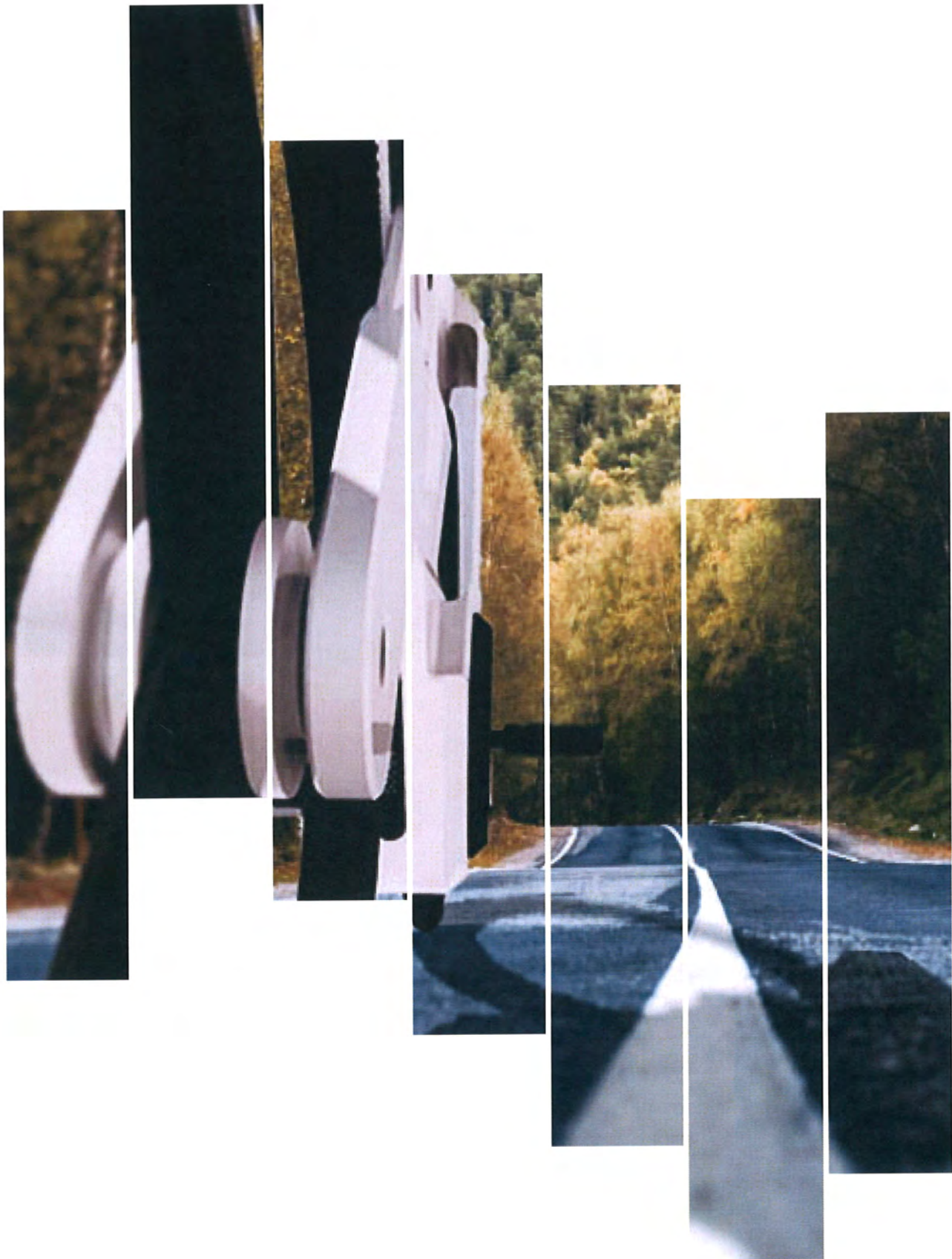


No part of the candidate evidence in this exemplar material may be presented in an external assessment for the New Zealand Scholarship award.



# BICYCLE PROJECT



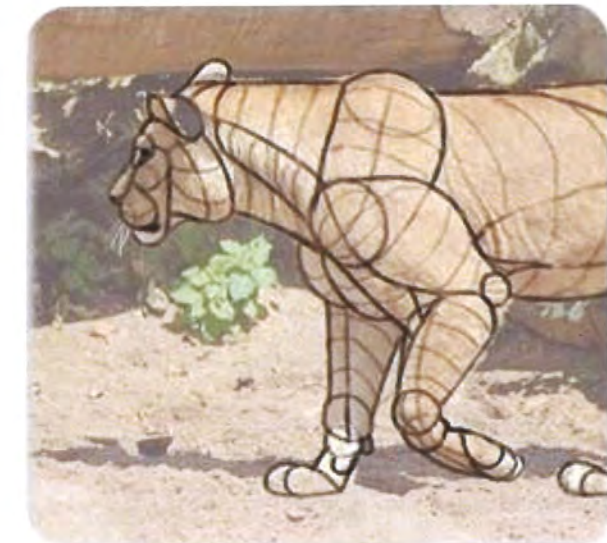
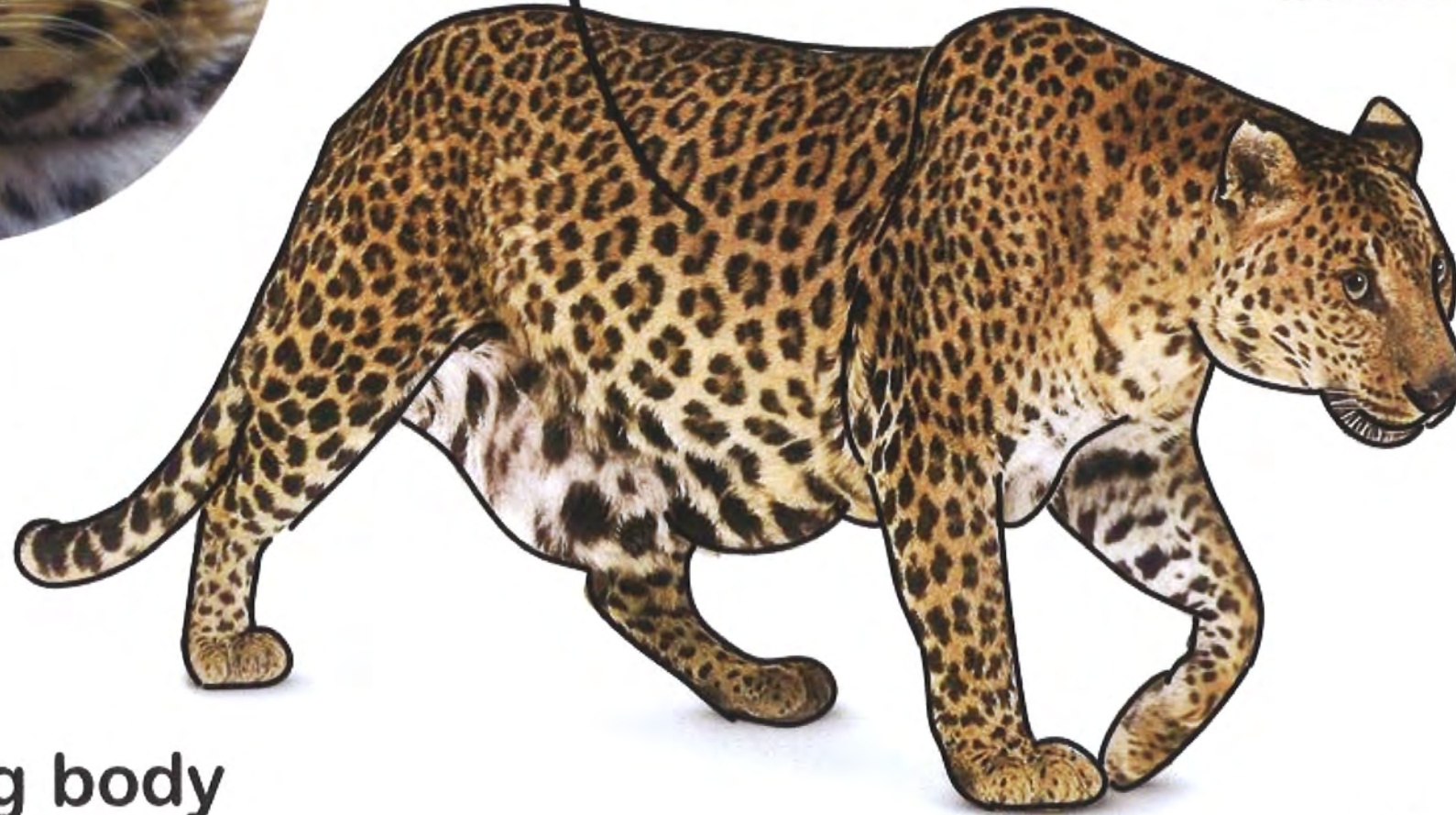


**Rosette  
mark  
fur**

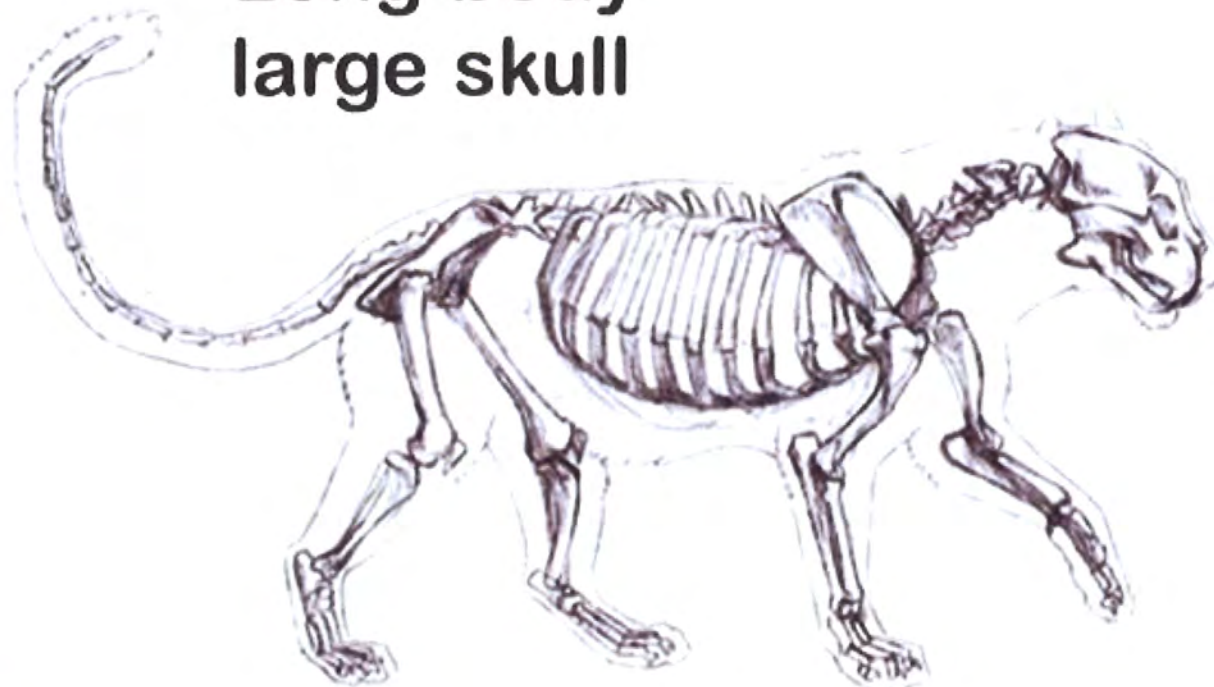


**Excellent leaping  
and jumping ability**

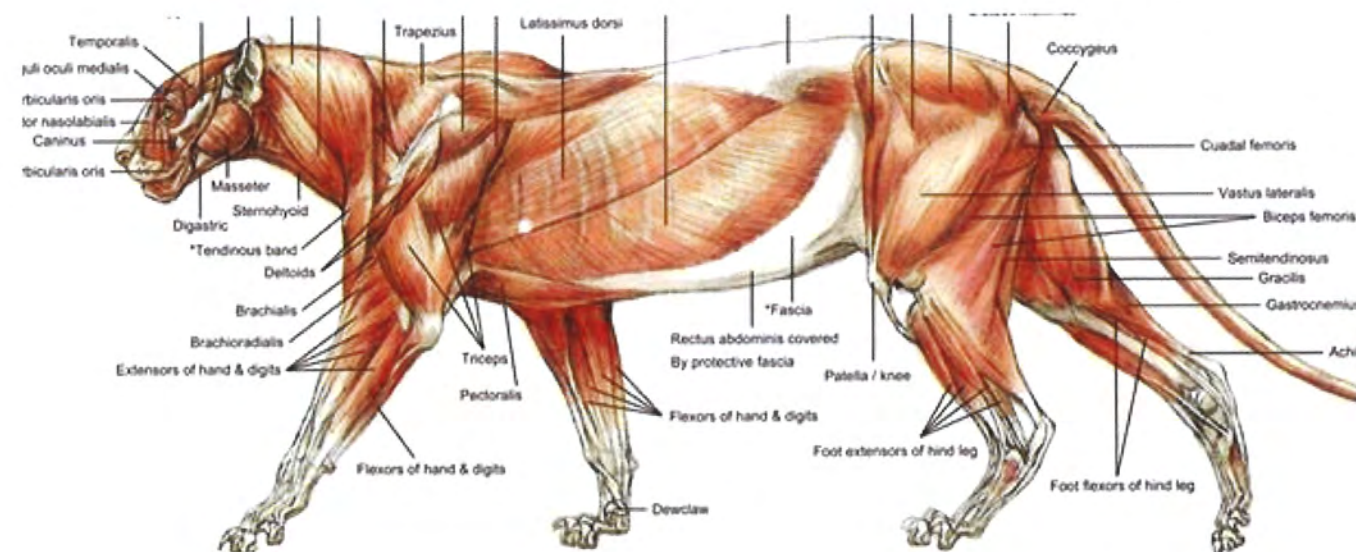
The leopard (*Panthera pardus*) is one of the five extant species in the genus *Panthera*, a member of the cat family, Felidae



**Long body  
large skull**



**Strong muscles**



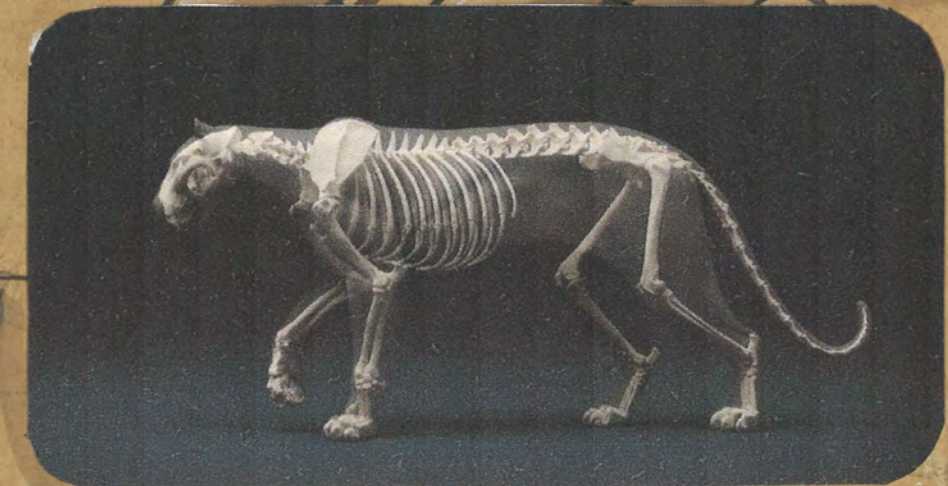


# Leopard Anatomy

Joints?

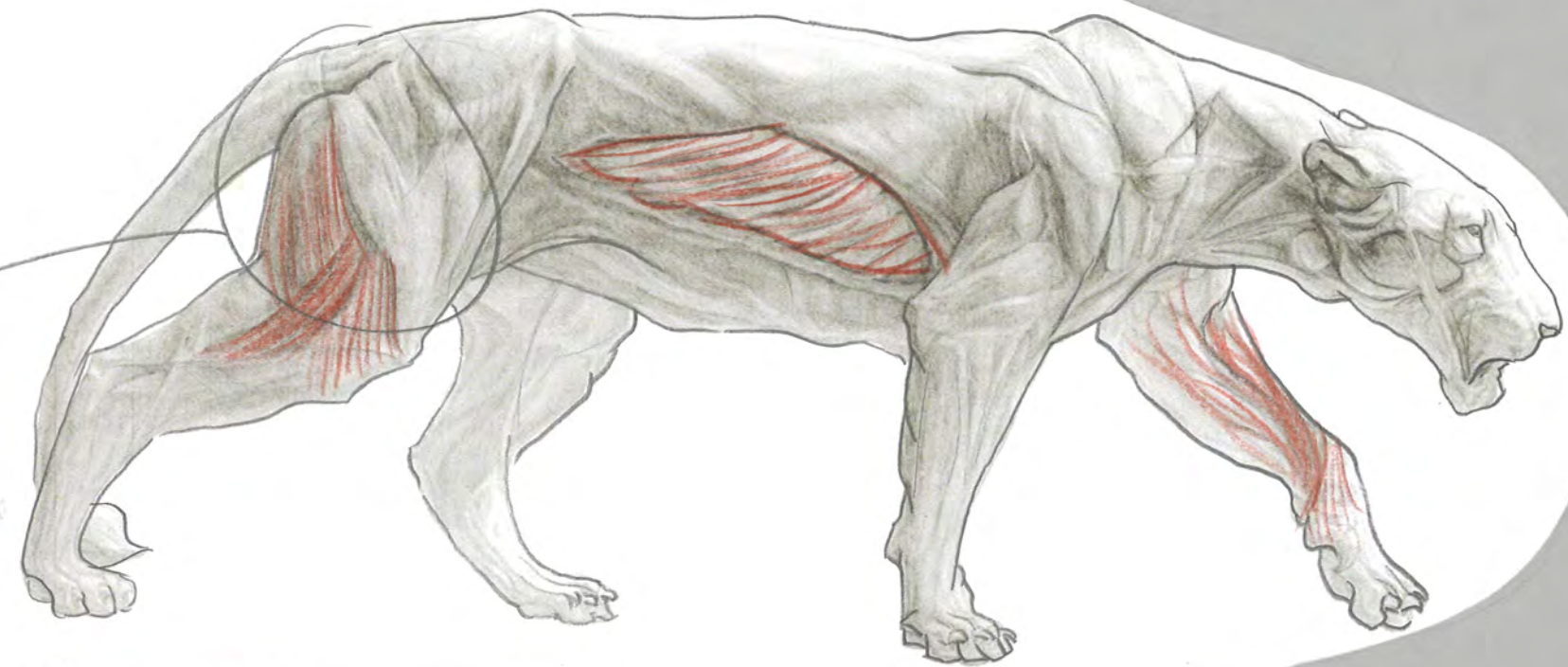


Connect?





Muscles are  
made up of  
"Muscle Fibers"



STRECH



FORMS



LEOPARD ANATOMY

IDEAS



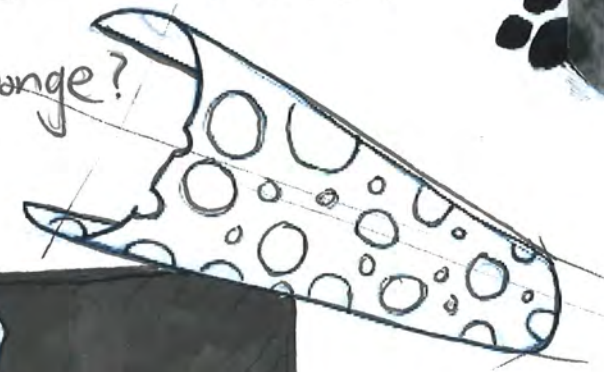
# EXPLORING PATTERNS INTO STRUCTURE



Or One Big,  
Two Small



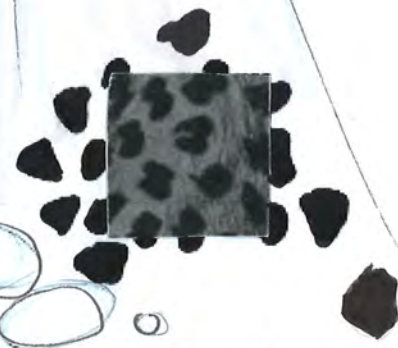
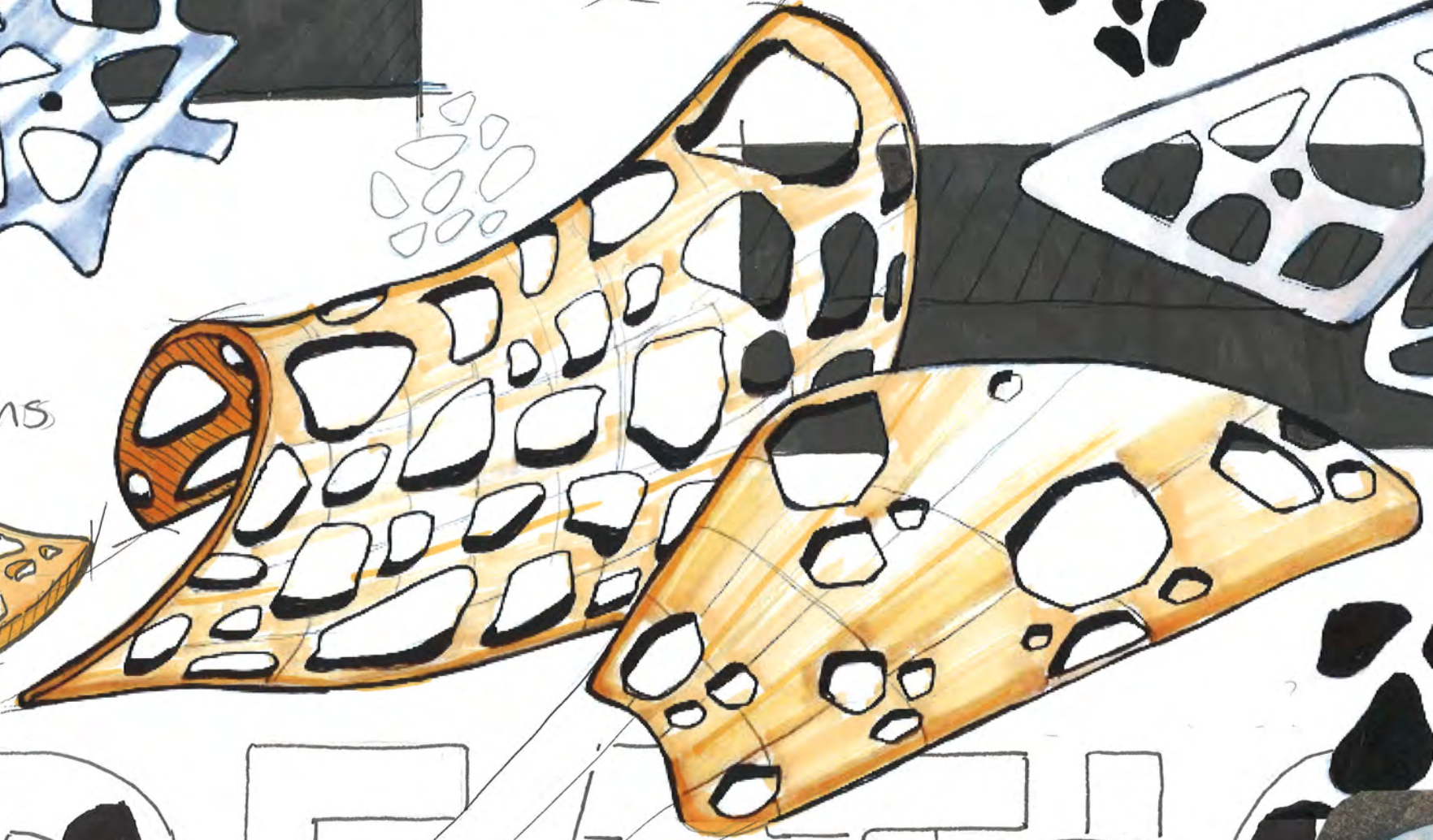
Like sponge?



Any Rules?  
One Big,  
Three Small.

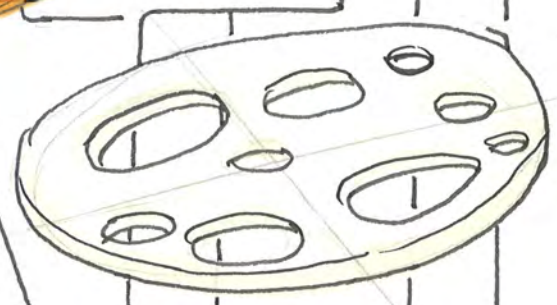


Repeated  
Patterns

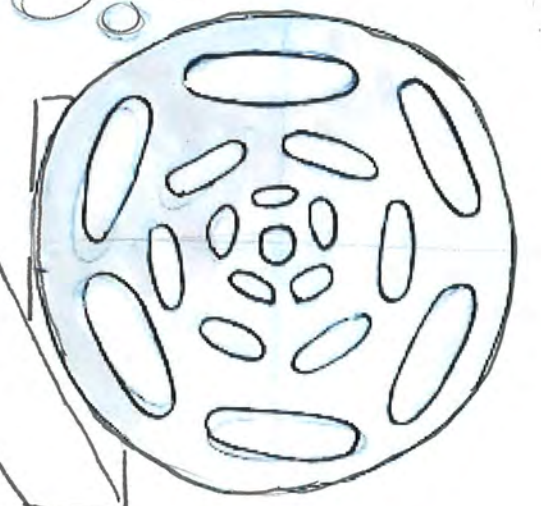


Same  
Patterns?

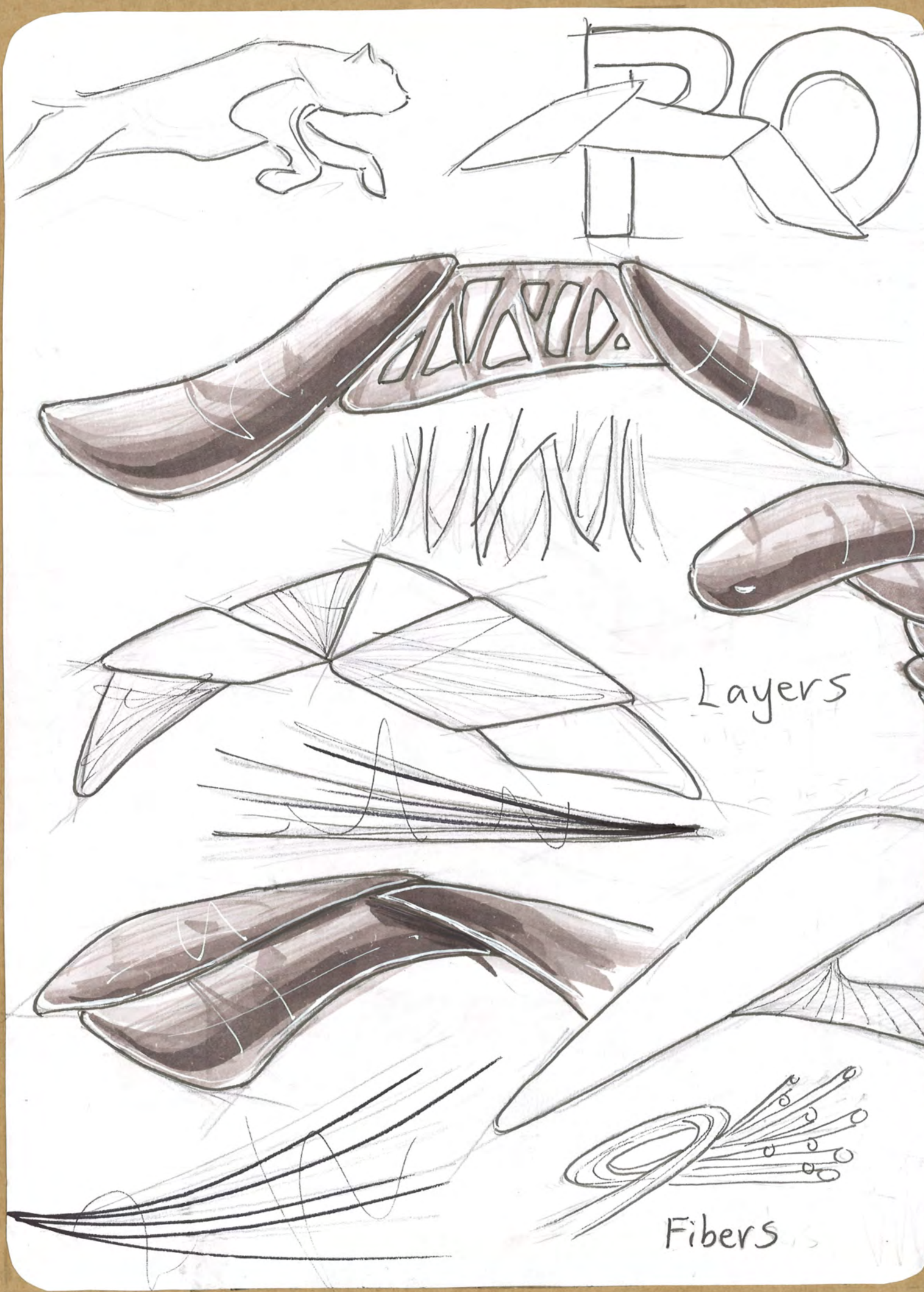
# IDEAS



Like Sea-Coins?

