

RACE CAR FOR LE MANS 2030

MOBILITY & VEHICLE DESIGN PROJECT III

MVD III-31

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INDIAN INSTITUTE OF TECHNOLOGY, BOMBAY

2016

DECLARATION

I declare that this written submission represents my idea in my own words, and where others' ideas or words have been included, I have adequately cited and referenced the original source. 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/sources in my submission. I understand that any violation of the above will be cause for disciplinary action by the institute and can also invoke penal action from the sources from which proper permission has not been taken, or improperly cited.

Sign :

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Roll No.:

Date:

APPROVAL SHEET

This Mobility & Vehicle Design project report entitled “Sports car for Le Mans 2030”, by Pankaj Kuli is approved in partial fulfilment of the requirement for Master of Design degree In Mobility and Vehicle Design.

Project Guide :

Chair Person:

Internal Examiner.:

External examiner:

Acknowledgment

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Pankaj Kuli

Date:.

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1. Introduction

There is nothing like the Le Mans 24 Hours. The world's greatest race has always been more than the pure pursuit of speed. Le Mans is the ultimate test of ideas, innovations, endurance, creativity and beauty. In recent years, Le Mans organizers have pushed for significant reductions in fuel, energy and tire usage. The open formulas available to achieve those results have made Le Mans the most relevant and exciting form of competition for manufacturers worldwide. This design project started out of my passion towards sports cars and race cars

2. Pre-research



IR 1

Before arriving at concepts, a pre- research was done which includes study of endurance racing , vehicles and driver's experiance to get a broader perspective of the race.

2.1. Endurance racing



IR 2

Endurance racing (World Endurance racing) is a form of motorsport racing which is meant to test the durability of equipment and endurance of participants. Teams of multiple drivers attempt to cover a large distance in a single event, with participants given a break with the ability to change during the race. Endurance races can be run either to cover a set distance in laps as quickly as possible, or to cover as much distance as possible over a preset amount of time.

One of the more common lengths of endurance races has been running for 1,000 kilometers (620 mi), or roughly six hours. Longer races can run for 1,000

miles (1,600 km), 12 hours, or even 24 hours. Teams can consist of anywhere from two to four drivers per event, which is dependent on the driver's endurance abilities, length of the race, or even the rules for each event.

2.2. 24 hrs. of Le Mans



IR 3

The **24 Hours of Le Mans** is the world's oldest active sports car race in endurance racing, held annually since 1923 near the town of Le Mans, France. It is one of the most prestigious automobile races in the world and is often called the "Grand Prix of Endurance and Efficiency".

The race is organized by the Automobile Club de l'Ouest (ACO) and runs on the Circuit de la Sarthe, which contains a mix of closed public roads and a specialist racing circuit, in which racing teams have to balance speed with the cars' ability to race for 24 hours without sustaining mechanical damage.



IR 4

2.3. Purpose

At a time when Grand Prix racing was the dominant form of motorsport throughout Europe, Le Mans was designed to present a different test. Instead of focusing on the ability of a car company to build the fastest machines, the 24 Hours of Le Mans would instead concentrate on the ability of manufacturers to build sporty yet reliable cars. This encouraged innovation in producing reliable and fuel-efficient vehicles, because endurance racing requires cars that last and spend as little time in the pits as possible..

At the same time, the layout of the track necessitated cars with better aerodynamics and stability at high speeds. While this was shared with Grand Prix racing, few tracks in Europe had straights of a length comparable to the Mulsanne. Additionally, because the road is public and thus not as meticulously maintained as permanent racing circuits, racing puts more strain on the parts, increasing the importance of reliability.

2.4. Brief history of Le Mans



IR 5

1923–1939 : The 24 Hours of Le Mans was first run on 26 and 27 May 1923, through public roads around Le Mans. Originally planned to be a three-year event awarded the Rudge-Whitworth Triennial Cup, with a winner being declared by the car which could go the farthest distance over three consecutive 24 Hour races, this idea was abandoned in 1928 and overall winners were declared for each single year depending on who covered the farthest distance by the time 24 hours were up. The early races were dominated by French, British, and Italian drivers, teams, and cars, with Bugatti, Bentley, and Alfa Romeo being the top brands

1949–1969 : Following the reconstruction of the circuit facilities, the race was resumed in 1949 with renewed interest from major automobile manufacturers. 1949 was also Ferrari's first victory, the 166MM of Luigi Chinetti and Peter Mitchell-Thomson. After the formation of the World Sportscar Championship in 1953, of which Le Mans was a part, Ferrari, Aston Martin, Mercedes-Benz, Jaguar, and many others began sending multiple cars backed by their respective factories to compete for overall wins against their competitors.

1970–1980 : For the new decade, the race took a turn towards more extreme speeds and automotive designs. These extreme speeds led to the replacement of the typical standing Le Mans start with a rolling Indianapolis start. Although production-based cars still raced, they were now in the lower classes while purpose-built sports cars became the norm. The Porsche 917, 935, and 936 were dominant throughout the decade, but a resurgence by French manufacturers Matra-Simca and Renault saw the first victories for the nation since the 1950 race.

1981–1993 : The rest of the 1980s was known for the dominance by Porsche under the new Group C race car formula that encouraged fuel efficiency. Originally running the effective 956, it was later replaced by the 962. Both chassis were affordable enough for privateers to purchase them on masses, leading to the two model types winning six years in a row. In 1992 and 1993, Peugeot dominated the race with its Peugeot 905 as the Group C formula and World Sportscar Championship were fading in participation.



IR 5.1

1994–1999 : Following the demise of the World Sportscar Championship, Le Mans saw a resurgence of production-based grand tourer cars.

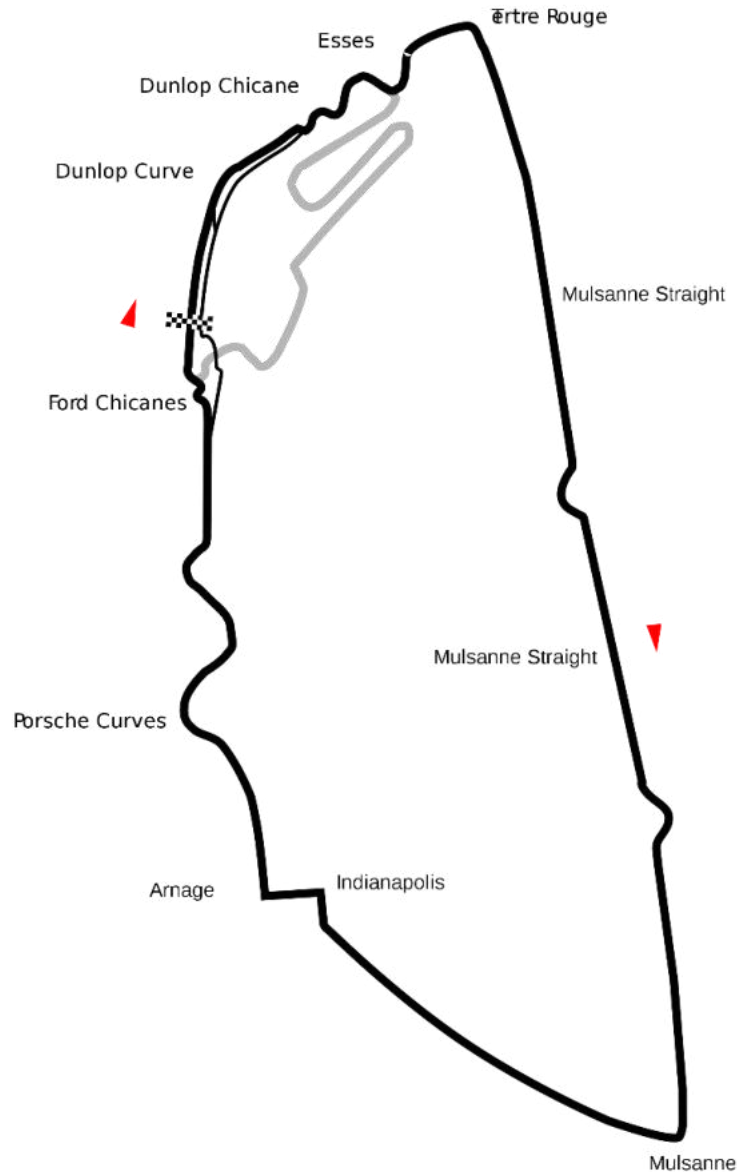
2000–2005 : Many major automobile manufacturers withdrew from sports car racing after 1999 due to the high cost. Only Cadillac and Audi remained, and Audi easily dominated with the R8. Cadillac pulled out three years later, and attempts by Panoz, Chrysler, and MG to beat Audi all fell short.

Since 2006 : At the end of 2005, after five overall victories for the R8, and six to its V8 turbo engine, Audi took on a new challenge by introducing a diesel engine prototype known as the R10 TDI. As of 2015, Porsche remains the most successful manufacturer with a record 17 overall victories, including a record seven in a row. After Audi's recent dominance of the event, Porsche returned to Le Mans in 2014 with a new factory LMP1 program to challenge Audi. Toyota has fielded competitive cars since 2012, and Nissan returned to run an LMP1 program in 2015.

2.5. Track : Circuit de la Sarthe

The Circuit des 24 Heures, also known as Circuit de la Sarthe, located in Le Mans, Maine, France, is a semi-permanent race course most famous as the venue for the 24 Hours of Le Mans auto race. The track uses local roads that remain open to the public most of the year. The circuit, in its present configuration, is **13.629** kilometres (8.47 mi) long, making it one of the longest circuits in the world. Capacity of the race stadium is **100,000**.

Le Mans is a race where up to 85% of the time is spent on full throttle, meaning immense stress on engine and drivetrain components. However, the times spent reaching maximum speed also mean tremendous wear on the brakes and suspension as cars must slow from over 200 mph (320 km/h) to around 65 mph



IR 6

2.6. Vehicles

The race has approximately 50 competitors. Each car was required to have at least two seats, but recently cars only need the ability to accommodate a second seat in the cockpit rather than the seat itself. No more than two doors are allowed; open cockpit cars do not require doors.

Although all cars compete at the same time, there are separate classes. A prize is awarded to the winner of each class, and to the overall winner. The number of classes has varied over the years, but there are now four.



IR 6.1

2.6.1. Classes

There are separate technical and sporting rules for each category, although some rules apply across the board, such as the 4-hour minimum for each driver. Following are the categories of vehicle and their sub-categories.

- **LM P Category**
 - "Le Mans" Prototype
 - "Le Mans" Prototype 2
- **LM GTE Category**
 - "Le Mans" Grand Tourisme
Endurance Professional
 - "Le Mans" Grand Tourisme
Endurance Amateur
- **Garage 56**



IR 6.2

LM P Category



IR 7

Le Mans Prototypes are exclusively made for 24hr of Le Mans. Their aim is to make motor sport more relevant to series production cars, and they put innovation at the very heart of the challenge by allocating a given quantity of energy to the entrants instead of imposing a technical specification.

While LM P1 is the category reserved for professionals, LM P2 puts the emphasis on amateurs as there must be at least one in each line-up. Mixing professionals and gentlemen drivers has always been part of the Le Mans legend.

LM GTE Category



IR 8

Grand touring cars have been part and parcel of the Le Mans 24-Hours tradition since the creation of the event in 1923. At the time cars were not specifically designed for motor racing and many of them arrived in the Sarthe by road! While times have changed there is still a real link between the track and the road as the GTs must be based on series production vehicles.

Garage 56



IR 9

Since 2012 a garage has been reserved for an innovative project promoting ground-breaking technologies. Thus, the ACO can invite an entrant whose vehicle does not comply with the current technical regulations although it must meet certain safety, performance and reliability criteria

2.6.2. Le Mans Prototype



IR 10

A **Le Mans Prototype (LMP)** is the type of sports prototype race car used in the 24 Hours of Le Mans, FIA World Endurance Championship, United Sports Car Championship, European Le Mans Series and Asian Le Mans Series. Le Mans Prototypes were created by the Automobile Club de l'Ouest (ACO). The technical requirements for an LMP include bodywork covering all mechanical elements of the car.

While not as fast as open-wheel Formula One cars, LMPs are the fastest closed-wheel racing cars used in circuit racing. Le Mans Prototypes are

considered a class above production-based grand tourer cars, which compete alongside them in sports car racing.

Modern LMP designs include hybrid cars that use electric motors to assist acceleration.

2.6.3. Case study : Porsche 919 Hybrid

The Porsche 919 was billed as the most complex competition car Porsche had ever built when it was launched

at the Geneva Motor Show in early 2014. Built to the LMP1 technical regulations the car was designed with

one purpose, to win Le Mans, something it achieved in 2015.



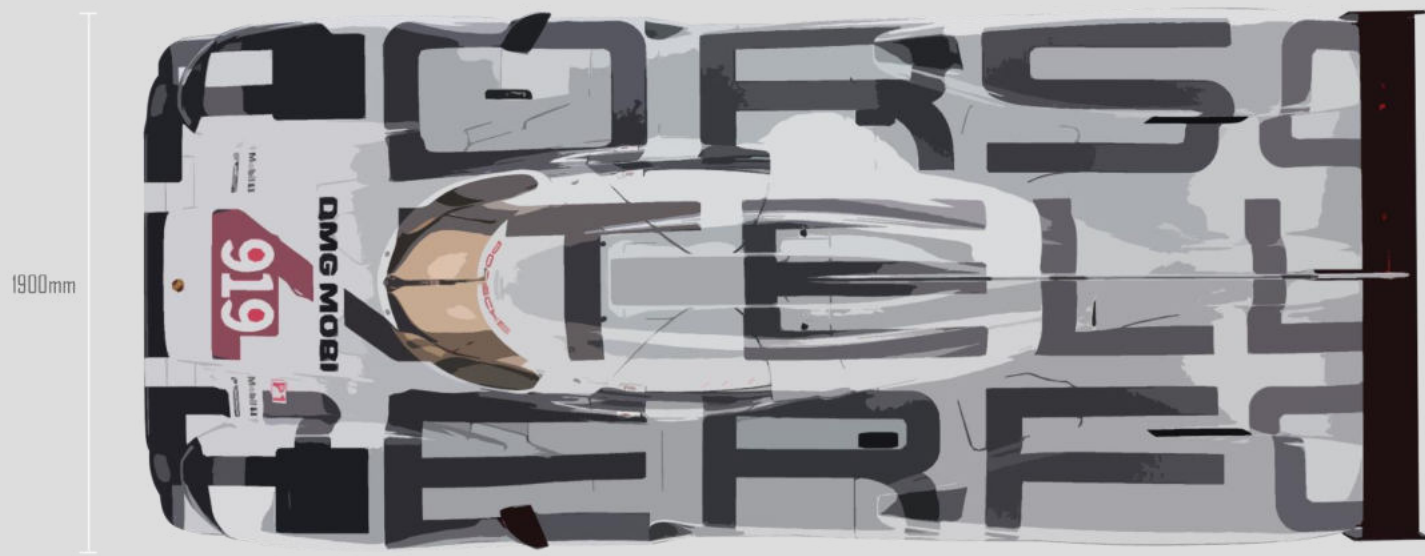
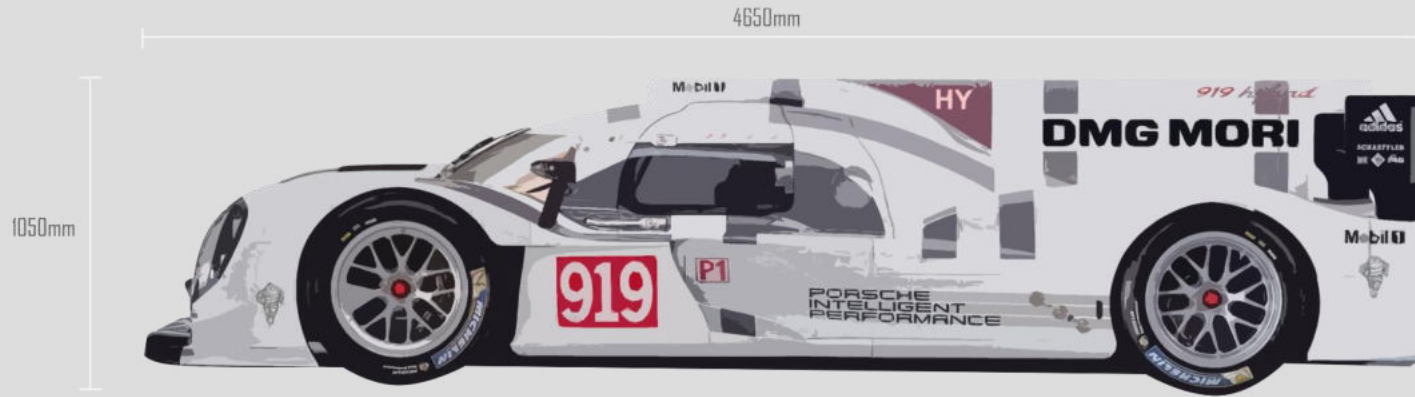
IR 11

Technical regulations

LMP1		
	Hybrid	Non-hybrid
Minimum weight	870 kilograms (1,920 lb)	850 kilograms (1,870 lb)
Maximum length	4,650 millimetres (183 in)	
Minimum width	1,800 millimetres (71 in)	
Maximum width	1,900 millimetres (75 in)	
Engine displacement	Free	Maximum 5.5 litres (340 in ³)
Fuel tank size for petrol engines	68.3 litres (18.0 US gal)	
for diesel engines	54.2 litres (14.3 US gal)	
Maximum wheel diameter	28 inches (710 mm)	
Maximum wheel width	14 inches (360 mm)	

The fuel tank size and minimum weight for non-hybrid cars may get adjusted to reduce the difference in performance between hybrid and non-hybrid cars. There are no limits on the number of cylinders for any type of engine. Bodywork is required to cover all mechanical elements of the car, so that it cannot be visible when the car is viewed directly from the front, side, or top.

The LMP1 cars are generally the most powerful, with faster straight-line speeds.



