LAB University of Applied Sciences

STANCE

2030 MITSUBISHI URBAN EV CONCEPT

Julius Ranta
Graduation Project
LAB University of Applied Sciences
Bachelor of Design
Vehicle Design
Spring 2020

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ABSTRACT

As a graduation project I researched what a near future urban vehicle could be like. In the project I aim to research the possibilities of future technologies in the design of a small urban vehicle. The final result is a year 2030 Mitsubishi urban car concept for four, which utilises future technologies to improve passenger comfort.

TIIVISTELMÄ

Opinnäytetyössäni tutkin millainen lähitulevaisuuden kaupunkiajoneuvo voisi olla. Projektissa pyrin tutkimaan tulevaisuuden teknologian tuomia mahdollisuuksia pienen kaupunkiajoneuvon suunnittelussa. Lopputuloksena on vuoteen 2030 sijoittiva Mitsubishin nelipaikkainen kaupunkiautokonsepti, joka hyödyntää tulevaisuuden teknologiaa matkustusmukavuuden parantamiseksi.

CONTENTS

1 INTRODUCTION

1.1 SUBJECT

This project began from an idea of a small hatchback that prioritises interior space and comfort. I wanted to make a future car concept that despite its short length, the interior would feel spacious. I also wanted to study the possibility to utilise the space that the electric hub motors release. It was important making the concept believable technically as well as visually.

The project brief was to make a small hatchback for the year 2030, that would combine human driving with assisting systems and autonomous driving. The concept would be mostly autonomous in rural areas but controlled by the driver in urban areas. A crucial part of the design was to ensure great visibility from the interior to make the vehicle feel bigger inside.

1.2 OBJECTIVE

The goal of this design process is to showcase different solutions for future urban vehicles. I wanted to research different ideas for the layout and the usage of space. I took a different approach to autonomous driving, having more interaction between human driver and the AI.

Packaging four people comfortably with great accessibility and visibility to less than a four metres long vehicle was also an important objective for the project.

I set myself a goal to learn how to model my own car design in 3D. Because of the schedule, I chose to learn modeling my vehicle concept in Blender.

The most important objective was nevertheless, making the concept feel believable and realistic.

2 RESEARCH

2.1 HATCHBACK

Hatchback is a vehicle type which is defined by a lift gate at the back of the vehicle. Hatchbacks are usually part of the economy cars segment, which include B, C and D segment vehicles. The common objective of economy cars segment is to provide affordable 5-passenger-plus-cargo transportation, so the packaging and layout need to be arranged efficiently. The designers goal is to fit as large interior space as possible to the smallest exterior dimensions. Everything from powertrain to body structures are optimized for space efficiency. Economy cars are designed to meet high production volumes to minimise the overall cost of a single vehicle. (Macey & Wardle 2009, 56.)

The traditional proportions of the hatchbacks consist of two boxes. The two box proportions are influenced by the occupants, cargo and powertrain packages. The body shape is also taking influence from aerodynamics as well as passenger and cargo locations. Hatchbacks are designed for multifunction between carrying cargo and rear passengers. (Macey & Wardle 2009, 72-73, 111.)

In this project I emphasize especially the meaning of smart packaging and fitting as spacious interior as possible. Choosing a hatchback body type was the most efficient way to achieve that.

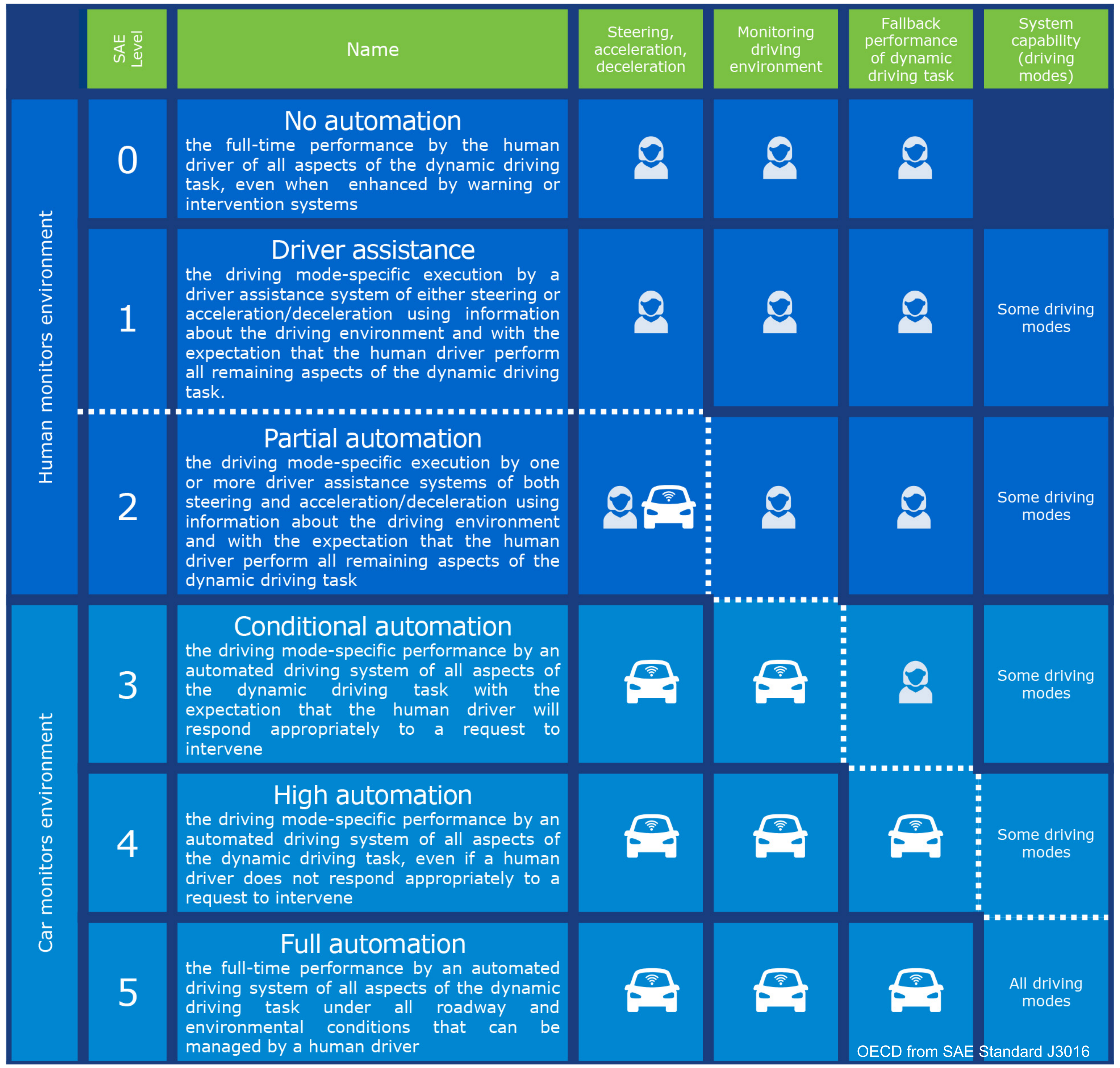
Volkswagen Golf

2.2 AUTONOMY AND DRIVING ASSIST SYSTEMS

Autonomous cars are cars that can drive independently. Depending on the level of autonomy, autonomous cars may use cameras, sensors, lasers, machine learning and intercommunication to drive independently. Autonomous cars have several major benefits compared to human-controlled cars which makes the technology one of the megatrends of future transportation.

Autonomous vehicles are divided to six different levels of automation, level 0 being fully human controlled and level 5 being fully automated. Level 0 of automation means that the vehicle is controlled by the human driver in every aspect of the dynamic driving task. From level 1 to level 2 the automation levels are counted as driver assist systems where the environment monitoring is the human driver's responsibility, although the vehicle has steering, acceleration and deacceleration assist from Artificial Intelligence (AI). The transition from level 2 to level 3 is the border of partial automation and conditional automation. Level 3 is also the level where most countries have drawn the line between non-automated and automated vehicles. From level 3 to level 5 the automated driving system monitors the driving environment. (OECD 2015, 14-15, from SAE Standard J3016, 2014.)

Autonomy requires sensors, cameras and lidars to work. In this project I count on the fact that they can be hidden behind the body panels and glass in the near future.



Levels of driving automation according to the Society of Automotive Engineers (SAE)

2.3 ELECTRIC HUB MOTORS

The idea of an electric hub motor is to have the electric motor inside the wheel itself. The main benefit from electric hub motors is that it takes much less space than combustion engines or chassis mounted electric motors. Since the motors are inside the wheels, the space in front of the vehicle can be used for something else. That opens an opportunity to change the layout from the traditional vehicle layout. Electric hub motors allow direct drive on each individual wheel which dispenses with transmission and differential. In that case the mechanical transmission parts don't wear or tear which makes the vehicle safer and it might improve the driving dynamics.

The mayor flaw of the electric hub motors is increased unsprung mass that affects vehicle control negatively. The negative effects can be minimized configuring the chassis so there won't be noticeable impact on driving comfort. (Frauenhofer-Gesellschaft 2010.)   Due to the location of the motor, there needs to be equal number of motors each side of the vehicle maintaining balance in the middle. For example, in this project's case there will be two electric hub motors located inside the rear wheels.

In this project, the space freed by electric hub motors is used for luggage space. That way luggage can be placed in the front of the vehicle which gives the interior more space to expand to the back without reducing much luggage space.

Electric car hub motor exploded view by Protean Electric

2.4 SMART GLASS AND TRANSPARENT DISPLAYS

Smart glass is dynamic, allowing a traditionally static material to become alive. The technology allows for the control of various forms of light including visible light, Ultraviolet (UV) and Infrared radiation (IR). Smart glass is based on technologies that allow transparent materials like glass and polycarbonate to switch from clear to shaded or entirely opaque.

There are two different types of smart glass: active and passive. These two types are defined by the fact, whether their functionality needs electrical charge to work. There are three types of active smart glass technologies: Polymer Dispersed Liquid Crystal (PDLC), Suspended Particle Device (SPD) and Electrochromic (EC). PDLC is for example used as privacy glass to prevent visible light in buildings or UV in vehicles. SPD is generally used in vehicle industry for windows that tint to shade. EC is used in coated windows that tint slowly. The passive smart glass category includes two different technologies: photochromic glass and thermochromic glass. Photochromic glass is used in eyeglasses that tint automatically in sunlight and thermochromic glass is used in coated windows that respond to temperature change.
(gauzy.com)

The most common use for smart glass is in the architectural, automotive, interior and product design industries. The smart glass technology is typically integrated into transparent surfaces such as building, vehicle or retail windows.

PDLC smart glass used as privacy glass

2.4 SMART GLASS AND TRANSPARENT DISPLAYS

Transparent OLED (Organic Light Emitting Diode) is a transparent display technology that displays dynamic or interactive information on transparent surface glass, allowing users to view what is shown on the display while being able to see through it.
(Planar 2020.)

There are a few different transparent display technologies on the market nowadays, transparent OLEDs and LCDs (Light Emitting Diode) being the most common. Transparent LCD displays rely on ambient light for displaying screen content, which results to a very low contrast and narrow viewing angles. Transparent LCDs also need a backlight for being usable so it's not suitable for windows.

Transparent OLED technology isn't very common in large surface panels due to its high production cost, but it is considered to become more common in near future as the technology becomes cheaper. Transparent OLEDs, as well as all OLED displays, can emit light from every pixel separately. It has also much better contrast, colour reproduction and viewing angles than LCD displays. That makes using transparent OLEDs as vehicle windows possible in the future as the technology develops.

Tansparent OLED touch screen

2.5 MITSUBISHI MOTORS

During the ideation process and benchmarking I decided to brand the vehicle concept as Mitsubishi Motors. Mitsubishi has a long history of selling small hatchbacks and urban vehicles to different markets around the globe so the brand fits well with the project brief. Mitsubishi has also manufactured a five-door hatchback electric car i-MiEV, which was the world's first modern highway-capable mass production electric car in 2009. It worked loosely as a conceptual example for this project. In this project I wanted to approach the brand from a different angle, making the design and styling different from the current design language.

Although the design of the concept differs from the Mitsubishi design language, I still wanted to include some elements from their unveiled near future design philosophy. Additionally, I also wanted to make the traditional Mitsubishi logo easily noticeable along with the iconic Mitsubishi red body colour.

mitsubishi-motors.com

Mitsubishi i-MiEV in Mitsubishi red metallic paint

mitsubishi-motors.com

Mitsubishi e-Yi concept showing the design language of near future

2.5 MITSUBISHI MOTORS

Mitsubishi Motors' history starts from a steamship company from 1870's. In 1917 Mitsubishi divided the shipbuilding division to a separate company and started to mass-produce passenger cars. The Model A was the first mass-produced car in Japan. In 1970 Mitsubishi started electric vehicle (EV) research and development. Mitsubishi was the first automaker to mass market an electric vehicle in the early 1970s. In the 1970s, Mitsubishi Motors started to compete in rally, which during the next 30 years, made them well-known globally. Lancer is one of the most known models, popularised by Mitsubishi's success in rally.

During its history, Mitsubishi Motors has researched more ecologically friendly driving. In 2008 it announced a new company policy to create vehicles designed to preserve and sustain environment. Since then Mitsubishi Motors has aimed to renew its line-up to hybrid and electric vehicles. In 2009 Mitsubishi launched fully electric hatchback i-MiEV followed by wide range of plug-in hybrid electric vehicles (PHEV). (mitsubishi-motors.com)

Mitsubishi Outlander PHEV

3 CONCEPT

commons.wikimedia.org

3.1 CONTEXT

The starting point in the design was to have an under four metres long small urban car that could fit four people comfortably but also have quite large space for luggage. Nowadays crossovers and SUVs are widely popular partly because of great visibility, driving comfort and feel of space inside the car. I wanted to bring those qualities to my concept without making it big and high. The concept vehicle is designed primarily for the European market, but since it's an urban vehicle it's also suitable for most urban areas outside of Europe.

The idea was to make the concept optimized primarily for city enviroment. In the near future, the traffic situation in most urban areas won't get much better which favours shorter and smaller vehicles. That is a good reason to reduce at least the average length of urban vehicles.

3.2 FORM AND STYLING

When I chose to brand the concept Mitsubishi, I decided to style it quite differently from the recent Mitsubishi design language. The current design language for the European market is quite complex and aggressive so I decided to simplify the overall design language and style to a more neutral form. The overall body shape started to form from an ordinary two box hatchback shape. During the ideation, the form started to change little by little to simpler one box shape. In the final design the body took shape somewhere between a traditional hatchback and minivan.

One of the main objectives in this project was to make the interior pleasant to be in. Nice lighting and visibility are important factors to make the interior feel more spacious and comfortable, so I wanted the body to have as much transparent surface as possible. I benchmarked a lot of already existing cars and concepts where I found Canoo car. The Canoo car has large surfaces of glass covering the exterior which lets lots of light in and improves the field of view from inside. That gave me the inspiration to have outer body surfaces made of glass from front to rear including front and rear panels, bonnet, windscreen, roof and rear window. I also extended the glass surfaces from the side windows a bit lower to make the interior feel more spacious. Since the concept has rear hub motors and the front space is empty, the glass bonnet and front panel also give a much wider view of the road to enhance road safety.

3.3 FUNCTIONALITY

The main function for the concept is to showcase different solutions and technologies that could be used in a small urban car in the near future. Some of the solutions introduced in the concept are already available nowadays but not used widely yet. I count to the fact that the current technologies will improve in the next ten years so that the functions will work better in this concept's case.

More advanced driving assist systems and autonomous vehicles are set to become more common in the coming decade. In the concept vehicle, I wanted to explore the possibility to combine level 3 autonomy with less advanced driving assist system where the human driver must be involved. I didn't research the technical execution very accurately but in 2030 the technology could be improved to the stage where sensors and possible lidars could be located but not seen from outside. The idea was to implement the level 3 autonomy in rural roads where there is less traffic and simpler infrastructure. When approaching urban areas, the concept would alert the driver from a good distance before the transition and make the switch from level 3 to a level 2 autonomy little by little. Driving in cities would be the human driver's responsibility with level 2 autonomy helping.

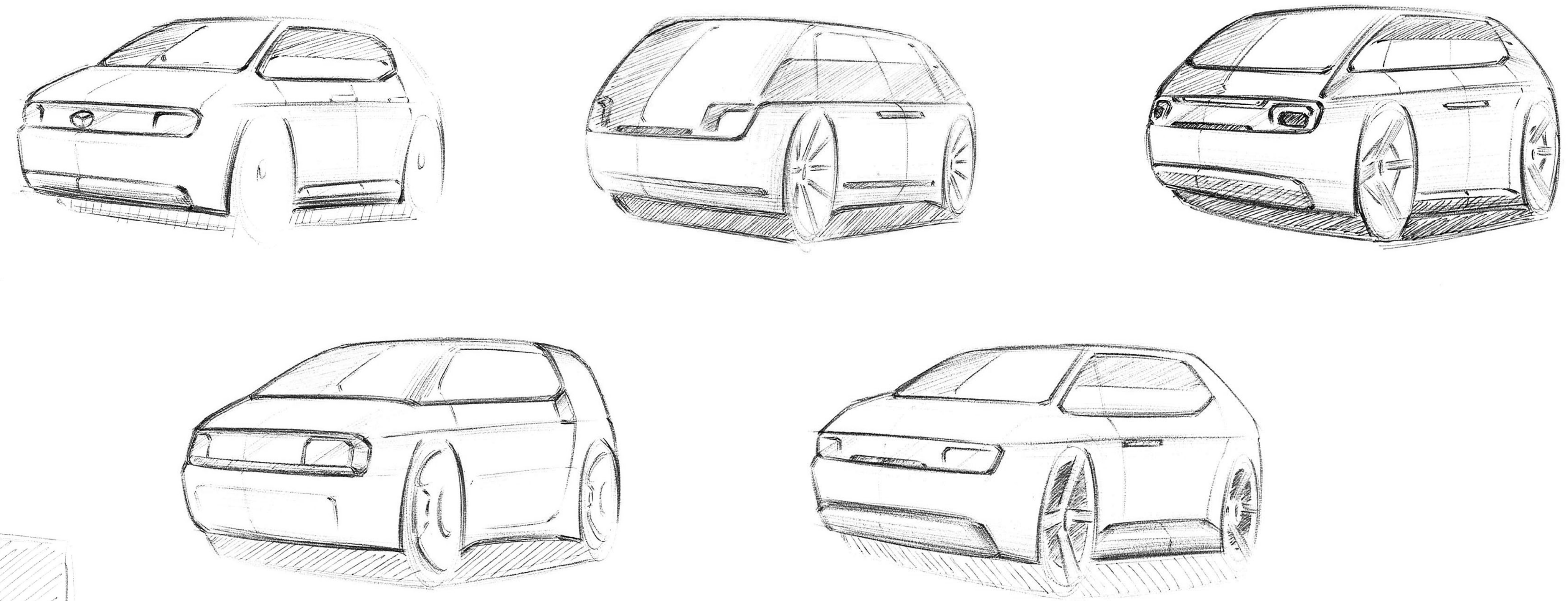
The concept vehicle is driven by two electric hub motors located in the rear wheels, which changes the whole layout. The location of the hub motors frees space from the front end where the main luggage space is located. Because of the body shape, the bonnet and windscreen are in the same panel. That resulted in an arrangement where the whole panel opens to get to the luggage. In fact, the concept isn't pure hatchback since it has hatches both in front and back.

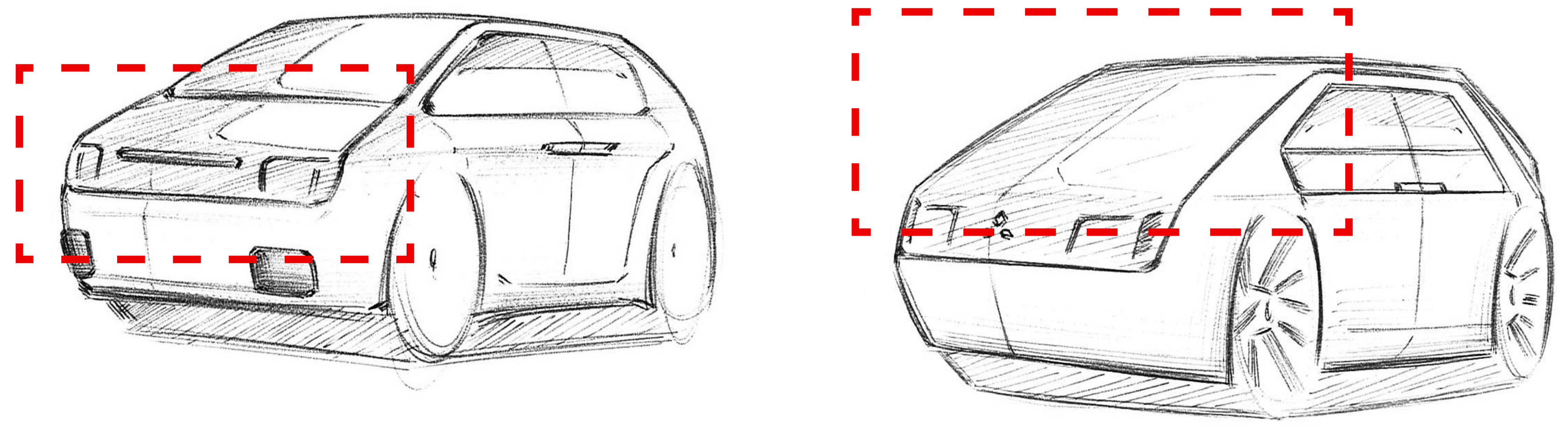
One of the key features was to include advanced smart windows to improve the transformability. Since the plan was to have large surface areas of glass, the possibility to dim the windows when the vehicle is unguarded, was necessary for safety reasons. The smart glass technology is presumably going to develop in the next 10 years, so I assumed it would be possible to include some features from transparent displays.

