Final Design Studio
Unveiling Humanity, Design Futures for Meaningful Interaction
2025©

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Methodology

Throughout the entire project development process, we employed a wide range of tools and strategies, focusing both on desk and field research as well as on testing and refining the prototype and interface.

Framing	Preliminary research ⊹Brainstorming ⊹Desk Research
Sensing & Scanning	Research on possible areas of interest ⊹Brainstorming ⊹Desk Research
Sense Making & Mapping	Specific research on possible areas of interest ⊹Interviews ⊹Workshops ⊹Brainstorming
Future Scenarios	Definition of 5 future scenarios ⊹Survey ⊹Interviews ⊹Brainstorming ⊹Desk research
Visioning	Idea definition ⊹Desk research ⊹P2P reviews ⊹Interviews
Designing	MVP definition ⊹Scenarios ⊹Personas ⊹Low-tech prototypes
Storytelling	User testing ⊹Hi-Fi prototypes ⊹User testing
Assessing	Refining the experience ⊹User testing ⊹P2P reviews ⊹Insight analysis
Refinement	Prototype & experience

Framing + Sensing & Scanning

When we first received the brief, we began by exploring, brainstorming, and researching across various directions to gain a deeper understanding of the field and its requirements. With all of us having a very limited knowledge in electric vehicles beyond some rare car-sharing instances, we decided to study how they work and analyze the differences between electric and combustion vehicles, focusing on potential challenges associated with both of them. Additionally, we researched combustion vehicles to gain insights into their functionality and recent advancements in HMI innovations.
Our preliminary research was on:

- Trends
- Car UI
- Innovation in the HMI area
- Infotainment systems
- Electric cars
- History of vehicles
- Crucial features in modern cars

After several brainstorming sessions that began with divergent exploration and gradually converged ideas into thematic clusters, many different topics and themes started to emerge among our group by the second week of the lab. By delving deeper into these areas and integrating insights from our prior research, we gathered some interesting topics:

Obsolescence

Given their long lifespan, how can cars evolve with technological advancements and adapt to the changing needs of their owners over time?

Handling downtime

Can driver interaction be minimized by reducing the time spent managing functions while driving, in order to improve safety and optimize the time spent in the vehicle?

The car as a space

How can the car's interior be reimagined not just for transportation but as a second private space—a second home?

Time optimization

How can driving time be transformed into an opportunity for self-reflection and engaging in meaningful activities, all while maintaining full attention on the road?

Emotions

How can driving maintain its sense of relaxation and freedom while addressing stress from traffic and fatigue, and how can electric vehicles compensate for the emotional appeal of traditional gasoline cars?

Zhao, Pengfei & Guan, Hongzhi & Wang, Pengfei. (2020). Data-Driven Robust Optimal Allocation of Shared Parking Spaces Strategy Considering Uncertainty of Public Users' and Owners' Arrival and Departure: An Agent-Based Approach.

Sense Making & Mapping

Following the initial research phase, we chose to conduct interviews with a diverse range of drivers, each with unique needs, driving habits, and expectations for their cars. This approach allowed us to establish a base understanding of user requirements.
The questions primarily focused on three key dimensions, Time, Space and Emotions, each exploring different aspects of the relationship between users and their vehicles.
After analyzing all the interviews, we organized the majority of the insights into distinct categories that we then explored.

Space management

Interviews revealed that many see their car as a "second home," serving diverse needs beyond transportation. Cars are used for sleeping, changing clothes, storing belongings, eating, and providing shelter during busy days. They are also valued as safe, private spaces for conversations or quiet reflection. Additionally, cars often function as makeshift offices, enabling work tasks like calls or emails on the go.

Emotional attachment

The car is viewed as a second home and a reflection of personal identity. Many drivers have a strong desire to own a car and develop emotional attachment to it over time. The car symbolizes freedom, and the joy of driving remains significant, with little expectation that it will be replaced by autonomous driving.

Perceived time

Trips are perceived differently based on their purpose: mandatory trips like commuting feel tedious, while leisure trips are enjoyable. Many prefer public transport for mandatory travel to use time efficiently, such as reading or working. Drivers make car time productive or enjoyable by listening to podcasts, making calls, or staying informed. Companion trips foster conversation and ease stress, while driving often symbolizes freedom and offers moments for introspection.

Hennessy, D. and Wiesenthal, D. (1999) Traffic Congestion, Driver Stress, and Driver Aggression, Wiley Online Library.

▲Data from 15 interviews with drivers aged 24-60 from diverse backgrounds. Of these, 12 drive at least twice daily, mainly for commuting.

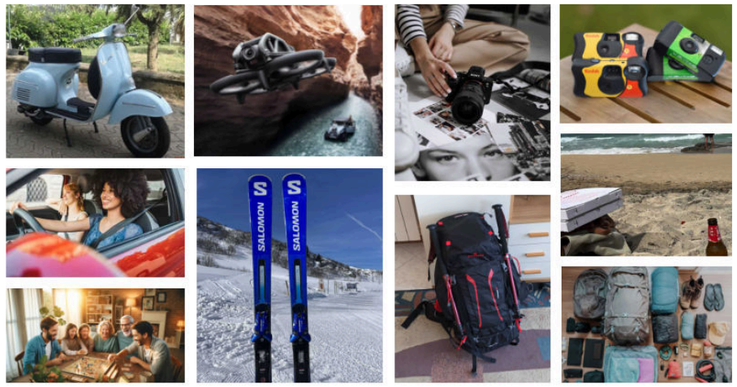
General improvements

The car is difficult to clean, with a need for removable parts. Temperature control is inefficient, and voice commands are often unresponsive. The central tunnel is seen as a barrier, and more privacy is desired when stationary.
The infotainment system is confusing, and drivers want better parking space info and alternative routes in traffic. Many wish for more flexibility on long trips and prefer smaller cars with efficient space use.

