E-bike for university students in future

Submitted in partial fulfillment of the requirements
of the degree of

Masters of Design

by

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INDIAN INSTITUTE OF TECHNOLOGY BOMBAY
2024

APPROVAL SHEET

This Mobility and Vehicle Design Project 2 titled 'Designing an electric bike for university students in future' by Navneet Maharana is approved in partial fulfillment of the requirements for Master of Design Degree in Mobility and Vehicle Design, IIT Bombay.

Project Guide-

Chairperson-

Internal Examiner-

External Examiner-

DECLARATION

I declare that this written submission represents my ideas in my own words and where others ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated any idea/ data/ fact/ source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited of from whom proper permission has not been taken when needed.

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Date:

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ACKNOWLEDGEMENT

My project Design of 'Designing an electric bike for university students in future' has been a great experience overall. It has taught me how to look at the problems faced by users on day to day basis and how to design for the people. All these wouldn't be possible without proper guidance so I would like to sincerely thank my guide, Prof. Sugandh Malhotra for his valuable guidance throughout this project. I would also like to thank Prof. Nishant Sharma for his valuable inputs. A big thank you for all the users and the people who contributed to my project. Finally a huge thanks to all my classmates for the valuable inputs and feedback throughout the project.

ABSTRACT

The project was aimed to design a concept for the personal mobility of students in the future universities which will be large-scale with high-tech infrastructure. Research was conducted to understand the user and their wants, needs and aspirations and a comprehensive study about the future technology and infrastructure was also done. The main aim of the project was to come up with a unique vehicle architecture which resembles the bicycle of the future. Various ideations were developed and the final concept was designed according to the future persona and the inspiration/ theme board. The concept was further detailed out by incorporating future tech and future scenarios.

CONTENTS

1. INTRODUCTION

Students in universities have to travel from one point to another especially from their hostel to their department with their backpack. They also travel to other places inside the campus such as activity centres (sports arenas, music rooms, dance rooms, theatre rooms, etc.) where they need to carry dedicated items- sports items, shoes, guitar etc. They also travel outside the campus as well.

Currently, there are rickshaws and e-buggys running in the campus to transport people but students also use bicycles which are privately owned in order to commute. There are a lot of advantages and drawbacks on the current design of bicycle which can be mitigated through design.

Universities are large and for daily commute, students are required to have a personal mobility and thus majority prefer to have a bicycle. People who come for the first time face difficulty to travel inside the campus as there are large walking distances and thus they also require some mobility solution so that their experience enhances.

2. METHODOLOGY

UNIVERSITIES [present scenario]

THE ANALYSIS [Technology, Human, Environment aspect]

SWOT ANALYSIS [Strength, Weakness, Opportunity, Threat]

USER STUDY
- Individual interviews
- Documented use case with items
- Journey Mapping
- Empathy mapping
- Current rating
- Future rating

ANALYSIS

INFERENCES

INFERENCES

DESIGN BRIEF

DESIGN BRIEF

FUTURE UNIVERSITIES [Future scenario and future technology]

FUTURE PERSONA

MOOD BOARD

FUTURE

PLATFORM

PACKAGING

BENCHMARKING

NEW PROPOSAL

IDEATION AND CONCEPTS

IDEATION

FINAL CONCEPT
- Final concept sketch
- 2D renders
- CAD model
- Physical scaled model

3. BACKGROUND RESEARCH

3.1 Current scenario

The current state of Universities

Universities are designed in a such a way that they are self-sustaining, meaning, all the facilities are there inside the campus. It includes all the departments, students' hostels, admin block, Students' activity centres, sports arenas, hospital, shops, canteens, guest houses, faculty/ staff residences, auditorium etcetera. And thus, in order to connect all of them, there are roads and pathways which are long.

For the students to travel from their hostels to their departments or any other location, they either walk or take public mobility solutions such as auto-rickshaws and e-buggys that run inside the campus on monetary basis.

A majority of the students, prefer to go with these public transportation rather than walking all the way from their hostel to the department as the distance between them is significant and also they are required to carry backpacks and laptop with them.

Another option for them is to own/ rent bicycles which is a personal mobility solution and then they can travel to any point at any given point of time without waiting on any of these public mobility solutions to arrive.

Bicycles as personal mobility

Bicycles as personal mobility solution for students has a lot of advantantages but at the same time has some disadvantages too. As compared to other transportation options (as shown in this figure), having a personal bicycle is beneficial.

Bicycles are convenient, it saves time, personalise as per your preference, no waiting time, ready to use, self sufficient and is feasible to move anywhere.

Though there are some cons to it as it becomes a liability for the students to take care of it and maintain it regularly which demands some efforts but then it serves many purposes which overpowers these cons.

As students are only allowed to have bicycles inside the campus and no vehicles, it becomes very necessary to own one regardless of the current situation of parking and security issues inside the campus.

ISSUES with bicycles

PERSONAL MOBILITY

Students are allowed bicycles (human powered) inside the campus.

Maximum cycles are not maintained.

It takes a lot of effort to pedal all the way from hostel to campus because of large contours.

1 Personal Bicycle

Pros:
- Convenient.
- Saves time.
- Personalisation.
- No waiting time.
- Ready to use.
- Self sufficient.
- Feasible to move anywhere.

Cons:
- Maintenance.
- Liablity.

2 E-buggy

Pros:
- Cheaper than Auto-rickshaw.
- Less energy consumption in travel.
- No liability.
- Reduce traffic congestion

Cons:
- Less frequency.
- Connectivity is poor.
- Weather protection is not suitable for rainy season.
- Safety issues.
- Speed is slow.

3 Autorickshaw

Pros:
- Consume less to travel.
- Weather protection.

Cons:
- Availability is less.
- Fare is expensive than all other alternative.
- Pollutes college compound.

4 Shared mobility

Pros:
- No liability.
- No maintenance cost.

Cons:
- Availability is less.
- Costly rides.
- Bicycles are not maintained.

KEY AREAS

solution?

3.2 Existing vehicles in use

Currently, students use different kinds of bicycles in the universities (as shown here). A majority number of students use geared bicycles as gears help them to travel at different speeds on slopes with less efforts. A small number of students use other kinds of bicycles as well such as the fatbike, electric bicycle, foldable bicycle, ladies bicycle etcetera depending on their preference and their budget.

These bicycles have to run as per the students' course duration atleast and sometimes students take their bicycle home or they sell/ give it to their juniors. And thus their budget depends, ranging from 7k-10k and it can go till 15k-20k. Very few students have bicycles worth more than that but they too exist.

4. ANALYSIS

4.1 THE Analysis

TECHNOLOGY

PRESENT

FUTURE

There are various analysis methods adopted in order to study a product and analyse it under certain categories in order to get some inferences out of it.

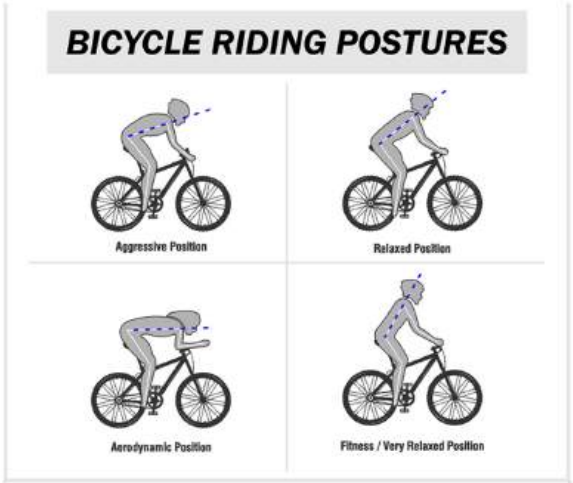
One such analysis method is **THE analysis**, where 'T' stands for Technology, 'H' stands for Human and 'E' stands for Environment. Under these 3 categories, a product has to be studied and every aspect related to these categories has to be explored. This analysis method was used to study bicycles and electric bicycles which will help in developing inferences which will further help in designing a future electric bike for university students in future.

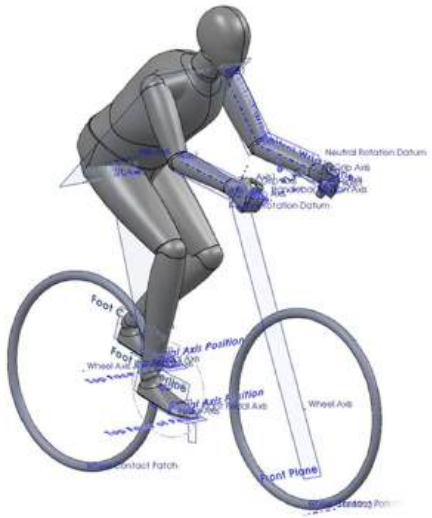
Technology

There are various technologies incorporated in making a bicycle such as powertrain, drivetrain, chassis, wheels, handlebar, saddle, suspension, brakes and interface for riders. All the technologies has been studied (as shown in the images) as in the present form as well as in the future form and the technological development.

HUMAN PHYSICAL

The bicycle's invention has had an enormous effect on society, both in terms of culture and of advancing modern industrial methods. Several components that played a key role in the development of the automobile were initially invented for use in the bicycle, including ball bearings, pneumatic tires, chain-driven sprockets and tension-spoked wheels.



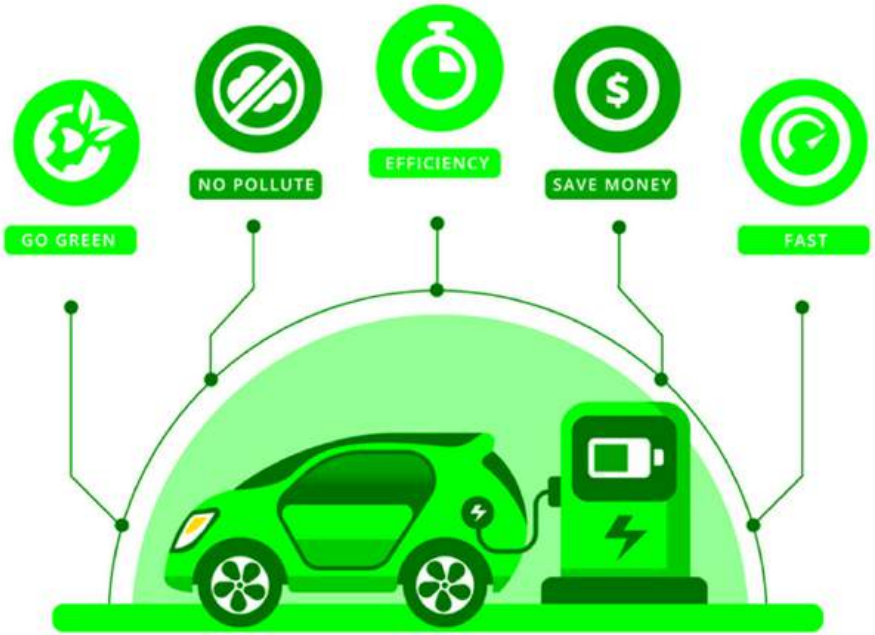


EMOTIONAL

Human

There is a very important human aspect to bicycles of how are they interacting with it. It rather has 2 aspects to it viz. physical aspect and an emotional aspect. The physical aspect deals with the ergonomics of a bicycle of how the bicycle is designed for a specific purpose and its related riding dynamics. And on the other hand, the emotional aspect deals with the fun and adventure a person feels while riding a bicycle.

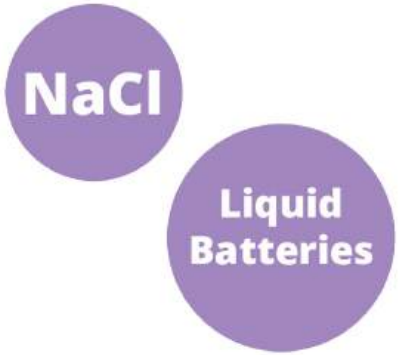
ENVIRONMENT



1. They offer zero emissions
2. They do not contribute to environmental pollution
3. They have long-lasting batteries
4. Saving the roads
5. Eco-friendly travel
6. Off-peak charging

7. Using sustainable energy
8. Going the distance
9. Replacing conventional vehicles
10. A healthy environment for healthy humans

11. Reduction in personal carbon footprint
12. Energy efficiency



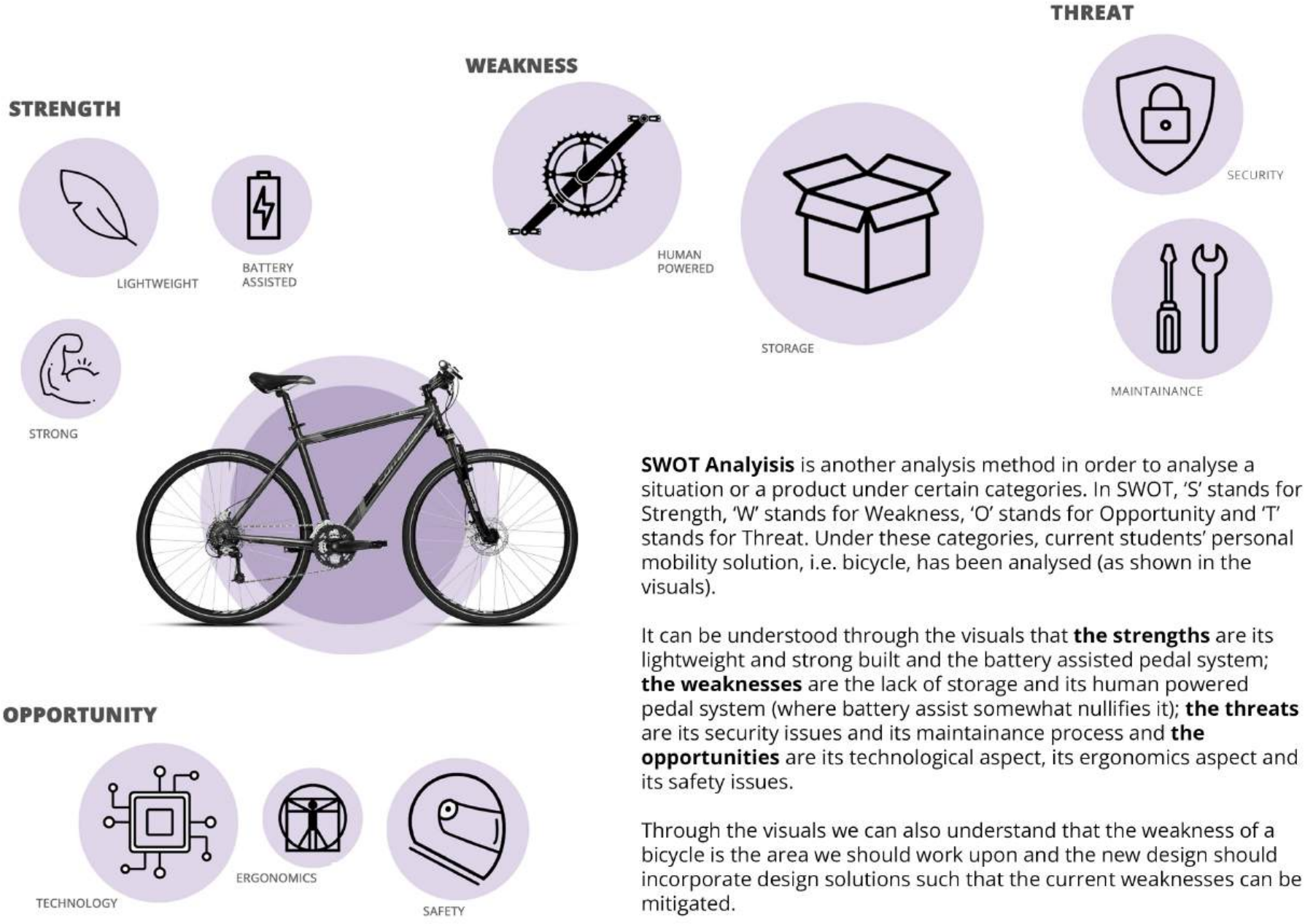
ALTERNATIVES
- Liquid batteries
- Fuel cell batteries
- Glass batteries
- Salt
- Seawater
- Magnesium

Environment

The environment category has also been analysed (as shown in the images) as how bicycles and electric bicycles are environment friendly and cause negligible environmental degradation.

There are various alternatives to the traditional Lithium-ion batteries such as- liquid batteries, fuell cell batteries, glass batteries, salt, seawater, magnesium etcetera and all these alternatives can be explored in the future and the most sustainable technology will be adopted for the mass development.

4.2 SWOT Analysis



SWOT Analysis is another analysis method in order to analyse a situation or a product under certain categories. In SWOT, 'S' stands for Strength, 'W' stands for Weakness, 'O' stands for Opportunity and 'T' stands for Threat. Under these categories, current students' personal mobility solution, i.e. bicycle, has been analysed (as shown in the visuals).

It can be understood through the visuals that **the strengths** are its lightweight and strong built and the battery assisted pedal system; **the weaknesses** are the lack of storage and its human powered pedal system (where battery assist somewhat nullifies it); **the threats** are its security issues and its maintainance process and **the opportunities** are its technological aspect, its ergonomics aspect and its safety issues.

Through the visuals we can also understand that the weakness of a bicycle is the area we should work upon and the new design should incorporate design solutions such that the current weaknesses can be mitigated.

5. USER RESEARCH

5.1 User classification

There are different type of students in an university- the one who uses public transportation to commute and walk the rest of the way, the one who walks all the way and the one who uses his/ her bicycle to commute.

And thus broadly there are 2 type of users- one is an active user and the other is not an active user as he/ her very seldom uses the bicycle to commute. The active user uses the bicycle on a daily basis and remembers where the bicycle has been parked and maintain the bicycle regularly. The non-active user usually forgets where he/ she has parked the bicycle as there are a lot of bicycles in an university and so the user doesn't use the bicycle regularly and thus not maintained.

The user research has been done inside the campus of IIT Bombay which has created some biases due to the location and culture (especially the fact that there are lot of elevation changes inside the campus) but efforts has been made to capture different types of users with varying backgrounds so that there is a diversity in the research data.

5.2 User study/ interviews

User experience surveys are meant to help us improve your user/customer experience, so we can adjust our product desgn and strategy. A set of questions was asked to users to understand thier problems and requirements.