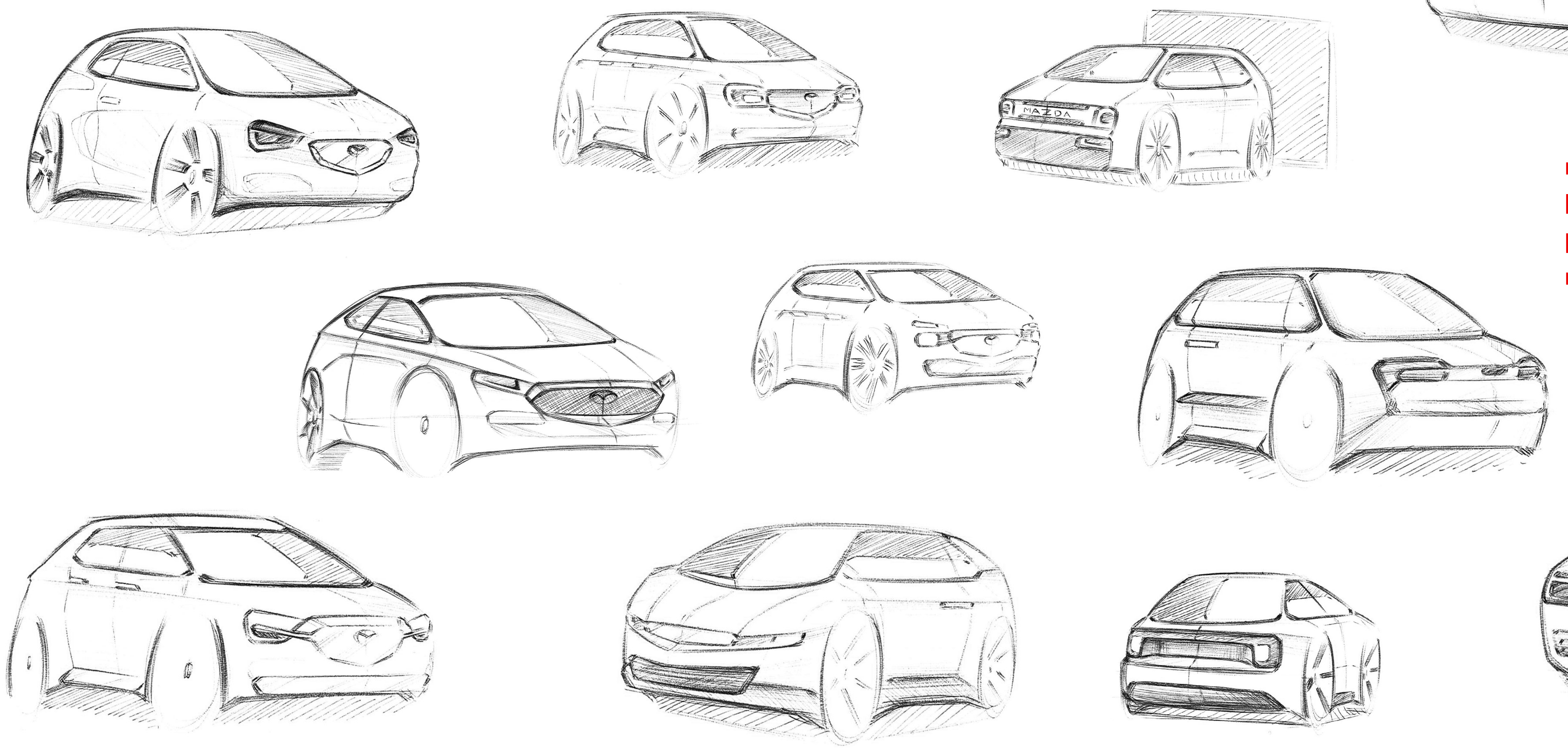
4 SKETCHING

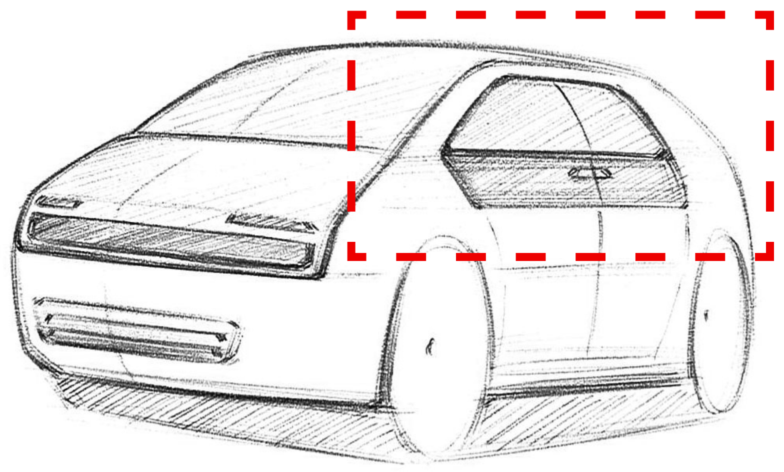
4.1 IDEATION

I started the ideation from sketching lots of small cars and hatchbacks. At the start of sketching I hadn't chosen Mitsubishi as the brand, so I sketched broadly from different shapes and forms. There were a few key elements I found from these sketches, although I was quite lost some time with the direction where the design was heading.







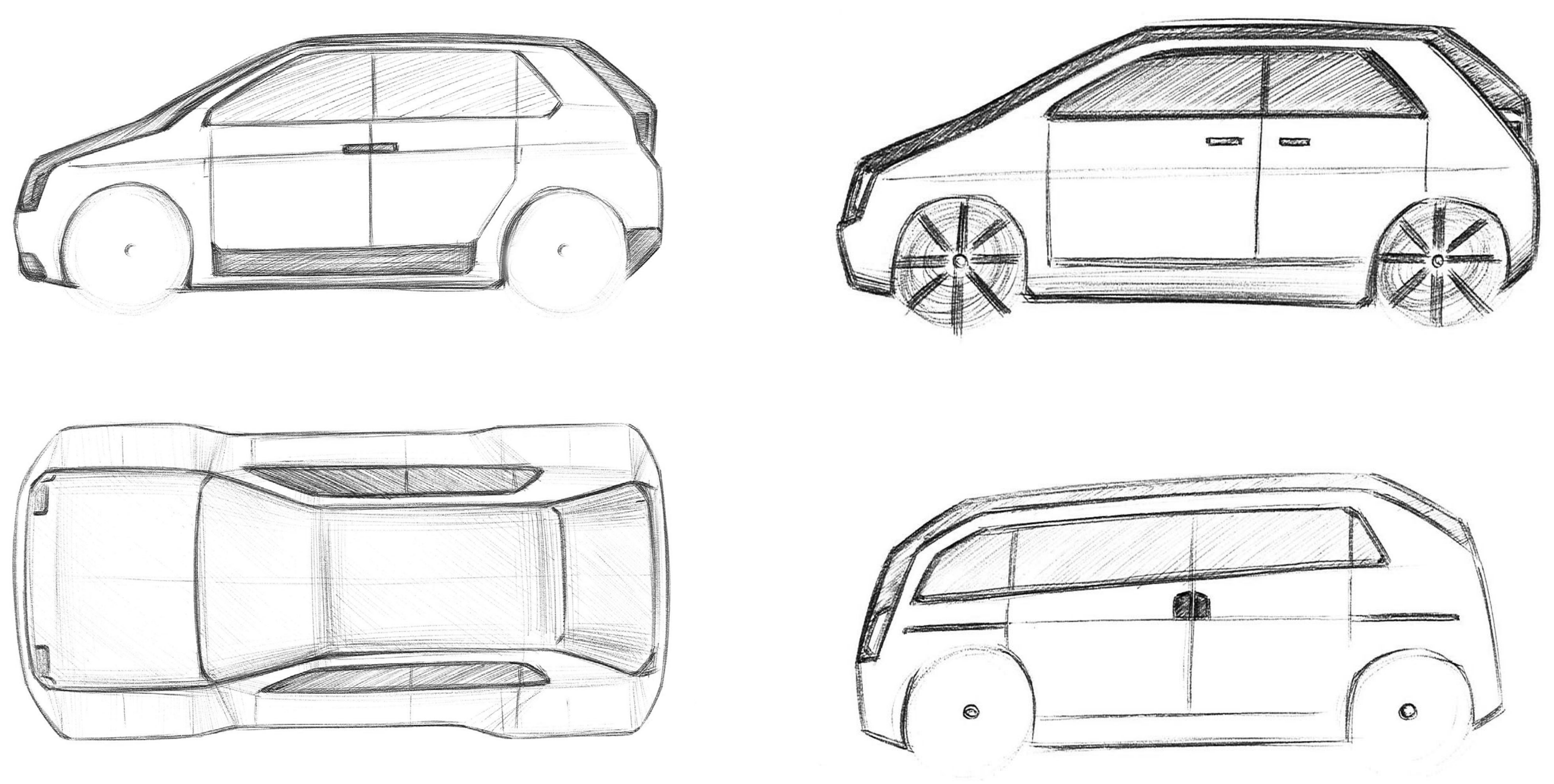


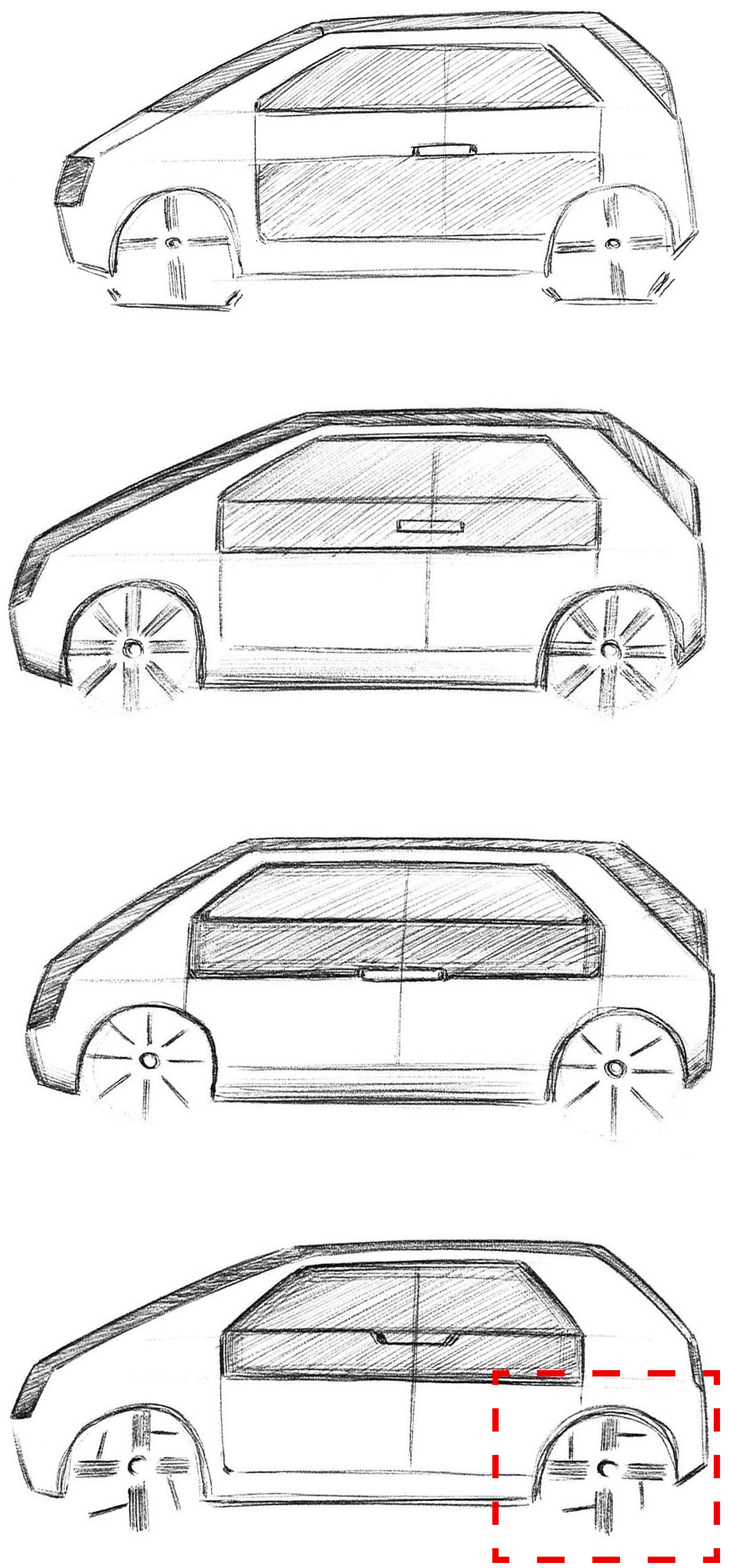
Key elements
The overall form began to take shape to a simpler direction. A few key elements stood out for development.

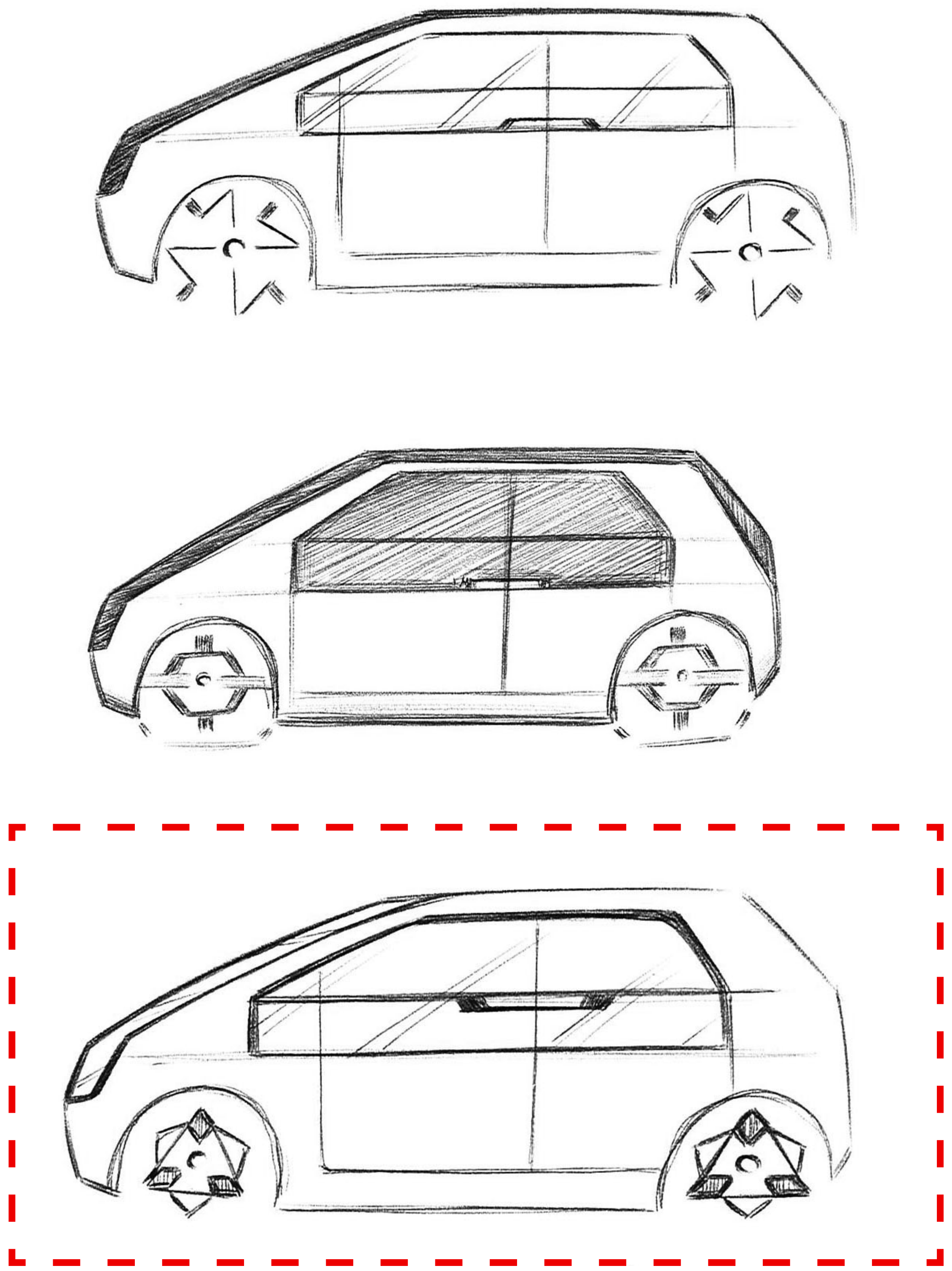
4.2 IDEA DEVELOPMENT

The design started to take shape bit by bit until it reached a quite simple one box shape. The bonnet and windscreen started to merge as well as the side windows started to extend lower. I tried the side look with several different pillar tilts to find out the optimal balance of the design. The rear end also changed to look more spacious to fit grown up rear passengers.Four horizontal lines also became a permanent element to stabilize the form.

The wheel design also started to take shape. The amount of spokes reduced, but they became more detailed.



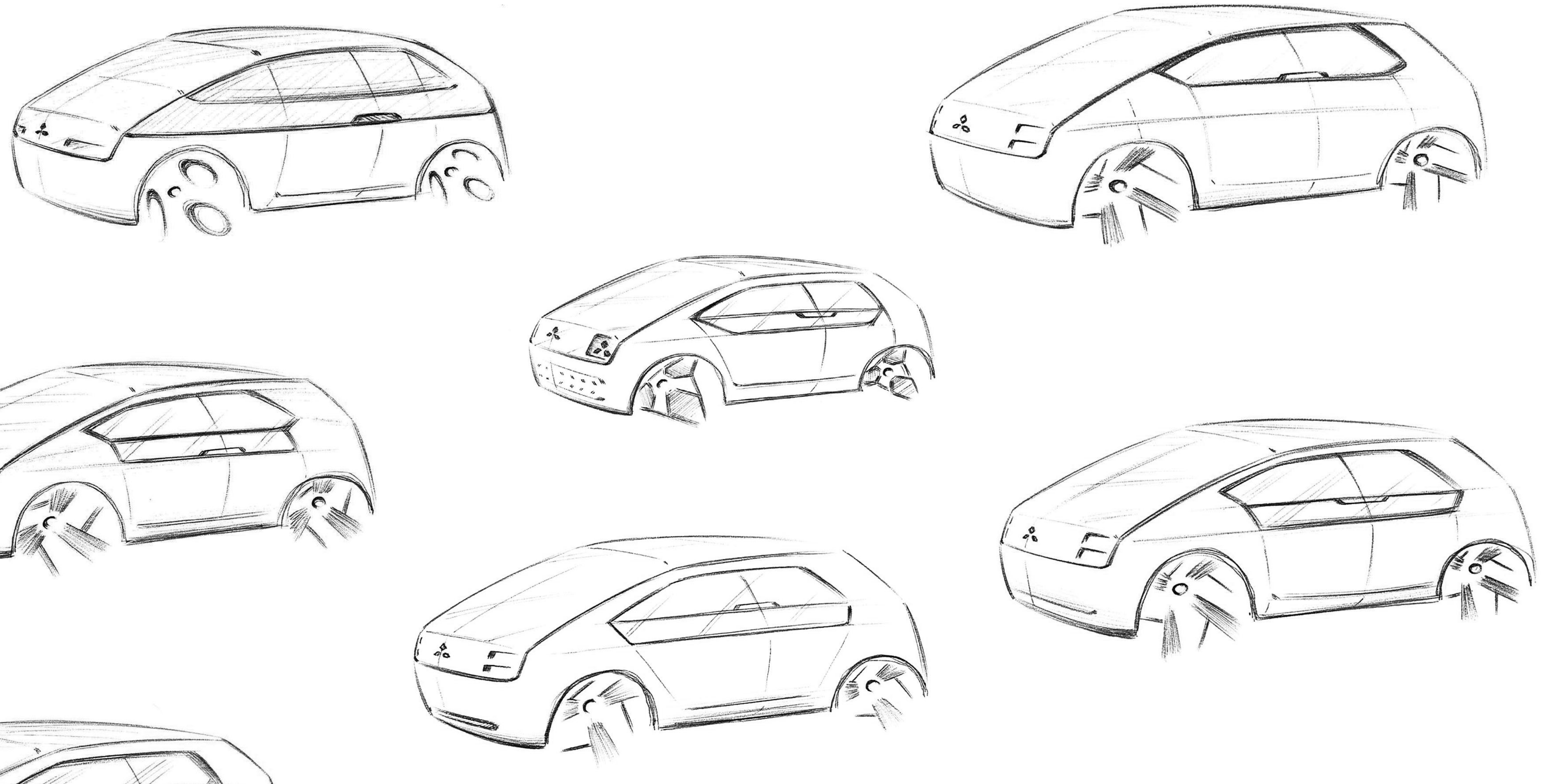


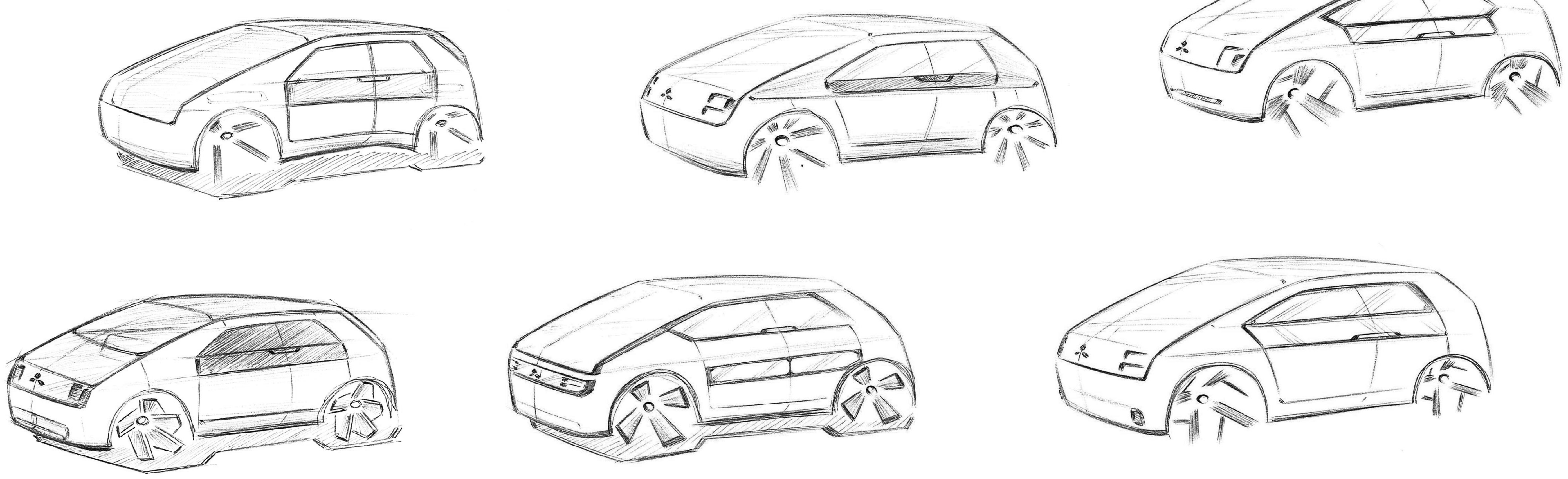


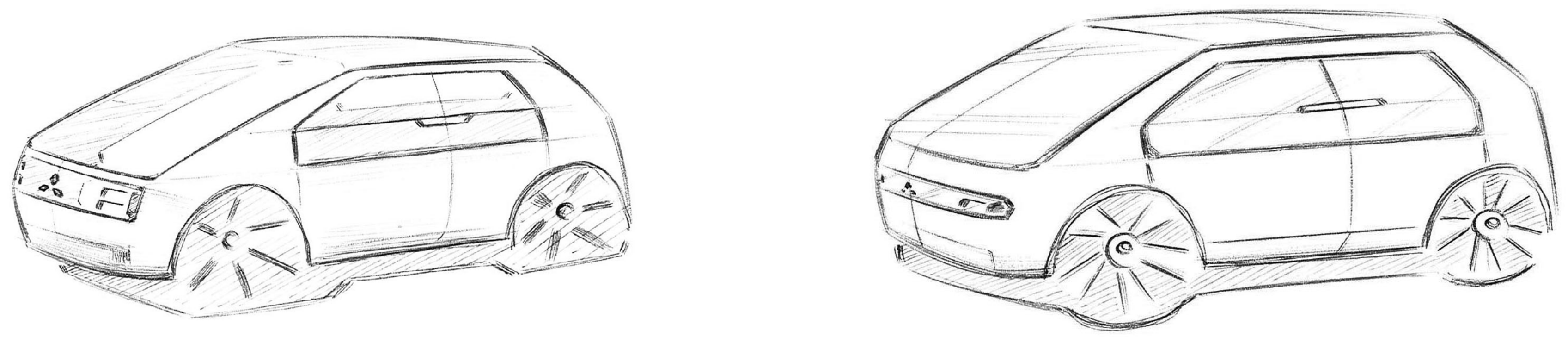
Key sketches
Body angles and window placements found their form. The direction of wheel design became clearer.

