# Autonomous Car Interior

## *From Context and Exterior to Lighting and Experience*

Graduation Thesis

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Industrial Design Engineering

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A special highlight of this experience was the opportunity to visit JLR's headquarters in Gaydon, which provided invaluable insights into the company's vision and approach. I am also incredibly thankful for the chance to attend and present my master thesis at The Red Cabin automotive conference in Munich, where I was able to engage with key players in the industry and share my research with a broader audience.

# EXECUTIVE SUMMARY


## PROBLEM

The automotive industry is undergoing a significant transformation due to technological advancements, especially in self-driving vehicles. This shift presents a unique challenge: designing an interior for autonomous vehicles. The goal of this project is to contribute to the change in the automotive industry by redefining the traditional driver-centric experience into a pleasant journey for passengers. Enhancing the user journey experience during long-term journeys while staying true to the Land Rover brand identity is a key focus.

## GOAL

The primary objective of this project is to create a human-centred interior concept for fully autonomous vehicles. This concept aims to promote user comfort and well-being during extended journeys. Several sub-goals support this aim. These include forming a vision of future mobility and defining a unique Land Rover user experience. Understanding user expectations for long-term rides and conducting a market analysis to guide the design direction are also important. Ultimately, the goal is to develop a validated concept through user testing.

## ANALYSIS

The context analysis utilized a DESTEP framework to explore demographic, economic, social, technological, environmental and political factors shaping the mobility sector.

There is an increasing demand for efficient and electric vehicles. This background informs the project its future vision, which predicts a convergence between public vehicles and privately owned cars. The brand analysis of Jaguar Land Rover shows its evolution from utility-focused vehicles to modern luxury offerings. The company emphasizes sustainability and user experience. Both, the future vision and brand focus, present new opportunities for design innovation.

## DESIGN PROCESS

The design direction is based on insights gathered from a context analysis, the Land Rover brand DNA, non-driving-related-taks (NDRT) literature and a concept car market analysis. The focus is on the aesthetic and functional aspects of the autonomous vehicle. This process involved analysing existing (concept) vehicle exteriors and defining key interior functionalities. Concerning the interior, special attention was given to creating an inviting ambiance, particularly in terms of lighting design. This lighting design aims to enhance the overall user experience by supporting the concerning NDRT. The prototyping phase detailed the evolution of both interior and exterior design. Functional elements such as seating, work surfaces, and tailored lighting systems were integrated to meet user needs during long journeys.

## EVALUATION

User testing was conducted to validate the interior lighting concept and assess its impact on user experience and task performance. Results showed that adequate lighting significantly improved the visibility, comfort and mood while working. The overall pleasantness of the environment also increased. Users preferred well-lit settings and provided specific preferences for lighting configurations that reduce shadows and enhance visibility.

Conclusions from the user tests indicated that optimising lighting placement and adjusting light intensity would further enhance the interior design.

## FINAL DESIGN

The design suggests implementing ambient lighting that is placed above and beyond the user. The focus lighting should also be positioned above the passenger but more centred over the seating area. The brilliance layer is mainly integrated into the doors and floor of the vehicle. Additionally, all light layers should have adjustable light characteristics such as intensity and colour. Finally, various lighting scenarios are shown to demonstrate the importance of flexibility for multifunctionality.


## ABBRIVIATIONS

AV
Autonomous Vehicle
CCT
Colour Temperature
EV
Electric Vehicle
JLR
Jaguar-Land Rover
LCD
Liquid Crystal Display
LR
Land Rover
LRX
Land Rover Experience
NDRT
Non-Driving Related Task
OEM
Original Equipment Manufacturer
SAE
Society of Automotive Engineers
SUV
Sports Utility Vehicle

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# PROJECT OUTLINE

## MOTIVATION

In collaboration with Jaguar Land Rover (JLR), the objective of this project is defined. The goal is to design an innovative car interior for a self-driving vehicle. This chapter introduces the design challenge and explores how this cutting-edge technology addresses the future of mobility, with a specific focus on JLR's vision and requirements.

# PROJECT OUTLINE

## COLLABORATION

This report is part of a master graduation project from the faculty Industrial Design Engineering at the Technical University (TU) of Delft. The graduation project at TU Delft is executed in collaboration with Jaguar Land Rover, located in the United Kingdom.

## JLR

Jaguar Land Rover (JLR) is a leading British automaker renowned for its luxury vehicles and robust sport utility vehicles (SUVs). Owned by Tata Motors Group, the house of brands produces cars under the iconic brands Jaguar and Land Rover (Defender, Range Rover and Discovery)see Figure 1. Jaguar is celebrated for its stylish and high-performance luxury cars, while Land Rover is synonymous with off-road capabilities, versatility and comfort (JLR dealership, 2024).

Committed to innovation and sustainability, Jaguar Land Rover is focused on developing electric vehicles and advanced technologies to enhance driving experiences and environmental friendliness (REIMAGINE | JLR Corporate Website, n.d.).
As autonomous driving advances, Jaguar Land Rover is exploring scientifically validated interior designs to enhance the passenger experience in future self-driving cars. This graduation project explores what a future-proof interior, preferred by passengers, might look like, helping JLR stay ahead in innovation.

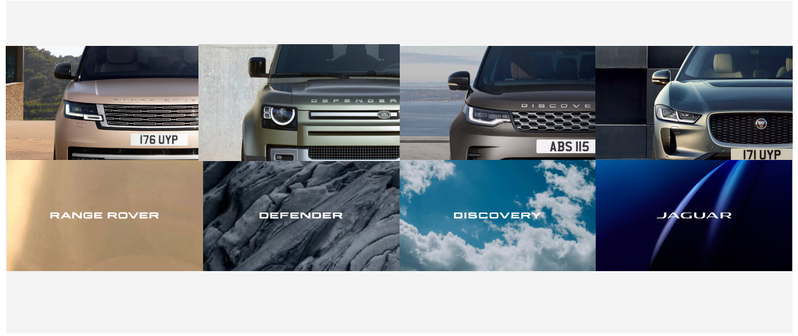



*Figure 1: JLR, House of Brand of Land Rover (Range Rover, Defender and Discovery) and Jaguar*

## AUTONOMOUS VEHICLE CONTEXT

Understanding the levels of automation is crucial for determining the user its ability to intervene during vehicle operation. According to the Society of Automotive Engineers (SAE) different levels of autonomous driving have been classified (Figure 2). The levels range from level 0, meaning fully manual, to level 5, meaning fully autonomous (SAE Levels Of Driving AutomationTM Refined For Clarity And International Audience, n.d.).
JLR specified that the vehicle its interior should be designed for a level 5 autonomous car. The user will thus not control nor be able to interfere with its driving.

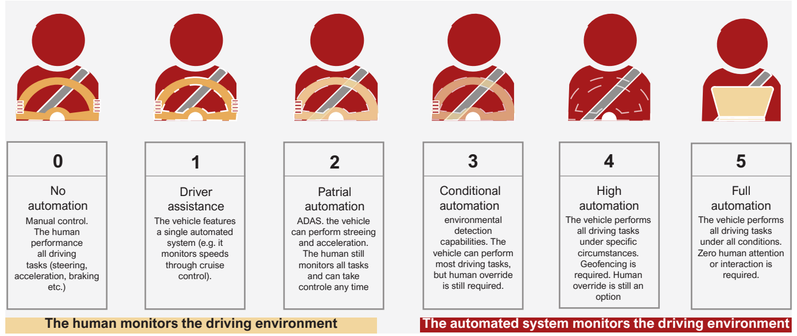



*Figure 2: SAE autonomous driving levels*

## DESIGN CONTEXT

This self-driving capability is a technologically driven development. It influences not only the way we travel but also the role of humans in this travel. No longer driving and no more drivers, but a journey experience with other activities like working, sleeping, looking out the window, socializing, etc. (Fischer et al., 2023; Li et al., 2022; Östling & Larsson, 2019; Wadud & Huda, 2023; Wilson et al., 2021; Wirsching & Fleischer, 2022; Wilson et al., 2022: Lopez Valdes et al., 2020 Koppel et al. 2019).

The current interior has always been based on the presence of a driver and the driving activity. In this conventional interior, the driver is central. The development of new types of vehicles offers interesting opportunities for creating new interiors, not just redefining the driving or passenger experience but the overall journey experience.

## PROBLEM DEFINITION

Designing the interior of an automated vehicle (AV) is not an easy task due to various reasons (Figure 3). The fully self-driving car (SAE level 5) is still far in the future. The technology, legislation, and social acceptance are not yet developed enough for the self-driving car to participate in traffic tomorrow.

Various cars now have SAE level 2+. Only in certain areas in America is it legally allowed for self-driving cars to participate in traffic. There has also been much research into possible non-driving-related-tasks (NDRT), that will be done during the ride. However, it is difficult for test subjects to describe what the (preferred) activities will be since the context does not yet exist.

Additionally, the car is also part of a much larger whole, namely the mobility sector. In this entire sector, self-driving developments, sustainable awareness, urbanization, and gentrification have an impact. Ultimately, the bigger question can be asked: What is the future role of the car within mobility?

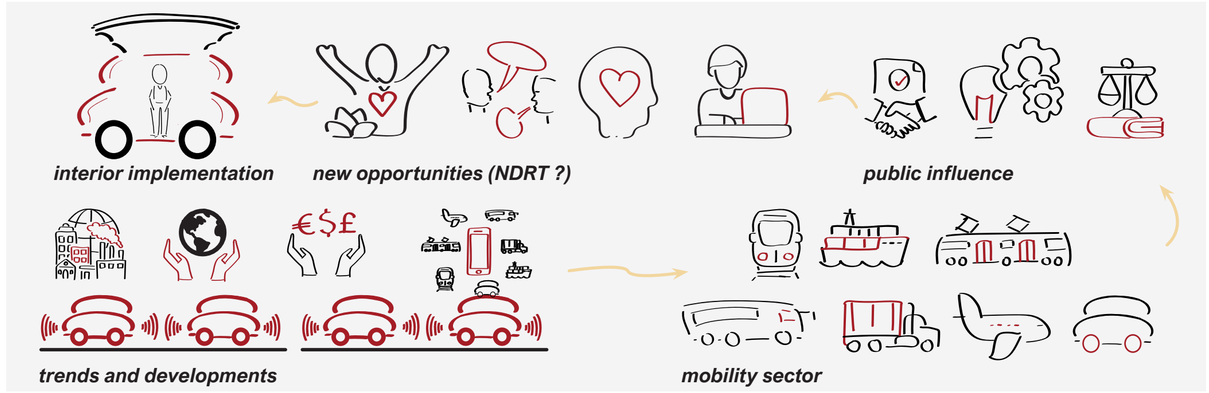



*Figure 3:* fully self-driving car (SAE level 5) is still far in the future *and multiple developments have to be tackled to benifit from it*



## SCOPE

In the automotive sector various levels of automated driving are defined (SAE International, 2021). From the official start of the project, it is discussed with Jaguar Land Rover to explore level 5 autonomous driving for the long-term concept of the ride combined with a human-centred approach. Long-term rides are, for example, defined by Withey (2024) as rides that last over one hour and cover significant distances, often traveling between cities or covering long distances within a city. The direction of the project was found to be interesting. The only further requirements were that sustainability and luxury need to be considered.

Jaguar Land Rover is a house of brands. For this project, based on personal and company preference, the focus is specifically on Land Rover. Specifically, the Defender and Range Rover models (Figure 4). No distinction is made between these models as the basis for the (conceptual) design.

It was also indicated that Jaguar Land Rover wants to design for a niche market. The house of brands does not want to compete with Mercedes but with Ferrari (Withey, 2024). Furthermore, the development of self-driving technology is the driving factor.

## GOAL

The project goal is to design a human-centred interior concept that enhances the journey experience by providing a pleasant and comfortable (long-term) Land Rover-specific journey experience.

## ASSIGNMENT

***"Design an interior prototype to create a luxury experience for passengers in level 5 autonomous vehicles for (long-term) rides."***

## STAKEHOLDERS

Several stakeholders need to be considered when designing the interior of an automated car. Firstly, the OEM Jaguar Land Rover, which is designing and selling the future automated driving cars. Secondly, the passengers are very important stakeholders, as the project goal is to provide them with a comfortable, pleasant, and luxurious travel experience. Other stakeholders include supervisory team (TU Delft and JLR) and myself, addressing the design brief. Furthermore, other stakeholders to consider when designing the car interior could include manufacturers of interior elements, maintenance and service crews, etc.


*Figure 4:* focus of the project is on the Ranger Rover and Defender Land Rover models

## OPPORTUNITIES AND LIMITATIONS

The car interior has remained largely unchanged for decades, with key elements such as the steering wheel, dashboard, centre console, and multiple seats always centred around the driver. This project offers opportunities to rethink the traditional layout, introducing a human-centred design that enhances the Land Rover experience to set the brand apart from other modes of transportation.
Land Rover can now shift its focus from the driving experience to the overall journey experience, moving away from long-standing interior designs (Figure 5). This shift presents a unique opportunity for the brand to establish a distinct competitive edge over other car manufacturers and transport options. A redesigned layout, consideration of how many passengers the vehicle should accommodate, and the use of sustainable materials can also be explored.However, there are limitations to consider. The automotive industry is well-established, and the transition to autonomous driving will take time, requiring interim steps. Current vehicles have defined dimensions, but future vehicles do not yet have a defined form. Additionally, human adaptability is a factor, as users are still accustomed to traditional transportation designs.

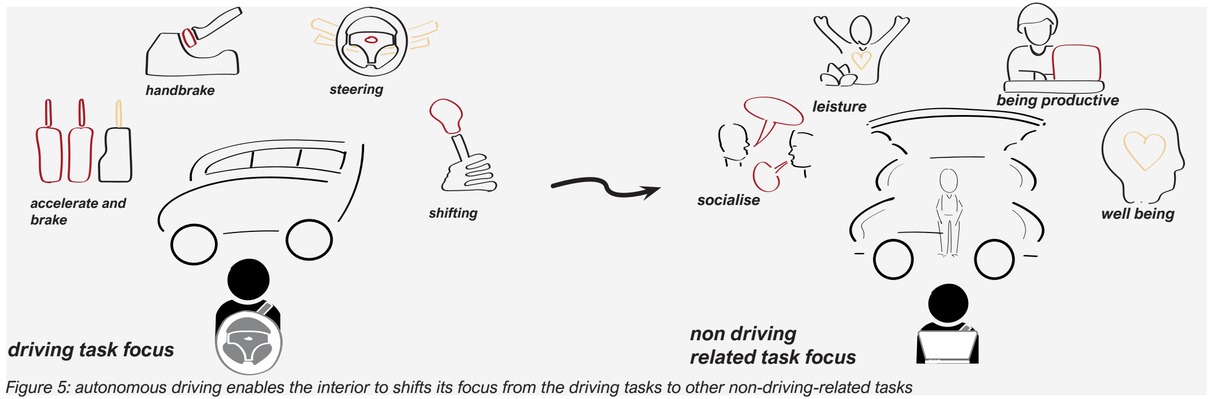



*Figure 5: autonomous driving enables the interior to shifts its focus from the driving tasks to other non-driving-related tasks*

## STRUCTURE

The project follows a specific “outside-in” approach (Figure 6 and 7). Initially focused on the vehicle its interior, the assignment quickly raised broader questions: What will the future exterior look like? How will the mobility sector evolve? To address these, the project first examines the bigger picture.

Broadly speaking, this includes the exterior design, the automotive industry, and the wider mobility sector, all of which are interconnected.

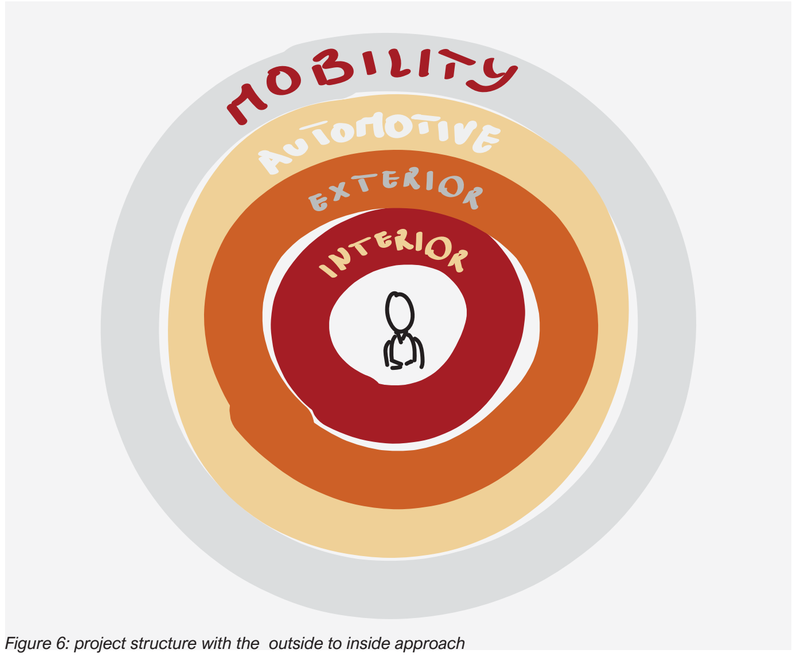



*Figure 6: project structure with the outside to inside approach*

**Mobility**

The mobility sector is a context that is driven by trends and developments. This context was analysed using a DESTEP method (Cornelissen, 2004). The goal is to create a vision of the future that JLR will be part of. Based on this analysis, a future vision is formulated.

**Automotive sector**

Next, a possible role of the automotive sector within this vision is examined. Land Rover was analysed using a company brand analysis (brand DNA). The goal is to create a clear brand identity in order to position Land Rover uniquely within the previously created future vision. This positioning is achieved by defining a future Land Rover experience explained by using a storyboard.

**Exterior**

Within the approach we are now one step ahead of the interior, namely the exterior. The exterior of the car now is significantly different from other modes of transportation and defines the brand. By looking at other concept cars, the future experience definition and positioning, some statements are made about the possible future exterior. This in its turn determines what the size of the interior will be.

**Interior**

The interior is the place where all context factors and the user come together. Because a human centred approach is chosen, there is now looked from the perspective of the Land Rover user at what may be desirable in the future. A design direction is chosen based on the Land Rover target group, literature and the brand DNA. The goal is to choose a direction that is desirable for both the Land Rover user and the Land Rover brand. The chosen design direction will form the basis for the final concept design.

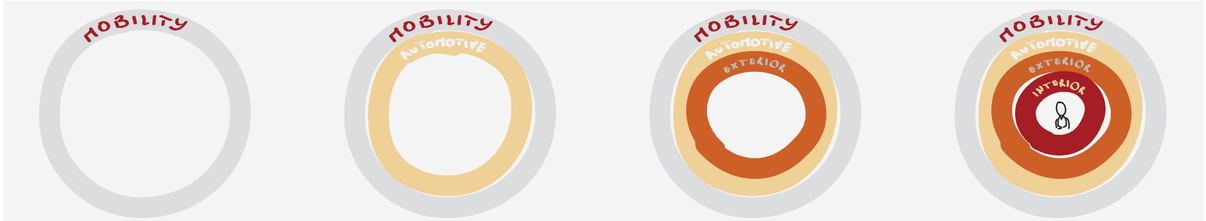



*Figure 7:* phases of the project structure of the outside to inside approach

## DESIGN DIRECTION

With autonomous driving, new activities and functions become possible. Changes in function often occur before changes in design. The first cars resembled horse-drawn carriages, and the first electric cars looked like gasoline vehicles. If we are not careful, the first self-driving cars may also resemble cars with drivers. This is a trap that should be avoided.

The foundation of the interior design is largely influenced by new external factors, such as the exterior design and developments in the mobility sector. It is a reflection of the ongoing changes. The impact of these factors on the interior is significant and revolutionary. New functions will emerge, leading to opportunities to create interiors that truly facilitate new activities (Figure 8).

The goal is to design an interior concept that meets future developments to finally deliver a validated and improved concept design to prepare both the user and Land Rover for its future.

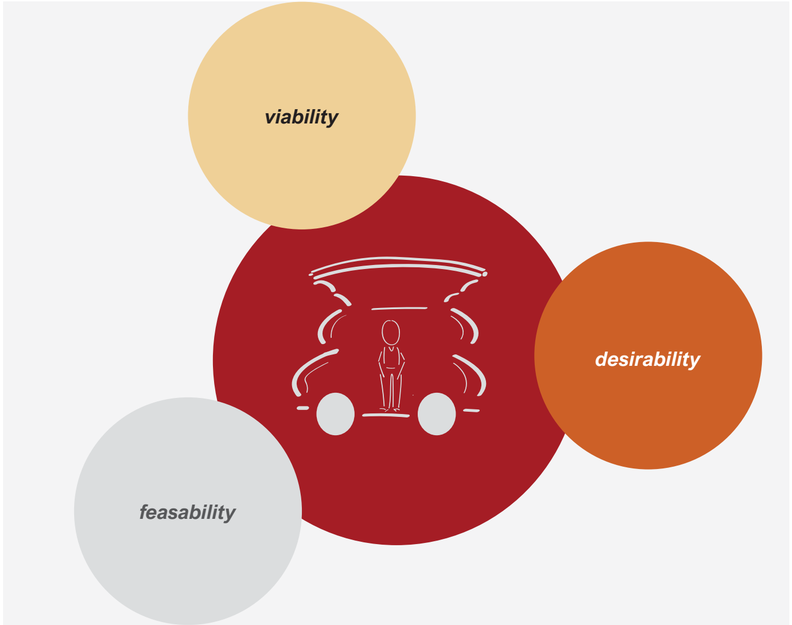
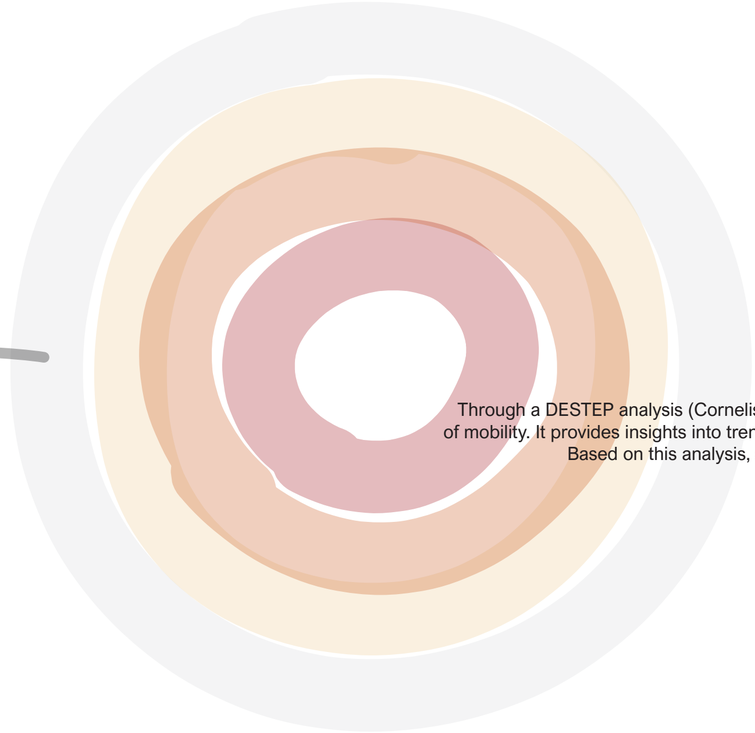



*Figure 8:* aim of the project approach is to create a viable, feasable and desirable interior

# CONTEXT ANALYSIS



## *MOTIVATION*

Through a DESTEP analysis (Cornelissen, 2004), this chapter examines the broader context of mobility. It provides insights into trends that will shape the future of the automotive industry. Based on this analysis, a forward-looking vision for JLR its future is developed.

## DESTEP

The DESTEP method (Cornelissen, 2004) has been used to analyse the mobility sector, the context of JLR. The aim is to gain insights into key mobility developments in the market to identify opportunities and threats for JLR. This involves examining demographic, economic, socio-cultural, technological, ecological, and political-legal factors (DESTEP) based on common trends and developments. This chapter presents only the key trends and developments for each category. The complete DESTEP analysis with referencing can be found in Appendix DESTEP.

### Demographic

Demographic trends are driving changes in the mobility sector, with a growing focus on increasingly crowded, diverse urban areas and a heightened awareness of sustainability. As a result, there is a societal demand and clear urban planning insight to limit the space used by cars in order to optimise the limited available space.

The autonomous vehicle offers new possibilities for urban planning, providing fresh perspectives and insights for city design. Reducing infrastructure can make cities more compact, which in its turn can lead to shorter travel times and various other benefits.

Increasing world population | Urbanization | Aging population | Increasing diversity | Sustainable awareness

### Economic

Economic trends are driving a transformation in the mobility sector, with a focus on sustainable energy, more accessible electric vehicles, and alternative modes of transportation.
The absence of a driver reduces costs. Trams are currently large to accommodate peak-hour demand. Increasing the number of trams during rush hour requires additional drivers, which is not always feasible. With driverless vehicles, public transportation can be optimised, making it more cost-effective. Smaller driverless trams, for example, would be more environmentally friendly and efficient, as less weight in motion means less energy consumption. Additional vehicles could be deployed only when necessary, reducing the number of cars needed for the same tasks.
This leads to fewer vehicles on the road, less demand for infrastructure and lower taxes, ultimately benefiting users. In the future, there may overall be fewer cars, but potentially cover more kilometres collectively. As Elon Musk has noted, transportation will become cheaper over time (Hawkins, 2024).

But what does this mean for the car? Several statements are made. Elon Musk (2024) argues, “Autonomy gives you your time back,” and time is money. Improved safety could lead to fewer road injuries, in its turn reducing costs as well. Additionally, autonomous vehicles do not need costly equipment, keeping production costs low (Hawkins, 2024). Another major impact is that autonomous cars could be used by everyone and thus be on the road much more often. Musk estimates five to ten times more than a regular car, giving it “five to ten times the value” of a typical vehicle and lowering the per-mile cost. Tesla considers it a realistic goal to make its vehicles cheaper than standard, unsubsidized public transportation (DPG Media Privacy Gate, n.d.). The operating cost for Tesla’s new Robotaxis, described as “the new individualized mass transport,” is expected to be about 0.2 cents per mile, compared to a bus at about 1 euro per mile (Hawkins, 2024). Additionally, these new Tesla models are expected to be sold for around 30,000 euros, significantly less than earlier Tesla models (Hawkins, 2024). All these predictions indicate that both the purchase and operational price of an autonomous vehicle will be lower than the price of a conventional car.

Investments in green energy | Growing competition and decreasing cost in electric vehicle | Rising alternatives | Well-being |

**Socio-cultural**

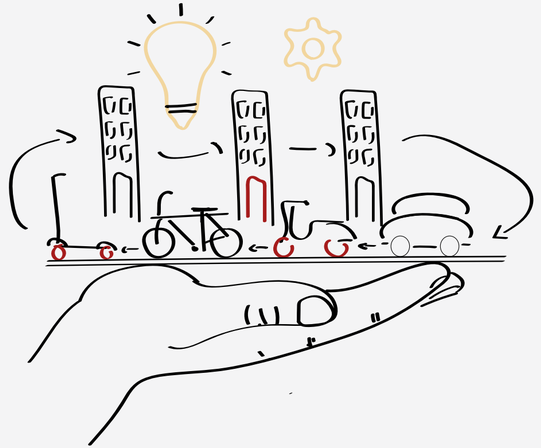
Social and cultural trends are driving a transformation in the mobility sector, with a focus on human well-being, sustainability, and the acceptance of new technologies.

The acceptance of automated vehicles is expected to change as people become more aware of their safety, well-being. They might be more willing to use and pay for alternatives. This will represent a significant step forward.

Well-being | Human-centred design | Sustainable awareness | Acceptance | Willingness

**Technological**

Technological trends are transforming the mobility sector, with a focus on efficiency and innovation. The self-driving capabilities of autonomous vehicles (AVs) offer new possibilities for optimizing road usage. Cars can travel closer together, saving space. A design that is taller and shorter, rather than low and long, allows vehicles to move even closer. Technology is used as an opportunity for improvements.

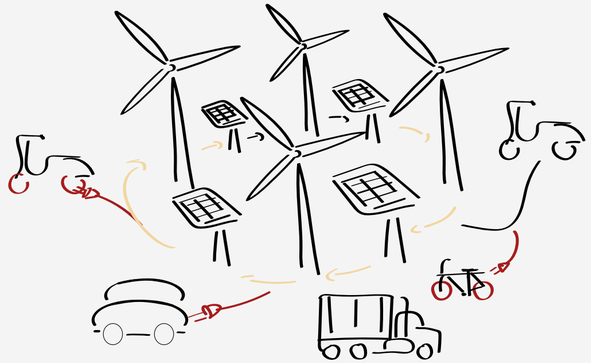


Connectivity | MaaS | Sustainable energy | Smart cities and infrastructures | Innovations
Electrification | Sustainable energy sources |

**Environmental**

Environmental trends are driving innovations and policy measures that guide the mobility sector toward more sustainable practices, aiming to reduce the ecological footprint and minimize environmental impact.

There is public interest to limit the number of vehicles and/or make them more environmentally friendly, with clear ecological benefits. Firstly, this results in zero emissions, and secondly, less space is used for vehicles, allowing for more green spaces (Musk, 2024).



Circular economy | Sustainable city development | Awareness

**Political-legal**

These trends reflect the increasing urgency and global efforts to make the transportation sector more sustainable, with laws and regulations playing a key role in guiding the market toward sustainable and reachable solutions.

Questions arise regarding accountability in the event of a collision, who is responsible, Tesla or the passenger? Additionally, how will autonomous vehicles be legalized? Significant steps must be taken to progress from SAE Level 1 to Level 5, requiring substantial legal adjustments.

Stricter emission standards | No more combustion engines | Subsidies | Zero-Emission Zones | Investments in Infrastructure | New regulations and agreements

## FUTURE VISION

**The future vision is as states:**

***"Public transport vehicles and private owned cars develop toward each other. Public transport vehicles will thus be (new) more advanced competitors of the private owned cars"***

According the DESTEP method, several trends within each category are identified. Then according to the Delft Design Guide, Future Visioning (Van Boeijen et al., 2022), five trends are formulated as value drivers of this future vision Figure 9.

