DEP703
Design Project – 3

Longhaul EV Truck for India in 2040

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Under the guidance of

Prof. Nishant Sharma
Prof. Vivek Kant

Declaration

I declare that this written report represents my own idea in my own words, and were others, ideas or words have been included,

I also declare that I have adhered to all principles of academic honesty and integrity and have not falsified, misinterpreted or fabricated any idea, data, facts or source in my submission.

I understand that any violation of the above will be cause for disciplinary action by the institute and can also penal action from the source from which proper permission has not been taken, or improperly cited.

Rahul R (216390011)

Approval Sheet

This Mobility and Vehicle Design report titled – "Longhaul EV Truck for India in 2040 " by Rahul R is approved in partial fulfilment of the requirements for Master of Design degree in Mobility and Vehicle Design.

Project Guide :

Chairperson :

Internal Examiner :

External Examiner :

IDC School of Design
अभिकल्प विद्यालय

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Last but not least, my thanks and appreciations also goes to my batchmates for their suggestions and criticism which helped me in developing the project.

Rahul R

Content

1. Introduction

Truck drivers in India play a crucial role in the country's transportation industry, ensuring the smooth movement of goods across vast distances. They are the lifeline of the Indian economy, facilitating the distribution of essential commodities, raw materials, and finished products to various corners of the nation.

These dedicated individuals endure long hours on the road, braving challenging conditions and unpredictable terrains to deliver goods on time. They often embark on journeys that span thousands of kilometers, connecting rural areas to urban centers and facilitating interstate trade.

The automobile business has undergone incredible changes throughout the years, and as we look to the future, it is critical to anticipate the wants and requirements of particular geographic areas. In this article, we examine truck design with a particular emphasis on India in 2040. India's fast expanding economy, expanding population, and changing infrastructure present the transportation industry with both distinct difficulties and opportunities.

The purpose of this report is to examine the important factors and design elements that will influence Indian trucks in the future. Our goal is to offer truck manufacturers, legislators, and other stakeholders in the transportation sector insights and recommendations by analyzing the anticipated socioeconomic, environmental, and technological developments.

India presents unique challenges for truck design due to its varied terrain, crowded urban regions, and substantial rural areas. In 2040, factors like rising urbanization, shifting consumer tastes, improved transportation infrastructure, and environmental concerns will significantly impact truck design and functionality. It is critical to foresee and handle these issues to provide effective and sustainable freight transport that supports the nation's development goals.

The rising trends and essential design factors that will influence the trucks of the future in India will be studied throughout this report. We'll look into fuel economy, renewable energy sources, autonomous technology, safety improvements, load capacity optimization, and connectivity options. By examining these elements, We want to give you a thorough grasp of the essential design ideas to help you create trucks tailored explicitly to India's needs.

2. Methodology of research

The design research methodology employed in this project was based on the PESTLE analysis framework. The analysis examined Political, Economic, Social, Technological, Legal, and Environmental factors. The following steps were undertaken to gather insights and guide the design process:

Collection of Design Drivers: An extensive list of design drivers was compiled using the PESTLE method. Industry experts were engaged in rating these drivers, providing valuable input and expertise.

Uncertainty and Importance Framework: Based on the ratings, a graphical representation was constructed to plot the design drivers. This framework established the levels of uncertainty and importance associated with each driver.

Categorization and Scenario Development: Through a thorough analysis of the uncertainty and importance framework, the design drivers were strategically categorized into distinct quadrants. These quadrants served as scenarios, offering insights into different design directions.

Stakeholder Identification and Research: Key stakeholders were identified, and secondary research was conducted to understand their requirements and needs for the concept's development. This research provided essential insights into the stakeholder landscape.

Design Brief Development: A detailed design brief was meticulously crafted by leveraging the gathered insights. The design brief captured crucial data and outlined the project's objectives, serving as a foundation for further design development.

Scenario Creation and Alignment: Building upon the design brief, a scenario was skillfully developed to align with the parameters and specifications outlined in the document. This scenario served as a guide for the subsequent design stages.

Platform and Packaging Consideration: Attention was given to the platform and packaging aspects of the vehicle. Multiple concepts were generated, emphasizing the optimal utilization of the chosen platform's packaging.

Concept Refinement and Validation: Through a systematic evaluation process involving rigorous assessments and iterations, a final concept emerged as the most compelling choice. This concept was further refined, creating a detailed 3D CAD model and a scale model for validation.

By following this methodology, which involved the utilization of the PESTLE analysis framework, the project effectively gathered critical insights, addressed uncertainties, and aligned the design with stakeholder needs. The methodology provided a comprehensive and systematic approach to guide the design research, resulting in a refined concept ready for further exploration and implementation.

2. 1 PESTLE Analysis

A PESTLE study is a tool for obtaining a broad overview of the business environment. Political, Economic, Social, Technological, Legal, and Environmental are often called PESTLE.

An extensive list of design drivers was compiled using the PESTLE method. Industry experts were engaged in rating these drivers, providing valuable input and expertise. Uncertainty and Importance Framework: Based on the ratings, a graphical representation was constructed to plot the design drivers. This framework established the levels of uncertainty and importance associated with each driver.

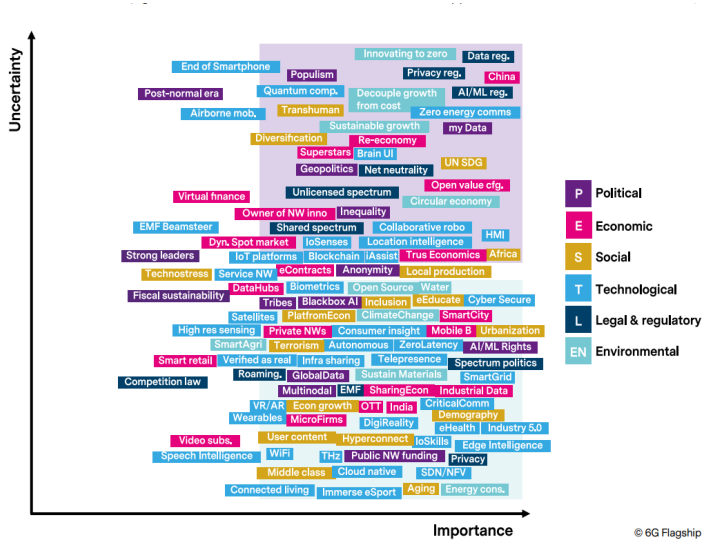


Figure 1. Ucertainity vs Importance graph

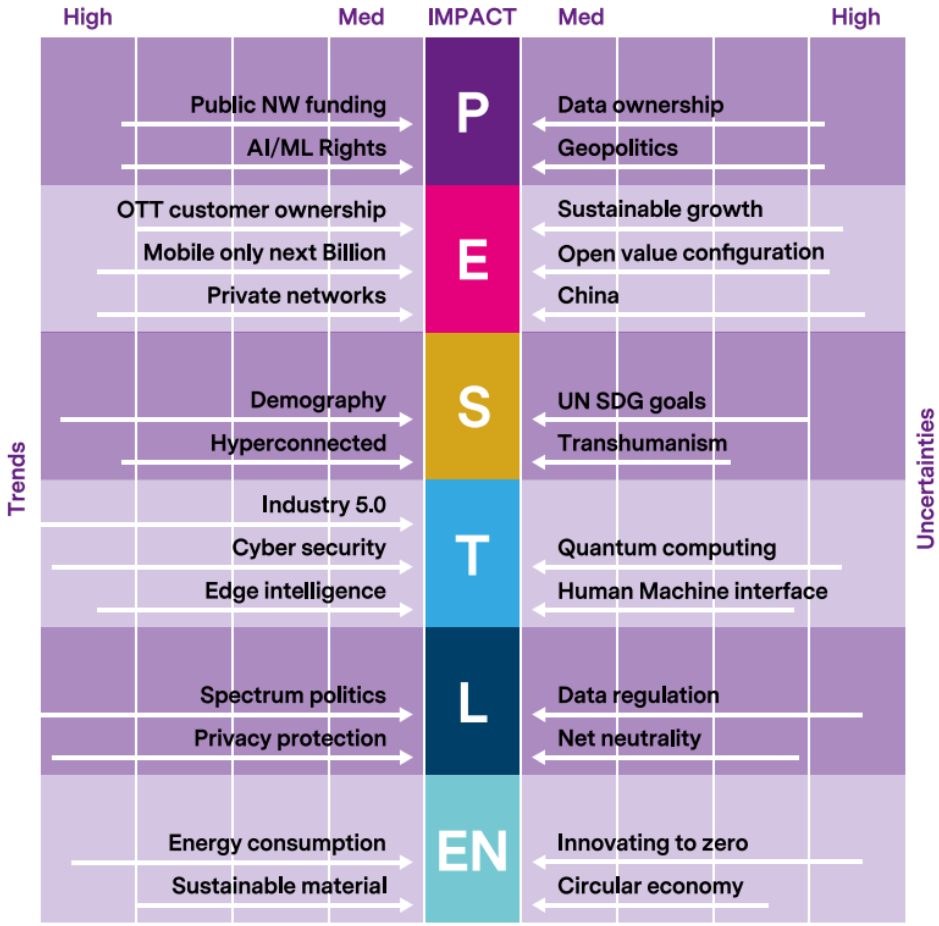


Figure 2. PESTLE

2. 2 List of Design Factors

Design drivers	Importance	Uncertainity
Safety regulations	5	1
National-level EV policies	5	1
Emission standards	5	1
Initiatives to promote manufacturing	3.5	2.5
Initiatives to improve logistics efficiency	5	2.5
Incentives on battery manufacturing	4	2
Sub-national actions and initiatives on ZETs	4	4
Close-up on demand- and supply-side policy	3	3
Demand-side policies to increase consumer demand	5	3
Supply-side policies	4.5	2.5
EU Green Deal	4	2
Charging Infrastructure	5	1.5
The Bharatmala and Golden Quadrilateral	4.5	2
National Green Hydrogen Mission	4.5	2
FAME II	4.5	1.5
NEV Mandate	5	1
Emmision Norms	5	1
Noise Pollution Regulations	4.5	2.5
Energy security	4.5	2
Labor regulations	4.5	2.5
Environmental regulations	5	2
Intellectual property rights	4.5	1.5
Recycling and waste management policies.	4.5	2.5
Smart grid regulations	5	1.5
Climate change mitigation policies	5	2
Incentive policies for sustainable transportation	5	2
Fuel pricing policies	5	2
Infrastructure investment policies	5	2
Cybersecurity regulations	5	2

Figure 3. design driver list

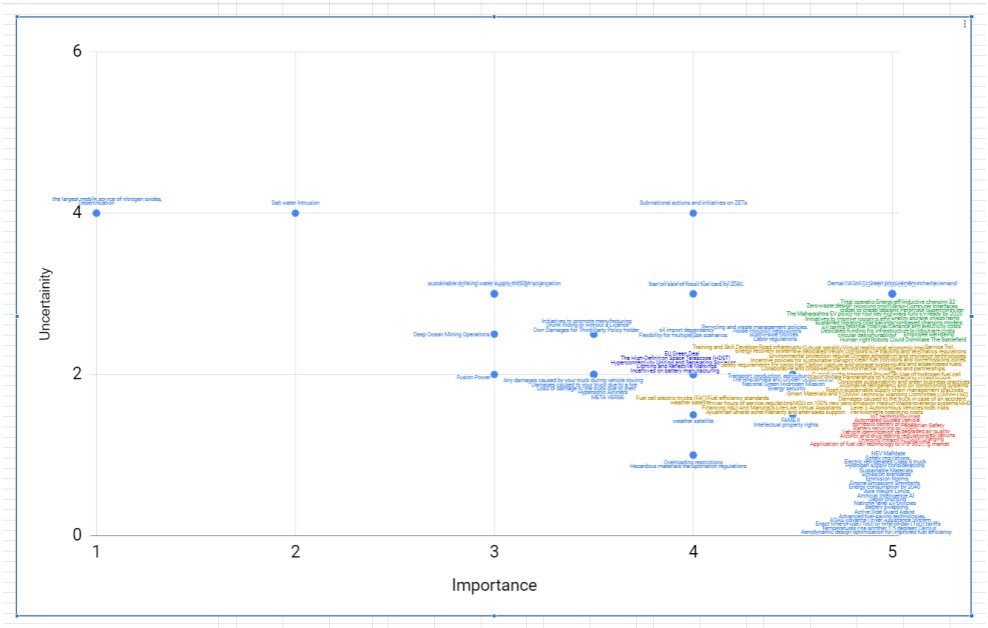
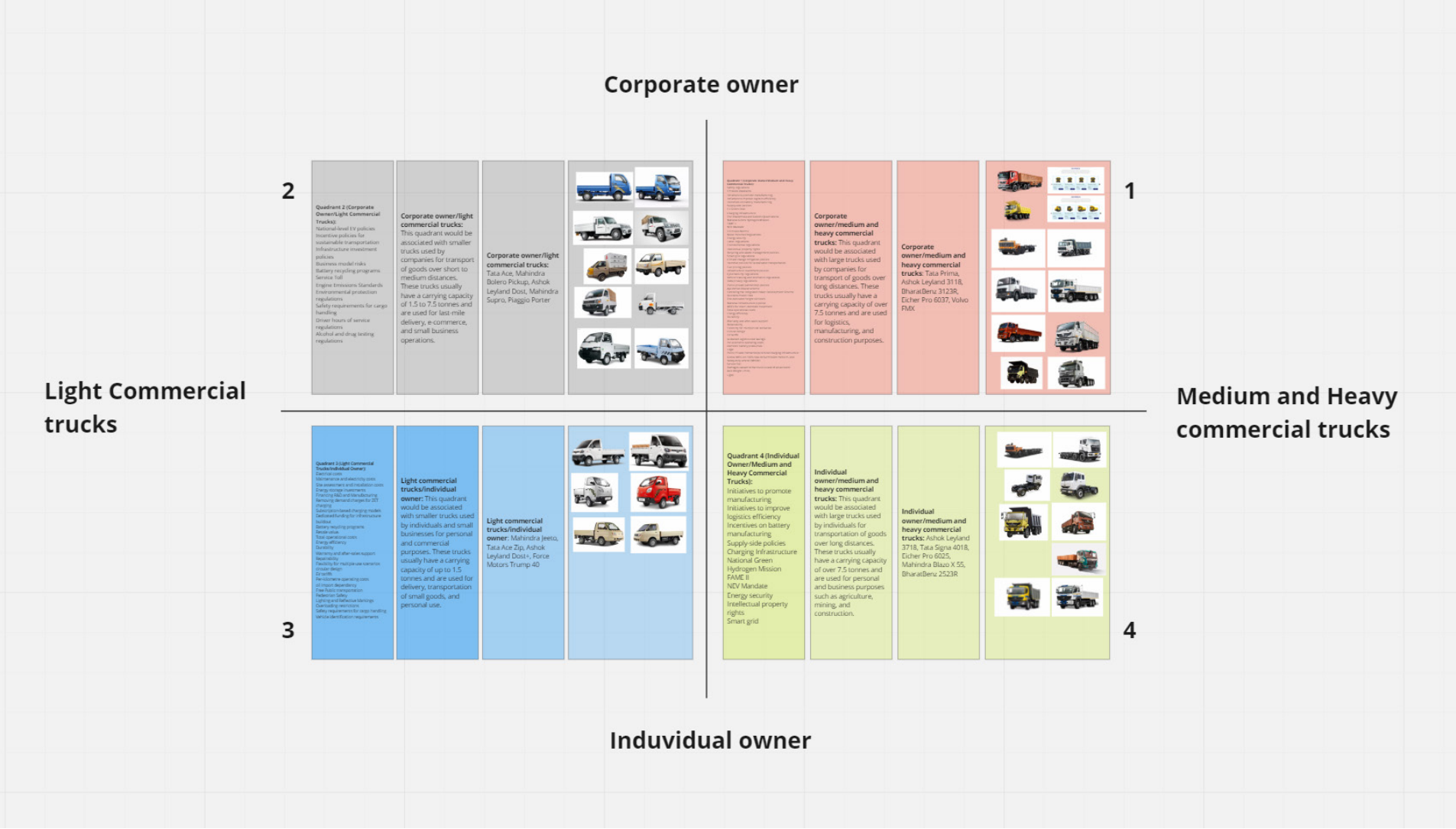
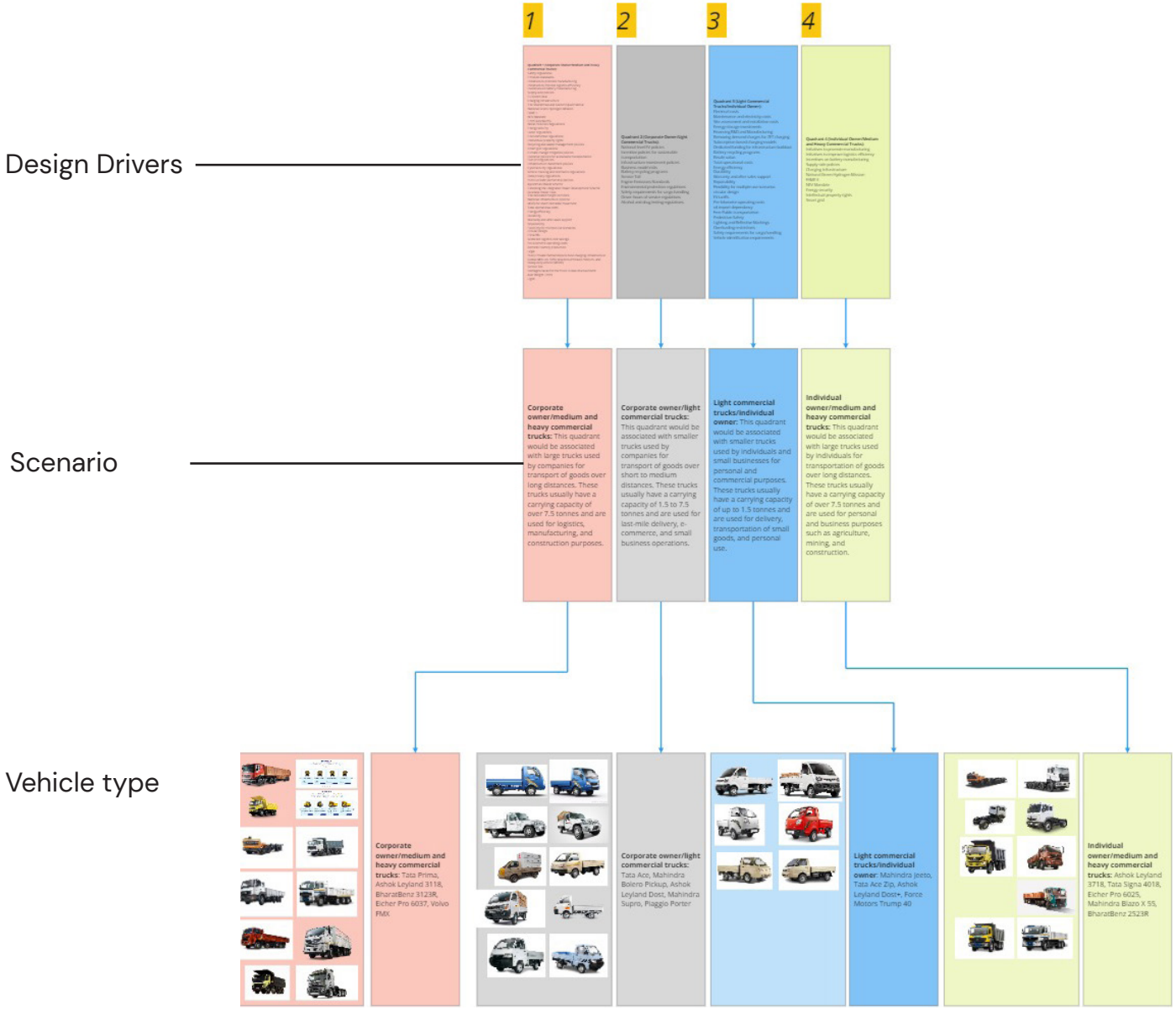


Figure 4. Uncertainity vs Importance

Categorization and Scenario Development: Through a thorough analysis of the uncertainty and importance framework, the design drivers were strategically categorized into distinct quadrants. These quadrants served as scenarios, offering insights into different design directions.

2. 3 Design Driver Matrix

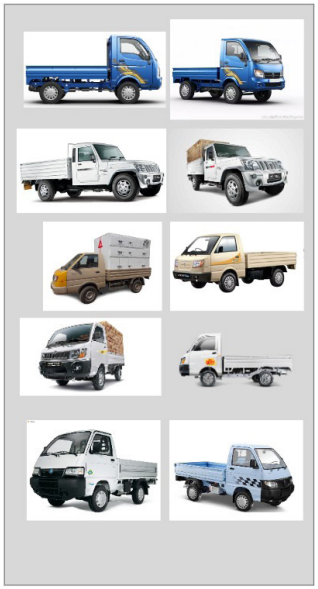



Design Drivers
Scenario
Vehicle type
1
2
3
4
Corporate owner/medium and heavy commercial trucks: This quadrant would be associated with large trucks used by companies for transport of goods over long distances. These trucks usually have a carrying capacity of over 7.5 tonnes and are used for logistics, manufacturing, and construction purposes.
Corporate owner/light commercial trucks: This quadrant would be associated with smaller trucks used by companies for transport of goods over short to medium distances. These trucks usually have a carrying capacity of 1.5 to 7.5 tonnes and are used for last-mile delivery, e-commerce, and small business operations.
Light commercial trucks/individual owner: This quadrant would be associated with smaller trucks used by individuals and small businesses for personal and commercial purposes. These trucks usually have a carrying capacity of up to 1.5 tonnes and are used for delivery, transportation of small goods, and personal use.
Individual owner/medium and heavy commercial trucks: This quadrant would be associated with large trucks used by individuals for transportation of goods over long distances. These trucks usually have a carrying capacity of over 7.5 tonnes and are used for personal and business purposes such as agriculture, mining, and construction.
Corporate owner/medium and heavy commercial trucks: Tata Prima, Ashok Leyland 3118, BharatBenz 3123R, Eicher Pro 6037, Volvo FMX
Corporate owner/light commercial trucks: Tata Ace, Mahindra Bolero Pickup, Ashok Leyland Dost, Mahindra Supro, Piaggio Porter
Light commercial trucks/individual owner: Mahindra Jeeto, Tata Ace Zip, Ashok Leyland Dost+, Force Motors Trump 40
Individual owner/medium and heavy commercial trucks: Ashok Leyland 3718, Tata Signa 4018, Eicher Pro 6025, Mahindra Blazo X 55, BharatBenz 2523R

The Matrix presented above plays a crucial role in developing distinctive scenarios and categorizing design drivers. Each axis represents polar opposite conditions, which aids in classifying various design drivers. Let's delve into each quadrant to understand the scenarios and the types of vehicles they entail:

Quadrant 1:
This quadrant represents a scenario where the corporate fleet owner possesses medium and heavy commercial trucks. Here, the design drivers are tailored to meet the specific needs and requirements of the corporate fleet. These drivers might include load capacity, durability, fuel efficiency, and advanced features suitable for long-haul transportation.

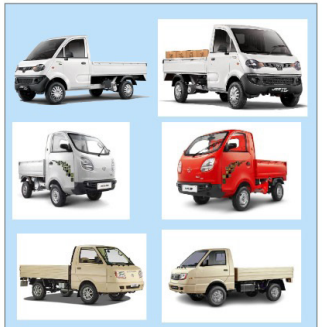
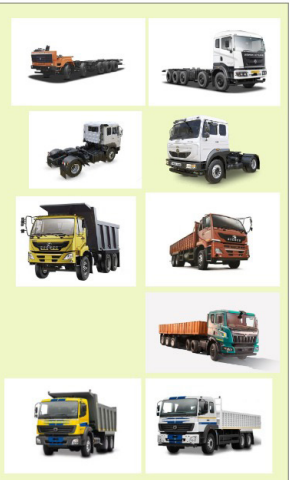
Quadrant 2:
In this quadrant, the scenario revolves around a corporate owner who owns light commercial trucks. The design drivers for this segment differ from quadrant 1, as light commercial trucks have distinct characteristics and purposes. These design drivers encompass agility, maneuverability, versatility, fuel economy, and features catering to shorter-distance deliveries or urban logistics.

Quadrant 1 (Corporate Owner/Medium and Heavy Commercial Trucks): Safety regulations Emission standards Initiatives to promote manufacturing Initiatives to improve logistics efficiency Incentives on battery manufacturing Supply-side policies EU Green Deal Charging Infrastructure The Bharatmala and Golden Quadrilateral National Green Hydrogen Mission FAME II NEV Mandate Emmision Norms Noise Pollution Regulations Energy security Labor regulations Environmental regulations Intellectual property rights Recycling and waste management policies. Smart grid regulations Climate change mitigation policies Incentive policies for sustainable transportation Fuel pricing policies Infrastructure investment policies Cybersecurity regulations Vehicle tracking and telematics regulations Data privacy regulations Public-private partnership policies Ayushman Bharat scheme Extending the Integrated Power Development Scheme Business model risks The dedicated freight corridors National infrastructure pipeline MDTs for short interstate movement Total operational costs Energy efficiency Durability Warranty and after-sales support Repairability Flexibility for multiple use scenarios circular design EV tariffs sustained logistics cost savings. Per-kilometre operating costs domestic battery production Legal Public Private Parinerships to fund charging infrastructure Global MOU on 100% new zero-emission medium- and heavy-duty vehicle (MHDV) Service Toll Damages caused to the truck in case of an accident Axle Weight Limits Lights	**Corporate owner/medium and heavy commercial trucks:** This quadrant would be associated with large trucks used by companies for transport of goods over long distances. These trucks usually have a carrying capacity of over 7.5 tonnes and are used for logistics, manufacturing, and construction purposes.	**Corporate owner/medium and heavy commercial trucks**: Tata Prima, Ashok Leyland 3118, BharatBenz 3123R, Eicher Pro 6037, Volvo FMX	
Quadrant 2 (Corporate Owner/Light Commercial Trucks): National-level EV policies Incentive policies for sustainable transportation Infrastructure investment policies Business model risks Battery recycling programs Service Toll Engine Emissions Standards Environmental protection regulations Safety requirements for cargo handling Driver hours of service regulations Alcohol and drug testing regulations	**Corporate owner/light commercial trucks:** This quadrant would be associated with smaller trucks used by companies for transport of goods over short to medium distances. These trucks usually have a carrying capacity of 1.5 to 7.5 tonnes and are used for last-mile delivery, e-commerce, and small business operations.	**Corporate owner/light commercial trucks:** Tata Ace, Mahindra Bolero Pickup, Ashok Leyland Dost, Mahindra Supro, Piaggio Porter	

Quadrant 3:
The third quadrant portrays a scenario where individual truck owners possess light commercial trucks. Design drivers in this segment are oriented toward respective truck owners' needs and preferences. Factors such as affordability, ease of maintenance, comfort, and customization options might be significant considerations in this scenario.

