Exploring Futuristic Automotive Forms

Industrial Design - **Project III**

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Approval Sheet

The Industrial Design project titled

"Exploring futuristic automotive forms",

by Karthik Narayan (07613801)

is approved for the partial fulfilment of the requirement for the post graduate degree in Industrial Design.

PROJECT GUIDE: _____

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CHAIRPERSON: _____

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Finally, I would like to thank Dhuri, Milind, Juny, Ratika, Bongo, Mythili and all my friends for everything they did.

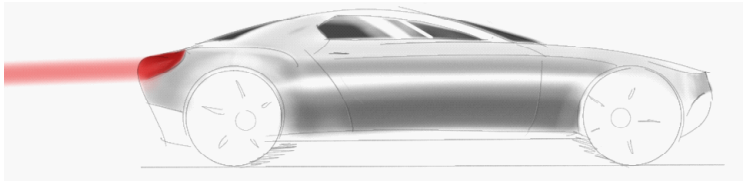
1. Abstract

The aim of the project was to style a concept vehicle for the future, taking into account the advancement in technology, the aspirations of the future user and the scenario in the times to come. First, the emotions related to automobiles were studied. Visual cues were enlisted from the study and ideation was done to explore form. Now, with understanding of technology and its applications, the form and the technology were amalgamated to conceive the concept vehicle.

Concerns:

- User
  - pride of ownership
  - ease of city use
- Technology
  - should answer green energy needs of the future
  - may not be viable immediately, but should be practical and economical in the future

2. Introduction



Though transportation is the primary function of an automobile, when it finally comes down to making a choice – various factors influence our decision. It is never merely about the car's performance or its economy; it is about feelings, about aesthetics, the emotions the automobile conveys. Even automobiles require social acceptance to be successful. Regardless of how expensive or cheap the vehicle is, it makes a statement about the owner.

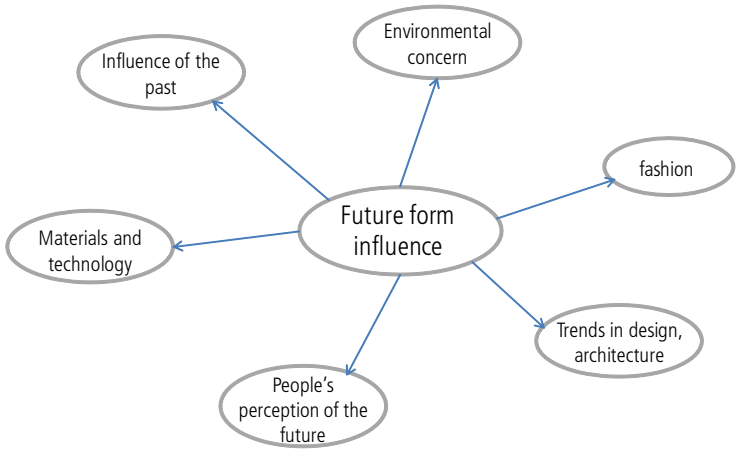
Most of the factors mentioned above pertain to styling and design; hence designers have the responsibility to make the car, a success.

Automobiles have undergone massive translation in the last five decades. The factors that have influenced this translation range from varying technology to change in perception of people; cultural influences; fashion to mention a few.

This project aims at developing a concept car for the future bearing in mind, among other things, the role that technology is going to play in the future.

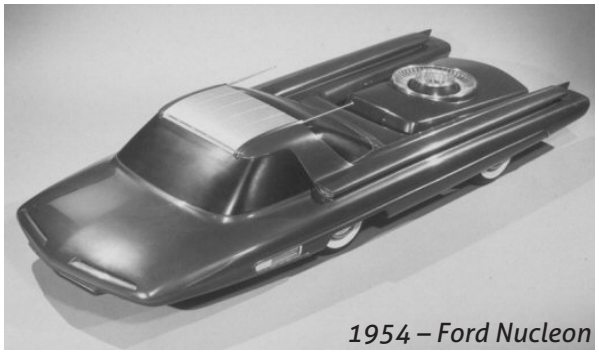
3. Factors Influencing Future Forms

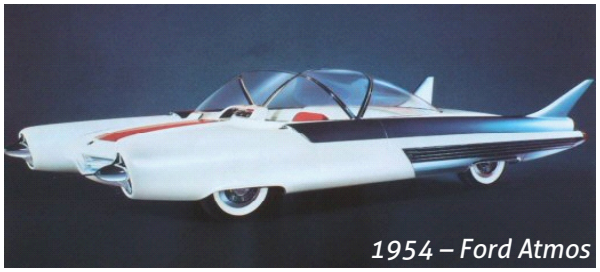
There are several factors that influence the form of an automobile. It could vary from the latest trends in architecture, to the materials and technology advancement during that phase. Even in the past, the forms and proportions were mostly influenced by events that had happened at that point of time. People's perception constantly kept changing according to what was perceived of the future. Environmental concern is another important attribute that contributes to the form/function of the vehicle.



3. Factors influencing future forms


1954 – GM firebird


1954 – Ford Nucleon


1954 – Ford Atmos

3.1 Influence of the past

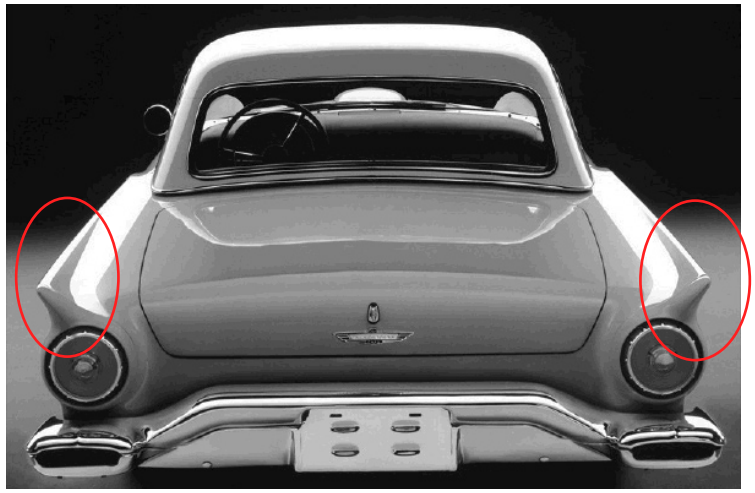
The perception that has been of the future in the past is an interesting benchmark for the present. This would give an idea why the concept car and hence the production cars looked the way they did.

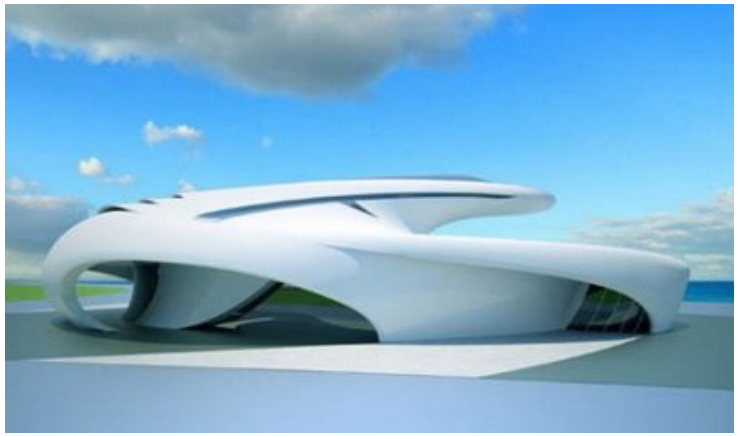
The 1950s and 60s was the era when US and Russia had their respective space programs in full swing. That was something that was completely new and futuristic. Space and rockets were so fascinating that space and space travel was considered the future of mankind.

Hence, most of the concept cars of the 50s and the 60s, even from companies like GM and Ford, had a very strong Rocket-inspired form.

3. Factors Influencing Future Forms

Shown here are the production cars of the same era. Though the production cars never happened to look like a rocket, most of the production cars of that era had a strong rocket semantic. The rear had visual features, which were prominently inspired by rockets tail fins/wings.





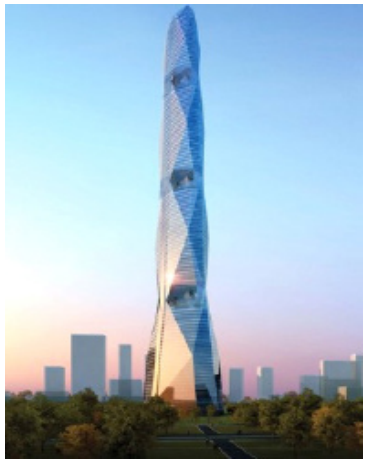
3.2 Trends in Architecture

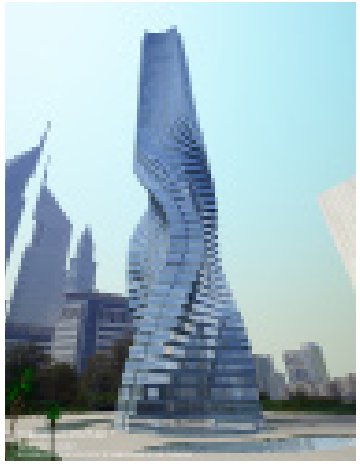
One way to understand how automobile forms may progress in the future is to understand how futuristic concepts will be in related fields of design. Architecture is one among them. Here are a few concept architectural models that might inspire new forms in automobiles.

3. Factors Influencing Future Forms

From observing futuristic architectural concepts, following visual features were derived.

- Complex yet geometric
- No symmetry/radial symmetry
- Perception of motion
- Unconventional finishes





Cars that run on CO_2 and emit O_2

Cars that go faster than sound

Flying cars

Cars that run on water (as fuel)

Intuitive control instead of steering

Modular cars for family

Wheel-less

Amphibious vehicles

Car that is your friend (knight rider)

Accident free cars

Single person cars

Cars that communicate with each other

Size adaptability based on family size

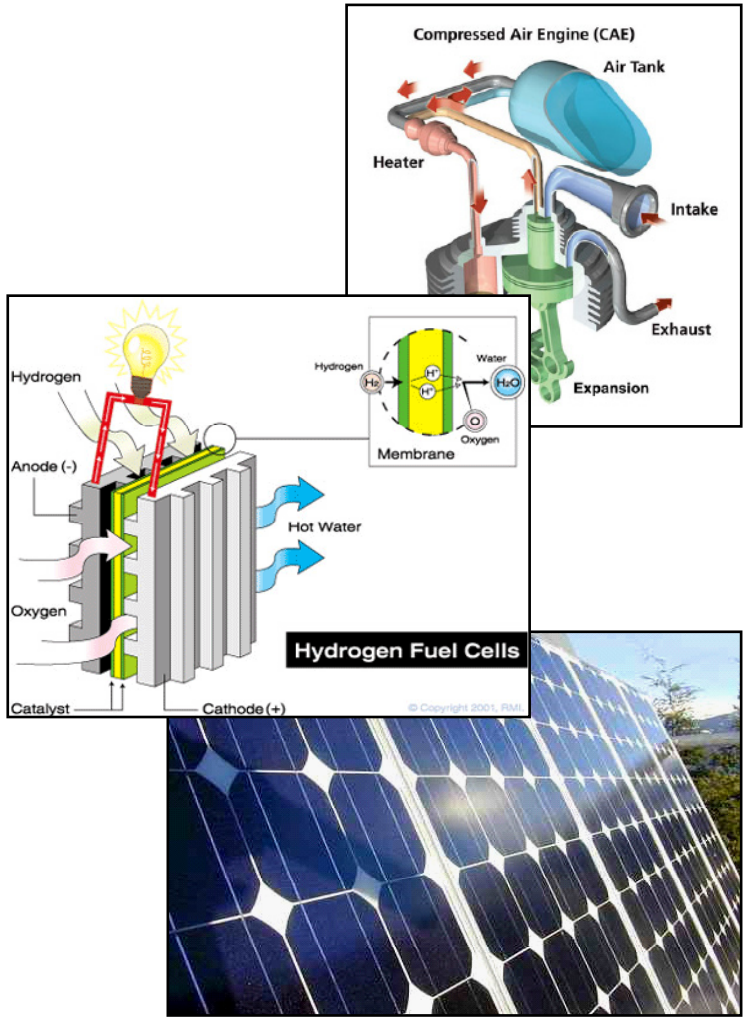
3.3 People's perception of the future

This is about the perception of people as to how the cars are going to be in the future. After interviewing a group of people, salient comments were listed down. After this, future car concepts were looked at to see what a car designer's perspective of the future is.

3. Factors Influencing Future Forms

The following inferences were derived at this point:

- Environmental concern
- Space concern
- Safety concern
- Need for speed
- Easy control
- Organic forms



3.4 Technology

Even though many factors have caused the form change, the underlying component in all the factors is technology and the changes in it.

Technology is perhaps the most important element that is going to influence the forms of the future. Changing technology in materials and drivetrain will be the stellar factors determining the future of automobiles and automotive forms.

Possible drivetrains of the future:

Compressed air engines
- Fuel cell
- Hydrogen ICE
- Electric vehicle
- Solar powered
- Magnetic superconductivity

Technology
- Inwheel motors with steering system
- Supercapacitor coupled Li-Ion batteries
- Solar nano-paints

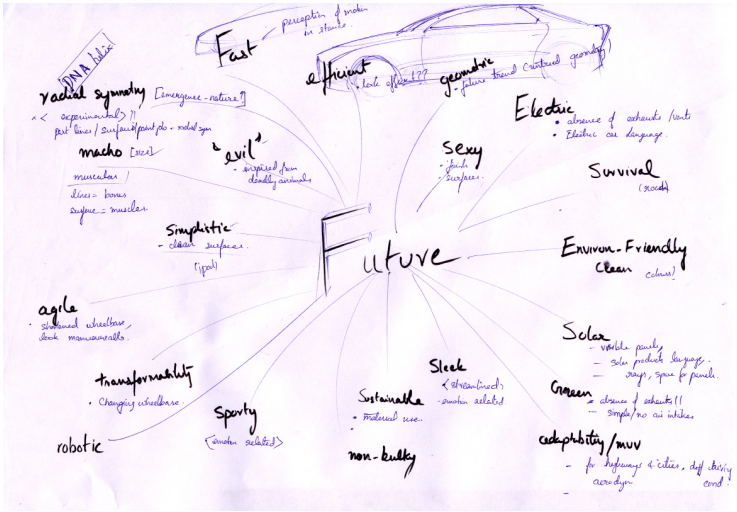
These are the possible technology options for the car of the future.

4. Emotions & Persona

As mentioned earlier, the emotion the car conveys is of uttermost importance. Here, the common emotions related to automobile are enlisted. These need not necessarily be pertaining to future emotions. These attributes have been derived from earlier analysis and hypothesis.

Now that the emotion is known, it has to be found out how the emotion could be implemented in the automobile. More specifically, how the emotions can be implemented on the form of the automobile.

In the next page, every emotion with corresponding way of implementing the emotion on the form is given.



Radial symmetry
Part lines
Surfaces
Colour combination

Fast
Perception of motion in stance

Efficient
Look efficient?

Geometric
Future trend
Simple geometric shapes

Evil
Inspired from deadly animals
Sharp form

Electric
Absence of Exhausts/vents
Electric car language

Macho
Muscular
Lines=bones
Surfaces=muscles

Sexy
Finish
Surfaces
curves

Simplistic
Clean surfaces

Future
emotions

Survival
Cockroach inspired

Agile
Shortened wheelbase
Look maneuverable

Environment Friendly
colors

Transformability
Changing wheelbase
Changing tracks

Sustainable
Material use

Solar
Visible panels
Solar visual language
Inspired from rays of light

Green
Colours
No exhausts/ intakes

Non-bulky

Sleek
Streamlined
Smooth curves

Adaptability/ Multi utility
For highways n cities, different driving cond.
Changing aerodynamics

Robotic

Sporty
Emotion related

4. Emotions & Persona

4.1 The mood board

In order to understand the emotions that were mentioned in the previous section, the emotions need to be visually represented. That is why the mood board needs to be made. Relevant images for each emotion have been collected and compiled into the mood board. Based on this mood board, the lines and the basic visual language is internalized.

Basic visual cues:

- Absence of exhausts
- Absence of air intakes/grilles
- Organic forms


speed
geometric
radial symmetry
robotic
agile / gracious
Solar
green / clean
sporty
transforming

4.2 The Persona

In order to understand what the future user might need in his car, one has to get into his shoes. For this reason, a persona is created. This persona represents the hypothetical user of the car, his needs, his frame of mind. It also extrapolates the kind of environment he would be in, the kind of gadgets he would use etc.

The person from the future will be very conscious about the environment, and will be determined in minimizing the carbon footprint of things that he uses. The society will take pride in being environmentally friendly and this will reflect on every individual's behaviour. They would like spending that extra dollar for being eco-friendly.

Next page has the image board of how the persona's environment would be, the bicycle he rides, the shopping malls he goes to, the kind of devices he would use, his home, his furniture and his office.

Name: Vishrut
Age: 31

Occupation:
Financial Analyst

Passions:
Motorsports, real-time gaming, 3d photography, music

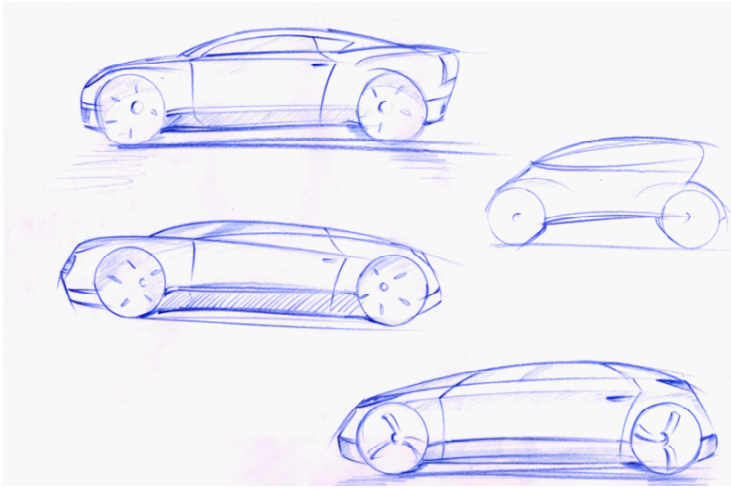
Sports:
Cycling

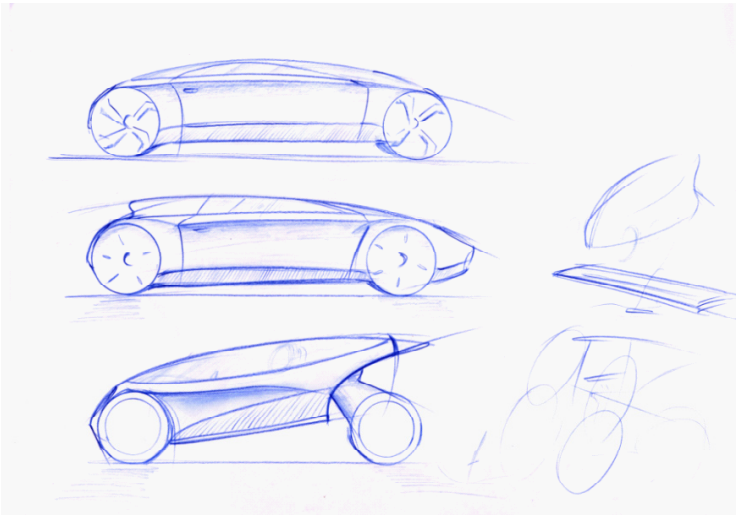
Activities:
e-book writing, voluntary work at enivronschool, weekend getaways


?
city
exercise / cycling
entertainment
work place

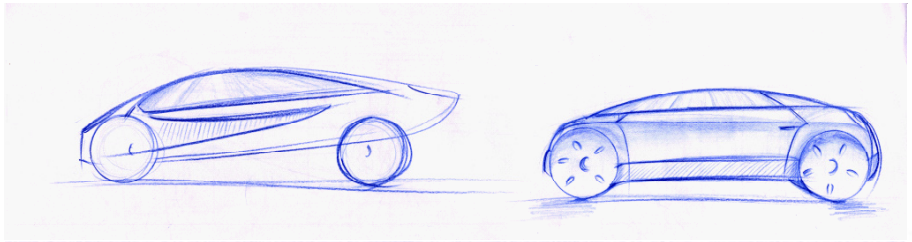
5. Ideation

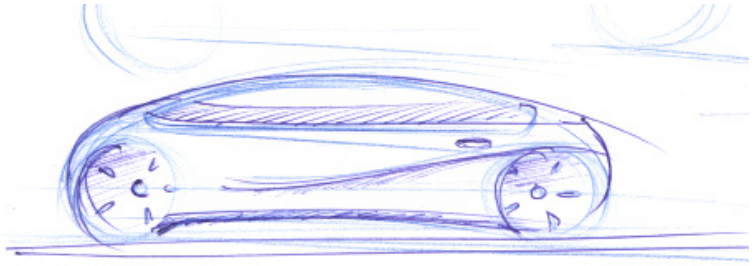
The last chapter gave an idea about how the lines and the visual language should be. With that at the back of the mind, ideation was started purely to explore various shapes and proportions without any kind of restrictions. This is a critical stage of the process as notions and visual cues manifest themselves into ideas. This process was done in parallel with research in technology.

