NURISH

Modular Foodbank Supply Vehicle

Bachelor of Industrial Design
Thesis Report

Modular Foodbank Supply Vehicle

by

Logan Dohar

Submitted in partial fulfillment of the requirements for the degree of

Bachelor of Industrial Design

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

Supervisors: Catherine Chong and Sandro Zaccolo

HUMBER
Faculty of Applied Sciences & Technology

Consent for Publication in the Humber Digital Library (Open Access)

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	☒	☐

Student Signature : _____

Student Name : Logan Dohar

Modular Foodbank Supply Vehicle

Logan Dohar

Bachelor of Industrial Design

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

2021

Abstract

Food insecurity is a prevalent issue around the world in our cities, and urban areas. It's a damaging situation where almost anyone can fall into, and can be caused by political, financial, health, and other situational circumstances. It predominantly affects individuals, followed by families, children, and the elderly. The mental and behavioural repercussions that people incur is lifechanging, and specific protocols are used

The scope of this thesis is to create a transport solution that focuses on food banks and their distribution methods, as this is the most widely adopted solution to support those who currently experience food insecurity. How may we mitigate food insecurity in urban areas? This thesis required ergonomic observations, workplace visits and in-depth studies of daily processes and challenges that food banks and their distribution network face with an intent to maximize the positive impact on users and clients.

Acknowledgements

« Use Body text or Normal style for text in this section (Double Spaced) »

Table of Contents

« The Table of Contents (TOC) can be inserted automatically here if you have used the appropriate styles for section, chapter titles, and for subheadings. In Word, you can check what will appear in the TOC by viewing in “Outline” mode, suppressing body text. Create hyperlink in TOC with the appropriate headings/sub-headings. You can create your own graphics style but keep it simple »

Table of Contents

« (**Continue if any**) The Table of Contents (TOC) can be inserted automatically here if you have used the appropriate styles for section, chapter titles, and for subheadings. In Word, you can check what will appear in the TOC by viewing in “Outline” mode, suppressing body text. Create hyperlink in TOC with the appropriate headings/sub-headings. You can create your own graphics style but keep it simple »

List of Tables

« Include: number of table – caption/description and/or URLs – page number, create hyperlink to the List of Tables. You can create your own graphic style but keep it simple »

List of Tables

« (**Continue if any**) Include: number of table – caption/description and/or URLs – page number, create hyperlink to the List of Tables. You can create your own graphic style but keep it simple »

List of Figures

« Include: number of figure – caption/description and/or URLs – page number, create hyperlink to the List of Figures. You can create your own graphic style but keep it simple »

List of Figures

« (**Continue if any**) Include: number of figure – caption/description and/or URLs – page number, create hyperlink to the List of Figures. You can create your own graphic style but keep it simple »

CHAPTER 1: PROBLEM DEFINITION

Fig 1. Joel Muniz @jmuniz, Community Power - Retrieved from https://unsplash.com/photos/3k3l2brxmwQ

CHAPTER #1
Problem Definition

This chapter will focus on the development and identification of this Thesis' topic. Food insecurity is a serious issue in our developed world, and the cities and suburbs we live in, so many demographics and lives are victim to this issue. Food banks and their programs and services they provide are the frontline of battling this issue, and this section will gain more insight into the significance and background from both the food bank and the users point of view.

2.1 Problem Definition

1.1.1 Problem Finding

This problem was found based on a combination of topic ideas in our initial assignments for the fall semester, the first focusing on reducing the impact of food waste which presents a large and avoidable issue urban and suburban regions that the international community faces and has such a large contrast to the lack of food for the less fortunate in our communities. The other is improving community food/cargo transportation, a very specific issue that has efficiency levels and carbon emission output work hand in hand and is a platform widespread in our world. It made sense to combine both topics since they complimented each other.

1.1.2 Problem Framing

This problem was framed to figure out a solution to the definition of:

How may we mitigate food insecurity in urban communities?

2.2 Rationale and Significance

The issue is significant on a societal level, an issue that relates to our human responsibility for addressing the basic needs of human life. In the technological, financial and policy advances our

developed world has gained since modern history, this issue should not exist at the scale we see today. Food banks were never intended to be a permanent fixture in our cities, more to help those in need in the worst of times.

The key questions needed to be asked are how the food banks function with these services, and the pains and gains involved from the institutions point of view and their workers and volunteers. The users themselves need to be asked key questions about their relationship with the food bank, on a user experience point of view. The goal is to gain insight from both points of view, two different perspectives, the supplier, and the user, and to help bridge that gap even better.

2.3 Background/History/Social Context

Food insecurity has been a prevalent issue in the post-industrial revolution world, with people moving on mass from an agriculturally based lifestyle to more industrial and corporate careers. Food insecurity, the type involved in this thesis takes place in urban contexts. As the cost of living, population, and migration increase, including other smaller factors become more common, the phenomenon of food insecurity affects more people.

For instance, economic trends influence people's financial standing whether it be a financial crash of 1929 and 2008, or most recently the Covid-19 pandemic, industries and economics slow or shut down, and it is a trickledown effect to the individual.

The demographic trends of people who face food insecurity in our developed regions have stayed the same, however this issue has grown to such a scale that almost anyone has a risk of facing food insecurity. More recently with the lifestyle trend of gig economics, the lack of long-term job security, and more people living on their own or without a family. These new lifestyles bring in an interesting

new demographic that is recognized for its short-term use of food bank services, however there are still users who rely on these programs and services for a much longer timeframe.

With the internet and easily accessible media formats, food insecurity has become more well known, however stigmas still are prevalent. One of the biggest is the interpretation of food insecurity being only linked to homelessness or the poor, but there is a different demographic affected that have different contexts, financial and social backgrounds.

The products itself that have been used to regard this issue have mainly circulated around food banks, and new programs and services circulate around these institutions. There are programs that attempt to adapt towards current issues and trends such as higher fresh food incorporation for those in need, rescuing food waste, and encouraging more donations and supplier connections and networking. Funding wise, food banks in Canada have not received mandated / governmental financial support apart from municipal grants and outside donations. Up until now with a serious international pandemic leading to record numbers of foodbank users there has been federal funding set aside for Food Banks Canada (FBC) to distribute nationally. Solutions may be subpar in thought regarding the link between the food and the user that needs it, with the method of transport being limited to box trucks with a filling process containing filled cardboard boxes, including the process of sorting, loading and unloading included. Direct user deliveries are a new trend being incorporated into the regular process at food banks and their agencies, with the pandemic adding additional policy pressure.

CHAPTER #2
PRODUCT RESEARCH

Fig 2. Han Chenxu @hanchenxu – Retrieved from https://unsplash.com/photos/20qcctvyR1Q

CHAPTER #2
Product Research

This chapter will focus on the research and development aspect of this Thesis project, showcasing initial research, benchmarking and insight from advisors and users. This specific topic fortunately has a wide reach of demographics for both the users of the vehicle and the food bank recipients. Throughout the research phase of this thesis. It has been a great challenge to gather specific information from those individuals experiencing food insecurity.

2.4 User Research

2.5 User Profile Persona

PRIMAY	SECONDARY	TETIARY
Primary (front end) **Farmers / Growers** -Oversupply -Subject to order cancellation -Mainly based off of demand of chain supermarkets **Grocers** -Source of mass waste -Quality standards -Lack of easy secondary source. To where? **Distributors** -Unnecessary transport -> higher C0^2 Emissions -Mainly to and from distributors / stores -Far distances	**Secondary (Middle)** **Restaurant Suppliers** -High product standards -Fluctuating demand -Leftover **Foodbank Volunteers** -More work involved -Sorting complexity -Higher demand through colder months -Running off of donations **Waste Management workers** -High level of unnecessary waste -Faster landfill use -More intense travel (C0^2) **WM Drivers** -Higher demand from domestic and commercial sources in addition to current load -More intense workforce and operations	**Tertiary (Back end)** **Families (Low S.E. Communities** -Higher number of people to feed -Distances to proper stores -More financial responsibility **Elderly** -More vulnerable to location -More of an embarrassment (also among with adults) -Limit of employment, financial and health risks **Kids** -More influential to lifestyles around them -Initially not the ones responsible for food purchasing **Individuals** -Go towards convenience -More time spent at work to sustain lifestyle basics, more than one job -Focused towards cheaper options

Demographics - Food Bank Users

Demographics for users were categorized into the following generalized groups; individuals, families, single parents, the elderly, and those who may experience mental or physical hardships.

Through further research into demographic reports and studies from food bank group representatives and organizations, the more vulnerable demographic to food insecurity is shown.

Food Bank Workers / Volunteers

Volunteers at food banks have a wide range of demographics, practically being a representation of the community itself. Food bank volunteers range from students, to retirees, to the elderly, almost anyone can become a volunteer. The Ottawa Foodbank (OFB) brings in on average 3000 volunteers, with fluctuations on seasonal and social changes throughout the year, more students in summer for example because they are out of school, etc.

Vehicle drivers and warehouse equipment operators would be the only specific demographic due to the requirement for license and official training for the operation of equipment.

User Behavior

The users of food banks, especially those who face food insecurity suffer greatly on a mental and behavioral scale. Many people, whether it be families, individuals, or single parents who suffer from food insecurity deal with the stigma and emotions of being in a food insecure status. There is a presumption of failure if you get into that situation, a feeling of loss of control financially, academically, and socially. It is a behavior that understandably leads food banks and their agencies to make their client information confidential, and also a reason why gaining insight from a user

perspective has been so difficult for this chapter, that workers who have an aspect of their career for user interaction have been a go to compromise.

The level of food insecurity would also affect the overall behavioral impact, with different lengths of time these users are struggling with food security, some can depend on food banks from a few days to a few years, and even longer than that.

2.5.1 User Observation – Current User Practices

For additional clarification based on the food bank system studied for this thesis, the Ottawa Food Bank (OFB) is the main food distribution and warehouse. The food bank agencies are separate organizations / agencies that order food directly from the OFB, and have direct interaction with individual users, one aspect that has changed since the pandemic.

Regular Ordering System (VIA Agencies)

- Agency orders through online system Bluelink, agencies login to this service and order what is needed approximately a week in advance. The food bank delivers these on a priority basis, only on weekdays, not on weekends.

- Orders are box based; one type of food is sorted by the box. Nonperishable food is sorted the day before order is intended to be delivered and placed on the agency's designated palette.

- Perishable food is sorted and loaded onto the designated palette. Palette is then wrapped in saran wrap for security purposes. Palettes are back loaded into vehicle and delivered to agency.

Ordering System (VIA Food Bank)

- All supplies for distribution are organized into 3 categories:

A. Essential items guaranteed in supply and optimal for ability to feed and make a meal, these can be soup mix, bread, milk, eggs, pasta etc. If the food bank doesn't have enough supply of these items, these will be purchased by the food bank in bulk from a supplier.

B. Material based essential items relating to baby supplies, toilet paper etc. These items are necessary for single parents. These items are predominantly purchased by the food bank or given through partnerships with other organizations.

C. Non-essential / nice to have items. These are items predominantly donated by the public, grocery stores. Any essential items donated are put into category A. Supplies in this category are not purchased by the food bank.

Individual delivery involves standardized 9x9x13 boxes filled with enough food to supply an individual for 2 weeks' worth of food. The OFB would follow an appointment model for individual clients up until the pandemic. Clients now book food help through phone, email and most recently online ordering, all methods require an eligibility check. These are delivered the next day to clients address via more inconspicuous methods of transport compared to branded vehicles.

Regular Tasks, Procedures and Attitudes – Employees and Volunteers

- Procedures done in a warehouse / freight environment.

- Organizing and Sorting donations and products

- Packing boxes with proper categorized food products

- Lifting boxes 25lb +
- Storing boxes / dry / cold foods
- Filling out orders given by agencies
- Loading orders onto palettes
- Utilizing routing software for distribution purposes
- (Driver specific) Ability to operate varying sizes of freight vehicles
- Positive workplace attitude
- Discreet interactions with users of food banks
- Communication and coordination with food agencies and other food banks
- Responding to hamper deliveries and rapid response

Non-routine Tasks, Procedure and Attitudes

- Admin roles
- Leading communication with other agencies / food banks

How Context Changes the Experience

Context can change the experiences of the workers / volunteers and the users who rely on the food bank while they are experiencing food insecurity.

Workers / Volunteers:

- Context of the food bank (capabilities, reach, volunteer base size)
- Context of community (teamwork etc.)

Users:

- Context of who is affected (Elderly vs young, individual vs group)
- Context of timeframe (Long term vs short term reliance)
- Context of place (Rural vs urban, what kind of food environment do they live in?)
-

2.5.2 User Observation – Activity Mapping

This user observation is taken from screenshots of an official FBC (Food Banks Canada) video showcasing the rough process used for food sorting and packaging based on a food bank in Toronto. These were used as a benchmark for the expert interviews to better understand their more specific situations.

Fig 2.1 - Initial sorting of product when brought in – Food banks sometimes purchase goods in bulk for a reduced price.

Fig 2.2 - Most Agencies and Food Banks are equipped with cold storage capabilities for milk, eggs, and other refrigerated food stuffs.

Fig 2.3 - Showcase of the use of compact storage and quantities seen.

Fig 2.4 - Some food banks, such as the one showcased in the video provide cooking services to prepare donations and to provide pre-prepared meals to those who use the food bank. Not every center provides this, specifically the one being researched, often the agencies themselves have cooking facilities since they have a more direct to user organization.

Fig 2.5 - Distribution centers organize and categorize the containers, bins and palettes by the delivery location and end user. The foods provided by the food bank are typically broken up into 3 levels,

A. Items guaranteed & easy to make meals from, if the food bank doesn't have enough of these supplies, they purchase them
B. Baby basics – Baby supplies
C. Nice to haves – Donations mainly, if they don't have it they will not purchase these items

Food banks typically sort out nonperishables the day before a delivery is scheduled, the morning of, perishable food is loading alongside the nonperishables for delivery.

Fig 2.6 - Showcase of a direct user to worker interaction and delivery of food. These instances would more likely occur at agencies that have a direct use by people who face food insecurity. Delivery can also occur more directly to users' homes (more popular due to the pandemic) but in a more discreet manner, typically in the form of an unmarked vehicle.

2.5.3 Human Factors – Research of Existing Products

Product #1 - Large Scale Freight

https://www.morgancorp.com/refrigerated/cold-star/

“Morgan Truck Body's Cold Star Refrigerated truck bodies lead the industry in design and engineering. From our Fastrak program to custom bodies that offer a wide range of options to satisfy your unique needs, Morgan's refrigerated bodies are designed to help you deliver fresh to frozen products - around the block or across the country! Home delivery, catering, floral, beverage, dairy, produce, meat, seafood, ice cream, and everything in between – the list is long, and the choice is clear - Nobody delivers like Morgan!”

Features

1. **Front Aerodynamics:** Aerodynamic front-end design, heady duty plastic dormer. Strategically positioned grab handles, folding steps. Reinforced corners for enhanced durability.
2. Subframe: Morgan’s Cold Star sub-frame provides superior protection, the steel center rail and I cross beams provide strength where needed and lighter weight overall.

3. **Rear frame**: Morgan protects your investment by using corrosion-resistant-stainless steel in areas where air exchange is greatest. Rain deflector in the rear and strategically placed grab handles and both curb and roadside level.
4. **Floor:** Polyurethane foam (PIP) ensures consistent density and insulation, air and moisture seeping are virtually eliminated
5. Standard 5-inch structural bumper to optional step, drop-step, immediate step and under ride bumpers, to walk ramps and lifts at the rear OR side – you can be sure that easier, safer movement is built-in.
6. Door: Features such as full perimeter thermal breaks to mitigate passive heat transfer, and seals are easily replaced to help ensure protection year after year.
7. Roof: The gentle bow is reinforced with anti-snag supports to provide added strength preventing pooling of water and ice
8. Lighting: All refrigerated units feature dome-lights with indicator switches in the cab, as well as exterior sealed LED lights
9. Insulation: Optimal temperature control conditions for INSIDE the vehicle that prevent heat transfer. Significant foam barrier. Morgan offers 4-5" insulation packages to help you overcome particularly challenging conditions.

Product #2- Urban Scale

http://www.amtechcorp.com/mealstar-cargo.php

The Mealstar® Cold/Frozen Van includes a 150 Cu. Ft. fully insulated and lighted fiberglass interior with an aluminum diamond plate floor and 8" lip around all four sides. This conversion can be all Cold

or have Frozen capabilities if requested for an additional cost. This conversion can be built into ½ ton, ¾ ton and 1 ton GM, Ford and Nissan Cargo Van chassis.

1. Custom Stainless Steel Racking System
2. Interior Dome Light
3. Diamond Plate Aluminum Flooring 8” Lip
4. Back up Alarm
5. Dash mounted thermo stat controls
6. Back-up Camera with Dash mounted monitor
7. Adjustable/ movable Insulated bulkhead Wall
8. 110v/220v plug in back-up System (Refrigeration Only)
9. Chrome Wheels
10. Additional Stainless-Steel Racks & /or Baskets
11. Rear Bumper back-up sensors
12. Custom Vinyl graphics package
13. Dash mounted thermostat controls

Product #3 - Mobile / Quick Transport

http://www.norco.com/bikes/urban/urban-lifestyle/heart/

Designed and built with Dutch craftsmanship, The Coupe is as beautiful as it is functional. Safety features like the impact-resistant expanded polypropylene (EPP) cargo box protect your most precious cargo, while sophisticated technology—like the Bafang mid-motor and auto-shifting Nuvinci hub—deliver an effortless riding experience that will have you and up to 2 kids (or dogs!) exploring your city like never before!

1. Near silent electric motor
2. Up to 75 miles of range / charge
3. Fits through any standard door
4. 3 point seatbelts
5. Fold down front door
6. Fenders with finger protection
7. Advanced Tech
    - Bafang Electric Mid-Motor
    - Nuvinci Hub with Auto Shifting
    - Ride All Day Battery
    - Frame Integrated Headlights

8. Comfort
    - Low-Step frame, upright seating
    - Lightweight Aluminum Frame
    - Angled Front Wheels
    - Schwalbe Big Apple Plus Tires
9. Versatility
    - Drop-Down Front Door
    - Integrated Rear Rack
    - Maxi-Cosi Car Seat Mount
    - Slim Profile

Product #4 - Backpack Style Transport

https://www.vollrathfoodservice.com/products/smallwares/food-delivery-transport/backpack-bags/3seriesbackpackbag

Delivery via bike or scooter can be an efficient way to bring food to your customers, especially in urban areas. But without the proper bag, this method can be problematic when it comes to food quality. Fortunately, we have your back (pun intended) with our 3-Series Delivery Bags. Their adjustable backpack straps make delivery comfortable and easy. The super durable, high-quality moisture-resistant liner shelters food from the elements and maintains temperature. And the high-performance insulation makes sure your food arrives as though it came fresh from the kitchen. An integrated frame provides added stability to keep containers in place during transport.

1. Adjustable backpack straps for comfort and stability when transporting food
2. Super-durable, high wuality moisture resistant liner shelters food from the elements
3. High performance insulation keeps food fresh
4. Integrated frame for added stability

Product #5 - Future Compact Transport

https://arrival.com/?topic=products&id=2

https://www.youtube.com/watch?v=I781itRPJH8

We've re-thought commercial cargo vehicles. Designed using a modular architecture, the Arrival Van can be configured based on battery capacity, height, length, and load space – tailored to specific commercial requirements.

1. Engineered to maximize space, for maximum payload and volume capacity

2. More for less, fleet and depot size down
3. Calculating efficiency, range and power usage through digital calculations based on specific loads
4. Digital side mirrors / improved visibility for the driver
5. Zero-emission vehicle, preserves air quality in high demand areas.
6. Wide cab, large windshield for easy viewing
7. Pre Production model, no lengthly F&B's yet.

