

DESIGN PROJECT 2

DESIGN OF COMPACT VEHICLE FOR NUCLEAR FAMILY



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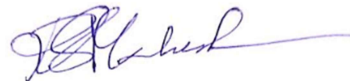
Mobility and vehicle design

(2017 -2019)

Guide: Prof. Nishant Sharma

DECLARATION

I declare that this written report represents my own idea in my own words, and where others ideas or words have been included, I have mentioned the original source. I also declare that I have adhered to all principles of academic honesty and integrity and have not falsified, misinterpreted or fabricated any idea, data, facts or 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 source from which proper permission has not been taken, or improperly cited.

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ACKNOWLEDGEMENT

This project would not have been possible without the help from a number of people, and I would like to express my sincere gratitude to them. I am deeply indebted to Prof. Nishant Sharma, who provided invaluable guidance and input during each and every stage of the project. His feedback was essential to ensure that the project was always moving in the correct direction. I would also like to thank Dr. Sugandh Malhotra, for providing his feedback and opinions during the stage presentations, which also helped to steer this project in the right direction. I am also thankful to my beloved friends who provided their own insights which helped me out with the project, not to mention their constant support. I would like to thank all public who participated in the user research for this project. Finally I am thankful to IDC for providing all the necessary facilities and infrastructure for me to carry out the project.

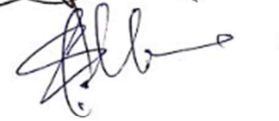
APPROVAL SHEET

This Mobility and Vehicle Design project entitled “Design of Compact Vehicle for Nuclear Family” by R.S.Mahesh is approved in partial fulfilment of the requirement for Master of Design degree in Mobility and Vehicle Design.

Project Guide :



Internal Examiner :



External Examiner :



Chair Person :



Date

: 23/11/2018

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PROJECT INTRODUCTION

1. INTRODUCTION

In India, most of the nuclear families use two-wheeler as their family vehicle. A person driving a two-wheeler in a congested manner in the narrow street and traffic road with his wife on pillion seat and a kid in front is a most common scene in India. Auto rickshaw is not as comfortable as car and car is too wide for narrow streets. These "Two-Wheeler" family is slowly moving into the hatchback segment increases the traffic density especially in urban cities which need to be controlled. Also, riding with more than two people is not safe. This project has addressed those problems and tried to solve this problem by introducing a vehicle between bike and auto rickshaw.



Fig. 1.1.1 Nuclear family traveling on two wheeler



Fig. 1.1.2 Unsafe driving



Fig. 1.1.3 Unsafe driving

1.1 Targeted problems and Users

For nuclear families with 3 members, who need a vehicle to travel in the city but not wealthy enough to afford an entry-level car or auto rickshaw for daily usage.

For parents who take their kids with bags on shoulders to drop at school on a two-wheeler, where there is not enough utility space to keep their luggage.

For two-wheeler users who travel in triples which is against safety norms not safe (fig. 1.1.1 and fig. 1.1.2)

For Urban cities like Mumbai, Chennai, Bangalore, etc., with heavy traffic and lots of narrow streets. Where travelling by auto rickshaw or car is very difficult. (fig. 1.1.3)

For micro families who have not enough parking area for a car or with parking area suitable for two-wheeler only.

For the users who want to convert their vehicle whenever required, based on a number of people who are going to travel in it.

For the users who want to carry goods and can resize the vehicle when there are no goods.

1.2 Nuclear Family

There is a gradual increase in the disintegration of the joint family system, the emergence of a nuclear family in India, especially in urban cities. A family consisting of father, mother and their children (1 or 2) and no other relations is called a nuclear family. Basically, the ratio of the nuclear family is high in India and it is growing at a fast rate because of industrialization. The nuclear family in an urban area is very high compared to a rural area. (Fig. 1.2.1 and Fig. 1.2.2)

Ratio of Nuclear families in India

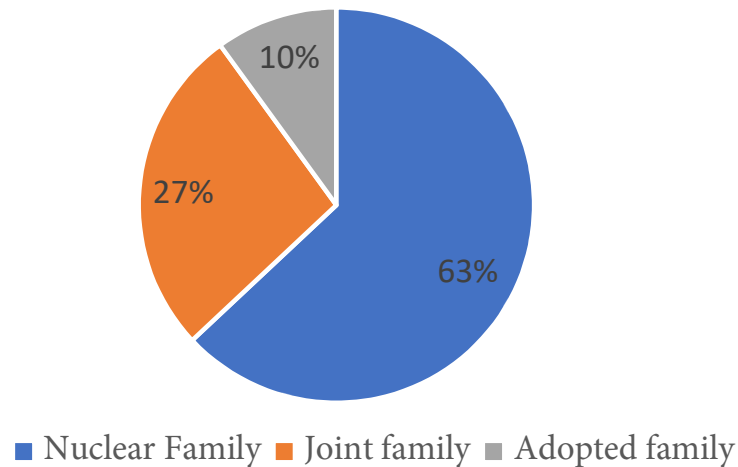


Fig. 1.2.1

Nuclear families in urban and rural India

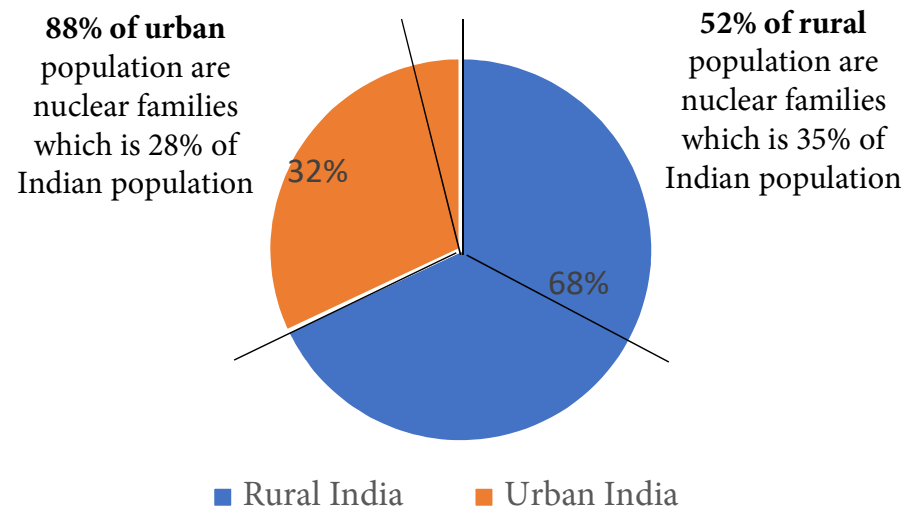


Fig. 1.2.2



Fig. 1.3.1



Fig. 1.3.2



Fig. 1.3.3

1.3 Commonly used vehicles by Nuclear families

Two wheelers, auto rickshaws, and small cars are the most preferable mode of transport by the nuclear family. Among them, two wheeler is most used because of many advantages like high mileage, easy to maneuver in traffic and affordable prices. Though upper middle class can afford cars they usually go for two-wheeler when it comes to in city transit for reasons like narrow streets, denser traffic, lack of parking space etc. People who can't afford a car prefer auto rickshaw whenever required and taxi nowadays as the prices are cheaper compare to auto rickshaws.

1.3.1 Two Wheeler

Pros: Small in size which is easy to handle, affordable, high fuel economy, easy to maneuver in narrow streets and heavy traffic, requires less parking area.

Cons: To ride with two pillions on a two-wheeler is against safety norms, prone to weather conditions, no backrest in seats for basic comfort, less space for luggage

1.3.2 Autorickshaw

Pros: Affordable public transport for a nuclear family (Comfortable for 3 people), easy availability, closed vehicle protects from weather conditions, boot space available for luggage

Cons: Not preferred as a private transport, big in size (almost 80% of a compact car size), Occasionally used as it is expensive, difficult to penetrate heavy traffic, need more parking area



Fig. 1.4.1



Fig. 1.4.2



Fig. 1.4.3



Fig. 1.4.4



Fig. 1.4.5



Fig. 1.4.6



Fig. 1.4.7

1.4 Observation study

Nuclear family using a two-wheeler against safety, like traveling without a helmet, carrying more luggage (Fig. 1.4.5), unsafe driving with bags (Fig. 1.4.3), using an umbrella while traveling (Fig. 1.4.2), ladies not wearing a helmet for the reason of their hairstyles and ornaments (Fig. 1.4.4), violating traffic rules (Fig. 1.4.1), lack of availability of an auto rickshaw during pick hours (Fig. 1.4.7), auto rickshaw got stuck in urban traffic (Fig. 1.4.6) etc. are major problems faced by a nuclear family.

TECHNOLOGY AND ERGONOMICS

2.1 Electric powered vehicles

In India electric powered vehicles are negligible when compared to total vehicles produced. In the last two years 2015 to 2017, the number of electric vehicles increased 7 times from 10321 to 72482. National Electric Mobility Mission Plan target of having 6-7 million electric vehicles by 2020. 40 per cent EV sales is possible by 2030 while aiming for a complete shift to EVs by 2047. Federation of Indian Chambers of Commerce and Industry and Rocky Mountain Institute estimates that with 100 percent electrification, India can save R20 lakh crore and 1 gigaton of CO2 emissions. For pollution control reasons, the new vehicle should be electrically powered vehicles.

Advantages of EV - Zero emissions - no air pollution, less noise pollution, health benefits because of no air pollution, Cheaper to run, easy to maintain because of less moving parts, Vehicle registration benefits, Reduces dependency of foreign oils.

Disadvantages of EV - Battery life cycle is less, Charging time is more, Aggressive driving decreases the EV range, Long mountain climbs decrease the EV range, AC usage will decrease the EV range, the Extra payload will decrease the EV range

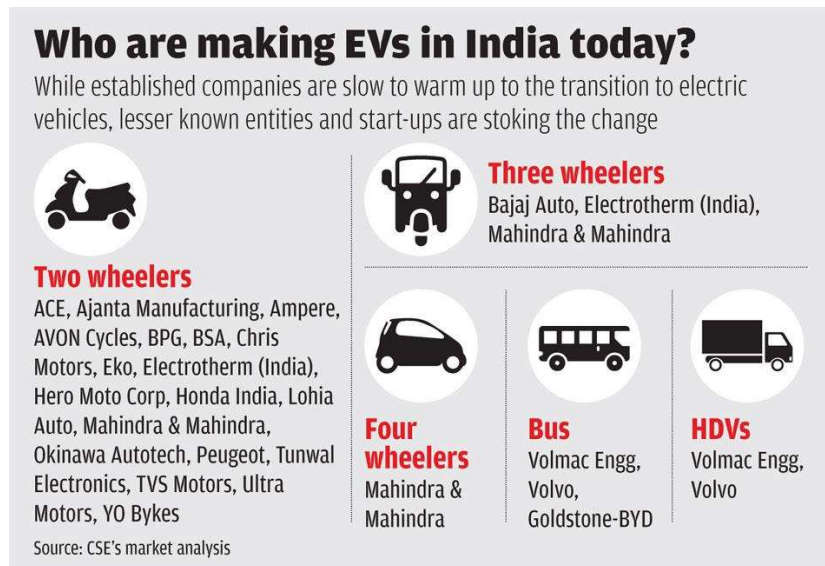


Fig. 2.1.1 : EV manufacturer in India

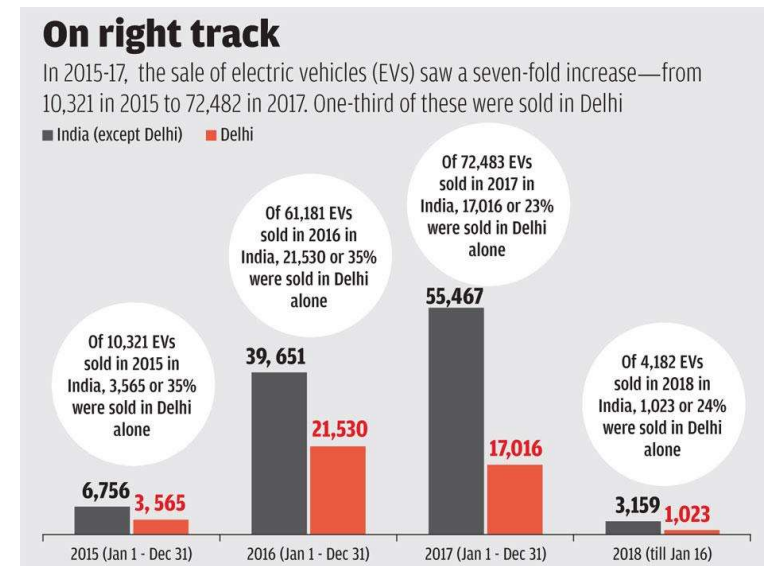


Fig. 2.1.2 Sales figure of an EV vehicle

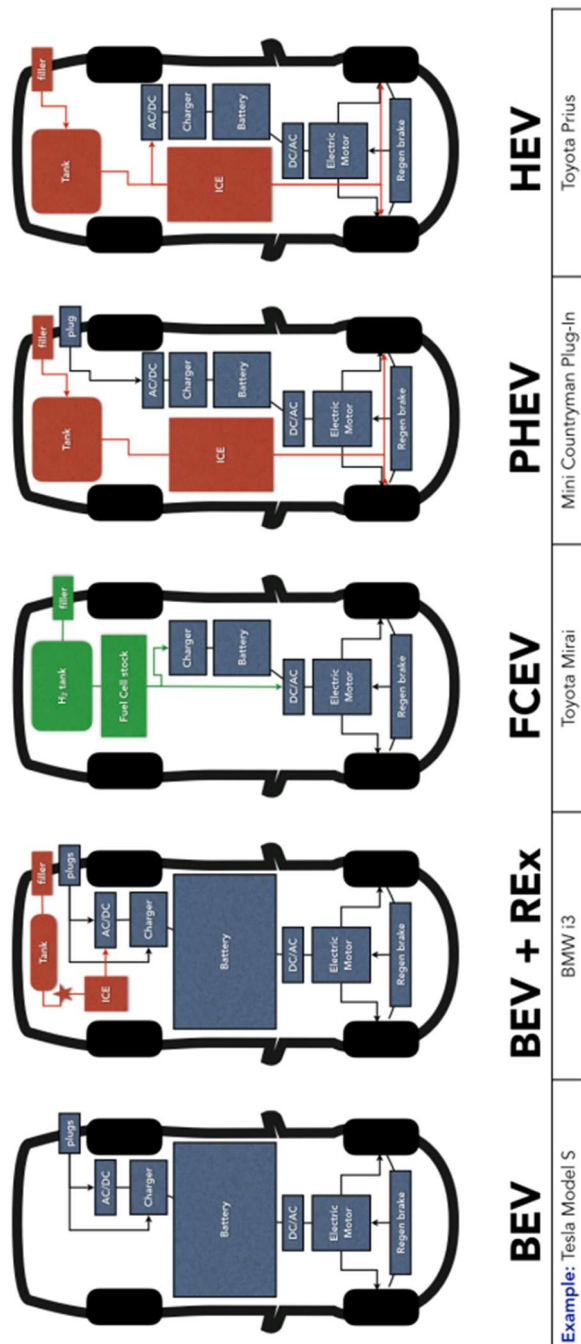


Fig. 2.1.1.1

2.1.1 Types of Electric vehicles and its construction

HEV (Hybrid Electric Vehicle)

- it carries both IC engines and small batteries
- both are capable of moving vehicle
- mode of drive will be decided by ECU. Mixed drive also possible
- battery is charged only by regen brakes

PHEV (Plug-in Hybrid Electric Vehicle)

- This is same as HEV with plug in charge port for charging the vehicle battery at home and charging outlets

FCEV (Fuel Cell Electric Vehicle)

BEV + Rex (Battery Electric Vehicle + Range Extender)

BEV (Battery Electric Vehicle)

- Fully battery operated vehicle
- battery is charged by plug in and regenerating brakes

For the project vehicle BEV is the best option as it is 100% pollution free vehicle

2.2 Batteries and charging methods

Currently available batteries for Electric vehicles.

1. Lead acid – Economical, serviceable, less life cycle, slow charging time, heavy in weight, more volume
2. Lithium-Ion – Expensive, not serviceable, comparatively more life cycle, fast charging time, lightweight, less volume
3. Lithium polymer – advanced battery technology, with high specific energy density

A new proposed vehicle can have any battery from the above list. Which will affect the price and maintenance of a vehicle the choice will be left to customer choice.

Different types of battery charging

Level 1 (Home Charging): around 40 miles trip added in 8 hrs. over night charge. commonly used in two wheelers and three wheelers.

Level 2 (Home and Public Charging): with typical 30 amps outlet 180 miles can be added in 8 hrs overnight charge. Commonly used in cars.

DC Fast Charging (Public outlet Charging): Outlet depends on the capacity of charge station. 50 to 90 miles can be added in 30 minutes.

Tesla has DC super fast charging equip. (170 miles in 30 min.)

DC fast charging option is proposed in order to reduce the conventional charging time from 8 hrs. to 1 hour.

Auxiliary Charging or Parallel Charging methods.

Regenerating Brakes (Fig. 2.2.3): When brakes applied to decelerate the regen brakes mechanism at drive wheels produces electrical energy which is used to recharge the battery. 2. Solar kit on a roof (Fig. 2.2.1) : continuously charges the battery during the daytime even if the vehicle is not moving. 3. Piezoelectric charging (New Idea): Power generation when a suspension is in action using a Piezoelectric principle.



