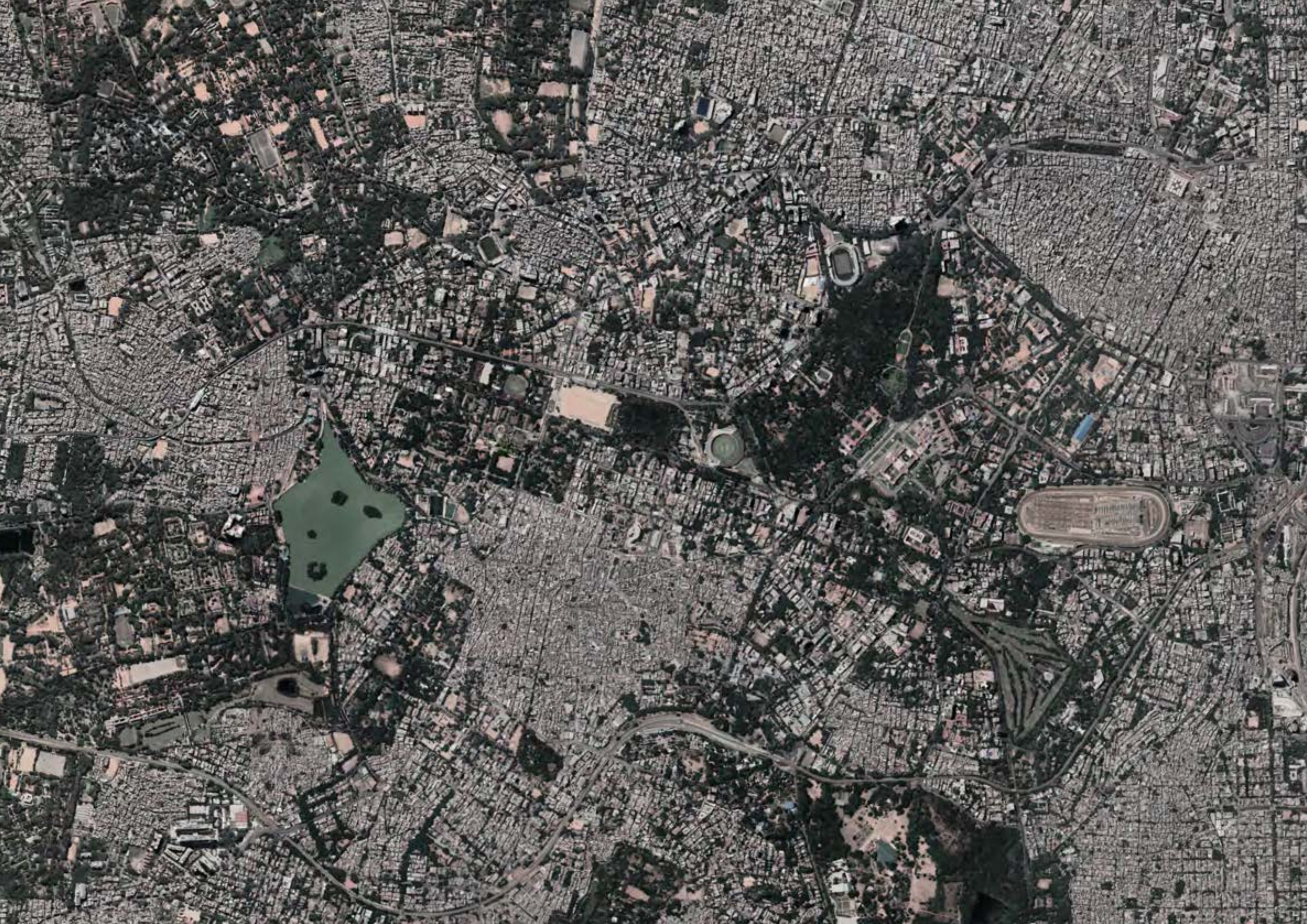
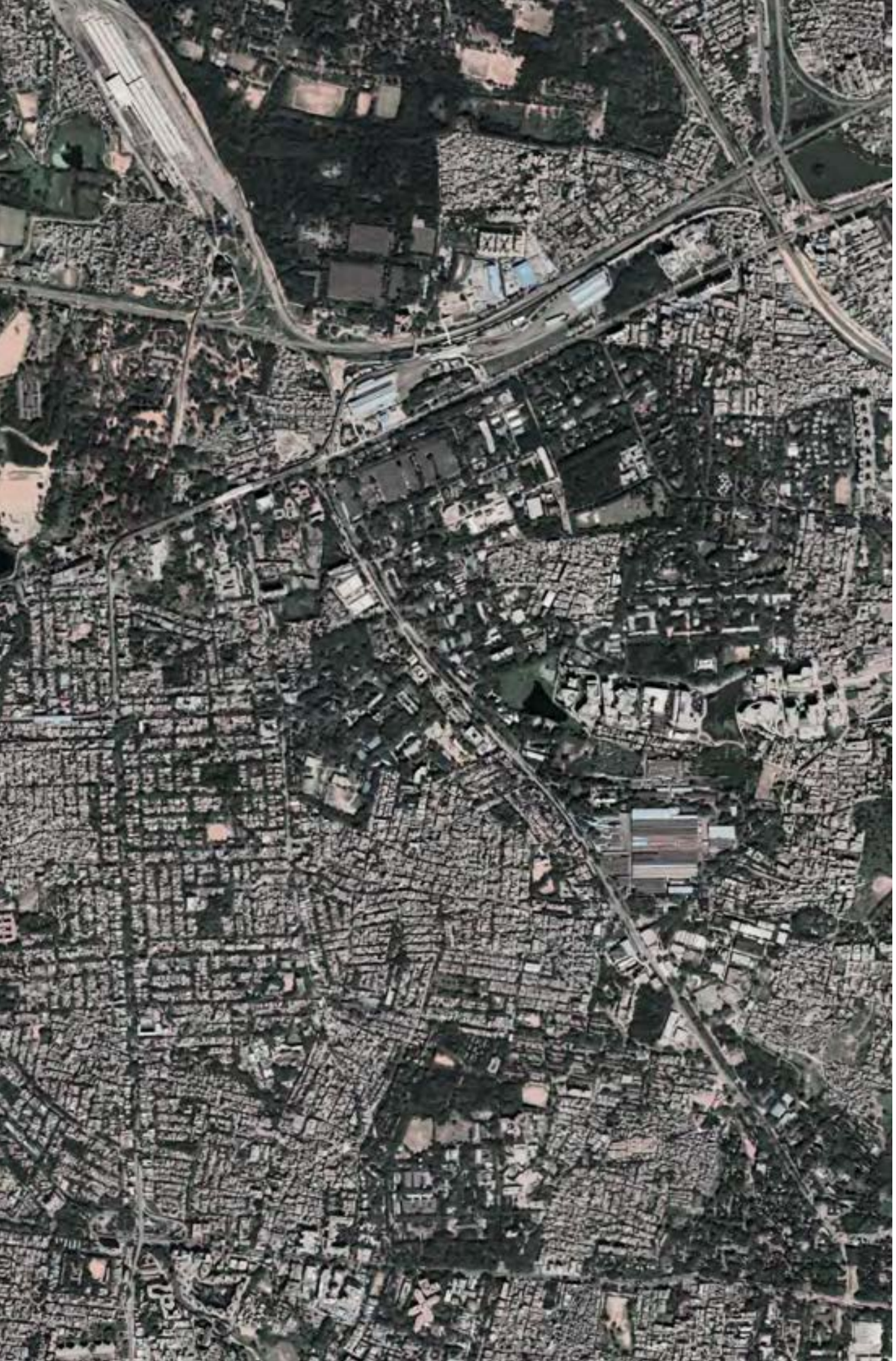
Micro - Mobile *EV*

Trasportation Design





Introduction

Ward 110 located in the central part of Bengaluru, Karnataka - India, houses prestigious parks / malls, public spaces and commercial / industrial marketplaces. It connects to centers such as the Bengaluru palace, racecourse, Karnataka golf association, Nehru planetarium, Cubbon park, Tipu sultan's palace, etc. The wards containment of such important sites attracts business and tourists alogside several opportunities. Some of the spaces explored for this project were S.P. road, Commercial street, Cubbon park, K.R. market, Golf association & Majestic metro station. Bengaluru faces inefficient commute for the majority of its population. Conducting primary and secondary research in ward 110 led to identifying problem statements around mobility. Studying past and recent mobility trends established a reliable framework for the project to build a brief around. Looking at communities, a shadowed group of small businesses and skilled workers emerged in S.P. Road. For the benefit of these businesses, a product idea of micro mobile EV's ensures new opportunities and revenue streams in ward 110. It is beneficiary for the makers, that involve businesses/vendors and small scaled skilled workers. The generated revenue comes from consumers all around Bengaluru, some identified users are Business centers such as IT parks, Universities, Cubbon Park and the Golf course. The product adds value by process and function, which benefits both the vendors and consumers of Bengaluru.

Project Brief

Mobility solutions today are quite insufficient for an average traveller due to cities rapidly growing denser. Focusing on the context, the aim is to create a product & systems intervention (transportation) catering to small business owners / community in and around ward 110. The Intervention should value street vendors and simultaneously adhere to Sustainability (material), Closed looped systems, Future (Protopolis), Urbanization & Emerging trends. The transport intervention would tap into the micro-mobility category, to focus on last-mile travel that most scooters and bikes cannot cater to. It would benefit the local business with resources and small scaled skilled workers in S.P. Road, by creating new business opportunities and generating revenue streams. With minimal training and access to special tools for its construction, any vendor or service provider would be able to add this task to his/her daily schedule. The product itself would be designed to fit into the community's available skillsets and resources reducing production and inventory costs. The final Micro–Mobile EV would benefit the consumers as an efficient & reliable mobility alternative. Being made locally using S.P. roads skillsets and resources, maintenance would be cost-effective with the effective availability of components. The micro-mobile vehicles would be placed in IT parks, Universities, public spaces for tourists or sports centres such as the golf association for recreation.

Community

The marketplaces located in ward 110 form several large communities, each of them operating in different ways under different sectors. These communities consist of thousands of individuals including businesses, vendors, service providers and skilled workers. Every one of these communities has its own separate set of needs and requirements, they have varied revenue streams and clients. These communities have been formed over decades, building relationships with other businesses and clients throughout these years. But most of these businesses do not rely upon year-old consumer relations, they work with one on one client interaction in their place of work. With growing opportunities, the communities started growing denser attracting newer businesses small or big. In the last 10 years population of small businesses in such commercial hubs has increased by over 38%, and the number of unrecorded personnel which also includes unskilled labour is still hard to calculate. There is rising saturation of personnel causing unequal distribution of opportunities, this forces businesses or workers to reduce their cost of operation to keep up with the competition. To keep their intel of clients intact, most bigger business shadow smaller businesses that lack the capital to compete. Despite this inequality, the community as a whole finds ways to adapt and function. The lack of opportunities makes it hard for the service providers, but the abundance of skill benefits consumers by lowering prices, keeping the loop well-oiled.

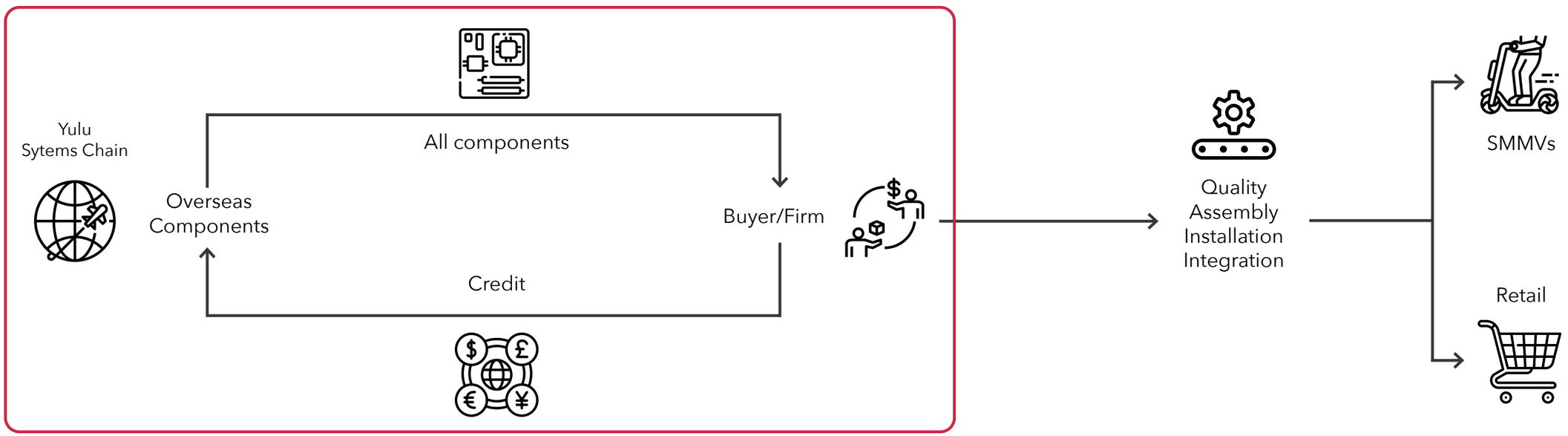
Micro Mobility

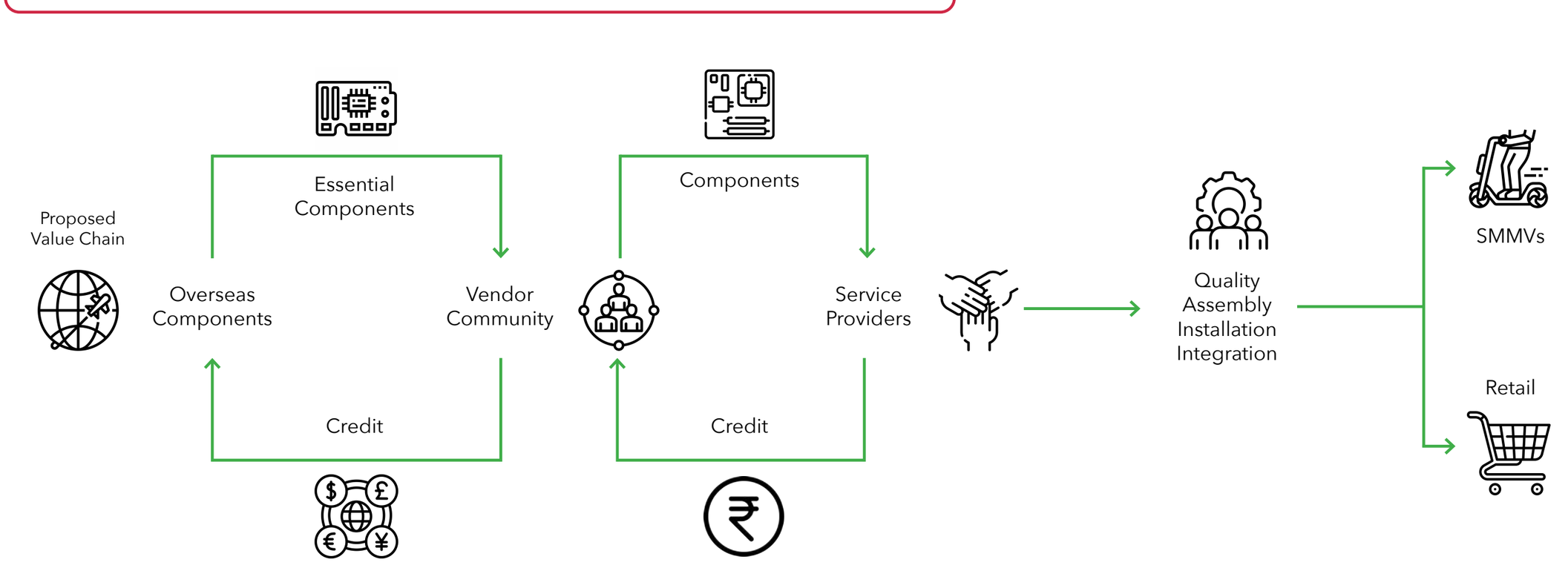
Human productivity crucially depends upon efficient transportation. Studies show effective mobility solutions are mentally and physically less taxing increasing work output by over 15%. It saves valuable time and lowers vehicle emissions. Narrow crowded roads, efficient connectivity and accessibility are a few reasons why transportation problems are difficult to tackle. It requires prior urban planning, and in old crowded cities that are growing rapidly, it is hard to bring about change due to high dependency. Micro-mobility initially was an area explored for recreation and making inclusive, small and efficient vehicles. Today it has entered many mainstream transportation services and is the future of quick hasslefree commutes. With rising EV innovations & trends, vehicles can now be made far more compact and sustainable. These MMVs are small, easy to use and have lower operating costs. They are designed for internal city commute leaving roads less crowded, they can be parked indoors and can be dismantled or folded for easy storage. The last-mile connectivity market in 2021 stood at $5.4 billion. Indian micro-mobility startups are estimated to rise in value by up to 80% by 2024. With developing infrastructure supporting EVs, India has seen an increasing number of electric transports and now is working towards supporting micro transit vehicles. The intervention slowly gaining the consumer's trust is becoming more and more mainstream in the Indian market and has the potential to replace city-level EV scooters/bikes.