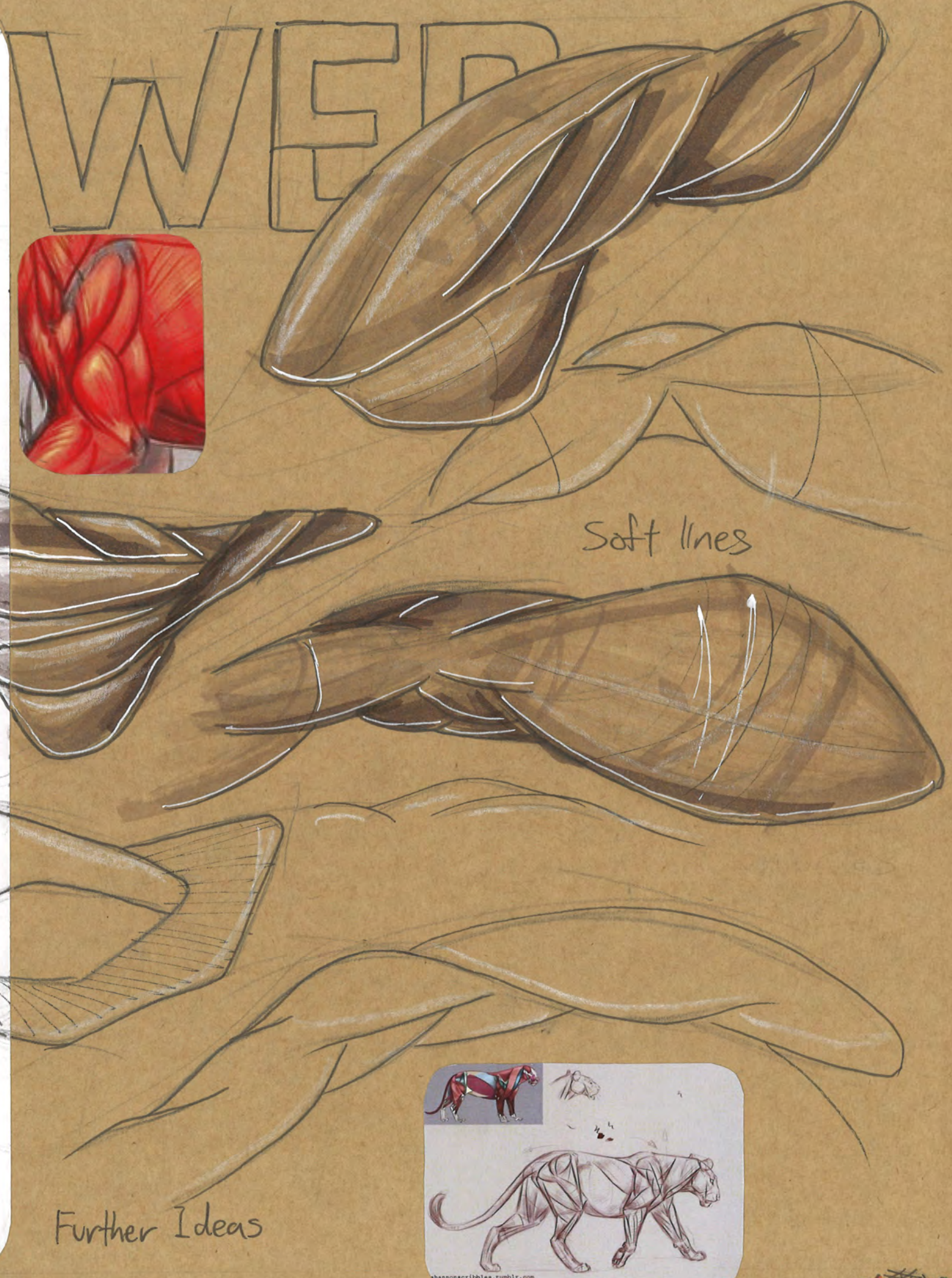






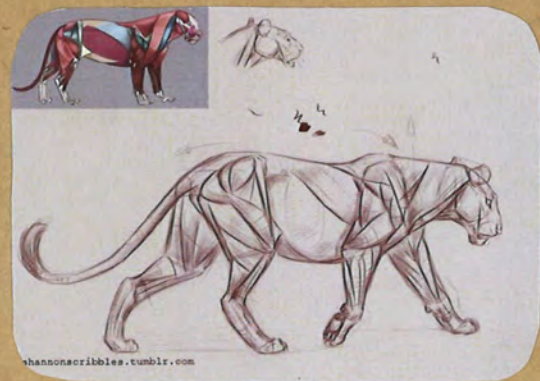
Layers

Fibers



Soft lines

Further Ideas





CHEETAH  
*Acinonyx jubatus*

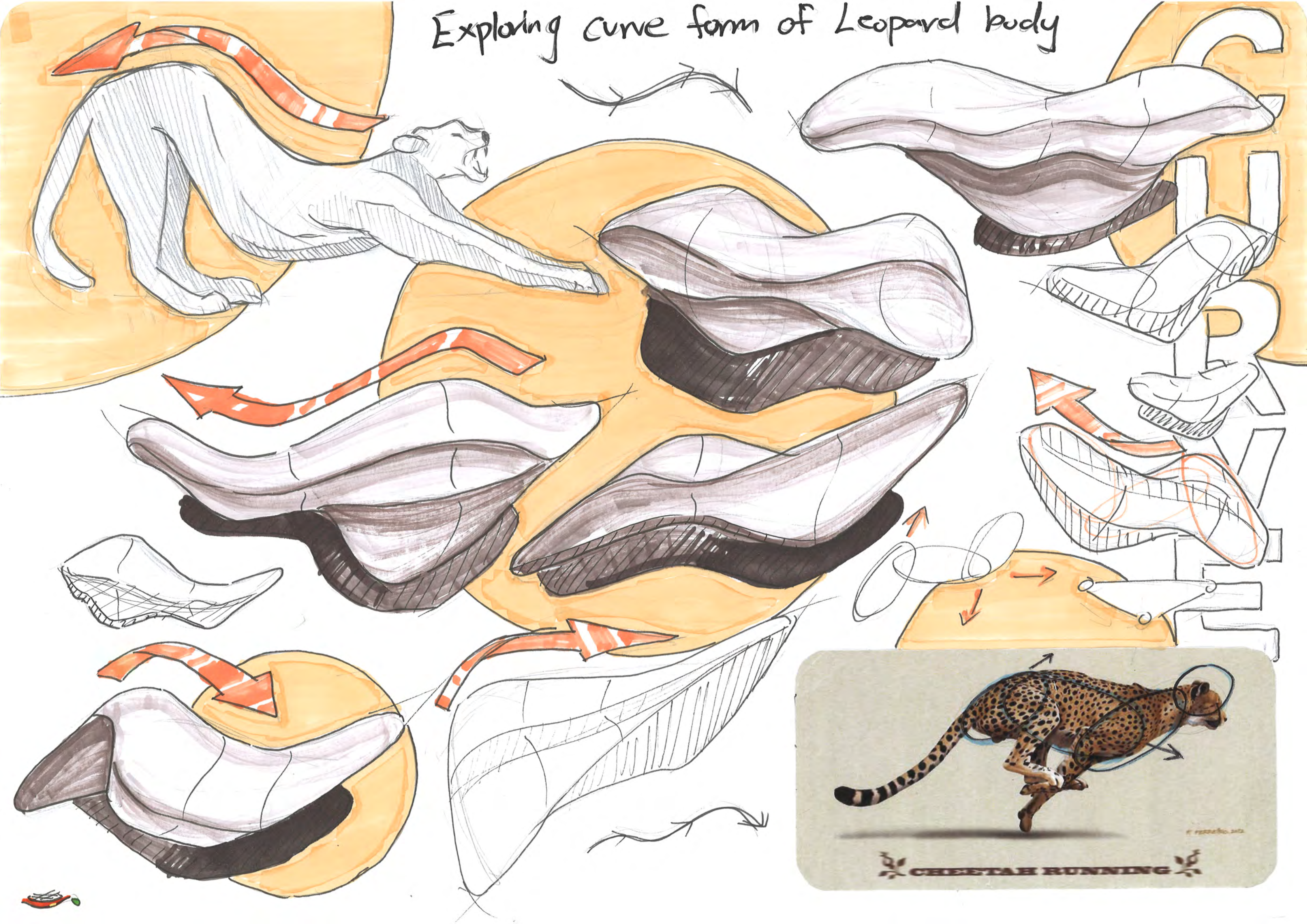


Exploring the body lines

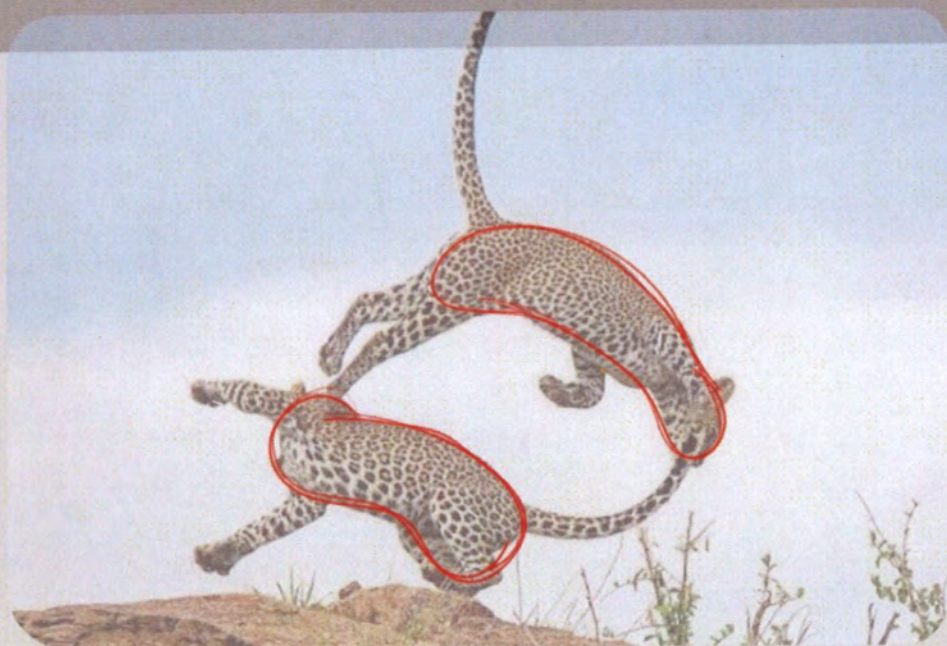
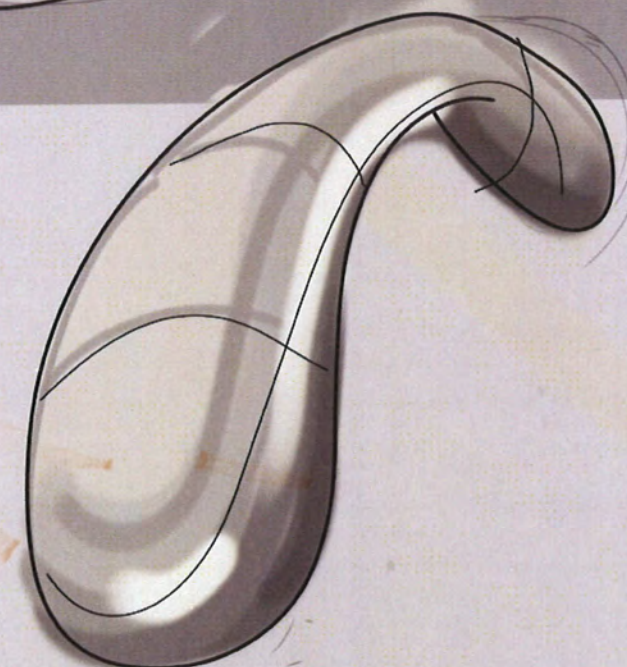
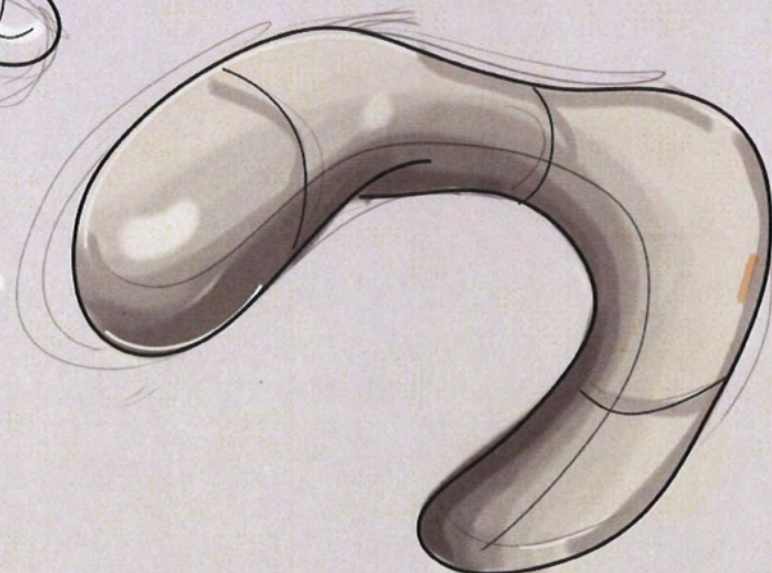
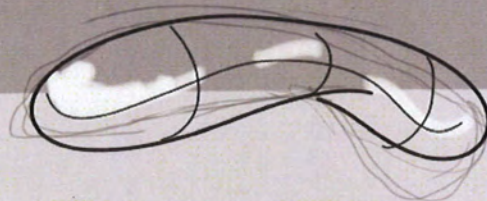
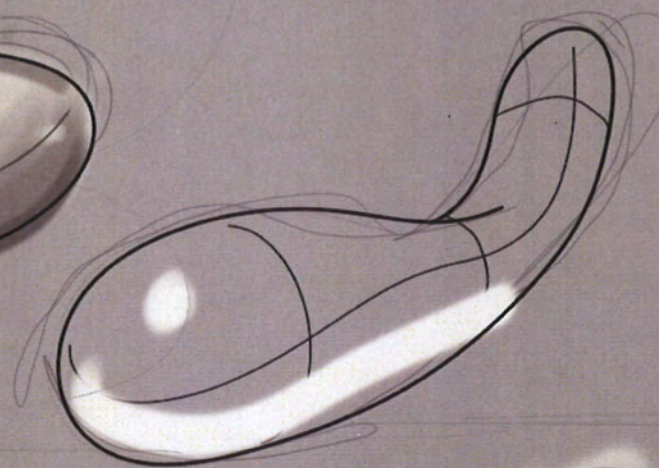
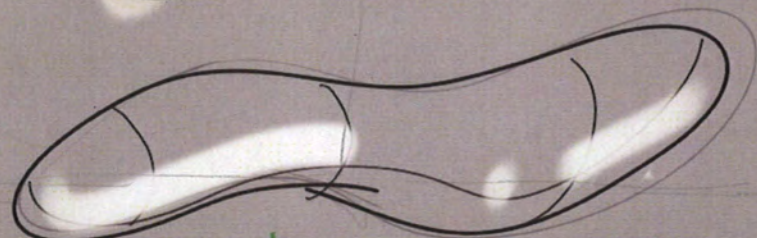
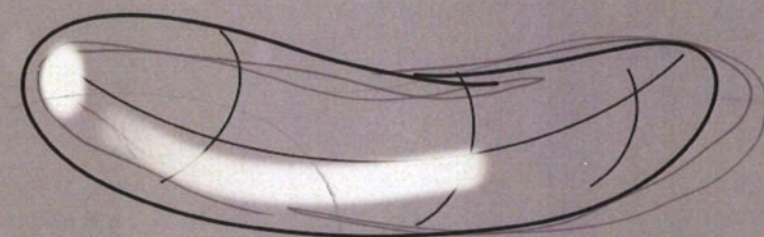
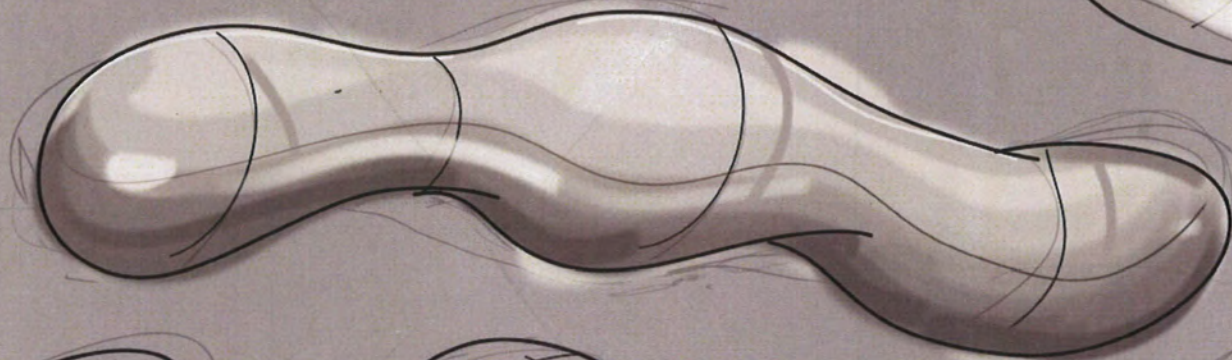
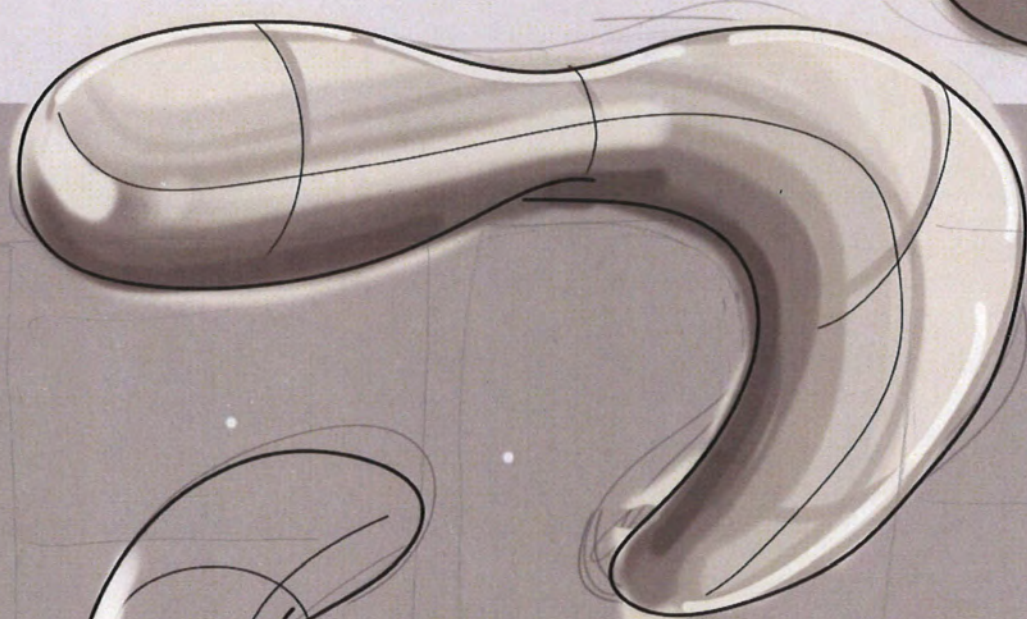
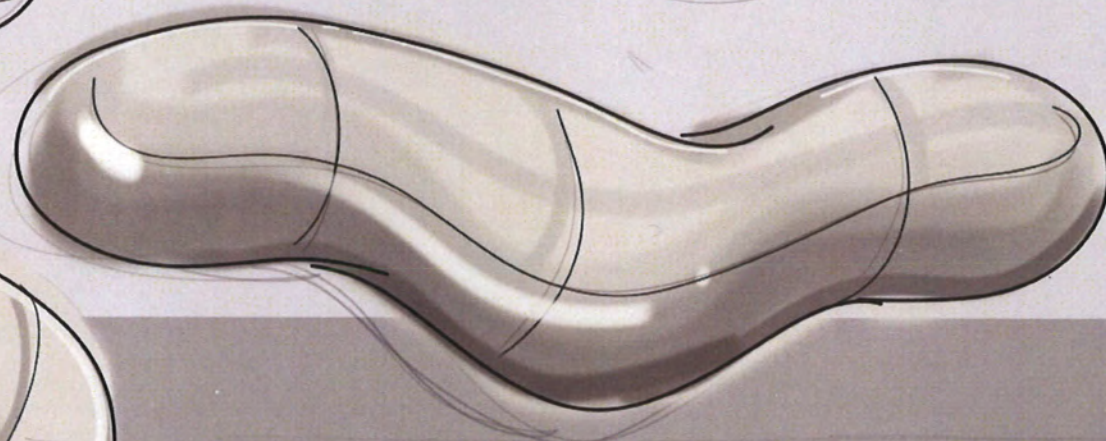
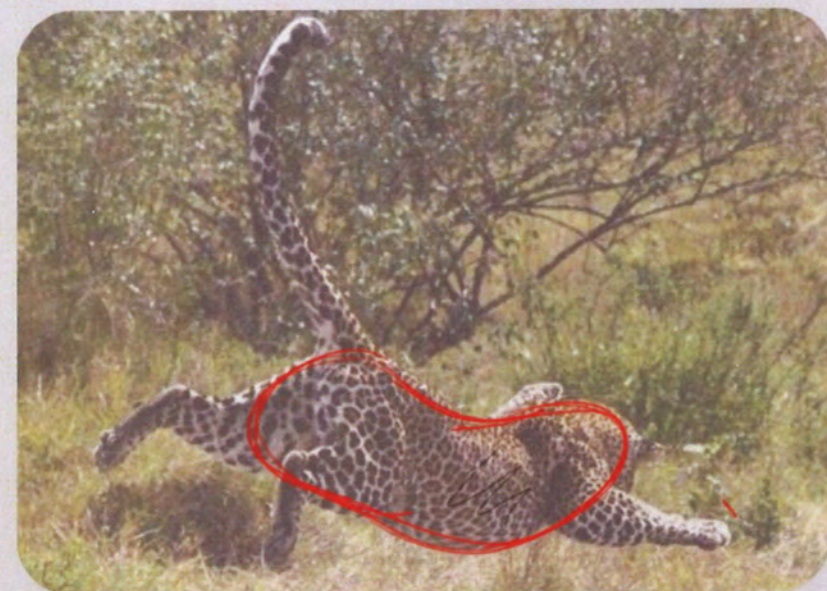




Exploring curve form of Leopard body











## Situation

Cycling has become a very popular sport. There are all different sorts of bicycles for different types of cycling sports. From beginners who as new cyclists facing challenges of deciding what type of bicycle they will buy, to experience sporting enthusiasts wanting the latest state of art superbikes. Technology is advancing at a great pace allowing almost futuristic bike designs. It is my challenge to try and design one of these modern-day bikes.

## Brief

To design a multi-purpose (mountain and road bike) that uses modern technologies for construction, performance, durability and sustainability.

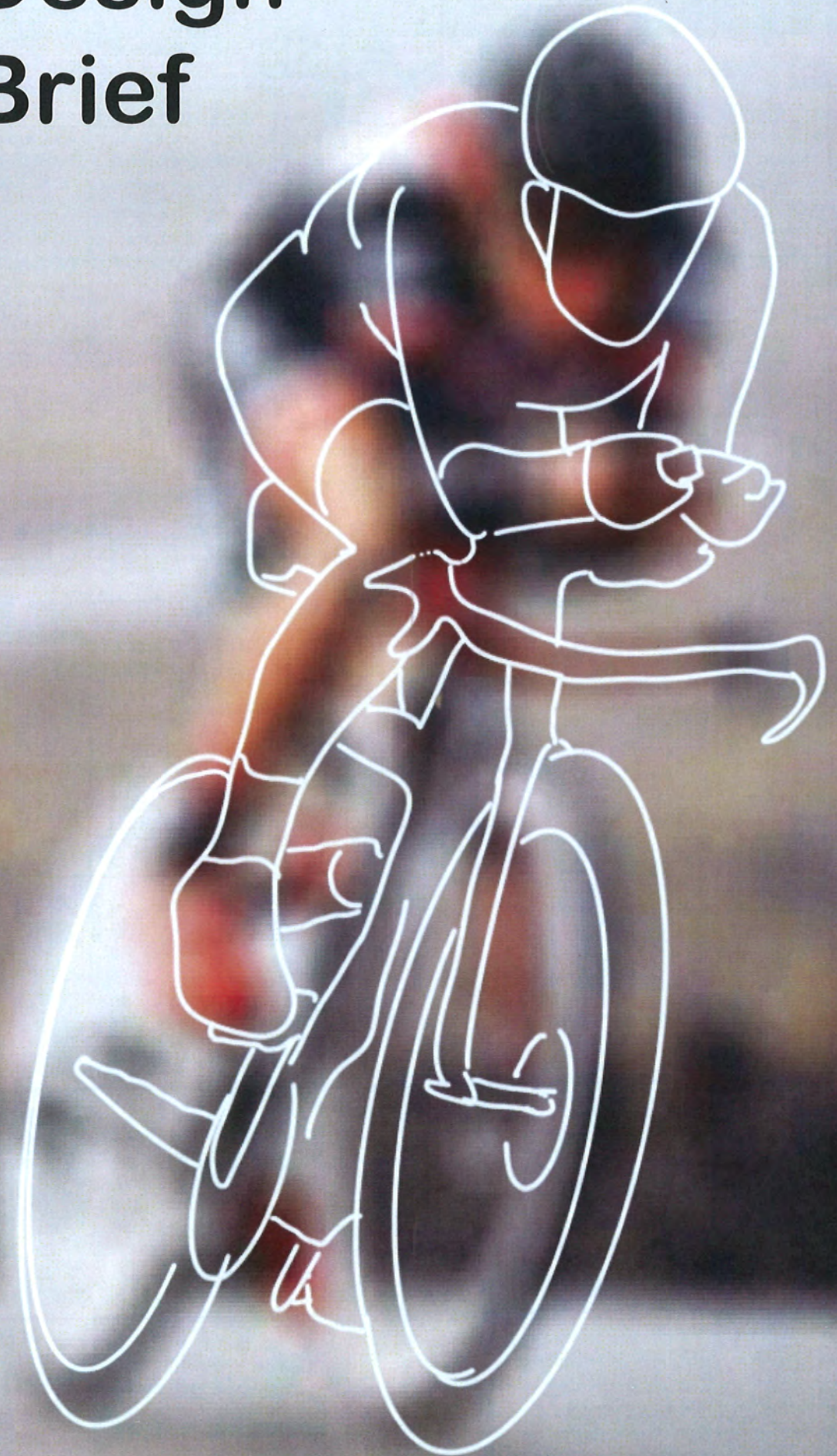
## Specifications

- Unique appearance that contain modern aesthetics appeal.
- Sustainable in different environment (mountain/forest/road)
- Considering the size and comfort on ergonomics.
- It will be light, fast and aerodynamics
- Durable and Stable (high strength materials and joints)
- Safe in slippery ground (anti-skid & sensitive brake)
- Safe for night-time cycling (head light & reflector)
- Stable and smooth riding experiencing  
( Shock absorber & Suspension)

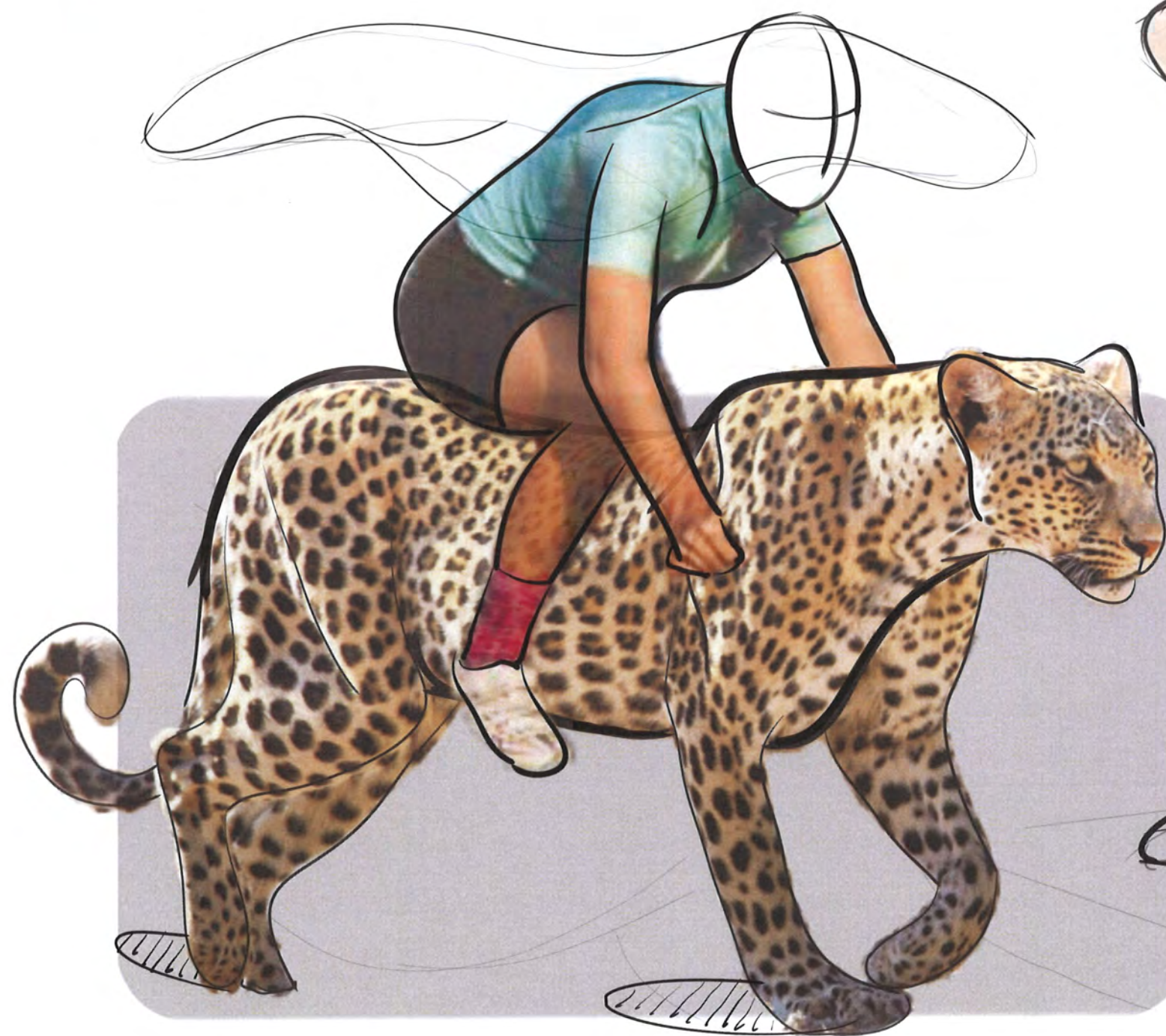
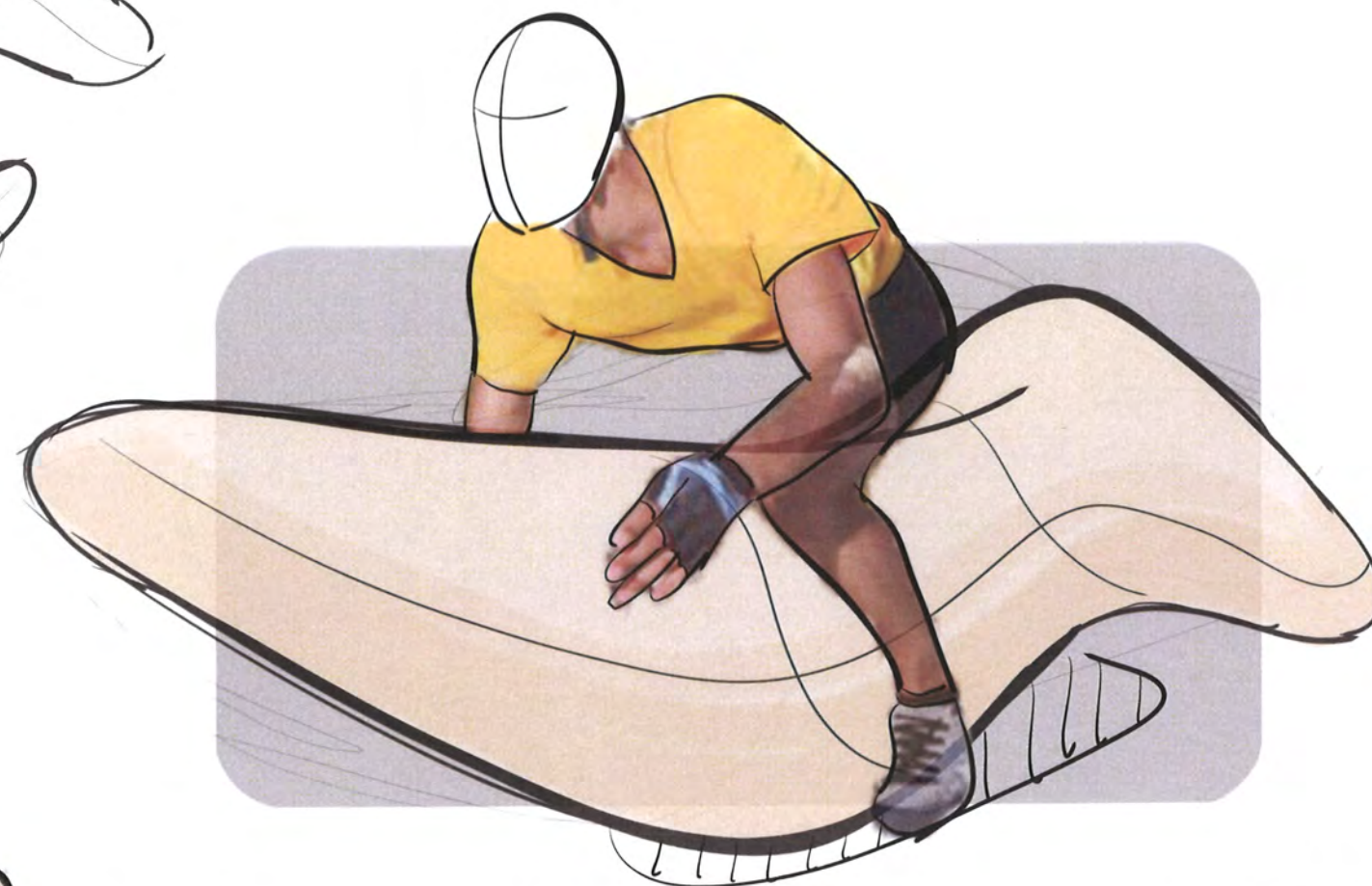
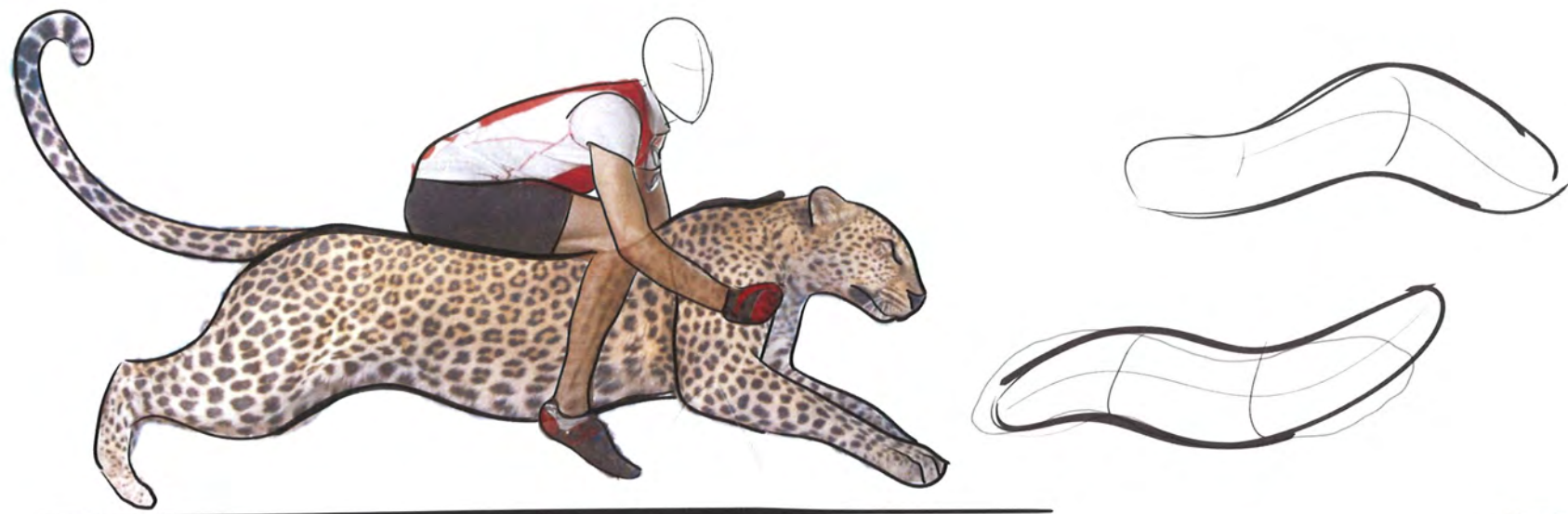
## SSS

- Speed
- Stability
- Safety

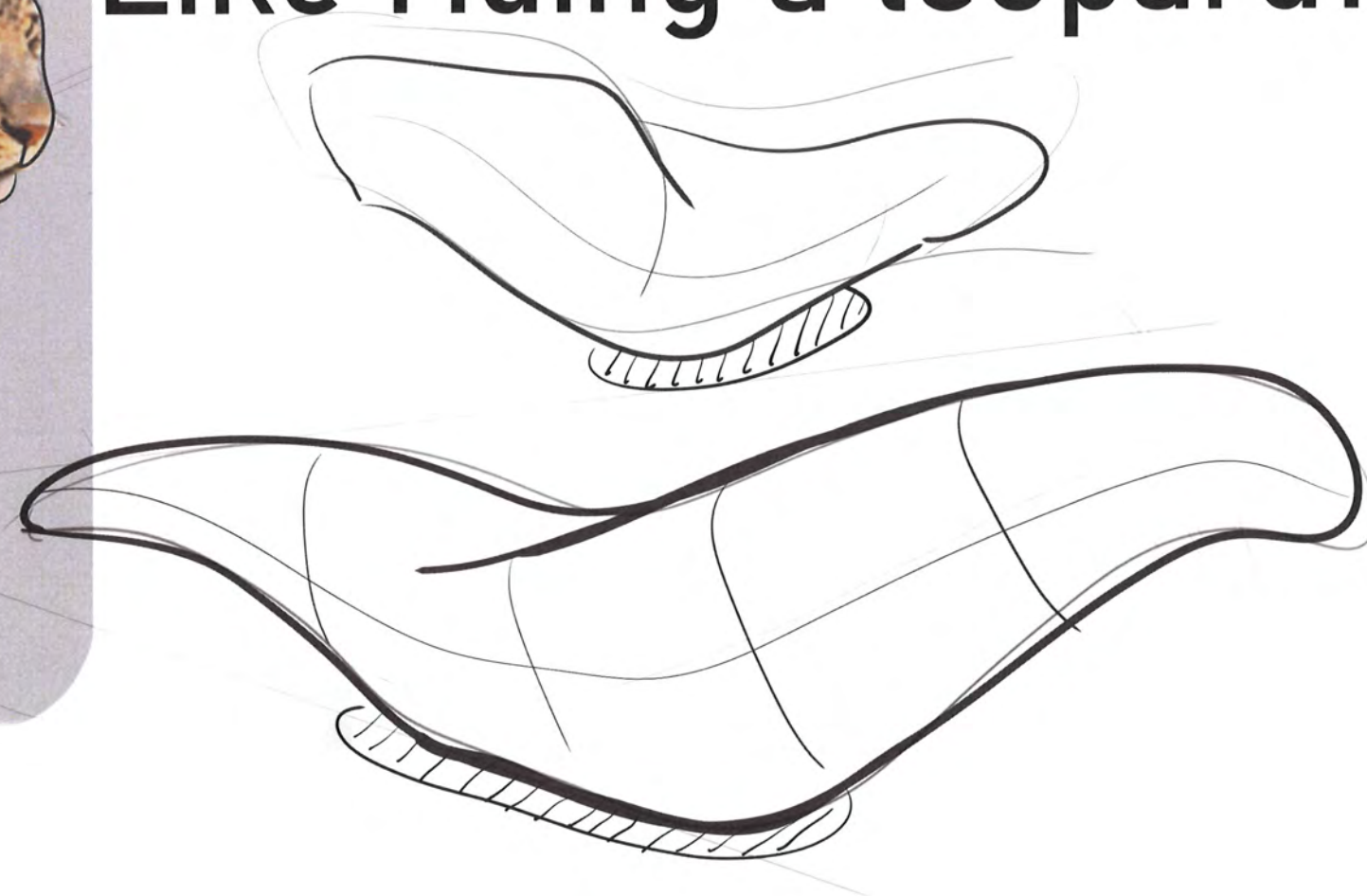
# Design Brief







Like riding a leopard?





# Futuristic Bike Concept

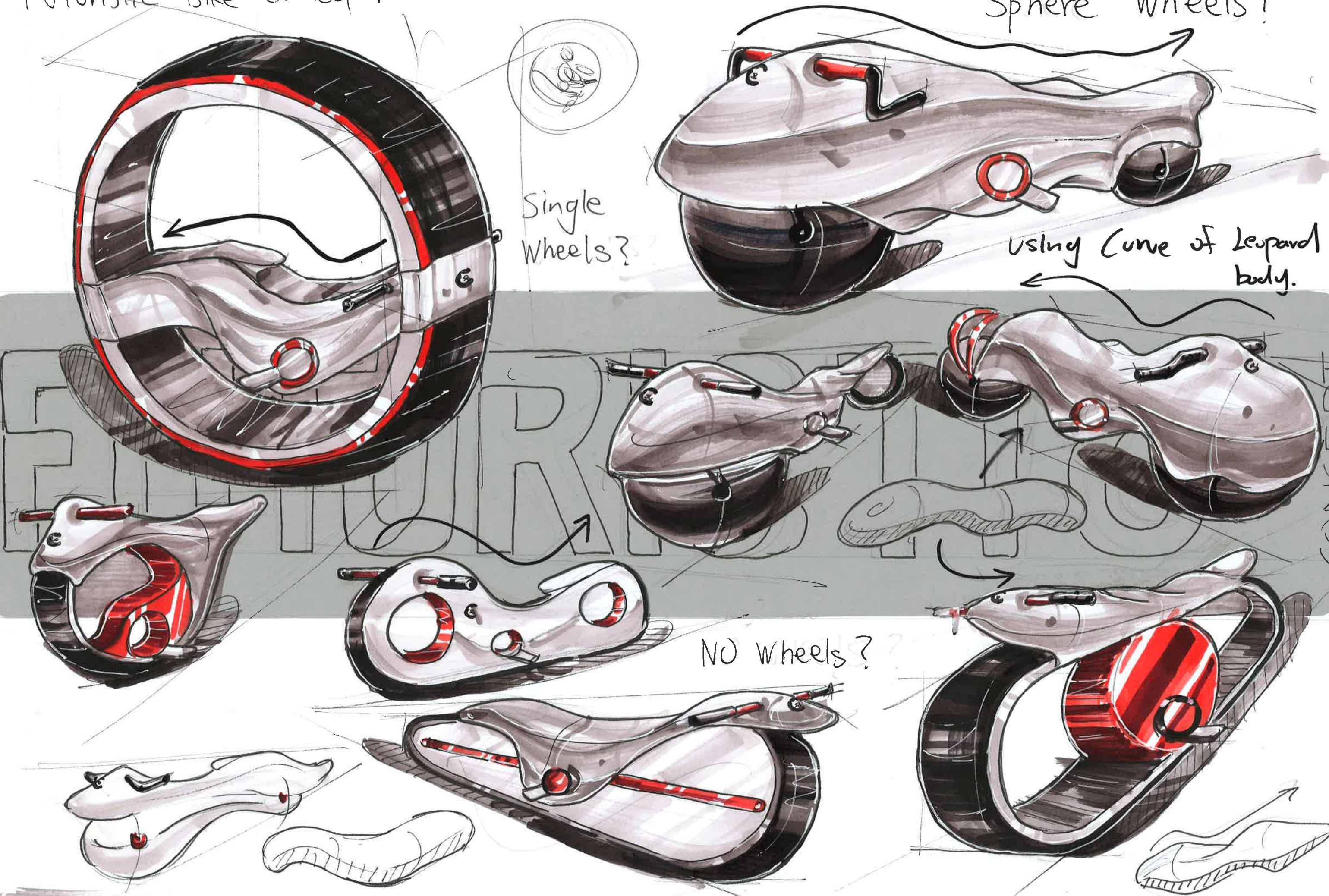
Sphere wheels?