Quadrant 4:
The final quadrant outlines a scenario where medium and heavy commercial truck operators own medium and heavy trucks. The design drivers in this quadrant primarily address the requirements of professional truck drivers and their companies. Factors such as power, towing capacity, safety features, driver comfort, and advanced technology integration could be crucial.

By employing this Matrix, I could identify the specific design direction for each quadrant and build corresponding scenarios. Moreover, it enabled me to discern the type of vehicles associated with each segment, providing a comprehensive overview of the diverse design requirements within the commercial trucking industry.

Quadrant 3 (Light Commercial Trucks/Individual Owner): Electrical costs Maintenance and electricity costs Site assessment and installation costs Energy storage investments Financing R&D and Manufacturing Removing demand charges for ZET charging Subscription-based charging models Dedicated funding for infrastructure buildout Battery recycling programs Resale value. Total operational costs Energy efficiency Durability Warranty and after-sales support Repairability Flexibility for multiple use scenarios circular design EV tariffs Per-kilometre operating costs oil import dependancy Free Public transportation Pedestrian Safety Lighting and Reflective Markings Overloading restrictions Safety requirements for cargo handling Vehicle identification requirements	**Light commercial trucks/individual owner:** This quadrant would be associated with smaller trucks used by individuals and small businesses for personal and commercial purposes. These trucks usually have a carrying capacity of up to 1.5 tonnes and are used for delivery, transportation of small goods, and personal use.	**Light commercial trucks/individual owner**: Mahindra Jeeto, Tata Ace Zip, Ashok Leyland Dost+, Force Motors Trump 40	
Quadrant 4 (Individual Owner/Medium and Heavy Commercial Trucks): Initiatives to promote manufacturing Initiatives to improve logistics efficiency Incentives on battery manufacturing Supply-side policies Charging Infrastructure National Green Hydrogen Mission FAME II NEV Mandate Energy security Intellectual property rights Smart grid	**Individual owner/medium and heavy commercial trucks:** This quadrant would be associated with large trucks used by individuals for transportation of goods over long distances. These trucks usually have a carrying capacity of over 7.5 tonnes and are used for personal and business purposes such as agriculture, mining, and construction.	**Individual owner/medium and heavy commercial trucks:** Ashok Leyland 3718, Tata Signa 4018, Eicher Pro 6025, Mahindra Blazo X 55, BharatBenz 2523R	

3. User study

Name: Rashal Singh
Place: Pind DALA, Amritsar
Experience: 10 years in VRL
Over all experience: 24 years

Ashok Leyland U 4923 TT

Name: Mohammad
Place: Karnataka
Experience: 15 years
All over india Transport

Ashok Leyland 1616

Name: Mishra
Age: 34
Place : Basti gau, Sant Kabir nagar Uttar Pradesh
Experience : 15 years

Ashok Leyland 1616

Name: Sardar Sarabjit Singh
Place: Punjab, tarn taran District, Pind sur singh
Experience: 15 years

Ashok Leyland 4020 4X2 Tractor

4. Observation

The drivers' earnings are significantly depleted by maintenance expenses. The drivers are greatly concerned with the upkeep of the truck’s tires

This is made from tube of the truck tyre, they use it store water to wash hands and utensils.

A water can is used to store drinking water, which they refill at local roadside stops.

Ventilation in cabin is not effective. The driver fabricated custom-built fans using
scrap parts

5. Design Brief

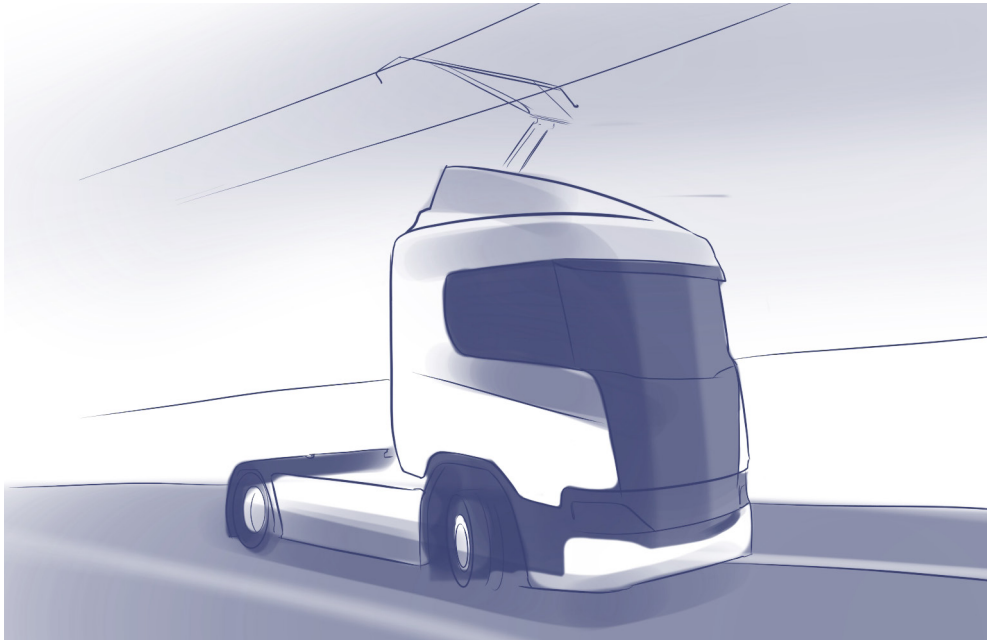
To Develop an innovative truck concept for Indian drivers in 2040, focusing on their unique needs during long-distance journeys.

The truck should provide functional space and comfort for two persons, minimize driver strain, . Integrate cutting-edge technologies, including renewable energy sources, advanced driver assistance systems, and seamless connectivity. Enhance safety, optimize ergonomics, and create a futuristic design that enhances the overall well-being and experience of Indian truck drivers in 2040.

6. Scenario

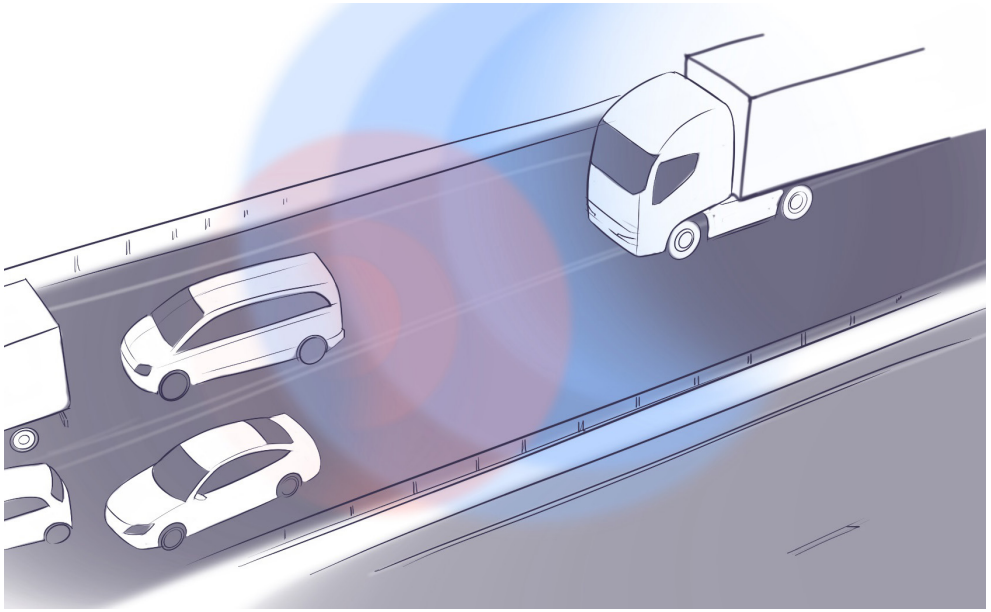
Name: Rohan
Age in 2040: 35 years old (born in 2005)
Place of residence: Delhi, India
Occupation: Business owner in the logistics industry

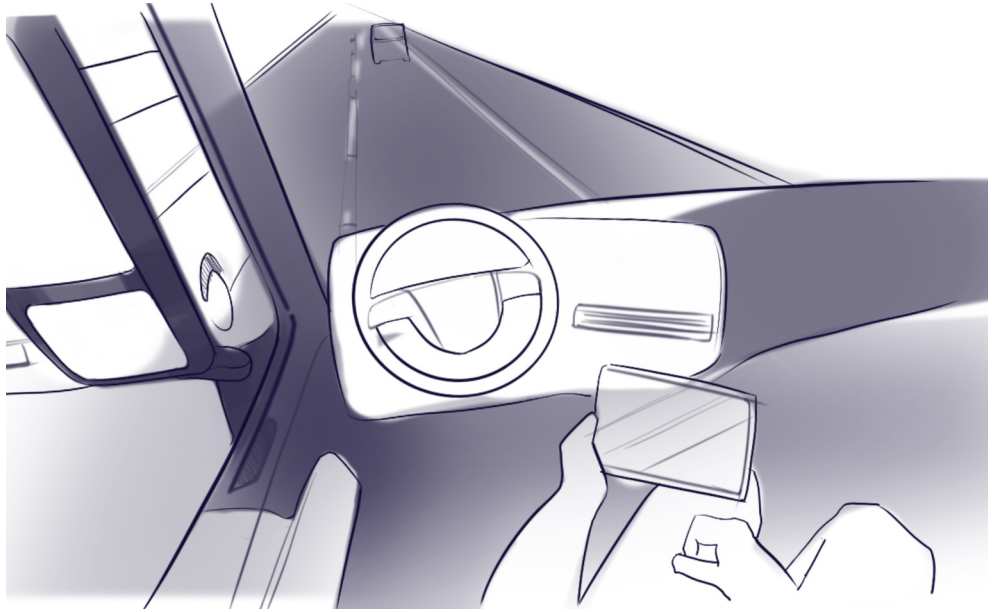
Rohan is the owner of a logistics company that operated a fleet of medium and heavy commercial trucks. His business had been hit hard by rising fuel costs, and he was struggling to keep his trucks running efficiently while also meeting the new emissions standards set by the government. Rohan had always been passionate about sustainability, and he knew that he needed to find a way to transition his fleet to electric vehicles if he wanted to stay competitive.



In 2040, Rohan seized the opportunity to embrace a greener future. Encouraged by supportive government policies and incentives, he made a strategic investment in a fleet of electric trucks. These vehicles not only reduced environmental impact but also proved to be more cost-effective in the long run. Rohan's drivers were delighted with the transition, as the electric trucks provided a quieter and more comfortable driving experience. Customers valued the company's commitment to sustainability, further strengthening its reputation.

To ensure seamless operations, Rohan leveraged smart grid technology and innovative charging solutions. This intelligent infrastructure enabled him to efficiently power and maintain his growing fleet, even as the demand for his services increased. With each successful delivery, Rohan took pride in knowing that his company was actively contributing to the transition towards a more sustainable future.





Reflecting on his decision to invest in electric vehicles, Rohan was confident that he had made the right choice. The positive impact on the environment, the improved driving experience for his employees, and the long-term cost savings all validated his commitment to sustainability and innovation.

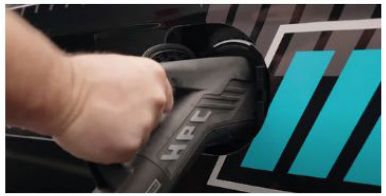
7. Benchmarking

Volvo HF Electric

Specifications – Volvo FH Electric

Features	Volvo FH Electric
Axle Configurations	Tractor: 4×2, 6×2, 6×4. Rigid: 4×2, 6×2, 6×4, 8×2, 8×4 All axles are air suspended
Cab	Low sleeper cab, sleeper cab, Globetrotter cab, Globetrotter XL cab
Gross Combination Weight	Up to 44 tonnes
Battery capacity	180–540 kWh, 2-6 batteries.
Range	Up to 300 km (4x2 tractor trailer)
Charging time (full charge)	9.5h with AC (43 kW) 2.5h with DC (250 kW)
Driveline	2–3 electric motors, I-Shift gearbox
Performance	Up to 330–490 kW (450–666 hp) continuous power
Applications	Suitability for body-work. 3 PTO:s (electrical, mechanical and transmission)

Mercedesse eActros

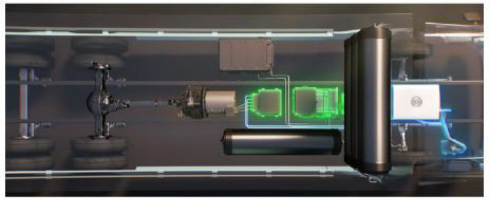


The eActros in two different versions.
Maximum vehicle lengths6150 mm
Width2,500 mm/
aluminium rims 2,550 mm2,500
Model variant 983.493
Wheelbase 4000 mm
Perm. gross vehicle weight 19 t (40 t)
Payload without body approx. 10.4 t
Cab/engine tunnelM ClassicSpace/engine tunnel 170 mmM
Axle load (air suspension) 8.0/11.5
Engine performance (max./cont.)400/330 kW
Engine output, engine PTO – low powerCurrently under development
Engine output, engine PTO – high powerCurrently under development
\Max. speed 89 km/h

TATA Prima electric

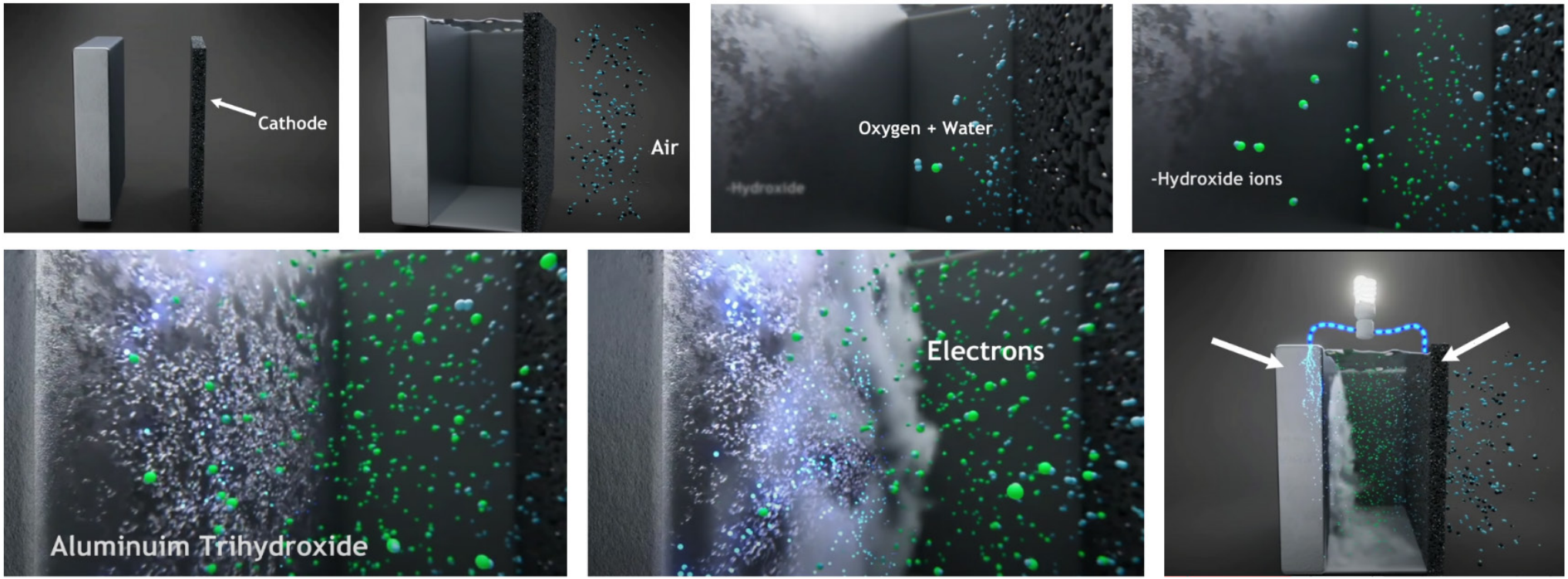
TATA TRUCK			
	PRIMA E.55S	PRIMA H.55S	PRIMA E.28k
ENGINE	ELECTRIC	HYDROGEN	ELECTRIC
POWER	296bhp	290bhp	323bhp
TORQUE	2500Nm	1200Nm	2950Nm
TRANSMISSION	-	9 Speed	2 Speed E-Gear
RANGE	350-500km	350-500km	150-200km

Ashok Leyland Trucks



8. Understanding the Technology

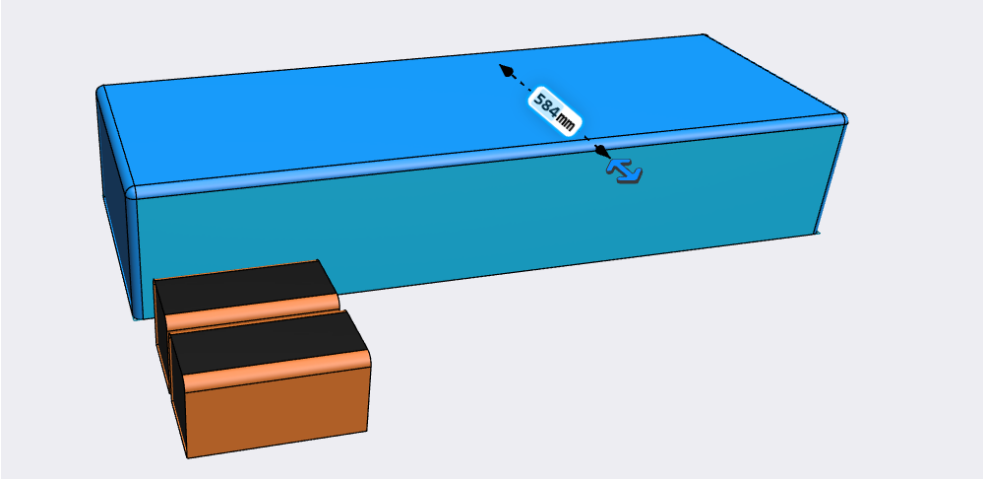
Aluminium battery is being developed by Indian oil corporation and israeli clean energy startup phinergy



The battery is constructer using Plastic aluminium and Electrolyte The metal-air battery, known as the aluminium-air battery, produces electricity by using aluminium as the anode and oxygen from the air as the cathode. Aluminium interacts with the hydroxide ions in the electrolyte during discharge to create aluminium hydroxide and release electrons. At the cathode, water and electrons react with oxygen from the air to generate hydroxide ions. Electricity is produced by this electrochemical process.

The high energy density of aluminium-air batteries is one of their main advantages, making them ideal for long-lasting power applications like electric automobiles. These batteries do have certain drawbacks, though. Once the aluminium anode has been used up, it is impossible to recharge the battery by merely switching out

the anode. It is necessary to totally swap out the used anode. The battery is constructer using Plastic aluminium and Electrolyte They do not get short circuited



Technical Specifications Lithium Battery Freedom 40Kwh

Max Energy [kWh] - 40..
Weight [kg] - 429.
Dimensions (Height x Width x Depth(wall)[mm])- 1656 mm x 584 mm x 306 mm.

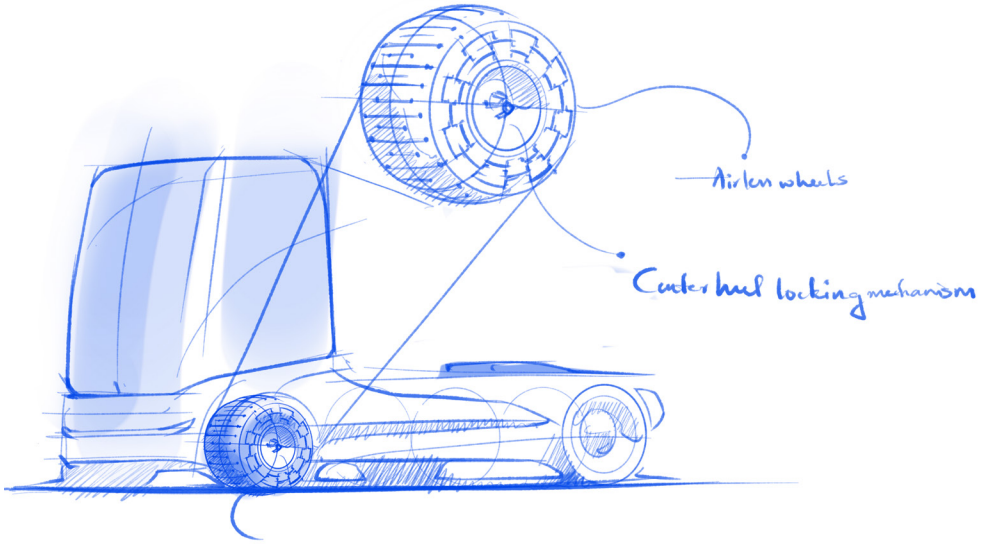
Technical Specifications Alumnium battery Freedom 50Kwh

Max Energy [kWh] - 50.
Weight [kg] - 30
Dimensions (Height x Width x Depth(wall)[mm])- 300 mm x 150 mm x 150 mm. (for 25kWh)

8. 1 Energy density

The total amount of energy in a system per unit volume. Alumnium battery is 8kwh/kg (even with half the density you get 4x higher range)
Lithium and other batteries is 1- 1.5kwh/kg

8. 2 Air less Tyre



Non-pneumatic tires (NPT), commonly called airless wheels, are cutting-edge wheel designs that don't need air pressure to work. Airless wheels are solid or feature an unusual internal structure that offers support and cushioning without the need for inflation, unlike conventional pneumatic tires filled with air.

Comparing airless wheels to pneumatic tires, there are various benefits. First, there is no chance of blowouts or flats brought on by sharp objects or leaks; therefore, they are puncture-proof. Airless wheels are beneficial in tough situations or for off-road applications because of this property.

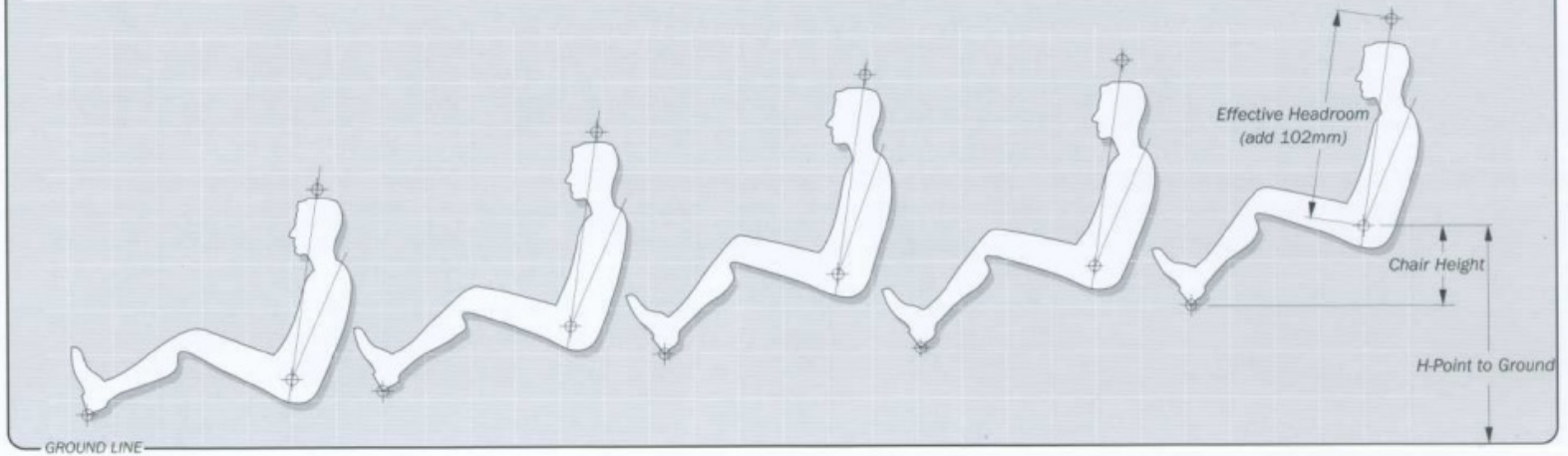
Airless wheels also do away with the requirement for tire upkeep, including air pressure checks and tire inflation. Doing this decreases the overall maintenance expenses, and reliable performance is guaranteed without the danger of underinflation or overinflation.

9. Vehicle packaging

Ergonomics Study

VARIOUS DRIVER HEIGHTS FROM GROUND AND POSTURES

H-Point to Ground	300 - 350*	400 - 500	700 - 750	700 - 800	700 - 950
Chair Height	135 - 180	200 - 250	300 - 350	300 - 350	300 - 350
Effective Headroom	950 - 960	970 - 1000	990 - 1010	1010 - 1020	1010 - 1020
Back Angle	28° - 30°	22° - 25°	22° - 24°	22° - 24°	22° - 24°



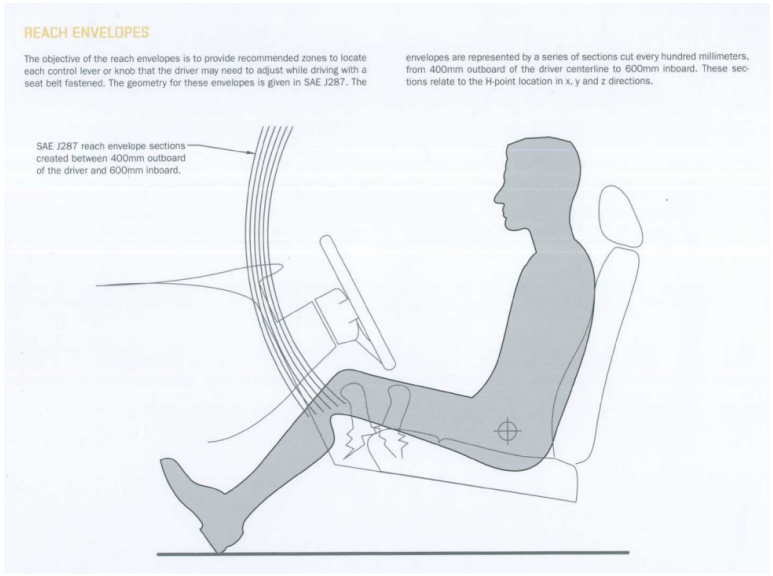
SPORTS CARS
The driver height is kept as low as possible to lower the center of gravity and reduce drag. Getting in and out of the car may be difficult but that is a compromise sports car owners will accept.

