MOBILITY BANK

MOBILE FOOD WASTE REINTEGRATION SYSTEM

MOBILITY BANK

INDUSTRIAL DESIGN THESIS REPORT

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HUMBER

Mobility Bank

by

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Abstract

In the last 5 years, the population affected by food insecurity in North America has continually increased with each passing year. The recent COVID-19 Pandemic has resulted in a larger portion of the population falling into poverty, and a significant portion of the population are turning to resources like food banks or soup kitchens to put food on the table. Those suffering from food insecurity are finding it more and more difficult, as these kinds of resources have been unable to keep up with the rising load of new clientele. Despite this, people are wasting more food than ever before, with 60% of our landfills being made up with food waste. This thesis proposes an in-depth study on the food waste habits of several large industries. Using observational studies, interviews, as well as surveys to develop a detailed analysis on the food industry can target and identify the most effective way to save food waste and redistribute it accordingly to those in need. A solution will be developed to minimize the food waste attributed to food industries. A complex food redistribution and processing system can be developed to effectively support food banks, and charitable organizations in their efforts to support citizens going hungry.

Acknowledgements

Special Thanks to Reefe Mark for his incredible insight at St. Paul’s Food Bank.

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CHAPTER # 1 - Introduction

1.1 PROBLEM DEFINITION

In the last 5 years the need for food banks has grown exponentially. Throughout the pandemic visits to food banks have increased by 200%, serving approximately 20,000 individuals per week compared to around 15,000 prior to COVID-19 (Daily Bread, 2020). As ¼ of food supply intended for human consumption is wasted every year (Stancu, V., Haugaard, P., & Lähteenmäki, L., 2016) it seems almost impossible that so many North Americans go without adequate food supply.

The goal of this thesis is to identify key areas of food waste and reallocate this waste to those in need. Learning that a single supermarket of about 5300 sqm can produce as much as 23.5 t of food waste over the course of a year, we can recognize that there is real opportunity to further support food banks in their goal of feeding those suffering from food insecurity (Stancu, V., Haugaard, P., & Lähteenmäki, L., 2016). Through the careful design of a streamlined system meant to reallocate this waste we can effectively support food banks using food that would otherwise be wasted.

1.2 PROBLEM DEFINITION

1.2.1 Key Information to be Determined

Understanding the end user is incredibly important in developing a system to mitigate the worldwide problem of food waste. Primary, Secondary, and Tertiary Users will have significant and wildly different roles in a solution to food waste. To understand these users, it is vital that user needs, wants and pain points are identified and incorporated into our solution. Identifying weak points and inefficiencies in the current systems used by food banks throughout North America will provide key insights in to how we might solve this problem. We will compare, evaluate, and determine these standards set by food banks to better evaluate the management system.

1.2.2 Key Questions to be Answered

To begin this design process, there are several key questions that must be answered. How can food waste be converted into a long-lasting food source for food bank clients? How will food waste be transferred from food retailers to food banks? How do we ensure this food is accurately recorded? These types of questions are vital to the natural progression of the design throughout.

1.2.3 Investigative Approach Planned

To develop a better scope of the project we must review and organize key information into useful subsections for reference throughout the design process. The investigation methods used will be:

- Literature Reviews
- Information Searches
- Mind Mapping
- User Observation Analysis
- User Research (Surveys & Interviews)
- Advisor Interviews
- Product Benchmarking
- Needs Analysis

In preforming each of these tasks a mental framework can be developed surrounding current solutions on the market, user struggles, and background information surrounding the topic.

1.3 BACKGROUND / HISTORY / SOCIAL CONTEXT

1.3.1 Demographic & Lifestyle Trends

To understand the role food banks, have in supporting those suffering from food insecurity it is important to understand the primary demographic being serviced by food banks. The average food bank client is often within the age range of 45 – 64. 51% of clients utilizing the services individually, with 34% of clients supporting a family. The vast majority of clients are of a minority group with

abnormally large distributions among Black, Latin American and indigenous groups (Daily Bread, 2021). Only 45.2% of food bank clients are uneducated or only have a high school diploma (Daily Bread, 2020) Meaning over half of the people going to food banks have some kind of post-secondary education.

The aim of this section is to understand why there is such an abnormal distribution of users coming from minority groups, why the percentage of food bank clients is so high for those of middle age, what challenges might be faced by users supporting a family and finally why over half of food bank clients with an education are unable to support themselves and their families.

1.3.2 Media Trends

In recent times, media attention on food banks has risen drastically during the COVID-19 pandemic and now. Even after the pandemic had ended, food bank usage had continued to rise. Many feel this is a direct reflection of the world's current economic state, so media has continually kept up to date with use of food banks. As more and more North Americans are forced to begin using food bank services, media attention will continue to rise as a direct reflection of the average person's fears.

1.3.3 Product Trends

The Many systems within food banks have stayed relatively static especially in smaller locations for a long period of time. Many keep physical records of food, and many of the systems are still completely analog. In larger institutions, there have been some developments like the inclusion of conveyor belts, and small-scale automation, however these solutions have been around for years and are regularly implemented in food retail or processing plants.

Many programs continue to be developed to support food insecurity, like drop box donation or even delivery systems like the "Order Ahead" system being implemented by Houston food banks, with the goal to supply students with lunch safely and without external judgement (OrderAhead, n.d.)

CHAPTER # 2 – Research

2.1 USER RESEARCH

It is vital for a designer to truly understand the user they are designing for. If the design takes liberties on the exact problems the user is facing the design could ultimately serve nobody. Ensuring we understand the end user we can design a solution tailored directly to their needs. We will be developing and researching the user using several methods of information compiling including:

- User Profile - Persona
- Current User Practices
- User Observation – Activity Mapping
- User Observation – Human Factors of Existing Products

2.1.1 User Profile

- 32-Years-Old
- Married
- Male
- Working Full-Time
- Customer Service
- Unable to afford Vehicle
- Lives in Apartment
- Single Child

PRIMARY PERSONA: TED

PARENT SUFFERING FROM FOOD INSECURITY

Ted is a 32-year-old Construction Inspector. He is a vital part to the approval of new build layouts throughout the city of Toronto. With his current job and pay, and the recent rent increase he's had to endure, he can no longer consistently put food on the table for his family. Ted hates the idea that he can't provide for those around him, he isn't able to take on more work and his wife is unable to pick up work due to recent medical issues. He prefers to eat healthy nutritious meals and must work with the little food he has to make something special for his family. Ted is rarely able to afford taking days off, because of this he must work when sick, and even when in extenuating circumstances should keep him home. Ted has recently made the decision to start using food bank services but isn't always able to get what he needs. He hates the idea of taking food from other people, even if he himself needs the food. He feels guilty and ashamed of his situation, despite the difficult situation he faces in life.

"I FEEL LIKE I'M TAKING FROM OTHERS WHEN I USE FOOD BANKS IN ONTARIO. I WISH THERE WAS A BETTER WAY FOR ME TO ACCESS THESE SERVICES."

MOTIVATIONS:

- FAMILY HEALTH
- MASSIVE RENT INCREASES
- MUST BE SOLE FAMILY PROVIDER
- WANTS A GOOD LIFE FOR CHILD
- WANTS TO SAVE TIME AND MONEY
- HEALTHY CLEAN EATING

GOALS:

- GET ENOUGH FOOD TO EAT TONIGHT
- SAVE FOR RENT THIS MONTH
- SAVE MONEY & FIND WAYS TO STRETCH IT
- PROVIDE NUTRITIOUS MEALS FOR FAMILY
- CHANGE CAREER PATHS
- PROVIDE HAPPY LIFE FOR WIFE AND CHILD

BARRIERS:

- HIGH RENT INCREASES
- UNABLE TO AFFORD FOOD
- RECENT SUPPLY-CHAIN ISSUES
- EXPIRY DATES
- FRESHNESS & QUALITY OF PRODUCE
- FOOD UNAVAILABLE AT FOOD BANKS

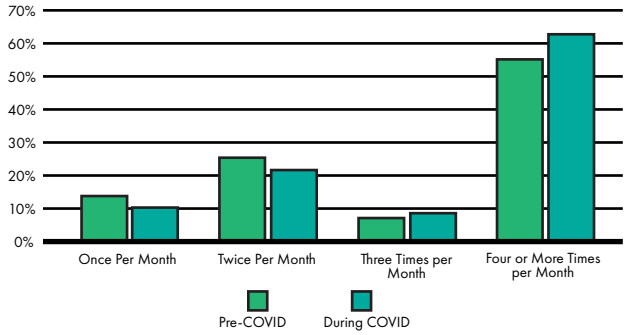
LIKES:

- TELEVISION AND MOVIES
- BASKETBALL (On Weekends)
- HEALTHY FOOD OPTIONS
- GOING TO PUB WITH FRIENDS
- HELPING OTHERS

AGES	2021	2022
0-2 Y/O	5.0%	5.1%
3-5 Y/O	5.1%	5.7%
6-11 Y/O	11.6%	12.0%
12-17 Y/O	10.2%	10.0%
18-30 Y/O	17.2%	19.0%
31-44 Y/O	20.3%	20.5%
45-64 Y/O	22.9%	21.8%
65+ Y/O	7.7%	5.7%

HOUSE COMPOSITION	2021	2022
SINGLE PERSON	5.0%	5.1%
SINGLE PARENT	5.1%	5.7%
TWO PARENT/GUARDIAN	11.6%	12.0%
OTHER	10.2%	10.0%
COUPLE, NO CHILDREN	5.1%	5.7%

FREQUENCY OF MONTHLY FOOD BANK VISITS



BY INCOME & EDUCATION

	Total	<50K	$50K - 75K	$75K - 100K	>100K	HS or Less	College	Univ. Degree
Ate less than you felt you should because there wasn't enough money for food since March 2020	22.9%	38.6%	38.6%	8.6%	3.6%	40.6%	25.9%	12.1%
Hungary but didn't eat because there wasn't enough food since March 2020	19.0%	33.1%	33.1%	6.2%	2.3%	36.3%	20.1%	9.6%
Did not eat for a whole day during COVID-19 because there wasn't enough money to purchase food	8.9%	16.5%	16.5%	2.4%	1.2%	20.0%	8.4%	3.8%
Accessed food or meals from a community organization before March 2020	8.8%	15.2%	15.2%	2.6%	1.5%	16.5%	9.4%	4.7%
Accessed food or meals from a community organization since March 2020	13.9%	24.2%	24.2%	3.4%	2.8%	26.2%	14.7%	7.2%

Primary User: Food Bank Client

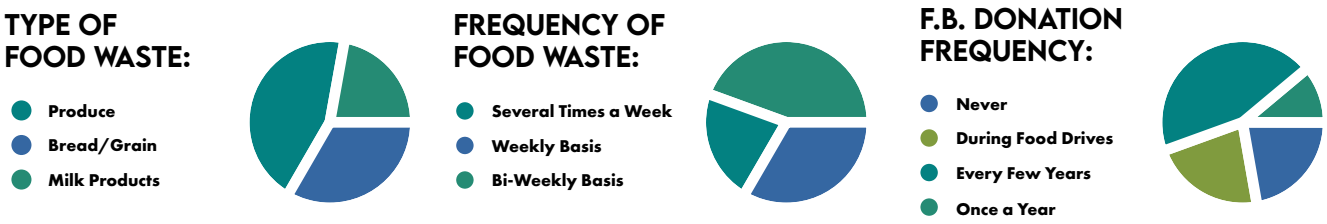
Secondary User: Food Bank Volunteer

Tertiary User: Employees of Food Retail Businesses

With unemployment rates among clients reaching 21%, fear of eviction reaching 27%, and 58% of clients going without food each week 58% it is becoming increasingly clear that many Canadians are struggling in the current economic climate (Daily Bread, 2021). Most food bank users receive service from food banks up to 4 times a month. These users are often living in single person homes and are experiencing hunger on a weekly basis, even up to a few times a week. Approximately 27% of food bank clients are incredibly worried about imminent eviction from their homes (Daily Bread, 2021). Many clients are looking for higher paying work, consistent work, and reliable housing. As a result, more individuals are falling into poverty every year, and are turning to food banks to keep themselves fed. As food banks struggle to keep up with the demand Mobility Bank aims to alleviate this pressure.

2.1.2 Current User Practices

Surveys. In-depth user feedback was conducted to determine the food waste tendencies of average grocery store users. A survey (Google Forms) was posted on Reddit forums and distributed to several grocery store shoppers between Oct 9-15, 2022.



Excerpt of Relevant Survey Results (Grocery Store Users)

User Interview. In-depth user feedback was conducted to determine and identify some of the shortcomings of the internal processes found in local food banks. The goal was to find out what individuals liked and disliked about the current system in place. A 1:1 interview was conducted with 3 Food Bank Volunteers; *M.W*, *S.A*., and *R.M*. over the phone on Oct. 8, 2022. The interview was recorded with permission and transcribed.

Excerpt from Interview with M.W.

Q: What were some of the challenges you faced when volunteering for your food bank?

A: We just don't have enough volunteers at the moment, we are extremely busy most days and that's just when we're able to open. Since the pandemic, donations haven't been coming in as frequently so there are days that we don't have enough to even open.

Q: In recent years, food bank clientele has increased dramatically. Has your food bank implemented any strategies to meet the need of this larger load?

A: Unfortunately, we haven't found many strategies to deal with it. We buy most of our food in bulk from grocery stores in the area because of the donation situation. On top of that we had to start Covid screening, which has stifled the number of volunteers willing to work with us.

Q: Would you be able to speak on some of the struggles the organization itself faces?

A: We just can't keep up with the load of clients recently. More and more people are registering as clients and we're receiving less and less donations. Since less volunteers are available, we've even had to close some of our programs like our grocery program.

Cont…

2.1.3 User Observation – Activity Mapping

A review of several YouTube videos encapsulating the internal experience at a food bank was conducted. From those videos, the one that seemed to represent this internal process the best was selected to further examine. To do so, we developed a map of the daily operations of a food bank.

Time	Setting	Say	Attitude (+)	Attitude (-)
0:37	Outdoors, Warehouse Lot	Explanation of Surrey Food Bank		
1:13	Kitchen	Overview of Programs associated with Surrey Food Bank	Proud	
1:28	Indoors	Tiny Bundles Program	Proud	
1:38	Outdoors	Overview of Line-ups for food bank		Sympathy
1:57	Kitchen	Teaching Programs		
2:42	Outside, produce stand	Overview of produce stands and general flow of traffic		
3:01	Inside	Overview of Necessity of Food Banks		Desperation
3:29	Interview	Introduction of different volunteers	Proud	
3:51	Interview	Overview of struggles clientele often face		Somber

Transcription of the User Observation (A Day in the Life of the Surrey Food Bank)

We then split up this information and codified it based on keywords used to categorize separate sections of the video.

Comfort for Individual	**Empathetic Responses**	**Importance of Assistance**
Protecting Dignity	Desire to help	Appreciation
Normalization for Food Bank Usage	Empathetic Response	Explanation of Services
Assistance for Clients general knowledge	Acknowledgement of Need & Statistics	Call to Action

2.1.4 User Observation – Human Factors of Existing Products

After getting the opportunity to volunteer within a food bank, permission was given to conduct user observation. A video was taken with Reefe Mark; a fellow volunteer walking me through the daily operations at St. Paul's Food Bank in Pickering, Ontario. Later the recording was reviewed, similar to the video observation, the information was put into a table and codified.

Time	Setting	Say	Attitude (+)	Attitude (-)
5:31	Food Bank (Back)	**R:** Donations come through the back door, a few of us go out to meet them and we pull everything and put it out on the middle table	Neutral	Neutral
6:38	Outside (Receiving Shipment)	**R:** Hey there, how are you doing? **D:** Not bad at all, where should we put these? **R:** All good, we'll just take them here. **D:** Oh… Thank you. **R:** No worries.	Appreciation	
7:01	Food Bank (Back)	**R:** It's pretty quick, once we get it in. We bag everything and put it up on the front shelf here.	Nonchalant	
7:22	Food Bank (Back)	**R:** We don't usually sort through the donations on the weekend, cause we have a lot more people coming in. **V:** Hey can you grab bring up this sugar for us? **R:** Yeah one-sec		Sympathetic
7:26	Food Bank (Front)	**R:** So, uh… **R:** We're just not supposed to pick anything heavy up by ourselves so we gotta bring someone with us. **V:** Yeah, too old to be taking risks like that. Don't you try and be a hero either		Annoyed Unsure

Consent forms were obtained.

Recorded with iPhone 8 S.E.

Conversations were recorded by means of video and note writing

The information was then codified based on keywords to categorize separate sections of the user observation.

Confidence	Annoyance	Unsure
Full understanding of what they are doing	Annoyed at the task at hand	Unsure of what to do next
Enjoyment in the task at hand	Unhappy doing a particular task	Unsure of exact steps to take
Strong Explanation	Busy and doing something	Unable to explain

This information was then collected and input into a task map to be evaluated. The task map showed us several relatively dangerous areas of ergonomic concern. Pulling heavy donated boxes of food out of the back of a car, used two people to pick up heavier items and difficulty navigating poorly supported carts. These areas of ergonomic concern are recorded and evaluated so the information can be referenced later and used to optimize the design of the vehicle interior and cart ergonomics.

Task: Food Bank Operations	**Ergonomics**	**Efficiency**	**Interaction**	**Satisfaction**
Pick-Up Delivery & Donations	Leaning in to pick up from cars Carrying Heavy Food Inside	Items could be sorted and stocked immediately Using Carts more	Move Donations to back Use Cart for heavy Supplies	Occasional pain from moving loads Appreciation from donors
Sorting & Stocking Items	Moving Heavy Containers Intricate Dextrous motion for labels	Digitization could improve efficiency Done by Hand	Difficulty Identifying Expiration Date Large Margin for Error	Minor frustration/ irretation when attempting to read dates
Assisting Front	Moving Heavy Containers Using Carts to move Heavier Containers	Heavy Loads Medium Distances Must use two for heavy loads	Interaction with cart Containers moved by two Volunteers	Occassional frustration with frequency of requests
	Ergonomics	**Efficiency**	**Interaction**	**Satisfaction**
	1. Lifting Heavy Items 2. Bending 3. Using Cart 4. Heavy load 2 people 5.Intricate Movements	1. Inefficient System (stocking/sorting) 2. Frequency of Cart Use 3. No digitization 4. Heavy load 2 people	1. Cart handle 2. Picking up/Moving Boxes 3. Reading small labels 4. Sorting through Product	1. Satisfaction of helping others 2. Minor Frustration with reading 3. Minor frustration with volunteer communication

2.2 PRODUCT RESEARCH

2.2.1 Benchmarking Benefits and Features of Existing Products

A comparative analysis of product features and benefits was taken of existing large-scale vehicles that might compare to the vehicle used in Mobility Bank. This product feature information will generally be used to gauge what requirements the vehicle used in Mobility Bank will require.

Benchmarked Product Features

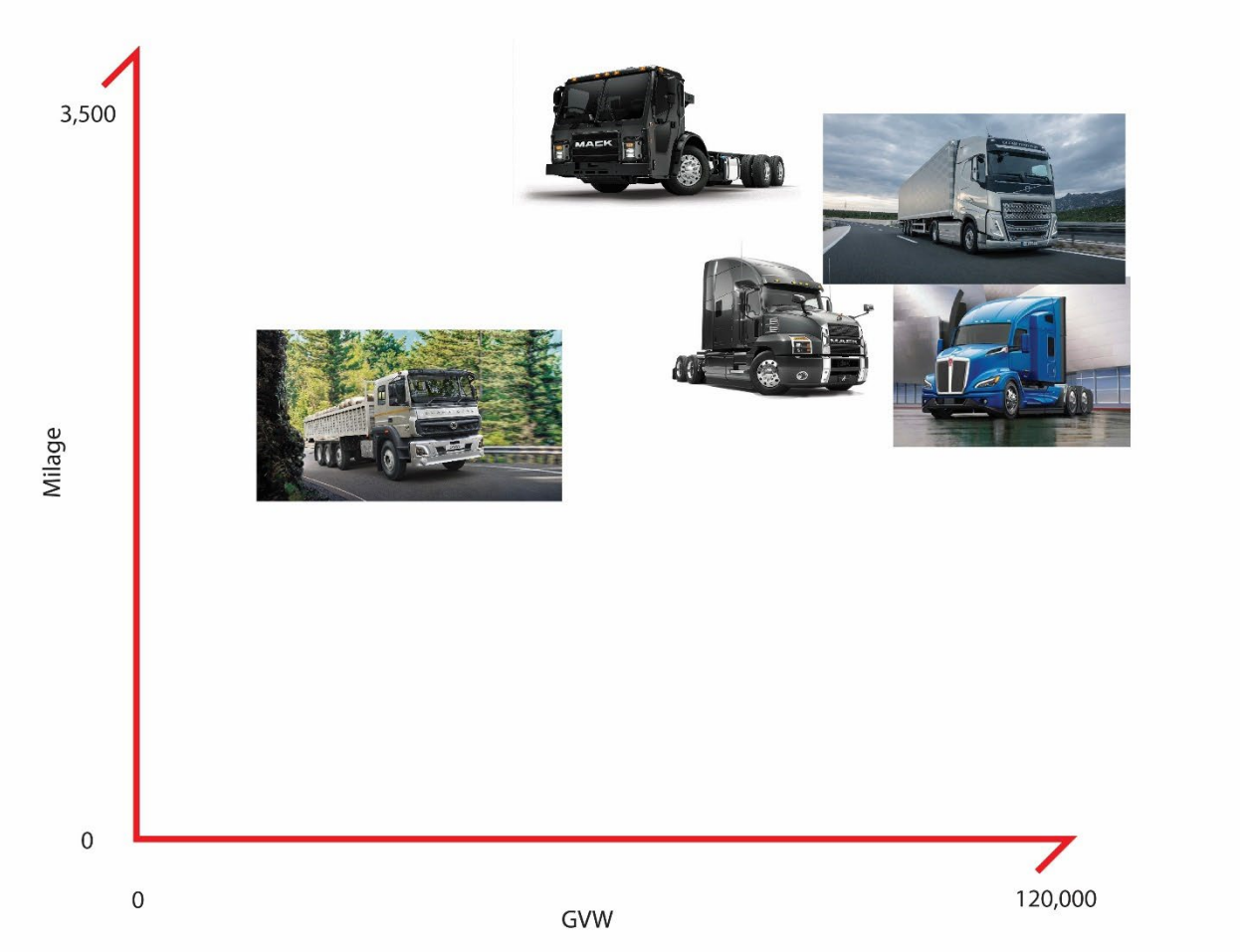
					
	1	2	3	4	5
Make	**MACK:** Anthem Model	**MACK:** LR Model	**Mercedes:** Bharat Benz 1215RE	**Volvo:** Globetrotter FH16	**KENTWORTH:** T680 Next Gen
Size (ft^2)	2700	200	1362	**N/A**	370
Milage (km)	2,200	3,100	2,000	2,800	2,500
Power (HP)	405-505	320-355	550-750	550-750	405-510
Weight Towable (GVW)	43,000-72,000	35,000-62,000	28,220	110,230	82,000
Weight (Kg)	30,000	25,000	13,000	16,000	24,000
Material	Steel, aluminum, copper, polypropelene	Steel, aluminum, copper, polypropelene	Steel, aluminum, copper, polypropelene	Steel, aluminum, copper, polypropelene	Steel, aluminum, copper, polypropelene
Manufacturing	Extrusion, Pressing, Assembly	Extrusion, Pressing, Assembly	Extrusion, Pressing, Assembly	Extrusion, Pressing, Assembly	Extrusion, Pressing, Assembly
Trailer Dimensions (L) x (W)	6'x 4'	**n/a**	6'x 4'	10' x 4'	8'x 4'

The product benefit information will be used to evaluate which values a user might have in a large-scale vehicle design. Using this information is often a more surface level value that might attract their customer-base. This information can then be used to identify broader values we might incorporate in the Mobility Bank vehicle to ensure it appears more attractive.

Benchmarked Product Benefits				
				
1	2	3	4	5
MACK: Anthem Model	**MACK:** LR Model	**Mercedes:** Bharat Benz 1215RE	**Volvo:** Globetrotter FH16	**KENTWORTH:** T680 Next Gen
Benefits				
Powerful Sleek Increased Towing capacity	Powerful Sleek Increased Towing capacity Great Milage	Good for smaller jobs Industrial style Lower Cost	Complex and intuitive interface functional style Increased Towing capacity Good Milage	Stylistic Powerful Good Milage

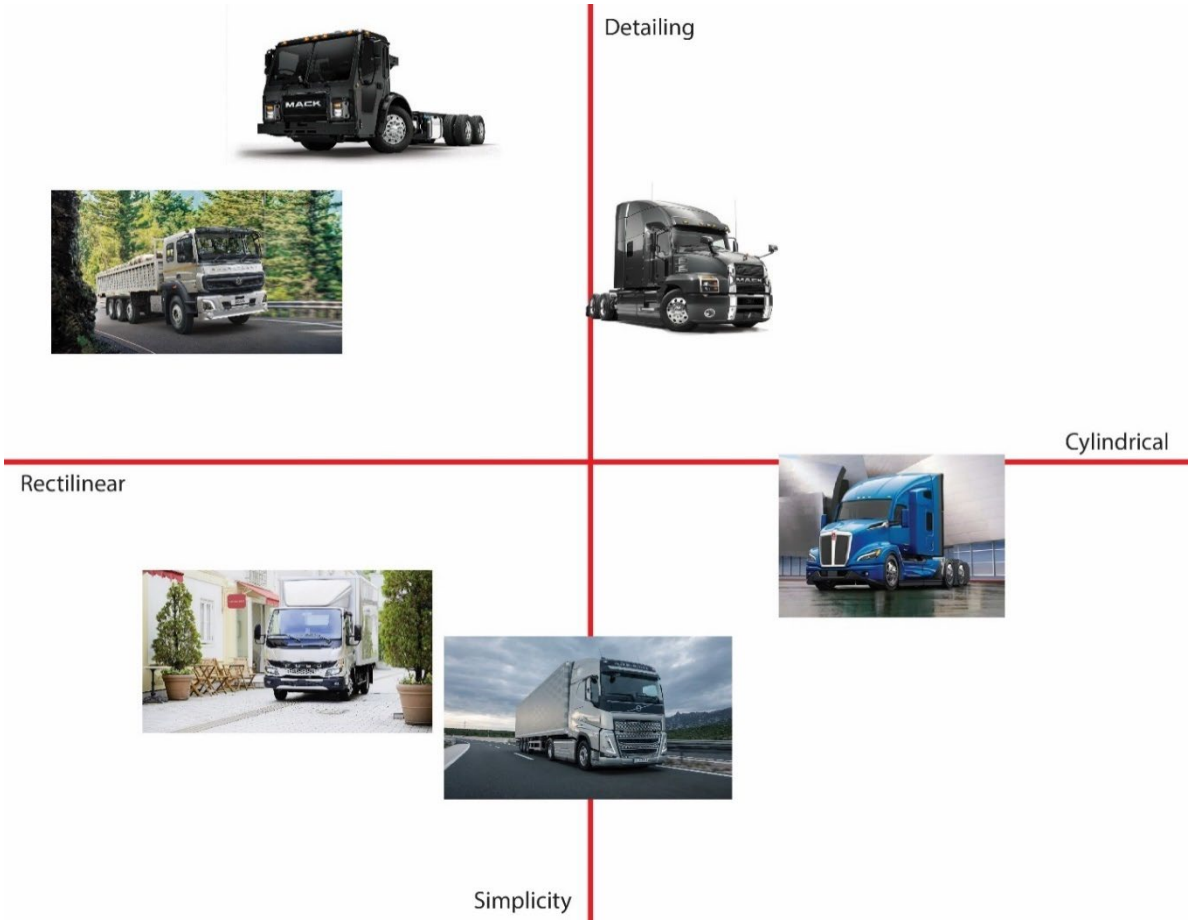
2.2.2 Benchmarking Functionality of Existing Products

A comparative analysis of product functionality was evaluated and plotted onto a graph. In it, we compare gas milage to towing capacity, attempting to identify which vehicles are the most efficient and why. Several reasons for the varying performance were identified and recognized. Some vehicles are set at higher overall price but provide ample towing capacity and mileage. These vehicles are often meant to drive large loads, long distances. While other products set their price lower and reduce their overall towing capacity to prioritize mileage performance. The information gathered in this section helps us develop a frame of reference for what kind of functionality the Mobility Bank vehicle will need to preform it's daily routine while reducing the overall price as much as possible.



2.2.3 Benchmarking Aesthetics & Semantics of Existing Products

To compare aesthetics and semantics, we developed a product map with four distinct sections each representing broad opposing design styles. We then plot the existing solutions based on their aesthetic appearance. This can help us better understand the popular design styles currently on the market.



After graphing each of the existing solutions, shape, patterns, texture, colours, and accenting were examined for design consistencies in each vehicle. A list of these consistencies was then compiled:

- **Shape:** Surface Blending features, Sharp folds, Blocky Structure with pronounced edges
- **Patterns:** Parallel lines, Symmetry, Venting Patterns, Rim Patterns
- **Texture:** Smooth, Gratey
- **Colours:** Black & White predominantly, otherwise loud statement colours
- **Accent:** Chrome, Bumper, Mirrors, Venting (Chrome)

2.2.4 Benchmarking Materials & Manufacturing of Existing Products

Considering materials and manufacture is an incredibly important part of maintaining sustainability in a product. Many materials have adverse effects on the environment, and with a complex product like the Mobility Bank, it is difficult to target and address every material change that can be substituted with an environmentally friendly alternative.

To keep this concise, only the larger changes will be addressed in this section with a further in-depth look at the material list required before production. Some larger changes were made to the Mobility Bank's interior to better suit its sustainability goals. Countertops can be made of Bamboo (MOSO, 2022), this affords maintenance of the countertop, and general replacement if required. Many appliances throughout the interior are made of metal. Generally, this metal will be made from anodized aluminum to ensure recyclability at the end of the product's life cycle as well as avoid unwanted corrosion of this metal (AAC, n.d.). Seats on this truck have been downsized, providing comfort for a shorter duration to minimize material and manufacturing requirements. Longer trips will rarely be taken on this vehicle, so the need for long-term comfort is generally unnecessary. Commonly used, polyurethane foam cushions will be replaced with latex padding (Pyle, 2022), and commonly used Nylon and Polyester upholstery will be replacing with an organic cotton alternative (Pyle, 2022). At the exterior changes were made to the type of paint used. Automotive paint is generally toxic for the environment, instead the Mobility Bank will use sustainable paints made from biowaste (BMW Group, 2022).

