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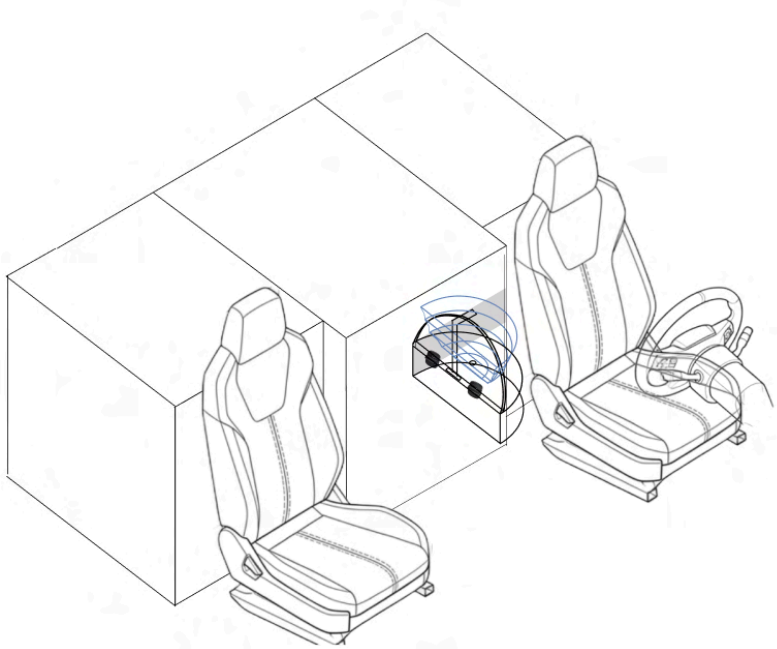

Designing for Everyday Hygiene in Long-Haul Truck Cabins:

Exploring Integrated in-Cabin Hygiene Solutions

Master's thesis in Industrial Design Engineering

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Cover: Early concept visualization of an in-cabin hygiene solution for long-haul truck drivers.

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Abstract

Long-haul truck drivers spend extended periods of time inside the truck cabin, which functions not only as a workplace but also as a temporary living environment. Despite the importance of everyday hygiene for health, comfort, and wellbeing, current truck cabins provide limited support for basic hygiene activities such as hand washing, face washing, and tooth brushing. Drivers therefore often rely on external facilities or improvised solutions, which may be inconvenient, unreliable, or perceived as unsafe.

This thesis investigates how heavy-duty long-haul truck cabins can better support everyday hygiene routines through the integration of in-cabin hygiene solutions. A user-centred design approach was applied, combining literature studies, interviews, online ethnography, benchmarking, co-creation activities, prototyping, and user evaluations. The research explored drivers' hygiene practices, challenges, and spatial constraints within the truck environment and translated these insights into design requirements and concept proposals.

The findings indicate a clear need for accessible, reliable, and space-efficient hygiene solutions within the cabin. Drivers frequently adapt their routines due to limited access to suitable facilities, while concerns related to cleanliness, convenience, privacy, and personal safety further increase the value of in-cabin alternatives. Three concept directions were developed and evaluated, highlighting different approaches to balancing accessibility, ergonomics, spatial integration, and implementation feasibility. The evaluations showed that solutions requiring minimal setup and providing convenient access were generally preferred by participants.

The project demonstrates that integrated hygiene solutions have the potential to reduce dependence on external facilities while improving comfort, convenience, and perceived safety for long-haul truck drivers. Furthermore, the results highlight hygiene as an under explored opportunity within truck cabin design and contribute knowledge regarding how future cabin environments can better support everyday life on the road.

Keywords: long-haul trucking, truck cabin, hygiene solutions, driver wellbeing, user-centred design, in-cabin experience.

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Contents

1 Introduction

Truck drivers play a critical role in global logistics and supply chains, yet the occupation is associated with significant health challenges. Previous research has linked long-haul truck driving to fatigue, sedentary behaviour, stress, obesity, sleep disorders, and limited access to healthcare services (Boyce, 2016; Singer, 2025). Long working hours, irregular schedules, and extended periods away from home create working conditions that are both physically and psychologically demanding for drivers (Singer, 2025).

Due to the nature of long-haul transportation, heavy-duty long-haul trucks are designed for extended driving periods where drivers may remain on the road for several days at a time. As a result, the truck cabin functions not only as a driving environment but also as a temporary living space. Modern truck cabins therefore commonly include features such as sleeping areas, storage, seating, climate control, and infotainment systems intended to support driver comfort during extended trips. During long-haul transport, drivers spend extended periods of time inside the cabin, using it for sleeping, eating, resting, and carrying out daily routines, placing high demands on comfort, safety, and functionality (Crizzle et al., 2017). Drivers frequently rely on truck cabins, truck stops, and roadside rest areas to perform essential everyday activities, including maintaining personal hygiene (Lise et al., 2024).

Despite how much time drivers spend in them, current truck cabins generally provide limited support for basic personal hygiene activities, such as access to water or handwashing facilities. Research also suggests that truck stops and rest areas do not always provide adequate infrastructure and services to support drivers' health and wellbeing (Lise et al., 2024). As a result, drivers are often dependent on external facilities that may be difficult or uncomfortable to access, particularly during nighttime parking, poor weather conditions, or in areas perceived as unsafe.

For some drivers, especially women, the need to leave the vehicle to access hygiene facilities may compromise feelings of personal safety and comfort, further contributing to the physically and psychologically demanding working conditions associated with long-haul trucking. Previous studies also show that female drivers remain underrepresented within the truck industry, accounting for approximately 10% of truck drivers in Sweden (Volvo Group Trucks Technology, 2024). However, the proportion of female drivers is increasing, highlighting the importance of looking at a broader range of user needs and experiences within truck cabin design.

Access to water and sanitation is today recognised as a fundamental human right and is addressed in United Nations Sustainable Development Goal 6. However, while previous research extensively examines issues such as fatigue, sleep quality, obesity, and occupational stress among drivers, limited attention has been given specifically to personal hygiene practices and hygiene experiences within truck cabin environments. Previous studies have identified a lack of research regarding personal hygiene resources and comfort for long-haul truck drivers (Lise et al., 2024). This indicates a research gap concerning how hygiene related activities are managed within the spatial and practical constraints of long-haul trucking environments.

Against this background, this project explores the need for, and design opportunities for, an integrated hygiene solution within the truck cabin, with the aim of supporting

everyday hygiene practices in a way that is accessible, safe, and adapted to the realities of long-haul driving.

1.1 Objective

The objective of this thesis is to investigate and propose how truck cabins can support basic daily hygiene routines, such as washing hands or face, or brushing teeth within the cabin environment. The project will explore feasible approaches for in-cabin hygiene, focusing on solutions that support safe, ergonomic, and sustainable hygiene practices within the truck cabin environment.

1.2 Delimitations

This project focuses on hygiene solutions within the truck cab and does not include a toilet function. This limitation is based on the restricted spatial conditions of the truck cab, as well as previous research indicating that drivers generally do not consider in-cab toilets to be hygienic or desirable. In addition, the development of toilet systems would require technical competencies and engineering considerations related to plumbing, waste handling, sanitation, and regulatory requirements that fall outside the scope of this project.

The work is therefore limited to basic hygiene needs such as hand washing, face washing, and personal cleaning inside the cab.

Lastly, the project focuses on the design of a compact, integrated solution within the cab and does not address larger system-level infrastructure such as full water supply or waste handling systems.

2 Method

2.1 Design Approach

This project follows a user centered design approach (van Boeijen et al., 2014), focusing on understanding the needs, behaviours, and challenges of truck drivers in relation to personal hygiene within the cabin environment. The approach ensures that the proposed solution is grounded in real user experiences while also addressing technical, spatial, and contextual constraints. A combination of qualitative research methods was used to capture both expressed needs and observed behaviours. This enables a more holistic understanding of the problem, supporting the development of relevant and feasible design solutions.

2.2 Design Process

The project was structured as an iterative design process consisting of four main phases: research, ideation, development (prototyping), and evaluation.

- Research: Building an understanding of the problem context, user needs, and existing solutions.
- Ideation: Generating and exploring a wide range of potential solution concepts.
- Development: Refining selected concepts through design detailing, prototyping, and integration
- Evaluation: Assessing concepts based on usability, feasibility, and alignment with user needs and requirements.

These phases were not strictly linear but overlapped throughout the project, allowing insights and findings to continuously inform design decisions.

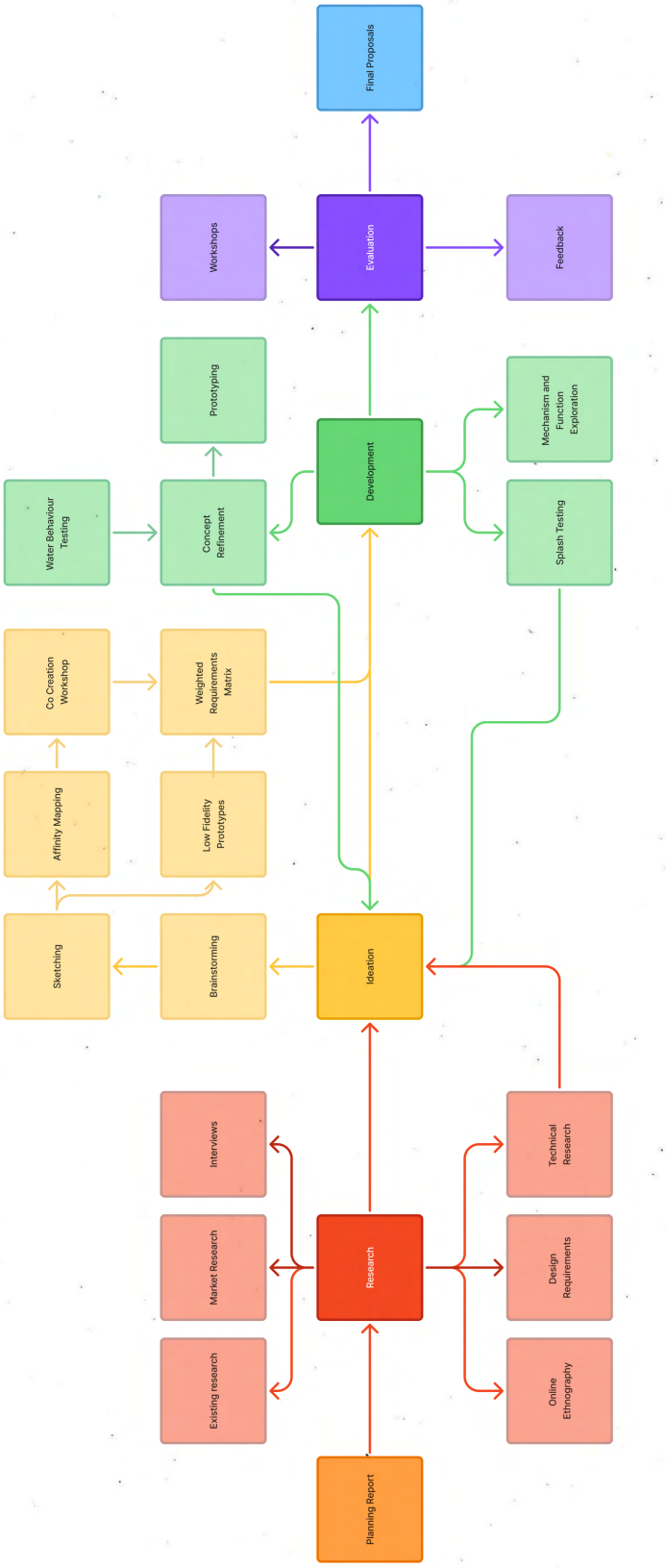


Figure 1: Project process diagram showing the main phases, methods, and iterations throughout the project.

2.3 Research Phase

The initial phase focused on building an understanding of the problem area, user context, and existing conditions related to hygiene within truck cabins. Multiple qualitative research methods were applied in order to capture different perspectives and establish a broader understanding of user behaviour, environmental constraints, and current practices.

2.3.1 Literature Review

A literature review was conducted during the beginning phase of the project in order to establish a broader understanding of truck drivers' working conditions, health, wellbeing, and living environments. Literature was primarily collected through searches in the Chalmers University library database using keywords related to the project topic, including "long-haul trucking", "truck drivers", "hygiene", "health", "sanitation", and "truck cabin". Particular focus was placed on identifying existing research related to hygiene practices, access to sanitation, and daily life within heavy-duty long-haul truck cabins. The collected literature was analysed thematically in order to identify recurring topics, research focus areas, and gaps within existing studies and current truck cabin solutions. The findings indicated that while several studies address driver health, fatigue, safety, and cabin comfort, limited research specifically focuses on personal hygiene practices and hygiene-related support within truck cabins. This highlighted a potential area for further design exploration within the context of heavy-duty long-haul transport.

2.3.2 Interview

A semi-structured interview (Kvale and Brinkmann, 2009) was conducted with one professional long-haul truck driver at a truck stop . The participant was selected based on accessibility and relevance to the target user group. The interview followed a guide covering key themes such as daily routines, hygiene practices, challenges, and existing solutions used in the cabin, while allowing flexibility for follow-up questions and open discussion. The interview was documented through written notes and analysed using a thematic approach, where recurring patterns, behaviours, and pain points were identified. This method enabled the collection of rich, experience-based data directly from a primary user and contributed to the development of key user insights and subsequent design requirements.

2.3.3 Online Ethnography

An online ethnographic study (Kozinets, 2015) was conducted to gain a broader understanding of truck drivers' hygiene practices and challenges in everyday situations. A total of ten publicly available YouTube videos were analysed, focusing on content that depicted daily life in the truck cabin, hygiene routines, and work-related activities. The videos were selected based on relevance to the research topic, using search terms such as "truck driver daily routine," "life in truck cabin," and "female truck driver hygiene." Particular attention was given to content from female drivers, as this user group is underrepresented and more difficult to access through direct interviews. The material was analysed qualitatively using a thematic approach, where recurring behaviours, workarounds, and challenges were identified and compared across sources. This method complemented the interview by providing a broader range of perspectives and enabling the identification of patterns that extend beyond a single user.

2.3.4 Benchmarking and Market Analysis

A benchmarking and market analysis was conducted to examine existing solutions within the truck industry as well as comparable domains. Existing truck models and cabin solutions from major manufacturers were reviewed through publicly available product material, manufacturer websites, industry reports, and visual references in order to understand current cabin layouts, features, and limitations related to hygiene and daily activities.

In addition, solutions from related environments such as aircraft cabins, ambulances, camper vans, and other compact living spaces were analysed to identify relevant design strategies for integrating hygiene-related functions within limited spaces. The selection of reference cases was based on similarities in spatial constraints, multifunctional use, storage integration, and user interaction within confined environments.

The collected examples were compared and analysed based on factors such as placement, space efficiency, ergonomics, usability, accessibility, and integration within the surrounding environment. The purpose of the analysis was to identify existing limitations, recurring design approaches, and opportunities relevant to the development of an integrated hygiene solution for long-haul truck cabins.

2.3.5 Joint Analysis & Requirements

The collected material from the literature review, interviews, online ethnography, and benchmarking analysis was synthesised using a thematic approach. Recurring patterns, behaviours, challenges, and workarounds related to hygiene practices within the truck cabin environment were identified and grouped into broader themes. These themes formed the basis for identifying key pain points and user needs. The identified needs and insights were subsequently translated into design requirements that guided the ideation and development phases of the project. The requirements included functional, ergonomic, spatial, safety-related, and contextual considerations, such as accessibility within limited cabin space, ease of use during extended trips, and adaptation to cold climate conditions.

2.4 Ideation Phase

Based on the insights that was gathered during the research phase, the project progressed into ideation and concept generation. The purpose of this phase was to translate identified user needs, behaviours, and design requirements into potential solution directions. The ideation process began through open brainstorming sessions and rapid hand sketching, where a large quantity of ideas and interaction principles were explored without early filtering or evaluation. This approach encouraged broad exploration and reduced the risk of prematurely narrowing the solution space. Following the initial brainstorming sessions, concepts were analysed and clustered into broader categories based on shared functional and spatial characteristics. Examples of concept categories included foldable sinks, pull-out drawer solutions, integrated wall-mounted systems, expandable concepts, and portable hygiene systems. Further ideation was then conducted within these categories, where concepts were combined, adjusted, and refined into more developed design directions.

2.4.1 Brainstorming

Initial ideation was conducted through brainstorming and rapid sketch exploration, where a large quantity of ideas were generated before evaluation or filtering (van Boeijen et al., 2014). The purpose of this method was to encourage broad exploration of possible solution directions and avoid prematurely constraining the design space. The brainstorming process focused on generating a wide variety of concepts related to placement, interaction, deployment, water integration, and spatial use within the truck cabin environment. Ideas were explored freely and without early judgement in order to support creativity and identify unexpected solution opportunities. This divergent approach enabled exploration of both realistic and more speculative concepts, forming a broad foundation for continued concept development and refinement throughout the project.

2.4.2 Affinity Mapping

Following the initial ideation sessions, affinity mapping was used to organise and analyse generated ideas by grouping concepts with similar functional, spatial, and interaction characteristics (Krause and Pernice, 2024). This method was applied repeatedly throughout the ideation process in order to manage the large quantity of generated ideas and identify recurring themes, categories, and design directions. The clustering process supported both divergent and convergent thinking by enabling broad exploration of ideas while also helping structure and refine emerging concepts. By visually grouping concepts into categories, such as foldable, integrated, portable, or expandable solutions, similarities and patterns between ideas became easier to identify and further develop. The method also supported iterative development throughout the project, as concepts were continuously reorganised, combined, and refined based on new insights gained from workshops, prototyping, and testing activities.

2.4.3 Co-Creation Workshop

A co-creation workshop was conducted to explore potential design solutions and to better understand how users interact with hygiene-related activities within the spatial constraints of a truck cabin (Sanders and Stappers, 2008). The workshop involved three participants, selected based on availability, who were asked to engage with the problem through scenario-based tasks. A simplified mock-up of a truck cabin environment was used to simulate the spatial context. Participants were asked to act out four different hygiene scenarios, such as washing hands or managing daily routines, and to propose and test potential solutions. The scenarios were designed to encourage participants to physically interact with the cabin environment and explore movement, accessibility, and placement within the limited spatial conditions. The workshop focused on aspects such as placement, interaction, ergonomics, and usability. Observations and participant feedback were documented through notes and analysed using a thematic approach, where recurring patterns related to behaviour, preferences, and spatial constraints were identified. This method provided valuable insights into how users interact with the environment and helped generate and evaluate early design ideas. A limitation of the workshop is that the participants were not professional truck drivers, which may affect the realism of the behaviours observed. However, the method is effective for exploring interaction patterns and spatial relationships in early design stages and complements findings from other research methods.

2.4.4 Weighted Requirements Matrix

To support concept evaluation and selection, a weighted objectives matrix was used to systematically compare concepts against identified user needs and design requirements (van Boeijen et al., 2014). The method was applied during the later stages of the ideation process in order to support structured decision-making and reduce subjective evaluation of concepts. Evaluation criteria were based on findings from the research and requirements phases and included aspects such as usability, spatial efficiency, ergonomics, feasibility, safety, and integration within the cabin environment. Each criterion was assigned a relative weighting based on its importance within the project context. The concepts were then scored against these criteria, allowing comparison between different solution directions and helping identify the most promising concepts for continued development. The method also supported reflection on trade-offs between different design qualities and feasibility considerations.