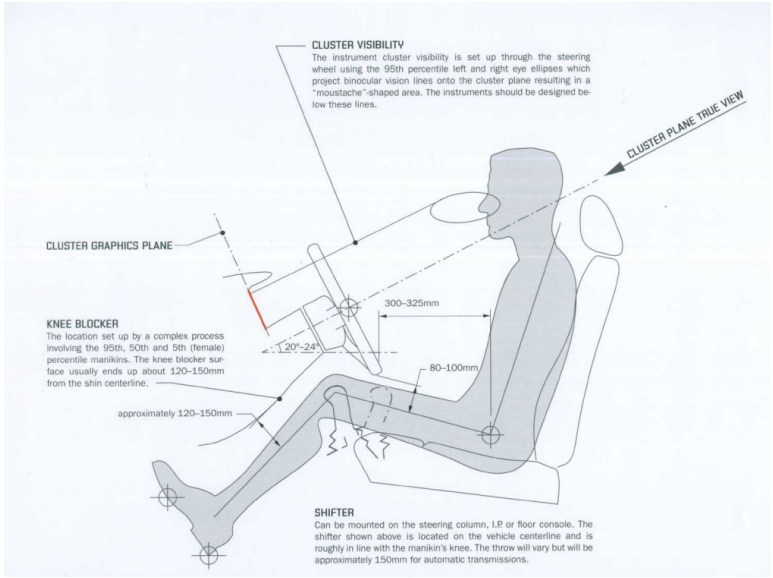
PASSENGER CARS
Most passenger car H-points are set up for a combination of easy ingress/egress and low center of gravity. Although not as extreme as most sports cars, they are relatively low.

MINIVANS
Usually set up quite high to provide a sense of security and good visibility. The tall chair height also helps to create an efficient package and provides excellent ingress and egress.

SUVs
A combination of high ground clearance and a durable underbody structure push the heel height up. The chair height is also tall to help the driver see over the engine, which is usually mounted high above the front axle.

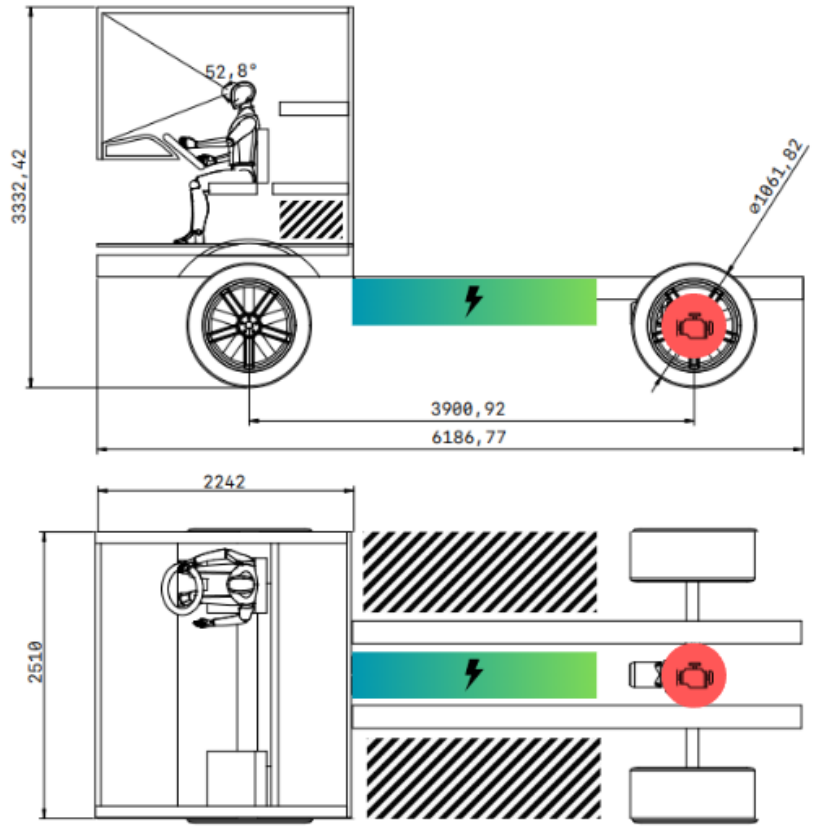
LARGE OFF-ROAD TRUCKS
Similar to SUVs, the occupants often sit very high because of the ground clearance and the separate frame that the body sits on. Because the engines are usually very large and mounted high, the driver's eye point may end up in a very high position.



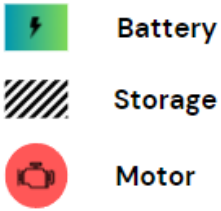


Seat dimension	Mean	St. Dev.	Percentile (%)		
			5th	50th	95th
TATA					
Seat height	47.3	0.2	47.0	47.3	47.5
Seat width	46.2	0.2	46.0	46.2	46.5
Seat depth	38.2	0.2	38.0	38.2	38.5
Backrest height	48.3	0.2	48.0	48.3	48.6
Steering wheel clearance	16.7	0.2	16.6	16.7	16.9
Back support to steering wheel	36.8	0.1	36.7	36.8	36.8
Back support to front of steering wheel	81.2	0.1	81.2	81.2	81.3
ASHOK LEYLAND					
Seat height	51.3	0.2	51.0	51.3	51.5
Seat width	48.3	0.2	48.0	48.4	48.6
Seat depth	44.2	0.2	44.0	44.2	44.5
Backrest height	47.2	0.2	47.0	47.2	47.5
Steering wheel clearance	12.7	0.1	12.5	12.7	12.9
Back support to steering wheel	37.4	0.2	37.2	37.5	37.5
Back support to front of steering wheel	83.7	0.1	83.6	83.7	83.8
ISUZU					
Seat height	36.3	0.2	36.0	36.3	36.6
Seat width	52.4	0.3	52.1	52.4	52.6
Seat depth	41.4	0.3	41.1	41.4	41.7
Backrest height	45.3	0.2	45.0	45.4	45.6
Steering wheel clearance	14.1	0.2	14.0	14.2	14.2
Back support to steering wheel	35.5	0.1	35.5	35.5	35.6
Back support to front of steering wheel	78.7	0.1	78.6	78.7	78.7

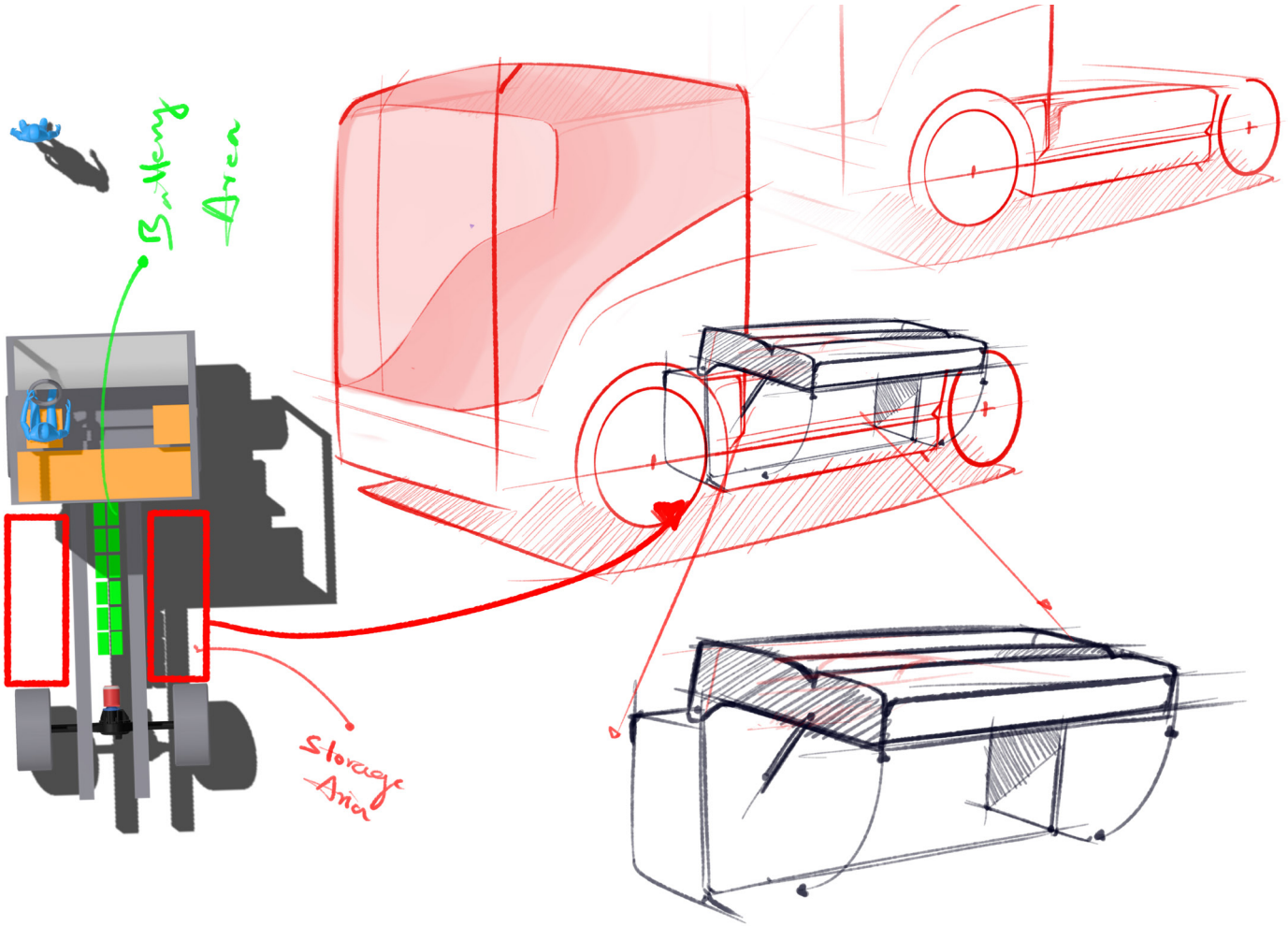
9. 1 Vehicle dimension



The vehicle packaging process was guided by benchmark vehicles, which influenced the dimensioning of the truck. Additionally, the positioning of the battery played a crucial role in determining the overall packaging of the vehicle. Extensive research was conducted to explore advanced battery technologies that effectively reduced the weight and space occupied by the battery within the chassis. This battery technology breakthrough optimized the vehicle's weight distribution and enhanced its overall efficiency and performance. By integrating these considerations into the packaging design, the final result achieved a well-balanced and optimized layout, showcasing a harmonious fusion of benchmark-based dimensions, strategic battery positioning, and innovative battery technology.

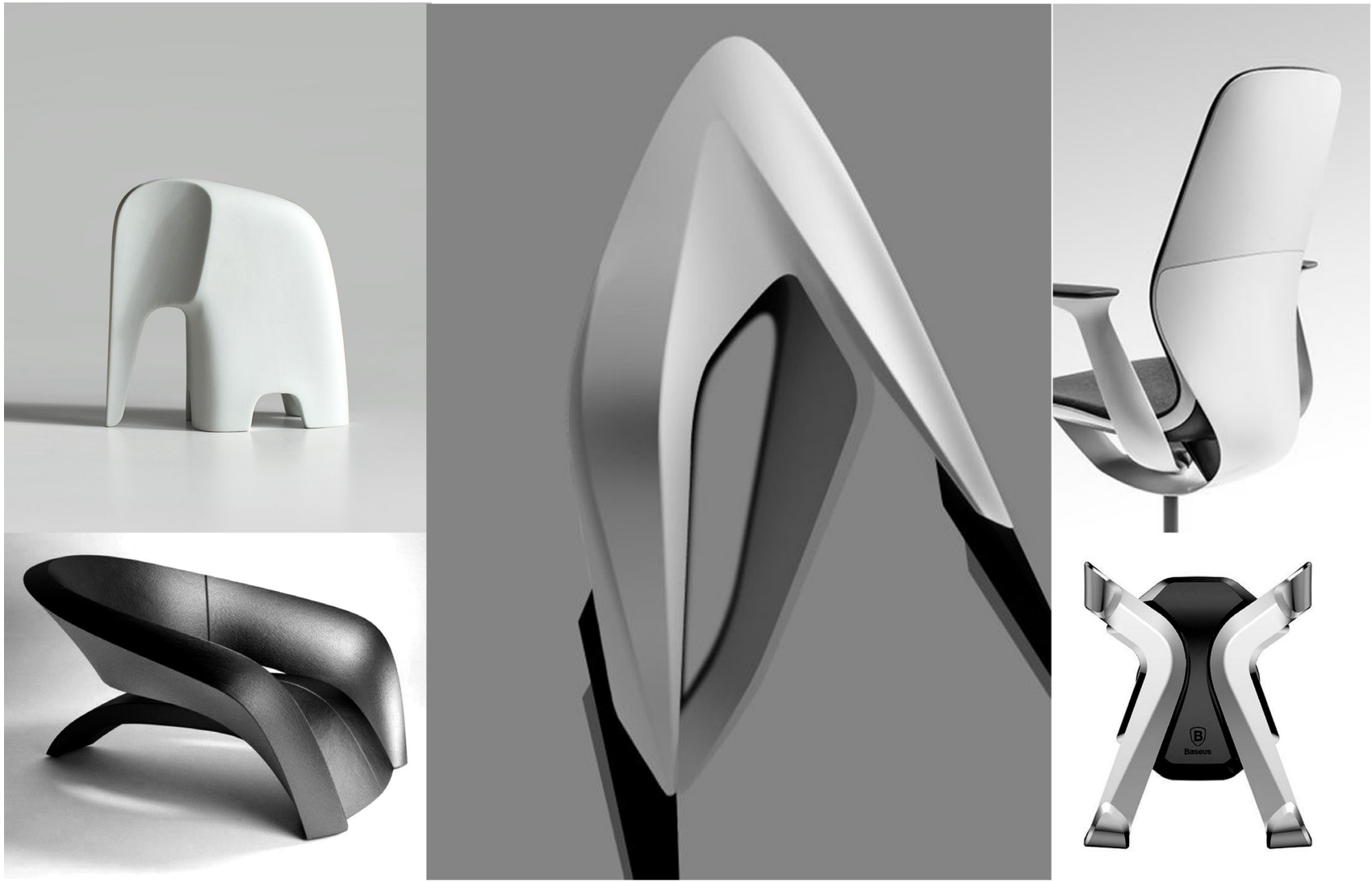


Space Allocation

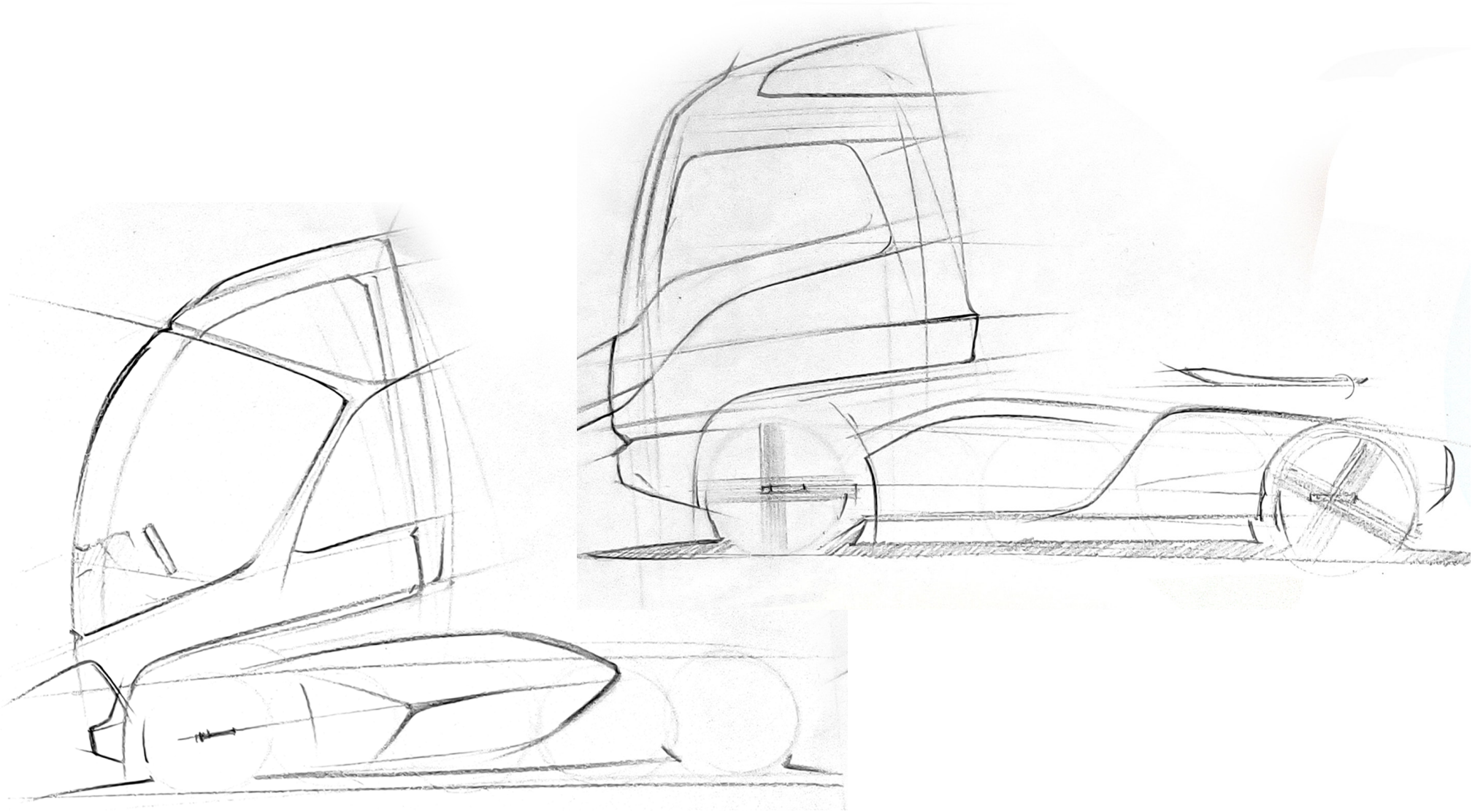


Using an Aluminium air battery drastically reduces the space required to place the battery inside the chassis, which results in additional storage space.