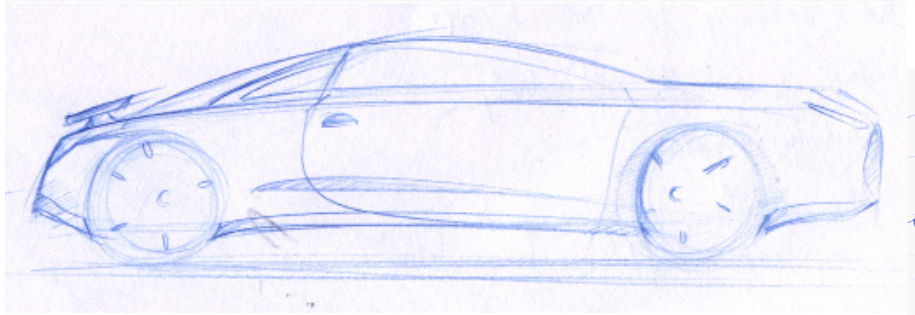


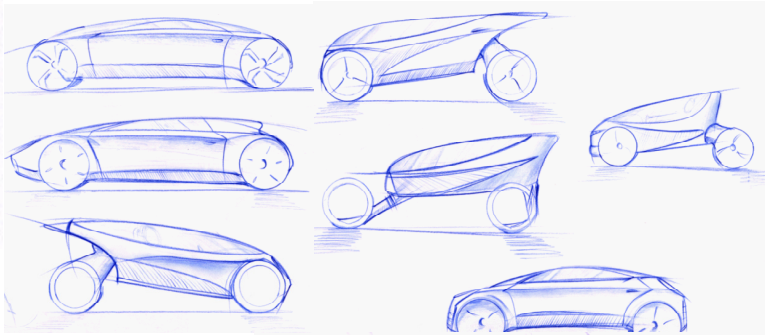


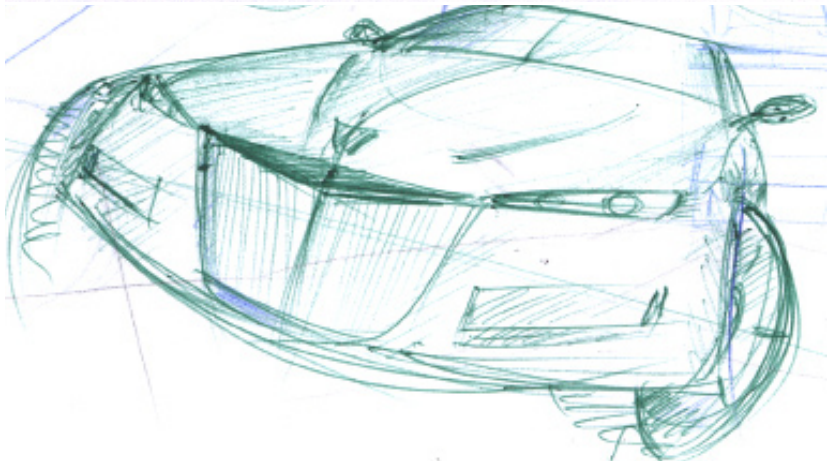
5. Ideation

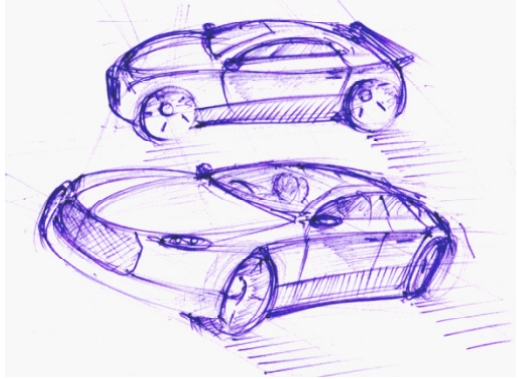






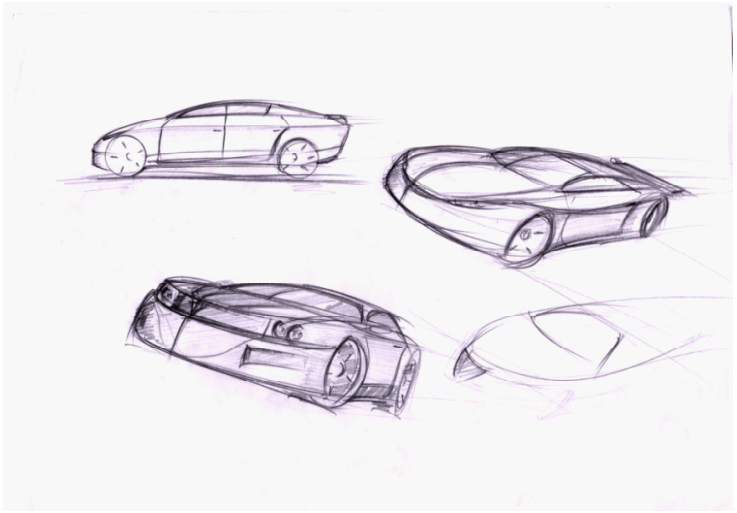


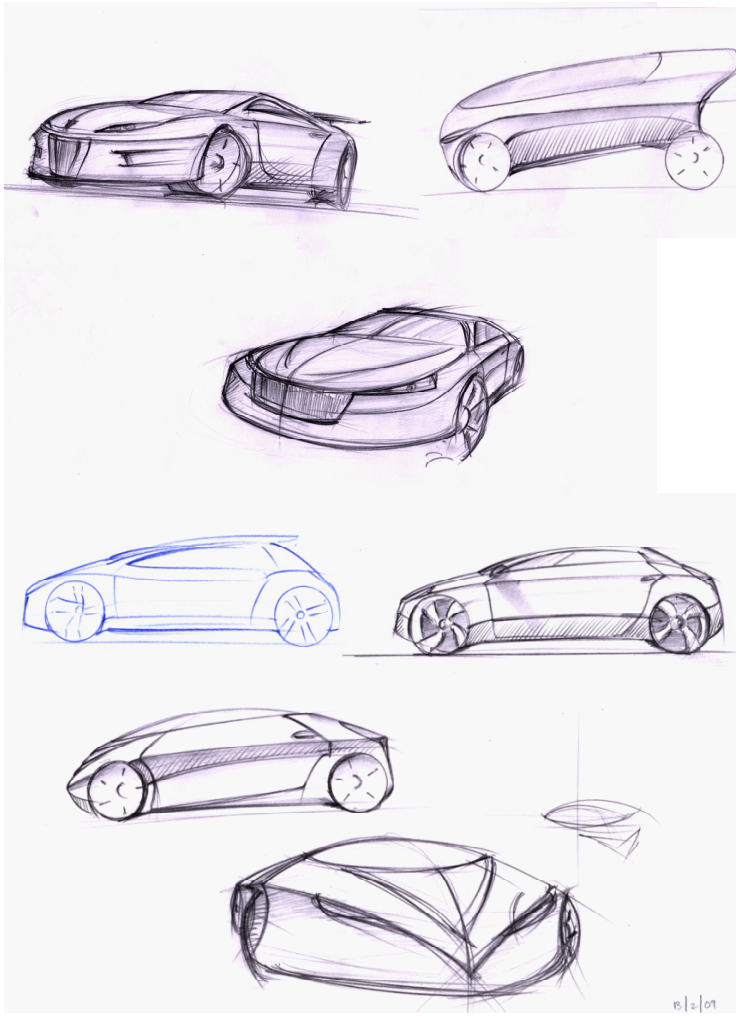


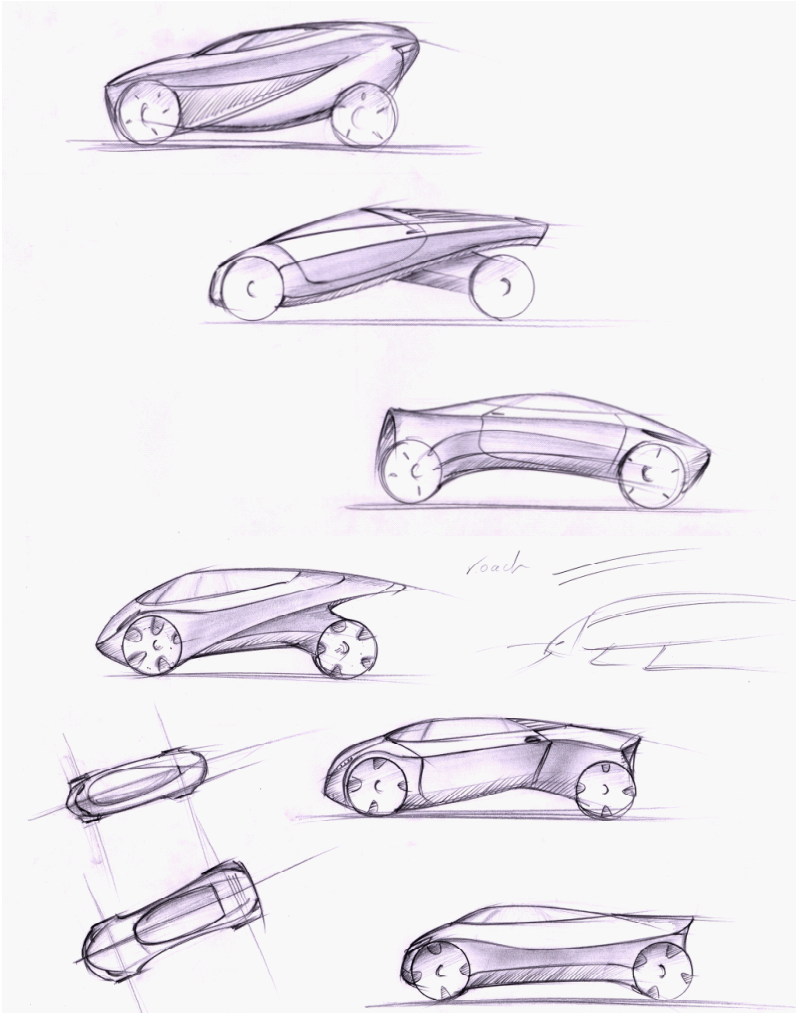


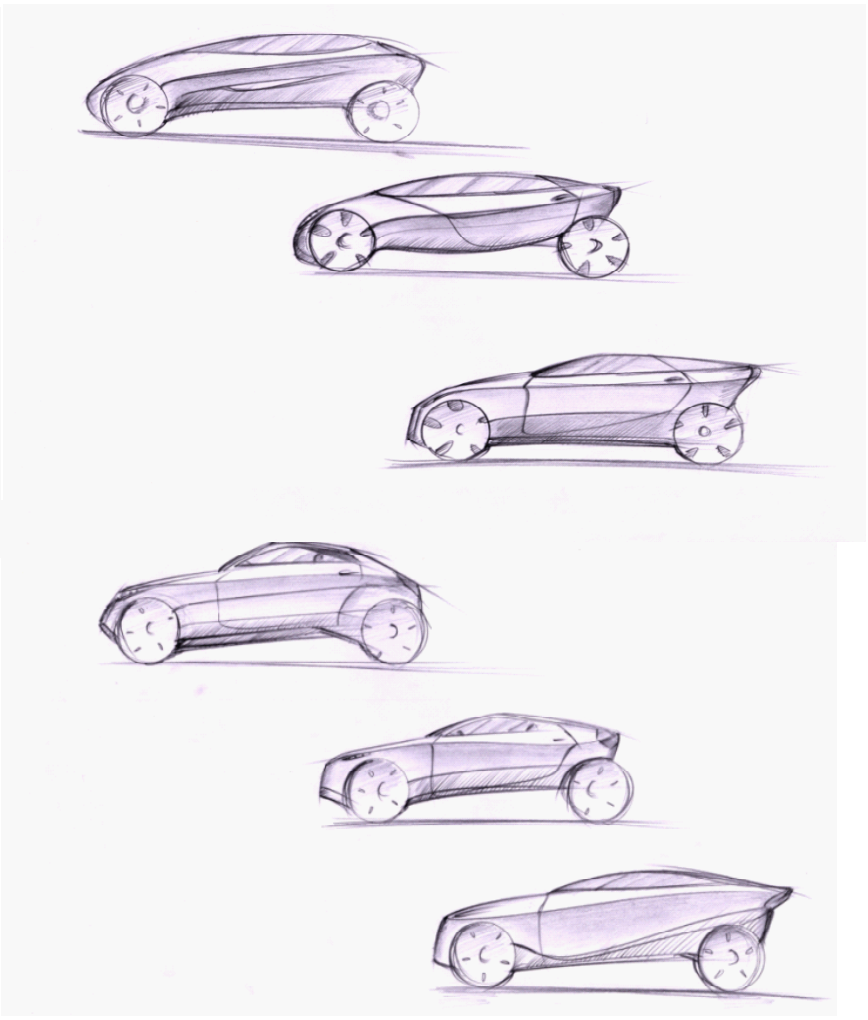
5. Ideation

Here, various form factors are tried out with inspirations from different objects and animals. The basic visual cue remains the same, absence of exhausts and vents. However a few were tried out to understand the impact of such visual cues. Some of these are inspired from an elongated sphere whereas others versatile stance of the vehicle.



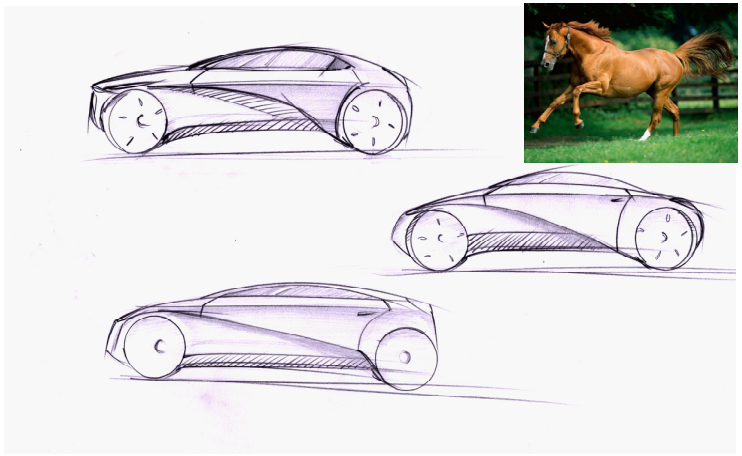


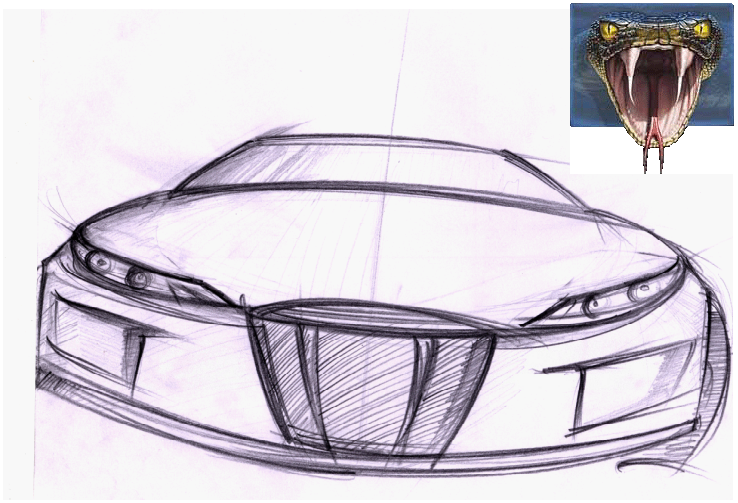

road

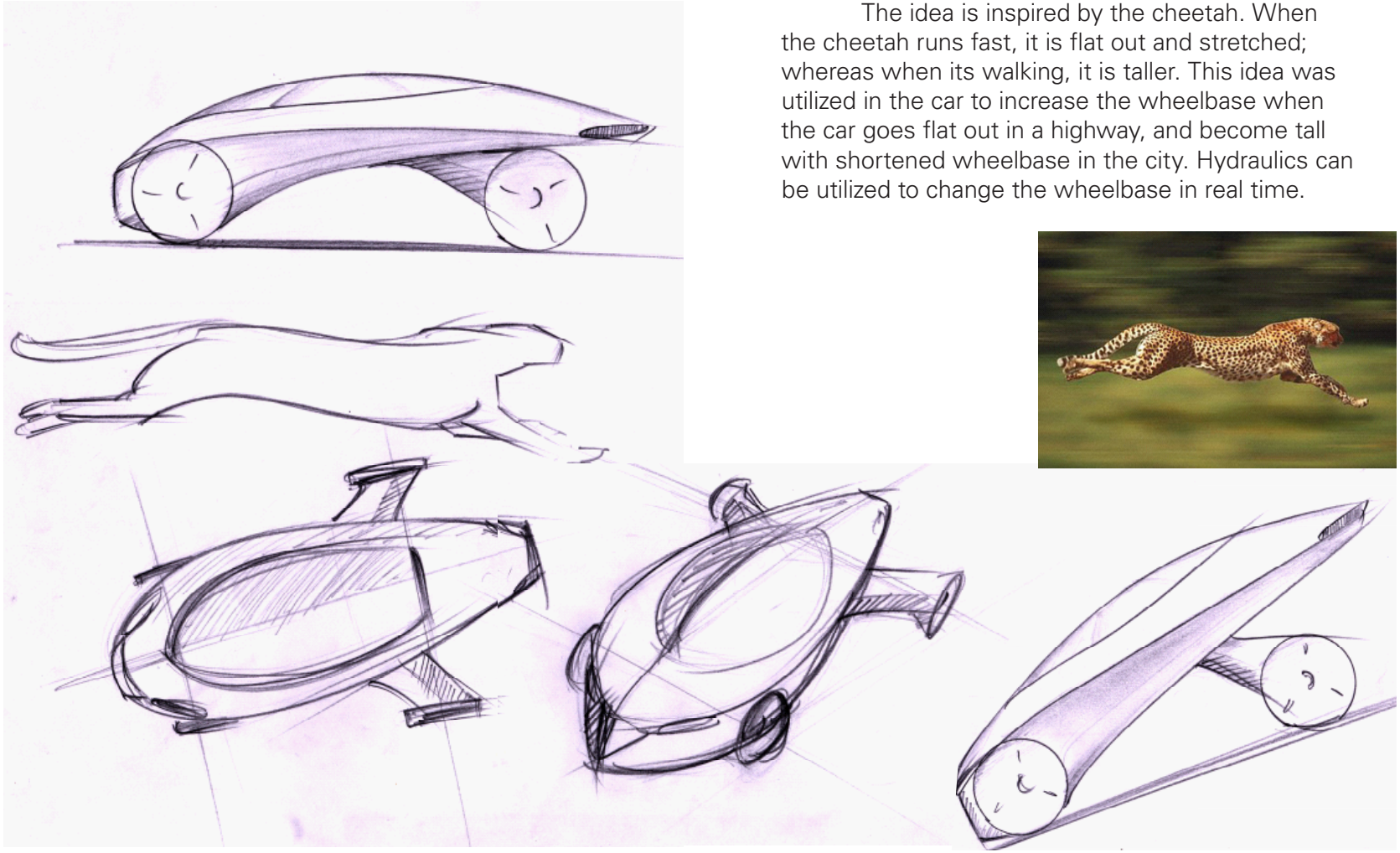


5. Ideation

The idea inspired by the horse has a very prominent secondary surface that accents the back muscle. This gives the car the stance and the strength. Three different variants of the same idea are shown below. The idea inspired by the viper snake is a direct application of visual features of the snake. The fangs and the eye sockets have become direct features of the car.