2.5.4 Safety and Health – Research of Existing Products

FEATURES	Re-order: NOUN first	Sort #1	Sort #2
From Promotional Material		DATA [On Menu Bar] →	Group like categories
Aerodynamic Design	Controls: Dash Mounted	Battery: All Day Range	**Cargo Box : 10**
Grab Handles	Controls: Thermal Controls	Battery: High Capacity	
Folding Step	Lights: Dome	Bulkhead: Adjustable and Insulated	Cargo Box: Aluminium Diamond Plate Floor
Reinforcement	Lights: Dome	Bumper: Structural	Cargo Box: Backup Refrigeration System
Sub-Frame	Lights: LED	Bumper: Structural	Cargo Box: Fibreglass Interior
Steel Center	Battery: High Capacity	Capabilities: Cold or Frozen	Cargo Box: Foam Insulation
Corrosion Resistant	Battery: All Day Range	Cargo Box: Aluminium Diamond Plate Floor	Cargo Box: High Load Capacity
Rain Deflector	Handles: Grab	Cargo Box: Backup Refrigeration System	Cargo Box: High Performance Insulation
Grab Handles	Handles: Grab	Cargo Box: Fibreglass Interior	Cargo Box: Impact Resistant
Foam Insulation	Bumper: Structural	Cargo Box: Foam Insulation	Cargo Box: Racking System
Structural Bumper	Bumper: Structural	Cargo Box: High Load Capacity	Cargo Box: Replaceable Seals
Walk Ramps	Frame: Integrated Headlights	Cargo Box: High Performance Insulation	
Step/Drop Step	Frame: Steel	Cargo Box: Impact Resistant	**Driver : 7**
Thermal Breaks	Frame: Steel Center	Cargo Box: Racking System	Driver: Back Up Alarm
Replaceable Seals	Frame: Slim Profile	Cargo Box: Replaceable Seals	Driver: Back Up Camera With Alarm
Dome Lights	Frame: Sub-Frame	Construction Thermal Breaks	Driver: Digital Side Mirrors
LED Lights	Frame: Wide-Cab	Construction: Corrosion Resistant	Driver: Large Windshield
Fibreglass Interior	Frame: Low Step	Construction: Height	Driver: Point Seatbelts
Aluminium Diamond Plate Floor	Frame: Modular Architecture	Construction: Length	Driver: Top Rain Deflector
Cold or Frozen Capabilities	Cargo Box: Fibreglass Interior	Construction: Reinforcement	Driver: Upright Seating
Stainless Steel	Cargo Box: High Performance Insulation	Construction: Walk Ramps	
Racking System	Cargo Box: Backup Refrigeration System	Controls: Dash Mounted	**Frame : 8**
Dome Lights	Cargo Box: Replaceable Seals	Controls: Thermal Controls	Frame: Integrated Headlights
Back Up Alarm	Cargo Box: High Load Capacity	Design: Aerodynamic	Frame: Steel
Dash Mounted Controls	Cargo Box: Impact Resistant	Driver: Auto Shift	Frame: Steel Center
Back Up Camera with Monitor	Cargo Box: Foam Insulation	Driver: Back Up Alarm	Frame: Slim Profile
Adjustable Insulated Bulkhead Wall	Cargo Box: Racking System	Driver: Back Up Camera With Alarm	Frame: Sub-Frame
Back-up Refrigerated System	Cargo Box: Aluminium Diamond Plate Floor	Driver: Digital Side Mirrors	Frame: Wide-Cab
Chrome Wheels	Bulkhead: Adjustable and Insulated	Driver: Large Windshield	Frame: Low Step
Structural Bumper	Design: Aerodynamic	Driver: Point Seatbelts	Frame: Modular Architecture
Dash Mounted Thermal Controls	Wheels: Chrome	Driver: Top Rain Deflector	
Impact Resistant Cargo Box	Driver: Upright Seating	Driver: Upright Seating	**Construction : 6**
Auto Shift	Driver: Top Rain Deflector	Frame: Integrated Headlights	Construction Thermal Breaks
Near Silent Electric Motor	Driver: Large Windshield	Frame: Low Step	Construction: Corrosion Resistant
All Day Battery Range	Driver: Point Seatbelts	Frame: Modular Architecture	Construction: Height
5 Point Seatbelts	Driver: Auto Shift	Frame: Slim Profile	Construction: Length
Frame Integrated Headlights	Driver: Back Up Alarm	Frame: Steel	Construction: Reinforcement
Low Step Frame	Driver: Back Up Camera With Alarm	Frame: Steel Center	Construction: Walk Ramps
Upright Seating	Driver: Digital Side Mirrors	Frame: Sub-Frame	
Slim Profile	Motor: Silent Electric	Frame: Wide-Cab	**Other : 19**
High Performance Insulation	Motor: Zero Emissions	Handles: Grab	Battery: All Day Range
Modular Architecture	Capabilities: Cold or Frozen	Handles: Grab	Battery: High Capacity
Battery Capacity	Construction: Corrosion Resistant	Lights: Dome	Bulkhead: Adjustable and Insulated
Height	Construction: Length	Lights: Dome	Bumper: Structural
Length	Construction: Height	Lights: LED	Bumper: Structural
Load Capacity	Construction Thermal Breaks	Motor: Silent Electric	Capabilities: Cold or Frozen
Digital Side Mirrors	Construction: Walk Ramps	Motor: Zero Emissions	Controls: Dash Mounted
Zero-Emissions	Construction: Reinforcement	Step: Drop Step	Controls: Thermal Controls
Wide Cab	Step: Drop Step	Step: Folding Step	Design: Aerodynamic
Large Windshield	Step: Folding Step	Wheels: Chrome	Wheels: Chrome

Handles: Grab	Handles: Grab
Lights: Dome	Lights: Dome
Lights: Dome	Lights: LED
Motor: Silent Electric	Motor: Silent Electric
Motor: Zero Emissions	Motor: Zero Emissions
Step: Drop Step	Step: Drop Step
Step: Folding Step	Step: Folding Step

BENEFITS	Sort #1	Sort #2
From Promotional Material	DATA [On Menu Bar] →	Groups like categories
Premium Cost	Beautiful	***Use Factor***
Innovative	Comfortable	Consistent Density and Insulation
Delivers	Consistent Density and Insulation	Delivers
Durability	Delivers	Durability
Superior Protection	Durability	Maximum Capacity
Provides Strength	Easier and Safer Movement	Maximum Payload
Consistent Density and Insulation	Easy	Overcome challenges
Easier and Safer Movement	Efficient Methods	Preserves A.Q
Superior Protection	Functional	Provides Stability
Provides Strength	Improves Visibility	Provides Strength
Water Prevention	Innovative	Provides Strength
Overcome challenges	Maximum Capacity	Superior Protection
Premium Cost	Maximum Payload	Superior Protection
Beautiful	Overcome challenges	Superior Protection
Functional	Premium Cost	Urban Areas
Superior Protection	Premium Cost	Water Prevention
Efficient Methods	Preserves A.Q	
Urban Areas	Provides Stability	**Efficiency:**
Comfortable	Provides Strength	Easier and Safer Movement
Easy	Provides Strength	Easy
Provides Stability	Sleek Look	Efficient Methods
Specifically Tailored	Specifically Tailored	Functional
Maximum Payload	Superior Protection	Improves Visibility
Maximum Capacity	Superior Protection	Innovative
Improves Visibility	Superior Protection	Premium Cost
Sleek Look	Urban Areas	Premium Cost
Preserves A.Q	Water Prevention	Specifically Tailored
		Comfort:
		Beautiful
		Comfortable
		Sleek Look

2.6 Product Research

This section will be focusing on the product benchmarking for related to this thesis topic, specifically products related to food transport for food banks and their programs to combat food insecurity. In addition to web-based product research, part of the advisor interviews had been used to better understand the current products used in the distribution and processing at the OFB. These insights help give an idea of what specifics the food bank looks for, and how the products characteristics help and improve the experience of the user and the worker.

2.7 Benchmarking - Benefits and Features

FEATURES		Sort #1	Sort #2	
From Promotional Material	Re-order: NOUN first	DATA [On Menu Bar] →	Group like categories	
Aerodynamic Design	Controls: Dash Mounted	Battery: All Day Range	**Cargo Box : 10**	
Grab Handles	Controls: Thermal Controls	Battery: High Capacity		
Folding Step	Lights: Dome	Bulkhead: Adjustable and Insulated	Cargo Box: Aluminium Diamond Plate Floor	
Reinforcement	Lights: Dome	Bumper: Structural	Cargo Box: Backup Refrigeration System	
Sub-Frame	Lights: LED	Bumper: Structural	Cargo Box: Fibreglass Interior	
Steel Center	Battery: High Capacity	Capabilities: Cold or Frozen	Cargo Box: Foam Insulation	
Corrosion Resistant	Battery: All Day Range	Cargo Box: Aluminium Diamond Plate Floor	Cargo Box: High Load Capacity	
Rain Deflector	Handles: Grab	Cargo Box: Backup Refrigeration System	Cargo Box: High Performance Insulation	
Grab Handles	Handles: Grab	Cargo Box: Fibreglass Interior	Cargo Box: Impact Resistant	
Foam Insulation	Bumper: Structural	Cargo Box: Foam Insulation	Cargo Box: Racking System	
Structural Bumper	Bumper: Structural	Cargo Box: High Load Capacity	Cargo Box: Replaceable Seals	
Walk Ramps	Frame: Integrated Headlights	Cargo Box: High Performance Insulation		
Step/Drop Step	Frame: Steel	Cargo Box: Impact Resistant	**Driver : 7**	
Thermal Breaks	Frame: Steel Center	Cargo Box: Racking System	Driver: Back Up Alarm	
Replaceable Seals	Frame: Slim Profile	Cargo Box: Replaceable Seals	Driver: Back Up Camera With Alarm	
Dome Lights	Frame: Sub-Frame	Construction Thermal Breaks	Driver: Digital Side Mirrors	
LED Lights	Frame: Wide-Cab	Construction: Corrosion Resistant	Driver: Large Windshield	
Fibreglass Interior	Frame: Low Step	Construction: Height	Driver: Point Seatbelts	
Aluminium Diamond Plate Floor	Frame: Modular Architecture	Construction: Length	Driver: Top Rain Deflector	
Cold or Frozen Capabilities	Cargo Box: Fibreglass Interior	Construction: Reinforcement	Driver: Upright Seating	
Stainless Steel	Cargo Box: High Performance Insulation	Construction: Walk Ramps		
Racking System	Cargo Box: Backup Refrigeration System	Controls: Dash Mounted	**Frame : 8**	
Dome Lights	Cargo Box: Replaceable Seals	Controls: Thermal Controls	Frame: Integrated Headlights	
Back Up Alarm	Cargo Box: High Load Capacity	Design: Aerodynamic	Frame: Steel	
Dash Mounted Controls	Cargo Box: Impact Resistant	Driver: Auto Shift	Frame: Steel Center	
Back Up Camera with Monitor	Cargo Box: Foam Insulation	Driver: Back Up Alarm	Frame: Slim Profile	
Adjustable Insulated Bulkhead Wall	Cargo Box: Racking System	Driver: Back Up Camera With Alarm	Frame: Sub-Frame	
Back-up Refrigerated System	Cargo Box: Aluminium Diamond Plate Floor	Driver: Digital Side Mirrors	Frame: Wide-Cab	
Chrome Wheels	Bulkhead: Adjustable and Insulated	Driver: Large Windshield	Frame: Low Step	
Structural Bumper	Design: Aerodynamic	Driver: Point Seatbelts	Frame: Modular Architecture	
Dash Mounted Thermal Controls	Wheels: Chrome	Driver: Top Rain Deflector		
Impact Resistant Cargo Box	Driver: Upright Seating	Driver: Upright Seating	**Construction : 6**	
Auto Shift	Driver: Top Rain Deflector	Frame: Integrated Headlights	Construction Thermal Breaks	
Near Silent Electric Motor	Driver: Large Windshield	Frame: Low Step	Construction: Corrosion Resistant	
All Day Battery Range	Driver: Point Seatbelts	Frame: Modular Architecture	Construction: Height	
3 Point Seatbelts	Driver: Auto Shift	Frame: Slim Profile	Construction: Length	
Frame Integrated Headlights	Driver: Back Up Alarm	Frame: Steel	Construction: Reinforcement	
Low Step Frame	Driver: Back Up Camera With Alarm	Frame: Steel Center	Construction: Walk Ramps	
Upright Seating	Driver: Digital Side Mirrors	Frame: Sub-Frame		
Slim Profile	Motor: Silent Electric	Frame: Wide-Cab	**Other : 19**	
High Performance Insulation	Motor: Zero Emissions	Handles: Grab	Battery: All Day Range	lles: Grab
Modular Architecture	Capabilities: Cold or Frozen	Handles: Grab	Battery: High Capacity	Handles: Grab
Battery Capacity	Construction: Corrosion Resistant	Lights: Dome	Bulkhead: Adjustable and Insulated	Lights: Dome
Height	Construction: Length	Lights: Dome	Bumper: Structural	Lights: Dome
Length	Construction: Height	Lights: LED	Bumper: Structural	Lights: LED
Load Capacity	Construction Thermal Breaks	Motor: Silent Electric	Capabilities: Cold or Frozen	Motor: Silent Electric
Digital Side Mirrors	Construction: Walk Ramps	Motor: Zero Emissions	Controls: Dash Mounted	Motor: Zero Emissions
Zero-Emissions	Construction: Reinforcement	Step: Drop Step	Controls: Thermal Controls	Step: Drop Step
Wide Cab	Step: Drop Step	Step: Folding Step	Design: Aerodynamic	Step: Folding Step
Large Windshield	Step: Folding Step	Wheels: Chrome	Wheels: Chrome	

BENEFITS	Sort #1	Sort #2
From Promotional Material	DATA [On Menu Bar] →	Groups like categories
Premium Cost	Beautiful	***Use Factor***
Innovative	Comfortable	Consistent Density and Insulation
Delivers	Consistent Density and Insulation	Delivers
Durability	Delivers	Durability
Superior Protection	Durability	Maximum Capacity
Provides Strength	Easier and Safer Movement	Maximum Payload
Consistent Density and Insulation	Easy	Overcome challenges
Easier and Safer Movement	Efficient Methods	Preserves A.Q
Superior Protection	Functional	Provides Stability
Provides Strength	Improves Visibility	Provides Strength
Water Prevention	Innovative	Provides Strength
Overcome challenges	Maximum Capacity	Superior Protection
Premium Cost	Maximum Payload	Superior Protection
Beautiful	Overcome challenges	Superior Protection
Functional	Premium Cost	Urban Areas
Superior Protection	Premium Cost	Water Prevention
Efficient Methods	Preserves A.Q	
Urban Areas	Provides Stability	**Efficiency:**
Comfortable	Provides Strength	Easier and Safer Movement
Easy	Provides Strength	Easy
Provides Stability	Sleek Look	Efficient Methods
Specifically Tailored	Specifically Tailored	Functional
Maximum Payload	Superior Protection	Improves Visibility
Maximum Capacity	Superior Protection	Innovative
Improves Visibility	Superior Protection	Premium Cost
Sleek Look	Urban Areas	Premium Cost
Preserves A.Q	Water Prevention	Specifically Tailored
		Comfort:
		Beautiful
		Comfortable
		Sleek Look

2.7.1 Benchmarking – Functionality

Transportation vehicles such as the ones benchmarked a very utilitarian and functional object, solely designed for moving a large or other specified amount and type of cargo in an easily approachable shape and layout, a driver cab in front, a box car situated on top of the main frame, with access available both from the rear and sides. One important aspect is the varying size of trucks, chosen for specific tasks and types of jobs. For food banks, the types of vehicles used vary, with the larger scale types being used for transport between the O.F.B. and their agencies, more officially between the distribution center and the accessible food banks.

One of the biggest pain points regarding the functionality of the trucks used is in the loading and unloading process, one of the most time-consuming steps within the whole procedure of food distribution. The OFB has a set procedure to sort and pack the ordered non-perishables a day before the actual delivery, the morning of perishable and refrigerate food is loaded, all together packed onto a palette, each designated to a set agency. Pallet jacks are used to move the loaded pallets between the warehouse and the vehicles, with the help of already installed lift gates on the trucks tail end. This is a lack of convenience for the agency's that the food is delivered to because of a lack of infrastructure, most agencies don't have a loading dock an array of pallet jacks on hand, a process which may take longer to unload the pallet and may have to be unpacked in the truck if no equipment is on hand.

The rate of which cargo can be loaded is another big holdback to better efficiency as only one pallet at a time can be loaded, planning has to take place beforehand in the warehouse or loading bay for organizing the sequence of deliveries. This issue is also catered by the only access at the rear of the vehicle, and the one liftgate. The process of gathering donations isn't exactly efficient either, grocery stores for example store prepacked donation bags in red cages and boxes, then loaded the same method as pallets.

Overall, the main functional drawback with these current vehicles is the lack of a proper vehicle designed specifically for food banks and food program transport at such a large and local scale that is seen in cities. Delivery vehicles like Canada Post, Amazon, and other related industries have their own style and specifically design vehicle benchmark, ambulances are specifically designed for the purpose

of rapid patient transport and medical aid. The functions of the vehicle needs to be better tailored to the industry that it's used for.

2.7.2 Benchmarking – Aesthetics and Semantic Profile

Aesthetics

- The vehicles used for food banks are fairly basic in aesthetic, used primarily to get the job done instead of looking good.
- Trucks typically have a cab that is predictable in design and shape.
- Boxcar in back is always the same shape for freight vehicles with a aluminum or steel frame, with insulated panels making up the body in between.
- The frame and mechanical parts of the vehicle is made up of metals, the external features that have no structural worth are a mix of both plastic and metal
- Graphics may include naming of the food bank, messages or advertising branded on the external sides of the box car, and even the front cab of the truck.
- The textures and finished are fairly neutral, nothing out of the ordinary or anything special, most of the focus is on function rather than aesthetics.

Symbolic

- The emotions of the product are pretty neutral at face value, but from a use perspective the product may be intended to give a personality of helpfulness and generosity, at a life-redefining level.
- The product is driven by the need to help and relief needed for those who face food insecurity, so symbolically it's because of the obligation and necessity to combat this sort of issue.

2.7.3 Human Factors – Materials and Manufacturing

There are many companies and business to benchmark in relation to materials, manufacturing, and the innovation in both of those sectors. Especially with the increased focus on electric vehicle production, there has been a rise of commercial vehicle development and innovation.

Arrival & Canoo

Many new electric vehicle startup companies have entered the commercial vehicle development industry in the past couple years as the cost of batteries and related technology become more accessible to a lower price bracket population. A couple of note is Canoo and Arrival, recent startups providing innovation in delivery vehicles, each with their distinguished manufacturing process, style, features, and end user.

Image 2.1 Canoo MPDV (Multipurposes Delivery Vehicle) Left, Image 2.2 Arrival Delivery Van

Manufacturing

The manufacturing process for these vehicles is unlike the traditional legacy automakers. While both vehicles focus on modularity and costumization of their skateboard battery platform, Arrival has a more distinguishable focus on the manufacturing process than the other. Microfactories and entirely automated in house material production and assembly are the focus for feasability of these vehicles and the potential for innovating to different vehicle sectors, makes, and models. The amount of time taken for setup, space, and lower resources used contrast greatly with traditional legacy automakers. This helps reduce the overall environmental impact of the manufacturing of these vehicles.

Materials

Plastics – Plastics compose a large amount of vehicle components. The exterior, interior paneling, dashboard, controls, seating, and engine components. Poly Propylene (PPE), Polyurethane (PU), and PVC.

Metals – These are used primarily as the internal core structure, frame and chassis of the vehicle. Aluminum and steel are one of the most common types of metals used in conventional manufacturing. These are followed by more expensive forms of magnesium and titanium.

Fabrics – These kinds of materials vary from many types of sources, threads, weaves and wefts, mainly for the use of upholstery, and control grips. More recently, recycled and more biodegradable fabrics have been used for this purpose. Another use is combining fabrics to create plastic composites to replace more conventional plastics for paneling and finishing, in the case for Arrival, they've utilized this as an inhouse process.

Packaging – Cardboard as a packaging material is the dominant solution for the transportation of goods in almost any form due to its rigidity, foldability, and easy manufacture. About 80% of typical corrugated cardboard is recyclable, as the majority of its composition is paper product. New innovative materials that have a more organic and environmentally friendly source could potentially become a contender to the cardboard monopoly. Starch from grain or corn, mycelium, and even seaweed are new materials that provide replacements for current aspects of packaging whether it be paper molds, foam or polystyrene.

2.8 2.2.5 Benchmarking – Sustainability

Metals – Of all the metals used in manufacturing of electric vehicles, aluminum is the most recyclable and cheapest of them all, one that does not include the injection of carbon and mass amounts of energy to produce like steel. For commercial transport vehicles, metal is used more for the framework and chassis of the vehicle.

Plastics – There are many types of plastics out there, one of the most sustainable being ABS, or PPE (PP), thermoformed plastic that can be melted down and remolded. A more recent process is plastic composites that at the end of the parts lifecycle are broken down mechanically into pellets to then be remolded. In the future, the ability to break down plastics and recycle them will evolve and improve within the coming decades.

Packaging – Overall, packaging consisting of cardboard is already fairly sustainable as a material, but it's more of the accompanying materials that are used as packaging for the products itself, whether it be cushioning, or molds. These can become more sustainable through the incorporation of new materials such as starch for molding, mycelium to grow packaging, all of these can contribute to a fully sustainable way of packaging.

Power – EV's and battery powered vehicles, both from private and commercial based platforms have really taken off in the last 10 years, with the first mass produced electric vehicle being the Nissan Leaf back in 2011. Battery technology continues to improve on efficiency, capacity and cost, as well as improving battery recycling programs. Solid state batteries are a clear future for batteries and drastically improving the efficiency of charging, discharging, and use.

- Materials used would include metals primarily for the equipment and mechanical content required for the moving of product.
- Plastics are used more for the facades and interior portions of the cab for instance, where most of the user to product interaction takes place.
- For metal manufacturing casting, extrusion molding, and bending would be the go-to methods.
- For plastic manufacturing, injection molding would most likely be the go-to method.
- Sustainable initiatives for current benchmarks would be the use of cardboard box products for the storage and sorting process at food banks

2.9 SUMMARY

Overall, there are key drawbacks with current benchmarks in the efficiency of use especially taking into fact of the scale of demand required from food banks. A time such as now shows how susceptible food banks, and their infrastructure are to external changes. There is a clear focus on potential improvements towards the logistics aspect of emergency food distribution. The loading and unloading process and the approachability of vehicles is probably the biggest influence on the whole procedure at the food bank. The materials and aesthetics used are rather basic, so approaching the issue doesn't require extreme goals and targets. Overall, the products used for the benchmarking are nothing special

in terms of standing out from other sectors and industries, their primarily made and used for getting the job done through its functions.

CHAPTER #3
ANALYSIS – NEEDS

CHAPTER #3
ANALYSIS

2.10 3.1 Analysis - Needs

2.113.1.1 Needs/Benefits Not Met by Current Products

- Unified system for unloading and loading infrastructure between agencies and food banks
- Established and effective discreet method of food delivery for users
- Easily approachable loading and unloading system
- Loading system that can be done from multiple angles
- Scalable capacity
- Climate controlled space for food storage
- Easy and approachable repairability and maintenance
- Ability to function with current routing and ordering software, also for improved user interfaces with this software while using the vehicle and hardware. Needs may include wireless connections with the food bank and its agencies.

3.1.2 Latent Needs

- Electric propulsion / motor (targeting for 10 years in the future, battery tech and efficiency will be more economical and efficient than current diesel- and petrol-powered counterparts)
- 2-person cab capacity (while mainly a one-person job,

- Need for a unobtrusive method of delivery. This is from the user perspective where the mental and behavioral impacts of food insecurity are important. They want a method of delivery where it's unobtrusive to their current confidentiality with the food banks.

- Easy cab and storage access

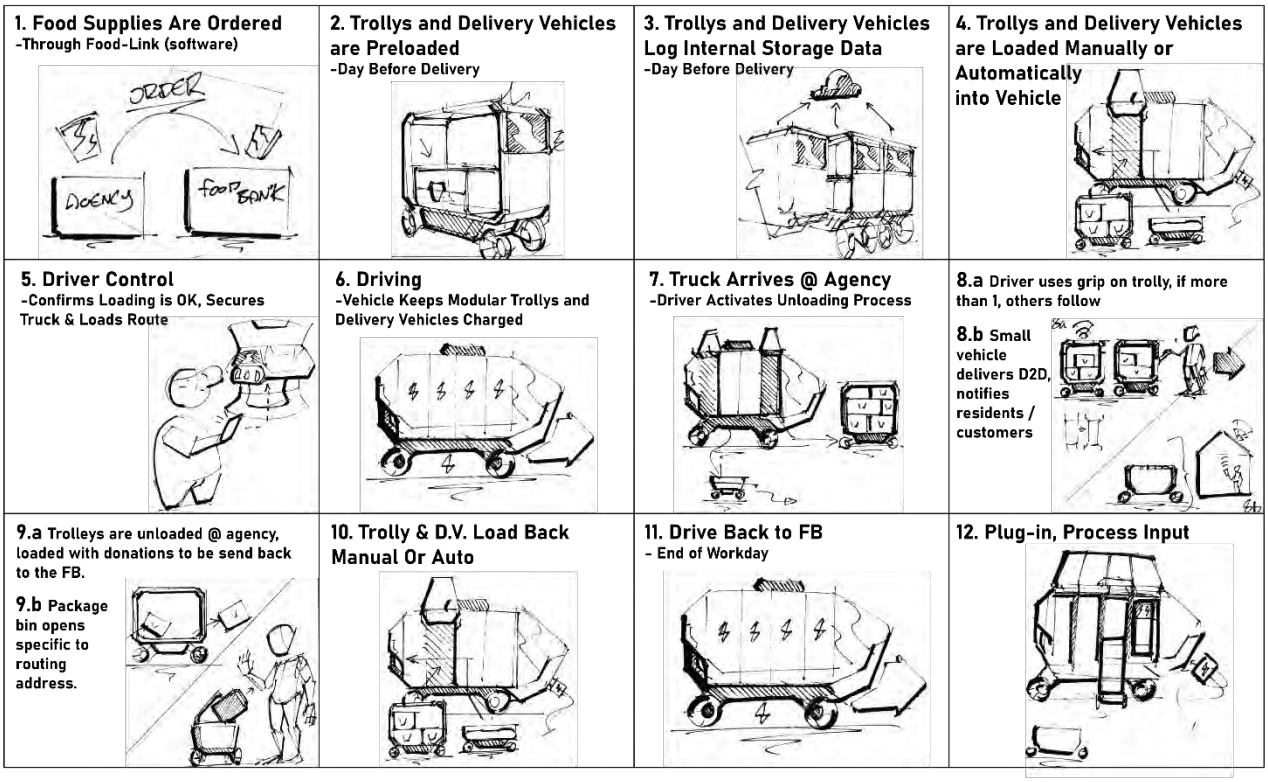
2.12 3.1.3 Categorization of Needs

Wishes	Wants	Latent Needs	Immediate Needs
Sustainable packaging of food products	Food banks to be related more to healthcare establishments (make it an essential service like paramedics)	Easily approachable loading and unloading system	Unified system for unloading and loading infrastructure between agencies and food banks
Electric Propulsion (targeting for 10 years in the future, battery tech and efficiency will be more economical and efficient than current diesel- and petrol-powered counterparts)	Established and effective discreet method of food delivery for users	2-person cab capacity (while mainly a one-person job,	Loading system that can be done from multiple angles
	System that can work for all demographics of volunteers and workers	Established and effective discreet method of food delivery for users	Scalable capacity
		Need for a unobtrusive method of delivery. This is from the user perspective where the mental and behavioral impacts of food insecurity are important. They want a method of delivery where it's unobtrusive to their current confidentiality with the food banks.	Ability to function with current routing and ordering software, also for improved user interfaces with this software while using the vehicle and hardware. Needs may include wireless connections with the food bank and its agencies.