Questionaire-

1. Demographic questions- Name, age, gender, department.
   [background, culture, taste and interests]

2. Which type of bicycle do you own? When did you buy it?

3. How often do you ride your bicycle and how many times in a day?
   [here the user will tell their daily schedule which will inturn tell their usage of their bicycle (important)]

4. According to you, what are the pros and cons of having a bicycle in the campus?

5. What are the advantages of bicycle over the shared mobility in the campus?

6. What are the disadvantages of a bicycle in terms of design?

7. What are the different use cases of your bicycle apart from using it to commute to your hostel and department?
   [here they might tell about the different items they carry to different places]

8. How can the disadvantages/ problems be resolved that the current bicycle has?
   [just to get different opinions and ideas]

9. If we imagine a future university, what type of infrastructure and scenarios will you imagine?

10. In the future university that you imagined, what type/ design of bicycle will function?
    [to get various ideas and concepts; needs and wants were captured from the above questions, this question will capture the users aspirations].

[DAILY SCHEDULE]

TANMAY

Mechanical department

- **9AM**

  Wakes up, have breakfast and go for the classes. He always carry a backpack and during rains it is difficult to store the raincoat as it is wet. Keeps the bicycle at the same place.

- **1PM**

  During lunch, he goes back to hostel for having the food. Doesn't prefer to carry the bag because he has to come back for the remaining classes. Sometimes misses the food too.

- **5PM**

  After classes gets over, he generally comes back to hostel to change clothes. He generally has to come back to department for team discussions and other cult sessions which runs till late evenings.

- **7PM**

  Goes to gym or to play if he doesn't go to department or if the discussion gets over early. He plays badminton and carries the badminton bag in which he keeps his rackets and shoes.

- **9PM**

  Will return back to hostel after the day ends. Goes to eat dinner and back to sleep. While returning back, he might shop a little so he carries that.

[DAILY SCHEDULE]

RISHABH

chemical department

- **9AM**

  Generally wakes up late but goes to classes whenever scheduled classes are there. Prefers to take e-buggy or autorickshaw to go to the department. Most of the time he searches for his bicycle in the hostel parking.

- **1PM**

  During lunch, he usually doesn't go back to the hostel for the meal. Prefers to eat snacks from the departmental canteen, even if he has bring the bicycle with him.

- **5PM**

  After classes gets over, he generally comes back to hostel or sometimes go outside with his friends. He mostly studies in his room and stays there at hostel for the whole evening.

- **9PM**

  He generally stays in his hostel room and seldom he goes outside. But whenever he is outside, he don't prefer to take his bicycle outside.

- **1AM**

  In the night, he goes outside to canteens with his friends so he doesn't take his bicycle. Most of them prefer to walk.

[DAILY SCHEDULE]

AKSHARA

Aerospace department

- **9AM**

  Wakes up, have breakfast and go for the classes. She carries a backpack and a secondary bag. She has difficulty in riding bicycles because of slopes but somehow manages the ride.

- **1PM**

  During lunch, she goes back to hostel for having the food. Sometimes she carries the breakfast in a tiffin box so that she can have that during lunch. Difficulty to ride again the slope back to the department.

- **5PM**

  After classes gets over, she generally comes back to hostel if there are no further classes. Ride back is comparitively easy and she don't find parking a difficulty as she is a daily rider so she knows where to keep it.

- **7PM**

  She plays volleyball so sometimes in the evening she goes to play with her friends. Or else she is in her hostel room completing the assignments.

- **9PM**

  After the game is over, she heads back to her hostel and parks her bicycle at the same position. Late night walks with her friends don't include bicycling.

5.3 Documented use case with items

Students carry different types of items depending on where they are going and what they are doing. Generally, they carry a backpack and inside the backpack there are a bunch of different stuff which depends on person to person. In the above image, the items carried by the students have been captured. This will certainly dictate the direction of the design as it is very important to understand what the students carry while they are bicycling inside the campus.

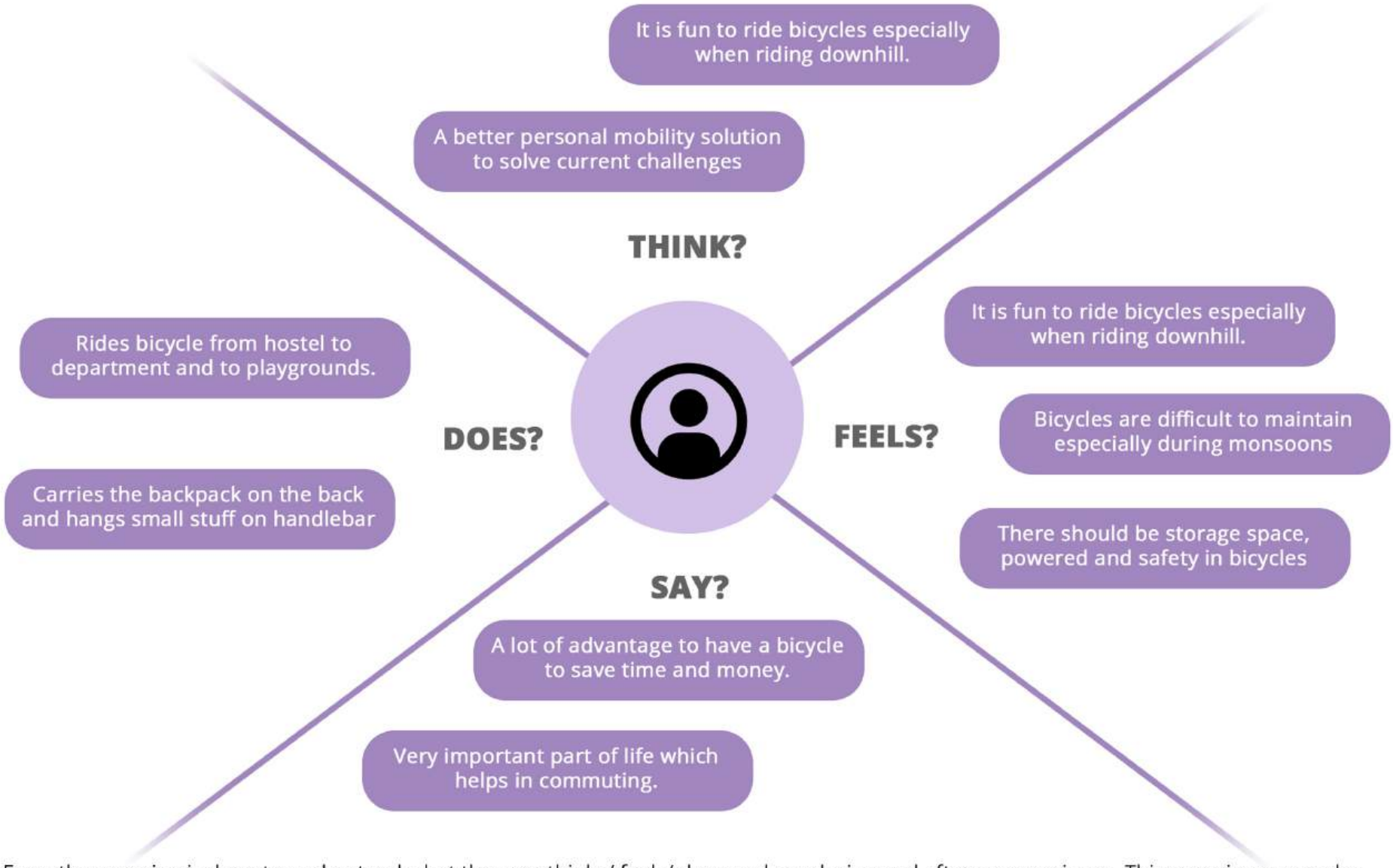
5.4 Journey map

STAGES OF JOURNEY	GOING TO DEPARTMENT	GOING BACK TO HOSTEL	GOING TO PLAY
Activities	Looking for the bicycle, unlocks it, rides to the department which is mostly uphill. After reaching finds place to park and locks it.	Unlocks the parked bicycle and goes back to hostel. This time the ride is mostly downhill so pedalling is mostly not required.	Ride to the playground from hostel while carrying the sports items and coming back to hostel after getting totally drained.
Emotions Very happy Satisfied Unhappy			
Experiences	A lot of efforts are to be made to ride the bicycle uphill especially when it is non-geared. Backpack weight just adds to the difficulty. But reaches on time.	It is very fun riding back to hostel as almost no pedalling is required. But sometimes it is dangerous as the brakes are not that good.	The distance to playground is not much so the efforts are average. Only issue is to carry sports item which is very uncomfortable while riding.
User's expectations	Efforts should be minimum and storage for backpacks and other items is necessary.	Should be safe while reaching fast speeds. Else the experience should remain more or less the same.	Should have secondary storage for sports items etc.

Journey mapping of a user is done to understand the journey of the user with the product and in the process understand his/ her pleasure points and pain points. Here, the various stages of journey has been captured where a student goes from his hostel to his department and comes back and when he goes to play. There are various types of experiences and various users' expectations during all the 3 activities which has been captured in the above table.

From the above table, we can understand that a student enjoys riding bicycle when he/ she is coming back from his/ her department to his/ her hostel as the road is sloaping down and minimum effort has to be made in peddling.

5.5 Empathy mapping

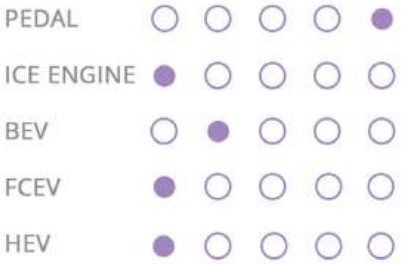


Empathy mapping is done to understand what the user thinks/ feels/ does and say during and after an experience. This experience can also be using a product and in this case, it is riding and owning a bicycle in the university campus.

This was captured during the questionaire with the students especially in the question where they tell their daily schedule as they elaborate on their emotions while telling their schedule as a story.

5.6 Current scenario Insights

POWERED

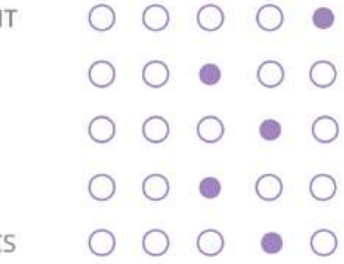


A lot of efforts is made to pedal long distances with backpack especially on elevations change when riding upwards.

STORAGE

Storage is the most important issue as a lot of weight has to be carried on back to travel from hostel to department.

BUILD



Most of the bicycles are sturdy and can withstand the test of time. And they are lightweight. Major issue is with rust in the rains.

PERSONALISATION.

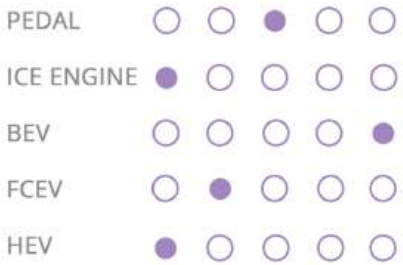
There are plenty of aftermarket options but students don't seem to install as it is very unsafe in the campus.

SERVICE

Parking and security of the bicycle is a major issue currently. People tend to forget where they've parked and it is prone to theft.

5.7 Future scenario Insights

POWERED



The future should provide a battery powered ecosystem where e-bikes prevail.

STORAGE

Incorporation of a storage compartment on the e-bike will make it more functional.

BUILD

Technology development will enable different automotive materials to be more lightweight and strong.

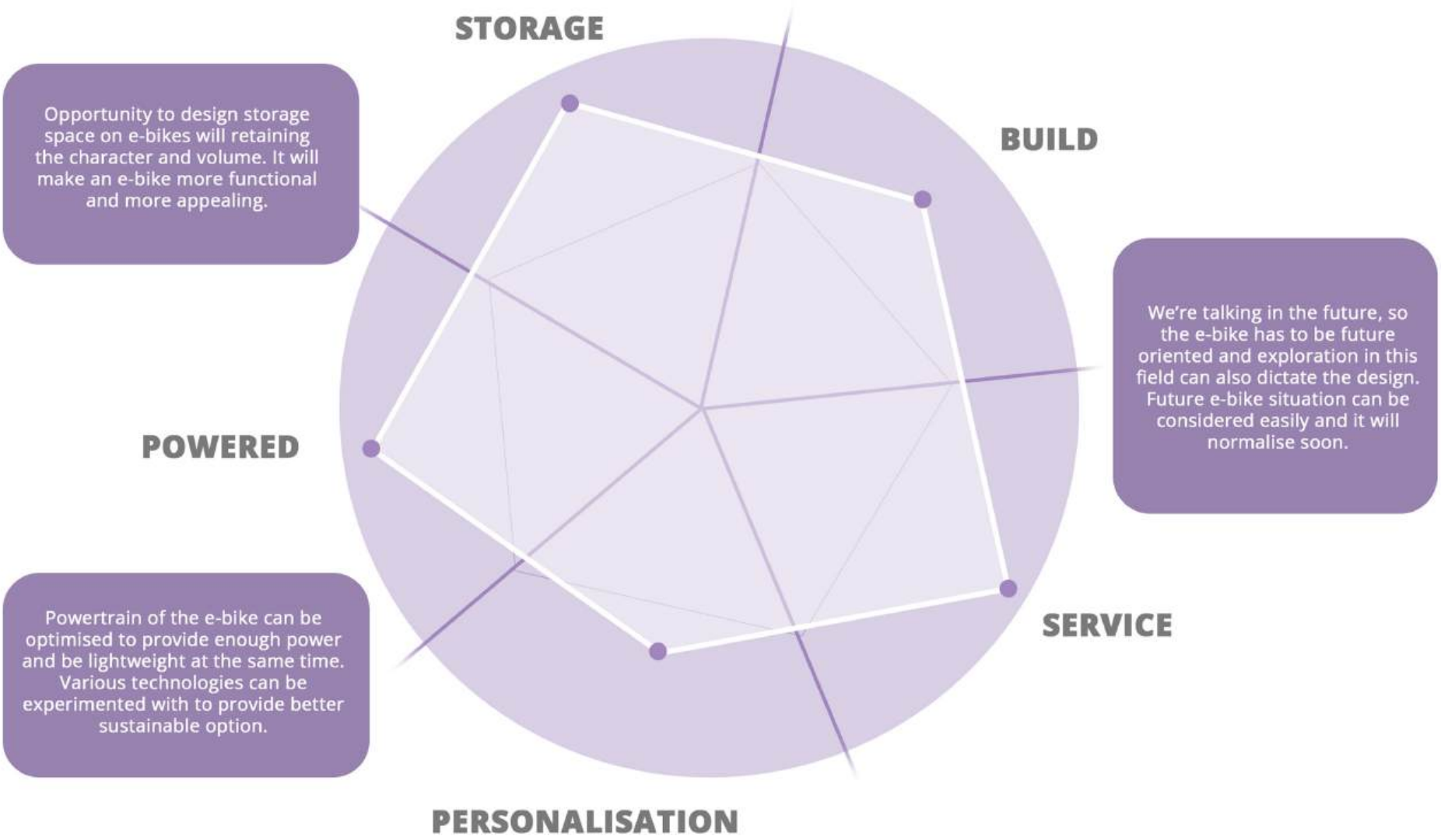
PERSONALISATION.

Modular personalisation of e-bikes will be a trend where-in exclusivity will still remain.

SERVICE

Infrastructure and services will also develop with the rise of e-bikes and it will be inclusive in this sense.

5.8 Inferences



6. DESIGN BRIEF

To design an electric bike for the university students in future. The design will explore a new platform and packaging tailored according to the needs of future students. The electric bike will provide innovation in terms of future scenarios and technologies and will also incorporate the modular personalisation and fun riding dynamics.

Subjects of exploration-

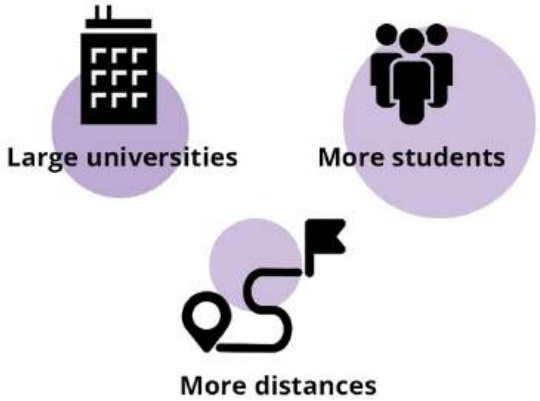
1. Platform
   powertrain, drivetrain, chassis
2. Storage
3. Materials
4. Ergonomics
5. Form
6. Services
7. Technology
8. Safety features
9. Modular personalisation

Technical Specifications-

Battery- 6-8kW [Lithium ion]
Saddle height- 700mm
Wheel size- 15" [standard]
Wheelbase- 1250 mm
Weight- 40-50kgs

7. FUTURE SCENARIO

7.1 Future Universities



Future-oriented universities will embrace emerging trends in teaching and learning (active, blended, hybrid learning, flipped classrooms, inquiry/problem-based learning) in order to strengthen the educational experiences of students. Universities that are futuristic continue to rethink how they teach and assess.

Universities in future will be very large in order to accomodate a large number of students which will make the design and planning of such universities in a way that there will larger distances to cover. There will also be innovations in technology, mobility solutions and infrastructure simultaneously so that these larger distances can be covered comparitively in a very short period of time.

FUTURE UNIVERSITY CAMPUS PLANNING

7.2 Future Technologies

intelligent

connected

infrastructure

As explained, we are talking about future, where the electric ecology will reign and electric vehicles will be common. Infrastructure related to it will also develop, taking in consideration an environment of having ample of charging stations in and around an university. The materials and technology will also develop in a way to provide better service to the user.

