

Concept Electric Bike for Tork Motors

*Design Project 1 Summer Internship by Rishi Soman (146390004)
IDC, IIT Bombay.*

Experience certificate



TORK MOTORS PVT LTD

Plot 4/25, Sector 10, PCNTDA
MIDC, BHOSARI, PUNE – 411026.
CONTACT: +919860491243

To,

Industrial Design Center

Indian Institute of Technology Bombay,

Powai, Mumbai, Maharashtra 400076

Subject : Experience Certificate

This is to certify that Mr. Rishi Soman, student from Industrial Design Centre, IIT Bombay has completed his internship with us from 5th May to 6th June 2015. Mr. Rishi has designed an electric street motorbike for Tork Motors Pvt. Ltd. as per our guidelines

Tork Motors Pvt. Ltd. is satisfied with the work done by Mr. Rishi

Thanking you

For TORK MOTORS PVT. LTD.

Director

Kapil Shelke
Director /Founder
Tork Motors Pvt Ltd

Acknowledgement

My thanks to Prof. Nishant Sharma for introducing me to the Tork Motors crew without which this internship wouldn't be possible.

I am thankful to Mr. Mohit Sharma for enlightening me with the technical details of motorcycle design and for the fruitful discussions throughout the tenure of the project.

I'd also like to thank Mr. Kapil Shelke for painting a vivid picture of the future of Tork Motors which helped in delivering a satisfactory design at the end of the project. Also his visionary take on the future of electric vehicle design and business plans has been an inspiration for me.

And lastly I'd like to thank my batchmate Sridhar G. for helpful inputs that helped me a lot while designing the bike.

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1. About Internship

I interned at Tork Motors for a duration of one month starting from 5 May to 6 June, 2015.

My motive behind joining Tork Motors for the internship was to gain experience in working in a small startup and being able to play a major role in the design process.

1.1 About Tork Motors

Tork Motors Pvt. Ltd. was established in April 2009 to specialise in design and development of the electric sports motorcycle.

Their first electric motorcycle prototype TOO1X gave them enough reasons to develop the parts and components for electric vehicle and proved ideal by winning the respected races like **Isle of Man TT** (the toughest circuit in the world) and **TTXGP**.

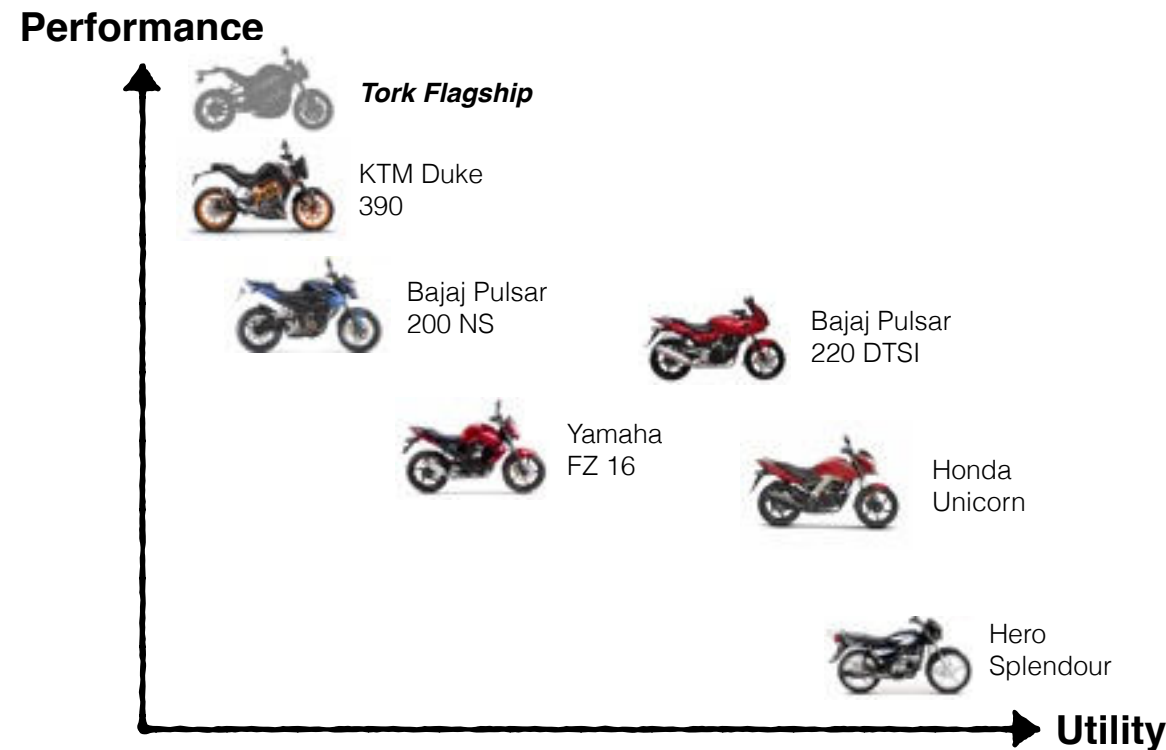
Therefore, Tork Motors has specialised in complete drivetrain solution and other components, with specific focus on controller units, Battery Management System (BMS), hall effect throttle etc.

2. Design Brief

To design a high performance electric street bike.

This high performance electric street bike is proposed to be the flagship product for Tork Motors. A prototype of this concept would be built to be used as a proof of concept and to invite potential investors.

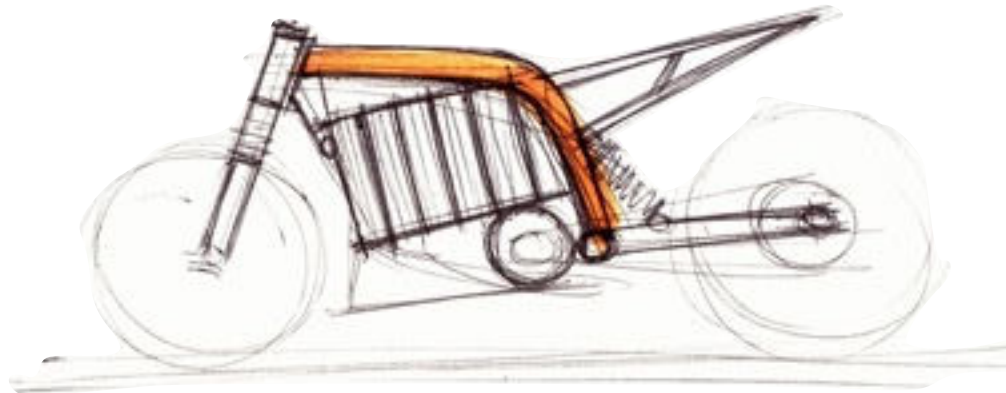
2.1 Product Placement



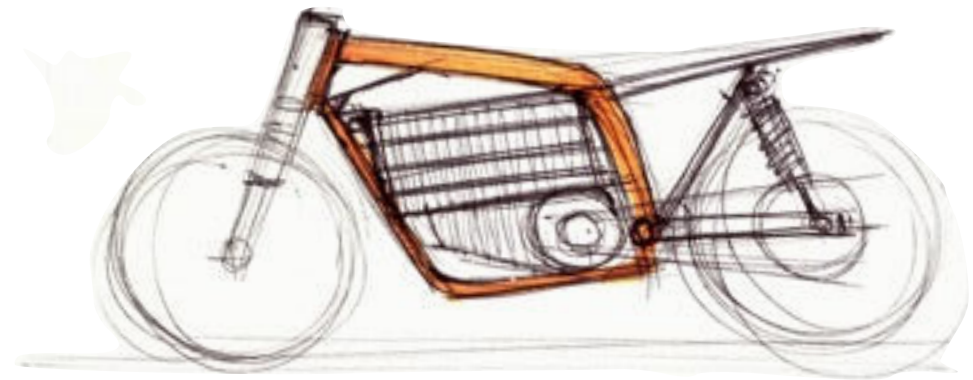
Tork Motors has a 'top-down' business model. They plan to enter the market first with a high performance bike that will be in the price range of 2 to 2.5 lakhs. Later, more affordable bikes with lesser power will be launched. Competitively priced utility bikes will be launched once the drive-train technology is much more affordable.

Their *flagship model* is proposed to be an 8KW naked street performance bike which will compete with the likes of a 400cc IC engine bike like the KTM Duke 390.