4.3 IDEA REFINEMENT

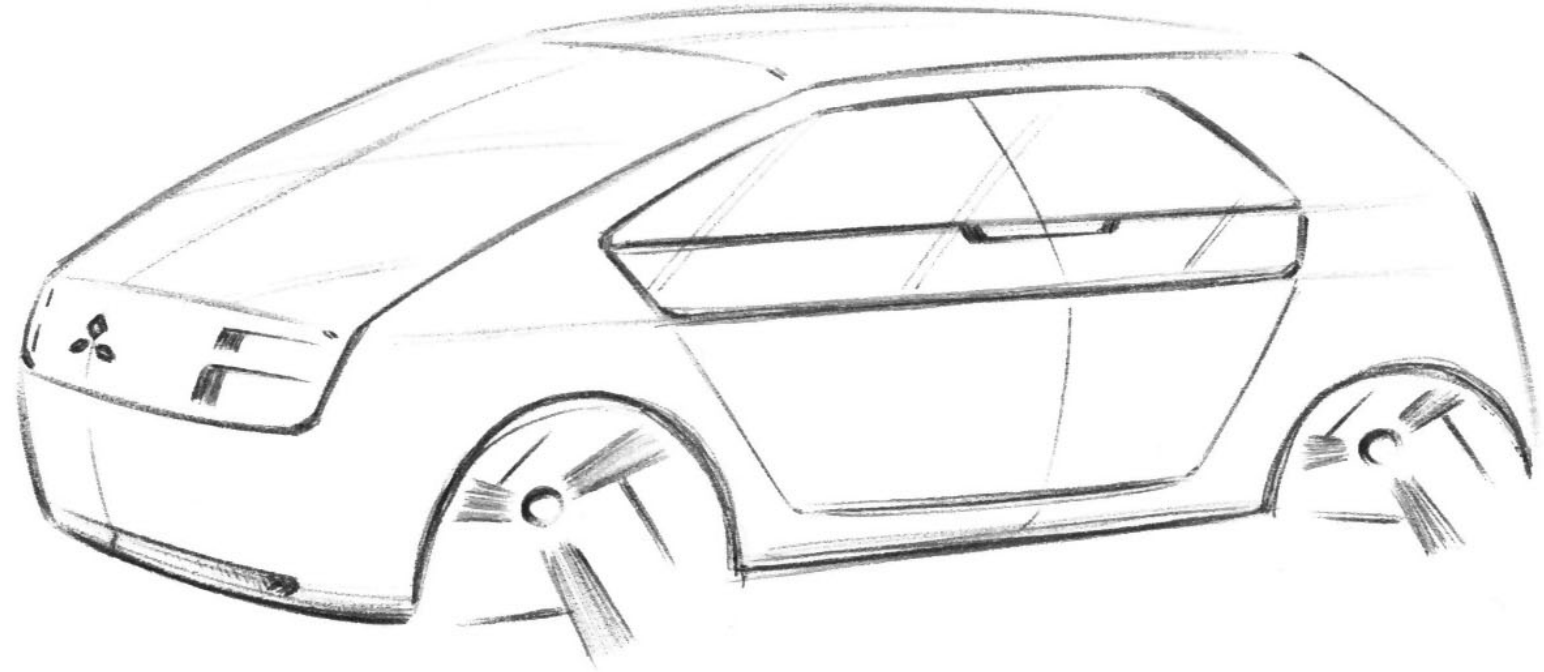
As the body form became established, the window graphics and details needed to be designed. The final shapes and proportions began to clarify, basic details started to form, and the main body seams found their places.





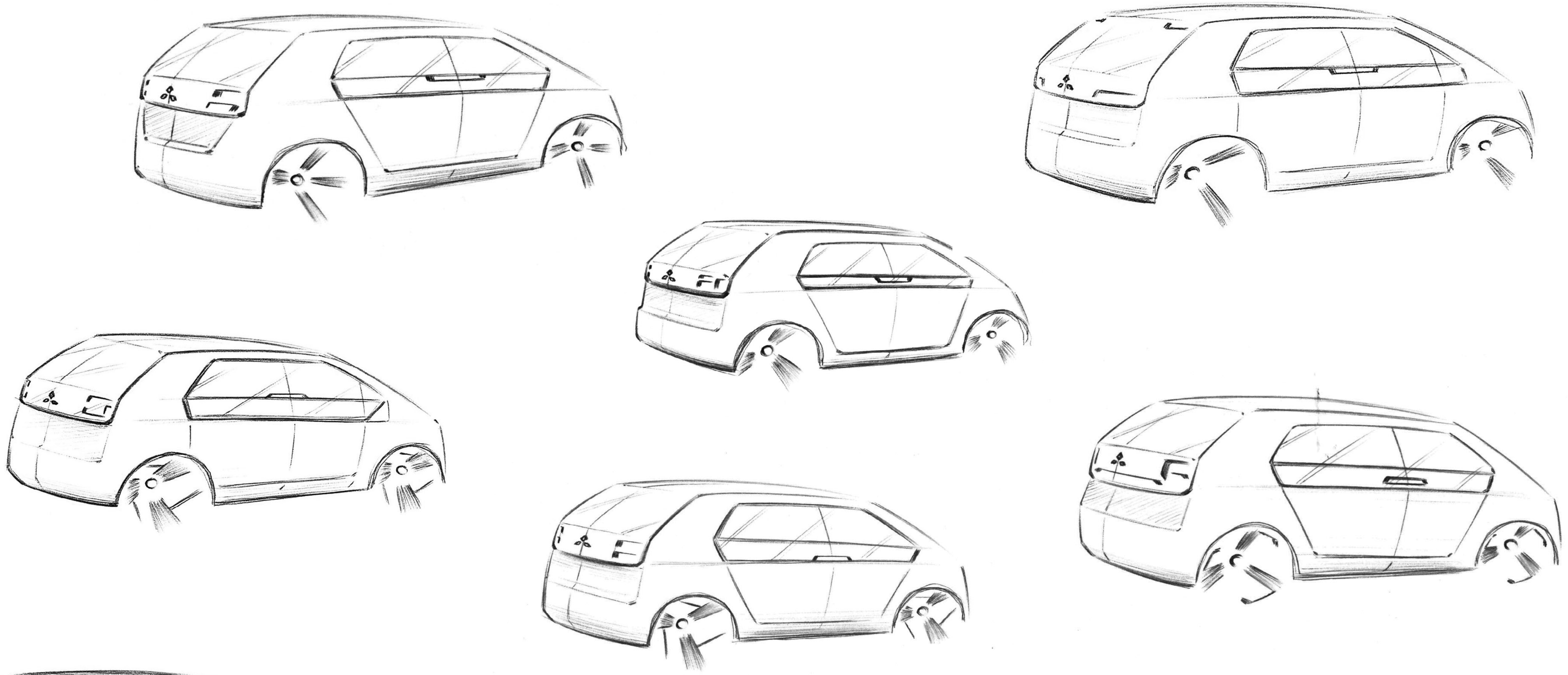


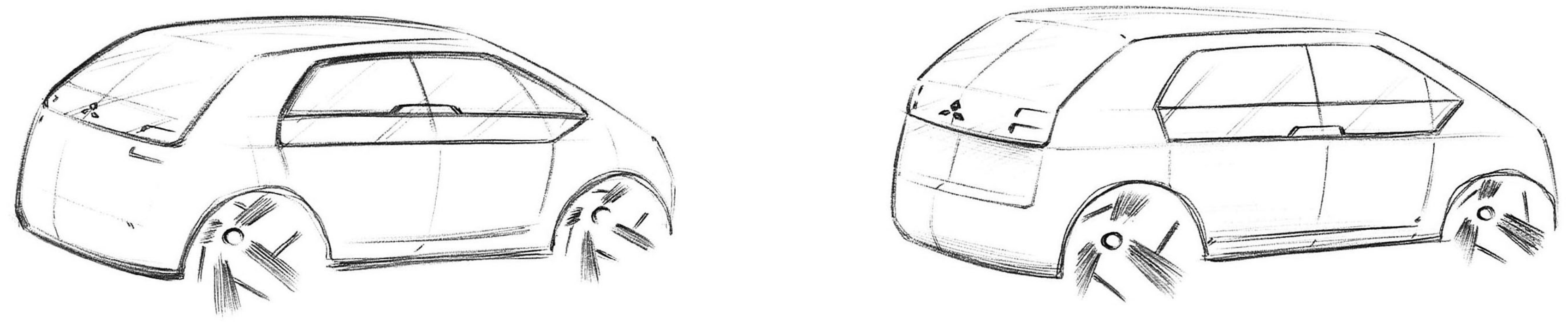
Key sketch
This is the sketch that the final design is based on from in front.

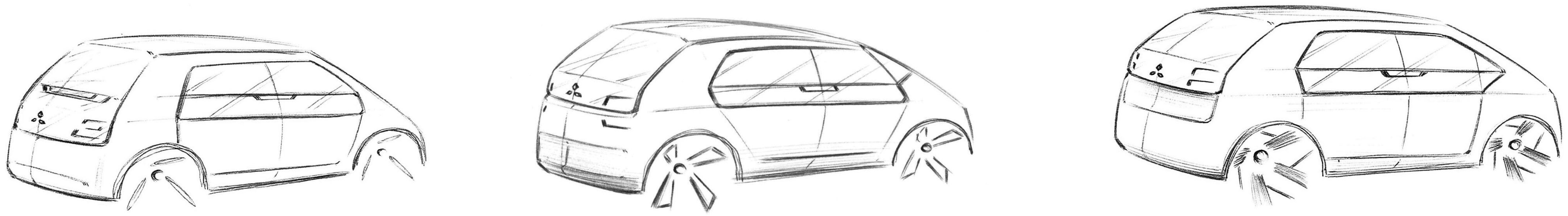


4.3 IDEA REFINEMENT

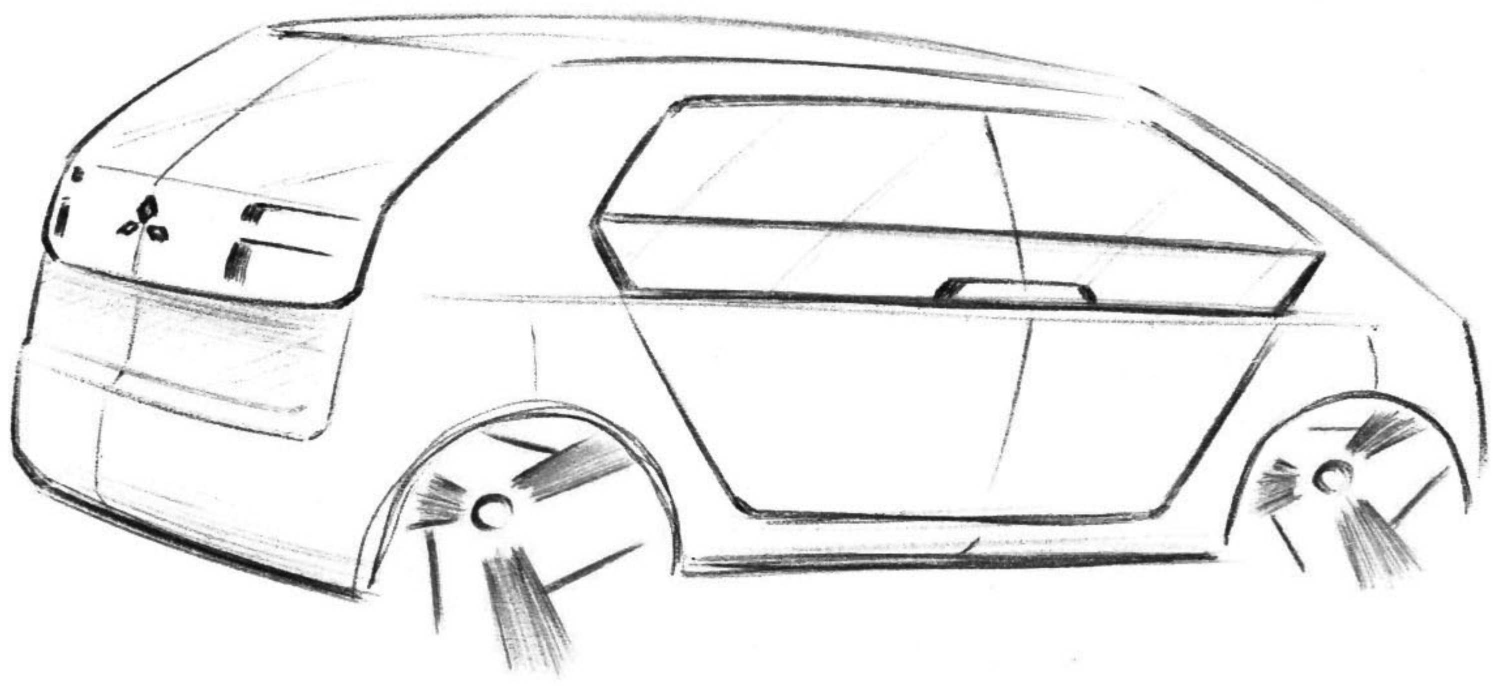
After freezing the design from the front and side, I sketched the rear end to match the frozen front end design. I wanted to keep it as simple as the rest of the car so the task at this point was to make the design language consistent thoroughout.



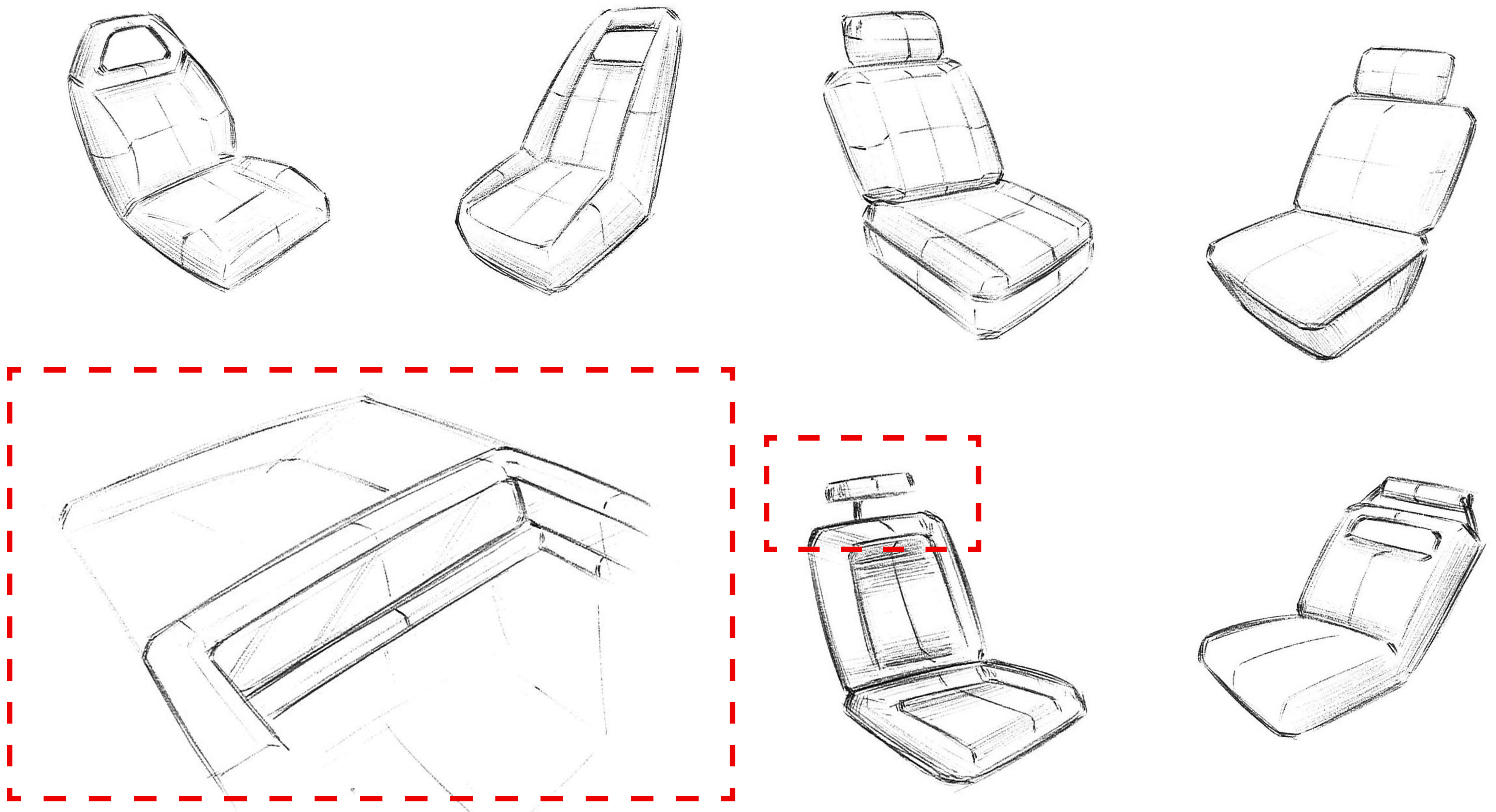




Key sketch
This is the sketch that the rear end is based on in the final design.

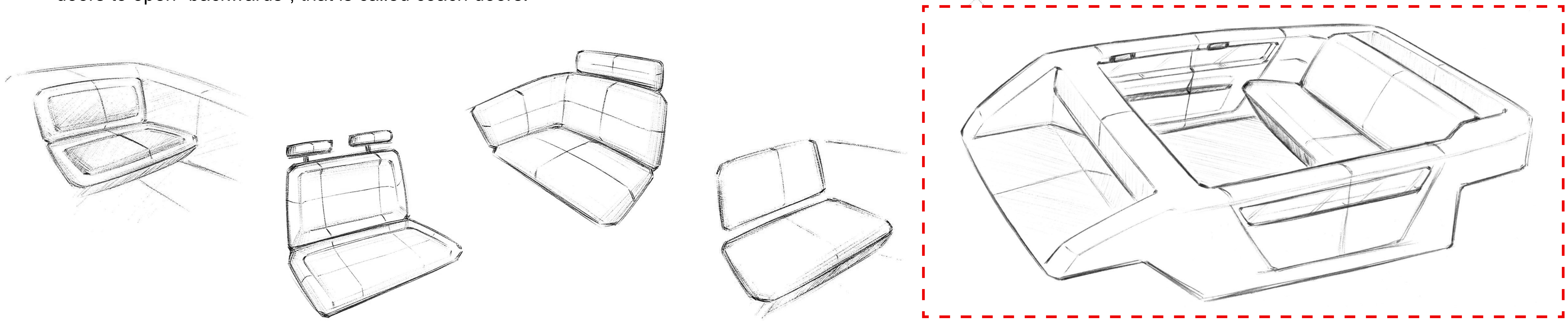


4.4 INTERIOR



The interior began to form from the exterior lines and window graphics. There were a few key elements that needed to be implemented to merge the interior to the exterior. As the bonnet and windscreen are the in the same opening panel, I wanted to highlight the light between the front luggage space and interior. The dashboard and other interior panels are designed to feel that both luggage spaces are in the same space as the cabin. The lower side windows needed to merge to the interior design which affected the door boards.

Losing the B-pillar between front and rear doors was an important element to make the entry inside the vehicle more pleasant. That influenced the doors to open “backwards”, that is called coach doors.



