Improving the Well-Being of Those Without Adequate Housing

by

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Abstract

This project aims to improve the well-being of unhoused individuals. It is estimated that over 235,000 Canadians experience homelessness every year. Rising housing prices and increasing costs of living are making it harder for people to afford a space for themselves, forcing some to live on the street. Building regulations make creating new housing difficult, especially in dense urban centres where there is not much space to begin with. With a lack of wealth and resources comes a lack of hygiene and personal care. Unhoused individuals, especially those not involved in shelter systems, often rely on public restrooms to fulfill their basic sanitary needs, and these restrooms may not get cleaned often enough. Interviews and surveys have been conducted to identify the immediate needs of the unhoused. Current solutions and services have been benchmarked to establish their benefits and features, and user pain points of those solutions and services analyzed. These insights will be used to inform the layout and usage of the final solution, taking the user's needs and preferences into consideration.

Keywords: homeless, hygiene, sanitation, services, unhoused

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Chapter 1: Introduction

1.1 Problem Definition

Homelessness is an issue that affects over 235,000 Canadians every year. The primary causes of this crisis are high rental prices and an expensive housing market. Even some of those working full-time jobs are unable to afford rent and are thus forced to live out on the street. Unhoused individuals face some of the worst living conditions in the world, often without adequate access to basic healthcare services, food, and sanitation. They must deal with harsh weather conditions, which is especially prominent in cities like Toronto with greatly contrasting hot summers and cold winters.

Sanitation and personal hygiene are necessities for all. Lacking them is not only detrimental to one's health, but may also affect their social interactions. Unhoused people have more difficulty with the upkeep of hygienic practices due to not being able to access services where they are available. They need services which allow them to sanitize and clean themselves because their harsh and unsanitary living conditions have negative effects on their health, and overall hygiene could help improve social interactions with others.

The intended solution would provide access to showers, laundry, and hairdressing services to all unhoused individuals.

1.2 Rationale & Significance

Initial research was done to identify major challenges for the unhoused population. Some questions the research aimed to answer included:

How do the unhoused access hygiene and sanitation facilities?

How much importance would you put on certain health and wellness services?

What are the most important factors in keeping one's property safe?

In addition to online searches for information about the unhoused, interviews with topic experts were conducted, as well as surveys and questions for unhoused people, the latter of which were distributed through Reddit's r/homeless subreddit. Existing relevant products and services have been

benchmarked and reviewed based on separate criteria. Information was gathered from their websites as well as image sources. Interview notes and survey results, as well as benchmarking information can be found in the Appendix of this document.

1.3 Background/History/Social Context

Historically, homelessness has been more prevalent among males. However, the number of unhoused women has been increasing, often due to domestic violence or family disruptions. Members of the LGBTQ+ community, particularly the youth, are at higher risk of becoming unhoused due to family rejection, discrimination, and lack of support networks. Many unhoused individuals also struggle with mental health issues and substance use. Mental health issues often go untreated among the unhoused population due to barriers in accessing healthcare services.

Some unhoused individuals may seek refuge in shelters provided by non-profit organizations, government programs, or religious groups. However, shelters may have limited capacity or specific rules that not everyone is willing to comply with, leading some to avoid them. Some individuals also have distrust in shelter systems regarding safety and security of themselves and their belongings. Unhoused individuals also face issues with law enforcement due to laws targeting activities such as loitering, sleeping in public spaces, or panhandling, which can worsen their situations.

Contrary to popular belief, a significant number of unhoused individuals have access to mobile phones or other personal communication devices. These devices are often vital for maintaining connections, seeking resources, or accessing support services. Apps have been developed which help connect unhoused individuals with resources such as shelters, food banks, healthcare services, and job opportunities. Additionally, many non-profit or healthcare organizations operate mobile clinics to provide medical care, mental health services, and substance abuse treatment to unhoused individuals. However, since the COVID-19 pandemic, many unhoused individuals have become too reliant on handouts from shelter services and other services coming to them, causing them to become complacent in their search for resources.

Chapter 2: Research

2.1 User Research

This section provides an overview of the product's users, existing hygiene practices, journey mapping of shower and laundry processes, and ergonomic design factors. All of this was used to inform the final design.

2.1.1 User Profile – Persona

The primary users are adult unhoused individuals of all genders. The secondary users are caretakers, service operators, and other service providers. The tertiary users are the municipal governments or organizations who purchase and are responsible for operating the service.

2.1.2 Current User Practice

Online video observations were conducted to see ways in which unhoused individuals access basic hygiene facilities, specifically showers and laundry. The first user observed is a male from Los Angeles. He begins his shower process by boiling water at a place where he goes to work on personal projects. He then pours the water into large plastic bottles, and uses those bottles as his water source for his shower. He applies shampoo to his hair, and soap to his body, and thoroughly washes it off. The second user observed is another male from Los Angeles, who opts to utilize a small washcloth and a sink basin at an outdoor shower area near the beach. The third user, a male based somewhere in the USA, was observed for his laundry routine. He lived in his car, and thus gathered his dirty clothes and detergent from his trunk. He used a laundromat to do both the wash and dry cycles of his laundry. After the machine cycles had finished, he folded his clothes and organized them in the trunk of his car. The fourth user, a male from the USA who was not unhoused, but had an alternate method of doing laundry, instead using a special watertight bag. He filled the bag with his clothes, then filled the remaining space with water. After tightening the bag and squeezing out the air, he rolled the bag back and forth on top of a towel on the ground for between 30 seconds and 3

minutes, and then dispenses the dirty water back into his sink. Following this, he rinses the washed clothes once again in the sink, and hangs them on a clothesline to dry.

2.1.3 User Observation - Activity Mapping

The following shows the user activity map for showering based on the online video observations.

	Preparation	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**	**Completion**
User Goals	Gathering items	Undress	First rinse	Soap (and shampoo) and rinse	Dry	Dress	Clean-up
User Actions	Acquiring soaps, hanging up towel	Taking off clothes, folding them, putting them on shelf/in cubby	Getting themselves wet, rubbing face, running hands through hair	Opening bottle, squeezing bottle, lathering in hands or on loofah/cloth, lathering on body/in hair, rinsing under water and scrubbing	Grab towel, rub towel on body, bottoms of feet	Grab clothes from shelf/cubby, putting them on	Gathering towel and other items, checking to make sure nothing is left behind, checking shower drain for hair
User Thoughts	Do I have everything I need? Are my clean clothes here?	I hope there is enough space here for everything I have. I hope my fresh clothes don't get wet. I hope the water is the right temperature	Is my hair wet enough to start lathering in shampoo?	Is this the right amount of soap/shampoo? Is it lathered enough? Did I miss any spots? Can I rinse it off now? Is it all rinsed off, or is there still some left?	Am I dry enough? Can I put my clothes on already?	Good, my clothes didn't get wet/Oh no, my clothes got a bit wet.	Did I leave any belongings? Did I leave hair in the shower drain?
User Feelings	Worried they will forget something	Might feel cold to get undressed	Feels nice to be under the water	Feels nice to rinse off soap, feel cleaner after, smell nice	Feel cold once water is shut off	Feel warm once their clothes are on again	Worried they will forget something, but also relieved to be done at last
User Experience 😀 🙂 😐 🙁 ☹	😐	🙁	🙂	🙂	🙁	😀	🙂
Problems/Challenges	Forgetfulness	Not enough space for clothes	N/A	N/A	N/A	Clothes get wet	Forgetfulness, shower drain plugged with hair
Ideas/Takeaways	N/A	Folding shelf for extra space	N/A	N/A	N/A	Cubby/drawer with door	Easily removable shower drain net

Table 1: User activity mapping – shower.

The following shows the user activity map for laundry based on the online video observations.

	Preparation	Task 1	Task 2	Task 3	Task 4	Completion
User Goals	Gathering items	Load clothes	Load detergent	Unload clothes	Fold and organize	Clean-up
User Actions	Acquiring detergent and dirty clothes, possibly putting them in a hamper or bag	Opening machine door, checking that it's empty, taking clothes out of hamper/bag into laundry machine, closing door	Taking cap off detergent bottle, opening lid of machine detergent reservoir, squeezing bottle/pouring detergent in, closing reservoir lid, closing cap of bottle	Opening machine door, taking clothes out of machine into hamper/bag, closing door	Take each clothing item out and fold, put in bag/on shelf, or wherever clothes are stored. Folding may occur before clothes are put back in hamper (under Task 3)	Checking machines for any clothing items left behind
User Thoughts	Do I have everything I need? Are all my dirty clothes here?	Is there anything in the machine from the last person using it?	I hope I put enough soap (detergent) in. Let's hope this machine is working properly.	I hope my clothes got washed properly and they're not soapy still.	N/A	Did I leave anything behind?
User Feelings	Worried they will forget something	Anxiousness	Anxiousness	Anxiousness	Relief, possibly finds folding clothes therapeutic?	Worried they have forgotten something, but also relieved to be done at last
User Experience 😀 🙂 😐 ☹ ☹						
Problems/Challenges	Forgetfulness	Sufficient space for clothes, door is difficult to open/close	Not being able to see status of machine or clothes inside	Opening/closing door may be difficult, clothes may still be soapy	Folding clothing may be difficult sometimes, especially in tight spaces	Forgetfulness
Ideas/Takeaways	N/A	Transparent components, weight sensor which checks if empty, different way of opening or closing door	Status indicator, timer, transparent components	Weight sensor suggests how much soap to put in?	Folding table or something that folds out	N/A

Table 2: User activity mapping – laundry.

Key Activity	Steps	Current User Experience	Potential Improvement
Shower	Undressing Washing Drying Dressing	Anxiousness in preparation (ensuring they have all items, water temperature)	Unsure
Laundry	Loading clothes Loading detergent Unloading clothes	Anxiousness that machine works properly	More transparency (literally, transparent materials), possibility of human operation rather than machine

Table 3: Takeaways from user activity mapping.

Potential improvements which may help inform design:

1. Compact layout of shower to ensure belongings do not get wet, while having enough space to move around as necessary.
2. Status indicators necessary for both laundry and shower spaces, so other patrons can know how long each has been in use, and time remaining.
3. Finding methods of reducing water flow will help decrease the space required for water tanks, and could help increase efficiency of water heating methods.

User needs which still need to be studied:

The most critical observations which still need to be studied is layout of shower spaces, and types of laundry machines. Further ergonomics studies are required for the shower spaces. Some laundry solutions exist, like some laundry drums, which are human-operated (thus not requiring electricity) and need much less water to work. Additionally they can also dry clothes in the same unit. They also require a lot less time to complete a full cycle as they have a much smaller capacity, which is a potential drawback.

2.1.4 User Observation - Human Factors of Existing Products

The potential human factors of opportunities are limited in relation to the opportunities for laundry machines.

Many existing small-capacity laundry machines, especially those seen during the user observations, require a lot of physical work and movements to function properly. Repetitive

movements such as rotating a handle or squeezing and rolling a bag put strain on one's body. Additionally, these smaller machines are often not at a comfortable height for the user, meaning the user must sit in an awkward position or kneel on the ground.

2.1.5 User Observation - Safety and Health of Existing Products

Majority of the health and safety issues of existing products (specifically of small-capacity laundry machines) are due to user error. The machines themselves are typically powered by the user and not by way of a motor or connected device. This means issues that may typically arise from appliances, including motor burnout or electrical failures are no longer an issue.

2.2 Product Research

Existing similar products and services was reviewed based on four areas: benefits and features, functionality, interface, and aesthetics. As no service vehicles are currently run which provide all three of shower, laundry, and haircutting services, the most relevant services will be reviewed. The six chosen services to be reviewed are as follows:

- Sherbourne Health Bus
- Sanguen Mobile Health Clinic
- Mainline Needle Exchange mobile shower trailer
- City of Hamilton Dental Health Bus
- Empowering Cuts mobile barbershop
- Krew Kutz mobile barbershop

Each service will be reviewed based on information gathered from their websites as well as from image sources. Additionally, some information was gathered on recreational vehicles (RVs), which will be discussed more in 2.2.4.

2.2.1 Benchmarking - Benefits and Features of Existing Products

Sherbourne Health Bus

This mobile service provides a variety of health and wellness services, including counseling, education, and harm reduction programs. It makes scheduled stops around the city of Toronto from Monday to Friday, during specified hours. It can service three clients at a time, with three or more staff on board. It is aimed at providing services to individuals facing barriers to accessing health care services.

Sanguen Mobile Health Clinic

This service provides basic health services and has a nurse practitioner, registered nurse, and social support workers on board. It services the Kitchener and Cambridge areas, with three to four scheduled locations in each of those cities, each at specified hours from Monday to Thursday. It can service one client at a time, with two to four staff on board. It aims to provide services to unhoused or precariously-housed individuals.

Mainline Needle Exchange mobile shower trailer

This was a pilot project which lasted for nine weeks and was stationed in a field in Dartmouth, Nova Scotia. It provided six shower stalls which anyone could use.

City of Hamilton Dental Health Bus

This service provides basic dental care to low-income individuals or those without dental coverage. It operates at pre-scheduled locations around Hamilton between 8:30am and 4:30pm, Monday to Friday.

Empowering Cuts mobile barbershop

This service is a haircutting service aimed towards unhoused individuals based in the Philadelphia area and is not operated by the government, but rather an individual running a barbershop business. It can seat three clients in the main space of the vehicle, and includes a waiting area and one bathroom.

Krew Kutz mobile barbershop

This service is in Brisbane, Australia which provides haircuts to the general male population (not specifically those who are unhoused). They operate throughout normal business hours, and can service one client at a time, with one staff on board.

2.2.2 Benchmarking - Functionality of Existing Products

The Sherbourne Health Bus provides the greatest variety of services within the single vehicle, followed by the Sanguen Mobile Health Clinic. Regarding client capacity, the Mainline Needle Exchange mobile shower trailer has the highest capacity, being able to service six clients at a time. Client capacity may be dependent on the variety of services available, as different services require different amounts of space, and most require some personnel or staff to function. Other criteria can be evaluated, including cost of manufacture and cost of operation.

2.2.3 Benchmarking - Aesthetics and Semantic Profile of Existing Products

Aesthetics were determined based on two main criteria: variety of exterior colour, and shape of the vehicle. The City of Hamilton Dental Health Bus was the most colourful of the services benchmarked, with a large, brightly-coloured ribbon adorning the bus's otherwise white exterior. The Mainline Needle Exchange mobile shower trailer was the only service whose main colour was not white. It was mostly light blue, with water droplets as the livery and large icons (male/female, handicapped) on the sides of the trailer. The mobile shower trailer was also the most rectilinear in shape, followed by the City of Hamilton Dental Health Bus, and the least rectilinear being the Krew Kutz mobile barbershop, due to the vehicle being a full-size van with a sloped windshield rather than a bus or trailer.

2.2.4 Benchmarking - Materials and Manufacturing of Existing Products

For the chassis of the vehicles listed, specific grades of metal differ depending on the vehicle manufacturer and material supplier. Limited information is available on the specific types of metals used. The Ford F-Series chassis (including the F-550) uses “fully boxed steel” with a “C-channel… made from high-strength steel, [and an] aluminum bed and cab” (Ford Motor Company, n.d., Light Metal Age, 2016). Their E-Series uses “single channel, 36,000 psi steel (Ford Motor Company, n.d.). Although specifics on the material used for the Ram Promaster’s chassis could not be found, “high-strength steel 50,000-psi C-channel frames” were specified for Ram’s 3500, 4500, and 5500 chassis cabs (FCA Canada Inc., 2018). Winnebago’s JS-Series RVs are built on Ford’s F-53 Motorhome chassis which uses “single-channel, 36,000-psi steel” (Ford Motor Company, n.d.). The Mercedes-Benz Sprinter van uses one of two grades of rolled steel, CR240LA or S235JRG2 (likely dependent on regional suppliers or application). Their yield strengths (see Figure 7 below) are comparable to the strength specified for the Ford E-Series, but less than that of Ram’s truck cabs.

Material	Yield strength	Tensile strength
CR240LA	260-340 N/mm²; 37700 psi-49300 psi	≥ 240 N/mm²; ≥ 34800 psi
S235JRG2	≥ 235 N/mm²; ≥ 34075 psi	340-510 N/mm²; 49300 psi-73950 psi

Figure 1: Types of steel found in the chassis of the Mercedes-Benz Sprinter (Mercedes-Benz USA, LLC, 2022).

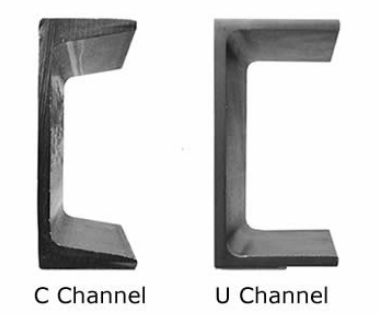


Figure 2: The shape of a C-channel steel piece, compared to a U-channel piece. Image source: Hebei Jinshi Industrial Metal Co., Ltd.

For RVs in general (not specific to a manufacturer), exterior panels are typically made from aluminum or fibreglass. Benefits of aluminum include it being a cheaper material to purchase, easier to repair, lightweight, and it not delaminating as fibreglass may tend to. Some drawbacks of aluminum are that it is prone to dents, and there is a potential for water leaks, which may cause any wooden panels inside the RV to rot. Meanwhile, fibreglass has a cleaner look and is more aerodynamic (especially than corrugated aluminum), and has more noise deadening. However, fibreglass is not easy to repair by oneself (unlike aluminum dents which may be hammered out), and delamination may occur (separation of resin and cloth layers) if water leaks through (RecPro, n.d.).

For the interior walls, typically either plywood, OSB, or thin MDF is used. Vinyl paneling may be used for more luxurious projects due to its higher price. Ceilings are typically made of FRP (fibre-reinforced plastic) or PVC due to them being lightweight and moisture resistant (De Cloet, 2023). Panels may be joined with staples or screws. Staples are cheaper, while screws are more solid and durable. Cabinetry (especially in luxury RVs, less so in service-purpose vehicles) is made from wood, often real wood for a more luxurious feel, but may be made from cheaper MDF or similar engineered wood products (Jayco, 2018).

The body panels of RVs may be made from aluminum or fibreglass. Aluminum either gets stamped into the shape of the desired body panel, or in the case of corrugated aluminum, gets rolled to shape. Fibreglass panels go through a process where sheets of the fibreglass material are laid on top of one another at different angles (depending on application and strength necessary) in a mold with a mix of resin and hardener. Then pressure or a vacuum is applied to ensure the layers stick together. Heat may be used to help cure the resin. Lastly, the fibreglass panel is removed from the mold (Industrial Quick Search, n.d.). Steel used in RV chassis are roll-formed (ArcelorMittal, n.d.).

Figure 3: A worker lays sheets of carbon fibre onto a surface, in a process similar to that of fibreglass. Carbon fibre is often used for high-performance automotive and aerospace applications. Image source: Automotive News Canada.

Figure 4: A worker spreads resin onto layers of fibreglass underneath. Image source: Fibre Glast Developments Corp.

For larger campers, generally the outer frame is built first, followed by the floor, cabinetry, walls, roof, and then finishing (Jayco, 2016). For campers in existing vehicle frames (e.g. a retrofit Mercedes-Benz Sprinter van), first the structural modifications are made to the frame, then electrical, plumbing, and HVAC systems are updated and installed, followed by the interior paneling (floors, ceiling, walls) with any doors and windows, then furnishings and fittings, and lastly finishings.

2.2.5 Benchmarking - Sustainability of Existing Products

These service vehicles were created around being able to provide services to clients in the most efficient way possible. Sustainability is not a primary concern of such services. Existing services also use existing vehicle platforms to reduce costs of R&D (research and development), materials, and manufacturing. Existing platforms are mostly diesel or gas powered, and EV (electric vehicle) powertrains are up and coming (especially for smaller chassis which are made by manufacturers with other EV platforms, e.g. Ford, Ram).

User health and safety is limited in most RVs, and often does not differ far from safety mechanisms found in homes and commuter vehicles. Driver assistance features such as adaptive cruise control, pre-collision braking, lane keeping assistance, and hill start assistance are already available in many RVs (Winnebago Industries, Inc., n.d.). Manufacturers also consider air quality, fire safety, and ergonomics. As for environmental initiatives, many techniques for improving energy efficiency and material sustainability are being used. Unfortunately, the interior styles found in RVs (especially luxury ones) often depend heavily on real wood and other heavy and unsustainable materials, increasing the carbon footprint of what is already a massive vehicle. Manufacturers are looking into different materials such as recycled plastics, bamboo, and reclaimed wood for finishing and carpentry, which may help reduce weight of the vehicle (and thus improve fuel efficiency) while coming from more sustainable sources. Methods of improving energy efficiency, such as the application of LEDs, energy-efficient appliances, and improved insulation are also being employed (Becker, 2022). Solar panels are also becoming more prominent in RVs, making use of those vehicles' large roof surfaces (Winnebago Industries, Inc., n.d., Rong, 2019). While EV platforms are on the rise, especially platforms manufactured by commuter vehicle brands such as Ford and Ram, the majority of RVs are still powered by diesel, with biodiesels being developed as an alternative fuel source (Cummins Inc., n.d.). RVs also implement low-flow water fixtures (toilets, showers), composting toilets, and greywater recycling.

The typically engineered laminates and composites often used in these vehicles are extremely durable and do not need replacement for a significant time. So, rather than using a more sustainably-sourced alternative that may need replacing after a few years, a more durable material is used which lasts longer.

2.3 Summary of Chapter 2 - Topic Understanding

In summary, unhoused individuals each have their own way of accessing hygiene services. Some access city-operated mobile services or public restrooms, while others may use facilities in gyms or restaurants, and some prefer to use their own equipment and methods. Whatever the method may be, it is crucial that unhoused individuals have a way to bathe themselves and clean their clothes.

Chapter 3: Analysis

3.1 Analysis - Needs

This section provides an overview of the needs of the different users, but mostly for the primary users, who are those without adequate housing.

3.1.1 Needs/Benefits Not Met by Current Products

Products examined were non-electric portable laundry machines. The approach used was to find similar products which were different in one major attribute, which helps draw out different sets of benefits and features. Aside from common benefits, other differentiated benefits would also become clear.

Two Products: Non-Electric Portable Laundry Machines – Hand-Crank vs. Pedal-Powered

Figure 5: Left – The Wonder Wash (The Laundry Alternative, Inc.), $79.99; right – Drumi (Yirego), $384.00 (USD).

Benefits and Features – from Promotional Literature

The Wonder Wash		Drumi	
Benefits	**Features**	**Benefits**	**Features**
Cleans laundry in 1 to 2 minutes	Brand-new, patent-pending lid snaps on and off in one motion	Wash, rinse, and spin dry up to 2kg of laundry in 5-10 min.	Net weight: 8.5kg
Pays for itself within 60 days	Dimensions: 12” x 12” x 16”	Lift up for easy portability	Dimensions: 400mm (15.75”) x 495mm (19.5”) x 416mm (16.4”)
Fully portable, no hookup required	Washing capacity: 7-8 dress shirts/10 t-shirts/2 pairs of jeans	Removable Drum gives you access to clean inside	Max spin speed: 600 RPM
Gentler on clothes, ideal for delicates		Reduce your carbon emission	

Table 4: Benefits and Features of two non-electric portable laundry machines.

3.1.2 Latent Needs

LINKING BENEFITS WITH NEEDS – Service Vehicle
(Shower, Laundry, Haircutting)

Product – Service Vehicle				
Needs	**Benefits and Underlying Needs**	**Level of importance**		
Basic Needs *Physiological*				
Food, water, shelter	Shelters users from elements		Moderate	
Pleasure, gratification *(sensory, compulsive responses)*	**Unhoused:** Shower feels comforting, clean **Caregiver:** Providing much-needed service		Moderate	High
Security *Safety, securing resources*				
Safety				
State, Group, Individual				
Securing resources *Optimization of limited resources (cost effectiveness)* • *Value* • *Accumulation of resources (wealth)*	Free or low-cost services (limited wealth)			High
	Reliability, routine, schedule			High
Control over environment (tasks)	*Product (tool) that amplifies human abilities*			
Convenience *Ease of Use*	Simple, intuitive controls		Moderate	
Speed (fast, less time)	Machine-operated or professional-performed much faster than manual or self-performed	**Slight**		
Control (precision, responsiveness, power)	Preferences in how cleaning/haircutting is done			
Long Term Security/Stability of Group *Health/care/education of children*				
Environmental sustainability	Environmental (operator) – use of freshwater, potential for recycling of greywater		Moderate	
Insurance (car, house), pension, investments	Insurance – looking clean may help keep a job			High

Social Belonging *Effort / resources to belong to a 'tribe'*				
Fear of Abandonment				
Fear of the enemy	Distrust of others Fearful others may take their belongings			High High
Tribal Identity				
Behavior cues for survival *(copying behaviors… safe to eat, learned skills)*	Cleaning and caring for oneself		Moderate	
Behavior cues for social interaction of group *(copying behaviors… Interaction cues, play, have fun)*	Social interaction with operators, hairdressers, other users		Moderate	
Peer Pressure				
Social Expectation *(social covenant (gift))*				
Esteem ***Personal influence in 'tribe'***				
Social Status'The elite have it…I want to be like them'	Performing a role within society		Moderate	
Social Recognition	Being clean and looking fresh			High
Sexual attractiveness				
Self-Actualization ***'Higher order' Functions/Needs Needs that are pre-dominantly 'outer cortex'***				
Intrinsic pleasure	Feeling of being clean Hairdresser – enjoyment in seeing client with an improved look – **MASTERY** of skills			High High
Creative endeavors	Hairdresser – may have some artistic expression in how a client's hair may look		Moderate	
Experiential (extrinsic)				
Experiential (intrinsic)				
Emotional				

Table 5: Linking benefits with needs.

