Master Thesis

The Future of Urban Distribution Trucking

A New Concept and Vision for DAF Trucks

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Faculty Industrial Design Engineering
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TU Delft DAF

Preface

This master thesis is the result of a graduation project for the master Integrated Product Design. The project was completed under the supervision of DAF Trucks and the TU Delft, during which I worked three days a week at the DAF Desing Centre in Eindhoven and two days at the faculty of Industrial Design Engineering in Delft. This project was my first automotive design assignment and so I was still quite inexperienced in the field, however I was very motivated and eager to learn. DAF Trucks welcomed me with open arms and attentively mentored me for the six months leading up to my master thesis. It was incredibly inspiring to be able to walk past the 1:1 clay models in the modelling studio at DAF and get a sense of the projects they were working on. I gained a clear insight of what it is like to work in the design team at DAF. Since the project involved a future context and the VIP (Vision in Product Design) method is widely used for projects with a future setting, I decided it would be useful to incorporate the method into my project. This was quite a challenge given that I had never used the method before. It took me quite some time to become familiar with the method. Fortunately, I benefited a lot from conversations with my chair Elmer or with fellow students who were familiar with the method. Combined with an already quite complex task, however, I encountered myself several times. It is challenging to keep a focus on the outline in a design assignment consisting of so many small sub-problems. Knowing myself, I preferred to be able to figure out everything myself and could get frustrated when things didn't work out, but these very moments were the biggest learning points in the process. Especially with this kind of styling assignment, you need the space and time to be able to take a break from your work to come back to it later. I was reminded of this during several times by my mentor at DAF Gerard (you were right). Overall, I can say that through this project at DAF, I learned a huge amount as a designer. I learnt what it is like to work with modellers and experts in different areas and how to manage a big project. Despite all the hurdles, I can say that I immensely enjoyed the project, the subject and the cooperation with DAF, I would do it again in a heartbeat.

Acknowledgements

Elmer Thank you for your support and faith in me. Thanks for the fun off-topic conversations, your openness, critical spirit and imagination. The meetings always made me feel at ease and full of energy.

JanWillem Thank you for your support and guidance. Your critical but necessary questions and your making sure that I stayed on topic. Unfortunately I never got to assist you during your drawing classes, but I did get to enjoy your automotive drawing lectures.

Gerard Thank you for your valuable mentorship and fatherly advice that I sometimes needed. Thank you for your patience and constant motivation throughout the process, you closely witnessed my struggling at times.

Bart Thank you for your direct yet always sincere feedback. You challenged me to step out of my comfort zone and think one step further.

The DAF design team I want to thank you all for your help and kindness. I really enjoyed our lunch walks and office chats. Peter and Richard, I'm grateful for your valuable modelling support. It was a pleasure working with you both. Stuart, thank you for your critical eye and insight. Dirk, your unique sense of humor was always appreciated. Lennart, I learned so much from your extensive knowledge about trucks. Lars, your drawing and VIP advice was incredibly useful. Chelsea, I appreciated your optimistic presence, and Freek, thank you for your level-headedness and thinking along.

Maarten Thank you for the amazing photography that exactly captured the design problem within the project.

Berend Thank you for always being there for me. For the endless listening, your genuine interest in my project and unconditional support.

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Glossary

ADAS = Advanced Driver Assistance Systems

AR = Augmented reality

BEV = Battery electric vehicle

Chassis = The framework or undercarriage of a truck, providing structural support for various components like the engine, cab, and cargo area.

DC = Distribution center

EV = Electric vehicle

FCEV = Fuel cell electric vehicle

GVW = (Gross Vehicle Weight) the total weight of a stationary and road-ready vehicle, as approved by the relevant authorities in its country of registration. This encompasses the vehicle's load, driver, and the authorized maximum number of passengers.

HDV = Heavy duty vehicle

HEV = Hybrid electric vehicle

LEVV = Licht elektrisch vrachtvoertuig / light electic freight vehicle

Payload = The weight of load the vehicle transports

Platooning = A set of virtually connected trucks that drive closely behind one another using automated driving technology

VR = Virtual reality

VRU = Vulnerable road user

Introduction

This TU master thesis is the documentation of a half-year project that delved in-depth into the way how society is distributing goods into the inner cities. In particular, the project deals with what effects distribution has on the people in the immediate surroundings of the distribution vehicle and comes with a solution for how the negative effects can be remedied in the form of a future design for an urban distribution vehicle. The project advocates for a more accepted and integrated approach to urban distribution, challenging authorities to consider all stakeholders. In collaboration with DAF, leading Dutch truck brand, the final concept proposal was made for a 2040 future context. I hope you enjoy reading this thesis report.

Figure 1: unloading on the Rosengracht Amsterdam, photo taken by Maarten van Haaff

Project partners

This project stems from a graduation internship that I was able to follow at the DAF Design Center in Eindhoven. Therefore, this project's partners are the TU Delft and DAF Trucks.

TU DELFT

This master thesis forms the final step before graduating from the master Integrated Product Design. In doing so, the TU Delft had the assessing role within the project. Next to this, the TU Delft provided me with valuable support through the guidance of my chair Elmer van Grondelle and mentor JanWillem Hoftijzer, with whom I had regular coach meetings.

DAF TRUCKS

The project is commissioned by DAF Trucks, who are interested in the subject of inner-city distribution and are keen on gaining new insights for their future designs. DAF has had an important guiding role throughout the project due to their long-term experience within the industry. Above all, Bart van Lotringen and Gerard Baten were truly like mentors wanting to prepare me for my future career for which I am very grateful.

1. The project

In this section the project assignment, context and research set-up will be explained. the design problem which triggered this project will be described to give the reader an idea of the context that this thesis deals with.

1.1 Project outline

PROBLEM DEFINITION

Globally, an urbanisation trend is underway wherein the migration of people to cities creates a high urban demand for goods and services. In Europe, urbanisation is expected to increase by 83.7% by 2050 (European Commission, 2020). This means that urban density will increase enormously compared to today. Especially in the Netherlands, with its limited geographical area, cities will be densely populated by the year 2040. This fact, combined with the rise of e-commerce and just-in-time delivery models, will lead to an increase in the frequency and volume of urban deliveries. However, this increase in urban deliveries clashes with the lives of city inhabitants. Today's distribution vehicles disrupt the urban environment by congesting the streets, increasing urban noise and polluting the air. Deliveries in the city are done with large trucks or lorries that are a direct burden to the city. Municipalities advocate for a liveable environment by imposing restrictions on (heavy) vehicles and strive for a truck-free city centre. There is no doubt that distribution vehicles will still be needed in the future urban landscape and will therefore have to adapt to contribute to a liveable environment.

ASSIGNMENT

The original design brief from DAF was as follows:

"Design a concept and vision for a 2040 DAF distribution truck that enhances the efficiency of delivering goods to urban areas."

Aware of the changing urban landscape and future municipal and environmental requirements, DAF wants to adapt to the new urban context. One of their priorities is to find an efficient solution adapted to the urban landscape.

FIGURE 2: Across the world, cities will become crowded

RESEARCH QUESTION

The challenge for the project lies in designing an urban distribution vehicle that is better integrated into the urban landscape. This must address the efficiency of delivering goods and minimising the negative impact on the urban environment. From there, the following research question was drawn up for the project:

How can we better integrate distribution into the dynamics of the city center?

DOMAIN

The time frame for the design has been set at the year 2040. This is because designing for a future context often results in more radical and creative concepts. These can serve as inspiration for DAF for future products. The domain within which the concept will be designed is therefore:

Urban proof distribution trucking in 2040.

FOCUS WITHIN THE PROJECT

For this project, the choice was made to focus on the exterior design of the vehicle. The reason for this being the significant impact of the exterior on the urban environment. However, attention was also given to the vehicle's layout and way of operating to ensure the design's logistical feasibility and practicality.

OUT OF SCOPE

Aerodynamics is outside the project's scope because, unlike long-haul transport, where aerodynamics play a crucial role in fuel efficiency, aerodynamics are negligible for inner-city distribution due to low speeds and frequent stops.

AUTOMATION LEVEL

Since the vehicle will operate in a future context, it is important to consider the degree of automation. Current developments in the automotive industry will lead to the automation vehicles in the near future. However, for heavy vehicles, full automation is not all that close due to the safety risks. Automation trials are ongoing in the truck industry, where platooning is being investigated for the sake of fuel efficiency (Einride, 2024; TuSimple, 2023). However, these developments are more advanced in the US and are primarily focused on long-distance transport. Automation for last-mile or inner-city transport may take longer and might not be ideal because the busy city center could cause vehicles to stop frequently due to the automated system's constant adjustments. Therefore, the project will take into account the presence of a driver. However, a high level of driver assistance systems will be available. With this information, automation level 2 from Figure 3 is applicable to the project.

Driver required

Level 0: No Automation	*Zero autonomy, the driver performs all tasks*
Level 1: Driver Assistance	*Vehicle is controlled by the driver, but some driving-assist features may be included in the vehicle design*
Level 2: Partial Automation	*Vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving*
Level 3: Conditional Automation	*Driver is a necessity, but it's not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice*

Full Driver-Out

Level 4: High Automation	*The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle*
Level 5: Full Automation	*The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.*

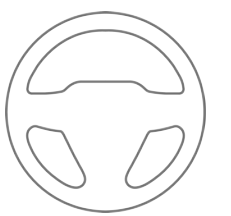


FIGURE 3: Automation levels explained

1.2 Project approach

The distribution vehicle can be seen as the middleman between the driver and city inhabitants. The vehicle interacts with the driver during his work, but also with the inhabitants (people on the street) through its appearance and positioning in the public space. Therefore, the project needed a two-folded approach: by analysing the behaviour, needs and wishes of the driver and those of the city inhabitants separately. This way, the interests of the stakeholders could be balanced. And combined with the Vision in Product Design method, a raison d'être for the design could be found.

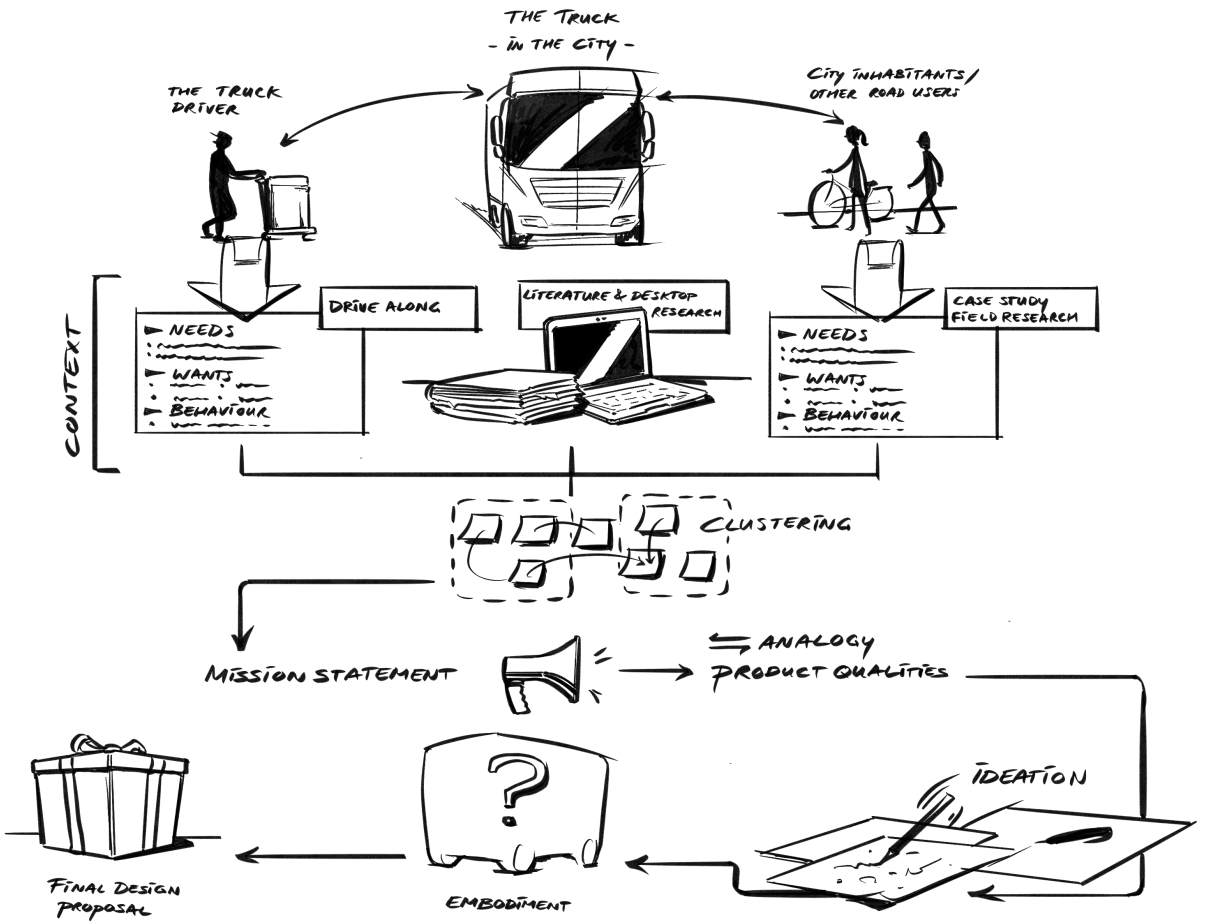


FIGURE 4: An overview of the project approach

1.3 Project strategy

ANALYSIS PHASE

As the research part of the project is two-sided and the project domain impacts the two main stakeholders: the driver and the city's inhabitants, literature and desktop research will be conducted, as well as field research in the form of drive alongs, interviews and case studies to understand the existing context for both stakeholders. Internal factors will be analysed to understand the DAF brand and their mission. At the end of this phase, the context factors are collected and analysed to proceed to the synthesis phase.

SYNTHESIS PHASE

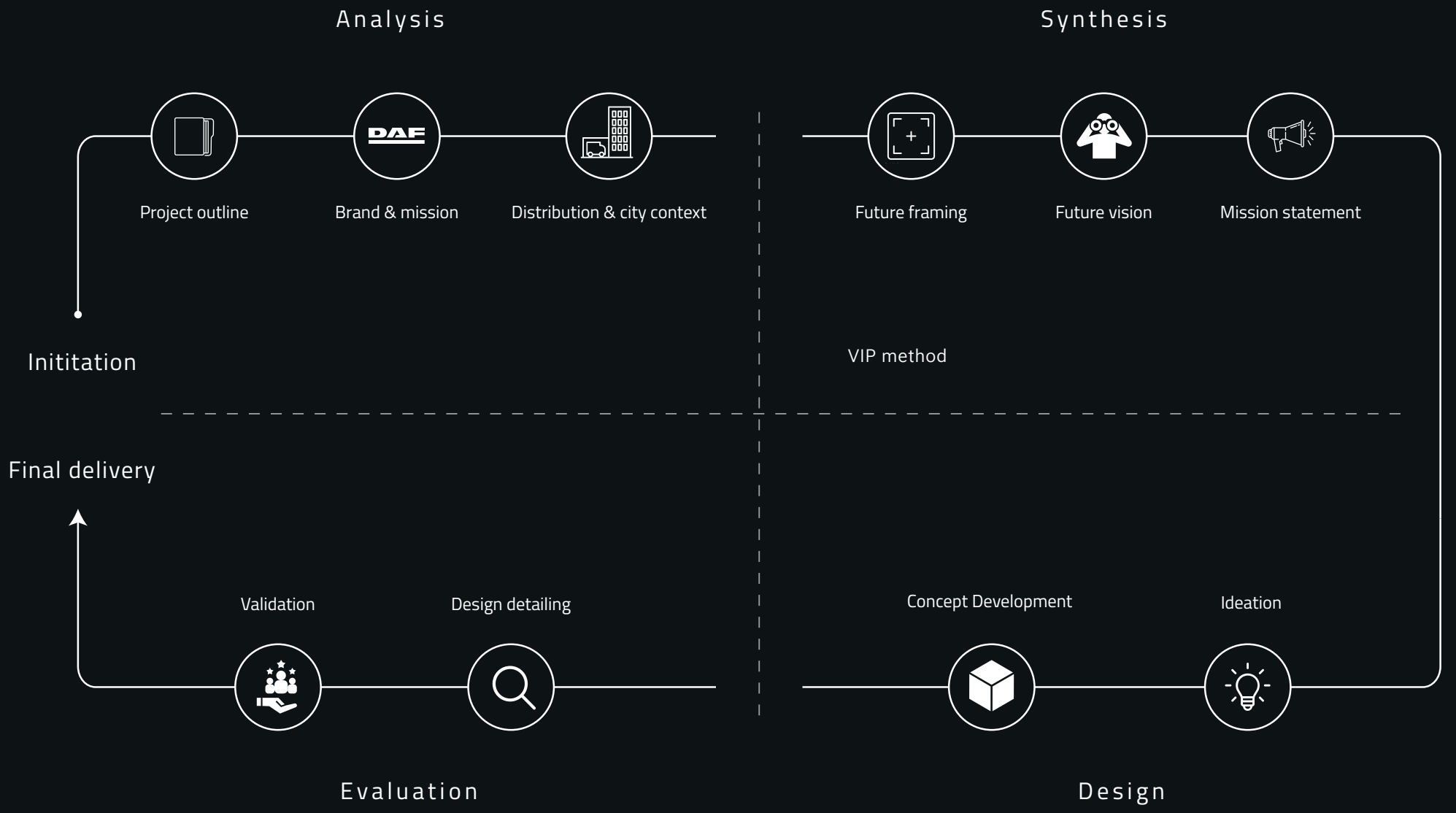
The context factors collected during the analysis phase are mapped out and compared to form context clusters. These clusters are then analysed to identify internal relationships, which help interpret possible future scenarios for the distribution vehicle to be designed. Knowing which future scenario the vehicle should operate in allows me, as the designer of the project, to form a vision of how DAF could add value to the inner-city context of the future. Through an analogy, the product qualities and features become clear and form the basis for ideation.

DESIGN PHASE

The design phase starts with a divergent ideation process where different ideas and solutions are generated that result in a morphological chart of different sub-concepts representing solutions that meet key design requirements. At this stage, a wide range of possibilities are explored and discussed with experts. Finally, during concept development, concepts are weighed against each other based on the requirements and a concept direction is chosen for further development.

EVALUATION PHASE

Optimisation and detailing of the concept will take place to arrive at a final design. This design will be validated with DAF experts as well as stakeholders. Before final delivery, a virtual prototype will be created to show how the design will operate.


Analysis
Synthesis
Project outline
Brand & mission
Distribution & city context
Future framing
Future vision
Mission statement
Inititation
VIP method
Final delivery
Validation
Design detailing
Concept Development
Ideation
Evaluation
Design

1.4 Methodology

VISION IN PRODUCT DESIGN

Because the final concept has to be designed for a future context - round the year 2040 - it is necessary to get a picture of how the future urban context could unfold. The choice was made in advance to use Paul Heckert's and Matthijs van Dijk's (2014) Vision in Product Design method for my research. This method provides a thorough context analysis allowing assumptions to be made about which future scenarios are possible and then determining how the design can add value for stakeholders in that context.

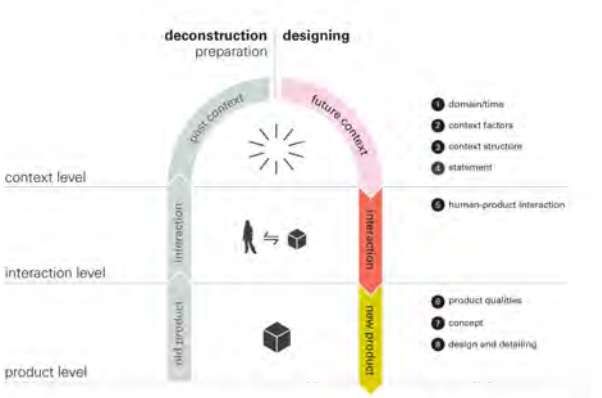


FIGURE 5: Vision in Product Design Method

DOUBLE DIAMOND STRUCTURE

The VIP process, like any design process, consists of an interplay of information gathering (diverging) and information processing (converging) to arrive at new valuable insights. To maintain this natural way of working, I decided to integrate the double diamond structure during the project. This way, each phase would have a diverging and a converging character.

DELFT DESIGN GUIDE

Various design techniques were used throughout the process. These included using the Delft Design Guide to find inspiration for usable techniques. These techniques provided tools to process information or initiate/promote the creative process.

AUGMENTED REALITY

By working at DAF I had the opportunity to make use of their advanced design resources. For example, one resource that has played a big role in the project has been the virtual reality techniques that DAF extensively uses to assess their designs with. Using augmented or virtual reality in automotive design makes it easy to assess designs without needing the actual materials saving costs and time. On top of that, the combination between physical elements and augmented reality creates a highly realistic experience of the design, from which you can gain many valuable insights.

FIGURE 6: Augmented / virtual reality tools

1.5 Stakeholders

To develop a valuable design proposal, it is important to know which stakeholders are involved in this project. Some stakeholders come into direct contact with the distribution vehicle at street level (driver, city inhabitants and retailers) and some indirect. This chapter gives an overview of all the stakeholders.

TRUCK DRIVERS

The person responsible for the timely and proper delivery of goods to the customer. He or she is employed by the distribution company that provides the address list and, in many cases, arranges the cargo in the vehicle. In the inner city, the driver has the challenging task of delivering to as many addresses as possible, while avoiding damage and accidents while driving through the chaotic fine-meshed inner city.

CITY INHABITANTS

All individuals using the city's public spaces. Using various forms of mobility on a daily basis to navigate the city, including walking, cycling, using public transport or travelling by car. In doing so, they frequently encounter distribution vehicles driving or parking in the street.

RETAILERS AND HORECA OWNERS

Catering concepts like restaurants and retail shops in the city that receive goods from distribution vehicles. These may include restaurants, supermarkets, fashion stores or shops owned by small entrepreneurs. They have commercial motives (interest in receiving the goods on time to make profit) and have personal contact with the truck driver delivering their goods.

OPERATORS OF DISTRIBUTION COMPANIES

Those responsible for managing, operating or supervising the processes involved in the distribution of goods or services. They plan and coordinate shipments, manage inventory, distribution channels and deal with the fleet of distribution vehicles used within the company.

TRUCK MANUFACTURERS (LIKE DAF)

The manufacturers of the heavy-duty vehicles that keep the distribution network running. They adhere to the requirements of their customers (operators) and therefore - since the operators depend on their truck drivers - to the demands of the truck drivers themselves.

MUNICIPALITIES

Local municipalities are responsible for enforcing regulations within the city and aim to create a liveable urban environment. In order to achieve this they implement policies on sustainability, urban planning and public safety.

KEY INSIGHT

When designing, I want to involve the less influential stakeholders as they have a significant interest in the concept. Currently, trucks are being designed to meet the needs of major players, but not enough consideration is given to the actual users and passers-by.

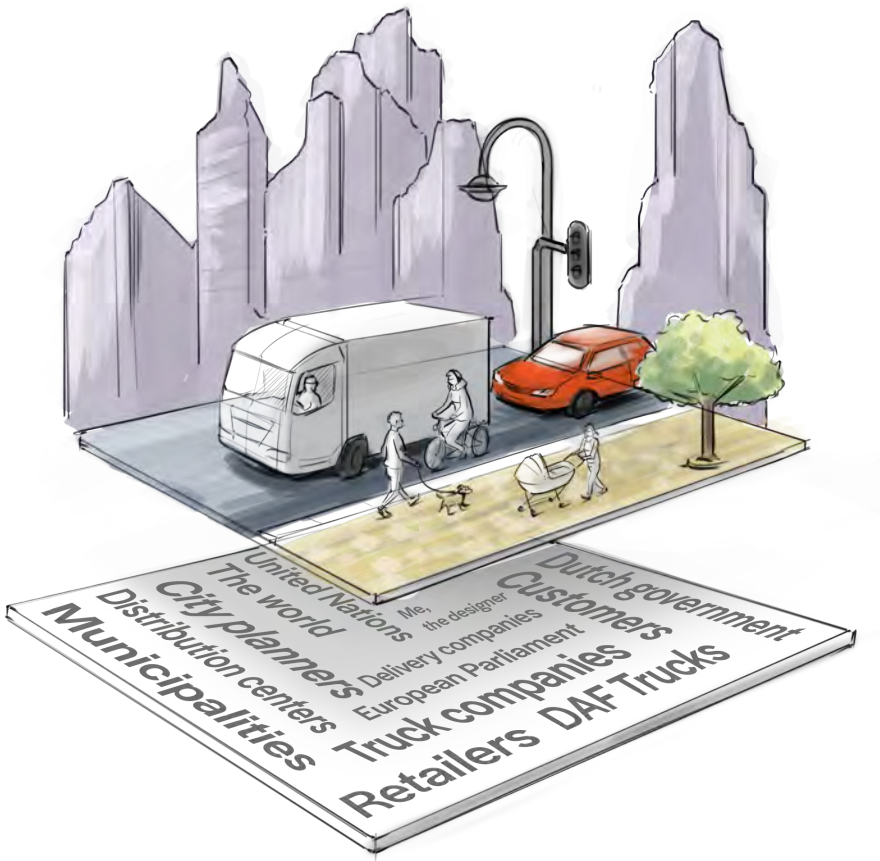


FIGURE 7: Overview of stakeholders

2. Analysis

This section will give answers to the following questions: what are the internal and external factors relevant for this project? What entails distribution in the inner-city? What are the specific problems regarding distribution in the inner-city? And what are the future developments in urban distribution?

2.1 Brand identity

To find out the internal factors surrounding the project it is important to take a brief look at DAF as a brand. Here, the core values of the company, their identity and history will be discussed. This will later be helpful in making the to be developed concept match with the brand identity of DAF.

CORE PRINCIPLES

There is quite some difference between truck brands and passenger car brands in their marketing strategies. Whereas passenger car brands often sell directly to individual consumers (Business to Customer), truck brands typically target large distribution companies (Business to Business). Distribution companies make a big investment in buying a truck: therefore, the truck must have a long lifespan (+- 25 years) and no downtime in order to make profit. DAF's core values and principles are therefore specifically tailored to the needs of distribution company operators who promise satisfaction with their product.

SAFETY

As a truck company, DAF is deeply committed to ensuring safe traffic situations. Aware of the risks that heavy commercial vehicles pose to vulnerable road users (VRUs) such as pedestrians and cyclists, DAF tries to minimise these risks by equipping their trucks with safety systems and designing their trucks in such a way that drivers will always detect VRUs.

COMFORT

DAF maintains a close relationship with the drivers who use their vehicles, focusing on their needs to create a practical and comfortable working environment. This includes providing additional cabin or storage space to enhance comfort. The attention to these details is why DAF is recognized for offering some of the most comfortable beds in the industry.

"START THE FUTURE"

"PURE EXCELLENCE"

"DRIVEN BY QUALITY"

EFFICIENCE & RELIABILITY

A truck must always be reliable and up to the task, as it is the main resource for carrying out distribution services. For long-haul transport, maximizing fuel efficiency is crucial to minimize unnecessary stops and extend operating time. This is why DAF has focused on improving the aerodynamics of their trucks as greater efficiency lowers operating costs and enhances sustainability.

FIGURE 8: Core principles DAF Trucks

QUALITY

A reliable and solid truck fleet is paramount for distribution companies to function properly. Therefore, DAF strives to provide high-quality products so that their trucks are the best choice for operators. The premium appearance of their trucks should exude the highest quality and excellence. Winning multiple 'Truck of the Year' awards underlines the fact that they have often lived up to this principle.

INNOVATION

DAF has always been known as a reliable and decent truck company rather than a progressive one. However, this image changed from 2021 when they moved to the forefront of innovative truck brands with the introduction of their New Generation DAF trucks (NGD). They were the first to respond to new legislation around cabin length and were able to develop extra spacious cabins, which became an important advantageous unique selling point for the company.

FIGURE 9: New Generation Daf Trucks

2.2 DAF exterior analysis

DAF's unique style is characterised by a number of elements. These were analysed to connect the form language of the final design with DAF's brand identity. This is to ensure that the final design is truly a unique DAF and would not be fitting for any truck brand.

What you see with the DAF truck are lines running upwards from the front to the rear, along the cab (see Figure 10). These emphasise performance and efficiency by highlighting the aerodynamics. If you compare the DAF cab to those of other truck brands, you quickly notice that those upward-sloping lines are unique to a DAF truck.

The grill occupies a large part of the front, it balances out the frond windscreen and creates a harmonious composition of style elements at the front. Silver strips outline the grill and give it a premium look.

FIGURE 10: DAF exterior characteristics

BRAND IDENTITY PRISM

After doing desktop research, the findings were discussed with Natasja Gerritsen (marketing and sales at DAF) from which a clear picture emerged of how DAF's brand identity is constructed. Here, Kapferer's (1996) brand identity prism was used (see Figure 11).

BRAND MISSION AND VALUES

After talking to Natasja, it became clear that DAF is more a practical-oriented company than a strategic one. Natasja indicated that there is not one specific mission or strategy within the company. In that sense, DAF is a rather down-to-earth company. However, several conversations with Gerard Baten and Bart van Lotringen at DAF revealed that DAF does feel a strong social responsibility. In which they want to be able to profile themselves in the future as a company committed to a liveable urban environment. This was also an important starting point in the development and marketing of the DAF XD.

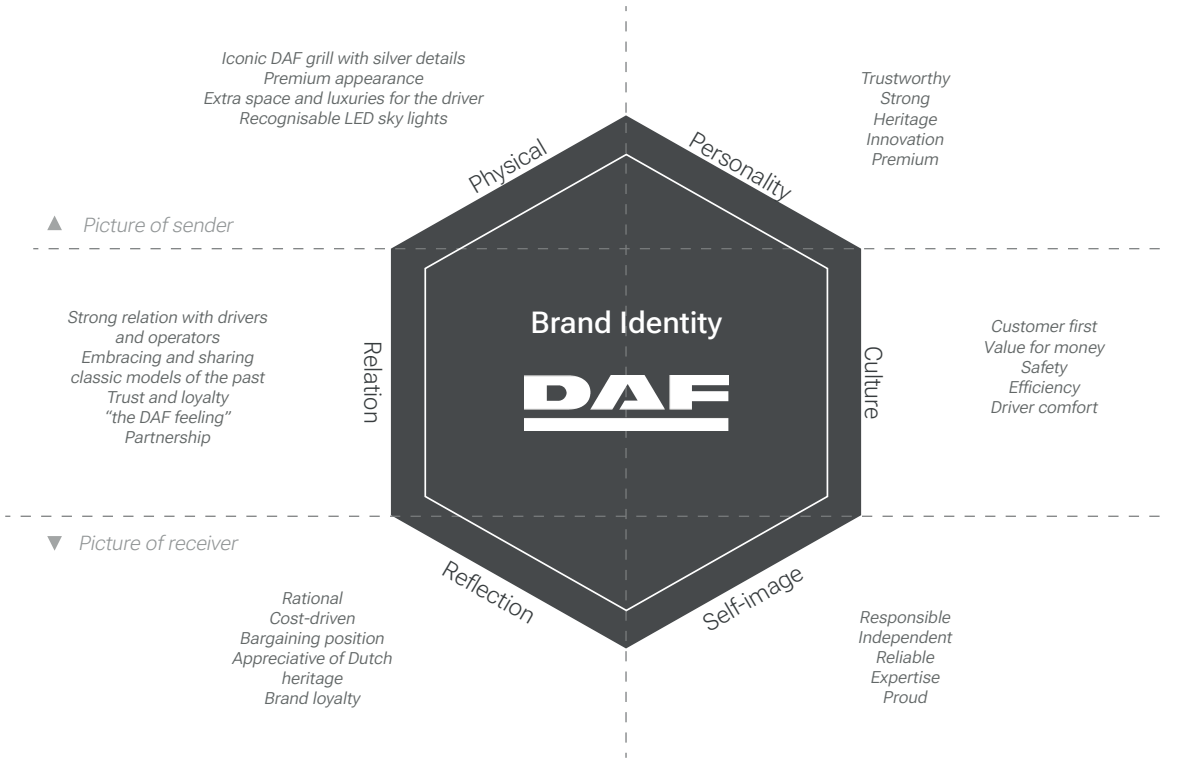


FIGURE 11: Brand identity prism DAF

BRAND HISTORY

DAF was founded in 1928 by Hub van Doorne in Eindhoven as a construction workshop 'Van Doorne's Aanhangwagen Fabriek'. The workshop grew into a successful truck manufacturing company after the first truck was launched on the market in 1949 (DAF Trucks, 2024). Ever since, DAF stands as a symbol of Dutch heritage.