FUTURE ORIENTED MOBILITY

futuristic

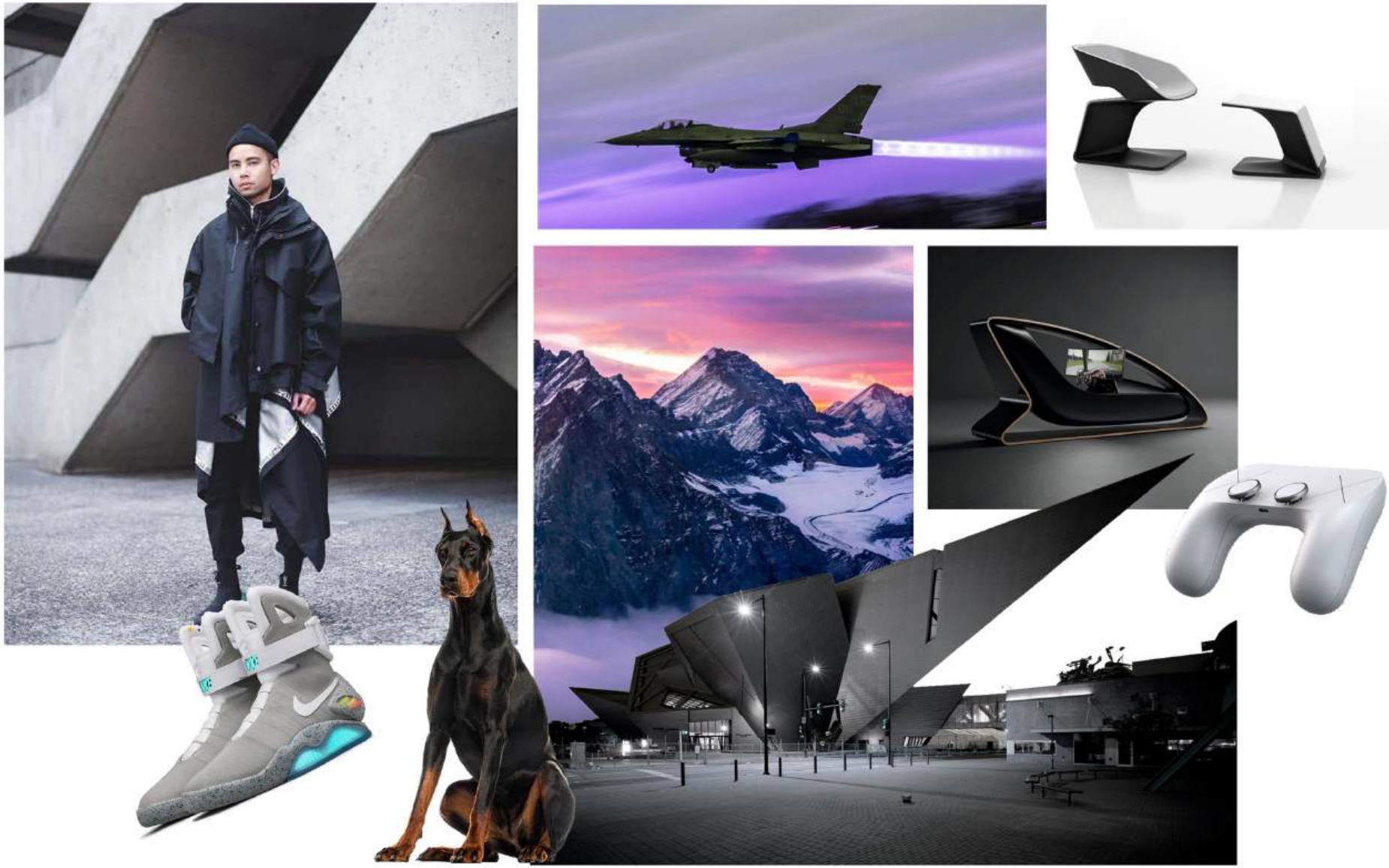
7.3 User Persona

DV

DV is the user persona in future. He is studying in a world class university in future and **pursuing music production** there. He has a sense of style statement and likes to **play basketball**. He is into hip hop culture and his idol is old school rap legend Eminem. He has an active personality and uses his e-bike in the university campus to move around. He has a **'work hard, play hard'** mindset and works on his music in the day and play sports in the evening and hangout with his friends only on special occassions and on weekends. He is also a tech geek. He has a very opinionated taste in everything and seldom likes any design, has a **sophisticated and unique taste.**

In the campus, he has his own e-bike which stands out amongst the rest which he regularly uses but it has some drawbacks. He needs an advanced e-bike that is more functional and can fulfill his needs. Again, it has to suit his taste in design and be compact and powerful.

7.4 Theme Board



8. NEW PROPOSAL

8.1 New platform

STROMER ST2
PEDELECS

NEW

A PLATFORM FOR ALL
A PLATFORM OF ALL

ELECTRIC MOTORBIKE
LIGHTNING LS-218

In the new proposal, according to the future scenario that has been developed in which future universities and future technologies will exist and function in a particular manner, a new platform for the electric bike is proposed for the students studying in universities in future.

This new platform proposed is an amalgamation of a bicycle and a motorcycle, taking the advantages of both the platforms (one is lightweight and the latter is motor-powered) and develop an altogether new platform which lies somewhere in between both the extremes.

8.2 New Packaging

HELMET

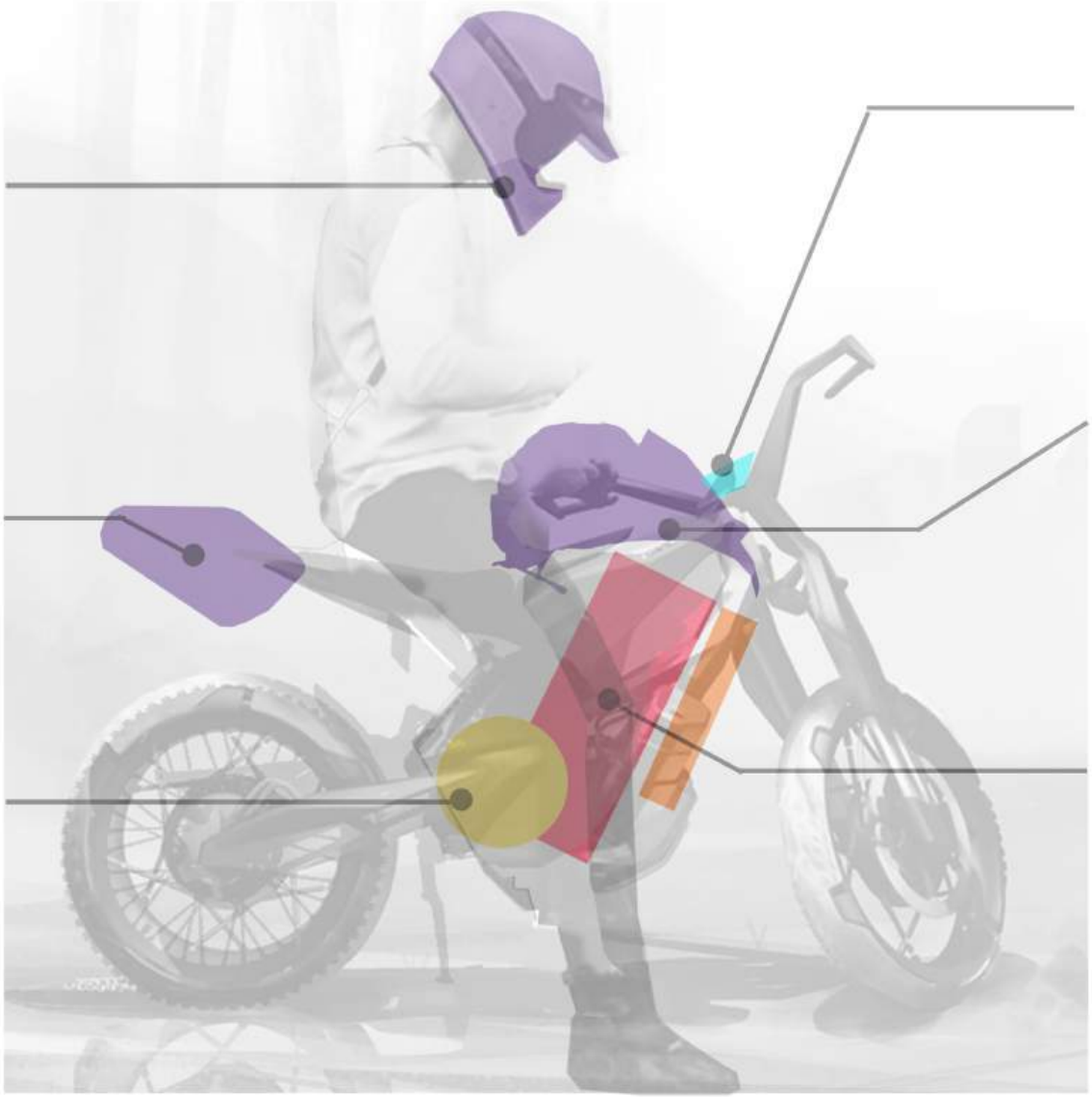
For safety purpose, the design will incorporate the helmet into the body of the bike so it stays with the bike.

REAR STORAGE

For extra storage, modular rear storage will be designed for small items.

MOTOR

Motor will help drive the rear wheel with the power output from the battery/ other powertrain.



INSTRUMENT CLUSTER

Person's phone will become the instrument cluster of the bike which also serves for tracking.

BACKPACK

The backpack/ laptop bag can be kept on the top where originally a motorbike tank's come.

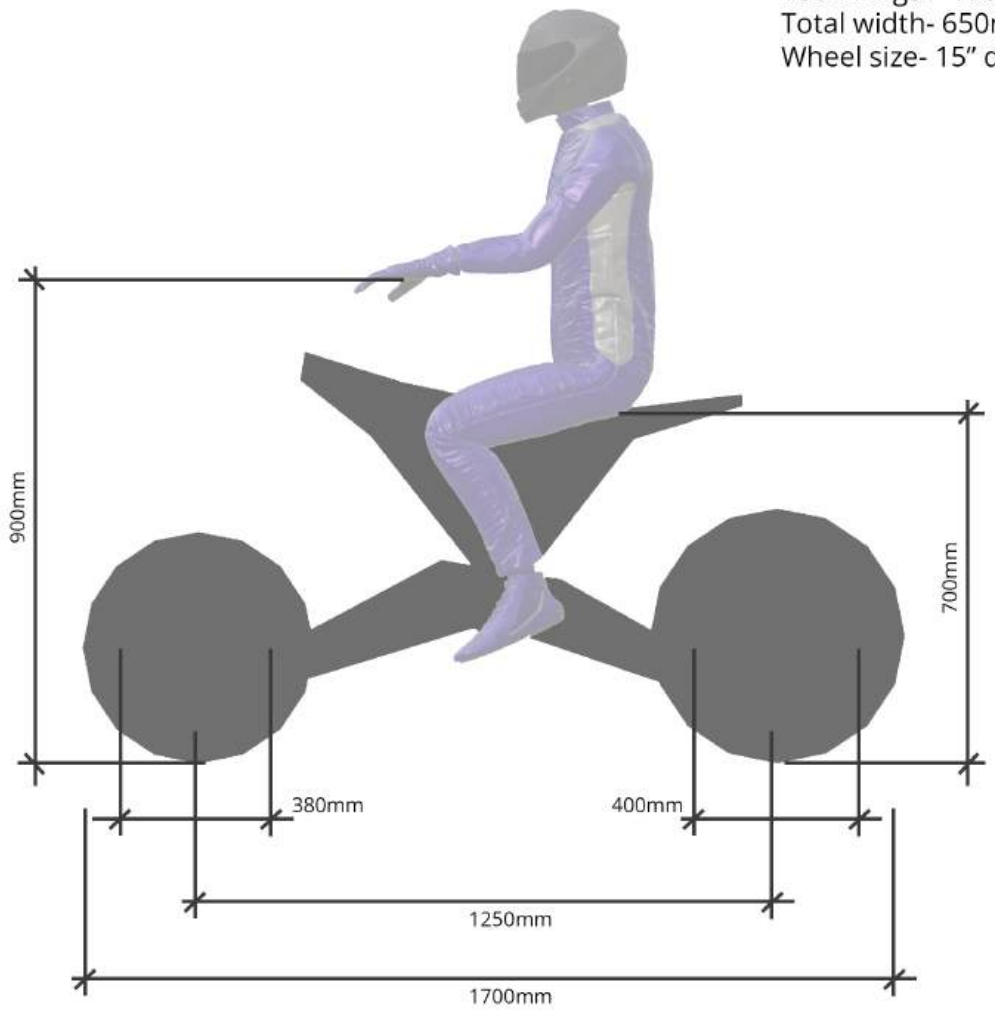
POWERTRAIN

Placement of the powertrain will depend majorly on riding stability and handling. COG.

8.3 Technical packaging

The final technical package includes following specifications-

Wheelbase- 1250mm
Total length- 1700mm
Total width- 650mm handle to handle
Wheel size- 15" dia front and 16" dia rear



9. PRODUCT RESEARCH

9.1 Benchmarking

NOVUS Bike

80V
100AH
battery

25kW
400Nm
power

90 MIN
The charging time from 0-80% with the fast charger

100 MM
front spring deflection

110 MM
rear spring deflection

73 KG
Empty weight without battery

103 KG
Total weight with battery

130 KG
Permitted total payload

1 PERSON
NOVUS One is a single-seater

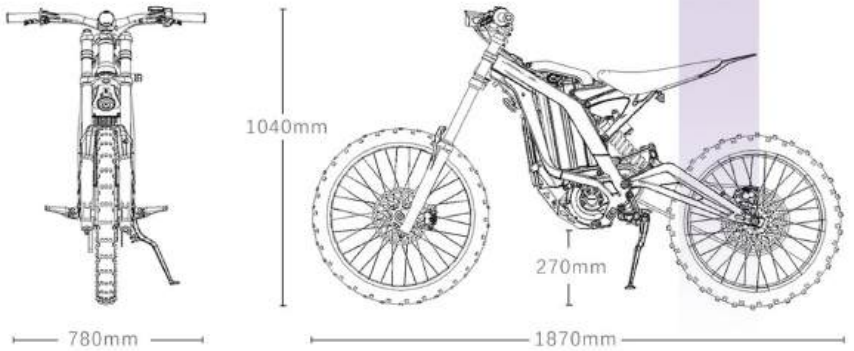
900 MM
Seat height without rider weight

SUR-RON Light Bee

60V
38.5AH
battery

6000W
250Nm
power

Dimension	1860mm×780mmX1050mm
Ground clearance	270mm
Wheel base	1255mm
Seat height	830mm
Dry/Curb weight	45kg/56kg
Carrying capacity	75kg
ront fork travel	200mm
Rear shock/wheel travel	87/210mm
Power system	Mid-drive BLDC motor + FOC sine wave controller
Maximum power	6000W
Maximum torque	250N.m
Top speed	75Km
Range	70Km (@40Km/h)
Battery Type	60V38.5AH 18650
Charge time	4 H
Front/ Rear tire	70/100-19



DAB MOTORS

50V
67AH
battery

10kW
250Nm
power

	Ukko S
Size(L×W×H)	1855mm*800mm*1045mm
Wheelbase	1295mm
Tyre	Front：100/80-14 Rear：120/70-14
Seat Height	770mm
Braking system	CBS
Rear fork	Aluminum alloy, single swing arm
Drive	Belt
Dashboard	5.5" TFT Screen
Motor	4kW with single-reduction gearbox, peak 8kW
Controller	FOC

SUPER 73 C1X

TALARIA XXX

UBCO 2X2 SE

EKX-X20

NOVUS BIKE

TROMOX UCCO-S

OX MOTORCYCLES

YULU

YULU WYNN

HRTC E-BIKE

CST SCOUT

DAB MOTORS

SONDORS

THE BEAST

9.2 Dimensions Study

To understand the optimum dimensions of the proposed vehicle design, It is important to study and analyse the packaging and dimensions of existing vehicles that have same or similar function. The vehicles that were chosen for the study are Novus bike, Surron Light-Bee and DAB motors.

The Parameters chosen to analyse and compare in these vehicles are Length, width, Height, Wheelbase, Ground Clearence, Seat hights, Rake angle, Wheelsizes, Rider trinagle dynamics etc. Based on this study it is conclued that physical dimensions of the proposed vehicle should ideally be:

Length - less than 2000mm
Width – 600-700mm
Wheelbase – 1200-1300mm

NOVUS ONE

SURRON LIGHT BEE

DAB MOTORS

9.3 Rider Triangle

It is the triangle that is formed by connecting three points - the rider's seating position, the handlebar position, and the footrest. The angles of the triangle change depending on the type of motorcycle.

