comfort.
- More storage solutions closer to the driver need to be designed so the driver can keep his eyes on the road while grabbing essential items.
- Workstation table sizing and storage solutions need to be determined to optimize organization and workflow.

3.4. Aesthetics and Semantic Profile

Taking into consideration the main demographics using the vehicle, and the nature of the job itself, the final concept will have a slightly geometric, utilitarian feel. The exterior design will emphasize clean surfaces, and will primarily rely on usable features of the vehicle for details and accents. Appropriate accent lines will be used to give off a feeling of strength and sturdiness. Overly organic lines and shapes and garish colours will not be used in on the vehicle. The truck will largely make use of monochromatic tones, and use small but bold hits of colour that will give the truck an exciting and dynamic feel.

The interior of the vehicle will match the utilitarian feel of the exterior. Less organic surfaces will be used on the interior to prevent the features from being obtrusive, and there will be a stronger use of subtle detailing to add interest to the living space. All the interior features of the living area and the cockpit will be cohesive in nature, similar levels of detail, and similar use of the colour. The interior will match the exterior with its of small amounts of bold colours.

3.4.1. Inspiration board

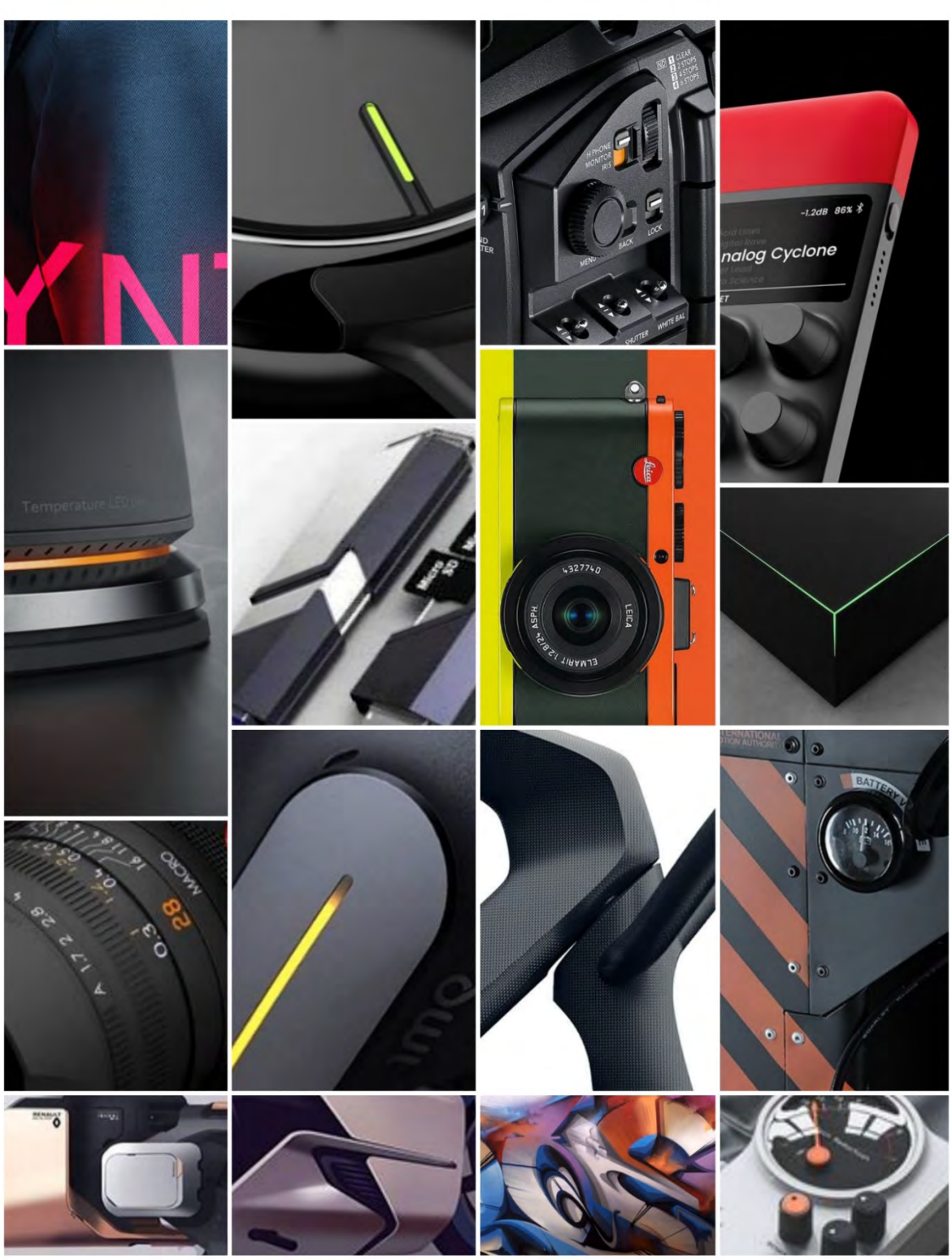


Figure 31 - Inspiration Board

3.5. Sustainability

3.5.1. Introduction

The trucking industry is critical for keeping essential businesses running. The trucking industry however has seen little innovation and is often criticized for the environmental impact of the trucks. “They are responsible for the 17% of the total fuel used by highway vehicles in the United States” (Depcik 2019). There is a slow shift happening from diesel to electric within the industry which if continued would make a significant difference, but the forms of these trucks remain largely the same. The electric trucks being released are not taking advantage of EV technology to change the for of the vehicle. This means that the interiors will still cause the drivers to suffer from the same health problems as they have been. Likewise, the materials have remained the same as well, mostly consisting of petroleum-based plastics and man-made, artificial leathers. The material processing procedures are also cause for excess carbon emissions in the atmosphere. Research on EV transportation technologies, as well as research on unique, eco-friendly materials was conducted to find design solutions that will meet the needs of drivers while also lowering the carbon footprint of the enhanced sleeper truck.

3.5.2. Literature Review

To gain a better understanding of current sleeper trucks, online research was conducted on how they are assembled, what materials they are made from and the environmental impacts they have. Additional research was done on renewable materials like pinetax leather, bamboo and mycelium to understand why they are considered sustainable, as well as their mechanical properties to gain insight on how they could be used and applied to the design.

3.5.3. Materials and Manufacturing

3.5.3.1. Materials

Little innovation has happened with regards to the materials of new truck interiors. Interiors currently consist largely of ABS or polypropylene plastics, placed on an aluminium frame, sometimes with artificial leather accents, and polyester hybrid textiles for the seats. None of these materials are considered sustainable and they often lead to a very cold, utilitarian feel.

Based on the conducted research, no specific alternatives to these materials are being analyzed for car interior use. There are however many renewable material options that could lend to a warmer, homey interior while also lowering the trucks general carbon footprint. Mycelium is a material that comes from fungi, and tests show that it can be easily modified to obtain mechanical properties useful for diverse design and architectural purposes (Noam, 2019). Using mycelium for the dashboard would eliminate a large amount of petroleum based plastics used on the interior. Mycelium also has insulating properties, meaning it could replace polymers as wall insulation for the truck. Mycelium is naturally more resistant to fire than typical wall insulation, which can protect the driver in the case of a fire. To provide a warmer feeling interior, bamboo could be utilized as a natural alternative to plastics as well. Bamboo is easily grown, strong, and it can self-regenerate from its own roots (Hymann, 2020). As society is switching to an eco-friendly way of living, vegan alternatives to leather are also being sought after. Pinatex leather is produced using only pineapple leaves. Using this for the seats would make the seats much easier to maintain and provide a more luxurious feel to the interior.

The use of these new materials will lend to a comforting, on-the-road living experience that is unlike any truck available. These renewable materials will also lower the trucks overall carbon footprint and mitigate a lot of harsh material refinement processes.

3.5.3.2. Manufacturing

The excess use of petroleum based plastics in truck interiors means that harmful material refinement processes are being used to to create the features of the interior. Fossil fuels are often used as a means of powering the manufacturing process due to the high levels of energy required to run the plastic refinement process. If large pieces of the interior can be replaced with mycelium, then the amount of plastic forming required for the vehicle can be mitigated. Mycelium can be grown in many different climates, making it plentiful. This leaves an opportunity for mycelium to be sourced locally, close to the manufacturer. This would largely eliminate some of the harmful processes of transporting goods across large distances. When mycelium is prepared correctly, it has the ability to be 3D printed, which can be fueled by electricity rather than fossil fuels. In 2013 Eric Klarenbeek proved this by 3D printing mycelium and bioplastic to create a functional chair that was completely made of sustainable materials (Fairs, 2013). Relying on more renewable materials such as mycelium, bamboo and vegan leathers, will be less damaging to the environment, and it will allow our limited minerals of the earth to be used for other purposes.

3.5.4. Sustainability

3.5.4.1. Benchmark Sustainable Initiatives

The trucking industry has been taking sustainable initiatives to mitigate the impact of its trucks on the environment, most noticeably in its effort to manufacture more electric trucks. If all diesel trucks were swapped with electric trucks, this would significantly improve the carbon emissions produced by these vehicles. Although the trucking industry has not addressed the impacts the materials have on the environment. Current trucks are largely still being made of the same metals and plastics that they have been, materials that end burning fossil fuels whilst being processed.

3.5.4.2. Health

The heavy use of diesel vehicles poses a potential threat to the health of drivers. Long-haul drivers spend most of their time living and working in and around sleeper trucks, which can expose them to excess diesel exhaust that can harm their lungs. “Diesel exhaust exposure induces inflammation, oxidative stress, and tissue damage… DE exposure is linked to both carcinogenic and non-carcinogenic multi-system effects.” (Reis, 2018). Eliminating the use of diesel fuel will eliminate these health risks and thus keep drivers healthier.

3.5.4.3 – Safety

The use of new power sources and unique materials means that trucks could potentially be made safer for the driver. Diesel fuel is flammable, and thus can be an extremely dangerous substance to be near in the event of an accident. Switching to an EV powertrain will mean the truck is carrying less hazardous liquids. Mycelium has natural flame-resistant properties, meaning in the event of an accident, this material will be less likely to catch fire, potentially protecting the driver from burns.

3.5.5. Sustainability Statement for Final Design

The use of electric power and renewable materials will lower the carbon footprint of the truck and provide a safer and more comfortable experience.

3.5.6. Conclusion

By switching to electric trucks, some steps are being made by the trucking industry to make trucks more sustainable. However, the industry has not acknowledged how the materials they are using are harming the environment, as well as the health and safety of the drivers. The final design will incorporate an EV powertrain to eliminate carbon emissions and provide an opportunity to expand the interior space. The interior of the vehicle will make use of innovative, renewable materials that will

mitigate the use of harmful plastics, and provide a homey and natural feeling to the interior that will be enjoyable to live and work in.

3.6. Feasibility and Viability

This section analyzes the commercial viability of the proposed enhanced sleeper semi-truck from material, manufacturing, and financial perspectives.

3.6.1. Materials and Manufacturing Selection

The general construction of the enhanced sleeper semi-truck will most likely keep a similar form to existing sleeper trucks. This will mean the truck can be used easily with current trucking infrastructure. This also means the manufacturing methods of the exterior will remain largely similar the current semi-truck manufacturing methods, allowing the truck to be easily mass produced with current manufacturing plants in place. The interior of the truck will make use of simple and elegant furniture to ensure ease of use and also ease of manufacturing. Having minimalist furniture means that it can be manufactured, easily, quickly and cost effectively.

3.6.2. Cost

Since the enhanced sleeper semi-truck will keep a largely similar form to existing sleeper trucks, a rough estimate of cost was conducted based on information on current sleeper trucks and material knowledge. The enhanced sleeper will make use of some innovative materials and implement them in unique ways. Those aspects of the design are more difficult to estimate a cost for. The rough estimate came out to $130,900.

Component	**Cost**
Chassis	$30,000
Body Paneling	$20,000

Electric Motors	$8,000
Battery	$15,000
Wheels	$8,400
Dashboard	$8,000
OLED Displays	$2,500
Seats	$500
Interior Walls	$10,000
Interior Flooring	$1,000
Furniture	$2000
TOTAL	**$130,900**

Table 15 - Component Cost Estimate

3.7. Design Brief

Ergonomic Support	Providing proper ergonomic support in the cockpit of the truck will minimize the risk of aches and pains and other more severe musculoskeletal issues, this in turn will help job performance overall mental health
Safety	The sleeper environment will be a secure space that the drivers will feel comfortable living in while on the road, it will protect them from other people as well the elements.
Productivity	A space designed for handling paperwork and researching routes will eliminate the need for external devices and assist in keeping the work and living sections of the truck as separate as possible. This will help the drivers mental health.

Aesthetics	Unique aesthetics will be used to give the truck an exciting and homey feel.
Implementation of new technologies	This truck will make use of new technologies to make working and living easy and convenient
Sustainability	EV technology will be used in this truck. This will eliminate the problem of idling overnight, because no diesel fumes will be emitted, which will help the environment and prevent exposure to harsh fumes
Healthy active living support	The proper amenities for a healthy active lifestyle will included to reduce the risk of health issues related to poor diets and lack of exercise. This will also improve the drivers overall mental well-being.
Comfort	The living area will provide a homey feel that the driver will feel comfortable living in, features will be put in place to eliminate noise coming from idling trucks while the driver sleeps, this will make getting proper rest easier and reduce fatigue
Storage Solutions	Adequate storage solutions will be implemented to accommodate for personal belongings, tools, and food to provide proper organization and cleanliness to the living area, a clean working environment will help the drivers well-being.
Self sufficiency	Features will be put in place that allow the driver to become more self sufficient and less reliant on truck stops. This will reduce stress when it comes to finding a truck stop arriving at a truck stop late when facilities may be closed.

Table 16 - Design Brief

CHAPTER 4 – DESIGN DEVELOPMENT

Figure 32 - Design Teaser Image

All the research and analysis conducted on long-haul trucking was used to create an innovative design solution that would improve the long-haul truck driving experience. The design development phase required the implementation of loose brainstorming sketches, as well as more developed concept sketches to assist in understanding the form and functions of the design solution. Gaining an understanding of the overall form is needed before CAD work can begin.

4.1. Idea Generation

4.1.1. Aesthetics Approach

At this point in the aesthetic approach, the style of the vehicle was to be bold and slick. It would make heavy use of darker materials with bright and vivid coloured accents. This would be an exciting new look for the otherwise industrial looking semi-trucks of today. It would make use of a relatively simple form factor and go for a “beauty in the details” approach. Where the colour accents would be placed as well as the locations of the parting lines and exterior features would lend to beauty of the exterior. It was important to ensure that the interior match the exterior of the truck to create one cohesive piece. Meaning that the interior had to make use of similar design elements to tie everything together; simple form factor; sharp colour accents; beauty in the details.

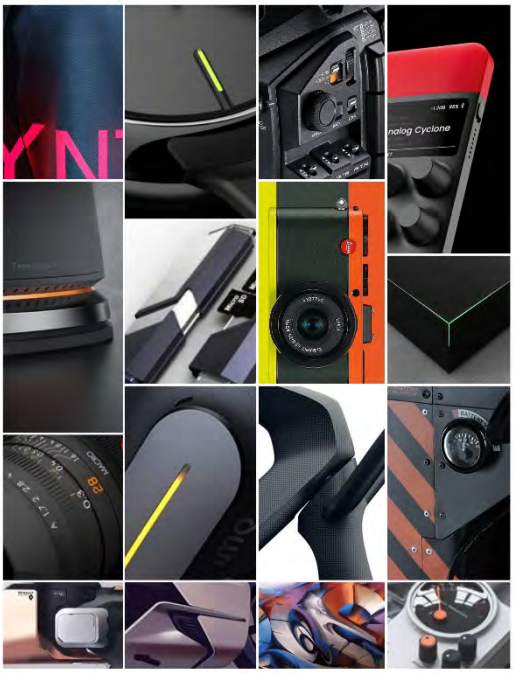


Figure 33 - Inspiration Board 2

4.1.2. Mind Mapping

Before the form development could begin, it needed to be determined what features were most necessary to have on the vehicle. This was done by using analyzing the issues at hand using mind maps, and organizing the drivers needs by importance vs. cost. These mind maps were crucial in narrowing down the most important features to include in the vehicle. Knowing what features would be included heavily influenced the sketches and the forms that were explored.

Figure 34 - User, Environment, Product Mind Map

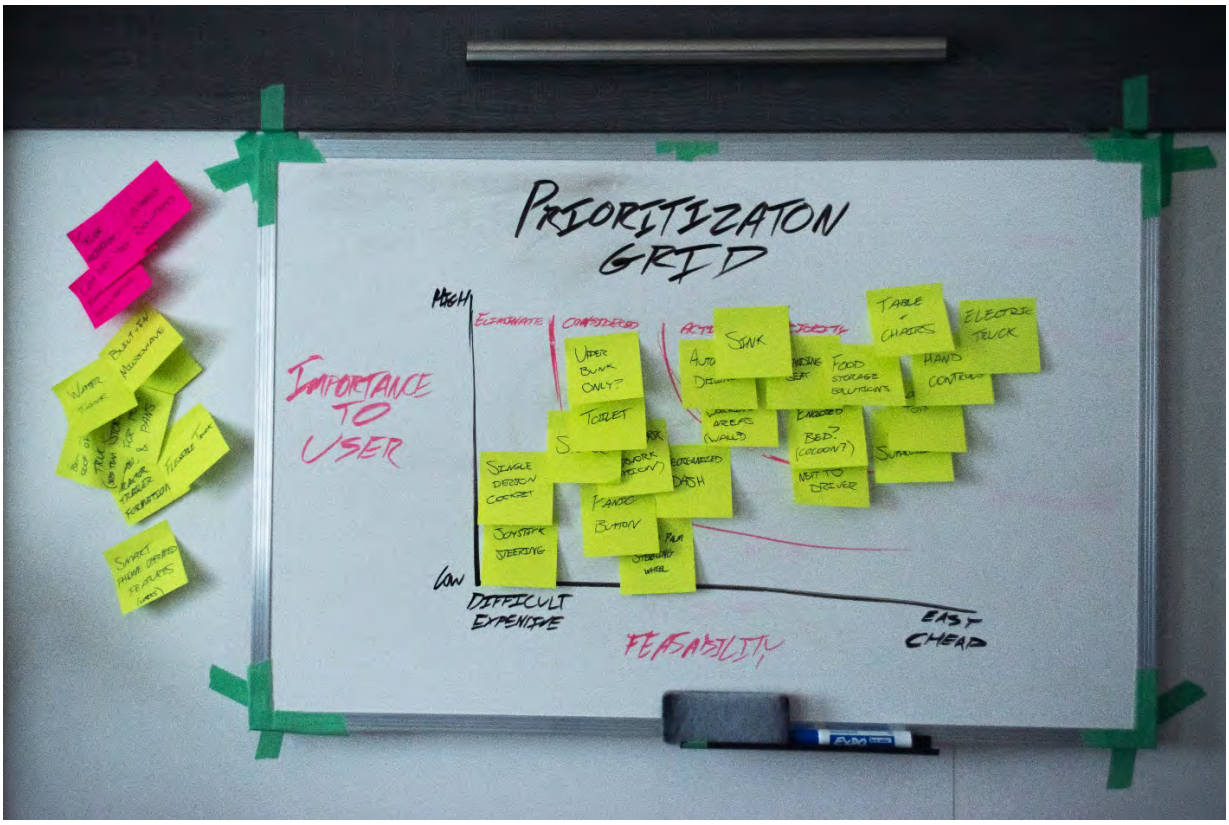


Figure 35 - Prioritization grid

4.1.3. Ideation Sketches

When ideation sketches began, it was not decided that the focus of the project would be the entire vehicle, meaning exterior, living amenities and cockpit ergonomics. They were handled as separate design directions. The initial sketches focused less on form factor but rather the purpose and usability of the vehicle’s key features.

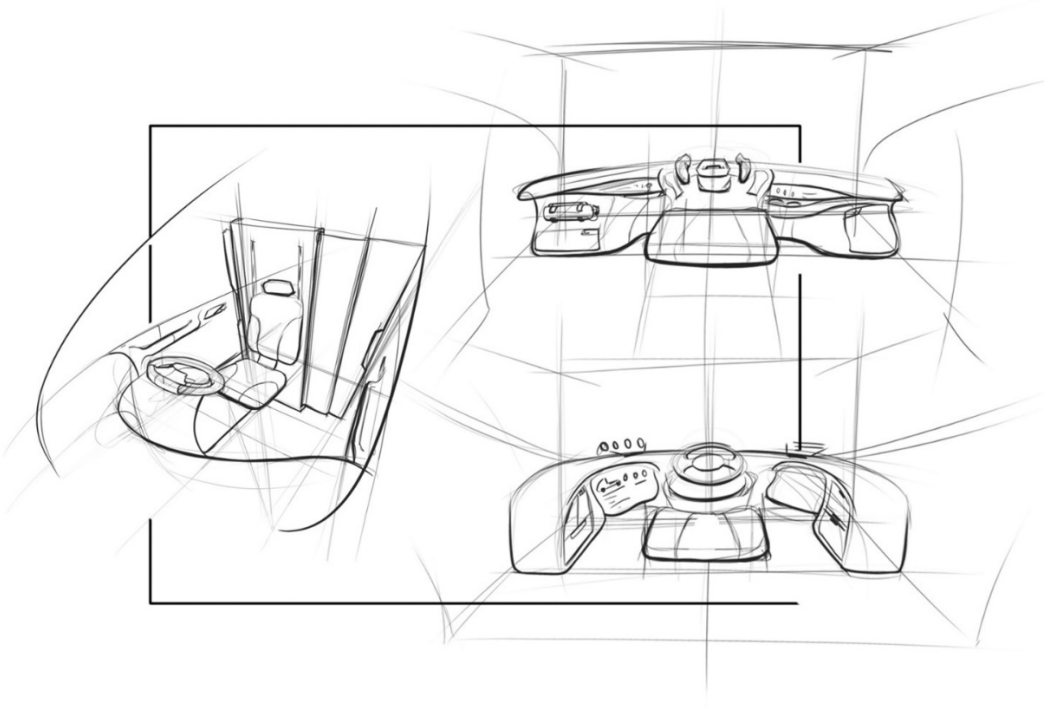


Figure 36 - Ideation 1

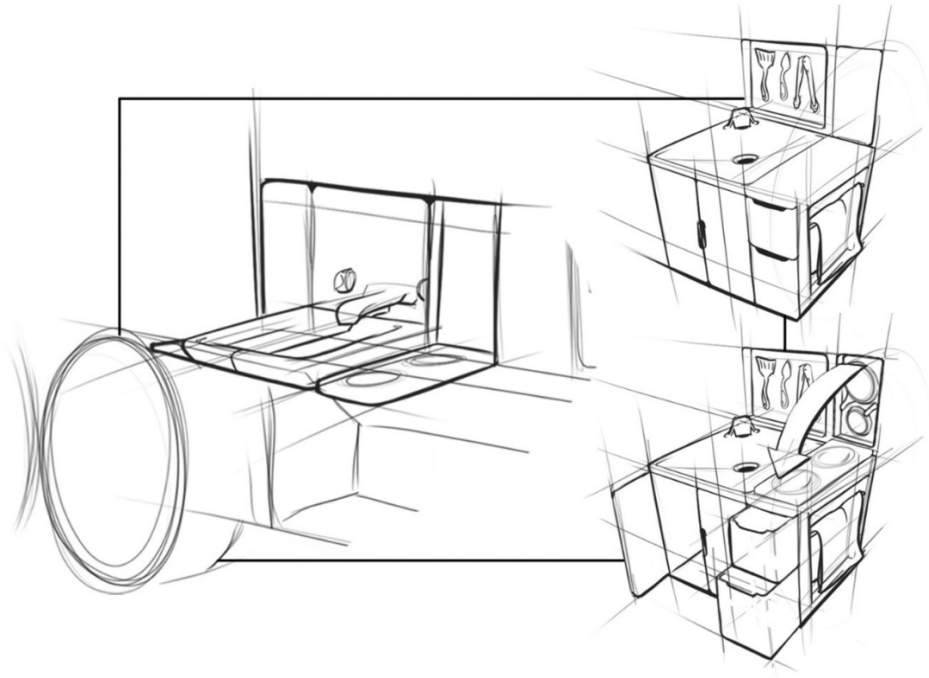


Figure 37 - Ideation 2

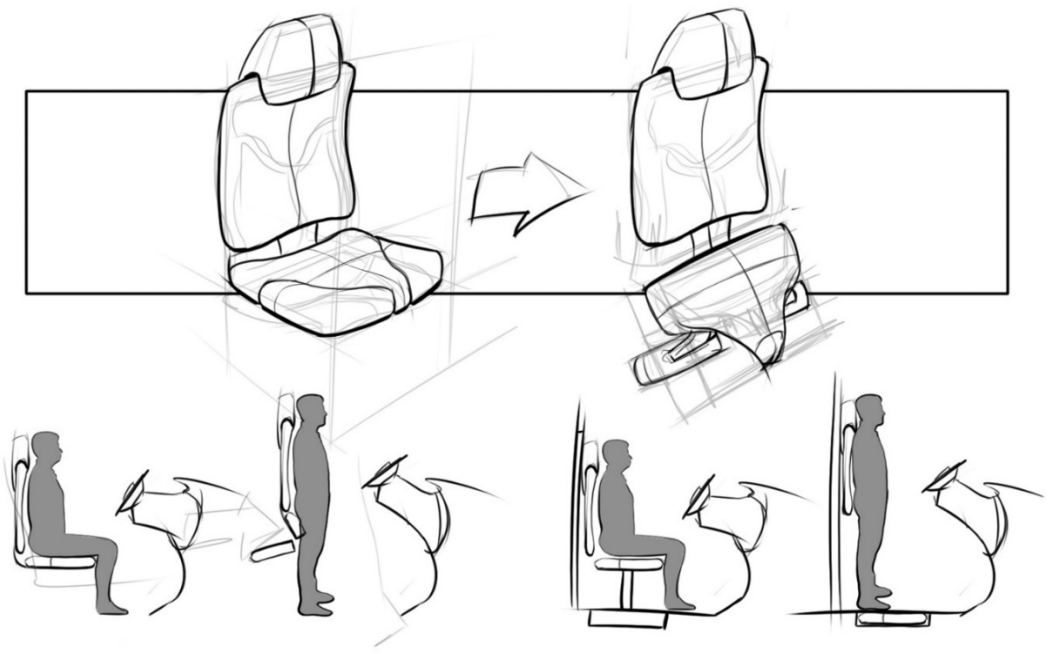


Figure 38 - Ideation 3

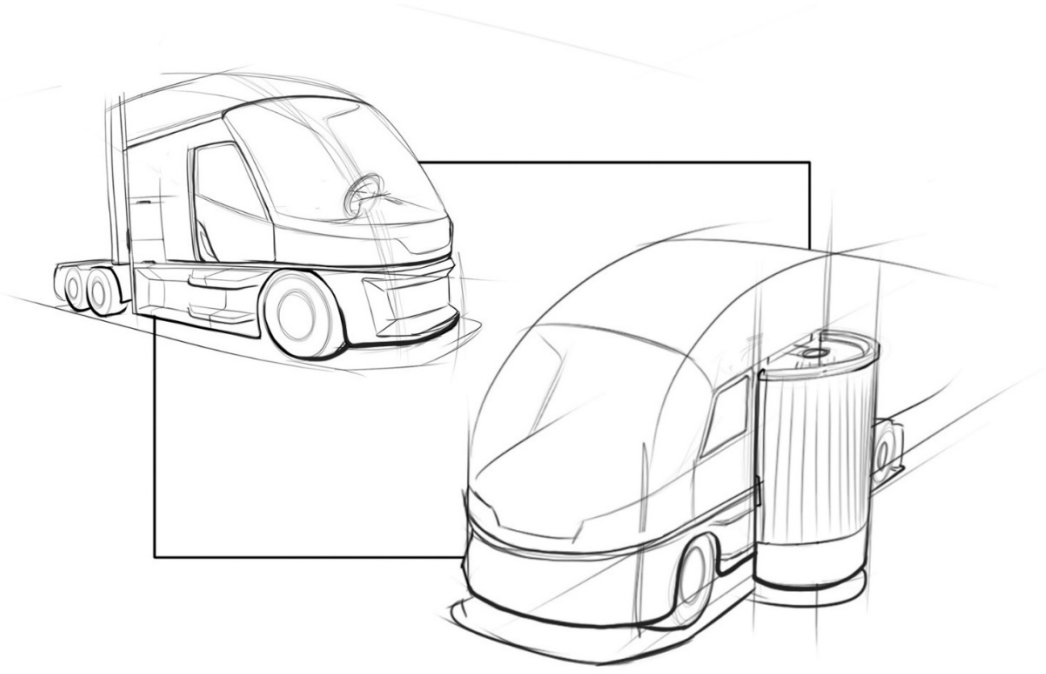


Figure 39 - Ideation 4

4.2. Preliminary Concept Explorations

At this point in the design process it was still undetermined what the final design direction should be, living or cockpit. A rough idea was proposed for each and it was decided that the project should encompass both the living and working aspects of long-haul truck driving.