In the early 1990s the commercial vehicle market declined, which led to DAF's bankruptcy in 1993. In 1996 DAF was acquired by Paccar Inc., saving the company and allowing Paccar to expand its brand presence to Europe. Today, DAF operates as a subsidiary of Paccar, alongside US truck brands Peterbilt and Kenworth.

Overall, DAF is a versatile company. It ventured into the passenger car market with the DAF600 Variomatic, participated in events such as the Paris-Dakar rally and produced military and police vehicles. DAF has distinguished itself in the truck market in the past by improving driver comfort in the cabin. Examples include the SpaceCab in '85, the SuperSpaceCab in '95 and the New Generation DAF XG+ in 2023.

At the moment it can be said that DAF is prospering as a company. Last year, it turned in a record production of 69.800 trucks and accounted for one-third of truck sales in the Netherlands (Anp, 2024).

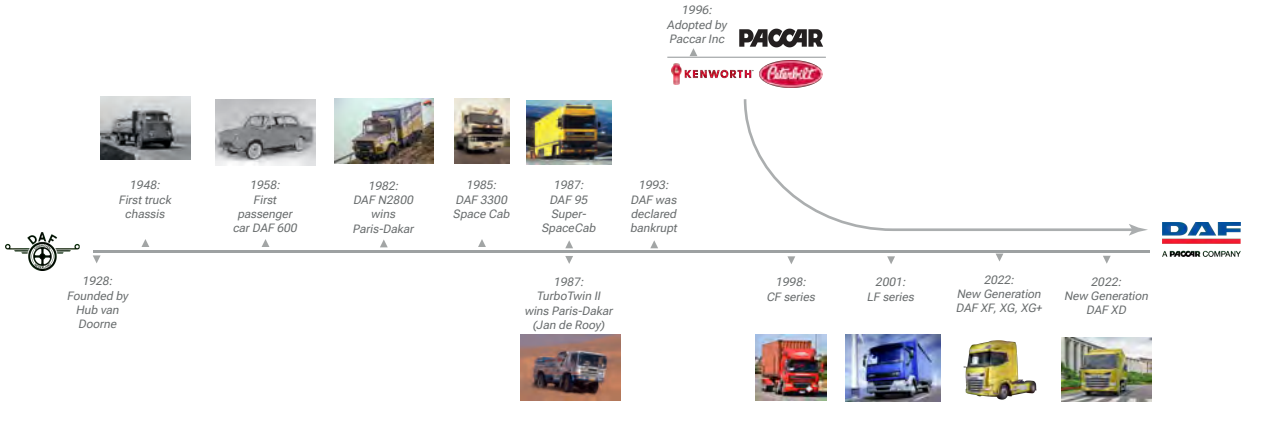


FIGURE 12: A timeline of DAF's brand history highlights

2.3 DAF museum visit

To gain a better understanding of DAF's history and values field research was conducted in the DAF Museum in Eindhoven where multiple vehicles, engines and old advertisements were on display.

KEY INSIGHTS

- DAF is of cultural value for the Netherlands as a leading truck company. Many historical moments happened along side the DAF vehicles.

- DAF stands out by its versatility: its vehicles served various different purposes. Police vehicles, army vehicles, passenger cars and garbage trucks.

2.4 Urban logistics

Since this project focuses on the last mile or inner-city distribution, it is essential to understand the context factors surrounding urban logistics. This chapter aims to provide a clear picture of this context.

MUNICIPALITIES

City centers are often characterised by restricted zones, one-way traffic streets and specific time slots for loading and unloading activities. These are examples of restrictions that municipalities impose on heavy duty vehicles in the city. The restricted zones are recognisable by the automated bollards in the ground (Figure 13). Within these zones deliveries are solely allowed during specific time windows to minimise the disturbance for habitants during the day.

As municipalities are concerned with the health and safety of the city inhabitants they aim to establish an emission-free urban environment. Under 'Actieplan Schone Lucht', the municipality of Amsterdam has mandated that from 2025 the city center will be inaccessible to diesel-powered vans and trucks (Gemeente Amsterdam, 2023). Similarly, cities like Rotterdam and Utrecht plan to implement zero-emission zones by 2025, encouraging sustainable transport solutions such as cargo bikes and electric vehicles.
Cities will allow distribution vehicles with emission class EURO 6 to operate until 2025 (Schoonmakend Nederland, 2023). Additionally, 'zones zwaar verkeer' requires vehicles heavier than 7.5 tonnes to obtain special exemptions (Gemeente Amsterdam, 2024).

Since the restrictions on heavy vehicles in the inner city will only increase, distribution vehicles must fully comply with all existing requirements. Truck manufacturers and logistics companies must therefore adapt to the new emission standards to still deliver services in the city.

KEY INSIGHT

The to be designed vehicle should align with the vision that local municipalities have for the city to be able to operate in the city.

FIGURE 13: Bollards that rise up after delivery times preventing traffic to drive past

URBAN LIVEABILITY

Because this project focusses on the design of an urban delivery vehicle, it is essential to understand the impact urban freight vehicles have on the public space and the inhabitants using it and find out what implications this will have on the design.

In busy and densely populated urban centres, both logistics companies and residents compete for the limited space available in urban areas. This competition often leads to conflict because the space required for urban distribution uses the public space that inhabitants rely on for their daily activities. Unpleasant situations arise when urban distribution vehicles start parking on the street or pavement to carry out their services. The road becomes blocked and road safety for VRUs decreases.

An example of this is the Oude Pijp in Amsterdam, where numerous complaints from residents led to investigations into delivery vehicles in the city. It turned out that 40-50 per cent of loading and unloading activities take place on the road, bike path or pavement (Altenburg & Ploos Van Amstel, 2017). In the area, distribution takes place throughout the day with a constant flow of delivery vehicles. Due to the lack of parking spaces, the public space is constantly obstructed by delivery vehicles. According to Altenburg, urban distribution can be achieved with half the current number of vehicles by collaborating and bundling deliveries.

The quality of life in the city is closely related to how public space is being used. When space is used for urban distribution, there is less space available for green or public facilities. Using public space for other purposes overlooks the spatial needs of the community and can ultimately lead to frustration. The public space should consider all users: pedestrians, cyclists, motorists, taxis, trams and urban distribution.

Vienna is ahead in terms of urban liveability. With the construction of the new Mariahilfer Strasse, they have exchanged a busy car street for a pedestrian-focused street. Not surprisingly, Vienna is the world's highest-scoring city in terms of liveability (Economist Intelligence, 2023).

FIGURE 14: Mariahilfer Strassa *(Vienna Solutions, 2020)*

URBAN CONSOLIDATION CENTERS

Urban consolidation centres (UCCs) or hubs increase efficiency levels in urban logistics. Hubs serve as central points where goods are collected, bundled and redistributed in the city. By strategically placing them near the city centre, the number of vehicles and the total number of transport movements in the city can be reduced.

Current urban collection centres have proven their effectiveness. A publication by Jensen and Ørving (2022) evaluated an urban collection centre in Oslo and speculated on its effects on space utilisation. For deliveries to the pedestrian street Torggata, the number of vehicles could be reduced by 80 per cent and the space occupied by freight vehicles by 45 per cent through the use of an urban consolidation centre (Jensen & Ørving, 2022). Another study on Amsterdam's urban logistics indicated that we can expect more urban hubs and decoupling points on the outside of zero-emission zones in the future (CBRE Investment Management, 2023).

Consolidation of deliveries in UCCs or hubs will become more relevant as it frees up urban space, allowing the creation of pedestrian zones, parks and wider cycle lanes, ultimately improving the quality of life in the city.

THE PHYSICAL INTERNET

In the future, the use of hubs will be combined with data-based processes that facilitate the shift from traditional supply chain systems to a more interconnected supply network known as the Physical Internet. There would be fewer competing distribution companies, but rather an open network processing all deliveries. Implementing such an open system would smooth the transition to zero-emission logistics and make urban logistics more efficient (ALICE, 2024).

HYPER-LOCAL CITIES

A concept that emerged during the COVID-19 pandemic was the use of "dark stores" in inner cities. These are physical stores unaccessible for customers operating as local fulfilment centres that cater exclusively to online orders to ensure fast home delivery of goods. Small businesses like Gorillas and Getir offered hyperlocal home delivery in this way with the promise of short delivery times. While it is questionable whether these companies can maintain their position in the market (as there is no longer a pandemic where people cannot do their own shopping) it is not unlikely that the '15-minute city' - where all services are within a 15 minute reach - will become a future reality (Khavarian-Garmsir et al., 2023). Large retail companies are likely to utilise micro hubs throughout the city in order to achieve hyper-local distribution of goods. The micro hubs could be used to restock larger stores overnight to minimise disruption during the daytime. This hyper-local system would increase the transfer of goods between hubs and delivery vehicles. Therefore, future delivery vehicles should be able to facilitate cross-docking to ensure smooth urban logistics.

FIGURE 15: Distribution activities on the Rosengracht in Amsterdam blocking the car lane, photo taken by Maarten van Haaff

SPATIAL FOOTPRINT

Without urban distribution, the city would stand still. Urban distribution vehicles are necessary for the functioning of the city. It is therefore important to think about the vehicle's use of space in order for it to be more tolerated in the city. When looking at the space use of a truck, the space occupied is often larger than the vehicle itself due to loading and unloading activities through opening the tailgate or manoeuvring a pallet truck on the kerb.

According to Jensen and Ørving (two Norwegisn researchers) the spatial footprint of a vehicle can be defined as area-time (m2t). Where area-time takes into account how long a vehicle stays in an area and the size of the vehicle (Jensen & Ørving, 2022). This means that a large vehicle that spends a short time in an area still has a smaller impact on its surroundings than a small vehicle that spends a longer time in the same area.

$$\text{Area-time} = t \times m^2$$

THE RISE OF THE DELIVERY VAN

In recent years, the use of vans as distribution vehicles has increased. In 2023, van sales in the EU increased by 14.6% (ACEA - European Automobile Manufacturers' Association, 2024).

Vans certainly have advantages: they do not require a C (truck driver) licence and they are easy to manoeuvre through cities making them suitable for delivering goods in dense city areas. It is also relatively simple and cheap for owners to drive electric vans. However, if you consider the size of the load, trucks might be more efficient. Vans have to make multiple deliveries a day because they have limited cargo space. Moreover, the proliferation of small vans in the city creates congested streets: for a smaller vehicle with less cargo space, you simply need more transport movements, leading to more traffic congestion. This makes the exclusive use of vans undesirable in the future city.

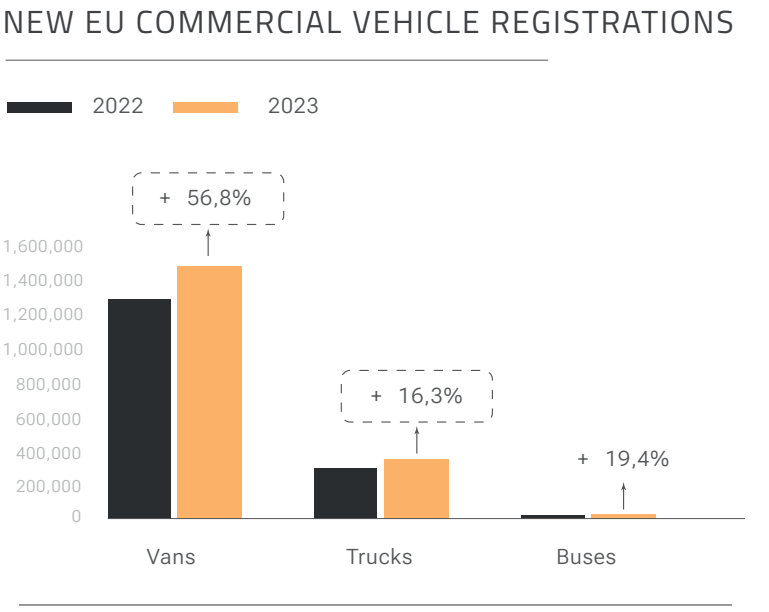


FIGURE 16: New EU commercial vehicle registrations (ACEA - European Automobile Manufacturers' Association, 2024)

THE CARGO BIKE VS THE TRUCK

To drive around the city more sustainably and agile, small and cleaner vehicles, such as cargo bikes or LEVs (light electric vehicles), are increasingly being used. These vehicles are ideal for the city, but have a limited payload. As eCargo bikes can carry 100kg and the largest LEVs can carry a maximum of 750 kg (Balm et al., 2018), they fall short when supplying large supermarkets or large catering establishments. It would require 100 cargo bikes to carry the load of one truck (Paul Schwarte, personal communication, 11 March 2024), which would lead to more transport movements and less efficiency. So while cargo bikes are more sustainable, easier to manoeuvre and less obtrusive in the streetscape, using cargo bikes for retail would not be feasible in the long term. A more realistic scenario would be for cargo bikes to be used for home delivery of parcels and take over as many small shipments as possible, but it is certain that large retail deliveries will still have to be done by larger vehicles.

FIGURE 17: The cargo bike vs the truck

FIGURE 18: Driver unloading his van, photo taken by Maarten van Haaff

Design implications

RETHINK THE USE OF SPACE: LOW AREA TIME

Improvements for urban distribution include centralised delivery of goods, smaller cleaner vehicles, more loading and unloading bays. However, there is currently no space available for more loading and unloading bays. So the solution has to be found from within the vehicle itself. Here, it is important to think about how the vehicle uses the space while respecting other road users. A starting point should be low area-time to avoid traffic congestion and frustration.

BALANCE IN VEHICLE SIZE AND CARGO CAPACITY

When it comes to space use efficiency, the design should consider a balance between sufficient cargo space and a smaller vehicle size to better suit inner city conditions. This is key if DAF wants to be an example of how distribution vehicles could be integrated into the city.

LOGISTIC NETWORK

The future of urban logistics will make use of a better logistics infrastructure: the physical internet. Several connected hubs in the city will be used as docking bays to deliver goods efficiently and sustainably. As the design will function in this context, it should facilitate cross-docking of deliveries at the hubs.

FIGURE 19: unloading on the middle of the driving lane, photo taken by Maarten van Haaff

2.5 Driver interviews

To get a more in-depth understanding of what distribution entails, I got into contact with five distribution drivers. With three of them an open interview was conducted and with two a drive-along during their regular workday could be arranged. In this chapter the insights from the interviews are listed.

INTERVIEW THEO

TIME MANAGEMENT

Theo has to deliver to 20 customers a day. Quick unloading is key to finish the delivery schedule. Everything must be done as quickly as possible.

VEHICLE MANEUVERABILITY

Navigating through narrow streets filled with other vehicles is challenging because Theo is constantly trying to prevent damage to the vehicle. For all damages, he is responsible himself.

ELECTRIC DRIVING

There is a lack of charging facilities for large vehicles in urban areas. Most common is the use of AdBlue and hybrid vehicles. Theo claims that this makes electric driving for heavy distribution vehicles non-viable at the moment.

SAFETY

Enhanced visibility is crucial for detecting VRUs. Direct vision from the cab is beneficial. Theo must be constantly alert to all dangerous corners so that he does not overlook ant passers-by.

IN AND EGRESS

Theo frequently has to step in and out of the cabin. Focus on low-entry points to facilitate easy and efficient ingress and egress, improving both speed and comfort for the driver is essential.

BRAND PREFERENCE

“DAF. No brand can match a DAF bed”

Theo

"In and egressing happens frequently, that's why I have a DAF CF: it has a low entry point, which saves time and effort"

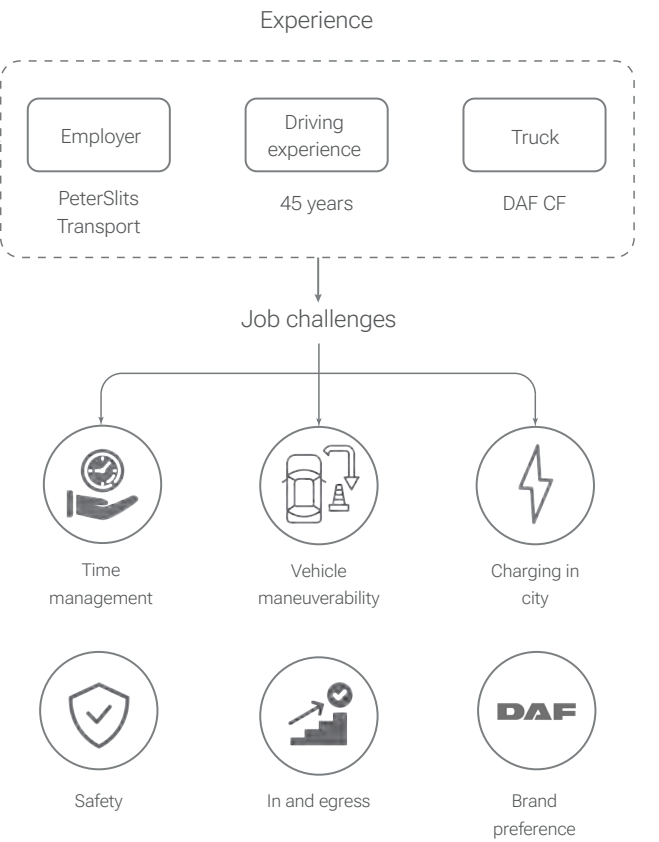


FIGURE 20: Observations from the interview with Theo

INTERVIEW ROB EN JAN

COMFORT

Rob and Jan highlighted the importance of comfort for drivers during mandatory breaks. Even if it is only a 30-minute nap, it is essential to take a nap to stay alert while working.

STRESSFUL JOB

Rob has a preference for rural distribution because urban distribution comes with too much risk for damage and accidents due to the fine-meshed character of the inner-city and the size of the truck.

MANEUVERABILITY

There is need for a smaller turning circle due to the narrow streets. Innovative axle configurations or trailer systems could achieve higher maneuvrability.

PUBLIC PERCEPTION

Rob and Jan often get irritated looks from people on the street. The relationship between the truck driver and the inhabitants is rather bad. This also sometimes makes them feel burdened during work.

BRAND PREFERENCE

“SCANIA. It is just the cream of the crop.”

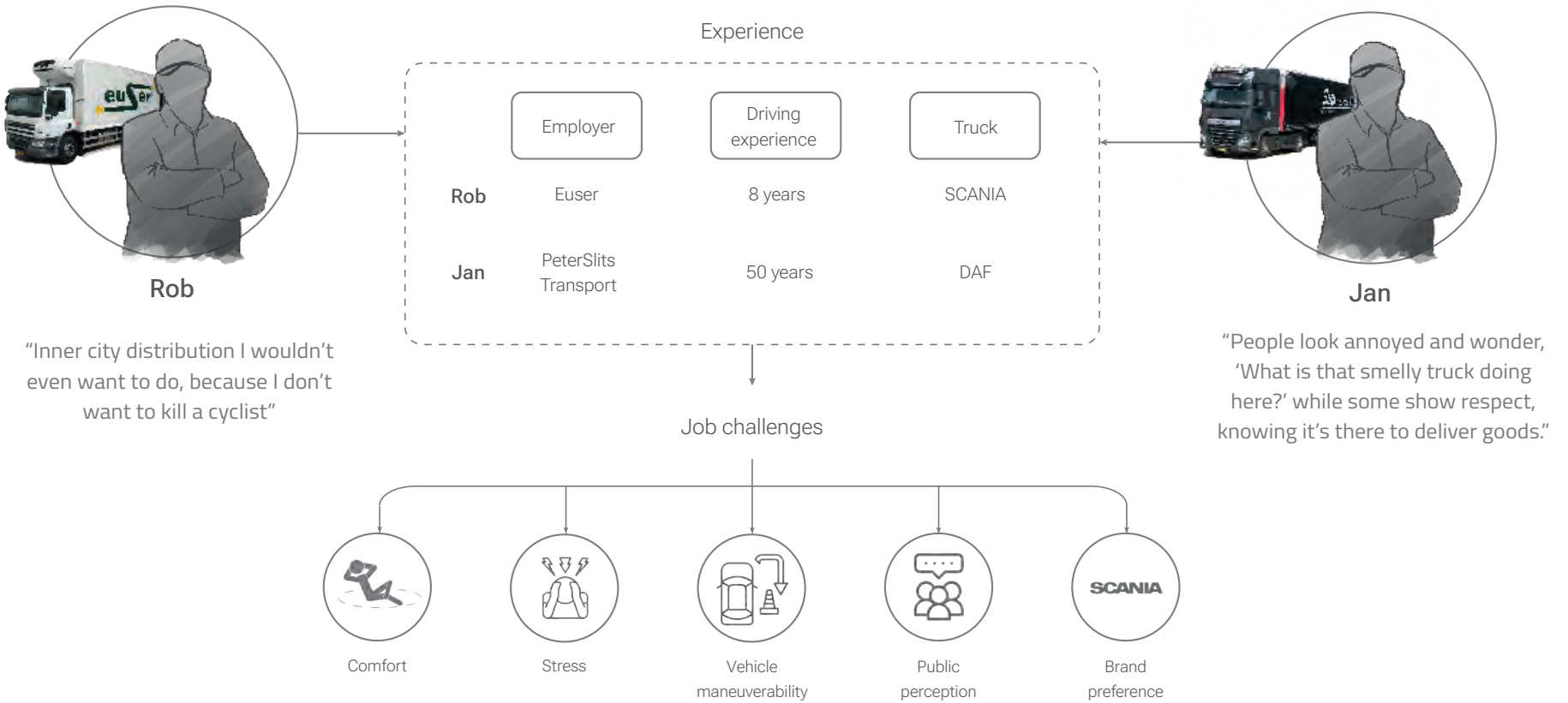


FIGURE 21: Observations from the interview with Theo

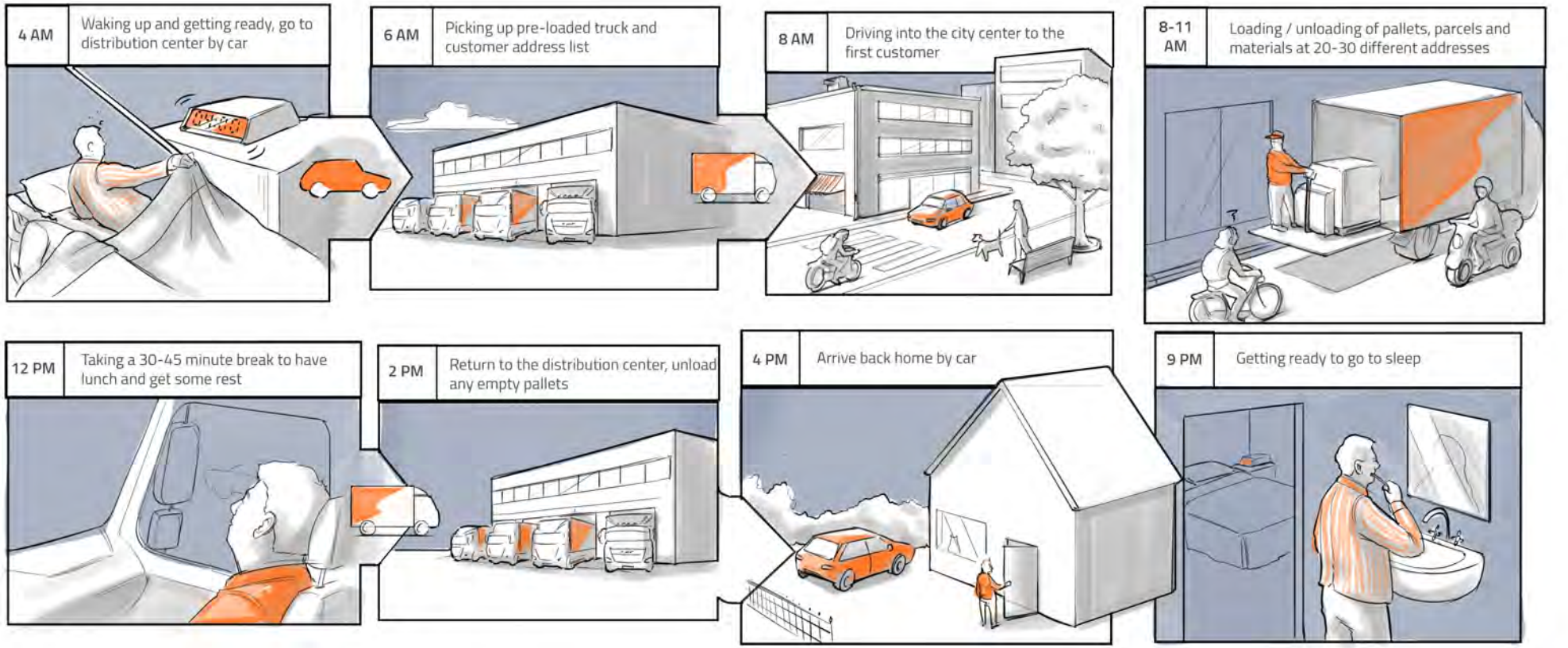


FIGURE 22: Scenario of a regular working day of a distribution driver

2.6 Drive along I

Piet is a regional distribution driver. He used to work at DAF, but after he retired he decided to work two days a week as a truck driver for ID Logistics Tilburg. He drives a DAF LF 210 from the company and delivers installation material to installation companies. On the 20st of March the region he was assigned to deliver was "De Kempen". The working day started at 5 in the morning and it ended around 5 in the afternoon.

Drive along 20 March 5 AM

PIET

"For me, this work is really about freedom. I'm trying to finish the address list, but generally I don't have to rush and I love that."

"There is lots of improvement space for efficiency of logistics, sometimes three different trucks deliver the same type of material for one address as distribution companies don't work together. There is still a lot of rivalry between companies."

FIGURE 23: Delivering with the DAF LF in the Kempen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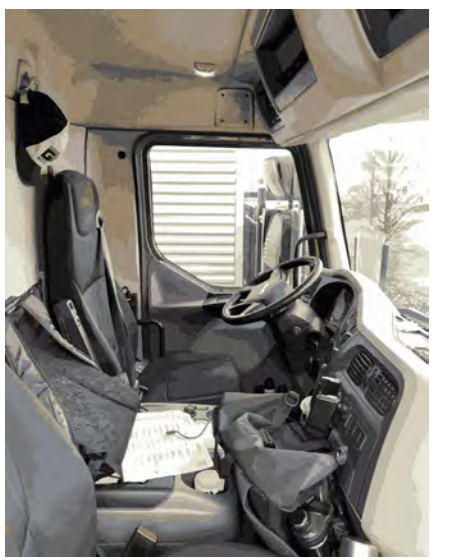


Load organisation

Piet's truck was pre-loaded the night in advance. The cargo was loaded in chronological order so that the first orders are already at the exit during the day.

Unloading system

Piet uses a pallet truck to unload pallets. With it he has to manoeuvre the pallet inside the vehicle and across the pavement.

Cabin space

There was limited space in the cabin. Enough space to sit down, but not to move around the cabin. Similarly, there was not enough space to store personal items.

Drive along I observations and insights

In and egress height

Piet has to climb in and out of the cabin more than 40 times a day to deliver orders. Due to the high cab, this takes a lot of physical energy. Combined with the physically intensive work of unloading and loading, this is not ergonomic.

Visibility

The high seating in the cabin in combination with the heigh dashboard reduced visibility on ground level. However, Piet did have good visibility over roundabouts.

Board computer

Piet used the board computer during his working day. He used it for navigation, administration and looking up cargo information.

DESIGN IMPLICATIONS

When designing the vehicle, it is important to take into account the order of unloading to increase efficiency during the working day. The loading layout should be designed according to which side is unloaded or loaded.

The ingress and egress hight should be designed lower by means of a low deck cabin. Furthermore, a staircase with a slight incline would be more pleasant.

The pallet truck works well, but climbing in and out of the container via the loading tailgate takes time and effort. This unloading system should be designed more efficiently by either automating more operations or reducing the loading height.

For the design, it is important to maximise visibility on ground level to be able to detect VRUs and improve their safety.

A cabin offering more space for the driver would be nicer and safer to work in.

Use of one personal device to regulate all distribution tasks should be integrated in the design to facilitate the job.

2.7 Drive along II

In contrast to Piet, Justin drives solely in urban areas and works for a distribution hub in Amsterdam. Instead of a truck Justin drives an electrical Volkswagen Crafter, his father's delivery van. Justin's workday started at 9 in the morning and he loads the orders himself: mostly small packages and some pallets. During his morning shift I drove along to Haarlem where he delivered several catering products like wine boxes to catering companies.

Drive along 29 March 9 AM

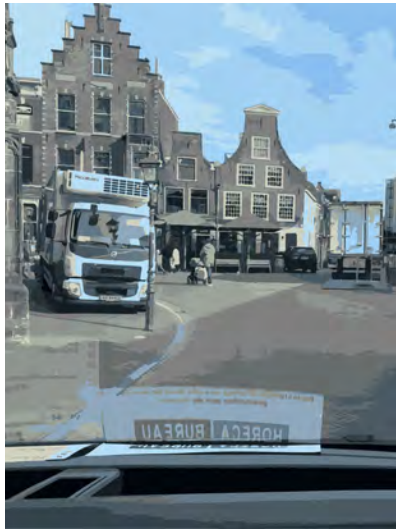
JUSTIN

"This volkswagen is perfect, Driving electric is really enjoyable, silent easy steering, such a smooth feeling., I love delivering in it."

"Very often at this time the street is completely congested with trucks and vans that all have to deliver their goods. It is a matter of maneuvering around each other."

FIGURE 24: Delivering with the Volkswagen e-crafter in Haarlem


ZONE



Load capacity

Because a maximum of 3-4 pallets fit in the van, Justin has to make several trips a day to meet all deliveries for the day.

Unloading system

Because justin lacks a tailgate, loading and unloading goods is considerably more difficult. He cannot move heavy pallets with a pallet truck and as a result he is forced to break up the pallets into sections.

Cabin space

The spacious cabin allowed the driver to move through the cabin easily. This caused the feeling of spaciousness and pleasant working space.

Drive along I observations and insights

In and egress

The Volkswagen Crafter's low entry height made for an ergonomic ingress and egress.

Visibility

The low cab makes it easier to detect persons at a lower height. As a result, visibility from the cabin is high for Justin and he detects VRUs with ease.

Regulation

There is limited parking space. Justin has occasionally been fined for parking in non-designated ares at times when he could not find a space anywhere else.

Navigation

Justin knows most routes by heart. If he has to deliver to a neighbourhood he does not yet know, it is more difficult to navigate especially in the busy city centre.

Charging

The range of the Volkswagen Crafter is 140 km. When the battery needs charging, Justin has to find a quick charger along the road. He usually manages to find one, but charging is expensive.

Delivery windows

In certain zones, timeslots apply in the morning for delivery within these areas. After 11am, the bollards go up. This time of the morning the streets are congested with vans and trucks.

DESIGN IMPLICATIONS

It is more efficient to have to make as few trips as possible, so the design needs to consider what load capacity is most suitable for the specific distribution task.

The low chassis of this van was perfect. The chassis of the design should not exceed this.

The vehicle design should facilitate the unloading of goods to reduce the effort for the driver.

For the design, it is important to maximise visibility on ground level to be able to detect VRUs and improve their safety.

Use of one personal device to regulate all distribution tasks should be integrated in the design to facilitate the job.

2.8 Understanding distribution

Before going deeper into specific distribution issues, it was important to know what distribution generally meant. And for me especially, where to focus within the broad field of distribution. This chapter therefore provides a broader perspective of the topic to be able to narrow my focus afterwards.

THE LAST MILE

The entire logistic journey can roughly be divided into three parts: the first mile, the middle mile and the last mile. During the first mile, manufactured products are brought to warehouses or distribution centers, the middle mile covers the journey between the distribution center and the fulfilment facility and the last mile is where the goods get delivered from a hub or retail store to their final destination (Pezeshk, 2022). The last mile is the part covered in the busy city and is therefore the most complicated and choatic part of the logistical journey.