Client

Micro-mobile vehicles surely have their ease of use, but they also target a very specific audience. Not all consumers would choose an MMV over a generic two-wheeled vehicle. With this selective target group, MMVs nowadays focus on inclusivity and are being built to include a wider range of audiences. The first criterion for an ideal micro-mobile vehicle consumer is being fully abled. Most MMVs do not provide seating which eliminates individuals who have difficulty standing for long periods of time. It usually targets people from the age of 16 to 38. Although these statistics are variable to every country and culture, this is said to be the ideal age group with the most percentage of fully abled individuals. A reason why it still has huge potential despite it being less viable for some people is because it is operated only for small distances. It also showcases a stunt of recreation that most individuals enjoy. This drive of adventure is crucial for the majority of its target audience. Another reason why it is niche is because it's a secondary mode of two-wheeled transport. A consumer would most likely be expected to own an MMV alongside a separate primary transport, eg. a car or a bike. Taking India into consideration, the two-wheeler market for the majority of individuals acts as a primary source of transport, hence MMVs are usually not a good choice for low-income strata. But for such countries, eliminating low-income groups from the target group drastically reduces the buying power of a product, this is usually tackled by creating a shared vehicle system, where individuals can rent out these MMVs for a small fee depending on their use. Shared mobility is commonly seen in India as well as in several other countries abroad. It makes travel more affordable and accessible for consumers. Yulu is a good example of a growing micro-mobility firm in India that focuses on shared micro transport and is soon going to enter the retail space.

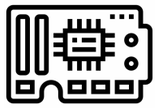
Tourists on Electric - Segways [Berlin, Germany]



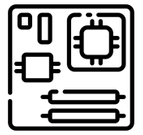


Systems Mapping

The first sytems diagram is of Yulu, a leading micro-mobility frim established in India. With india having high import duties for majority of countries, nations like china are an exception. China stands first in Indias import statistics with double the amount of imported goods than the second nation in line (United States). For firms looking to maximise profits with the least amount of manufacturing cost, the best alternative is to outsource components, due to the availibility being scarce or expensive in india, firms reach out to countries like china. Yulu imports majority of electric and functional components from China. Here in Tamil Nadu, the raw materials for the bike frame are aquired and assembled along with the imported components at the Yulu assembly plant.

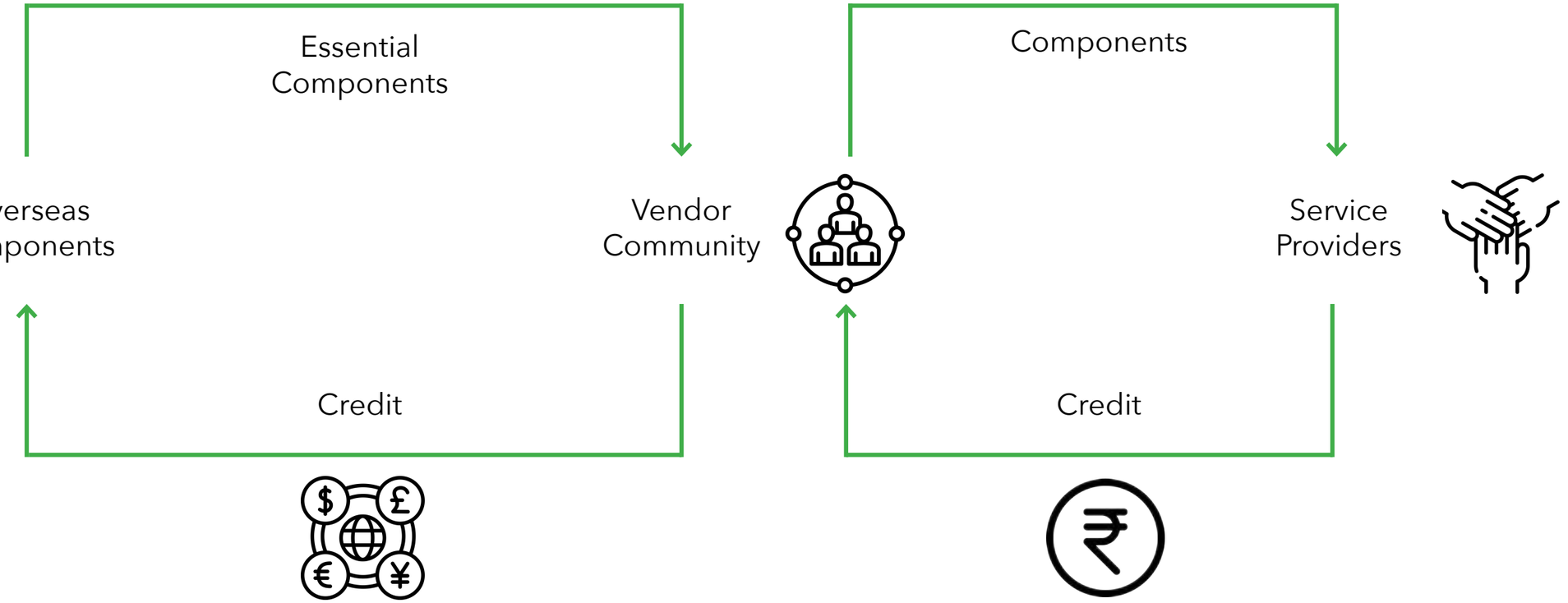


- Motor
- Battery cells
- Controller



- Battery assembly
- Bolts/nut
- Metal & Welding
- Wiring
- Indicator Display
- Stepdown converter
- Lights
- Charger and port
- Plastics
- Braking
- Throttle
- Tap, foam & sealant

Detailed Proposed Sytems Diagram



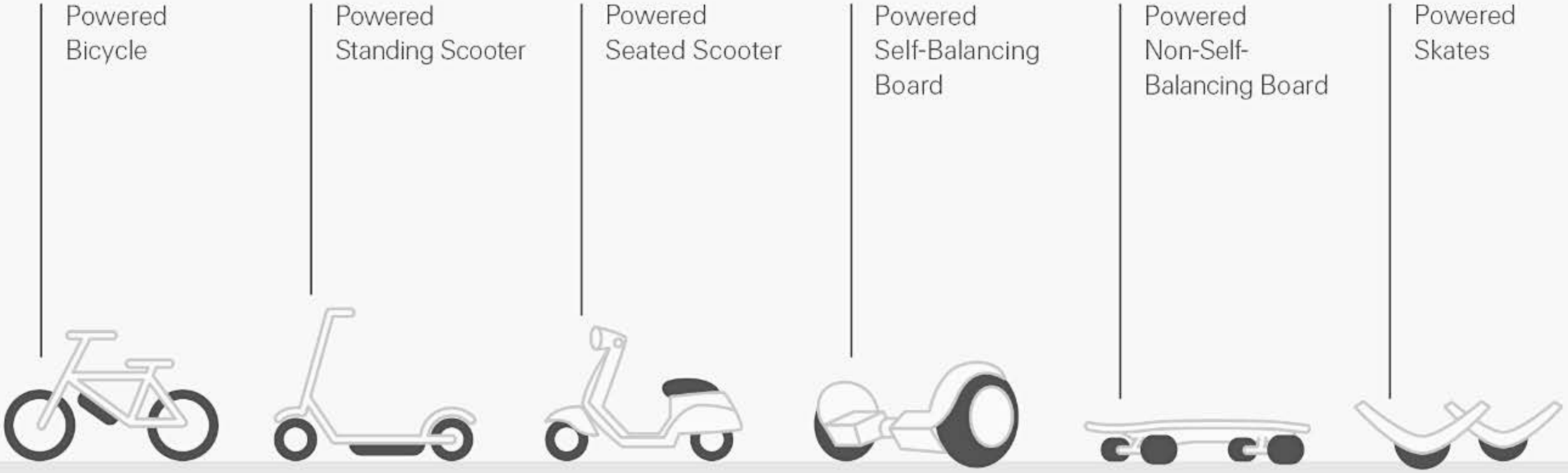
Above is a deatailed systems diagram of the proposed value chart. This loop within of an already existing loop gives better emphasis on the benefit for vendors of ward 110 aswell as the product itself. This gives oppotunity for smaller bussinesses to come collectively and create someting that can compete with industry level products. Although outsourcing in general be it in india or overseas is an expensive process due to the service provider margin, it doesnot take any significant prior investment. with small scale service providers, the prices could be drastically lower than expected. The crdit exchnage in india contributes to the economy of the S.P. road community aswell as the country compared to the first sytems diagram where majority of credit goes overseas. An ideal automobile company if set up for the production of a vehicle would invest in a wide range of employes and tools, where as here it only takes a few additional individuals to oversee this new process in an already existing, trusted & reliable industrial network.

Types of Micro-Mobile Vehicles

E-micromobility – electrically powered e-scooters and beyond – is evolving fast, with ever new vehicle types and uses. It promises a sustainable response to traffic-loaded urban centres, and also to consumer demand for convenient and cheap short-distance rides. Regulation, however, needs to keep up with the changing dynamics and for insurers, new risks keep emerging.Technological advancements in the feild of automated fabrication have enabled us to construct at a micro level making components and products more compact and efficient. MMVs are now electrically powered causing them to adopt their compact size, the word micro not only adresses last mile connectivity but also the form of the vehicle. With rising MMV demand, the product has diversified into several other catagories. It is now catering to a wider audience with varied needs helping individuals choose a product that is fit for their commute and physical needs. Some are designed for storage and others are made to perform, there is still a significant differance between micro vehicles and generic thertiary transport such as scooters and bikes. Most of these MMVs depend on the infrastructers ability to create performance driven environments, by doing this micro vehicles could increase in number drastically reducing traffic and emmisions. Incorporating thye concept of last mile commute into already existing MMVs is a reliable practice, bicycles are the most common example of last mile travel. They have been used for centuries and now are equipped with modern day technology to become efiicient modes of travel. Some common micromobility vehicles are e-foot scooties, segways, e-boards & powered bycycles. Electric foot scooties or standing scooters have gained popularity recently due to its versitility and modern design. They have proved to be very efficient and are already replacing many fueled vehicles.

Micro - Transit Vehicle Catagories

Powered Bicycles and scooters can be considered as primary MMVs. These vehicles adopt the concept of micro mobility in an already existing framework. it needs no special infrastructure to implement and has a vast target audience. Powered standing scooters or foot scooties are the future of micro travel, its versitile design enables it to be used in varied senarios. it is mainly for short distance commute and doesnot provide adiquate storage for the user. This vehicle has been a popular rental option for tourists or delivery executives due to its limited but effecient performance and ease of use. Powered self-balancing boards and skates are the tertiary group of micro vehicles. These have not been tested asmuch and have a very narrow user base. It is mainly made for leasure and has a sence of adventure to it. Currently it is diversly used for recreation in parks or community centers. The smaller these vehicles beome, they are less efficient due to engeenering limitations. These have the narrowest target group making it a very neiche product.



Yulu India

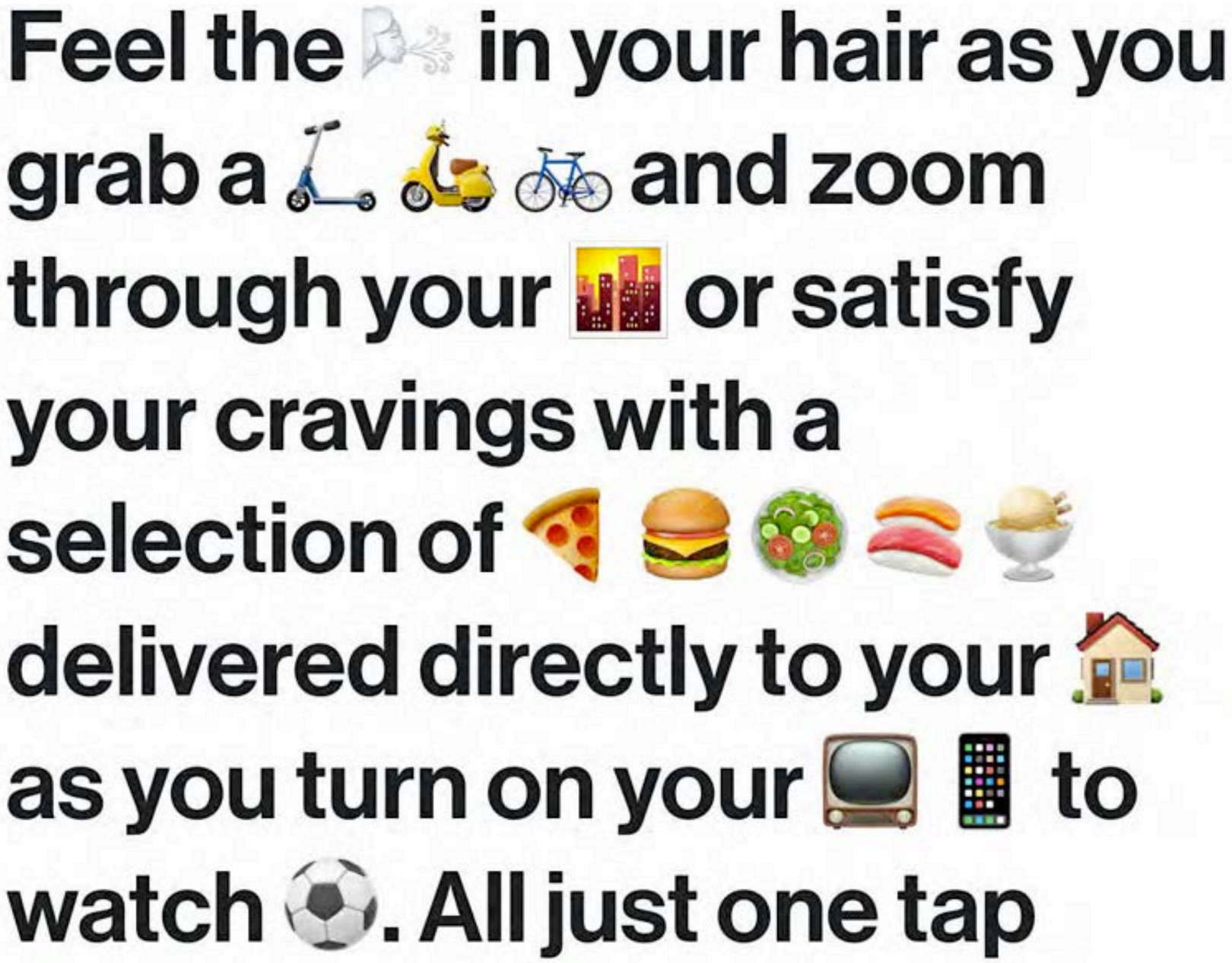
Case Study 01

Yulu aims to make urban mobility in India seamless, shareable and sustainable. They started off as an initiative to reduce traffic congestion and pollution in Indian cities, is now redefining urban mobility across the country. They are empowering residents in Indian cities to create a paradigm shift in the mobility industry, by making the urban commute more efficient and eco-friendly. Yulu is a technology-driven mobility platform that enables integrated urban mobility across public and private modes of transport. Using Micro Mobility Vehicles (MMVs) through a user-friendly mobile app, Yulu enables first and last-mile connectivity that is seamless, shared and sustainable. Yulu is Indias leading micro mobility giants with more than 18,000 bikes in use currently spread across 5 major metropolitan cities. With increased investments, Yulu is now launching a wider range of products not just as a shared MMV but also as a commertially owned vehicle.

Dott

Case Study 02

A shared micro mobility transport based in Europe focusing on high performance MMV's. Their product strongly emphasizes on safety and performance making it extremely reliable. It wishes to develop a strong network of not just shared MMV's but products that can replace fuel scooters in the future. The business is built majorly around student communities creating opportunities for young mind/entrepreneurs. By doing this, it in turn employes and providES for the young age group who are the primary users of rising MMV's. Dott overlooks all operations personally keeping costs low and ensures the products quality and reliability. They design their vehicles for shared use and build them to last. Electric micromobility is crucial to the fight against air pollution and global warming, this is why dott aims to keep a limited carbon footprint. From the very beginning, Dott has been dedicated to achieving carbon neutrality and in 2019, they compensated CO2 emissions through green initiatives and reached that goal. They constantly work towards reducing their carbon footprint with the goal to reduce it by 56% by 2024. They are approaching this by keeping their eye on the entire value chain, from eco-design of swappable batteries and 100% electric recharging of logistics vehicles with renewable energy, to constant repair and reuse, and when parts are no longer salvageable,they recycle them all.