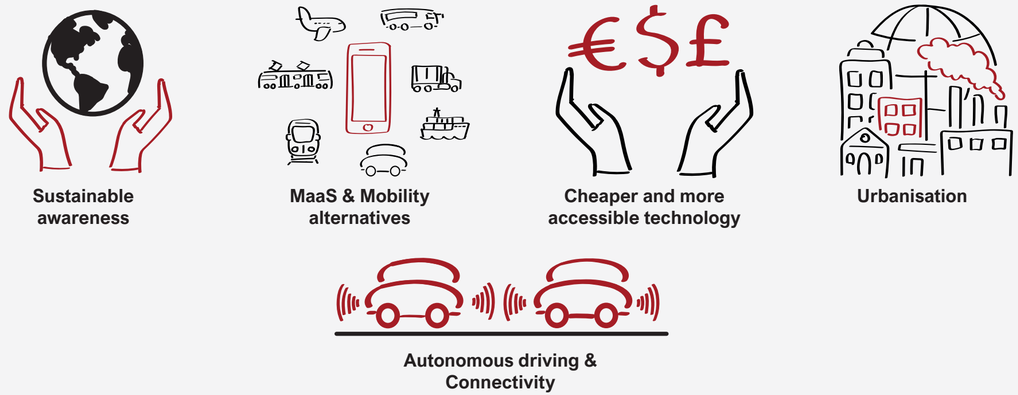



*Figure 9:* the five main development, reffered to as value drivers

## VALUE DRIVERS

Here the meaning of the five formulated value drivers is explained an argued.

### Autonomous driving

It is anticipated that by 2025, passenger vehicles in Europe and North America will reach SAE levels 3 to 4 in autonomous capability (The Future of Mobility: Mobility Evolves, 2023).

Self-driving technology will allow these vehicles to be accessible to all (Musk, 2016). Tesla its Robotaxi, for instance, is expected to operate continually, functioning like a shared vehicle even though it looks like a personal car. Purchased for around 30,000 euros and it will be available for use by others when not needed by the owner (Hawkins, 2024). A shared vehicle used more frequently would likely have a lower cost per mile, thus reducing the number of vehicles needed for the same population size (Hawkins, 2024). This alternative to private cars could be even more affordable than current public transportation (Hawkins, 2024).

### Sustainable awareness

People, companies, and organizations are increasingly focused on reducing environmental impact. Consumers are becoming more aware of the ecological effects of their mobility choices, which is driving demand for sustainable transport options like electric vehicles, public transportation, and shared mobility (Bain, 2024).

Additionally, substantial investments are being made in the public transportation sector due to its perceived lower environmental impact compared to private vehicles. For instance, the Netherlands is investing in public transport innovations (Ministry of Infrastructure and Water Management, 2016).

Alongside this increased focus on sustainability, studies indicate that 12% of the consumers is willing to pay more for sustainable products (Ware, 2023).

### MaaS and alternatives

Micromobility, including e-scooters and e-bikes, is rapidly growing and transforming urban transportation. The micromobility market is projected to grow from $175 billion in 2022 to $360 billion in 2030, driven by demand for more efficient and environmentally friendly transport options (The Future Of Mobility: Mobility Evolves, 2023). There is also a trend towards using alternatives to private cars, such as public transportation. Factors influencing this choice include efficient travel time, direct routes, transfers, and high service frequency (Ulahannan & Birrell, 2022).

In the future, more alternatives to private cars are anticipated, enabling direct travel from point A to B. Autonomous driving technology will likely contribute to this trend, as self-driving cars could be integrated into Mobility as a Service (MaaS) fleets, generating ongoing service-based revenue (Nunes, 2019). Tesla its Robotaxi is a predicted example, offering a cost-effective alternative to public transport without requiring private ownership (Hawkins, 2024).


### Cheaper and more accessible tech

Electric cars are becoming increasingly affordable. Musk (2006) outlined a plan to use revenue from each model to fund the development of progressively more affordable vehicles. In addition to the decreasing purchase costs, it is predicted for self-driving cars to have decreasing operational costs. Autonomous vehicles can be used more frequently, which eventually lowers the cost per use. Furthermore, these vehicles contain fewer complex components, making them less expensive to manufacture (Hawkins, 2024).


### Urbanisation

Furthermore, people are increasingly settling in cities. In 1900, only 10% of the population lived in cities. Now, it's already 50%, and it's predicted that by 2050, 75% of the world its population will reside in cities (Ritchie et al., 2024).

Ideas have emerged about the "ideal" human-centred city, where urban planning is based on human movement patterns. Examples include the "one-hour commuting city" (One Hour Commuting According to Different Urban Transportation Modes | The Geograp hy Of Transport Systems, 2022) and the 15-minute city (Allam et al., 2022).

## CHANGING TRAVEL JOURNEY

Observed is that these value drivers have a significant impact on mobility. However, first, there is looked at the influence of autonomous driving. A trend for which there is already much speculated about the influence it may have on the car. A car, like the Robotaxi, that can be shared or might no longer be owned (Hawkins, 2024). However, there is insufficient attention paid to the influence autonomous driving may have on other modes of transportation. Even though all are part of the same “transport system”. Therefore, it is important to shift the focus to these other modes of transportation. According to the future visioning method (Van Boeijen, 2022) various changes are being considered for other modes of transport (Figure 10).

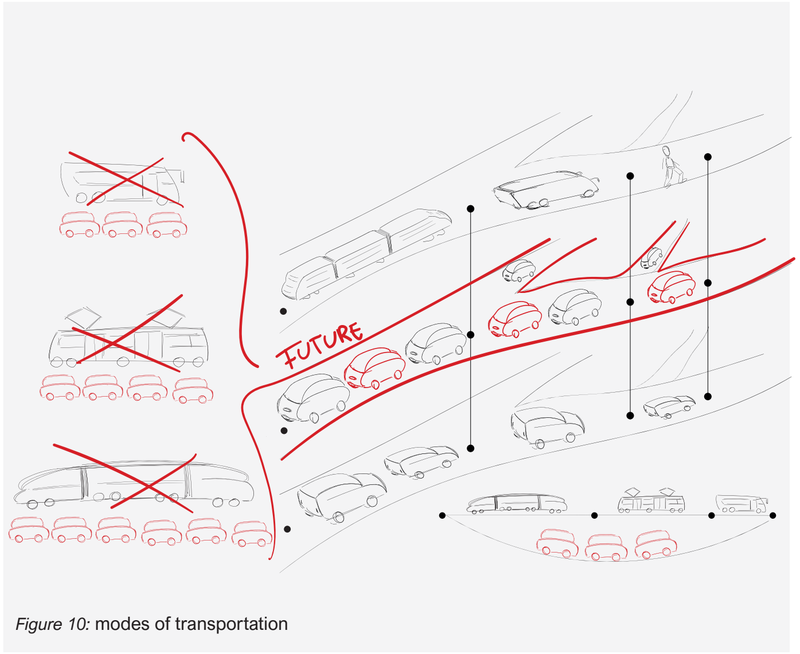



*Figure 10:* modes of transportation

### Current travel journey

So, assume other modes of transportation, for example public transport vehicles, become driverless. Now we are dealing with large vehicles transporting groups of people from stop to stop on a fixed route. The current travel journey is shown schematically in Figure 11.

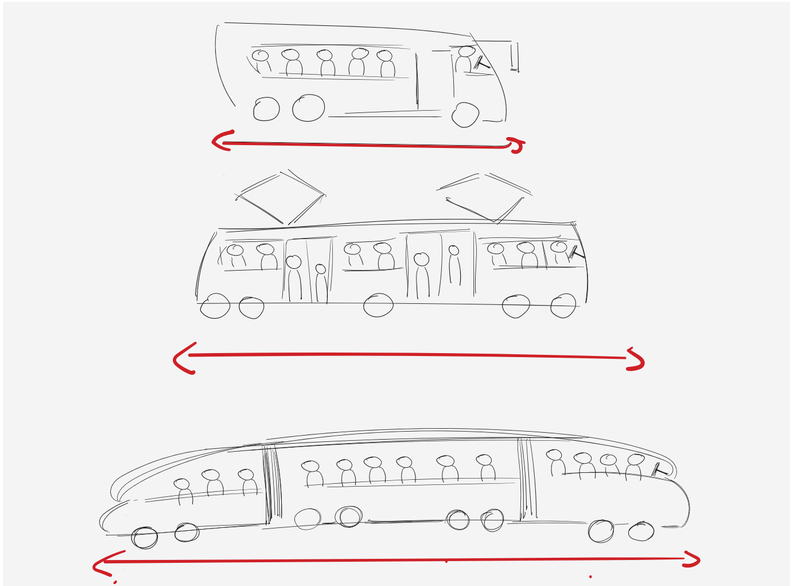


Figure 11: A schematic representation of public transportation with a driver during peak hours. Outside of peak hours, the system is largely underutilized and mostly empty.

### Future travel journey

In the future traveling might be done in smaller vehicles, transporting individuals over more personalised routes and to more specific destinations as a driver is no longer present. Already predicted are multiple shared alternatives proving a direct door-to-door connection as well (Hawkins, 2024). The vehicle is no longer bound to a specific route along which, the driver with the vehicle, must pick up as many people as possible. Instead, it can drive a route that better suits the occupants. Since this differs per person and there is no longer a driver present, this could just as well be a smaller vehicle that drives independently from A to B. A smaller vehicle that no longer has to pass by large collection points, stops, in order to optimally use the capacity of the vehicle (and the driver).
The possible future travel journey is shown schematically in Figure 12.

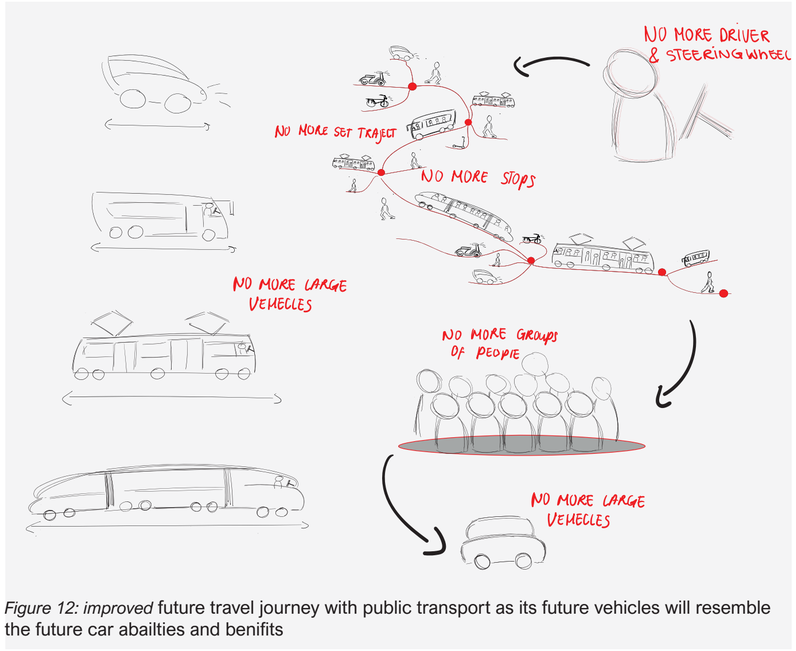



*Figure 12: improved* future travel journey with public transport as its future vehicles will resemble the future car abailties and benifits

### The rise of a universal vehicle

It could be that a universal vehicle arises. A public transport vehicle that is smaller and drives more personalised routes. A vehicle that increasingly resembles the car in appearance, function and use. So next to the already existing benefit, of being able to do non-driving-related-tasks, public vehicles will provide the benefit of a direct door-to-door connection as well. A vehicle that is actually comparable to the car of the future. Both, without a driver, both a personalised route, both part of the same transport system (Figure 13).

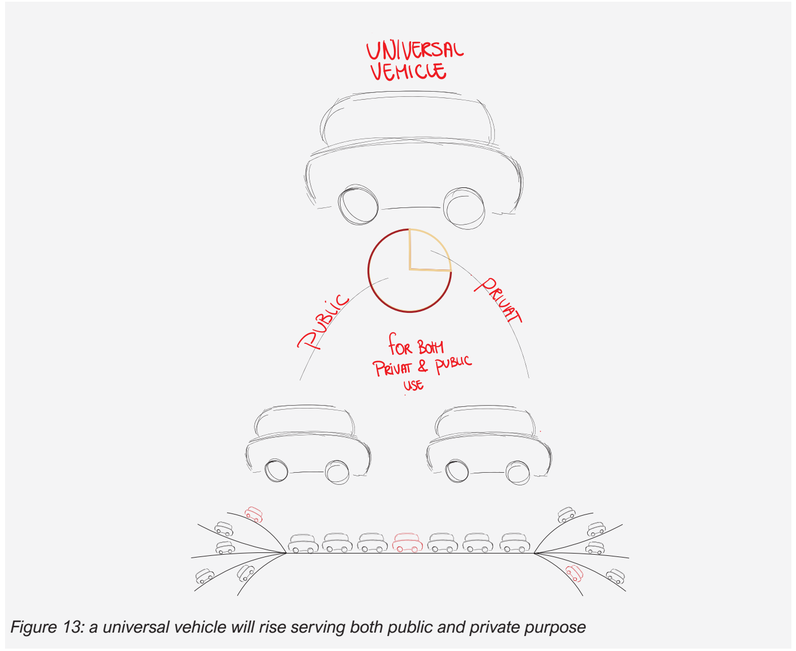



*Figure 13: a universal vehicle will rise serving both public and private purpose*

## OTHER VALUE DRIVERS

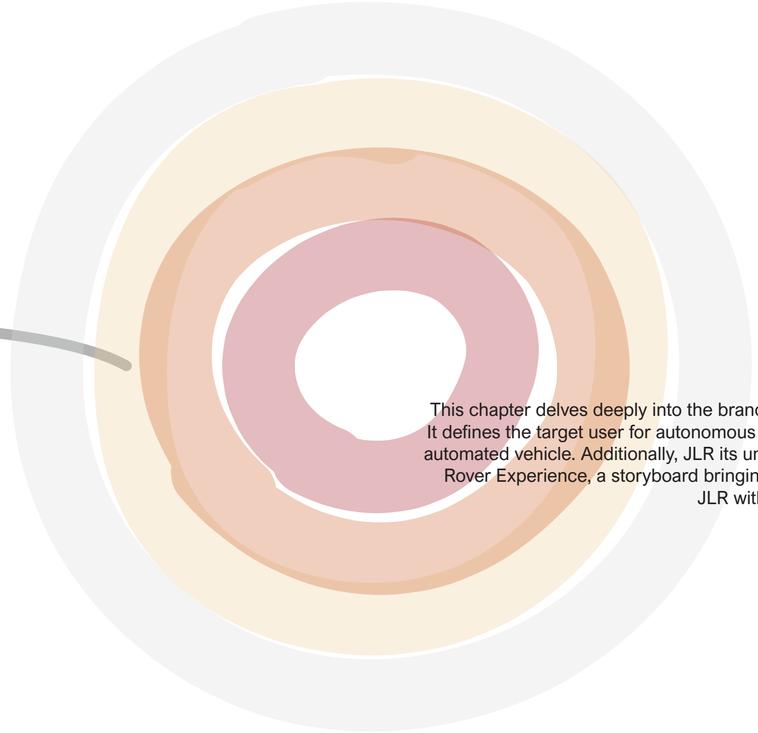
So, the autonomous technology enables the shared use of (private owned) vehicles (Musk, 2016; Hawkins, 2024) and speculated is that it possibly enables the transition from large public vehicles to smaller public (shared) vehicles. As for the other value drivers; connectivity, urbanisation, sustainable awareness, MaaS, cheaper and more accessible technology, it looks like these future public vehicles, other than the car, may be more desirable and accessible in the future (Figure 14). Public transportation has generally been more affordable than privately owned cars in most scenarios (Klein et al., 2022). Technological advancements are making it increasingly feasible to reduce production and operational costs for cars (Hawkins, 2024). This also applies to public transport vehicles. Cities and people often no longer want a car from a sustainability perspective (Bain, 2024; Ulahannan & Birrell, 2022). The city is too crowded, less stuff is more happiness and having your own car is not perceived as sustainable. Additionally, there are also more and more alternatives to owning your own vehicle (The Future Of Mobility: Mobility Evolves, 2023). This in combination that this is already cheaper in some cases and will become relatively cheaper in the future makes other transport alternatives an even more present competitor in the future than they already are.


*Figure 14: Value drivers additional to autonomous driving*

***Key note:***
With autonomous driving technology, more advanced vehicle competitors are emerging that mirror the benefits of future (autonomous) vehicles. Land Rover will need to compete with these developments.

***Key question:***
What does the rise of a universal vehicle, suitable for both public and private use, mean for Land Rover?

# BRAND ANALYSIS



## *MOTIVATION*

This chapter delves deeply into the brand DNA of Land Rover and their vision of future mobility. It defines the target user for autonomous vehicles, focusing on their motivations for choosing an automated vehicle. Additionally, JLR its unique driving experience is illustrated through the Land Rover Experience, a storyboard bringing the future customer experience to life. This positions JLR within the competitive landscape of autonomous vehicles.

# LAND ROVER DNA

To get a better idea of how the car, and specifically the Land Rover car, should position itself within this future vision, this chapter looks into the brand. The characteristics that distinguished Land Rover from other cars and modes of transportation (Van Boeijen et al., 2020).

The brand DNA can be divided into two parts. What Land Rover aims to convey, its brand identity, and how Land Rover is perceived, its brand image. Both aspects have been analysed through interviews, observations, literature review, mission statement, Land Rover its history, advertising forms and propositions, use of social media channels, sponsorships, brand ownership, myths, sales channels, product portfolio, concept cars and model range. The extensive analysis can be found in Appendix Brand Analysis. Finally, both the brand identity and image are translated into a Land Rover experience, the LRX.

## BRAND HISTORY

Over the years, Land Rover its advertising proposition has evolved significantly. Land Rover pioneered in 4x4 capabilities and transitioned from a utility vehicle to an icon (Figure 15). Early advertisements emphasized the purposeful functional Land Rover, focusing on its utility and working image, suitable for farmland and practical use. Later, the brand shifted towards promoting the Range Rover as capable of recreational and explorational pursuits focussing on the ability of the Range Rover to take you anywhere. With the introduction of the Range Rover and its adaptation for road use and the American market, luxury became increasingly emphasised.

While early models prioritised functionality and later models emphasised adventure and exploration, their current proposition focuses heavily on projecting sustainability and modern luxury (REIMAGINE | JLR Corporate Website, n.d.). However, luxury, which was crucial from the outset of the first Range Rover, remains a core aspect, off-road capabilities are still present but less emphasized. Each Land Rover model now offers a distinct experience: the Defender focuses on adventure, the Range Rover on luxury, and the Discovery on family trips (Withey, 2024).

Terms like “all-terrain,” “adventure,” and “explore” have become less prominent in Land Rover its identity, but customers still perceive the brand as rugged, adventurous, and luxurious, an imposing vehicle of prestige. Sustainability, while increasingly important in their current image, remains somewhat secondary for customers. Advertisements also highlight the design and refinement of both the interior and exterior, emphasising elegance and sophistication.

## USERS

Land Rover and representatives such as dealerships emphasize exclusivity and attracting the upper class. Professionals like notaries and executives fit well into this image. However, there are also interested parties such as farmers or those declined, that do not necessarily match the class and style that Land Rover wishes to be associated with (JLR dealership, 2024). Yet, Land Rover has been quite successful in appealing to this “other target group” that is not highly exclusive. For instance, the Range Rover Sport, designed for the sportier driver, is seen more frequently on the streets than other models (JLR dealership, 2024).

## COMPETITORS

Currently, Land Rover competes primarily with large luxury vehicles such as high-end Tesla’s and larger Porsche Cayennes (JLR dealership, 2024). In the future, Land Rover aims to be part of a niche market currently occupied by (super) luxury brands (Withey, 2024).


*Figure 15:* time line of the Land Rover evolution

## BRAND DNA

The complete analysis on the Brand DNA van be found in Appendix Brand Analysis. The current brand identity and brand image of Land Rover, based on this analysis, can be summarised in keywords figure 16 and 17.

**Brand identity**

What the brand wants to convey:


*Figure 16:* the Land Rover brand identity in a mood board explaining what Land Rover wants to convey

**Brand Image**

How the brand is perceived:


*Figure 17:* the Land Rover brand image explaining how Land Rover is perceived

## DESIGN GOAL

Considering the history of Land Rover, functionality is one of the aspects that attributed to their success. It is the rugged, prestigious and independent image derived from their off-road capabilities that continues to differentiate Land Rover from other brands. By emphasizing functionality alongside emotional appeal, the goal is to create value for Land Rover once again.

## JLR's TARGET GROUP

The target group is described as a wealthy, hardworking and time-conscious demographic for which every minute counts. Creating an optimal environment that aligns with their work-centric lifestyle is crucial. Research has shown that work-related journeys are the most popular among full-time working passengers (Wilson et al., 2022). Higher income has been found to improve privately owned AV adoption as well (Howard & Dai, 2013; Wang et al., 2020). This is supported by Kyriakidis et al. (2015) and Bansal et al. (2016), indicating that individuals with higher incomes are more willing to purchase personal automated vehicles (PAVs) (Sweet & Laidlaw, 2019). Findings supporting the wealthy and exclusive target group there is aimed for.

## MOTIVATION TO OWN AN AV

Literature emphasizes the importance of both functional and emotional aspects of a car. The largest effect size for owning an AV is found in "being proud" and "usefulness" (Wilson et al., 2022). This suggests that an AV purchase is partly for utility. However, being proud to show off an AV could also be an emotional purchase as well. Supporting that the experience of the brand is an important contributor to whether the band is desirable for ownership of not. Additionally, well-being has also been identified as a significant motivating factor. According to Wilson et al. (2022) the four most frequently mentioned activity categories among participants are "socialise," cited by 70% of the group, "wellbeing" by 75%, "leisure activity" by 88%, and "being productive" by 55% (Figure 18). Research surveys on Non-Driving-Related-Tasks (NDRT) and passenger needs indicate that activities differ based on journey type (Wadud & Huda, 2019), country (Schoettle & Sivak, 2014), and the level of automation (Kyriakidis et al., 2015). Specifically, the commute journey, fitting the Land Rover user, involves different activities. During the outbound trip, often productive work is done, categorized under "be productive". On the return trip, relaxation is common, categorized under "wellbeing" (Wilson et al., 2022). All these findings highlight the importance of both the brand experience related to the vehicle and the different functionalities that the vehicle should support during the journey. Thé two motivation for the user to own an AV.


*Figure 18:* the four most mentioned activities. The percentage is the amount of mentionings

## MOTIVATION TO OWN A JLR AV (LRX).

Based on the Brand DNA analysis and the defined target audience for AVs, the Land Rover Experience (LRX) is defined as "imposingly in control".

**Control:**
Control refers to the ability to do everything. The 4x4 feature originally provided both recreation and functionality. This led to a tough, adventurous, free, and independent feeling. The ability to drive anywhere and anytime the user wants. Full control, the Land Rover luxury.

**Imposing:**
Imposing refers to the robust and angular characteristics associated with Land Rover. High on wheels and large tires. This results in a sense of prestige and status suitable for Land Rover's intended exclusive target group.

This experience (Figure 19) aims to align the LR brand DNA with its target audience. It mainly emphasises the emotional aspect. "Imposing" seeks to support the "pride" aspect (Wilson et al., 2022), while "Control" addresses another motivation for AV ownership (Sweet & Laidlaw, 2019).

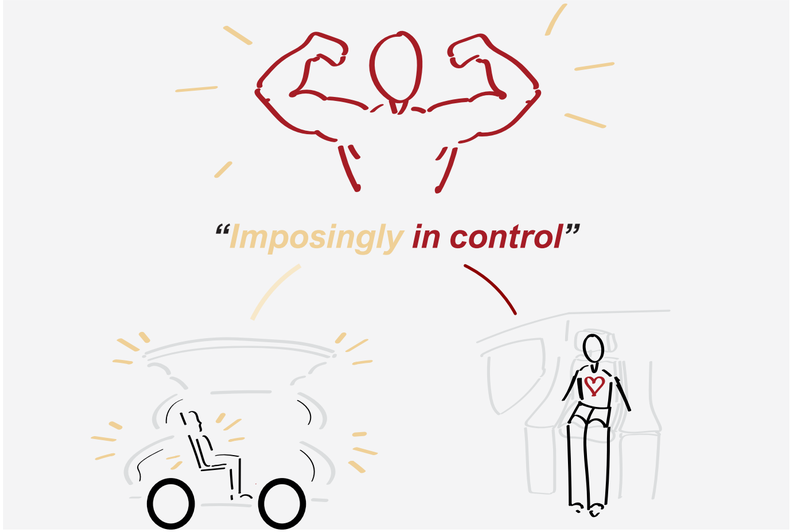



*Figure 19:* the future Land Rover experience (LRX)

# LAND ROVER EXPERIENCE

## COMMENT

Aspects such as sustainability and modern luxury should certainly be considered but are not used as unique selling points. These are requirements from mobility developments and not something to make the brand unique. Companies cannot avoid sustainability due to demands from employees, customers, and regulatory parties. Luxury is dynamic and always changing. Something users always strive for. Too many brands already aim for a “luxury image”.

## STORYBOARD

The future mobility vision and Land Rover experience are illustrated in a storyboard. This storyboard was created by analysing the current journey experience (Appendix Design Direction, Current Journey Analysis). Its aim is to address current pain points that negatively impact the journey. Additionally, the LRX, is incorporated. The process involved sketching.

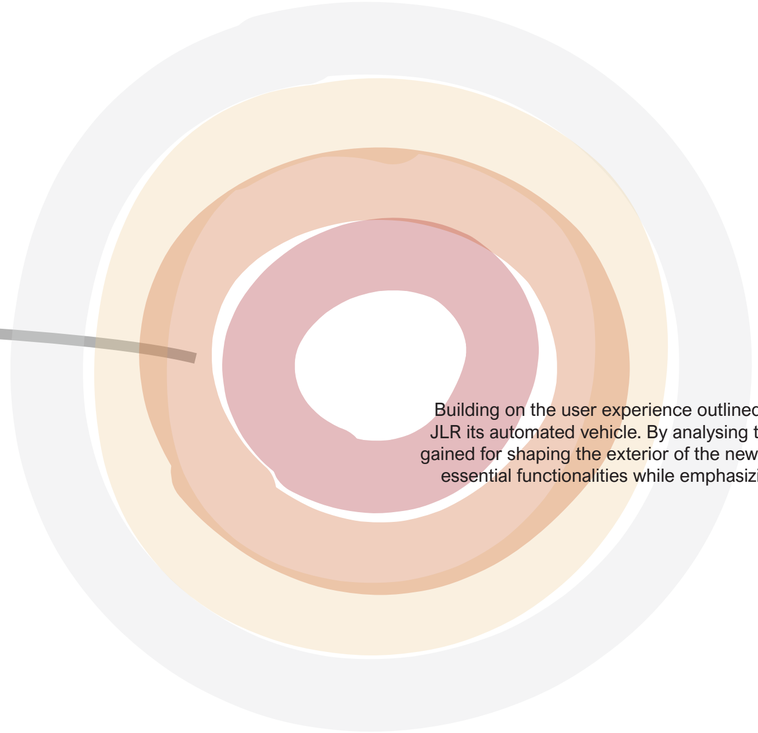
***Key note:***
The imposingly in control experience should uniquely position Land Rover within the mobility sector and the formed vision. Based on this experience definition, a storyboard has been developed in which the LRX is envisioned (LRX Storyboard, next page). This also addresses the ingress and egress of the car.

***Key question:***
What does this experience look like?

## LRX STORYBOARD

The Land Rover Experience (LRX) envisioned in the travel journey. The current journey storyboard can be found in Appendix Brand Analysis


# DESIGN DIRECTION



## *MOTIVATION*

Building on the user experience outlined earlier, this chapter focuses on the design choices for JLR its automated vehicle. By analysing the exterior design of existing vehicles, key insights are gained for shaping the exterior of the new model. The focus then shifts to the interior, presenting essential functionalities while emphasizing atmosphere, with special attention to the vehicle its lighting design.

## EXTERIOR ANALYSIS

### MARKET ANALYSIS

As seen in the storyboards specific vehicle characteristics are envisioned to convey the LRX. This combined with the analysis of other concept cars is used to form a vision of what the future Land Rover exterior might look like.

In figure 20 some examples are shown. The extended analysis can be found in Appendix Concept Car Analysis.


*Figure 20: multiple concept cars of other brands showing new exterior characteristics such as symmetrical, higher and an inovative door opening*

### PARKSHUTTLE

In Rotterdam, there is an autonomous shuttle, The Park Shuttle by Transdev, that connects to the Kralingsezoom metro station (Figure 21). This vehicle was visited and used as part of the field research. The Park Shuttle is an electric and symmetrical vehicle that operates autonomously on a dedicated track, isolated from other traffic. The shuttle is quite long and contains 8 seats, along with standing room. The interior is very similar to that of current public transport like buses and trams, featuring hard upholstered seats that are not adjustable



*Figure 21: the autonomous Transdev park shuttle in Kralingsezoom driving a course shielded from the rest of the traffic*

## FREE LANE ROADS

In the USA, autonomous vehicles are currently developed and tested on public roads.

It is important to recognize that in the Netherlands transportation modalities are well-separated. Sidewalks and bicycles lanes are present almost everywhere, unlike in America, where they are often absent (outside urban areas). Additionally, there are designated lanes for and public transport, such as buses and tram, so called “free lane roads” (“vrije baans wegen”) (Figure 22). This sets The Netherlands apart from other countries. Here there is an opportunity to test AVs on these free lane roads. In contrast to the USA, where self-driving cars must handle all traffic tasks immediately, the Netherlands has a unique position for the development of autonomous vehicles worldwide. Testing can occur in phases, starting on free lane road and potentially moving to normal undefined routes later on.

Foreigners are often surprised by these modalities but do not think of testing AVs in the Netherlands. Rail systems can be modified to traditional road as the tire tracks are just as precise as the rails itself (Figure 22). This makes it easier to introduce AVs in cities where space is limited.

The Dutch Ministry of Infrastructure and Water Management is considering certain roads to be designated for driverless vehicles (Ministerie van Infrastructuur en Waterstaat, 2019). There is also discussion about creating highways specifically for AVs as an addition to existing open roads.

Jaguar Land Rover (JLR) could also consider this free lane road principle for a service that would make AVs easier accessible in urban areas.

***Key note:***
Jaguar Land Rover (JLR) could also consider the free lane road principle for a service that would make AVs easier accessible in urban areas.

***Key question:***
What would the future Land Rover exterior and interior look like?


*Figure 22: the free lane rodes offer opportunities for JLR to test AVS and to offer a JLR service in, for example, the city centre (where the car will probably not even be allowed to go in the future)*

## MARKET ANALYSIS

Given the proven importance of both experience and functionality, this section explores what the mobility industry might offer in the future (see figure 23). Many interiors are designed around specific activities, with adaptable layouts or designated activity zones. These are all NDRT-interiors, where the interior is treated almost as a standalone component, such as in the case of the Citroën Autonomous Mobility Vision. Various “living room” concepts exist, but what seems to be lacking is an interior that truly supports working activities, despite “being productive” being one of the four most frequently mentioned activities (Wilson et al., 2022).