5 MODELING

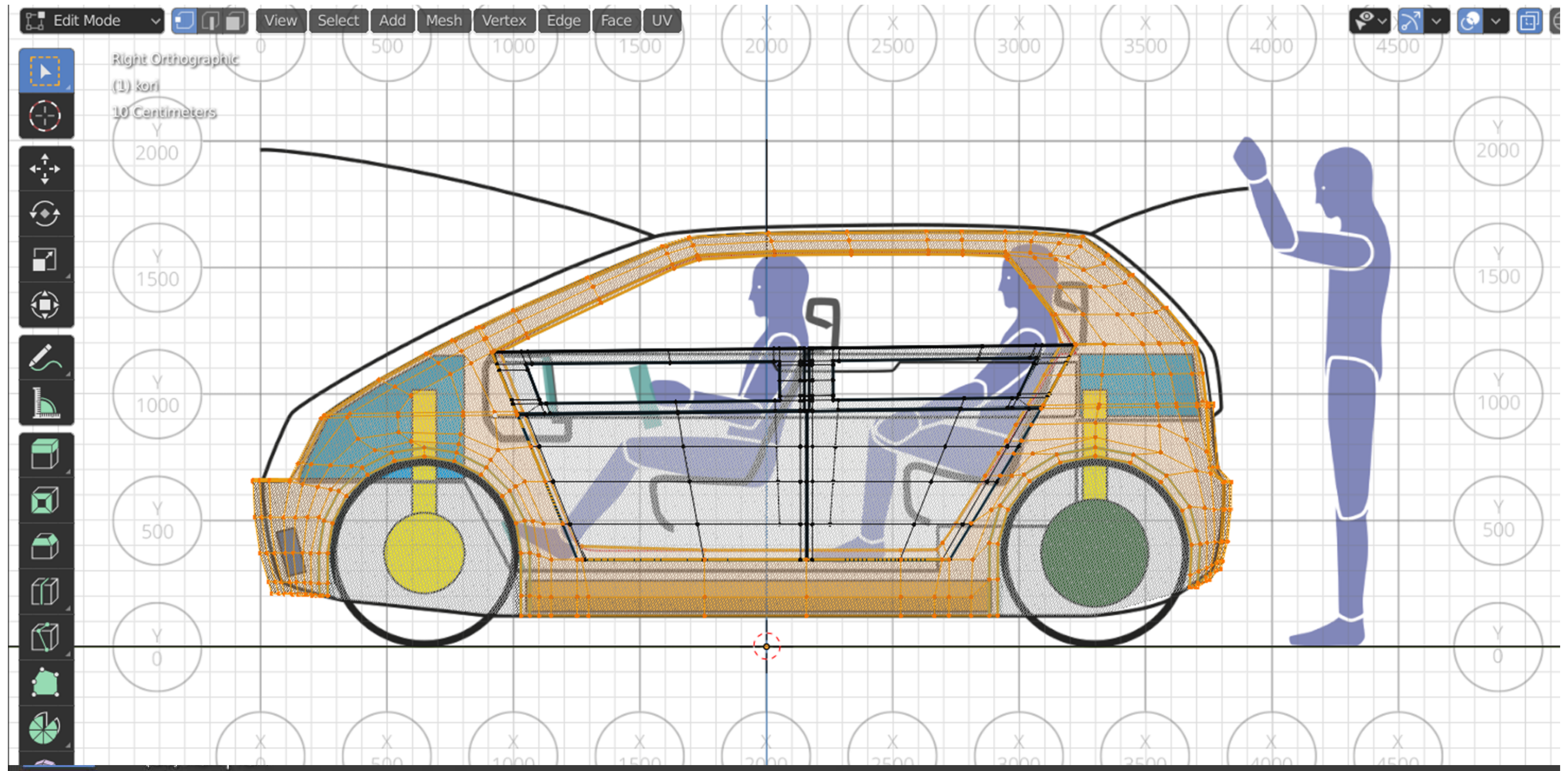

Edit Mode
View
Select
Add
Mesh
Vertex
Edge
Face
UV
Global
Options
User Orthographic
Battery Packs
Luggage Space
Battery Cooling System
Controls
97.5% male
Vehicle Dimensions
Length: 3700 mm
Width: 1800 mm
Height: 1700 mm

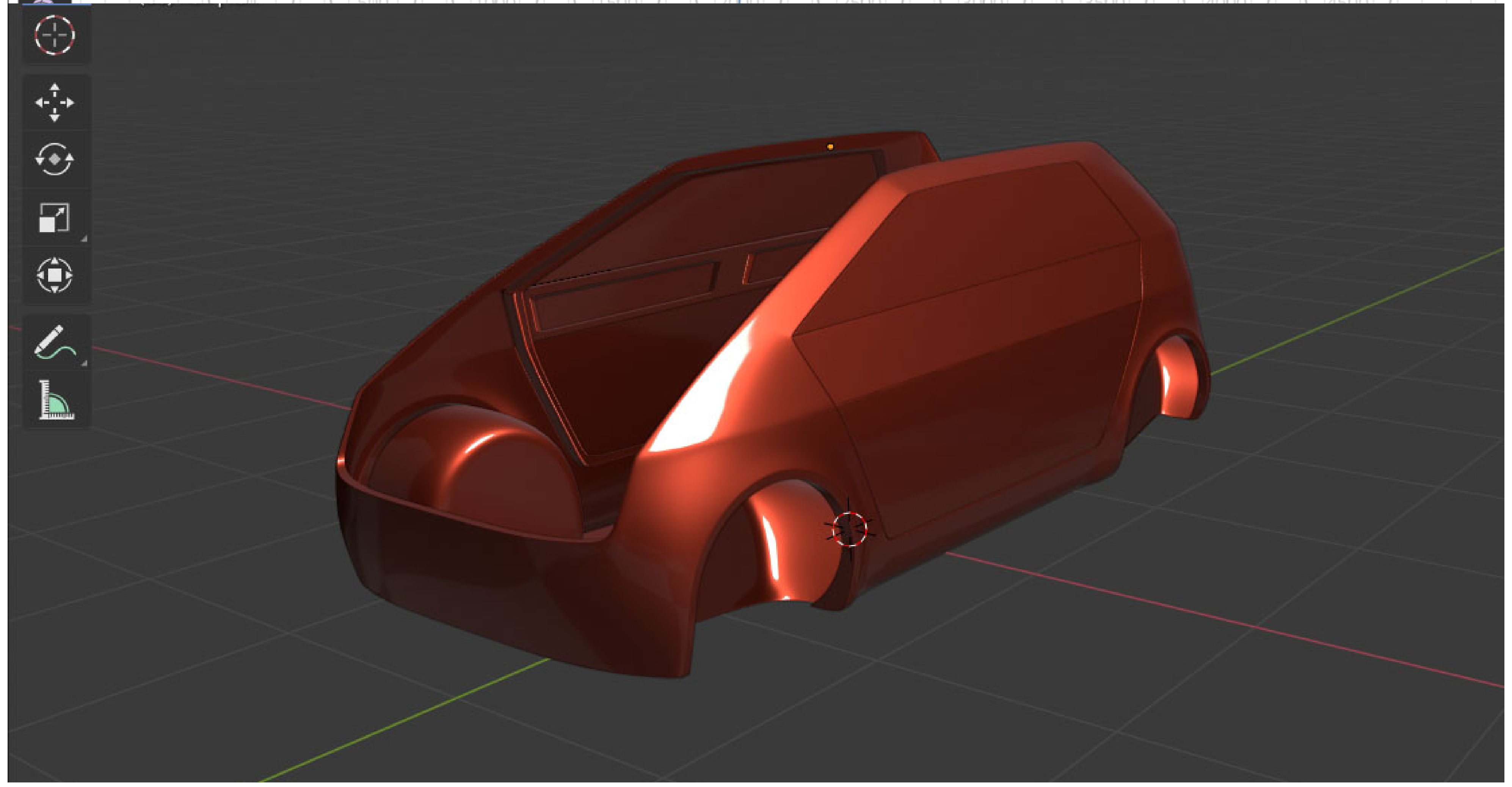
5.1 PROPORTIONS AND SURFACES

When starting to prepare for the graduation project, I set myself a goal to learn modeling a car in 3D. Since I had some experience from Blender, I chose to model the vehicle there to reach the target by the deadline. Because Blender is a polygon-based 3D software, it was an effective choice to make more informative sketch model first after sketching (Meadows 2018, 154).

I started the modeling in Blender with tentative package drawings I had made based on the frozen design sketch. The package drawings were quite accurately sized which made proportioning the main outlines fairly clear in 3D.

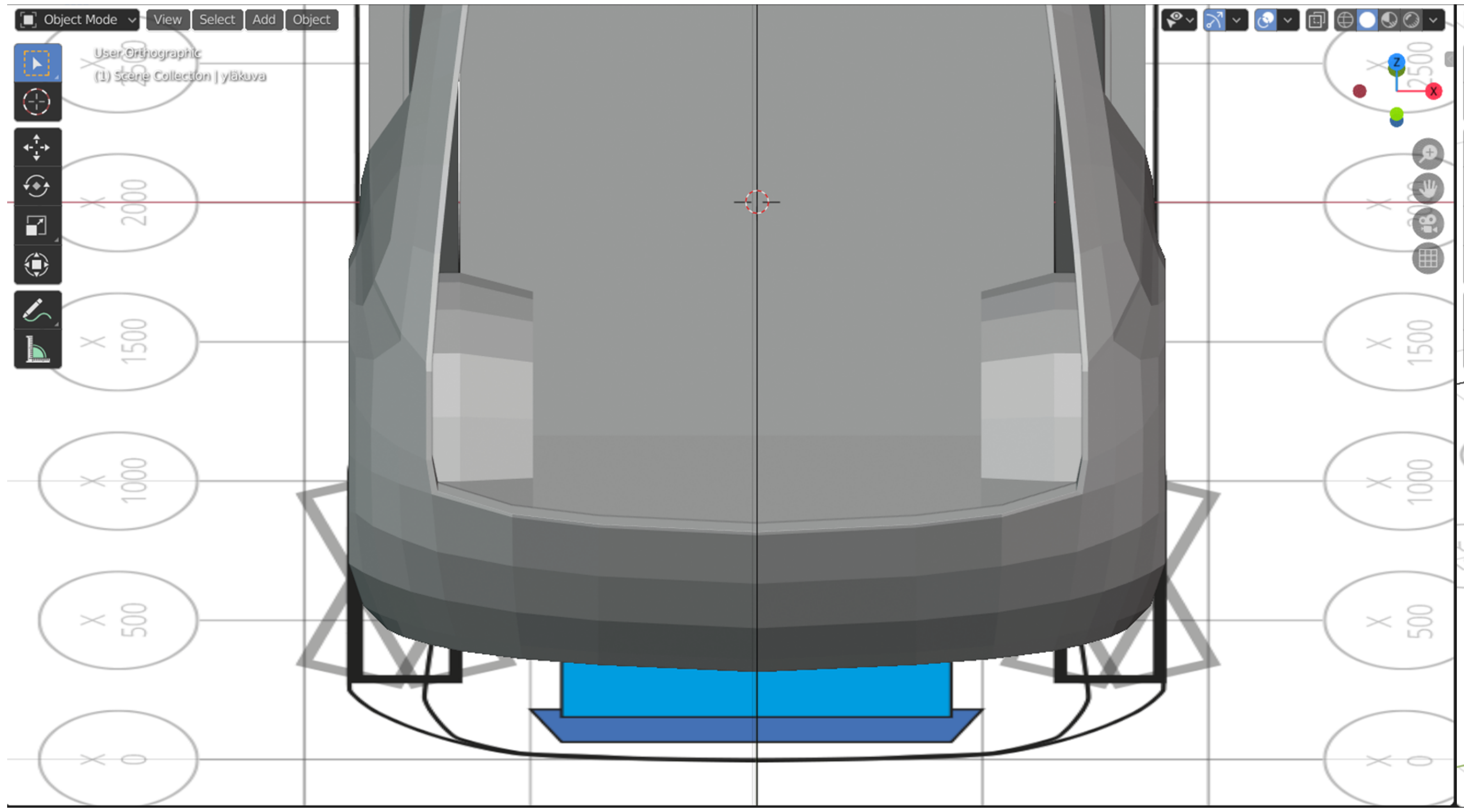
As this was my first car design project where I used Blender as modeling tool, I had some difficulties to construct a clean mesh to achieve smooth surfaces. With the advice of online tutorials and fellow students, I found a way to get the proportions and surfaces looking good. I used a car paint material capture (matcap) when building the exterior surfaces to check light reflections.

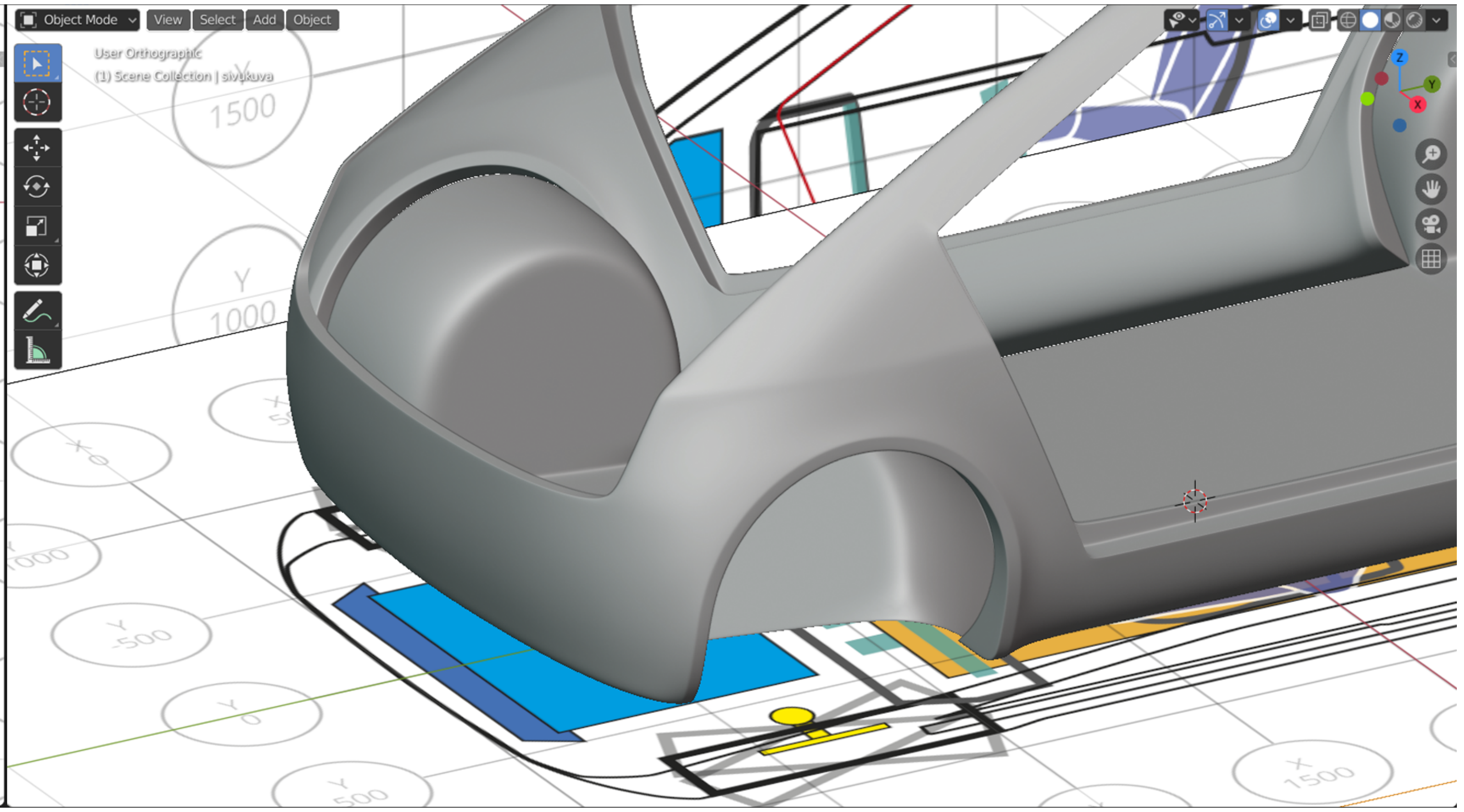




5.2 FRONT

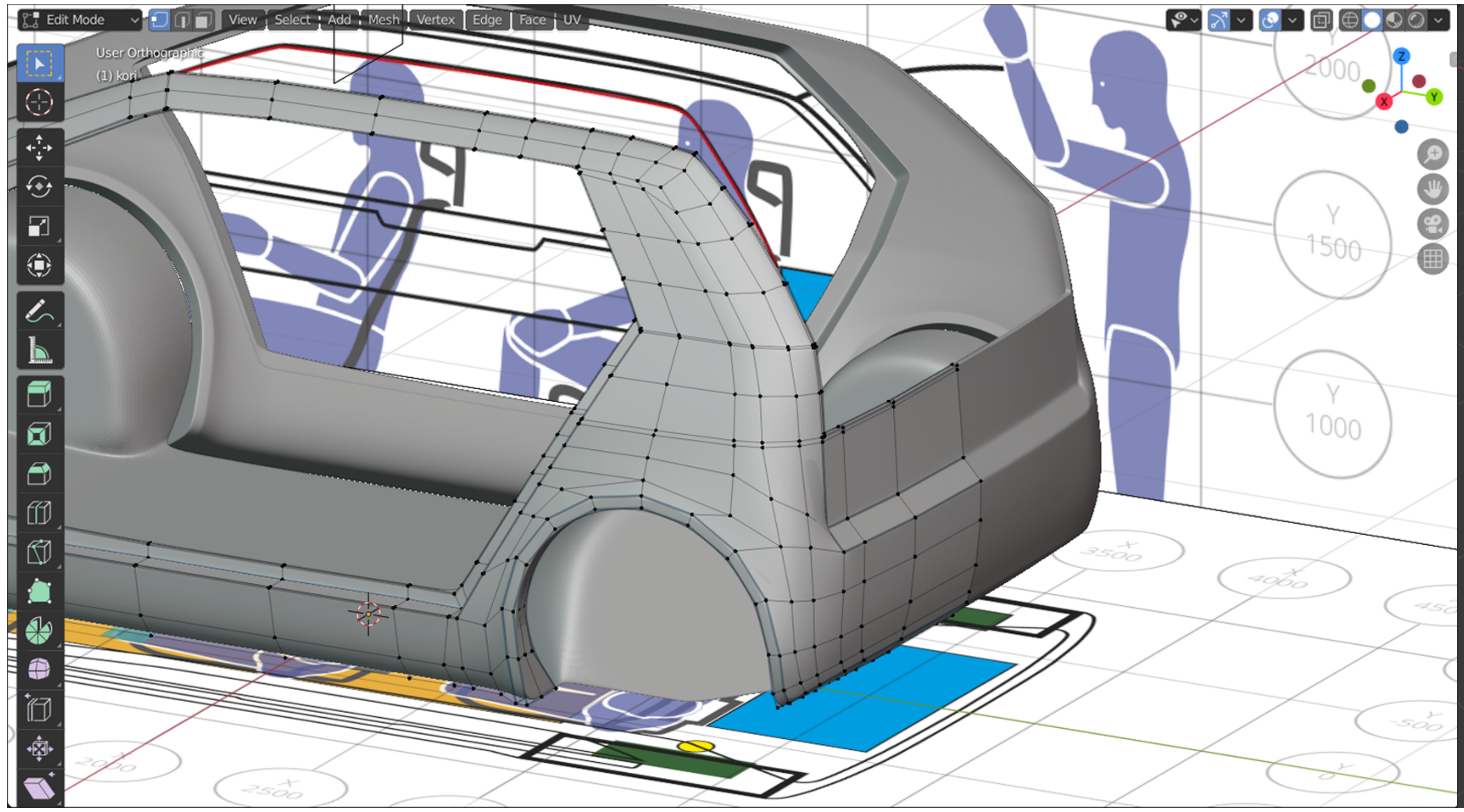
Forming the front of the body started from the wheel arches. As the bonnet and windscreen go up as one big surface, it leaves a triangle area between the bonnet and side windows. That made constructing the mesh quite problematic in front and took a lot of work to be solved.

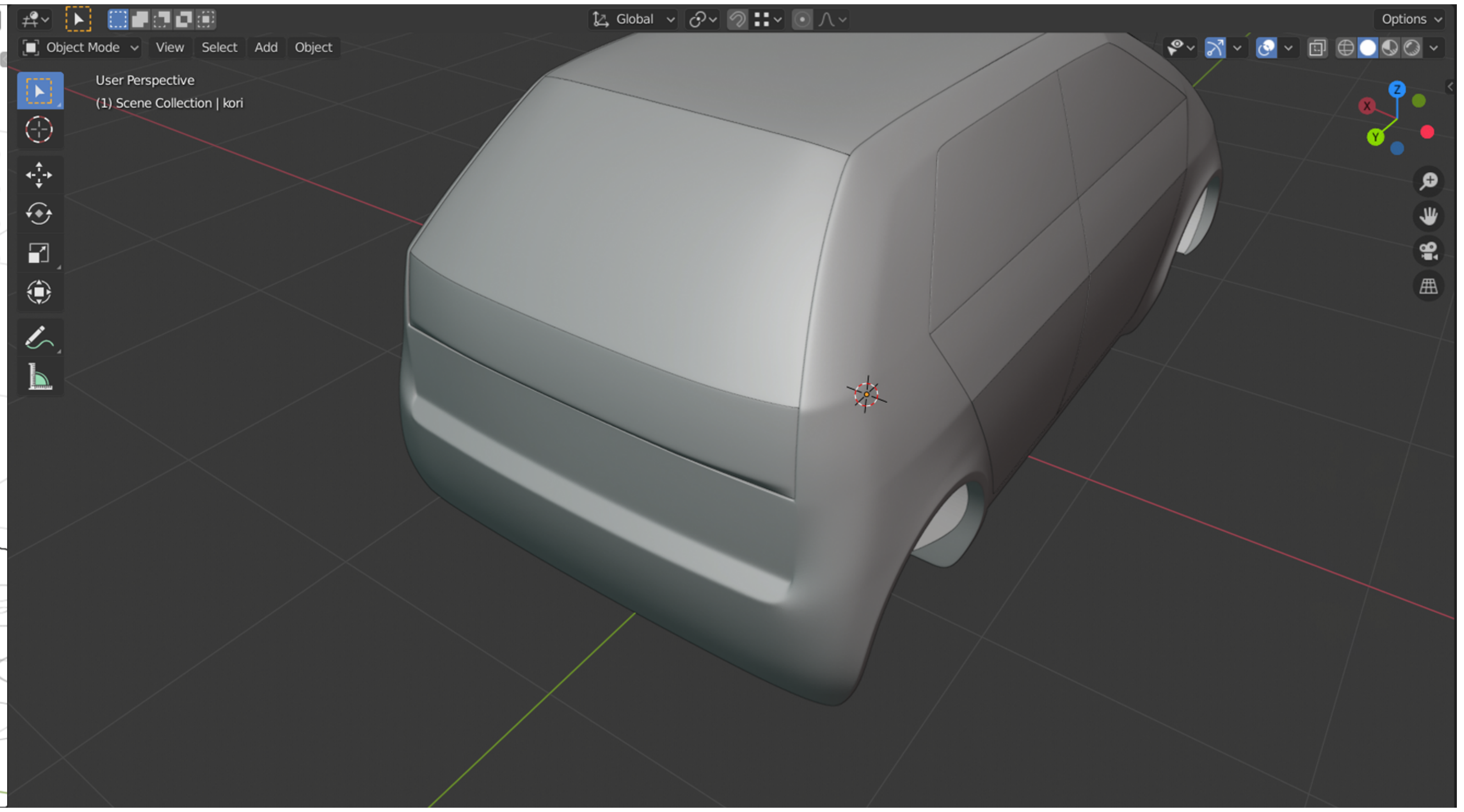




5.3 REAR

The most important element in the rear end is the inset between the rear glass panel and rear bumper. Making it look identical to the sketches turned up to be challenging because of the short rear overhang. The actual place of the rear wheel arches modified the rear end a bit, making it look quite different from the key sketch.