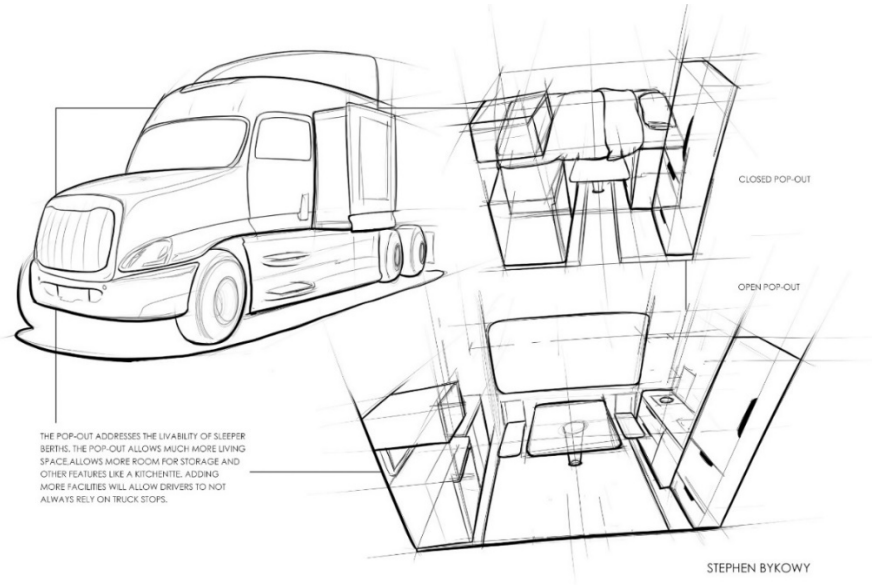


Figure 40 - Concept Explorations 1

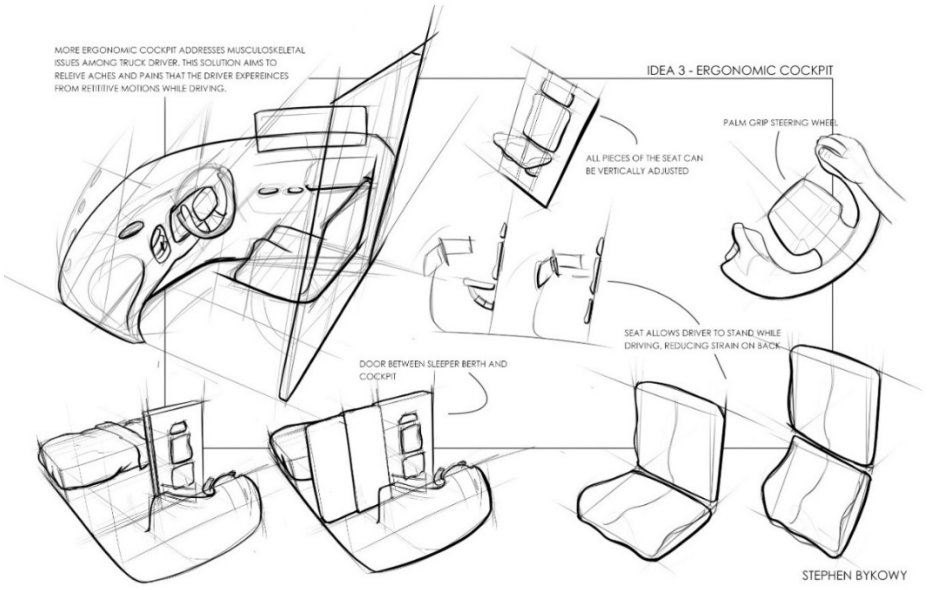


Figure 41 - Concept Explorations 2

4.3. Concept Strategy

The final direction that was decided upon is a concept for an entirely new sleeper truck with an innovative cockpit and living quarter design. It would also make use of modern EV technology to allow the expansion of the interior space, meaning there is more room to implement features that will meet the drivers needs. The sketches that followed were much more cohesive. They focused on the truck as a whole and how each piece related to each other, rather than treating the pieces as separate entities.

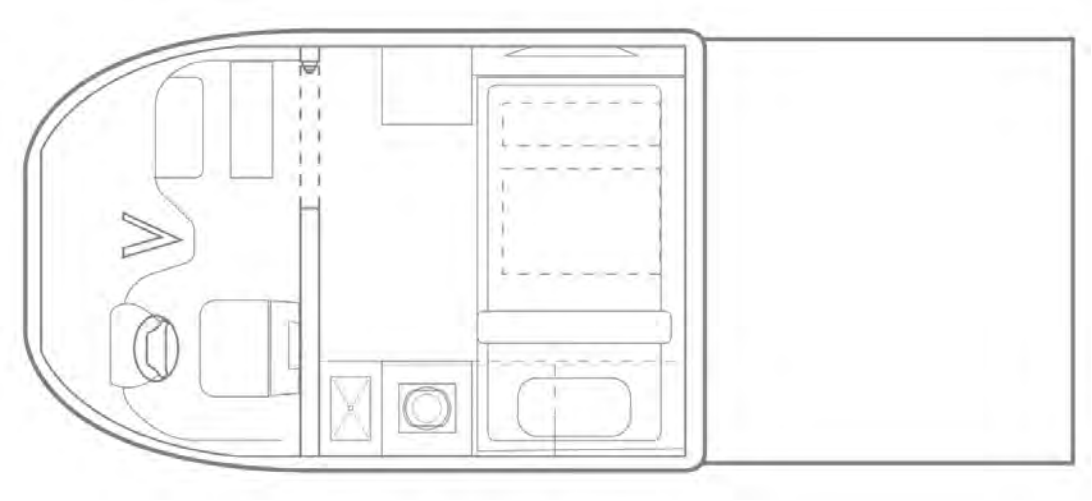


Figure 42 - Concept Strategy 1

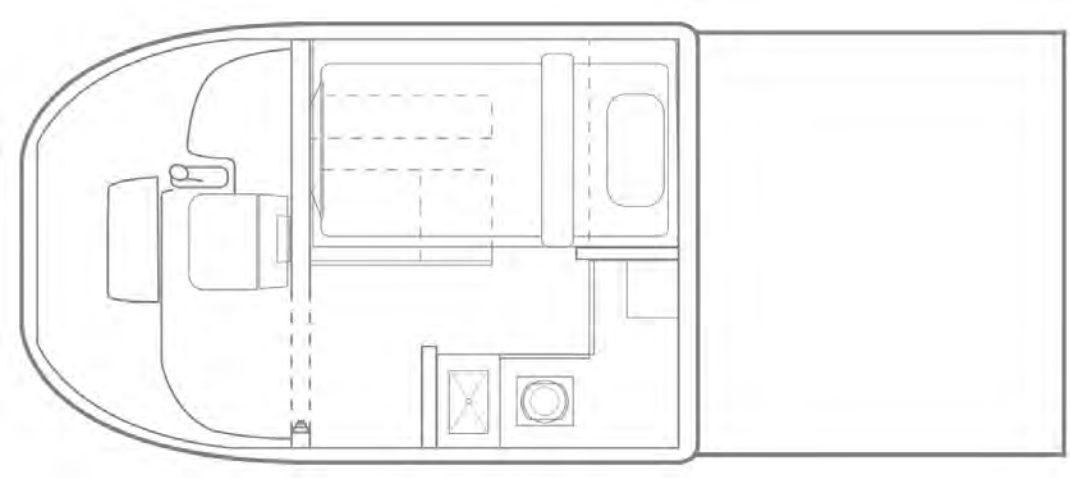


Figure 43 - Concept Strategy 2

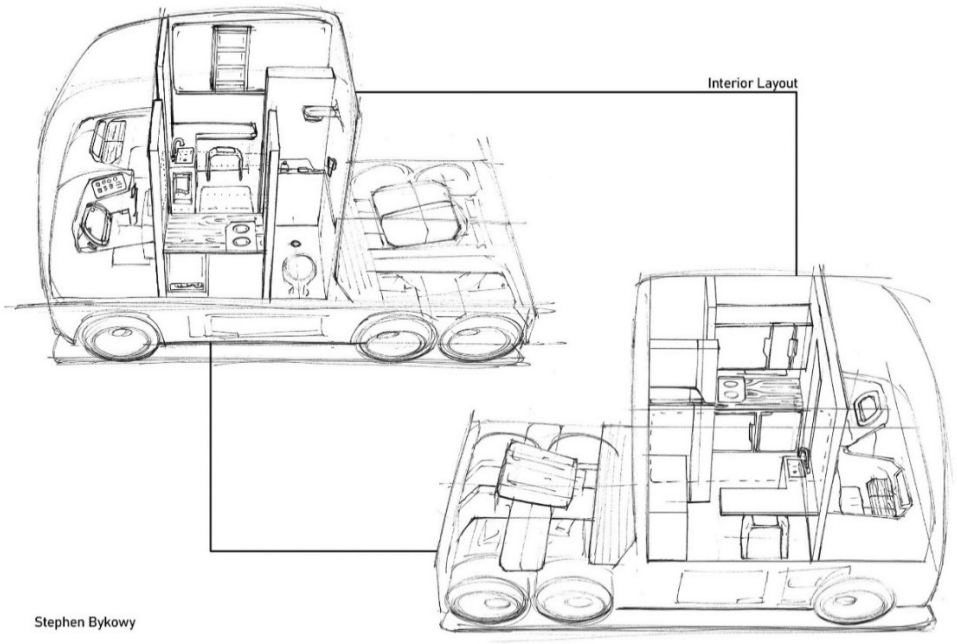


Figure 44 - Concept Strategy 3

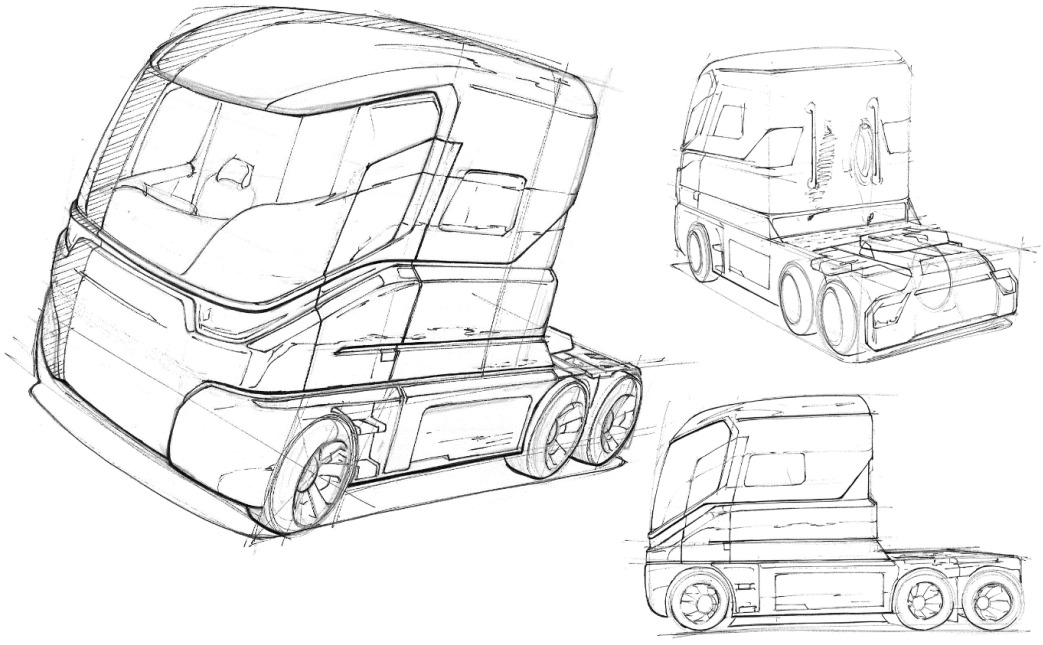


Figure 45 - Concept Strategy 4

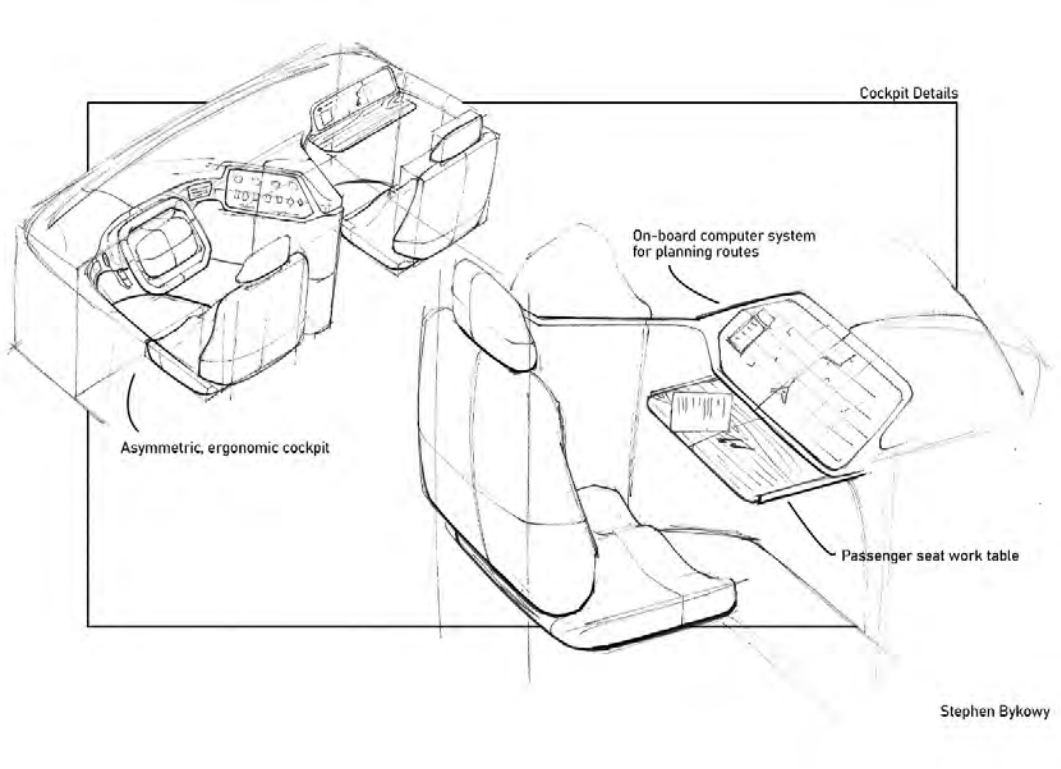


Figure 46 - Concept Strategy 5

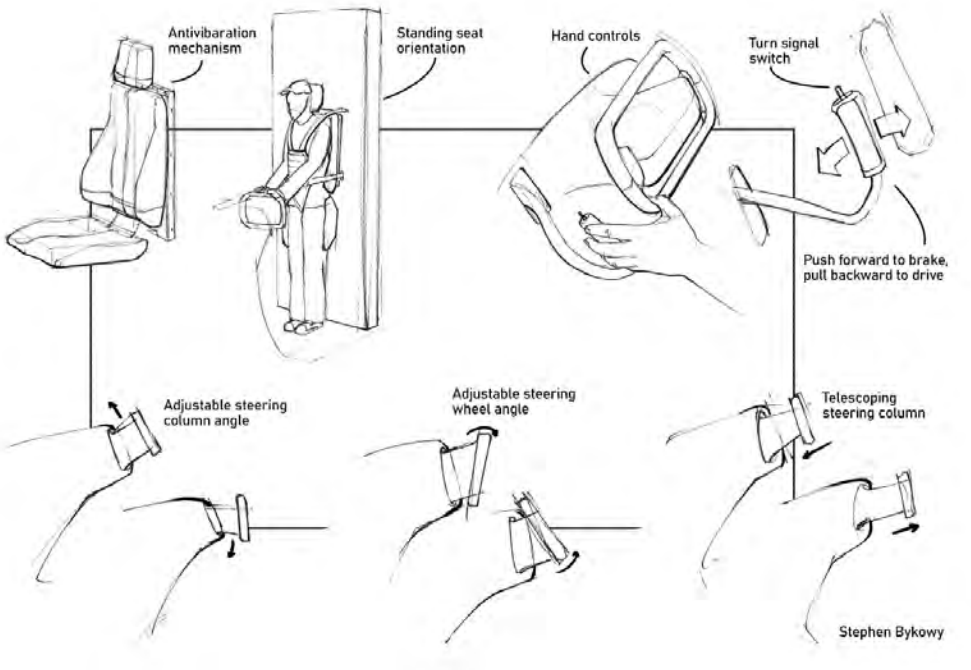


Figure 47 - Concept Strategy 6

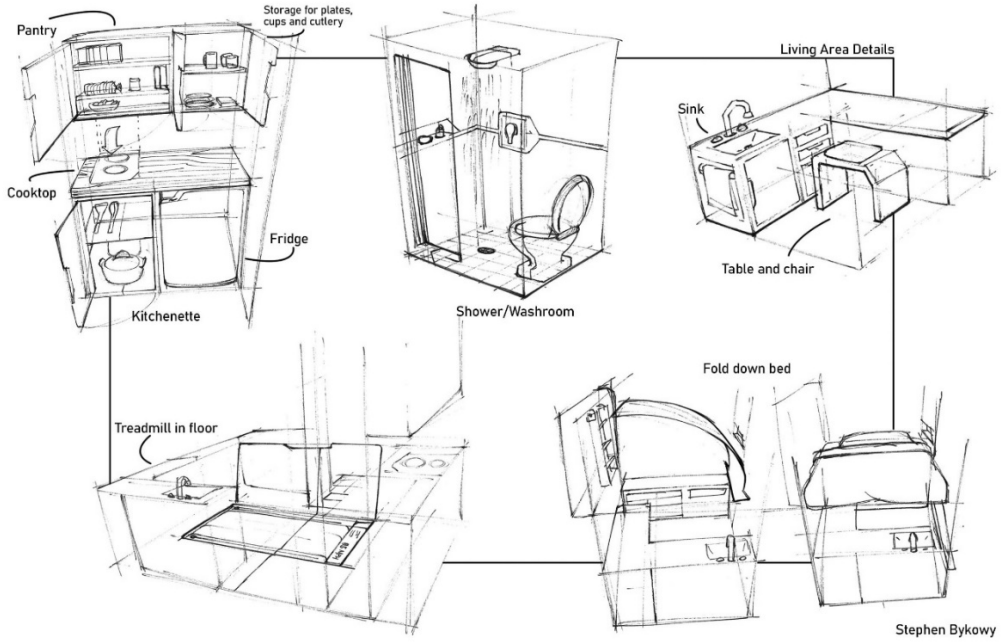


Figure 48 - Concept Strategy 7

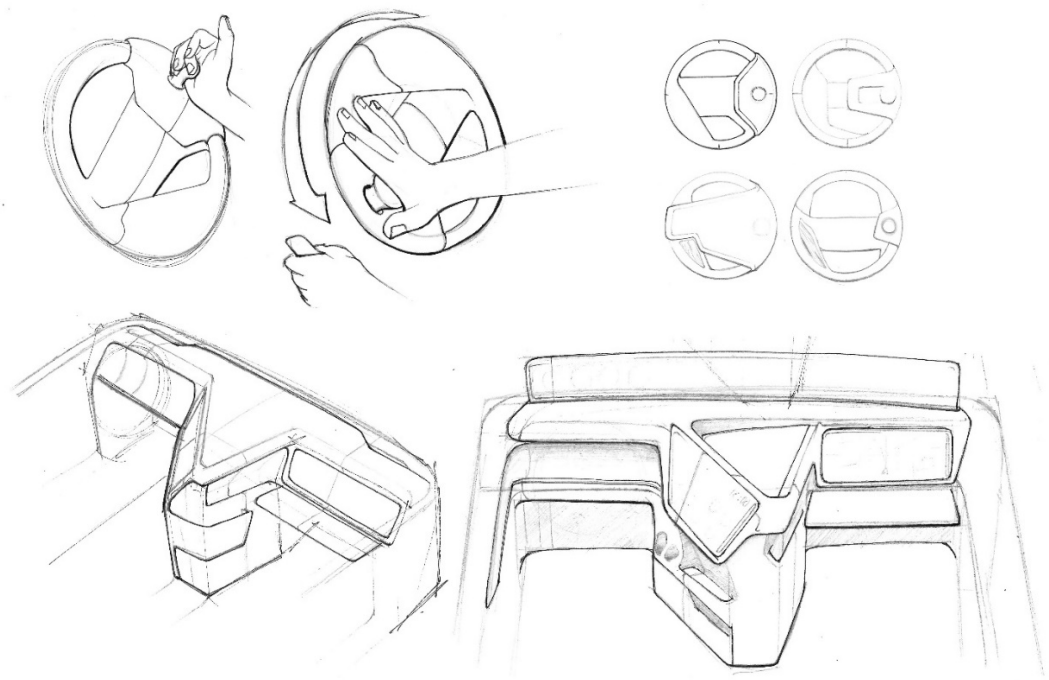


Figure 49 - Concept Strategy 8

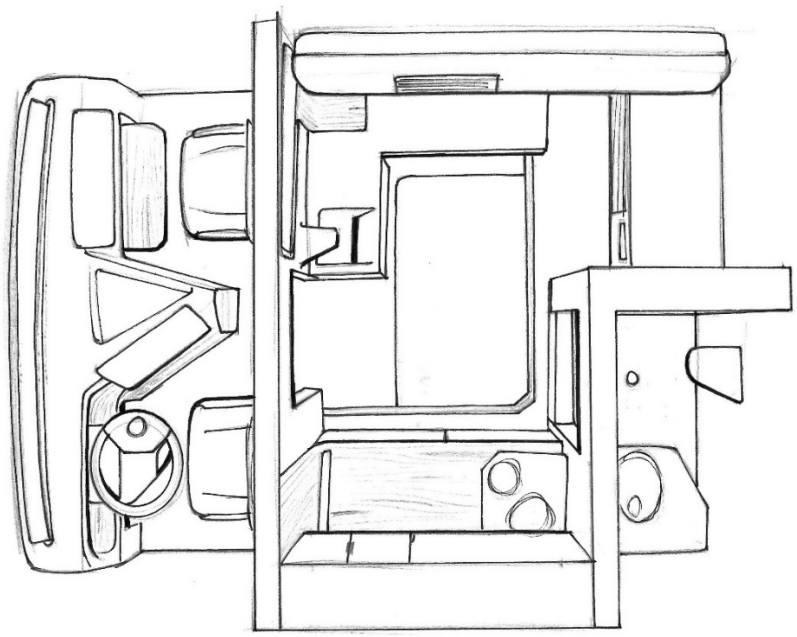


Figure 50 - Concept Strategy 9

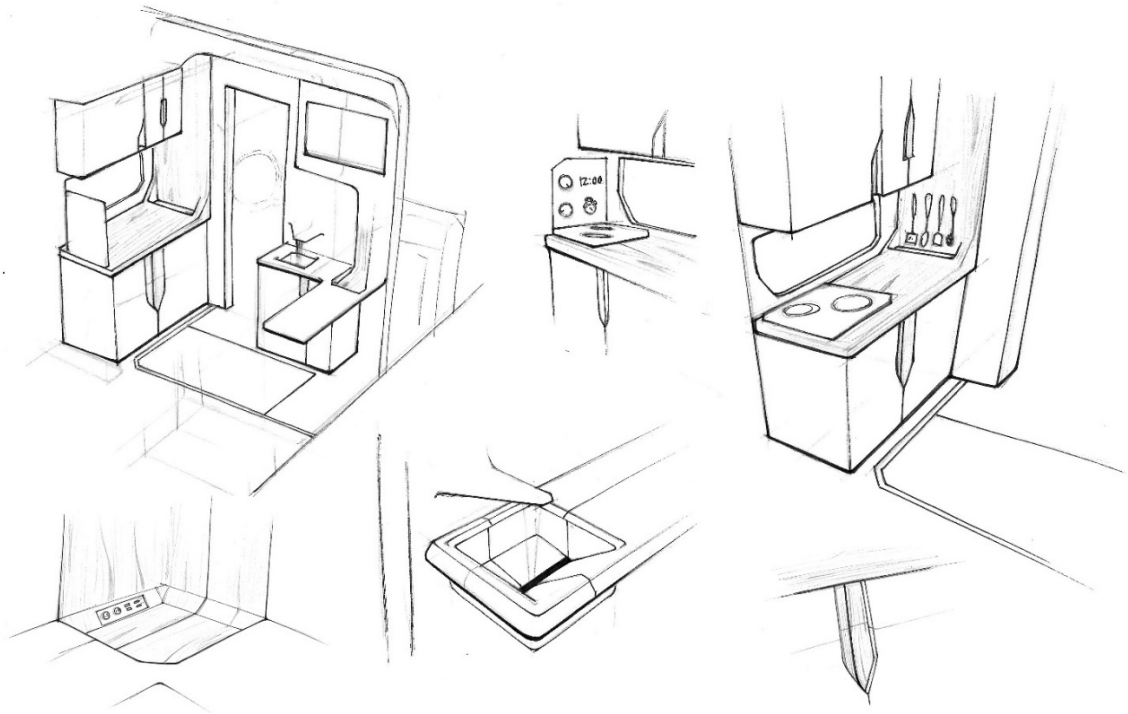


Figure 51 - Concept Strategy 10

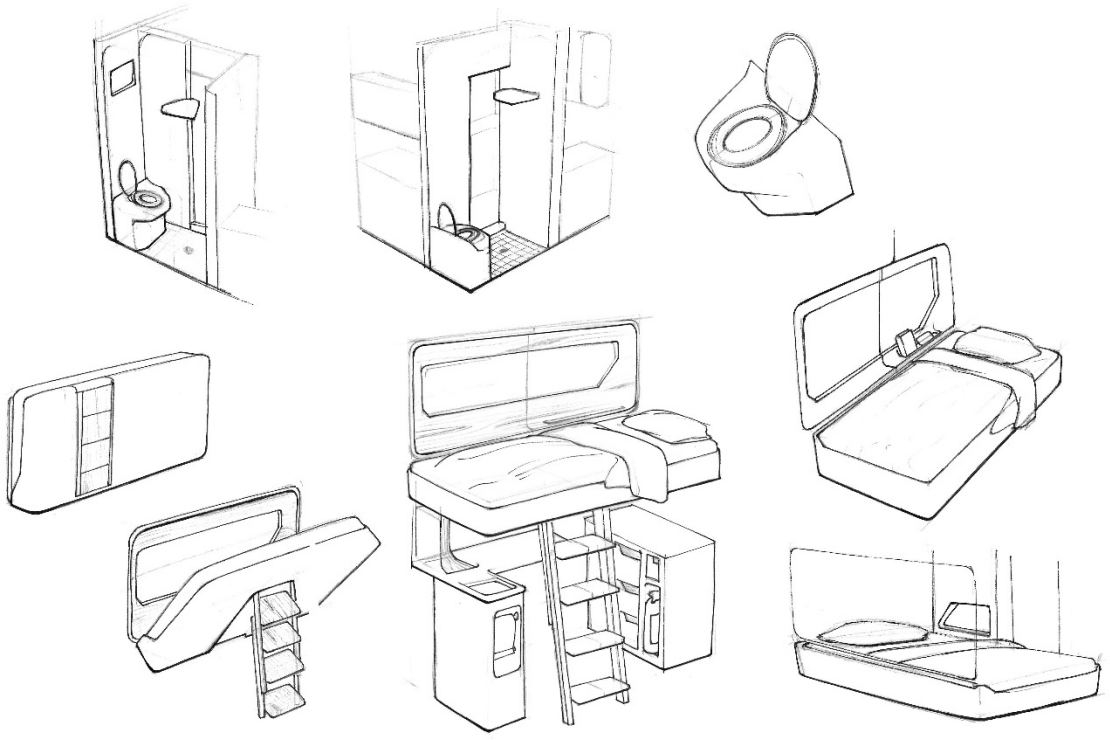
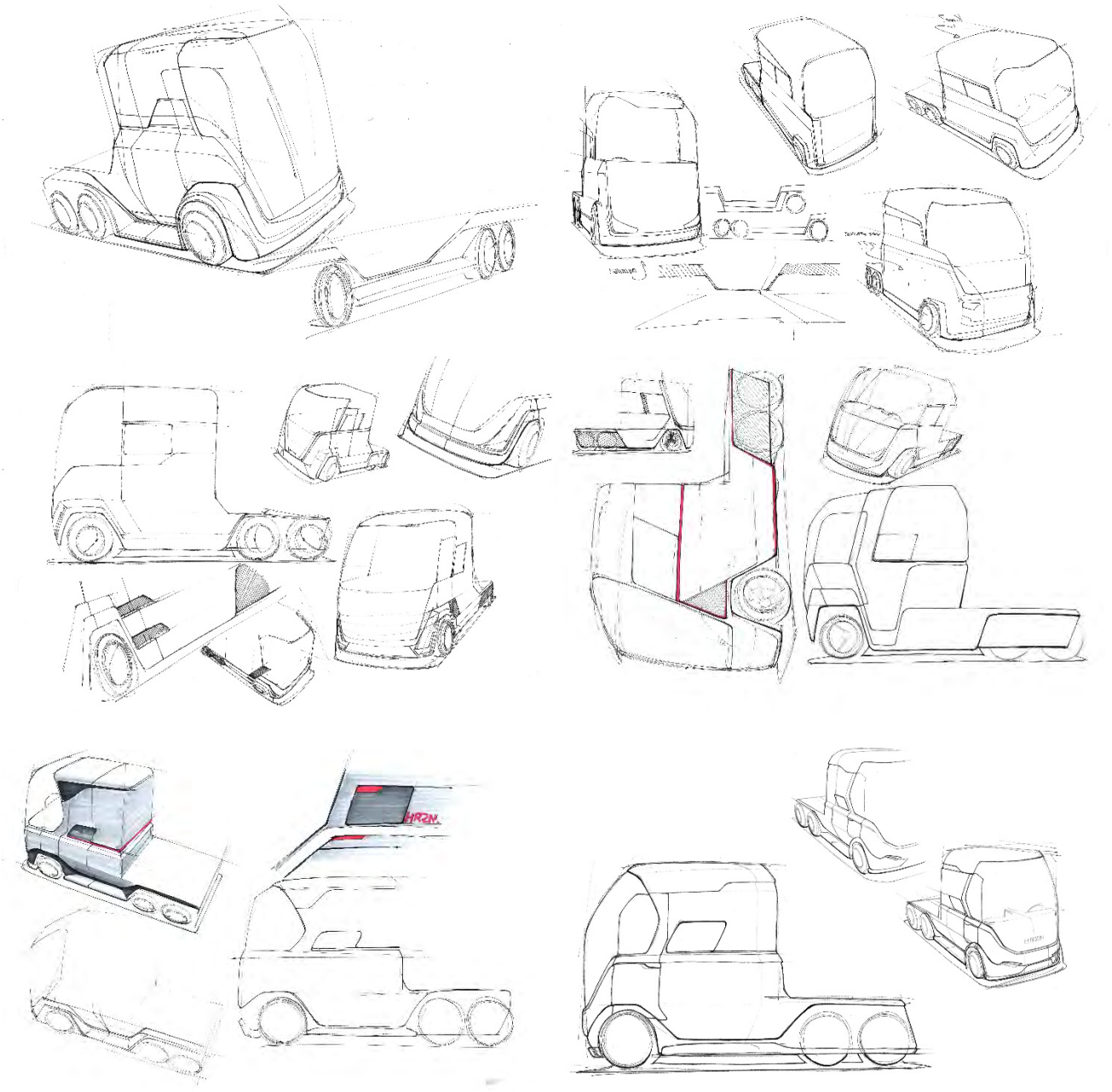