*Figure 23: multiple concept cars of other brands showing new interior characteristics*

## FUTURE EXTERIOR

The following characteristics shape the new exterior for the envisioned Land Rover experience:

Higher, symmetrical, big windows and optimized for two

### IMPOSING EXTERIOR

The sense of “imposing” is achieved through the external features of a robust vehicle that is high on its wheels. The ease of entering and exiting the vehicle in an upright position also contributes to this. It is important that this looks pleasant, luxurious and therefore imposing. Not stooped or awkwardly getting in but with the greatest of ease. The doors open upwards and hinge close to the middle to achieve this upright entry and exit.

Additionally, the vehicle features large windows to allow a sufficient amount of natural light inside, contributing to a chic and exclusive appearance.

### OPTIMISED FOR TWO

The car is optimised for two to enable optimal space use. According to Kilincsoy et al. (2014) there are on average 1.3 people in a car. Optimising for two people and efficient use of space is also a trend seen in concept cars. The Volkswagen Sedric for examples features two comfortable-looking seats with two additional seats that can be folded away when not in use. Similarly, the Lincoln L100 can eliminate two seats to optimize the car for two passengers (Appendix Car Analysis).

### SYMMETRICAL

The exterior is symmetrical along two axes and lacks a front nose. Many fully autonomous vehicle concepts also feature innovative exteriors. For example, Bosch and Adient its self-driving capsule features a symmetrical, elevated exterior without a traditional front. Similarly, Citroën’s Future Mobility Vision also embraces a symmetrical design.

***Key note:***
The exterior: higher, symmetrical, big windows and optimized for two

***Key questions:***
What does the interior need to facilitate the working acticity?

**The key for supporting the work activity**

## FUNCTIONALLITY & AMBIENCE

For interior design to effectively support activities, both the functionality of the space and the desired mood or atmosphere must be considered (Reddy et al., 2012). With this in mind, two key aspects should be addressed: features that support the activity and elements that shape the ambience, such as lighting and acoustics (Figure 24).

In consultation with JLR, the focus of the interior design has been narrowed to interior lighting. However, to create a holistic interior concept, it is important to also consider key features that enhance functionality.

More aspects need to be considered, such as seat belts and air conditioning controls. These elements may or may not change, but they still need to be operated from the seat. The question is how this should be done. While these aspects should be taken into account, they will be set aside for now.

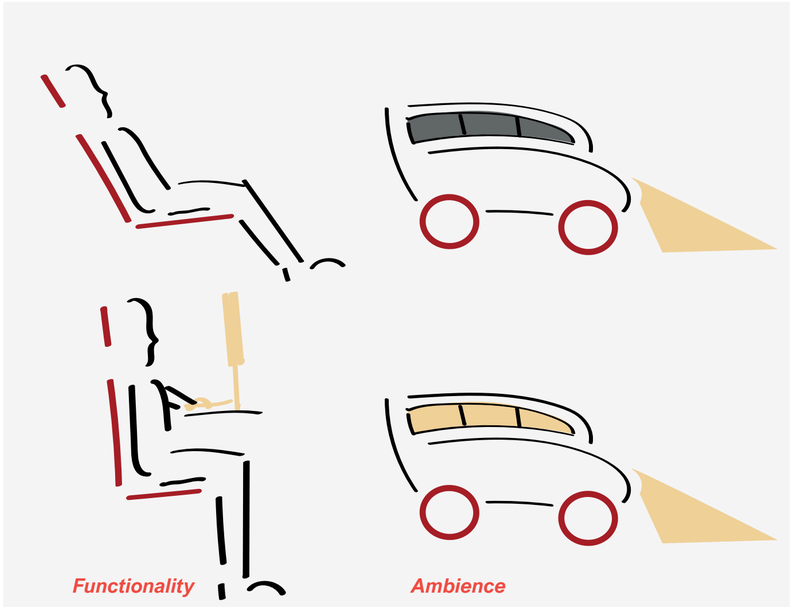



*Figure 24: important aspects to support the (work) activity: features and atmosphere*

## FUNCTIONAL ELEMENTS

The primary components desk (Figure 25), chair, the type of computer interface utilized by the user and peripheral devices should be factored in (Emerson et al., 2021). These elements have been integrated into the interior design to form a cohesive and effective workspace.

### Seat

The seat in the vehicle should be designed to accommodate various postures. When working, the seat is positioned higher with a more upright backrest. In contrast, for relaxation, the seat is set lower, close to the floor, and the backrest reclines significantly, similar to lounge chairs. The car seat quite resembles these lounge chair characteristics which unfortunately makes it not suitable for work settings (see Figure 26).

Given that the vehicle must support both relaxation and work, it features a unique chair that can transition between these modes. In the relaxation position, an adjustable calf support can also be deployed for added comfort. Figure 27 illustrates the transition between the two postures.

*Figure 25: essential features in conventional interior*

*Figure 26: wrong posture*

*Figure 27: it is important to be able to shift postures suitable to the activity*

### Screen

The interior features a screen. The screen should be adjustable in height and can move toward or away from the user.

### Desk

The workspace includes distinct zones, as identified by Emerson et al. (2021), including the near, midrange, and far reach zones. The keyboard and mouse should be positioned within the near-midrange zone for optimal accessibility. Making the position adjustable, allows users to customise it to their personal preference.

### AMBIENCE (LIGHTING)

The consensus to further explore lighting in a car interior offers many opportunities. Previously, car interiors were almost entirely unlit to avoid distractions during driving, with only minimal spotlights providing direct light. The key difference for the future, with autonomous vehicles, is that lighting can be adjusted to both illuminate and obscure the cabin when needed.  Without a driver, the cabin can not only be illuminated more brightly but can also be darkened during the day to prevent unwanted light and reflections. Therefore, it is not just about dimming the interior artificial lighting but also about controlling the amount of external daylight. Moreover, lighting offers opportunities to enhance the overall journey experience, influencing mood and well-being (Herrera, 2023).
Currently, JLR has no specific plans in place for this (Flgure 28), and within the industry, it presents an opportunity for innovation and differentiation from competitors.

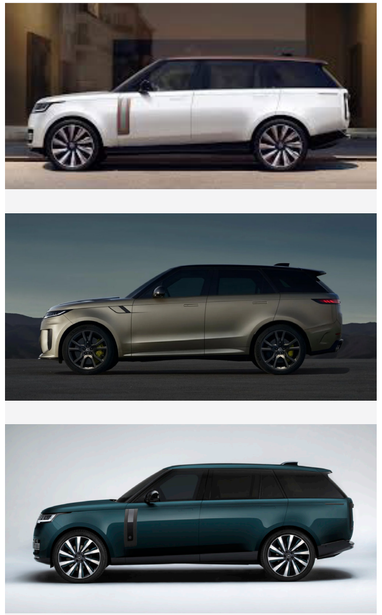
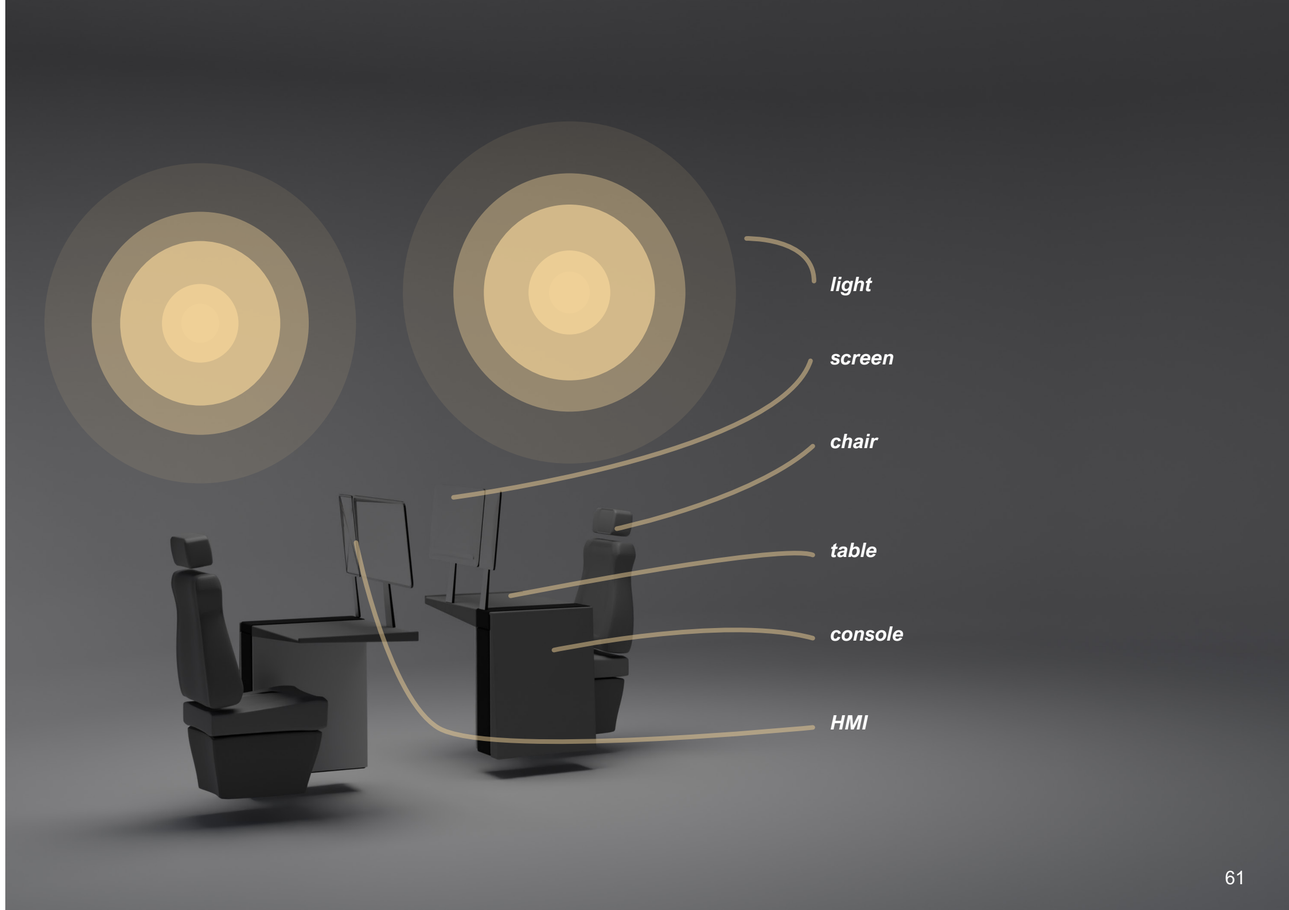


*Figure 28: Range Rovers all dark from the inside*



***Key note:***
The new interior should support the activity done inside of the car. This can be done with facilitating the right features and atmosphere. Here the focus is on facilitating the right lighting as part of the atmosphere.

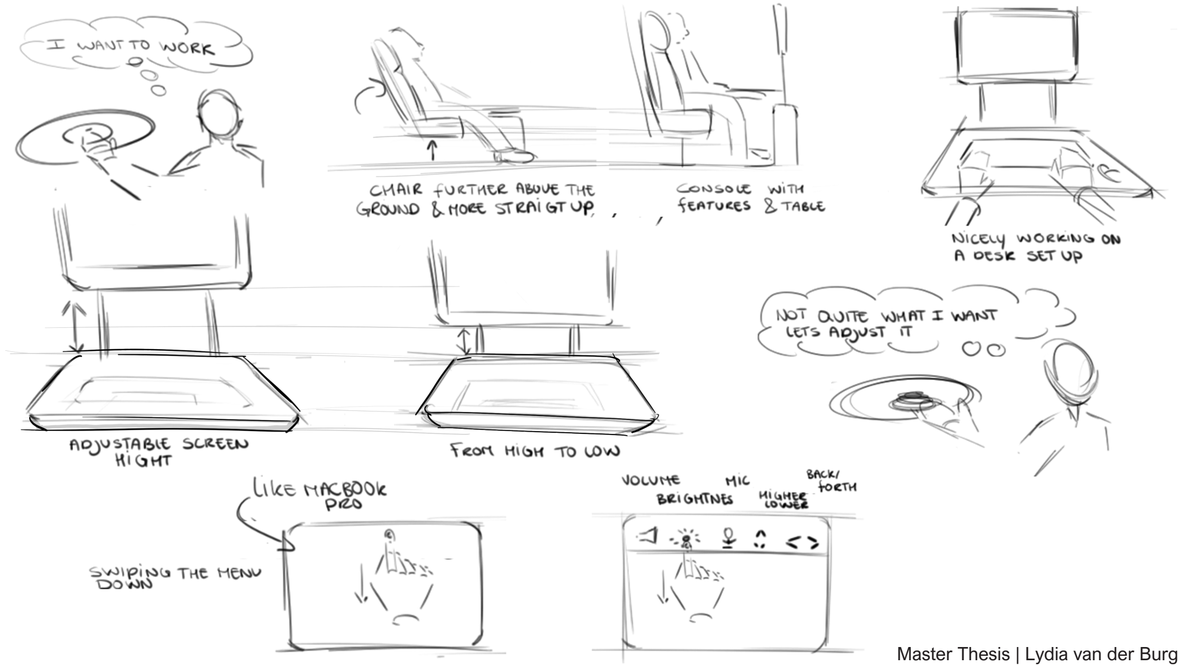
***Key questions:***
What light characteristics and placements supports the working and relaxing activity?

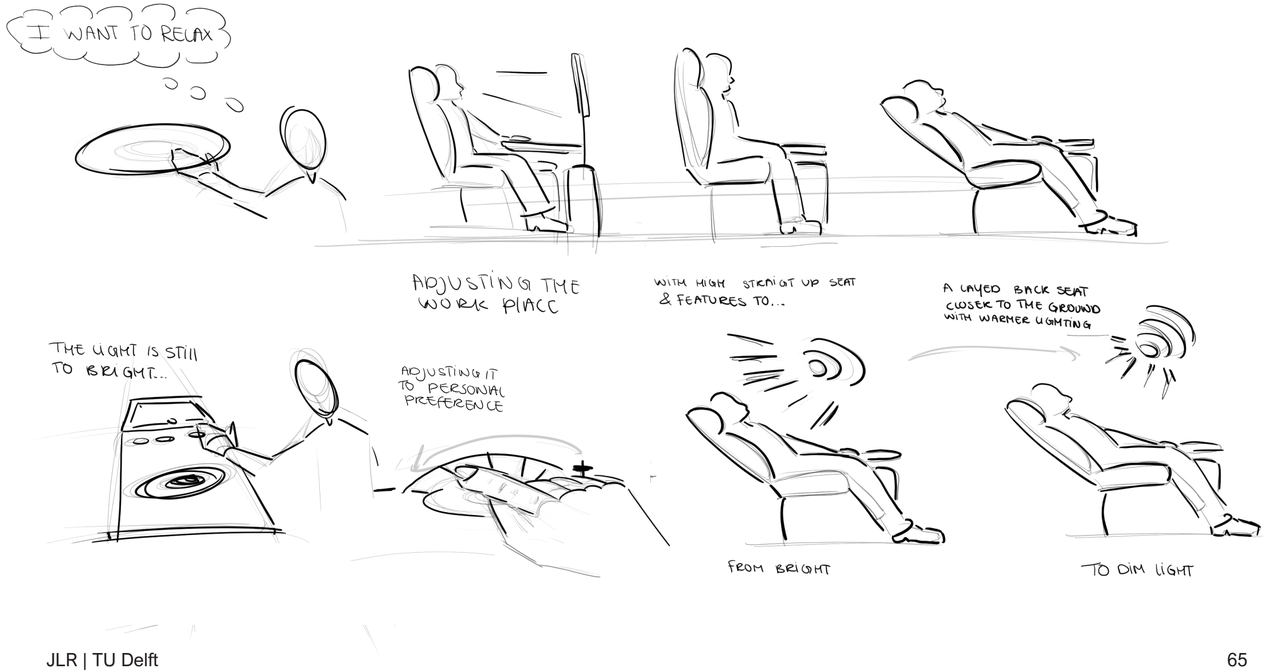




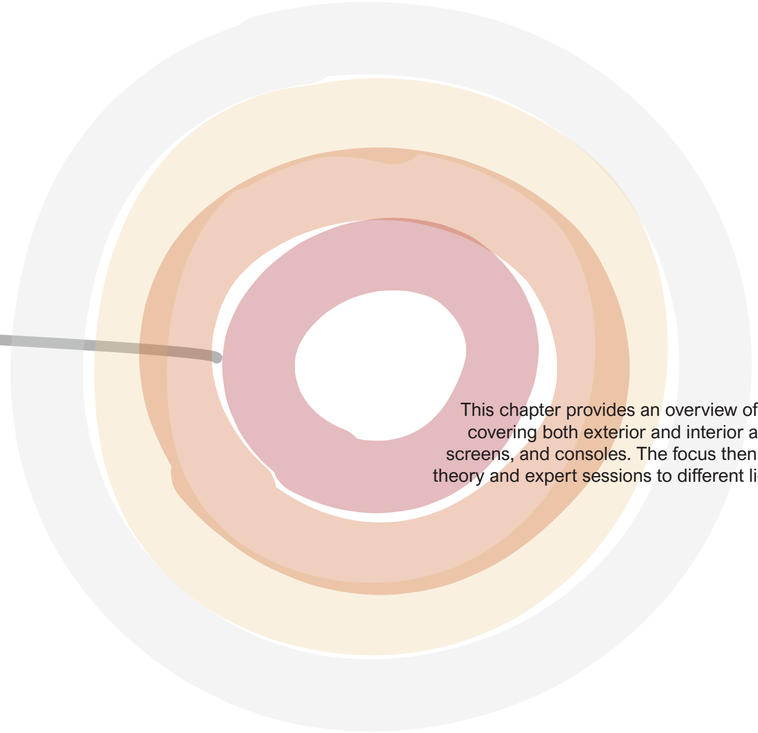
## LRX WORKING STORYBOARD

In the LRX working storyboard the new functionality of the interior is envisioned.



# PROTOTYPING



## *MOTIVATION*

This chapter provides an overview of the design process and the evolution of the prototype, covering both exterior and interior aspects, including functional elements like seats, tables, screens, and consoles. The focus then shifts to lighting, presenting a series of concepts, from theory and expert sessions to different lighting positions, culminating in the final lighting design that defines the vehicle's interior ambiance.

## SKETCHING AND 3D MODELLING

In consultation with JLR, there is chosen to focus on lighting that supports the functionality of the interior space. Observations indicate that light reflections can disrupt work activities. To facilitate both work and relaxation, lighting and shading options were explored. The design, based on literature review and expert consultations, was developed using sketches and 3D modelling in Blender. The process is shown in Figure 29, with additional details in Appendix Prototyping Expert Consult.

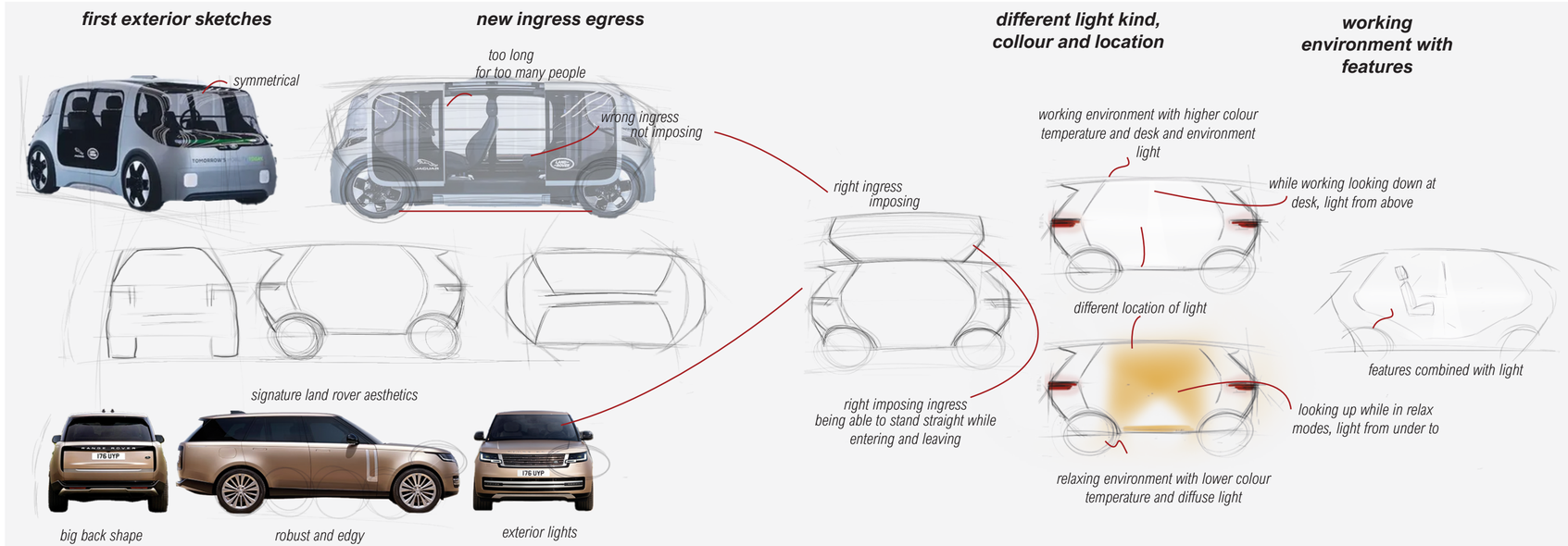
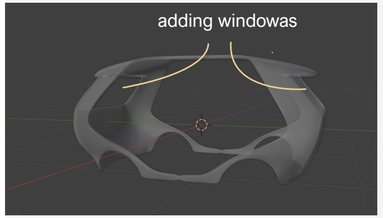


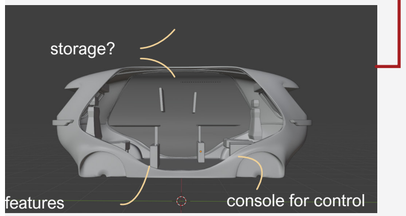

*Figure 29: design proces starting at the exterior and ending at the interior light concept*

Exterior shape of the JLR project vector is symmetrical and slightly higher as well. But the length and doors are changed.

The front and back are the same signature Land Rover light is implemented. Also an imposing egress and ingress with doors opening upwards is considered. Further, the vehicle is shorten in lenghth to optimise for a smaller group of people. For facilitating the activity different lightings are sketched. Additionally, features are added.

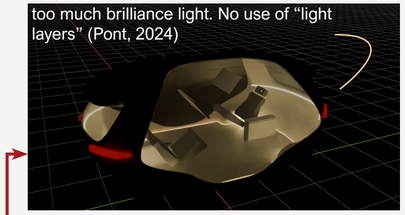
**Exterior and features 3D modelled**

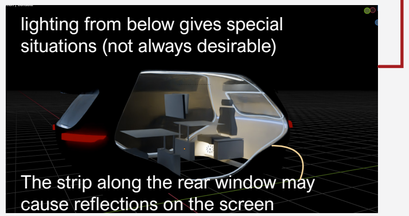



Blender is used to 3D model the exterior that shapes the interior.
Also features and lighting are implemented.

**Light characteristics 3D modelled**

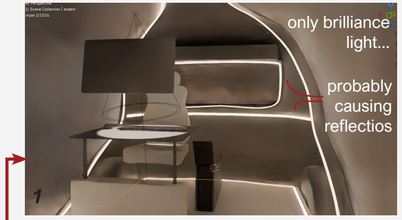



For the working environment higher colour temperatures are used.
For the relaxing lower CCTs are applied.
Additionally, the position of the chair and the features are adjusted.

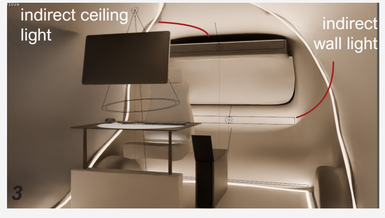
**Different light concepts**

**based on expert feedback**



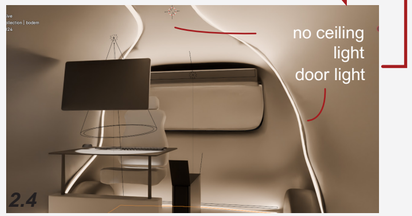


While experimenting with Blender different light locations and sources are considered. According to light expert Pont, too much brilliance light is used insead of multiple light layers.

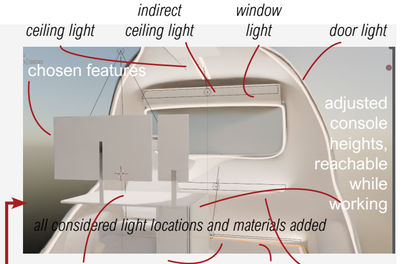


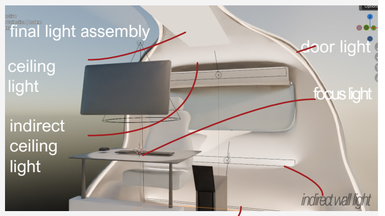

*adjusted to an indirect light source*


The brilliance light is changed to into ambient, focus and brilliance layers (as advised by Pont, 2024). In blender renders different light situations are considered and compared
Several variations of these light layers are made into concepts.
This is done to evaluate which light assembly allowed the most natural light looking environement en lead to the least amount of reflections.


**Final concept**




Based on all tried render simulations and expert consultations one final concept is considered to provide the most even light without too many screen reflections.

*time to do physical prototyping....*

## PROTOTYPING

The goal of the prototyping phase is to gain insights that cannot be achieved through drawings and 3D models alone and to conduct some initial testing. This exploratory testing aims to gather preliminary insights about whether the location of the light source was pleasant for the work experience.

### Light inside

The previously gathered insights on lighting have been incorporated into a buck as well. This setup includes four different light sources (Figure 30). The ceiling light serves as ambient light, using two LED panels with a colour temperature of 4000K. Additionally, a lamp with diffused light is mounted behind the seat, providing indirect lighting with a colour temperature of 5000K. A desk lamp is also installed in the ceiling for focused lighting at 5000K. Furthermore, LED strips with a colour temperature of 5000K are mounted at the door openings. The floor lighting has been removed, as it does not contribute to illuminating the environment and only serves as indication lighting.

### Light characteristics

For the prototype, light sources were used that do not all precisely match the desired lighting characteristics such as colour temperature, lux etc. However, this is not a significant issue, as the primary goal of this prototype was to determine the effect of the particular location of the light source on the work experience. Each lighting layer, however, does include a light source that corresponds to the type of lighting: diffuse, focused, or decorative.

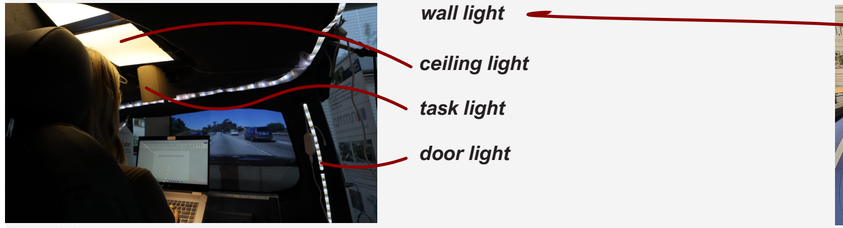



*Figure 30: lighting inside of the buck*

### Features inside

#### Seat

The previously mentioned features, essential for supporting work activities, have been integrated into a buck available at the TU Delft (Figure 31). A Range Rover seat, the L460, has been installed, with the backrest positioned upright to resemble the angle between the backrest and seat of an office chair.

#### Table

The dashboard includes a work surface that can be tilted up and down to facilitate entry into the vehicle.

#### Laptop stand

A laptop stand is mounted on the work surface, allowing the laptop to be positioned at a more ergonomic height, directly in the passenger its line of sight during work activities.

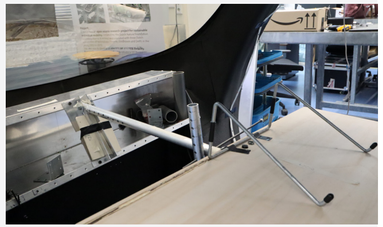


*Figure 31: features inside of the buck*

## INSIGHTS

The physical prototype led to several insights about the different light sources/layers (Figure 32):

### The wall light

The indirect lighting on the wall does not cause any reflections on the screen and provides an evenly lit environment. Looking at the illuminated surface was also not uncomfortable.

### The ceiling light

The ceiling light was a very strong light source. Due to the high contrast with the rest of the ceiling, it was visible on the screen from certain angles. This was not necessarily disturbing, but looking directly at the light source was uncomfortable.

A possible insight from this is that the ceiling light should not be a small surface with very high intensity. Instead, it should have a lower intensity and cover a larger area to reduce the contrast between different sections of the ceiling. However, further validation is needed for this observation.

### The desk lamp

The desk lamp was too bright for as it was not focussed enough which made the light shine in your eyes. An important insight from this what that due to the low ceiling height the light source itself should not be visible and thus covered or shielded.

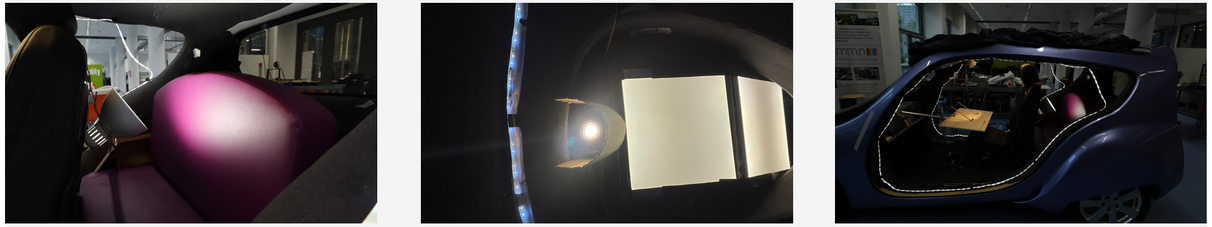


*Figure 32: the different light sources used*

### The door light

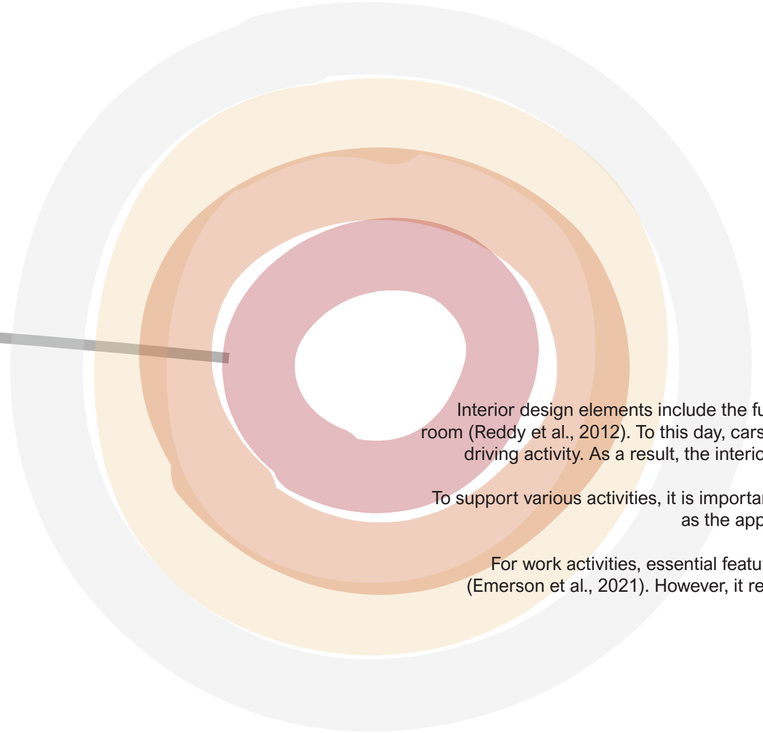
The door light was visible on the computer screens due to reflections. Dimming the light or adjusting the screen position could improve this issue. Additionally, when looking around, the light source was too bright. An important insight from this is that the door light should not be too bright or used as an indirect light source.