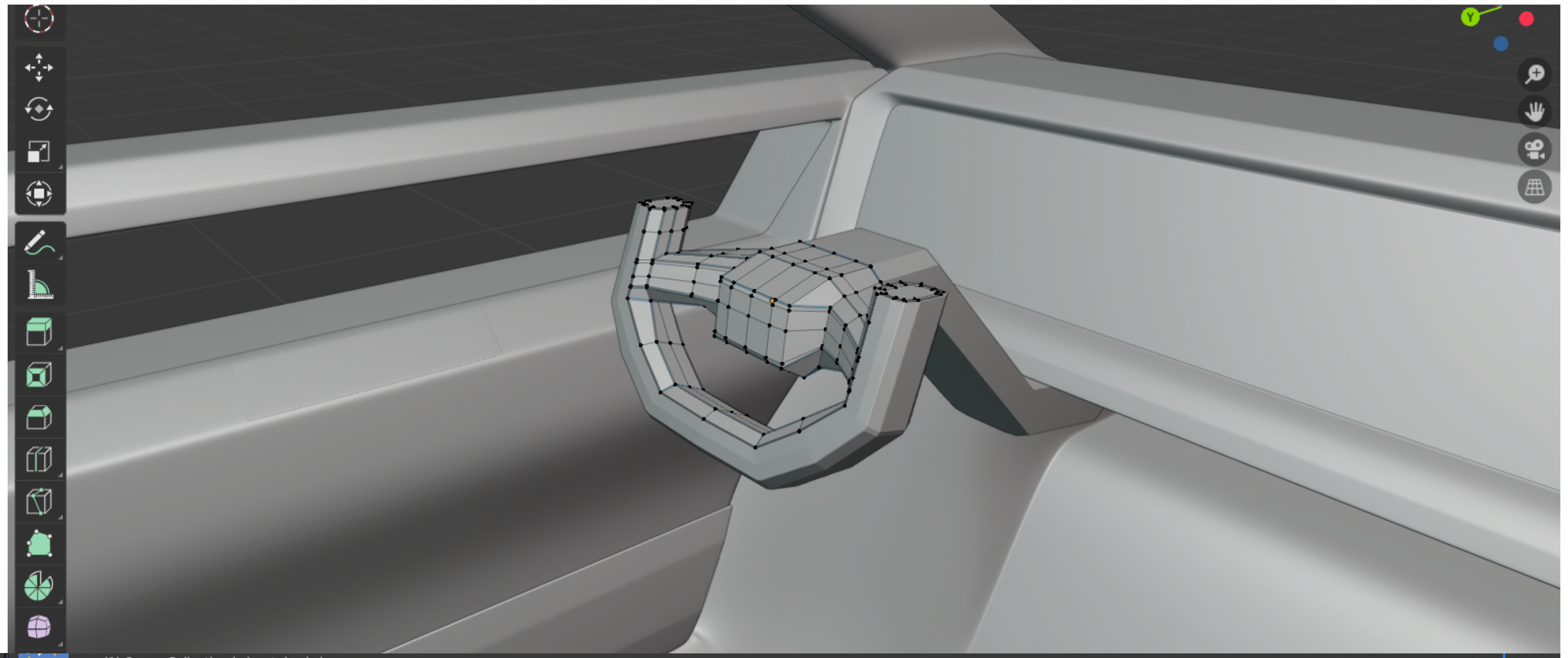


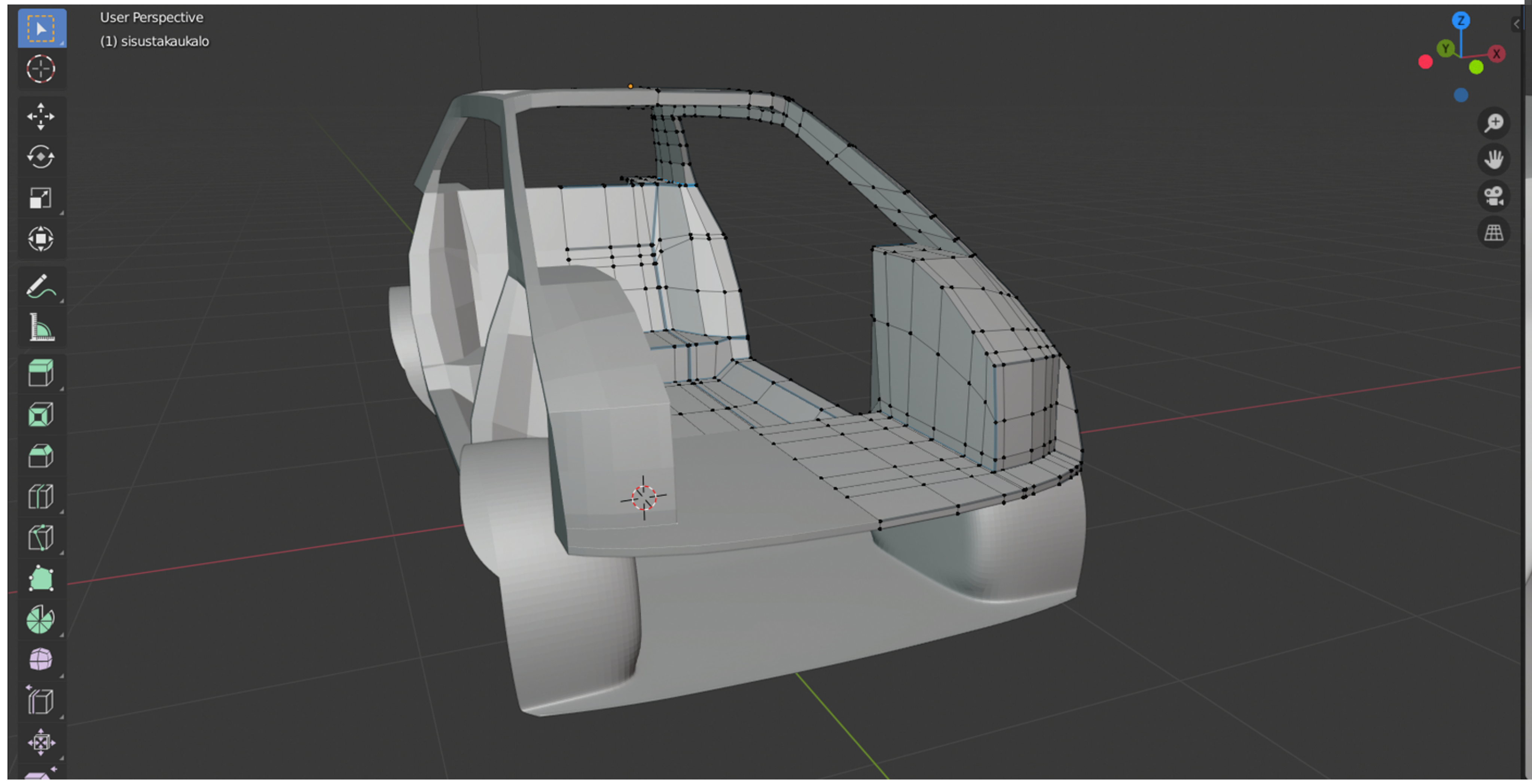
5.4 INTERIOR

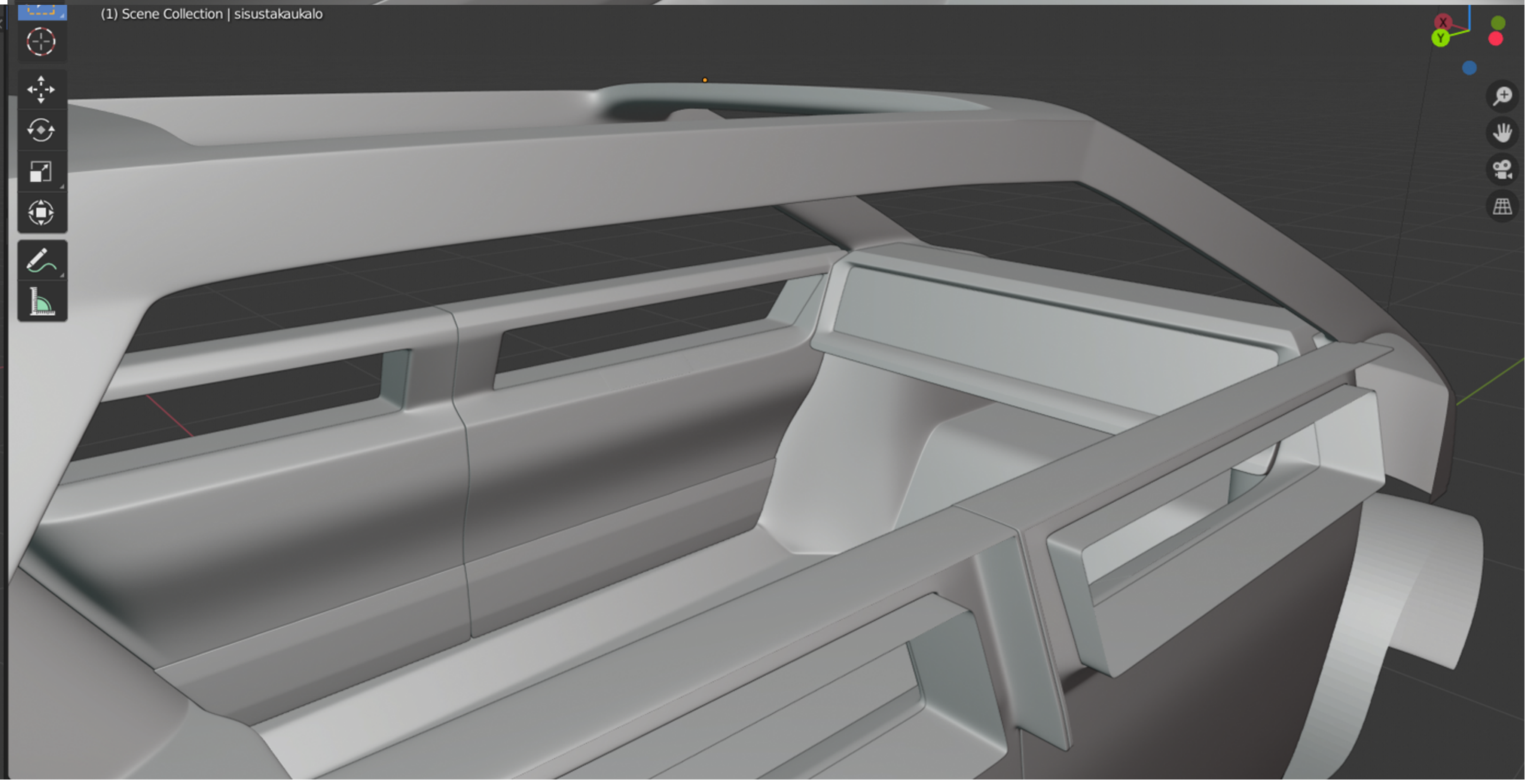
I started the interior modeling from the outer panels which unite to the exterior panels. It defined the external interior dimensions which with the help of package drawings helped to find the correct places for all interior elements.

The main design element in the interior was to align the lower horizontal side window line to the dashboard screen.

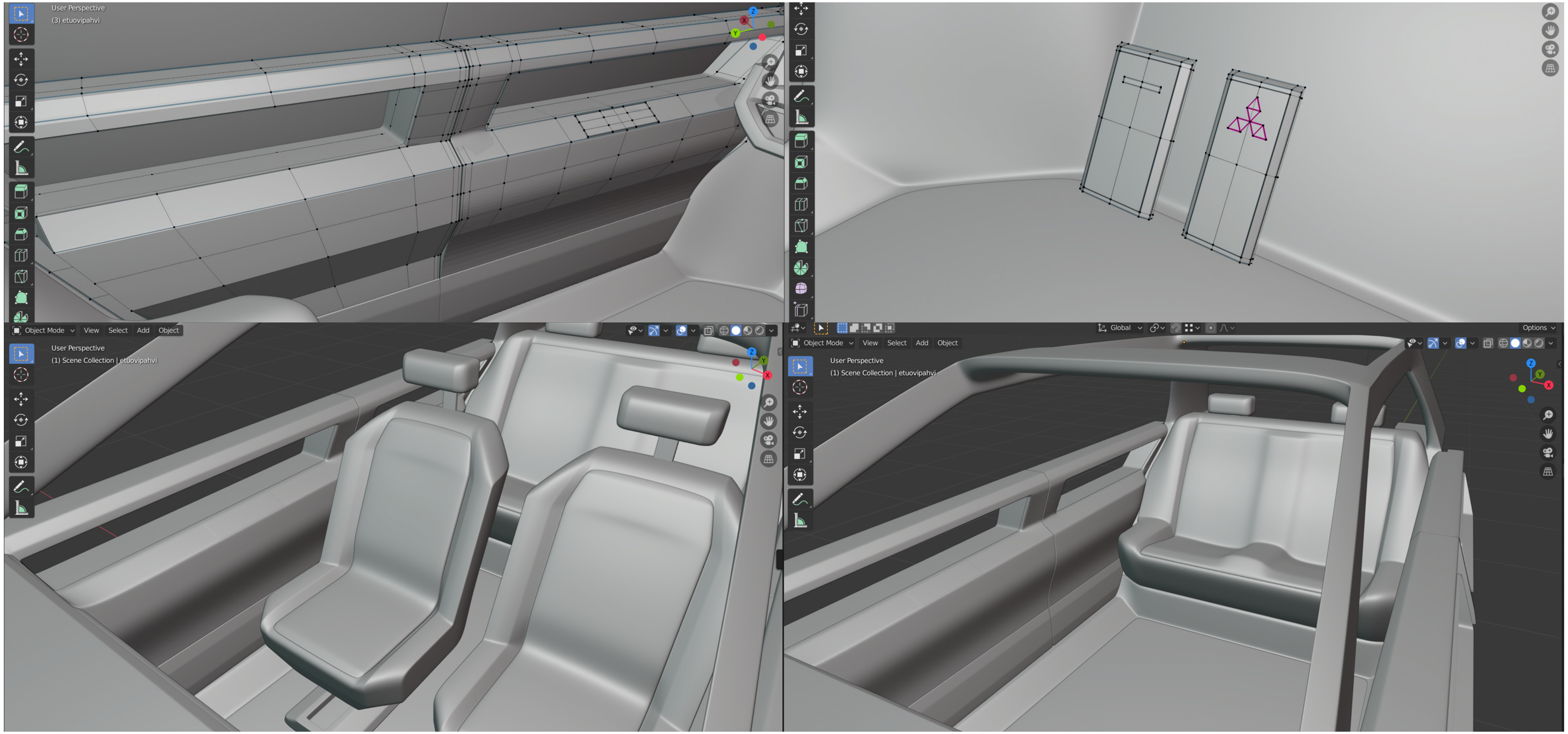
The steering wheel is designed to fold back when entering the autonomous mode. As I didn’t want the dashboard to be large, I made the steering wheel small and light so it wouldn’t require much space to hide.





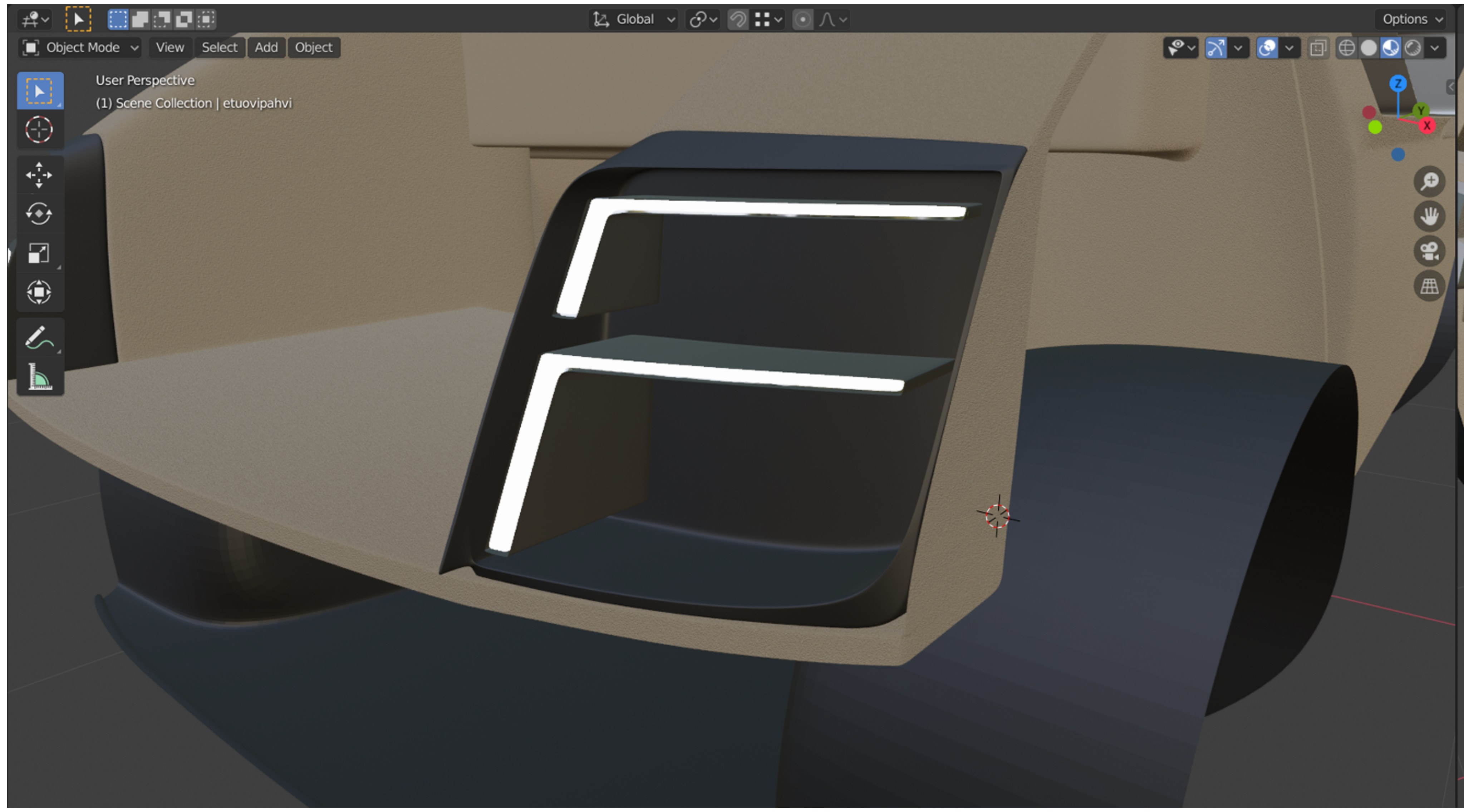


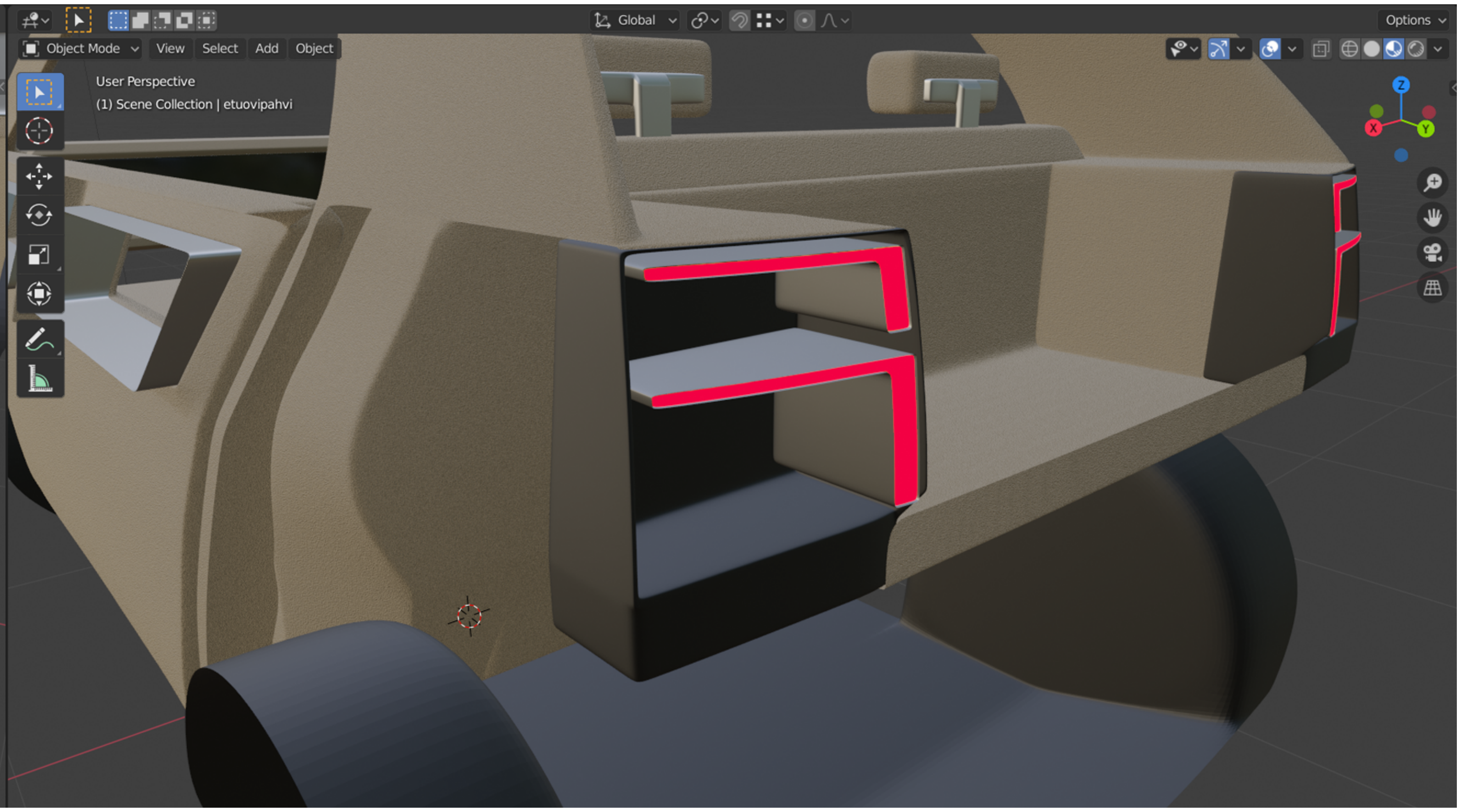
5.4 INTERIOR


User Perspective
(3) etuovipahvi
Object Mode
View
Select
Add
Object
User Perspective
(1) Scene Collection | etuovipahvi
Global
Options
Object Mode
View
Select
Add
Object
User Perspective
(1) Scene Collection | etuovipahvi

5.5 LIGHTS

In the lights I wanted to preserve something from the current Mitsubishi design philosophy. Like in the current design philosophy, the lamp layout is separated to daytime light and turning signal on top and headlight below.





