AMPHIBIOUS VEHICLE

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Guide: Prof. V. P. Bapat

A report on

Amphibious vehicle

Submitted by

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Under the guidance of
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Submitted in partial fulfillment of the requirement of the degree of Master of Design in Industrial Design.

Industrial Design Centre
IIT Bombay
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Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/ source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Approval sheet

The Industrial Design Project-II, titled

"Amphibious vehicle"

by Kamlesh Baba Sawant (08613802) is approved for the partial fulfillment of the requirement for the post graduate degree in Industrial Design.

Guide

Chair Person

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Internal Examiner

Acknowledgment

I would like to express my sincere thanks to my guide Prof. V. P. Bapat, for his valuable guidance and support. It was an immense learning experience for me.

Furthermore, I would like to thank the IDC Faculty for their feedback and constructive criticism.

I would also like to thank all members of IDC family for their help and support at various stages of this project.

I want to thank all my friends, for all their ever extending support, interest and valuable opinions.

Kamlesh Sawant

Abstract

As the roads are getting flooded with automobiles, the supporting infrastructure is under constant pressure. Soon the other modes of commuting like water and air will start gaining importance for daily travel. An amphibious vehicle will be a perfect solution with its capabilities to travel in more than one medium.

An amphibious vehicle with land and water surface as modes of travel is considered as a scope of this project. Aim of this project is to design a motorized amphibious two wheeler for youth.

The evolution of technology and formal treatment were also noted while studying developments in the amphibious vehicles over year. Initial ideation was focused towards making 2 wheeler afloat on water & results were groped into categories. The group of inflatable pontoons was chosen on the basis of its feasibility. A configuration with pivoted flaps for housing inflatable pontoons, on either side of a two wheeler was chosen after evaluating other possible configurations. The dimensions of pontoons in inflated mode and in deflated storage mode were calculated before finalizing the layout. Contemporary motorized two wheeler was taken as reference for structural and ergonomic issues for deciding the layout.

The targeted segment of user youth was expressed with lifestyle boards and mind maps. Expression of fearless was chosen for formal treatment of the proposed vehicle, which was decoded by analyzing vsuals with that expression. Scaled mock-ups, sketches were used for getting the concepts evaluated by potential users.

Apart from youth, the proposed amphibious vehicle can also find its use as police patrolling vehicle, flood relief vehicle and a personal mode of commuting in inland water bodies.

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BACKGROUND

Image 1: Policemen on amphibious vehicles attend a parade in Mumbai November 26, 2009, on the first anniversary of Mumbai attacks *[3]*

Image 2: Mumbai Police Commissions Sealegs Amphibious Boats, Nov'09 *[4]*

1. Background

An amphibious vehicle concept has been around for more than century now. Earlier attempts were a result of a aspiration to conquer land and water. But amphibious vehicles, because of their uniqueness, can be much more than just a toy of riches. The recent purchase of amphibious vehicles by Mumbai police for patrolling the coastline validates the preceding statement. *Image 1* and *2* shows the newly commissioned amphibious vehicles with Mumbai police.

There are plans to purchase more such vehicles. Considering India's long coastline; not to mention inland water bodies and each vehicle costing not less than INR 40 lakh each *[1],* amphibious vehicle may create its own new segment in India.

The recent revived plans of sea commute along Mumbai coast with hovercraft *[2]* also indicates the need to leave jammed roads and find an alternate route through water.

The word 'amphibious' means combining two qualities, kinds, traits, etc. and is mostly referred to be able to live on land and in water. This study is limited to amphibious vehicles which can operate on land and on water surface.

UNDERSTANDING AMPHIBIOUS VEHICLES

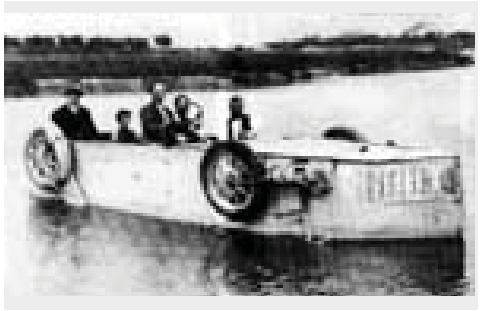


Image 3: Hydromobile,
Year - 1924 built with retractable wheels, Good water performance *[5]*

Image 4: Aquada,
Year - 2003 looks of a sports car with aerodynamic curved body and hydrodynamically shaped bottom, retractable wheels *[6]*

2. Understanding Amphibious vehicles

Please refer the *chart 1*- named Diachronic and synchronic analysis in the appendix section.

Image 3 and *4* shown beside tries to capture the changes which took place in the technology and the appearance of amphibious vehicles.