Single  
Wheels?

Using Curve of Leopard  
body.

NO wheels?

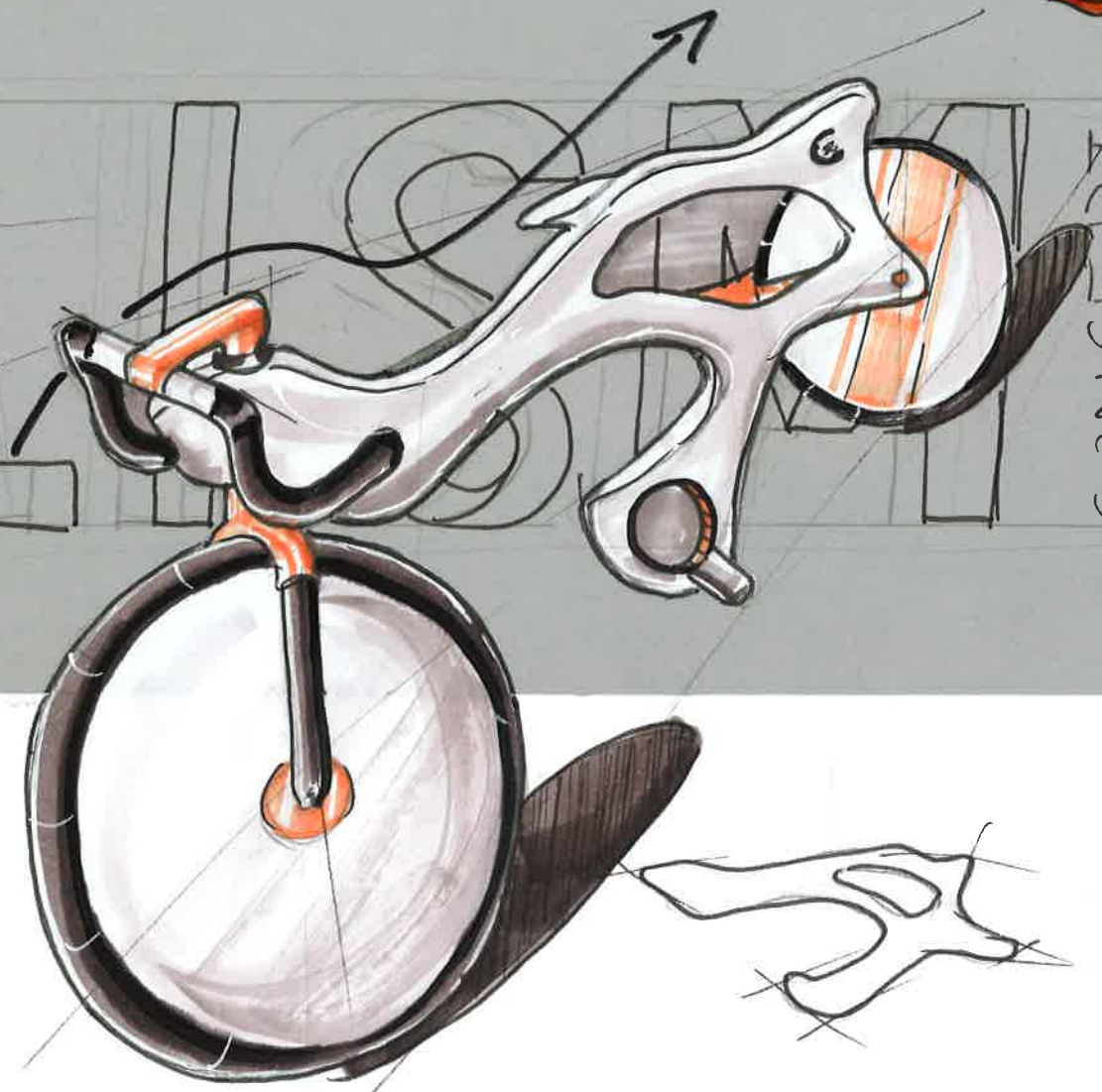
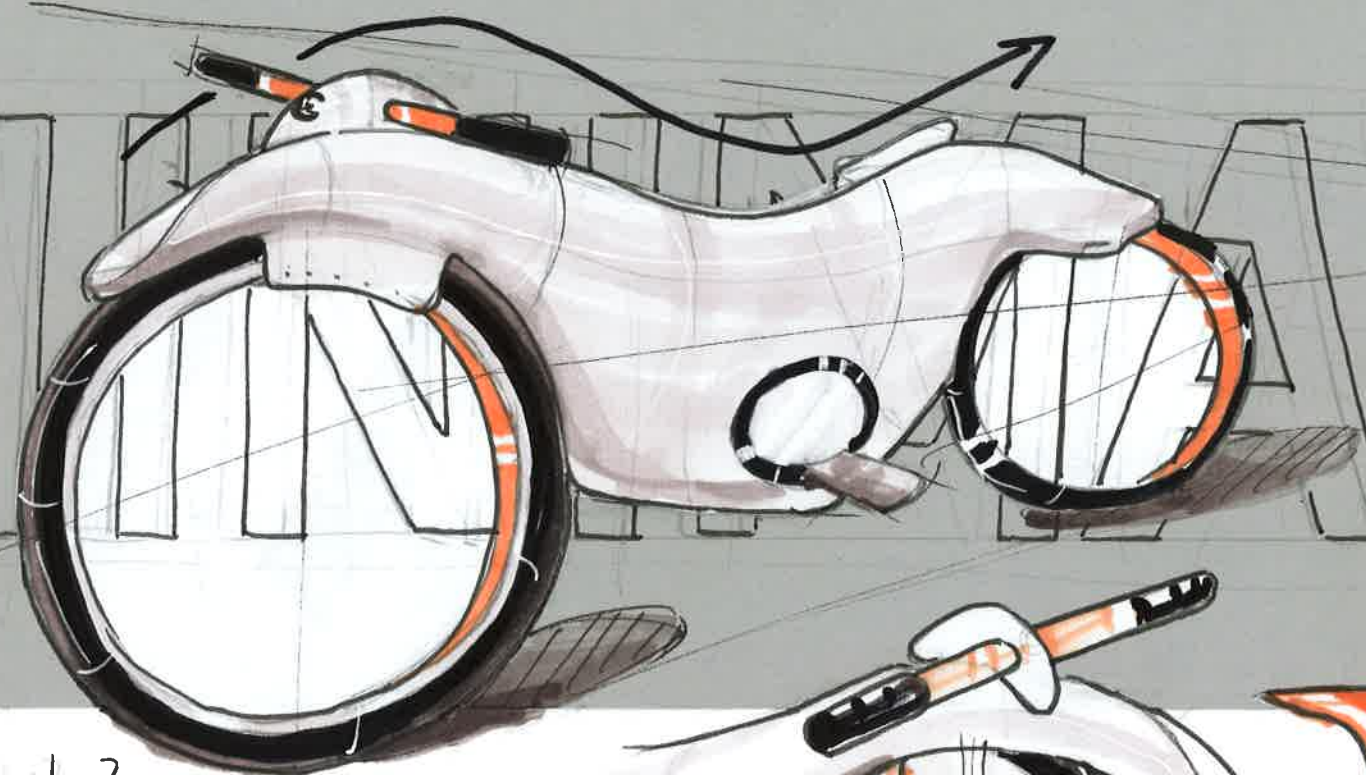
CONCEPT



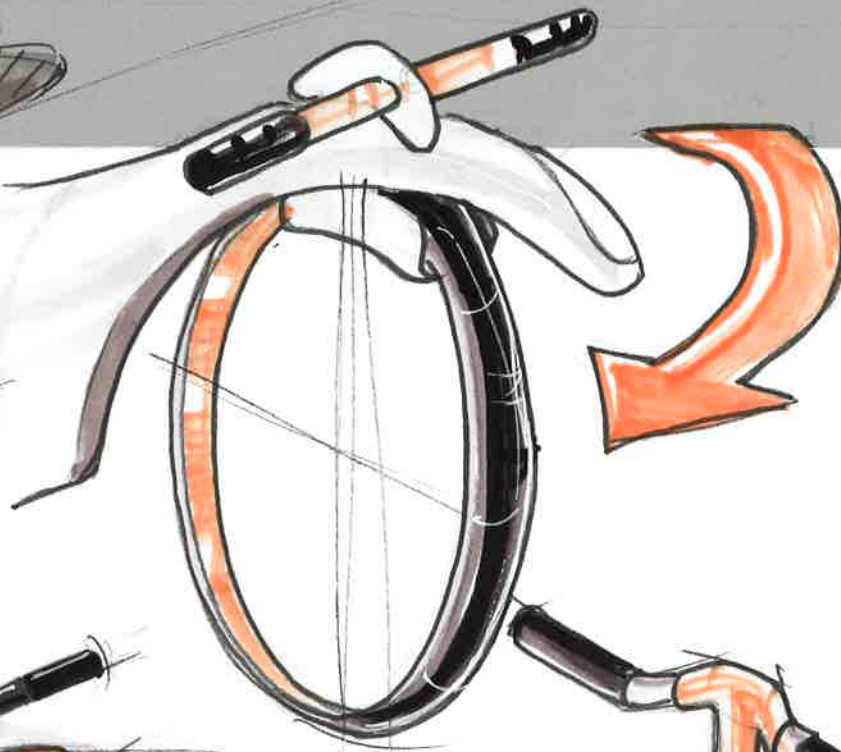
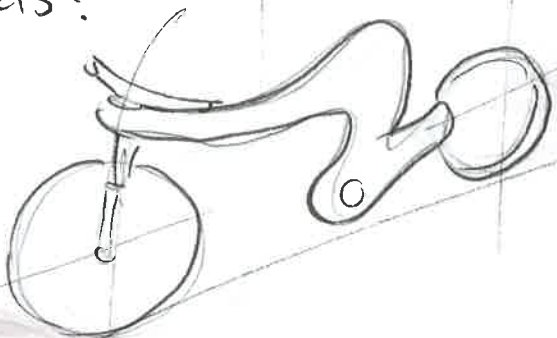


M

CONCEPT



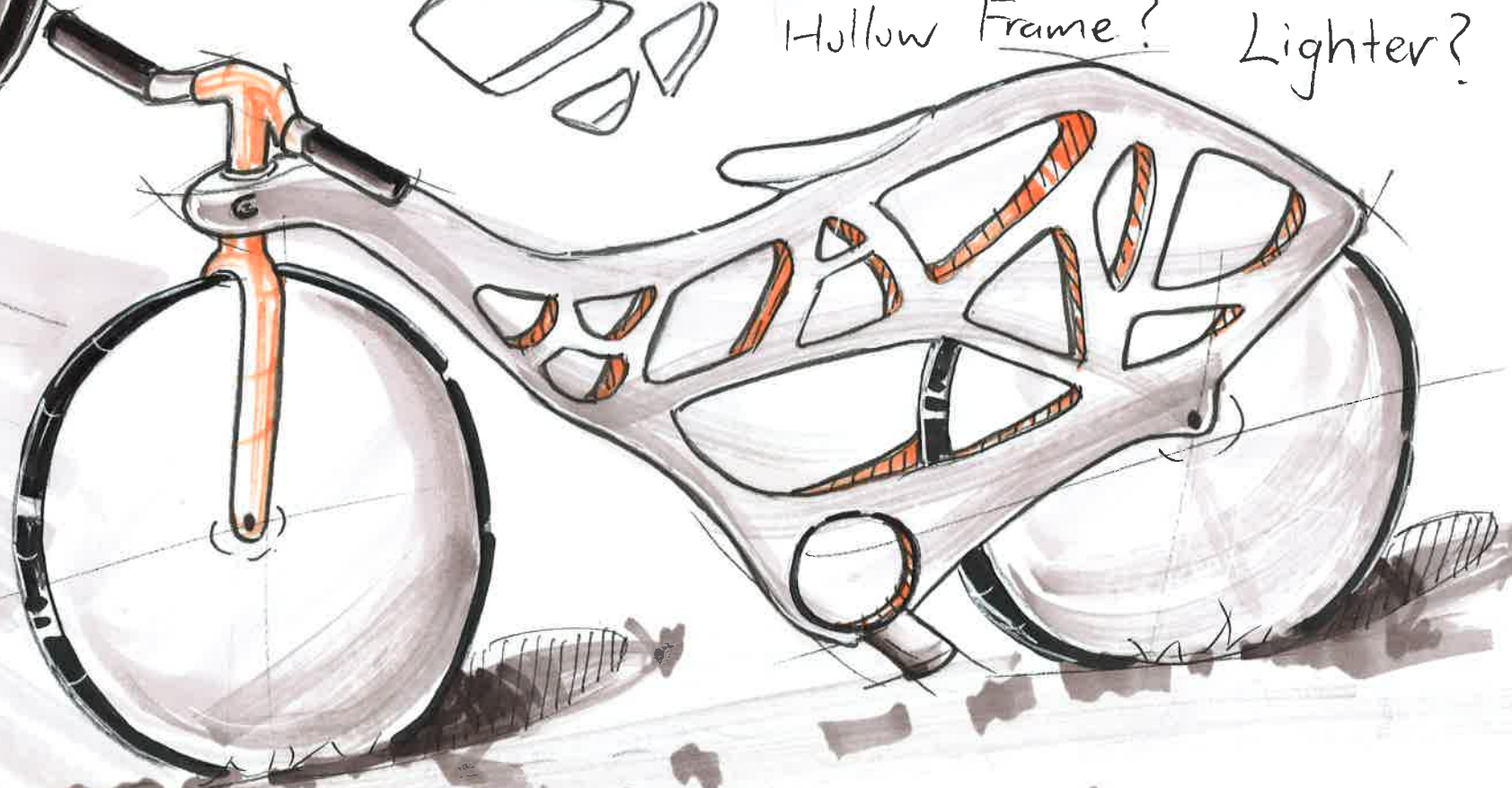
Hollow wheels?



Hollow Frame? Lighter?

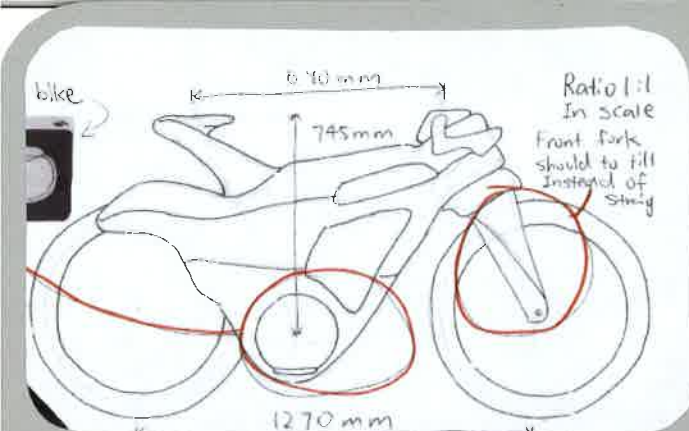


Thin wheels?





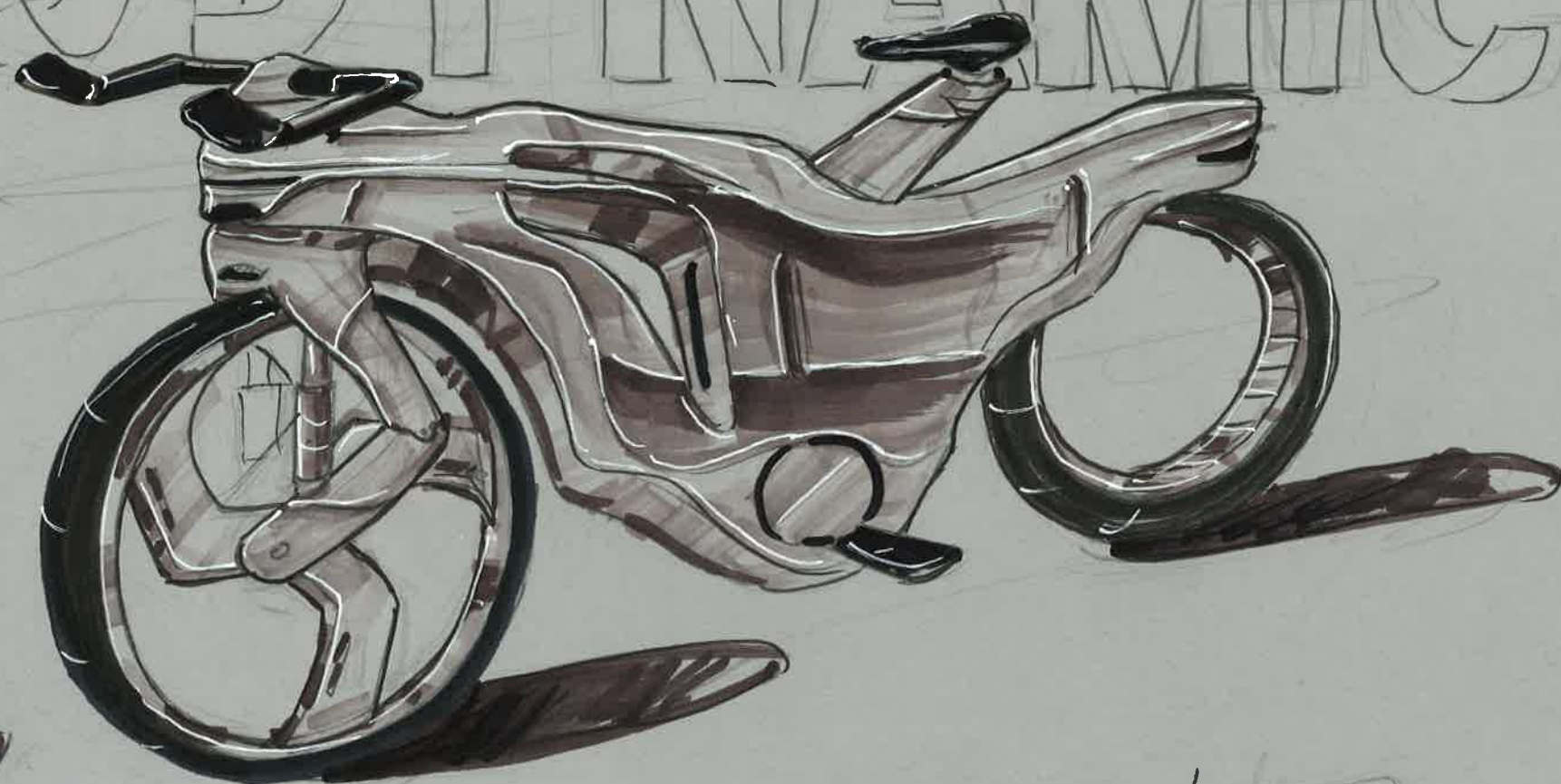
# AERODYNAMIC



Previous bike

Decrease  
Air resistance  
In the  
front

Flow LINES?

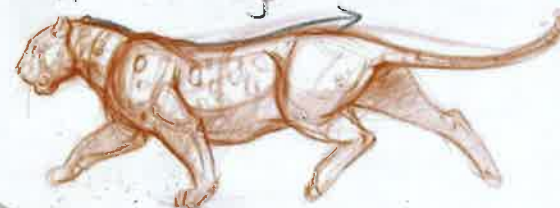


Air will push bike down

Increase down Force

Allow Air  
flow through

Leopard body lines



DYNAMIC

FORM?

All edge is

Increase  
down  
force

Rounded

Air more easier to flow through



## Safety is the priority on the road:

The death in bicycle accident has increased 30% in the past 10 years. According to the data from national center for health statistic, there is 1024 bicyclist death in 2018, and 682 of them died in motor vehicle crashed.

- Car crash are the major reasons cause bicycle accident, biking without a good front and back light will cause other road users not able to see the cyclist easily, especially in raining day, foggy day or nighttime. This will put the cyclist on risk of accident.
- High humidity in winter and raining day will cause a decrease in visibility. The cyclist will face a challenge of the handlebar and pedal will be more slippery. There will be less friction between the road and the tire, reduced the grip cause the bike more difficult to control.
- A heavyweight bicycle will take more energy of the cyclist in long-distance biking or climbing up on a hill.
- Incorrect size bike and uncomfortable seat for cyclist in long-distance travelling might evoke neck pain, back pain, or knee issues.
- The danger can come from the road itself, riding in a poor state road with potholes will cause a serious issues. Passing through the potholes with a high speed might cause a danger to the cyclist.



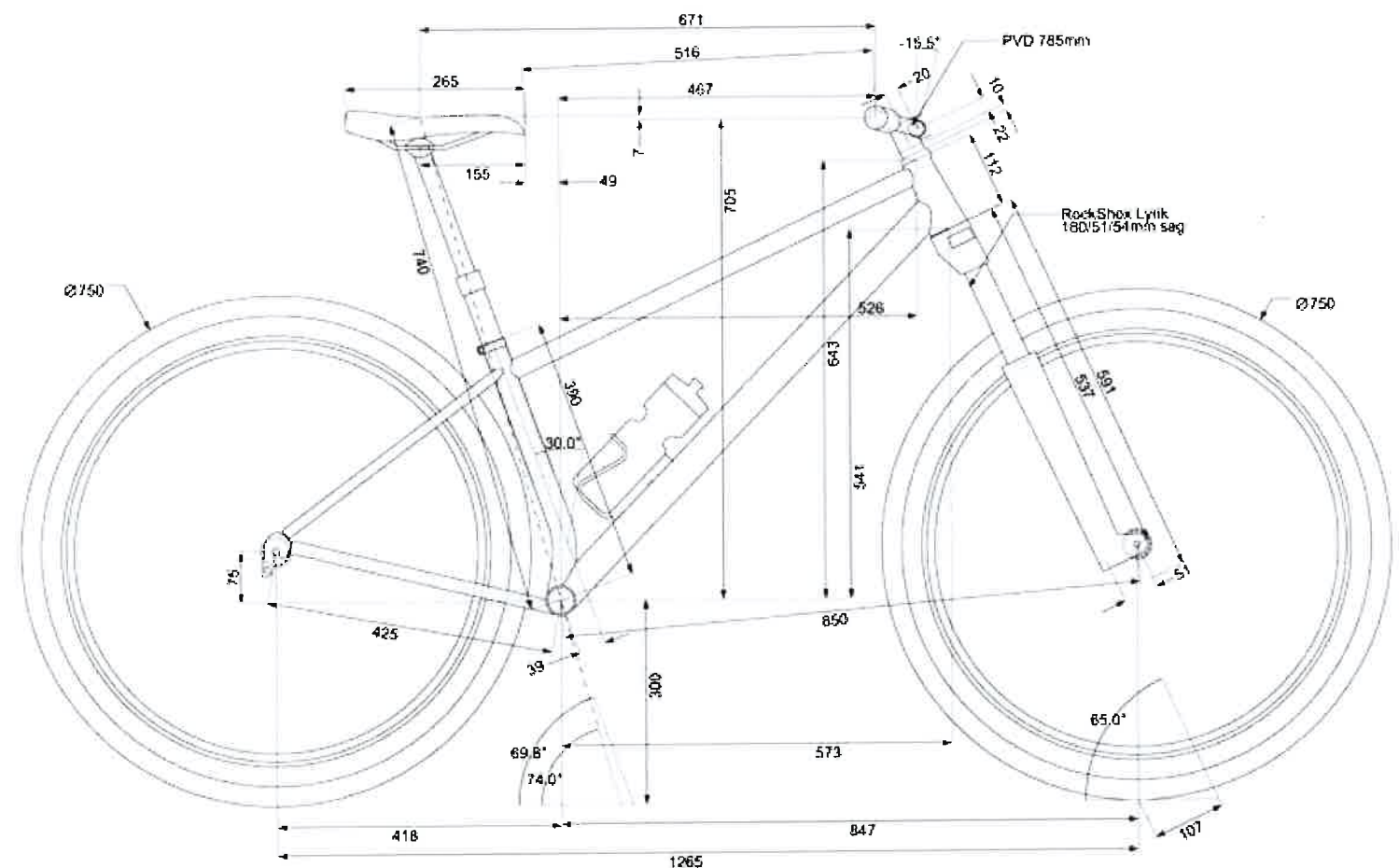
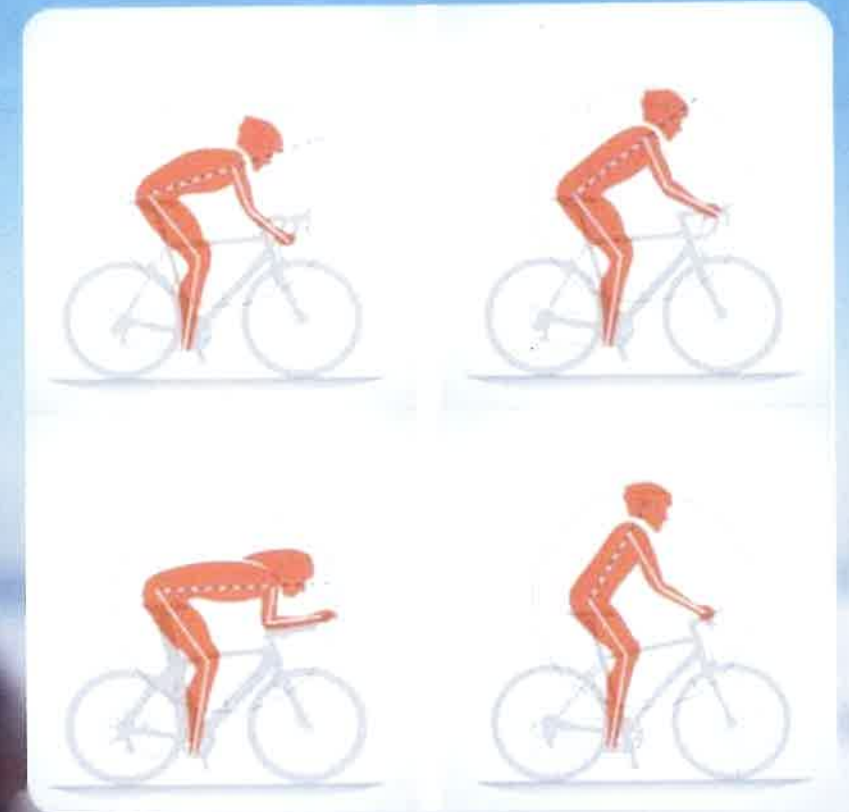
# What issues is cyclist facing?



# Ergonomics

Ergonomics is concerned with the fit between the user, product, and environment. It is necessary to prevent repetitive strain injuries and make the user feel comfortable using the product.

During the cycling there are five-point contacts with the bike; two grips, two pedals and the seat. The height of the seat determines the strain on arm and wrist, also the pedal efficiency. The most suitable height of the seat should be slightly higher than handlebar and allows; the arm and wrist on the minimum pressure, the knees coming parallel to the ground at their maximum height, and the legs should be just straight at the bottom of the loop of the pedal. A full rotation on pedal should be easy, comfortable and natural, while keep the center of gravity over the middle of the bicycle. The body should be approximately 15 to 30 ° angle to the horizontal, and 90 ° to the arm.







## Greg Lemond Method:

Saddle height formula:

Inner leg length  
× multiply by **0.883**  
Is the distance from  
Centre of pedal circle  
to the seat.

If adjust  
seat height  
by a pivot.

×(0.883)

Rider height		Leg inseam	
Feet/Inches	Centimeters	Inches	Centimeters
4'10"-5'1"	148-158 cm	24-29"	61-73 cm
5'1"-5'5"	158-168 cm	25-30"	63-76 cm
5'5"-5'9"	168-178 cm	26-31"	66-78 cm
5'9"-6'0"	178-185 cm	27-32"	68-81 cm
6'0"-6'3"	185-193 cm	28-33"	71-83 cm
6'1"-6'6"	193-198 cm	29-34"	73-86 cm

Graph shows relationship between height  
& Leg inseam

Too far

Will increase  
distance  
to handle

Shorter seat height,  
longer distance to  
handle bar.

Shorter seat height  
shorter distance to  
handle bar.

But if adjust it  
by pushing down, the  
relationship between seat & handle won't change.

Scales helps to adjust

# SADDLE HEIGHT

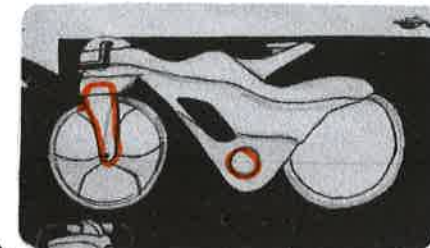


# DEVELOPMENT

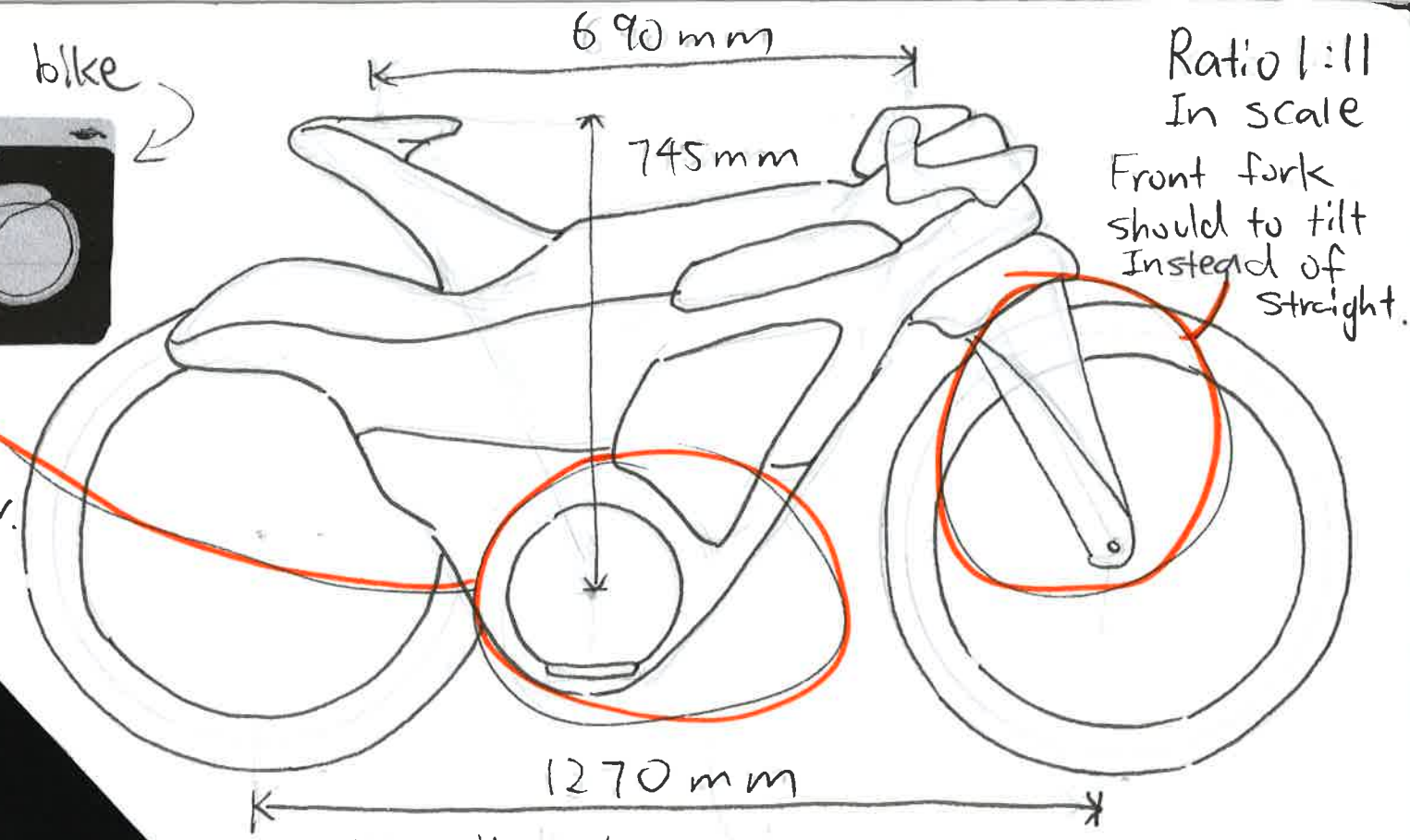
## Ergonomics - Body



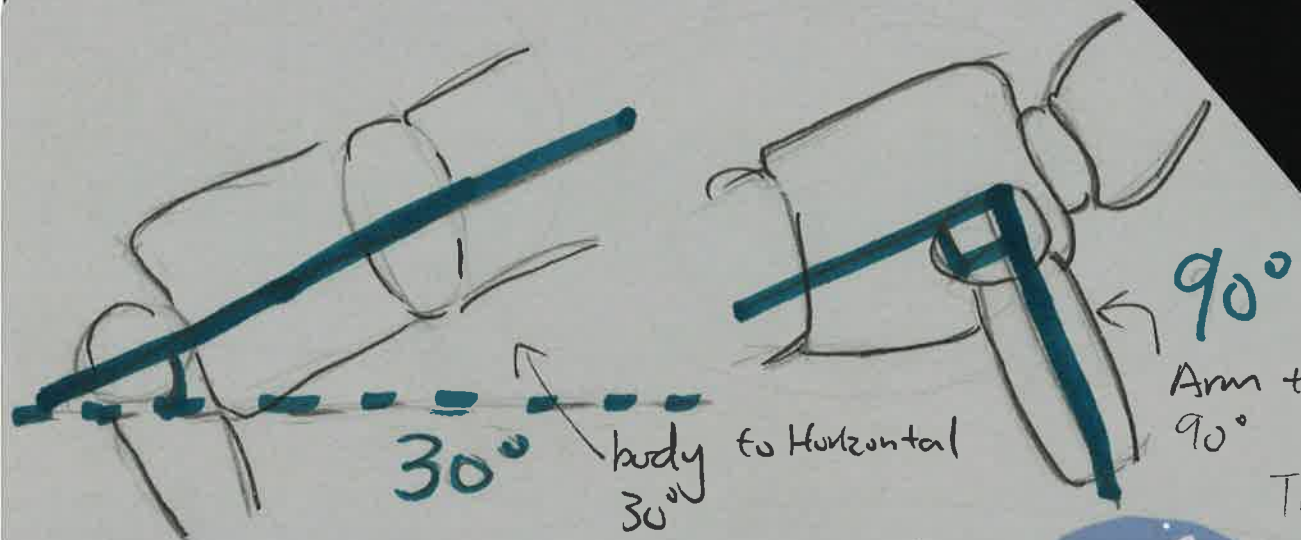
Previous bike



Crank set should be much bigger.

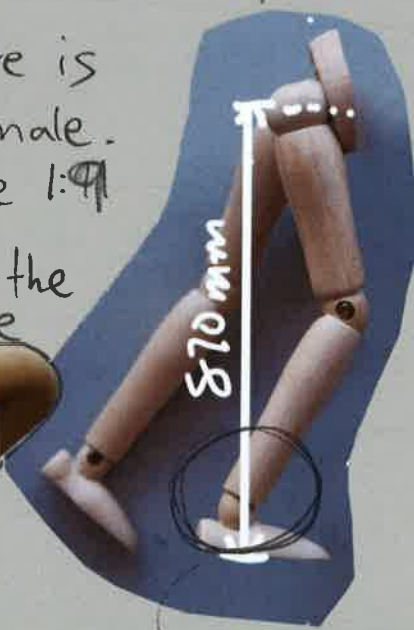


Adjust the size due to ergonomic purpose, Refine the frame, front fork & crank set from previous.