Figure 52 - Concept Strategy 11

4.4. Concept Refinement

Some reworking had to be done to resolve the final design. It was advised that the appearance should be more unique, especially regarding the exterior. At this point there was a shift in focus. Since the innovative design features of the vehicle are more interior-centric, the interior aesthetic of the vehicle should influence the exterior, rather than the other way around. As a result, the design aesthetic shifted from a bold and punchy look to a more elegant and homier feel. Inspiration started being drawn from Scandinavian furniture design. It was decided that this look would be a more unique addition to the trucking industry than the previously proposed design direction and would lend itself well to the healthy/active subject matter of the thesis topic. It was at this point that the name HORIZON was given to the vehicle. This was chosen because the word “horizon” speaks to the idea of traveling, going far and “driving towards the horizon”, which is appropriate given the topic of long-haul truck driving.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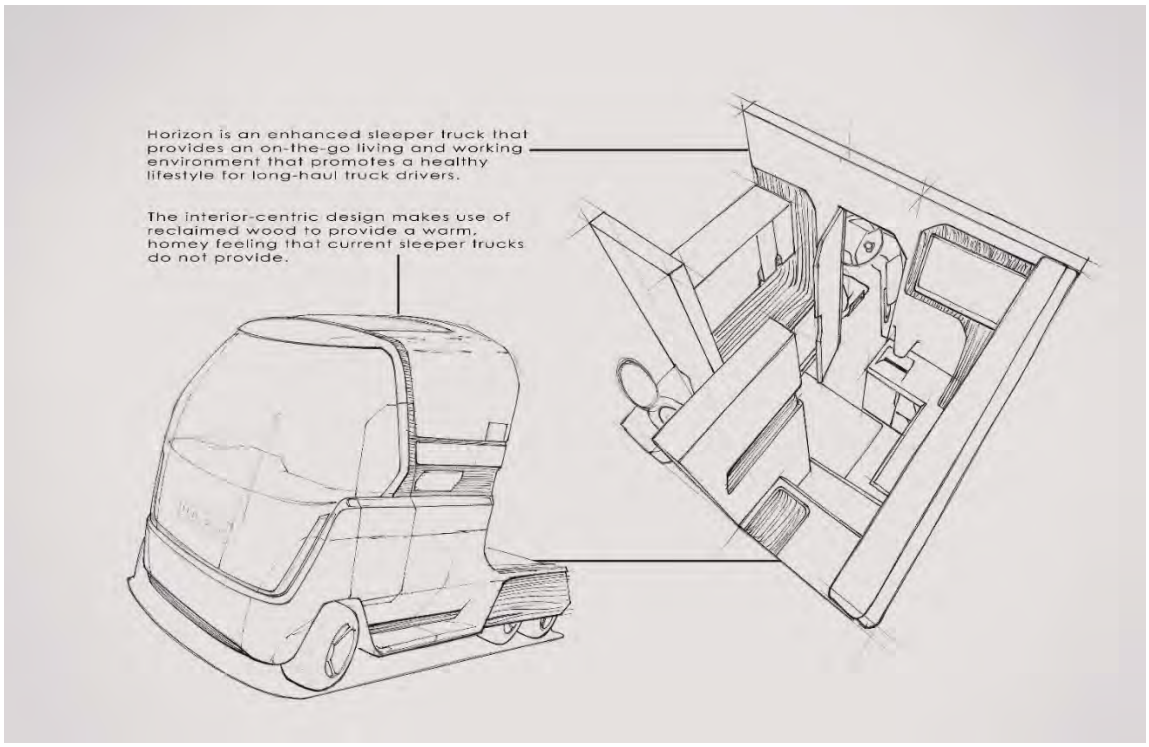


Figure 53 - Concept Refinement 1

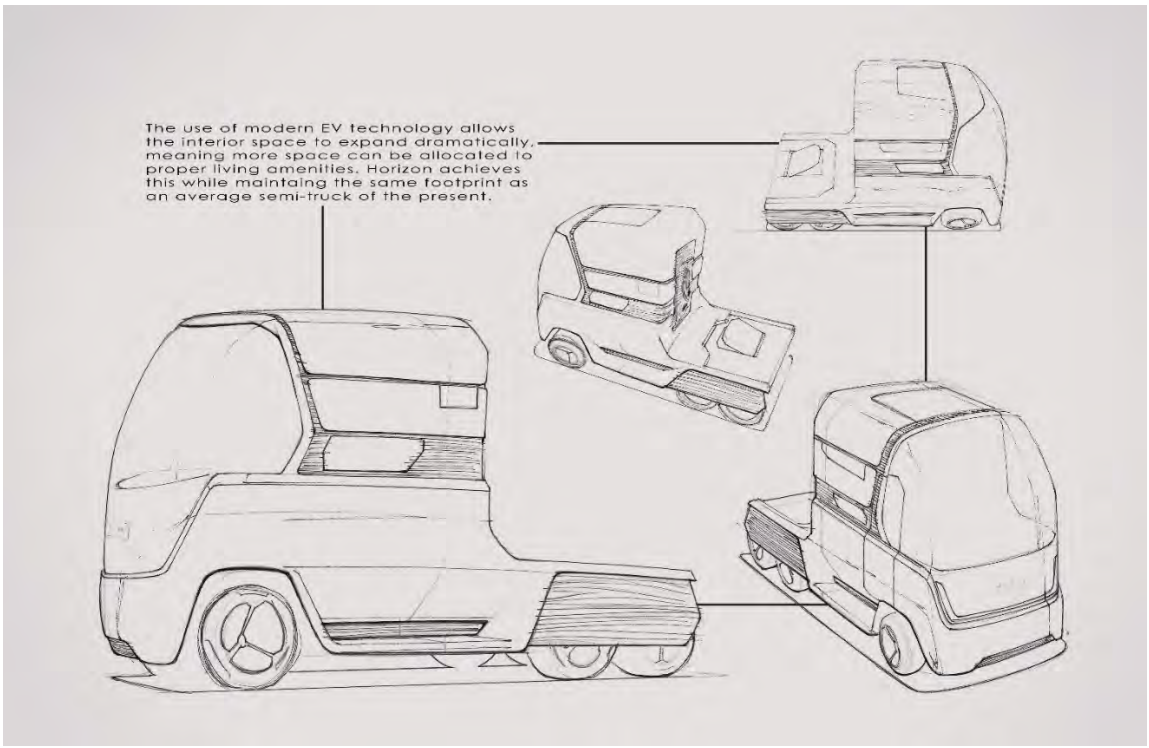


Figure 54 - Concept Refinement 2

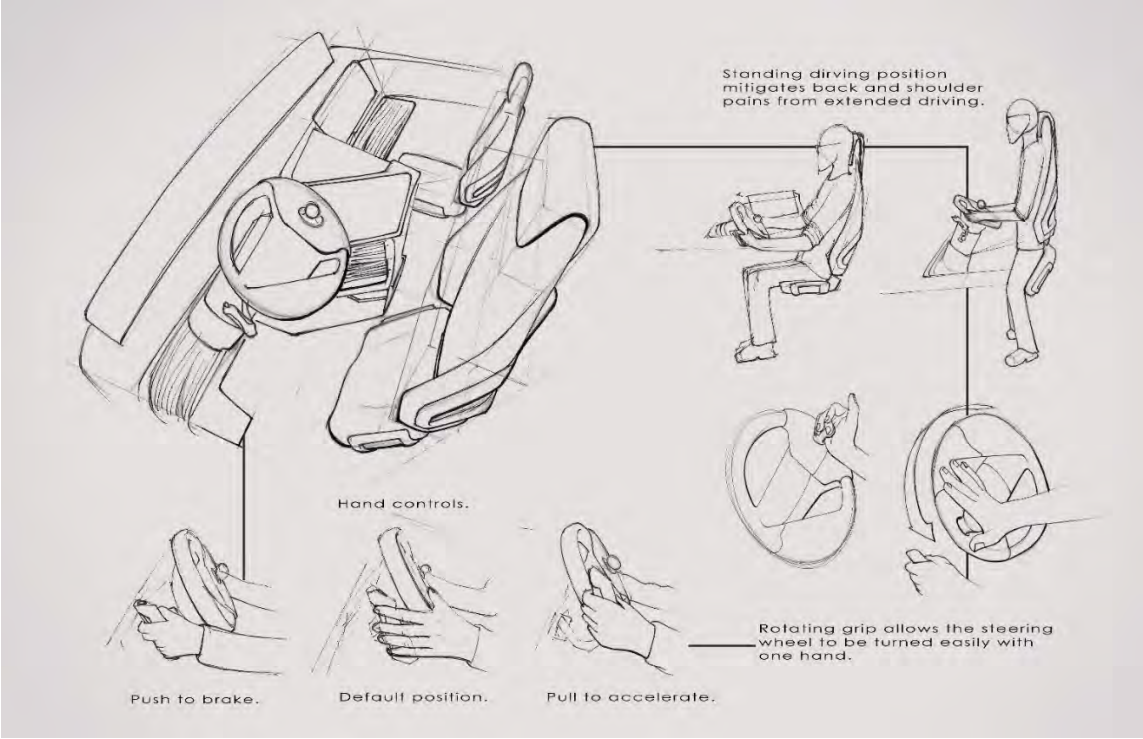


Figure 55 - Concept Refinement 3

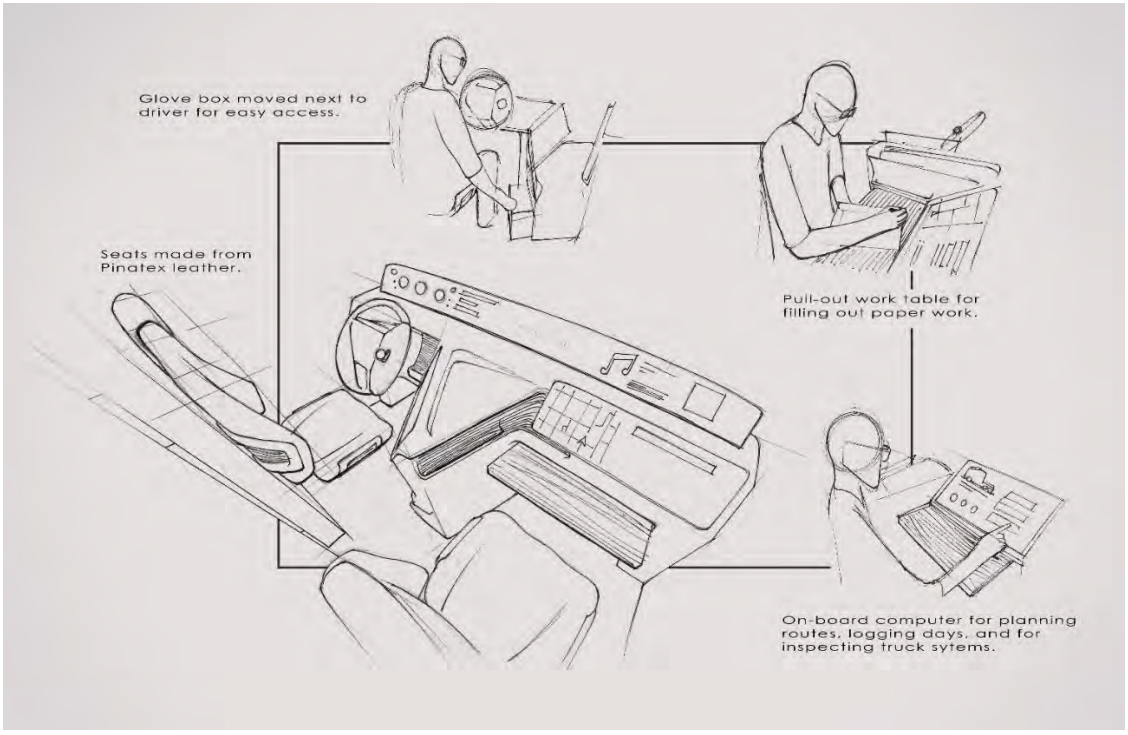


Figure 56 - Concept Refinement 4

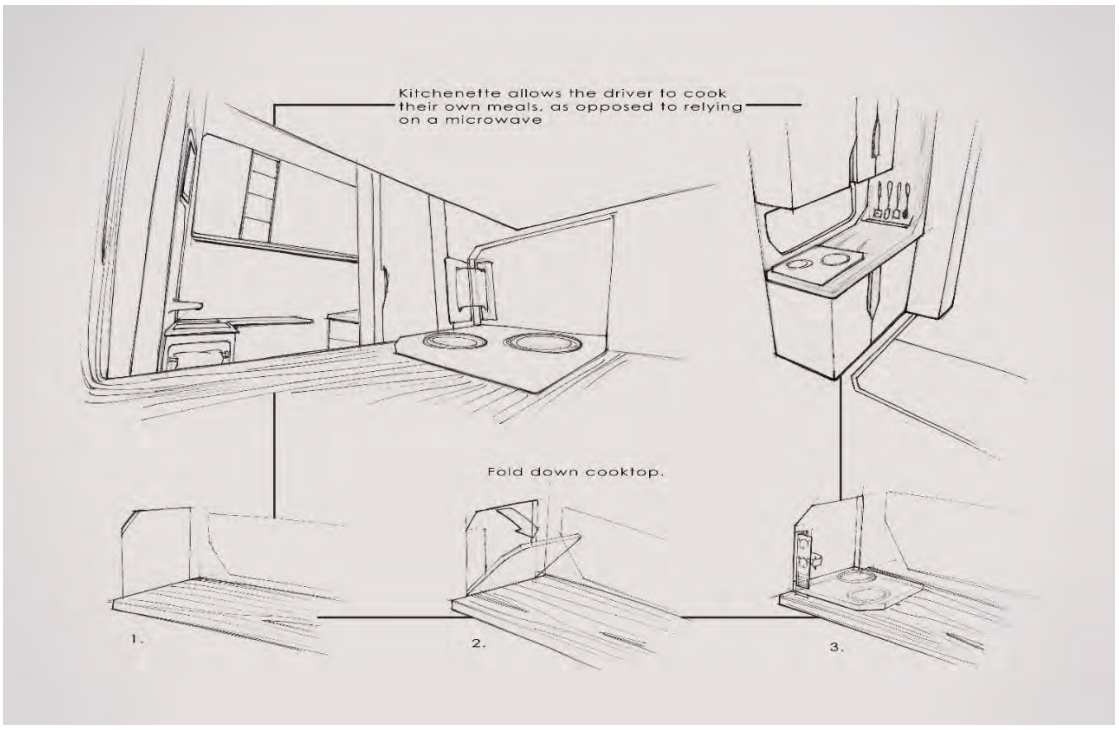


Figure 57 - Concept Refinement 5

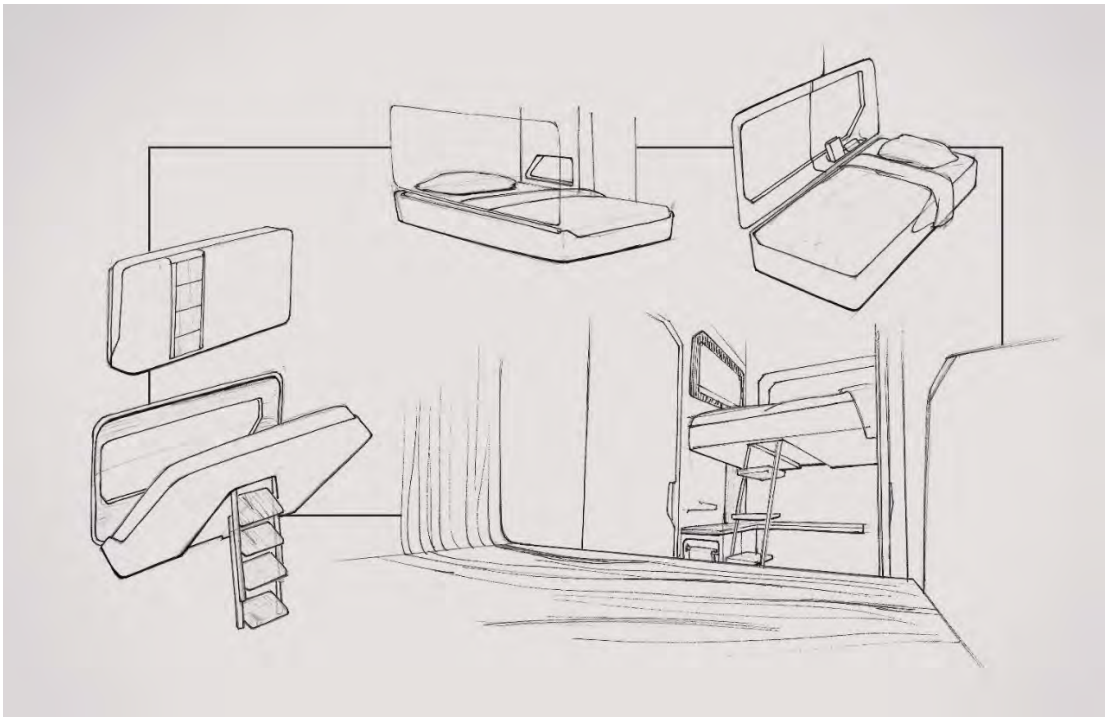


Figure 58 - Concept Refinement 6

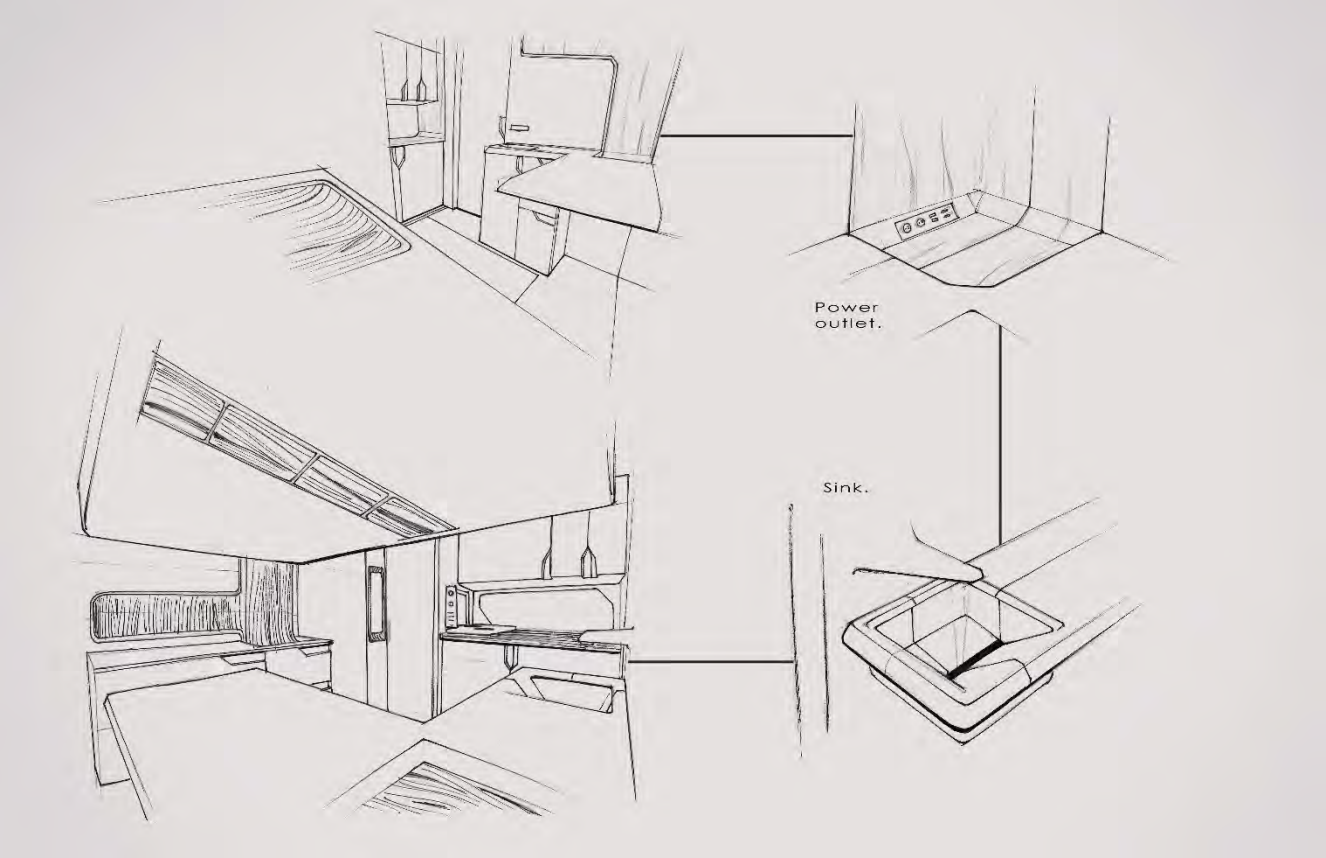


Figure 59 - Concept Refinement 7

4.5. Design Realization

4.5.1. Physical Study Model

A sketch model was of the vehicle was constructed to gain a stronger understanding of the interior space and the exterior surfacing. The model was made entirely out of cardboard boxes at 1:14th scale. It really emphasized the size of the space being worked within. To ensure that the vehicle features can be utilized easily, implementing proper ergonomic sizing and spacing in the vehicle was of utmost importance. The model shed light on how the vehicles exterior surfaces should be built in CAD, and also what parts of the more refined physical model will be difficult to build.

Figure 60 - Physical Study Model 1

Figure 61 - Physical Study Model 2

Figure 62 - Physical Study Model 3

Figure 63 - Physical Study Model 4

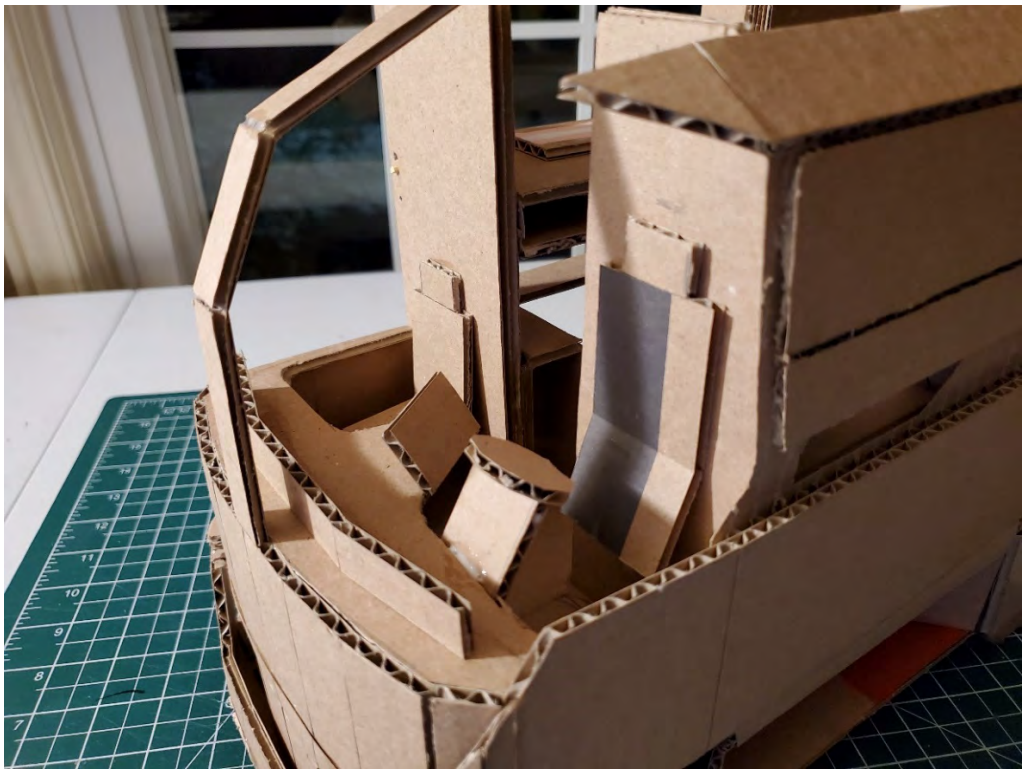


Figure 64 - Physical Study Model 5

Figure 65 - Physical Study Model 6

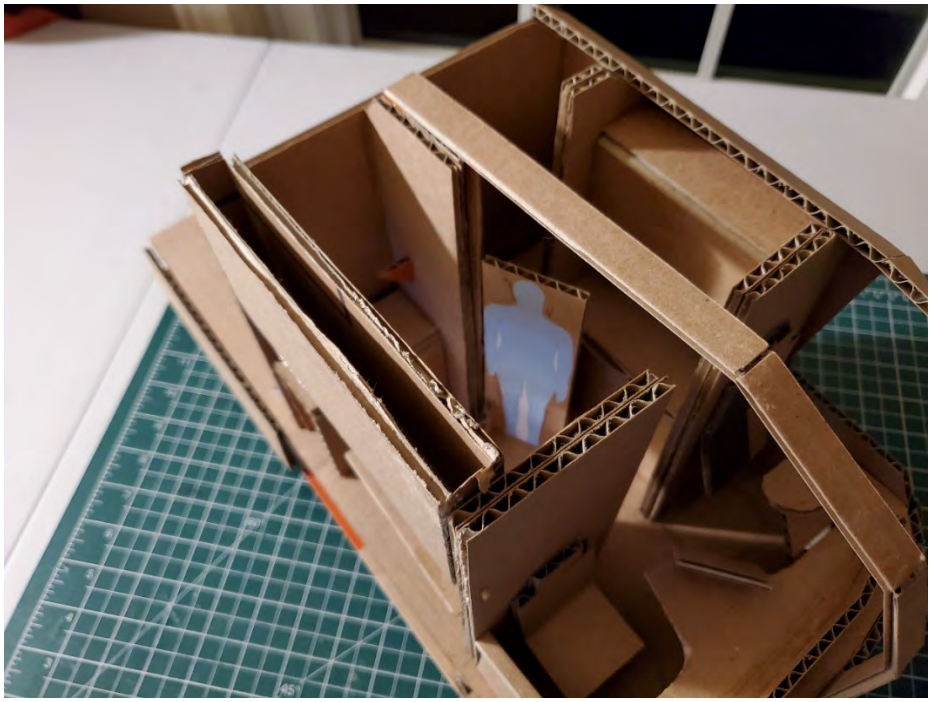


Figure 66 - Physical Study Model 7

Figure 67 - Physical Study Model 8

4.5.2. Product Schematic

To resolve the health issues caused by current sleeper trucks, proper ergonomic size and spacing had to be considered whilst coming up with the final design. This will ensure that the driver remains healthy and can do their job easily with no strain on the body. In the figures below, HORIZON has been compared to the size of an average sleeper truck and the interior has been divided into different, colour coded sections. These sections represent different spaces and features within the interior. This gives a clearer sense of the floor plan of the vehicle and also how the size of the different sections compare to each other. And below those are more detailed configuration layouts demonstrating how the 99th percentile male and the 5th percentile female can use the trucks features.