2.2.5 Benchmarking Sustainability of Existing Products

Sustainability has been at the forefront of the world's thoughts for the last decade and more corporations than ever are getting involved. Large automotive manufacturers all have their own set of sustainability initiatives touching on emissions, carbon footprint and electric vehicles. As the world looks to electric vehicles (E.V) over its internal combustion engine (I.C.E) predecessor automotive companies are continually striving towards greener vehicles.

Many of these companies produce vehicles with unique sustainable attributes, for example, BMW has developed a sustainable alternative for automotive paint and coating (BMW, 2022). However, there are several broader areas of which can be improved through material, and manufacturing while reducing vehicle footprint (Industry Today, 2020). Most companies have committed to reducing CO2 Emissions from their vehicles, with goals to implement E.V. alternatives. Companies are consistently promising to clean up their supply chains and reduce emissions from these processes. Companies like MACK have even promised a future climate neutral supply chain (Mack, 2023). One of the largest focusses for sustainability in these companies is the goal to increase remanufacture throughout their supply chain. Companies like Tesla have begun to reuse as much as 92% of materials in the remanufacture of their batteries (Tesla, 2021). Finally, it appears that the rampant use of water to meet production needs has begun to fall out of popularity, as companies like Ford and Tesla work towards reducing the amount of water intake needed to accomplish these operations (Tesla, 2021). Ford has even barred manufacturers from using freshwater resources for anything but drinking on site (Ford, 2020).

All automotive brands strive to ensure the user is safe in their vehicle, as advances are made each year on the forefront of vehicle safety. However, this is not always true for their employees. Companies like Ford aim for zero fatality goals in their workplaces as well as a zero serious injury goal. They also aim to implement a more competitive lost-time policy for workers (Ford, 2020). Other

companies like MACK aim to reduce their accident rate by 75% (Mack, 2023), and BMW aims to rework and reform management at their locations to achieve the highest level of occupational safety certification (BMW Group, 2023). A commitment to supplying workers with proper health benefits appears to be an industry-wide commitment from several major automotive brands. The increase of employee benefits is providing labour workers with more health security than ever before (Ford, 2020).

2.3 RESEARCH – SUMMARY

2.3 Summary of Chapter 2

A large focus in this chapter is put on showcasing context and contextual research. Developing an accurate user profile, identifying problem areas of our user's day-to-day life, and benchmarking existing products were the main focusses of this chapter. Several statistics found throughout scholarly articles were transcribed into a set of takeaways that were developed and used to define an accurate user profile and demographic of food bank clients.

Various research methods were conducted throughout this stage of the thesis. Surveys helped us develop a framework for the average waste a grocery store customer makes, while the 1:1 interviews presented several pain points with food bank volunteers and reinforced many of the pain points already discovered in our local food bank. Video observation is performed to identify the various services a food bank practices, as well as to understand the struggles many clients go through. In-person observation was later conducted to test the ergonomic of equipment in St. Paul's Community Food Bank. This not only gave us an in-depth look at the internal operations at St. Paul's but also addressed several shortcomings of the relatively cheap equipment being used there.

Lastly, this section contained various benchmarking exercises of which existing solutions are compared to one another. Throughout benchmarking, determining the differences and similarities between existing solutions are both incredibly important. The process of benchmarking these solutions led to several useful insights like why certain vehicles prioritize gas milage over haul capacity or vice versa. We were then able to identify a list of restrictions and cost-saving measures to ensure that the Mobility Bank vehicle is able to perform its job optimally at a the most reasonable price possible.

CHAPTER # 3 – Analysis

3.1 ANALYSIS - NEEDS

3.1.1 Needs/Benefits not met by Current Products

Many individuals that use food bank services often have a lack of self-worth. This is only exacerbated by the concept that you are always better off than someone else. This type of ideology is dangerous and leaves many individuals with nowhere to turn in times of need. It also seems to create a dynamic of inadequacy when using these services. Mobility Bank aims to rationalize this thought process and normalize using services designed to help those in need by ensuring these types of services are more visible and can be seen by the general population (Rizvi et al., 2021).

Many food banks are unable to meet the newfound demand of their growing client bases. Just like for the client, rising food prices means food banks aren't able to buy as much food for themselves, leaving even less to ration out to a larger than ever client base (Harrison, 2023).

Most landfills store food waste in an anaerobic environment which prevents food from breaking down naturally. As a result, a massive amount of food waste never properly decomposes in such an environment. Alternative solutions like composting are available but are tedious to set up and perform regularly, many are just turned away from the concept by the odors that composting can produce (Mckenzie, 2022).

3.1.2 Latent Needs

Using Maslov's Hierarchy of needs, a template was put together to evaluate a food bank user's need. By assigning each need a priority of Slight, Moderate or High. Using this method, we can determine what needs would objectively benefit the client the most. After completing this list, it left us with an organized list of which needs would be best to consider when forming our design.

Food Bank				
Needs	**Benefits and Underlying Needs**	**Level of importance**		
Basic Needs				
Shelter	Clients need shelter from the elements			*High*
Food	Clients all need food to continue surviving			*High*
Disposal of Waste	Clients all need somewhere to dispose of their waste		*Moderate*	
Security				
Safety	Protection from elements, and dangers		*Moderate*	
Security of Property	Protection of items and property from dangers	Slight		
Job Security	Important for Clients to have steady income			*High*
Housing Security	Reliability of Residency		*Moderate*	
Social Belonging				
Fear of Social rejection	Worry of feeling like an outcast			High
Fear of being unable to support family	Low self-worth, unable to meet expectations		Moderate	High
Fear of taking a meal away from others	Worried they are not able to use services			
Social Expectation	Social stigma says not to use food bank services		Moderate	
Esteem:				
Social Status:	Worried about personal view of themselves			High
Social Recognition	Wants to be seen as someone well-off			High
Sexual attractiveness	Wants to have money to find significant other	Slight		
Self-Actualization:				
Intrinsic pleasure	Eating a meal with the family		Moderate	
Creative endeavors	Ability to focus on personal goals and hobbies	Slight		
Experiential (extrinsic)	Being able to focus on job search, or career progression		Moderate	
Experiential (intrinsic)	Being able to afford a night out	Slight		
Emotional	Dampening of financial stress Feelings of self-worth		Moderate	

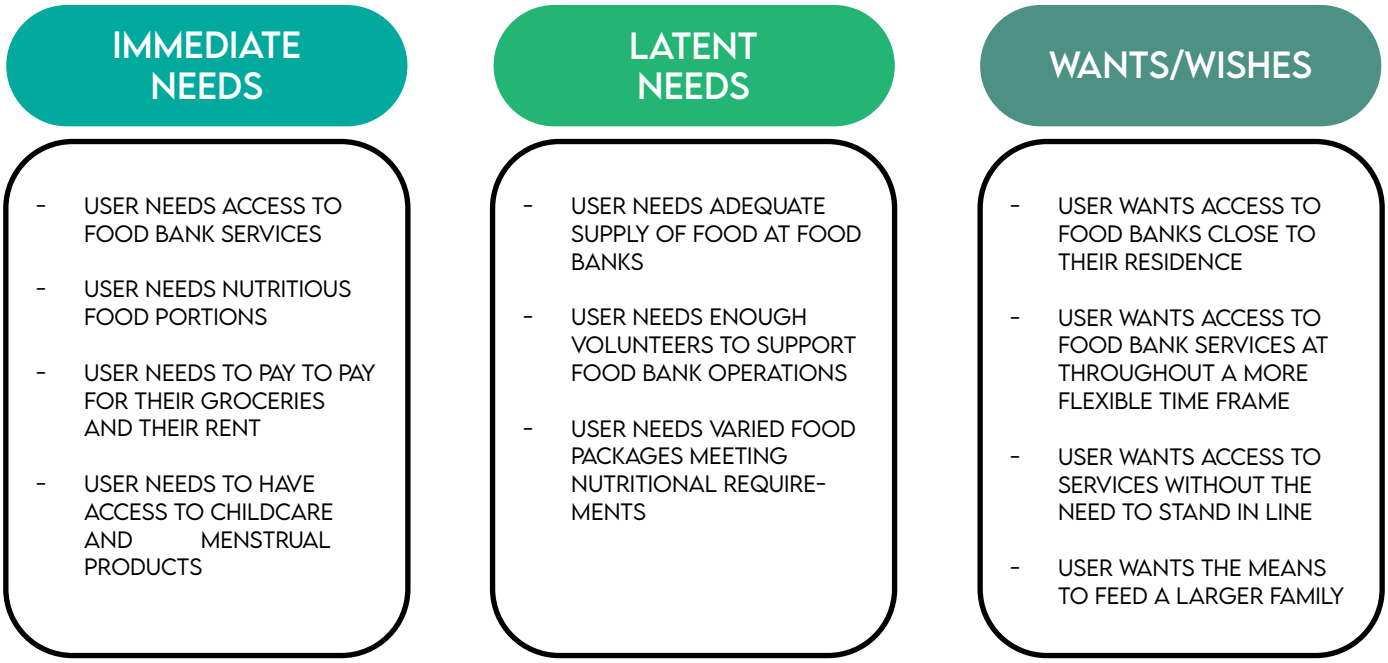
These needs statements were then derived from the previous table:

A client's nutritional needs (Basic Needs) are able to be met through various interactions with a food bank. Being assisted with package retrieval (Usability), lets the user avoid the fear of social rejection (Social Belonging and Esteem).

Providing clients with further financial security (Security), and ease of lifestyle challenges provides the client with further options more options. With some kind of financial security a client might be able to spend some money on themselves (Satisfaction).

3.1.3 Categorization of Needs

The categorization of needs focuses on 3 major categories of user needs. To continue catering this thesis to human-centered design these needs were ranked based on Immediate needs, Latent needs, and wants/wishes.



The immediate needs of the user include their need for nutritious food, the need to pay bills, and their need for hygiene products. These are generally necessities that every human being needs to survive.

The latent needs are often hidden and rarely thought about, however, these needs would have a great impact on the user's experience if they were to be met. For our user, these needs include an adequate supply of food at local food banks, enough volunteers working within a food bank to keep their doors open, and lastly some level of variation in the food packages received at food banks.

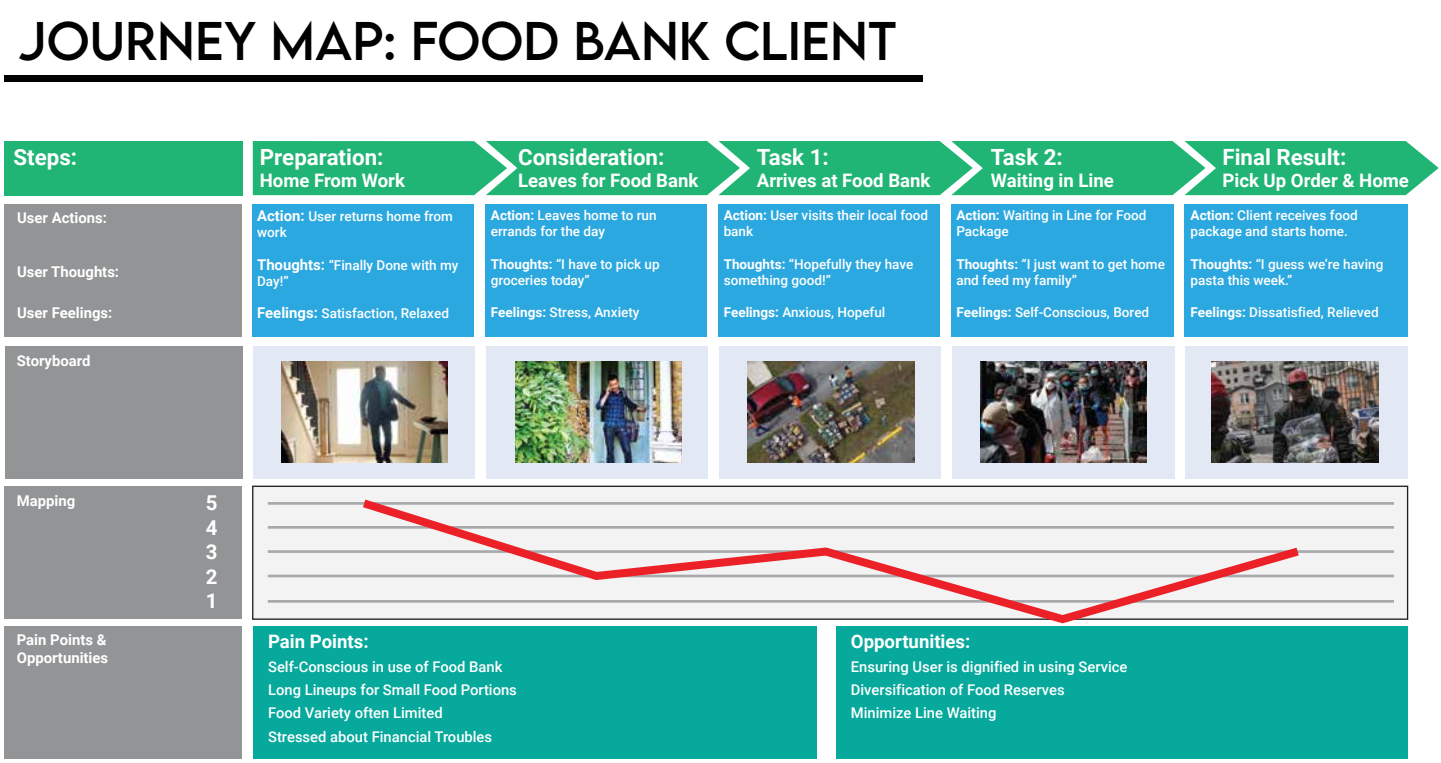
Wants/wishes aren't a true need, just things that the user might wish to have, or general goals of which they strive to obtain. The wants and wishes of a food bank user are obtaining food bank services closer to home and being able to use the services at a more reasonable time in the day. The

user wants to avoid standing in line to use the food bank as there is very little privacy. Finally, a user might want the means to have a family or grow a current family.

3.2 ANALYSIS - USABILITY

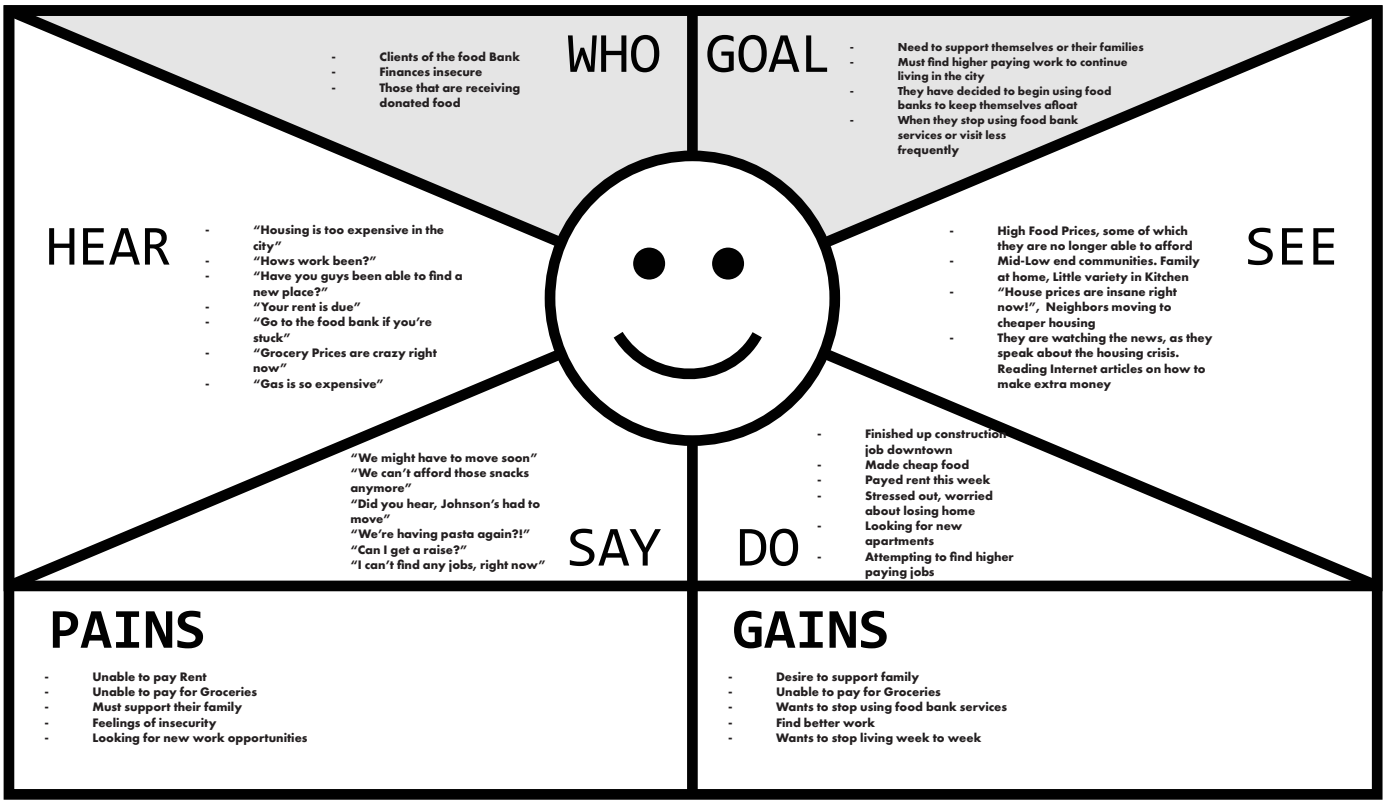
3.2.1 Journey Mapping

It is vital for a designer to truly understand the user they are designing for. If the design takes liberties on the exact problems the user is facing the design could ultimately serve nobody. Ensuring we understand the end user will aid us on our journey to designing a solution tailored directly to their needs. We will be developing and researching the user using a journey map. Here we break down the full experience of a client going to a food bank to pick up their assigned package of food.



3.2.2 Empathy Mapping

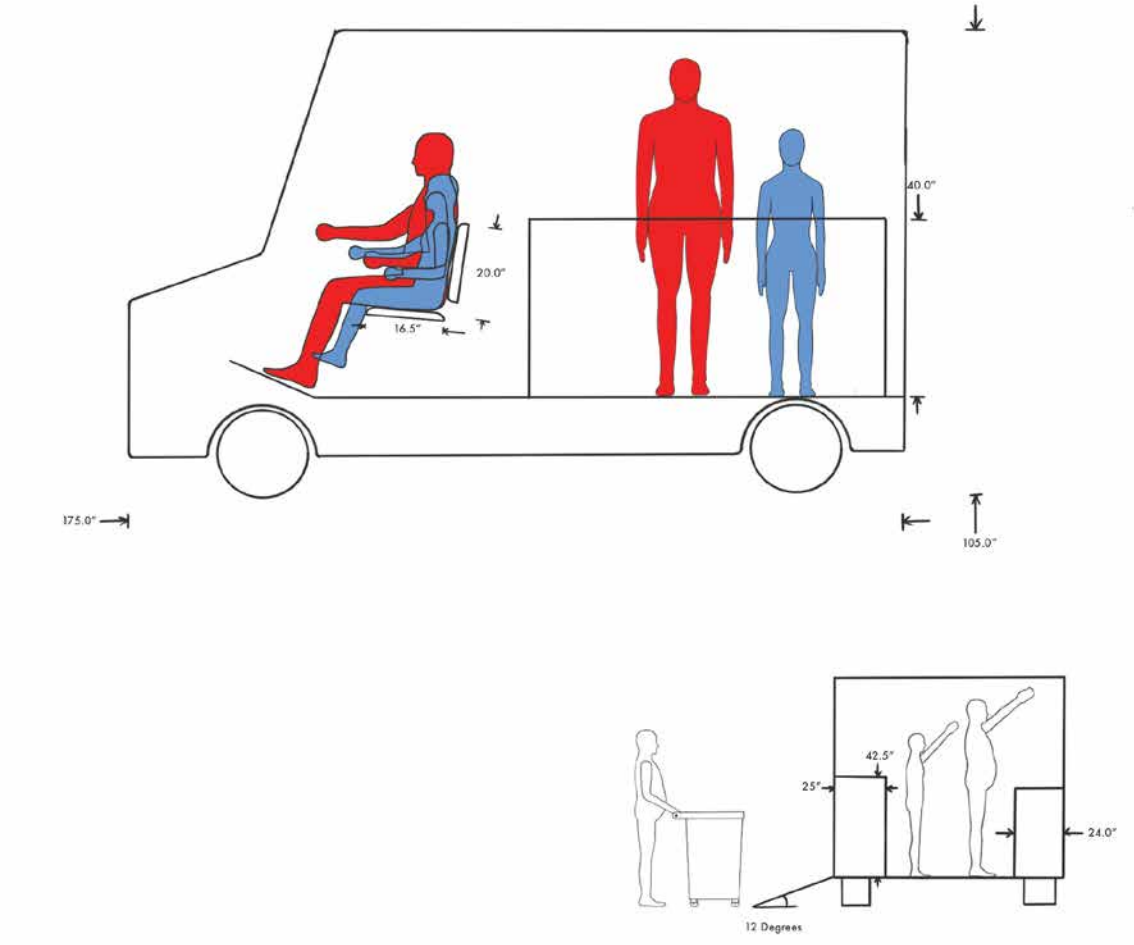
To continue furthering our understanding of the user we must empathize with them. Using an empathy map we map out what a user might see, hear, do or say in their daily lives. This information can be incredibly useful especially as we look for opportunities to mitigate the effects of social pressures and judgement.



3.3 ANALYSIS - USABILITY

3.3.1 Product Schematic – Configuration Diagram

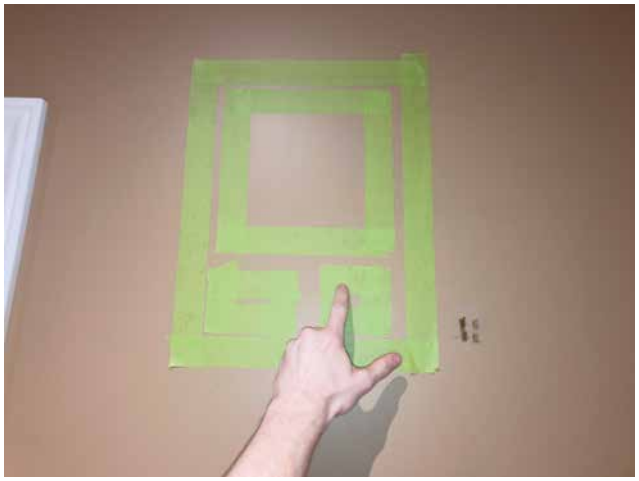
Carrying on with our leading concept, a vehicle size was selected, comparable to the size of an ice cream truck. Initial ergonomic measurements researched at this stage to better service the user working on the interior of the vehicle. The ergonomic measurements of vehicle seating, countertop width and height, ramp angles and general vehicle sizing were reviewed and incorporated throughout the vehicle.

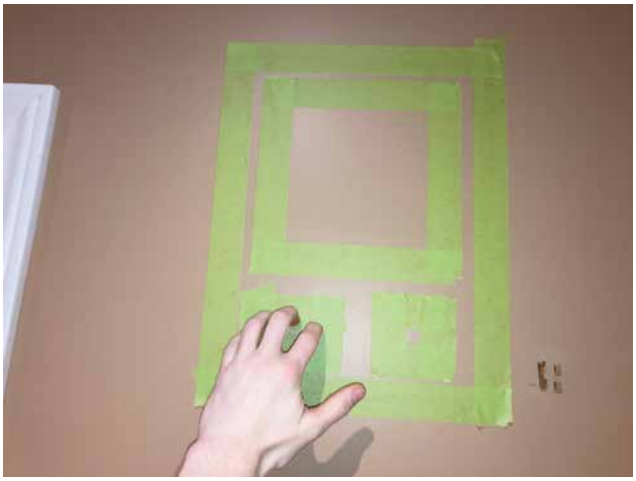


At this stage of concept development, a shift in focus to food waste coming from local businesses was made. A set of carts were implemented to carry food waste on and off the vehicle for food processing purposes. However, many details of this loading process were still undefined.

3.3.2 Ergonomics – 1:1 Human Scale Study

A 1:1 Human scale study model was developed. A full-sized cart model was developed, to test site lines, handle ergonomics as well as spacing required between trays used in the dehydrator part of the cart. Interface button sizing and overall height was also tested at this stage.





3.4 ANALYSIS – AESTHETIC & SEMANTIC PROFILE

3.4 Aesthetics & Semantics Profile

Reviewing previous benchmarking of aesthetic and semantic profiles provided a list of keywords and trends that can be utilized during idea generation. It provides in-depth context into the commonalities we see amongst many large-scale vehicles on the market.

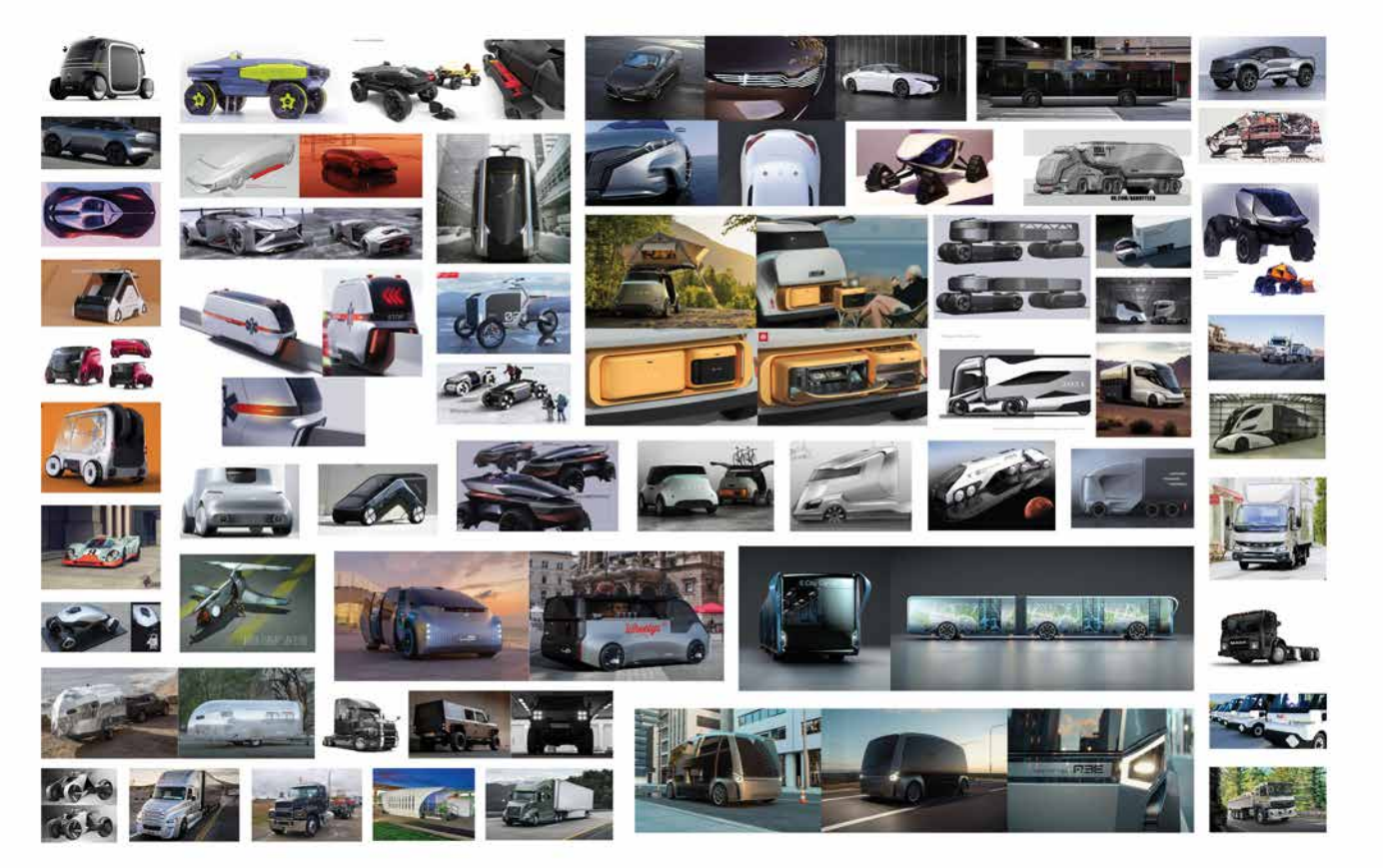
Much of the information on aesthetic and semantics profiles became disconnected as the concept grew into its own. Many of the design elements and focal points of existing large-scale vehicle designs used features like windshields or grills as focal points. They built off these features to incorporate a consistent design language throughout the vehicle. Due to the change in automation to Mobility Bank, many of these elements were no longer required. It was important to begin reviewing and reworking design element of other electric vehicles or automated vehicles to better reflect the Mobility Bank's cutting-edge technology.

Regardless of the shift in focus, many elements found in existing solutions can still be incorporated and prioritized, with overall form being a great example. Many of the existing solutions reviewed were rectilinear in form. Much of this is due to functionality of cargo space but it is also

useful to understand how this rectilinear shape is pulled off. In some cases, an industrial style is incorporated into a rectilinear design. While the overall form is rectangular and simple, the detailing throughout is complex, and honest. In other cases, the rectilinear form was hidden with large fillets and curved surfaces, this helped to incorporate a flowing movement throughout the design and softened what would otherwise be sharp corners.

Parting lines seem to play an important role in the design of large-scale vehicles. It helps to create sectioned off areas and focal points throughout the design. Venting and rim detailing often reflects the overall design style or company branding. It seems to be a common area of design where a unique feature or shape is incorporated as there is more freedom in what can be manufactured.

A common theme that continues to play in these large-scale vehicles was that most are advertised in white, gray, or black. Often chrome features are incorporated to contrast with the plain exterior colour. On the opposite end of the spectrum, companies like Kenworth seem to advertise most of their large-scale vehicles in bright and loud colours like red, blue or green.