Helbiz

Helbiz is a dedicated team of innovators, engineers, technologists, and creatives who are driven by the desire to improve people's lives through technology. They are committed to work collaboratively with governments, communities, companies, and individuals to offer safe, equitable, and sustainable transportation solutions around the world. It targets the delivery streams in countries such as the US, Italy & Singapore where the cost of delivery is extensively high. It offers an affordable alternative for those who need last minute and mile transportation.

Helbiz

Case Study 02

By making the enterprize more sustainable, Helbiz targets net zero carbon emmissions for the manufacturing and operation of its products. It offers a wide range of products suitable for different levels of transit, smort and long distance. Their vehicals are high endurance, made to last harsh conditions for a long period of time. this increased longevity feature gives the partners and users a sense of trust in the products quality and performance. The vehicles are fueled by 100% clean energy by Enel Energia. They focus on circularity by parnering up with Li-Cycle, a world leading battrey recycler to sustainably recover the end-of-life batteries from their vehicles. Helbix follows both generic and non generic vehicle forms, this helps customers who want a sense of relatibility with their products. They operate in more than 50 cities catering to the service sector, general public and also spaces such as universities or commertial parks.

Indian Micro Mobility Market and Growth

Being a developing country, metropolitan cities in India are increasingly facing inefficient commit due to overcrowding. One of the steps taken by the country to solve this problem in the last decade was to introduce a new medium of primary transportation. Although it does solve inept long distance commute, a large percentage of the population solely relies on last mile connectivity. Road conditions day by day are improving but lack of space triggers difficult traffic conditions. Asia according to a stratigic study has potential to be the largest MMV market but lacs infrastucture. South India was recorded as the lagest MMV market by region in 2019, from 2020 to 2025 it is estimated that East India would be the fastest growing market. The market size for MMVs in India was approximatly 1.02 billion dollars and is predicted to reach the 4 billion mark by 2025 with a markey growth rate of 56.8 %. Since 2019, there has been a 44% increase in shared mobility, about 7550 electric scooters were sold in the first half of 2020. India aims on having over 80 % electric 3 wheelers such as auto rickshaws by 2026. With mobility companies such as Yulu and the rising EV trend, it is estimated that India would expect a sale ofelectric scooters exceeding 2 million units.

SDG

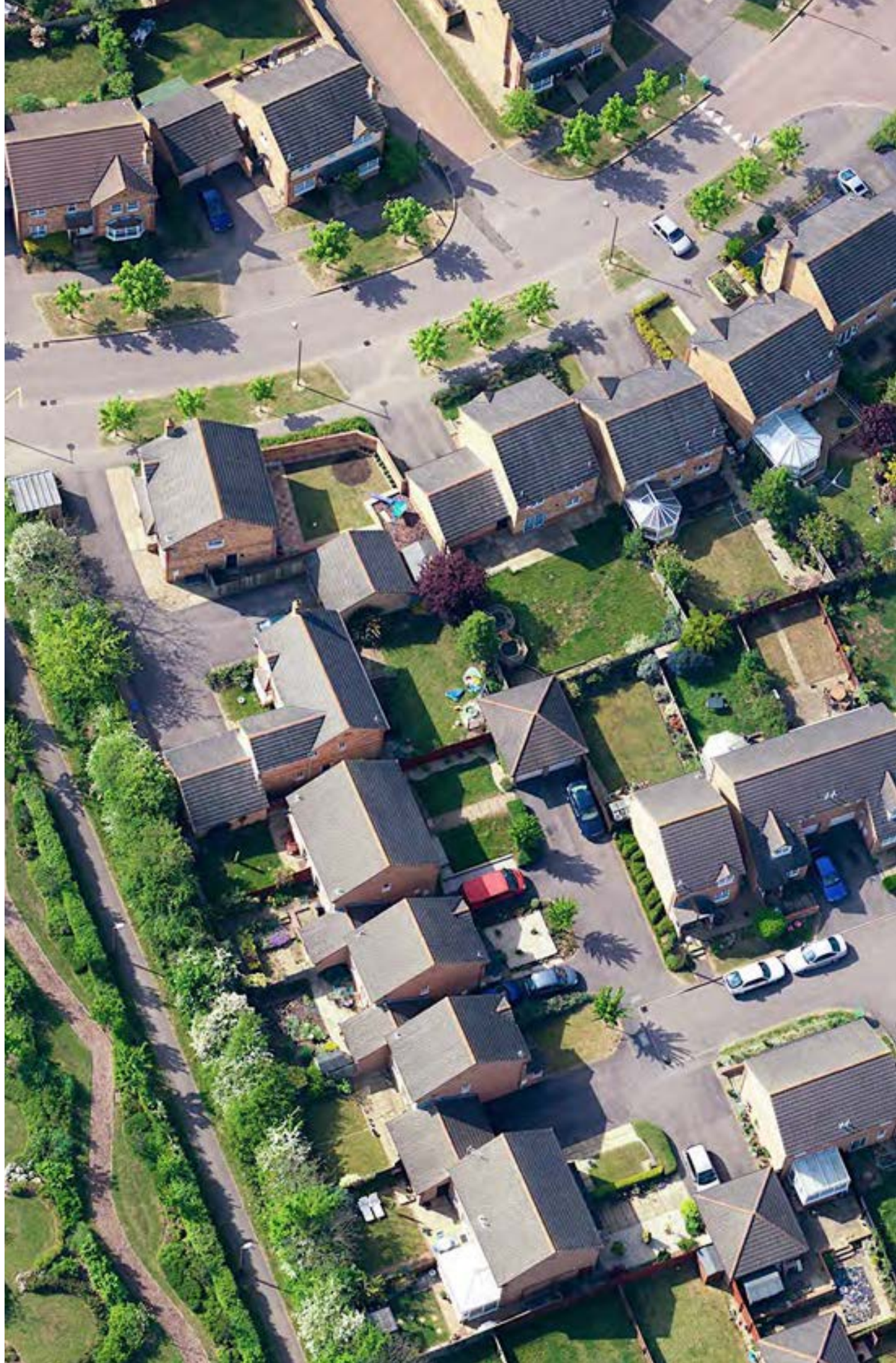
Sustainalbe Development Goals

UN Sustainable Development Goals highlighted :

09 INDUSTRY, INNOVATION AND INFRASTRUCTURE
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Investing in efficient transport and its infrastructure for 28% of the population facing last mile connectivity. This change will drive economic growth by saving lost commute time. Using renewable energy to sustain urban transportation creating a healthy environments. The intervention upcycles raw materials for its construction significantly reducing production costs. Its making fits into existing economies spread throughout ward 110 eliminating the need to create a completly new business model.

- Inclusivity for small scale business to carry out tasks responsible for the interventions making.
- Co creation: business opportunities that are mere extensions of their daily service.



Consumer Research 01

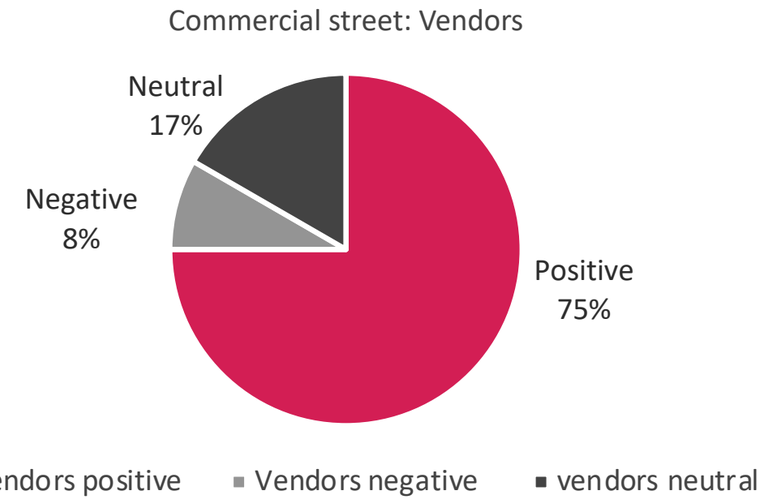
Site – Ward 110, BENGALURU
Area of intervention – Transportation Design : **Micro Mobility**

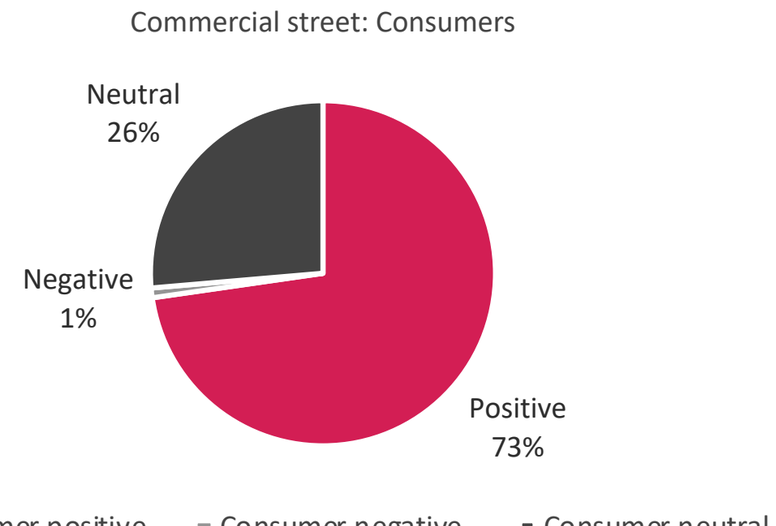
Method: Primary Reasearch - One on One conversation

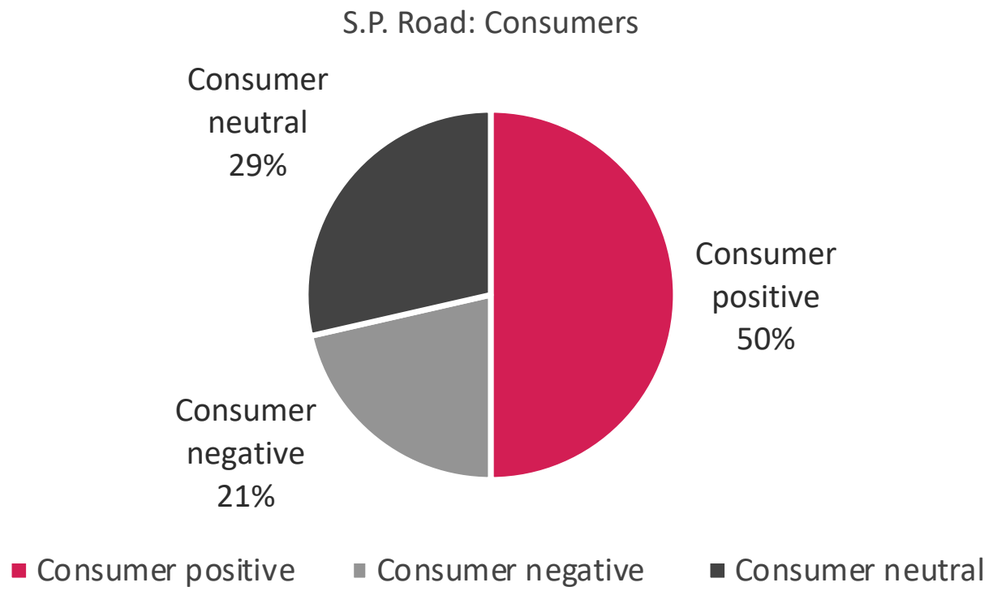
Sample size

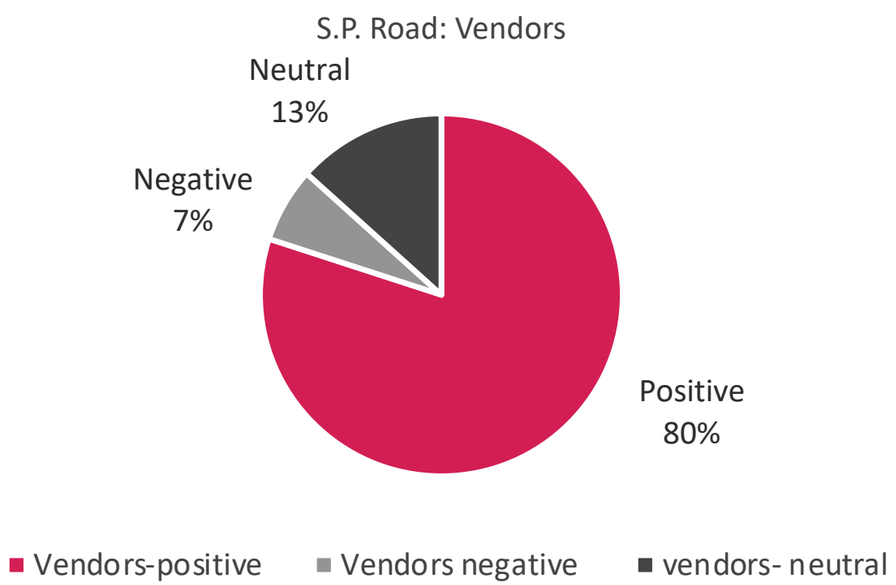
Commertial Street: **15 Vendors - 7 Consumers**
S.P. Road: **15 Vendors - 8 Consumers**

- Transportation as a service (Consumer)
- Intervention as a business opportunity (Small Business)



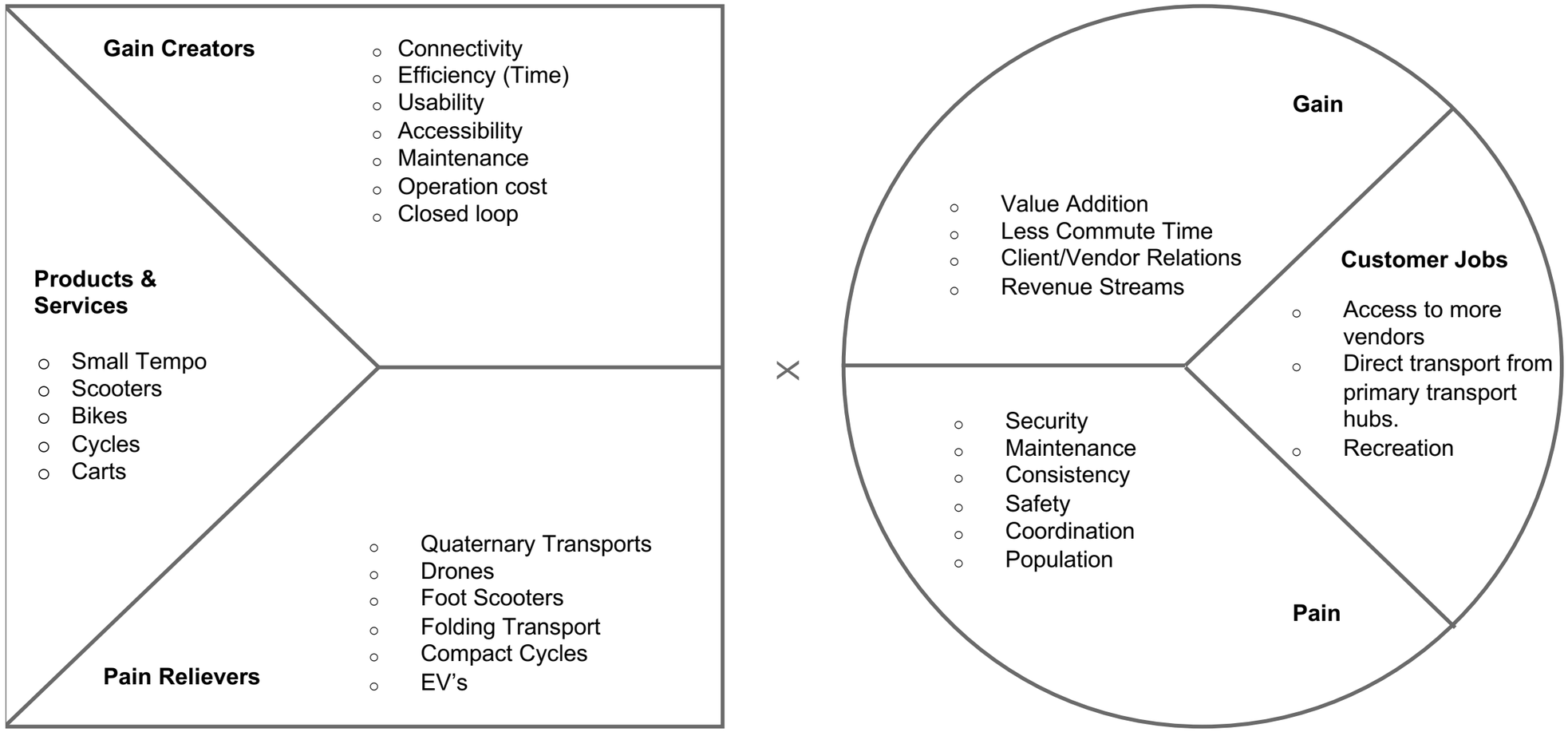






The outcome's creation benefits the local business of S.P. Road. There are opportunities created for vendors with resources and skills. With minimal training and no need for providing access to special tools for its construction, any vendor or service provider would be able to add this task to his/her daily schedule. The final product would benefit the consumers as an efficient reliable mobility alternative. Being made locally using S.P. Roads skillsets and resources, maintenance would be cost-effective and efficient.