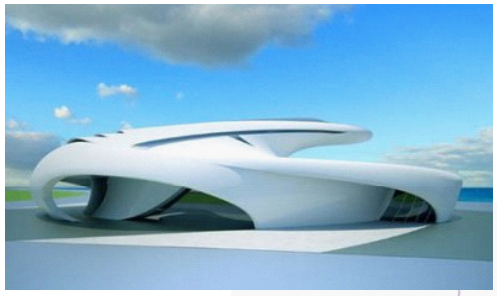


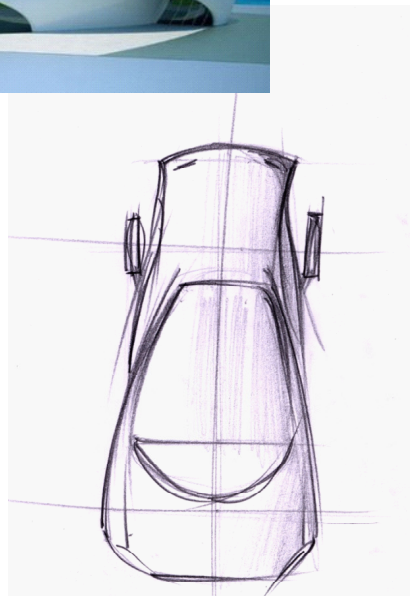


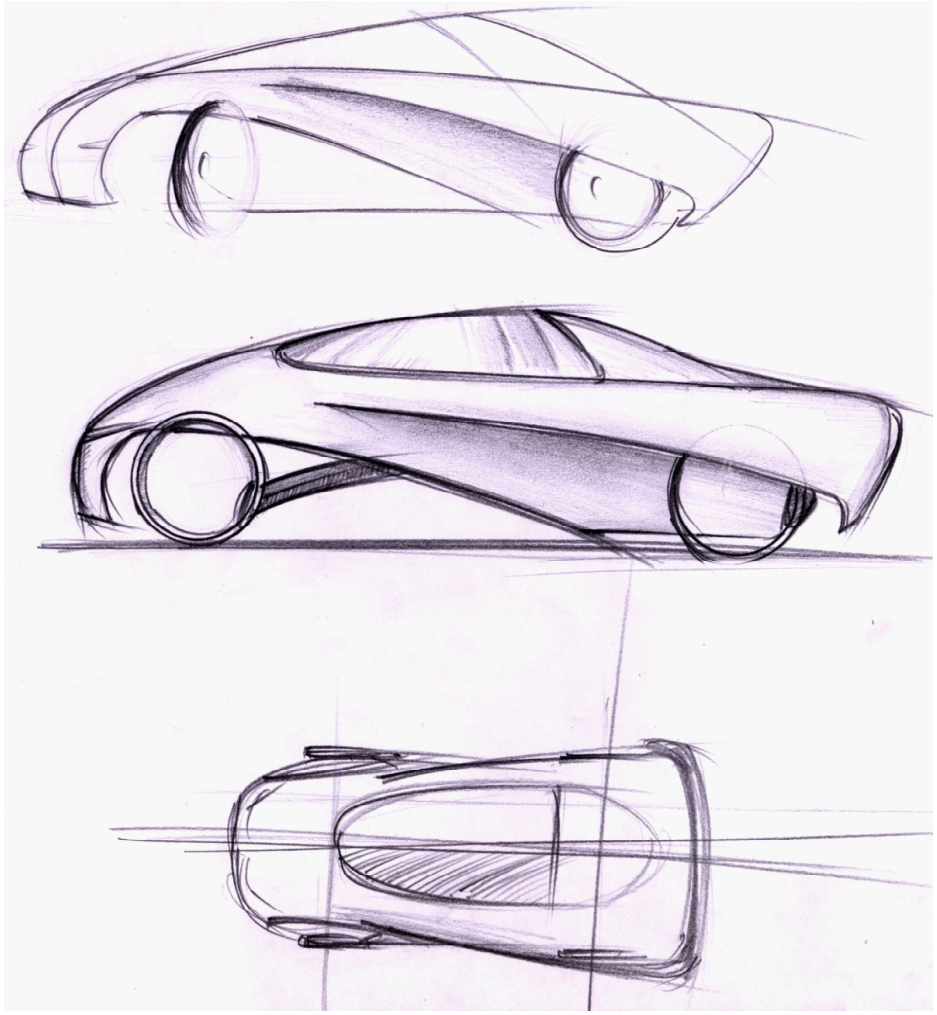
The idea is inspired by the cheetah. When the cheetah runs fast, it is flat out and stretched; whereas when its walking, it is taller. This idea was utilized in the car to increase the wheelbase when the car goes flat out in a highway, and become tall with shortened wheelbase in the city. Hydraulics can be utilized to change the wheelbase in real time.

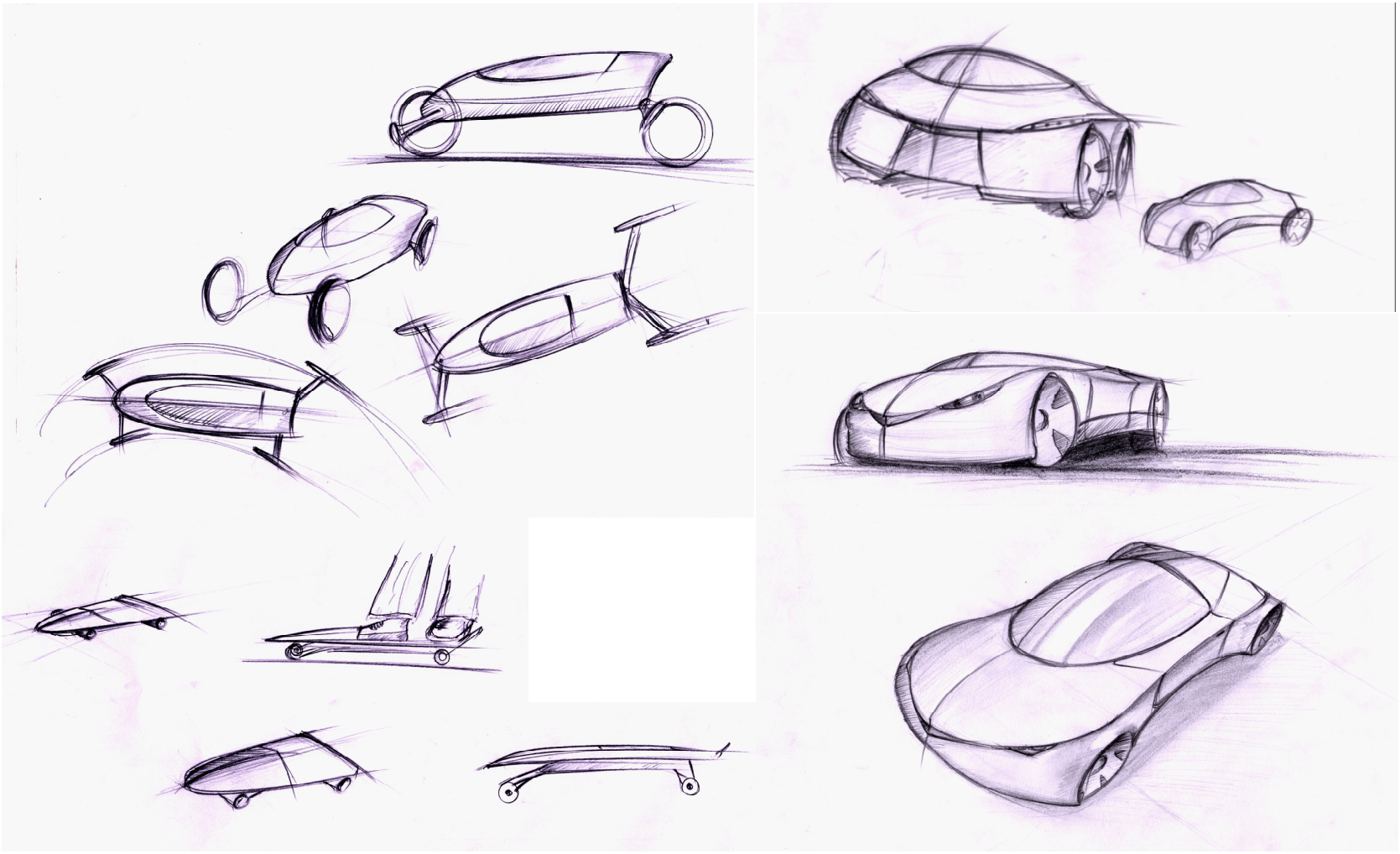
5. Ideation

The architectural concept shown in the picture uses completely radical form and surface treatment. The lines were so impressive that the rendering was chosen to inspire a car. The sketch shows how the car would be if it had been inspired by the building. Prominently different surfaces adds muscle to the car.



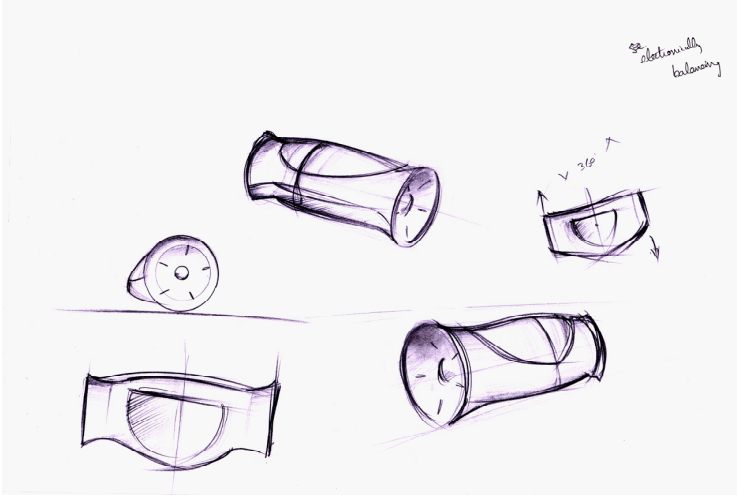


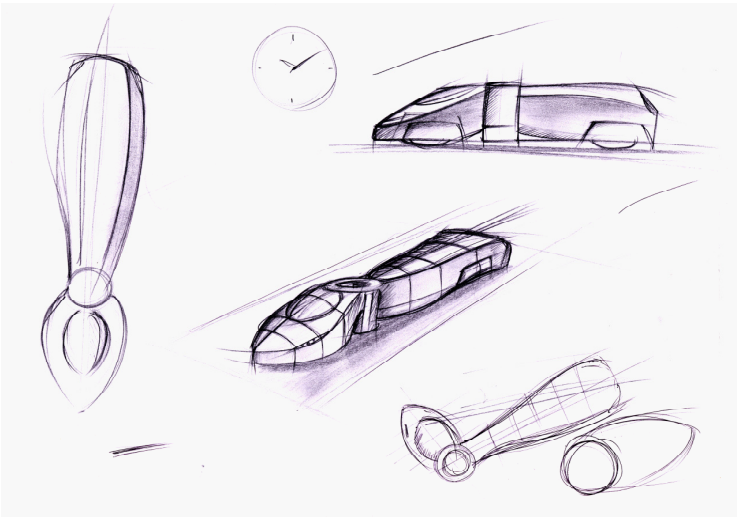


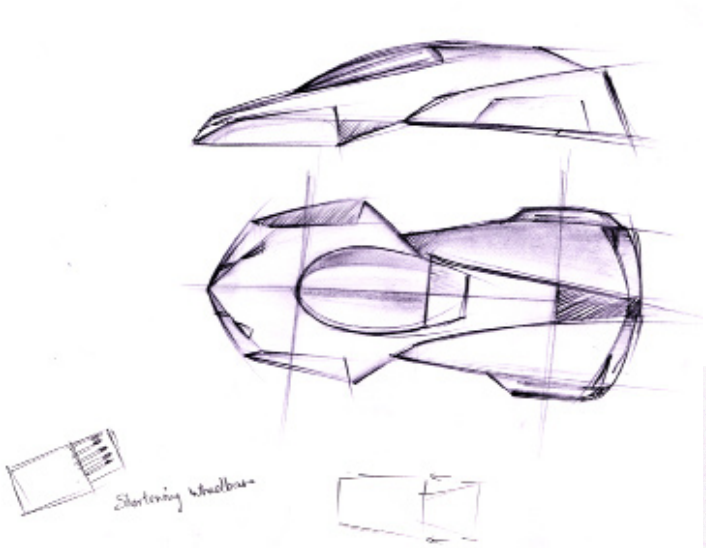


5. Ideation

When the ideas that were coming out were more or less car-like, it was decided to go for some entirely divergent ideas that may not look like a car. One was a powered skateboard with intuitive controls. The rendering below was inspired from a cylinder and will be electronically balanced. It is a two wheel car. The other on the right bottom corner was inspired from a clock.

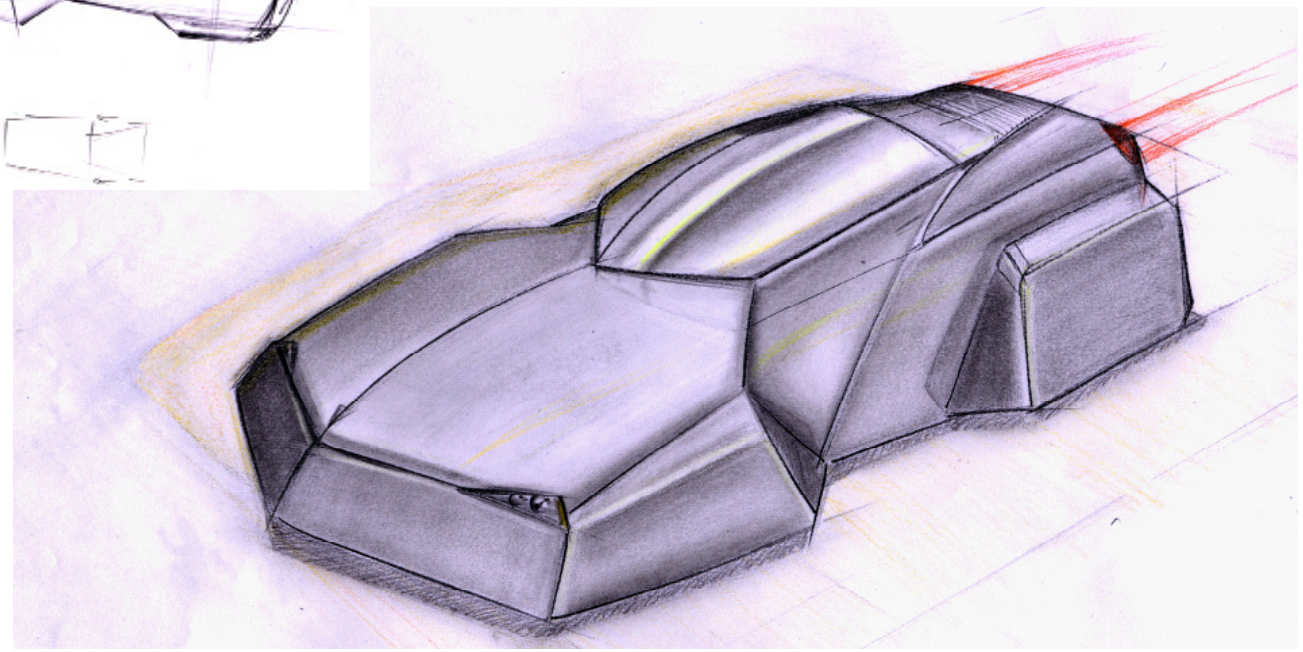






This idea was inspired from the functionality of a matchbox. The adaptability is brought in by the fact that the car adjusts its wheelbase according to requirement. The lines are such that it captures the speed of the vehicle. The overall form and the language was adapted from a fighter aircraft.

Shortening wheelbase also means that the seats on the rear join to the front to make the car a 2-seater, thus saving space as well.



6. Refocus

Michelin Challenge Design 2010

Even though the form, the proportions and lines were explored, it was realized that a specific direction was needed, as the avenues at this juncture were innumerable. This was when Michelin challenge Design 2010 was announced. The theme of the contest was relevant to what was aimed at from the project.

Theme of the contest as mentioned, was to design a passenger vehicle using innovative powetrain, which would reduce environmental impact and increase efficiency. It should contain one or more electric driven components in the design and should use innovative technologies in different components.

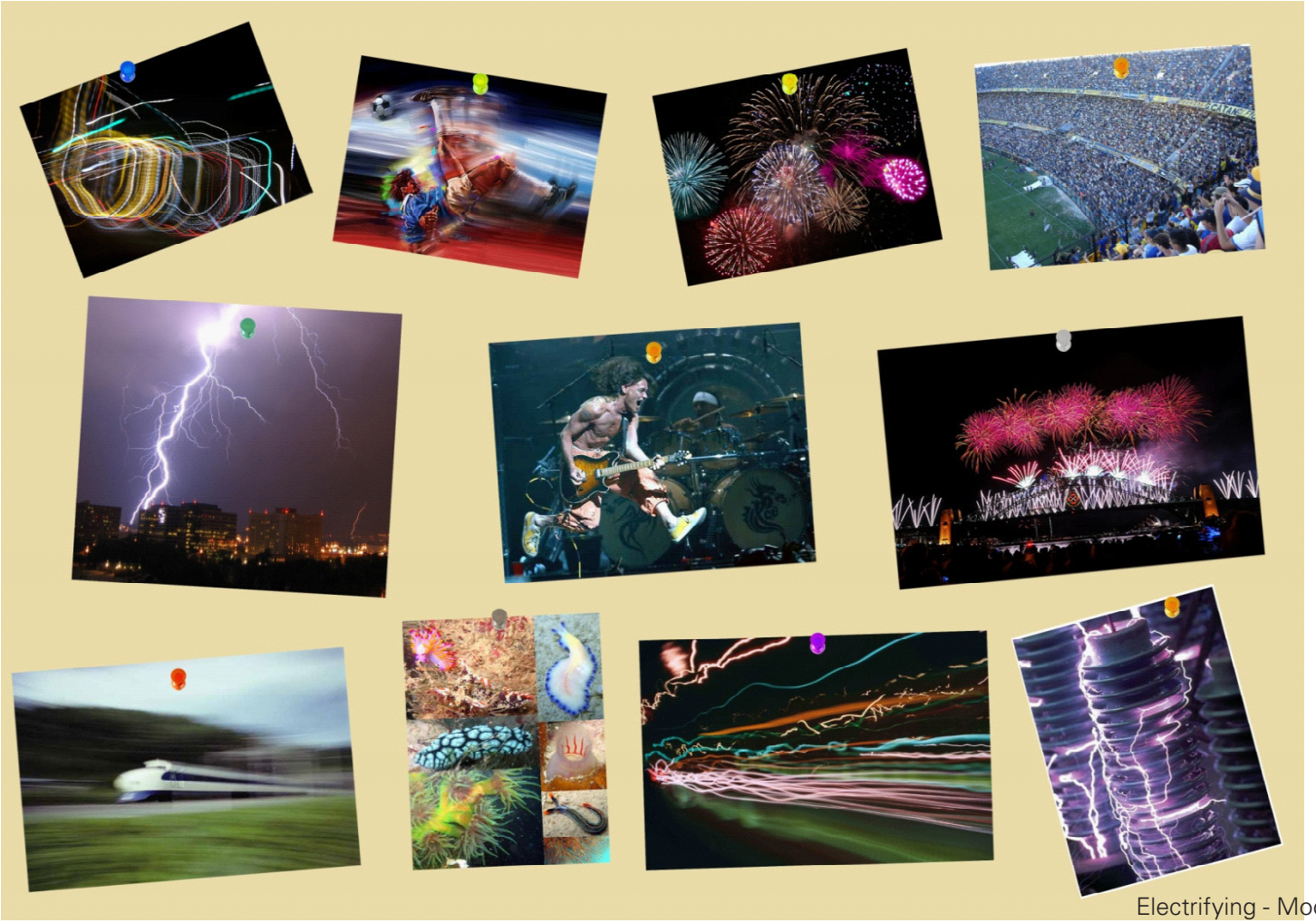
With the requirements in mind, specific mood boards were made for specific emotions that need to be conveyed. First, the emotion "electrifying" was chosen and then "radiant".

Direction:
Radically new Technology -----> New visual language for the vehicle

A regular office-goer's car remains stationary for almost 21 hours a day. This time should be put to use.