3.5 ANALYSIS – SUSTAINABILITY, HEALTH & ENVIRONMENT

3.5 Sustainability, Health & Environment

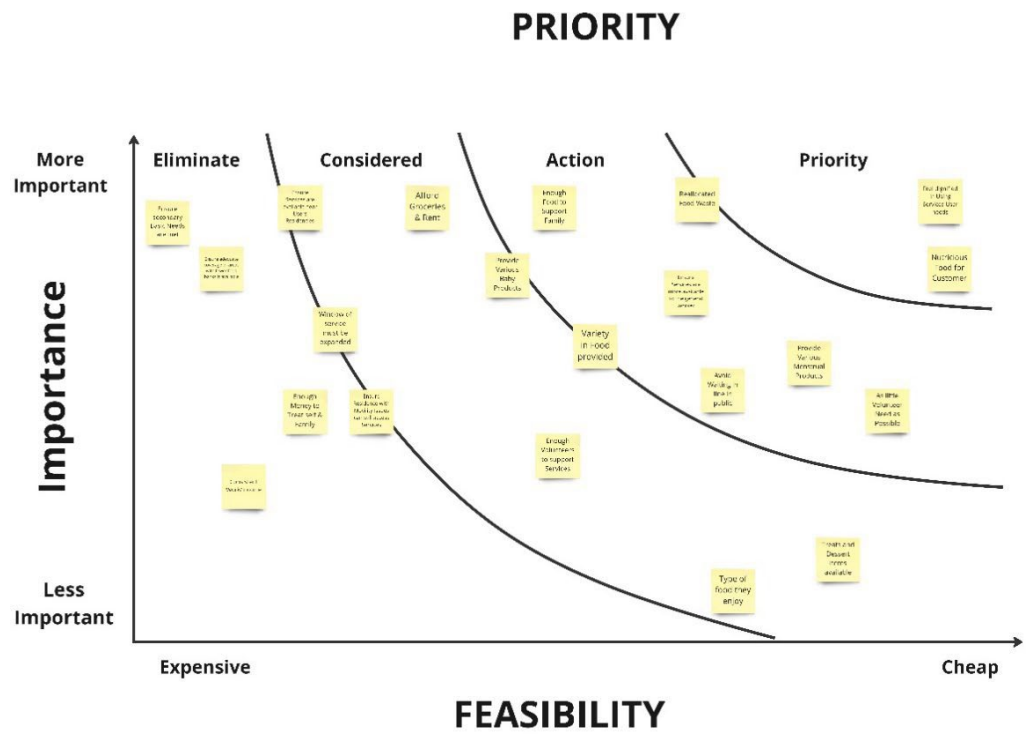
A large differentiator of Mobility Bank to many other automotive companies is the goal to keep all possible manufacturing operations in a single dedicated plant, reducing a large percentage of emission created transporting parts and materials short distances (Tesla, 2021). While emissions are still created through charging, the inclusion of an electric engine affords a significant reduction in emissions created by Mobility Bank vehicles. As technology advances, battery capacity and efficiency increase each year. Emissions created from charging an electric vehicle of this size will reduce dramatically over the next decade (Wellbrock et al., 2020). Finally, a remanufacture plan has been incorporated in the Mobility Bank vehicles, ensuring that we reuse durable, high value parts for manufacture later on when a vehicle comes to the end of its lifespan, helping to reduce waste as well as save money (TWI, 2021).

3.6 ANALYSIS – INNOVATION OPPORTUNITY

3.6.1 Needs Analysis Diagram

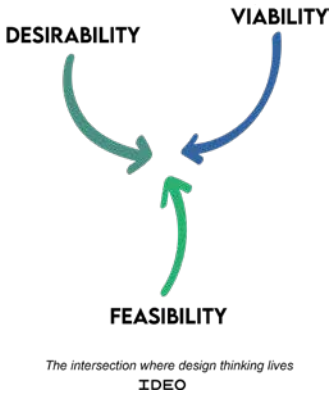
The analyzation of needs began by identifying several pain points that would be relevant throughout the design of the interaction process. These were then plotted into an affinity diagram. The analyzation of needs began by identifying any pain points, insights and delights a client might experience using food bank services. Each of these points were then sorted into groups with similar attributes to one another. For each group, an overarching theme was decided.

After compiling a list of insights, we plotted them onto a prioritization grid, to rank each insight in importance and feasibility. Several insights were then made upon each of the identified pain points, both positive and negative in nature, enhancing our general understanding of these pain points.



Breaking these results down can help to rank the insights and pain points by priority. The final graph should confirm the viability of these different proposed solutions.

3.6.2 Desirability, Feasibility & Viability



Following the IDEO's ideologies on human-centered design, there are three large components of a design which create opportunities for true innovation. These categories are: desirability, feasibility, and viability.

Desirability

In recent years, food insecurity has grown exponentially. More people than ever before are using food bank services. After speaking with several different food bank volunteers and even working in a food bank ourselves, it has become apparent that food banks are unable to meet the needs of an ever-increasing load of clients. Mobility Bank aims to collect arbitrary food waste from local organizations like grocery stores, using dehydration technology to recover this food and ensure it lasts an extended period. Mobility Bank the uses this recovered food to supplement the food supply of local food banks to help ensure everyone receives the food they need, all while reducing the amount of waste coming from these larger organizations.

Feasibility

The general operations that make up the Mobility Bank service are relatively easy to pull off. While it is a complicated process, the streamlined state of the interaction process makes it simple to perform the responsibilities in and outside the vehicle. As of now in the business plan, Mobility Bank has named food bank volunteers as our operators. While this would be ideal, it is difficult to assume that a job with a large labour requirement would be unpaid. In the end Mobility Bank would likely need to hire several operators to run a fleet of vehicles. Hiring employees itself would come with a lot of benefits, however employees have been avoided in this concept as there is no proven means to fund them.

In terms of day-to-day operations, the largest concern would be negligence on the side of a volunteer. Due to a specific sanitization solution (Sodium Metabisulfite) there should be no risk of microbiological contamination. If a volunteer were to skip this treatment however, there is a chance of food contamination (Chitrakar et al., 2018). Despite this, the risk of microbiological contamination would still be incredibly low but regardless of low risk, it is worth mentioning.

Viability

The largest viability concern with Mobility Bank is the cost. A charity organization or large grocery store brand would likely need to sponsor or fund the project. Mobility Bank itself is a charity organization. No revenue is generated by running the service and large costs will inevitably be involved, producing all the equipment, storing vehicles and likely several paid employees. This is likely the largest hurdle Mobility Bank would have to overcome to move forward as a business model.

3.7 ANALYSIS – SUMMARY

3.7 Summary of Chapter 3

The primary goal of Mobility Bank is to mitigate the effects of food waste. The route taken to do so is by repurposing food waste through dehydration and redistributing it to those in need. This brief will act as a framework throughout the rest of the Mobility Bank concept development using 10 key usability issues identifies throughout.

Ergonomics & Safety:

Lifting: Must lift heavy items consistently and often.

Bending: Bending to pick up loads, or sort through food items on low shelves.

Intricate Repetitive Movements: Tasks that require repetitive intricate movements can cause pain in joints.

Efficiency:

Inefficient System: System is performed through rigorous bookkeeping, and label-making.

No Digitalization: Far too slow to do a significant portion of internal operations on a single computer.

Inefficient Cart path: Unable to use carts for most in-house transport due to high-traffic walking paths.

Interaction:

Push Carts: Interaction with Push Carts.

Boxes: Picking up and moving heavy boxes.

Labels: Making and reading small labels with dates.

Sorting/Stocking: Sorting through product requires finding small expiry date throughout packaging.

Satisfaction:

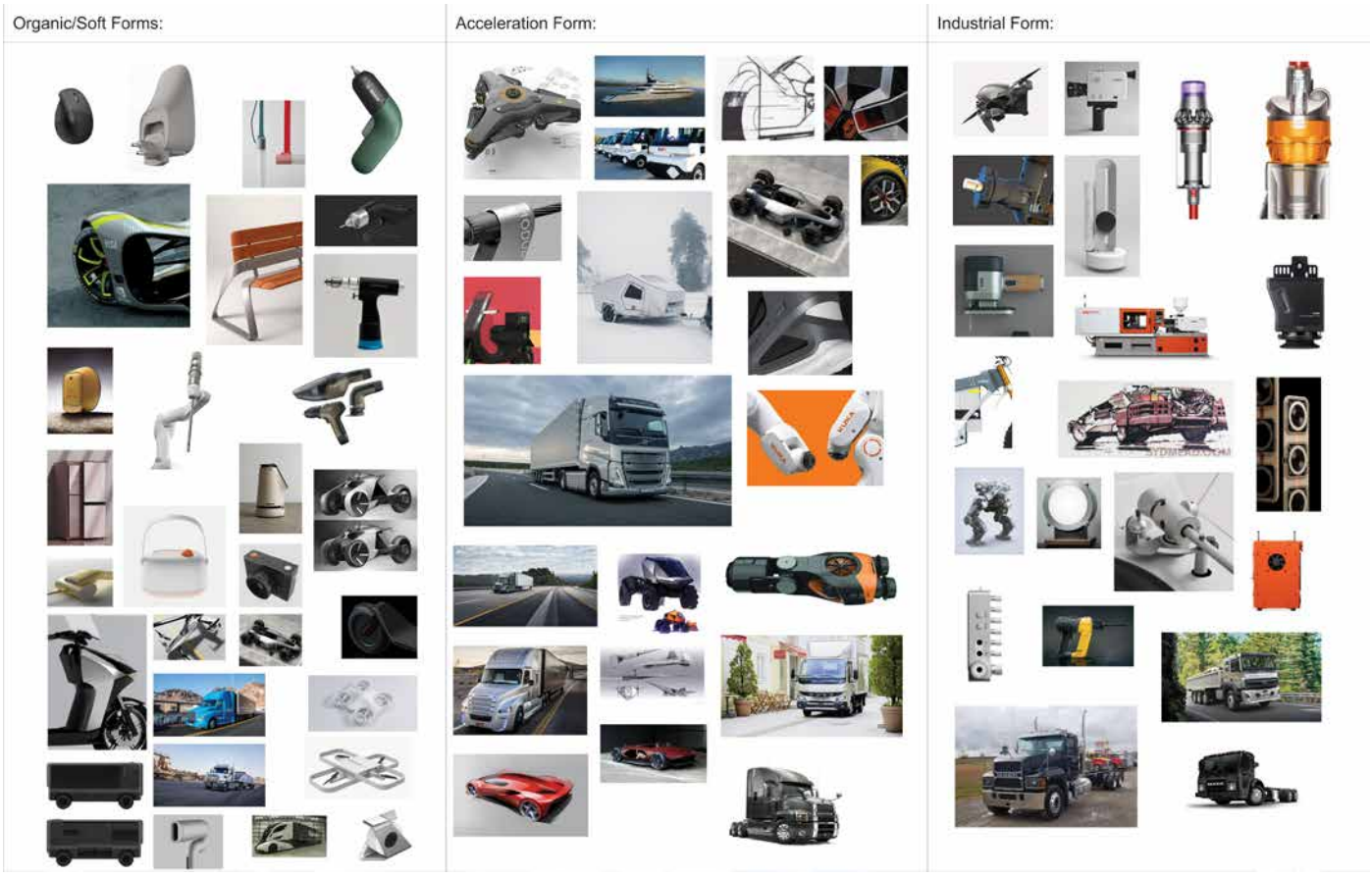
Frustration Expiry Dates: Frustration with reading small expiry dates and labels.

CHAPTER # 4 – Design Development

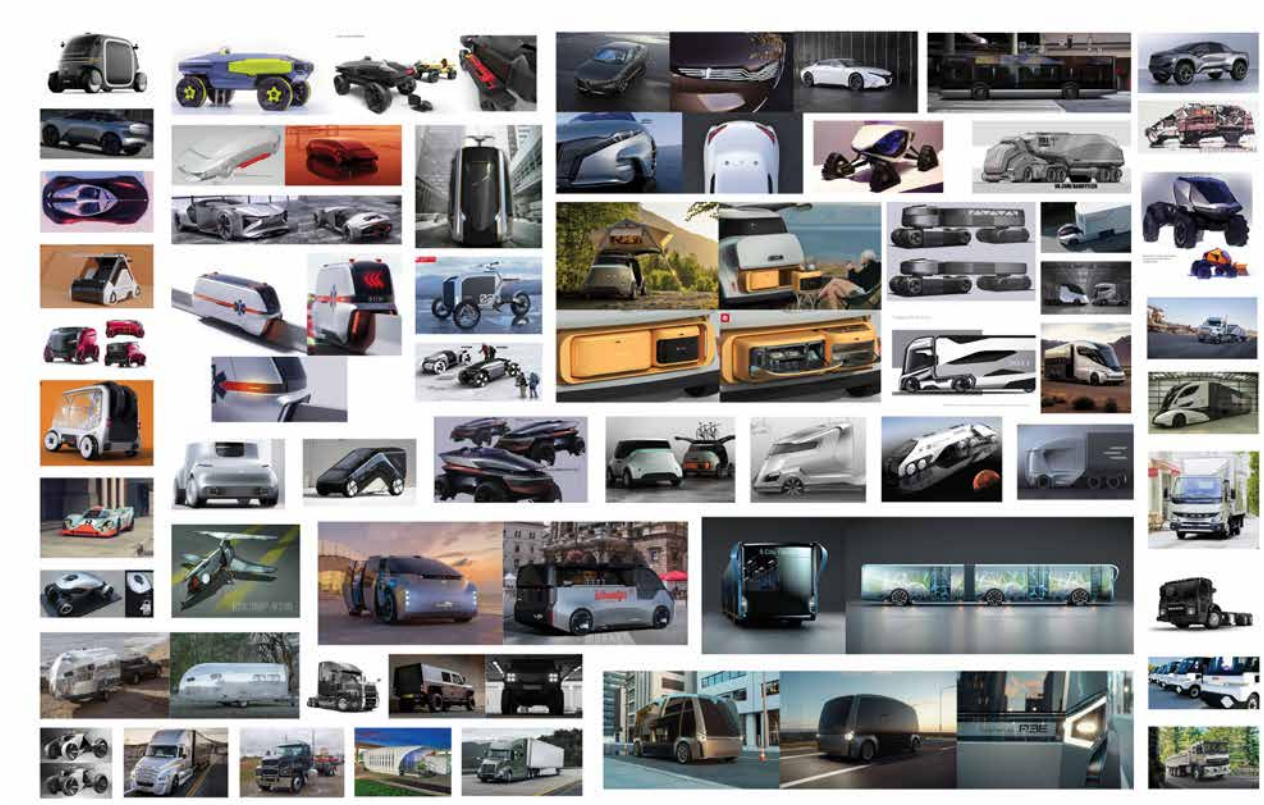
4.1 INITIAL IDEA GENERATION

4.1.1 Aesthetics Approach & Semantics Profile

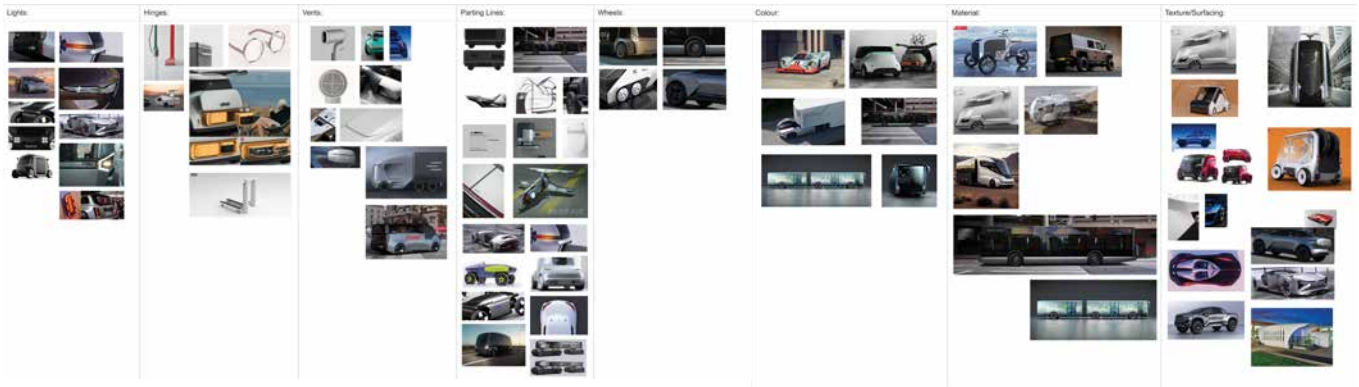
At the beginning of the design process, it was important that a broad style was chosen to build upon. Several styles were explored based on forms associated with or that are synonymous with the brand of Mobility Bank. Of these styles three were chosen and various images were found to represent; Organic/Soft, Acceleration, and Industrial forms.



Upon further review, soft forms and acceleration forms seemingly fit Mobility Banks value accurately. Representing emotions like modern, fast, simple yet detailed. From here we moved on to a final overarching design style that mixed elements from both soft forms and acceleration forms.

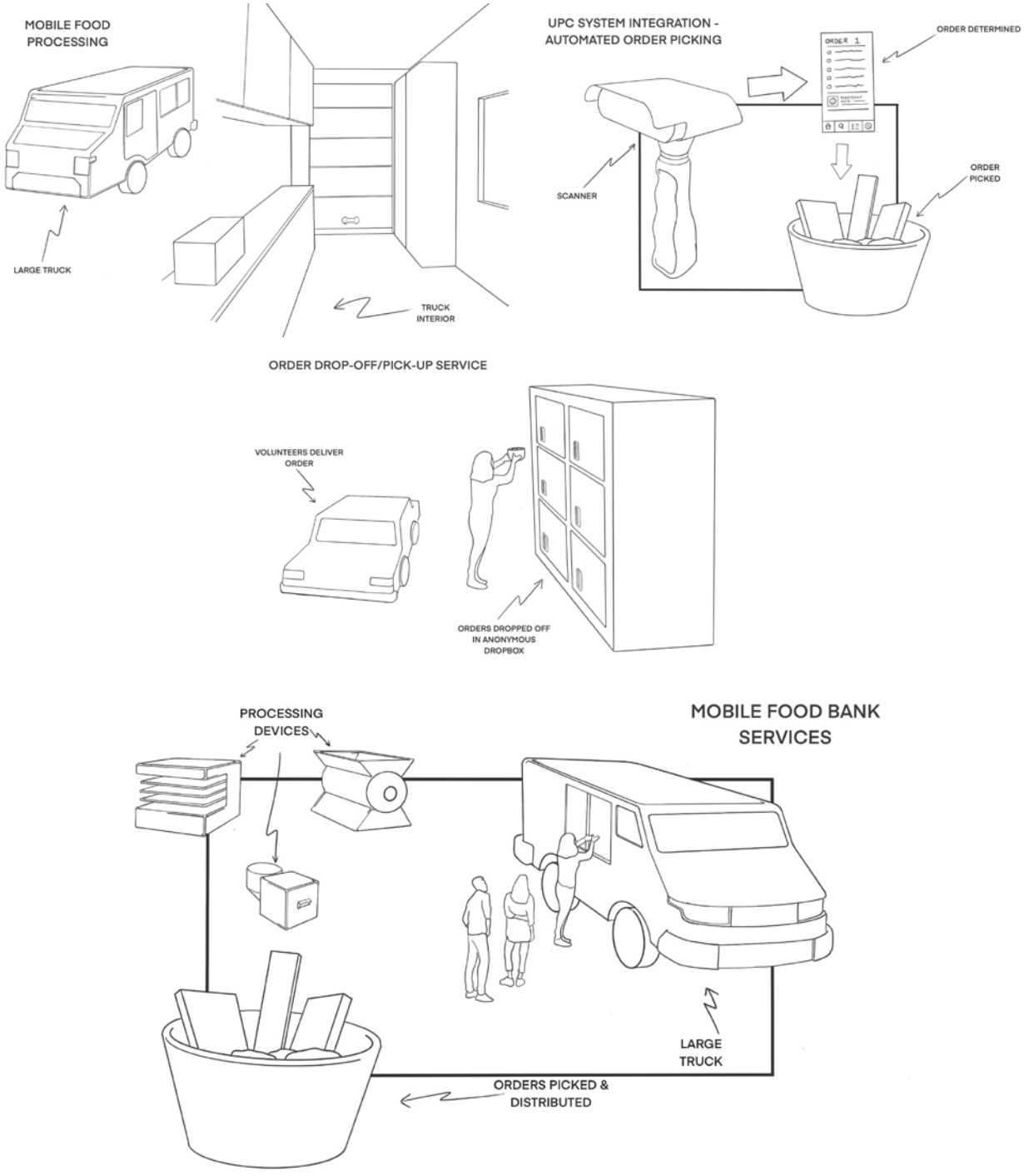


We then continued to look for further examples fitting into a similar design language as the one established above. However, the goal of these new board was to identify product details and design elements fitting within our design style. A large board was split into numerous categories representing common design details. The product details prioritized were lights, hinges, and parting lines, and design elements prioritized were colour, material, texture/surfacing details.



4.1.3 Idea Generation

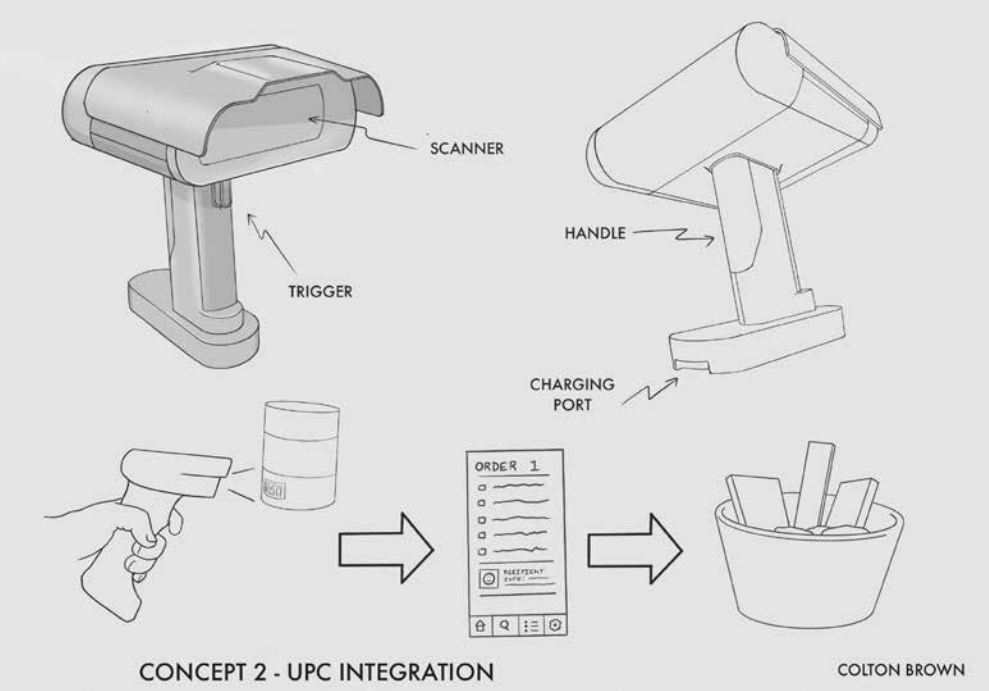
After identifying the general style, idea generation began. Going through various sketches and iterations is an incredibly important step in the design process. At this point, very little is off the table, any user pain point, insight or area of inefficiency might be targeted for these initial concepts.



4.2 CONCEPT EXPLORATION

4.2.1 Concept 1 – UPC Scanning/Automating Services

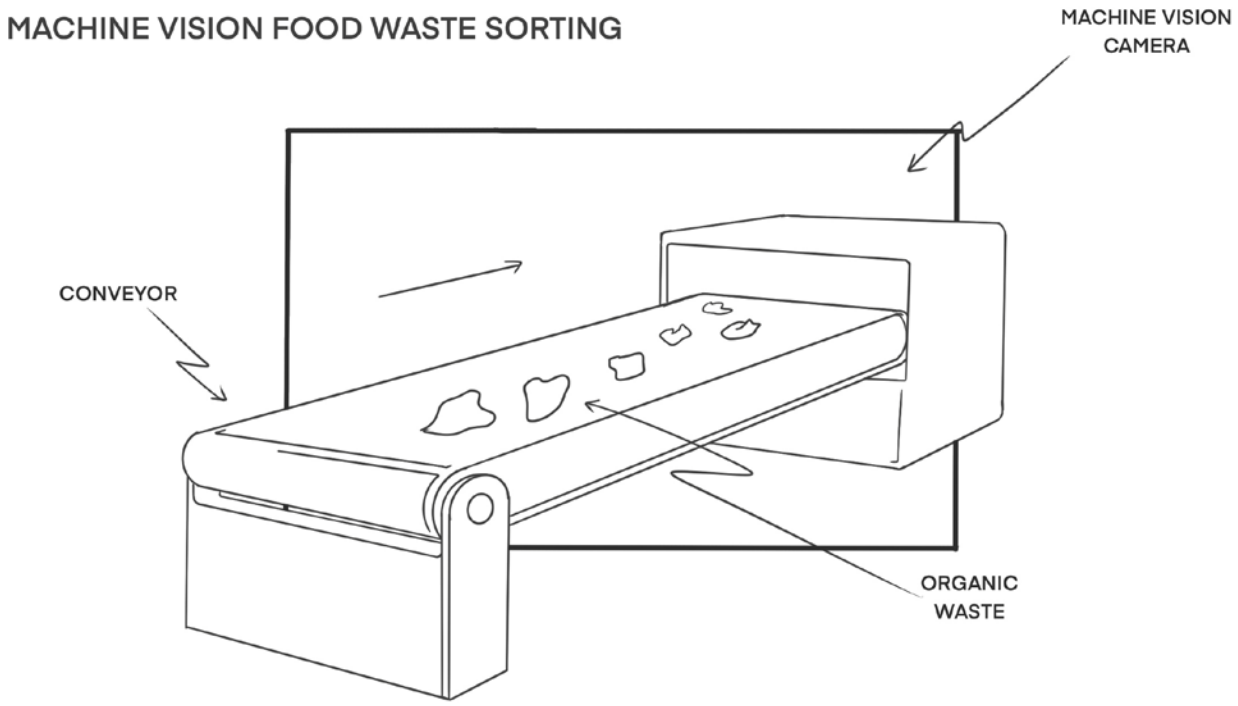
The first concept explored was heavily related to UPC scanning. Just introducing UPC scanning to food banks would likely make the process of sorting and packaging food much simpler, but there are several other opportunities for development.



Every food bank observed categorized their food by date to avoid any kind of spoilage. With the sheer quantity of food stored in food banks, this becomes disorganized and messy very quickly. Despite sorting by expiry date, many cans and other non-perishable items get mixed up during the workday, so anytime an order goes it is required to rechecked dates. This quickly became a large pain point as many volunteers are older and retired. Volunteers would often had difficulties reading these smaller expiration labels without glasses on. A future addition to this concept would be to include a rotating axis of ink cartridges or adhesive stickers dispensed from the UPC Scanner directly onto the food item.

4.2.2 Concept 2 – Machine Vision Sorting and Processing

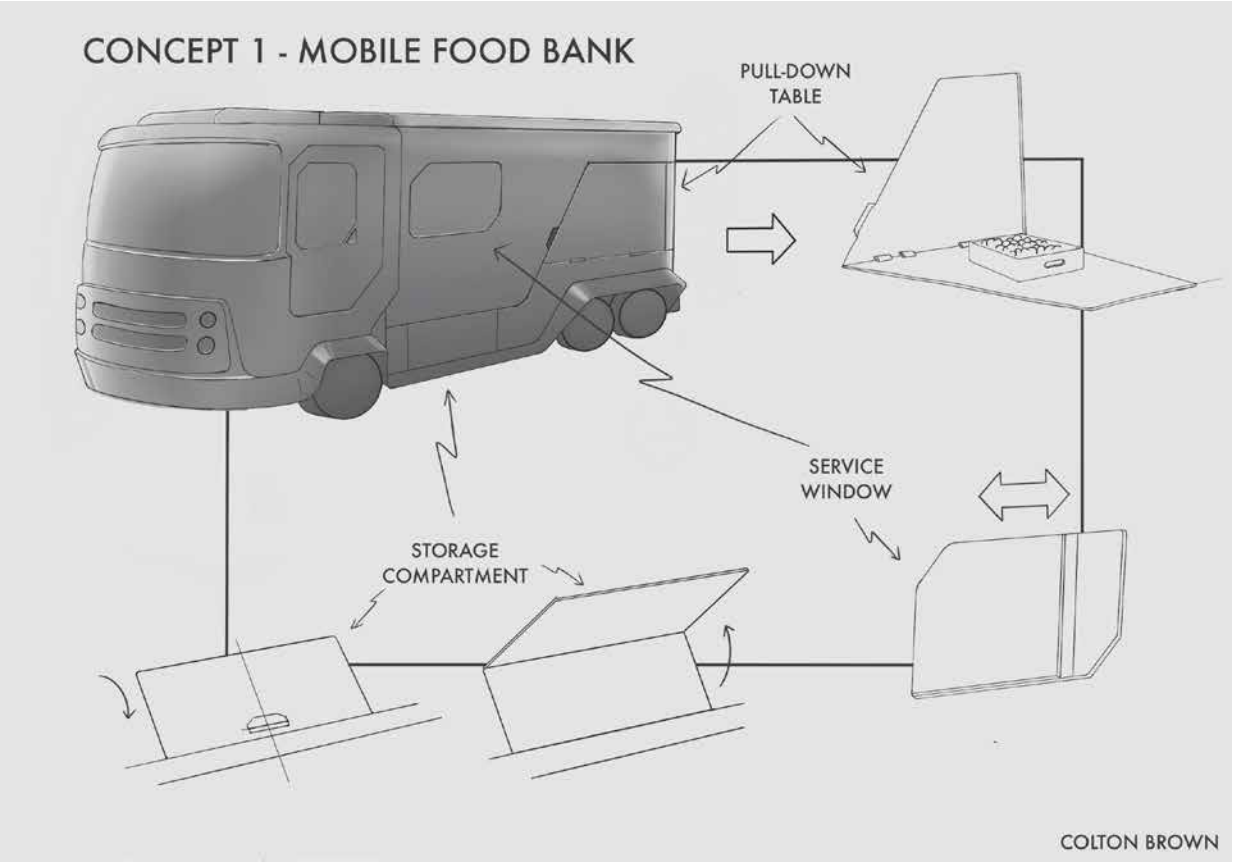
Another leading concept was automating the process of sorting and processing food. This would target food processing plants, making it easier for the plant employees to identify food that would later be rejected early. Rejected food could then be donated to food banks around the area with a much longer lifespan than what would be received from even grocery stores.