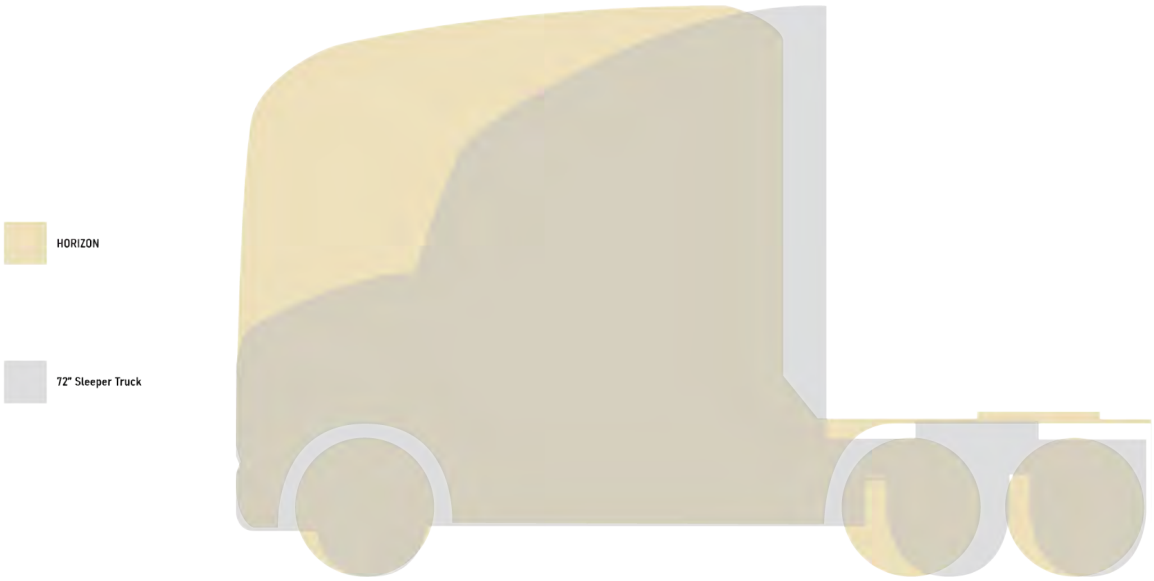


Figure 68 - Size Comparison

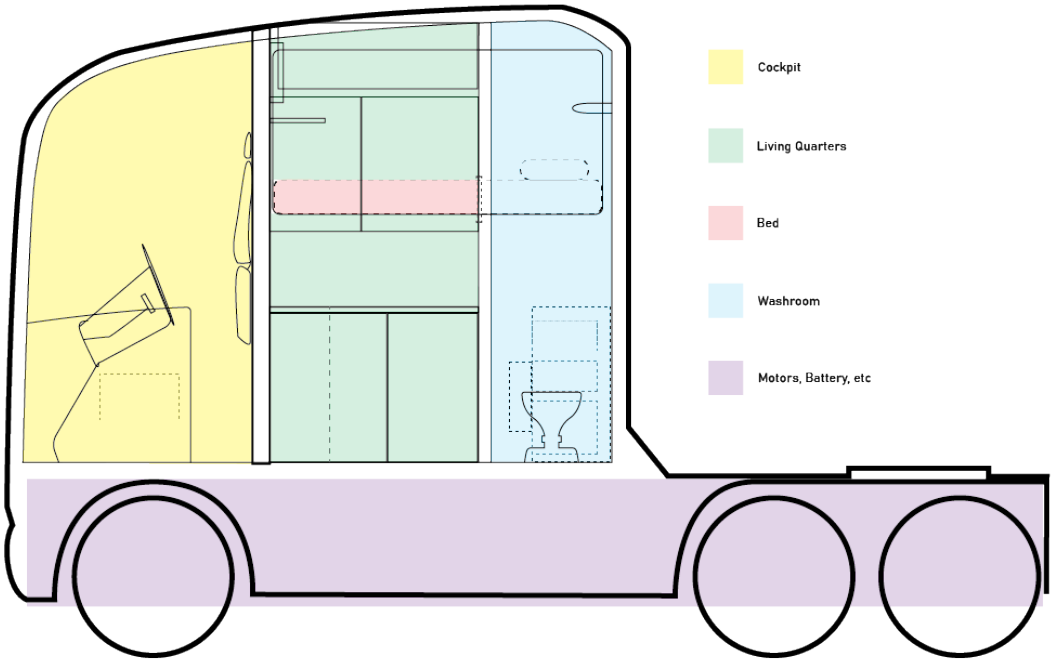


Figure 69 - Interior Layout 1

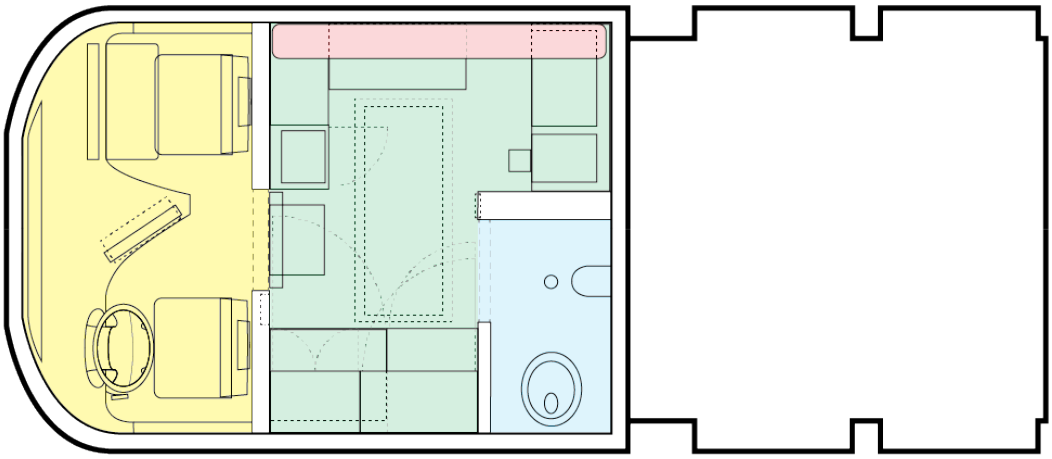


Figure 70 - Interior Layout 2

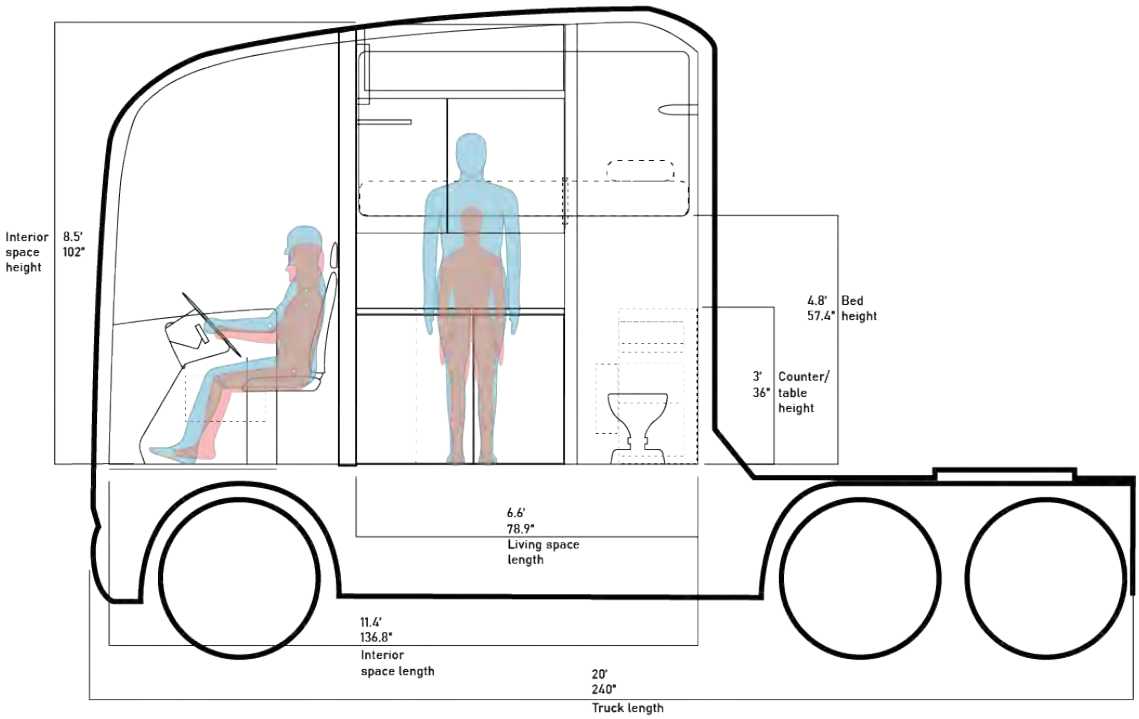


Figure 71 - Product Schematic 1

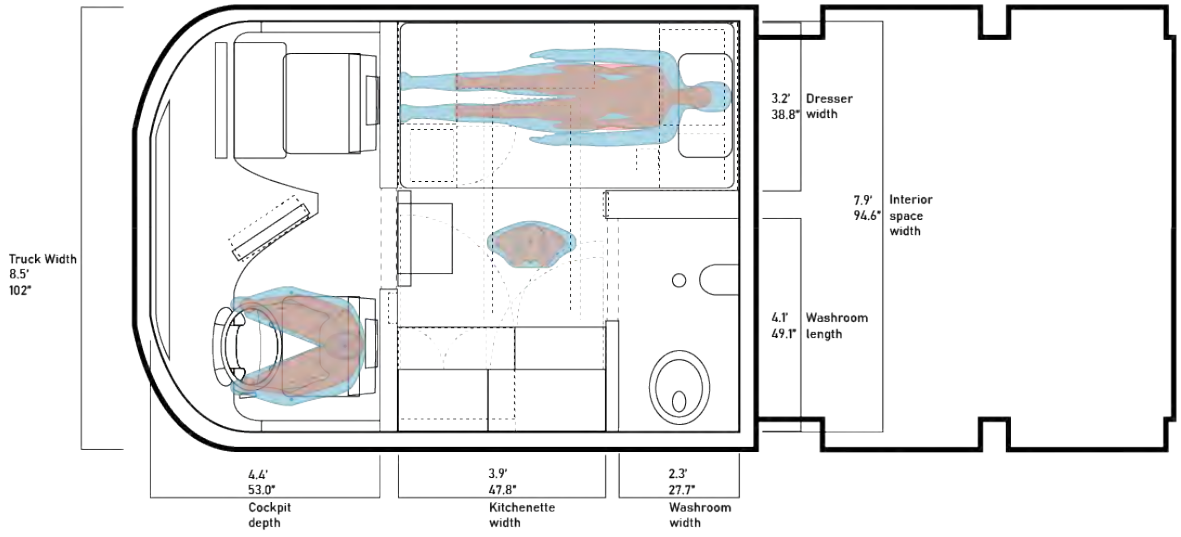


Figure 72 - Product Schematic 2

Figure 73 - Product Schematic 3

4.6. Design Resolution

HORIZON’s final design takes into consideration the basic needs and wants of long-haul truck drivers to ensure that they can live healthily on the job. The expanded interior space makes use of innovative features that are accurately designed with real human proportions and ergonomic considerations. The interior and exterior were designed as one cohesive piece, unlike earlier on the ideation process. This demonstrates that the interior and exterior construction work together to create a realistic vision of how it would work. HORIZON’s aesthetic changed quite dramatically from the beginning phases of the design. The final design achieved a pleasant and natural feel by making use of natural materials and warm colours. This makes the interior feel much homier than the previously proposed aesthetic as well as current sleeper trucks.

This sketch represents the final design direction that was chosen before moving into the CAD development phase of the project.

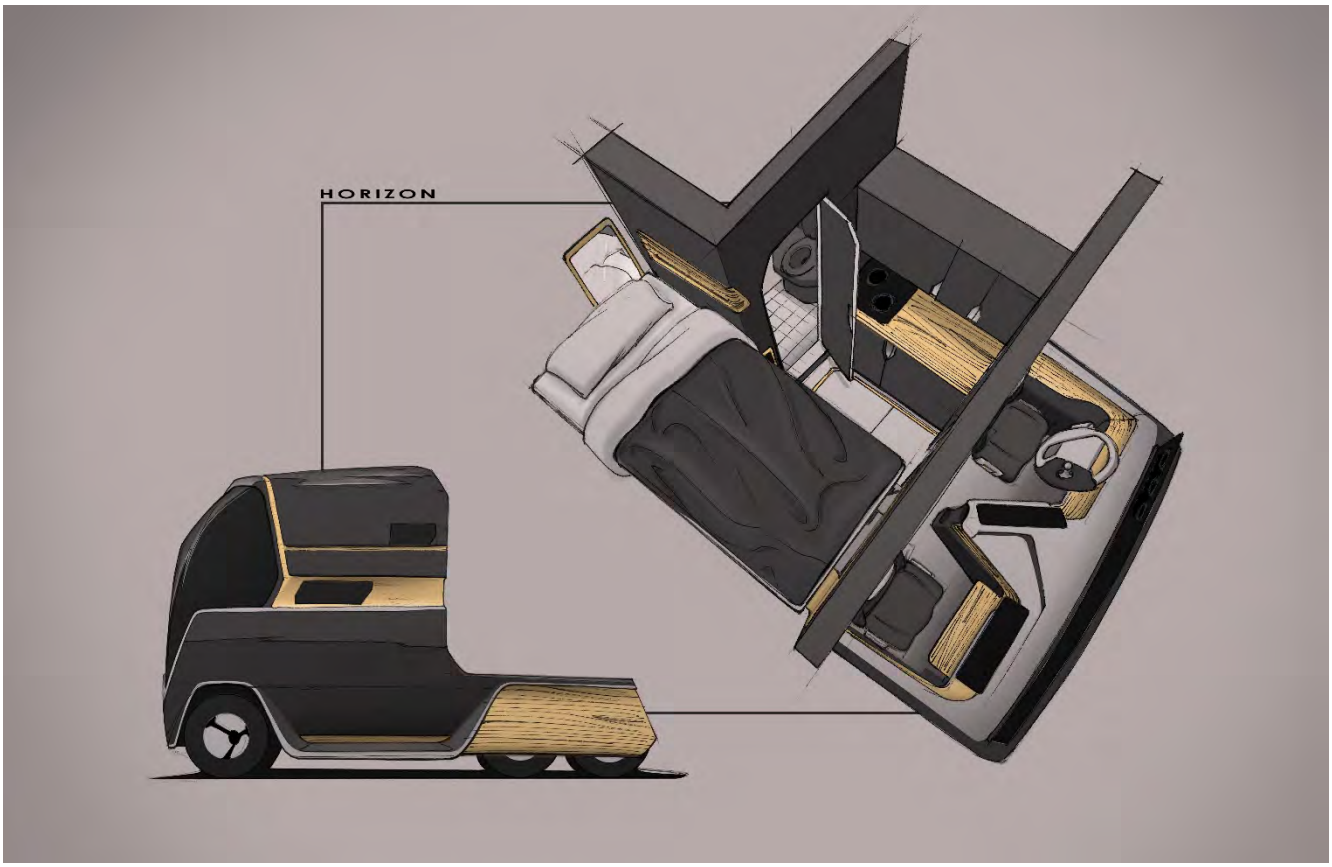


Figure 74 - Design Resolution 1

4.7. CAD Development

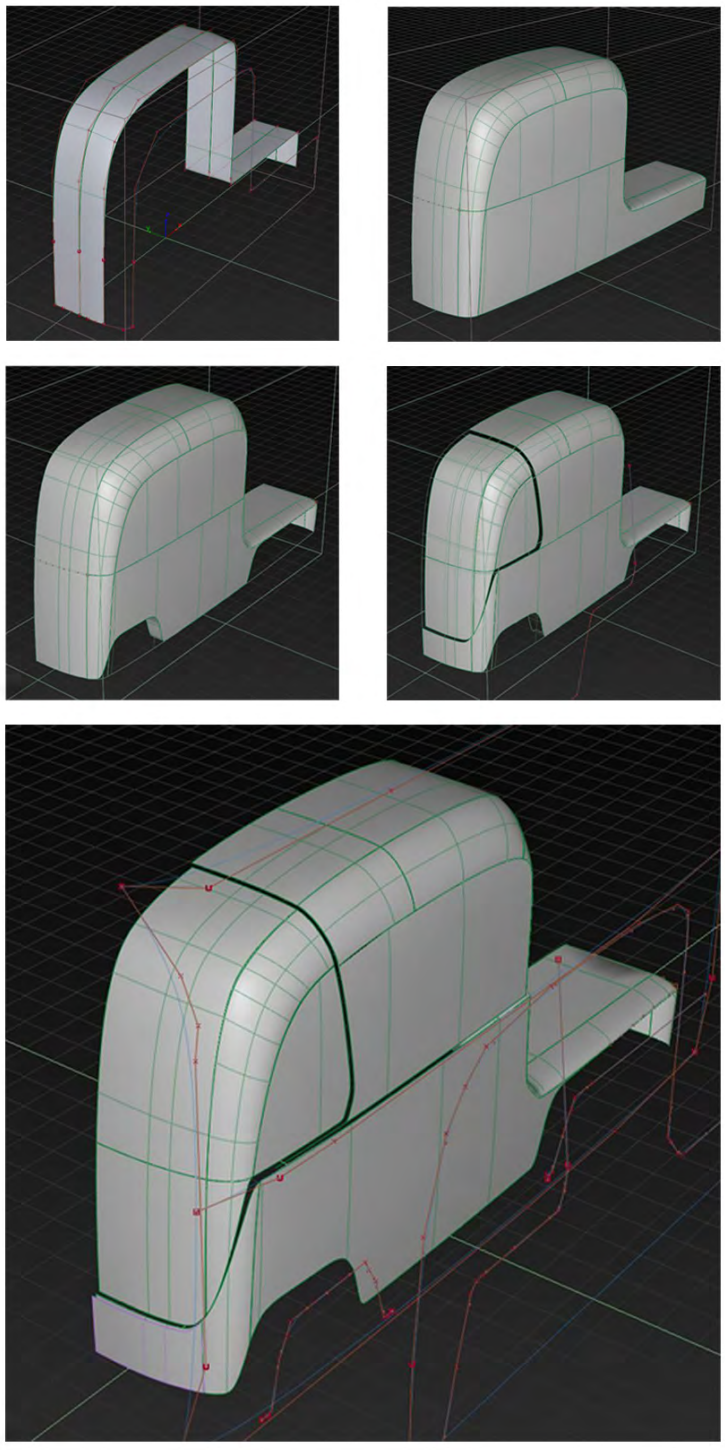


Figure 75 - CAD Development: Body Shape

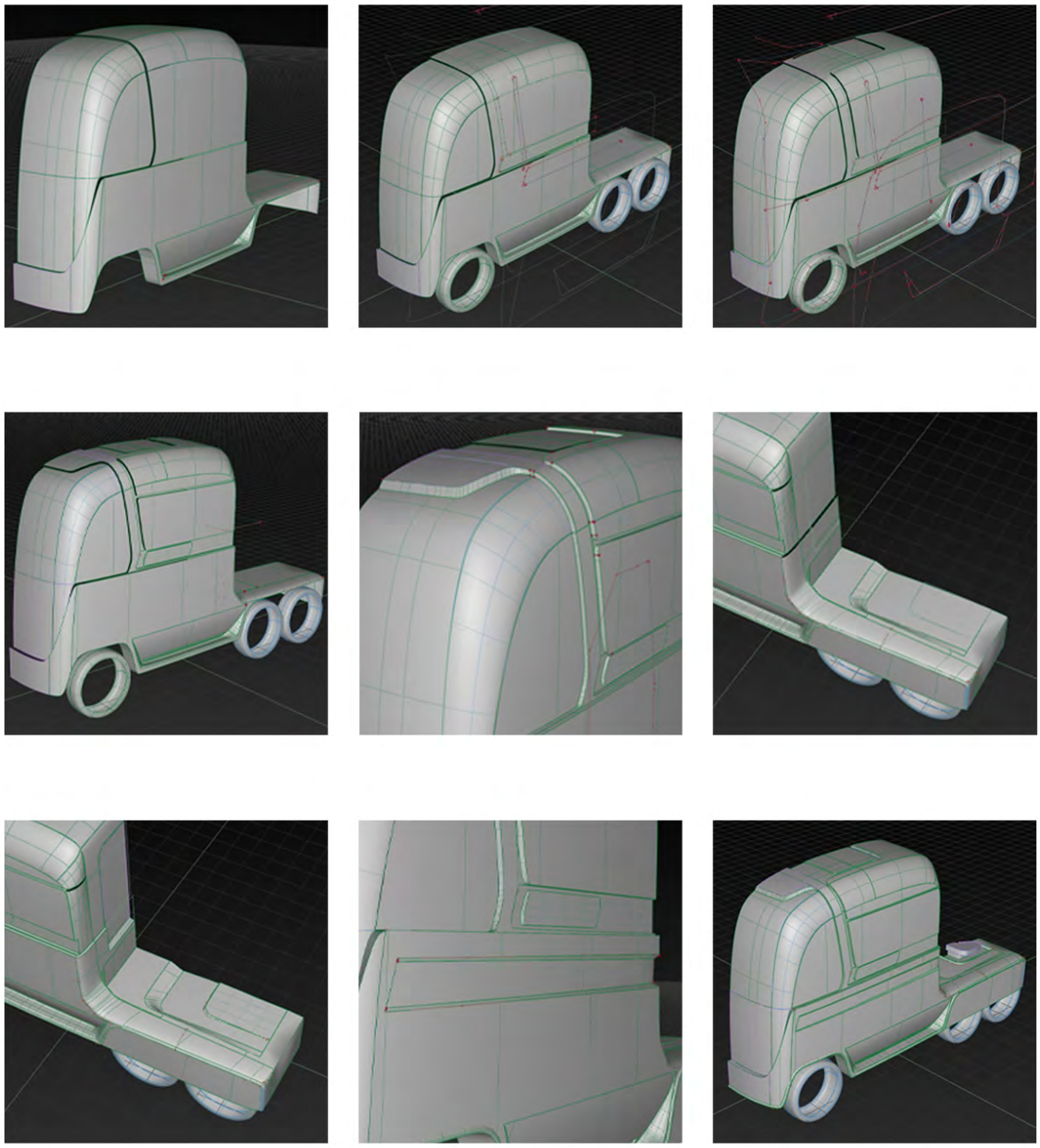


Figure 76 - CAD Development: Body Details

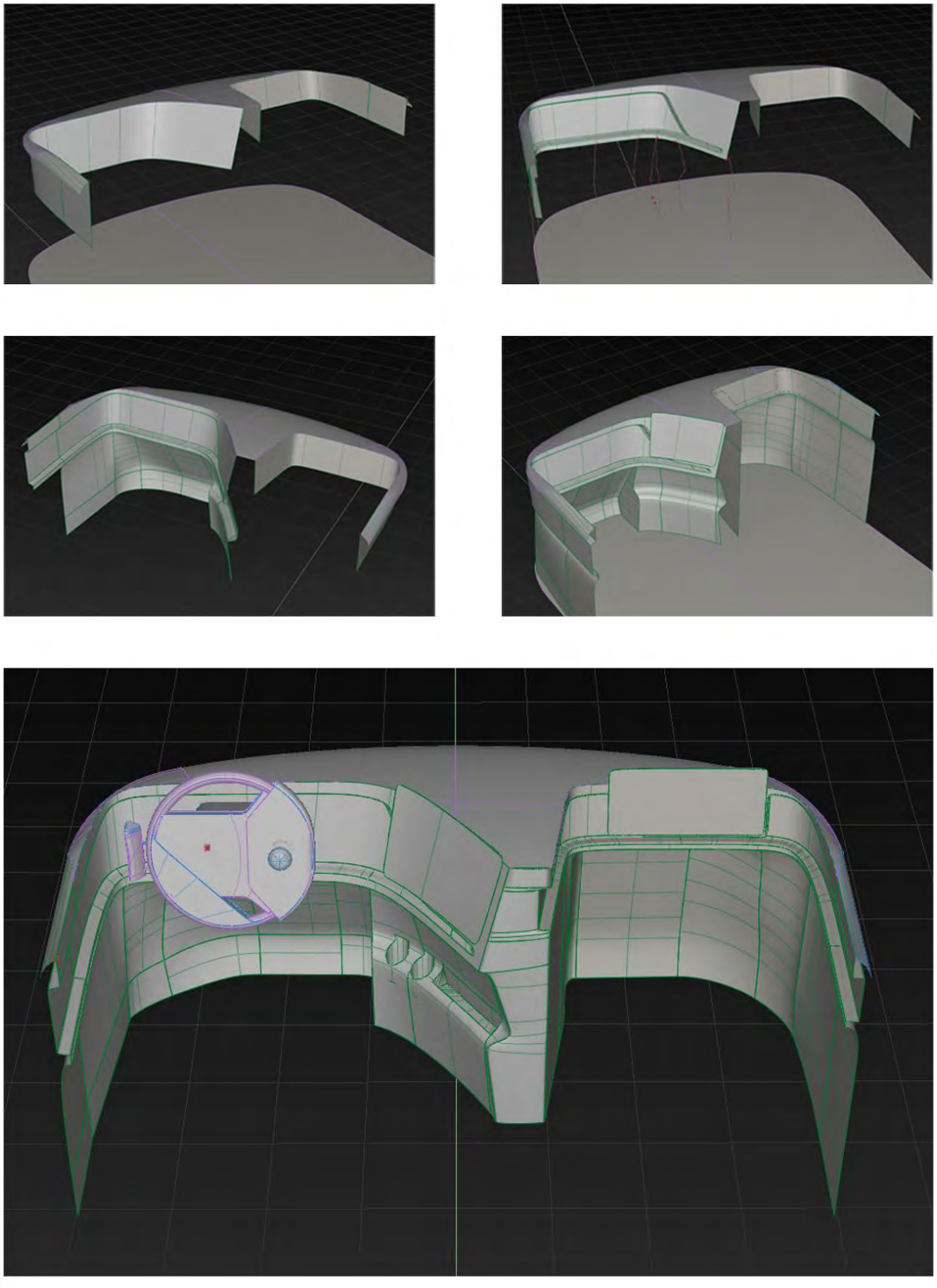


Figure 77 - CAD Development: Dashboard

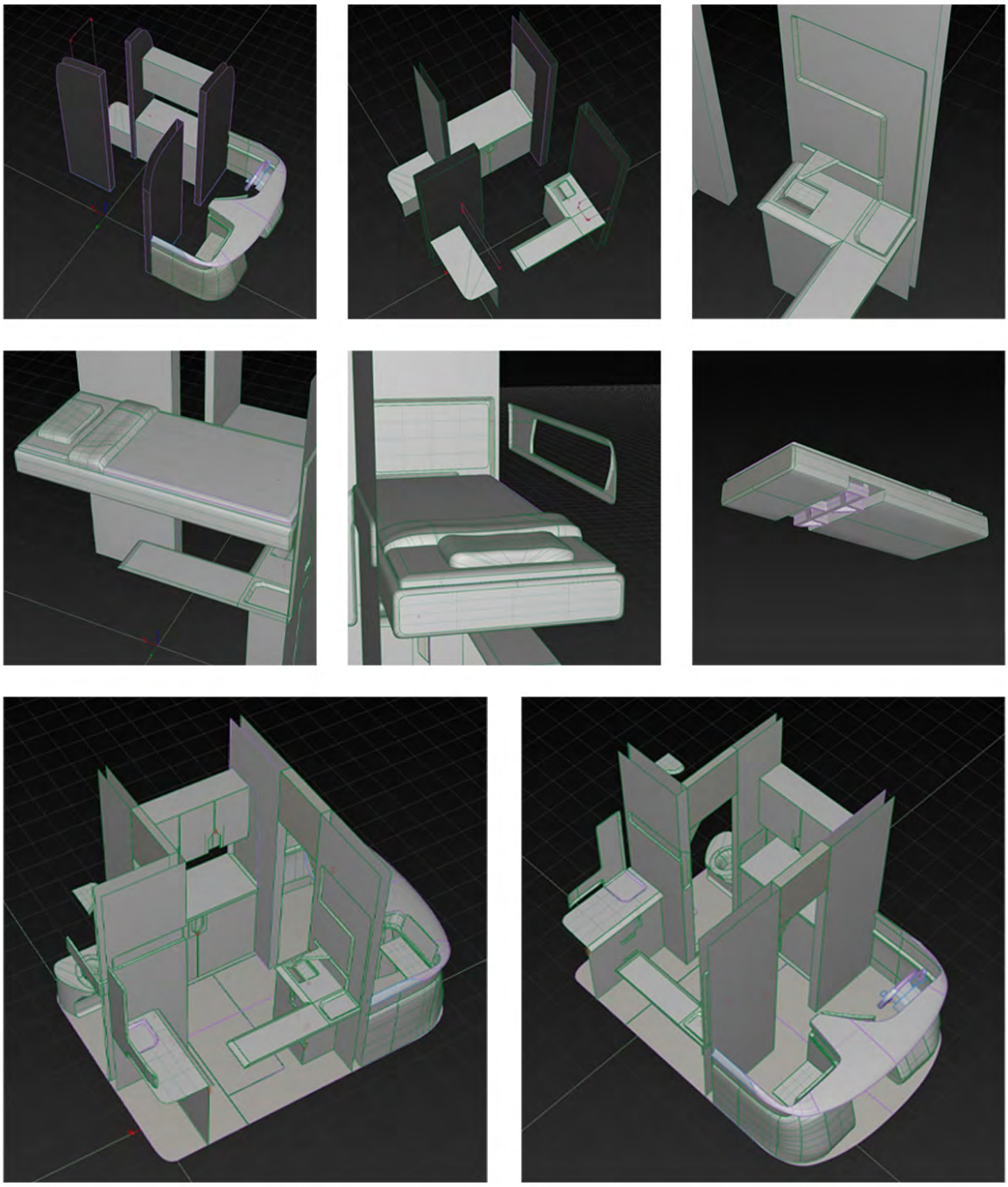
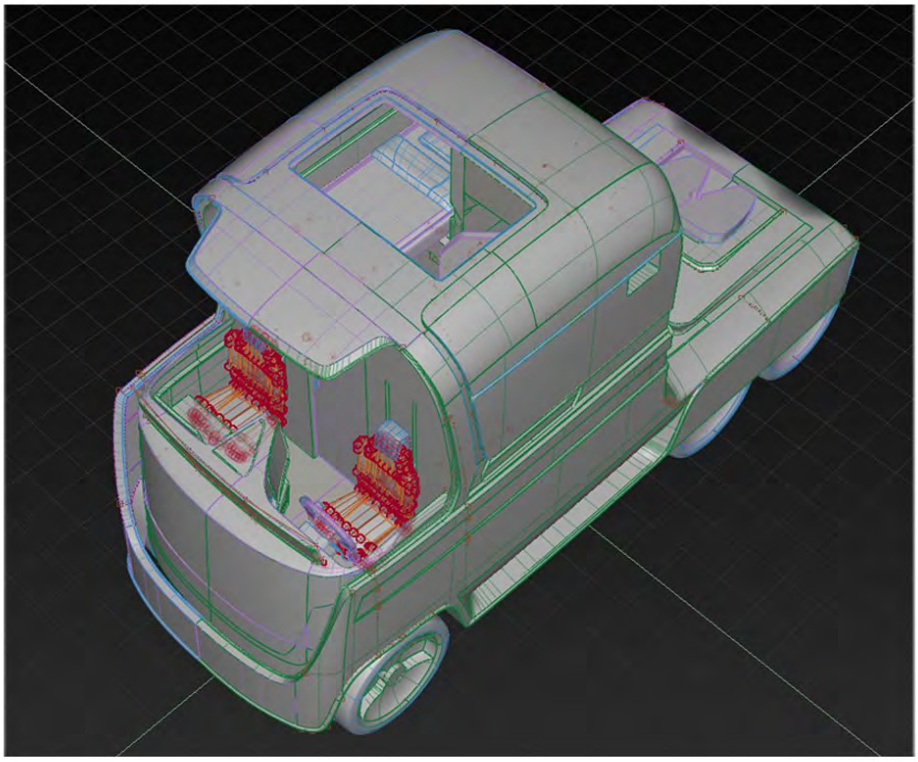


Figure 78 - CAD Development: Living Quarters



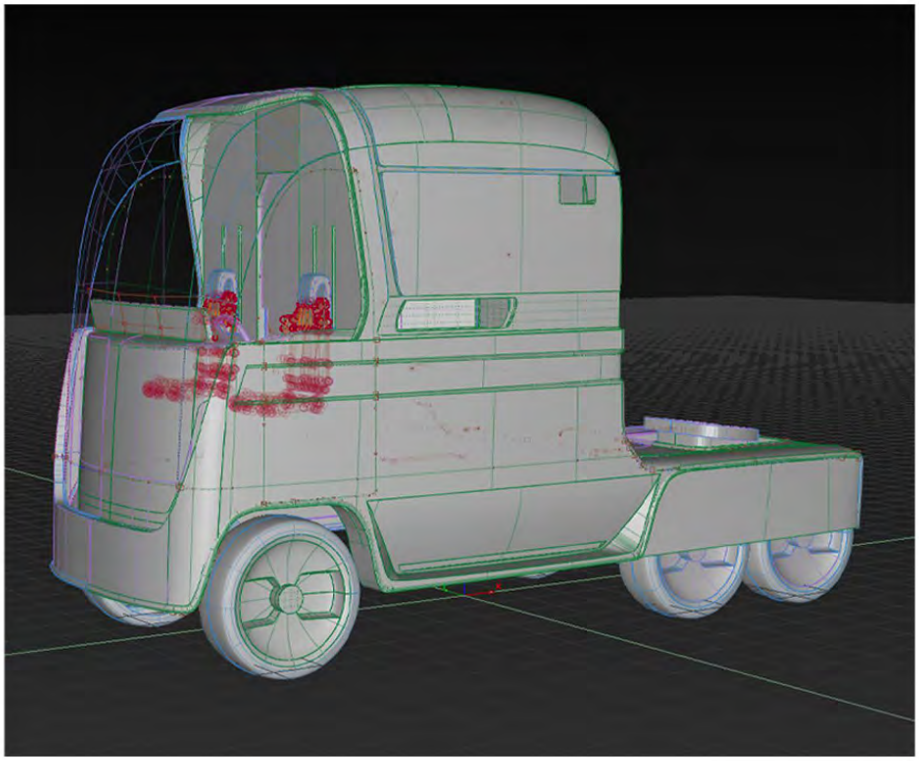


Figure 79 - CAD Development: Finished Model

The CAD process about a month to complete. The entire model was done using Autodesk Alias 2021. Alias is surface modeling program that excels at creating complex surfaces, which was handy for this model. For this reason it is the standard CAD modeling tool across the automotive industry. The CAD process was long but generally smooth, there were not a lot of progress-halting issues that interfered with completion. The use of Alias however meant that the model could not be 3D printed easily. All of the surfaces in the model have zero thickness, meaning that a solid 3D print could not be produced for modeling purposes.