		Easy and approachable repairability and maintenance	Climate controlled space for food storage
		Easy cab and storage access	

3.2 Analysis – Usability

2.13 3.2.1 Activity – Workflow Mapping



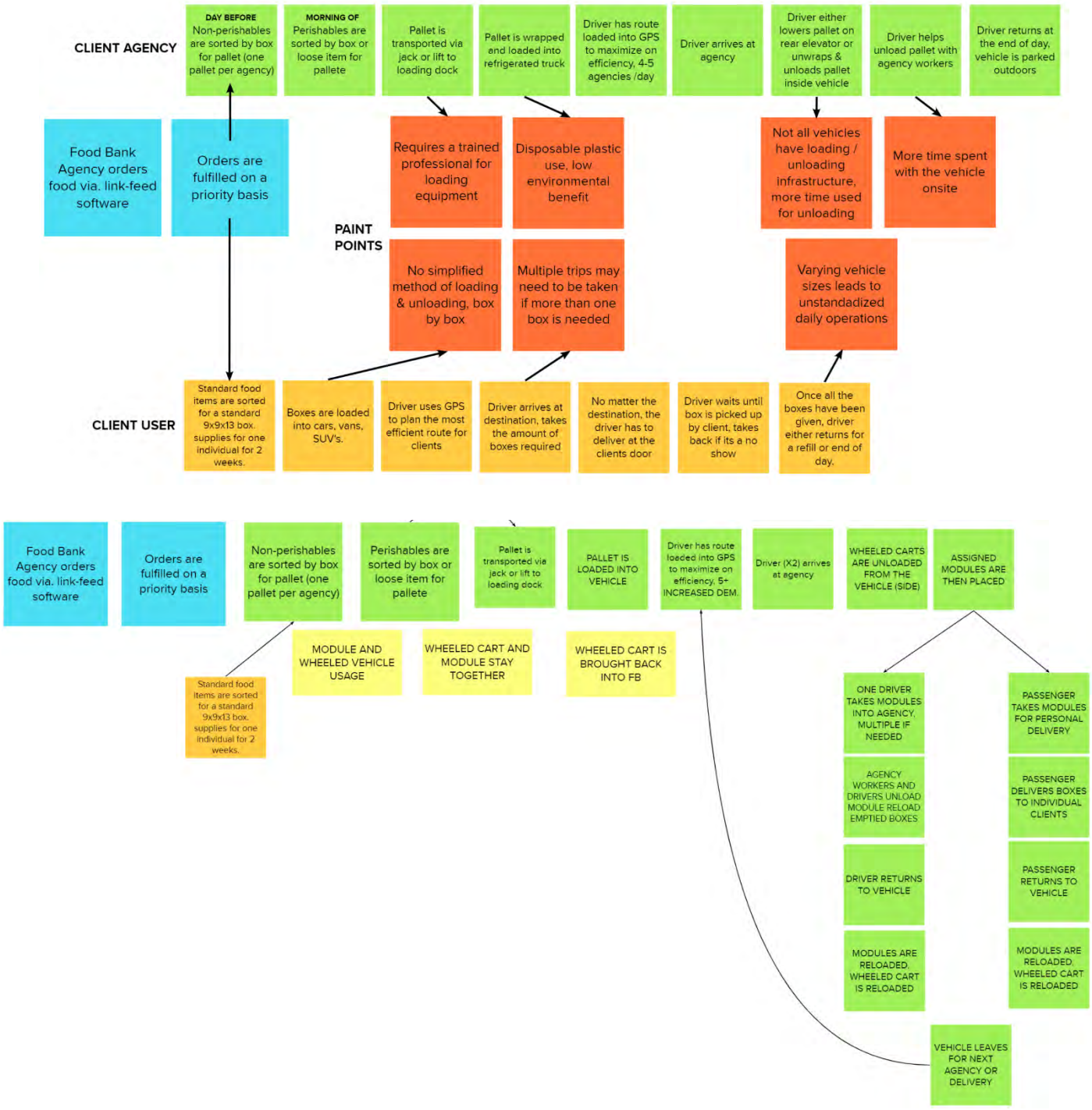

CLIENT AGENCY
DAY BEFORE
Non-perishables are sorted by box for pallet (one pallet per agency)
MORNING OF
Perishables are sorted by box or loose item for pallete
Pallet is transported via jack or lift to loading dock
Pallet is wrapped and loaded into refrigerated truck
Driver has route loaded into GPS to maximize on efficiency, 4-5 agencies /day
Driver arrives at agency
Driver either lowers pallet on rear elevator or unwraps & unloads pallet inside vehicle
Driver helps unload pallet with agency workers
Driver returns at the end of day, vehicle is parked outdoors
Food Bank Agency orders food via. link-feed software
Orders are fulfilled on a priority basis
Requires a trained professional for loading equipment
Disposable plastic use, low environmental benefit
Not all vehicles have loading / unloading infrastructure, more time used for unloading
More time spent with the vehicle onsite
PAINT POINTS
No simplified method of loading & unloading, box by box
Multiple trips may need to be taken if more than one box is needed
Varying vehicle sizes leads to unstandadized daily operations
CLIENT USER
Standard food items are sorted for a standard 9x9x13 box. supplies for one individual for 2 weeks.
Boxes are loaded into cars, vans, SUV's.
Driver uses GPS to plan the most efficient route for clients
Driver arrives at destination, takes the amount of boxes required
No matter the destination, the driver has to deliver at the clients door
Driver waits until box is picked up by client, takes back if its a no show
Once all the boxes have been given, driver either returns for a refill or end of day.
Food Bank Agency orders food via. link-feed software
Orders are fulfilled on a priority basis
Non-perishables are sorted by box for pallet (one pallet per agency)
Perishables are sorted by box or loose item for pallete
Pallet is transported via jack or lift to loading dock
PALLET IS LOADED INTO VEHICLE
Driver has route loaded into GPS to maximize on efficiency, 5+ INCREASED DEM.
Driver (X2) arrives at agency
WHEELED CARTS ARE UNLOADED FROM THE VEHICLE (SIDE)
ASSIGNED MODULES ARE THEN PLACED
Standard food items are sorted for a standard 9x9x13 box. supplies for one individual for 2 weeks.
MODULE AND WHEELED VEHICLE USAGE
WHEELED CART AND MODULE STAY TOGETHER
WHEELED CART IS BROUGHT BACK INTO FB
ONE DRIVER TAKES MODULES INTO AGENCY, MULTIPLE IF NEEDED
PASSENGER TAKES MODULES FOR PERSONAL DELIVERY
AGENCY WORKERS AND DRIVERS UNLOAD MODULE RELOAD EMPTIED BOXES
PASSENGER DELIVERS BOXES TO INDIVIDUAL CLIENTS
DRIVER RETURNS TO VEHICLE
PASSENGER RETURNS TO VEHICLE
MODULES ARE RELOADED, WHEELED CART IS RELOADED
MODULES ARE RELOADED, WHEELED CART IS RELOADED
VEHICLE LEAVES FOR NEXT AGENCY OR DELIVERY

Fig.

3.3 Human Factors

The main goal of this process was to study and evaluate the ergonomic challenges and the full-bodied-human-interaction design (FBHID) that come with warehouse and freight equipment used in a food bank setting (Chong, Zaccolo, Kappen, Thomson, Burke & White, 2020). Considering the requirement for interaction from 3 major body parts, rationale was taken to find the most important aspects of the current process of equipment use, and to identify the positive and negative elements of current ergonomic setups, ease of use, and overall convenience.

Decision(s) to be Made

The following interactions relevant to three specific contact points were investigated due to repetitive instances of use. Major body part areas (Chong et al., 2020) were investigated to minimize the negative experiences and maximize the positive experiences of:

1. Loading and unloading packaged food and essential consumables. (Hands & Back)
2. Steering and operating cargo transport equipment (In addition to push and pull (Hands & Feet))
3. Visibility during operation of equipment (Head, Neck, & Shoulders)

Description of Users Targeted by Product

The target users for this product are reflective of the foodbank workforce and those who use their services. Since most of the process is built up of volunteers, the food bank workforce is essentially reflective of the community its based within. Making a consensus from the research done, the most representative demographics would be:

- Between the ages of 30-40
- Male or Female

- Not experiencing food insecurity (financially stable to be able to volunteer)
- Education can vary, not specific on the ability for volunteering
- Lives within the urban boundary of Ottawa or any other urban region.

Evaluation process

These evaluations are based off from the design of a full scale 1:1 ergonomic buck of The evaluation process consisted of designing a full scale (1:1) ergonomic buck of the cabin (Badaraco, 2016; MacDonald, 2016; Pedulla, 2016) which allowed for critical observation of the following:

1. Observing how the user operates and steers equipment.
2. Observing and documenting sightlines and blind spots when using equipment.
3. Observing and documenting handle and grip positioning for ideal control use for turning, pushing, and pulling movements (presuming being moved from an external position)
4. Documenting the use of a raised platform and how it affects controls and ease of use.

Description of User Observation Environment Used in this Study

For this study of warehouse-based transport equipment, two locations were used for this study. For the OFB (Ottawa Food Bank) a walkthrough of the warehouse space and an explanation of the processes involved for the food distribution process was undertaken to better understand potential experience conflicts. Unfortunately, due to Covid-19, the study was only possible after hours. The equipment studied were:

- Pallet jacks both powered and unpowered
- Forklifts
- Trolly carts

These were all measured and photographed in regards of human interactivity. The different positions that would occur during use of relative equipment were taken into consideration with the measurement process. Pushing, pulling and turning were actions taken into consideration as well.

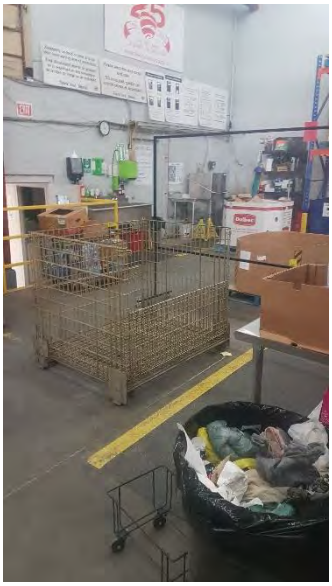
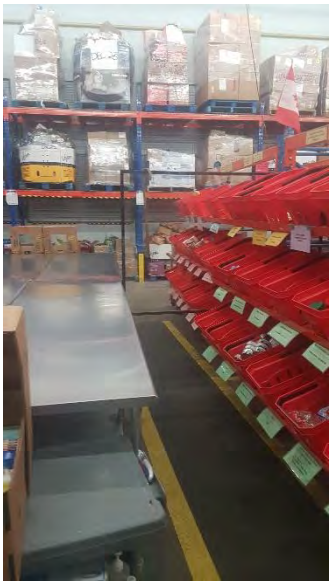
Location and Timeframe

Date of Observation(s): 7/01/2021 (Observation & Study 1)

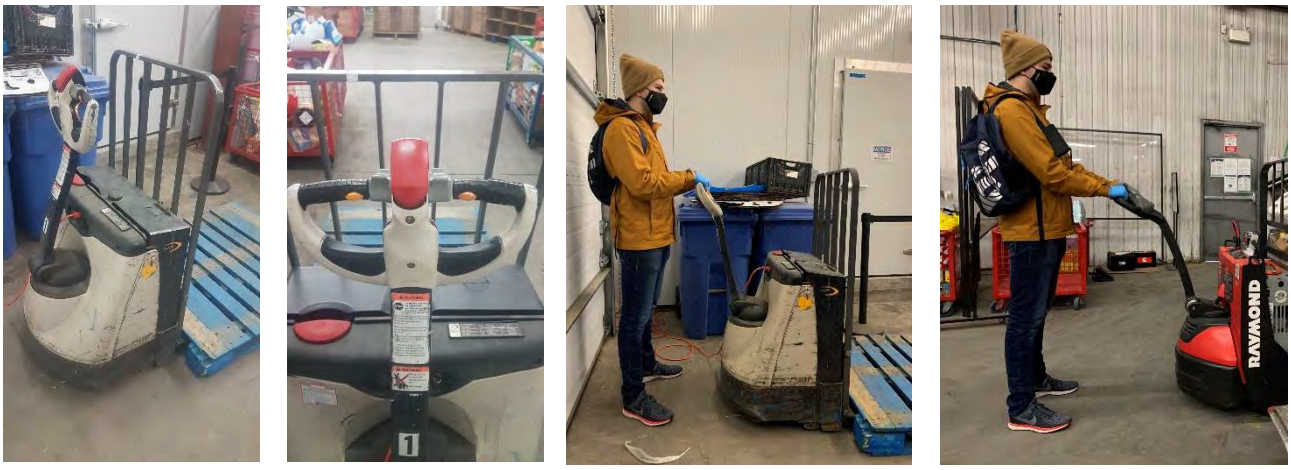
9/01/2021 (Observation & Study 2)

Location of Observation(s): Ottawa Food Bank (Observation & Study 1)

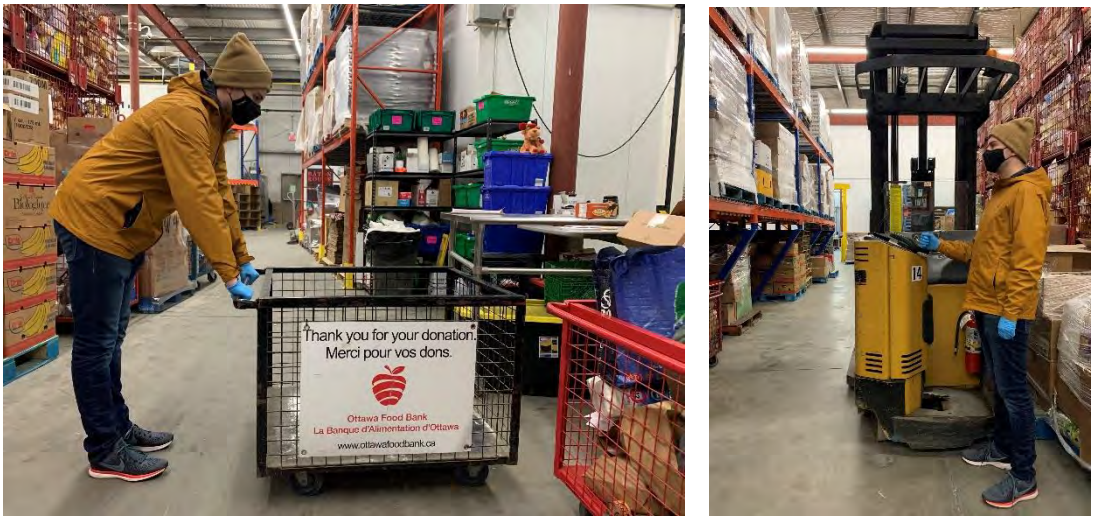
Veritas Tools (Observation & Study 2)

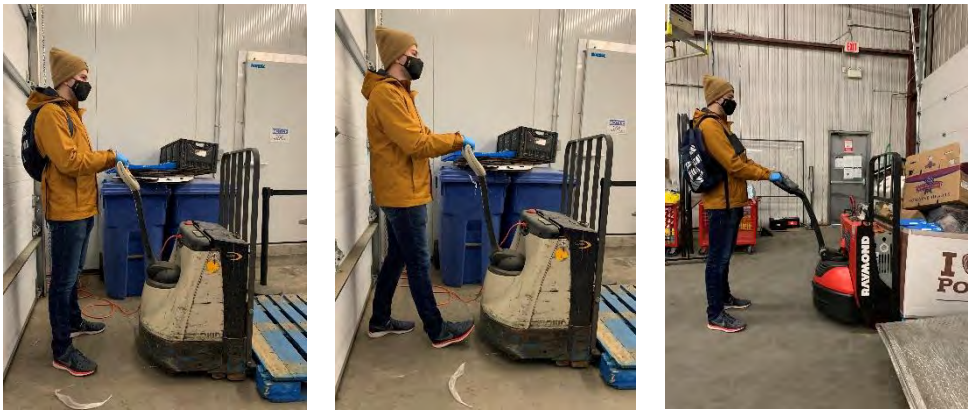

Fig


1
RAYMOND

Fig


Thank you for your donation.
Merci pour vos dons.
Ottawa Food Bank
La Banque d'Alimentation d'Ottawa
www.ottawafoodbank.ca

Fig


RAYMOND

Fig

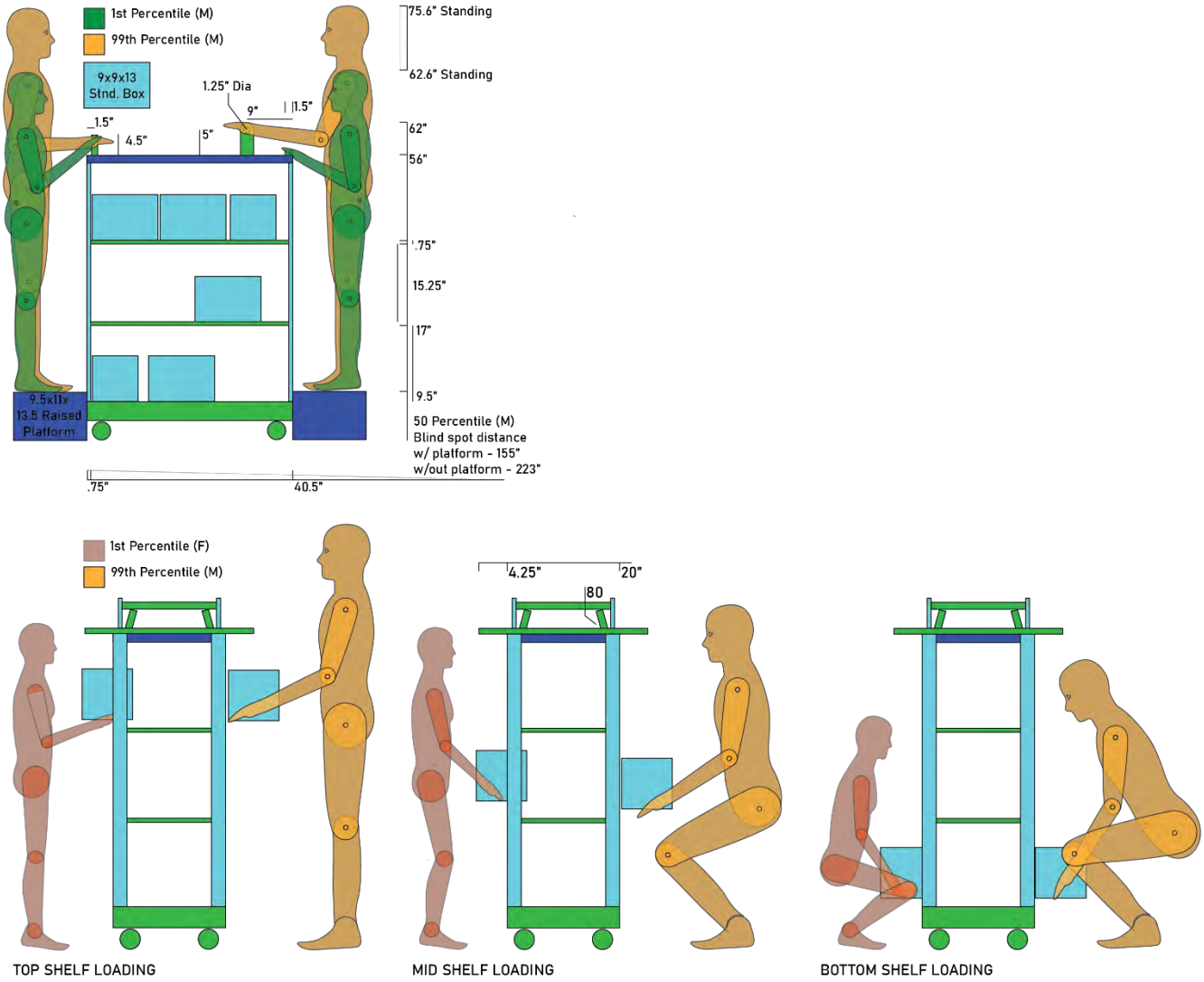


Fig. Ergonomic profiles of Male and Female 1st Percentiles, including Male 99th Percentiles, are all referred from "The Measure of Man & Woman" by Henry Dreyfuss

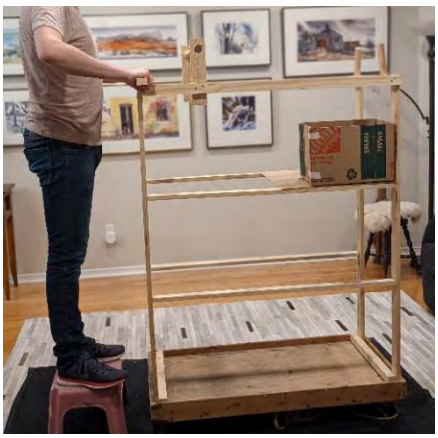
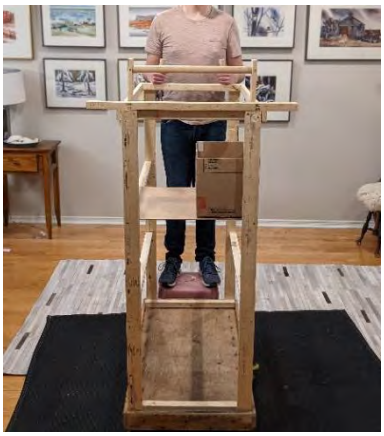
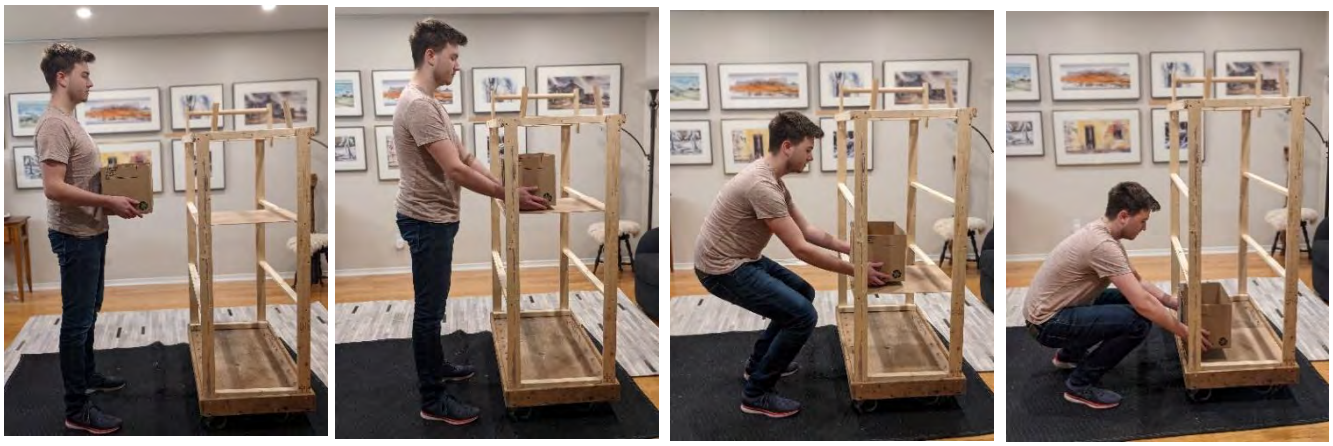




Fig The mockup was built off of an existing trolly, the frame built on the inside edge. Proportions in length, width, and height with this mockup may not determine the final product.