2.5 Development Phase

The development phase focused on refining selected concepts through prototyping, exploratory testing, and spatial integration studies. Low-fidelity prototypes and mock-ups were developed using simple materials such as cardboard and paper in order to quickly evaluate aspects such as deployment mechanisms, placement, ergonomics, and interaction within the cabin environment. Exploratory testing was also conducted to better understand practical challenges related to water use in confined spaces. This included water behavior testing during activities such as hand washing and face washing, helping identify issues related to water containment, usability, and contamination of surrounding areas. The development phase also involved continuous iteration between sketches, mock-ups, and testing, where concepts were repeatedly adjusted based on findings from prototyping and evaluation activities.

2.5.1 Prototyping and Testing

Early stage prototyping was used as both an exploratory and evaluative method (van Boeijen et al., 2014). Low-fidelity prototypes were developed to explore spatial integration, deployment principles, interaction, and functional features of proposed concepts. Constructed from simple materials such as cardboard and paper, these prototypes enabled rapid testing and iteration throughout the ideation phase.

The prototypes were also used to explore different deployment mechanisms, including simple hinges, slide-out solutions, rotary movements, and constant-torque hinge principles. These explorations helped evaluate how different mechanical approaches influenced accessibility, spatial integration, and user interaction.

In parallel, exploratory tests were carried out to investigate water behaviour during activities such as hand washing and face washing. These tests helped identify challenges related to splashing and water containment, which subsequently influenced design decisions such as the integration of splash guards.

In later stages of the project, higher-fidelity prototypes were developed for the selected concepts. These prototypes were built at full scale and used to evaluate accessibility, deployment mechanisms, spatial integration, and overall usability within a real truck

cabin environment. The prototypes supported concept refinement and helped assess how the concepts interacted with existing cabin functions and space constraints.

2.6 Evaluation Phase

The evaluation phase of the project focused on evaluating the developed concepts and prototypes in relation to the identified user needs, design requirements, and project objectives. The purpose of the evaluation was to assess how well the concepts supported everyday hygiene activities within the truck cabin environment and to identify strengths, limitations, and opportunities for further development. Particular attention was given to usability, accessibility, ergonomics, spatial integration, and the possibility of reducing dependence on external hygiene facilities.

2.6.1 User Evaluation

The developed concepts were evaluated through user testing involving five participants. The evaluation utilised the same routine scenarios previously developed during the co-creation workshop. Reusing the scenarios enabled the concepts to be assessed against the same realistic situations that informed the early stages of concept development. The scenarios included activities such as morning hygiene routines after waking up in the cabin, washing hands after unloading cargo, and quick hygiene interactions during rest periods inside the truck. These scenarios were selected to represent different movement patterns, accessibility requirements, and interaction situations within the limited cabin space. Participants were asked to interact with the concepts and provide feedback regarding usability, accessibility, ergonomics, and spatial integration. Particular attention was given to body positioning, reachability, setup complexity, movement within the cabin, and how the concepts interacted with surrounding cabin functions during use. Observations and participant feedback were documented through written notes and analysed using a thematic approach, where recurring patterns related to usability, ergonomics, accessibility, and spatial integration were identified. The findings were subsequently used to compare the strengths, limitations, and trade-offs associated with the different concept directions.

3 User Research & Needs Analysis

This section presents the findings from the user research conducted throughout the project. By combining interviews, online ethnography, workshops, and previous industry research, a broader understanding of drivers' daily routines, challenges, behaviours, and hygiene-related needs within the truck cabin environment was developed.

The insights gathered through the research formed the foundation for identifying user needs, design opportunities, and key requirements for the development of an integrated hygiene solution.

3.1 User Background & Groups

3.1.1 General Driver Profile

Truck drivers represent a diverse user group with varying ages, experiences, and working conditions. Many drivers spend extended periods of time in the vehicle, often staying several nights per week inside the cabin during long-haul transport (Volvo Group Trucks Technology, 2019). The truck cabin therefore functions not only as a workspace, but also as a temporary living environment where activities such as eating, resting, and personal hygiene take place (Volvo Group Trucks Technology, 2019).

The user group includes both company-employed drivers and owner-operators, with different routines depending on transport type, schedules, and driving distances. Some drivers mainly operate regionally with frequent stops, while others spend long continuous periods on the road with limited access to external facilities.

Drivers also differ in how they organize and adapt the cabin environment to support everyday activities. This creates varying needs regarding storage, accessibility, ergonomics, and hygiene support within the cabin space.

3.1.2 Female Drivers – Background Characteristics

Previous industry research indicates that female truck drivers currently represent a small but growing part of the driver population, accounting for approximately 5–10% of drivers in parts of Europe and Scandinavia (Volvo Group Trucks Technology, 2024).

The research suggests that many female drivers belong to an experienced age group, commonly ranging between approximately 35–55 years old. Several studies also highlighted challenges related to safety, comfort, and hygiene during long-haul driving.

In some situations, drivers described avoiding external facilities during night-time or in isolated areas, influencing how and when hygiene routines were carried out. These insights emphasize the importance of designing inclusive and accessible solutions that support a diverse range of users and everyday routines within the truck cabin environment.

3.2 Context of Use

Previous studies show that drivers spend on average around five nights per week in the truck, and most of them are alone during this time. This means that the truck cabin

functions not only as a workspace, but also as a temporary living environment (Volvo Group Trucks Technology, 2019).

Daily routines often include eating, resting, and managing personal hygiene within or around the truck. Many drivers prepare and eat food inside the cabin, increasing the importance of access to basic hygiene solutions. According to WHO guidelines, hand hygiene is connected to several everyday activities such as eating, food preparation, and personal care (World Health Organization, 2022).

Several recurring hygiene situations were identified throughout the co-creation workshops and user research activities. The scenarios represented everyday situations within long-haul transport, including morning hygiene routines after waking up in the cabin, washing heavily soiled hands after unloading cargo, cleaning hands after extended driving periods, and quick hygiene activities while relaxing in the sleeping area the bed storage compartment beneath the sleeping compartment.

These scenarios helped clarify how hygiene needs occur repeatedly throughout the day and vary depending on activity, location, and surrounding conditions. The scenarios also highlighted the importance of solutions that are quick to access, adaptable to different situations, and possible to use directly within the cabin environment.

At the same time, opportunities to stop are often limited due to schedules, parking availability, and driving regulations. Online observations and social media content also showed that drivers frequently adapt their hygiene routines depending on access to facilities and surrounding conditions. In several cases, drivers described using improvised hygiene solutions inside the cab when external facilities were unavailable, unclean, or perceived as unsafe.

For some drivers, particularly women, additional challenges related to safety can affect how and when hygiene routines are carried out. Drivers may avoid leaving the truck during night-time or in isolated areas, making access to hygiene solutions inside the cabin especially important.

These conditions highlight the need for solutions that support everyday routines directly within the cab. A compact and easily accessible hygiene solution could reduce dependency on external facilities and improve both comfort and perceived safety.

3.3 Previous Industry Research

This section presents insights gathered from previous industry research related to drivers' daily routines, hygiene conditions, and spatial possibilities within truck cabins. The research material was provided in confidence by a large truck manufacturer and included studies related to driver behaviour, cabin usage, and living conditions within long-haul transport.

The findings provided an important foundation for understanding user needs and identifying opportunities for integrated hygiene solutions within the cab environment.

3.3.1 Hygiene Conditions & Challenges

The research indicated that many hygiene-related challenges are connected to the quality and reliability of external facilities rather than a complete lack of access (Volvo Group

Trucks Technology, 2019). Commonly identified issues included unclean facilities, limited availability, and poorly maintained infrastructure.

This evidence indicates that the problem is not necessarily whether facilities exist, but whether they are practical, hygienic, and reliable enough to support everyday routines during long-haul driving.

For this project, these insights indicate an opportunity to support basic hygiene activities directly within the truck cabin. If external facilities are perceived as unreliable or unpleasant, the value of an integrated in-cabin hygiene solution increases.

3.3.2 Interest in In-Cab Hygiene Solutions

The research also showed a clear interest in having access to water-related functions within the cabin environment (Volvo Group Trucks Technology, 2019). Features related to basic hygiene, such as access to water for hand washing or face washing, were generally perceived positively.

At the same time, more extensive sanitary solutions, such as integrated toilets, were viewed less favorably and were often considered unsuitable within the cabin context. Instead, the findings pointed towards a preference for compact solutions supporting simple everyday hygiene routines.

These insights prove especially relevant for this thesis, as they strengthen the motivation for exploring integrated and space-efficient hygiene concepts adapted to the truck environment

3.3.3 Safety & Inclusivity Aspects

Previous industry research also highlighted additional challenges related to safety and accessibility, particularly for female drivers (Volvo Group Trucks Technology, 2024). In some situations, drivers described avoiding external facilities during night-time or in isolated areas due to concerns related to personal safety.

This affects how and when hygiene routines are carried out, and in some cases leads to improvised solutions or avoidance of certain locations altogether. These findings point out the importance of creating hygiene solutions that can support everyday routines directly within the cabin environment.

The research also highlights the relevance of considering a multiple user group with different experiences, routines, and physical conditions when designing integrated cabin solutions.

3.3.4 Daily Work Life & Safety Aspects

Knowledge of drivers' daily work life further emphasized challenges connected to both hygiene and personal safety. Although drivers are generally able to find places to stop during longer trips, the condition as well as reliability of public facilities were commonly perceived negatively.

Safety concerns were also identified, particularly during night-time or in isolated areas. In some situations, drivers preferred avoiding unnecessary visits to public spaces, modifying how and when hygiene routines were carried out.

Research additionally showed that drivers commonly spend several nights per week inside the truck cabin, increasing the importance of supporting everyday routines directly within the vehicle (Volvo Group Trucks Technology, 2019). This increases the importance of supporting everyday routines directly within the cabin.

The studies also identified several spatial opportunities inside the truck, including storage areas and compartments that could potentially support additional integrated functions.

Together, these findings show the need for solutions that reduce dependence on external facilities and instead support safe, accessible, and convenient hygiene practices within the truck cabin.

3.3.5 Cold Climate Challenges

A recurring challenge identified in the research was related to external water access during colder conditions. Existing personal water solutions outside the cabin may become difficult to use during winter due to freezing temperatures, limiting access to water and increasing dependence on external facilities.

Overall, the results show that current hygiene routines are often dependent on improvised or individual solutions rather than being fully supported by the truck environment itself. This further reinforces the need for more integrated and reliable hygiene solutions within the cabin.

3.4 Pain Points & Key Insights

The user research revealed several recurring challenges and patterns related to personal hygiene during long-haul driving:

- External facilities are often **unclean, crowded, or poorly maintained**, reducing their usability for everyday hygiene:

Across the collected user insights as well as research findings, external hygiene facilities were consistently described as unclean, crowded, or unreliable. This was also reflected in the interview, where the driver preferred using personal solutions rather than relying on external infrastructure. These limitations reduce the usability of existing facilities and increase the need for alternative solutions within the cabin.

Overall, this indicates that the issue is not necessarily the absence of facilities, but rather their lack of reliability and quality under real-world conditions.

- Drivers frequently rely on **improvised hygiene solutions**, such as water bottles, wipes, and personal water containers

Across both the interview and online ethnography, a consistent pattern appeared showing that truck drivers frequently rely on improvised hygiene solutions because of limited access to reliable and convenient facilities. Both the interview and online ethnography highlight how hygiene is often managed through personal systems rather than integrated support within the truck.

The online ethnography revealed several examples of drivers carrying personal water supplies, wet wipes, hygiene kits, and emergency hygiene products inside the cabin. One driver explained that “I clean my face with wipes if I can’t get to a proper place” (Queen

P Babyy, 2022). Another driver described how hygiene routines often require adaptation to the realities of long-haul trucking, stating that "you can't be too girly in this business" (Highway To Sunshine, 2017). Similar patterns were observed in other videos, where drivers described carrying emergency hygiene supplies and backup water to manage personal hygiene needs during long-haul operation, particularly in situations where facilities were unavailable, inconvenient, or perceived as unsafe (Niesha K., 2021).

In the interview, the driver described bringing personal water containers and soap to wash hands, as well as regularly using wet wipes inside the cabin. These solutions were stored within easy reach, such as in door compartments or storage areas, to enable quick access during daily routines. These outcomes indicate that hygiene practices are currently dependent on individual initiative rather than supported by integrated systems. While these solutions enable basic functionality, they are commonly inefficient, inconsistent, and temporary. The interview guide can be found in Appendix A.

Left: Personal water containers stored inside the cab.

Right: Soap stored in the door compartment for daily use.

Figure 2: Examples of improvised hygiene solutions brought by the driver.

- Hygiene routines are often **quick, situational, and not fully supported** by the truck environment

Hygiene routines are strongly influenced by time pressure and working conditions.

The interview highlighted how tight schedules between stops make it difficult to access external facilities, strengthening the need for quick and accessible solutions. This pattern was also evident in the online ethnography, where driver frequently described performing hygiene tasks during short breaks or transitions between activities.

As a result, hygiene behaviour is often quick situational, and adapted to time constraints, rather than structured or supported by dedicated solutions.

- Drivers regularly encounter **dirty hands** during tasks such as fueling, loading, and handling equipment

Another recurring insight is the frequency of hygiene needs throughout the day. Both the interview and online ethnography show that tasks such as fueling, loading, and handling equipment regularly result in dirty hands, creating a repeated need for quick and accessible cleaning solutions. According to WHO guidelines, hand hygiene should be performed repeatedly throughout the day during several "key moments," such as before eating and when hands are visibly dirty (World Health Organization, 2022).

Similarly, 1177 Vårdguiden highlights that regular hand washing with soap and water is important for reducing the spread of illness and recommends washing hands for approximately 30 seconds to ensure effective cleaning (1177 Vårdguiden, 2022).

Good hand hygiene is also connected to comfort and wellbeing in everyday life. A survey presented by Kurera found that many people associated regular hand washing with enhanced mood and a greater sense of freshness and wellbeing (Kurera, 2020).

However, existing solutions such as wipes are not always sufficient result in increased waste. This illustrates the need for solutions that support frequent, efficient, and easily accessible hygiene routines throughout the working day.

- Access to water can be **limited or unreliable**, especially in cold conditions whereby external water systems may freeze

Access to water was identified as a key challenge, particularly in relation to reliability.

In the interview, the driver described using an external water solution that became unusable during cold weather due to freezing. This significantly limited access to water and increased dependence on external facilities.

This issue is further supported by findings from the online ethnography, where drivers described difficulties in sustaining steady access to water in different conditions.

These findings stress the importance of developing solutions that ensure reliable water access regardless of environmental conditions.

Figure 3: The driver's external frozen water solution mounted outside the truck.

- Drivers may **avoid leaving the truck** due to weather, time pressure, or safety concerns

In certain situations, hygiene routines are performed directly inside the cabin. The online ethnography revealed that drivers sometimes avoid leaving the vehicle due to weather, time pressure, or safety concerns, leading them to carry out hygiene activities internally. This includes both basic routines and, in some cases, more personal hygiene needs. The interview supports this pattern, showing that current practices already extend into the cabin, despite the lack of exclusive support. This highlights a mismatch between how the cabin is used and how it is designed.

- The cabin functions as both a **workspace and living space**, increasing the priority of maintaining cleanliness

The truck cabin functions as both a workspace and a living environment, which increases the priority of maintaining cleanliness. Findings across all methods indicate that drivers eat, rest, and manage daily routines within the same space. This creates a need to balance hygiene activities with preserving a clean and comfortable environment, particularly within areas associated with rest. Insights from the co-creation workshop additionally strengthen this, as participants expressed reluctance to introduce water or hygiene activities into areas such as the bed. This twofold function of the cabin introduces important spatial and behavioural constraints for design.

- Wet wipes are widely used but are **not always effective and generate waste**, indicating limitations of the current solutions

Current hygiene solutions, such as wet wipes, are widely used but present limitations. Across multiple sources, wipes were described as a convenient but insufficient solution, particularly for tasks that need water. Additionally, their frequent use results in increased waste, raising sustainability concerns. This suggests that existing solutions do not fully meet user needs and points to the potential for more effective and sustainable alternatives.

- Female drivers highlight additional challenges related to **privacy, safety, and hygiene management**, especially in situations where access to facilities is limited

Safety and privacy emerged as important factors influencing hygiene behaviour, particularly for female drivers. The online ethnography highlighted that drivers sometimes avoid leaving the truck due to safety concerns, especially at night or in isolated areas. This leads to increased reliance on in-cabin solutions. Additionally, female drivers emphasised the need for privacy and control when managing hygiene, particularly in situations in which external facilities are unavailable or unsuitable. These findings indicate that hygiene solutions must not just address functionality, but also support a sense of safety and privacy.

These findings show a clear gap between current hygiene practices and user expectations, indicating the need for more integrated and user-centered solutions within the truck cabin.

3.5 User Needs

Based on the identified pain points and behavioural insights from the user research, a set of key user needs was defined. These needs translate the research findings into design-oriented objectives and form the foundation for the design requirements presented in Chapter 6.

The identified needs relate both to the overall relevance of an in-cabin hygiene solution and to the functional and spatial requirements influencing the design of such a solution.

3.5.1 User Needs Related to Hygiene Access

- Strong need for hygiene access inside the cabin, reducing dependence on external facilities
- Preference of clean and reliable alternatives to external facilities, which are often seen as unclean, crowded, or poorly maintained
- Need for privacy and safety, especially in situations where drivers prefer not to leave the vehicle
- Need to handle frequent hygiene situations, such as dirty hands after fueling, loading, or eating
- Need for solutions that work in cold conditions, where outside water systems may freeze
- Need for less dependence on disposable products, such as wet wipes, to improve sustainability
- Need for solutions that support different user groups, including female drivers with additional hygiene-related requirements

3.5.2 User Needs Related to Solution Design

- High interest in water inside the cab, indicating demand for basic water-based hygiene solutions

- Need for quick and simple hygiene solutions that support frequent and time-efficient use during the day
- Need for solutions that fit within limited cabin space and do not interfere with key living areas such as the bed

3.6 Gender & Inclusivity Aspects

The research indicates that safety, privacy, and access to hygiene facilities may affect drivers differently depending on context and user group. Findings from the online ethnography suggest that female drivers in particular experience additional concerns related to personal safety, privacy, and menstrual hygiene management during long-haul driving.

In situations in which external facilities are perceived as unsafe, unavailable, or unhygienic, some drivers prefer to remain inside the vehicle, even when managing more personal hygiene-related needs. This highlights the need to consider inclusivity, privacy, and perceived safety within the design of in-cabin hygiene solutions.

As female drivers remain underrepresented within the transport industry while simultaneously representing a growing user group, these perspectives are important to acknowledge in order to support a wider range of user needs and experiences.

4 Spatial Aspects & Ergonomics

4.1 Truck Cabin Environment

The truck cabin functions both as a workspace and a temporary living environment, where drivers spend extended periods of time. In addition to driving, activities such as resting, eating, and personal hygiene are managed within a limited and multifunctional space.

The cabin layout includes areas for sleeping, storage, and everyday activities, creating a need for solutions that are compact, accessible, and well integrated into the existing interior. The limited available space within the cabin creates challenges when adding new functions, since solutions must coexist with existing storage areas, sleeping functions, and everyday activities.

The limited available space within the cabin creates challenges when adding new functions, since solutions must coexist with existing storage areas, sleeping functions, and everyday activities. This increases the importance of compact, multifunctional, and spatially efficient design solutions within the cab environment.

4.2 Spatial Opportunities & Constraints

In the current truck configuration explored during this project, the bed storage compartment offers a relatively large and underutilised volume within the cabin. The compartment is accessible both from outside the vehicle through an external access hatch and from inside the cabin beneath the sleeping area. Due to its size, accessibility, and closeness to existing cabin infrastructure, this area was identified early in the project as an encouraging location for integrating a hygiene solution.

In addition to the bed storage compartment, a pull-out storage unit located adjacent to the sleeping area was identified as another potential opportunity. This area provided convenient access from a seated position within the cabin and offered possibilities for integrating hygiene-related functions while remaining closely connected to existing daily activities.

