- Everyday, ***491*** vehicles are added to Mumbai roads.
- Pollution is increasing: People are demanding ***closed*** vehicles
- Average occupancy rate of cars in India has gone to ***1.8***
- Cars are rigid structures, ***occupy***ing large space all the time.
- Above all, area of ***land is limited*** and so is the road width.
- ***Fossil fuel*** source, the powering element for cars is vanishing.

Do we have a **solution** for this????

The vehicle scenario today…

What can it be???

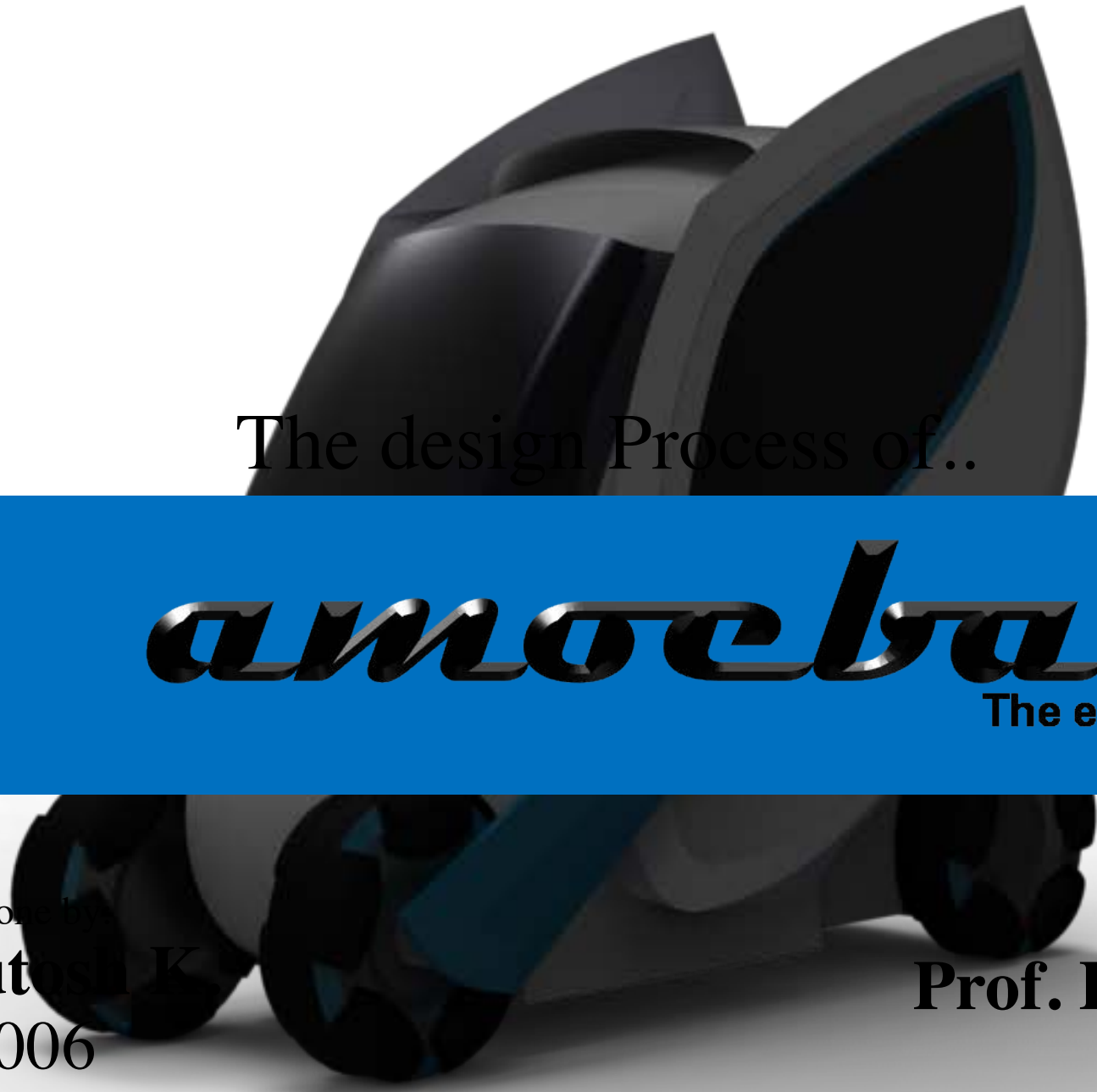
- Public transport? …Infrastructure, privacy, rigidity
- E- bikes? …Open
- Micro cars? …Still rigid, occupancy of extra person
- Bicycles? …Tiring, slow,
- Fuel cell cars? …Large volumes
- Battery operated cars? …limited range, rigid

Or **“Something”** beyond obvious?

- That occupies **Minimum space** while parked…
- That needs **minimum space for parking operation…**
- That **opens up as per the need** of the user…
- A PMV **with 300% more hidden space…**
- That runs on a **fairly new power source…**
- That is **easy to operate…**

What beyond usual?

“Something” that adapts…



The design Process of..

amoeba

The e-SAV

A project done by

Aashutosh K

10639006

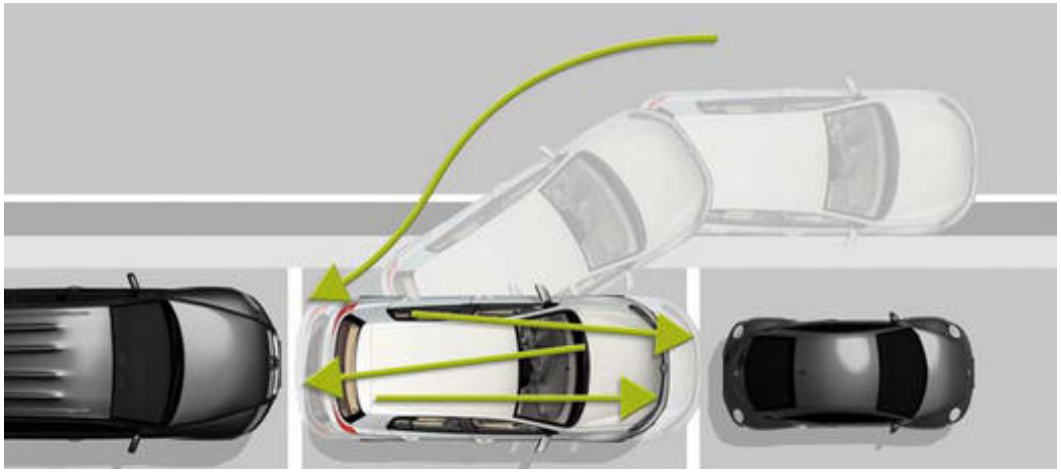
IDC | IIT Bombay

Guided by:

Prof. K. Munshi

The Research

Defining the Problems..



Defining the Problems..

- Today, the number of vehicles is increasing rapidly, but on other hand, infrastructure supporting it is not growing that fast.
- People are struggling their ways in busy city traffic and to find parking spaces.
- Due to present environmental condition, everyone is going for a closed vehicle… a four wheeler.
- Privacy issues have brought down the vehicle occupancy rate to 1.8.

Setting the goal

- Foldable closed vehicle.
- Should open up as per requirement to maintain occupancy 100%
- Should occupy minimum possible area on road at all the times.
- Should get parked easily and in minimum area.
- In short adapt rapidly to any approaching challenge.
- Should run on non polluting source of power.

Defining a Vehicle

- A conveyance that transports people or objects from one place to another.
- A Rigidly defined Metallic Shell, driven by an autonomous power source.
- Concept of Adaptability…
  *What **extra** a vehicle can do apart from doing its basic functions?*

Defining Adaptability

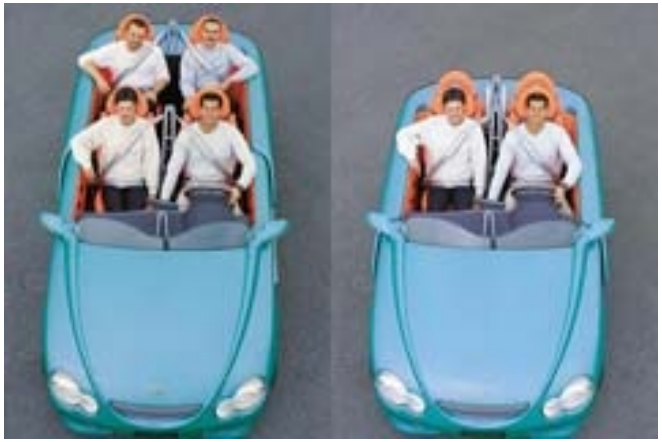
- The act of becoming suitable to new or special application.
- The extra things a vehicle can do apart from its base specific function.
- The following slides will discuss about the adaptability in present and future.

Present Adaptations

- Convertibles; which can apply or remove the top cover as and when required..
- Amphibians; which are capable of running on both ground and water surface.
- Divers; which can dive underwater

Present Adaptations

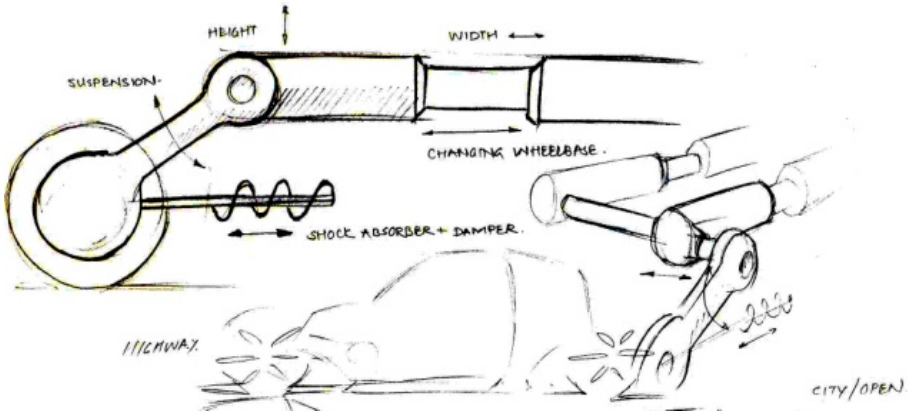
- Duel Fuel/ Hybrids; which can switch to a suitable power source.
- Flying cars; which can commute on road or in air
- Flexible cars; which can extend/contract as per required.

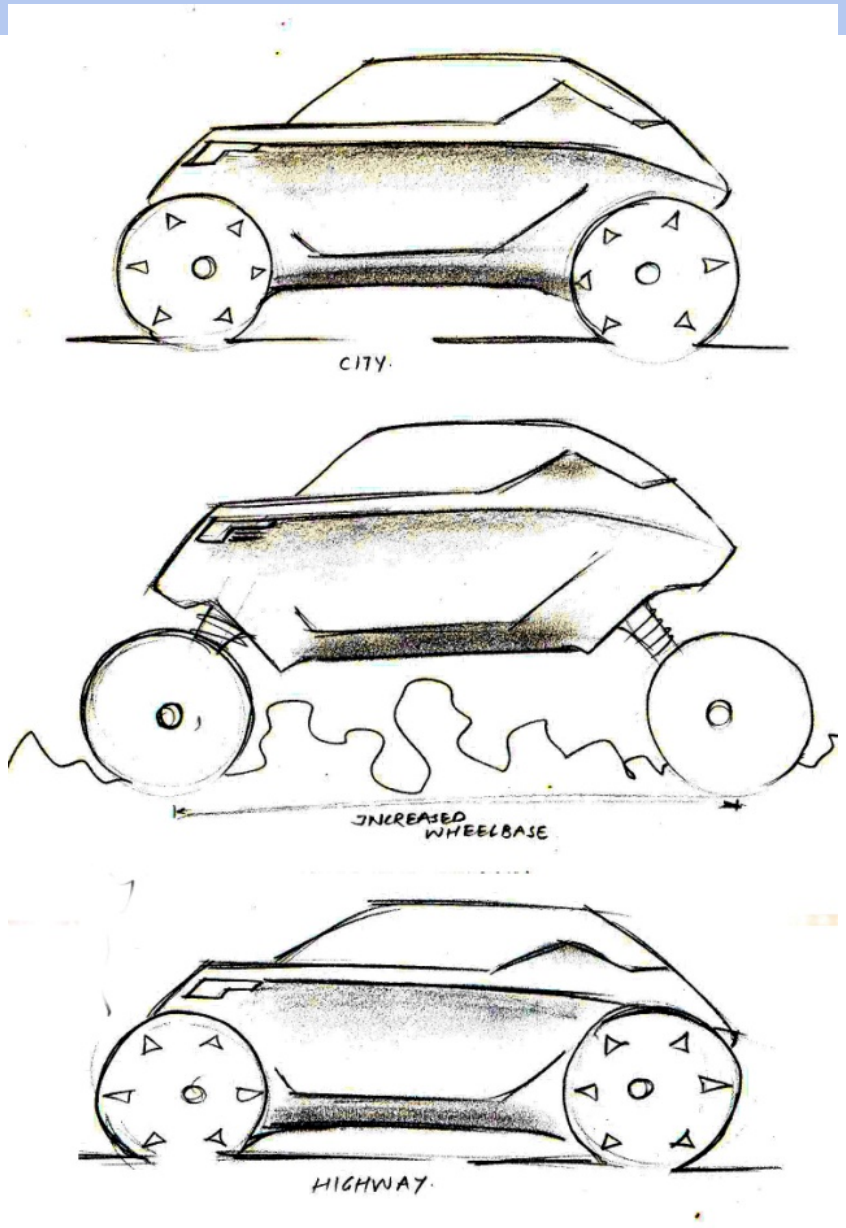


Future possibilities

- Terrain adaptability

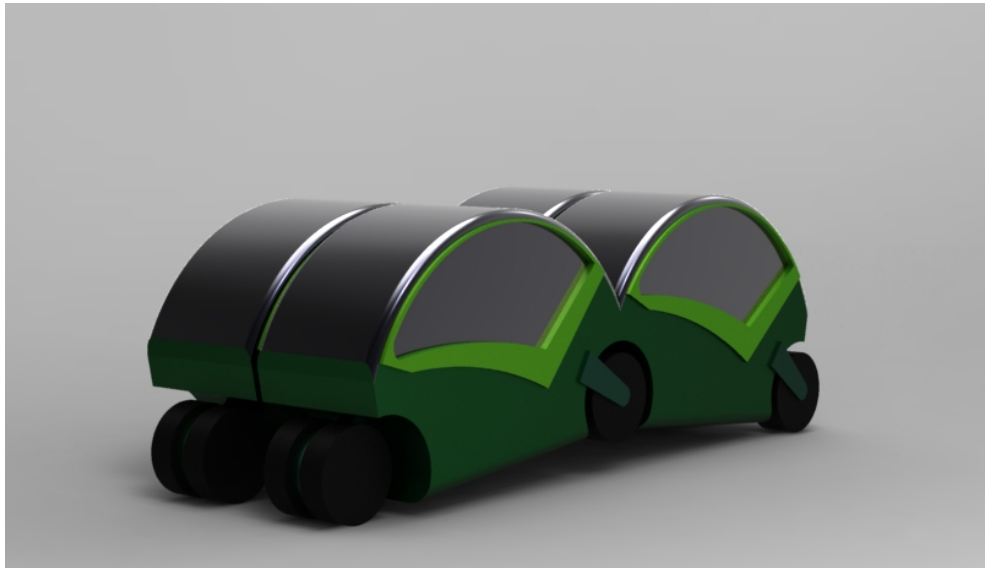
  Depending upon the terrain, the vehicle can shift its ground clearance and wheelbase to suit the comfortable ride.

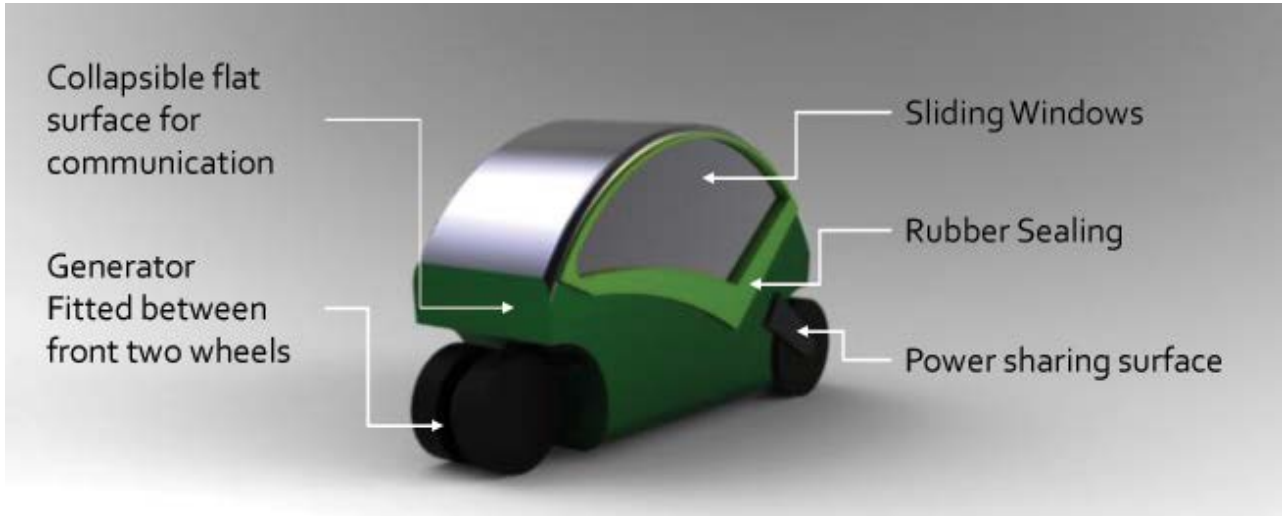




Future possibilities

- Modularity:
  The vehicle will be composed of four independent units, capable of operating individually but when together, they form a single vehicle.





Future possibilities

- Stackability:
  these kind of vehicles will be capable of reducing their footprints when parked. They will consume the same area while driving.