- An example of a Product – Driven transport service
- A feasible quaternary transport for consumers making smaller businesses more accessible
- Focusing on manufacturing cost and affordable connectivity.
- Intervention creating business opportunities for communities
- A closed loop product service intervention maximizing efficiency
- Upcycling waste by incorporating it into the interventions development



Value Proposition

Intervening into Micro-mobility solutions by creating business opportunities for the communities and a product service for the consumers. The product contributes to the waste economy by upcycling materials such as metals and plastics for its construction. The intervention would be curated such that it can be easily manufactured and sustained using the communities skill sets and resources. A loop of vendors categorized by skill and service would be identified and created for the transports curation.

Consumer Research 02

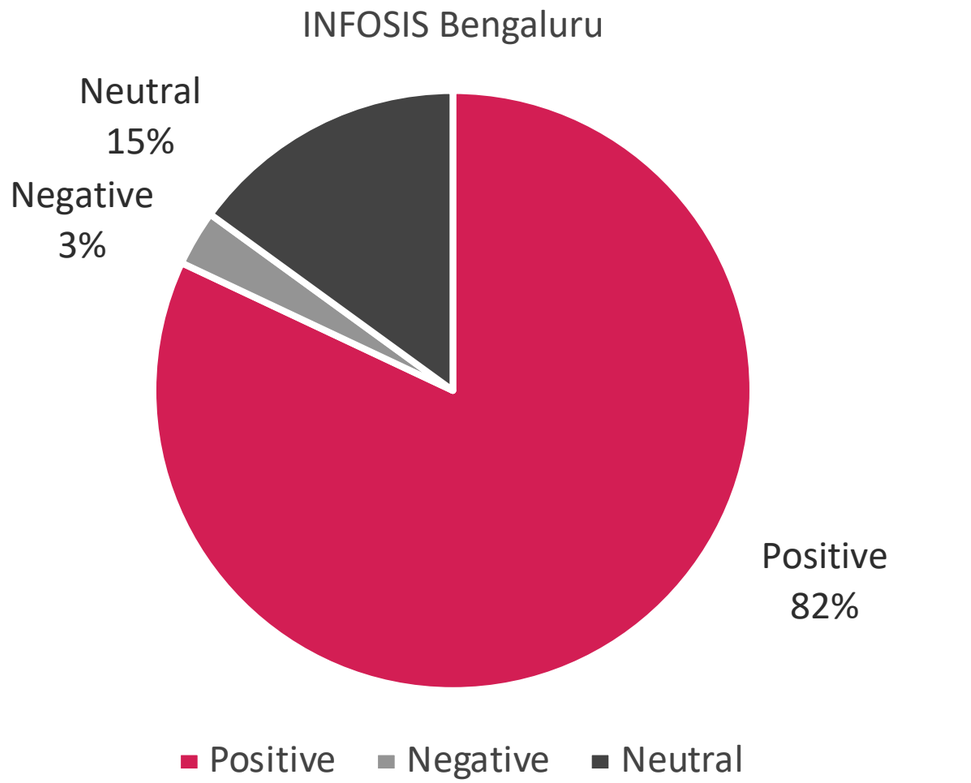
Site – Universities, IT Park
Area of intervention – Transportation Design : **Micro Mobility**

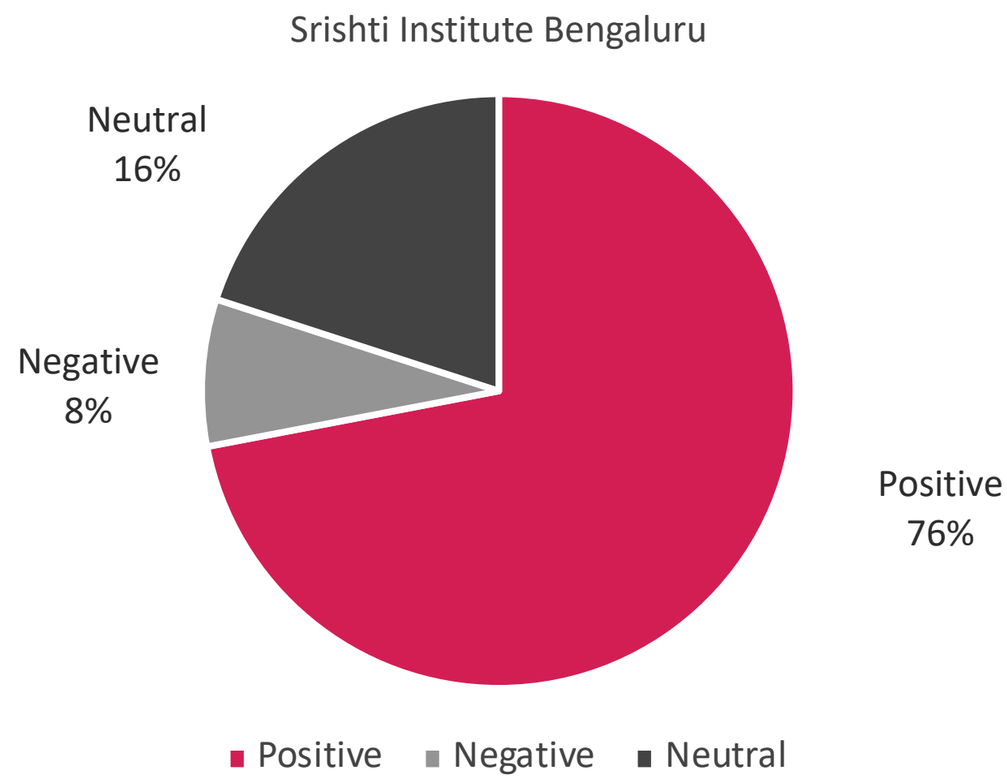
Method: Google Forms - Virtual

Sample size

Infosis IT Park Bengaluru: **58 Employees**
Srishti Institute Bengaluru: **32 Students**

- Transportation as a service (Consumer)
- Intervention as a business opportunity (Small Business)





The Product Intervention supported a new circular economy in ward 110 genrating employment and revenue streams for varied bussinesses, but its implementation was more fit for public spaces, Institutions, commertial spaces or A quaternary rental trasnport. Looking at the consumer reaserach it is most likely to be utilised in institutions and commertial spaces. IT parks such as Infosis Bengaluru house massive complexes. Currently, electric golf carts are issues arounf the campus for faster commute. Implemention a micro mobile vehicle enhances the experiance of the park not only for emploies but for potential clients and visitors. Being a tech company, the use of such products to better campus lifestyle highlights their industry motive.

Srishti bengaluru has multiple campusses spread out across a 5 km radius. A Micro mobile vehicle capable of efficient storage and fast short distance commute is ideal for students. Mainatinence and storage are major concerns for a student owning a vehicle. A compact micro vehicle can be stored indoors, charged as per convinience and acts as a sustainable, reliable and convinient mode of trasport.

Research Observations

Convinience comes at a cost and is not always prioritised by all individuals. When it comes to micro mobility, its about reaching last mile destinations without a hassle, this is achived by creating compact vehicles that cut through narrow lanes and traffic. Storage is a problem in most two wheeled scooters, the ones that require a helmet such as bikes in most cases do not provide storage. In micro EVs, storage is even lesser, but a lot of individuals do preffer the versitility it offers. In busy market places, micro EVs are convinient to reach vendors placed at the heart of the site saving valuable time, but consumers interacting in such places have a need to carry belongigs/ purchased items which makes such a transport intervention invalid. Looking at the case studies and other cities aaround the globe who have implemented micro EVs, it targets fully abled, busy or adventure driven individuals. There is a wide market for this target group in India. IT parks according to my research shows positive results. The student community also shows promising results with more than 75% individuals intriagued by the idea.

Research Insights

The applications for micro vehicles are varied hence they carry out differnt forms catering to different audiences. Electric foot scooters are one of the most commonly used and tested form of micro mobile vehicles. The form significantly changes the type of audience from the perspective of catered needs or age. With my current target being the student community and IT parks, the EV form needs to be compact but should also cater to a considerable amount of range. The ideal choice would be a hybrid design that sits somewhere in between scooters and electric footscooters.

What does the Audience Want?

After conducting an avid survay to gauge the consumers needs, 11 catagories were identified. Each of these catagories were of varied priorities depending on the consumer. Some catagories of these catagories are eesential for the product and some add value. Most consumers were interested in catagories such as the cost, range & the maintainence. This gives me a framework to start the designing process keeping these needs in mind. When it comes to owning a vehicle, it is important that the cost complements its value. The audience wants the cost to reflect in the products performance and aesthetics.

The catagories are divided into essentials and non essentials. There is a thin line that diffrentiates majority of the catagories but here the essentials focus of making the product perform and the no essentials add value. Below are essential needs the EV needs to perform and retail in he first place.

- Range
- Cost
- Maintainence
- Usability

Other catagories are secondary and add value to the product. Safety is rated as a secondary catagory as in 2 wheelers, driver safty is not promised. Safty and security of the products components and functioning can be controlled but the consumers safty largely depends on themselves. Some sub catagories indirectly contribute to the essentail needs such as weight, it ultimatly increases range and betters usability.

- Speed
- Safety
- Aesthetics
- Storage
- Charging
- Weight
- Inclusivity

Range

Speed

Aesthetics

Cost

Safety

Storage

Charge Duration

Weight

Maintainence

Usability

Inclusivity

Bussiness Model Canvas

Key Partners

- Government
- Investors
- Vendors
- Distributors
- Manufacturers
- Service Providers
- EV Showrooms
- Automobile Dealers
- Marketers

Key Activities

- Production
- Manufacturing
- Component Sourcing
- Assembly
- Distribution

Key Activities

- Production
- Manufacturing
- Component Sourcing
- Assembly
- Distribution

Value Proposition

- Maintainence
- Locally Sourced Parts
- High Performance
- Availibility
- Customisation
- Recreation

Consumer Relationships

- Information Exchange
- Awareness
- Inclusivity
- Customization
- Customer Service

Channels

- Online Portals
- Automotive Stores
- Distributors/ dealers

Customer Segments

- Students
- Tourists
- Delivery Executives
- Bussiness Parks
- Parks
- Public Spaces
- Metro Stations

Cost Stucturing

- Raw Materials
- Component Inventory
- Marketing and Sales
- Maintainence

Revenue Streams

- Sale of Product - Located Clients, Self Sustaining Housing Communities, Educational Spaces, Recreation, Bussiness Centers, Public Spaces, Tourism, Rental

Product

A Semi - Micro Mobile EV incorporating convenience of compact MMVs & efficient performance from two-wheeled vehicles

Product category: Transportation - Electric Vehicles
Industrial Design

Micro - ***EV***

This semi-micro mobile EV sits in between two drastic categories, compact MMVs that maximise convenience over performance and generic two-wheeled vehicles that maximise efficiency and performance over compactability. It harnesses a similar MMV body framework enabling users to cut through short-distance traffic by utilising both roads and pavements. Its narrow and sleek design helps manoeuvre it through significantly thinner gaps.

Feild Testing by Designer and Maker - Rishikesh Sonawane

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The EV incorporates cutting-edge performance with a high-functioning lithium-ion battery with an average range of 25 kilometres, that sits under the footrest and a secondary battery for regenerative breaking placed in the frontal panel. The secondary battery harnesses kinetic energy lost during braking before converting and storing it as electrical power, this in turn charges the primary battery increasing its output significantly. The added front panel not only acts as a shield against minor collisions but also balances out the rear motor weight bringing the centre of gravity in line with that of the user maximising driving control. The vehicle is driven by a high-torque 24V - 350W rear electric hub motor. A fully aluminium 6061-T6 aerospace alloy makes up the significantly lightweight chassis of the vehicle, providing strength, anti-corrosion and effective heat dissipation for the battery. Limited access to the battery enclosure ensures safety for the user and pedestrians in the event of an accident, containing harmful fumes and avoiding combustion. Lightweight ABS body panels protect the mainframe from damage and ensure convenient/cost-effective replaceability & maintenance. The frontal panel, handlebar module and wheel covers increase the product's aerodynamics cutting and redirecting air around and over the user. The design supports a seat attachment that can be added for longer travel distances. A manually adjustable sleek high beam headlight lights up the road ahead. Indicator lights on the rear and either side ensure the user's and vehicle's visibility in low-light conditions. A retro aeroplane switch powers the vehicle after the key switch has unlocked the vehicle accompanied by a small display indicating the speed, voltage and battery capacity along with an overheating indicator. 10 - inch pneumatic wheels reduce weight and absorb shocks eliminating the need for external suspension. An innovative mudguard design covers what's necessary, keeping the attachment light, aesthetic and functional. A lockable carabiner helps users securely hang belongings such as small bags or even a helmet.


Throttle
LED Headlight
Drum Break Lever
Bearing Service Plate
Streering Fork
Mud Gaurd
Foot Grip
Charge Port
Aero Cover

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Handelbar Lock &
Phone Mount
Indicator Display
Kill Switch
Carabiner
SS Disasembly Bolts
Rear LED Indicators
Side LED Indicators
Hub Motor 10″

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ABS Side Panels with
Carbon Fiber Imprint

10″ Pneumatic Front
Streering Wheel

24V 350W High Torque 10″
Hub Motor with Pneumatic
Wheel & Drum Break.

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Curated at Srishti Institute of Art, Design & Technology for **Bengaluru Design Week 2022**