## ADJUSTMENTS

Based on these conclusions, it was decided to make the desk lamp more focused by placing a paper tube around the desk lamp. The intensity of the door lamp was reduced. Nothing was adjusted for the wall and ceiling lamp. See Figure 33.


*Figure 33: after initial testing the focus light is shielded and the door lights are dimmed*

# USER TESTING



## *MOTIVATION*

Interior design elements include the functionality of the space and the intended mood of the room (Reddy et al., 2012). To this day, cars are primarily designed for a driver and to support the driving activity. As a result, the interior is not optimally equipped to facilitate other activities.

To support various activities, it is important to have the right features and functionalities, as well as the appropriate atmosphere (Kirsh, 2023; Reddy et al., 2012).

For work activities, essential features may include a screen, a desk, and suitable lighting (Emerson et al., 2021). However, it remains unclear what constitutes essential and pleasant lighting in a car at different times of the day.

# INTRODUCTION

## PROBLEM STATEMENT

Elements of an interior design include the functionality of the space, as well as the intention or mood of the room (Reddy et al., 2012).

Until this day, the car has been designed for the presence of a driver and supporting the driving activity. For this reason, the car is not optimally designed to support other activities.

To support activities, the presence of the right features/functionalities and the right atmosphere is important (Kirsh, 2023; Reddy et al., 2012)

For the work activity, think of features such as a screen, desktop and the right lighting (Emerson et al., 2021). Looking at lighting, it is unclear what the essential and pleasant lighting in a car is at different times of the day.

## OBJECTIVE

This innovative direction, currently not featured in vehicles, requires a proof-of-concept validation to understand its value and functionality particularly for level 5 autonomous cars.
This test serves as exploratory research, aiming to generate initial insight for further developments rather than testing specific hypothesis. Additionally, the focus is on obtaining qualitative research data rather than quantitative.
This validation research will test, by means of a user study, whether the supposed essential lighting contributes positively or negatively to the travel experience (in terms of functionality and emotion) for both the day and night situation (Figure 34). By comparing the concept with the current situation, the goal is to find out whether the lighting implemented from literature is an actual improvement compared to the current situation (without lighting).

*Figure 34: the four situations in the test. Day with light, day without light ans night with light and night without licht*

## RESEARCH QUESTION

***"Does the lighting in both day and night situations contribute positively to the passenger its travel experience when carrying out the work activity?"***

## CONCEPT ASSESMENT

With this test two key elements of the light concept are tested. Firstly, the level of visibility and comfort are tested. Secondly the contribution to facilitating the work function is tested.

## PARTICIPANT SELECTION METHOD

In consultation with JLR, it is decided not to formulate a specific target group for this test and to conduct the test at population level. The participants for the research were approached via online and physical recruitment based on random selection.

## PARTICIPANT DATA COLLECTION

Both general information and specific body measurements of participants will be collected. The general information is primarily focussed on gathering background details of the participants.

## EXCLUSION CRITERIA

For this research two exclusion criteria are formulated. Firstly, the participant is not allowed to be visually impaired. Secondly, the participant is not allowed to be colour blind.

## OVERALL OPINION

At the end of the test the overall opinions of the participants regarding the concept are collected. The aim is to identify potential improvements not covered by the test.

## MATERIALS

For the test, to replicate the real-life environment, a buck is employed.  A buck is a full-scale model of a car, usually made from materials like wood, clay, or foam. It is used in the design process to give designers and engineers a physical representation of the vehicle and for testing purposes, as in this case. Although this specific buck does not match the dimensions of the envisioned exterior, it still provides a vehicle environment for participants during testing.

In the buck, a Range Rover seat, the L460, is installed. Furthermore, a table, screen and paper text are provided (Chapter Prototyping). This ensures that assessments conducted during testing are as accurate and reflective of actual conditions as possible. During the test a car cover is also used to simulate the night situation. Additionally, a screen depicting an on the road situation is placed in front of the buck. All the materials used during testing, including the test set-up, are shown in Figure 35.

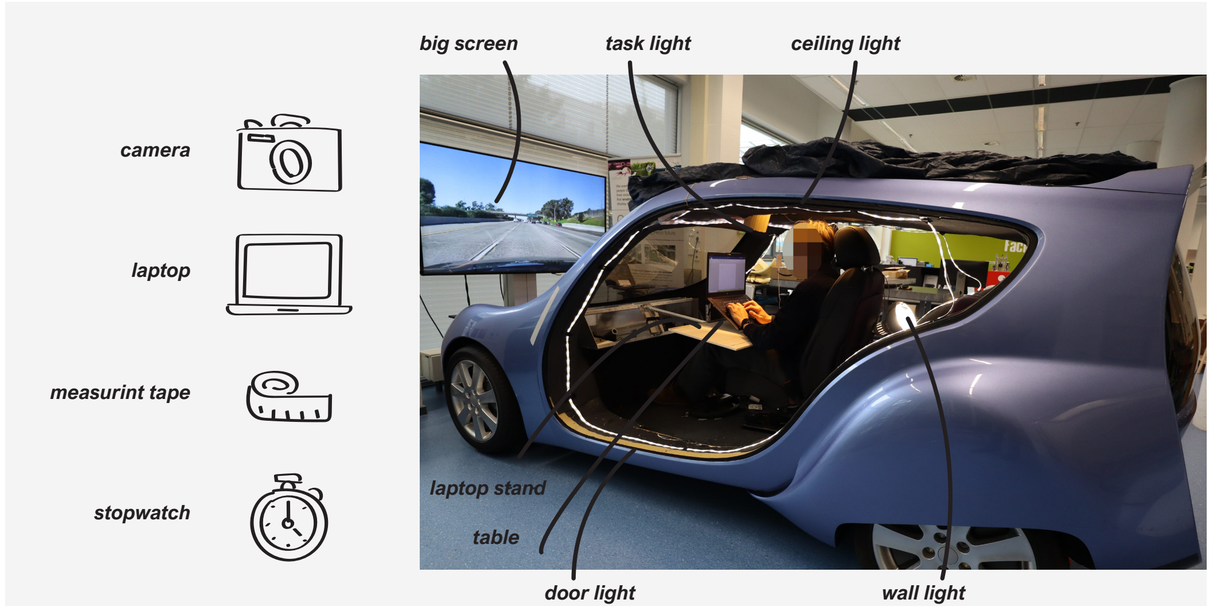



*Figure 35: the materials used during user testing*



# PROCEDURE

## INITIAL TESTING PROCEDURE

Following the pilot test, several modifications are implemented. This chapter outlines the final testing procedure.

### 1. Introduction and informed consent form

At the beginning the study is verbally explained as follows:

“We are conducting a study on a new concept for fully autonomous vehicles designed to enable users to work comfortably while traveling. Thereby the focus is on the lighting within the vehicle.
During the testing process, you will be asked to retype a specific text on your laptop. This text is divided into four parts. Please inform me when you start typing and when you finish each part. After each section, I will take some notes and ask you a few questions. I will then adjust the lighting in the car, and you may remain seated. Again, please let me know when you start and finish typing the next part. We will repeat this routine for a total of four sections.
At the end of the test, you will complete a final general questionnaire. You may pause the testing at any time if needed, and you are encouraged to vocalize your thoughts throughout the process. If this is okay with you, could you read the consent form and sign it?”

The consent form can be seen in Appendix User testing.

### 2. Information collection

First, preliminary questions were asked to the participants. The focus is on obtaining basic personal information. General outcomes are captured in the results chapter. However, individual participant background results are excluded from the appendix due to privacy constraints.

### 3. Bodily measurements

The participants are instructed to sit while measuring the sitting hight according to Molenbroek et al. (2017) as depicted in Figure 36. The measurements are conducted outside of the buck.

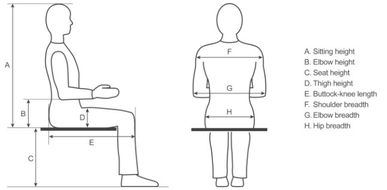



*Figure 36: Sitting hight measurement taken during the test*

### 4. Entering the buck

Participants were instructed to enter the buck where the chair, table and screen are already installed after which the text on paper is handed over. They are assisted by lifting the table while entering and handing the laptop after seated.

**5. Testing for different situations**

The test is done with 18 occupants. All participants are exposed to the four different situations (Figure 37):

1 reading and typing in day situation without light
2 reading and typing in the day situation with light
3 reading and typing in the night situation without light
4 reading and typing in the night situation with light

The situation sequence is varied for the different participants between the options 1234 and 2143. It was considered important to have a variation in the sequence to find out the influence of with or without the light on the functionality of the room.

The study starts by placing the participant in the first situation. The first and following situations are sequenced as described earlier. After, the participant is asked to type over the first part of the text. The start and finishing of this task in vocally indicated by the participant. This total typing time (between starting and finishing) is measured with stopwatch and written down per text part. As the participants have to type over the provided text, the time the participant is exposed to each situation is dependent on this typing time. So the precise time needed depends on the participant. After the questionnaire is completed. This is done in the same situation as the typing task. After the situation is changed to the second situation. The participant again indicates the starting and finishing time after which the questions are asked. This sequence of steps is repeated in a total of 4 times (equal to the four situations). At the end there an additional questionnaire is filled in.

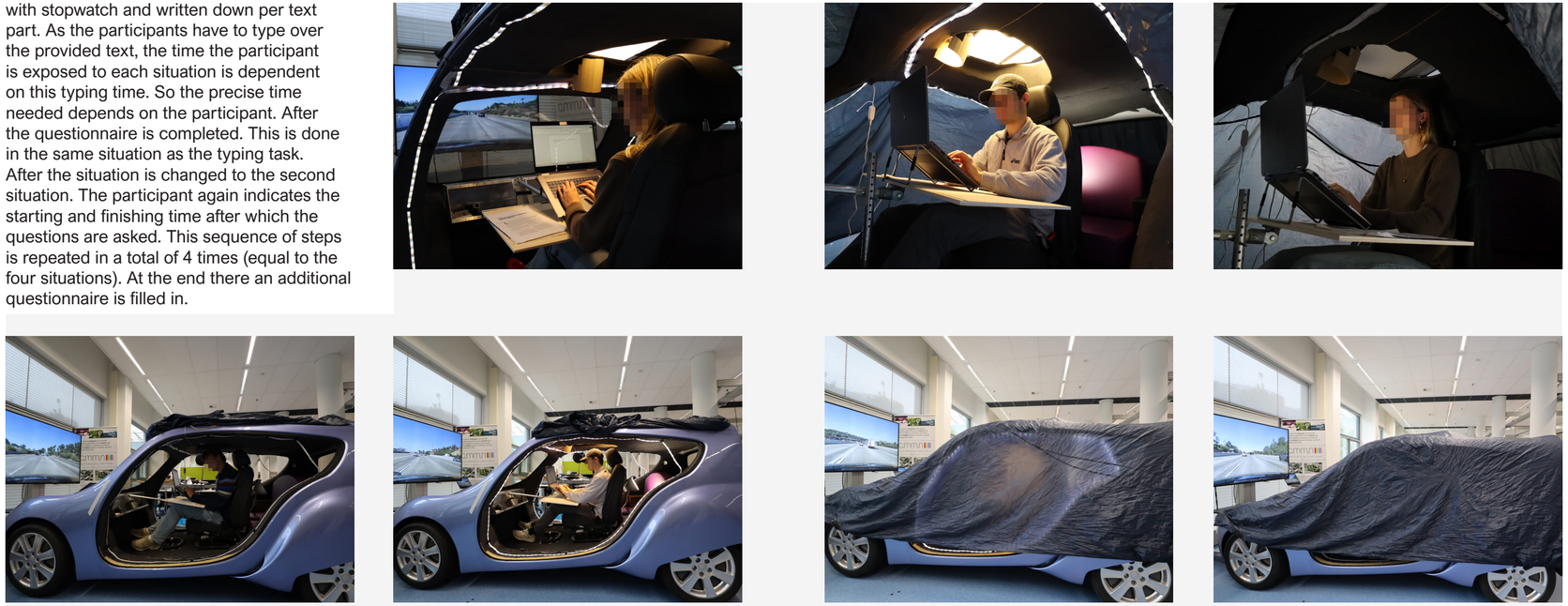


*Figure 37: the four situations during the test*

A pilot test was conducted as well. The adjustments are implemented in this procedure.

**6. Data collection**

The research data was collected using a questionnaire that is asked to the participants during the test. The goal, to find out with this questionnaire is: Whether the situations with light are an improvement to the situations without light. Whether the lighting is pleasant and stimulative in terms of functionality.

**End**

The participants were asked for their final thoughts and thanked for the participation.

# PILOT

## ADJUSTMENTS

Following the pilot test, some adjustments were made to the questions asked during the study. These changes were made to clarify that the questions refer to the specific situation at hand, rather than hypothetical scenarios. Additionally, certain questions were revised to more clearly focus on the lighting, rather than factors like the distance between the paper and the screen.

Furthermore, some modifications were made to the environment. To minimise distractions, the space around the car was tidied. A screen displaying a dashboard camera view was also placed in front of the car to create a more realistic environment, simulating the experience of being on the road.

The pilot participant mentioned that the “pleasant/unpleasant” question seemed redundant. However, we decided to keep these two questions separate as a form of control. The participant also found typing on the laptop holder uncomfortable. Despite this, there is chosen to retain the laptop holder to keep the screen at a more realistic height, better simulating the potential work environment. No extra keyboard was added, as there was not enough space on the desk. Additionally, participants needed the flexibility to place the paper on the left, right, or centre to gather as much feedback as possible regarding the lighting on the work surface.

## RECOMENDATIONS

Additionally, the car did not have any windows. To further improve the experience, more contextual adjustments could be made. For instance, semi-transparent plastic could have been mounted on the sides of the car to simulate the feel of glass. Moreover, the desk could have been made more stable.



# RESULTS

The test results provide several insights into interior lighting, see Appendix Results. The study primarily evaluated the feasibility of the task (usefulness), user experience, and preferences or advice related to the interior environment. With a paired sample t-test the situations with and without light are compared for both the night and day.

## TYPING

First, the typing speed (average seconds per word) was measured to assess task feasibility across different lighting conditions. The results show that the “day with light” scenario has an average typing speed of 1.89 seconds per word. Following this was the “night with light” situation at 2.09 seconds, “day without light” at 2.18 seconds, and finally “night without light” at 2.27 seconds (Figure 38).

The t-test for paired samples showed there is a significant difference (t-value= 3.012, p-value= 0.008) in typing speed for the night situation for with and without light. However, there is no significant difference in typing speed (p>0.05) for the day (t-value = 0.632, p-value= 0.535) situation for with or without light.

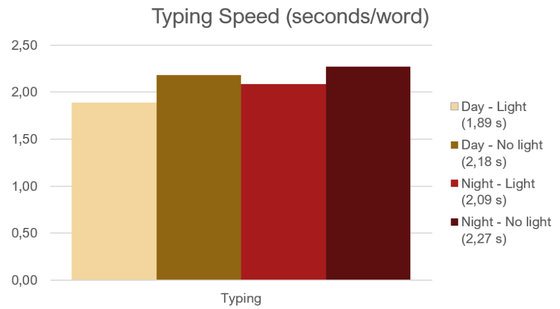



*Figure 38: average typing speed during test*

## PAPER WORK EXPERIENCE

The experience of reading on paper was evaluated in terms of visibility and reading comfort. The results indicate that situations with light performed better than those without light. For visibility on a scale from 1 to 5, the “day with light” scenario scored 4.4, while “night with light” scored 4.3. The “day without light” scored 3.3, and “night without light” scored only 1.3 (Figure 39). Comfort ratings were similar to the visibility scores.

The t-test for paired samples, with a t-value of 4.610 and p-value smaller than 0.001 showed a significant ($p<0.05$) difference in visibility for situations with and without light during day. Additionally, the t-test for paired samples, with a t-value of 11.735 and a p-value smaller than 0.001 showed a significant ($p<0.05$) difference in visibility for the night situation for both circumstances.

Concerning comfort the t-test for paired samples with a t-value of 3.449 and a p-value of 0.003 showing that there is a significant ($p<0.05$) difference in comfort for the situations with and without light during day. Additionally, the paired sample t test with a t-value of 9.220 and a p-value smaller than 0.001 showed that there is a significant ($p<0.05$) difference in comfort for the night situation with and without light as well.

### Additional Insights

- The participant its head and laptop created shadows on the desk.
- Text on the paper reflected the light.
- Poorly lit desks caused neck strain among participants during reading.

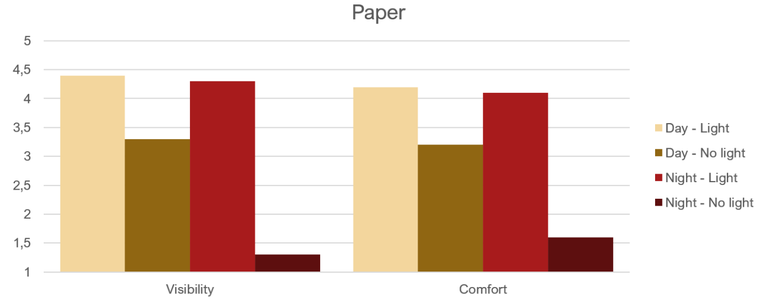



*Figure 39: average score on visibility and comport of reading the paper*

## SCREEN WORK EXPERIENCE

The experience of reading on a screen was also assessed for visibility and comfort. The results show that visibility scored between 4.3 and 4.5 in all scenarios. However, comfort ratings were lower in situations without light. The “day with light” and “night with light” scenarios both scored 4.3 for comfort, while the “day without light” scored 3.8 and “night without light” scored 2.7 (Figure 40). The t-test for paired samples, with a t-value of 0.437 and a p-value of 0.668 showed no significant ($p>0.05$) difference in visibility for the situation with and without light during day. Additionally, the t-test for paired samples, with a t-value of 1.0 and a p-value of 0.331 showed that there is also no significant ($p>0.05$) difference in visibility of the screen for the situation with and without light during the night.

Concerning comfort the t-test for paired samples with a t-value of 1.686 and a p-value of 0.110 showing that there is no significant ($p>0.05$) difference in comfort for the day situation with and without light during day. However, for the night situation the test with t value 6.216 an p-value smaller than 0.001 showed a significant ($p<0.05$) difference in comfort for the night situation with and without light.

### Additional Insight

- The screen was easy to read at a comfortable height.
- Some participants noticed reflections on their laptop screens caused by the door lights.
- The strong contrast between a poorly lit paper (due to lack of lighting) and a bright screen led to an uncomfortable reading experience.
- Keyboard lighting was considered pleasant by participants.

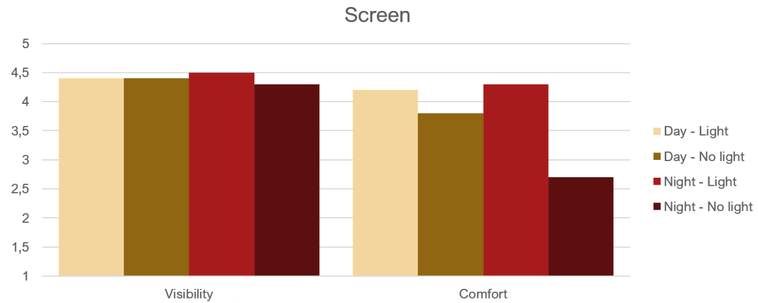



*Figure 40: average score on visibility and comport of reading the screen*

## OVERALL EXPERIENCE

The overall experience was discussed to understand how participants perceived the interior and lighting in terms of how pleasant, activating, and intense the lighting was.

The pleasantness of the environment scored highest in situations with light, with a rating of 3.9 out of 5. In contrast, situations without light scored lower: 2.9 for “day without light” and 1.8 for “night without light” (Figure 41).

The t-test for paired samples (t-value of 4.675 and a p-value smaller than 0.001) showed a significant ($p<0.05$) difference in pleasantness for the situation with and without light during day. Additionally, the test showed a significant (t= 6,453 and $p<0.001$) difference in pleasantness for the situation with and without light during the night.

Regarding how energising the environment was, lighting again played a crucial role. The “day with light” scenario scored 4.1, and “night with light” scored 4.2, while the “day without light” and “night without light” scenarios scored 2.6 and 1.9, respectively. The paired t test showed a significant difference for both day (t=5.588 and $p<0,001$) and night (t=9.621 and $p<0.001$) situation for with or without light.
The light intensity was also evaluated, with the “day with light” scenario scoring 3.5 and “night with light” scoring 3.4. In comparison, “day without light” scored 2.3 and “night without light” scored 1.4. The paired t test showed a significant difference for both day (t=5.905 and $p<0,001$) and night (t=8.737 and $p<0.001$) situation for with or without light.

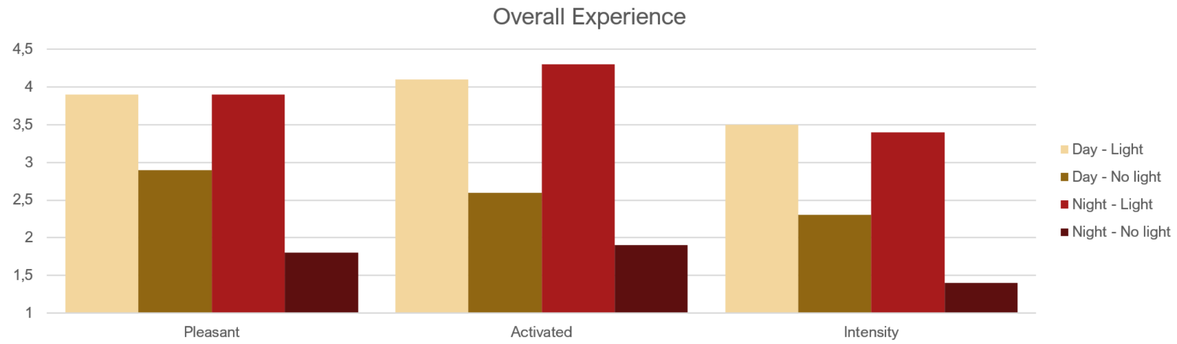



*Figure 41: average score of the overall experience rated on pleasantness, activation and intensity*

### Additional Insights

#### Lighting

- LED near the door was appreciated.
- Participants preferred angular illumination over round ones to better illuminate the desk.
- Ceiling lights were considered too intense and too close to participants.
- Current lighting positions caused shadows due to the participant and laptop.

#### Focus

- A dark environment with focused lighting increased concentration for participants, with one commenting on a “locked-in” feeling.
- Windows were a source of distraction for participants.

## PREFERRED SITUATION

Participants were asked to indicate their preferred situation. They were asked to rate on a scale from 1 to 5 whether they preferred a night (1) or day (5) setting and whether they wanted the space to be lit or not.

Two out of the 18 participants preferred no lighting; however, this was combined with a well-lit daytime setting, receiving a score of 5. The remaining participants preferred an illuminated interior. The average score between day and night was 3.4, showing a slight preference for working in a daytime setting.

***Key note:***
The lighting showed a significant improvement concerning pleasantness, energised mood, intensity, paper visibility and paper and screen comfort. For screen visibility and typing speed no significant differences can be seen. However, the average typing speeds was higher for the situations with light compared to the situations without light.

***Key questions:***
What can be concluded from these results?

# CONCLUSIONS

The user tests reveal several insights into the impact of lighting on the interior (Figure 42).

### 1. Lighting and Performance

The typing speed was significantly faster for the night situation with light compared to the night situation without light. This indicates a performance improvement due to the presence of sufficient lighting. The scenario “day with light” showed no significant performance improvements compared to the “day without light” situation. However, a trend of a faster typing pace can be seen for the situations with light.

### 2. Comfort and Visibility

A significant improvement concerning comfort and visibility for the situations “day with light” and “night with light” can be seen for paper reading compared to the situations without light. Paper work benefited from adequate lighting, with users reporting better readability and fewer physical complaints, such as neck strain. Poor lighting, particularly at night, led to discomfort and slower task execution.

For screen reading no visibility or comfort improvements are made for the situation with light compared to the situation without light for the day. So, for this situation the presence of light can be considered as a comfort improvement.

### 3. Overall Experience

Participants rated environments with lighting as more pleasant, energising, and conducive to focus. Poor lighting not only detracted from the environment its pleasantness but also made the space feel less stimulating and functional.

### 4. User Preferences

Overall, the situation with light were preferred. Users highlighted specific lighting preferences, such as the need for focused lighting without shadows and found a nicely visible keyboard to be a valuable addition for task comfort.

*Figure 42: participants during test*

### 5. Focus

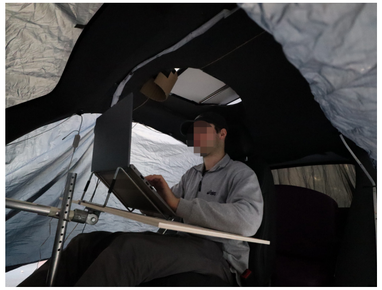
In the night setting, some participants noted improved focus due to reduced environmental distractions. This suggests that obscuring or matting the glass could further enhance concentration in the interior.

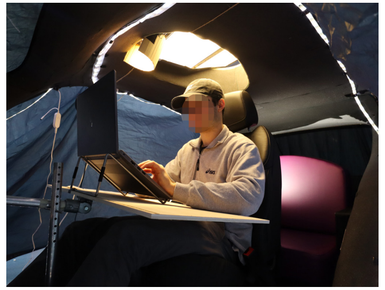
### 6. Diffuse vs focussed and Indirect vs direct

Participants did not see the indirect diffuse light of the wall light as a hindrance, nor did it cause unwanted screen reflections. This indicates that diffuse indirect lighting is suitable for both paper and screen use.

Several participants noted that a well-lit worksurface improved the focus on the task. Therefore, there is concluded that illuminating the work surface positively supports work activities. Some participants questioned the need for the task lamp, as the surface was already well-lit. The focused light, when not covering the whole working surface, created a too high contrast. However, indicated was that the task lamp its presence was appreciated. This suggests that while task lighting might not be essential in a well-lit room, it should still be available.

A few participants found the ceiling light too intense, likely due to its proximity. This suggests that the ceiling light should either be positioned further from the user or emit less intense, more evenly distributed light.





### Further Improvements

#### 1. Optimise Lighting Placement

Current lighting positions caused shadows on work surfaces due to the participant its head or laptop. Repositioning ceiling lights or adding adjustable task lighting could reduce these shadows and improve visibility.

#### 2. Adjust Light Intensity:

Participants felt the ceiling lights were too intense and too close. Introducing dimmable lights or indirect lighting could help reduce glare and make the space more comfortable, particularly for long-term use.

#### 3. Reduce Screen Reflections

Some participants experienced unwanted reflections from LED strips on their laptop screens. To avoid this, consider using diffused or indirect LED lighting to reduce glare while maintaining sufficient brightness for task visibility.

#### 4. Improve Desk Lighting

Focus light providing angular illumination could be installed to better illuminate work areas without casting shadows on the surface. This would enhance comfort for both reading and typing tasks.

#### 5. Balance Lighting Between Screen and Paper

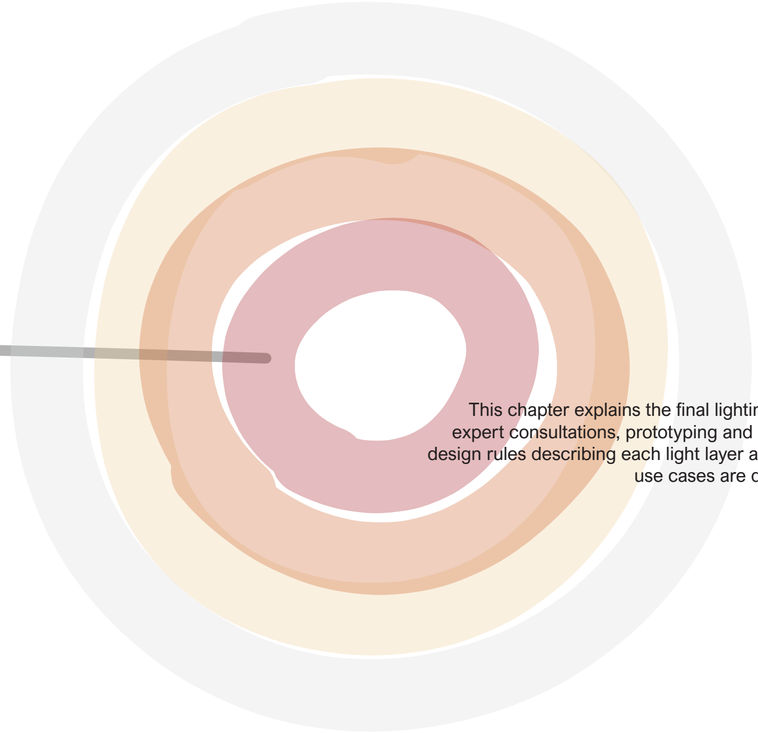
Users noted discomfort due to the strong contrast between a poorly lit paper and a bright screen. Providing balanced lighting across the workspace can minimise this disparity and create a more cohesive, comfortable work environment.

#### 6. Enhance Focus Lighting

Participants reported that a dark environment with well-placed lighting helped increase focus. Designing a lighting scheme that allows users to control light levels and focus lighting on specific areas could help maintain this “locked-in” feeling and improve productivity.

By addressing these areas, the interior lighting design can be significantly improved to support a more comfortable, efficient, and pleasant environment for users.

# FINAL DESIGN



### *Motivation*

This chapter explains the final lighting design. The light assemblies are based on literature, expert consultations, prototyping and user testing. By combining all information and insights, design rules describing each light layer and source are formulated. After more specific example use cases are described with different considerations to keep in mind.