Defining the scope

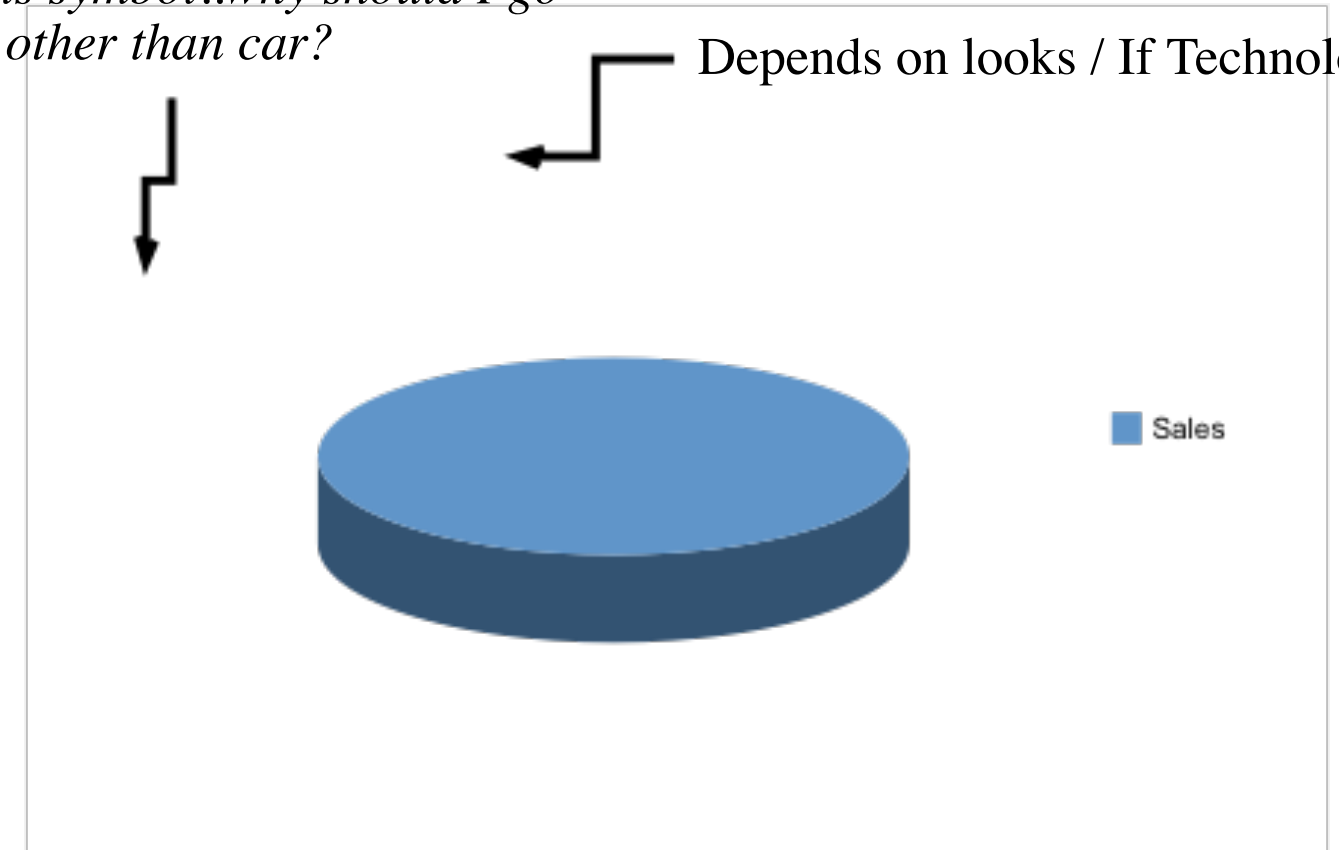
- All adaptable vehicles are still rigidly defined metallic structures.
- The scope of project is ***breaking the rule of fixed volume*** and going for flexibility imparted to shell itself.

Do we need it? Ask people…

- User survey: 16 people, various cities and professions from middle class families. Telephonic conversations.

Car is a status symbol..why should I go for a vehicle other than car?

Depends on looks / If Technology permits



What it should be like?

What are the requirements?

- Foldable
- Should be of the capacity of a normal car i.e. 4 people.
- Drivable in all modes i.e. PMV, 2 seats or 4 seats
- Should be able to adapt on the go…as and when required.
- Minimum footprint at all times.
- New power source, which will be environment friendly and renewable.

Why not…

What MIGHT be the disadvantages?

- Delicate
- Increased weight
- Overpowered in folded condition
- Changing form
- Maintenance

Setting up the brief..

- To design a closed vehicle for middle class strata of the society in cities
- Which will be capable of shifting its boundaries to accommodate different number of people. In this case, the limits range from one to four.
- It should be essentially a foldable personal mobility Vehicle, which will, as per the need change its size, shape and/or some attribute to fit itself for the purpose.
- It should be powered by some non conventional power source and should be built with a set of materials following the cyclic economy.

The brief.

- To design a closed vehicle for middle class strata of the society in cities
- Which will be capable of shifting its boundaries to accommodate different number of people. In this case, the limits range from one to four.
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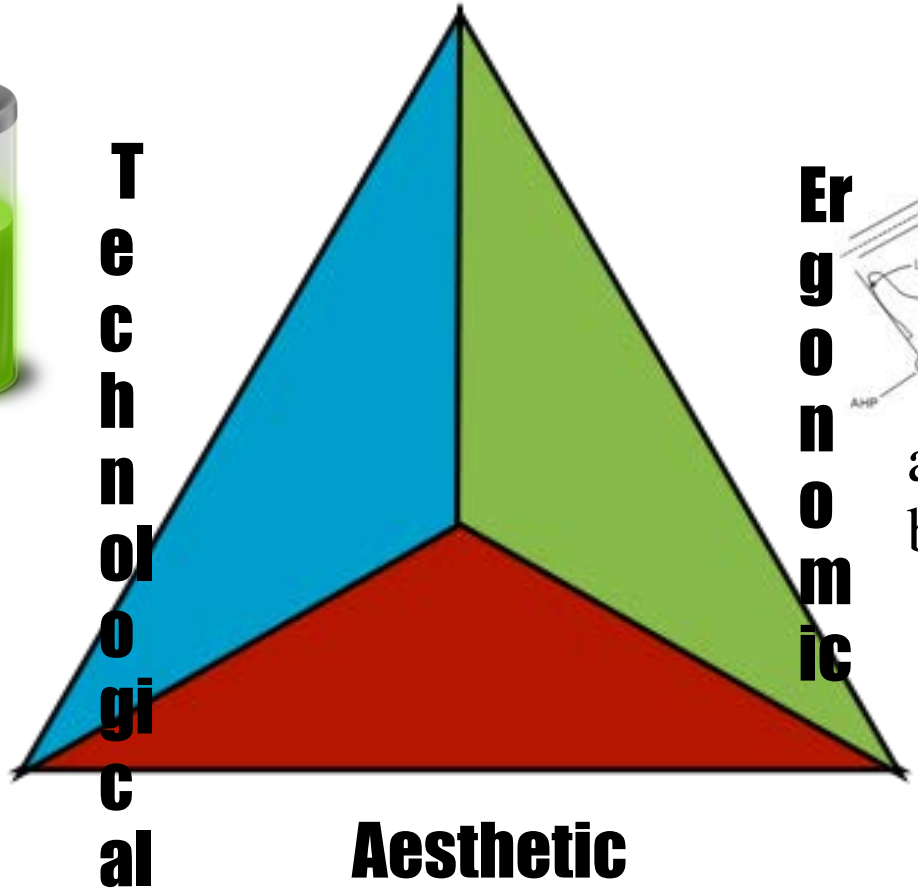
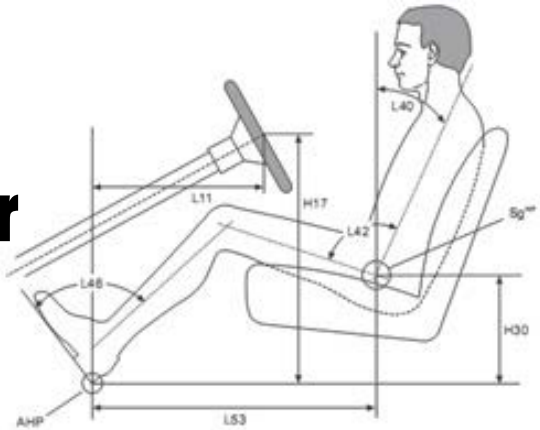
- It should be powered by some non conventional power source and should be built with a set of materials following the cyclic economy.

The Design Process

The Design Triangle

a. Mechanisms
b. Power sources





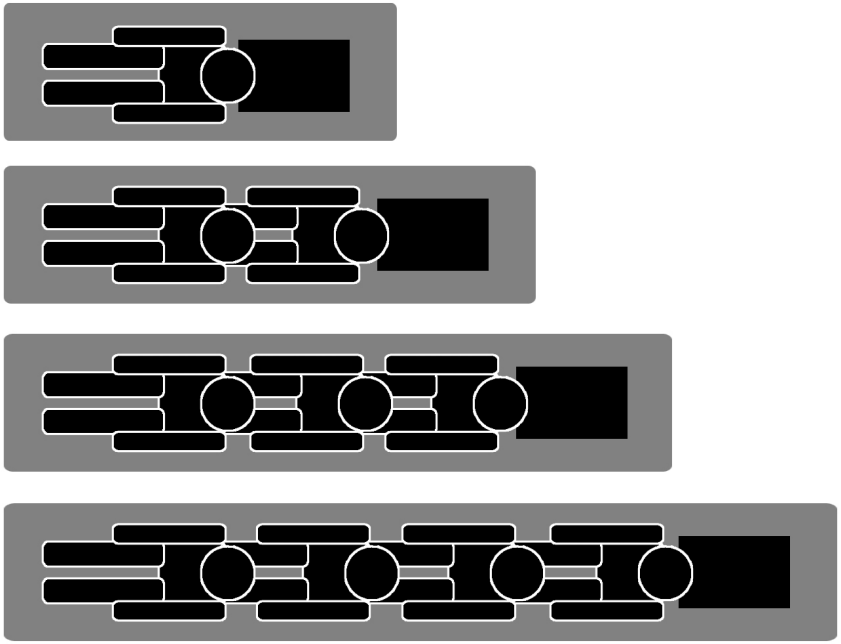
a. Seating layout
b. Dimensioning

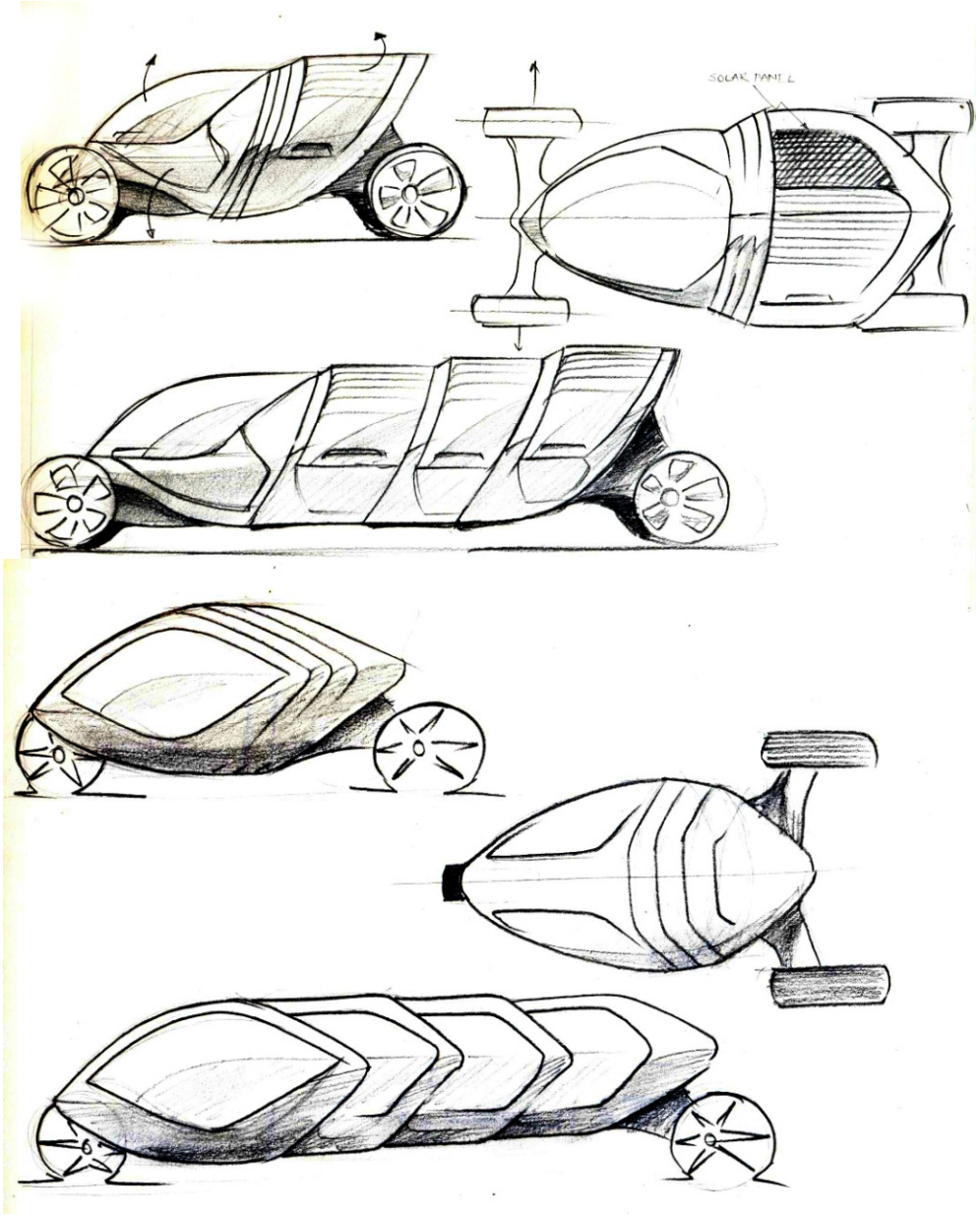
Section I: Ergonomics.

a. Seating layouts

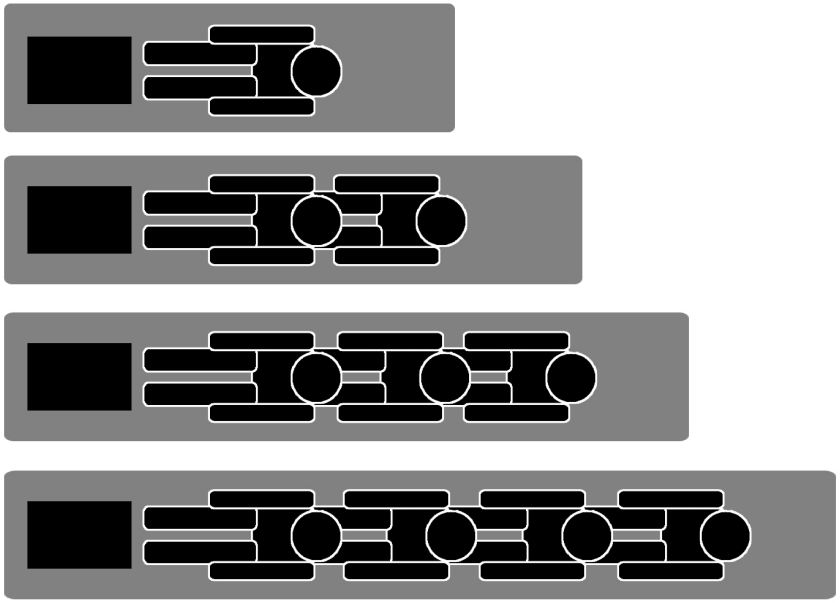
- Different layouts in which 1 to 4 people can sit in a vehicle were made and were compared to each other using the design evaluation tool.
- The results were to be plotted on a humanistic vs. Technological matrix and best suitable layout was to be selected.