Image 5: Diachronic analysis of amphibious vehicle
Refere *appendix 1*

Image 6: Modern day amphibious vehicles and amphibious two wheelers. Refere *appendix 1*

2.1 Inferences from the study:

(please refer the *chart 1* in appendix) - the thumbnail view of the chart is shown in *image 5 & 6*

Technology & Engineering

- Amphibious vehicles started by mounting wheels on boat
- Though retractable wheels concept came in 1930s it was used in later half of century more effectively.
- Various propulsions are tried for propelling on water surface – Peddles, Propeller (Air & water), waterjet

Visual aspect

- Most of the attempts to build an amphibious vehicle were to just float – a boxy structure
- Most attempts are with ATV which once in water acts as a floating structure.
- Though boat and a road car serve different functions than amphibious vehicle most of the forms are of contemporary cars.
- The recent vehicles like Aquada, Watercar, etc. can be differentiated with the sleek hydrodynamic bottom of a boat hull and a car body on top.
- Waterjet outlet and propellers are one of the additional elements carried by an amphibious vehicle.

General

- Most of the automobile manufacturers attempted an amphibious vehicle.
- Amphibious vehicles are now available in all versions – bus, car, a personal transport even a human powered cycle.

FINDING AN AREA FOR DESIGN CONTRIBUTION

3. Finding an area for Design contribution

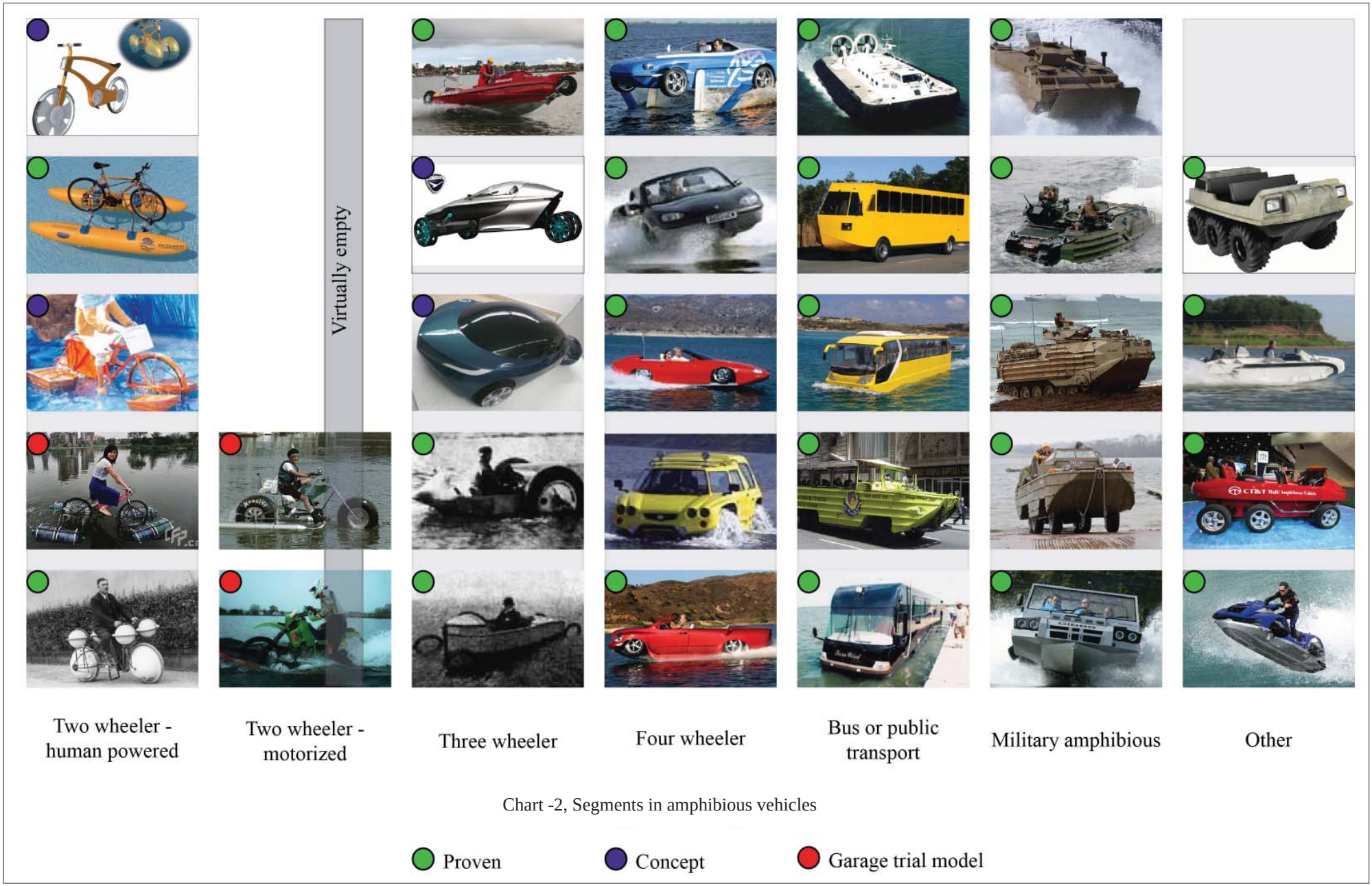


Chart -2, Segments in amphibious vehicles

It is clear from the preceding chart-1 that the two wheeler area is left unattended in category of amphibious vehicles. Hence the further study is focused with an intention to create a motorized amphibious two wheeler. At this stage the youth who has an experimental nature and who is ready to accept changes, was visualized as a potential user for such a vehicle. But before formulating a design brief, more clarity was required on the feasibility of such a vehicle.