Needs/Benefits Relationship for the Related Products

Summarizing the results from the Table, with filtering based on *Level of Importance*, we obtain:

Benefits of Both – Laundry Machine

- Both machines get the clothes cleaned properly **assurance** for user
- Task gets done in a quick manner **ease of use** for user

Benefits of Each

Product A: Hand-Crank Machine

- Fewer moving parts reduces cost and weight **value** for vehicle manager
- Fewer moving parts reduces chance of maintenance issues **assurance** for vehicle manager
- Manual operation provides trust in machine operation **assurance** for user

Product B: Pedal-Powered Machine

• Much less manual effort needed	**ease of use** for user
• Less manual effort and interaction may mean less wear-and-tear	**assurance** for operator
• More durable materials mean less wear-and-tear	**assurance** for operator
• Faster cycle times	**assurance** for user, **comfort** for operator

3.1.3 Categorization of Needs

Service Vehicle

Need Type	Product Benefits (marketing)	Human Needs (psychology)
Immediate Needs		
	Marketing- Existing Need **Short term** need. • Personal hygiene, sanitation • Upkeep of physical appearance	**Psychology- Unfulfilled Human Needs** **Pain point alleviation:** • Body odour • Buildup of dead skin, germs, dirt, other biomaterial • Fatigue/tiredness
Latent Needs	Latent needs are **unknown**, the user being unaware of them	
	Examples of latent product benefits **Breakthrough Products** • Autonomously operated, self-cleaning stations • Improvements in laundry technology (faster cycle times) **Unanticipated Experience** • N/A	***Examples of latent needs*** **Fundamental human needs (Maslow)** • Social acceptance, especially in workforce '***Hidden Persuaders***' N.A>
Wants / Wishes		
	Marketing- a.k.a. Incipient Needs • Increased productivity of machines and flow of services/people inside	**Psychology- Unfulfilled Human Needs** • Social acceptance, not just in immediate relationships but in the public eye

Table 6: Categorization of needs.

Unhoused people need services which allow them to sanitize and clean themselves because their harsh and unsanitary living conditions have negative effects on their health, and sanitation could help improve social interactions with others.

3.2 Analysis – Usability

Analysis of the data related to usability was conducted and the results prioritized.

Usability is defined primarily by 4 quality components:

1. Ergonomics — How safe is it to do the task?
   How comfortable is it for the user to do the task?
2. Productivity — How quickly can the user perform tasks?
3. User Interface — How easy is it for users to get feedback and respond?
4. Ease of Use — How easy to use is it for the user to do the task?
   How pleasant and fulfilling is it to use the design?

Maps based on surveys, interviews and user observations were generated (see Chapter 2). These maps filtered the data to emphasize pain points, points of delight, as well as the thoughts and feelings (user experience) of the user. The main points related to usability are summarized below.

3.2.1 Journey Mapping

An Empathy Map was generated from video user observations.

Main pain points related to usability:

1. Anxiousness in preparation of items
2. Water may not be right temperature
3. Machine may not be working properly

A User Journey Map was generated from video user observations.

Main pain points related to usability

1. Compact shower layout to ensure everything is within reach, yet personal belonging will not get wet
2. Simple interface on laundry machine to ensure user is not confused or overwhelmed
3. Covers/doors of laundry machines are easy to open and close, do not require too much effort

3.2.2 User Experience

Focused user observation: laundry (loading, unloading, washing, drying, etc.)

TASK: Laundry	Ergonomics – Safety & Comfort	Productivity (Efficiency)	User Interface	Ease of Use
Loading laundry: Take clothes out of bag, load into machine.	Take off backpack, place backpack on floor, bend down, open backpack pocket, open cover of machine, take out clothes, put clothes into machine, close cover of machine. *Bending, lifting, pulling, pushing.*	Pulling and pushing open/close door/cover of machine. Door may get stuck, or **unclear whether door is closed** properly.	Backpack pocket containment method (zipper, buttons, etc.), machine door/cover handle.	Need space to take clothes out of bag.
Choosing settings: Press buttons, load detergent.	Select laundry settings (typically water temperature, load size). Acquire detergent, pour/place into machine. *Pressing (buttons), twisting.*	Pouring the **correct amount** of detergent – typically differs depending on load amount. Unsure of which **settings** to use, may be too **complicated.**	Settings panel on laundry machine, cap of laundry detergent (typically twist cap or snap).	Ensure settings are straightforward, only as many settings as needed for the task (not overcomplicated).
Unloading laundry (washer): Take clothes out of machine, into dryer.	Open cover of both machines, bend down to transfer clothes from one machine to another. *Bending, lifting, pulling, pushing.*	Would be easier if everything could be done in one machine – **transferring clothes takes time**.	Machine door/cover handle.	Need to transfer clothes from one machine to another. Ensure nothing was left in first machine.
Unloading laundry (dryer): Take clothes out of machine, fold clothes, put away.	Open cover of machine, take out clothes, fold, put away in bag/basket/hamper, close cover of machine. *Bending, folding, lifting, pulling, pushing.*	May have **insufficient space** to fold clothes properly – **takes longer** than expected.	Machine door/cover handle.	Need space to fold clothes, and to organize clothes before putting them away.
Common Issues	**Ergonomics - Safety**	**Efficiency**	**User Interface**	**User Experience**
	Bending, putting strain on back and knees.	Distance between washer and dryer.	**Indicators**	Understanding of the machine's status
	Lifting too much at once, too high.	Enough space to sort items and fold clothes.	Lights, sound (cycle complete, setting choice confirmation), icons, words	
	Twisting knobs, pulling open and pushing closed doors/covers may put strain on arms/hands.	May use too much detergent and thus clothes do not get cleaned well enough, and requires extra wash cycle to fully remove soap.	**Controls**	Intuition of a machine's functions, how simple a task is to complete
			Handles (machine doors/covers)	

Table 7: Focused user observation of laundry process.

Summary: How Usability May Inform Design

Ergonomics & Safety

Bending and lifting (transfer of clothes from bag to machine, machine to machine, machine to bag)

Productivity

Optimal use of detergent and water (clothes not too soapy nor not soapy enough)

Distance between machines and organization space

Interface

Understanding of control panel, keeping things simple

Ease of Use

Space required to organize clothes

Ensuring machines are working properly

3.3 Analysis - Human Factors

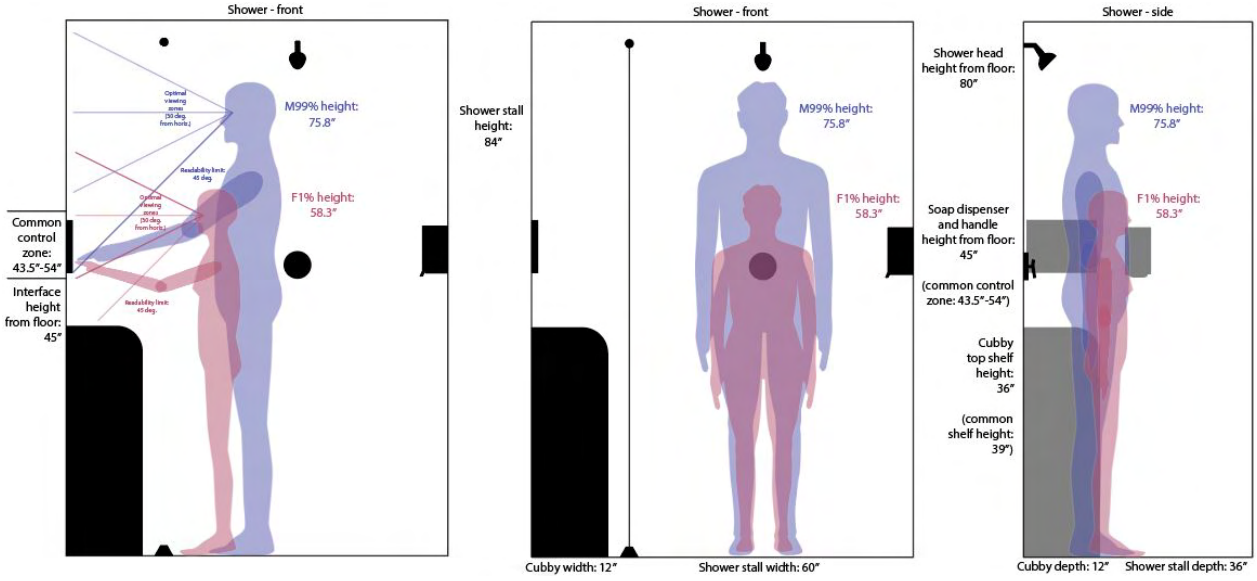


Figure 6: Ergonomic drawings of proposed shower stall.

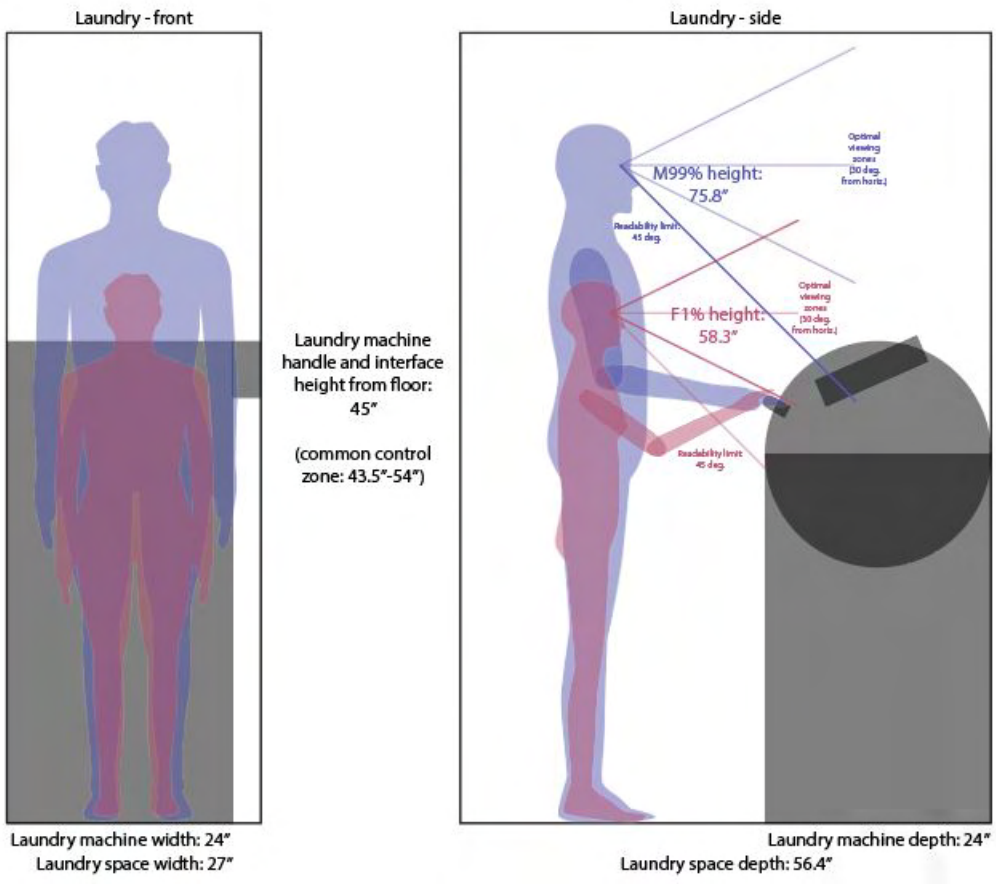


Figure 7: Ergonomic drawings of proposed laundry space.

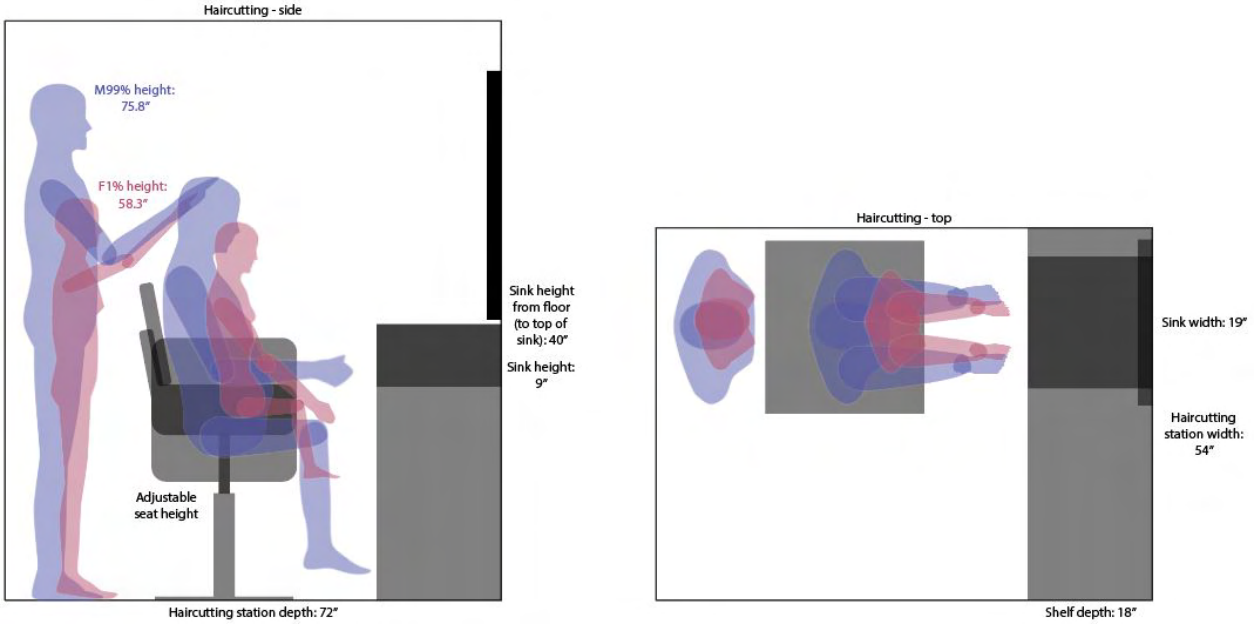


Figure 8: Ergonomic drawings of proposed hairdressing station.

3.3.1 Product Schematic - Configuration Diagram

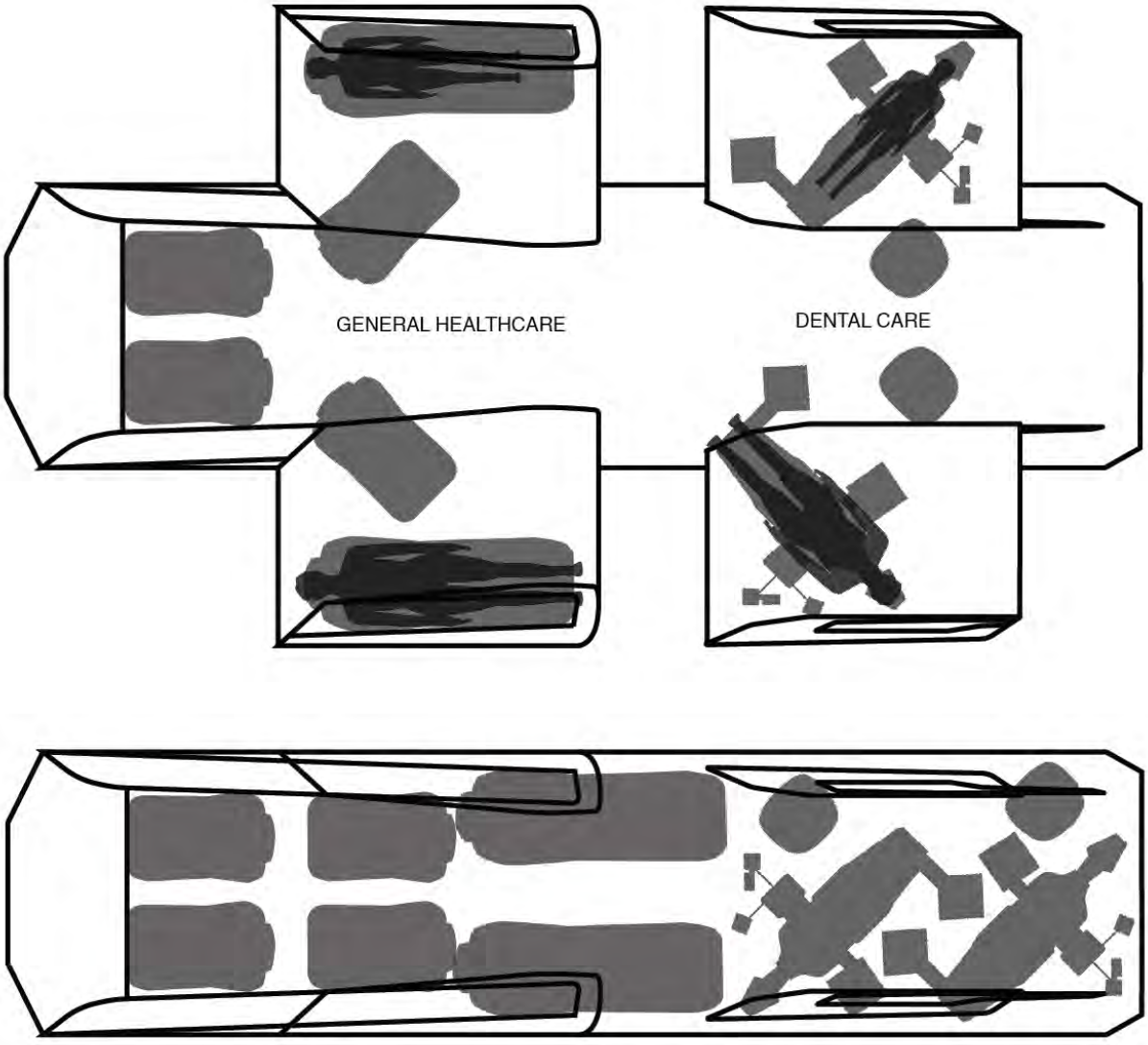


Figure 9: Layouts shown of a potential service vehicle solution.

3.3.2 Ergonomic - 1:1 Human Scale Study

Figure 10: 5th percentile vs. 95th percentile males standing in shower, rear view.

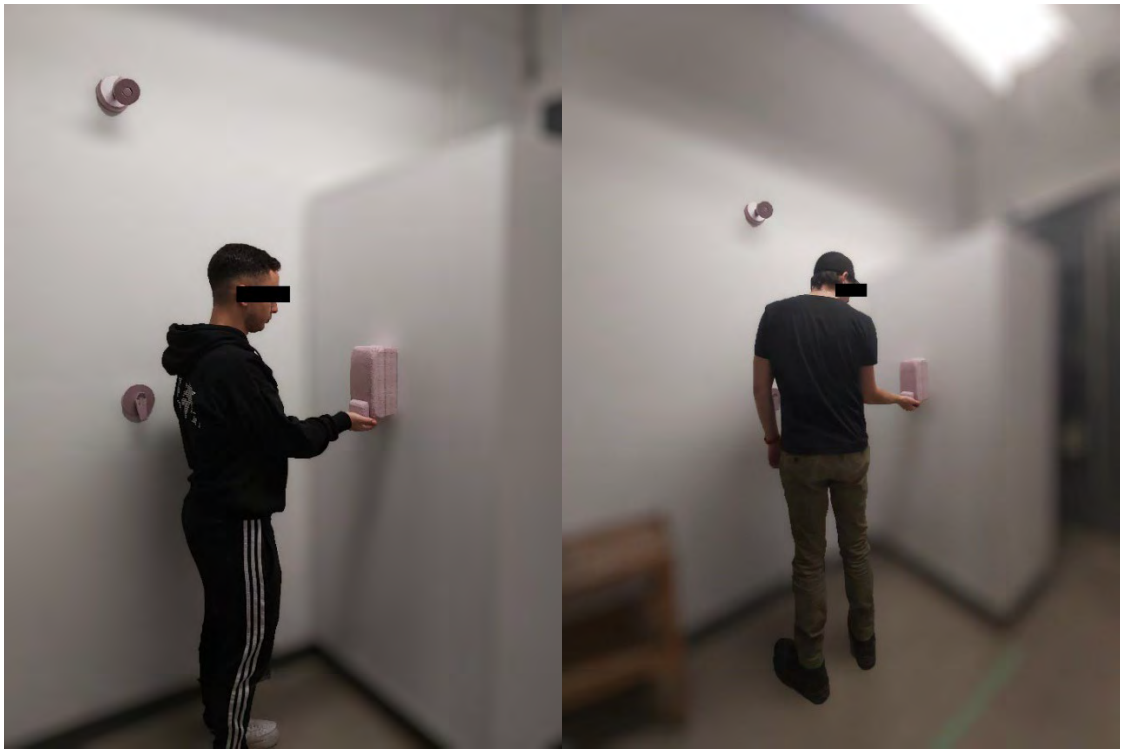


Figure 11: 5th percentile vs. 95th percentile males using soap dispenser, ¾ view.

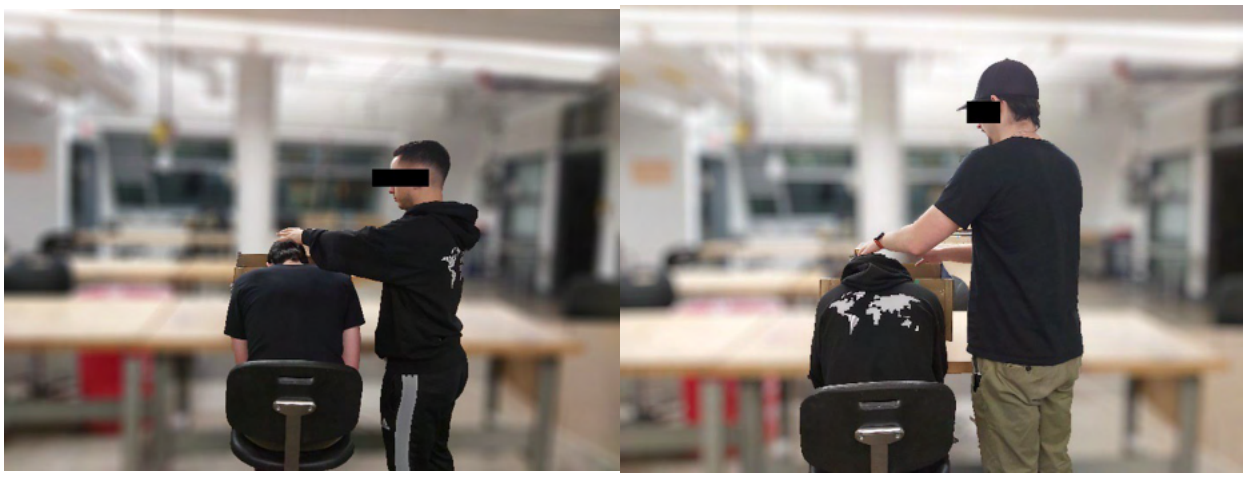


Figure 12: Left - 5th percentile male attending to 95th percentile male; right - 95th percentile male attending to 5th percentile male, rear view.

Figure 13: Left - 5th percentile male attending to 95th percentile male; right - 95th percentile male attending to 5th percentile male, side view.

3.4 Analysis - Aesthetics and Semantic Profile

The forms, materials, and colours used in the final solution should be soothing and promote a feeling of relaxation. The reduction of institutional-style materials and colours is necessary, as some users may find those triggering. Universally-recognized symbols must be used to reduce perplexity when using services or operating machines.

3.5 Analysis - Sustainability: Safety, Health, and Environment

The health and well-being of clients is a primary concern. The proposed vehicle would include self-disinfecting showers and toilets, with a disinfecting spray automatically being emitted after every use of the shower, and an automatic floor sweeper deployed with every use of the toilet. Additionally, the vehicle's operator would inspect the showers after every use to ensure cleanliness of the space, and that no clients had left any belongings behind. A towel and sandals would be provided to each client and washed after each use. Emergency switches would be within reach in each of the private enclosed spaces (i.e. toilets and showers) to notify the operator of any incidents that occur. Security cameras would be employed in common spaces for the safety of all clients. All cameras and emergency notifiers could be monitored by a master control panel located in the driver's compartment.