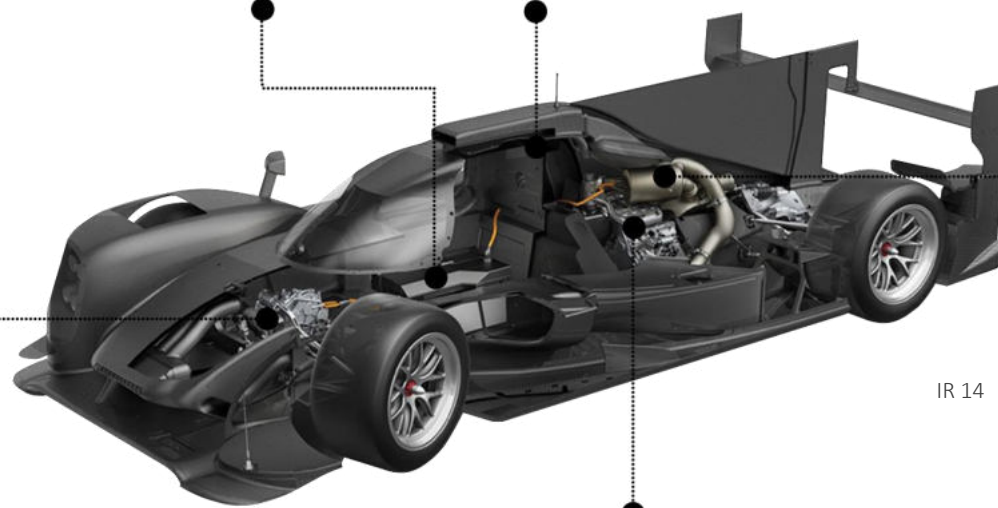
IR 12

ENERGY RECOVERY FROM BRAKING SYSTEM

BATTERY PACK

COCKPIT

ENERGY RECOVERY FROM EXHAUST

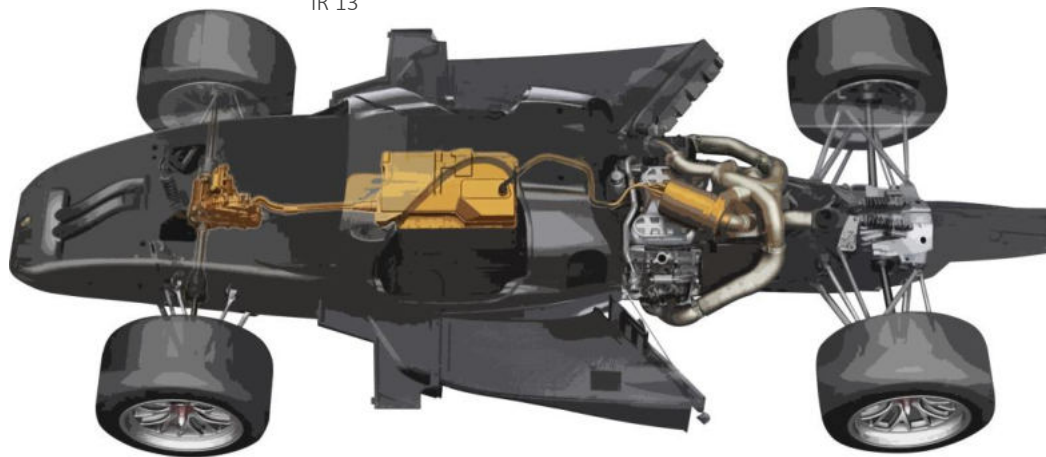


IR 14



2L V4 ENGINE

IR 13



The V4 engine powers the rear axle with over 500 bhp according to Porsche. When the driver recalls the stored energy from the battery, around 400 bhp drives the front axle additionally (at 8MJ). This way the Porsche 919 Hybrid temporarily turns into a four-wheel drive car with around 1,000 bhp system performance.

The engine is however known to use Formula 1 style exhaust gas recovery and an Audi style front mounted electric motor. Energy storage is a battery pack mounted in the passenger compartment with cells developed by A123 systems, who also supply a number of F1 teams. Not the single exhaust exit, suggesting that the car has a mono turbo layout.

OPENING TO REDUCE AIR PRESSURE

REAR WING



AIR OUTLET

ENGINE EXHAUST

DIFFUSER

AIR INTAKE FOR ENGINE



VERTICAL STABILIZER

AIR INTAKE FOR COCKPIT

SPLITTER



IR 15

Multi function T steering wheel with 24 buttons and switches on the front and six paddles on the reverse side.

Rectangular shape due to space required during quick driver changes and enough room for legs inside the cockpit

Central display which shows speed, what gear is engaged, motor management presets and charge status of the lithium ion battery.

Fluorescent color on the buttons respond to black light lamp situated above the drivers' helmet.

Made of carbon fiber and slip resistant rubber on the grip.

Paddles for upshifting, downshifting and clutch.

2.7. Drivers



NICO HULKENBERY

Vehicle 919 Hybrid

Only F1 and LMP1 driver in the world

View points -

Difference about F1 and LMP1: F1 are rear wheel drive cars and LMP1 are four wheel drive car, it is totally different in that way and traction controls in LMP1 which makes it stand out

Four wheel drive has different ways of driving and different style. LMP1 are easy to pull out of corners on the other hand F1 car's rears always try to step out.

The effect of downforce is more in high speed than less speed.

LMP1 feels more lazy due to heavier compared to F1 cars.



JANN MARDENBOROUGH

Nissan NISMO LMP1

Gaming to racing

View points -

Virtual games cannot replicate the forces the driver feel while accelerating, braking or cornering
But I performed unimaginably well when I jumped from games to actual vehicle.

There is no reset button in real life

Race cars are not designed for comfort.

You will feel the heat of the race and engine inside the vehicle.



KARUN CHANDHOK
Nissan NISMO LMP1

View points -

Le Mans is not about 24hrs race, it is about the months of hard works and preparations.

Drivers have to co-operate with the team mates because they are driving the same cars despite having them different styles, the needs to be set up to suit all of them

A race driver should be both physically and mentally prepared.

2.8. Design Scope

After watching many race videos and interviews with the drivers, some scope for design are observed.

Survival

Crash

Slippery roads

Hit by another car

Lose control in the corners

Engine failure

Mechanical failure

Electrical Malfunction

Fuel leak

Distance

Speed

Aero dynamism

Driver's focus on the race

Engine performance

Time

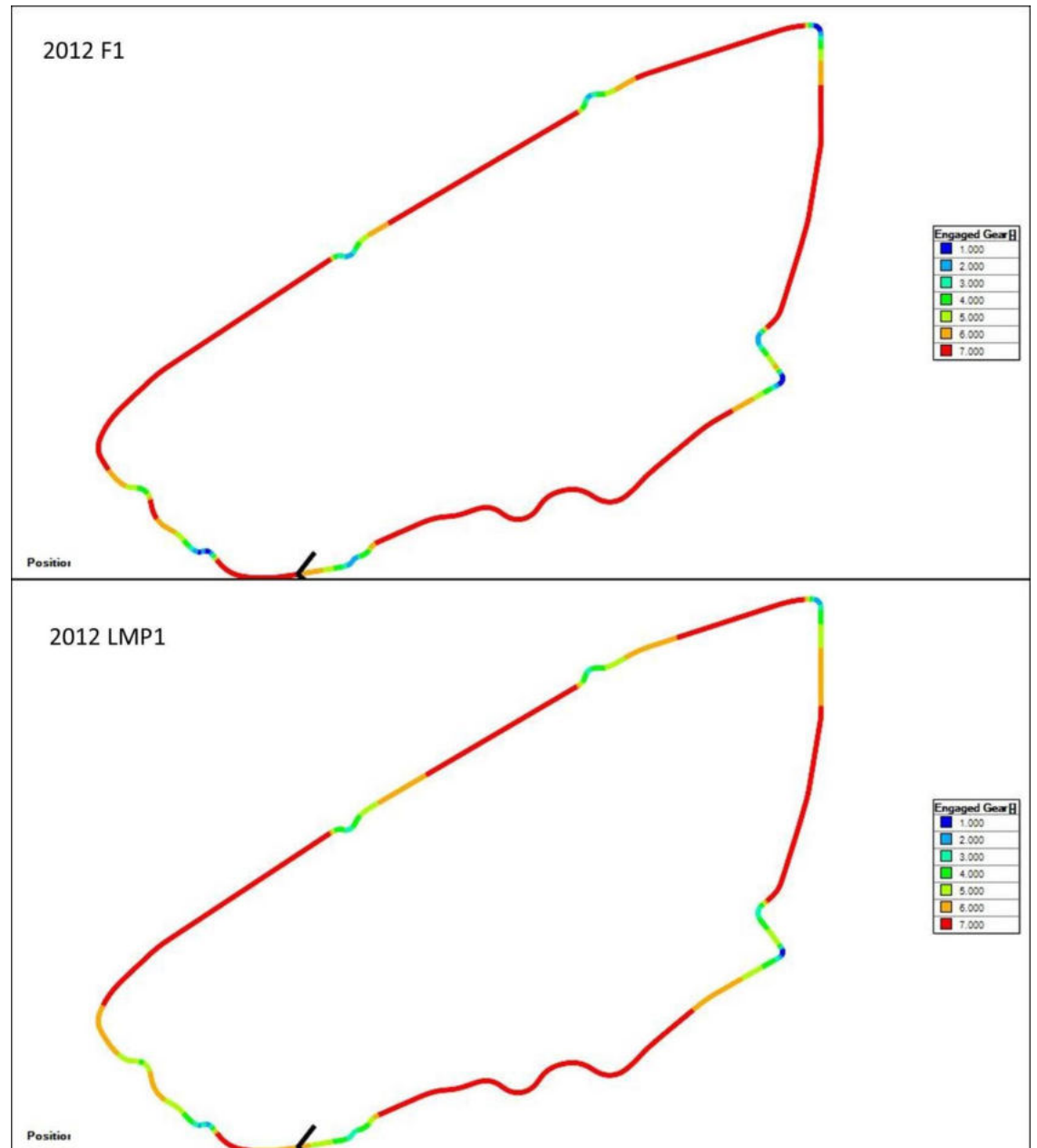
Slower at the corners

Pit stops

Visibility during night

2.8. High speed cornering

The main focus of the design will be high speed cornering. Since Cornering's are big challenge for drivers . As we can see in the map which compares gear shifting between F1 and LMP1. Most of the gear shifting happen in the corners. So when there is more gear shifting there is reduction in acceleration and hence it's a time consuming activity.



2.8. Brief

To design a breakthrough race car to win the Le Mans 24 hours in the year 2030 by utilizing future-looking technologies, innovations, and pioneering problem solving skills to design a car that reinforces the premium brand image of a company that is ready to elevate its brand through a Le Mans 24 hours win.

Objectives

To design a vehicle which takes cornering at ease.

Vehicle which adapt to various situations by changing it's shape and form.

Augmented reality to enhance driver's experience

4.1. Endurance

Endurance is the ability of an organism to exert itself and remain active for a long period of time, as well as its ability to resist, withstand, recover from, and have immunity to trauma, wounds, or fatigue. It is usually used in aerobic or anaerobic exercise. The definition of 'long' varies according to the type of exertion – minutes for high intensity anaerobic exercise, hours or days for low intensity aerobic exercise. Training for endurance can have a negative impact on the ability to exert strength unless an individual also undertakes resistance training to counteract this effect.

Among mammals, humans are well adapted for running significant distances, and particularly so among primates. The endurance running hypothesis suggests that running endurance in the *Homo* genus arose because travelling over large areas improved scavenging opportunities and allowed persistence hunting. The capacity for endurance running is also found in migratory ungulates and a limited number of terrestrial carnivores, such as dogs, wolves and hyenas

ENDURANCE

The ability to endure an unpleasant or difficult process or situation without giving way.



4.2. Technology & human evolution

Neolithic revolution
Stone age-Bronze age-Iron age
Ancient greek &
Roman technology
Medieval technology
Renaissance technology
Industrial Revolution
Atomic Age
Jet Age
Space Age
Digital Revolution
Information Age



Tools & Technology has made life so convenient for us that it's almost scary to think of what would happen if we had to go without our favorite gadget for an extended period of time. We have to face facts: Technology has made us dependent.

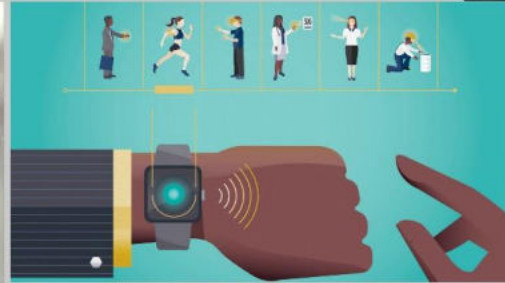
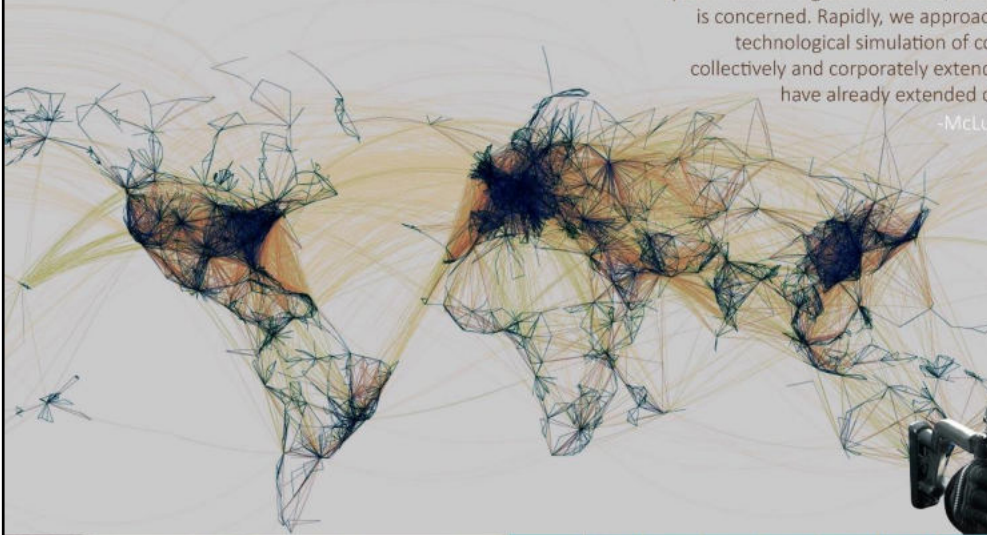
During the information age, the phenomenon is that the digital industry creates a knowledge-based society surrounded by a high-tech global economy that spans over its influence on how the manufacturing throughput and the service sector operate in an efficient and convenient way. In a commercialized society, the information industry is able to allow individuals to explore their personalized needs, therefore simplifying the procedure of making decisions for transactions and significantly lowering costs for both the producers and buyers. This is accepted overwhelmingly by participants throughout the entire economic activities for efficacy purposes, and new economic incentives would then be indigenously encouraged, such as the knowledge economy.

www.khanacademy.org

TECHNOLOGY HAS BECOME EXTENSION OF HUMAN BODY

During the mechanical ages we had extended our bodies in space. Today, after more than a century of electric technology, we have extended our central nervous system itself in a global embrace, abolishing both space and time as far as our planet is concerned. Rapidly, we approach the final phase of the extensions of man- the technological simulation of consciousness, when the creative process will be collectively and corporately extended to the whole of human society, much as we have already extended our senses and our nerves by the various media

-McLuhan, 1965



SCENARIO 2030

50 % MORE FOOD
45 % MORE ENERGY
30 % MORE WATER

60 %
URBAN
POPULATION

UNDER WATER
CITIES

3D
PRINTING

The internet will
come to you

The internet will simply exist as part
of everyday interactions. Just like
the air you breathe, it will be a
critical component of your life, but
you won't necessarily recognize its
presence.

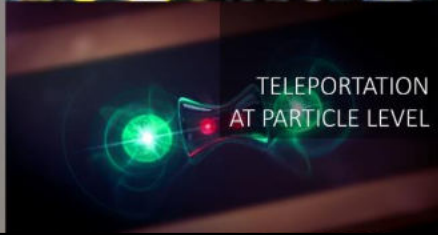
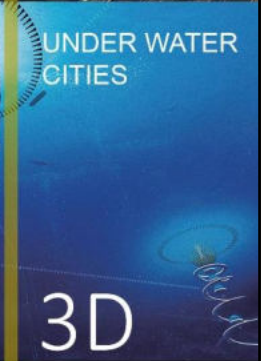
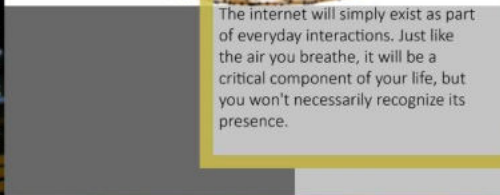
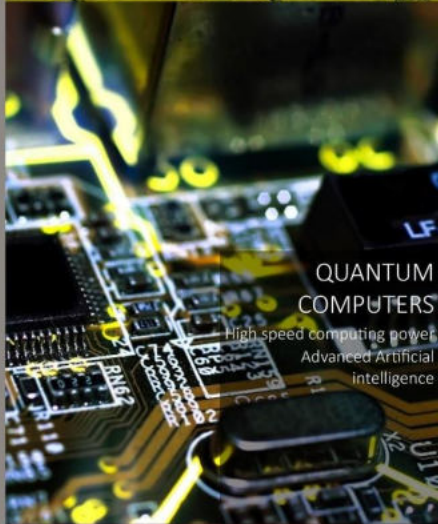
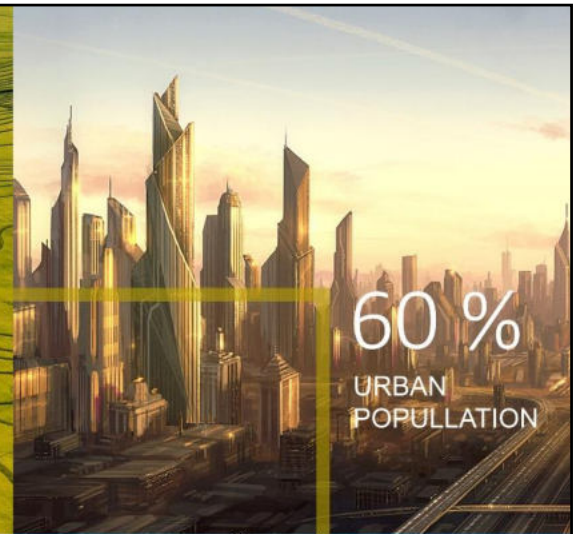
QUANTUM
COMPUTERS

High speed computing power
Advanced Artificial
Intelligence

NANOBOTS

Potential applications for
nanorobots in medicine include
early diagnosis and targeted
drug-delivery for cancer, biomedical
instrumentation, surgery, pharmacok
inetics, monitoring of diabetes, and
health care.

