Design Of Solar Powered Vehicle

Project –III

Industrial Design Center

IIT Mumbai

Guide:

Prof. U.A .Athavankar

Rajat Shail Singh

Introduction – “The Solar logic”

The greatest problem that faces the world today is **Global warming**. It is more apparent here in India than anywhere else , specially Rajasthan where temperatures over the last few years have risen from 32deg C to 36deg C to last summer of 42deg C to 46 deg C.

Renewable Energy

The principle forms of renewable energy suitable for places which lie in the tropics is the wind and solar energy. The solar panels seen on the roof tops are usually for producing hot water and should not be confused with those used to produce electricity which are photo voltaic panels. They are made of 2 thin plates of silicon containing slight impurities which when exposed to sunlight experience a stimulation of electrons. If positive and negative terminals connected by a wire are added, as in a battery, the electrons will flow round the wire producing electricity.

The Process

1) Preliminary **data collection** of the existing solar technology and its analysis.

2) Assessment and locating suitable applications and **niche areas** for the technology.

3) Comparing different **applications zones** and locating the most probable areas where a four wheeler vehicle with the respective technology will work.

4) Identifying the **existing vehicles** and their characteristics in these selected scenarios for which the vehicle has to be designed.

5) **User study** through scenario building in the areas where the vehicle is to be used.

6)Developing a design brief.

7)Basic anthropometric requirements and an ergonomic study.

8)Initial ideation and concepts .

9) Visiting the engineers and the fabricators in udaipur and discussing possibilities with structure and details.

10) Concept generation.

-over all form

-structure

11) Form exploration through semantic study of the object.

12) Final concept selection and variations.

The Solar Rickshaw

The introduced prototype and its features are as follows:

1. Self sufficient on solar energy
2. Capable of a speed of 25- 40 km/h.
3. Capable of climbing up hill on an average inclination of 15deg to 30 deg.
4. Seat 4 people.

Individual Constituent parts Of Prototype

Solar panels- 85 Watt BP solar panels placed on the roof and

Motor- Lynch motor, which offers the best efficiency greater than 90 % and has a weight of only 9 kgs. At 12 Volts the motor can run at 2.5 KW aprox 4 HP

Batteries- The batteries mainly store the excess power from the solar panels to give backup for night hours use. They also supply the initial torque to start the motor. The batteries are 2 x 12 Volt Exide sealed traction, deep discharge batteries.

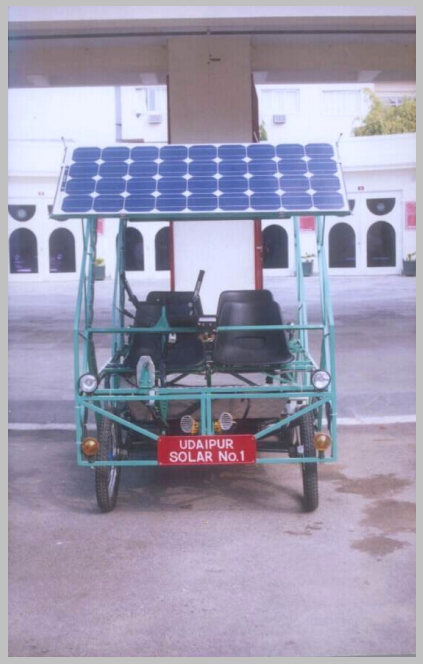
Solar Controller- The Solar controller is like a fuse which regulates the current from the panels to the motor.

Running gear- Bicycle wheels with spokes have been used and on later versions stronger wheels will be used. A differential is incorporated in the back axle and 3 speed Strumy archer gears used in the drive system.

Brakes Hydraulic disc breaks are fitted to all 4 wheels.


UDAIPUR
SOLAR No.1


UDAIPUR
SOLAR No.1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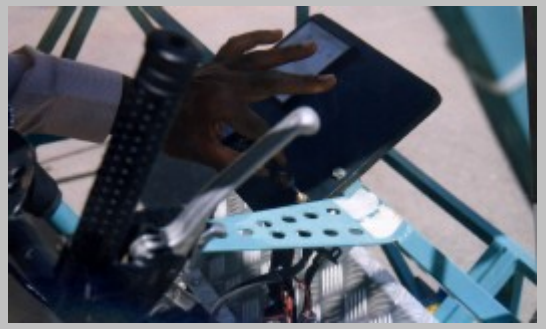

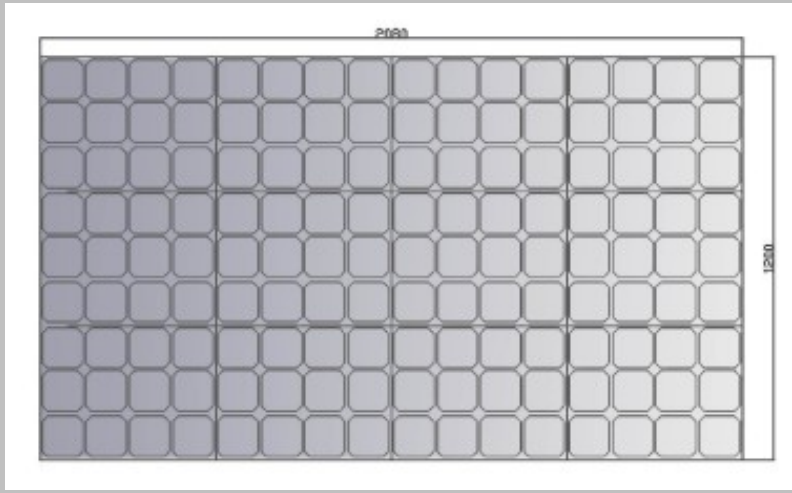
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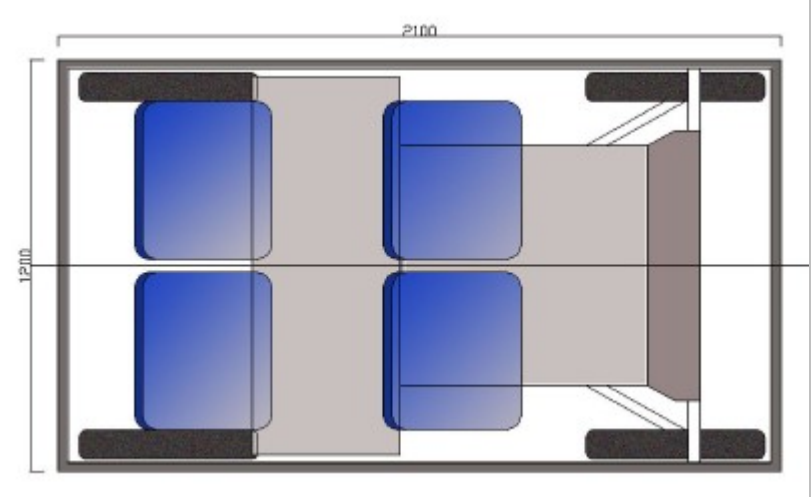
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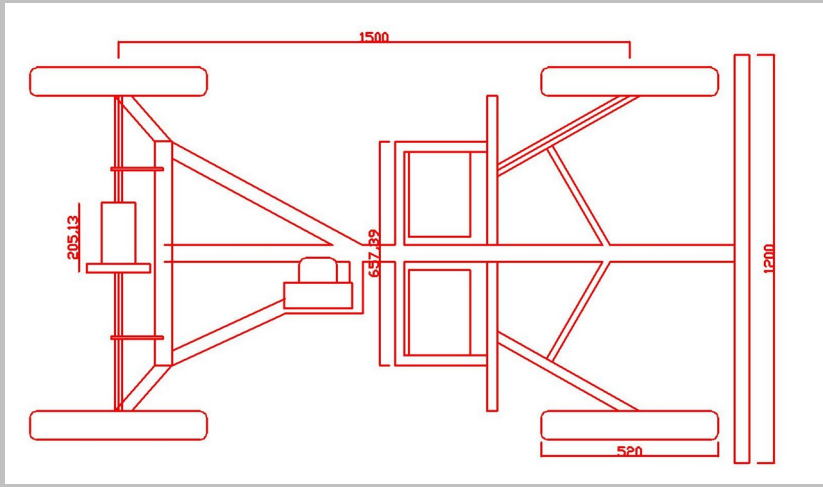
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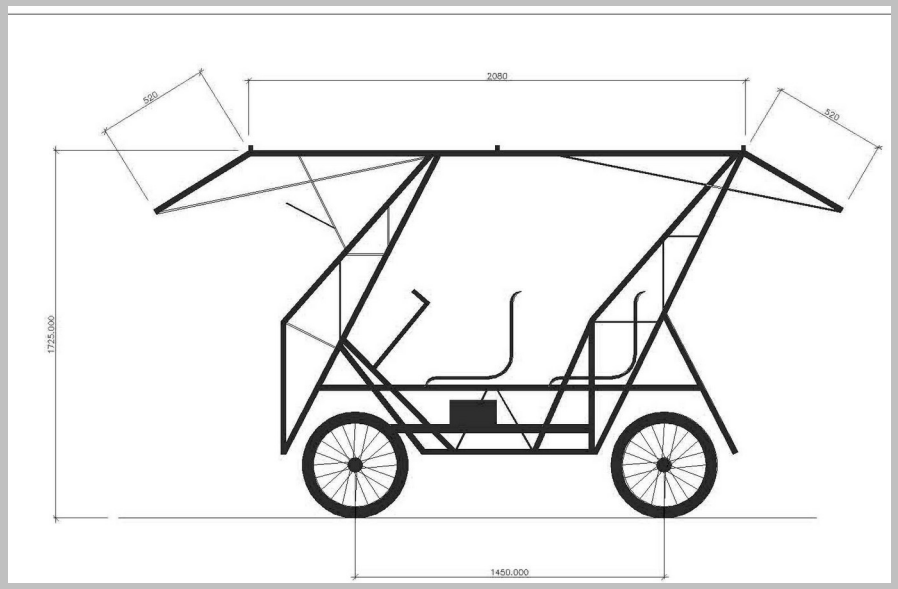
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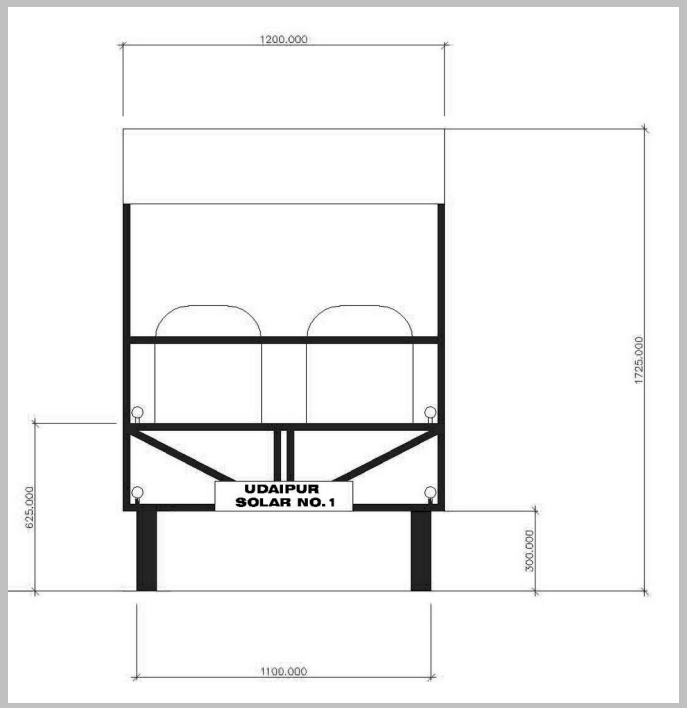
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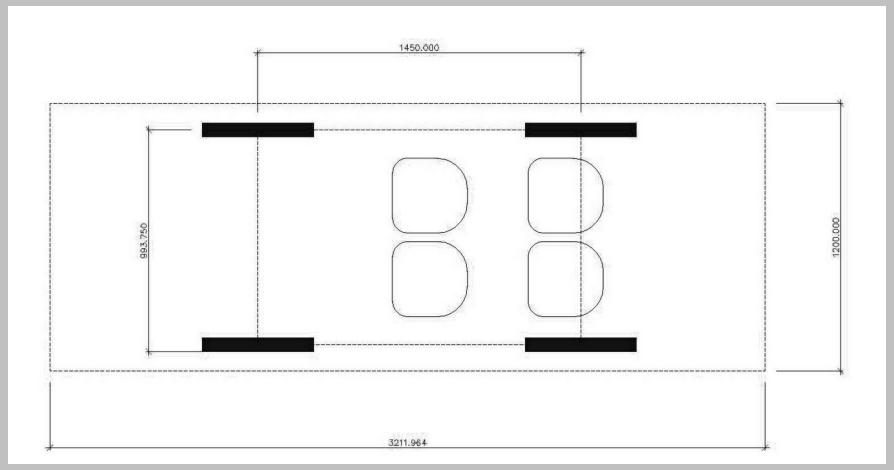
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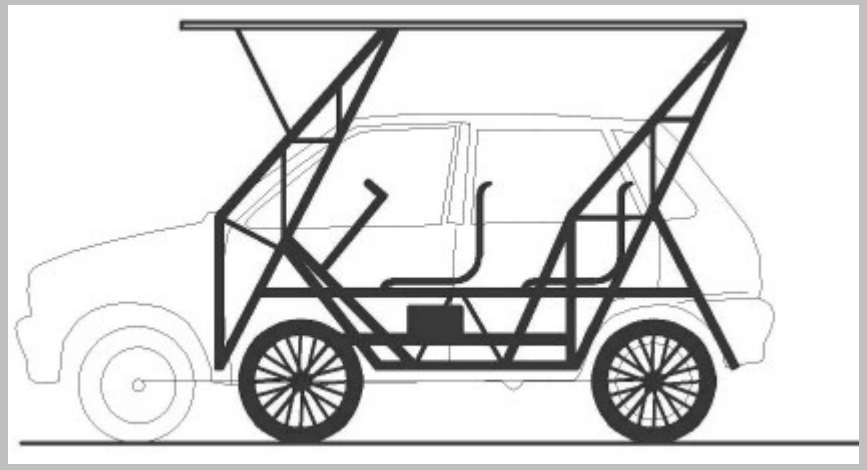
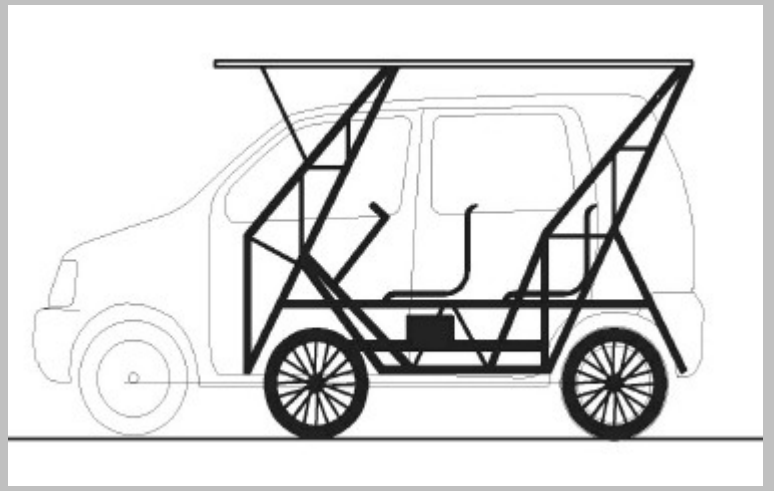
Size comparative with Maruti 800 and Wagon R





Design Criteria for Improving Solar Rickshaw as proposed by the client.

1. Ideal balance between weight and **stability**.
2. Seating to be **more comfortable**.
3. 18" of room between seat and floor.
4. Wider wheels for more stability.
5. Better suspension.
6. Efficiency of motor suitable for higher gradients.
7. **Aero dynamic** body
8. Road clearance
9. Passenger cover for monsoon
10. Seat belt and safety features.

Comparative study between traditional Auto rickshaw and Solar rickshaw.

<u>Specifications of Traditional Auto Rickshaw</u>	Rs 85,000
-Capital cost of Auto Rick shaw (including insurance and registration).	Rs 31/lt
-Petrol cost	
-Average mileage of each Auto Rickshaw when new (A)	24km/lt
-No. of hours each Auto runs in total on an average (B) mostly daylight hours	6hrs/day
-Average speed of an Auto (C)	30km/hr
-Total consumption of petrol (B) x (C) / (A)	7.5lts/day
-Total cost of Petrol for each Auto	Rs 232.5/day
<u>Solar Rickshaw</u>	
-Approximate Capital Cost of Solar Rickshaw	Rs 2,00,000
-Avoided costs of fuel per solar rickshaw	Rs 232.5/day
-Total fuel cost avoided in one year through one solar Rickshaw	Rs 85, 862.5

-If in 3 years a market penetration of 50,000 vehicles is projected this translates into a fuel savings of rs 424.3 carore

Comparative between petrol/diesel operated vehicle and solar vehicles

Petrol/Diesel Vehicle

-High fuel costs-approx Rs 232.5 per day per auto

-High maintenance

-High annual CO_2 emission- roughly 7 tons/vehicle

-Severe noise pollution

-Regular increase in fuel prices

-Most estimates are based on ideal conditions but as vehicles age and adulterated fuel, efficiency decreases.

Solar powered Vehicles

Zero fuel costs

Low maintenance

Zero noise pollution

Does not get affected by inflation in fuel prices

No possibility of adulteration

Constant research on solar panels is providing more efficient conversion ratios which would lead to further improvement

Entitled to CO_2 emissions credits in accordance to Kyoto Protocol.

Possible application areas

- Intercity public transport
- Inter Airport
- Inter campus-Academic, Industrial e.g. Godrej , Infosys, Maruti
- Safari parks
- Amusement parks
- Zoos
- City tours
- Golf buggies
- Surveillance
- Large span exhibition areas e.g. Pragati Maidan
- Inter village Info kiosks
- Mobile telephone booths
- Mobile banks
- News paper kiosk

Application selection-

Incampus- non academic e.g godrej, telco, infosys

Zoos- short trails and bird sancturies e.g sultanpur , borivili national park

Amusement parks- Appu Ghar, Essel world

Exhibition areas

Criteria of selection was based on largest common factors between application needs and vehicle capabilities.