# DESIGN RULES

## INTRODUCTION

The autonomous vehicle offers broader functionality compared to current cars. In response to this innovation, the final design further addresses the features, seating, and control but focusses on the lighting. All these different interior components are interconnected and tailored to specific usage scenarios. Through the control panel located beside the seats, interior components can be adjusted to provide a seamless curated Land Rover experience. First the design rules addressing specific light characteristics will be presented.

## DESIGN RULES

Based on the previously literature and user testing, design rules have been extracted for the lighting layers and light sources in the vehicle (Figure 43). The formulated design rules address three specific lighting characteristics: intensity (lux), colour temperature (CCT), and spatial distribution (diffuse/focused and indirect/direct). Although there are other lighting characteristics, these three were chosen specifically. According to Van Erp (2008), these three properties (intensity, CCT, and spatial distribution) affect perceptual attributes. Meaning that people can distinguish between different levels of these characteristics. This is crucial because if people could not perceive these differences, these characteristics would likely not impact the perceived atmosphere.





*Figure 43: Light sources in interior according to designrules*

## AMBIENT LIGHTING

The ambient lighting includes ceiling and wall lamps. According to Flynn et al. (1973) and Flynn et al. (1979), peripheral and non-uniform lighting creates a pleasant, relaxing impression, while overhead and uniform lighting feels more evaluative. Therefore, a mix of indirect and direct diffuse lighting is used for ambient light, positioned both overhead and peripherally. This aims to balance uniform and non-uniform lighting, avoiding harsh shadows.

### WALL LIGHT

According to Durak et al. (2007), wall washing and cove lighting contribute to a pleasant impression of a space. This is supported by the user testing indicated that indirect diffuse lighting enhances a uniform and comfortable illumination without causing screen reflections. Based on these insights, additional indirect diffuse wall lighting is incorporated into the design compared to earlier test and Blender models. This lighting illuminates the space indirectly, using either warm or cool colour temperatures depending on functionality, creating comfortable lighting without unwanted reflections (Figure 44).

It is important to avoid too high CCT values with high intensity diffuse lighting, as this can create a detached feeling (Van Erp, 2008). High intensity with a relatively low CCT is perceived as less tense, less cozy but lively, suitable for work environments. Additionally, at low intensity, CCT has less impact on room perception, allowing different atmospheres to be created with moderate CCT but depending on intensity.

### CEILING LIGHT

High intensity needed for some working tasks can for indirect diffuse lighting feel more detached than for directional light at high colour temperatures (Van Erp, 2008). Therefore, in addition to indirect lighting, direct diffuse ceiling lighting is used. Though this may produce less even lighting and more shadows, it provides a possible balance. User tests revealed that some participants found the ceiling light too intense, as it was overly bright, localised and positioned too close. Even though the final exterior design has a slightly higher ceiling, by which the light is placed further from occupants, these comments are still considered. As a result, the final ceiling design lamp covers a larger ceiling area, allowing a lower intensity to achieve the same light level. Additionally with the potential to provide more even lighting and reducing harsh shadows.

*Figure 44: Indirect difuse wall light*

## FOCUSSED LIGHTING

This layer includes task lighting. Directional light is perceived as cozier, more lively, and less tense than diffuse light at the same brightness level (Van Erp, 2008). This is relevant for work tasks, where focused light with an illuminance of 500–1000 lux is recommended for properly lighting the work surface (Pont, 2024). Studies by Kim & Mansfield (2021) and Kuijsters et al. (2014) found that task lighting in the 5000–5500K CCT range promoted a sense of liveliness. Thus, cool, focused, direct light with higher colour temperature (5000–5500K) is used for task lighting.

In user tests, a well lit work surface was preferred. However, several participants indicated that task lighting was helpful but optional. When present, the light its angle should be wide enough to cover the entire work surface, avoiding dimly lit areas and improving visibility.

In the final design, as in the test model, task lighting is integrated into the ceiling. This direct, focused light source is positioned above the work surface and has a higher intensity than the surrounding ceiling light when in use.

Kim & Mansfield (2021b) also identified lighting characteristics that evoked unwanted emotions. For example, gloom was reported for low task illumination (around 250 lux) combined with indirect lighting like wall washing. Tension was evoked with high task illumination (around 1500 lux) using direct lighting at 6500K. These lighting characteristics should therefore be avoided.

### Gradient

The ceiling light has a gradient, with the most intense light above the work surface, functioning as task lighting (Figure 45). The light intensity gradually decreases further from the user. This gradient serves two purposes: whether task lighting is necessary depends on the user. Also, light behind the user can cause screen reflections. By dimming the light further back, reflections are reduced (Smit, 2024). However, keeping the light relatively intense on the work area of the user is important to ensure sufficient lighting for tasks.





*Figure 45: Direct difuse ceiling light with incorperated direct focussed task light*

## BRILLIANCE LIGHTING

This layer includes lighting for the door and floor areas (Figure 46). Limited research exists on brilliance lighting in work environments (Pont, 2024), but generally, its role is more aesthetic than functional, adding a striking visual element to the space (Pont, 2024). The design accentuates the unique door and window shapes specific to the new Land Rover vehicle, enhancing brand presence. The organic, flowing shape aligns with biophilic design principles, aiming to positively influence user emotions through form, and colour.

Originally, the door lighting was intended to replace natural daylight when unavailable. However, it could cause reflections at a too high intensity. Remaining at a low intensity helps minimise these unwanted reflections (Smit, 2024).

The floor light is diffuse but moderated in intensity to avoid disruptive lighting effects (Pont, 2024). This lighting emphasises Land Rover its distinctive design and adds spatial depth. Additionally, it can function as indication light, signalling different conditions, such as red lighting to indicate an unfastened seatbelt or an open door.





*Figure 46: Diffuse dime brilliance light incorperated in the floor and door*

## WINDOW FROSTING AND OBSCURING

Window frosting or obscuring prevents unwanted or uncontrolled light inside the vehicle. LCD (Liquid Crystal Display) technology for shading, known as electric dimmable glass or smart glass, uses a thin layer of liquid crystals between two glass or plastic layers, switching from transparent to opaque with an electric current (Withey, 2024).

For Land Rover, this could be a lighter, more integrated alternative to traditional shades. It is simple, energy-efficient and stylishly modern (Withey, 2024). With the press of a button, the glass can be adjusted without affecting its seamless design (Withey, 2024). The Boeing 787, for example, already uses this technology (Vink, 2024; Withey, 2024; Pont, 2024).

The shading uses different glass tones, from frosted white to various shades of frosted grey, providing options for blocking light and ensuring privacy (Figure 47). Frosting or darkening the glass could also aid concentration (Chapter Conclusions). The glass properties must be considered, as materials and textures influence light through reflection or absorption (Pont, 2024; Smit, 2024). To minimise colour shifts, only black (grey) and white tones are used.





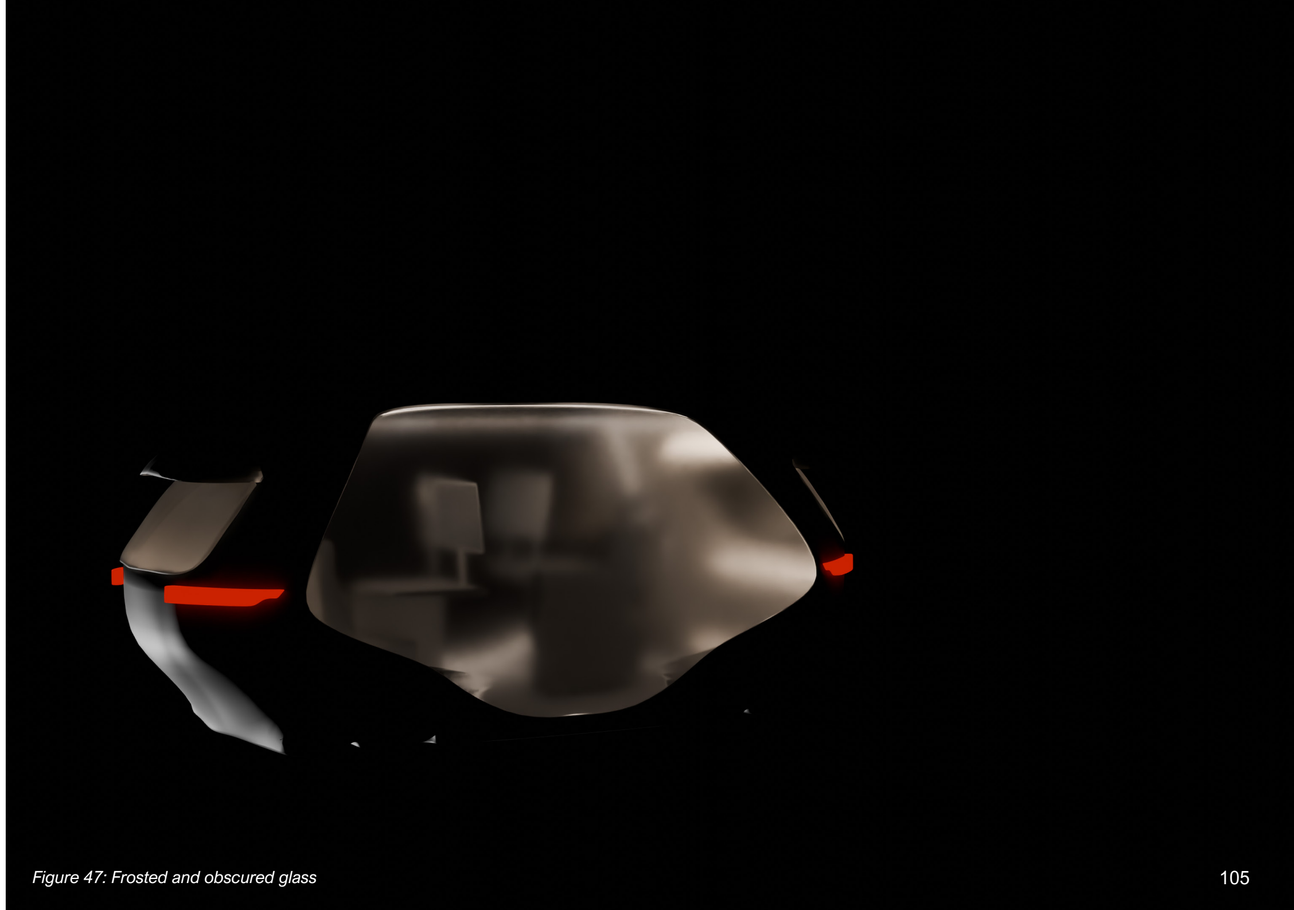


*Figure 47: Frosted and obscured glass*

## DAY AND NIGHT

Activities can occur at different times of day (Figure 48), each requiring specific lighting levels and characteristics. For general tasks, around 500 lux is suitable, while more precise work may need up to 1000 lux (Pont, 2024; Ganslandt and Hofman, 1992). Artificial lighting should account for natural light from outside, as highlighted during user testing. With for example the use of sensors, lighting and shading can be adjusted to the environment, creating the ideal atmosphere within the vehicle.

## ADJUSTABILITY

Literature suggests ranges for light temperature rather than specific ideal values for specific situation. User testing also showed that preferences for intensity and colour are personal. Some found the lighting too bright, others found certain lights cozy while some felt it was too dim or distracting. This variation aligns with findings of Charlotte (2021) indicating a preference for personalised experiences.

In the design, ranges for colour temperature and intensity were chosen within recommended limits. Efforts were also made to minimise any negative emotional effects of the lighting. The Kruithof Curve was also considered, which graphically represents the relationship between light intensity and colour temperature. The curve indicates that light is perceived as pleasing when intensity is within a certain range relative to CCT, predicting outcomes as bluish, reddish, or pleasant (Van Erp, 2008).





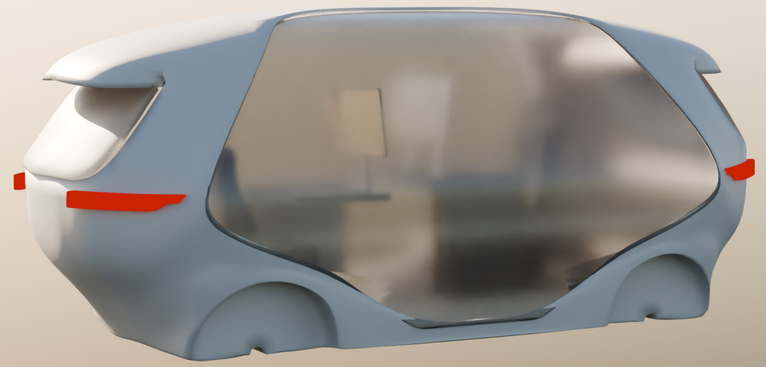


*Figure 48: Vehicle in day situation*

## DESIGN SCENARIOS

### INTRODUCTION

Various usage scenarios are presented, visually illustrating the relationship between interior components, such as lighting, shading, seats, and features (Figure 49). While the focus remains on lighting properties, the surrounding environment must still be taken into consideration.

As noted, journey activities vary depending on journey type (Wadud & Huda, 2019), country (Schoettle & Sivak, 2014), and automation level (Kyriakidis et al., 2015). For example, commuting trips often involve different activities, productive work on the outbound trip and relaxation on the return (Wilson et al., 2022). This highlights the need for the vehicle to support multifunctionality and flexibility.

Based on this knowledge, various activity scenarios were designed to cover both work and relaxation settings.

For work scenarios, setups are designed for screen-based tasks, paper-based tasks, and virtual meetings. User testing indicated that screen reflections. Virtual meetings were also prioritised, as co-creation sessions noted that calls are a common activity, possibly evolving to improved video conferencing (Airbus, 2024). For wellbeing, the scenario of relaxing and socialising are shown, both cited as frequent activities (Wilson et al., 2022).

Lighting properties are defined for each scenario by lighting layer (Pont, 2024) and source (ceiling, wall, door, and task lighting).



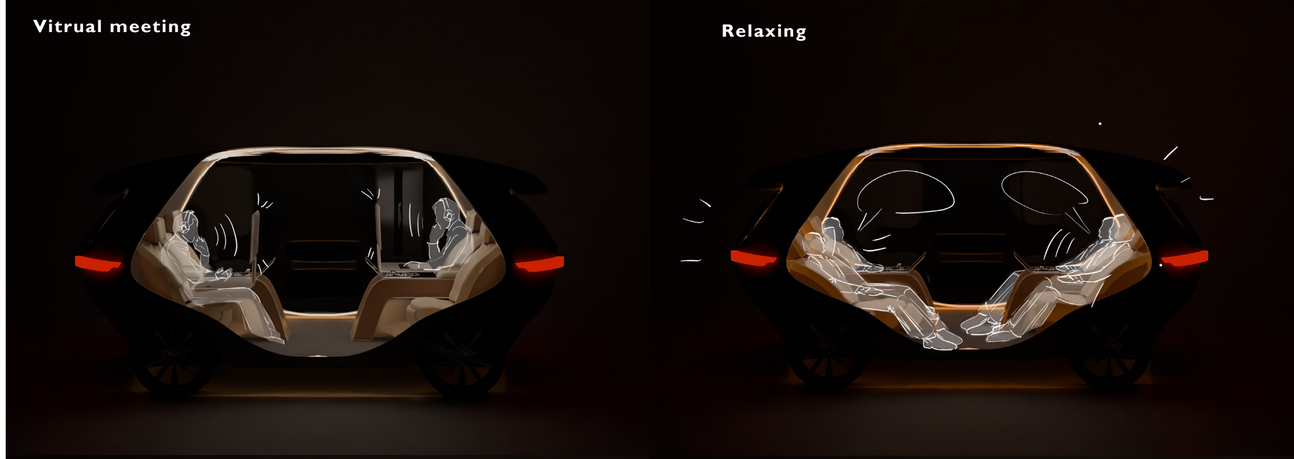



*Figure 49: Different interior use cases*


## SCREEN WORK

User testing showed that screen visibility was minimally affected by the space lighting. However, in the “night without light” scenario, the high contrast between the screen and the surrounding environment caused discomfort for some participants. Other occupants preferred the dark surroundings as it reduced distractions and increased focus (Chapter Conclusions). Preferences varied per occupant, but on average, less intense lighting is needed for screen work compared to detail work or paperwork, as visibility is minimally affected. However, for comfort it is still suggested.

Regardless of intensity, a functional workspace still requires a colour temperature between 3000K and 6500K (Van Erp, 2008; Kim & Mansfield, 2021) with the exact setting depending on personal preference. A lighting level of 200 to 500 lux is ideal for the work surface (Ganslandt and Hofman, 1992). The immediate surroundings must be properly lit, but to a lesser extent than the work surface

### Ceiling and Task Lighting

The ceiling light with direct diffuse lighting is set between 4000K and 6500K.

### Wall Lighting

The wall light with indirect diffuse lighting is set to neutral or white light between 3000K and 4000K/5000K.

### Task Lighting

Optional task lighting with direct and focused light at 5000K is integrated into the ceiling light above the work surface.

### Door and Floor Lighting

Both have a cool blue tone (Kim & Mansfield, 2021; Kuijsters et al., 2014). The preferred intensity varied by occupant, as some were disturbed by reflections and others were not, indicating the need for adjustability. Since these lights are less crucial than the other sources, their intensity remains low.





## PAPER WORK

For paper-based tasks, lighting plays a significant role in both visibility and comfort. A well-lit workspace is crucial (Chapter Conclusions). A cool colour temperature (3000K to 6500K) is preferred (Ganslandt and Hofman, 1992; Van Erp, 2008; Kim & Mansfield, 2021). A lighting level of 300 to 1000 lux on the work surface is ideal, as the lighting should also support precision tasks as well (Ganslandt and Hofman, 1992). The surrounding environment must be properly lit, but to a lesser extent than the work surface.

### Ceiling and Wall Lighting

The ceiling light is set between 3000 and 6500K with direct diffuse lighting, while the wall is lit within 3000 and 4000K indirect diffuse lighting. The ambient lighting features a lower colour temperature to avoid a detached feeling (Van Erp, 2008), given the required higher lux levels.

### Task Lighting

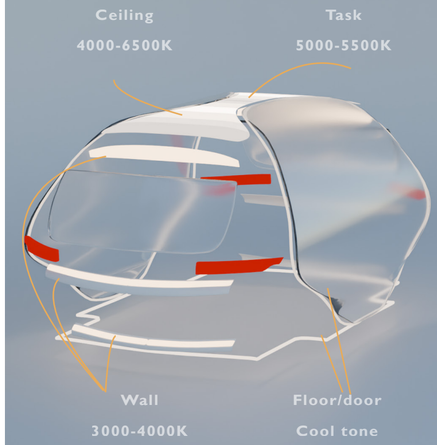
In this scenario, focused lighting is key (Ganslandt and Hofman, 1992) to optimise both reading comfort and visibility (Chapter Conclusions). A colour temperature between 5000K and 5500K is preferred (Pont, 2024).

### Door and Floor Lighting

The door and floor lights have properties similar to the screen work scenario. They can be adjusted based on personal preference.

### Additional Explanation for Wall and Ceiling in Scenarios

Given the high intensity and diffuse nature of the ambient light, it's important to keep the colour temperature lower to avoid a detached feeling and create a cozier environment (Van Erp, 2008). For screen work, a higher colour temperature is chosen for both wall and ceiling lighting compared to paper tasks. While high CCT with high intensity may lead to a detached feeling, the lower intensity for screen tasks allows for a higher CCT.



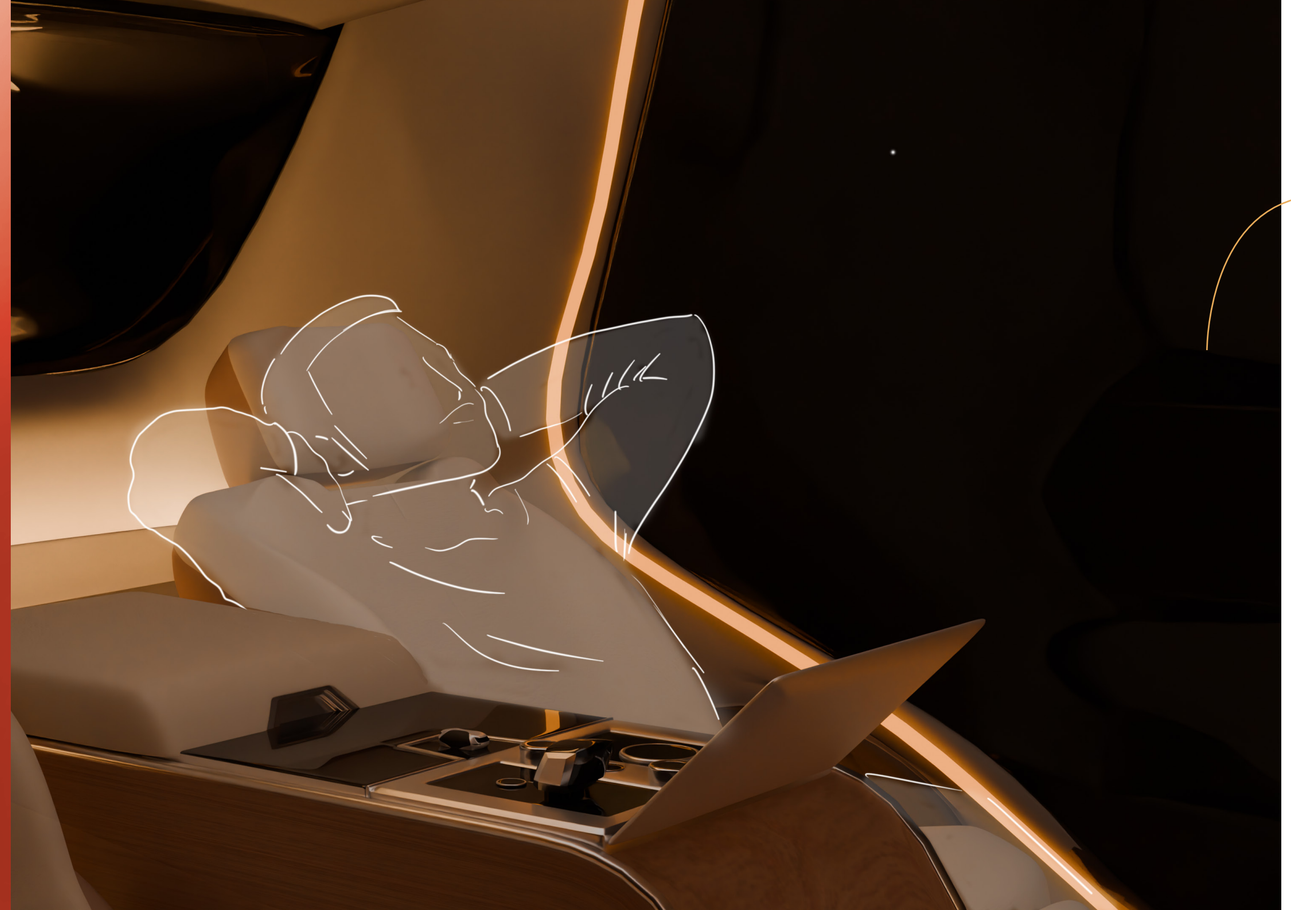

## (ONLINE) MEETING

A final scenario concerns (online) meetings, which was not tested but could be considered for design. It is important that the occupant's face is well-lit and that they can comfortably see their surroundings. Backlighting from windows or wall lights should be avoided. A neutral colour temperature of 3300-5000K is recommended (Ganslandt and Hofman, 1992). For illuminance, 100-500 lux is suitable for workrooms not in continuous use and simple visual tasks (Ganslandt and Hofman, 1992). Both the diffuse direct ceiling light and the indirect diffuse wall light should fall within this temperature range. In this scenario, task lighting can be optional and initially turned off but can be activated with a colour temperature between 4000-5500K.

### Door and Floor Lighting

For the floor light, it is important not to illuminate the face from below, which could create an inappropriate situation (Pont, 2024). Additionally, depending on preference (and the type of meeting), either saturated or unsaturated light can be used.

This is an additional example to show that specific lighting considerations must be made for each scenario based on how it affects the passenger's experience.





## RELAXING

For relaxation activities, diffuse warm dim light is used as it creates a cozy and less tense atmosphere (Van Erp, 2008). Additionally, peripheral and non-uniform lighting creates a pleasant, relaxed impression (Flynn et al., 1979). Therefore, a lower colour temperature of 2700 to 4100K is appropriate (Ganslandt and Hofman, 1992). The desired illuminance is 50-300 lux, suitable for general lighting and activities such as relaxed reading (Vandebeek, 2024).

### Ceiling Light

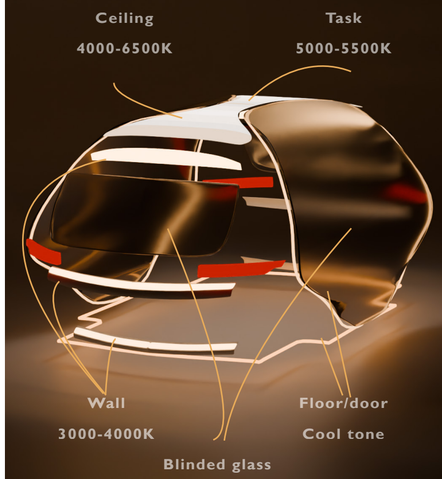
The ceiling light is set to a moderate intensity. Direct light is less appropriate for relaxation, as the seat backrest is typically reclined, and the user tends to look upward. Bright light sources can be uncomfortable to look at, as confirmed by user testing. To avoid overcomplicating light sources, the colour temperature range of the ceiling light can be kept neutral or high. At a high intensity, the colour temperature is less noticeable, as different colour temperatures are perceived as equally lively at low intensities (Van Erp, 2008).

### Wall Lighting

Diffuse settings with a low CCT are perceived as more cozy, less tense, and less detached than high CCT lighting (Van Erp, 2008).
For the relaxation activity, a warmer colour temperature with moderate intensity is used. Wall-washing lighting creates a pleasant room atmosphere (Kim & Mansfield, 2021). Peripheral and non-uniform lighting further enhances a relaxing effect (Flynn et al.,1973; Flynn et al.,1979).

### Door and Floor Lighting

The combination of warm white lighting with warm-coloured accent lighting (such as orange) creates a cozy and lively ambiance (Kim & Mansfield, 2021). Based on this insight, the door and floor lamps have been adjusted to a warm, saturated colour.



# ADJUSTABILITY

## INTRODUCTION

Adjustability offers opportunities for personalisation. This personalisation, based on personal preferences, in its turn could enhance the new Land Rover Luxury Experience, “imposing in control.” Instead of controlling the vehicle its driving, the user now has control over optimising the task at hand. However, JLR has indicated that limited personalisation should be available as curated settings and experiences are favoured. What the user wants is one aspect, but what Land Rover aims to offer and project to users is another (Withey, 2024).





*Figure 50: Addjusted lighting, features and seat*

## ADJUSTABILITY

### CONSOLE

Previously, cars always featured a dashboard, a central area where the driver controlled all functions. Now, instead of a dashboard, there is a console located next to the seat. The control panel on this console allows passengers to adjust various settings, such as seat height, backrest angle, window frosting/ obscuring, available features, and lighting. It can also include controls for existing functions like temperature, volume and more.

### DESIGN

To ensure the console, features, and seats align with the JLR style, various design elements have been incorporated, including the material selection, colour schemes and the shapes of straight lines combined with soft curves.

Given the diminishing control associated with automation, inspiration for the controls has been drawn from various manual driving functions, such as the gear shift and handbrake.




## ADJUSTABILITY

### Adjustment Scenarios

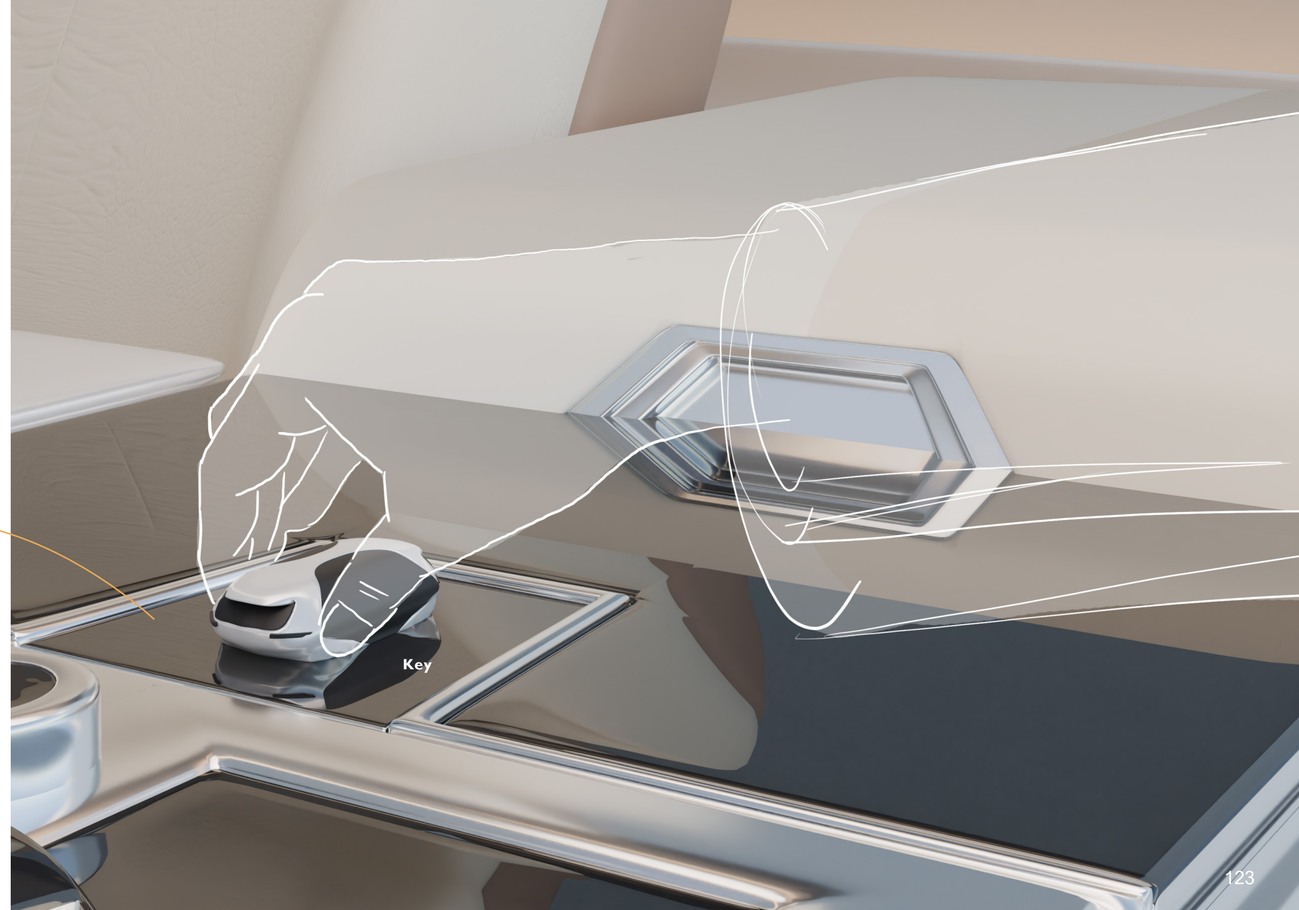
To demonstrate the control and adaptability of the Land Rover, example scenarios are provided to illustrate possible in-ride experiences. It is important to explicitly mention that these scenarios solely intend to showcase the versatility the control could offer in terms of functionality. However, these are merely scenarios meant for inspiration and not fully developed ideas.