TELEPORTATION
AT PARTICLE LEVEL





SMARTER VEHICLES



MAN ON MARS

SPACE TOURISM

Space tourism is space travel for recreational, leisure or business purposes. A number of startup companies have sprung up in recent years, such as Virgin Galactic and XCOR Aerospace, hoping to create a sub-orbital space tourism industry.



HYPERSONIC AIRCRAFT

A speed where dissociation of air begins to become significant and high heat loads exist.

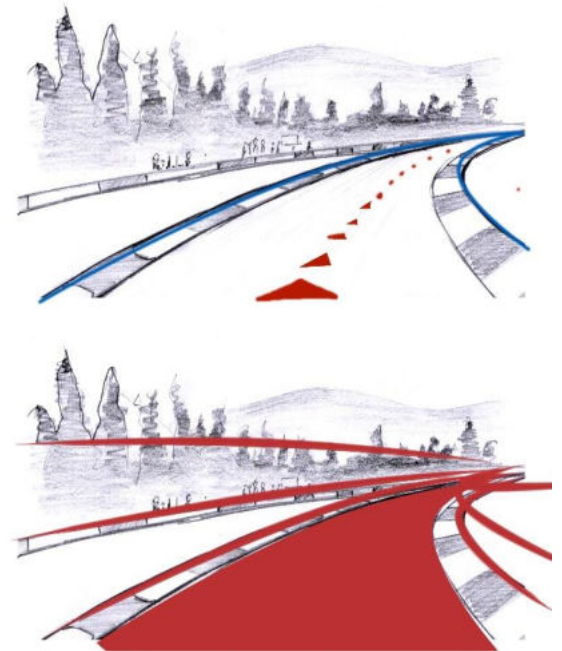


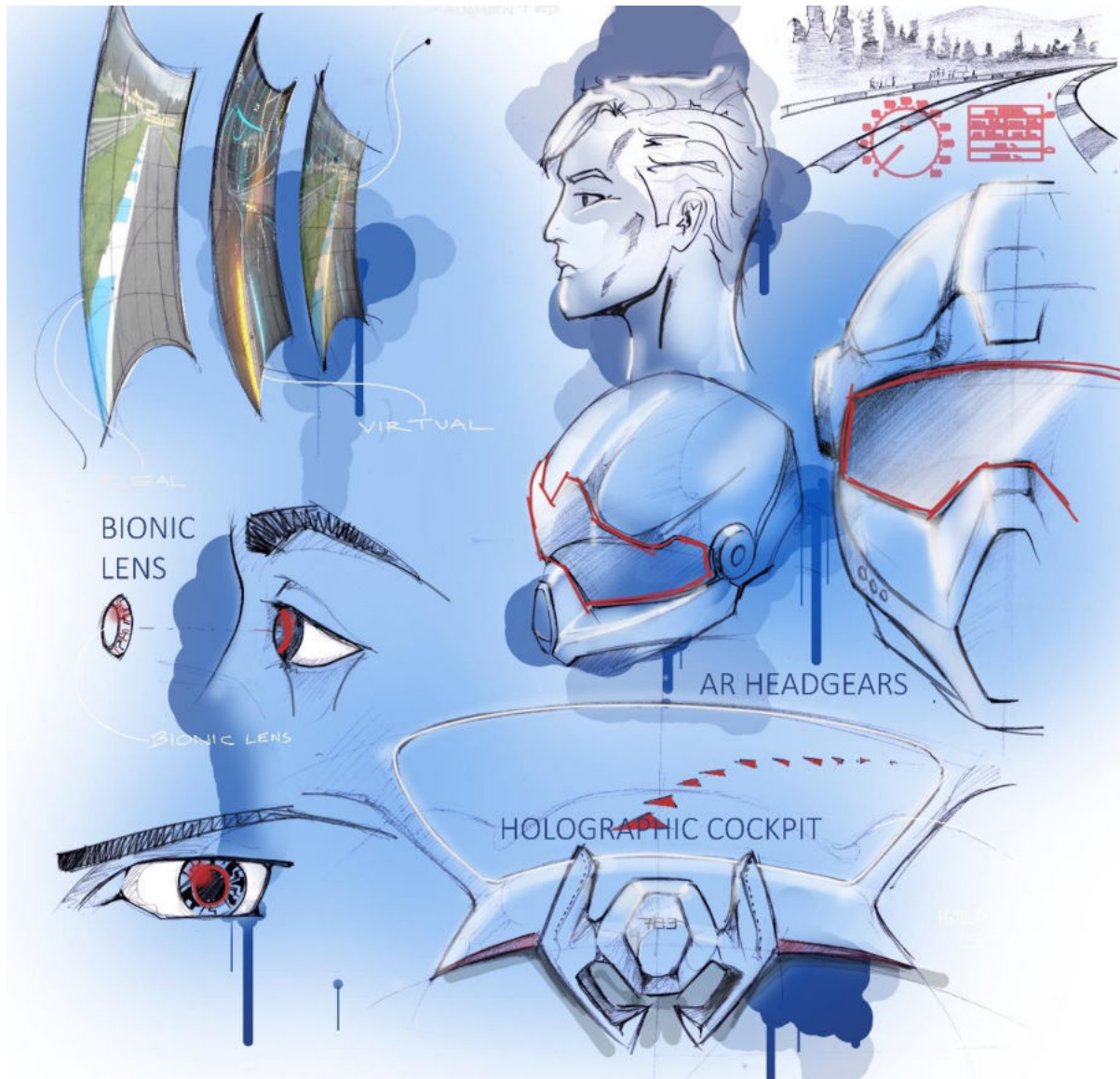
In a major space policy speech at Kennedy Space Center on April 15, 2010, U.S. President Barack Obama predicted a manned Mars mission to orbit the planet by the mid-2030s, followed by a landing

4.4 Augmented Reality

Augmented reality (AR) is a live direct or indirect view of a physical, real-world environment whose elements are *augmented* (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data. It is related to a more general concept called mediated reality, in which a view of reality is modified (possibly even diminished rather than augmented) by a computer. As a result, the technology functions by enhancing one's current perception of reality

A combination of a real scene viewed by a user and a virtual scene generated by a computer that augments the scene with additional information.





Augmented reality (AR) An AR system adds virtual computer-generated objects, audio and other sense enhancements to a real-world environment in real time.

What is the Goal of AR?

To enhance a person's performance and perception of the world

Create a system such that a user CANNOT tell the difference between the real world and the virtual augmentation of it.



IR 16

Augmented Reality vs. Virtual Reality

Augmented Reality

System augments the real world scene.

User maintains a sense of presence in real world

Needs a mechanism to combine virtual and real worlds

Virtual reality

Totally immersive environment

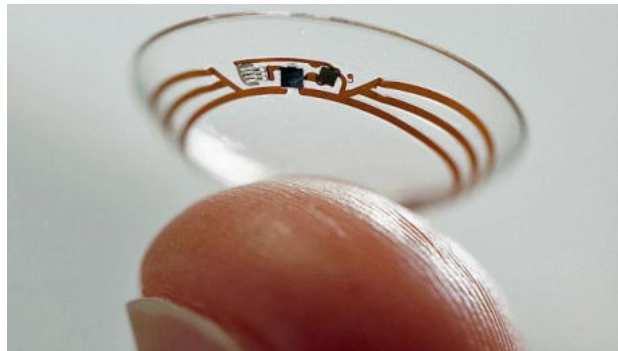
Visual senses are under control of system (sometimes aural and proprioceptive senses too)



IR 17



IR 18



IR 19

DISPLAY

Head-mounted (HMD)

Device paired to a headset such as a harness or helmet

Eye Glasses

Eye wear that employs cameras to intercept the real world view and re-display it's augmented view through the eye pieces

Contact Lenses

Contain the elements for display embedded into the lens including integrated circuitry, LEDs and an antenna for wireless communication.

Virtual Retina Display

A personal display device under development

A display is scanned directly onto the retina of a viewer's eye.



IR 20



IR 21

Handheld

A small display that fits in a user's hand.

Portable

Ubiquitous

Physical constraints of the user having to hold the device

Distorting effect

Spatial

Makes use of digital projectors to display graphical information

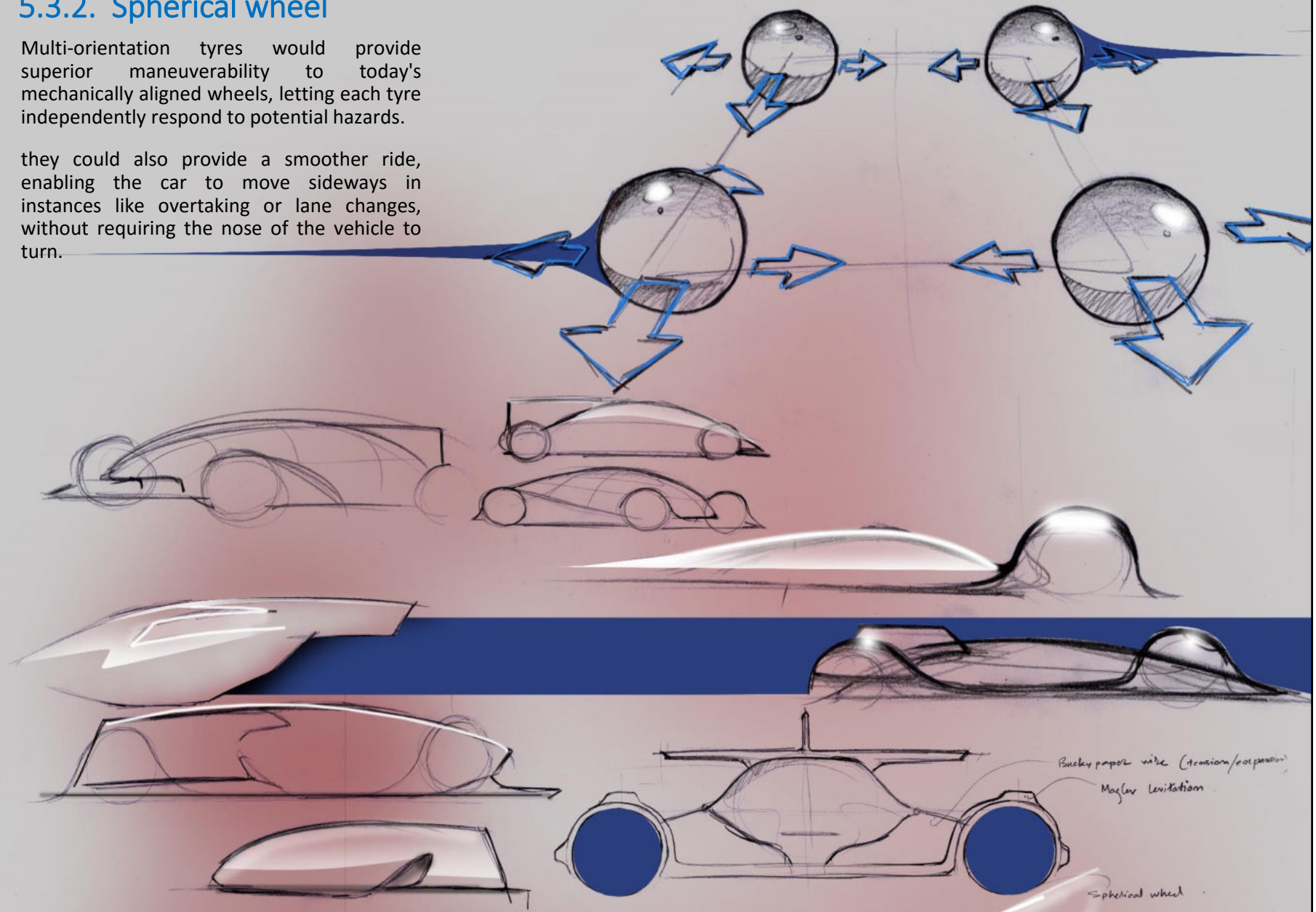
User is not required to carry equipment or wear the display over their eyes.

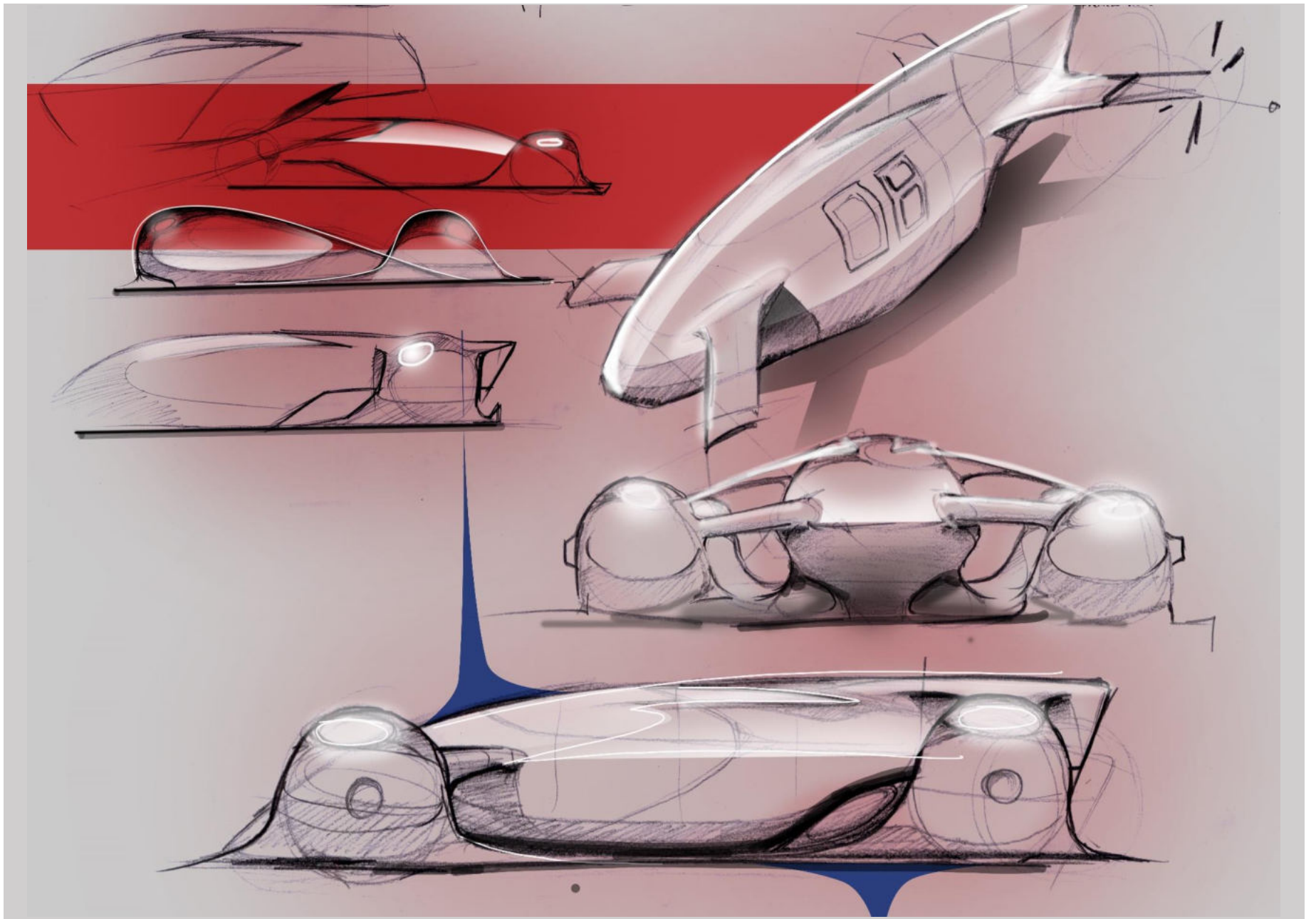
Can be used by multiple people at the same time without each having to wear a head-mounted display.

5.3.2. Spherical wheel

Multi-orientation tyres would provide superior maneuverability to today's mechanically aligned wheels, letting each tyre independently respond to potential hazards.

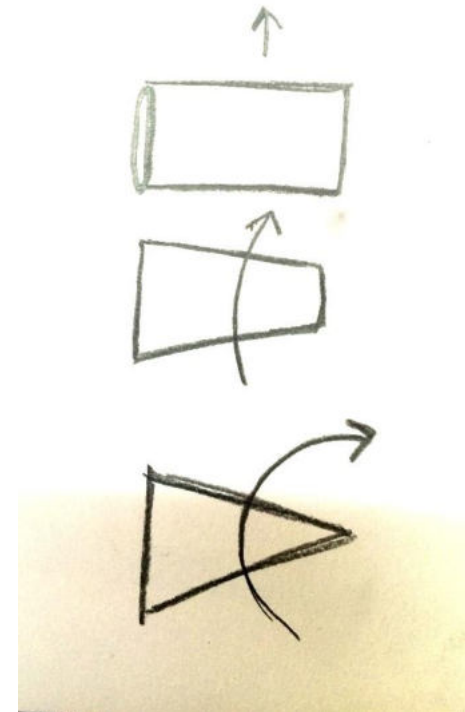
they could also provide a smoother ride, enabling the car to move sideways in instances like overtaking or lane changes, without requiring the nose of the vehicle to turn.