Fig. 2.2.1 : Roof top solar kit



Fig. 2.2.2 : Roof top solar kit in use

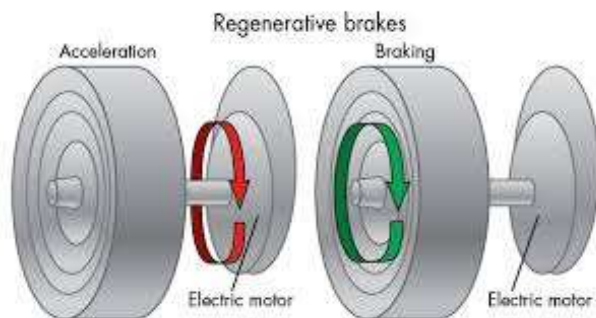


Fig. 2.2.3 : Regenerating brakes

2.3 Vehicle Ergonomics

H.Point textbook and SAE international ergonomic standards were taken into consideration for efficient packaging, better visibility and for easy ingress and egress (Fig. 2.3.1)

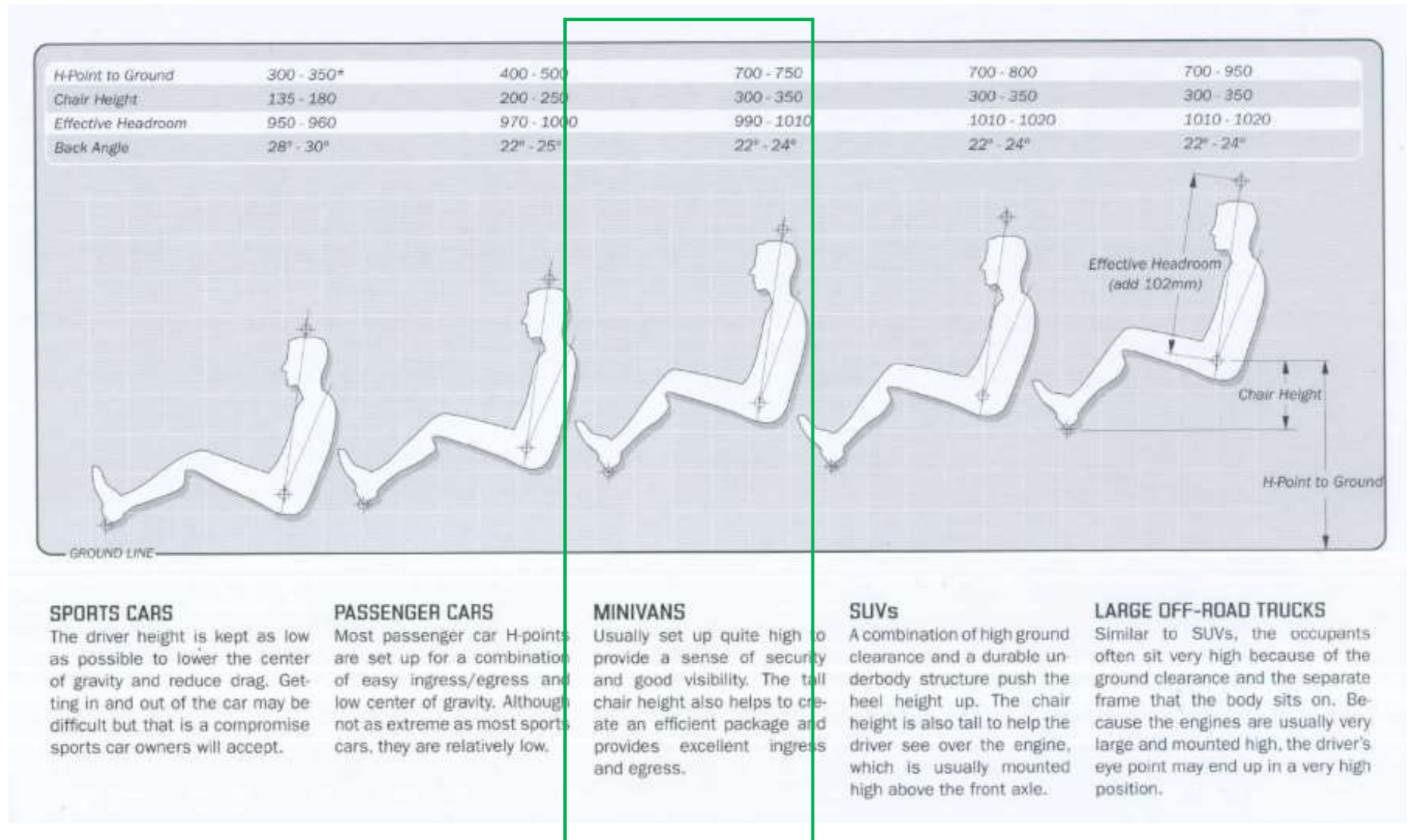


Fig. 2.3.1 : Regenerating brakes

2.4 Anthropometry Dimensions

For Indian seating dimensions the following references are taken from Indian anthropometry dimensions data book – Debkumar Chakrabarti (National Institute of design)

Ref No 121 – Height from to seat surface (fig.2.4.1)

Ref No 108 – stretched sitting – Top of the sitting stretched posture (fig.2.4.2)

Ref No 128 – Buttock to leg toe in normal sitting (fig. 2.4.3)

Ref No 133 – Maximum horizontal distance over the shoulder deltoid muscles (fig.2.4.4)

Ref No 137 – Maximum horizontal distance across the hips (fig.2.4.5)

These are the 2 different posture considered for this new vehicle design.

1. Up straight posture - which has 10° backrest inclination. (fig.2.4.6)
2. Relaxed Posture – Which has 20° backrest inclination. (fig.2.4.7)
3. Creo Industrial modelling software manikin is taken as reference for the packaging and it is verified with respect to the above mention anthropometry dimensions

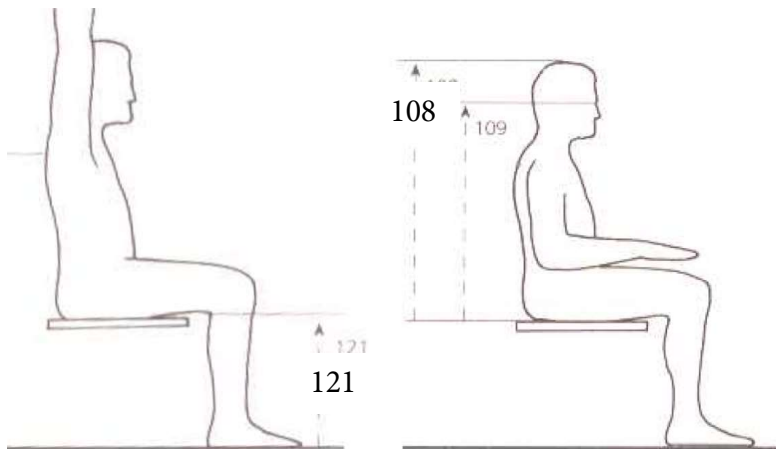


Fig. 2.4.1

Fig. 2.4.2

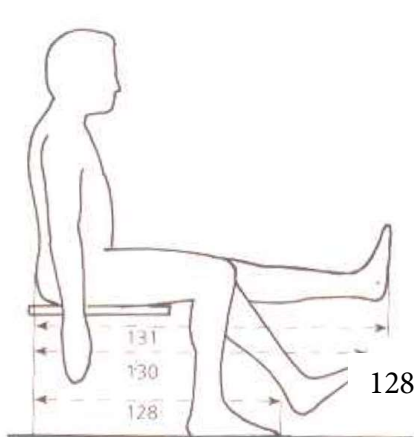


Fig. 2.4.3

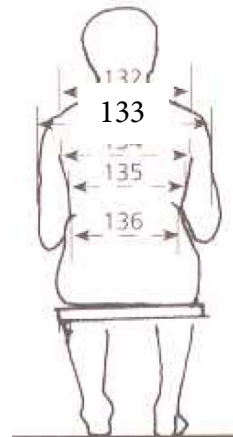


Fig. 2.4.4

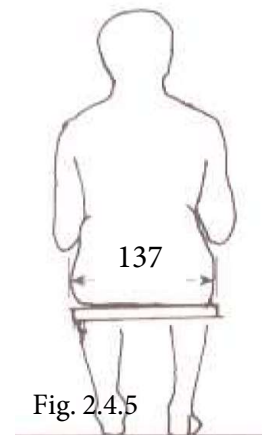


Fig. 2.4.5

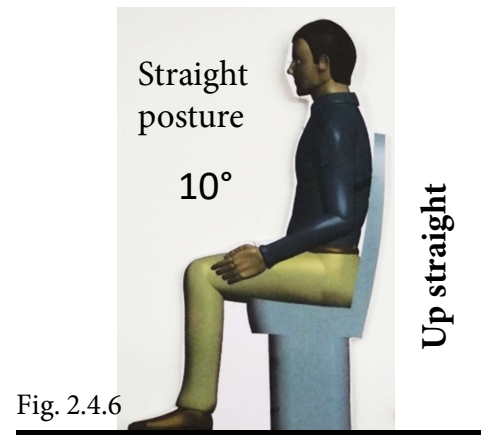


Fig. 2.4.6

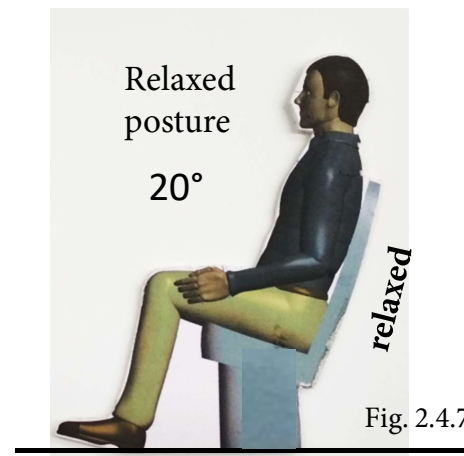


Fig. 2.4.7

USER RESEARCH

3.1 User Research

In order to understand the problems faced by the user in their current vehicle and to understand the actual need from a user perspective, a unique participatory research kit is designed. Refer the below figure (fig.3.1.1). it is basically a 2D board where the user can assemble the manikin and luggage and the frame the boundary of the vehicle. Before starting this exercise, the need of a new vehicle and no of seats (3 seaters) to be used is briefly explained to the user and asked each user to build their own new vehicle in the given kit.

Participatory research kit consist of following parts:

1. Side view board with vertical and horizontal slider – 1no.
2. Top view board with vertical and horizontal slider – 1 no.
3. Side view manikins with up straight posture – 2 nos.
4. Side view manikins with inclined posture – 2nos.
5. Top view of manikins – 3 nos.
6. Engine with different width – 3 nos.
7. Luggage with different width – 3 nos.
8. Wheels in side view – 2 nos.
9. Wheels in top view – 2 nos.

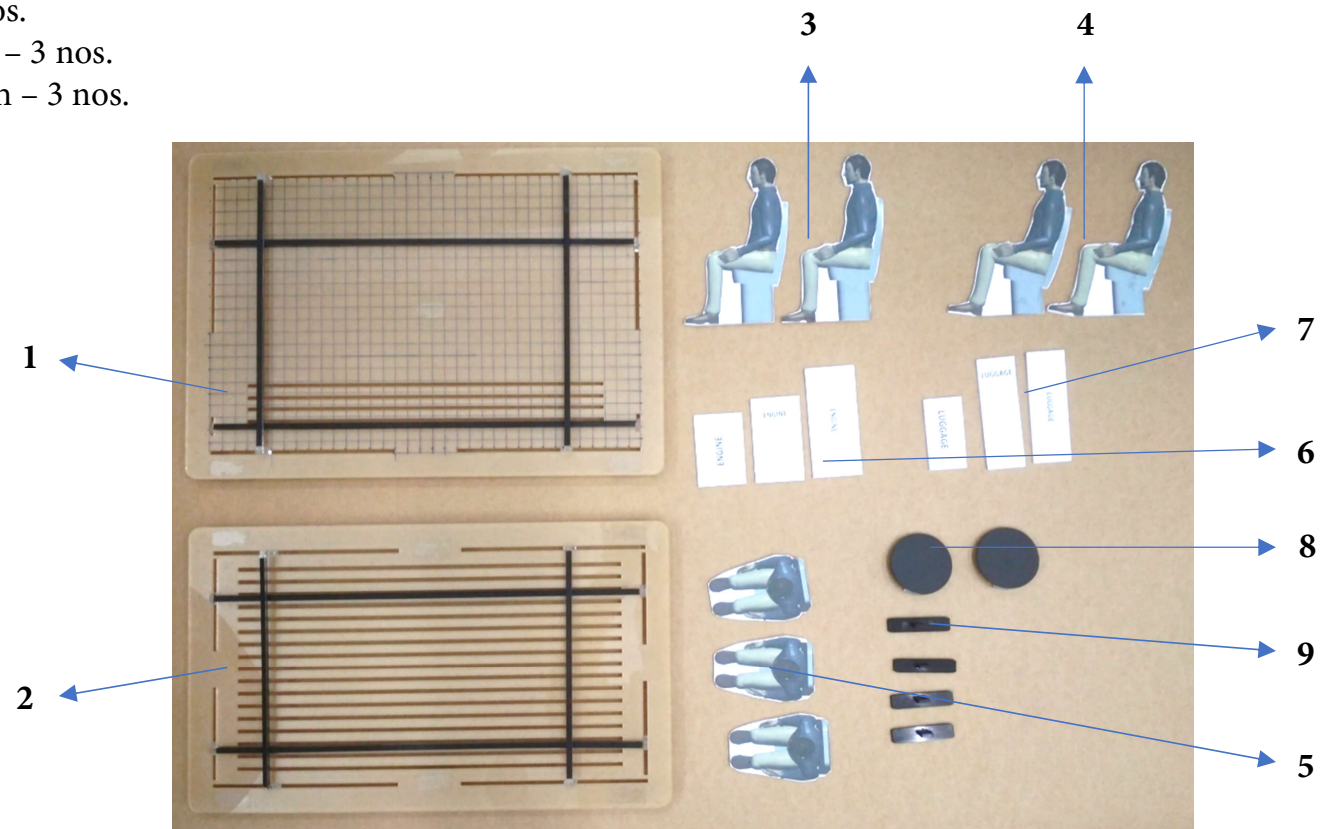


Fig. 3.1.1

3.1.1 Example outcome through participatory research

A user starts from packaging the plan view by placing an engine, mannequin, and luggage. By sliding horizontal and vertical sliders he/she can adjust the size of the vehicle for a plan view. Likewise he can package a vehicle for the side view and can get the overall vehicle proportion. Figure 3.1.1.1 shows the typical outcome from one of the users. From which the dimensions of a vehicle (Length, height, width, wheelbase, ground clearance), no of wheels, occupant packaging are observed.

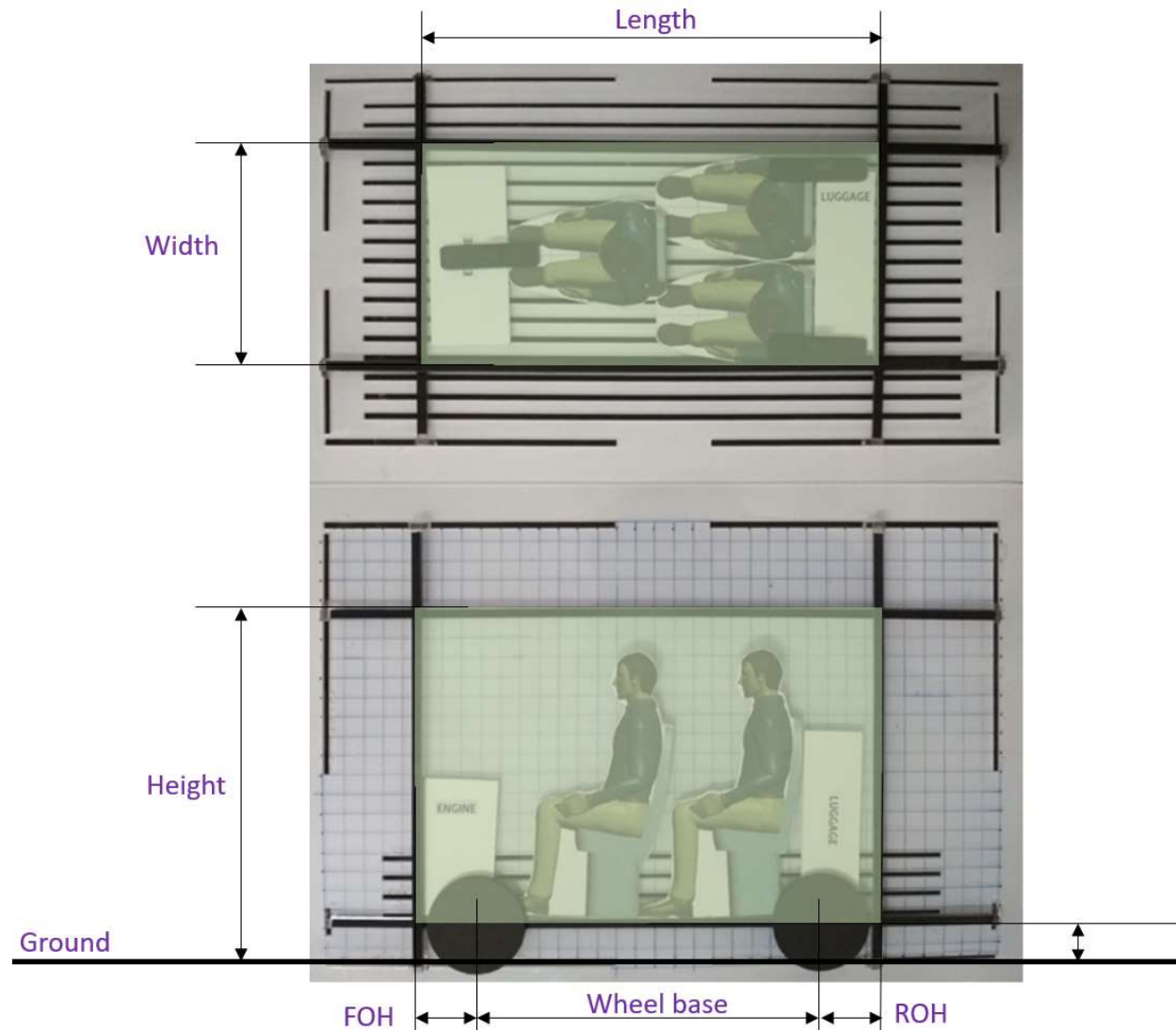


Fig. 3.1.1.1

3.2 User Persona

Participatory research conducted with 20 diverse users from different professions, and gender. The Below images show the engagement with the participatory design kit (Fig 3.2.1 and Fig 3.2.2)