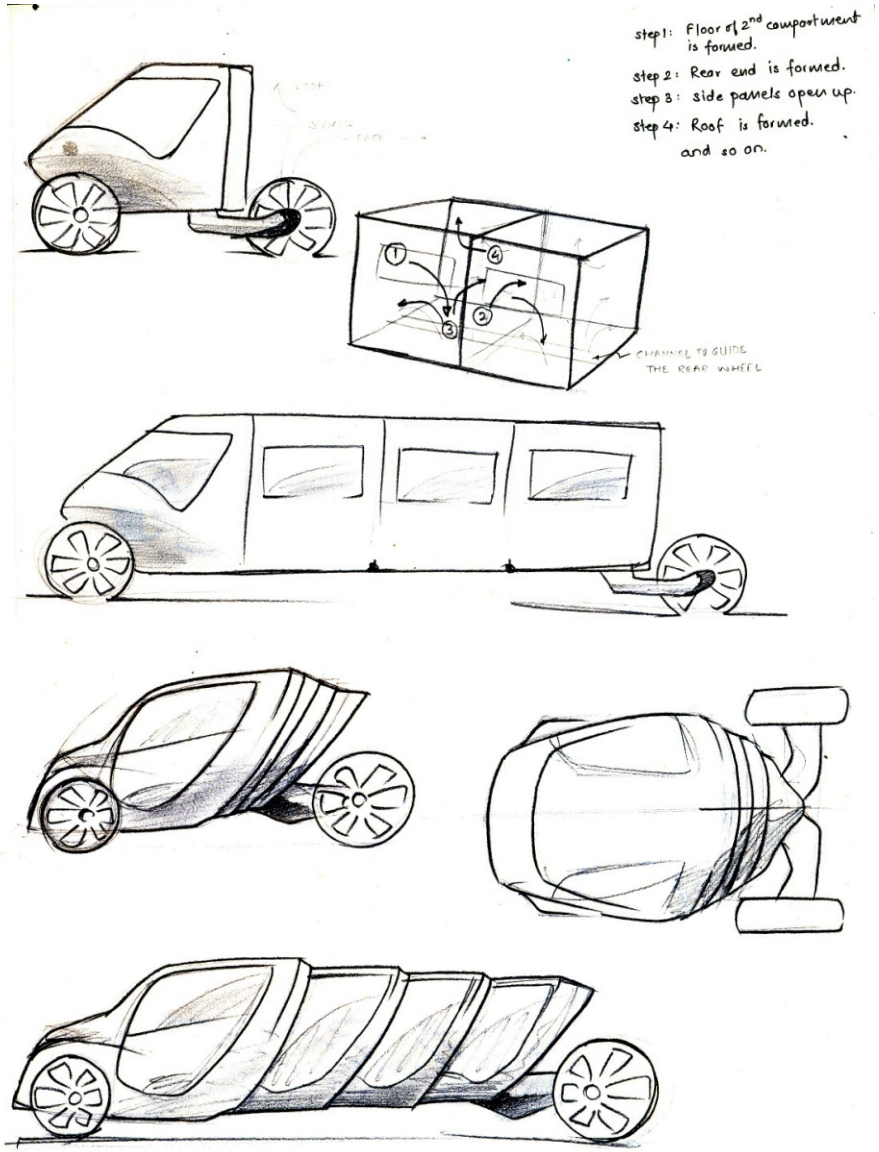
Option 1



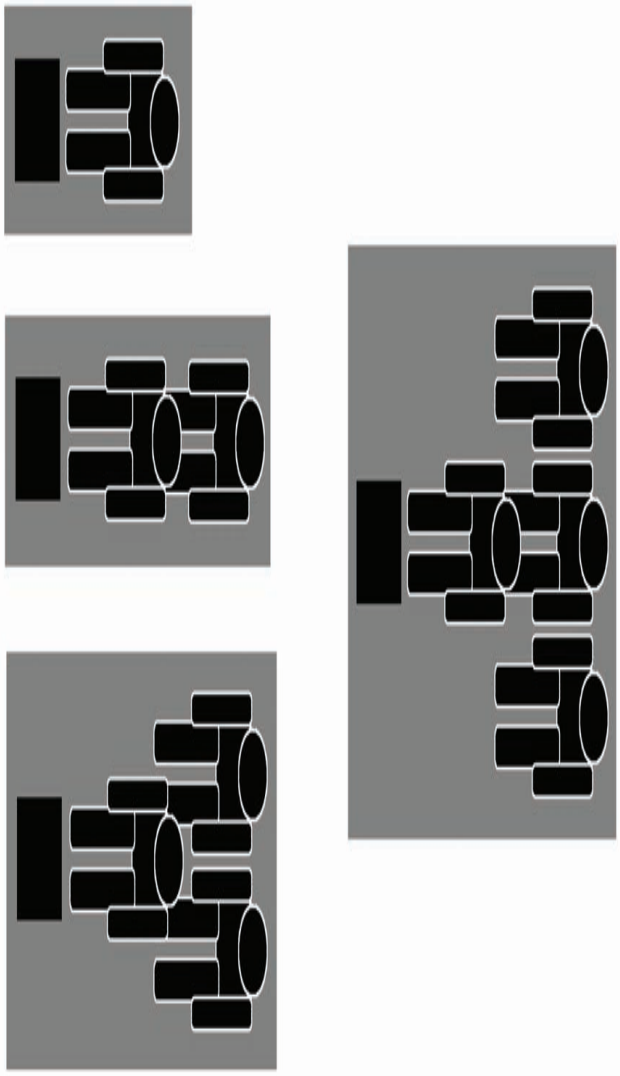


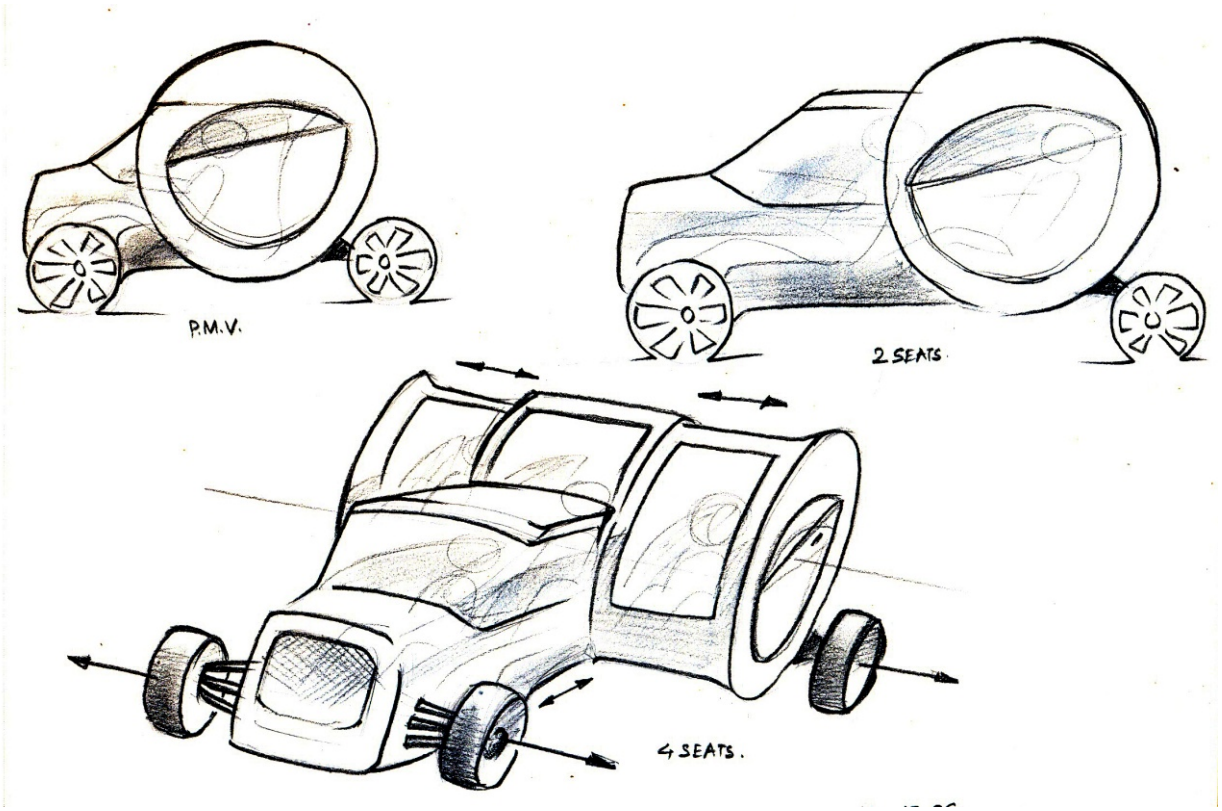
Option 2



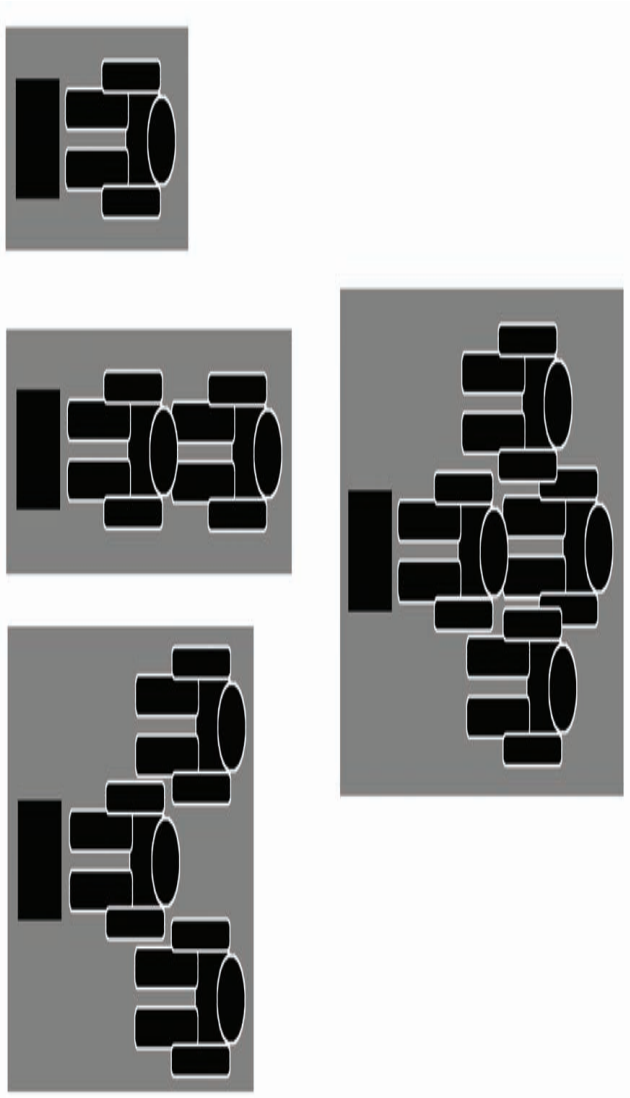

step 1: Floor of 2nd compartment is formed.
step 2: Rear end is formed.
step 3: side panels open up.
step 4: Roof is formed.
and so on.
CHANNEL TO GUIDE THE REAR WHEEL