Safety

Many expressed concerns about reckless drivers, blind spots from A-pillars, and insecurity due to road conditions. Interacting with the car interface was seen as distracting, while drowsiness and time pressure were noted as significant safety risks.

During the same week, we participated in a class workshop where we explored patterns in people's behaviors and developed a metaphor to encapsulate our project. This exercise was incredibly helpful in narrowing our focus and consolidating the various topics we had identified earlier.



The car experience as a travel backpack.
It's not just for getting from one place to another, but for carrying everything that makes the journey enjoyable.
It's a flexible container that adapts to the needs of the moment, transforming the trip into part of the experience, not just a means to reach the destination.

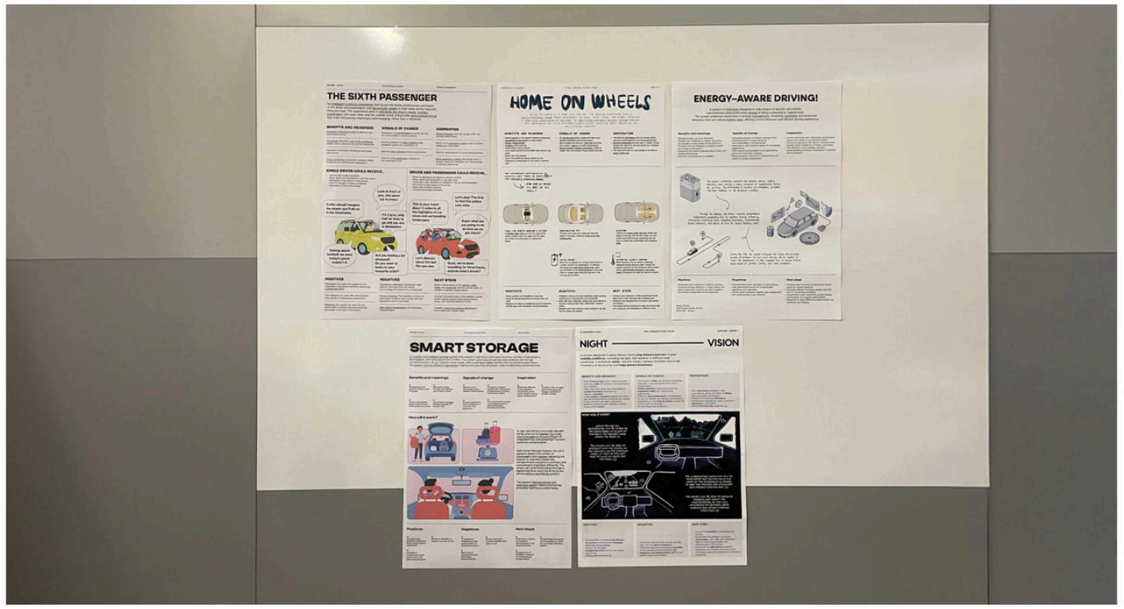
From this, we defined several scenarios to research and explore in greater depth:

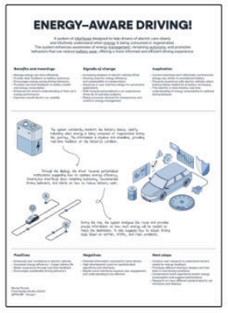
- Travelling alone
- Travelling in group
- Space efficiency
- Driving with kids
- Driving in adverse weather
- Pleasure of driving
- Autonomy
- Safety
- Relationship with the outside
- Night travel
- Car as a second home

Futuring scenarios

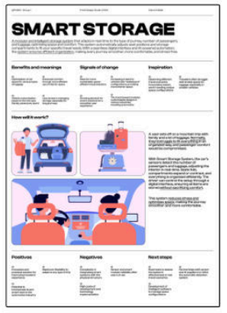
Building on the work done in the previous week, and after a thorough discussion, we chose to focus on five scenarios that we found most interesting and promising. For the first milestone, we created five posters that summarized and showcased the insights gathered during our research.

▼Our poster wall during the exhibition





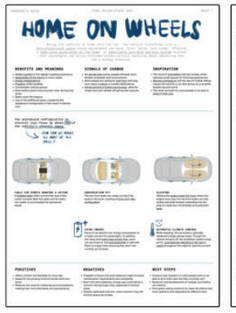
Energy-Aware Driving
A set of interfaces designed to help electric vehicle drivers understand energy consumption and regeneration, raising awareness of energy management and encouraging better battery use.



Smart Storage
A modular, adaptive storage system that adjusts seat positions and compartments based on the user's travel needs, offering efficient organization and maximizing space utilization.



The Sixth Passenger
Focused on delivering an intelligent in-vehicle experience designed to anticipate driver needs, enhance passenger connections, and provide meaningful, engaging journey experiences.



Home on Wheels
Focused on optimizing the newfound space in electric vehicles thanks to the skateboard configuration, which frees up around 20% of the vehicle's interior space, making it feel more like a home on the road.



Night Vision
A system that assists drivers during long-distance journeys in low-visibility conditions, enhancing safety, reducing stress, and preventing drowsiness by addressing monotony.