by Rishikesh Sonawane

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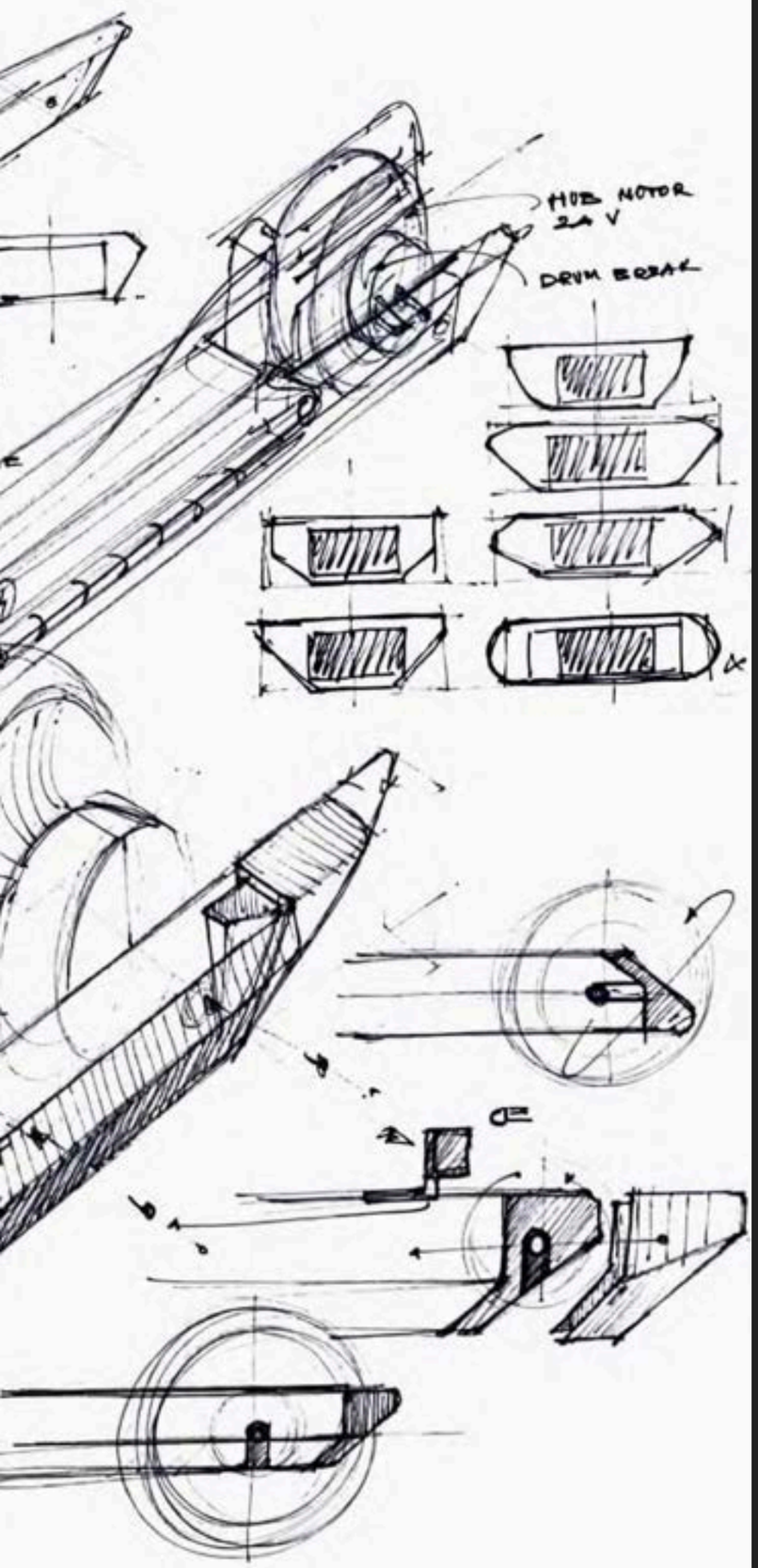
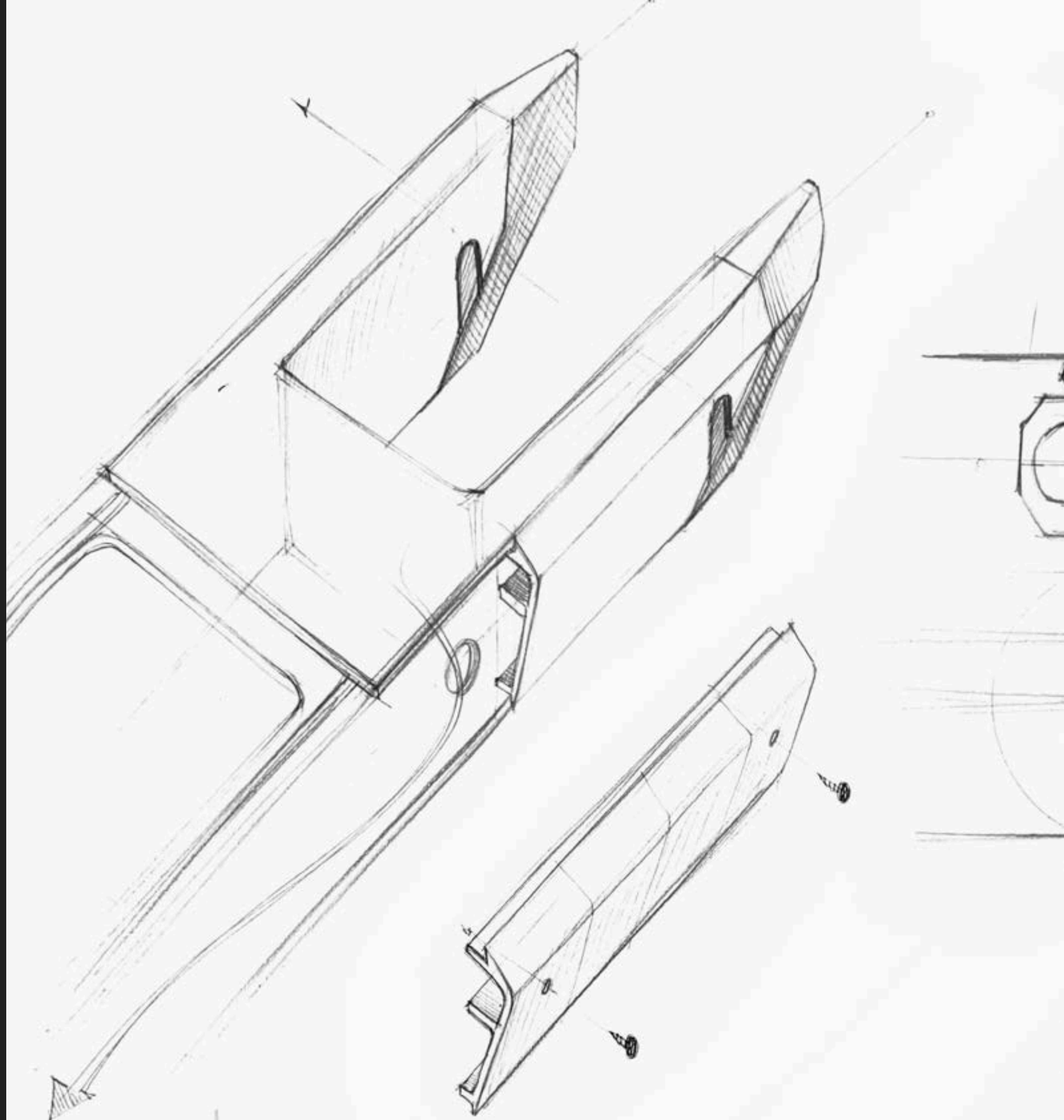
Scanned Hand Sketches on Paper

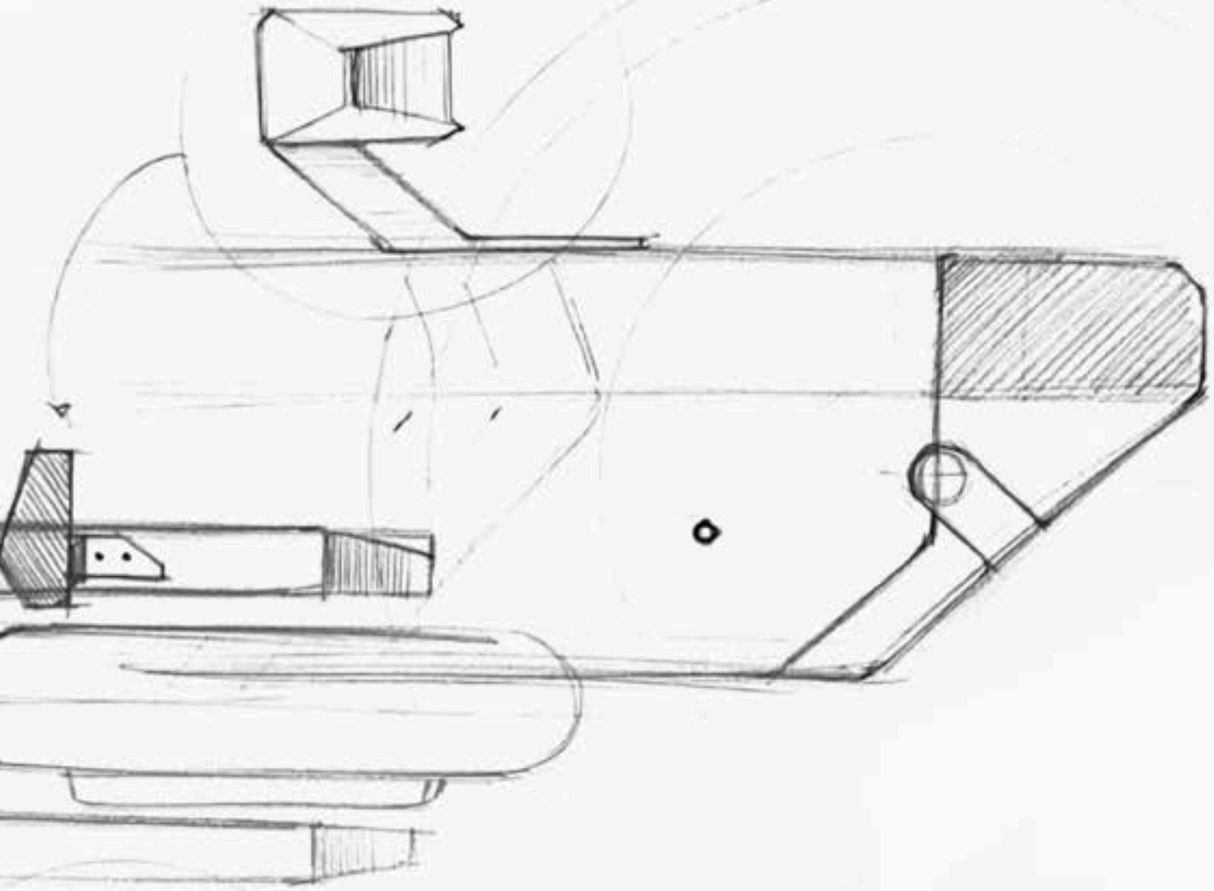


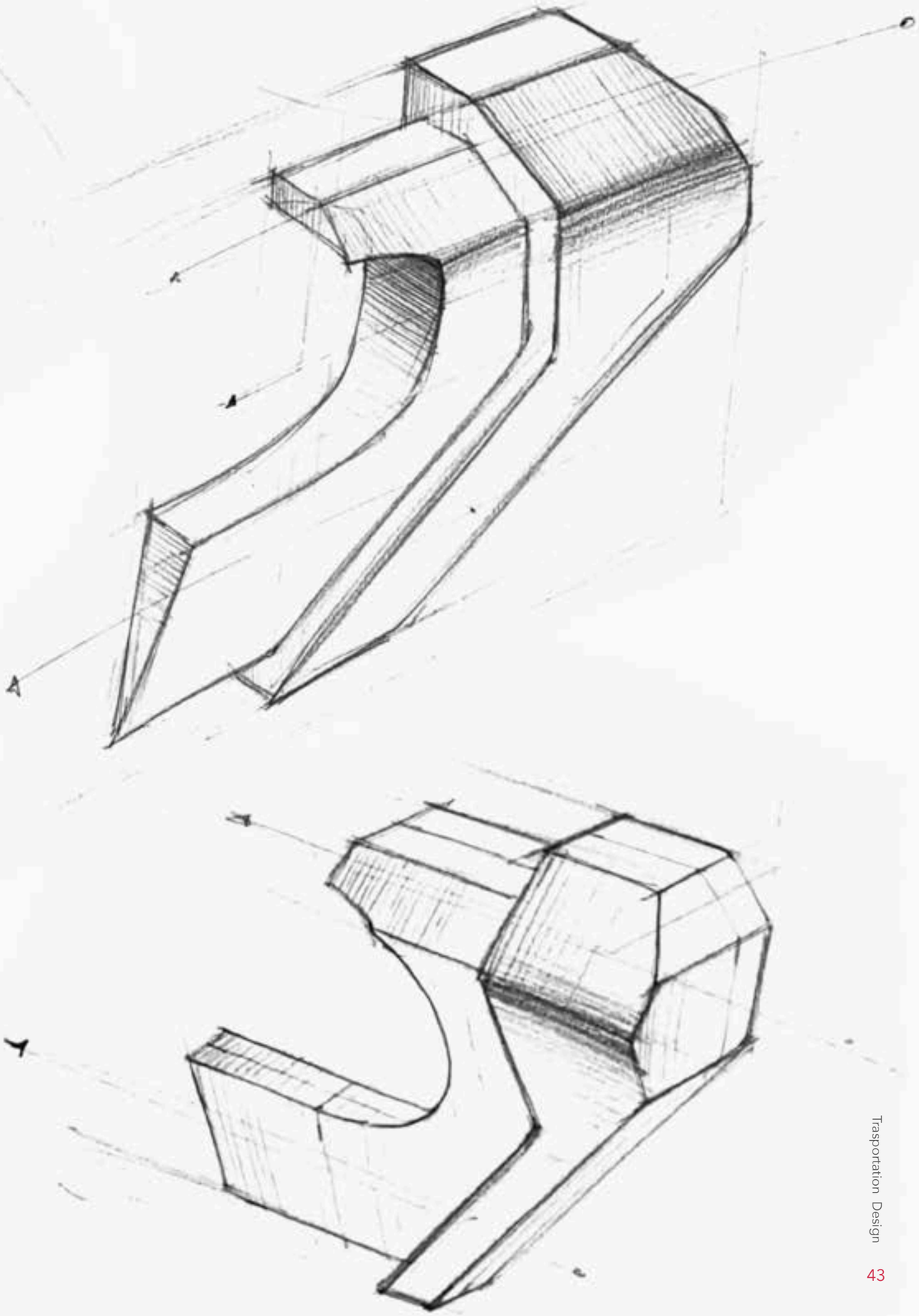
Ideation

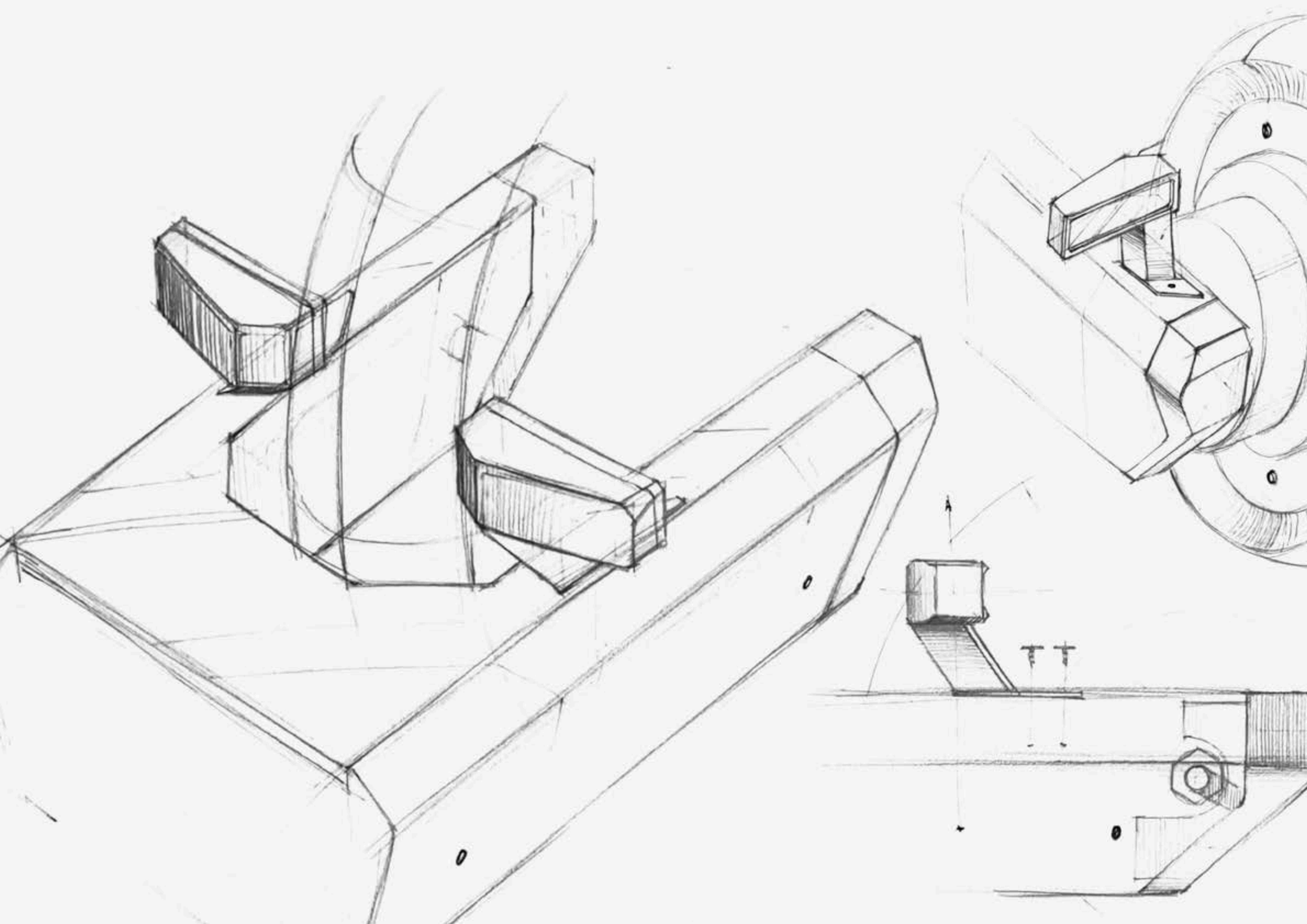
The ideation process started by making small iterations highlighting the rudimentary form of a micro mobile foot scooter. Since the project revolves around creating revenue stream for ward 110, the design was curated keeping the availibility and size of components in the site. Visualising the components and their placement, a design jacket was created around it starting with the fundemental chassis. The Mainframe supports every load and stress the ride would brinfupon the vehicles components hence it had to be focused on the most. It is the backbone of every vehicle and ensures the safety of the rider and individuals around. A basic form factor was decided upon and was modelled virtually to map out the approximate dimentions of the bike. Each component was precisely measured using callipers and modelled virtually, eventally giving a more definative form for the design. The design language emphasises on minimalistic sleek exteriors, with simple components that fit the average consumer taste.