4.8. Physical Model Fabrication

The final model was made using a myriad of different modelmaking materials including illustration board, foam core, pink foam, industrial clay and 3D Printing. As mentioned, the model needed to be made by hand because of the use of Alias. After the model was made in Alias, the interior cabinetry was reconstructed in Solidworks so that it could be 3D printed. This was done because of their simple construction; they were easy to build in Solidworks and did not waste much time. And whilst those pieces were printing, the other parts of the truck were made.

The model took about 4 days to build, after which the gaps in the model were filled using bondo. Unfortunately because the model was hand built, some of the mistakes were too large to fix by simply using bondo. Nevertheless the small gaps were sealed, and the bondo was sanded smooth before being primed with grey Krylon spray primer. After the primer dried, 600 grit sandpaper was used for final touch ups, then it was primed again.

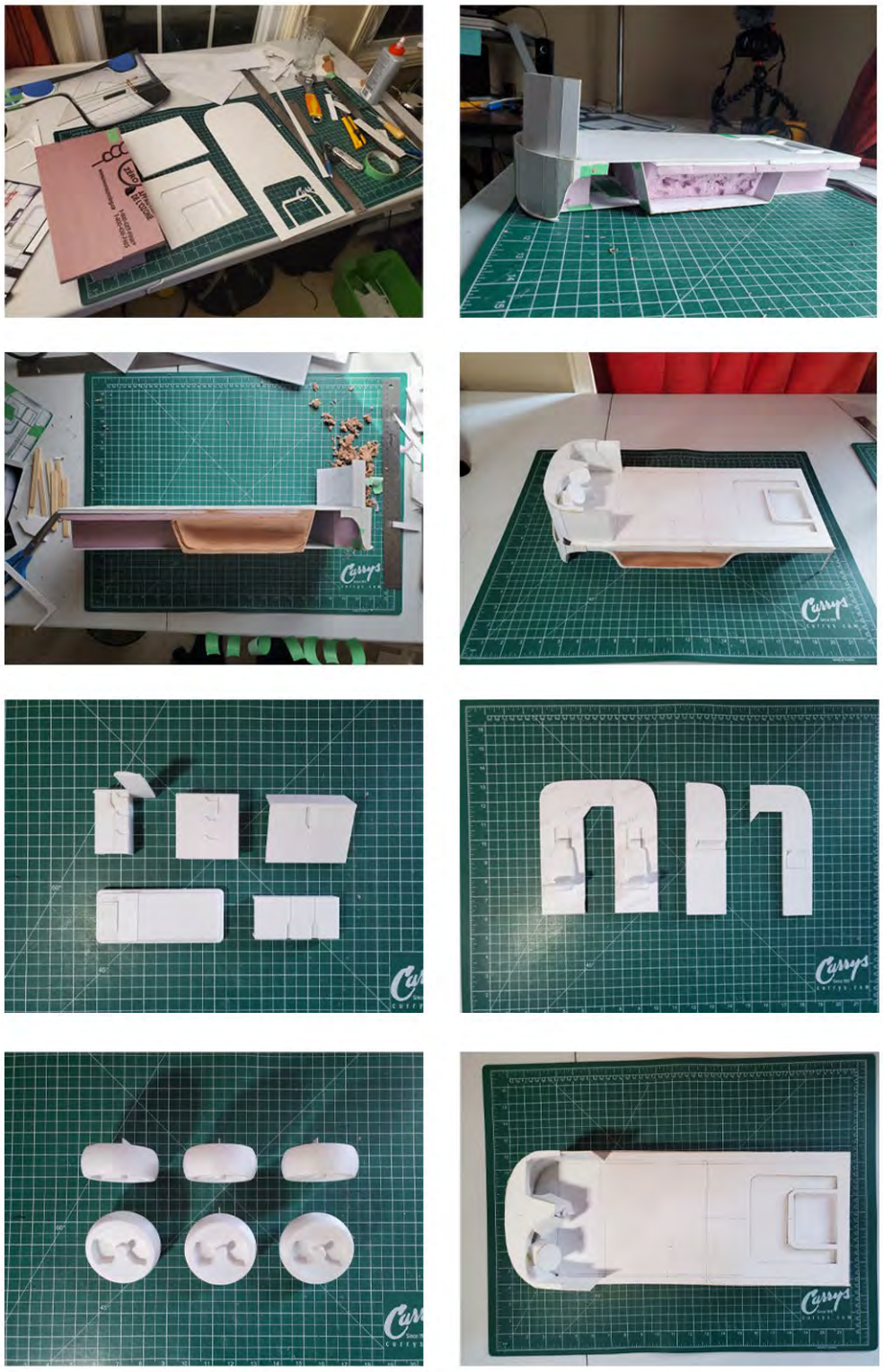


Figure 80 - Physical Model Fabrication 1

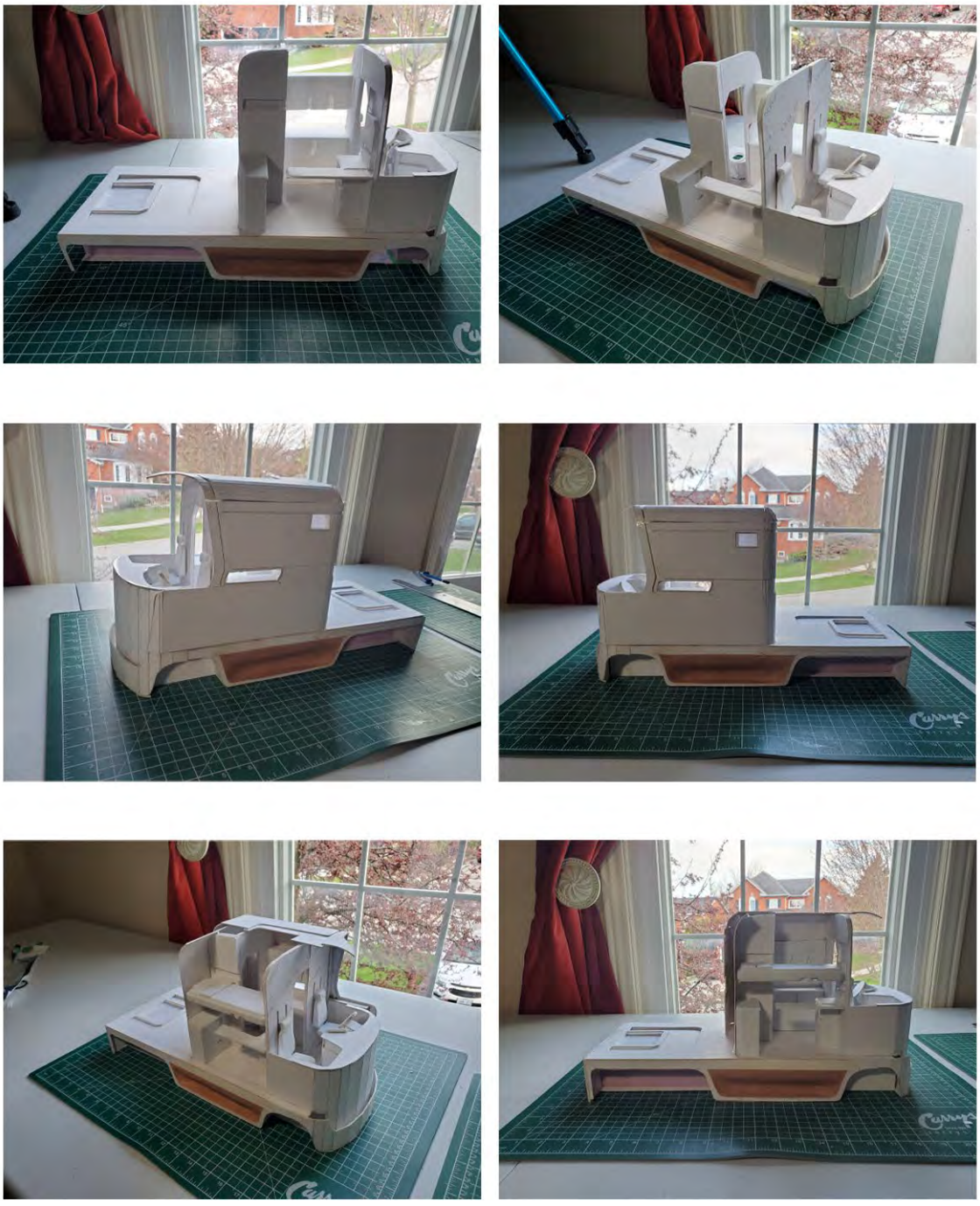


Figure 81 - Physical Model Fabrication 2

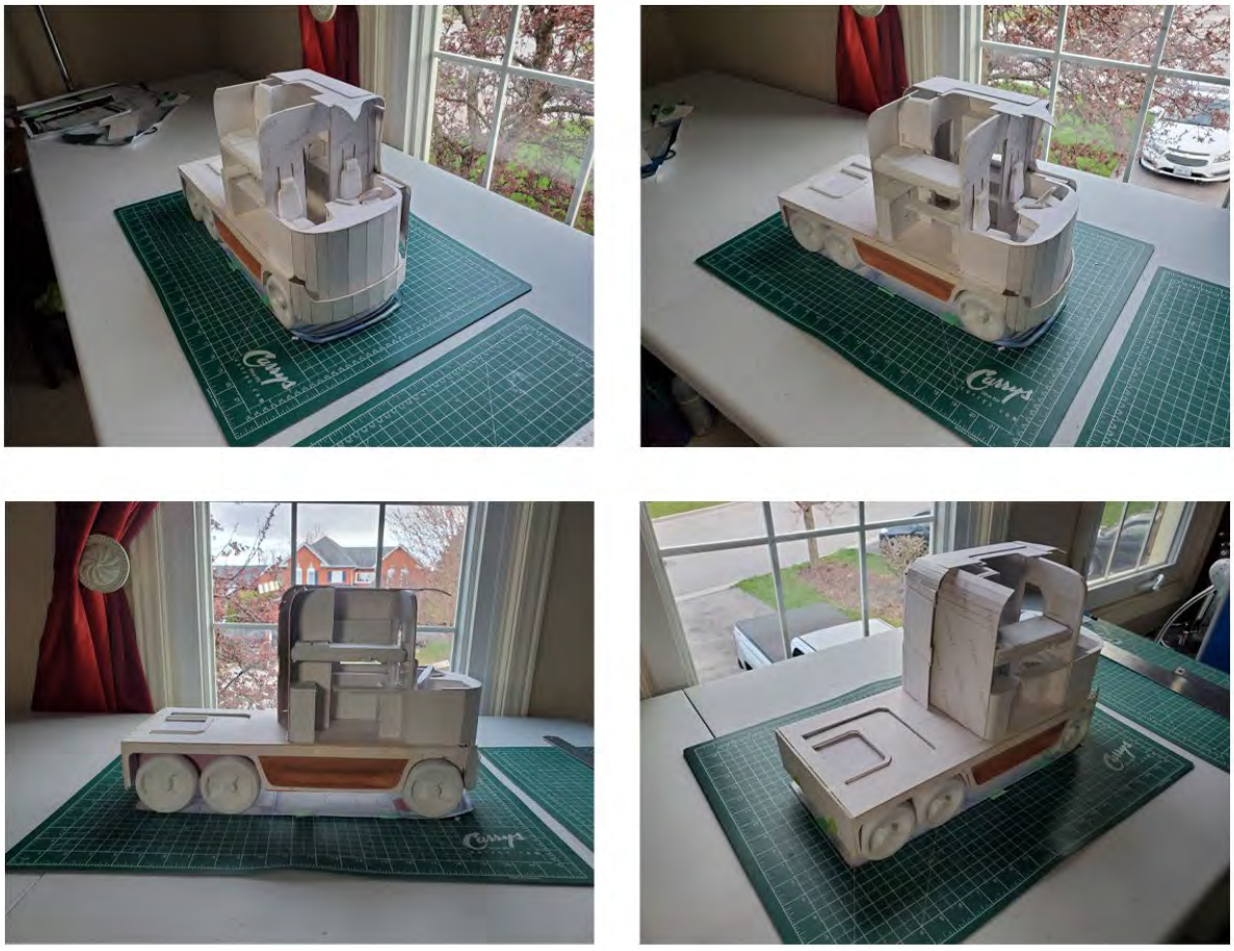


Figure 82 - Physical Model Fabrication 3

CHAPTER 5 – FINAL DESIGN

Figure 83 - Truck on Country Road - Retrieved from Unsplash

5.1. Summary

5.1.1. Description

HORIZON is an enhanced sleeper semi-truck that makes use of modern EV technology to expand the interior and make the truck more livable for long-haul truck drivers. It provides the means for drivers to stay healthy, active and self-sufficient while on the road, and mitigates health risks related to the job currently.

5.1.2. Explanation

The long-haul truck transportation industry is responsible for delivering essential goods to consumers all around the world. Long-haul truck drivers are required to work and live on the road in their trucks for days or even weeks at a time. Current sleeper trucks are adequately built to be lived in for long periods of time. The confined environment of current sleeper trucks can cause serious detrimental health effects. The lack of ergonomic innovation and proper living amenities can result in musculoskeletal disorders and cardiometabolic diseases, which affects the drivers overall mental health as well as their job performance. These living conditions make the long-haul trucking job undesirable and is resulting a high turnover rate across the trucking industry.

HORIZON makes use of EV technology to create a space that can house the means to a healthy/active lifestyle on the road. It includes a uniquely designed cockpit that mitigate the effects prolonged and repetitive driving motions, and has a dedicated living quarter where the driver can prepare fresh meals, wash up and sleep. All this while maintaining the same footprint as an average sleeper truck.

5.1.3. Benefit Statement

HORIZON makes use of the expanded interior space to provide the means to healthier lifestyle while on the road. Providing the driver with these means will allow them become more self-sufficient,

and drivers will not be at the mercy of truck stop facilities for healthy food and washrooms. This will improve the quality of life and job performance of drivers, which will make long-haul truck driving a more desirable profession and lower the turnover rate across the trucking industry. HORIZON's use of EV technology and renewable materials means it will not emit harsh diesel fumes into the atmosphere, and will lower the overall carbon footprint of the vehicle.

5.2. Design Criteria Met

5.2.1. Full Bodied Interaction Design

Figure 84 - Full Bodied Interaction Design 1

Full body interaction design techniques were used throughout the process of designing HORIZON. HORIZON provides an entire environment that the user works in and lives, this made a full ergonomic study extremely important to ensure that not only can the vehicle be used effectively without strain but also enjoyed by the driver. The ergonomic study used the measurements of the 99th percentile male and the 5th percentile female to gauge the size of the interior features. The features are sized such that they

can be used effectively by both percentiles and take up the least amount of floor space possible while still being useful. Overall the entire vehicle provides a unique on-the-road environment that serves as an effective workspace and livable home.

Cockpit

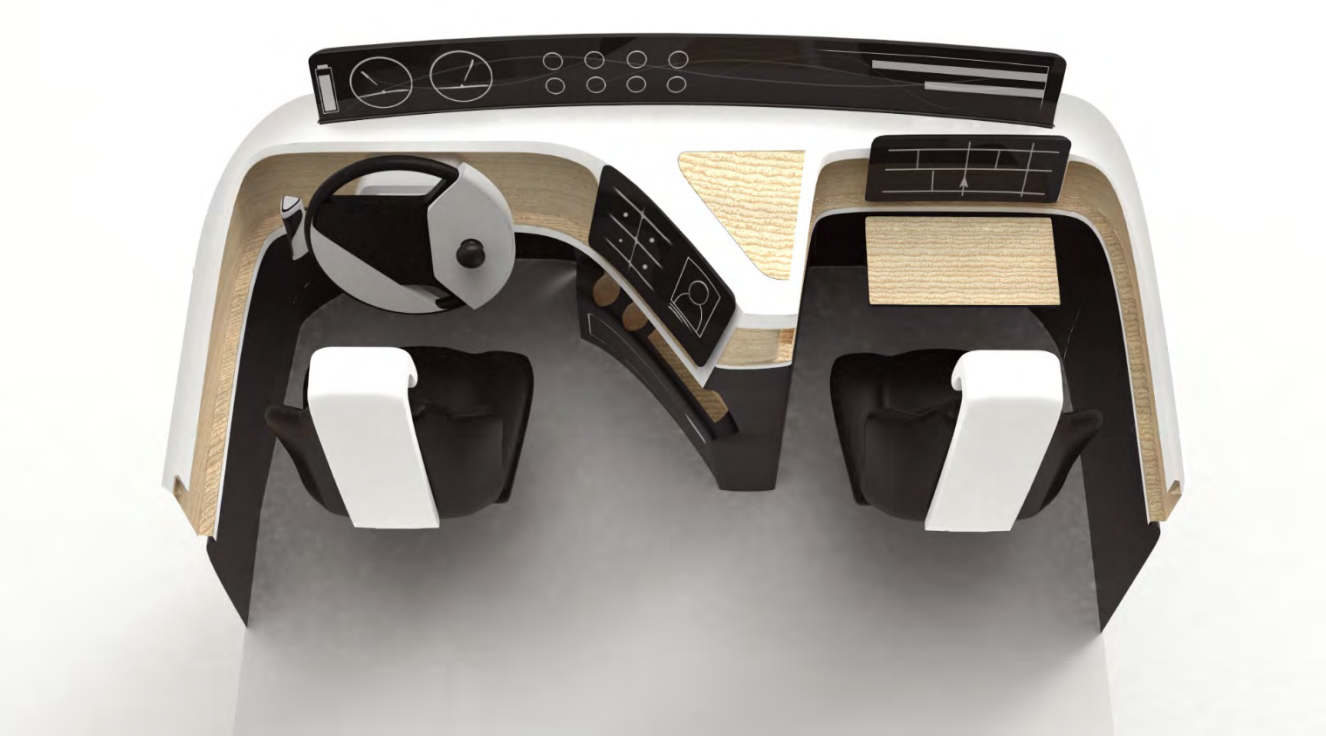


Figure 85 - Full Bodied Interaction Design 2

HORIZON’s cockpit provides a more ergonomically friendly dashboard and seat that enhances the vehicle operating experience and mitigates the risk of musculoskeletal injuries. The adjustable seat and steering column allow the driver to use the standing orientation of the seat. Long-haul drivers are at the wheel for 11 hours a day, the prolonged sitting can cause aches and pains in the back and shoulders, and occasionally more serious health issues like thrombosis. The standing orientation of the seat promotes better posture and has the driver on their feet even while driving, mitigating the effects of prolonged sitting. The dashboard features an angled instrument panel for accessing vehicle controls

and infotainment features. The large curved display is used for vehicle readouts like battery life, speedometer, tachometer, etc. As well as information regarding vehicle systems and information coming from outside the truck. The glove box has also been moved to beneath the instrument for easy access by the driver. At the passengers seat, where the glovebox would be, there is an onboard computer system and pullout table for filling out paperwork and planning routes. This dedicated space can be used by the passenger while the driver is driving, or by the driver when parked. This feature is meant to simulate a desk, a space where work is to be done. And by providing this space, the on-truck tasks of the job are localized to the cockpit, meaning that the living quarters can be its own space that is not affected by the jobs tasks. This creates a mental divide between the working and living spaces which can increase productivity and improve quality of rest.

Living Quarters

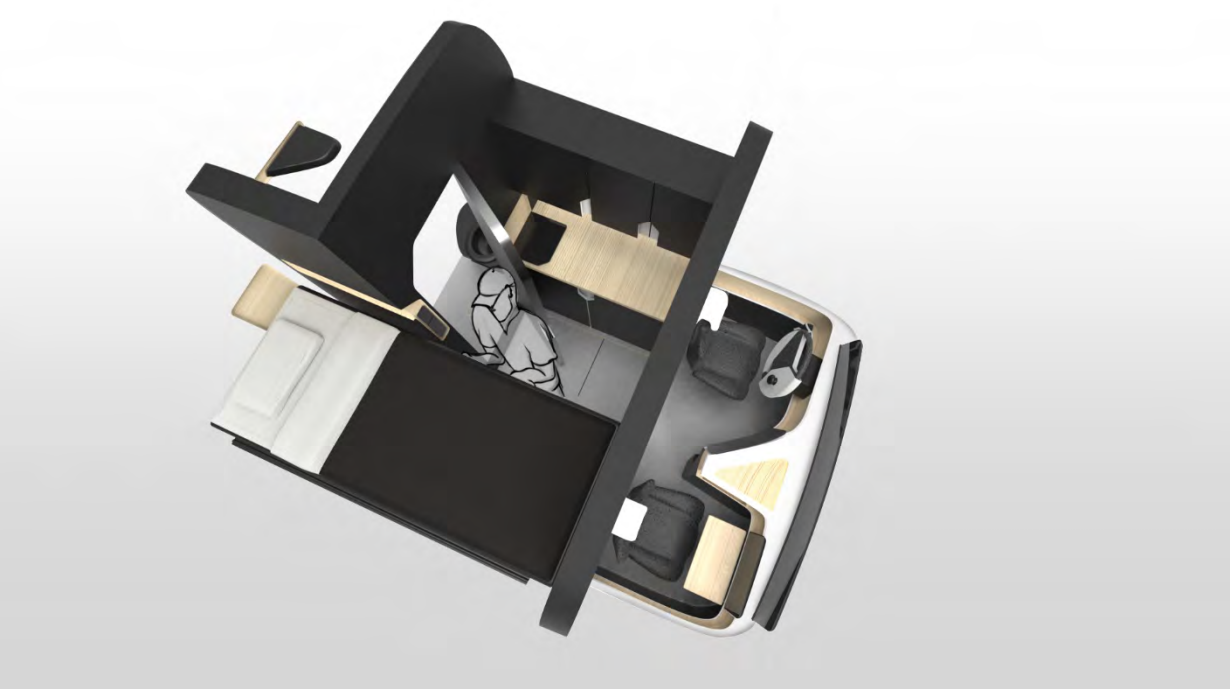


Figure 86 - Full Bodied Interaction Design 3

HORIZON’s living quarters provides the driver with the means to live a healthy/active lifestyle while on the road. Though still a small environment, it includes a lot features that will improve the quality of life of drivers. Everything in the living quarters, has been designed with ergonomic considerations in mind to ensure ease of use and enjoyment.

Kitchenette

Figure 87 - Full Bodied Interaction Design 4

The interior includes a kitchenette with a fold down stovetop that can be used to prepare fresh cooked meals, as opposed to relying on microwave meals and truck stops. The kitchenette also provides a fridge and adequate food storage, as well as storage for cooking and eating utensils. There is also a sink across from the kitchenette that can be used for cleaning dishes and other general purposes.

Two-In-One Washroom

Figure 88 - Full Bodied Interaction Design 5

An onboard two-in-one toilet and shower has been designed so the driver does not have to rely on truck stops for washrooms and showers.

Bunk Bed

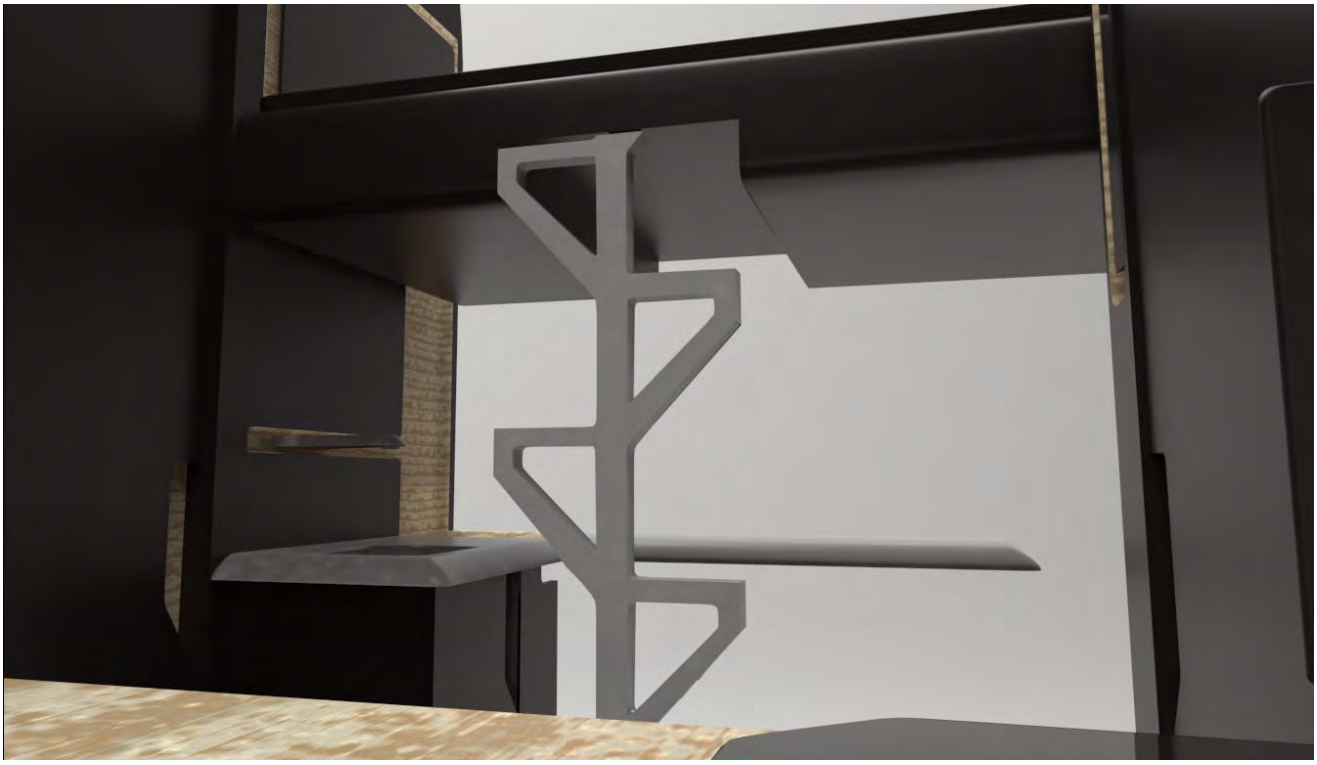


Figure 89 - Full Bodied Interaction Design 6

The bunk bed can be unfolded from against the wall when the driver wants to sleep. And attached to the bottom of the bed theres a foldout ladder for the driver to use to get up to the bed. At the end of the bed there is a OLED television that can provide some late night entertainment.