Beyond these locations, several other areas within the cabin were also explored, including available storage volumes and vertical cabin surfaces. These investigations formed the basis for multiple concept directions and helped evaluate how different locations influenced accessibility, spatial impact, and user interaction.

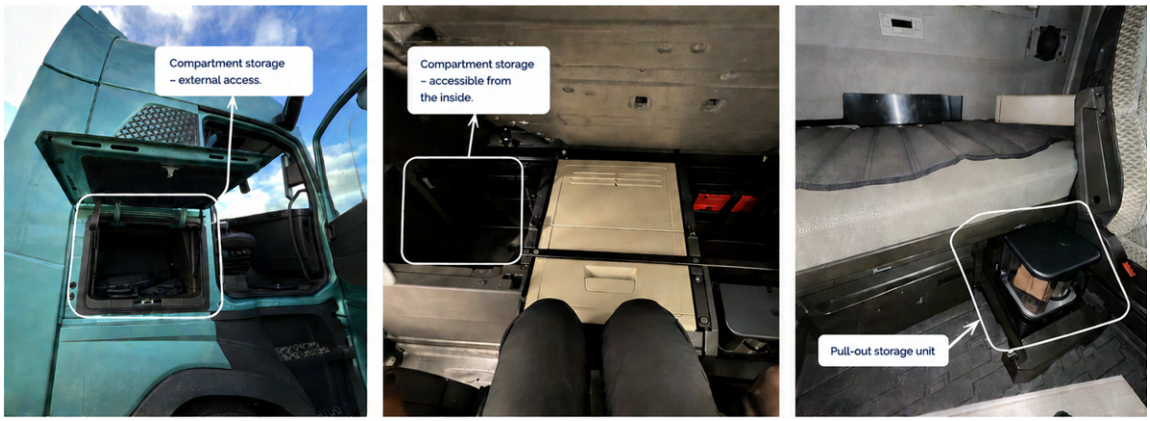


Figure 4: Images from the truck cabin showing the bed storage compartment and the pull-out storage unit.

4.3 Hygiene System Components

An integrated hygiene solution within a truck cabin could consist of multiple linked components that together enable water storage, distribution, use, and waste handling within a confined mobile environment. Unlike stationary hygiene systems, truck-integrated systems must operate under conditions such as limited space, vehicle vibration, temperature variations, and movement during transport. Therefore, each component introduces specific technical and spatial considerations that influence the overall system design.

Fresh Water Storage

The fresh water tank functions as the primary storage component for clean water within the hygiene system. In the context of a truck cabin, the design of the tank demands balancing water capacity with limitations related to available space and added vehicle weight.

In addition to capacity considerations, the tank should support practical use and maintenance through accessible refilling, cleaning, and drainage. Since the system operates within a moving vehicle, secure sealing and stable integration are also important to reduce the risk of leakage during driving, tipping and vibration.

Determining an exact estimate of daily water usage within a truck environment was difficult due to limited existing research specifically addressing hygiene frequency among truck drivers. The estimated water capacity was therefore based on recurring hygiene situations identified through interviews, online ethnography, and everyday activities such as eating, fueling, loading, and handling equipment.

Based on these observations, the concept was dimensioned to support approximately ten basic hygiene occasions per day. However, the actual water consumption may vary depending on user behaviour, climate conditions, and the type of hygiene activity performed. Further research and user testing would therefore be needed to better understand realistic water usage patterns and optimal tank sizing within long-haul truck environments.

Grey Water Management

A grey water tank is required to collect wastewater generated during hygiene activities such

as hand washing or face washing. Similar to the fresh water tank, the grey water system must function reliably within a confined and mobile environment. Key considerations cover preventing leakage and odour formation, while also supporting accessible emptying and maintenance. Ventilation and pressure equalisation may also be necessary to ensure stable drainage and prevent unwanted backflow within the system.

Pump and Water Distribution

A pump system is required to transport water from the fresh water tank to the user interface, such as a faucet or dispenser. Within a truck environment, the pump system must take into account for factors such as limited energy availability, vibration, and noise.

Within a truck environment, the pump system must account for factors such as limited energy availability, vibration, cabin tilting, and low noise levels within the confined cabin environment.

Sink & User Interface

The sink area represents the primary point of interaction between the user and the hygiene system. Due to the limited spatial conditions within the truck cabin, the sink and surrounding interface require compact and adaptable integration.

Plumbing & Drainage

The plumbing system connects the various components and enables the transportation of clean and wastewater throughout the system. This includes hoses, valves, connectors, and drainage pathways. The routing and placement of hoses and connections additionally influence maintenance, accessibility, and integration within the cabin structure.

Thermal Management

Thermal management represents an important consideration for hygiene systems intended for use in cold climates. In places such as Sweden, low temperatures may cause water within tanks, hoses, or pumps to freeze, likely reducing system functionality or causing damage to components.

These conditions may also create requirements related to drainage, emptying, or winter adaptation of the system during prolonged exposure to low temperatures.

4.4 Accessibility & Reach

The variation in users' age, experience, and physical characteristics draws attention to the importance of designing for a wide range of body sizes, reach capabilities, and movement patterns within the limited cabin environment. These factors affected ergonomic considerations throughout the design process, specifically about accessibility, positioning, ease of use, and interaction within confined spaces. Since the hygiene-related activities explored in this project primarily involved short-duration interactions such as handwashing and face washing, ergonomic considerations focused mainly on accessibility, reach, natural movement patterns, and general comfort within the confined cabin environment. Compared to longer-duration occupational tasks, slightly constrained or non-neutral body positions were considered more acceptable during these brief hygiene routines.

The co-creation workshop and concept evaluations emphasised the importance of accessible placement and interaction zones within the truck cabin. Participants generally preferred hygiene-related activities to be positioned near existing seating or standing areas while avoiding locations closely associated with rest, particularly the bed area, as water, cleaning activities, and hygiene-related equipment were perceived as unsanitary within spaces associated with relaxation and sleeping. Easy access, minimal setup, and limited contact with surrounding surfaces were identified as important factors influencing usability and ergonomic integration, particularly to reduce contamination of nearby cabin areas during hygiene activities.

Particular attention was also given to reducing excessive bending, twisting, and restricted reach during interaction. At the same time, slightly constrained or non-neutral body positions were considered more acceptable for brief hygiene routines compared to longer-duration occupational tasks.

4.5 Posture & Body Positions

Participants expressed a preference for solutions that support multiple body positions, including sitting, standing, or leaning, depending on the situation and available space. At the same time, physically uncomfortable positions, such as sitting on the floor, were generally avoided. These conclusions highlight the importance of designing hygiene interactions that correspond with natural movement patterns and ergonomic comfort within the confined cabin environment.

4.6 Comfort, Safety & Usability

Since the hygiene solution is intended for frequent everyday use within a confined cabin environment, comfort, usability, and perceived safety became important considerations throughout the project. The concepts aimed to support simple and intuitive interaction while minimising unnecessary movement and physical effort during use.

Participants expressed a preference for solutions that could be accessed quickly and used with minimal interaction steps. Based on these insights, the concepts were developed to require as few deployment actions as possible, with a target of no more than approximately three interaction steps during normal use.

Another important aspect involved minimising contact with surrounding cabin surfaces during hygiene activities. This was considered particularly relevant in relation to cleanliness, comfort, and maintaining the surrounding cabin environment.

Safety and stability were also important considerations due to the moving vehicle environment. The concepts therefore explored stable integration, secure positioning, and interaction solutions suitable for use within a truck cabin exposed to vibration, movement, and limited space.

Perceived safety and privacy additionally influenced the development of the concepts, particularly in situations where drivers preferred to remain inside the cabin during hygiene activities. Supporting comfortable and accessible in-cabin use was therefore considered an important aspect of the general user experience.

4.7 Key Takeaways for Concept Development

Based on the spatial and ergonomic analysis, the following design implications had been carried forward into concept development:

- The solution should utilize existing cabin volumes and avoid reducing living space.
- The solution should be accessible from natural seated or standing positions.
- Excessive bending, twisting, and reaching should be minimized.
- The solution should support short and intuitive interactions with few deployment steps.
- Hygiene activities should be separated from sleeping and resting areas.
- The solution should maintain cleanliness and minimize contamination of surrounding cabin surfaces.
- The solution should function safely and stably within a moving vehicle environment.
- The solution should accommodate different body sizes and user preferences.

5 Market & Benchmarking

This chapter presents an overview of existing truck cabin solutions together with relevant benchmark examples both within and beyond truck applications. The aim is to understand current design directions, identify existing solutions, and highlight gaps related to in-cabin hygiene.

5.1 Benchmarking of Truck Cab Interiors

The truck industry includes several manufacturers such as Volvo, Scania, Mercedes-Benz, DAF, and Iveco, all continuously working to improve driver comfort, space utilisation, and living conditions within the cabin. Recent concept vehicles and interior studies show a clear trend towards treating the truck cabin as a living environment rather than solely a driving workspace. Examples include extended cabin volumes, flat floors, integrated storage compartments, multifunctional living areas, and improved sleeping environments (Volvo Group Trucks Technology, Inspiration and Competition, 2025).

Benchmarking of existing truck interiors further highlights an increasing focus on usability during long-distance transport, supporting activities such as sleeping, eating, resting, and entertainment within the cab environment. Current developments primarily focus on comfort, storage optimisation, and driving ergonomics. As shown in Figure 5, several manufacturers already include functions such as foldable tables and swivel seats, while integrated sink or water-based hygiene solutions are still absent across the benchmarked cabins.

Although these advancements, hygiene-related functions remain limited and are generally not integrated as a core part of cabin design. Existing solutions are often restricted to coolers, water containers, or storage for personal hygiene products rather than integrated washing functionality.

Feature	Volvo	Scania	Merce des	MAN	Iveco	DAF
Sink/ Water tank	×	×	×	×	×	×
Foldable table	×	✓	✓	✓	×	✓
Swivel seat	×	×	✓	×	✓	✓

Figure 5: Benchmark comparison of selected cabin interior functions among major truck manufacturers.

Interestingly, earlier truck interiors from the 1970s and 1980s occasionally included simple foldable washbasins or compact hygiene solutions. Over time, these features largely disappeared as cabin layouts shifted towards storage optimisation, simplified manufacturing, and increased reliance on external roadside facilities. This indicates that

hygiene integration within truck cabins is not entirely unexplored historically, but remains largely absent in modern cabin configurations.

This suggests that everyday hygiene activities such as hand washing or brushing teeth are currently not fully supported within modern truck cabins.

5.1.1 Existing Solutions within the Truck Industry

Benchmarking was also carried out on existing hygiene-related solutions already used within the truck industry. At present, no major truck manufacturer was identified as offering a fully integrated sink solution inside the truck cabin. Existing solutions mainly consist of basic water tanks or external washing setups intended for simpler hygiene tasks.

Volvo Trucks currently offers basic water tank solutions, demonstrating that water storage already exists as part of certain truck configurations.

An additional reference was identified through WSTransportation, where an exterior sink and shower solution had been integrated into an exterior compartment accessible from outside the vehicle. This was particularly interesting due to similarities with one of the identified spatial opportunities explored during the project.

Figure 6: Existing exterior hygiene solution accessible from outside the truck cabin.

However, since the solution is only accessible from outside the truck, limitations related to weather conditions, safety, and convenience become apparent. During colder climates or night-time use, drivers may prefer avoiding leaving the cabin entirely, illustrating the importance of interior accessibility.

The benchmarking also included investigations into alternative water tank placements outside the main cabin volume. One example explored was the use of cylindrical water tanks mounted along the exterior vehicle structure as a complementary solution when interior space is limited.

At the same time, the storage compartment beneath the sleeping area remained particularly interesting due to its accessibility from both inside and outside the truck. This created opportunities for solutions that could support both interior and exterior use depending on the situation and user needs.

However, using externally placed water tanks would require an efficient and integrated way of transporting water to the hygiene area, including considerations related to routing, pressure, and connection points within the cabin structure.

5.2 Benchmarking of Hygiene & Compact Solutions

To explore possible design directions beyond the truck industry, inspiration and benchmarking were carried out across several environments defined by limited space and multifunctional use. These included aircraft cabins, camping setups, ambulances, submarines, and existing compact hygiene products.

Figure 7: Benchmarking of compact hygiene and deployment solutions.

5.2.1 Wall Solutions

Wall-mounted solutions were explored early in the process because of their capacity to save floor and storage space. Several examples from compact bathrooms, boats, and camping environments showed how sinks and hygiene products could be folded against a vertical surface when not in use.

The concept appeared promising from a spatial perspective, especially in narrow environments. However, during co-creation activities and spatial testing, wall-based concepts were perceived as less practical within the truck cabin. Participants often experienced them as intrusive, difficult to position ergonomically, and less intuitive during use.

Another challenge was integration and modularity. Since truck cabins vary between models and configurations, wall-mounted systems would likely require more permanent installation and adaptation to existing interior structures. This reduced flexibility compared to more self-contained solutions.

Despite these limitations, the exploration of wall solutions contributed useful insights regarding compact mechanisms, foldable structures, and vertical deployment strategies.

5.2.2 Pull-Out Solutions

Pull-out solutions became an important area of exploration throughout the project. Existing examples showed how sinks or hygiene modules could be integrated into drawers or compartments and only extended when needed.

This type of solution was considered beneficial in situations where unused storage volume already existed within the cabin. By integrating the sink into a pull-out drawer, the product could remain hidden during non-use while still being quickly accessible. This concept was considered most suitable for future cab solutions with increased interior space.

Several existing examples also demonstrated how pull-out systems can create a clearer work surface and improve ergonomics by bringing the sink closer to the user. At the same time, such solutions call for careful consideration regarding stability, drainage, water routing, and ease of cleaning.

The pull-out principle later became one of the more relevant directions due to its balance between accessibility, compactness, and integration potential within the truck environment.

While these products demonstrate effective approaches for hygiene in limited spaces, many rely on manual setup and portable use rather than being integrated into a fixed environment. In a truck cabin, however, ease of use, stability, and effortless integration into the interior are essential requirements.

5.2.3 Foldable Solutions

Foldable and collapsible solutions became a major focus area during the benchmarking phase. Due to the limited available space inside the truck cabin, flexible structures were considered highly relevant for enabling a larger sink volume while minimizing the occupied space during storage.

Particular attention was given to silicone-based products and collapsible containers commonly used in camping and compact living environments. These products demonstrated how soft and flexible materials could expand during use and compress afterwards.

Different spatial situations within the cabin led to different foldable principles being explored. In tighter areas around the driver seat, concepts involving upward expansion were considered more suitable in order to avoid placing the sink too low. In larger storage areas beneath the sleeping compartment, downward-expanding solutions appeared more practical due to the available depth.

Physical inspiration was also gathered from existing household products, including foldable buckets and portable washing containers, which helped explore material behaviour, folding mechanisms, and storage effectiveness.

5.2.4 Inspiration from Other Industries

Several industries and environments with comparable spatial constraints were studied during the concept exploration phase. Aircraft cabins, ambulances, camping setups,

submarines, and compact living environments all demonstrated different approaches to integrating functionality within restricted spaces.

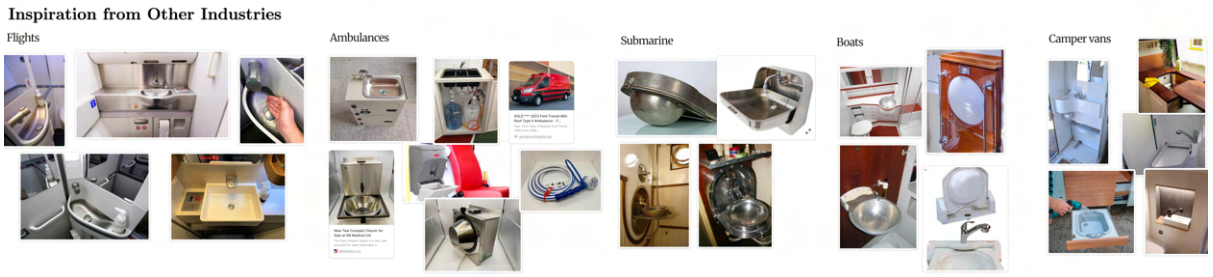


Figure 8: Benchmarking solutions from other industries.

Aircraft and ambulance interiors provided inspiration regarding hygienic surfaces, accessibility, and efficient use of storage compartments. Camping products demonstrated practical approaches to portability and temporary deployment, while compact living solutions highlighted multifunctional use of furniture and storage.

Submarines became particularly interesting due to their highly space-constrained interiors and compact folding mechanisms. Older submarine sink solutions inspired some of the fold-out functions explored in the project, specifically about how panels and lids could unfold into usable components.

5.3 Key Takeaways for Concept Development

Based on the spatial and ergonomic analysis, the following design implications have been carried forward into concept development:

- Existing truck cabins currently lack integrated hygiene solutions.
- Interior accessibility is preferable to exterior-only solutions.
- Foldable and collapsible structures offer strong potential for space-efficient integration.
- Pull-out concepts provide a good balance between accessibility and compact storage.
- Multifunctional solutions are important in space-constrained environments.
- Solutions should be integrated into existing cabin architecture rather than added as separate products.
- Inspiration from camping, aviation, ambulances, and submarines demonstrates opportunities for compact deployment mechanisms.
- Future concepts should combine usability, hygiene functionality, and efficient use of cabin space.

6 Design Requirements

6.1 Design Requirements Overview

The design requirements for this project were developed based on the findings from the literature review, contextual analysis, user research, and benchmarking. These requirements serve as a foundation for the subsequent ideation and concept development phases, ensuring that proposed solutions are grounded in real user needs and practical constraints.

The research highlighted several key aspects that influence the design of an in-cabin hygiene solution. These include limited space within the truck cabin, the need for safe and controlled water management, and the importance of supporting quick and simple hygiene routines during the driver's daily workflow. In addition, factors such as usability, ergonomics, maintenance, and environmental conditions were identified as critical considerations.

6.2 Functional & Technical Requirements

The functional and technical requirements define what the solution must achieve in terms of performance, integration, and safety within the truck cabin environment.

A primary requirement is that the solution must enable basic daily hygiene activities, such as washing hands, face, or brushing teeth, directly inside the cabin. This responds to the identified need for independence from external facilities and supports drivers in maintaining hygiene during long periods on the road.

Due to the confined nature of the truck cabin, the solution must be compact and efficiently integrated without interfering with existing functions such as driving, sleeping, or storage. This includes the need for foldable, removable, or concealable elements that allow the solution to occupy minimal space when not in use.

Safety is a critical aspect, particularly in relation to water usage within a vehicle environment. The solution must ensure safe handling of both clean and waste water, while minimizing the risk of leakage near sensitive components such as electronics. Additionally, the solution must remain stable under conditions such as vibration and cabin movement.

Technical considerations also include environmental conditions, such as temperature variations, where the solution must function reliably even in cold climates where water systems may be at risk of freezing.

6.3 Ergonomic & Usability Requirements

In addition to functional performance, the solution must provide a high level of usability and ergonomic quality in order to be practical in everyday use.

The research indicates that drivers perform hygiene routines in a time constrained and spatially limited environment. Therefore, the solution must be intuitive and easy to use, requiring minimal setup and effort. It should support quick and efficient routines that can be performed during short breaks or transitions between activities.

Ergonomically, the solution must accommodate different user positions within the cabin such as passenger seat and/or driver seat. It should also be accessible for users with varying body sizes and physical capabilities. Placement and interaction should allow for comfortable use without requiring awkward postures or unnecessary movement.

Furthermore, the solution should be easy to clean and maintain, as poor hygiene maintenance could lead to bacterial growth, odors, or reduced usability over time. The design should therefore support simple cleaning procedures and minimize areas where dirt or water can accumulate.