Visioning

After numerous discussions with peers and professors, we collectively decided to focus on what we all agreed was the most promising idea: Energy-Aware Driving.
This marked the beginning of our in-depth research phase, as we aimed to gain a comprehensive understanding of how electric vehicle interfaces communicate energy usage within the car's system.
We began by analyzing the cockpit UI of leading car manufacturers and the most popular electric vehicles worldwide. At the same time, we conducted research into the workings of electric engines, comparing them to combustion engines. We explored how interfaces communicate fuel usage versus energy consumption and regeneration through regenerative braking. We also delved into best practices for maintaining the car's battery and examined various other topics relevant to our concept.

Battery, findings

- Always using fast charging can damage car batteries
- Outside temperature can affect battery life and autonomy
- Ideal battery range: 20–80% to avoid autonomy loss
- EV autonomy is harder to predict due to driving styles
- Gradual regenerative braking improves efficiency

UI interfaces, findings

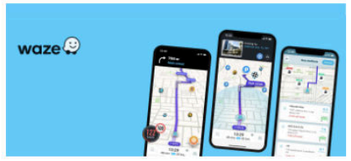
- Range and battery state of charge (SoC) are top priorities
- Trust in consumption data drops after 3-6 months
- Users prefer simple interfaces and familiar units
- Energy efficiency info (e.g., for air conditioning) needs clarity
- Clear feedback on driving behaviors is lacking
- Present data redundantly (SoC + range) for consistency
- Include predictive tools and group related info

Case studies - What do we trust?



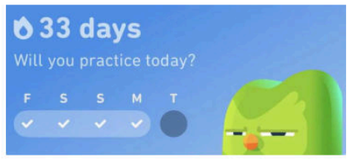
Personal goals and clear visuals make engaging interactions

Fitness,
health and well-being app



Trusted traffic forecasts reassure users, reducing planning effort

Waze,
navigation app



Mascot's friendly tone and streaks build habits and engagement

Duolingo,
learning app

Kreißig, I. and Krems, J. (2015) Battery electric vehicles - implications for the driver interface, Research Gate.

Cockpit UI research



Remaining miles prioritized

Kia EV9
Driver display



Regeneration refers to regenerative braking

Porsche Taycan
Driver display



Battery charge shown as bars, no percentage

Jaguar I-Pace
Driver display

Questionnaire

After selecting the scenario, we designed a questionnaire to gain deeper insights into how people perceive electric cars and their engines. Our goal was to gather perspectives from both those who have never owned an electric car and those who have transitioned from a combustion engine to an electric vehicle.

Our primary focus was understanding how non-owners perceive electric vehicles, whether they are skeptical about buying one and, most importantly, the reasons behind their skepticism toward electric cars and the concept in general. On the other hand, we were curious about the motivations behind the switch from combustion cars to electric vehicles for current owners, as well as what they liked and disliked about their electric cars.

Google Form questionnaire (link)
255 respondents aged 20 to 70, nearly half with over 10 years of driving experience.▶

Electric car owners

- Electric car ownership: ≤4 years.
- Unclear link between kilometers and battery percentage.
- Lack of knowledge on long-term battery care.
- Charging on long trips is a key challenge.
- Most recharge at home.
- Main reasons: cost savings, low maintenance, environment.

Non-electric car owners

Have you ever considered buying an electric car? No, because –

- No home charging, distrust in public infrastructure.
- Long charging times, low range for long trips.
- High purchase costs, limited eco-benefits.

Have you ever considered buying an electric car? Yes, because –

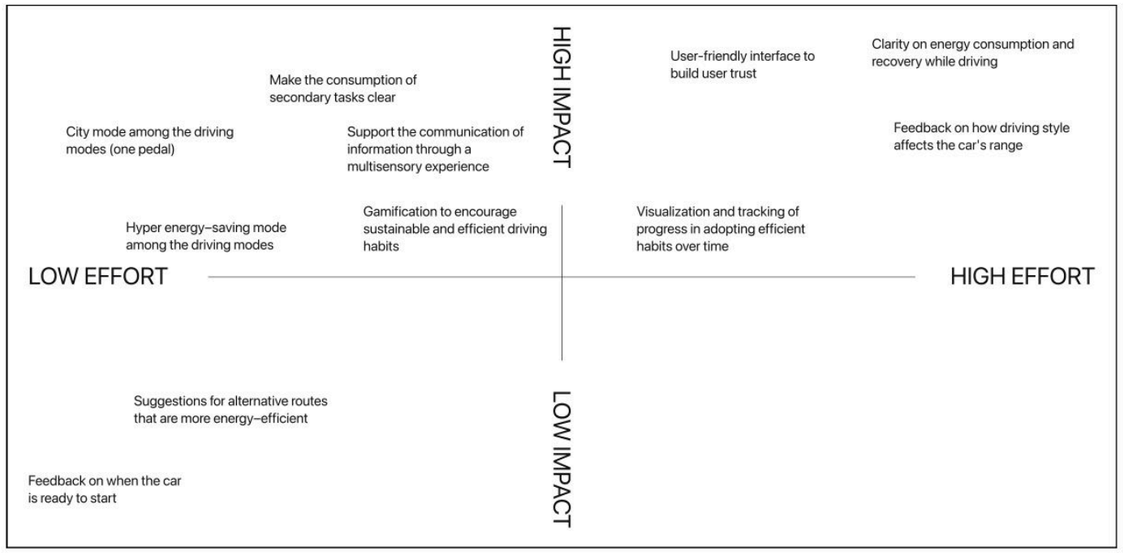
- Environmentally friendly, less pollution.
- Savings via incentives, fuel, and maintenance.
- Mainly for short trips and daily use.