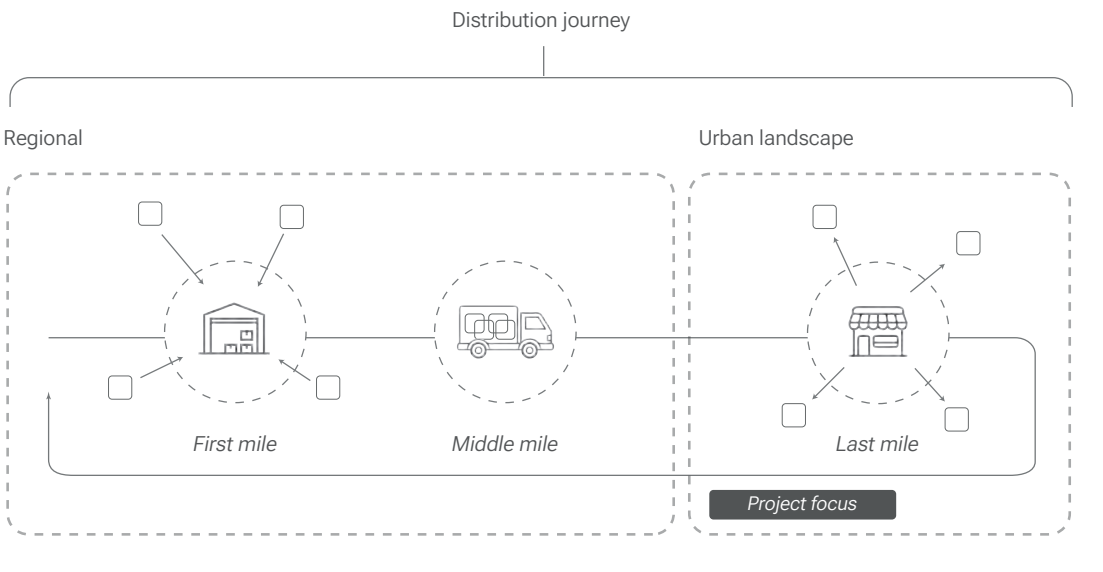


FIGURE 25: The distribution journey

THE DISTRIBUTION LANDSCAPE

When we talk about distribution in general, we are dealing with a broad topic. Distribution includes the exchange of all goods transported to and from a specific geographic area, from their origin to the point of sale (DHL Freight Connections, 2024). Therefore, all different distribution segments should be considered. Transportation of perishable goods (such as food and beverages for supermarkets) and non-perishable goods (including building materials, fashion goods, waste, parcels and mail) are all recognised types of distribution (CBRE Investment Management, 2023). Each distribution type has its own specific transport requirements and is therefore designed in a specific way. A garbage truck has a significantly different vehicle design than a standard retail distribution truck. In Figure 26 on the next page the different use cases of distribution vehicles can be seen.

CHOICE IN DISTRIBUTION SEGMENT

As this project can dive into any type of distribution segment, it is essential to make design choices to arrive at a tangible product proposal. Therefore, the choice was made to focus on the segments: retail and supermarket/hospitality/wholesale. This choice was made because the other segments have too specific needs in their vehicle's design. The decision not to design for package delivery was made because this is a relatively small segment and because other more appropriate solutions will be available (such as cargo bikes, package copters or an underground pipeline system). For the selected segments, the use of rolling containers and pallets should be considered. This means that this project is trying to find a solution for the distribution of larger goods in the city. I see this as an interesting design challenge because so far there seems to be a gap in research on solutions for the larger distribution vehicles for use in the inner city, although they will be much needed in the future.

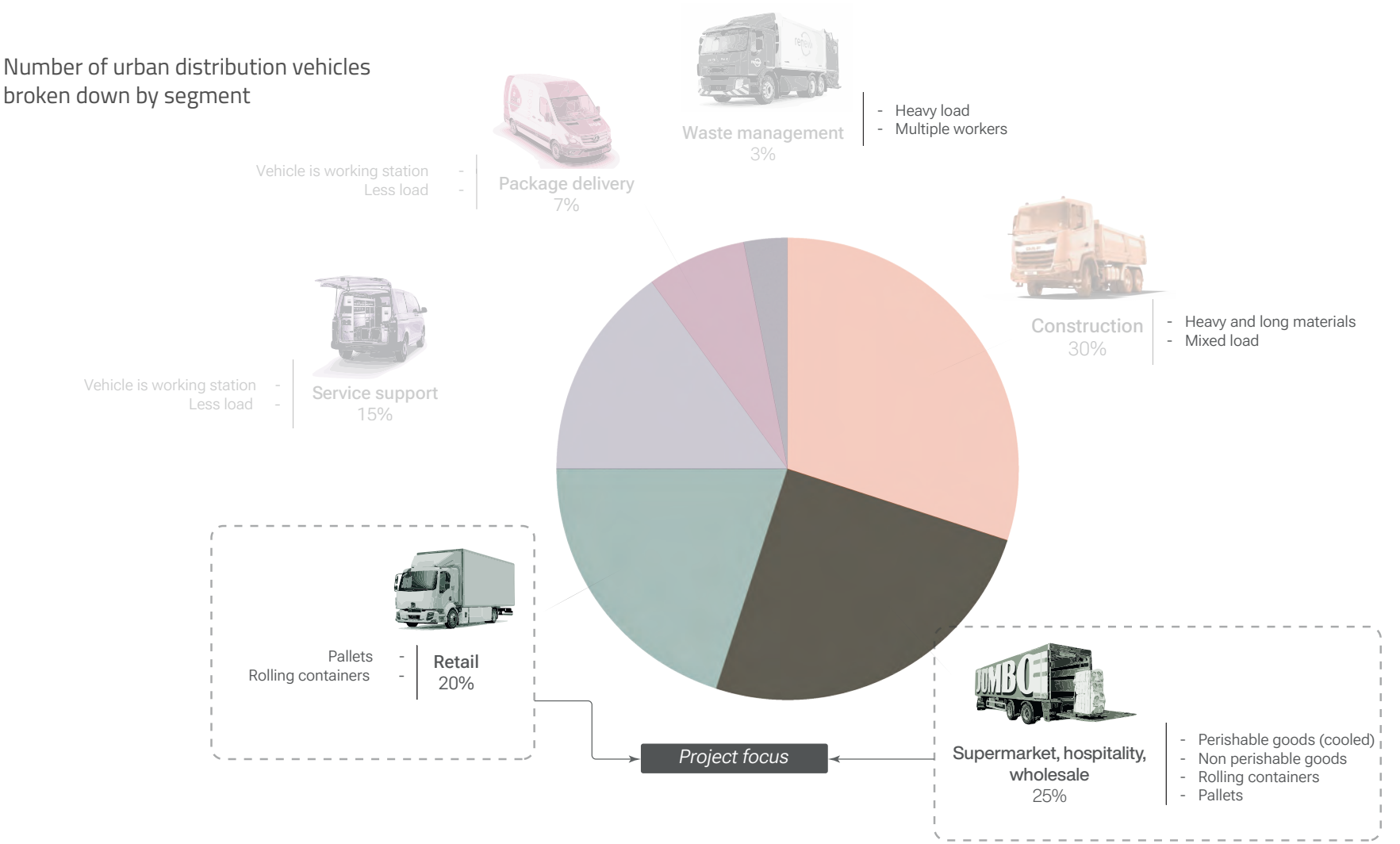


FIGURE 26: Share of longer heavy vehicles (LHV) and heavy-duty vehicles (HDV) in Amsterdam traffic by activity in 2022, illustration based on data from CBRE Investment Management (2023).

ABOUT THE LOAD

According to product planner Paul Schwarte at DAF a distinction can be made between two main categories when considering different types of load: volume transport and weight transport. This is due to the fact that some distribution is concerned with the transportation of light goods, such as flowers, small retail packages, or post, which are limited by volume. Whereas weight transport involves heavy goods like construction materials, heavy electrical appliances, or waste, are restricted by their weight and require consideration of the Gross Vehicle Weight (GVW) (P. Schwartze, Personal Communication, 11 March 2024). In practice, volume and weight transport often overlap. Several distribution companies deliver goods in different sizes and weights and work in a hybrid way, where the most efficient way of delivering goods is by putting different goods of different sizes and weights in one container.

DISTRIBUTION LIMITATIONS

Paul also clarified that the most limiting factor to consider in carrying capacity is the axle load and the type of tyres underneath the vehicle. Each tyre has a specific maximum weight it can carry at a certain speed. This information can be found in the International Load Index (Tyrecom Ltd, 2024). To carry more weight, additional tyres or axles are needed to distribute the weight. Moreover, the size of the tyres determines the height of the deck because the tyres are connected to the chassis via the axles. The bigger the tyres, the higher the deck and therefore the higher the container. This is crucial to consider as it affects the (un)loading height for the driver.

THE SIZING DILEMMA

When we look at city level, a dilemma arises. The city infrastructure is dense, has narrow corners, parked vehicles, and obstacles to navigate around. Therefore, the distribution vehicle must be small to maneuver easily through crowded or dense areas. However, with a smaller vehicle, the maximum weight capacity is reached faster, resulting in limited load capacity. A tradeoff seems to exist between either having a maneuverable small vehicle with less load capacity or a large vehicle with poor maneuverability but with more load capacity. Can’t a middle ground be sought after all? Where loading capacity has to be sacrificed as little as possible.

FIGURE 26.1: unloading on the middle of the driving lane, photo taken by Maarten van Haaff

2.9 The future of urban logistics

RETHINKING THE STREET

As urban planning will become more adjusted to the needs of the city's inhabitants, cyclists and pedestrians will take centre stage. New initiatives for the urban infrastructure are considering multi modal streets to serve more people. Here, the number of cars would be reduced to create more space for public use (Global Designing Cities Initiative, 2022). Modifying the street design in this way would increase the capacity of the street. Figure 27 shows the street capacity for a car-oriented street and for a multimodal street. With the space created, there would also be more room for loading bays and parking spaces for urban freight.

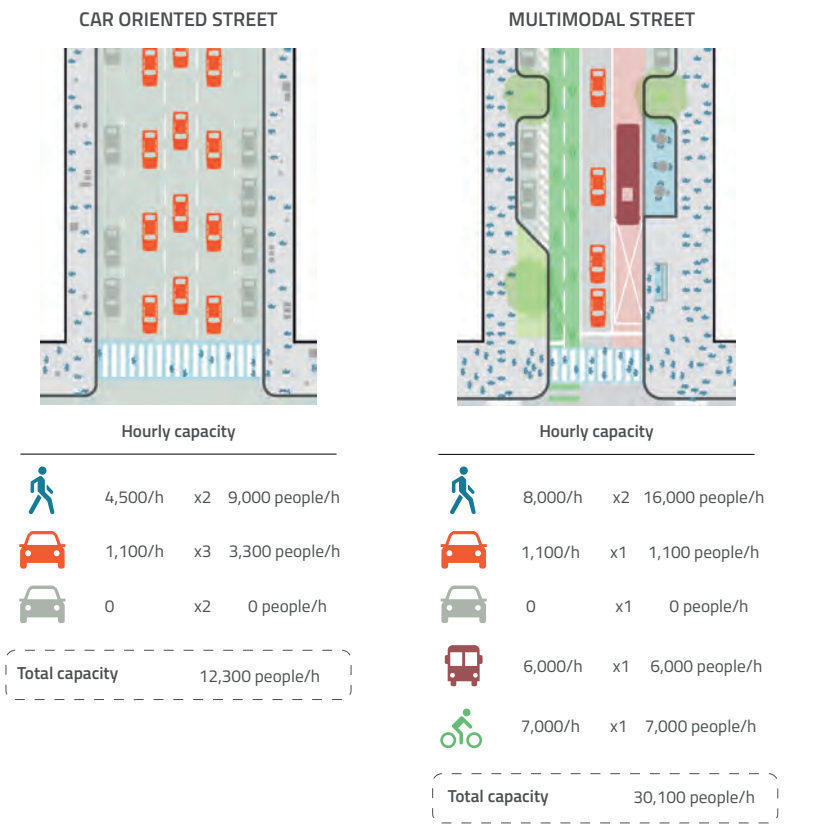
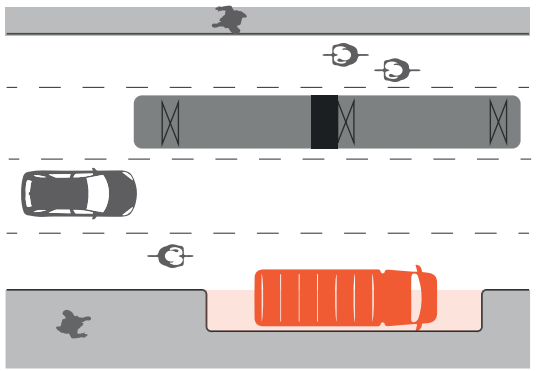


FIGURE 27: Hourly capacity of a car-oriented street and of a multimodal street, (Global Designing Cities Initiative, 2022)

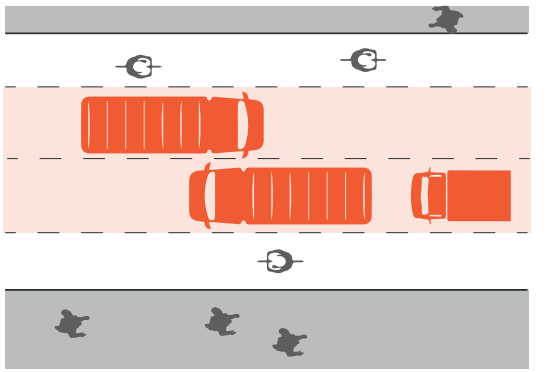
THE FUTURE URBAN LANDSCAPE

In their research report, urban design studio Posad Maxwan (2022) explored four different future scenarios of what urban logistics may look like in 40 years. The future scenarios described are based on the degree of focus on city-centric urban planning and degree of integration of logistics. The different urban scenarios can be seen in Figure 28. In each scenario, distribution takes place in the city but in different ways. What is clear is that in each scenario distribution vehicles are needed to supply the city centre either in a segregated way or in an integrated way. These scenarios are relevant to consider and will be related back to during the synthesis phase.

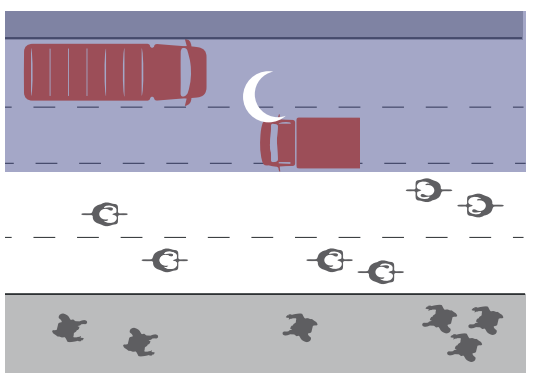
SCENARIO 1
Integrated logistic system,
city-centric urban planning



SCENARIO 2
Integrated logistic system,
logistic-centric urban planning



SCENARIO 3
Segregated logistic system,
city-centric urban planning



SCENARIO 4
Segregated logistic system,
logistic-centric urban planning

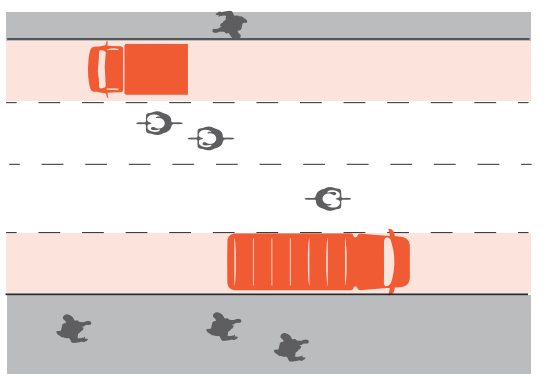


FIGURE 28: Illustration based on the four different scenarios for urban logistics in 2040 (Posad Maxwan, 2022)

ZERO-EMISSION

As mentioned in Chapter 2.4, municipalities are aiming for a zero-emission inner city by forcing all vehicles to become zero-emission by 2030 (and distribution vehicles from the year 2025). In addition, the 2015 Paris Agreement has been a major driving factor for truck manufacturers around the world to reduce their carbon footprint. This agreement set the global goal of limiting global warming to no more than 1.5 degrees Celsius, reducing emissions by 45% by 2030 and reaching net zero by 2050 (United Nations, 2023). By these targets, truck and car manufacturers will have to adapt in their strategies to reduce their CO2 footprint in order to remain competitive. The situation around the year 2040 will therefore most likely be characterised by the presence of emissions-free vehicles.

FIGURE 29: Paccar's electric chargers

ELECTRIFICATION

Currently, electric driving for trucks is not fully established. This is due to limited battery range and inadequate charging infrastructure. However, developments are underway to make electric driving viable. Rapid charging stations are increasingly being offered to minimize vehicle downtime, such as the Rotterdam Port charging plaza (2024). In China, developments in the realization of battery-swapping are well advanced (Cheng, 2024). In terms of battery range, the development of the solid-state battery would allow even large vehicles to travel more miles on a single charge. With their high energy density and increased safety, they promise to be a good alternative to current lithium batteries, although many challenges remain to be addressed in their realization (Njema et al., 2024). Trend reports expect solid-state batteries to go into mass production in 2030 - 2035 (TrendForce, 2023). As shown in Figure FIXME, the volumetric energy density of the battery is expected to increase, further facilitating the adoption of electric vehicles.

FROM LINEAR TO CIRCULAR

If the European Parliament's goal of living climate-neutral by 2050 is achieved (European Parliament, 2024), the way we live in cities will be different. There will be a greater focus on the repair and recycling of goods. For urban logistics, this will require more flexibility and facilities to collect used goods.

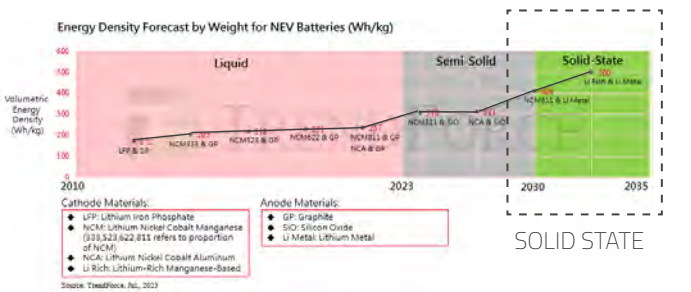


FIGURE 30: Increase of volumetric density of batteries (TrendForce, 2023)

2.10 Business models

B2B OR B2C

The two different main business models of urban distribution are B2B (business-to-business) and B2C (business-to-consumer). For example, B2C deals with package and grocery delivery at home and B2B applies to construction or shop supply. In general, the B2B models are the most common in the city and also have the largest shipment sizes. So for my concept, I am mainly looking at distribution with this business model.

COMPETITION

The urban distribution market consists of different market segments based mostly on a difference in payload and GVW. Figure 33 shows this dispersion of distribution vehicles distinguished by weight class. Within these weight manufacturers compete with each other to deliver added value to customers in order to guarantee their position in that market segment. Here, the main unique selling point is offering a vehicle with the highest payload as this reduces logistics costs for operators.

GVW = payload + unladen weight

The payload is the maximum weight the vehicle can carry and it depends mainly on the vehicle's unladen weight. This, because the payload plus the vehicle's own weight comes out to the GVW and the higher the vehicle's unladen weight, the less payload it can carry.

A clear example of this is the Iveco Daily which, due to its low unladen weight, has a high payload compared to other vehicles in the weight class 3.5 to 8 tonnes and is therefore successful in the market.

A new trend is becoming evident in the market where new companies are launching vehicles that can sustainably, efficiently and safely deliver goods in inner-city areas with higher payloads. Volta Trucks is an example of this (see Figure 32). Ultimately, the competition for this project will be with these types of companies. The companies that seek innovative solutions to offer the best truck for urban distribution.

FIGURE 32: (Volta Trucks, 2024)

DAF'S MARKET POSITION

DAF's position in the market is more in the heavier truck segment. They do produce lighter trucks like the DAF XB which has a GVW of 7.5 tonnes, but their main focus has been on producing heavier trucks suited for regional distribution. To gain more foothold in the market, DAF could focus more on the lighter segments. By launching a smaller, zero emission vehicle they would meet the increasing demand for efficient, safe and sustainable trucks and will be ahead in the market.

FIGURE 31: Main competitors in the European market

Figure 33: Dispersion of the weight segments in the distribution vehicle market

SWOT

Strengths

- DAF has the reputation of producing high-end trucks
- Has a strong connection with the users of their products (truck driver) end their customers (operators)
- Has a head start in the industry because of their extra spacious cabins
- DAF is marketleader in the Netherlands (one in three Dutch trucks sold of 15 tonnes and above is a DAF truck (NIDV, 2023)
- DAF is known for delivering cabins with a high level of comfort for the driver
- As DAF is a subsidiary of Paccar Inc. it has a reliable supply stream of parts and valuable connections in the US with Peterbilt and Kenwort to exchange knowledge

Weaknesses

- In the "race to zero" DAF is still behind in terms of sustainability and zero-emission readiness (Transport and Environment, 2023)
- DAF's product portfolio is sufficient in heavier trucks (>16 tonnes), but has viewer smaller, lighter vehicles that are more suited for inner-city use

Opportunities

- Invest in battery innovations to achieve 100% emission-free earlier than their competitors
- Work together with battery swapping companies
- Focus on adding more smaller, lighter and better manoeuvrable trucks in their product portfolio to adapt to the dense inner-city infrastructure

Threats

- Chinese truck manufacturers like Weichai or Quantron taking over the urban truck market
- Becoming redundant in the inner-city due to porter service companies taking over the last-mile deliveries (Taylor & Francis, 2023)

FIGURE 34: Parcel delivery van on the Prinsengracht Amsterdam, photo taken by Maarten van Haaff

2.11 Case study Amsterdam

To identify the conflicts of current inner-city distribution, I decided to conduct a case study in the centre of Amsterdam on a weekday morning. Why Amsterdam? Because this is an extreme example of a busy city in which distribution takes place. To anticipate the conflicts in an extreme scenario, the final design would be prepared for the most challenging situations. The following page shows the results of this case study.

The bollards in the ground go up by the end of the delivery time window (Until 11/12 am).

A loading and unloading parking area in the middle of the city centre. There are few such parking spaces to be found throughout the city.

A traffic sign marking loading and unloading hours in the morning on Leidsedwarsstraat. In the morning distribution traffic is less disruptive as there are fewer people on the street.

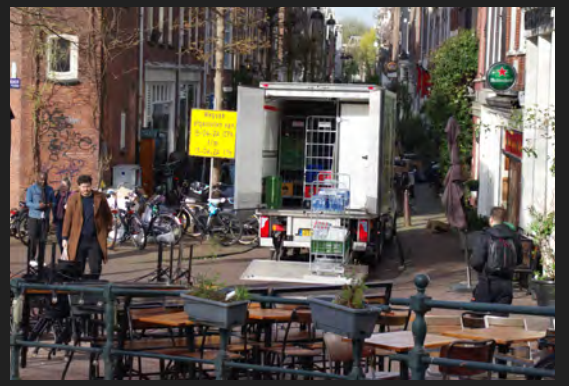
In the morning, the street is packed with distribution vehicles to minimise inconvenience for inhabitants.

The truck has to manoeuvre past a small corner creating a dangerous situation for cyclists.

This truck is illegitimately parked on the entire pavement to unload disrupting the environment.

Here, the vehicle is parked partly on the street and partly on the pavement. The driver has placed a warning pawn to increase safety for VRUs.

Due to its size, this distribution vehicle completely blocks this narrow street, leaving no space for passers-by and making it unpleasant to walk past it due to the noise and smell.



The unloading situation does not look pleasant for people walking by. The roll cages and the inside of the truck show the low-tec reality of distribution. This moment could be made more elegant.

Design implications

PARKING SPACE SHORTAGE

In the city centre, there is a shortage of parking spaces for distribution vehicles. As a result, vehicles park in spots that block the way for other road users. For design purposes, it is important to either look at dedicated parking spaces or ensure minimal blocking when the vehicle is parked on the pavement.

LACK OF REGULATION

What is currently happening is that many vans park on the pavement because it is the easiest option for unloading and there is no clear enforcement. To avoid streets becoming filled with distribution vehicles, vehicle parking should be regulated so that it's always clear to drivers where they can park and for how long.

DISTURBANCE TO SURROUNDINGS

Despite the fact that in some zones, only during the mornings deliveries take place to cause as little disruption as possible, in many cases vehicles are still parked in such a way that they block the road to the annoyance of cyclists and pedestrians. Vehicles stand for longer than necessary, are not a pleasant sight for passers-by. The design of the vehicle could be modified in a way that if it is standing in the way it would be nicer to look at and less of a blockage.

SAFETY

Currently, very little is being done on the safety of VRUs while a truck poses safety risks in the busy city. Putting a pawn next to the truck resembles a hopeless attempt to make the situation safer.

The vehicle will have to be designed more with this safety aspect in mind so that people can pass safely.

2.12 Perspective of passers-by

During the case study, I asked a few people on the street what they thought of trucks standing in the road. This gave an impression of how people view the vehicle on which could be anticipated with the design.

DISRUPTING TRAFFIC FLOW

The moment of loading or unloading is the most common and critical interaction moment between the truck and other road users. When the vehicle stops on the road or pavement, it disrupts the traffic flow, forcing cyclists and pedestrians to navigate around the vehicle not seeing what traffic is behind it. This can result in collision with oncoming traffic or losing balance during the maneuver for cyclists. The open tailgate protrudes dangerously and may cause cyclists to crash into it, resulting in accidents. On the next page in Figure 35 an example is shown in which this problem is clearly visible.

"I once crashed into a tailgate while cycling because I had not seen it, I was hospitalised for months afterwards. Trucks are murder weapons"

- Person 1

"I find trucks irritating because when I am on the road with my dog or grandchild because of the truck, cyclists come over the pavement in a hurry. As a cyclist you are above the pedestrian, so to speak. Furthermore, I would rather see cargo bikes than a truck."

- Person 2

Figure 35: Unloading on the Rosengracht Amsterdam causes a dangerous situation for other road users, photo taken by Maarten van Haaff

2.13 Urbanistic perspective

In an interview with Jort van den Broek (urban planner at the municipality of The Hague) vehicle size was discussed. From this interview it became apparent that the idea of a shorter, more manoeuvrable truck is attractive from a municipal perspective.

Municipalities have to take into consideration the turning circles of trucks when planning the urban space. The large turning circles of long vehicles require more space on the street, leaving less space for greenery, parks or other public amenities that promote a liveable environment. Figure 36 shows a technical drawing of a municipal project taking into account turning circles. Here, a truck with a length of 10,4 metres needs a road width of at least 8 metres. Whereas a shorter truck would be able to drive through a narrower road, leaving more space for greenery in urban planning.

The municipality's current directive is that they want to solve as much distribution indoors as possible. This way, a truck could drive through a building to deliver its goods and does not have to reverse in front of the building. This is feasible for big retailers like Albert Heijn, but not for smaller retail companies. Plus, with this strategy, the municipality puts the responsibility on retailers who do not take inhabitants' safety risks into account. In the end, most distribution will still occur on the street, making parallel unloading a relevant issue to solve.

'If you live in the city, you can expect noise. The city is allowed to make noise, which of course should not get out of hand, but the main issue here is the safety of city inhabitants. If you have one big truck compared to three smaller ones that are safer, then designing such a smaller truck definitely adds value."

- Jort

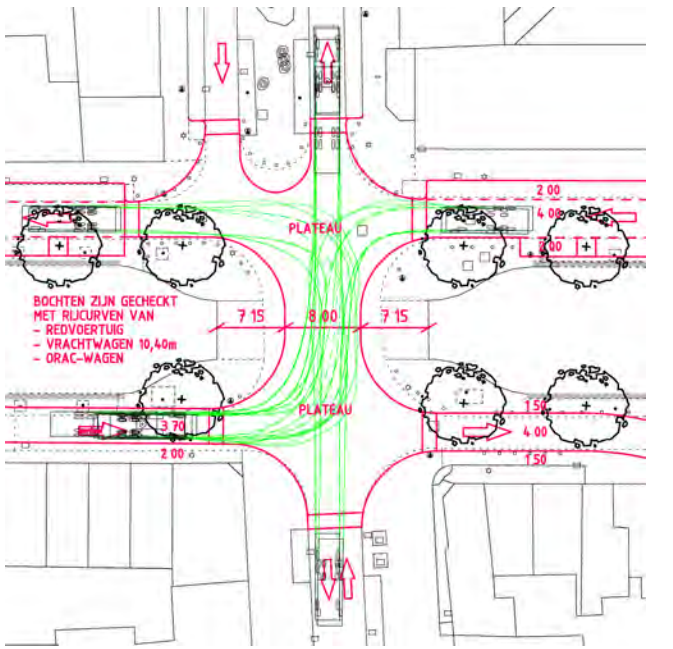


FIGURE 36: Technical sketch from municipal project regarding turning circles of trucks

2.14 Concluding the analysis

FOCUS ON INHABITANTS

A tension becomes apparent in this project. Where there is a logistic side, and a side of city inhabitants and municipalities who are concerned about safety, liveability and sustainability. The truck driver stands exactly on the dividing line between these two sides. DAF is a company that listens to the wishes of operators and drivers. For this project, it seems valuable to extend the targetgroup further to the side of the city inhabitants to meet their needs as well.

CHOICE IN DISTRIBUTION SEGMENT

Because there are many different forms of distribution, it is necessary to make a decision to focus on one distribution segment to achieve a more detailed final design. The specific segment I will therefore focus on will be retail and supermarket / wholesale / horeca distribution (think larger orders: roling containers and pallets). This is because smaller goods can be allocated to e-cargo bikes or smaller electric vans in their delivery and the added value for DAF will therefore lie in the delivery of larger goods. This choice is made to be able to dive more into detail during the design phase. Other distribution segments would be equally relevant to this project such as waste, facility and services or construction logistics distribution. However, it is essential to have a clear direction during this project to arrive at a complete design. Ideally, the main principle of the concept could also be applicable to other distribution segments.

FOCUS ON MINIMISING AREA-TIME

For higher efficiency, the focus should be on reducing the vehicle's area-time. This can be achieved by designing a smaller vehicle that requires shorter stops. This has and advantage for the driver and benefit for the city inhabitants.

2.15 Design requirements

Now that the completion of the analysis phase has given me a clear idea of the problems considering city logistics, a number of design requireme nts could be listed formed from the conclusions and implications from the research. This programme of requirements, can be found in the Appendix. The main design requirements that form the building blocks for the design are summarised in Figure 37.

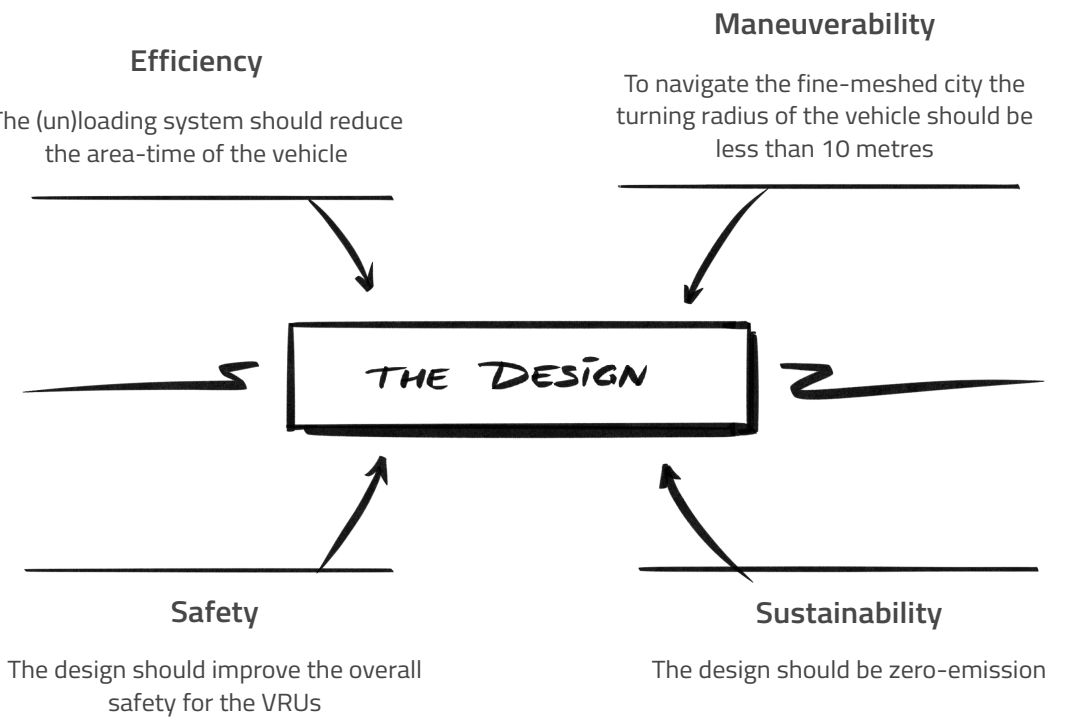


FIGURE 37: Technical sketch from municipal project regarding turning circles of trucks

FIGURE 38: Two distribution workers unloading rolling containers from a truck on the Leliegracht Amsterdam, cyclists have to move past this situation, photo taken by Maarten van Haaf

3. Synthesis

This part of the thesis elaborates on the processing of the context factors and the creation of a design vision.