IDEATION

Image 7: Ideas to make a two wheeler afloat

Refer *appendix 2*

4. Ideation

The It is clear from the *chart 3* (appendix) that a amphibious motorized two wheeler are results of crudely attaching a pontoon to the frame or attaching a large wheel with pontoons to stabilize it in water. Since none of this is a creditable solution to make a motorized two wheeler afloat; ideation was done to solve this problem. The stability of two wheeler in water was also a concern while ideating. The result of the ideation is attached in a chart.

The ideas were grouped into following four categories:

Group 1.

Self floating with in-built volume

Group 2.

Collapsible and expandable volume with mechanical flaps

Group 3.

Collapsible and expandable volume with framework and stretchable fabric

Group 4.

Collapsible and expandable volume with inflatable pontoon

After evaluating each group on the basis of its merits and demerits as shown in *table -1* on next page, group no. 4 'Collapsible and expandable volume with inflatable pontoon' was chosen for further exploration.

Group no.	Description	Representative image	Feasibility *	Supporting reasons
1	Self floating with in-built volume		4	It will have less transverse stability in water The volume required to make it afloat, will make it look bulky and hard to manoeuvre on road
2	Collapsible and expandable volume with mechanical flaps		3	Moving parts, less reliability, more complications in linkages and actuators Mechanical systems associated with the volume required to make it afloat, will make it look bulky and hard to manoeuvre on road
3	Collapsible and expandable volume with framework and stretchable fabric		6	Moving parts, less reliability, more complications in linkages and actuators The framework required to stretch the fabric to give required volume should be strong enough to withstand forces in dynamic condition. Vulnerable to sharp objects – but can be overcome by choosing proper material
4	Collapsible and expandable volume with inflatable pontoons		8	When deflated the pontoons become a sheet which should be properly secured and packaged. Vulnerable to sharp objects – but can be overcome by choosing proper material

Table 1: Evaluation of ideas to make a two wheeler afloat.
* - Feasibility rating 1 to 10 scale(10- most feasible and 1 less feasible); rated with my personal opinion

4.1 Configurations of inflatable pontoon

Various possible configuration with inflatable pontoons were considered as shown in following *table 2*. The configuration with wing like flaps on either side of a two wheeler was chosen on the basis of its feasibility and its advantages.

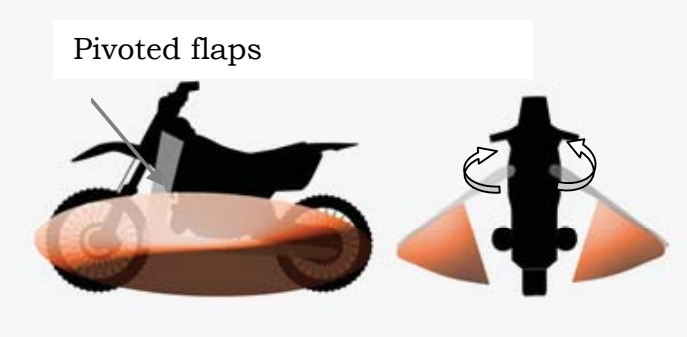
Sr. No.	Configuration	Description
1		Inflatable pontoons at bottom side of two wheeler **Merits:** • Compact construction **Demerits:** • No space for putting down leg for balancing • Transverse stability may be a problem with less beam (breadth)
2		Inflatable pontoons at bottom side of two wheeler, split in front and rear **Merits:** • Compact construction • Space for keeping down legs for balancing **Demerits:** • With total four pontoons, more complex structure • Transverse stability may be a problem with less beam (breadth)
3		Inflatable pontoons at bottom side of two wheeler, Attached to side flaps **Merits:** • Compact construction • Space for keeping down legs for balancing • Transverse stability can be achieved with increase in beam because of pivoted flaps. **Demerits:** • Overhang of flaps should be addressed with structural strengthening

Table 2: Possible configuration with inflatable pontoon

4.2 Technology survey for mobility

A brief study was done of available technologies as shown in the chart 3 (appendix). Conventional IC engine was selected as a power plant for the vehicle in land mode. Podded electric propulsion was chosen as propulsion in water mode. Various propeller positions were also considered before fixing on two propellers on either side of rear wheel and near rear wheel axis.