Designing

Starting from the findings from both literature review and the questionnaire, we developed two distinct scenarios, both aligned with the selected context, and defined their unique value propositions (UVPs). We also created two impact/effort matrices to better identify where to focus our efforts during the initial stages and what to leave for later phases. Lastly we defined two storyboards of how the interaction could happen in both scenarios.

When developing the two scenarios, we focused on two key aspects related to energy: the desire of car owners to maximize energy savings and the initial fear of running out of battery, particularly for new electric car owners who are still adapting to the concept and are often influenced by common stereotypes.

Saving Scenario - Impact effort matrix

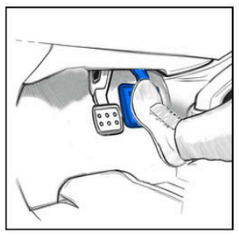


Saving Scenario - Lucia

Lucia relies on her car for daily commuting as public transport isn't an option from her home. After careful consideration, she decided to buy an electric car to save on fuel costs and reduce her environmental impact. However, she discovered that her previous driving style with a traditional car doesn't allow her to fully benefit from the savings of an electric vehicle. Additionally, the estimated range often doesn't match the actual km driven, causing her to lose trust in the system and avoid relying on the information provided by the car.
Lucia seeks to find a driving style that allows her to optimize her electric vehicle's efficiency, but she hasn't yet figured out the right adjustments.



Steering wheel button changes usage stats



Haptic feedback optimizes driving efficiency



Driving stats and tips available via the car app

MVP

- Display + UI
- Steering wheel + buttons
- Pedal with haptic feedback
- Smartphone + UI

Clarity on energy consumption and recovery while driving

User-friendly interface to build user trust

Support the communication of information through the experience

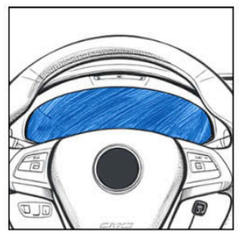
Feedback on how driving style affects the car's autonomy range

Fear Scenario - Renzo

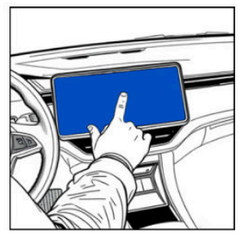
Renzo recently bought a mid-range electric car with eco-incentives. Initially unsure, he's adjusting to the charging system. With a phone that barely lasts a day, he compares its battery to the car's, fearing a low charge despite only needing 70 km daily. He struggles to trust the car's estimated range, especially in traffic, and often checks the battery level. His past experience with quick gasoline refueling now makes him anxious about finding charging stations. Even nearby ones are often occupied, leaving him stressed about when and where to recharge. He wishes for the peace of mind he had with his gasoline car.



Display shows range, switched via steering wheel button



Intuitive display, stress-free



Touchscreen gives range and charging advice at journey's end

MVP

- Display + UI
- Steering wheel + buttons
- Touchscreen + UI

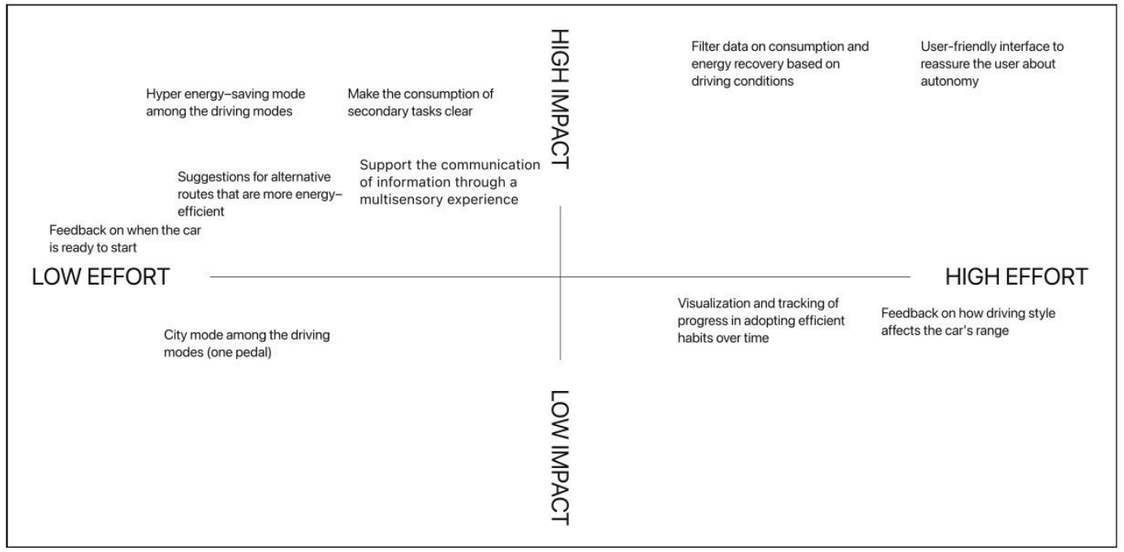
Filter data on consumption to prevent causing stress in the user

User-friendly interfaceto reassure the user about autonomy

Make the consumption of secondary tasks clear

Hyper energy–saving mode among the driving modes

Fear Scenario - Impact effort matrix



While discussing which scenario to pursue, we realized that the 'fear' scenario primarily occurs during the initial stages of using an electric car. Addressing this issue might have limited long-term value, as users tend to become accustomed to their vehicles over time.
As a result, we decided to focus on the energy-saving scenario, while still considering the needs identified in the fear scenario. This allowed us to address both aspects by incorporating solutions for initial anxieties into the system design.