"The theme for the competition is **Electrifying!** Beautiful, Innovative and **Radiant**… using innovative technologies, materials, electronics, and shapes and sizes, in new and unprecedented ways…**vehicle featuring an** alternative powertrain … **minimize environmental impact** "

Michelin challenge Design 2010



Electrifying - Mood board

6. Refocus

"Electrifying" is an emotion that has myriad representations. The mood board on the previous page tries to capture most common manifestations of the emotion. In a direct manner, it could be represented by a stroke of lightning or the sparks (or more precisely, arcs) in an electric circuit. It could be an electrifying display of fireworks, or could be an electrifying atmosphere in sports. It can also be a brilliant guitar solo in a rock concert, lightning speeds in which train travels or it could even be just a splendid play of colours. With these ideas, a mood board was made to represent the emotion.

"Radiant" is more often than not, pertaining to light. When one thinks of the word radiant, one would imagine light or colors being emitted from a source or a point. It could be the sky that catches the sunlight and radiates, it could be an eclipse. Psychedelic lighting, especially in music concerts and dance floors could be deemed radiant. To sum up, 'radiant' as a line quality could be more of radiating lines from a point. As far as the colour is concerned, it is bright.

Radiant Mood-Board

7. Technology Research

One of the main factors mentioned in the competition theme was the use of innovative technology and powertrain. For this to happen, research needed to be done on technology and its appropriate use. After initial research on technology and possible green powertrains for the future, specific research was needed to be done for understanding the newer upcoming possibilities that might solve the problem of fossil fuel dependency.

The brightest ones were:

- Harnessing solar energy with nanotechnology
- Hydrogen production by biotechnology
- Compressed air engines
- Magnetic levitation
- Electric cars
- Hydrogen hybrids
- Bio-diesels

It would ideally be a combination of two of the above mentioned, to form a successful technology for the future. The ones that are to be seen in detail are the biotechnology and nanotechnology.

7. Technology Research

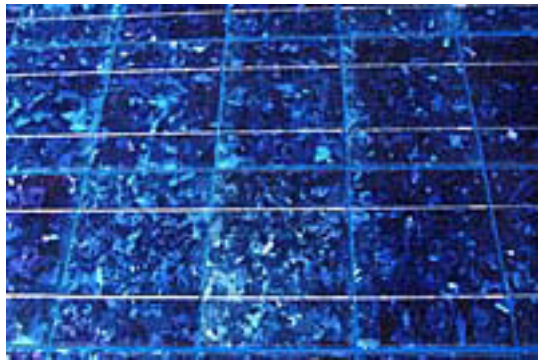
7.1 Nano coated spray-on solar cells

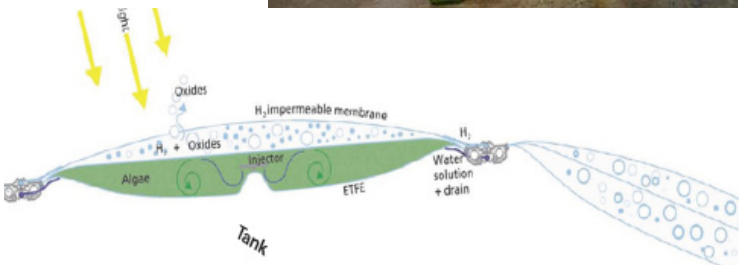
Sun delivers tremendous amount of energy to the earth's surface, and its hardly utilized to full potential. The basic bottleneck is the size of the solar panel that can be used and also the fact that conventional solar panels do not absorb energy from the infrared spectrum.

Scientists have now invented plastic solar cells which work on nanotechnology, that could be sprayed on any surface to act as receptors of solar energy. The main advantage is that it can absorb energy from the infrared spectrum, thus making it much more efficient compared to the ones that exist now.

This is another completely clean technology, with time could completely be the answer to all our energy needs.

- Sun Delivers more than 10,000 times the energy consumed by man today.
- Even if 0.1% of the earth's surface is covered with this panel, all our energy needs could be met.
- It is predicted that this technology will be able to harness almost 30% of sun's energy compared to 6% by the best of solar panels available today.





7.2 Biological Hydrogen production

Green algae can produce hydrogen gas, H_2, in a process called "biophotolysis" or "photobiological hydrogen production." This process is carried out by photosynthetic enzymes, which split water to obtain electrons, excite these electrons with photons, and eventually use these electrons to reduce 2H+ to H_2. The scientific challenge associated with this approach to hydrogen production is that the enzyme that actually releases the hydrogen, called a "reversible hydrogenase", is sensitive to oxygen. The process of photosynthesis, of course, produces oxygen and this normally stops hydrogen production very quickly in green algae. So, to overcome this problem, O_2-tolerant, H_2-producing mutants of the green alga Chlamydomonas reinhardtii was generated by various genetic approaches.

A normal algae can produces 100ml of H_2 per litre of of solution where as the mutants produce 500ml of H_2 per litre. Scientists predict that it would be five times greater than that.

Sunlight to H_2 efficiency - 0.1%
Efficiency for economic feasibility - 7-10%
Genetically altered algae - 2-2.5%
H_2 efficiency of the process - 10%

Scientists predict that it could be as high as 85-90% as photosynthesis is a perfect process.

7. Technology Research

First image shows the algae solution and the second shows the setup required for homemade production of Hydrogen.

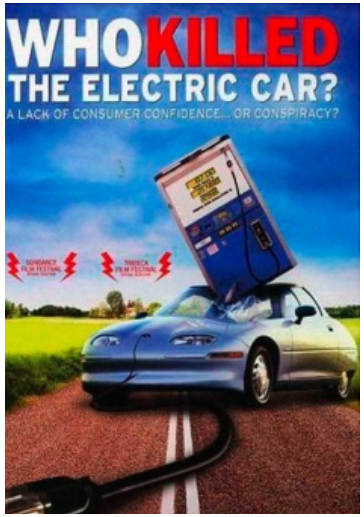
One of the more efficient methods is to keep the algae flowing continuously (using tubes), so that surface area does not limit the amount of H_2 generated. The gas is collected by downward displacement of water.

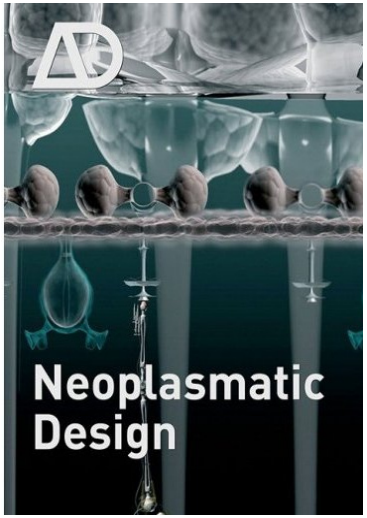
Understanding the algae technology:

Valcent Technologies specializes in growing different strands of algae for the purpose of extracting bio-diesel. Through a vertical setup the algae solution keeps moving constantly due to gravity. This way, the production is not limited by the surface area of algae exposed but by the volume of algae solution. It flows through large plastic pouches, almost like pipes and they keep constantly flowing. They get re-circulated from the same algae solution storage tank.
The key components are,

- algae tank
- transparent pipes or tubes containing algae solution
- H_2 storage tanks

These could be visual elements of the design to show the technology.
Hence, the technology is rewarding because the by-product of the H_2 production is oxygen, which could be released into the atmosphere.





7.3 “Who killed the electric car?” A documentary

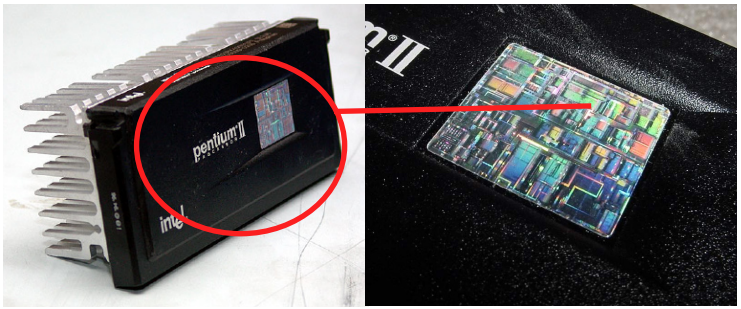
‘Who Killed the Electric Car?’ is a 2006 documentary film that explores the creation, limited commercialization, and subsequent destruction of the battery electric vehicle in the United States, specifically the General Motors EV1 of the 1990s. The film explores the roles of automobile manufacturers, the oil industry, the US government, the Californian government, batteries, hydrogen vehicles, and consumers in limiting the development and adoption of this technology. The film interrogates into the destruction of a perfectly fine Electric vehicle and the speculated conspiracy behind it.

7.4 Architectural Design magazine

The issue of Architectural Design magazine had its focus on neoplasmatic design. It had one of the articles as , a design of a perfectly eco-friendly building where algae was used in the exterior to actually purify the air around the building. It was cultured in precise conditions to give the output. This was when it was realized that biotechnology (algae) could be used in the car for fruitful purposes.

7.5 Technology Manifestation

Technology has manifested into product forms in many cases. In some, deliberate attempts were made to showcase technology in the form. For example, the Intel Pentium II processor had a completely new technology compared to Pentium I. Hence, the form factor was changed, and a piece of chip was exposed to show "high technology" (while serving the purpose of heat dissipation).



A few companies (especially energy companies, related to automobiles) exhibit their product through a concept car/bike that exhibits technology. Two well known examples are

- Env vehicle was designed to showcase fuel cells by Intelligent Energy company
- Pininfarina B0 was made to exhibit Bellore', an energy company in France.

In a similar way, the form should exhibit the algae technology.

7. Technology Research

Previously, all the other products that needed to be demonstrated through technology, had a form to it. But now, the technology, which is amorphous needs to be demonstrated through form.

Hence, amorphous products being given a language would be an interesting study.

The image shown is a water bottle designed by the famous designer Ross Lovegrove. The concept bottle, which looks like a disfigured bottle when empty, gets its characteristic when filled with water.

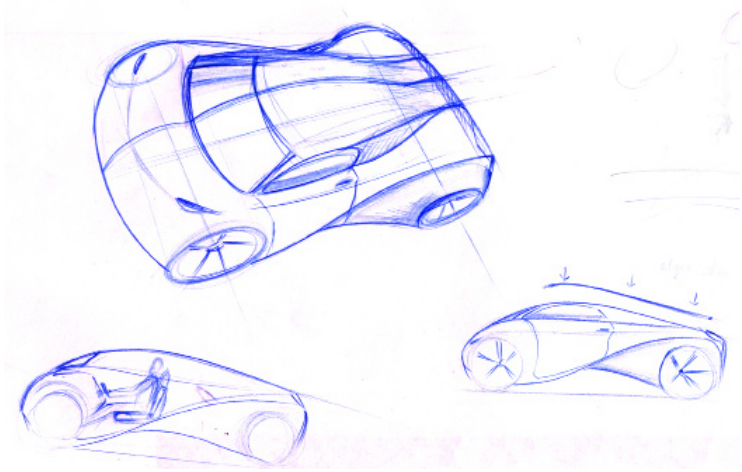
It could be an engine oil company like mobil 1 trying to express their catchphrase by the design language of their packaging.

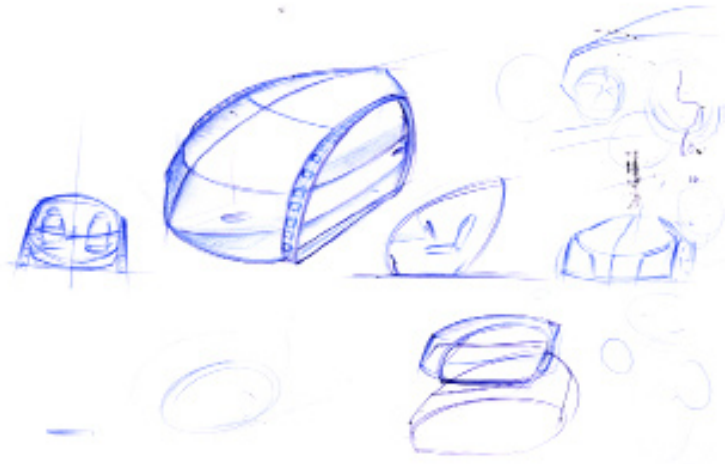
Hence, what is to be done here is to "Package Energy" into a relevant form.

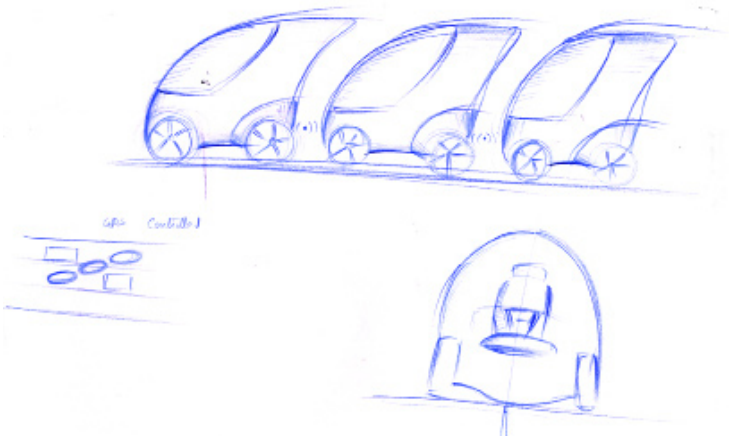
8. Concept Generation

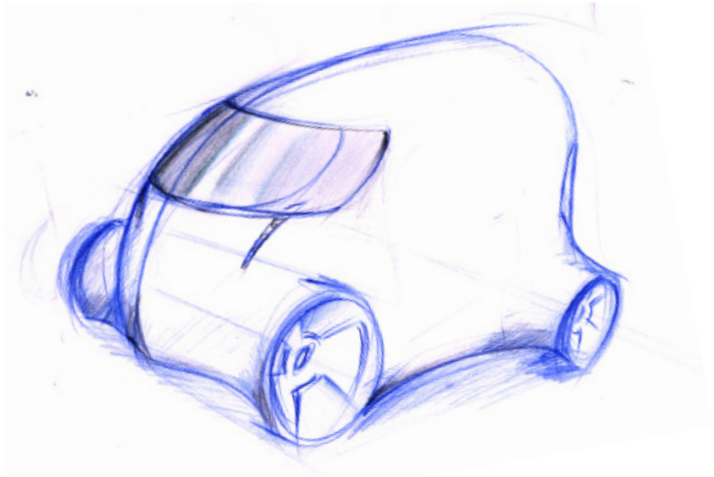
With the technology in mind, focussed ideation was done. The concepts were to be generated around the technology options that were mentioned earlier. The first few sketches were made with electric vehicles in mind, as the form could be completely anything, with a few visual cues.

Then, an organic form was sketched to bring out the bio-feel to it. Sketches were made with top facing surfaces for use with nano-coated spray on paints. Simple non-aerodynamic compressed air technology was also experimented with.







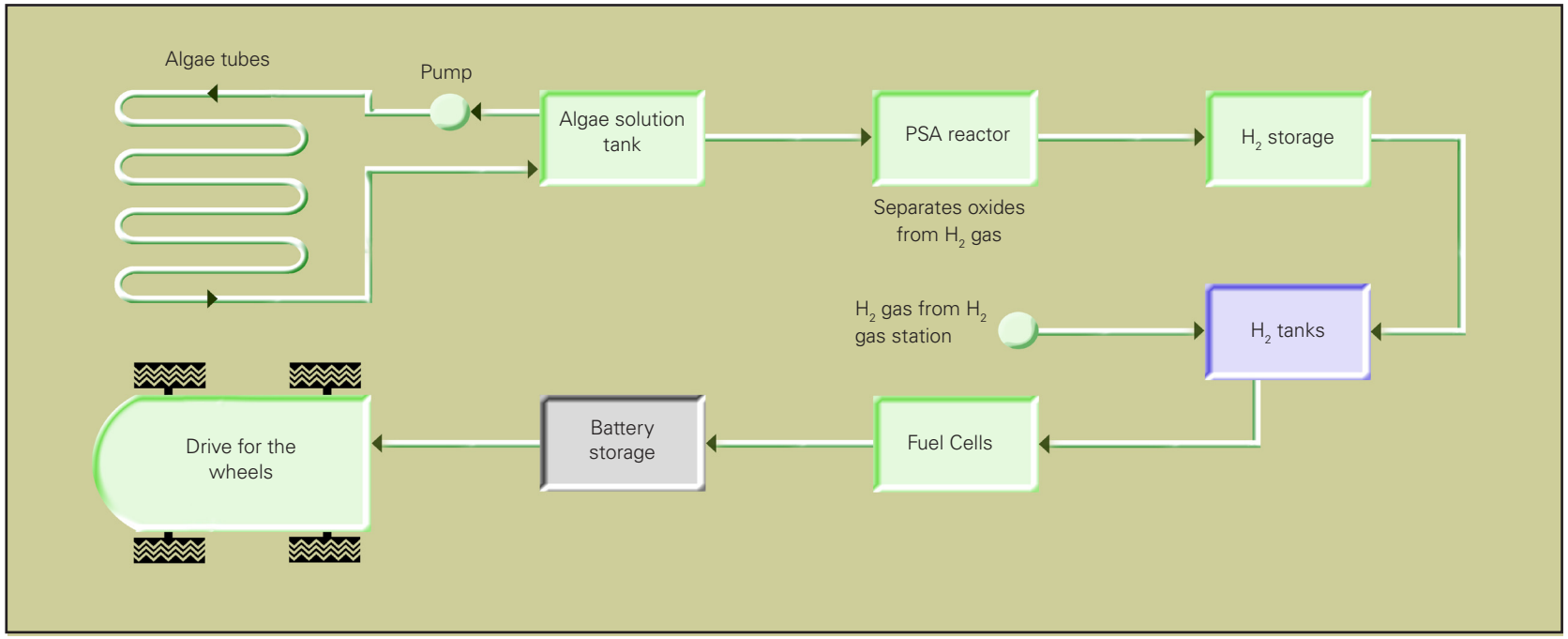


8.1 Algae Hydrogen concept

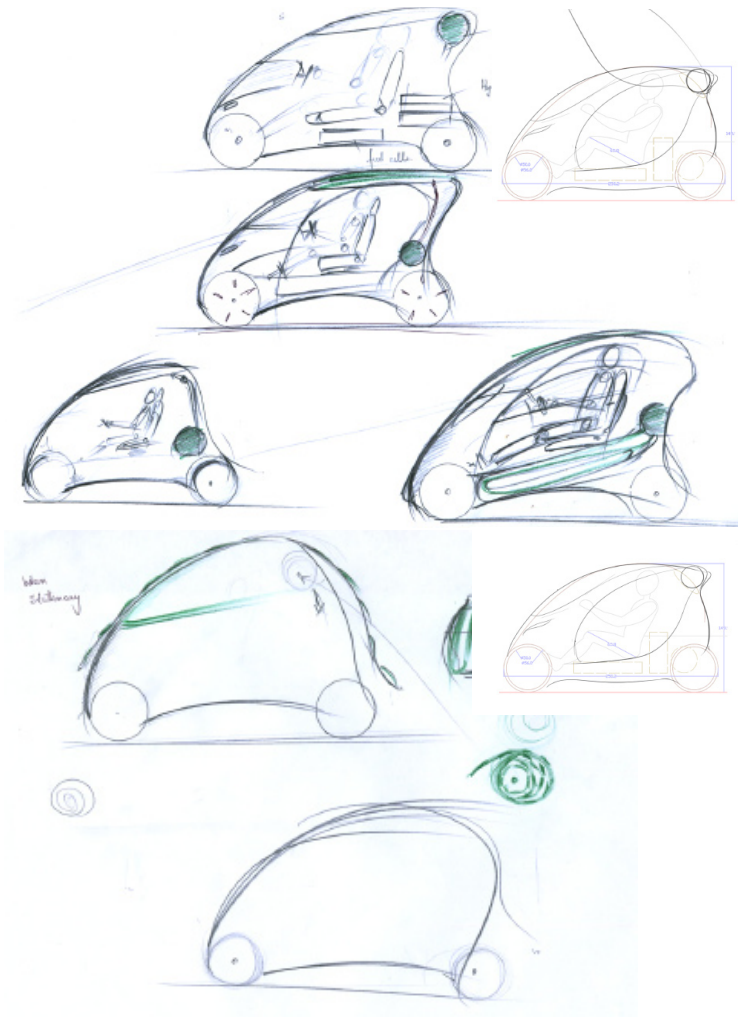
It was decided to choose the technology and build the concept around it. First chosen technology was Algae hydrogen production. Visually, the "bio-ness" in the concept needs to be captured in the form. This will happen by addressing the technology and building a form around it.