4.3 Details of inflatable pontoon

The basic dimensions of the pontoon were calculated to support a weight of 350 kg. Please refere appendix 3 for more details. The overall dimensions of the pontoons are as shown in *fig 1.*

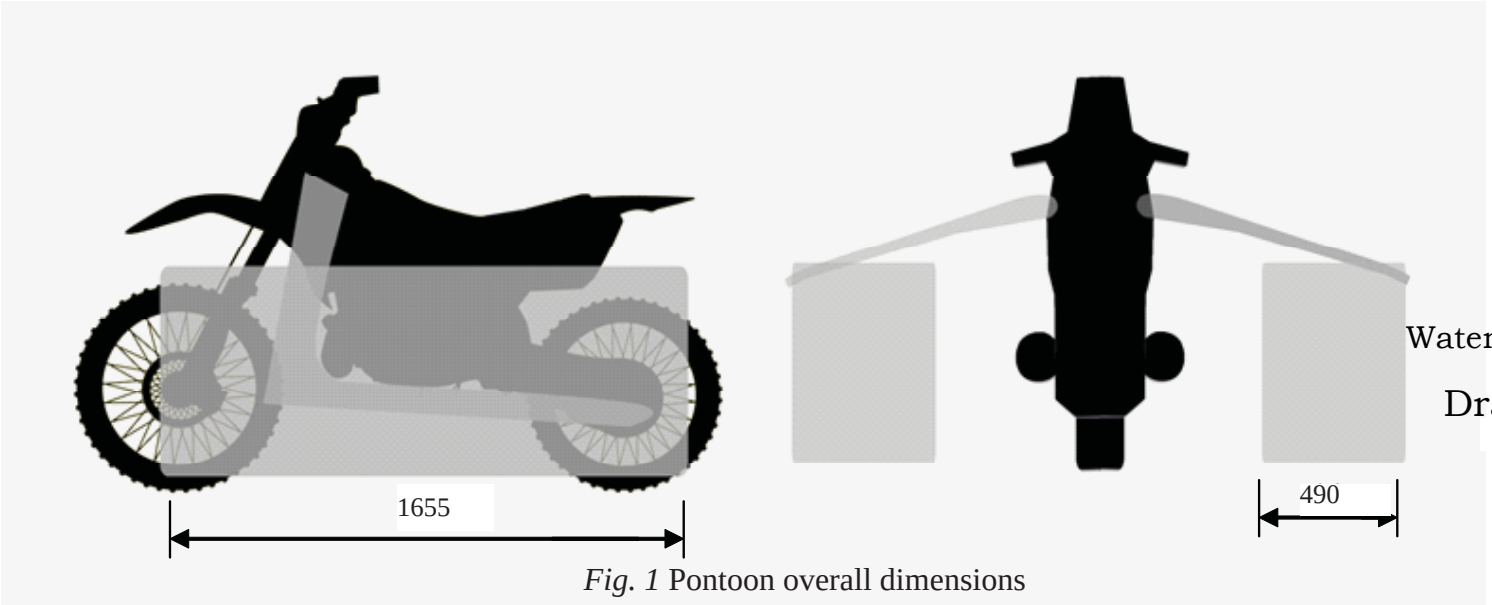


Fig. 1 Pontoon overall dimensions

DESIGN BRIEF

5. Design brief

Design an amphibious motorized two-wheeler for youth.

Aesthetic requirement:

The two wheeler should be designed for the youth segment who is more inclined to accept changes, experimental in nature and enjoys freedom. It should also evoke a feeling of - 'more than a bike', with its appearance.

Ergonomic requirement:

For, 2 persons, Tandem seating

The posture and human interaction points of driver and pillion namely seat, foot rests, controls should be inline with the contemporory two wheelers.

On road requirements

Wheelbase – 1355 mm

Saddle height – 790 mm

Overall dimensions

- Maximum height – 1100 mm
- Maximum length – 2000 mm
- Maximum width – 770 mm

Water mode requirement

Maximum weight - 350 kg

Overall dimensions

- Maximum height – 1500 mm
- Maximum length – 2300 mm
- Minimum width – 1800 mm

Engine

4 stroke, single cylinder, air cooled
Starter – Electric
Primary drive – Gear
Final drive – chain
Water propulsion – Podded propellers with electric motors

Chassis Type – Diamond
Suspension (Front) – 41 mm Telescopic fork
Suspension (Rear) – Adjustable monoshock
Brakes (Front) – Single hydraulic
Brakes (Rear) – 130 mm dia drum
Tire (F/R) – 100/80-17 / 140/60-R17

Electricals

Battery – 12V
Instrumentation – Display showing digital speedometer, tachometer, fuel gauge, GPS for navigation, Tell-tale lights
Podded propulsion electric motors

UNDERSTANDING YOUTH

6. Understanding youth

The study involved study of different articles regarding youth and personal observations. Their routine life involves fun and mundane activities.