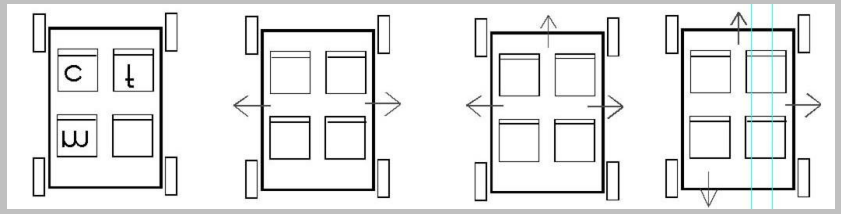
Scenario building and user study.

A. Zoos and Amusement parks

Scenario - 1 couple + 1child (5 years-10years)

Episode 1. Quick stops "easy to get out and get back in"
-To see animals closely
- To take a particular ride
- To use the toilet .
-To buy something (candy floss, peanuts, icecream)

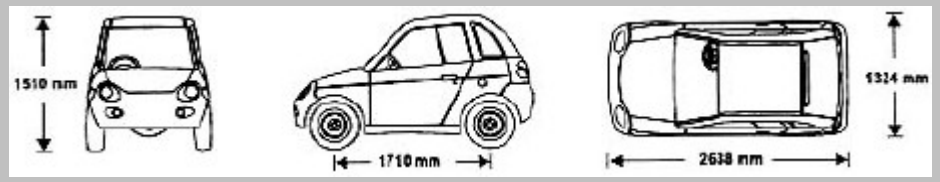
Design Implications
Layout -



- Minimum side paneling , good view of the outside from most of the sides.
- Minimum opaque surfaces.
- Position of seating or standing in which getting up and getting out frequently is easy.
- Enough headroom.
- One step ground clearance.
- Non slippery and sharp edges of flooring(possible nosing or beading)
- " Rightfull " placement of supports and grips (study of postures part of anthropometric study)
Both in motion and static

Looking at similar vehicles

Similarity in function, weight and size (basic dimension), number of passengers they carry .



Design brief

- Technical specifications which are followed from the existing prototype are:
The basic chassis structure with permissible modification in the size of the wheelbase.
Over all mechanics of the vehicle constituting parts like motor, battery, controller and instrumentation remains unchanged.

- **Minimum surface area** of the solar panels to be 2.4 square meters. The solar panels are currently 50cm x 120 cm, they can be broken into 3 parts of 50 cm x 40 cm (each panel containing minimum 12 cells.
-Minimum surfaces and skining.
In order to increase higher visibility from inside to outside.

-**Light weight vehicle**, which means under 350 kg kerb weight to be maintained approximately.
- Designing a solar powered vehicle for locomotion in areas like non academic incampus, entertainment parks, safari parks and exhibition areas, to be used by tourists, middle class families , executives and workers.
-An **ergonomically designed** vehicle to accommodate 4 people.

-Possibility of storage space or collapsible area to generate extra storage floor area.

-**Safety of passengers**
Safety here does not imply emphasis on collision safety rather safety of passenger from slipping due to inertia while moving and breaking and arresting the person in the sitting position if the vehicle topples.

-Strong and distinct visual identity

-Simple interface and minimal interior elements

Basic anthropometrics and ergonomic requirements

Basic antropometric study to create a minimum dimensional requirement for sitting and standing.
Volumetric requirement for batteries instrumentation and other mechanical parts.

Ergonomics –

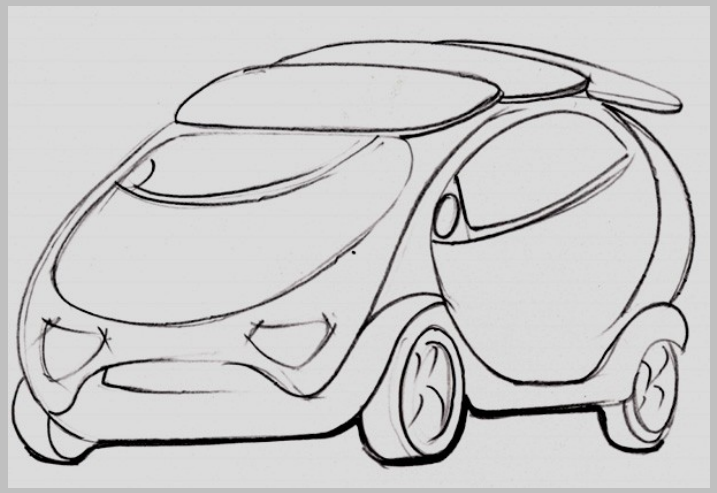
Study of how people sit and how people get in and get out of a maruti versus tall boy like wagonr.

Forces acting on a person while standing in a train or a bus.

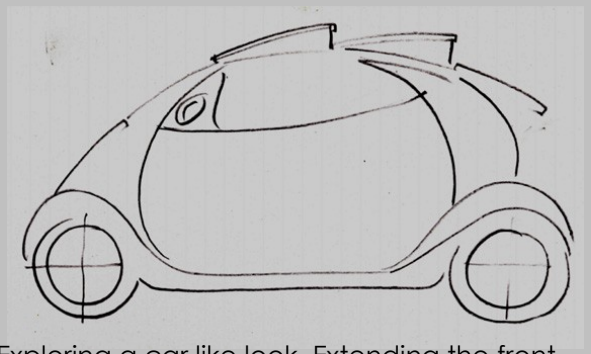
Most comfortable position and dimensions in a half standing position which aids in easier ingress and egress to and from the vehicle.

Supports required to get in and get out and while in motion.

Initial Ideas and images

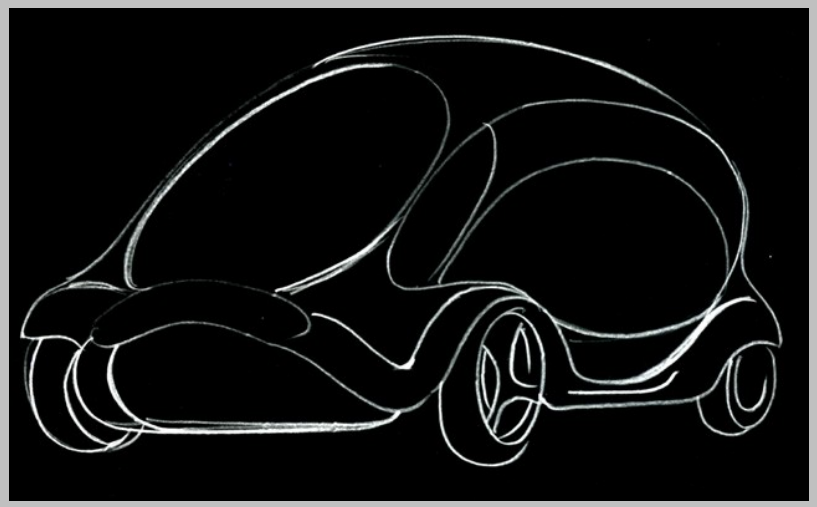


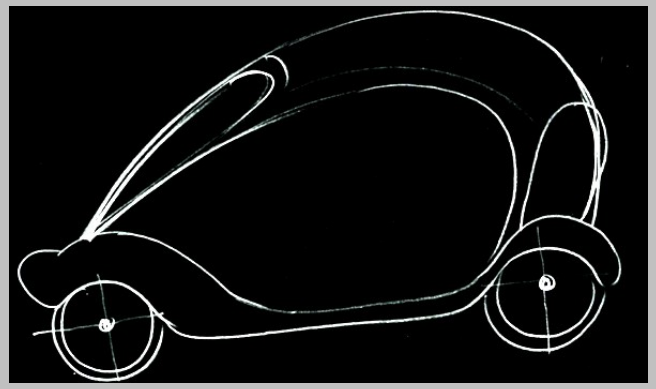
initial ideation and images



Exploring a car like look. Extending the front area or bonet with bumper like forms , placement of windscreen with space for head light. Extending a flow of line between the front and the back fenders.

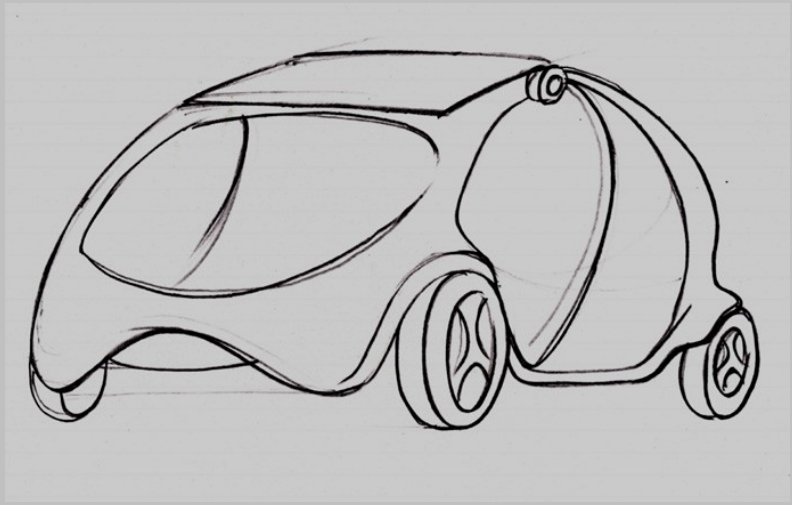
Idea was based on creating a possible movement through staggering of the panels on the roof by breaking the panels or maybe exploring a turtle like appearance.

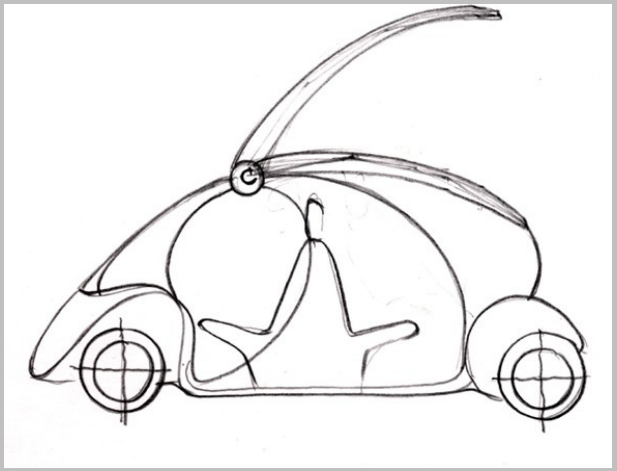




Turtle- multi faceted roof (breaking the panel into smaller units

initial ideation and images





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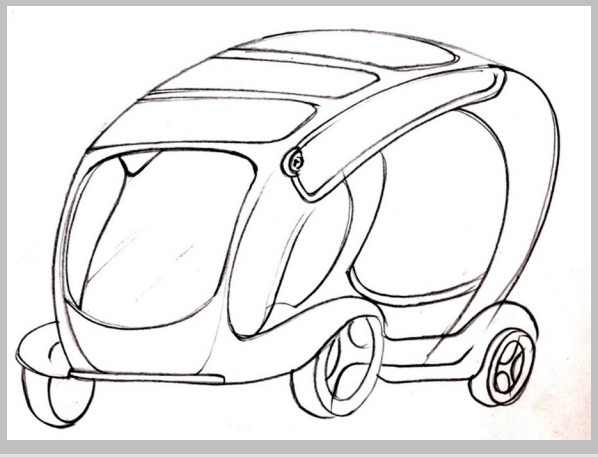
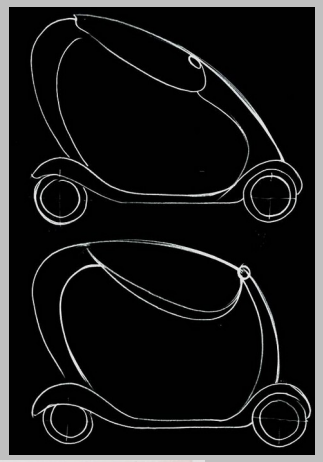
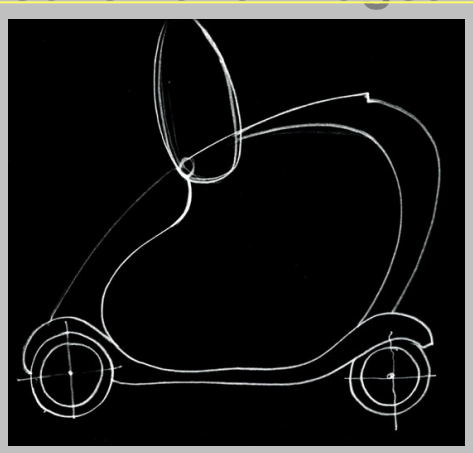
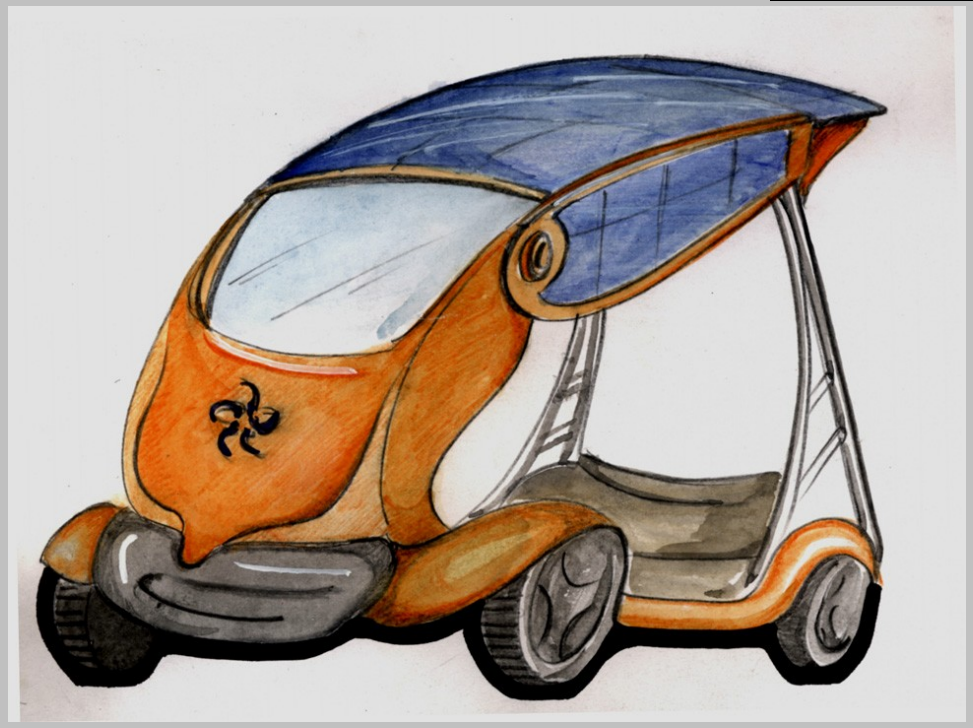
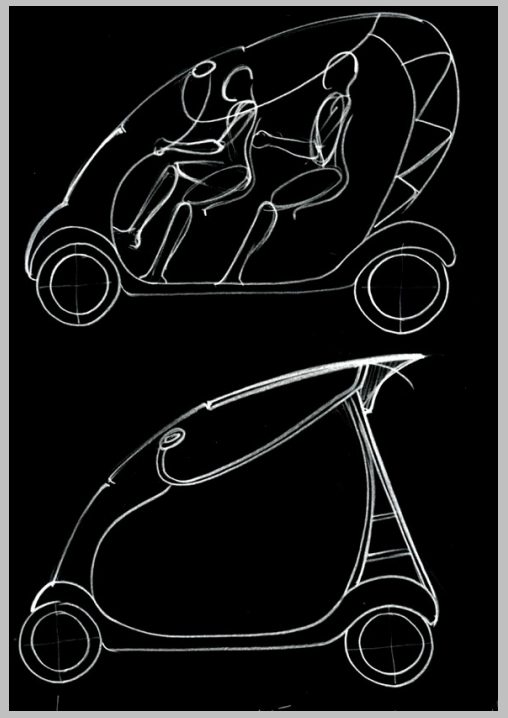
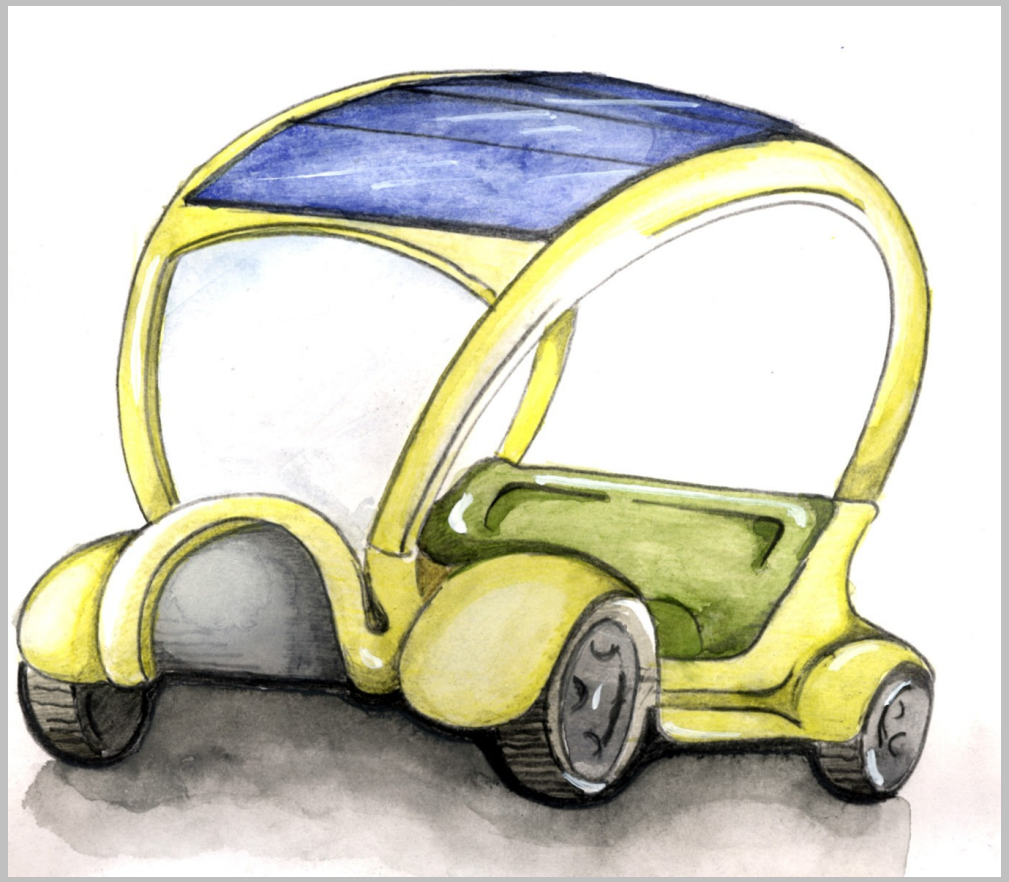