2018 Ducati Panigale V4

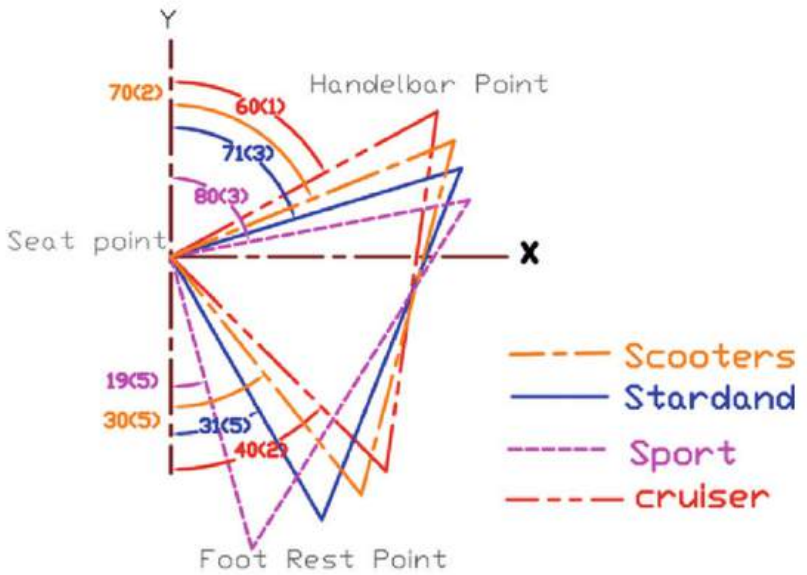
2023 Ducati Multistrada V4

2013 Ducati Diavel

2013 Ducati Hypermotard 821

2014 Ducati Monster 1200S

2015 Ducati Scrambler



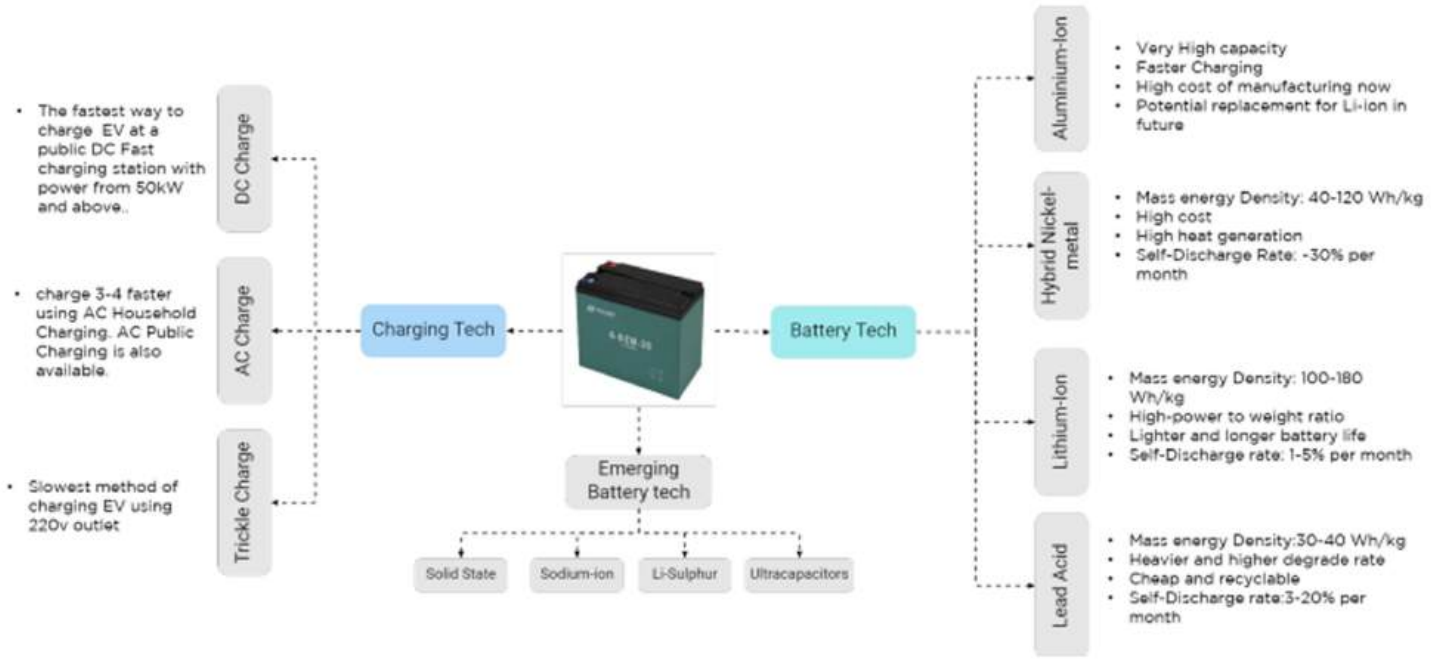
2023 Ducati Streetfighter V4

2010 Harley-Davidson Fat Boy

Now, to find a perfect rider triangle for the particular use case of riding an electric bike in an university campus that too in the future is a work of research and development and with the inferences and scenarios provided, **Ducati Scrambler** has the closest similarity to the riding triangle the future user will be comfortable with.

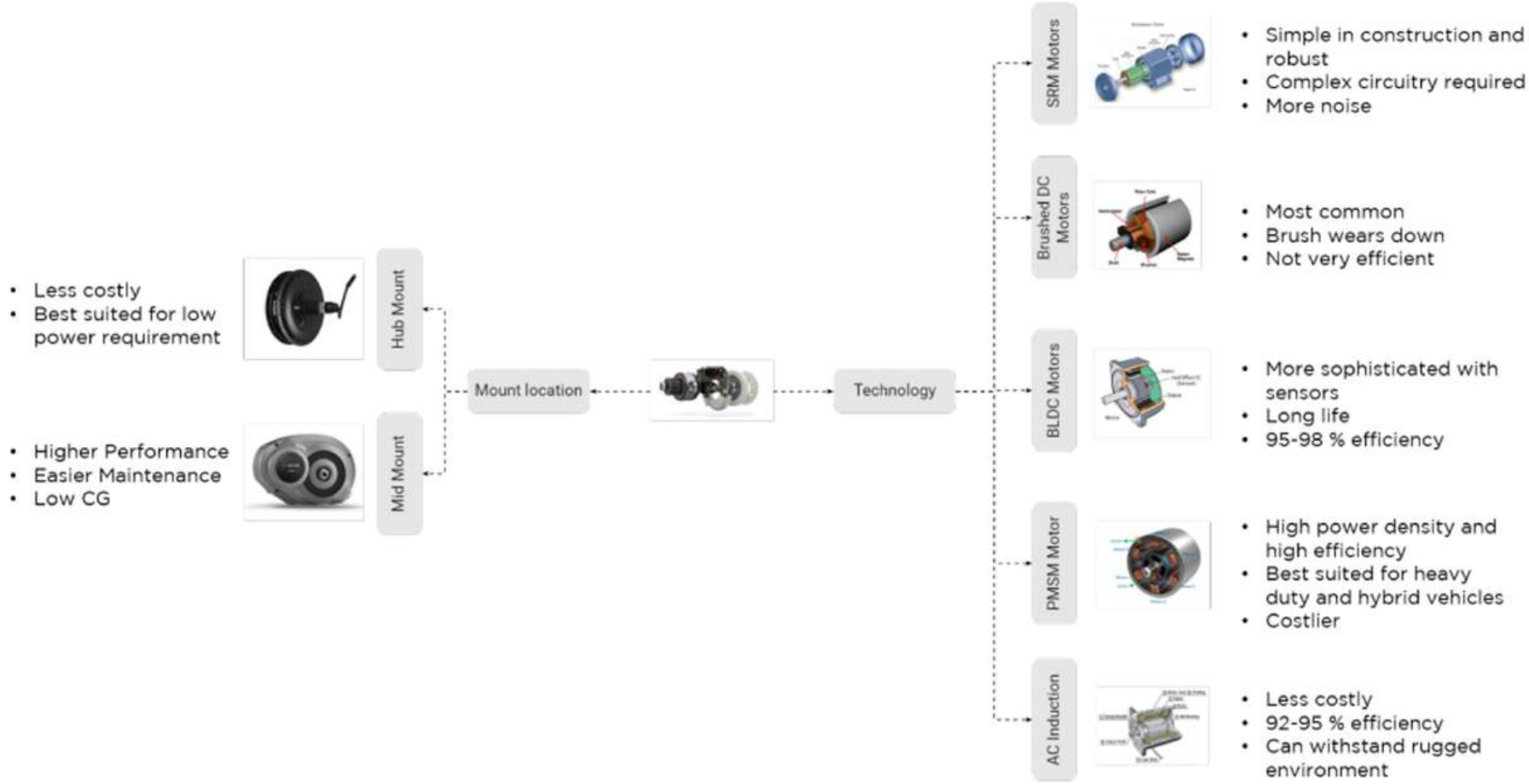
9.4 Battery System

An electric vehicle battery is a rechargeable battery used to power the electric motors of a battery electric vehicle (BEV) or hybrid electric vehicle (HEV). The most common battery type in modern electric vehicles are lithium-ion and lithium polymer, because of their high energy density compared to their weight. Other types of rechargeable batteries used in electric vehicles include lead–acid ("flooded", deep-cycle, and valve regulated lead acid), nickel-cadmium, nickel–metal hydride, and, less commonly, zinc–air, and sodium nickel chloride ("zebra") batteries. Swappable batteries also very suited for vehicles since they will in continous use of 6-8 hours/per day and riders cannot afford to spend several hours to get thier battery charged. swappable batteries allows them work more effiecently without wastage of time. In addition to a fixed battery, provision for swappabale battery system will add more value to the product.



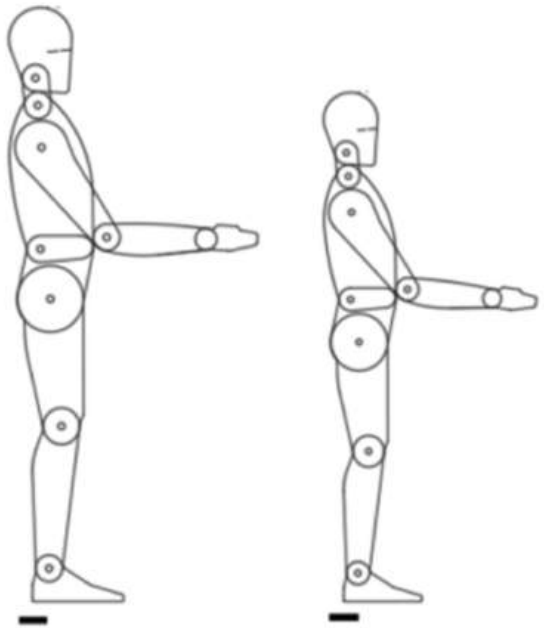
9.5 Electric Motor

All-electric vehicles, also referred to as battery electric vehicles (BEVs), have an electric motor instead of an internal combustion engine. There are differnt types of electric motors suited for vehicle based on thier technology and method of mounting. The project proposes a hubless wheel so the motor is attached with the batteries onto the frame or it is mounted on the swingarm.



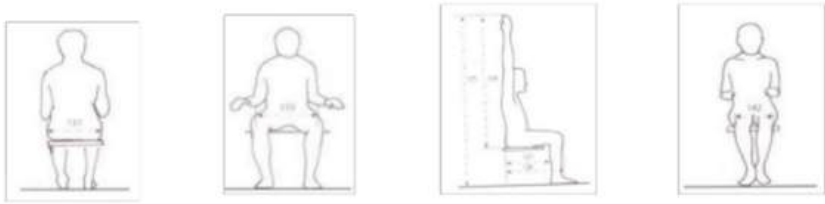
9.6 Anthropometrics

Anthropometry is the science that defines physical measures of a person's size, form, and functional capacities. For this particular exercise physical dimensions of 95th percentile Indian male and 50th percentile Indian female were considered since they represent the two extreme ends of physical dimensions of the potential users. Represented data is sourced from ' Indian Anthropometric Dimensions'.



95th percentile male

50th percentile female

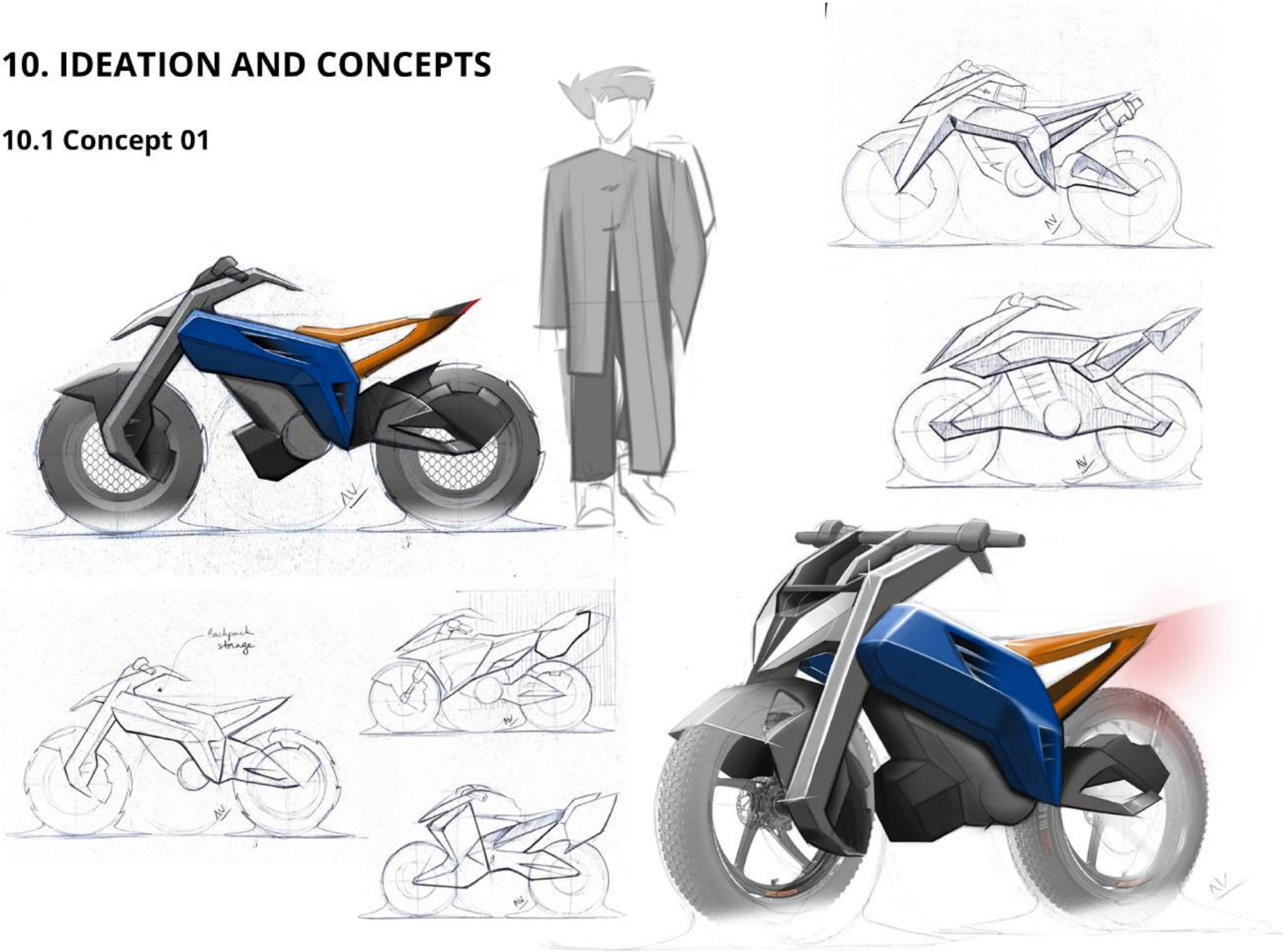


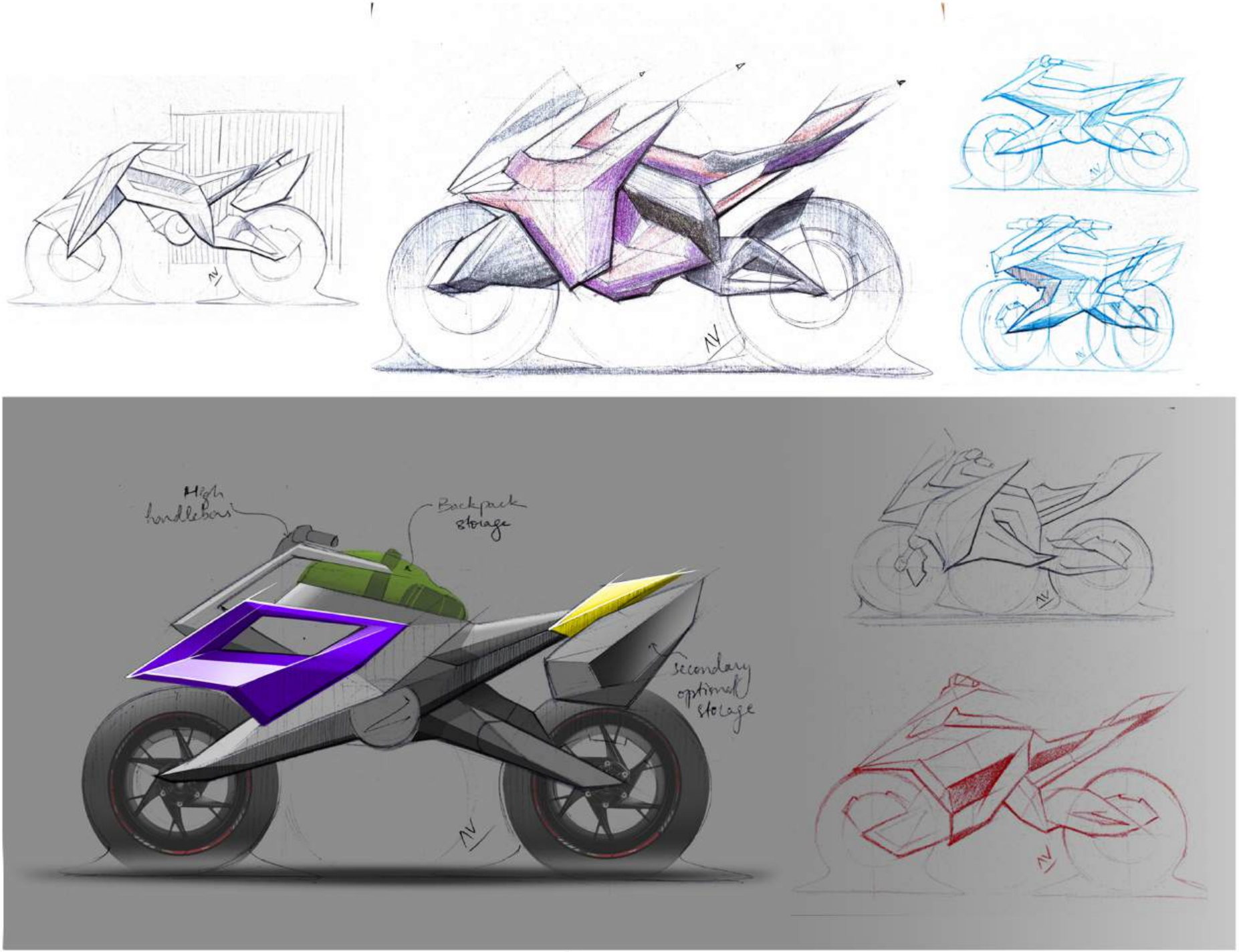
	Hip	Mid thigh-thigh external breadth	Buttock to popliteal length	Knee to knee length (closed)
95th percentile male	405	449	512	235
50th percentile female	314	379	439	189