Given that our primary focus was on effectively communicating how to use regenerative braking for maximum energy efficiency, we began by exploring the best ways to inform users about braking techniques. Our goal was to guide them on how to optimize regenerative braking and make the most of its capabilities.
At first the interaction looked like this:



Elettra wakes up with the car, greets Lucia as she enters

Lucia adjusts her driving with info and haptic feedback

Elettra changes appearance based on driving behavior

Lucia activates Elettra via gesture or voice, receiving tips and feedback

At her destination, Lucia gets a summary of her driving on the app

Elements of the interaction

Haptic feedback pedal

The haptic feedback pedal played a crucial role in guiding the user to brake optimally and remain within the range displayed on the cockpit, maximizing energy recovery. Through subtle vibrations, it signaled the optimal brake pressure. If the braking was too abrupt, the pedal vibrated to indicate inefficiency in energy recovery, while still allowing sharp braking in emergencies.

Cockpit integration

The cockpit further supported energy-efficient driving by dynamically adjusting the speedometer. Based on the driver's style, it displayed an optimal speed range to maintain, helping to enhance regenerative braking and minimize energy consumption during acceleration.

App

The app provided users with an easy way to access their driving statistics and monitor improvements over time. By collecting trip data and maintaining a driving history, it calculated performance metrics and allowed users to track their progress in adopting more energy-efficient driving habits.

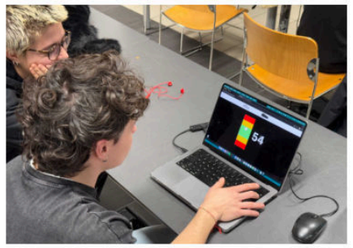
Elettra as the soul of the car

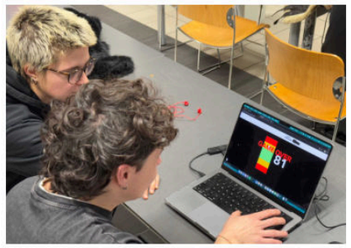
Elettra was envisioned as the car's essence, represented by a dynamic LED that changed its appearance based on the driving style adopted by the user throughout their journey. Rather than offering feedback on individual actions, Elettra provided a holistic overview of driving behavior for the entire trip.
Its appearance conveyed energy usage information by:

- Analyzing the balance between energy consumed due to driving style and secondary tasks versus energy replenished through regenerative braking.
- Visually adapting to effectively communicate this balance.
- Offering vocal explanations when summoned by the user, helping them understand the reasons behind its appearance.

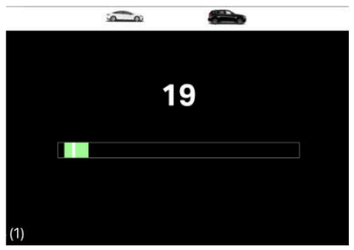
Following this initial interaction concept, we decided to focus on the element we found to be the most impactful and innovative, rather than pursuing interactions that could prove challenging to prototype and potentially less useful for the user.
As a result, we shifted our efforts to the cockpit, concentrating on how to effectively communicate with the user about optimal braking techniques. Our aim was to help drivers maximize the benefits of regenerative braking and enhance their overall energy efficiency through visuals on the cockpit.

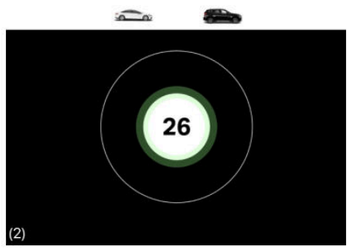
To determine the most effective way to display cockpit information, we conducted user tests with six driving simulations created using the p5.js library. In each simulation, the user controlled a white car positioned at the top of the screen. By pressing "Enter" to accelerate and "Spacebar" to brake, the goal was to stop before colliding with a black car moving at a constant but slower speed, coming to a stop at the screen's end. While the driving dynamics were the same across all simulations, the key difference was the type of feedback presented on the screen. This allowed us to test six different visualizations of optimal braking feedback and identify the most effective designs as well as areas for improvement.

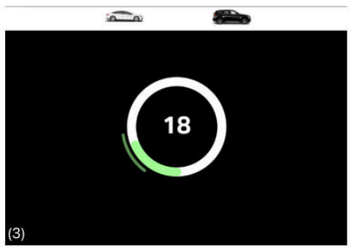




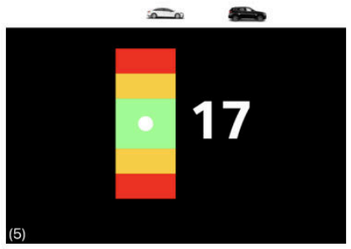
15 people with good technological knowledge aged 20 to 40, Willing to change their driving habits to recover more energy.▼

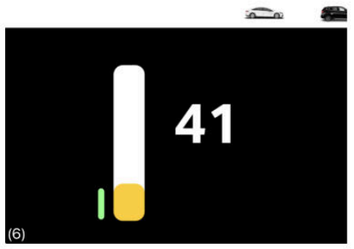








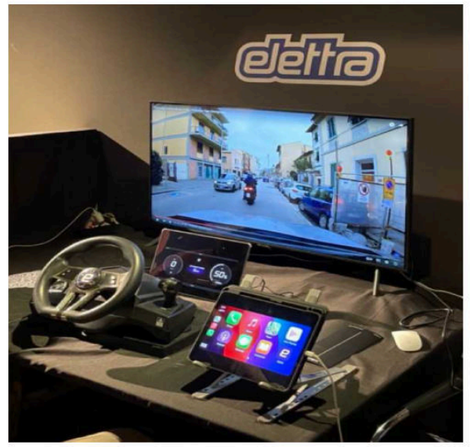




The winning display was number (3). Users preferred it because it retained the circular design, familiar from the speedometer of traditional cars. It clearly highlighted the optimal braking range on the outer edge, and the color coding allowed users to quickly assess whether they were within range. Additionally, it wasn't overly distracting compared to other more complex displays, like number (5), allowing users to stay focused on the car's movement.