Treadmill

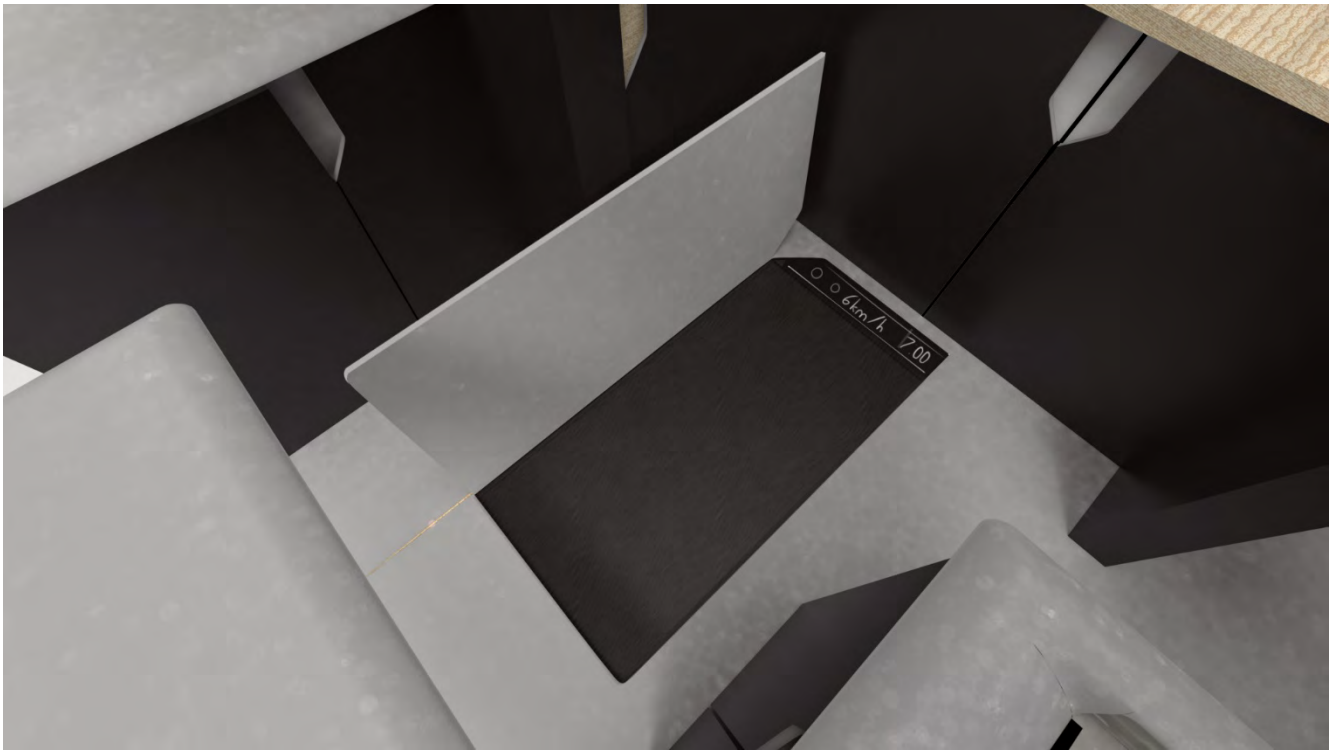


Figure 90 - Full Bodied Interaction Design 7

The hatch in the floor reveals a treadmill that can be used for light exercise. When the weather is poor or if the driver simply does not want to venture out the truck, the treadmill can be used to get exercise after 11 hours of driving.

5.2.2. Materials, Processes and Technology

Many materials were considered when it came to the design of HORIZON. The chassis and body paneling will both be made out of aluminum to ensure lightweight and strength. The construction of these pices will remain largely similar to how they are currently constructed, using various combinations of stamping, bending and casting. The various materials and parts needed for electrical components will be outsourced to a company that shares a similar vision of the sustainable manufacturing. Sheets of bamboo wood will be outsourced and steam bent into the proper shape for

the exterior accents. Bamboo sheets will also be kerf cut and bent to be used for the interior accent pieces. A current manufacturing method for mycelium products is to have the mycelium grow into a mold of the shape that's required. This method will be implemented on a larger scale for the construction of the dashboard. The material processing and manufacturing methods will be conducted by companies that share a vision for sustainable design and manufacturing. Companies that are committed to cutting carbon emissions where they can throughout the manufacturing process. This will lower the carbon footprint of HORIZON even further.

5.2.3. Implementation feasibility & Viability

The total cost of the materials and manufacturing will require further study as this project moves forward. As more electric semi-trucks become available, researching proce points has become slightly easier. However no truck like HORIZON exists yet, especially with the use of wood and mycelium. Based on online research and by comparing the cost of current electric semi-trucks, a rough bill of materials was produced.

Bill of Materials				
Class A				
Component	Material(s)	Description	Manufacturing Methods	Cost
Chassis	Carbon Steel	Structural frame of the vehicle.	Metal folding and pressing	$30,000
Body Paneling	Aluminum Bamboo	Paneling on the exterior of the vehicle.	Deep drawing and stamping (aluminum) Steam bending (bamboo)	$20,000
Electric Motors	Various	Attached to chassis, used to propel the vehicle.	Various	$8,000

Battery	Various	Vehicle power source.	Various	$15,000
Class B				
Component	Material(s)	Description	Manufacturing Methods	Cost
Rims	Aluminum alloy	Attaches to axel, holds tire.	Die casting	$1000 (x6)
Tires	Rubber	Provides adequate ground traction .	Tire builder	$600 (x6)
Dashboard	Mycelium	Made from mushrooms, houses main vehicle controls.	Casting	$6000
Extendable steering column	Carbon Fibre	adjustable for ergonomic support when sitting or standing at the wheel.	Die casting	$2000
OLED Displays	Various	Used for various screen displays around the truck.	Various	$2500
Seats	Pinatex Leather	Made from pineapple leaf fibres.	Upholstered and sewn	$500
Class C				
Component	Material(s)	Description	Manufacturing Methods	Cost
Interior Walls	Starch based bioplastic	Organizes the layout of the interior. Houses some electrical components .	Thermoforming	$8000
Interior Flooring	Vinyl Flooring	Used for entire truck cabin.	Thermoforming	$1000

		Provides homey feel .		
Cabinet Walls/Doors	Starch based bioplastic	Used for storage.	Injection molding	$1000
Cabinet Tops/Tables	Starch based bioplastic	Used for holding item and performing various tasks.	Injection molding	$1000
Interior Wall Insets	Bamboo	Aesthetic detail. Provides space for various features to be put.	Kerf bending	$2000
				TOTAL $130,900

Table 17 - Bill of Materials

5.3. Final CAD Rendering

Figure 91 - Final CAD Rendering 1

Figure 92 - Final CAD Rendering 2

Figure 93 - Final CAD Rendering 3

Figure 94 - Final CAD Rendering 4

Figure 95 - Final CAD Rendering 5

5.4. Physical Model

The physical model was made mostly by hand using illustration board, foam core, pink foam, and industrial clay. The interior cabinets were 3D printed on a purchased Creality Ender 3 printer using white PLA filament.

Figure 96 - Physical Model 1

Figure 97 - Physical Model 2

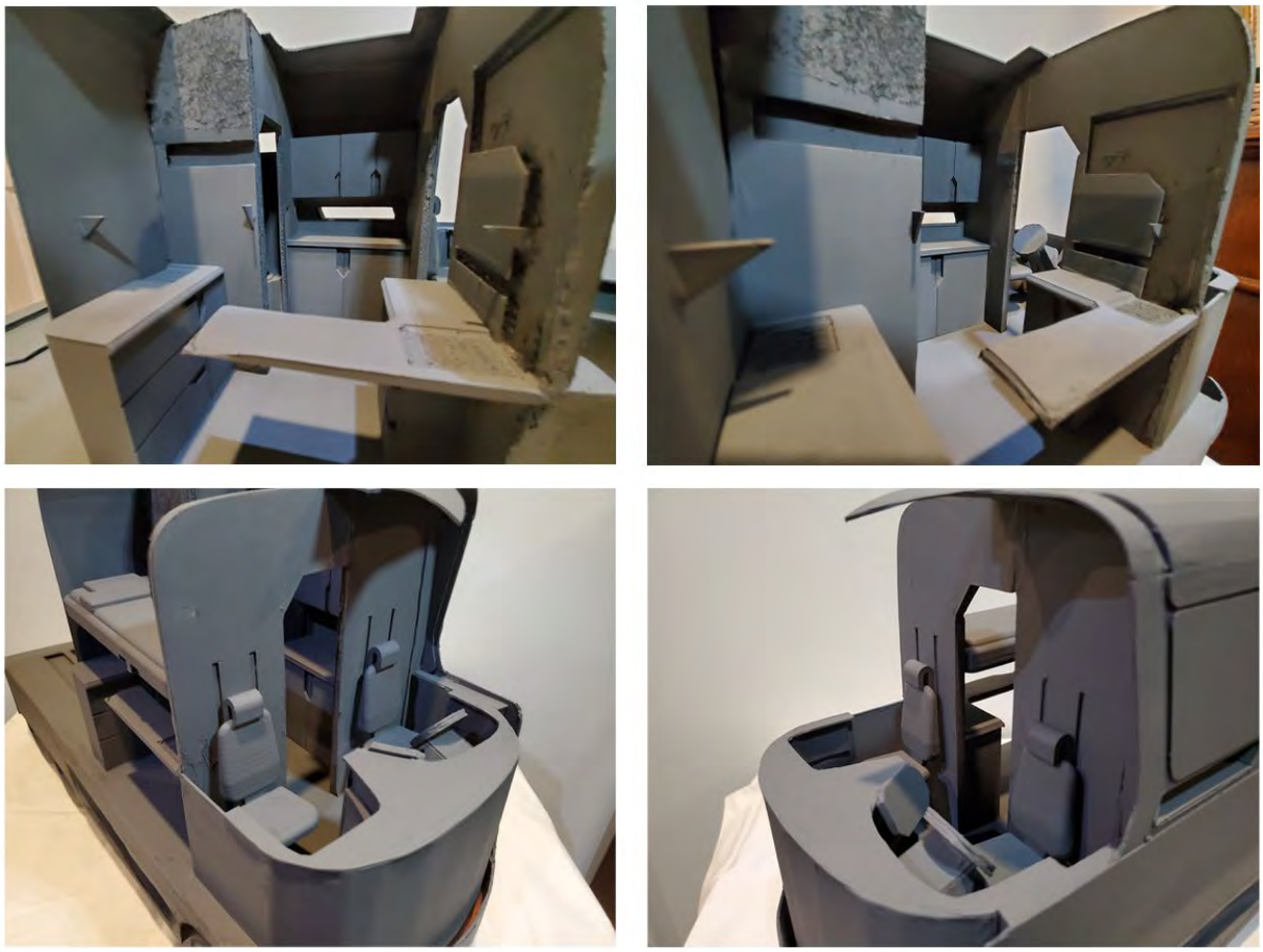


Figure 98 - Physical Model 3

5.5. Technical Drawings

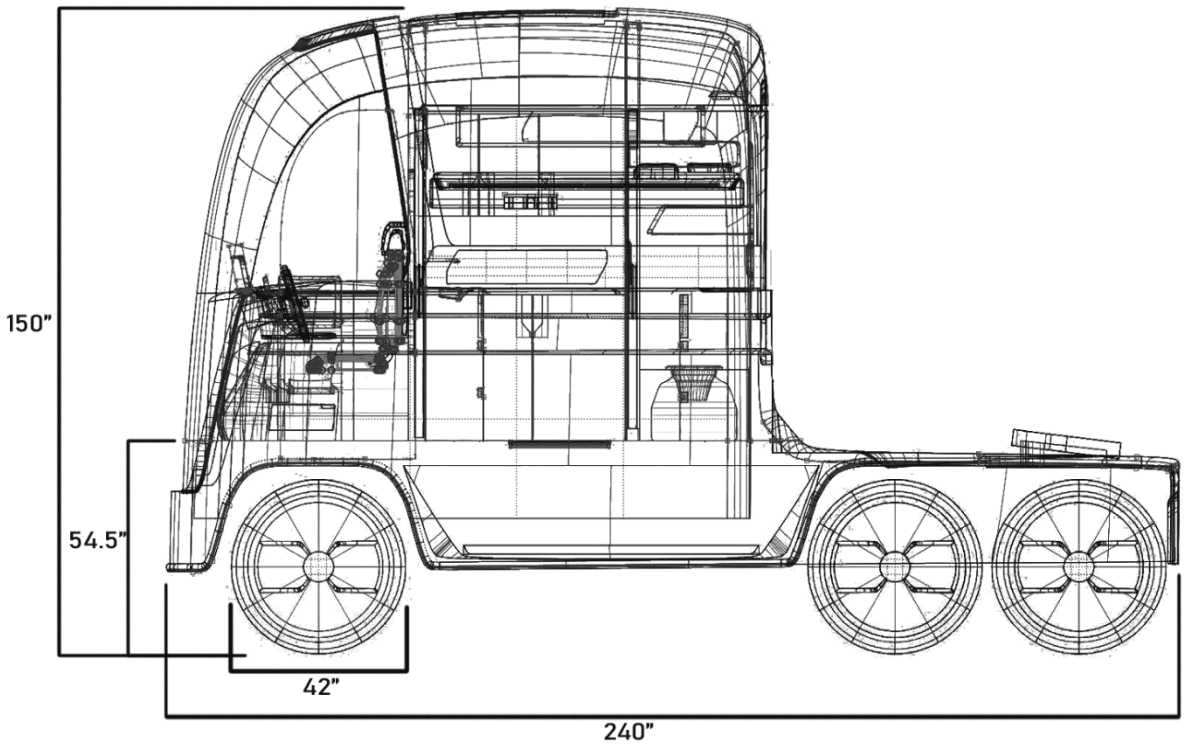


Figure 99 - Technical Drawing 1

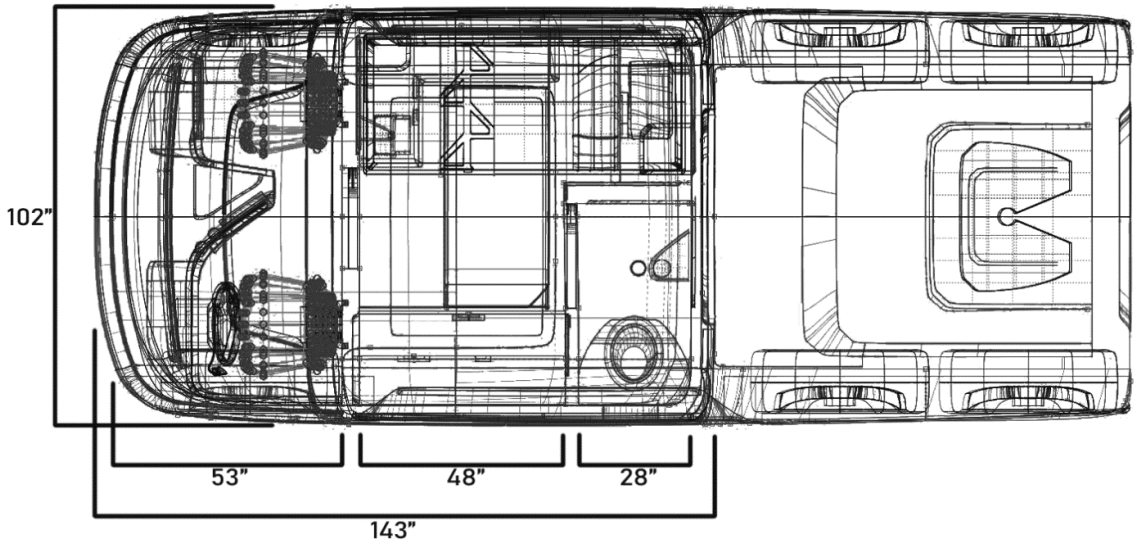


Figure 100 - Technical Drawing 2

5.6. Sustainability

The trucking industry has been criticized for being responsible for excess diesel emissions. It is not uncommon for long-haul drivers to leave their trucks on over night for the sake of how power in the interior. Trucks sometimes need to remain on in order to use the heating and cooling untis, which poses a problem for drivers when they are in extremely hot or cold weather. Not to mention it also poses a problem for drivers adjacent to idling trucks, who have to try to sleep while a truck runs right next to them all night. HORIZON makes use of electric power to eliminate the harsh diesel fumes emitted into the atmosphere. While parked, the interior can silently remain powered which will give nearby drivers peace and quiet overnight.

HORIZON also makes use of sustainable materials. The interior and exterior make use of bamboo as an accent colour and material. This gives HORIZON a natural feel. The seats are made from Pinatex leather which is a vegan leather made from pineapple leaf fibres. And the dashboard is completely made out mycelium, which replaces the harsh plastics used to create dashboards currently. All these materials contribute in helping lower the carbon footprint of HORIZON.

CHAPTER 6 -CONCLUSION

Figure 101 - Conclusion: In Situ

Long-haul truck drivers are essential workers that are responsible for delivering goods to consumers in every country and locale around the world. However, the trucking industry still battles with high turnover rates, the industry can recruit drivers but cannot make them stay for very long. The Problem is that current sleeper semi-trucks do not properly equip the drivers wit the amenities needed to live healthily. And the truck features can be the cause of serious musculoskeletal and cardiometabolic health risks. If a driver is struck with a health problem, that can affect mental health, and in turn their happiness and job performance.

HORIZON is an enhanced sleeper semi-truck that was conceived because of these issues. It makes use of electric vehicle technology and innovative materials to create a unique on-the-road environment that can be lived and worked within easily. The full body interaction design approach ensures that HORIZON can be used effectively by many different users. The new truck space will allow the driver to live a healthy/active lifestyle whilst on the road, without having to depend upon truck stop facilities.

HORIZON will make long-haul trucking more enjoyable for new drivers to come, who will not suffer the same health risks of those currently living in sleeper trucks. And this will in turn help the trucking industry retain more drivers.

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CHAPTER 7 - APPENDIX

Figure 102 - Appendix In Situ

Appendix A - Discovery

How might we improve the livability and working conditions inside of sleeper semi-trucks?

Long-haul truck drivers are on the road for days and sometimes even weeks at a time, during this time they are living in the confined space of their truck all alone. The living space these trucks provide as well as job related issues, causes poor mental health in the drivers and poor lifestyle choices like unhealthy eating, and sleep deprivation. This often causes a lot of drivers to quit their jobs, which is why the long-haul trucking industry has a high turnover rate, they can get drivers to come but cannot get them to stay.

This topic has been chosen because of the importance of the trucking industry, truckers are often time essential workers and their service is needed to keep other businesses running. Rethinking the interior of sleeper trucks will not only benefit drivers mental and physical health, but it also help the trucking industry find and keep new drivers for a longer period of time, and in turn help customers that these trucking companies serve.

Tabulated data

USER	PRODUCT	ENVIRONMENT
Primary User Long Haul Driver (Owner operator/independent contractor) Tasks - Operate Truck and Trailer - Pre and Post Trip Inspections - Shipping Freight - Activity Logging - Checking for properly secured freight - May ship dangerous goods	Truck Seats Cons - Usually cloth (harder to clean and holds stains) - Not always built to so suit the job (pains from prolonged sitting, bulky, takes up space) - Can cause musculoskeletal disorders - Theres often two seats (is that needed?) Pros - Built with proper sitting support	Freight terminals - Airports, seaports, railroad terminals, trucking terminals - Truck terminal is where trucks are stored and dispatched - Trucking companies have trucking terminals for receiving and distribution of goods - Lots of activity happening in these environments - Requires driver to be alert

Challenges - Strict time constraints - Long Hours - Monotonous Tasks (low stimulation) - Lack of physical activity (lots of sitting down) - Social Isolation	- Very adjustable Notes - Can the second seat fold down? - Could the first seat fold down? (More space?)	
Primary User Long Haul Company Driver Tasks - Operate Truck and Trailer - Pre and Post Trip Inspections - Shipping Freight - Activity Logging - Checking for properly secured freight - May ship dangerous goods Challenges - Strict time and route constraints - Long Hours - Monotonous Tasks (low stimulation) - Lack of physical activity (lots of sitting down) - Social Isolation	Auxiliary Power Units (APU) Cons - Can only be accessed from outside of the cab - Trucks are not always given an APU, meaning the engine has to be on in order turn on heat/AC when sleeping, huge environmental issue Notes - How can we better integrate an interior power source?	Warehouses - Warehouses are where trucks are loaded with goods to be shipped - Warehouse workers load goods into trailers, often using forklifts - Driver is responsible for driving trucks out of the dock, stopping to get out and close the trailer doors and continue to drive them to their destination - Requires driver to be alert
Secondary User Shunter	Food Storage	Rest Areas

Tasks - Move trucks and trailers around truck yard - Sometime suing designated shunter vehicle - Driving sort distances frequently Challenges - Using trucks that are not built for driving short distances - Frequent exposure to diesel fumes	Cons - Lack of adequate food storage (not a lot of refrigeration) - Dry, pre packaged food is easier to manage given the truck storage space, which could encourage poor eating habits - Poor diet means a higher risk for obesity or other CMD's - Lack of adequate food prep station Notes - How can we change the interior in such a way that it encourages better eating habits?	- Places for trucks to park for when drivers are on break or finished for the day - Sometimes they have fast food restaurants, or even "Driver Only" restaurants - Occasionally have convenience stores - Truckers will sleep in their cabs while at these rest areas, use their entertainment devices, or even engage in conversation with other drivers (although that is less common)
Secondary User Mechanic Tasks - Finding mechanical issues inside trucks - Repairing broken trucks - Short test drives Challenges - Frequent exposure to diesel fumes	Truck Internals Problems - Use a lot of diesel fuel, bad for the environment - Truckers are often exposed to diesel fumes a lot when managing their own truck or sitting at truck stops and rest areas. - Increased risk of breathing problems like wheezing and coughing, as well as lung cancer	Truck Cab - The cab is where the drivers work and live, its their home away from home, or even their "home" home in some cases - The space is small, compact living tactics are necessary in this environment - This is also where the drivers personal belongings are stored, and where the driver eats - Very solitary - Noise cancelling is needed for proper rest

		- Proper insulation is needed for proper comfort while living in cab - Cab does not always have its own power unit
Secondary User Driver Supervisor Tasks - Managing certain groups of drivers - Occasional ride alongs - Speaking to management on behalf of drivers Challenges - Relaying information from drivers to management - Managing large groups of drivers - Risk of injury from occasional ride alongs	Dashboard Pros - Trucks often include an angled dash board, making it more ergonomically friendly for the driver Cons - Don't always include a screen (makes gps usage less convenient) - Appears cluttered - Glove box cannot be easily accessed by driver Notes - How much more do drivers use their phones instead of the built in gps? - Does the interior even need a glove box?	Customer Facilities - Where freight is delivered and dropped off - Drivers might need to wait in order to drop off freight (this can be stressful for drivers who are on tight schedules)
Tertiary User Drivers Family Challenges	Steering wheel Pros - Standard shape	Arid Environments - Drivers might need to travel through areas that are hot and dry - In these areas, proper insulation is important

- Face stress for Drivers well being - Can be subject to poor behaviors developed by drivers - Marital strain	- Certain controls are easily accessible on the steering wheel - Adjustable positioning Notes - Could steering wheel be improved in anyway?	for drivers to feel comfortable while sleeping, as well as cool air flow
Tertiary User Warehouse Workers (Truck Loaders) Tasks - Load freight on to trucks - Operating forklifts - Managing loading docks Challenges - Can be subject to poor behaviors developed by drivers	Bed Pros - Usually foldout Cons - Not a bunk bed (takes up a lot of floor space otherwise	Frigid Environments - Drivers may need to travel through areas that are freezing cold - In these areas, proper insulation and adequate heating are needed for drivers to get proper rest
Tertiary User Customers Challenges - Can be subject to poor behaviors developed by drivers - May be late to attend truck delivery (can aggravate the driver)	Entertainment Pros - Includes radio and tv - Wall plugs for charging devices Cons - No wireless internet in semi-trucks - Internet can only be accessed at stops	Unkept roads - There are situations where drivers need to drive over rough terrain - Adequate seat support is necessary for these situations to avoid discomfort, and mitigate the risk of musculoskeletal disorders

	- Could affect drivers ability to connect with friends and family	
Tertiary User DOT Inspector Challenges - Exposure to diesel fumes	Storage Pros - Includes storage for personal belongings, clothes, and dry food Cons - Space can easily become cluttered because of its size - Is the amount of storage adequate?	Highways - Driving on highways is a certainty for truck drivers - Long stretches of highway driving is not very stimulating - Risk of drivers getting drowsy while driving on the highway
	Trailer - No way to automatically close trailer doors from cab (when driving out of a dock, driver needs to get out and close them) - Not all trucks have a safe means of getting in and out of the trailer	Truck Depots - In certain systems trucks may be driven from HQ to truck depots, where different drivers will then bring the freight to the destination - Requires drivers to be alert

Table 18 - User Environment Product Table

How might we improve the livability and working conditions inside of sleeper semi-trucks? Sleeper truck cabs currently are only built as vessel that can be slept in, there is little regard for how this tiny environment will affect the physical and mental well-being of truck drivers living within them. The trucking industry today has high turnover rate, drivers are often hired but a lot leave after a relatively short period of time. This is because of the high stress of the job, and the working conditions drivers are put through. Designing a new interior for these trucks so that they are more livable, will help the drivers mental and physical well-being, as well as the trucking industry at large. The primary user of sleeper trucks are the drivers themselves because they are the only ones who are working and living in these trucks. The secondary and tertiary users are all people that can potentially face some of the

effects caused by the drivers living situation, or the truck itself. This is an automotive design project that is focused mainly on the interior of the vehicle, and the goal of the project is research new transportation technologies, as well as compact living tactics to create a new environment for the inside of these sleeper trucks to make trucks drivers jobs better. Research will be done into how drivers interact with the products within the interior as well the environment itself, as well sustainable transportation solutions to help the environment and the drivers physical health. This project will not only require a unique automotive design solution, but it will also require a lot of product solutions for the interior. Products like the seats, steering wheel, storage compartments and food storage will need to be addressed to find a proper solution to this issue. A proper in-depth study of FBHID is possible for this project, such information will be quite beneficial to have when coming up with a solution. And said solution has the potential to take on many different forms. The shift from gas powered vehicles to electric is causing a huge shift in the automotive design industry, and it is changing how people even think about designing vehicles. Making use of these new technologies will allow a new sleeper truck interior to potentially take a form no one has ever seen before.

Appendix B – Benchmarked Products

1. **Recaro Pole Position N.G. Series Seat**

   https://www.carid.com/recaro/pole-position-n-g-series-seat.html

Figure 103 - Appendix B 1

Description

Pole Position N.G. Series Seat by Recaro. It is a thoroughbred racing shell, licensed for sporty driving on the open road - even the world's most famous secret agent has already entrusted his body to it: The Recaro Pole Position (ABE) fulfills the highest demands at the interface between race track and road. A single-piece seat shell, it is made from glass fiber reinforced plastic (GRP) or from Carbon-Kevlar composite (CFRP). Its perfect ergonomics have long since made it one of the most used racing shells in club sport, and exclusive vehicle manufacturers also produce special editions with the Recaro product.

Specifications

- Single Piece
- Glass fibre reinforced plastics
- Carbon-kevlar composite
- Recaro Proprietary ergonomics
- Aggressive thigh and torso bolstering
- Flame retardant upholstery
- Replaceable seat and back cushions
- Durable foam
- FIA certified

2. **Bestop Trailmax II Pro Seats**

   https://www.autoanything.com/seats/61A7506A0A0.aspx

Figure 104 - Appendix B 2

Description

As the premier buckets in Bestop's lineup, TrailMax II Pro Seats deliver an elite level of coziness and customization. With enhanced side bolsters, sculpted lumbar support, high-density foam padding and variable-rate springs, they keep your body just as comfy on rocky roads as smooth streets. And, each Bestop TrailMax II Pro sports a 4-way adjustable headrest and a reclining lever, so you can dial in the sitting pleasure the same way you'd fine-tune your suspension.

Specifications

- Enhanced side bolsters
- Sculpted lumbar support
- High density foam padding
- Variable rate springs
- 4-way adjustable headrest
- Vinyl with fabric insert
- 20 seat back positions
- Corrosion resistant atlas frame

3. **edirb 110**

https://bride-jp.com/en/seat/edirb/110_redleather.html

Figure 105 - Appendix B 3

Description

edirb110 is a reclining seat which uses STREAMS (by BRIDE brand) as a base along with a high-functionality, high-quality seat material to create a product that's a higher grade. Its defining features are its elegant design and fine detailing. This is a seat design which aims for increased comfort during long drives and the reduction of bodily fatigue for the driver.
This reclining bucket seat were designed with ergonomics in mind to provide a solid hold and maintain a comfortable driving position, reducing the burden on muscles and lumbar vertebrae when the car moves from side to side or jolts up and down due to road conditions.
Protein Leather is a high quality synthetic leather. Its features a texture like the real leather of a high grade sofa for a smooth touch. In addition, it is perfect as a seat material for reasons such as its easy maintenance compared to real leather, its extreme superiority in terms of durability and water resistance, etc.
Back the high-fashion new material Ultra Suede highly breathable, used in the bearing surface, we further enhance the sense of quality. This allows the driver to enjoy long drives in comfort.

Specifications

- Enhanced side bolsters
- Sculpted lumbar support
- High density foam padding
- Variable rate springs
- 4-way adjustable headrest
- Vinyl with fabric insert
- 20 seat back positions
- Corrosion resistant atlas frame

4. **Wide Ride + Serta**

   https://www.bostromseating.com/en-us/product/seat/wide-ride-serta

Figure 106 - Appendix B 4

Description

The Wide Ride+Serta® truck seat redefines premium seating in the trucking industry. We've partnered with Serta®, America's leading Mattress Company, to develop the most comfortable truck seat in the market. We have integrated Serta's Cool Action™ Gel memory foam with our newest truck seat technology. Better than standard memory foam, the Serta® Cool Action™ Gel provides 2x the support and 7x the cooling ability, wicking heat away rather than trapping it near your body. Two climate options are also available; a seat heater and a heat+ventilation (leather only) system to keep you comfortable all year round.

Specifications

- Serta's cool action gel memory foam
- Seat heater
- Ventilation
- Personalized fit
- Optional 16" armrests
- Air powered bolsters
- Front and rear cushion tilt
- 23" seat surface
- High performance damper
- Air lumbar support
- Extendable cushion
- Wide Ride Serta Series isolating air suspension

5. **Minimizer – Long-haul Series Suspension Seat**

   https://www.truckid.com/minimizer/long-haul-series-suspension-seat.html#features

Figure 107 - Appendix B 5

Description

Long Haul Series Suspension Seat by Minimizer®. Minimizer Truck Seat System is designed with the driver's health and safety in mind. Leveraging decades of research in seats and suspensions by Isringhausen, an industry leader in seat manufacturing, Minimizer has incorporated ergonomics, safety and hole body health into one "system" that provides all of the desired features requested by professional drivers, and more! The Minimizer Truck Seat System meets the physical and functional demands that are inherent to operating big trucks. Minimizer is so sure that Minimizer seats will provide the comfort, support, safety and durability you require, Minimizer cover these seats with Minimizer Lifetime Warranty.