Another method of managing traffic flow within the proposed vehicle would be the separation of interior spaces using pocket door partitions, and the entry/exit points of the vehicle. One entryway would be located near the front of the vehicle for the driver's compartment and hairdressing spaces. One entryway would be dedicated to the showers and one of the toilets, and one entryway dedicated to the laundry space. Additionally, a second toilet would only be accessible from outside the vehicle.

3.6 Analysis - Innovation Opportunity

Initiatives can be made to improve the use of resources on board. Solar panels can be used to power auxiliary equipment. A sand battery can be used to heat the water and reduce the energy used to do so over the course of a day. Low-flush toilets can be employed to reduce water usage. Small-capacity laundry machines can be used, which would not require as much water to operate.

3.6.1 Needs Analysis Diagram

Figure 14: User needs, pain points, insights, and delights.

Prioritization of User Needs:

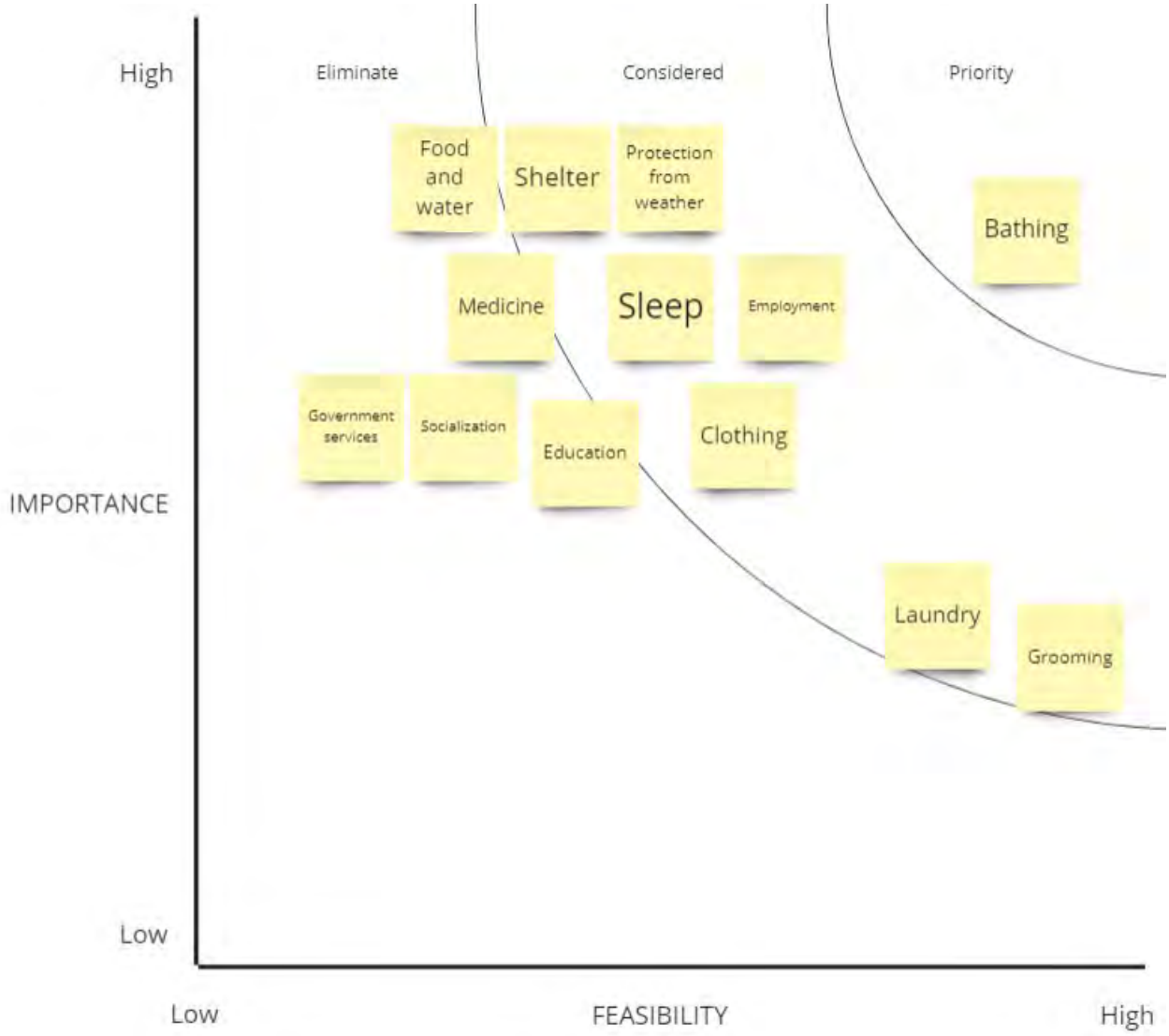


Figure 15: Prioritization of user needs.

3.6.2 Desirability, Feasibility, and Viability

There is a great desirability for sanitation services among the unhoused, who primarily use public restrooms to keep themselves clean. The high traffic flow of public restrooms means they are often not sufficiently clean throughout most of the day. Having a clean space to conduct sanitary practices is necessary for those who cannot otherwise do so.

One factor which would hinder feasibility is the necessity of plumbing and electricity in such a small space. Extra consideration must be given to these systems in the vehicle.

Financial viability is a concern, as municipalities often have very strict budgets. Materials and manufacturing processes must be made sufficiently inexpensive such that they can be made affordably.

3.7 Summary of Chapter 3 - Defining Design Brief

The Goal of the Design Thesis

To improve the living conditions of those without adequate housing.

Objectives

The 8 **objectives** that will guide the design of a solution for hygiene services for unhoused are:

1. Provide basic bathing, laundry, and grooming services.
2. Establish a secure environment where users feel confident about the safety of their belongings.
3. Mitigate body strain from lifting or bending motions.
4. Ensure easy access to facilities considering location and opening hours.
5. Minimize confusion or perplexity of processes through simple interface controls.
6. Streamline the process involved by minimizing the number of steps.
7. Improve the aesthetic appeal of the services for the user.
8. Implement eco-friendly materials and efficient use of resources.

Chapter 4: Design Development

4.1 Initial Idea Generation

Intent: Aim to give users a sense of care, community, independence while fulfilling their most essential needs

Maslow's Hierarchy of Needs: Unhoused Individuals

Self-actualization	Maintain discipline, realize self-improvement and education
Esteem	Independence in daily tasks, perform a certain role within a group
Love and belonging	Feeling of community, trust in themselves and others
Safety needs	Protected from aggressive individuals, avoid burns, avoid cuts, avoid traumatic injuries
Physiological needs	Air, water, food, shelter, sleep, clothing

Figure 16: Maslow's Hierarchy of Needs for Unhoused Individuals, as found through research.

4.1.1 Aesthetics Approach and Semantic Profile

The product should have a welcoming, friendly design which invites users to it. Symbols and signs should be used over words when possible to improve accessibility for all. To reduce user error, any machines should require the fewest number of steps possible, and could use sensors to help aid any decision-making processes. Materials should be used which can put up with wear and tear.

4.1.2 Mind Mapping

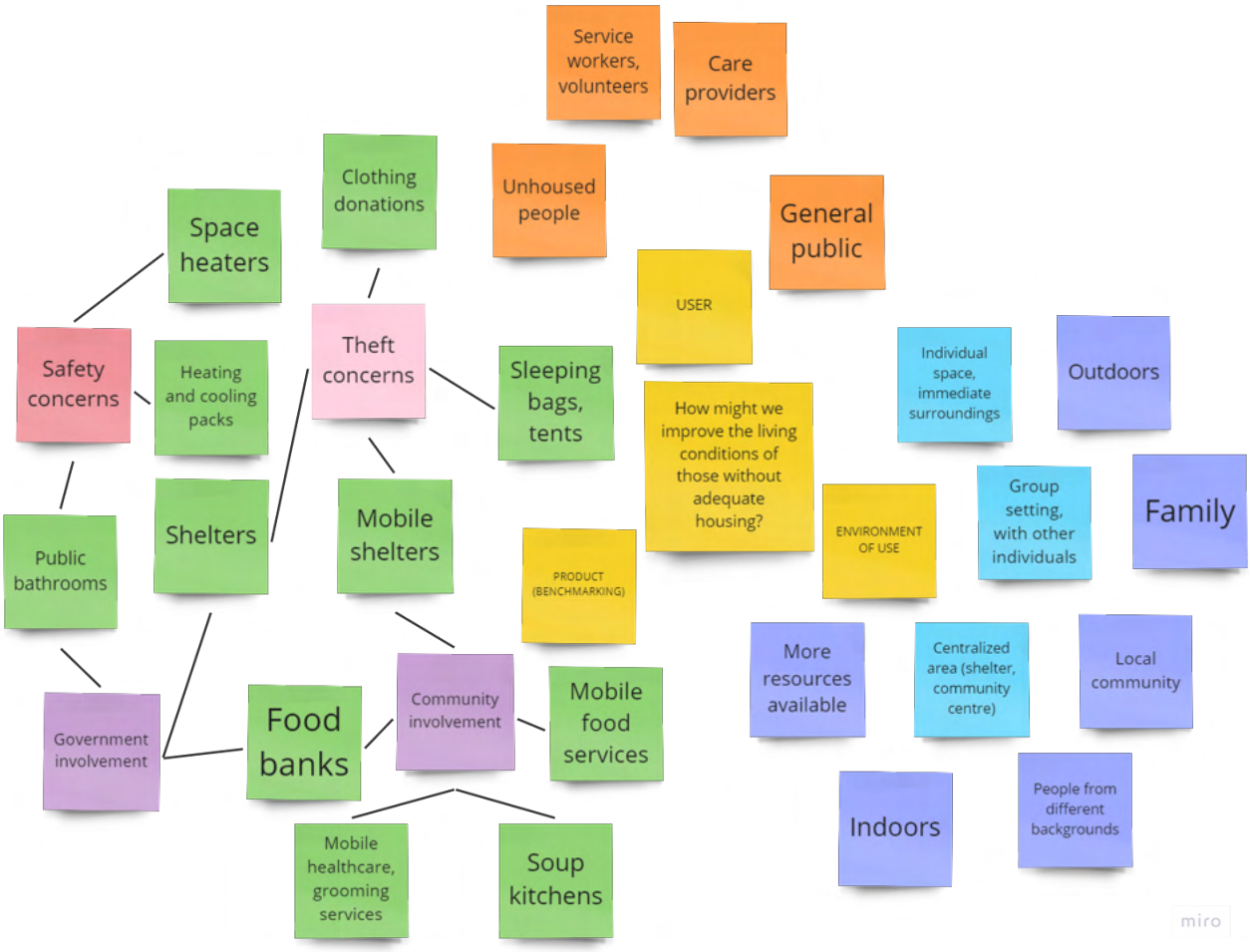


Figure 17: Mind mapping of user, product benchmarking, and environment of use.

4.1.3 Ideation Sketches

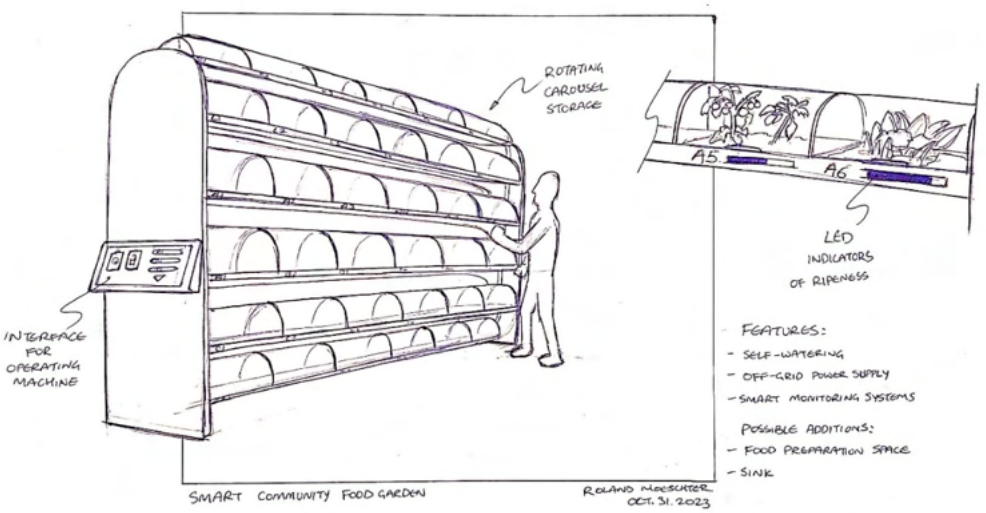


Figure 18: Ideation #1 – smart community food garden.

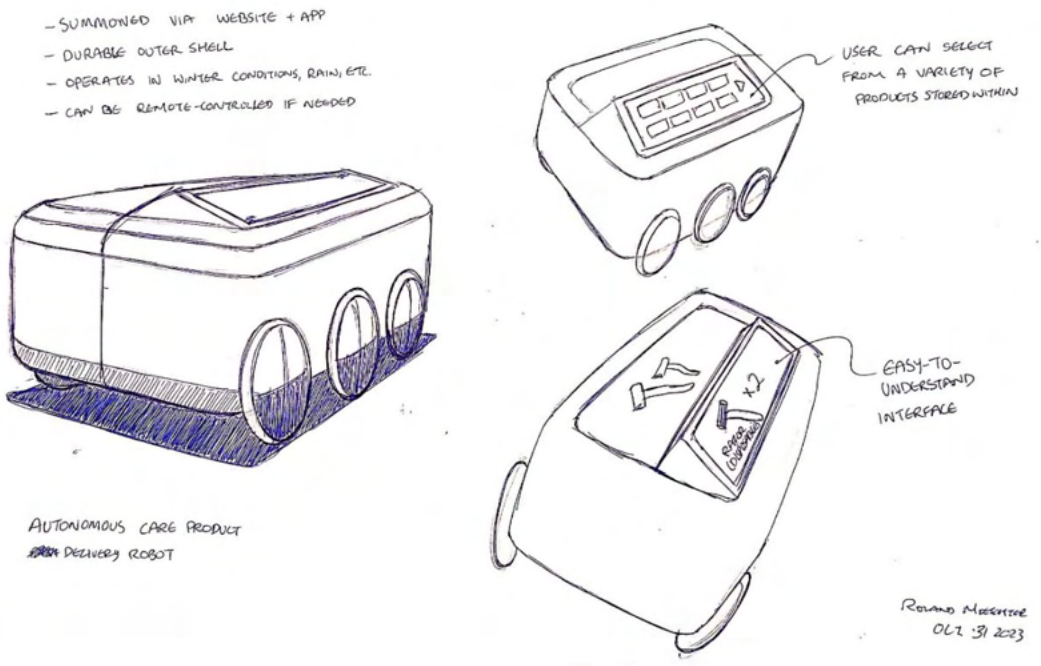


Figure 19: Ideation #2 – autonomous care product delivery robot.

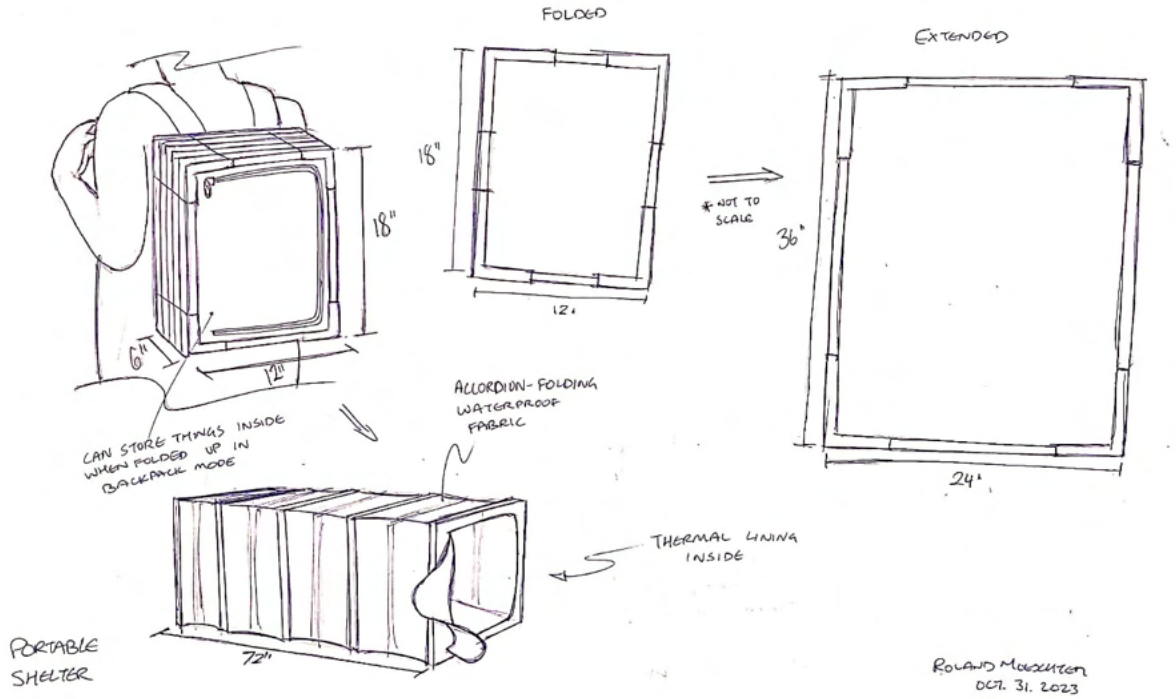


Figure 20: Ideation #3 – portable shelter.

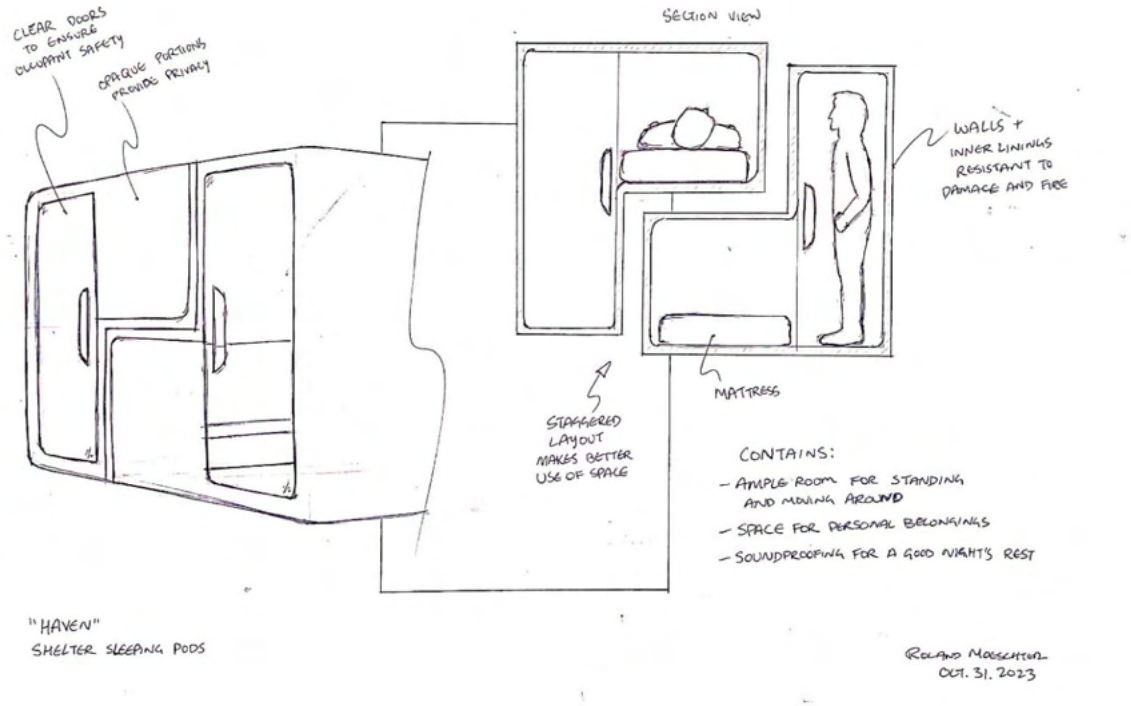


Figure 21: Ideation #4 – shelter sleeping pods.

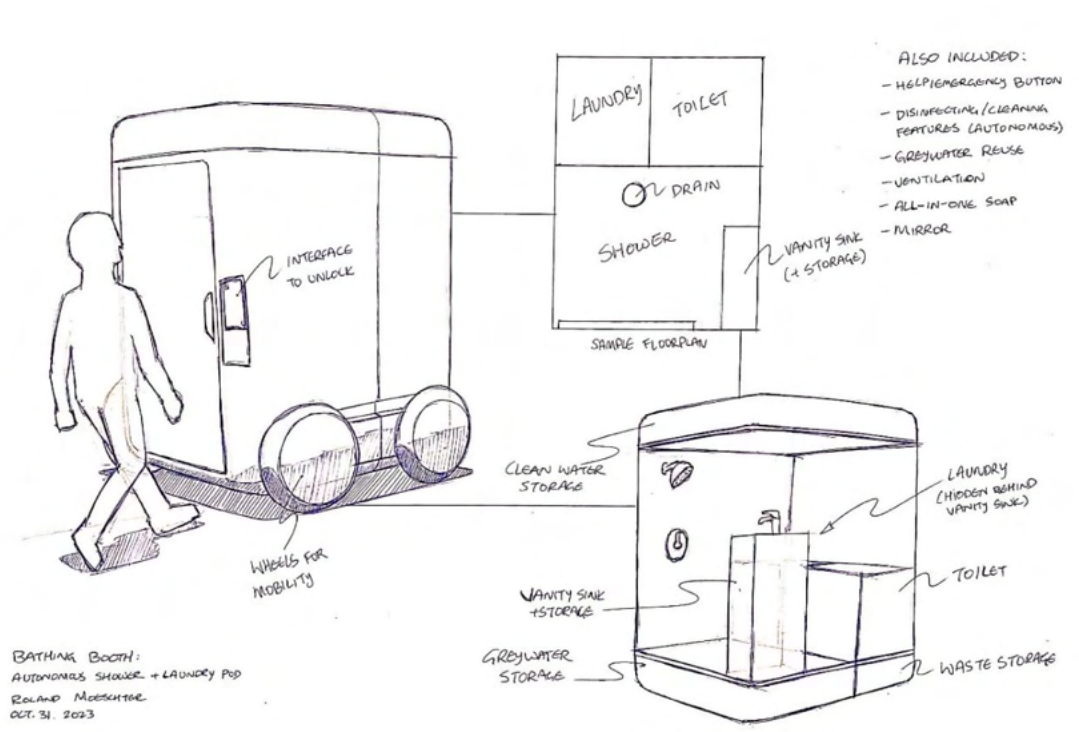


Figure 22: Ideation #5 – autonomous shower and laundry pod.

4.2 Concepts Exploration

4.2.1 Concept One

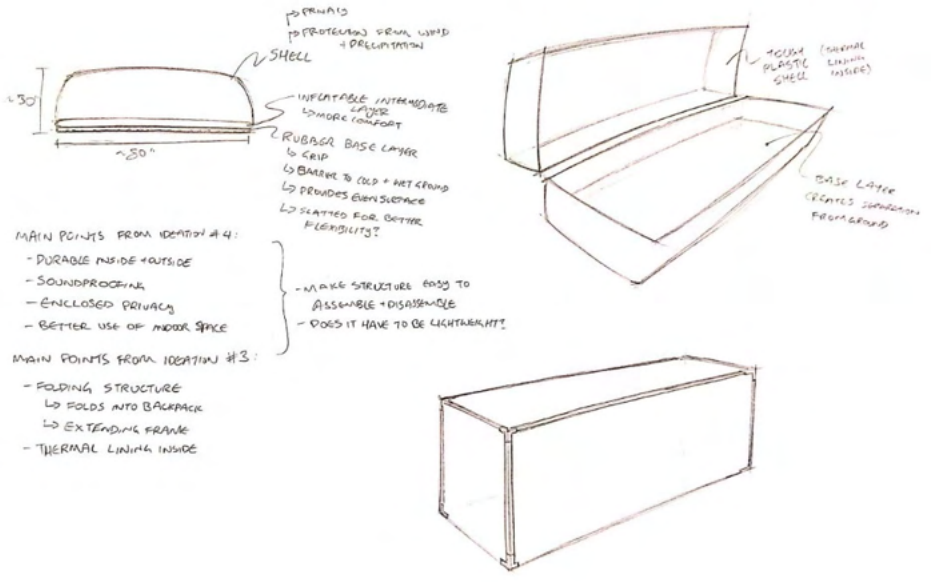


Figure 23: Concept exploration of portable shelter.