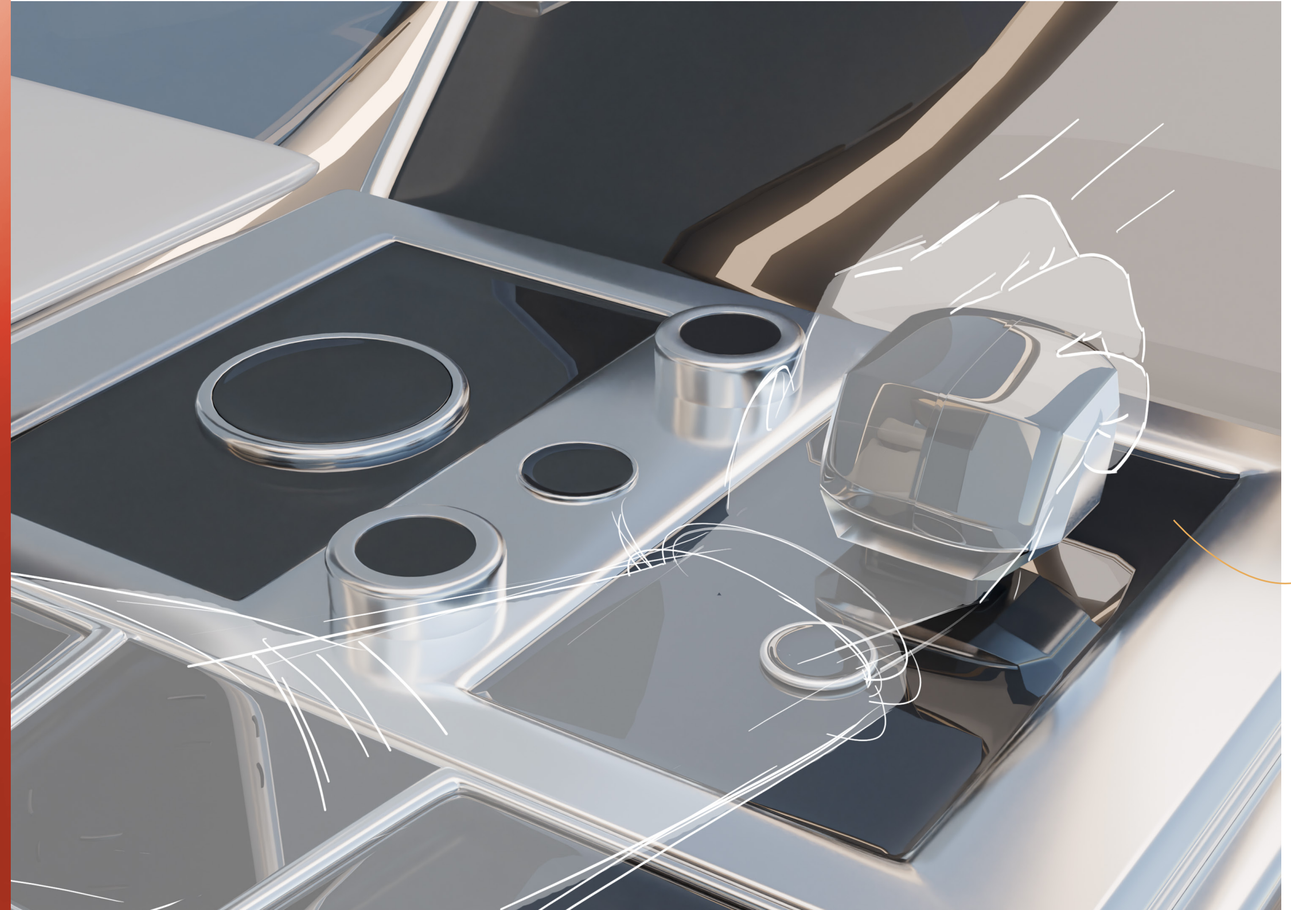
#### Entering the Vehicle

When the passenger enters the car and places the key in the designated slot, the vehicle identifies the user and automatically sets their preferred settings, such as adjusting the seat height.

#### Ready to Depart

When the user is ready to start the journey, the handbrake is released by pressing its button.





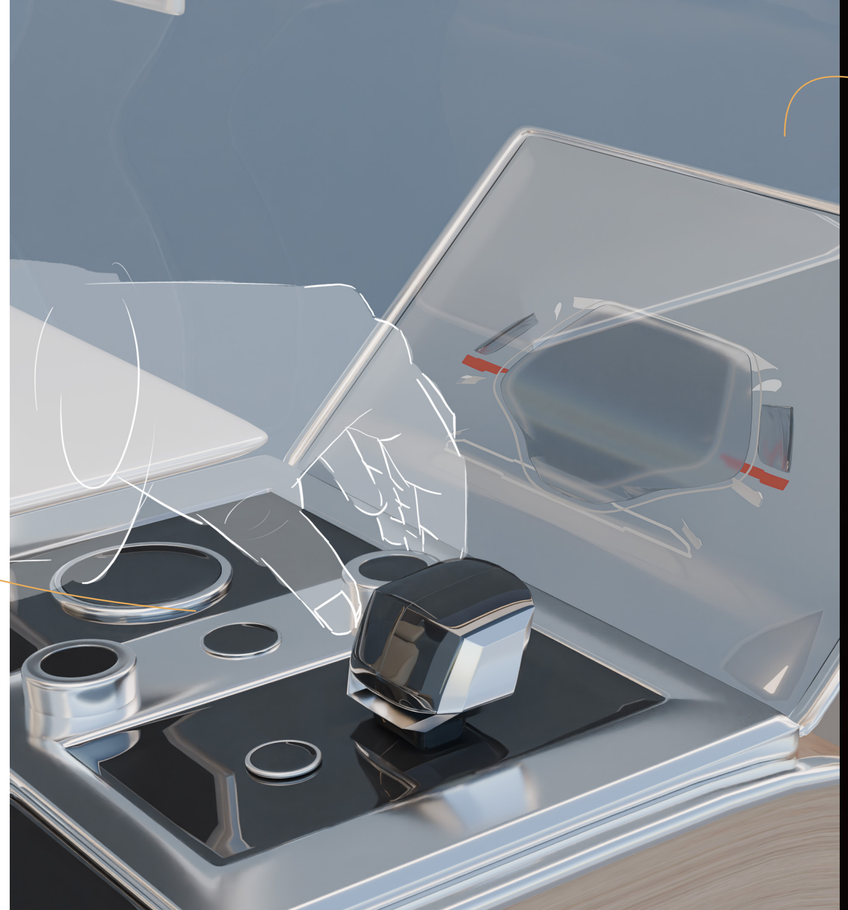
**Working on Screen**

The passenger sets the “gear shifter” to the functionality screen work mode, activating suitable features, lighting, and seat adjustments for optimal screen use.

## ADJUSTABILITY

**Adjusting Lighting**

By setting the turning the buttons the user can make various lighting adjustments. The screen could show a visual of the car, allowing the user to tap specific light sources for targeted adjustments.



# CONCLUSION

The project began with the brief: “Design an interior prototype to create a luxury experience for passengers in level 5 autonomous vehicles for long-term rides.”

The trends analysis and future visioning method resulted in the development of a broader mobility vision. It highlights the need for JLR vehicles to compete not only with other cars but also with public transportation, which is predicted to become more accessible and desirable due to societal developments. As autonomous vehicle technology evolves, vehicles are expected to converge into a universal format suitable for both public and private use.

After, Land Rover is strategically positioned in this future vision with the LRX “imposing in control” reflecting the brand its characteristics. Imposing refers to what the brand and user want to convey. The robust and angular characteristics associated with the Land Rover. Resulting in a sense of prestige and status suitable for its intended exclusive target group. This is incorporated in the exterior design by the vehicle its elevated stance and design for upright entry emphasising status. Control refers to the Land Rover feeling. The ability to do everything anywhere. The 4x4 feature originally provided both recreation and functionality. This led to a tough, adventurous, free and independent feeling. Full control, the Land Rover luxury.

Considering the history of Land Rover, functionality is one of the aspects that attributed to their success. The off-road capability continues to differentiate Land Rover from other brands. By emphasising functionality alongside emotional appeal, the goal is to create value for Land Rover once again. Instead of the “relax” or “living room” concepts, this project focuses on supporting work functionality. A functionality needed, not yet addressed in the market and highly relevant to Land Rover its “always working” target group.

Following this design direction the assignment was redefined to “Design a vehicle interior that provides an ‘imposingly in control’ long-term journey experience and facilitates both working and relaxing.” To facilitate these activities aspects such as functionality (features) and atmosphere can be taken into account. However, in consultation with JLR the focus was placed on lighting. Given that this is found to be an interesting component for which no specific purpose has been found within JLR yet.

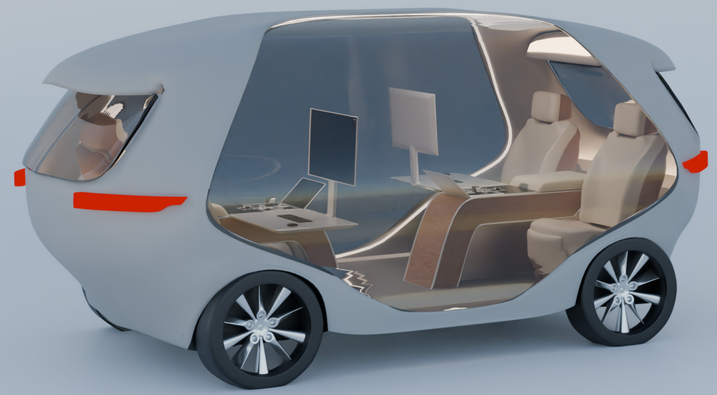
Based on literature and prototyping, various light sources part light layers, were applied in the interior. The research question of the user test stated: “Does the lighting in both day and night situations contribute positively to the passenger its travel experience when carrying out the work activity?”. Results showed that the incorporated light indeed contribute to positively influencing the work activity. Statistical tests also showed that a large part of the data for both the day and night situation for which a comparison was made with and without light yielded a significant difference.

# CONCLUSION

Based on this, design rules were developed for different lighting layers. For the ambient light layer, both direct diffuse ceiling light and indirect diffuse wall light are used. By using a gradient in the ceiling lamp, task lighting is provided if necessary. The brilliance light layer consists out of diffuse dim door and floor lighting. These light layers are incorporated in the final design alongside with features and a manual control. Using scenarios, specifications are given about the characteristics of lighting. In addition to this, the seating, features, obscuring and frosting of the glass are visually shown as all should be interconnected.

Finally, the console can be seen to which the (work) features are connected. On the console, among other things, the lighting can be operated. Regarding the light characteristics, there are no fixed values. However, there are ranges that are suitable for certain use cases. This offers opportunities for JLR to offer a curated experience within this range in which the user is given the opportunity to personalise. Personalisation by adjustability. An important aspect of the luxury experience. Instead of having complete control over the driving activity, the user now has control over the interior properties.

“Working wherever, whenever, and exactly however you prefer”



# DISCUSSION

Early on in the project, the decision was made to design for Level 5 autonomous driving. However, achieving this future vision involves progressing through intermediate levels of autonomy. While this project focused on creating a potential final design, future considerations should address how these intermediary steps can be approached strategically. However, the project its timeframe necessitated concentrating on the end goal to provide a clear direction.

During prototyping, it was observed that the bright task light became uncomfortable when placed at a short distance of the participant its head and not adequately focused, causing glare. Lighting directed towards the face is blinding. In the final design, task lighting is integrated into the ceiling using a gradient.

The new proposed illumination from the ceiling is therefore at a larger distance from the participant its head compared to the test model. However, it remains important to ensure that the lighting is sufficiently focused to not cause glare. Whether the ability to look directly into the light is an issue is debatable. Similar to a desk lamp positioned above, users naturally avoid looking directly at the light source.

Alternatives, such as incorporating task lighting from closer proximity or using a movable section of the ceiling to bring light closer to the passenger, could be explored in future iterations. However, in this design, these options were not developed further. Shared workspaces, such as universities or flexible offices, often lack individual task lamps, relying instead on sufficient ambient lighting.

Additionally, during testing, participants noted that while the presence of task lighting was appreciated it was not essential. The workspace and surrounding environment were already adequately illuminated, suggesting that the existing setup provides a sufficient balance between functionalities and user comfort.



# RECOMMENDATIONS

## GENERAL

After selecting the design direction, the design primarily focusses on lighting. Other aspects influencing the experience should be considered in future developments. These include for example autonomous vehicle acceptance and elements of atmosphere such as acoustics, scent, and tactile qualities.

## TASK LIGHTING

The task lighting can be further refined, particularly in terms of placement. Additionally, it should be investigated whether task lighting is essential for this specific target group.

## DYNAMIC LIGHT

Natural light changes throughout the day and year. For example, moonlight has a colour temperature of approximately 4100K, while sunlight and daylight range between 5000–6000K and 5800–6500K, respectively (Ganslandt and Hofman, 1992). Natural light is inherently dynamic. To complement this effectively, artificial lighting might have to exhibit dynamic properties as well. Further research into dynamic lighting is recommended for future development.

## TEST

In the current test setup, only half of the vehicle its lighting configuration was evaluated. For example, the user experienced wall lighting behind them but not in front, as designed in the final concept. Wall lighting in front could influence the space differently. Future tests could explore whether lighting should be balanced on both sides or if lighting behind the user should be brighter compared to the lighting in front of the user.

Additionally, the buck could be placed in a more realistic environment, such as on the road, to assess how external factors affect the interior and settings.

The test buck featured black upholstery, rather than Land Rover materials like wood and beige finishes. As a result, the test did not fully reflect how the materials might influence the lighting. For instance, the wall lighting was described as pleasant, but its interaction with non-representative materials does not accurately simulate Land Rover its interior. In future iterations, the impact of wall lighting on reflective surfaces, such as large beige panels with metallic details, should be examined to prevent excessive brightness. A buck closer to the final design would also allow for better evaluation of the space its shape and its influence on lighting.

The light sources used in the test did not match the specific values for lumen, lux, and CCT. While this provided insights into spatial light distribution, it did not account for the impact of colour temperature and other characteristics. Future tests should incorporate precise lighting parameters.

The test was conducted with a random population sample due to limited access to JLR its target audience. Future testing should involve participants representative of JLR its user base for more accurate results.

Lastly, the test involved only a single user, despite the design being optimised for two passengers. Future tests should evaluate the impact of having additional passengers. This could provide insights into what could happen when the passengers demand different functionalities and how a relaxing and work environment influence each other.

## VALUES AND CHARACTERISTICS

### Illumination and Luminance

Current scenarios focused on the required illumination levels (lux) within the space. Future research could explore luminance (the amount of light emitted by each source) to achieve these illumination levels. This involves other interior aspects such as materials, forms, and textures. While time and equipment constraints prevented this during the project, defining precise lighting values would enhance the design and refine the design rules.

### Brand-Specific Lighting

The lighting implemented in this project does not use Land Rover its brand-specific light colours. Future studies could investigate lighting characteristics that align with the brand identity and evoke appropriate emotions.

### Emotional and Experiential Impact

The LRX design emphasised “Imposing in Control,” focusing on both the experience and the user its appearance. Further research could assess how lighting influences mood and whether this aligns with JLR its DNA. This includes studying the emotional impact of colour usage and its integration into the lighting design.

### Glass Obscuring and Frosting

The current project provides only illustrations of glass obscuring and frosting. Future research could explore precise glass specifications to optimise the balance between natural and artificial light. Additionally, the impact of glass obscuring and frosting on motion sickness should be considered.

### Adjustability

Concerning adjustability, for example, the intensity could be increased or decreased. Important is that within this adjustability other characteristics such as colour temperature adjust accordingly. Care must be taken to avoid undesirable emotions such as gloom or tension with diffuse light with a too high intensity and colour temperature (Van Erp, 2008). Future work should explore this further, ensuring it aligns with the curated Land Rover experience.

How the lighting might be controlled is lightly addressed. Future iterations should expand to include controls for other features, such as air conditioning and acoustics, as these elements significantly contribute to the overall interior experience as well. These controls are not yet integrated into the interior design but should be addressed in future developments.

Cars often feature illuminated buttons to ensure visibility in the dark or to signal specific message. However, lighting for the console and interior components has not yet been explored. This could be considered in the future.

## FEATURES

The essential work features have been included in the current design. However, their precise functionality and source are not yet fully detailed. For instance, the seat its adjustability in height has been mentioned but not developed further. Future work should explore and specify the mechanisms and integration of these features.

# REFLECTION

Initially, after four and a half years of studying, I doubted whether I was ready to start my graduation. Despite this, I decided to start and I have no regrets. It has been quite a journey.

It was only during this project that I realised I could not design an interior without understanding the context in which it exists. This goes far beyond just the interior itself; I needed to understand the role of a car in society. I could not avoid examining the broader context, as without this, designing the interior would have been purely arbitrary. I was somewhat taken aback by this realisation, as I wanted to deliver something concrete. However, looking back, I have no regrets about my approach. This was an important step that I would not have wanted, or been able, to skip in order to achieve this result.

The broader perspective also made me more enthusiastic. Designing a new interior was already interesting to me, but by expanding the scope, it became truly fascinating. Perhaps to look at the bigger picture is a character trait as I have done this in previous projects as well.

So, I extended the orientation phase by exploring broader opportunities. By examining the wider context and Land Rover its brand DNA, a future vision and a concept for the Land Rover experience were developed. I was inspired by this which led me to a design direction that felt right and suitable within the predicted future.

The learning objectives I set for this project included improving my visual skills (sketching and CAD) and advancing my research skills by conducting a large-scale user study. Additionally, I aimed to enhance my stakeholder management, communication, and presentation skills. Both my bachelor and master program were primarily focused on group work. This was the first major project I had to complete entirely on my own. Quite exciting.

For this project, I wanted to deliver a final result that was also well presented in 3D. I modelled and rendered all visuals in Blender resulting in a design presented at the quality that I was aiming for. What I liked about Blender is that I found it more enjoyable to work with because it is more design-oriented rather than engineering-focused. It suited the design phase I was in much better. In the future, I would like to dive further into materialisation, as there are many more options to fine-tune the design.

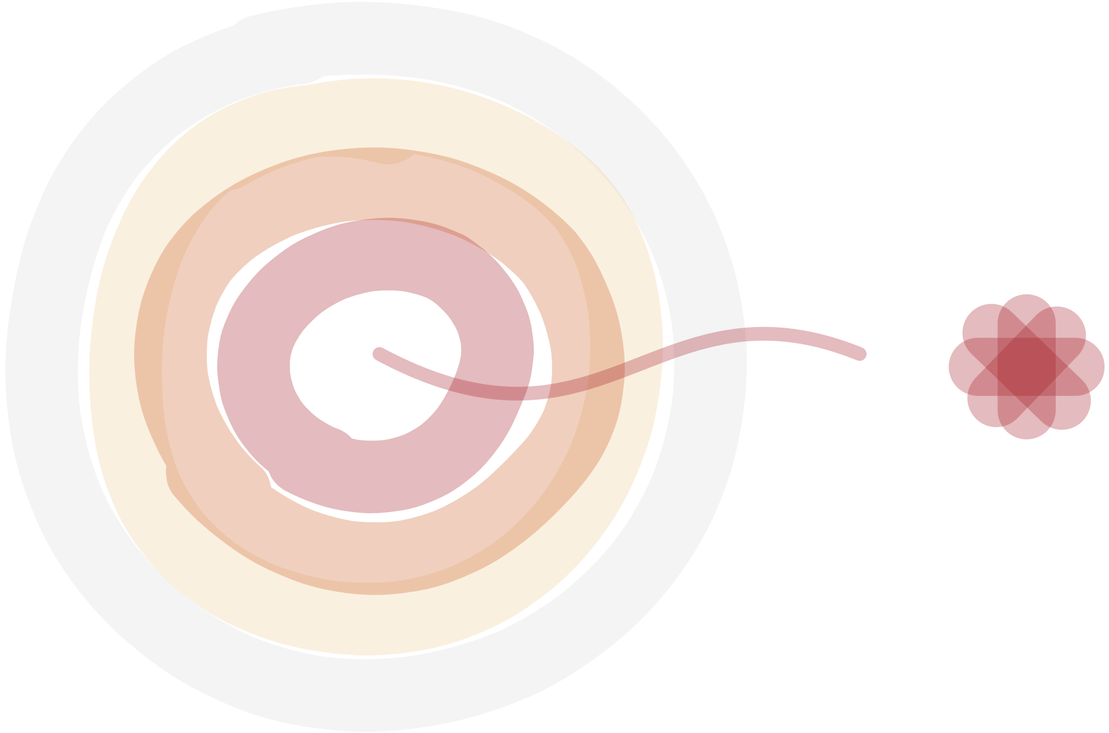
An interesting aspect of my master thesis was experimenting with light and discovering how impactful it can be. I learned a great deal from this. Initially, I envisioned more advanced lighting sources and a specific interior shape. However, for the research, I had to simplified these elements significantly, narrowing them down to the essentials. While the physical model (buck) and lighting setup were not identical to my original idea, they still provided valuable insights. The differences between diffuse, focused, direct, and indirect lighting proved to be significant. This was particularly “enlightening”. If I were to do this again, I would ensure at least one lighting characteristic, such as colour temperature, is accurate. This would reduce the number of uncertain variables potentially influencing the results, providing more reliable data.

I was also given the opportunity to present my work at the Red Cabin Automotive Conference in Munich and at JLR in Gaydon. These experiences taught me valuable lessons. Although lighting now seems almost intuitive to me, it turned out to be an innovative direction that sparked real interest. Experts responded very enthusiastically, confirming that I was on a right track. After spending 20 weeks immersed in a topic, it felt self-evident to me, but that is far from the case for my audience.

Looking ahead, the key lesson I take from this graduation project is to find a balance between a broader approach and a focused end result. Broad learning and exploration spark inspiration, allowing me to craft a story and direction I truly believe in. This approach not only makes the design process more enjoyable but also more effective. It is important not to let time and ambition create too much pressure.

In conclusion, I am incredibly enthusiastic about this topic. There are still so many aspects I would have liked to explore further, such as specifying the lighting more precisely or refining the adjusting interaction. However, that could be a whole new graduation project itself.
During the project, I realised how fascinating I find not just the car itself, but also the broader context in which it exists. I discovered a true affinity for the automotive field and thoroughly enjoyed tackling the complex and social challenges it presents. Looking back, I am proud of a graduation project that exceeded all my expectations and brought me immense joy.

# APPENDIX



# Appendix Context Analysis

## Demographic

The world population is increasing. Where there were once one billion people on the planet in 1800, there are now around eight billion (Ritchie et al., 2024). It is predicted that this growth will continue, although the largest increases have already occurred. Furthermore, people are increasingly settling in cities. In 1900, only 10% of the population lived in cities. Now, it's already 50%, and it's predicted that by 2050, 75% of the world's population will reside in cities (Ritchie, Samborska, et al., 2024). This increased city bustle is driven by both urbanization (Urbanization Trends, n.d.) and by increasing life expectancy. By 2040, a quarter of the population will be 65 years or older (Centraal Bureau voor de Statistiek, n.d.). While the global population is growing, urban areas will experience even faster relative growth.

The fastest-growing populations globally, alongside increased migration, also lead to greater diversity (Hugo & National Centre for Social Applications of GIS, University of Adelaide, 2005). Additionally, the proportion of Europeans in the world is expected to decline. Currently at 6%, it is predicted to drop to 4% by 2070 (De Gevolgen van de Demografische Veranderingen in Europa, 2023).

Between 2019 and 2020, the number of people working from home increased from 1 in 7 to 1 in 5. By 2021, approximately 1 in 4 people worked from home. This fluctuation is likely related to the COVID-19 pandemic (De Gevolgen van de Demografische Veranderingen in Europa, 2023).

### Influence of Gen Z

Among the Gen Z generation, born between 1997 and 2012, there is a strong desire for safety, connectivity, and convenience with a focus on sustainability to reduce greenhouse gas emissions. According to the Deloitte Global 2022 Gen Z & Millennial Survey, 24% of Gen Z sees climate change as their top priority/concern, with 29% considering the cost of living a greater issue. This generation is the first born into a world where technology is revolutionizing transportation, and they have the potential to reshape its future. They are tech-savvy, creative, and willing to challenge norms, reflecting their vision for future mobility. The Deloitte report highlights that Gen Z and millennials want employers to provide sustainability-focused benefits and support for making environmentally friendly choices. By leading advocacy for change, Gen Z will play a significant role in transforming transportation (Future Transport-News, 2023).

## Economic trends and developments

Currently, significant investments are being made to reduce CO2 emissions. There is a rising trend in global investments in clean energy such as wind, electric, and solar power (Overview And Key Findings – World Energy Investment 2023 – Analysis - IEA, n.d.). Additionally, there is substantial investment in the public transport sector under the assumption that it has a lower environmental impact than private vehicle use. For example, the Netherlands is investing in innovations in public transport (Ministerie van Infrastructuur en Waterstaat, 2016).

European legislation on climate gases is also being researched. Chinese electric vehicle (EV) manufacturers, such as BYD, are gaining market share in Europe due to their competitive pricing (Euronews, 2024). These EVs are expected to become more affordable in the market, aided by substantial government subsidies from countries like China (Rammeloo, 2024).

Micromobility, including e-scooters and e-bikes, is rapidly growing and transforming urban transportation. The micromobility market is projected to grow from $175 billion in 2022 to $360 billion in 2030, driven by demand for more efficient and environmentally friendly transport options (The Future Of Mobility: Mobility Evolves, 2023).

The cost of integrating self-driving systems into cars has prevented widespread adoption in mainstream vehicles. Implementing SAE Level 4 autonomy is estimated to cost automakers $4,000 "at scale," making it economically viable primarily for luxury vehicles. Consequently, many self-driving cars are being used in Mobility as a Service (MaaS) fleets to generate recurring service-based revenues, though this approach has proven challenging (Nunes, 2019).

## Social cultural trends and developments

Among people, there is growing sustainable awareness, partly driven by extreme weather events. Studies show that 12% of individuals are willing to pay more for sustainable products (Ware, 2023). Additionally, there is a trend towards using alternatives to private cars, such as public transportation. Factors influencing this choice include efficient travel time, direct routes, transfers, and high service frequency (Ulahannan & Birrell, 2022).

Ideas have emerged about the "ideal" human-centred city, where urban planning is based on human movement patterns. Examples include the "one-hour commuting city" (One Hour Commuting According To Different Urban Transportation Modes | The Geography Of Transport Systems, 2022) and the 15-minute city (Allam et al., 2022).

Furthermore, changes in livelihoods and lifestyles have led to smaller family sizes (Currie, 2024).

## Technological trends and developments

Technological trends influencing the mobility sector play a crucial role in shaping the future of transportation. Here are some key technological developments:

### Improvement in Battery Technology

Innovations in battery technology, such as solid-state batteries, enhance energy density, reduce charging time, and extend the lifespan of EVs. This makes EVs more practical and appealing to consumers (StartUs Insights, 2024).

### Charging Infrastructure

The development of fast-charging stations and wireless charging helps alleviate concerns about EV range and charging times (Bain, 2024).

Companies like Unleash Future Boats are developing emission-free electric boats for both freight and passenger transport, contributing to the sustainability of maritime transportation (StartUs Insights, 2024).

Battery technology is crucial for EV growth. The demand for lithium-ion batteries is expected to grow annually by 25% until 2030, driven primarily by the need for batteries in EVs (Fleischmann et al., 2023).

**Autonomous Vehicles (AVs)**

**AI and Machine Learning:**
Developments in autonomous vehicles are rapidly advancing. AI algorithms currently handle driving tasks through advanced driver assistance systems (ADAS), marking progress towards fully autonomous vehicles (StartUs Insights, 2024). These AVs utilize advanced AI algorithms and machine learning to make real-time decisions and navigate safely. This includes object recognition, route planning, and responding to unexpected obstacles (StartUs Insights, 2024). It is predicted that passenger vehicles in Europe and North America will have autonomous capabilities ranging from SAE level 3 to 4 by the near future of 2025 (The Future Of Mobility: Mobility Evolves, 2023). Mid-priced vehicles are expected to follow in 2026-27 (What's Holding Up Self-Driving Cars?, 2020). Various startups like Waymo from Google (Waymo - Self-Driving Cars - Autonomous Vehicles - Ride-Hail, n.d.) and NVIDIA DRIVE are actively developing and testing this technology (World Leader in Artificial Intelligence Computing, z.d.). The development of autonomous vehicles remains a significant area of investment. While full adoption of autonomous technologies may take longer than initially expected, investments continue in levels of partial autonomy (such as level 3, where vehicles can drive independently but human intervention is still possible). The realisation of fully autonomous vehicles (SAE level 5) is predicted for later in the future due to technological, regulatory, verification, and business case challenges (What's Holding Up Self-Driving Cars?, 2020)

The challenge lies in hardware rather than software, indicating that achieving widespread autonomous driving capability will take time (Van Grondelle, 2024).

Startups like Indian Minus Zero and Canadian NuPort Robotics are developing advanced autonomous driving technologies for cars and trucks respectively, focusing on safety and efficiency (Top 10 Mobility Industry Trends in 2024  StartUs Insights, 2024b.
LIDAR and Sensor Systems: Improvements in LIDAR (Light Detection and Ranging) and other sensor systems enhance the accuracy and safety of autonomous vehicles, enabling them to better handle complex traffic situations (Top 10 Mobility Industry Trends in 2024 StartUs Insights, 2024).

**Connected Vehicles:**

**Vehicle-to-Everything (V2X):**
Technologies enabling communication between vehicles and infrastructure (such as traffic lights and road conditions) help optimize traffic flow and prevent accidents (Top 10 Mobility Industry Trends in 2024 StartUs Insights, 2024).

**5G Networks:**
The rollout of 5G networks supports the data transfer needed for connected vehicles, improving real-time communication and response times (Top 10 Mobility Industry Trends in 2024 StartUs Insights, 2024).