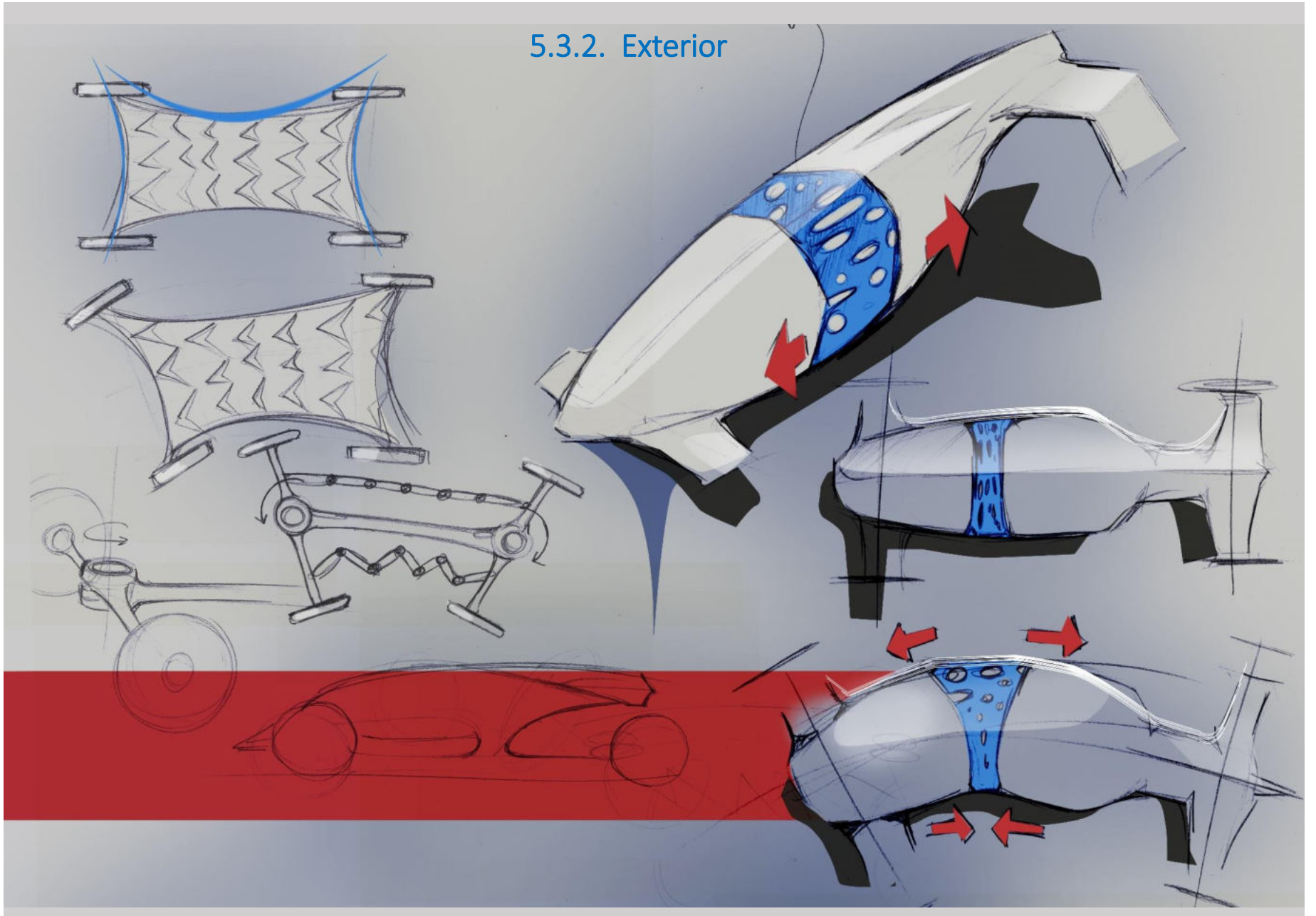


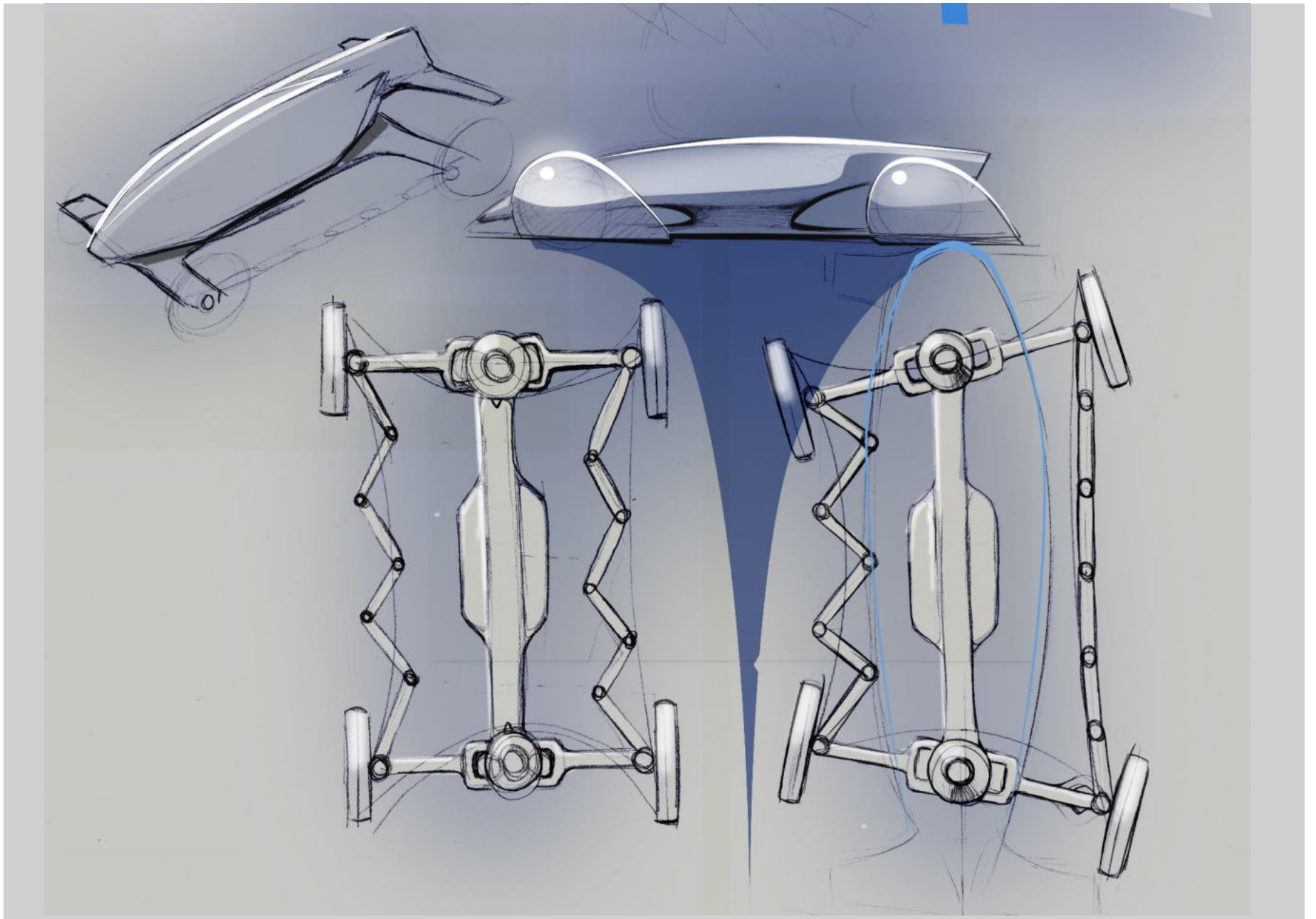
5.3.2. Skateboard concept

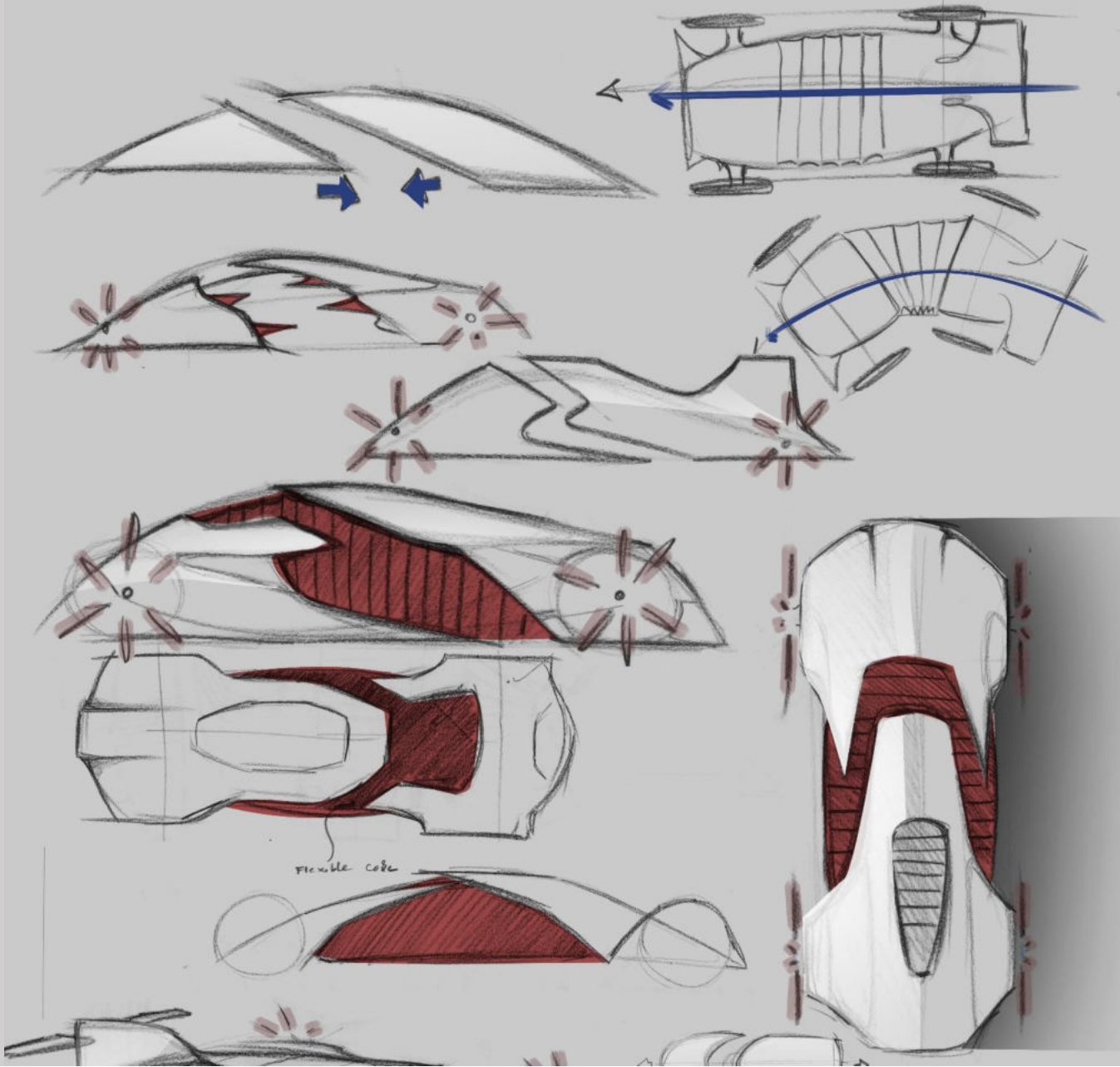
Bushs. Four. Two on each truck made of rubber, nylon, Teflon, silicone. Bush's are central to the trucks pivot mechanism on which it supports the wheels and board bearing the riders weight shifts. The riders weight exerts pressure on the bush's which give way enough to create a bias in the wheels alignment forcing a turn left or right