Fig



Fig

3.4 Aesthetics and Semantic Profile

3.5 Sustainability – Safety, Health, and the Environment

With food transportation, especially for a program that specializes in helping those in need in the urban areas around or world, efficiency is what makes their service successful. Making food transport within food banks sustainable helps to reduce costs and maximize overall efficiency of their processes.

Utilizing high quality, durable and innovate materials, a modular electric food bank utility vehicle as a whole is created to be more efficient, and sustainable for a better environment.

2.14 3.6 Feasibility and Viability

Batteries and Power

This is the main component of the transport vehicle, providing power to the drivetrain, internal storage system and vehicle controls. This component would ideally be part of a modular skateboard platform, one which the vehicle itself would be attached and bolted to in assembly. In 10 years, this

would ideally be solid state lithium-ion (unless silicone or graphene batteries prove more cost-effective) packs as they can charge at a higher rate and are more energy dense. These packs would not be manufactured to provide the highest range possible for the skateboard platform, instead be geared to the city that the food bank is situated in, range varying from 140 – 200 miles a.k.a. (225 – 321km). For the long-term safety and health of the vehicle and its users, the main chassis would be constructed out of steel, especially the battery casing.

Metal Framing

This composes the main structure of the vehicle around and on top of the main vehicle chassis. Using aluminum would help cater to a more environmental standpoint due to it's recyclability. The front end and box section frame would ideally have the most reinforcement out of the whole structure. Composed of extruded beams and sheets bolted together to form the structure. The mechanical component structure would be composed of the same material.

Plastic Paneling

For the non-structural components of the vehicle and its modules, they would be composed primarily of plastic, more specifically thermoplastic composites. Using this method from Arrival and their paneling process, these components would be a mix of thermoplastic and fabric, as mentioned before can be broken down into pellets and remolded without losing strength and durability, another benefit using this material for the vehicle package is its resistance to impact related damage, something that aluminum or any metal-based panel lacks in. This may help reduce the need for remolding parts and vehicle maintenance, lowering overall cost post-purchase.

Modularity – Having the chassis, framing, and food transport components built out of modular components also makes the overall manufacturing and assembly process modular in itself, components are smaller in scale, thus not needing as large investment and scale to manufacture them also ideally lowering overall emissions.

Repair and Replacement – In addition to the components being modular, ideally their smaller scale would cater to a more streamlined process of manufacturing. This will help extend the lifetime of the vehicle and help provide long lasting vehicle infrastructure.

Organics – Trying to incorporate more sustainable packaging methods, trying to reach farther than cardboard boxes which are pretty standard today, expanding into different packaging materials such as starch molding, bamboo and hemp combinations, as well as pushing more experimental options such as seaweed, and mycelium, they can help create a fully biodegradable and zero-impact product lifecycle while also utilizing a straightforward manufacturing process.

2.15 Business Model & Economics

Circular Economy – The entire food bank distribution system is a constantly repeated cycle between it and its member agencies, for the OFB (Ottawa Food Bank) 122 of them in total. This business model brings the potential to utilize sustainable, durable materials within the vehicles components to create a circular economy and product cycle. Reusability of boxes and transport modules would nearly eliminate waste and create an unending exchange of these components. Specially made boxes would ideally be used only between the food bank and its agencies to guarantee return where there is constant pick up and return.

Economical Food Transport – The vehicle itself, with a focus on material quality and durability will provide a long-lasting product, a long lifecycle backed up with modular assembly, durable and

sustainable internal and external components. The electrical format lowers the long run maintenance and running costs of the vehicle as well as charging, improved with onboard energy capture for self-charging through solar. Using durable, modular components on the exterior packaging helps greatly with safety as well as maintenance, and may reduce the need for part replacement, further lowering the long-term vehicle running cost.

2.16 3.7 Design Brief

1. Purpose design solutions based on the following values: enhancing the quality of human life, user experience, convenience, efficiency and social responsibility.
2. Evaluate and develop design solutions based employing a variety of design methods.
3. Incorporate design elements to enhance both the product experience for the worker and the user.
4. Understand the attributes and methods of the company and their products for synonymous design.
5. Create an established and efficient system through design for food distribution between food banks and their agencies.
6. Apply ergonomic principles for all components for human interaction.
7. Apply electric vehicle infrastructure to the design.
8. Develop an approachable and user-friendly loading system to apply to worker demographics.
9. Ensure a large scale and economically viable solution compared to current methods.
10. Demonstrate good organizational and project management skills through timely project deliveres that meet the assigned criteria.

CHAPTER #4

DESIGN DEVELOPMENT

CHAPTER #4
DESIGN DEVELOPMENT

4.1 Idea Generation

4.1.1 Aesthetics Approach

Fig 4.1.1.1 & 4.1.1.2 – Showcase of function and form inspiration, retrieved from Behance

Fig 4.1.1.3 – 4.1.1.6 – Showcase of benchmarking of current urban solutions, deriving form and function, retrieved predominantly from Pinterest







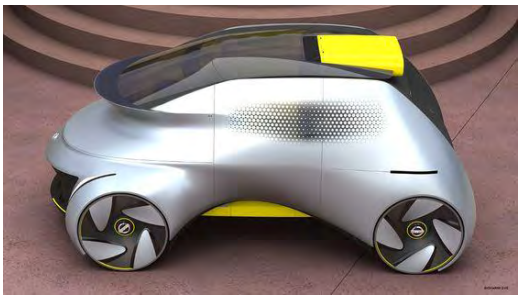
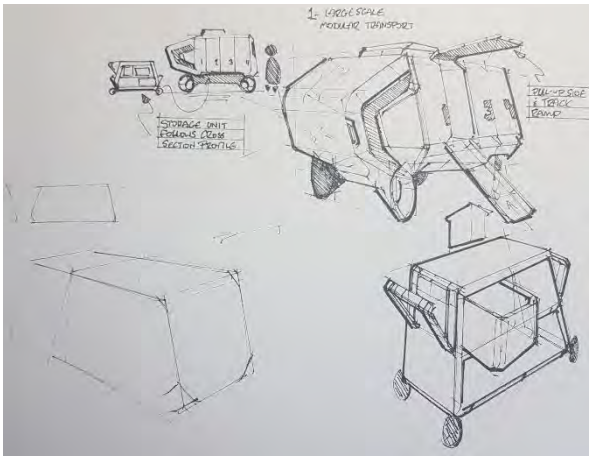



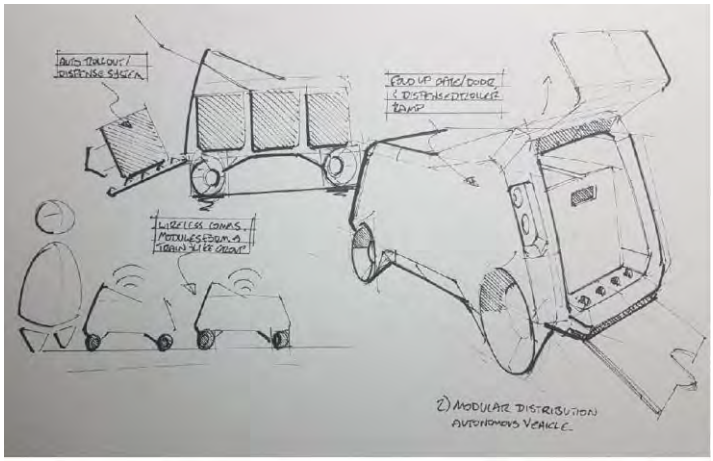
Fig 4.1.1.7 – 4.1.1.14 – Showcase of vehicle and body form, inspiration for emotion that the vehicle and module would give, with an urban and friendly design language while remaining subtle.

4.1.2 Mind Mapping – Words and Ideas

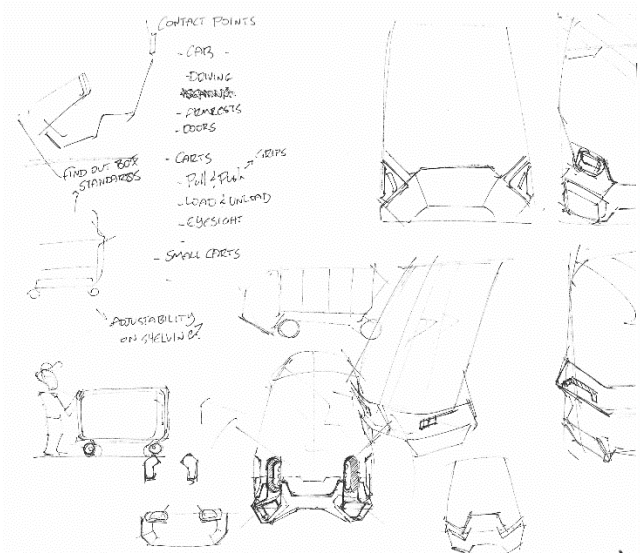
Unobtrusive	Evolved system	Future-proof
Friendly	Modular components	
Convenient	Interchangeable storage	
Honest	Functional construction	
Approachable	Semi-Autonomy	
Connection	Giving	