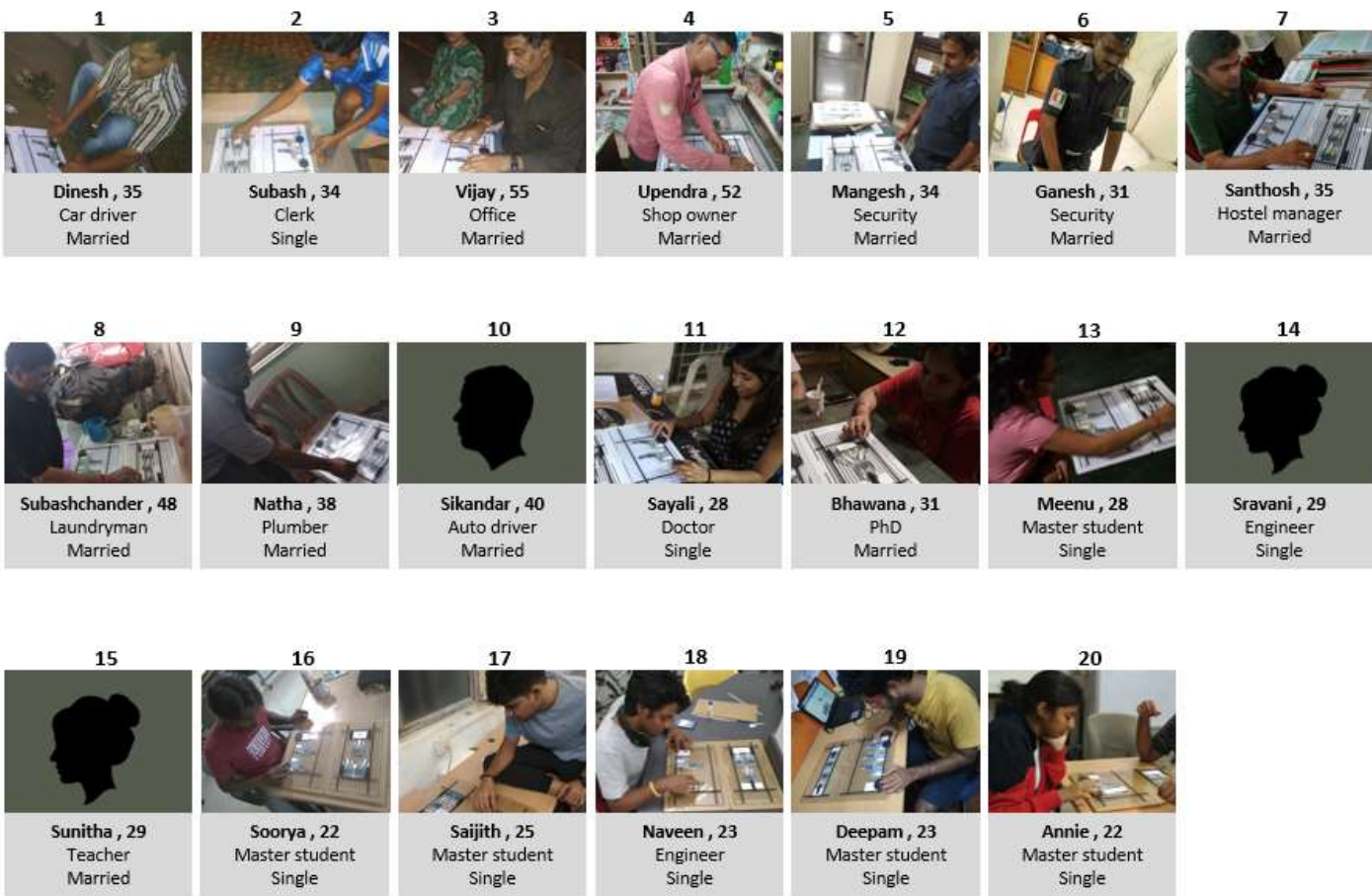


Fig. 3.2.1

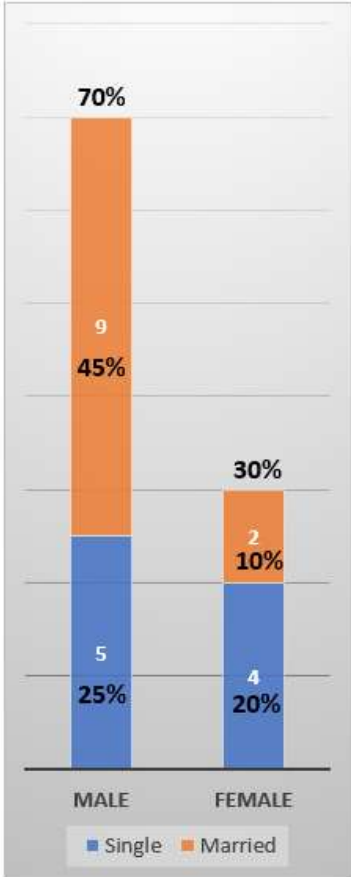


Fig. 3.2.2

3.3 Occupant packaging and vehicle boundaries through participatory research

The below pictures (fig.18) are the outcome from each user which show the occupant packaging, vehicle proportions, luggage placement and no of wheels. Refer Annexure for the detail response of packaging by each participant .



Fig.18

3.3.1 Preferred packaging patterns

From the various configurations (Fig. 3.3.1.1, 3.3.1.2), type A (driver in front row center and the 2 seat at the rear facing front) was the most preferable one due to reasons like

- 1) A driver can sit comfortable and all three sides without any obstruction.
- 2) People who sit at the rear can stretch the legs in front comfortably.
- 3) Cabin luggage can be kept at either side of the driver also under the rear seat.

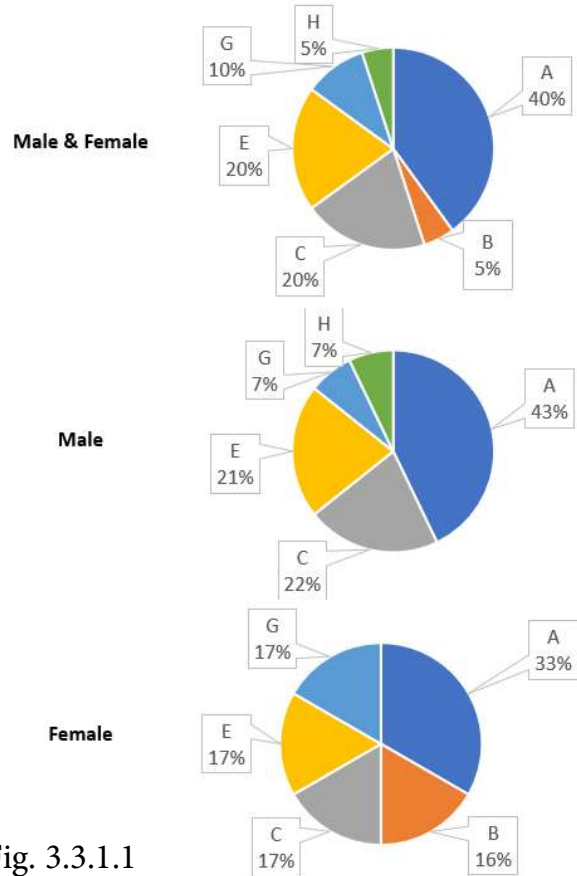


Fig. 3.3.1.1

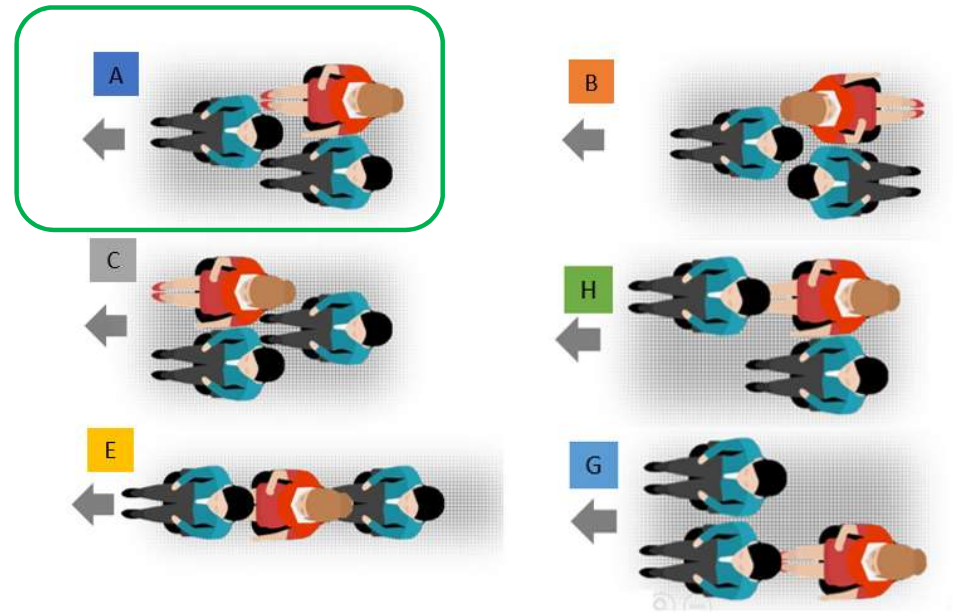
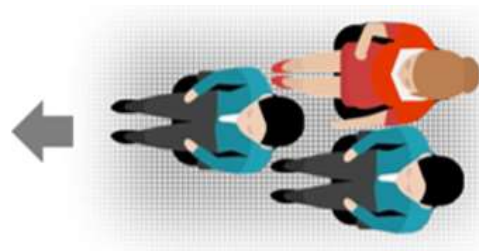


Fig. 3.3.1.2

Pattern of users are in grouped with different nomenclature. for example group A is named as 2R_1F2R_SP which means 2Row / 1 in Front, 2 in Rear / symmetrical occupant packaging (ffig 3.3.1.3, 3.3.1.4) . Complete matrix is generated and their thinking process is captured during each action

2R_1F2R_SP (2Row / 1Front, 2Rear / symmetric packaging)



6 out of 20 users

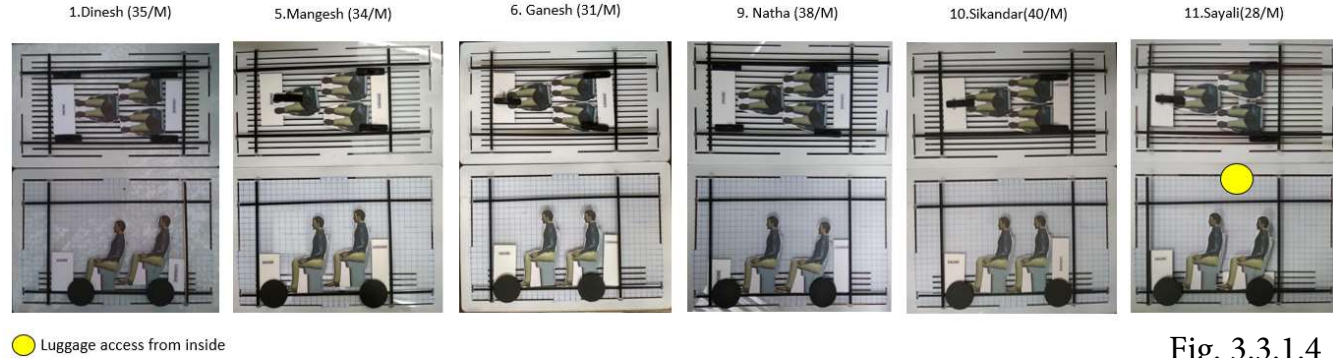


Fig. 3.3.1.4

Fig. 3.3.1.3

Dimensions and packaging assumptions of each users output is tabulated below (Fig 3.3.1.5)

U No	M/F	Nomenclature	Name	Age	Marital status	Profession	Driver posture	Passenger posture	Rear row raised	no of wheels	GC	height	Length	Width	FOH	ROH	WB	See thru area	Luggage access	steering control
1	M	2R_1F2R_SP	Dinesh	35	M	Driver	R	R	1	4	AR	1900	2600	1350	600	500	1500	A	rear No disturbance for pass	SW
5	M	2R_1F2R_SP	Mangesh	34	M	Security	S	S	1	3	AR	1900	2400	1250	300	300	1800	A	rear	HB
6	M	2R_1F2R_SP	Ganesh	31	M	Security	S	S	0	3	AR	1900	2400	1300	300	500	1600	A	rear	HB
9	M	2R_1F2R_SP	Natha	38	M	Plumber	S	R	0	4	HB	1950	2550	1300	300	550	1700	A	rear Car feel	SW
10	M	2R_1F2R_SP	Sikandar	40	M	Auto driver	S	S	0	3	AR	1850	2450	1250	350	350	1750	B	rear better vision	HB
11	F	2R_1F2R_SP	Sayali	28	S	Doctor	S	R	0	3	AR	1850	2350	1250	350	350	1650	A	Inside Car feel	SW

Fig. 3.3.1.5

2R_1F2R_IP (2Row / 1Front, 2Rear / Inclined packaging)

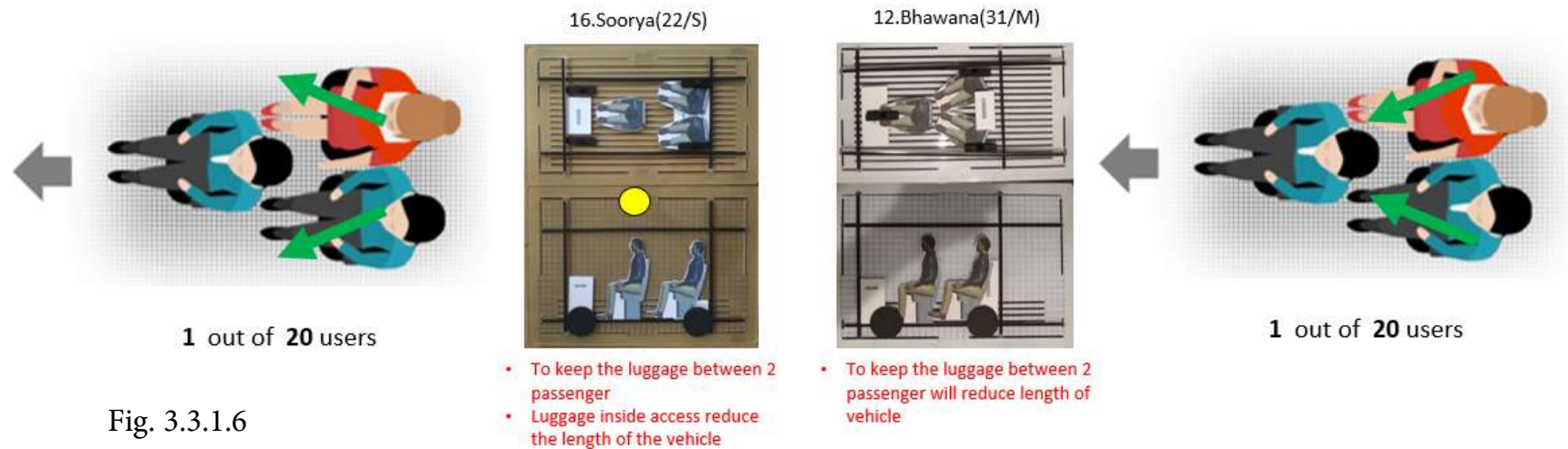


Fig. 3.3.1.6

Dimensions and packaging assumptions of each users output is tabulated below (Fig 3.3.1.7)

U No	M/F	Nomenclature	Name	Age	Marital status	Profession	Driver posture	Passenger posture	Rear row raised	no of wheels	GC	height	Length	Width	FOH	ROH	WB	See thru area	Luggage access	steering control
12	F	2R_1F2R_IP	Bhawana	31	M	PhD Student	S	R	1	3	AR	1800	2300	1500	450	300	1550	B	rear	HB
							Alert all time	Passenger need not alert	For better visibility	For smaller vehicle	Average							Average		
16	M	2R_1F2R_IP	Soorya	22	S	M. Student	S	R	0	4	SUV	1800	2400	1250	250	250	1900	B	Inside	SW
							Alert all time	Passenger need not alert		Better stability	For bad roads		Luggage under seat reduce L	Min as possible	Wider WB better stability	Wider WB better stability	Wider WB better stability	Average	Reduce L	Easy control 4 wheels

● Luggage access from inside

Fig. 3.3.1.7

In the above two groups there are similar kind of thought process happening during the research. As part of researcher I was asking many questions to the users while they build their vehicle in the given 2D board to understand their sense of packaging. Those factors are highlighted in red fonts. Refer above 2 tabular columns.

3.4 Insights through user research

During participatory research, Users had common thinking in certain considerations. Which resulted in similar occupant and luggage packaging. The following are the thought process when they built the 2D vehicle in the kit.

Tallboy concept to reduce the length of the vehicle which helps to cut traffic, tall boy concept will raise the seat height which can be used to keep luggage under a seat and tall posture will have better visibility

Spacious interior to keep luggage inside and to save the length of a vehicle

Four wheeler for better stability and to feel like traveling in a small car. Users don't want a three-wheeled vehicle, which feels like an autorickshaw

Good ground clearance for Indian bumpy roads to keep luggage inside

Steering wheel control to get the feel of a car

Stronger structure for safety

A closed vehicle for weather protection and safety

Tall headroom considering Indian roads

Free space for a driver for better driving comfort, hence 1 at the front and 2 at rear

Wider wheel base for better stability

Modern stylish looking vehicle

DESIGN PHASE

4.1 Design Brief

To design a compact four wheeled three seater vehicle for nuclear families living in urban cities. The design should satisfy the following.

1. Sufficient space for three adults
2. Adequate Luggage space inside cabin as well as in rear boot space
3. Strong structural design for safety
4. Closed vehicle to get protected from worst weather condition
5. Steering control system for the feel of car
6. Satisfy the approximate specification and dimensions mentioned below

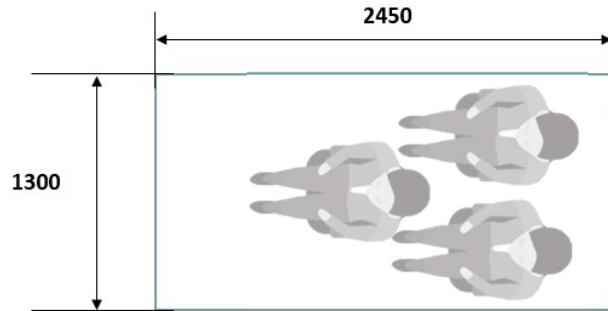


Fig. 4.1.1

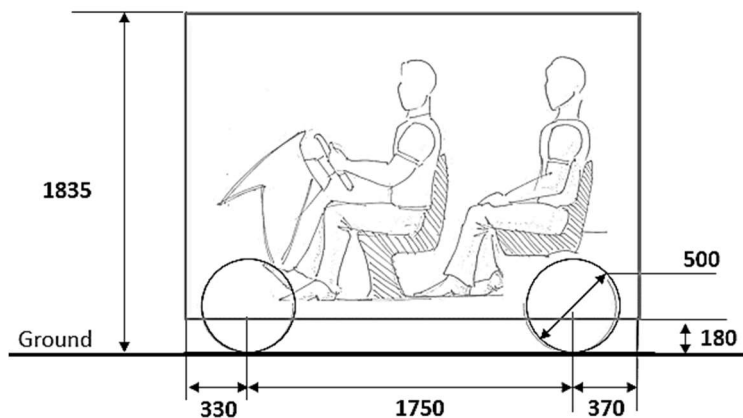


Fig. 4.1.2

Specifications

Vehicle type - 4 wheeled 2 doors compact vehicle

No of seats - 3 Adult seat

Maximum speed – 80 kmph

Range – 120 km

Luggage space – approx. 150 litres (Including Inside and Rear boot space) which is equal to a boot space of the compact hatchback

Based on the above specifications and compact driveline, Electric motor selection, steering system, battery selection to be done. Arcimoto FUV has compact front engine driveline with sufficient power and battery capacity.