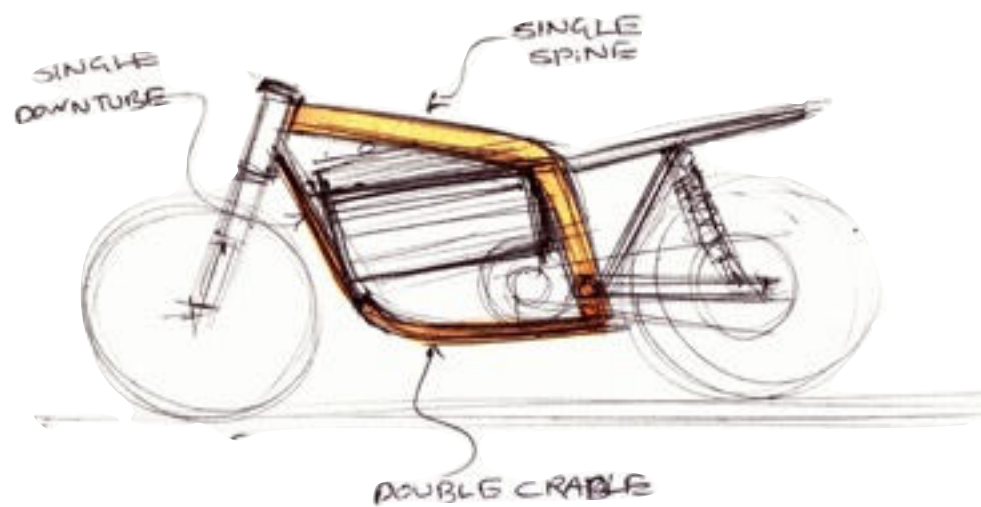
3. Chassis Study



Spine & Back-bone



Single Cradle & Full Duplex Cradle

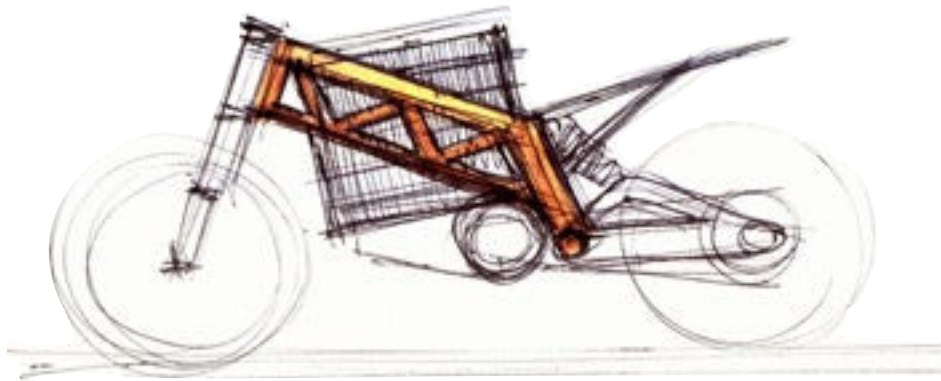


Half Duplex Cradle

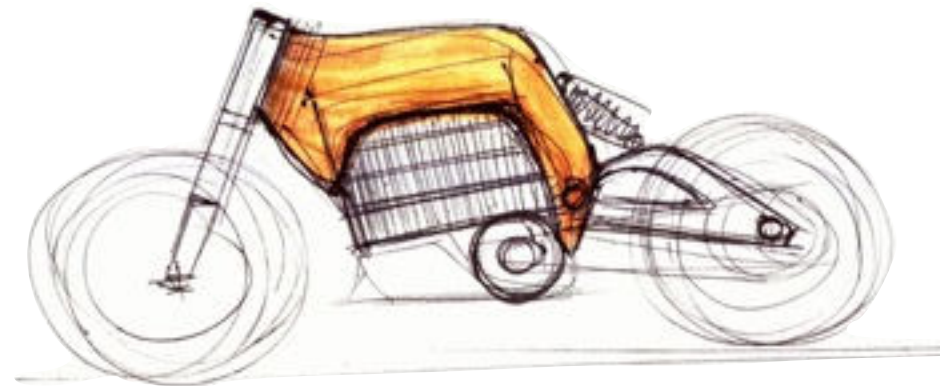


Perimeter

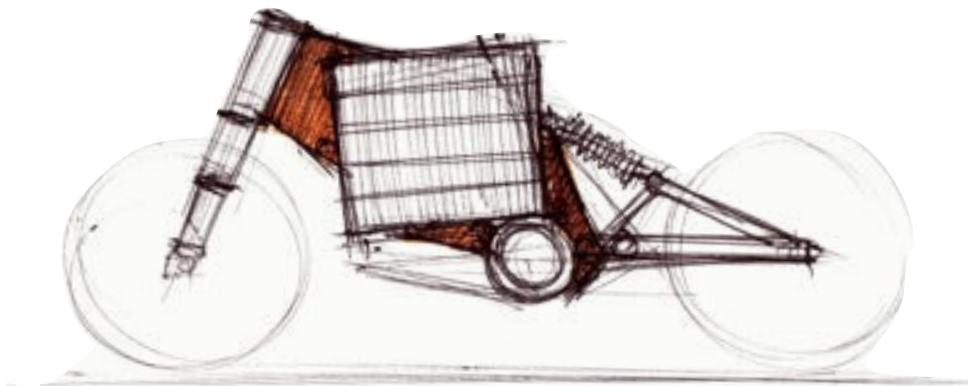
3. Chassis Study



Trellis Perimeter



Monocoque

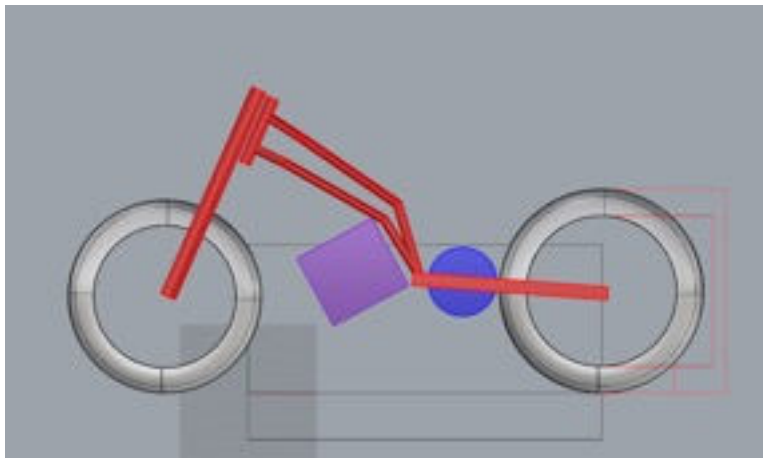


Stress Member

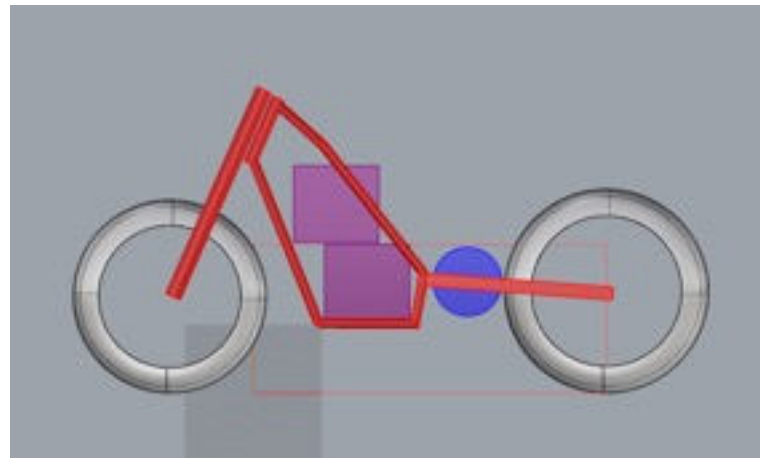


Perimeter-Alloy
Hybrid

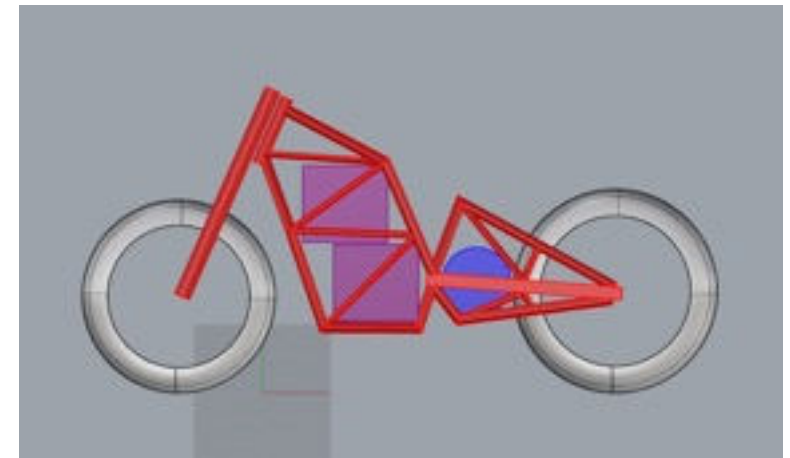
3. Chassis Study



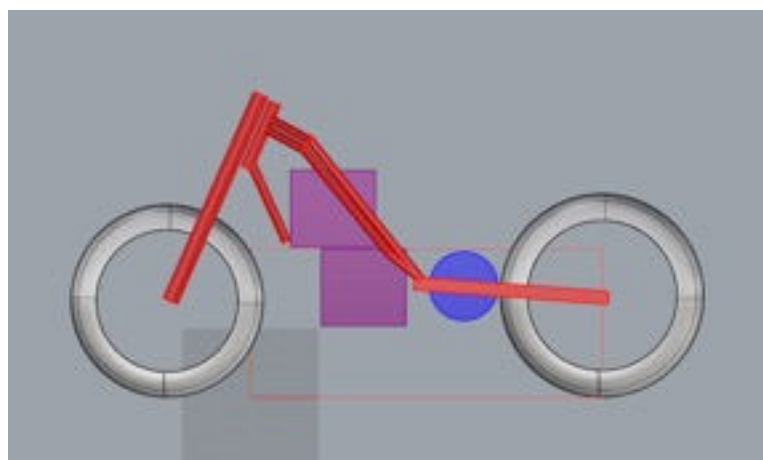
Perimeter Frame
with Double Bars



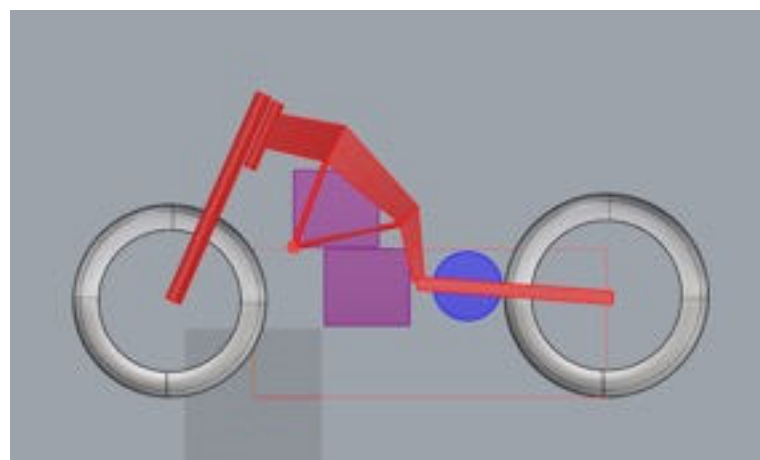
Full Duplex Frame



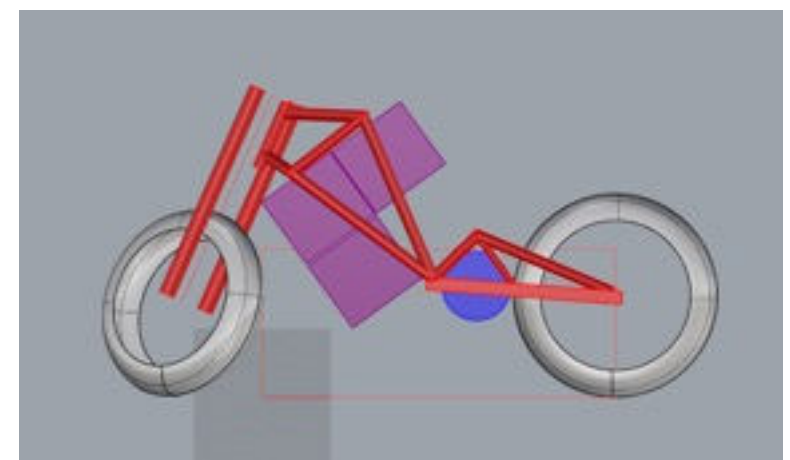
Full Duplex Cage



Perimeter Frame
with Downtube

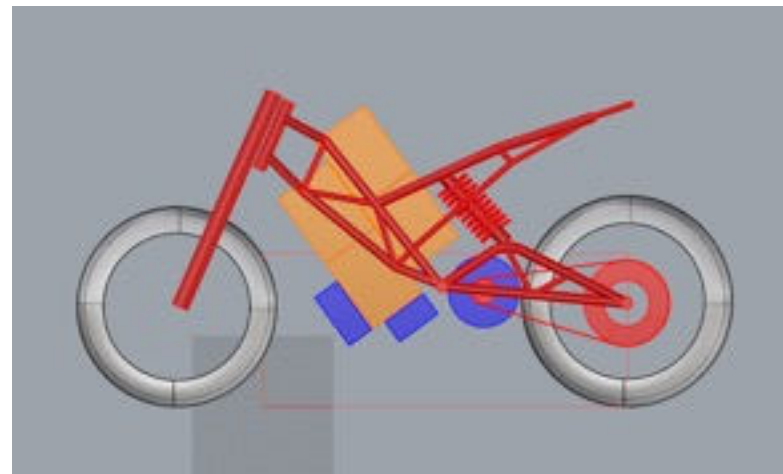


Perimeter Frame
with Downtube



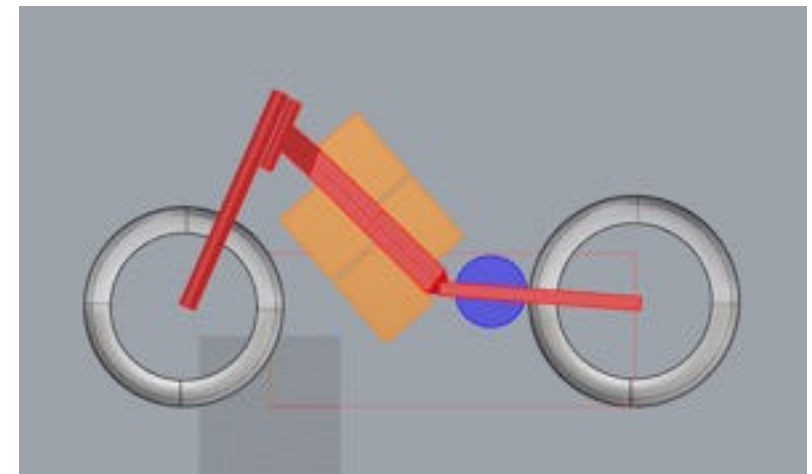
Sturdy Perimeter
Frame

3. Chassis Study



Perimeter Trellis
Frame

Various types of chassis were studied to accommodate the electric drive-train that consists of the *battery pack, motor, on-board charger and control module*. Swing-arm mounted motor was elected from the beginning as it frees up space in the main cage for the battery.



Pressed Steel
Perimeter Frame

Hub motor layout was not considered as it increases the unsprung mass which in-turn hampers the handling characteristics of the bike.