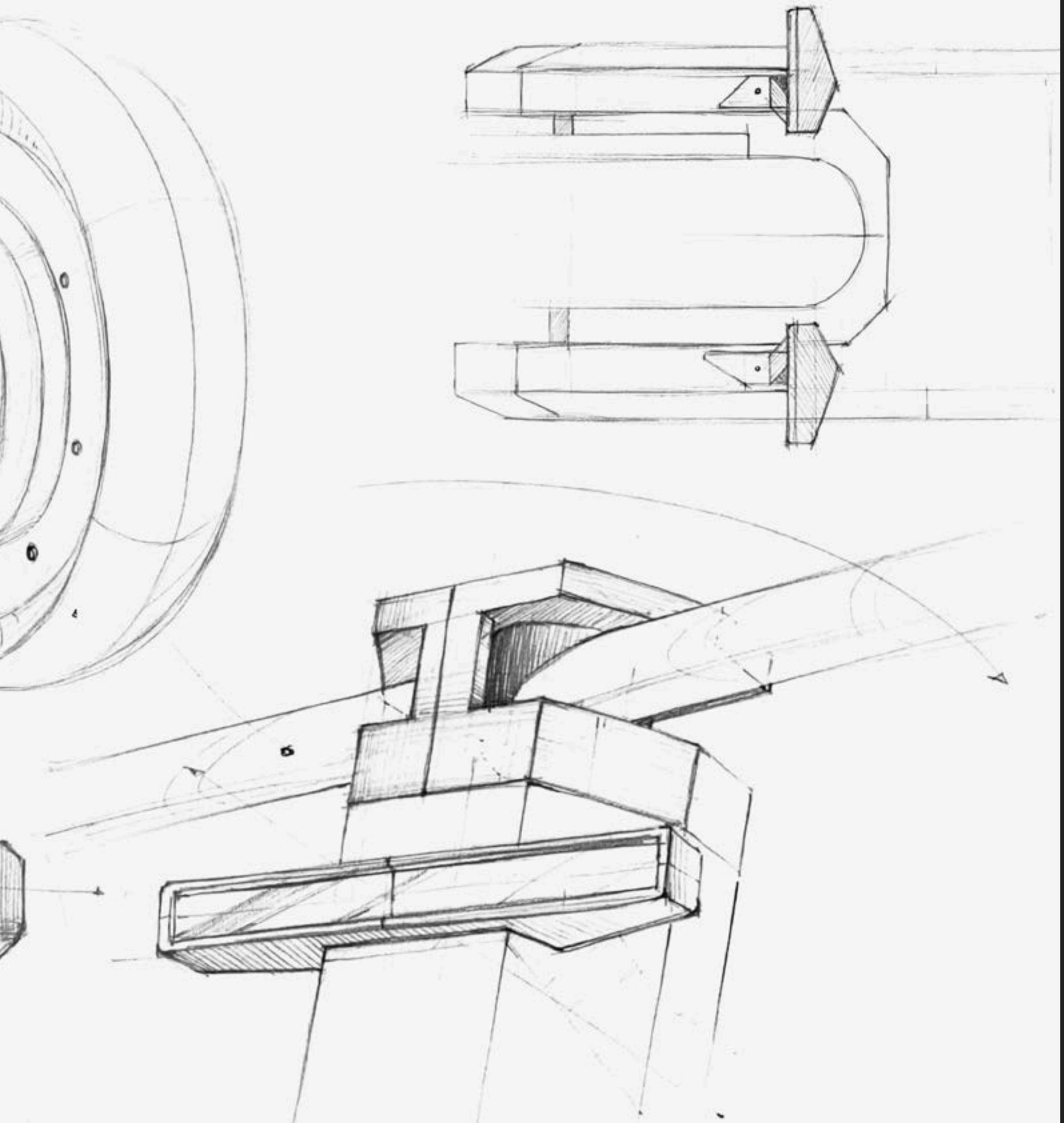
Sketching panel components in detail highlighting interlocks and pairing of bodies. Ideating end caps with internals to house components.





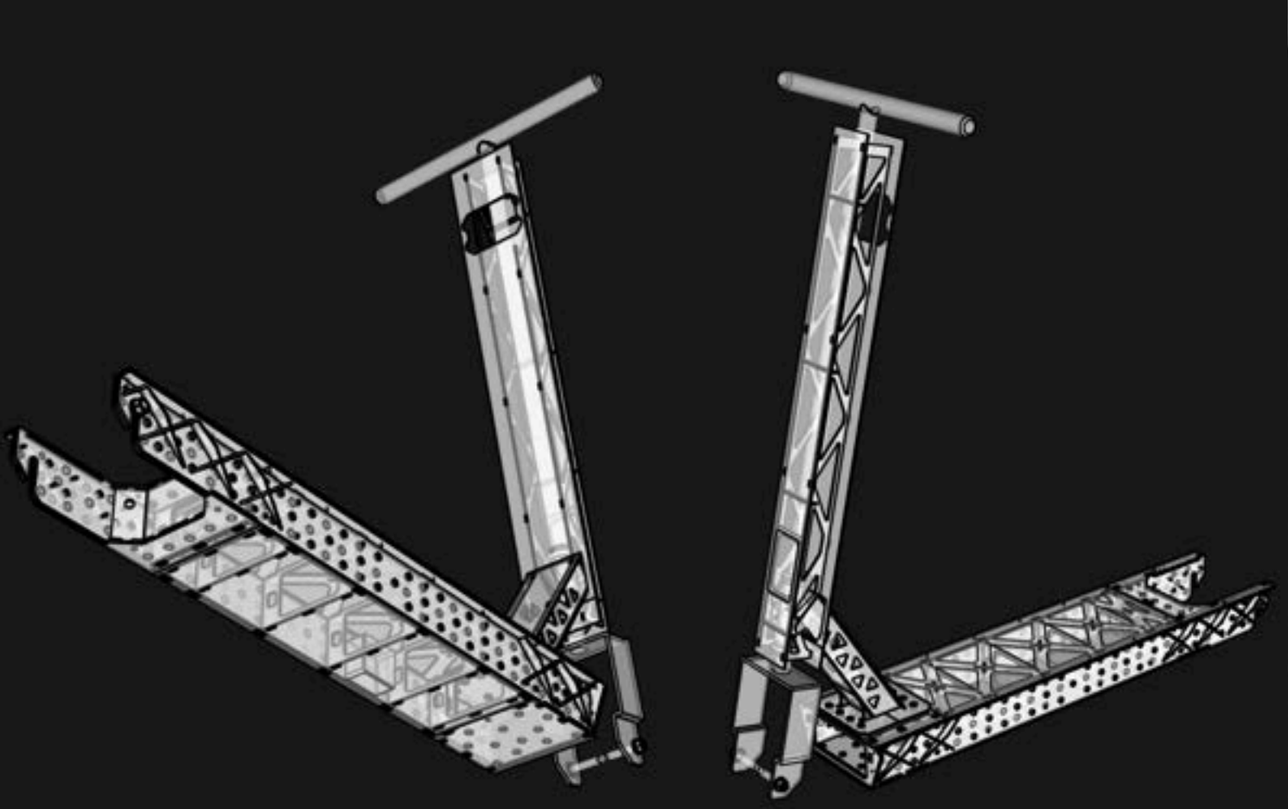


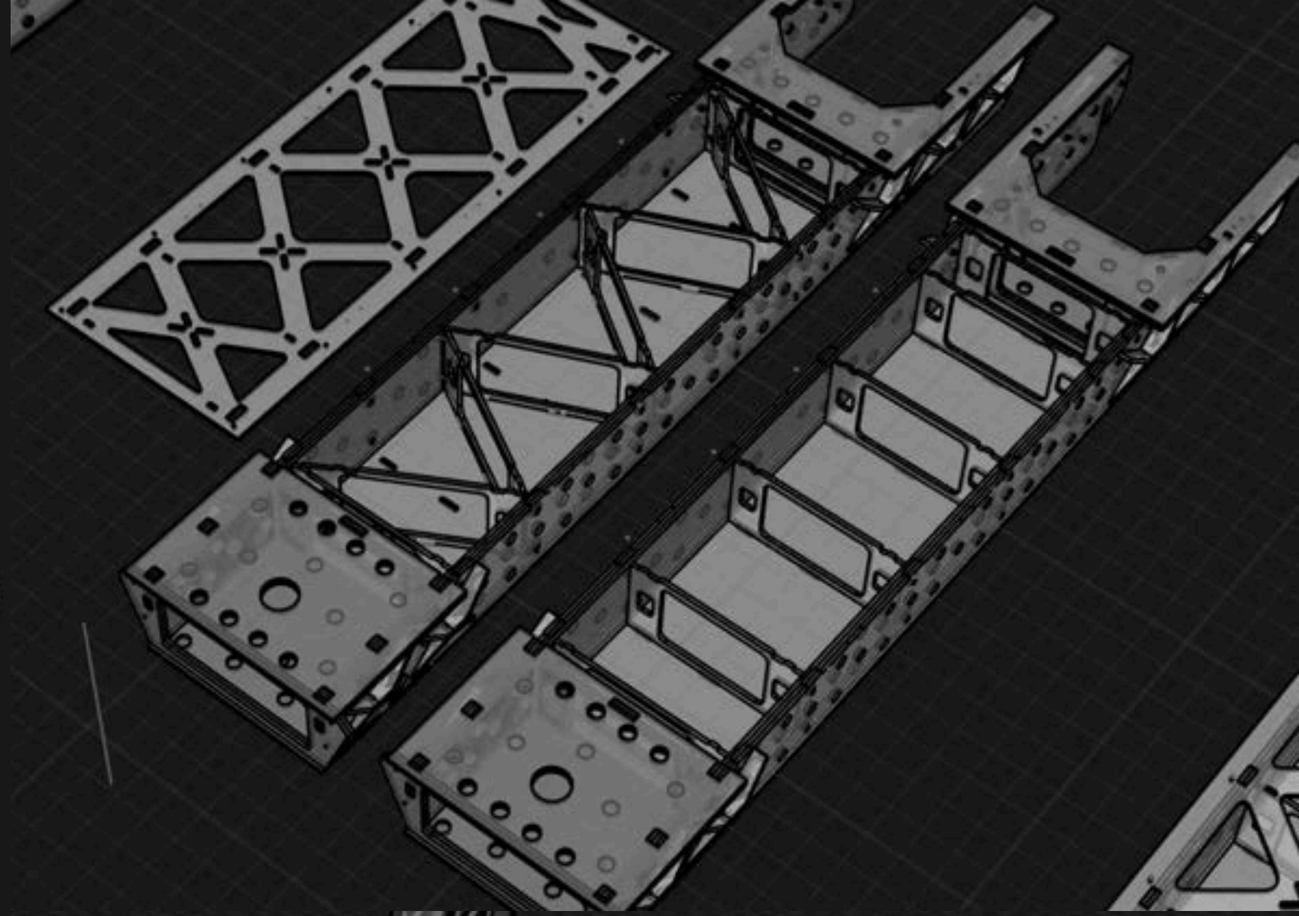


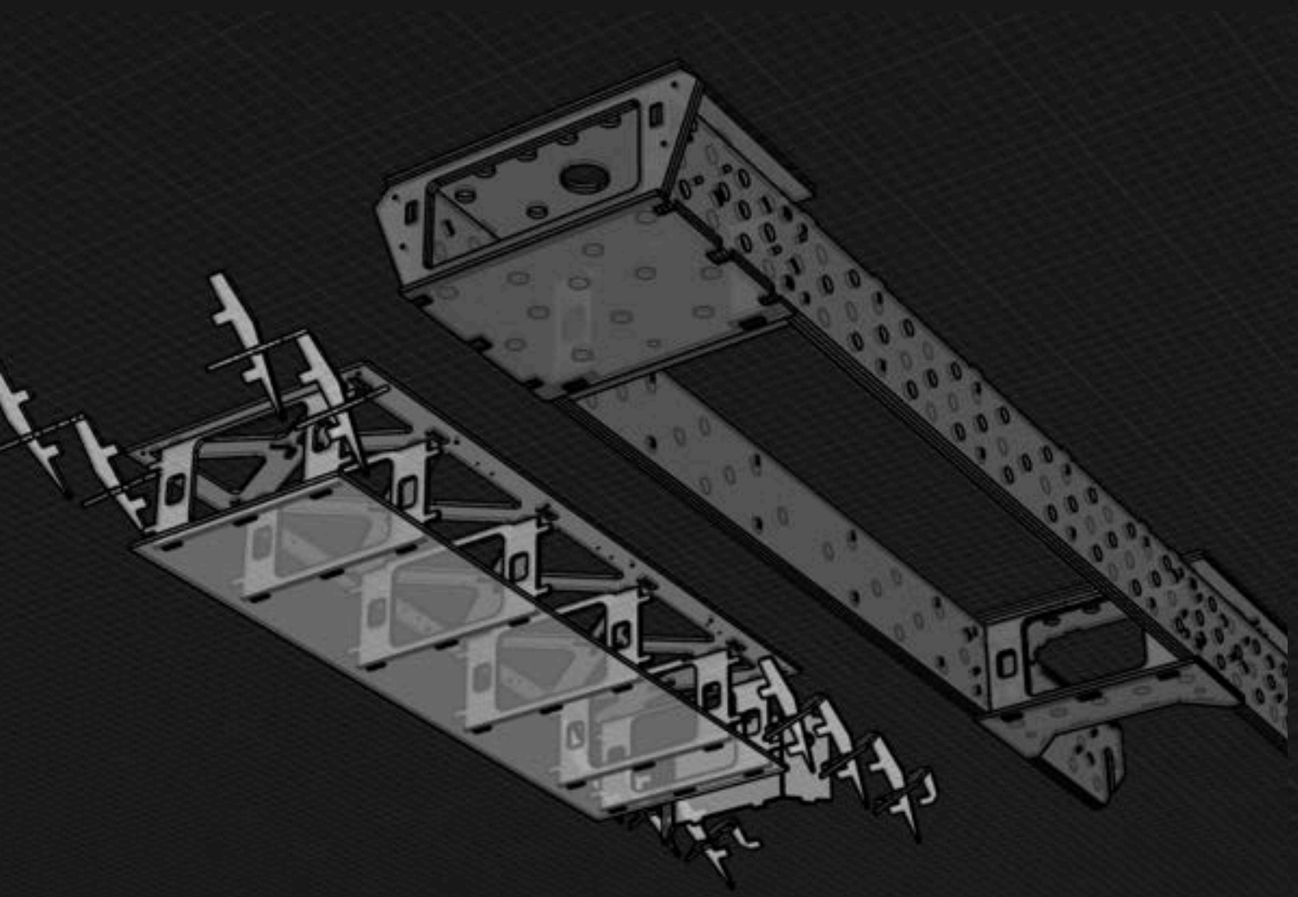


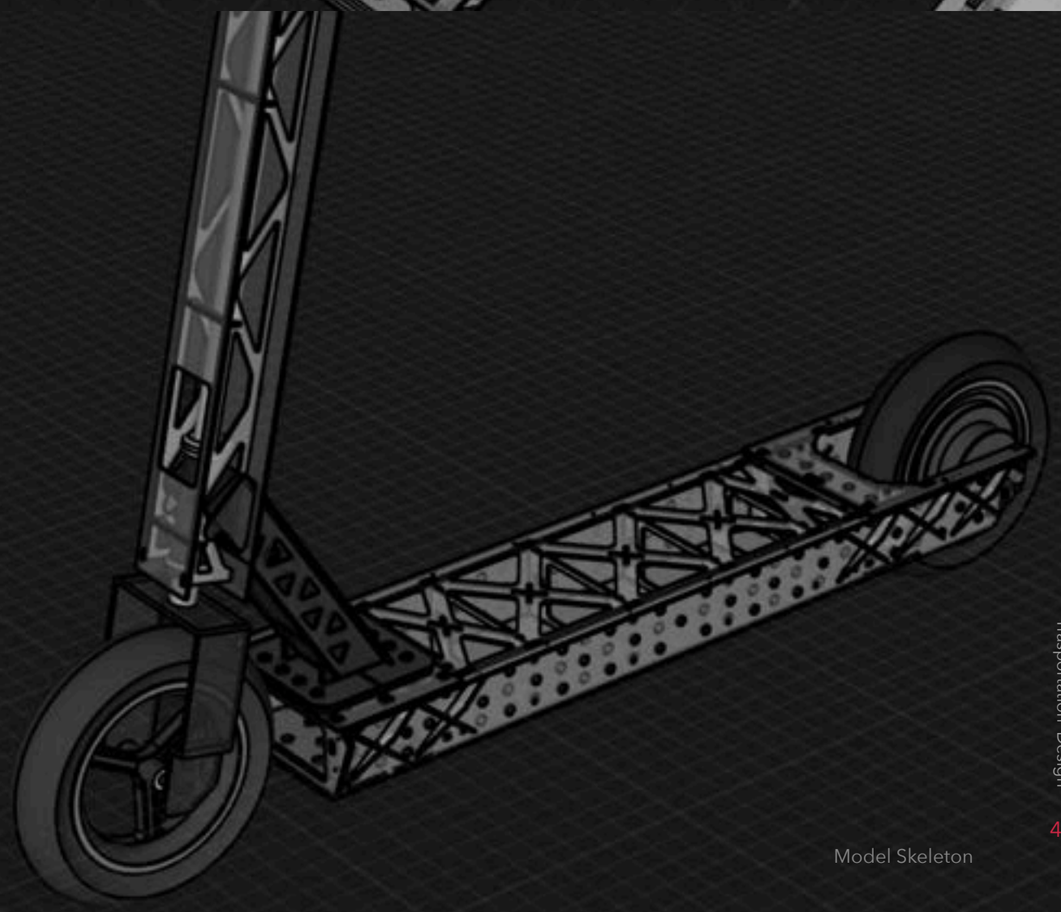
Deatailing lights and front handelbar housing. Showing movement and breif assembly using dynamic arrow lines. Sketching components to give a sense of scale.