Finally, the solution should contribute to a sense of comfort and personal space within the cabin. As the truck cabin functions as both a workplace and a living environment, it is important that the hygiene solution does not negatively impact the perceived cleanliness or comfort of the space.

6.4 Design Requirements

Table 1: Design requirements developed from the identified user needs and research findings.

Design Requirements		
Category	Requirement	Description
Hard Requirements		
Function & Usability	Enable basic hygiene	Shall support approximately 10 basic hygiene activities, such as hand washing, face washing, and tooth brushing, before refilling is required.
	In-cabin use	Shall be usable from a seated position inside the cabin.
	Independent functionality	Shall provide clear value independently of external facilities.
Integration & Space	Compact integration	Shall fit within cabin space without obstructing driving, sleeping, or storage.
	Space efficiency	Shall be foldable, removable, or concealable when not in use.
	Minimal modification	Shall not require major permanent modifications to the cabin.
	Low weight	Shall minimise added weight to the vehicle.
Safety	No leakage risk	Shall not introduce risks related to water leakage near electronics.
	Stable in motion	Shall remain stable during driving, vibration, and cabin tilting.
	Vehicle safety compliance	Shall comply with safety principles for use in a moving/parked vehicle.
	Crash Tested	Shall remain in a safe locked position in potential crashes
Hygiene & Maintenance	Prevent contamination	Shall prevent bacterial growth, odours, and hygiene degradation.
	Easy to clean	Shall be easy to clean using simple methods.
	Water management	Shall include separate handling of fresh and grey water without leakage.
	Minimal contamination interaction	Shall minimise the need to touch surrounding cabin surfaces during hygiene activities.
	Splash containment	Shall minimise water splashing onto surrounding cabin surfaces during use, especially in front of the user and preferably along the sides of the sink area.
Environment	Temperature resistance	Shall function in cold climates and minimise risk of freezing during normal winter conditions.
Soft Requirements		
User Experience	Ease of use	Should be intuitive and require minimal learning.
	Limited steps to use	Should require no more than 3 interaction steps during deployment and use.
	Time efficiency	Should enable quick and convenient hygiene routines.
	Ergonomic usability	Should be usable for different body types and seated positions (passenger seat and/or driver seat.
	Comfort	Should feel comfortable and safe to use.
	Privacy & perceived safety	Should support hygiene routines in situations where users prefer to remain inside the cabin for privacy or safety reasons.
	Reduce external dependency	Should reduce the need to leave the cabin for hygiene.
	Preserve clean/rest zones	Should avoid negatively affecting areas associated with rest and comfort, such as the bed space.
	Quick deployment	Should be deployable and ready for use within approximately 10-15 seconds.
Feasibility	Implementation feasibility	Should be feasible to develop within 1–3 years.
Sustainability	Resource efficiency	Should minimise water use and reduce waste.
	Sustainable lifecycle	Should consider materials, durability, and maintenance impact.

7 Ideation & Concept Development

7.1 Ideation & Concept Generation

Based on the findings from the research phase and the identified design requirements, the project progressed into ideation and concept development. The purpose of this phase was to investigate potential solution directions capable of addressing the identified user needs, spatial constraints, and usability challenges within the truck cabin environment. The ideation process resulted in a broad range of concepts exploring different approaches to integrating hygiene functionality within the cabin. These concepts varied in terms of spatial integration, deployment mechanisms, interaction principles, and implementation feasibility. Through iterative development and evaluation, several recurring concept directions emerged and were developed further.

7.2 Concept Clustering & Design Directions

Following the initial brainstorming phase, the generated ideas were analyzed and clustered into broader concept categories based on shared interaction principles, spatial strategies, and functional characteristics. This helped structure the ideation process and identify recurring design directions. The main concept categories included:

- Mist Dispenser
- Drawer or box based system
- Pull up sink solutions behind passenger seat
- Table or stable surface integration
- Fold out wall mounted solutions
- Expandable or collapsible sinks
- Other experimental concepts

This clustering process enabled further ideation within each category, where concepts were combined, modified, and refined to explore new opportunities and variations.

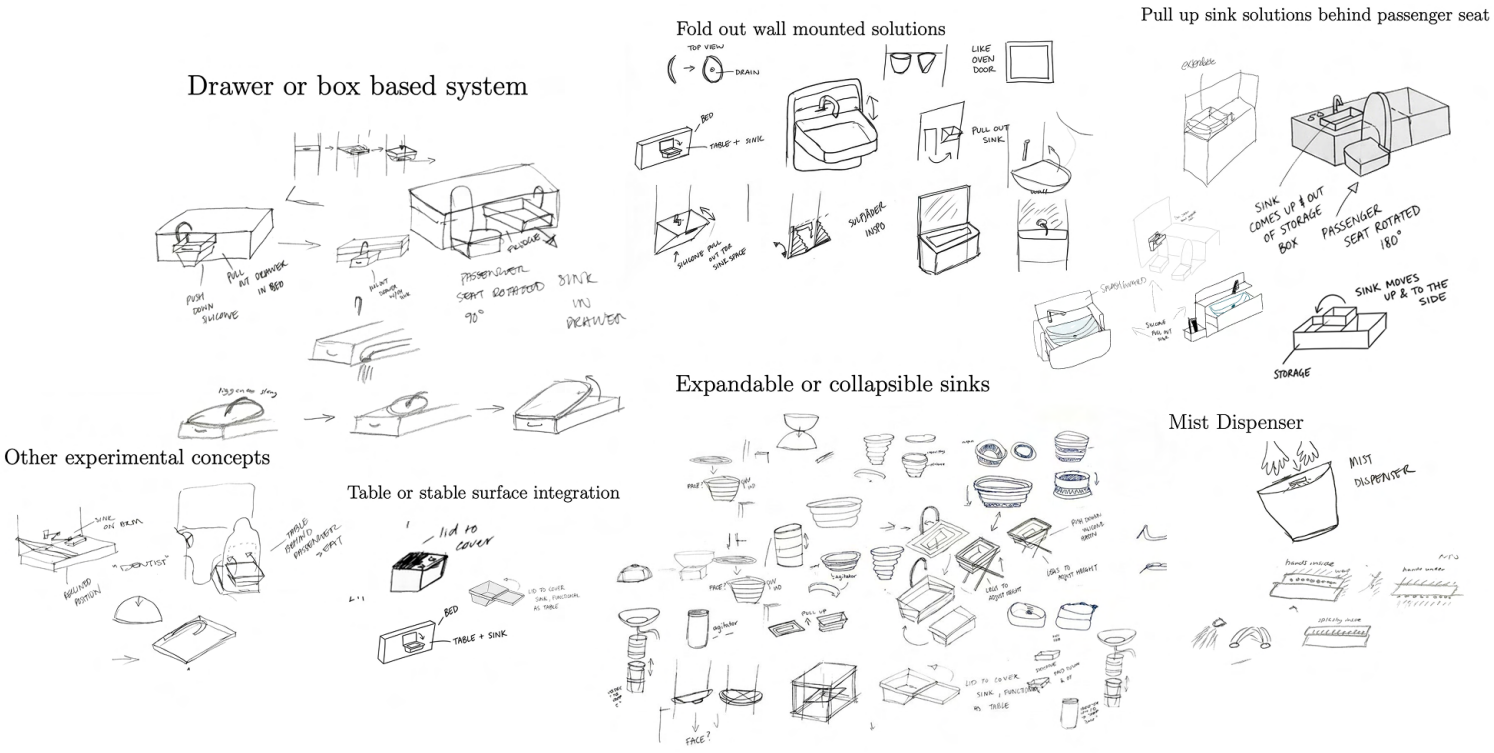


Figure 9: Affinity Diagram of Sketches

7.3 Exploratory Testing & Mock ups

To support the ideation process, a series of exploratory tests and low fidelity mock ups were developed. Early physical experiments were conducted to better understand how water behaves during hygiene activities such as hand washing and face washing within confined spaces. Particular attention was given to splashing behaviour and user interaction.

The water behaviour tests showed that water often landed on the far side of the bowl and to the sides during both hand washing and face washing. The amount of splashing varied depending on bowl size and geometry, but the observations consistently highlighted the need for splash management. These findings contributed to the development of integrated splash guards and influenced several of the later concept directions.

Figure 10: Bowl 1: Left: Handwashing, Right: Face Washing

Figure 11: Bowl 2: Left: Handwashing, Right: Face Washing

Figure 12: Bowl 3: Left: Handwashing, Right: Face Washing

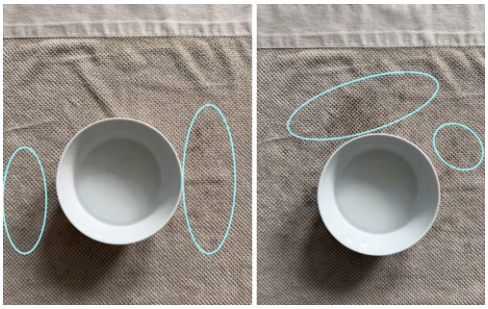


Figure 13: Bowl 4: Left: Handwashing, Right: Face Washing

In parallel, quick mock ups were constructed using simple materials such as cardboard and paper. These mock ups were used to evaluate deployment mechanisms and spacial integration and user interaction.

These exploratory prototypes were mainly used to test ideas, identify challenges, and support quick iterations throughout the concept development process.

An early cardboard mock up was developed to explore a rotational deployment mechanism. The prototype was used to evaluate how a semi-circular component could rotate between different positions and how the movement influenced accessibility and spatial integration within the available cabin space.

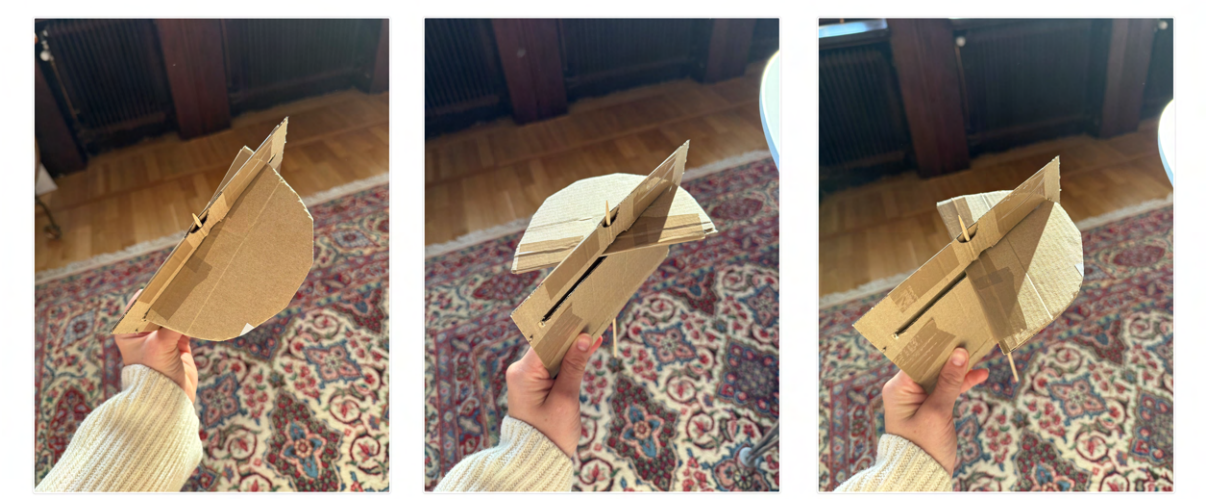


Figure 14: Cardboard mock up used to evaluate a rotational concept principle.

Additional mock ups focused on splash management and spatial containment. Different wall configurations and enclosure principles were explored to better understand how water could be controlled while maintaining compact packaging dimensions.

Figure 15: Early cardboard mock ups used to explore splash containment, foldable side walls.

Several exploratory studies were conducted to investigate alternative deployment principles and sink configurations. These included rotational mechanisms, expandable geometries, and inspiration from existing foldable and flexible products.

Figure 16: Exploratory mock ups and reference studies used to investigate deployment principles, rotational movement, and potential expandable sink geometries.

7.4 Design Decisions & Excluded Directions

Based on insights gathered from user research, benchmarking, and concept exploration, several design directions were identified as important to continue developing, while others were excluded during the process.

Design directions carried forward

- The solution should preferably function inside the cabin in order to reduce dependency on external hygiene facilities.

- Splash protection became an important aspect during concept generation, particularly on the side opposite the user where most water accumulation occurred during testing. This led to the exploration of integrated splash guards and foldable back panels in several concepts.
- The solution should be accessible from multiple positions within the cabin, considering limited movement space and different user situations.
- The bed storage compartment beneath the sleeping compartment was identified as having strong potential due to its size, accessibility, and possibility to be reached from both inside and outside the cabin.
- Placement was prioritised during concept development, as location within the cabin was found to strongly influence accessibility, ergonomics, and overall usability.
- Flexible silicone-based solutions were explored to increase sink volume while maintaining compact packaging dimensions. Upward-expanding concepts were generally found to utilise the available cabin space more efficiently than downward deployment.
- Foldable, concealable, or multifunctional concepts were prioritized in order to minimise space usage when the solution is not in use.
- The design should minimise contamination of clean and comfort-related areas, such as the bed space.
- The concept should remain stable during vehicle movement and cabin tilting to avoid loose components or water spillage.
- Existing cabin functions and storage opportunities should, as far as possible, be preserved and integrated into the solution.
- Opportunities to optimise or replace existing cabin components were considered where this could improve functionality or space efficiency.

Excluded design directions

- Wall-mounted solutions were excluded due to limited available wall space and potential interference with existing cabin functions.
- Solutions placed close to the head or sleeping area were seen as less suitable due to hygiene concerns and the feeling of discomfort.
- Large or permanent water systems were excluded due to space, complexity, and implementation difficulty.
- Concepts requiring long pipe distances between the sink and water tank were considered less practical due to feasibiltiy and maintenance challenges.
- Solutions highly dependent on warm water were not prioritised due to increased technical complexity and energy requirements.
- Certain concepts were reconsidered due to risks related to freezing temperatures and water management during winter conditions.

7.5 Co-Creation and Iterative Ideation

The workshop highlighted the importance of quick accessibility and minimal spatial obstruction within the limited cabin environment. Participants generally preferred solutions that could be reached directly from the bed or seating area and that required minimal setup before use. The explorations also revealed challenges related to body movement, reachability, and interaction within confined spaces, particularly during hygiene-related activities performed while seated or partially reclined. These insights contributed to continued exploration of compact, multifunctional, and easily accessible concept directions throughout the ideation phase.

7.6 Concept Categorisation & Feasibility

As the concept development progressed, it became necessary to distinguish between different levels of implementation feasibility. While the project was primarily focused on the current heavy-duty truck platform, the design process also explored opportunities that would require varying degrees of modification to the existing cabin architecture.

To structure this, concepts were categorised into three levels:

- **Concepts requiring no major cabin modifications**

  Solutions that could realistically be integrated into the current cabin architecture with minimal changes.

- **Concepts requiring minor cabin modifications**

  Solutions requiring limited repositioning, replacement, or adaptation of existing cabin components.

- **Future oriented concepts requiring major modifications**

  More speculative concepts involving larger structural or architectural changes to the cabin environment.

This categorisation enabled broader exploration while maintaining awareness of practical implementation constraints and the limitations of the existing cabin systems.

7.7 Concept Evaluation & Selection

Following the iterative ideation process, the concepts were evaluated using three separate weighted requirement matrices representing different levels of implementation feasibility within the existing truck cabin. The concepts were grouped based on whether they required no major cabin changes, limited modifications, or more extensive structural changes.

The evaluation criteria were directly based on selected design requirements and focused primarily on aspects considered most important during the early concept phase, including:

- Ease of use
- Limited interaction steps
- Implementation feasibility

- Space efficiency
- Accessibility within the cabin
- Minimal cabin modification

The evaluation primarily focused on soft requirements related to usability, accessibility, interaction, and implementation potential, since many technical hard requirements could not yet be fully assessed during the early concept stage.

The concepts were evaluated within their respective feasibility categories rather than directly against all concepts, allowing fairer comparison between solutions with different levels of implementation complexity. The weighted matrices helped identify concept directions that showed strong potential regarding usability, spatial integration, and implementation feasibility.

Requirements related to resource efficiency and sustainable life cycle were marked as uncertain across multiple concepts during this stage, since these aspects required additional technical development and material evaluation before they could be properly assessed.

7.7.1 Concepts requiring no major cabin modifications

The concepts presented in this stage focused on ideas considered possible to integrate without requiring major modifications to the existing truck cabin. The evaluation explored concepts that could potentially fit within the current cabin structure while maintaining relatively low implementation complexity.

As shown in Figure 17, three concepts moved forward in the process after the first weighted requirements matrix. At this stage, the evaluation also began to highlight the importance of separating concepts based on both required cabin modifications and placement within different cabin areas.

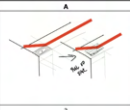
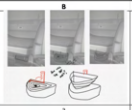
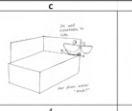
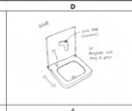
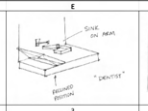
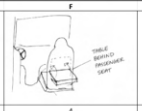
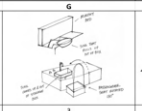
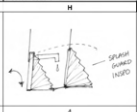
Weighted Decision Matrix						Ideas that are feasible without any changes			
									Created: 2026-04-17
Criterias	**Alternatives**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
	Weight								
Ease of use	**4**	2	3	4	4	3	4	3	4
Limited steps to use product	**4**	2 (3+ steps)	3 (2+ steps)	4 (1+ steps)	4 (1+ steps)	5 (1 step)	4 (1+ steps)	3	4 (1+ steps)
Time efficiency	**3**	2	3	4	4	4	3	3	3
Ergonomic accessibility	**3**	2	2	2?	3	3	3	5	2
Comfort & safe to use	**3**	3	3	1	3	2	2	2	2
Reduce external dependency	**5**	5	5	5	5	5	5	5	5
Implementation feasibility	**5**	5	3 (hoses a problem?)	1	3	2	2	3	3
Brand alignment	**4**	4	4	1	1	2	3	3	3
Space efficiency	**3**	5	5	3	2	2	3	4	5
Minimal modification	**2**	5	4	2	2	3	4	4	3
Total score		138	137	109	120	118	126	134	136
Further development?		Yes	Yes	No	Take inspiration from?	No	Maybe not?		Yes

Figure 17: Weighted Requirements Matrix 1

Focusing on specific areas inside the truck cabin made it easier to understand which types of solutions were suitable for each location and how the surrounding space influenced usability, accessibility, and integration possibilities.

Concept A focused on a solution integrated within the under-bed storage compartment. The concept explored how a flexible silicone-based basin could either extend upwards or fold downwards during deployment while remaining compact when not in use.

Concept B explored a similar silicone-based principle where the basin expanded upwards in order to increase the available sink volume during use, the flexible and foldable silicone

interaction became an important source of inspiration for what later evolved into Concept 2.

Concept H focused on a foldable splash guard principle inspired by spring-like or fan-shaped movement. The idea aimed to contain water within a limited area during use while remaining compact when folded away. This principle later continued developing within Concept 1.

The silicone-based explorations also highlighted that upward-expanding solutions were generally more suitable than downward deployment in several cabin areas, since the available upper volume could be utilized more efficiently within the confined cabin environment.

7.7.2 Concepts requiring minor cabin modifications

The concepts presented in this stage focused on ideas considered possible to integrate with only limited modifications to the existing truck cabin. The goal was to explore concepts that could potentially be implemented through one or two larger cabin changes while still fitting within the current interior layout.