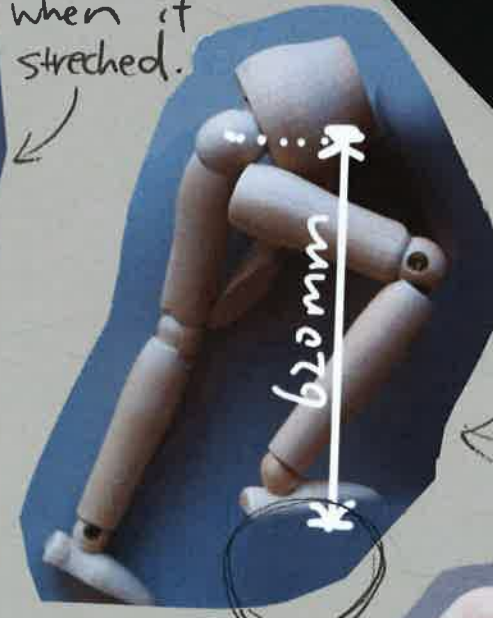


Assume the figure is a 180cm tall male. the ratio will be 1:9

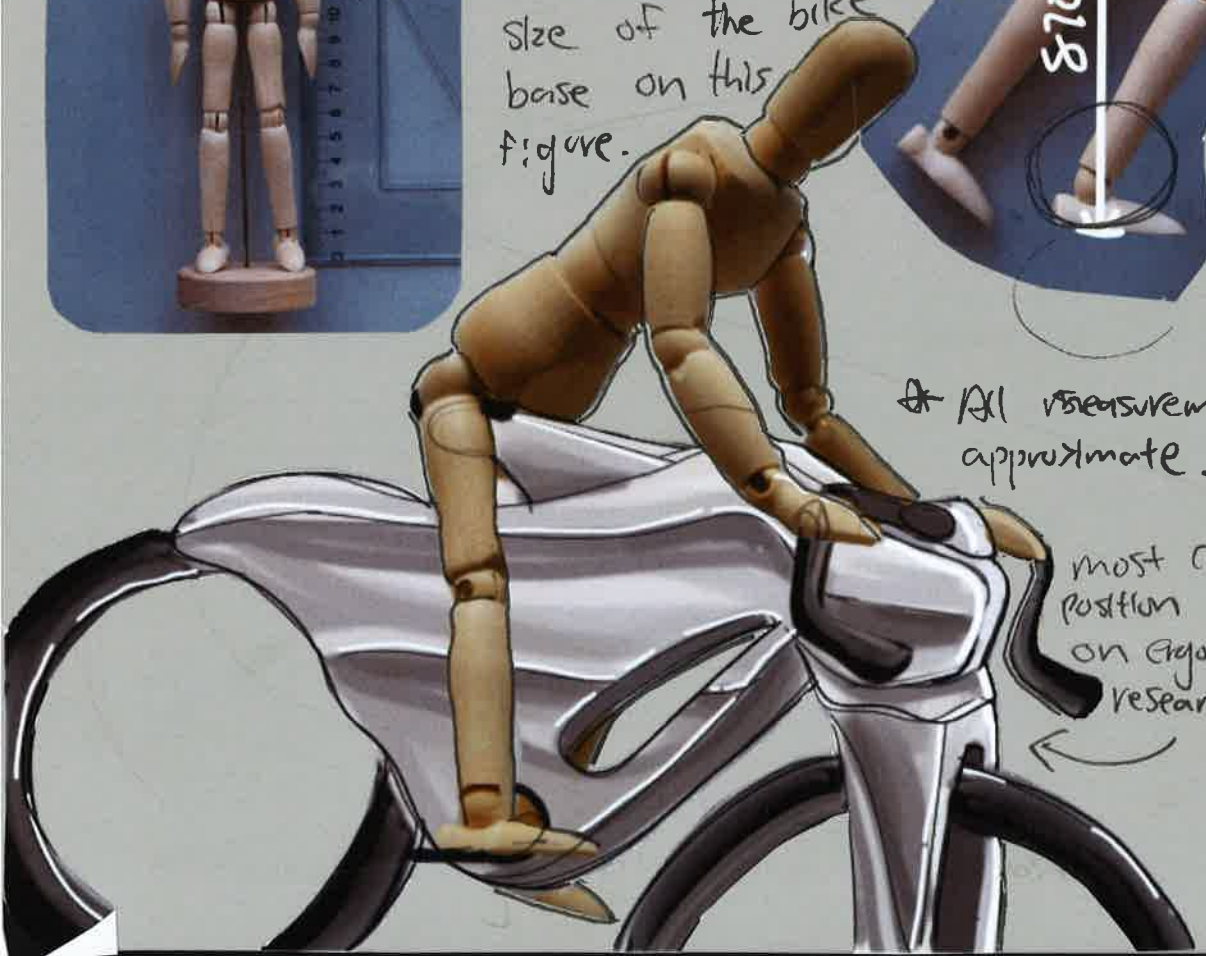
We can refine the size of the bike base on this figure.



The leg will be 870mm when it stretched.

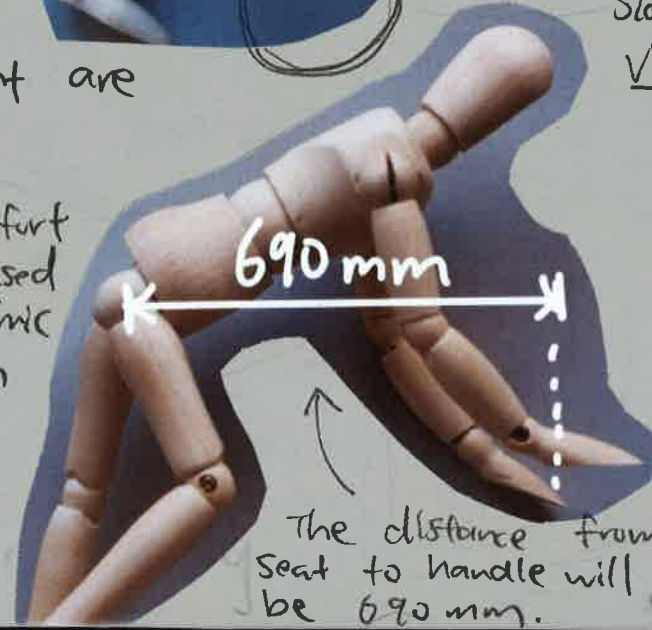


And 620mm when it bent.



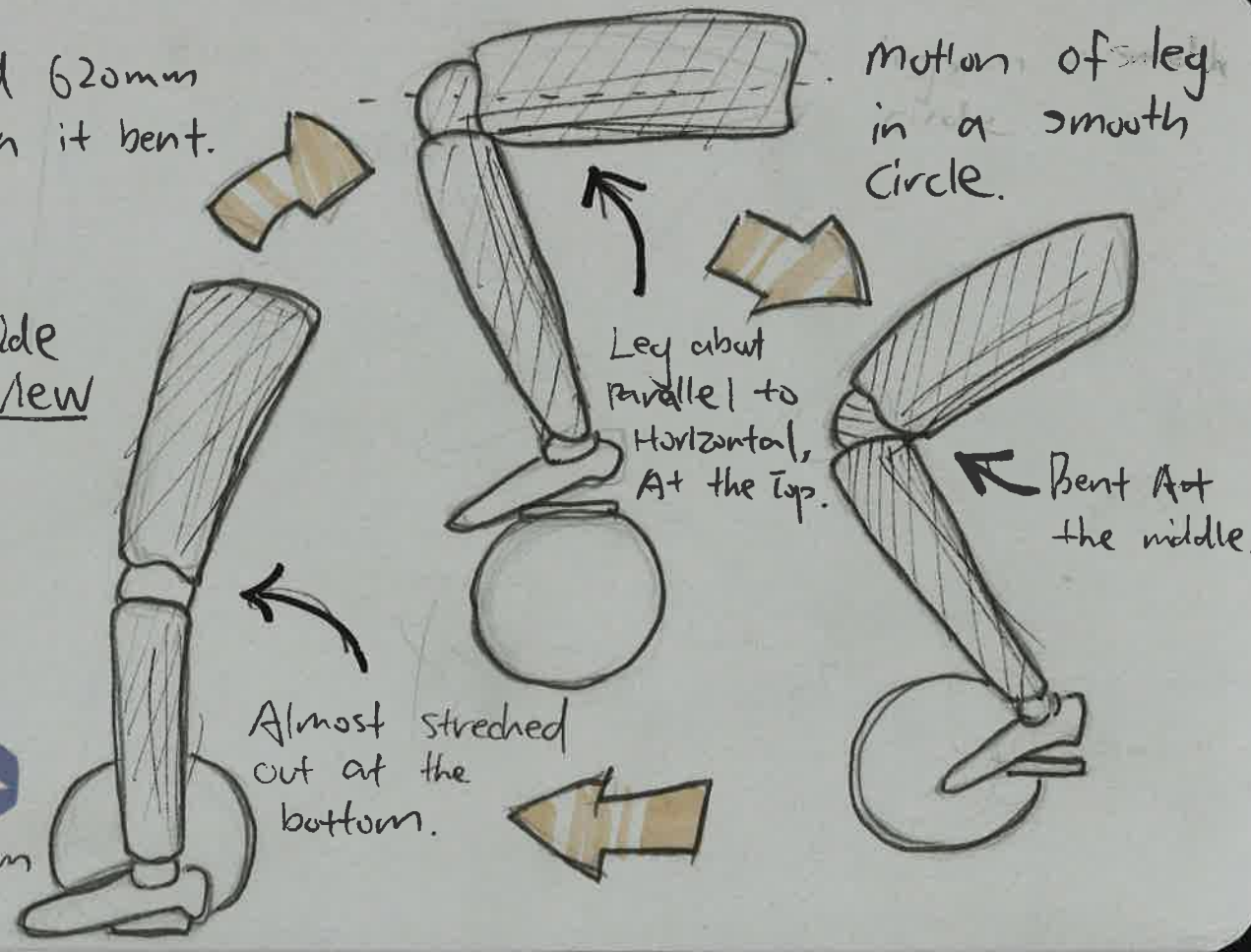
All measurement are approximate.

most comfort position based on ergonomic research



The distance from seat to handle will be 690 mm.

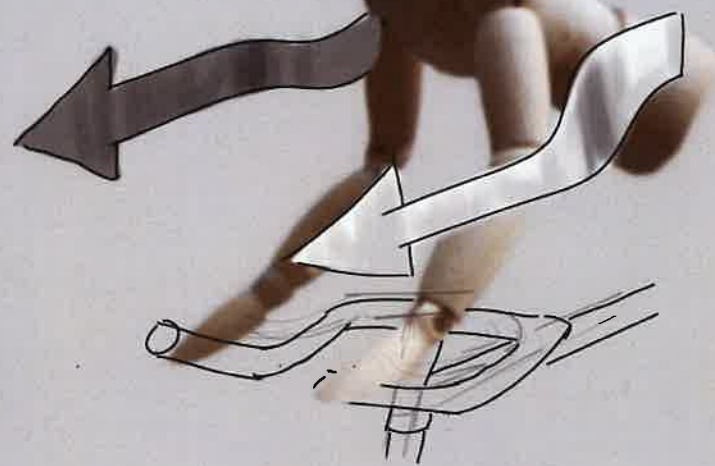
Side view



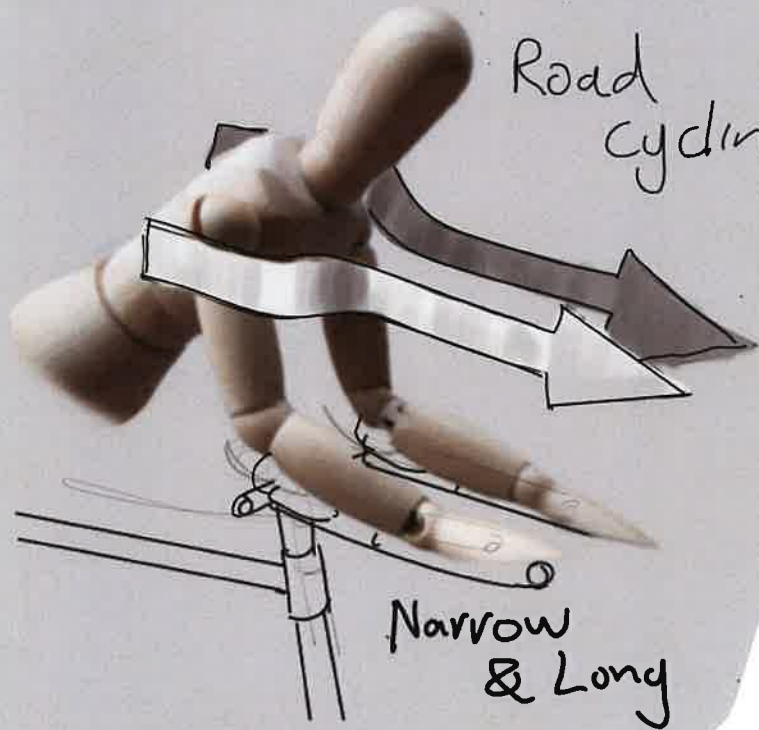


Wide & short

mountain  
cycling

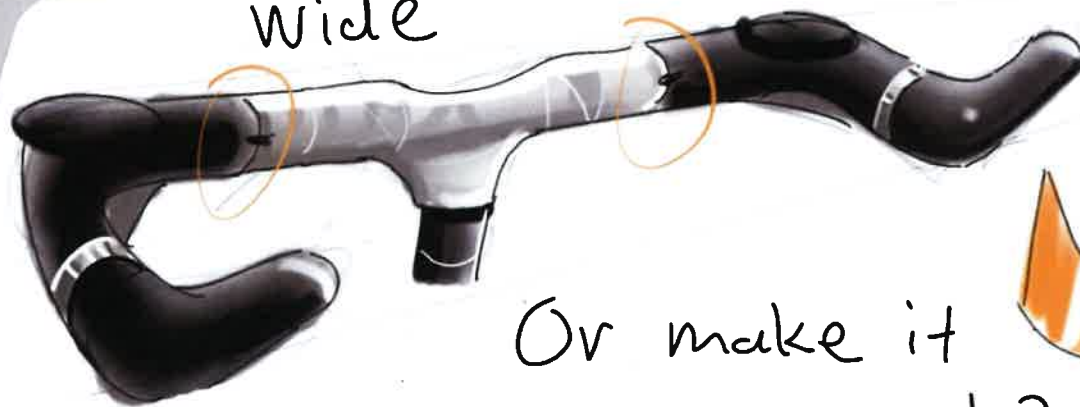


Road  
cycling



Narrow  
& Long

Wide

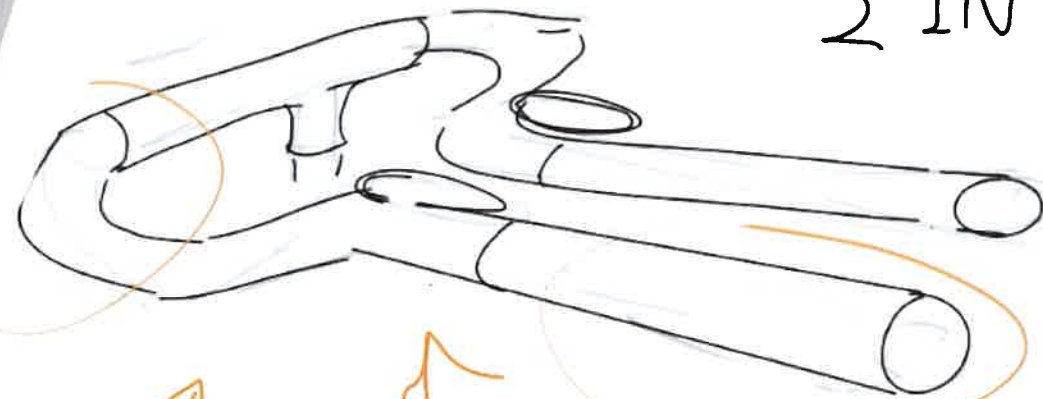


Or make it  
2 IN 1?

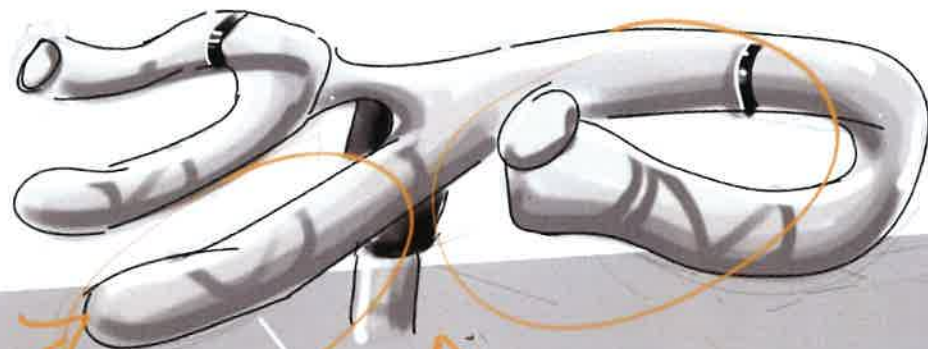
Fold In



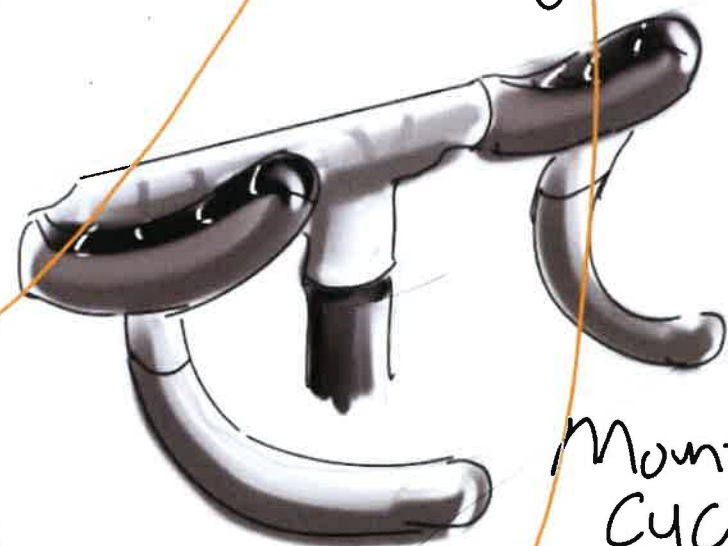
Narrow



Simply Join Together?



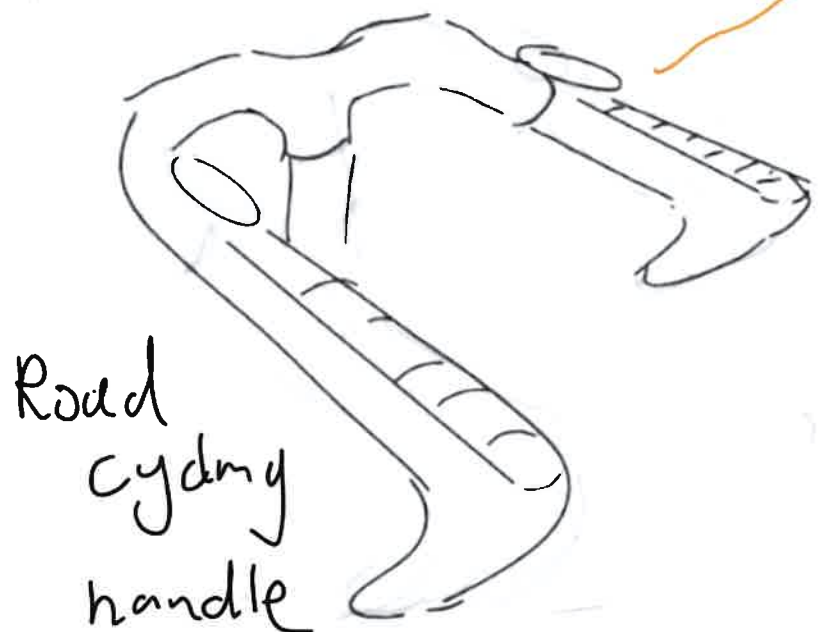
one for mountain  
one for Road?



Mountain  
Cycling handles



Road cycling  
handle



Road  
cycling  
handle





Easy shape clay

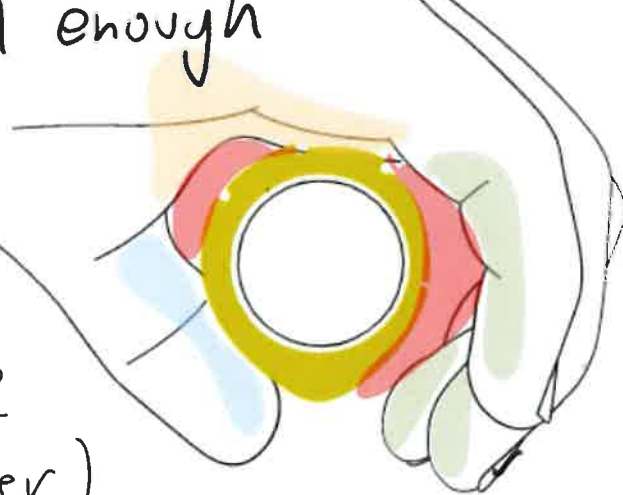


Hold Tight



Normal handle grip doesn't fit the hands well enough

Side (Finger)

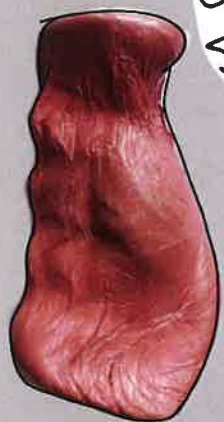


Finger Area  
Thumb Area



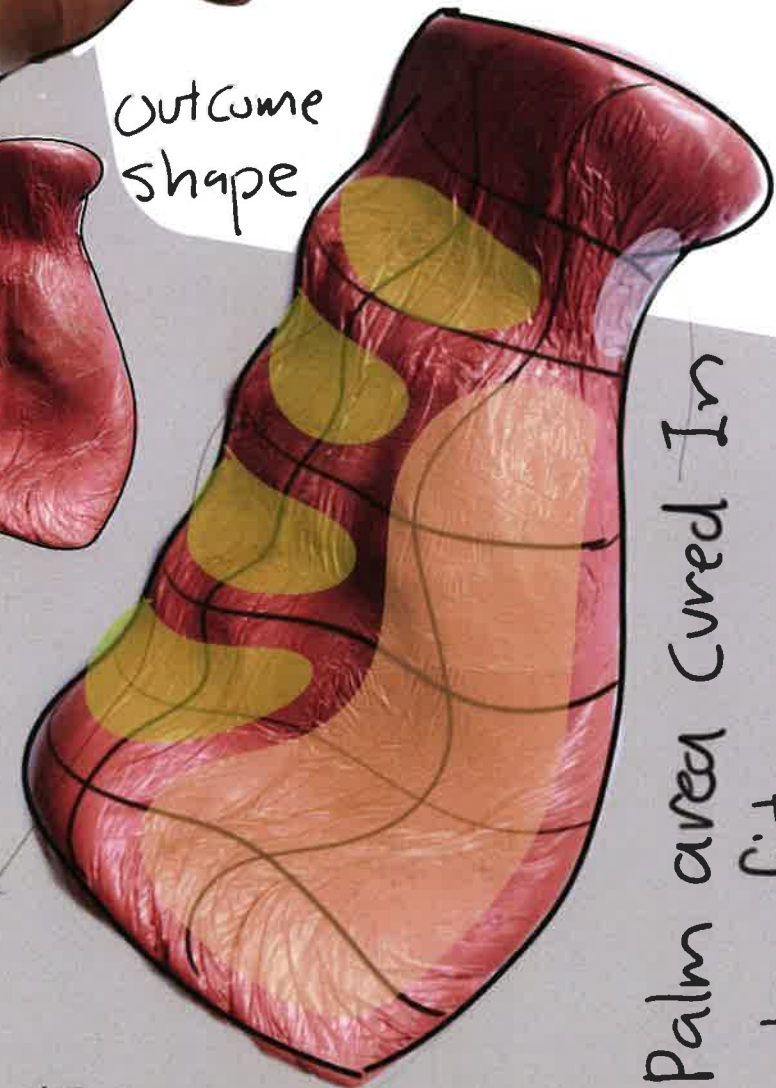
Palm Area

Ergonomic of handle grip



Outcome shape

Exploring shape of grip

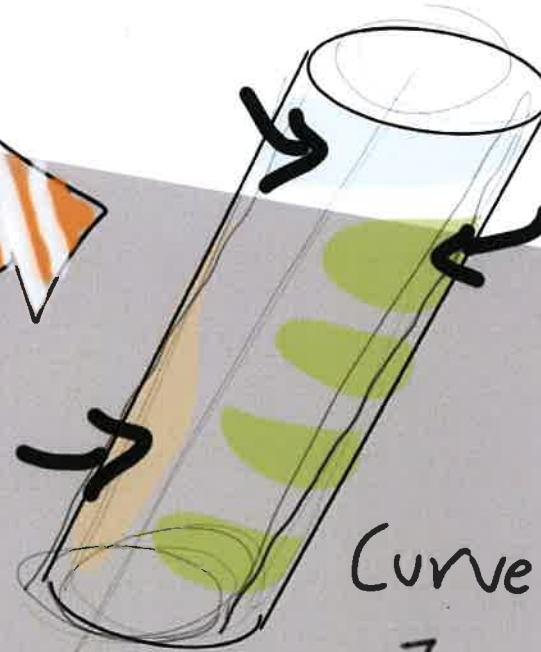
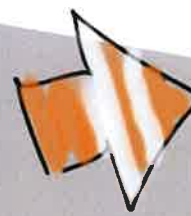


Front (palm)

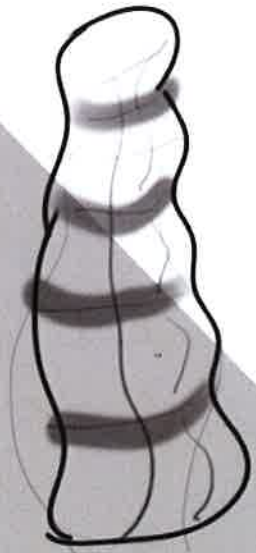
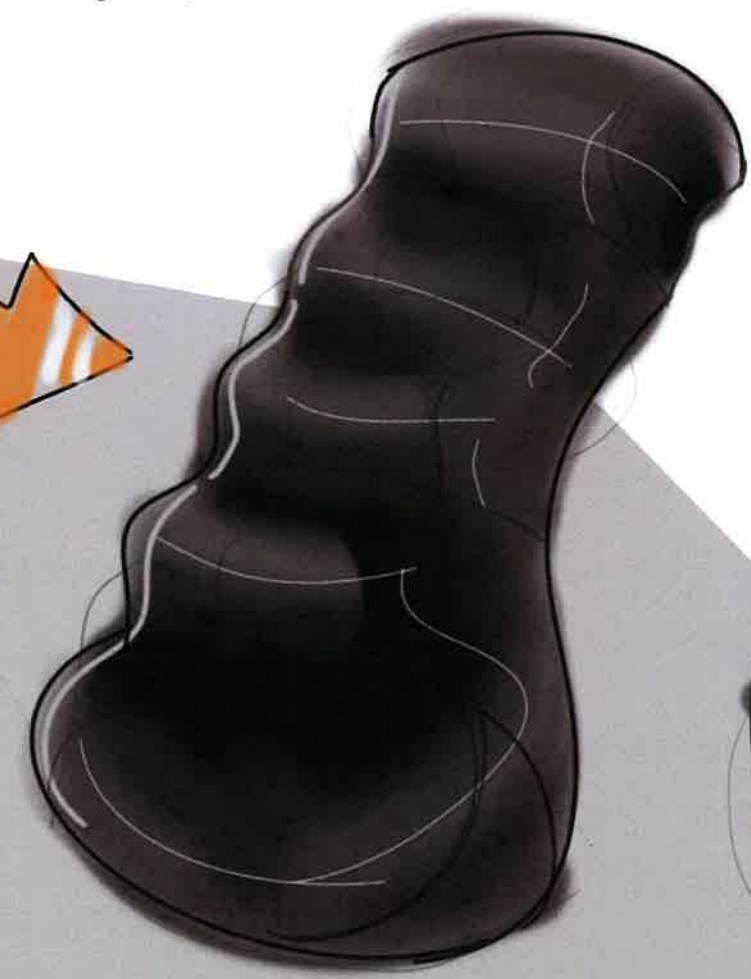
Palm area curved in to fit.



Back (Finger tips)



Curved In

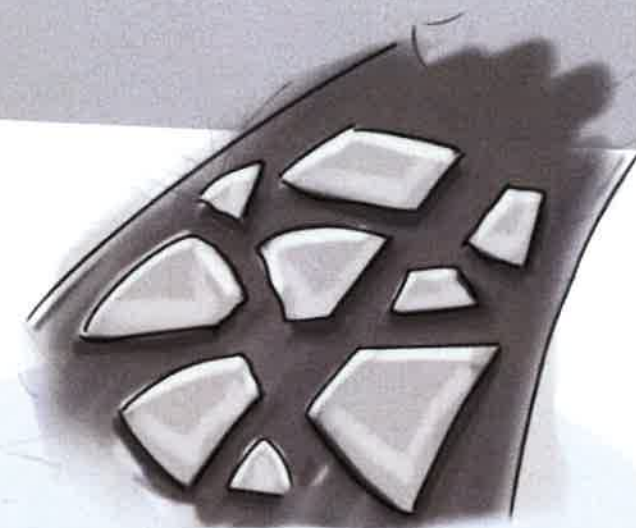
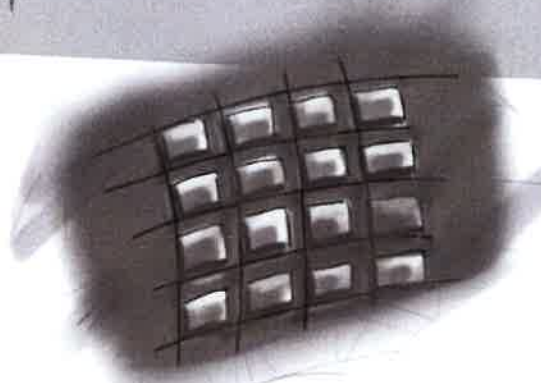




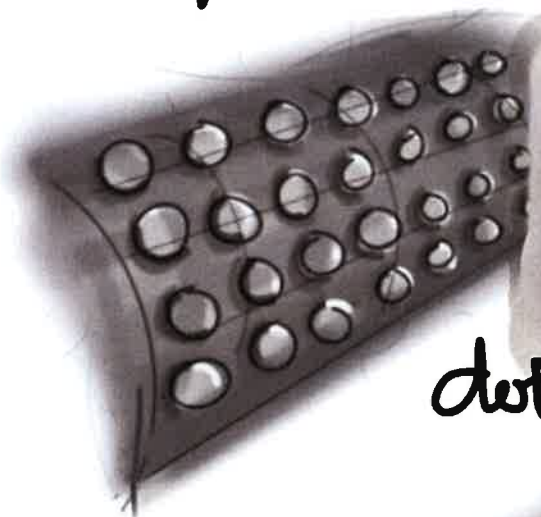
REFINING: REFINING THE TEXTURE ON HANDLE BAR



Grip pattern



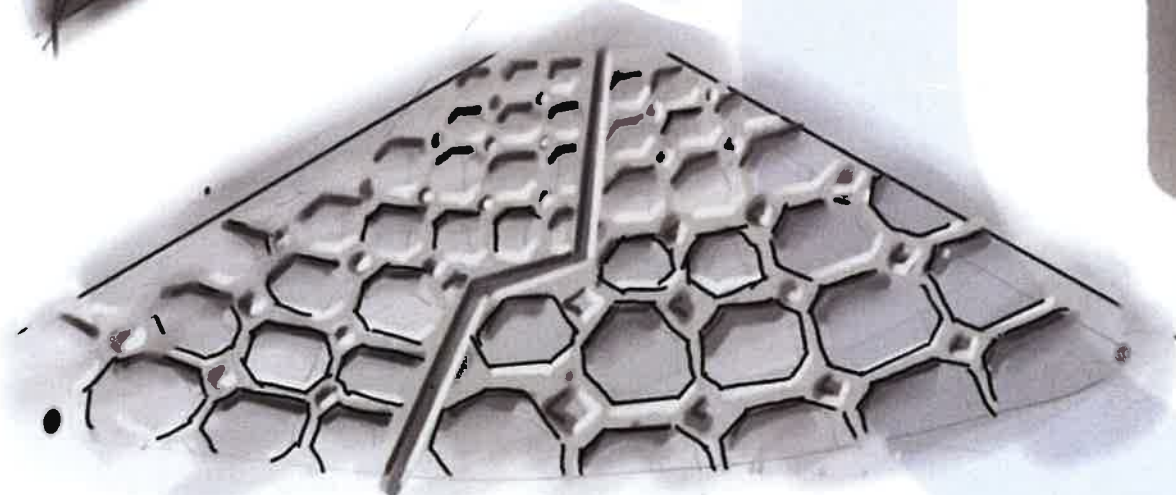
Irregular pattern



dot pattern



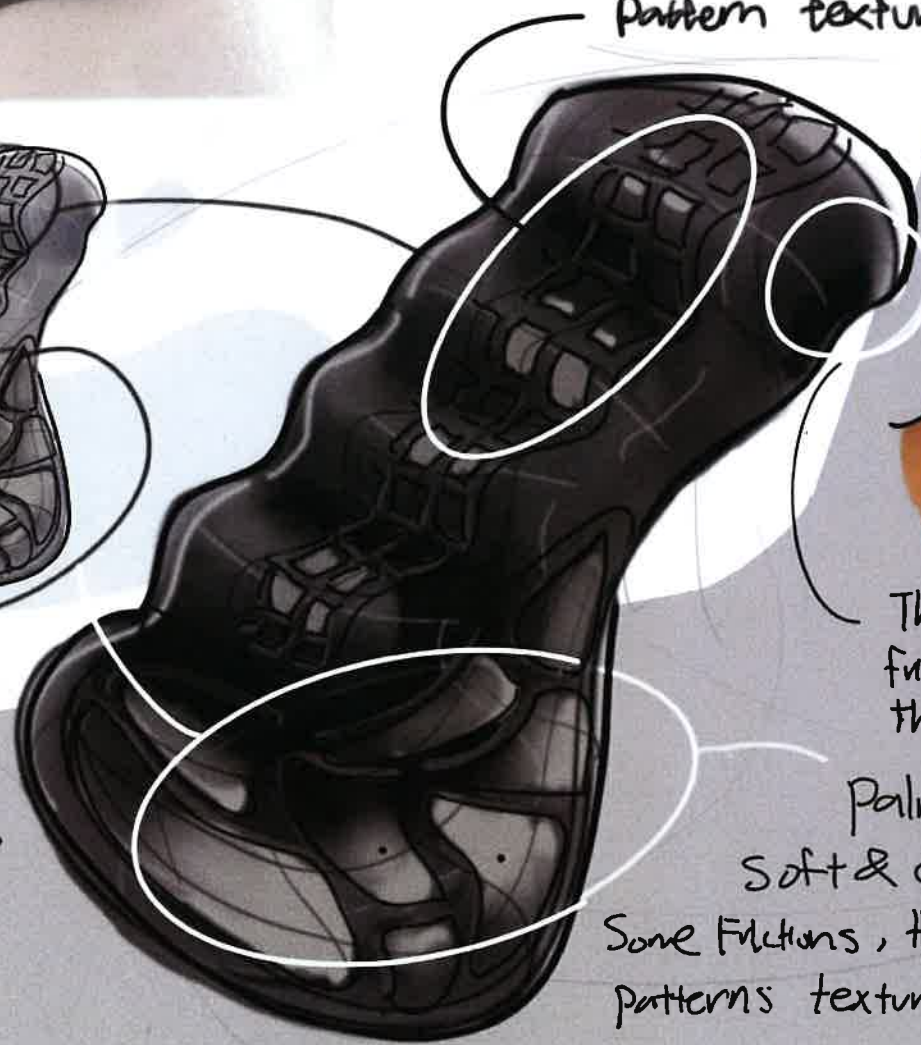
holding the handle grip



Beehive pattern



Exploring different texture



Finger area should have more Friction, therefore using Grid Pattern texture.

Top view

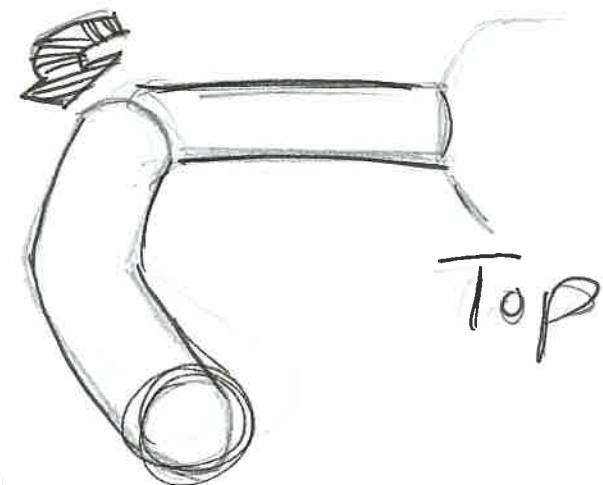
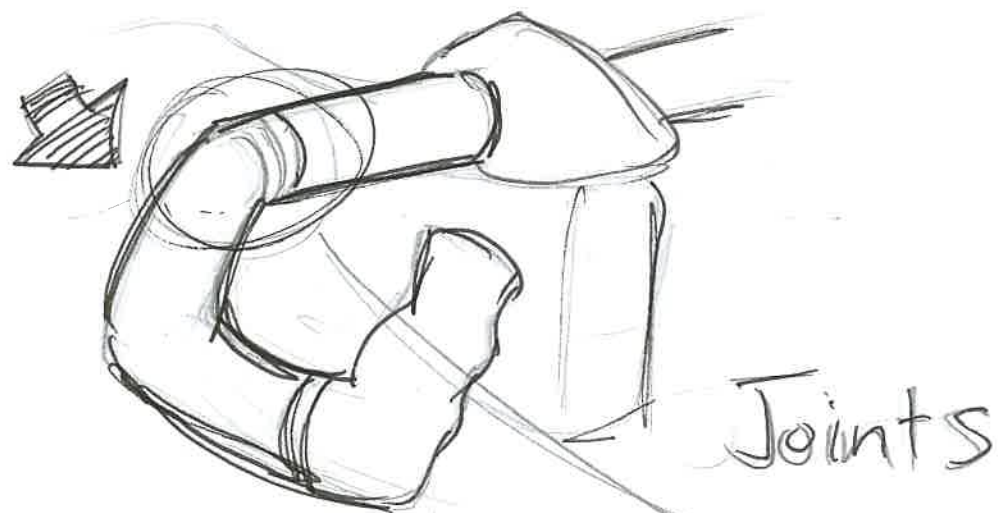


Thumb area have less friction due to switching, therefore no texture.