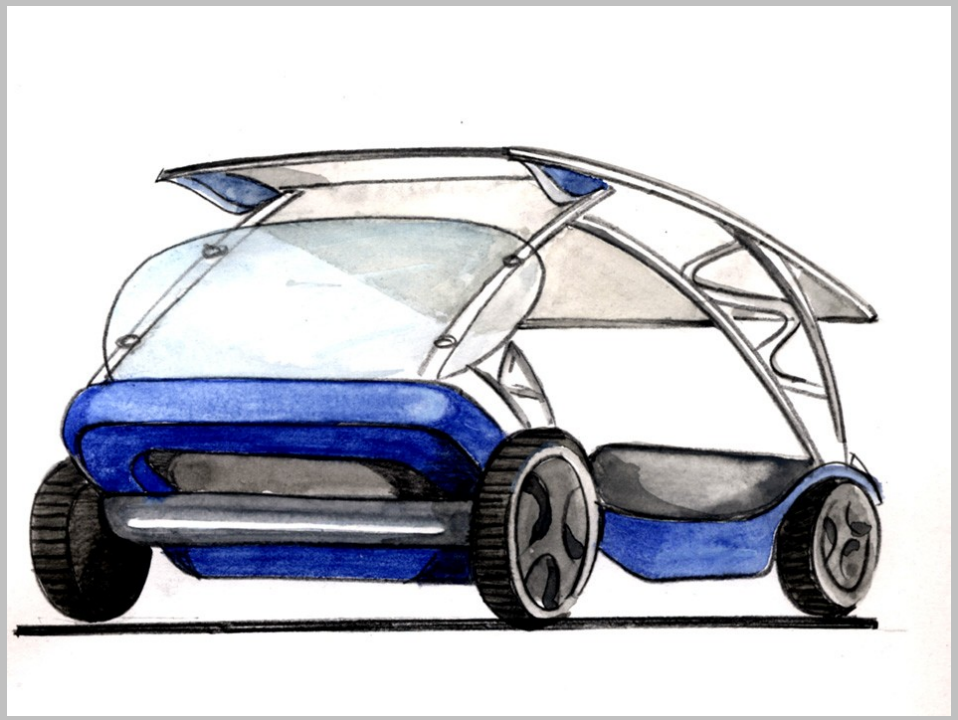


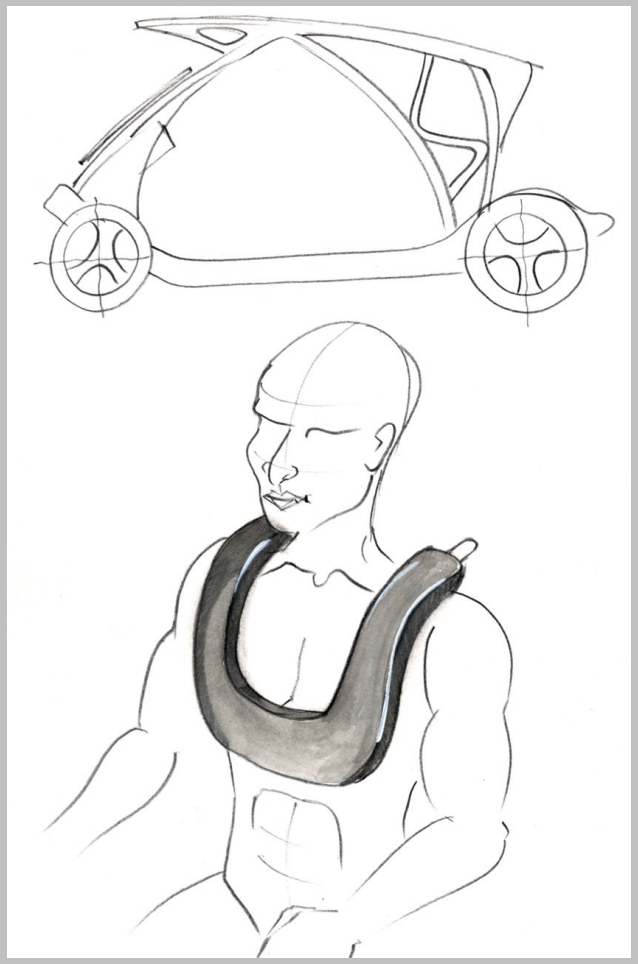




Toy car approach.
This form emerged out of looking at toy vehicles seen in places like amusement parks and entertainment zones. The aim was to explore playfulness and friendliness in the form . Some elements like the oversized round fenders are seen in bumper cars and dune buggies.

initial ideation and images





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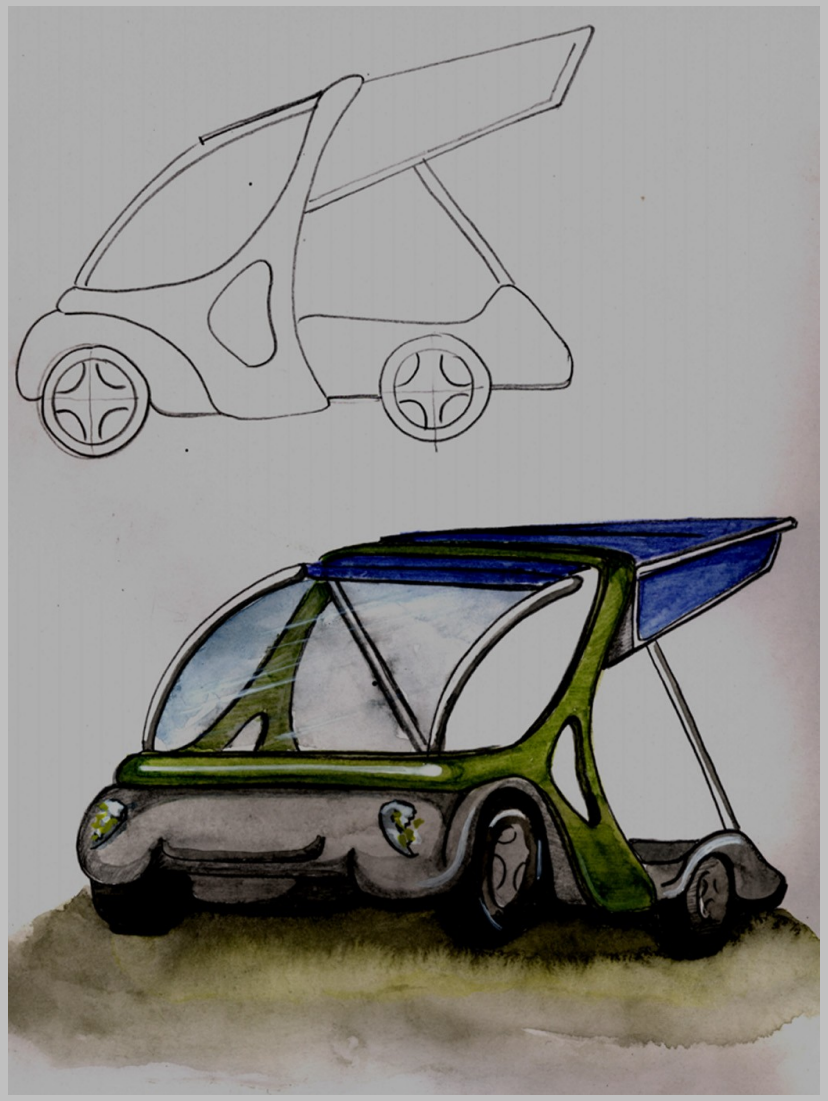
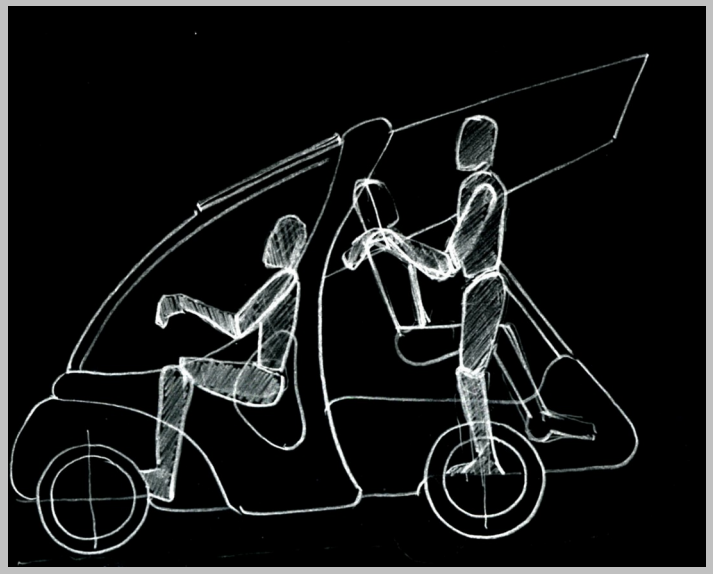
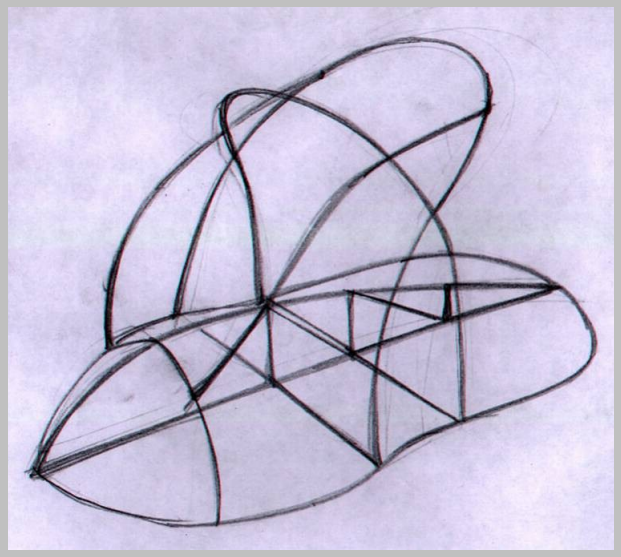
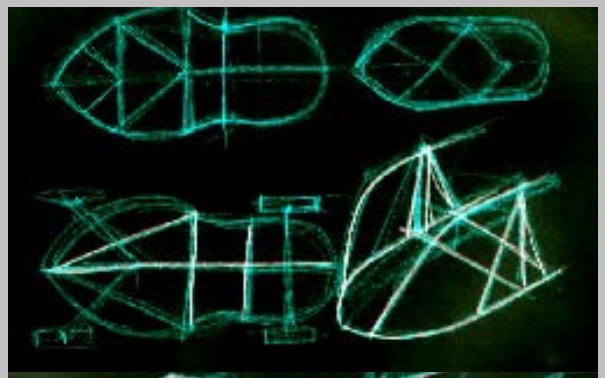
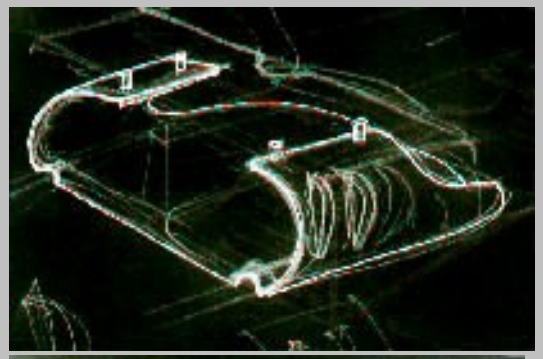


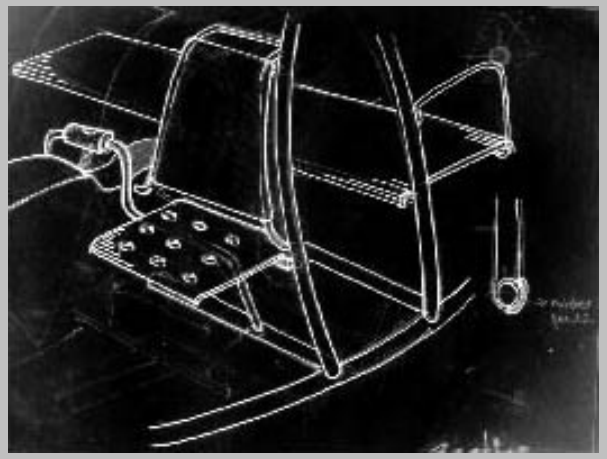


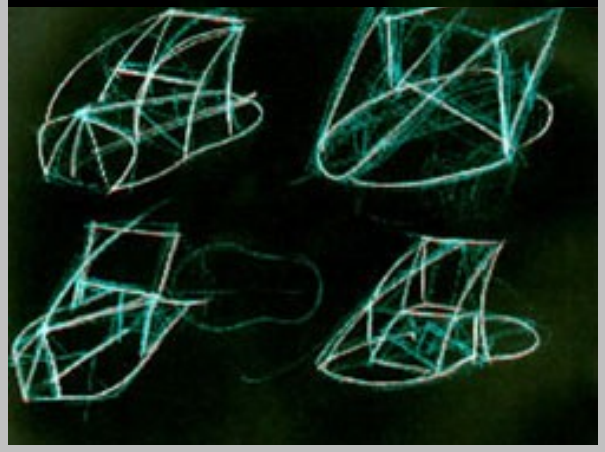
Visit to the engineers and the fabricators in udaipur and discussing possibilities in structure and details

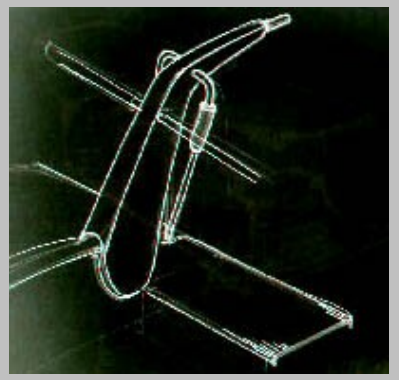












Concept development

Three level

1) " Inside out to Outside in" approach form well integrated with material and structure and complimentary to the overall functional requirements, interior elements with certain level of flexibility , innovation and convenience

2) Exploring attributes like

   unconventional

   sporty,

   light,

   dynamic,

   extrovert,

3) Experiments with lighter materials like metal sections (m.s and aluminum), fiber reinforced plastics and allunimium sheets keeping in mind the main constraint of accommodating surfacing surface area of 4'x 7'(14 sq feet)

Searching for an expression of " Product Identity"

1. State concepts as a linguistic expression.

Lexical definition

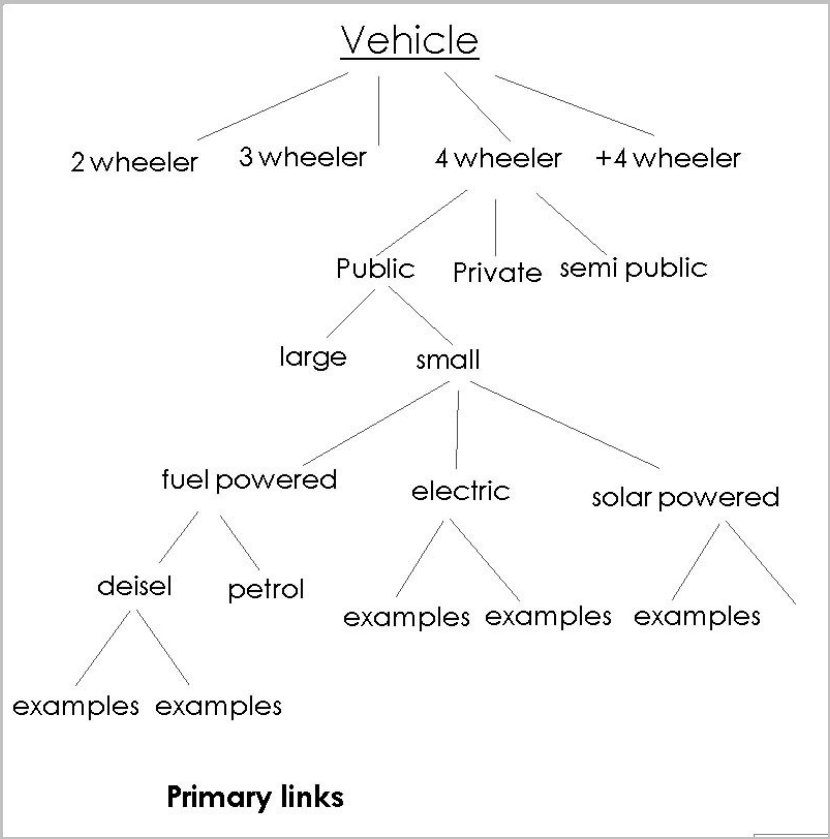
After the data collection and initial study one realised that, there was a need to develop a visual identity or profile of the object which emerged in the linguistic definition as design of a **" light weight solar powered slow moving public/semi-public vehicle (car/buggy/ cart) for Indian use."**

2. Identify visual clues, elements which manifest the concept. In this case " **lightness**"
Investigation into visual clues which communicate links to superordinate concept " solar powered rickshaw "

3. Select potential visual clues. Through charts exploring collecting visual images relating to notions of "Indianess", "solarness" and "lightness". *e.g figure 3*

4. Assimilate them with product form.
5. Effect
-Add new dimension to the current way of looking at the category.
-Develop a new perspective and view point.
-Product acquires its individual and unique position, exclusiveness.

streamlined , exposed solar panels , low seating, surface defined by the repetitive unit of the panel which is doubly curved. Lightness perceived through the proportions.