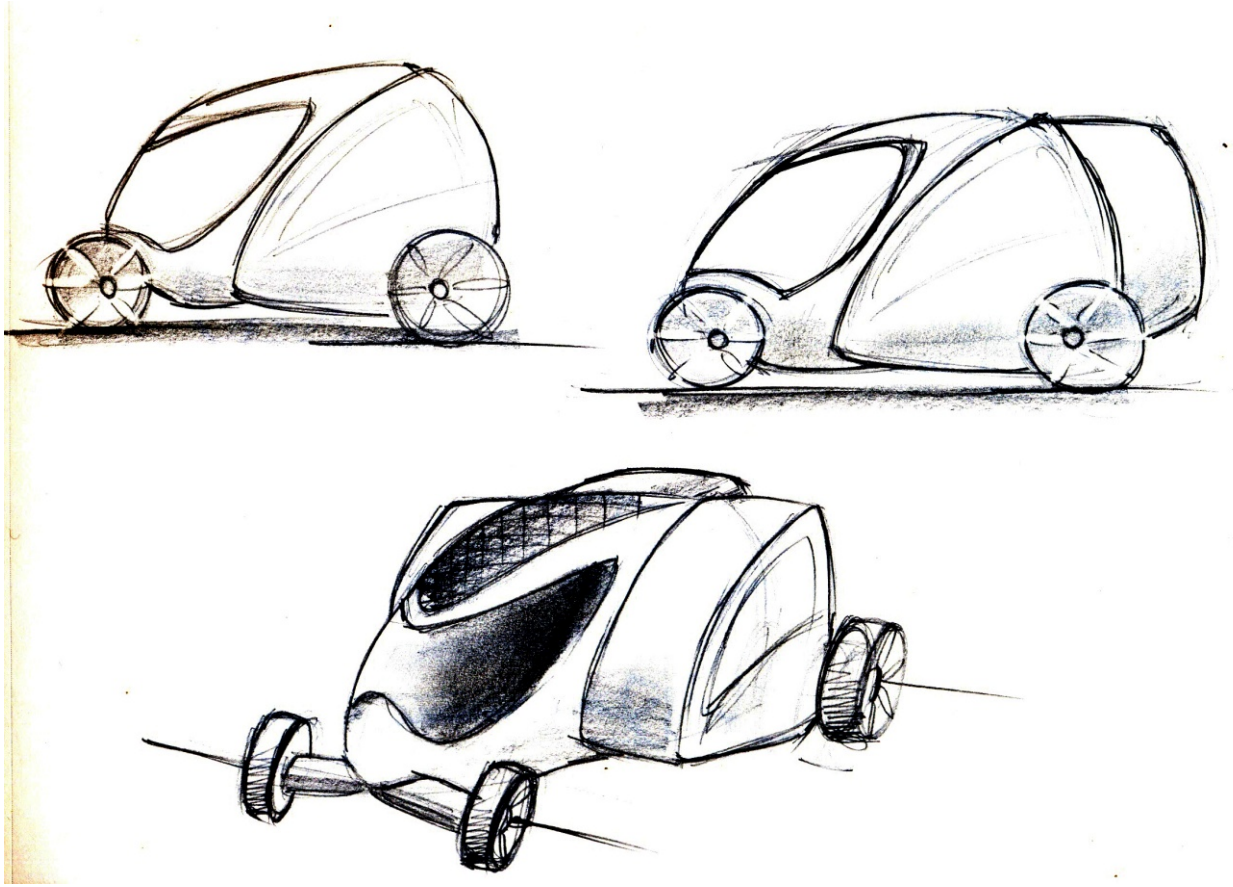
Option 3



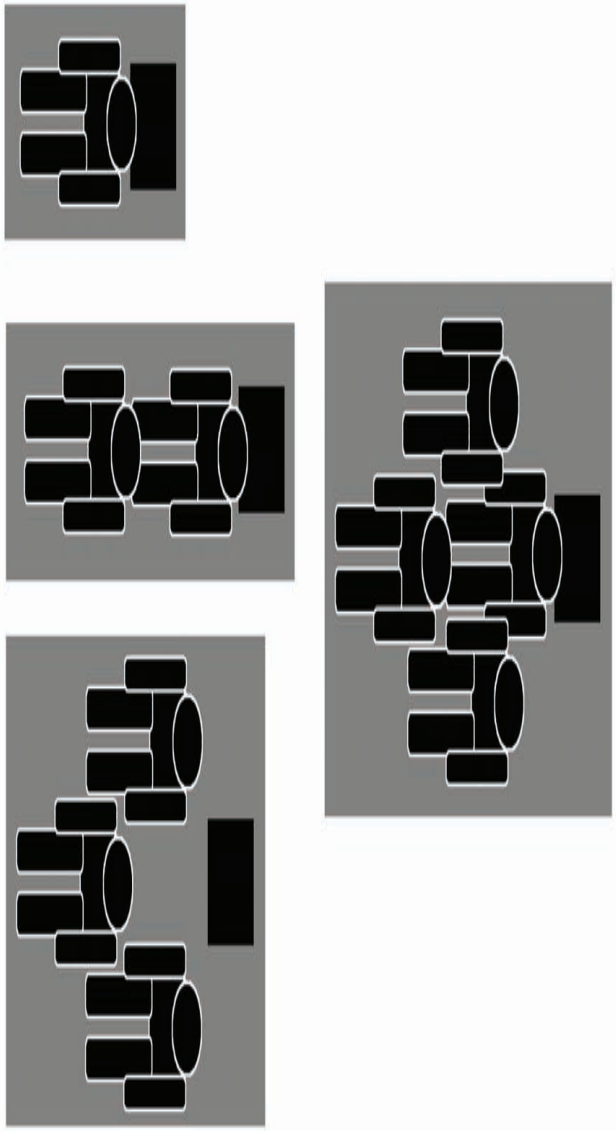


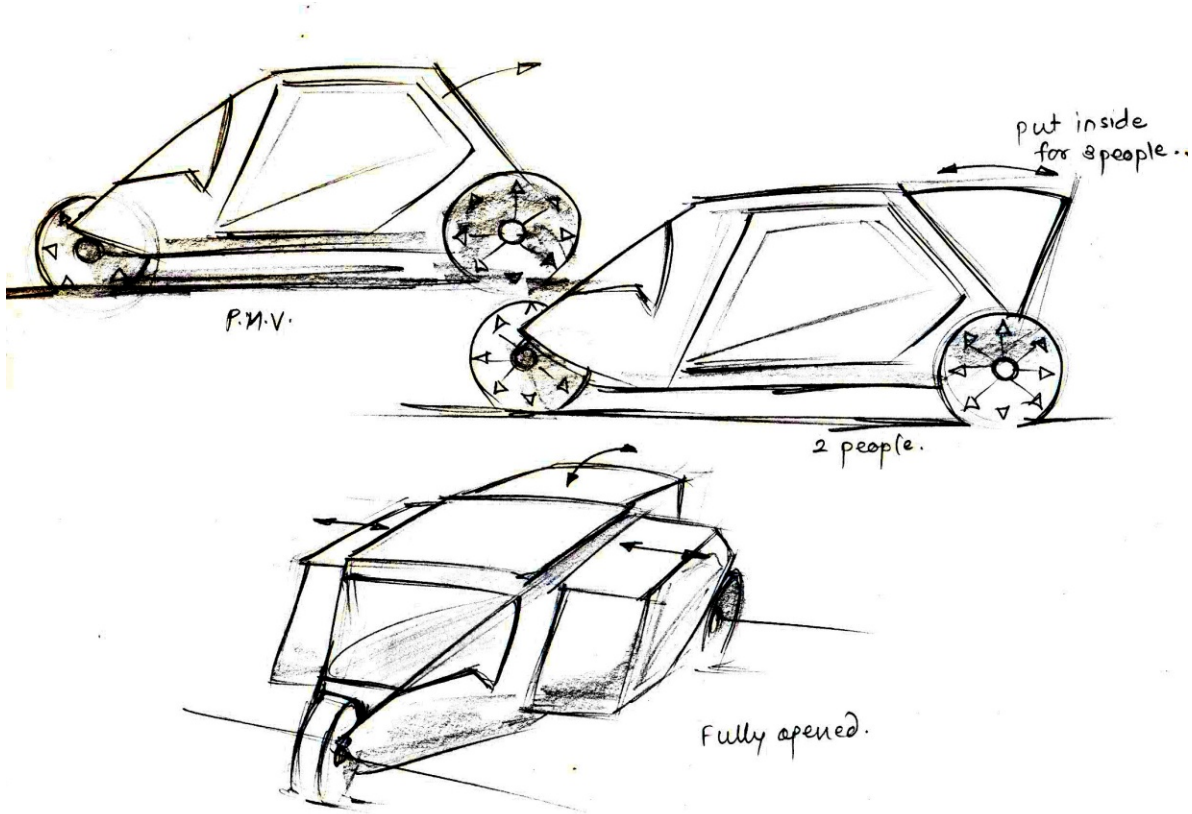
Option 4



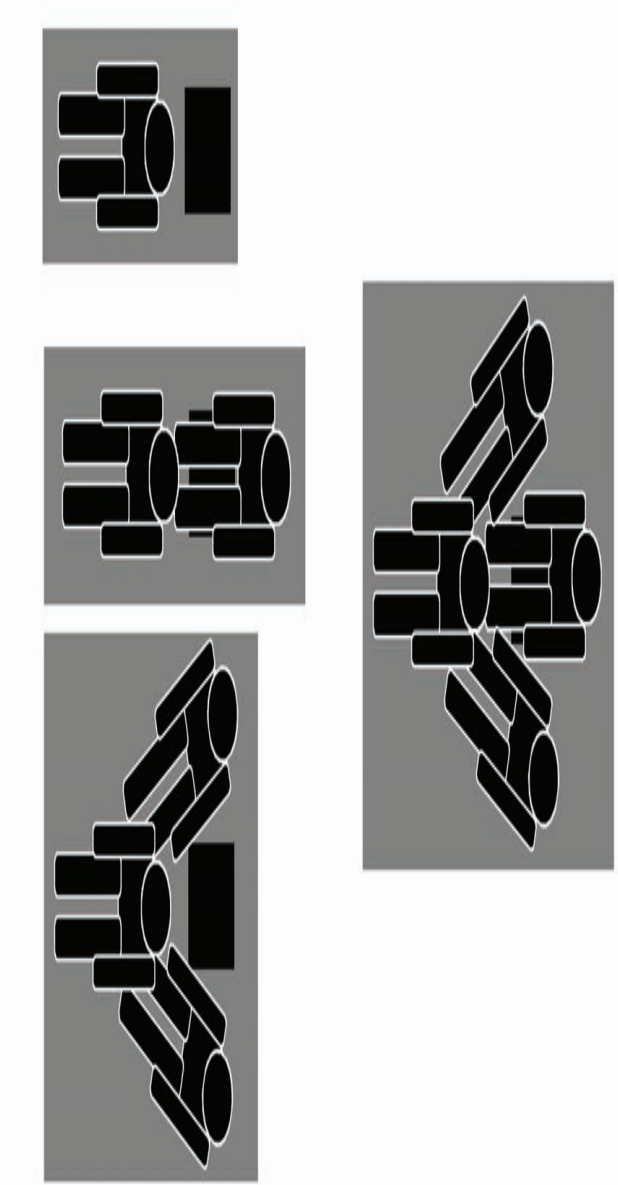


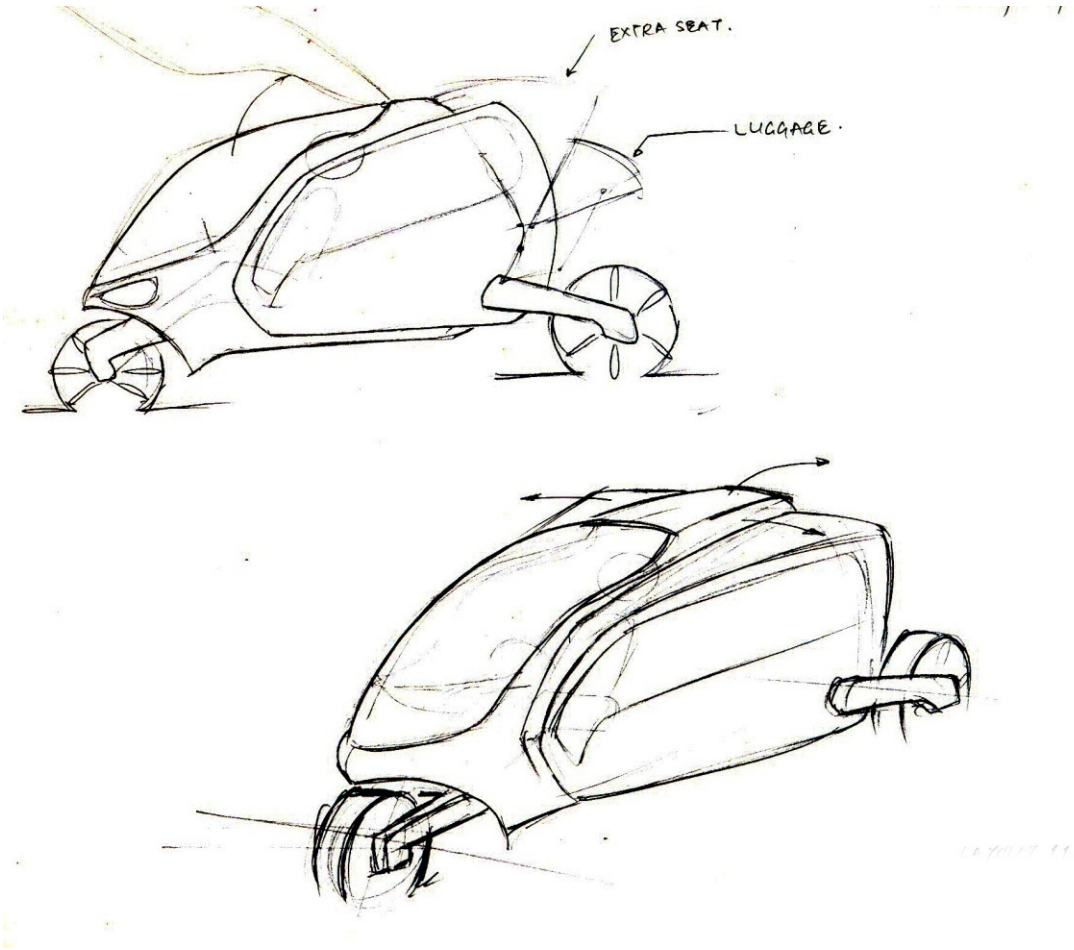
Option 5





Option 6





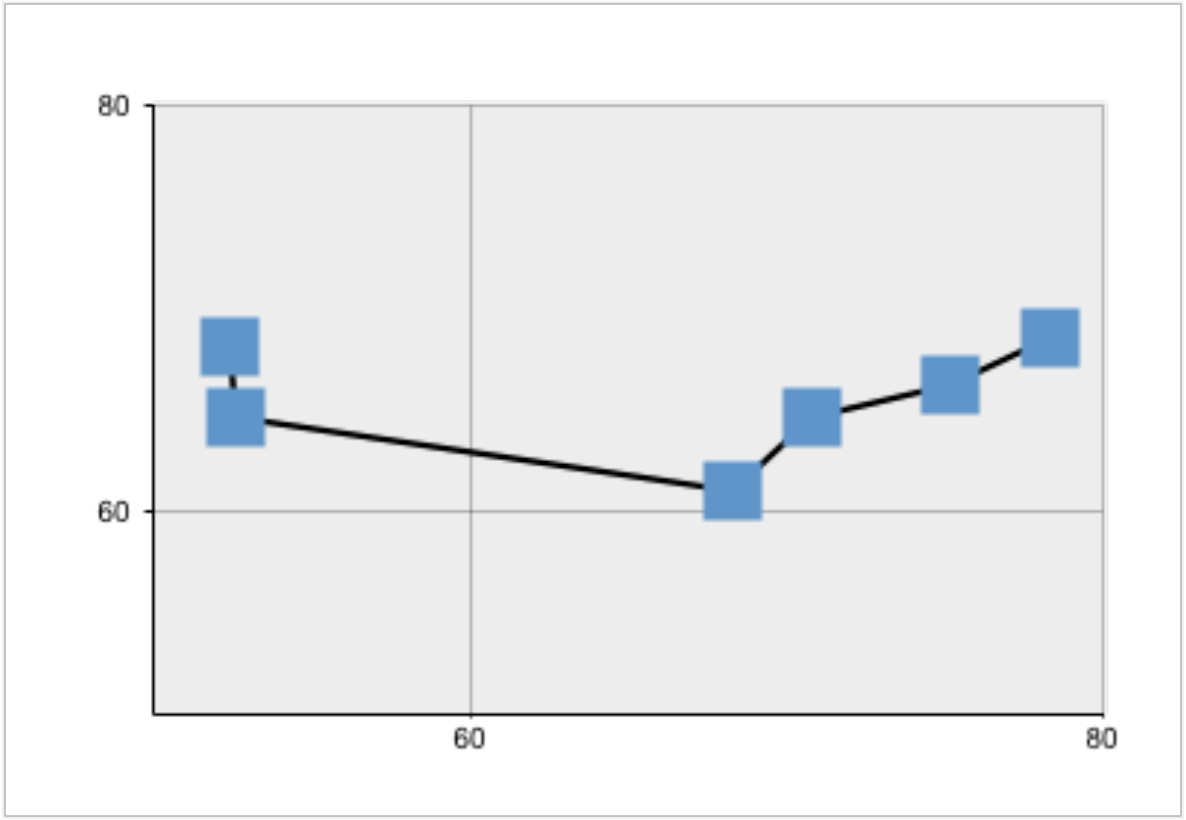
Evaluation Criteria

Criteria	MF	Reasons
Space efficiency	5	Since this was the aim of the project, this criterion has the highest weight
Feasibility	1	Technology can always evolve
Uncomfortable positions	1	Technically uncomfortable positions, like near power source, sitting in an overhang etc.
Ingress/Egress of Individuals	3	Since the vehicle will involve a lot of moving parts, ingress, egress shouldn't be difficult
Maneuverability of expanded vehicle	2	Since the vehicle is going to change in size and shape, driver should feel minimum pain in adjustments
Overall comfort at positions		
(1) Driver	2	How comfortable the driver will be.
(2) 2nd person	5	Everything ok for the pillion or not
(3) 3rd/4th Person	1	
avg.	2.7	
Rating as a family Vehicle	3	If this vehicle is to be used by a family, then will you use or not
Rating for interaction	5	How well people can interact. This always needs to be there so highest weight.
Adaptability of the driver	3	
Legspace	4	Is there sufficient leg-space? This criterion was important.
Site seeing for everybody?	3	
Orientation	1	

Evaluation

- 8 designers were interviewed and the respective rating against each column was recorded. The values were plotted on the graph.

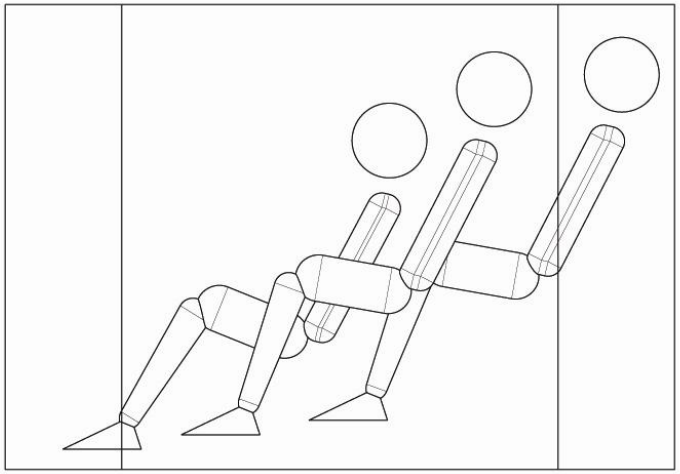
PLOT	Humanistic	Technological
LAYOUT 01	52.45098	68.05556
LAYOUT 02	52.61438	64.66049
LAYOUT 03	68.30065	60.95679
LAYOUT 04	70.83333	64.66049
LAYOUT 05	75.1634	66.2037
LAYOUT 06	78.34967	68.51852

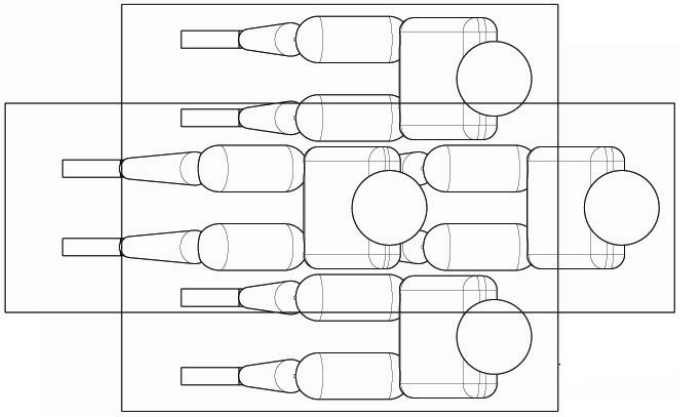


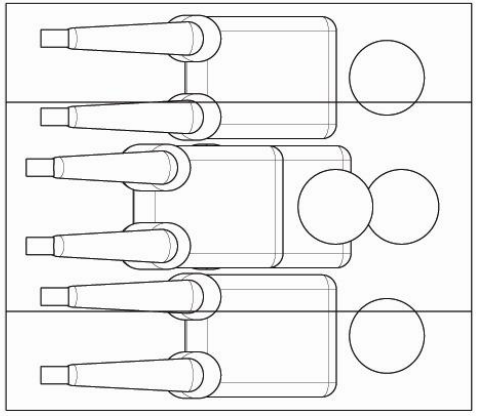
Evaluation

- Layout 5 and Layout 6… comparable results.
- A new layout was to be generated with the benefits of both and eliminating drawbacks of both.
- As per requirement, the new layout was generated.
- Drawbacks of layout 6: angular sitting
  Benefit of layout 6: Multilevel sitting
- Drawbacks of layout 5: blinding of the rear person.
  Benefit of layout 5: Correct orientation and communication

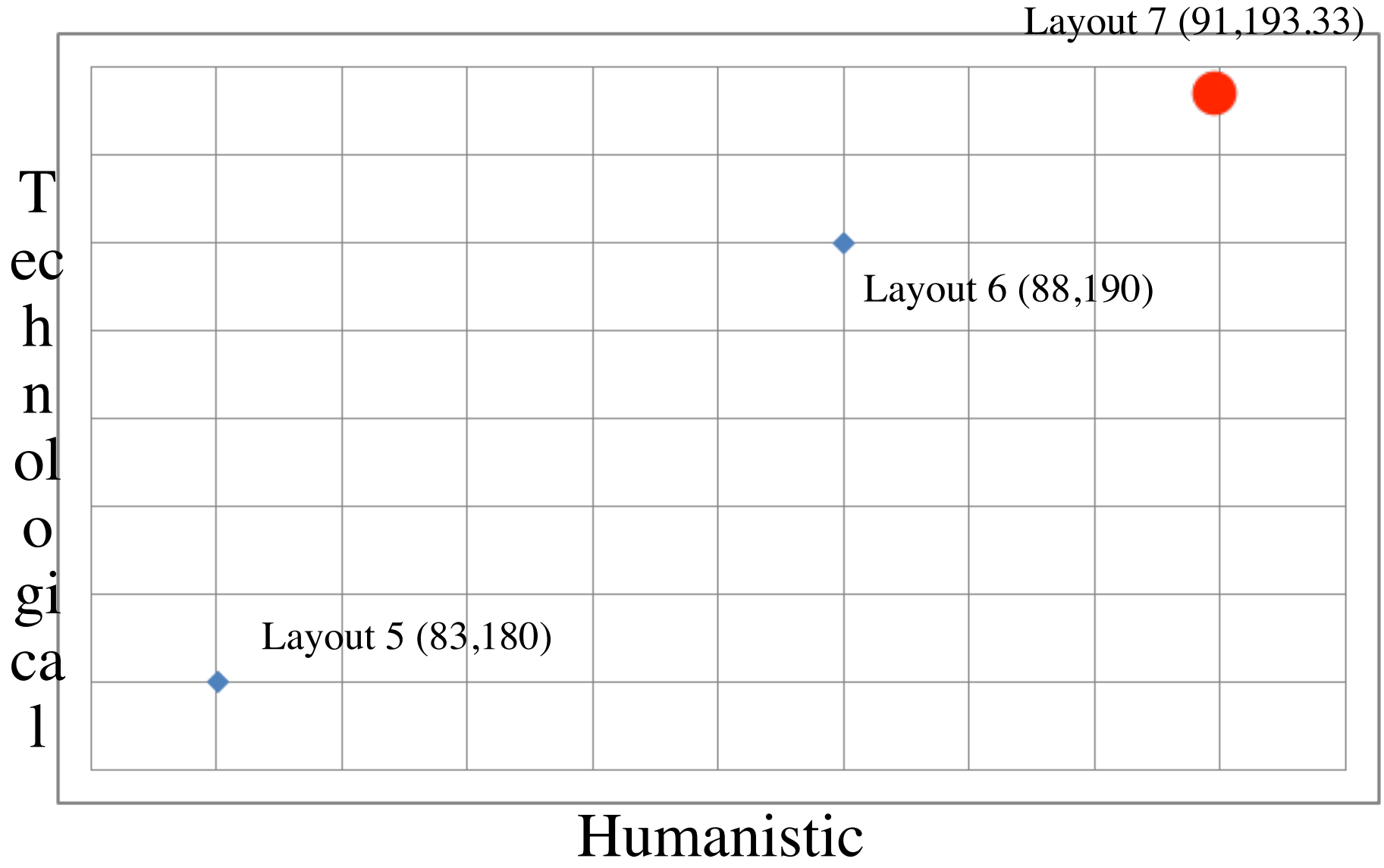
Option 7



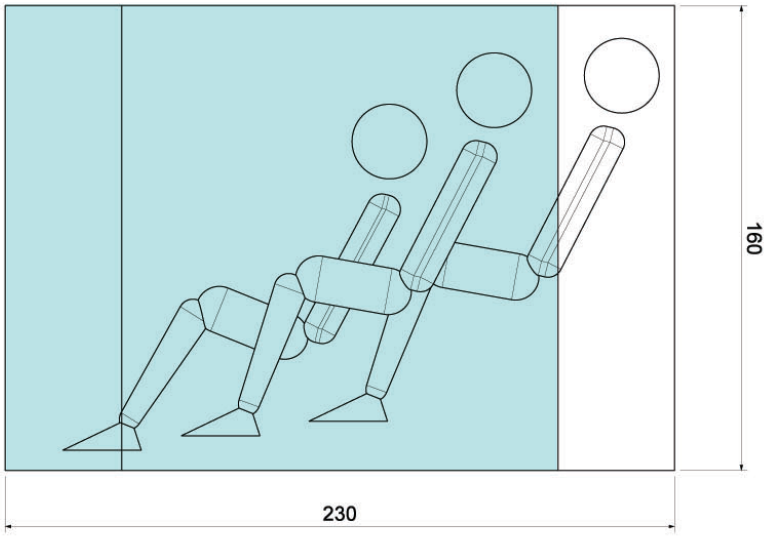


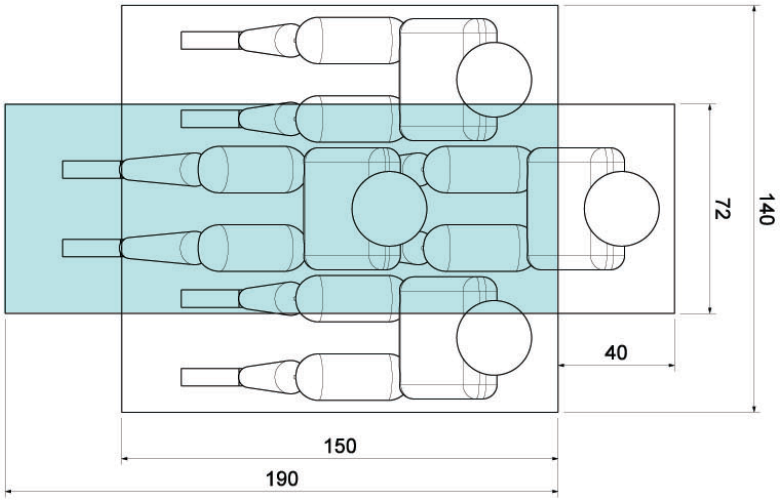


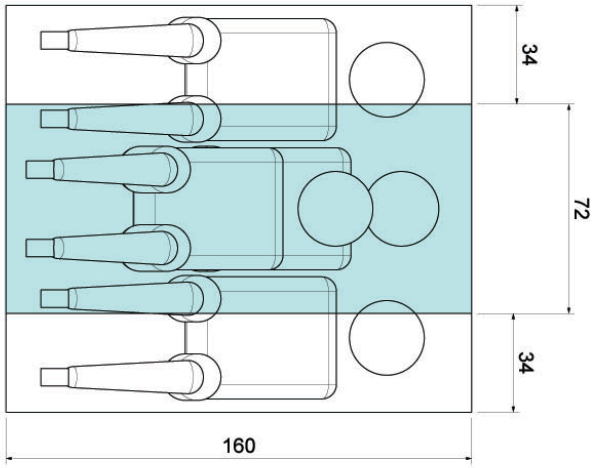
Evaluation phase II



b. Dimensioning [Ref: 95% Indian male, NID Publication book]