On the following page is the block diagram of how the algae system might work in a car. The tubes continuously keep circulating the algae solution which gets exposed to light. The solution is processed at intervals. It goes into the pressure swing absorptions reactor

8. Concept Generation



8. Concept Generation



Detailed ideation was done for the placement of the algae tanks and tubes on the surface of the concept. Whether tank should

1. Be on top of the car
2. Roll out when the car is stationary

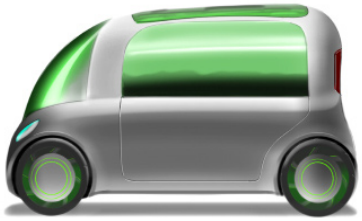
These were the two options were later evaluated against, to select one final concept for this technology.

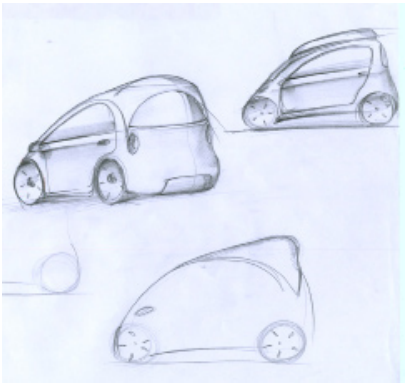
If one imagines the technology and thinks what it does, it actually breathes in CO2 and gives of energy for the car to run (hydrogen) and O2 as a by-product. So, what the car essentially does is photosynthesis. In short this is a living breathing car, that cleans the environment. The best inspiration would be the leaf, the idea is illustrated below.

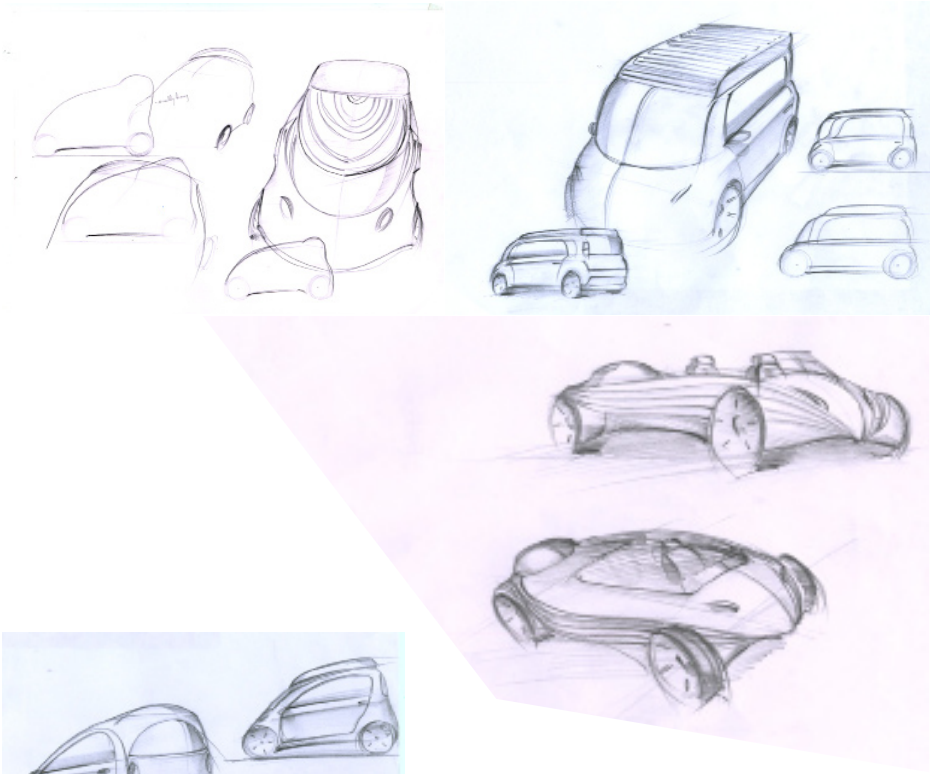
8. Concept Generation

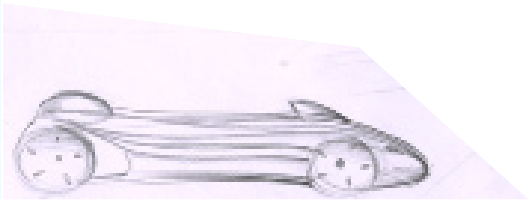
Different combinations were tried out for the flow of algae and how it could be placed in the car. Here, attempt was made to make the tubes carrying the algae, a visually prominent element. The bulge on the top of the car is that of the algae tank. Below, the algae tank is put at the rear of the car, and the algae solution flows all around the car to produce hydrogen. This was to demonstrate the technology as it is.

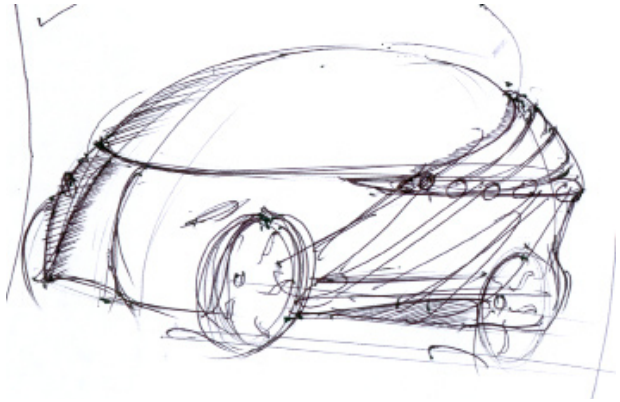
The side body is full of tubes containing algae, which is a visual element. It conglomerates into the algae tank, which is a sphere at the back of the car. The whole arrangement of the tubes that flow into the sphere conveys the fact that, the sphere (algae tank) is the source of energy.

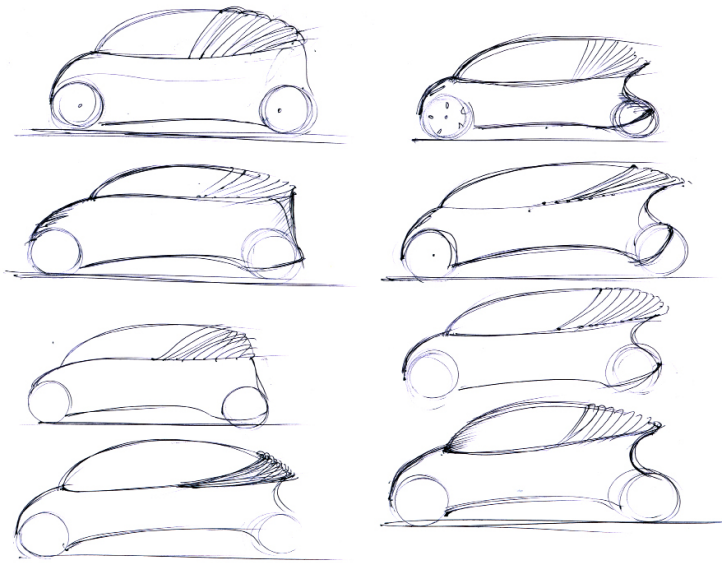






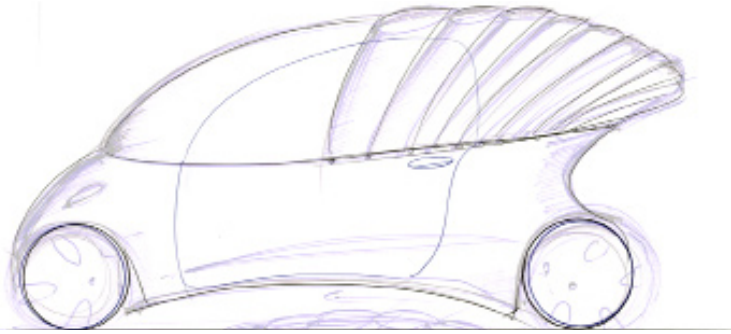






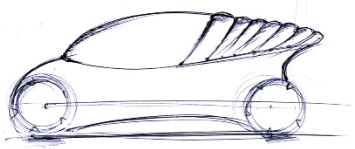
Earlier, the technology was to be exhibited by the presence of a prominent tank on top of the vehicle in addition to the tubes that contain the algae solution. That was specifically done to make the tank a visual element. It was felt that, the functional requirement and the requirement for exhibiting technology could be combined into one with further ideation. Hence, this idea was evolved wherein, the algae solution would flow in pouches around the surface of the car when stationary. These pouches would retreat when the car is in motion, which would create a prominent visual element at the back of the car.

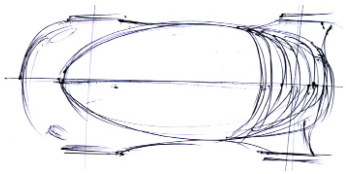
A few sketches were made to find out how to emphasize the rear structure to bring out the technology. Options were tried out with a flatter back and ones with a negative curve. It was found that the latter emphasizes the rear structure in the car. Within these two ideas, options were tried out.

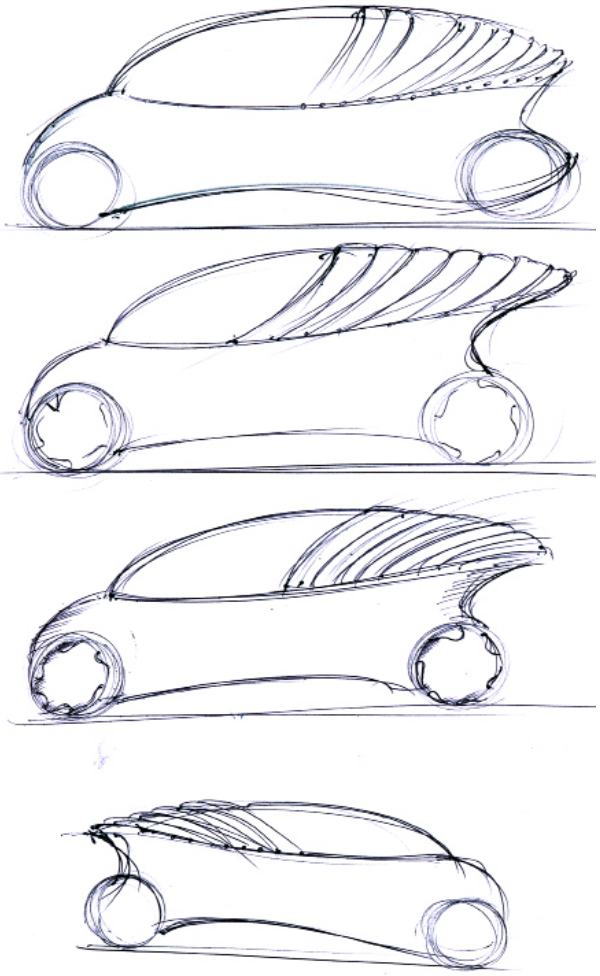


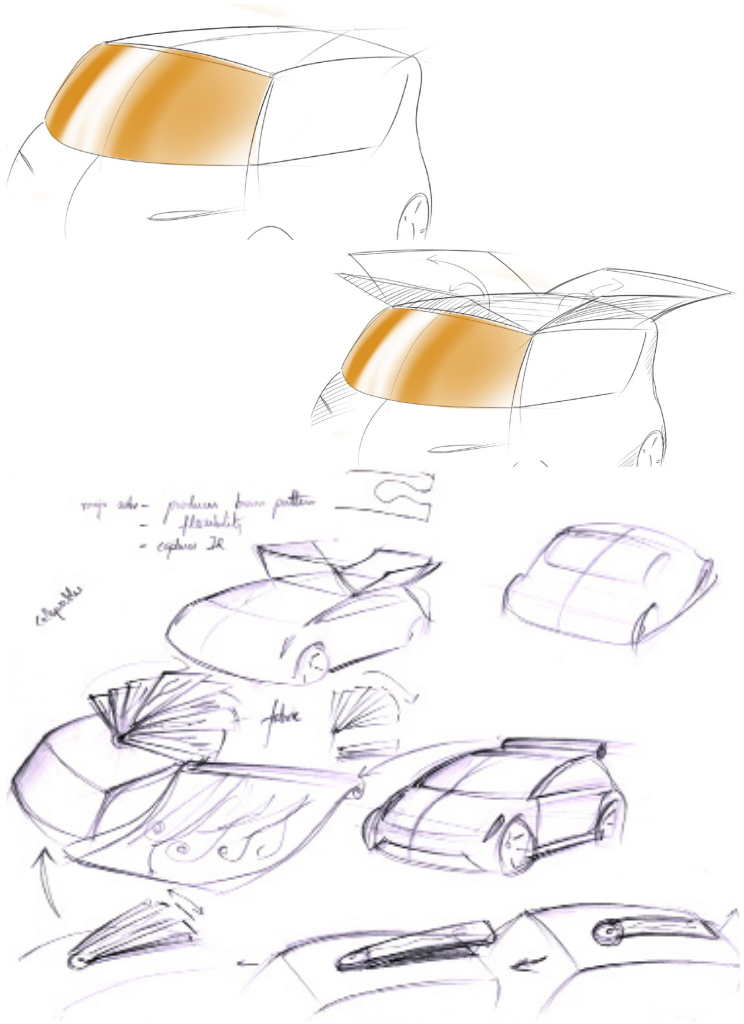
8. Concept Generation

With the ‘projecting out’ rear fixed, variations were tried out for the stance of the car. The sketch shows rails along the shoulder line, along which the whole structure would slide in to cocoon the DLO of the car. This would be electronically controlled. To concretize and visualize the idea, a quick render was made, which is shown below.









8.2 Solar nano-coated concept

From the technology research chapter, it is understood that the basic advantages of this technology over conventional solar panels are that

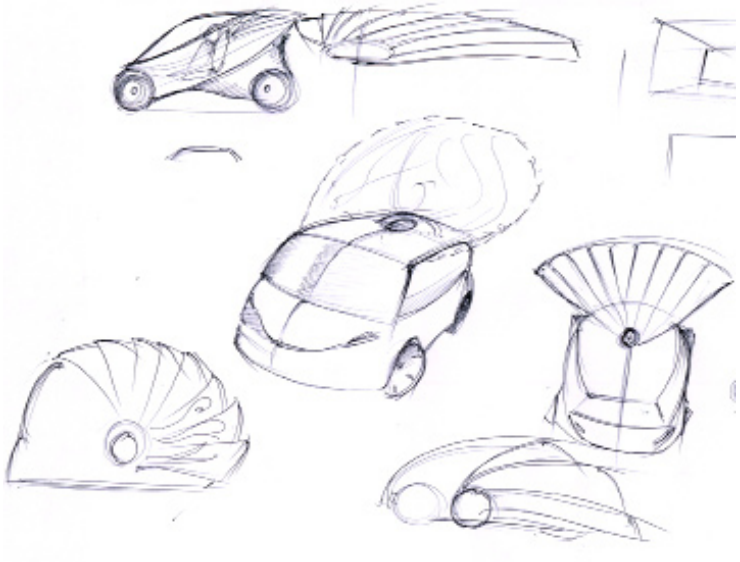
- This could be applied of flexible surfaces and materials too.
- The spray-on concept could be used to its advantage by producing patterns on the surface using this nano paint.
- It captures energy from the infrared spectrum thus, increasing the efficiency.

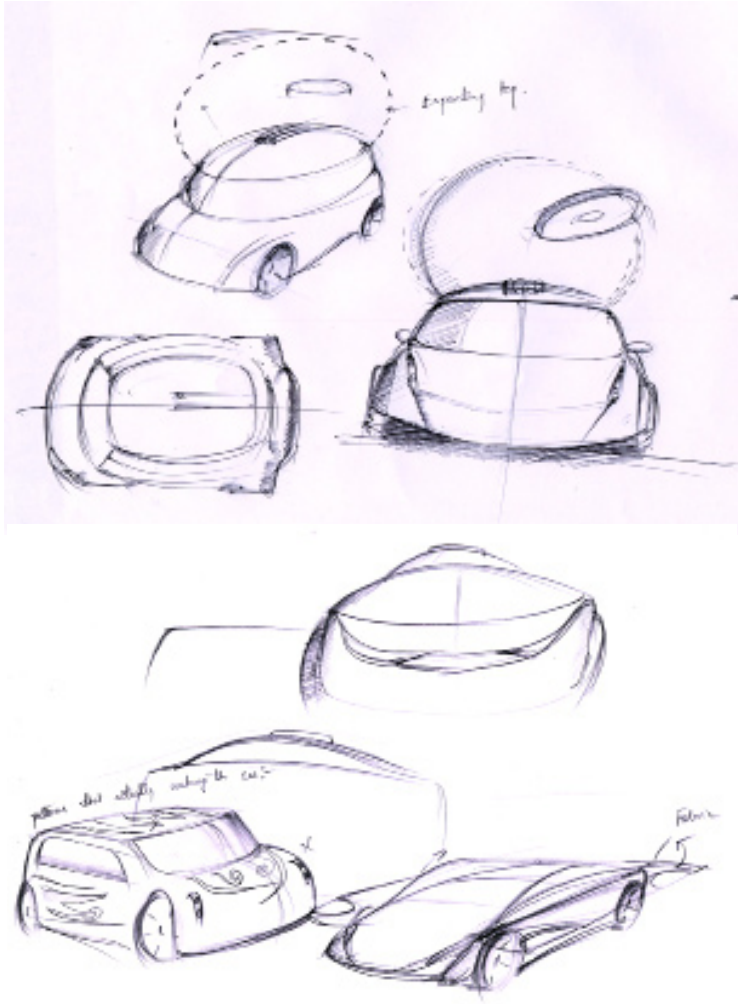
With these points in mind, and a few analogies, attempt was made to capture the technology in the vehicle. The basic principle of this concept would be increasing surface area, as that is what the technology is dependant on.

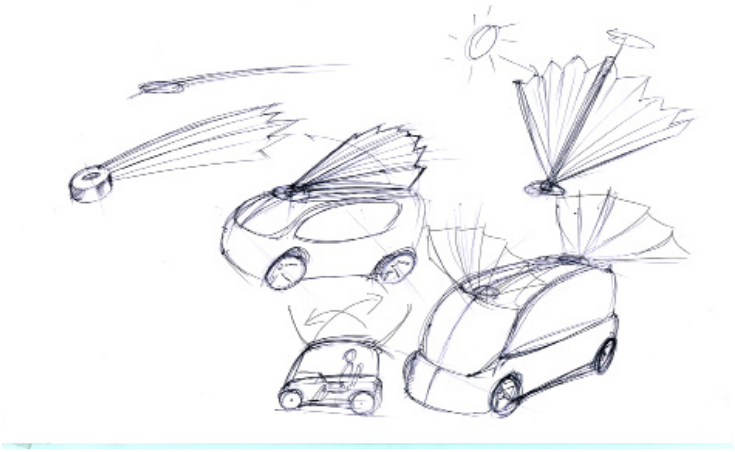
From the initial sketches, it was realized that merely opening the surfaces on top does not make the idea any different from a normal solar panel. To be able to use up this specific part of the technology, the flexibility and the fact that it produces patterns could be used up. The sketches show options wherein the patterns are painted upon the fabric that opens up when the car is stationary. Another way this could be done is to rollout a material containing nanocoated solar panels.

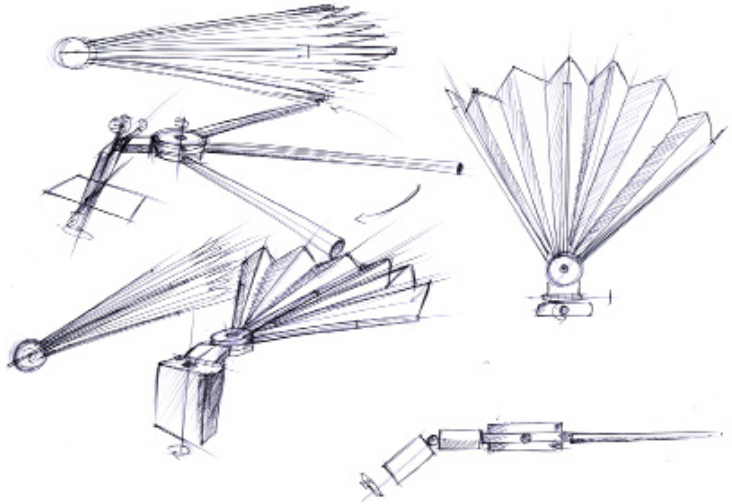
8. Concept Generation

A few more options were tried out wherein the increase in area of exposure is achieved by blowing of a balloon material on top of the vehicle, which contains the nano spray on solar paints. Ideation was also done to work out how the opening up of the panel happens.