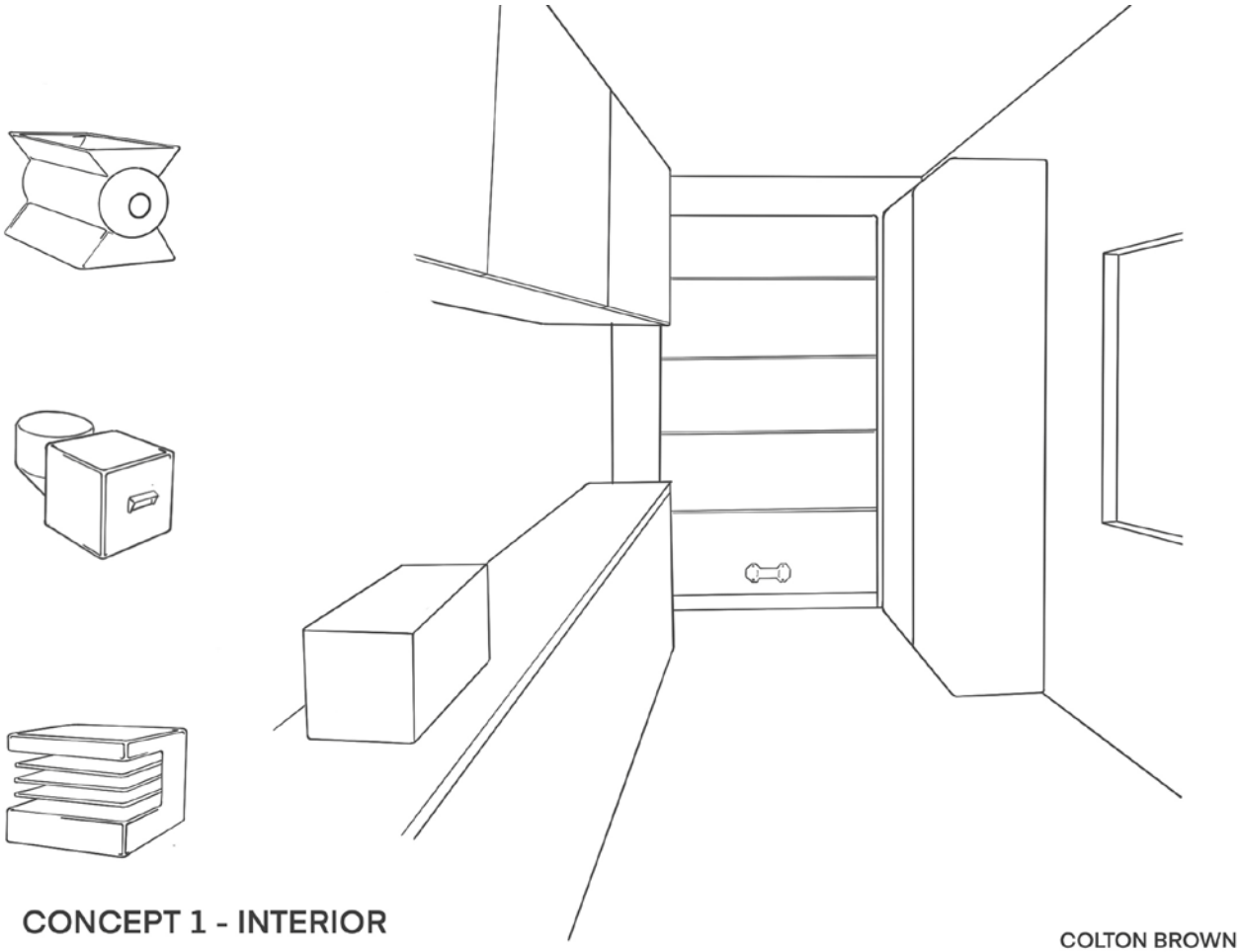
Upon further exploration of this concept, it was discovered this concept would quickly turn into an engineering problem. While it might be impressive to successfully prove this concept, it would not be a good reflection of the capabilities of a designer.

4.2.3 Concept 3 – Mobile Food Bank

The final concept that was selected was the Mobile Food Bank concept. At this stage of the design, the vehicle would act similarly to a food truck, however, using an application available to all clients, we would be able to inform clients in advance when a truck would be arriving in their area. This provides clients with a hotspot between many clients and their local food bank, making it easier for clients to get to.



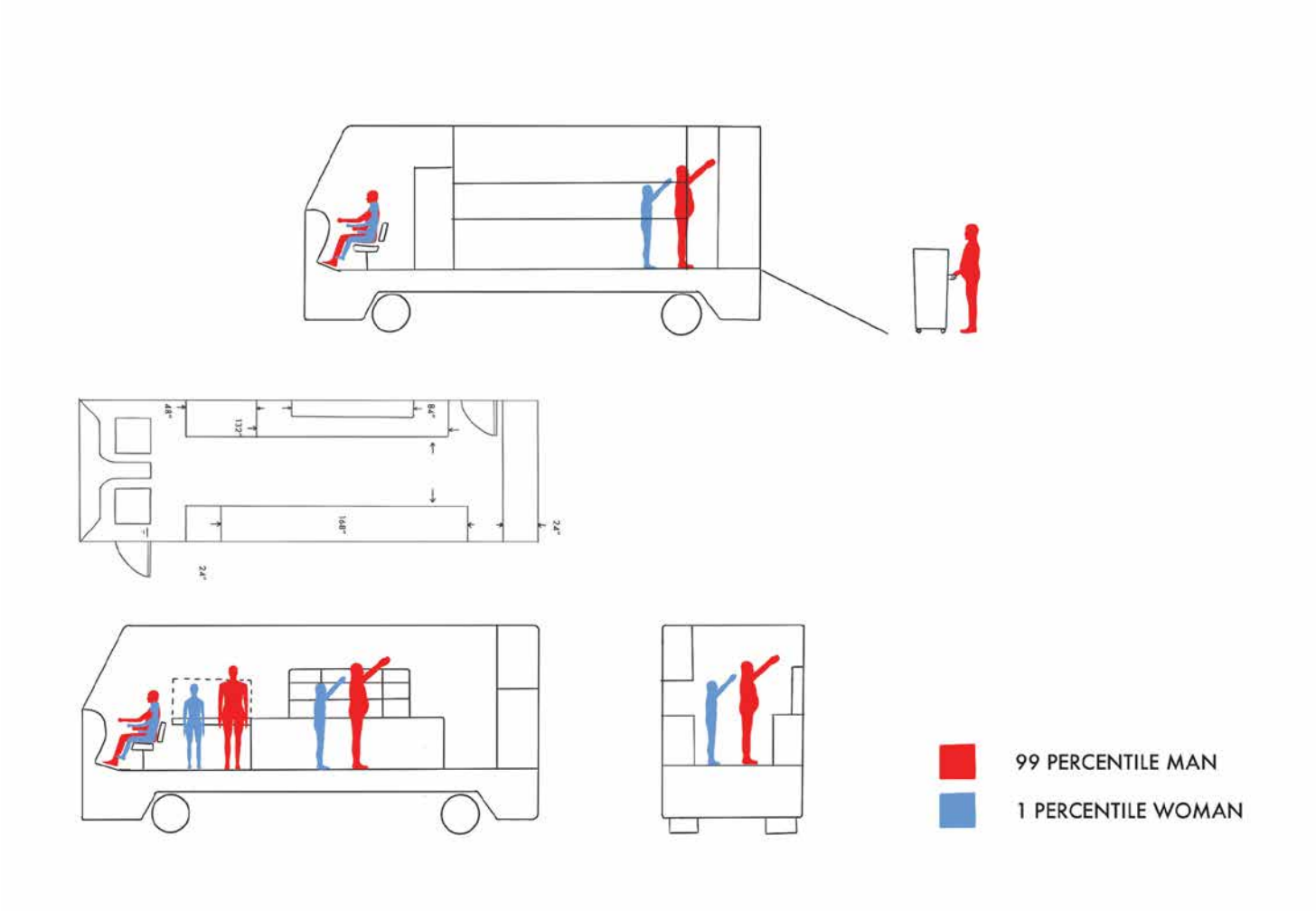
The interior would be used primarily as a storage unit containing food reserves from local food banks, as well as various pieces of processing equipment. The exterior provides a large working space for a volunteer to sort and put together food packages for clients coming by.



4.3 CONCEPT STRATEGY

4.3.1 Product Schematic 1

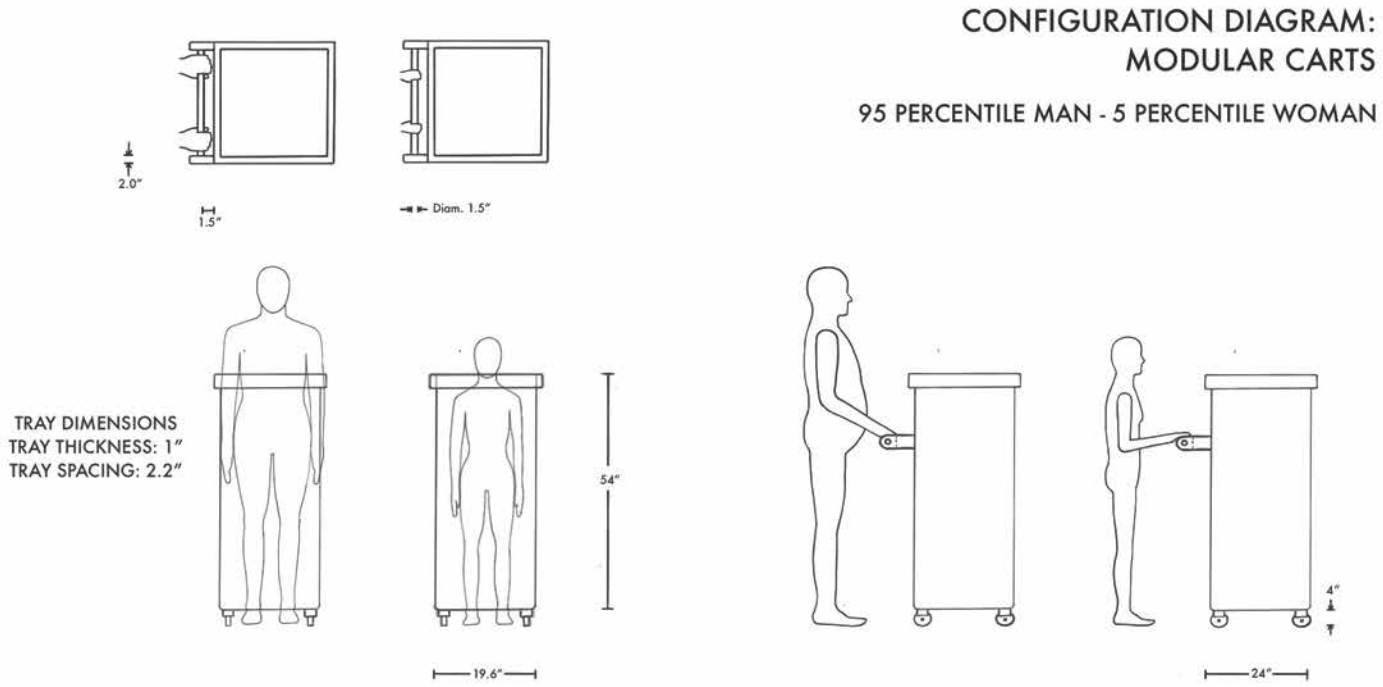
Carrying on with our leading concept, we began by attempting to fit everything into an Ice Cream Truck Sized vehicle. Several ergonomic considerations were made to better service the user on the interior of the vehicle.



At this stage of concept development, a shift in focus to food waste coming from local businesses was made. A set of carts were implemented to carry food waste on and off the vehicle for food processing purposes.

4.3.2 Product Schematic 2

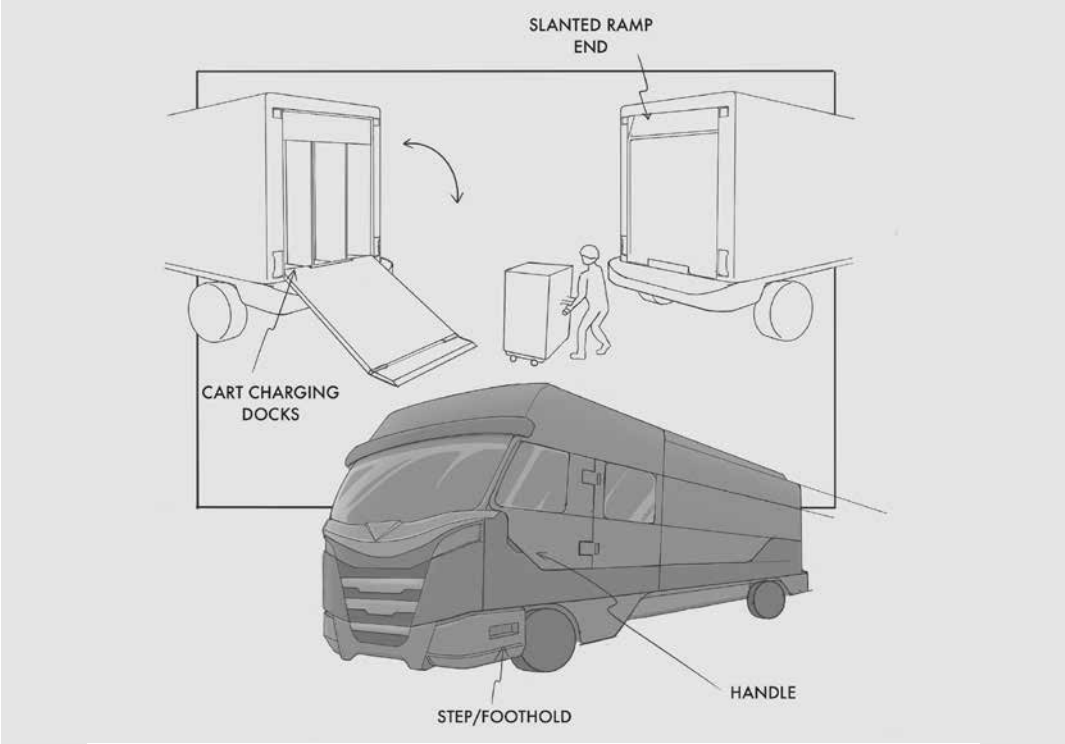
Further exploration into the modular carts was made and the ergonomic dimensions were worked out.

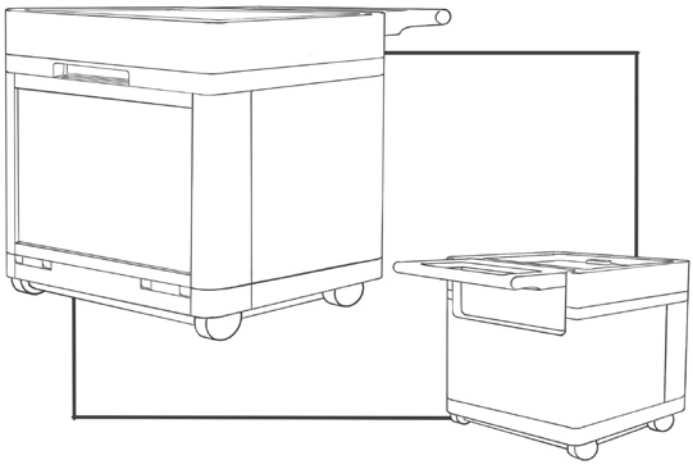


4.4 CONCEPT STRATEGY

4.4.1 Design Refinement

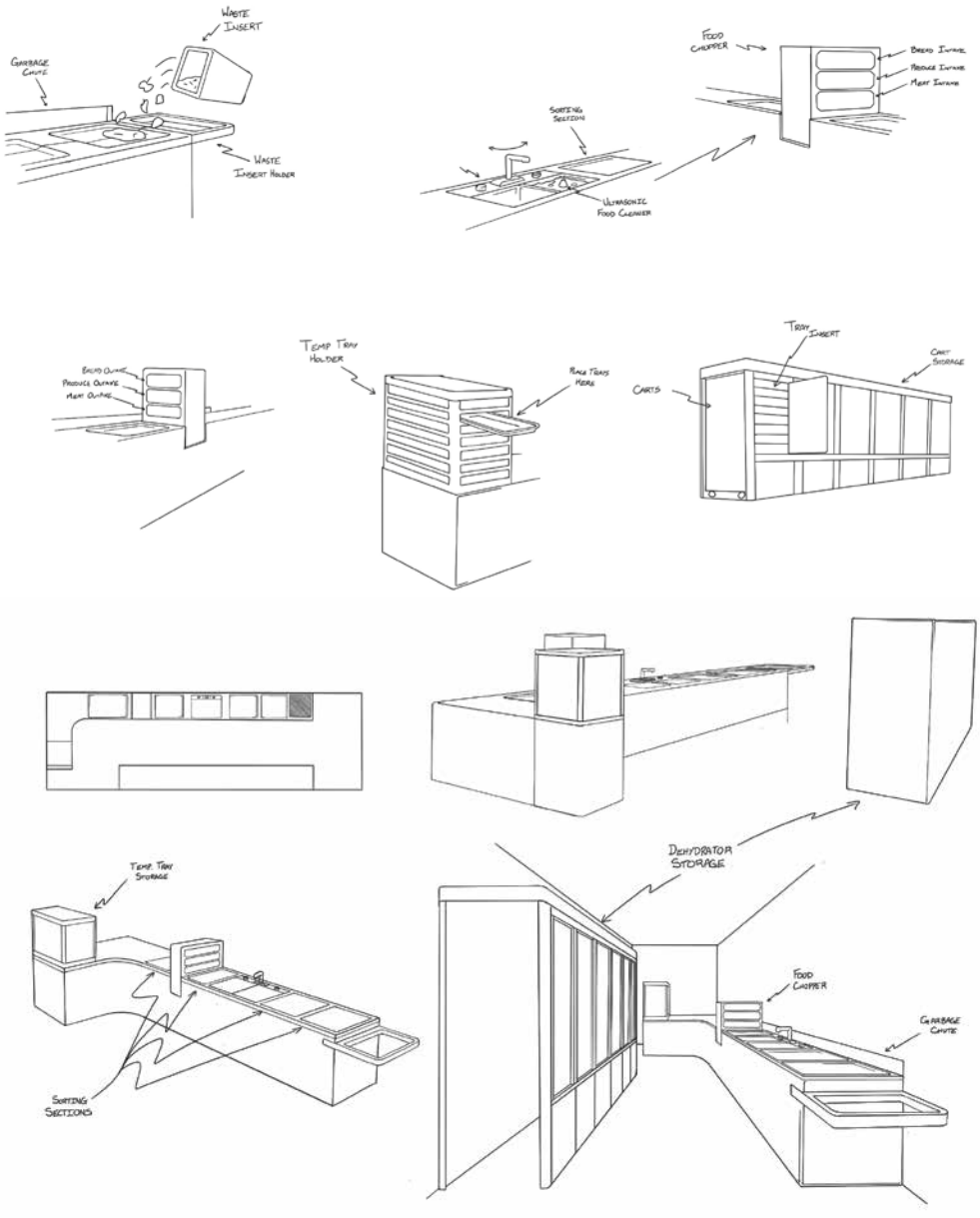
As the Concept continues to develop, many of the affordances offered by the design we recognized. Working out a system on the interior as well as exterior is incredibly important. The modular carts had food dehydrators implemented into them, the loading process was better recognized and thought out.



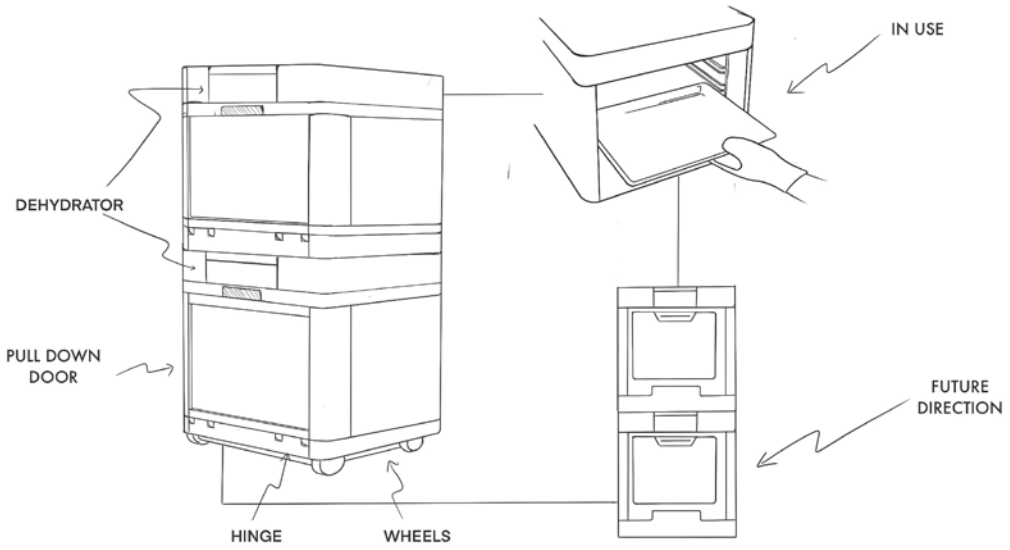


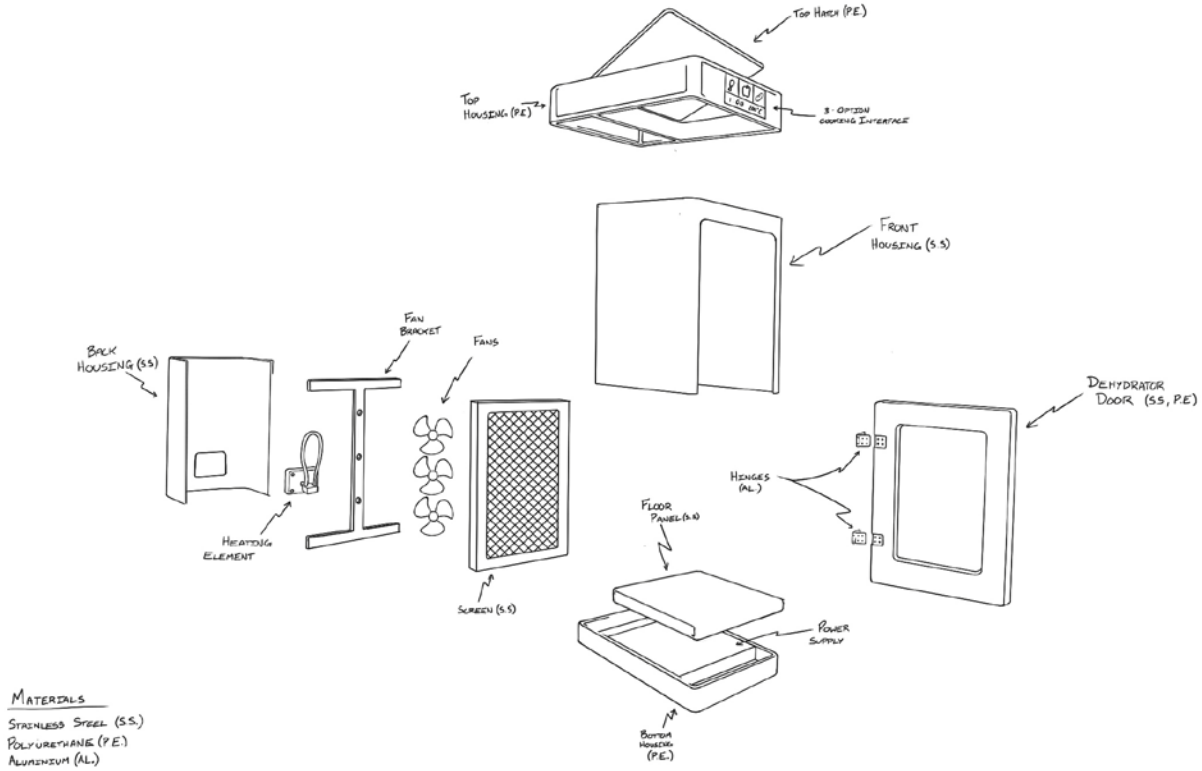
4.4.2 Detail Development

At this stage the interior interaction process of the vehicle needed to be realized. A mapping of this process from start to finish was put together and tested for efficiency. From here we identified the shortcomings of a standard countertop kitchen system and added several unique features to assist the user in their routines.



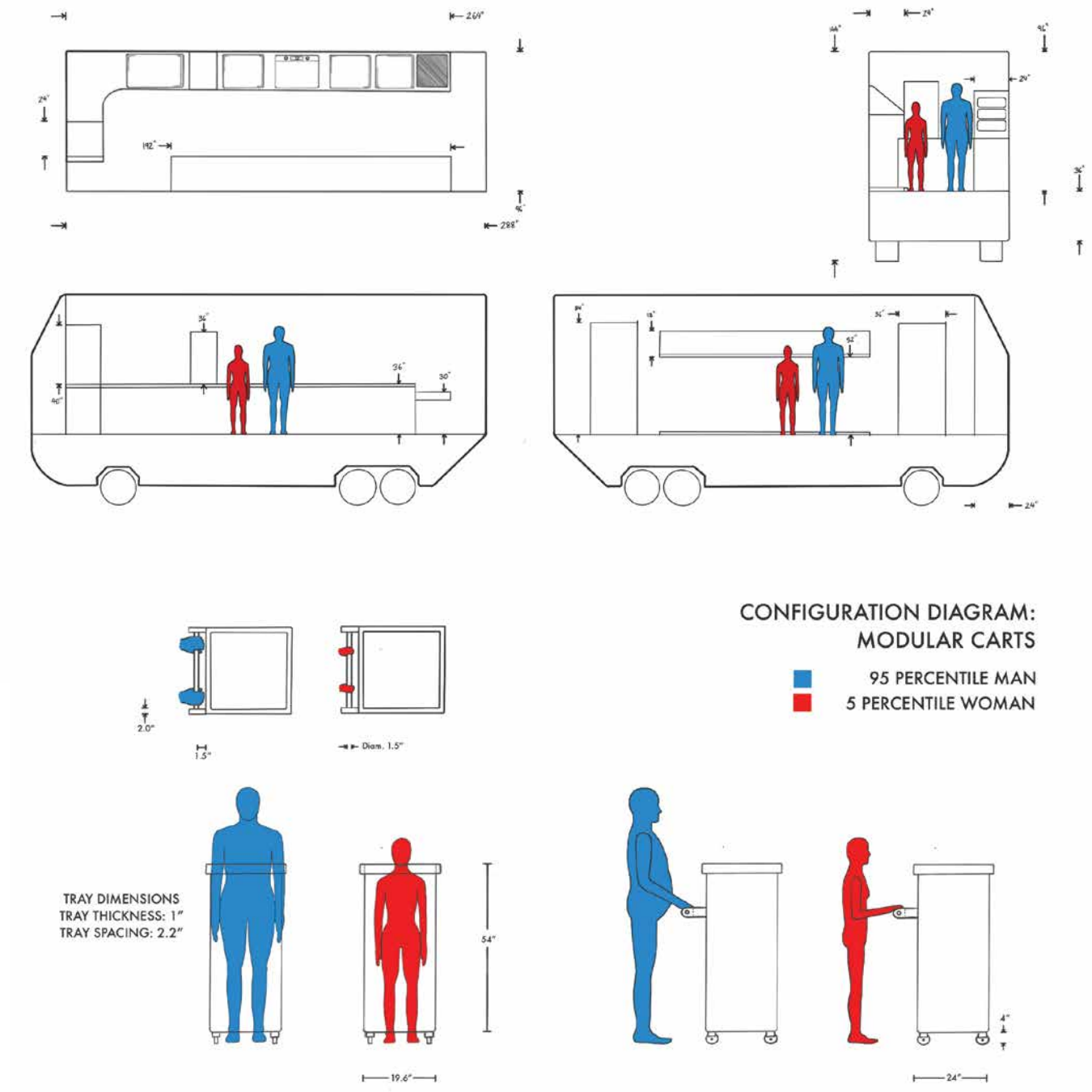
It was also important to work out how we would incorporate dehydration into our modular carts effectively. We broke down the components, how much internal space would be required and attempted to follow our preconceived design style.





4.4.3 Refined Product Schematic & Key Ergonomics

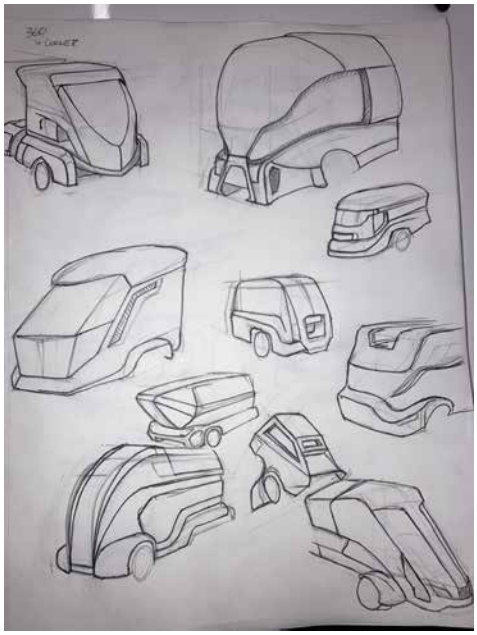
After the design has been developed, ergonomic configuration diagrams were updated with more detailed dimensions and considerations.