College, class bunks, hangouts are routine life where they mix with their own group of friends and enjoy their life to full. But at the same time when it comes to studies and personal development they are very focused and serious. Youngsters are involved seriously in personal development and with skills in music, sports, computer and many more. Also at time outing, picnics, trekking and partying are frequent in this age group. They have their own group at each place they visit. They easily get mixed with same aged people but are choosy selecting friends. They use different products, accessories and cloths to project themselves.

A lifestyle board was created to capture the gist of all observations which is shown in image no.8 on next page.
The next step was to create mind map for youth to translate the images in the lifestyle board into words. The mind map is shown in the *fig 2*.

Image 8: Youth lifestyle

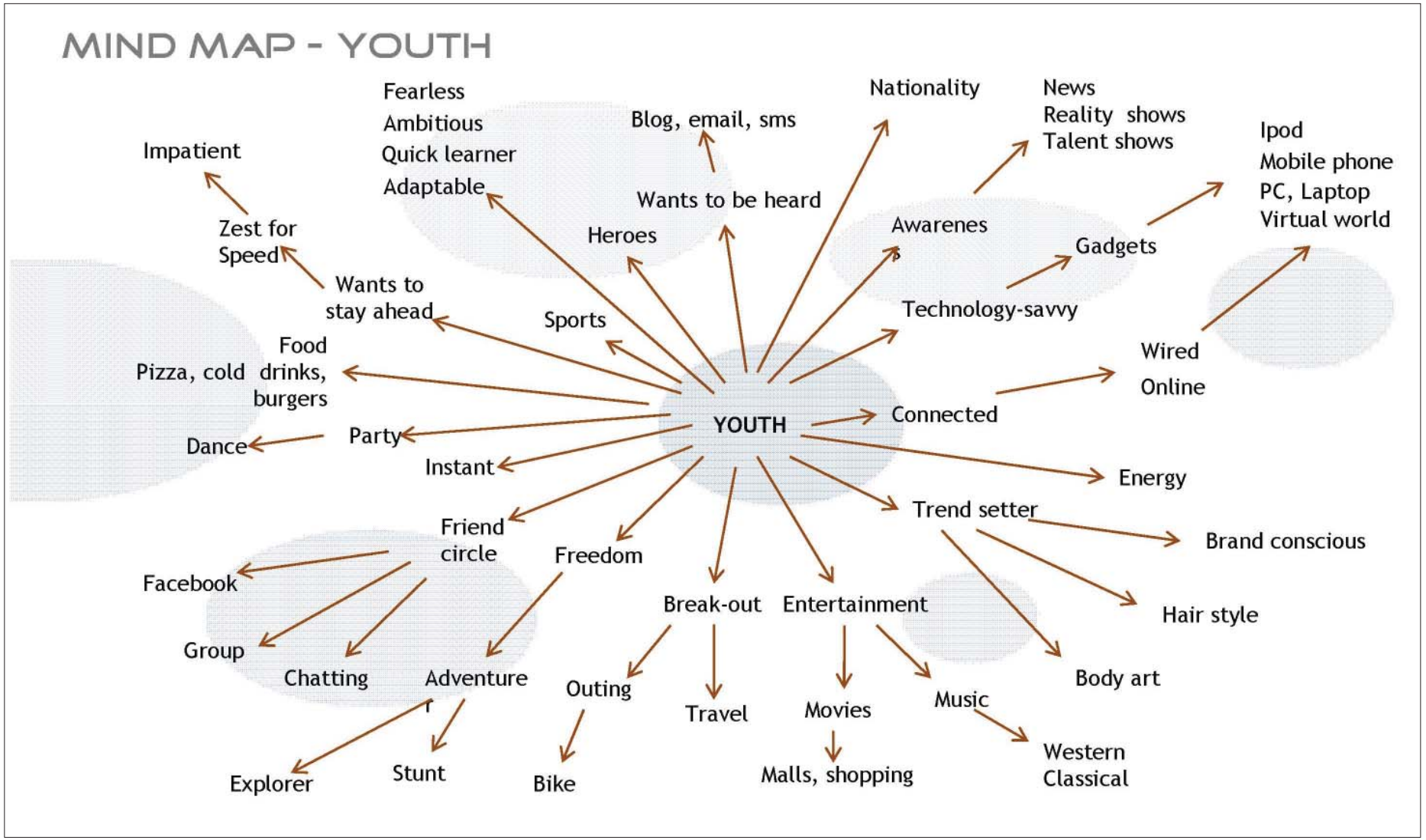


Fig 2: Mind map - Youth

6.1 Finding keywords

Words generated through mind map were grouped together as shown in the *fig 3.* These new categories represented a character of youth which can be translated through styling of a product.