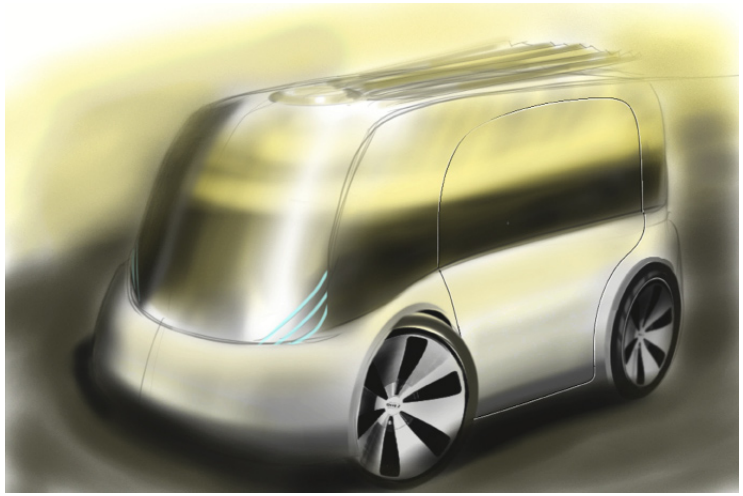








Here, the details of how the opening mechanism is made and the final idea are shown. The top would contain the fabric that would open up on two sides, and then open up about its own axis to further increase the surface area of exposure.



9. Concept Evaluation

Product brief

To design a 2-seater concept car using innovative powertrain for city use in the future.

User
- Pride of owning a clean car
- For regular office goers
- Travel less than 150Km/day
- Ease of use

Technology
- Should be an answer to green energy needs of the future
- May not be feasible today, but with time, would be practical and economical.

Scenario
- Society conscious about individual carbon footprint
- Welcome green technology as they have disposable incomes
- Stringent Laws governing emission and environmental impact.

The evaluation criteria was derived from the product brief that was made.

Concept evolution:

User
- Aesthetic appeal
- Ownership pride
- Room
- Distance travelled
- Ease of use – parking, ingress/egress

Technology
- Addressing of technology
- Concept evolution
- Feasibility

Scenario
- Impact on environment
- Whether system level?

With these parameters, the concepts were evaluated.

The two concepts were evaluated against each other to select the best. Ownership pride and addressing technology were given special weightage as the focus was on that. The algae technology was evaluated as the best for the current purpose.

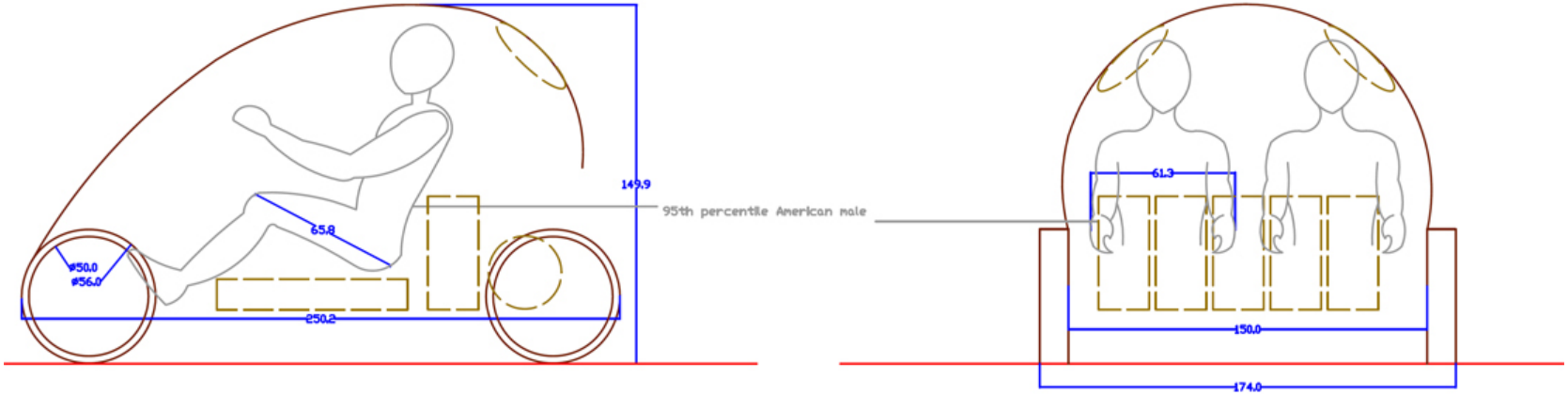
Concept Selection		
	01 : Nano coat	**02 : Algae**
User		
Aesthetic appeal	3	4
Ownership pride (3x)	4	5
Distance travelled (hypthesis)	3	4
Ease of use in city (parking etc)	2	5
Technology		
Addressing technology (3x)	4	4
Concept evolution	3	3
Feasibility	2	1
Scenario		
Impact on environment (lesser the better)	3	5
Whether system level	3	5
	45	59

9. Concept Evaluation

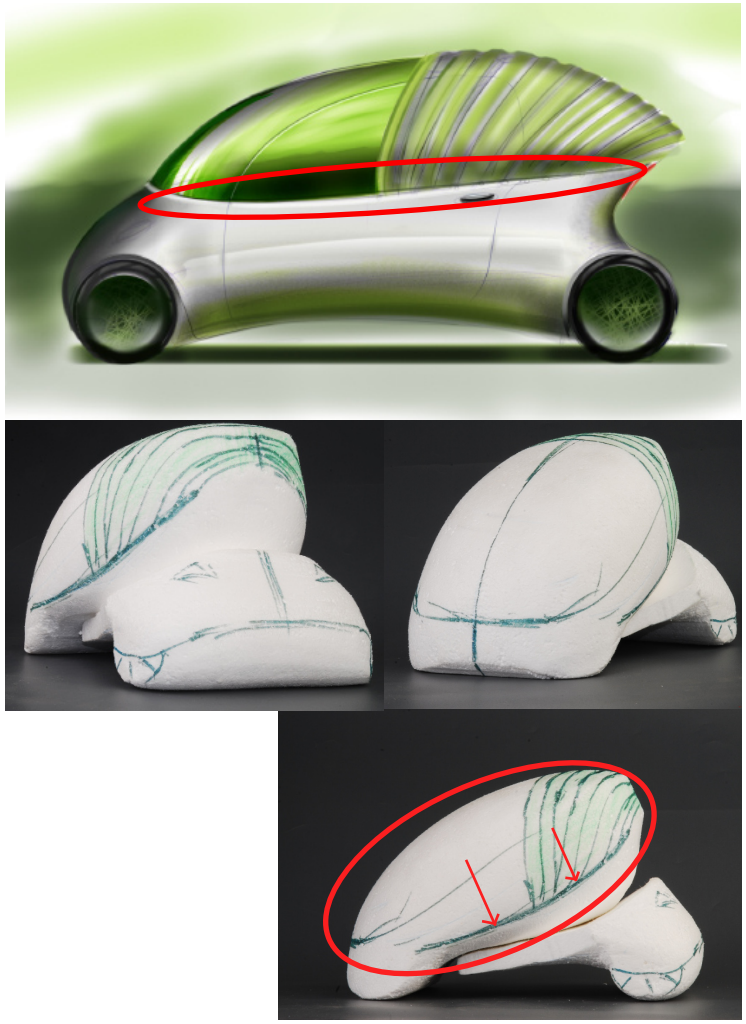
First, basic packaging needs to be done to accommodate a 95 percentile American male. The package needs to contain space for

- 2 95 percentile American males
- Hydrogen fuel cells
- Hydrogen tanks
- Algae tanks

Different layouts were tried out and the layout shown was arrived at.



9. Concept Evaluation



The algae concept was selected for further development. The concept was analyzed thoroughly and the a few observations were made that needed to be changed.

Even though the conventional language of the car was broken, the straight shoulder line was still a strong visual element that was present in the car to remind one of the old visual language.

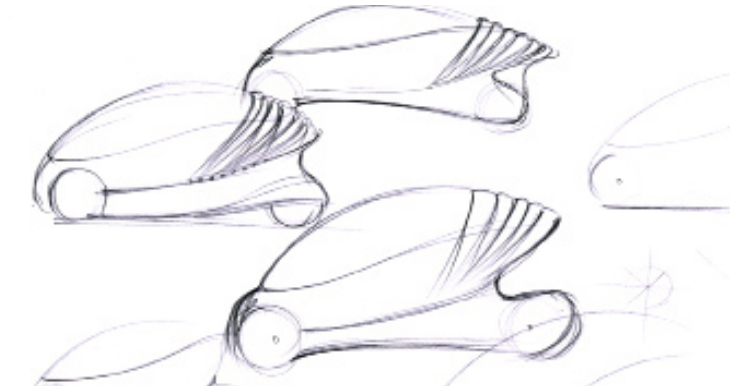
The fact that the rails of the algae tube cover runs along that line, stresses on the presence of a prominent shoulder line. Also, the algae component of the car needed more prominence. Hence it was decided to visually break the algae component of the car from the rest of the car.

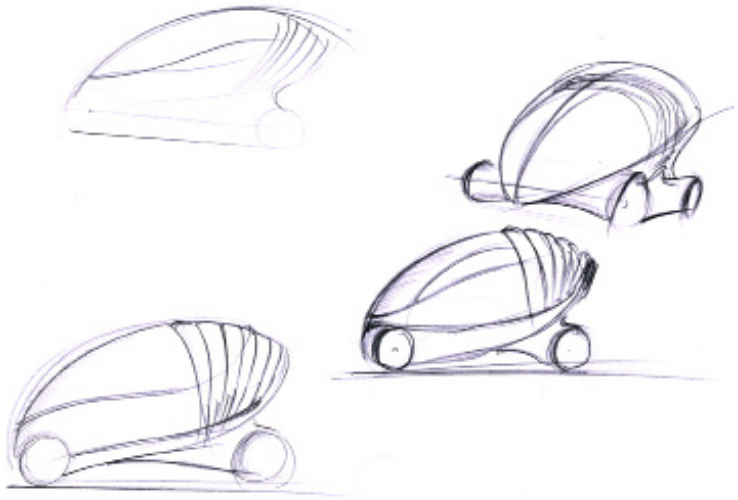
To visually separate the algae component from the rest of the car, a mockup was made to physically separate the two components, as shown in the figure. The components were physically and separated and placed together with minor modifications. This brought in a lot of importance to the technology that drives the car. The angle of the shutlines were made more dynamic to emphasize ‘flow’.

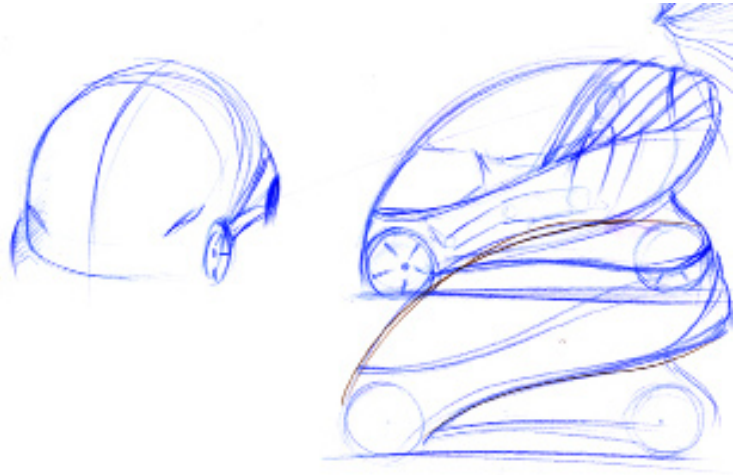
Also, the algae pouch that covered the top of the car was increased to cocoon the algae component when stationary.

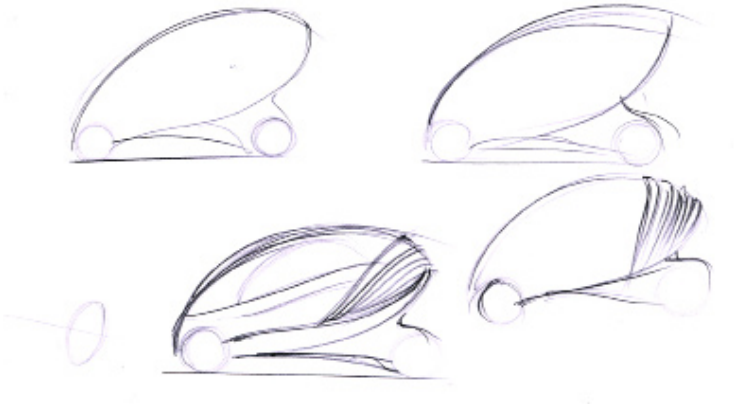
9. Concept Evaluation

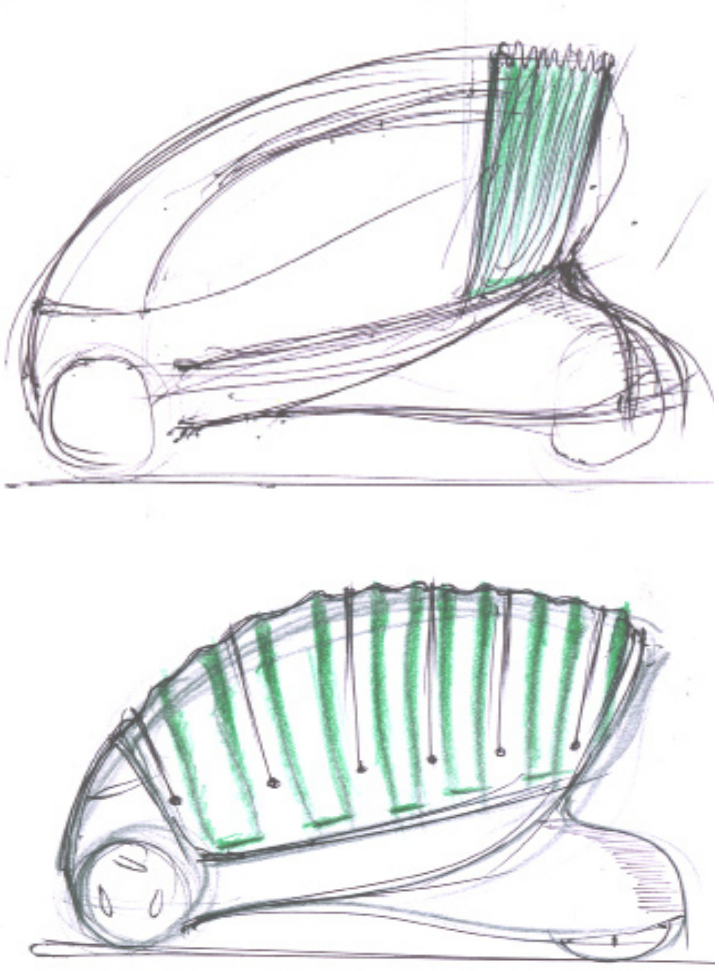
Based of this development, sketches were made to visually separate the components.



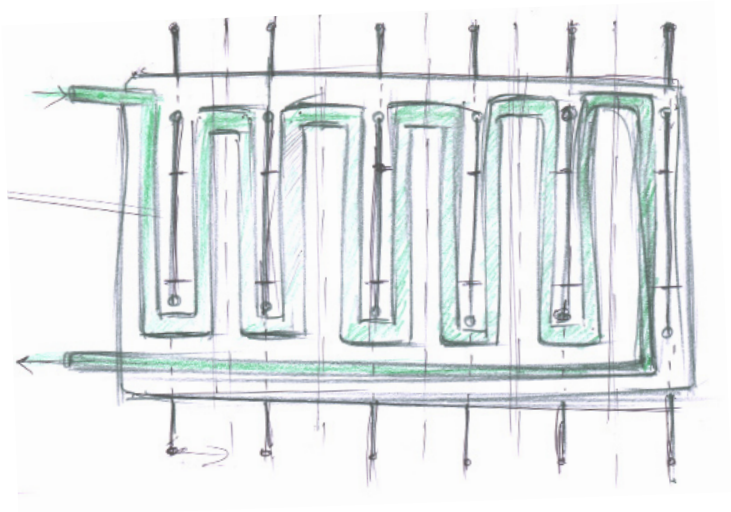






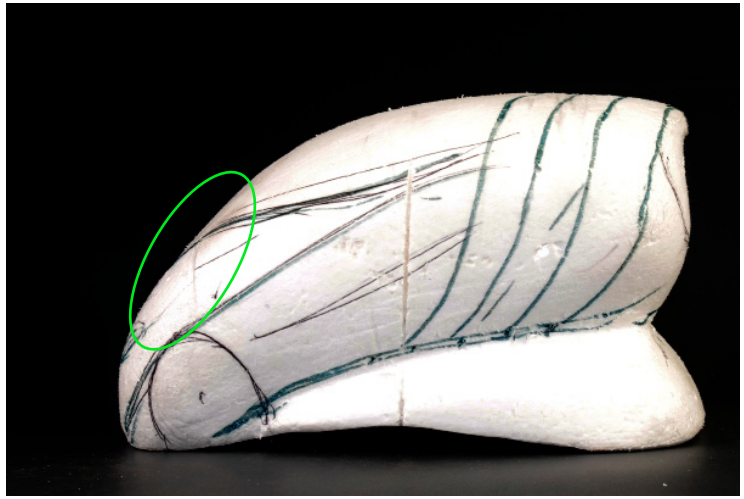


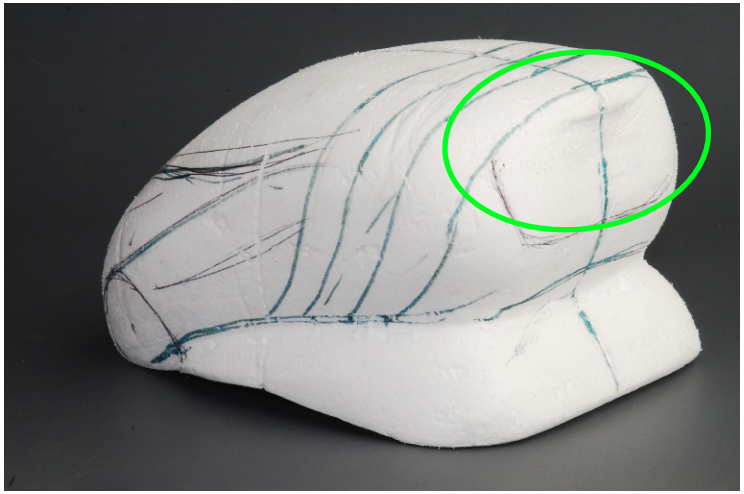
Now that the algae pouches come down beyond the shoulder, new mechanism was needed. The sketch shows how it works. First sketch shows the car when it is running, when the canopy is retracted. When the car is stationary, the canopy covers the car and circulates algae solution to generate fuel. The image below shows how the canopy can be made. The algae pouch would be welded together leaving gaps for the solution to flow. It will have holes to fasten the flexible strings. These strings are in turn connected to rollers along the rails, which are along the surface.



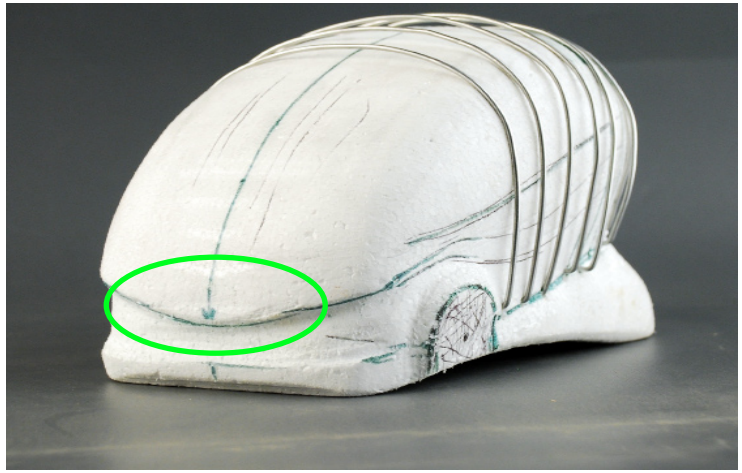
9. Concept Evaluation

Mockups was made from the sketch to explore forms further. The front had a characteristic stance which was unique. Here, the rear wheel was covered to emphasize the algae component. This made the rear end prominent. Also, the fact that the rear was flat made it different from the cars of today. The mockup was sketched upon to try out different options for the DLO.