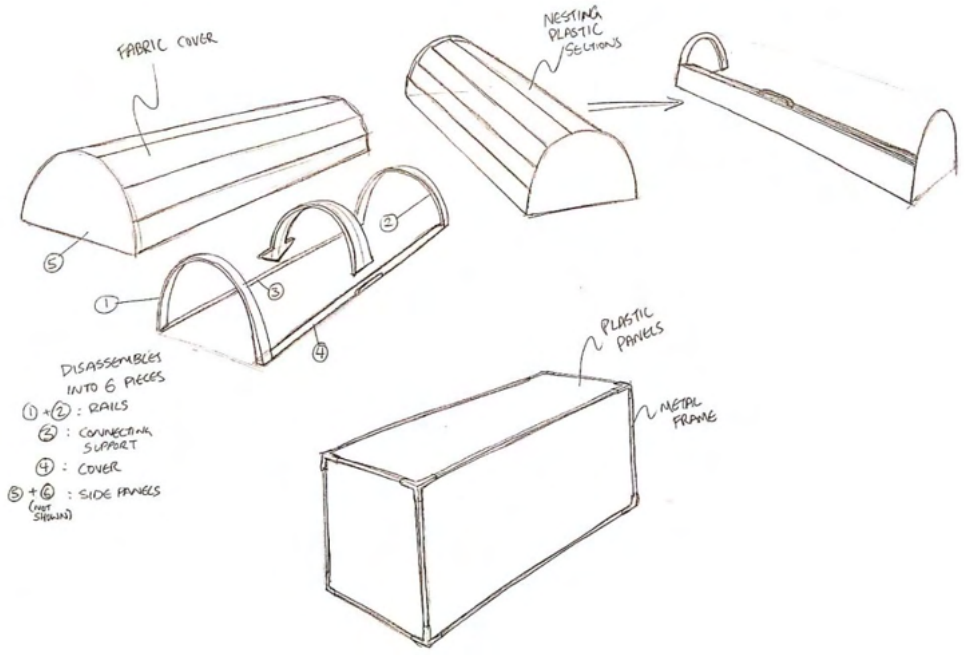


Figure 24: concept exploration of portable shelter.

4.2.2 Concept Two

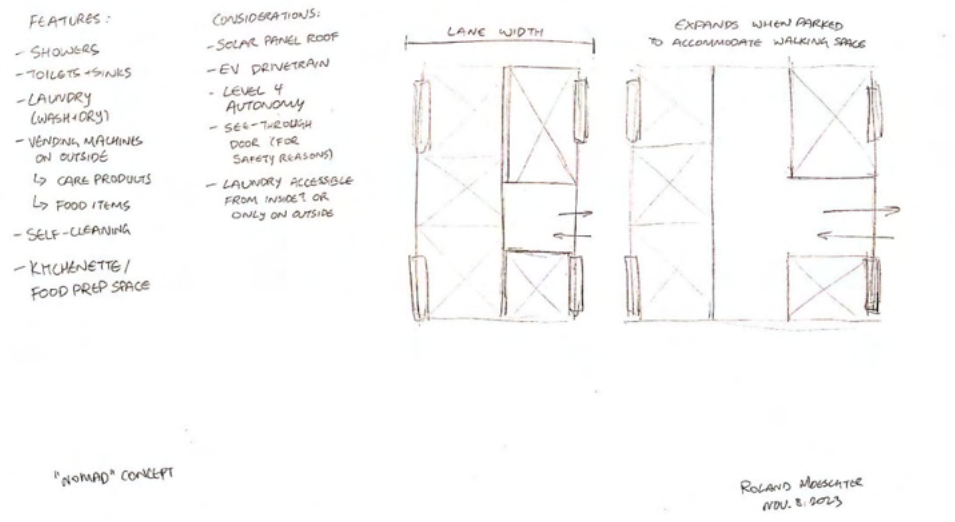


Figure 25: concept exploration of shower and laundry vehicle.

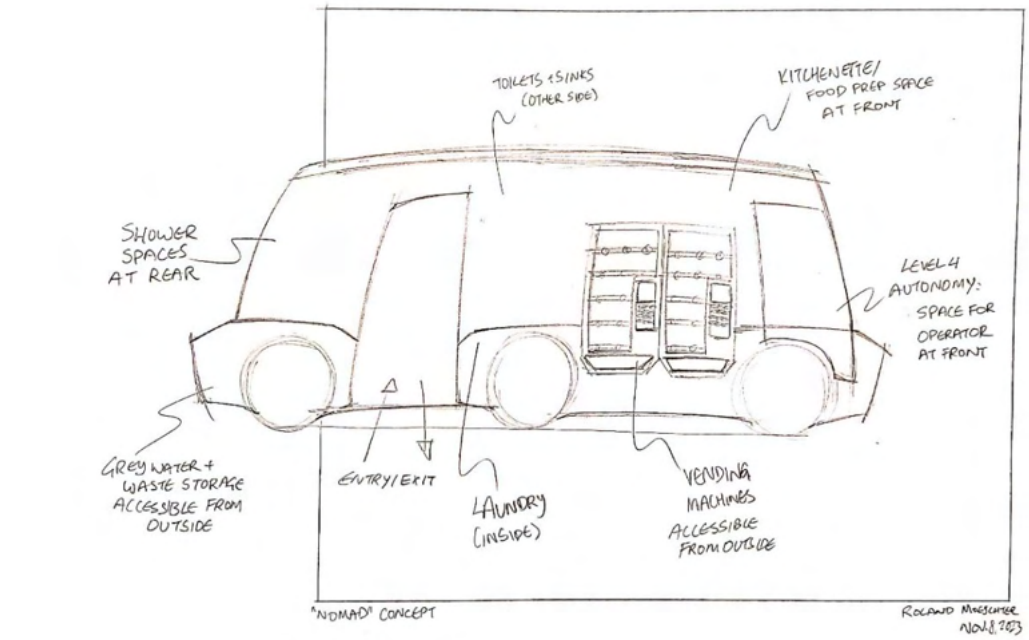


Figure 26: concept exploration of shower and laundry vehicle.

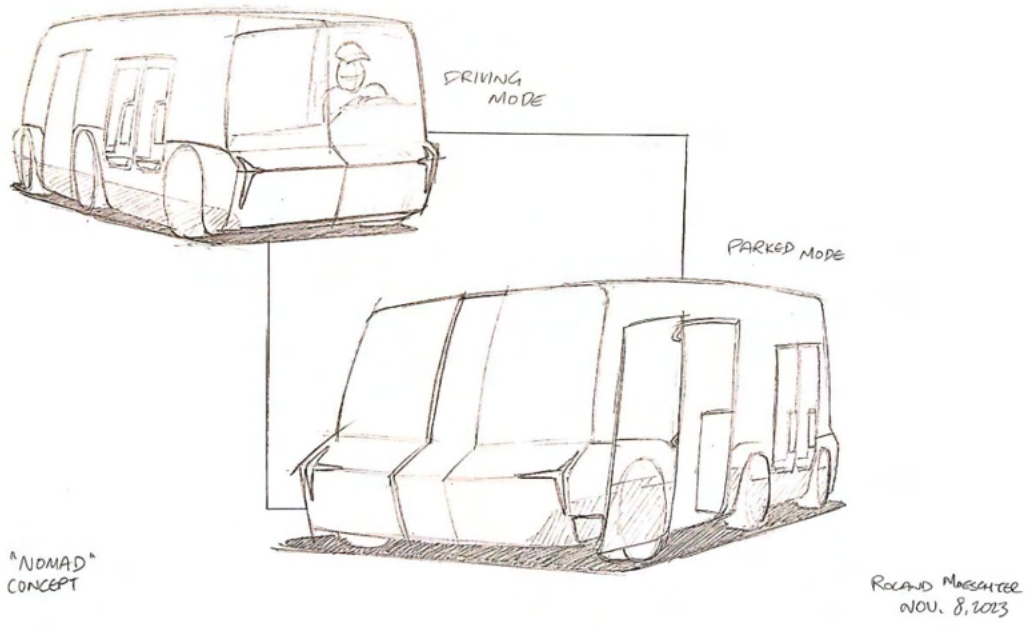


Figure 27: concept exploration of shower and laundry vehicle.

4.3 Concept Strategy

Social:

Brings much-needed shelter, supplies, resources to unhoused

Technological:

Autonomous features, smart features

Environmental:

Use of renewable energy, recycling of resources

Value:

Makes unhoused individuals feel cared for, sense of community

4.3.1 Concept Direction and Product Schematic One

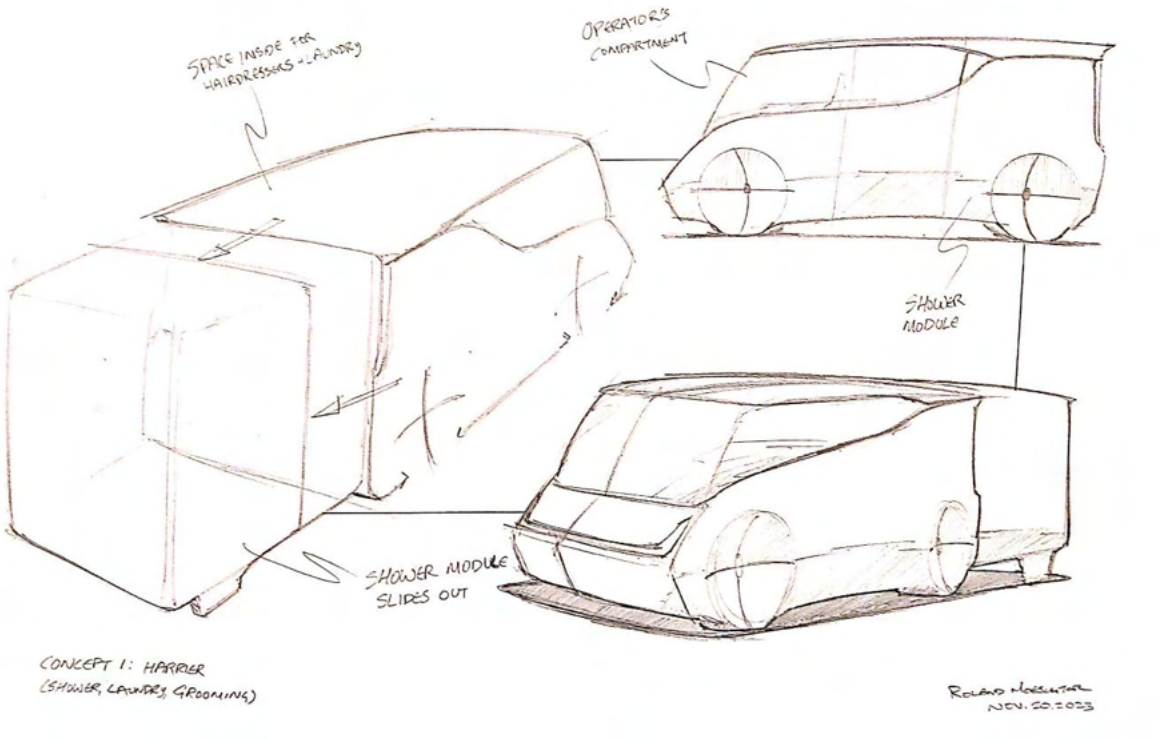


Figure 28: Concept development of shower, laundry, and hairdressing service vehicle.

4.3.2 Concept Direction and Product Schematic Two

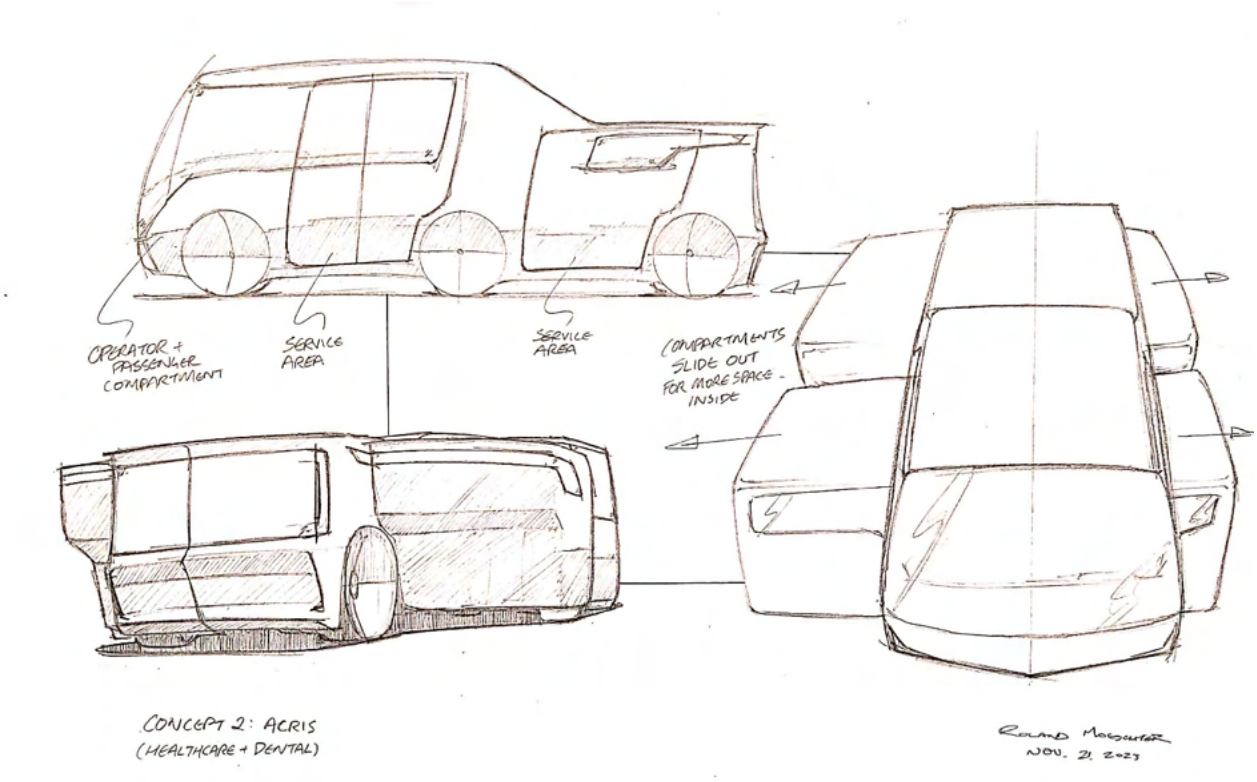


Figure 29: Concept development of healthcare and dental service vehicle.

4.4 Concept Refinement and Validation

4.4.1 Design Refinement

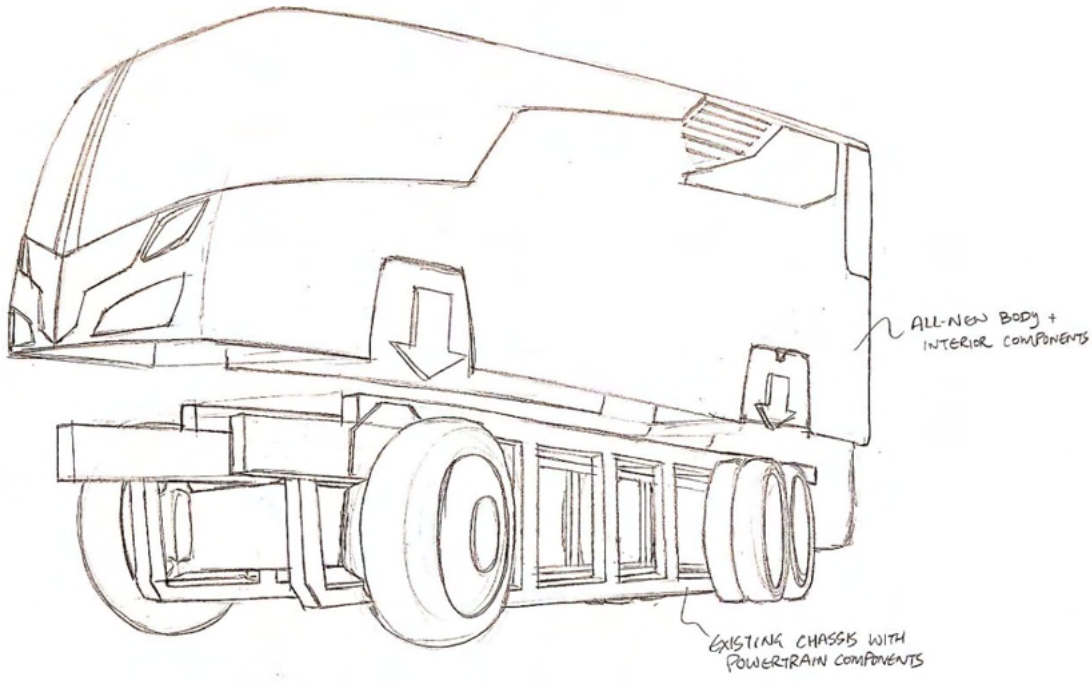


Figure 30: Concept refinement of RV. Body would be built on existing frame.

Figure 31: Concept refinement – interior design.

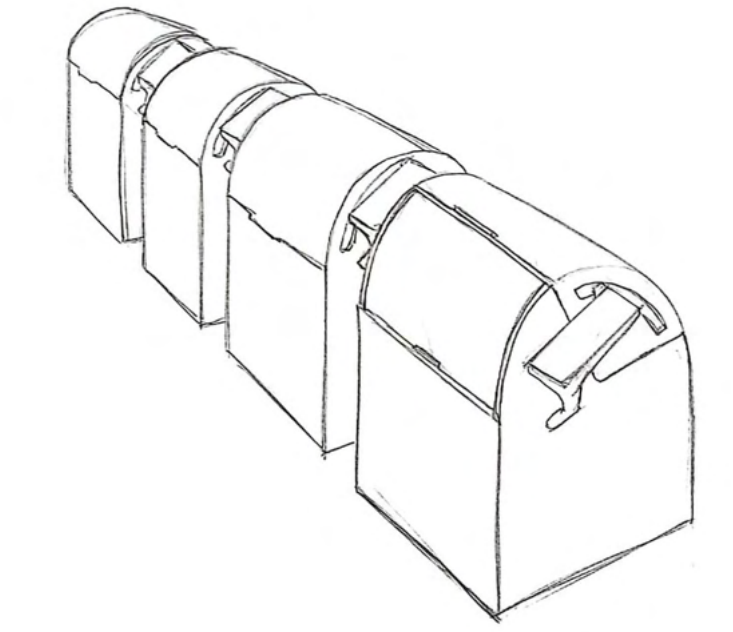


Figure 32: Concept development of laundry machines.

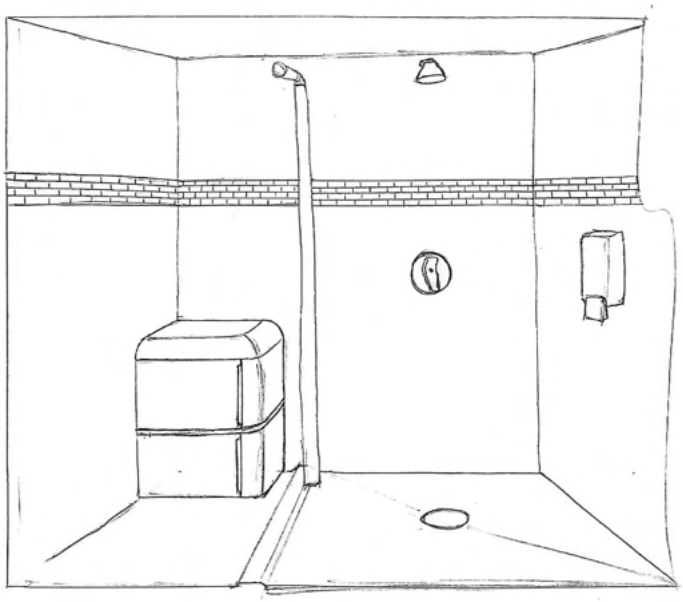


Figure 33: Concept development of shower.

4.4.2 Design Development

Figure 34: Concept development of laundry machines and layout with humans overlaid.

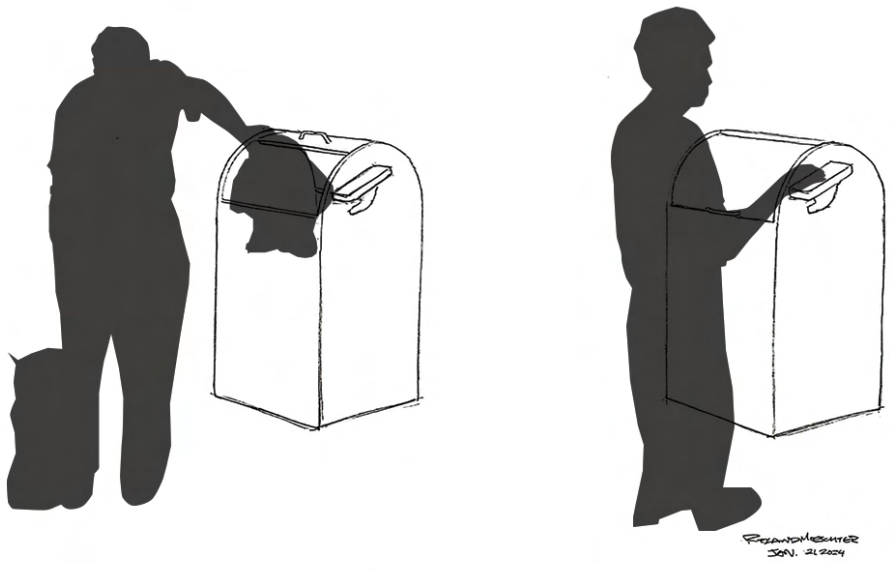


Figure 35: Concept development of laundry machines with humans overlaid.

4.4.3 Refined Product Schematic and Key Ergonomics

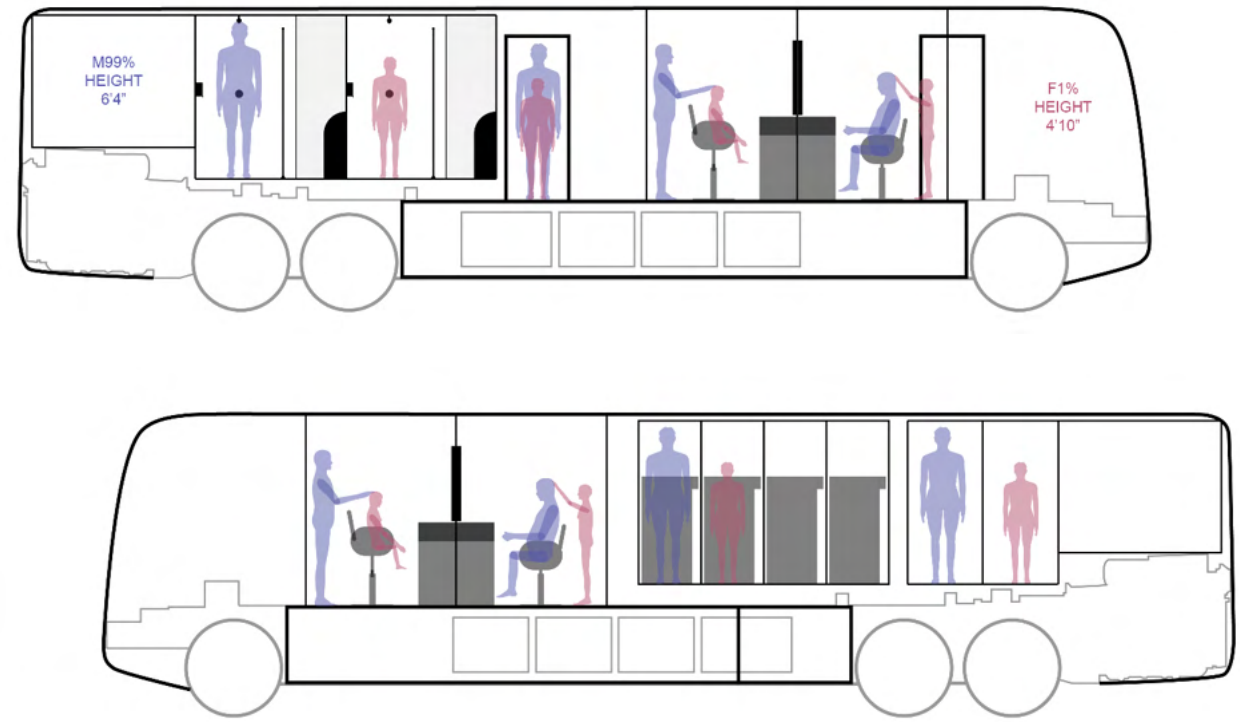


Figure 36: Developed product schematics.