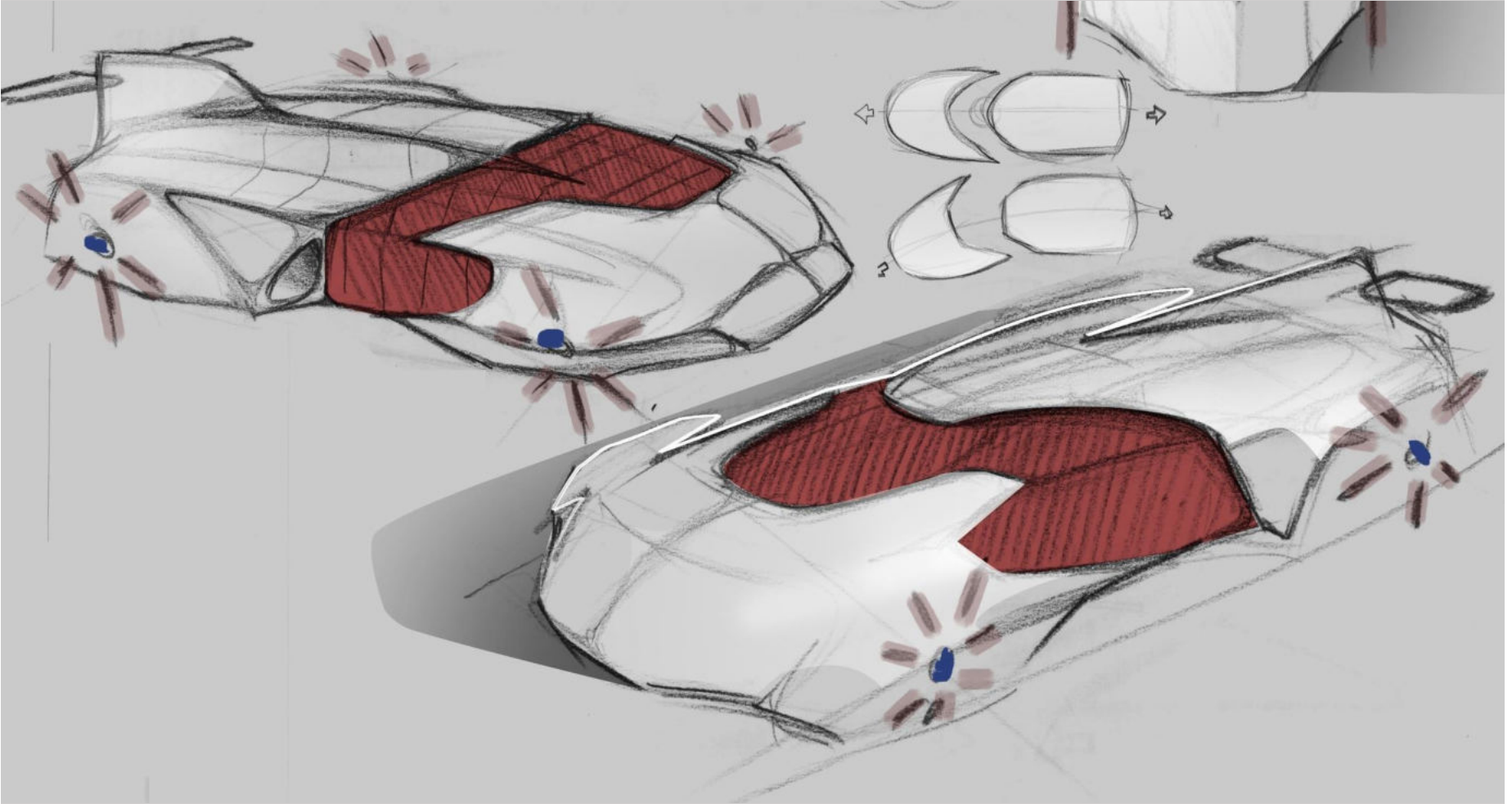


5.3.2. Exterior

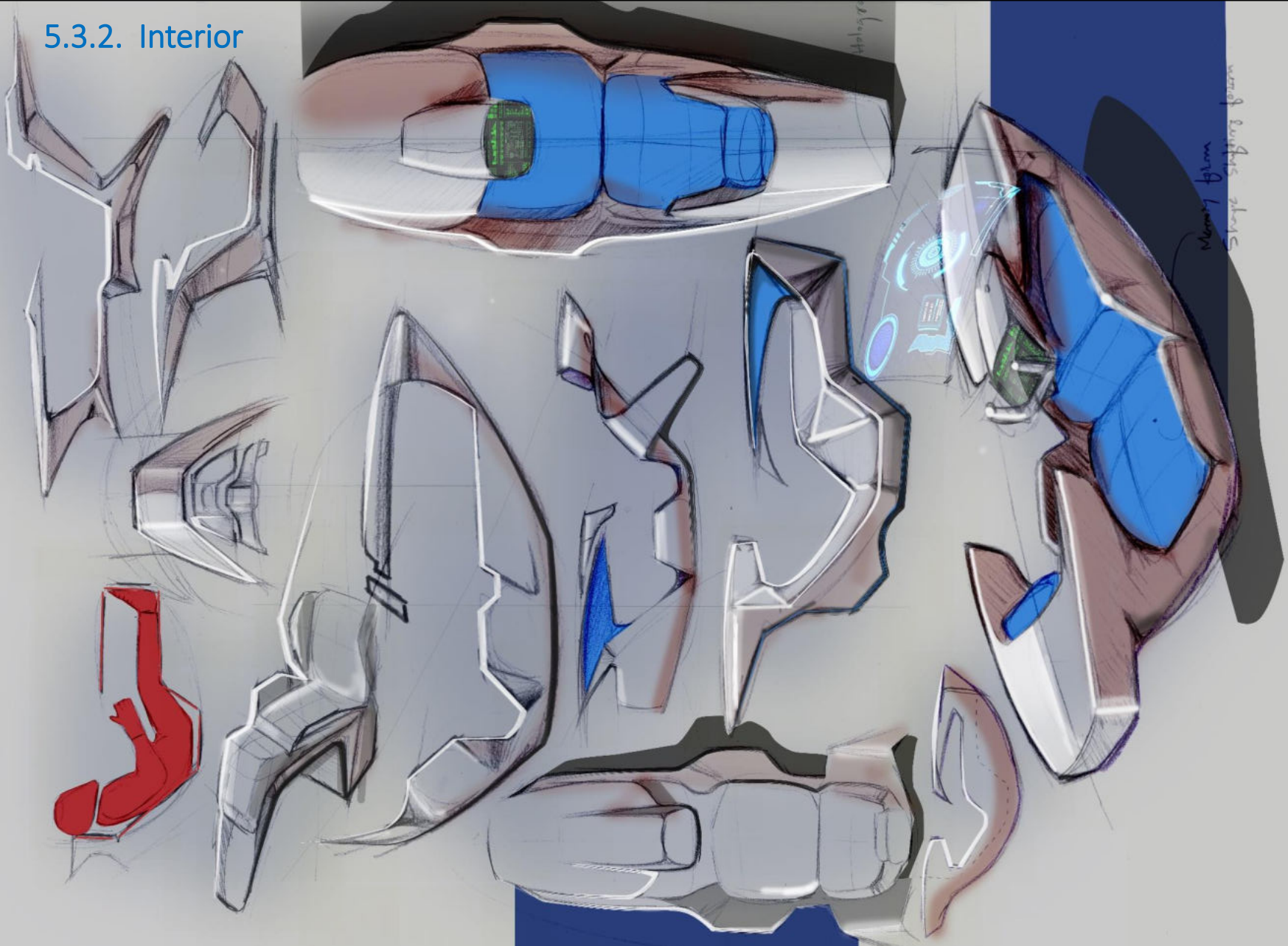






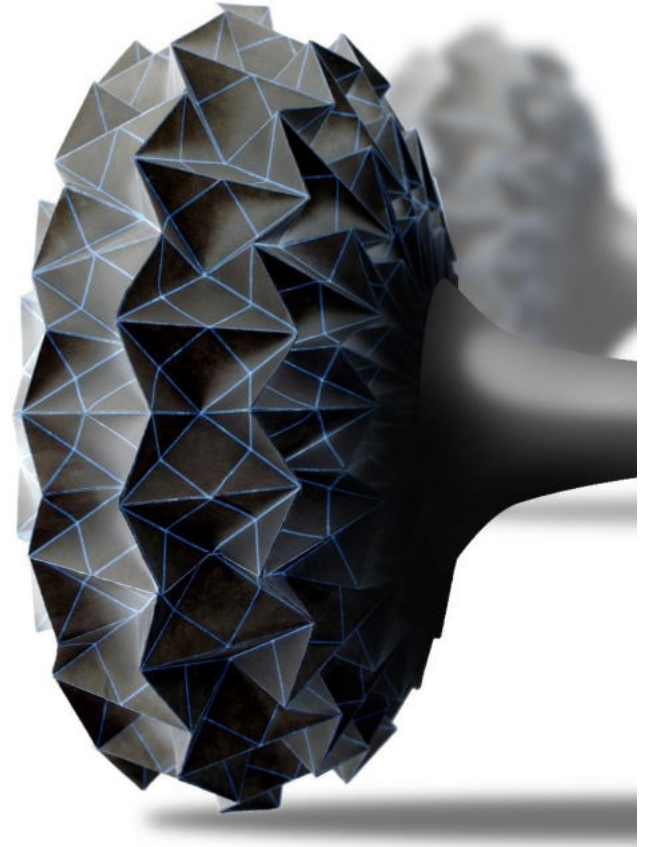
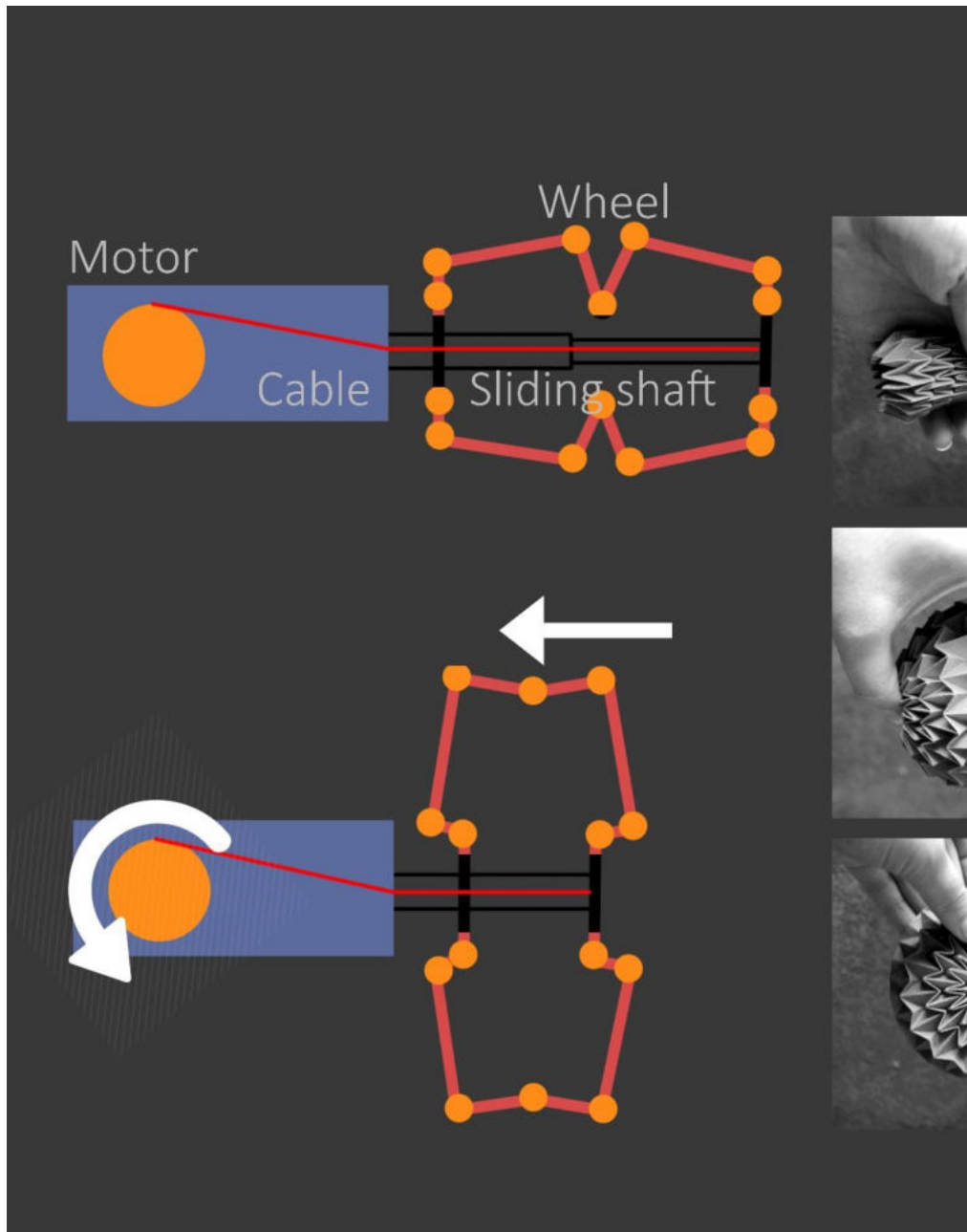


5.3.2. Interior



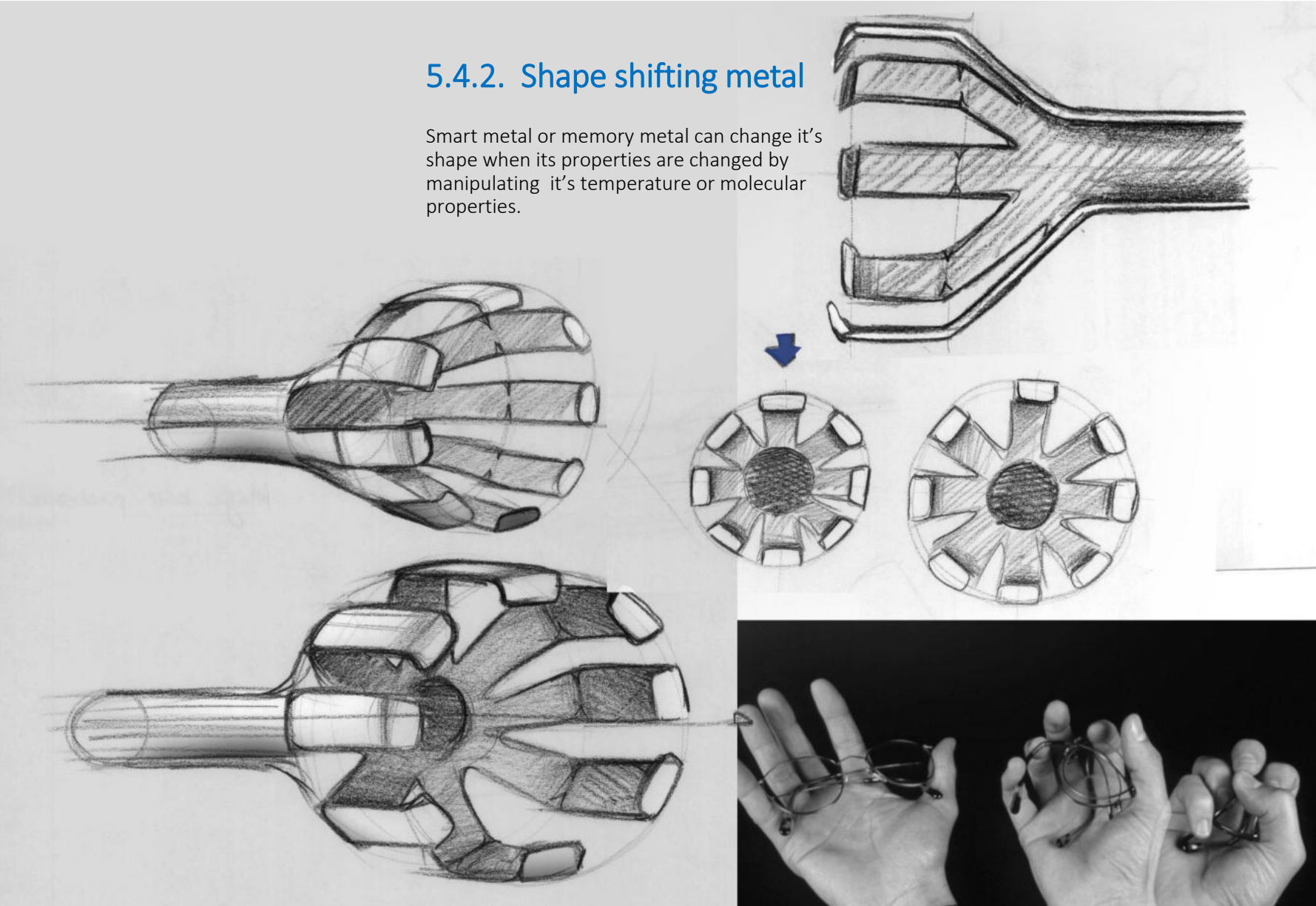
Memory from stage setting from

5.4.1. Origami wheel

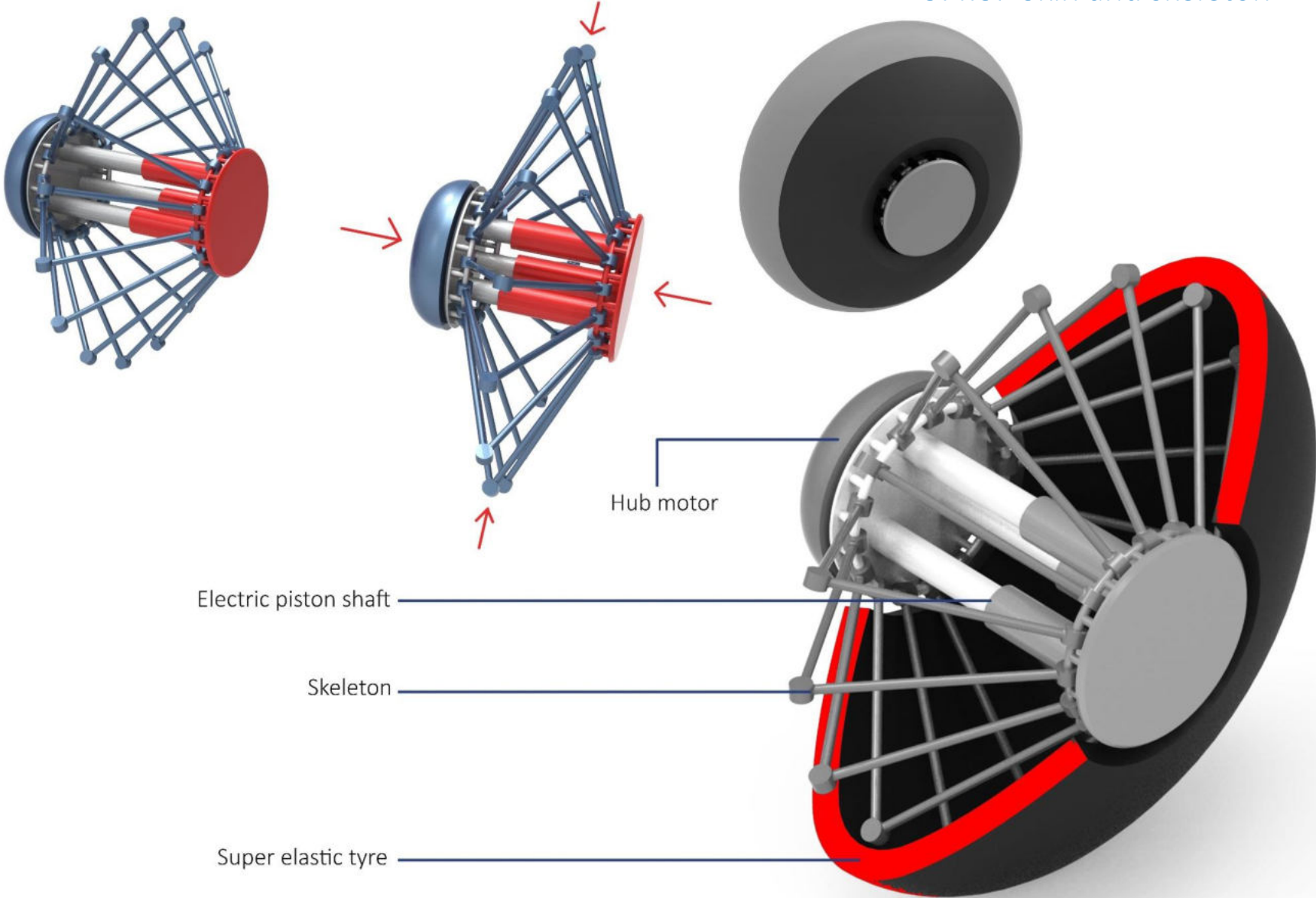


5.4.2. Shape shifting metal

Smart metal or memory metal can change it's shape when its properties are changed by manipulating it's temperature or molecular properties.

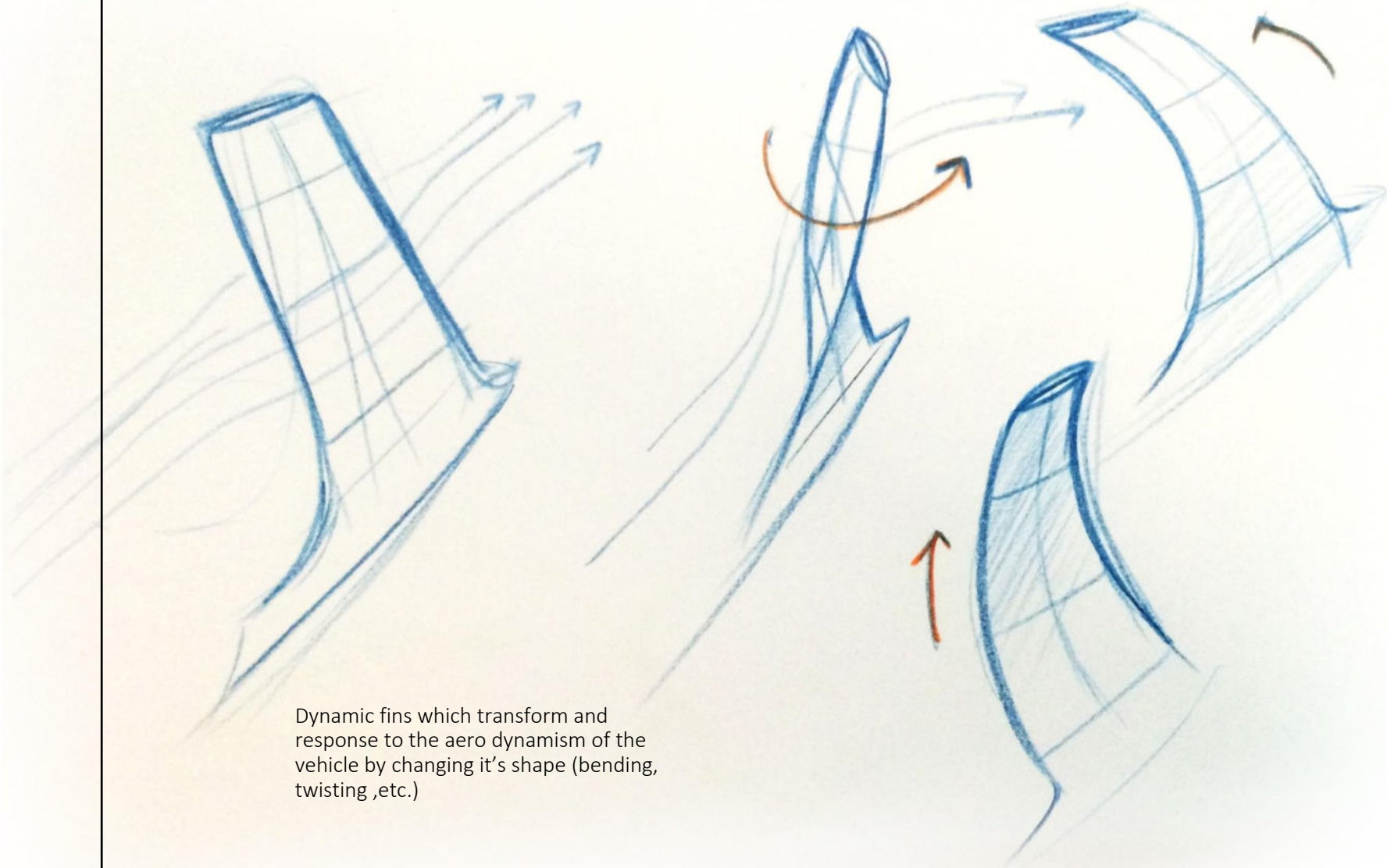


5.4.3. Skin and skeleton



5.4.3. Adaptive fins

Dynamic fins which transform and respond to the aerodynamic of the vehicle by changing its shape (bending, twisting, etc.)