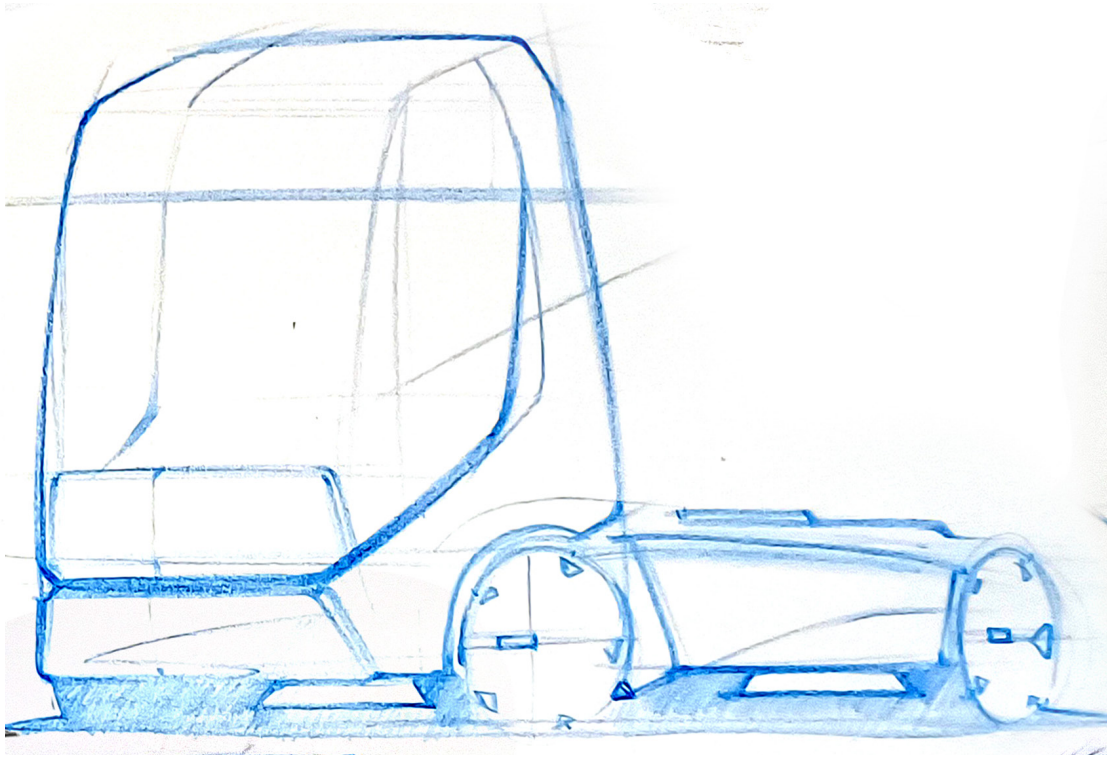
10. Inspiration Board

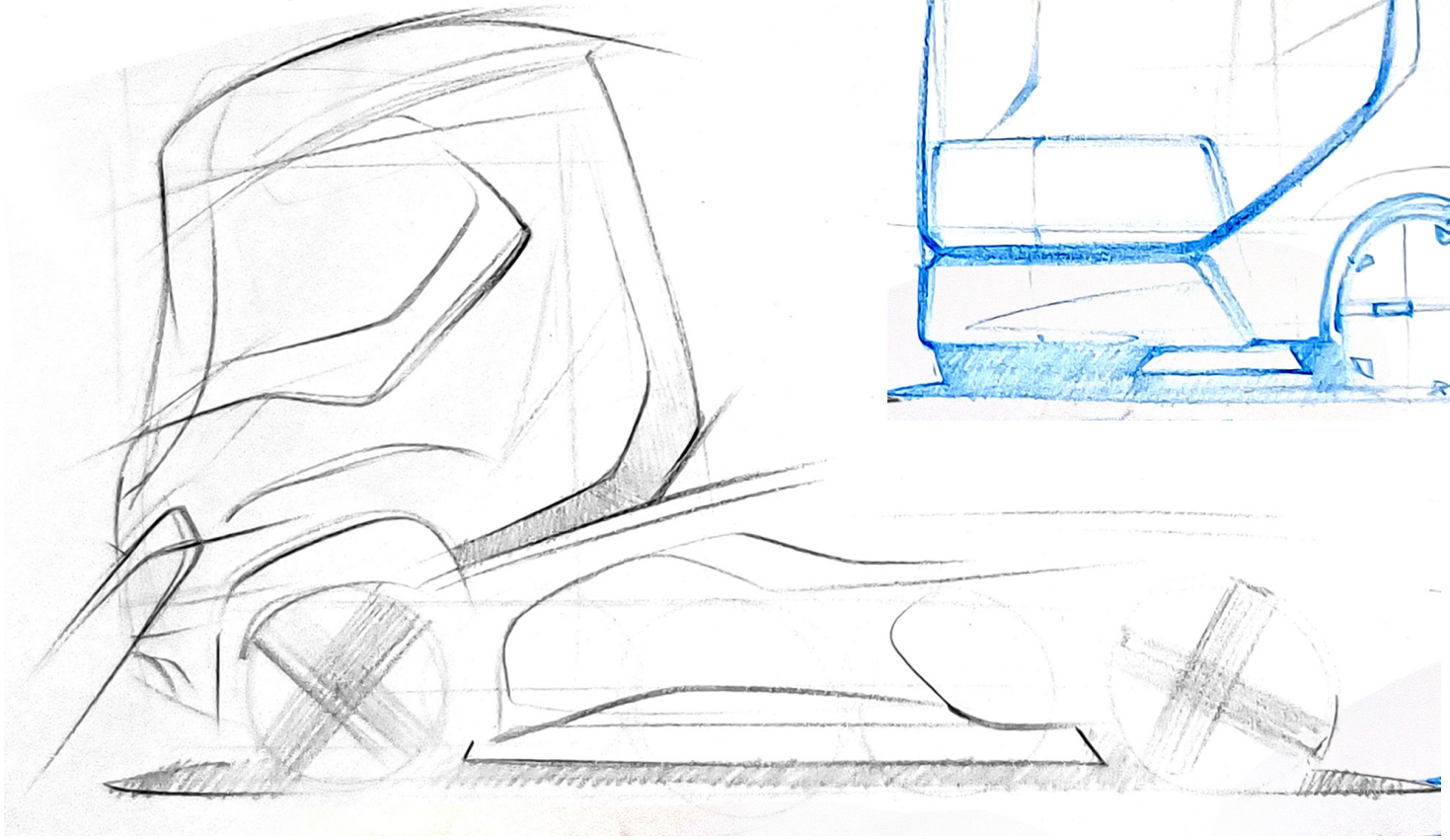


11. Ideations

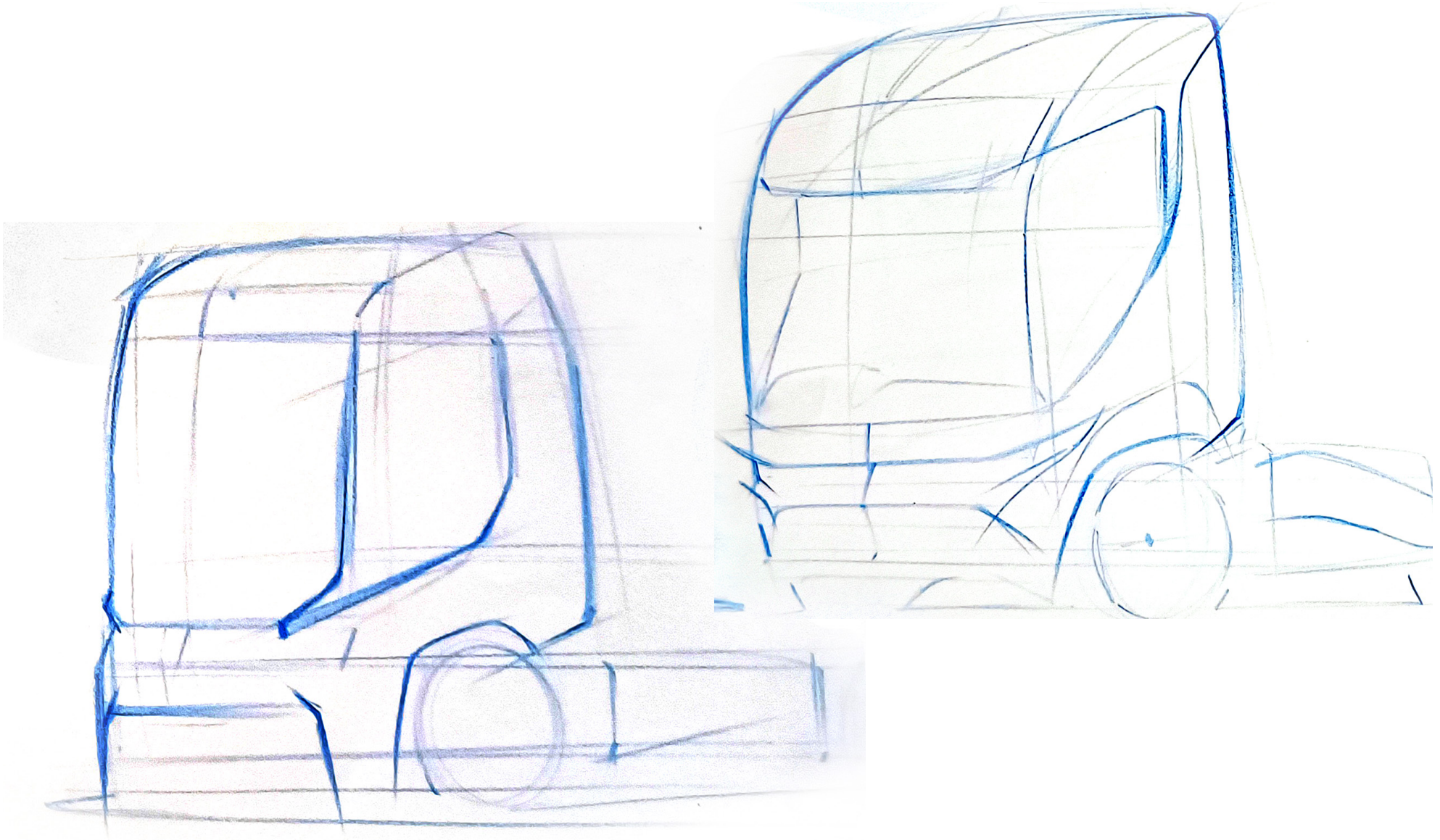


Ideations

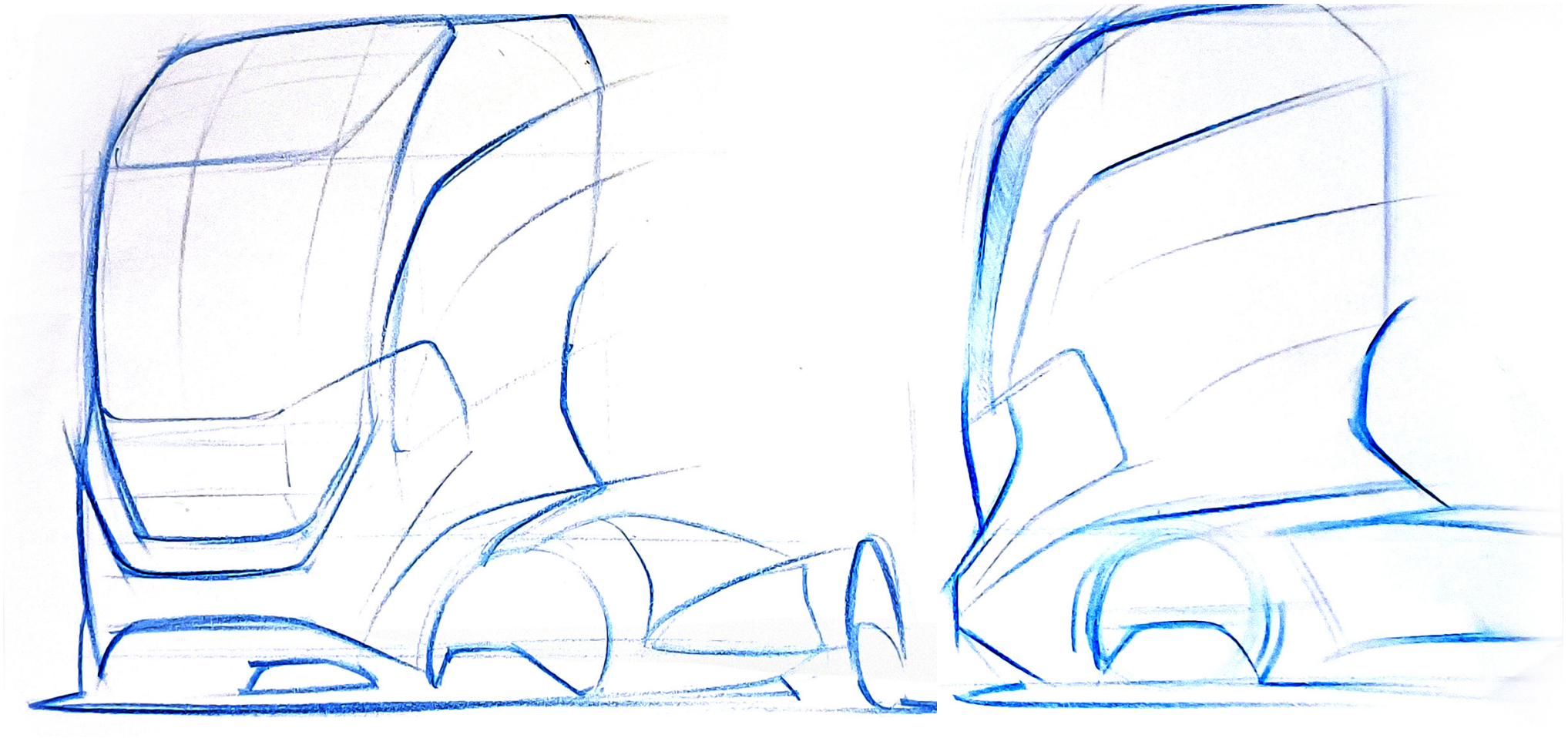




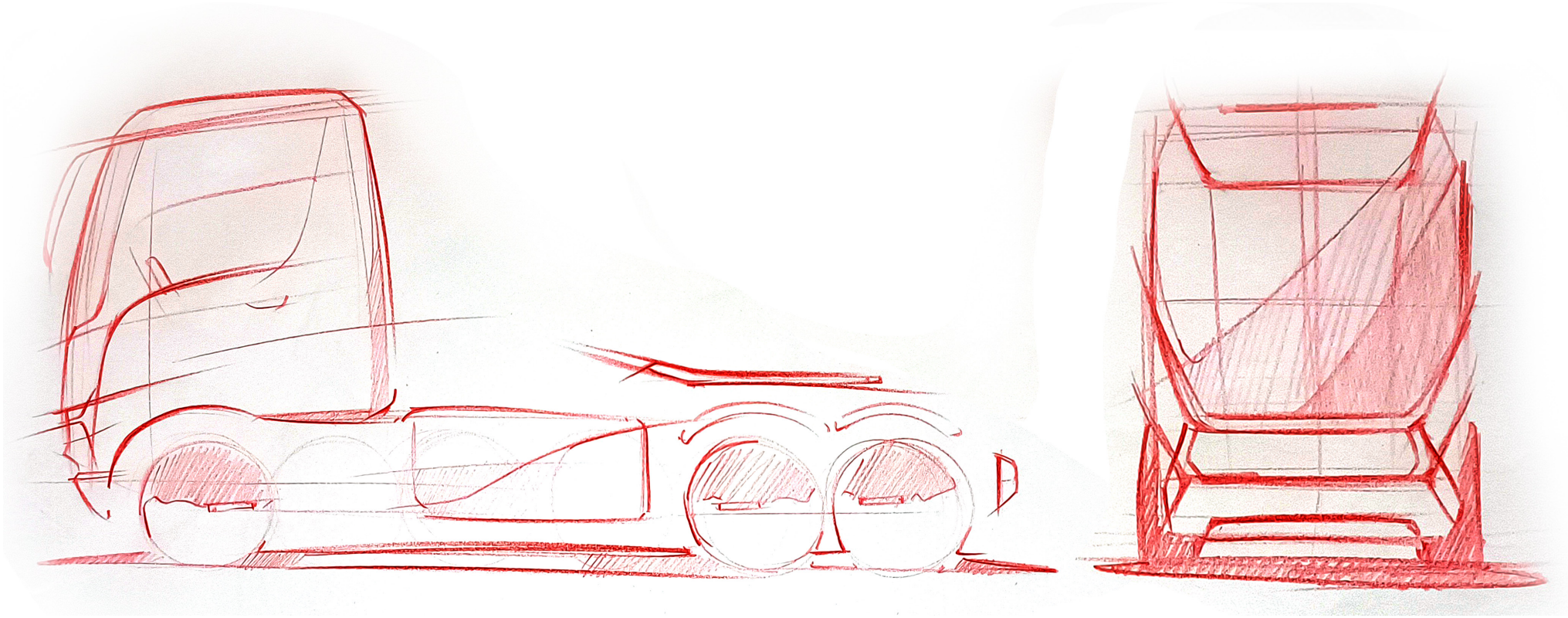
Ideations



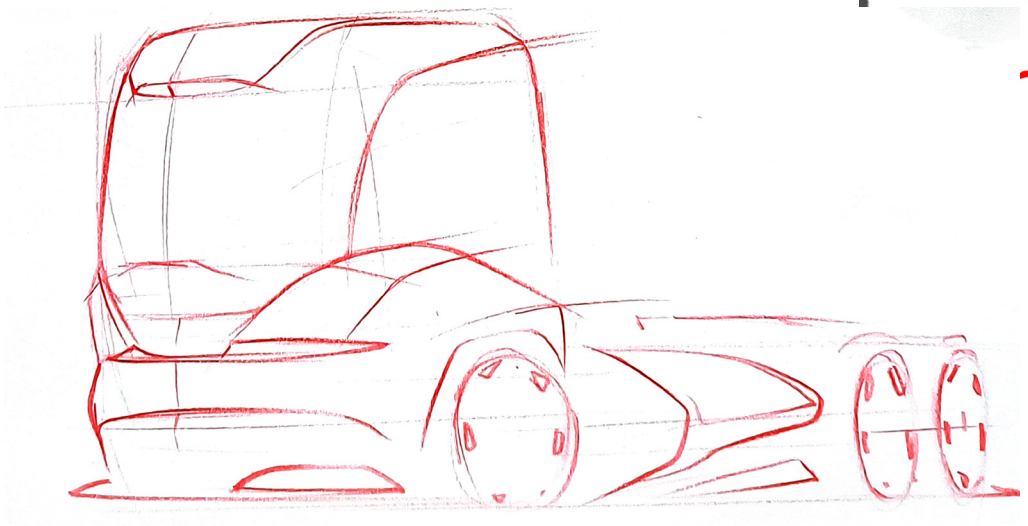
Ideations

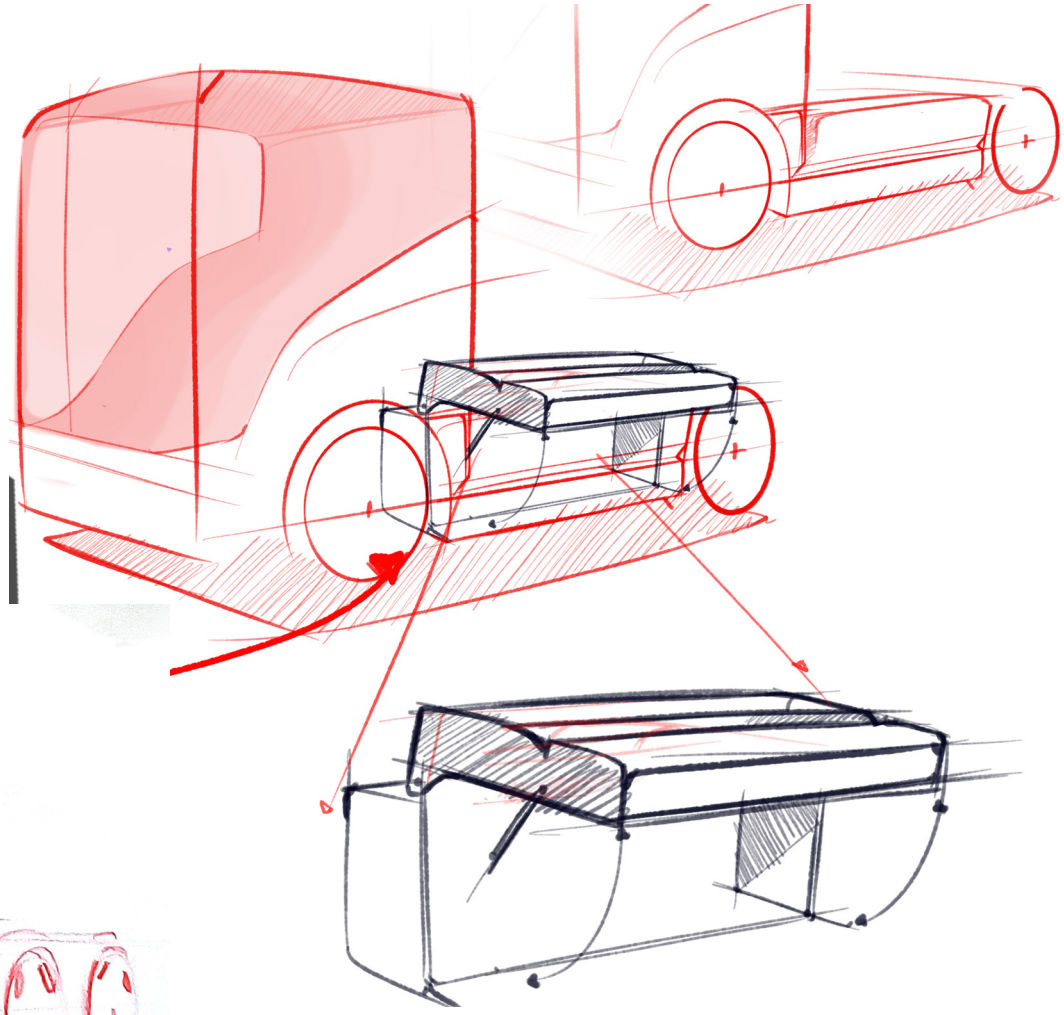


Ideations

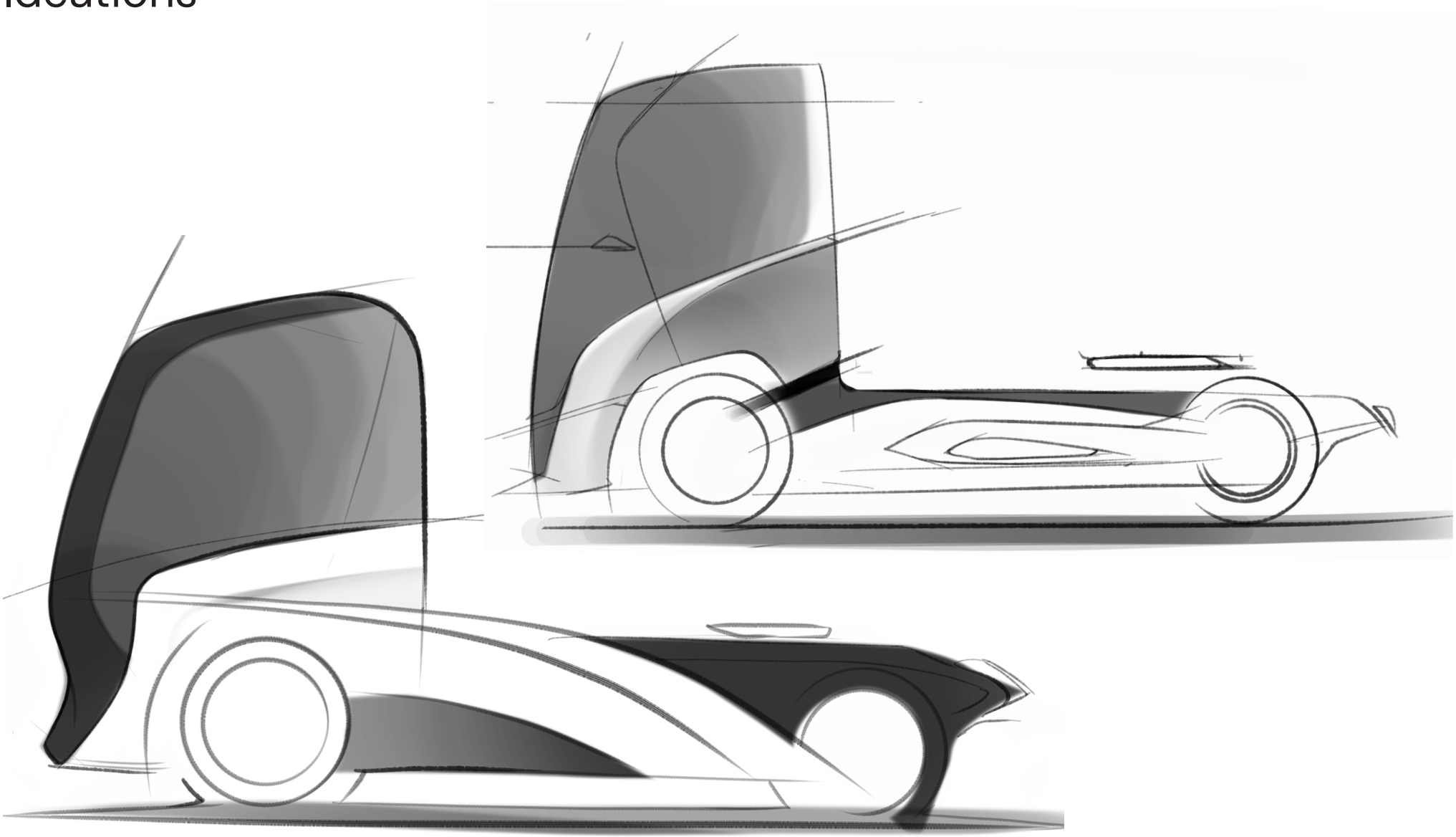


Ideations

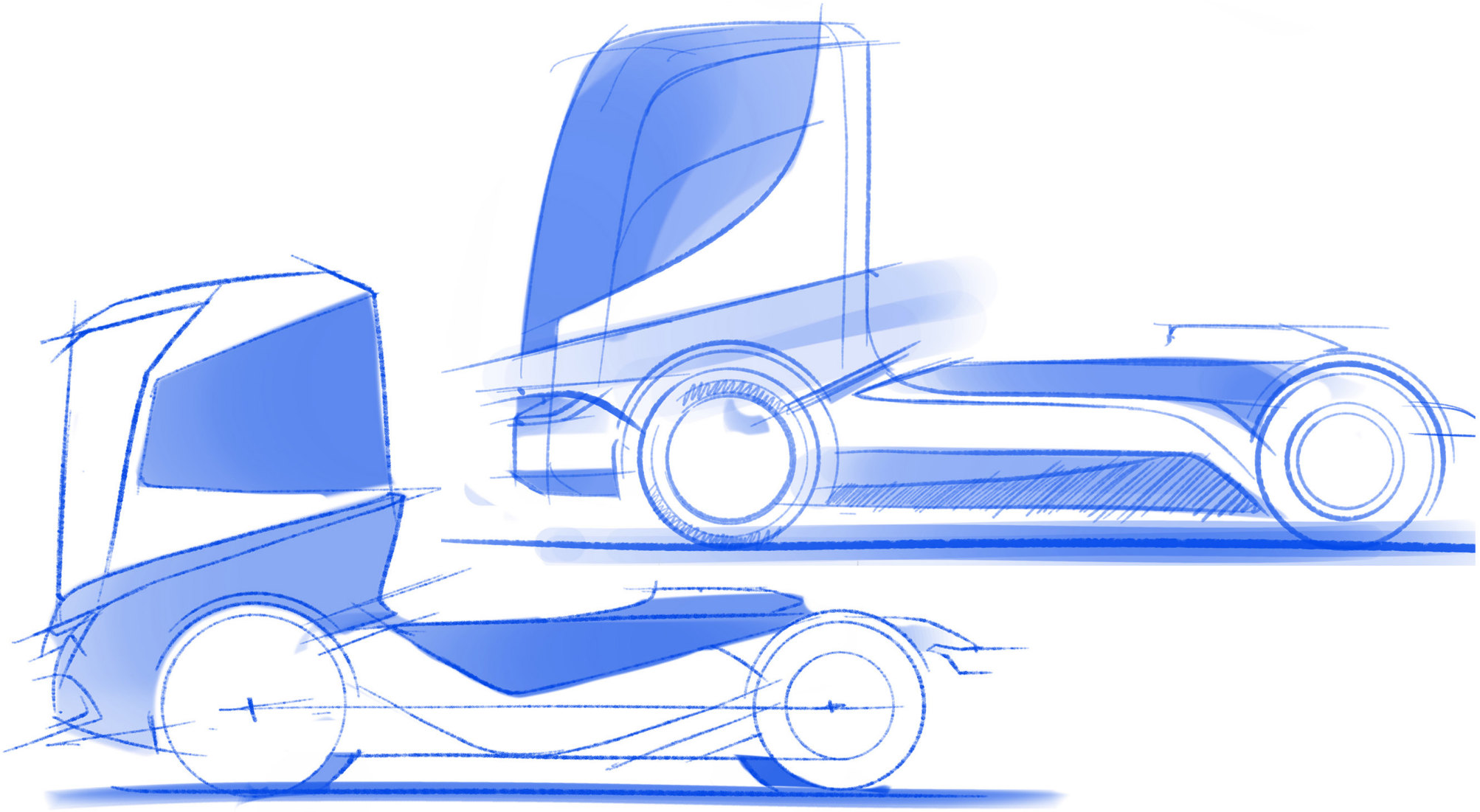




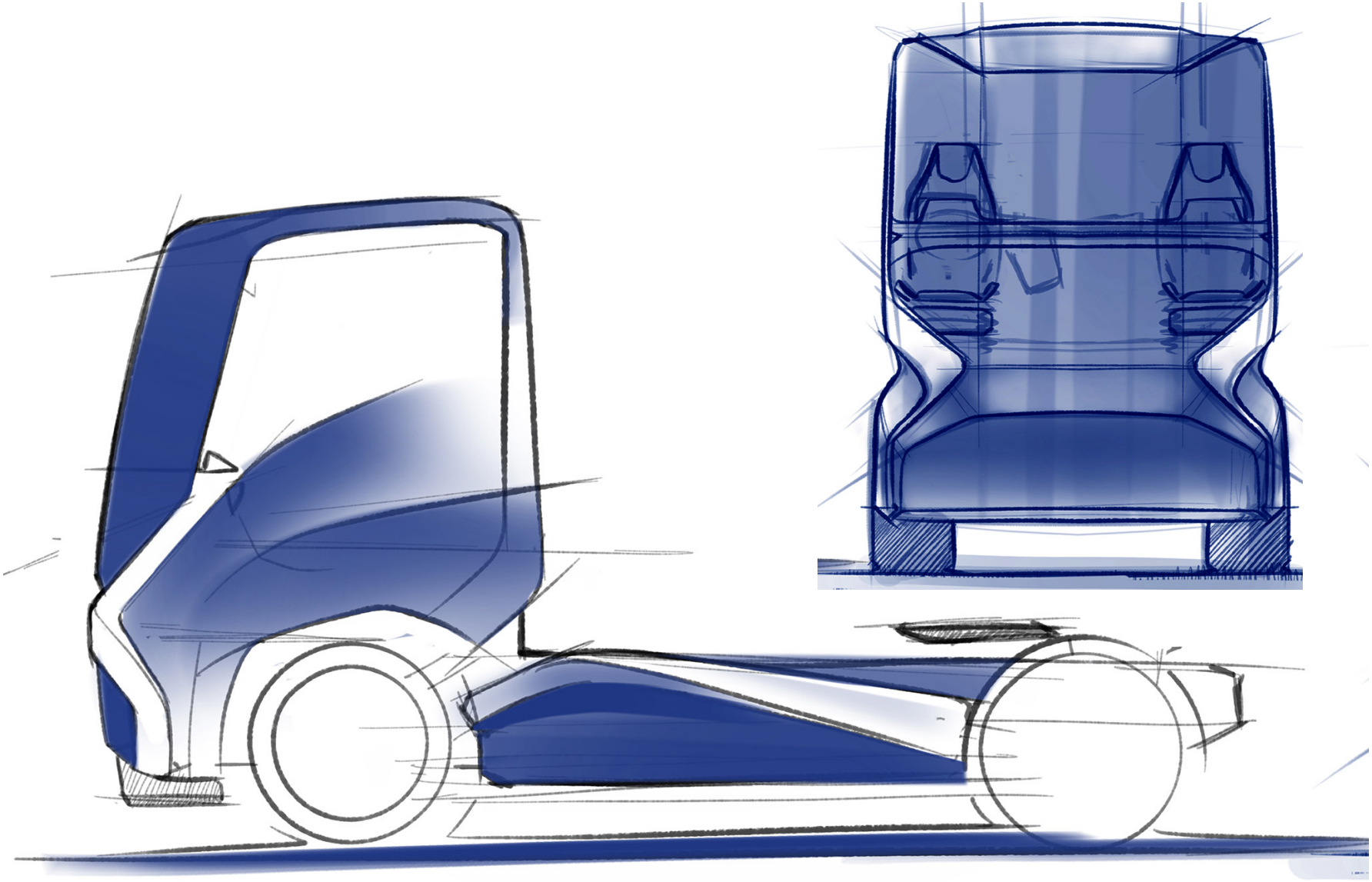
Ideations