Vehicle
2 wheeler
3 wheeler
4 wheeler
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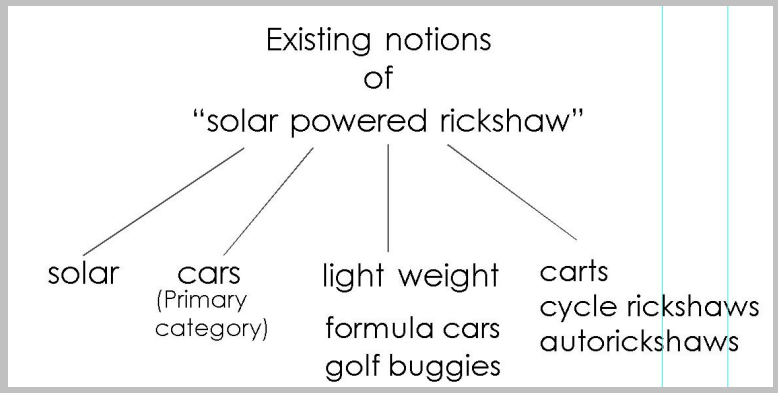
Primary links


Existing notions
of
"solar powered rickshaw"
solar
cars
(Primary
category)
light weight
formula cars
golf buggies
carts
cycle rickshaws
autorickshaws

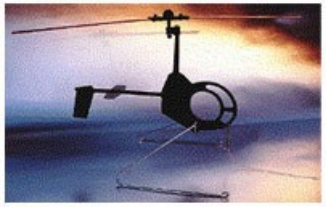
" lightness "





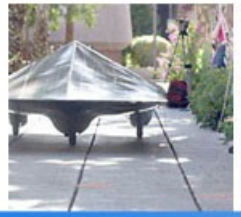








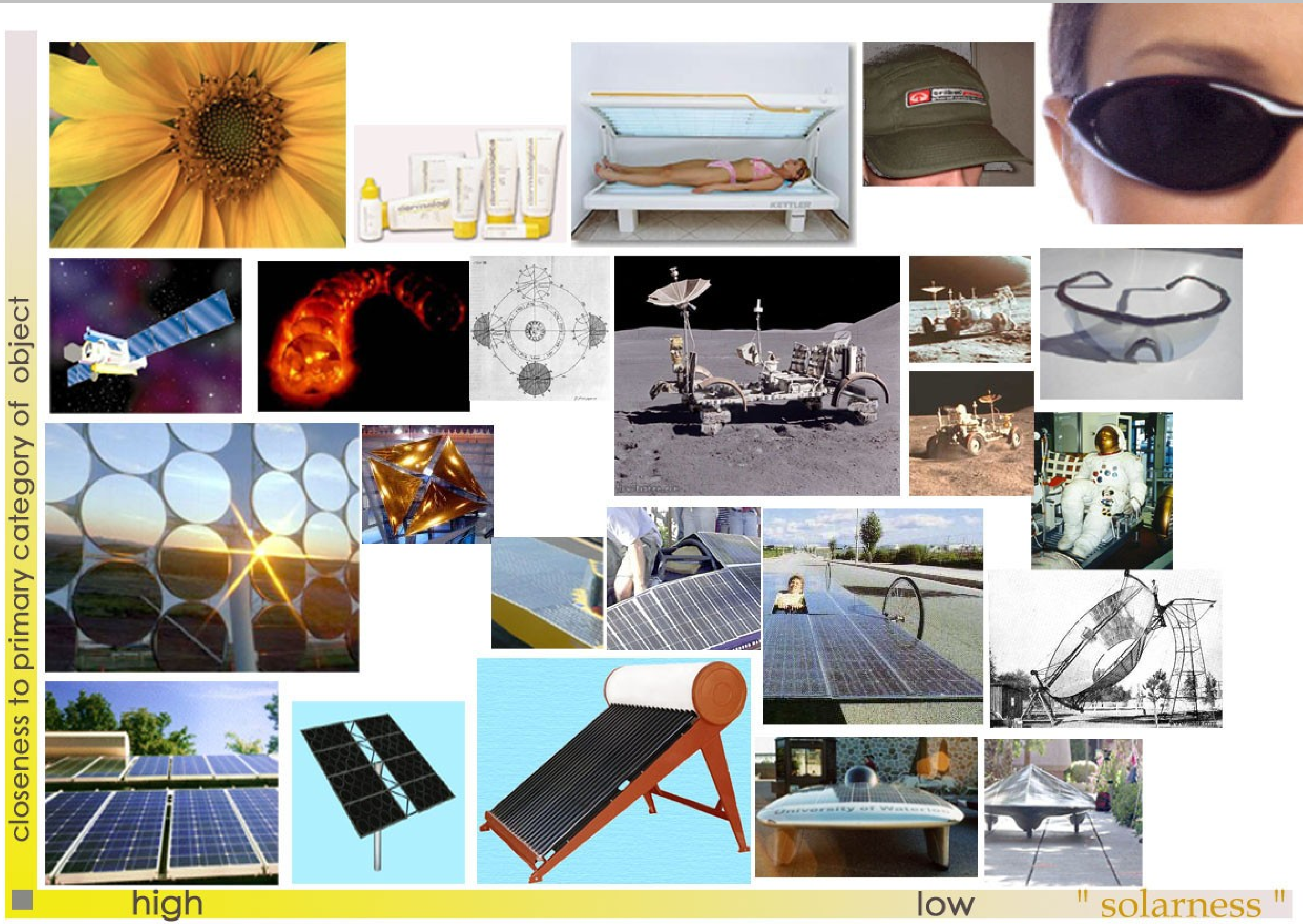



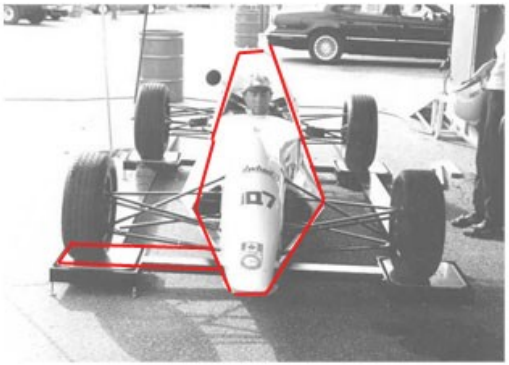

closeness to primary category of object

high

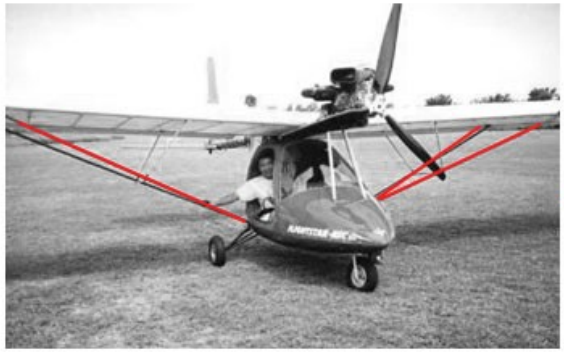
low

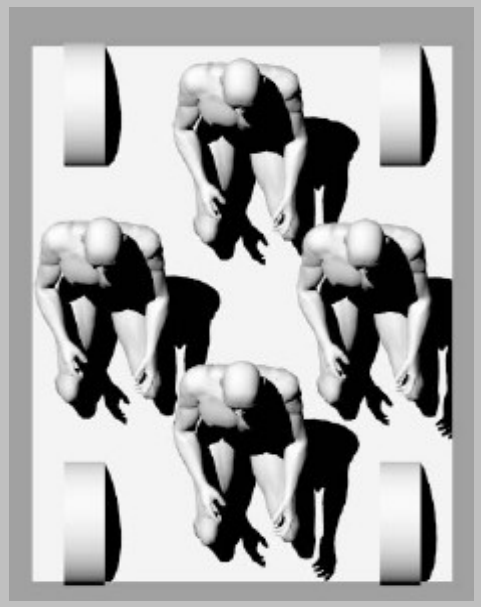

closeness to primary category of object
Indianess
high
low


closeness to primary category of object
high
low
" solarness "



Central string member with lighter cantilevering memebrs outside .
Presence of tension members like ropes, strings and wires to support large spanning wings like a string supporting a kite.
Presence of sleek and dynamic shapes like the fins on the sides and the tail of the plane.
Presence of lots of lines to tie together different





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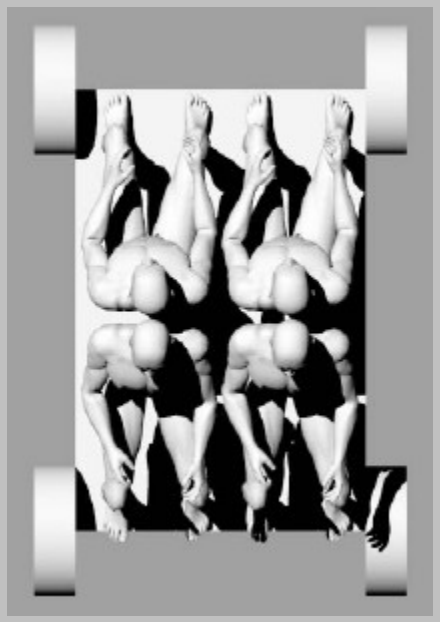

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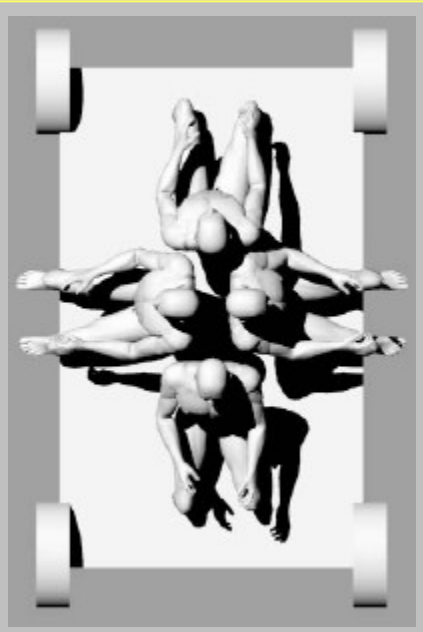

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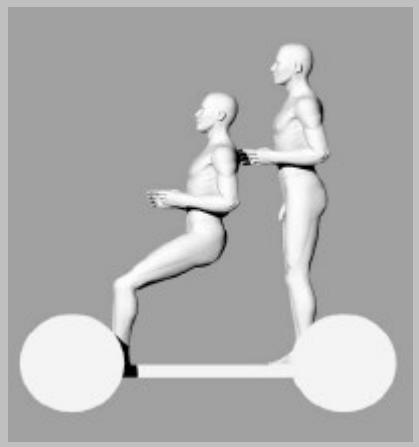

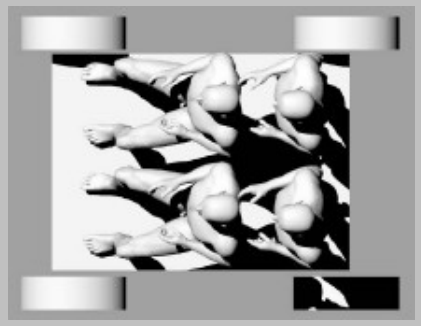

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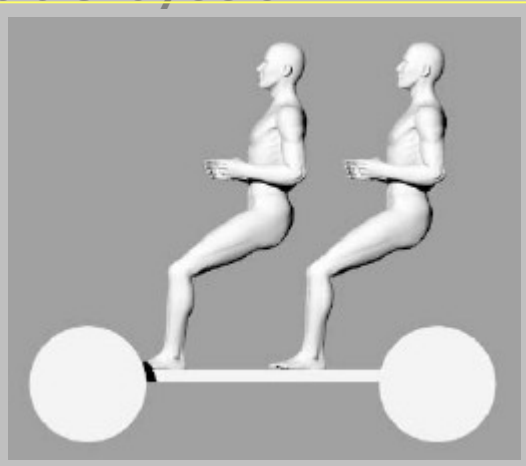

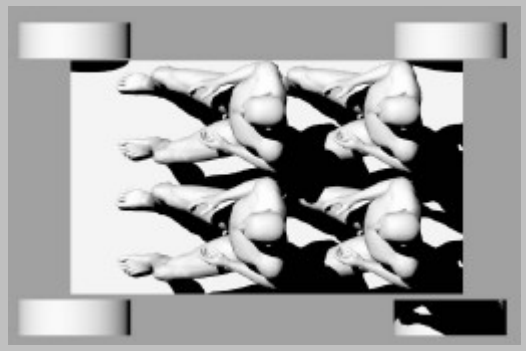

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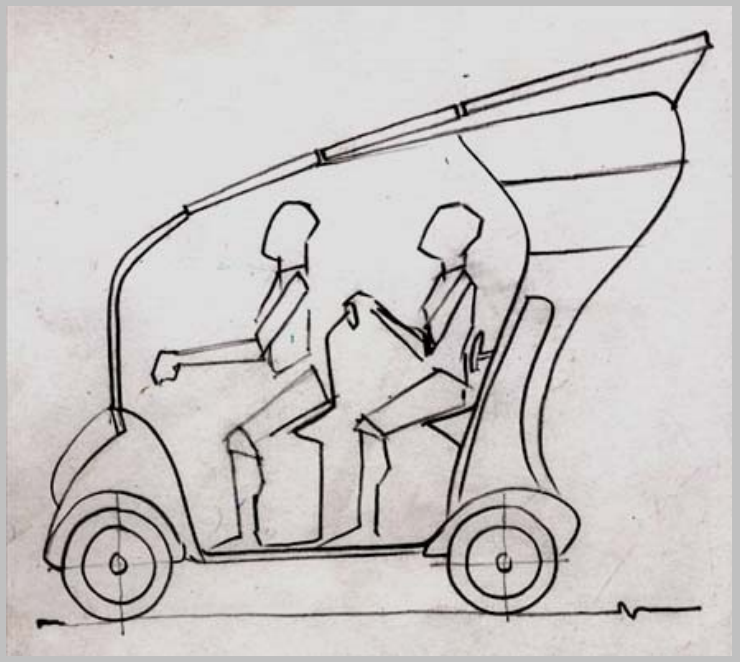
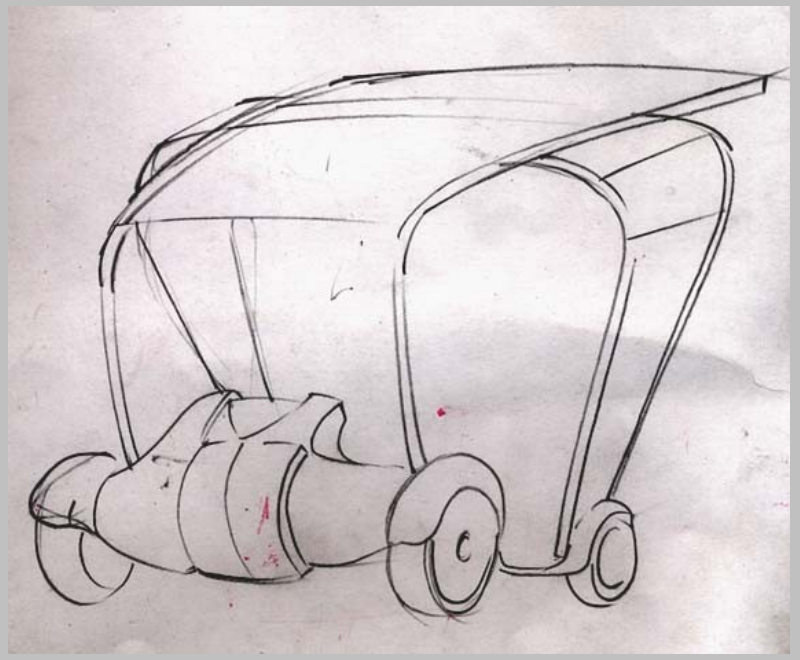
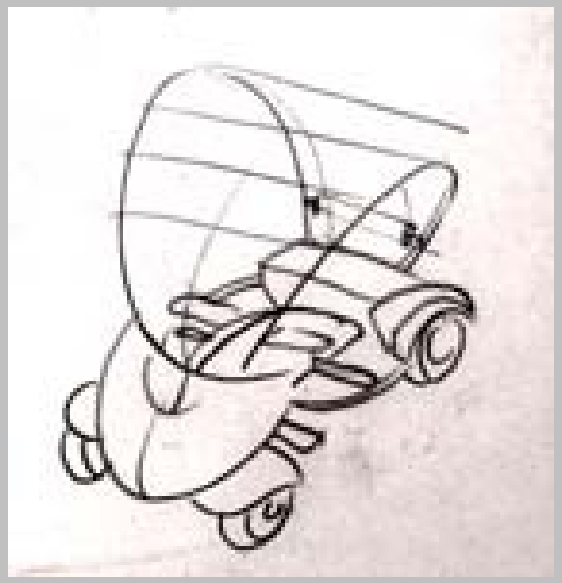
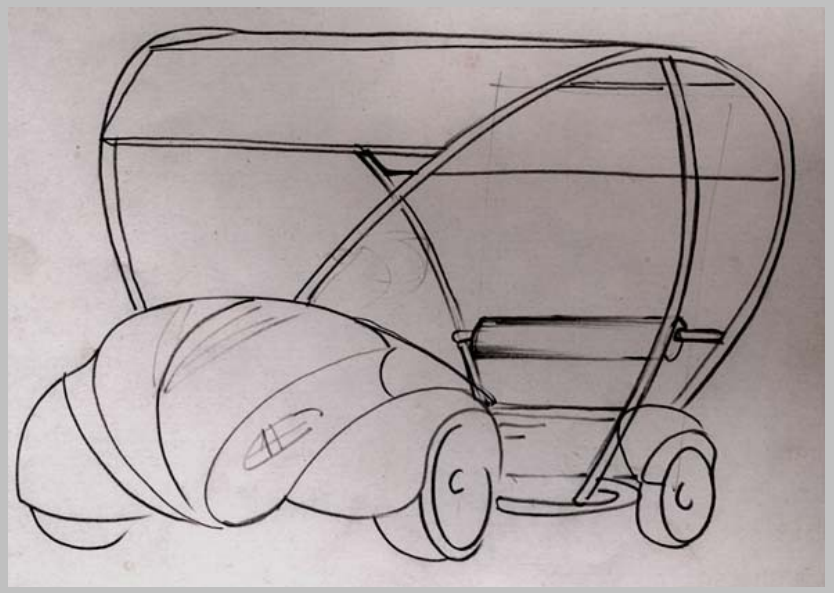
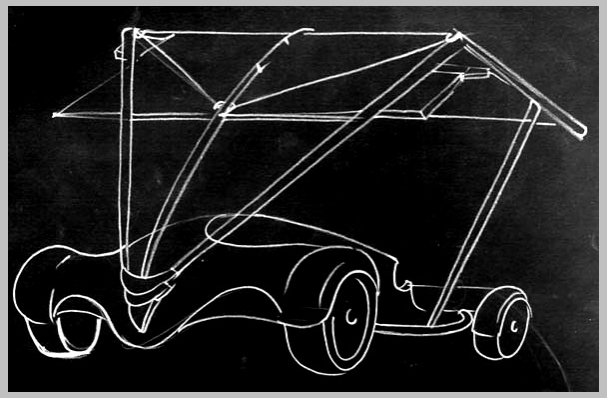