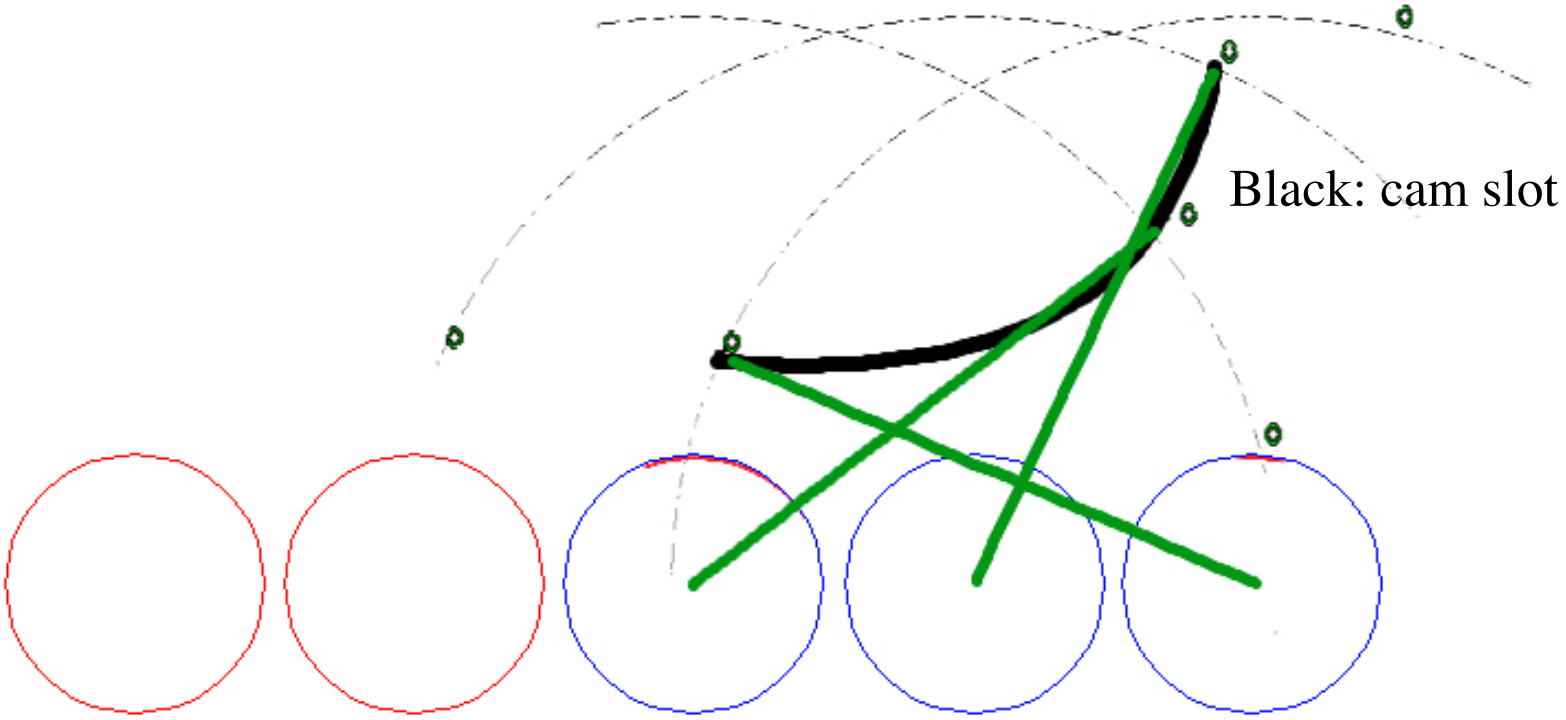


Section II: Technology.

a. Mechanisms

- Since there were all moving parts, sufficient technical backup was necessary.
- The mechanisms were required for
  - Wheelbase adjustment
  - Track width adjustment
  - Ground clearance adjustment and
  - Parking in tight spaces.

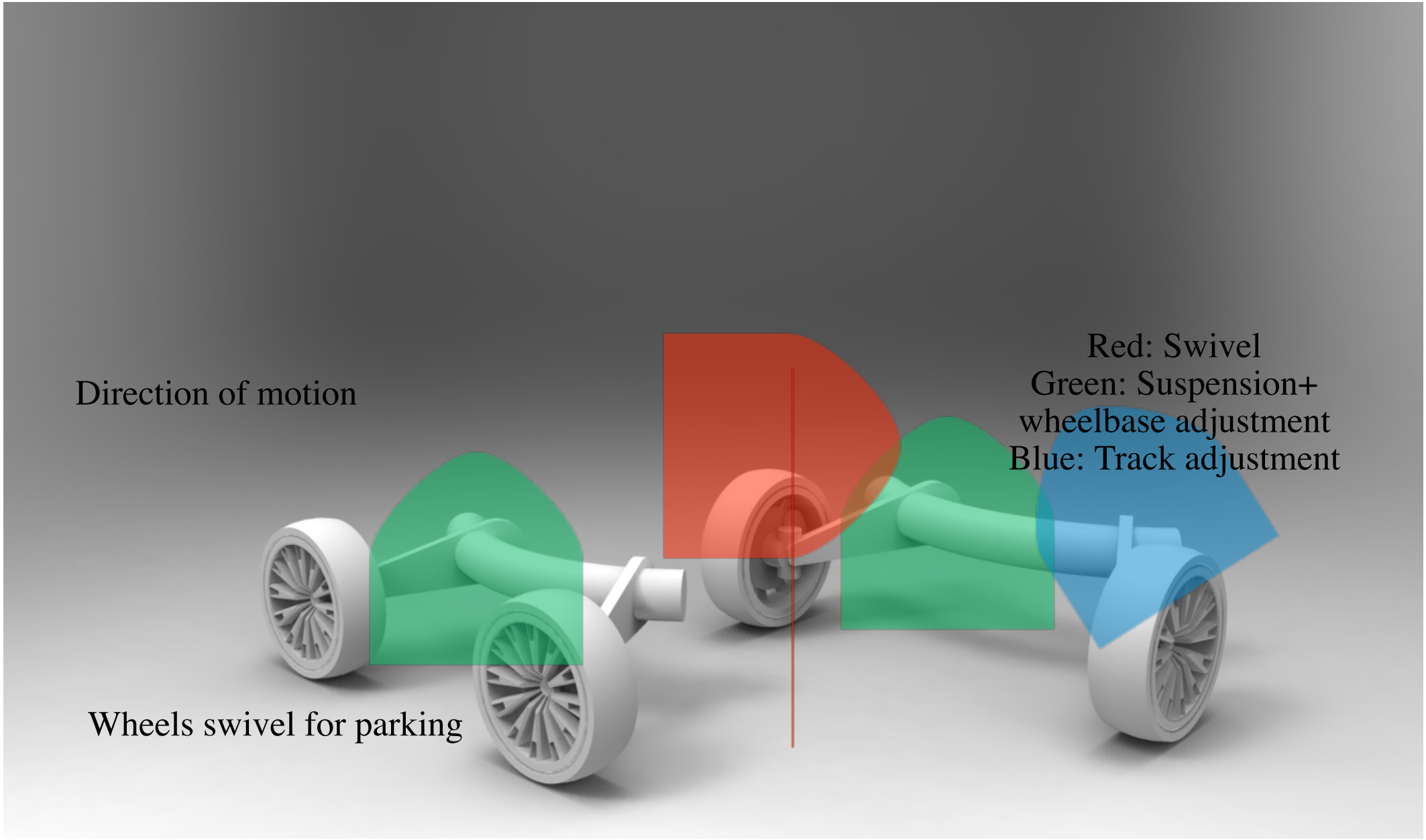
1. CAM operated rear wheel



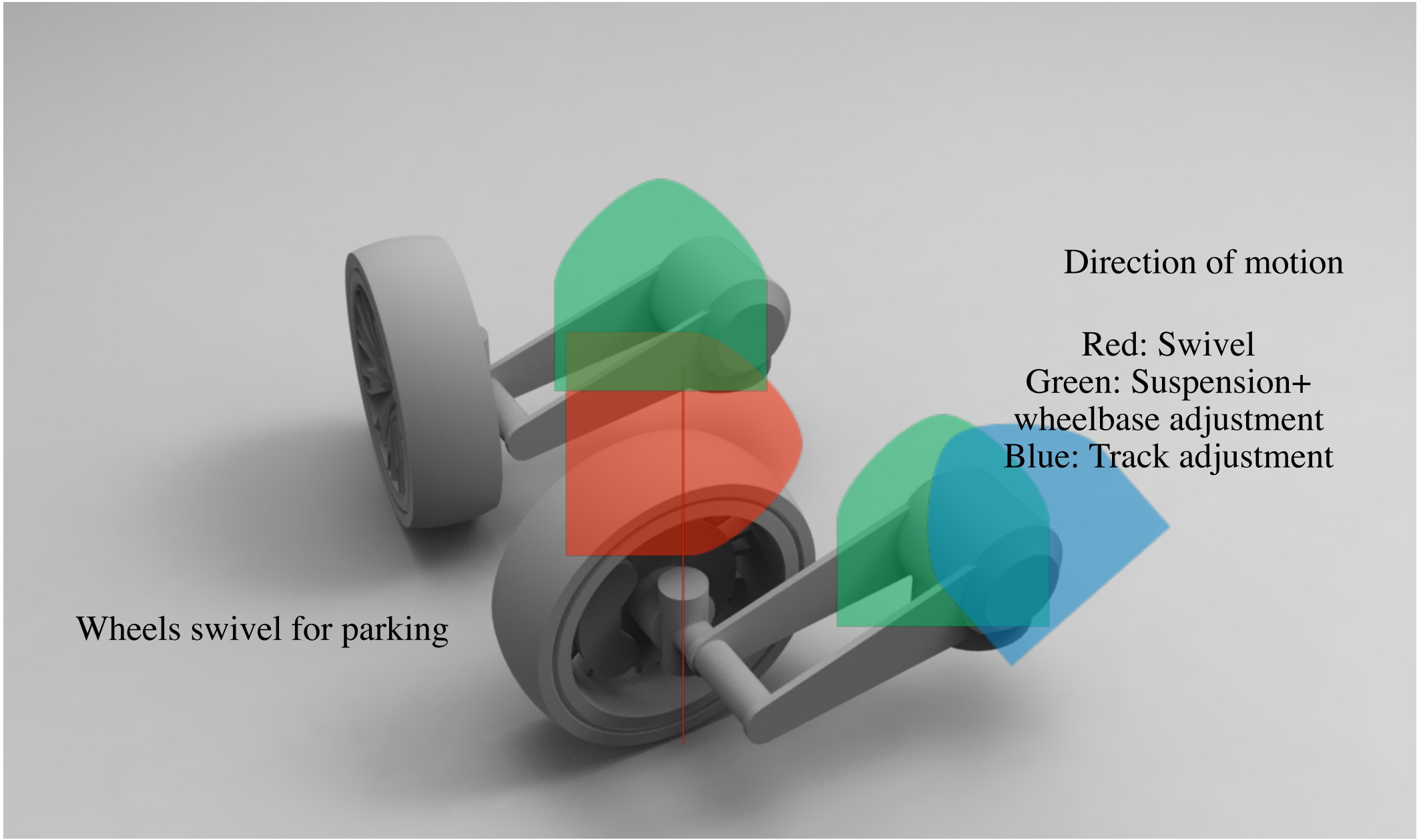
Two positions of
Front wheel
Normal and parked.

Three positions of the rear wheel
Parked, Normal, Extended.

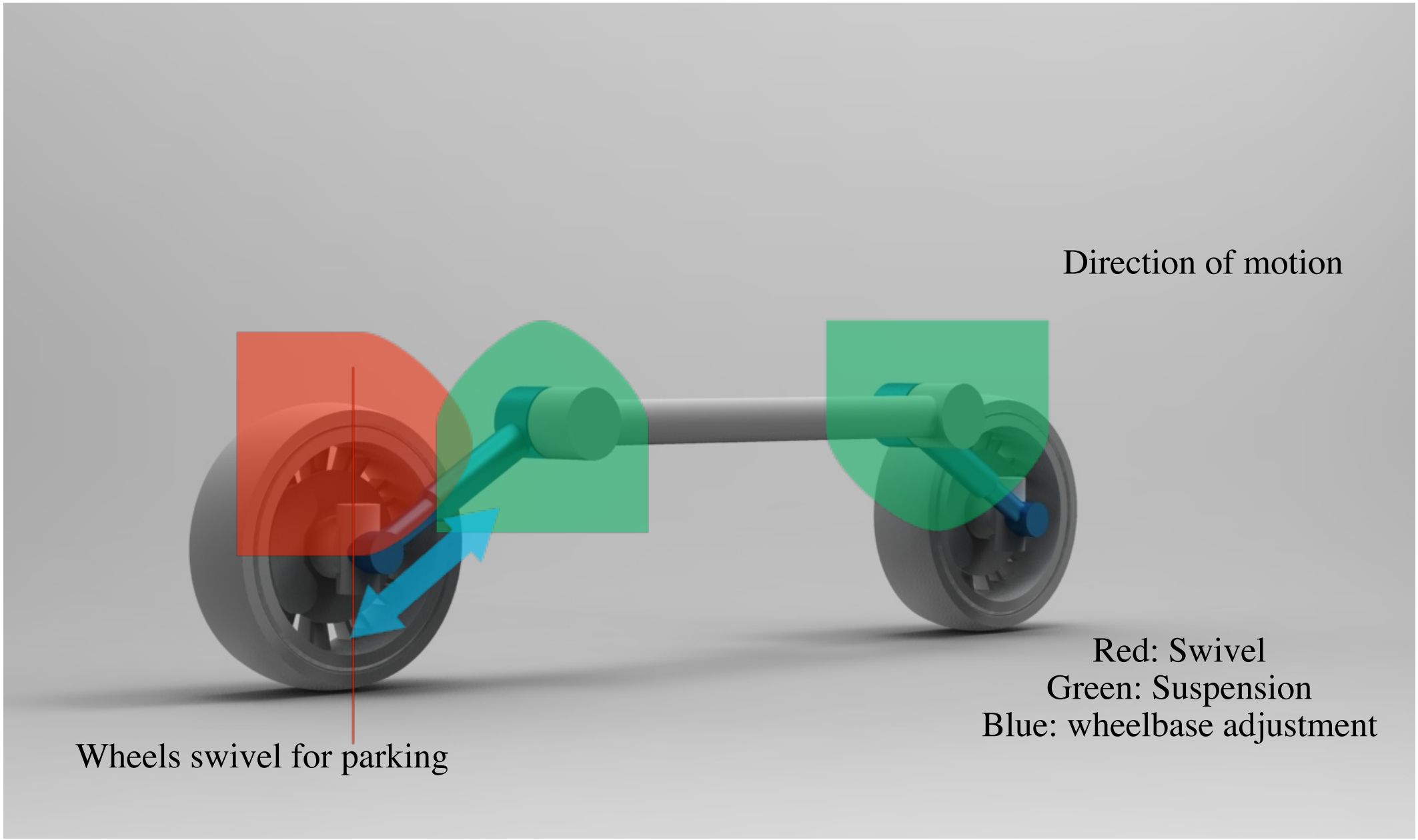
2. Cylindrical chassis moving arm configuration