6.1..Mood Board

Bold and Elegant



IR 23



IR 24



IR 25

Swift and Wispy



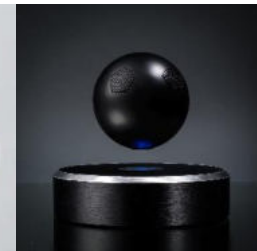
IR 26

IR 26

IR



IR 27

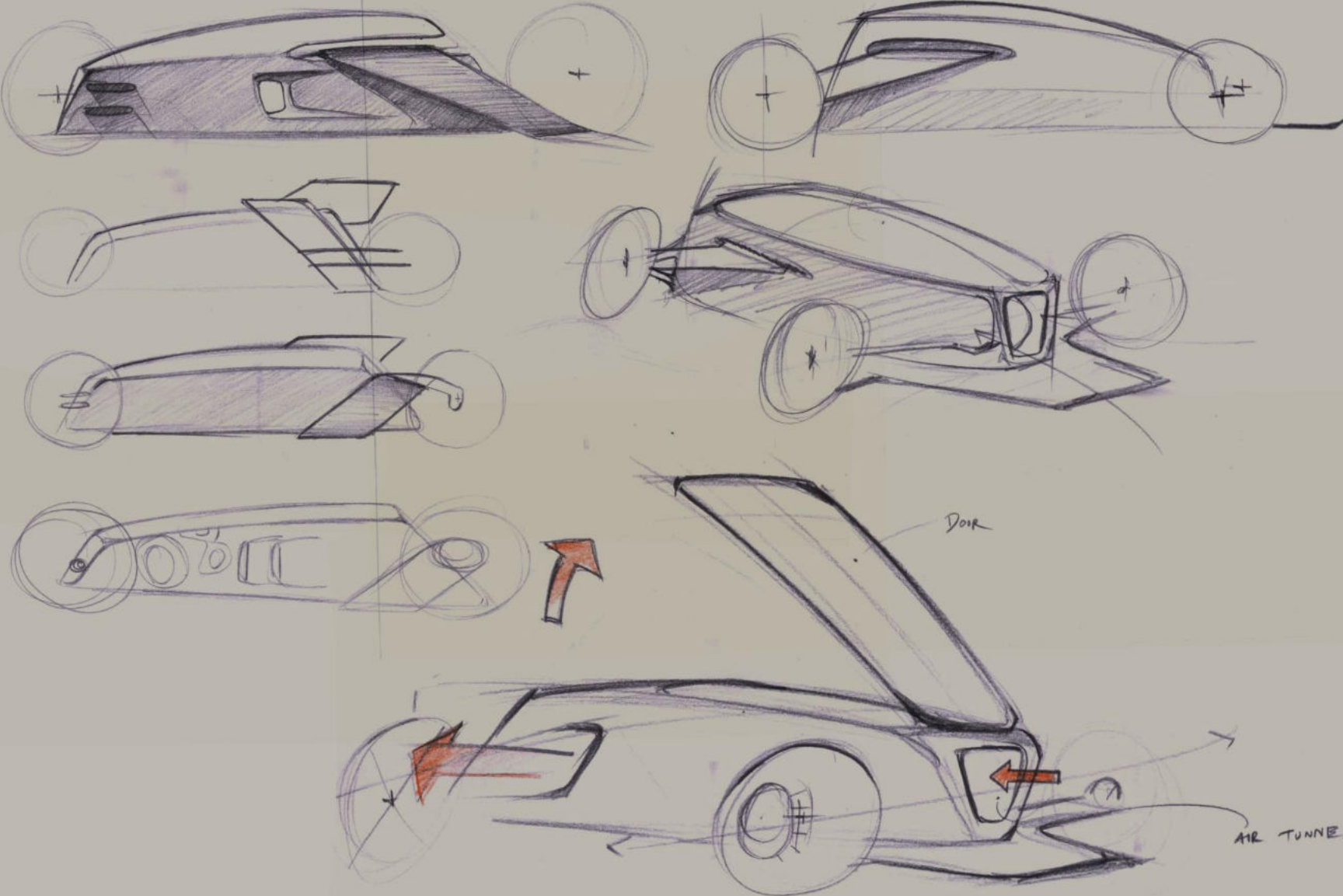


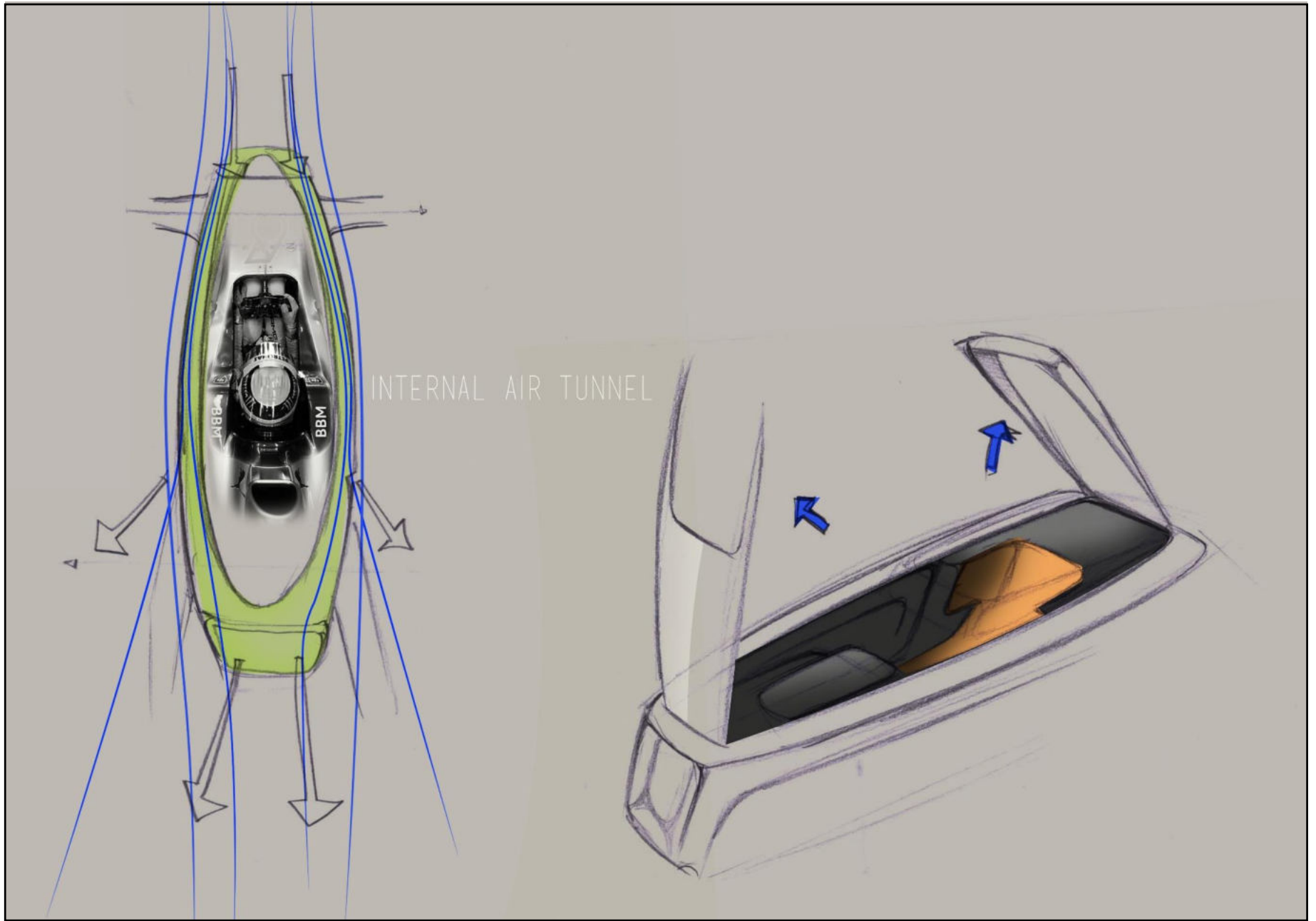
IR 28

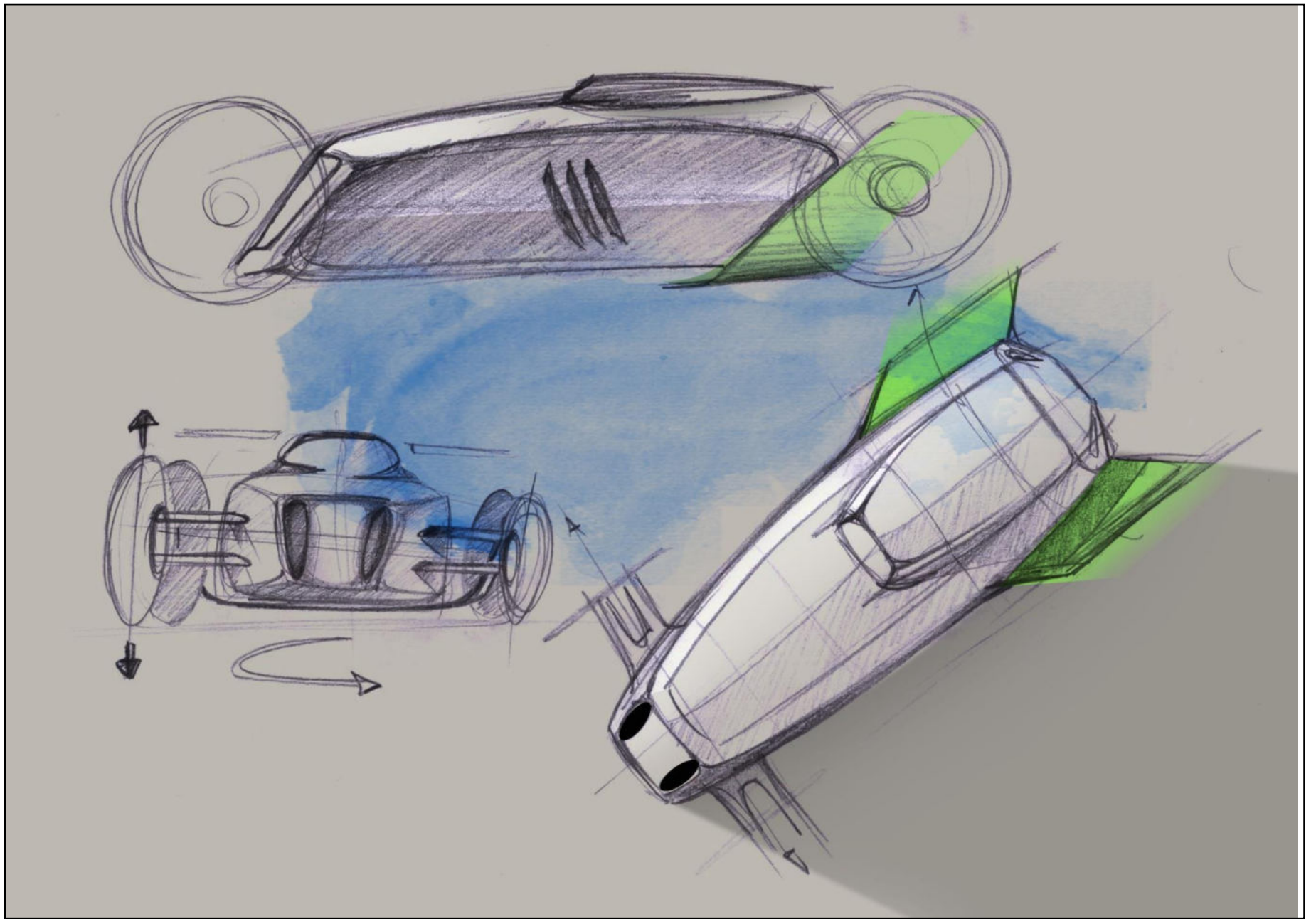


IR 29

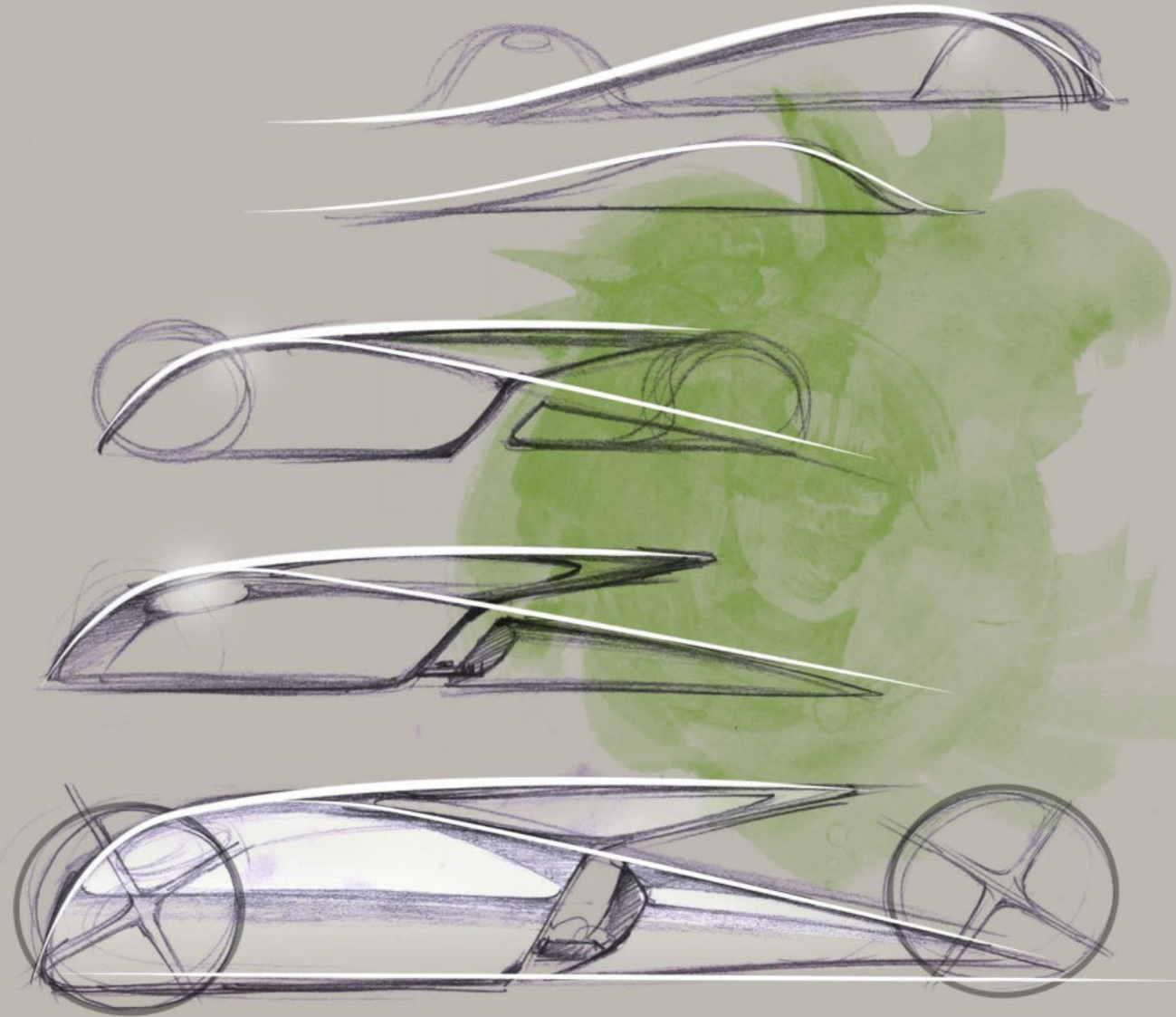