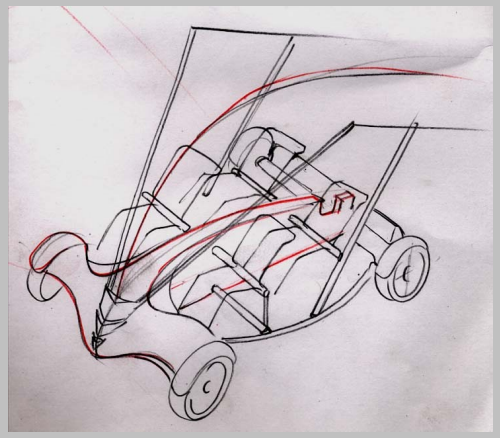


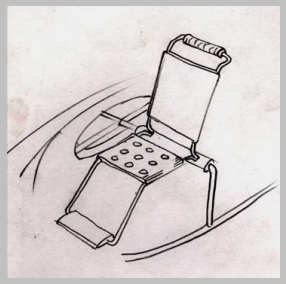
Concept one was based on exploring possibilities with the roof surface and integrated over all structure where structure becomes and aesthetic expression. Possibilities of user in a semi standing position was explored, in order to reduce the wheel base and over all dimensions and also aid in easy ingress and egress.



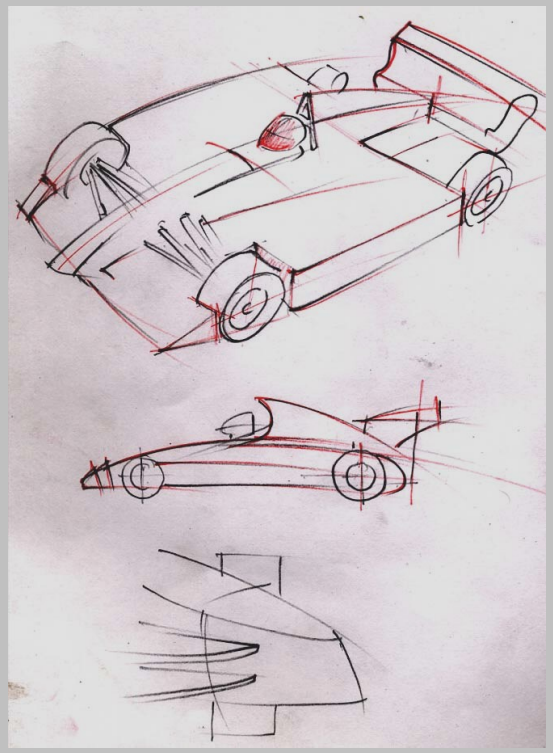




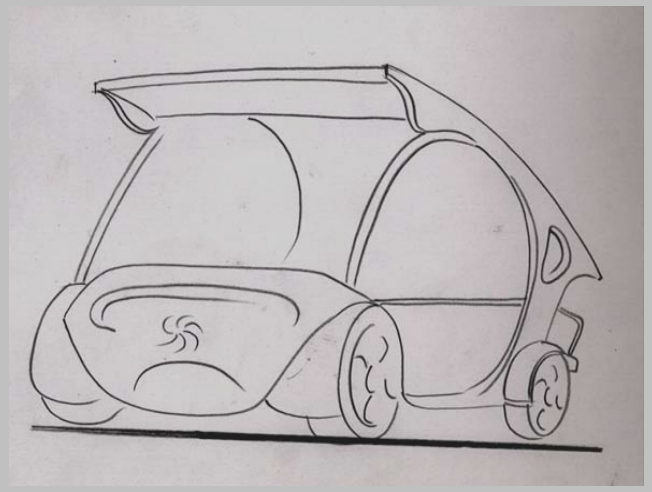


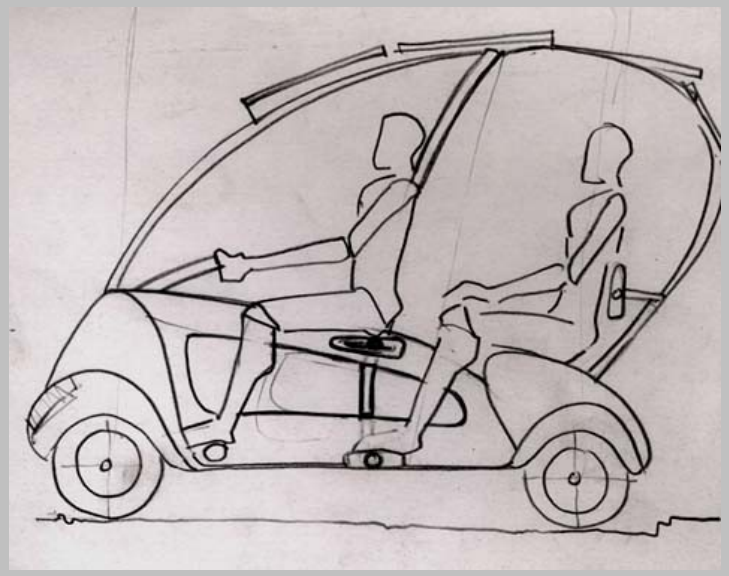


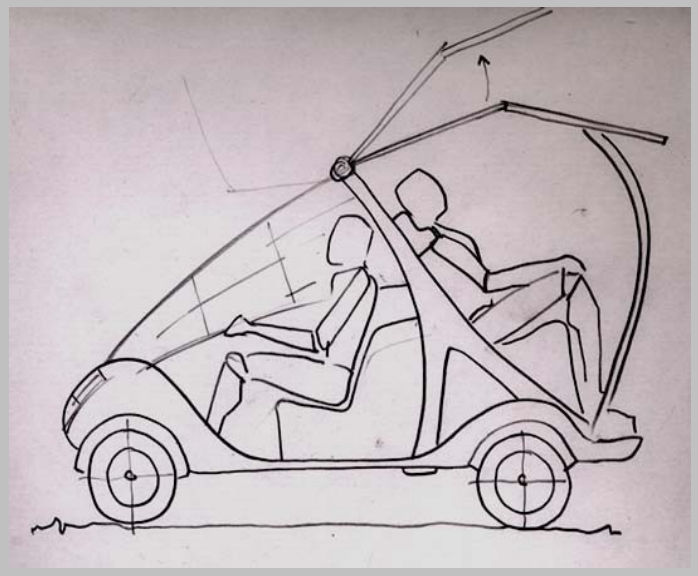
Tubular frames for seating , combination of fabric net and plastic



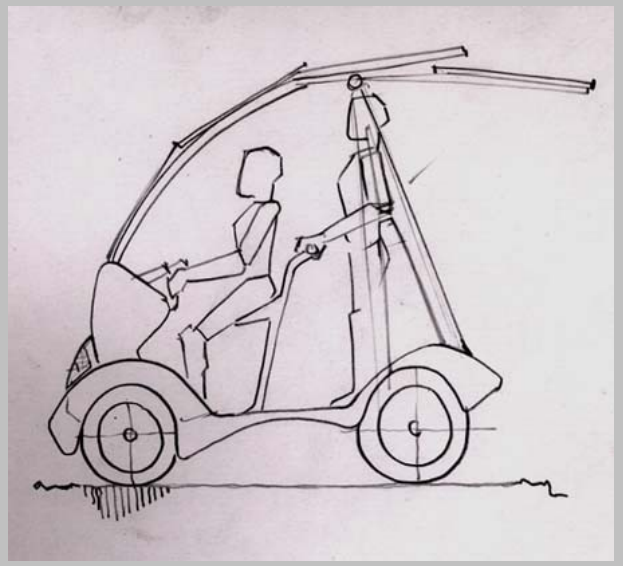
Concept two was inspired from the taking some characteristics from the formula racing cars for the lower portion of the vehicle and light weight tension structure to support for the roofing surface.

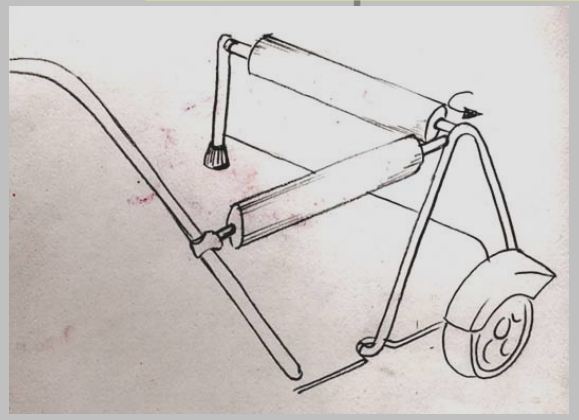


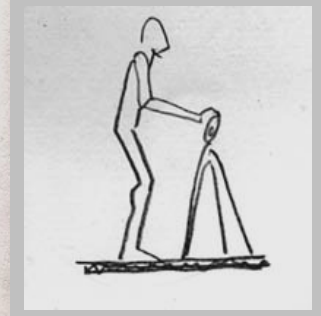


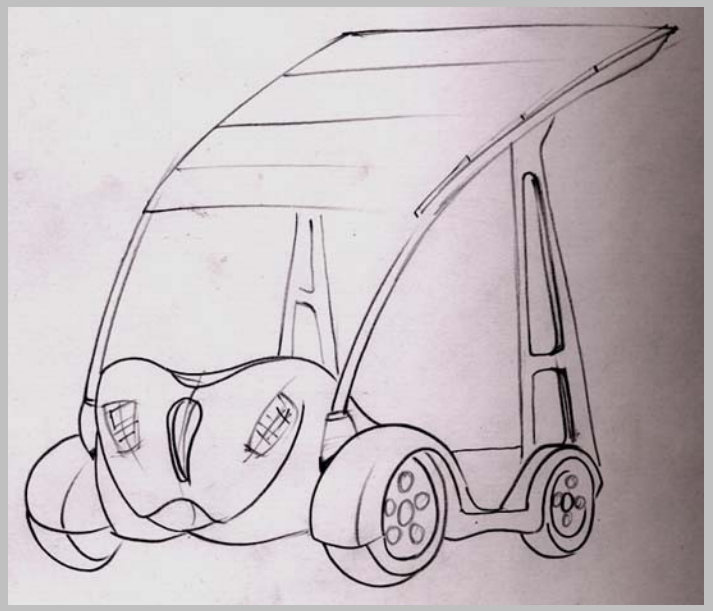


Concept three was based on how we sit in tongas and cycle rickshaws and how a layout could be generated from it.

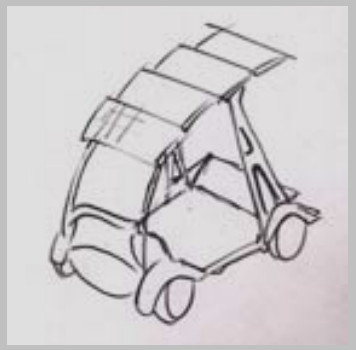




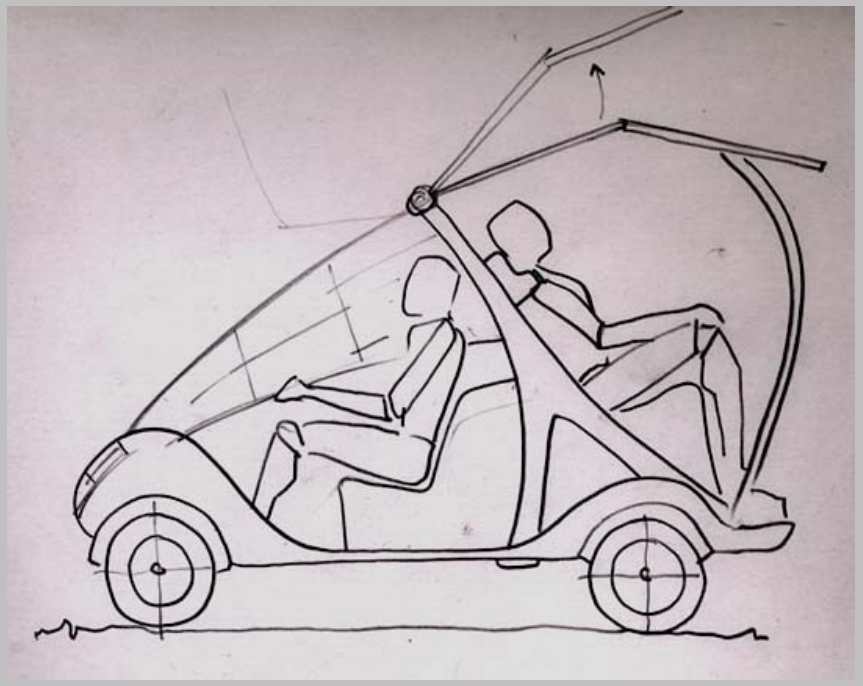


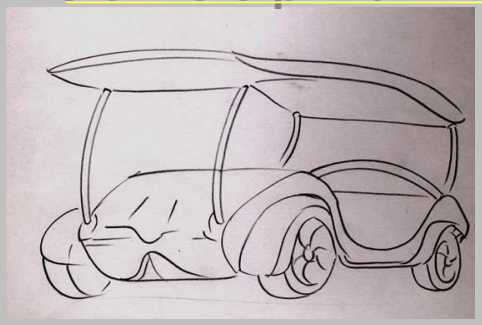


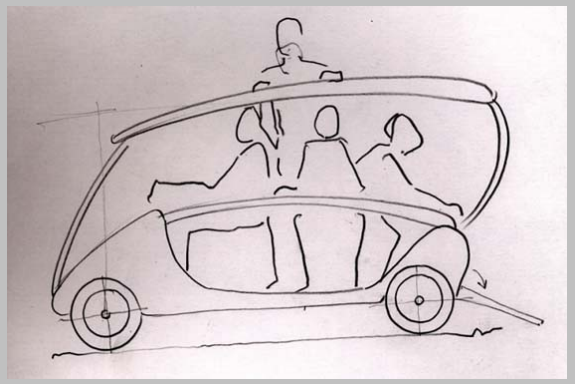
Concept four was a based on reducing the wheelbase by assuming a semi sitting and standing position. The panels could be staggered like a venetian blind to reduce air drag. Standing supports which cloud be rotated around to change configuration and direction of standing .