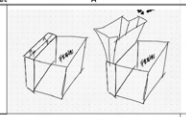
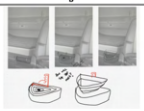
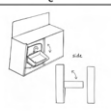
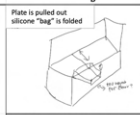
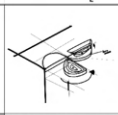
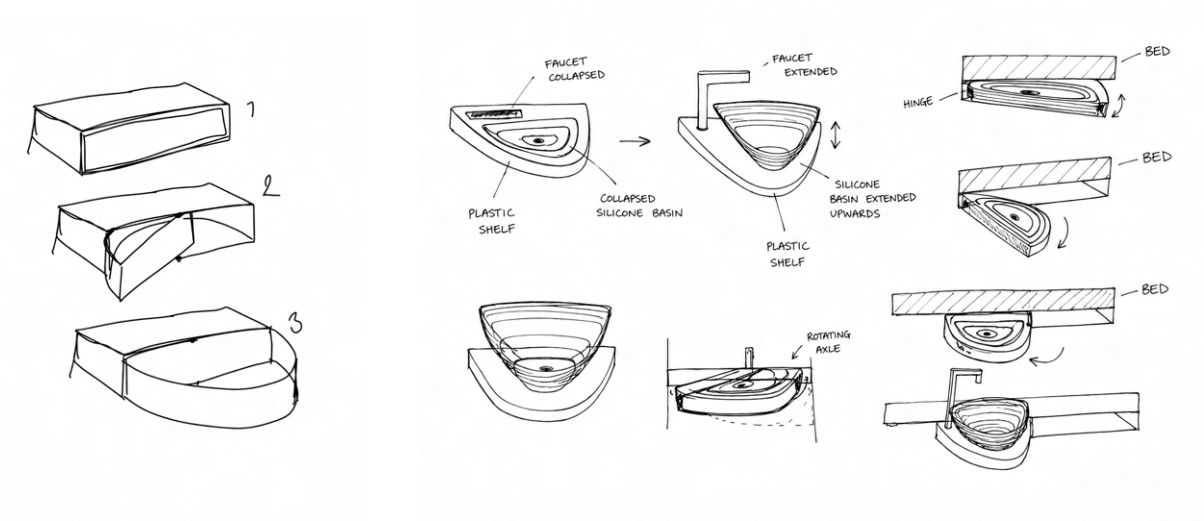
Weighted Decision Matrix					Ideas that are feasible with 1-2 changes in the cab		
							Created: 2026-04-17
Criterias	**Alternatives**	**A**	**B**	**C**	**D**	**E**	**F**
							
Weight							
Changes needed		Make fridge skinnier and a pull up sink next to it	(not in coffee area but in heighted bed area)	Rotate chair 180 degrees and more chair space?	Rotate chair 180 degrees and more chair space?	Move forward chair, 180 rotatable passenger seat	180 rotatable seat
Ease of use	4	2	4	4	2	4	3
Limited steps to use product	4	3	4	4	2	4	4
Time efficiency	3	3	3	4	2	3	3
Ergonomic accessibility	3	3	4	2	3	4	4
Comfort & safe to use	3	3	4	3	2	4	3
Reduce external dependency	5	5	5	5	5	5	5
Implementation feasibility	5	2	4	2	4	4	4
Brand alignment	4	3	4	3	4	4	4
Space efficiency	5	4	4	4	3	3	3
Minimal modification	2	1	3	3	4	3	3
Total score		116	152	122	121	147	140
Further development?		No	Yes	No	No	Yes	Maybe

Figure 18: Weighted Requirements Matrix 2

As shown in Figure 18, Concepts B and E were the only concepts that moved forward in this stage of the process, receiving the highest scores in the weighted requirements matrix. Both concepts explored compact foldable sink solutions integrated within existing cabin areas while maintaining relatively good space efficiency and usability.



Concept development sketch B

Concept development sketch E

Figure 19: Concepts B and E selected from Weighted Requirements Matrix 2

The main difference between the concepts was their movement and placement flexibility. Concept B rotated around its own center point, creating a more fixed deployment position. While both concepts occupied a similar amount of space when opened, Concept E allowed greater flexibility regarding placement within the cabin. Since it was not limited to one fixed rotational point in the same way as Concept B, it created more opportunities for integration in different cabin locations and layouts.

7.7.3 Future oriented concepts requiring major modifications

The concepts presented in this stage explored ideas requiring more extensive modifications to the truck cabin and were therefore considered future-oriented concepts rather than solutions intended for near-term implementation. The evaluation focused on concepts that introduced new spatial possibilities within the cabin environment while still aiming to support accessibility, usability, and integration.

Weighted Decision Matrix						Future ideas	
							Created: 2026-04-17
Criterias	**Alternative**	**A**	**B**	**C**	**D**	**E**	**F**
	Weight						
Changes needed		Extra storage space under bed	Extra storage space under bed	Extra storage space under bed	More floor space, 180 degree turn, extended height of bed	Extra storage space under bed	Extra storage space under bed
Ease of use	**4**	4	3	3	4	4	4
Limited steps to use product	**4**	4	3	3	4	3	3
Time efficiency	**3**	3	3	3	3	3	3
Ergonomic accessibility	**3**	4	4	4	4	4	3
Comfort & safe to use	**3**	5	3	3	4	4	4
Reduce external dependency	**5**	5	5	5	5	5	5
Implementation feasibility	**5**	4	4	3	4	4	3
Brand alignment	**4**	4	4	4	4	4	4
Space efficiency	**5**	4	3	3	4	3	2
Minimal modification	**2**	3	3	3	3	3	3
Total score		155	136	121	147	143	130
Further development?		Yes	Maybe	No	Yes (without laying bed)	Yes	Maybe

Figure 20: Weighted Requirements Matrix 3

As shown in Figure 20, Concept A was the only concept selected for continued development within this category. The concept showed strong potential regarding accessibility,

interaction simplicity, and space efficiency while utilizing the additional storage volume beneath the bed area. Compared to the other explored concepts, it also maintained a relatively balanced relationship between functionality and implementation complexity despite requiring larger cabin modifications.

Several of the remaining concepts explored alternative interaction principles, rotational movements, or extended deployment solutions. Although some ideas were not selected for further development as complete concepts, individual functions and interaction principles continued influencing later concept development where considered more suitable.

Throughout the concept evaluation process, the development gradually resulted in three primary concept directions positioned within different areas of the truck cabin. At the same time, the process remained iterative, where functions, mechanisms, and interaction principles were continuously transferred and combined between concepts when considered beneficial for usability, spatial integration, or accessibility.

7.8 Selected Concepts for Further Development

The evaluation process resulted in three primary concept directions being selected for continued development:

1. Accordion Lid
2. Swinging Sink
3. Pull out Table Sink

The selected concepts represented different approaches to integrating hygiene-related functionality within the truck cabin environment. The concepts were chosen to explore varying levels of cabin integration, ranging from solutions requiring minimal modification of the existing cabin architecture to more future oriented concepts involving larger spatial and structural changes.

In addition, the concepts were intentionally positioned in different areas of the cabin in order to investigate how placement influenced accessibility, ergonomics, spatial obstruction, and interaction during everyday hygiene activities. This allowed the project to explore multiple interaction principles and spatial strategies within the limited cabin environment.

The selected concepts were further developed based on their balance between usability, spatial efficiency, feasibility, and alignment with identified user needs and design requirements. Each concept therefore contributed different strengths, challenges, and opportunities for future integration within heavy duty long haul truck cabins.

7.9 Concept Development

7.9.1 Concept 1: Accordion

Concept 1 explored a compact sink solution featuring an accordion-style lid mechanism intended to minimize occupied space while allowing the sink volume to expand during use. The concept was designed as a semi-integrated unit positioned within the storage area beneath the sleeping compartment, a location identified as a relatively underutilized volume within the cabin interior. The placement also provided close proximity to the lower

external storage compartment beneath the cab, creating opportunities for integrating water tanks and technical components within the available space.

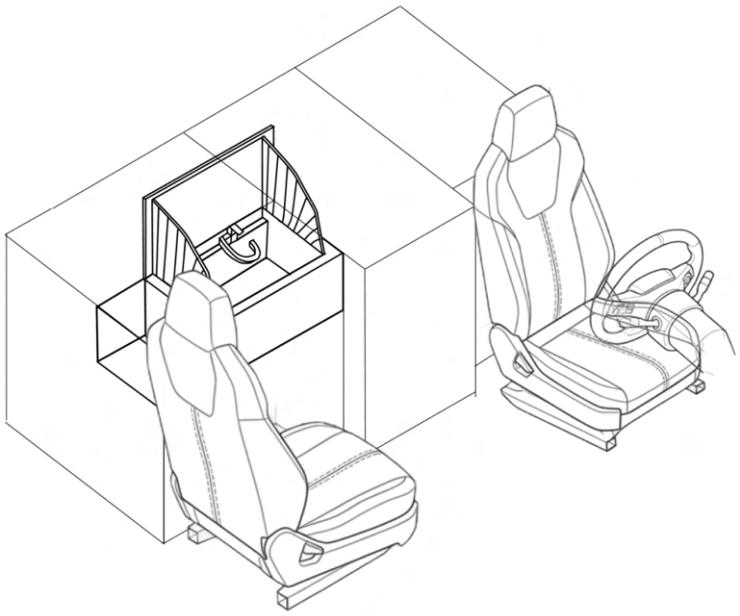


Figure 21: Concept 1

The expandable lid structure was intended to create a flexible enclosure around the sink while reducing the required vertical packaging space when closed. A drainage outlet was integrated into the base of the sink to support water handling and emptying, while an adjacent storage compartment was included for hygiene-related items. The lid mechanism utilized Southco E6/ST constant torque position control hinges to support stable positioning during opening and use. To secure the unit during vehicle movement, a rotary push-to-close locking mechanism was integrated into the front section of the lid.

One advantage of this concept was the available internal volume, which created opportunities for integrating components such as water tanks, plumbing, and storage within the same area. The placement also enabled potential access both from inside and outside the cabin, increasing flexibility for maintenance and refilling. At the same time, the concept introduced spatial challenges related to deployment and interaction within the already limited cabin environment. The opening mechanism and surrounding structure required careful consideration to avoid interference with nearby cabin functions such as the bed and existing storage areas. In addition, the accordion structure introduced increased mechanical complexity and potential challenges related to cleaning, sealing, and long-term durability.

7.9.2 Concept 2: Swinging Sink

Concept 2 explored a compact fold-out hygiene solution integrated into the existing coffee machine area within the truck cabin. The concept was designed around a swinging sink mechanism that could be unfolded when needed and folded away to minimize spatial impact during non-use.

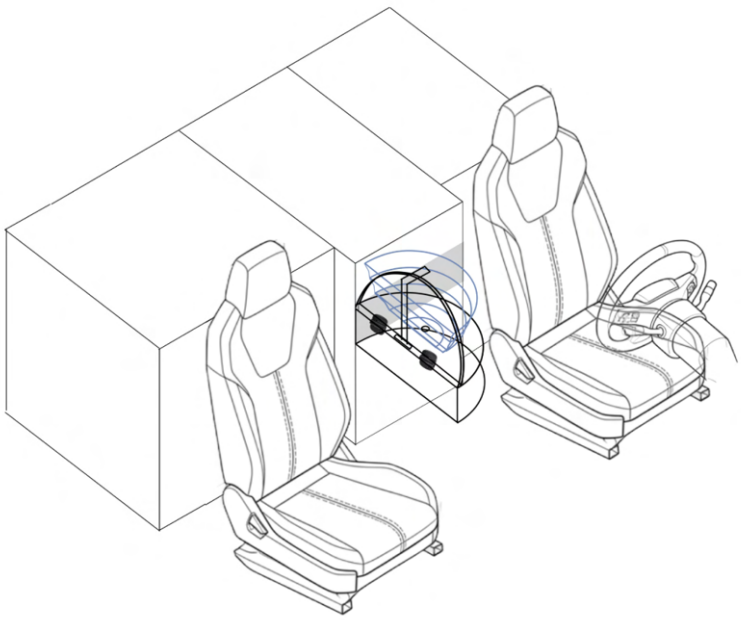


Figure 22: Concept 2

The concept included a flexible silicone pull-up sink combined with a foldable faucet solution in order to reduce the required installation depth and support compact storage. A lid was developed to function both as a protective cover in the closed position and as a splash guard during use. This approach aimed to improve usability while reducing water spillage within the cabin environment.

To support controlled movement and positioning of the sink unit, the concept utilized Southco E6/ST constant torque position control hinges for the swinging mechanism. These hinges were selected due to their ability to maintain stable positioning without additional support components. The lid mechanism utilized a Southco C6 hinge solution to enable smooth opening and closing behaviour while maintaining a compact integration.

The concept was designed around a rotating sink mechanism that can be deployed through a sequence of movements. The sink unfolds from a compact storage position and rotates approximately 180° into its intended use position, allowing the user to access the hygiene function while minimising space usage when not in use.

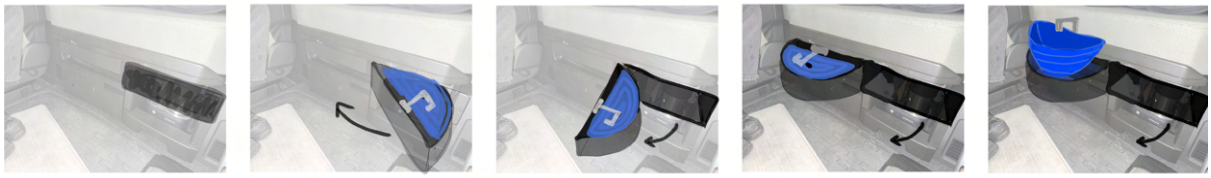


Figure 23: Concept 2

The concept was intentionally developed as a flexible solution that can be adapted to different cabin layouts. Since the sink mechanism is based on a rotating deployment principle, the installation position can potentially be mirrored or relocated to the opposite

side of the central cabin area depending on available packaging space and surrounding components.

The concept therefore represents an interaction principle rather than a fixed installation location. Future integration would require adaptation to the specific cabin architecture and available installation volume.

7.9.3 Concept 3: Pull Out Table Sink

Concept 3 explored a pull-out sink solution integrated within the cabin structure. The concept was developed as a multifunctional unit combining a compact hygiene station with a pull out table function, allowing the solution to serve both hygiene related activities and general cabin use. The concept was primarily intended for future cabin configurations where larger integration opportunities may be available.

The concept utilized a drawer based pull out mechanism that extended the sink unit outward from the storage structure when in use. Two alternative lid configurations were explored during the concept development phase. The first solution consisted of a "slideable" lid designed to remain upright in the open position and the other a double lid opening, meaning it can be used from both sides, with a splash guard no matter what position the driver is in. Both alternatives were developed using the same overall spatial dimensions and pull-out interaction principles.

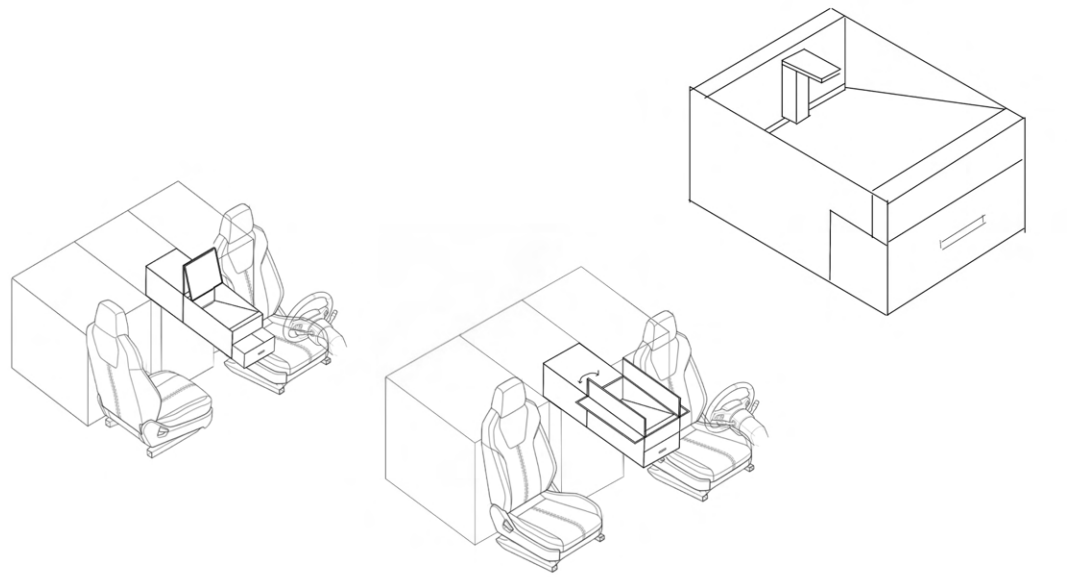


Figure 24: Concept 3

The pull-out structure was designed to provide a larger and more stable working surface compared to the previous concepts. The integrated drawer functionality also enabled placement of hygiene products, personal belongings, or electronic devices during use. Advantages identified during concept evaluation included improved stability, increased usable sink area, multi functionality, and clearer integration with the cabin interior architecture. However, the concept also introduced challenges related to packaging depth, drawer extension requirements, water management, and mechanical complexity.

7.10 Water Management Exploration

To support basic hygiene activities within the cabin environment, preliminary water management layouts were explored for each concept direction. The purpose of these explorations was to investigate how fresh water supply, drainage, and grey water storage could potentially be integrated within the limited spatial constraints of the truck cabin.

Each concept utilized a dedicated fresh water tank combined with a separate grey water tank positioned within the surrounding storage structure. The layouts explored different routing solutions depending on the sink configuration and interaction principles of each concept. A compact electric pump system was proposed to transport water from the fresh water tank to the faucet, enabling controlled water flow despite the low placement of the storage tanks relative to the sink position. Particular attention was given to hose routing, drainage direction, and the relationship between movable sink components and the fixed water storage system. The pull-out and foldable concepts required flexible hose management solutions to accommodate moving parts while maintaining functionality during use.

Cold climate conditions were identified as an important consideration during the development of the water management system, particularly regarding the risk of water freezing within tanks, hoses, and drainage components during sub-zero temperatures. Inspiration was drawn from water management systems used in recreational vehicles and mobile living environments, where insulated tanks, heated water systems, and frost protection strategies are commonly utilized to maintain functionality in colder climates (Barr Plastics, 2025; Truma, 2023). Existing solutions within these domains include insulated tanks, positioning water systems inside heated zones, and frost protection systems that are designed to reduce the risk of freezing.

Within the explored concepts, potential strategies included insulated tank placement, positioning the tanks closer to heated cabin areas, and reducing exposure to exterior-facing surfaces. The proximity between the proposed sink locations and the lower external storage compartment also created opportunities for integrating external access points for refilling, draining, and maintenance of the water system. However, the detailed thermal performance and technical implementation of insulation, active heating, or frost protection systems were not explored within the scope of the project. The water management explorations were therefore primarily conceptual and intended to evaluate spatial feasibility and system integration rather than define final technical solutions.