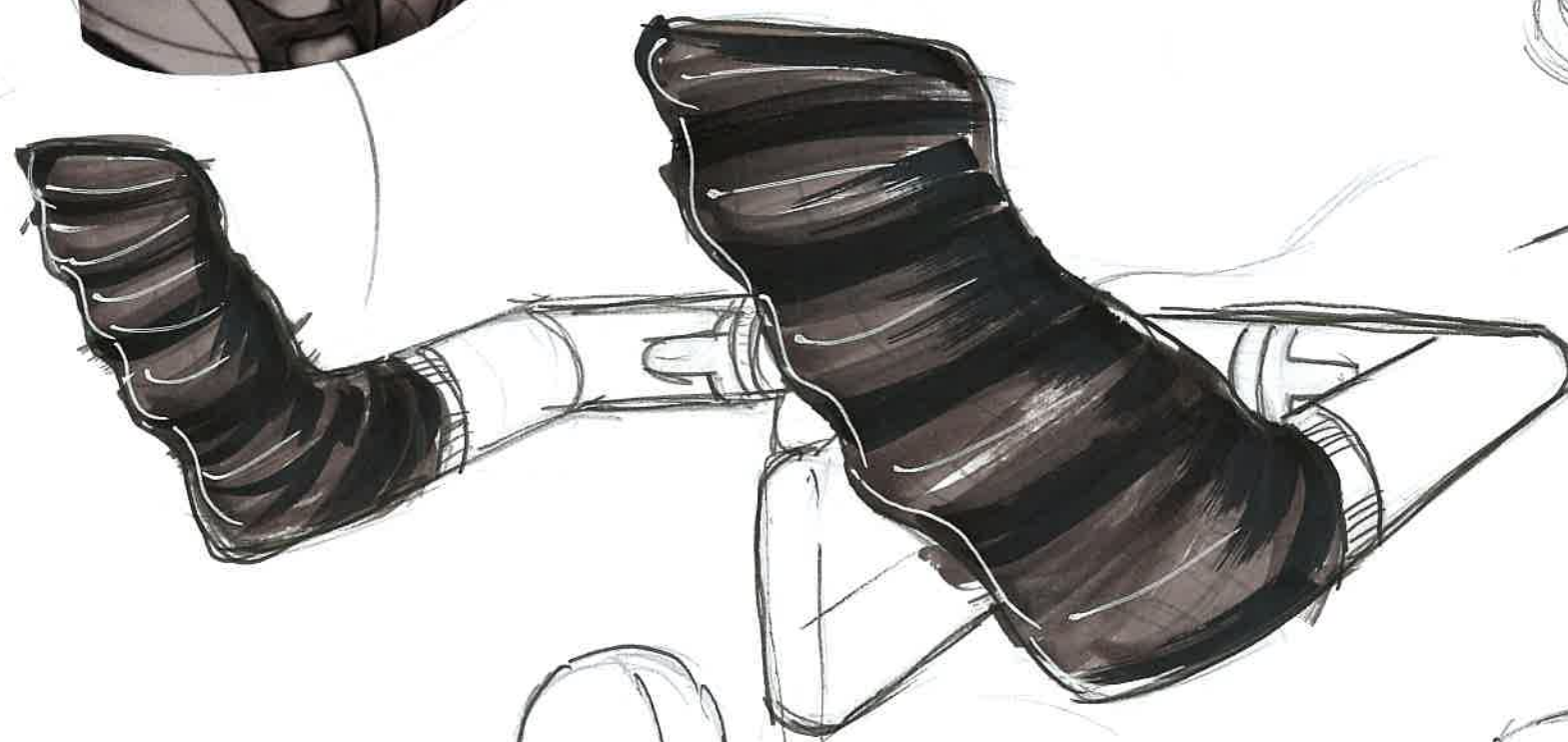
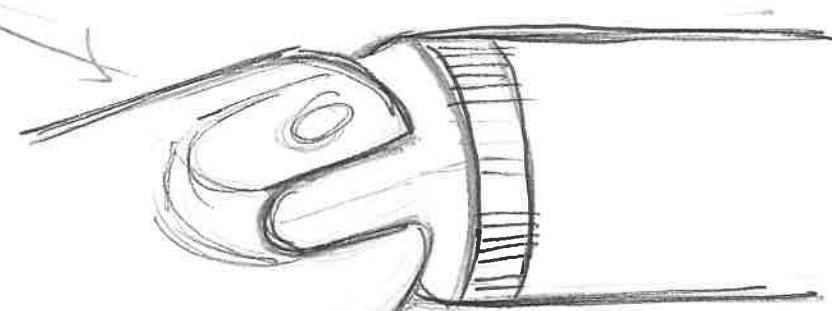
Palm area should be Soft & comfortable, Also have Some Frictions, therefore using big Irregular patterns texture.



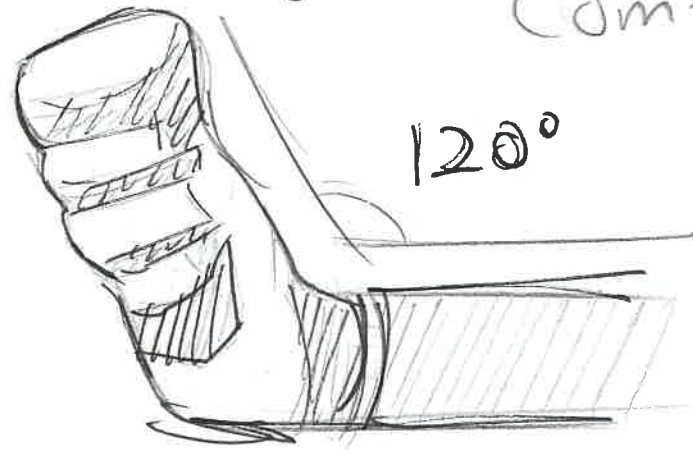
# FINALISE HANDLE



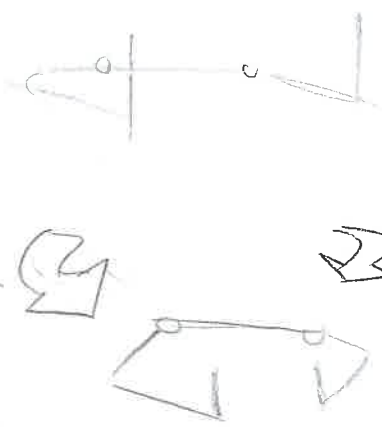
Texture



120°  
Comfort



Switch





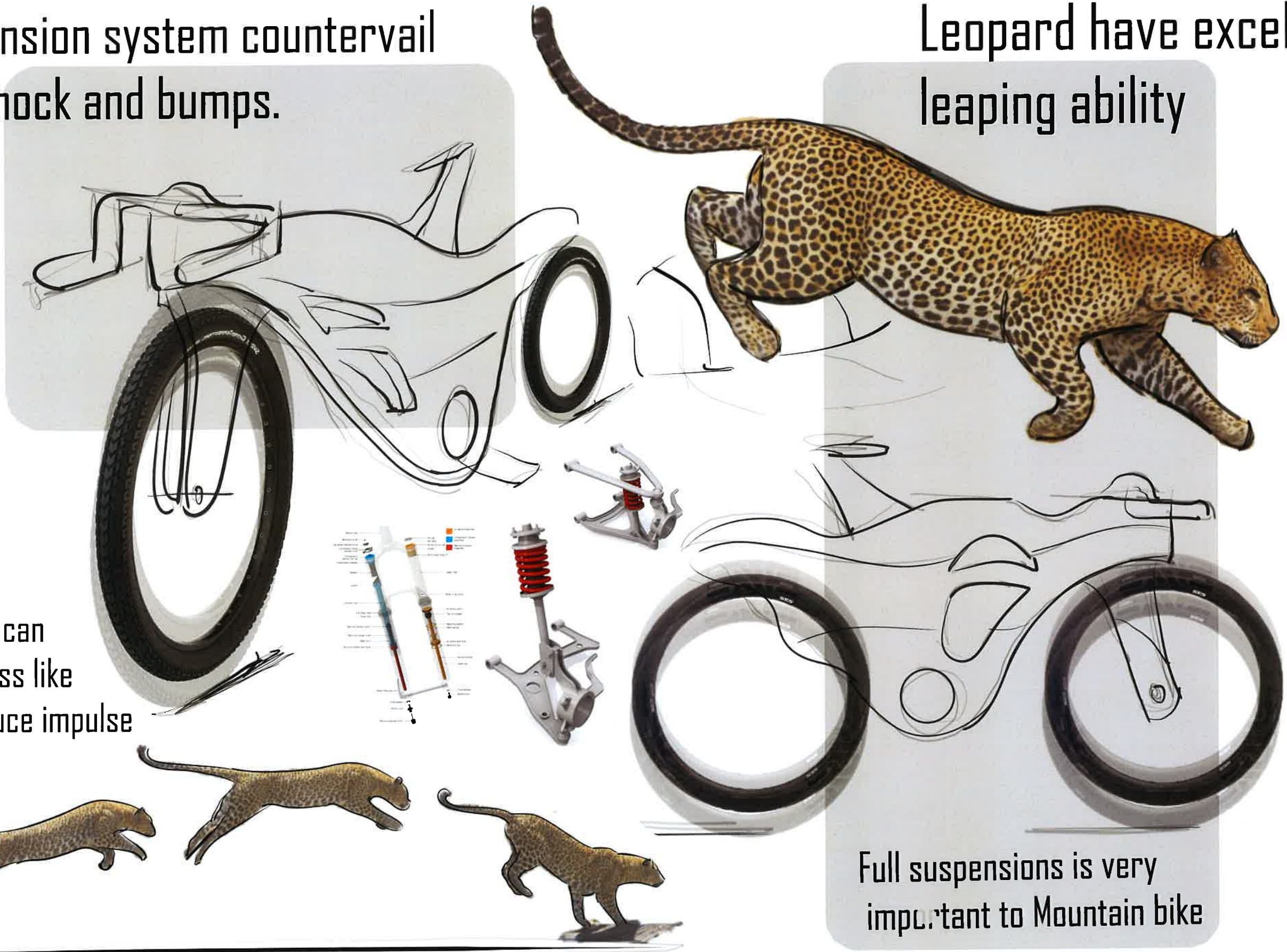
Suspension system countervail  
the shock and bumps.

Leopard have excellent  
leaping ability

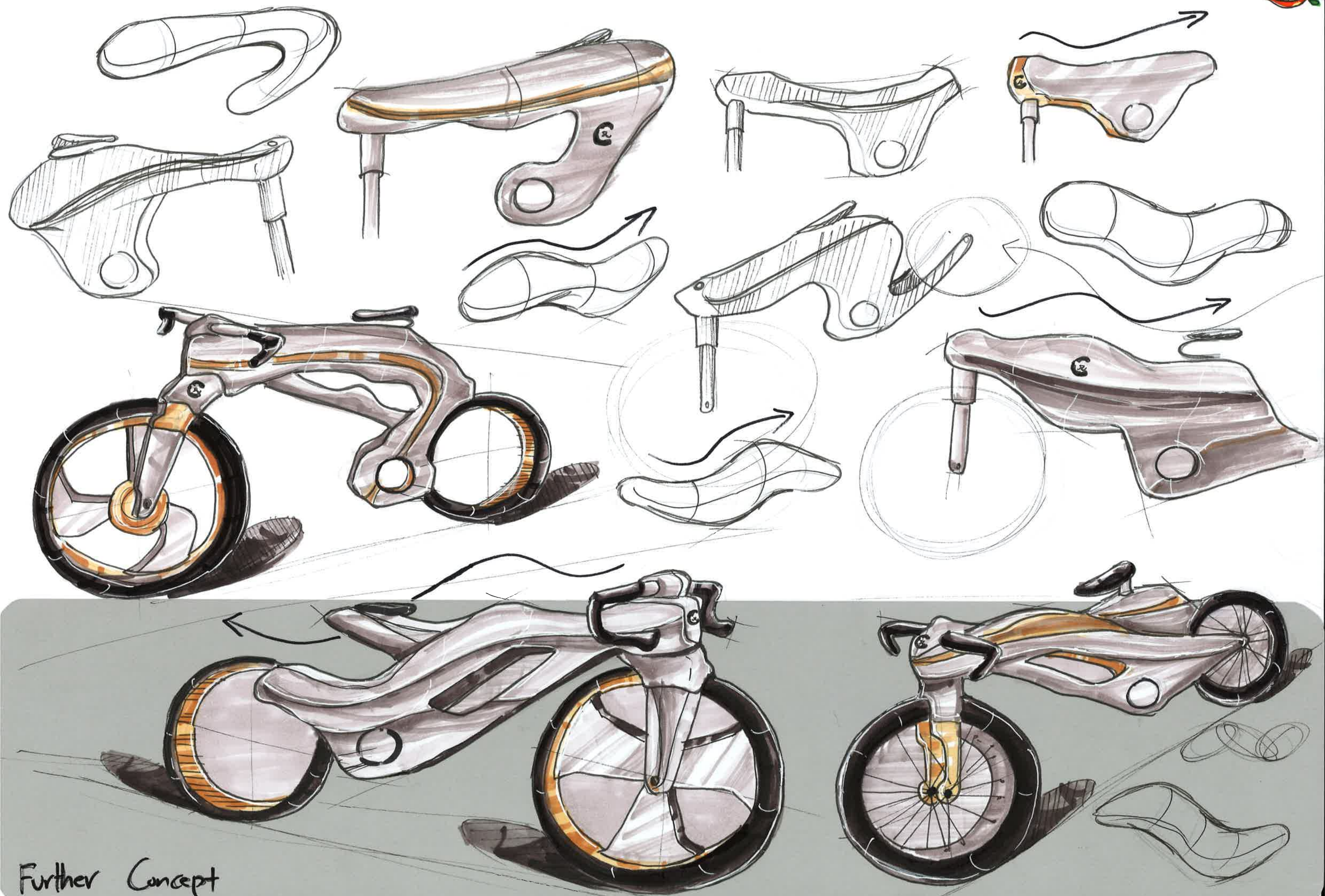
Leopard's leg can  
bend, compress like  
spring to reduce impulse

Full suspensions is very  
important to Mountain bike

# BICYCLE SUSPENSION SYSTEM

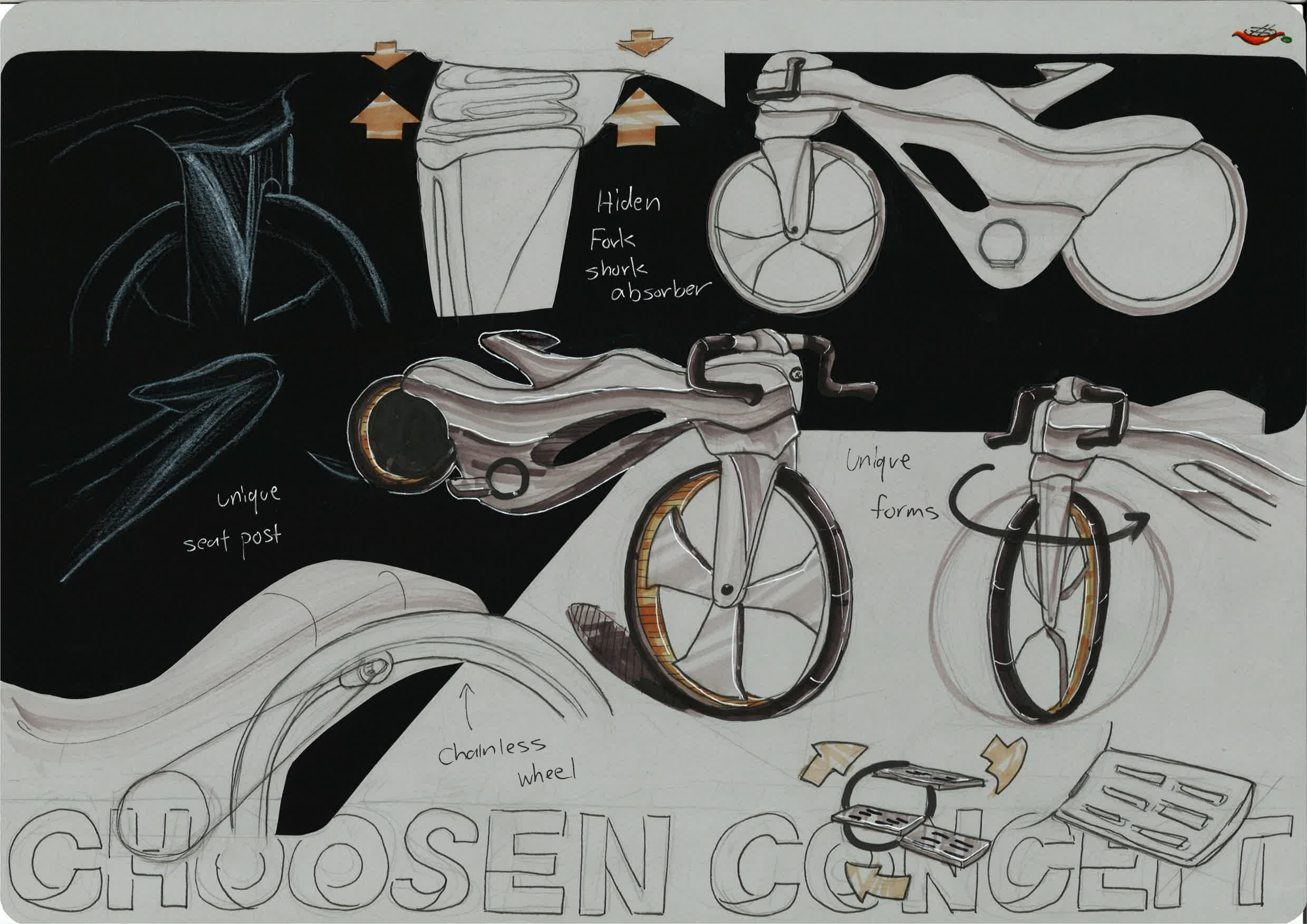






Further Concept





Hidden  
Fork  
shork  
absorber

unique  
seat post

Unique  
forms

## Chainless wheel

# CHOOSING CONCEPT



Like a spring?

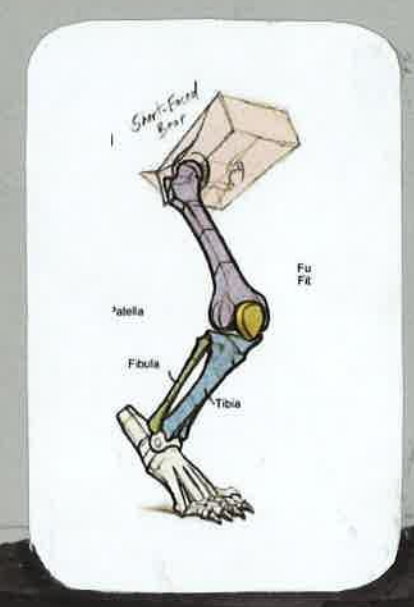
Compress?

Single?

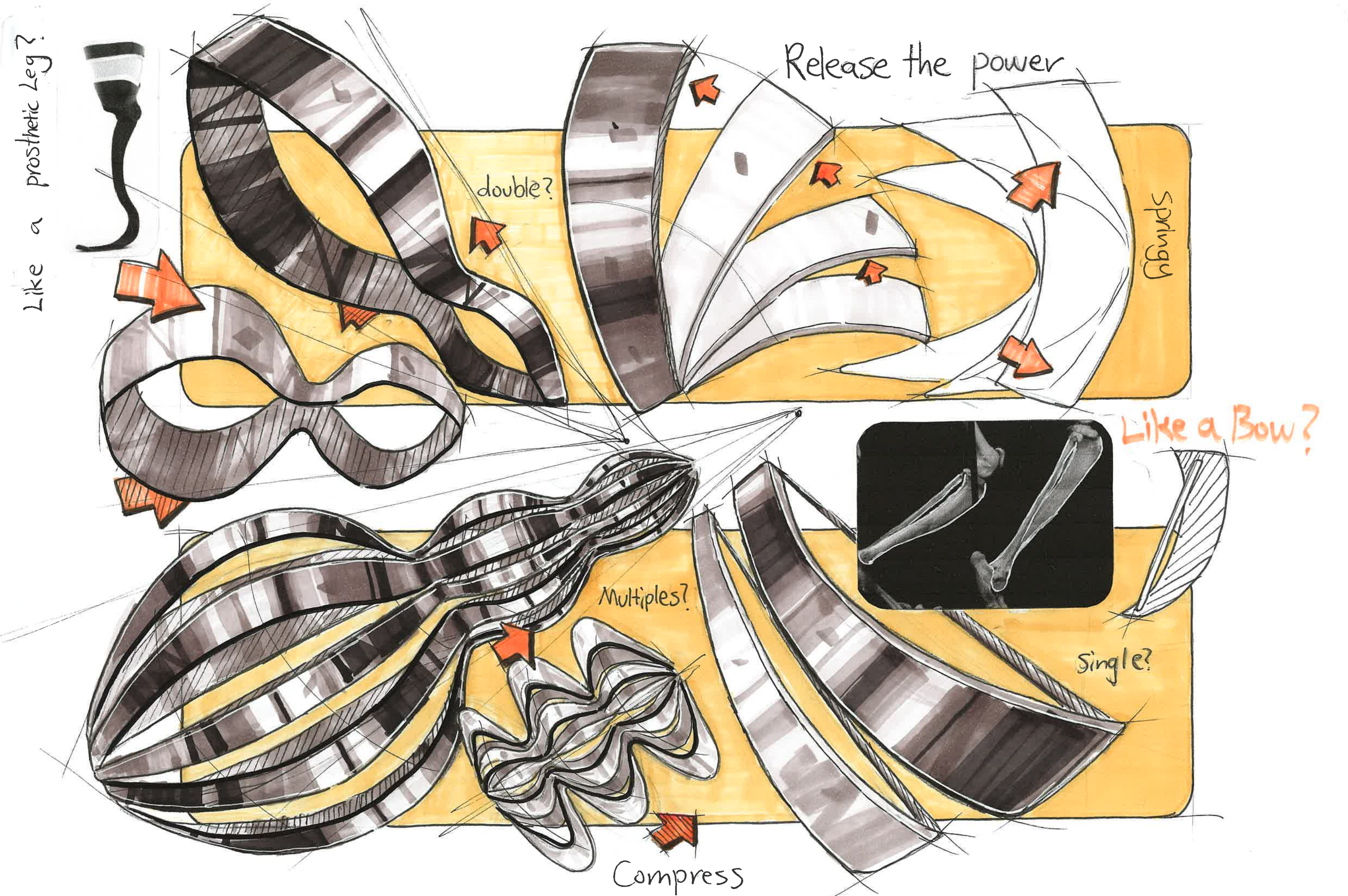
Crosses?

Multiples?

Combined?







Like a prosthetic Leg?

double?

Release the power

springs

Like a Bow?

Multiples?

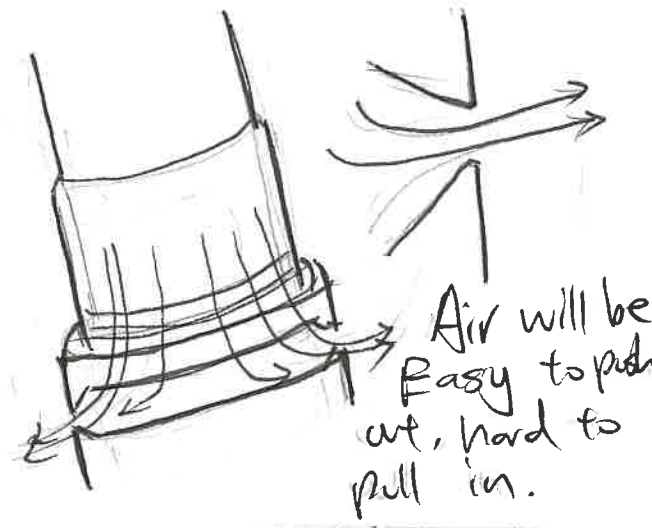
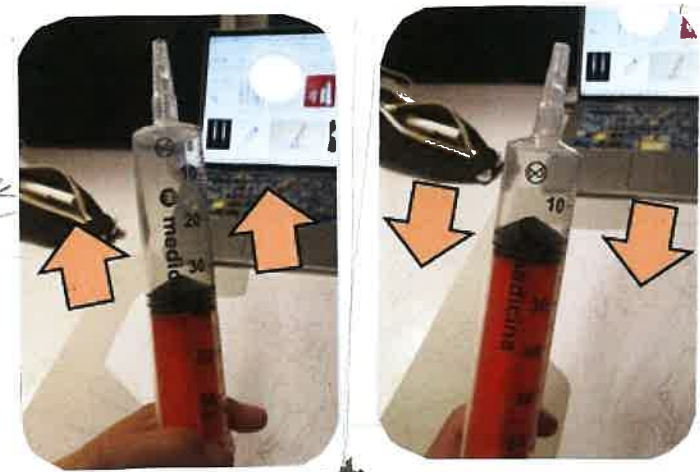
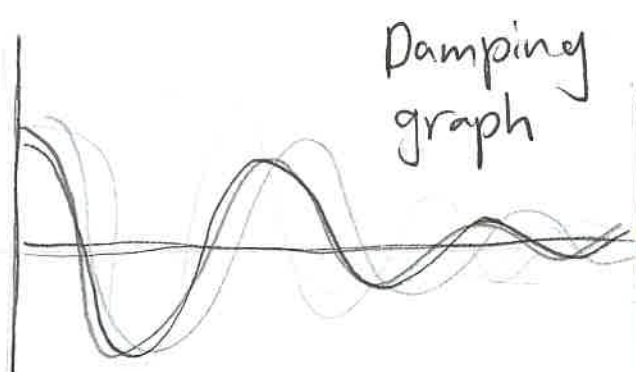
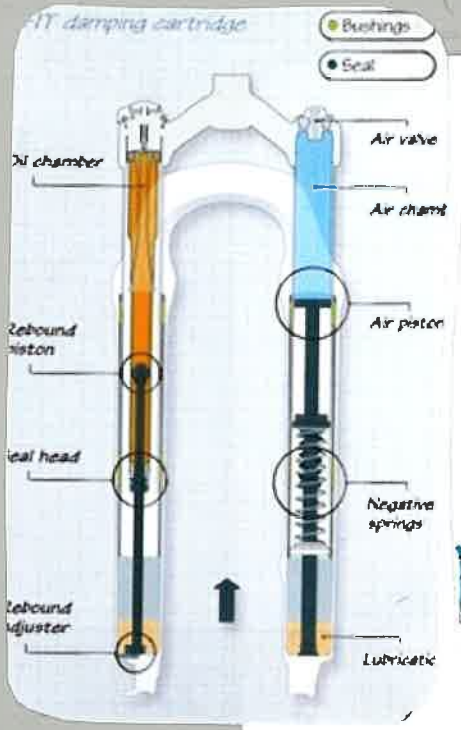
Compress

single?





# DEVELOPMENT Fork Suspension



Spring to storage the Impulse  
Air tube to resist the repulse



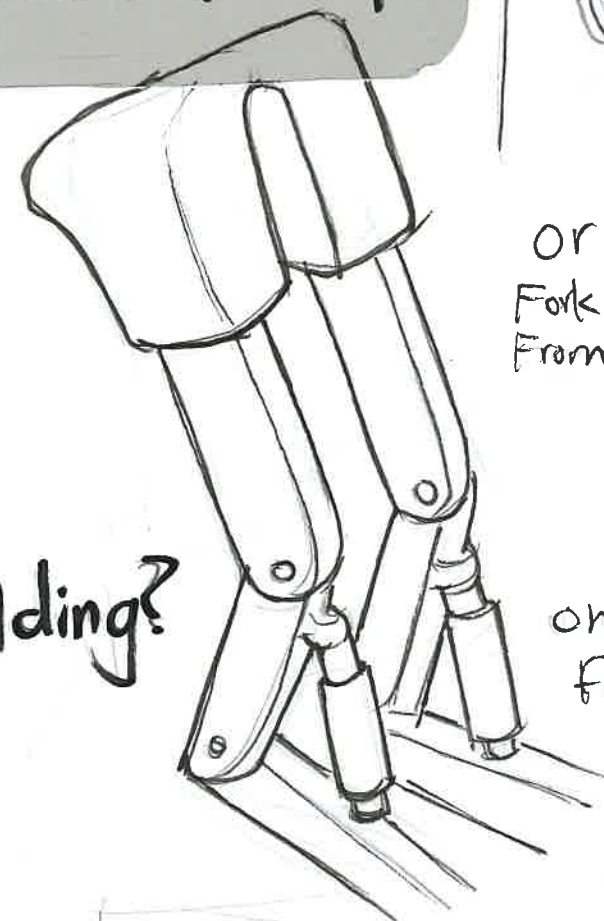
Spring suspension

In a Arc?

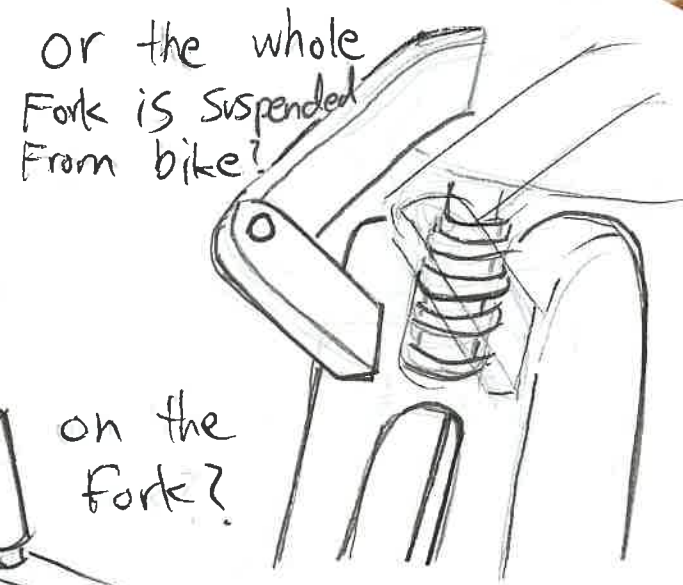


open & close

Negative tube of Air  
Positive tube of spring



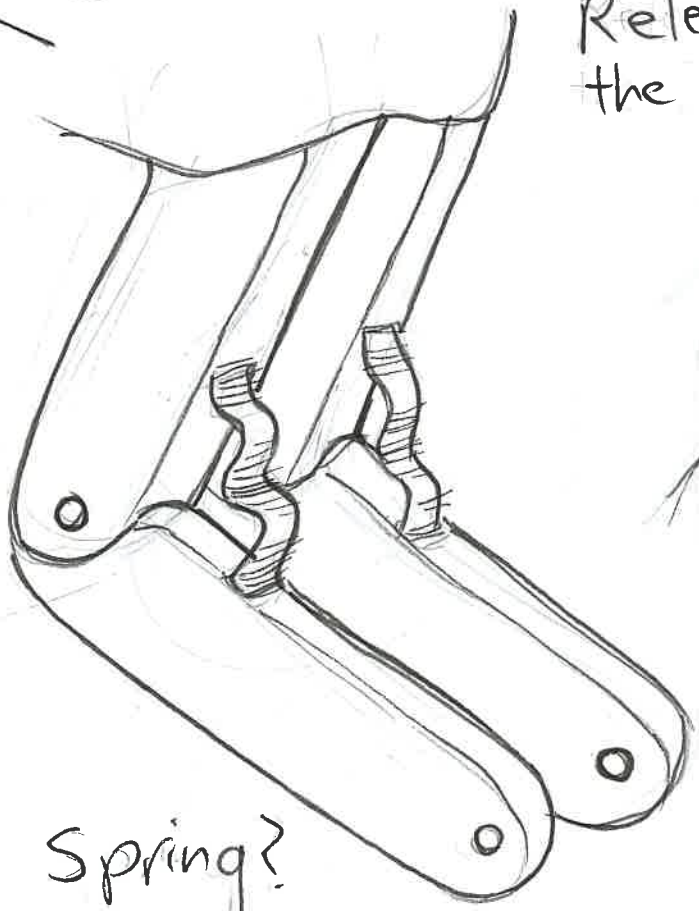
Folding?



or the whole Fork is suspended from bike?

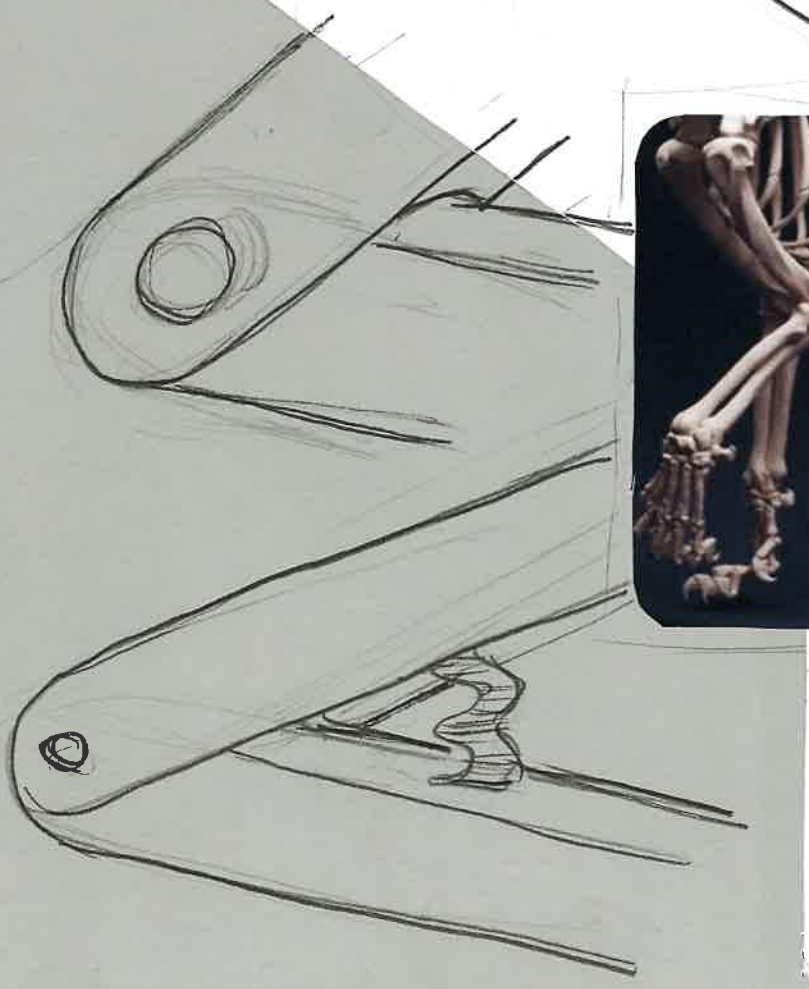
on the fork?