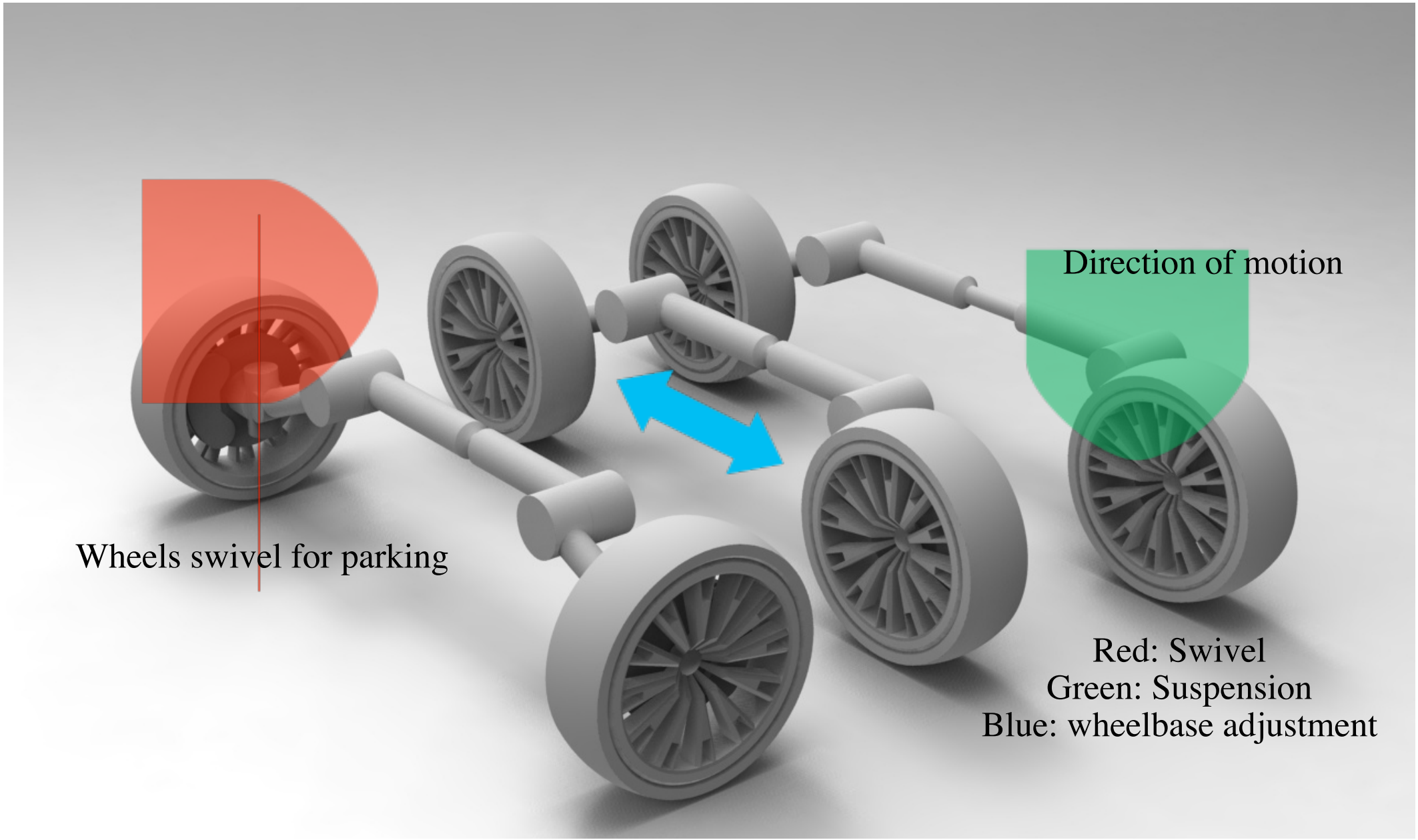
3. Independent wheel assembly



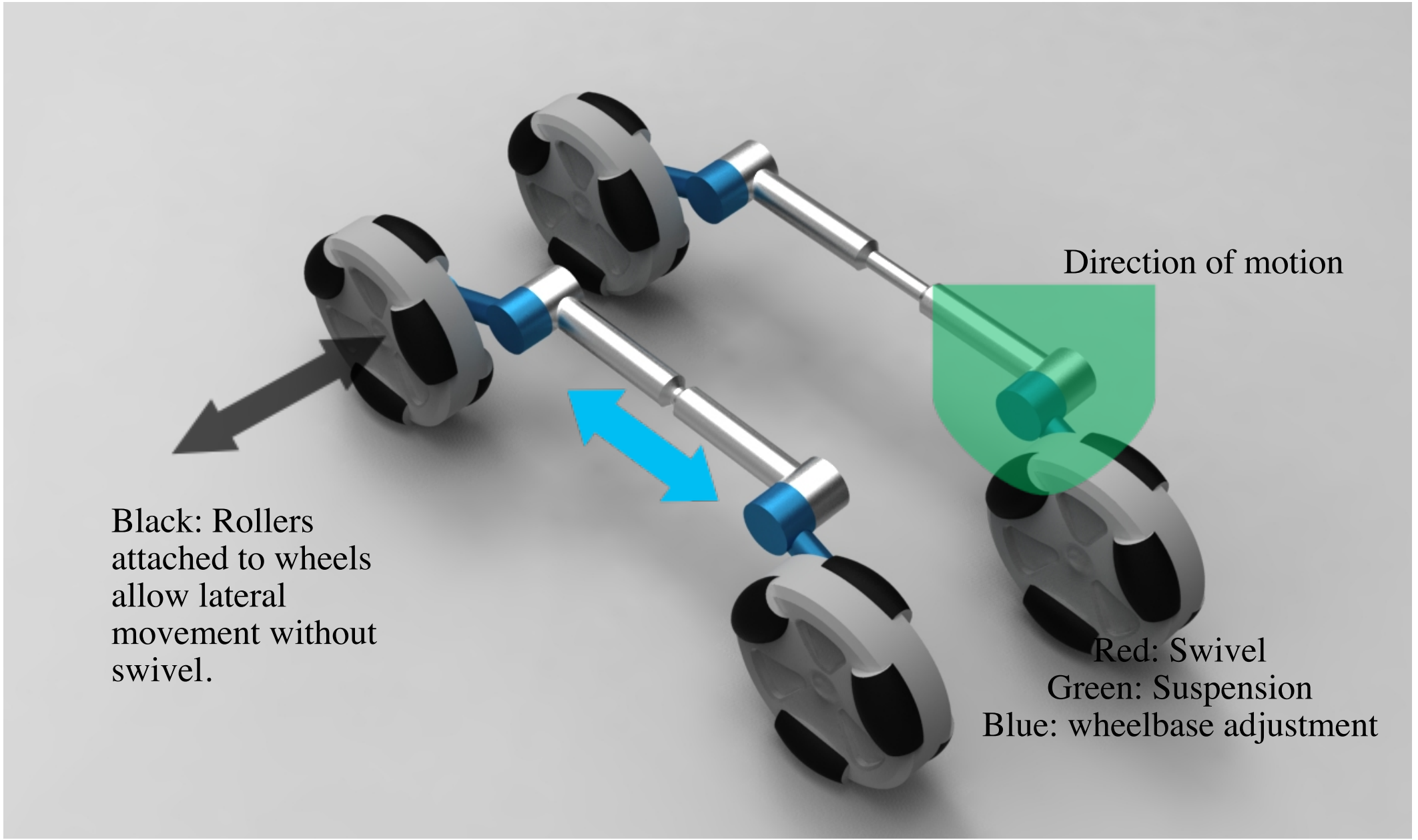
4. Rigid beam telescopic arm assembly



5. Telescopic beam rigid arm assembly

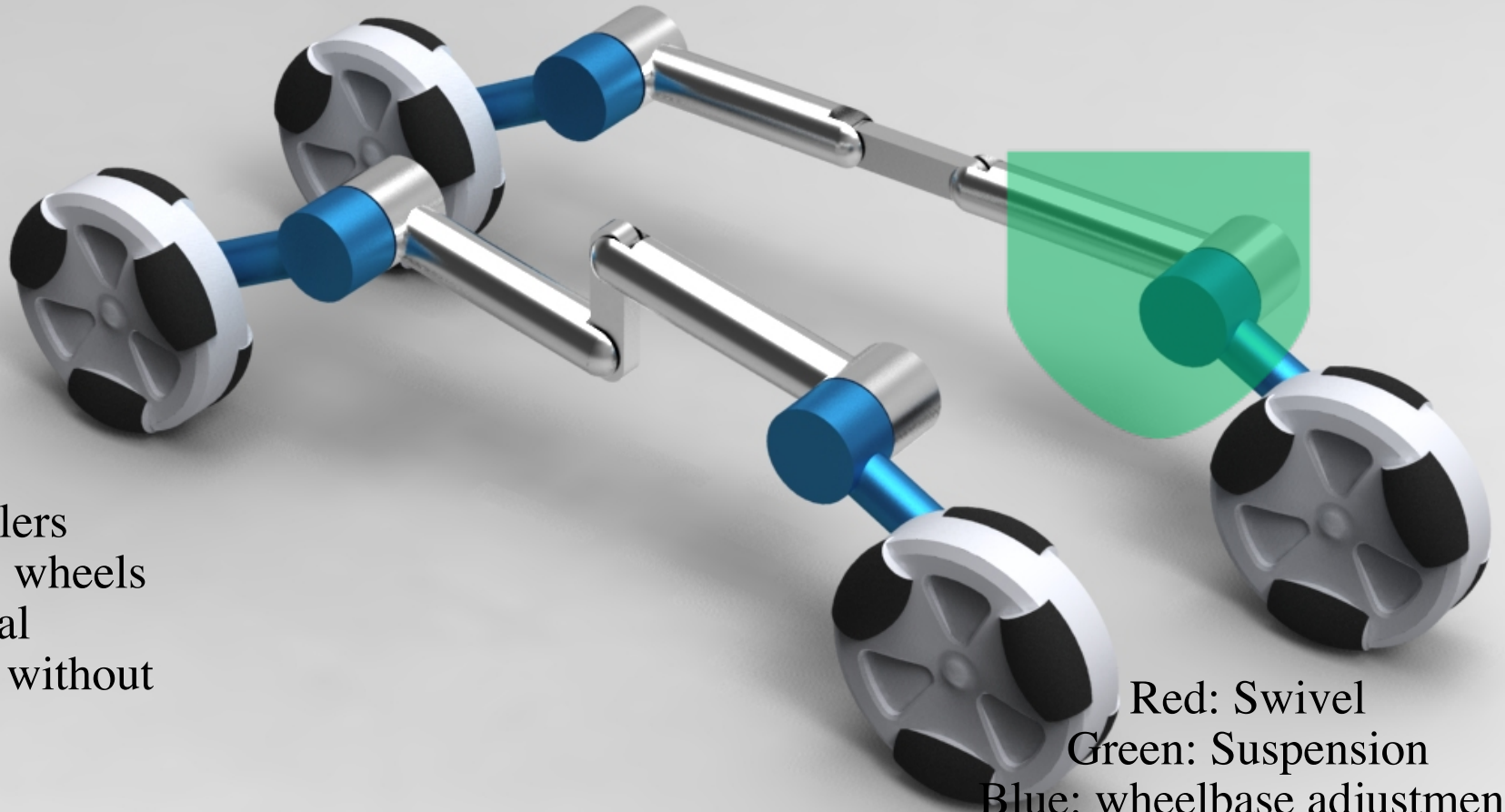


6. Telescopic beam rigid arm roller assembly



7. Folding beam rigid arm roller assembly

Direction of motion



Black: Rollers attached to wheels allow lateral movement without swivel.

Red: Swivel
Green: Suspension
Blue: wheelbase adjustment

Mechanism Evaluation Criteria

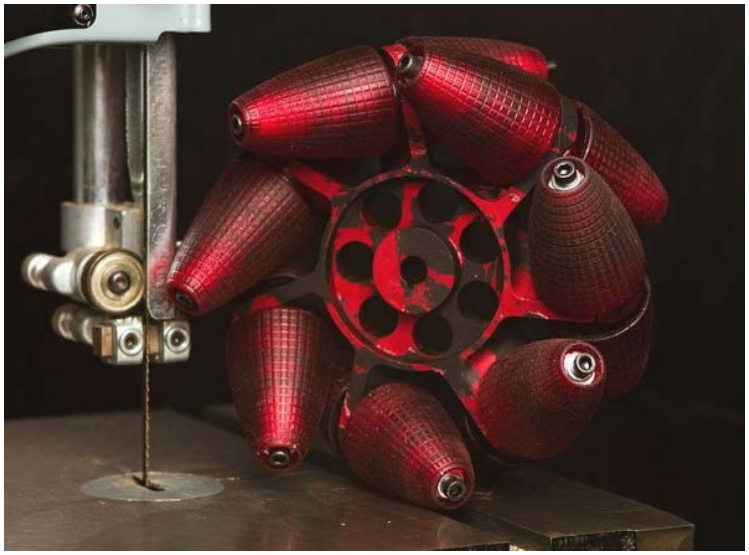
The Mechanisms were evaluated based on the following criteria.

- Strength
- Safety
- Ease of parking
- Construction
- Weight
- Independence of operation
- Space required for operation

Mechanism Evaluation

Criterion/ Concept no.	Strength	Safety	Parking	Construction	Weight	Independence [G.C., W.B. & T.W.]	Working joints	Space required	Total
1	1	1	3	1	3	3	1	1	14
2	3	3	2	2	1	1	2	1	15
3	1	1	2	1	3	2	1	2	13
4	2	3	2	3	2	3	2	2	19
5	2	3	2	3	2	3	2	2	19
6	2	3	3	2	2	3	3	3	21
7	2	3	3	2	2	3	3	1	19

The wheel



The Mechanum wheel

The Tri-bot wheel

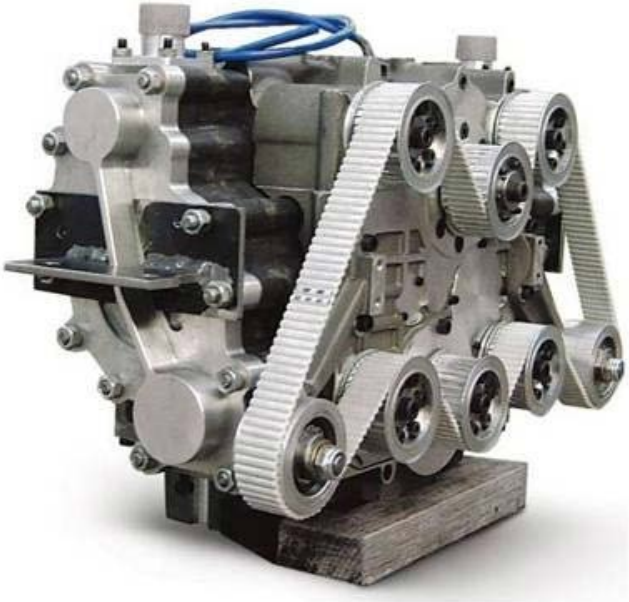
The omni-directional wheel

Section II: Technology.

b. Power sources

Clean, silent, High grade energy.

Cost, P/W ratio, Limited Range



Cheap, Zero Pollution, Reliable

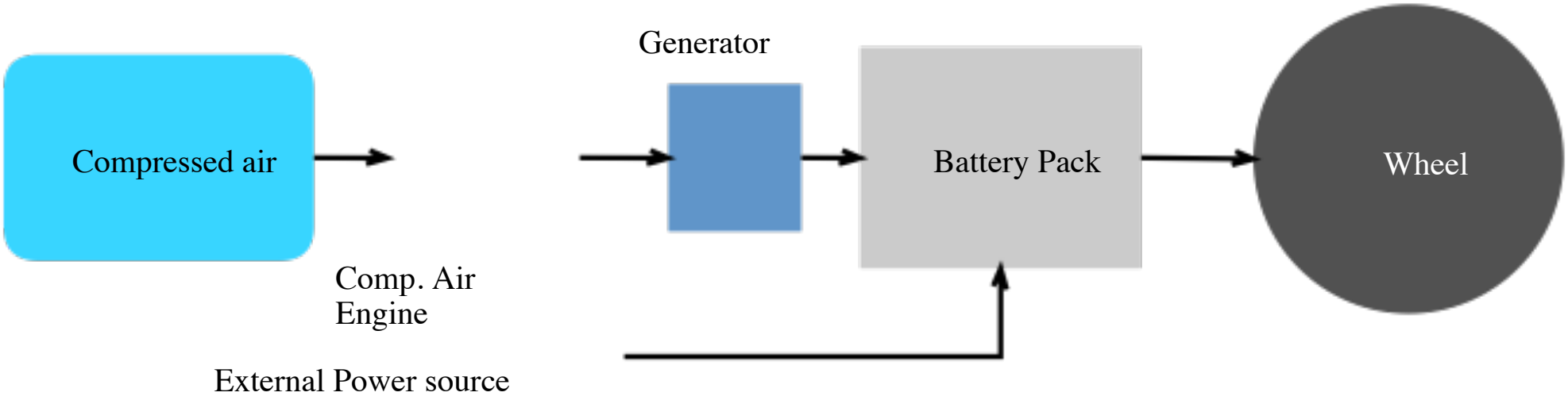
Bulky construction, Noise, Heat

High grade, Zero Pollution, No running cost

Cost, Efficiency, Uncertainty

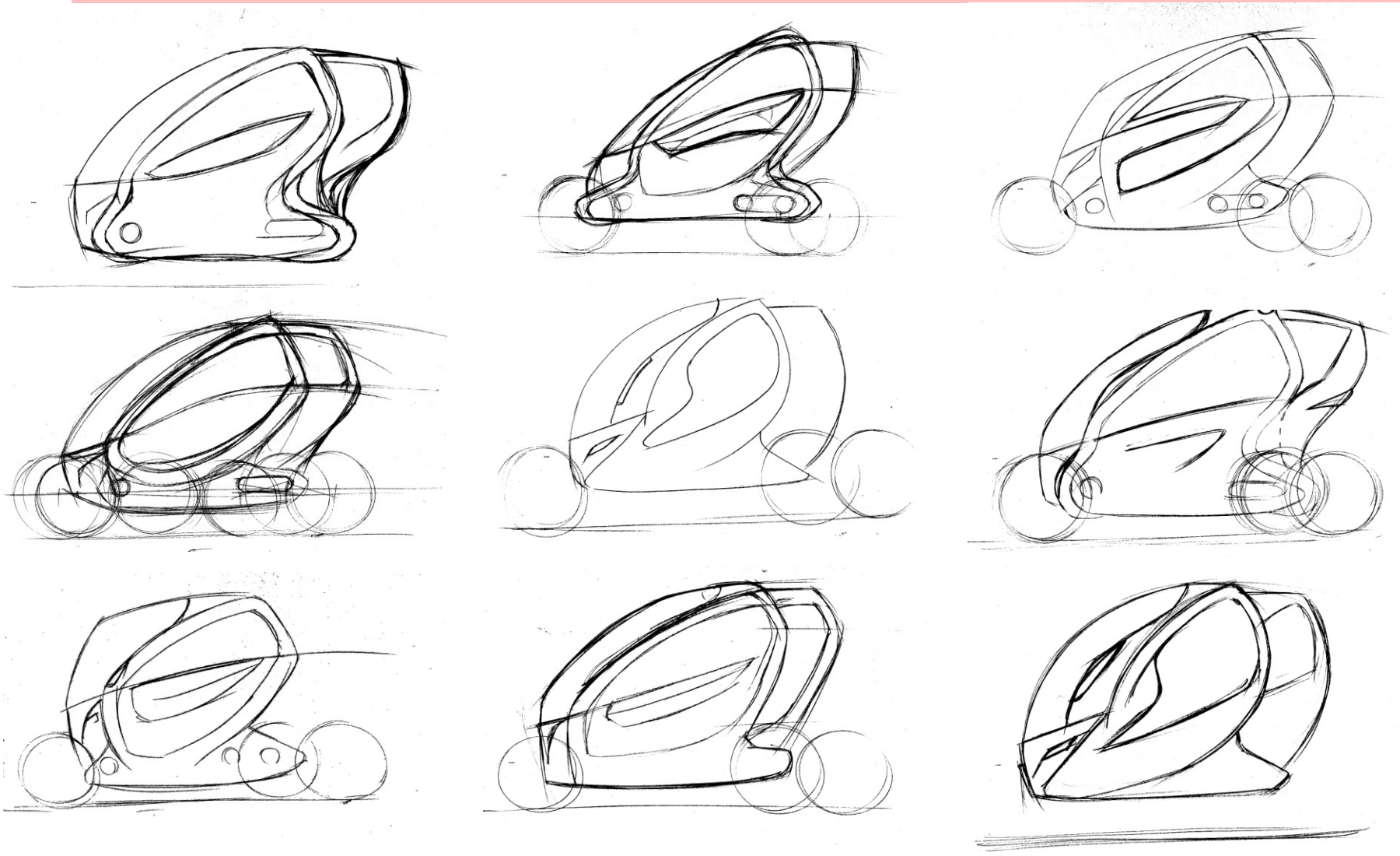
Suggested power source

- The benefits of the Guy Negre's air engine and the battery storage can be combined by connecting them in series hybrid mode..