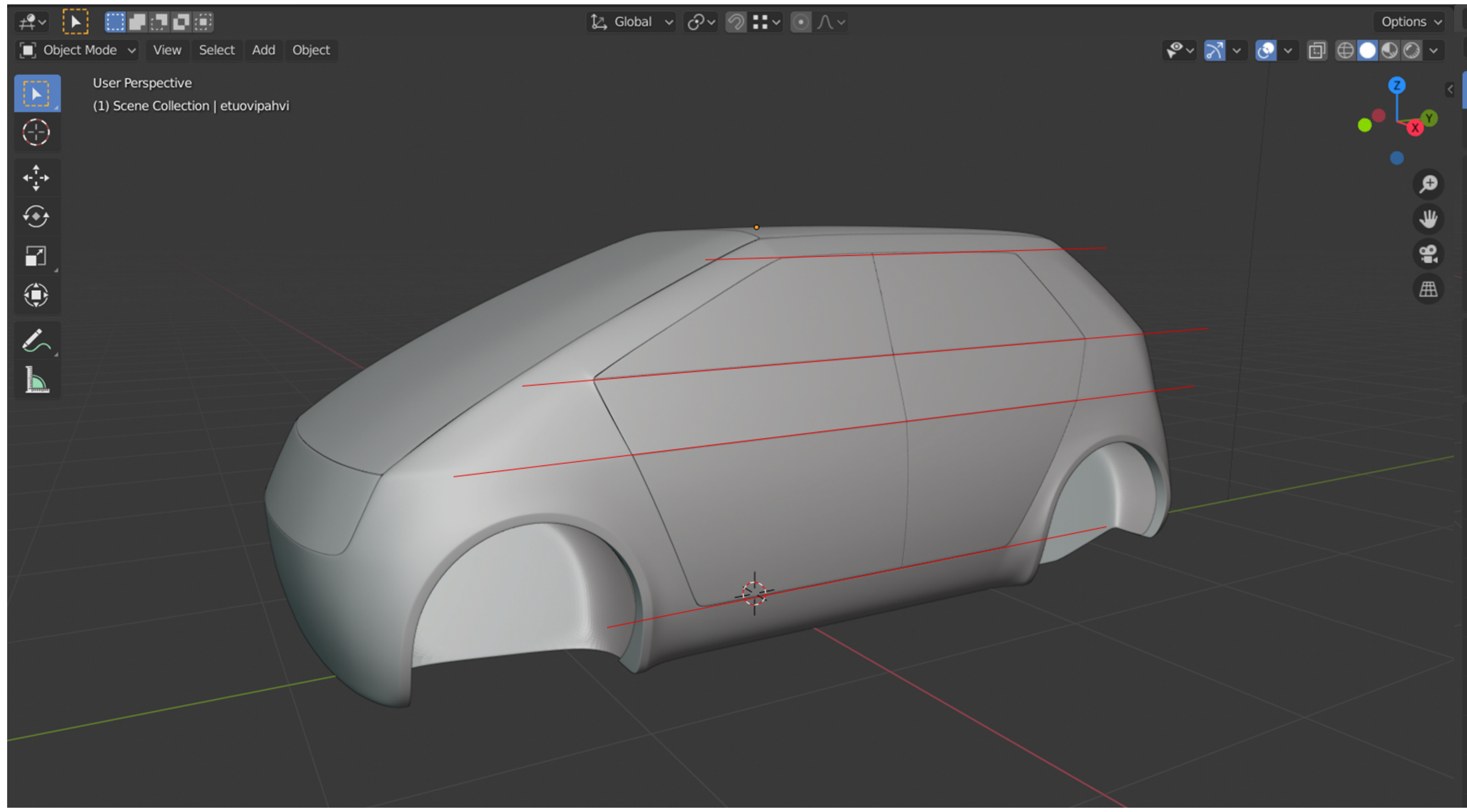
5.6 DETAILS

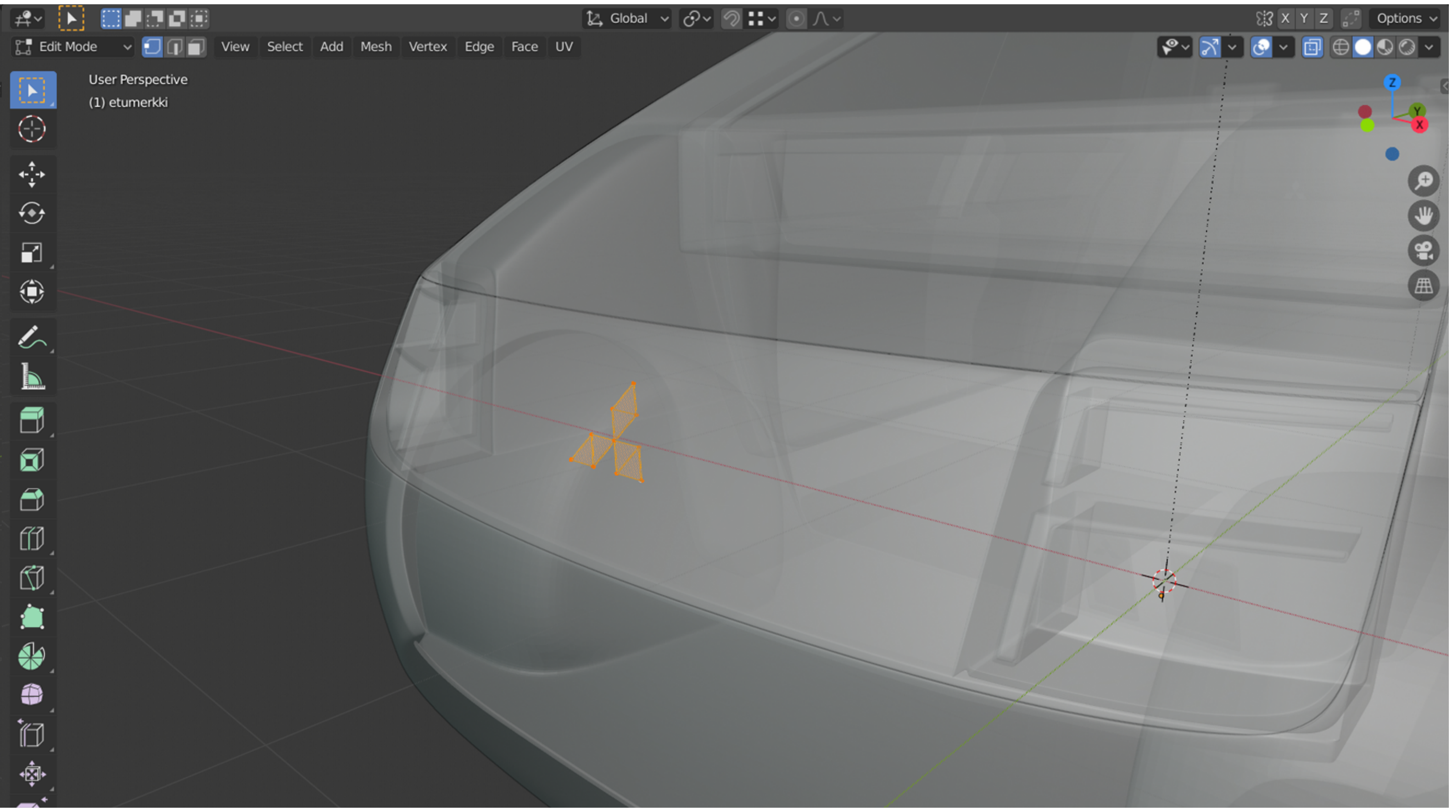
Body details

There are four horizontal lines dividing the body: line on top of the main windows, line at the bottom of the main windows, main side bevel and bottom line of the doors.

Logos

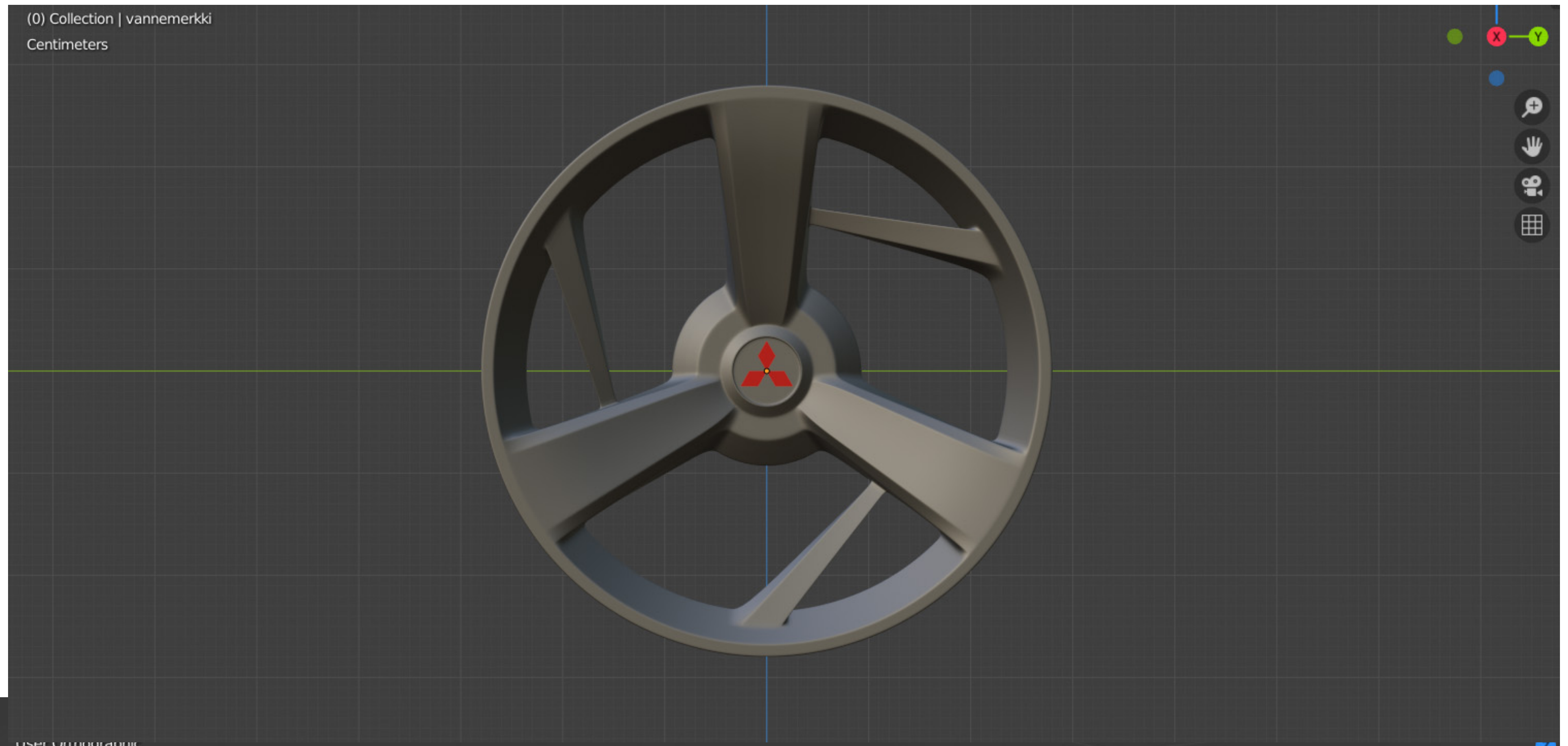
The exterior logos are located inside the front and rear glass panels. They are also able to glow in the dark to make them visible.

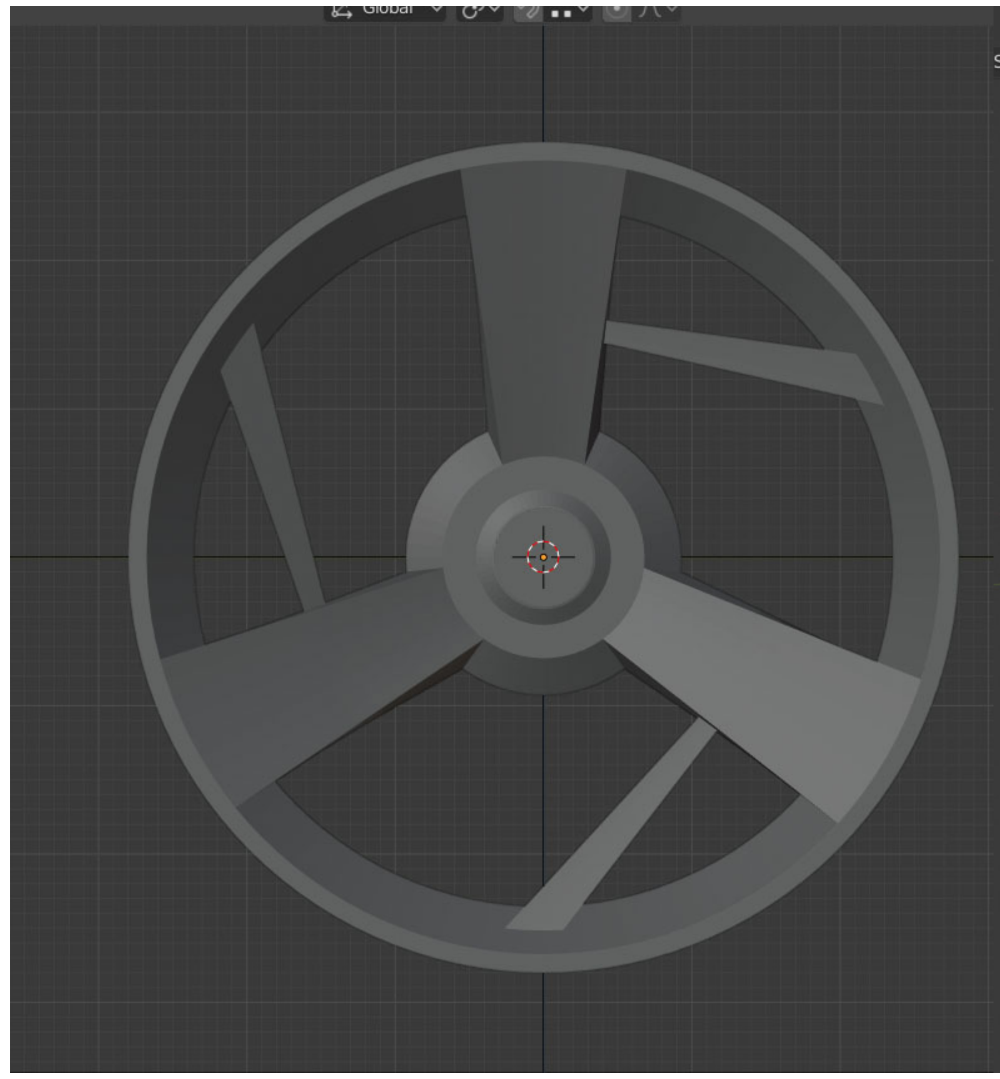


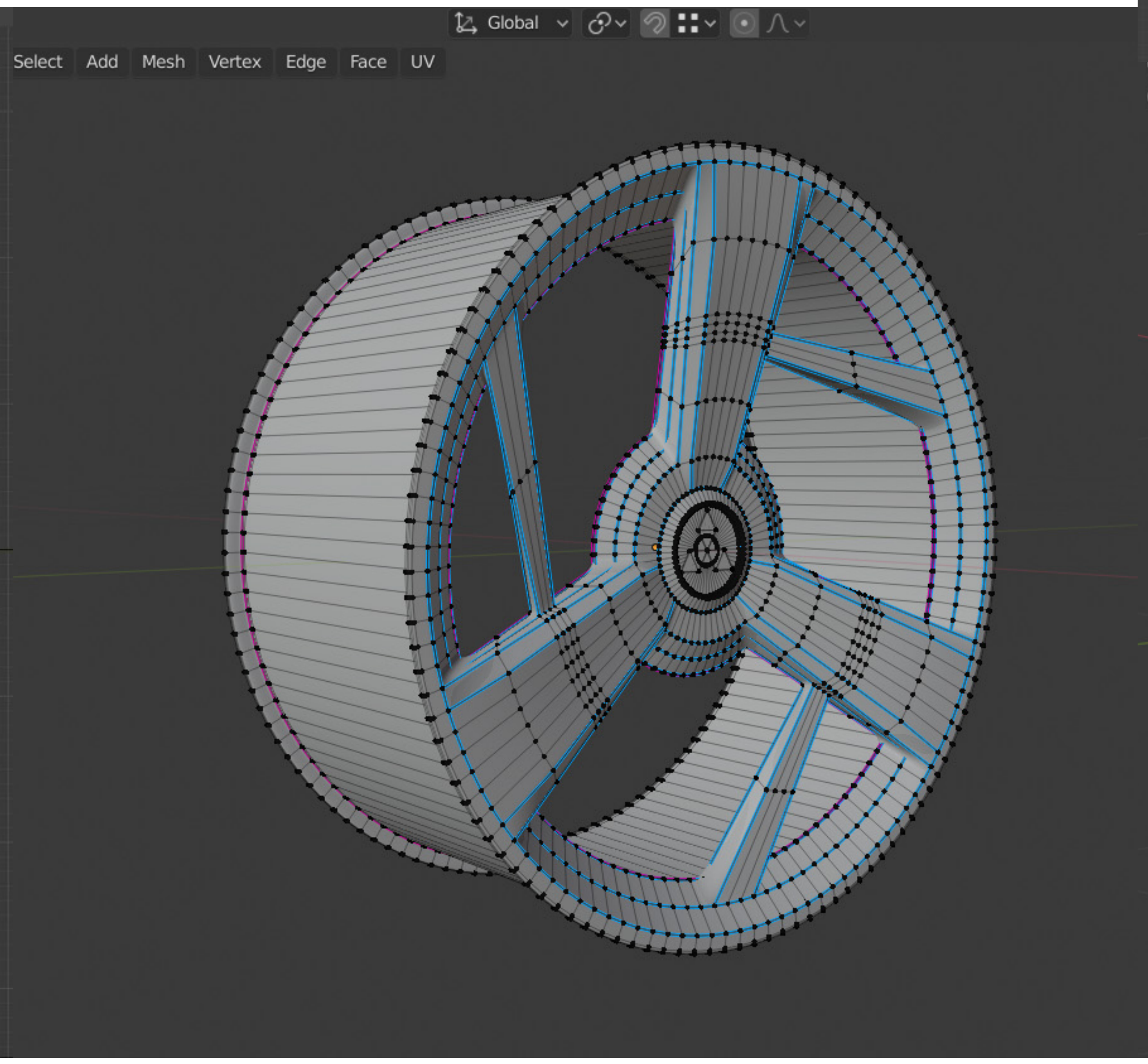


5.7 WHEELS

In contrary to the steady and simple exterior, I wanted the wheels to give some edge to the overall look. Since there are electric hub motors inside the rear wheels, I thought they should be seen through the rims. That affected the design to be three-spoked with some details.







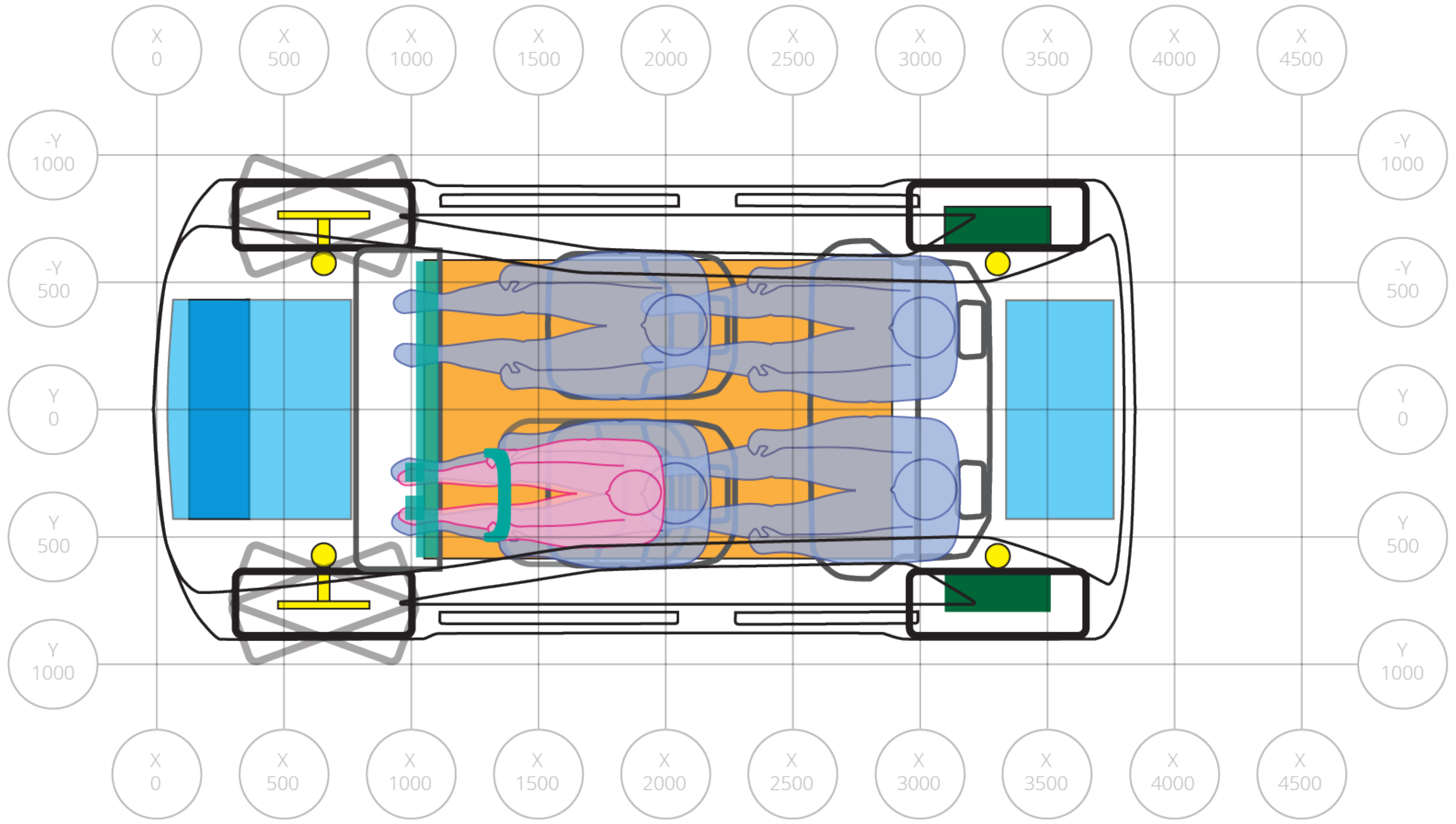
6 FINAL DESIGN

6.1 PACKAGE DRAWING

This is the basic package drawing of the vehicle. The dimensions are accurate but for the technical part the drawing is approximate estimation.