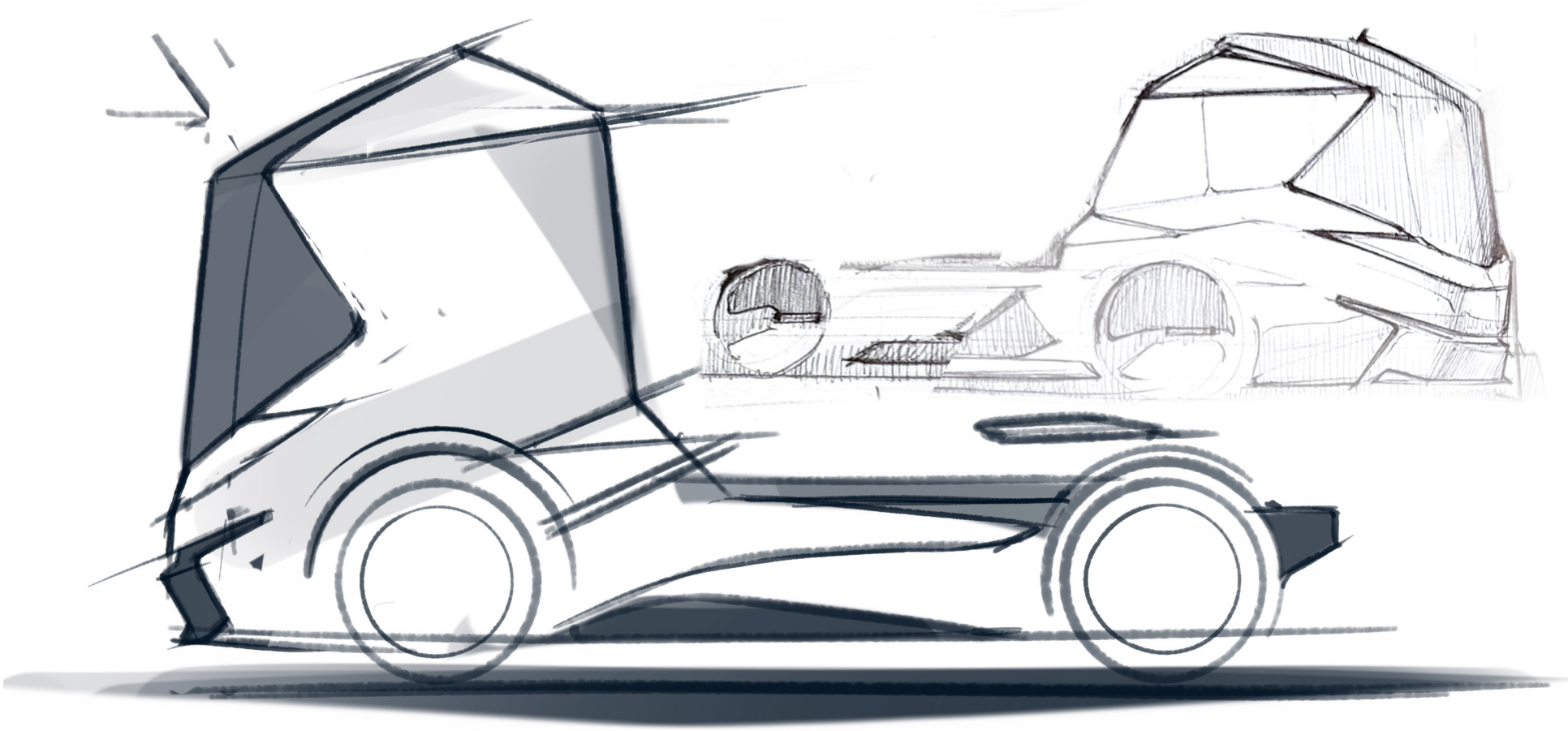
Ideations



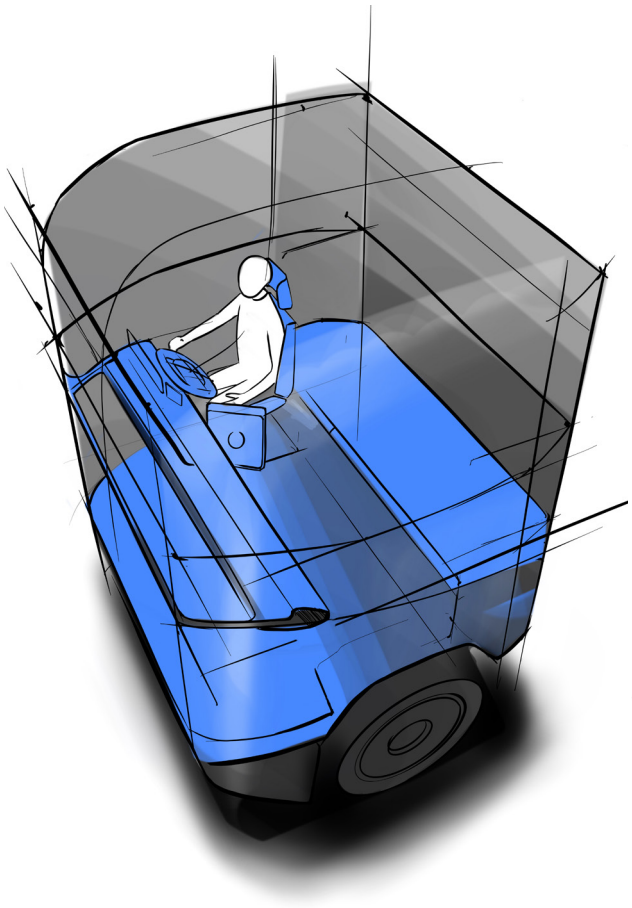
Ideations

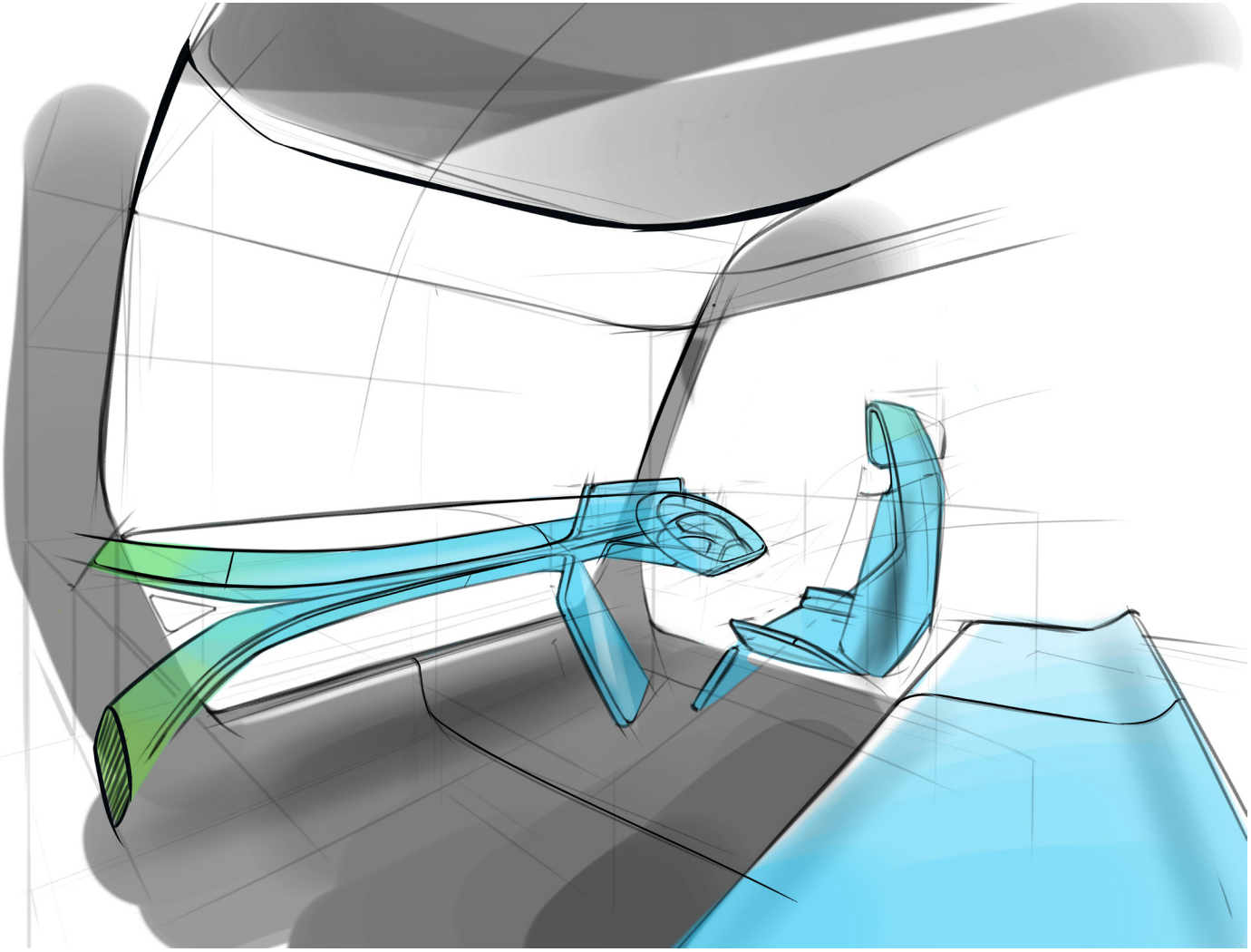


Ideations

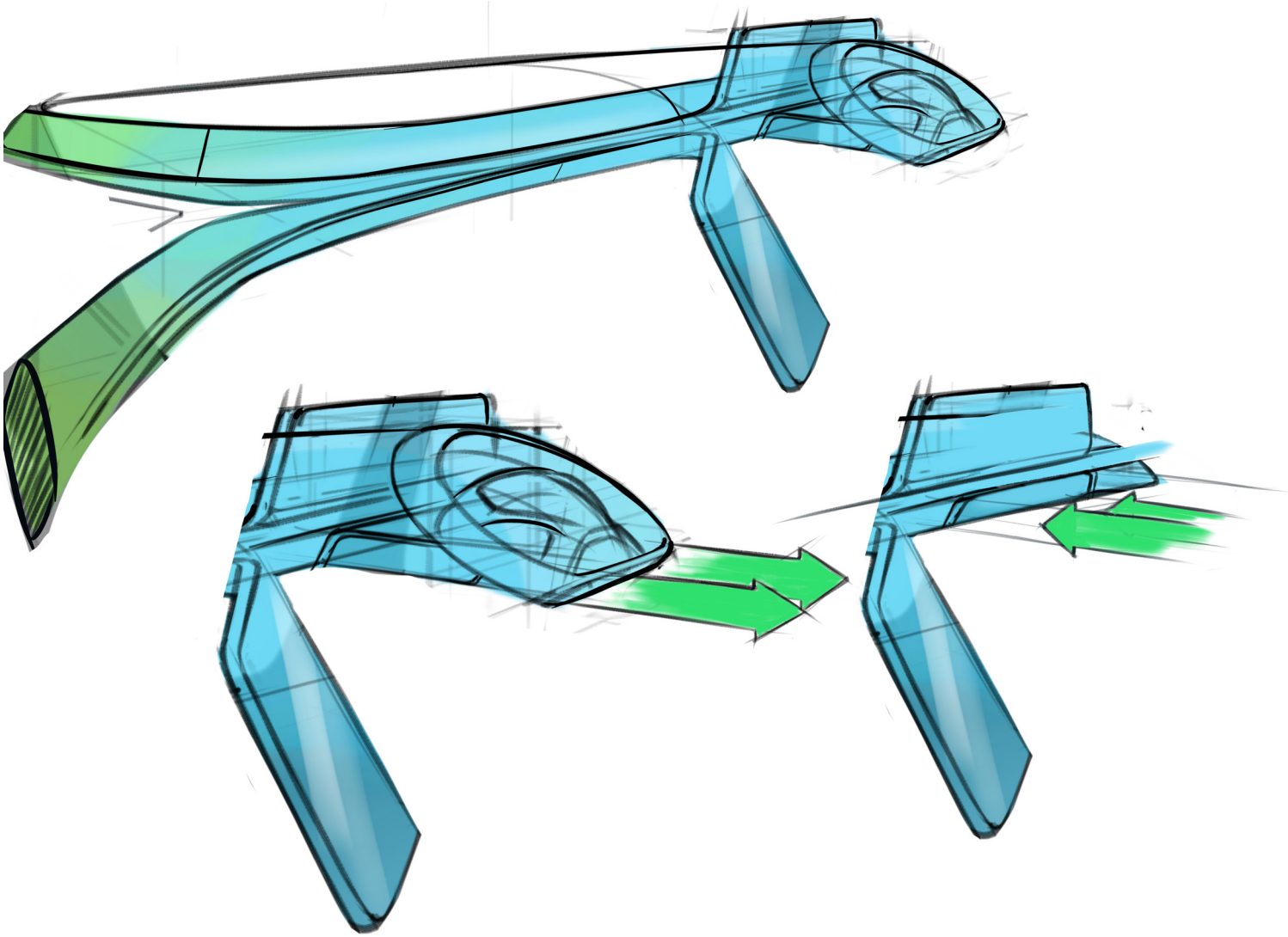


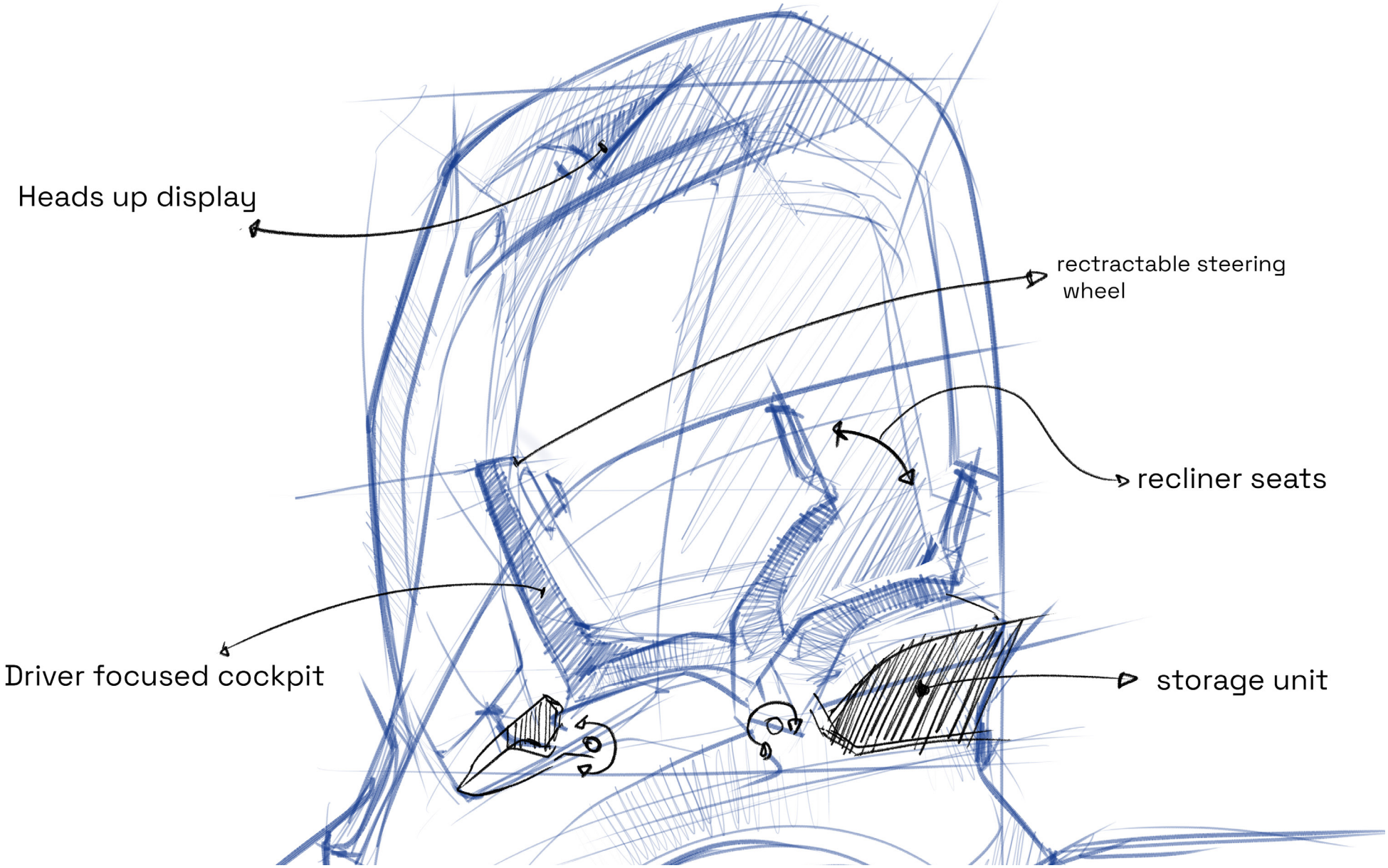
Interior Sketches



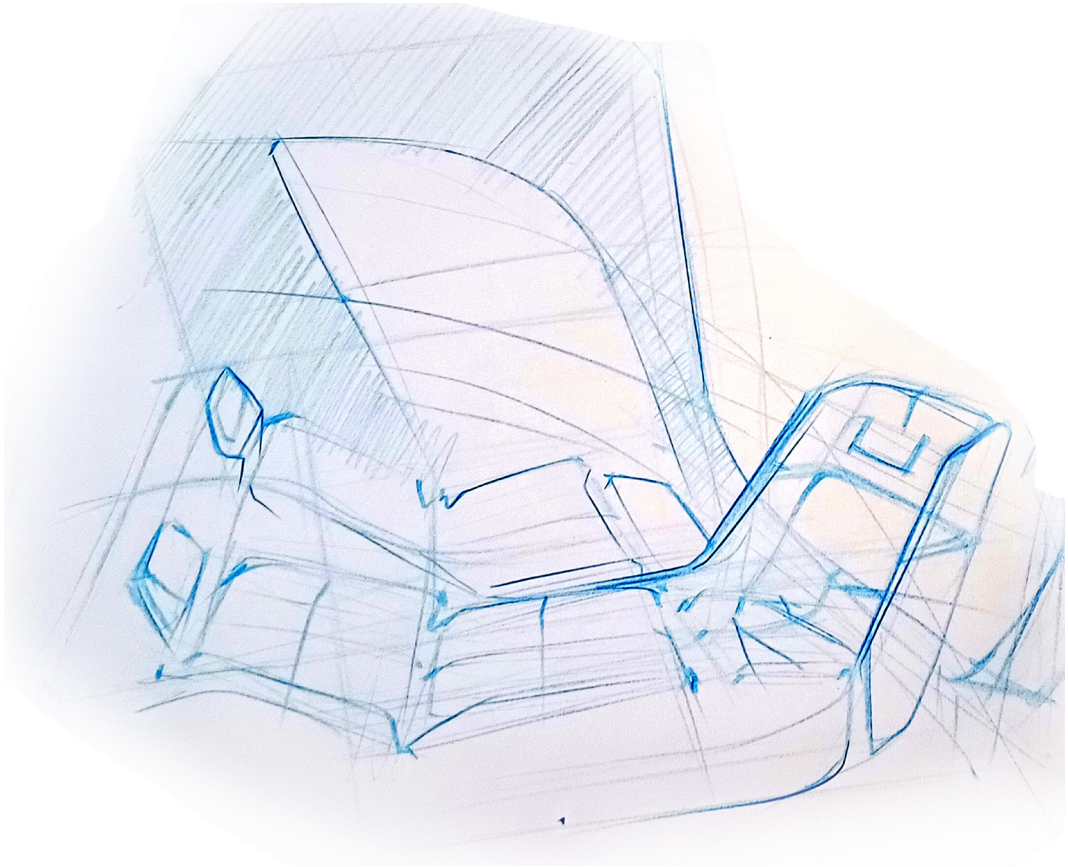


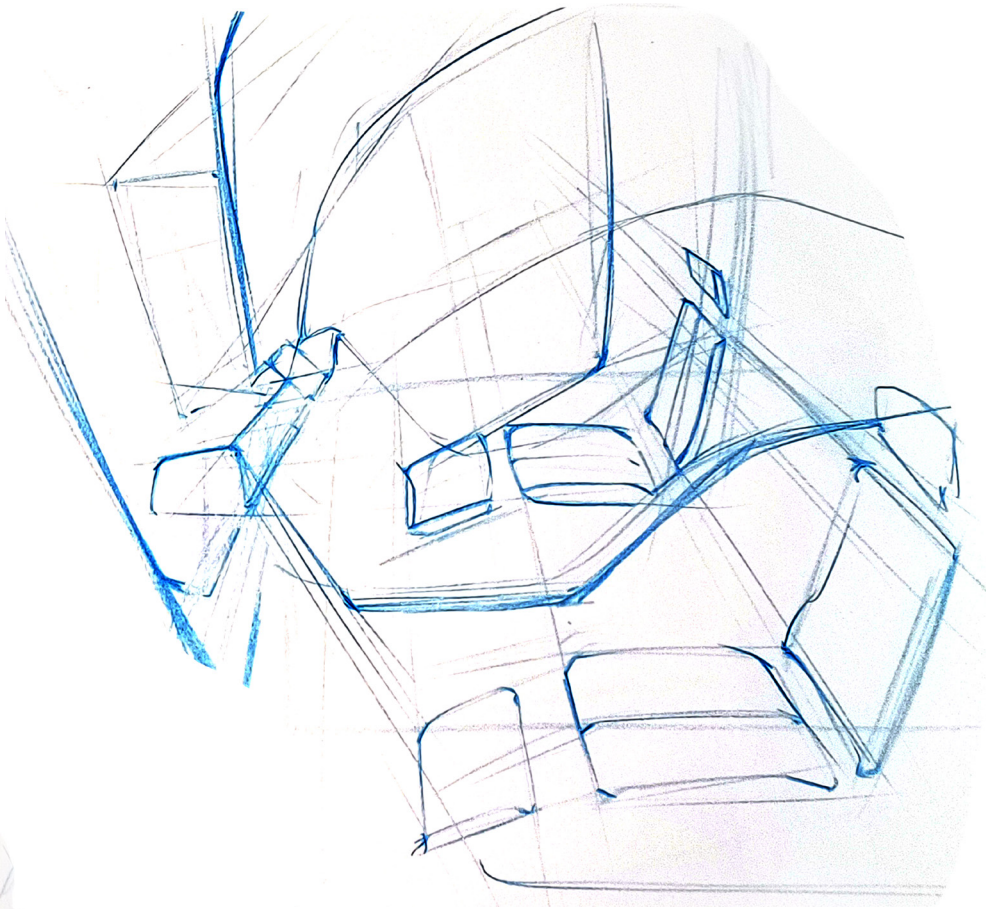
Interior Sketches

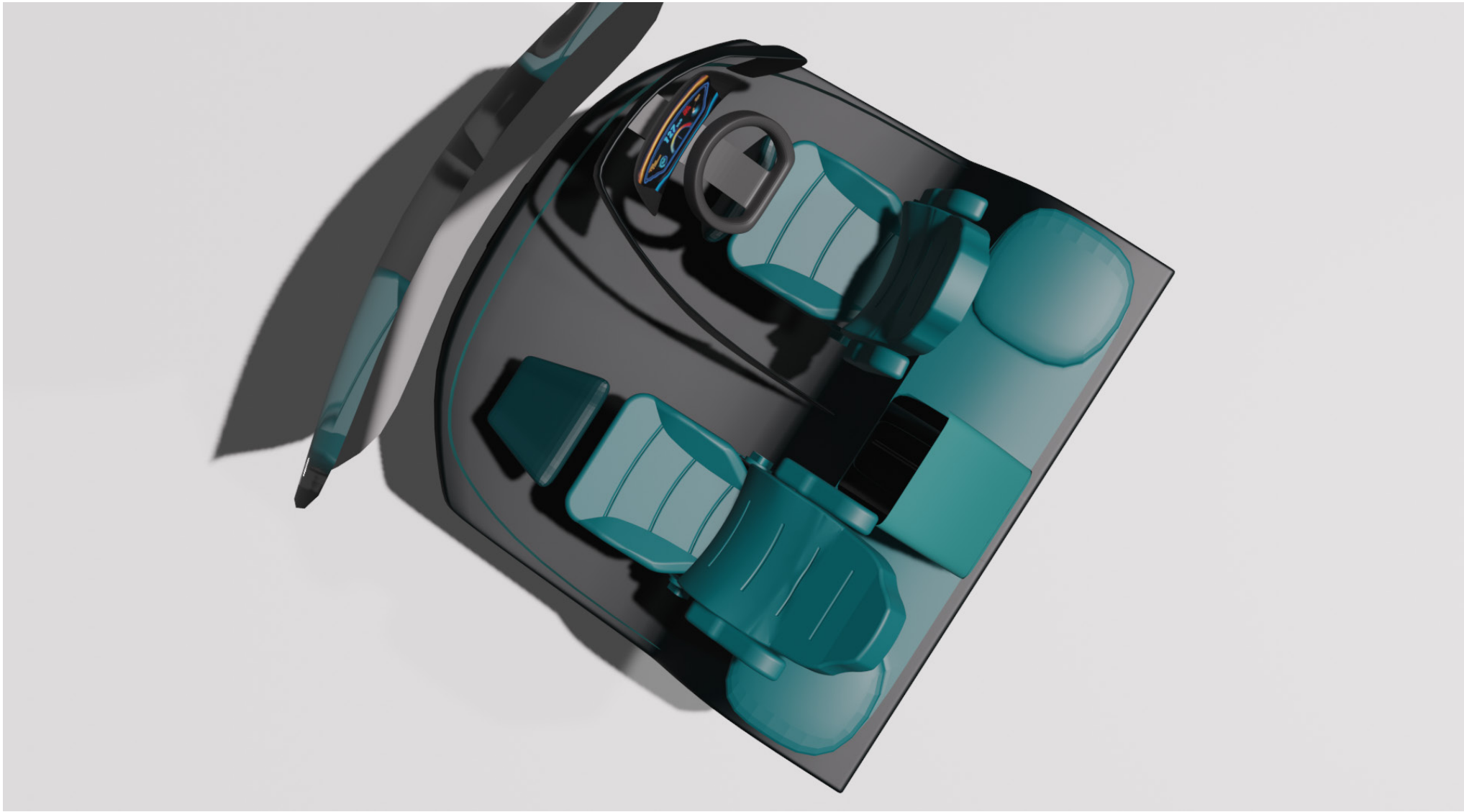


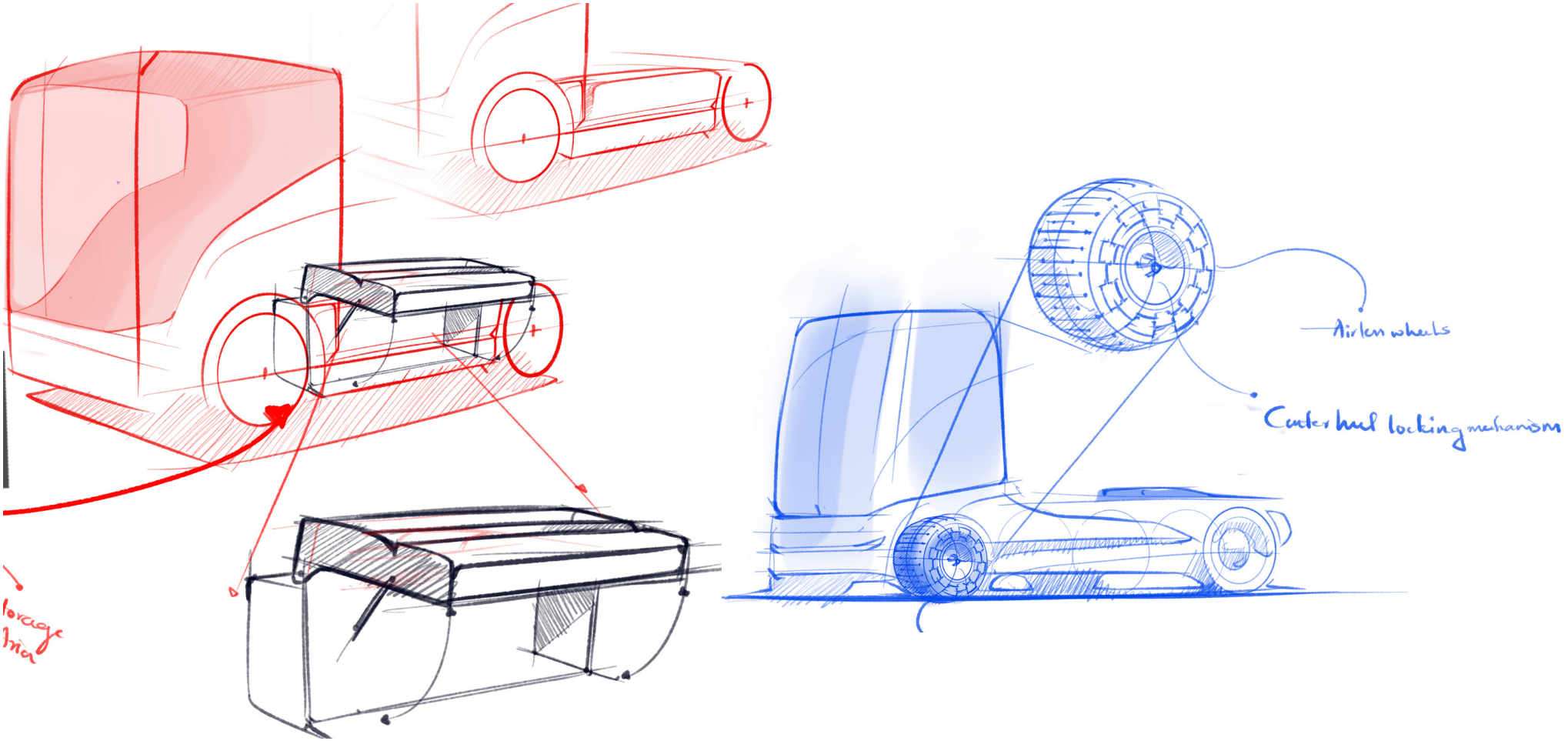

Heads up display
rectractable steering wheel
recliner seats
Driver focused cockpit
storage unit