3.1 Clusters and factor gathering

Throughout the analysis phase context factors were gathered that were relevant for the project domain: urban-proof distribution trucking in 2040. These context factors formed the buidling blocks to construct a relevant future context for the year 2040. By mapping out these factors and finding relations between them, a plausible context could be formulated within which the design shall operate.

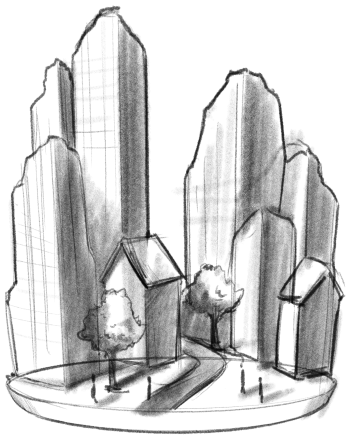
FACTOR GATHERING

The literature research that preceded the clustering process was filtered on which factors provided valuable information about the future. These were divided into several categories (biological, cultural, demographic, economic, environmental, political, psychological, sociological and technological). To ensure diversity in factors for a realistic and valuable future context, a subsequent distinction was made between trends, principles, states and developments. A full list of the context factors and references can be found in the appendix.

CLUSTERING

Clustering the factors was an iterative and lengthy process. After five clustering sessions, the final clusters emerged that formed a valuable interpretation for the 2040 context. The final clusters are introduced on the next page.

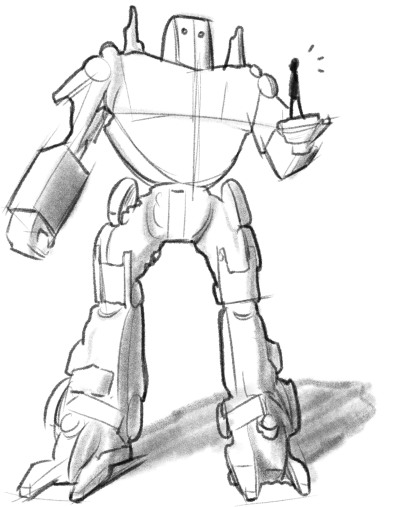
FIGURE 39: Context factors



Cluster 1

THE TRUCK-FREE CITY

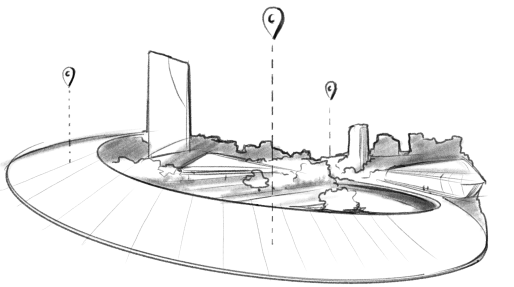
In this future, there are no heavy vehicles in the city centre or they do not interact with people on the street. The hierarchy on the street is different: bikes and pedestrians are now prioritised in a car-free city centre. Healthy and sustainable distribution modes are preferred such as e-cargo bikes, LEVVs or underground pipeline systems.



Cluster 2

THE ADAPTED TRUCK

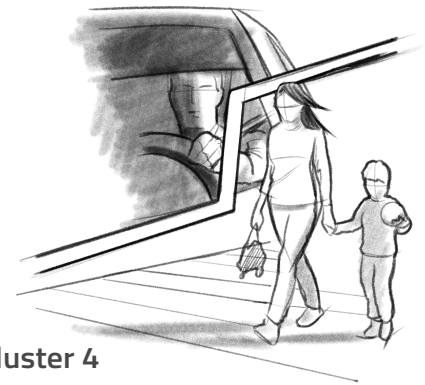
The distribution vehicle will be present and integrated in the city, but in a completely modified form. The vehicle will be completely subject to the rhythm of city inhabitants and take on a submissive role. it should improve the interaction between the distribution vehicle and other road users in a sustainable and safe manner.



Cluster 3

HYPER-LOCAL CITY LOGISTICS

Urban logistics has become hyper-local. Instead of one large distribution centre outside the city, there is now also a network of microhubs in the city. Through cooperation between the DC's and microhubs, redistribution of goods takes place through resulting in efficient and fast deliveries.

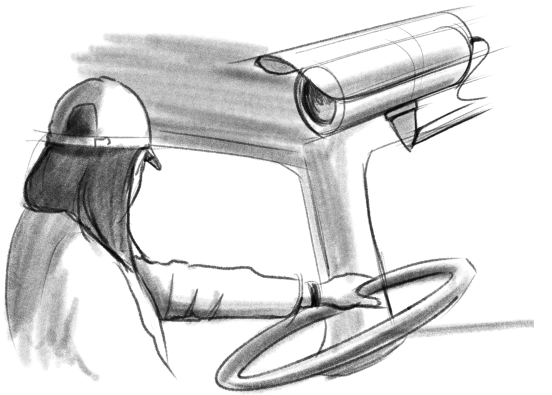


Cluster 4

DISTRUST IN

HUMAN-OPERATED VEHICLES

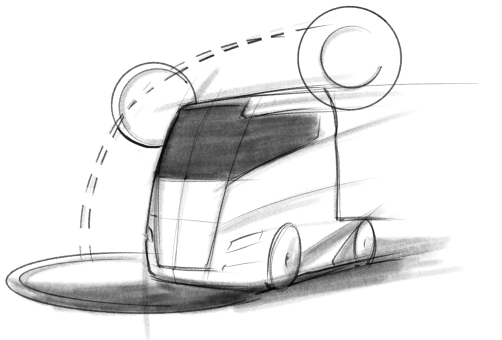
People are increasingly concerned about the risks of urban traffic. With more automated vehicles driving in cities, people are starting to perceive human-driven vehicles as more dangerous because of the greater likelihood of accidents due to human error. Therefore, the perceived safety of the distribution vehicle should be improved.



Cluster 5

THE MONITORED DRIVER JOB

Due to the advanced on-board monitoring systems controlling the driver's behaviour the freedom in work disappears for the driver. Distribution drivers long for the past, when the job was more romantic and adventurous in its nature. This could ultimately cause drivers to get burnouts and eventually resign from the job.



Cluster 6

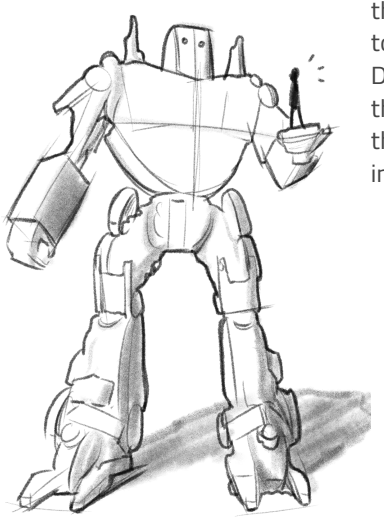
Data driven systems

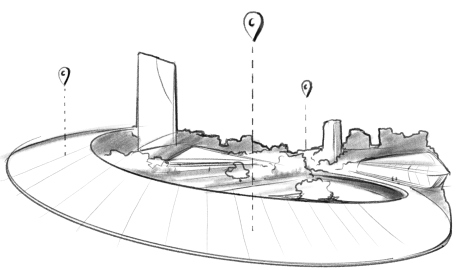
Data systems have become more sophisticated and play a major role in the driver's daily tasks. The on-board computer system has taken most tasks off the driver's hands, giving him more time and freedom. He now has the opportunity to rest or perform other tasks, such as reading or communicating with his/her colleagues or loved ones. In this context, the vehicle should be more suitable for alternative activities.

3.2 Framework and positioning

From these clusters and after discussion with DAF the decision was made to focus on cluster 2 in combination with cluster 3: “the adapted truck in the hyper-local city”. Being convinced that DAF can add value in the urban context for city inhabitants as well.

DAF could provide a new distribution vehicle that is fully adapted to the city by meeting the personal wants and needs of inhabitants. This future context would overlap most with scenario 1 of Posad Maxwan’s report: an integrated logistic system with city centric urban planning. Designing for this future context fits with DAF’s mission to support a more liveable environment. DAF would have the opportunity to fulfil their societal role and engage more with the less powerful stakeholders (city inhabitants).





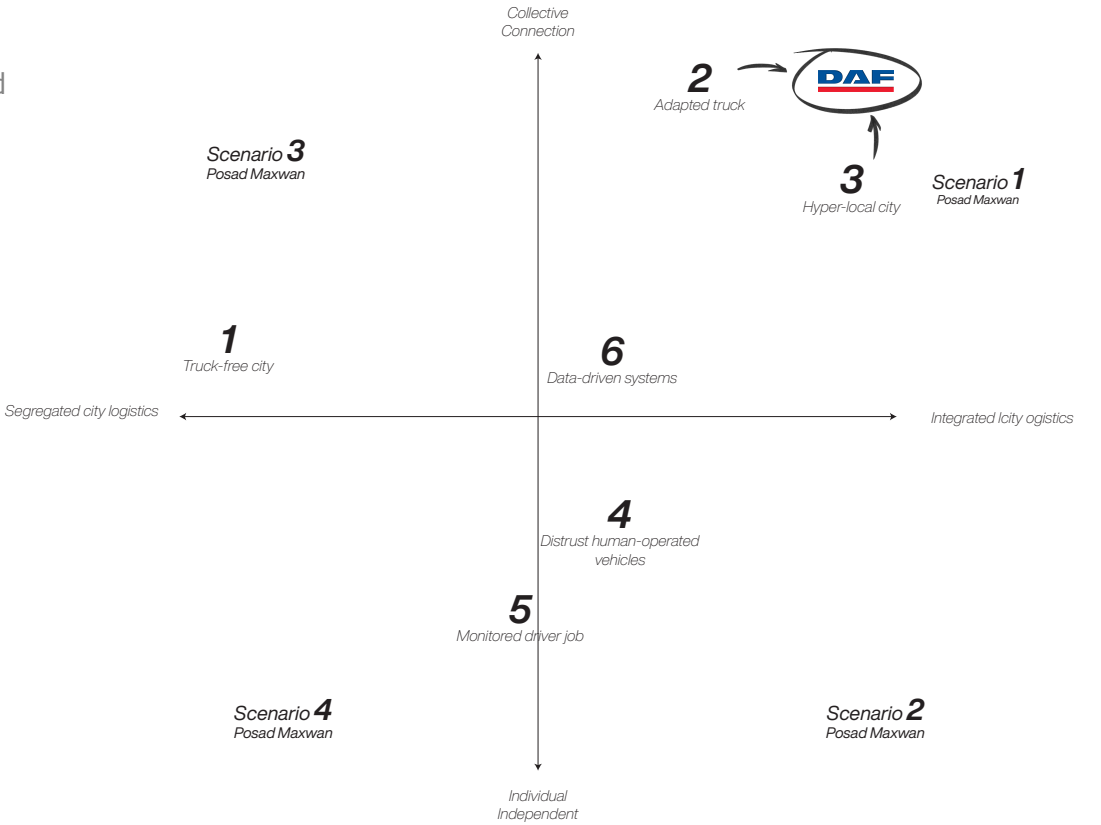


FIGURE 40: Framework of for what future DAF could provide meaning

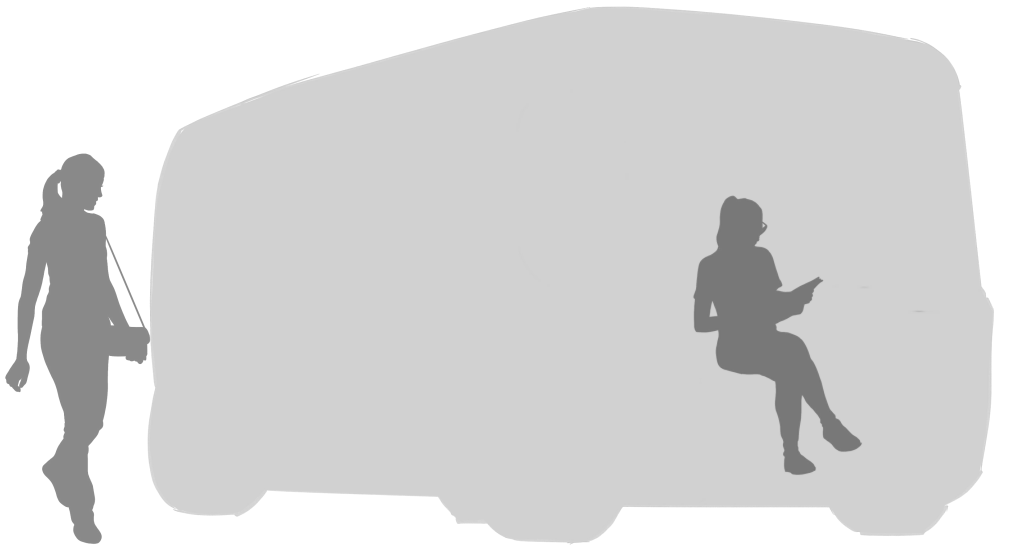
FIGURE 41: Unloading on the Leliegracht the driver has to roll the containers over the kerb, photo taken by Maarten van Haaff

3.3 Future vision

Before starting the design phase, the context analysis and discussions on DAF's positioning in the future context enabled the establishment of a mission statement to guide the overall design process.

MISSION STATEMENT

"I want people to experience harmonious urban logistics by providing an urban delivery vehicle that seamlessly integrates into the city fabric, enhancing the level of efficiency and acceptance perceived by the city inhabitants."



From the aforementioned mission statement, the following analogy was found that fits the preferred interaction between the distribution vehicle and the stakeholder within the city best:

ANALOGY

"The urban delivery vehicle of 2040 should be like a waiter in a busy restaurant who swiftly manoeuvres past the guests' tables while being approachable and respectful to the guests for whom he provides his service"

The same is true for the urban delivery vehicle in the city centre. Which has to manoeuvre between narrow streets to efficiently deliver to as many customers as possible and deliver high-quality service. Especially within the future context of the truck having to adapt to inner city and its inhabitants, the truck should be more at the service of street users and will have to subordinate itself to the new hierarchy where more vulnerable road users like pedestrians and cyclists will have priority.

The truck will thus have to take on a new role in this context: to be more humble and respectful towards the environment like the waiter in the analogy. This vision contrasts with the current situation where the truck interrupts the street setting and forms no connection with the people passing by.

It is important to mention that in this vision, the driver should not be given a serving role. The truck should be servicing to the driver, supporting him in his distribution tasks and easing the physical work.

3.4 Product qualities

From the aforementioned analogy, product qualities could be deduced that the design must have in order to be in line with the vision. A list of these qualities was drawn up to use as starting points for the design phase. The interpretation of the qualities can therefore take different directions. In any case, the design must be characterised by the following qualities:

CALM

The appearance of the vehicle should make people on the street feel reassured, at ease and uninterrupted. For this, the vehicle should exude a certain calmth and tranquillity. This calmth can be achieved by minimising noises, by avoiding unexpected movements or thourgh the vehicle's appearance having a calming effect on its surroundings.

APPROACHABLE

Just like how the waiter is approachable to his guest in the analogy, the vehicle should be approachable to people in the city. This, because the vehicle should not claim extra space from the public space and should not have an intimidating attitude. To be accepted in the city, the vehicle should be open, transparent and helpful.

PROFESSIONAL

As much as the vehicle must remain approachable, it is important that it also continues to exude professionalism having the responsibility of delivering goods to the customer in the correct manner. The vehicle should not become frivolous in its degree of friendliness and should therefore appear professional and discrete.

In the end, these product qualities especially influence the styling of the concept. These will therefore return in the design phase after the main functioning principle of the design has been established.

4. Design

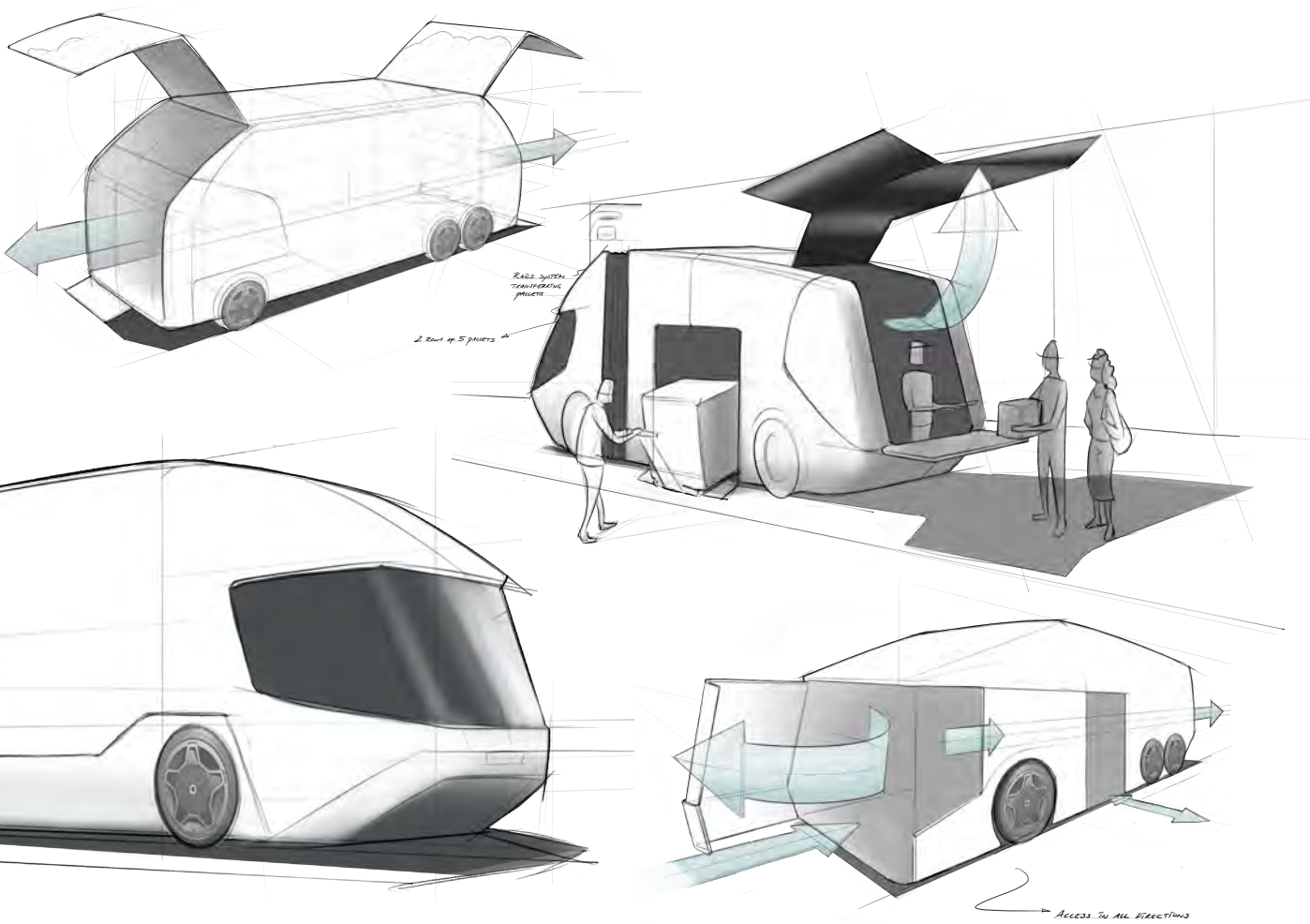
Now that there was a clear mission statement and vision established the design phase could be commenced. This section of the report is therefore characterised by sketches of ideas that show the process of how the final design came into being.

4.1 Ideation

FIRST IDEAS

As the design scope was quite broad, the different components of the design had to be broken down to find separate solutions. This method, called a morphological map (Van Boeijen et al., 2014), is often used in complex design projects to arrive at an all-encompassing concept. By filling in the map, combinations can be made of different solutions that ultimately form a concrete concept.

The morphological map and explanation of the first concepts can be found in the Appendix.



4.2 Chosen concept

SIDE LOADING AND UNLOADING

The concept ultimately chosen is a vehicle that can be loaded and unloaded from the sides for more flexible use. In doing so, the vehicle lowers to the ground, making it easier to reach the cargo inside. This unloading system supports the driver during loading and unloading activities.

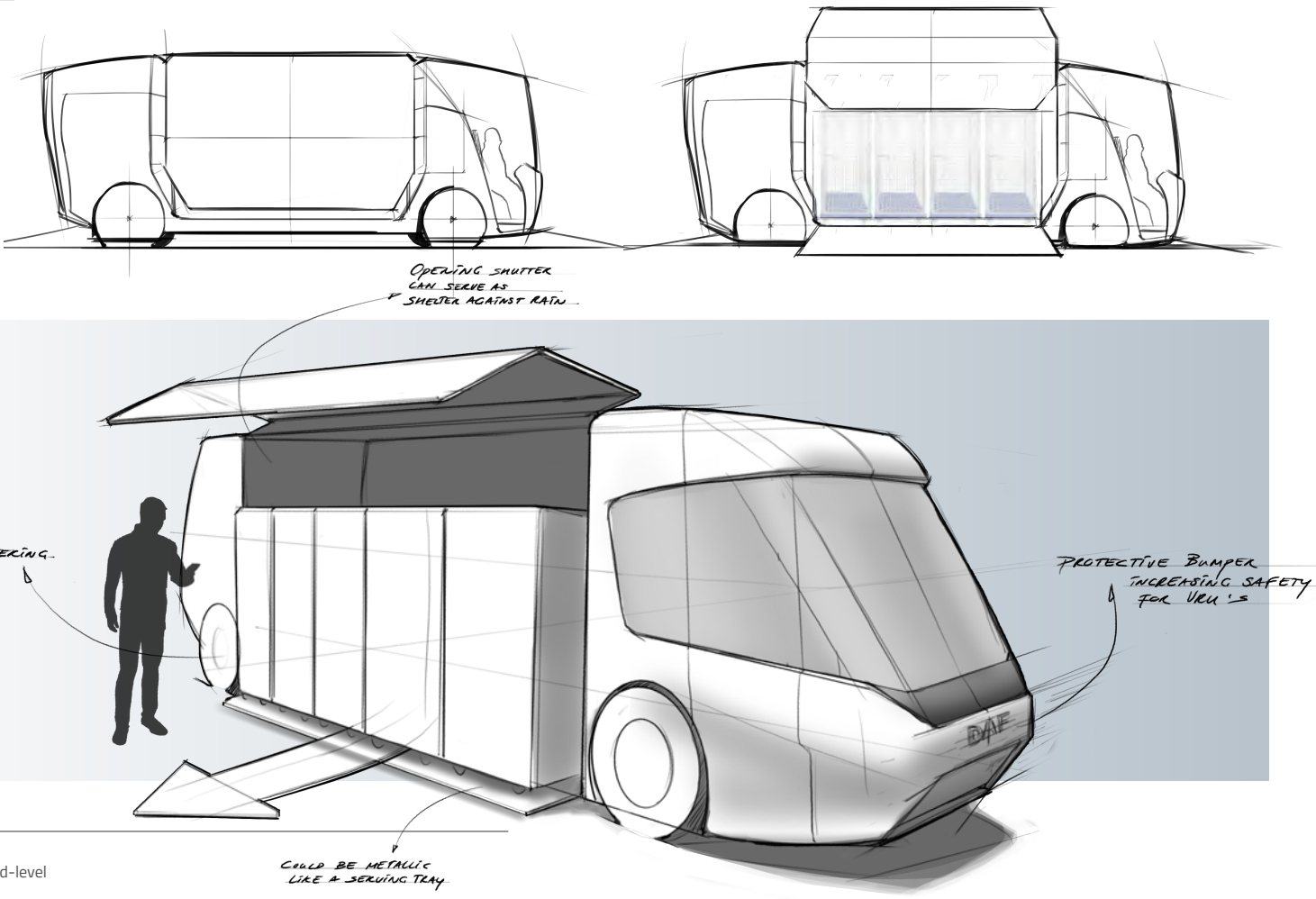
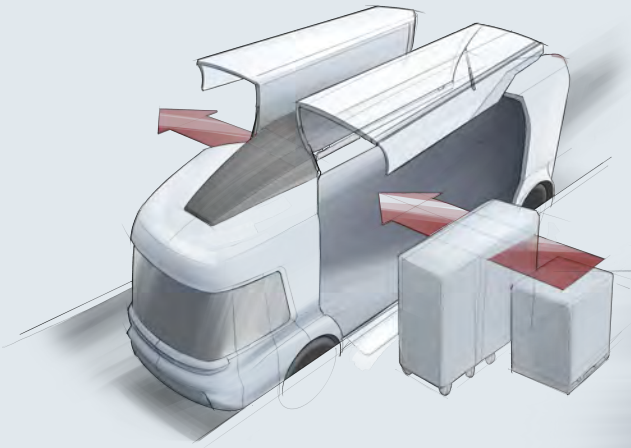


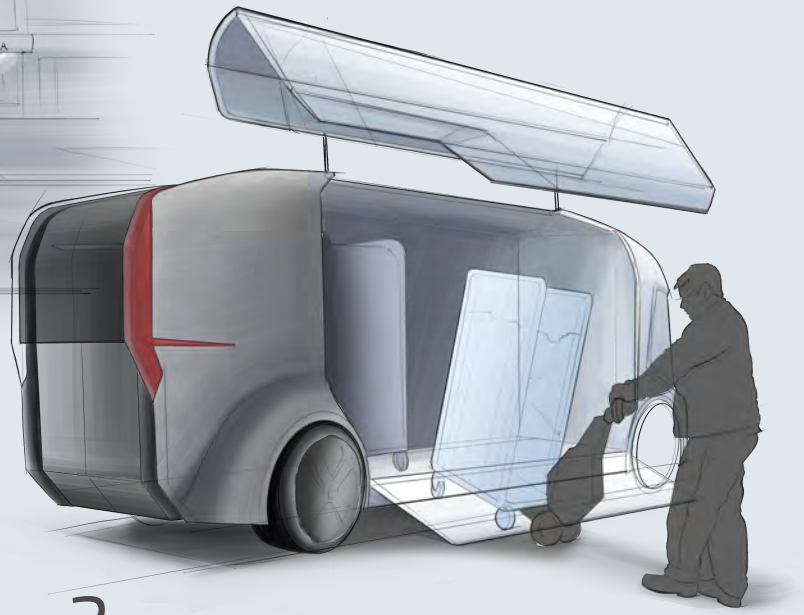
FIGURE 41: Unloading from the side on ground-level

Use scenario



1. Cross-docking at distribution center

2. Driving through the inner-city



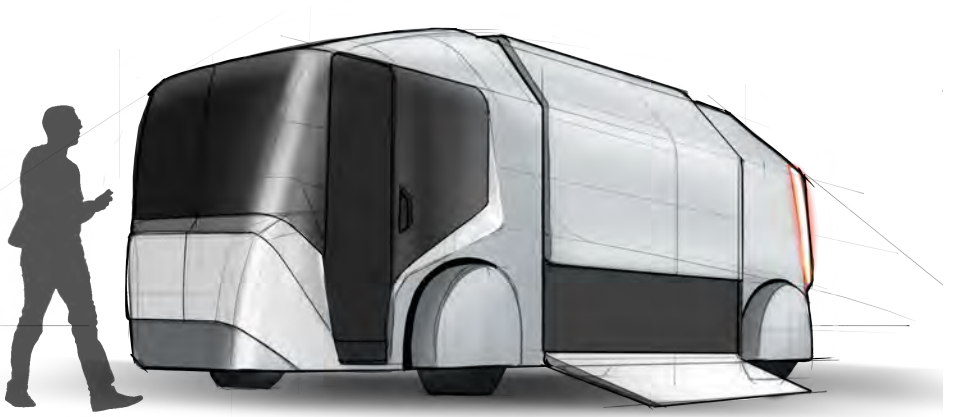
3. Side unloading on the pavement

FIGURE 42: Use scenario

4.3 Validation of concept

Walther Ploos van Amstel

Professor in City Logistics Amsterdam University of Applied Sciences & Chairman steering group "Steden en Ruimte Topsector Logistiek"



DISTRIBUTION SEGMENT

"The distribution segment you design for – retail – is a very good option as it is one of the biggest distribution segments there is. 60% of retail is fashion. For this segment you need a relatively heavy vehicle. The segment is always mixed in types of load: you see rolling containers and pallets being used.

In the future there will be "local heros" making use of the Physical Internet, where hubs work together on the outside of the city center, delivering between 7 and 12 in the morning and afterwards delivering other goods like to catering and horeca companies. Because of robotisation in sorting systems, the vehicle would have to travel no more than 60 kilometers. This definitely goes for the concept you propose, a smaller vehicle with bundled cargo for multiple addresses.

MANEUVERABILITY

The maneuverability is also an important aspect. Distribution vehicles get lots of damage: the average DHL van has 4 damages a year. If you design for higher maneuverability you could avoid this from happening.

(UN)LOADING SYSTEM

The cargo has to be able to go in and out seamlessly. Your concept has a very large and low loading floor, which is quite efficient. Furthermore, the more you can open up of the vehicle the more efficient you can use it. And also the easier it is for the driver, because if you look at driver absenteeism, it is considerably high due to all the lugging of pallets and roll containers.

Posad Maxwan assumes that you get a mixed streetscape and solve distribution at street level. Look the idea is, if you have to unload on the street anyway what cleverness can I bring to that? You want the interaction to be better with people and get out of the area as quickly as possible."

"We are not going to see a truck-free city in the future. You will always need some type of vehicle that can carry 10-15 rolling containers."

4.4 Lay-out study

To make sure the vehicle truly serves its purpose, it was important to consider the layout of the loading floor so that the vehicle can transport a maximum amount of cargo. To test this, I experimented on a 1:10 scale with the dimensions of roll containers and pallets to arrive at an optimal cargo grid.

After the interview with Walther Ploos van Amstel, I knew that to make the design valuable, 10-15 rolling containers had to fit inside. The biggest challenge was to find a configuration for rolling containers and pallets that would not make the vehicle too long or wide. In the end I found a lay-out that was flexible for (un)loading, a combination of pallets and rolling containers and of reasonable dimensions.

FIGURE 43: Experimenting with the cargo grid on a 1:10 scale

4.5 Augmented reality process

After choosing the concept, I was able to assess the design in augmented reality with the help of DAF's virtual reality expert. This was an iterative process which took place throughout the design phase to provide direct and realistic feedback on aspects of the design.

CHECKING THE MAIN DIMENSIONS

Using augmented reality (AR) was very effective in validating the dimensions of the vehicle. Because I could walk around the model, I was able to experience how it would feel for passers-by to walk past the vehicle. The vehicle could not feel intimidating and because of the augmented reality I could instinctively judge the size of the vehicle.

CHECKING IN AND EGRESS

For the driver's perspective, the height of the chassis could be evaluated in AR to decide whether the rolling containers could be easily be unloaded by the driver. The in- and egress could be tested by aligning foam blocks to the virtual model. I could actually step into the vehicle and experience whether the ingress was ergonomical considering the height of the steps.

CHECKING VISIBILITY

Sitting in the cabin could also be simulated in the same way, which gave great insight about window height, visibility and spaciousness.

The AR process really provided realistic spatial feedback that allowed for quick design decisions.