Power 25kW with battery range 12kWh pack.

Dimensions

The shown proportions Refer (fig.21). and the dimensions are generated from participatory research. Drive line and Exterior to be designed approximately to the specified dimensions

Length – 2450

Width – 1300

Height – 1835

Ground clearance – 180

Wheel base - 1750



AUTORICKSHAW



QUTE



REVE E2O



NANO

4.2 Compact urban vehicle study

Indian and global compact urban vehicles are compared in terms of dimensions. Occupant packaging for a different vehicle is shown in figure 4.2.1. These small vehicles mostly used by nuclear families. Indian compact vehicle has 4 seats, whereas global vehicles have only 2 seats. The new design target dimensions are comparatively less.

Manufacturer	Model	Length	Width	Height	No. of seats
Bajaj	Autorickshaw	2625	1300	1710	3+1
Bajaj	Qute	2752	1312	1652	4
TATA	TATA nano	3690	1665	1485	4
Mahindra	REVA	3280	1514	1560	4
Arcimoto	Arcimoto (FUV)	2769	1550	1550	2
Renault	Twizy	2320	1190	1460	2
Micro	Microlino	2435	1500	1459	2
Daimler BenZ	smart fortwo	2500	1510	1500	2
New Vehicle targeting		aprox 2400	aprox 1300	aprox 1700	3

Fig. 4.2.1



TWIZY



ARCIMOTO FUV



SMART FOR TWO



MICROLINO

Arcimoto drive line



Electric motor /
Controller

Fig. 4.3.1

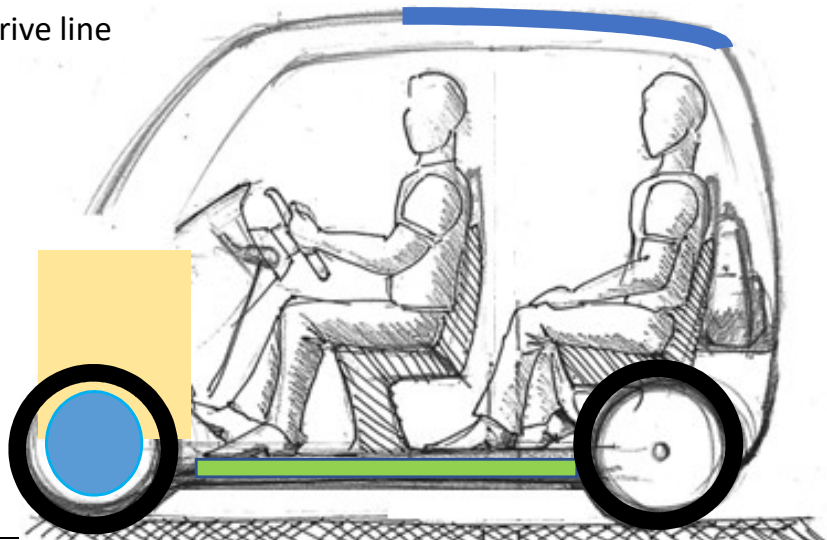
Drive wheel with
Regenerating
brakes

Battery under
platform

Free wheel

Small
boot
space

Proposed drive line



4.3 Drive line packaging and reference

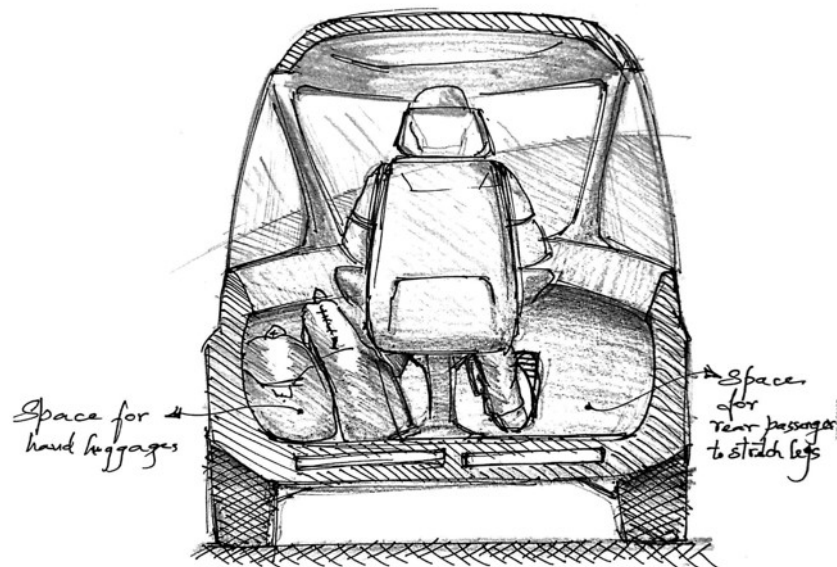
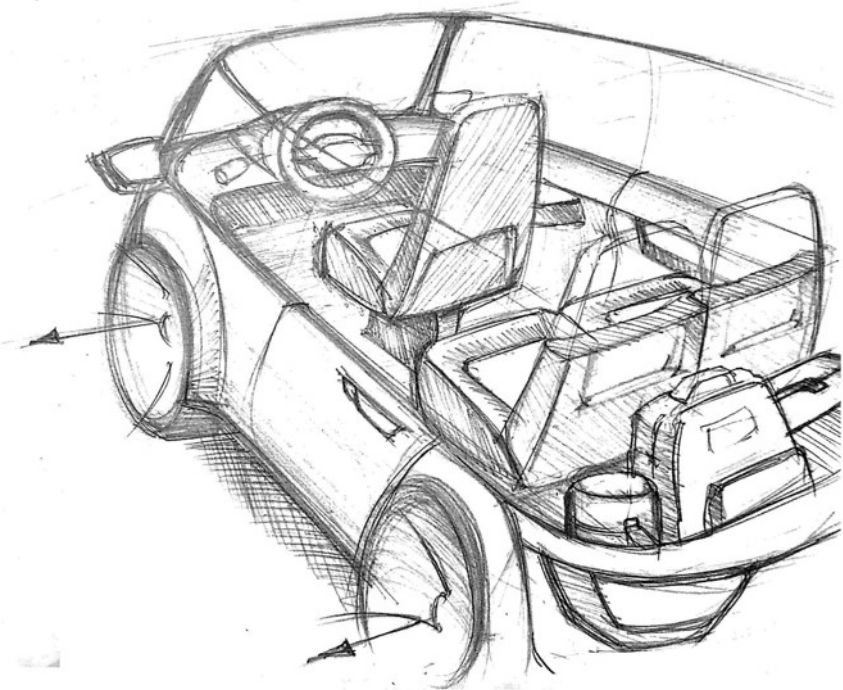
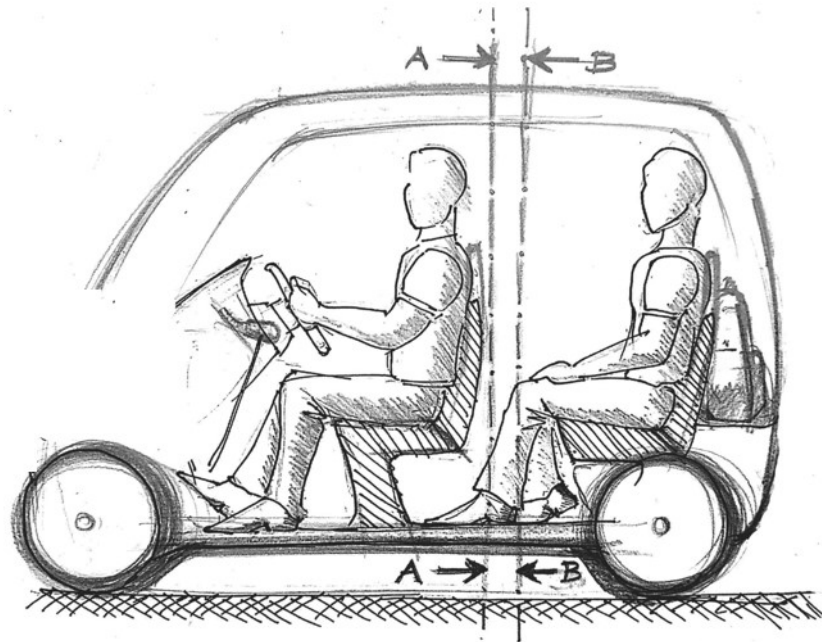
ARCIMOTO FUV (fun utility vehicle) has a compact and powerful electric motor in the front of the vehicle. In comparison, this front elector motor drive line is one of the best driveline packaging in terms of space utilization. Since the new design vehicle has a front engine, there is a possibility to provide space for luggage under the rear seat.

Arcimoto Specification for refernce

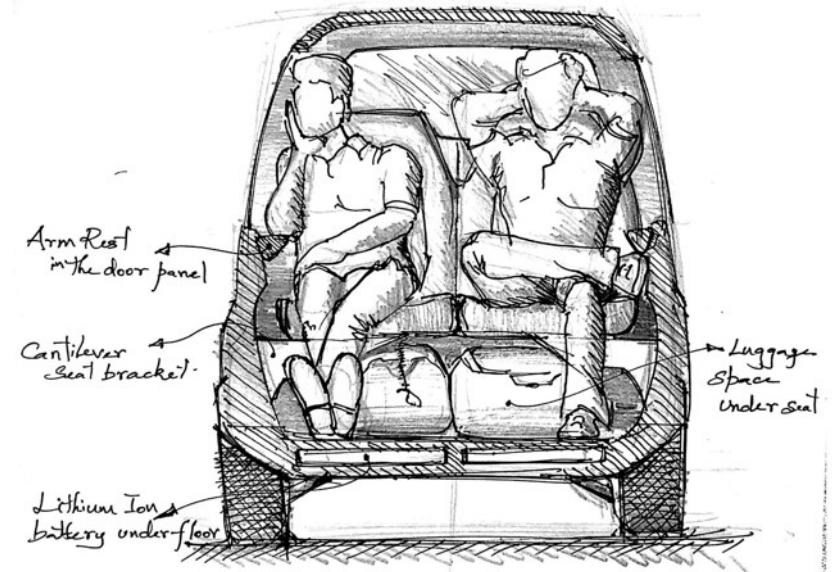
Performance	Weight & Measures
Acceleration: 0-60 in 7.5 s	Overall Length: 109" (9'1")
Top Speed: 80 mph	Overall Width: 61"
Turning Circle: 27 feet	Max Height: 61"
Range (12 kWh pack): 70 mi	Ground Clearance: 5.75"
Range (20 kWh pack): 130 mi	Wheelbase: 77.5"
Power Plant (kW): Dual 25 kW	Track Width: 56.5"
Power Plant (HP): 67 HP	Weight: 1,100 lbs.

- Dual electric Motor front wheel drive and controller
- Fast chargeable Lithium Ion batteries
- Regenerating brake charging
- Solar kit in the roof for auxiliary charging

4.4 Interior space utilization



Section B-B



Section A-A

4.5 ARAI requirement for 4Wheeled EV

Automotive Research Association of India has framed the set of validation requirement and the standard need to be followed. Refer the chart. This new vehicle falls under M1 category as it has 4 wheels to carry the passenger as per clause 3.1.1.1 (AIS-053)

AIS – 053

3.1.1 M category

A Motor vehicle with at least four wheels used for carrying passengers.

3.1.1.1 M1 category

A vehicle used for carriage of passengers, comprising not more than eight seats in addition to the driver's seat.

Definitions of type of bodywork for passenger cars of M1 Category are given in Annex 1.

Battery operated 4wheeled electric vehicle bill of validation requirement and standards

4 Wheeler Passenger Vehicle (M1 Category) (BOV)			
CMVR- Vehicle Related Tests			
Sr.No	Tests	CMV Rule No.	Reference Standard
VEHICLE EVALUATION LAB TESTS			
1	Photographs	---	ARAI Procedure
2	CMVR physical verification	93 to 125	CMVR, 1989
3	Vehicle weightment	95	IS : 11825
4	Vehicle dimension measurement	---	ARAI Procedure
5	Coast down test	115	ARAI Procedure
6	Brake test	96(4)	IS : 11852
7	ABS	96(4)	IS : 11852
8	Turning circle diameter test	98(2)	IS : 12222
9	Steering effort test	98(3)	IS : 11948
10	Speedometer calibration test	117(1)(2)	IS:11827
11	Pass by noise test	120(2)	IS : 3028
12	Gradeability test	124(23)	AIS - 003
13	Ground clearance		IS 9435
14	External projection test	124(11)	AIS 120
15	Tell tale symbols test	124(19)	AIS-071
16	Hood latch test	124(17)	IS : 14226
17	Wheel guards test	124(13)	IS : 13943
18	Vehicle identification number including month and year of manufacture.	122(1)	AIS:065
19	Temporary use spare wheel / tyre and Run Flat Tyre (if different from normal tyre)	95 (7)	AIS 110

4.6 Voluminous and Modern

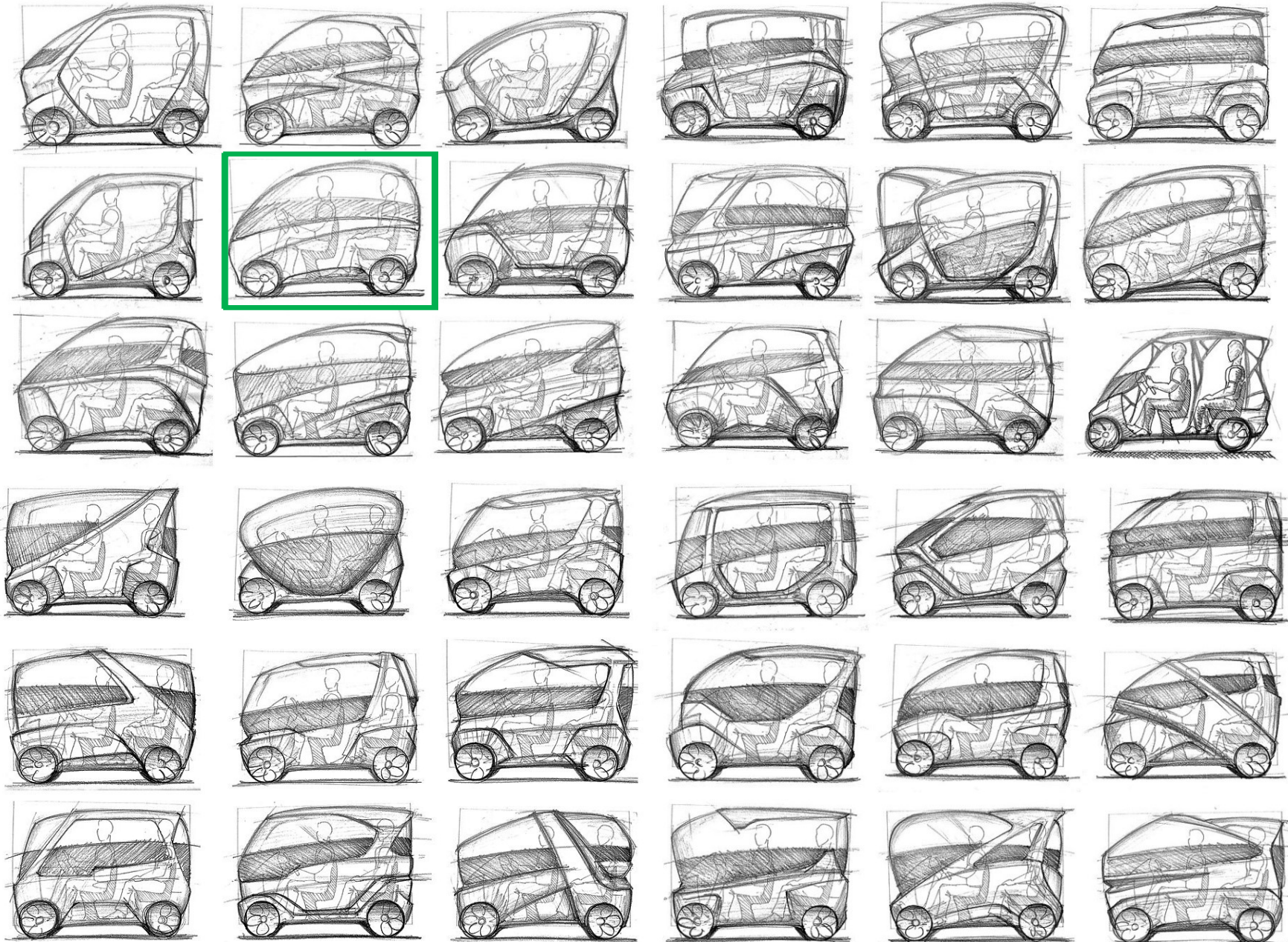
The keywords Voluminous and Modern are generated based on the participant feedback and the below mood board is made



4.7 Ideation sketches

Ideation sketches are made with design aspiration of voluminous and modernity.