3.1 Chassis Direction

Perimeter Trellis Frame

Round Section Steel Tube

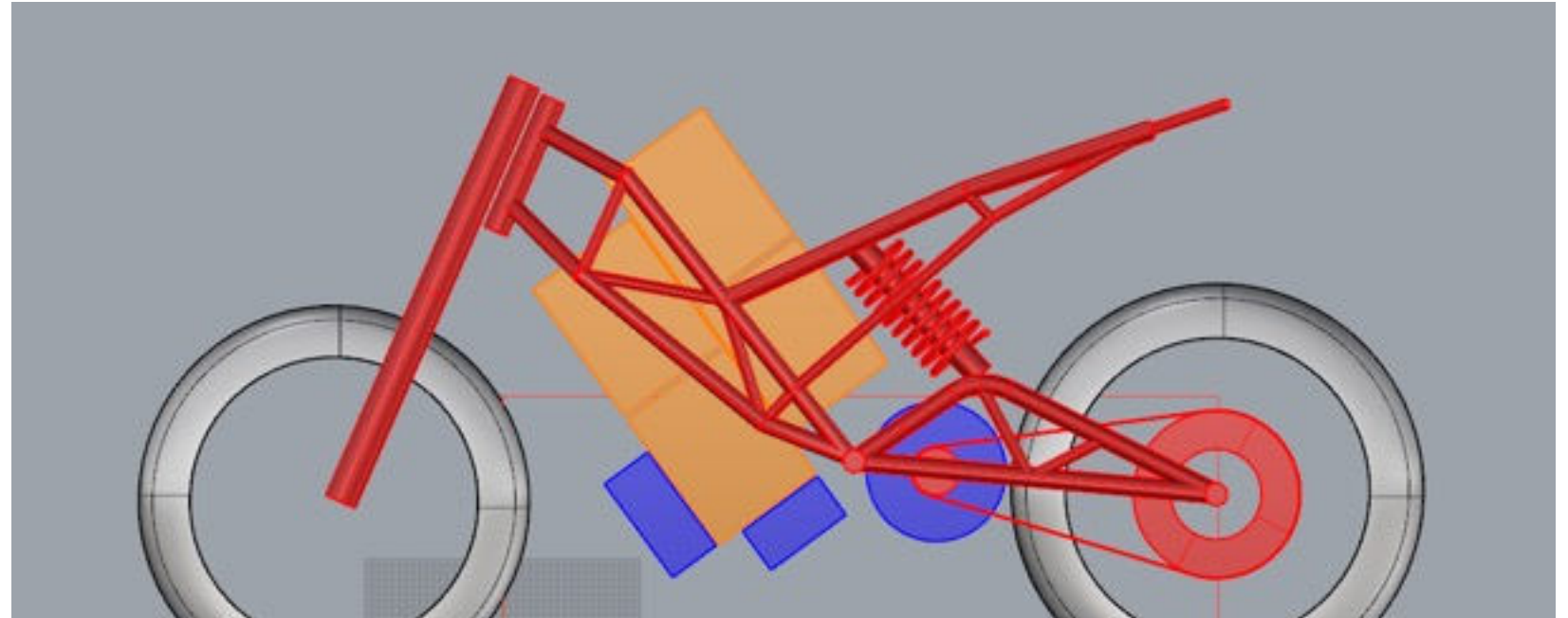
Battery Capacity: 4 X 2KW air-cooled

Final belt drive

Swing-arm mounted motor

Front inverted telescopic hydraulic suspension

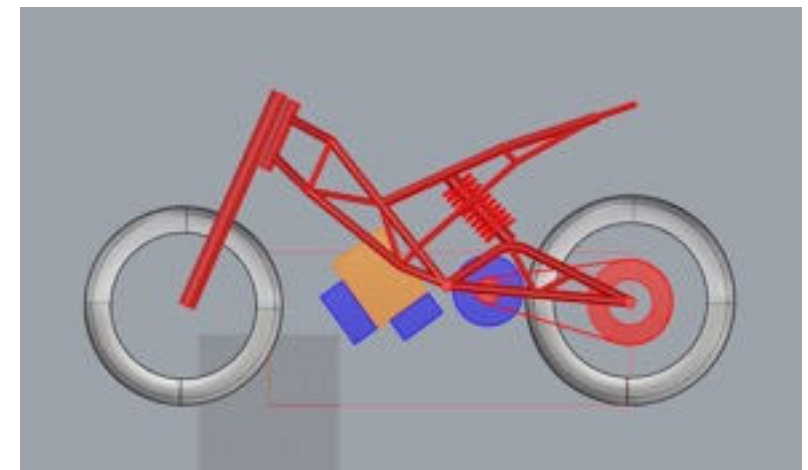
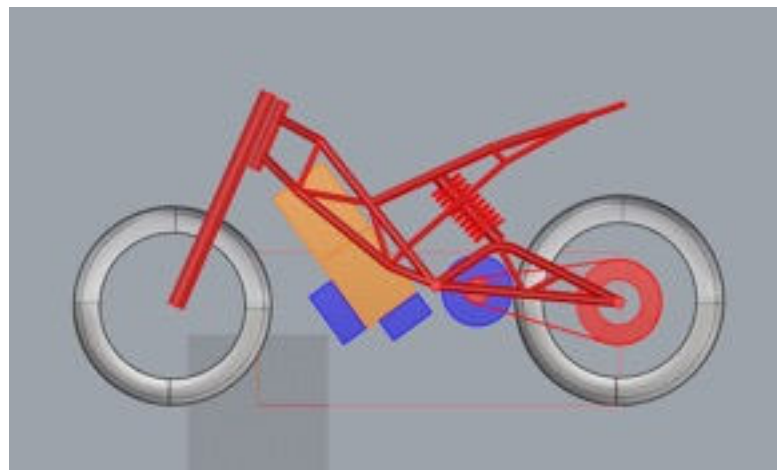
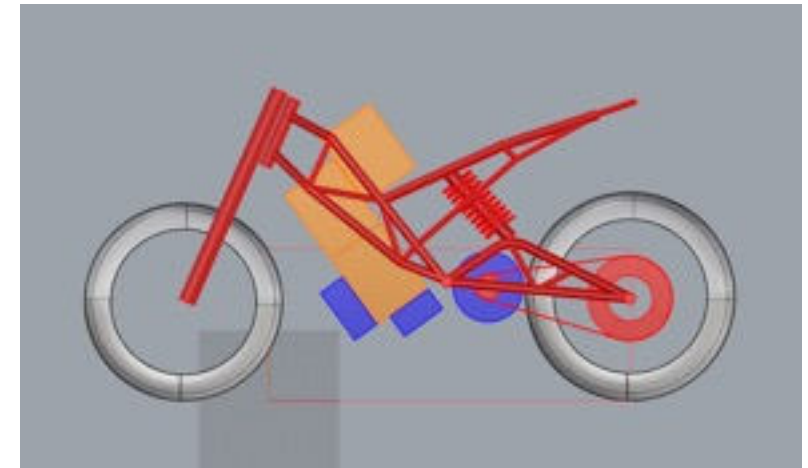
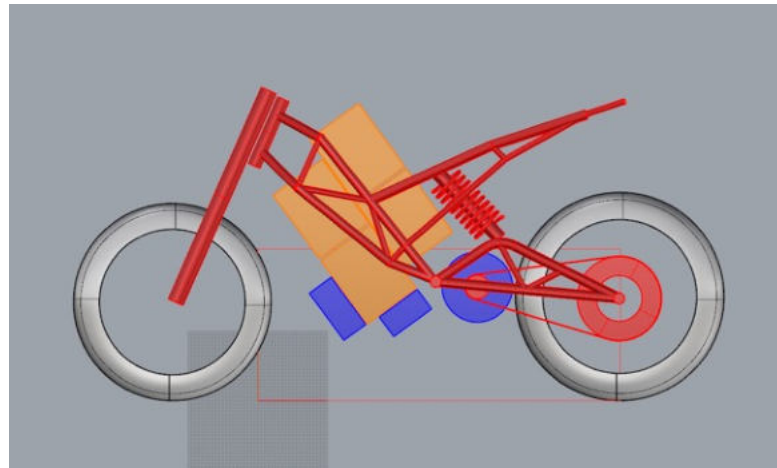
Rear gas assisted mono-shock



Construction of a **trellis frame** needs a more complicated process than, say, an alloy beam frame, it requires only a simple jig and a competent welder.

No heavy capital outlay is required, so a trellis frame is ideal for a model that may be made in relatively small numbers, and for this reason, the trellis frame option has found favour with European manufacturers and hence a stable candidate for Tork Motors.