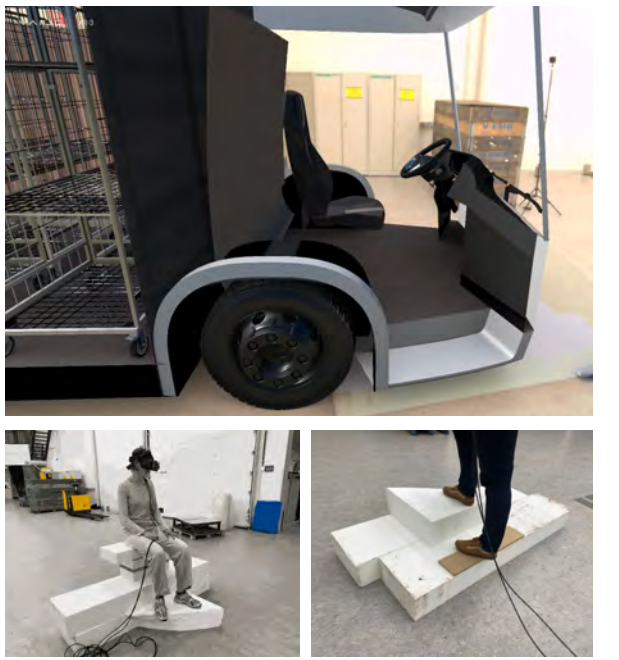


FIGURE 44: Testing the concept in augmented reality

4.6 Package

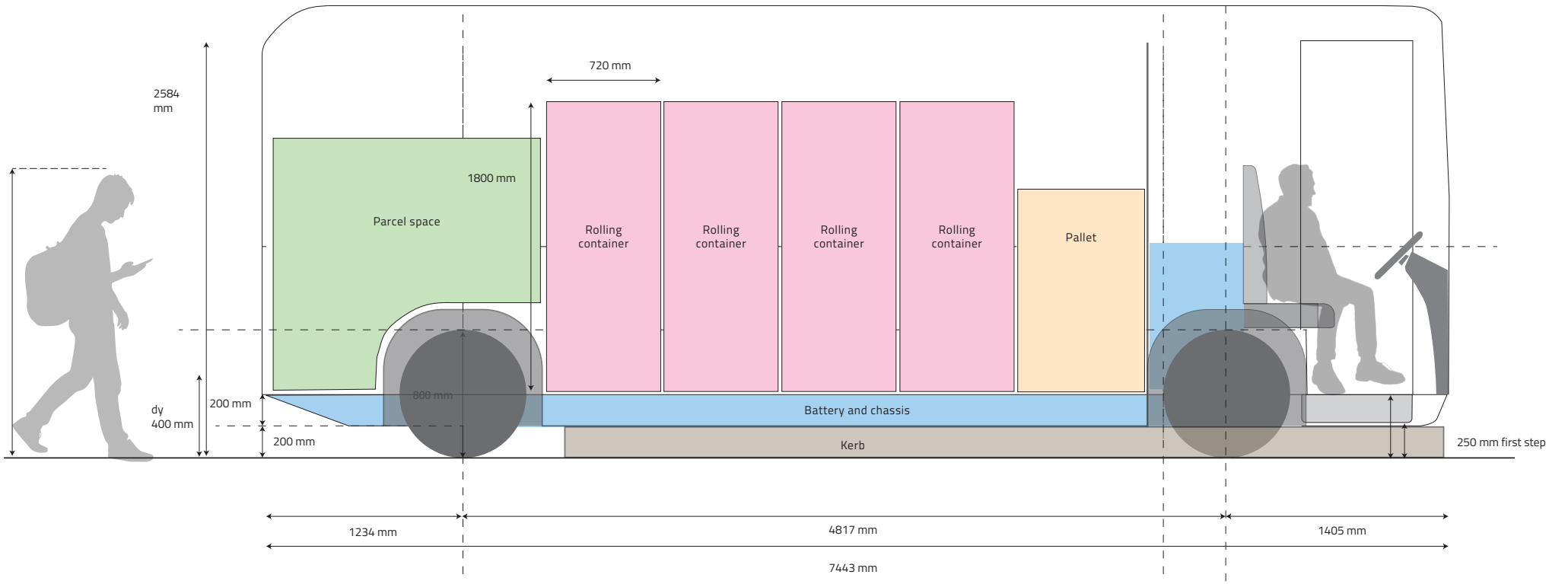


FIGURE 45: Cross-section of the vehicle and it's main dimensions

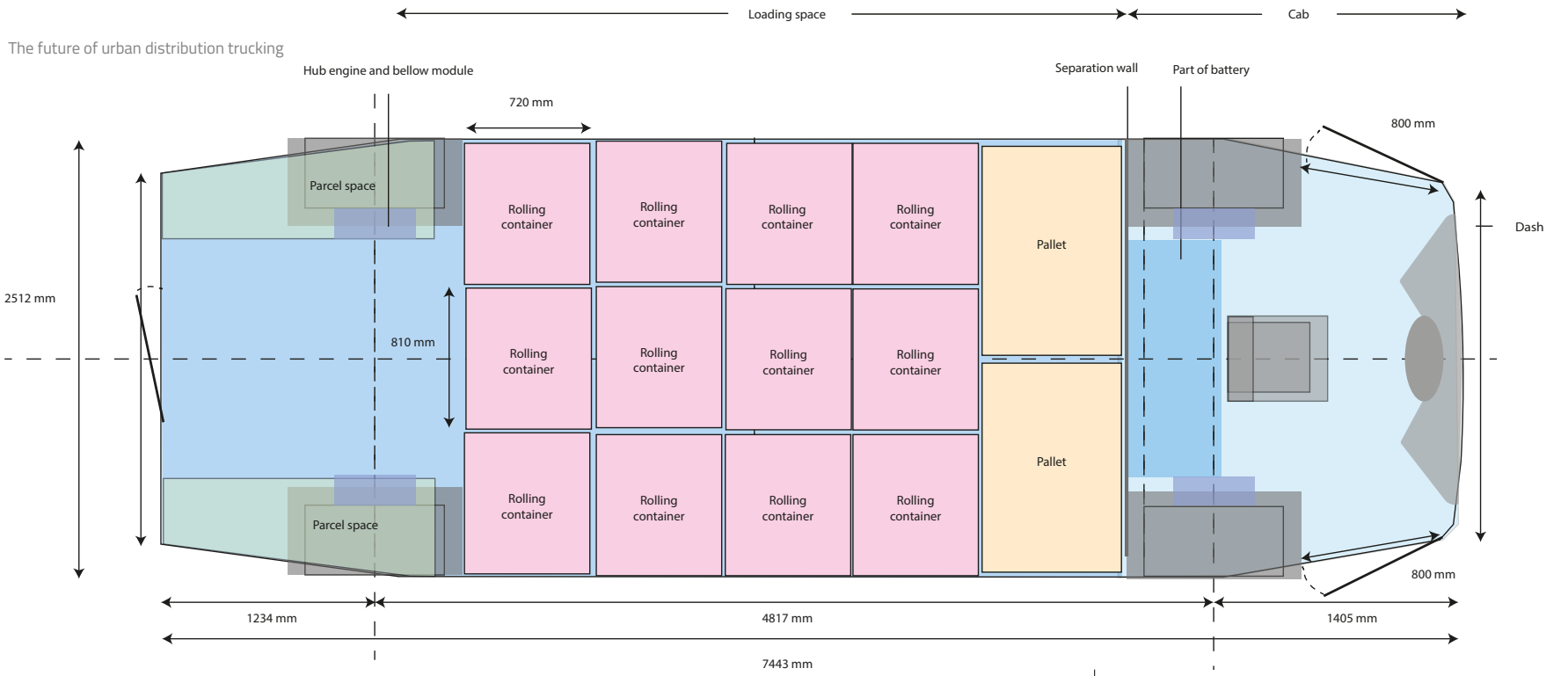
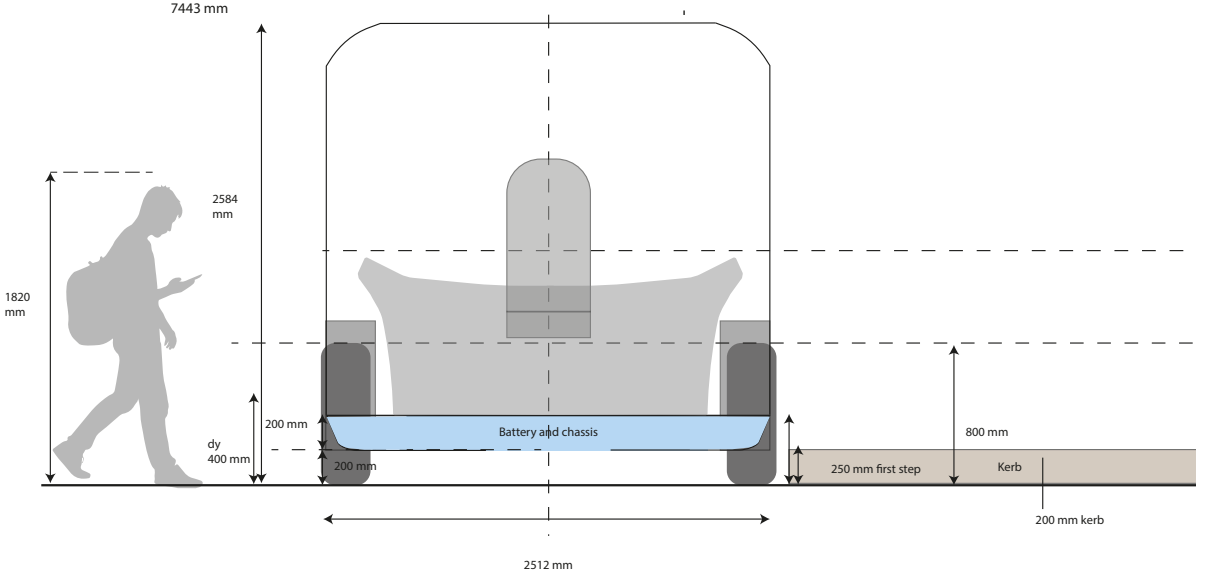


FIGURE 46: Top view

The package is based on a grid of 12 roll containers plus space for two pallets. The option of taking 15 roll containers more would therefore also be possible. The cargo must sit between the wheels in the width to be unloaded. This first left an unused space at the rear, however I then realised that this would be perfect for smaller parcels and storing of a pallet truck.

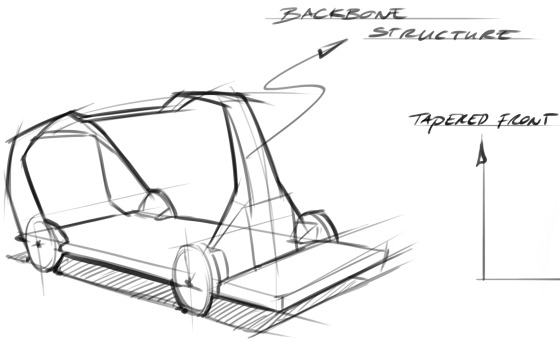


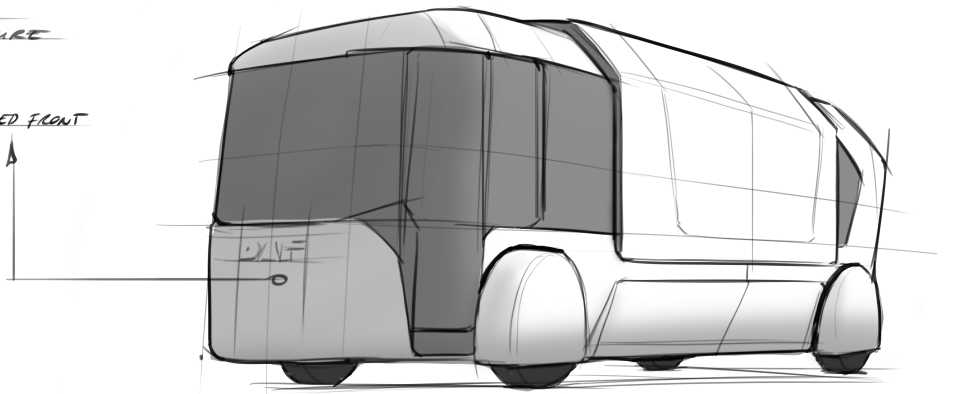
4.7 Form exploration

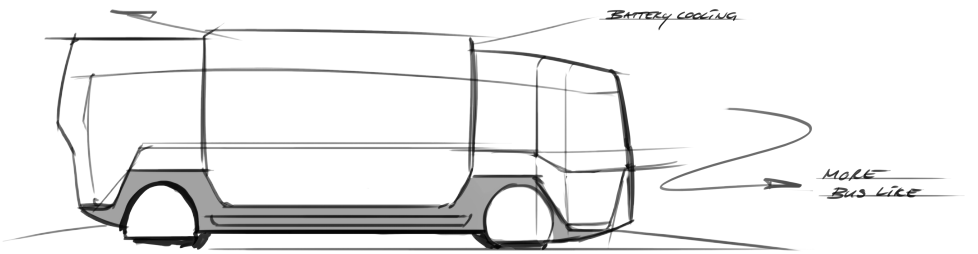
Now that the package had been established, the styling phase could be commenced. To guarantee the right experience for passers-by around the vehicle, it was crucial to find the right aesthetic in terms of exterior. The styling phase started with finding the right silhouette and shape theme. During this phase, a creative and experimental approach was required. In collaborative sessions, sketches were discussed with the designers at DAF and supervisors at TU Delft.

FIGURE 48: Collaborative sessions at DAF and at the TU Delft with my supervisors

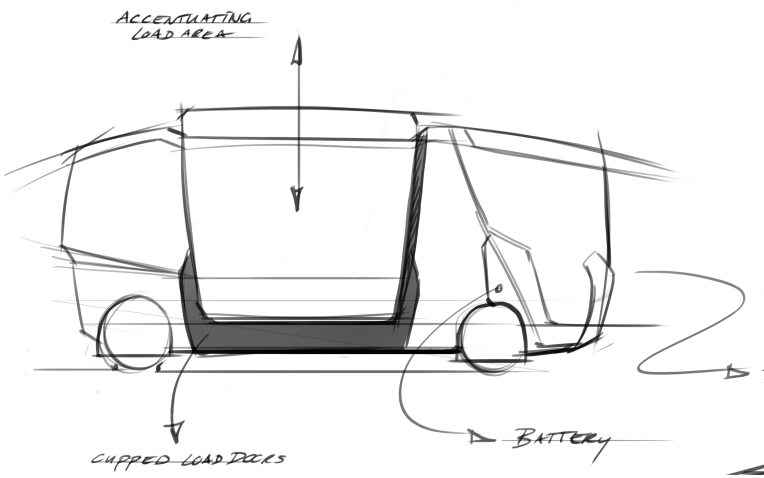
While looking for a form that would balance out the proportions, the idea of a backbone structure connecting the different parts of the vehicle emerged, inspiring to new shape themes.







After various sketching sessions, a design theme finally emerged that strongly matched the vision. This can be seen in Figure FIXME. The shape theme emphasises the main function by highlighting the loading area with a protruding loading hatch and the silhouette gives the vehicle a certain tension.



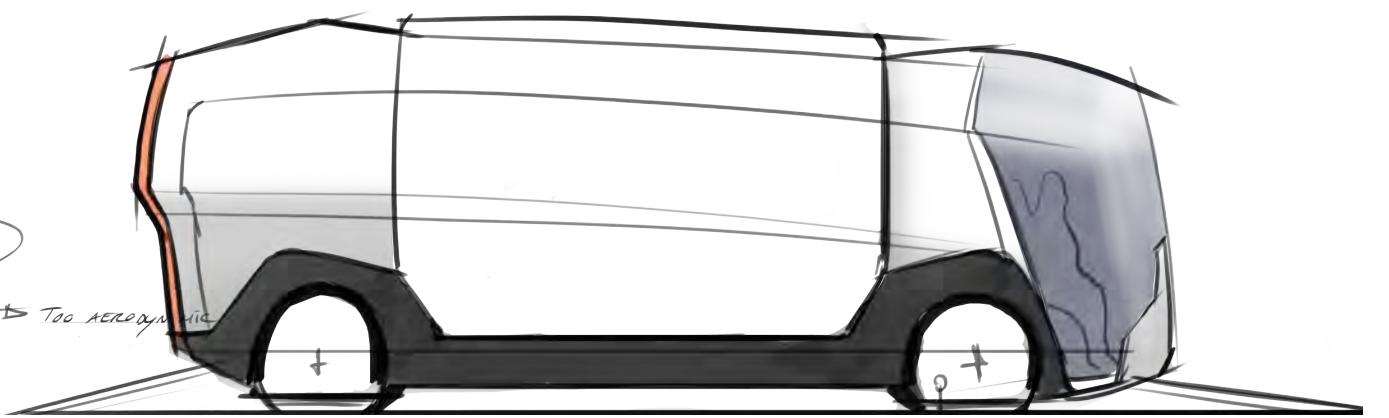


FIGURE 49: Design theme

4.8 Design philosophy

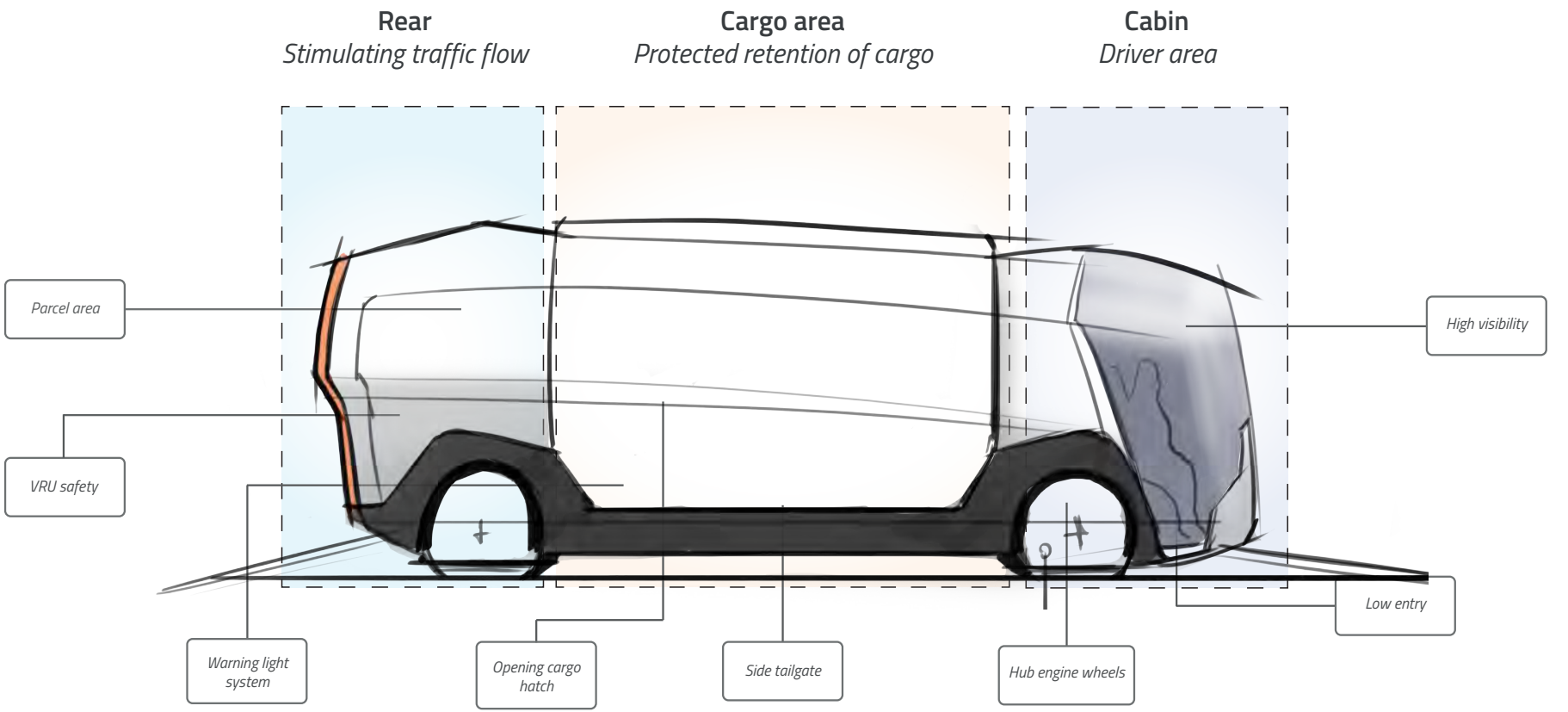
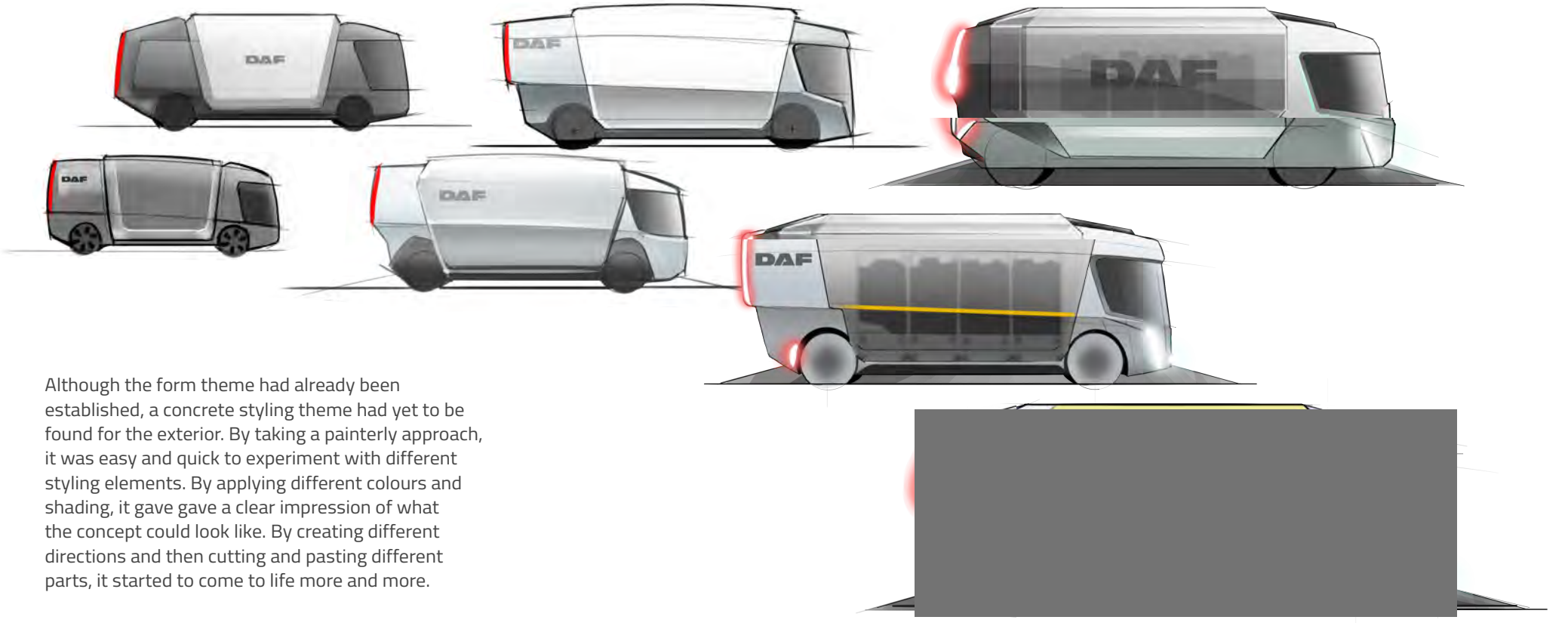


FIGURE 50: Phylosophy of the design

4.9 Styling



Although the form theme had already been established, a concrete styling theme had yet to be found for the exterior. By taking a painterly approach, it was easy and quick to experiment with different styling elements. By applying different colours and shading, it gave gave a clear impression of what the concept could look like. By creating different directions and then cutting and pasting different parts, it started to come to life more and more.

FIGURE 51: Sketching side views

KEY SKETCH

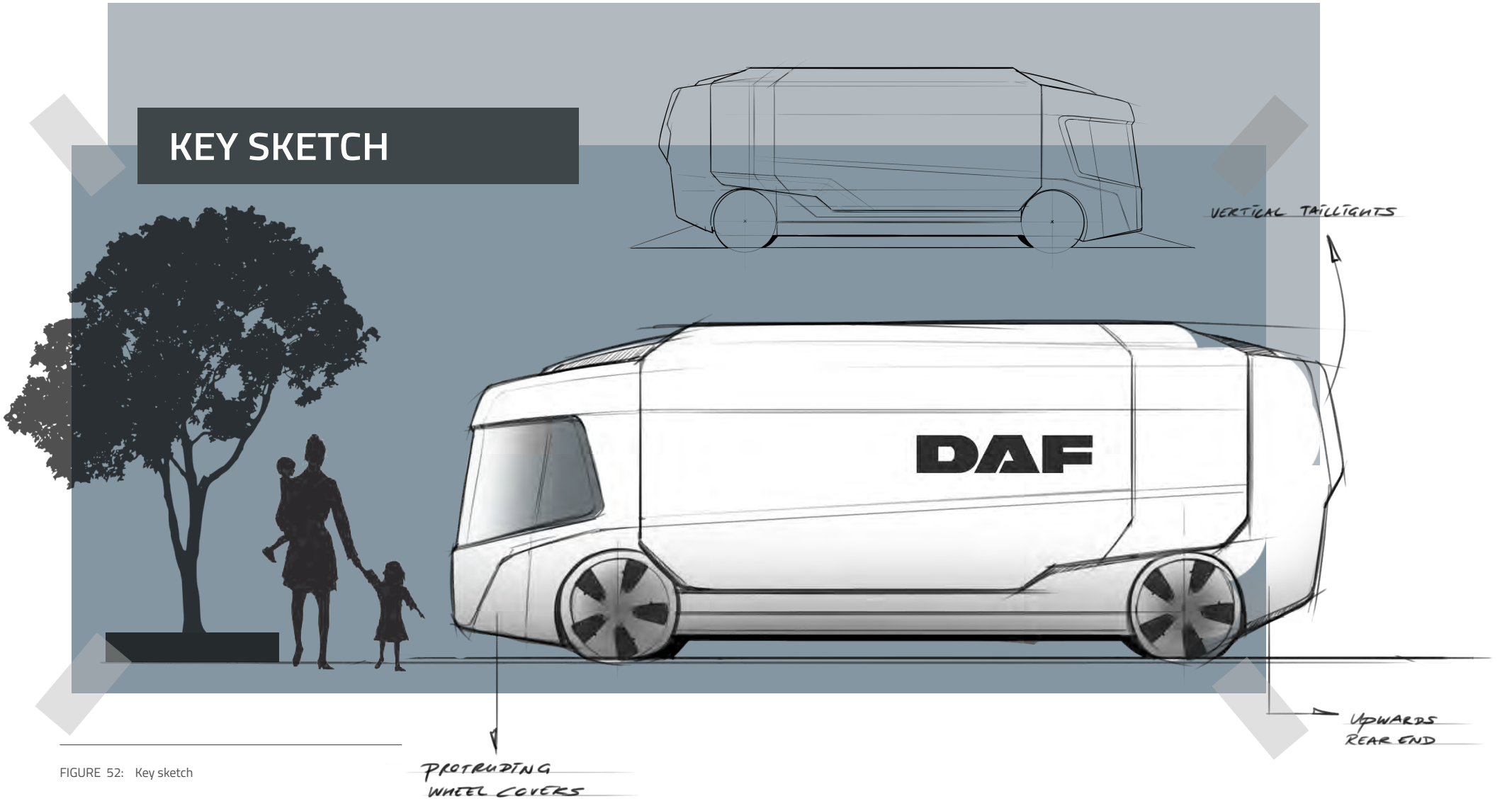
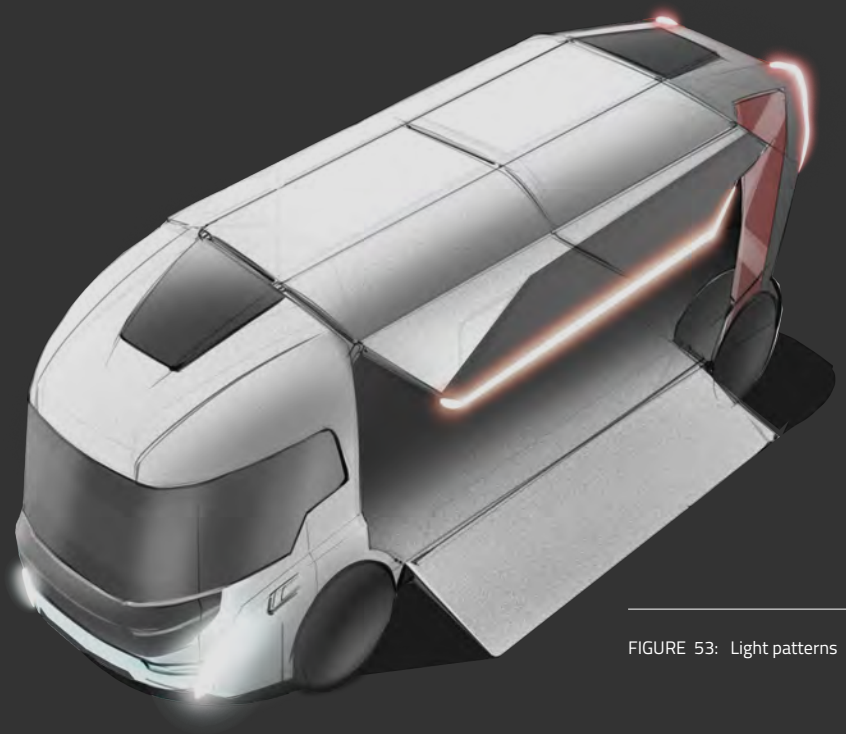


FIGURE 52: Key sketch

4.10 Lighting pattern

The lights on the vehicle will be integrated at the front into the wheel covers that open with the cabin door. The rear will have vertical lights on the corners of the vehicle so that they are visible from multiple angles. In the cargo hatch, a red LED light will be visible for when unloading to indicate the unloading zone near the vehicle.

Looking at the vehicle from above, you can see into the cargo area from above through the semi-transparent hatches. This gives the possibility for people from outside to see that cargo is being transported, emphasising the necessity of the distribution vehicle.