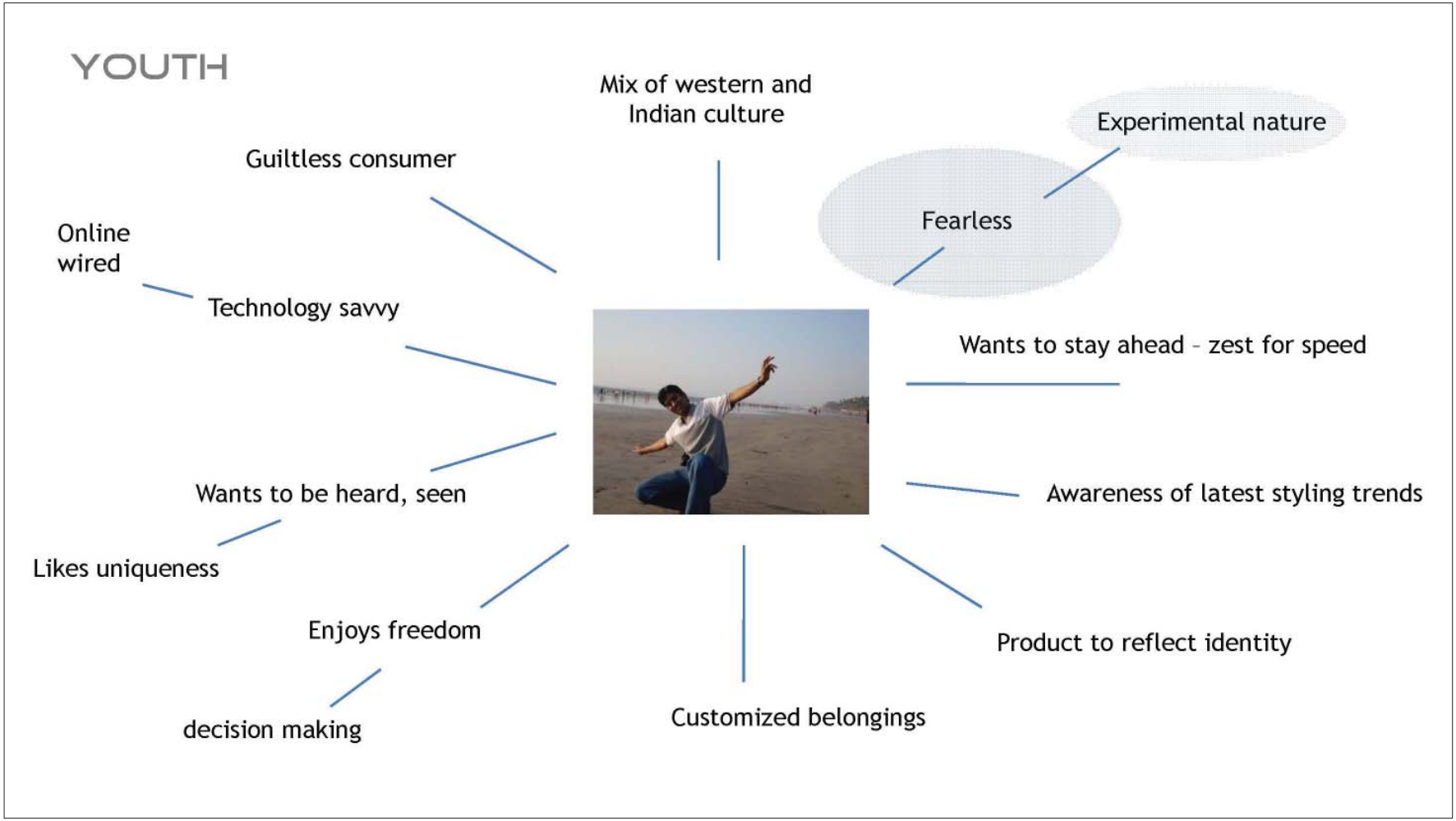


Fig 3: Youth keywords

Image 9:
Streamlined body of a penguin *[10]*

Image 10:
Streamlined bottom side of a duck [11]

6.2 Land and water mode - Looking in nature

As the requirement of the proposed amphibious vehicle is to run on land and on water surface, similar analogies were also considered before deciding the character of the vehicle.

A penguin *(image 9)* is also called as a water bird with its streamlined body, wings evolved to flippers and the legs acting as peddles. Frogs are the well known amphibioans in nature. Their legs have evolved to jump as well as swim. Ducks *(image 10)* and crocodiles also show the adaptation with their peddle like legs and a relatiely more hydrodynamic bottom half of their body.

6.3 Defining character of an amphibious two wheeler

Word 'amphibious' means capable of two qualities, kinds or traits and is mostly referred to be able to live on land and in water. This also means multidisciplinary, multidimensional, convertible, transformable, adaptable, non monotonous. Amphibious quality gives freedom from the constraints of medium and thus it can also be said to be fearless from drowning in water or roaming on land.

The word 'Fearless' was chosen for character statement for the amphibious two wheeler.