*All dimensions are in mm

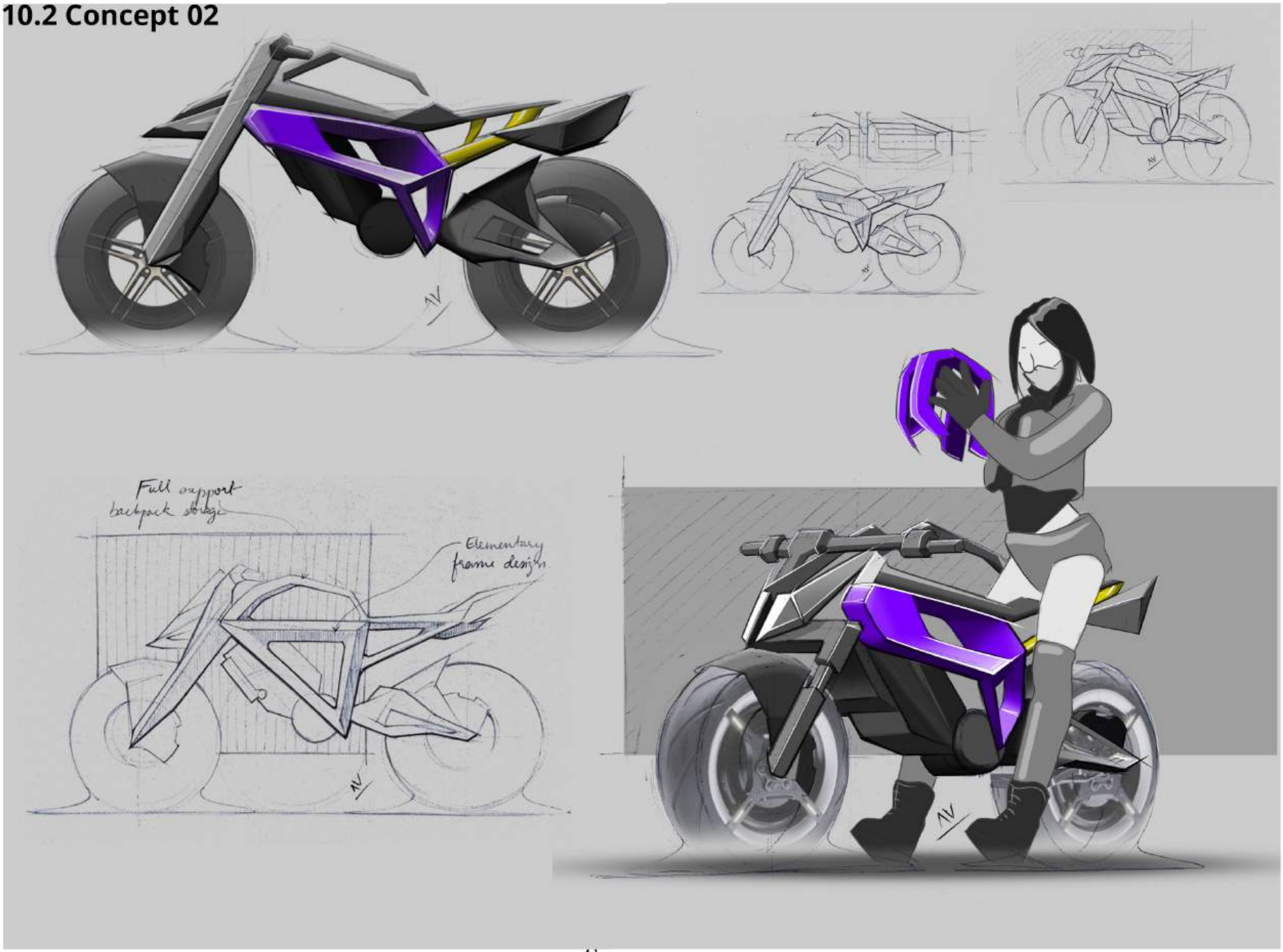
10. IDEATION AND CONCEPTS

10.1 Concept 01

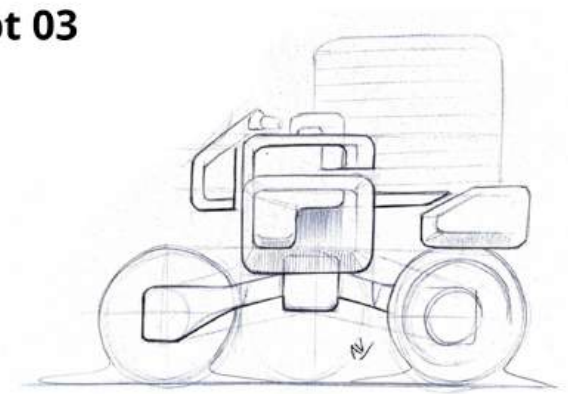


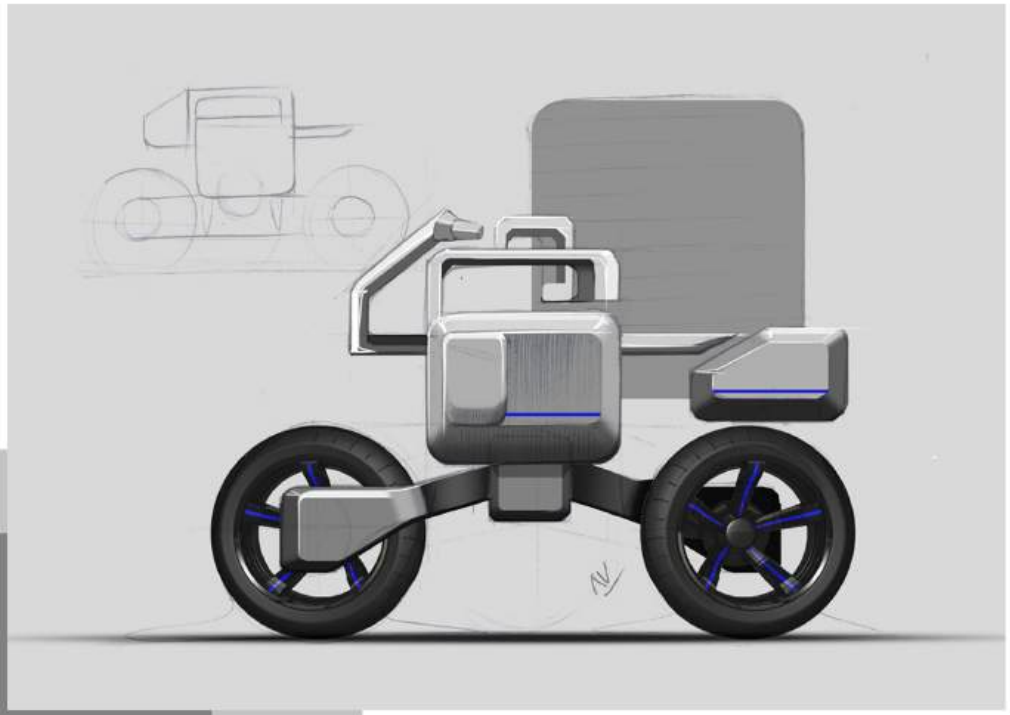

High handlebars
Backpack storage
Secondary optional storage

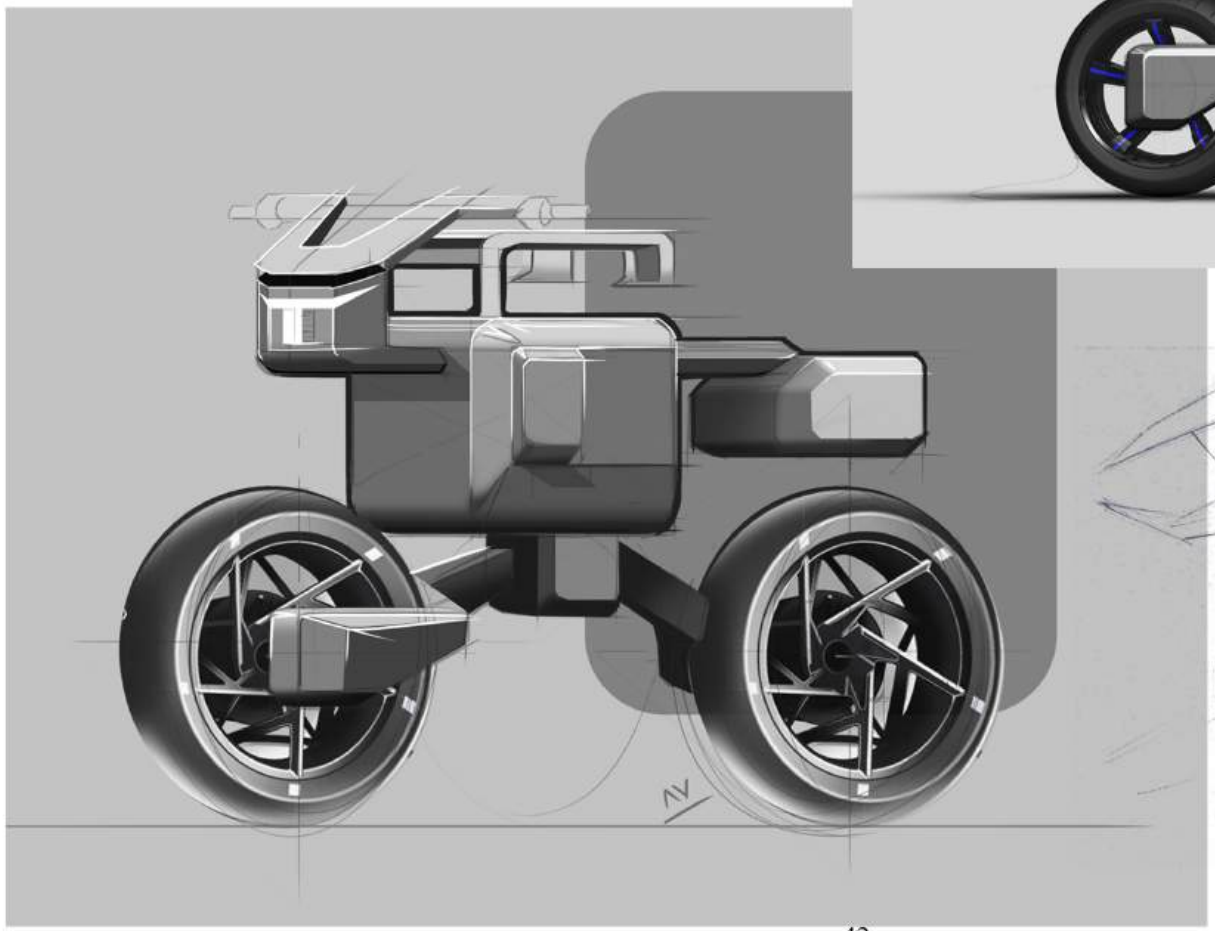
10.2 Concept 02

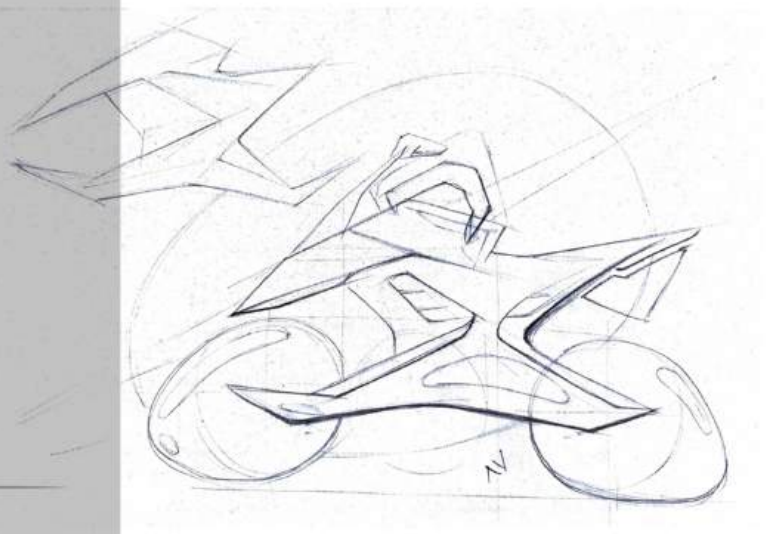


10.3 Concept 03

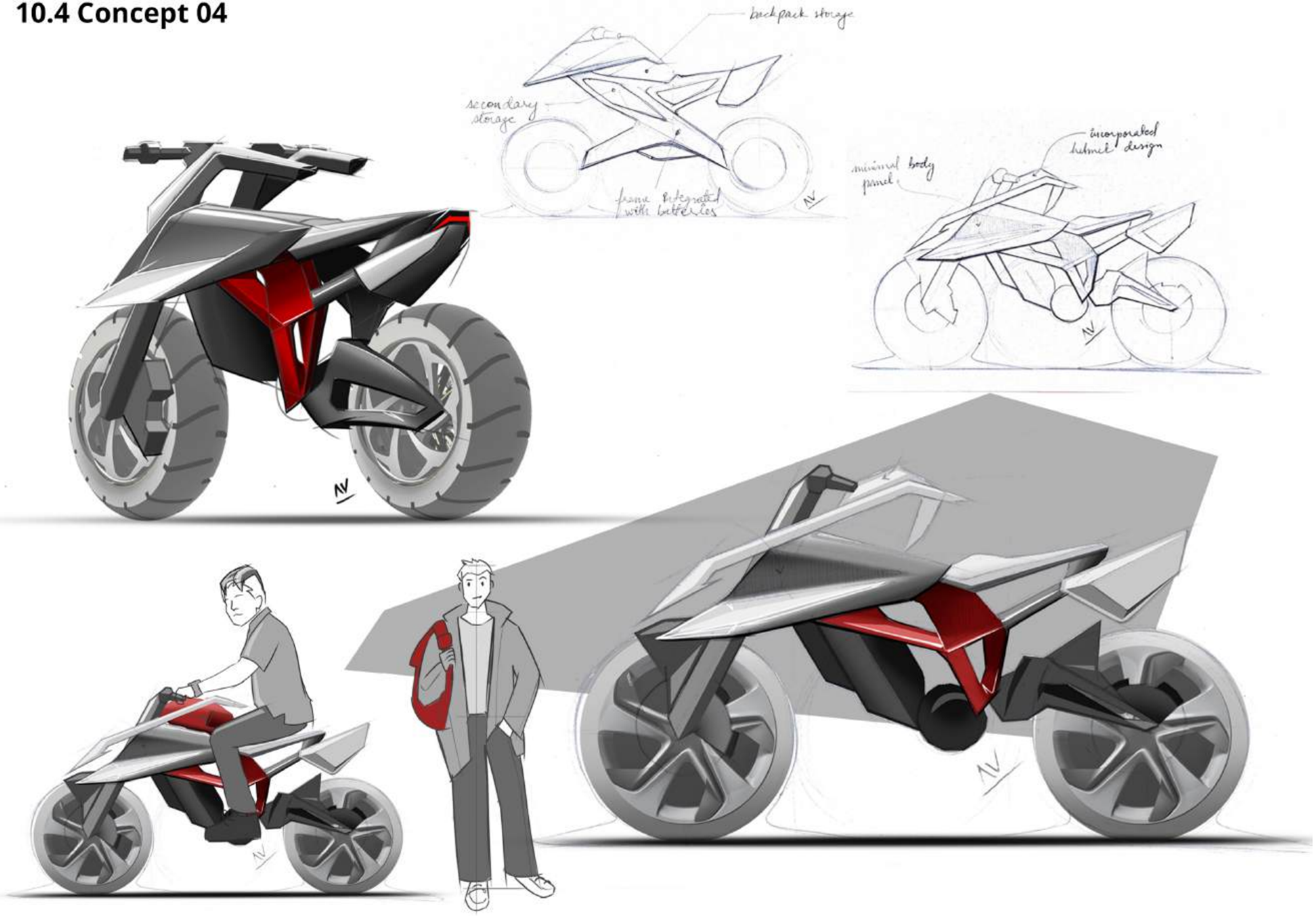




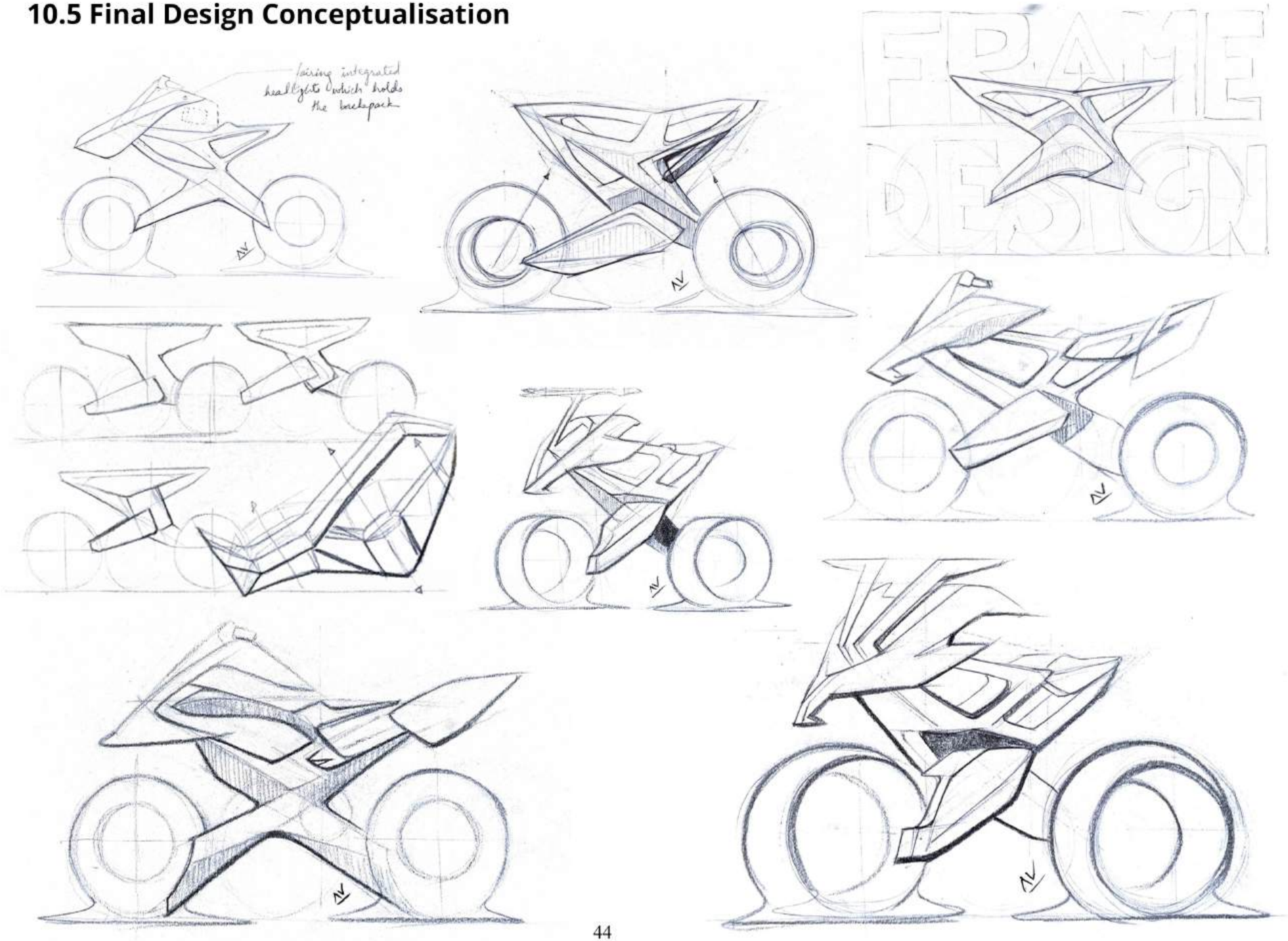




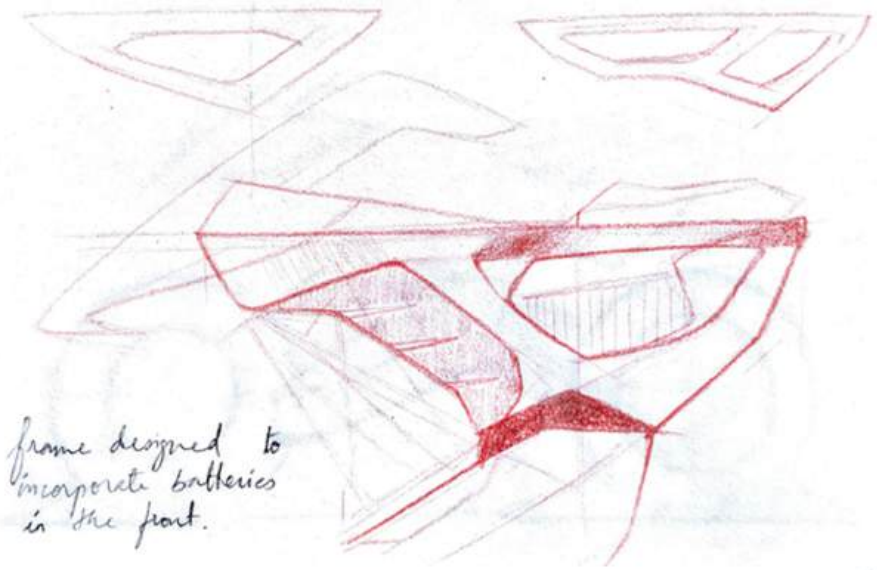
10.4 Concept 04