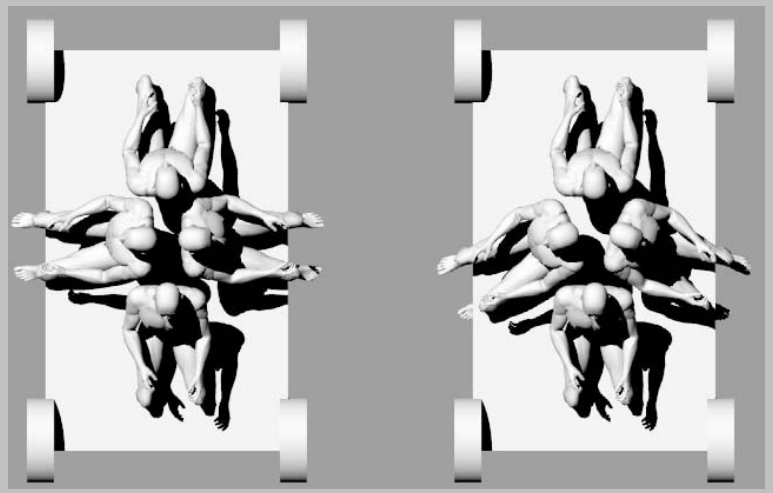


concept-5

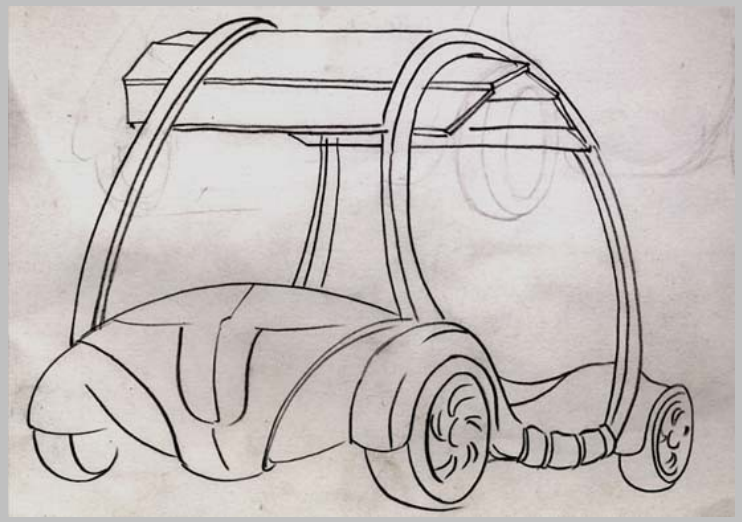


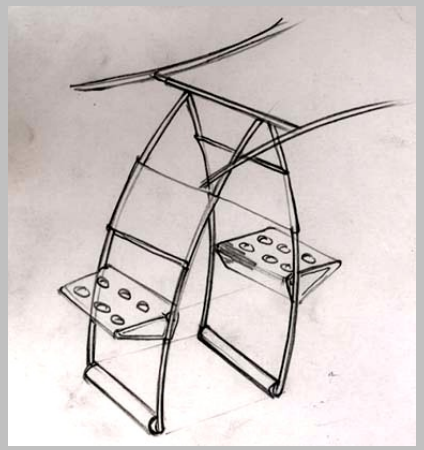




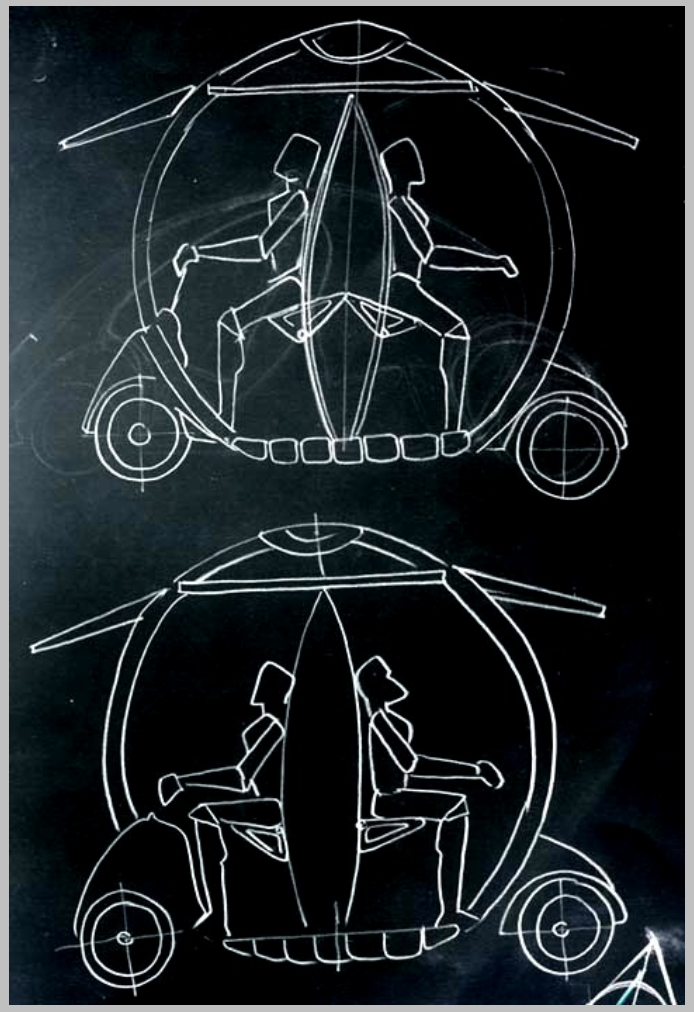


Concept five was based on changing level of the flooring of the vehicle so that people could be placed at different heights and this height variation could provide a sleek form to the vehicle . Entry for the back passengers could be from the back side with collapsible panels.

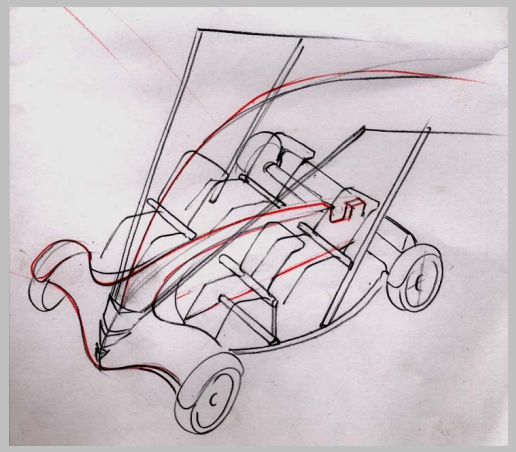


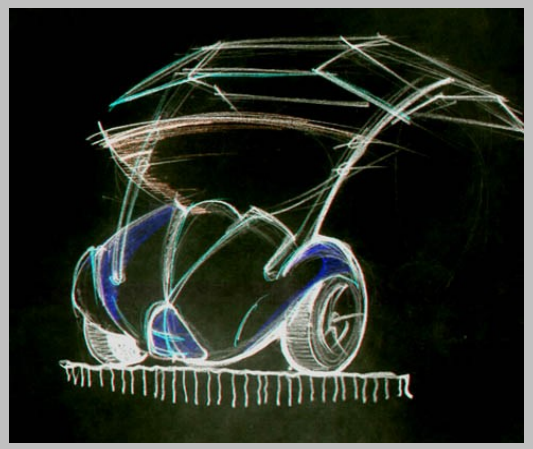


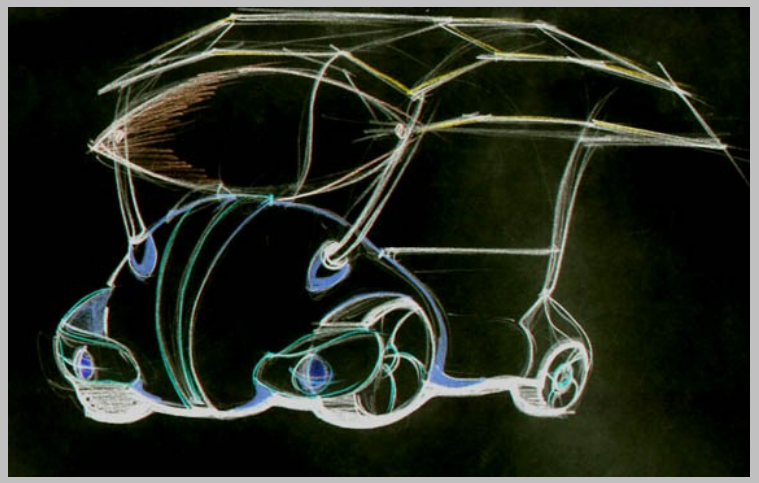
Concept six was based on having an integrated structure of the floor and the roof and seating to be made in such a way that it provides otion between semi standing and sitting