4.5 Concept Realization

4.5.1 Design Finalization

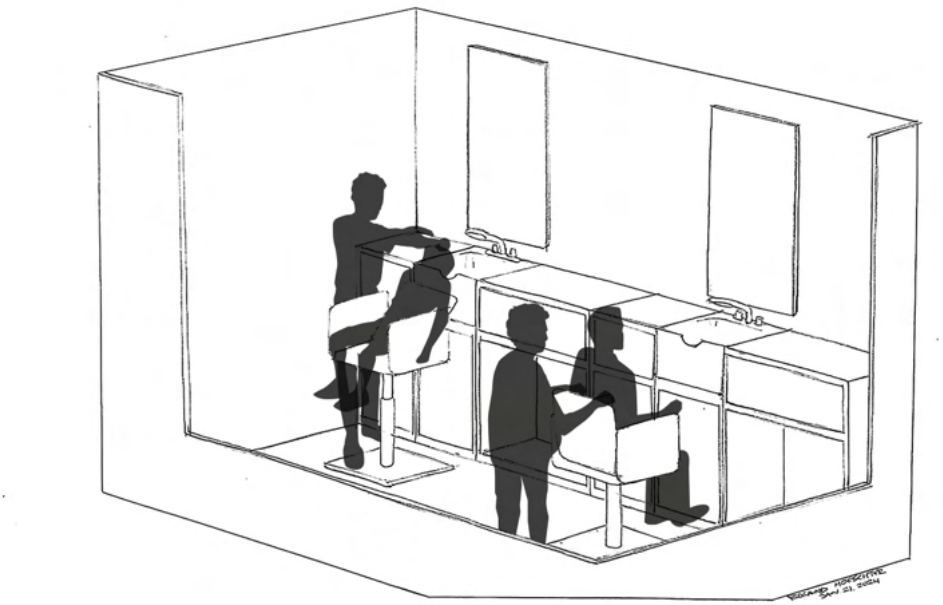


Figure 37: Development of hairdressing stations with humans overlaid.

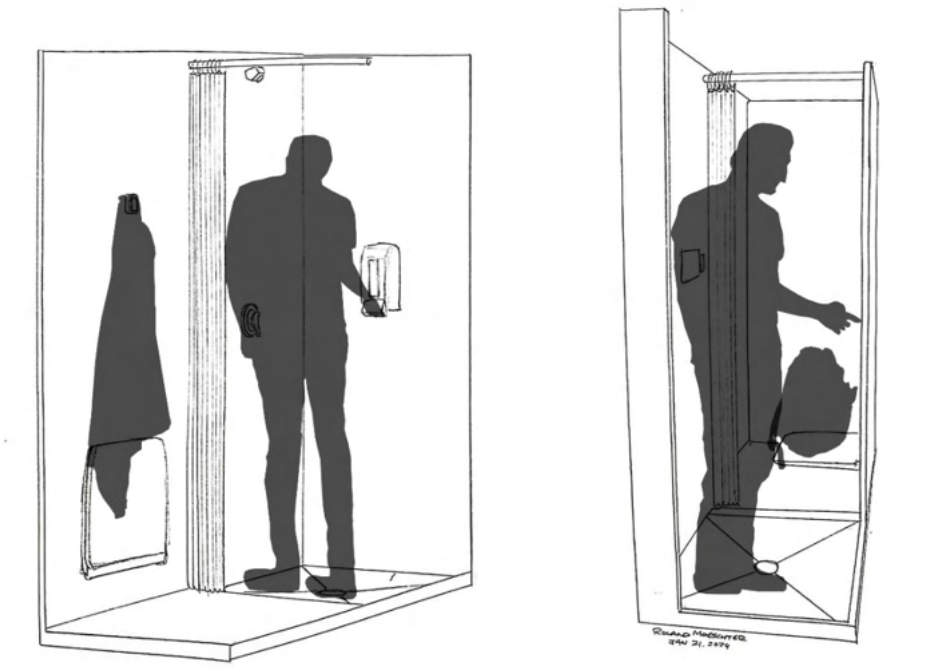


Figure 38: Development of shower with humans overlaid.

Figure 39: Development of toilet stall with humans overlaid.

4.5.2 Physical Study Models

Figure 40: Front ¾ view of physical study model.

Figure 41: Rear view of physical study model.

Figure 42: Top view of physical study model showing hairdressing area.

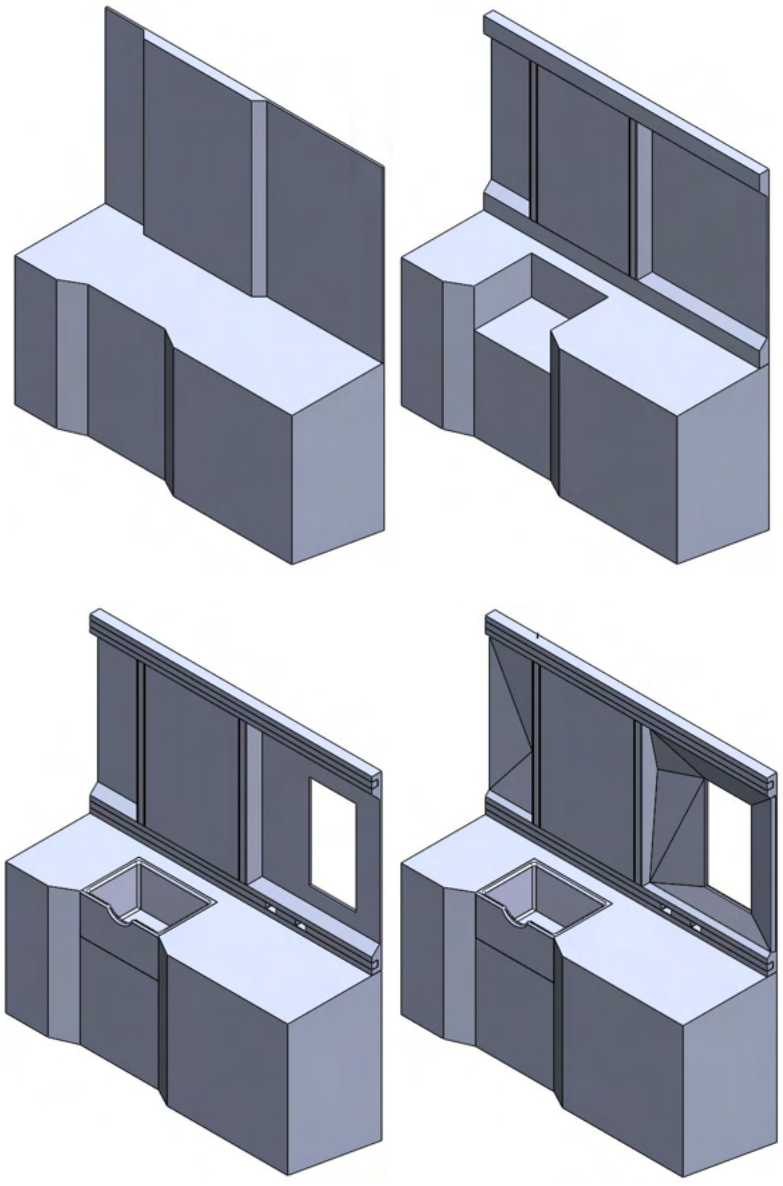
Figure 43: Top view of physical study model showing shower stations and toilets.

Figure 44: Top view of physical study model at an angle, showing shower stations and toilets.

4.6 Design Resolution

Some key changes were made from the concept development stages to the sketch model fabrication, and lastly to the final design. Firstly, the laundry machine configuration was changed to stack two machines on top of one another, and have two sets of these, thus doubling the number of machines in the same footprint. A water heater space was added between the two toilets. The exterior was iterated several times before the final design language was decided upon.

4.7 CAD Development



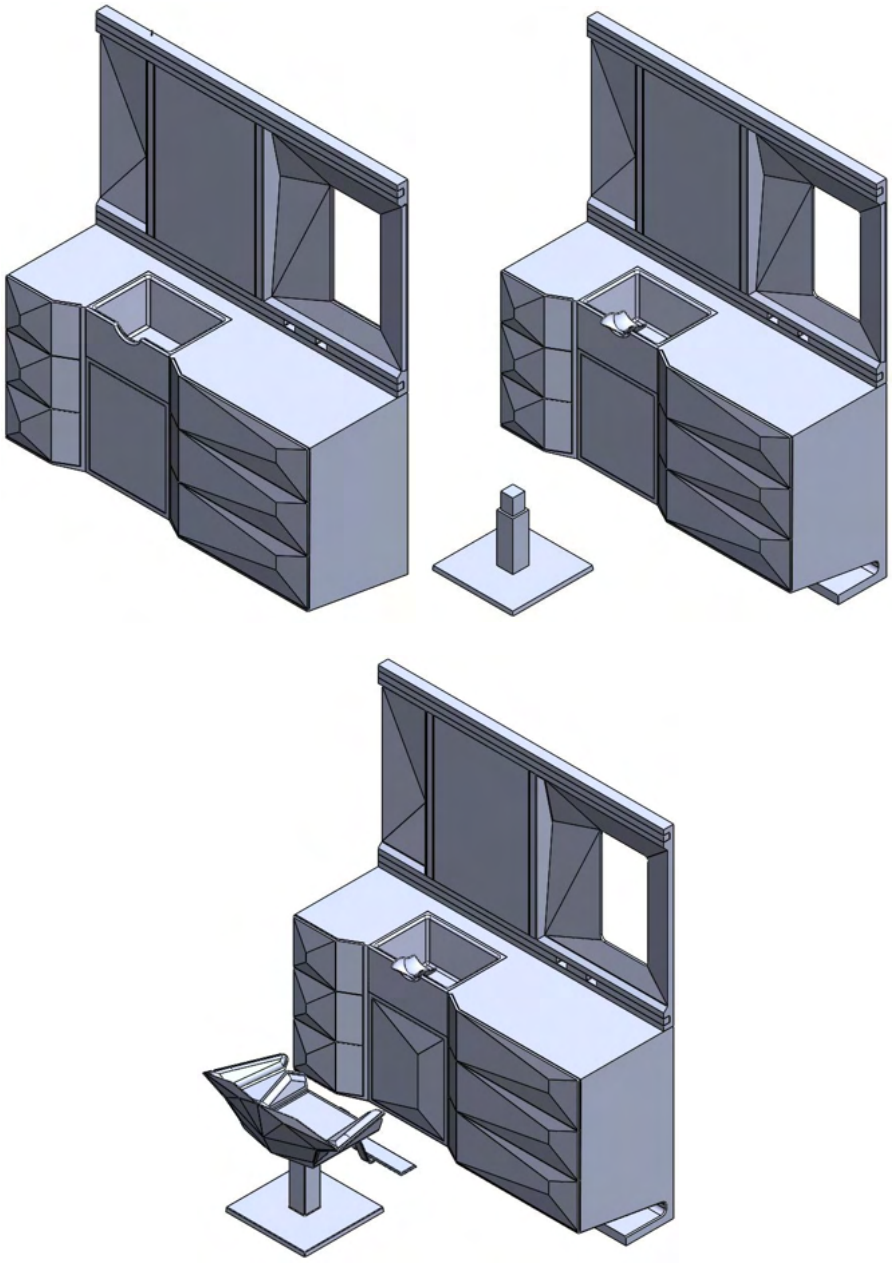


Figure 45: CAD development of hairdressing area.

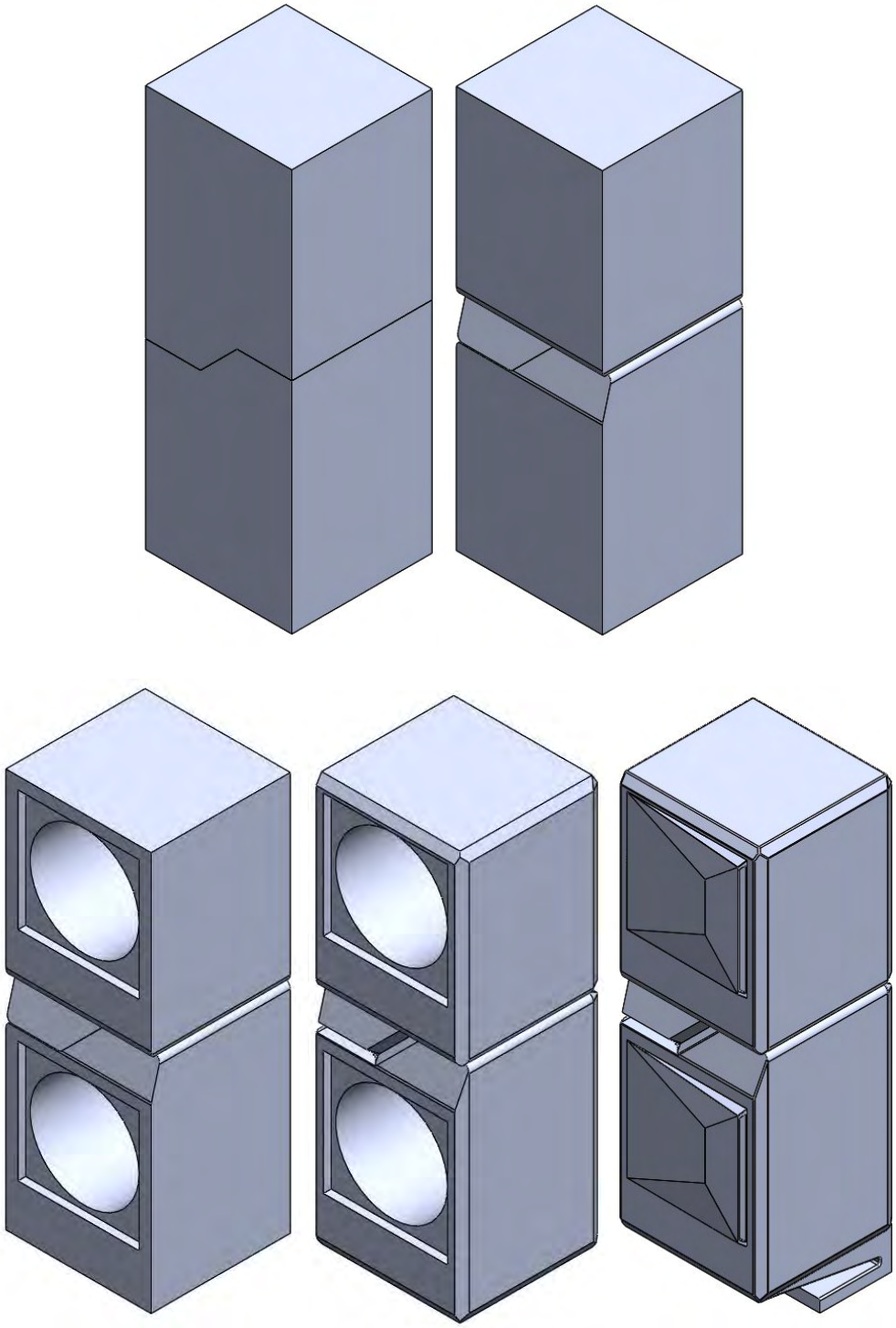


Figure 46: CAD development of laundry machines.

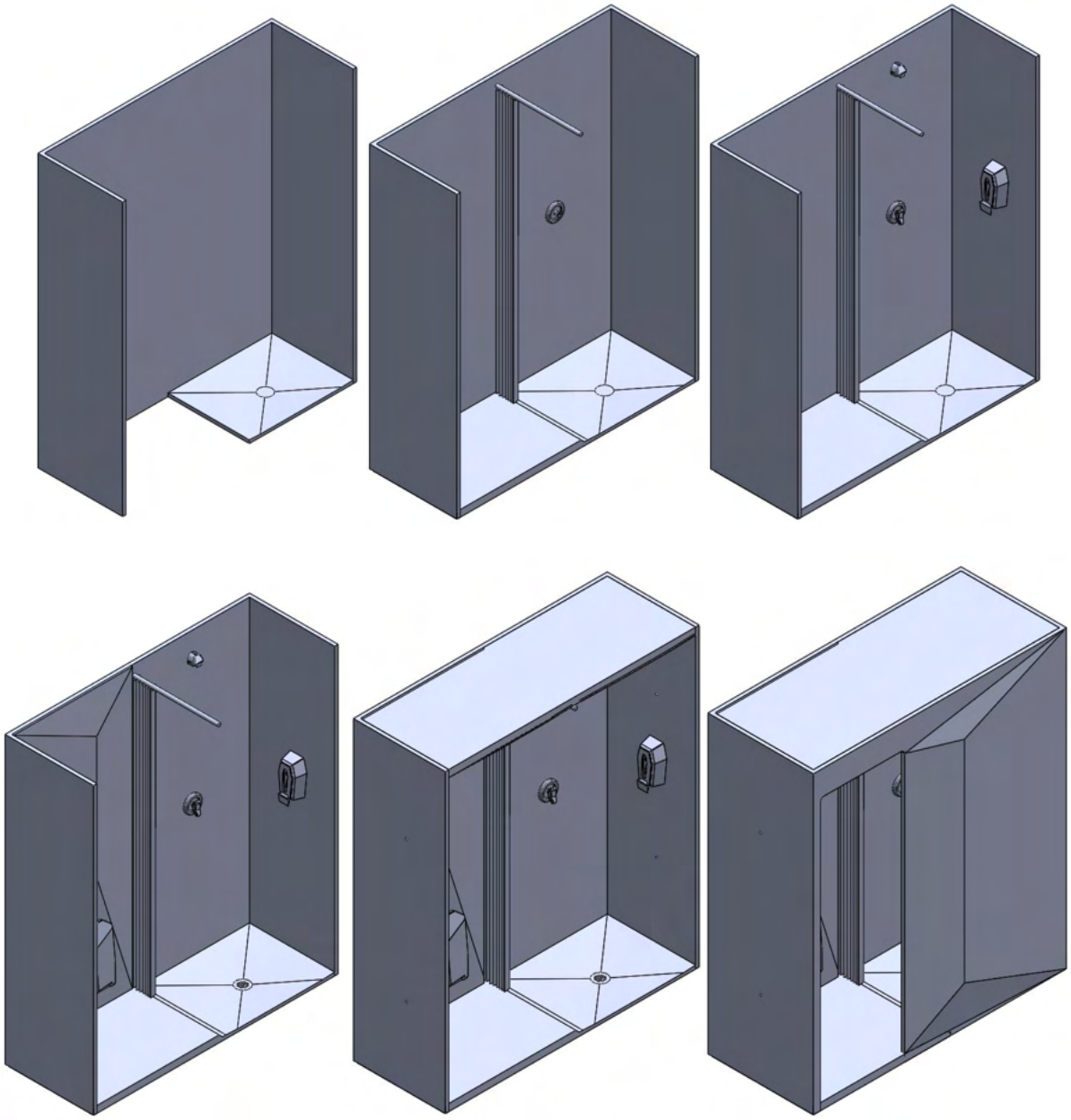


Figure 47: CAD development of showers.

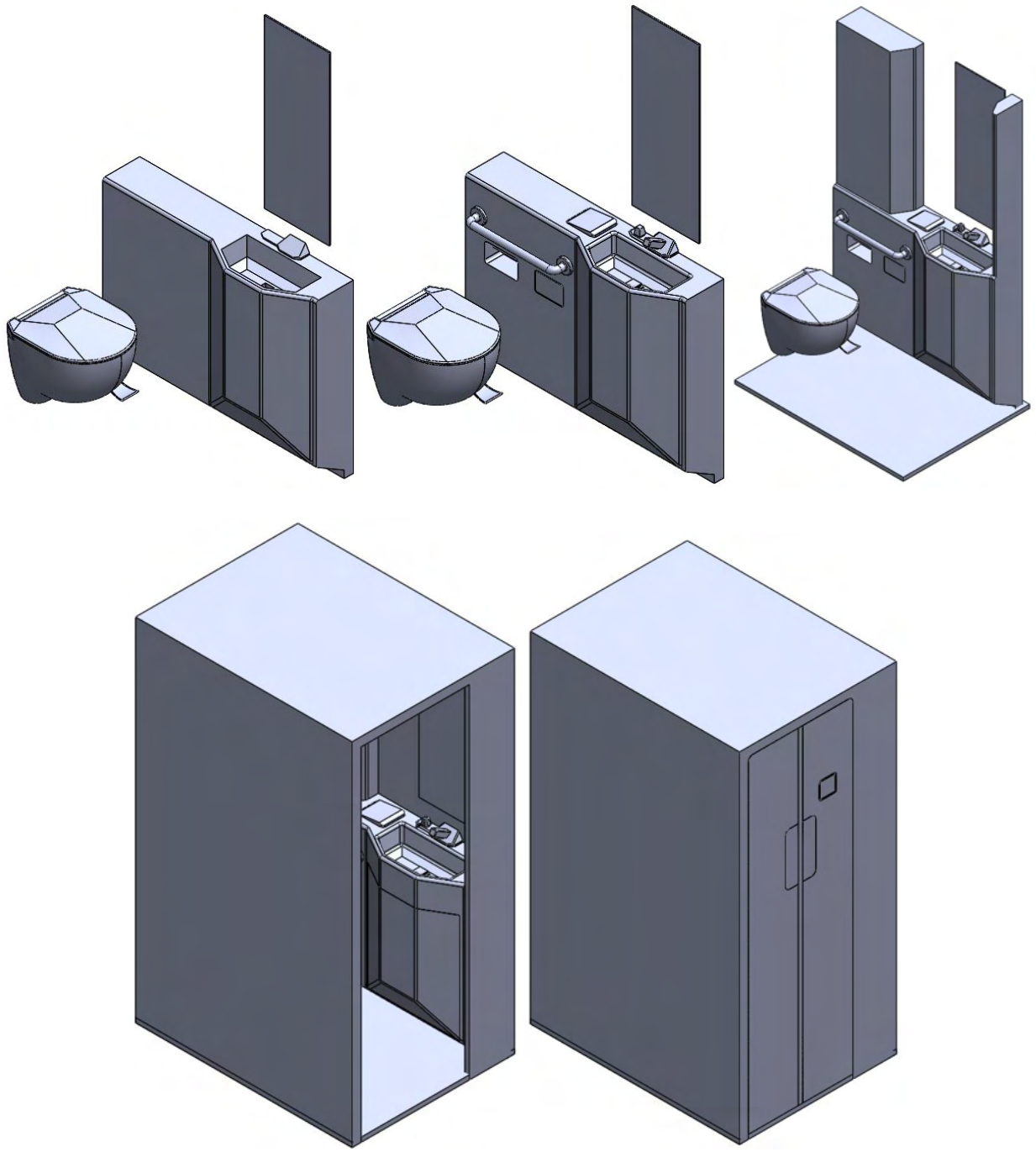


Figure 48: CAD development of toilet stall.

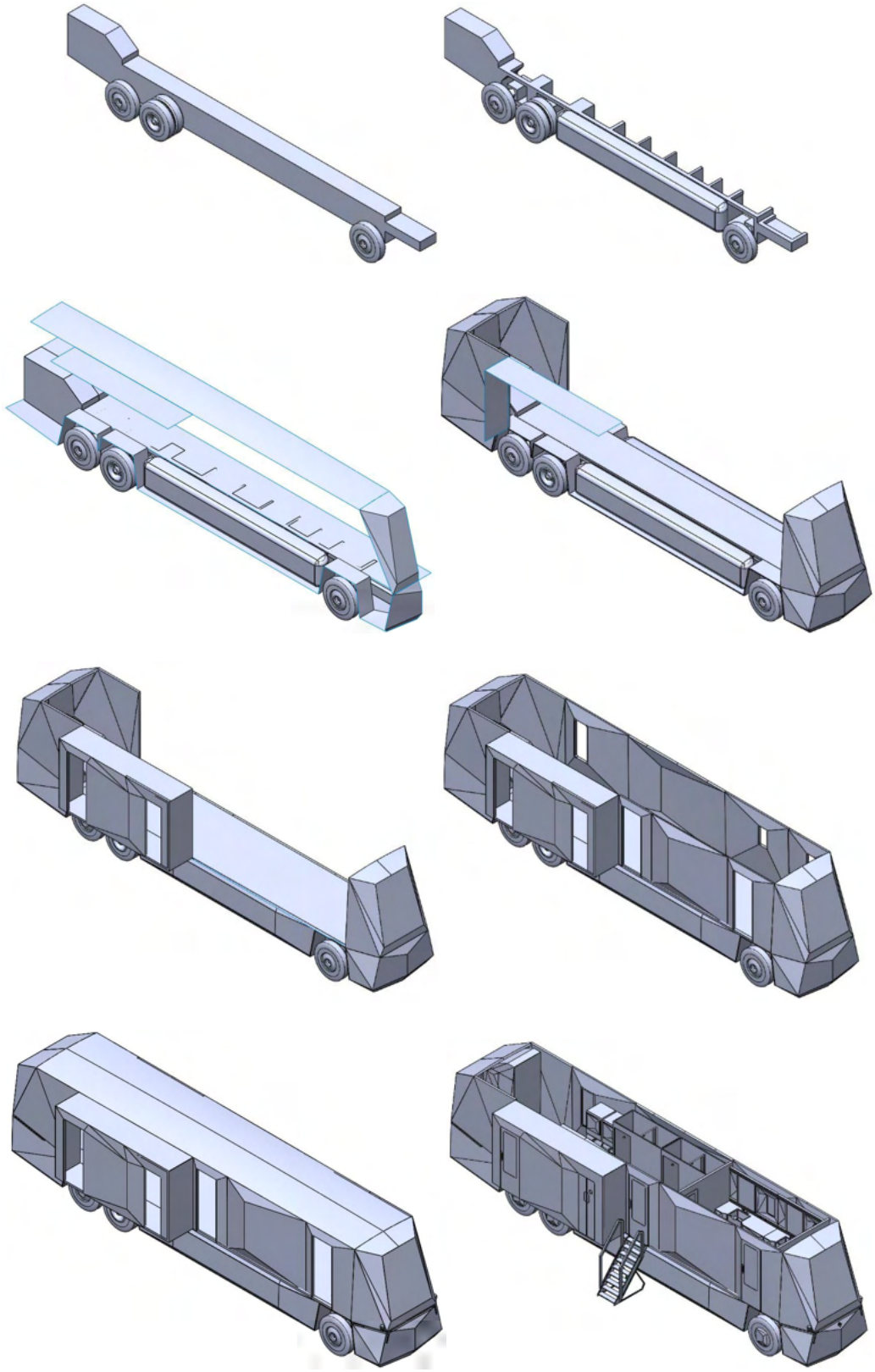


Figure 49: CAD development of chassis and layout.