Ideation



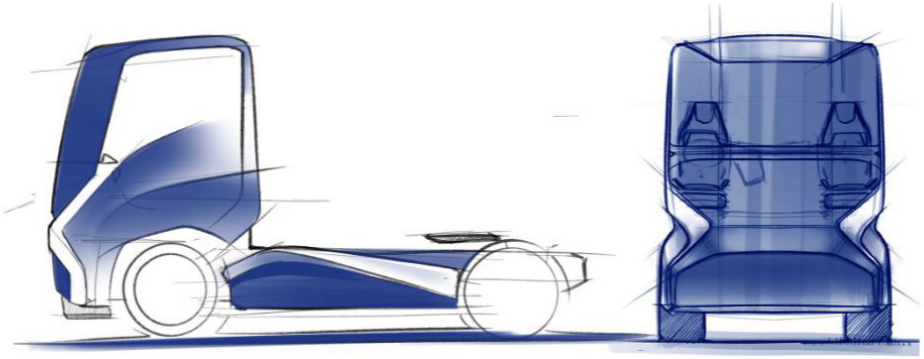





Airless wheels
Center hub locking mechanism

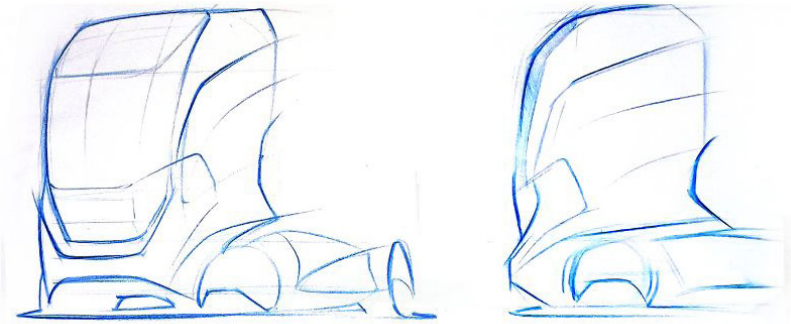
12. Concept Selection

Concept 1



1/8

Concept 2



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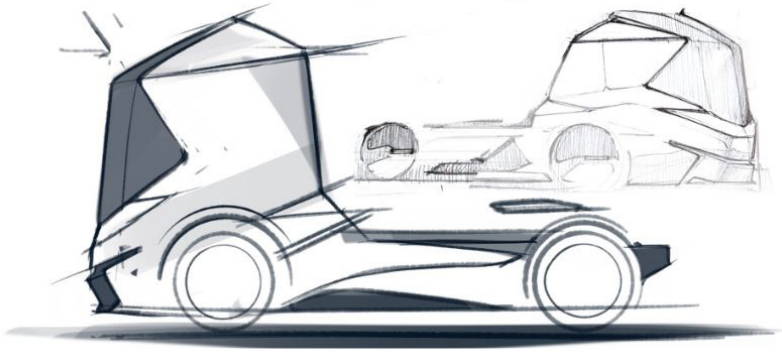
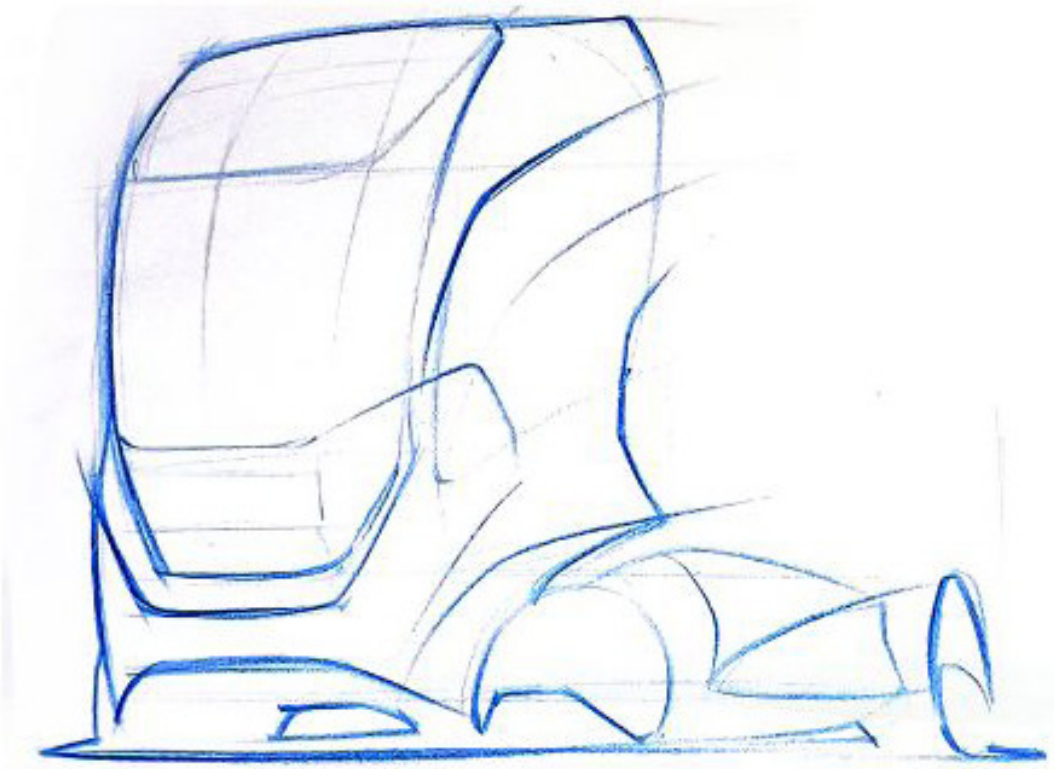
Concept 3

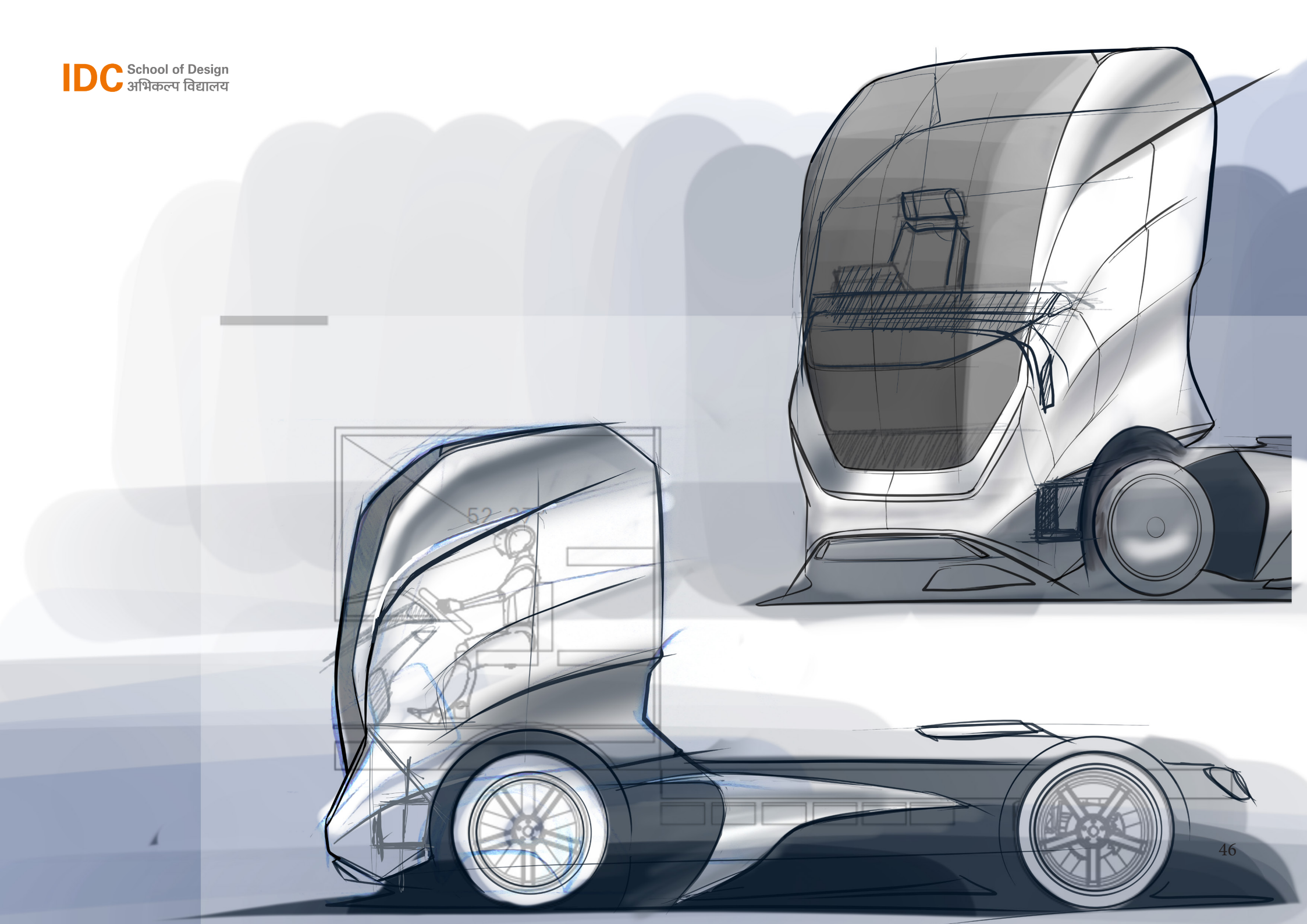


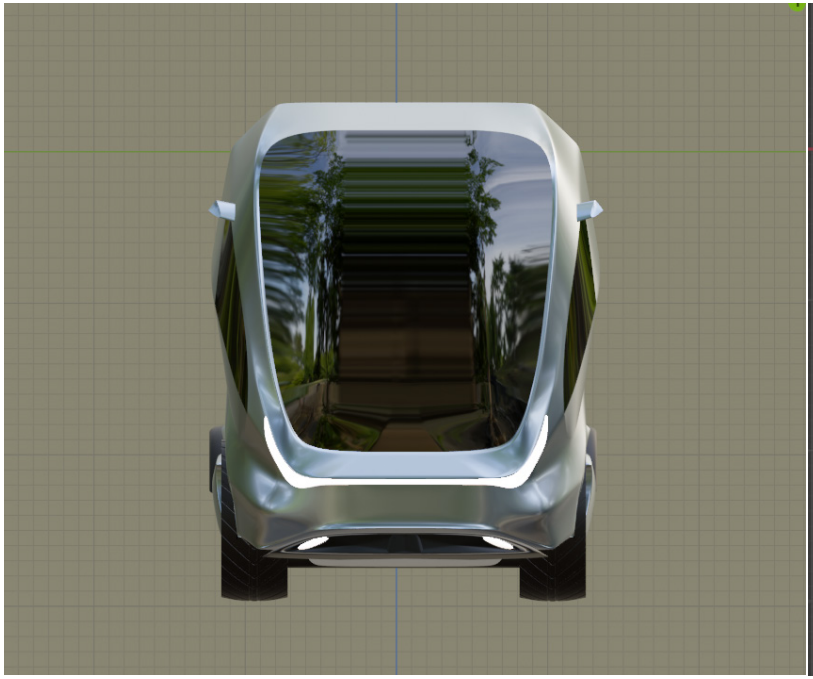
1/8

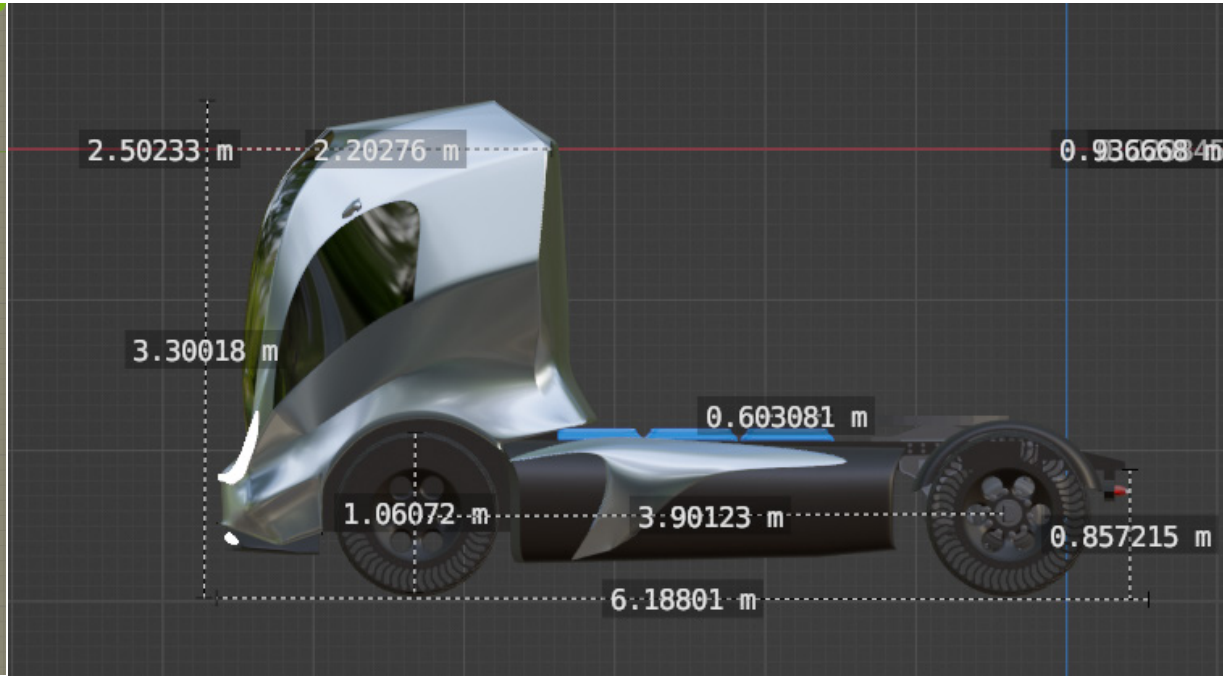
13. Final concept

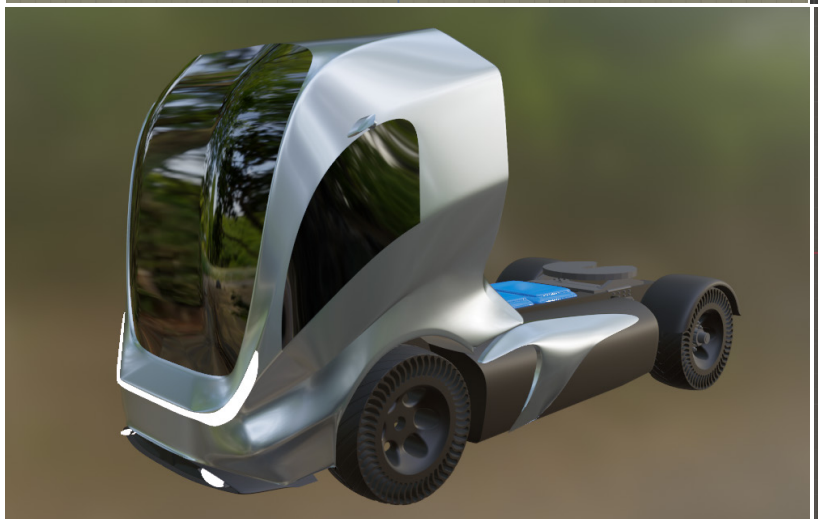
Concept 2

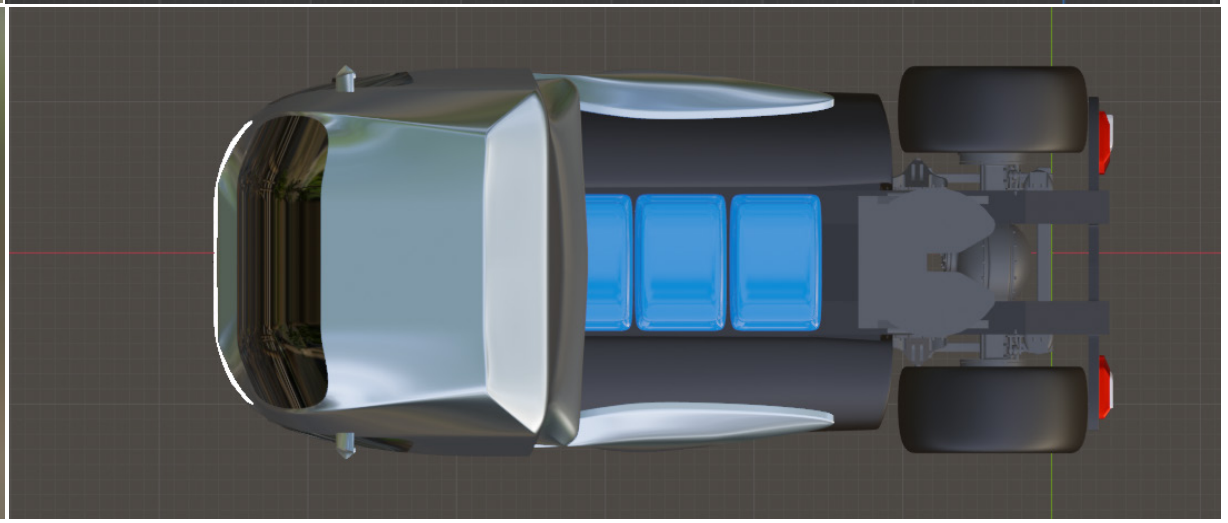




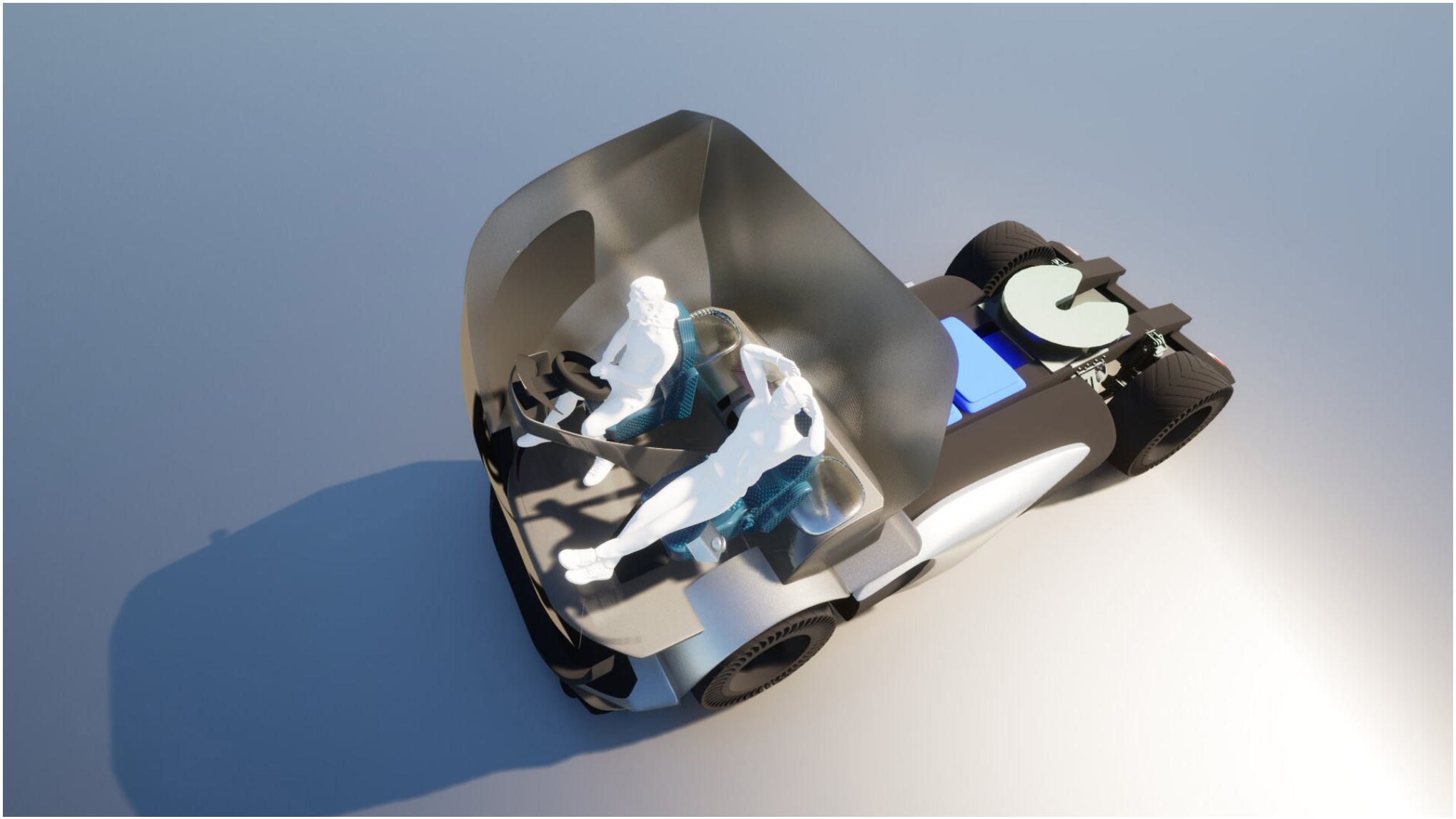


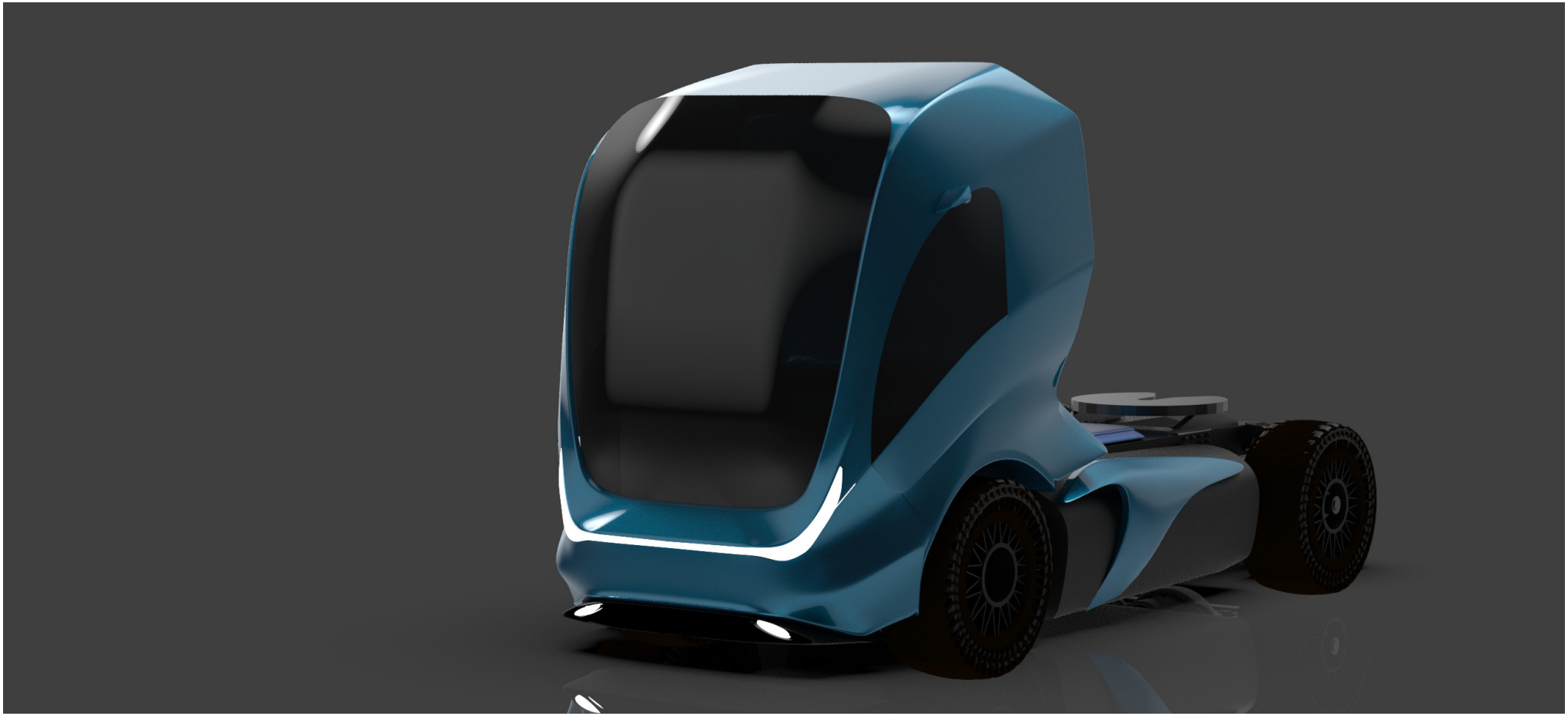

2.50233 m
2.20276 m
3.30018 m
0.603081 m
1.06072 m
3.90123 m
0.857215 m
6.18801 m