Product scale using average Indian height 5.7 feet





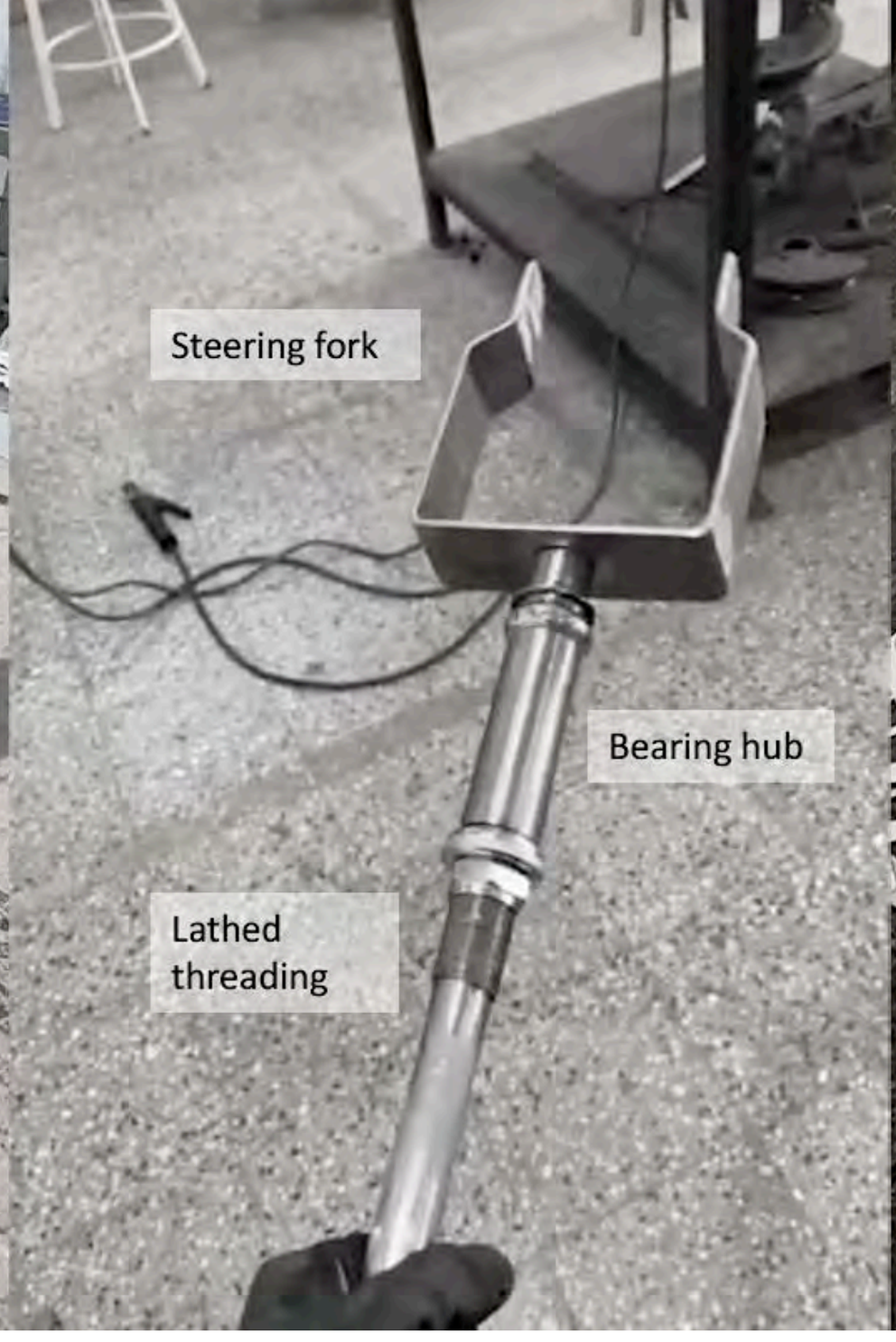


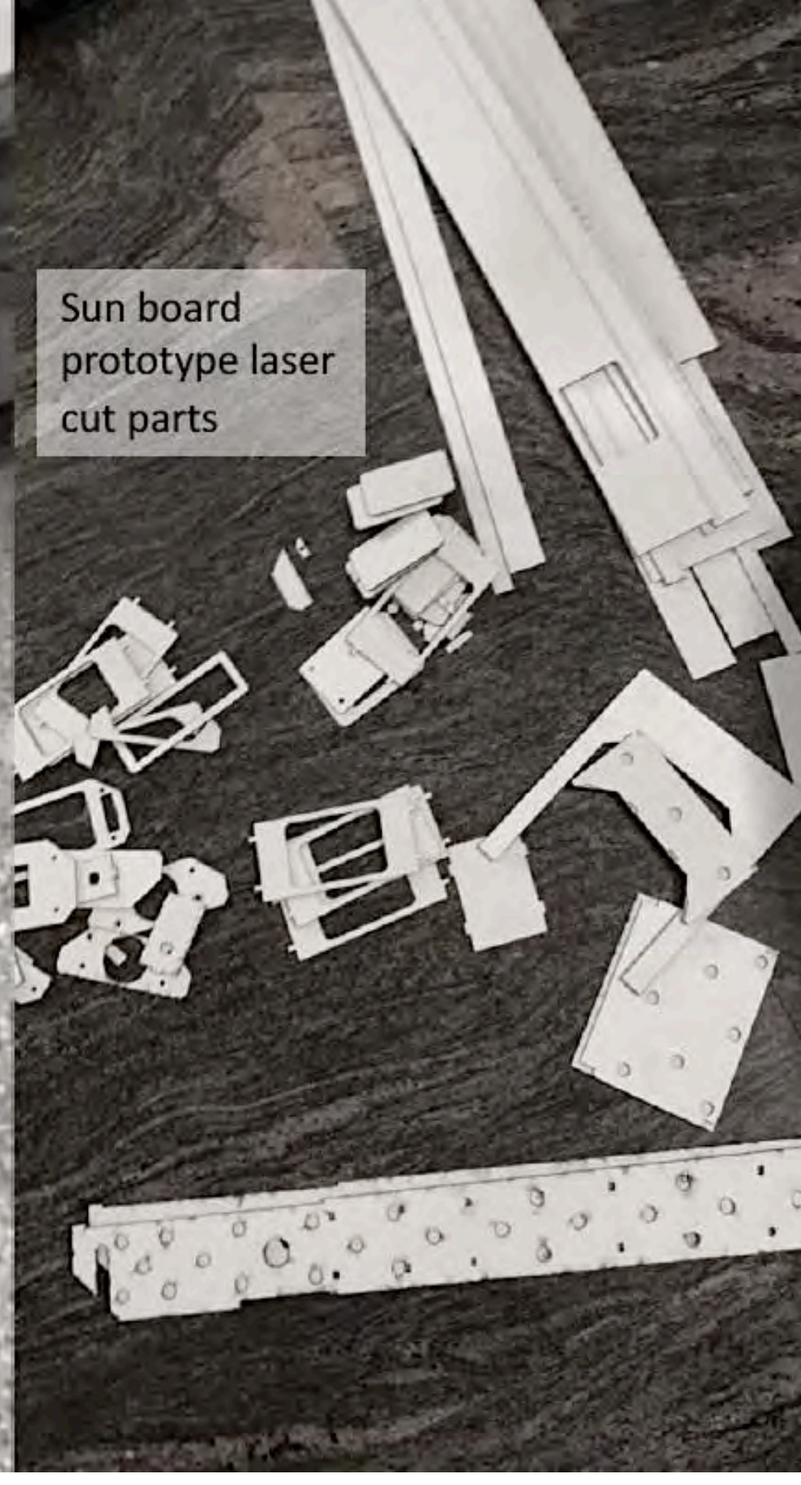


Model Skeleton

Low Fidelity Protytype 01

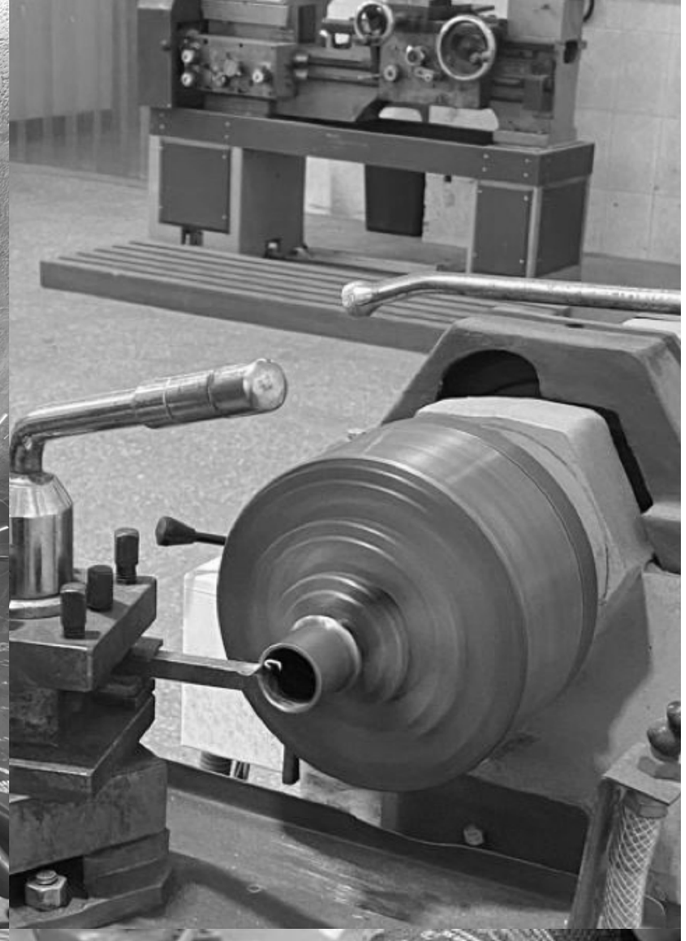
Before accurately modelling interlocks for each component, a to scale mock up was constructed using 3mm foam board. The pieces were precisely laser cut and glued together. All major components were fit inside the model and any errors were measured using a calliper and recorded. The bearing hub was constructed and paired with the model to give a physical constructed component as a reference for the virtually constructed ones. This technique ensures reliable experimenting with minimal errors.





Bearing Hub Construction Process

The hub was constructed using mild steel. The bearing hub houses 2 sets of ball bearing rings held into place by a nut. The handelbar slides into the hub and locks into place using 2 bolts, to stop free rotation and sliding repectively. the hub was then welded onto a rectangular pipe attached to a 5mm steel plate. 5 mm steel plate was cut and bent into shape for strength. The fork was then TIG welded to the turned bearing housing. The components were then sprayed with primer and painted for weater proofing.



Bearing Hub Construction Process

After the hub was painted and constructed, there were 2 errors with the fork. The fork seemed to flex and was not proving to be strong enough. 2 small trusses were cut out and later welded inside the fork to increase strength and feduce the amount of flex. The hole placement for the steering wheel was inaccurate as the wheel was interfearing with the body of the scooter preventing it from rotating. The holes for the front axel were offset by 8 mm forward to solve this problem. The axel was later cut to size according to the fork.



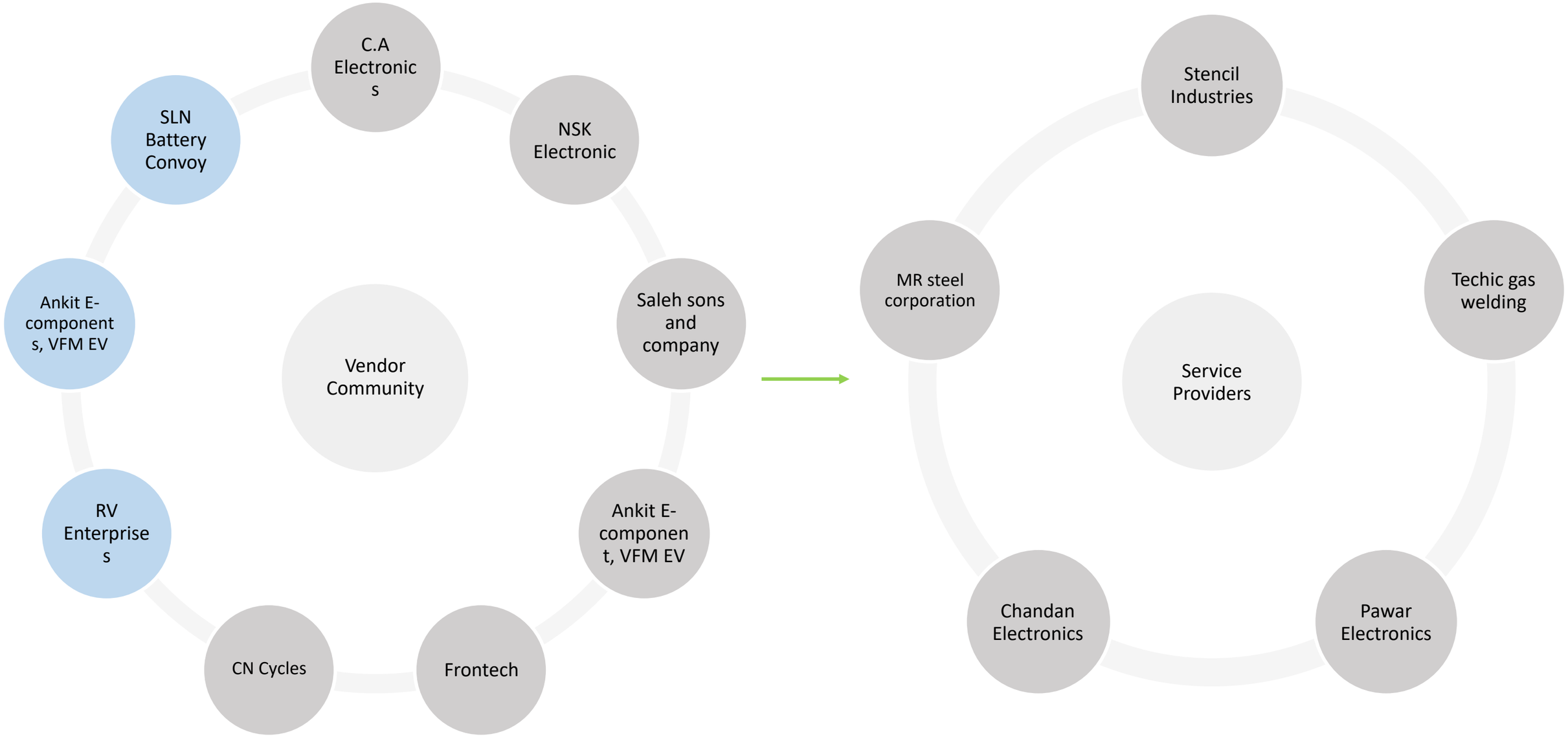

Low Fidelity Prototype 02

After making changes recorded from the first mock up, the seconf mock was very accurate and needed minimal change. A components such as the lights and panels were 3D printed with minimal infill to finally check the fitment. The changes for the plastics were recorded and the final parts were printed using ABS. Basic wiring for the functioning of the scooter such as the display and motor were completed in the prototype. After making required changes the final file for the chassis was prepared for laser cutting using 6061 T6 Aerospace aluminium.