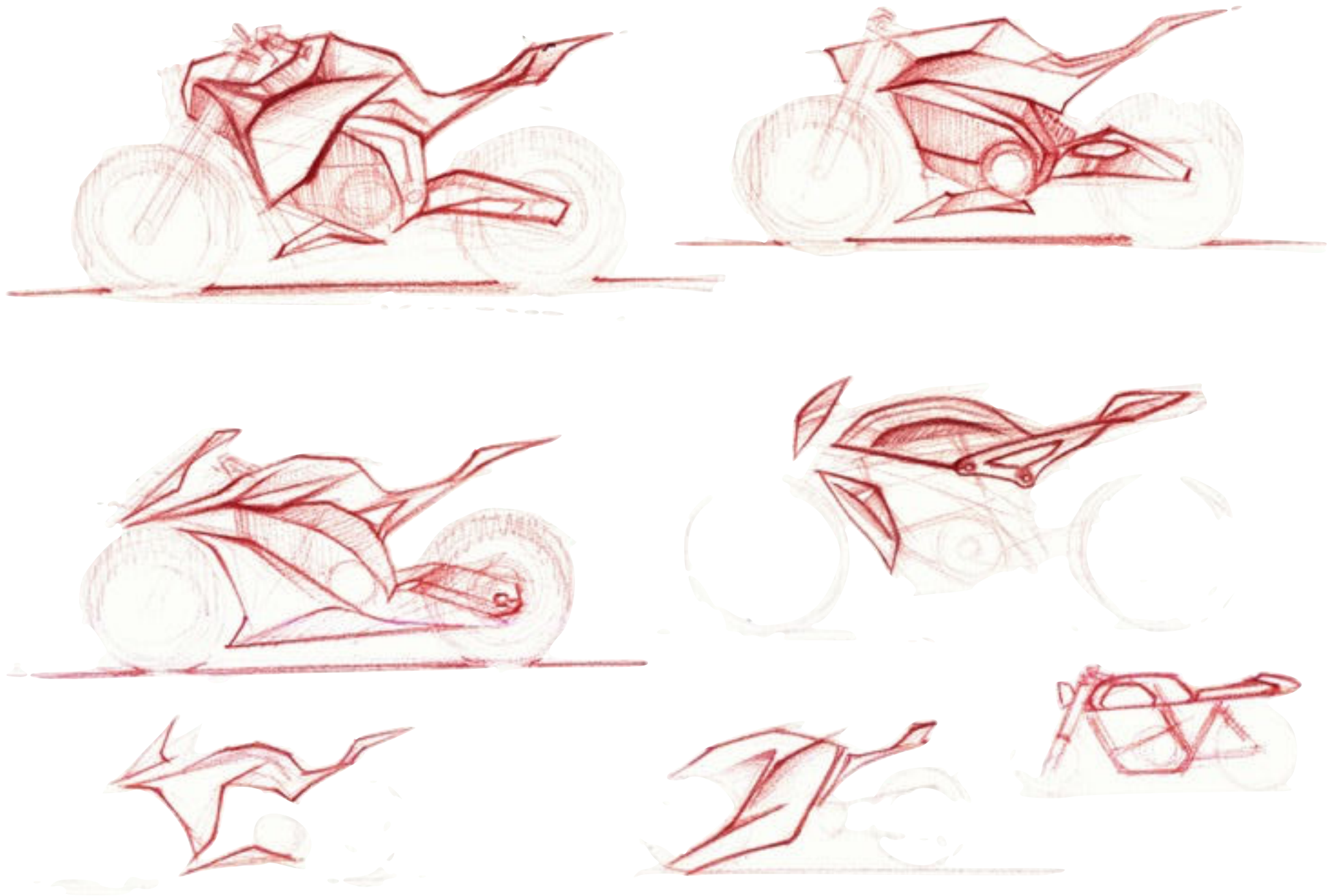
3.2 Scalable Platform



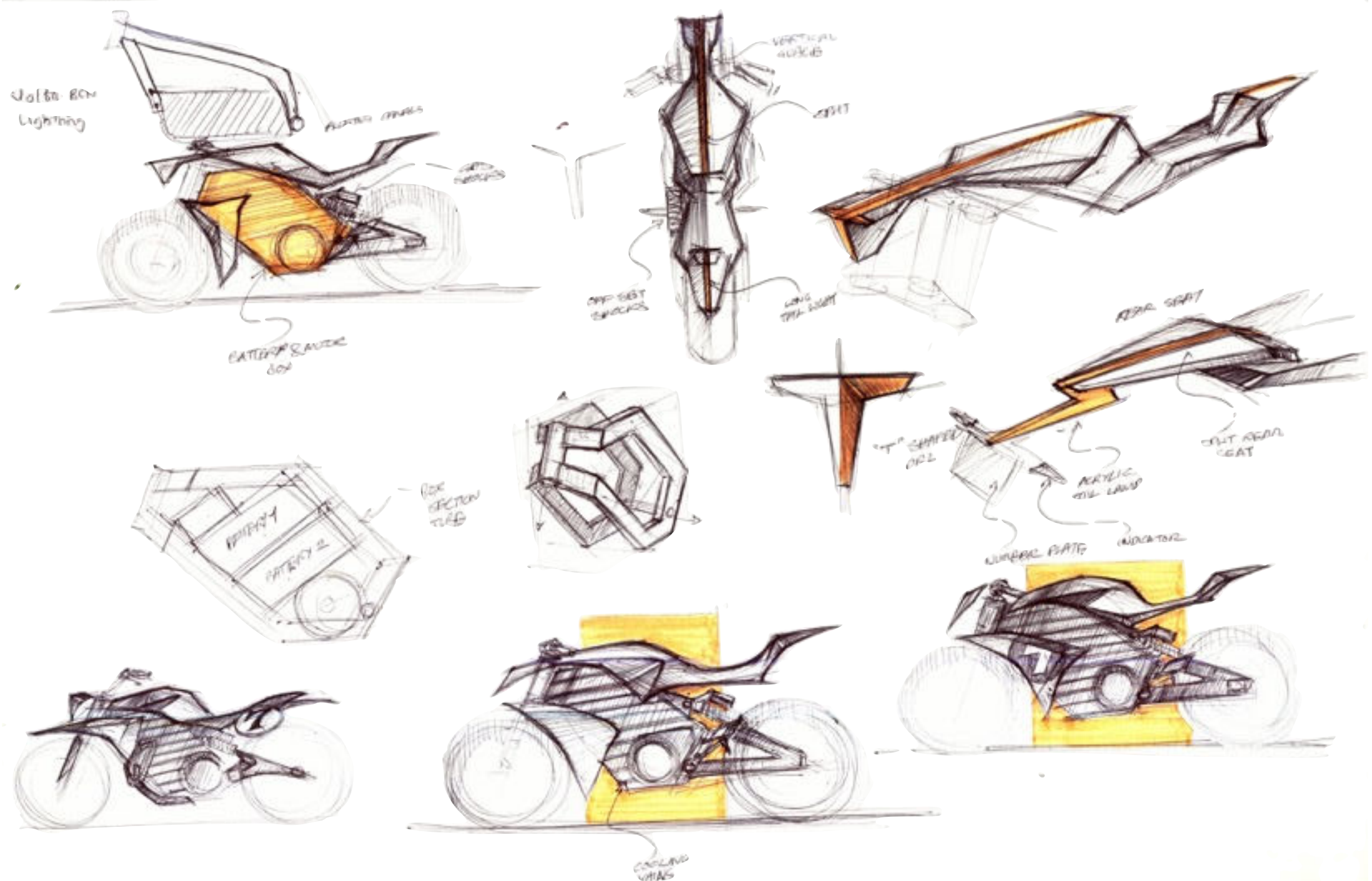
The battery pack is scalable. A maximum of **4 units of 2KW** battery packs can be mounted on the chassis. In effect, the same

chassis can be used for 2KW, 4KW, 6KW and 8KW models. Low power models of the bike will have more storage space.