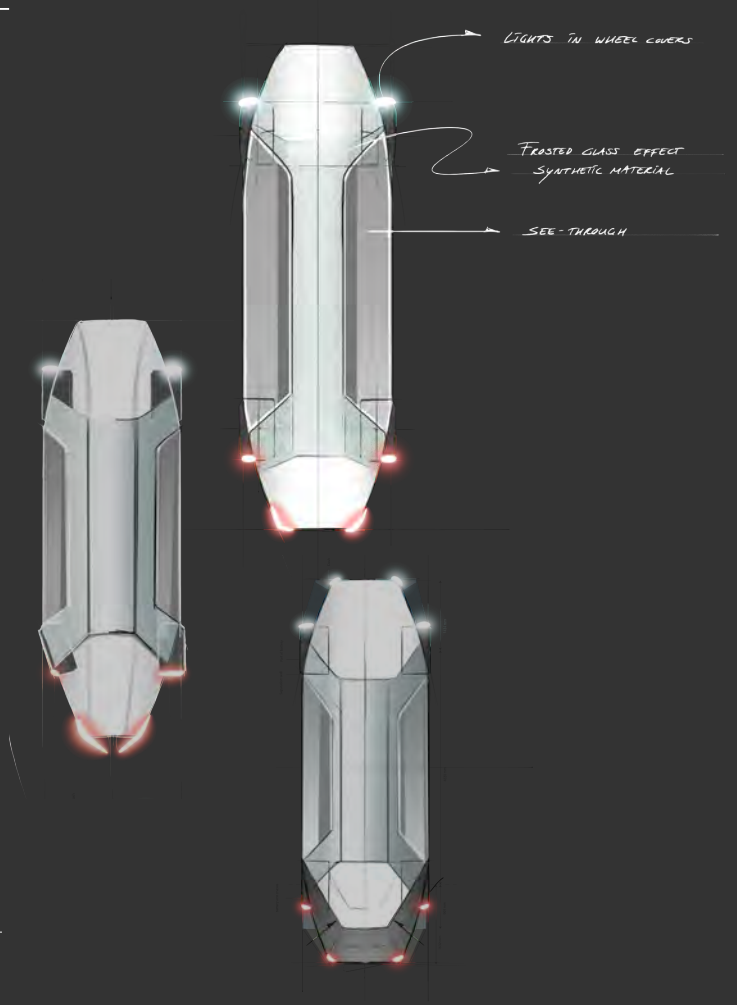


FIGURE 53: Light patterns

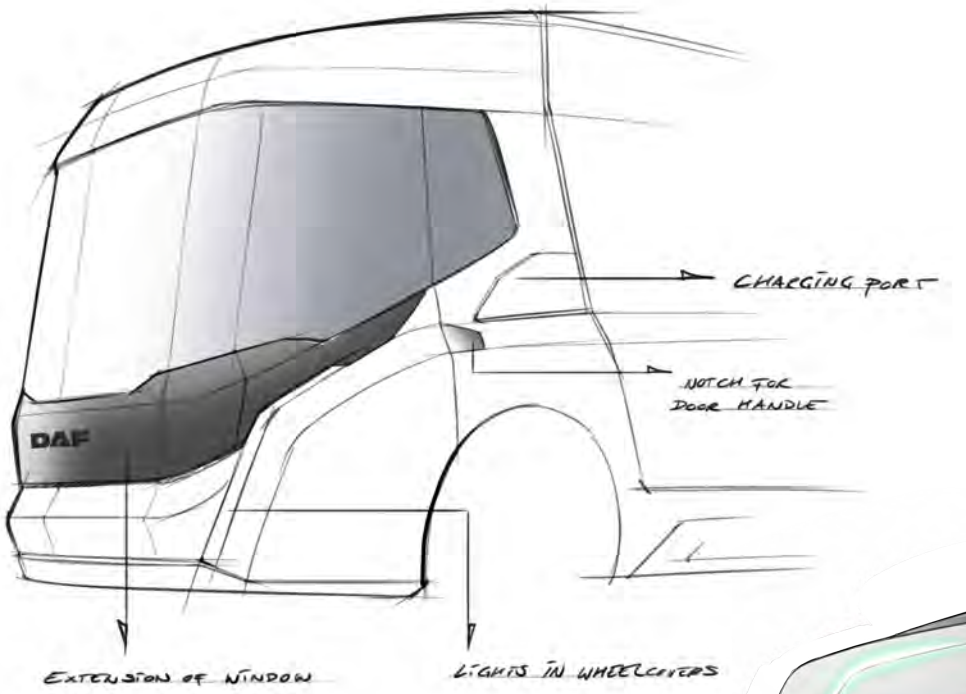


FIGURE 54: Big windscreen insead of grill

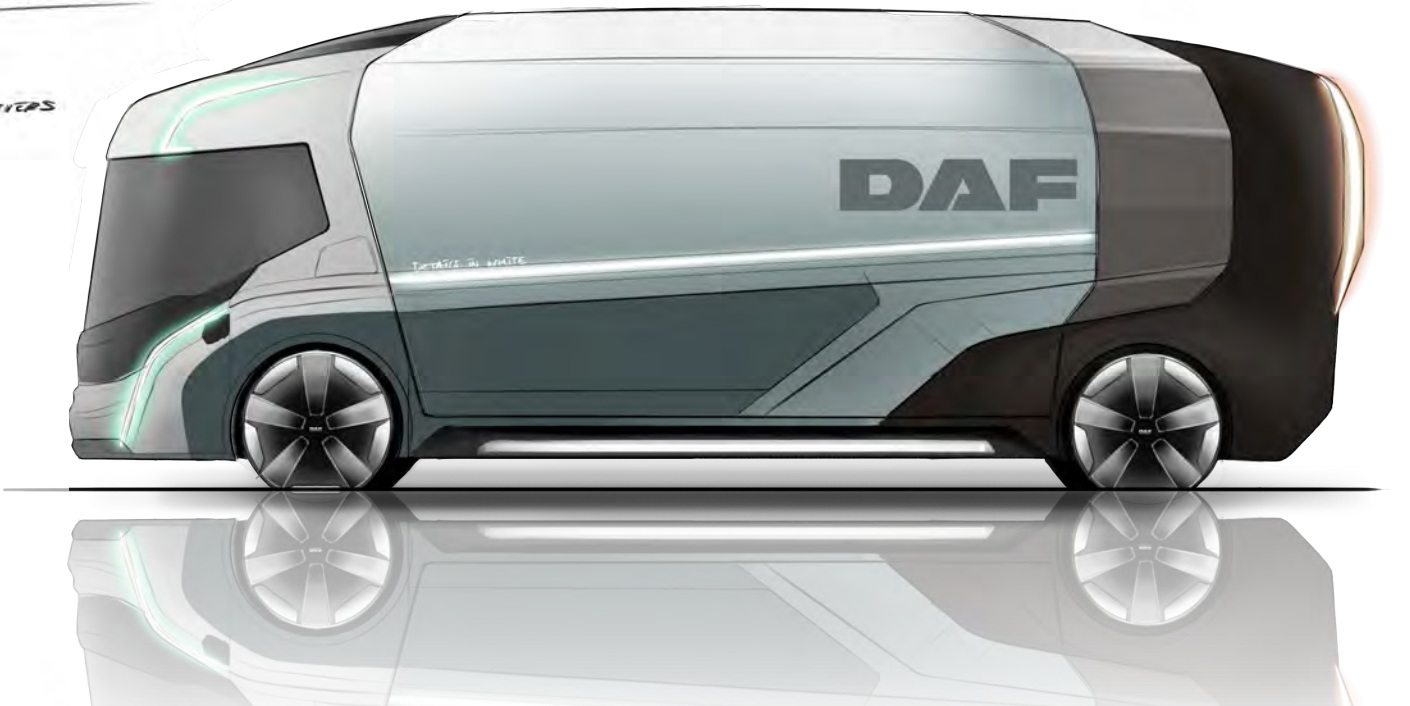
WINDSCREEN

Since the vehicle is electric and a large grill did not match this, it was decided to make an extension of the windshield. DAF's trademark ascending lines were included in this design of the cabin.

COLOUR THEME

The final colour scheme was created by testing out different colours on the design. This calm and modern colour palette ultimately proved to merge best with the urban environment.

FIGURE 55: Final colour theme



5. Final design

DAF TxM2

The concept's name derives from the area-time formula, which is the core principle behind the vehicle's design. By increaing efficiency and reducing loading and unloading times, its area-time is significantly lower than that of other distribution vehicles.

DAF TxM2

5.1 Docking efficiency

The vehicle has to be loaded with cargo before it can deliver in the city centre. This will be done at docking stations specially equipped for these vehicles.

CITY DOCKING POINTS

For convenient delivery in the city centre, a network of docking stations situated around the city centre is used. This way, the distribution vehicle needs to cover fewer kilometres and is able to easily pick up a new load of cargo for subsequent delivery to other customers. In Figure 57 this network is clarified.

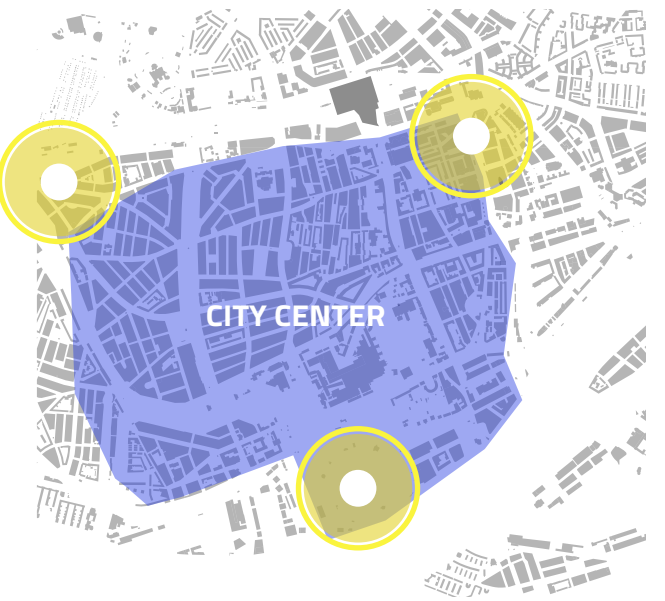


FIGURE 57: Docking station network

CARGO FLOW

The docking stations are designed for easy drive-through loading, allowing the vehicle to be loaded in no time. This is made possible by a cargo loading flow where full pallets and/or rolling containers are loaded from one side, while empty containers are unloaded from the other.

FIGURE 58: Loading cargo at the docking station

FIGURE 59: Unloading cargo via the pavement

5.2 Unloading efficiency

The main design goal was to deliver in the city as efficiently as possible. Here, unloading from the side should be facilitated by the vehicle itself. The following aspects should ensure this.

LOW UNLOADING

After the vehicle arrives at the unloading site, the vehicle has a kneeling function where the chassis will lower to the ground through the use of air bellows. As a result, the loading floor is lowered making it easier for the driver to take the load out of the vehicle.

ACCESSIBILITY

The side hatch of the vehicle opens and the side ramp lowers, making the full length of the cargo area available. This eliminates the need to manoeuvre the load into the vehicle and allows the driver to simply remove the load without boarding the vehicle.

INDICATED LOADING ZONE

The warning light system for passers-by indicates the unloading area where unloading is taking place. The lights on the other side highlight the possibility of a smooth passage following the traffic flow on that side of the vehicle.

PERSONAL DEVICE

By using a personal device, the cargo hatch can be controlled. In addition, this device is used to manage all distribution-related tasks such as parking and administration. This further simplifies the driver's task.

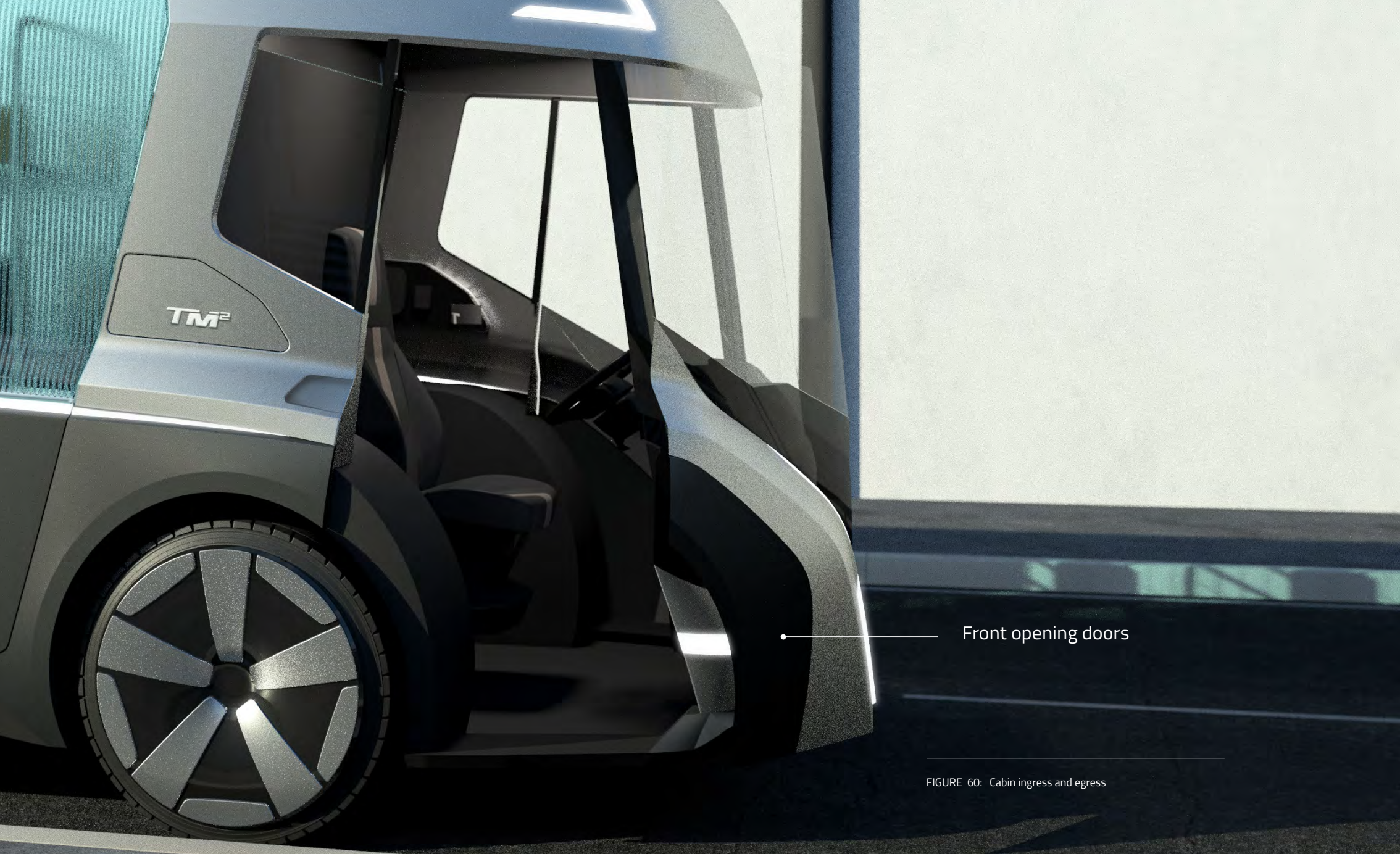


FIGURE 60: Cabin ingress and egress

5.3 Cabin and maneuverability

How the driver boards the cab and how he or she subsequently drives through the city is explained here.

INGRESS AND EGRESS

The ingress and egress is ergonomic due to a very low step-in. Once the vehicle has lowered to the ground, the first step is only 20 cm high. This significantly lowers the physical effort of the driver compared to today's distribution trucks.

MANEUVERABILITY

With a shortened length of 7.4 metres, the turning circle of the vehicle is smaller. Additionally, because the rear wheels steer while turning (active steering), the corners can be made much narrower.

SYMMETRICAL CABIN

The cabin is symmetrical, meaning the driver sits in the middle and can easily get in and out from both sides. This could be made possible because the co-driver seat is redundant due to underuse. With a symmetrical cabin, the space for the driver is increased.

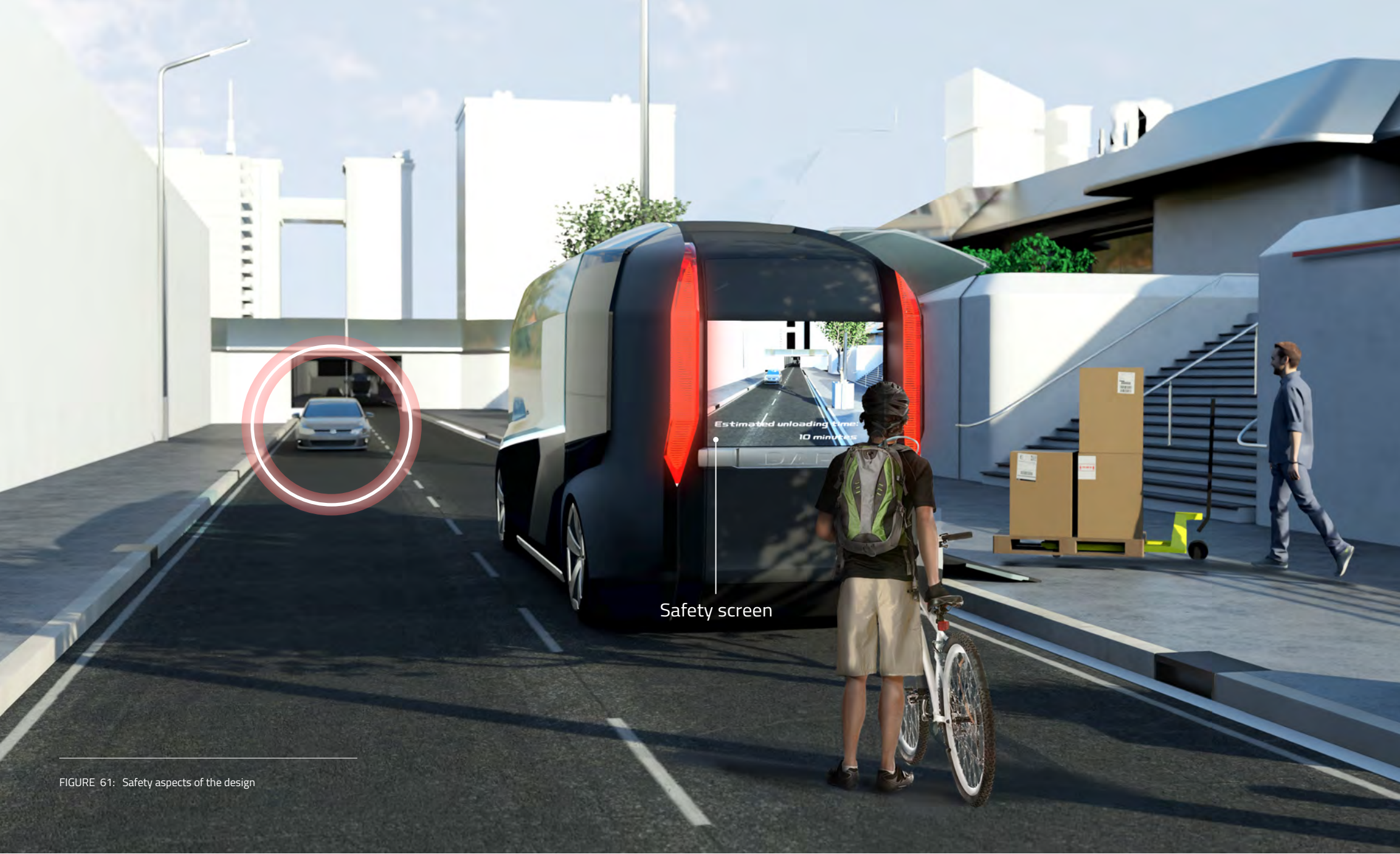


FIGURE 61: Safety aspects of the design

5.4 Safety

A unique selling point of this vehicle compared to current distribution vehicles is that the safety of other road users has been factored into the exterior design. Below the safety elements of the design are listed. By incorporating these elements, the vehicle compensates for the temporary blockage on the road or pavement which ultimately will increase the acceptance of the vehicle for other road users.

SAFETY SCREEN

As the vehicle blocks the view for cyclists and other road users during unloading which could lead to dangerous traffic situations, a safety screen has been added at the rear of the vehicle. This screen is integrated in the rear door and projects the traffic situation in front of the vehicle. With this feature, road users can see if traffic is approaching and will not be surprised by unexpected oncoming traffic.

TAPERED SHAPE

For increased traffic flow, the vehicle itself is front and rear tapered. Note that in the top view from the package (Chapter 4.6), the front and rear are slightly tapered. This was done to reduce the sharp, dangerous corners of the vehicle.

REAL-TIME UNLOADING PROGRESS INFORMATION

Information has also been added at the bottom of the safety screen that gives an estimate of how long unloading will take. Being transparent about loading activities will ultimately increase the level of acceptance for passers-by.

TRAFFIC REGULATING LIGHT SYSTEM

With a warning light system on the front, the loading status is communicated giving VRUs more information: the lights indicate with arrows the side for safe passing past the vehicle.

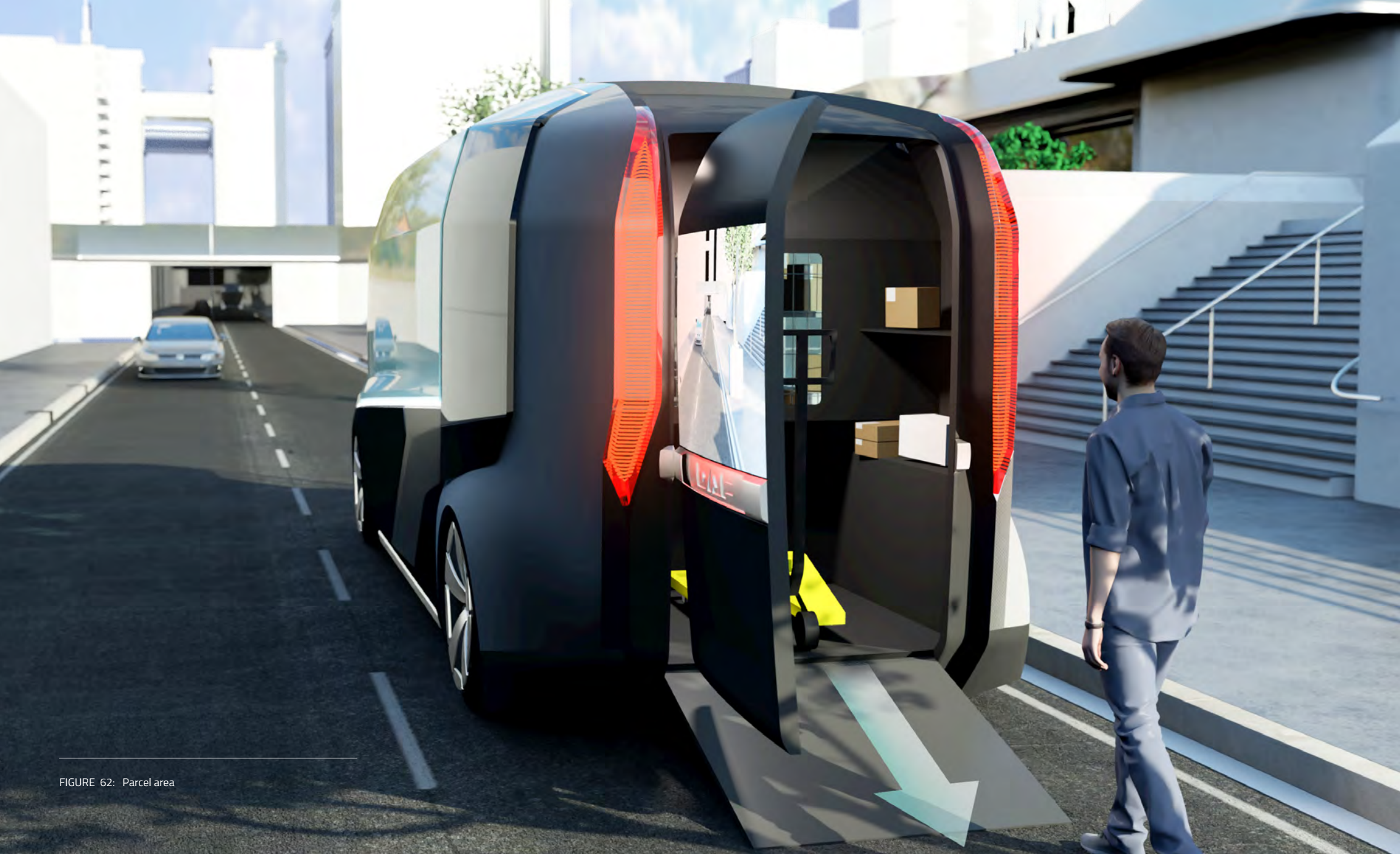


FIGURE 62: Parcel area

5.5 Parcel area

The parcel space is located at the rear of the vehicle. This space is intended for small individual parcels that do not conveniently fit in the main cargo area. There is also space to accommodate a pallet truck if pallets are also transported.

REAR TAILGATE

From the back of the chassis, the rear tailgate can be extended in case the pallet truck needs to be rolled in or out of the vehicle.

SIDE PARCEL DOOR

From the outside, it is possible for the driver to remove parcels from the vehicle via the parcel door so there is no need to climb in. This door when opened has the second function of indicating and blocking the loading side for passers-by (see Figure 64 on the next page).

BACK DOOR MECHANISM

The rear door can be opened on both sides by a pressure-spring mechanism shown schematically in Figure 63. The advantage of being able to open the door on both sides is that it can again shield the dangerous loading side from traffic.

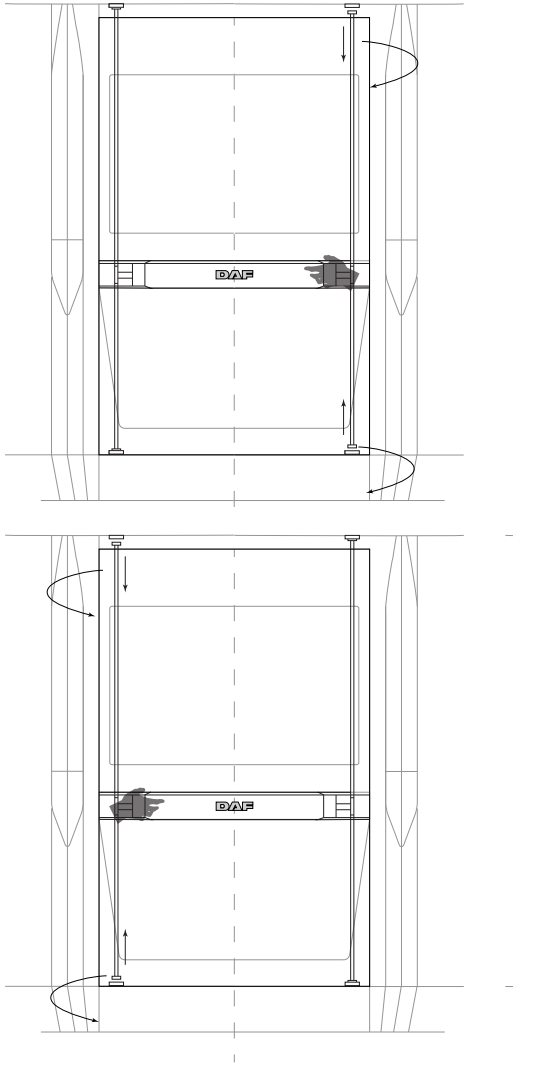


FIGURE 63: Backdoor mechanism

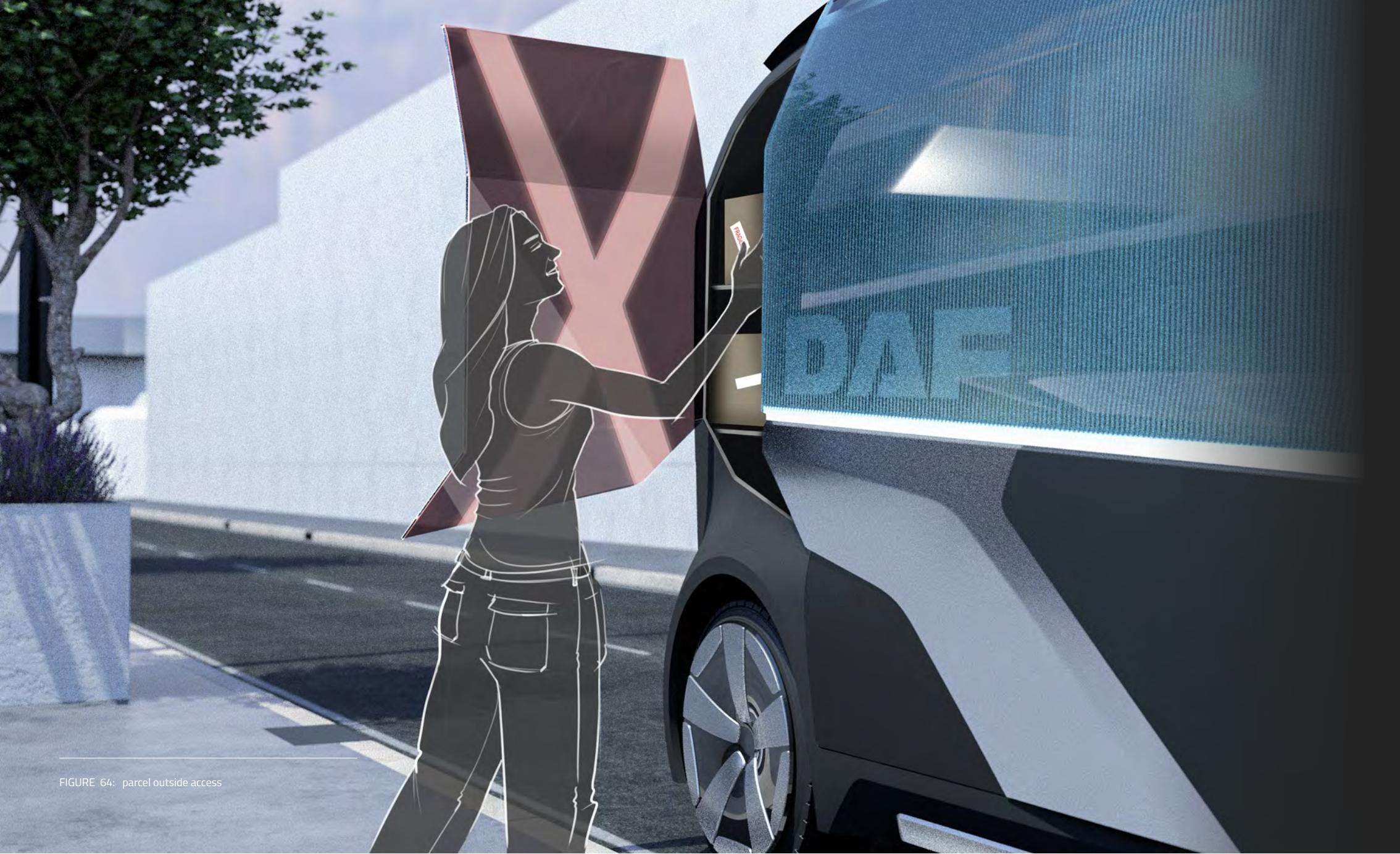
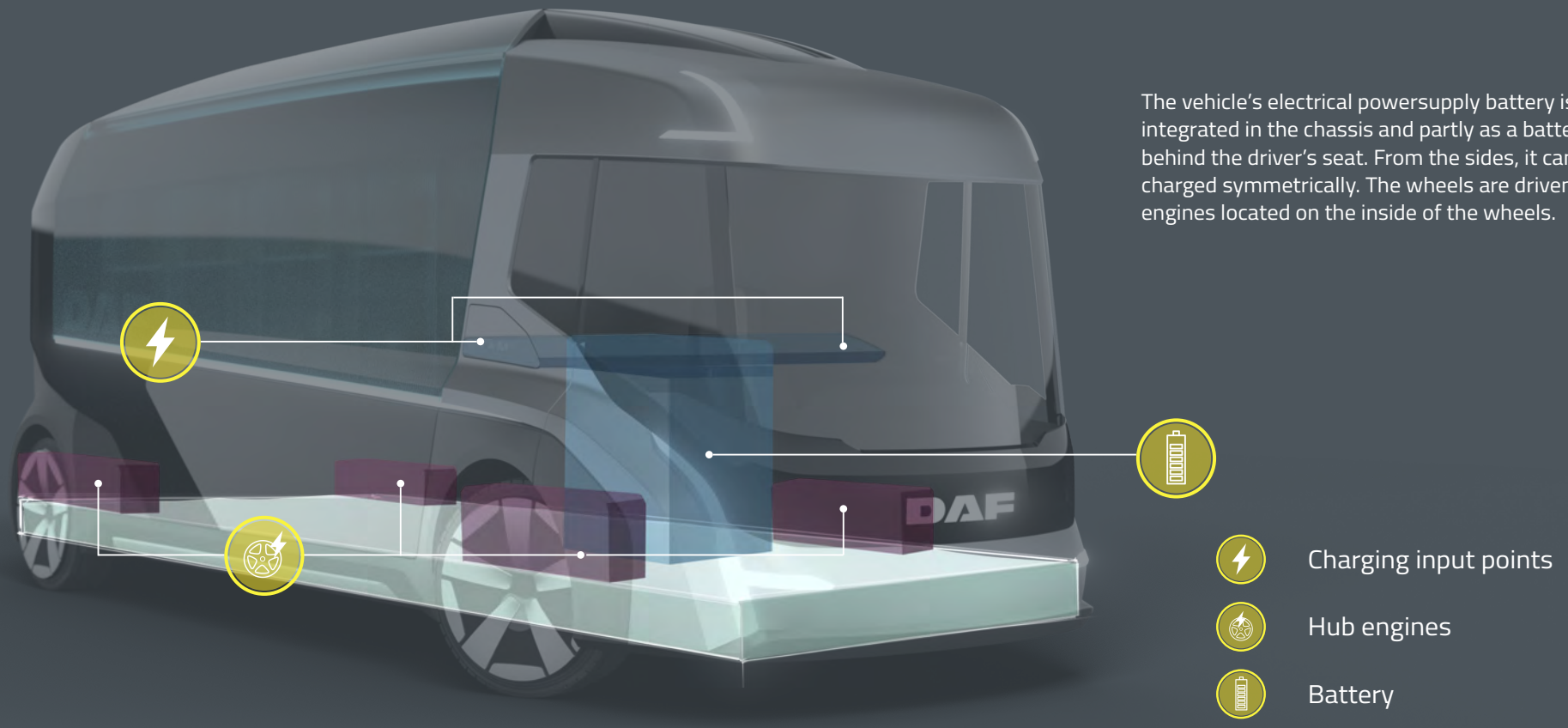


FIGURE 64: parcel outside access

5.7 Battery layout



The vehicle's electrical powersupply battery is partly integrated in the chassis and partly as a battery unit behind the driver's seat. From the sides, it can then be charged symmetrically. The wheels are driven by hub engines located on the inside of the wheels.