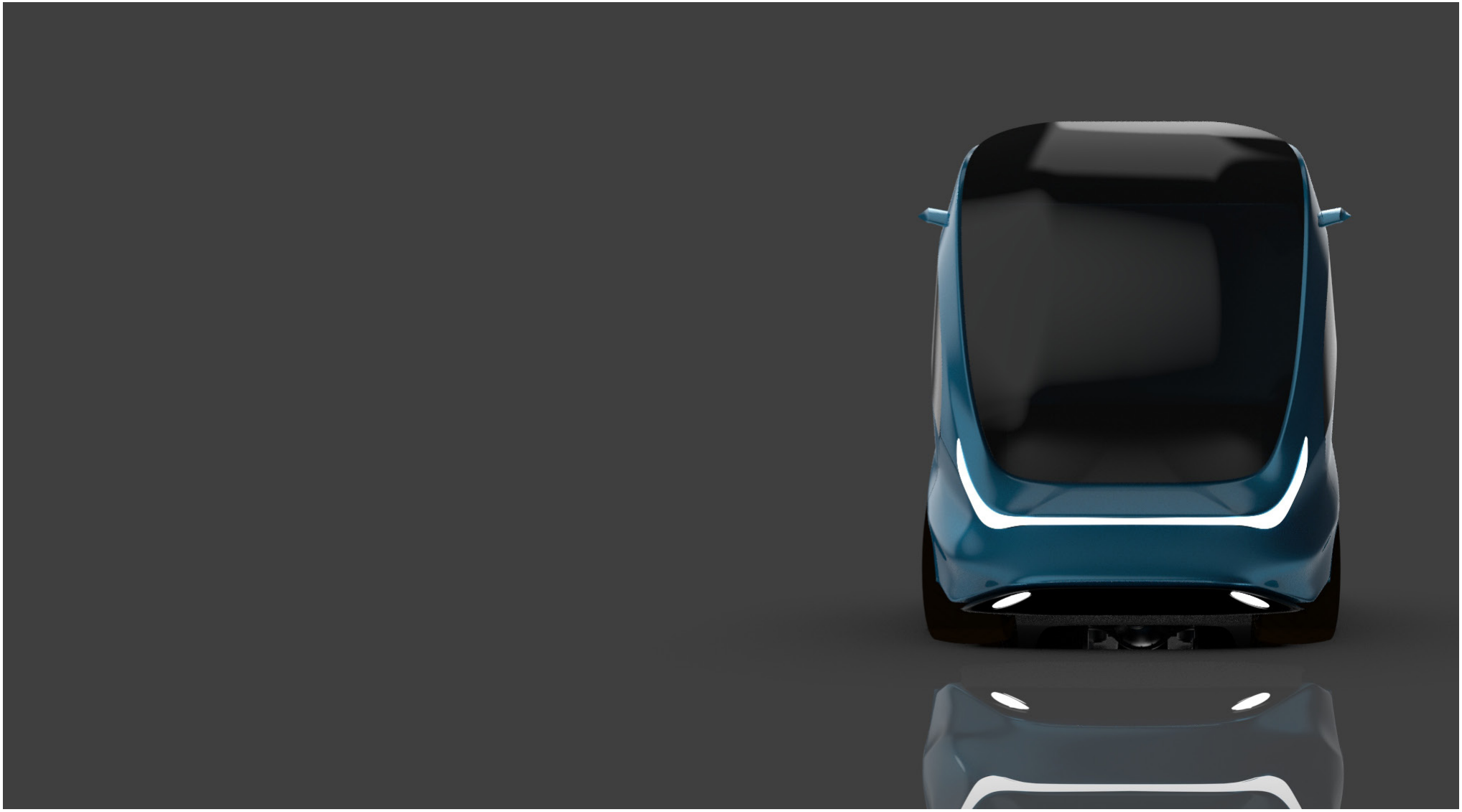


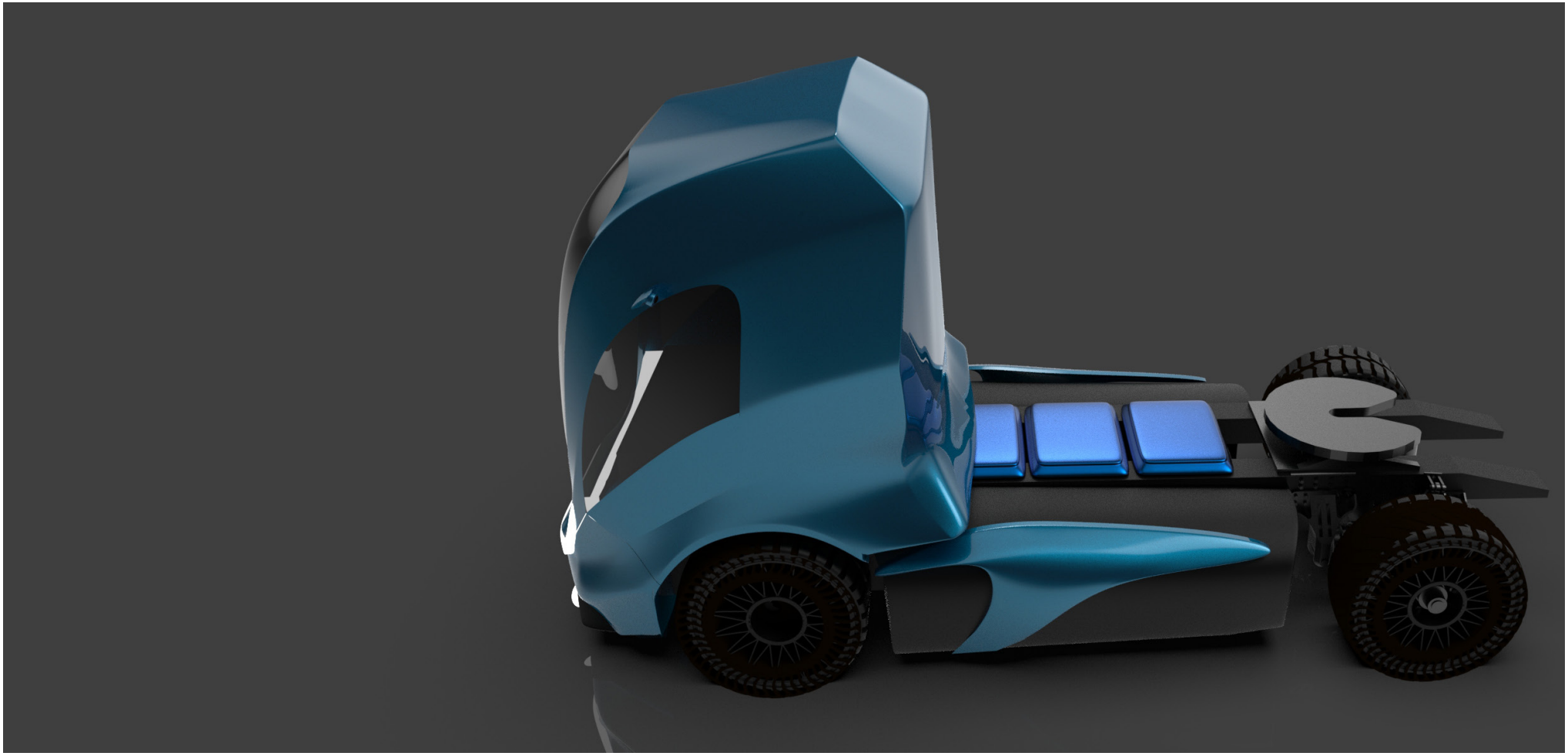


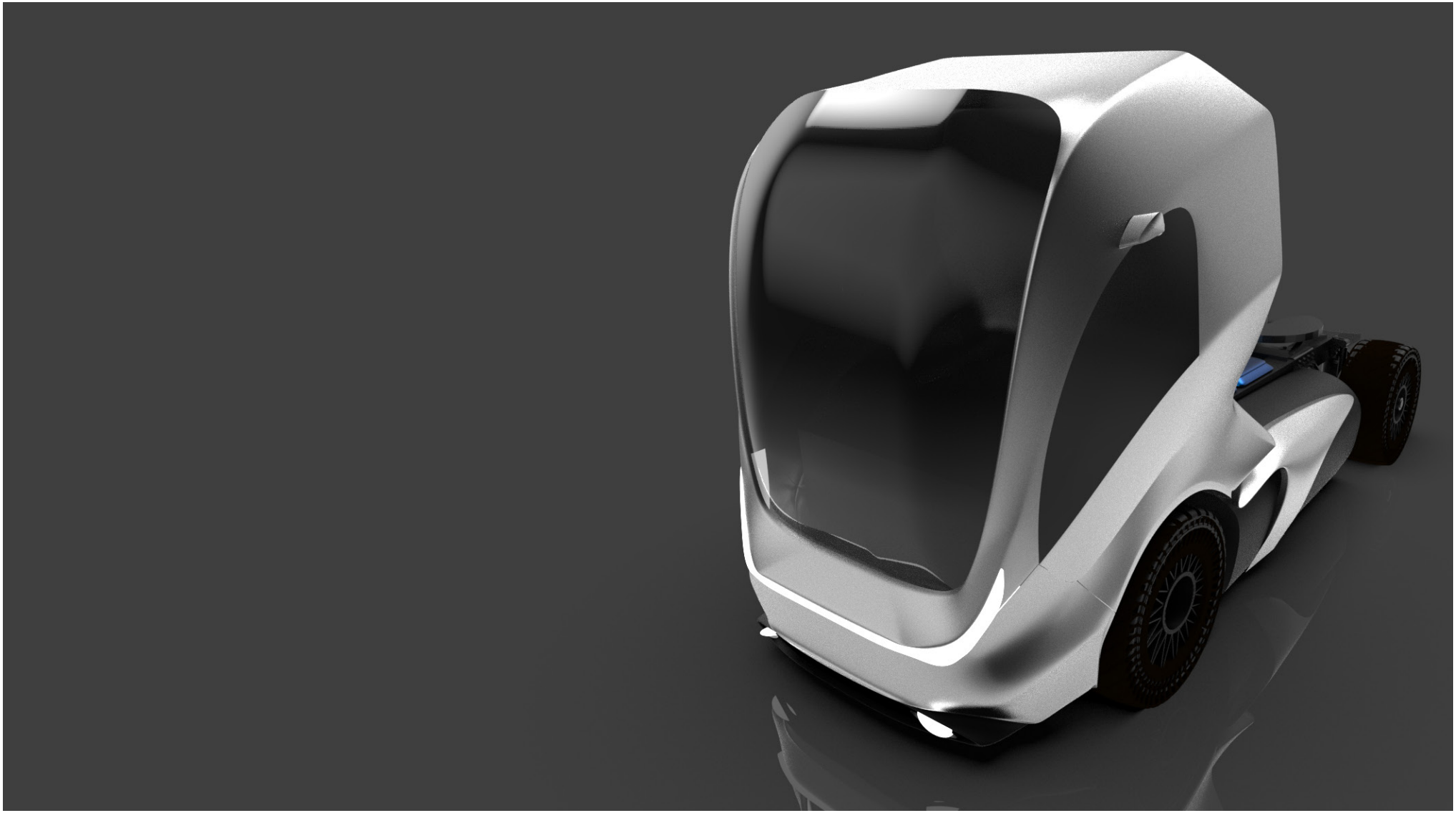
14. Exterior Renders

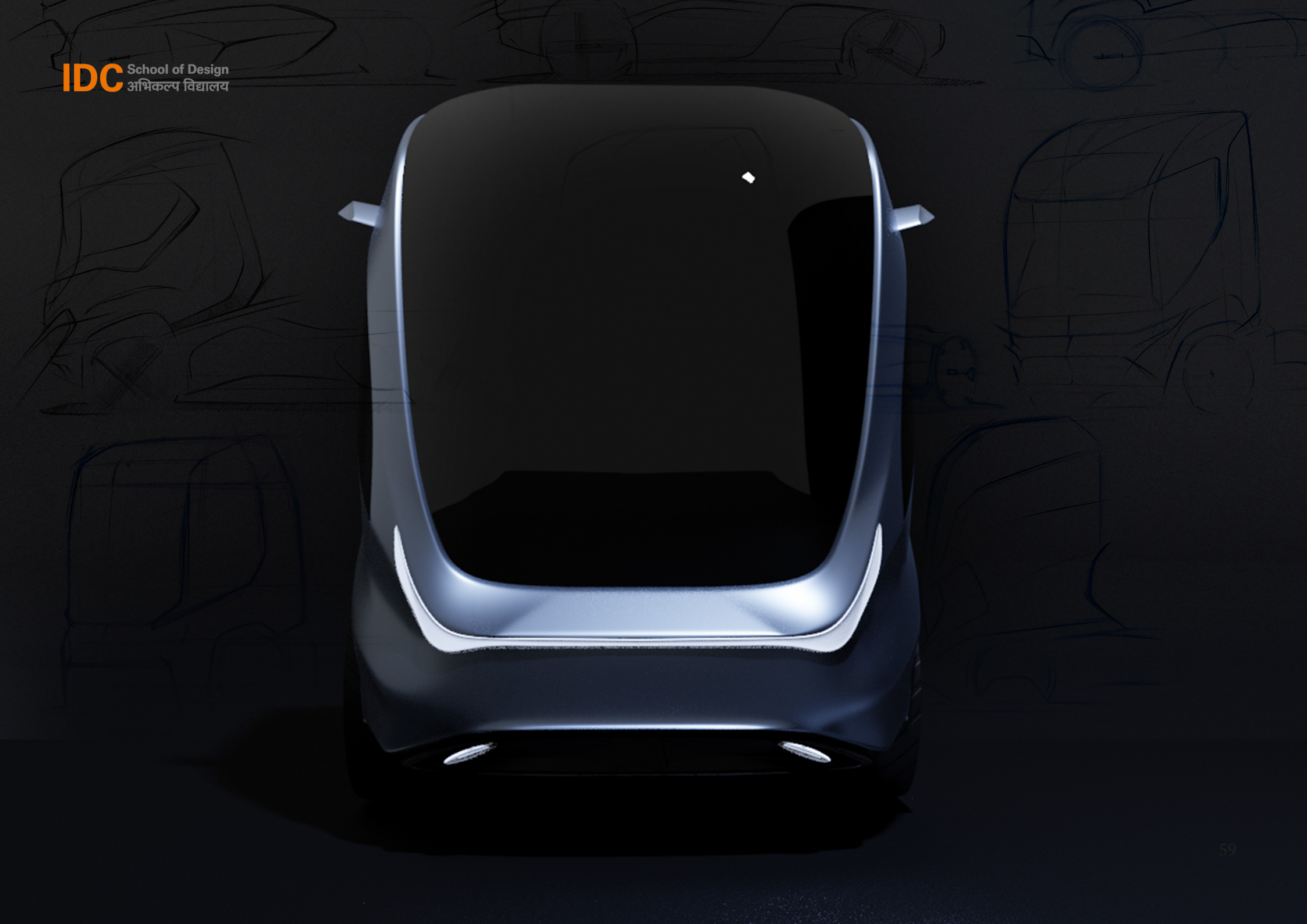


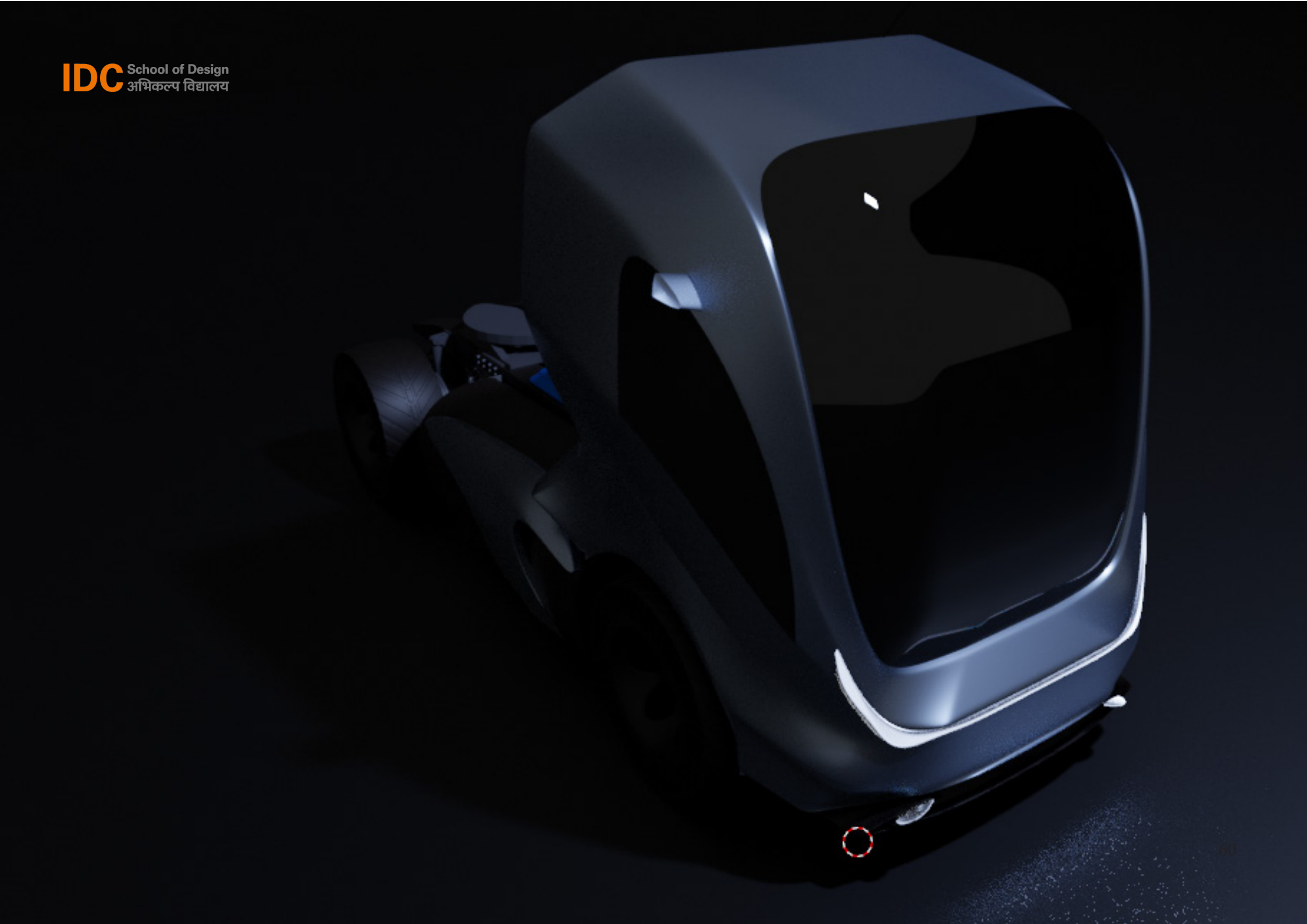


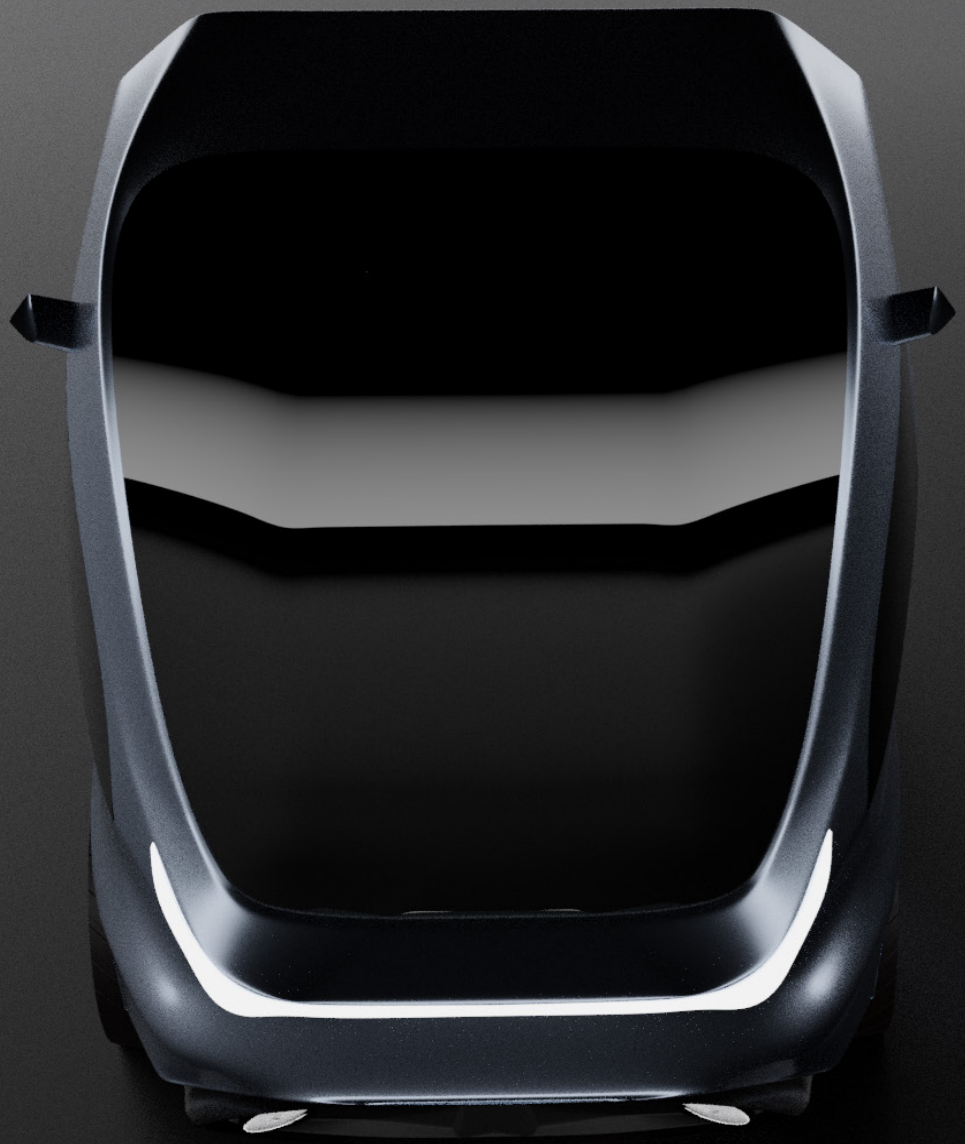


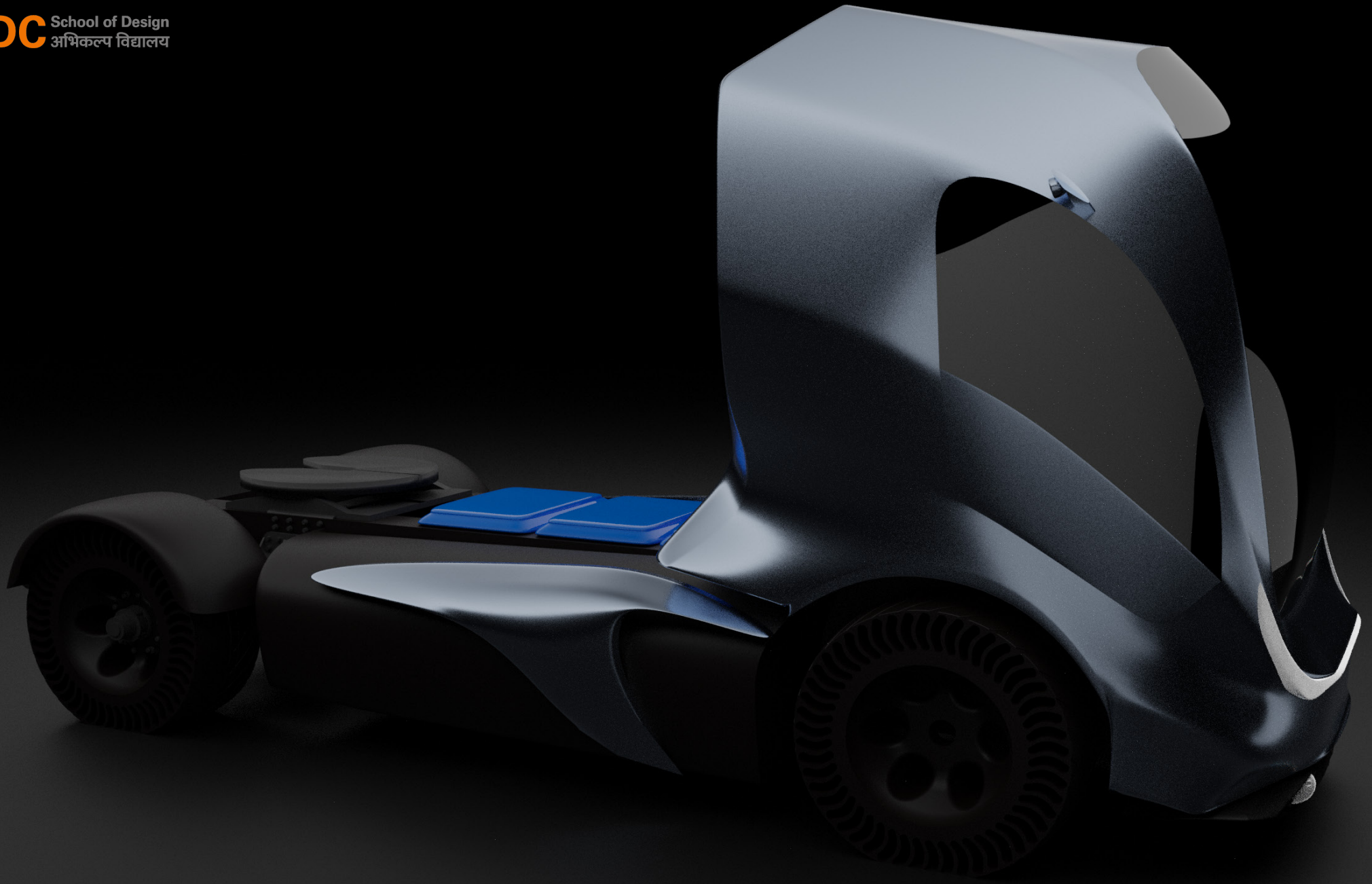


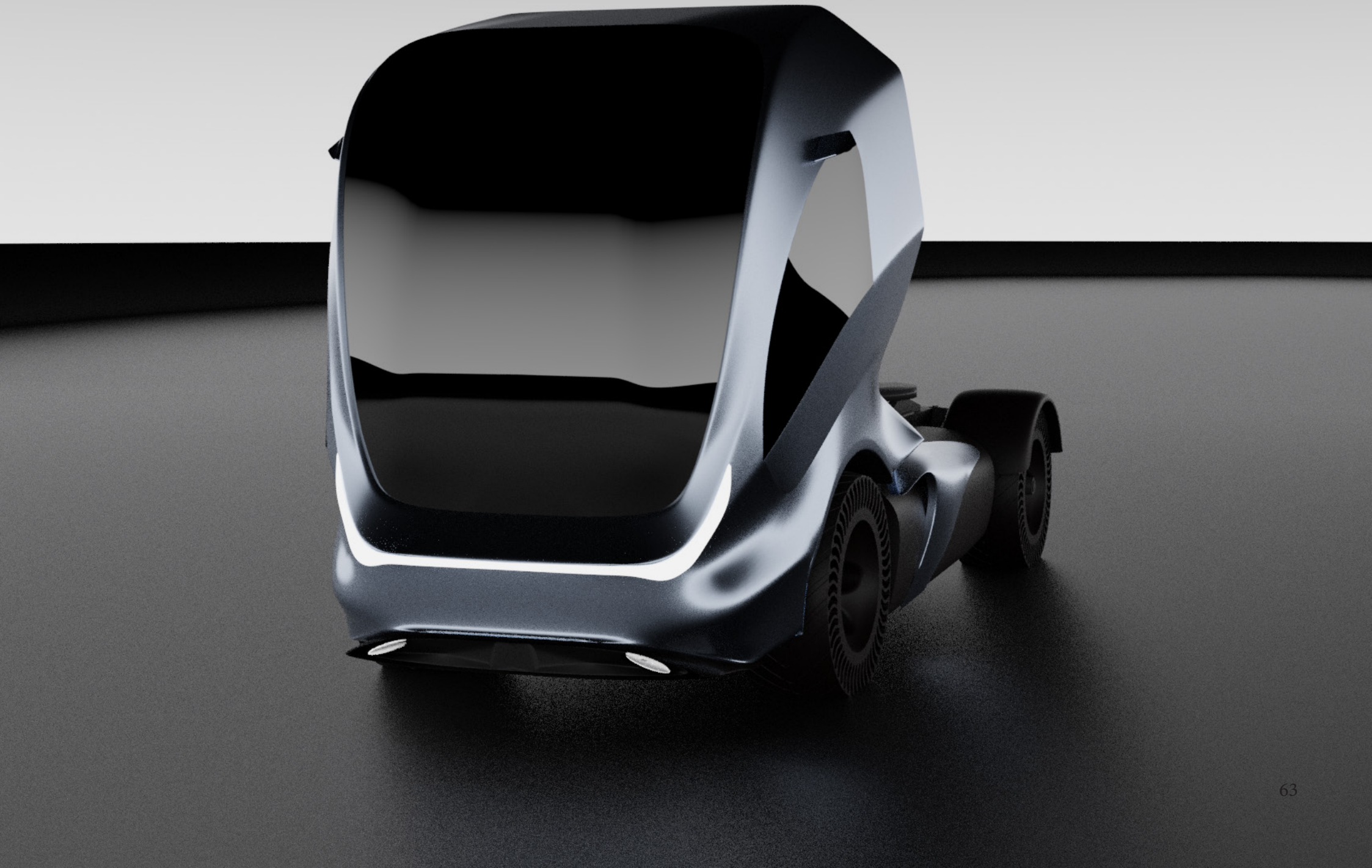


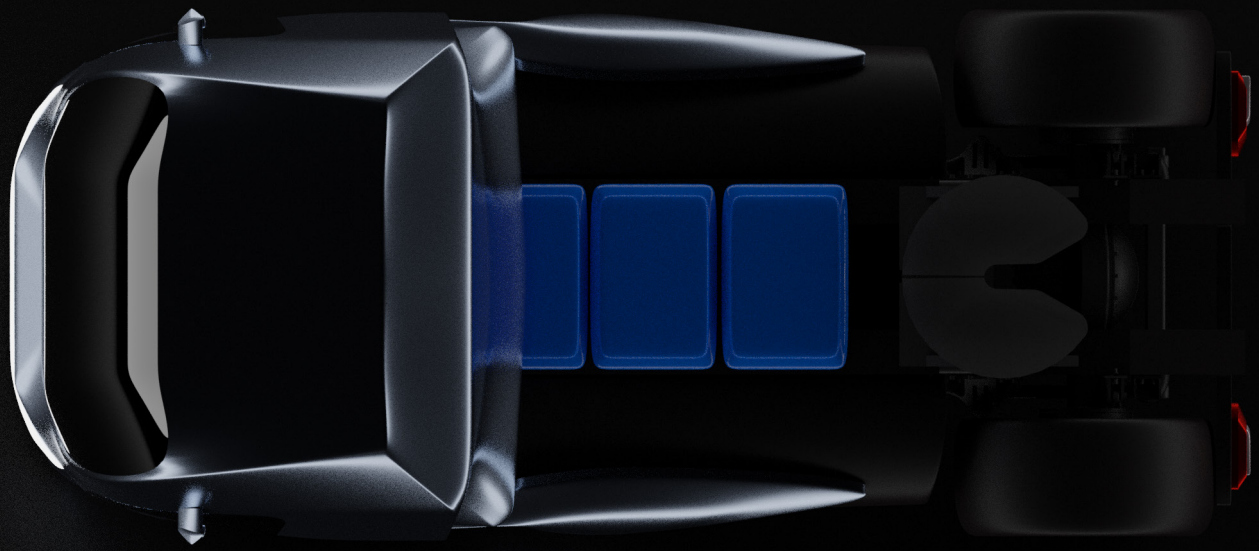




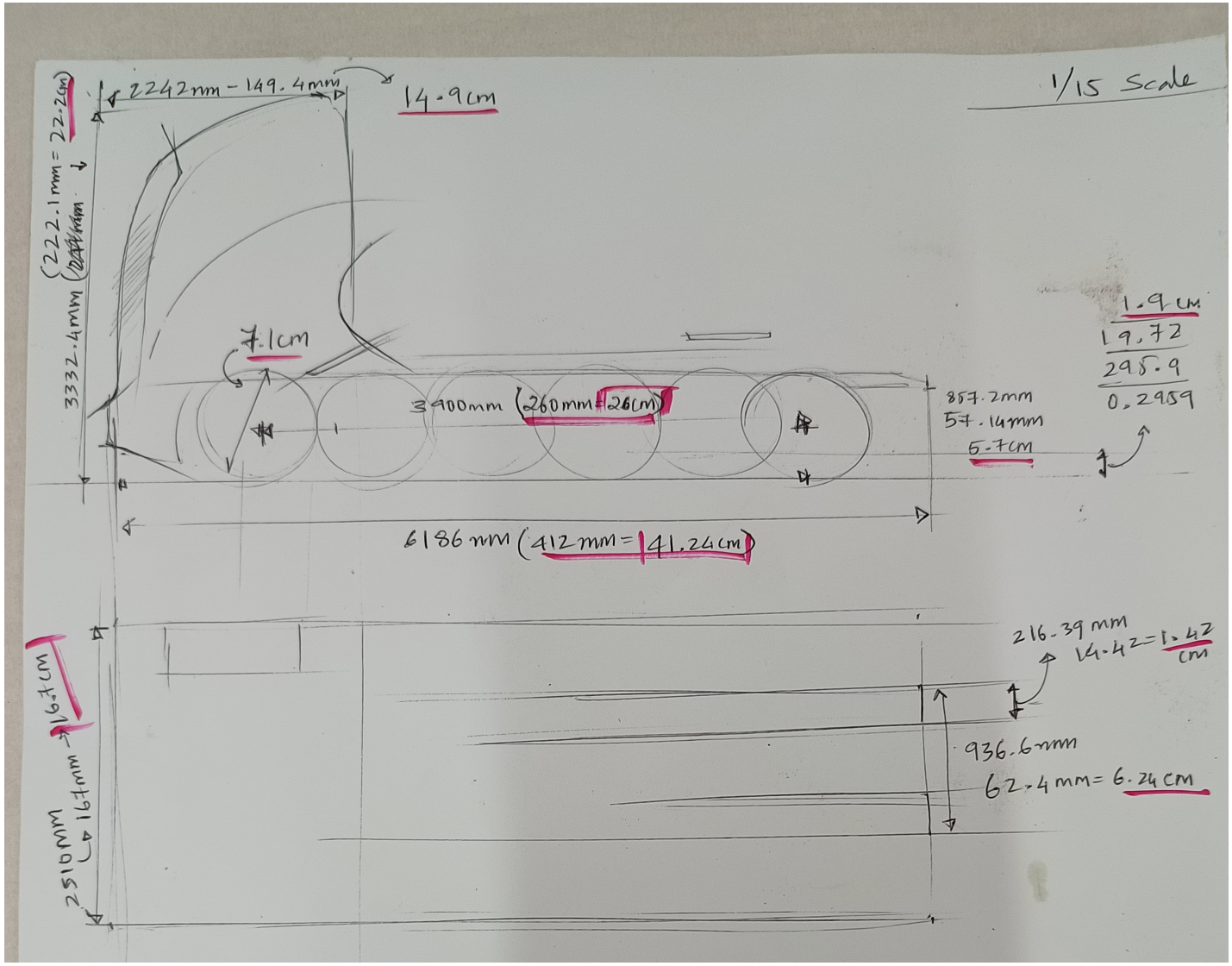








15. Construction of scale model

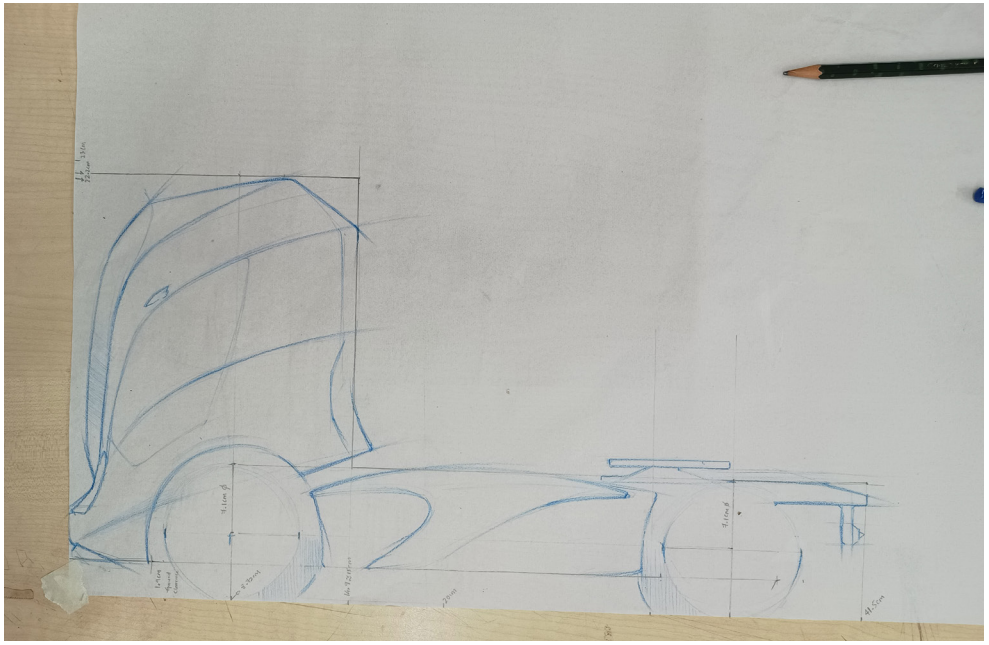


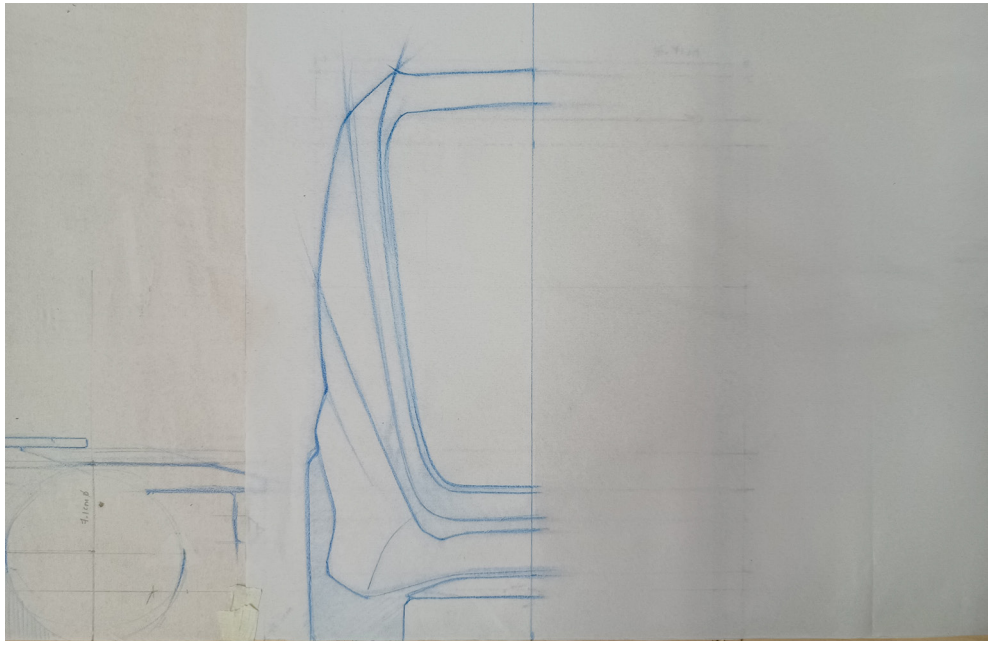