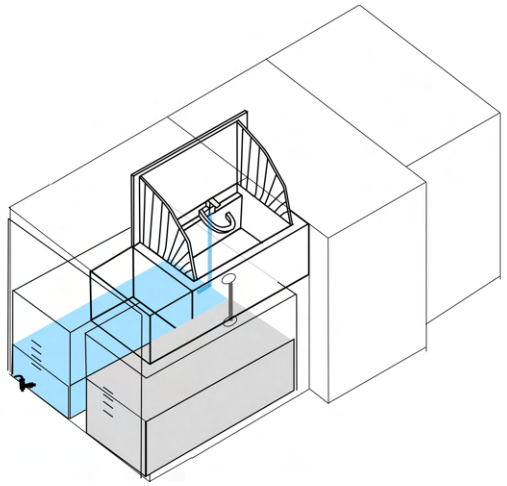


Figure 25: Concept 1 Water Management

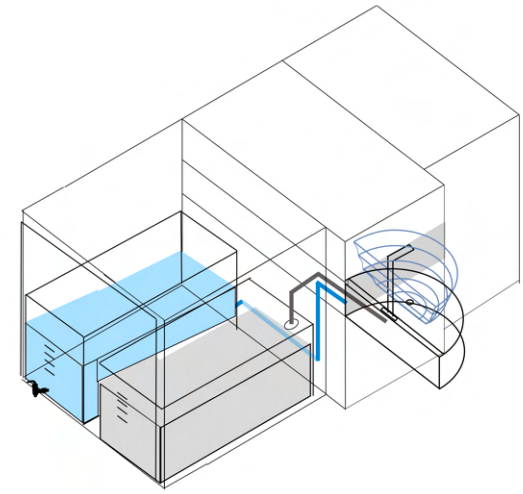


Figure 26: Concept 2 Water Management

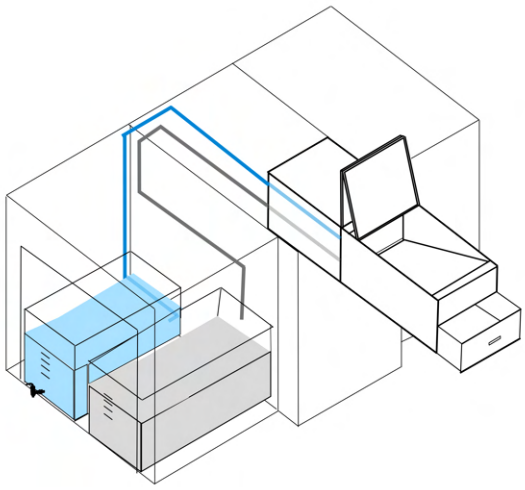


Figure 27: Concept 3 Water Management

8 Prototyping

8.1 Prototypes

Three physical prototypes were developed to evaluate each concepts within the truck cabin environment and to better understand spatial integration, movement, and user interaction. The prototypes were mainly used to explore accessibility, deployment principles, and how the concepts functioned within the limited cabin space.

Simplified full-scale prototypes were primarily constructed using wood materials in order to evaluate proportions, movement, accessibility, and spatial integration within the truck cabin. The prototypes focused mainly on the overall form and interaction principles, while technical components such as water systems, pumps, and final silicone solutions were not fully integrated during this stage.

8.1.1 Concept 1 Prototype

A physical prototype of Concept 1 was developed to explore how the hygiene solution could be integrated within the storage area beneath the sleeping compartment. Compared to Concept 1, this concept explored a more fixed and integrated solution where surrounding surfaces and folding elements became a larger part of the interaction area. The prototype focused primarily on placement, accessibility, spatial integration, and interaction within the existing cabin environment.

Figure 28 presents dimensional studies and prototype measurements used during the development process. The sketches were primarily used to explore proportions, available sink volume, and surrounding spatial constraints within the storage compartment beneath the bed area.

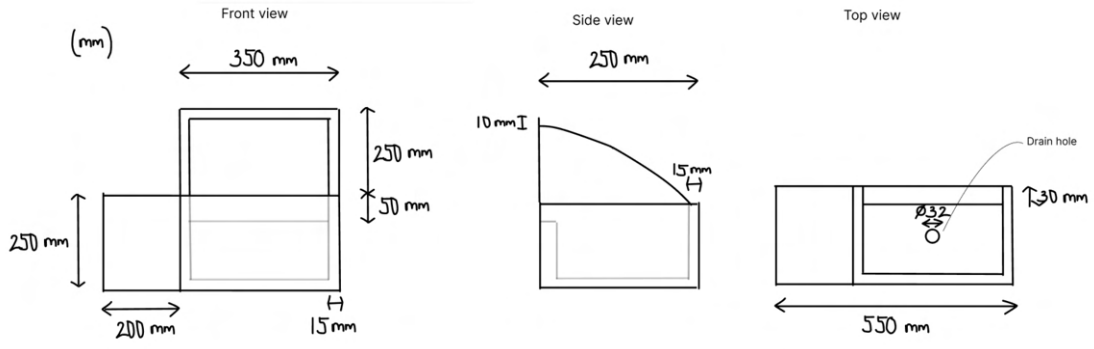


Figure 28: Concept 1 Measurements

Figure 32 illustrates early mechanism explorations and prototype construction studies. The concept explored different opening positions and interaction possibilities from the passenger side of the cabin. The concept was intended to be used primarily from a seated position using the rotated passenger seat, where the surrounding interaction area could support short-duration hygiene activities.

Prototype assembly and lid mechanism exploration

Foldable splash guard exploration and interaction study

Figure 29: Prototype explorations of the lid mechanism and foldable splash guard solution for Concept 1

A foldable lid mechanism was integrated to conceal and protect the sink area when not in use while maintaining a cleaner and more integrated appearance within the cabin interior. In addition, splash guard solutions were explored both at the front and preferable on the sides of the sink area through a foldable "fan-like" mechanism. The foldable splash guard exploration investigated how surrounding surfaces could support water containment without requiring permanently extended side walls.

Figure 30 presents the prototype integrated within the truck cabin environment. The interaction sequence required activation of the bed lifting mechanism before accessing the sink area itself. The prototype was also used to study surrounding movement space and the relationship between the sink area and nearby cabin functions such as the bed and storage areas.

Figure 30: Concept 1 prototype integrated beneath the sleeping compartment within the truck cabin environment

The cabin integration studies additionally highlighted how the surrounding geometry beneath the bed created opportunities for larger sink volumes and more integrated technical packaging compared to concepts positioned within more restricted cabin areas.

The available volume beneath the sleeping compartment additionally created opportunities for integrating technical components such as water tanks, plumbing, and storage within the same area. The location also maintained proximity to the lower external storage compartment beneath the cab, potentially supporting future serviceability and packaging opportunities.

8.1.2 Concept 2 Prototype

The Concept 2 prototype was developed to explore how a rotating sink solution could be integrated within the truck cabin environment. The prototype focused primarily on evaluating rotational movement, accessibility, spatial requirements, and interaction possibilities within the limited cabin space.

Figure 31 presents early development sketches and dimensional explorations used to support the construction of the physical prototype. The sketches helped communicate the overall geometry, proportions, and rotational movement of the concept while exploring how the solution could integrate within the surrounding cabin structure.

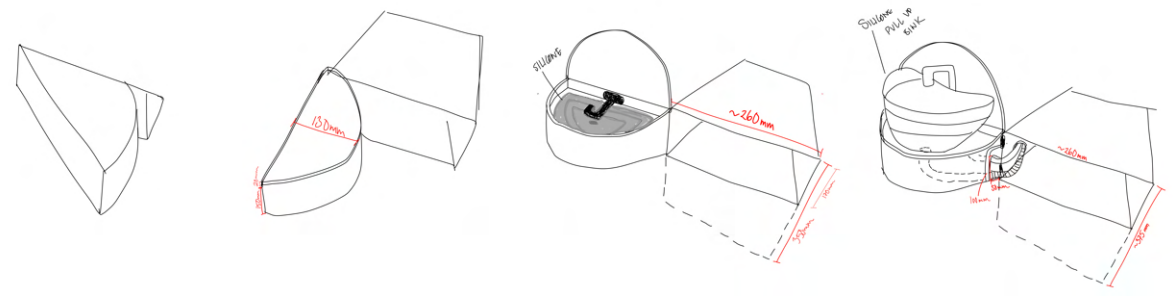


Figure 31: Concept 2 prototype development and dimensional explorations

The concept initially aimed to include a flexible silicone-based basin integrated within the rotating section. However, during the prototyping process it became evident that the achievable sink depth was strongly constrained by the semi-circular geometry of the rotating form. Since the sink depth was directly related to the overall width of the concept, increasing the basin volume also required a wider rotating structure. This created limitations regarding achievable sink capacity while still maintaining compact integration and the intended rotational movement within the confined cabin environment.

The silicone-based explorations during the ideation process also highlighted that upward-expanding solutions were generally more suitable than downward deployment within several cabin areas. Utilizing the available upper volume created better opportunities for increased sink depth and interaction space while maintaining a compact footprint within the limited cabin environment.

Prototype construction and internal structure

Assembly and rotation testing of the prototype mechanism

Figure 32: Prototype construction and rotational mechanism evaluation for Concept 1

Figure 33 illustrates how the prototype was explored in multiple rotational positions within the truck cabin environment, including closed, 90° rotated, and 180° rotated configurations. The physical prototype was used to investigate how different rotational positions influenced accessibility, surrounding movement space, and spatial interaction within the confined cabin environment.

Closed position *90° position* *180° position*

Figure 33: Prototype positions explored within the truck cabin environment, including closed, 90° rotated, and 180° rotated positions

The physical prototype additionally enabled early evaluation of usability and body positioning during interaction. Testing within the cabin environment helped identify how the concept affected reach, accessibility, surrounding movement space, and interaction comfort during short hygiene-related activities, as illustrated in Figure 34.

Figure 34: Prototype interaction test within the truck cabin environment

8.1.3 Concept 3 Prototype

A physical prototype of Concept 3 was developed to investigate the feasibility of integrating a pull-out table sink within the truck cabin environment. Unlike the previous concepts, Concept 3 explored a multifunctional approach in which hygiene-related functions were combined with a usable table surface and integrated storage. The prototype was developed to explore the overall packaging of the concept, the pull-out mechanism, lid deployment, tap integration, and how these elements could be combined within the limited cabin space. The prototyping process also provided an opportunity to evaluate the spatial requirements of the concept and to assess how the different functions interacted during deployment and use.

Figure 35 presents the overall geometry of the Concept 3 prototype. The drawings were used to support prototype construction and to explore proportions, packaging constraints, and integration within the available cabin space. Due to confidentiality restrictions, dimensional values have been omitted from the figure. Some dimensions were also approximated during prototype development and are therefore not shown.

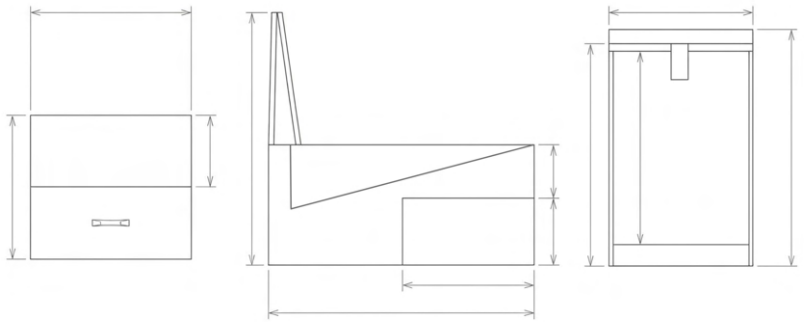


Figure 35: Concept 3 prototype geometry and proportions

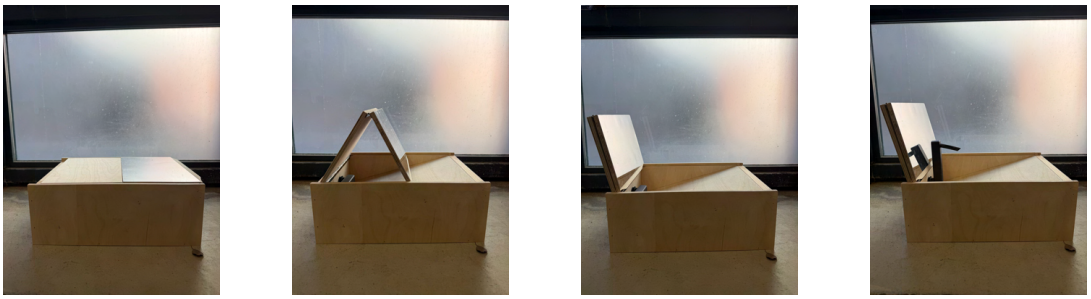
Prototype assembly exploring the pull-out drawer and hinged lid mechanism

Concept 3 prototype showing the deployed sink compartment configuration

Figure 36: Prototype development of Concept 3, exploring the pull-out drawer mechanism and integrated sink enclosure

Figure 37 illustrates the opening sequence of the prototype. In its closed configuration, the upper surface functions as a table suitable for activities such as eating, working, or placing personal belongings. During deployment, the lid unfolds around the sink area, transforming the unit from a multifunctional table into a dedicated hygiene station. Once fully opened, the lid panel creates a defined area while also functioning as splash guards intended to contain water during use. The tap is then manually rotated into position, creating a clear interaction sequence between opening, preparing, and using the sink. This

staged deployment was intended to maintain a compact configuration when not in use while supporting intuitive operation during hygiene-related activities.



Closed Position *Initial Opening* *Lid Fully Open* *Tap Deployed*

Figure 37: Prototype 3 Deployment

An integrated drawer (See Figure 38) was incorporated beneath the sink area to provide storage for hygiene products and personal care items. The addition of storage further supported the concept's multifunctional objective by combining hygiene functions, storage, and a work surface within a single unit.

The prototype also enabled exploration of how these functions could coexist within the same footprint as making efficient use of the available cabin space. By consolidating multiple activities into one integrated solution, the concept aimed to minimize spatial impact while maintaining accessibility and usability during everyday cabin routines.

The prototyping process highlighted both possibilities and challenges related to integrating multiple functions within a single cabin component. While the concept demonstrated potential regarding space efficiency and multifunctionality, the prototype also revealed the importance of carefully balancing storage, sink volume, accessibility, and deployment space within the confined cabin environment. These insights informed the subsequent evaluation of the concept and its suitability for everyday use scenarios.

Figure 38: Concept 3

9 Evaluation

The evaluations revealed several recurring themes related to accessibility, ergonomics, spatial integration, and the role of in-cabin hygiene solutions within the truck environment. While the concepts differed in terms of placement, functionality, and implementation requirements, common patterns emerged regarding how participants perceived usability and interaction within the confined cabin space. The findings presented in this chapter combine observations and feedback gathered during the prototype evaluations and focus on the key themes that came up across the concepts.

9.1 Accessibility and Ease of Use

Accessibility emerged as one of the most important factors influencing the preference of concepts. Participants generally preferred concepts that could be reached directly from existing seating positions and required minimal setup before use. This became particularly evident during the morning hygiene scenario, where participants valued the ability to access the sink shortly after waking up.

The scenario involving handwashing before relaxing on the bed showed the importance of accessibility from the sleeping area. Participants generally preferred concepts that could be reached directly from the bed or nearby seating positions, allowing quick hygiene activities without disrupting relaxation or requiring extensive deployment.

Concept 1 was generally perceived as less accessible due to its location beneath the sleeping compartment. Participants frequently highlighted the additional interaction steps required before use, particularly during scenarios involving quick hygiene activities. Although the concept was considered functional once deployed, the required setup was often viewed as a barrier for spontaneous use.

Concept 2 was generally perceived as the most accessible solution due to its placement near the passenger seat and the flexibility provided by the swinging mechanism. The truck driver explained that the passenger seat would typically already be rotated after parking for the night, making the sink easy to access during morning routines. One participant described the concept as: “It feels like the most versatile solution. I would have chosen this concept in this scenario” (translated from Swedish).

Concept 3 occupied a middle ground between the other concepts. Participants appreciated the integration of hygiene functions within an existing cabin feature but suggested modifications to improve accessibility, including adjustments to sink orientation and working position.

Overall, the findings suggest that ease of access and limited interaction steps strongly influenced participants’ perceptions of the concepts. The evaluations also indicated a tendency to perform hygiene-related activities from the passenger side of the cabin rather than from the driver seat. Participants often associated the passenger area with greater flexibility, easier access to surrounding space, and a more suitable environment for short hygiene routines when parked. This was particularly evident in the given scenarios involving morning routines and activities performed before relaxing in the sleeping area.

9.2 Ergonomics and Body Position

Ergonomic considerations emerged throughout the evaluations, particularly regarding sink height, body positioning, and reachability. Due to the spatial constraints of the truck cabin, all concepts required some degree of forward reach or bending during interaction.

To support the evaluation, body positioning studies were conducted for each concept, as seen in Figures 39, 40 and 41. These studies were not intended as formal ergonomic assessments, but rather as a visual tool for identifying potential challenges related to posture, reachability, and movement within the cabin.

The evaluations showed that ergonomic preferences varied depending on the activity being performed. During scenarios involving morning hygiene routines, such as brushing teeth and washing the face, participants became more aware of sink height and working posture due to the longer interaction time. In contrast, scenarios involving quick handwashing before relaxing or after eating highlighted convenience and accessibility rather than ideal ergonomic positioning.

Concepts 2 and 3 generated similar feedback regarding working height. Users often adopted a forward-leaning posture when interacting with the sink, particularly during activities such as brushing teeth or washing the face. Several participants suggested raising the sink position to reduce forward bending and improve comfort. Participants also expressed a preference for being positioned directly in front of the sink rather than interacting from the side.

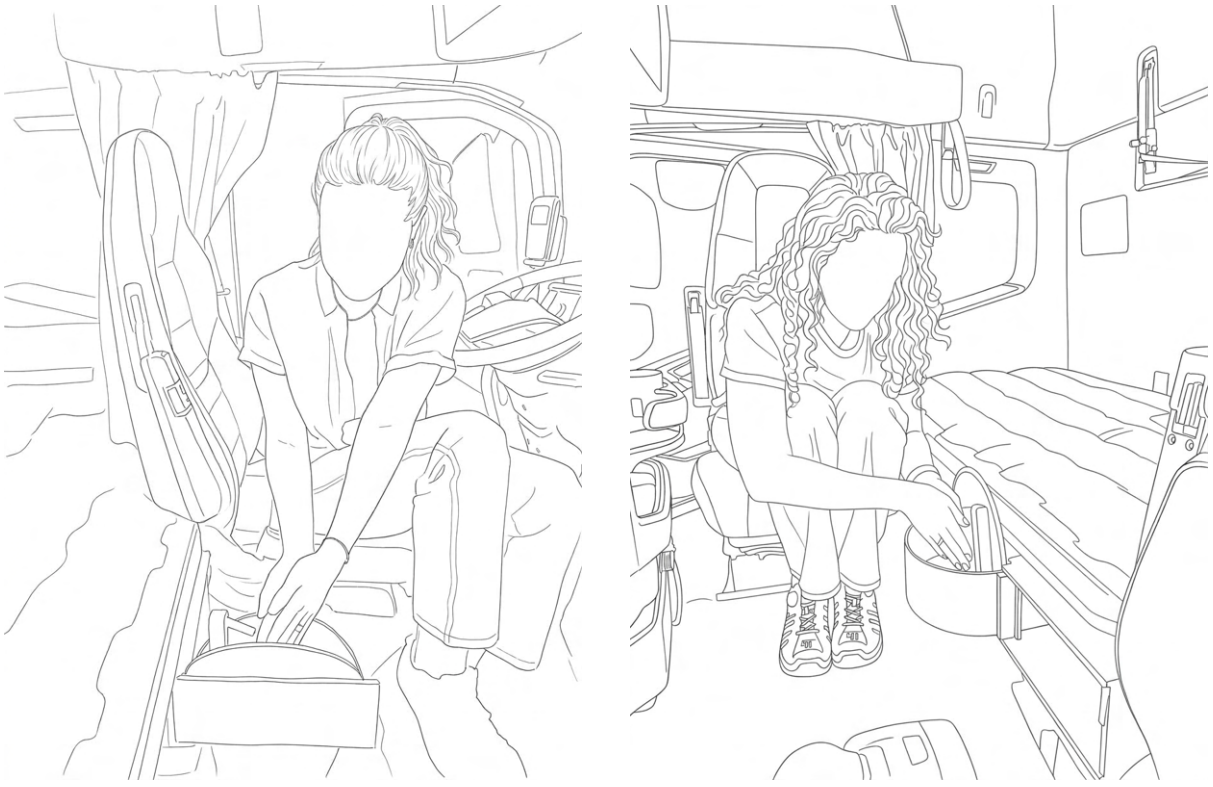
Despite these observations, participants generally considered minor ergonomic compromises acceptable due to the short duration of the intended hygiene activities. As one participant explained, “Being in a slightly uncomfortable position for a few seconds does not feel problematic” (translated from Swedish). This was particularly evident in the given scenarios involving quick handwashing, where accessibility and ease of use appeared more important than achieving ideal ergonomic postures.