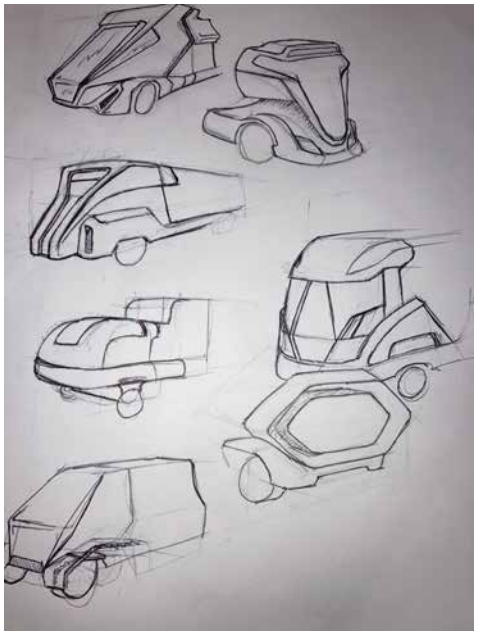


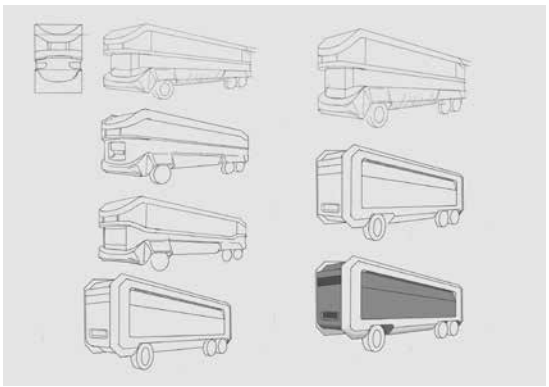
4.5 CONCEPT STRATEGY

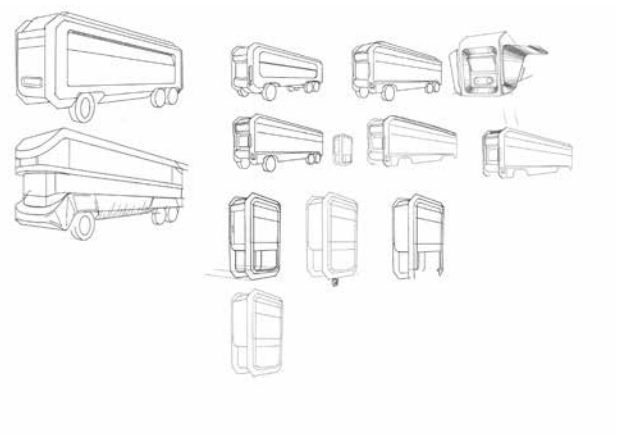
4.5.1 Design Finalization

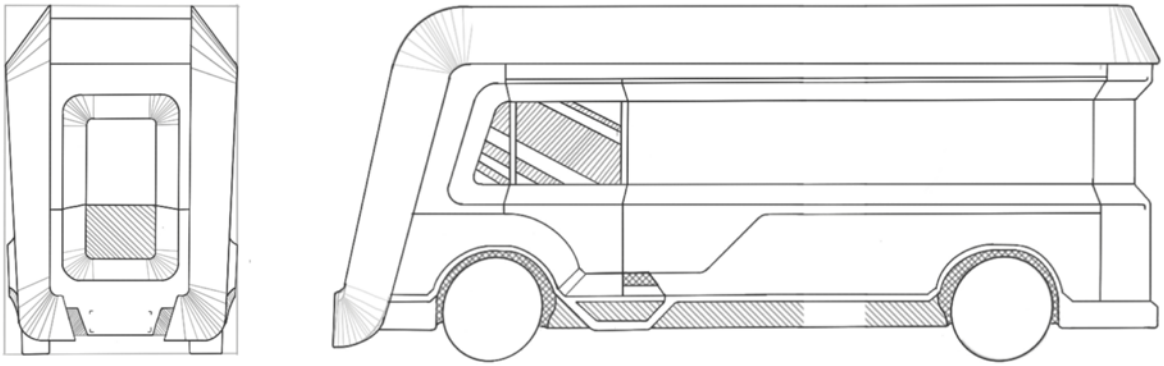
While consistent, the design language no longer felt as though it reflected the values of the Mobility Bank, so a large rework was put into action. After deciding that this vehicle would be automated, we knew we no longer needed a windshield or front window, providing several new opportunities for design development.











All the technical aspects worked out previously were still applied despite a large change to the vehicle's design language. The new design language does afford new design opportunities to improve on the functionality of the previous iteration. Smaller details like a bumper along the side of the vehicle dips down to provide a step up into the side door. Several changes were considered and implemented, vehicle height was raised to afford docking at grocery store docking bays, along with several interior sizing and layout changes.

4.5.2 Physical Study Models

Every measurement was put into 20:1 scale. Simply using illustration board, and pencil for detailing, it was very easy to work out how everything on the interior would be laid out.

4.6 DESIGN RESOLUTION

4.6 Design Resolution

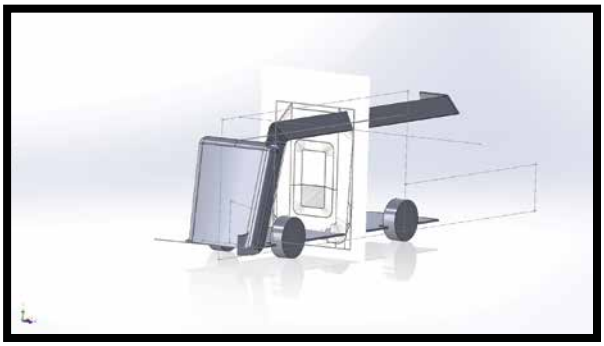
The design of Mobility Bank's line of products went through several changes throughout the entire process. The vehicle design started off looking like a standard large-scale vehicle and slowly after incorporating features and details, it became clear that the design had become too aggressive for what Mobility Bank stands for. A functionality development was made towards the end of the development cycle when vehicle automation was incorporated. As a result, many features and details used as focal points in the previous design were no longer needed.

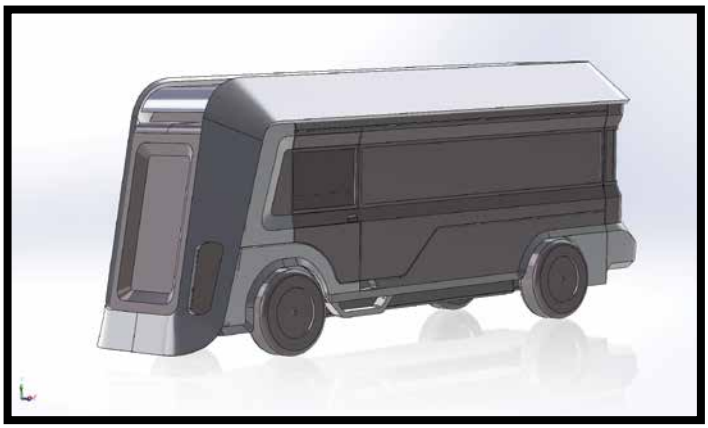
With the addition of new recent technologies, a shift in the design style made sense. A sleek futuristic design style slowly emerged from the previous iterations while still maintaining a functional look.

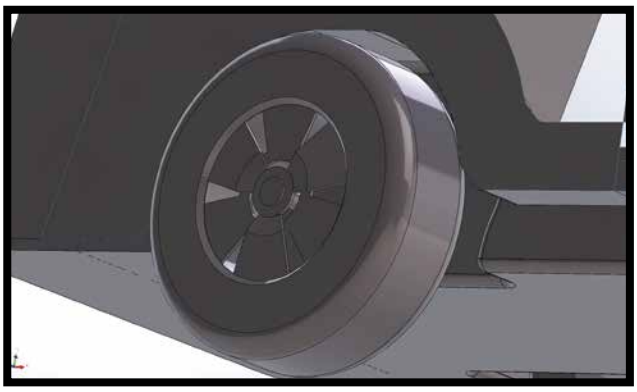
4.7 CAD DEVELOPMENT

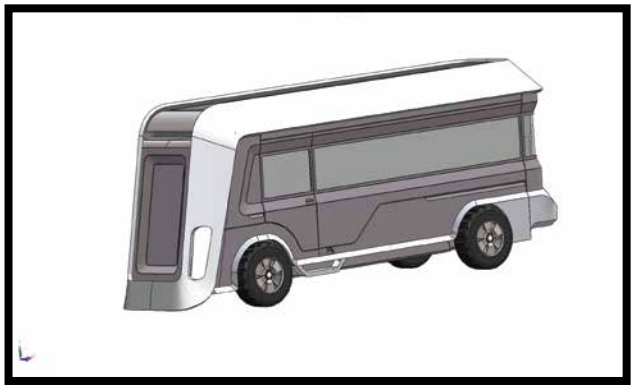
4.7 CAD Development

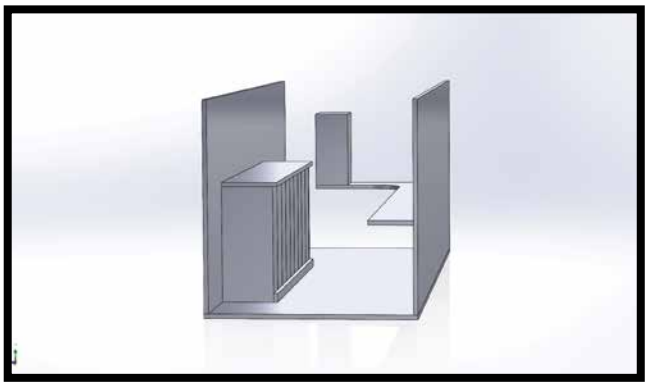
Due The first stages of CAD development were spent blocking in the shapes of the chassis to begin building upwards form there. Using a simple sweep command the front face is also modeled on top of the previously built chassis.

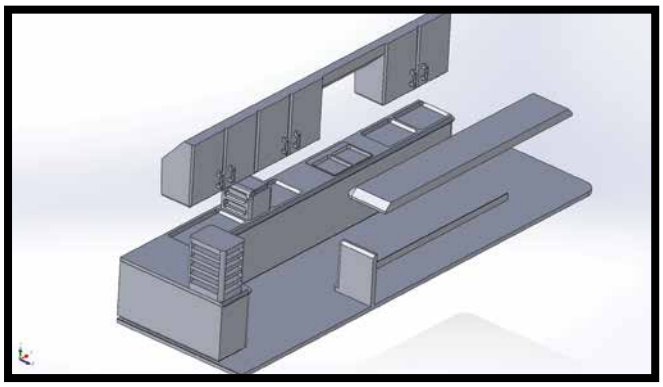


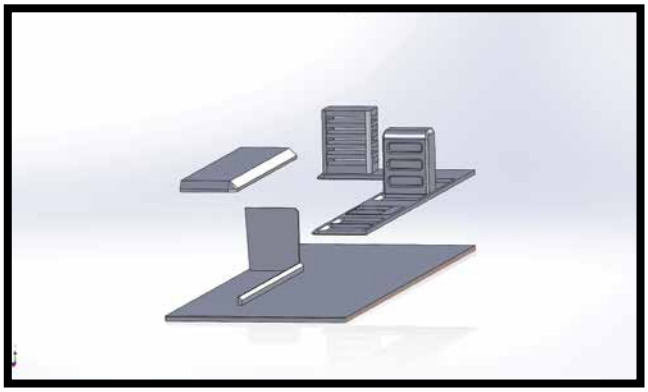


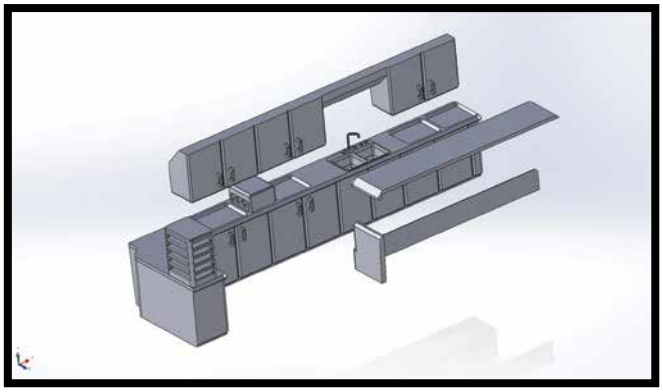


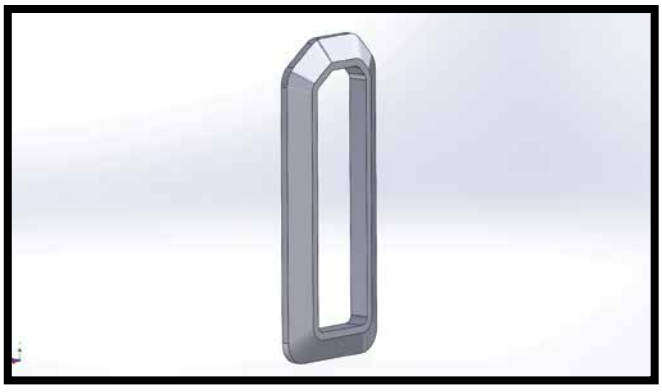


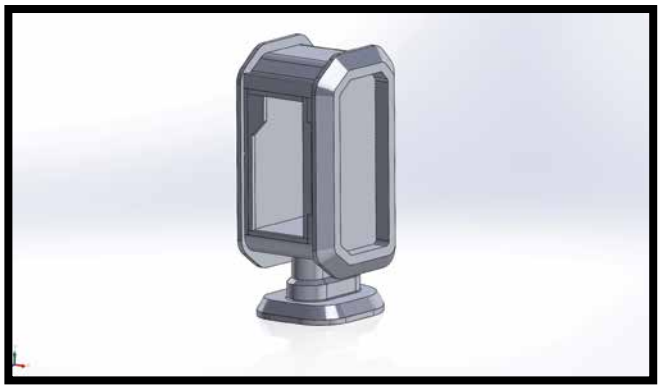


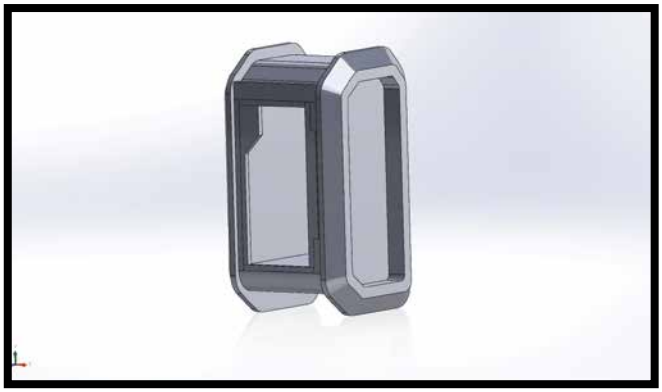


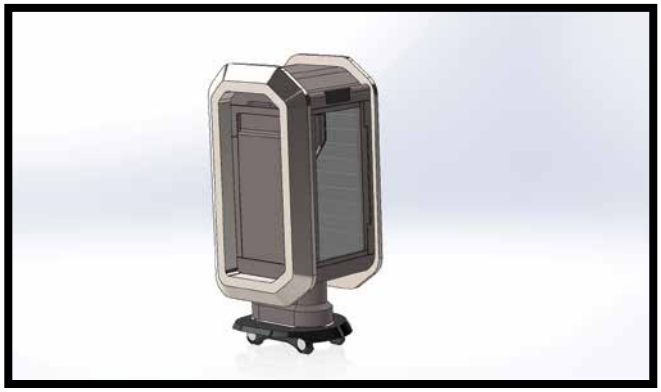








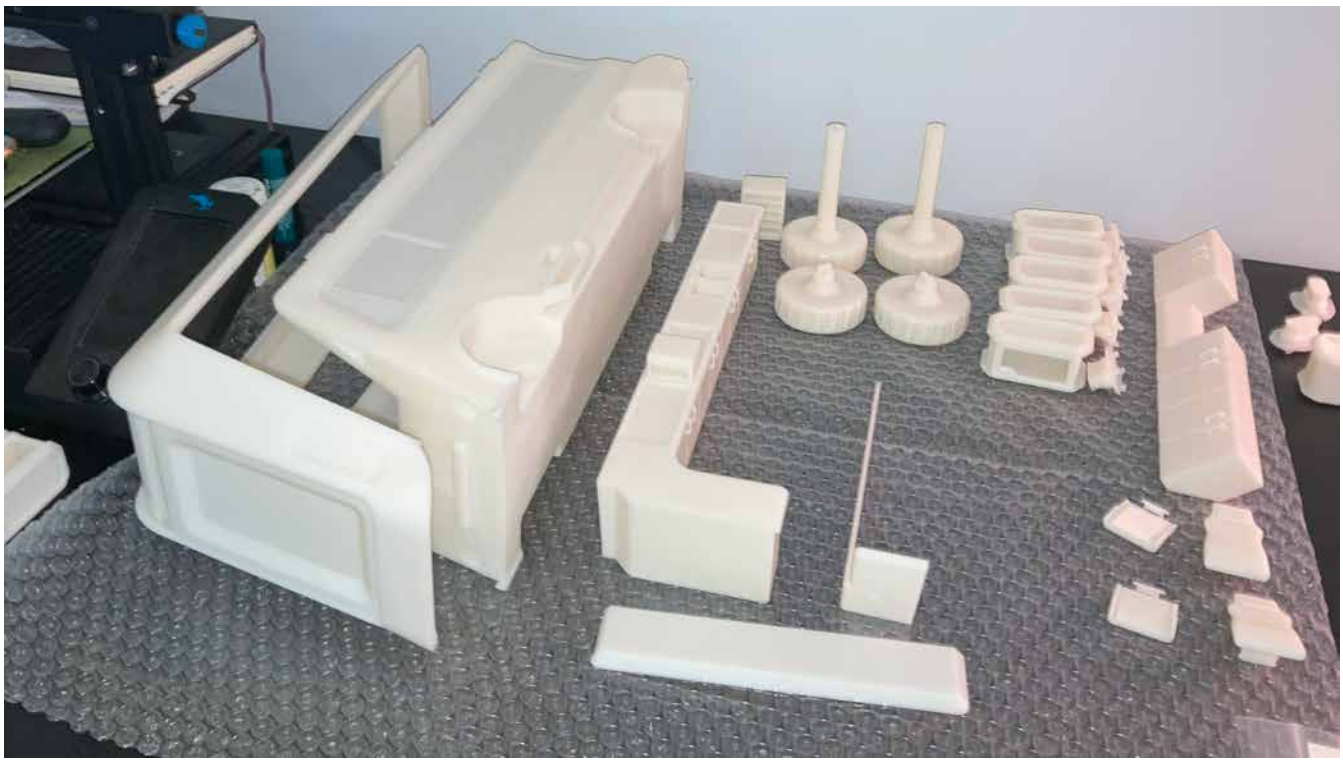




4.8 MODEL FABRICATION

4.8 Model Fabrication

Model is in painting process, to better present our final model for this thesis show, we have sacrificed the progress images for this stage of the process.



CHAPTER # 5 – Final Design

5.1 DESIGN SUMMARY

5.1 Design Summary

Mobility Bank begins their route at the beginning of the day from a fleet yard where they charge overnight. The vehicle will set up an automated route for the day, that can be changed by the user at any time, starting at a grocery store. Here Mobility Bank Volunteers will collect food waste collected throughout the grocery store. After bringing this waste onto the vehicle, sorting can begin. Food is sorted based on its type (i.e. bread/grain, fruit/vegetable, meat) and inspected at the same time, a small inlet at the back of the counter offers a simple way to discard unusable food.

Our volunteer will then transfer this food to the sink. The sink will be filled with ¾ water and sanitizing solution. It then utilizes an ultrasonic cleaner that is built into the perimeter of the sink. The food will sit in the sink and clean over a short period (5-10 minutes). During this time, more food can be sorted from our initial food receptacle. After cleaning, food is removed from the sink and our user begins to use our processing equipment. The food processing unit provides 3 inlets, each of which is labelled as a particular food group. The corresponding food is processed in the labelled inlet and comes out the other side sliced or diced depending on the food category. From here ample space is allotted for the user to begin sorting the processed food onto metal trays.

After filling up one tray, the user can place it into a nearby tray rack as to avoid interrupting workflow. The tray rack will only hold enough trays to fill up one modular dehydration cart. After filling the rack, the user knows to transfer individual trays to an empty dehydration cart. After filling the cart, the door is closed, providing a tight fit to each of the trays, this helps deter jostling during cart transport. The door can then be locked, and the user will begin this process again until any remaining food waste has been processed and stored by the user.

After recovering the previous grocery store’s food waste, the user sits their pull-down seat buckling their belt. A small screen slide-open touch screen can be activated to adjust the route and

start the travel process. Upon arrival at a nearby food bank, each dehydration cart is unloaded. A charging station will be located at each food bank, and the previous days dehydration carts will remain from our previous delivery. These empty carts are removed and brought back onto the Mobility Bank vehicle while the carts filled in our previous trip are plugged in. The user can then use a touch interface to lock the dehydration carts in the charging station and will begin the dehydration process. These carts will be left for an extended period of time, as the user will continue on their route with new carts on board the vehicle.

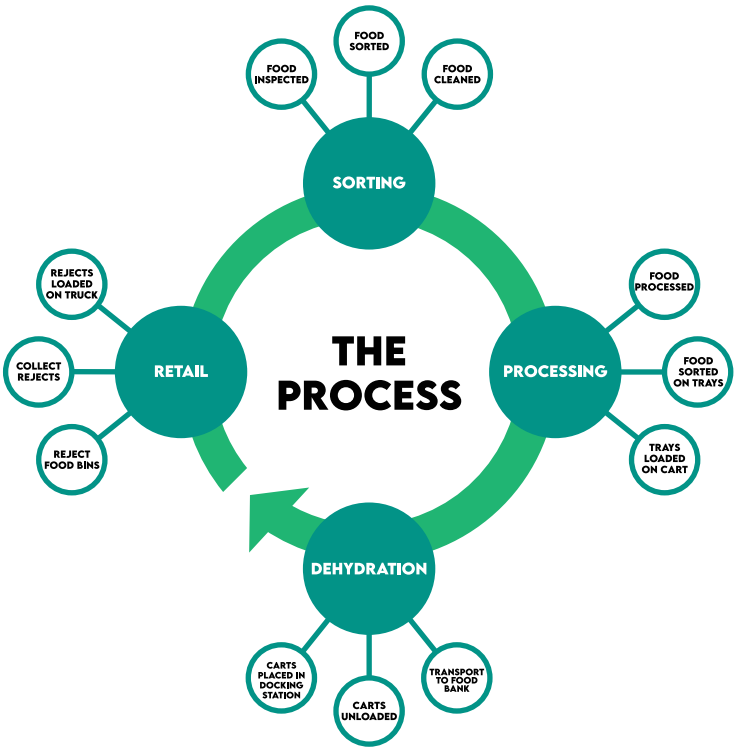
5.2 DESIGN CRITERIA MET

5.2.1 Full Bodied Interaction Design

Mobility Bank prioritized several elements of human interaction & user centric design in order to create a flowing and cyclical interaction system. Mobility Bank has several automated systems in place to ensure certain areas of concern are as simple and easy-to-use as possible. The transport, dehydration, and even cleaning processes are all entirely automated systems. This ensures the user does not need to split their attention on multiple tasks at a time as most steps in the process have been designed to be performed in stages. We have done this to avoid confusion, and unneeded stress that a user might go through.

Mobility Banks ergonomic and human factor considerations were a priority throughout the design process. It was incredibly important to us to ensure any stature from 5 percentile female to 99 percentile man were accommodated. Every aspect of the design process has considered these areas of ergonomic concern. Everything from the walkways on the vehicle interior to the dehydrator carts handle have been carefully planned out for efficiency with all users. Mobility Bank aims to support anyone with the desire to help those in need.

Several smaller human-centered design decisions are what make the Mobility Bank successful. These decisions are vital to the success of the overall design and were prioritized throughout the interior design of the vehicle. Features like inset countertops help to stop food from getting knocked or falling off the side. Mobility Bank's sink basin has an ultrasonic cleaner built into the perimeter of the basin. After filling with sodium metabisulfite solution, the user must only press a button to start the cleaning process.



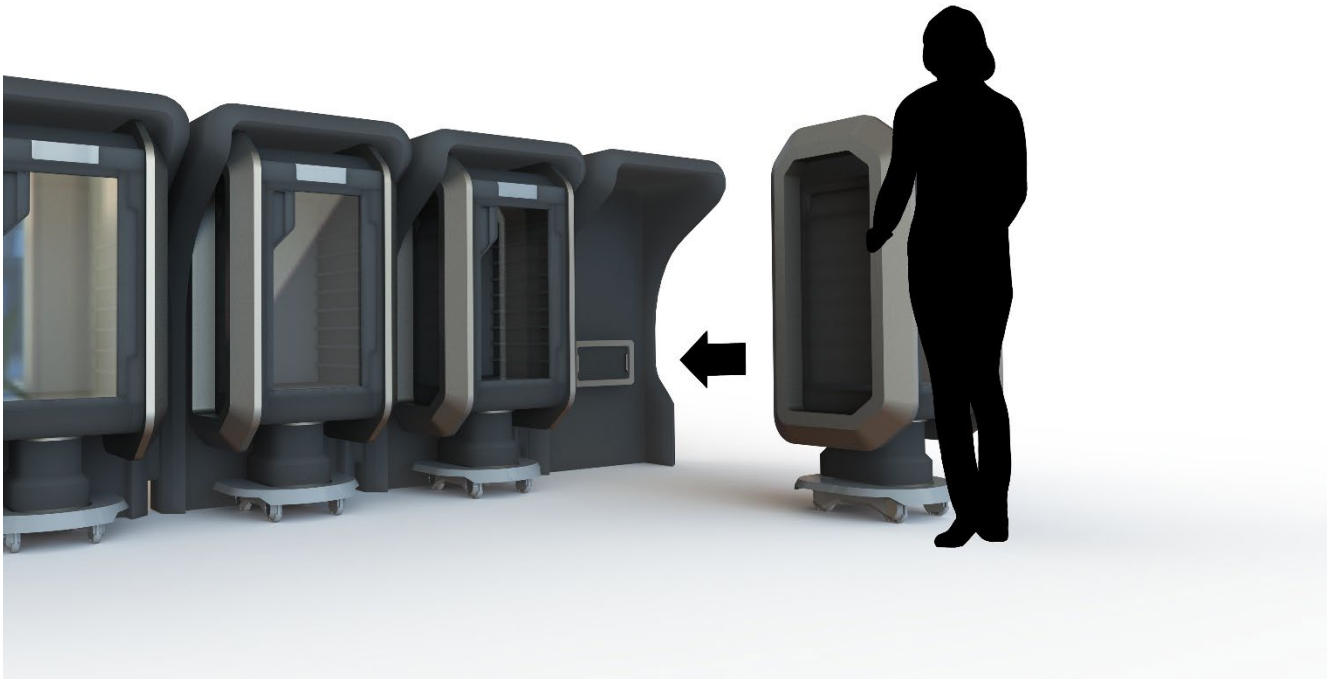
The food processing unit used is designed with 3 labelled inlets corresponding to the supported food recovery groups. This provides a fool-proof system that deters contamination among products. A temporary tray storage unit was implemented to let a user store their sorted trays before loading them into a dehydration cart. This maximizes the users' workspace and keeps their workflow uninterrupted. Even small space saving strategies like our flip down seating were used to maximize the interior space and ensure the vehicle doesn't feel claustrophobic.

5.2.2 Materials, Processes & Technology

Mobility Bank exclusively uses electric engines to power their fleet of vehicles. Each vehicle is powered by a large bank of lithium-ion batteries stored in the base of the vehicle. Mobility Bank's fleet of vehicles are entirely automated through a series of machine vision cameras strategically laid out in various locations throughout the vehicle's body. Mobility Bank vehicles only use recycled aluminum in their exterior shell, and incorporate this recycled aluminum as often as possible in the interior of the vehicle (i.e. aluminum countertop, tray storage, fastening mechanisms in carts, etc.). This aluminum is anodized to prevent rust and affords the ability to recycle these parts at the end of their lifecycle. Finally, natural rubber is used to make up our tires providing a further eco-friendly alternative to synthetic rubber tires. Any paint used throughout the Mobility Bank product family is made from biomass. This biomass paint is made entirely from renewable raw materials, things like biowaste or waste from sewage treatment plants can be utilized as a starting material for these paints (BMW GROUP).