Specifications

- Adjustable armrests
- Ful swivel base
- Seat tilt adjustment
- Seat cushion length adjustment
- Fore/aft adjustment
- Fore/aft lockable isolator
- Air dump
- Adjustable shock absorber
- Air height adjustment
- Lower and upper lumbar air support
- Side air support bolsters
- Head and shoulder adjustment
- Full recline backrest

6. **Bostrom Seating® - Lopro 910 Sc Manual Lumbar Mid-Back Truck Seat**
   https://www.truckid.com/bostrom-seating/bostrom-seating-lopro-910-sc-manual-lumbar-mid-back-333649203.html

Figure 108 - Appendix B 6

Description

Universal Lopro 910 Sc Manual Lumbar Mid-Back Truck Seat by Bostrom Seating. Air Compressor Suspension. This product is made of high-quality materials to serve you for years to come. Designed using state-of-the-art technology and with customers in mind, this product by Bostrom Seating will last a lifetime. It will meet your needs and deliver great quality at an affordable cost.

Specifications

- Expertly crafted
- Premium materials
- Reclining
- Air ride

7. **Product #7: MasterCraft Safety® - Baja RS™ Premium Reclining Suspension Seat**
   https://www.carid.com/mastercraft-safety/baja-rs-premium-reclining-suspension-seat.html

Figure 109 - Appendix B 7

Description

Baja RS Premium Reclining Suspension Seat by MasterCraft Safety. The first reclining suspension seat for off-road enthusiasts, the Baja RS® retains the safety, comfort and fatigue-fighting ergonomics of MasterCraft Safety's suspension seats. An all metal heavy-duty 9-position reclining mechanism is standard, for years of trouble-free comfort. Baja RS® shares the same flexibility in mounting as the Rubicon series seat.

Specifications

- 9 position reclining seat
- High-resilience foam
- Laser cut tubular frame construction
- UV-treated marquesa fabric
- Accepts 5-point seatbelts
- Hip containment: 6.5”
- Many additional options available (seat heaters, lumbar support, pockets).

8. **Distinctive Industries - Deluxe Touring II Front Bucket Seats more details**

   https://www.carid.com/distinctive-industries/deluxe-touring-ii-front-bucket-seats.html

Figure 110 - Appendix B 8

Description

Deluxe Touring II Front Bucket Seats by Distinctive Industries. The Distinctive Industries Touring II seat is manufactured using the proven Procar by Scat seat frame and foam and is covered in high quality, Distinctive Industries restoration upholstery. The steel seat frame is TIG welded and electrostatically coated for strength and durability. The completed seat offers a 20 position reclining seat back and includes a 18 position sliding seat track built into the frame all which adds up to a comfortable and customizable seating position for the occupant.

Specifications

- 20 position reclining seat
- Frame designed to support high bolstered foam
- 18 seating track positions
- TIG welded and electrostatically coated frame and seat tracks
- Factory reproduction interiors capture the essence of original manufacturing techniques

Features and Benefits Text Cue Analysis

	BENEFITS		
From Promotional Material	Alphabetized	Categories	
Sporty driving	affordable	***Comfort***	***Ergonomics***
High quality	best starting position	Comfort	Breathable
Best starting position	breathable	Comfortable	Fatigue fighting
feel the difference	budget friendly	Comfy	Feel the difference
competitive edge	comfort	Coziness	Preventing fatigue
structured support	comfortable	Increased comfort	Reduce back pain
elegant design	comfy	Medical comfort	Reduction of bodily fatigu
outstandingly comfortable	competitive edge	Most comfortable	Stable
preventing fatigue	contemporary	Outstandingly comfrtable	Structured support
comfortable	coziness	Pleasure	Support
functionality	durability	Soft	
safety	elegant design		
sportiness	elite	***Quality***	
premium quality	excellent quality	Affordable	
contemporary	fatigue fighting	Budget friendly	
quality	feel the difference	Excellent quality	
elite	fine detailing	Firm	
coziness	firm	Functionality	
comfy	functionality	Great quality	
pleasure	great quality	High end	
luxury	high end	High quality	
soothe	high fashion	Higher grade	
soft	high quality	Premium	
firm	higher grade	Premium quality	
support	increased comfort	Quality	
meidcal comfort	luxury		
functionality	medical comfort	***Design***	
higher grade	most comfortable	Best starting position	
fine detailing	outstandingly comfortable	Competitive edge	
increased comfort	pleasure	Contemporary	
reduction of bodily fatigue	premium	Durability	
superiority	premium quality	Elegant design	
breathable	preventing fatigue	Elite	
high fashion	quality	Fine detailing	
high end	reduce back pain	High Fashion	
excellent quality	reduction of bodily fatigue	Luxury	
premium	safety	Safety	
most comfortable	soft	Soothe	
stable	soothe	Sportiness	
reduce back pain	sportiness	Sporty Driving	
comfort	Sporty driving	Superiority	
durability	stable		
affordable	structured support		
great quality	superiority		
fatigue fighting	support		

Table 20 - Benefits Text Cue Analysis

FEATURES			
From Promotional Material	**Alphabetized (by noun)**	**Categories**	
Single piece	Armrests	***Seat***	***Extras***
Glass fibre reinforced	Armrests: adjustable armrests	Piece: single piece	Cushion: extendable cushion
Carbon-kevlar composite	Bolstering: aggressive thigh bolstering	Seat: 18 seat track positions	Cushions: replacable back cushions
Adjustable shock absorber	Bolstering: aggressive torso bolstering	Seat: 20 position recline seat	Cushions: replacable seat cushions
Aggressive thigh bolstering	Bolsters: air-powered bolsters	Seat: 9 position seat recline	Frame: corrosion resistant frame
Aggressive torso bolstering	Bolsters: enhanced side bolsters	Seat: bucket seat	Frame: high bolster foam supported frame
Replacable seat cushions	Bolsters: side air bolsters	Seat: full recline seat	Frame: tubular frame construction
Replacable back cushions	Bolsters: side bolsters	Seat: reclining seat	Harness: 4, 5, 6 point harness
Durable foam	Carbon-kevlar: composite	Seat: seat tilt adjustment	Harness: 5 point harness
Lumbar support	Cushion: extendable cushion	Armrests	Seat: heavy-duty seat recline mechanism
4, 5, 6 point harness	Cushions: replacable back cushions	Armrests: adjustable armrests	Seat: seat heater
Enhanced side bolsters	Cushions: replacable seat cushions		Seat: water resistant
Sculpted lumbar support	Foam: durable foam	***Material***	
High-density foam	Foam: high-density foam	Carbon-kevlar: composite	
Adjustable headrest	Foam: High-resiliency foam	Foam: durable foam	
Extendable cushion	Foam: memory foam	Foam: high-density foam	
Vinyl	Frame: corrosion resistant frame	Foam: High-resiliency foam	
20 position seat recline	Frame: high bolster foam supported frame	Foam: memory foam	
Side bolsters	Frame: tubular frame construction	Glass fibre: reinforced	
Corrosion resistant frame	Glass fibre: reinforced	Leather: protein leather	
Reclining seat	Harness: 4, 5, 6 point harness	Seat: high quality seat material	
High quality seat material	Harness: 5 point harness	Suede: ultra suede	
Bucket seat	Head & shoulder: head and shoulder adjustment	Vinyl	
Water resistant seat	Headrest: adjustable headrest		
Ultra suede	Leather: protein leather	***Support***	
Protein leather	Lumbar: air lumbar support	Bolstering: aggressive thigh bolstering	
Seat heater	Lumbar: lower and upper lumbar air support	Bolstering: aggressive torso bolstering	
Memory foam	Lumbar: Lumbar support	Bolsters: air-powered bolsters	
Armrests	Lumbar: sculpted lumbar support	Bolsters: enhanced side bolsters	
Air-powered bolsters	Piece: single piece	Bolsters: side air bolsters	
Air lumbar support	Seat: 18 seat track positions	Bolsters: side bolsters	
Air suspension	Seat: 20 position recline seat	Head & shoulder: head and shoulder adjustment	
Adjustable armrests	Seat: 9 position seat recline	Headrest: adjustable headrest	
Seat tilt adjustment	Seat: bucket seat	Lumbar: air lumbar support	
Lower and upper lumbar air support	Seat: full recline seat	Lumbar: lower and upper lumbar air support	
Side air bolsters	Seat: heavy-duty seat recline mechanism	Lumbar: Lumbar support	
Full recline seat	Seat: high quality seat material	Lumbar: sculpted lumbar support	
9 position seat recline	Seat: reclining seat	Shock absorber: adjustable shock absorber	
High-resiliency foam	Seat: seat heater	Suspension: air suspension	
Tubular frame construction	Seat: seat tilt adjustment		
Heavy-duty seat recline mechanism	Seat: water resistant		
5 point harness	Shock absorber: adjustable shock absorber		
18 seat track positions	Suede: ultra suede		
high bolster foam supported frame	Suspension: air suspension		
Head and shoulder adjustment	Vinyl		

Table 21 - Features Text Cue Analysis

Appendix C – Approval Forms


PANEL ON RESEARCH ETHICS
Navigating the ethics of human research

TCPS 2: CORE

Certificate of Completion

This document certifies that

Stephen Bykowy

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

Date of Issue: **29 September, 2020**

Figure 111 - Certificate of Completion

Appendix D – Analysis

Empathy Map Construction

Objective of the user observation

The objective of this user observation is to learn the main pain points of long-haul truck drivers while they are operating the trucks and living in the sleeper berth. The information gained from this study help steer the final design and ensure that the design is solving relevant problems.

User (Individual)

Middle-aged man who currently works as a long-haul truck driver. Has had 14 months of experience doing deliveries from Canada to the United States and vice versa.

User Background

White, middle aged male from Mississauga, formerly worked as a manager at a call centre.

Method

Interview questions were created using the Empathy Map analysis method.

- Who are we empathizing with?
    - Can you tell me about yourself?
    - Can you tell me about your background?
    - How long have you been a long-haul truck driver?
    - How do you feel about long-haul trucking?
- What do they need to do?
    - What is the process once you have dropped off your freight?
    - What are some of the tasks you have related to your work, to do aside from driving?
    - Do you need to live in your truck while not on a delivery?

- What do they see?
    - Can you describe the space inside the truck?
- What do they say?
    - What goes on in your head while you drive?
- What do they do?
    - How do you prepare at the start of several-day shipment? How do you prepare in the mornings when you wake up in the sleeper? Frustrations? Satisfactions?
    - What do you usually eat while on the road? Do you eat in the truck cab?
    - How do you stay in contact with friends and family while on the road?
    - Do you browse the internet in your down time?
- What do they hear?
    - Do you listen to anything while you drive? Is there a particular reason why you listen to that?
- What do they think and feel about?
    - Pains?
        - Is there anything you find difficult about working inside of a sleeper truck?
        - If you could change anything about the interior of your truck, what would it be and how would it benefit you?
    - Gains?
        - What do you find enjoyable about working/living in a sleeper truck?

Interview Method

The interview was conducted over the phone, and the user's thoughts were written down as he spoke.

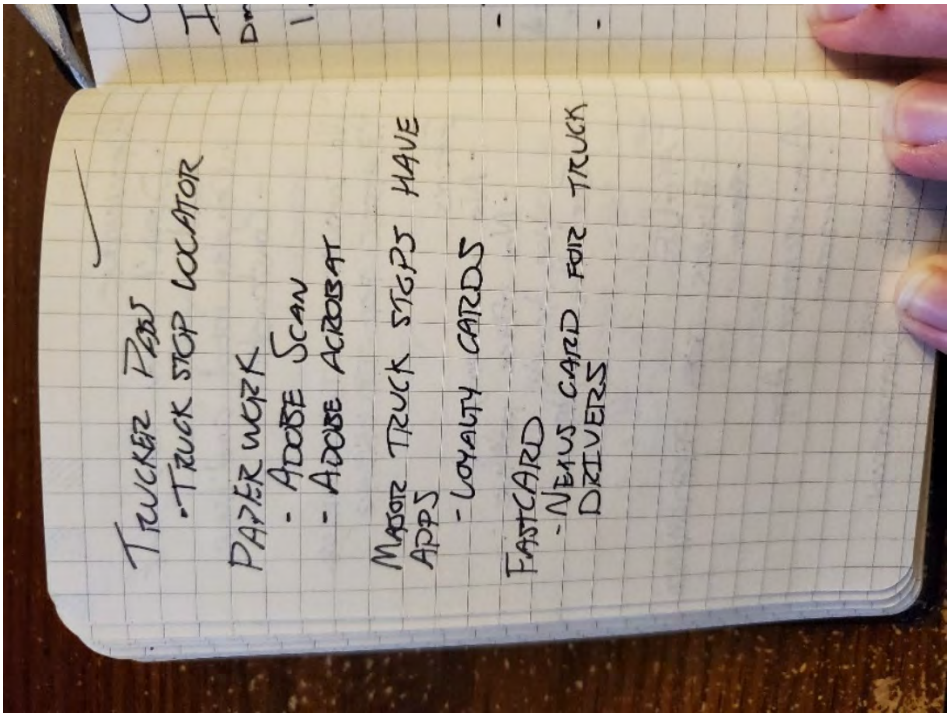


Figure 112 - Interview Notes 1

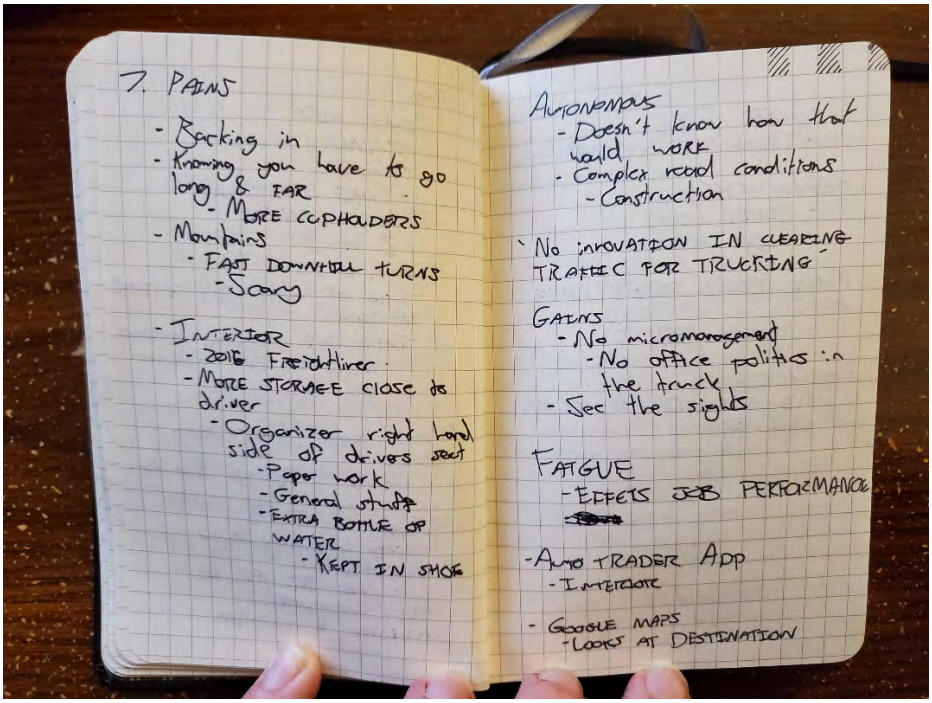


Figure 113 - Interview Notes 2

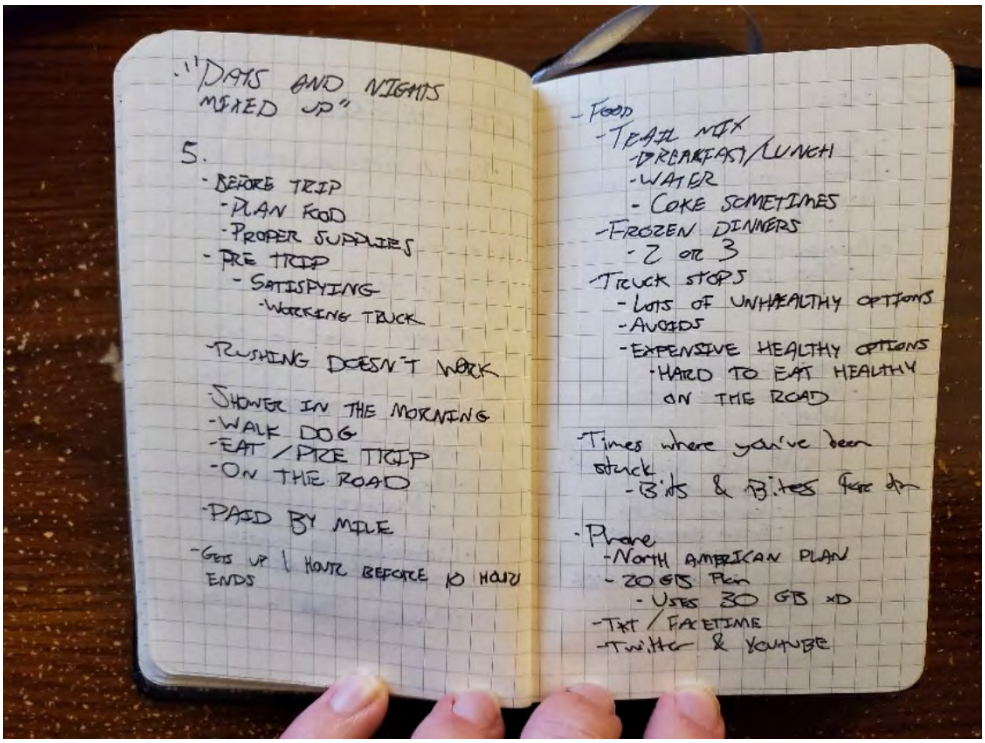


Figure 114 - Interview Notes 3

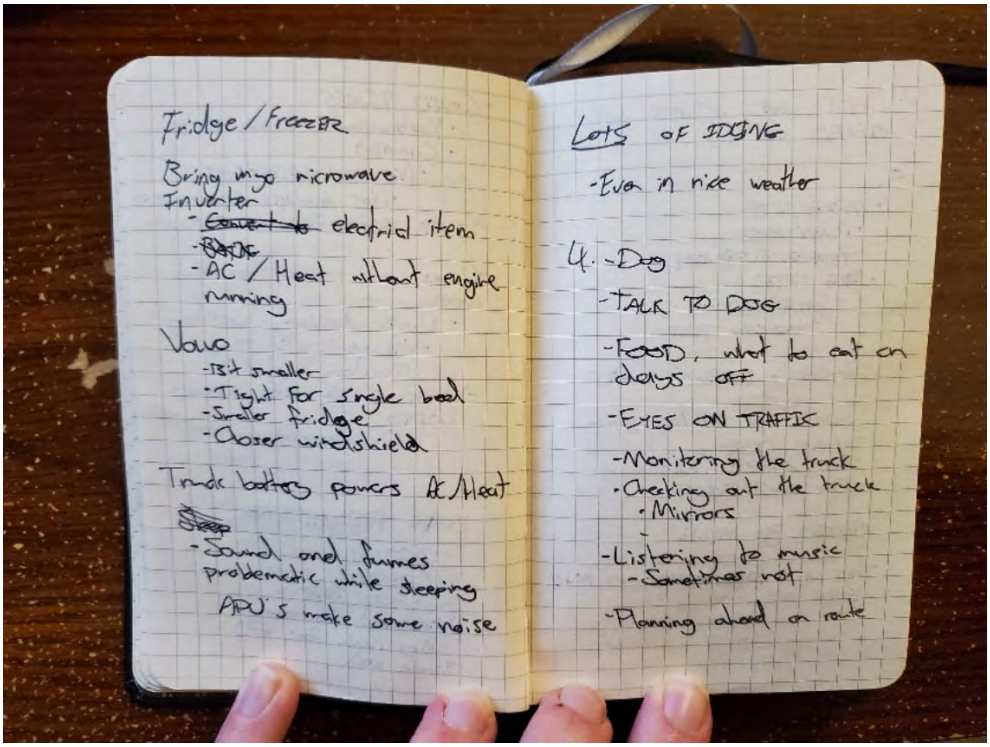


Figure 115 - Interview Notes 4

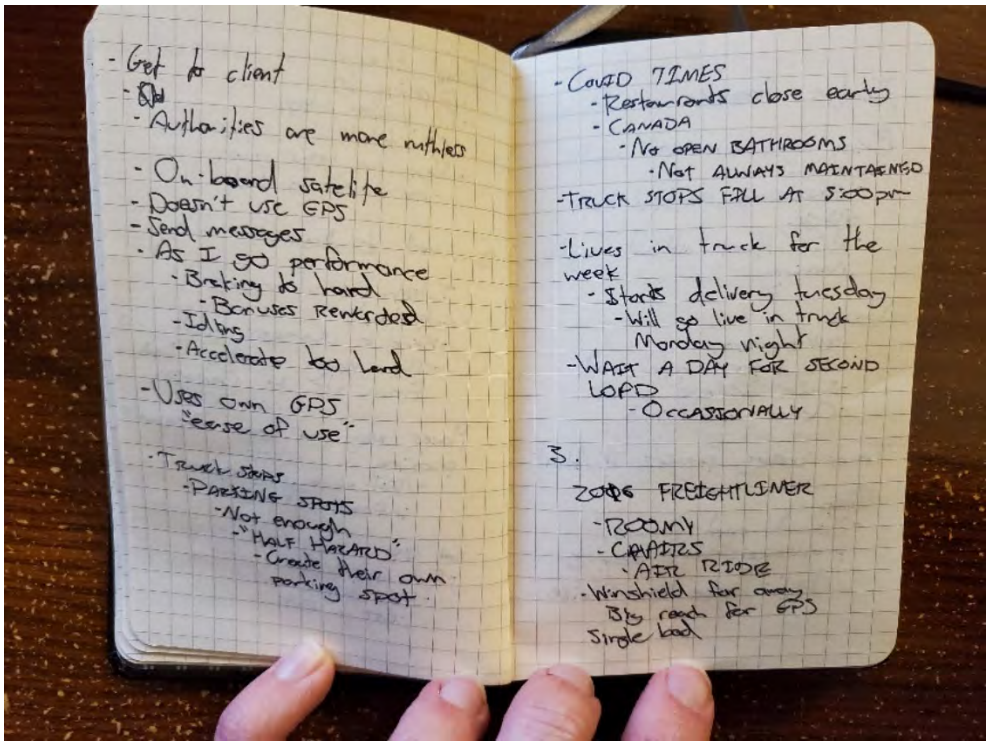


Figure 116 - Interview Notes 5

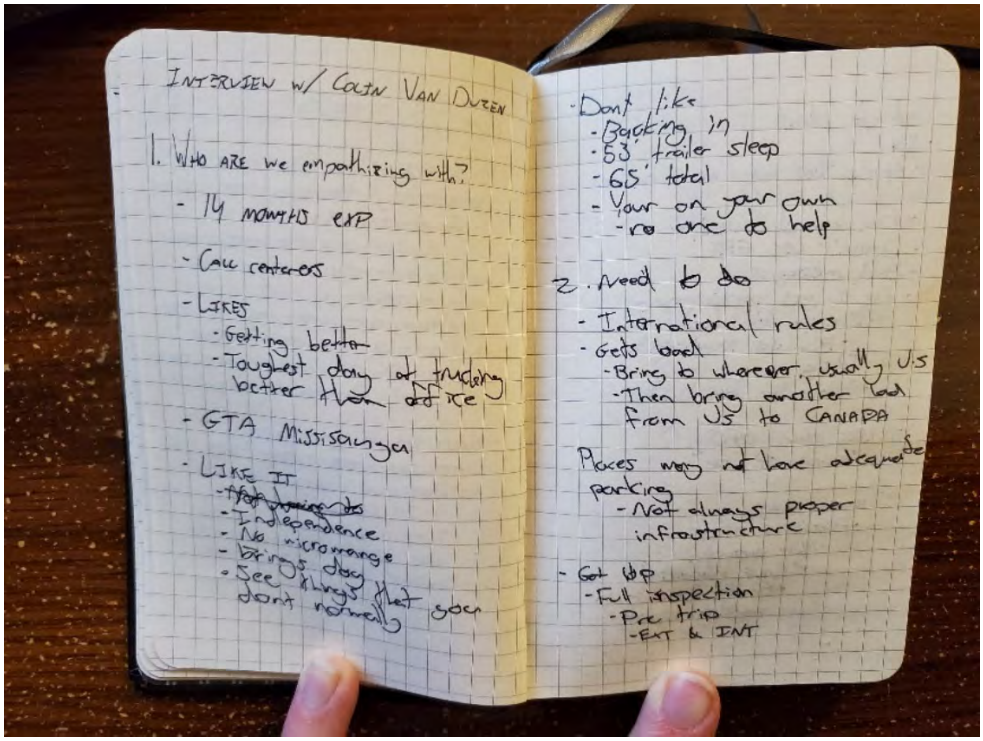


Figure 117 - Interview Notes 6

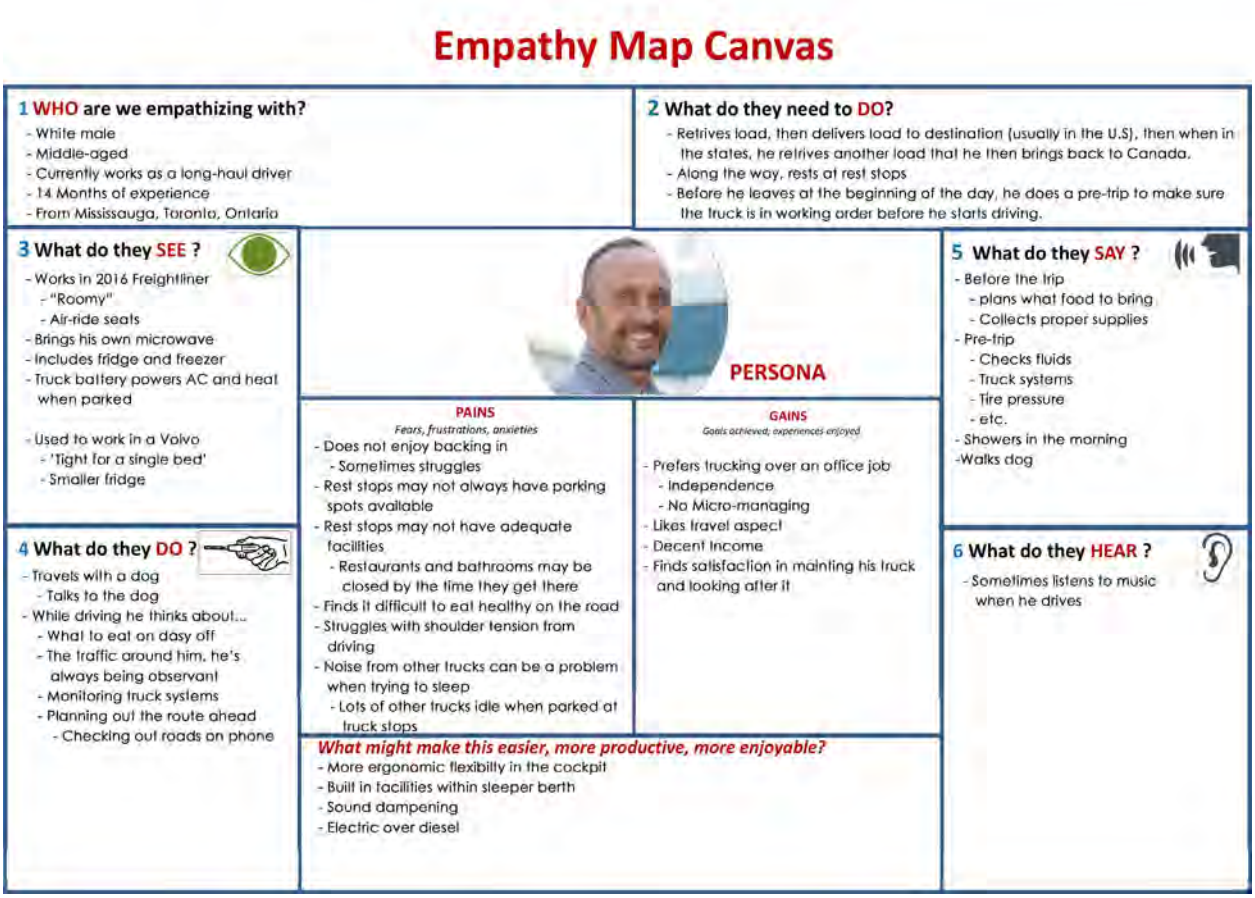


Figure 118 - Empathy Map Canvas

Appendix E – Advisor Consent Forms, Meetings and Initiatives

Advisor Initiatives – Oct 18, 2020

For this study, research will need to be gathered from primary sources, people who are currently in the long-haul transportation industry. The research is necessary because it will lead to a more curated design solution that will solve the most important issues the drivers face. To gather this information, participants will need to be found in order to conduct user interviews; a trip to see a sleeper truck in person will need to be planned for a user observation; forums and blogs will need to be found to

conduct surveys; and an advisor will need to found in order to keep a constant contact within the industry.

The following information is a plan that describes how these searches are going, and/or how they plan to be carried out in the weeks to come.