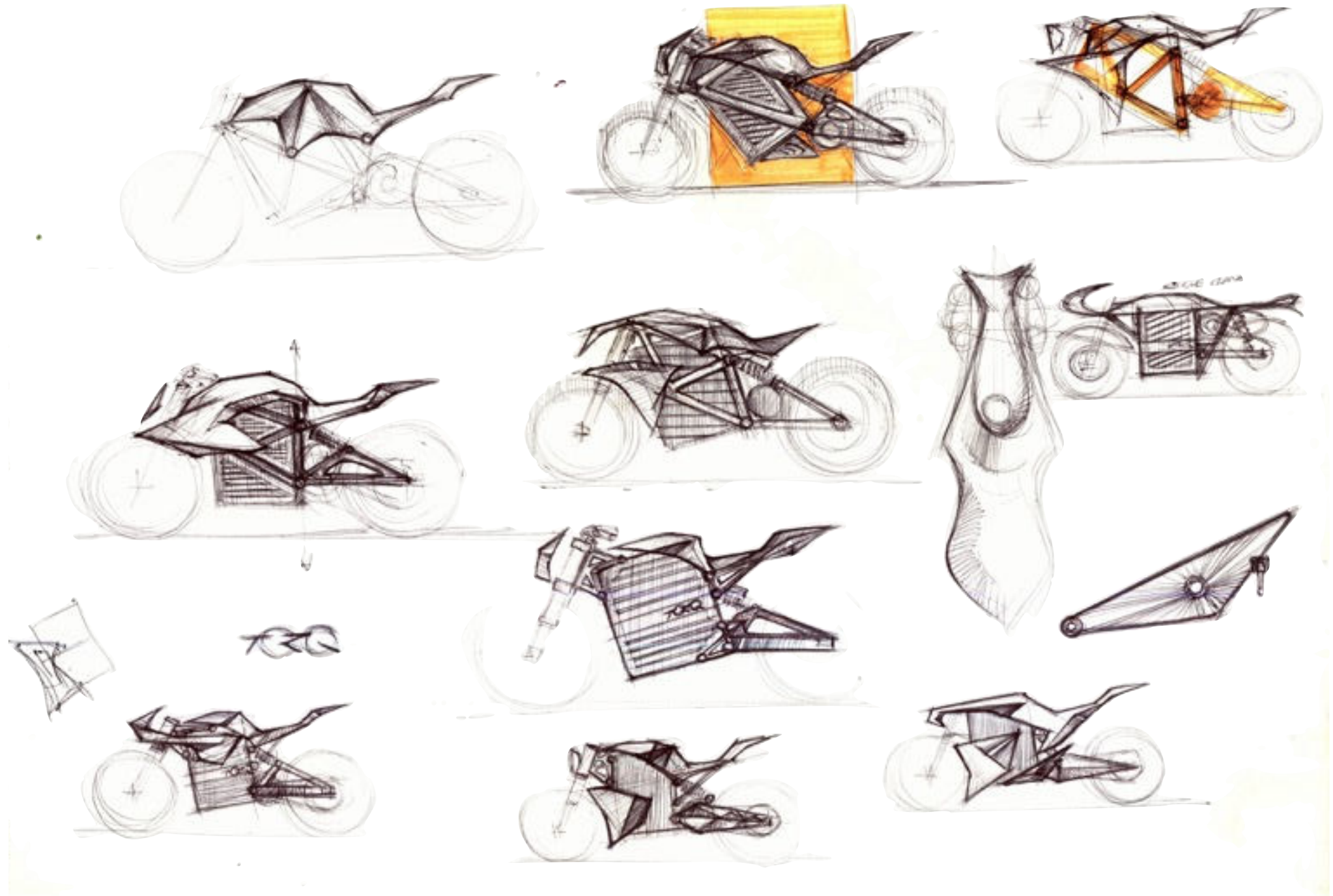
4. Initial Sketches



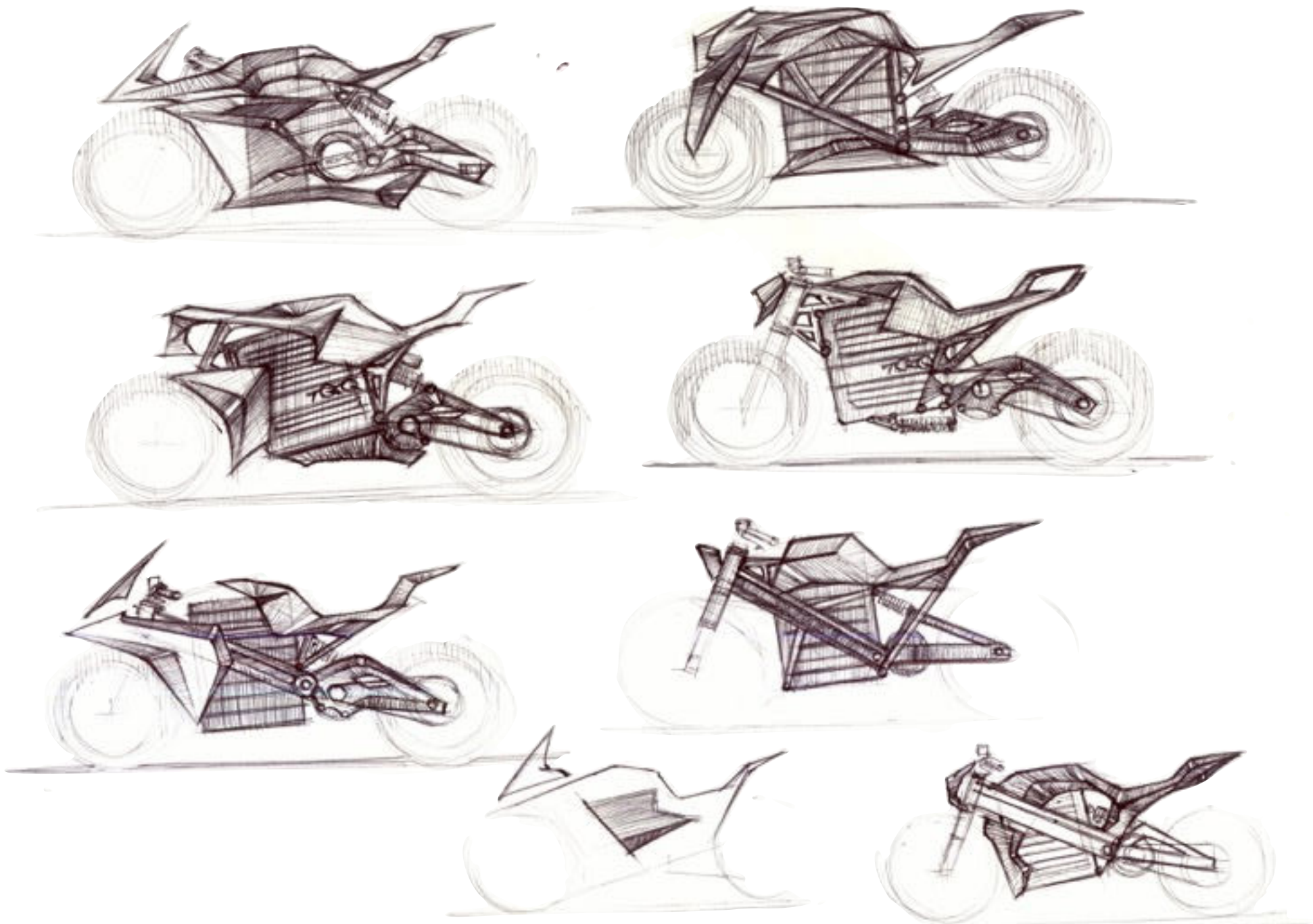
4. Initial Sketches



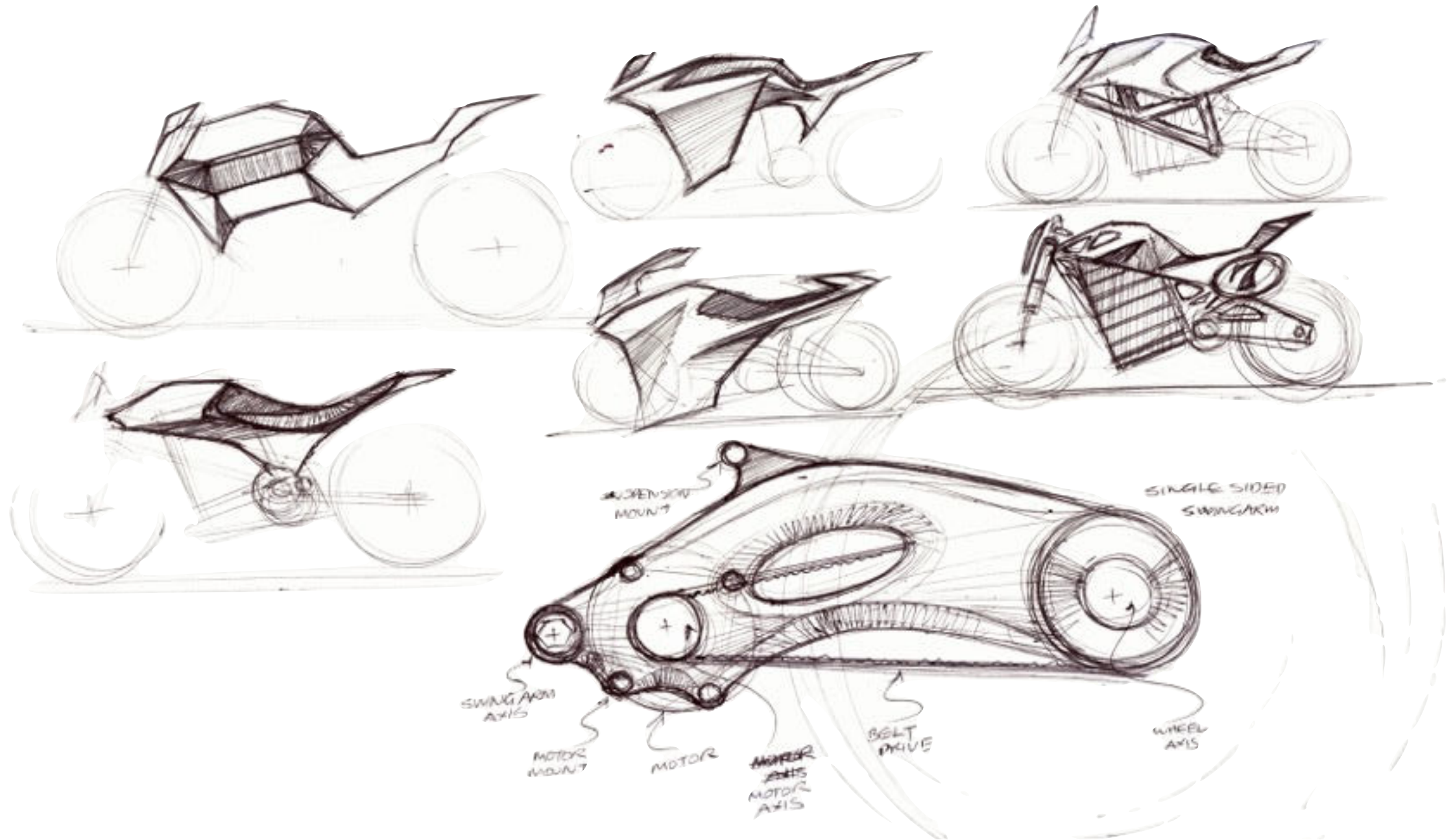
4. Initial Sketches



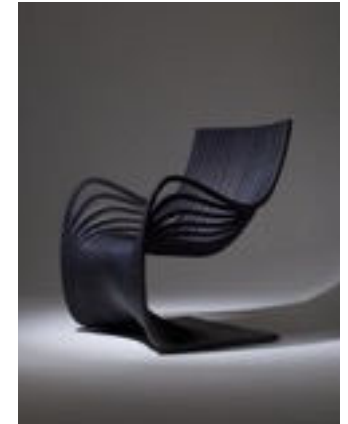
4. Initial Sketches



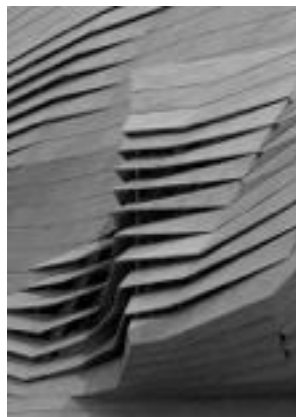
4. Initial Sketches



5. Moodboard



Elegant



Aggressive



Clean

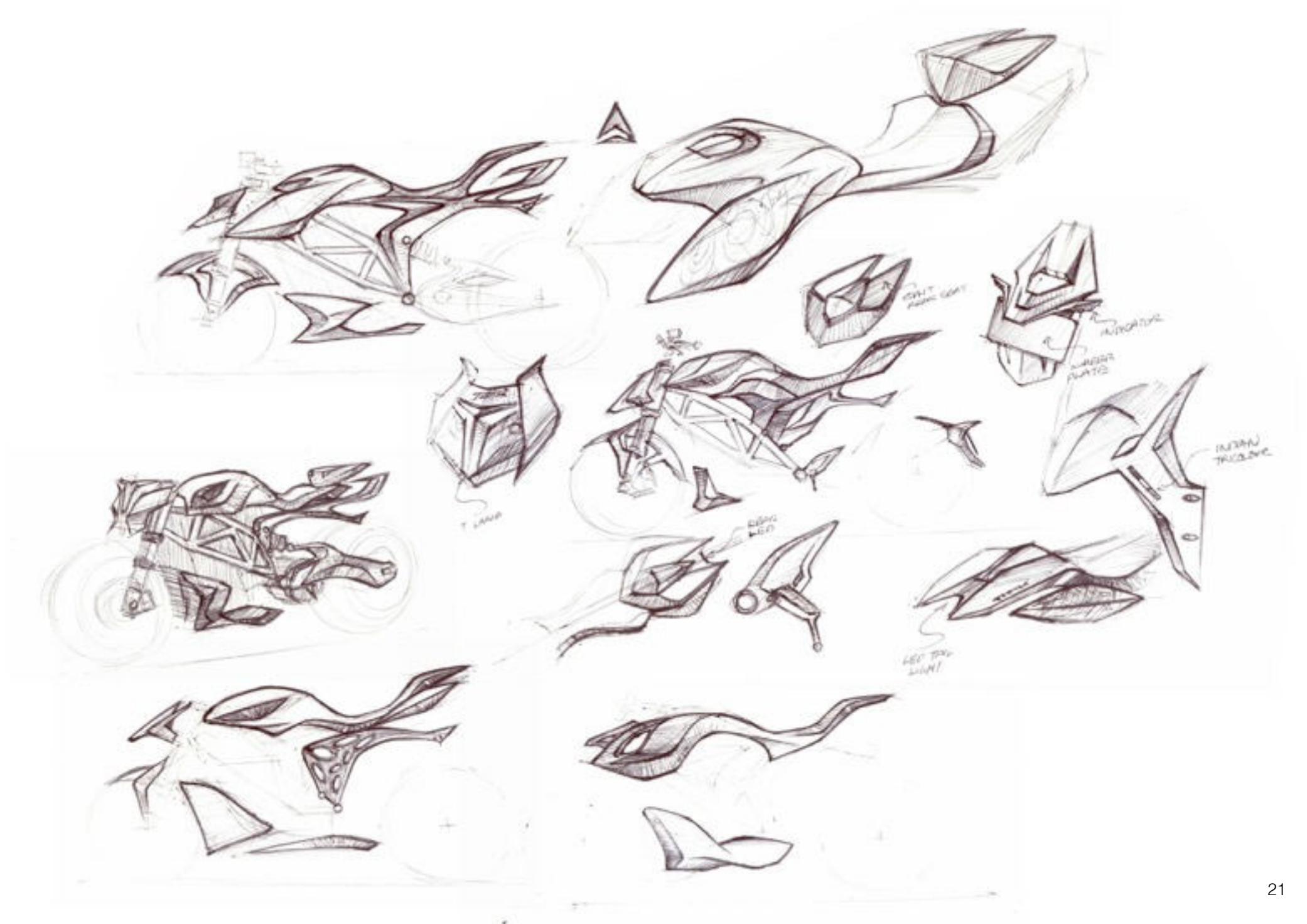


After much discussion and debate with the team at Tork Motors about their vision of a Tork bike, the final design mood board was arrived upon. Aggressive, clean and elegant

were the three words that best represented Tork Motors future aesthetic direction. Appropriate images from the internet were pulled and compiled into the final moodboard.