Sr. no.	Vendor	Part	Units	Cost
01	RV Enterprises (S-One Electrix)	24V 350W DC Brushless Hub Motor 10” Pneumatic: Drum Brake, 10” Steering Wheel Pneumatic with front axel.	2	8,550
02	SLN Battery Convoy (MICRONIX Li Batteries) (manufacturer)	24V, full charge 29.4V, 15AH, Max current 3A Lithium Ion battery.	1	10,800
03	Ankit E-components, VFM EV	24V 350W PMDC E-bike Controller: aluminum casing	1	1500
04	C.A Electronics	ETC 24-60V capacity, 60V Tri-pin charge port female.	2	450
05	Balaji Electronics, Phoenix Contact (manufacturer)	Injection molding, Die maker	-	-
06	MR Steel corporation, Stencil Industries	Metal, 18 to 25 Rs. per kg, pipe + sheet	6	325
07	Frontech (new Chandan electronics)	LED bar IP 65 rating 12V 6W 2500 lumens white. Red led IP 65 rating 12V. Airplane Switch IP65 12V.	6	955
08	NSK Electronics	Voltage/Current + battery indicator display. 25A-3A 350W DC-DC stepdown buck converter with heat sink.	2	1560
09	Saleh Sons and company (manufacturer)	10 mm 304 SS Allen key head bolt + nut. 6061 T6 Al 4X4 feet	8	6880
10	SN Cycle Store, Cycle World, Abir Spare parts	Brake, Brake wire, Bell, Handlebar grips, Al Carabiner	4	-
11	Techic Gas welding	Welding TIG	N/A	3000
12	X	Wires, Insulation Foam, Electrical Tape, Gasket Tape, Grip Tape, Screws, Silicone sealant, Plastics	8	-

Cost Sheet

Total – 34,020 INR +miscellaneous



Stakeholder Mapping

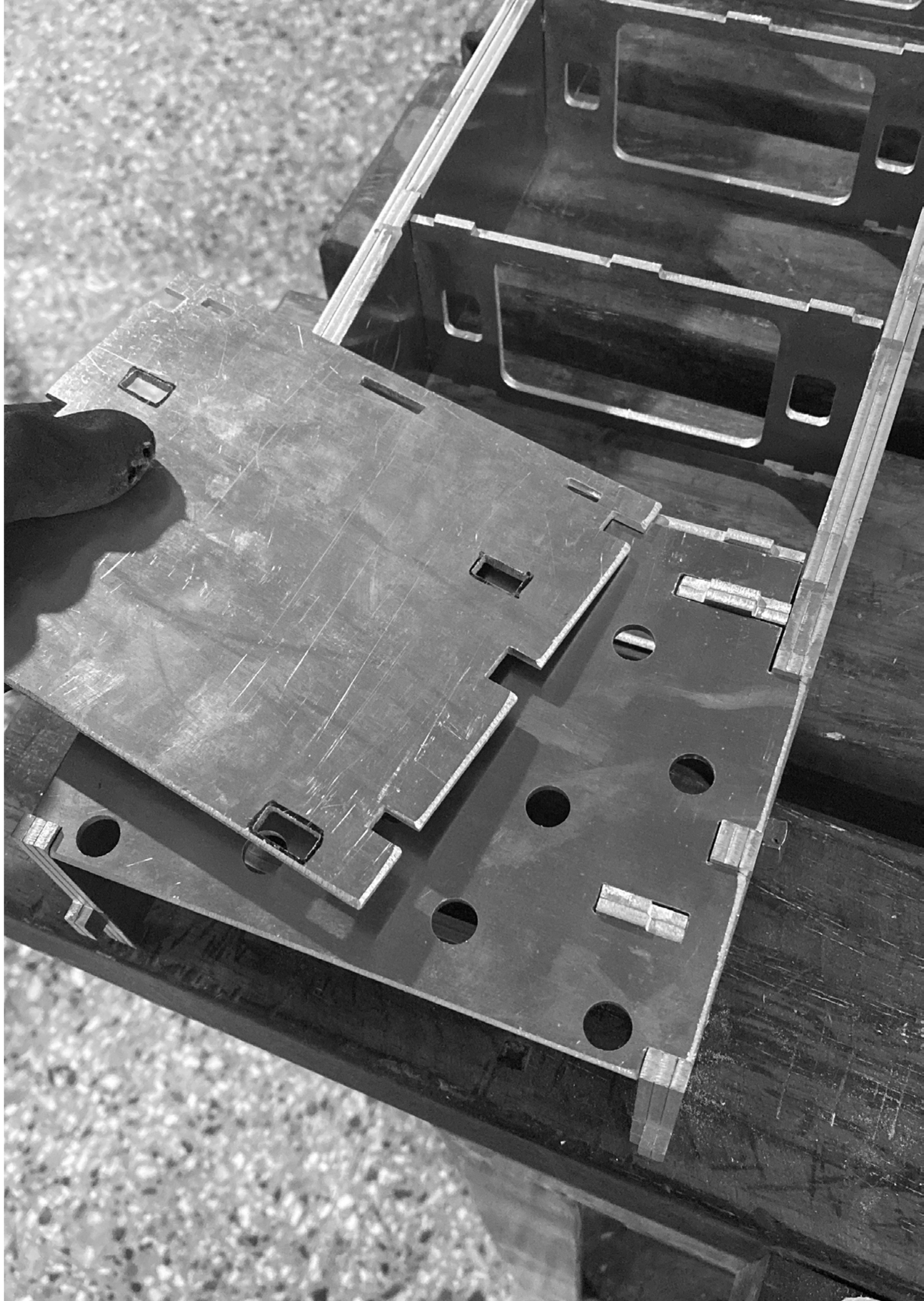
Above is a diagram showing the new circular loop presented in tye proposal. The cycle includes all vendors located in ward 110 that aquire the skill sets and resources to execute this product. The 2 cycles have their own contributions to the cycles. the vendor cycle provides the service cycle with the components, these service providers mainly small scale workers help put the product together and is later hander over to a tertiary body that is responsible to check and coordinate with the community for quality checks and marketing.

Final Construction Process

The metal was cut according to the initial prototype. The parts were tallied and cleaned using rubbing alcohol. The interlocking was then reviewed and small files were used to file away any metal residue. The whole mainframe was then assembled and all 29 parts were taped together. Because the parts interlocked into each other, there was no need for large quantities of fastning, just holding the top and bottom plate together secured the entire frame.

Using an angle grinder to create chamfers along edges that need welding. The chamfers on both sides create a small V shaped valley that fills up with moulten metal. The tig welding process is then carried out acurately and ensures the frames strength. The filler metal once melted doesnot crack and release the metal surface, if the edges were to be left un chamfered, the reliability of the welds and thereby the entire mainframe cannot be ensured. This process can be compared to that of scoring clay during pottery.

The parts were constantly altered and checked for fitment to ensure tight interlocks. The interlocks not only act as a guide for assembly but also hold parts in place during welding. This stops warpage and ensures a clean as is mainframe after fabrication. The holes on either plates were made to reduce weight and to open up surfaces for welding. This way no additional weight of the filler rod gets added to the frame.

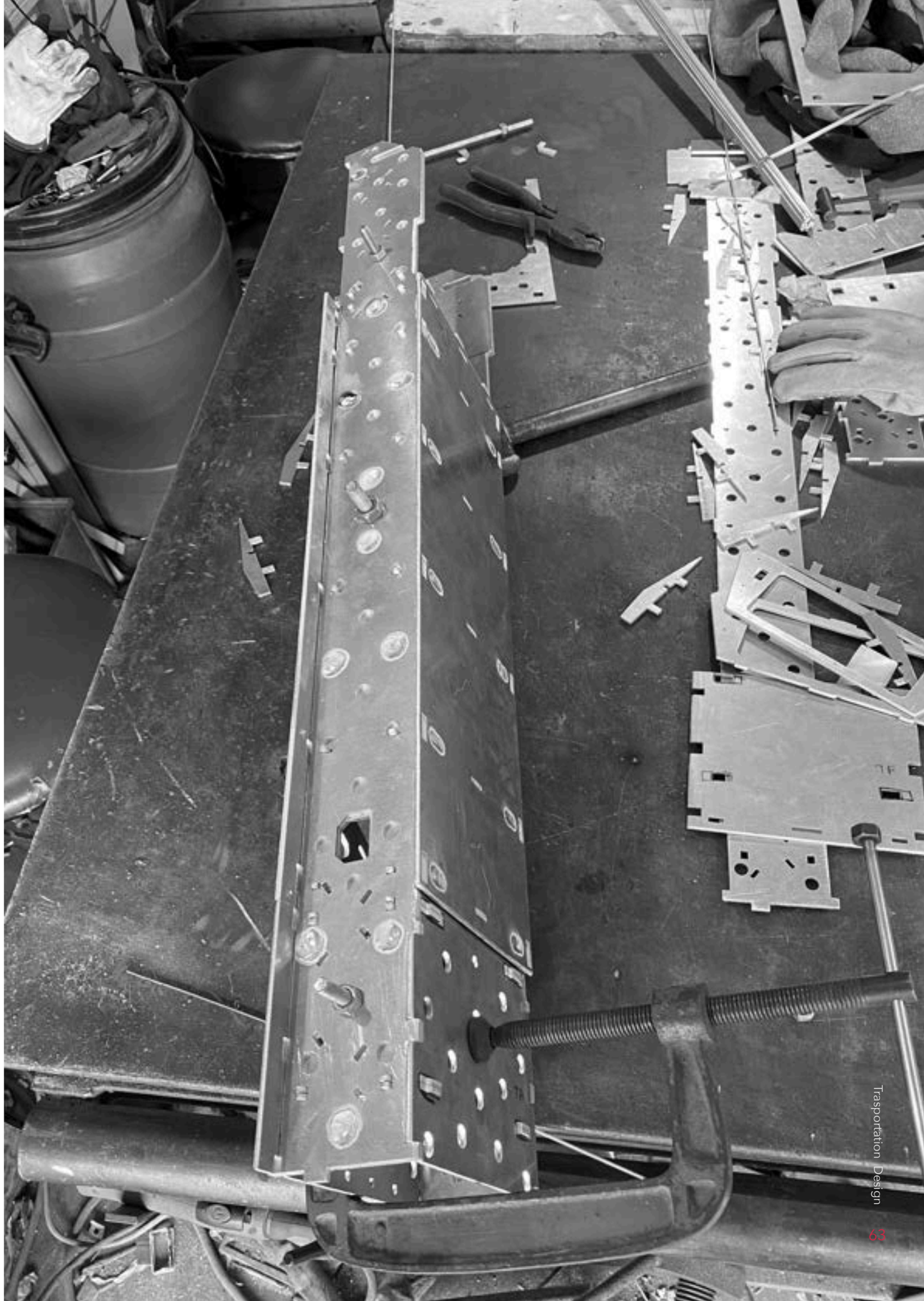


Once the frame was assembled, first it was secured using tape. 3 holes spread out across the spine of the frame were marked and drilled. Each hole was used to slide a threaded rod slightly longer than the width of the scooter. These rods were then tightened using nuts to hold the entire frame into place as the tape would need to be removed during the welding process. The rods provided additional support for warpage too.

Finishing Plastics

All plastics were printed and sanded clean. They were prepared for the final fitting process that would be carried out after the welding. A few defects during printing were either sanded or removed using a dremel. The negative space created after removing defected material was then filled using plaster body filler similar to the ones used to patch up dented or damages car panels. The plaster was left to cure and was the spray painted to isolate it. The first 2 coats of paint were left to dry and sanded one last time before the final painting process, this made the surface extremly smooth and finished.

The welding process started off by lightly clamping a few parts. The clamp also acted as a stand to angel the welding surface. The parts were tack welded without using filler rods to hold them in place. the interlocking was then reviewed and then the final welding process was initiated.

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The final welding process was initiated. The stress points of the mainframe were alrready identified and marked out, these points had to be welded with exta care to ensure strength. Filler rod was used for such joinaries. The holes made to reduce weight and to open up windows for welding were welded without any filler by melting the edge of the hole itself. The welding was executed personally using an AC- DC TIG welding machine. 5754 grade aluminium filler rod was used to weld the entire frame. A lower grade of filler rod is appreaciated as it melts faster and penetrates gaps deeper to make stronger welds.

After Welding, any splattered metal was filed or grinded away. Since aluminium is a very soft metal, it doesnot spark, a soft sand paper grinding wheel was used to remove less quantities of metal. The sand paper dick also ensures a smooth finish which would later save time during the buffing process.

After all excess weld material was grinded down the frame was buffed. Using a hand drill, holes for the bearing hub were marked and drilled into the frame. The plastics were then placed on repective positions to check fitting. Some filler welds were interfering with the panels hence they were either grinded down further or a small cut was made into the panel.

After thye panels were fit the mountings were secured onto the frame using bolts and screws. The mounts were also 3D printed according to the panels. The panels click fit into the mounts and then were screwed into place.

The final step was the wiring. A small mock circuit was made to check the working, using a multimeter the voltage and current was adgested where needed. The DC-DC step down buck converter was callibrated after calculating the LED power consumption using simple formulas. the mock wiring was then scaled up and completed inside the scooter and it was taken out for a test run.

Final Product

Micro - Mobile *EV*

Trasportation Design

Mechanics

The EV chassis follows a unibody construction over a body-on-frame assembly. This is because unibody frames incorporate the strength aspect into the chassis using the panels themselves, which makes the body sleeker, more accommodating towards components and lighter in weight. Sheets of various shapes pre-cut, slot and interlock together for efficient assembly and increased strength. This method is implemented by the majority of middle + high segment automobile manufacturers both for EV and non-EV. What separates these two methods when it comes to mass manufacturing is the difference in cost and time. Body on frame is a simpler and cheaper method of making chassis and is usually used for low-segmented vehicles or even heavy-weight vehicles such as buses and trucks. It usually consists of a ladder frame that is the backbone of the vehicle, it supports heavy components such as the engine, transmission, wheels or battery. The frame that encapsulates the driver is then attached to the frame externally. Since this micro mobile EV due to its use of relatively expensive components and technologies falls under the premium vehicle segment, the unibody method is implemented as it caters to its performance needs more effectively.

Validating and Reviewing

Student Validation

Testing and recording flaws around university vicinity. The vehicle could easily absorb bumps and poyholes due to the 10" pneumatic wheels. The turning is smooth and is stiff enough to provide stability diring high speeds. With the high torque motor slopes can be overcome without significant change in speed. The breaking is soft and gradual due to the drum break, disk breaks tend to stop vehicles faster but for such speeds it is not required and is an added cost. The vehicle was used to commute between 3 different campuses with a distance of approximatly 4 km. The small form factor enables the user to take it through small pavements and road congesion. The throttle sensitivity is more gradual than linier, this helps accelerate slowly and also conserves charge. The front panel helps agaist minor coulisions and gives the user a sense of encapsulation or protection. The EV has an approximate range of 20 to 25 Km depending on road conditions. In gated communities with smoother tarmacks the range can well over exceed 30 km, which means it needs to be charged less often and can positively be used as a shared micro mobile vehicle.

Negatives

A slight rattle in the handelbar creates discomfort during bumps or potholes. It was fixed using a rubber grommet placed arounf the inside of the handelbar module. The rear lights are susceptable to breaking due to the foot placed at the back. The lights were initially inside but were moved towards the foot pad as the supports interfeared with the bolt nut. The rear light design needs to be changed or should be relocated to its original position by altering the problem supports underneath. The brake was a little too soft hence was slightly tightened. The ride is smoother after regulating the tire pressure

Reflection

The project brief gave me scope to explore and carry forward a product catagory that i always wanted. transportation is a subject that cannot be done justice too in short time spans such as studios. Initially it was hard to decide an output for the given brief. As the research continued the the problem areas started looking clearer and eventually i decided on taking micro mobility as my area of intervention. Being a srudent myself i have faced commute problems specially in Srishti with multuple campuses streatched out across 1 to 5 km. Even my visits to ward 110 made it hard to access marketplaces or even pass through traffic. I was fortunate enough to finish my project in the given time span. With the kind of output I was planning i had reserved majority of time for the making of the product. I had very little margin for errors and my aim was to be sure of what I execute. I feel my project fits the brief in a very non generic way, this project was not only about ward 110 but also to showcase my abilities and skillsets i have aquired over my time in Srishti. I think that micro-mobility is going to be a big part of the future in terms of how we get around and how we interact with our environment in general. But I also feel like some things need to happen before it becomes mainstream because if you look at where we are today, there are still a lot of people who don't have access to this technology. There are still a lot of places where there is no access to smart efficient vehicles making travelling a hassle and reducing community productivity. So what is the future of micro-mobility? There is no definitive answer to this question as the future of micro-mobility will largely depend on the success of various initiatives in terms of meeting consumer demand and addressing infrastructure challenges. However, if successful, micro-mobility has the potential to transform how people move around cities and could play a significant role in reducing traffic congestion and air pollution. Overall learning about this topic was challenging yet exciting and i am surely satisfied with my final output.

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