**Internet of Things (IoT):**
Previously focused on entertainment and convenience, IoT now emphasizes vehicle maintenance and safety (Top 10 Mobility Industry Trends in 2024 | StartUs Insights).

**Mobility as a Service (MaaS):**
Integration of Diverse Transport Services: MaaS platforms combine various forms of transportation (such as cars, bikes, public transit) into one user-friendly app, enabling seamless and efficient travel experiences.

**Data Analysis and Optimisation:**
By leveraging big data and advanced analytics, MaaS platforms can optimise traffic flows and transport services, leading to improved efficiency and user satisfaction (Top 10 Mobility Industry Trends in 2024 | StartUs Insights).

According to a report by PTV Group (2022) various technological drivers within public transport include electrification and decarbonization having the greatest impact, with autonomous and connected driving expected to have a 22% influence in the next 5 to 10 years. As developments progress, autonomous and connected driving will become more prominent over time.

**Hydrogen Fuel Cells:**
Hydrogen fuel cell technology is increasingly seen as a viable option for heavy-duty transport and long-distance vehicles due to rapid refueling times and high energy density (Boerboom, 2024).

**Biofuels and Synthetic Fuels:**
The development of biofuels and synthetic fuels provides alternatives to fossil fuels, with lower CO2 emissions and reduced environmental impact.

The Dutch company Lightyear is developing a solar-panel car for the market (Lightyear — Solar Electric Vehicle, n.d.).

**Smart City Initiatives:**
Integrated Transport Networks: Cities are investing in smart infrastructure utilizing IoT (Internet of Things) to monitor and manage traffic, leading to more efficient and sustainable urban mobility (StartUs Insights, 2024).

**Sustainable Urban Mobility:**
Projects such as car-free zones, smart parking management, and advanced public transportation systems contribute to reducing congestion and pollution in urban areas.

The Boring Company, founded by Elon Musk in 2016, aims to alleviate urban traffic congestion by developing an underground network of tunnels for high-speed travel. The company focuses on creating more efficient and cost-effective tunnel boring machines. Notable projects include the Hyperloop for intercity travel and the Loop system for intra-city travel, with the Las Vegas Convention Center Loop already operational (The Boring Company, n.d.).

**E-scooters and E-bikes:**
The rise of shared e-scooters and e-bikes provides flexible and environmentally friendly options for short distances in urban areas (Io, 2023). Electric bicycles are gaining popularity. This allows for longer distances to be covered and keeps elderly people mobile for longer (Kuys, 2021).

**Autonomous Last Mile Delivery:**
Autonomous vehicles and drones for package delivery offer efficient solutions for last mile delivery, reducing reliance on traditional transportation methods (StartUs Insights, 2024).

"Robot-as-a-service business models are

emerging in startups developing last-mile automated delivery technologies" (What's Holding Up Self-Driving Cars?, 2020)

These technological trends are driving a transformation in the mobility sector, focusing on efficiency, sustainability, and innovation.

### Environmental trends and developments

The mobility sector is heavily influenced by various environmental trends focused on sustainability and reducing the ecological footprint. Some aspects mentioned earlier include vehicle electrification and the use of sustainable fuels:

**Recycling and Reuse:**
The automotive industry is increasingly adopting principles of the circular economy, such as recycling materials and reusing parts. This reduces waste and lowers the ecological footprint of vehicle production (Top 10 Corporate Social Responsibility Trends StartUs Insights, 2023).

**Life Cycle Assessment (LCA):**
Manufacturers use LCA to assess and optimise the environmental impacts of vehicles throughout their entire life cycle, from production to recycling.

**Smart Cities:**
Investments in smart city technologies help create sustainable urban mobility. This includes advanced public transport systems, shared mobility (such as bike-sharing and car-sharing), and traffic management systems that enhance efficiency and reduce pollution (Top 10 Mobility Industry Trends in 2024 StartUs Insights, 2024).

**Green Urban Planning:**
Cities are designing infrastructures that promote walking, cycling, and the use of public transport, contributing to a reduction in CO2 emissions and improvement in air quality (Top 10 Mobility Industry Trends in 2024 StartUs Insights, 2024).

**Changes in Climate Policy:**
Policymakers are increasingly focusing on measures for climate adaptation and mitigation, such as implementing emission ceilings and promoting technologies that contribute to lower CO2 emissions (Bain, 2024).

**Impact of Climate Change:**
The mobility sector needs to adapt to the consequences of climate change, such as extreme weather and changing infrastructure requirements, to remain resilient and sustainable.

**Consumer Awareness:**
There is a growing awareness among consumers about the environmental impact of their mobility choices. This leads to increased demand for sustainable transport solutions such as EVs, public transportation, and shared mobility (Bain, 2024).

**Corporate Social Responsibility (CSR):**
ompanies in the mobility sector are integrating sustainability into their business models and increasingly reporting on their environmental impact and sustainability initiatives (Top 10 Corporate Social Responsibility Trends StartUs Insights, 2023).

These environmental trends stimulate innovations and policy measures that steer the mobility sector towards more sustainable practices, aiming to reduce the ecological footprint and minimize environmental impact.

### Political and legal trends and developments

**Stricter Emission Standards:**
As a result of the Paris Agreement, many countries have implemented stricter emission standards and regulations for vehicles to reduce greenhouse gas emissions. The EU, for instance, has committed to reducing CO2 emissions from new cars by 37.5% by 2030 compared to 2021 levels (The State Of Emissions Reduction in The Automotive Industry, 2024). This mandates automakers to produce cleaner and more efficient vehicles. The European Union has tightened CO2 emission standards for new cars and vans, aiming to lower average emissions per kilometre. The agreement encourages investments in R&D for new technologies capable of reducing emissions. This includes advancements in battery technology, the development of hydrogen fuel cells, and other innovative propulsion methods (The State Of Emissions Reduction in The Automotive Industry, 2024).

**Phasing Out Internal Combustion Engines:**
Europe climate ministers agreed to now longer allow the sell of combusting engines from 2035 in Europe (NOS, 2022). Additionally, there are in the Netherlands for example tax benefits for (business) drivers choosing electric vehicles.

**Subsidies and Incentives for Electric Vehicles (EVs):**
To accelerate the adoption of EVs, many countries offer subsidies, tax benefits, and other financial incentives (Policies To Promote Electric Vehicle Deployment – Global EV Outlook 2021 – Analysis - IEA, n.d.). In the United States, federal tax credits are provided for EV purchases, and China offers substantial subsidies and investments in charging infrastructure (Bain, 2024)..

**Implementation of Zero-Emission Zones:**
Cities around the world are introducing zero-emission zones where only vehicles that do not produce emissions are permitted to operate. This policy is being implemented to improve air quality and reduce the emission of harmful substances. Examples include London's Ultra Low Emission Zone (ULEZ) and plans for similar zones in cities such as Paris and Madrid. Cities like Amsterdam and Rotterdam also have plans to establish zero-emission zones where only zero-emission vehicles are allowed. This initiative aims to enhance air quality and mitigate emissions of harmful substances.

**Investments in Charging Infrastructure:**
To support the transition to EVs, governments are heavily investing in expanding charging infrastructure. In the European Union, the goal is to have at least 1 million public charging points by 2025 ising to three million by 2030. The US government has also invested billions of dollars in building charging stations through infrastructure legislation (Charging Infrastructure, 2022).

**Sustainable Mobility Strategies:**
Many governments are developing comprehensive strategies for sustainable mobility, aiming to promote not only the adoption of EVs but also the use of public transport, cycling, and walking. For example, the Netherlands has ambitious plans to further increase cycling and improve cycling infrastructure (Bain, 2024). Moreover, cities are increasingly becoming car-free to reduce bicycle accidents (Kuys, 2021).

**New Regulations for Autonomous Vehicles:**
With the rise of autonomous vehicles, governments are introducing new regulations to ensure the safety and deployment of these technologies (New EU Rules To Improve Road Safety And Enable Fully Driverless Vehicles in The EU, 2022). This includes guidelines for testing and implementation, such as those from the European Commission and the National Highway Traffic Safety Administration (NHTSA) in the US.

**Climate Goals and International Agreements:**
The Paris Agreement and other international climate accords are pressuring countries to reduce their transportation emissions. This has led to national policies focused on reducing CO2 emissions and promoting sustainable transport solutions (Krishnan et al., 2023).

These trends reflect the growing urgency and global efforts to make the transportation sector more sustainable, with laws and regulations playing a crucial role in steering the market towards environmentally friendly solutions.





**Land Rover Series**

In 1948, the Wilks brothers of the Rover Car Company introduced the first Land Rover, the Series I. A four-wheel-drive vehicle designed to compete with the American Jeep, characterized by its purposeful and functional design, well-suited for off-road use. The original Land Rover was designed by Tom Burton and was built within a year. Due to a steel shortage in the post-war period, aluminium was used as an alternative material. The initial idea was to create a versatile utility vehicle to replace horse-drawn wagons. Soon, this powerful 4x4 vehicle was also used for adventurous and recreational purposes (JLR Corporate Website, 2023).

In 1958, ten years later, the Land Rover Series II was introduced. It improved upon the first model with features such as a larger rear window for better visibility, non-scratch glass, and doors with external handles and locks. This second model was easier to drive without compromising on durability. Later, the Land Rover Series III was also released (JLR Corporate Website, 2023).

**Defender**

In 1983, the first Land Rover Defender was introduced. Initially designated as the Land Rover One Ten (110) and Land Rover Ninety (90), referring to their wheelbases of 110 and 90 inches respectively. The name Defender was officially adopted later to distinguish these traditional Land Rover models from the new Range Rover and Discovery series (JLR Corporate Website, 2023).

**Range Rover**

In 1970, the first Range Rover was introduced, combining off-road capabilities with luxury features. It marked the debut of a Sport Utility Vehicle (SUV) designed for both on-road and off-road use. In 1987, a more luxurious version of the Range Rover was released for the American market. Until then, a combination of market choices, technical and regulatory challenges, and the need to establish adequate support networks were reasons for not operating in America (JLR Corporate Website, 2023).

In 1994, for the 25th anniversary of the Range Rover, a new vehicle assembly plant was established.

**SUVs**

In the 1980s, the popularity of SUVs, which combined off-road capabilities with comfort and luxury, increased significantly. The appeal of these vehicles included higher seating positions, a sense of security, and versatility.

To distinguish itself, Land Rover also focused in the 1990s on improving the buying experience by opening Land Rover Centres (JLR Corporate Website, 2023).

**Name and Acquisitions**

Land Rover was founded in 1947 as part of the Rover Company. In 1967, the Rover Company became part of British Leyland Motor Corporation (BLMC). In 1978, Land Rover became a separate entity within Leyland and operated as Land Rover Limited. After the reorganization of British Leyland in 1986, Land Rover Limited became part of the Rover Group (Bach, z.d.).

In 1994, BMW acquired the Rover Group, which included various brands such as Land

Rover, Rover, Mini, and MG. In 2000, Rover Group was split up by BMW, leading to the sale of Land Rover to Ford. Eight years later, in 2008, Land Rover and Jaguar were sold by Ford to the Indian automaker Tata Motors. This acquisition led to the formation of Jaguar Land Rover (JLR) as an entity of originally British automobiles (Bach, n.d.).

### Model Range and Product Portfolio

Over the years, Land Rover has introduced many different models. Currently, Land Rover offers 3 main models: the Range Rover, Defender, and Discovery. Over the years, various editions of these models have been released (Land Rover. 4x4-modellen en Luxueuze SUV's, n.d.).

The Land Rover Freelander was produced from 1997 to 2014. The first generation, known as the Freelander 1, was built from 1997 to 2006. The second generation, known as the Freelander 2, was produced from 2006 to 2014. Production ceased in 2014, and the model was replaced by the Land Rover Discovery Sport (Land Rover Monthly, 2022).

Production

Land Rovers are manufactured at various locations worldwide. The main production facilities are located in the United Kingdom, but there are also factories in other countries such as India, Slovakia, China, and Brazil (Withey, 2024).

### Mission Statement

Jaguar Land Rover aims to be a leader in the development, production, and delivery of premium vehicles that adhere to the highest standards of quality, innovation, and sustainability (REIMAGINE | JLR Corporate Website, z.d.).

### Future Vision

"Proud creators of modern luxury" .

In 2021, Jaguar Land Rover introduced the Reimagine strategy, signalling a comprehensive rethink of everything the company does ((REIMAGINE | JLR Corporate Website, n.d.).

"Our Reimagine strategy has set us on an exceptional journey of transformation. It lays out a clear vision to become proud creators of modern luxury and be a carbon net zero business by 2039. Designed to create a new benchmark in environmental, societal and community impact for luxury business." (REIMAGINE | JLR Corporate Website)

This strategy underscores Jaguar Land Rover's commitment to sustainability, innovation, and setting new standards in the luxury vehicle market.

Within this strategy, the focus is on the four following pillars:
Modern Luxury
Electrification
Sustainability
Enterprise

Jaguar Land Rover has unveiled its new corporate identity, transitioning to a House of Brands organization (REIMAGINE | JLR Corporate Website, n.d; Withey, 2024). This approach moves away from a single brand with one identity to multiple models, each with its own brand identity. Range Rover represents luxury, Defender embodies adventure, and Discovery is tailored for family trips (Withey, 2024).





"The new brand identity aims to eliminate ambiguity and highlight the distinctive DNA of each of JLR's brands – Range Rover, Defender, Discovery, and Jaguar – while accelerating the realization of the company's vision to be Proud Creators of Modern Luxury." (REIMAGINE | JLR Corporate Website, n.d.).

"JLR presents four distinct and emotionally-engaging brands, each built on a foundation of exemplary British design and craftsmanship." (PROF. GERRY MCGOVERN, CCO).

### Advertising (Form and Proposition)

Advertising form refers to how advertisements are shown to people. Advertising proposition refers to the main message. This can include different types such as print ads in magazines, newspapers, posters, TV commercials, radio ads, or online ads. This section examines these two parts of advertising.

### Online Advertisement:

Online, various methods are used to advertise. On platforms like YouTube, you can see ads both as standalone videos and before desired content. These ads often use phrases like "above and beyond," feature uplifting music, and then unveil the new Range Rover Sport. The ad showcases both exterior and interior aspects of the vehicle without narration. The focus is on detailing, line design, and the overall experience. Terms like "breathtaking modernity, peerless refinement, and unmatched capability" and "stress-free and harmonious environment" are emphasized.

From earlier times, there are various print advertisements and catalogues available.

### Social Media

It's interesting to note that Jaguar and Land Rover, while part of Jaguar Land Rover, handle their advertising separately, except for on the JLR.com website. The social media channels are indicated on the main website. Both brands have their own and different channels. Land Rover has accounts on YouTube, LinkedIn, Instagram, Twitter, Facebook, and TikTok (in collaboration with rapper Kano). One key difference in their social media presence is that Land Rover utilizes TikTok, whereas Jaguar uses LinkedIn.

### Partnerships and Sponsorships

#### Jaguar Land Rover

The house of brands Jaguar Land Rover has sponsorship agreements with the following parties (PARTNERSHIPS | JLR Corporate Website, 2021.; JLR & NVIDIA Automotive Partner, z.d.; Meet Our Newest Self-driving Vehicle: The All-electric Jaguar I-PACE, n.d.)

Royal Geographical Society
The Tusk Trust
International Federation of Red Cross and Red Crescent Societies
Waymo
NDVIA

With the International Federation of Red Cross and Red Crescent Societies (IFRC), Land Rover has a humanitarian partnership. For example, the British Red Cross uses 57 vehicles to deliver medicine and food

to vulnerable people in the UK. The Tusk Trust is a British charity focusing on wildlife conservation in Africa, particularly elephants, rhinos, and lions. The Royal Geographical Society (with IBG) is the UK's learned society for Geography. It supports and promotes geographical research, education, fieldwork, and expeditions, and the transfer of knowledge to policy (PARTNERSHIPS | JLR Corporate Website, 2021). All three sponsorships focus on nature and humanity.

#### Land Rover

Land Rover is specifically involved in sponsoring events such as the Rugby World Cup France 2023, the Invictus Games, equestrian activities, and humanitarian and conservation efforts (Overview - Sponsorship - Land Rover, n.d.). The Invictus Games is an international sports event for wounded, sick, and injured military personnel and veterans, inspired by Prince Harry's belief in the power of sports to aid in recovery. Equestrian refers to activities related to horse riding or horse-related matters. Humanitarian Conservation focuses on protecting natural resources and the environment, with an emphasis on the well-being of both humans and animals.

Land Rover specifically showcased the Defender model at the Rugby World Cup in France. This information is listed on the Land Rover website under sponsorships. Central to Land Rover's sponsorships are themes of sports, nature, and human well-being.

### Interviews with brand owners

According to the JLR Corperate website, "JLR UK presents four distinct and emotionally-engaging brands: Jaguar, Range Rover, Defender, and Discovery. The recently appointed team of Brand Directors will bring to life each brand's distinctive identity, whether it's adventures in Defender, family trips in Discovery, or the refined luxury of Range Rover. Each brand embodies an exclusive, desirable lifestyle that will resonate with UK clients." (Land Rover Media Newsroom, 2024)

Additionally, a change in leadership structure led by UK Managing Director, Patrick McGillycuddy, was announced: "How clients view mobility and how they interact with luxury brands has changed vastly in recent years, so how we present our brands, products, and services must also change. As we move to a fully electric future, we must innovate at every part of the client experience to deliver a sustainability-rich reimagination of modern luxury" (Land Rover Media Newsroom, 2024).

In consultation with a Jaguar Land Rover brand owner, discussions focused on what Land Rover aims to convey and the key aspects relevant to the project scope. It's important to note that the ongoing research will prioritize the Defender and Range Rover models, as there is some internal uncertainty regarding the Discovery model. Furthermore, it was concluded that modern luxury and sustainability are central to the assignment, aligning with Land Rover's strategic direction (Withey, 2024).

### Storytelling and myths

Various stories about Land Rover circulate, and some of these stories and myths are listed below:

Origin on Welsh Beach: It is said that the first Land Rover was conceived on a Welsh beach, where its design was sketched in the sand (Corey, 2024).





**The Queen's Land Rover:**
The story goes that the British royal family has been using Land Rovers for decades on their estates and during hunting parties. Some Land Rover models have even been specifically designed for royal use (Herincx, 2016). Land Rovers are prominently featured in shows like "The Crown," depicting the British royal family.

**Indestructibility:**
A common myth is that Land Rovers are indestructible. While they are renowned for their ruggedness and off-road capability, they are not immune to damage. Nevertheless, they have earned a reputation for enduring tough conditions and surviving challenging terrains (New Land Rover Defender: The Definition Of Durability, 2020).

**The Camel Trophy Legend:**
The Camel Trophy was an annual off-road competition held from 1980 to 2000. Land Rover vehicles were often favoured by participants for their off-road prowess. This competition contributed to the myth-making around Land Rovers as ultimate off-road vehicles (Atlantic British Ltd., n.d.).

**The "Land Rover" Effect:**
Some people claim that merely owning a Land Rover awakens an adventurous spirit within them. The brand evokes feelings of freedom, adventure, and independence, connecting owners with a special community of adventurers.

**James Bond and Land Rover:**
Land Rovers have appeared in several James Bond films, often modified with various gadgets and weapons. This has reinforced the image of Land Rovers as tough, adventurous vehicles suitable for dangerous situations. To commemorate the 60th anniversary of the first James Bond film, Land Rover decorated and prepared a Defender 90 for the Rally North Wales. The vehicle was driven by Mark Higgins, a three-time British rally champion and stunt driver in Bond films like Quantum of Solace, Skyfall, SPECTRE, and No Time To Die (Defender Rally-auto Eert 60 Jaar James Bond – Land Rover, n.d.).

**Global Recognition:**
It is rumoured that Land Rover was the first vehicle ever seen by one-third of the world's population.

**Longevity:**
Another myth suggests that 90% of Land Rovers ever sold are still in use today.

These stories and myths contribute to the rich history and legendary status of Land Rover as a brand.

### Sales channels

Land Rover operates various dealerships where both new Land Rover and Jaguar models are sold.

Within the same sales location, the Land Rover department is situated on one side and the Jaguar department on the other side. Additionally, there are exclusive showrooms, events, exhibitions, and online sales platforms such as the official website and marketplaces.

### Concept cars

On the Land Rover website, several old concept cars such as the Range Rover LRX, Range E, Range Stormer, and Discovery Vision are shown (Conceptcarz, 2014). One concept car that Jaguar Land Rover has since moved away from is the Project Vector. It was a concept car that portrayed the vision of an autonomous, electric, connected future for urban mobility. It was designed to be used both as a shared vehicle and for private use (Project Vector and the future of urban mobility – Jaguar Land Rover).







**Interesting quote:**

“The megatrends of urbanisation and digitalisation make connected urban mobility systems necessary and inevitable. Shared and private vehicles will share space and connect to public transport networks, enabling on-demand and autonomous driving. This is a complex task, best achieved by working with partners across the spectrum of vehicles, infrastructure and the digital world. With Jaguar Land Rover’s technological and engineering strengths, we can offer innovators a unique opportunity to develop highly functional urban mobility services that are seamlessly integrated into our daily lives. In the future, urban journeys will be composed of private and shared vehicles, access to online taxi systems and on-demand services, in addition to public transport. Our vision shows that vehicles are a flexible part of the urban mobility network that can be adapted to different purposes”  dr. Tim Leverton, Project Director.

**User/ target group**

**Who drive them?**

During a visit to the Jaguar Land Rover Dealership in Forepark, The Hague, information was obtained about Land Rover’s target group. In the showroom, various models were on display including the Range Rover Special Vehicle (SV), the Range Rover Sport, and the Defender. The customers for the Range Rover SV were described as professionals like doctors, notaries, and executives, typically older in age. Users of the Range Rover Sport were characterized as “fast drivers,” often younger individuals like footballers. Recently, a Range Rover Sport was even sold to a grower. According to the dealer, the Defender could also appeal to professionals like doctors, notaries, or executives, but those looking for a more adventurous variant. Land Rover drivers were described as individuals who value both their appearance and the image they project, not just as farmers but as landowners with multiple properties (Withey, 2024).

Additionally, it was mentioned that Land Rover aims to be an exclusive luxury brand, similar to Hermes and Louis Vuitton—difficult to obtain and expensive. They emphasized that “discount seekers” wouldn’t fit this exclusive image and wouldn’t contribute value to Land Rover, as their services are geared towards premium pricing for things like garage services and parts. Retaining existing customers was prioritized over attracting new ones, especially since some cars were not readily available. Customers who didn’t fit Land Rover its target demographic were sometimes outright “refused”.

To compare with the Land Rover dealership, the BMW dealership at Forepark, The Hague was also visited. It was noticeable that there were prominent promotions and less specific customer preferences here. The sales staff also showed more age diversity. Furthermore, the dress code differed significantly: at Land Rover, both salespeople wore trousers, shirts, jackets, and leather shoes, while at BMW, several salespeople were casually dressed in trousers, shirts, and sneakers throughout the dealership.

### Testing the car

During the visit, various Land Rover models were also tested (see ). It was striking that the largest Land Rover model, the Range Rover SV, was quite cramped inside. A person measuring 1.93 meters could barely fit in it. When asked about this, the dealer responded: “You’re not paying for space but for luxury.” To further explain the luxury, feel, the dealer demonstrated how the front passenger seat could be folded forward so that the person in the rear seat could experience a “chauffeur-like feeling” with their feet up. In the Range Rover and Discovery, a person measuring 1.78 meters also struggled to fit comfortably.

Additionally, in the Range Rover SV, there was a rotary knob visible under the armrest. Explained by the dealer, this was said to be “typically Land Rover”.

When asked what distinguishes Land Rover from a luxurious Mercedes, the answer was: “The comfort of the Land Rover is by far the best.”

From Land Rover, data was also obtained regarding their customers’ preferences and characteristics





### Where do you see them?

On the street, several Land Rovers were observed. Many were parked in front of fairly large houses with driveways or parking spaces. The most commonly seen model was the Range Rover Sport and its various editions.

### How are they being used?

According to the dealership (2024) Land Rovers are used as a status symbol, a car that carries prestige in which users enjoy being seen.

## Competitors

Several competitors are recognized: “Competitor brands to JLR are as follows and are agnostic of our brands” (Withey, 2024).

During the visit to the Land Rover Dealership, inquiries were made about potential competitors of Land Rover. The response included: “larger vehicles such as the Porsche Cayenne, BMW X5 and X7, high-end Tesla’s, larger Audis, and Mercedes”.

Mentioned is that Land Rover does not intend to compete directly with Mercedes or BMW in the future. The brand aims to enter more into a luxury niche market where brands like Porsche, Maserati, and Ferrari are also present (Withey, 2024).

SUPER LUXURY BRANDS

BENTLEY

LUXURY BRANDS

Maserati PORSCHE

CORE PREMIUM BRANDS

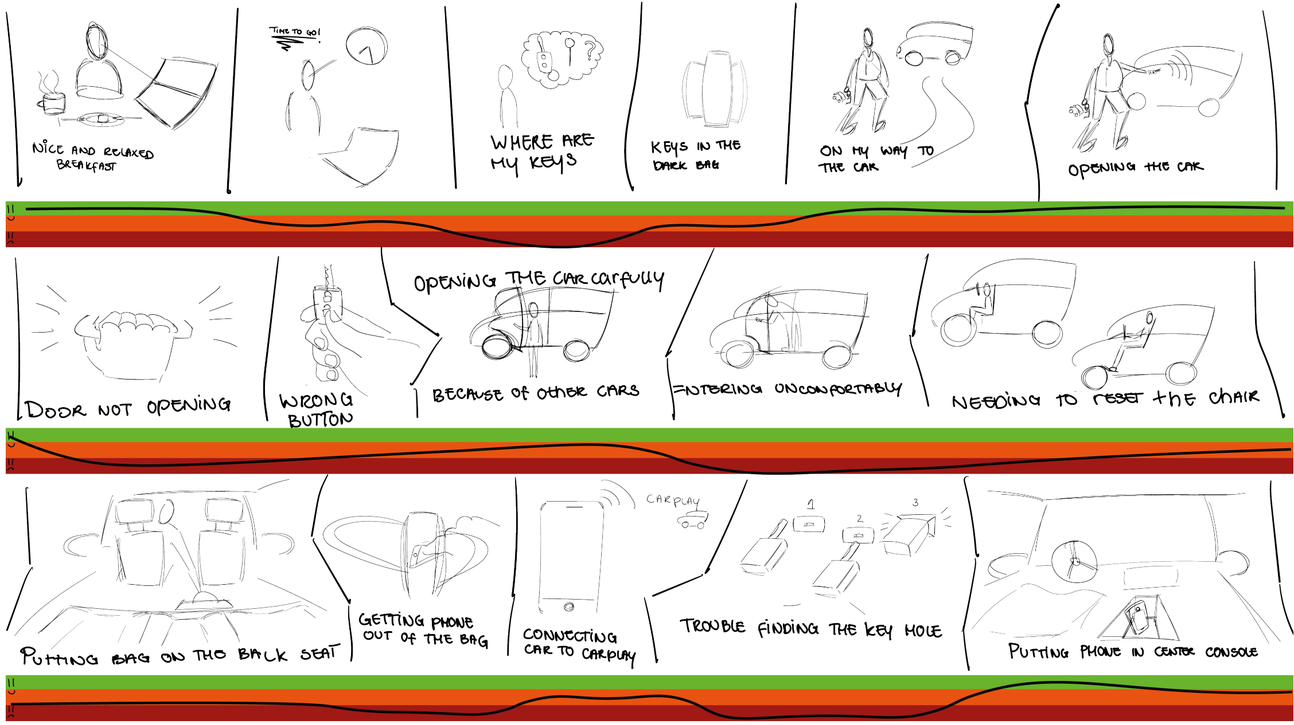
LEXUS RIVIAN

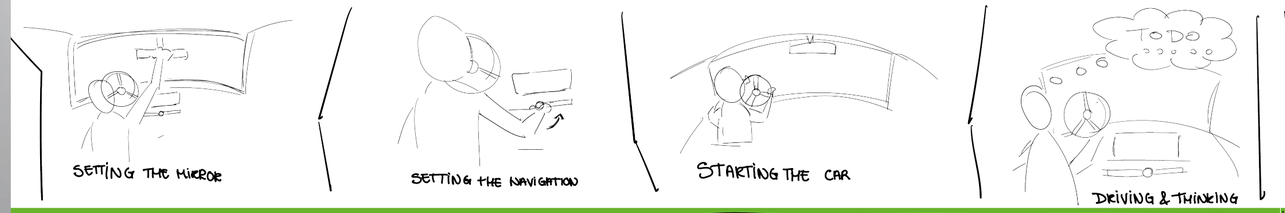


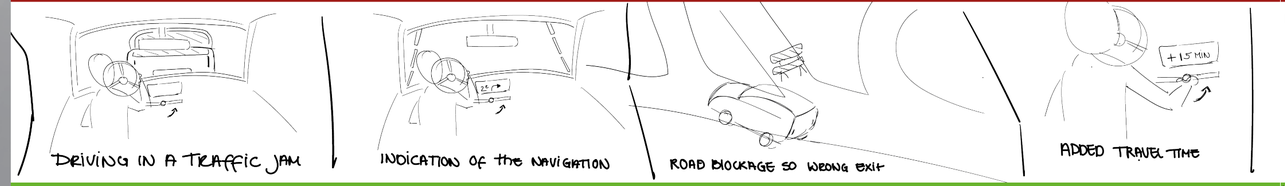


Appendix Brand Analysis

### Current travel journey

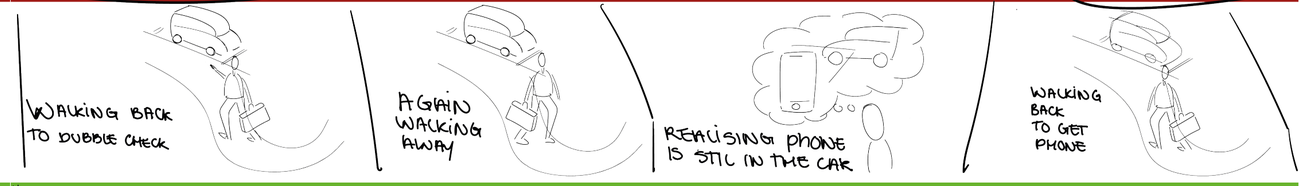






Appendix Brand Analysis


## Appendix Exterior Analysis

Some examples showcase the ability to change character. The BMW Vision Dee, for instance, can change colour, and the BMW Gina can alter the shape of its exterior. Nearly all models are electric, with sustainability being a significant aspect. The Citroën Oli, for example, is made of cardboard to create the lightest possible car, and the interior is designed to be minimalist and functional. The Mercedes Vision EGXX also considers sustainability, with features like closed rims for reduced air resistance and a sunshade on the roof.