FIGURE 67: Technical layout of powersupply

6. Evaluation

Now that the final design is finalised this final section of the report will evaluate the design and the process. Furthermore, recommendations for hypothetical further development of the design and a final personal reflection on the past months have been added.

6.1 Evaluation of the final design

By referring to the programme of requirements in Appendix FIXME, the final design proposal can be evaluated by reviewing the different aspects of the design.

POWERSUPPLY

The powersupply should be easily accessible for cable charging, but with the current layout it was hard to make it suitable for battery swapping as well. Assuming that battery swapping becomes the future, possibilities for this should be investigated further.

MANOEUVRABILITY

Overall, the design should scores well on maneuverability with a few remarks: a turning circle with a radius of less than 10m should be achievable with double axle steering, but this would only be 100 percent certain if tested in practice. In addition, the width of the truck is currently just slightly wider than 2.50m (2.55) because pallets and roll containers have to fit in the loading floor. However, on second thought, this has no impact on manoeuvrability. The length has the most impact and it is significantly shorter than the average current trucks (7.5 instead of 10+ m).

LOAD

Something especially difficult to assess here is the balance between payload and GVW as the vehicle's weight would only become clear after full materialisation and technical implementation. However, with regard to the fact that we are dealing with a relatively small vehicle and a load of 10-15 roll containers that normal trucks also carry, it can be assumed that the payload is high. In addition, the payload is flexible in its use for roll containers and pallets.

SUSTAINABILITY

Since the vehicle runs on an electrical powersupply, there are no CO2 emissions to the environment. However, this project did not investigate what is emitted during the production process.
In terms of expressing sustainability, brushed aluminium and transparent materials were chosen to make a 'clean' impression on the environment. Natural materials have been left out so that the vehicle is more robust and can last longer.

SAFETY

Compared to an average truck, the design is expected to increase safety significantly. There are no high protruding tailgates and the vehicle is safer to move around the vehicle due to the added safety screen and warning signs. The tapered shape of the vehicle increases traffic flow and the cabin windows are large to achieve maximum visibility. I dare say that the aforementioned elements make the design much safer than an average truck.

ACCESSIBILITY

The in and egress was tested in augmented reality in combination with foam blocks placed at the same level as the steps. Boarding felt comfortable and natural. Because the vehicle is low to the ground, it is even easier for the driver to get in and out. The same goes for unloading the roll cages. Physical effort is consequently minimised for the driver. The unloading test also showed that unloading was effortless.

STYLING

With all the technical elements required for the vehicle to function, the styling also took on quite a technological character. Still, I believe it produced an intriguing look, something people would like to look at on the street. The vehicle fits into the street environment and does not disturb the eye. Finally, the safety features on the vehicle radiate the increased safety to its surroundings.

EFFICIENCY

The most important aspect of design. Is the vehicle really more efficient in its use? I tested this at DAF, where we unloaded a roll container from the height of my design, and then from a DAF LF. Accurately timing the actions was difficult as the test setup didn't have the cargo hatch that would open. What became clear: the action itself isn't significantly faster than with a normal truck (51 seconds compared to 1 minute and 5 seconds), but what can be said with certainty is that, because a normal truck's tail gate can only hold 3 roll containers at a time and the design 4-5 roll containers, the total unloading time is **twice as fast.** Because a normal truck has to go up and a second time to unload the same amount of cargo.

FIGURE 68: Efficiency testing

6.2 Recommendations

Finalising the project, I realise there are still some areas of improvement for the design that could be developed furthere for a potential continuation of the project. In this chapter I summerise a number of aspects that I recommend to develop or investigate further.

USER VALIDATION

As there were many feedback moments with the drivers in the research phase of the project, it would have been complete to validate the final design with them. Due to the lack of time this was unfortunately not possible. Therefore, I recommend the following if a driver test were to take place: first of all, it would be valuable if the drivers where to test the model in augmented reality. Here, their direct feedback on the size, ingress and spaciousness of the cabin could be used to improve the design further. Secondly, it would be valuable to recreate the main dimensions of the design on a 1:1 scale with wood and let the drivers take out the roll containers. Their direct feedback would presumably reveal lots of things to improve.

ACCESSIBLE BATTERY

To make the design ready for battery swapping, more time would have to be invested in figuring out how the battery can be easily removed and inserted into the vehicle. Currently, the design is fit for electrical charging, however it is not unlikely that battery swapping will play a more important role in the future to decrease vehicle down-time.

COOPERATION BETWEEN COMPANIES

If the design should ever come to a point of development, it is important that companies/operators that own the vehicles work together in order to let the docking network function properly. Only then maximum efficiency can be achieved.

6.3 Personal reflection

By referring to the programme of requirements in Appendix FIXME, the final design proposal can be evaluated by reviewing the different aspects of the design.

THE RESEARCH

Looking back, the research phase was quite chaotic. I think this was due to the broad assignment of designing a more efficient distribution truck when there are many different types of distribution and multiple stakeholders. So in the beginning, I investigated different distribution segments, the experience of drivers and, on the other hand, the experience of residents. Because these segments and stakeholders differ so much, I found it difficult to find a common thread. In retrospect, all the field research was very useful for the project, but at the time it felt like I was researching all kinds of things at once without a clear structure. It was necessary to make important decisions quite early in the project. Halfway through, I managed to find a clear angle and regained structure.

VISION IN PRODUCT DESIGN METHOD

As this was the first time I used the ViP method within a project,I had to become familiar with the method during the project. Especially in the beginning, I was figuring out how to apply the ViP method in parallel with my research, which occasionally caused unnecessary pressure. It helped a lot to talk to people around me who had worked with the method before, such as my chair or fellow students. The VIP method helped me a lot in the beginning to understand the context, but sometimes it was also necessary to let go of it a bit more when making practical design choices.

IDEATION

Because the research was diverse, it produced many small design problems. In the end, I knew that the main goal was to increase the efficiency of loading and unloading. Where the biggest challenge was to come up with something even more efficient than the current trucks already designed to increase efficiency. This process took a long time and was often frustrating, extensively sketching at times without a clear goal, but eventually I managed to tie the knot in time. The simplest concept of unloading from the side turned out to be the only one that could really increase efficiency. From then on, I noticed a surge of motivation and was also more able to communicate my ideas to my supervisors at DAF.

STYLING

The styling phase was new territory as I had never done an automotive styling project before. This phase ended up taking longer because I needed more time to overcome stylistic challenges. But this was also where I learnt the most from the whole project. I really noticed that towards the end, I got better and better at rhyming styling elements and communicating about it with the designers at DAF. I also realised, that six months to design the exterior of a truck is very short compared to the 20 years that normally precede the release of a new generation of trucks at DAF. So in the end, there are many things I could have worked on longer. But keeping the time limit in mind, I am quite satisfied with the end result for my first real automotive design project.

PRESENTING

As the project progressed, I started presenting more and more fluently. I think I gained more confidence in my project and this shone through during presentations. The interim presentations at DAF were sometimes clumsy and lacked a common thread, but that was mainly because I was not yet sure what I was working on. It was nice to see that after my green light, the presentation for the office went a lot better because I had found a logical story that I supported myself. In the first presentations, I tried to show too many things when I could have kept it more abstract by presenting my design problems or project strategy.

DECISIVENESS

As the project progressed, I started presenting more and more fluently. I think I gained more confidence in my project and this shone through during presentations. The interim presentations at DAF were sometimes clumsy and lacked a common thread, but that was mainly because I was not yet sure what I was working on. It was nice to see that after my green light, the presentation for the office went a lot better because I had found a logical story that I supported myself. In the first presentations, I tried to show too many things when I could have kept it more abstract by presenting my design problems or project strategy.

PROJECT MANAGEMENT

Making schedules, arranging the contact moments of supervision and taking the lead in the meeting in those moments were things I had to integrate into my project. Making the planning clear for myself was not so much the challenge, but especially communicating my planning and project progress to my supervisors at DAF was a big challenge in the beginning. Once I visualised it on a large board, it became a lot clearer for everyone. The supervision moments at TU always felt very natural to me and I enjoyed attending them.

DAF AND TU DELFT

In the early stages of the project, I had to get used to the internship setting. I was very insecure about the project and I had quite a lot of contact moments with DAF. During this period, I found the meetings at the TU, where my coaches were used to this kind of project, more valuable. Eventhough I found the internship context intense at first, I realise now that I gained a lot from it and in the end I really felt at home at DAF.

RESULT

When I look at the final result, there is still a lot to criticise about parts of the vehicle that could be different in my opinion. However, what matters most is what the concept achieves. I am very satisfied with what the concept has achieved and I feel passionate about it. If I were allowed to do the project again, I would have taken the same direction, but possibly developed the styling somewhat further with more time.

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Appendix

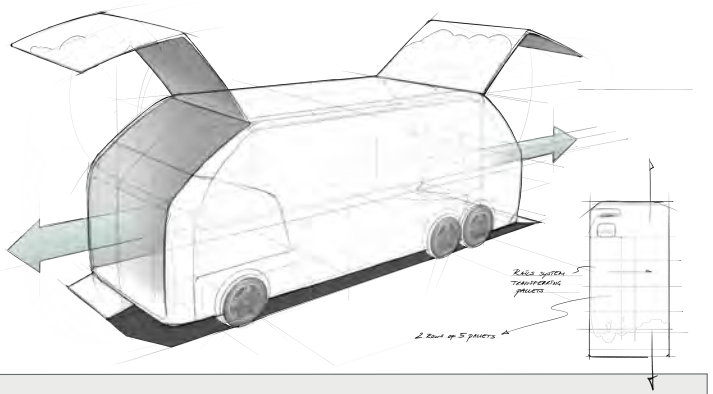
Program of requirements

Categories	Requirements	Wishes
1. Maneuverability	1.1 The configuration of wheels, axes and steering mechanism should reach turning radius less than 10 meters;	- The design could be modular and could be used for multiple distribution purposes; - The interior design should add to the comfort of the driver;
2. Load	2.1 The balance between the payload and the GVW should be optimal for maximised load capacity; 2.2 The design should be able to transport rolling containers and pallets;	
3. Sustainability	3.1 The design should be zero-emission;	
4. Efficiency	4.1 The (un)loading system should reduce the area-time of the vehicle in a safe way; the area-time should be less than 15 minutes;	
5. Safety	5.1 The design should improve the overall safety for VRUs; 5.2 The sight from the cabin should be 100% for increased visibility and easy detection of VRUs; 5.3 The design should have safety systems to detect VRUs; 5.4 The exterior design should add to the perception of safety for VRUs;	
6. Accessibility	6.1 The cabin should be low-deck for an easy in- and egress; 6.2 The cabin should have a kneeling function for easy in- and egressing; 6.3 The step height of the cabin stairs should be less than 30 cm for an ergonomic in- and egress; 6.4 The loading space should be easy to access for the driver;	
7. Powersupply	7.1 The placement of the battery should should facilitate charging or battery swapping; 7.2 The powersupply should be safely and securely integrated into the design;	
8. Styling	8.1 The design should radiate that that it is an integrated part of the urban environment through its styling;	

First concept directions

Concept 1: Symmetric (un)loading

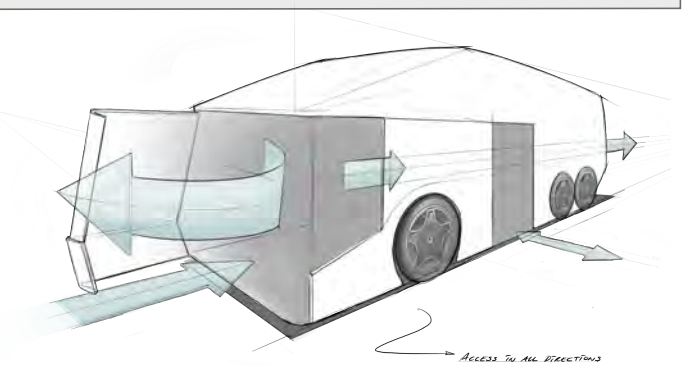
This concept stemmed mainly from the fact that the current way of loading and unloading is usually in one direction, requiring drivers to park in front of delivery addresses in such a way that their loading exit is properly aligned for unloading. This is accompanied by having to turn awkwardly on the street. Symmetrical unloading and loading would eliminate the need for them to turn and



The concept complicates the loading layout by making it unsuitable for collecting goods: on the inside the vehicle turns into a complicated tetris puzzle that only makes the driver's job harder. On which side does the driver unload and where can collected goods be put back?

Concept 2: Walkthrough

Since a driver has to climb in and out of the cab more than 40 times, which takes energy on a working day that is already physically demanding, this concept provides better accessibility between the driver and the loading area. The driver does not have to get out of the vehicle, but can walk



By creating walking space within the vehicle, the loading space is minimalised and therefore also the load capacity. Reduced loading capacity would mean that more trips would have to be made to be able to deliver the same amount of cargo in a day.

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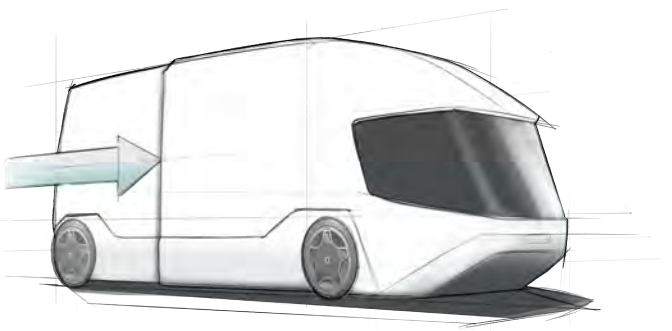
Concept 3: Shrinking truck

Since the length of a vehicle affects the radius of the turning circle the most, the length must be reduced to achieve greater manoeuvrability. With this concept, the vehicle gets smaller as more cargo goes out and through the shorter wheelbase, a smaller turning radius can be achieved,



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In reality, it is often not the case that the vehicle gets more empty. Often cargo is added along the way such as empty pallets or packaging material. Nor is it the case that the same amount of cargo gets delivered per address during the day.

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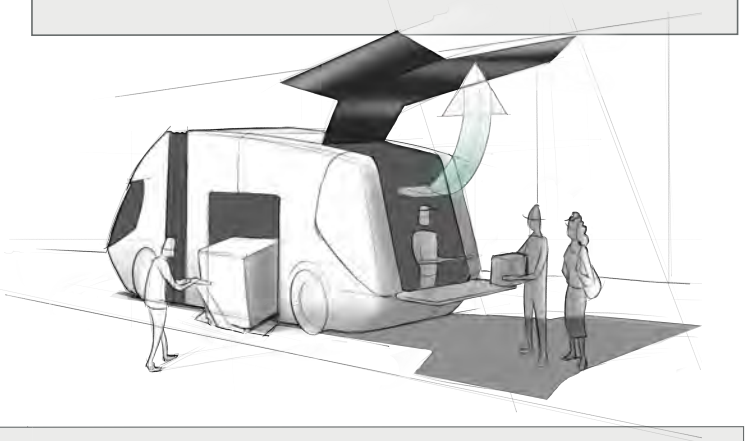
Concept 4: Second functionality

To increase residents' acceptance of distribution vehicles, one way could be to add a second functionality to the vehicle while it is stationary. For example, this could take the form of a drop-off or pick-up point for parcels, or it could be a place where people meet on the street to interact.



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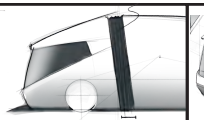
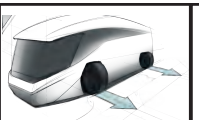
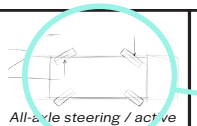
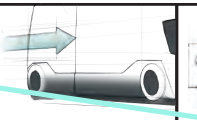
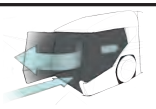
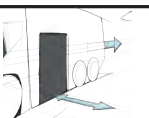
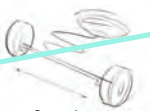
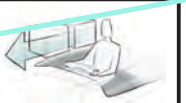
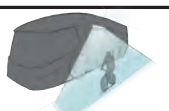
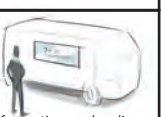
This concept will complicate the driver's task and probably require finding a co-driver or another employee to help during the day, which is difficult given the driver shortage. Moreover, the vehicle will not be stationary for more than 15 minutes for the unloading of cargo, making the time window to use the second shift too short.

Maneuvering through tight corners	 *Harmonica*	 *crab steering*	 *All-axle steering / active steering system*	 *Shrinking truck*	 *Short wheelbase*	 *Trailer*		
Ease of loading / unloading	 *Hydraulic tailgate*	 *Side unloading*	 *Front and back unloading*	 *Automatic unloading rails system*	 *Separate loadings levels*	 *Automatic unloading tailgate*	*Tetris system with wheels underneath*	 *Unloading platform between wheels*
Accessibility	 *Front door ingress*	 *Side door*	 *Kneeling function*	 *Steer by wire*	 *Small parcels pop-up next to driver*	 *Automatic opening doors*	*Rounded cockpit*	
Powersupply	 *Battery swapping*	 *Wireless charging from above*	 *Wireless charging from underneath*	 *Hub engines*	 *The mobile batterypack in loading space*			
Interaction with road users	 *Cycle path projection*	 *Second functionality*	 *Giving back space*	 *Drill warning sign*	*Recognition feedback*	 *Information on loading time*		

Aa Name	Tags	Multi-select	Description	Date
1. People are ordering more stuff online (rising of e-purchase and home delivery).	trend	Economical	Russo, F., & Comi, A. (2012). The simulation of shopping trips at urban scale: Attraction Macro-Model. Procedia - Social and Behavioral Sciences, 39, 387–399. https://doi.org/10.1016/j.sbspro.2012.03.116	
2. Governments want a sustainable public space that enables encounters and regional distribution of city services.	principle	Political	Gemeente Amsterdam. (2021). *Policy: Urban Development*. amsterdam.nl. Retrieved March 15, 2024, from https://www.amsterdam.nl/en/policy/urban-development/#h8fde8a2a-3c95-4927-8f17-79d972bc5898	
3. Mixing public transportation with delivery service. Co-modality: Shipping firms working together with public transit companies.	trend	Economical	Ronald, N., Yang, J., & Thompson, R. G. (2016). Exploring Co-Modality using On-Demand transport Systems. *Transportation Research Procedia*, *12*, 203–212. https://doi.org/10.1016/j.trpro.2016.02.059	
4. Separating the first mile, middle mile and last mile in the future of distribution for higher efficiency.	development	Technological	My CAR Update. (2024, January 9). *CES 2024	HYUNDAI HYDROGEN FUTURE PRESENTATION CITY POD* [Video]. https://www.youtube.com/watch?v=EbImTydm3jU	
5. Growing demand for e-commerce delivery will result in 36% more delivery vehicles in inner cities by 2030, leading to a rise in both emissions and traffic congestion.	trend	Environmental	World Economic Forum. (2020, January 10). Urban Deliveries Expected to Add 11 Minutes to Daily Commute and Increase Carbon Emissions by 30% until 2030 without Effective Intervention. Retrieved March 15, 2024, from https://www.weforum.org/press/2020/01/urban-deliveries-expected-to-add-11-minutes-to-daily-commute-and-increase-carbon-emissions-by-30-until-2030-without-effective-intervention-e3141b32fa/	
6. Chinese brands taking over the automotive industry in Europe because their vehicles are cheap and fit-for-purpose.	development	Economical	Allianz Research. (2023). The Chinese challenge. Retrieved March 15, 2024, from https://www.allianz.com/content/dam/onemarketing/azcom/Allianz_com/economic-research/publications/specials/en/2023/may/2023-05-09-Automobile.pdf	
7. Urbanization: a global trend of more and more people moving to the city.	trend	Demographical	European Commission. (2020, July). *Urbanisation in Europe	Knowledge for policy*. Retrieved February 24, 28 C.E., from https://knowledge4policy.ec.europa.eu/foresight/topic/continuing-urbanisation/urbanisation-europe_en	
8. Hydrogen powered trucks.	development	Technological	Zepp Solutions. (2023, November 17). *Europa: next generation hydrogen-powered truck - Zepp.Solutions*. Zepp.Solutions. Retrieved April 2, 2024, from https://zepp.solutions/nl/europa/	

Context factors

Aa Name	Tags	Multi-select	Description	Date
9. Urban planners are focussing on clean urban transport for sustainable living environments.	development	Environmental	Gemeente Amsterdam. (2021). *Policy: Urban Development*. amsterdam.nl. Retrieved March 15, 2024, from https://www.amsterdam.nl/en/policy/urban-development/#h8fde8a2a-3c95-4927-8f17-79d972bc5898	
10. 15 minute-city: high accessibility, everything within a 15 minute reach, small geographical area for future inner city distribution.	trend	Technological	Khavarian-Garmsir, A. R., Sharifi, A., & Sadeghi, A. (2023). The 15-minute city: Urban planning and design efforts toward creating sustainable neighborhoods. *Cities*, *132*, 104101. https://doi.org/10.1016/j.cities.2022.104101	
11. Automation of distribution vehicles (platooning) for long haul, but long road to full automation, less enjoyment for truck drivers.	trend	Technological	Bhoopalam, A. K., Van deBerg, R., Agatz, N., & Chorus, C. (2023). The long road to automated trucking: Insights from driver focus groups. *Transportation Research Part C: Emerging Technologies*, *156*, 104351. https://doi.org/10.1016/j.trc.2023.104351	
12. Trucking is a lifestyle.	state	Cultural		
13. Dark stores in big cities, couriers bringing groceries to people's doorsteps. More companies like Gorilla and Flink coming up.	trend	Economical	Eurocities. (2023, March 17). *Dark stores: Amsterdam hits the pause button - Eurocities*. Eurocities - Home. Retrieved March 15, 2024, from https://eurocities.eu/stories/dark-stores-amsterdam-hits-the-pause-button/	
14. Smart traffic systems. Concepts like FlexKerb: a flexible kerb, to balance the need of all road users,	development	Technological	*Arup shortlisted in competition to make streets fit for driverless cars - Arup*. (2018, September). Retrieved March 15, 2024, from https://www.arup.com/news-and-events/arup-shortlisted-in-competition-to-make-streets-fit-for-driverless-cars	
15. Parcelcopters for last-mile delivery might make road distribution redundant.	development	Technological	InMotion, D. (2017, October 2). Successful trial integration of DHL Parcelcopter into logistics chain. *DHL InMotion*. Retrieved March 15, 2024, from https://inmotion.dhl/en/dr1/article/successful-trial-integration-of-dhl-parcelcopter-into-logistics-chain	
16. E-cargo bikes for last-mile delivery might make motorized vehicles redundant.	development	Technological	EAV Solutions. (2023, October 31). *EAV – Powered by people	EAV Cargo Bikes - Transforming Logistics*. EAV. Retrieved March 15, 2024, from https://eav.solutions/	
17. Underground delivery pipeline system for parcels might make all distribution traffic redundant.	development	Technological	Magway. (2023). *Magway	Sustainable goods transport*. Retrieved March 15, 2024, from https://www.magway.com/	
18. Third-party involvement: porter service to reduce transport costs.	development	Economical	Taylor & Francis. (2023). *Improving last-mile parcel delivery through shared consolidation and portering: A case study in London : WestminsterResearch*. https://westminsterresearch.westminster.ac.uk/item/w3vzy/improving-last-mile-parcel-delivery-through-shared-consolidation-and-portering-a-case-study-in-london	
19. People want fast and qualitative delivery service.	principle	Sociological		
20. The goal that all vehicles should be 100% CO2 neutral by 2050.	development	Environmental	European Parliament. (2023a, February 13). *EU-verbod op de verkoop van nieuwe benzine- en dieselauto's vanaf 2035 uitgelegd	Onderwerpen	Europees Parlement*. Onderwerpen	Europees Parlement. Retrieved April 2, 2024, from https://www.europarl.europa.eu/topics/nl/article/20221019STO44572/eu-verbod-op-de-verkoop-van-nieuwe-benzine-en-dieselauto-s-vanaf-2035-uitgelegd	

Name	Tags	Multi-select	Description	Date
21. Wind and solar energy are almost certain to grow faster than any other energy source.	development	Technological	*Global Trends 2040*. (2021, March). Retrieved March 19, 2024, from https://www.dni.gov/files/ODNI/documents/assessments/GlobalTrends_2040.pdf	
22. Data will serve an ever more critical role in the shopping journey of tomorrow's consumer.	development	Technological	Euromonitor. (2021, October). *Commerce 2040: The Future of the Retail store in a digital. . .* Retrieved March 19, 2024, from https://www.euromonitor.com/commerce-2040-the-future-of-the-retail-store-in-a-digital-world/report	
23. Hyper-local e-commerce delivery models. Direct delivering of goods from seller to costumer.	development	Technological	Shipsy. (2023, January 9). *Hyperlocal Delivery- what it is and how it is done*. Retrieved March 19, 2024, from https://shipsy.io/blogs/hyperlocal-delivery-what-it-is-and-how-it-is-done/	
24. People want low shipping costs and short delivery waiting times.	principle	Sociological	Melton, J. (2017, March 27). *Consumers want free shipping, and they're not willing to wait very long for delivery*. Digital Commerce 360. Retrieved March 19, 2024, from https://www.digitalcommerce360.com/2017/03/27/consumers-want-free-shipping-and-theyre-not-willing-to-wait-very-long-for-delivery/	
25. Truck drivers want a truck that improves overall safety.	principle	Sociological	User interview	
26. Truck drivers need facilities to have a proper rest/break.	principle	Sociological	User interview	
27. Bigger vehicles directly linked to higher death rate among pedestrians.	principle	Biological and health	Jonathan, M. (2024, January 24). Tall vehicle hoods really are increasing pedestrian deaths. *WIRED*. Retrieved March 19, 2024, from https://www.wired.com/story/tall-truck-suv-hoods-pedestrian-deaths/	
28. Practicality and safety are key in new EVs, transparent displays can become key to improve cockpit user experience.	development	Technological	*Transparent displays come into focus*. (2024, February 8). WardsAuto. Retrieved March 19, 2024, from https://www.wardsauto.com/industry-news/transparent-displays-come-focus	
29. Transparent trucks projecting blindspot to improve road safety.	development	Technological	Savov, V. (2015, June 21). Samsung makes big trucks transparent in the name of road safety. *The Verge*. Retrieved March 19, 2024, from https://www.theverge.com/2015/6/21/8820059/samsung-road-safety-truck-prototype	
30. Remaining Diesel vehicles with AdBlue to reduce harmful emissions.	development	Environmental	Eurol. (2024). *Wat is de functie van AdBlue?* Retrieved March 19, 2024, from https://www.eurol.com/nl/actueel/kennisartikelen/wat-is-de-functie-van-adblue	
31. More charging stations will become available for E-trucks.	development	Technological	Port of Rotterdam. (2024). *Charging station for electric trucks*. Retrieved March 19, 2024, from https://www.portofrotterdam.com/en/port-future/energy-transition/making-logistics-chains-more-sustainable/charging-station-for	
32. Fast cycling lanes connecting cities, more priority will be given to cyclists.	development	Political	ECF. (2016, October 5). *Fast cycling routes*. Retrieved March 19, 2024, from https://ecf.com/what-we-do/urban-mobility/fast-cycling-routes	
33. One big truck-park near the city center for all trucking facilities to enhance the efficiency (charging,	development	Technological	SNAP. (2024). *Truckpark of the future*. Snapacc. Retrieved March 19, 2024, from https://snapacc.com/truckpark-2049/	

Name	Tags	Multi-select	Description	Date
washing, parking, battery-swapping, driver support etc.)				
34. People get annoyed when obstacle is blocking the way, they want a smooth journey with the least resistance.	principle	Psychological	Feeling that everybody has	
35. Eye contact is an important communication tool for safety. Direct vision is in that sense better than indirect vision.	principle	Biological and health	Loughborough Design School. (2016). *Eliminating truck blind spots – a matter of (direct) vision.* Retrieved March 21, 2024, from https://www.transportenvironment.org/wp-content/uploads/2021/07/2016_07_Trucks_direct_vision_briefing_FINAL_0.pdf	
36. Hesitancy about AI tech will vanish. No perceived safety concerns for VRUs (Vulnerable road users) around automated vehicles compared to HOVs (human operated vehicles).	principle	Psychological	Hulse, L. (2023). Pedestrians' perceived vulnerability and observed behaviours relating to crossing and passing interactions with autonomous vehicles. *Transportation Research Part F: Traffic Psychology and Behaviour*, *93*, 34–54. https://doi.org/10.1016/j.trf.2022.12.007	
37. The rise of the physical internet: fully functional and operating open logistics networks where there is less focus on organisations and more on people working together.	development	Technological	ETP ALICE. (2015, February 18). *Towards Physical Internet Implementation: ALICE research and innovation roadmaps* [Video]. YouTube. https://www.youtube.com/watch?v=4vc7XoEYUs8	
38. People value freedom. Driving a truck gives a sense of freedom and empowerment.	principle	Psychological	user interview	
39. The DAF feeling: the sense of comfort and space.	principle	Psychological	user interview	
40. The appearance of the truck has impact on the client (associated with quality service).	principle	Psychological	user interview	
41. The driver experiences a sense of responsibility because he is accountable while driving the truck (more risk in the city).	state	Psychological	user interview	
42. Calm headspace. 70% of drivers believe that a quieter cabin would improve their mood and reduce stress during time spent in the car.	principle	Psychological	Zapmap. (2023, December 4). New study suggests EVs are less stressful to drive than noisy conventional cars. *Zapmap*. Retrieved April 2, 2024, from https://www.zap-map.com/news/new-study-suggests-evs-are-less-stressful-than-noisy-conventional-cars/	

Aa Name	Tags	Multi-select	Description	Date
43. Having overview of the road is of highest priority to guarantee safety.	principle	Biological and health	user interview	
44. Drowsiness of the driver will be monitored in the future.	development	Technological	user interview	
45. Electrical trucks will become as affordable as diesel trucks in the future.	development	Economical	Busch, C. (2024, March 7). Electric trucks will be cheaper than diesel – years faster than expected. *Forbes*. Retrieved March 25, 2024, from https://www.forbes.com/sites/energyinnovation/2024/03/06/electric-trucks-will-be-cheaper-than-diesel--decades-faster-than-expected/?sh=6d903b24bcac	
46. All the administration will be done via the boardcomputer. Paperwork will be redundant.	development	Technological	Trimble transport and logistics. (2024). *Manage your fleet with on-board computers – Trimble Transport & Logistics*. trimbletl.com. Retrieved March 25, 2024, from https://www.trimbletl.com/fleet/on-board-computers/	
47. Truck drivers need to have a minimum amount of resting time to operate safely.	principle	Biological and health	user interview	
48. Driving in urban areas is riskier than in rural areas.	principle	Demographical	user interview	
49. Advanced Driver Assistance Systems (ADAS) to reduce human error as a standard element in each vehicle.	development	Technological	Bogdanov, V. (2023, May 31). *Advanced Driver Assistance Systems Development: current trends and future Outlook*. rinf.tech. Retrieved March 25, 2024, from https://www.rinf.tech/advanced-driver-assistance-systems-development-current-trends-and-future-outlook/	
50. Solar powered cars and trucks.	development	Environmental	*Solar-powered cars	TNO*. (2024). tno.nl/en. Retrieved March 26, 2024, from https://www.tno.nl/en/sustainable/renewable-electricity/integrated-solar-safety/solar-powered-cars/	
51. Battery swapping (BaaS: Battery as a Service).	development	Economical	Scott, D. (2024, March 19). *In China, a growing body of real-world data on electric trucks - International Council on Clean Transportation*. International Council on Clean Transportation. Retrieved March 26, 2024, from https://theicct.org/china-growing-rw-electric-trucks-mar24/	
52. ATMS: Advanced Traffic Management Systems. Smart transportation systems in urban areas.	development	Technological	MarkWide Research. (2024, January). *Advanced Traffic Management System (ATMS) Market 2024-2032	Size,Share, Growth*. Retrieved March 26, 2024, from https://markwideresearch.com/advanced-traffic-management-system-atms-market/	
53. MaaS (Mobility as a service).	development	Economical	Rijkswaterstaat. (2024). *Factsheet Mobility as a Service (MAAS)*. Duurzame Mobiliteit. Retrieved March 26, 2024, from https://rwsduurzamemobiliteit.nl/slag/toolbox-slimme-mobiliteit/factsheet-mobility-as-service-maas/	
54. People are in need of more sustainable living environments and with that sustainable urban transport.	trend	Environmental	Filippi, F. (2022). A Paradigm Shift for a Transition to Sustainable Urban Transport. *Sustainability, 14*(5), 2853. https://doi.org/10.3390/su14052853	
55. Governments are installing zero-emmission zones.	trend	Political	*Vanaf 2025 zero-emissiezones in steden*. (n.d.). Ondernemersplein. https://ondernemersplein.kvk.nl/vanaf-2025-zero-emissiezone-in-veel-steden/	