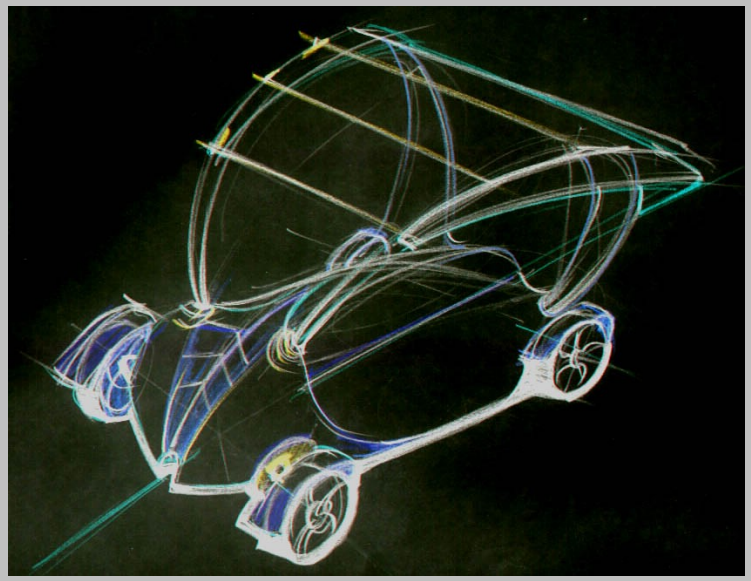


final concept

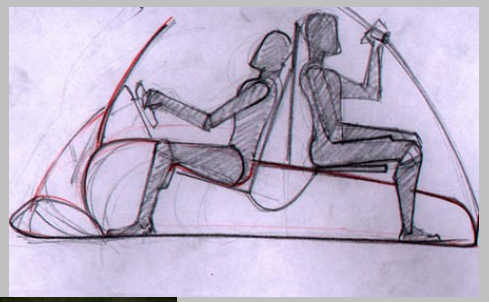


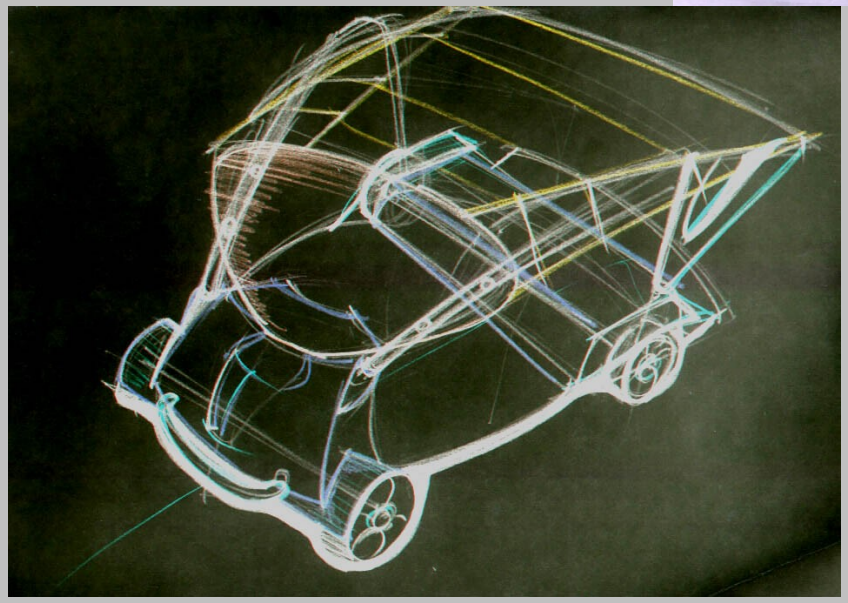




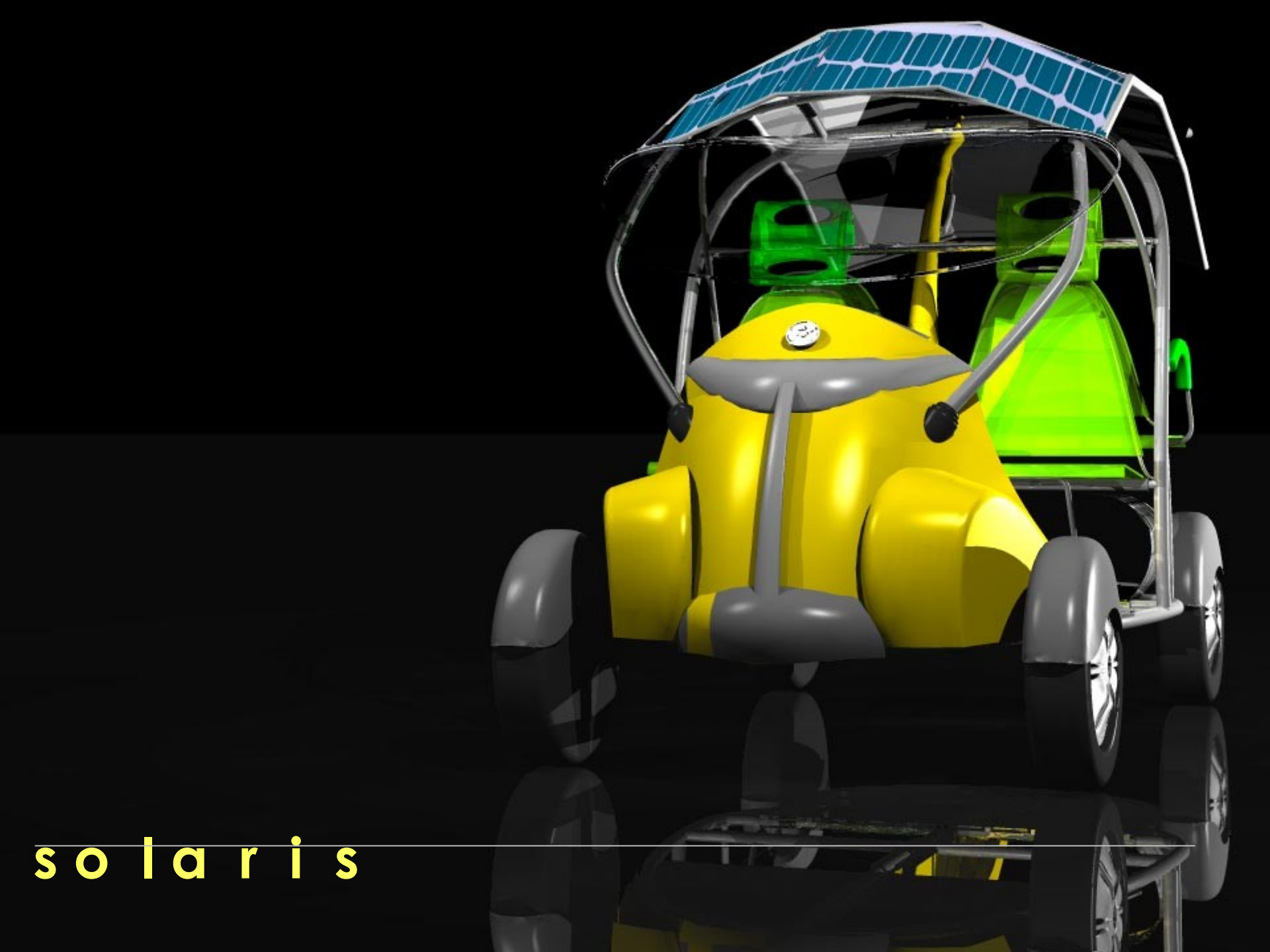


final concept development





s o l a r i s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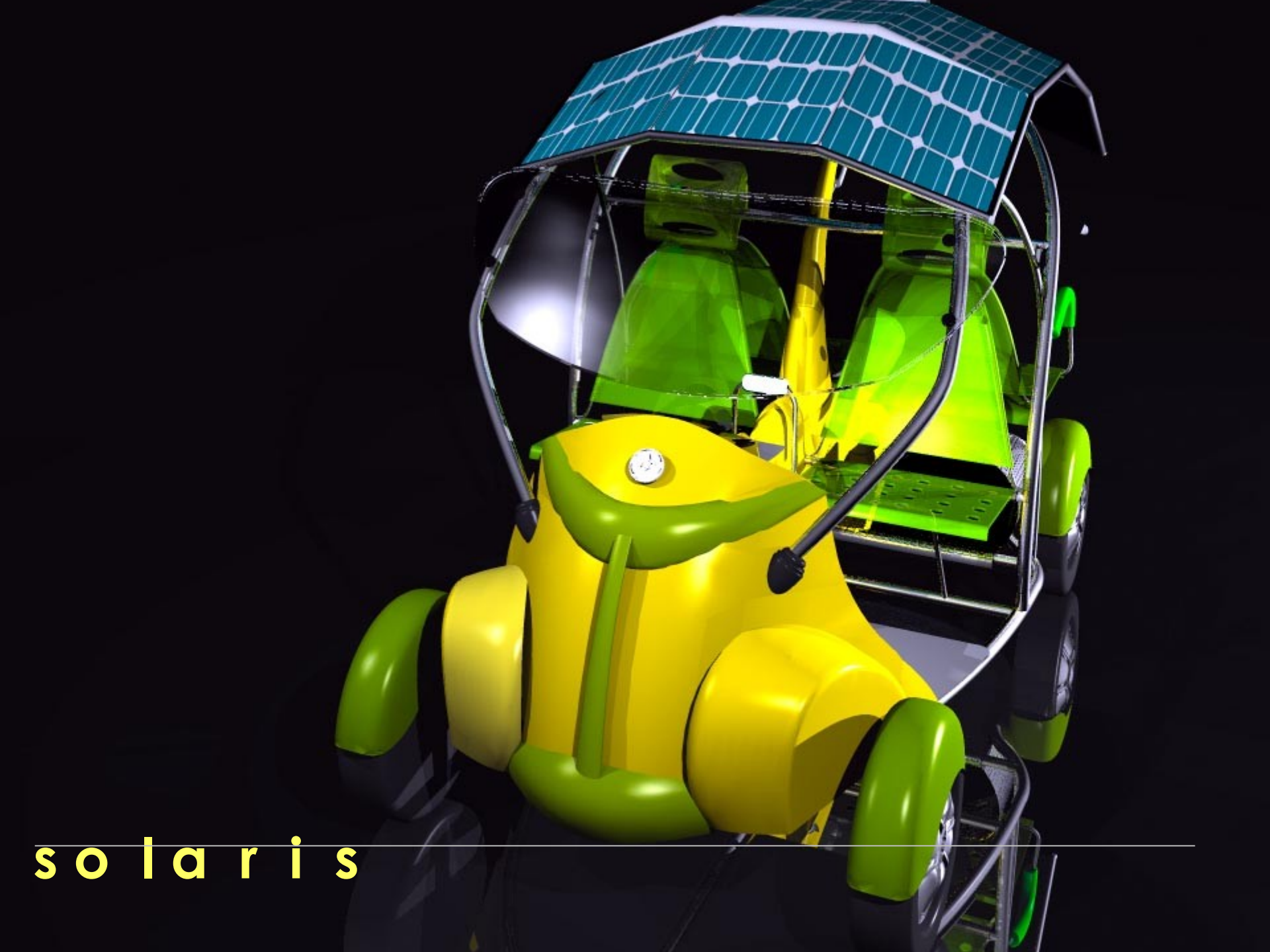
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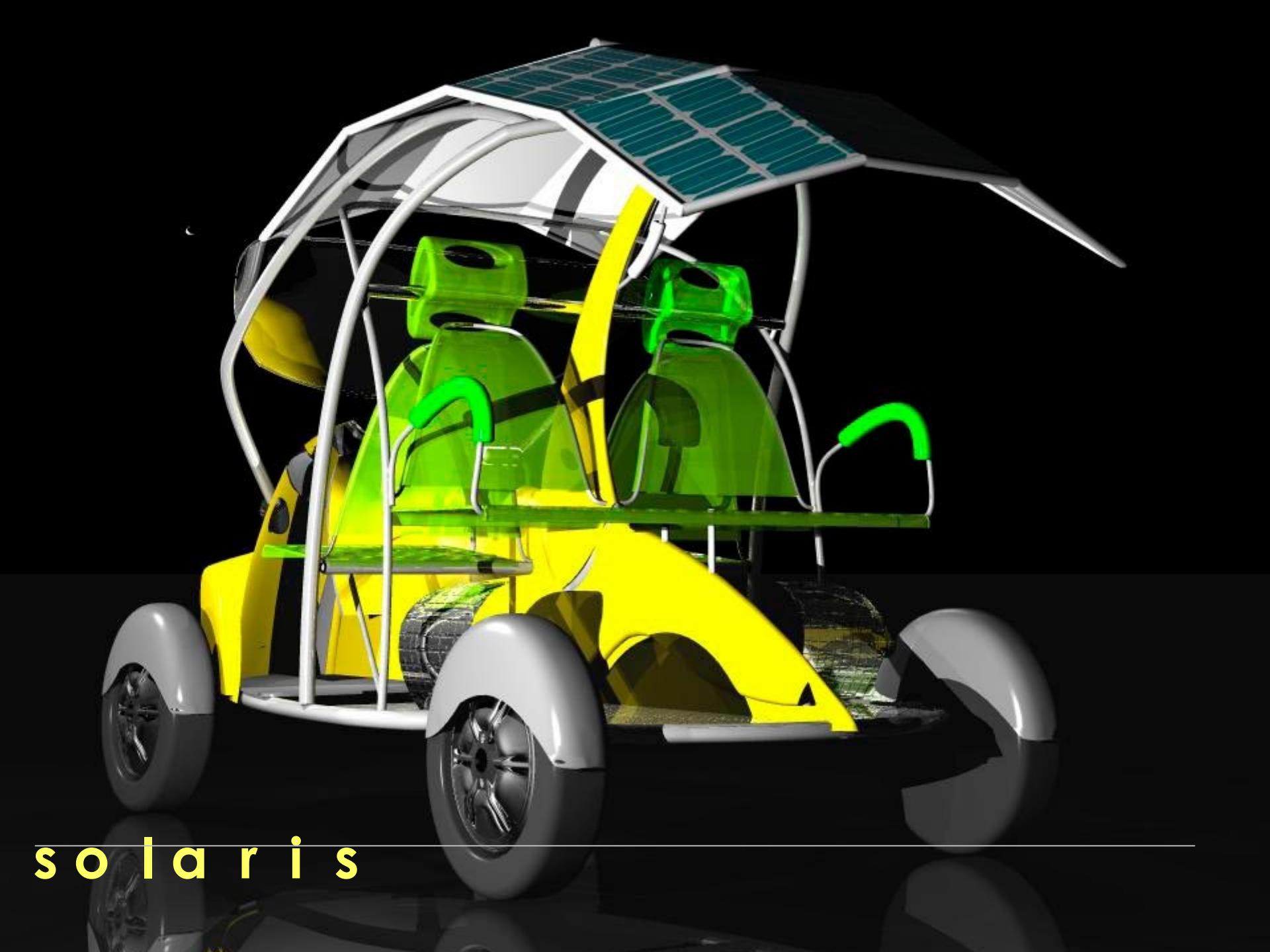
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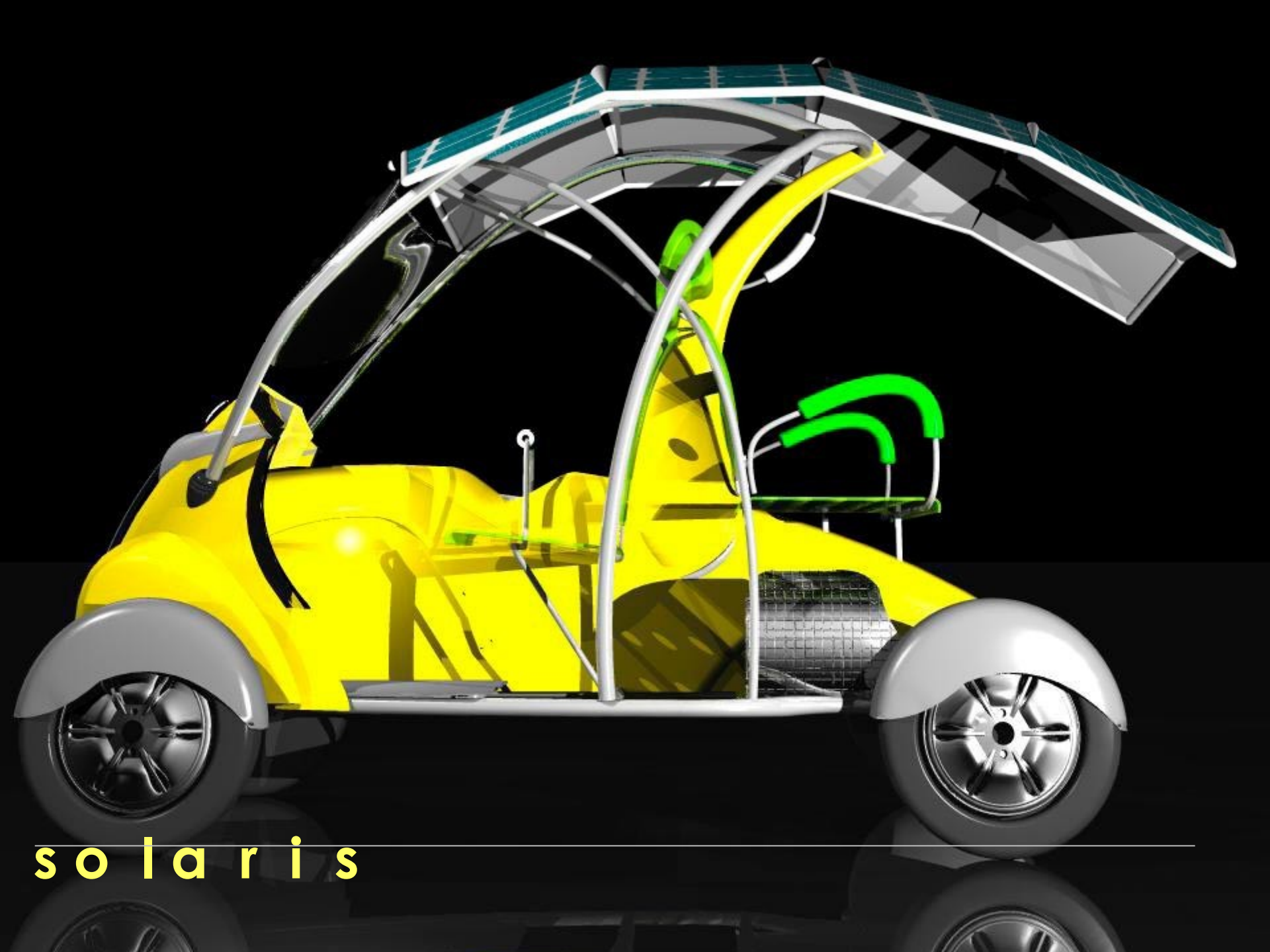
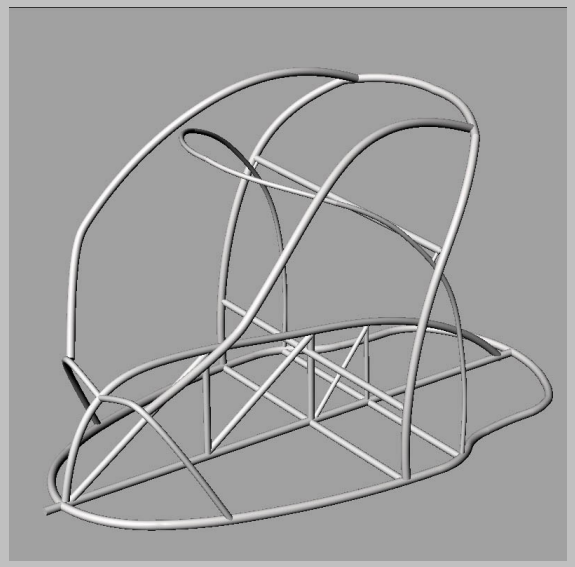
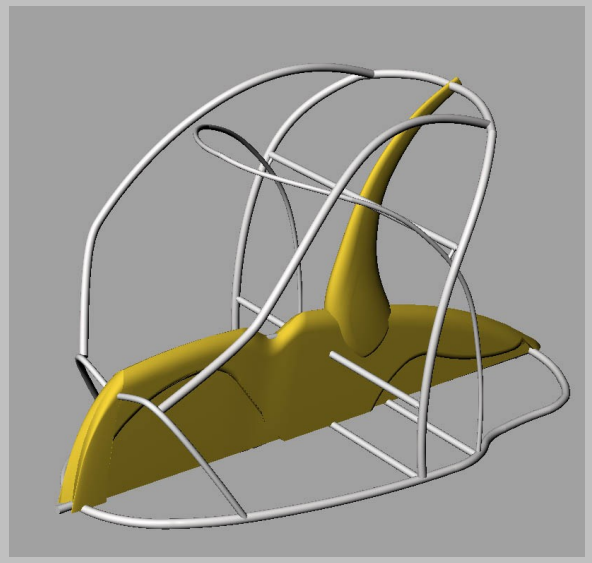
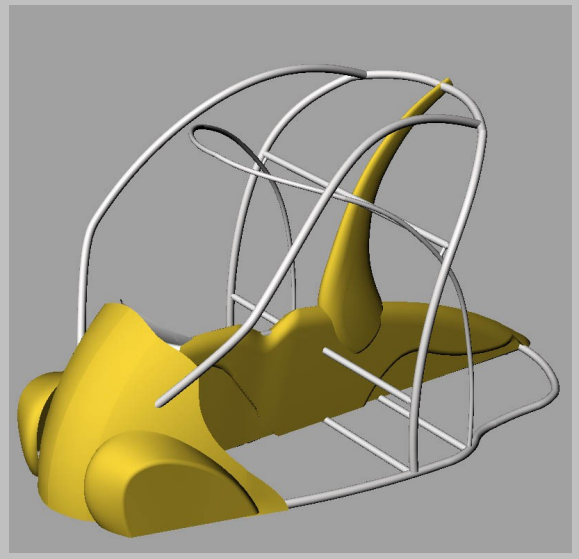
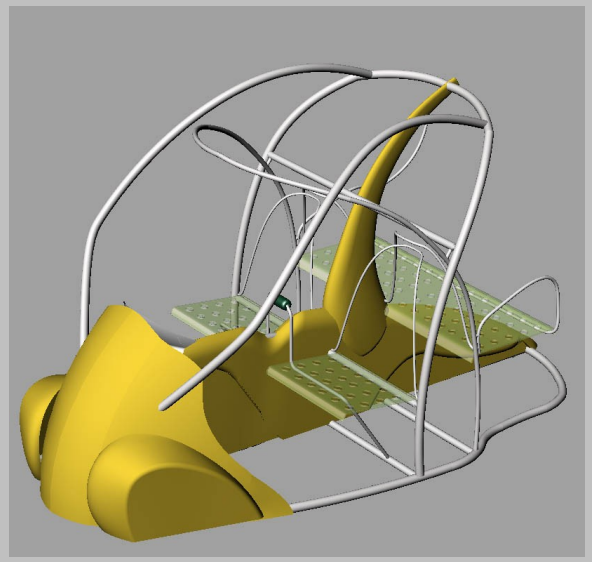