6. Concepts

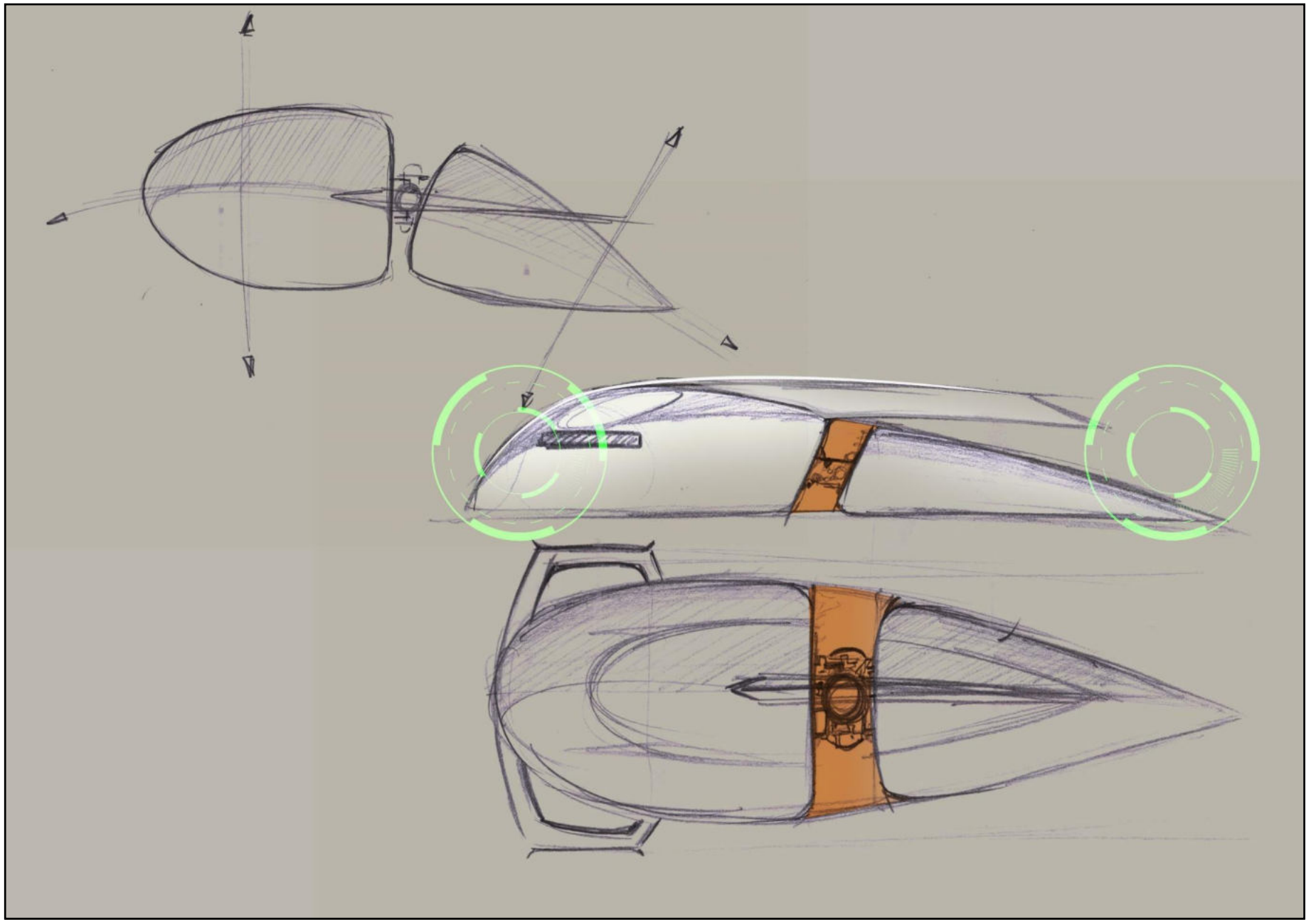




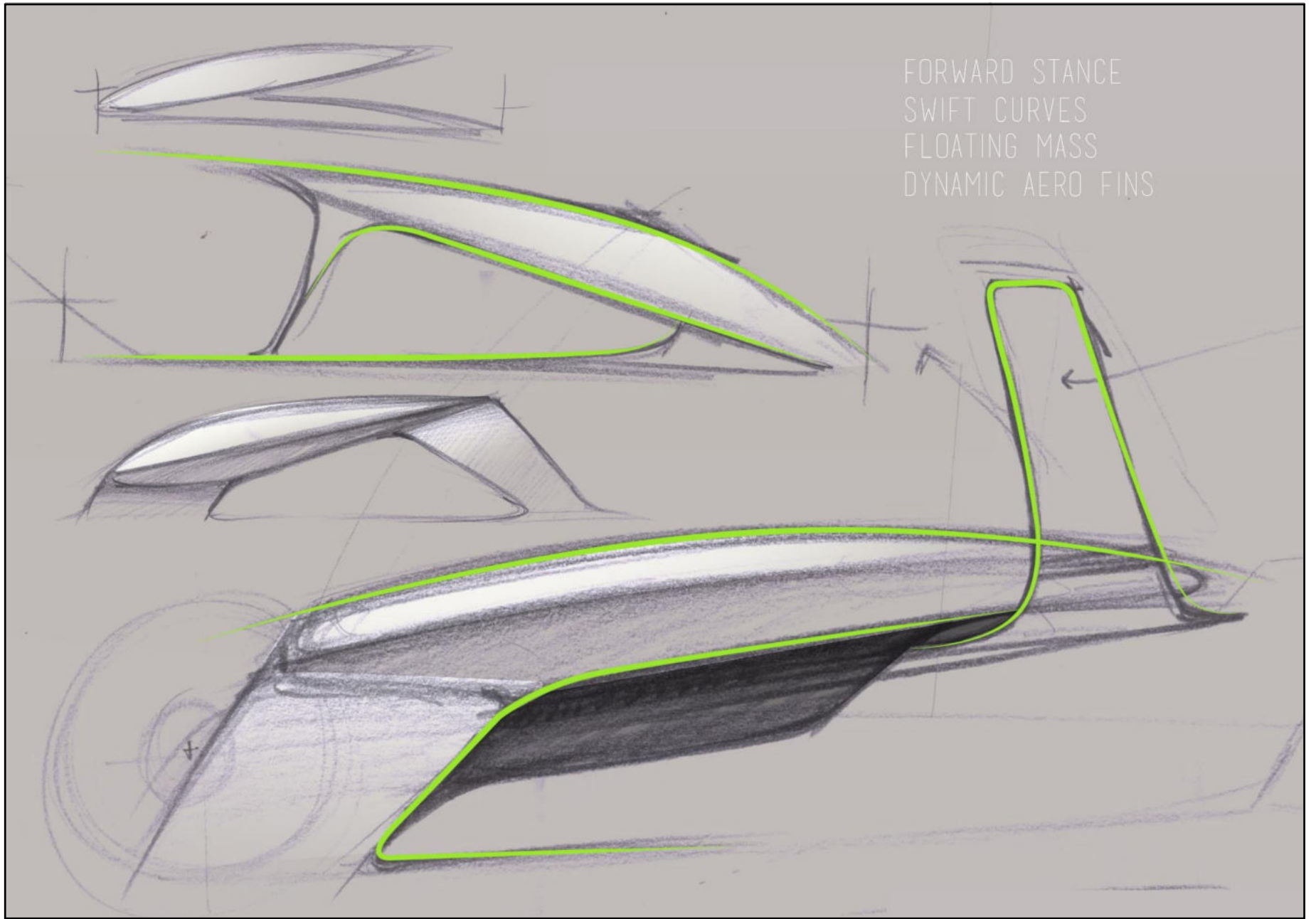


6.3. Concept 2

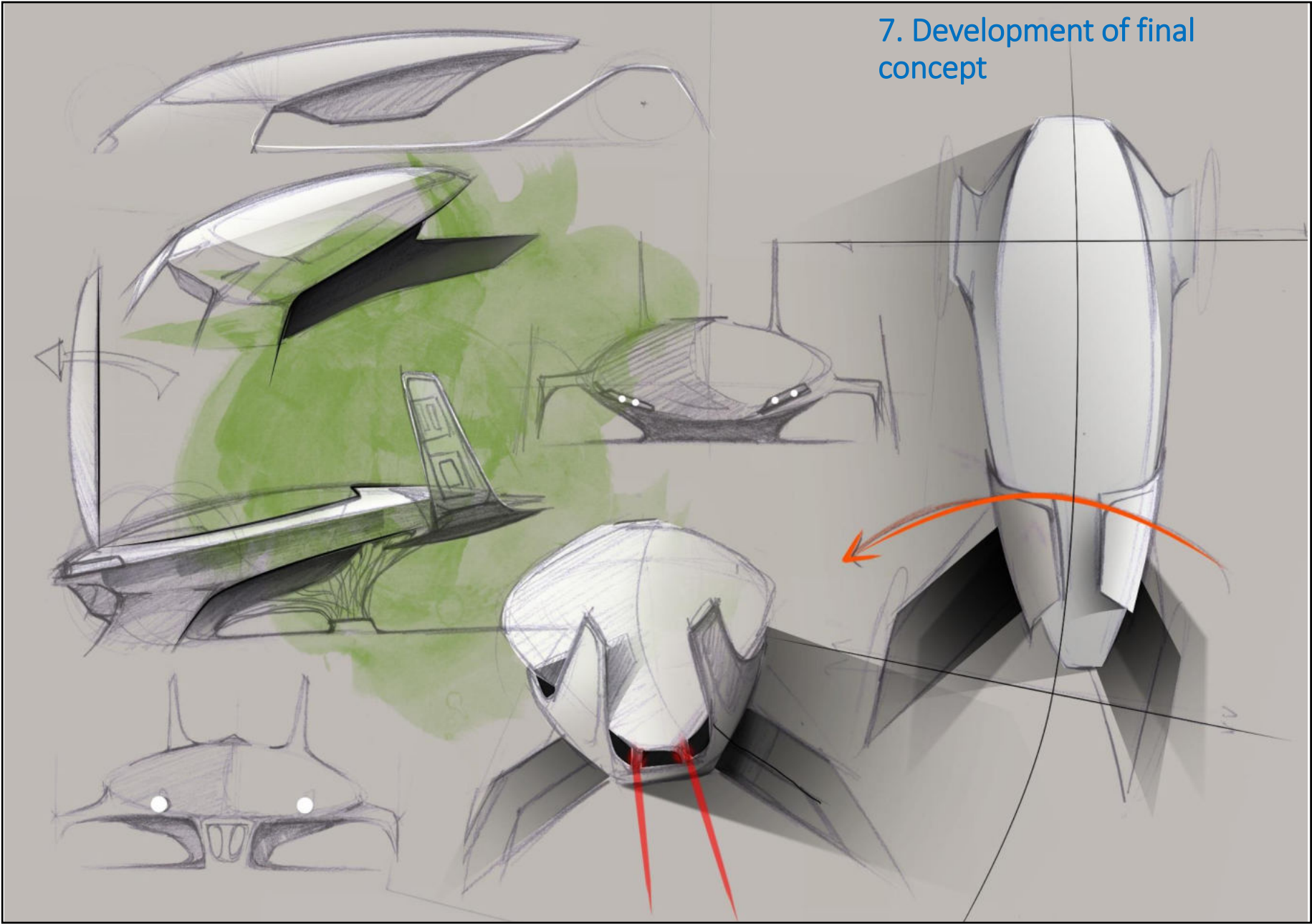


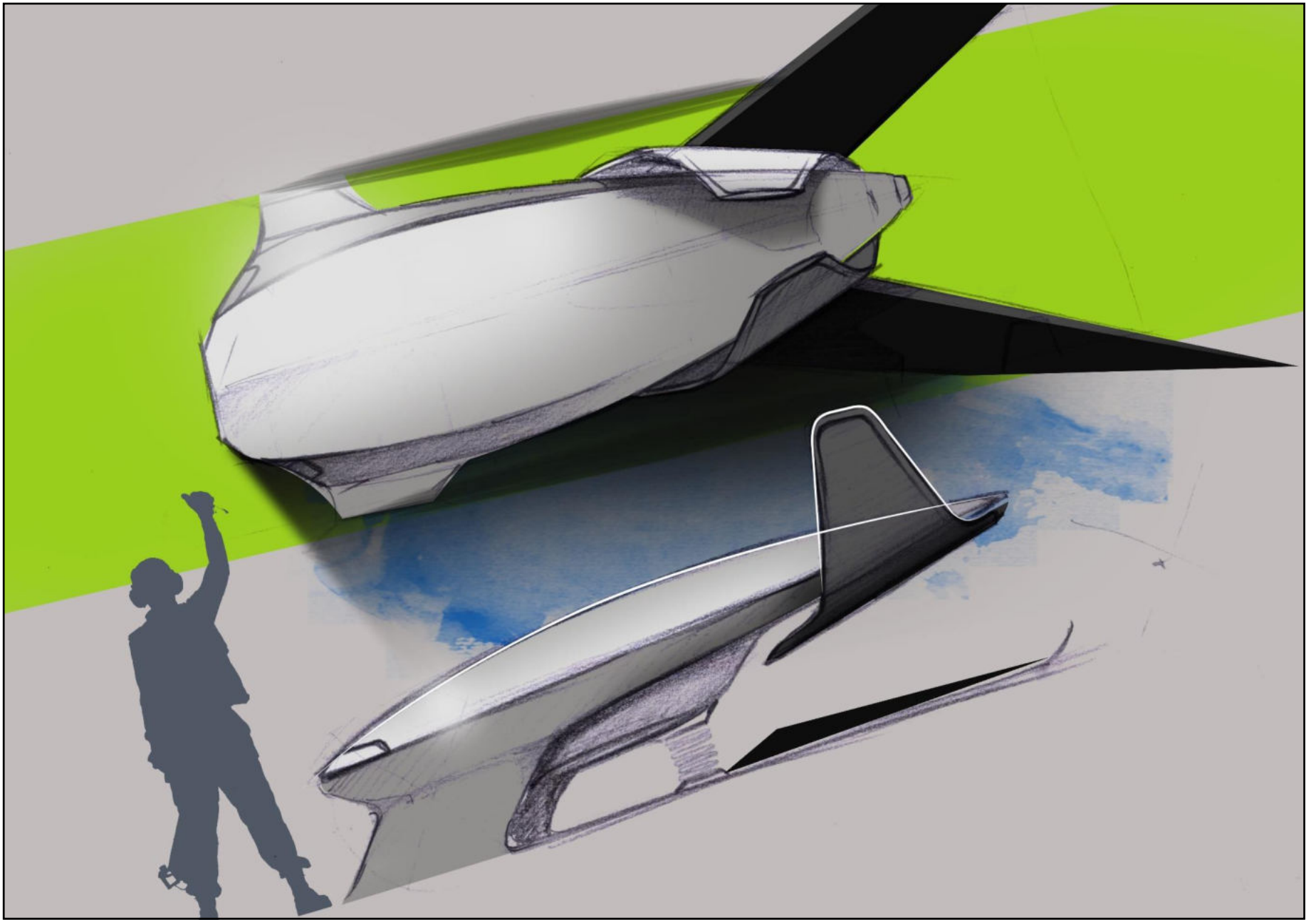


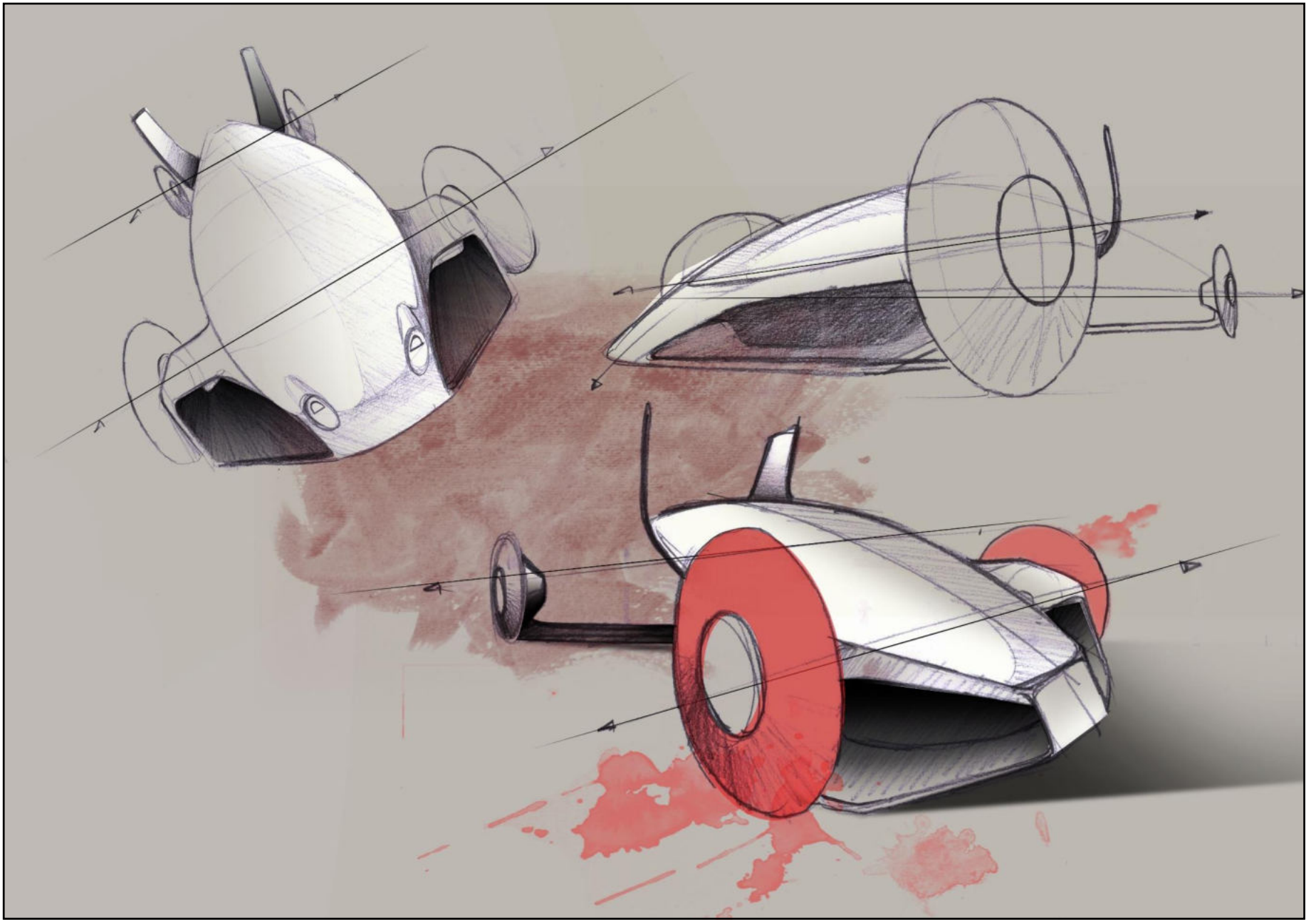
FORWARD STANCE
SWIFT CURVES
FLOATING MASS
DYNAMIC AERO FINS