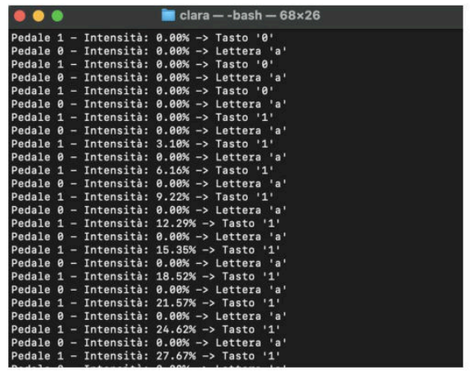
Storytelling

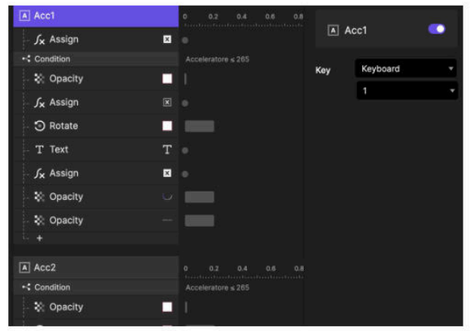
Once we had defined the core interaction, we proceeded to create a high-tech prototype to be used during Project Madness. This prototype allowed us to test the interaction as we envisioned it, enabling us to gather valuable insights on its functionality and effectiveness. While testing, we asked participants questions about the overall experience, not just the braking aspect. During the test, participants were seated in a chair and instructed to simulate driving by following a video of a car traveling along a road with a driving simulator consisting of a steering wheel and pedals.



▲Our setup included a cockpit interface placed behind the steering wheel, a screen on the side acting as the central display, and a TV in front showing the road video.

While the steering wheel was not a key part of the project and had no interaction points with the system, serving only to immerse the user in the driving experience, the pedals (accelerator and brake) were connected to a computer to act as input devices for triggering changes in the UI. However, since the pedals were not natively recognized by the MacBook, they were reprogrammed as a peripheral device using Python. Because the pedals did not produce analog signals but rather digital ones, Python was also used to simulate the feeling of acceleration and braking based on the pressure applied. By default, the pedals pressed "0" for the accelerator and "A" for the brake when the user was not applying pressure, triggering the "coasting" state in the UI built with Protopie. When the pedals were pressed, this default state changed: for example, a brief press of the accelerator corresponded to the keyboard character "1," while holding the pedal down longer generated "2," and so on. A similar system was implemented for the brake pedal using letters, progressing from "B" to "D." Both pedals operated with three levels of pressure to simulate varying intensity. This setup allowed us to use Protopie, where keyboard inputs served as triggers for modifying the user interface.





▲MacBook terminal that prints pedal pressure converted into a keyboard character, Protopie trigger related to the keyword character pressure.

While driving interaction → Cockpit

input → step on the throttle

output → white power bar
→ speed



input → throttle release

output → gradient speed bar
→ purple optimal brake range bar
→ purple autonomy gained gradient
→ "RECUPERATION" indicates the battery is being recharged when the car is cruising



input → hit the brake

output → gradient speed bar
→ purple optimal brake range bar
→ purple autonomy gained gradient
→ "RECUPERATION" indicates the the battery is being charged through regenerative braking when the brake pedal is pressed



input → completing an optimal brake

output → purple elettra "e" logo
→ sound feedback
→ growth of km of autonomy



Scenario 1 – Optimal brake

input → hit the brake

output → white speed bar
→ purple optimal brake range bar



input → complete the brake

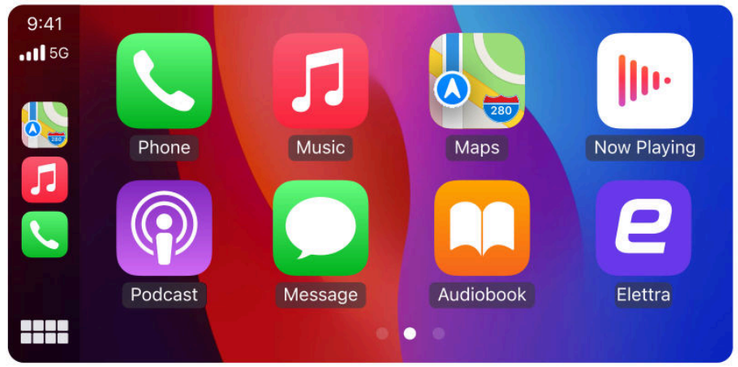
output → white speed bar
→ purple optimal brake range bar