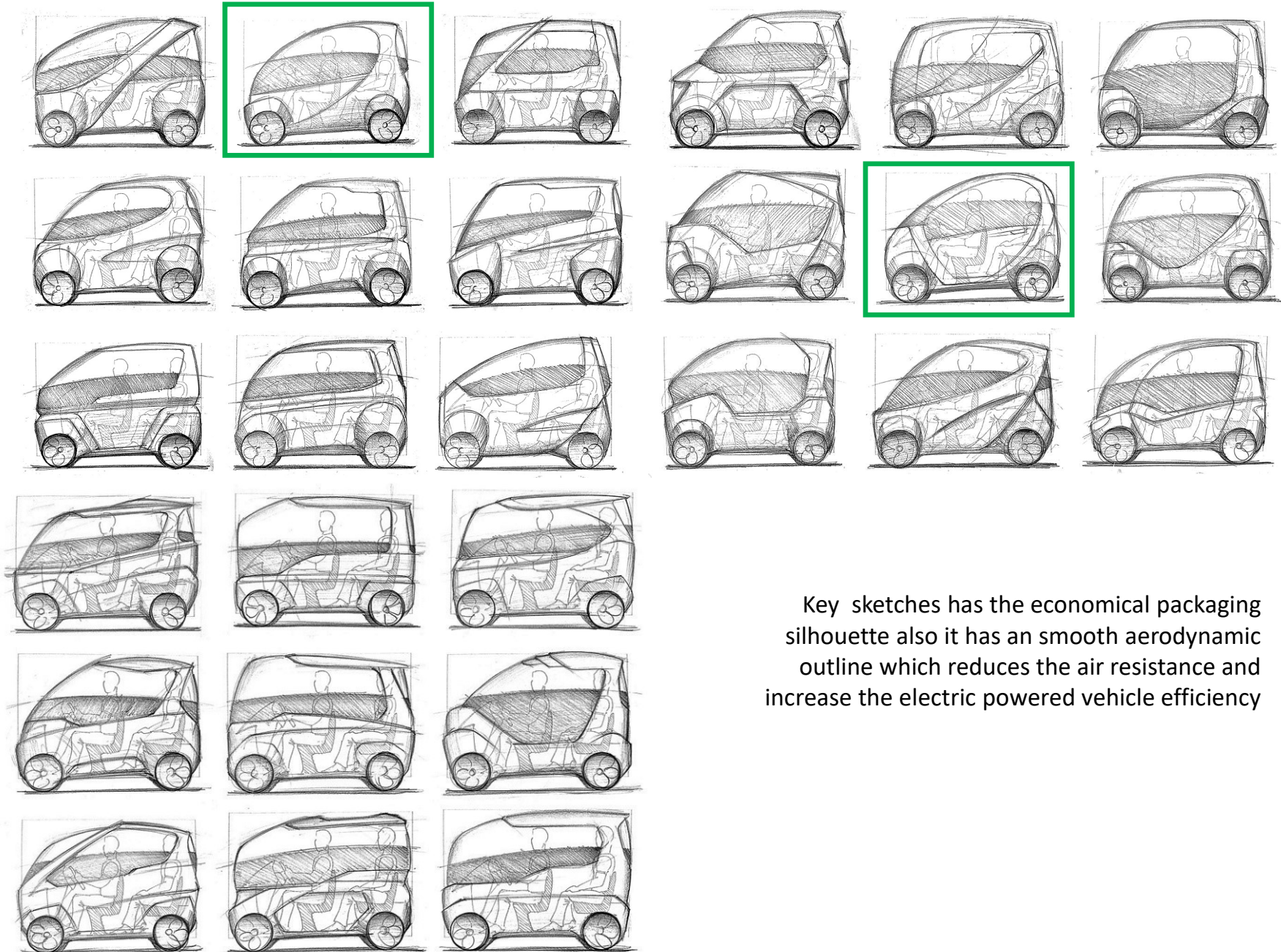
Key sketches are high lighted



Ideation sketches

Ideation sketches are made with design aspiration of voluminous and modernity.

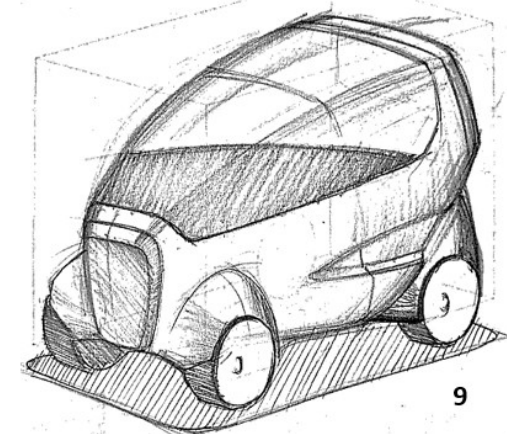
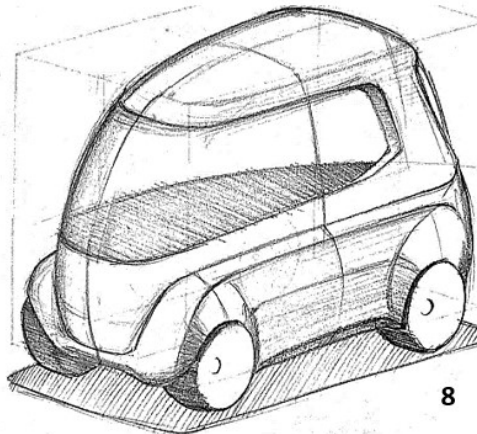
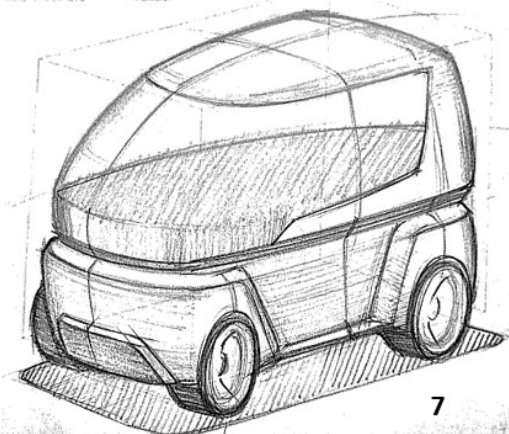
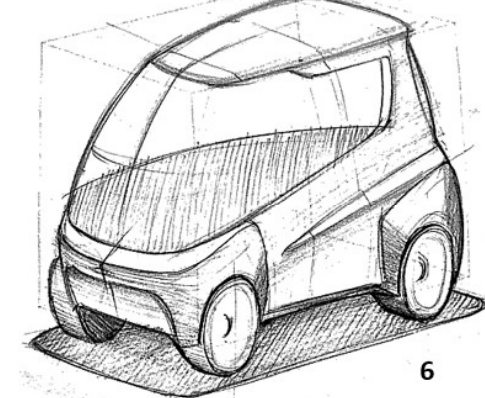
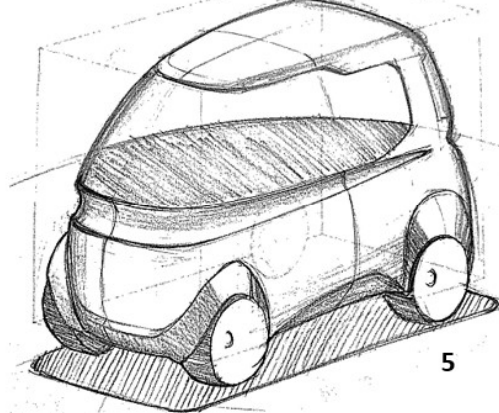
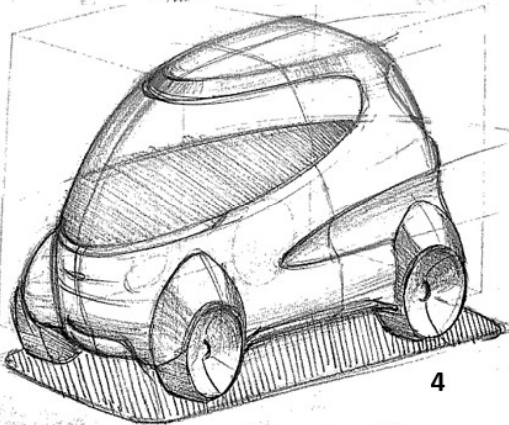
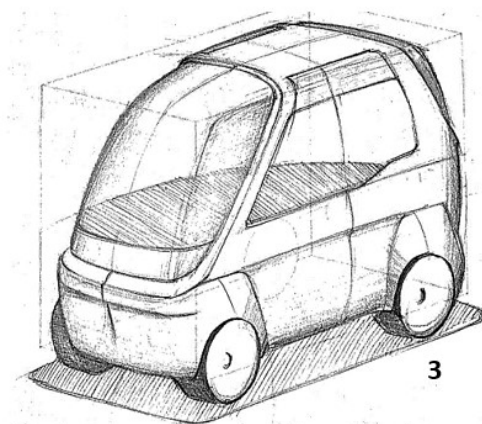
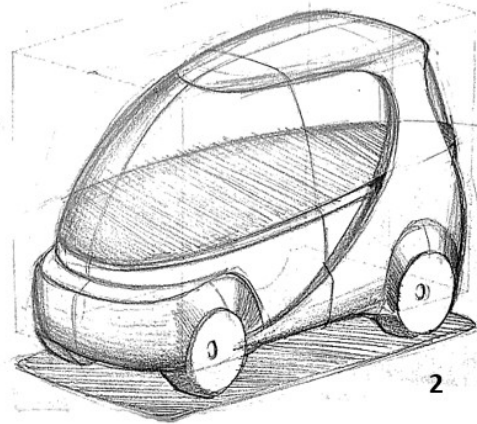
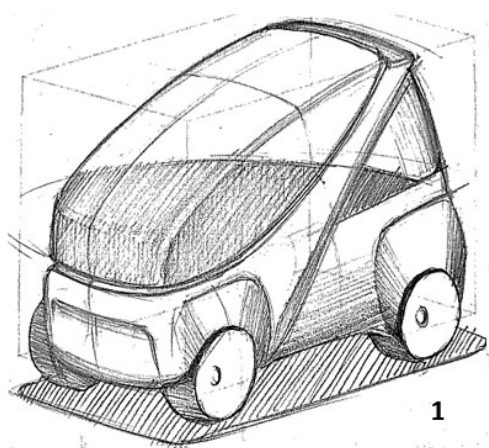
Key sketches are high lighted



Key sketches has the economical packaging silhouette also it has an smooth aerodynamic outline which reduces the air resistance and increase the electric powered vehicle efficiency

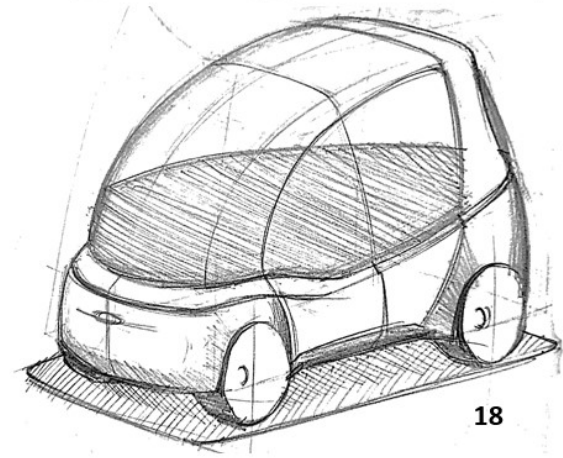
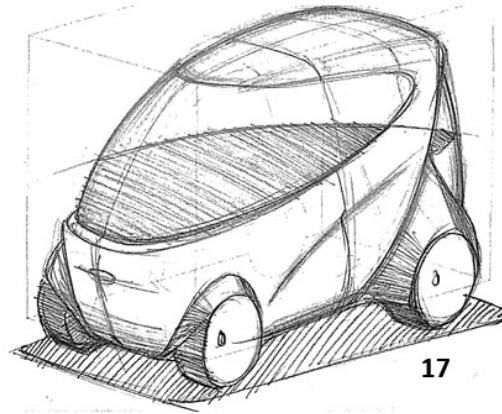
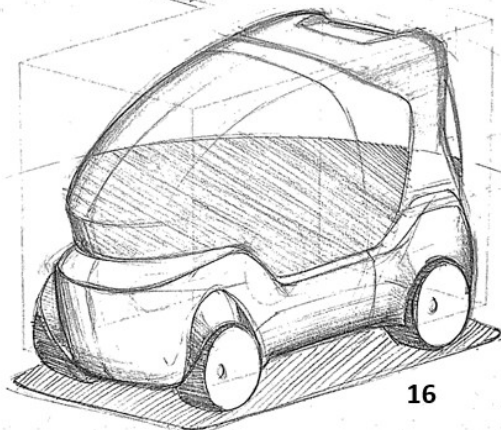
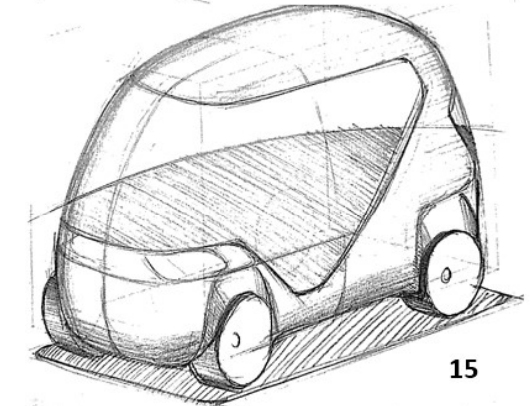
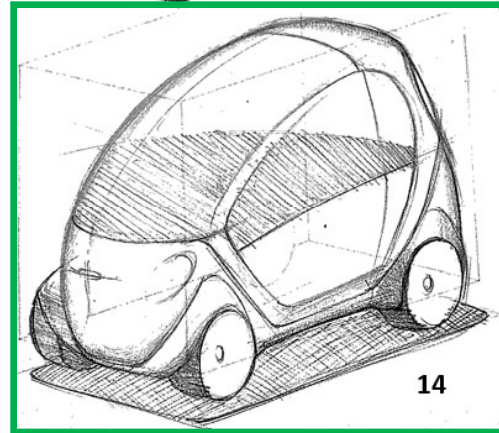
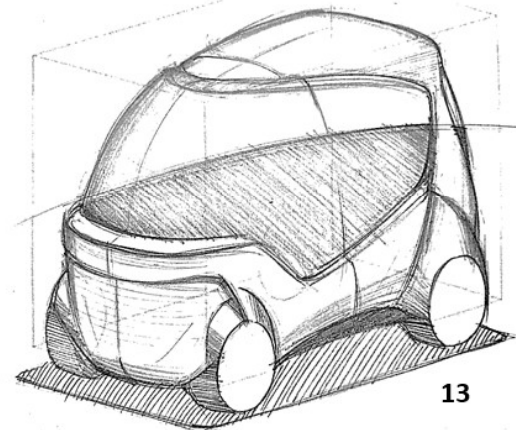
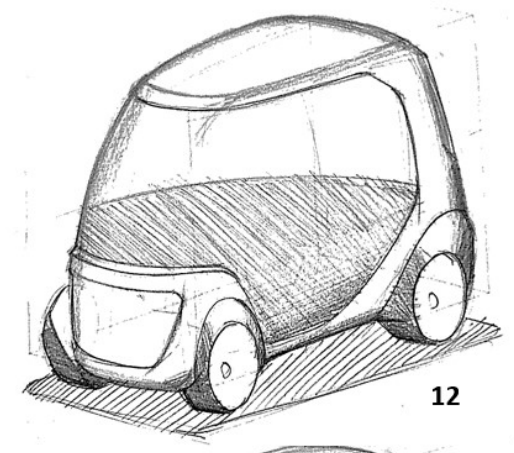
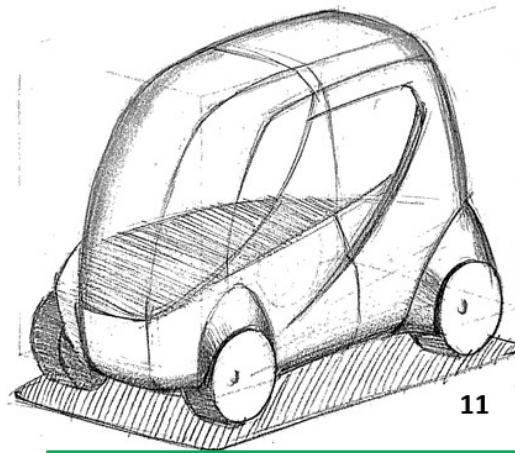
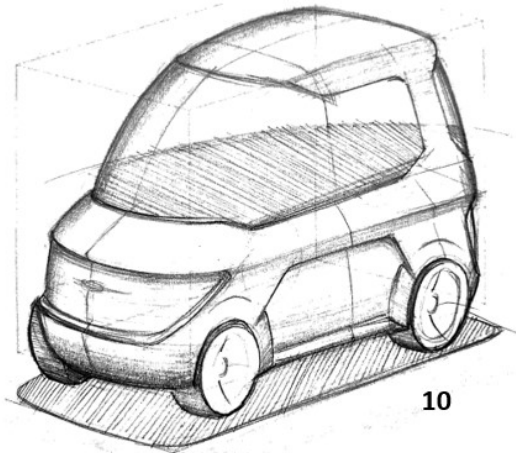
Ideation sketches

Ideation sketches are made with design aspiration of voluminous and modernity.