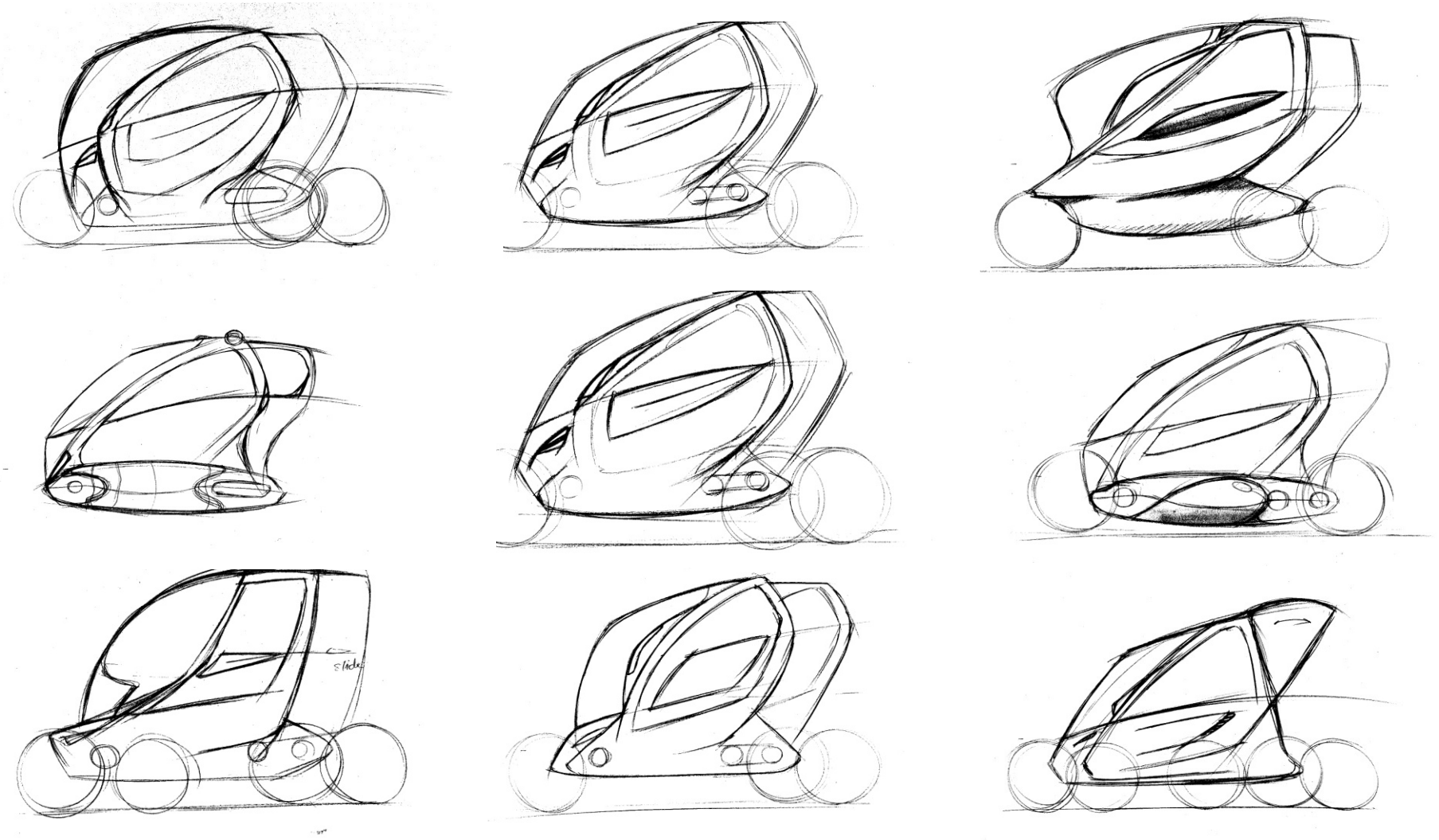


Section III: Aesthetics.

Form Sketches



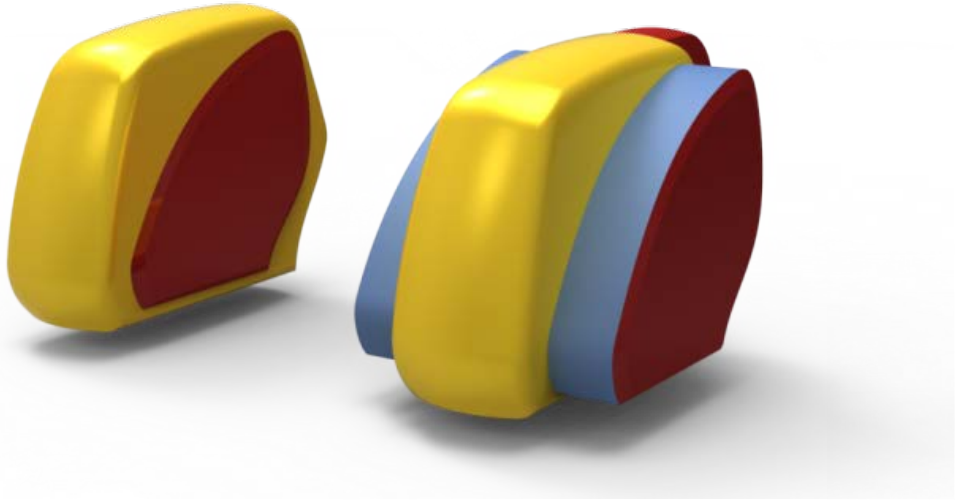
Form Sketches

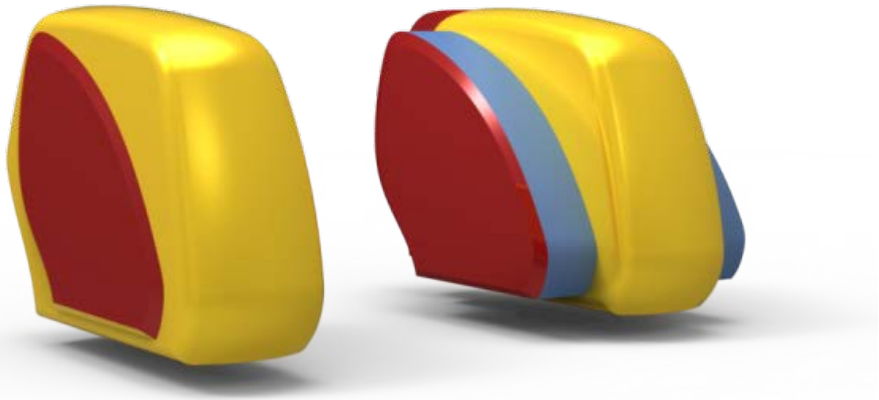


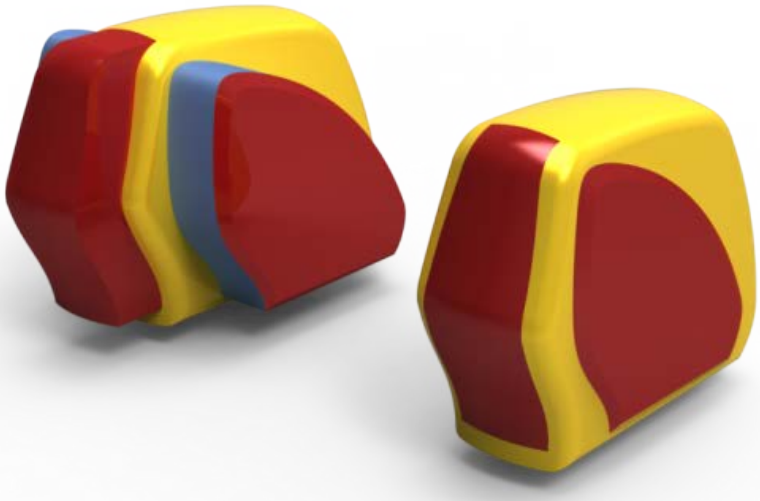
Form

- Form of this vehicle was highly dynamic.
- It was going to change the dimensions as per the number of occupants.
- So the method of static form decision was to be replace by 3D form ideations.
- Based on the ideas from the sketch, some basic 3D forms were created.