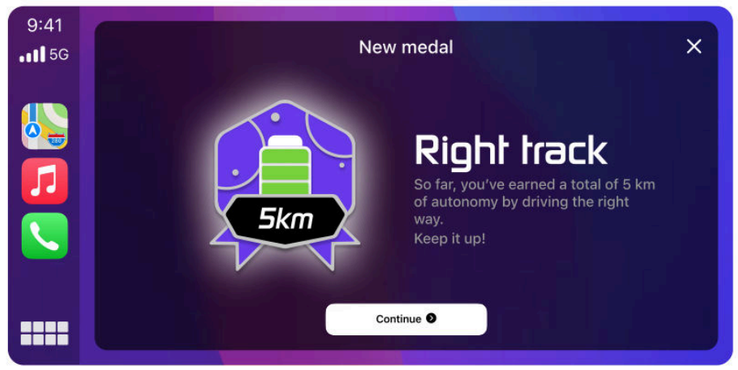
Scenario 2 – Improvable brake

After driving interaction → Central display

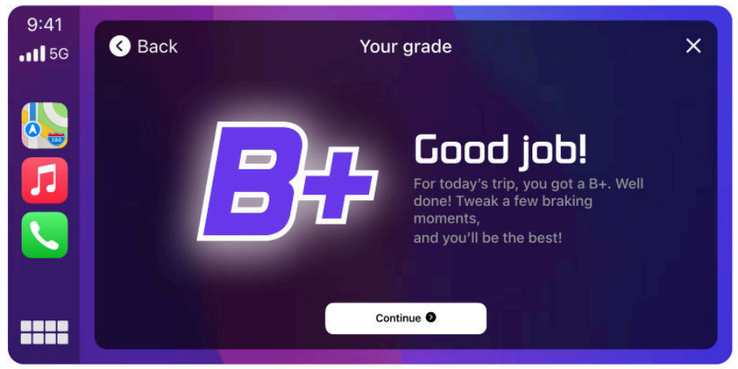
Elettra application
CarPlay home page



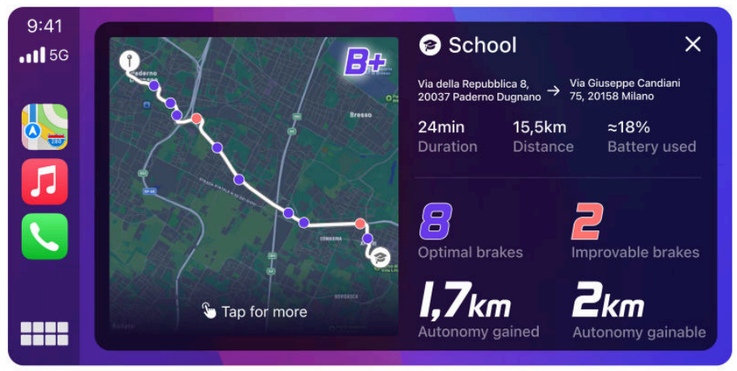
Trip summary 1/3
→ rewards, they are gained whenever a milestone is hit.



Trip summary 2/3
→ trip efficiency grade, to help with gaining a perspective on the driving style



Trip summary 3/3
→ detailed information on the trip
- itinerary details
- % of battery used
- number of optimal brakes
- number of improvable brakes
- km of autonomy gained
- km of autonomy that could have been gained if all brakes were optimal
- brakes made along the way, and how they were



Assessing

During the Project Madness user tests, we were pleased to find that the way the brake range and other information were displayed was effective and clearly understood by the majority of users. Additionally, the planned interaction was intuitive for most testers both in the cockpit and in the central display.

Full project FigJam (link) where to find all test results▼



Visibility and distraction issues

Testers frequently highlighted that the interaction in the cockpit wasn't prominently visible. They had to lower their gaze to check the speedometer for braking feedback, which diverted their attention from the road and was considered distracting.



Pedal behavior and realism

Another significant concern was the unrealistic coding of the pedals, which didn't align with how real car pedals function. This discrepancy made it challenging for participants to maintain control and adhere to the 100 km/h speed limit and made the interaction less enjoyable. Acknowledging this issue, we prioritized resolving it in the next tests.



Optimal brake feedback

The sound feedback feature that indicated when an optimal brake was achieved, was found annoying and potentially distracting, even though testers understood its intended purpose and liked the idea of a feedback when the task was completed successfully.
For this reason, we decided to simplify the feedback mechanism for the next test by limiting it to the 'Elettra' logo turning purple to indicate optimal braking.

Refinement

In the weeks following the Project Madness exhibition, we reviewed all the insights gathered during the assessing phase and implemented several crucial changes to both the project and the prototype.



Increasing visibility

We decided to move the information showing the correlation between speed and optimal braking range to the head-up display (HUD). This adjustment ensured the information was more visible to drivers without causing distractions.

Refining the level of information

Initially, we considered adding a more detailed level of information within the braking range, distinguishing between a 'perfect' braking speed and an 'acceptable' one to help users achieve maximum precision. However, after presenting this idea to our colleagues during a peer to peer review, we found it caused confusion and detracted from the interface's clarity. In response, we simplified the design, limiting it to displaying only the optimal braking range to enhance user understanding and ease of use.

Redesigning the format

With this relocation, we realized that the previously used round format was not well-suited for the HUD. Recalling our earlier tests, we revisited the second most-preferred design—a horizontal visualization. Since it had already been tested and found to be both intuitive and comprehensible, we adopted this format for the HUD.

Fixing the prototype

Finally, the prototype was completely redone in order to feel more realistic and match better with the interaction, allowing for users to feel more involved during the simulation experience.