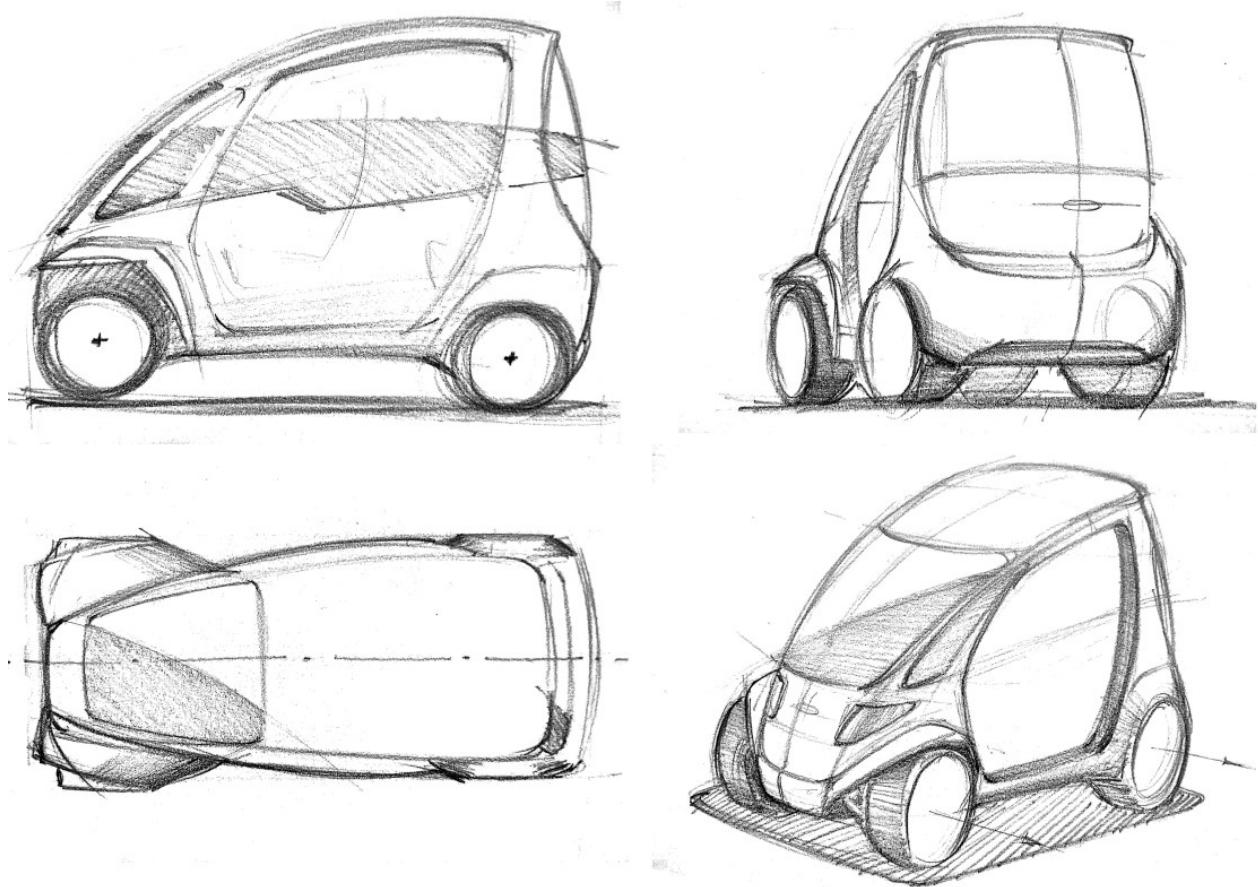
Ideation sketches

Ideation sketches are made with design aspiration of voluminous and modernity.
Key sketches are high lighted



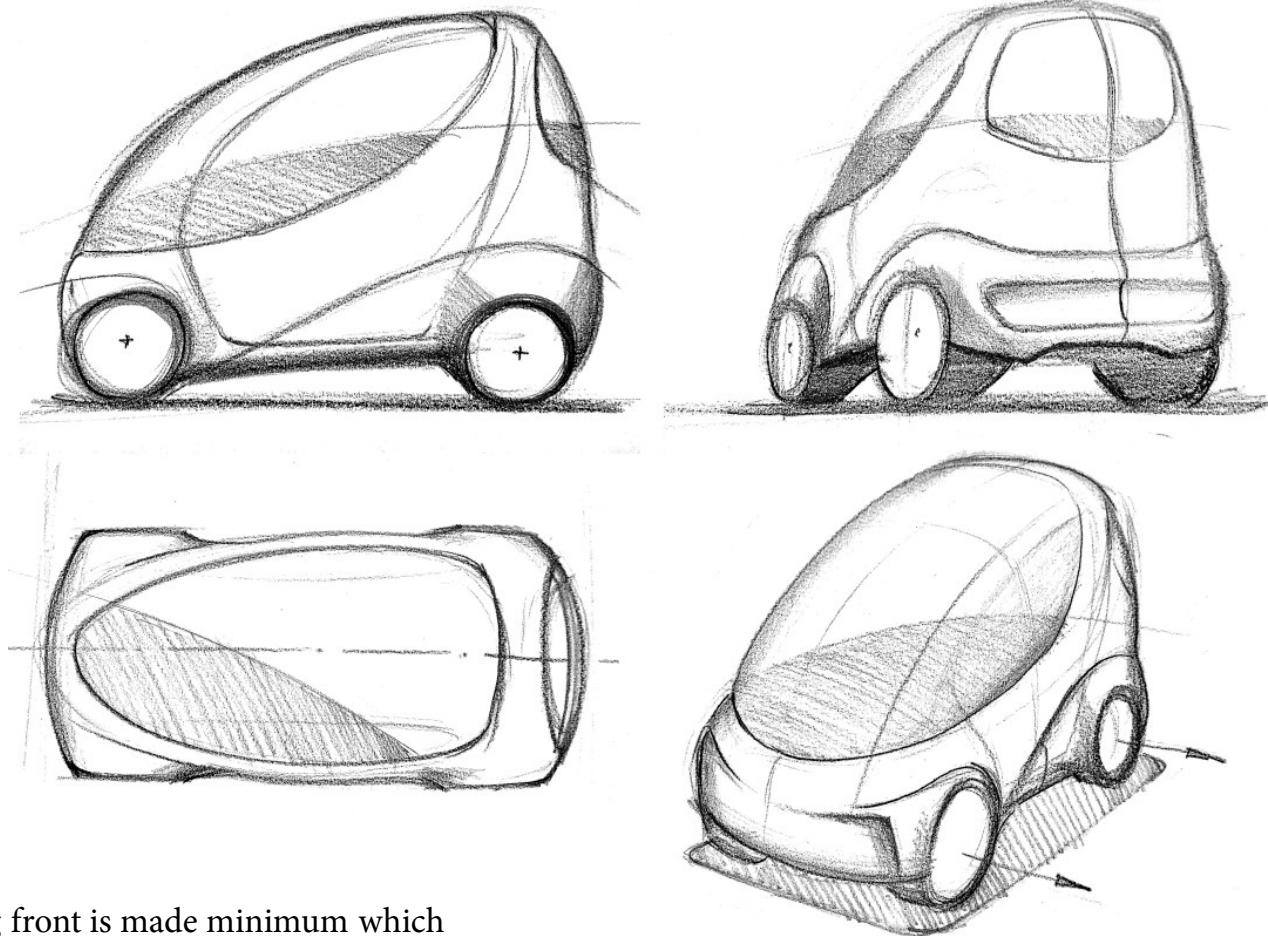
4.8 CONCEPTS

Concept 1



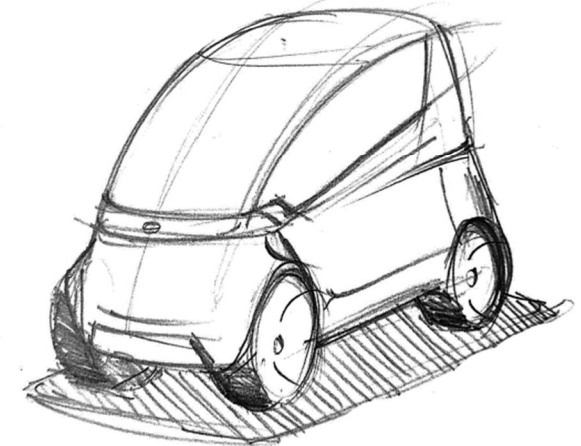
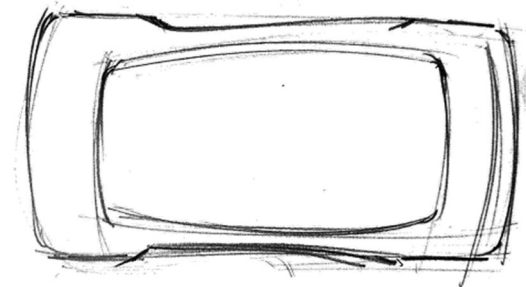
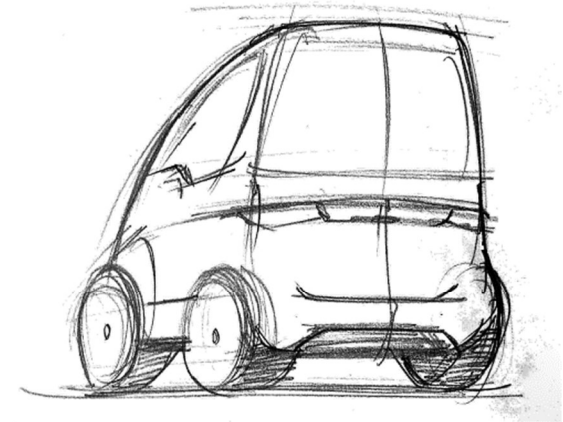
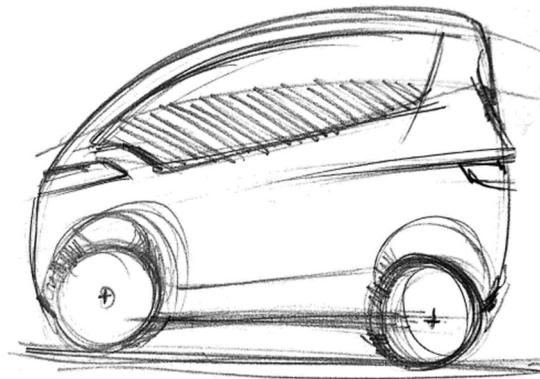
This concept is voluminous at the rear and narrows in the front as the seating arrangement asks for one in front and two at rear. It has better visibility for the rear passengers as a sudden drop on the belt line makes the DLO bigger. The narrowing volume of the vehicle at the front makes the front wheel more prominent and makes the vehicle visually stable. More or less front narrowing resembles the shape of an autorickshaw.

Concept 2



In this concept narrowing front is made minimum which make the vehicle look voluminous also stable. The upward sweeping beltline enhances the forward stance of the vehicle. The extrude rear wheel fender complement the shape of the belt line. Roof and front shield is a continuous shell which gives a more modern look to the vehicle

Concept 3 (Final concept)



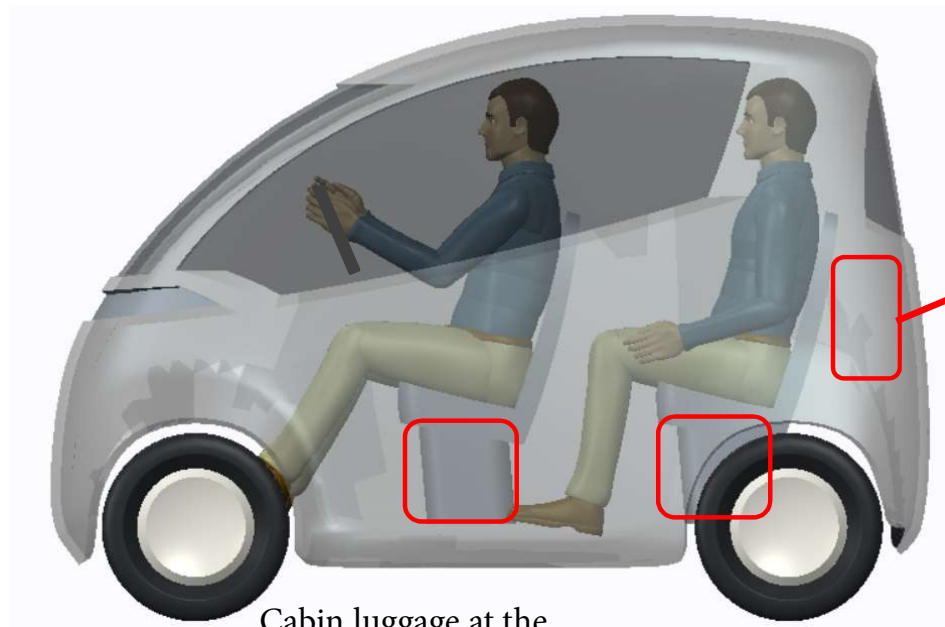
- The vehicle looks tall and voluminous for the given boundaries
- Light Character lines, inclined belt lines and sleek lights gives the modern look.
- Front shield is easy to manufacture when compare to other two concepts which are very curvy.
- Silhouette suits perfectly for tall boy concept as well as aerodynamic

4.9 Final Concept Rendered



Vehicle and human proportions

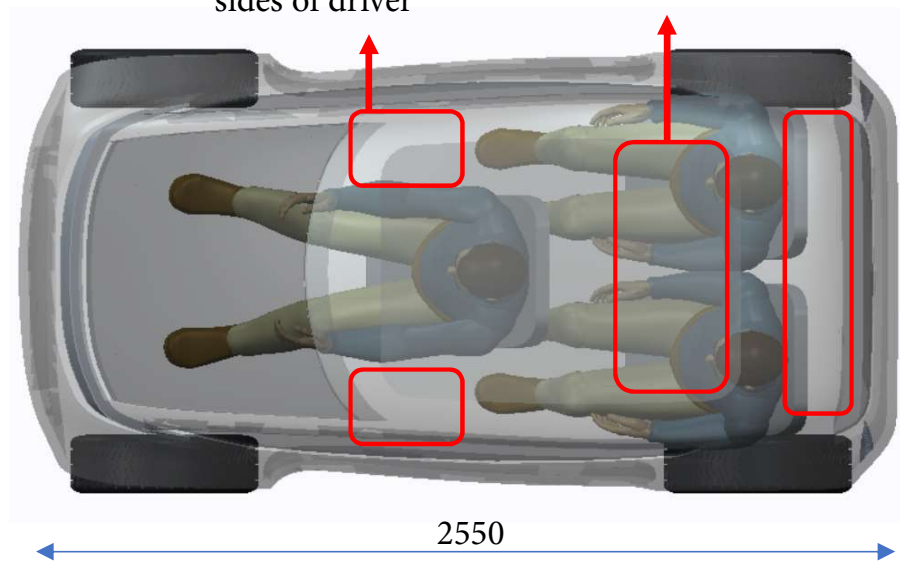
95th percentile human proportions considered for packaging



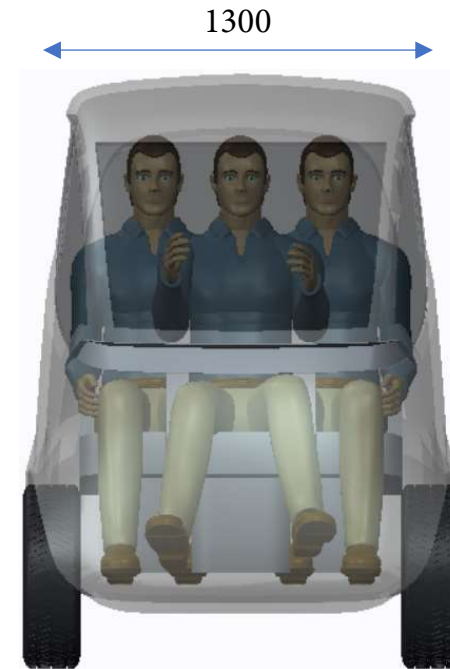
Luggage at
boot space

Cabin luggage at the
sides of driver

Luggage under street



2550



1300

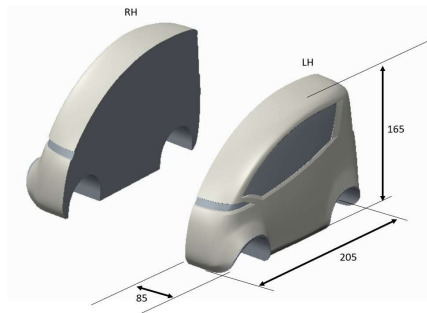


1750

4.10 Final , Scale down model (1:8)



1. 3D modelled



2. MDF CNC milled



3. fine finished and primer applied



4. Masking done over DLO and glass



5. Final primer



6. Fine finished and painted



6. Clear coat applied



6. Wheels and other details added



5. Project time Plan vs. Action

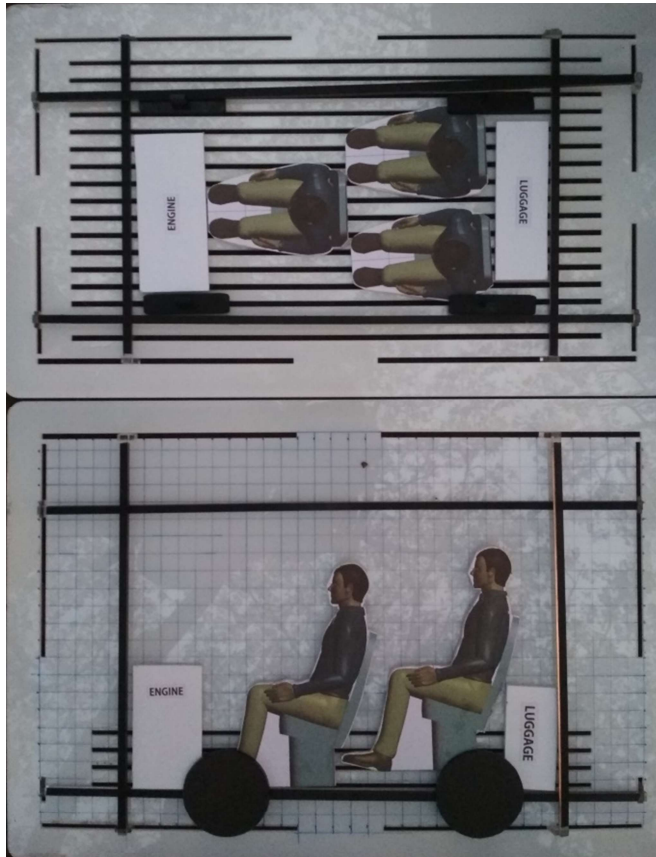
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				Wk2	Wk3	Wk4	Wk1	Wk2	Wk3	Wk4	Wk1	Wk2	Wk3	Wk4	Wk1	Wk2	Wk3	Wk4	Wk1	Wk2	Wk3	Wk4
I	Pitching P2 Topic		Plan																			
			Action																			
	P2 Topic finalization		Plan																			
			Action																			
	Product research	Technology research	Plan																			
			Action																			
		User research	Plan																			
			Action																			
		ergonomics & Anthropometry research	Plan																			
Action																						
II	Finalizing the Product brief		Plan																			
			Action																			
	Occupant Packaging		Plan																			
			Action																			
	Initial vehicle Ideation		Plan																			
			Action																			
	Design brief		Plan																			
			Action																			
	Concept generation		Plan																			
Action																						
III	Finalisation of concept		Plan																			
			Action																			
	Working on forms		Plan																			
			Action																			
	Detailing / Rendering		Plan																			
			Action																			
	Scale down Model making		Plan																			
			Action																			
	Panel Creation		Plan																			
Action																						
P2 presentation no. 1									29													
P2 presentation no. 2												26										
P2 presentation no. 3															24							
P2 presentation no. 4																		14				
P2 Defence																				26-30		