Release the Impulse



Only Spring?

using high flexibility steel



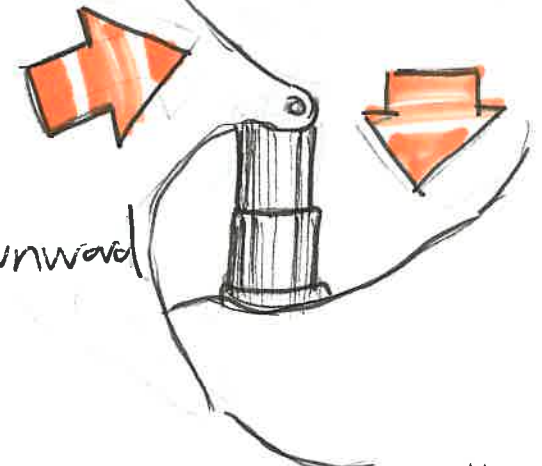
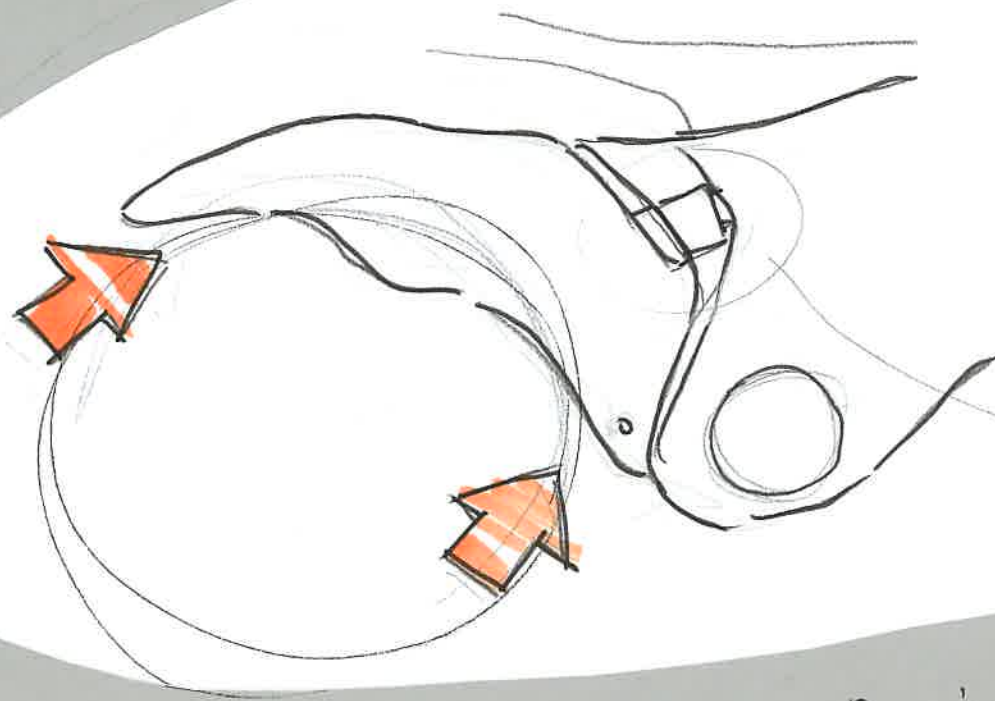


Normal Suspension

Install a Large Shock absorber on bike Frame?

or Further upgrade?

This is only suspension in single axis

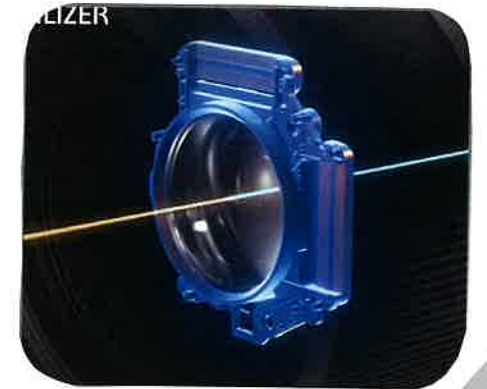


By installing the Stabilisation System in the bike, completely separate the wheel & the Frame of the bike.

But, Can we make the wheel really Suspended from the frame?

Four Axis Suspension?

minimise the impulse from wheel on the bike.

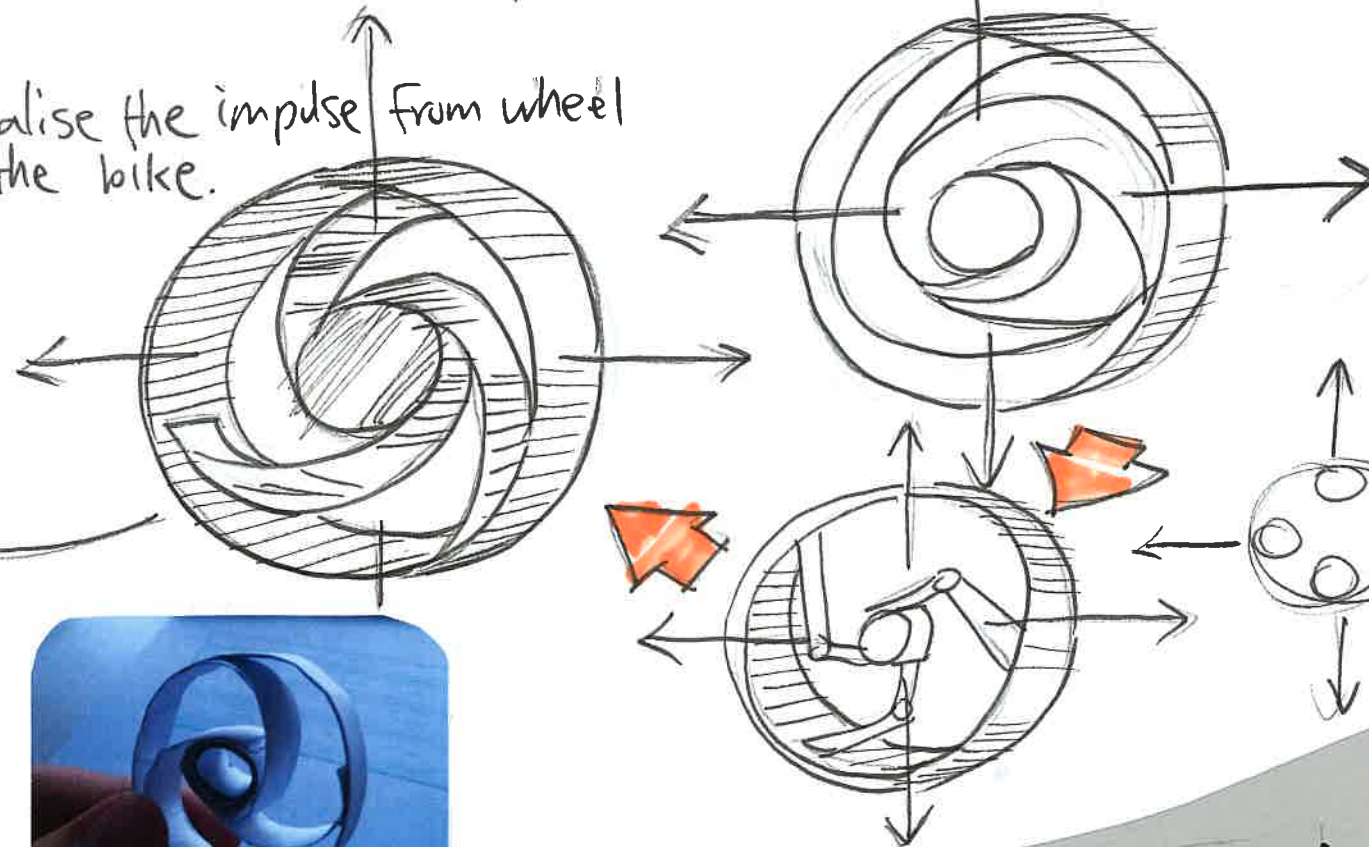


Like the Stabilization on camera?

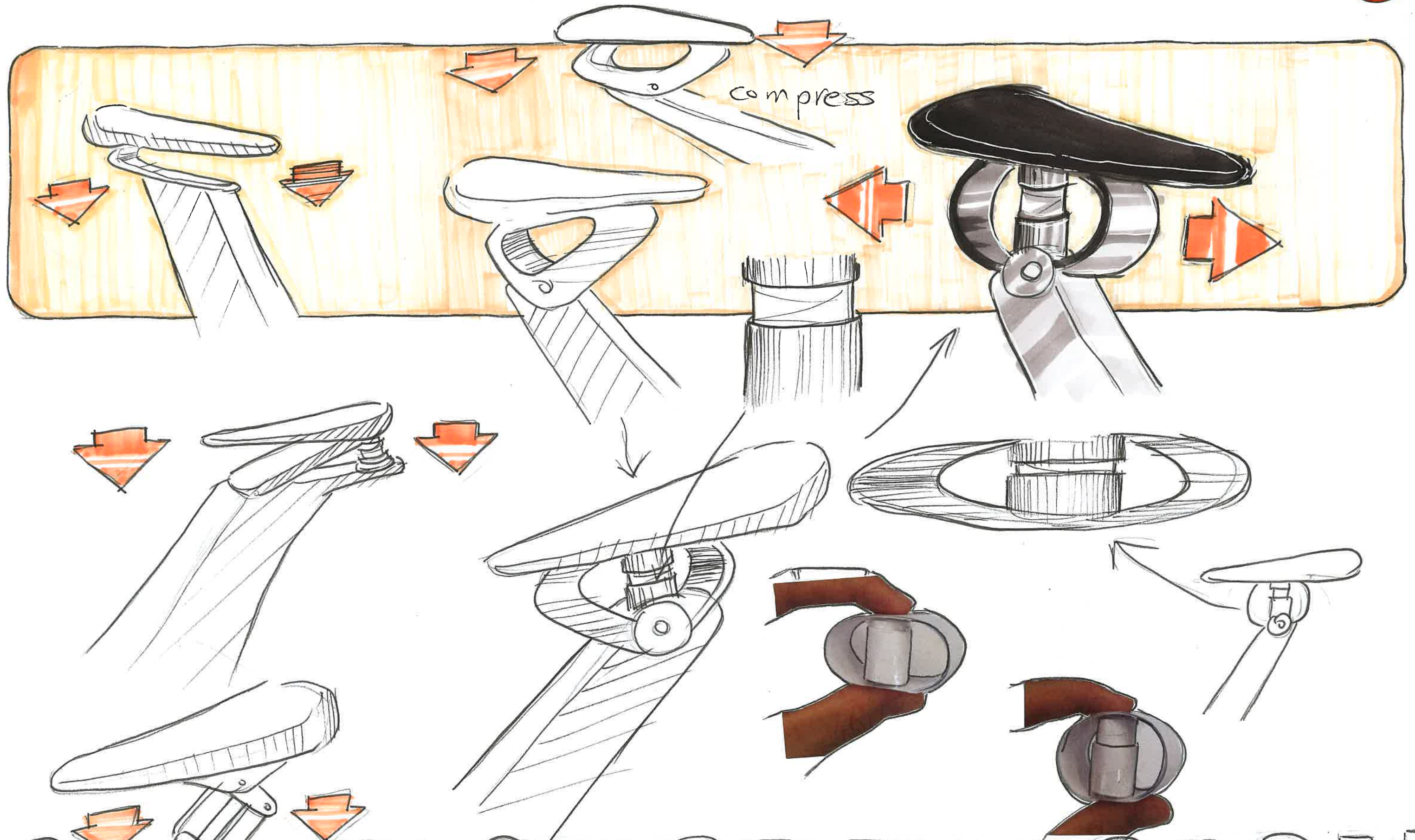
Rear Suspension

DEVELOPMENT

There will be a part that drive the wheel install on the suspension system.







# SEAT SUSPENSION



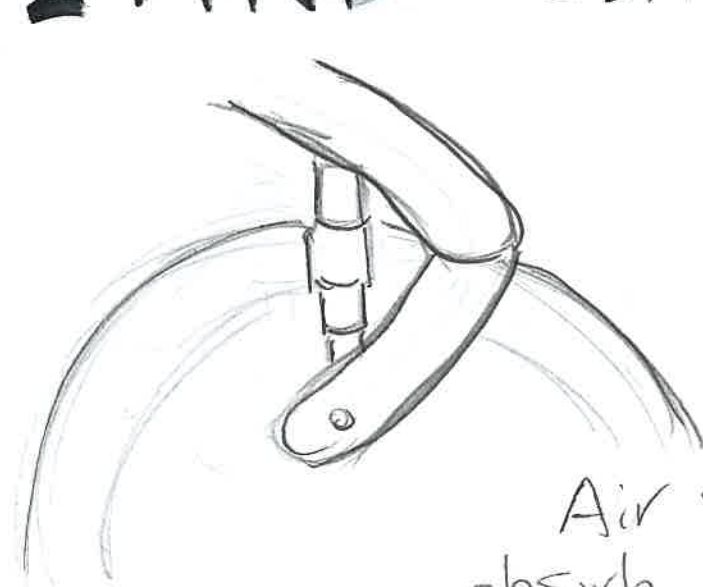
# SUSPENSION SYSTEM



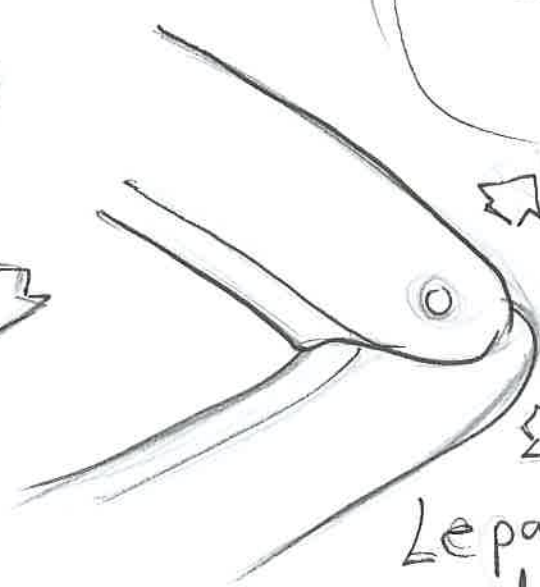
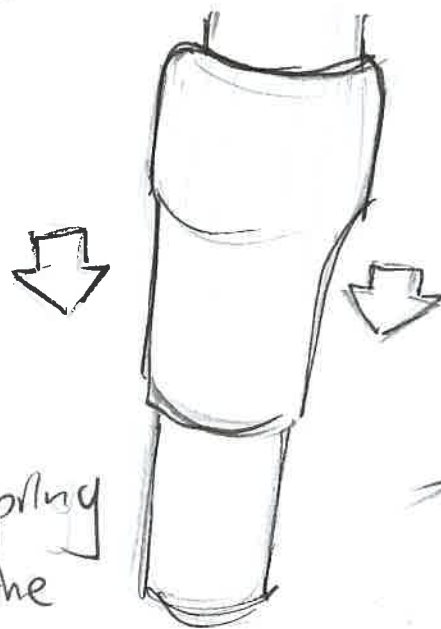
Leopard Leg  
& 4 Axis  
Suspension



LAND LIKE LEOPARD



Air Spring  
absorb the  
shock energy



Leopard arm  
provide Friction  
releases energy & shock





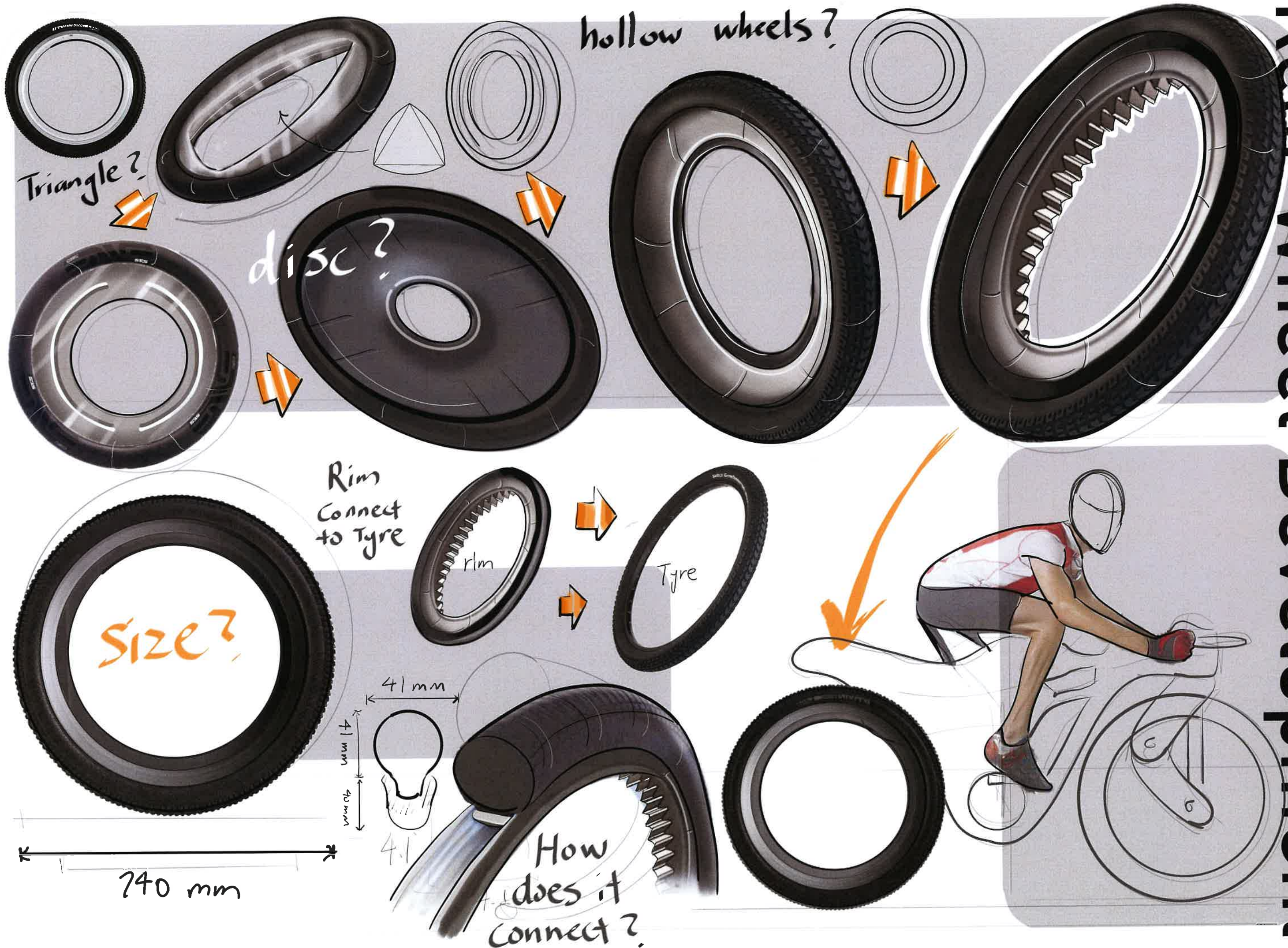
Triangle is **MOST STABLE** structure

# FRONT WHEEL DEVELOPMENT





# Rear Wheel Development





Chain-less  
Driving system

How Does  
The Rear  
Wheel  
Driving?

Bearing and track  
to fixed the wheel

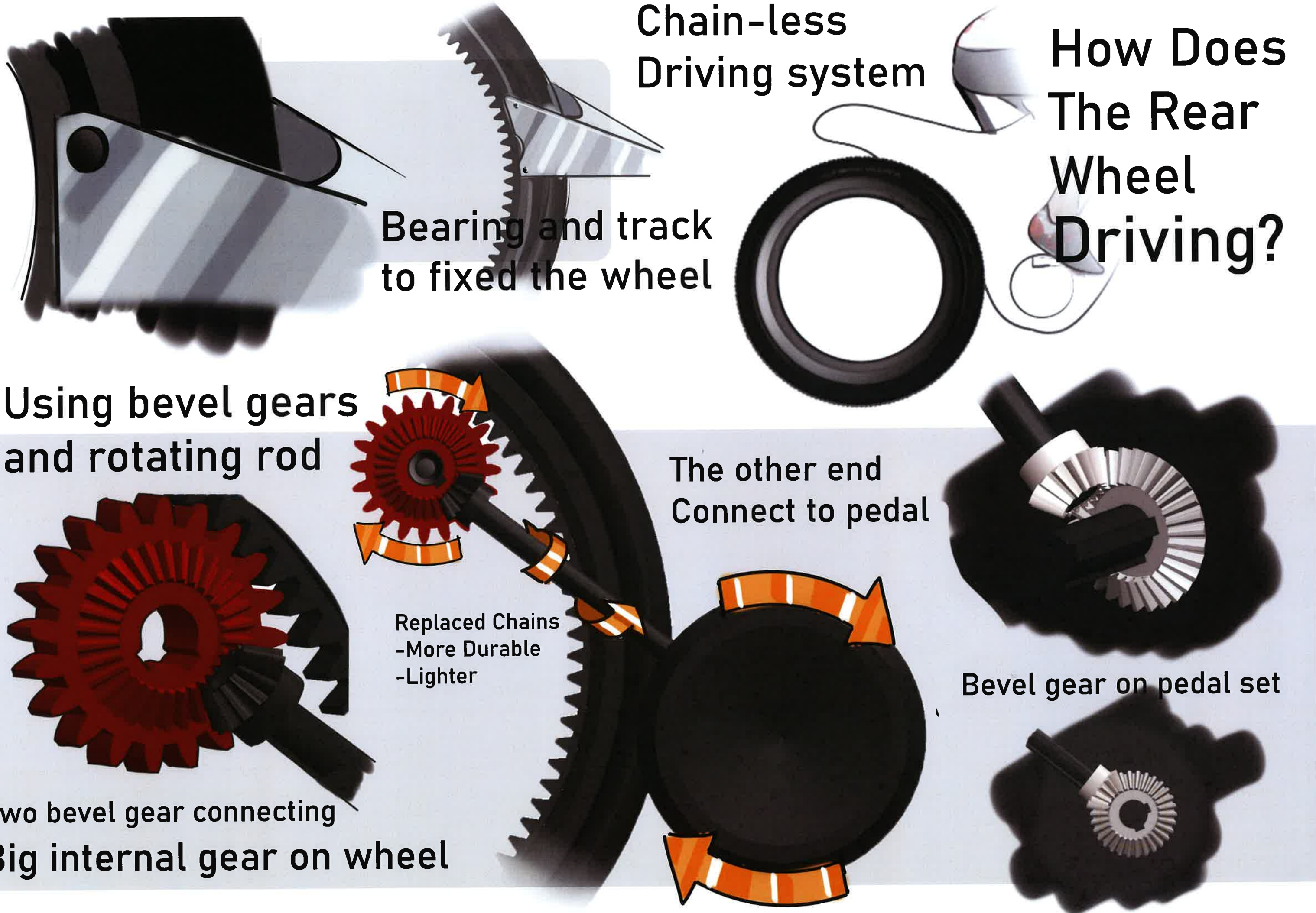
Using bevel gears  
and rotating rod

The other end  
Connect to pedal

Replaced Chains  
-More Durable  
-Lighter

Bevel gear on pedal set

Two bevel gear connecting  
Big internal gear on wheel





# Tyre Material

I have chosen solid tyres for my bike. Solid tyres have a reputation for being slow, heavy, uncomfortable, but using microcellular rubber overcomes this issue. It has benefit of puncture resistance, which perfect for situation like mountain cycling.



heavier & harder

Solid Tyre?

Soft & light

Microcellular Rubber



Fine Cell Structure



Puncture Resistant

durable

Natural Rubber

- Used in tread & side wall.



- Elastic
- lighter
- will be punctured

Butyl Rubber

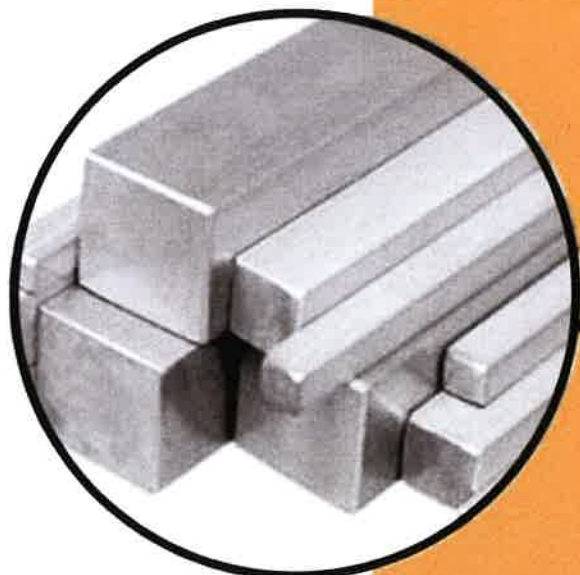
- Usually used in tyre's casing, flexible & good vibration damper.

Air Tyre?



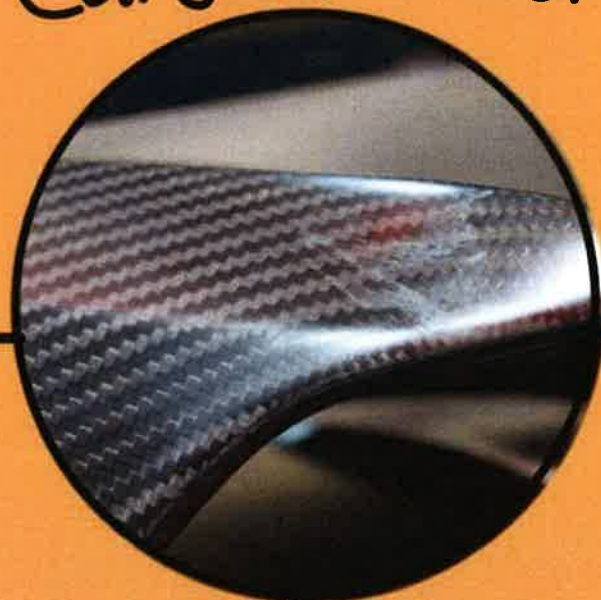
# MATERIAL DECISION

Steel



- greater flexibility

Carbon Fiber



- high stiffness, Light

Aluminium



- lighter, 1/3 of steel's weight

Rim Material

I has chosen Carbon fibres as the material for my bike rim, but carbon fibres tends to perform poorly in wet and long descent situation, which normally see in mountain cycling. To solve this problem, I decide to use an existing approach of carbon fibre bike rim which a surface of aluminium.





head tube

handle

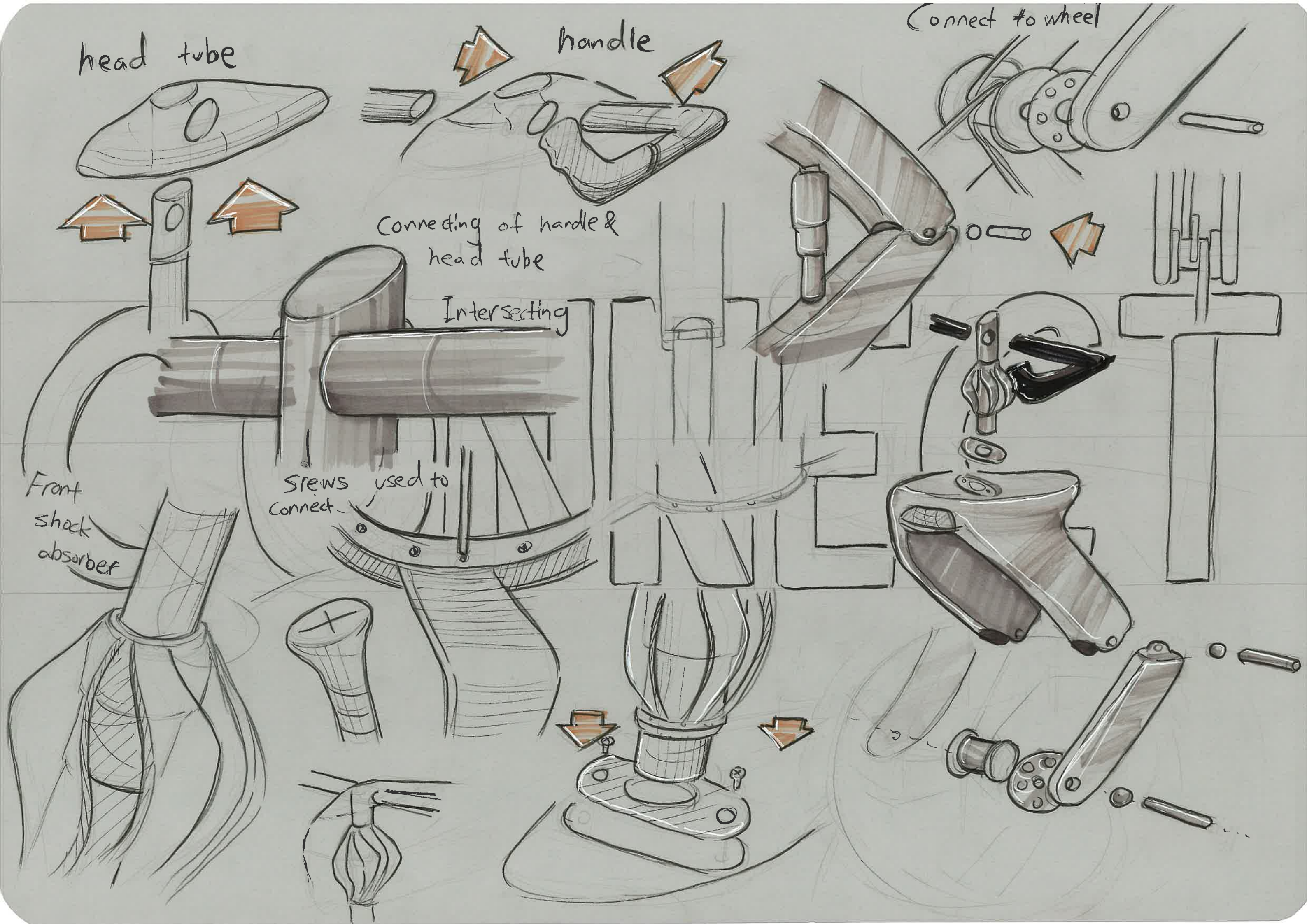
Connect to wheel

Connecting of handle & head tube

Intersecting

Screws used to connect

Front shock absorber





# SHINING IN THE DARK?

Light is necessary for night cycling; I want to design an in-built light for my bicycle light. It will integrate with the design of the bike instead of separate from the bike.



There are many different types of Bike front and rear lights .



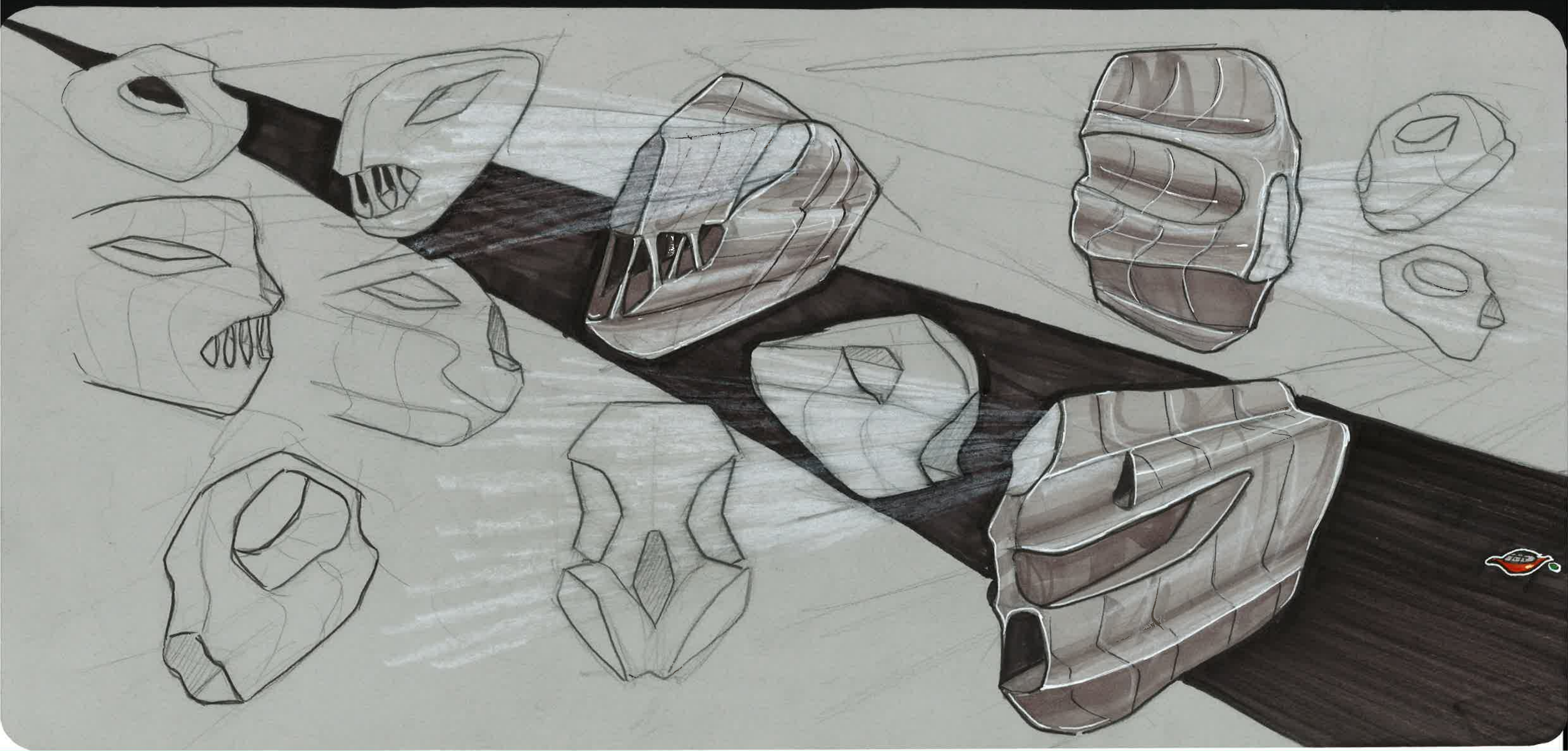
Most of the existing bicycle light are external lights hanging on the bike.



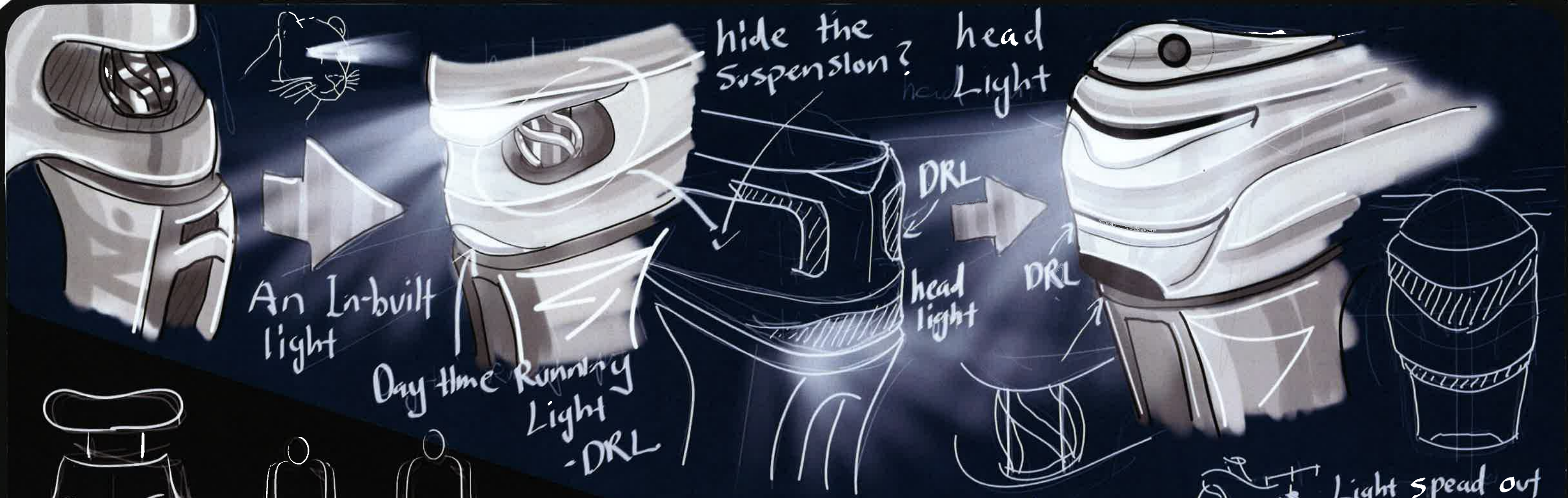
Front light are usually white and rear light are usually red













Reflector on  
Bike?

Light on  
wheel?

Light Bar  
instead of  
reflector?

Light Color  
When Rotating

Light Shine on  
side?

Light that helps other  
driver to see the bike.

Cold white  
Light in  
front wheel,  
helps other  
to identify the  
front & Back of  
Bike.