4.8 Physical Model Fabrication

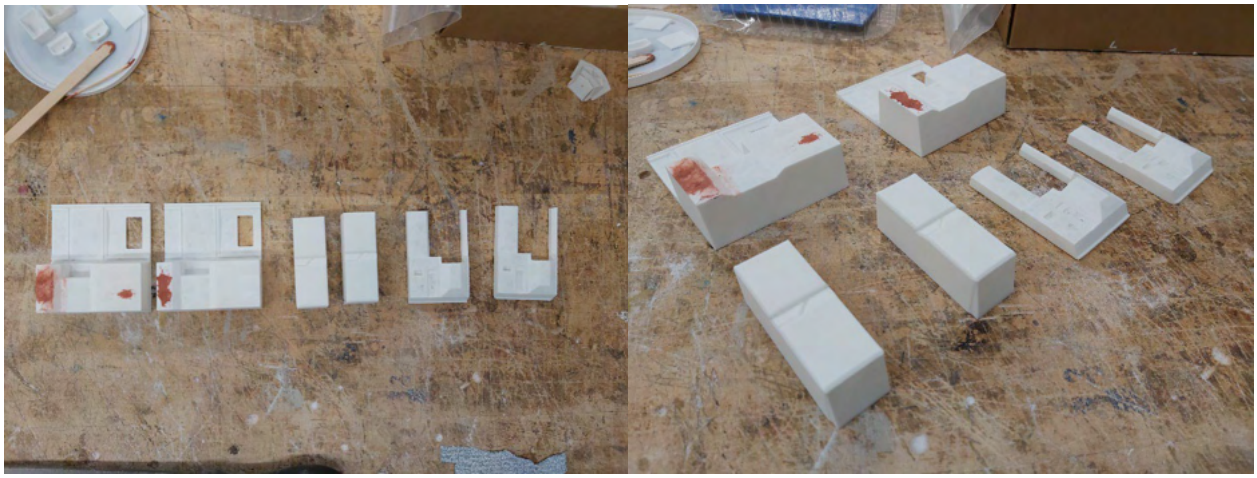


Figure 50: 3D-printed hairdressing desks, laundry machines, and toilet stall counters.

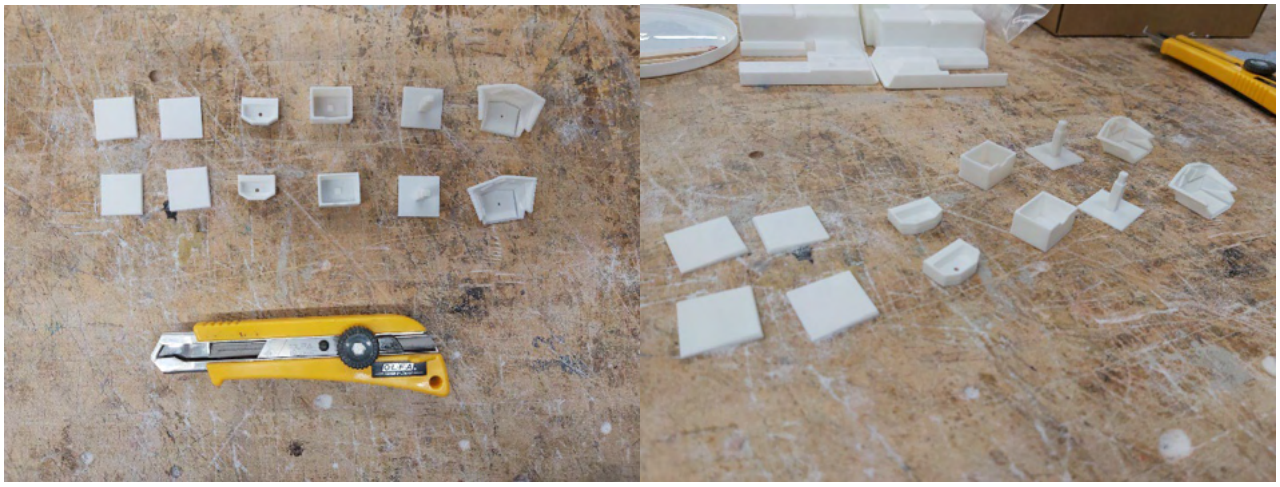


Figure 51: 3D-printed laundry covers, sinks, and seat parts.

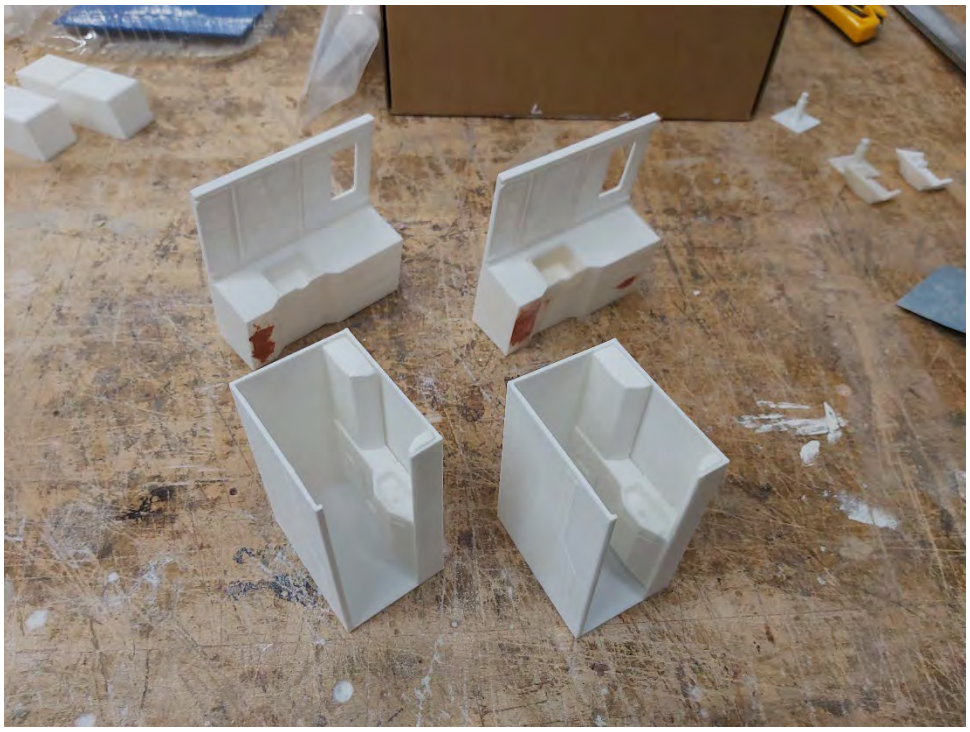


Figure 52: 3D-printed hairdressing desks (top), and toilet stall counters inside the toilet stall (bottom).

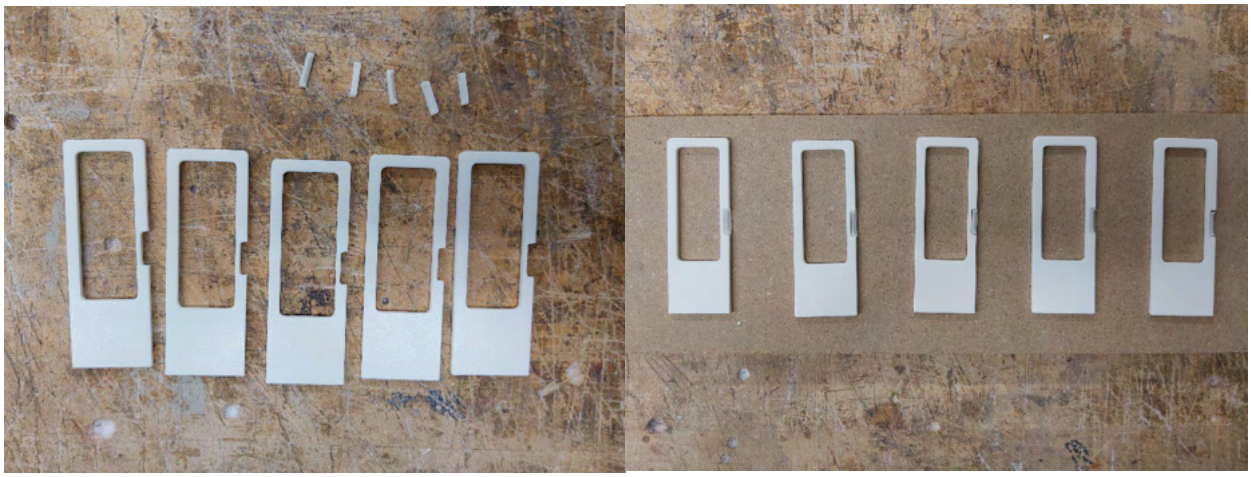


Figure 53: 3D-printed door pieces (left), 3D-printed door pieces assembled (right).

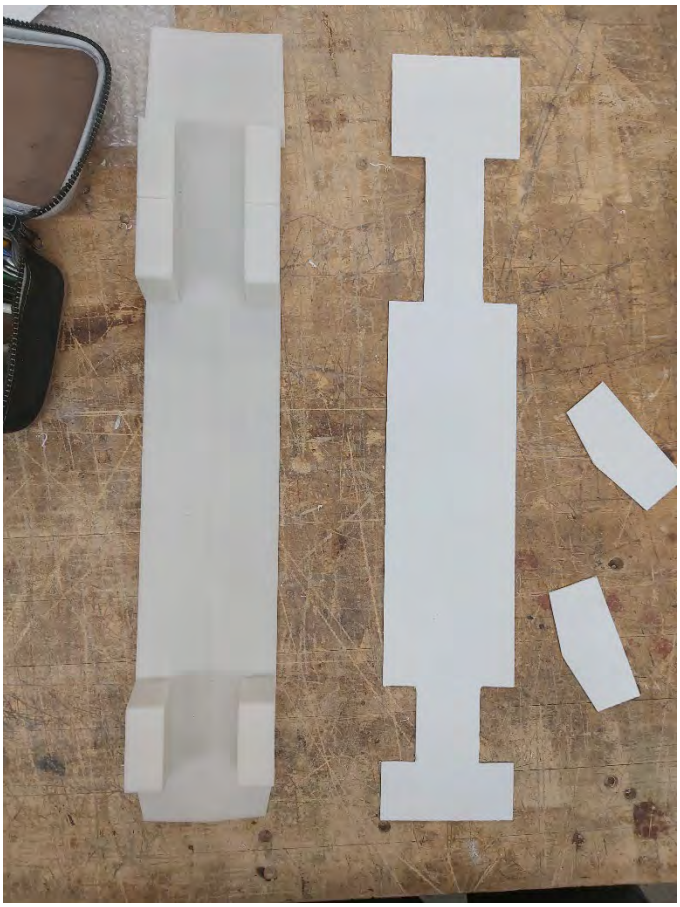


Figure 54: 3D-printed vehicle floor (left) and styrene cutouts for interior floor (right).

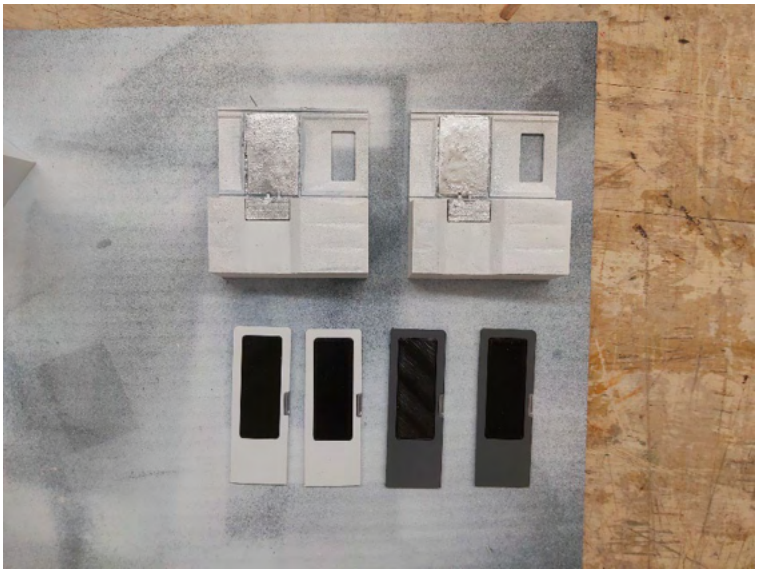


Figure 55: Assembled hairdressing stations (top) and doors (bottom).

Figure 56: Assembled shower stall.

Figure 57: Assembled toilet stall counters (left), assembled toilet stall (right).

Chapter 5: Final Design

5.1 Design Summary

Those without adequate housing often lack regular access to sanitation and hygiene facilities. Lacking sanitation is detrimental to one's health, and may also negatively affect one's social interactions, making it more difficult to maintain relationships or employment. SENTINEL provides showers, laundry, and hairdressing services among other amenities to anyone who needs them. Two hairdressers are on board, as well as a vehicle operator who ensures that all the facilities in the vehicle are running smoothly. With better access to these basic services, people will be able to live longer, happier lives.

5.2 Design Criteria Met

5.2.1 Full-Bodied Interaction Design

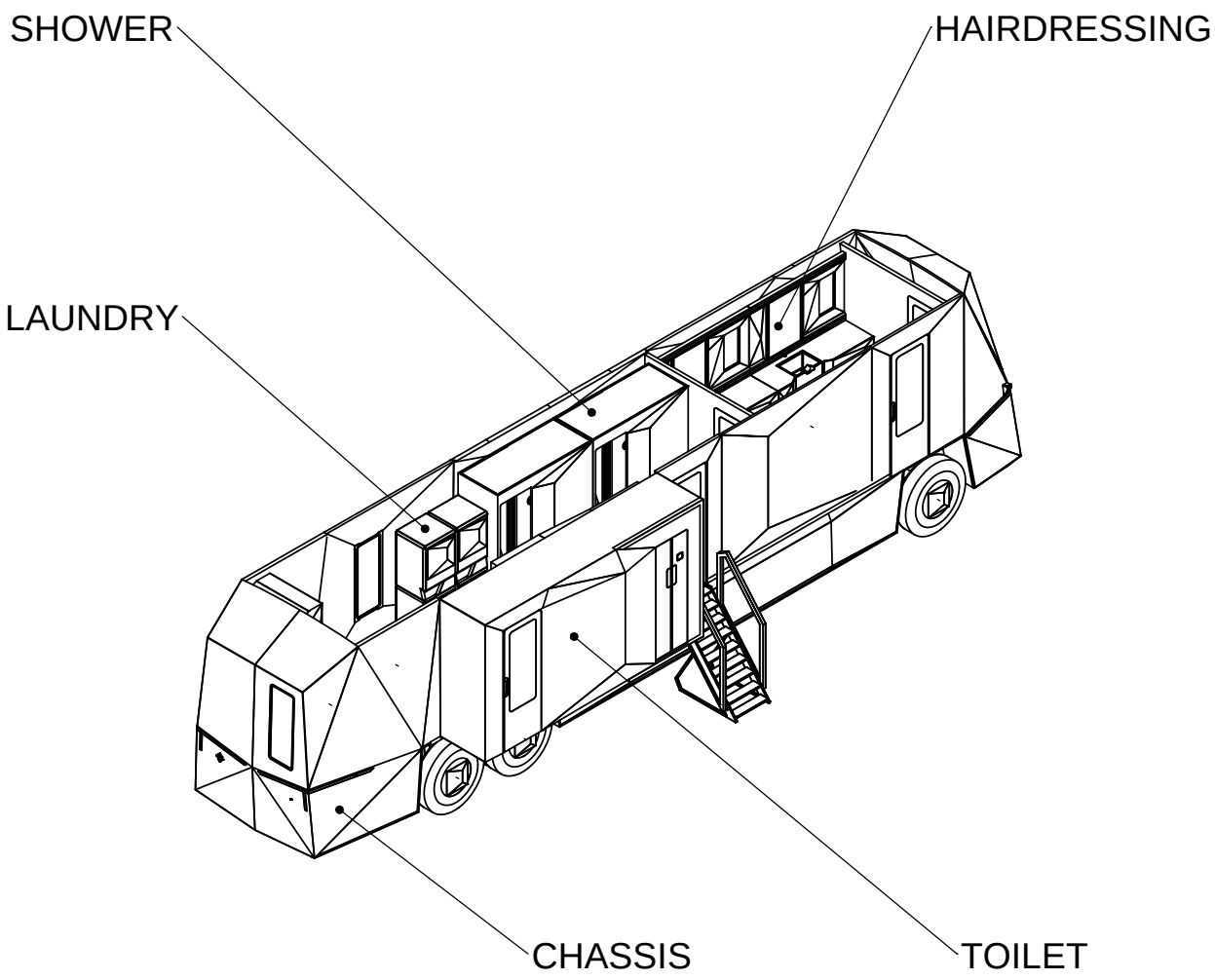
The various components of the service vehicle have been designed to meet the ergonomic needs of the 5th-percentile female to the 95th-percentile male. For ergonomic schematics, please see section 4.4.3.

5.2.2 Materials, Processes, and Technology

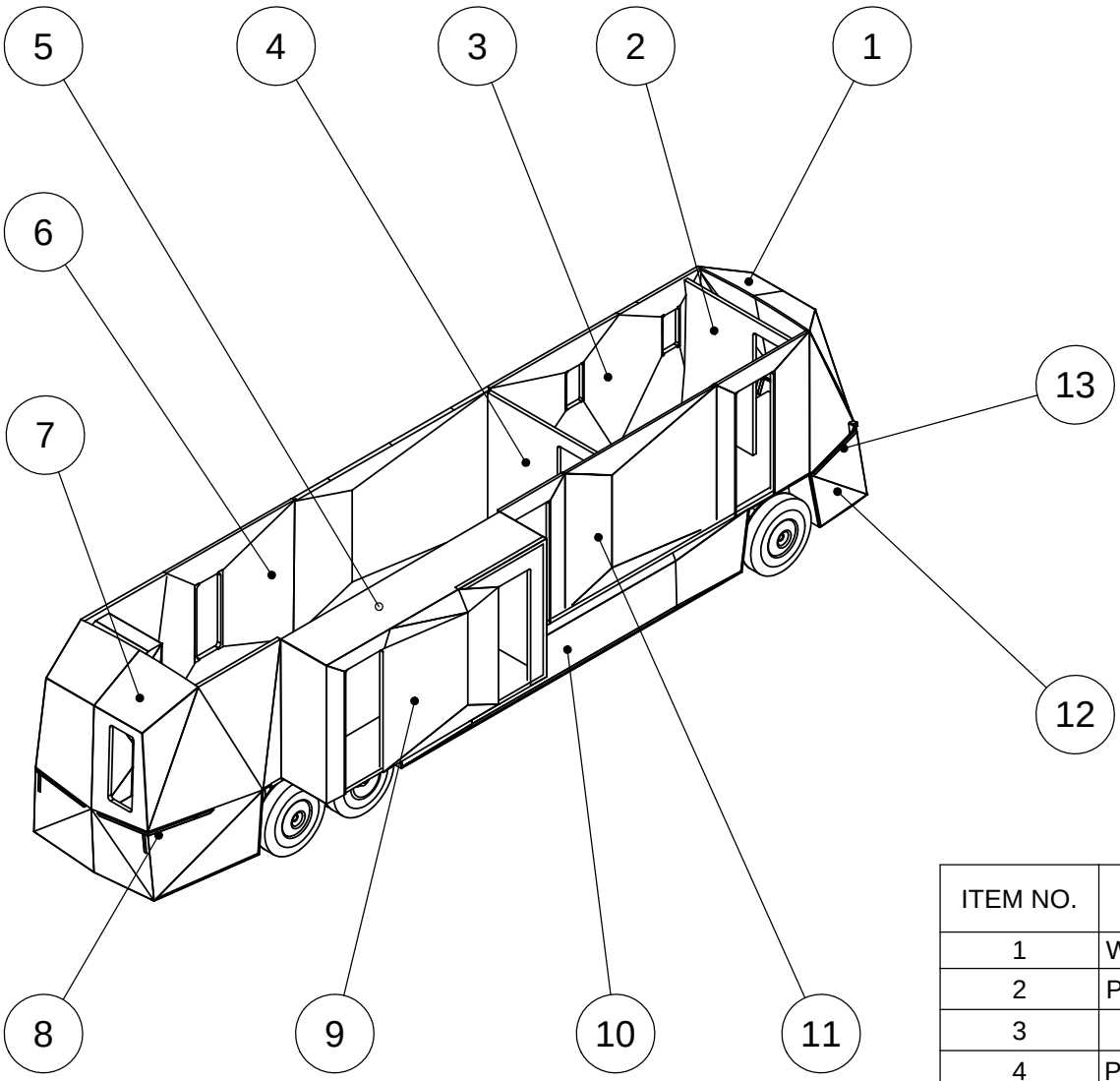
The vehicle’s chassis and powertrain components would be based on an existing RV frame. The vehicle’s exterior panels would be made primarily from aluminum, which is highly recyclable and lightweight, helping reduce the vehicle’s carbon footprint. Interior components were be primarily constructed using high-pressure laminates to ensure durability and longevity.

5.2.3 Design Implementation

Below shows parts lists of various parts of the service vehicle.