UNDERSTANDING 'FEARLESS'

7. Understanding 'Fearless'

A mind map was created as a first step to decode the elements in a fearless character which is shown in *fig. 4.*

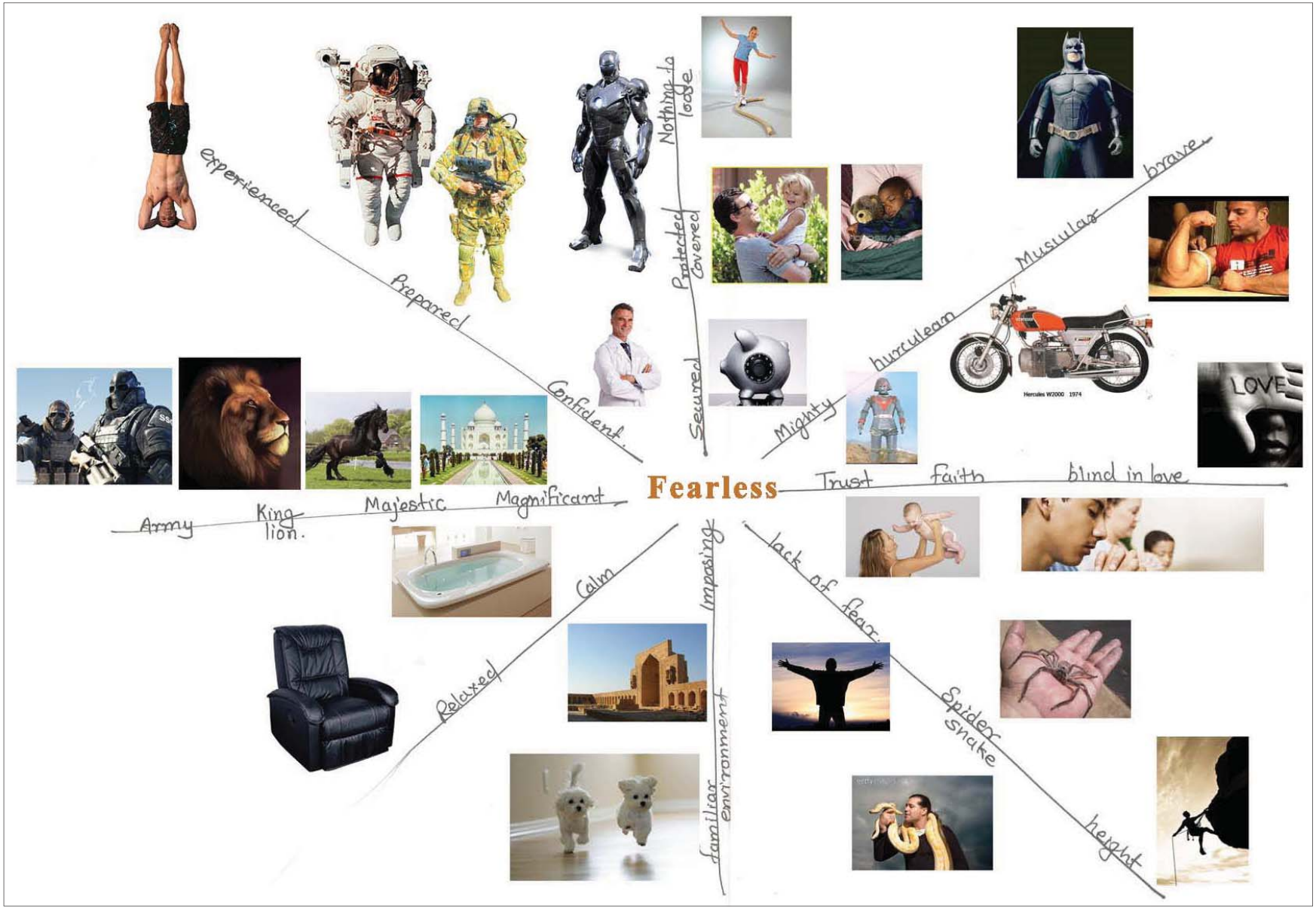


Fig. 4:
Mind map
Fearless

7.1 Mood board - Fearless

A mood board as shown in the *image 9* was created for further investigatigation and understnding.