ANNEXURE

1



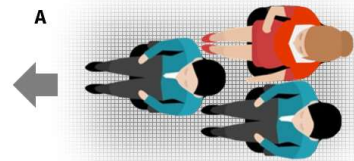
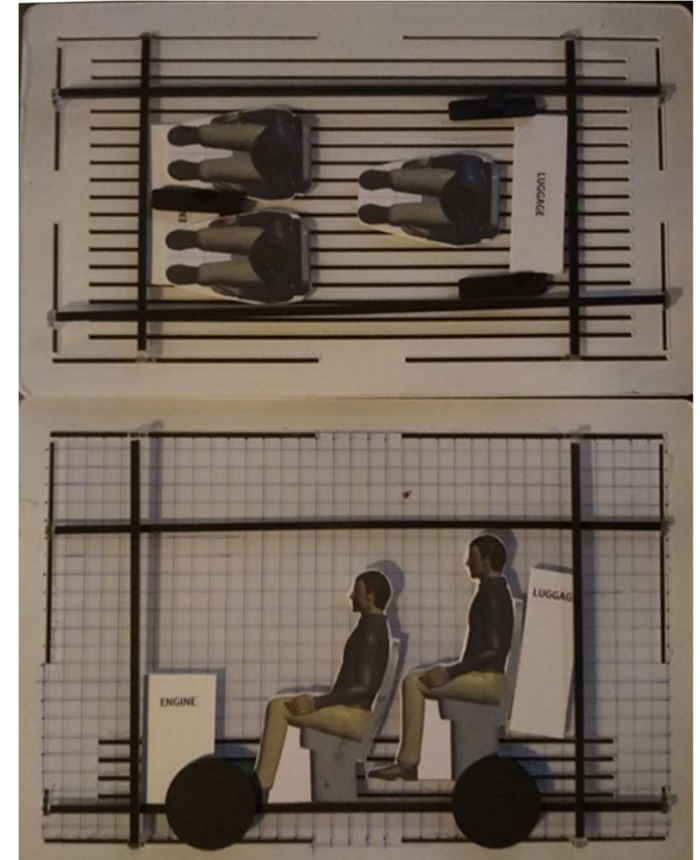
Dinesh , 35
Car driver
Married



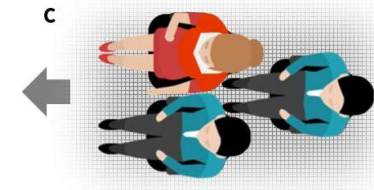
2



Subash , 34
Clerk
Single



2R_1F2R_SP

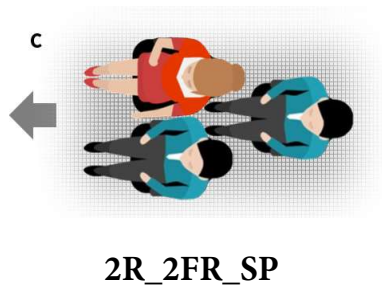
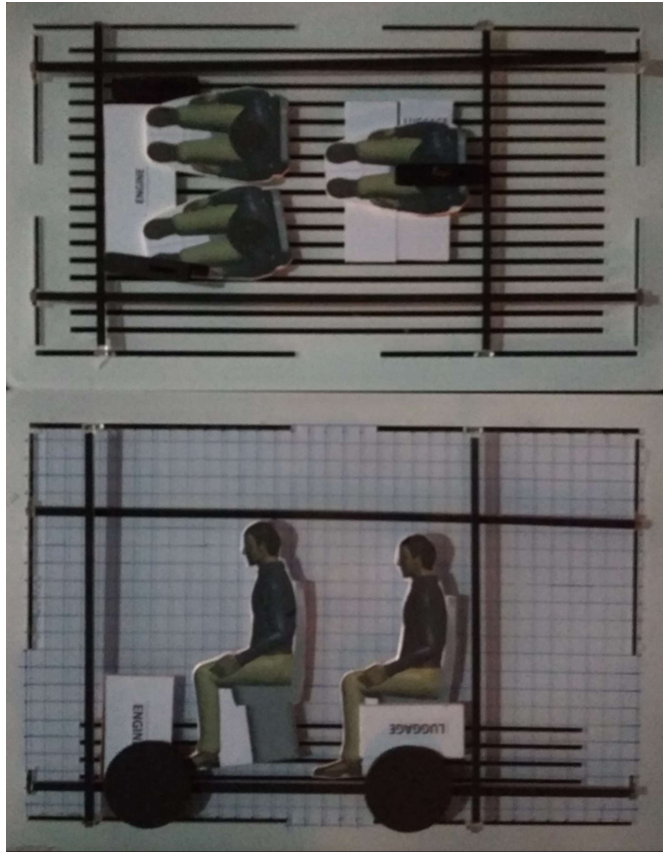


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3



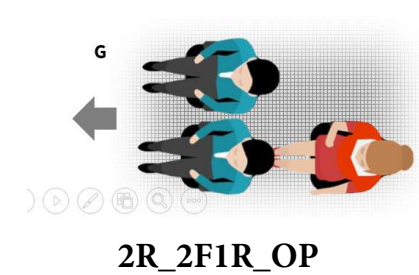
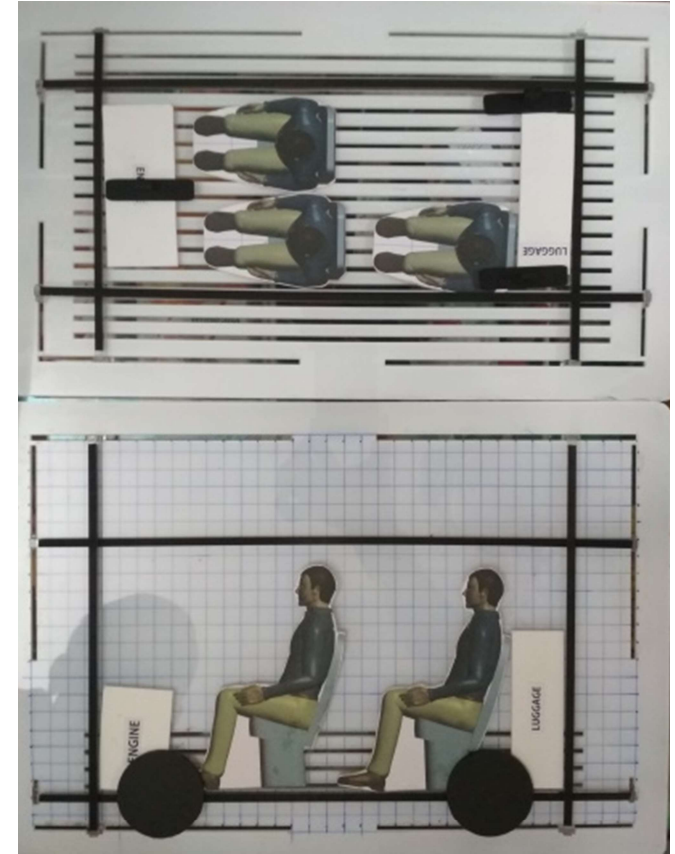
Vijay , 55
Office
Married



4



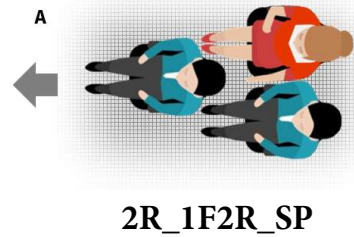
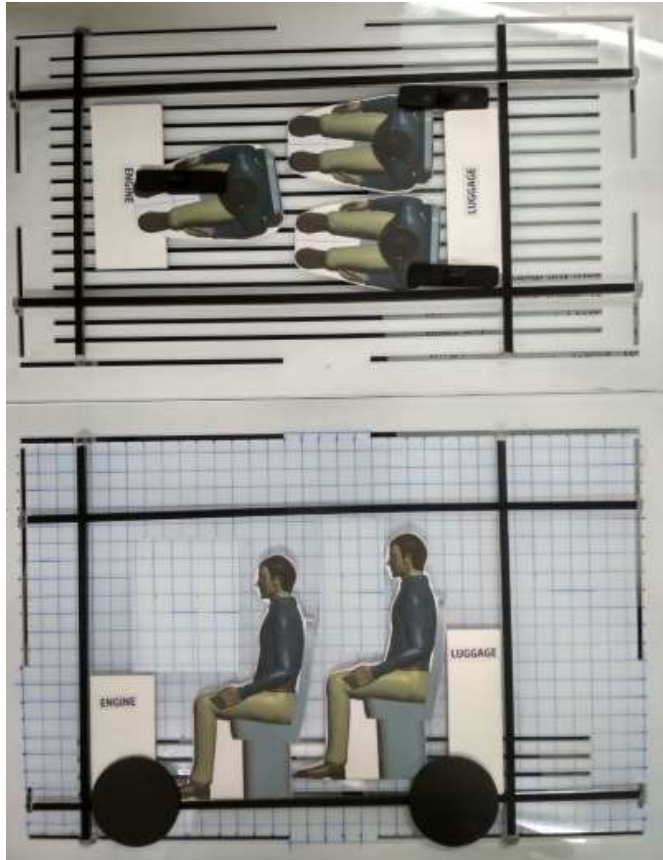
Upendra , 52
Shop owner
Married



5



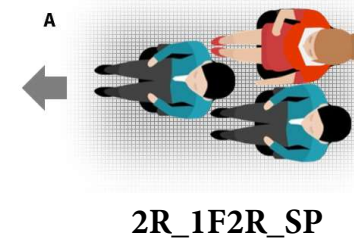
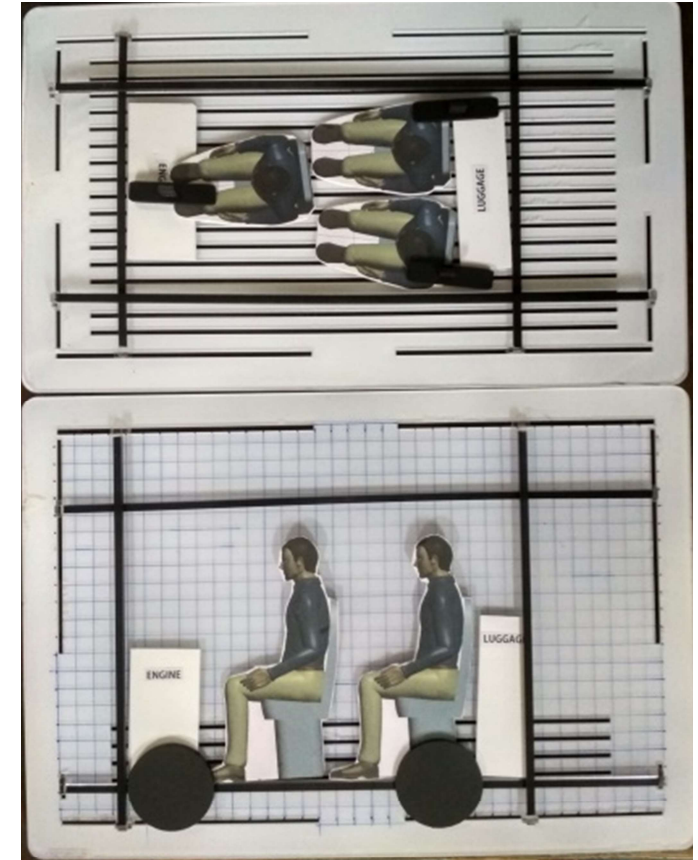
**Mangesh ,
34**
Security
Married



6



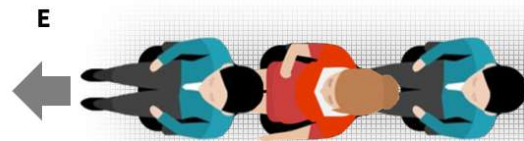
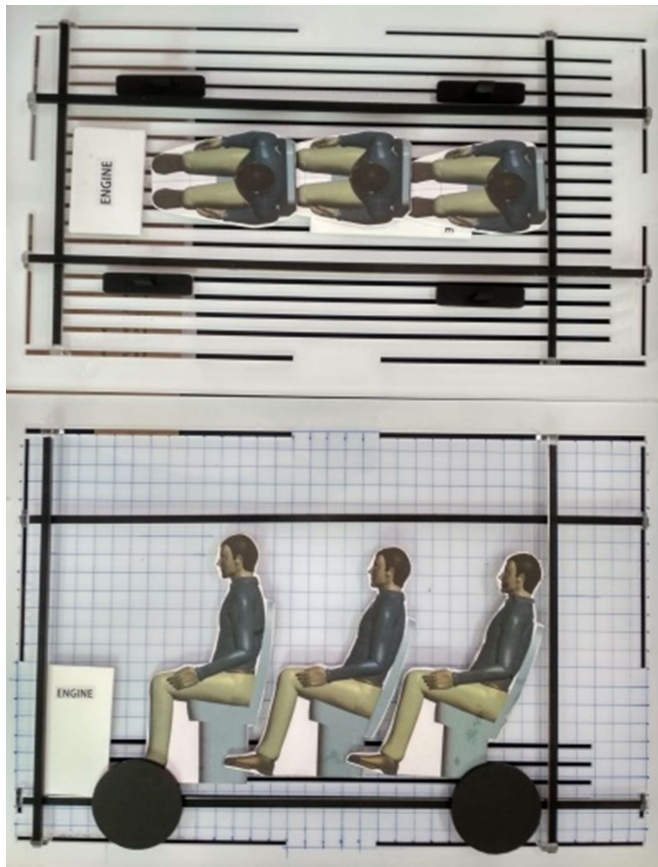
Ganesh , 31
Security
Married



7



**Santhosh ,
35**
Hostel
manager
Married

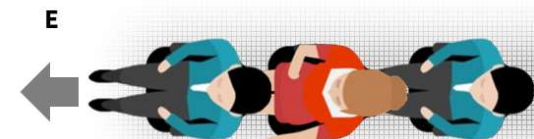
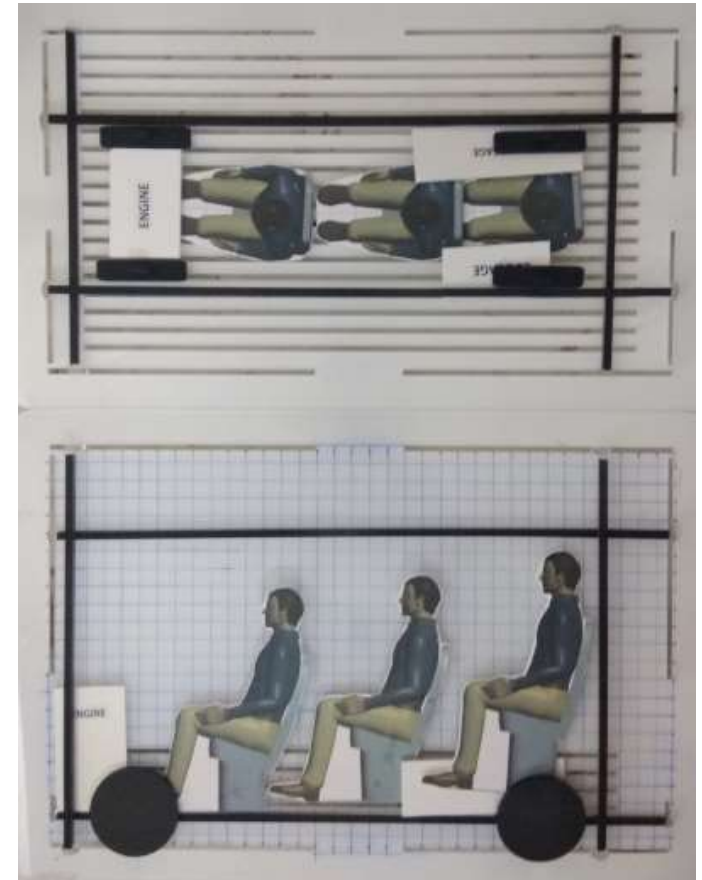


3R

8



**Subashchan
der , 48**
Laundryman
Married

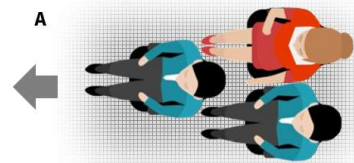
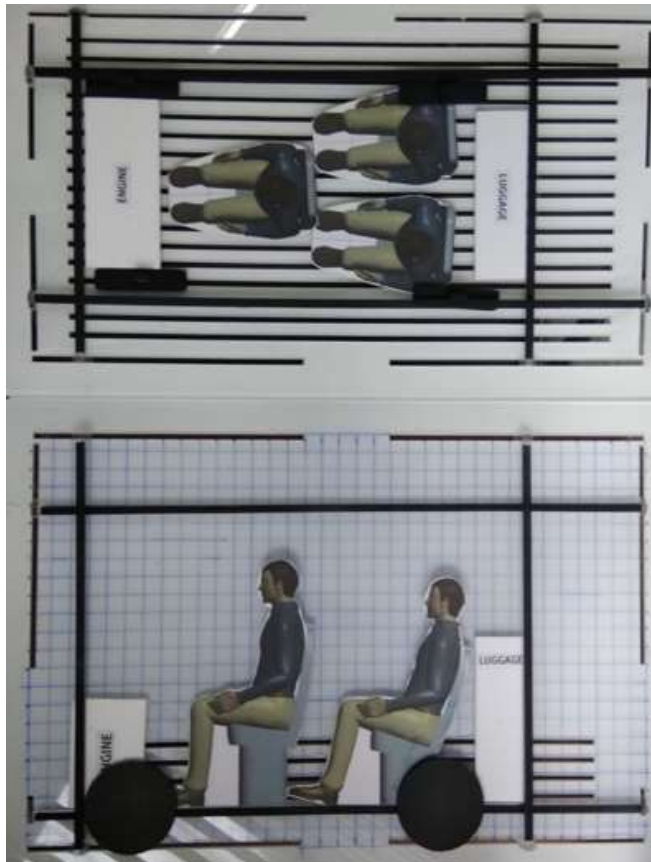


3R

9



Natha , 38
Plumber
Married

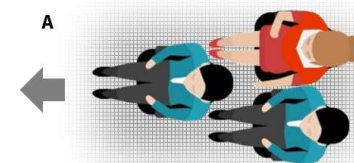
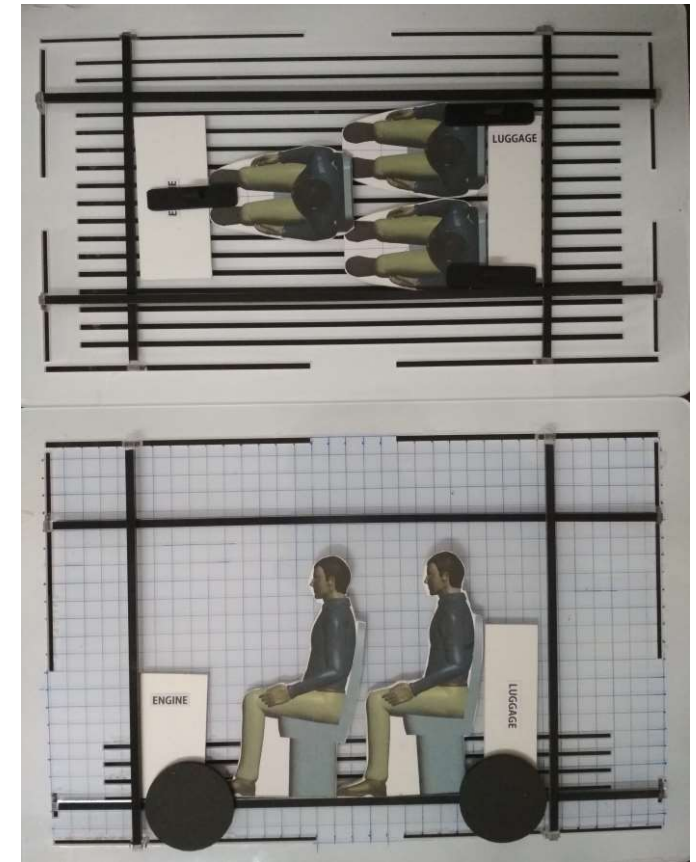