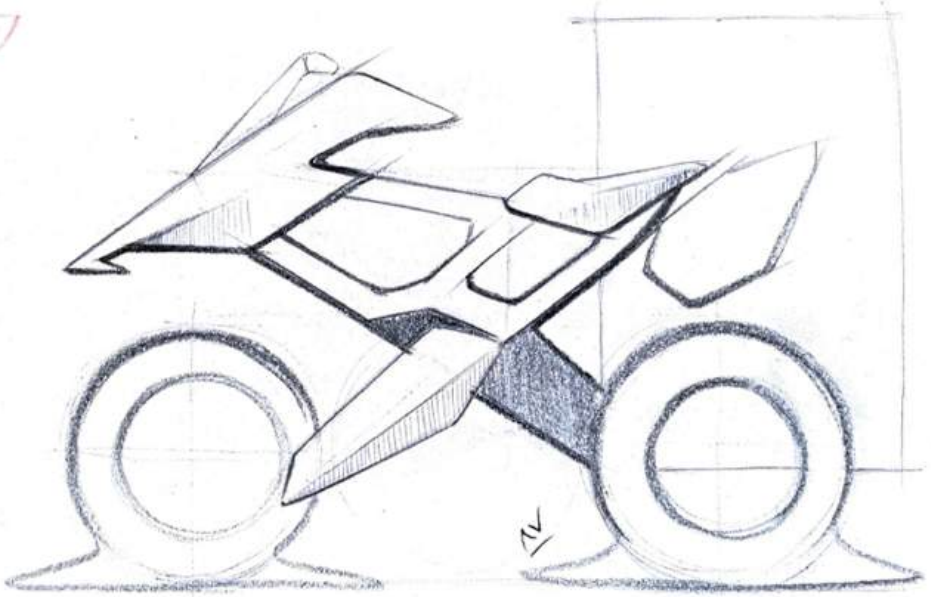


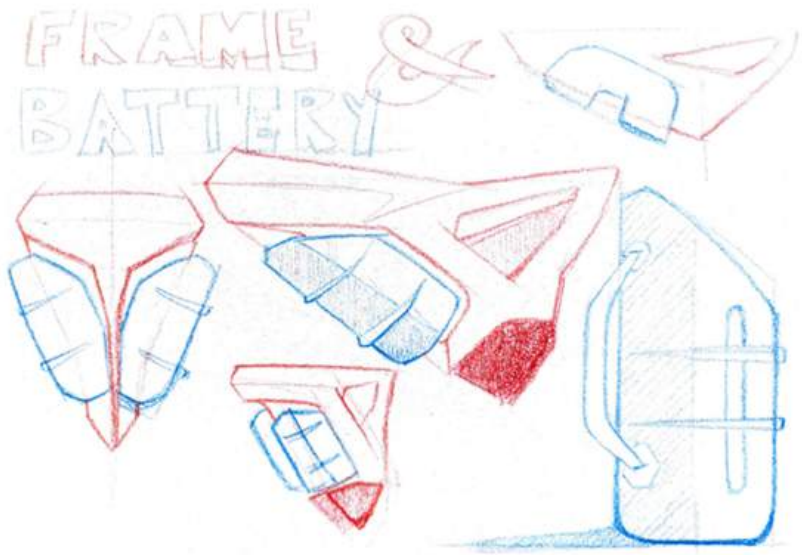
10.5 Final Design Conceptualisation

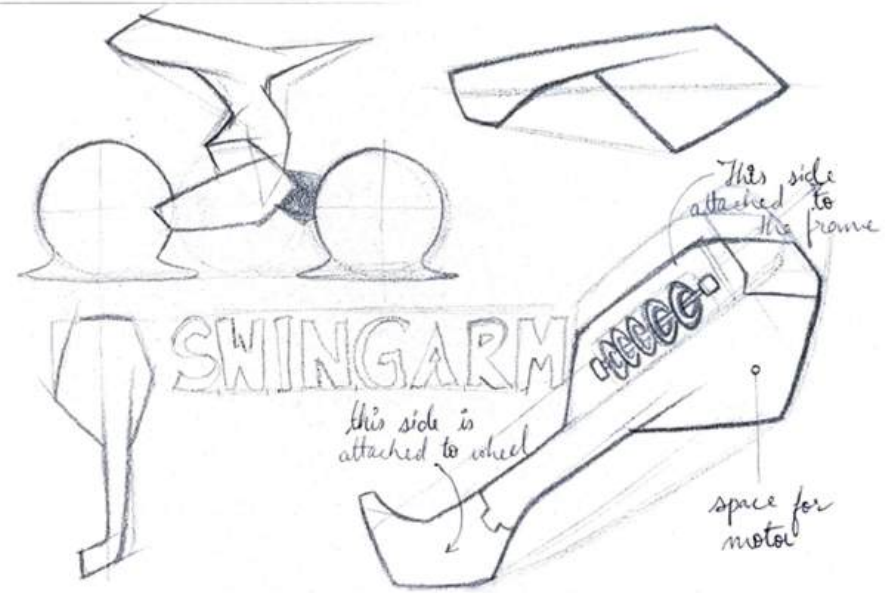


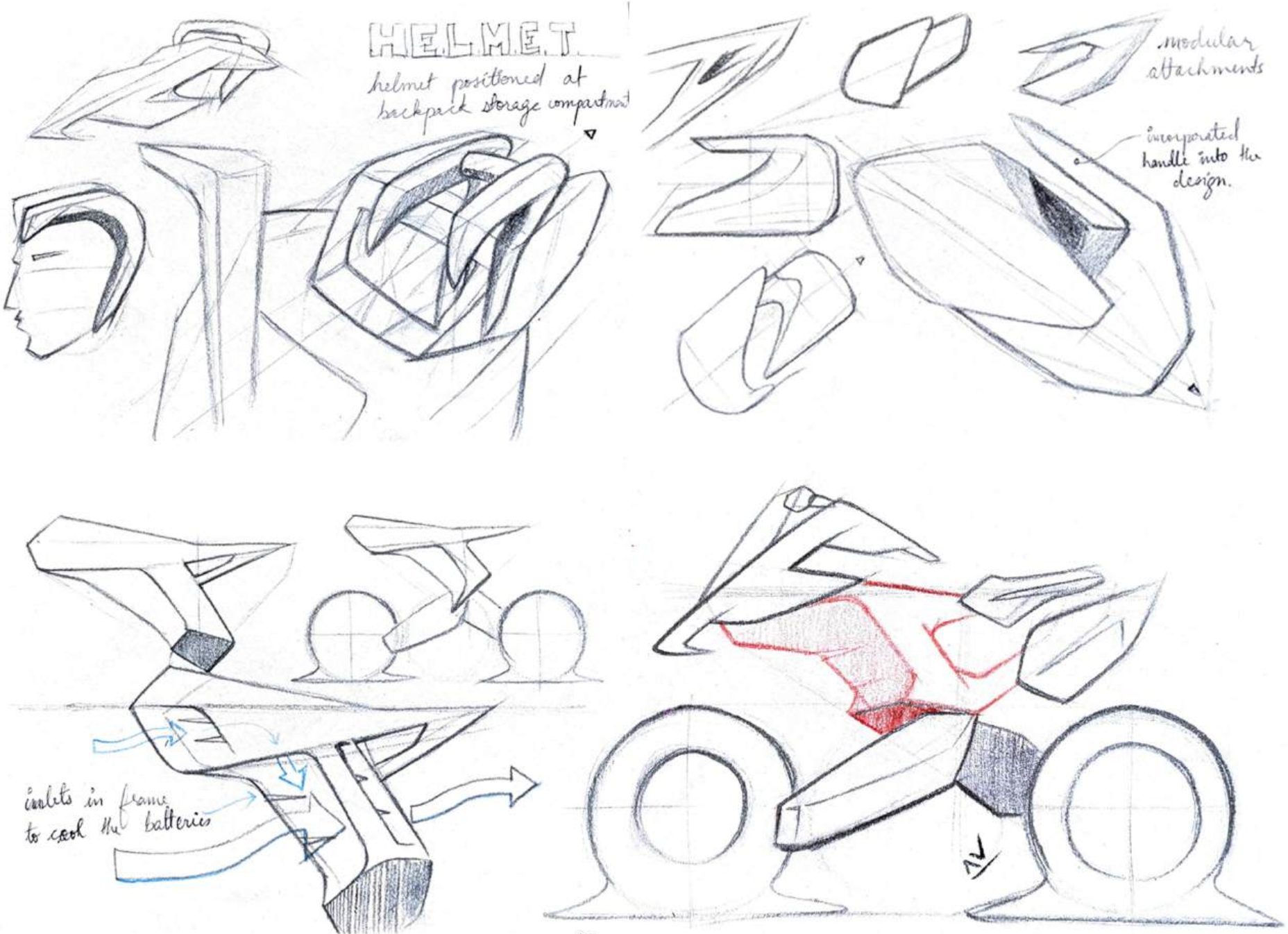
10.6 Key Sketch and Details



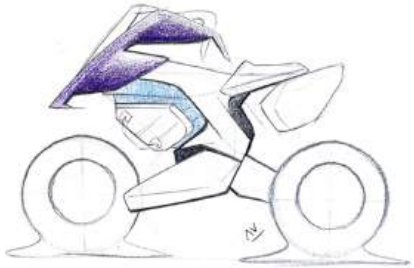


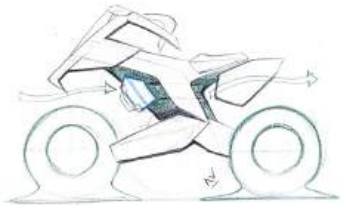


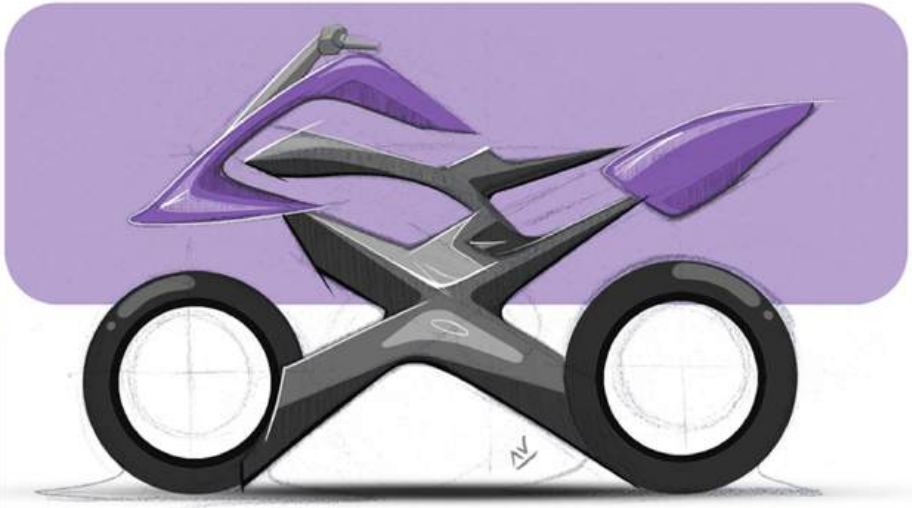


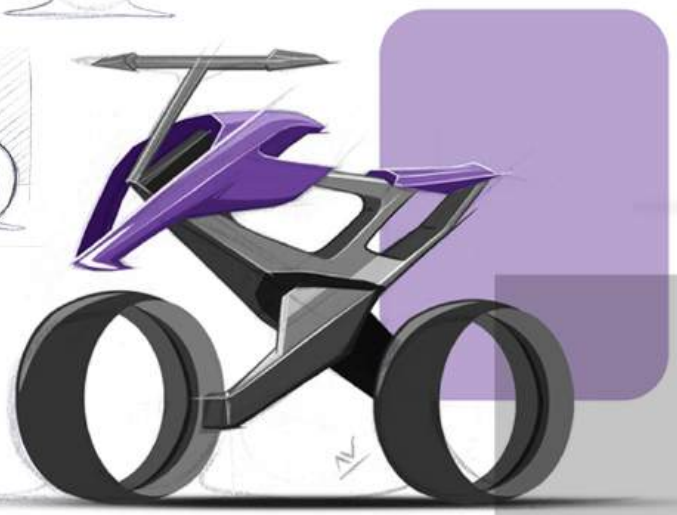

HELMET
helmet positioned at backpack storage compartment
modular attachments
incorporated handle into the design.
inlets in frame to cool the batteries