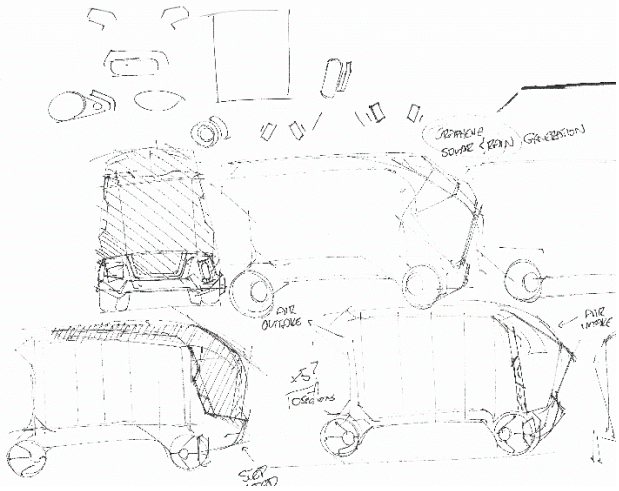
4.1.3 Ideation Sketches

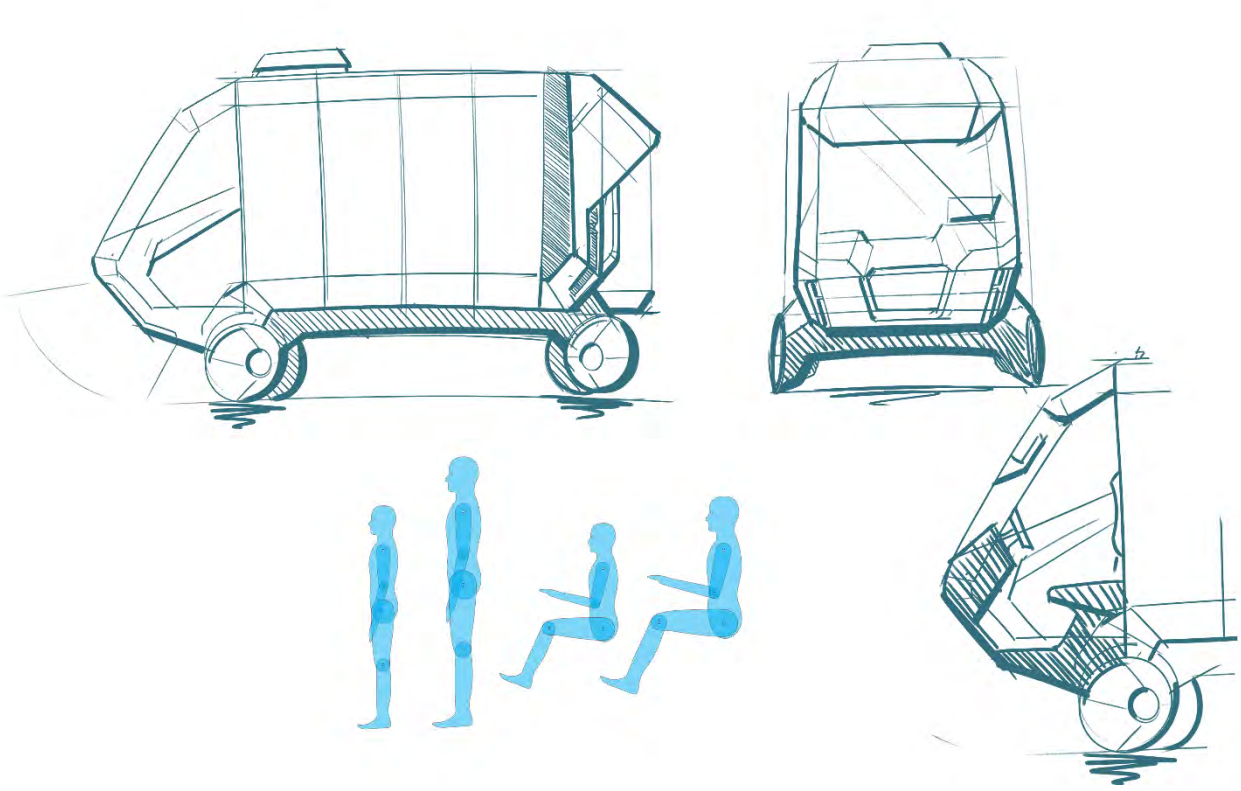




4.2 Preliminary Concept Explorations

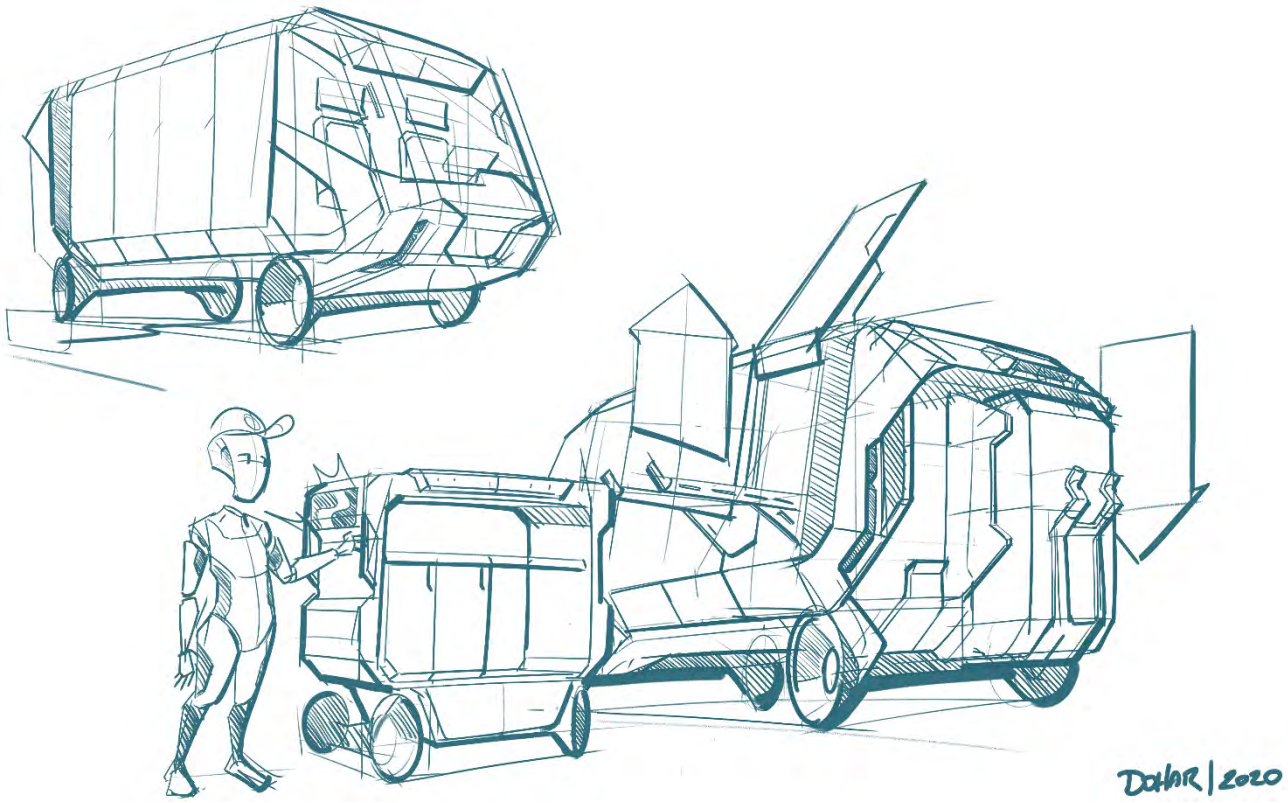


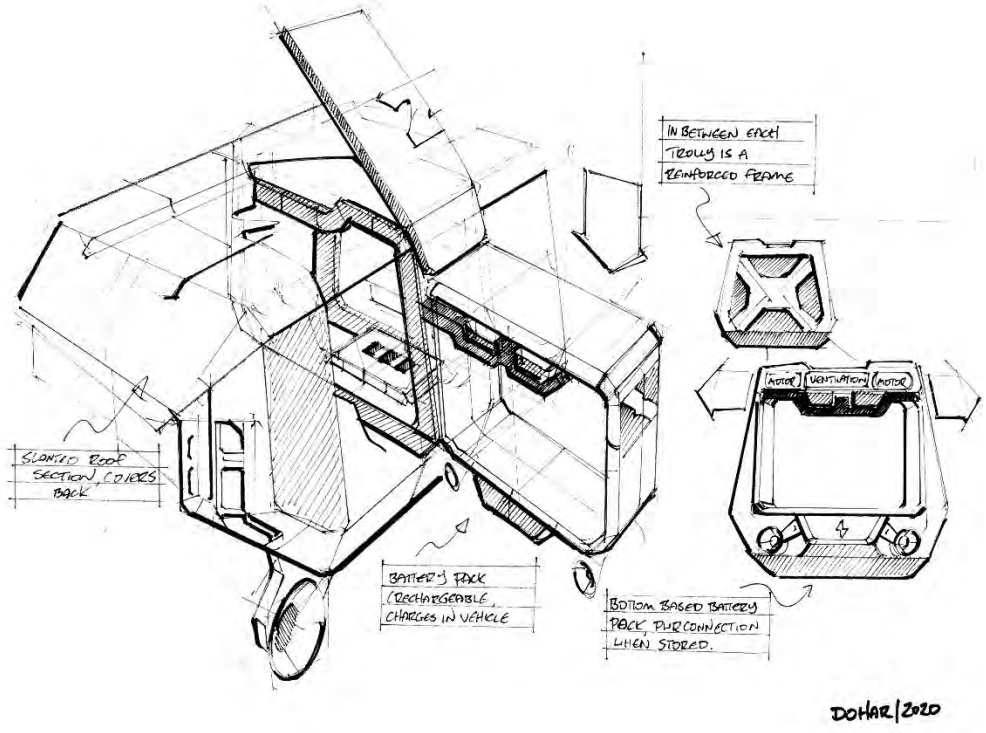




Fig

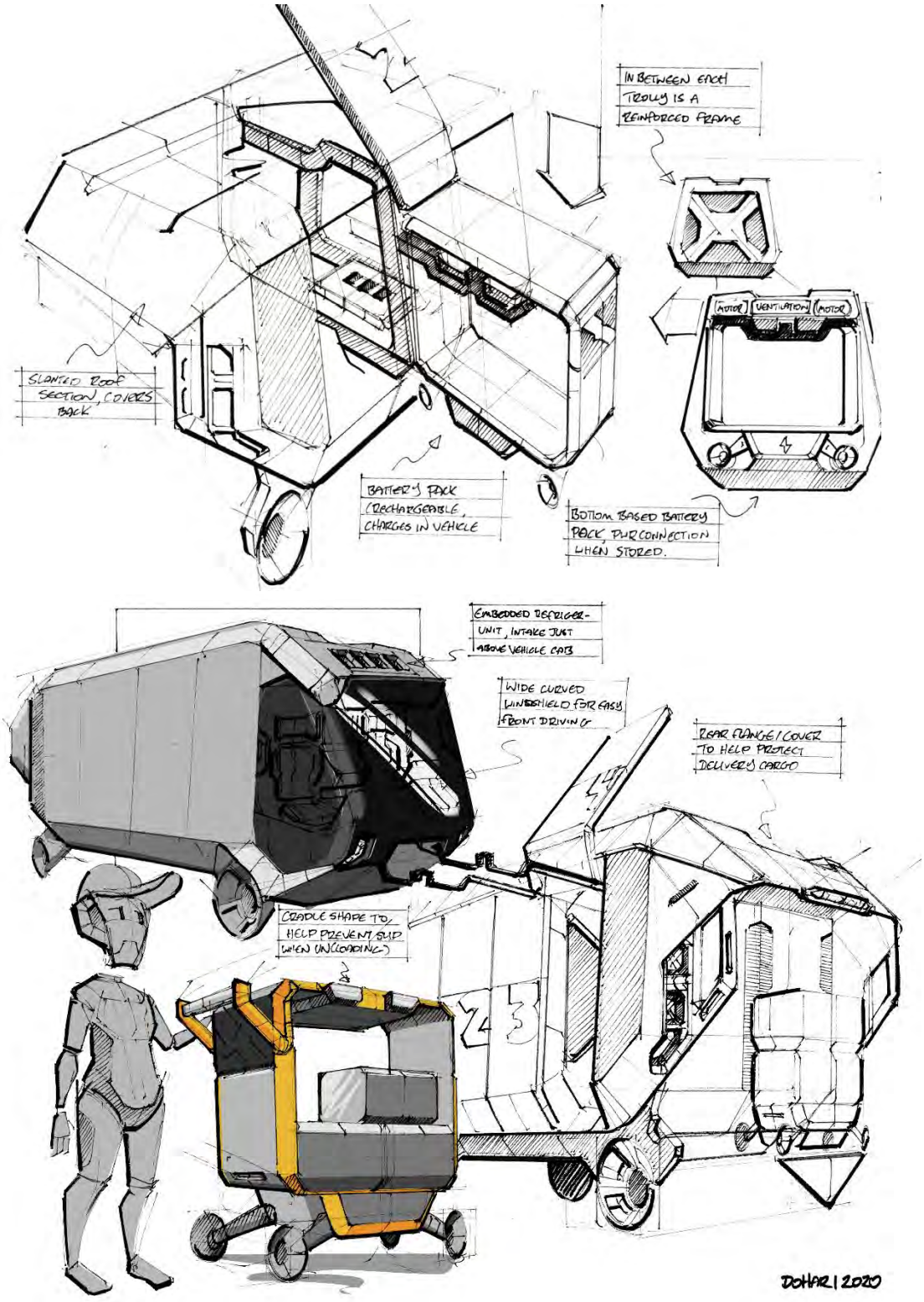
Fig


DOHAR | 2020

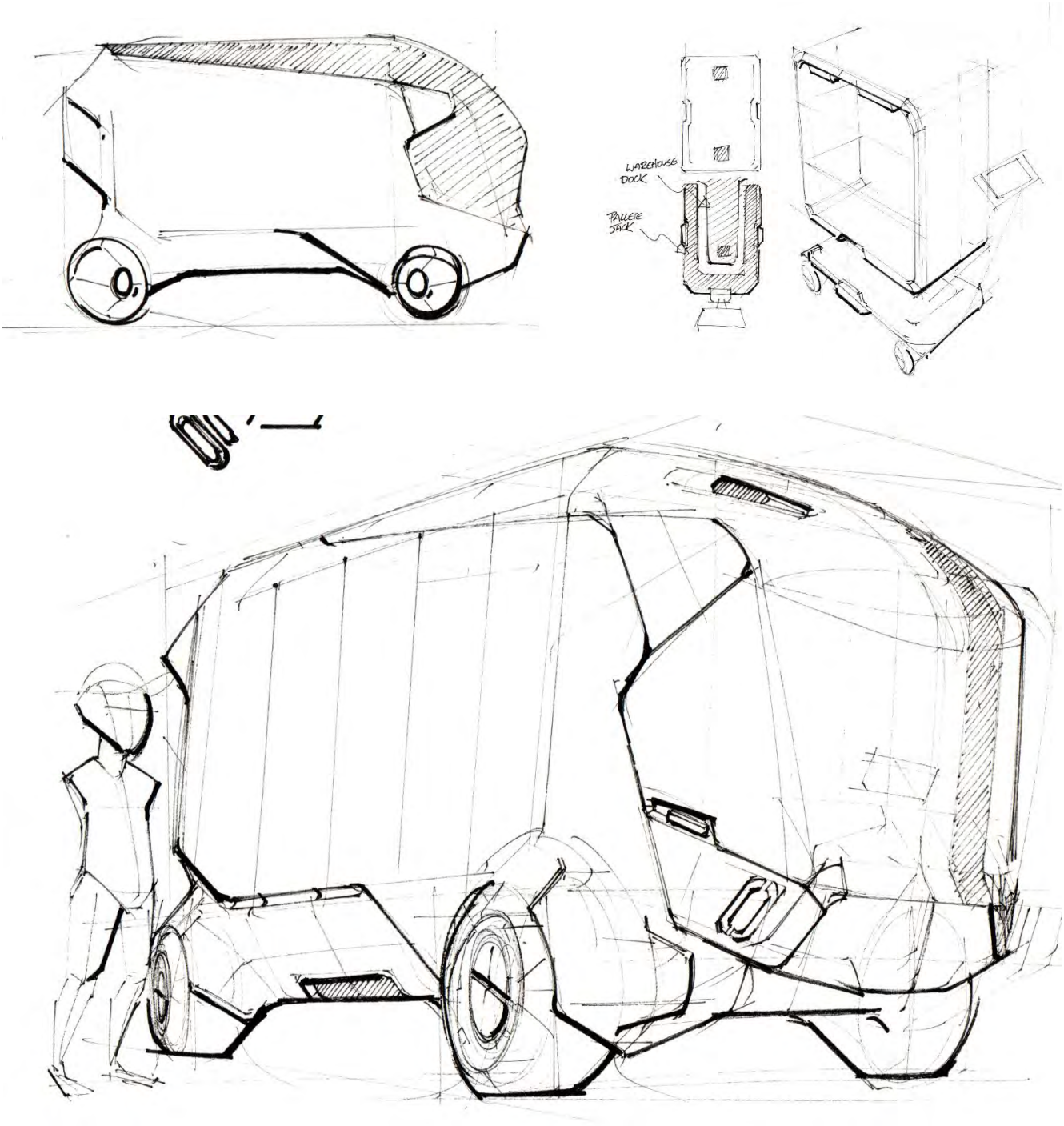

IN BETWEEN EACH TROLLY IS A REINFORCED FRAME
MOTOR
VENTILATION
MOTOR
SLANTED ROOF SECTION COVERS BACK
BATTERY PACK (RECHARGEABLE, CHARGES IN VEHICLE
BOTTOM BASED BATTERY PACK, PLUG CONNECTION WHEN STORED.
DOHAR | 2020

Fig

Fig


IN BETWEEN EACH TROLLY IS A REINFORCED FRAME
MOTOR
VENTILATION
MOTOR
SLANTED ROOF SECTION, COVERS BACK
BATTERY PACK (RECHARGEABLE, CHARGES IN VEHICLE
BOTTOM BASED BATTERY PACK, DISCONNECTION WHEN STORED.
EMBEDDED REFRIGERATOR UNIT, INTAKE JUST ABOVE VEHICLE CABS
WIDE CURVED WINDSHIELD FOR EASY FRONT DRIVING
REAR FLANGE/COVER TO HELP PROTECT DELIVERY CARGO
CRADLE SHAPE TO HELP PREVENT SLIP WHEN UNLOADING
DOHAR | 2020

4.3 Concept Strategy



4.4 Concept Refinement

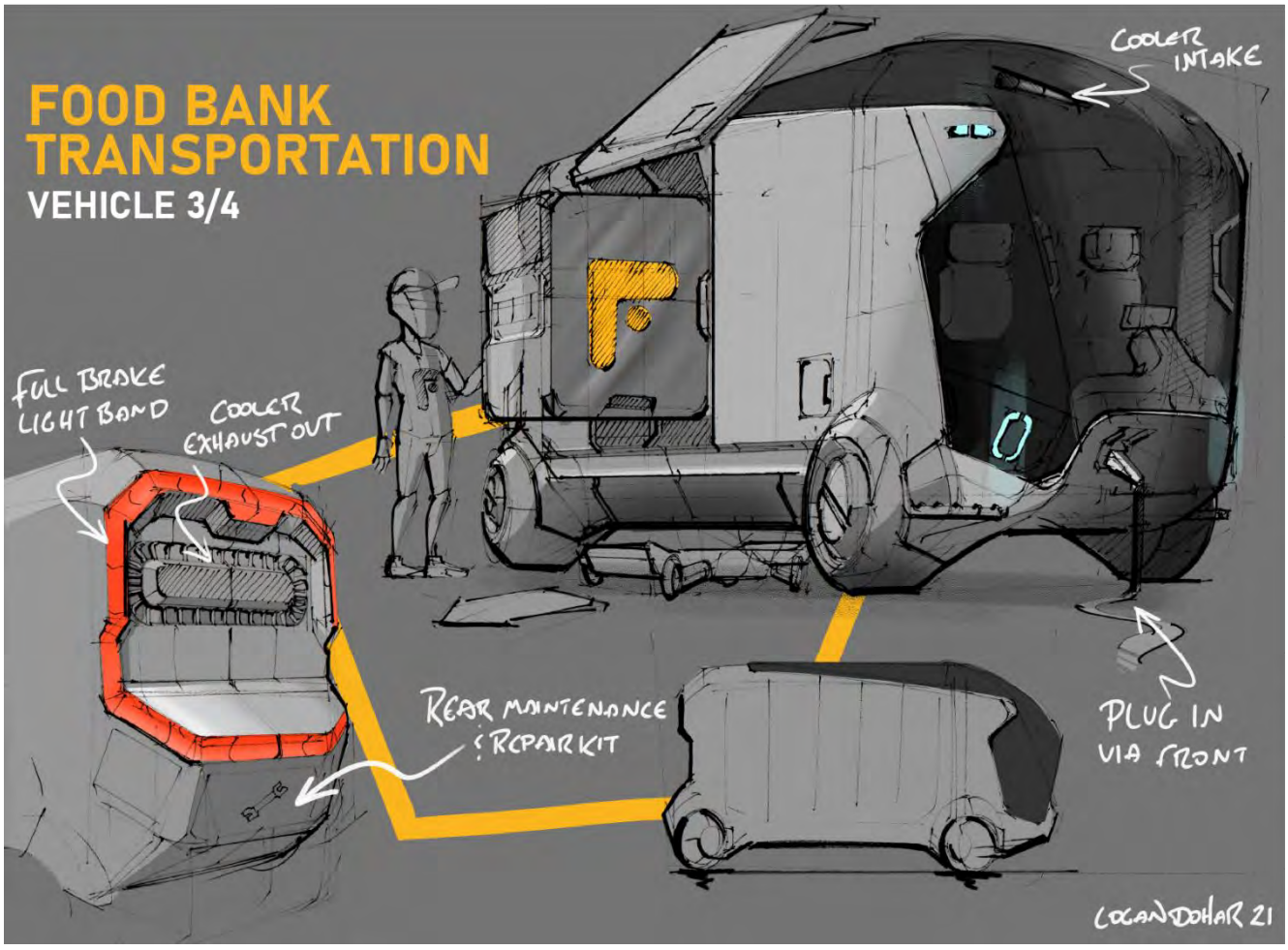
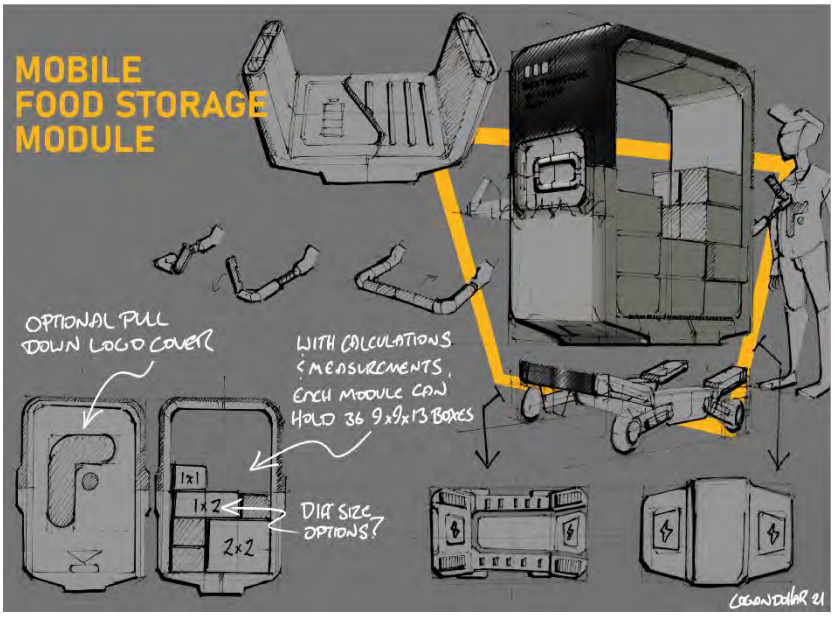
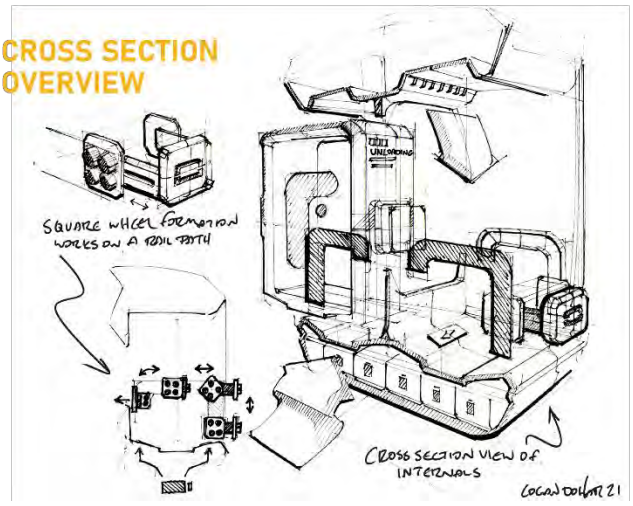
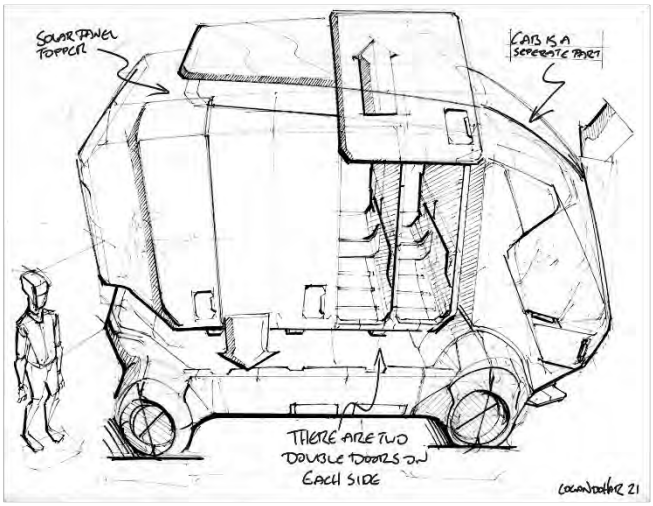
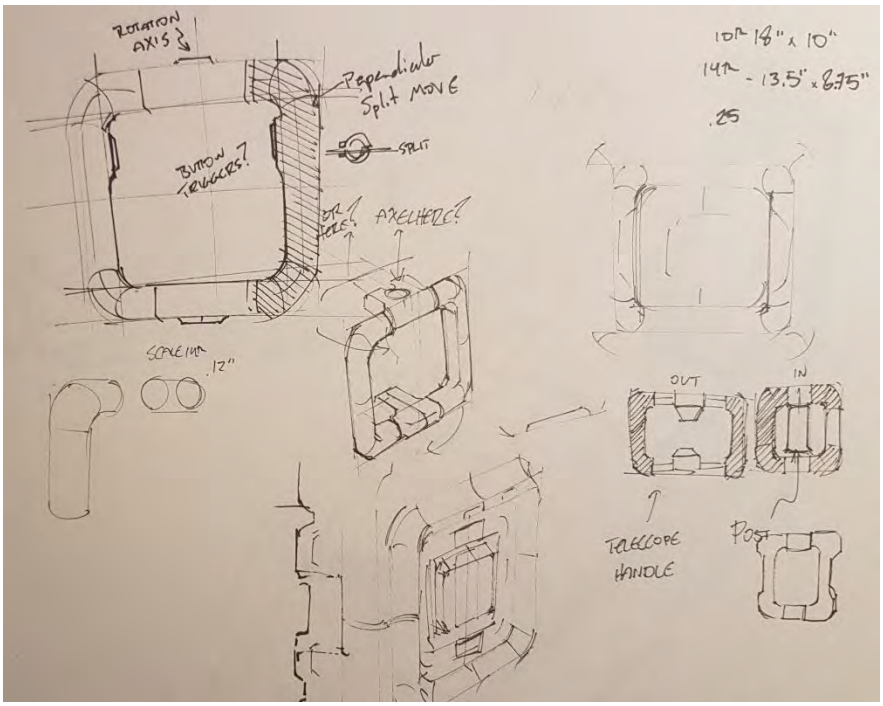