s o l a r i s

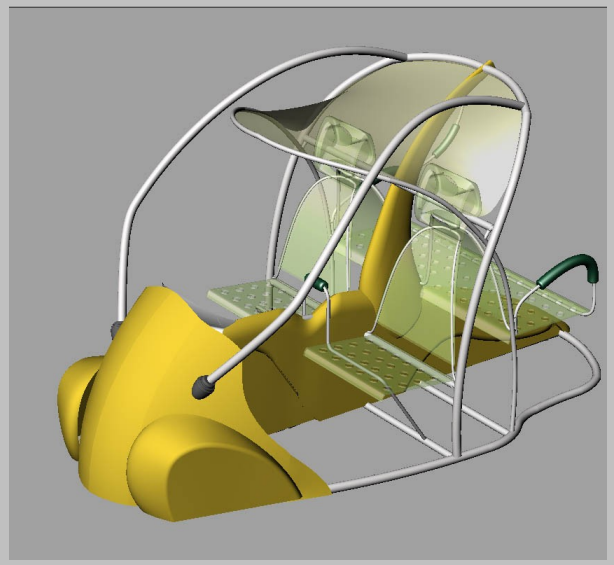





assembly





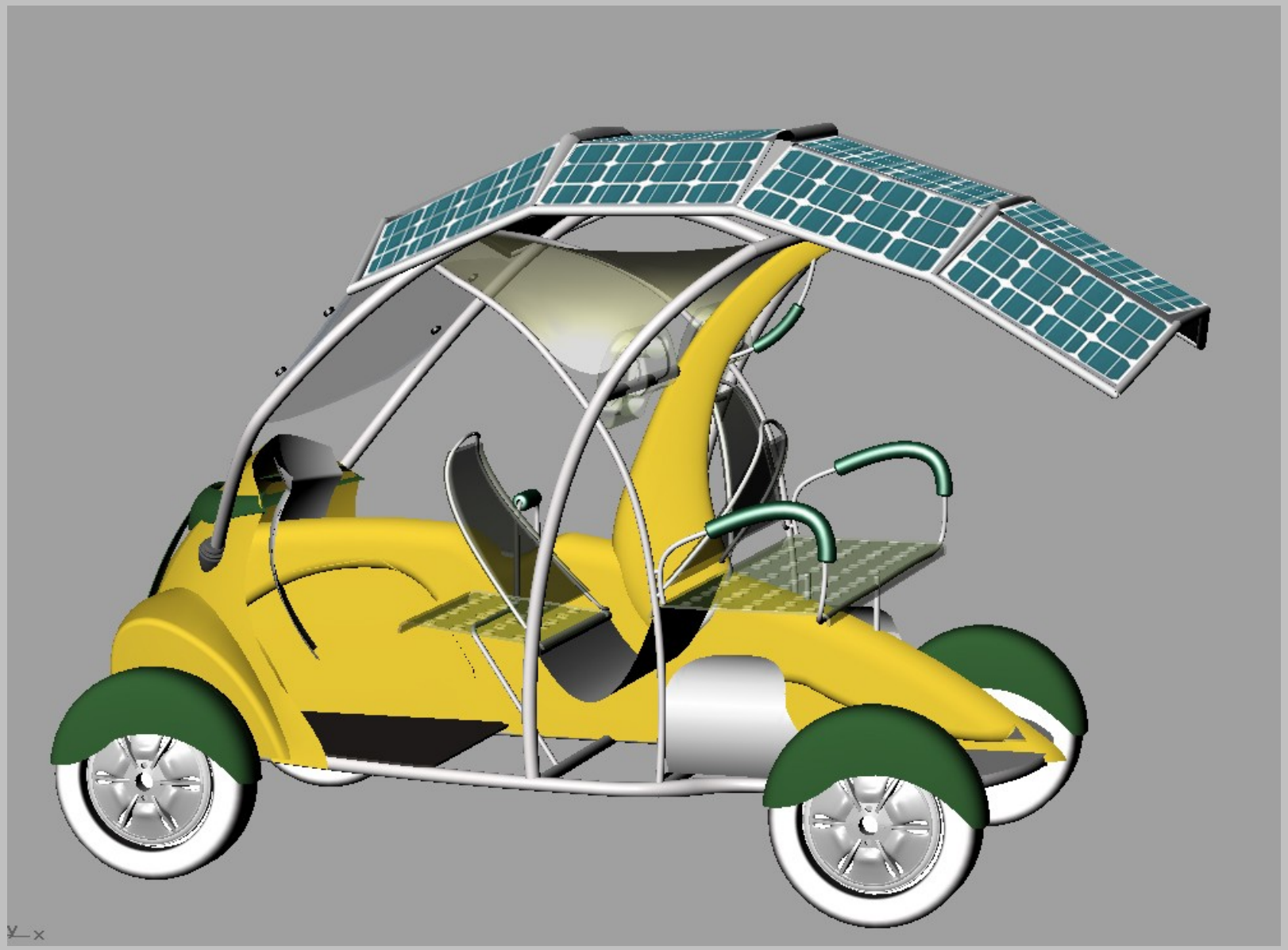


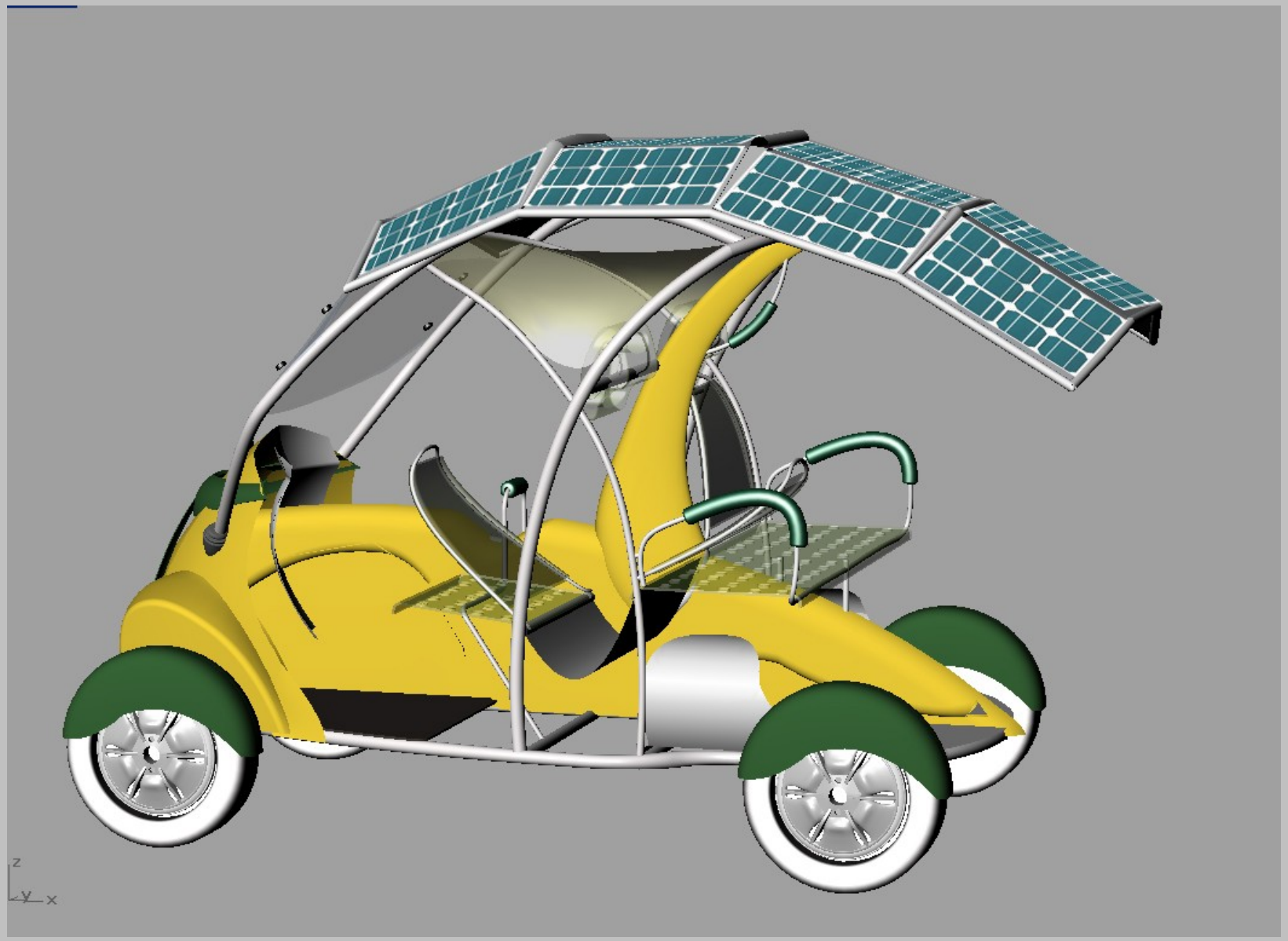

z
y
x

roofing

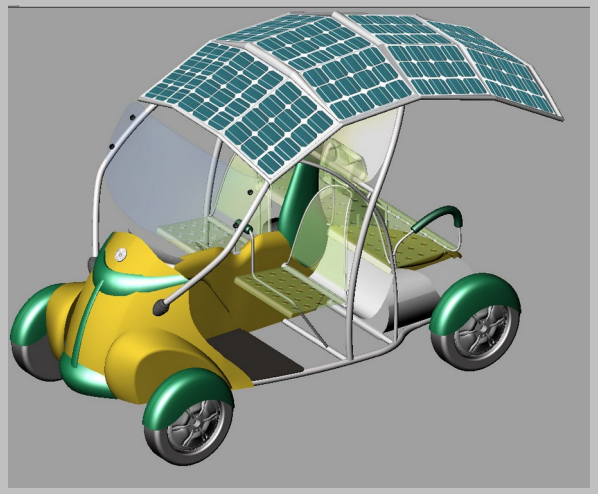

z
y
x

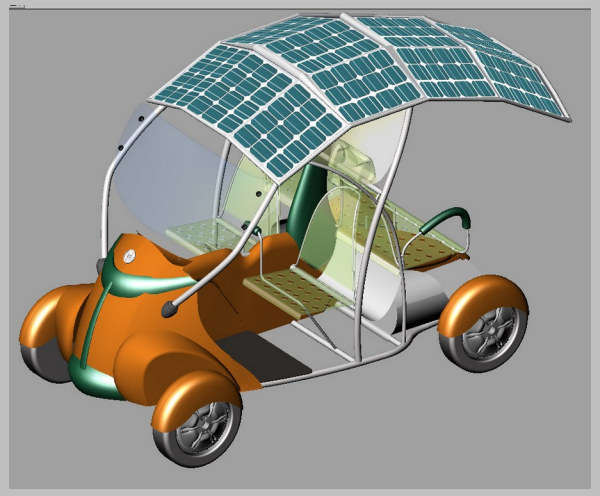

z
y
x

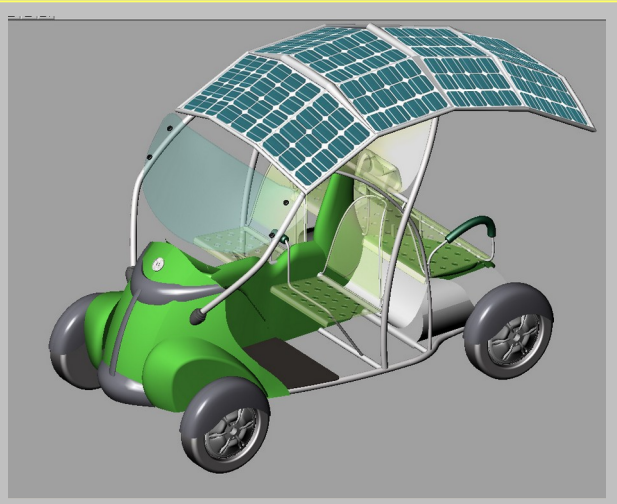


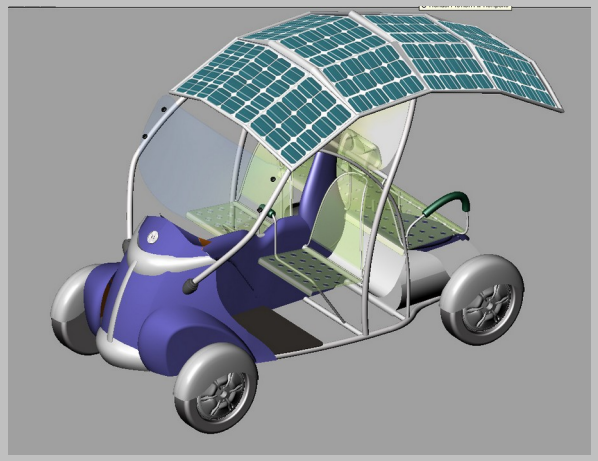

z
y
x

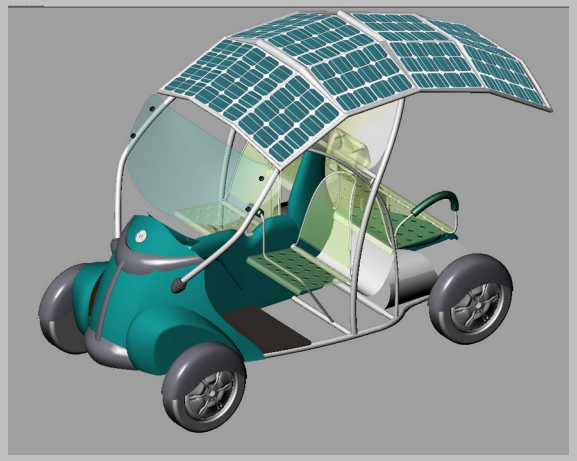
colours

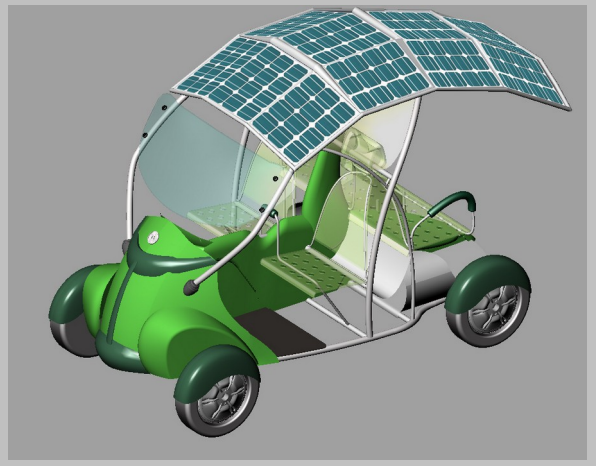




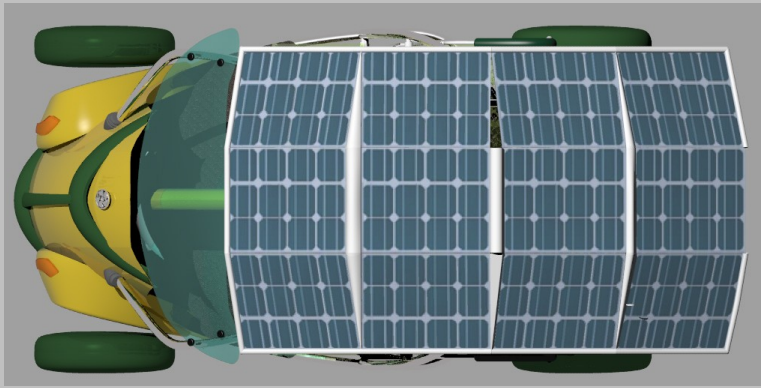


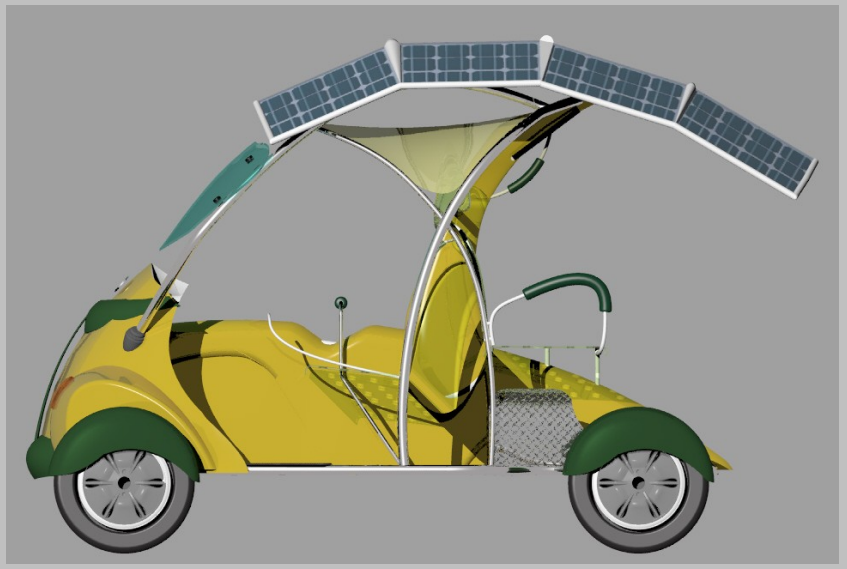


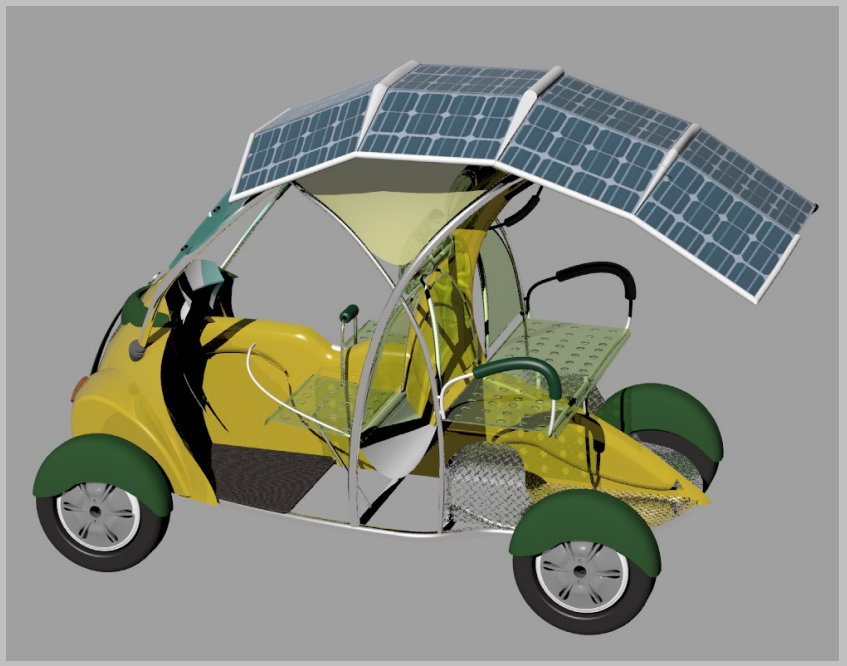




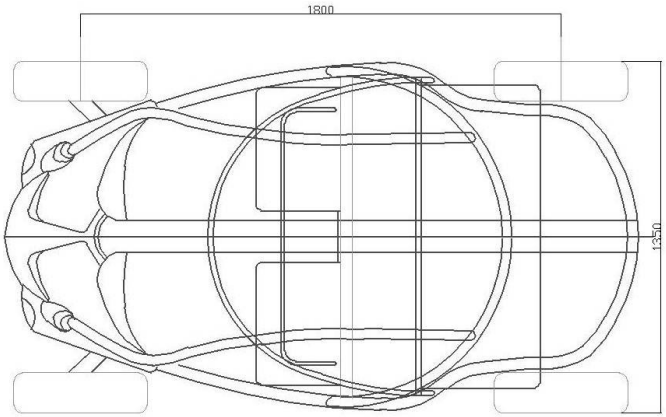
views

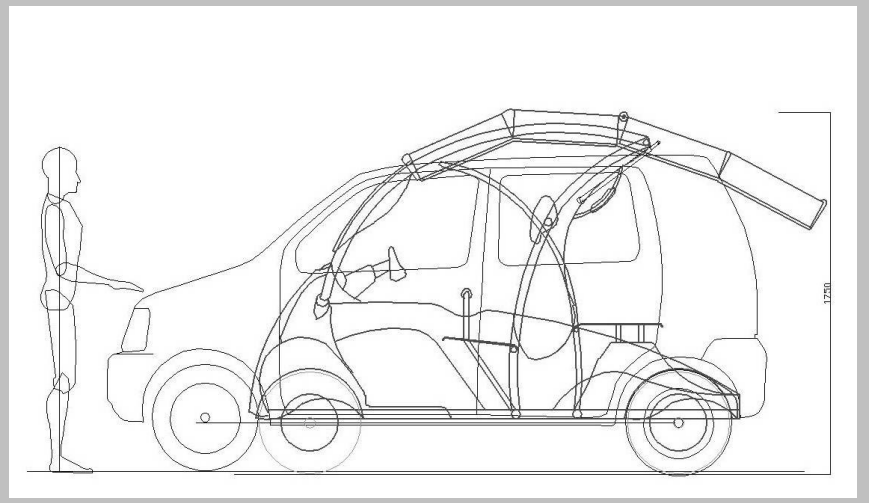


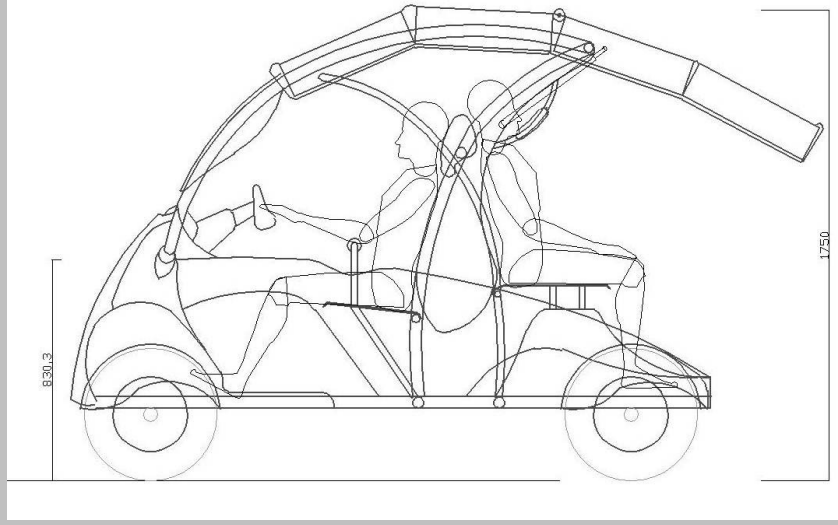


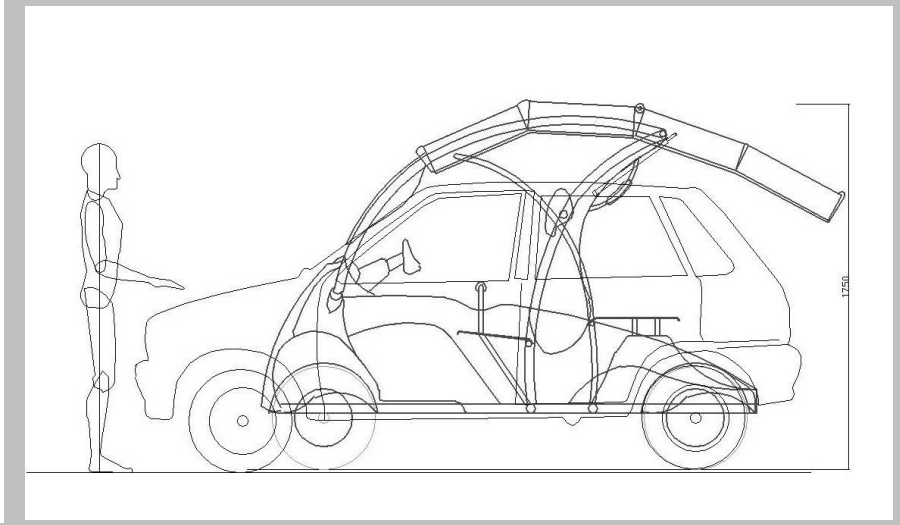


dimensional drawing









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