Aa Name	Tags	Multi-select	Description	Date
56. Global truck driver shortage.	trend	Demographical	IRU. (2024, March 4). Global truck driver shortage to double by 2028, says new IRU report. *International Road and Transport Union*. Retrieved March 26, 2024, from https://www.iru.org/news-resources/newsroom/global-truck-driver-shortage-double-2028-says-new-iru-report	
57. Supermarkets are committing to 100% electrical distribution, focus on sustainability as a marketing tool, but also to safe costs.	development	Environmental	*Albert Heijn doet proef met elektrische vrachtwagens - ManagementSite*. (2019, February 18). ManagementSite. Retrieved March 27, 2024, from https://www.managementsite.nl/de-laatste-meter/albert-heijn-doet-proef-met-elekrtische-vrachtwagens	
58. Sales in electrical vehicles rising.	trend	Economical	ACEA - European Automobile Manufacturers' Association. (2024, February 13). *New commercial vehicle registrations: vans +14.6%, trucks +16.3%, buses +19.4% in 2023*. Retrieved March 6, 2024, from https://www.acea.auto/cv-registrations/new-commercial-vehicle-registrations-vans-14-6-trucks-16-3-buses-19-4-in-2023/	
59. Euro 7: stricter emission regulations. From 2031 for trucks.	development	Environmental	European Parliament. (2023, December 18). *Euro 7: Deal on new EU rules to reduce road transport emissions	News	European Parliament*. Europarl.europa. Retrieved March 27, 2024, from https://www.europarl.europa.eu/news/en/press-room/20231207IPR15740/euro-7-deal-on-new-eu-rules-to-reduce-road-transport-emissions	
60. Trucking companies in a race to zero.	trend	Environmental	Transport & Environment. (2023, June 19). *Scania, Mercedes, MAN the only EU truck brands on track to decarbonise*. Retrieved March 6, 2024, from https://www.transportenvironment.org/discover/scania-mercedes-benz-man-the-only-eu-truck-brands-on-track-to-decarbonise-study/	
61. Improvements in the logistic system. Backhauling, co-loading, use of HCVs and more.	development	Technological	*The Future of Trucks – Analysis - IEA*. (2017). IEA. Retrieved March 6, 2024, from https://www.iea.org/reports/the-future-of-trucks	
62. Urban consolidation centers (UCCs) reducing freight traffic in a target area and reducing logistic costs.	development	Economical	Dreischerf, A. J., & Buijs, P. (2022). How Urban Consolidation Centres affect distribution networks: An empirical investigation from the perspective of suppliers. *Case Studies on Transport Policy*, *10*(1), 518–528. https://doi.org/10.1016/j.cstp.2022.01.012	
63. Cities are sprawling, lots of road congestions and transport movement.	trend	Demographical	OECDiLibrary. (2024). *4. Transformational Change #2: from sprawl to proximity*. Oecd-ilibrary. Retrieved March 5, 2025, from https://www.oecd-ilibrary.org/sites/6a44f843-en/index.html?itemId=/content/component/6a44f843-en	
64. People need to feel safe and secure.	principle	Psychological	Feeling that everybody has	
65. The street is a social and open space for everyone.	principle	Sociological	Feeling that everybody has/should have	
66. Customers appreciate to get their orders delivered sustainably as it gives self gratification to know the footprint of the order is lower.	state	Psychological	User interview	
67. People enjoy driving EVs and would not go back to driving diesel/petrol vehicles. They	trend	Psychological	Zapmap. (2023a, December 4). New poll shows high satisfaction among EV drivers. *Zapmap*. Retrieved April 2, 2024, from https://www.zap-map.com/news/new-poll-satisfaction-electric-vehicles	

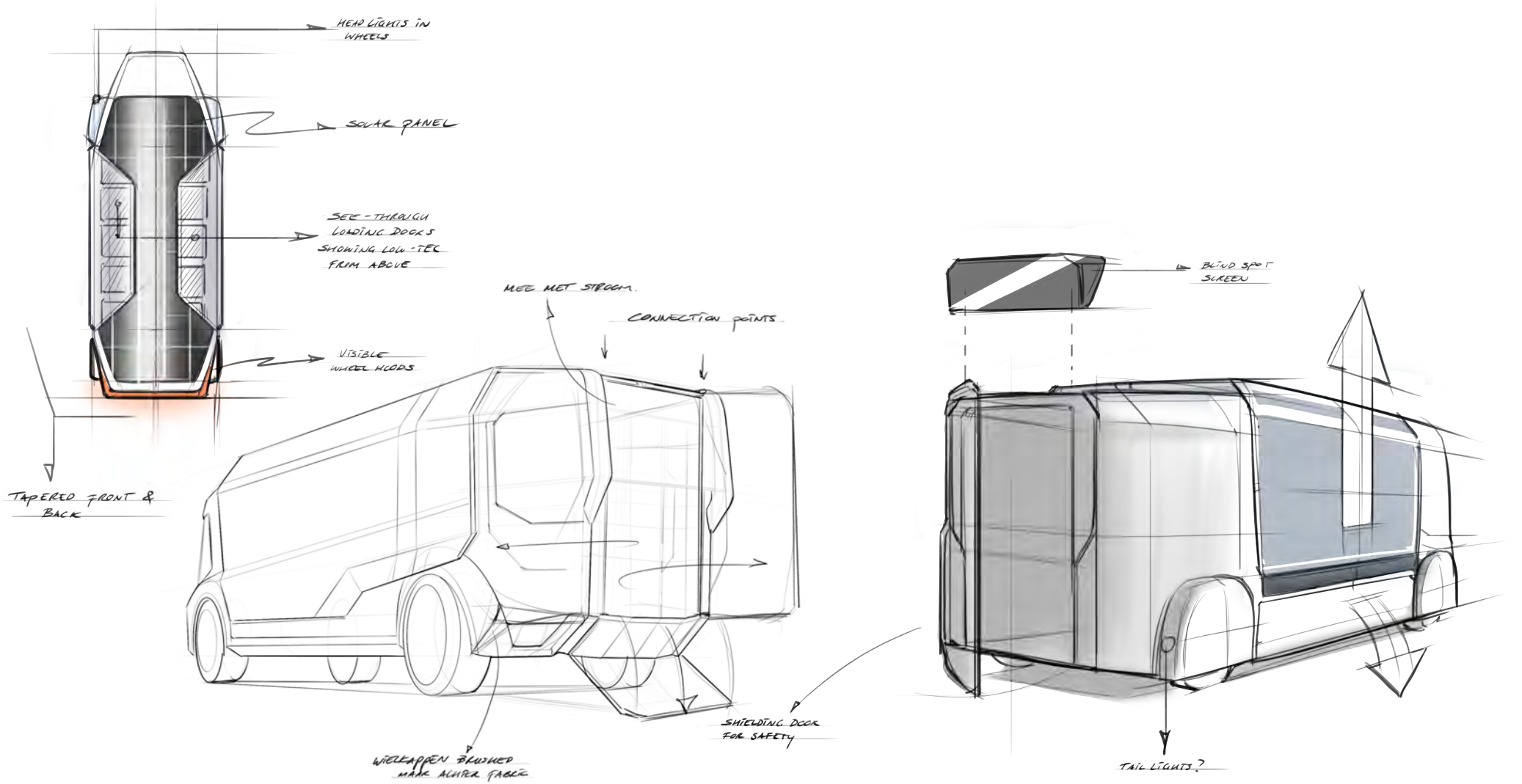
Name	Tags	Multi-select	Description	Date
appreciate the electric driving experience.				
68. More (XXL) distribution centers taking up more square meters to fulfil e-purchasing demand.	principle	Economical	Verweij, K. (2018, June 1). Top 100 Logistiek Dienstverleners: 'Onder de oppervlakte broeit het.' *bciglobal.nl*. Retrieved April 2, 2024, from https://www.bciglobal.nl/nl/top-100-logistiek-dienstverleners-onder-de-oppervlakte-broeit-het	
69. More leeway in driving licenses. Because entrepreneurs are encouraged to purchase electric vans, the drivers of zero-emission vehicles with license B are now allowed to drive electrical vans til a maximum weight of 4250kg.	trend	Political	Transport en Logistiek Nederland. (2023, March 14). *Nieuwe vrijstellingsregeling voor ZE-bestelauto's tot 4250 kg - Transport en Logistiek Nederland*. Transport En Logistiek Nederland. Retrieved April 2, 2024, from https://www.tln.nl/nieuws/nieuwe-vrijstellingsregeling-voor-ze-bestelautos-tot-4250-kg/#:~:text=Bestuurders%20met%20een%20B%2Drijbewijs,vrijstelling%20van%20het%20C%2Drijbewijs.	
70. Truck drivers (vocational and distribution) care more about maneuverability, cab height, direct vision and comfort than about vulnerability.	trend	Psychological	User interviews	
71. Private ownership of vehicles is decreasing as lease services are rising.	trend	Demographical	FleetNews. (2021, November 29). *Private vehicle ownership falls by 42% in Europe as leasing grows*. https://www.fleetnews.co.uk/news/leasing-news/2021/11/29/private-vehicle-ownership-falls-by-42-in-europe	
72. Majority of transport jobs held by men.	trend	Demographical	Eurostat. (2020, April 21). Majority of transport jobs held by men. *Eurostat*. Retrieved April 2, 2024, from https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20200421-1	
73. Poor hygiene facilities for chauffeurs leads to annoyances among chauffeurs.	trend	Psychological	Gowans, G. (2021, August 10). Haulier slams disgusting truck stop toilets amid Europe's growing driver shortage. *trans.info*. Retrieved April 4, 2024, from https://trans.info/en/haulier-slams-disgusting-truck-stop-toilets-amid-europe-s-growing-driver-shortage-247276	
74. The driving public perceives big commercial vehicles as dangerous and feels unsafe when driving in proximity of a truck.	principle	Psychological	Admin. (2020, September 22). *Nervous when driving near trucks? These tips will keep you safe — Every Little Thing Birth and Beyond 360 magazine*. Every Little Thing Birth and Beyond 360 Magazine. Retrieved April 5, 2024, from https://www.birthandbeyondmagazine.com/lifestyle-news-blog/nervous-when-driving-near-trucks-these-tips-will-keep-you-safe	
75. Drivers from Eastern Europe brought to Western Europe to drive with low hourly wage.	trend	Demographical	International Transport Workers Federation. (2024). *Exposed: European trucking's systemic exploitation of workers*. ITF Global. Retrieved April 4, 2024, from https://www.itfglobal.org/en/sector/road-transport/european-trucking-exploitation-of-workers	
78. 52% of truck drivers report fatigue and want to take more breaks, however they are unable to do so due to poor working conditions	trend	Biological and health	European Transport Workers' Federation. (2022, December 8). *Driver fatigue - ETF: European Transport Workers' Federation*. ETF: European Transport Workers' Federation. Retrieved April 4, 2024, from https://www.etf-europe.org/activity/bus-and-coach-road/	

Name	Tags	Multi-select	Description	Date
79. More private owned SUVs on the road, giving users the egocentric perception of personal protection while comprimising on public safety.	trend	Psychological	Thomas, J. A., & Walton, D. (2008). Vehicle size and driver perceptions of safety. *International Journal of Sustainable Transportation*, *2*(4), 260–273. https://doi.org/10.1080/15568310701359015	
80. Citizens are becoming more important to get involved with urban planning to achieve a liveable environment.	trend	Political	Bouma, J., De Hollander, G., Van Doren, D., & Martens, A. (2023). Betrokken burgers – Onmisbaar voor een toekomstbestendige leefomgeving. In *Signalenrapport*. PBL Planbureau voor de Leefomgeving. Retrieved April 4, 2024, from https://www.pbl.nl/sites/default/files/downloads/pbl-2023-betrokken-burgers-signalenrapport-4957_1.pdf	
81. Customers are willing to consolidate on delivery waiting times for a better price. (Willing to pick deliveries up at a parcel drop off point for example or wait longer when charged for next day delivery). They need an incentive to make a more ethical choice.	trend	Psychological	Kokkinou, A., Quak, H., Mitas, O., & Mandemakers, A. (2024). Should I wait or should I go? Encouraging customers to make the more sustainable delivery choice. *Research in Transportation Economics*, *103*, 101388. https://doi.org/10.1016/j.retrec.2023.101388	
82. The use of cars is becoming less and less, people are trying out different modes of mobility (car sharing, electrical bikes etc).	trend	Demographical		
83. The new standard is that people will work more remotely in the future.	trend	Demographical		
84. Internet of Things: hyper connectivity of devices exchanging data.	trend	Technological		
85. "The smart home of the mid-21st Century will be a hub in the Internet of Things (IoT)."	trend	Technological	Hammond, R. (2019). Super-Smart Living: the mid 21st century home. In *allianz-partners.com*. Retrieved April 5, 2024, from https://www.allianz-partners.com/content/dam/onemarketing/awp/azpartnerscom/new-zealand/reports/Allianz-Partners-The-World-in-2040-Super-Smart-Living.pdf	
86. People are social beings: unexpected pleasant encounters on the street continue to be seen as small moments of happiness.	principle	Sociological		
87. People live in their own bubble: Urban planners will have to think about the coming together of population groups (meeting possibilities) as the gap between rich and poor residents continues to	trend	Sociological	NOS. (2024, April 4). *Arm en rijk in Eindhoven: "Mensen leven een beetje in hun eigen bubbel"* [Video]. NOS. Retrieved April 5, 2024, from https://nos.nl/video/2515518-arm-en-rijk-in-eindhoven-mensen-leven-een-beetje-in-hun-eigen-bubbel	

Name	Tags	Multi-select	Description	Date
widen and the groups do not interact.				
88. People are slowly moving away from the mass consumption culture as customers are more critically aware and demand better durability of goods and services.	trend	Cultural	PricewaterhouseCoopers. (2023, February). *69% of consumers hold back on non-essential spend as cost of living rises; 90% adopt cost-saving behaviours: PwC Consumer Insights Survey.* PwC. Retrieved April 5, 2024, from https://www.pwc.com/gx/en/news-room/press-releases/2023/global-consumer-insights-pulse-survey-february-2023.html	
89. Future shopping in the metaverse. The customer experience will take place in a virtual space.	development	Technological	IAB - Interactive Advertising Bureau. (2023, August 8). *Virtual shopping in the metaverse* [Video]. YouTube. Retrieved April 5, 2024, from https://www.youtube.com/watch?v=YpU6A0LST6g	
90. Gamification will have a key role in sales as customers attentionspans are decreasing and brands need to make incentives for customers to interact with their brand.	development	Technological	Trend Hunter Inc. (2024). *Trend Hunter Consumer Insights - Gamification megatrend.* Retrieved April 5, 2024, from https://www.trendhunter.com/megatrend/gamification	
91. People are losing trust in big organisations and governments. They want full transparency and honesty.	trend	Cultural		
92. Mindfulness. Living in the now as a counterreaction to the online world.	trend	Psychological		
93. People do not like big sudden changes as we are all creatures of habit.	principle	Psychological		
94. The risk of damaging customer trust. Once a company lets a customer down, it is hard to regain his trust.	principle	Psychological		
95. People give more importance to self-care and mental well-being.	trend	Biological and health		
96. People feel the need to have a purpose in life to stay motivated and happy. It is not only about a good paycheck.	principle	Psychological		
97. Since COVID19 the importance of health and hygiene has become	trend	Biological and health		

Name	Tags	Multi-select	Description	Date
more evident and will be in the future.				
98. People need certainty: the feeling that they made the right decision is comforting.	principle	Psychological		
99. People get happier in nature. Interacting with nature has been proven to increase serotonin levels.	principle	Biological and health		
100. We are social animals. People have the natural desire/need to belong to a group.	principle	Sociological		
101. Cultural differences create different degrees of individualism in society.	principle	Cultural	Sociaal en Cultureel Planbureau. (2004). *Individualisering en sociale integratie* (P. Schnabel, Ed.). https://repository.scp.nl/bitstream/handle/publications/1045/Individualisering_en_sociale_integratie.pdf?sequence=1&isAllowed=y	
102. People are rethinking the importance of community and want a stronger sense of belonging and resonating with each other.	trend	Cultural		
103. People experience nuisance from noise and smell from trucks in public spaces.	principle	Demographical	Omroep Brabant. (2019, May 21). *Bewoners hebben last van lawaai en stank door aardappelhandel: "Het lijkt wel een soort lijklucht."* Retrieved April 5, 2024, from https://www.omroepbrabant.nl/nieuws/3001806/bewoners-hebben-last-van-lawaai-en-stank-door-aardappelhandel-het-lijkt-wel-een-soort-lijklucht	
104. People show respect and gratitude to workers delivering their products.	principle			
105. More women in truck jobs in the future answering to the current demand for women in trucker jobs and more gender equality.				
105. Smart unloading zones, making it easier for couriers to deliver goods. "Coding the curbs". Making the process smart.	trend	Technological	Coding the Curbs. (2023, September 14). *Coding the Curbs - Smart Zone Explainer - English* [Video]. YouTube. Retrieved April 5, 2024, from https://www.youtube.com/watch?v=7WlEKLtczU4	
106. City inhabitants are experiencing nuisance from loading and unloading vehicles double parked on the pavement or street.	trend	Demographical	Altenburg, M., & Ploos Van Amstel, W. (2017, February). *DPG Media Privacy Gate*. Parool.nl. Retrieved April 5, 2024, from https://www.parool.nl/columns-opinie/laden-en-lossen-kan-echt-met-minder-problemen-en-overlast~b4e9a249/	

Aa Name	Tags	Multi-select	Description	Date
107. Heavy vehicles will be restricted to enter the inner city. Exemptions apply for transport vehicles heavier than 7.5 tonnes in city centres.	principle	Political	Gemeente Amsterdam. (2024). *Zwaar verkeer*. Amsterdam.nl. Retrieved April 5, 2024, from https://www.amsterdam.nl/verkeer-vervoer/zwaar-verkeer/	
108. Heavier road vehicles				
109. People like to show off with stuff.	principle			
110. Operators of distribution companies want to reduce logistics costs as much as possible.	principle	Economical		
Untitled		Environmental		


HEAD LIGHTS IN WHEELS
SOLAR PANEL
SEE-THROUGH LOADING DOORS SHOWING LOW-TEC FRAM ABOVE
VISIBLE WHEEL MOORS
TAPERED FRONT & BACK
MEE MET STROOM.
CONNECTION POINTS
WIELKAPPEN BRUSHED MARK ACHTER FABRIC
SHIELDING DOOR FOR SAFETY
BLIND SPOT SCREEN
TAIL LIGHTS?


Rotation

Interview notes

Interview notes Walther Ploos van Amstel

- The assignment box trucks of the future is a lot more interesting than the smaller trucks though, DAF also has a big dominance in that from NL just from their origins and that's where we will see the biggest developments in vehicle technology and DAF is horribly behind so we might be a bit interested
- Specific distribution segment is very important, retail is a good option. Then you just have to decide ambient (dry products only) or also vehicles that can carry chilled products and frozen. And small retail food and city stores or larger ones that only transport pallets and roll containers (think HEMA and companies like that).
- The segment is always mixed, in one segment you always see and pallets and roll containers
- Yes good that you think about efficiency and small turning radius, otherwise you won't get into town anymore
- A possible concept that we will get is to work with overhead lines as powersupply, then you need smaller batteries.
- Long distances, hema or a hunkemoller only has 1 central warehouse and deliveries are made from there
- 60% of retail is fashion so that's basically what you have to make it for, so you need a relatively heavy vehicle. Fast charging we will have in the future so you could practically charge within 20 minutes.
- Major development is physical internet, containerisation, so the load carrier is being standardised. The whole concept is that on the outskirts of the city, hubs will work together. That would reduce the need for trucks to deliver in the city centre. There will be robots sorting cargo and therefore the vehicles will also need to travel less distance, so that concept of yours would not need to travel more than 60 km. Definitely the concept you propose, smaller vehicles with bundled for multiple addresses.
- These will become local heroes who will do delivery between 7 and 12 and in the afternoon they will deliver other goods. You could also do catering delivery very well with such a van. And if you look at the number of addresses with a delivery window, it is less than 1% also in Amsterdam. 35% of shipments have a window time and 95% of that is because the customer wants it at that time (they don't want to be open at 7am). There are only 5 streets in downtown Amsterdam with delivery windows. So delivery windows are usually not a big problem. And you can put the vehicles to good use the rest of the day.
Future: There will be more car-free inner cities and car-free residential areas, but if you look at the rate at which that is progressing. Half a per cent of delivery addresses every year. Only new neighbourhoods are going to prohibit heavy duty vehicles.
- Manoeuvrability is very important because we have a lot of damage. Average DHL van has 4 damages a year.
- Ease of unloading. That one is very important. And you see an extreme number of vehicles that are not developed for that. The cargo has to be able to go in and out seamlessly. Some work with a Last Mile Box where the loading part can be seconded from the driving part, Leen Menken has that. You can leave one part behind as a micro hub, which can be picked up later. So a kind of container system. But this is for very low volumes. What they do in London

is the Porter model, where big trucks drive up to the outskirts of the city, put down a container which is delivered out by four third-party delivery drivers. And so that, again, comes down to cooperation between logistics companies. Sligro also uses this concept with stop & go. Only with this train you cannot manoeuvre backwards, so in that sense it is not a suitable vehicle.

- First I was on walk-through methods but that's not so practical. - No indeed, this would only be useful for parcels. Look at the picnic cars, the future is that unloading is done on the outside. What is important though is keep in mind that vehicles are increasingly carrying parcels in addition to rolling containers and pallets. Retail is a segment with a huge mix in types of cargo.
- Symmetrical unloading system also wouldn't work indeed, as something often returns at each address. So you are indeed faced with that Tetris problem you describe.
- I think we will have no more pallets in 10 years' time. Because there will be such robotisation in retail and that robotisation does not work well with pallets. Pallets also get in the way a lot for retail, roller containers don't. For retail, about 90% is done with roll containers. Those are also easy to remove from the warehouse.
- Second functionality. Indeed, the role becomes too complicated. The decoupling does make sense: the person who transports the load and the person who does the final delivery. But this second person is not necessarily in the vehicle.
- You don't need to aerodynamically style the vehicle. You have so little mileage.
- It's also not going to happen that the city would function without trucks. The municipality has to keep up maintenance on the city (for example fixing the quay walls in Amsterdam which you can't do that with small vehicles), it would cost too much. The same goes for waste collection, waste is worthless so you want to collect as cheaply as possible. We are not going to see a truck-free city in the future. You will always need some type of vehicle that can carry 10-15 rolling containers.
- The servant role: they are guests in the city. A kind of butler concept. He should indeed become invisible and blend into the environment. But clearly offer a service to the people at the addresses where you deliver. - I find that idea of being a guest and being invisible very strong.
- It is not feasible that all distribution would be solved indoors. It will be outside on the street.
- Add unloading direction. You would definitely reduce loading time with it. In catering, you already see that many trolleys have a door in the side, but certainly with this concept you would be very flexible and the distance to the door would be reduced. The municipality will also rearrange the loading and unloading areas better so that there is more space for unloading in this way. The more you can open up the vehicle the more efficiently you can use it. And also the easier it is for the driver, because if you look at driver absenteeism, it is considerably high due to all the lugging of pallets and roll containers.
- The kerb will disappear because there are far too many accidents with cyclists, you can already see that happening in cities. So you will have to lower on the platform to the street.
- You are working with a vehicle which basically has a very large low loading floor, which is quite efficient.
- The bridges in Amsterdam are very steep though so you have to have enough ground clearance.
- 90% of fine dust on the street comes from tyres. So the tyres have to be non-wearing and circular.

- Posad Maxwan assumes that you get a mixed streetscape and solve distribution at street level. Look the idea is, if you have to unload on the street anyway what cleverness can I bring to that? And that's what this concept does. You want the interaction to be better with people and get out as quickly as possible.
- A screen that shows what is happening at the front is ideal for promoting safety.
- You want to be able to use both sides because you have a lot of streets with one-way traffic. Then you want to be able to access it from both sides.
- Look you don't want to annoy people in your presence, so you want to blend more into the street scene. But for safety, you do want to be visible. A bright yellow DHL van does stand out.

Interview notes Theo

Theo (working for PeterSlits Transport distribution to city centers, experience: 45 years truck driver experience), rides a CF

- Time is key: Delivering to 10-20 customers per day. More than 40 times getting in and out of the vehicle. Loading and unloading has to be quick. Navigating has to go smooth (knowing the neighborhood helps a lot).
- Turning radius has to be small as there are very small streets in the city centers so a shorter wheelbase is preferred. Cars parked next to the water and you veer out even further with the back of the car so you have to watch out not to damage anything. Sometimes trailer with handlebar axes is more practical as it breaks up the wheelbase. Shorter wheelbase = smaller vehicle = more maneuverable.
- Electrical charging impossible during distribution work. No charging stations where a truck fits in the city center. (Truck does not fit under the usual charging stations). "AdBlue works best with diesel now. Use of tailgate and lighting also uses electricity, so not economically viable.
- Tailgate most efficient way of removing load as the load is ordered in chronological order and two pallets fit on the tailgate. The first order to deliver is nearest to the tailgate. Not always in chronological order! Sometimes one pallet stands in the way for a long time. Tailgate behind the truck is most safe for other road users as well.
- Direct vision is a plus. New cabs already have the see-through window which is perfect because you can see everything through the door.
- Sense of freedom that comes with the responsibility of executing the job.
- "Mensen fietsen gewoon door in de stad, die kijken gewoon niet of je eraan komt."
- "Difference between city and regular driving: in the city, you have to keep locking the doors all the time, otherwise, it might get stolen. That's why easy opening and closing is important; a sliding door is quite handy."
- "Every day follows a set route, so you become familiar with all those customers and people."
- "Getting in and out happens frequently, that's why I have a CF; it has a low entry point, which is much easier and saves time and effort."
- Bestelbusjes veel beperktere lading 3 meter vs 6 meter mijn CF. Wat ook veel gebeurt is in kleinere busjes verdelen.
- "Weggebruikers worden af en toe een beetje boos, want de mensen hebben geen geduld. Mensen lopen gewoon tegen je aan. Maar dat is het werk. Met mooi weer kan je een lekker broodje halen ergens in de stad, dus dat is het mooie."
- Preference for DAF: lots of space and comfort. The DAF-feeling:

"je zit lekker rustig en je kijkt om je heen. Betere service ze komen je gelijk helpen. Minder problemen met DAF dan met SCANIA."

- Always sleepcab integrated because it's more lucrative for resale.
- "Geen enkel merk kan op tegen het bed van DAF"

Interview notes Rob and Jan

Rob en Jan (distribution in rural areas for Euser and PeterSlits transport, Rob: 8 years experience, Jan: more than 50 years experience) heft wel binnenstad distributiewerk gedaan

- Comfort also important for distribution. Taking a break 30-45 minutes is mandatory. Break in truck often, with nice weather outside at a gas station / parking area. Nice to be able to take a nap (even if it is only 10 minutes).
- Rob "distributie in de binnenstad zou ik niet eens willen, want ik wil geen fietser doodrijden en altijd geouwehoer met auto's en schades die je maakt en de tijden in bepaalde gebieden moet je zo laat erin en zo laat er weer uit zijn. Heel andere beleving als chauffeur om binnenstad werk te doen dan buitenstad. Veel stressvollere beleving."
- "liever stoerdere grotere auto op snelweg, dan kleinere auto en het risico moeten opzoeken"
- "Je moet 21h naar bed, probeer dat maar eens"
- Mercedes of DAF. Voorkeur: SCANIA; "hele fijne auto, neusje van de zalm"
- "Mensen kijken boos wat doet die stinkvrachtwagen hier, sommige tonen respect want ze weten die komt spulletjes brengen."
- "Bestuurbare camera's zou fijn zijn, camera achter op de oplegger. Bij aandokken is het lastig in te schatten hoe ver ben ik nog van dock af. Gepiep is irritant."
- Straat indraaien met bakwagen, nauwe straatjes, achterste wiel meer naar voren dan zwaait hij meer uit. Zo kan je schade maken. Schadeformulier invullen, mag je aansluiten bij een cursus van de verzekeraar. "
- Elke middag slaap ik een uurtje dat is heerlijk. Distributiechauffeurs moeten net zo goed pauze houden. Kunnen slapen is belangrijk al is het maar 10 minuten. Slaapcabine belangrijk.
- "Kortere draaicirkel door kortere wielbasis, maar container langer door: zwenkt hij meer uit. Liever een trailer dan want door knik kortere draaicirkel. Met trailer zit de as vaak verder naar achter."

Interview notes Drive along Piet

Drive along distribution with Piet (working for ID Logistics in rural areas: de Kempen, experience: 4 years eperience)

- Sight = main premise / starting point. Counting the amount of cyclists first in the mirror and second after passing by is a necessity, only way to grand safety. There are cameras and radar sensors, but your own observations are most trustworthy. Systems still have some fault rate.
- Having the overview is really important: for outer city use it is preferred to sit higher to see over roundabouts for example. But for inner city use it is important to sit more at eye height with VRUs to reduce blind corners.
- Efficiency: everything is done with the boardcomputer (navigating, scanning parcels, order list). Increasingly less paperwork onboard due to digitalization.
- "Lots of improvement space for efficiency of logistics, sometimes 3 different trucks deliver the same type of material for one address as distribution companies don't work together / discuss, still a lot of rivalry between companies."
- Some distribution centers are adopting charging stations, but this is more of a try-out phase because currently electrical vehicles are more expensive than diesel trucks.
- Still the work is about freedom: not being in a hurry and seeing places and recognizing things.
- Delivering pace differs also due to where the pallets can be placed and how fast the documents can be signed by the customer.
- The load differs a lot: amount of parcels / pallets / long material. The amount of collos per customer differs.
- Break: sometimes longer at the customer to drink a coffee (they know their addresses) sometimes at a gas station / parking area. 45 minutes break is mandatory and is monitored.
- Space for 8-12 pallets

Interview notes Drive along Justin

Drive along distribution with Justin in a electrical delivery van (Volkswagen crafter) (wosket maar werkt ook voor cityhub, 2 jaar ervaring)

- No tailgate, so harder to unload because then you have to open up the plastic wrap of the pallet and deliver them separately by use of a trolley (steekkar)
- 11h these poles go up, so before that time you should have done the delivery. No vehicle can cross afterwards unless you have a permit. "Once I was too late to deliver then I had to walk with the packages. And once I was too late to go out of the center, that's quite a hassle because you have to call somebody to lower the poles again."
- 140 km electric afterwards he has to find a fast charger next to the road or at gas stations (quite expensive (45 eu for a full battery)
- "Customers appreciate electrical delivery, they appreciate to get their order delivered sustainably. And they're not too happy about having their package delivered by such a smelly diesel car"
- Knowing the route saves a lot of time, for Amsterdam he gets a route from the manager.
- Space for 3-4 pallets
- "Very often it's completely congested here with trucks and vans."
- "They can be quite cheeky, those cyclists, but I suppose they might say the same about me."
- "Loading the van by yourself is also efficient, because I know exactly what to deliver where."
- Normally he uses an app on his phone for administration, but it had a crash so now he just makes pictures of the delivery receipt.
- "I get a fine for parking on a regular parking spot so you're forced to stop right in the middle of the street."
- "I think the height of this crafter is perfect, I just miss a tailgate"
- "With a regular drivers license you can drive till 500kg (those electrical MB sprinters), but above you have to get a license."
- "This rear-view camera is very convenient."
- Mostly drives alone, sometimes his nephew goes with him. Three seats for his job is a redundancy.
- "Driving electric is really enjoyable, silent easy steering, such a smooth feeling."
- The sight is great: dashboard follows the eye line downwards to the street.
- Actually lots of leg space