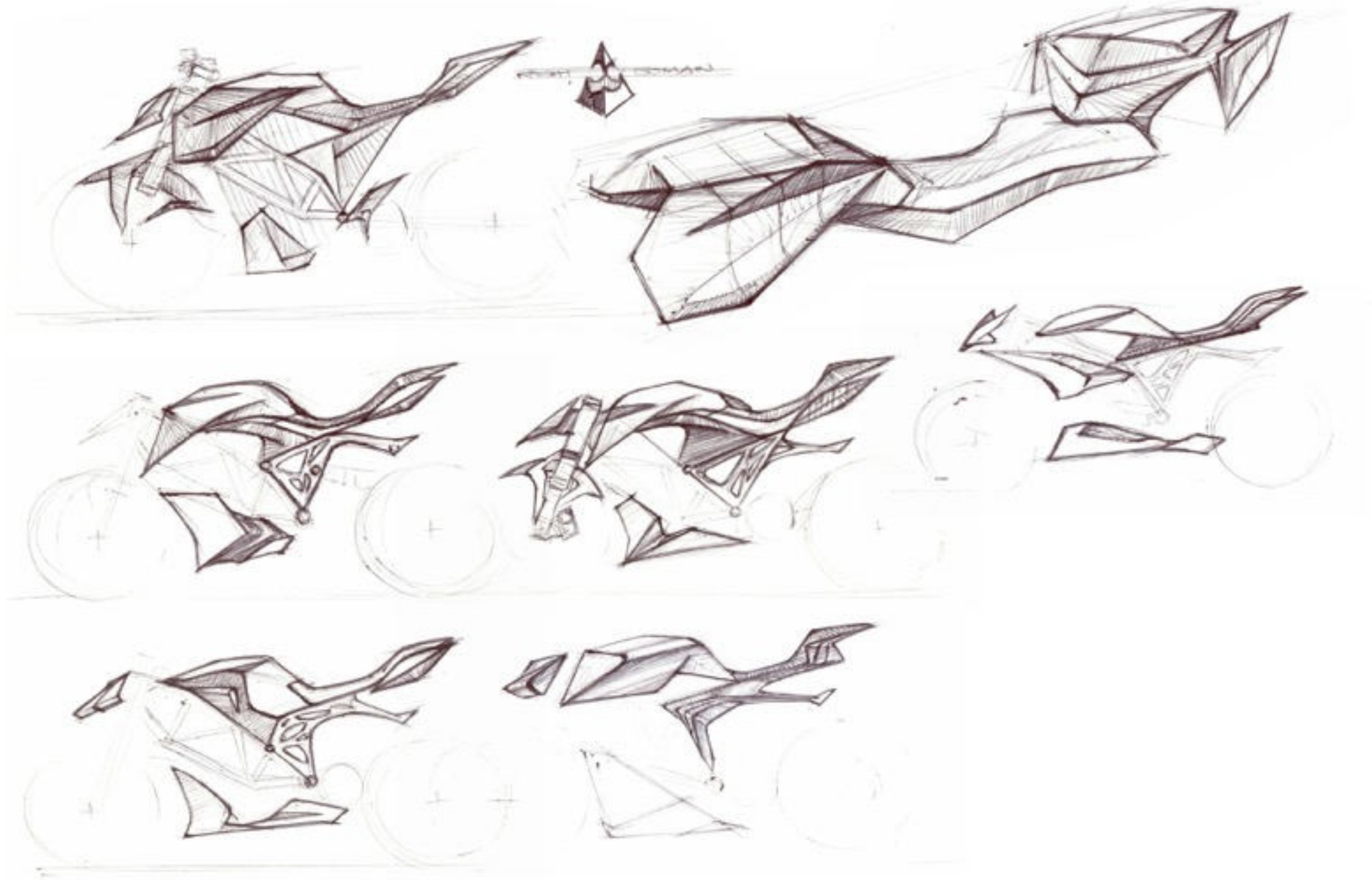
5.1 Design Direction

5.1.1 *Elegant Flow*



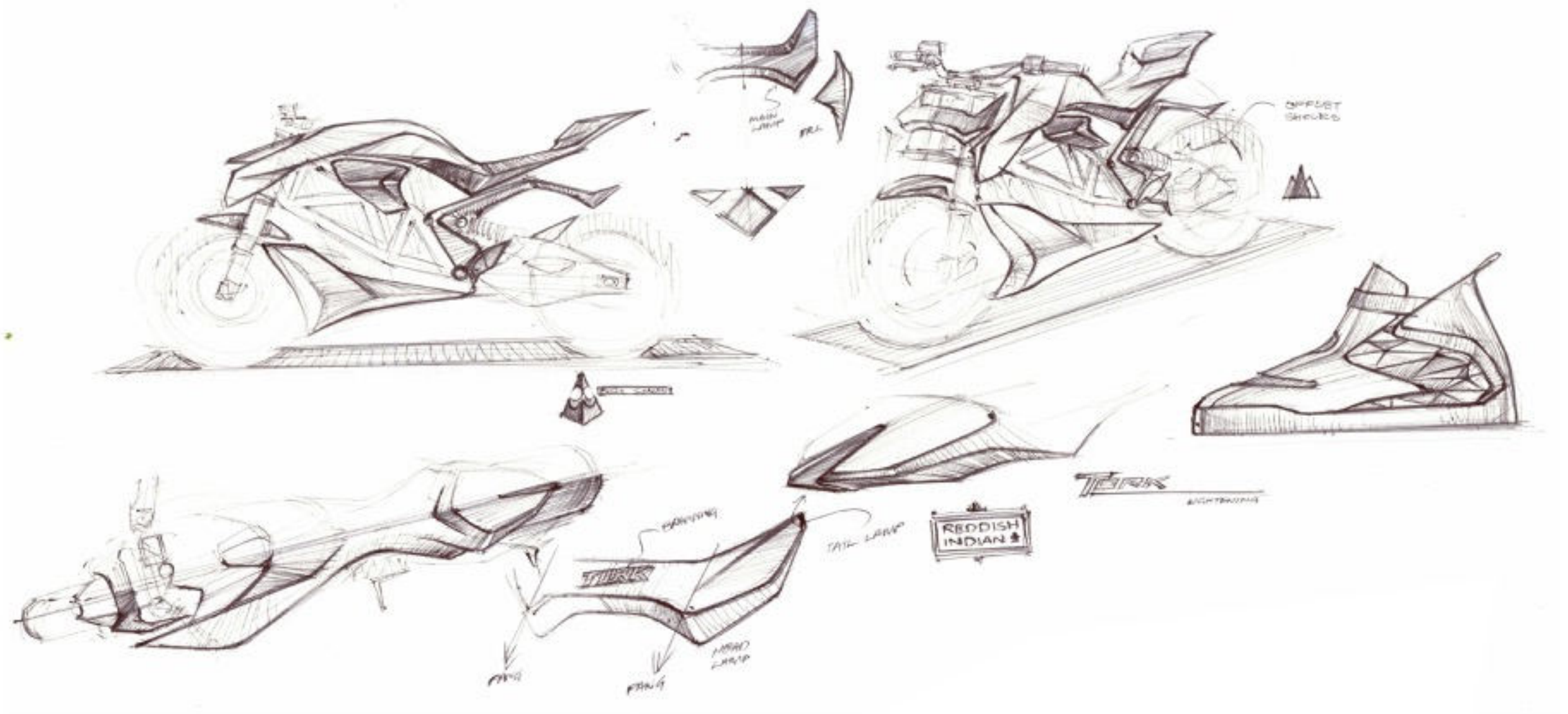
5.1 Design Direction

5.1.2 Geometric Beauty



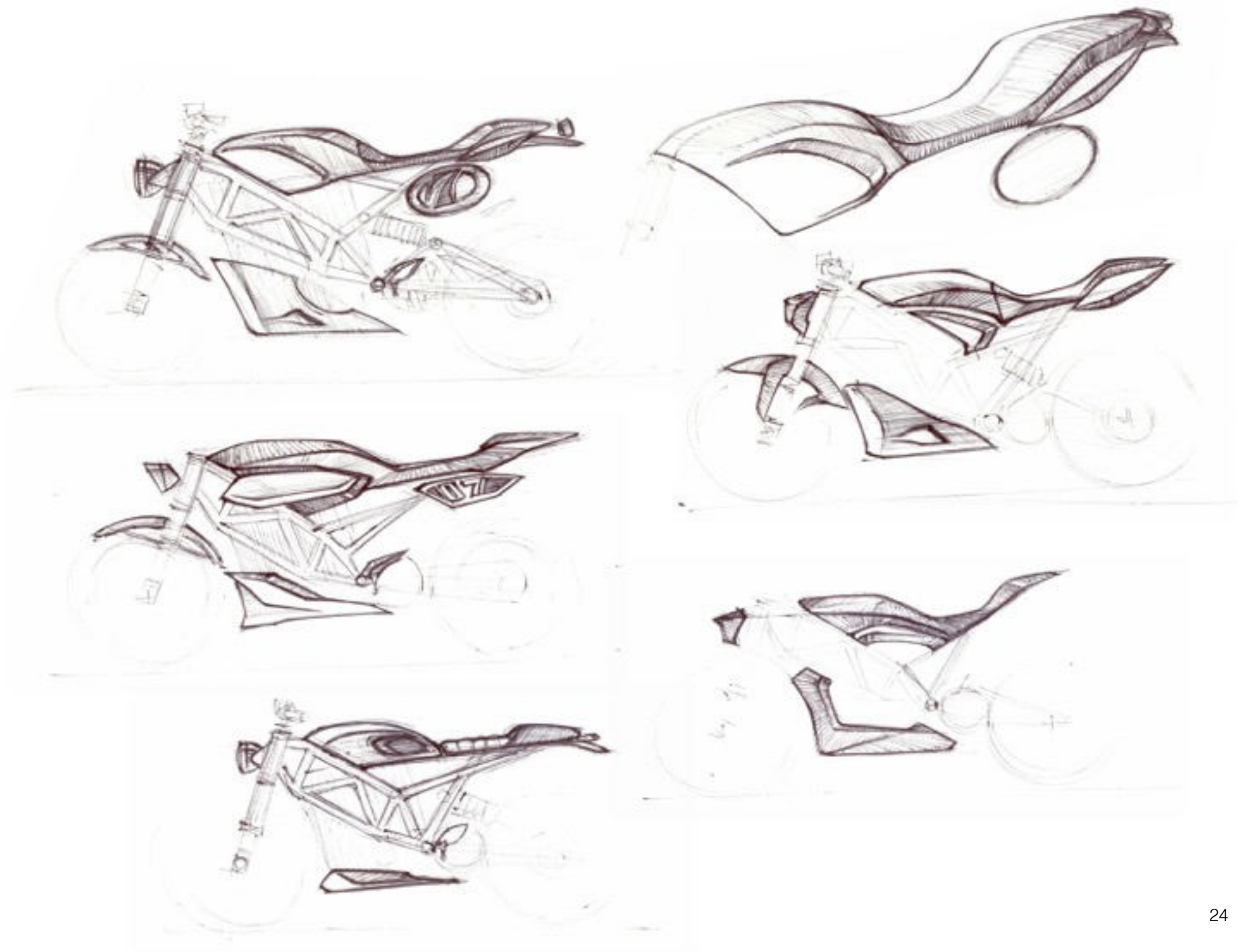
5.1 Design Direction

5.1.3 Muscular Sculpture

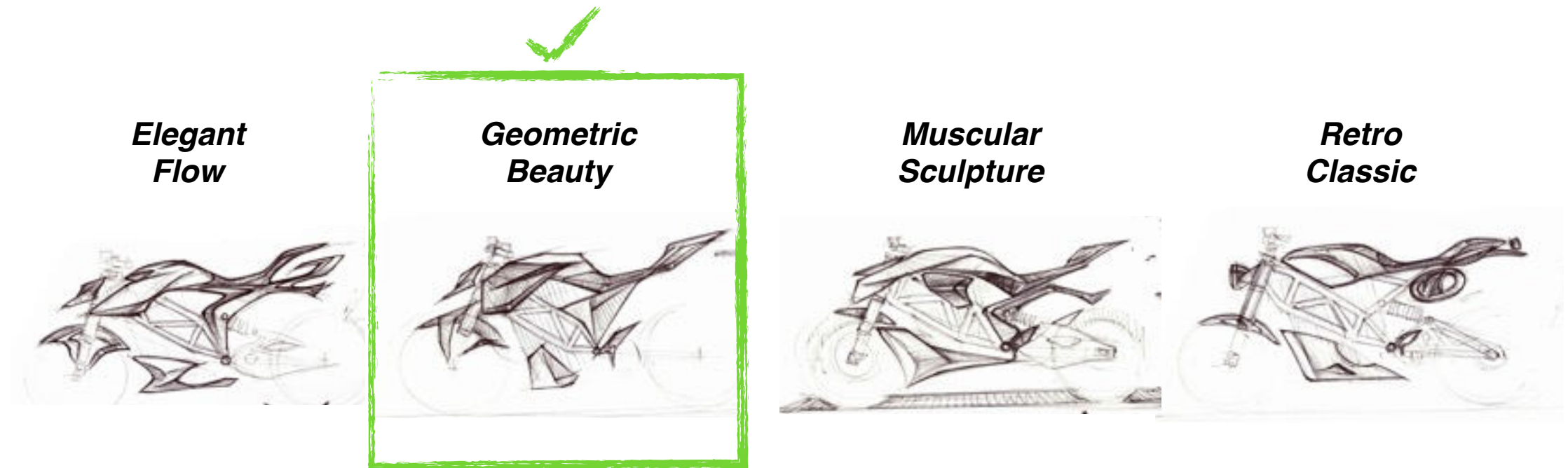


5.1 Design Direction

5.1.4 Retro Classic



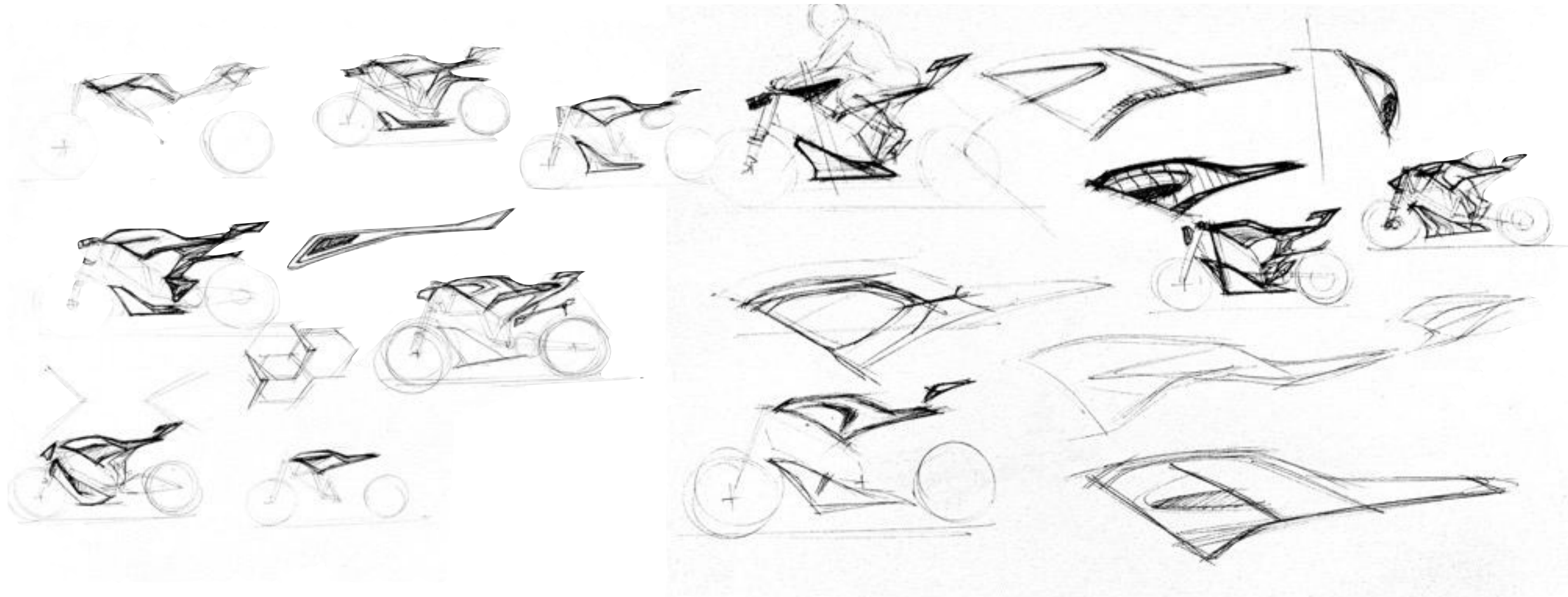
5.2 Final Design Direction



Four design directions were arrived upon: *elegant flow*, *geometric beauty*, *muscular sculpture* and *retro classic*. The team at Tork Motors preferred the contemporary geometric approach. Also this design direction felt more appropriate for

an electric bike. After all the design itself had to reflect the electric drive-train technology of the bike. The geometric design direction would also set it apart from the current crop of IC engine bikes in the market.