DRAWING BY ROLAND MOESCHTER	
SERVICE VEHICLE ISOMETRIC VIEW WITH CALLOUTS	
IDSN 4502 SENIOR THESIS	CATHERINE CHONG FREDRIC MATOVU MICHAEL VANDERVELDE
SCALE 1:100	APRIL 16, 2024

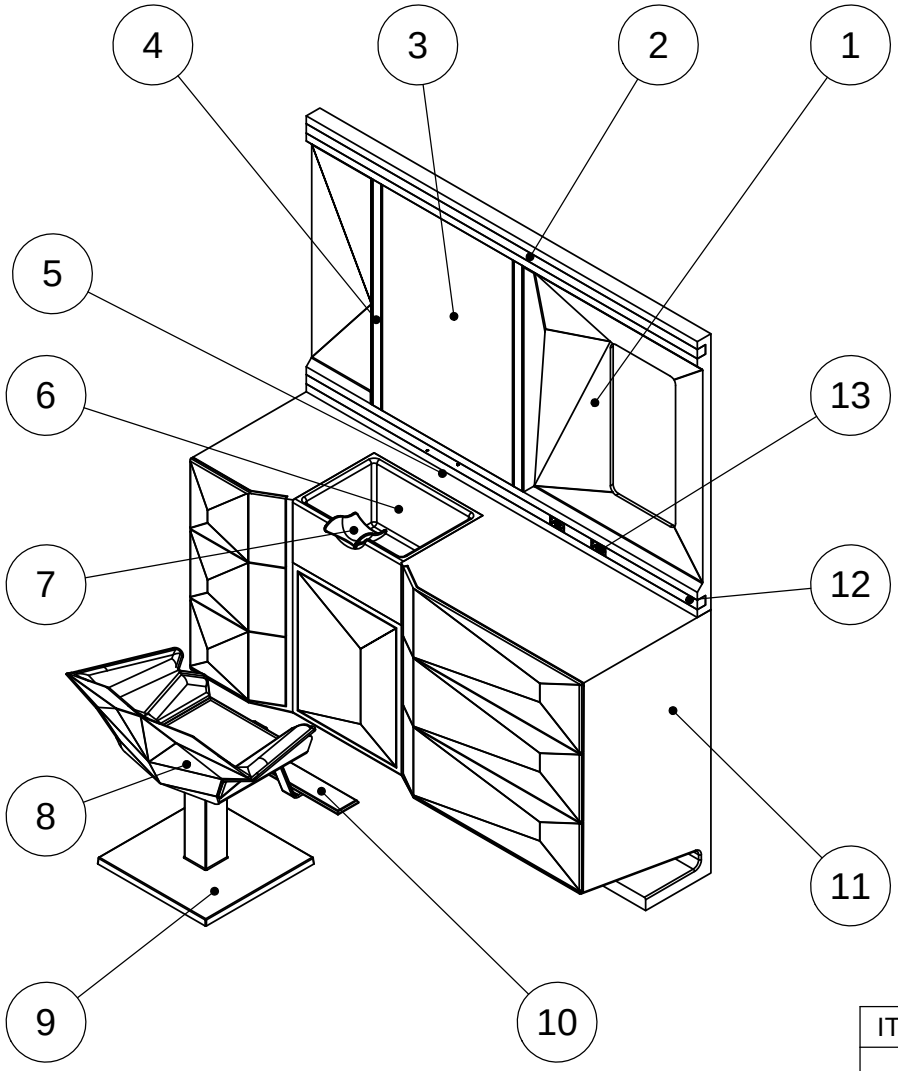


ITEM NO.	PART	QTY.
1	WINDSHIELD	1
2	PARTITION-F	1
3	WALL-LF	1
4	PARTITION-R	1
5	TANK-L (HIDDEN)	1
6	WALL-LR	1
7	REAR	1
8	LIGHT-R	1
9	EXTENSION	1
10	TANK-R	1
11	WALL-R	1
12	BUMPER	1
13	LIGHT-F	1

DRAWING BY ROLAND MOESCHTER

SERVICE VEHICLE
CHASSIS - PARTS LIST

IDSN 4502 SENIOR THESIS	CATHERINE CHONG FREDRIC MATOVU MICHAEL VANDERVELDE
SCALE 1:100	APRIL 16, 2024

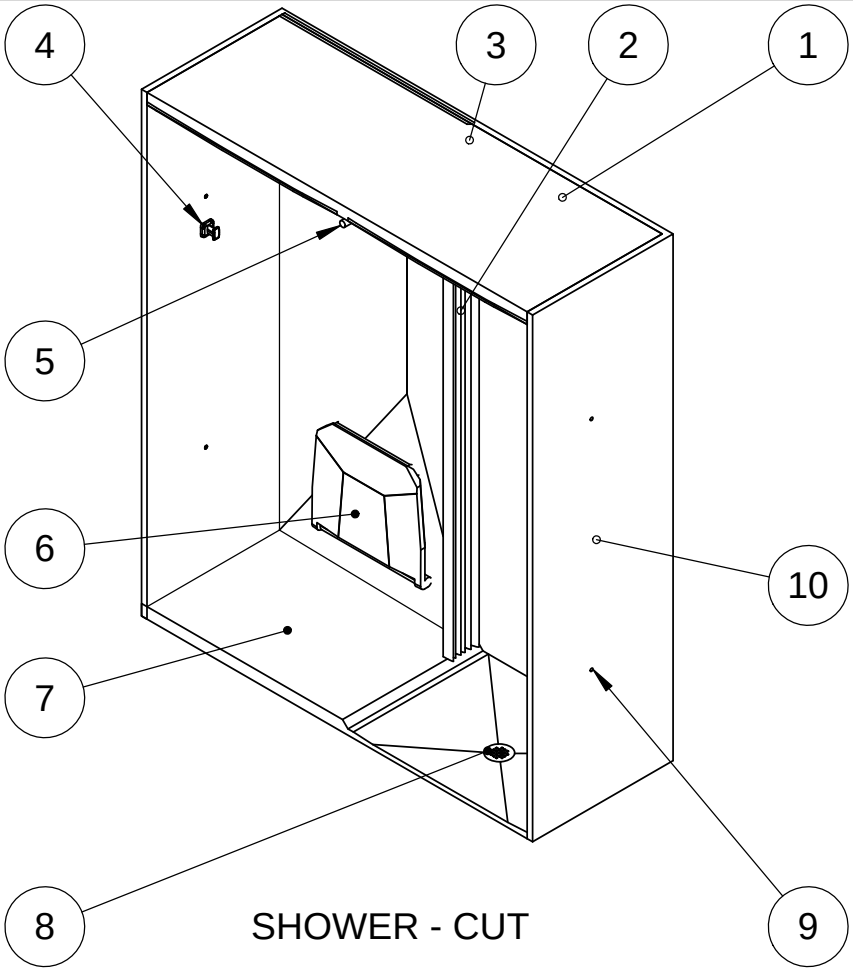


ITEM NO.	PART	QTY.
1	WALL	1
2	ACCENT-1	1
3	MIRROR	1
4	LIGHT	2
5	FAUCET-ASSY	1
6	SINK	1
7	NECK-SUPPORT	1
8	SEAT	1
9	SEAT-BASE	1
10	SEAT-FOOTREST	1
11	SHELF-UNIT	1
12	ACCENT-2	1
13	OUTLET	2

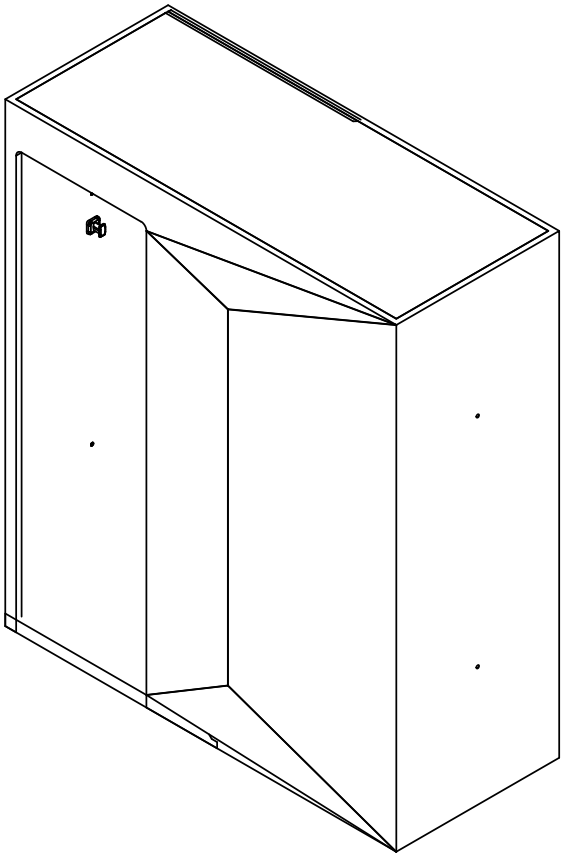
DRAWING BY ROLAND MOESCHTER

SERVICE VEHICLE
HAIRDRESSING - PARTS LIST

IDSN 4502 SENIOR THESIS	CATHERINE CHONG FREDRIC MATOVU MICHAEL VANDERVELDE
SCALE 1:25	APRIL 16, 2024



SHOWER - CUT



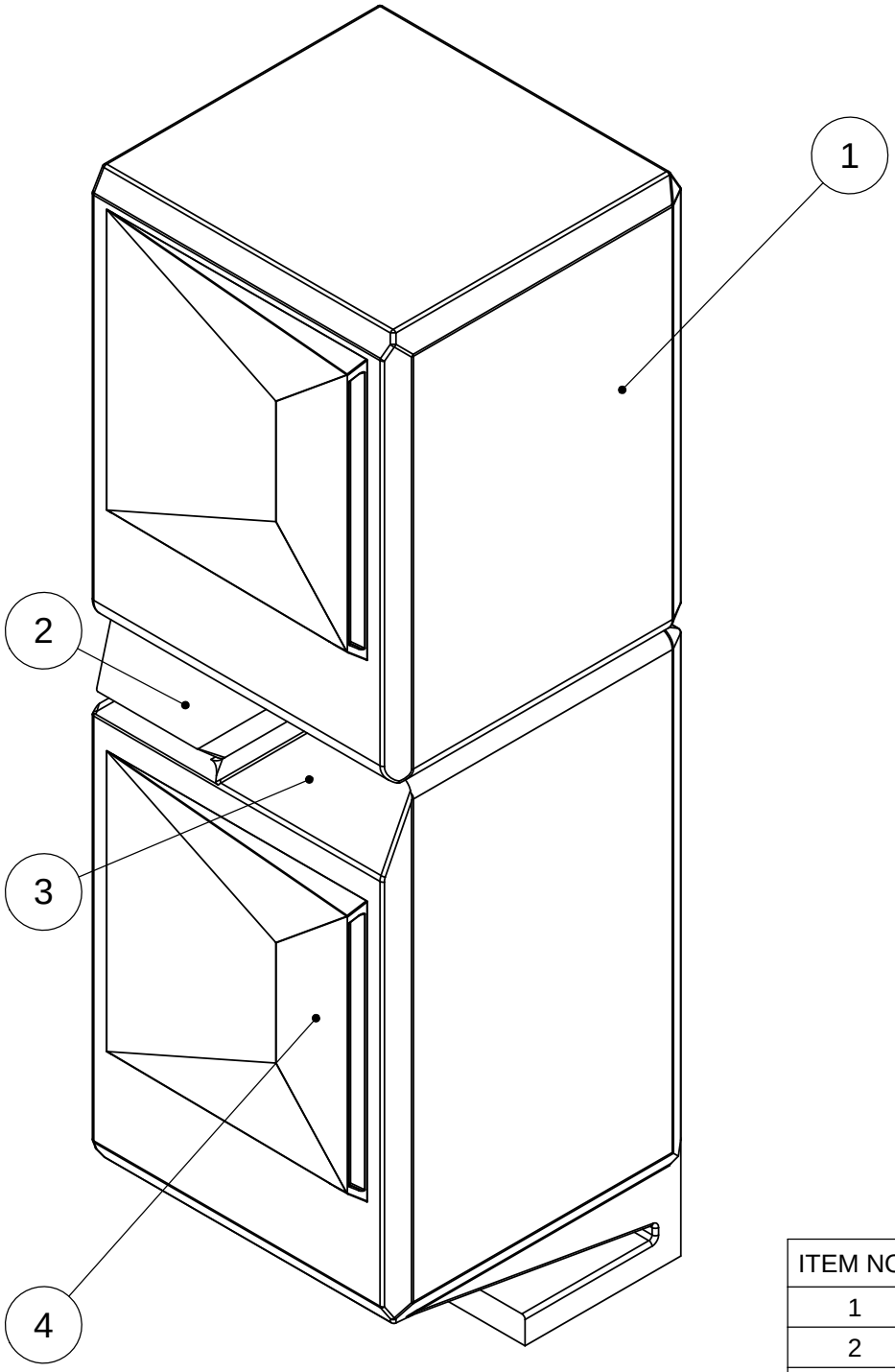
SHOWER - COMPLETE

ITEM NO.	PART	QTY.
1	SHOWER HEAD (HIDDEN)	1
2	SHOWER CURTAIN	1
3	SHOWER CURTAIN RING (HIDDEN)	7
4	LAVATORY HOOK	2
5	SHOWER CURTAIN ROD	1
6	PLATFORM	1
7	FLOOR-WALLS	1
8	DRAIN	1
9	DISINFECTING NOZZLE	4
10	SOAP DISPENSER (HIDDEN)	1

DRAWING BY ROLAND MOESCHTER

SERVICE VEHICLE
SHOWER - PARTS LIST

IDSN 4502 SENIOR THESIS	CATHERINE CHONG FREDRIC MATOVU MICHAEL VANDERVELDE
SCALE 1:25	APRIL 16, 2024

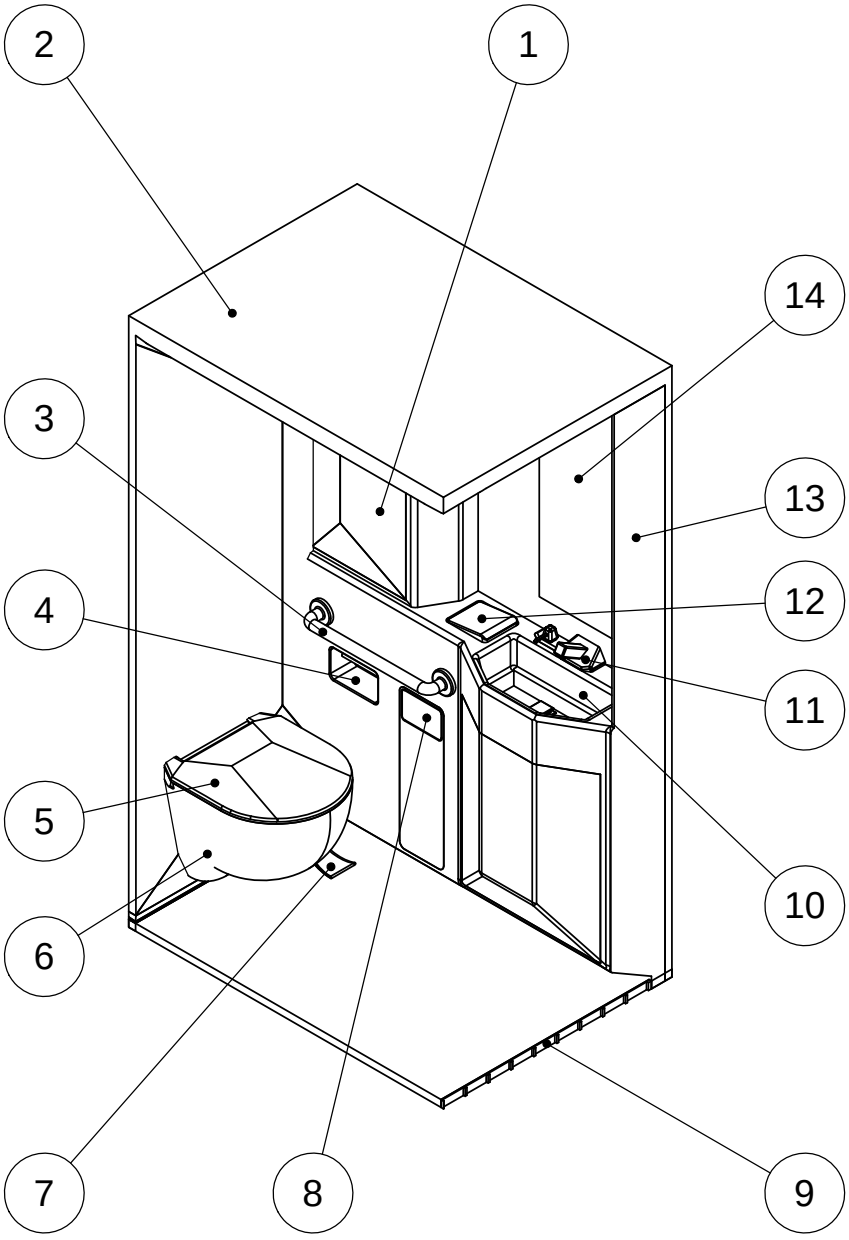


ITEM NO.	PART	QTY.
1	MACHINE-BODY	1
2	INTERFACE-TOP	1
3	INTERFACE-BOTTOM	1
4	COVER	2

DRAWING BY ROLAND MOESCHTER

SERVICE VEHICLE
LAUNDRY - PARTS LIST

IDSN 4502 SENIOR THESIS	CATHERINE CHONG FREDRIC MATOVU MICHAEL VANDERVELDE
SCALE 1:10	APRIL 16, 2024



ITEM NO.	PART	QTY.
1	STORAGE-1	1
2	FLOOR-WALLS	1
3	RAILING	1
4	TOILET-PAPER	1
5	TOILET-LID	1
6	TOILET-BOWL	1
7	TOILET-FLUSH	1
8	GARBAGE-BOTTOM	1
9	DRAIN	1
10	SINK	1
11	FAUCET	1
12	GARBAGE-TOP	1
13	STORAGE-2	1
14	MIRROR	1

DRAWING BY ROLAND MOESCHTER

SERVICE VEHICLE
TOILET - PARTS LIST

IDSN 4502 SENIOR THESIS	CATHERINE CHONG FREDRIC MATOVU MICHAEL VANDERVELDE
SCALE 1:20	APRIL 16, 2024

5.3 Final CAD Rendering

Figure 58: Final render of service vehicle with human models.

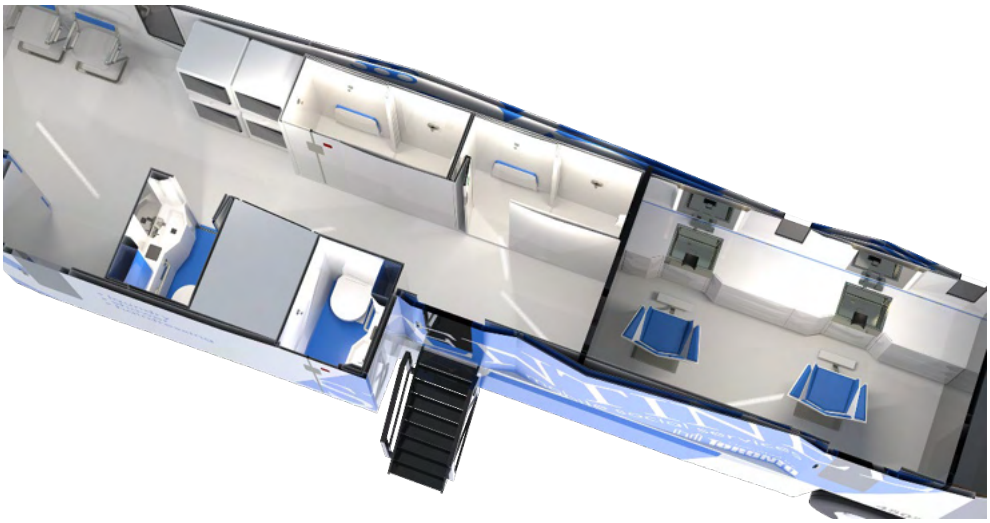


Figure 59: Final render of vehicle interior.

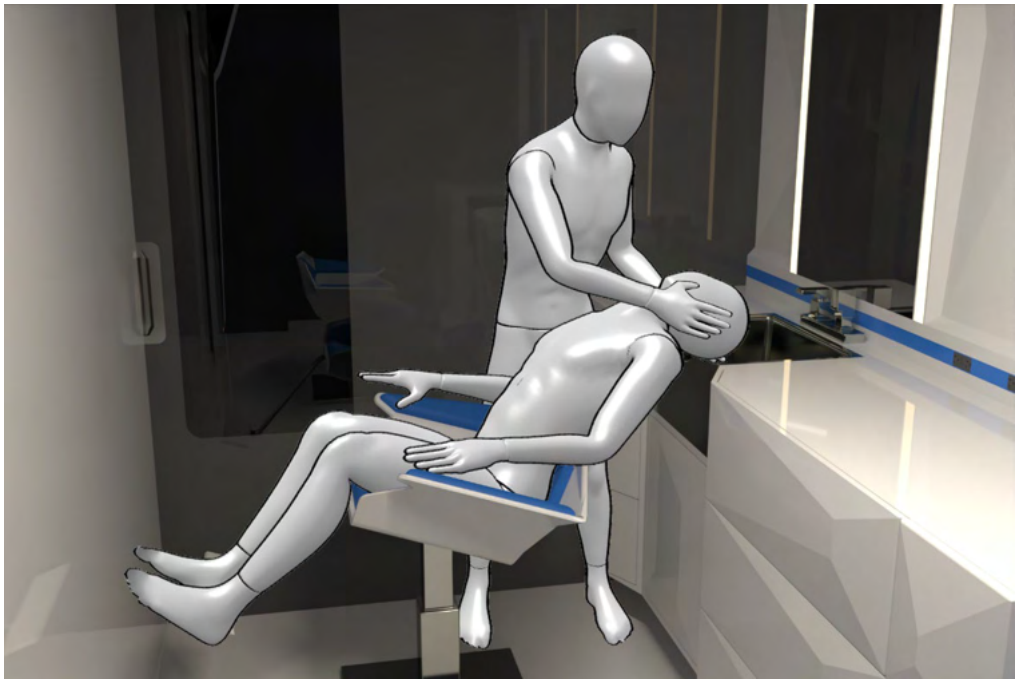


Figure 60: Final render of hairdressing station in use.

Figure 61: Final render of laundry station in use.

Figure 62: Final render of shower station in use, with two different sizes of user.

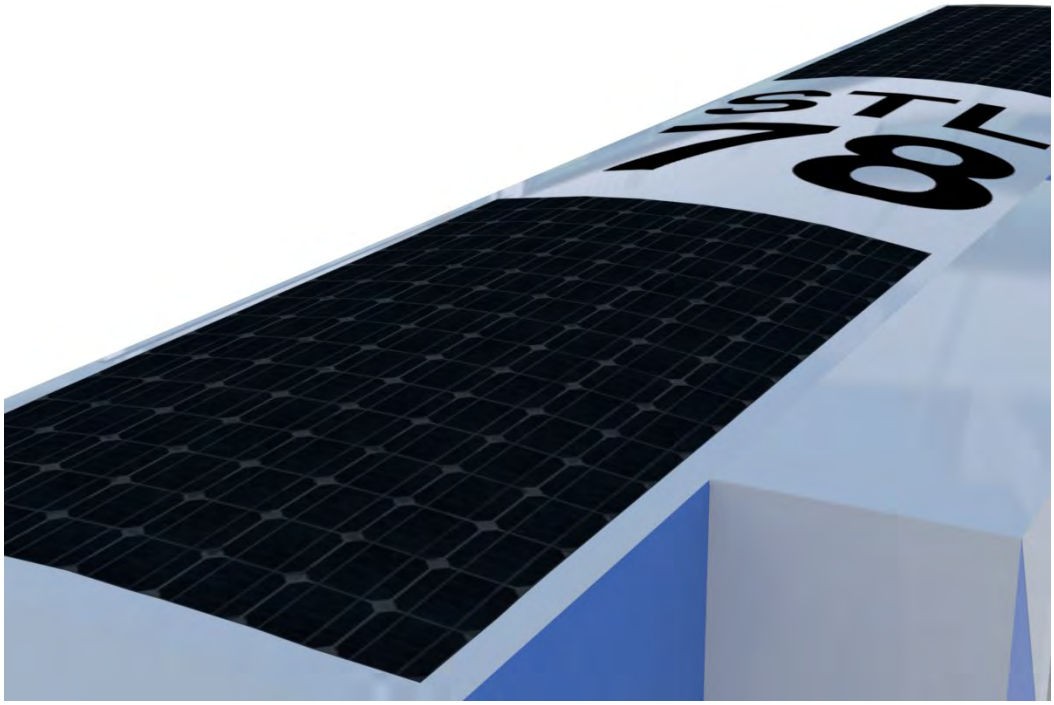


Figure 63: View of vehicle’s roof, with solar panels and aerial markings shown.

Figure 64: Final render of hairdressing station.

Figure 65: Final render of laundry station with shower beside it.

Figure 66: Final render of shower station. Walls have been cut to better view inside.

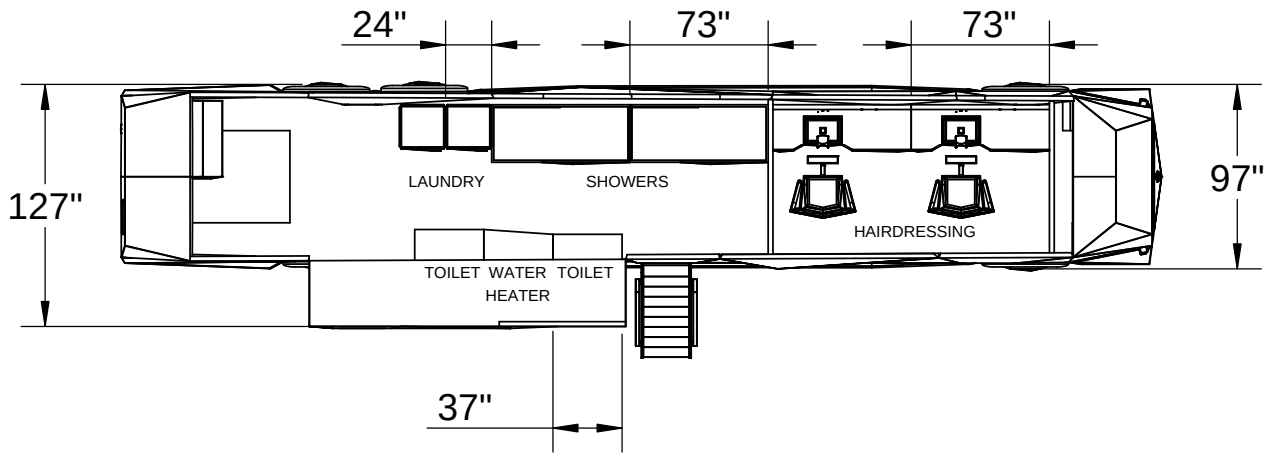
Figure 67: Final render of toilet stall. Walls have been cut to better view inside.

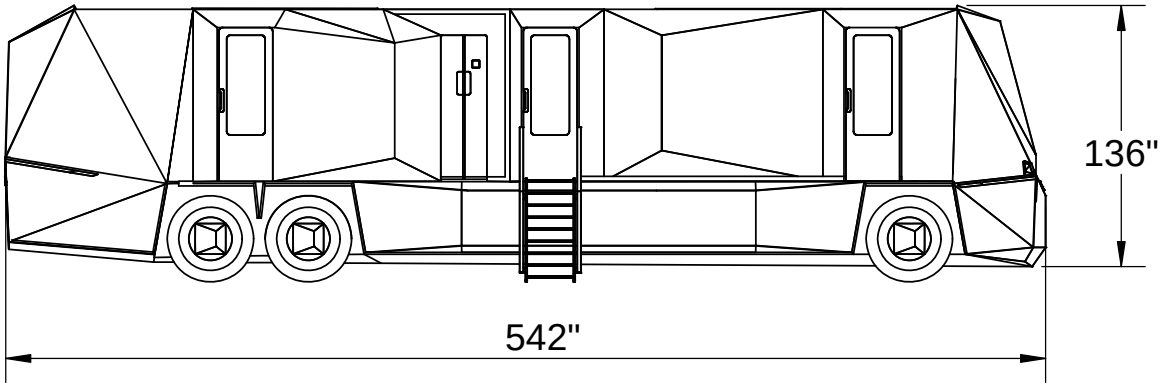
5.4 Physical Model

Figure 68: Physical model approaching completion.