Warm red  
Light in  
rear wheel  
Safer for  
night cycling

white

Red

white

When seeing a Car  
At night, usually white Light  
In front & Red Light in the  
Back

LED  
Light

Red



# Aerodynamics

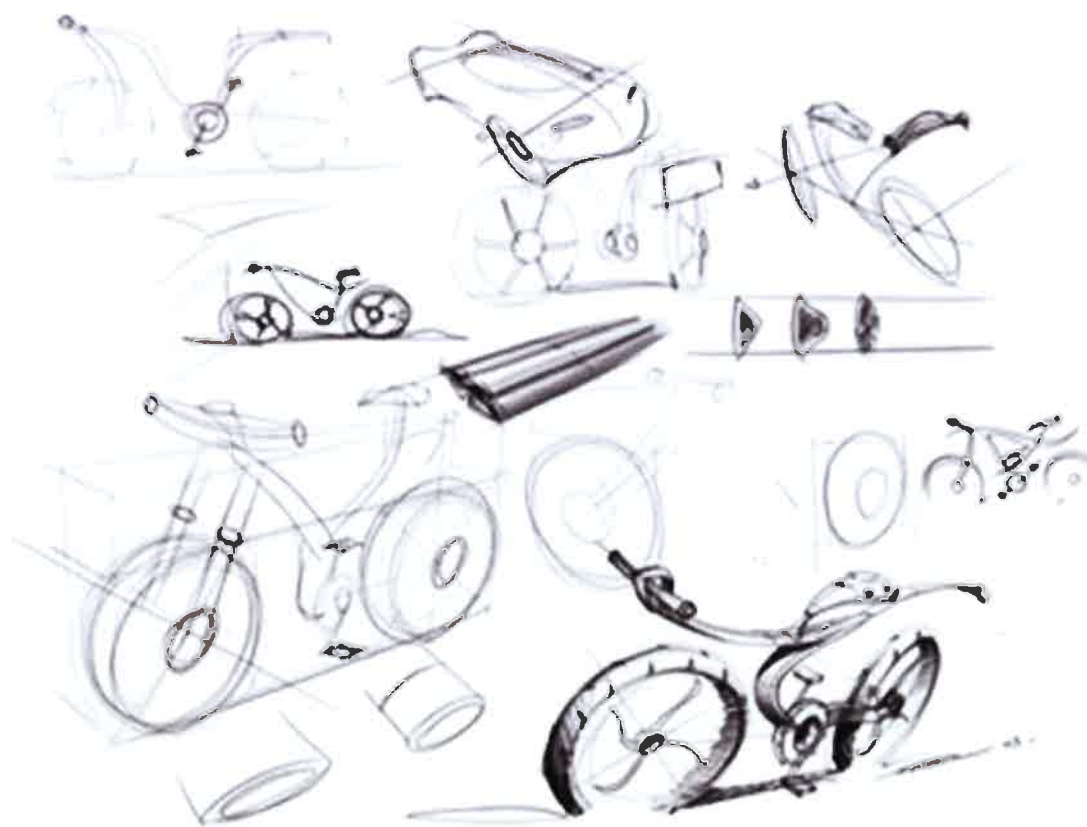
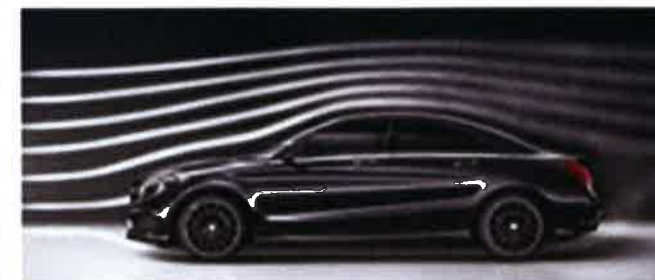
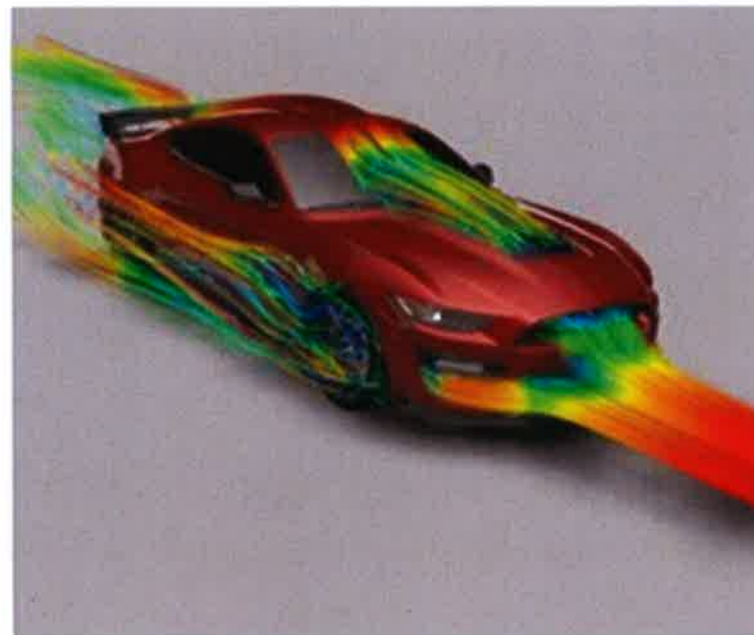
Aerodynamic is a sub-field of fluid-dynamics. Aerodynamics is about to overcome the air resistance. When an object is moving, the air particles will slam into the object and creates a drag force. When a bicycle is riding faster than 30-km/h, 90% of the power goes into overcoming air resistance.

Automotive aerodynamic designs reduce the air resistance by reduce the frontal area to minimize the difference in pressure, is allow the air to flow smoothly, also creates a downforce that can improve the traction and cornering abilities.

U (m/s)  
14.00  
12.5  
10  
7.5  
5  
2.00



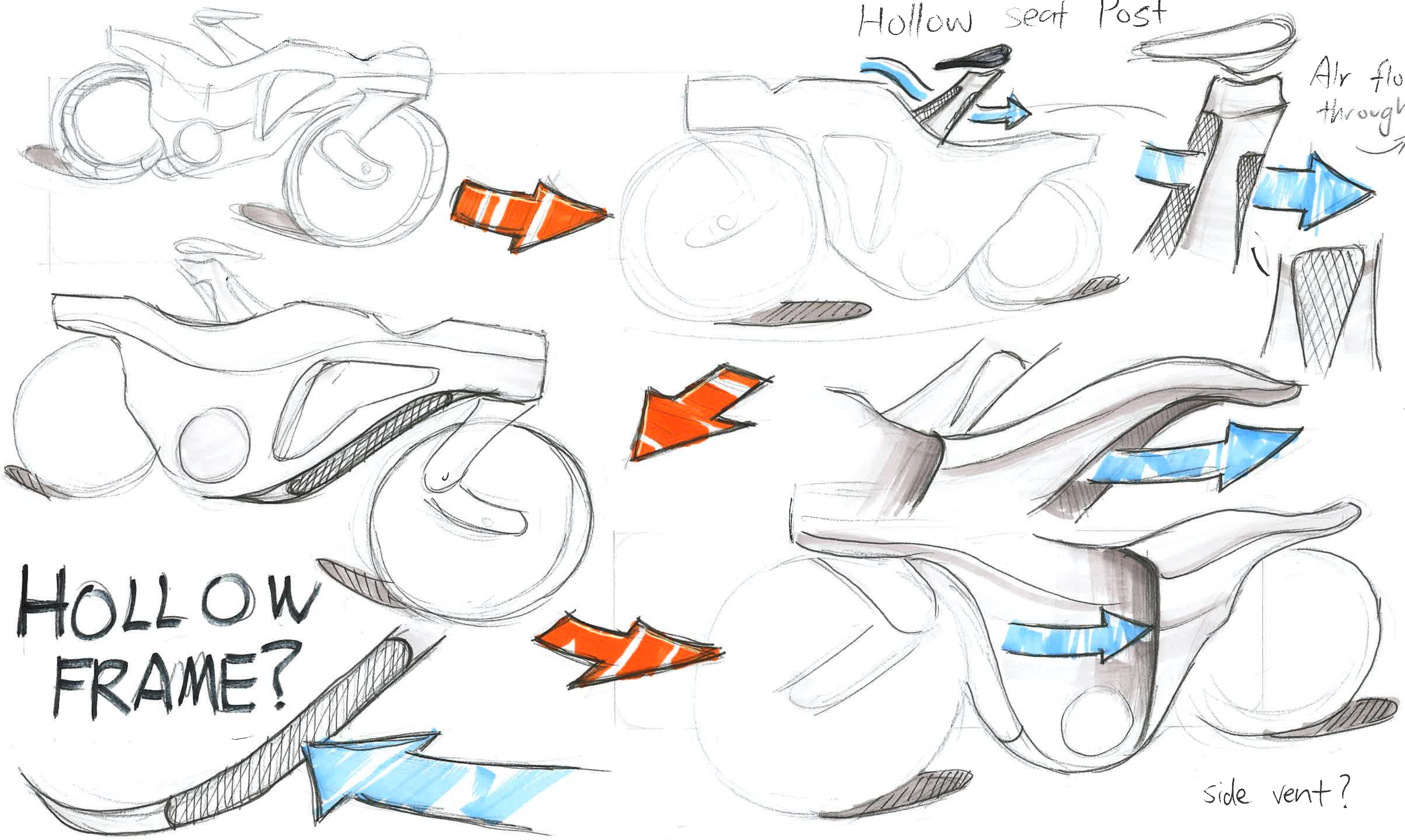
Cross-flow (m/s)  
5.0  
4.5  
3.6  
2.7  
1.8  
0.9  
0.0





Hollow seat Post

Air flow  
through

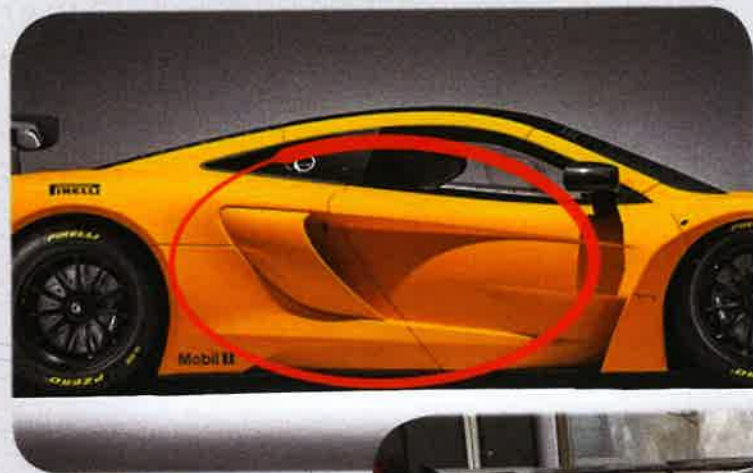


HOLLOW  
FRAME?

side vent?

AERODYNAMIC

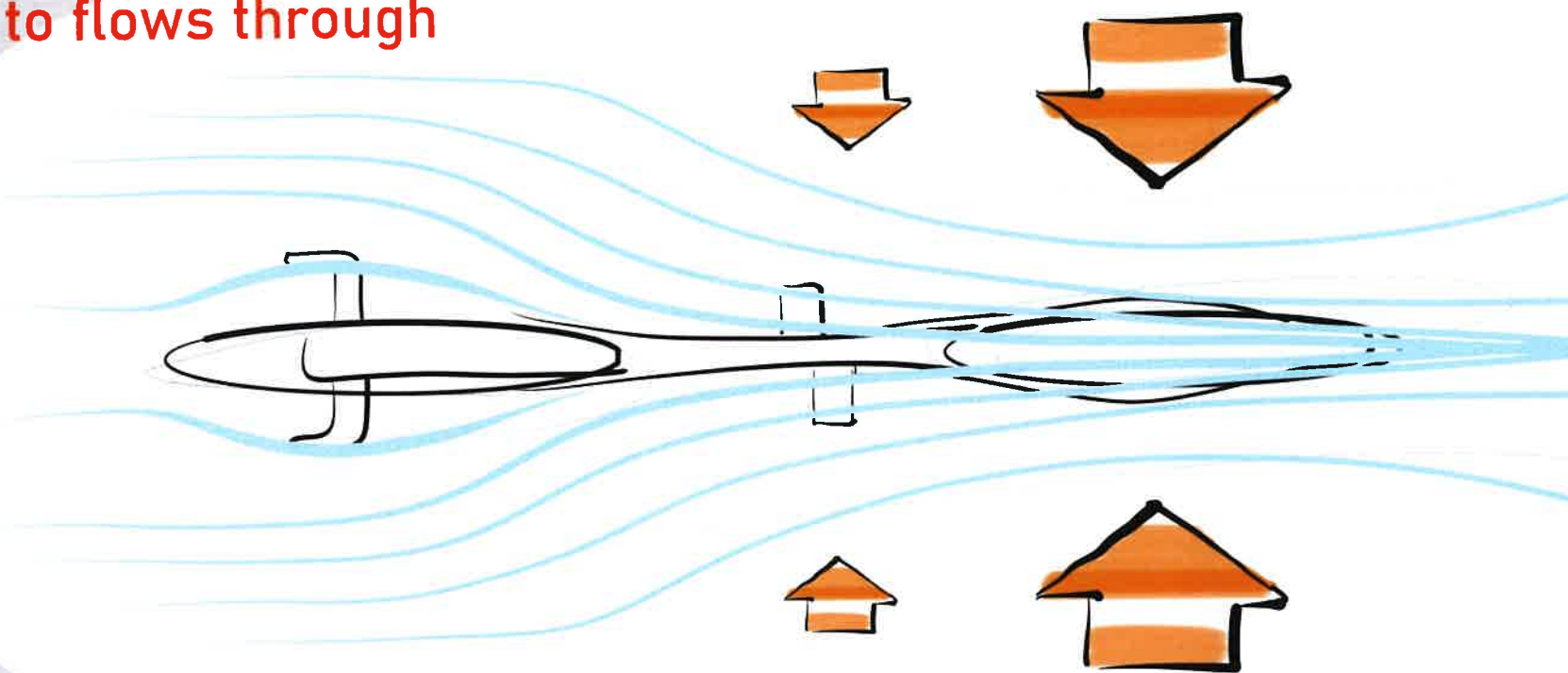




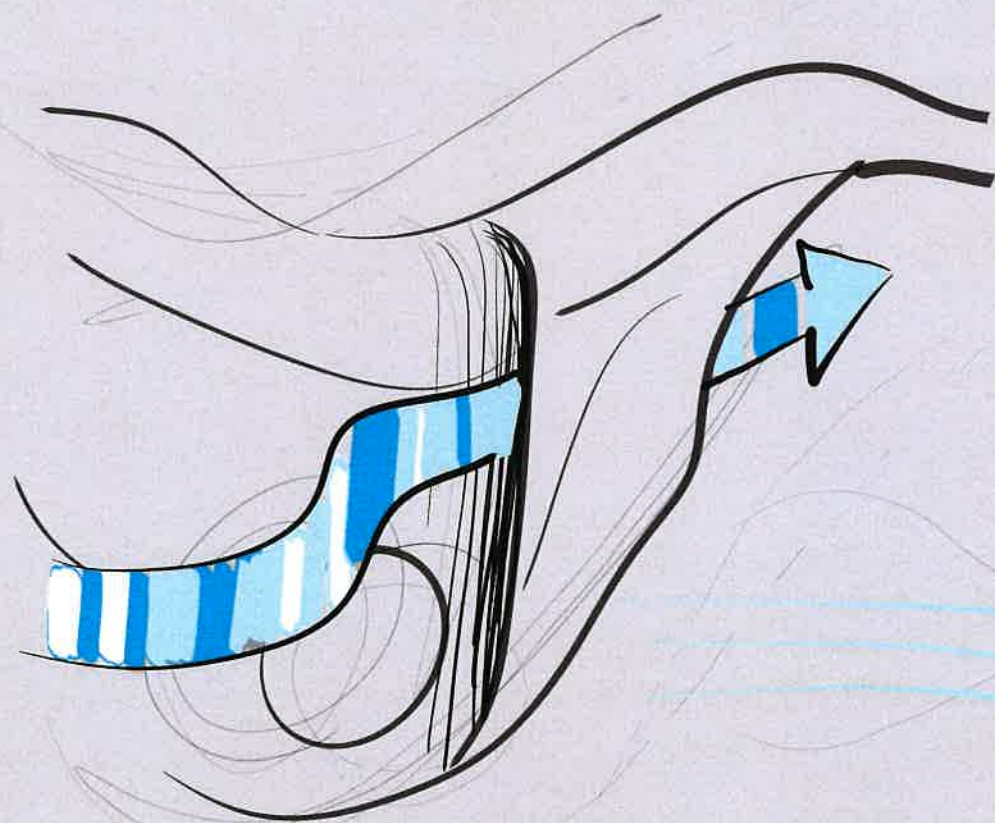
side vents on sports car  
allows the air to flows through



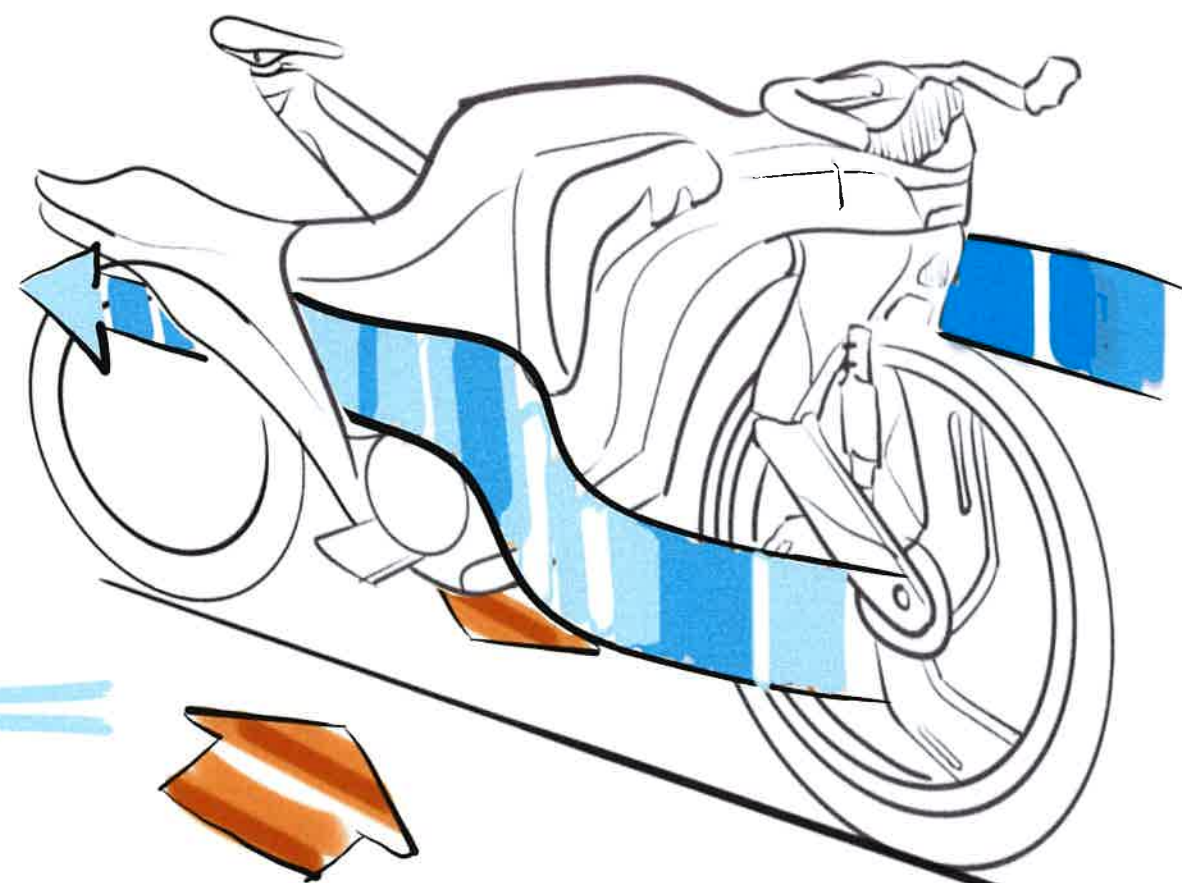
Helps to cooled  
the engine and  
decrease air  
resistance



The airflows push the bike on both side, physically assist  
the bike riding in straight lines without much control needed

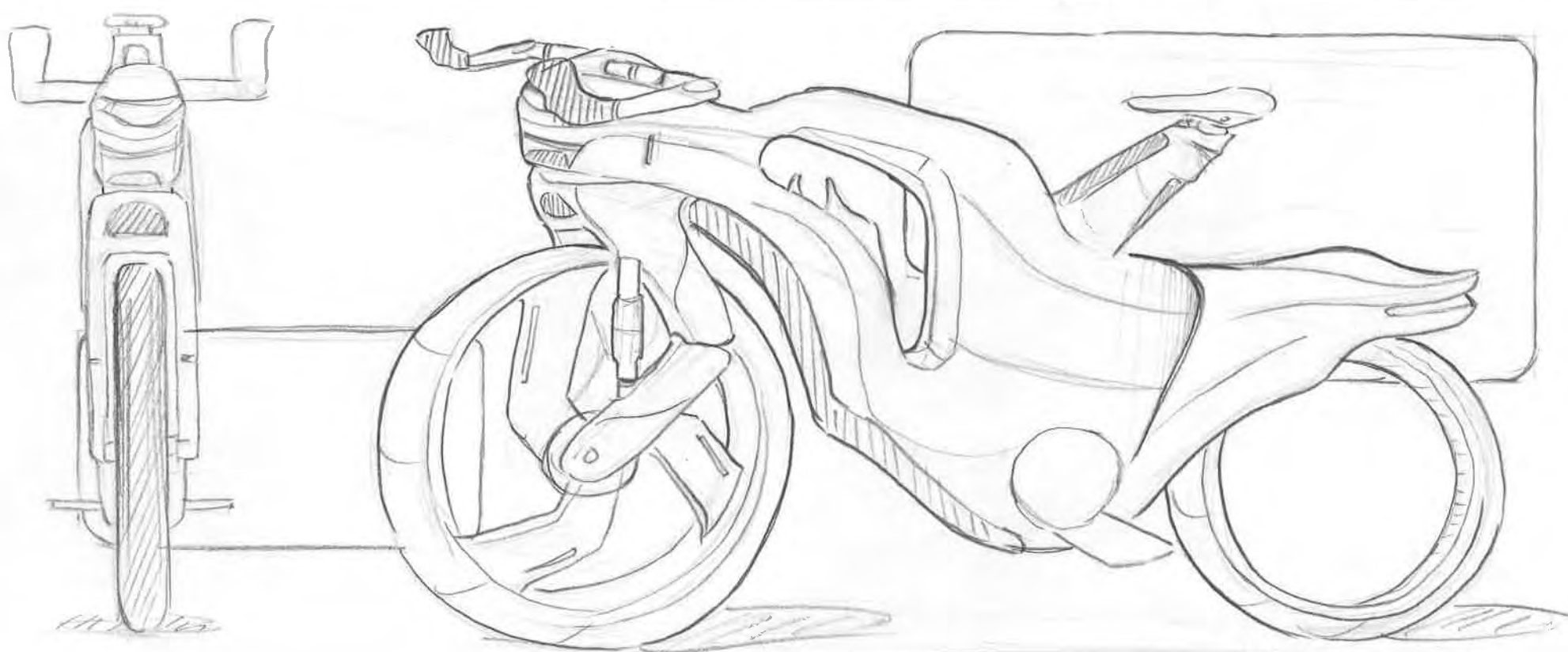
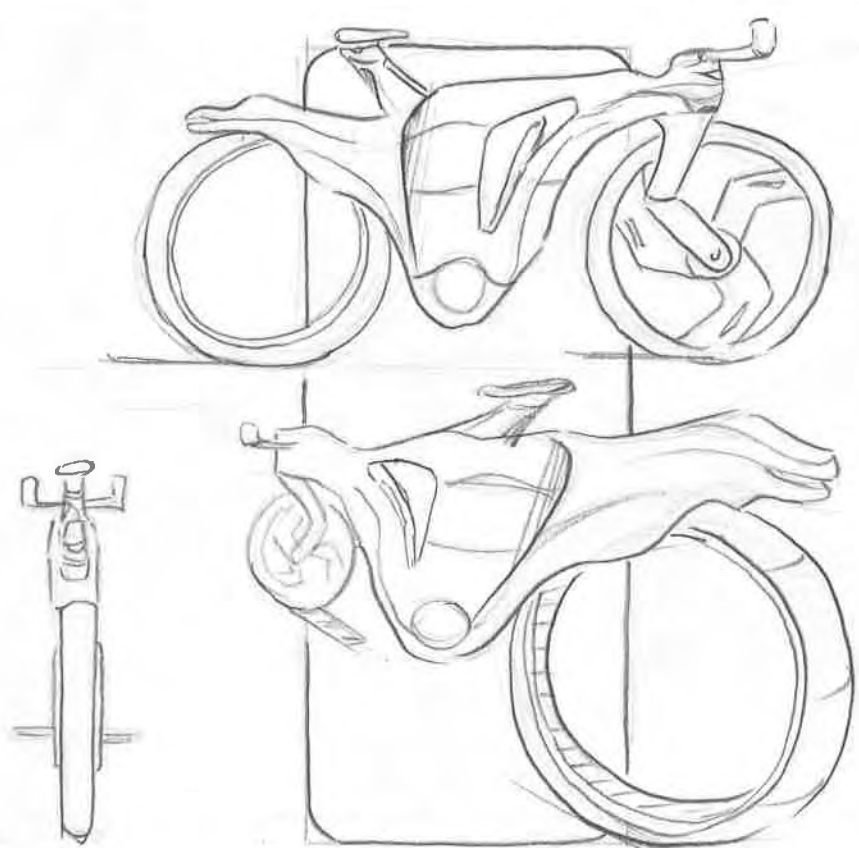


The airflow  
converge  
like a zip



# AERODYNAMIC- SIDE VENTS







# BOTTLE HOLDER



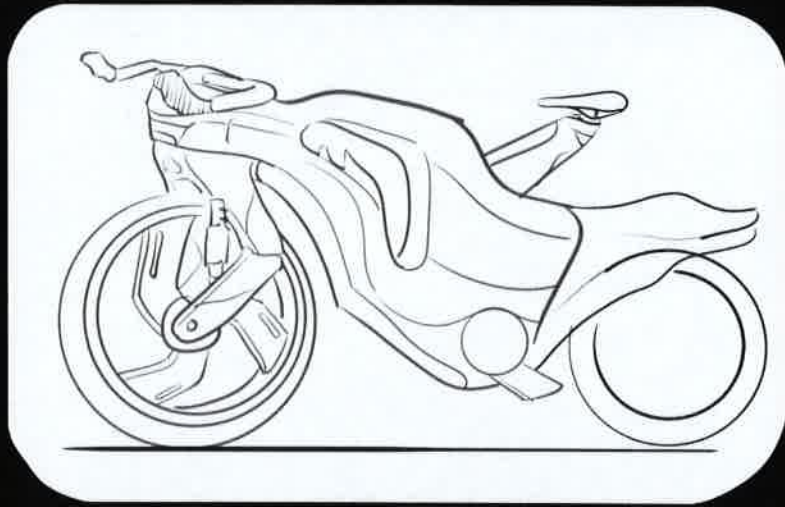
on Bike  
Down tube  
?

on seat?

on Bike  
frame?

on Bike  
tail?





Looks too chunky?



How does other design do?

Flow & simple

Black & white



Pure & clean



Minimalise

reduce ornament

Clean

No unnecessary elements



Modern

Simple

# LESS IS MORE

functional

Abstract

Form  
clour

Space

minimalism

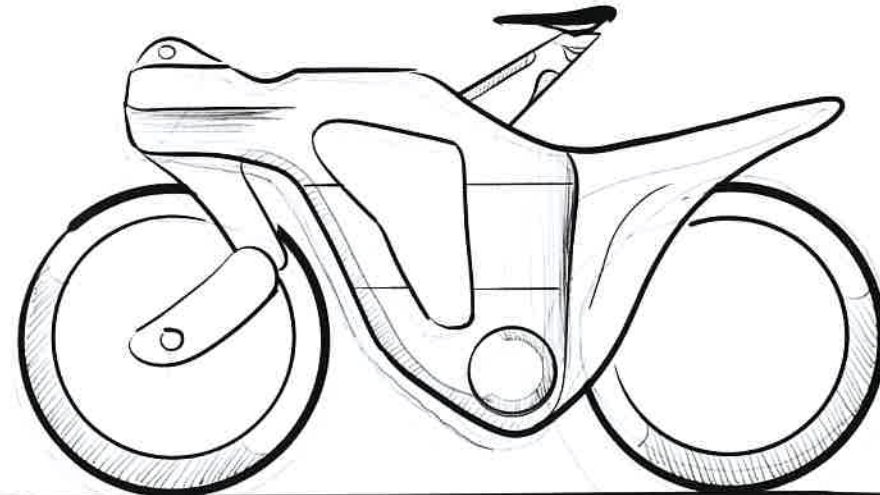
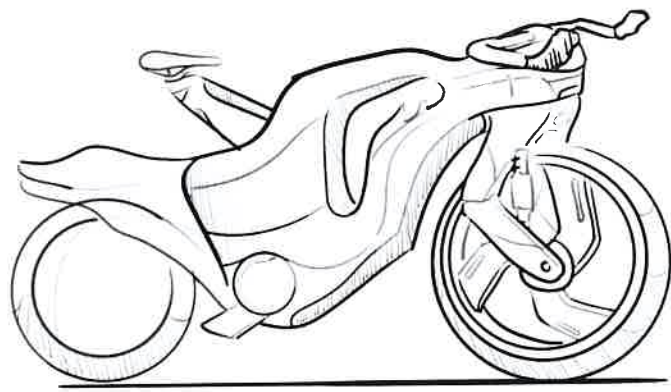
Geometric

Less

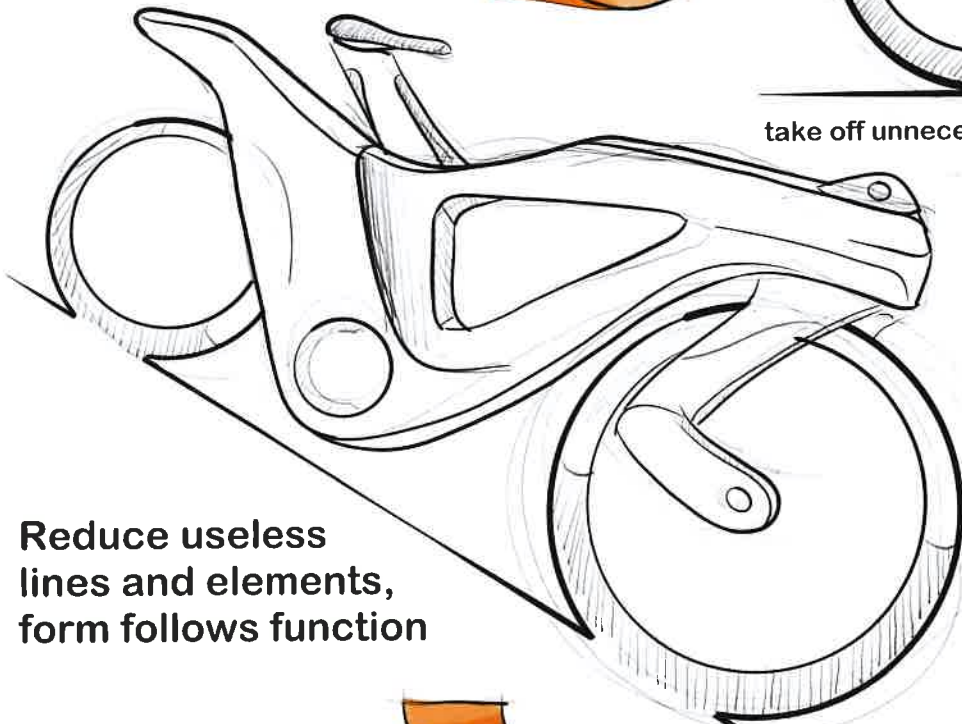


# REFINING - AESTHETICS

Slimmer the body,  
reduce the weight + less air resistance



take off unnecessary elements



Reduce useless  
lines and elements,  
form follows function



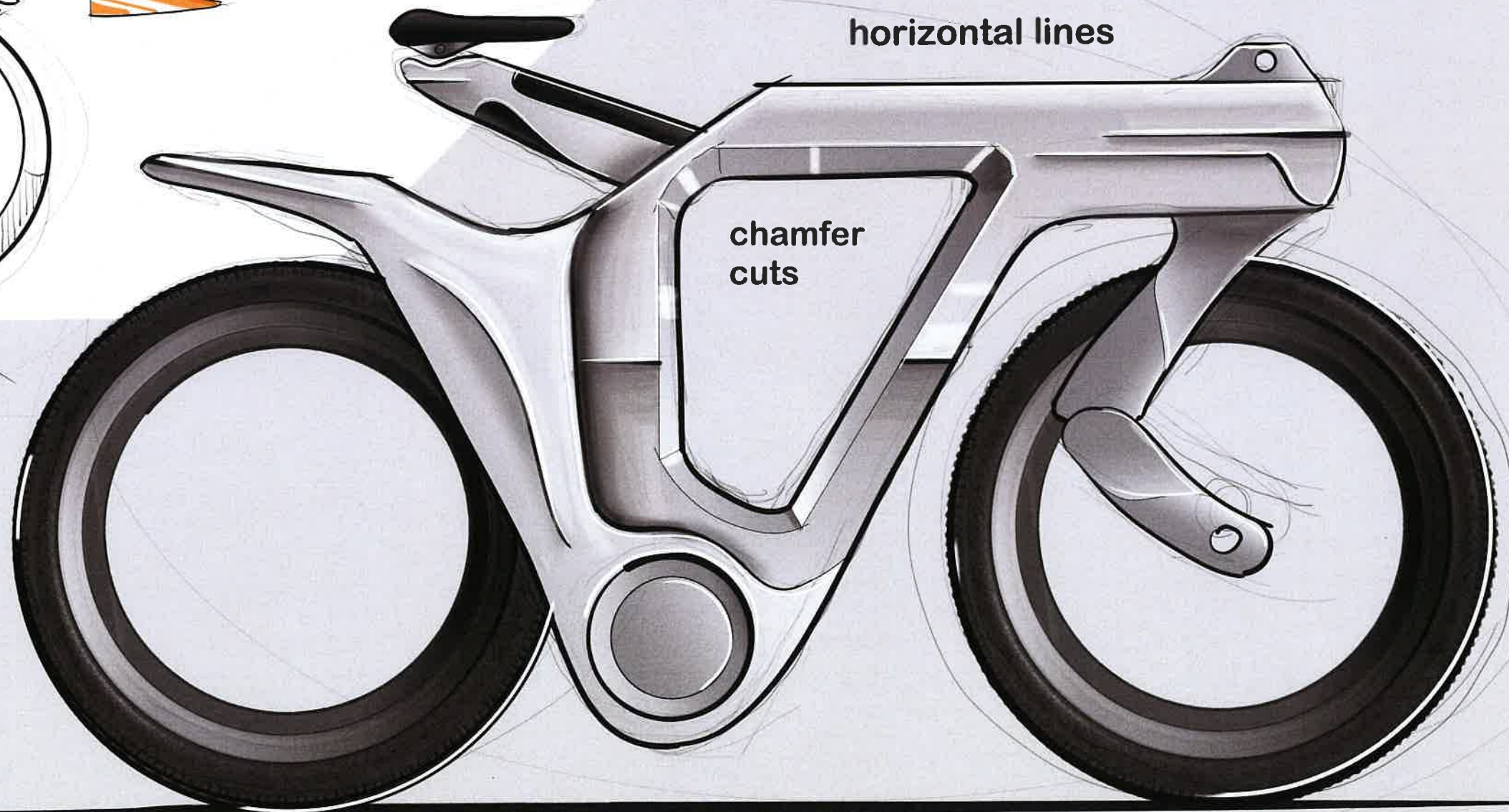
Minimalizing unnecessary elements

simple & clean

slimmer & lighter

horizontal lines

chamfer  
cuts







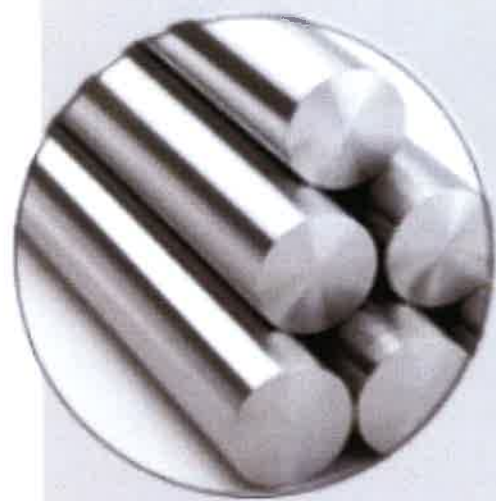
The seatpost is also connected to the main frame by screw.

The saddle and the seat post is connected by a screw

The connecting of pedal set and the pedal to the main frame of the bike.