Rather than eliminating all non-neutral postures, the evaluations indicate that the design should focus on providing convenient access, intuitive interaction, and sufficient comfort for short-duration hygiene activities within the confined truck cabin environment.

Figure 39 illustrates how interaction with Concept 1 required the user to approach the sink from the side while leaning into the bed storage compartment. This interaction created a more dedicated hygiene area but also limited legroom and movement compared to the other concepts. While participants generally preferred performing hygiene-related activities from the passenger seat, Concept 1 was largely restricted to this interaction position.

Figure 39: Intended user position when interacting with Concept 1 from the passenger seat

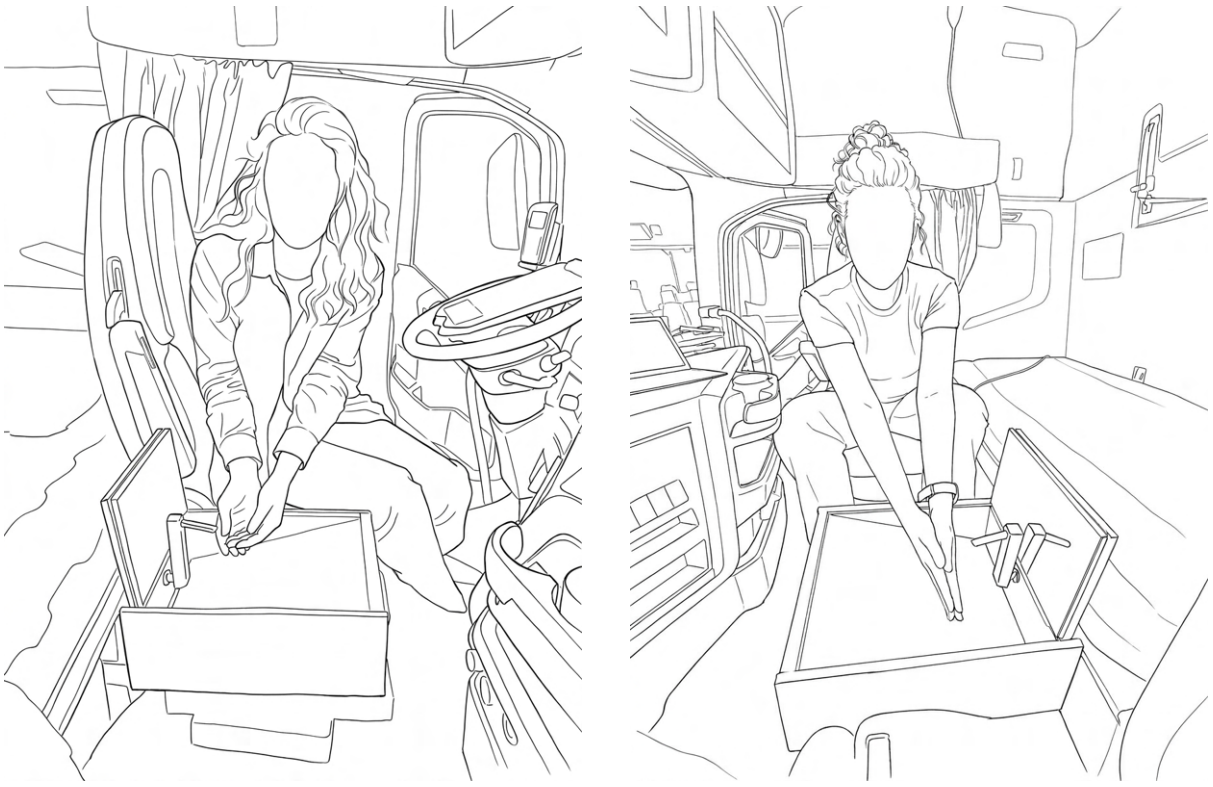
As illustrated in Figure 40, Concept 2 could be accessed from both the driver and passenger side of the cabin. This flexibility was generally perceived positively, as it allowed users to adapt their position depending on the activity being performed and the available space within the cabin.



Body Position from Driver Seat *Body Position from Passenger Seat*

Figure 40: User body positioning during interaction with Concept 2 from the driver and passenger seat.

Figure 41 shows that Concept 3 also allowed interaction from multiple seating positions. However, the concept occupied a larger portion of the central cabin area during use, which influenced surrounding movement space to a greater extent than Concept 1.



Body Position from Driver Seat *Body Position from Passenger Seat*

Figure 41: User body positioning during interaction with Concept 3 from the driver and passenger seat.

9.3 Reduction of Dependence on External Facilities

A recurring theme throughout the evaluations was the potential value of reducing dependence on external hygiene facilities. Participants generally viewed all three concepts positively because they enabled basic hygiene activities to be performed without leaving the truck cabin.

The scenarios involving morning routines and hygiene activities before relaxing on the bed highlighted the convenience of having access to water within the cabin. Participants associated the concepts with increased comfort, flexibility, and control over daily routines, particularly during poor weather conditions or when external facilities were unavailable. Participants also indicated that the choice between using in-cabin hygiene functions and external facilities would likely depend on the situation. Weather conditions, available facilities, and personal preferences were all described as factors influencing where hygiene activities would be performed.

At the same time, the scenario involving heavily soiled hands after unloading cargo revealed some limitations. The truck driver explained that dirty hands would often be cleaned before entering the cabin and that wet wipes were frequently used as a first step. This suggests that integrated hygiene solutions are most valuable for supporting everyday

hygiene routines such as brushing teeth, washing hands and washing the face, rather than replacing all external hygiene infrastructure.

The findings nevertheless support the project's objective of decreasing dependence on external facilities while increasing the accessibility of everyday hygiene activities within the truck cabin environment.

9.4 Spatial Integration and Feasibility

The evaluations highlighted clear differences in how the concepts utilized available cabin space and interacted with existing cabin functions.

Concept 1 was often described as the most dedicated hygiene solution. Participants appreciated the separation between hygiene activities and the surrounding cabin environment, with one participant commenting: "It feels like the most hygienic solution, since water is less likely to spill into the cabin" (translated from Swedish).

The enclosed sink area created a clear hygiene zone and reduced concerns about water affecting surrounding surfaces. However, the concept was also perceived as more dependent on modifications to the cabin layout and was frequently associated with future cabin designs rather than existing configurations.

Concept 2 was generally perceived as the most feasible solution for integration within current truck cabin architectures. Participants appreciated its compact footprint and the flexibility provided by the swinging mechanism. The possibility of approaching the sink from multiple positions was viewed positively and contributed to the concept's versatility.

Concept 3 was valued for its multifunctionality and efficient use of cabin space. The integration of a sink, storage compartment, and table surface within a single unit was generally perceived positively. Several participants noted the potential of combining hygiene activities with existing cabin functions, although suggestions were made regarding sink size, orientation, and working height.

Overall, the evaluations demonstrated that each concept represented a different balance between accessibility, spatial efficiency, multifunctionality, and implementation feasibility.

9.5 Summary of Concept Strengths

The evaluations uncovered distinct strengths and weaknesses for each concept. Concept 1 was viewed as the most dedicated hygiene solution, offering a clear separation between hygiene activities and the surrounding cabin environment. Concept 2 was generally perceived as the most versatile and accessible solution due to its flexible placement and minimal interaction steps. Concept 3 was valued for its multifunctionality and its ability to combine hygiene-related activities with existing cabin functions.

No single concept outperformed the others across all evaluation criteria. Instead, the concepts represented different approaches to balancing accessibility, hygiene separation, spatial efficiency, and multifunctionality within the truck cabin environment.

Rather than identifying a single preferred concept, the evaluations demonstrated that each concept addressed different user needs and cabin constraints. The findings suggest that future solutions may benefit from combining successful features from multiple concepts

depending on the intended installation location and desired balance between accessibility, hygiene separation, multifunctionality, and implementation feasibility.

10 Discussion

This project aimed to investigate how truck cabins can support basic daily hygiene routines within the cabin environment and to explore feasible approaches for integrated in-cabin hygiene solutions. The discussion reflects on the findings from the user research, concept development, and evaluations in relation to driver wellbeing, accessibility, ergonomics, and the spatial constraints of the truck cabin environment. Particular attention is given to how hygiene-related activities are currently managed, the challenges associated with existing conditions, and the opportunities and limitations connected to future integrated hygiene solutions.

10.1 Everyday Life Inside the Truck Cabin

One of the clearest findings from this project is the gap between drivers' everyday hygiene needs and the limited support currently available within the truck cabin environment.

The research showed that drivers already manage hygiene routines inside or around the cabin through improvised solutions such as water bottles, wipes, portable containers, and personal storage systems. In some cases, particularly among female drivers, remaining inside the cabin was also connected to concerns related to safety and comfort when accessing external facilities. These behaviours indicate that hygiene-related activities are already part of everyday life on the road, despite not being fully supported by the current cabin design.

At the same time, the truck cabin functions as both a workspace and a temporary living environment, where activities such as eating, resting, and personal care take place within the same confined space. This creates challenges related to accessibility, cleanliness, comfort, and spatial organization when introducing hygiene-related functions into the cabin.

The findings indicate that hygiene within truck cabins represents a relatively underexplored area compared to other aspects of driver wellbeing and cabin design. Existing research and industry developments often focus on factors such as sleep quality, ergonomics, storage, comfort, and safety, while everyday hygiene activities receive less attention.

However, the user research conducted throughout this project demonstrates that hygiene is a recurring and important part of drivers' daily routines. Activities such as washing hands, brushing teeth, cleaning the face, and handling dirty hands occur repeatedly throughout the working day.

The findings additionally suggest that hygiene is not only about staying physically clean, but also about feeling comfortable and maintaining normal daily routines during long periods on the road. This shows that hygiene plays a larger role in everyday life inside the truck cabin than what current cabin solutions often support.

The project therefore contributes by bringing attention to and validating the importance of hygiene in health and working conditions as a potential design opportunity within future truck cabin development by showing its connection to driver comfort, well being, and everyday working conditions. The findings suggest that improved in-cabin hygiene accessibility may contribute to increased independence, comfort, and perceived safety during long-haul operation, particularly in situations where external facilities are inaccessible,

uncomfortable, or perceived as unsafe.

This may be especially relevant in relation to female drivers, whose experiences throughout the project highlighted additional connected to privacy, safety, and accessibility during hygiene related activities on the road. As the proportion of female drivers within the truck industry continues to increase, future cabin development may profit from considering a broader range of user experiences and everyday needs. In this context, integrated hygiene solutions may represent one example of how truck cabin design could contribute to improved working environments and more inclusive long-haul transport conditions.

10.2 Hygiene as an Underexplored Need in Long-Haul Transport

One of the clearest findings from this project is the gap between drivers' everyday hygiene needs and the support currently available within the truck cabin environment. While truck cabins are designed to support activities such as sleeping, working, and storage, hygiene related activities are still largely managed through external facilities or improvised personal solutions.

The research showed that drivers frequently rely on water bottles, wipes, portable containers, truck stops, and public facilities to manage everyday hygiene routines. These solutions show adaptability, but also highlight the lack of dedicated hygiene support within the cabin. In many cases, drivers described external facilities as inconvenient, unreliable, crowded, or poorly maintained, making hygiene routines highly dependent on situational factors such as weather, location, schedules, and perceived safety.

The findings also indicate that hygiene is about more than physical cleanliness. Activities such as teeth brushing, washing hands, and washing the face contribute to comfort, well-being, and the ability to maintain normal daily routines during extended periods on the road. This was particularly evident in findings related to female drivers, where concerns regarding safety, privacy, and comfort sometimes influenced decisions about whether to use external facilities.

Together, these findings suggest that hygiene represents a relatively underexplored aspect of truck cabin design. The project therefore contributes by highlighting hygiene as a potential design opportunity connected not only to cleanliness, but also to driver comfort, independence, accessibility, as well as perceived safety during long-haul driving.

10.3 Spatial Constraints, Accessibility, and Design Trade-Offs

A big challenge throughout the project was balancing accessibility, ergonomics, and usability with the limited space available inside the truck cabin. Unlike traditional hygiene environments, truck cabins must support sleeping, storage, work, movement, and relaxation within the same confined volume. Introducing additional hygiene functionality therefore required continuous trade-offs between accessibility and efficient use of space.

The findings showed that placement strongly influenced usability, ergonomics, and interaction complexity. Solutions positioned close to existing seating areas were generally perceived as more convenient, while highly integrated concepts often required additional deployment steps. At the same time, increased accessibility often came at the cost of occupied cabin space or reduced flexibility.

Throughout the project, it became increasingly clear that the most important design question was not the sink itself, but where hygiene related activities should take place within the cabin. Different cabin locations offered different opportunities and limitations regarding accessibility, movement patterns, ergonomics, and integration with existing cabin functions.

An important insight from the project was that the success of a hygiene solution depended less on the sink design itself and more on where it was located within the cabin. Throughout the concept development process, it became increasingly clear that placement influenced accessibility, ergonomics, deployment complexity, available storage volume, and overall usability.

This suggests that future development should not begin with selecting a specific concept or mechanism, but rather with understanding where and when hygiene activities most naturally occur during a driver's daily routine. To identify suitable locations, future studies could benefit from following drivers throughout an entire working day in order to better understand how hygiene related activities are performed in different situations and cabin areas. Such insights could provide a stronger foundation for selecting cabin locations and, consequently, for developing and evaluating detailed design solutions.

The findings demonstrate that future hygiene solutions will likely require a balance between accessibility, flexibility, implementation complexity, and efficient use of cabin space. Rather than identifying a single optimal location, the project highlights the importance of understanding how placement influences both user experience and implementation feasibility.

10.4 Concept Development and Design Directions

The first weighted requirements matrix helped structure the early concept selection process by comparing ideas based on usability, implementation complexity, spatial efficiency, and cabin integration. Rather than identifying a single final direction, the matrix helped narrow down promising concept principles for further exploration.

An important insight from this stage was that the concepts naturally began grouping into different categories depending on how many modifications to the existing cabin structure they required. This created a clearer framework for evaluating feasibility and implementation potential throughout the continued design process.

The process also highlighted the importance of evaluating concepts in relation to specific cabin areas rather than treating the cabin as one uniform space. Different locations inside the truck created different opportunities and limitations regarding accessibility, movement space, integration possibilities, and interaction positions. As a result, the design process gradually shifted from focusing on the sink itself towards identifying suitable locations for hygiene-related activities within the cabin.

Rather than representing three completely separate solutions, the concepts were developed as explorations of different cabin locations and interaction principles. This approach made it possible to compare accessibility, ergonomics, spatial integration, and implementation complexity across different areas of the cabin. Throughout the development process, successful features and design principles were continuously transferred between concepts when considered more suitable for a different cabin location or interaction scenario.

Several design directions were explored during the ideation phase but were not selected for continued development. Many of these concepts focused on highly portable solutions, externally mounted systems, or hygiene functions positioned within areas strongly associated with sleeping and relaxation. These directions were gradually deprioritized due to concerns related to accessibility, contamination of surrounding areas, limited integration potential, or conflicts with existing cabin functions.

Several concepts additionally shared similar underlying principles despite being positioned differently within the cabin. In particular, foldable silicone-based sink structures and compact splash containment solutions continued appearing across multiple concepts. The silicone explorations also indicated that upward-expanding solutions generally offered greater potential than downward deployment, as the available upper volume could often be used more effectively within the confined cabin environment.

The concept development process highlighted the value of exploring multiple cabin locations in parallel rather than committing to a single solution early in the project. This approach made it possible to identify recurring design principles, compare different interaction strategies, and better understand how placement influenced the opportunities and limitations associated with each cabin area.

10.5 Reflections on Implementation and Research Methods

While the project identified promising opportunities for integrated hygiene solutions, several challenges remain regarding implementation and validation. Water-based systems introduce additional complexity related to packaging space, maintenance, leakage prevention, durability, freezing conditions, and integration with existing truck systems. These challenges may partly explain why integrated hygiene solutions are still uncommon within truck cabins today.

Unlike stationary living environments, truck cabins are exposed to continuous vibration, movement, changing temperatures, and limited installation volume. Components such as water tanks, pumps, drainage systems, and hose routing require additional packaging space while also needing to remain accessible for maintenance, cleaning, and refilling. Water leakage, moisture management, and long-term durability therefore become important considerations when introducing hygiene-related systems into a confined living environment.

Cold climate conditions further complicate the integration process, as stored water may require insulation, drainage strategies, or heating solutions to reduce the risk of freezing during winter conditions. At the same time, additional technical systems may increase energy consumption, maintenance requirements, and overall system complexity. These factors highlight the importance of balancing usability, accessibility, technical feasibility, and spatial efficiency when developing future hygiene solutions for truck cabins.

From a methodological perspective, access to professional truck drivers was limited throughout the project. To broaden the understanding of driver experiences, additional methods such as online ethnography, workshops, benchmarking, and previous research were used. The fact that similar findings appeared across multiple sources strengthened confidence in several key insights, particularly those related to hygiene needs, improvised solutions, and dependence on external facilities.

At the same time, some findings should be interpreted with caution. Workshop participants were not professional truck drivers, and several aspects related to technical implementation, long-term durability, water management, and full-scale cabin integration were only explored through concept development and prototyping. Further engineering development and broader user validation would therefore be required before firm conclusions can be drawn regarding implementation.

10.6 Project Limitations

This project is subject to several limitations related to scope, time and access to data. Firstly, the user research is based on a limited number of direct interactions with truck drivers, complemented by online ethnography and secondary data. While this supplies valuable insights, it may not represent the diverse experiences across different driver groups, regions and working conditions to the full extent.

The co-creation workshop was conducted with participants who were not professional truck drivers. Although this provided valuable exploratory output, the results should be interpreted as inspiration rather than as a direct representation of user behaviour.

The project is constrained by time, which limits the extent of iteration, testing and user validation. The proposed concepts were primarily developed and evaluated from an industrial design perspective and were not fully technically validated regarding manufacturing feasibility, long term durability, water system integration or regulatory requirements.

Furthermore, no detailed cost analysis was conducted and material selections were only explored at a conceptual level. Compliance with relevant EU regulations, certification requirements, and implementation constraints was therefore not fully assessed within the scope of the project.

Several findings related to placement, accessibility, interaction patterns, and user preferences were supported by multiple activities throughout the project, including user research, co-creation workshops, concept evaluations, and prototyping. These insights are therefore considered relatively robust within the scope of the project.

In contrast, conclusions regarding technical implementation, material selection, long-term durability, water management, and full-scale cabin integration remain more uncertain. These aspects were explored primarily through concept development and early prototyping and would require additional engineering development and user testing before firm conclusions can be drawn.

Additional testing with a broader user group and further technical development would be required to full evaluate and refine the proposed solution.

10.7 Recommendations

Understanding Hygiene Behaviour and Cabin Placement

An important finding from this project was that the success of a hygiene solution depended strongly on where it was located within the cabin. Accessibility, ergonomics, deployment complexity, and overall usability were all influenced by placement. While the detailed design of the sink remains equally important, the project showed that understanding and

selecting a suitable cabin location is a necessary first step, as it influences which functions, interaction principles, and design solutions are most appropriate.