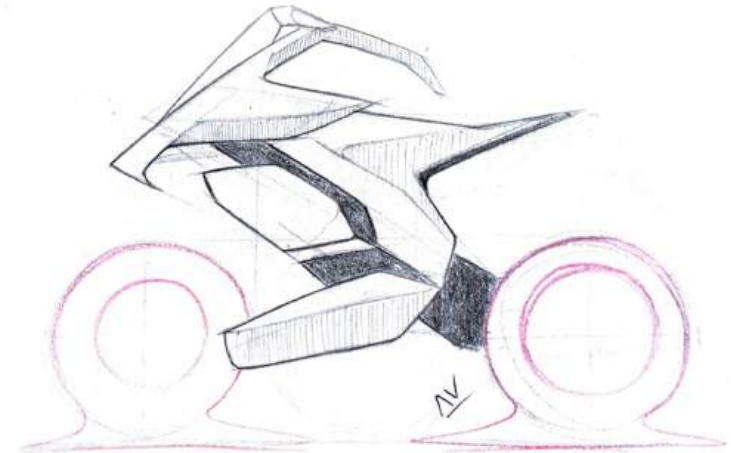
10.7 Refining the Concept

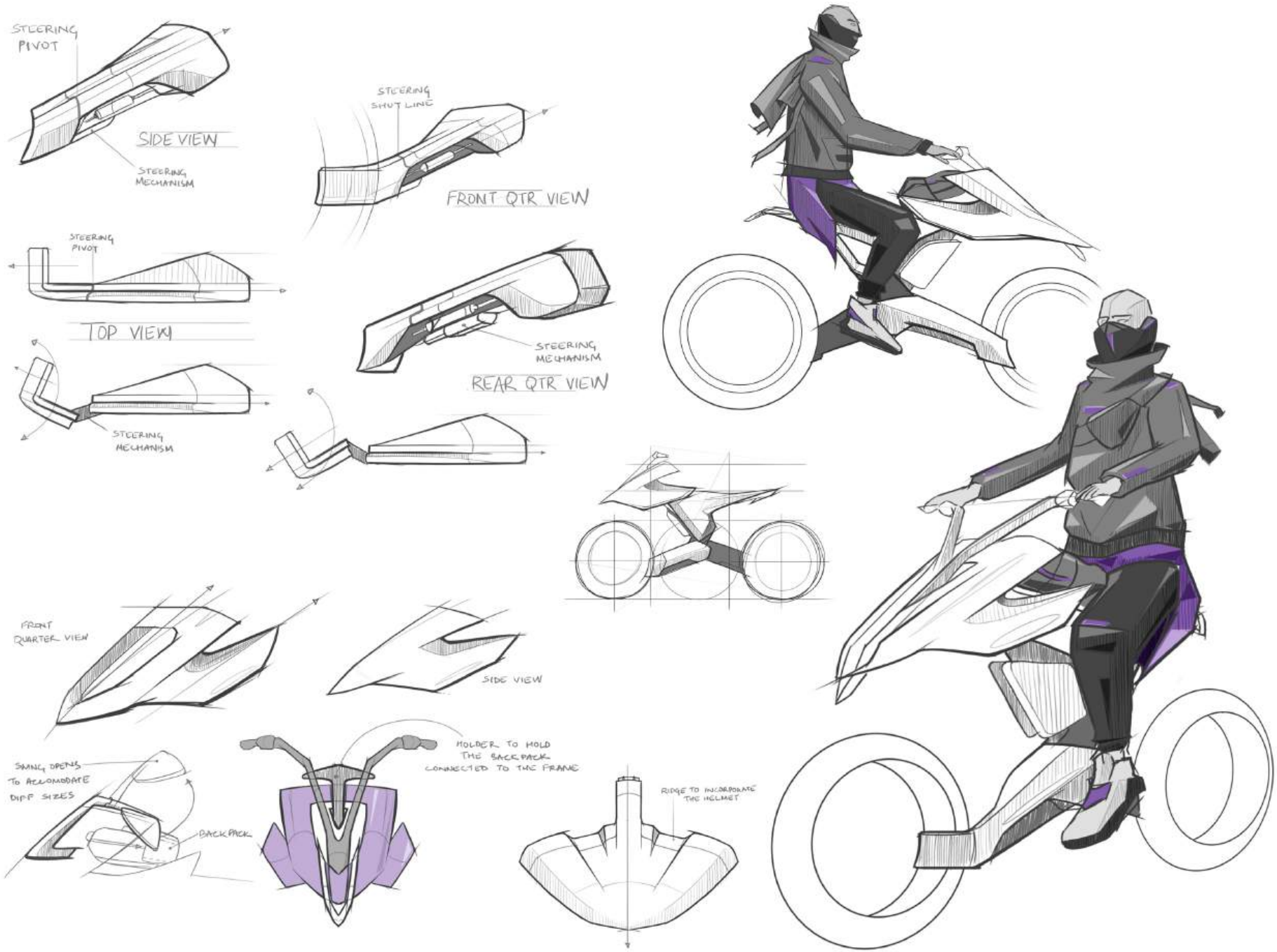




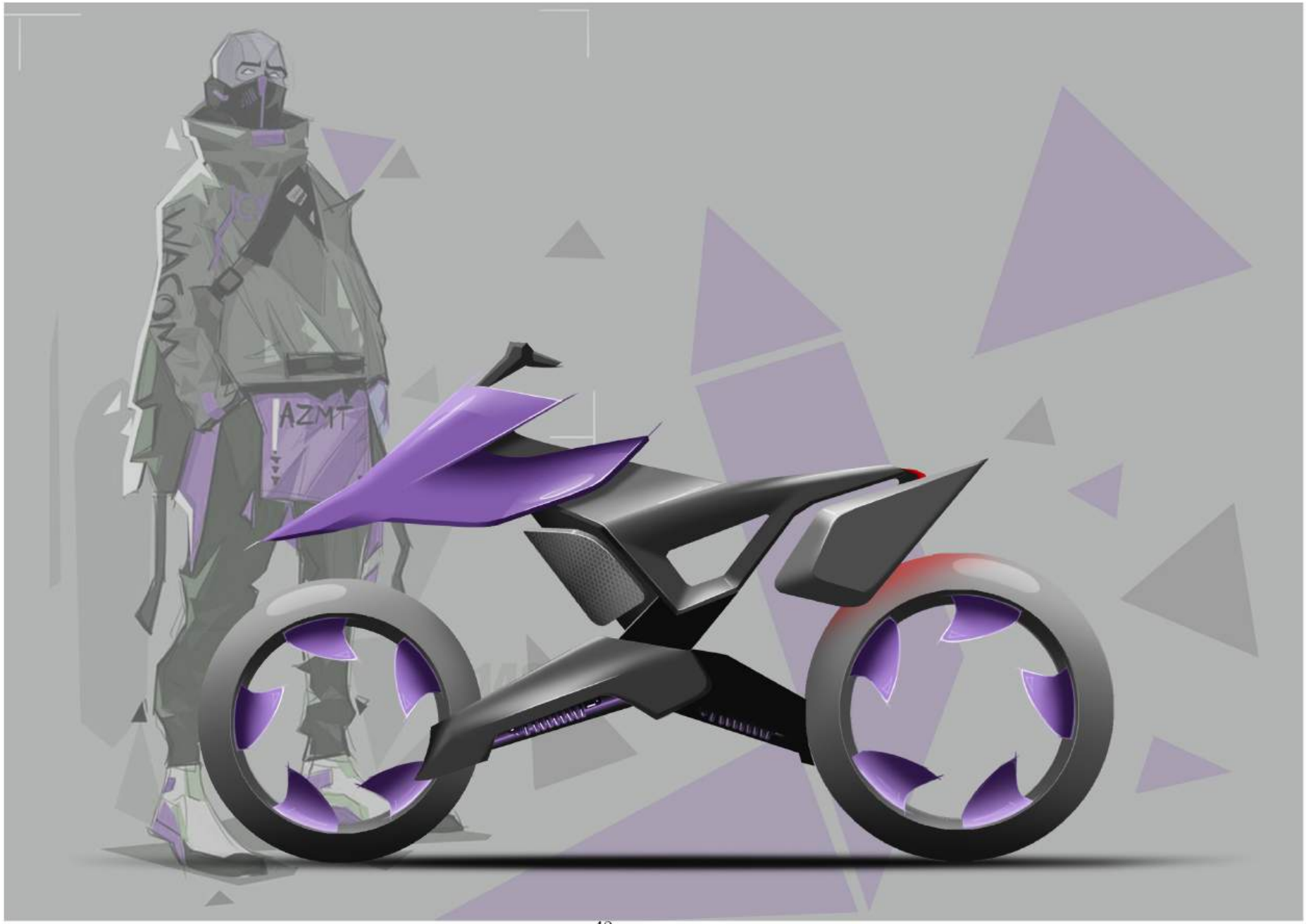




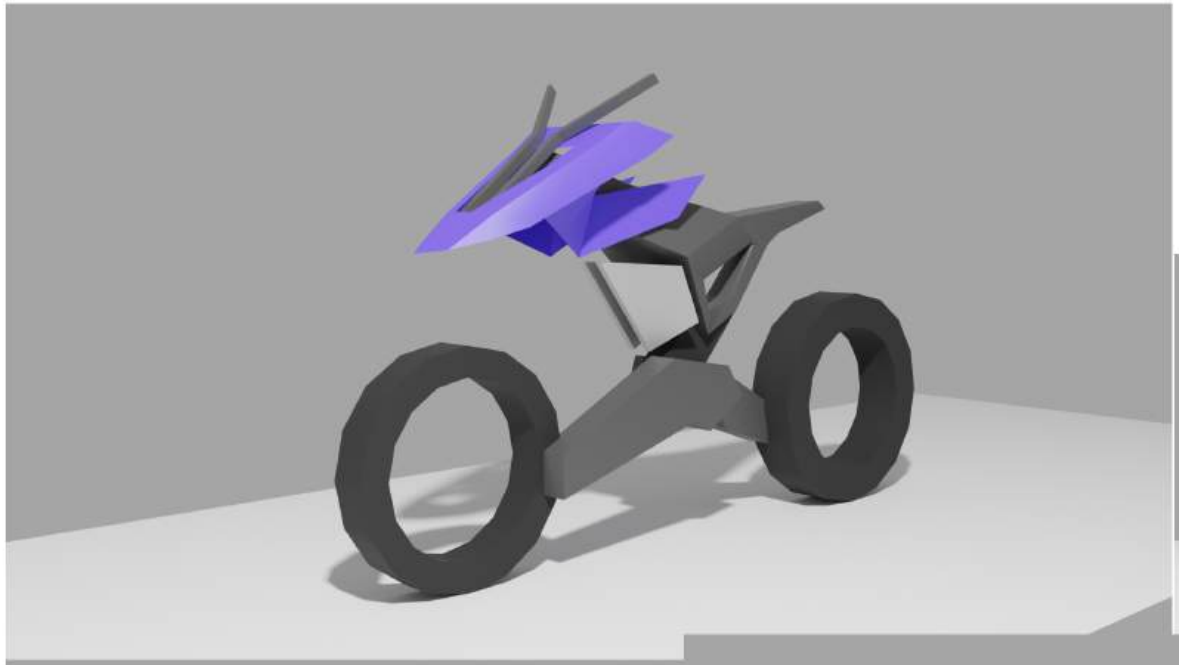



STEERING PIVOT
SIDE VIEW
STEERING MECHANISM
STEERING SHUT LINE
FRONT QTR VIEW
STEERING PIVOT
TOP VIEW
STEERING MECHANISM
STEERING MECHANISM
REAR QTR VIEW
FRONT QUARTER VIEW
SIDE VIEW
SWING OPENS TO ACCOMODATE DIFF SIZES
BACKPACK
HOLDER TO HOLD THE BACKPACK CONNECTED TO THE FRAME
RIDGE TO INCORPORATE THE HELMET