While driving interaction → Cockpit + head-up display

input → step on the throttle

output → white power bar
→ speed
→ “POWER” indicates the car is using battery energy



input → throttle release

output → purple recuperation bar
→ purple battery status
→ “RECUPERATION” indicates the battery is being recharged when the car is coasting



input → hit the brake

output → purple brake recuperation bar
→ optimal brake range bar
→ purple battery status
→ “BRAKE RECUPERATION” the battery is charging optimally, braking is in range



Scenario 1 – Optimal brake

input → hit the brake

output → red brake bar
→ optimal brake range bar
→ "BRAKE" indicates that the the battery is not charging optimally, braking is not in the range



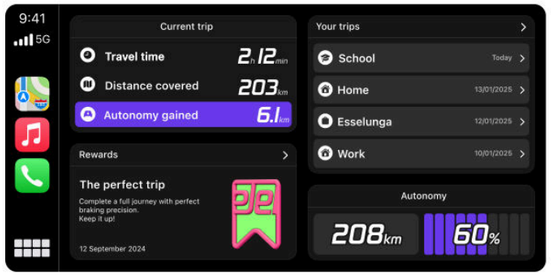
Scenario 2 – Improvable brake

After driving interaction → Central display

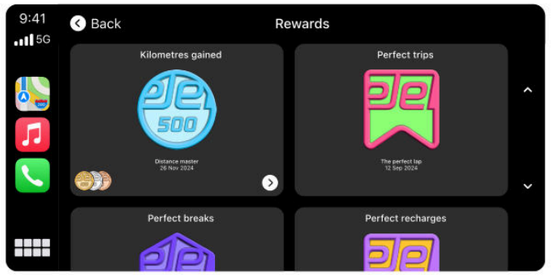
Unlocking splash screen
→ to prevent distractions while driving



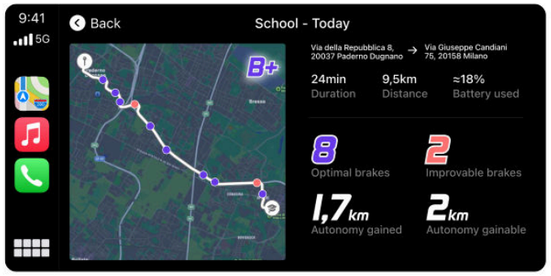
Dashboard
→ to give a clear overview of the informations



Rewards section
→ to foster good driving habits

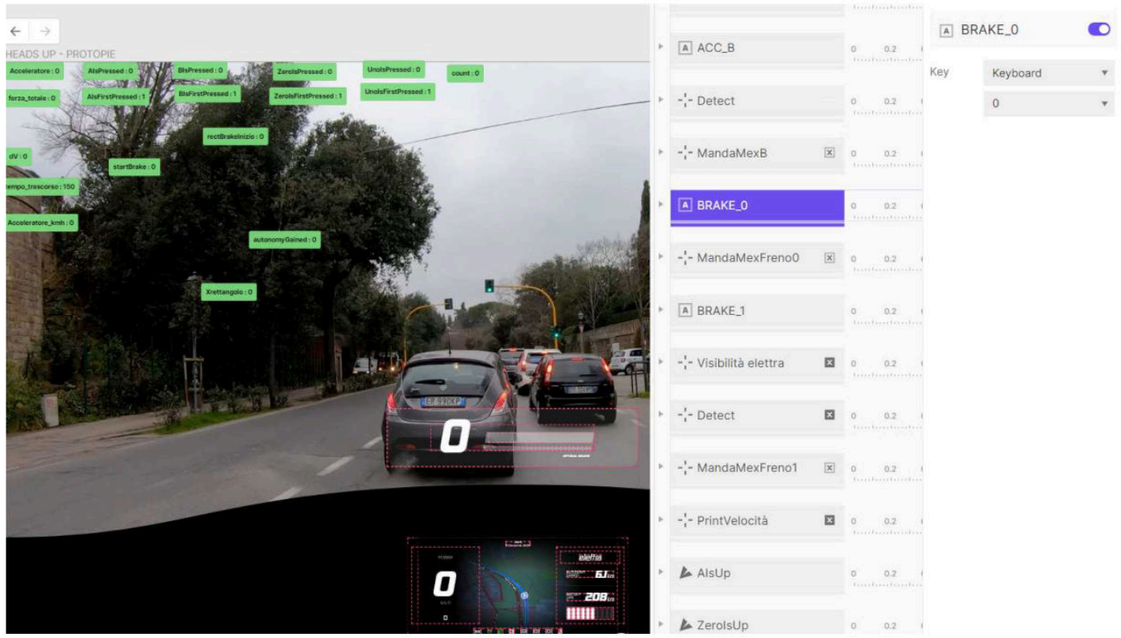


Trip information section
→ to give the user the possibility to learn



Prototype hardware

The interaction with the driving simulator prototype underwent significant improvements to enhance both functionality and realism. By optimizing the way inputs are mapped and incorporating advanced calculations for acceleration and braking, we created a more immersive and realistic driving experience. Below is a breakdown of the updated system:



Updated interaction

- Connection of the driving simulator to a Windows computer, which recognizes two types of pedal pressure always digitally
- Used AntiMicro to map pedal signals to keyboard inputs, removing the need for Python

Input mapping

- Accelerator: Light press →"A, "Strong press → "B"
- Brake: Light press → "0," Strong press → "1"

UI integration

- The user video is embedded in Protopie
- The head-up display is layered over the video for a cohesive interface

Coasting state

- No longer requires a specific key press
- Implemented a variable-based system in Protopie to detect when no pedals are pressed, triggering the coasting display on the head-up

Improved realism

Acceleration is now exponential, calculated using:

- Car mass
- Static and dynamic friction coefficients
- Time elapsed since pedal press

Implemented through variables in Protopie for more realistic acceleration and braking

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