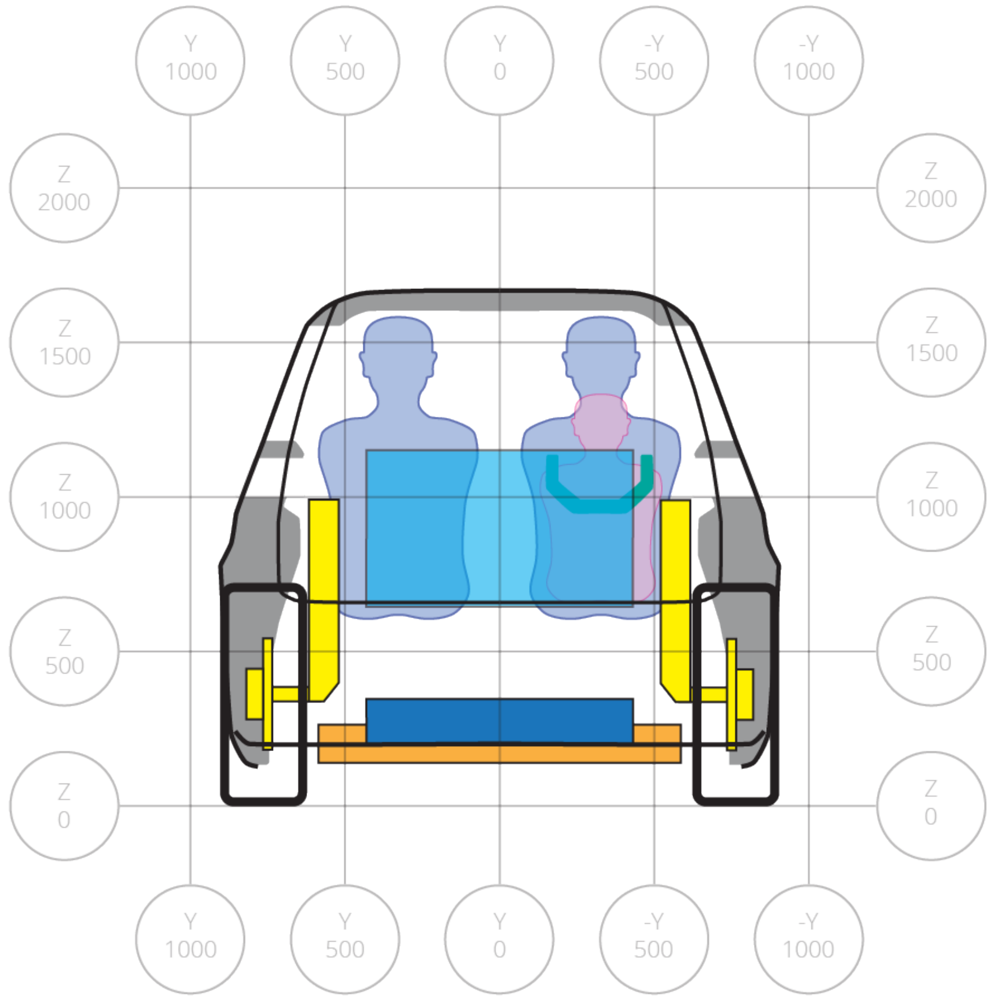
Vehicle Dimensions

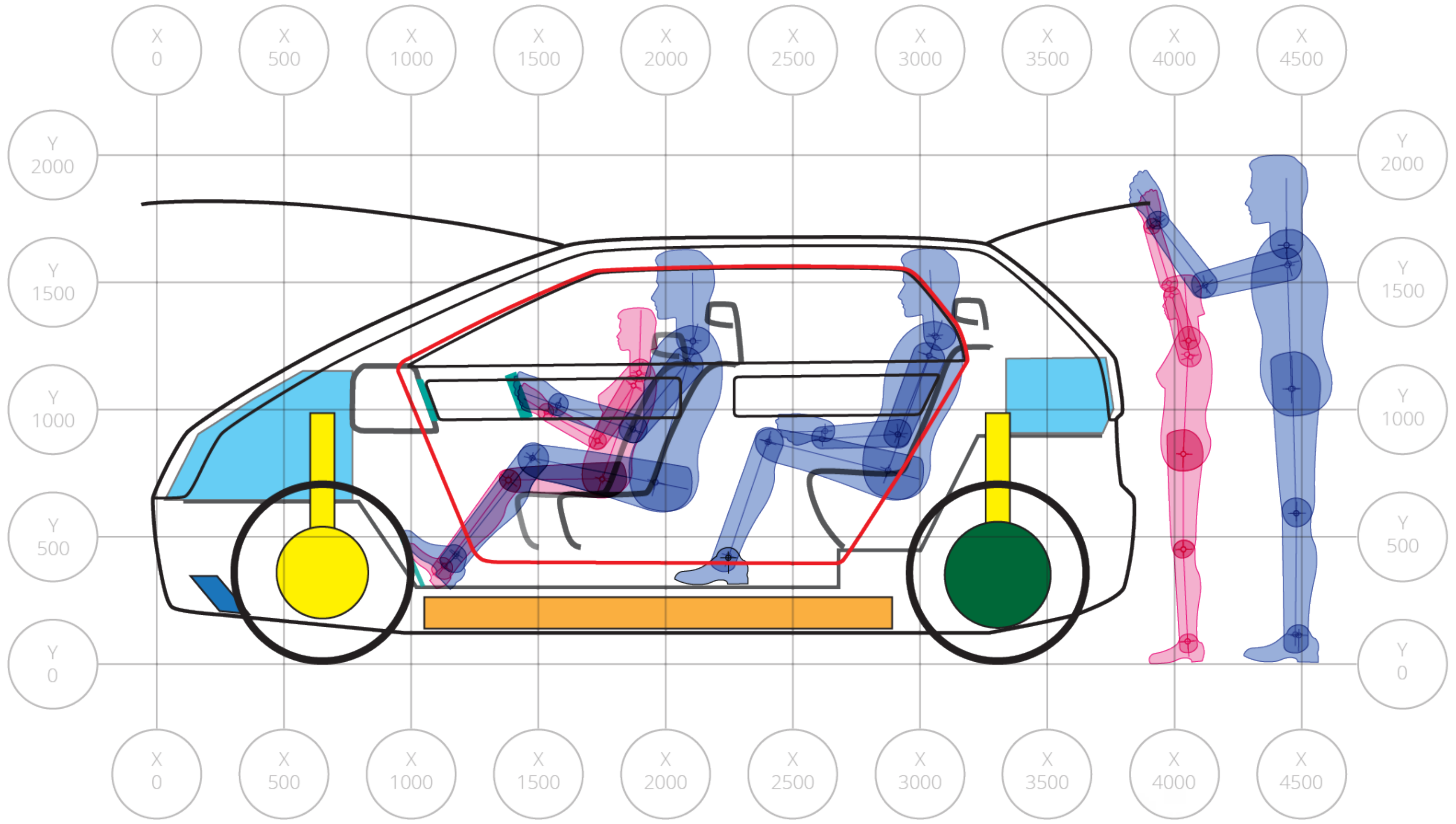
Length: 3860 mm
Width: 1810 mm
Height: 1680 mm

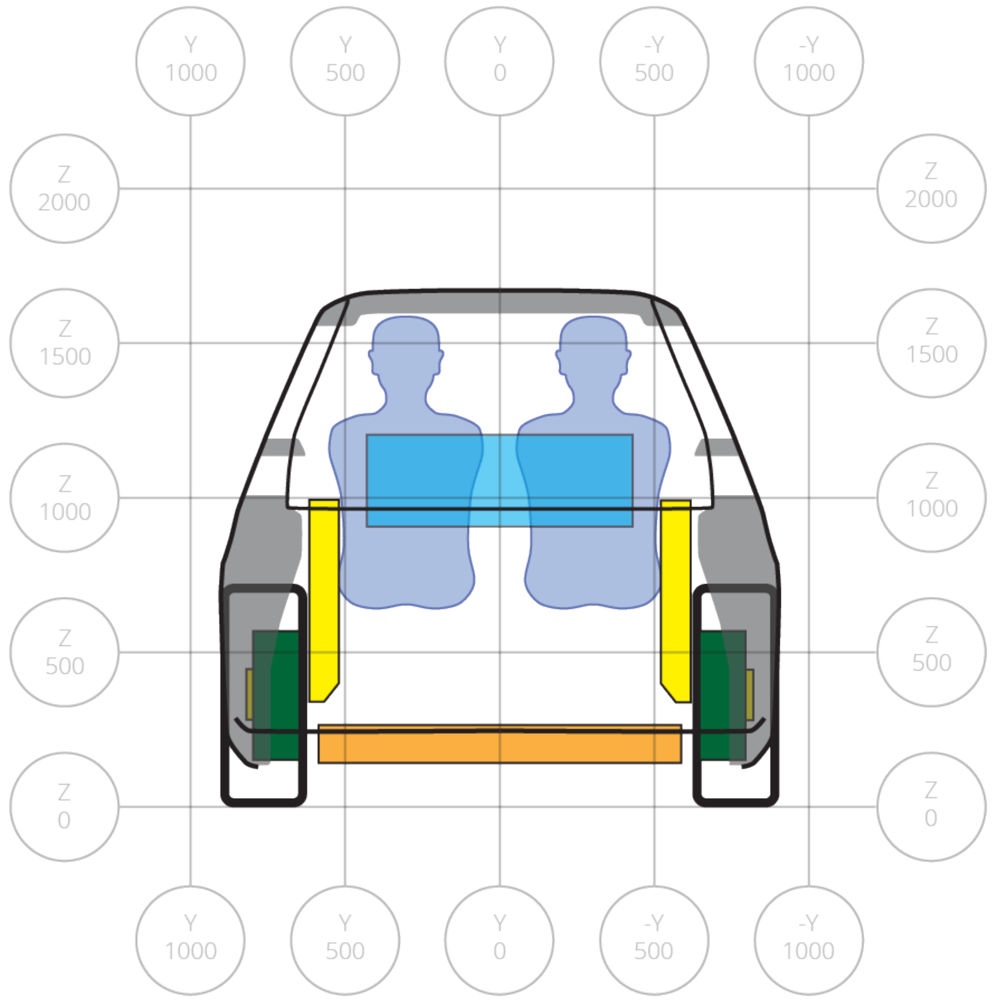


Components

- Electric Hub Motors
- Battery Packs
- Luggage Space
- Battery Cooling System
- Suspension
- Controls
- 97.5% male
- 2.5% female



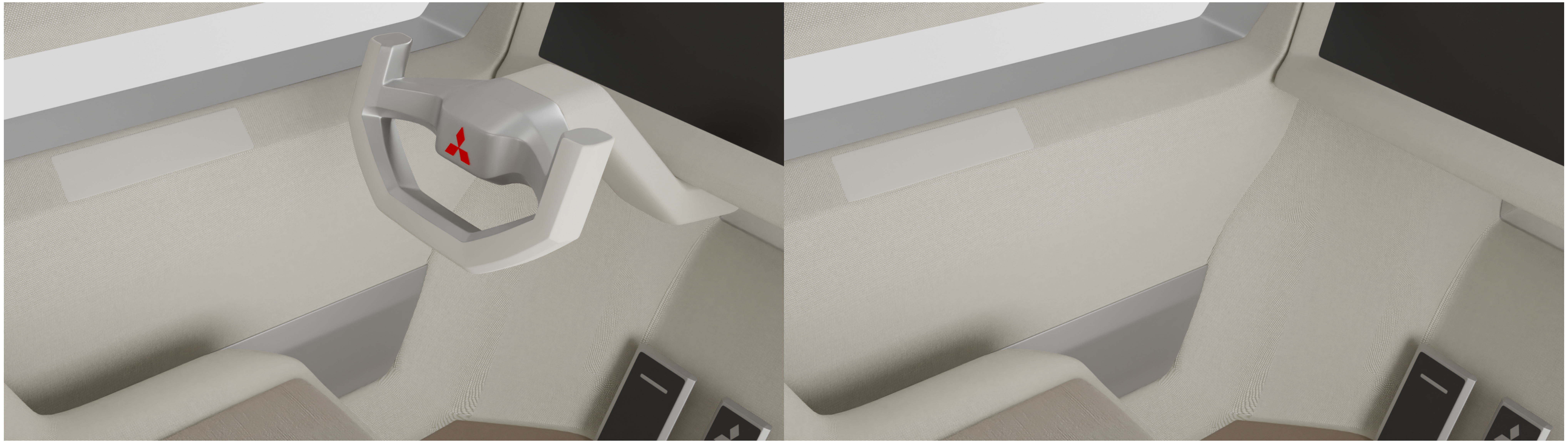




6.2 FEATURES

Changing between autonomy and human driver

The steering wheel folds out of sight as the vehicle leaves urban area. Autonomy can be turned off if desired. That and other features are accessible from the touch pads located in the front doors.

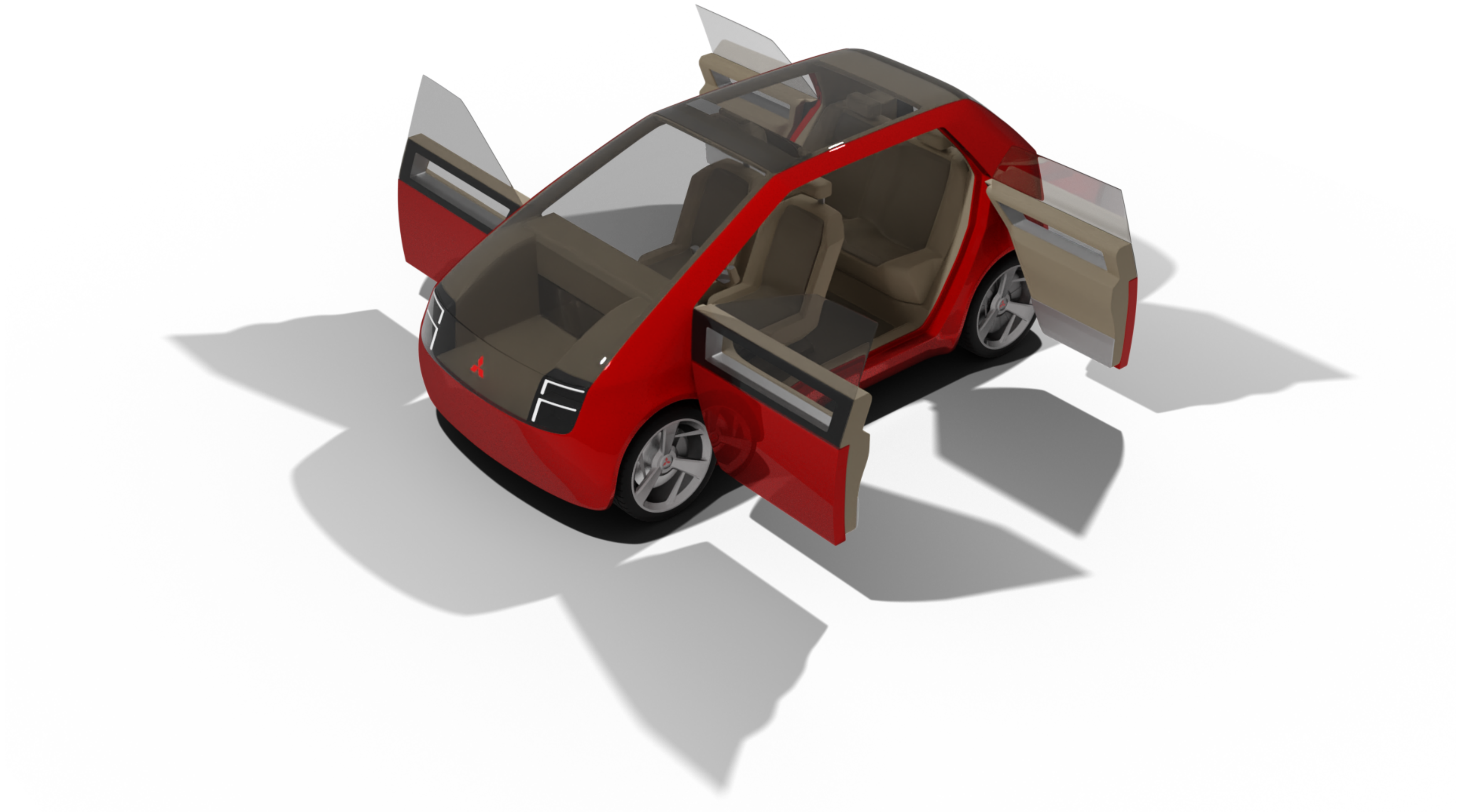


6.2 FEATURES

Rotating front seats

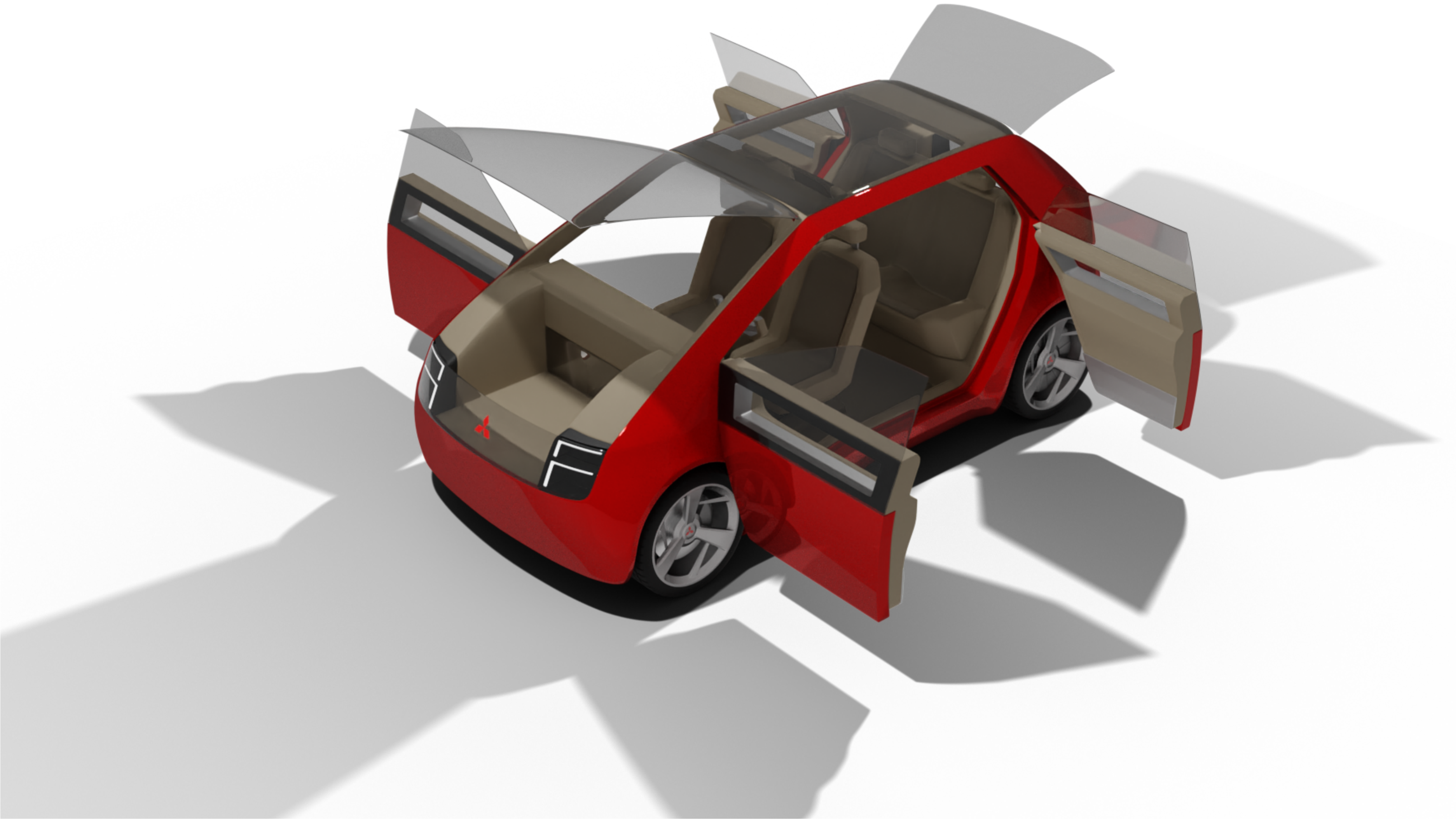
When empty, the front seats can be rotated to face the rear passengers.
The front seats are attached to stands that move on rails.

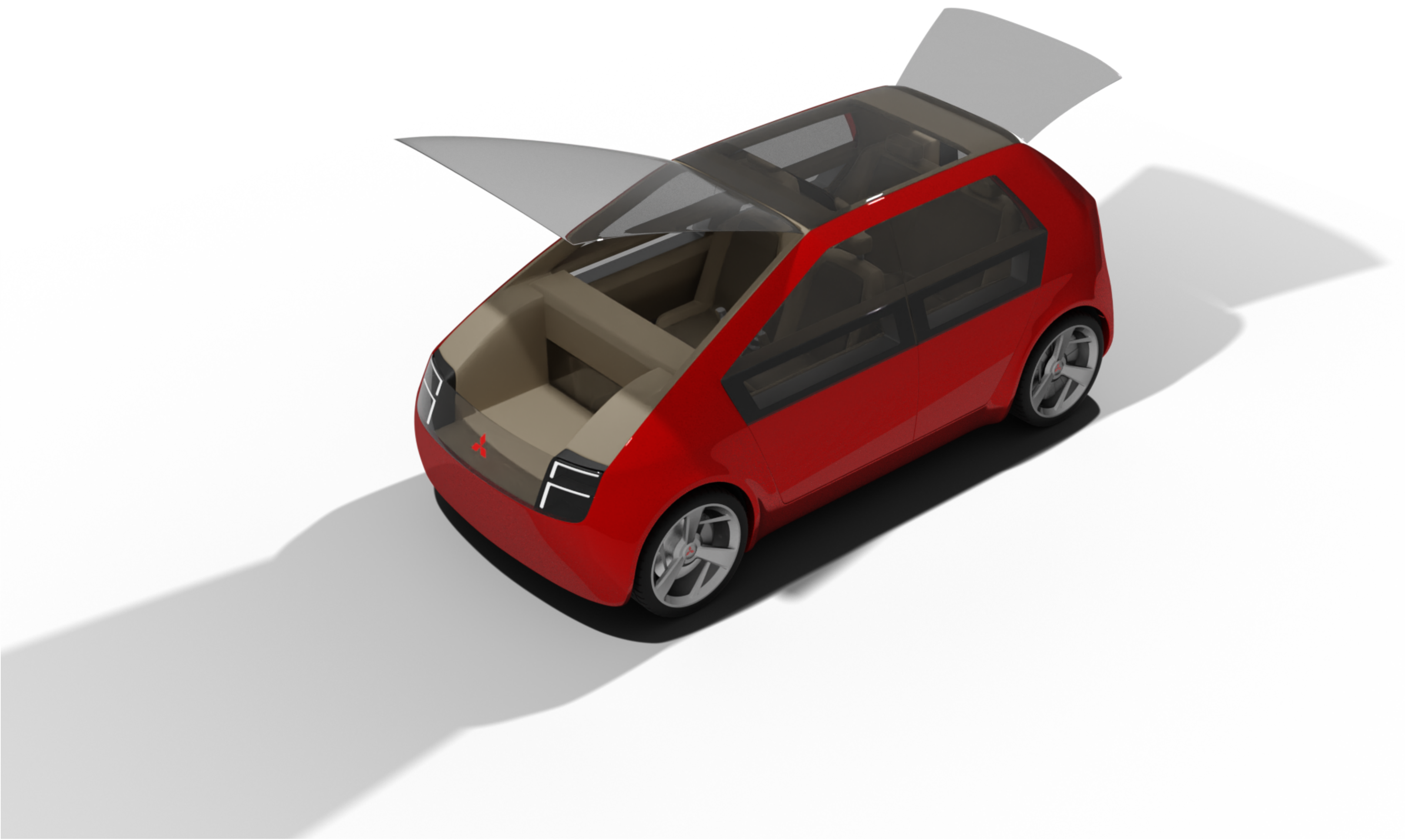
6.2 FEATURES



Doors and opening body panels

Getting into the vehicle happens via coach doors from either side. The B-pillarless body structure makes entry to the vehicle much easier and the coach doors open the entry area is suitable for most people. There are hatch doors at both ends, which makes access to both luggage spaces easy.