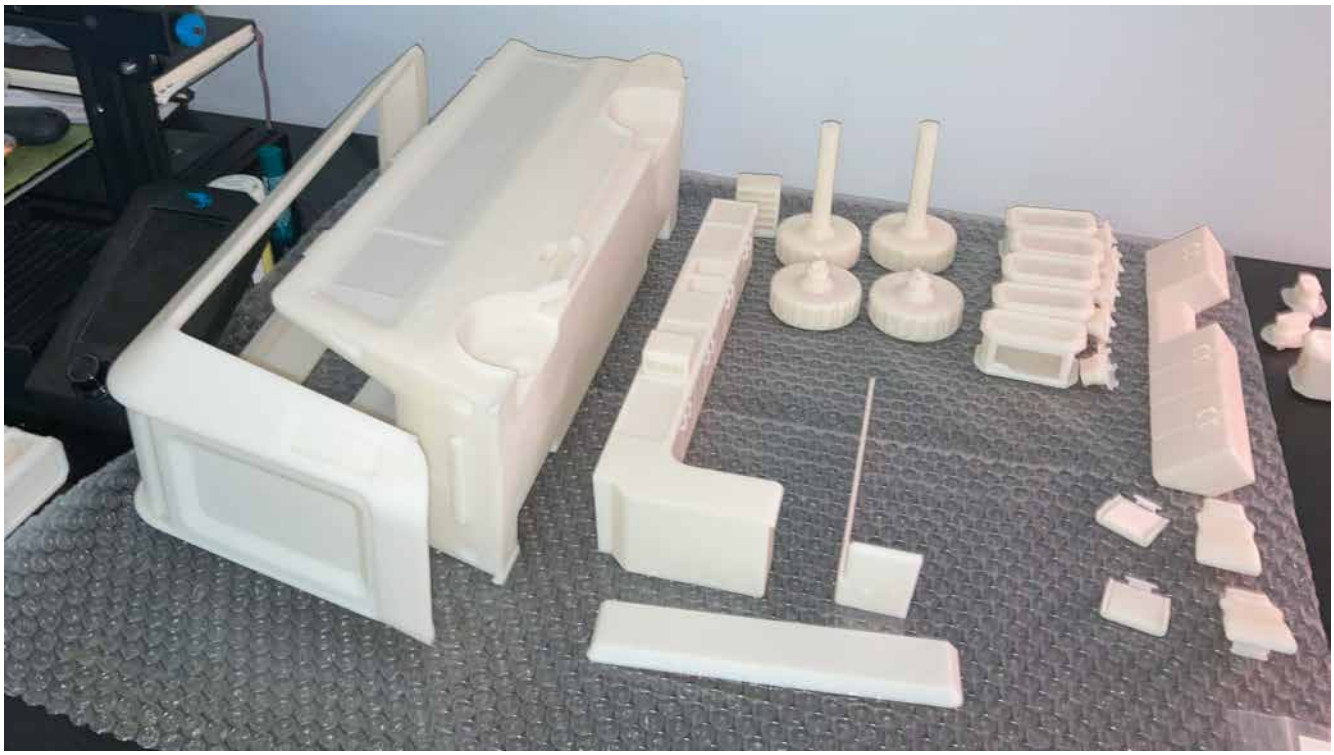
5.2.3 Design Implementation

5.3 Final CAD Rendering



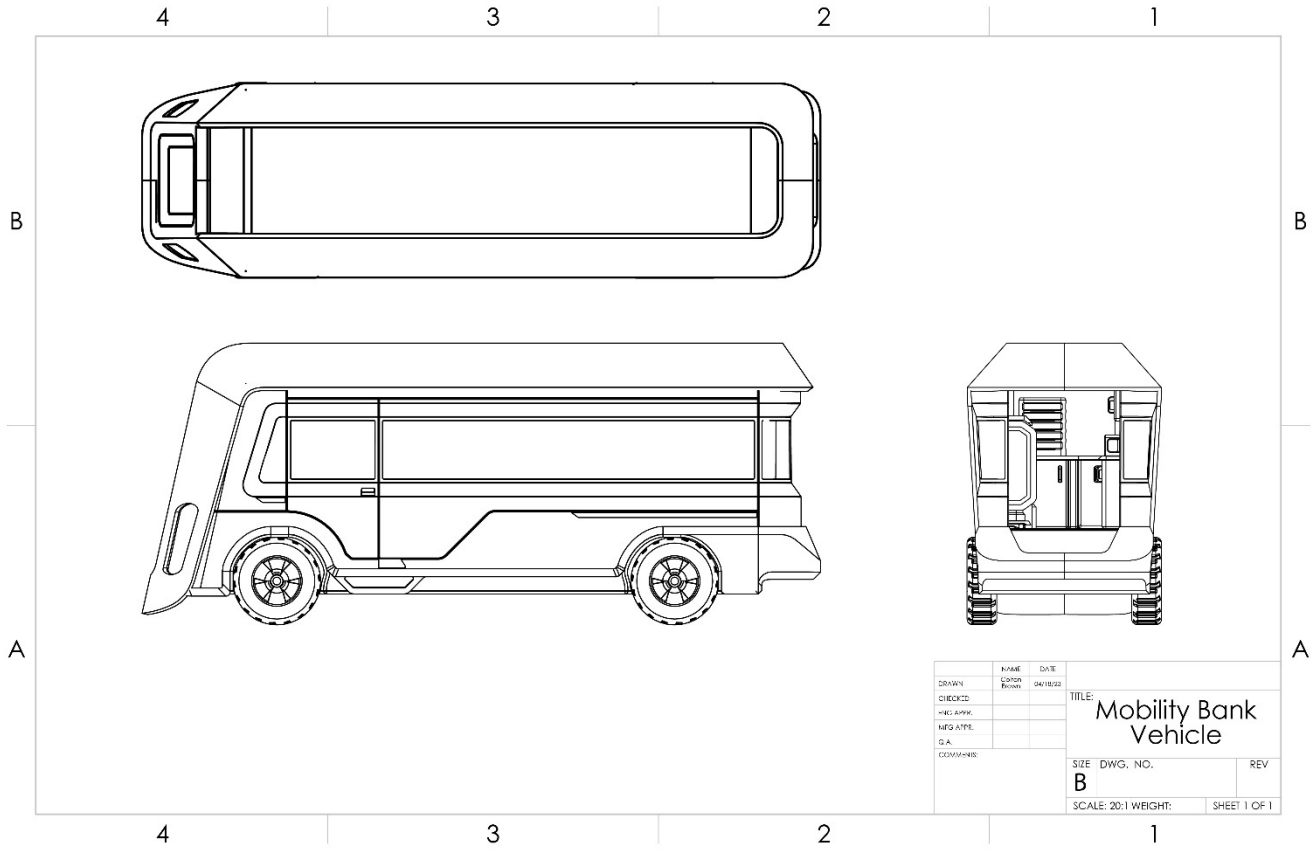
5.4 PHYSICAL MODEL

5.4 Physical Model

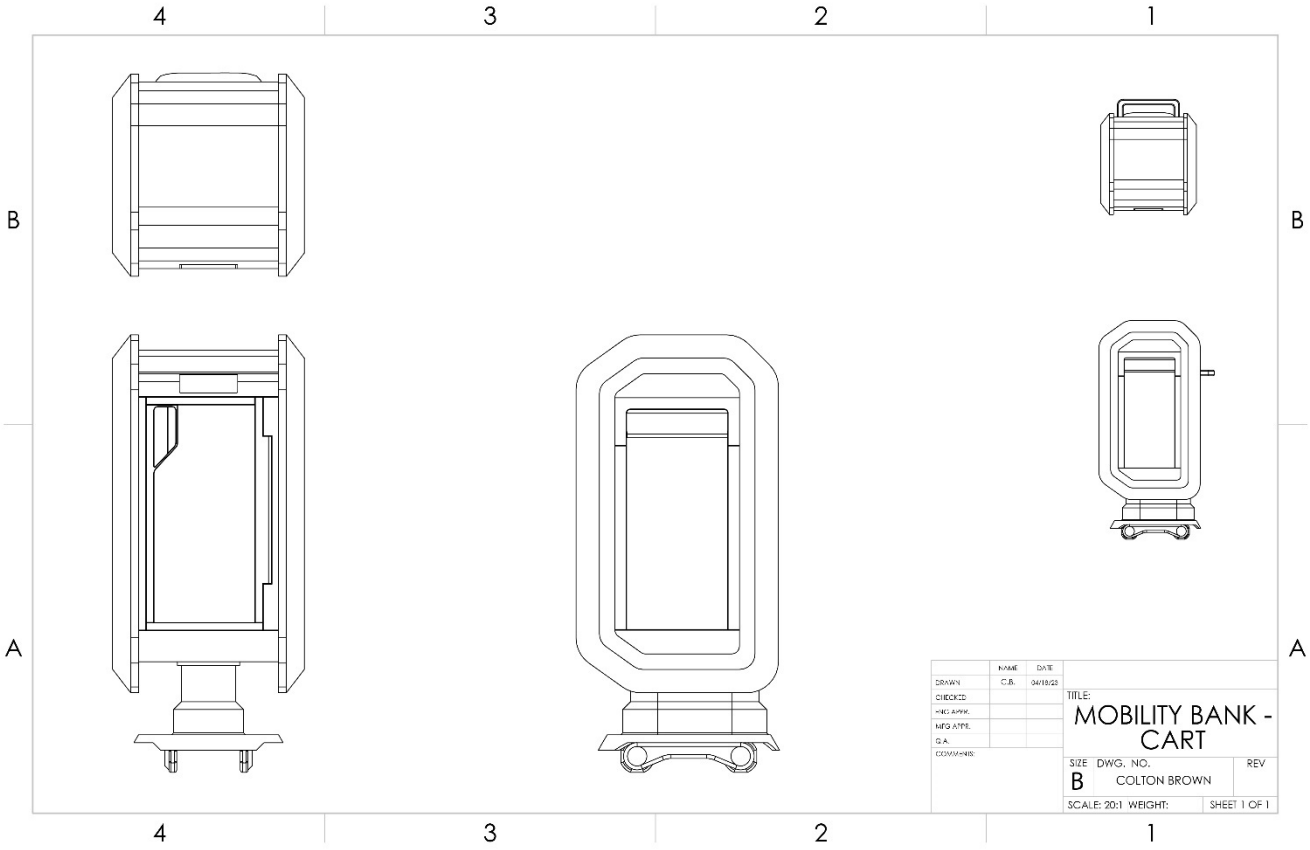


5.5 TECHNICAL DRAWINGS

5.5.1 Mobility Bank Vehicle – Technical Drawing



5.5.2 Mobility Bank Dehydration Cart – Technical Drawing



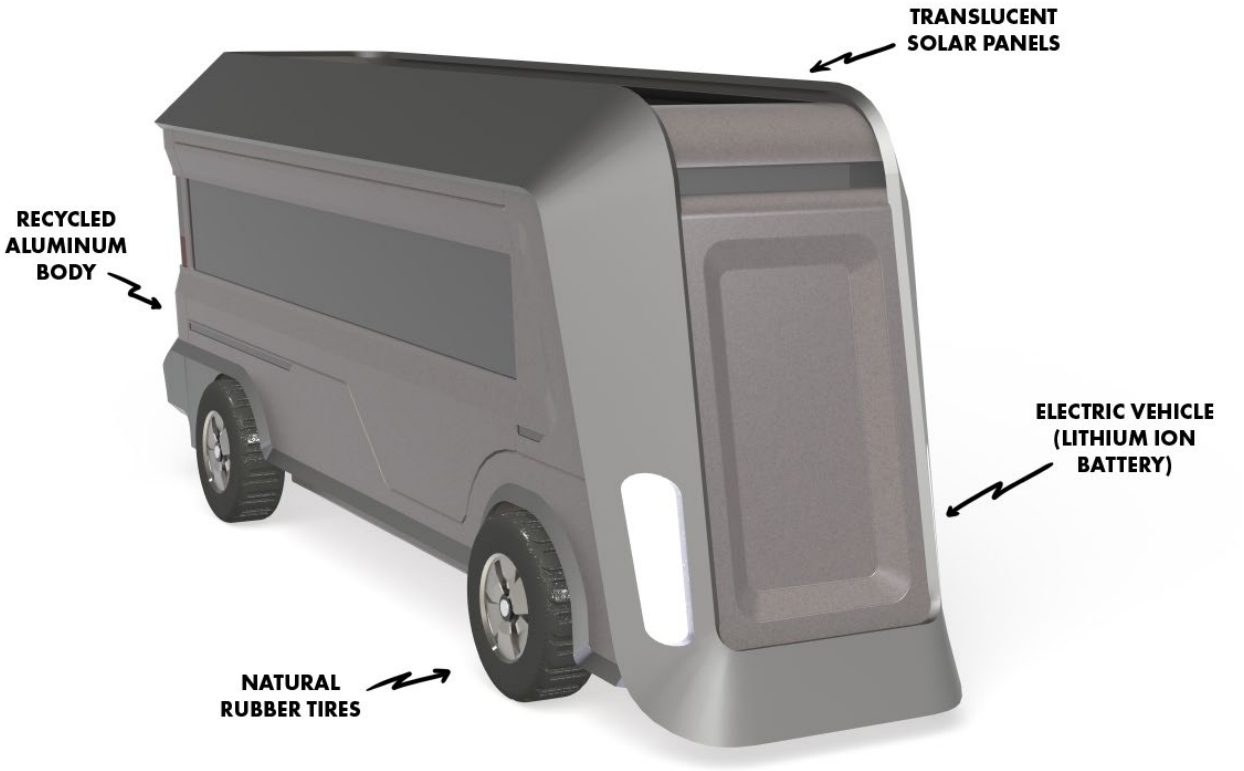
5.6 SUSTAINABILITY

5.6 Sustainability

There are several factors which must be considered to ensure our product is as sustainable as it can be. The Mobility Bank has been designed to collect, sort and reform food waste being disposed of by food retailers. A modular system has been developed that affords a simple transfer of food waste from organizations like grocers to the Mobility Bank vehicle, where it can be sorted, processed, and arranged into several dehydration units. The Mobility Bank vehicle will transport these dehydration units to local food banks in the area before reloading dehydration units, repeating the process. The largest goal of Mobility Bank is to enhance human lifestyle and take on further social responsibility. To do this we must avoid looking exclusively at the function of the vehicle. Instead, it is important to investigate sustainable materials, sustainable manufacturing methods, all while ensuring the safety and health of the user.

The Mobility Bank's manufacture will ideally be performed in a dedicated plant. This allows for several manufacturing operations to be performed in the same building, reducing a large percentage of emissions created by transporting parts and materials short distances (Tesla, 2021). Manufacturing facilities are never to use freshwater to perform operations. Investigating how much water is needed to preform necessary manufacturing operations is incredibly important (Wellbrock et al., 2020). While many companies are concerned by vehicles footprints, many of these issues are alleviated by the inclusion of an electric engine. This generally eliminates emissions throughout the use of the vehicle. While emissions are still made during charging of the vehicle, battery capacity and efficiency rise every year. The emissions created from charging a vehicle of this size should be reduced greatly over the next decade (Wellbrock et al., 2020). Remanufacture is of massive importance to the automotive industry, reusing complex, durable high value parts for later manufacture. This will not only help reduce waste left in landfills but can even save money for the company involved (TWI, 2021). Finally, a general reduction in waste is necessary to achieve sustainability in material and manufacturing

production. It is necessary that plants, factories, and manufacturers only use material necessary to get the job done instead of sending extra material off to landfills.



CHAPTER # 6 – Conclusion

6. Conclusion

At the Mobility Bank is a unique, highly integrated system prioritizing human-centered design. Arbitrary food waste can simply be collected from large food retailers, repurposed and redistributed to those in need. Mobility Bank strives to mitigate the effects of both food insecurity and food waste by taking advantage of problem areas identified in each.

Despite the depth of this report, Mobility Bank is far from a finished product. There are still many questions that must be answered and areas of design that must be resolved. Many of these unanswered questions can simply be attributed to the dependency of Mobility Bank's business model on funding from outside sources.

The problems Mobility Bank is trying to solve remain prevalent, as food insecurity continues to run rampant throughout the world. A complex systematic solution, while efficient in nature would still only provide a bandage to the food waste problem we are attempting to solve. The goal of Mobility Bank as a concept is to bring attention to the ever-increasing rate of food waste and food insecurity throughout the world. Only by pushing the boundaries of what we believe is possible will we find a solution that can truly stop this worldwide phenomenon.


MOBILITY BANK

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Yasin, N. H., Mumtaz, T., Hassan, M. A., & Abd Rahman, N. A. (2013). Food waste and food processing waste for Biohydrogen Production: A Review. Journal of Environmental Management, 130, 375–385. https://doi.org/10.1016/j.jenvman.2013.09.009

Appendix A – Discovery

Food waste and food processing waste for biohydrogen production: A review

Yasin, N. H., Mumtaz, T., Hassan, M. A., & Abd Rahman, N. A. (2013). Food waste and food processing waste for Biohydrogen Production: A Review. Journal of Environmental Management, 130, 375–385. https://doi.org/10.1016/j.jenvman.2013.09.009

Highlights:

- We represent food waste as potential feedstock for biohydrogen production.
- We explain the influence of physicochemical factors on biohydrogen yield.
- Effect of food type and composition on biohydrogen production is elaborated.
- Prospects and challenges of biohydrogen production from food waste are discussed.

Background

- Food waste and food processing wastes are abundant and rich in carbon content. The waste can be utilized as renewable substrates for sustainable biohydrogen production.
- Many studies of food processing waste and food retail waste has shown good percentages of hydrogen in gas composition, production yield and rate.
- Physiochemical factors like pre-treatment to seed culture, pH, temperature, etc. are also important to ensure dominance of hydrogen-producing bacteria in dark fermentation.

Objective:

The purpose of this systematic review is to evaluate the potential for food waste and food processing waste for biohydrogen production and provides a brief overview of several physiochemical factors that affect biohydrogen production in dark fermentation.

Methods:

The author reviewed 167 articles on the topic of biohydrogen production primarily through the means of dark fermentation.

Results:

The review of dark fermentation as a means to create biohydrogen-based fuel appears to be the most economical process for renewable energy production. With that being said, additional research is still required to improve the efficiency of biohydrogen production from food waste through anaerobic fermentation processes to be competitive with fossil fuel technologies. Utilizing biohydrogen fuel in tandem with a range of renewable primary energy sources (i.e. wind, solar, etc) is ideal for gradually replacing fossil fuels.

Conclusions:

The review revealed that biohydrogen could be efficiently produced from renewable waste feedstocks like food waste or food processing waste.

Summary Statements:

1. Physiochemical factors are incredibly important to ensure dominance of hydrogen-producing bacteria during the dark fermentation process.
2. Using dark fermentation as a strategy to create biohydrogen-based fuel appears to be the most economical process to create renewable energy.
3. Using biohydrogen fuel in tandem with other renewable energy sources can be effective in gradually replacing fossil fuels in the future.
4. Biohydrogen could be efficiently produced from renewable waste feedstocks like food waste or food processing waste.

5. Compared to the lipid, protein and cellulose components, the carbohydrate fraction in food waste plays an important role in the hydrolysis step during anaerobic degradation.

The value of food waste: An exploratory study on retailing

Cicatiello, C., Franco, S., Pancino, B., & Blasi, E. (2016). The value of food waste: An exploratory study on retailing. Journal of Retailing and Consumer Services, 30, 96–104. https://doi.org/10.1016/j.jretconser.2016.01.004

Highlights:

- Increasing concern over food waste but few research on retail food waste.
- Attempt to estimate the environmental, social and economic value of retail food waste.
- The environmental value of the food recovered is assessed basing on the consumption of natural resources.
- The social value is estimated as the number of meals which can be prepared with the food recovered.
- The economic value is based on the analysis of the revenues and costs of the project.

Background

- Food waste is a massive sustainability issue, with 90 million tons of food wasted in the EU every year. The production of much of this waste is directly linked to the food chain operations, including the retail stage.
- The role retail takes in food waste has been neglected in many studies. This paper attempts to determine the extent of food waste in retailing as well as it’s environmental, social and economic values.

- The extent of food waste in retailing is considerable, both in quantity and economic value. We found evidence that the waste can be greatly reduced with significant limitation of it's environmental impact, the mechanism of recovery.

Objective:

The objective of this exploratory study on food waste was to analyze food waste on the retail level. Many studies have been preformed about food waste at the supply-chain level but rarely are customer-driven businesses assessed in their annual food waste.

Methods:

The author reviewed 134 articles on the topic of food waste at the retail level. The author preformed a case study on the food waste levels in an Italian supermarket for approximately 1 year and interviewed several employees from the nearby Caritas soup kitchen.

Results:

Overall, the results show that a single supermarket of 5300 sqm produces as much as 23.5 t of food waste in one year. Most of this waste is made up of bread and bakery products (17.13 t), meat products (1.96 t) and fruit (1.67 t). This leaves us with an estimation that 4.5kg of edible food waste is produced per square metre of sales area, every year.

- On the environmental side, results show that the type of food being discarded has a large impact on it's environmental footprint. Despite the sheer quantity of bread-based product being discarded in comparison to meat products, meat products have a greater environmental value due to the larger needs during the production process.
- The study determined that the single supermarket involved in the study was able to recover enough for 12 full meals every day. This translates to 3624 meals per year, per supermarket.
- Economically, the study showed that providing food waste recover can translate up to 4.5 times the amount of money it would take to begin implementing systems like this.

Conclusions:

The exploratory study confirmed that the role of retailers may assume in reducing the impact of food waste by starting the recovery for food items that remain unsold but are still suitable for human consumption. According to the first findings provided by this study, the environmental, social and economic value of the food they would be able to recover is really relevant and it deserves the design and application of supermarket-based strategies aiming to avoid the waste of the edible fraction of the unsold products.

Summary Statements:

1. Food waste is a massive sustainability issue, with 90 million tons of food wasted in the EU every year. The production of much of this waste is directly linked to the food chain operations, including the retail stage.
2. It’s estimated that 4.5kg of edible food waste is produced per square metre of sales area, every year.
3. A single supermarket of 5300 sqm produces as much as 23.5 t of food waste in one year. Most of this waste is made up of bread and bakery products (17.13 t), meat products (1.96 t) and fruit (1.67 t).
4. Despite bread product being more widely discarded, a significantly smaller portion of discarded meat produces a larger carbon footprint.
5. The study determined that the single supermarket involved in the study was able to recover enough for 12 full meals every day. This translates to 3624 meals per year, per supermarket.

Possible Thesis Focus:

Approaches to food-chain issues:

Repurposing food waste due to production standards into biohydrogen fuel resources.

Encouraging food retail-based businesses with redistribution strategies that provide economic gains.

Developing a collection and distribution system that removes the burden or allocating food to food banks or soup kitchens.

Approaches to consumer-based issues:

Redistributing food to those suffering from food insecurity in North America.

Redistributing discarded or wasted food to food banks throughout North America.

Developing a systematic approach to waste collection, making it easier to integrate food waste of differing categories into the production of biohydrogen fuel.

Appendix B – Contextual Research (User)

- 32-Years-Old
- Married
- Male
- Working Full-Time
- Customer Service
- Unable to afford Vehicle
- Lives in Apartment
- Single Child

PRIMARY PERSONA: TED

PARENT SUFFERING FROM FOOD INSECURITY

Ted is a 32-year-old Construction Inspector. He is a vital part to the approval of new build layouts throughout the city of Toronto. With his current job and pay, and the recent rent increase he's had to endure, he can no longer consistently put food on the table for his family. Ted hates the idea that he can't provide for those around him, he isn't able to take on more work and his wife is unable to pick up work due to recent medical issues. He prefers to eat healthy nutritious meals and must work with the little food he has to make something special for his family. Ted is rarely able to afford taking days off, because of this he must work when sick, and even when in extenuating circumstances should keep him home. Ted has recently made the decision to start using food bank services but isn't always able to get what he needs. He hates the idea of taking food from other people, even if he himself needs the food. He feels guilty and ashamed of his situation, despite the difficult situation he faces in life.

"I FEEL LIKE I'M TAKING FROM OTHERS WHEN I USE FOOD BANKS IN ONTARIO. I WISH THERE WAS A BETTER WAY FOR ME TO ACCESS THESE SERVICES."

MOTIVATIONS:
- FAMILY HEALTH
- MASSIVE RENT INCREASES
- MUST BE SOLE FAMILY PROVIDER
- WANTS A GOOD LIFE FOR CHILD
- WANTS TO SAVE TIME AND MONEY
- HEALTHY CLEAN EATING

GOALS:
- GET ENOUGH FOOD TO EAT TONIGHT
- SAVE FOR RENT THIS MONTH
- SAVE MONEY & FIND WAYS TO STRETCH IT
- PROVIDE NUTRITIOUS MEALS FOR FAMILY
- CHANGE CAREER PATHS
- PROVIDE HAPPY LIFE FOR WIFE AND CHILD

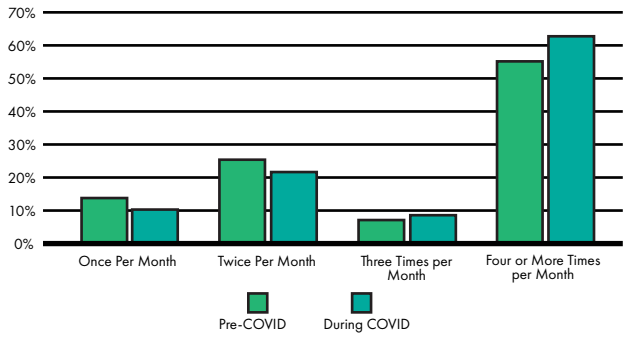
BARRIERS:
- HIGH RENT INCREASES
- UNABLE TO AFFORD FOOD
- RECENT SUPPLY-CHAIN ISSUES
- EXPIRY DATES
- FRESHNESS & QUALITY OF PRODUCE
- FOOD UNAVAILABLE AT FOOD BANKS

LIKES:
- TELEVISION AND MOVIES
- BASKETBALL (On Weekends)
- HEALTHY FOOD OPTIONS
- GOING TO PUB WITH FRIENDS
- HELPING OTHERS

AGES	2021	2022
0-2 Y/O	5.0%	5.1%
3-5 Y/O	5.1%	5.7%
6-11 Y/O	11.6%	12.0%
12-17 Y/O	10.2%	10.0%
18-30 Y/O	17.2%	19.0%
31-44 Y/O	20.3%	20.5%
45-64 Y/O	22.9%	21.8%
65+ Y/O	7.7%	5.7%

HOUSE COMPOSITION	2021	2022
SINGLE PERSON	5.0%	5.1%
SINGLE PARENT	5.1%	5.7%
TWO PARENT/GUARDIAN	11.6%	12.0%
OTHER	10.2%	10.0%
COUPLE, NO CHILDREN	5.1%	5.7%

FREQUENCY OF MONTHLY FOOD BANK VISITS



BY INCOME & EDUCATION

	Total	<50K	$50K - 75K	$75K - 100K	>100K	HS or Less	College	Univ. Degree
Ate less than you felt you should because there wasn't enough money for food since March 2020	22.9%	38.6%	38.6%	8.6%	3.6%	40.6%	25.9%	12.1%
Hungary but didn't eat because there wasn't enough food since March 2020	19.0%	33.1%	33.1%	6.2%	2.3%	36.3%	20.1%	9.6%
Did not eat for a whole day during COVID-19 because there wasn't enough money to purchase food	8.9%	16.5%	16.5%	2.4%	1.2%	20.0%	8.4%	3.8%
Accessed food or meals from a community organization before March 2020	8.8%	15.2%	15.2%	2.6%	1.5%	16.5%	9.4%	4.7%
Accessed food or meals from a community organization since March 2020	13.9%	24.2%	24.2%	3.4%	2.8%	26.2%	14.7%	7.2%

TYPE OF FOOD WASTE:

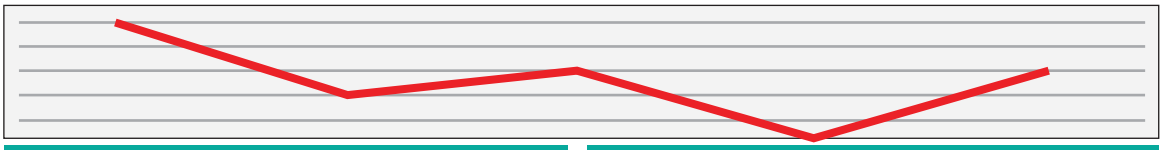
- Produce
- Bread/Grain
- Milk Products

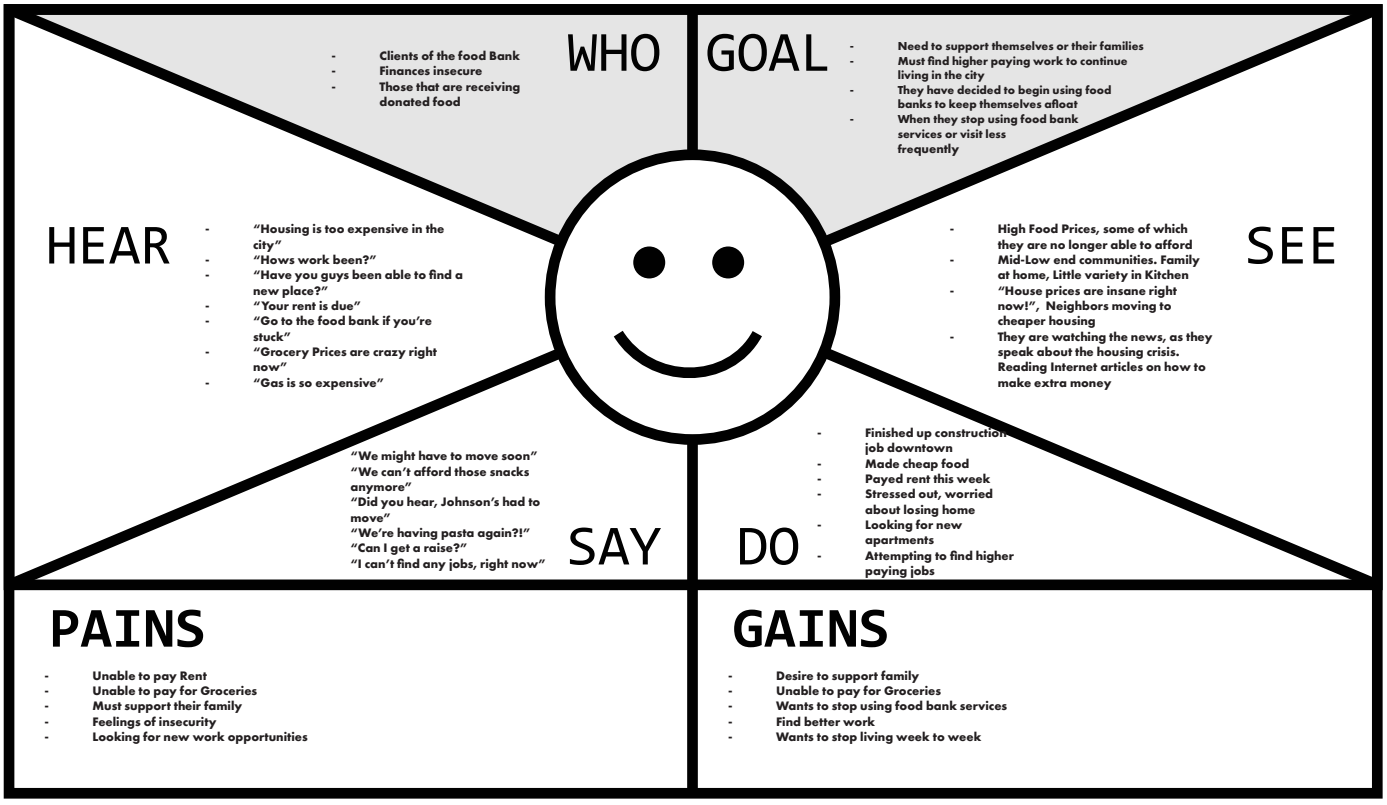
FREQUENCY OF FOOD WASTE:

- Several Times a Week
- Weekly Basis
- Bi-Weekly Basis

F.B. DONATION FREQUENCY:

- Never
- During Food Drives
- Every Few Years
- Once a Year

Steps:	Preparation: Home From Work	Consideration: Leaves for Food Bank	Task 1: Arrives at Food Bank	Task 2: Waiting in Line	Final Result: Pick Up Order & Home
User Actions: / User Thoughts: / User Feelings:	**Action:** User returns home from work **Thoughts:** "Finally Done with my Day!" **Feelings:** Satisfaction, Relaxed	**Action:** Leaves home to run errands for the day **Thoughts:** "I have to pick up groceries today" **Feelings:** Stress, Anxiety	**Action:** User visits their local food bank **Thoughts:** "Hopefully they have something good!" **Feelings:** Anxious, Hopeful	**Action:** Waiting in Line for Food Package **Thoughts:** "I just want to get home and feed my family" **Feelings:** Self-Conscious, Bored	**Action:** Client receives food package and starts home. **Thoughts:** "I guess we're having pasta this week." **Feelings:** Dissatisfied, Relieved
Storyboard					
Mapping 5 4 3 2 1					
Pain Points & Opportunities	**Pain Points:** Self-Conscious in use of Food Bank Long Lineups for Small Food Portions Food Variety often Limited Stressed about Financial Troubles			**Opportunities:** Ensuring User is dignified in using Service Diversification of Food Reserves Minimize Line Waiting	



Interview:

Q: What were some of the challenges you faced when volunteering for your food bank?

A: We just don't have enough volunteers at the moment, we are extremely busy most days and that's just when we're able to open. Since the pandemic, donations haven't been coming in as frequently so there are days that we don't have enough to even open.