Multifunctionality is a recurring theme. The Volkswagen Gen, for instance, has a modular interior where modules can be swapped to better suit different activities. Optimizing for two people and efficient use of space is also a focus. The Volkswagen Sedric features two comfortable-looking seats with two additional seats that can be folded away when not in use. Similarly, the Lincoln L100 can eliminate two seats to optimize the car for two passengers.

Many cars also reconsider the type of seating and its arrangement. The Vision Urbanistic, for example, replaces individual seats with a large round bench. The Renault EZ-GO follows a similar concept. The term “living room on wheels” is often used. The Renault Symbioz is designed with this in mind, featuring four seats arranged in pairs facing each other, with a coffee table in the middle, creating a living room extension. Future designs may even feature moving seats within the car. The ID Buzz shows various seat configurations, and the Renault Espace already featured seats that could slide, rotate, and fold.

Speculation about interiors on wheels is prevalent. In 2023, Citroën presented the Autonomous Mobility Vision concepts, including the Citroën Skate, a self-driving EV platform with three new Pods offering diverse experiences: Immersive Air, Cozy Capsule, and Wander Café. The Cozy Capsule maximizes relaxation during travel, offering a cocoon-like feeling, inspired by French perfume bottles with a crystal exterior shell. The Wander Café is an open-air pod providing a tasting experience while cruising through cityscapes, ideal for sunny afternoon tea or happy hour gatherings. The Immersive Air pod is an entertainment space for playing video games, watching movies, listening to music, or singing songs.

When fully autonomous vehicles become mainstream, non-automotive companies may enter the market. For example, Hilton could provide ideal sleeping cabins, focusing on the interior while another company handles the autonomous technology (Wouter Kets, 2024). Many fully autonomous concepts also feature different exteriors. Bosch and Adient’s self-driving capsule, for example, has a symmetrical and higher exterior, without a traditional front nose. The Future Mobility Vision by Citroën is similarly symmetrical.



## Appendix Intrior Analysis

In 2018, NS published the train interior of the future. This was developed in collaboration with the architectural firm Mecanoo and project interior designer Gispen. The new train layout focuses on zones designated by activity. There is a lounge, work, and socialize zone, each with an interior designed for that specific activity (Interieur | Over NS | NS, n.d.).

Continental released a classic T2 bus with a redesigned interior centred around the activities of driving, working, and relaxing. According to Continental, these are three activities that converge in the car of the future. Although not yet a fully autonomous vehicle, it is interesting to note that this single compartment is divided into different zones to facilitate these activities.

In more concepts like the Citroën Future Mobility Concept and the Renault Symbioz, the importance of an interior tailored to specific activities is also emphasized.

What is seen in the market offer is that there are a lot of options for the activities in the style of relaxation. But what we do not see is an interior that truly supports the working activity. Even though “being productive” was one of the four most mentioned activities mentioned (Wilson et al., 2022).

Bronnenlijst

Interieur | Over NS | NS. (n.d.). Nederlandse Spoorwegen. https://www.ns.nl/over-ns/reis-van-morgen/interieur/treininterieurvisie.html

## Appendix Park shuttle visit

In Rotterdam, there is an autonomous shuttle, the Park Shuttle by Transdev, that connects to the Kralingsezoom metro station. This vehicle was visited and used as part of the field research.

The Park Shuttle is an electric and symmetrical vehicle that operates autonomously on a dedicated track, isolated from other traffic. The shuttle is quite long and contains 8 seats, along with standing room. The interior is very similar to that of current public transport like buses and trams, featuring hard upholstered seats that are not adjustable. Additionally, there are two poles/ columns inside for standing passengers to hold onto. Both inside the shuttle and at the various stops, there are tables where passengers can indicate their stop, so the shuttle knows where to pick up and drop off passengers.

During the visit, conversations were held with two passengers and Transdev service employees. One passenger was a student who used the shuttle daily for his internship. When asked if he found it exciting the first time, he used the shuttle, he replied that he was mostly curious about how it worked.

He had seen cameras inside the shuttle and assumed that it was guided by these cameras. Although this was not correct, it gave him a sense of understanding and thus trust in the shuttle.

The other passenger was a woman who used the shuttle once a week. She found it convenient and had no issues with it. However, she mentioned that passengers needed to hold on during the ride in case the shuttle made an emergency stop. “Otherwise, you could fly through it.”

Two Transdev employees present at the Kralingsezoom station were also briefly interviewed. The shuttle is made by ToGetThere. They talked about the shuttle’s autonomous capabilities, explaining that if the track was suddenly entered and a person stood in front of the shuttle, it would stop immediately. The vehicle is also capable of slowly manoeuvring around certain obstacles. In the event of a malfunction, they could control the shuttle and get it back on the correct course, although they did not elaborate on how this would be done.


### Expert consult Pont

As a follow-up to the previous findings on interior design for both work and relaxation, further research was conducted through literature review and consultation with lighting expert Sylvia Pont.

Lighting can be divided into three layers (Pont, 2024). The first is ambient light, which provides diffuse lighting to reveal the overall space. The second is focused light, used to highlight specific surfaces or objects. The third layer is brilliance light, which adds texture or emphasizes forms in the environment for aesthetic appeal.

In addition to lighting, other factors such as materials, design, and texture greatly influence the lighting's effect on the environment (Pont, 2024 & Reddy et al., 2012).

Pont provided feedback on the initial lighting principles, noting a strong focus on brilliance light but urging greater attention to ambient light, with suggestions to explore what makes ambient lighting comfortable or not (Pont, 2024). Regarding the floor lighting, it was suggested that lighting from below, often used in dramatic settings, could evoke undesirable associations. For this reason, the floor lighting was adjusted to serve as accent lighting, with reduced intensity aimed solely at emphasizing the car's form.

Based on this feedback, the design process was refined to clearly distinguish between ambient, focused, and brilliance lighting. Additionally, it became evident that lighting should not be considered in isolation; other aspects such as materiality, shape, and texture must also be accounted for. While the project's timeframe limited deep exploration of these elements, it is recommended that future designs address material properties in more detail.

The principle "the angle of incidence equals the angle of reflection" is relevant when considering how light interacts with materials in the vehicle, especially in relation to reducing screen reflections (Pont, 2024).

Lastly, the physiological effects of lighting on the human eye, particularly how cones perceive light, and their impact on vision should also be factored into the design process (Pont, 2024).





### Expert Consult Charl Smit

To gain more insight, lighting expert Charl Smit was consulted. By presenting the Blender model, feedback and advice were gathered. As expected, Smit highlighted the impact of materials and surface properties on the car's interior, predicting that the screen would likely reflect multiple light sources.

For the design, several aspects can be considered. The first is the transition between different lighting modes, such as shifting from work to relaxation. Should this transition occur automatically or manually, and how does this impact the smoothness of the shift? Is one approach more gradual than the other?

Another key focus is lighting comfort: "What works well and what doesn't?" Does the lighting enhance comfort and support the activity being performed?

The car's interior is a small space with a low ceiling, making it likely that both desk and ceiling lights would reflect on the screen. Dimming the lights was suggested as a solution to reduce reflections (Smit, 2024).

For such a compact space, Smit recommended minimizing contrast by illuminating the area as evenly as possible (Smit, 2024).

The importance of experimenting with "lighting comfort" was emphasized during the discussion, to better understand what works and what doesn't.

Following discussions on the multifunctionality of the space, the idea of pre-set lighting modes for various activities, such as working and relaxing, was proposed. Within the work category, different modes could be designed for focused concentration, relaxed reading, or meetings.

Since it's not yet clear what constitutes comfortable lighting, the initial focus is on lighting comfort. In the future, further research could explore seamless transitions between comfortable lighting modes.

# Appendix User Research

### Initial questionaire

- What is your age?
- What is your gender?
- Do you have any eye defects or wear glasses/contacts? If so, please specify.
- Any previous working experience in a vehicle? If so, can you describe your previous working experience?
- Length?

### Final questionaire

When did you find the activity more pleasant to perform—during the night (1) or the day (5), or did you have no preference (3)? Explain why

Did you prefer tge situation with or without light? Explain why

Do you have any additional comments or observations regarding how lighting affected your experience? Feel free to share anything

### Questionnaire for situations

**Notes taken (by each situation):**
- Posture description
- Typing time

**Questions asked (for each situation)**

How easy is it for you to read the text on the paper? How would your rate this visibility on a scale from 1 to 5? With 1 insufficient and 5 sufficient.

How would you rate the comfort of reading the paper? On a scale from 1 to 5 with 1 uncomfortable and 5 comfortable

if applicable, what factors make it either pleasant

if applicable, what factors make it unpleasant?

How easy is it for you to read the screen? How would your rate this visibility on a scale from 1 to 5? With 1 insufficient and 5 sufficient.

How would you rate the comfort of reading the screen? On a scale from 1 to 5 with 1 uncomfortable and 10 comfortable

if applicable, what factors make it either pleasant

if applicable, what factors make it unpleasant?

Concerning the light, how pleasant would you rate your working experience inside the interior of the car on a scale from 1 to 5?

Concerning the light, how activated do you feel while inside the car on a scale from 1 to 5?

How would you rate your experience of the car's interior concerning light? On a scale from 1 to 5 with 1 unpleasant and 5 pleasant

Concerning the light, how activated do you feel while inside the car on a scale from 1 to 5? with 1 deactivated and 5 activated





**Concent form**

| PLEASE TICK THE APPROPRIATE BOXES | Yes | No |
|---|---|---|
| **A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION** | | |
| 1. I have read and understood the study information dated 25/09/24, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction. | ☐ | ☐ |
| 2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason. | ☐ | ☐ |
| 3. I understand that taking part in the study involves:<br>- Pictures being taken (faces will be blurred)<br>- Questions being asked during the study<br>- Being asked to use the concept<br>- Speak my thoughts out loud | ☐ | ☐ |
| 5. I understand that the study will end in around 40 minutes | | |
| **B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)** | | |
| 6. I understand that taking part in the study involves the following risks: physical discomfort. I understand that these will be mitigated by the possibility to stop the experiment at any point. | ☐ | ☐ |
| 9. I understand that the following steps will be taken to minimise the threat of a data breach, and protect my iden4ty in the event of such a breach by face blurring in pictures. | ☐ | ☐ |
| 10. I understand that personal information collected about me that can identify me, such as my age, occupation, and nationality, will not be shared beyond the study team. | ☐ | ☐ |
| 11. I understand that the (identifiable) personal data I provide will be destroyed after the 1st of December | ☐ | ☐ |
| **C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION** | | |
| 12. I understand that the after the research study the de identified information I provide will be used for a thesis project, published on TU Delt repository | ☐ | ☐ |
| 13. I agree that my responses, views or other input can be quoted anonymously in research outputs | ☐ | ☐ |
| **D: (LONGTERM) DATA STORAGE, ACCESS AND REUSE** | | |
| 16. I give permission for the de-identified data that I provide to be archived in the TU Delft repository so it can be used for future research and learning. | ☐ | ☐ |
| 17. I understand that access to this TU Delft repository is open. | ☐ | ☐ |

**Signatures**

Name of participant [printed] Signature Date

*[Add legal representative, and/or amend text for assent where participants cannot give consent as applicable]*

I, as legal representative, have witnessed the accurate reading of the consent form with the potential participant and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Name of witness [printed] Signature Date

I, as researcher, have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

Researcher name [printed] Signature Date

Study contact details for further information: [*Name, phone number, email address*]

# Appendix Results

**DAY WITH**

| | | | Paper | | Screen | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Participant | TYPING (s) | Visibility | Comfort reading | Visibility | Comfort reading | Interesting insights | Pleasant | Activated | Intensity | Interesting insights |
| 1 | 158 | 4 | 3 | 5 | 5 | Betere focus | 4 | 4 | 2 | Laptop geeft slagschadum op papier |
| 2 | 167 | 5 | 5 | 5 | 5 | Goede verlichting | 4 | 4 | 3 | Bureaulamp zorgt voor ongelijke verlichting |
| 3 | 142 | 4 | 4 | 4 | 4 | Paper goed te zien | 2 | 5 | 4 | Bureaulamp is iets te rond |
| 4 | 135 | 5 | 5 | 4 | 4 | Groot contrast zwart/wit op papier | 4 | 4 | 4 | Led bij deur is fijn |
| 5 | 152 | 4 | 3 | 5 | 5 | Goed belicht toetsenbord | 4 | 4 | 3 | Licht van boven minder sterk |
| 6 | 219 | 5 | 4 | 5 | 5 | Scherm op aangename hoogte | 4 | 3 | 3 | Toch nog veel onverlichte plekken |
| 7 | 140 | 5 | 4 | 4 | 4 | Schaduwen | 4 | 4 | 4 | Plafondlicht niet direct boven hoofd |
| 8 | 125 | 2 | 3 | 3 | 3 | Reflectie van de tekst | 2 | 4 | 4 | Plafondlicht hoger plaatsen |
| 9 | 148 | 5 | 5 | 4 | 4 | Ongelijk belicht | 5 | 5 | 3 | |
| 10 | 121 | 4 | 4 | 3 | 3 | Reflectie van de ledstrip op scherm | 4 | 4 | 3 | |
| 11 | 247 | 5 | 5 | 5 | 5 | Scherm minder prominent door omgevingslicht | 5 | 5 | 4 | |
| 12 | 111 | 4 | 3 | 4 | 4 | Positie toetsenbord | 4 | 4 | 3 | |
| 13 | 226 | 5 | 5 | 4 | 4 | | 4 | 4 | 4 | |
| 14 | 160 | 5 | 5 | 5 | 4 | | 4 | 4 | 3 | |
| 15 | 111 | 5 | 4 | 5 | 5 | | 5 | 4 | 3 | |
| 16 | 118 | 3 | 3 | 4 | 4 | | 4 | 4 | 4 | |
| 17 | 253 | 5 | 5 | 5 | 4 | | 4 | 3 | 5 | |
| 18 | 125 | 4 | 5 | 4 | 4 | | 4 | 4 | 4 | |
| Average | 158,8 | 4,4 | 4,2 | 4,4 | 4,2 | | 3,9 | 4,1 | 3,5 | |
| Seconds/word | 1,89 | | | | | | | | | |

**DAY WITHOUT**

| | | | Paper | | Screen | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Participant | TYPING (s) | Visibility | Comfort reading | Visibility | Comfort reading | Interesting insights | Pleasant | Activated | Intensity | Interesting insights |
| 1 | 117 | 3 | 3 | 4 | 4 | Zonder licht minder fel contrast op de werkplek | 3 | 2 | 3 | Nauwelijks schaduw |
| 2 | 130 | 4 | 5 | 5 | 5 | Licht van buiten helpt lezen (anders geen licht) | 4 | 3 | 3 | Schaduw van buitenlicht en het raam |
| 3 | 158 | 5 | 4 | 5 | 5 | Aangenaam daglicht | 3 | 2 | 3 | Dak is donker, dus er komt weinig licht binnen |
| 4 | 180 | 4 | 3 | 5 | 5 | Moeilijk lezen > dichtbij kijken > klachten nek | 3 | 2 | 3 | Scherm blokkeert raam > minder licht op tafel |
| 5 | 122 | 3 | 3 | 5 | 2 | Schakelen scherm en papier grootfel contrast | 2 | 2 | 1 | Geen verlichting minder fijn dan (te) veel verlichting |
| 6 | 160 | 4 | 5 | 5 | 4 | Geen reflecties op laptop scherm | 4 | 4 | 2 | Meer licht (klein peertje toevoegen) |
| 7 | 201 | 4 | 2 | 4 | 3 | Hoogte en groote aangenaam | 3 | 3 | 2 | Tafel verder weg, plat toetsenbord |
| 8 | 125 | 2 | 3 | 4 | 2 | Achter scherm donker > hogere focus scherm | 2 | 2 | 1 | 'n slaap vallen' |
| 9 | 185 | 3 | 4 | 4 | 4 | Afleiding door ramen en voorruit | 3 | 2 | 2 | |
| 10 | 133 | 4 | 3 | 3 | 3 | | 3 | 2 | 2 | |
| 11 | 176 | 4 | 4 | 4 | 4 | | 3 | 3 | 2 | |
| 12 | 77 | 3 | 3 | 5 | 5 | | 3 | 2 | 2 | |
| 13 | 204 | 2 | 2 | 4 | 3 | | 2 | 4 | 3 | |
| 14 | 208 | 3 | 2 | 5 | 4 | | 3 | 2 | 2 | |
| 15 | 120 | 4 | 3 | 5 | 5 | | 3 | 4 | 2 | |
| 16 | 96 | 3 | 3 | 4 | 4 | | 3 | 3 | 3 | |
| 17 | 188 | 2 | 3 | 5 | 3 | | 4 | 3 | 3 | |
| 18 | 166 | 2 | 3 | 4 | 4 | | 2 | 2 | 2 | |
| Average | 152,6 | 3,3 | 3,2 | 4,4 | 3,8 | | 2,9 | 2,6 | 2,3 | |
| Seconds/word | 2,18 | | | | | | | | | |

**PREFFERED SITUATION**

| Participant | Day (5) / Night (1) | With / Without |
|---|---|---|
| 1 | 4 | With |
| 2 | 5 | Without |
| 3 | 4 | With |
| 4 | 2 | With |
| 5 | 5 | With |
| 6 | 5 | Without |
| 7 | 5 | With |
| 8 | 1 | With |
| 9 | 5 | With |
| 10 | 2 | With |
| 11 | 4 | With |
| 12 | 5 | With |
| 13 | 1 | With |
| 14 | 1 | With |
| 15 | 5 | With |
| 16 | 2 | With |
| 17 | 5 | With |
| 18 | 4 | With |

**NIGHT WITHOUT**

| | | | Paper | | Screen | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Participant | TYPING (s) | Visibility | Comfort reading | Visibility | Comfort reading | Interesting insights | Pleasant | Activated | Intensity | Interesting insights |
| 1 | 160 | 2 | 2 | 4 | 2 | Alleen iets te zien door verlichting laptop | 1 | 1 | 1 | Geen last van schaduwen (er is nauwelijks licht) |
| 2 | 190 | 2 | 2 | 5 | 5 | Tekst op papier lezen lastig en onaangenaam | 2 | 2 | 1 | Meer licht vanaf de zijkant (natuurlijk licht) |
| 3 | 263 | 1 | 1 | 5 | 2 | Moeilijk schakelen licht scherm en donder papier | 1 | 1 | 1 | Rustig licht van boven |
| 4 | 243 | 1 | 1 | 5 | 2 | Positie en grootte scherm aangenaam | 2 | 1 | 1 | Leeslampje voor papier |
| 5 | 174 | 1 | 1 | 3 | 2 | Geen reflectie op het scherm | 1 | 1 | 1 | Specifiek het werkblad verlichten |
| 6 | 316 | 3 | 3 | 5 | 5 | Makkelijk focussen want het is de enige lichtbron | 3 | 3 | 2 | |
| 7 | 287 | 1 | 2 | 4 | 2 | Gelukkig gaf het toetsenbord ook licht | 2 | 2 | 4 | Quote participant (eerste reactie): "dit kan ik niet zien dit wordt een strijd" |
| 8 | 196 | 1 | 2 | 4 | 1 | | 1 | 2 | 1 | |
| 9 | 255 | 1 | 1 | 4 | 2 | | 2 | 2 | 1 | |
| 10 | 208 | 1 | 1 | 4 | 4 | | 2 | 2 | 1 | |
| 11 | 274 | 1 | 1 | 5 | 2 | | 1 | 2 | 2 | |
| 12 | 120 | 1 | 2 | 5 | 2 | | 2 | 2 | 2 | |
| 13 | 256 | 1 | 1 | 4 | 4 | | 1 | 2 | 1 | |
| 14 | 253 | 1 | 1 | 4 | 2 | | 1 | 1 | 1 | |
| 15 | 191 | 2 | 2 | 5 | 2 | | 2 | 3 | 1 | |
| 16 | 131 | 2 | 2 | 3 | 3 | | 2 | 2 | 1 | |
| 17 | 356 | 1 | 1 | 5 | 3 | | 4 | 3 | 2 | |
| 18 | 211 | 1 | 2 | 4 | 3 | | 2 | 2 | 1 | |
| Average | 226,9 | 1,3 | 1,6 | 4,3 | 2,7 | | 1,8 | 1,9 | 1,4 | |
| Seconds/word | 2,27 | | | | | | | | | |

**NIGHT WITH**

| | | | Paper | | Screen | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Participant | TYPING (s) | Visibility | Comfort reading | Visibility | Comfort reading | Interesting insights | Pleasant | Activated | Intensity | Interesting insights |
| 1 | 170 | 4 | 3 | 5 | 5 | Goede belichting lezen papier | 4 | 4 | 4 | Verlichting van boven zorgt voor schaduw |
| 2 | 197 | 4 | 4 | 5 | 4 | Weinig afleiding van buiten, alleen maar licht | 4 | 4 | 4 | Spotlight en laptop zorgt voor schaduw |
| 3 | 180 | 5 | 5 | 4 | 4 | Deur leds zijn fijn, anders te veel focus op tafel | 4 | 5 | 5 | Licht van boven vrij intens |
| 4 | 181 | 5 | 5 | 5 | 5 | Aangenaam dat er er alleen maar artificial lights | 5 | 4 | 3 | Liever meer licht dat lijkt op daglicht |
| 5 | 172 | 3 | 3 | 5 | 5 | zijn en niet ook licht van buiten | 5 | 3 | 2 | Spotlight liever hoekig dan rond |
| 6 | 269 | 3 | 3 | 5 | 5 | Geen afleidende lichten van buiten | 4 | 3 | 3 | Voordelen want "Gevoel van locked in" |
| 7 | 221 | 5 | 4 | 4 | 4 | Te veel licht van boven (schijnwerpers) | 3 | 5 | 4 | Bureaulamp andere hoek, want nu zorgt je eigen hoofd |
| 8 | 156 | 4 | 4 | 4 | 3 | Reflectie papier en licht | 4 | 5 | 4 | voor schaduw |
| 9 | 211 | 4 | 4 | 4 | 4 | Schaduw van de laptop | 4 | 4 | 3 | Spotlight mikken op papier zou fijner zijn |
| 10 | 160 | 5 | 5 | 4 | 4 | Niet naar buiten kunnen kijken | 4 | 4 | 3 | Toetsenbord reflecteerd |
| 11 | 205 | 5 | 5 | 5 | 5 | Scherm lichter dus geen last van reflecties | 2 | 3 | 3 | |
| 12 | 114 | 4 | 4 | 4 | 4 | Verschil scherm en omgevingslicht klein | 4 | 4 | 3 | |
| 13 | 290 | 5 | 5 | 5 | 5 | Geen afleiding | 5 | 5 | 3 | |
| 14 | 207 | 5 | 4 | 5 | 4 | Reflectie ledstrips | 5 | 5 | 3 | |
| 15 | 173 | 5 | 4 | 5 | 5 | Spotlight op toetsenbord | 4 | 4 | 3 | |
| 16 | 132 | 4 | 4 | 3 | 3 | | 4 | 4 | 3 | |
| 17 | 406 | 4 | 3 | 5 | 4 | | 2 | 5 | 5 | |
| 18 | 160 | 4 | 4 | 4 | 4 | | 4 | 5 | 4 | |
| Average | 200,2 | 4,3 | 4,1 | 4,5 | 4,3 | | 3,9 | 4,2 | 3,4 | |
| Seconds/word | 2,09 | | | | | | | | | |

# IDE Master Graduation Project

## Project team, procedural checks and Personal Project Brief

In this document the agreements made between student and supervisory team about the student's IDE Master Graduation Project are set out. This document may also include involvement of an external client, however does not cover any legal matters student and client (might) agree upon. Next to that, this document facilitates the required procedural checks:

- Student defines the team, what the student is going to do/deliver and how that will come about
- Chair of the supervisory team signs, to formally approve the project's setup / Project brief
- SSC E&SA (Shared Service Centre, Education & Student Affairs) report on the student's registration and study progress
- IDE's Board of Examiners confirms the proposed supervisory team on their eligibility, and whether the student is allowed to start the Graduation Project

### STUDENT DATA & MASTER PROGRAMME

Complete all fields and indicate which master(s) you are in

| | |
|---|---|
| Family name | van der Burg |
| Initials | L.O. |
| Given name | Lydia |
| Student number | 4849779 |

IDE master(s): IPD [X] DfI [ ] SPD [ ]

2nd non-IDE master:

Individual programme (date of approval):

Medisign [ ]

HPM [ ]

### SUPERVISORY TEAM

Fill in he required information of supervisory team members. If applicable, company mentor is added as 2nd mentor

| | | | |
|---|---|---|---|
| Chair | P. (Peter) Vink | dept./section | SDE |
| mentor | E.D. (Elmer) van Grondelle | dept./section | DA |
| 2nd mentor | D. (Dave) Withey | | |
| client: | Jaguar Land Rover (JLR) | | |
| city: | Coventry | country: | United Kingdom |
| optional comments | | | |

! Ensure a heterogeneous team. In case you wish to include team members from the same section, explain why.

! Chair should request the IDE Board of Examiners for approval when a non-IDE mentor is proposed. Include CV and motivation letter.

! 2nd mentor only applies when a client is involved.

### APPROVAL OF CHAIR on PROJECT PROPOSAL / PROJECT BRIEF -> to be filled in by the Chair of the supervisory team

Sign for approval (Chair)

Peter Vink Digitally signed by Peter Vink Date: 2024.04.18 13:18:11 +02'00'

Name: peter vink Date: 18 Apr 2024 Signature:

## Personal Project Brief – IDE Master Graduation Project

Name student: Lydia van der Burg Student number: 4,849,779

### PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT

Complete all fields, keep information clear, specific and concise

**Project title:** An interior design for long distance automated driving

*Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.*

**Introduction**

*Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)*

Mobility is undergoing a profound shift worldwide. There is huge demand for sustainable mobility. The electric automated
car could be a suitable luxury replacement for current luxury travel options.
Jaguar Land Rover (JLR) is the house of the brands Range Rover, Defender, Discovery and Jaguar (JLR, 2024). In February
2021 Jaguar Land Rover announced the strategic plan "Reimagine". The aim of this strategy is to transform the company
Jaguar Land Rover to a pure-electric luxury brand from 2025 to contribute to a more sustainable future with net zero
carbon emissions by 2039.
TU-Delft and JLR are running a project together for a new interior for automated driving. Focused on automated driving this
project offers several opportunities including the potential for an interior suitable for the long term (automated) rides that
promote efficient utilization and provides an enhanced comfort and luxury experience, encouraging travellers to opt for
automated electric cars over less sustainable modes of (longterm) travels such as planes.
In the current research done by the TU Delft in cooperation with JLR several aspects of the automated car interior are
researched. Ergonomics, social activities and short term experiences are taken into account. The long term experience is
not yet taken into account. This provides the opportunity to research the long term experience concerning several aspects
such as activities, posture, complaints etc. Current seats of JRL could be used for this test as a starting point

space available for images / figures on next page



## Personal Project Brief – IDE Master Graduation Project

**Problem Definition**

*What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice.*
*(max 200 words)*

Automated driving
The current interior of cars is based on the presence of a driver. This is not suitable for automated vehicles (level 5) as a
driver will no longer be needed. Due to this transformation, the Reimagine strategy, there is considerable room for the
possible alteration or improvement of the conventional interior. Looking into the overall experience, this could lead to
interesting design opportunities concerning the interior or parts of the interior to enhance the luxury experience while
automated driving.
Long term
During the research of the TU Delft in cooperation with JLR there is already looked into the social aspects, ergonomics and
short term experience of automated driving. Long term driving is not yet taken into account, resulting in one of the p
aspects of automated driven yet not being taken into account.

**Assignment**

*This is the most important part of the project brief because it will give a clear direction of what you are heading for.*
*Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence)*
*As you graduate as an industrial design engineer, your assignment will start with a verb (Design/investigate/Validate/Create), and you may use the green text format:*

Design an interior prototype to create a luxury experience for passengers in automated vehicles for long term rides.

*Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)*

The project will start with literature research. General about automotive, automated driving, interior comfort, -ergonomics, -experience and future developments. Also research already done by the TU Delft in cooperation
with JLR will be used. After, a pilot and user research test with approximately 36 participant in a imitated automated car
interior will take place. Afterwards, the data will be analysed. Through this comprehensive research encompassing current
car seats and upcoming developments in the driving domain, I aim to examine the passengers experience and to identify
potential opportunities for interior and layout enhancements to optimise the driving experience. Depending on the
literature and research analysis outcome, I will create a vision/design direction that will serve as the foundation of the
design. The envisioned design can encompass a holistic transformation of the general car space, or it can be

**Project planning and key moments**

*To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a **kick-off meeting, mid-term evaluation meeting, green light meeting** and **graduation ceremony**. Please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any (for instance because of holidays or parallel course activities).*

*Make sure to attach the full plan to this project brief.*
*The four key moment dates must be filled in below*

| | |
|---|---|
| Kick off meeting | 18 Apr 2024 |
| Mid-term evaluation | 28 Jun 2024 |
| Green light meeting | 27 Sep 2024 |
| Graduation ceremony | 31 Oct 2024 |

*In exceptional cases (part of) the Graduation Project may need to be scheduled part-time. Indicate here if such applies to your project*

| | |
|---|---|
| Part of project scheduled part-time | X |
| For how many project weeks | |
| Number of project days per week | |

Comments:
The first ten weeks of my graduation will be
part time as I am also following the course
Automotive Sketching (ID5247). After

**Motivation and personal ambitions**

*Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).*

*Optionally, describe whether you have some personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology. Personal learning ambitions are limited to a maximum number of five.*
*(200 words max)*

In my future career, my aspiration is to work within the automotive sector, focusing on the sustainability, integrated system
in mobility and physical modalities, aiming at enhancing user experience. I want to start this project to gain more knowledge
about the automotive industry to improve my chances of working for a company as Jaguar Land Rover. During my studies I
enjoyed using user and market research as a basis for a (conceptual) design. For my graduation project I would like to
deliver a conceptual and prototyped automotive related design to further my competencies and ambitions. The JLR
assignment "design an interior that is scientifically substantiated" appealed to me as it aligns perfectly with my competencies, interests and ambitions.
This project presents an opportunity for me to demonstrate, for my future career, that I can adopt a holistic approach to the
concept of an automated driving vehicle interior. Throughout the course of this project, I have outlined the following
Learning Objectives:
1. Improve my professional visual skills (sketching and CAD)

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Smith, S. (2024) – Light Expert

Van Grondelle, E. (2024) – Program Manager Advanced Automotive Design

Withey, D. (2024) – Technical Specialist - Seating Innovation & Comfort

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