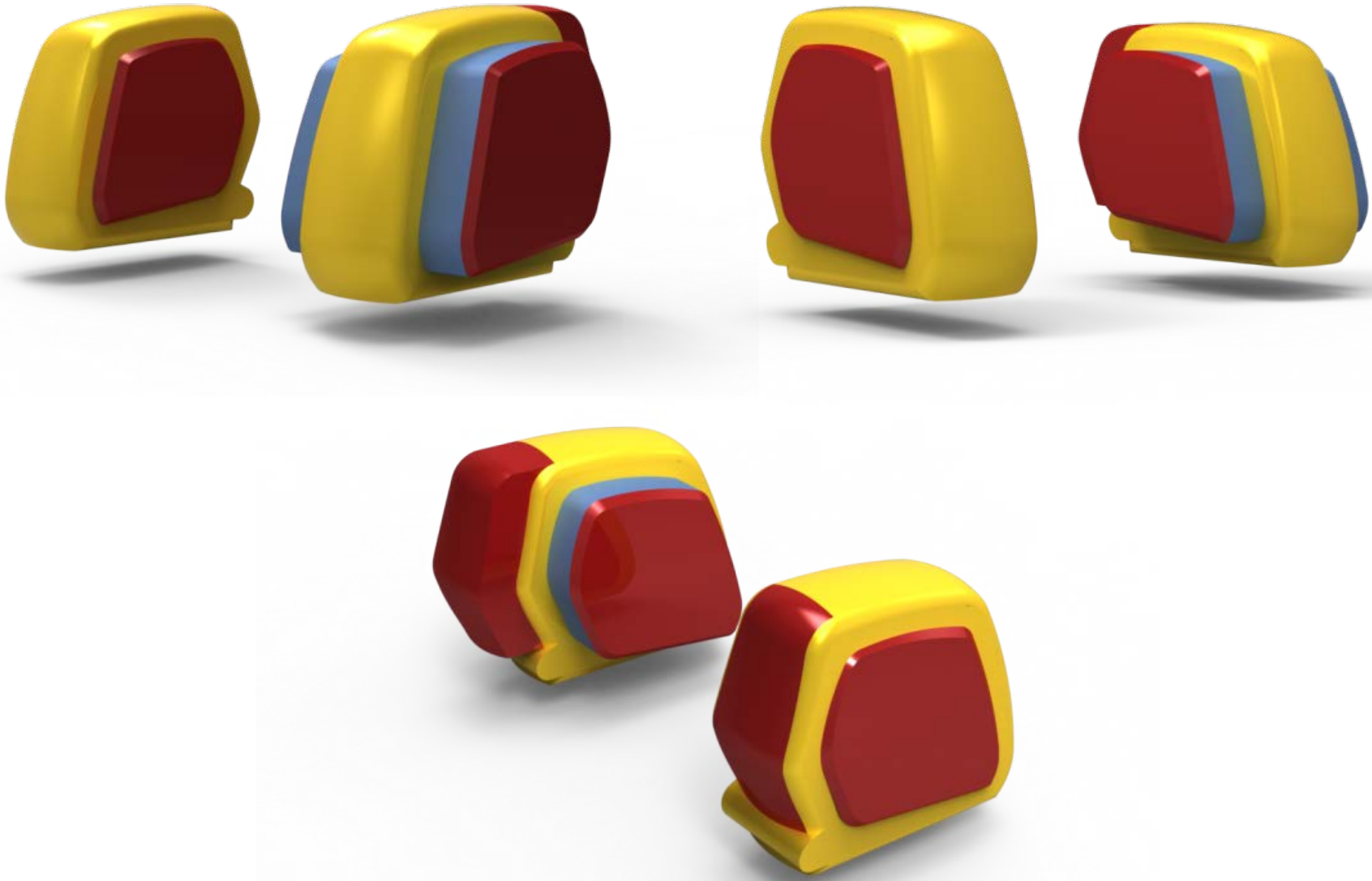
Form Option 1



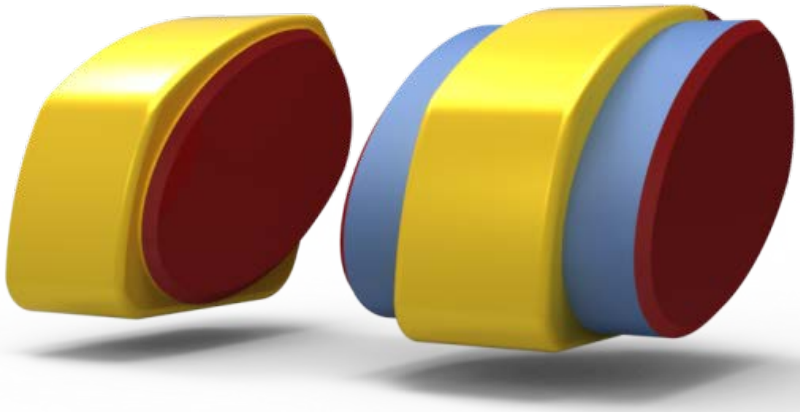


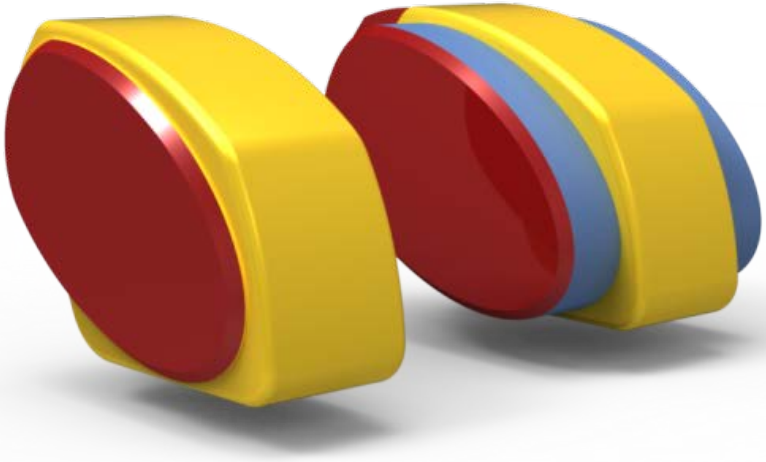


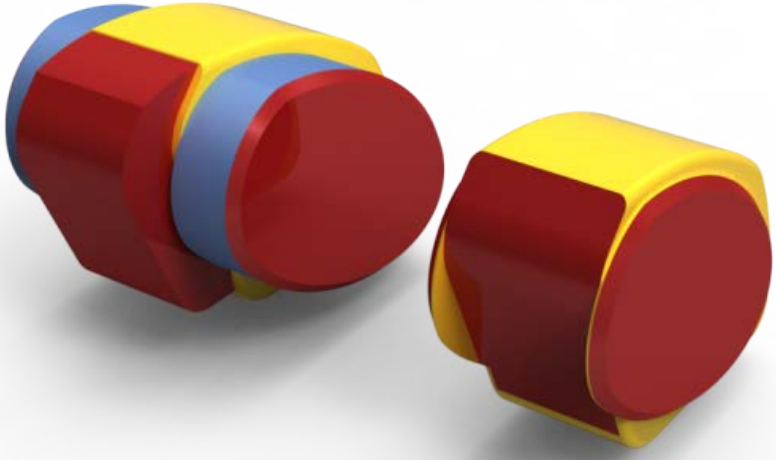
Form Option 2



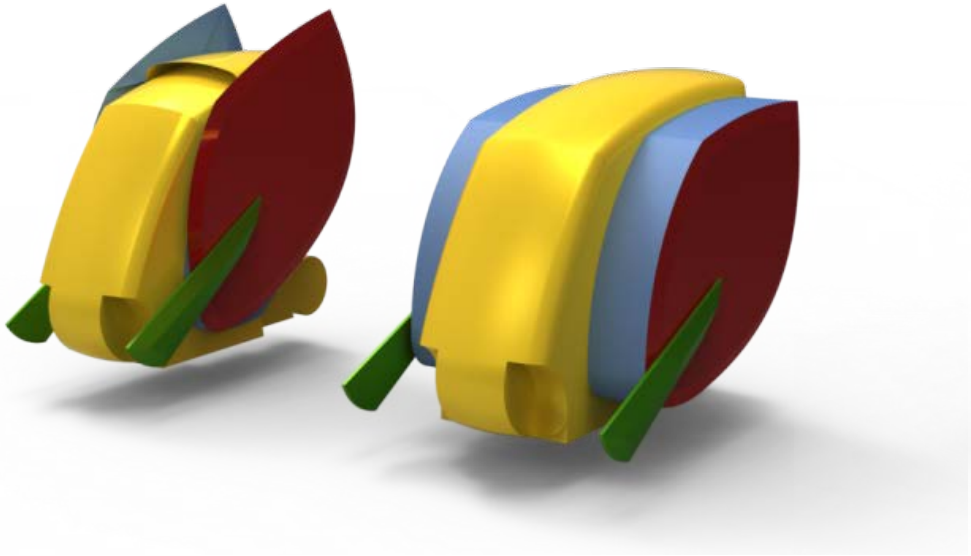
Form Option 3

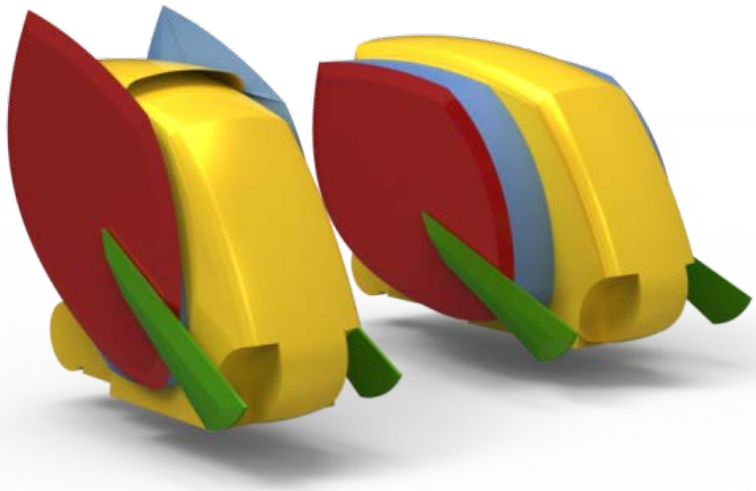


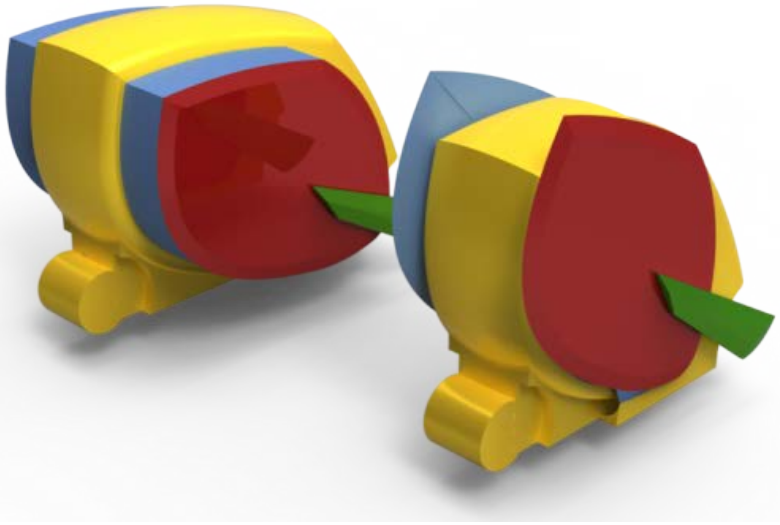




Form Option 4



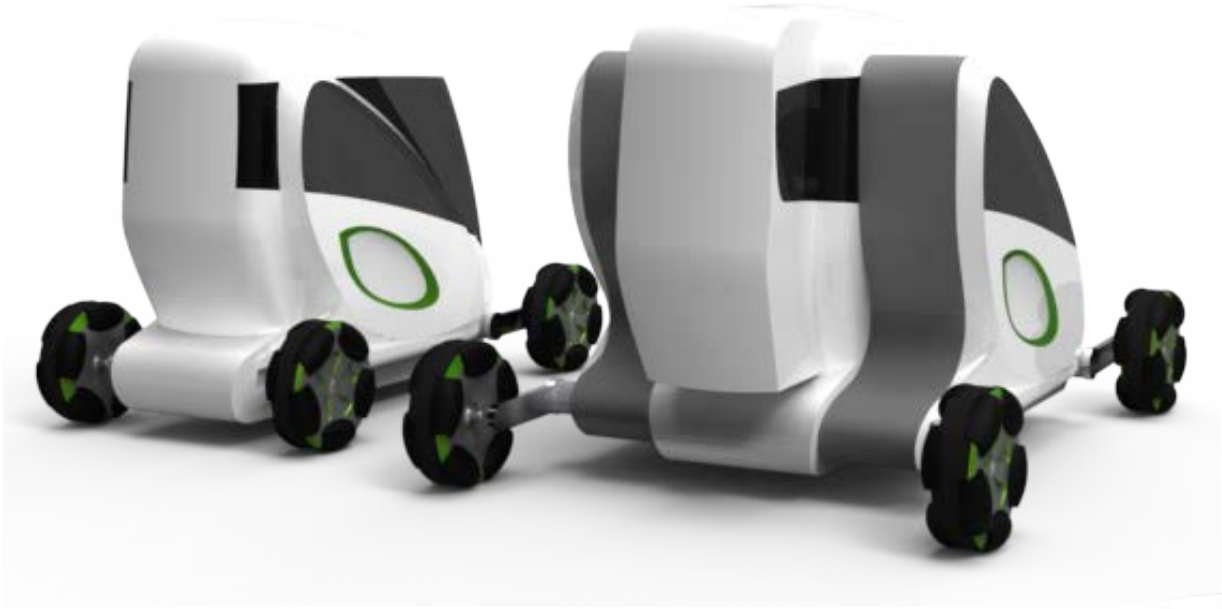




Form Evaluation

- The four selected forms were shown to 10 different people, simultaneously on four different screens, where they could zoom and rotate the objects.
- Based on the votes, form 2 and 4 were taken for further development.

Concept Vehicle 1.



Concept Vehicle 2.

Selection

- Based on the space requirements and form, second vehicle was taken for further development.

Final Concept

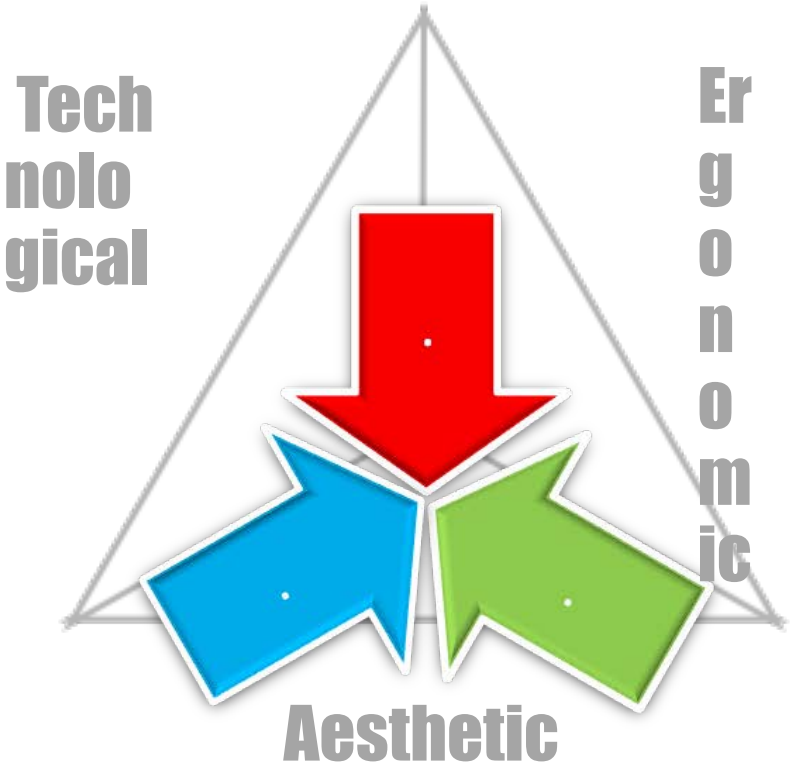
amoeba
The e-SAV

Combining the triangle.

- Dimensions, Layout, mechanisms, space block for power source and form was combined into a vehicle..

Mechanism option 6.

Series hybrid power source



Layout 7

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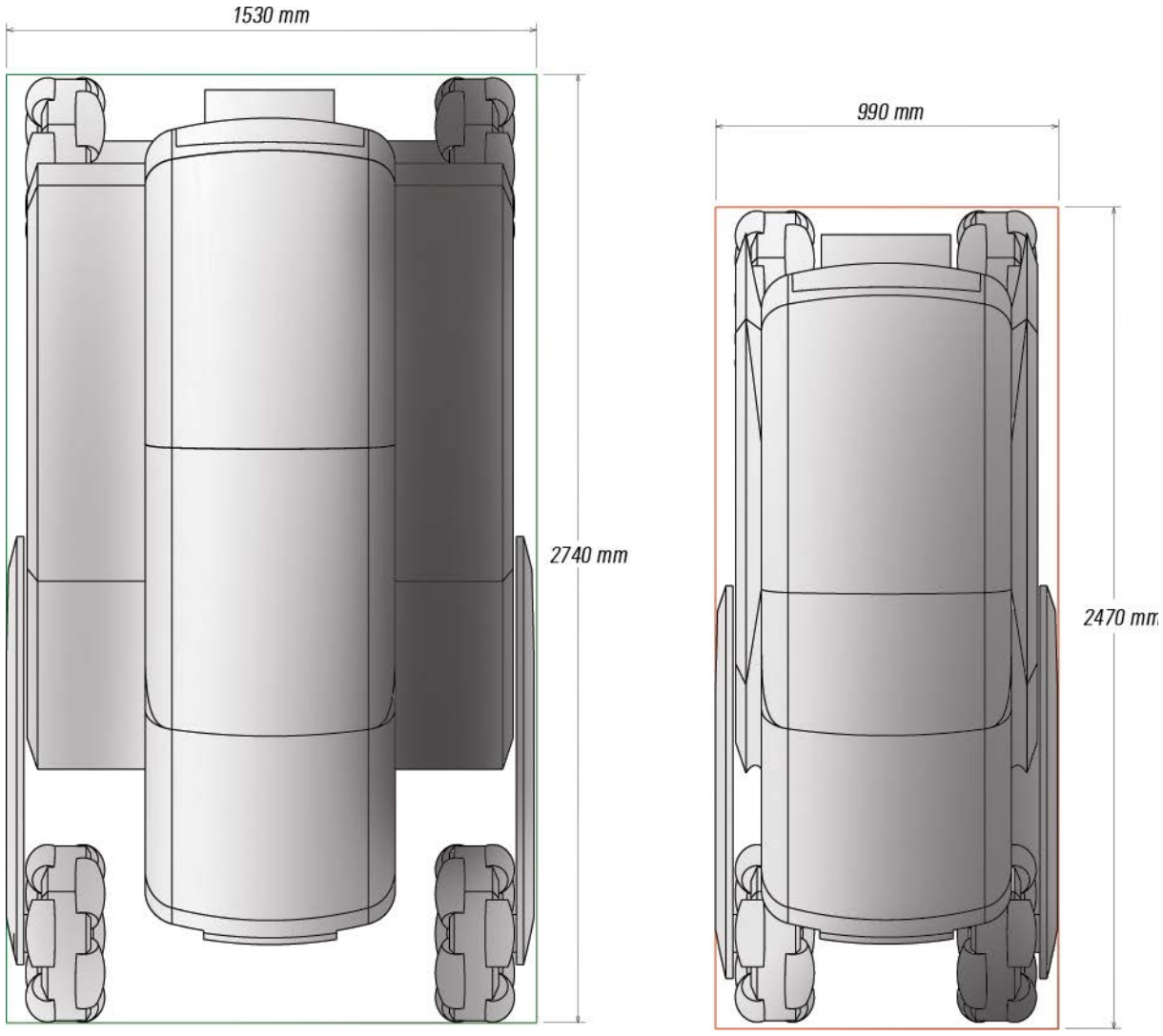
Minimum dimensions of the package

From based on variation 2

Dimensioning.



Footprint Dimensions

Dimensions:

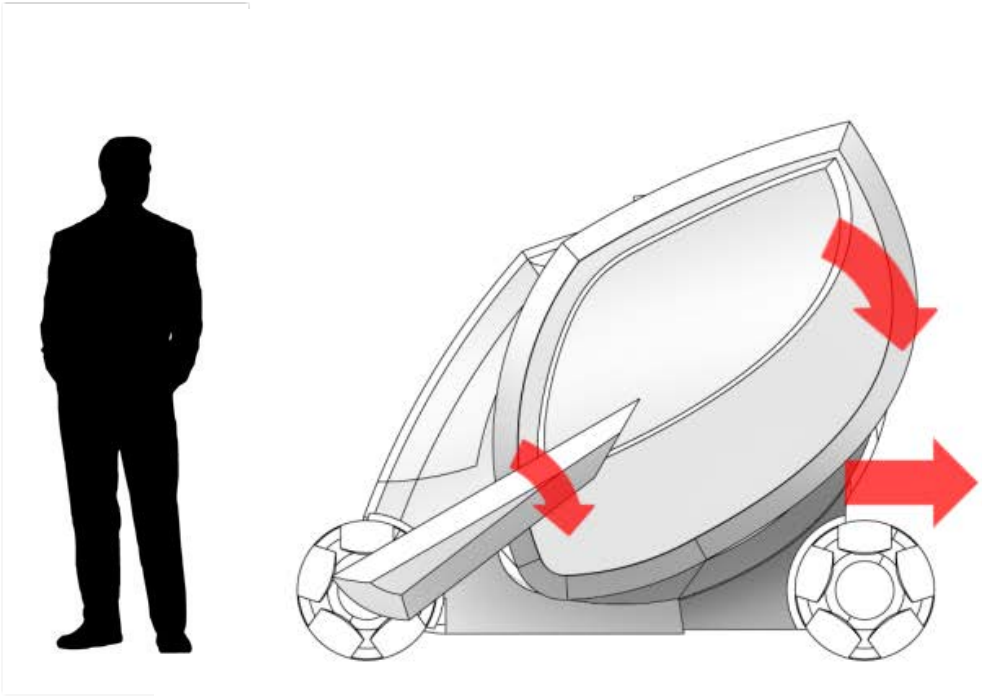
Folded:
2470 mm X 990 mm

Opened:
2740 mm X 1530 mm

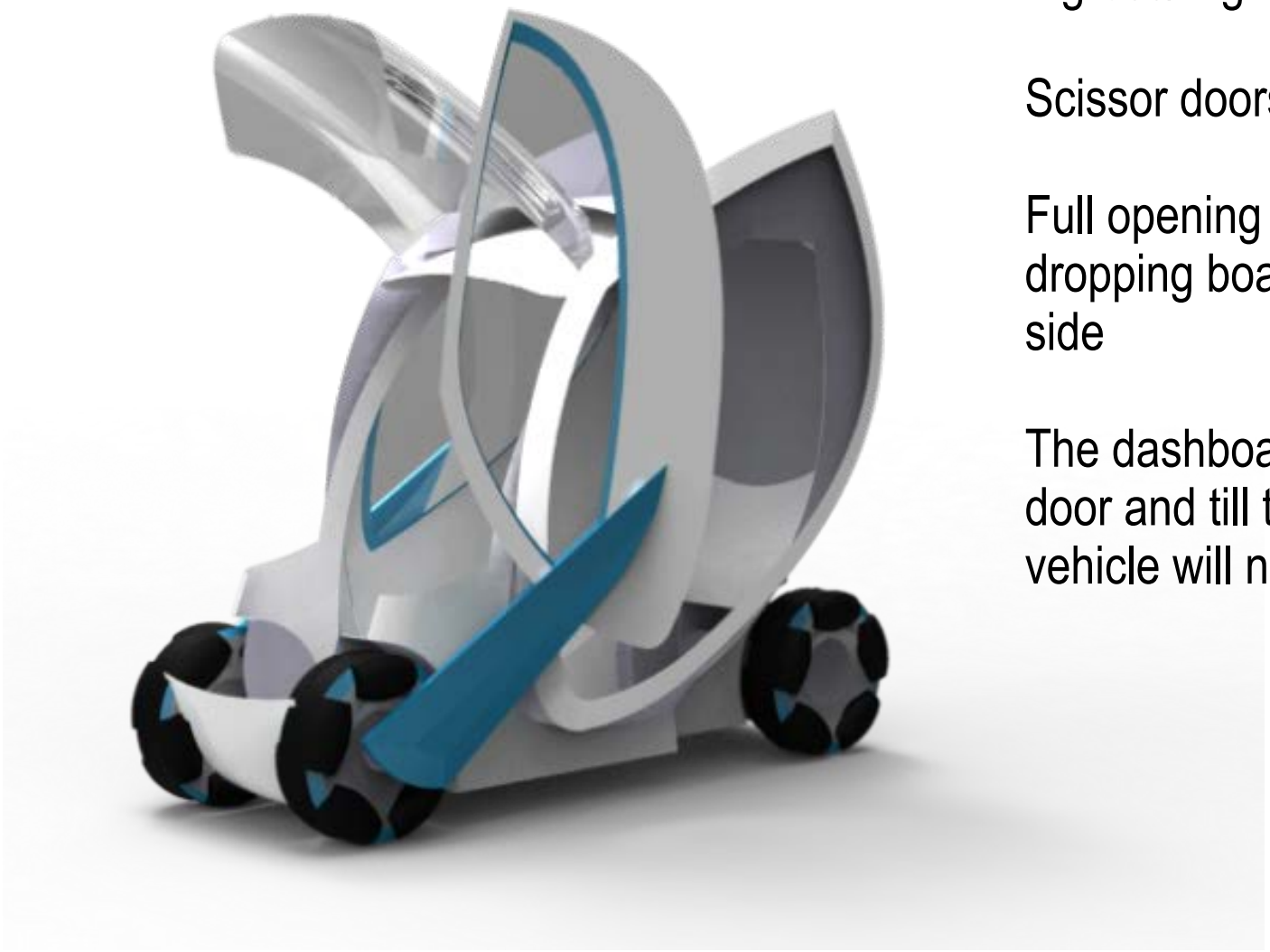
Tata Nano:
3099 X 1495 mm

Smart Electric:
2500 X 1510 mm

Operations.



Ingress/Egress.



Ingress/ Egress:

Scissor doors operate in tight spaces

Full opening front door, along with dropping board allows access from front side

The dashboard will be connected to front door and till the door is closed, the vehicle will not be functional.

Thank you.