5.5 Technical Drawing

The drawing below shows the overall dimensions of the full-scale vehicle.





DRAWING BY ROLAND MOESCHTER	
SERVICE VEHICLE VIEWS WITH DIMENSIONS	
IDSN 4502 SENIOR THESIS	CATHERINE CHONG FREDRIC MATOVU MICHAEL VANDERVELDE
SCALE 1:100	APRIL 16, 2024

5.6 Sustainability

Findings and analysis of the product benchmarking impacts the design primarily in the materials used. Firstly, since the proposed vehicle was intended to use an existing chassis, this would significantly reduce many costs but particularly that of R&D and manufacturing, with not having to determine an entirely new chassis and powertrain design, and not having to determine structural requirements to ensure the chassis could support the weight necessary. In terms of materials, highly durable materials would be used for both the exterior and interior, additionally saving weight and thus improving fuel efficiency. These materials are also relatively easy to customize (look, colour, form) to help increase the vehicle's visual appeal and keep a consistent design language.

A combination of energy-efficient practices would be employed to both reduce the amount of energy consumed within the vehicle, and reduce reliance on recharging throughout the day, primarily through solar panels to power the majority of internal systems and a sand battery to keep water heated.

Chapter 6: Conclusion

Sanitation and maintaining personal hygiene are fundamental for everyone. The absence of these practices not only poses risks to one's health but can also impact their social interactions. Individuals experiencing homelessness face challenges in upholding hygienic standards due to limited access to relevant services. It is imperative to offer facilities that enable them to sanitize and maintain cleanliness, as their harsh living conditions have adverse effects on health, and improved hygiene could positively influence social interactions.

Research was conducted to initially identify the key issues that unhoused people face. User observations were conducted, to become familiar with the existing methods that unhoused people use to bathe themselves and clean their clothes. Ergonomic studies were conducted with 5th-percentile and 95th-percentile males to ensure the greatest usability amongst different body types.

SENTINEL, the proposed service vehicle, aims to provide all unhoused individuals access to showers, laundry, and hairdressing services. Two hairdressers and a vehicle operator are always on board the vehicle. This ensures that users feel comfortable and safe inside, while feeling secure of their belongings. Ergonomics were studied to mitigate body strain from repetitive motions, and simple interfaces were employed to minimize likelihood of human error with machines, and to streamline the user experience. Materials were used to improve the aesthetic appeal of the vehicle and make it more inviting. Sustainable initiatives were also used to help reduce the carbon footprint of the vehicle.

Figure 69: Final render of service vehicle with extension closed.

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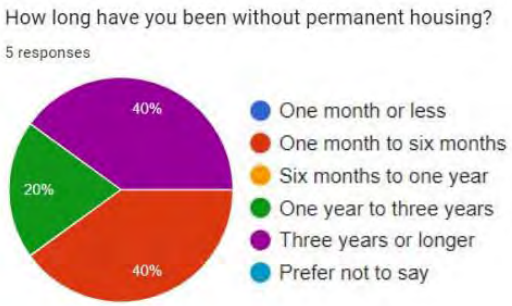
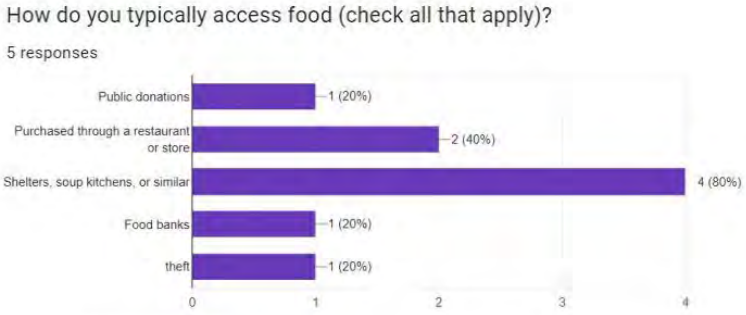
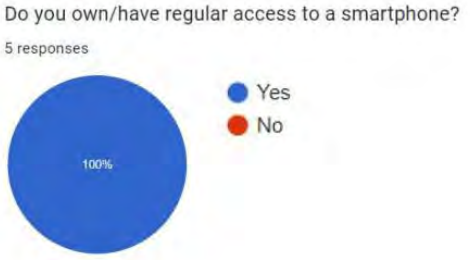
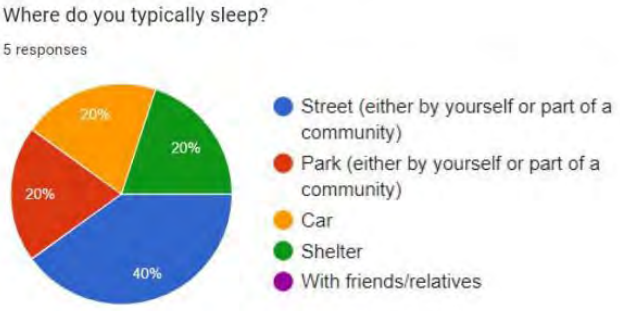
Appendix A – Field Research

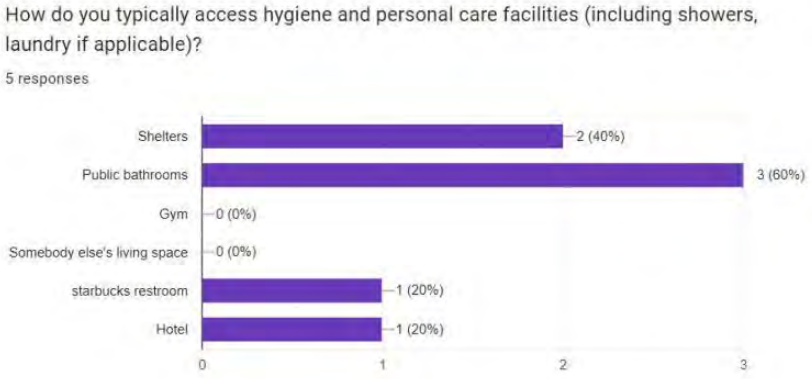
Survey Results:

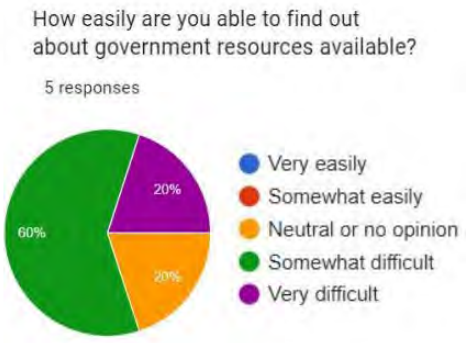


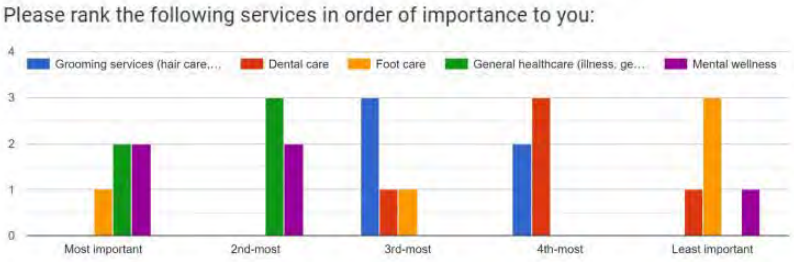


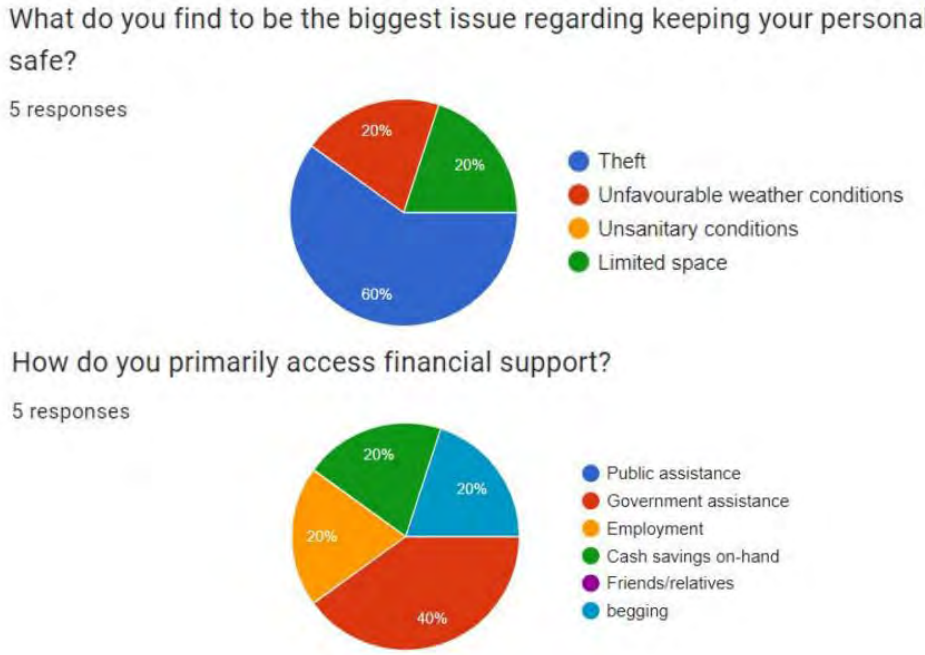












Summary of answers from surveys:

Q: What are the major challenges you have, or have encountered in finding stable housing?

A: Availability, put on waitlists but never go anywhere, nobody will take ESA (emotional support animal), not having a postal address, finding someone to rent after eviction

Q: What key factors could help improve your overall health currently?

A: Shelter and income, drugs, shelter with shower and kitchen, health and hygiene services, better food (vegetables, fruit, lean proteins)

Q: How comfortable are you with using new technology (including smartphone apps, or new products with smartphone integration)?

A: Very, good, ok, theft and power are concerns

Q: How comfortable are you with accessing public facilities (bathrooms, libraries, restaurants), and what are your main concerns, if any, with those spaces?

A: Often not welcomed, people are judgemental and kick them out, safety concerns

Q: Any further questions, comments, concerns?

A: “Need more money for homeless people and better food at shelters. [We] are human too [...] sick of stealing and begging just to get what [I need]”

Interview participants:

Oct. 9, via Discord call (recorded with OBS Studio)

Worked at employment centre, volunteered at homeless shelter and holiday food bank

Oct. 10, via phone call (recorded with OBS Studio)

Client service worker, City of Toronto Shelter, Support and Housing Administration (SSHA)

Oct. 13, in-person (not recorded)

Case manager, Salvation Army Hamilton Booth Centre

Oct. 17, via Zoom call (not recorded)

Manager of Development, Homes First Society

Oct. 24, via Teams call (recorded with OBS Studio)

Associate Medical Director and Research, Evidence and Quality Lead - ICHA

Takeaways from interviews:

<u>Interview 1</u>

Clients at employment centre were not typically computer users, but navigated smartphones easily

Food bank ran out of hygiene supplies quickest (razors, toothbrushes, soap, etc.)

Safety at homeless shelter was never really ensured, as the rooms were large and open with many beds. Security guards were employed to do checks, and there was a police station nearby.

<u>Interview 2</u>

Many shelters may be unpleasant, unwelcoming. Potentially more harassment and issues with belongings. Lots of rules.

Being in a shelter may make people feel more agitated/frustrated, similar to how people automatically tend to become frustrated easier when in an airport. It is human nature.

Some shelters have a lack of resources, having things in new condition rather than used, feeling as though they are getting the leftovers. Would like to be able to give the clients services and experiences that they would not normally have access to, things that we take for granted.

Interview 3

Clients may be destructive of their environment, either by lack of awareness or by taking things apart to sell scrap material.

Clients' personal property may get stolen by other clients, thus fights may break out. Some clients are disruptive while others just want some sleep.

The main resource lacking is a lack of space, more beds are needed.

Interview 4

There is a need for furniture and amenities which look pleasing, are comfortable, yet resilient. The "institutional" look of many fixtures may be triggering to people.

Theft and privacy are some of the main concerns of clients.

Interview 5

Unhoused often rely on walk-in doctors to deal with injuries or trauma, family physicians not available. Some may have trouble waiting due to mental issues. Some cannot be contacted easily.

Younger patients may have more acute conditions rather than chronic. May experience more abuse, trauma, also may need more LGBTQ+-friendly support.

Specialists may be able to do virtual visits, depending on both patient and case worker availability.

Appendix B – Completion of TCPS 2: CORE 2022 and Topic Approval

PANEL ON RESEARCH ETHICS
Navigating the ethics of human research

TCPS 2: CORE 2022

Certificate of Completion

This document certifies that

ROLAND MOESCHTER

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 # 0000946112 **8 September, 2023**

THESIS TOPIC APPROVAL Bachelor of Industrial Design / FALL 2023

Student Name	Roland Moeschter
Topic Title	How might we improve the living conditions of those without adequate housing?

TOPIC DESCRIPTIVE SUMMARY (PRELIMINARY ABSTRACT)

This project aims to improve the living conditions of unhoused individuals. It is estimated that over 235,000 Canadians experience homelessness every year. Rising housing prices and increasing costs of living are making it harder for people to afford a space for themselves, forcing some to live on the street. Building regulations make creating new housing difficult, especially in dense urban centres where there is not much space to begin with. With a lack of wealth and resources comes a lack of hygiene and personal care. Approximately two-thirds of unhoused individuals have issues with their feet, and oral health issues are also prevalent. Harsh weather conditions outside may also lead to heat stroke and frostbite, other illnesses, and sometimes death. Additionally, unintentional injuries including burns, cuts, and bruises often go untreated leading to more chronic health issues. To better understand the issues that unhoused individuals face, members working in associations for the unhoused will be contacted in order to conduct surveys and interviews. Data will be collected from past interviews conducted with unhoused individuals. Findings from these interviews will be used to identify the key issues that unhoused people face, and the issues surrounding existing solutions. Current solutions such as shelters, soup kitchens, and food banks often do not address the individuals' personal care and hygiene. A solution which allows unhoused individuals to better withstand environmental concerns and keep up personal care and hygiene would go a long way to improving their quality of life.

Student Signature		**Instructor Signature(s)**	
Date	04 / 10 / 2023	**Date**	10 October 2023

Appendix C – Advisor Agreement Forms and Meetings

IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

HUMBER
Bachelor of Industrial Design / FALL 2023 & WINTER 2024

INFORMATION LETTER

Research Study Topic: Improving the living conditions of those without adequate housing

Investigator: Roland Moeschter | rolymoes@gmail.com | 289-981-3367

Sponsor: Humber College ITAL, Faculty of Media & Creative Arts (IDSN 4002 & IDSN 4502)

Introduction
My name is Roland Moeschter, I am an industrial design student at Humber College ITAL, and I am inviting your participation in a research study on various problems that unhoused individuals face. These problems include weather conditions, food insecurity, upkeep of personal care and hygiene, and other general living conditions. The results will contribute to my Senior Level Thesis project.

Purpose of the Study
This study is being conducted as an aid in designing a product to be used by unhoused individuals that may have the ability to improve their living conditions, possibly including but not limited to providing greater access to food and water, providing a form of shelter, or increasing the security of the user's belongings. The product to be designed is inspired by the issues currently facing unhoused individuals. With your help, I plan to address problems that unhoused individuals encounter on a day-to-day basis. This study is primarily based on understanding ergonomics, human interaction design activities, and user experience aspects of the research area.

Procedures
If you volunteer to participate in this study, any responses to questions will be noted and may be recorded with permission. Any activities involving interacting with a device or equipment will be observed and documented. Your activities will be documented by means of a phone camera while operating the device or equipment. You will be asked questions pertaining to the device or equipment and how you use it.

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

Participation and Withdrawal
Your participation in this study is completely voluntary and you may interrupt or end the study and the session at any time without giving a reason or fear of being penalized. If at any point during the session, you feel uncomfortable and wish to end your participation, please let the moderator know and they will end your participation immediately.

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

IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

HUMBER
Bachelor of Industrial Design / FALL 2023 & WINTER 2024

INFORMATION LETTER

Conditions of Participation

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

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

Amy Claus		Oct 10 2023
Participant's Name	Participant's Signature	Date

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

Email: rolymoes@gmail.com

Phone: 289-981-3367

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

IDSN 4002 /4502
SENIOR LEVEL THESIS ONE & THESIS TWO

HUMBER
Bachelor of Industrial Design / FALL 2023 & WINTER 2024

PARTICIPANT INFORMED CONSENT FORM

Research Study Topic: Improving the living conditions of those without adequate housing

Investigator: Roland Moeschter | rolymoes@gmail.com | 289-981-3367

Sponsor: Humber College ITAL, Faculty of Media & Creative Arts (IDSN 4002 & IDSN 4502)

I, Amy Claus *(first name & last name)* have carefully read the Information Letter for the project improving the living conditions of those without adequate housing, led by Roland Moeschter. A member of the research team has explained the project to me and has answered all of my questions about it. I understand that if I have additional questions about the project, I can contact Roland Moeschter at any time during the project.

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

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

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

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

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

I understand that I can verify the ethical approval of this study, or raise any concerns I may have by contacting the Humber Research Ethics Board:
Dr. Lydia Boyko, REB Chair, 416-675-6622 ext. 79322, **Lydia.Boyko@humber.ca** or
Roland Moeschter at **rolymoes@gmail.com**.

Verification of having read the Informed Consent Form:

☑ I have read the Informed Consent Form.

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

Amy Claus		Oct 10/23
Participant's Name	Participant's Signature	Date

IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

HUMBER
Bachelor of Industrial Design / FALL 2023 & WINTER 2024

INFORMATION LETTER

Conditions of Participation

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

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

MICHAEL LYSTER	[signature]	Oct. 18 2023
Participant's Name	Participant's Signature	Date

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

Email: rolymoes@gmail.com

Phone: 289-981-3367

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

2

IDSN 4002 /4502
SENIOR LEVEL THESIS ONE & THESIS TWO

HUMBER
Bachelor of Industrial Design / FALL 2023 & WINTER 2024

PARTICIPANT INFORMED CONSENT FORM

Research Study Topic: Improving the living conditions of those without adequate housing

Investigator: Roland Moeschter | rolymoes@gmail.com | 289-981-3367

Sponsor: Humber College ITAL, Faculty of Media & Creative Arts (IDSN 4002 & IDSN 4502)

I, MICHAEL LYSTER *(first name & last name)* have carefully read the Information Letter for the project Improving the living conditions of those without adequate housing, led by Roland Moeschter. A member of the research team has explained the project to me and has answered all of my questions about it. I understand that if I have additional questions about the project, I can contact Roland Moeschter at any time during the project.

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

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

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

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

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

I understand that I can verify the ethical approval of this study, or raise any concerns I may have by contacting the Humber Research Ethics Board:
Dr. Lydia Boyko, REB Chair, 416-675-6622 ext. 79322, **Lydia.Boyko@humber.ca** or
Roland Moeschter at **rolymoes@gmail.com**.

Verification of having read the Informed Consent Form:

☒ I have read the Informed Consent Form.

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

MICHAEL LYSTER		Oct. 18, 2023
Participant's Name	Participant's Signature	Date

3

From: **Roland Moeschter** <rolymoes@gmail.com>
Date: Mon, Oct 16, 2023 at 4:45 AM
Subject: Re: Roland M. - seeking expertise from an advisor on issues of unhoused people
To: Michael Lyster <m.lyster@homesfirst.on.ca>

Hello Michael,

Thanks for following up, let's do Tuesday (17th) at 1pm.

Would you be able to create a Zoom meeting link for that? It's been a while since I've used Zoom.

Please let me know.

Roland

From: Roland Moeschter <rolymoes@gmail.com>
Sent: Tuesday, October 17, 2023 2:04 PM
To: Michael Lyster <m.lyster@homesfirst.on.ca>
Subject: Fwd: Roland M. - seeking expertise from an advisor on issues of unhoused people

Hello Michael,

Thanks again for your time today and the insights you provided.

I have attached the advisor Information Letter and Consent forms to this email, please sign them at your convenience.

Please let me know if you have any questions or concerns.

Thanks,
Roland M.

Michael Lyster <m.lyster@homesfirst.on.ca>
to me

Morning – hope this works? I only attached the signatory pages, which I assume is all you need.

Michael Lyster (Pronouns: He/Him)
Manager of Development
Homes First Society
(416) 455-6928
m.lyster@homesfirst.on.ca
@homes_first
http://www.homesfirst.on.ca
www.facebook.com/HomesFirstTO
everyone needs a home

From: Roland Moeschter <rolymoes@gmail.com>
Sent: Wednesday, November 15, 2023 5:20 AM
To: Michael Lyster <m.lyster@homesfirst.on.ca>
Subject: Roland M. - update on thesis project - concepts

Hello Michael,

Hope you are doing well.

I just wanted to update you on the progress of my thesis project on improving living conditions of homeless individuals, and to gain some insights from you regarding the direction of my concepts.

Both of my concepts revolve around mobile services for homeless people. They are both large self-driving vehicles (designed new from the ground-up, not retrofitting an existing vehicle) with a human operator to ensure safe operation of the vehicle and safety of the clients. The vehicles park up at predetermined locations throughout a city to allow clients to use their services and facilities.

The first concept is aimed at helping people look more presentable, i.e. basic hairdressing service, showers, quick laundry service. It could support roughly five or six clients at a time. The second concept would be for more healthcare-oriented services, including a general practitioner, dentist, and dental hygienist. Both concepts would also have a couple basic bathrooms available for clients to use, with care packages (razors, nail clippers, toothbrush and toothpaste, feminine hygiene products, etc.) for the clients if they so need it.

What are your thoughts on these ideas? Are they too similar to mobile services that already exist, and if so, do you know of any ways I could set my ideas apart?

Thanks and take care.
Roland M.

Michael Lyster <m.lyster@homesfirst.on.ca> Wed, Nov 15, 2023, 1:00 PM
to me

Hi Roland – I think these are both great ideas! FYI, there is a program (you may be familiar with it) called the Health Bus that does attend shelters and provides some of what you proposed (nurse, personal care items):

https://healthbus.ca/

I also mentioned your ideas to a couple colleagues, and I have a couple questions/suggestions. Do you have time for a quick call this week?

Michael Lyster (Pronouns: He/Him)
Manager of Development
Homes First Society
(416) 455-6928
m.lyster@homesfirst.on.ca
@homes_first
http://www.homesfirst.on.ca
www.facebook.com/HomesFirstTO
everyone needs a home

Amy Claus <Amy.Claus@salvationarmy.ca> Tue, Oct 10, 2023, 11:54 AM
to me

Hi Roland!
I have reviewed and signed the attached consent for you. Just let me know what you need from me at any time. If you want to come to the shelter to interview me or even a few of our Case Workers you are welcome to pop by.

Thanks and have a good day

Amy Claus
Program Services Manager

Hamilton, Halton and Brantford Housing and Support Services
94 York Blvd, Hamilton, ON L8R 1R6
Email: Amy.Claus@salvationarmy.ca [Phone: 905-527-1444 ext. 222 [Cell: 226-802-0220

Roland Moeschter <rolymoes@gmail.com> Tue, Oct 10, 2023, 1:04 PM
to Amy

Hi Amy,

Thanks so much for the quick response.

I was thinking of coming by on Friday (13th) to speak with you. Would you be available then? If so, when would be a good time of day to visit?

Thanks,
Roland

Amy Claus <Amy.Claus@salvationarmy.ca> Tue, Oct 10, 2023, 3:13 PM
to me

I am available on Friday if you want to come by. Looks like I don't have any appts or meetings that day so let me know what time is good for you.

Thank you

Amy Claus
Program Services Manager

Hamilton, Halton and Brantford Housing and Support Services
94 York Blvd, Hamilton, ON L8R 1R6
Email: Amy.Claus@salvationarmy.ca [Phone: 905-527-1444 ext. 222 [Cell: 226-802-0220

Roland Moeschter <rolymoes@gmail.com> Wed, Oct 11, 2023, 1:26 PM
to Amy

Hi Amy,

I was thinking of coming down for 1:30p on Friday. Hopefully that is after lunch time for you?

Roland

Amy Claus <Amy.Claus@salvationarmy.ca> Wed, Oct 11, 2023, 1:36 PM
to me

Yep 1:30pm is fine with me, see ya then

Thank You

Amy Claus
Program Services Manager

Hamilton, Halton and Brantford Housing and Support Services
94 York Blvd, Hamilton, ON L8R 1R6
Email: Amy.Claus@salvationarmy.ca [Phone: 905-527-1444 ext. 222 [Cell: 226-802-0220

Appendix D – Additional Ergonomic Study Images