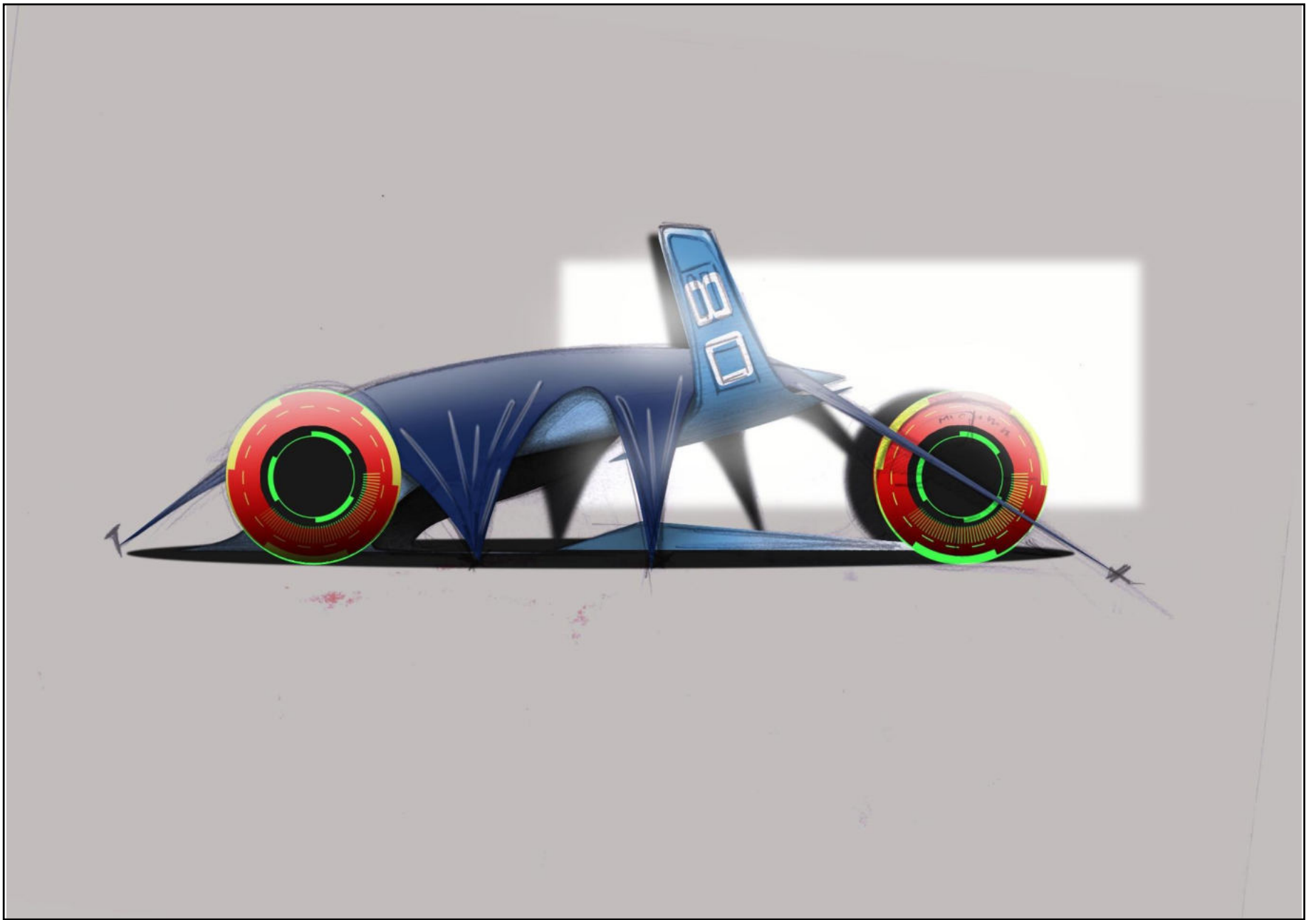


7. Development of final concept

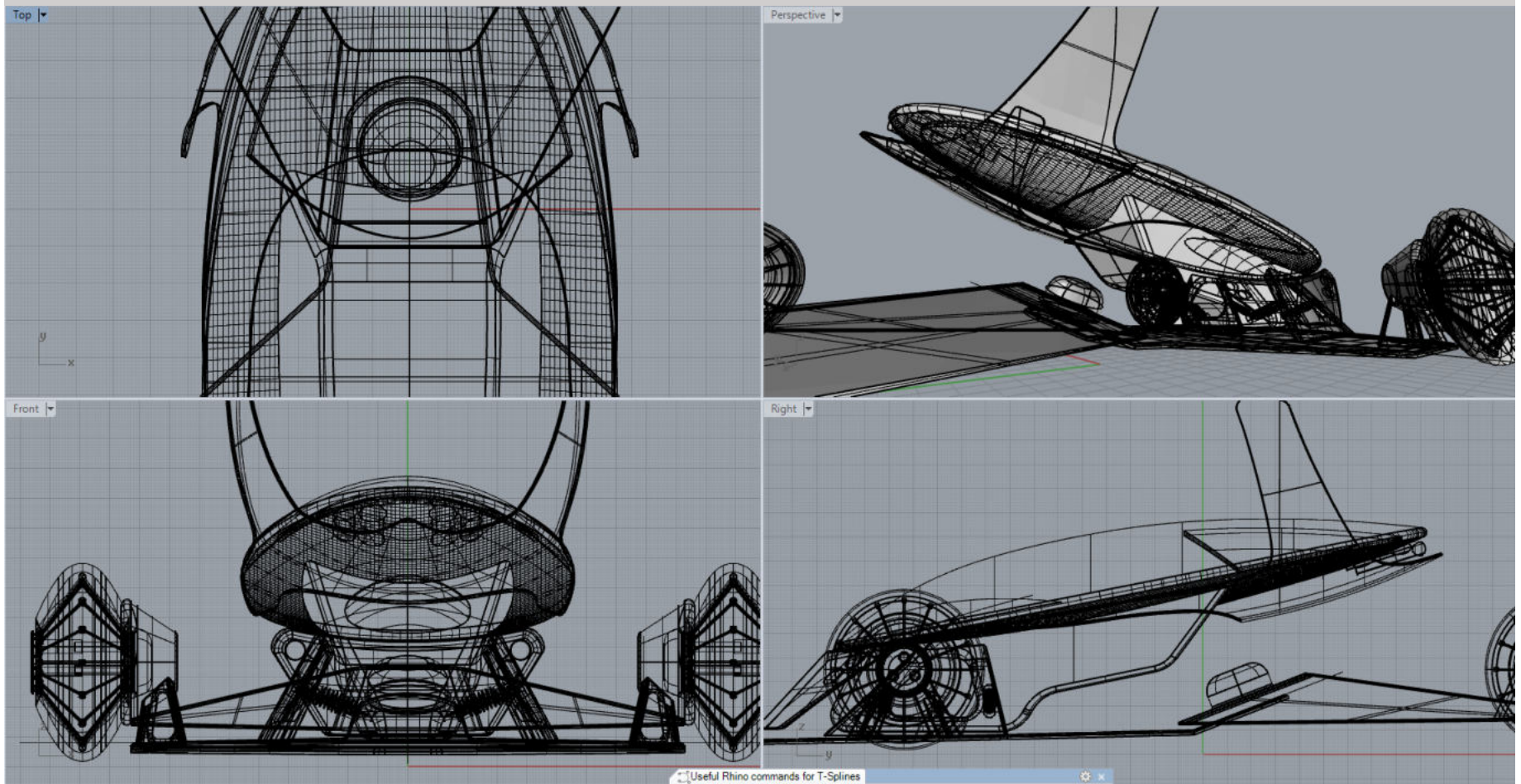








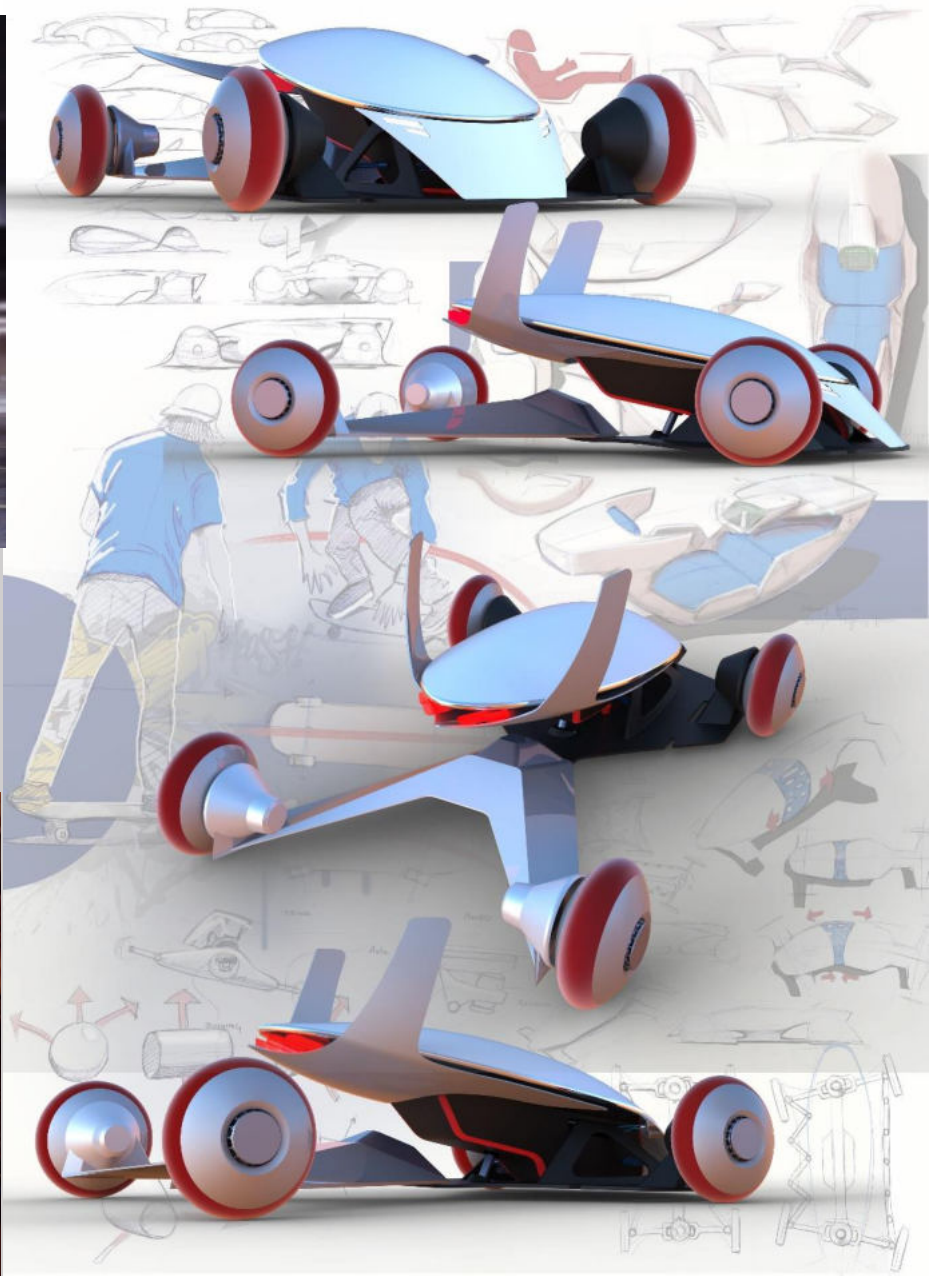
7.2 CAD Model



7.3. Renders









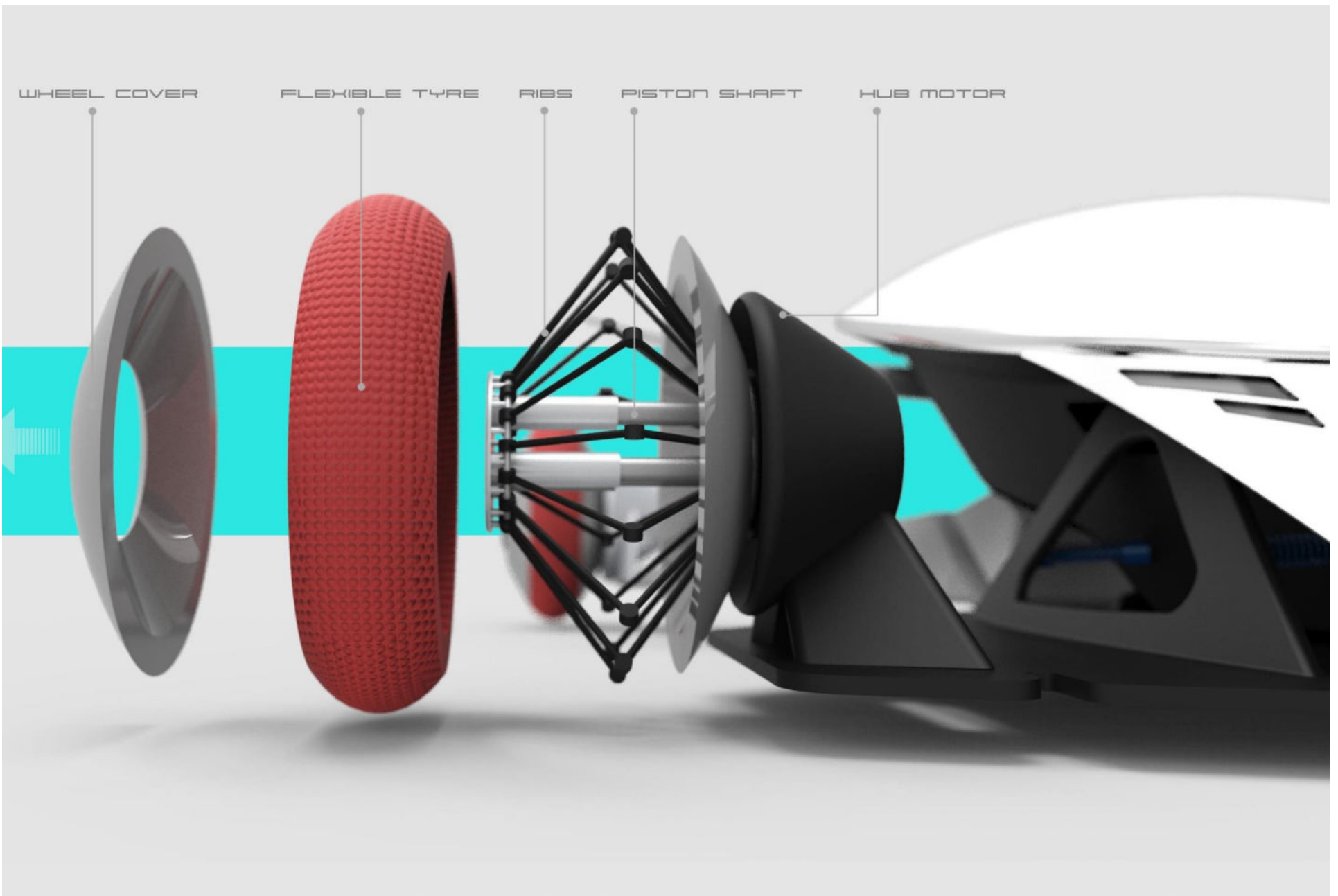


SMART WHEEL

DYNAMIC FINS

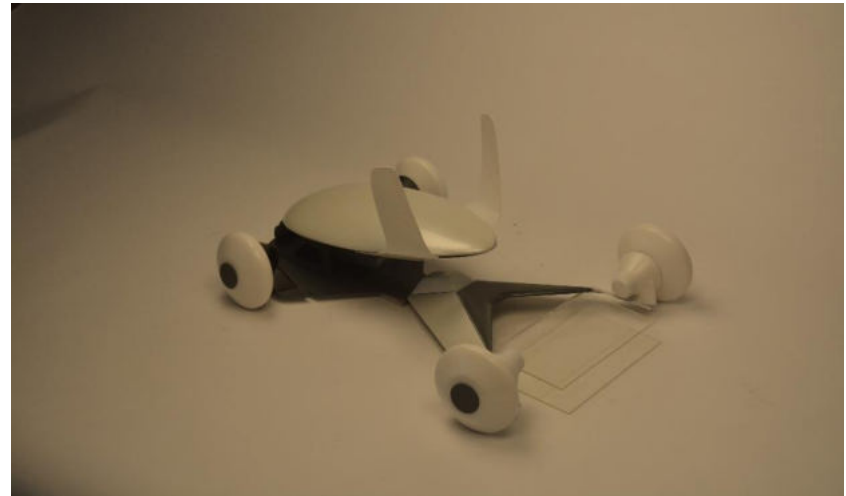
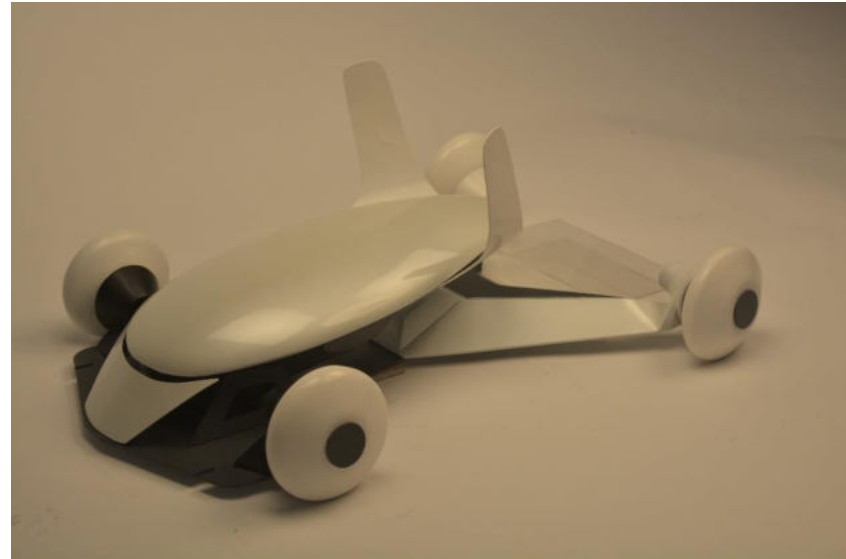
INDEPENDENT
SUSPENSION

HUB MOTOR



8. Physical model

Scale - 1 : 8



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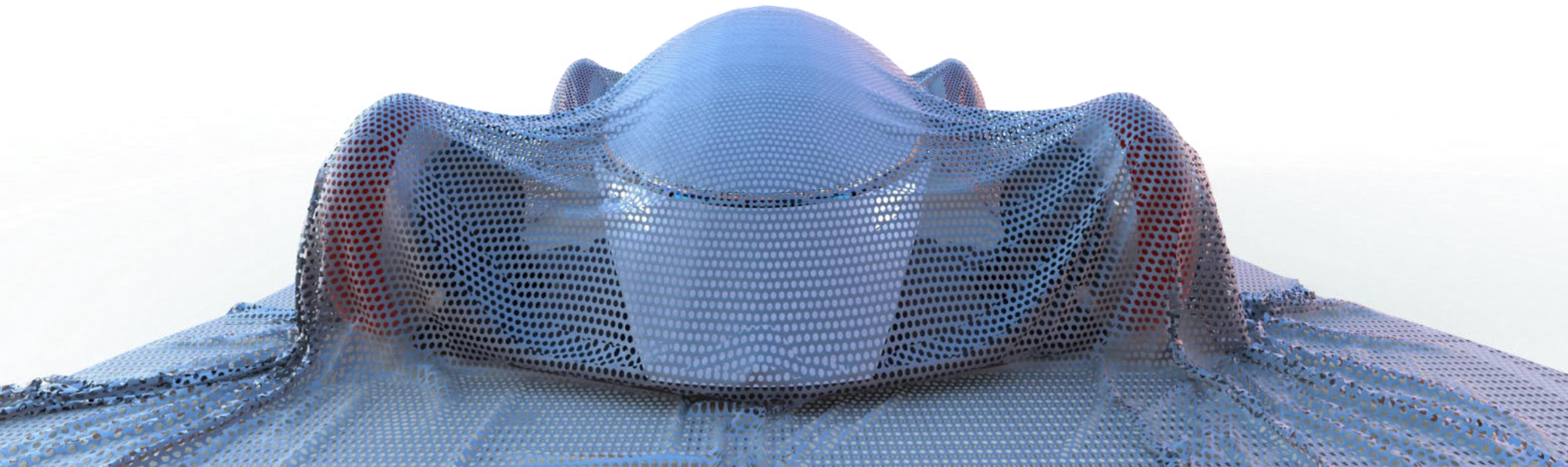


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