Fig 4.4.1



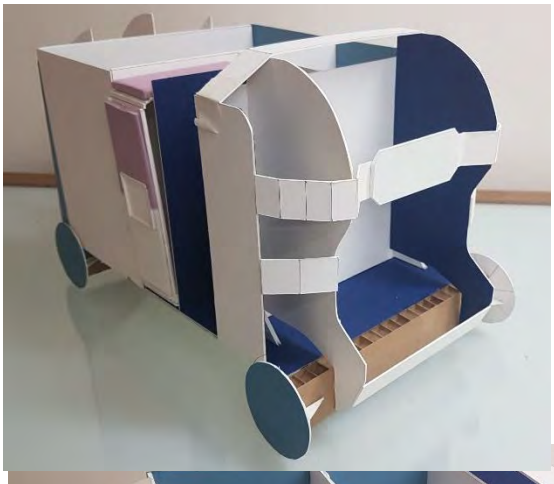

CROSS SECTION
OVERVIEW
SQUARE WHEEL FORMATION
WORKS ON A TRAIL PATH
CROSS SECTION VIEW OF
INTERNALS
LOGAN DOHAR 21


SOLAR PANEL
TOPPER
CAB IS A
SEPERATE PART
THERE ARE TWO
DOUBLE DOORS ON
EACH SIDE
LOGAN DOHAR 21


ROTATION
AXIS
Perpendicular
Split MOVE
SPLIT
BUTTON
TRIGGERS?
AXELHEDS?
SCALE 1/4" .12"
OUT
IN
TELESCOPE
HANDLE
POST
.25

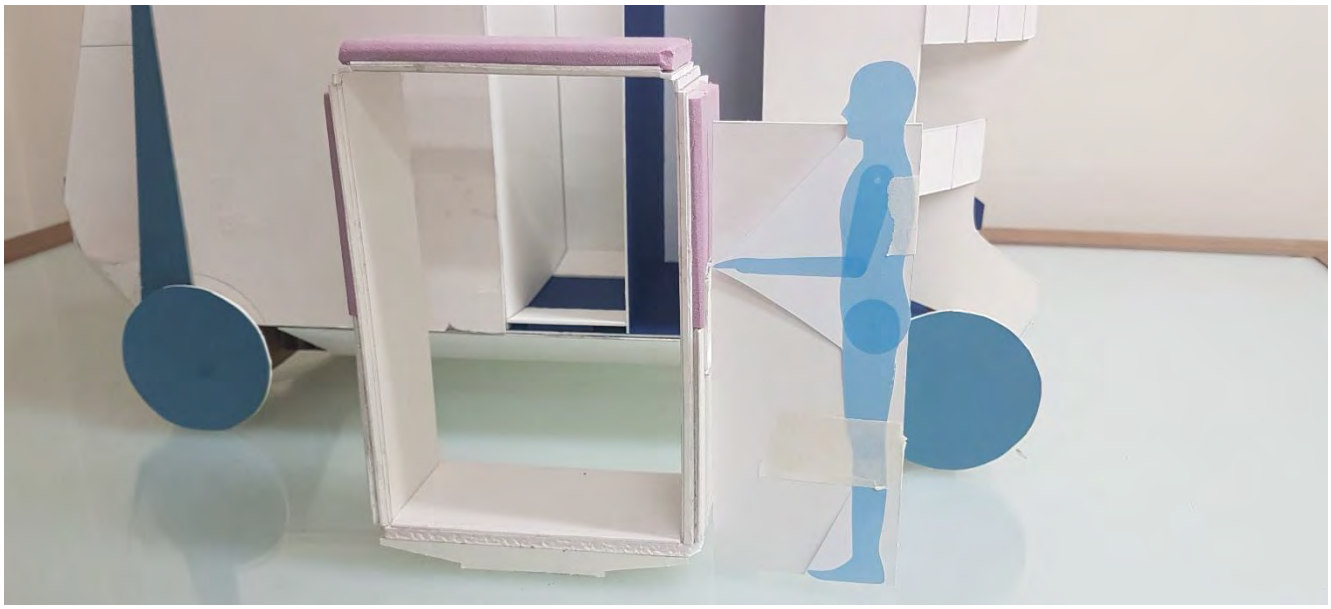
4.5 Design Realization

Fig 4.5.1 & 4.5.2

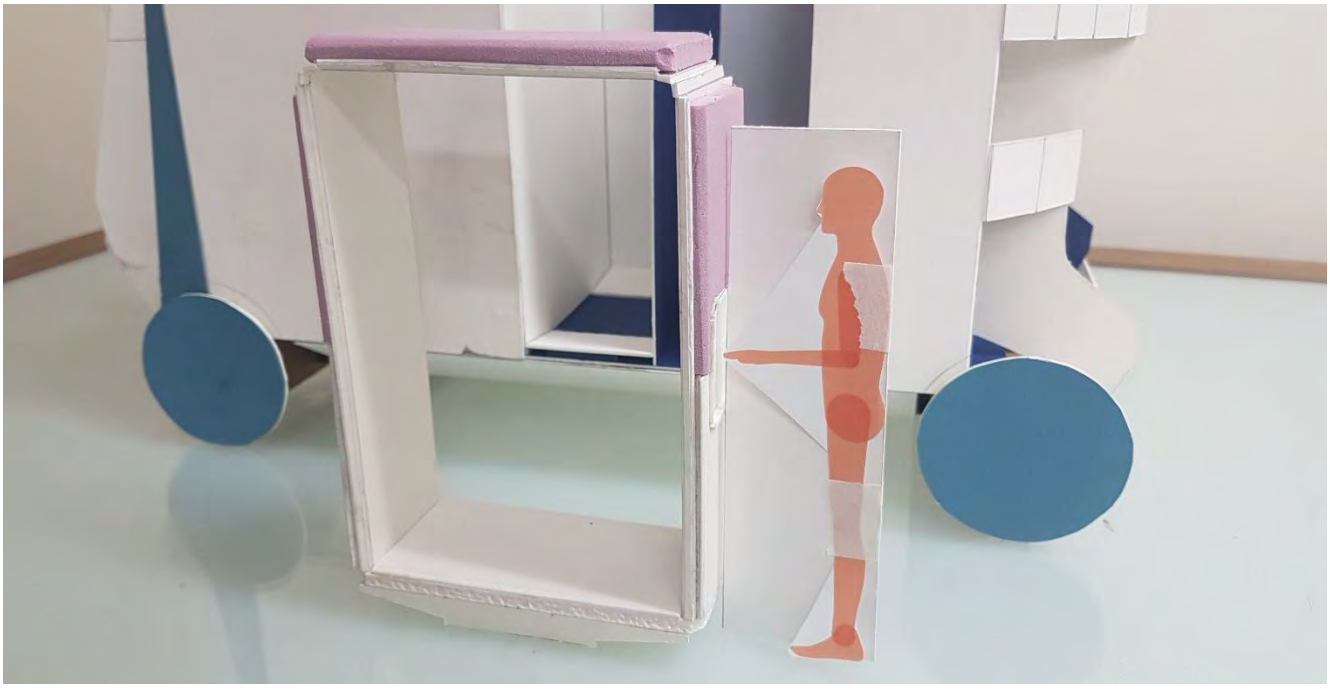


Fig

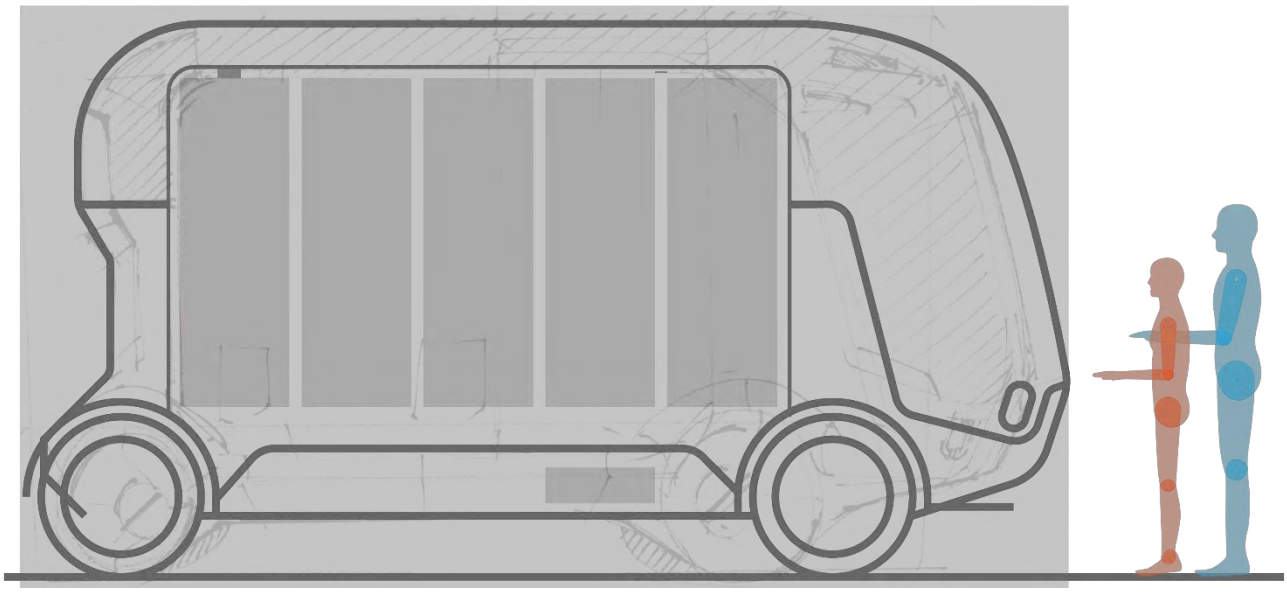
Fig 4.5.3 & 4.5.4



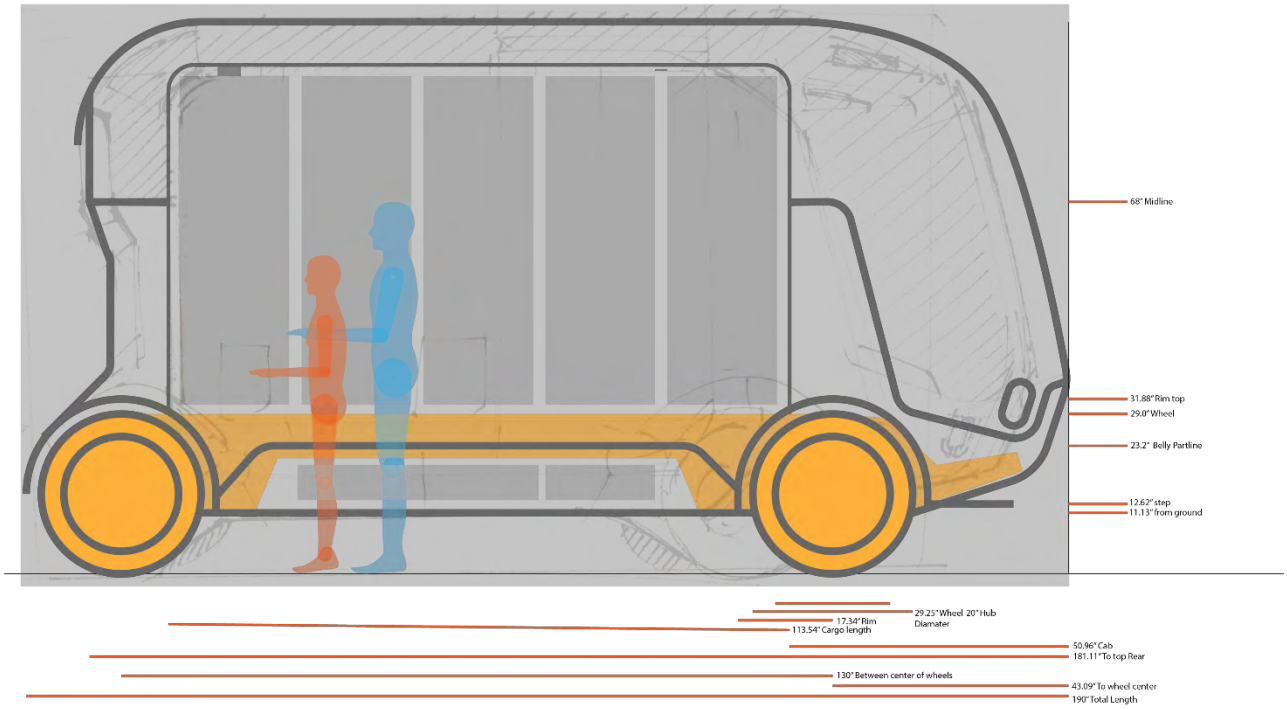
Fig



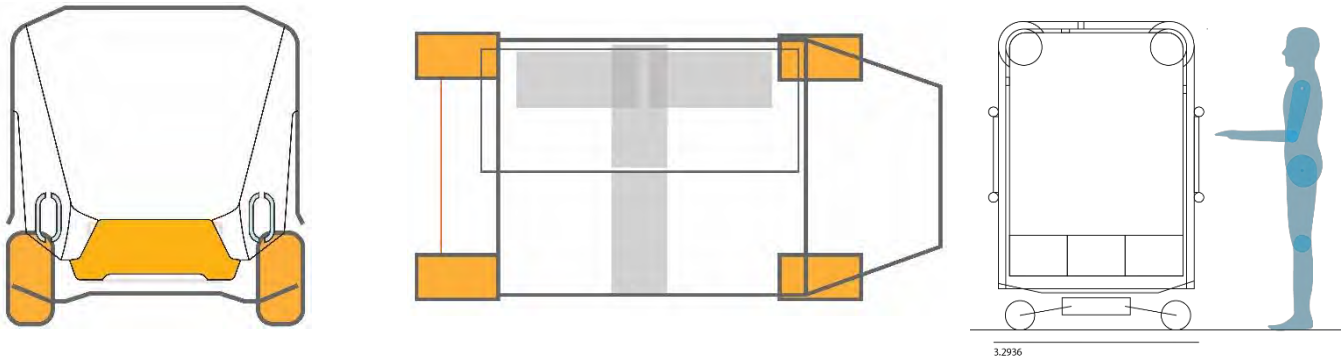
Fig



Fig

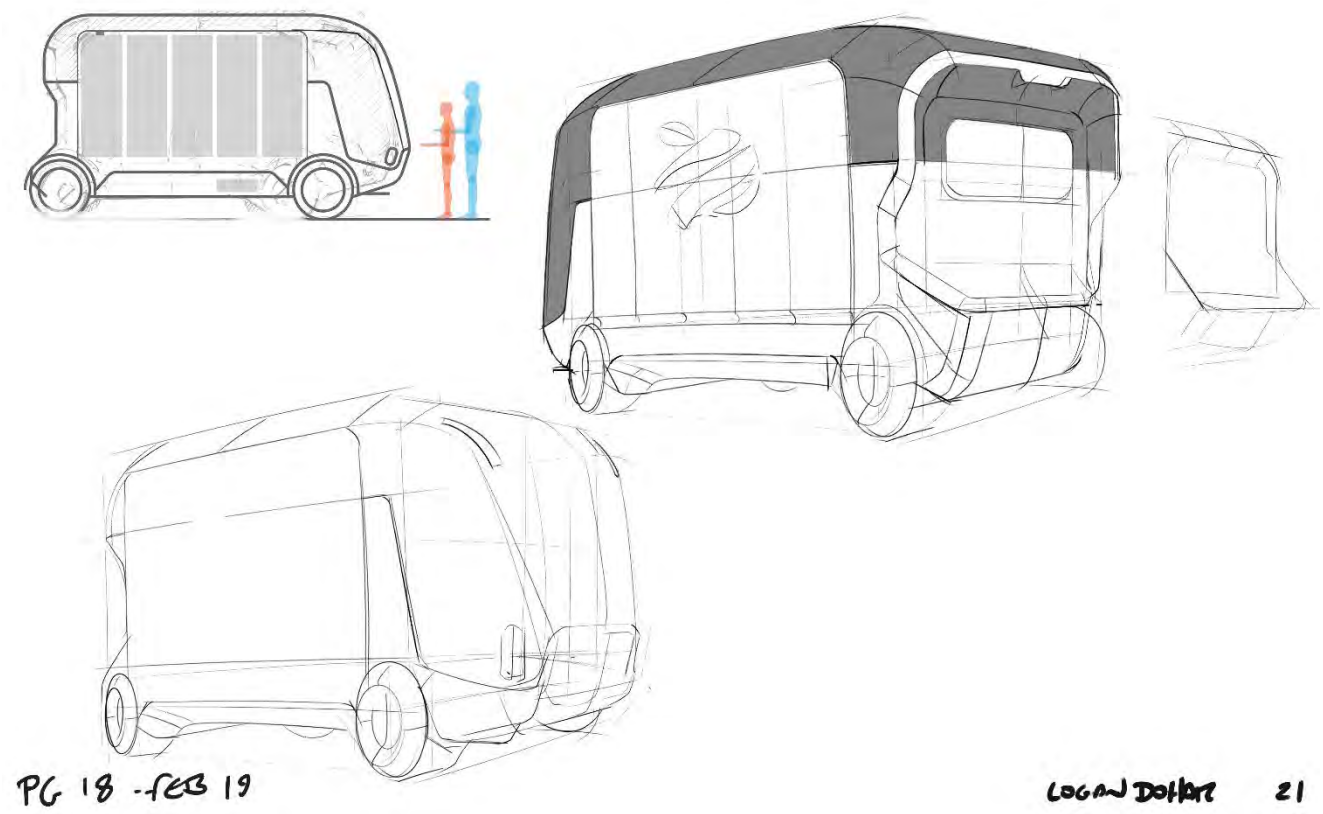

68" Midline
31.88" Rim top
29.0" Wheel
23.2" Belly Partline
12.62" step
11.13" from ground
29.25" Wheel 20" Hub Diamater
17.34" Rim
113.54" Cargo length
50.96" Cab
181.11" To top Rear
130" Between center of wheels
43.09" To wheel center
190" Total Length