Q: In recent years, food bank clientele has increased dramatically. Has your food bank implemented any strategies to meet the need of this larger load?

A: Unfortunately, we haven't found many strategies to deal with it. We buy most of our food in bulk from grocery stores in the area because of the donation situation. On top of that we had to start Covid screening which has stifled the number of volunteers willing to work with us.

Q: Would you be able to speak on some of the struggles the organization itself faces?

A: We just can't keep up with the load of clients recently. More and more people are registering as clients and we're receiving less and less donations. Since less volunteers are available, we've even had to close some of our programs like our grocery program.

Q: Do you think creating more opportunities for people to donate food would yield a significant increase in food reserves?

A: At the moment it would be more beneficial to donate money directly to us. If you donate $100 worth of food, we might be able to use all of it but sometimes we can't. If we receive that $100, we can get discounts and can buy food in bulk. We'll just end up getting more out of it.

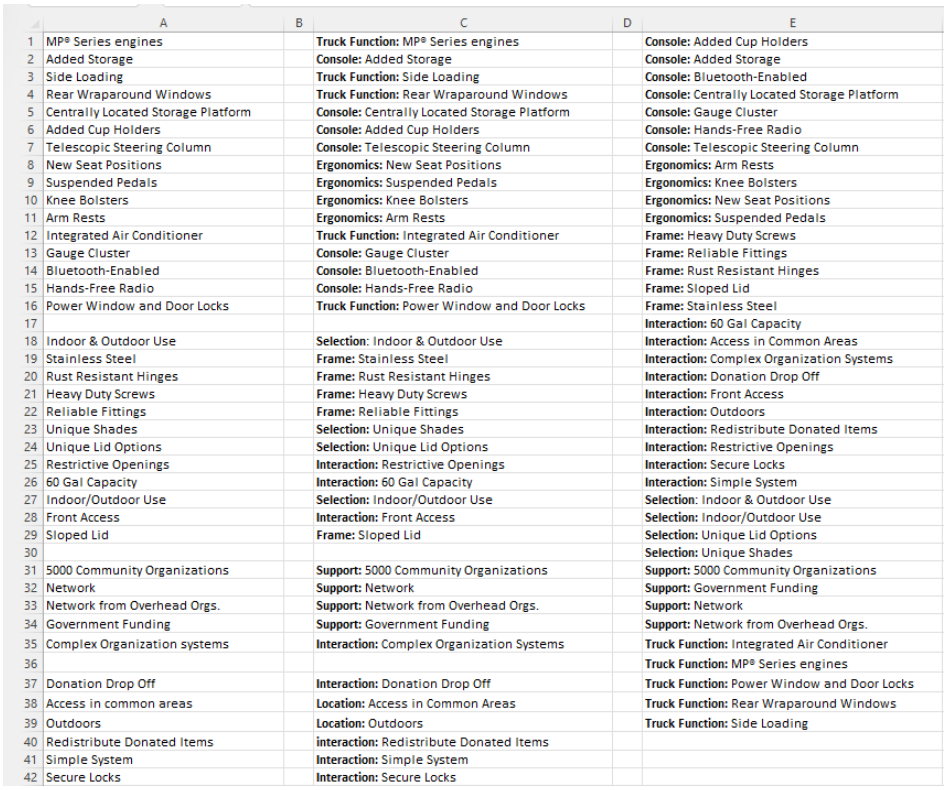
Q: How often is donated food wasted in your food bank?

A: Not very often, we occasionally have to throw away food products too close to expiry but that is relatively uncommon for us.

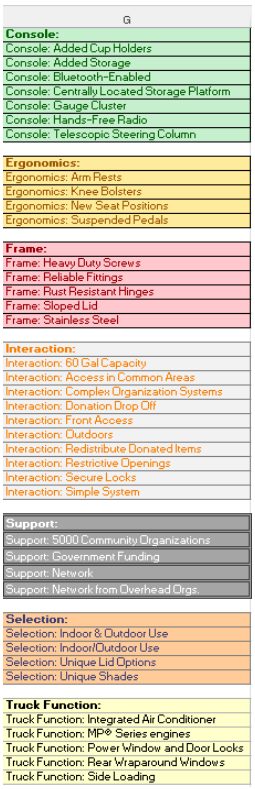
Appendix C – Field Research (Product)

	A	B	C
1	Performance		24 Hours Service
2	Storage		Accessible
3	Visibility		Alw ays continue Operations
4	Comfort		Attractive
5	Enhanced Technology		Built to Last
6	Quicker		Cleanlieness
7	Simplicity		Comfort
8	Safety		Communication
9	Maneuvering		Control
10	Space		Customizable
11	Ergonomic Adjustments		Donations
12	Relief during hot days		Dry & Clean
13	Control		Durability
14	Vision		Easy to Use
15	Space for Storage		Enhanced Technology
16	Storage Space		Ergonomic Adjustments
17	Communication		Fits into Space
18			Government Funding
19	Customizable		Innovative
20	Sustainable		Location near you
21	Attractive		Maneuvering
22	Durability		No Servicing Needs
23	Performance		No Cost
24	Fits into Space		Performance
25	No Servicng Needs		Performance
26	Dry & Clean		Quicker
27	Innovative		Relief during hot days
28	Sustainable		Safety
29	Built to Last		Safety of Donations
30	Wide-Range Collection		Security
31	Cleanliness		Simplicity
32			Simplicity
33	Support		Space
34	Donations		Space for Storage
35	Government Funding		Storage
36	Alw ays continues Operations		Storage
37	Support		Support
38	No Cost		Support
39			Sustainable
40	Accessible		Sustainable
41	24 Hours Service		Visibility
42	Simplicity		Vision
43	Easy to Use		Wide-Range Collection
44	Security		
45	Safety of Donations		
46	Locations near you		

E
Performance:
Communication
Ergonomic Adjustments
Enhanced Technology
Maneuvering
Performance
Performance
Quicker
Relief during hot days
Accessibility:
Accessible
Easy to Use
Location near you
No Cost
Simplicity
Simplicity
Attractive:
Attractive
Customizable
Fits into Space
Innovative
Sustainable
Sustainable
Wide-Range Collection
Reliability:
24 Hours Service
Alw ays continue Operations
Built to Last
Durability
Donations
Government Funding
No Servicing Needs
Safety
Safety of Donations
Support
Support
Security
Safety + Comfort:
Control
Cleanlieness
Comfort
Dry & Clean
Visibility
Vision
Storage:
Storage
Storage
Space
Space for Storage



	A	B	C	D	E
1	MP® Series engines		**Truck Function:** MP® Series engines		**Console:** Added Cup Holders
2	Added Storage		**Console:** Added Storage		**Console:** Added Storage
3	Side Loading		**Truck Function:** Side Loading		**Console:** Bluetooth-Enabled
4	Rear Wraparound Windows		**Truck Function:** Rear Wraparound Windows		**Console:** Centrally Located Storage Platform
5	Centrally Located Storage Platform		**Console:** Centrally Located Storage Platform		**Console:** Gauge Cluster
6	Added Cup Holders		**Console:** Added Cup Holders		**Console:** Hands-Free Radio
7	Telescopic Steering Column		**Console:** Telescopic Steering Column		**Console:** Telescopic Steering Column
8	New Seat Positions		**Ergonomics:** New Seat Positions		**Ergonomics:** Arm Rests
9	Suspended Pedals		**Ergonomics:** Suspended Pedals		**Ergonomics:** Knee Bolsters
10	Knee Bolsters		**Ergonomics:** Knee Bolsters		**Ergonomics:** New Seat Positions
11	Arm Rests		**Ergonomics:** Arm Rests		**Ergonomics:** Suspended Pedals
12	Integrated Air Conditioner		**Truck Function:** Integrated Air Conditioner		**Frame:** Heavy Duty Screws
13	Gauge Cluster		**Console:** Gauge Cluster		**Frame:** Reliable Fittings
14	Bluetooth-Enabled		**Console:** Bluetooth-Enabled		**Frame:** Rust Resistant Hinges
15	Hands-Free Radio		**Console:** Hands-Free Radio		**Frame:** Sloped Lid
16	Power Window and Door Locks		**Truck Function:** Power Window and Door Locks		**Frame:** Stainless Steel
17					**Interaction:** 60 Gal Capacity
18	Indoor & Outdoor Use		**Selection**: Indoor & Outdoor Use		**Interaction:** Access in Common Areas
19	Stainless Steel		**Frame:** Stainless Steel		**Interaction:** Complex Organization Systems
20	Rust Resistant Hinges		**Frame:** Rust Resistant Hinges		**Interaction:** Donation Drop Off
21	Heavy Duty Screws		**Frame:** Heavy Duty Screws		**Interaction:** Front Access
22	Reliable Fittings		**Frame:** Reliable Fittings		**Interaction:** Outdoors
23	Unique Shades		**Selection:** Unique Shades		**Interaction:** Redistribute Donated Items
24	Unique Lid Options		**Selection:** Unique Lid Options		**Interaction:** Restrictive Openings
25	Restrictive Openings		**Interaction:** Restrictive Openings		**Interaction:** Secure Locks
26	60 Gal Capacity		**Interaction:** 60 Gal Capacity		**Interaction:** Simple System
27	Indoor/Outdoor Use		**Selection:** Indoor/Outdoor Use		**Selection**: Indoor & Outdoor Use
28	Front Access		**Interaction:** Front Access		**Selection:** Indoor/Outdoor Use
29	Sloped Lid		**Frame:** Sloped Lid		**Selection:** Unique Lid Options
30					**Selection:** Unique Shades
31	5000 Community Organizations		**Support:** 5000 Community Organizations		**Support:** 5000 Community Organizations
32	Network		**Support:** Network		**Support:** Government Funding
33	Network from Overhead Orgs.		**Support:** Network from Overhead Orgs.		**Support:** Network
34	Government Funding		**Support:** Government Funding		**Support:** Network from Overhead Orgs.
35	Complex Organization systems		**Interaction:** Complex Organization Systems		**Truck Function:** Integrated Air Conditioner
36					**Truck Function:** MP® Series engines
37	Donation Drop Off		**Interaction:** Donation Drop Off		**Truck Function:** Power Window and Door Locks
38	Access in common areas		**Location:** Access in Common Areas		**Truck Function:** Rear Wraparound Windows
39	Outdoors		**Location:** Outdoors		**Truck Function:** Side Loading
40	Redistribute Donated Items		**interaction:** Redistribute Donated Items		
41	Simple System		**Interaction:** Simple System		
42	Secure Locks		**Interaction:** Secure Locks		

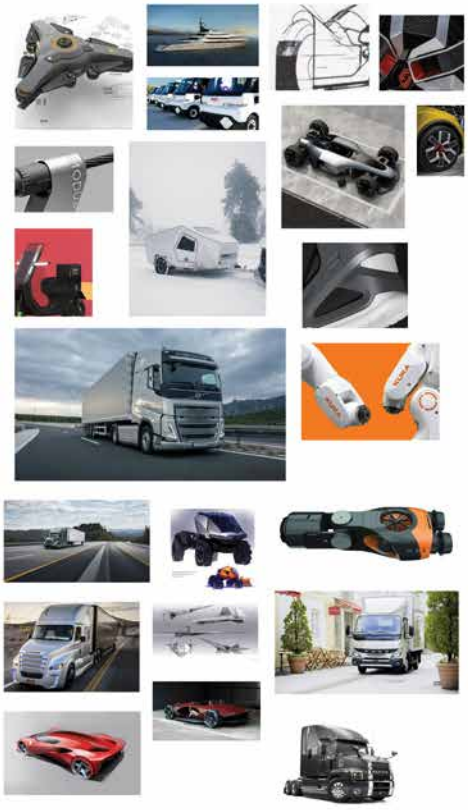


G
Console:
Console: Added Cup Holders
Console: Added Storage
Console: Bluetooth-Enabled
Console: Centrally Located Storage Platform
Console: Gauge Cluster
Console: Hands-Free Radio
Console: Telescopic Steering Column
Ergonomics:
Ergonomics: Arm Rests
Ergonomics: Knee Bolsters
Ergonomics: New Seat Positions
Ergonomics: Suspended Pedals
Frame:
Frame: Heavy Duty Screws
Frame: Reliable Fittings
Frame: Rust Resistant Hinges
Frame: Sloped Lid
Frame: Stainless Steel
Interaction:
Interaction: 60 Gal Capacity
Interaction: Access in Common Areas
Interaction: Complex Organization Systems
Interaction: Donation Drop Off
Interaction: Front Access
Interaction: Outdoors
Interaction: Redistribute Donated Items
Interaction: Restrictive Openings
Interaction: Secure Locks
Interaction: Simple System
Support:
Support: 5000 Community Organizations
Support: Government Funding
Support: Network
Support: Network from Overhead Orgs.
Selection:
Selection: Indoor & Outdoor Use
Selection: Indoor/Outdoor Use
Selection: Unique Lid Options
Selection: Unique Shades
Truck Function:
Truck Function: Integrated Air Conditioner
Truck Function: MP® Series engines
Truck Function: Power Window and Door Locks
Truck Function: Rear Wraparound Windows
Truck Function: Side Loading

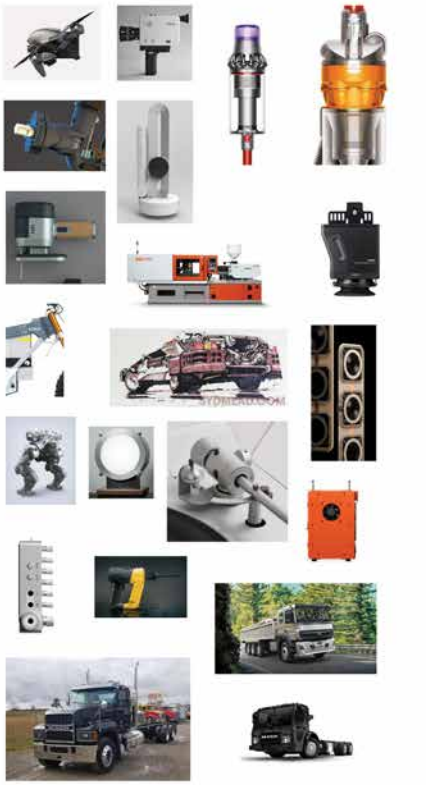
Food Bank				
Needs	**Benefits and Underlying Needs**	**Level of importance**		
Basic Needs				
Shelter	Clients need shelter from the elements			*High*
Food	Clients all need food to continue surviving			*High*
Disposal of Waste	Clients all need somewhere to dispose of their waste		*Moderate*	
Security				
Safety	Protection from elements, and dangers		*Moderate*	
Security of Property	Protection of items and property from dangers	Slight		
Job Security	Important for Clients to have steady income			*High*
Housing Security	Reliability of Residency		*Moderate*	
Social Belonging				
Fear of Social rejection	Worry of feeling like an outcast			High
Fear of being unable to support family	Low self-worth, unable to meet expectations		Moderate	High
Fear of taking a meal away from others	Worried they are not able to use services			
Social Expectation	Social stigma says not to use food bank services		Moderate	
Esteem:				
Social Status:	Worried about personal view of themselves			High
Social Recognition	Wants to be seen as someone well-off			High
Sexual attractiveness	Wants to have money to find significant other	Slight		
Self-Actualization:				
Intrinsic pleasure	Eating a meal with the family		Moderate	
Creative endeavors	Ability to focus on personal goals and hobbies	Slight		
Experiential (extrinsic)	Being able to focus on job search, or career progression		Moderate	
Experiential (intrinsic)	Being able to afford a night out	Slight		
Emotional	Dampening of financial stress Feelings of self-worth		Moderate	

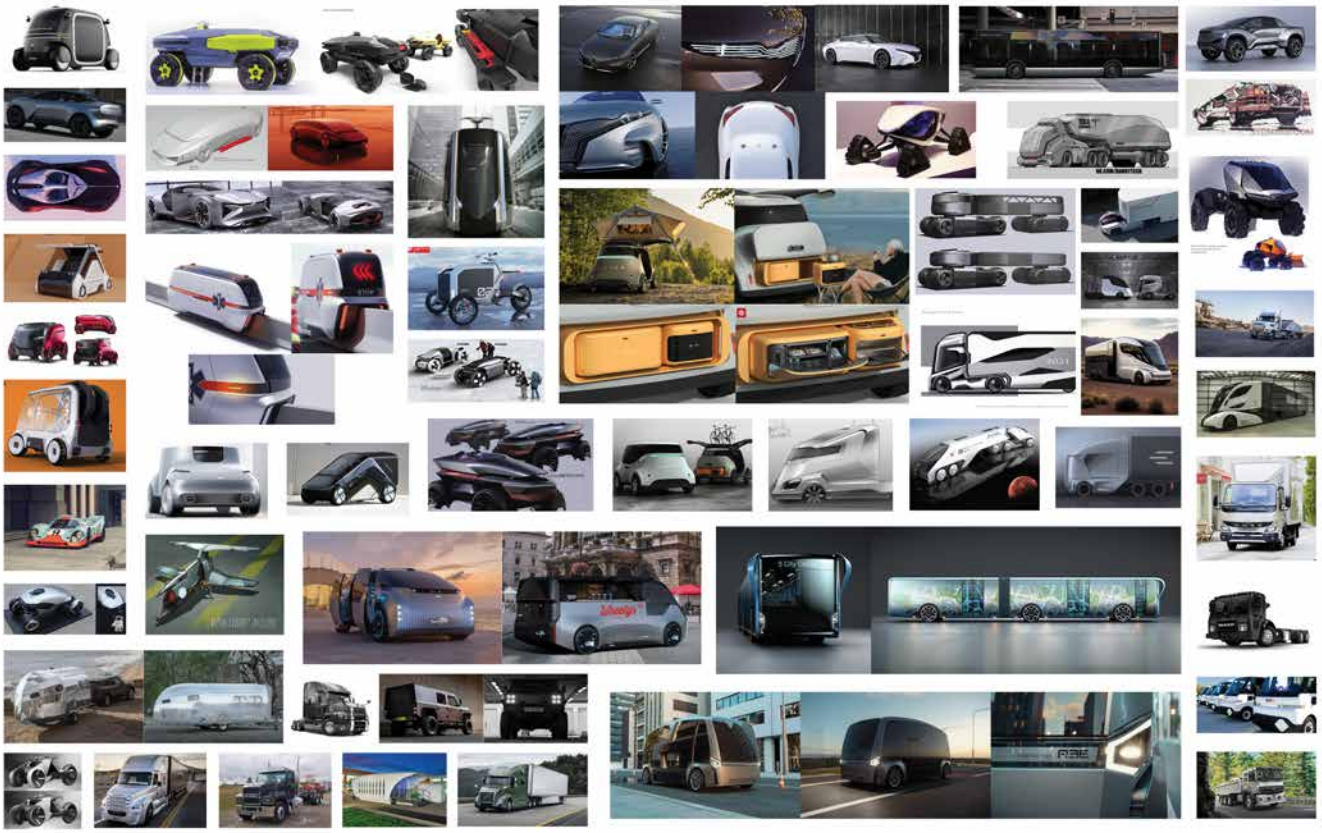
Organic/Soft Forms:

Acceleration Form:



Industrial Form:





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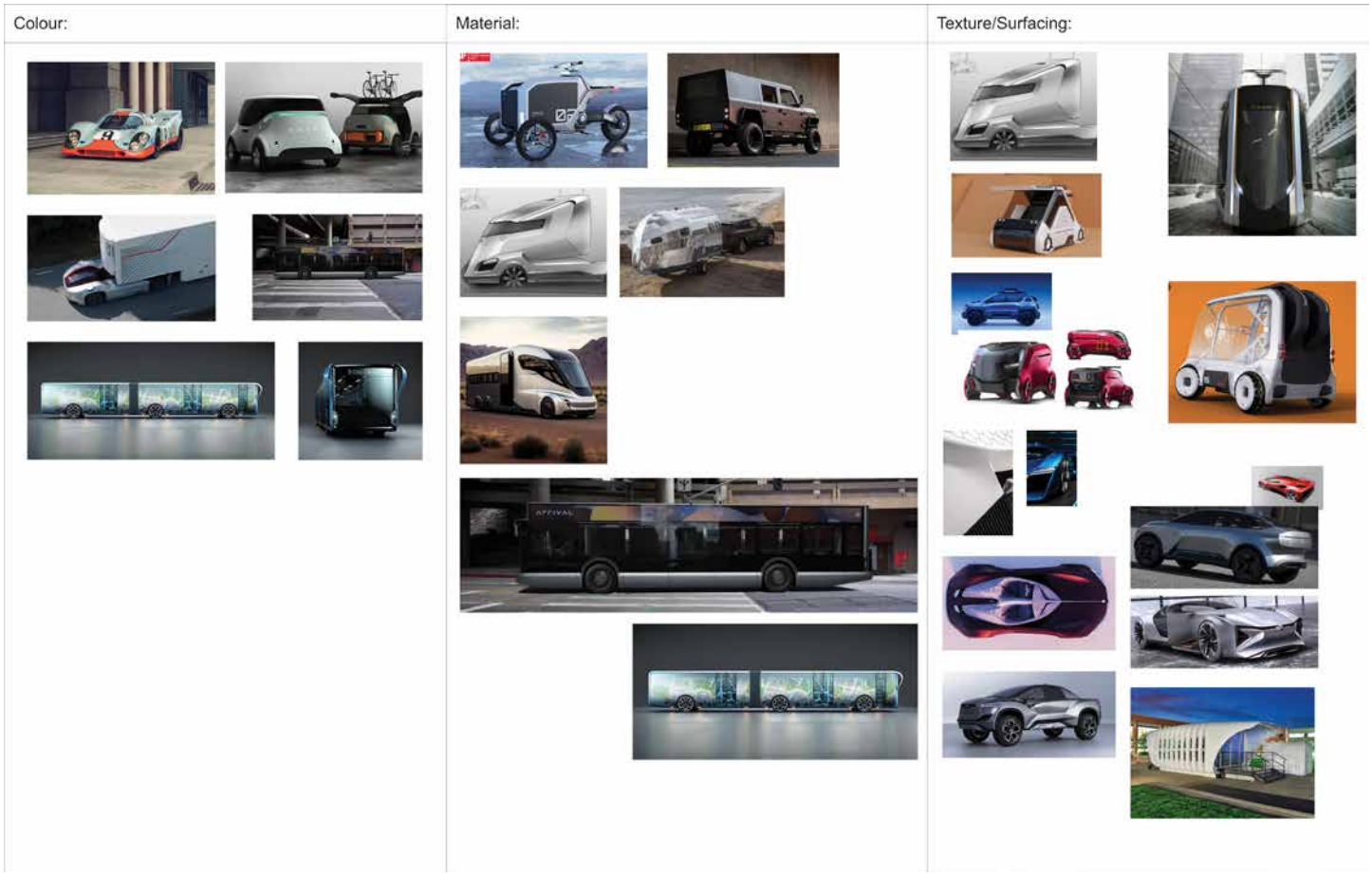
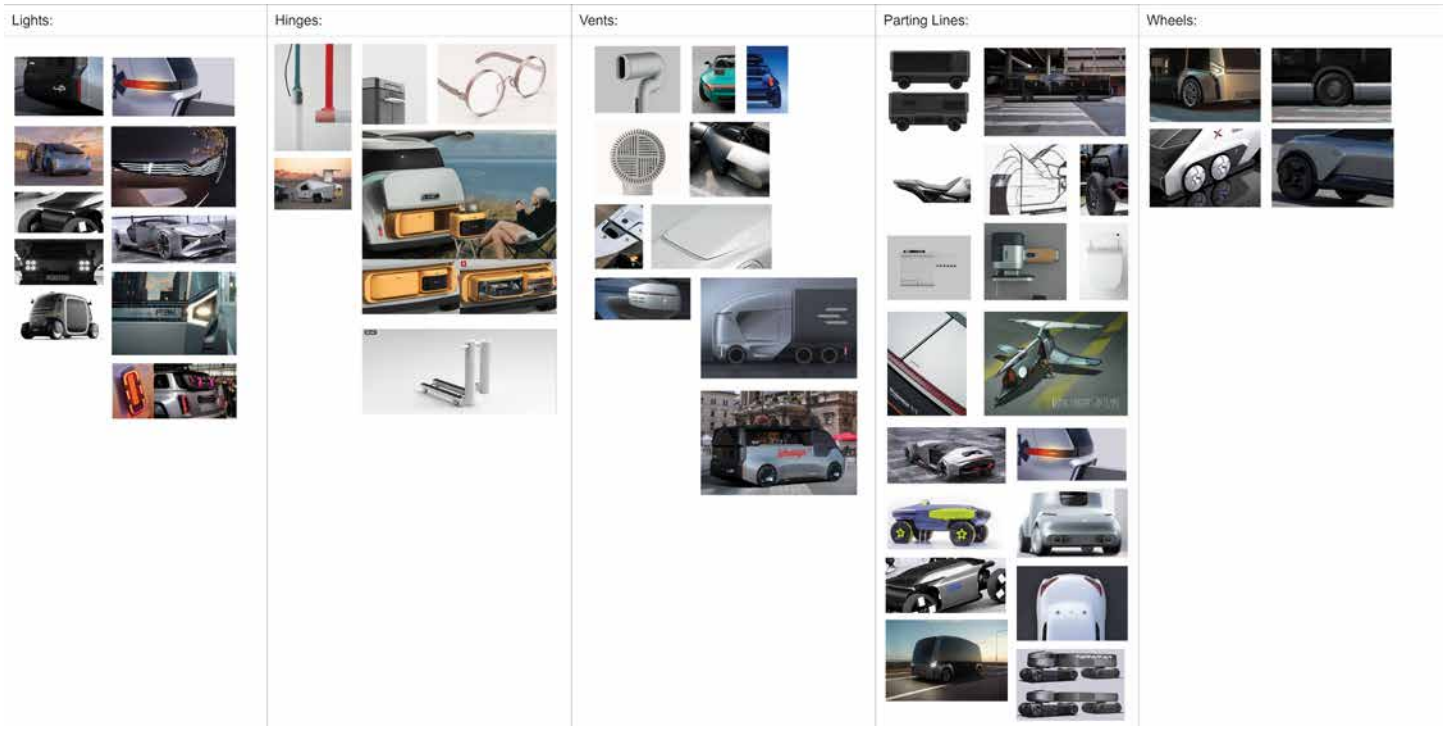
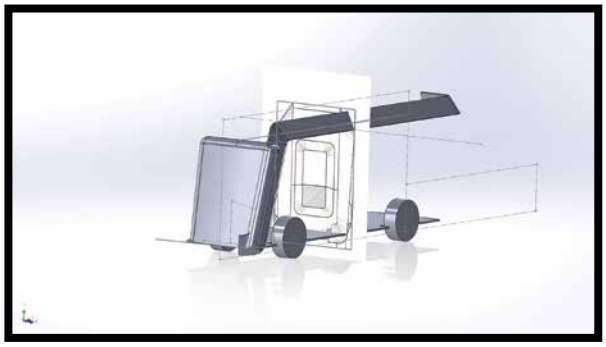
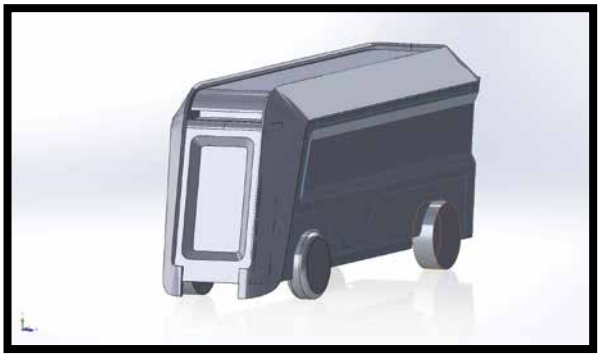


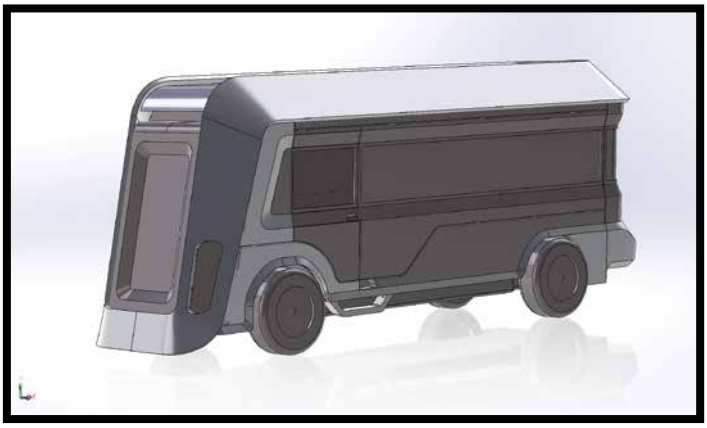
Product Details:

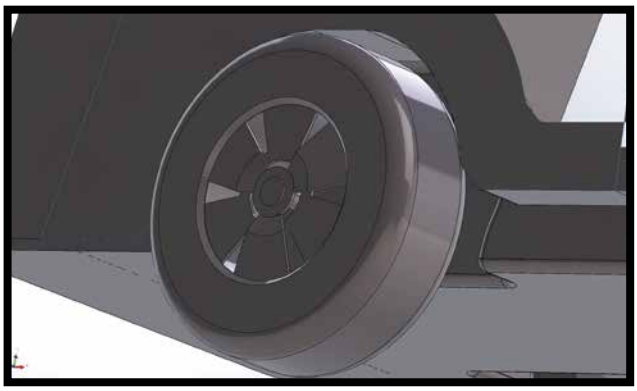


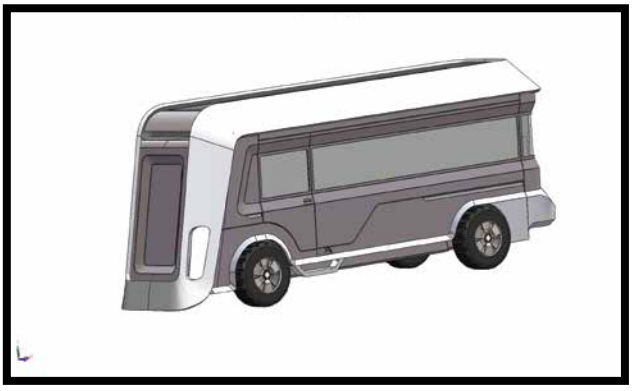
Appendix E – CAD Development

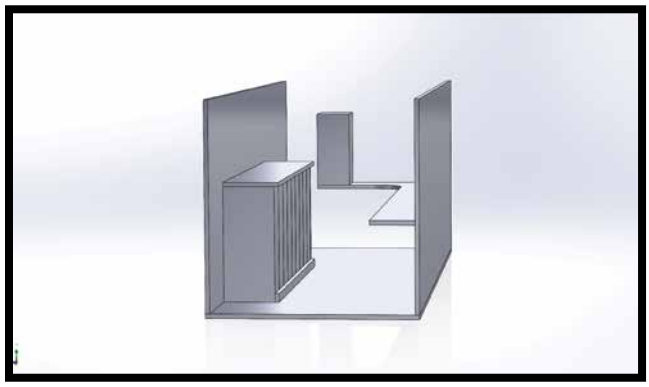
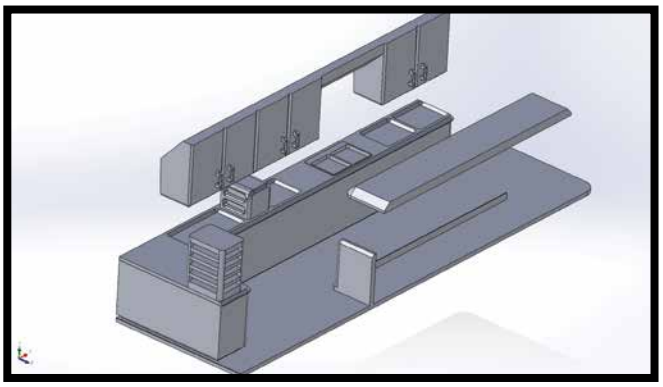
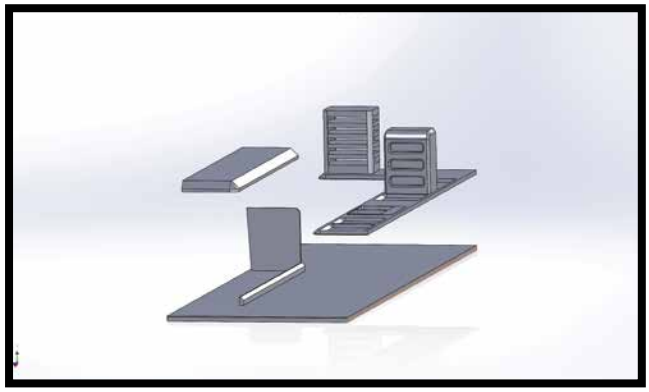
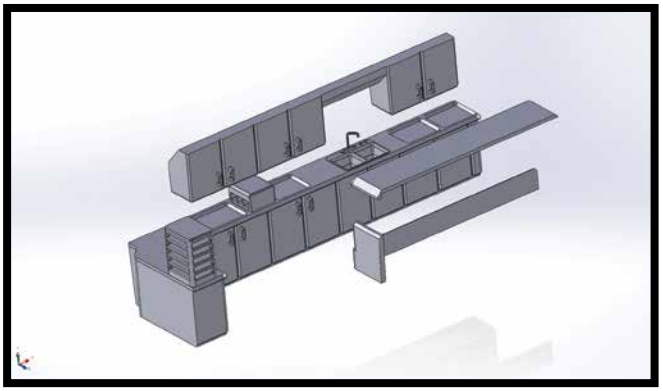
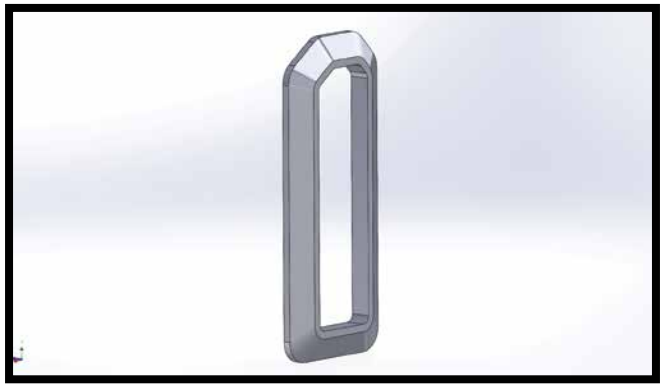
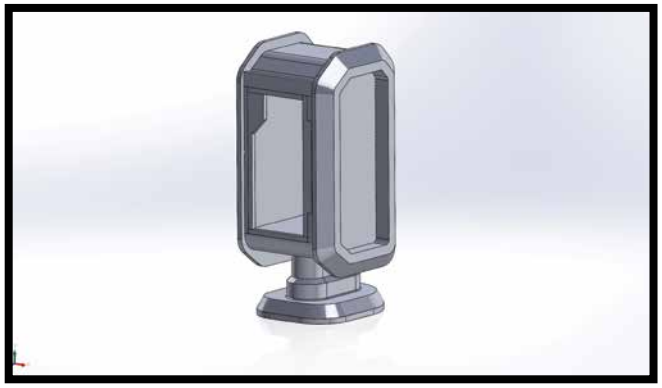
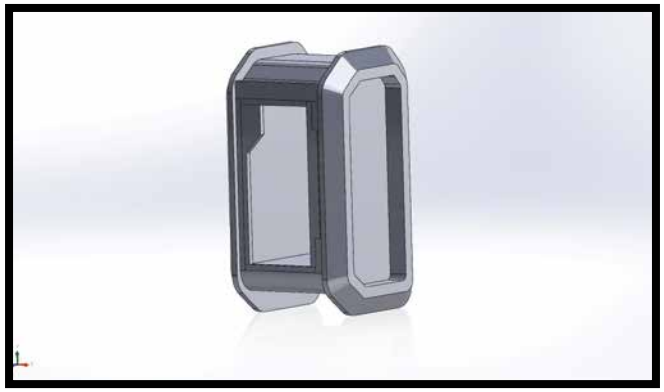
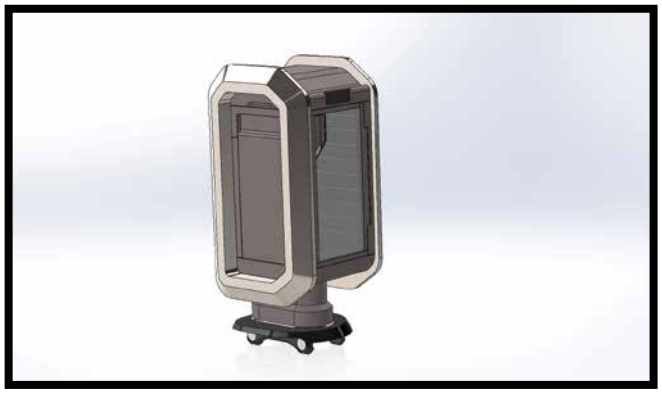


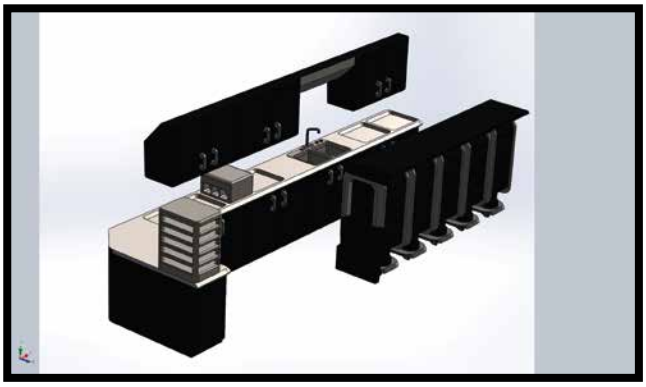


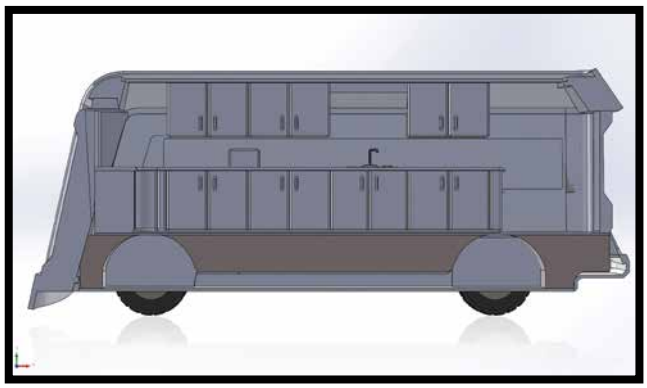


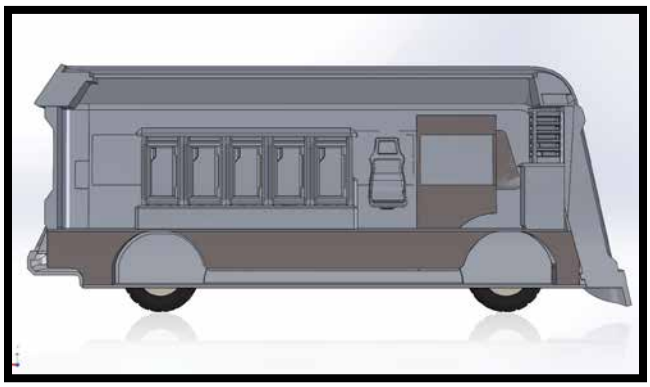




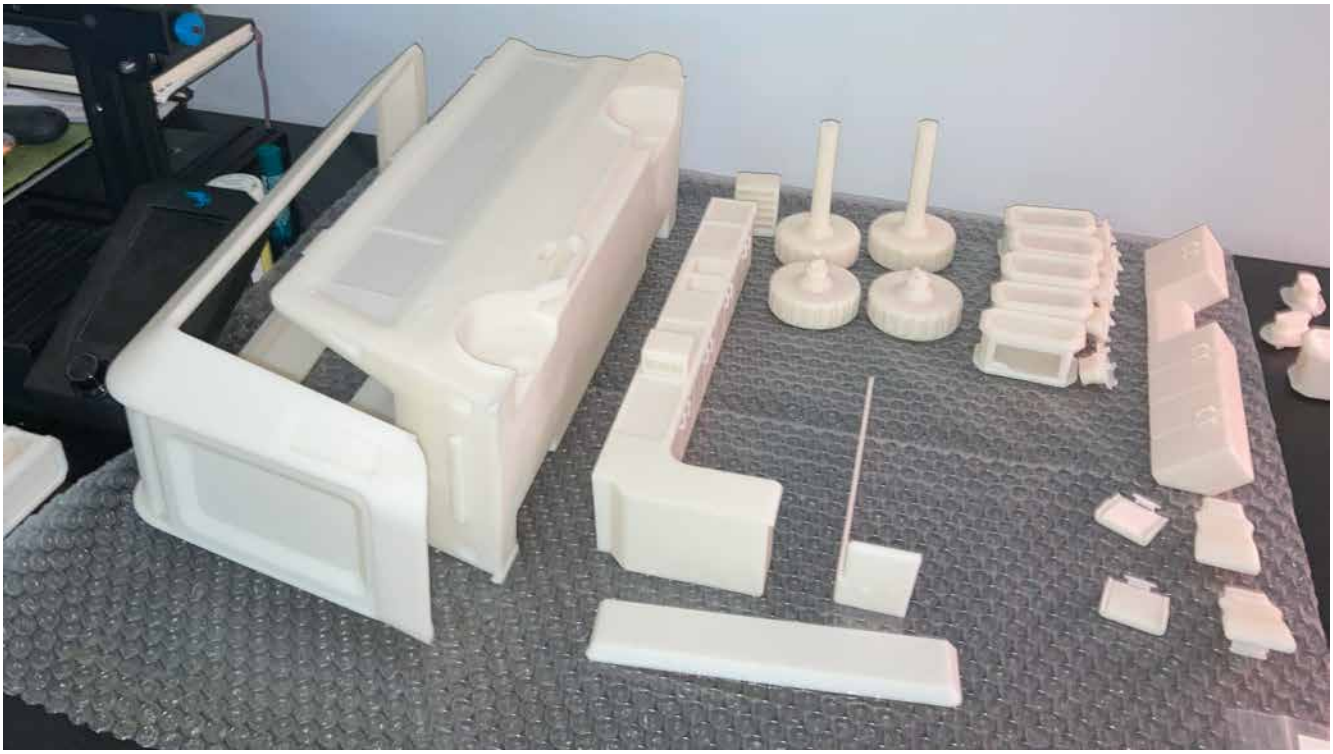











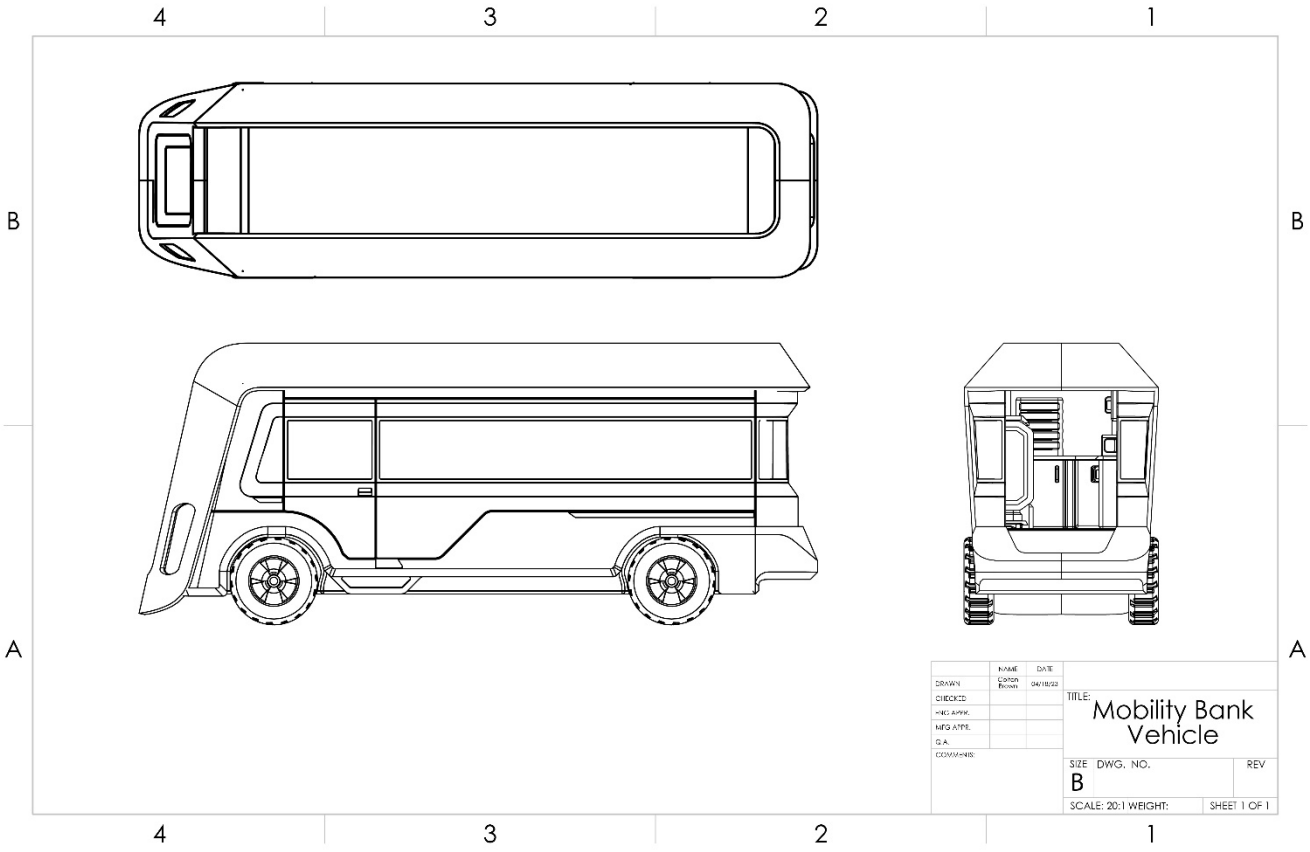


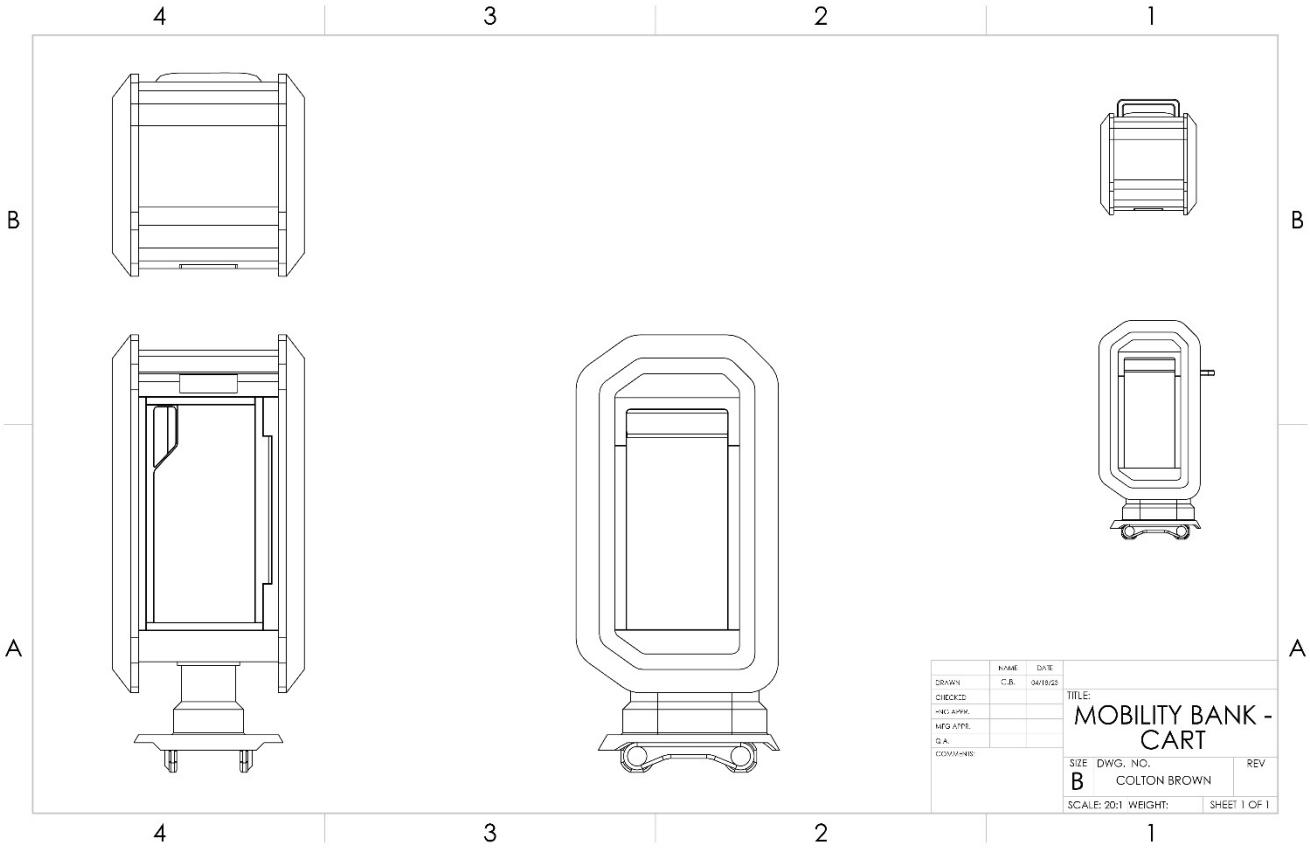


Appendix F – Physical Model Photographs



Appendix G – Technical Drawings

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COLTON BROWN
SCALE: 20:1 WEIGHT:
SHEET 1 OF 1

Appendix I – Sustainability Info

Introduction

Sustainability has become an incredibly important focus of the design industry in the last few decades. Now more than ever, it is important to reduce as much waste and produce as little emissions as possible throughout the manufacture and lifecycle of a product. Automotive companies have begun to design with sustainability in mind as they continue to develop and advance their sustainability goals.

The Mobility Bank is to be produced as sustainably as possible. Using sustainable materials, meeting sustainable manufacturing standards and ensuring the Mobility Bank's business model is beneficial to human lifestyle and takes on a level of social responsibility. These attributes are all vital to the success of the Mobility Bank's design.

Literature Review

Dehydrated foods: Are they microbiologically safe?

Abstract:

Dried foods are low water activity foods with water activity ranging from 0.03 to 0.7. They are commonly misconstrued to be inherently safe from food borne pathogenic bacteria. However, there are many reported cases where many food borne illnesses were caused by the consumption of dried foods contaminated with Salmonella spp., Cronobacter spp., Staphylococcus spp. and E. coli. In this work, we have systematically reviewed the literature dealing with the effect of drying/dehydration on the survival of pathogenic microorganisms with special focus on Salmonella spp. We have also reviewed and synthesized the literature dealing with the effect of drying process on microorganisms in dried vegetables, meat, fish,

spices, mushroom and powdered foods. This review concludes that dried foods are not inherently safe microbiologically and required other hurdles to achieve microbial safety.

Introduction:

Since [dried foods] are low in residual moisture content and water activity, they inhibit the growth of spoilage as well as pathogenic microorganisms"(Chitrakar et al., 2018). Therefore, these types of foods are generally seen as "safe" from food borne bacteria.

This however is a common misconception, "research has revealed that food borne pathogens, including Salmonella can survive and persist in dried foods" which in turn can cause food borne outbreaks (Chitrakar et al., 2018).

Cross-contamination can result from a variety of things including, inadequate sanitation practices, contaminated equipment, lack of specific knowledge of hygiene in food handlers, and even improper storage conditions (Chitrakar et al., 2018).

Conclusion:

"Research on dehydration shows that dehydration alone is not enough to inactivate the pathogens load in food[…]. Various pre-drying treatments such as NaCl, citric acid, ascorbic acid, sodium metabisulfite, sulfur as well as blanching are required to inactivate the microbial population to a required level" (Chitrakar et al., 2018).

Of the different pre-drying treatments tested; sodium metabisulfite and acid treatments have shown to be effective in eliminating pathogen load in dehydrated food. Further testing into novel drying and hybrid drying should be preformed to review their hurdle effects (Chitrakar et al., 2018).

Finally, “sanitation and hygiene of employees and avoiding contamination, cleaning and disinfection procedures, are areas to be focused to ensure the safety of dried food products” (Chitrakar et al., 2018).

Materials & Manufacture

Considering materials and manufacture is an incredibly important part of maintaining sustainability in a product. Many materials have adverse effects on the environment, and with a complex product like the Mobility Bank, it is difficult to target and address every material change that can be substituted with an environmentally friendly alternative.

To keep this concise, only the larger changes will be addressed in this report with a further in-depth look at the material list, required before production. Some larger changes were made to the Mobility Bank’s interior to better suit it’s sustainability goals. Countertops will be made of Bamboo (MOSO, 2022), this affords maintenance of the countertop, and general replacement if required. Many appliances throughout the interior are made of metal. Generally, this metal will be made from anodized aluminum to ensure recyclability at the end of the products life cycle as well as avoid unwanted corrosion of this metal (AAC, n.d.). Seats on this truck have been downsized, providing comfort for a shorter duration to minimize material and manufacturing requirements. Longer trips will rarely be taken on this vehicle, so the need for long term comfort is generally unnecessary. Commonly used, Polyurethane foam cushions will be replaced with latex padding (Pyle, 2022), and commonly used Nylon and Polyester upholstery will be replacing with an organic cotton alternative (Pyle, 2022). At the exterior changes were made to the type of paint used. Automotive paint is incredibly toxic for the environment, instead the Mobility Bank will use sustainable paints made form biowaste (*BMW Group,* 2022).

Many of the manufacturing practices are continually being reworked and revamped to achieve greater sustainability. While many of these practices can be improved upon, it is difficult to go into detail on the manufacturing techniques that can be improved. The aim of manufacturing the Mobility Bank is to produce it as sustainably as possible. Operations like remanufacture of recycled parts, reduction of water consumption and reduction of waste are all important aspects of the manufacturing process that must be controlled. Using a central location for all manufacturing operations will reduce the carbon footprint made at the transportation stage of the design (Tesla, 2021). In the future, a full break down of manufacturing processes will be required to ensure the entire vehicle has been reviewed.

Benchmark Sustainable Initiatives

Sustainability has been at the forefront of the world's thoughts for the last decade and more corporations than ever are getting involved. Large automotive manufacturers all have their own set of sustainability initiatives touching on emissions, carbon footprint and electric vehicles. As the world looks to electric vehicles (E.V) over its internal combustion engine (I.C.E) predecessor automotive companies are continually striving towards greener vehicles.

Many of these companies produce vehicles with unique sustainable attribute, for example, BMW has developed a sustainable alternative for automotive paint and coating (BMW, 2022). However, there are several broader areas of which can be improved through material, and manufacturing while reducing vehicle footprint (Industry Today, 2020). Most companies have committed to reducing CO2 Emissions from their vehicles, with goals to implement E.V. alternatives. Companies are consistently promising to clean up their supply chains and reduce emissions from these processes. Companies like MACK have even promised and a future climate neutral supply chain (Mack, 2023). One of the largest focusses

for sustainability in these companies is the goal to increase remanufacture throughout their supply chain. Companies like Tesla have begun to reuse as much as 92% of materials in the remanufacture of their batteries (Tesla, 2021). Finally, it appears that the rampant use of water to meet production needs has begun to fall out of popularity, as companies like Ford and Tesla (Tesla, 2021) work towards reducing the amount of water intake needed to accomplish these operations. Ford has even barred manufacturers from using freshwater resource for anything but drinking on site (Ford, 2020).

All automotive brands strive to ensure the user is safe in their vehicle, as advances are made each year on the forefront of vehicle safety. However, this is not always true for their employees. Companies like Ford aim for zero fatality goals in their workplaces as well as a zero serious injury goal. They also aim to implement a more competitive lost-time policy for workers (Ford, 2020). Other companies like MACK aim to reduce their accident rate by 75% (Mack, 2023), while others like BMW aim to rework and reform management at their locations to achieve the highest level of occupational safety certification (BMW Group, 2023). A commitment to supplying workers with proper health benefits appears to be an industry-wide commitment from several major automotive brands. The increase of employee benefits is providing labour workers with more health security than ever before (Ford, 2020).

Sustainability Statement For Design

There are several factors which must be considered to ensure our product is as sustainable as it can be. The Mobility Bank has been designed to collect, sort and reform food waste being disposed of by food retailers. A modular system has been developed that affords a simple transfer of food waste from organizations like grocers to the Mobility Bank vehicle, where it can be sorted, processed, and arranged into several dehydration units. The

Mobility Bank vehicle will transport these dehydration units to local food banks in the area before reloading dehydration units, repeating the process. The largest goal of Mobility Bank is to enhance human lifestyle and take on further social responsibility. To do this we must avoid looking exclusively at the function of the vehicle. Instead, it is important to investigate sustainable materials, sustainable manufacturing methods, all while ensuring the safety and health of the user.

The Mobility Bank's manufacture will ideally be performed in a dedicated plant. This allows for several manufacturing operations to be performed in the same building, reducing a large percentage of emissions created by transporting parts and materials short distances (Tesla, 2021). Manufacturing facilities are never to use freshwater to preform operations. Investigating how much water is needed used to preform necessary manufacturing operations is incredibly important (Wellbrock et al., 2020). While many companies are concerned by vehicles footprint, many of these issues are alleviated by the inclusion of an electric engine. This generally eliminates emissions throughout the use of the vehicle. While emissions are still made during charging of the vehicle, battery capacity and efficiency rises every year. The emissions created from charging a vehicle of this size should be reduced greatly over the next decade (Wellbrock et al., 2020). Remanufacture is of massive importance to the automotive industry, reusing complex, durable high value parts for later manufacture. This will not only help reduce waste left in landfills but can even save money for the company involved (TWI, 2021). Finally, a general reduction in waste is necessary to achieving sustainability in material and manufacturing production. It is necessary that plants, factories, and manufacturers only use material necessary to get the job done instead of sending extra material off to landfills.

Conclusion

There are several steps being taken towards sustainability in the automotive sector, Mobility Bank aims to achieve these same levels of sustainability and more. As a large-scale automated E.V., Mobility Bank stands at the front of sustainable change trends in the automotive industry. In being careful with the selected manufacturers, remanufacturing previously used parts, reducing water waste, and reducing landfill waste as much as possible is broadly defined way of reducing emissions throughout the manufacturing process. If it's possible to create a large multi-purpose manufacturing facility, the reduction of emission created in transport of materials and parts will significantly impact the emissions created during the manufacturing process and can even increase the efficiency of employees. Ensuring safe travel for those using our service is incredibly important. Safety precautions like seatbelts and securing measures will protect volunteers and users on the Mobility Bank. Nobody asks to be hurt volunteering for a good cause, so we aim to minimize this potential as much as possible. The health of Mobility Bank's users is a massive concern as the unorthodox method of acquiring food will likely be looked down upon. The risk of an illness spreading through food made by the Mobility Bank System can turn many away from even using the product recovered. Precautionary measures must be taken to ensure the health and safety of our users.

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Appendix J – Approval Forms

PANEL ON RESEARCH ETHICS
Navigating the ethics of human research

TCPS 2: CORE 2022

Certificate of Completion

This document certifies that

Colton Brown

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

Certificate # 0000852416 **25 September, 2022**

IDSN 4002
SENIOR LEVEL THESIS ONE

Humber ITAL / Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2022
Catherine Chong / Frederic Matovu

THESIS TOPIC APPROVAL:

Student Name:	Colton Brown
Topic Title:	How May We Reform the Process of Food Waste in Urban Conditions?

TOPIC DESCRIPTIVE SUMMARY (PRELIMINARY ABSTRACT)

In the last 5 years, the population affected by food insecurity in North America has continually increased with each passing year. The recent COVID-19 Pandemic has resulted in a larger portion of the population falling into poverty, and a significant portion of the population are turning to resources like food banks or soup kitchens to put food on the table. Those suffering from food insecurity are finding it more and more difficult, as these kinds of resources have been unable to keep up with the rising load of new clientele. Despite this, people are wasting more food than ever before, with 60% of our landfills being made up with food waste. This thesis proposes an in-depth study on the food waste habits of several large industries. Using observational studies, interviews, as well as surveys to develop a detailed analysis on the food industry can target and identify the most effective way to save food waste and redistribute it accordingly to those in need. A solution will be developed to minimize the food waste attributed to food industries. A complex food redistribution and processing system can be developed to effectively support food banks, and charitable organizations in their efforts to support citizens going hungry.

Student Signature(s):	**Instructor Signature(s):**
Date: 04 / 10 / 2022	**Date:** 06 October 2022

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Chong, Kappen, Thomson, Zaccolo