6.2 FEATURES

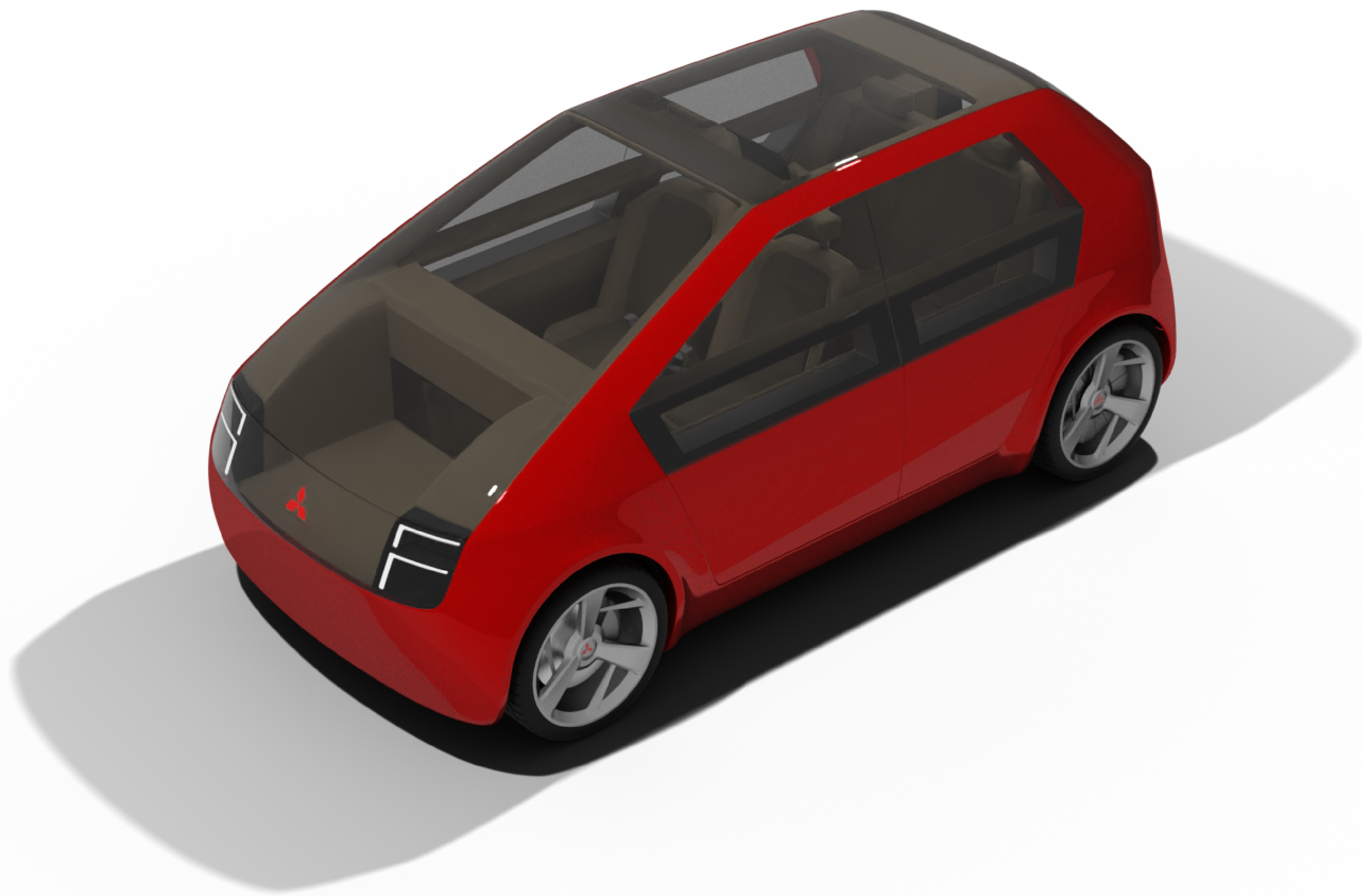
Luggage space

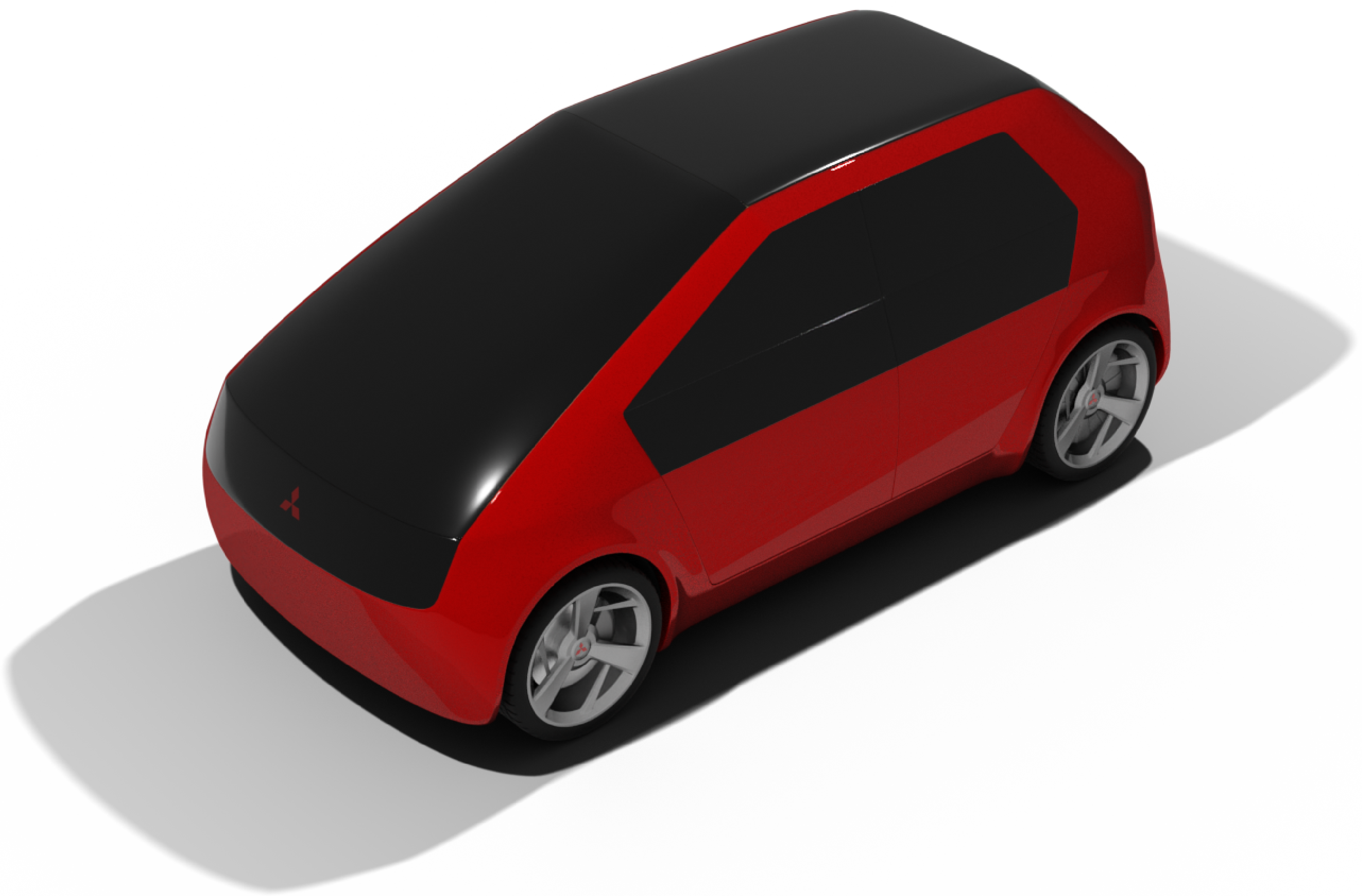
The concept has luggage space in both ends. To help access the main luggage space in front, the hatch opens all the way from the top of the wind-screen. Both luggage spaces can be reached from inside as well.

6.2 FEATURES

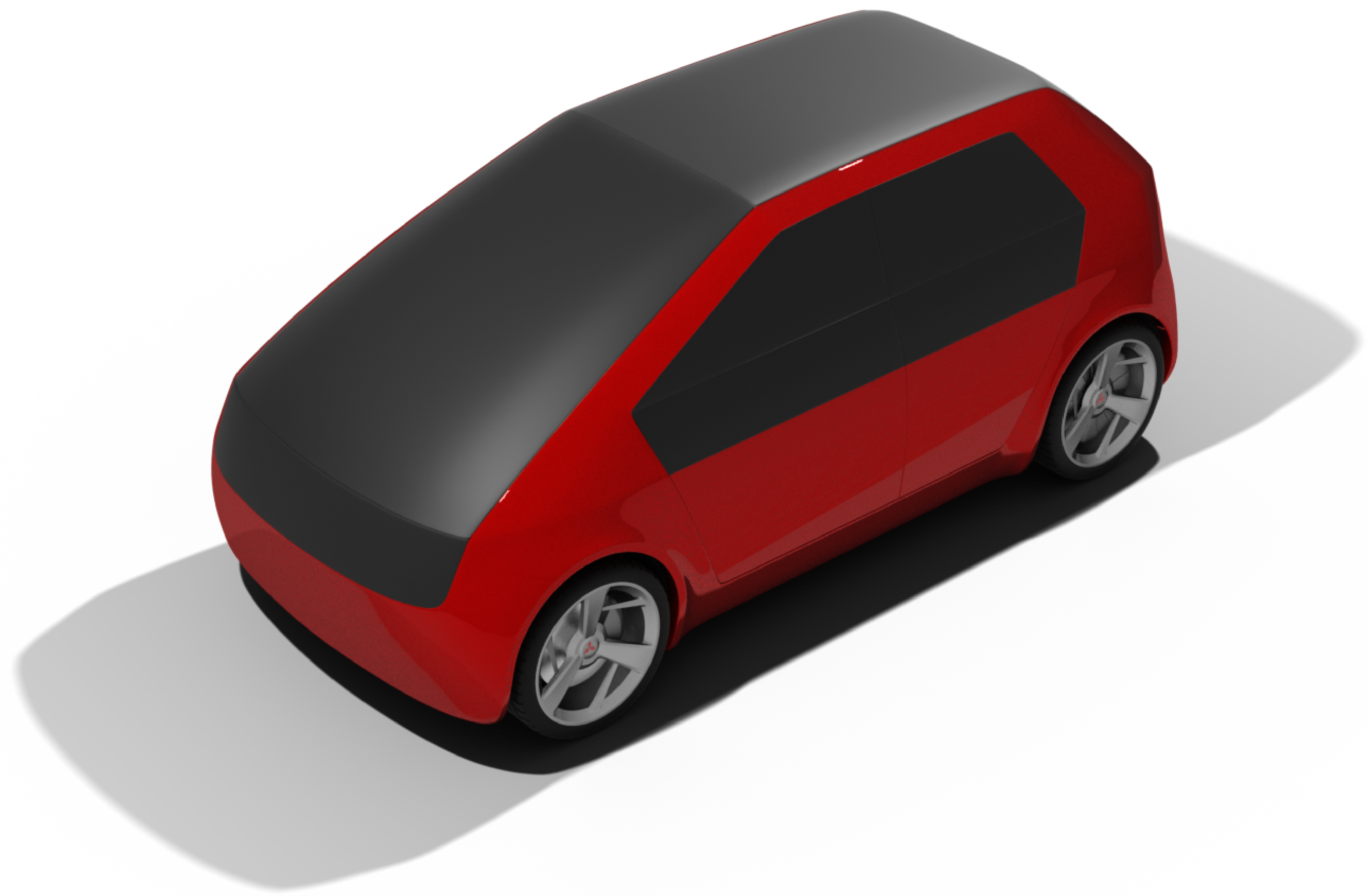
Smart windows

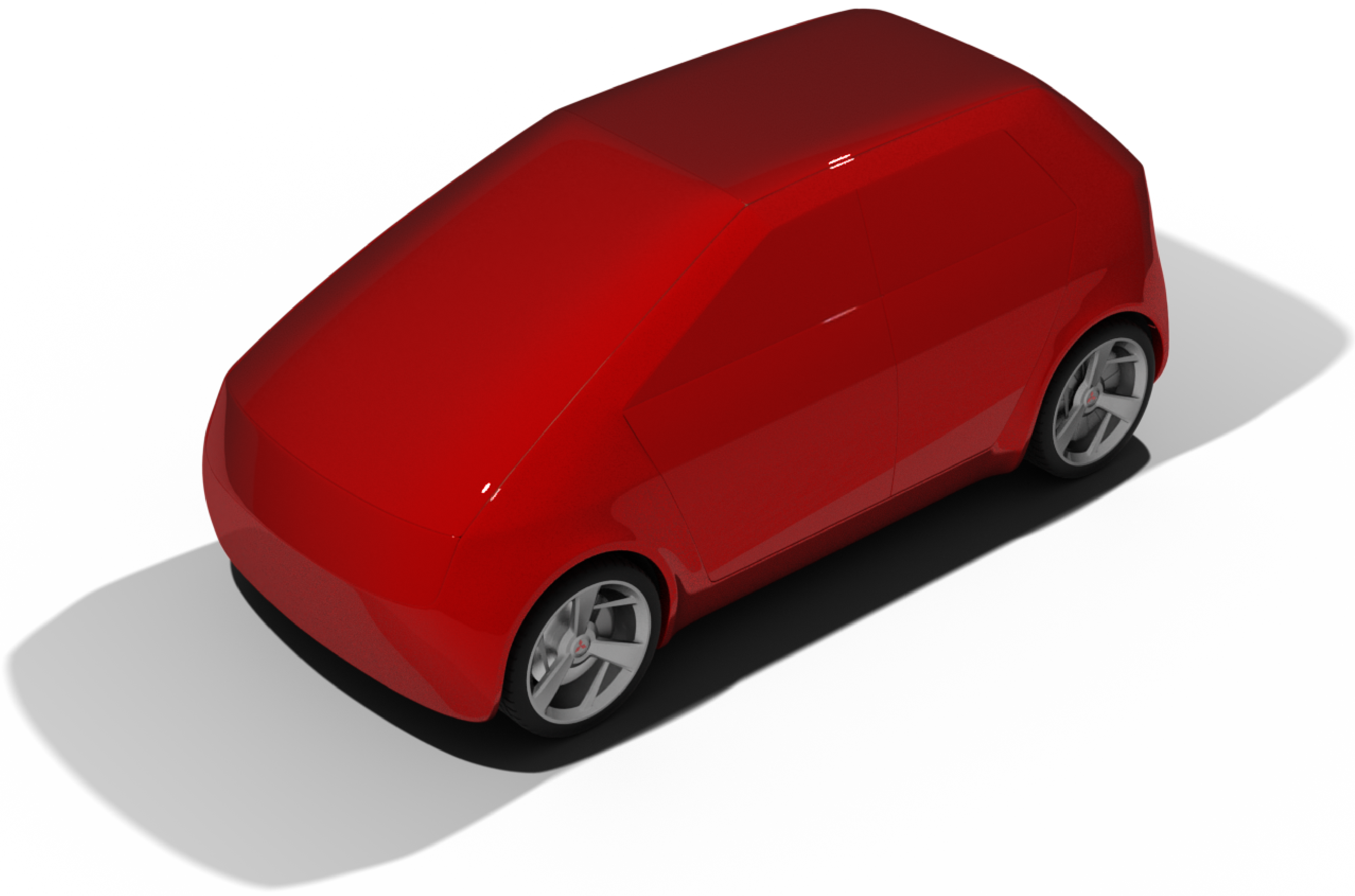
The glass surfaces in the vehicle are active smart glass. In this concept's scenario, smart glass can project screen content as well as change its surface colour and cloudiness. Since the vehicle has lots of glass surfaces covering also luggage, the glass needs to be made opaque during parking in public areas.





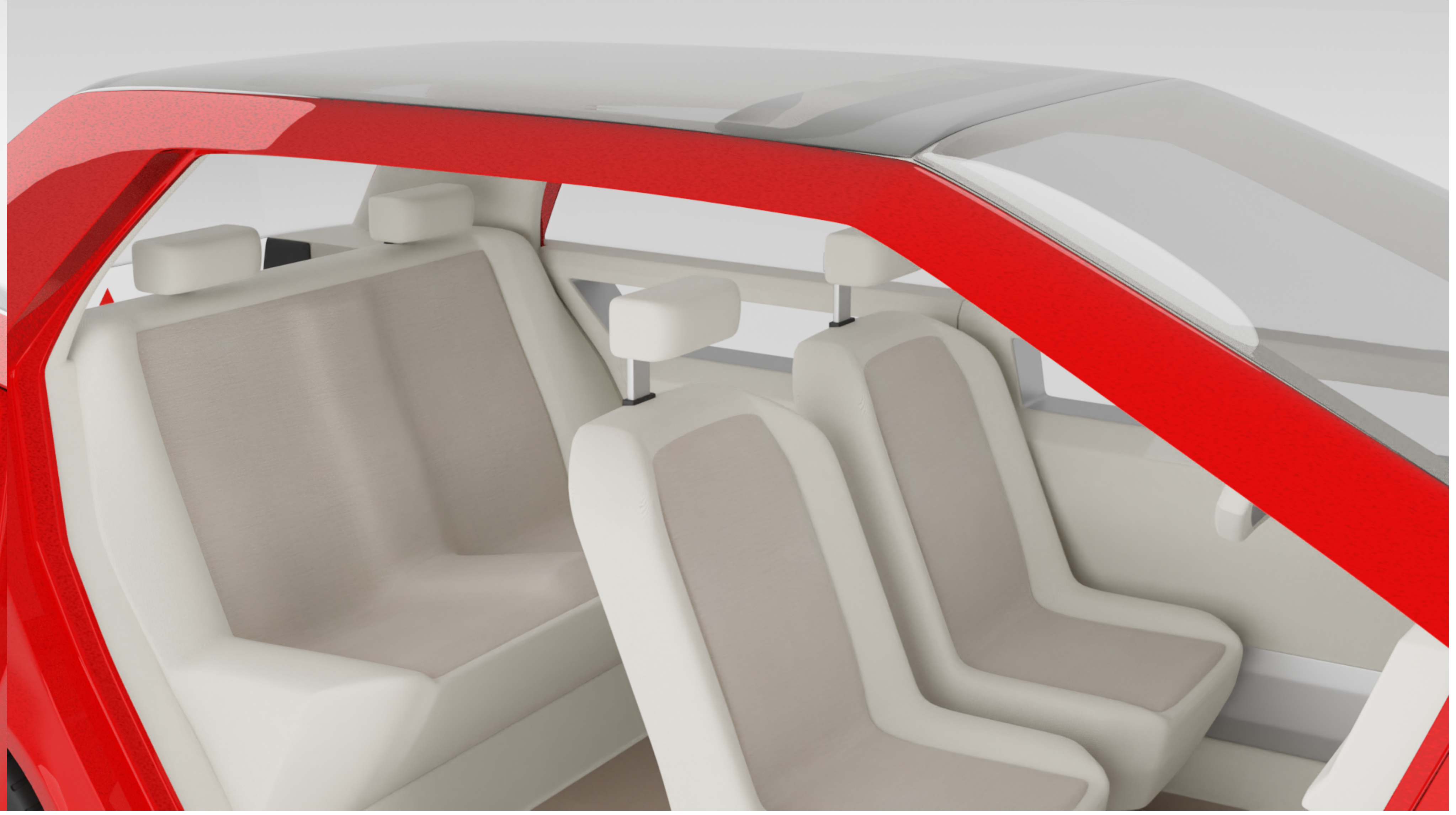
6.2 FEATURES





6.3 INTERIOR

The interior is designed to be simple and fitting to the exterior. The dominant theme inside is horizontal lines which include the lower side windows aligned to meet the dashboard screen panel.



6.3 INTERIOR

Background picture: Paul Lobe Haus (Zaal 2016)

6.3 INTERIOR

Background picture: Paul Lobe Haus (Zaal 2016)

6.4 EXTERIOR

Background picture: Shadowplatz (Zaal 2016)

6.4 EXTERIOR

Background picture: Shadowplatz (Zaal 2016)

6.4 EXTERIOR

Background picture: Paul Lobe Haus (Zaal 2016)

6.4 EXTERIOR

Background picture: Paul Lobe Haus (Zaal 2016)

6.4 EXTERIOR

Background picture: Dresden Square (Zaal 2016)

6.4 EXTERIOR

Background picture: Dresden Square (Zaal 2016)

7 EVALUATION

7.1 PROCESS AND FINAL PRODUCT

The process was overall really instructive, although I felt it quite hard at times. Part of the difficulty I felt was because of the schedule. It took me pretty long to catch up my original schedule which ultimately resulted that the written part was a bit shorter than I had hoped.

The start of the process was slow since I had to make my own brief. It took me several weeks to define the brief to something I was really interested in. In the first few weeks the direction of the process was quite lost, I began the process with a lot of research. After the first phase of research the brief still changed a bit.

I started sketching after benchmarking current small hatchbacks. Benchmarking gave me some ideas that started to develop into something more original. After consulting with my project mentor Lee Walton and my classmates, the sketching found a clear direction. The final design developed quite quickly after a lot of sketching and I was ready to move to the next phase.

I made an instructive package drawing to help me model the design in Blender. The modeling phase took a lot of time since I hadn't modelled a car in any 3D software ever before. I learned Blender for a previous school project, so I chose it for this project as well. If I had had more time for this project, it would have been a great idea to learn model the concept in Alias instead. I targeted making as photorealistic model and renders as I could, but again the schedule made some limitations to the amount of details.

I'm pretty happy with the outcome considering the time spent on the model. Although it could have been a lot better if I had had more time to orientate myself to some Blender features. Afterwards it's easy to say that I would have made a lot of things differently if I could do the process again.

I have a lot to thank to my classmates for great feedback during the process. It motivated me and gave me some valuable external opinions. Since I didn't have any client for my project the feedback was extremely valuable for the progress.

I think I had some decent ideas considering the used technologies and the design language. The design could need some redevelopment in the future but I'm quite happy where I got with this time limit. I think that scheduling the process should have been much better to reach better overall outcome. Now the visual side ended up being much better than the written side. To summarize, I think the final product was quite successful, although explaining the project ended up being too short.

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