Fig

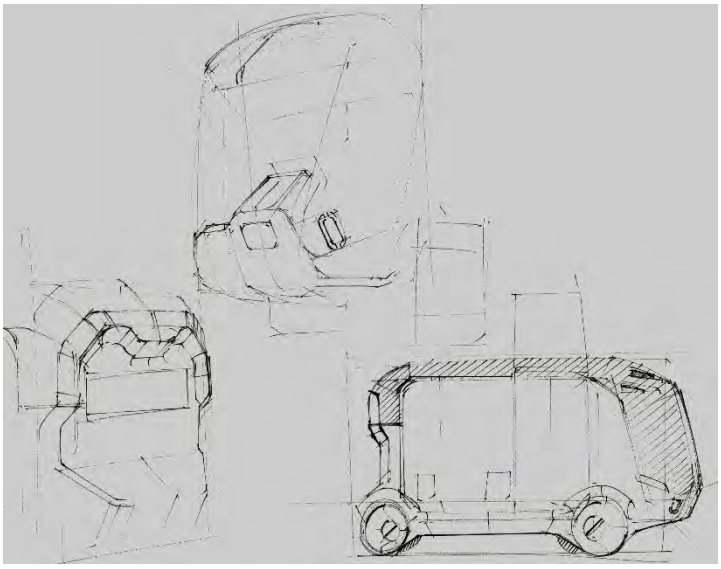


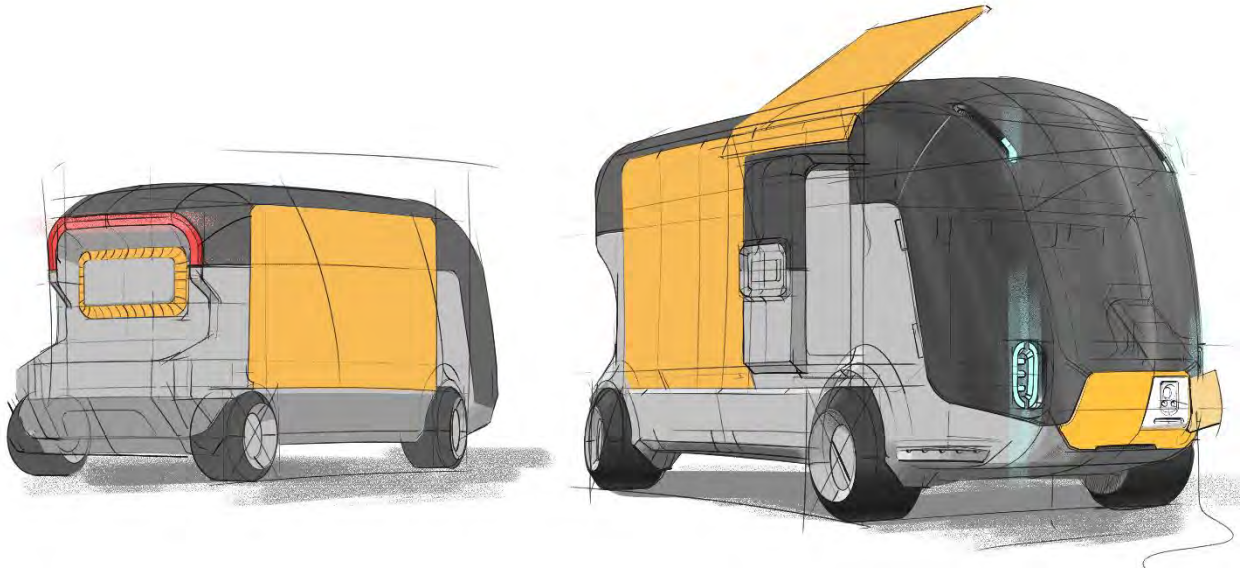
Fig

4.6 Design Resolution



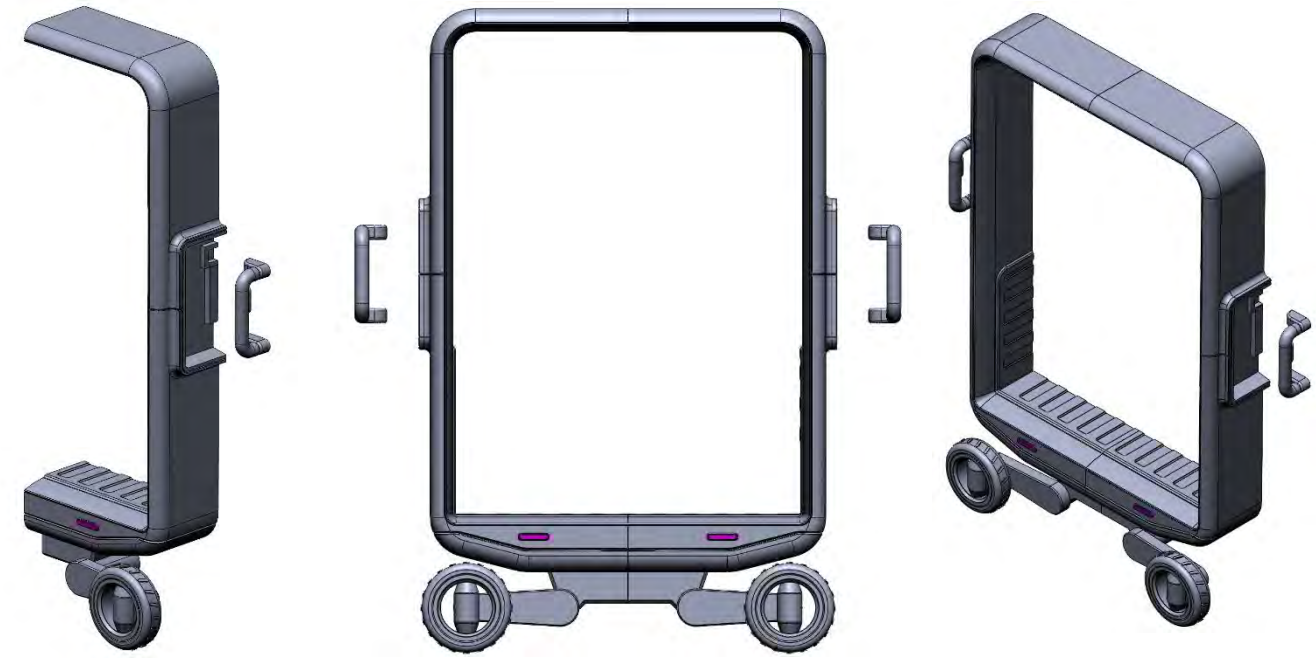
Fig





Fig

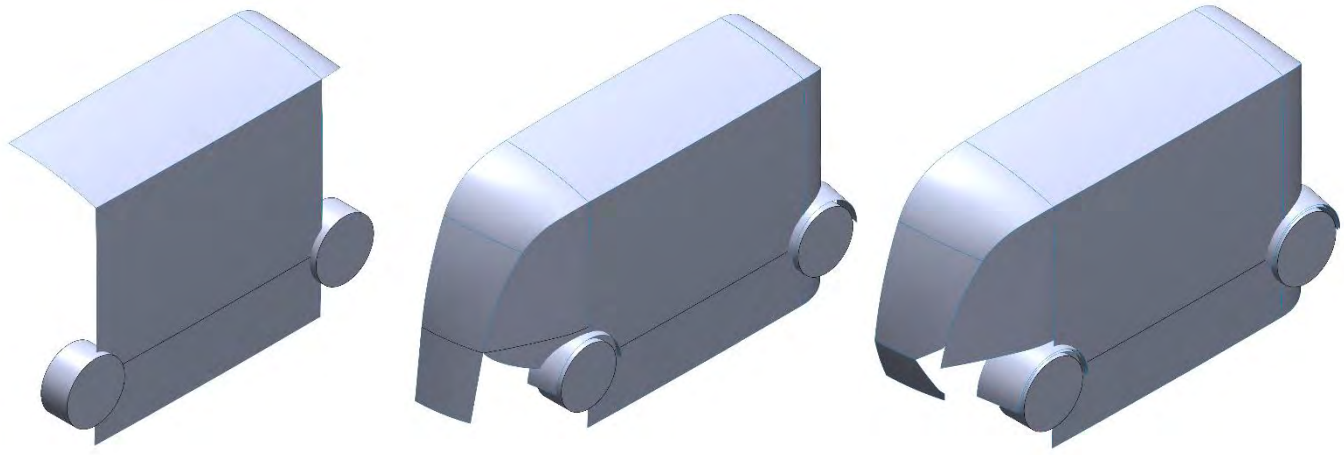
4.7 CAD Development



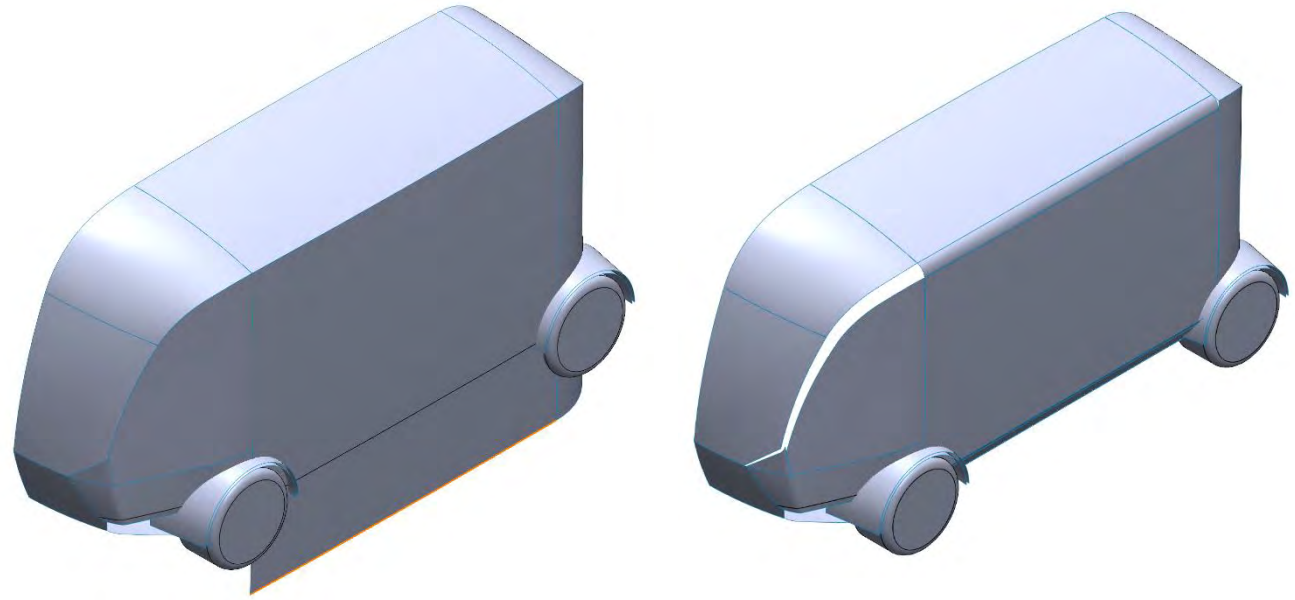
Fig

Fig

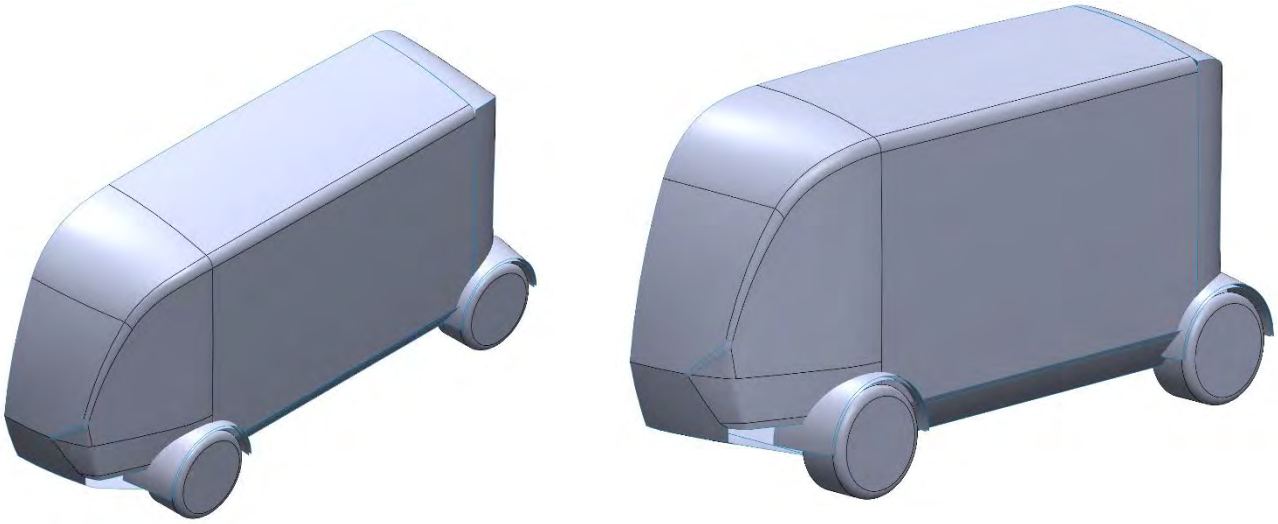
VEHICLE CAD



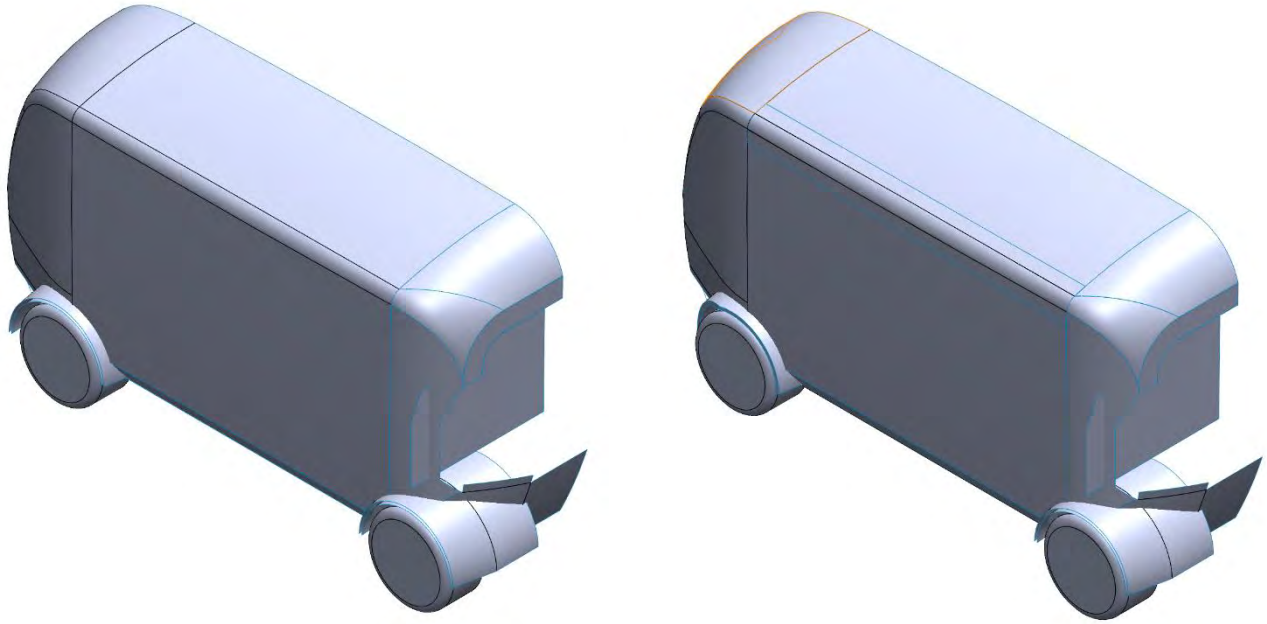
Fig



Fig

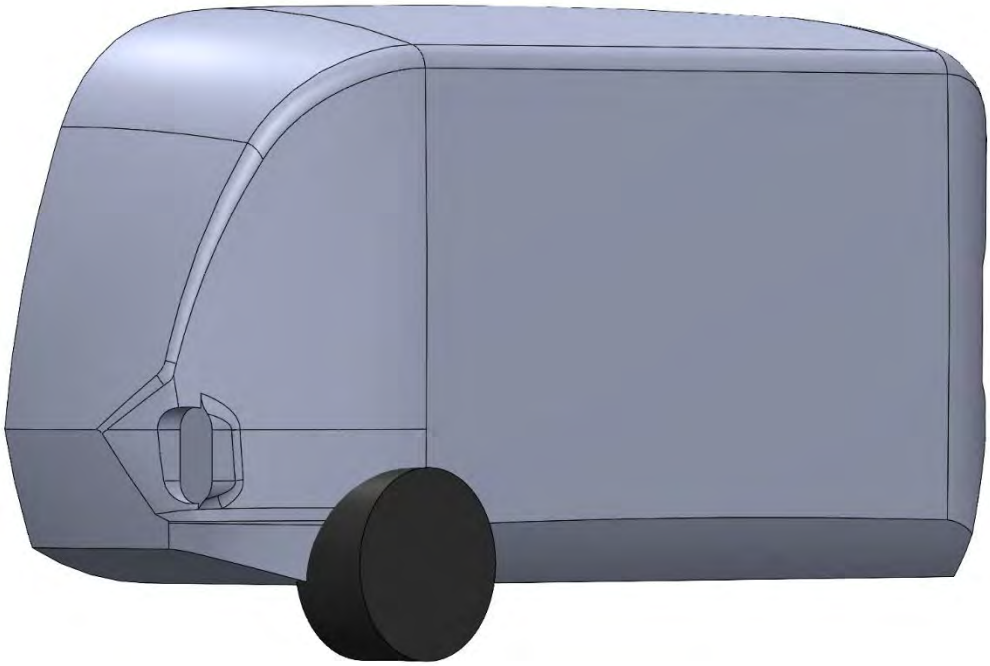


Fig

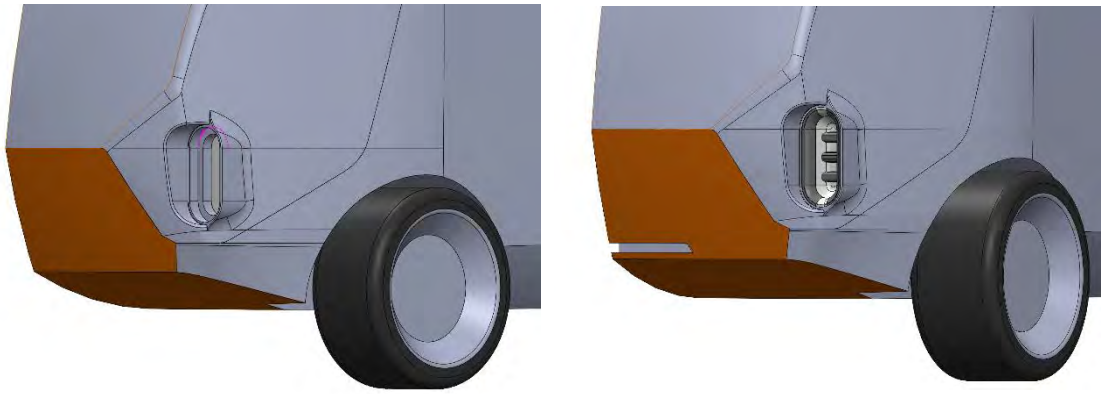


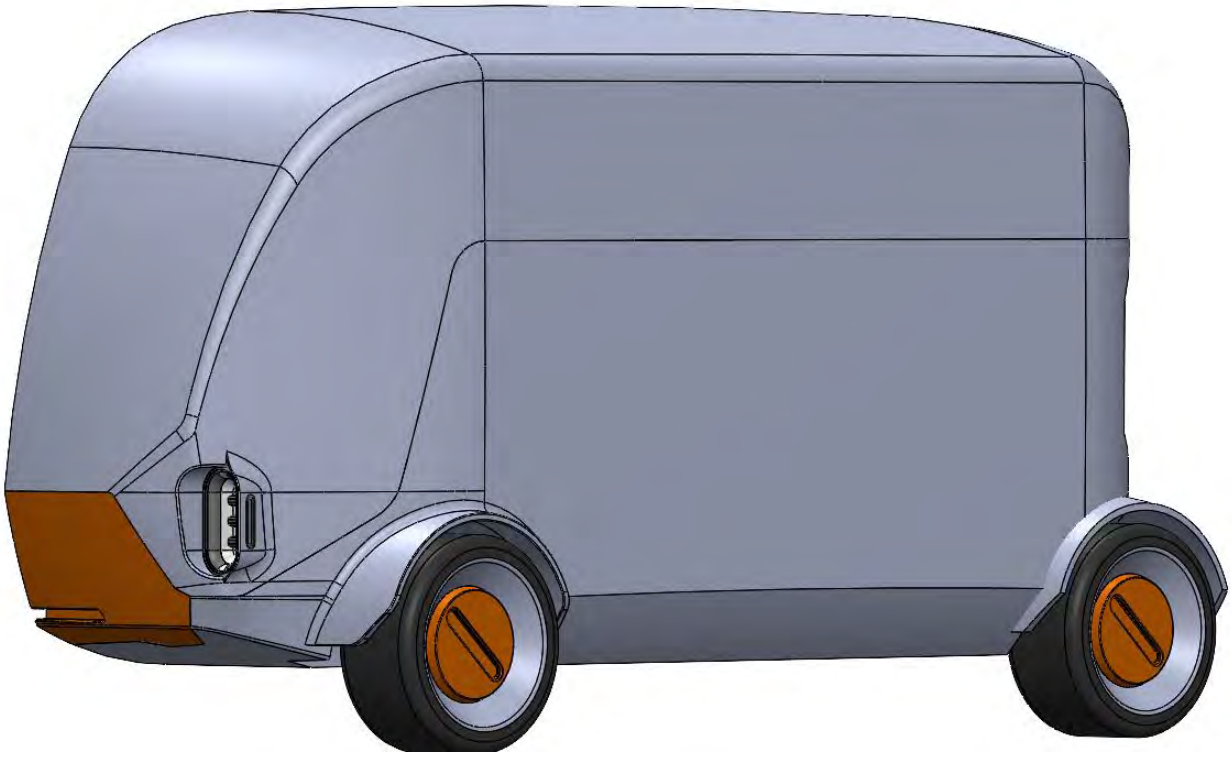
Fig

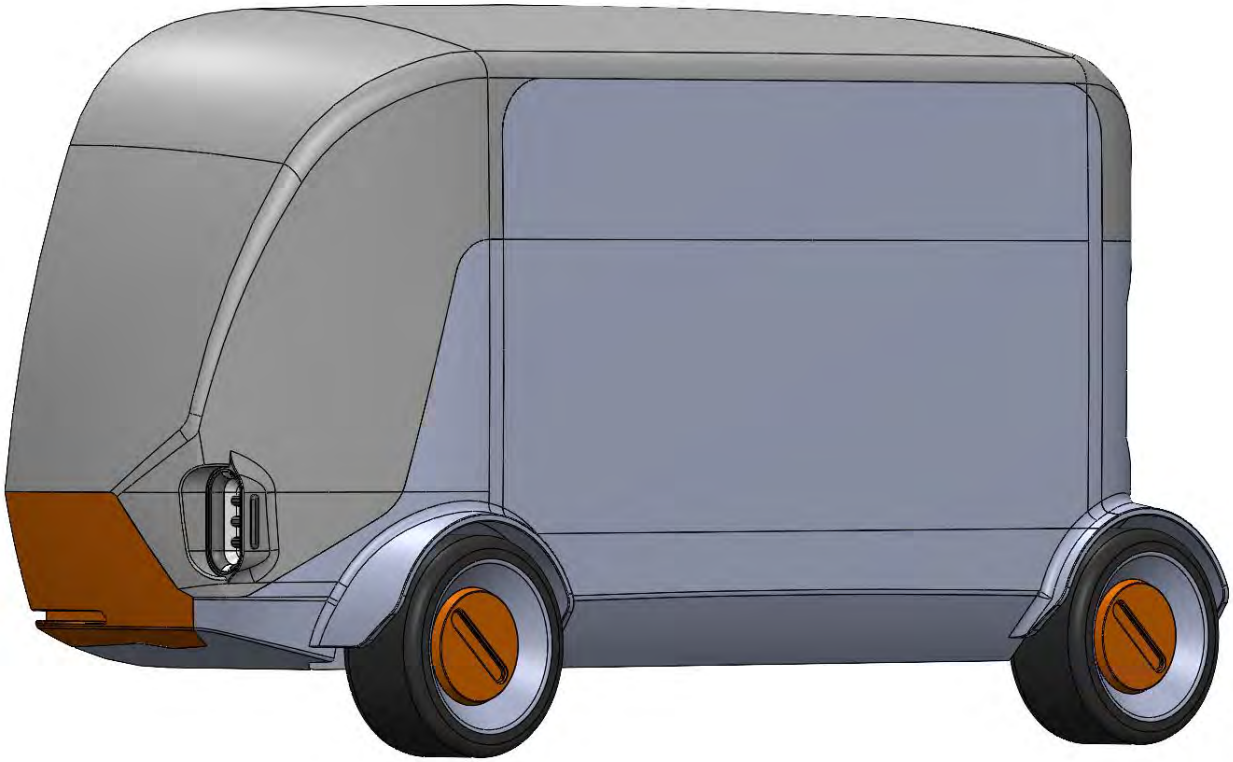
Fig

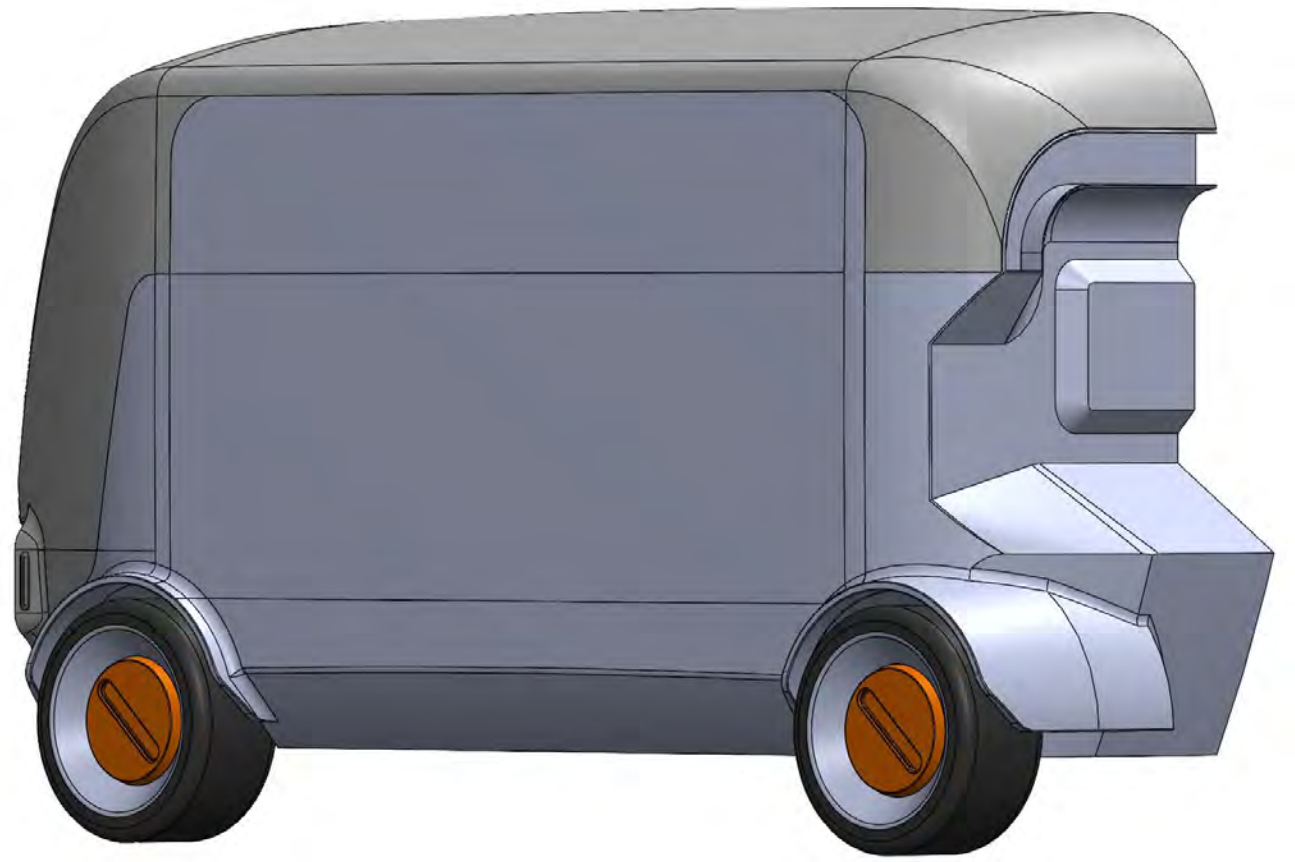


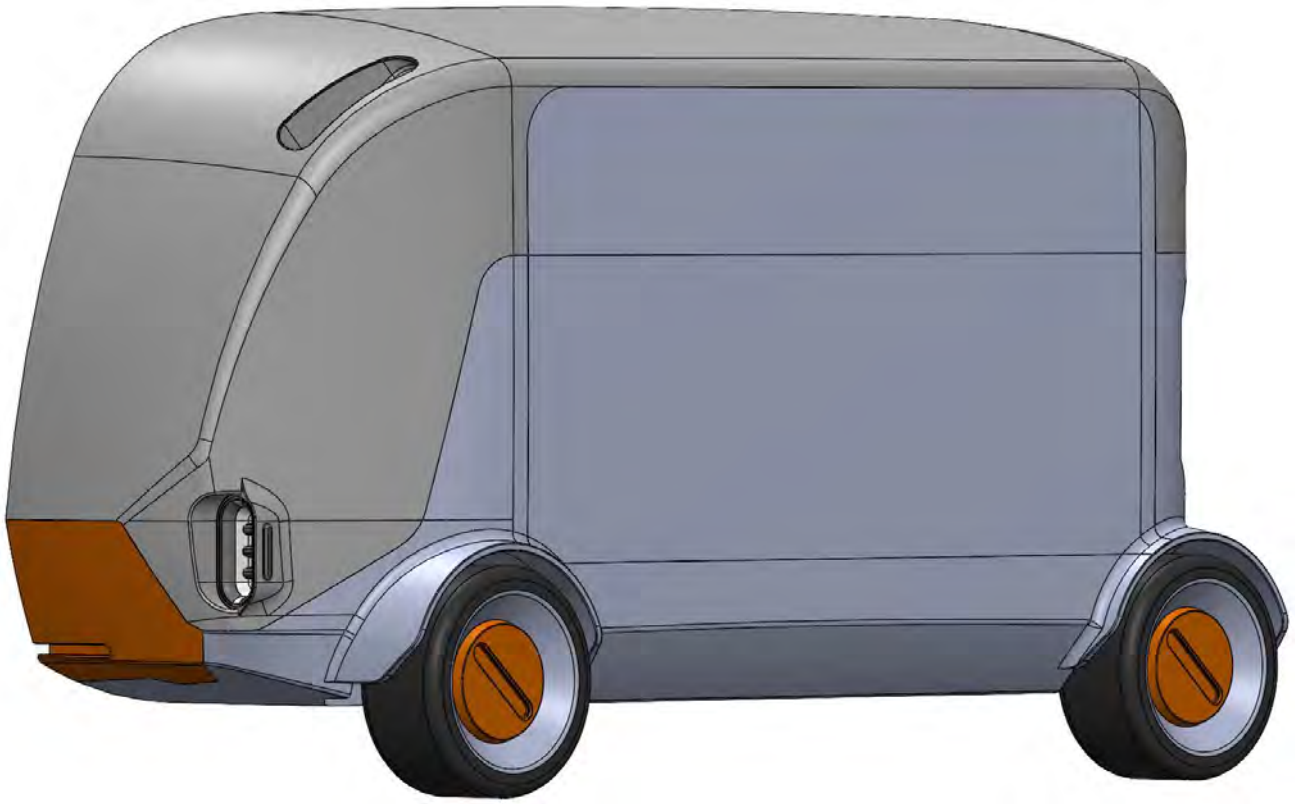
Fig

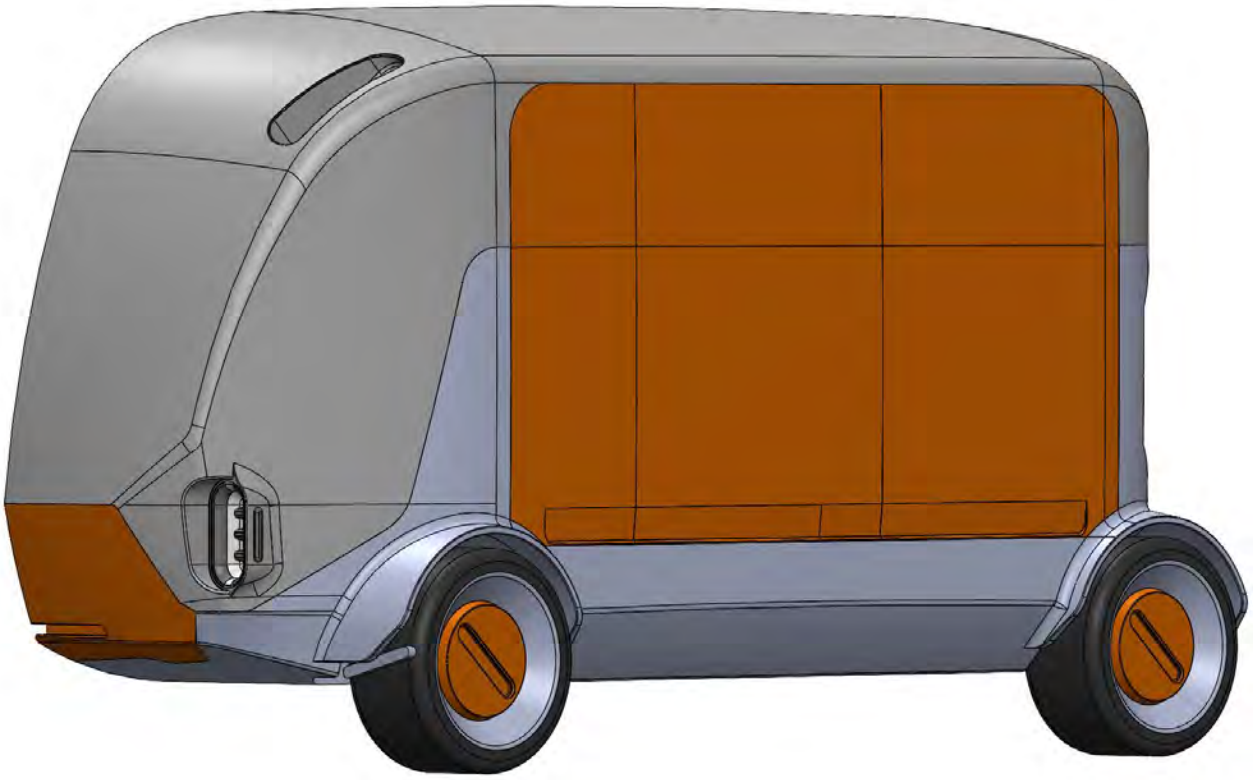


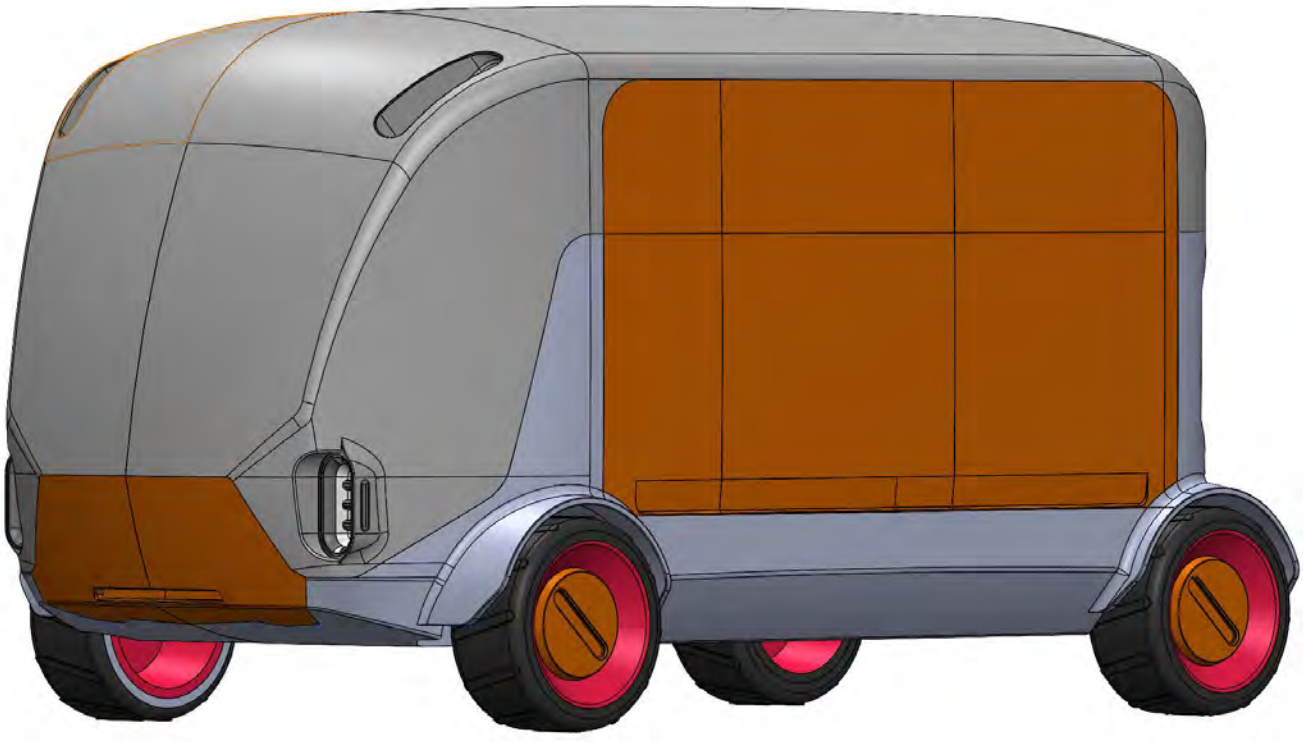


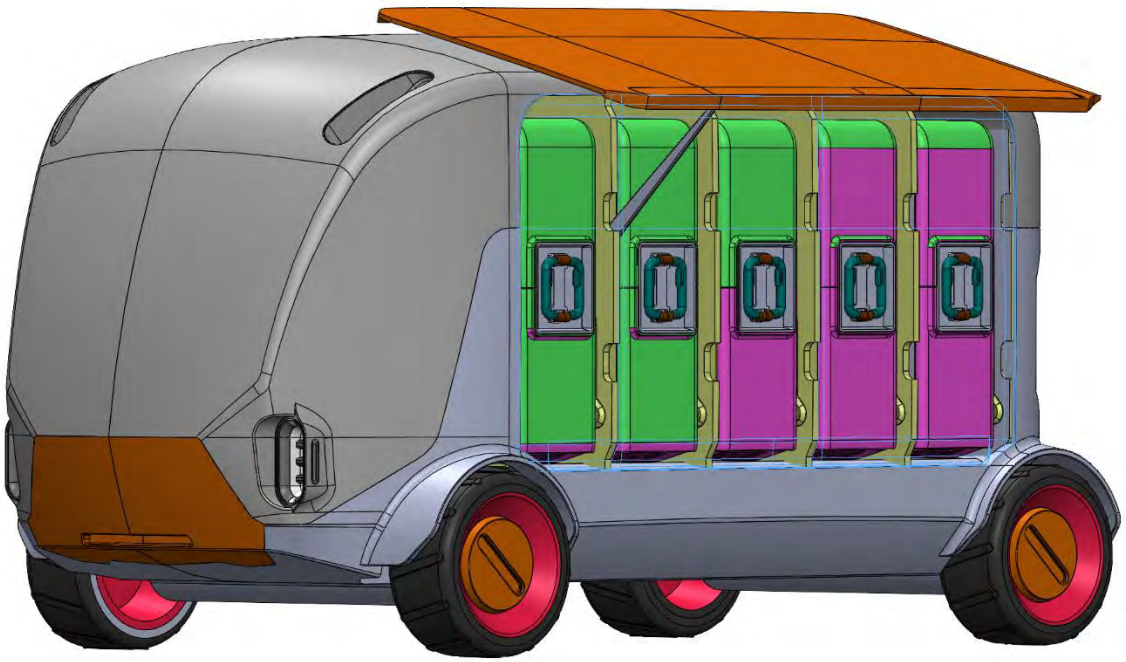


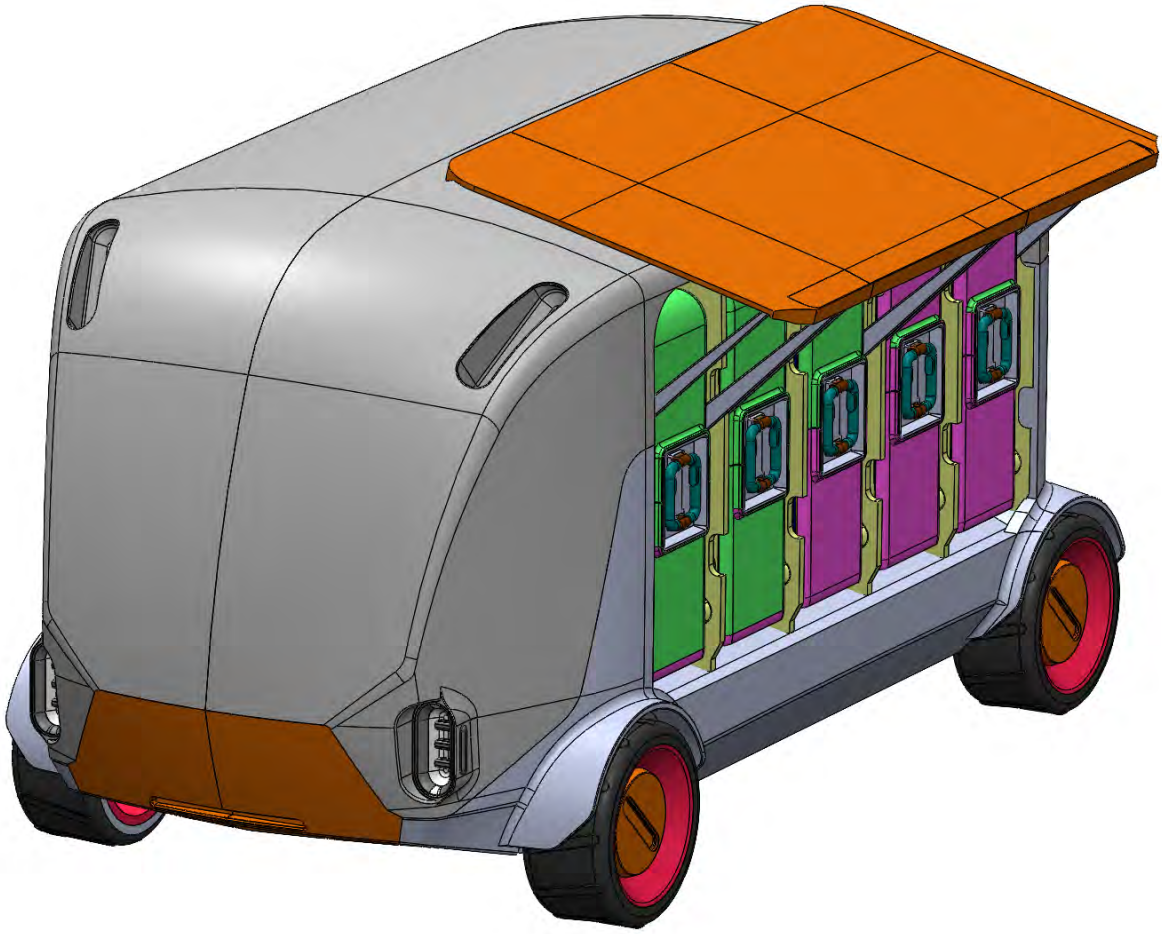






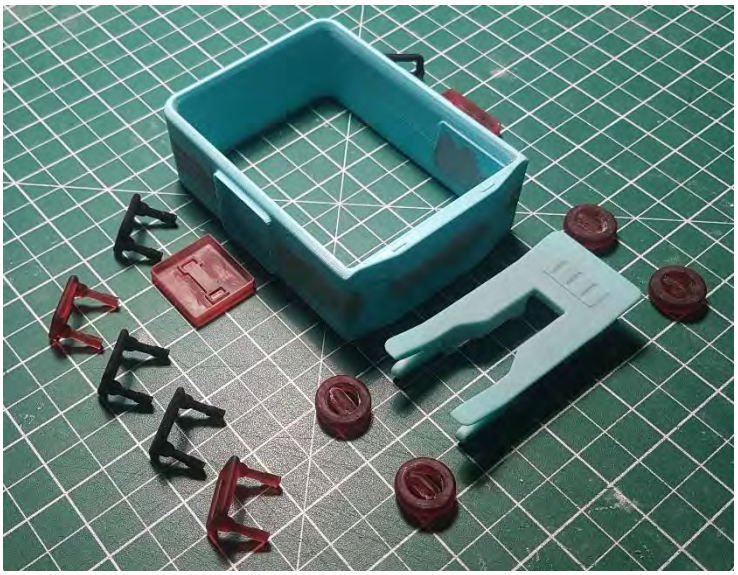






4.8 Physical Model Fabrication

Fig 4.8.1 & 4.8.2 left-right – Photos of 3D printed module components prior to sanding, combination of filament and resin printing



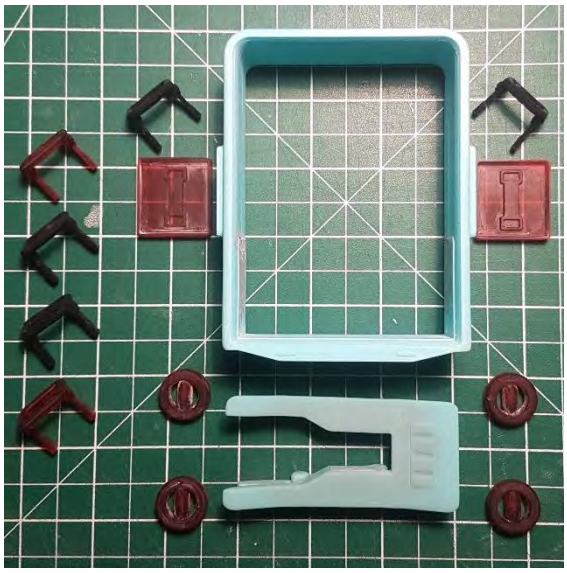


Fig 4.8.3 & 4.8.4 left-right – Photos of 3D printed module components after sanding, handle components received. Parts and support material filed down where needed. Rest of the components sanded with 400grit wet sandpaper

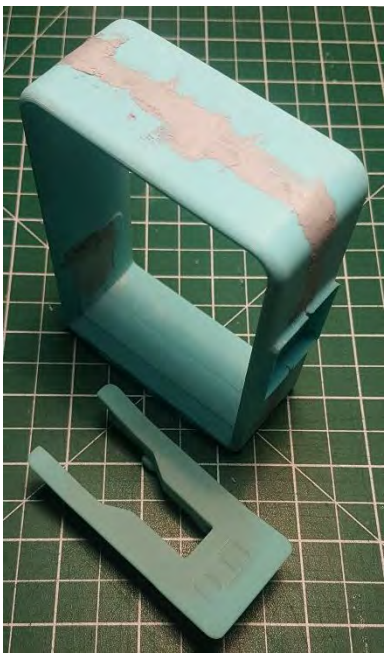
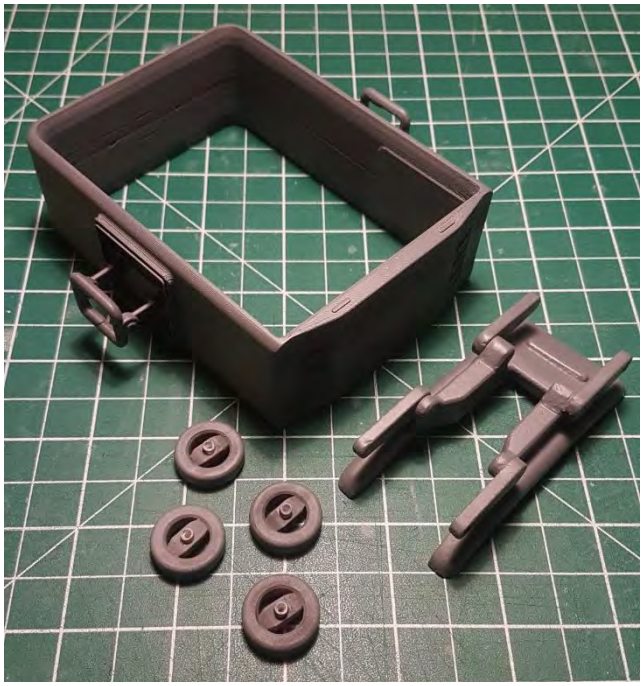


Fig 4.8.5 & 4.8.6 left-right – Photos of 3D printed module components after sanding, main module glued together and puddy added along the seamline, yet to undergo final sanding



Fig

Fig

Fig


PERMANENT AND FLEXIBLE
PERMANENT ET SOUPLE
14.2 fl.oz.

Fig

CHAPTER #5

FINAL DESIGN

5.1 Summary

5.2 Design Criteria Met

5.2.1 Full Bodied Interaction Design

5.2.2 Materials, Processes and Technology

5.2.3 Implementation – Feasability & Viability

5.3 Final CAD Rendering

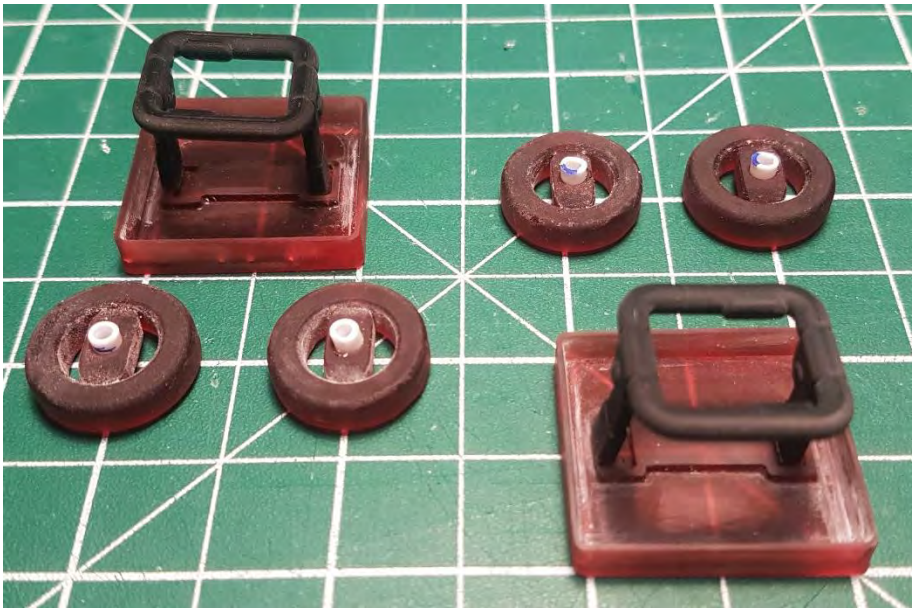
5.4 Physical Model

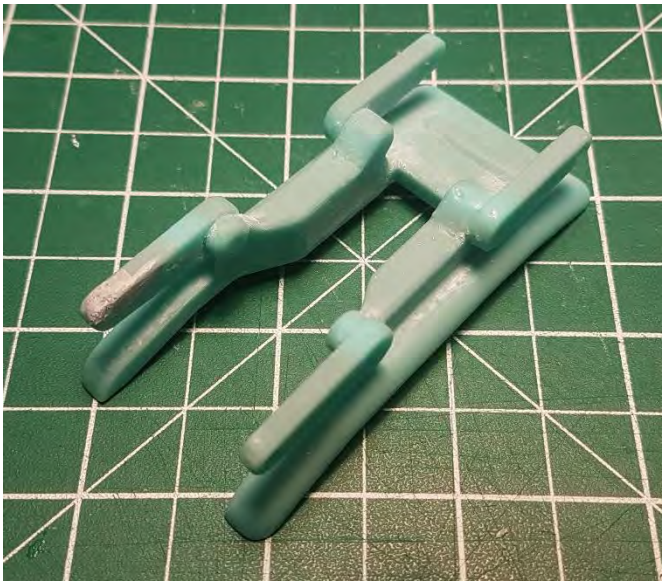
5.5 Technical Drawings

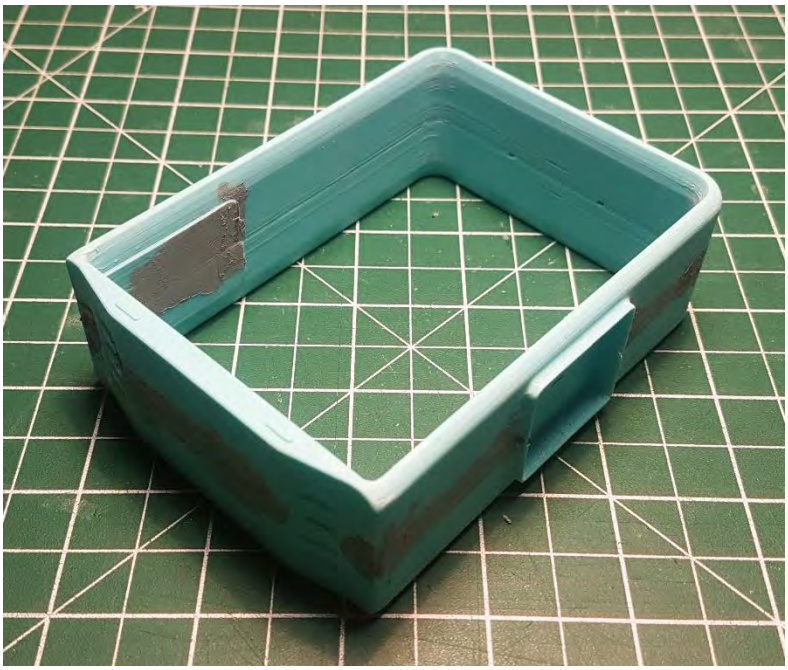
5.6 Sustainability

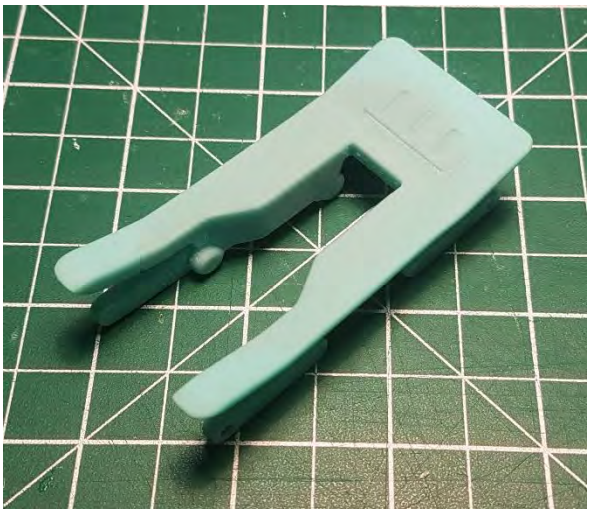
Appendix

A Discovery
B User Research
C Product Research
D Analysis
E CAD Development
F Physical Model Photographs









G Technical Drawings
H Manufacturing Cost Info / Data
I Sustainability Info / Data
J Approval Forms
K Advisor Meetings and Agreement Forms