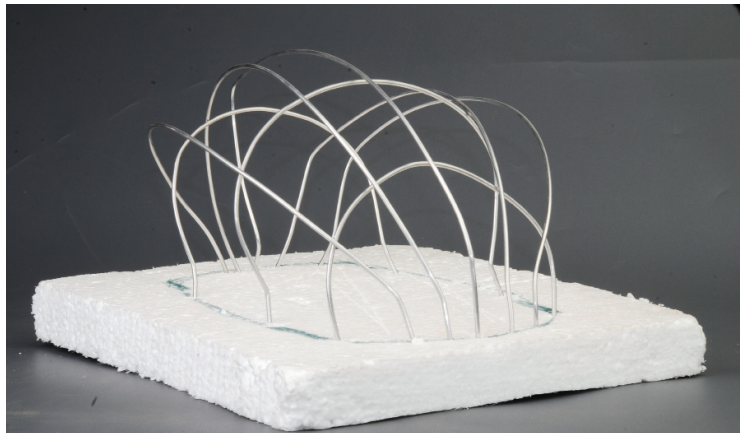


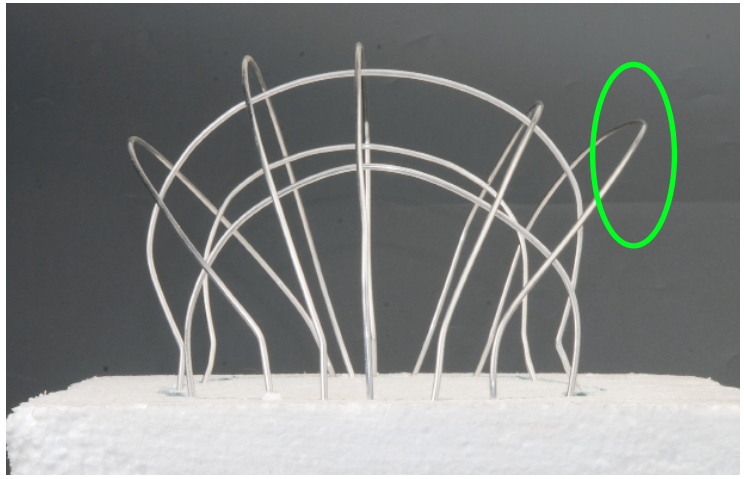
The model was made to see how the flexible frames sit on the car. Once again, sketching was done on the mockup to try out variations in the DLO. The main breakthrough with this mockup was the fact that, the front goes in, as indicated in the figure. This was done to abstract the fact that there is no mechanism needed there. The rear of the car was explored further to make it more rounded compared to the 'chopped off' back of the previous concept.



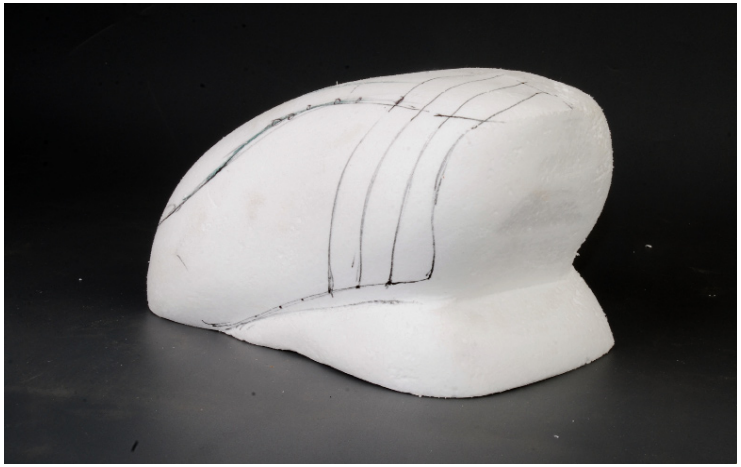
9. Concept Evaluation

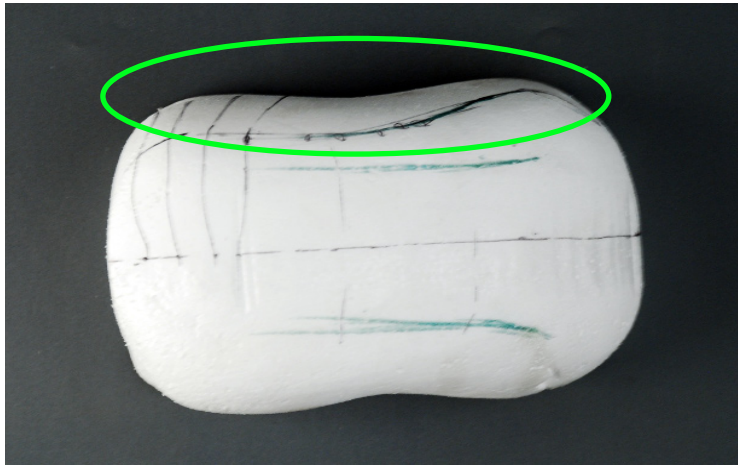
After the first few mockups, it was felt that there was a potential for the surface flow to be better. So, a wireframe mockup was made to study the flow lines of the surfaces. The figure shows wire being adjusted to try out different flow of surfaces. This method was found to be a quick and effective way to come up with different flow of surfaces. This method lead on to further explorations in mock ups as shown.





From the previous exercise, it was inferred that there is a scope to improve the flow lines. The image on the left shows the thick black line that indicates the flow of lines. The top view shows how the overall footprint has changed owing to the change in flow of lines. The lines gave another dimension to the overall form.





9. Concept Evaluation

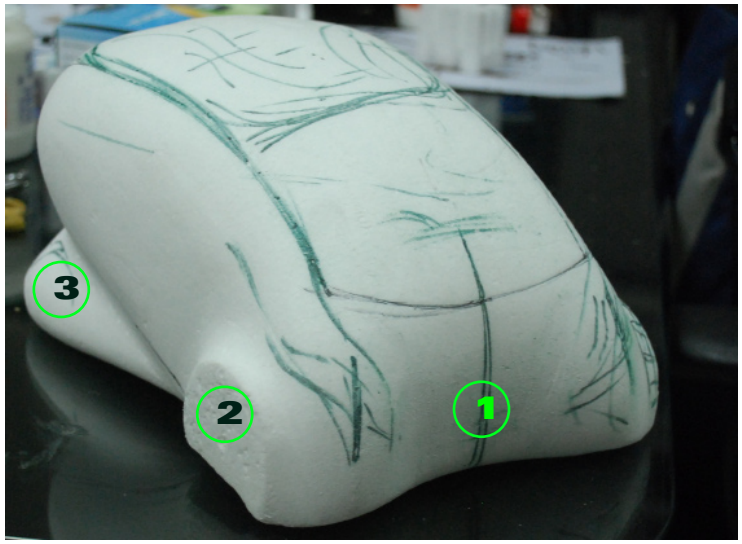
All the previous exploratory models were looked into, and the best features of each model were analyzed. This resulted in a refined exploratory model:

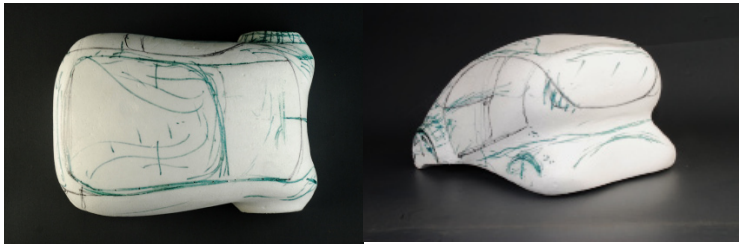
1- The concave surface: This was derived from exploratory model where the front went inwards. This totally changed the visual language of the vehicle giving it a completely distinctive look.

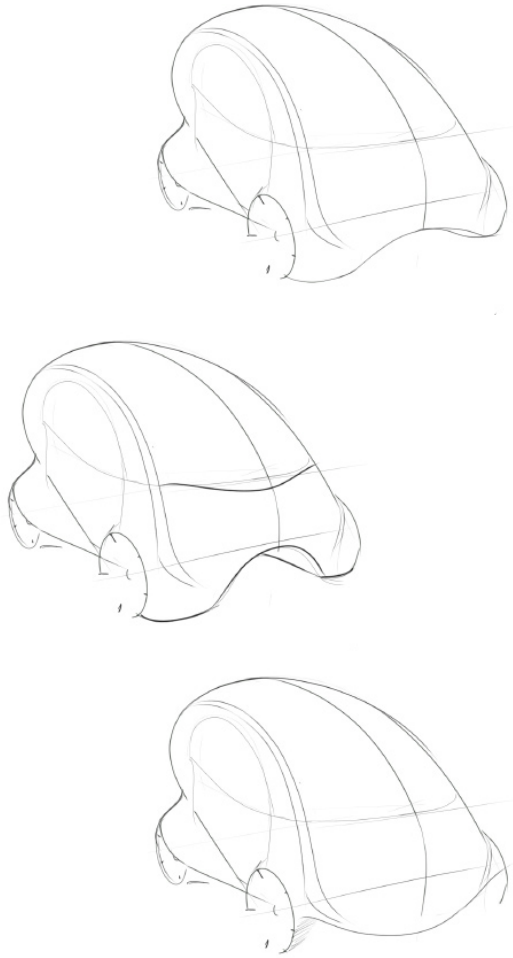
2- Flaring wheel arches: This was derived from an earlier idea which gives the vehicle road presence.

3- Bulging skirt: This separates the algae component from the part which contains the cylinders; hence the form.

4- This back was derived from the first mock up model.





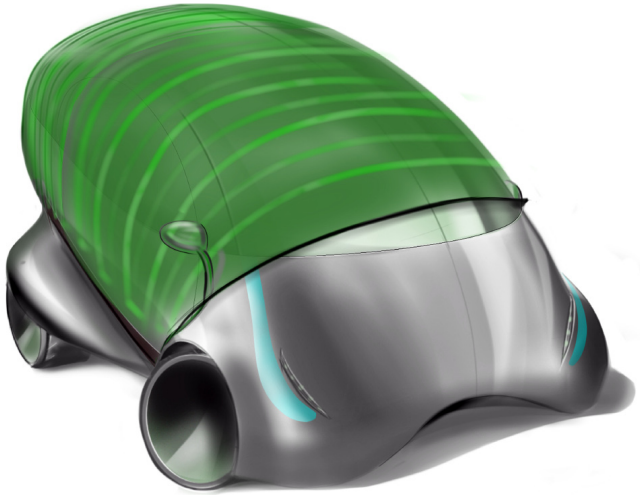


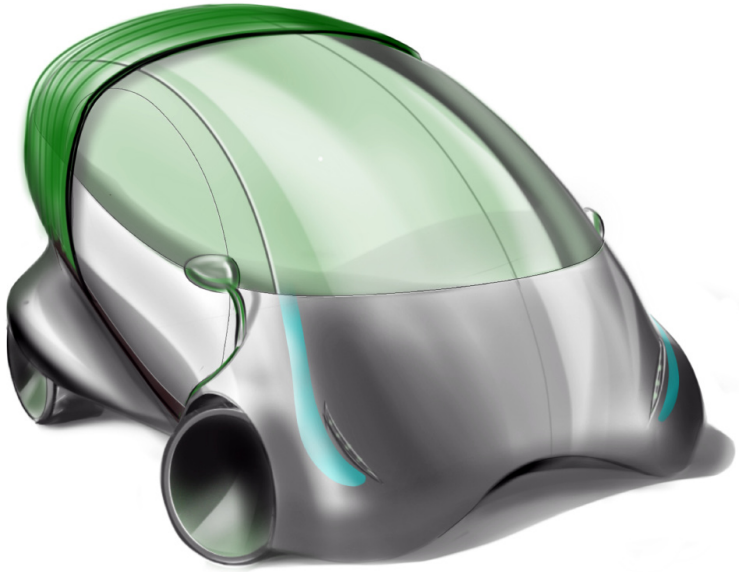
It was realized that the concave part of the nose came way down to the ground. It was decided to try out other layouts for the front to stress more on the fact that no mechanism is needed for the front. The DLO was also modified to try out different options.

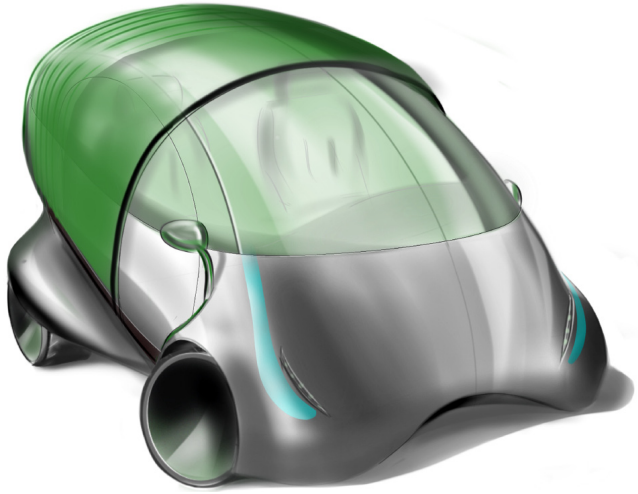
The strip along the A-pillar houses the rails for the canopy to open and close. This became a strong element which was similar to conventional cars. So, this was toned down. The algae component needed to be stressed upon. The frame of canopy can come and rest on the structure shown below. This was combined into the rear view mirror component.

10. Final Concept

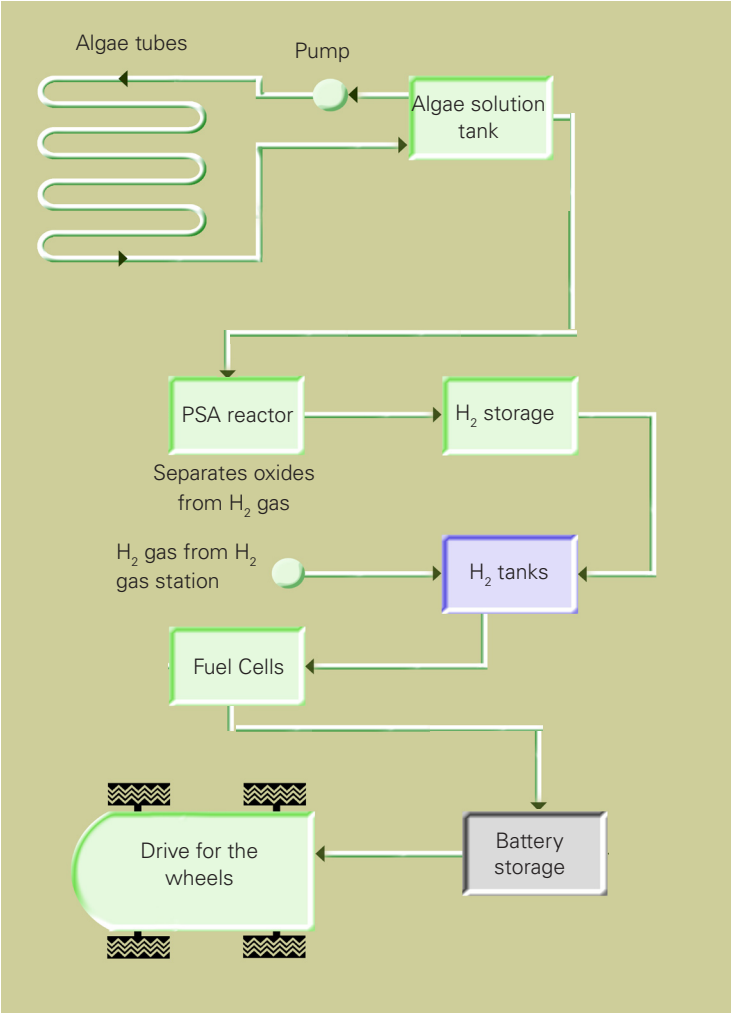
This is the proposed final concept. The rendering below shows the car when it is in running mode, where the retracted canopy becomes a prominent visual element. When the canopy covers the car, the algae solution starts flowing, producing hydrogen gas and oxygen as a by-product that cleans the environment.







11. Specifications



Dimensions

Overall Length (mm)	2640
Overall Width (mm)	1760
Overall Height (mm)	1600
Wheelbase (mm)	1760
Ground Clearance (mm)	120
No. of Doors	2

Powertrain Hydrogen fuel cell based
Motors In-wheel
Hydrogen tank Ti-Mg-Li alloy
Algae subsystem to regenerate the hydrogen fuel.
Steering In-wheel
Suspension In-wheel with electronic damping
Wheels 145/70 R12

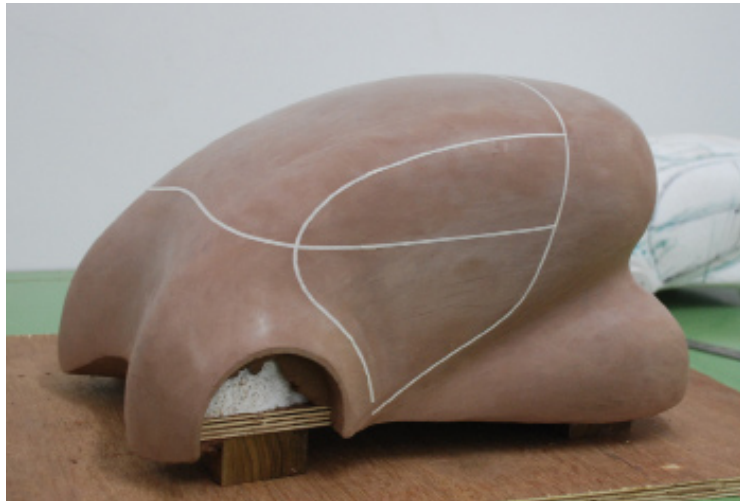
Michelin Active wheel
With in wheel motors, suspension and steering mechanism

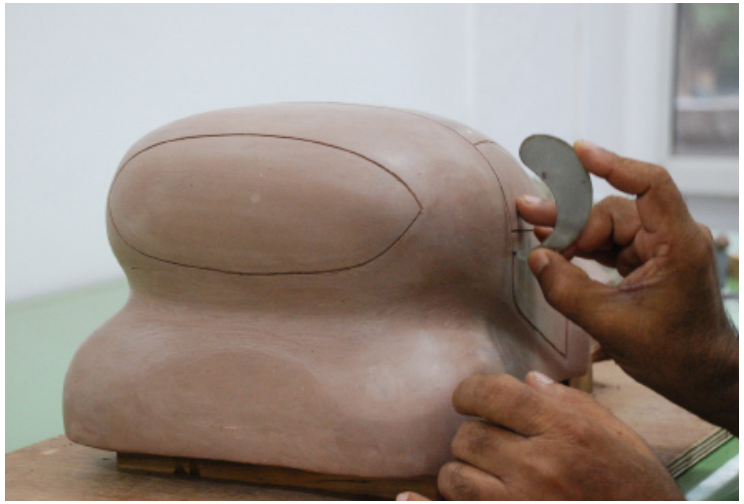
12. Clay model

Making of the clay model was one of the important creative processes followed in the styling process. 1:8 scale model was decided to be made. The base armature was made out of wood and thermocole was used to make the skeleton. The surface of the thermocole was heated to harden it, so that it forms a stable base for the clay to hold onto. The clay was applied and shaped using the clay modelling tools. Base was used to sculpt the wheel arches. The clay was applied and reapplied until the desired surface quality and surface continuity was achieved. More of finishing was done to perfect the surfaces.