Scale 1 : 15

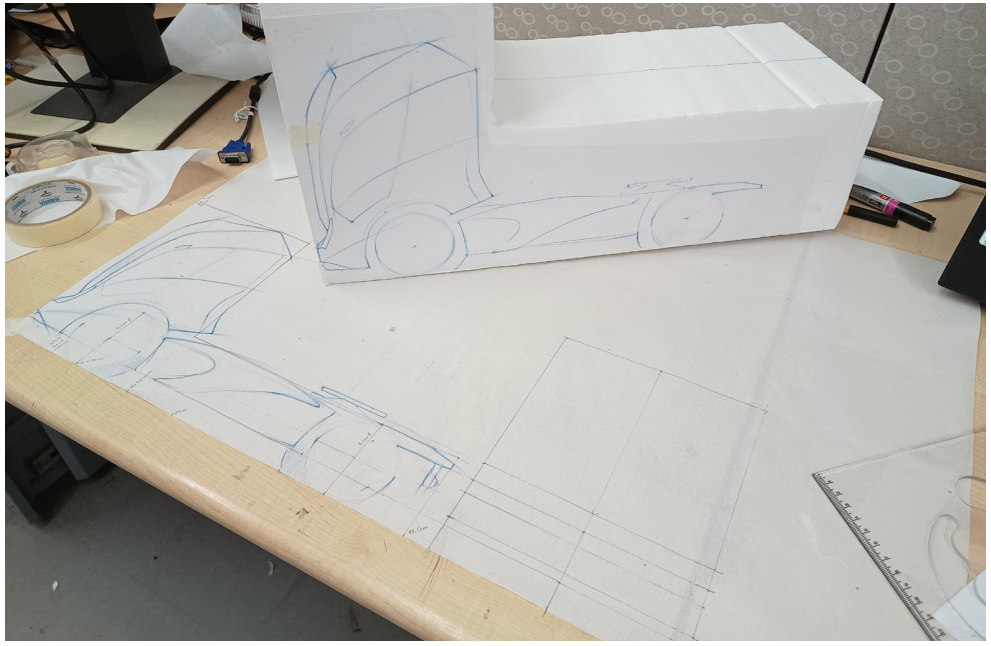
Length : 41.24 cm

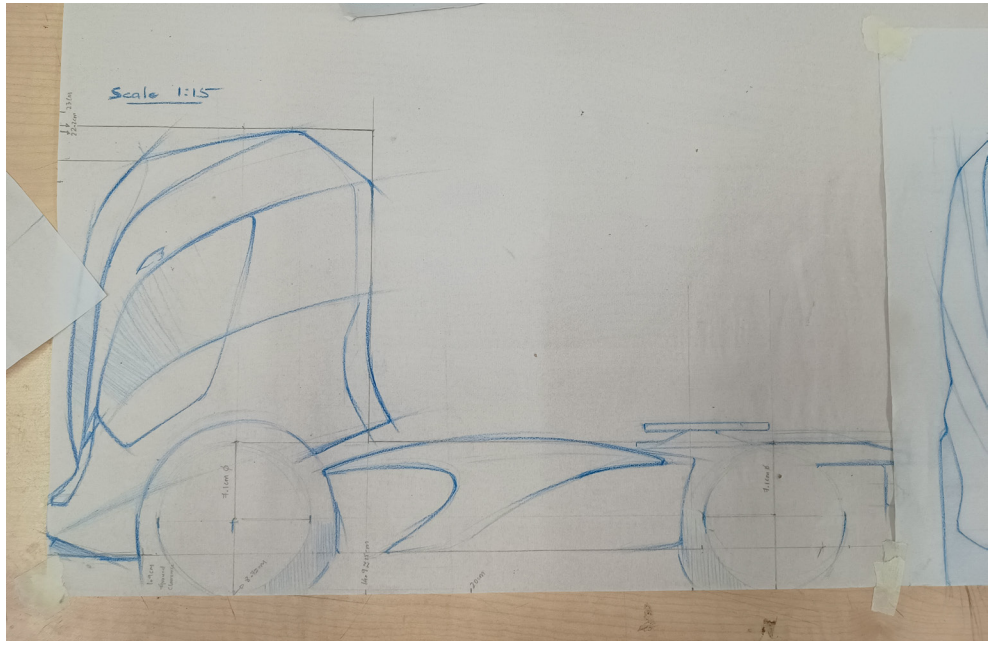
Width : 16.7 cm

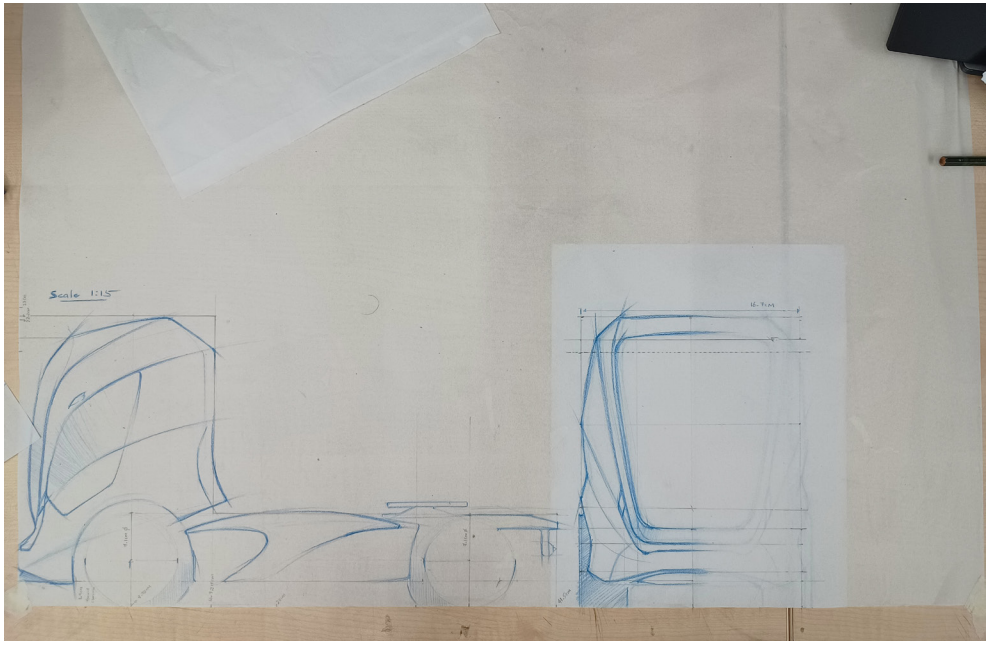
Heifht : 22.2 cm

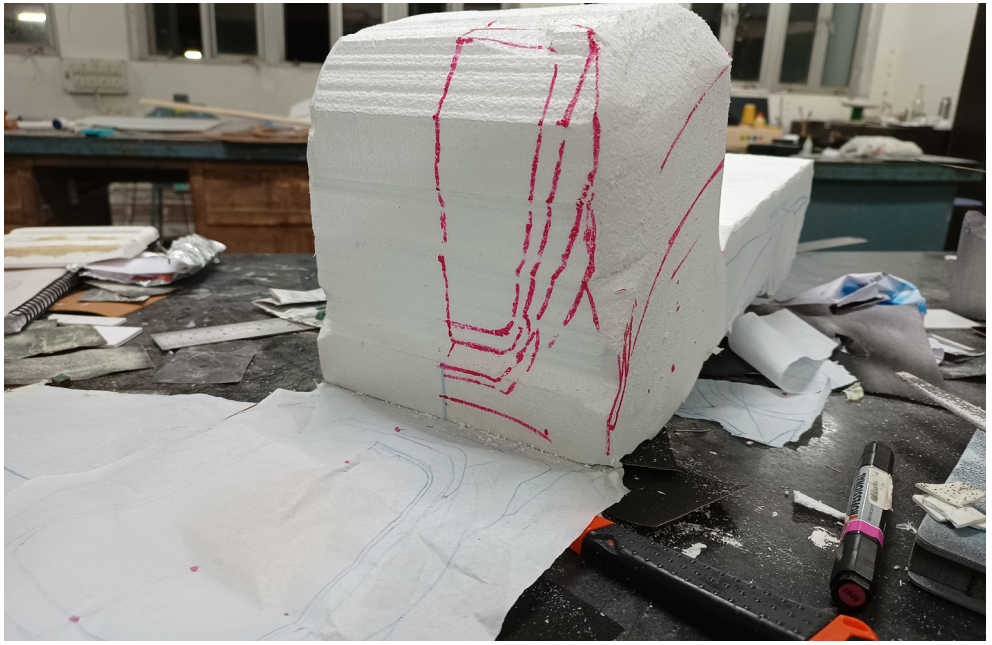


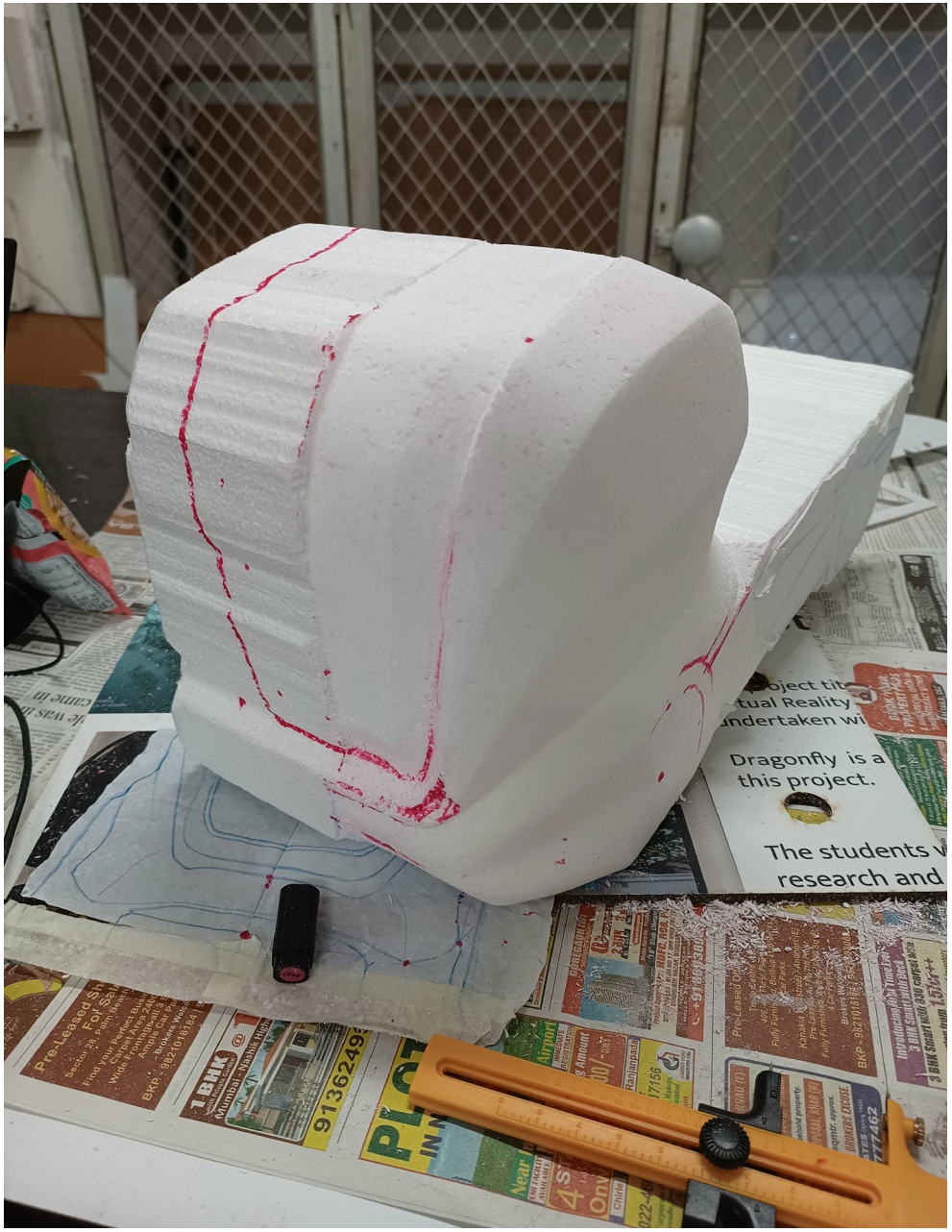





Scale 1:15

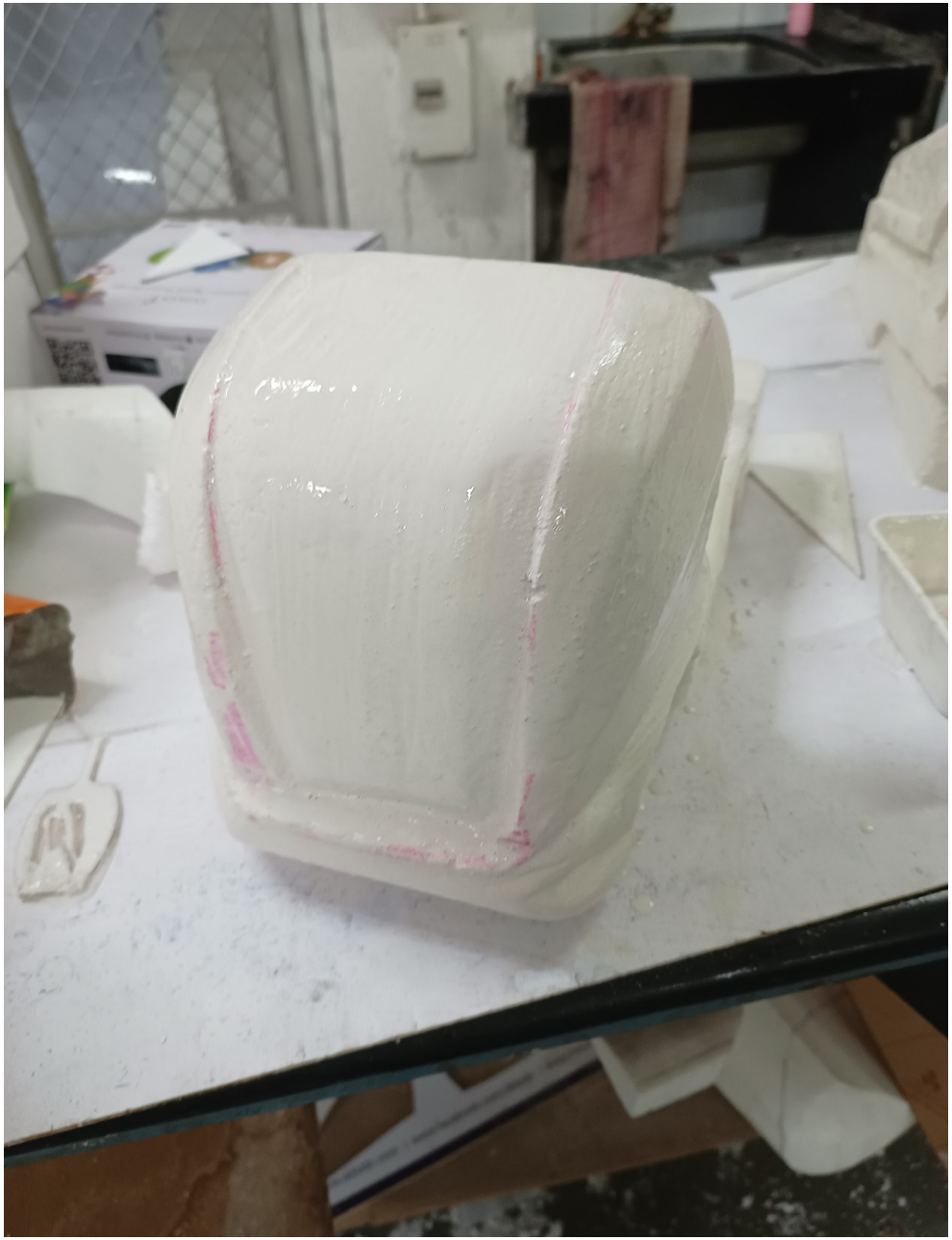

Scale 1:15




Dragonfly is a
this project.
The students
research and


EMERY


DOUBLE LINE
PROFESSIONAL




Asian Paints
WALL FINISH

16. Reference

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