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10



Sikandar , 40
Auto driver
Married

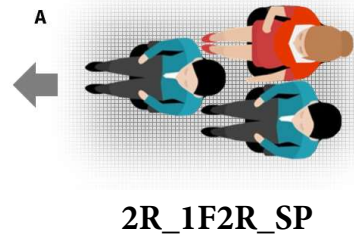
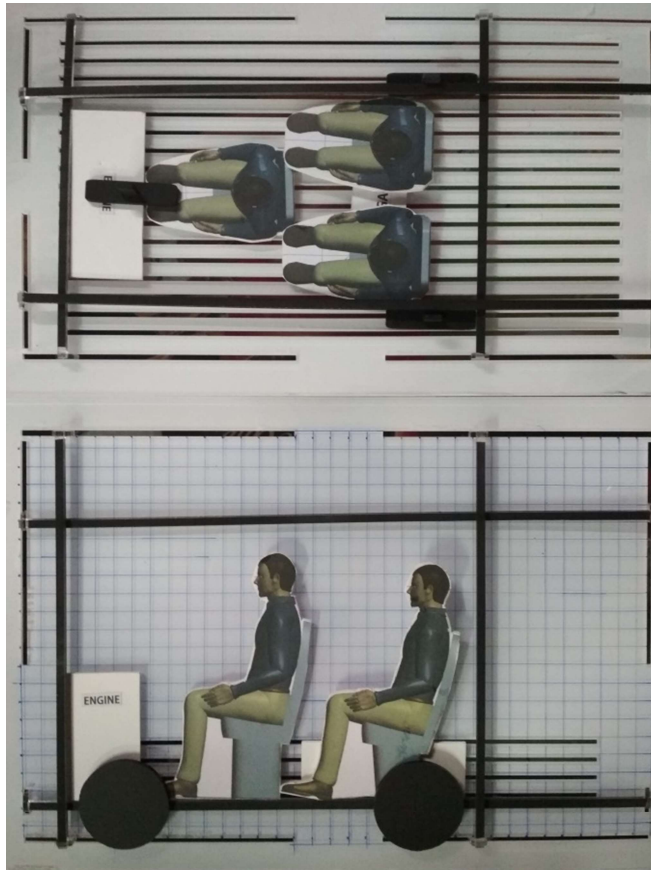


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11



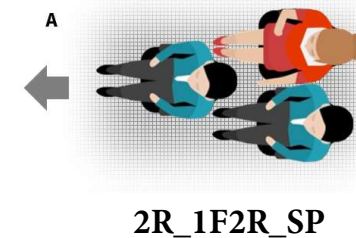
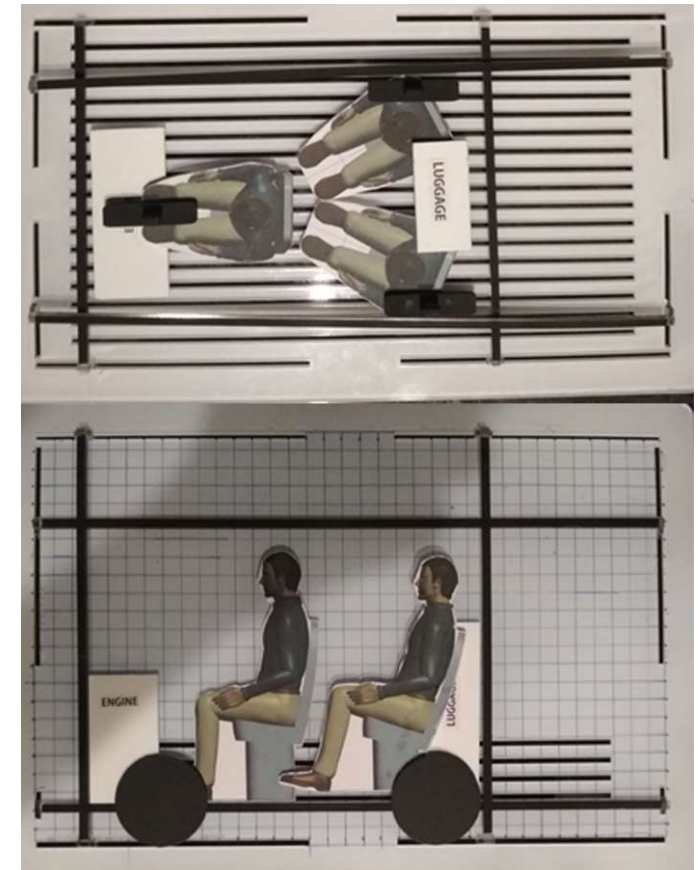
Sayali , 28
Doctor
Single



12



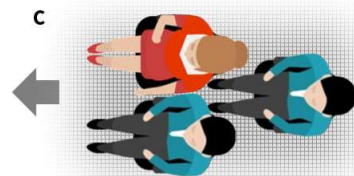
Sikandar , 40
Auto driver
Married



13

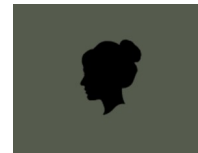


Meenu , 28
Master
student
Single

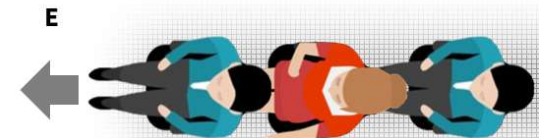
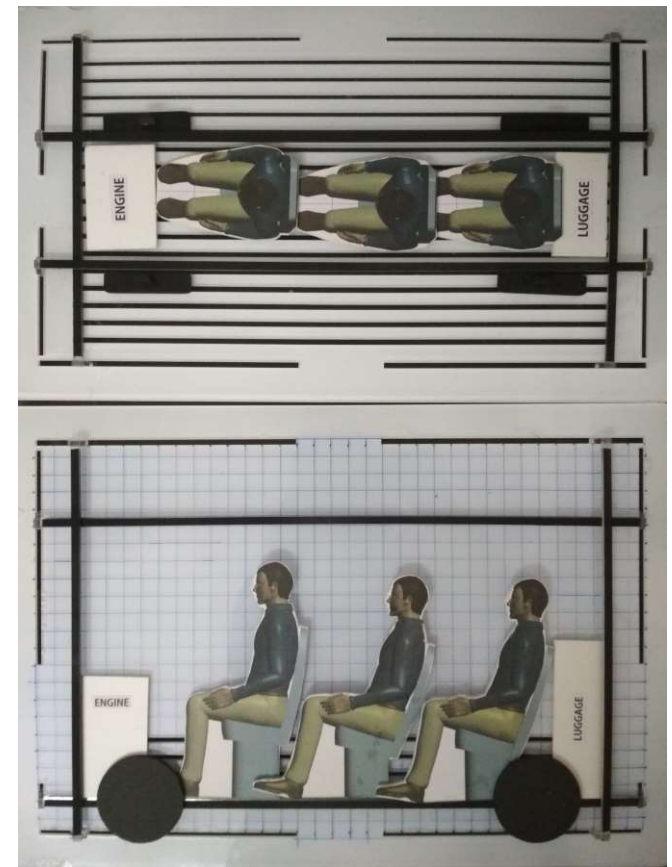


2R_2FR_SP

14



**Sikandar ,
40**
Auto driver
Married

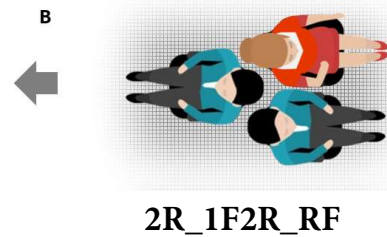
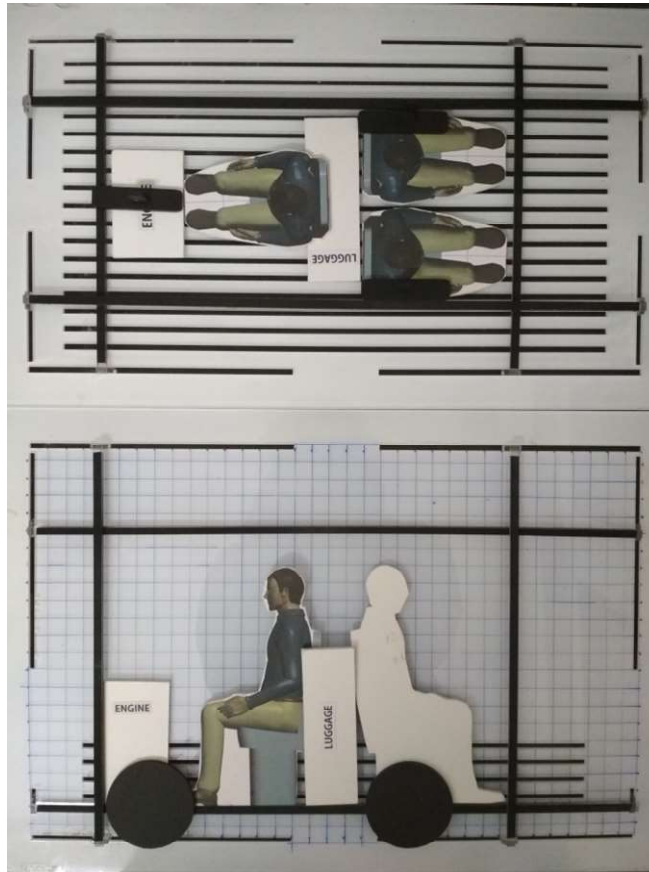


3R

15



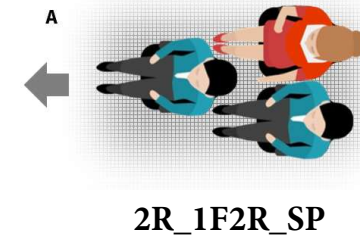
Sunitha ,
29
Teacher
Married



16



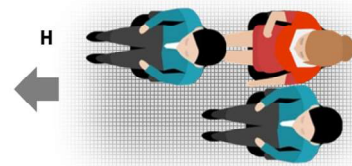
Soorya , 22
Master
student
Single



17



Saijith , 25
Master
student
Single

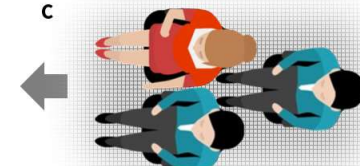


2R_1F2R_OP

18



**Naveen K T ,
23**
Engineer
Single

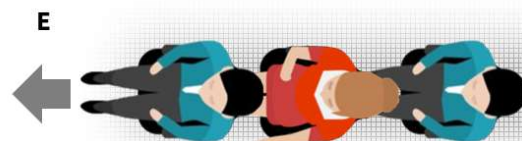
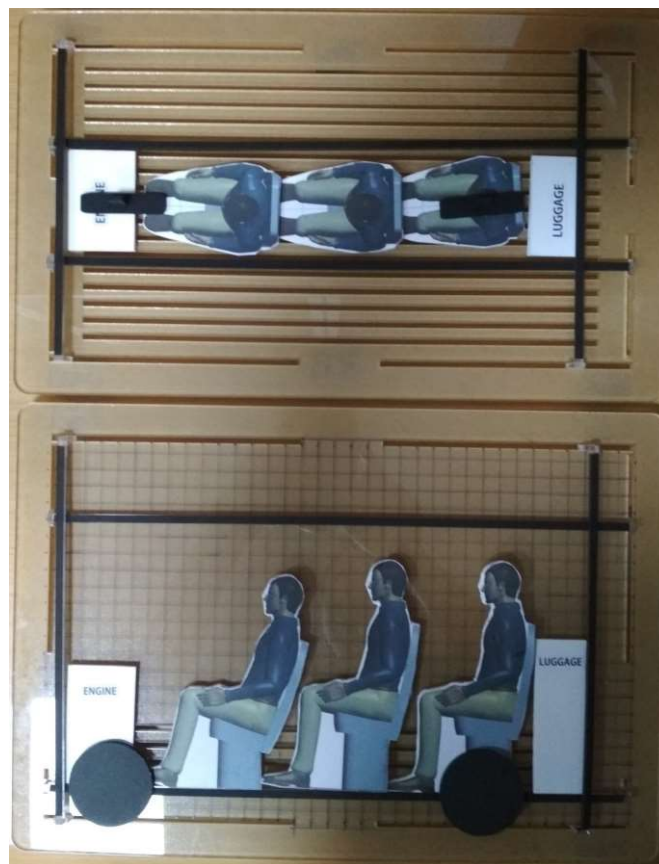


2R_2FR_SP

19



**Deepam ,
23**
Master
student
Single

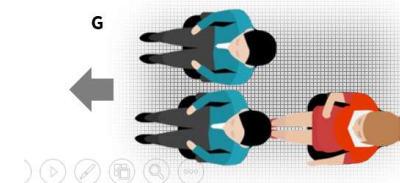


3R

20



Annie , 22
Master
student
Single



2R_2F1R_OP

6. References

- 1) (Fig. 1.1.1) https://www.wired.com/images_blogs/autopia/2009/12/hybridmoto.jpg
- 2) (Fig.1.1.2) <https://www.documentingreality.com/forum/f149/indian-family-fall-off-their-moped-1341883>
- 3) (Fig.1.1.3) <https://www.thehindu.com/todays-paper/tp-national/tp-karnataka/Traffic-is-usually-a-nightmare/article15235372.ece>
- 4) (Fig. 1.3.2) <https://www.alamy.com/stock-photo/indian-family-on-scooter.html> (Fig. 1.3.2)
- 5) (Fig. 1.3.3) http://www.wikiwand.com/en/Auto_rickshaw
- 6) (Fig. 1.4.1) <https://www.alamy.com/stock-photo/indian-family-on-scooter.html>
- 7) (Fig. 1.4.2) Toddler on Töff. The helmet is almost bigger than the child, <https://test.20min.ch/schweiz/basel/story/-Der-Helm-ist-fast-groesser-als-das-Kind--30453659>
- 8) (Fig. 1.4.3) <https://udaipurtimes.com/license-to-be-cancelled-if-found-talking-on-phone-while-driving/>
- 9) (Fig 1.4.4) <https://www.thehindu.com/todays-paper/tp-national/tp-tamilnadu/intense-vehicle-check-in-thoothukudi/article19394511.ece>
- 10) (Fig. 1.4.5) <https://www.alamy.com/stock-photo/indian-family-on-scooter.html>
- 11) (Fig 1.4.6) <https://www.hindustantimes.com/punjab/seminar-on-traffic-rules-held-at-faridkot-school/story-stZu4CfQfkwwphDqxsDiYP.html>
- 12) (Fig. 1.4.7) <https://www.thehindu.com/news/cities/bangalore/No-auto-driver-is-ready-to-go-by-the-meter-in-Bengaluru/article15007773.ece>
- 13) (Fig. 2.1.1, 2.1.2) <https://www.downtoearth.org.in/coverage/energy/the-future-is-electric-59653>
- 14) (Fig. 2.1.1.1) <https://onewedge.com/2018/02/19/an-ev-taxonomy/>
- 15) (Fig. 2.2.1) <http://www.bestecoshop.com/100w-12v-white-solar-panel-kit-with-corner-side-mounts-cable-entry-10-amp-dual-battery-controller-5m-extention-cables-branch-connectors.html>
- 16) (Fig 2.2.2) <https://www.autoexpress.co.uk/99319/new-toyota-prius-plug-in-2017-review-pictures>
- 17) (Fig 2.2.3) <https://goo.gl/9cdmd4> (FIg 2.2.3)
- 18) Indian anthropometry dimensions data book – Debkumar Chakrabarti (National Institute of design)
- 19) The future is electric. *Downtoearth.org*, Feb 2018, <https://www.downtoearth.org.in/coverage/energy/the-future-is-electric-59653>
- 20) (Fig. 4.3.1) <https://pdxpeople.com/mark-frohnmayr-founder-of-arci-moto/>

6. References

- 21) Two-wheeler sales in India from 2010/11 to 2017/18 (in units). Statista.com.
<https://www.statista.com/statistics/318023/two-wheeler-sales-in-india/>
- 22) Postato il . An EV taxonomy. *Onededge.com*, Feb 2019, <https://onewedge.com/2018/02/19/an-ev-taxonomy/>
- 23) Electric Vehicles, *Ergon.com* <https://www.ergon.com.au/network/smarter-energy/electric-vehicles/electric-vehicle-range>
- 24) Electric Vehicle Charging: Types, Time, Cost and Savings, *ucsusa.com*. <https://www.ucsusa.org/clean-vehicles/electric-vehicles/car-charging-time-type-cost#.W2b1xigzZPY>
- 25) Build Your Own Electric Vehicle, *issuu.com*, Dec 2010 <https://issuu.com/dokumentacija/docs/electricvehicle>
- 26) VIVA: India's first quick charging station for electric vehicles now commercially available, *youtube.com*, July 2005. <https://www.youtube.com/watch?v=uB1SbbH2vSs&feature=youtu.be>
- 27) Headlamp Cares, July 2011, <http://cz210jidousha.blogspot.com/>
- 28) The Battery Revolution. End of Gasoline?, Futurelab, *youtube.com*, June 2018
<https://www.youtube.com/watch?v=lATQEbd2Yh4>
- 29) Auto rickshaw, *wikipedia.org*. https://en.wikipedia.org/wiki/Auto_rickshaw
- 30) Automotive industry in India, *wikipedia.org*, https://en.wikipedia.org/wiki/Automotive_industry_in_India
- 31) <https://www.gettyimages.dk/detail/news-photo/an-indian-family-ride-on-a-motorcycle-through-a-downpour-in-news-photo/175508510>
- 32) Testing and evaluation standards for ev and hev, *emobility.araiindia.com*.
<https://emobility.araiindia.com/standards/>
- 33) Automotive Vehicles-Types-Terminology
https://araiindia.com/hmr/Control/AIS/11292016102244AM AIS_053.PDF
- 34) H.Point – fundamentals of car design ,by Stuart Macey and Geoff Wardle