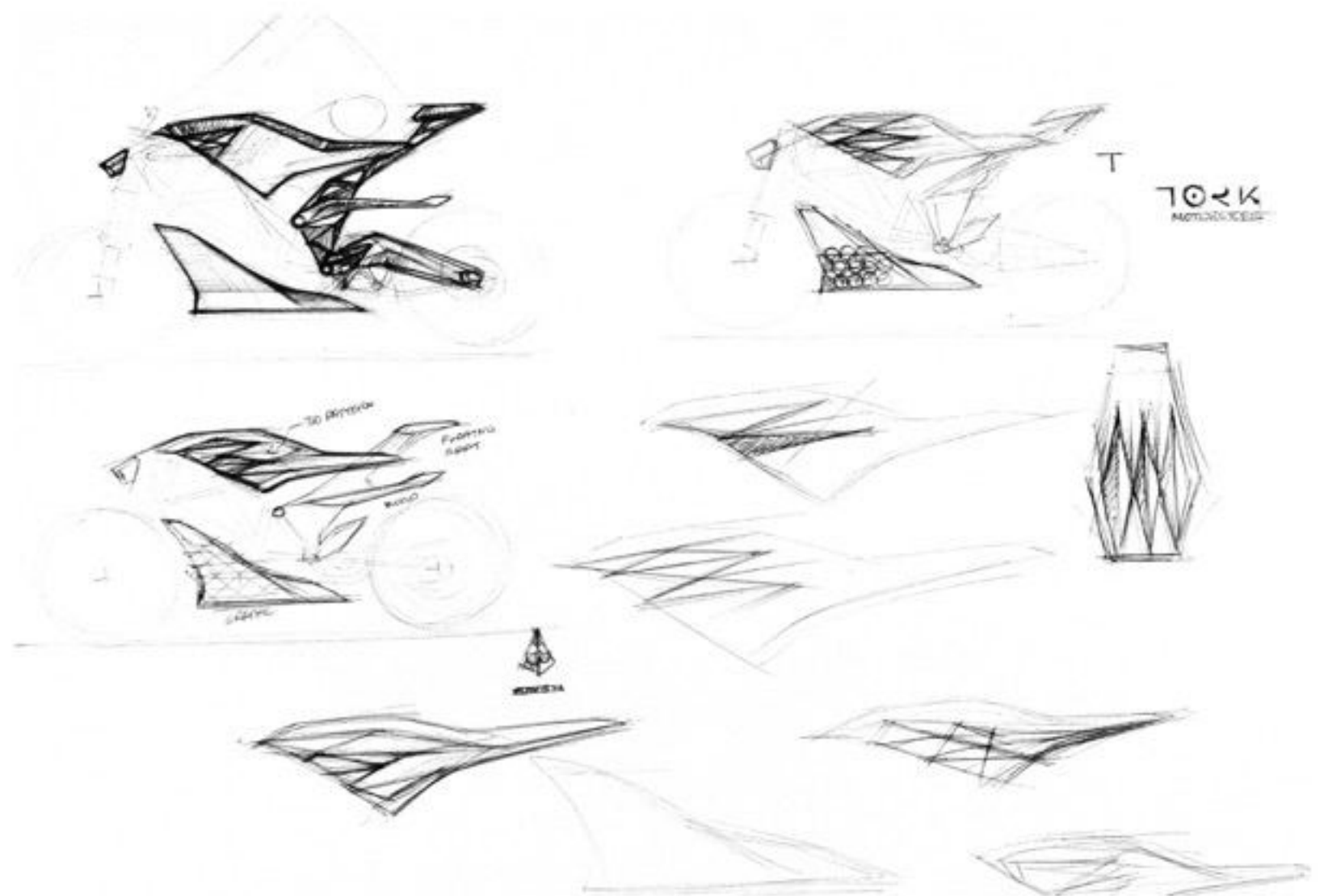
5.2 Final Design Direction



5.2 Final Design Direction

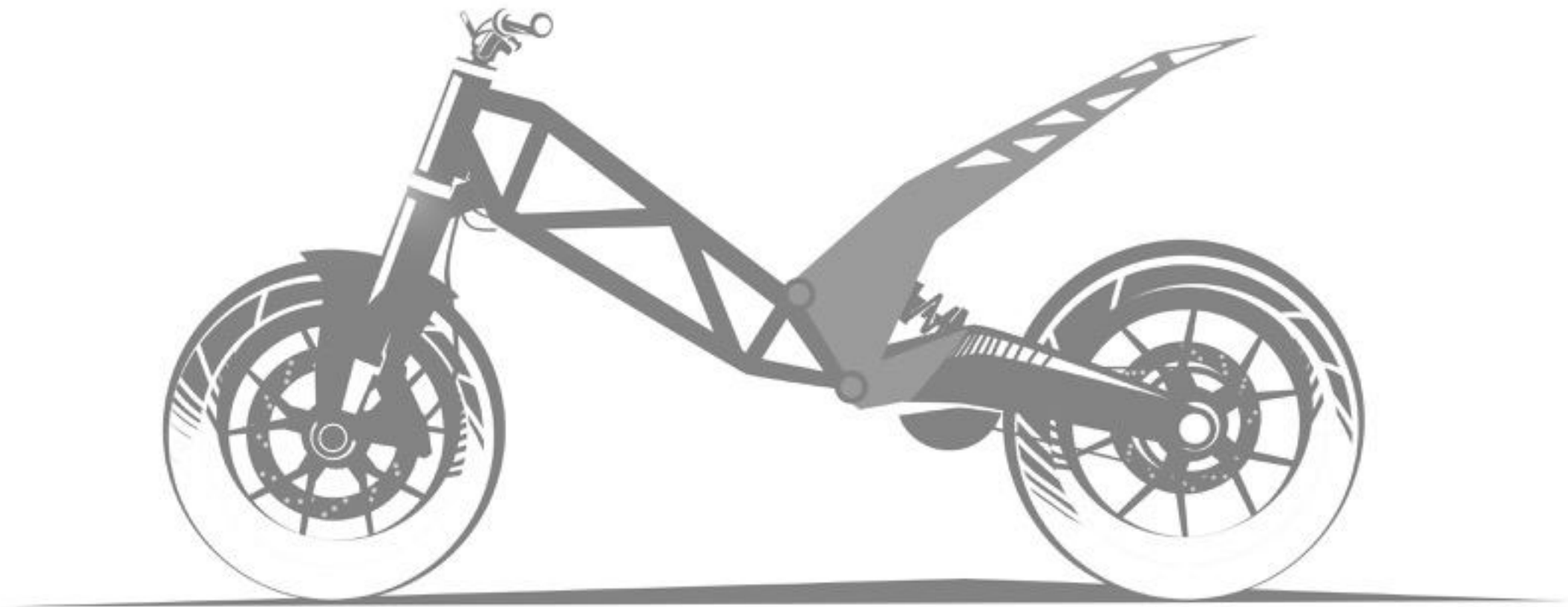


Design Inspiration



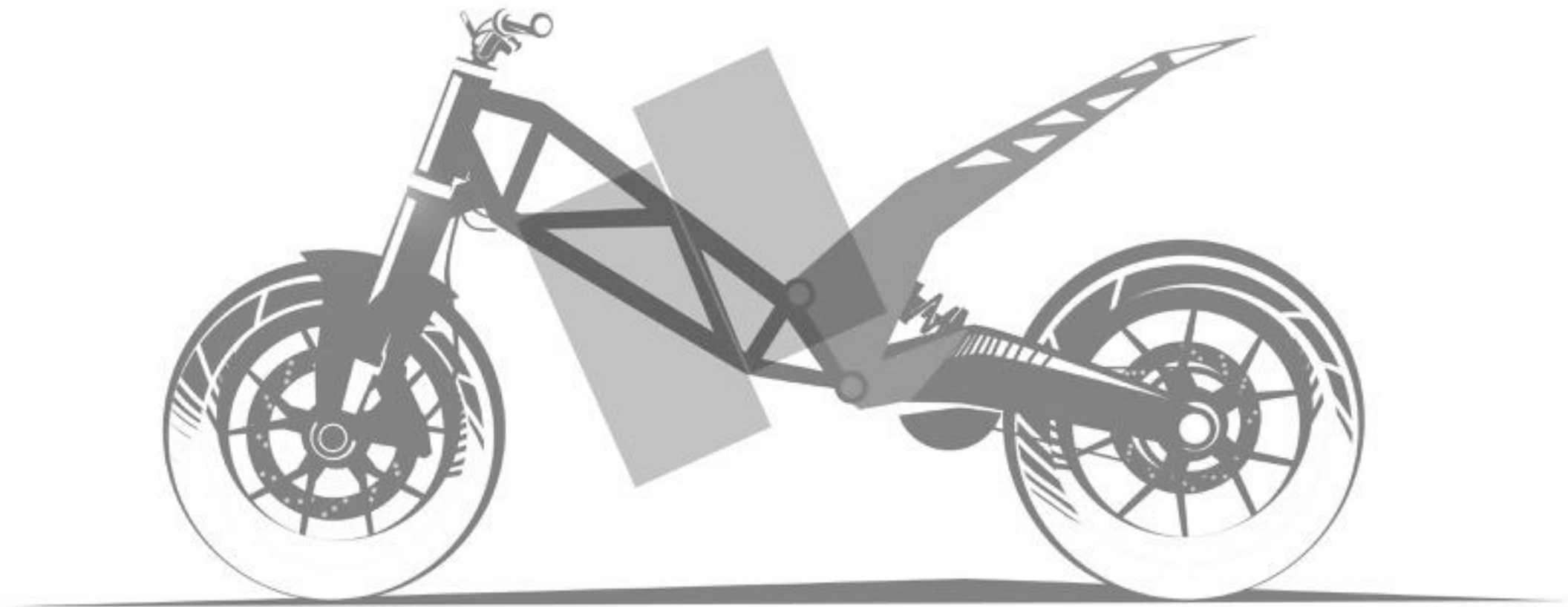
Modern contemporary designs heavily influenced the final design. A very clean design with 3D geometric patterns and simple and purposeful lines define the final design.

5.3 Final Design



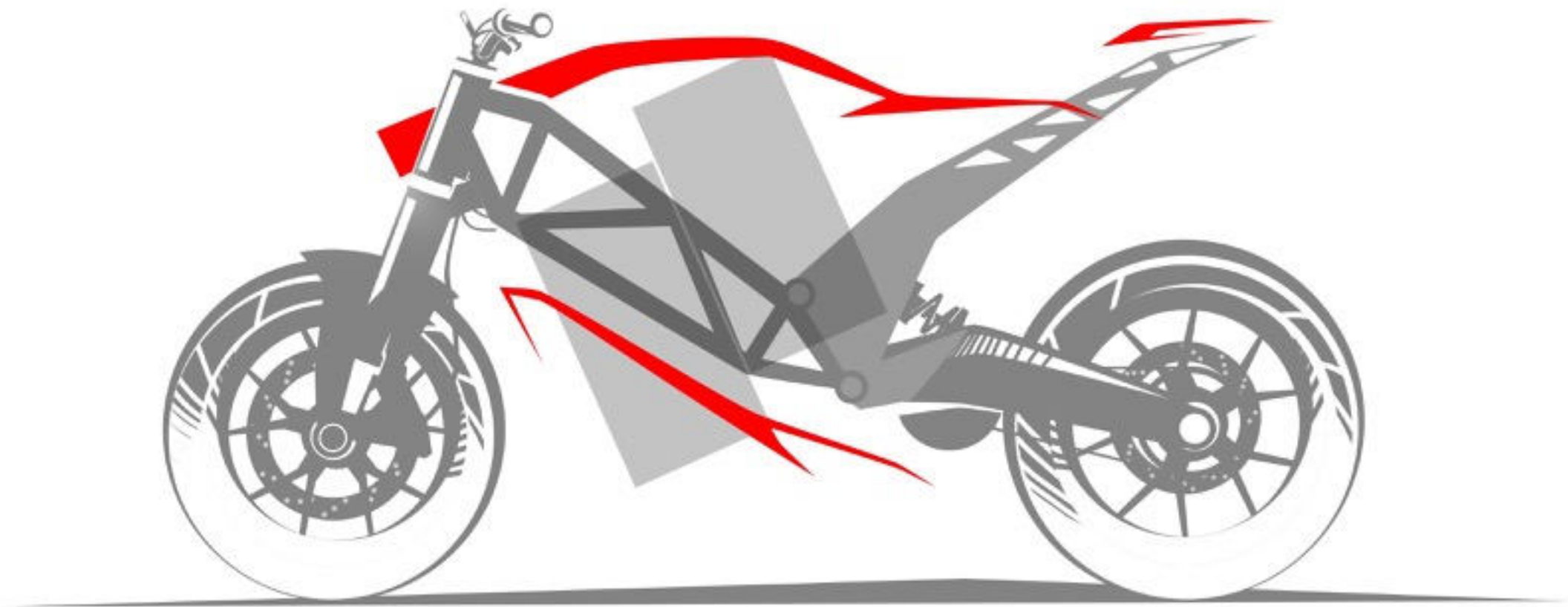
Trellis frame + Exposed single piece
aluminium subframe