Stages	**Progress/Steps**
Participant Search	1 Participant found - Colin Van Duzen - Long-haul truck driver - User interview is set for Oct 19 in the afternoon Plan to find more - Ask Colin if he knows anyone that might be willing to participate - Utilize Kijiji to find people selling sleeper trucks and inquire if they have had experience working in them themselves - https://www.kijiji.ca/v-heavy-trucks/mississauga-peel-region/2015-freight-liner-ca125slp-cascadia-sleeper-truck-tractor/1530068871 - Ask former coworkers if they know any long-haul drivers
Advisor Search	No Advisor found yet Plan to find an advisor - As user interviews are conducted, their job position and the amount of experience they have will determine whether they are fit to be an advisor - Worthy participants will be asked if they are willing to take on such a roll - If yes, they will be sent the consent form where they can make the final decision, without being pressured over the phone.
User Interviews	1 Interview planned, no user interviews have been conducted yet Planning interviews - Potential participants will be contacted via email, where a brief description of my project and purpose will be conveyed - They will be asked if they are willing to participate in the study by having a 15-minute phone interview - Willing participants, will be asked a series of questions regarding their job, and their experiences working and living in sleeper trucks
User Observation	User Observation has not been conducted

	Plan for user observation - The user observation will be done by visiting a truck dealership with one other person - Notes will be taken about the exterior and interior of the truck, and the user interaction with all the different features - The user will be asked about their first impressions, likes and dislikes - Photographs and videos will be taken for visual reference
Survey	A survey is currently being planned - A community of truck drivers has been found on Reddit - https://www.reddit.com/r/Truckers/ - ~55,000 people are following this page - The questions for a ten-question survey are currently being planned - The questions will focus on the job, and the pains and gains of living and working inside a sleeper truck - The participants will also be asked if they are aware of any other forums or blogs where this survey could be posted

Table 22 - Advisor Initiatives

Key Dates

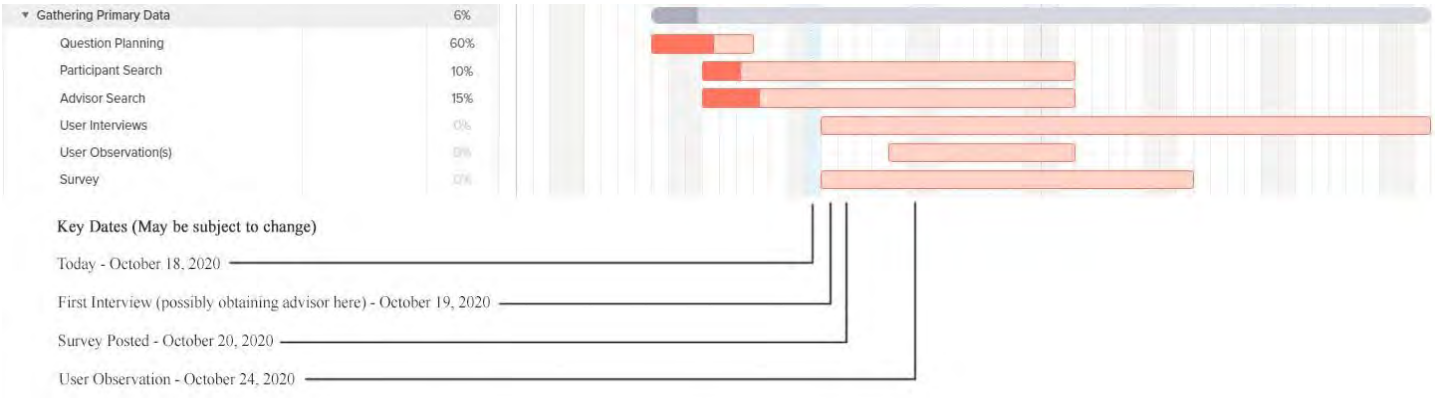


Table 23 - Advisor Key Dates

Questions for Survey

URL 1: https://www.reddit.com/r/Truckers/

URL 2: https://www.facebook.com/groups/truckerfeed/

1. What is your gender?
   - Male
   - Female
   - Other
   - Prefer not to say
2. What is your age?
   - 24 and under

   - 25 – 34
   - 35 – 44
   - 45 – 54
   - 55 – 64
   - 65+
   - Prefer not to say
3. How long have you been working as a long-haul truck driver?
4. Approximately how long does it normally take for you to complete one delivery? (From pickup location to drop off location)
5. Approximately how many hours do you drive per day?
6. Do you suffer from any of the following? Check all that apply.
   - Aches and pains
   - Arthritis
   - Other musculoskeletal disorders
   - High Blood Pressure
   - Diabetes
   - Obesity
   - Chronic fatigue
   - Anxiety
   - Loneliness
   - Depression
   - Other…
   - None of the above
7. Of the items you selected above, do you feel that any of them might have been caused by the living/working conditions of your truck? If yes, specify which and how it was caused.
8. Of the issues you selected above, do you feel they affect you job performance?
9. Currently, do you find anything enjoyable about working/living inside a sleeper truck? If so, what?
10. If you could change anything about the interior of your sleeper truck, what would it be? (think small – features). How would this change benefit you?
11. If you could re-imagine the interior of your sleeper truck, what would it look like? (think big – mobile office, more living space, better driving setup, etc). How would this change benefit you?
12. Do you leave your truck idling while at truck stops?
    - Always
    - Most of the time
    - Sometimes (50/50)
    - Mostly not
    - Never
13. What are your thoughts on the idea of autonomous trucks?

My name is Stephen and I am currently doing research on the mental and physical well-being of long-haul truck drivers for my final thesis project in school.

I am studying industrial design, which is basically product design. We design anything from kitchen appliances, to shoes, electronics, and cars and trucks.

The goal of this project is to gather data from real truck drivers, and use it to design a solution to any problems they may have, and in turn, making their (or your) life easier.

If you could fill out this survey, it would be very much appreciated, it will help a ton.

This survey is being done under the supervision of the Humber College Research Ethics Board. By participating in this survey you will be giving consent for me to use this data in my thesis report.

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2020 & WINTER 2021

IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

INFORMATION LETTER

Research Study Topic: Long-haul Truck Driving
Investigator: Stephen Bykowy / 289 926 6200 / stephen.bykowy@rogers.com
Sponsor: Humber ITAL, Faculty of Applied Sciences & Technology (IDSN 4002 & IDSN 4502)

Introduction
My name is Stephen Bykowy, I am an industrial design student at Humber ITAL, and I am inviting your participation in a research study on various problems that long-haul truck drivers deal with. These problems include livability of sleeper berths, how sleeper trucks can influence one's lifestyle choices, and musculoskeletal issues that come from long hours of driving and living in a confined space. 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 modified sleeper that allows drivers to drive comfortably for extended periods of time without suffering from aches and pains, and provide a living space that does not negatively influence one's lifestyle choices. 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 activities in interacting with the truck, as well as your relationship to the job itself will be documented. Your activities and experiences will be documented by means of interviews, digital camera / video camera (you will not be asked to take video or photos while driving), and through email. You will also be asked questions pertaining to your truck and how you use it.

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, as well as company logos, 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**

Figure 119 - Advisor Information Letter

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2020 & WINTER 2021

IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

PARTICIPANT INFORMED CONSENT FORM

Research Study Topic: Long-haul Truck Driving
Investigator: Stephen Bykowy / 289 926 6200 / Stephen.bykowy@rogers.com
Courses: IDSN 4002 & IDSN 4502

I, Colin VanDuzer *(First Name/Last Name)*, have carefully read the Information Letter for the long-haul truck driving project, led by Stephen Bykowy. 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 Stephen Bykowy at any time during the project.

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

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

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

Privacy
All data gathered is stored anonymously and kept confidential. Only the principle investigator /researcher, Stephen Bykowy and Prof. Catherine Chong or Prof. Sandro Zaccolo 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 Stephen Bykowy / 289 926 6200 / Stephen.bykowy@rogers.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.

Colin VanDuzer — Participant's Name
Participant's Signature
11/19/20 — Date

Figure 120 - Participant Informed Consent Form

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2020 & WINTER 2021

IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

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.**

Colin Van Dusen — Participant's Name
Participant's Signature
11/20/20 — 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: 289 926 6200
Email: Stephen.bykowy@rogers.com

My supervisors are:

Prof. Catherine Chong, **catherine.chong@humber.ca**
Prof. Sandro Zaccolo, **sandro.zaccolo@humber.ca**

Figure 121 - Advisor Information Letter 2

User Observation Interview Transcript

Colin Van Duzen

I'll tell you one thing about the Volvo. Before we get started and off track. If you see where the fridge is and where you sleep. The fridge cycles, all night long, and it's great beside your head.

Stephen Bykowy

Yeah, I was gonna ask about that it's like. So like this dude like who's making the video, he isn't a truck driver. He's sitting in a parking lot for one night in this truck so I was curious to get your take on what the experience is like when you're on the road when you have been on the road for days at a time. And what it's like sleeping in it for many days.

Colin Van Duzen

It's not like how has it. There's trucks coming and going and people honking, the other night in Arkansas, people were fighting over spots, all night long honking and fighting. When I had to get up and get going, I was blocked in I had to go knocking on doors, and you're hoping they don't have a gun.

Stephen Bykowy

So there's a lot of like external factors. What about the bed, which he described as being quite comfortable, what about on the inside that you just described like the fridge is sitting right next to your head that's sort of annoying, I suppose.

Colin Van Duzen

Yeah that's right and the way that it's set up, has to be that way in the Volvo Cars. You've got your outlets that are there. That's a little bit, you know, frustrating. If you take a look at the video, again, you'll see that the upper bunk is a set bed like you can't change that mattress. Yeah it's part of the fold down. As for the comfort of the bed you can put in any type of mattress that you want. He asked Volvo if he can do that, so they've obviously set him up with the highest end stuff. So of course he probably had like the super cooling, memory foam mattress. You know my company gives me like, it's like sleeping on the sidewalk so I have to I put my own mattress toppers on there but few other on there to make it a little bit more livable. That was basically he is right when he says it's hot. I'll tell you that on both those videos where I think it's a little bit off for my truck it's an ambient temperature, so I can, you know, it's not I don't have to just put on the heat and the heat stays on I just don't put on the AC, and the AC stays on, I'm, I just pick a temperature and it does its own thing.

Stephen Bykowy

Okay, all right, that's interesting. That was all I really had for that video, I was just curious I was struck by this guy's description of it it's like, ‘oh it’s the best thing ever’, sort of thing.

Colin Van Duzen

Yeah. So there's nobody parked beside them with the engine running all night long. Yeah, so it's not. It's noisy in the truck stop things are coming and going, you need a good set of earplugs. You know to keep them going and then when you got the heater going or the AC going and then the fridges recycling, the whole truck is vibrating right so you feel. I mean, you get used to it. So, you know, it's not that bad. They talked about like those thermal curtains that you pull. Those are the best. It makes everything really dark, it'll keep it cooler it'll keep the warmer. But it's sort of like getting into your own little cave then at that point in time it's quite cozy so

Stephen Bykowy

In the training video, at the very beginning like the beginning portion that talks about like the pre trip. It is all that stuff that they mentioned like accurate to what you do like checking all the fluids?

Colin Van Duzen

Yup, all the fluids, check the brakes, they didn't get into checking the brakes and checking the wheels. There's probably some Ministry of Transportation or Department of Transportation and they'll list, what the biggest violations are. And the biggest ones will be brakes out of adjustment and wheels, tires are just too bald. Cracks cools, flat. So those things are important to check, I mean that really impacts the public in general, as long as they get an air brake system so if there's a leak in any of the air hoses and stuff, that could have a real serious impact on the driving public. You know wheels have the grease or the oil to keep it lubricated as it's rolling down the road if there's a leak in that in any way. Those are when the wheels fall off and kill people right so they didn't talk about that stuff which is, I mean everything about the pre trip is important but that means, you really have to focus on the wheels and the brakes, that's what keeps the public safe.

Stephen Bykowy

And you expressed in our previous interview that you find the pre trip satisfying. Do you find these tasks fun in some way? Or like, do you find particular things sort of annoying to reach for weird things to check or?

Colin Van Duzen

Sometimes you got to get under it and look at things right so it's not fun I mean nothing really ever does fine like you know so if you reach the wrong way or you're not paying attention you get covered in grease and then there's a shirt that's ruined right, its got to go in the garbage, so it can be expensive at times. Another situation is, I was a pedestrian hit by a truck in New Jersey. And I got up and walked away, he got the better of me. I was landed on my head and on my knee. I was really hobbled for three, four weeks. Nothing broken. But you know, when your knee heals and it's like that new skin, it's really sensitive. And then I was back at work and I had a situation where something wasn't looking right so I had to get down on the pavement on my knees, and then it turned into a great big huge blood blister the size of a loony. So, I mean there's parts of it that's a pain, but at least I get satisfaction knowing that I've done everything I can to make sure that this vehicle is safe. So that there won't be a problem. And if there is a problem, and God forbid something happens at least I had the satisfaction of knowing I didn't take the shortcut.

Stephen Bykowy

Yeah okay yeah that makes sense. The sleeper in that training video. Would you consider that to be a good sleeper? Based on like the features that they're showing off like is that a particularly nice one?

Colin Van Duzen

Yeah that was nice. International seems to have more options. I don't see a lot of them on the road, because I don't think that overall they last too long. So, you know, if you would compare it you know to like you know your cars and stuff like that that might be, you know, not, it's not your Cadillac. So it's a little bit more economically priced.

Stephen Bykowy

And the Custom Truck video. Like that one struck me as interesting just because like, the thing is massive. I was wondering is that practical when it comes to finding work, because I know that there's a weight limit on how much you can carry.

Colin Van Duzen

I'd say no. And a couple of things. One is that when you have to back into places most of the time, that takes up so much room. Even in the truck stop it doesn't fit in to a regular spot. You've got to take up two spots or block out other tribes, you know who I see driving those as you know like the moving companies. So they're moving either offices or big homes from one part of the country to another. It's mostly them. And I think it's because the regular truck is kind of set up for two people. I think that that's almost set up for a crew of guys. Probably four guys who are doing the moving jobs, so they load up and then they drive across the country and then they unload. So they've got a little bit more space in there so more guys can sleep. But they're huge. I've only seen a few on the road but not often.

Stephen Bykowy

Yeah, yeah, I was just about to ask as like how many of those do you see. Something that I couldn't really find a good video of was just the process of driving and arriving at your drop off location. A lot of the time in the videos that I saw like driving is glossed over, and whoever's taking the video doesn't record like 'oh I've arrived here's what's happening' sort of thing, presumably because they have to work.

Colin Van Duzen

Yeah, but I'll give you some step by step set on what to do, like, from the start of the day from the pickup to the drop off or

Stephen Bykowy

Yeah sure, if you don't mind.

Colin Van Duzen

So I mean you do that that pre trip inspection. If you wanted to know all the steps involved in that without getting overly technical but somewhat technical. Go to The Ministry of Transportation and look up Schedule A for commercial trucks, that lists all the items that we're supposed to take a look at. And whether they're major defaults or minor defaults. Major, you can't drive you got to stop. You can drive minor, you have to report that too but you can finish your day or get to a service station. So, the big majors would be like brake failure tire failure, exhaust issues, if you have exhaust coming into the cab. Minors, you might have a small stone chip, things that you can continue to keep going that isn't going to have a major impact of road safety. You've normally been assigned your load the night before. So you'll get the address you put that into your GPS. I keep Google Maps on my phone, so I can take a look at the address. Because your GPS will give you the address to the front door. But sometimes, the loading dock is on a side street around the corner, I'd like to have a look at that and make sure that I can see where the loading docks are, and where the address would be, as well as taking a look at how to get in there a lot of places, they're amazing, it's right off the highway. Some places, when you're in an old part of town, right turns might be very hard to make so sometimes you have to sort of plan it and go around the block making left turns, just so that you're not going to take down any posts, street signs and stuff like that. Those are the important things I usually do that the night before I take a look at it and figure it out. Sometimes I like to take a look at the

docks too because sometimes the docks are really tight and really small. So I sit there and don't sleep all night panicking on how am I going to get that done, but you take a look at it. They load you up. And they'll just tell you when you get there. Sometimes some people call, some places you have to go in, but some just tell you what dock door to go to, you'll open your back doors and you back into wherever they tell you and sit and wait. They load it up, they give you the paperwork, and you're on your way. You know your destination so you just, again you get that you know into the the GPS and off you go. A GPS from the company that you work for will sometimes tell you like the shortest way to get there. Sometimes the shortest way takes you on roads that will take longer, roads that take me off the interstate to go on a State Road, with traffic lights so I got to accelerate and slow down. I'm going to be wasting more gas than just having it on. To save, take the route that seven kilometers longer, more economical, just to have my cruise control on and down the road. So yeah, definitely, I tried to stay to the interstates, as much as possible. You gotta check all those gauges right so we talked about air brakes. Feeling for where the air is they have a gauge right there. You want to keep an eye on you will and, DEF, diesel exhaust fuel. If it's going down too fast, there's something, there's something wrong. So you got to take a look at that. I check the mirrors all the time. I mean that goes without saying, even in the car you check your mirrors all the time. I'm also checking to make sure that nothing like the wheels, if they had a little oil leak, eventually, they'll start smoking. So when I'm checking the traffic around me. I'm also looking at the wheels. You know from them so you know that's ongoing not only am I checking traffic, I'm checking the truck. Speed limits are changing you know all the time. I've got, like every car every truck has, a speedometer, my GPS tells me how fast I'm going, so I just keep an eye. My GPS it's a little bit closer. And I can keep an eye out for turns in the road or anything you know along those lines. Every all of our company tracks and most tracks will have a satellite to communicate with the office. Our satellite, it also measures many performance indicators, it gives you a scorecard. To make sure that I'm within that scorecard range the company requires us to get like 80. If you get 80 I think you get an extra two cents per mile for every mile, like you run the quarter. I think for about six weeks now I've been at 100. The last time I didn't get it was from when somebody cut me off and I had to break hard. There's one spot in Virginia where it's a straight downhill. And you can put as far as you can see there's no turns and it goes downhill and uphill. And sometimes the truck goes over 120, and I'm like, oh, because when you set your cruise control, it also sets the air brake so if you go 10 kilometers an hour faster than what you were Cruz's set at the brake is supposed to set in, but sometimes because you're up and down and up and down you forget if it's on like you think that it's on but you touch the brake and it's off so yeah so I lose that happened to me seven weeks ago and that was the last time I didn't get 100, I'm on a roll it's easy for me now, other guys have a hard time but I've got it figured out. So let's say that it's a place that's gonna be two days away. You know, so the when I get into stop at the night, it's either a truck stop or a rest area. Each has its benefits. Truck stop if you want a hot meal, you need a shower. You know, it's good. It can be a little bit challenging because it's tough sometimes to find parking. If you don't get there early enough. And it's noisy all night long you've got people beside you running their engines, playing their music, just whatever right so it can be a little bit challenging on that side. The rest area is pretty good. You don't really have to back into a spot you just drive right in. People are usually a little bit quieter, but there's no hot meal there's no shower. Bring your own food. Whatever that microwave in the Volvo was, that was pretty cool. I have to bring my own, the smallest one that I bought is still too big for the truck. And I have to store it so anytime I want to use it I got to pull it out it's just not there so it is what it is.

Stephen Bykowy

Yeah I noticed that too, I sent out like a survey on a few like trucking forums and one guy said that yeah I wish there was a microwave and I'm like, they're not built in.

Colin Van Duzen

Yeah, they do have them but it's the texture. Right, so there's a Camilo and it's not, you know, it's dealer prices. It's okay. It's not one word phrases. Yeah. You know that microwaved probably class you know four or $500. You know, whereas I can go to mine cost me like I think 74. Right. Yeah. There's a huge difference. So anyways, I get the night before I start to plan my route into where my deliveries. Okay, yeah. So, again, checking Google Maps taking a look at the property. Where will I get in planning my route in from from the interstate. So again I'm taking a look, you know, at those turns right so a lot of places it's not so bad if I'm away to Virginia like you know where the old towns are and you know where the new cities are right. If you send me to like the Northeast right so I'm going to Jersey or Massachusetts. I know I'm gonna have a challenge. Right into sending me to Indiana. You know, it's gonna be a big wide open loading dock and, you know, it'll be no problem it's the same it's like trauma, right, they send you into places into Toronto and you know it's. Oh, here we go, sort of thing right so you. You just know where the newer places are and you know not to worry. You know, so much, or you know the name of the company right like when I went to Houston last week they were sending me to Amazon. I didn't worry about that I didn't plan that, you know, so much. The thing with the Amazon is. There's a company around the corner from where the yard is. And they're the company that makes the machines for the Amazon so like the sorters and stuff like that. So we tend to deliver exclusively for them to the new Amazon plants and the new Amazon plants aren't in GPS yet. So, that can be a little bit. You know, I find stuff I've tried to work way around. As you kind of get more experienced on stuff you, you figure it out, right so is the address doesn't show up on my GPS, I get into my handy Google Maps again. And I just look for an address next door. Um, you know, you know, and then I'll, I'll go there. Yeah, you know, just follow the science right so there's all little tricks. You know, that we do. So yeah, so we'll get to the spy, depending on their COVID rules. Some say don't come in, call us. You know the time we went door to go to and leave the paperwork in the back so I break the seal I opened the doors. I put paperwork in the back. Mm hmm. They do what they have to do they sign their paperwork and they knock on my door they call me and say, we're done. So I don't even go in, I don't contact anybody. Other people. You know, you go in nobody's in a mask, everybody's crowded around your truck and it's like, I'm not comfortable with this. From time to time, they all send instructions talking about their COVID policy now you have to wear a mask, and you get there and they don't always do it. Sometimes I'll just call my dispatcher and I'm like this is a situation where you want me to do. Yeah, you call them, and you tell them that they're not following their own policy. You know, and that the driver feels. You know, not safe. So, I've done that one. That's crazy there, the the place that I did it, believe it or not, was a place where I was picking up personal protective equipment to bring back.

Stephen Bykowy

Ah, the irony.

Colin Van Duzen

So yeah, this is right at the height of the pandemic. And I don't know if you remember on the news where President Trump was talking about stopping those trucks from crossing the border. Oh yeah, and then chrystia Freeland came out and said well you know we have an arrangement and that. Yeah, I

was getting loaded up at that time. And two of our trucks were actually stopped at the border and they had to wait eight hours. Oh wow, you know, well they were very out to get released. Mm hmm.

Stephen Bykowy

That's craziness,

Colin Van Duzen

So yeah. Yeah, there are, you know, things, things along those lines. You see a lot of things on the road. That just make you shake your head. Okay, yeah, some good, some bad it's just, you know, just in the ass to see it and I don't know I'd shake my head. Patience is the biggest thing that a truck driver can have can't get rattled. You have to remain calm, you're out there you're on your own, things are going on. There's really nobody coming to help you right like the next guy is 200 miles away. He's four or five hours. So, yeah, you know you you can't do it right so you know I've been in spots where I there's no way I can back in, and I'm stuck right and it's like, I got to do it. And there's nobody coming to help me. So, you know, gotta calm down and, you know, figure it out. Yeah. You know, or, you know, you get lost right you get bad directions and you're lost. Mm hmm. How to get out and the roads are getting narrower and, you know, you know. Yeah, because that gets to really be my panic, you know, in the beginning, you know as the roads would get narrower but now it doesn't bother me now I just, I block all the lanes, I don't care if I have to make a right hand turn, and I have to go onto the wrong side of the road to start my turn and i and i have to continue on to the wrong side of the road, as I go around. Soviet. Mm hmm. You know, I don't care. Yeah. If I don't do it like that, and I take down a lamppost or the truck gets stuck because it won't fit through. Anybody who was oncoming traffic at that time is going to be waiting a lot more than 20 seconds for me to get around that corner.

Stephen Bykowy

Yeah, for sure,

Colin Van Duzen

Because I'll be blocking that road for hours until the record comes and pulls me out of there and, yeah.

Stephen Bykowy

Thank you for that description, by the way, based on like the previous interview and also now it's like, I guess. Generally speaking, it's a it's a good job and driving itself isn't really a huge issue. What I was wondering, you described having like shoulder tension, sometimes like from driving for extended periods of time. Does that in turn affect some of the other processes like does it sometimes. Can you feel it sometimes when you're doing a pre trip, or when you're doing certain motions or something like that.

Colin Van Duzen

You know where impacts me the most is on just overall tiredness. So you know I'm tired I'm stiff it takes longer to relax in at night, and that you know impacts, my sleep ability. One thing I'll talk about is hours of service. Right. So, coming back from Texas This was probably the best example. I was set to deliver Friday morning at 9am. And I picked up my load. I think it was Tuesday. No Monday. Right. So, typically you know I like to get going at four, five o'clock in the morning so let's say it's five o'clock in the morning I can drive, 11, hours a day. I'm supposed to take a 30 minute break. I don't try to pull 11, because I may not find the spot to park I don't want to leave it to the end because then you're in violation. So I'll drive 10 hours a day on my mo for 11 hours, right. So I start, let's say I started Tuesday then at 5am. And then at 430. And I have to take a 10 hour. Sleep break. And then I can start again. So I'm not starting out, if I'm in a rush this is where a driver can make up some time. And so starting at my usual five o'clock. Now the next day. I'm starting at three. Huh, right and then I'll do my 10 hours of or 10 and a half hours but, you know, whenever an hour break I'm finishing around two o'clock. Take my 10 hour break, I can get going. You know, at midnight. So if you're pushing for time that's sort of how you can do it like you mess up with your circadian clock right like you know your days and your nights. Yeah, you know, kind of get, you know, mixed up but this time down there. I mean not to get overly political if you take a look at that map of the republican voting system, all the ones that voted you know for for Trump. I went right down the middle of that. Oh, all in a row, you know, areas, and they're very political. And they're angry. So, you know, I didn't want to anyone spend more time there than I had to So I did that every day. I just took, you know, The minimum required, you know, to sleep and get back on the road so I'd be leaving at like one o'clock in the morning and man, I'd be dead by noon. It's really interesting to think about, you know, so yeah so but yeah I mean other things too, right, like if you don't want to talk, you know, weird stuff and it's not so much of a big deal but it kind of gets to you a little bit on your happiness depression scale is you get down to Texas and you get out and you put on your shorts and your T shirt and it's like it's wonderful. And then you get back up, you know once you start to get into like Indiana and you get out of the truck. You got a theoretical back here and put on pants and find your winter coat. So it's little that you know it's it's it's crazy right weather stresses right so two weeks ago, I was coming back from Indiana and the wind was just so strong. All's I could do is hold that will. Oh my main. You know, I had to take lots of breaks. You know, coming home. Yeah, right, there's gonna be snow and ice. Soon, that gets that gets to people. So,

Stephen Bykowy

yeah, yeah, yeah I remember experiencing that like I was like a summer helper at this job so like I worked like up till the beginning of September. And, but like I knew I wanted to come back the following year so to just sort of stay on the payroll I was like hey I'll work like holidays, through the winter and yeah, it was weird, like, like going in and out of the refrigerated trailer like it's just flippin cold.

Colin Van Duzen

Yeah. Yeah. Yeah, that's the big added to the heat well even the summer weather right it rains so heavy at times you know you can barely see the road, and you have to go like, you know. Mm hmm. You can't, you can't, you know, works got to get done so you got to, you know, if you're in your car you're like oh I'm just gonna pull over and go into that mall. Okay. I can't fit my truck in there so you know I have to keep going until there's a truck stop So, um, let's see so so those are some of the drawbacks right yeah you know where you see a lot of things, you know on the side of the road, you're like, man, I'd like to go there, but you can't say, Oh, no, this this trip was pretty cool though cuz the company tells you where to fill up for gas. Right, so I just don't go out of my mind company does that because they've negotiated deals with all kinds of people. Right. So, this one it just worked out that the place where they told me to get the gas. It was sort of. It was 800 kilometers away. So, even though I had more time on my clock I had like three hours on my clock. When I got there. When I got there, I didn't even fill up right away. I just saw a parking spot, and I took it, because it was right beside. Little Rock, Arkansas. It was right in the middle of a factory outlet mall, and they had like a chick fil a there I wanted to try that for the first time. So yeah, they had like, you know, an amazing mall and stuff so I just, I stayed. You know, and spent spent the night there, which is cool in the south, they have that sort of stuff up in the north. All the truck stops are out in the middle of nowhere. Ah, you know, so there's little shopping. Yeah, But, Arkansas and Texas. You know, there's a lot of shopping in the food. Oh my god. You know, so yeah, spend money on on food barbecue.

Stephen Bykowy

Yeah no, craziness. That was sort of all questions I had really no, it was just, yeah, more stuff pertaining to just like yeah, like the processes and what you thought of certain things and especially those videos.

Images

Here are some of the images collected from the user observation videos. The videos were chosen based on how they showcased different parts of the long-haul trucking process, and the truck driving experience.

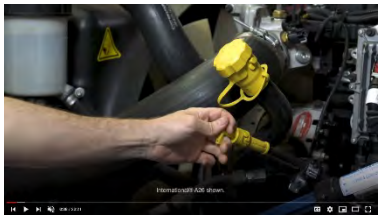
Big Rig Sleeping Is Better Than You Think | Time for Trucks Extra	International Truck Driver Training Video	2016 Kenworth W900 ICT 180" Custom Sleeper
		
Figure 122 - Big Rig Sleeping Is Better Than You Think | Time for Trucks Extra. Image received from https://www.youtube.com/watch?v=a9ew6KQeZfs&t=156s	*Figure 123 - International Truck Driver Training Video. Image received from https://www.youtube.com/watch?v=jVSEFnAGLvg&t=492s*	*Figure 124 - 2016 Kenworth W900 ICT 180" Custom Sleeper. Image received from*

Figure 125 - Big Rig Sleeping Is Better Than You Think | Time for Trucks Extra. Image received from

Figure 126 - International Truck Driver Training Video. Image received from https://www.youtube.com/watch?v=jVSEFnAGLvg&t=492s

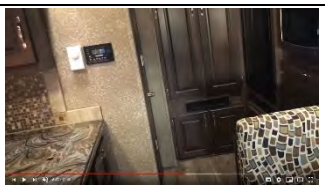


Figure 127 - 2016 Kenworth W900 ICT 180" Custom Sleeper. Image received from https://www.youtube.com/watch?v=AELtmh0UmCc&t=542s

Figure 128 - Big Rig Sleeping Is Better Than You Think | Time for Trucks Extra. Image received from https://www.youtube.com/watch?v=a9ew6KQeZfs&t=156s

Figure 129 - International Truck Driver Training Video. Image received from https://www.youtube.com/watch?v=jVSEFnAGLvg&t=492s

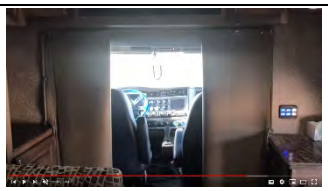


Figure 130 - 2016 Kenworth W900 ICT 180" Custom Sleeper. Image received from https://www.youtube.com/watch?v=AELtmh0UmCc&t=542s

Figure 131 - International Truck Driver Training Video. Image received from

Analysis

A Journey Map and a User Experience Map were constructed based on the data collected from the user observation video review. These maps illustrate the main tasks of a long-haul truck driver in order of operation, as well as the inherent challenges with those tasks, and how the user feels while performing them.