Future work could therefore focus on gaining a deeper understanding of when, where, and how drivers perform hygiene-related activities during a typical working day. Methods such as contextual observations, ride-alongs, or day-long user studies could give valuable insights into hygiene behaviours, movement patterns, and cabin usage throughout different situations.

Such knowledge could help identify suitable locations for hygiene-related activities and provide a stronger foundation for concept selection and further design development. The project also demonstrated that understanding placement within the cabin is a significant design challenge in itself, requiring careful consideration of user behaviour, available space, existing cabin functions, and accessibility.

As a result, future development may benefit from first establishing where hygiene activities are most likely to occur before refining detailed design solutions. This could help ensure that future concepts are developed around realistic user needs and cabin usage patterns rather than predefined placement assumptions.

Future User Testing & Validation

Future development of the proposed concepts would benefit from broader user testing and validation within real truck cabin environments. Due to the exploratory nature of this project and the limited number of direct interactions with professional truck drivers, additional testing could provide deeper understanding of how hygiene related functions are used during everyday long haul transportation.

Particular focus could be placed on evaluating ergonomics, accessibility, and usability during realistic use situations. This may include testing how drivers interact with the solutions during short stops, overnight stays, periods of fatigue, or under different weather conditions. Long term testing could also grant valuable insights into maintenance needs, cleaning behaviour, durability, and how integrated hygiene solutions affect everyday routines within the cabin. Future studies could additionally involve a broader range of users with varying driving experience, cabin layouts and working conditions in order to better understand differences in preferences, routines, and accessibility needs

The findings from additional user testing could also support further iterations of the proposed concepts. As the concepts were developed within the scope of an exploratory project, additional refinement and testing could help improve aspects such as accessibility, ergonomics, deployment mechanisms, and overall cabin integration. Further iterations may also reveal opportunities for combining successful features from different concepts into future design directions.

Water Management & Cold Climate Adaptation

Future development of the proposed concepts could further investigate technical solutions related to water management, system integration, and cold climate adaptation. Particular focus could be placed on insulation performance, active heating systems, and frost protection strategies to ensure reliable functionality during sub-zero temperatures. Future

development could also further investigate faucet interaction methods, including manual, foot-operated, and touch-free solutions, to balance hygiene, reliability, and water efficiency.

Potential development areas include insulated or heated water tanks, heat tracing for hoses and plumbing, and automatic drainage or frost protection systems inspired by existing recreational vehicle solutions. Additional work could also explore externally accessible refill and drainage points to simplify maintenance and improve usability during long-haul operation. Further technical validation would also be required regarding water leakage prevention, moisture management, vibration resistance, energy consumption, durability, and integration with existing truck electrical and cabin systems

Integration Within Future Truck Cabins

The project highlights how future truck cabin development may increasingly benefit from considering hygiene related functions as part of the overall living environment inside the vehicle. As truck cabins continue evolving towards more comfort oriented and living focused spaces for long haul operation, the need for accessible and integrated hygiene solutions may become increasingly relevant.

Future development could therefore explore how hygiene related systems may be integrated more seamlessly into existing cabin architecture through modular storage systems, multifunctional furniture, or adaptable surfaces. The project also suggests opportunities for combining hygiene related functions with other cabin features in order to maximize usability while minimizing occupied space.

Emerging developments within electrification, autonomous driving, and extended in cab living may further influence how future cabin environments are designed and used. This may create additional opportunities for integrating functions that support everyday well-being, comfort, and independence during long haul transport.

Future development could also explore combinations of the concepts presented in this project. Since the concepts were developed as explorations of different cabin locations and interaction principles rather than mutually exclusive solutions, successful features from each concept could potentially be combined into future iterations. For example, the available installation volume explored in Concept 1, the accessibility and flexibility provided by Concept 2, and the integration opportunities identified through Concept 3 may together provide valuable directions for future cabin development.

11 Conclusion

The objective of this thesis was to investigate how heavy-duty long-haul truck cabins can support basic daily hygiene routines, such as washing hands, brushing teeth, and washing the face, within the cabin environment. Through a user-centred design process, the project explored drivers' hygiene practices, identified challenges associated with current solutions, and developed concepts for integrated in-cabin hygiene systems.

The findings show that personal hygiene is an important but insufficiently supported aspect of everyday life on the road. Drivers frequently depend on external facilities that are perceived as unreliable, unclean, inconvenient, or inaccessible. As a result, many drivers rely on improvised solutions such as water bottles, wet wipes, and portable containers to manage daily hygiene activities. These behaviours indicate a mismatch between how truck cabins are currently used and how they are designed.

The research further demonstrates that hygiene is not only a matter of cleanliness, but also relates to comfort, convenience, privacy, and personal safety. These aspects were particularly evident in findings concerning female drivers and situations where drivers preferred not to leave the vehicle during night-time stops or in isolated locations. The project therefore contributes by highlighting hygiene as an important yet relatively overlooked aspect of truck cabin design.

Three concept directions were developed and evaluated to explore different approaches to integrating hygiene functionality within the truck cabin. The evaluations highlighted distinct strengths and limitations associated with each concept, illustrating different ways of balancing accessibility, spatial efficiency, ergonomics, and implementation feasibility. While no single concept fully addressed all identified requirements, the evaluations showed that accessibility, ease of use, and minimal setup requirements were the factors that most strongly influenced user preference. The concepts therefore provided important and useful insights into how integrated hygiene solutions can be designed and adapted to the spatial and practical constraints of the truck cabin environment.

Overall, this thesis demonstrates that integrated hygiene solutions have the potential to improve everyday life inside the truck cabin by reducing dependence on external facilities and supporting drivers' ability to perform basic hygiene activities independently. The project also highlights hygiene as a worthwhile opportunity for future truck cabin development and contributes knowledge regarding how such solutions can be designed within the spatial and practical constraints of long-haul transport.

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Appendices

Appendix A

Interview Guide

Questionnaire for truck drivers 20/1

Shorter interview- more general questions

1. For how long have you been driving a truck?
2. Do you usually drive alone or together with someone else?
3. How many days do you usually stay in the truck during a trip and do you often sleep in the truck?

About the hygiene today

4. Do you have any hygiene routines that you perform in the truck, or do you do everything at rest stops? (brushing teeth, washing face, etc)
5. How hard/easy is it to keep good hygiene while driving long distances and is it important to you?
6. What is the most frustrating or hard thing about hygiene on the road today?
7. When it comes to hygiene in the truck driving long distances, what do you feel the need of doing?
8. Is it something missing today inside the truck?
9. How and where do you usually brush your teeth/wash your hands when you are on the road? How clean are these places usually?
10. Do you sometimes skip doing hygiene things in the truck you usually do?
11. Do you bring something special with you on the trip that is not included? For example, wet wipe?

Safety (note if it's a female or male answering these)

12. Do you often drive the same roads/spots so you are familiar with the places you stop at? Do you feel different about safety depending on where you are parked?
13. Are there situations when you avoid going outside the truck? For example, in the morning/night?
14. Does weather (cold, rain, darkness) affect if you go outside or not?

More in depth questions

Hygiene station concept

15. Would you like to have more hygiene solutions inside the truck?
16. Would brushing your teeth/washing your hands inside the truck feel more comfortable?
17. How important is privacy for you when it comes to hygiene?
18. What would you expect from a hygiene station inside the truck?
19. What is most important: comfort, cleanliness, or easy use- or other stuff?
20. How much space do you think such a solution could take?
21. How often do you think you would have used it and when during the day?
22. Is it something you would not like to do inside the cab when it comes to hygiene?
23. Have you found own solutions or routines for hygiene in the truck today?
24. Would you prefer to be inside or outside the truck when performing hygiene rutines?

Add for females:

25. Do you think female drivers have different needs when it comes to hygiene?
26. Do you think you feel more afraid as a women to step outside the truck at unknown/dark places?
27. Are there situations where hygiene feels more uncomfortable as a woman on the road/doing stops?

Figure 42: Interview Questions

Appendix B

Cocreation

Figure 43: Cocreation Set Up

Figure 44: Cocreation Participants

Appendix C

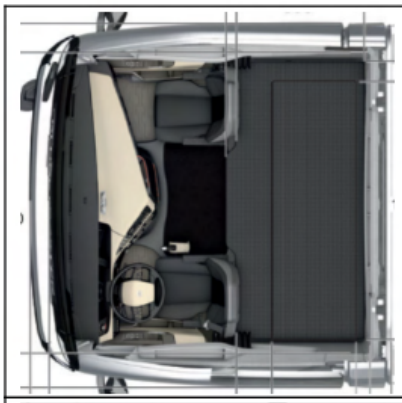
Cocreation Templates

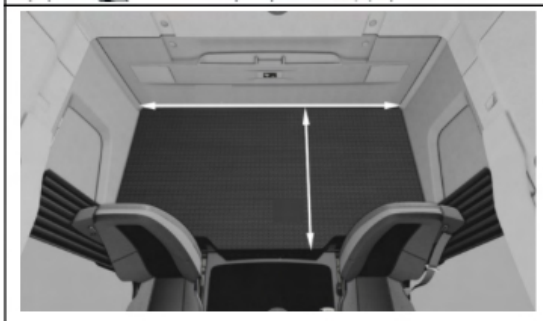
Scenario 1: Waking up from bed- brush teeth and washing face

You have just woken up after sleeping in your truck cabin during a long-haul trip. It is early morning and you want to freshen up before starting the day. Imagine you are still a bit tired and moving around in the limited space of the cabin.

What is important in this scenario?

Where is the sink stored? (Mark on images)





Quick Sketch:

How does the driver use it?

Key features:

Advantages:

Potential problems:

Improvements:

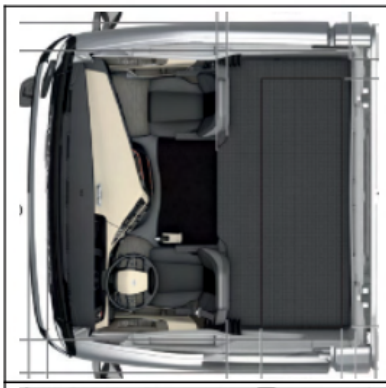
Figure 45: Scenario 1 Template

Scenario 2: Super dirty hands after unloading the truck

You have just finished unloading cargo from the truck. Your hands are very dirty from handling equipment, doors, and packages. Before continuing your trip, you want to quickly wash your hands inside the cabin. Imagine you just climbed back into the truck and haven't fully settled into the seat yet."

What is important in this scenario?

Where is the sink stored? (Mark on images)



Quick Sketch:

How does the driver use it?

Key features:

Advantages:

Potential problems:

Improvements:

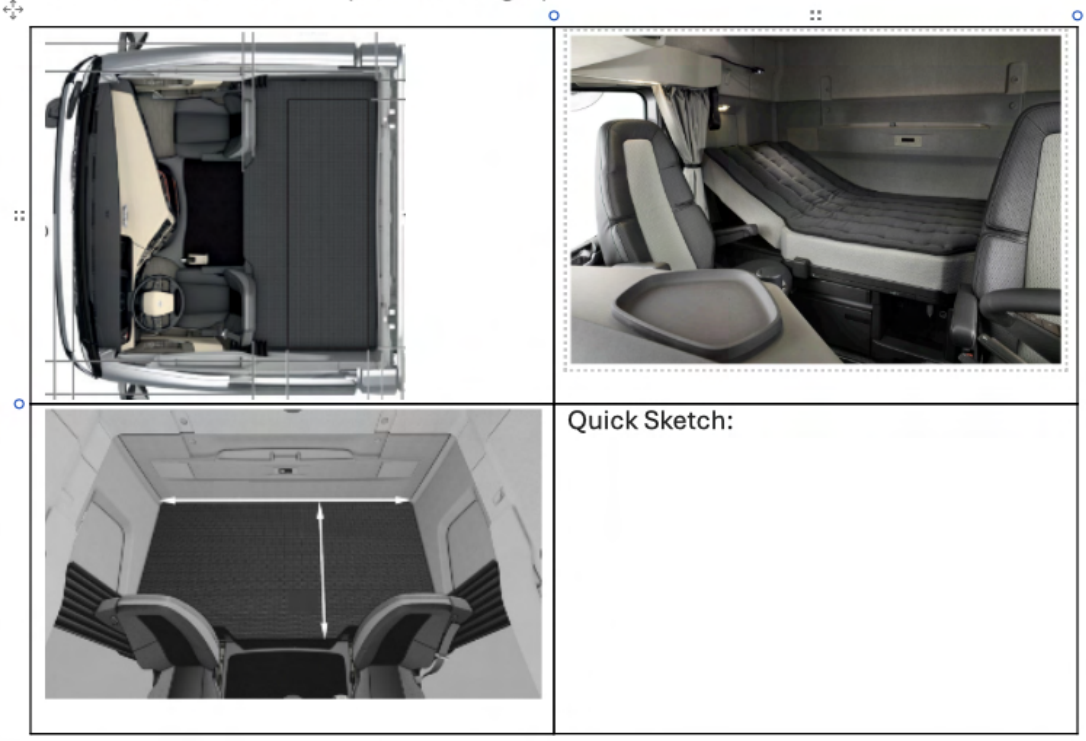
Figure 46: Scenario 2 Template

Scenario 3: After driving for a while, wanting to wash hands before chilling on bed

You have been driving for several hours and have now stopped for a break. Before relaxing on the bed in the cabin, you want to wash your hands and freshen up a bit.

What is important in this scenario?

Where is the sink stored? (Mark on images)



How does the driver use it?

Key features:

Advantages:

Potential problems:

Improvements:

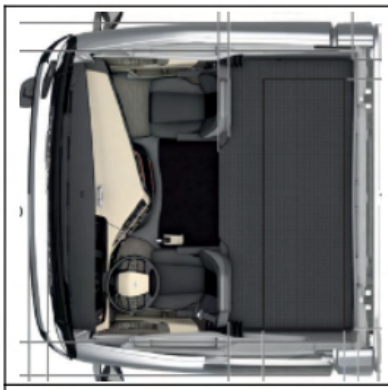
Figure 47: Scenario 3 Template

Scenario 4: Sitting and chilling on bed and having a snack, wanting to wash hands quickly.

You are sitting and relaxing on the bed inside the cabin, watching something on your phone and eating a snack. Your hands feel sticky and you want to quickly clean them without leaving the cabin.

What is important in this scenario?

Where is the sink stored? (Mark on images)



Quick Sketch:

How does the driver use it?

Key features:

Advantages:

Potential problems:

Improvements:

Figure 48: Scenario 4 Template

Appendix D

Sketches and Renders of Ideas

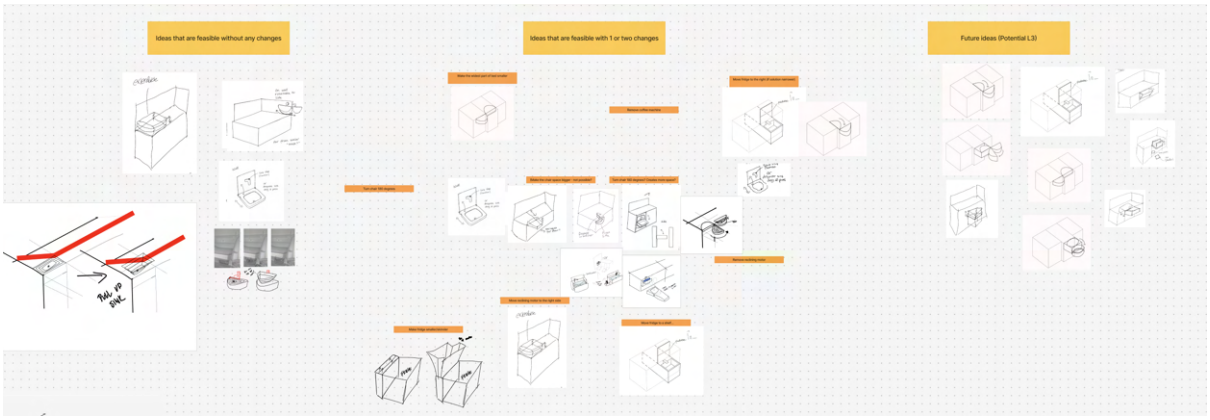


Figure 49: Idea Categorisation

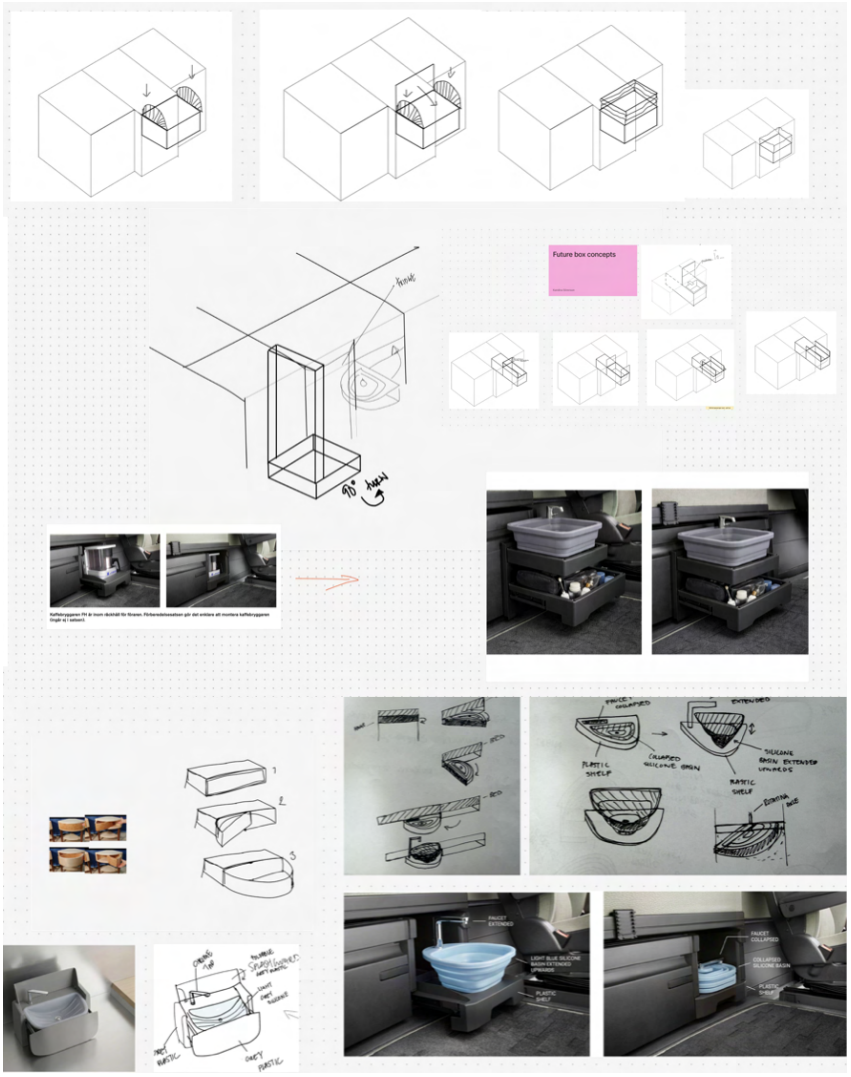


Figure 50: Sketching and Renders of Concepts

Appendix E

User Evaluation Questions

User Evaluation of Prototypes

Is it easy to use?

How does the number of steps required to access it feel?

How does the product feel to use?

Does it take up too much space in the cabin?

What do you think about the placement?

Is it uncomfortable to stretch or twist your body to use it? (distance, height, etc.)

Would you use the sink in a scenario like this, or would you do something else?

What feels good, and what feels difficult?

What would you change?

Which one is your favorite?

Evaluation Criteria

- Ease of use
- Minimal interaction steps
- Feasibility of implementation
- Space efficiency
- Accessibility within the cabin
- Integration with existing cabin areas
- Minimal cabin modifications

Any other comments?

Figure 51: User Evaluation Supporting Questions

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