5.3 Final Design



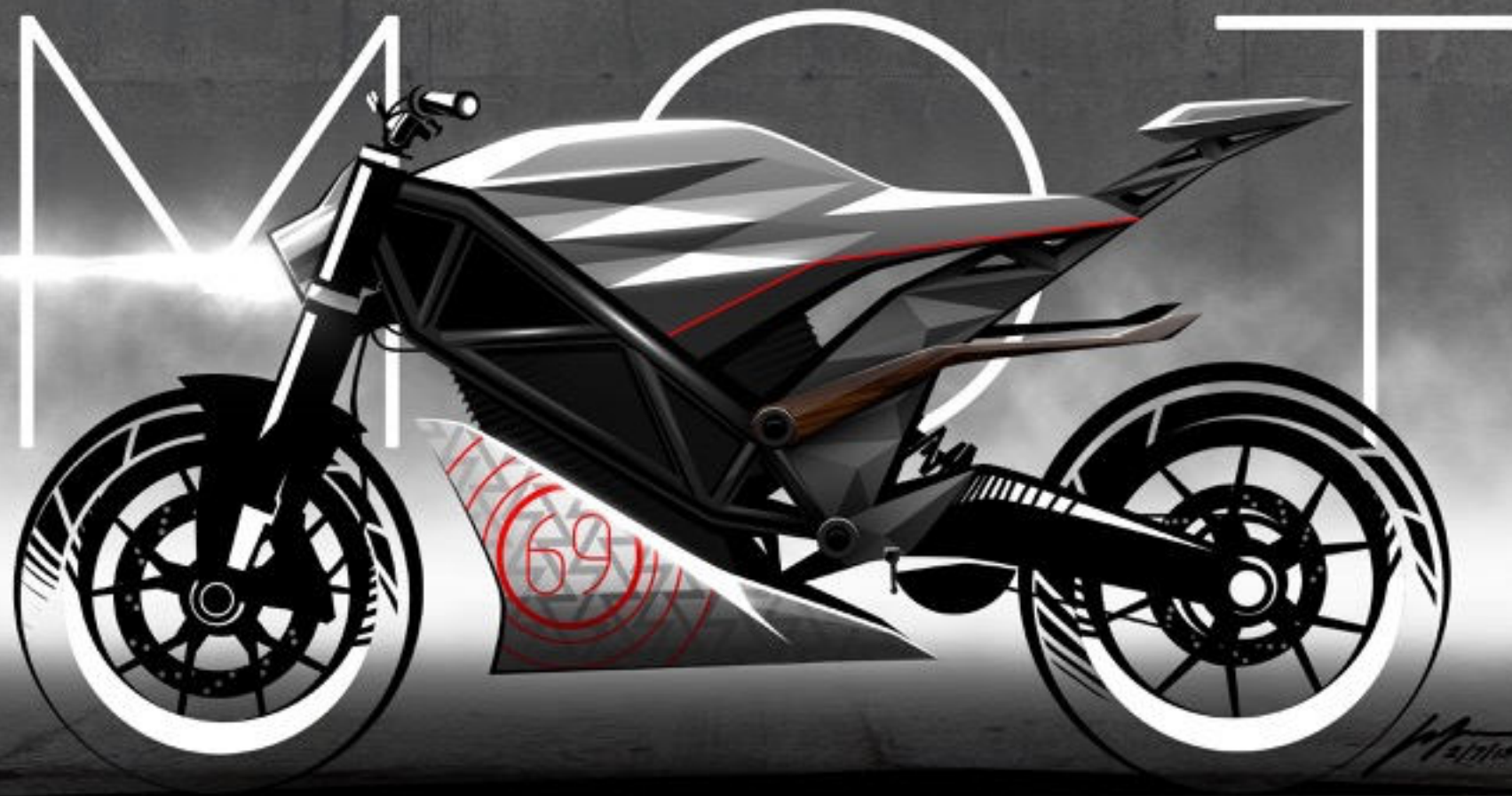
Staggered layout of the battery package
(4 X 2KW battery)

5.3 Final Design



Character lines that define the final design

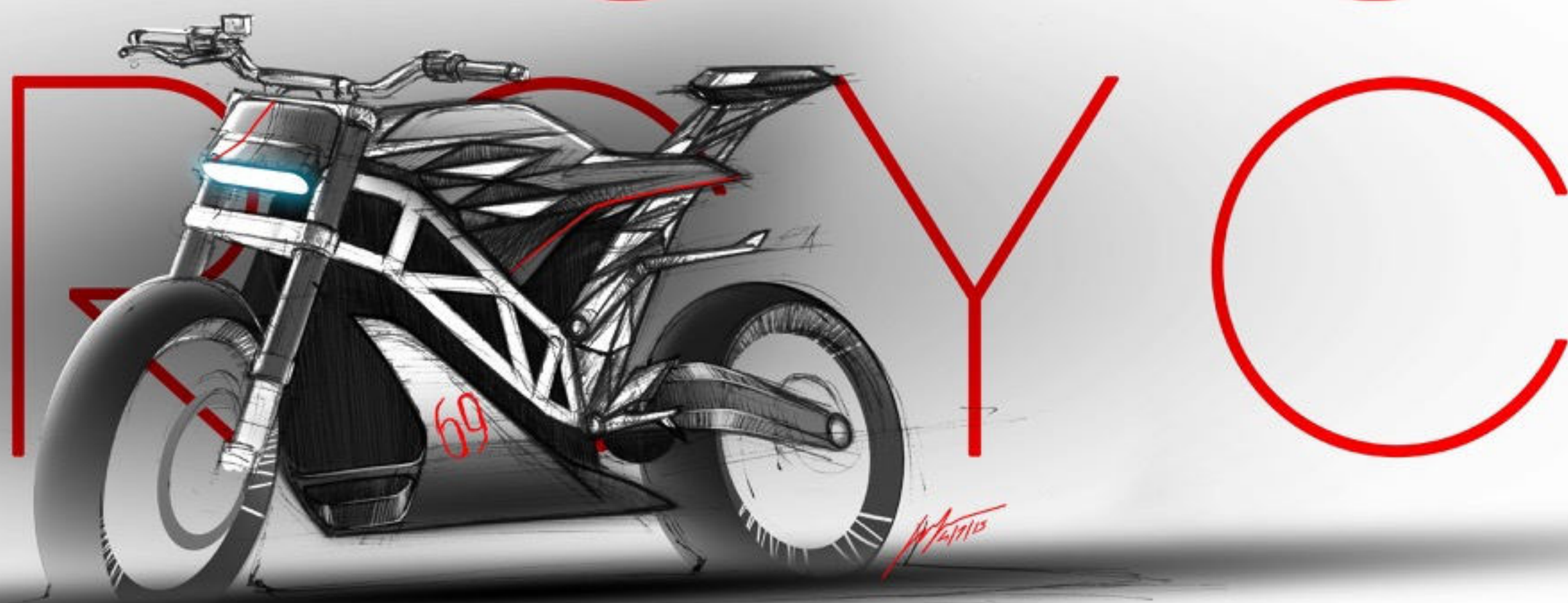
TORK



TORK ONE

Concept Electric Bike design
by Rishi Soman

MOTO



BYC

One piece
tank and seat.
Low poly tank
details.

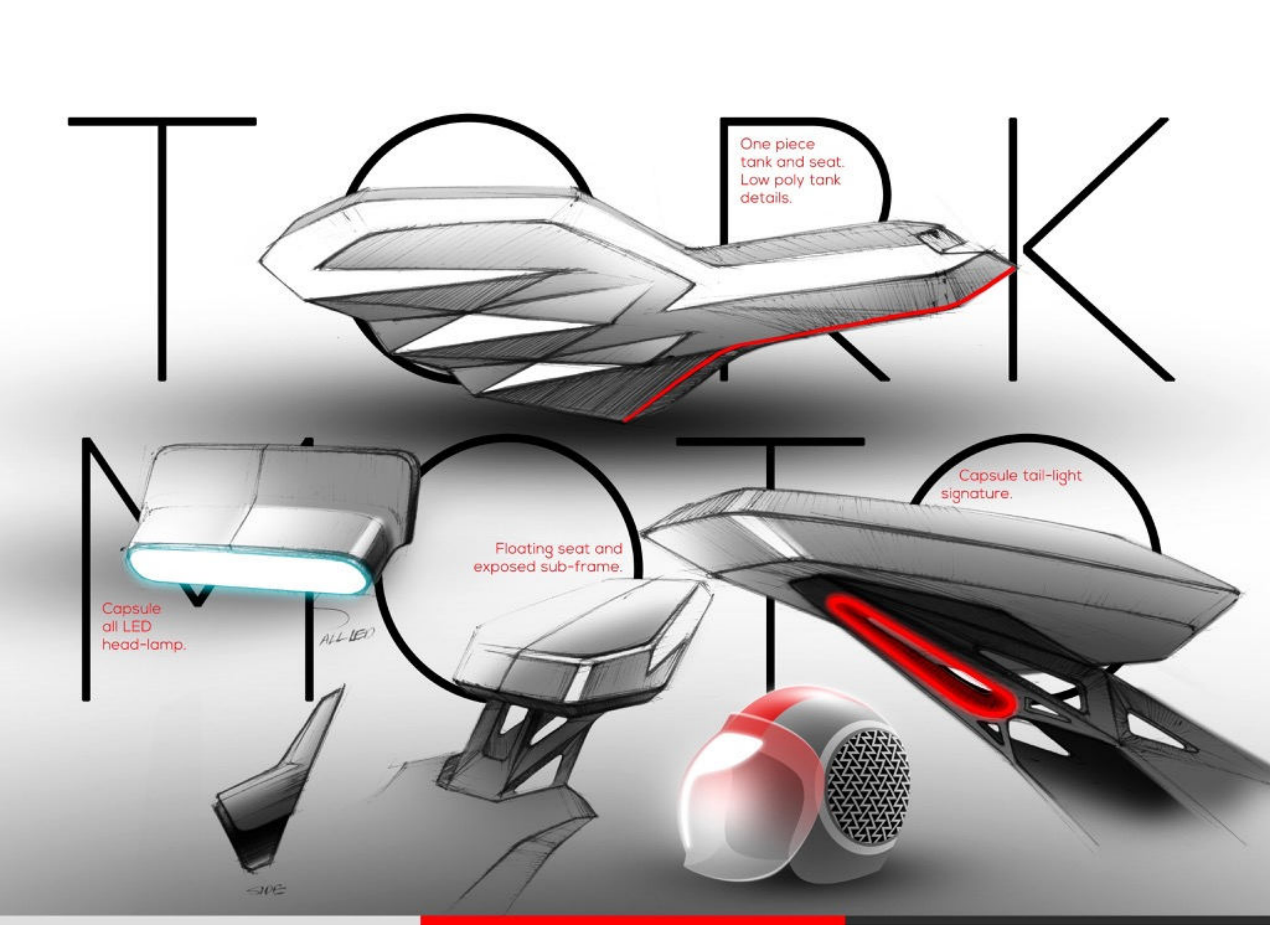
Capsule tail-light
signature.

Floating seat and
exposed sub-frame.

Capsule
all LED
head-lamp.

ALL LED

SIDE



5.4 Concept Features

- The bike is named Tork ONE as it signifies the first proposed production model for Tork Motors.
- A single piece tank and rider seat simplifies the main graphic of the design. 3D geometric patterns on the tank fade away gently towards the seat.
- Exposed subframe with faceted gem-like surface support the high set rear seat. The subframe has excavated faces towards the top to have a low CG.
- Wood rear foot-peg adds drama to the design, otherwise dominated by materials like metal or plastic.
- Capsule like head-lamp and tail-lamp design give the bike a very distinct *electric* feel.
- A lower cowl cleans up the clutter created by the staggered battery pack and also makes the bike aerodynamically efficient.
- The bike is painted in very light grey with subtle red details.

6.1 Learnings

- Packaging constraints and compromises made due to engineering hard-points.
- Various types of chassis and their applications.
- Cycle dynamics and the importance of CG while designing a motorbike.
- Using lattice girder principles while designing a trellis frame.
- Application and placement of motors in an electric drive-train.
- Cooling requirements of an electric drive-train is very much different from that of an IC engine.
- Bike ergonomics and various rider postures that are required for different riding styles.
- R&D limitations while working at a small startup.

6.2 Conclusion

The one month internship project concludes with renders of the final design of the bike. Furthermore, 3D model will be made for better representation of the design.

Tork Motors plans to make a prototype of the bike to study the reactions of the market and also invite prospective investors. The manufacturability of the design has to be studied for future application.

The team at Tork Motors are satisfied with the proposed design.

6.3 Bibliography

- <http://torkmotorcycles.com/about-us/>
- https://en.wikipedia.org/wiki/Motorcycle_frame
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- <http://cycle-ergo.com>
- <http://www.suspact.com>
- <https://www.pinterest.com>
- https://en.wikipedia.org/wiki/Electric_motorcycles_and_scooters
- Motorcycle Handling and Chassis Design: The Art and Science (ISBN: 8493328634)
- The Upper Half of the Motorcycle: On the Unity of Rider and Machine (ISBN: 1884313752)