L Other Supportive Raw Data

M Topic Specific Data, Papers, Publications

References or Bibliography

« Use the “APA 6th Edition” style to format references »

Darmon, N., & Drewnowski, A. (2015). Contribution of food prices and diet cost to socioeconomic disparities in diet quality and health: A systematic review and analysis. *Nutrition Reviews, 73*(10), 643-660. doi:10.1093/nutrit/nuv027

Prescott, S. L., & Logan, A. C. (2017). Each meal matters in the exposome: Biological and community considerations in fast-food-socioeconomic associations. *Economics and Human Biology, 27*(Pt B), 328-335. doi:10.1016/j.ehb.2017.09.004

S., & (. (2019). The Avoidable Crisis of Food Waste: The Roadmap. Retrieved October 15, 2020, from https://secondharvest.ca/wp-content/uploads/2019/01/Avoidable-Crisis-of-Food-Waste-The-Roadmap-by-Second-Harvest-and-VCMI.pdf

Broton, K. M., Cady, C. L., & Goldrick-Rab, S. (2020). *Food insecurity on campus: Action and intervention*. Baltimore: Johns Hopkins University Press.

Tarasuk, V., Fafard St-Germain, A., & Mitchell, A. (2019). Geographic and socio-demographic predictors of household food insecurity in canada, 2011–12. *BMC Public Health, 19*(1), 12-12. doi:10.1186/s12889-018-6344-2

Sustainability

https://packhelp.com/sustainable-packaging/

https://www.mushroom-appreciation.com/mushroom-spawn-cardboard.html#sthash.x9AGjvuJ.dpbs

https://haeckels.co.uk/journal/haeckels-packaging/

https://www.canoo.com/mpdv/

https://arrival.com/?topic=products

https://www.azom.com/article.aspx?ArticleID=17014#:~:text=While%20the%20typical%20car%20includes,plastic%20commonly%20found%20in%20automobiles.

https://cotesautobody.com/top-5-common-types-of-metal-used-in-car-manufacturing/

Chapter 4

https://www.behance.net/gallery/87739339/TOYOTA-Micro-Palette

Benchmarking

https://www.pinterest.ca/pin/810507264180730458/

https://www.pinterest.ca/pin/810507264187338130/

https://www.pinterest.ca/pin/810507264187681535/

https://www.pinterest.ca/pin/810507264187681997/

Form

https://www.pinterest.ca/pin/810507264180730458/

https://www.pinterest.ca/pin/810507264189895838/

https://www.pinterest.ca/pin/810507264189895848/

https://www.pinterest.ca/pin/810507264190489903/

https://www.pinterest.ca/pin/810507264187682078/

https://www.pinterest.ca/pin/810507264187679043/

https://www.pinterest.ca/pin/810507264187337913/