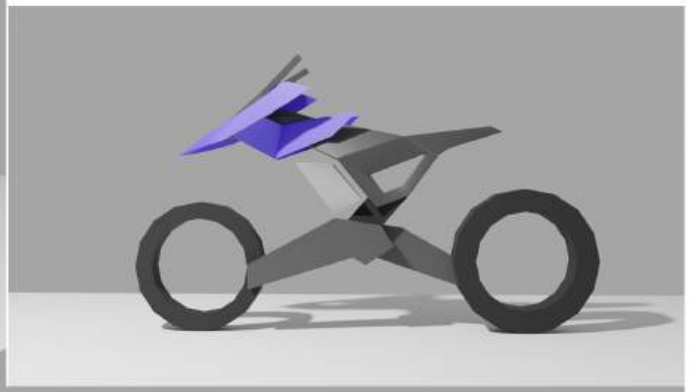
10.8 Concept Renders

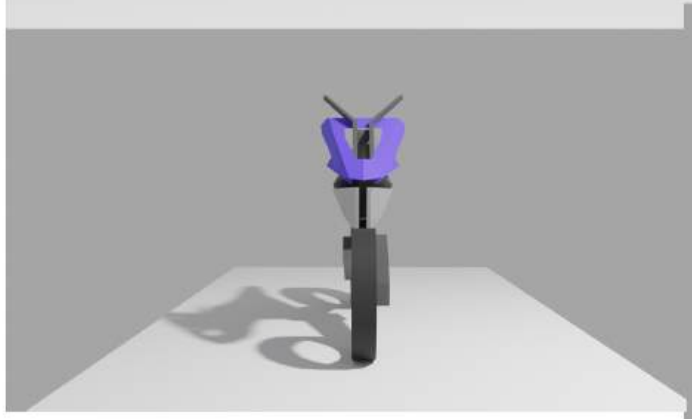


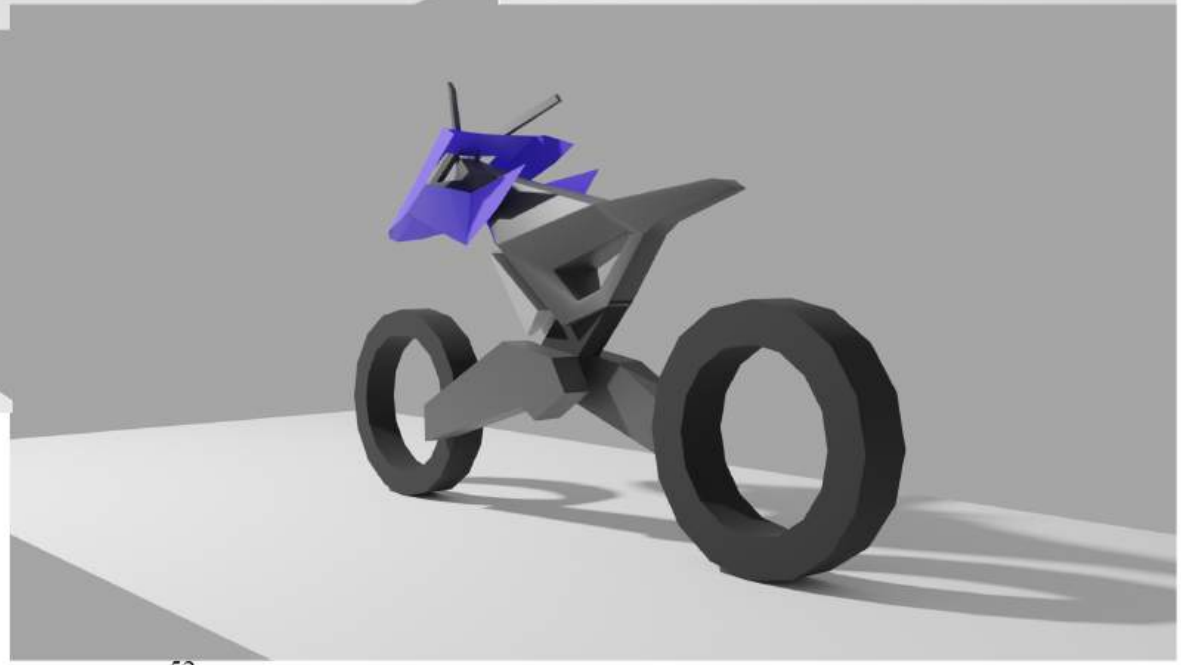
10.9 CAD Model

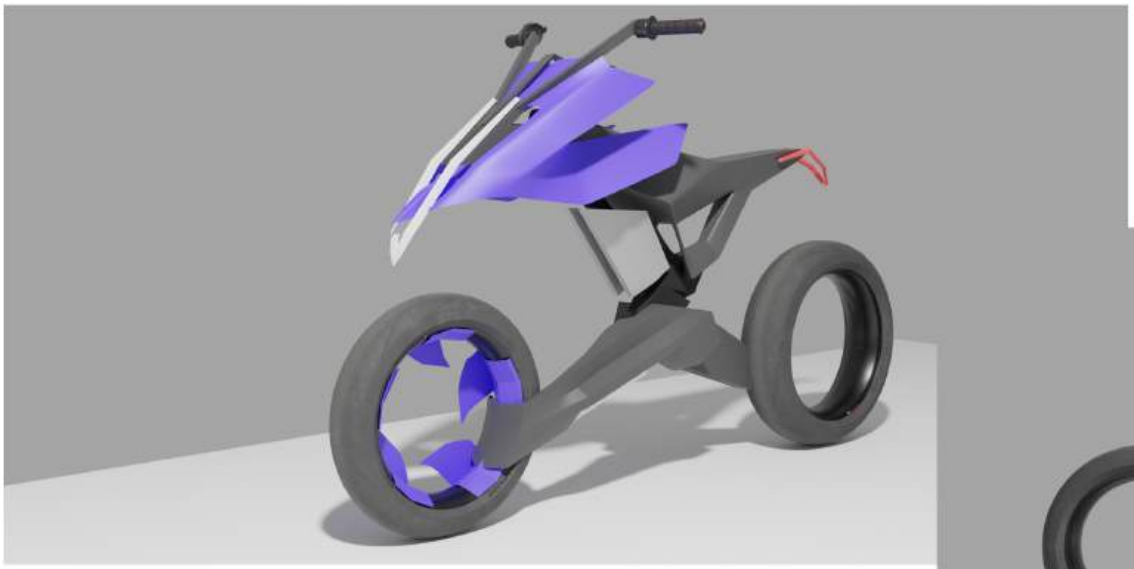


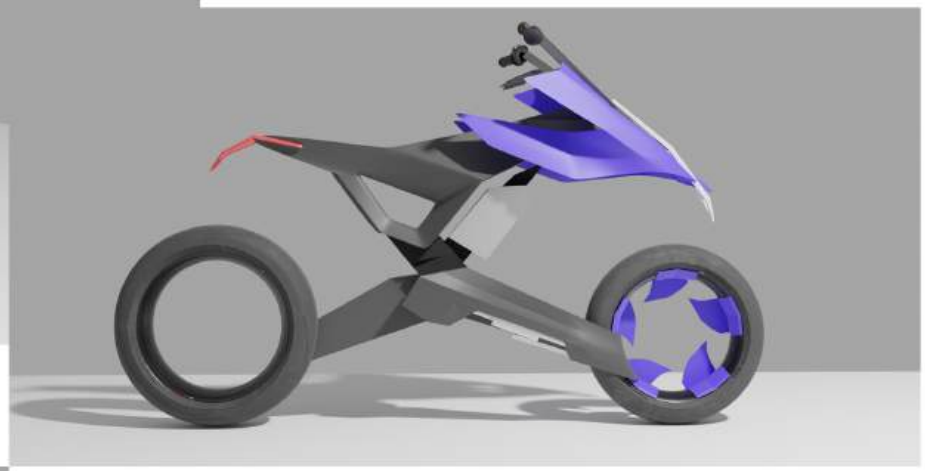
Stage 1

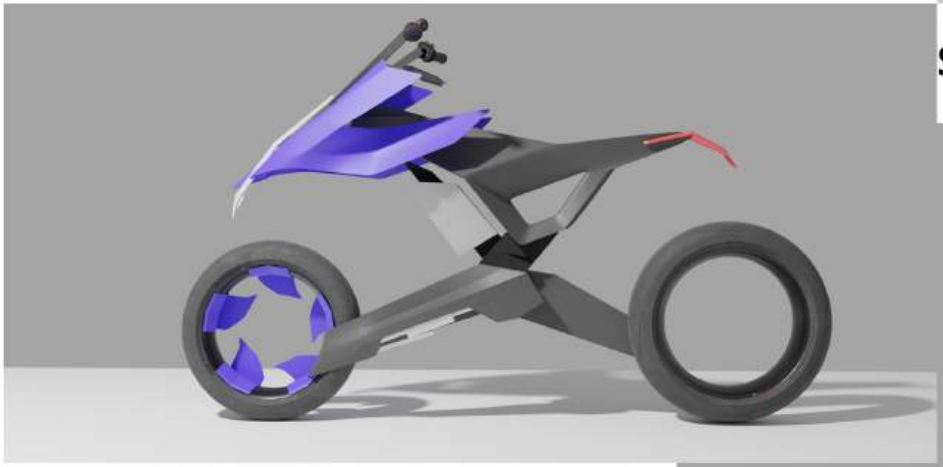






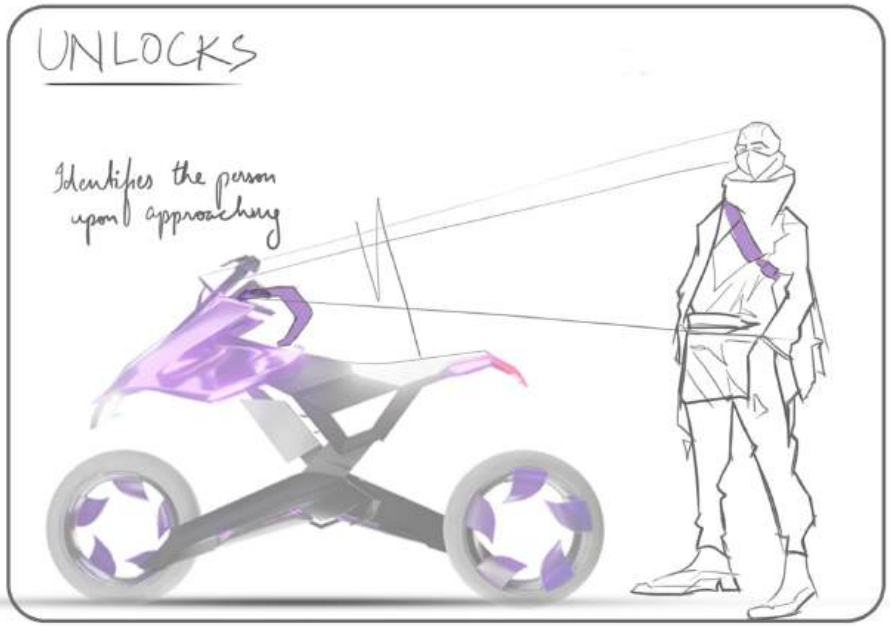


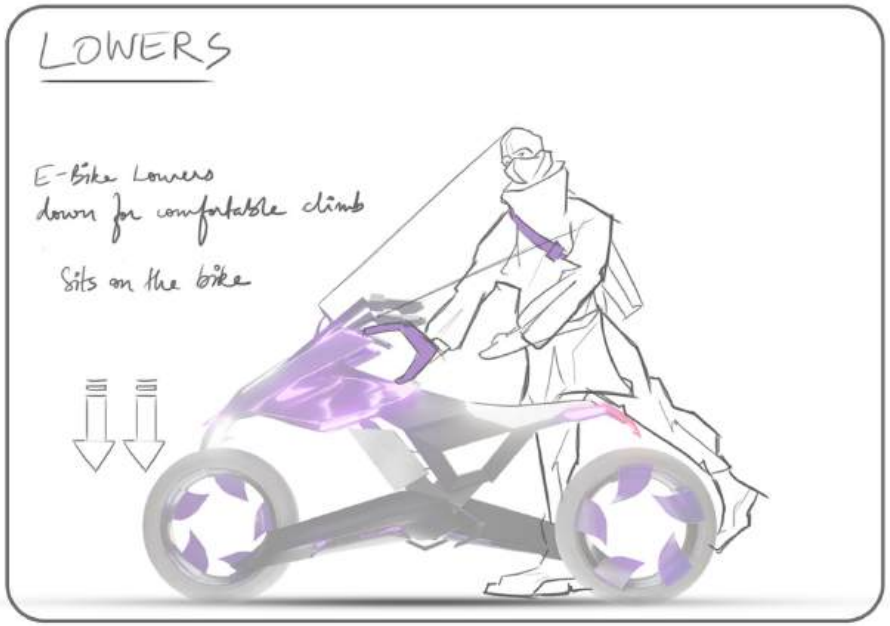


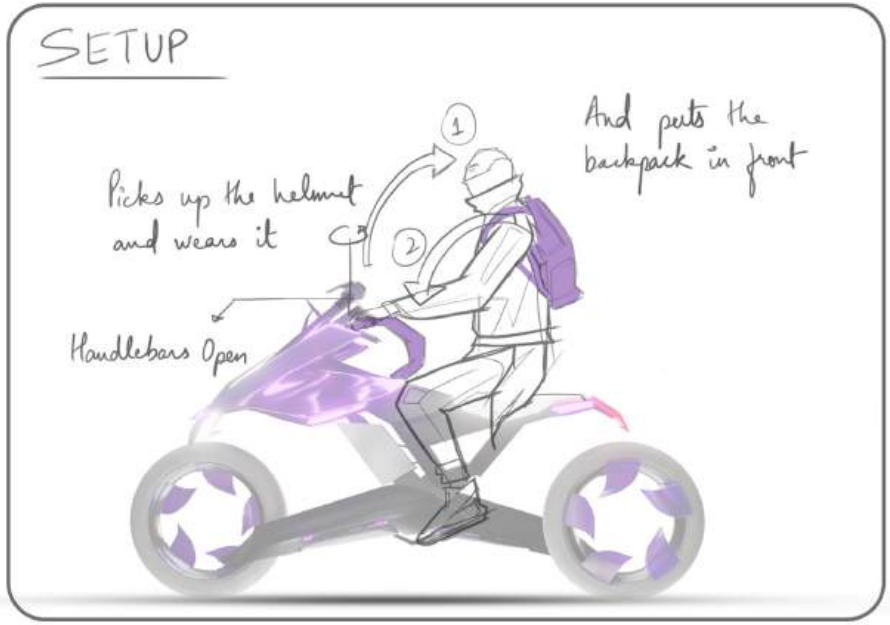


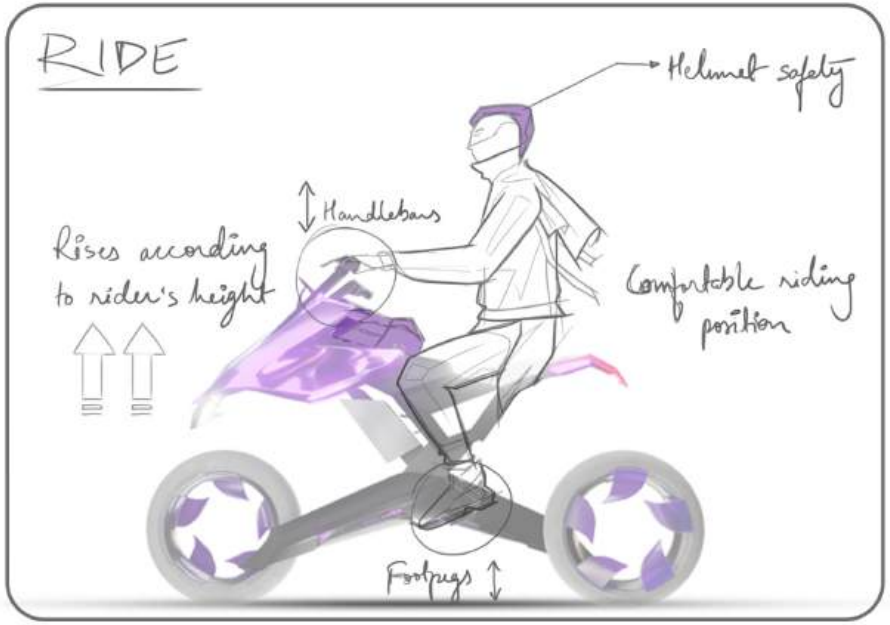
Stage 2

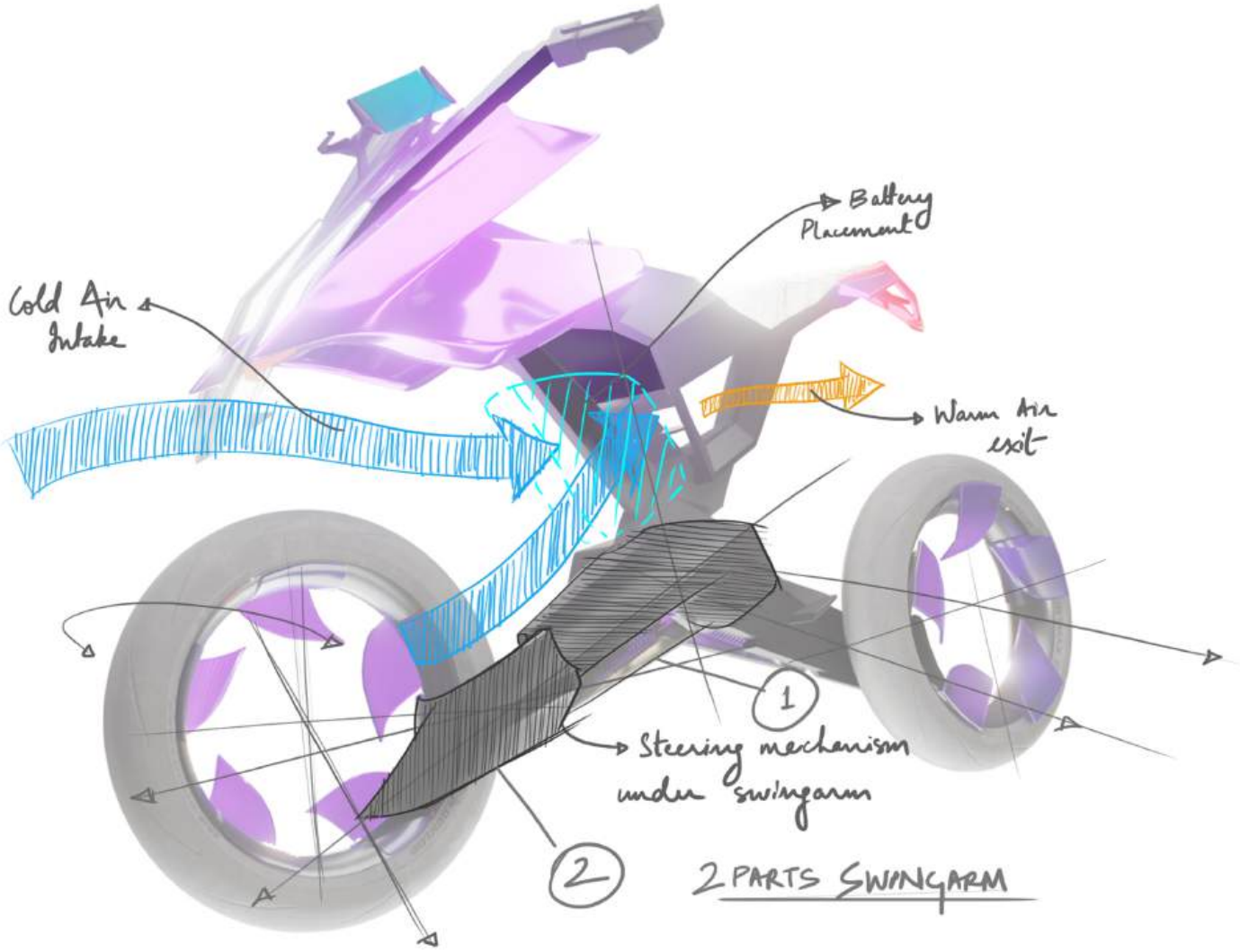
11. E-BIKE DESIGN IN FUTURE SCENARIO

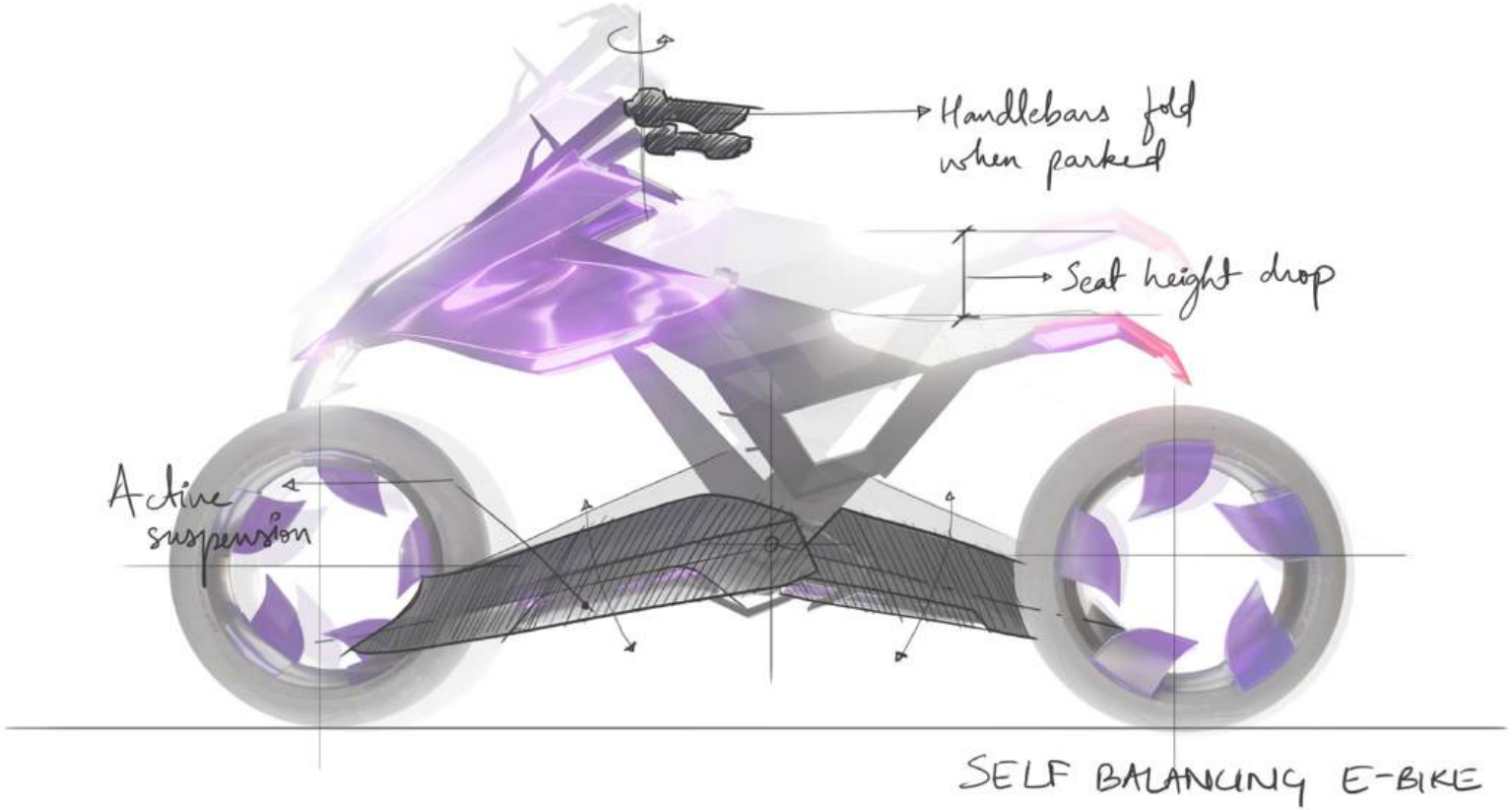


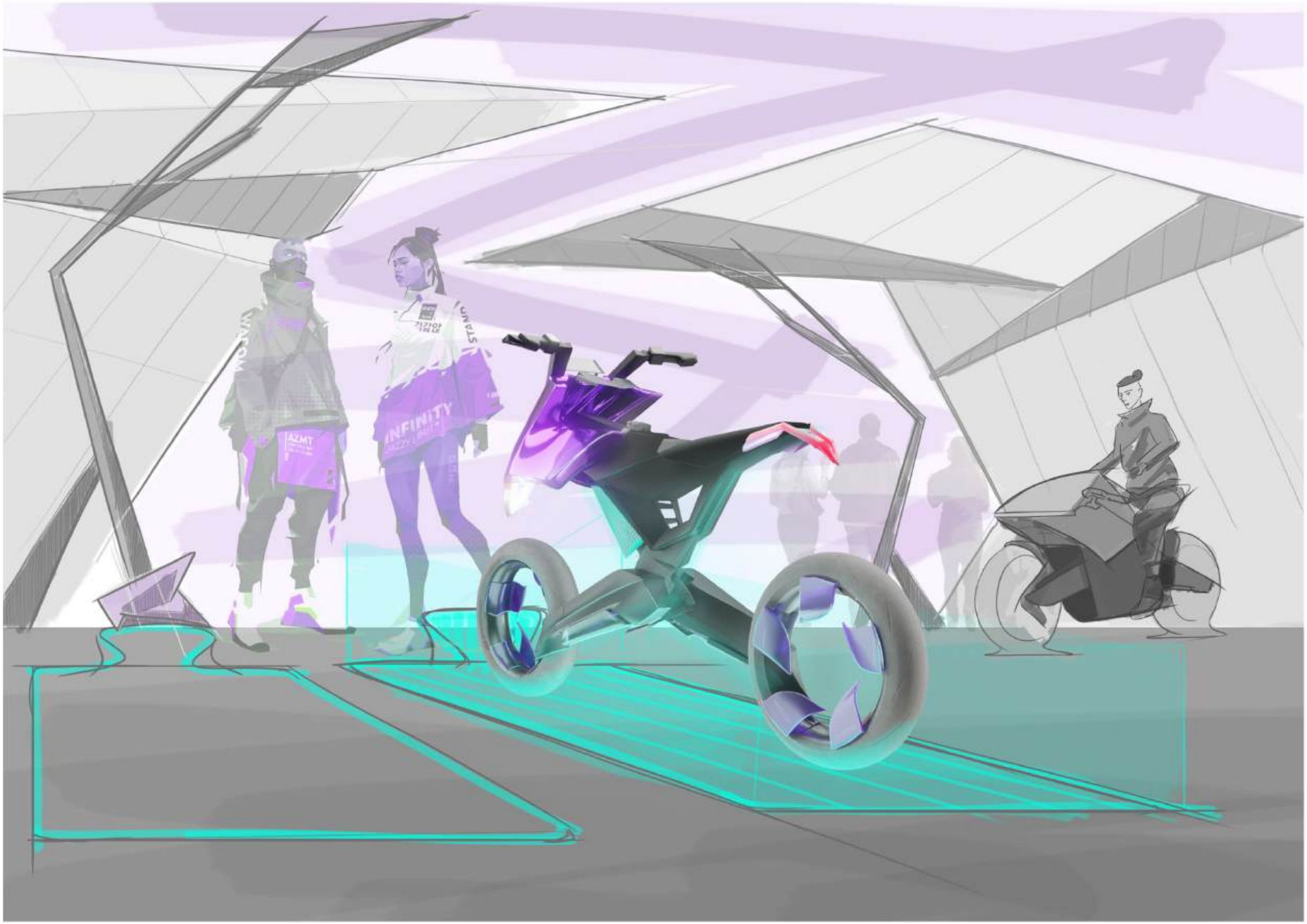







Battery Placement
Cold Air Intake
Warm Air exit
1
Steering mechanism under swingarm
2
2 PARTS SWINGARM


Handlebars fold when parked
Seat height drop
Active suspension
SELF BALANCING E-BIKE


INFINITY
AZMT

12. FINAL DESIGN RENDERS


*with accessories

13. 1/5 SCALE PHYSICAL MODEL

14. REFERENCES

https://surron-global.com/light-bee/
https://novusbike.com/home-2/
https://dabmotors.com/
https://images.google.com/
https://in.pinterest.com/
https://thenounproject.com/
https://universitiesofthefuture.eu/
https://theglobestalk.com/advantages-and-disadvantages-of-electric-cars-environment/
https://rezap.com/batteries-and-the-environment/
https://en.wikipedia.org/wiki/Electric_vehicle_battery
https://www.iotm2mcouncil.org/iot-library/news/smart-cities-news/continental-and-iteris-develop-intelligent-infrastructure/

Thank you