12. Clay model

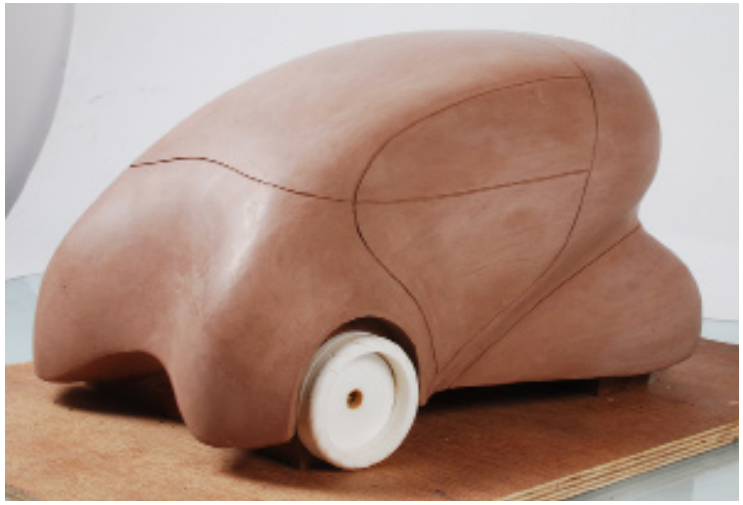
After refinement from the previous stage, surfaces were checked once again by applying dinoc film on the surface. The reflectivity of the film magnifies any surface imperfections that may exist. With specific lighting, the flow of reflections can also be checked using the application of the film. Then, DLOs were decided by applying masking tape strips on the surface as shown in the figure. Multiple options were tried out for the lines to go with the overall form and to ensure line continuity. Once the DLOs were fixed, it was carved on the surface as shown below. The shut lines were also carved out in a similar, but with more weight.



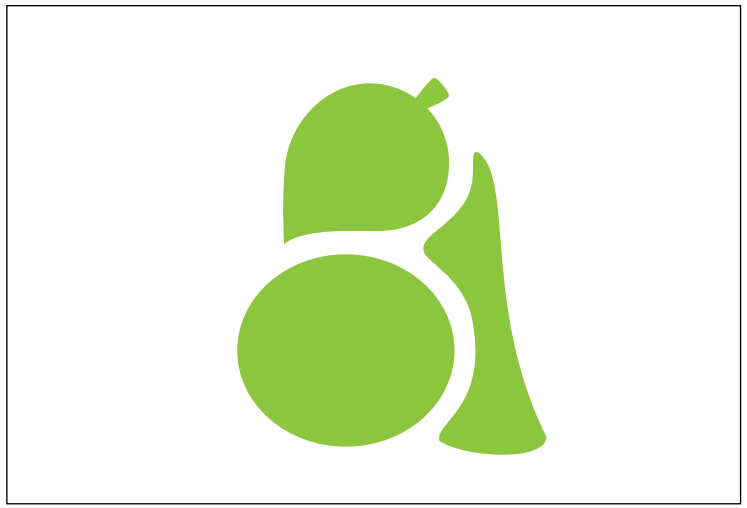


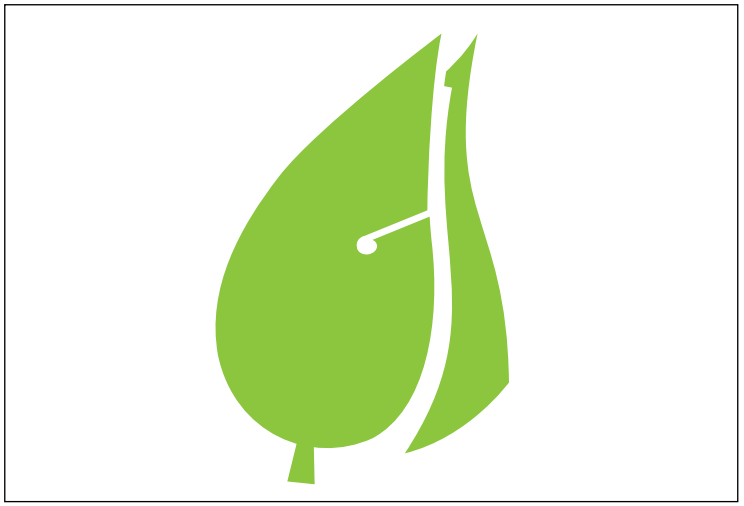
12. Clay model

Once the shut lines and DLOs were sculpted on the surface of the clay, the wheels were made. Three 6 inch pieces were cut in CNC and joined together to make the wheels. The disc for the wheels were formed by filling clay in the cavity. After that, the clay model was cleaned with water to remove any clay particles. A layer of DuPont primer was applied directly on the surface of the clay to harden it. This followed by two thick coats of gray putty. Surface was sanded with a P600 grade sand paper. A thin coat was applied on top of that. The surface was further sanded with 1000 grade sandpaper, after which the model was ready for painting.



13. Branding



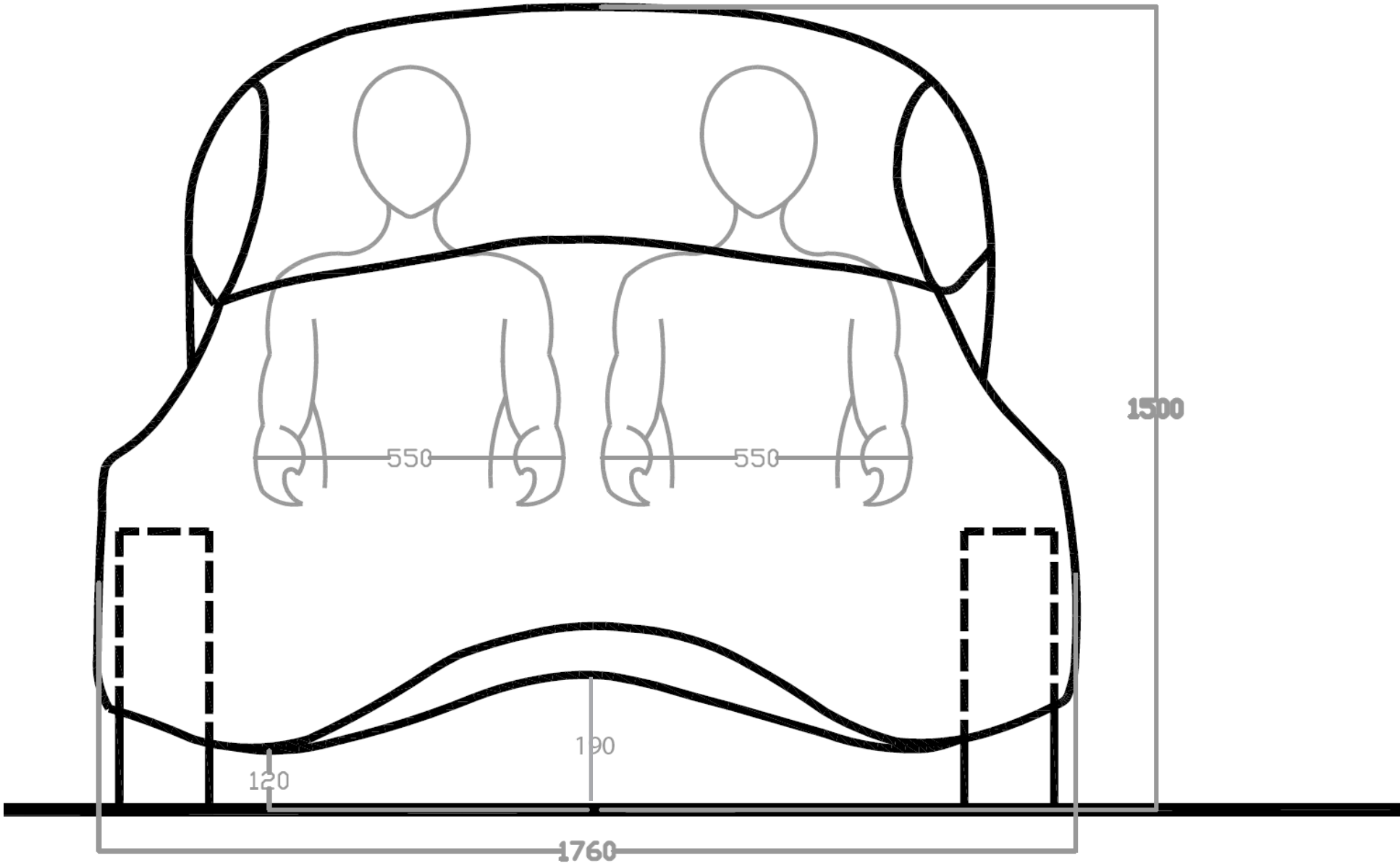


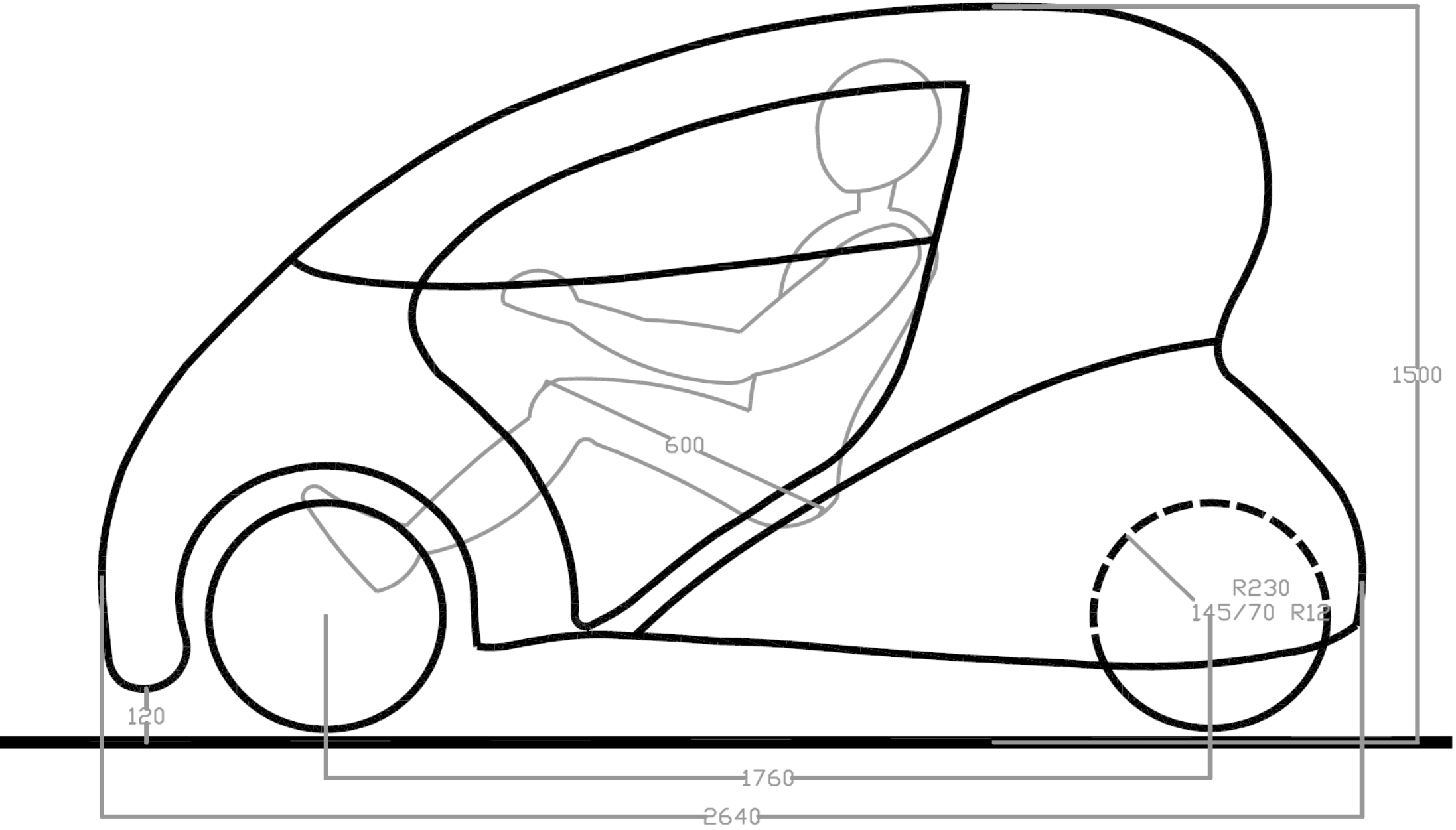
The car essentially photosynthesizes and gives out oxygen. Hence the name "Jeevan". The letter 'G' is present in oxyGen, hydroGen, alGae, Green, nextGen. This car is the first of its kind that actually releases oxygen as a by-product. Hence the car is called "G1". The name completely captures what the car stands for. The presence of the leaf was important in the logo.

The paint was bluish silver and green which represents the hydrogen and algae component of the car.

IDC - G1

14. Dimensions and packaging




1500
600
R230
145/70 R12
120
1760
2640

15. Final model and design features

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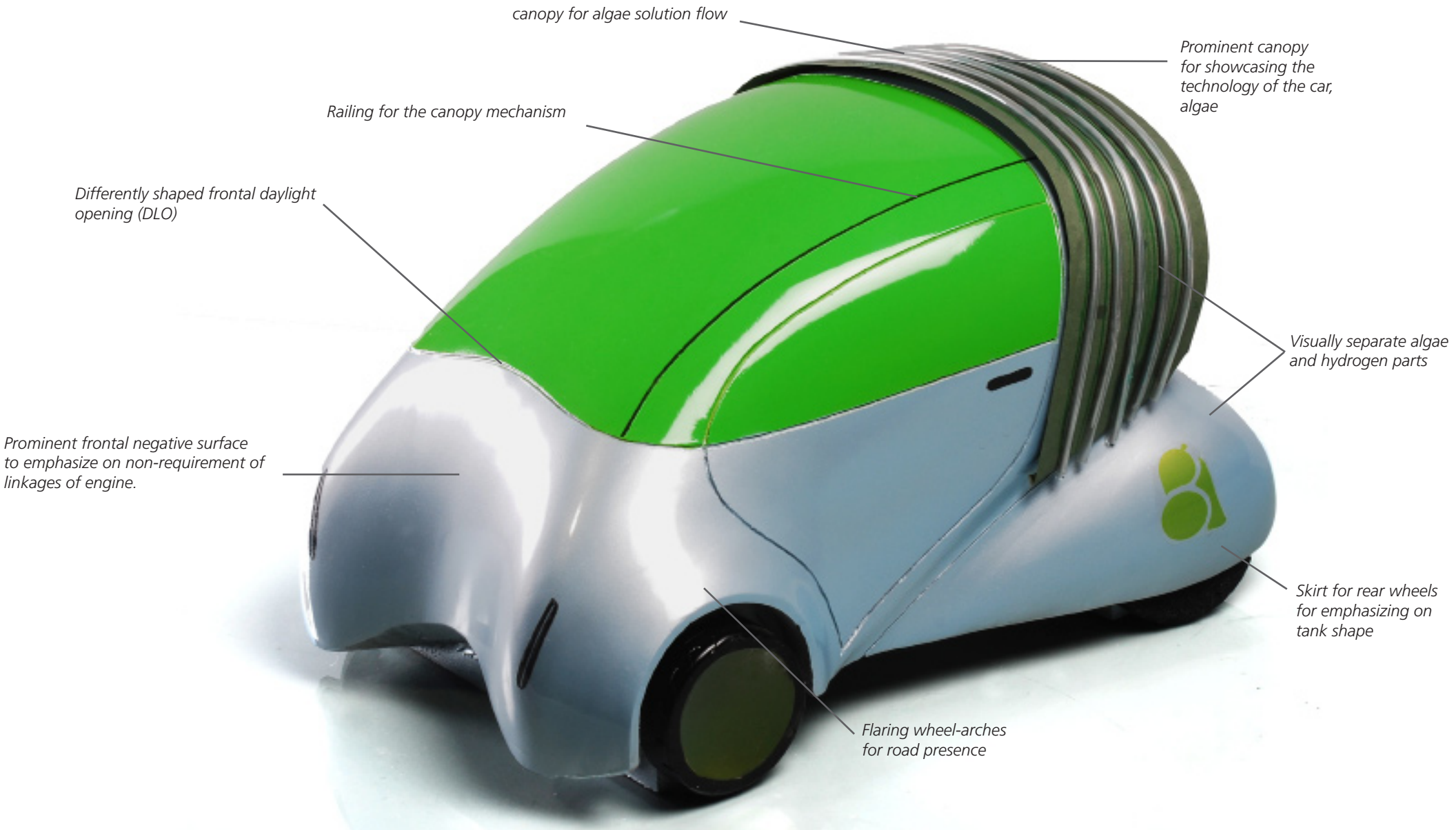

15. Final model and design features

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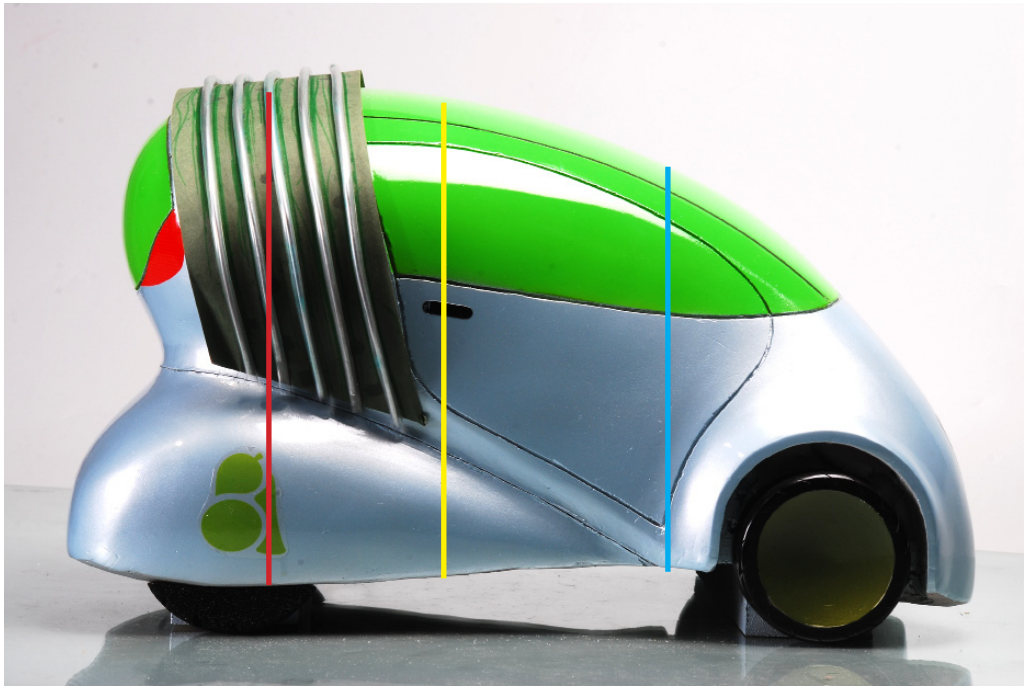
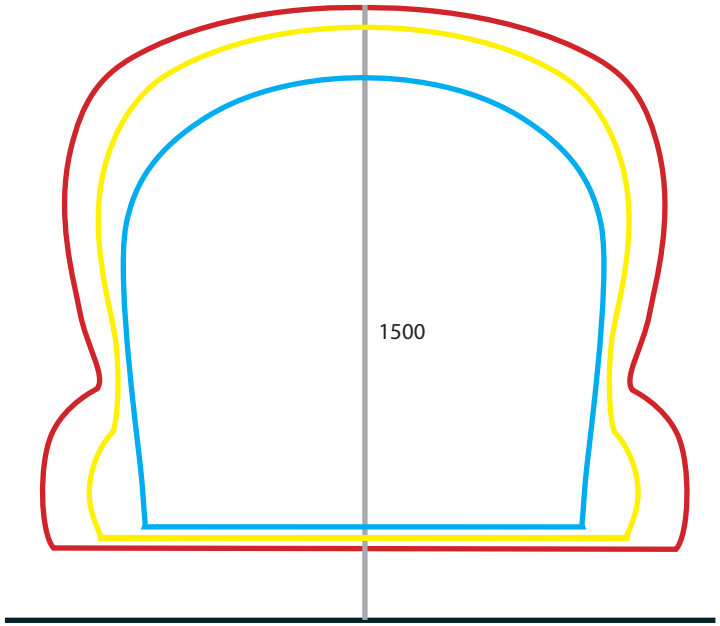


Three cross sections of vehicle are shown below. The sections are colour coded in the side view and are shown.



16. Conclusion

To summarize the whole concept - IC Engine cars have a certain visual language owing to their technology, electric cars have a certain language because of their technology; so if there was to be an algae car in the near future, how would its visual language be?

Also, it was realized that the car remains stationary for most part of the day, and this idle time could be put to use. These two concerns have resulted in this concept vehicle.

Algae culture and biological fuel culture is an coming up in a huge way. Scientists have predicted that the efficiency of the process should reach 85-90%.

The future cars should be green to an extent that they should actually be able to reverse the environmental damage created by the cars of the last century. The best technology to realize that requirement - Algae.

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