# DETAIL OF CONNNECTING



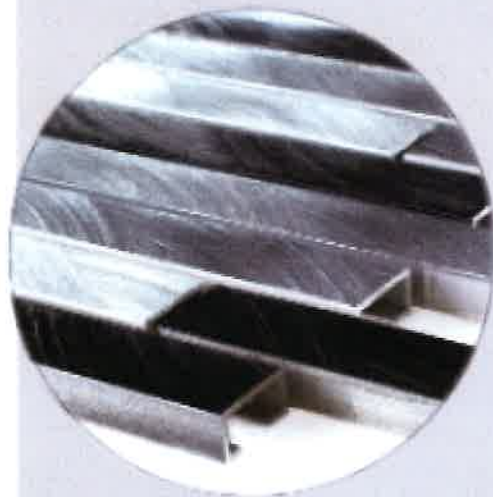


Titanium is one of the longest lasting, most expensive, strongest and most expensive frame material. Many cyclist and expert feel that it combine the best characteristic of all the other frame material. It is as comfortable as steel

Carbon fiber is a relatively and unique because it's not a metal. It is a fabric that's impregnated with a glue called resin that allows shaping and joining the material. Carbon frames are extremely light, stiff and durable. It's greatest advantage is that can be manipulated essentially in endless way.



Aluminum is the lightest frame material, even lighter than carbon and titanium. Aluminium frame is great choice for racing and time trialing. unlike steel, it won't rust. Aluminium fork are stiff and light, and can shaped aerodynamically. They also offer excellent compliance for comfort on rough roads.



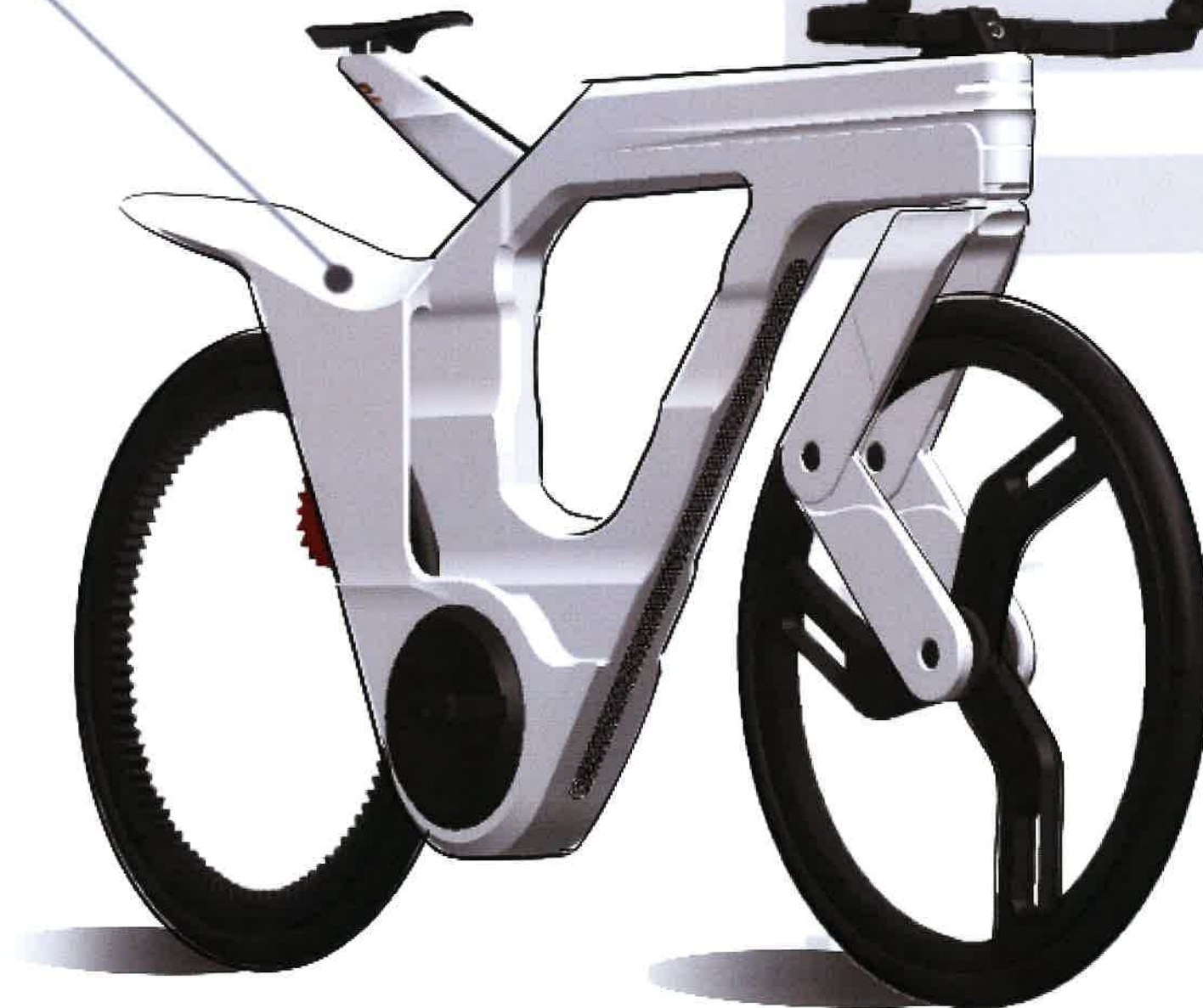
The most traditional frame material, many types of steel tubing are available and the material is easy to bend and shape. It's plenty strong and it also absorbs shock to soften rough road. Steel forks are heavier than those built of lighter material such as aluminum and carbon fiber.



I decide to use a type of steel called Chromoly Steel, it is lighter than regular steel, more flexible than aluminium, more cost efficient than titanium and the perfect material for bike. It is resistance to extreme temperature. It also maintain similar strength as steel. This translates to a sleeker frame, faster speed and comfortable maneuverability. Chromoly steel is naturally shock-absorbent. Instead of adding bulky shocks to your front wheel, or worse, jettisoning along with every bump and crack along the way, the frame itself catches unpleasant road vibration.



I decide to use aluminium as it is the lightest frame material. The fork will be stiff and light using the aluminium, it is also easier to shape into the form.



# MATERIAL-BIKE FRAME



## Curve Lines

from the body lines of leopard

## Aerodynamic

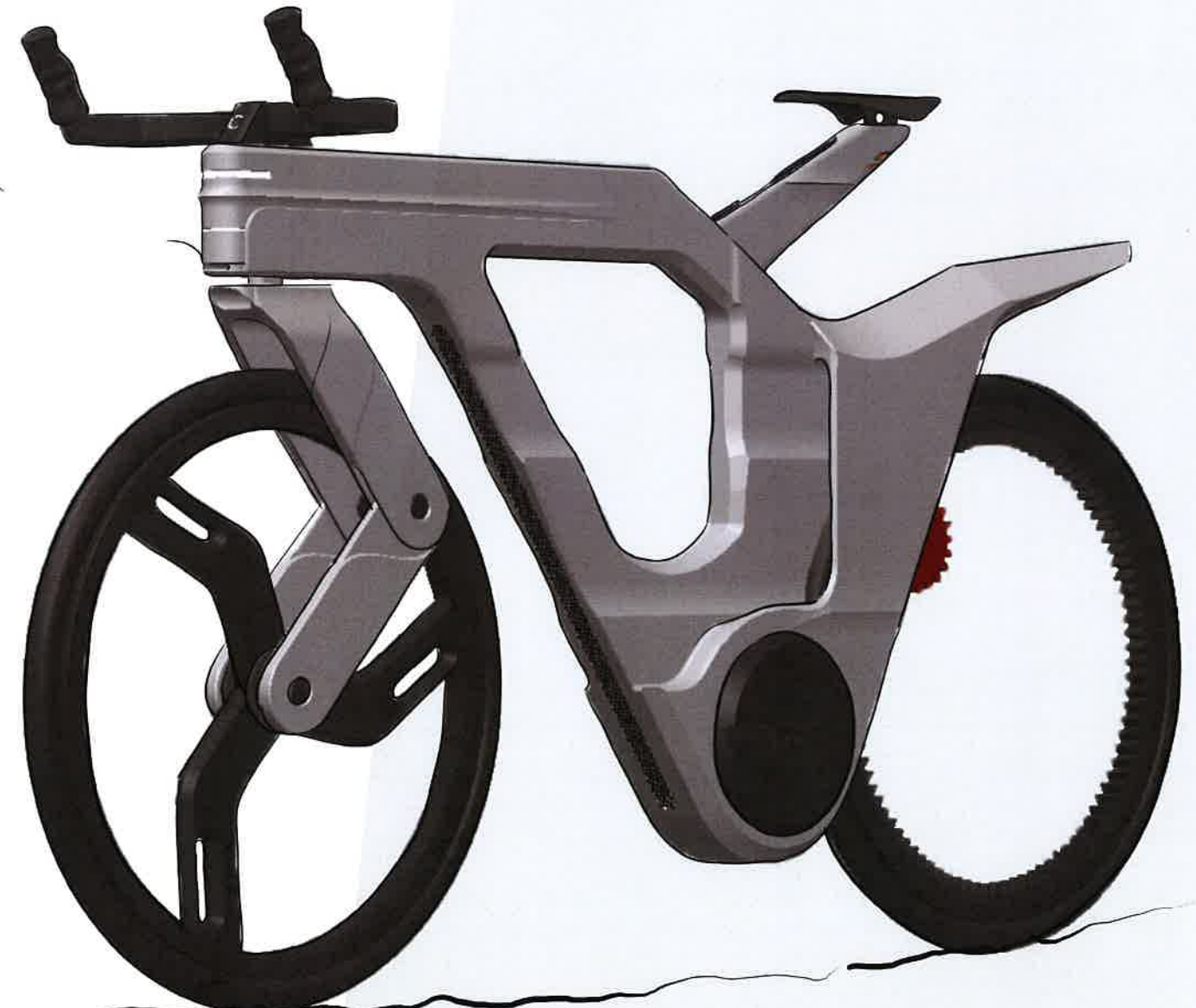
Air flows through smoothly

## Suspension

like the leg of leopard  
bends when landing

## Ergonomics Handles

switch between narrow  
and wide position.





## SUMMARIES

It is suitable for both mountain and road cycling. The ergonomic handle is modelled from the actual human hand data. The size and the proportion of each part are precisely calculated and considered to ensure the comfort of long time riding. The handle can switch from wide to narrow for road cycling and mountain cycling. The bike's frame is hollowed, with honey cone ventilation reducing the air resistance while preventing rocks from stuck inside the bike frame. The horizontal cuts on the frame are designed for better aerodynamics, with a bionic front-wheel suspension inspired by the leopard landing motion. The unique design of the rear-wheel abandoned the traditional. It bikes design and uses bevel gear for driving instead. It is an extraordinary modern bicycle that fits the new era of industrial design for everyone who loves cycling.

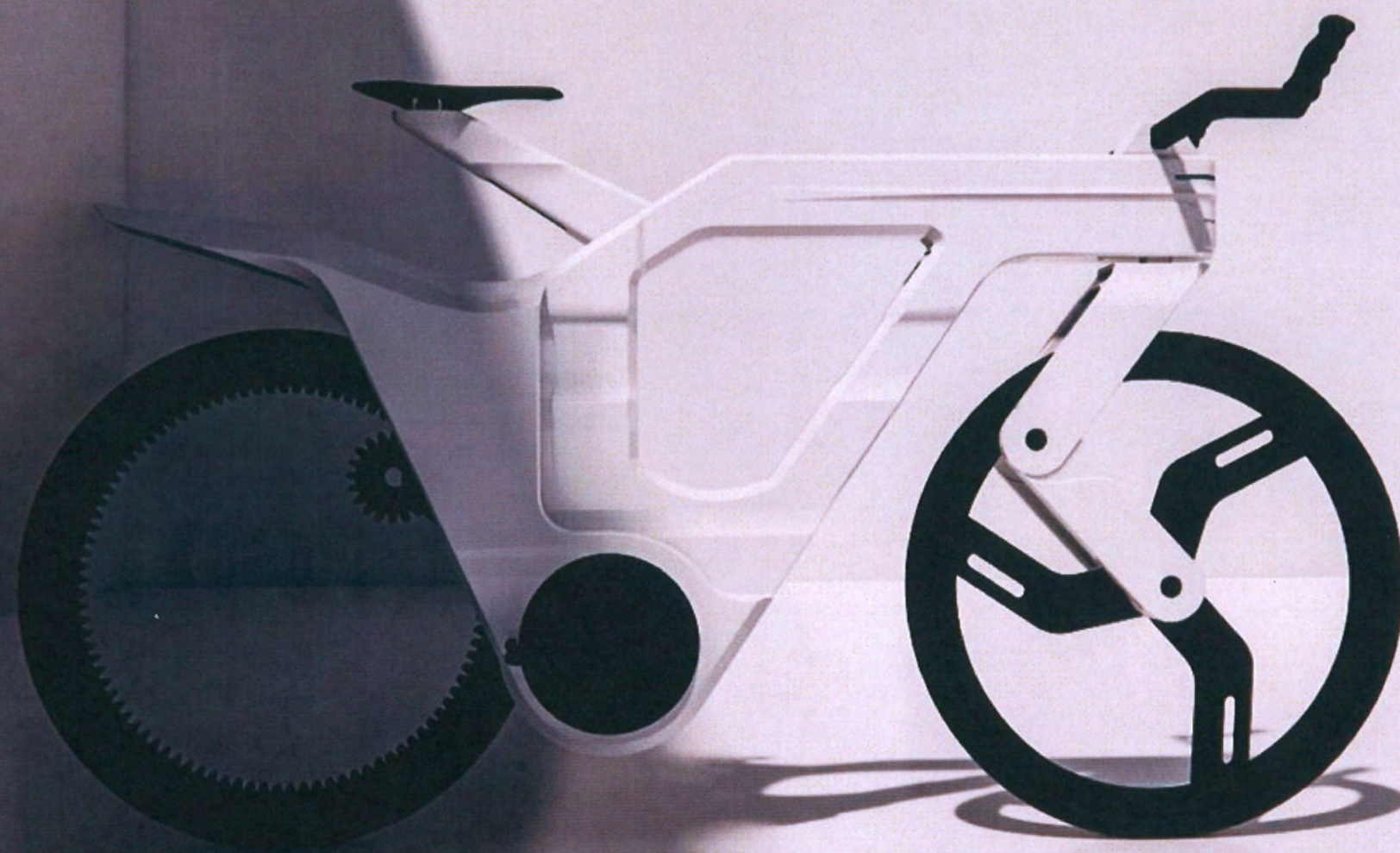
**SSS**  
**SPEED**  
**STABILITY**  
**SAFETY**

## EVALUATION

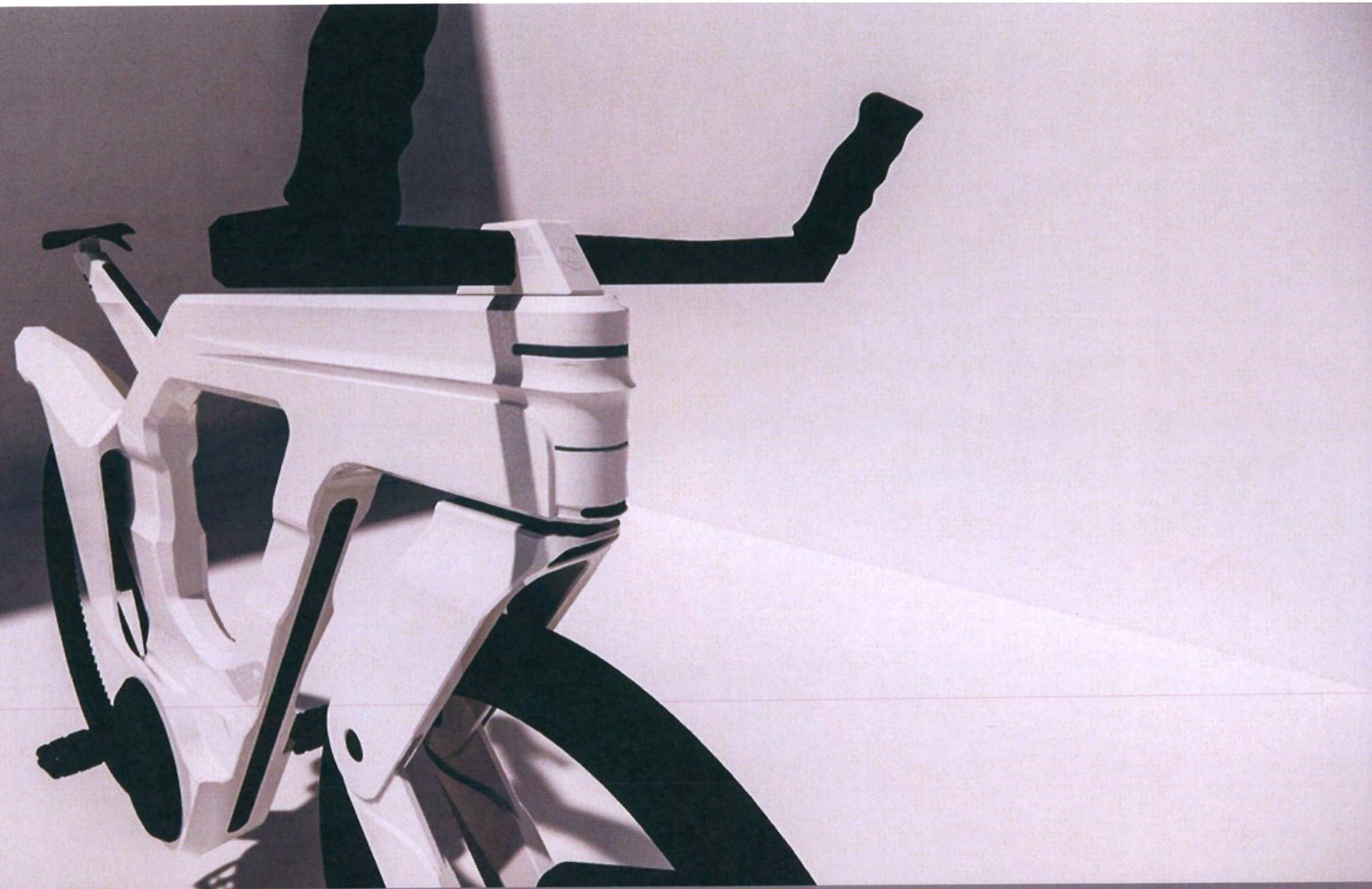
### MEETING THE SPECIFICATIONS

- Flow & Minimalistic appearance that contains modern aesthetic appeal.
- Using material such as microcellular rubber, carbon fibre, and switchable handle suitable for the different cycling environments.
- Accurate proportion and ergonomic handle for comfort.
- Hollow frame and lightest material-aluminium to control the weight and ensure durability.
- Contain two headlights and two rear lights for safe nighttime cycling.
- Bionic shock absorber and suspension system.



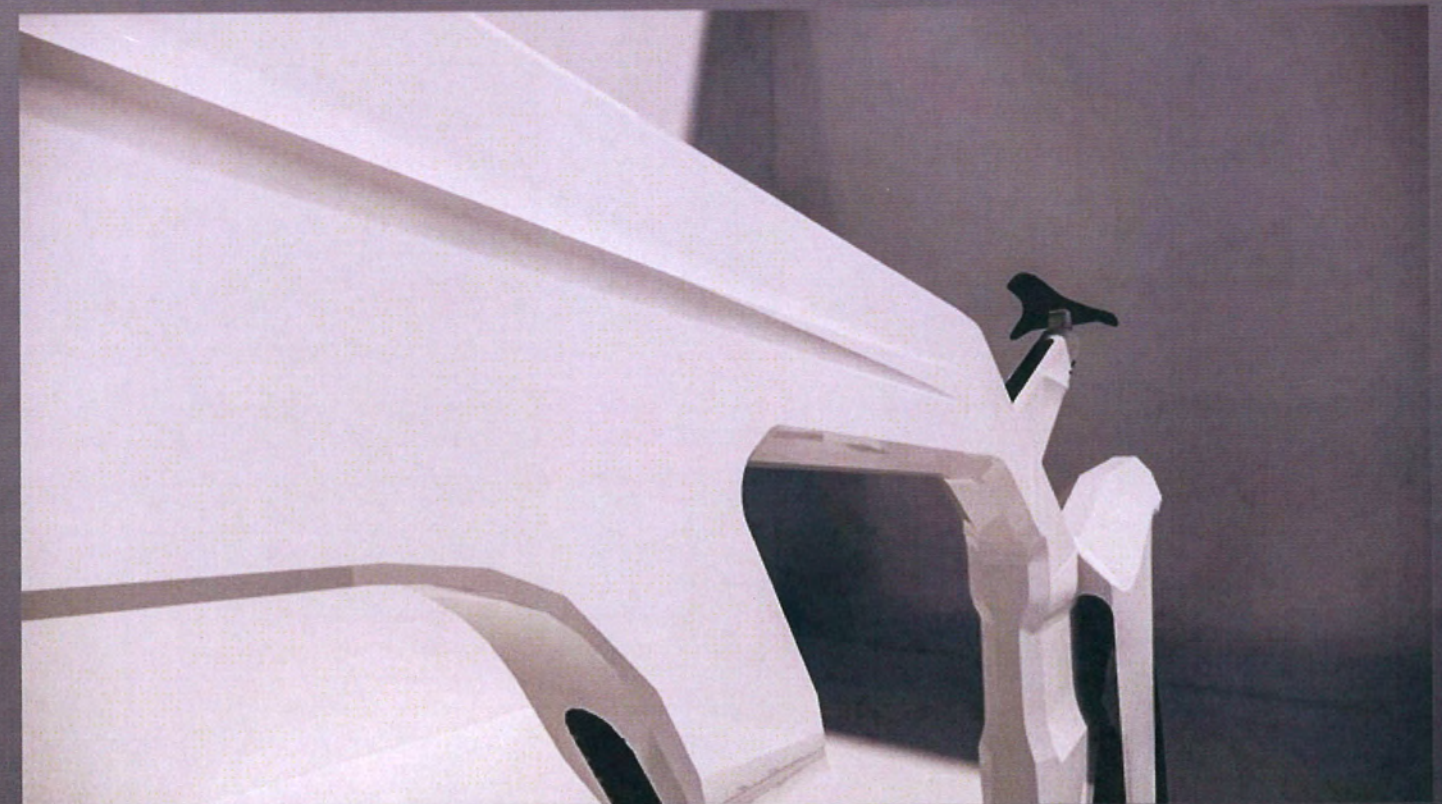




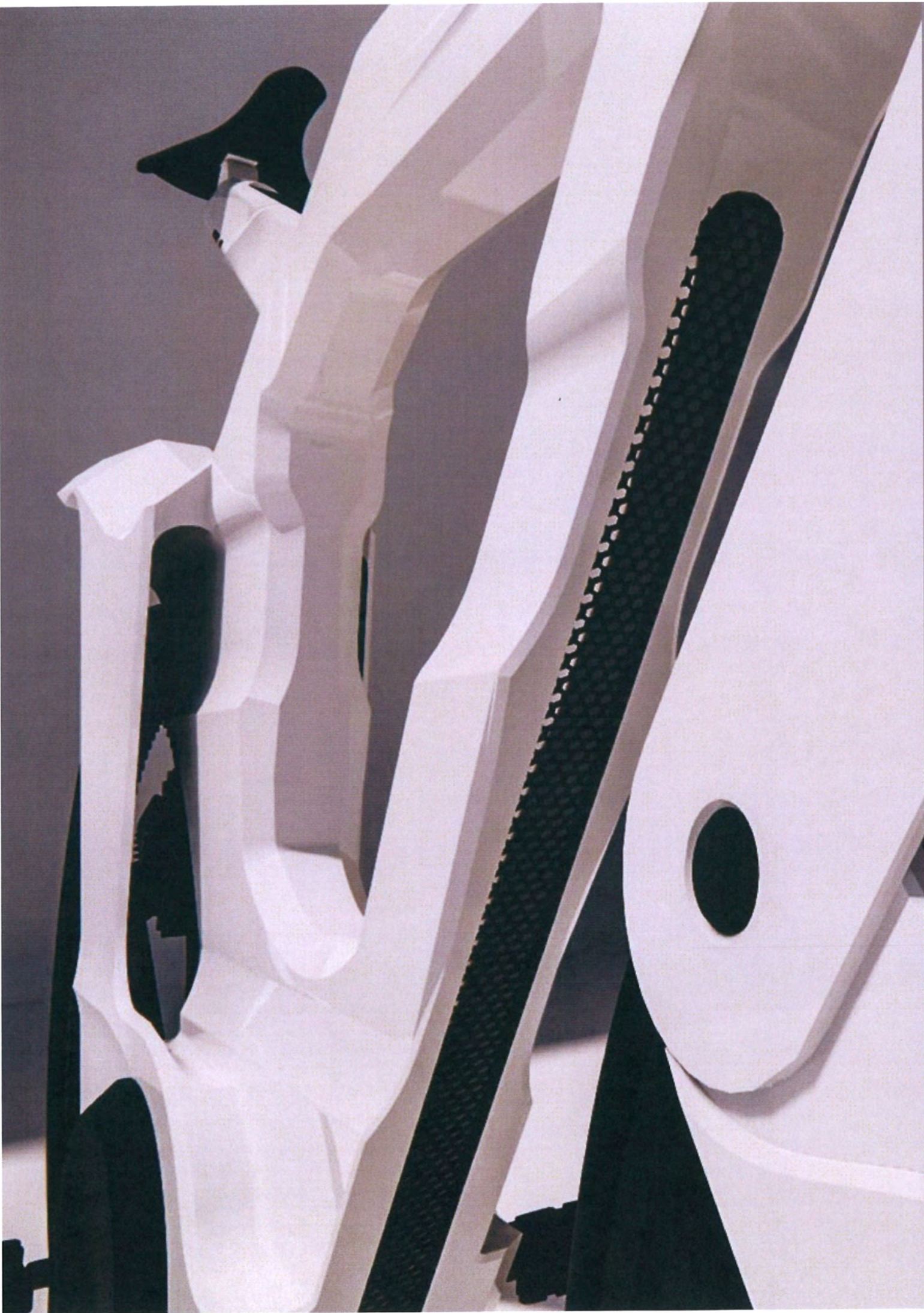


Elegant Styling

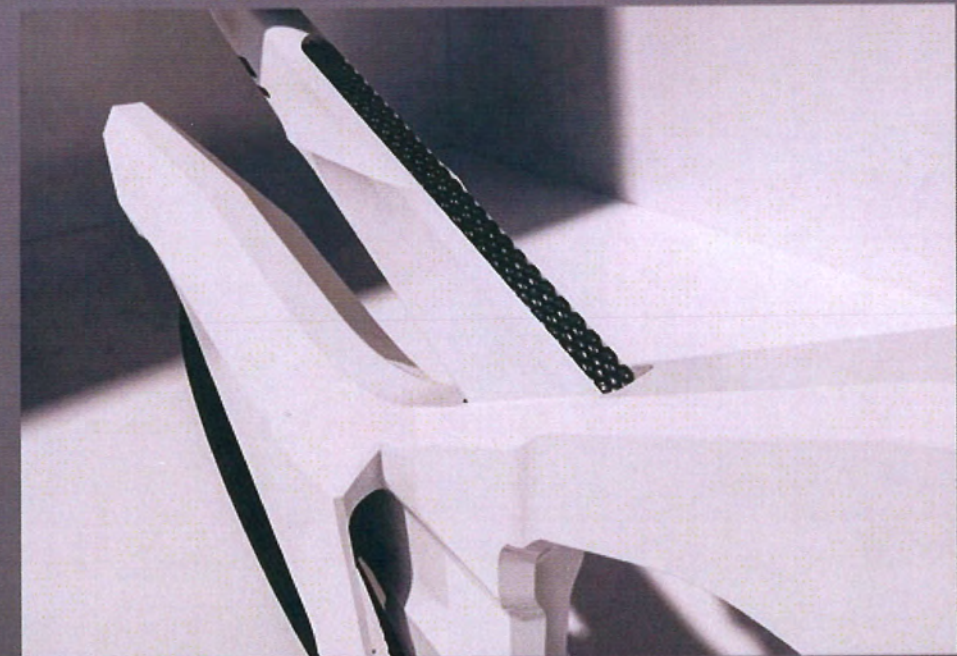
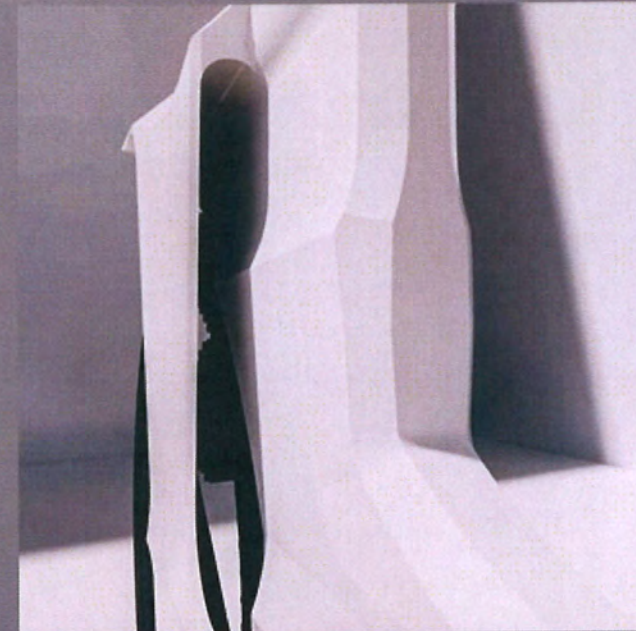
Efficient Aerodynamic Forms







Smooth & dynamic surface  
Minimalize Air-Resistance act on the bike

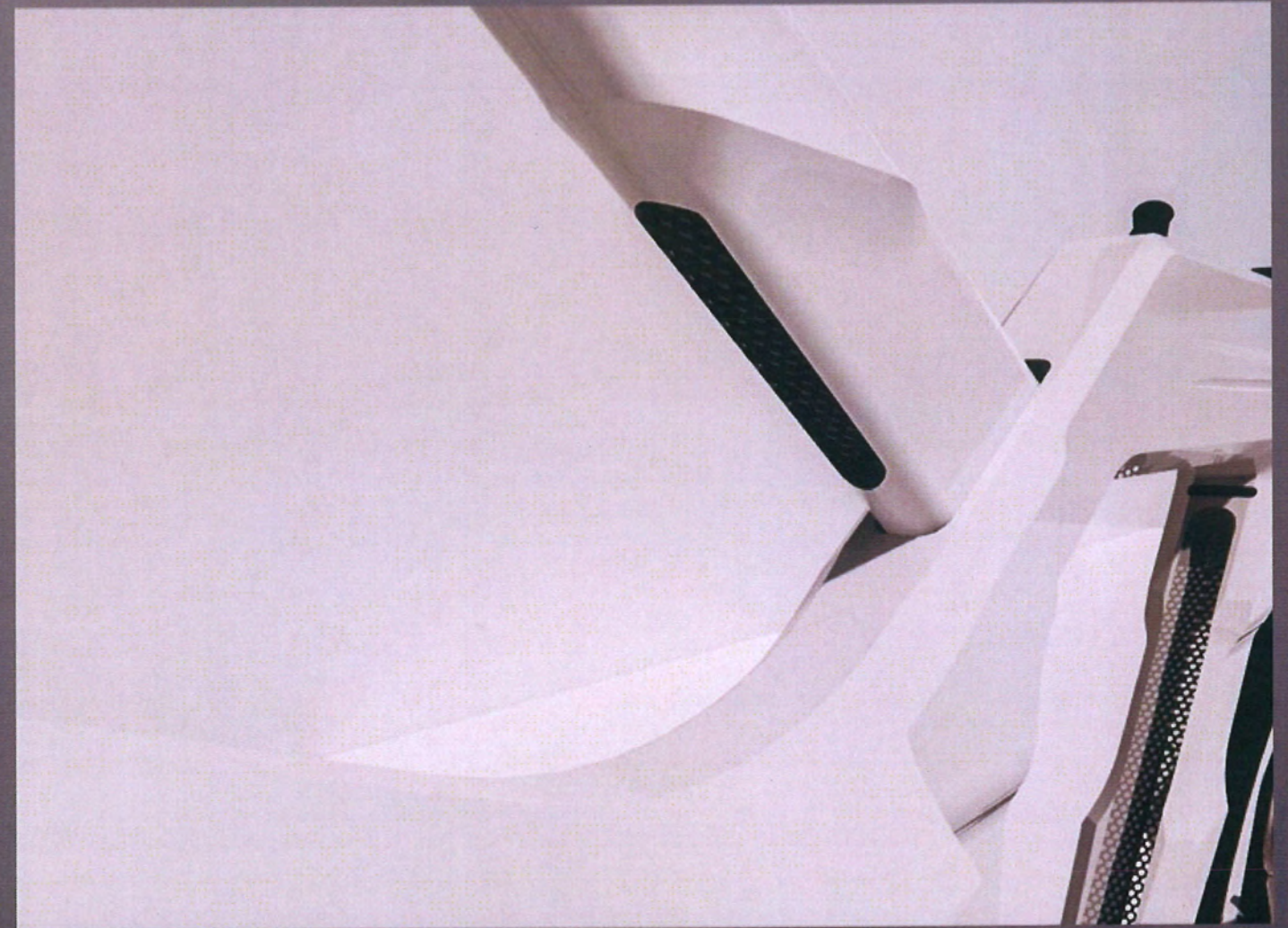






Chamfer edges-  
Slims the bike frame

Hollow seat post



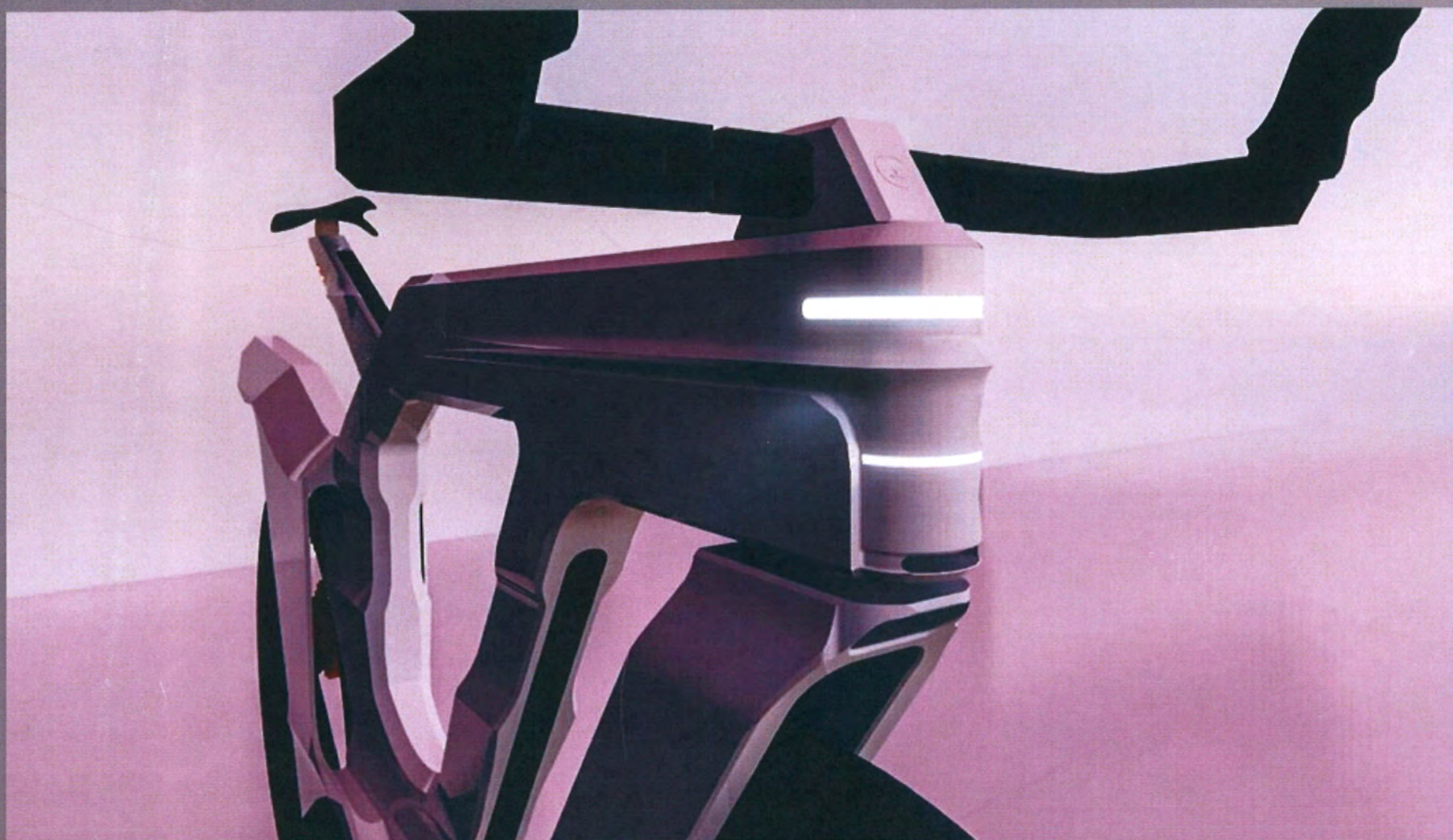




**Bionic Front Fork Design-**  
Inspired from the motion of leopard leg landing







Light the way

Brighten the darkness