Image 11:
Mood board
Fearless

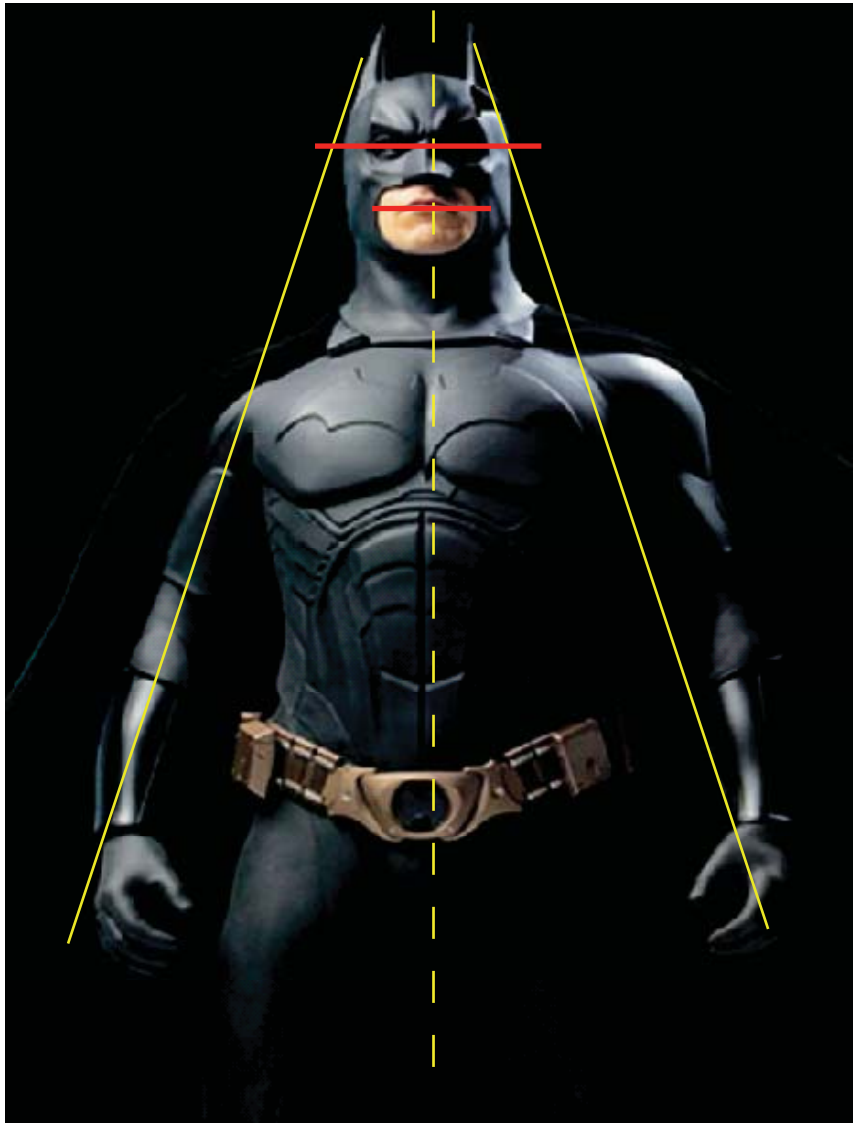


Image 12:
Batman *[15]*

7.2 Fearless

The images predominated with feeling of fearlessness were analyzed for understanding the visual language. The aim was to find the common features which were most influential in those images.

Fist image as shown in *image 10* was of a comic character hero Batman.

Words that describe the image:
Poised, brave, upright stance, composed, Muscular, equipped, controlled aggression

Elements in the image:

Lines	: Straight, large curves
Corners	: Bevel, small fillets
Shape	: Geometric: symmetric, organic
Texture	: matt finish
Value	: Strong contrast

Direction of lines: Dominated by vertical lines with the horizontal lines made by eyes and mouth coming on face.

Along with fearless, other attributes like powerful because of muscular body and stability because of upward pointing vertical lines, strong because of verticality of face, aggressive because of pointed elements of face mask; are also evoked while watching the image.

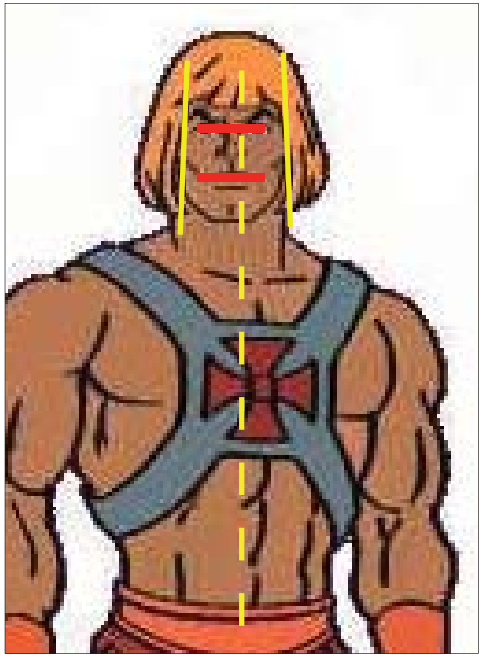


Image 13: Mr. incredible *[16]*

Image 14: Superman (top left) *[17]*

Image 15: He-man *[18]*

7.3 The brave and fearless, powerful heros

The other super heros like Superman, He-man, Mr. Incredible shown in *images 11, 12, 13* can also be analyzed on the same lines of Batman.

Direction of lines: Dominated by vertical lines with the horizontal lines coming on face which are made by eyes and mouth. Please refer *image 12.*

Other attributes which share the beside images with fearlessness are powerful because of muscular body, strong because of vertical lines of face pointing upwards. Pointed elements like nose lines adds a tint of aggression. The symbols made with geometric elements and sharp corners and the placement of symbol on chest pulls it out and makes it dominating.

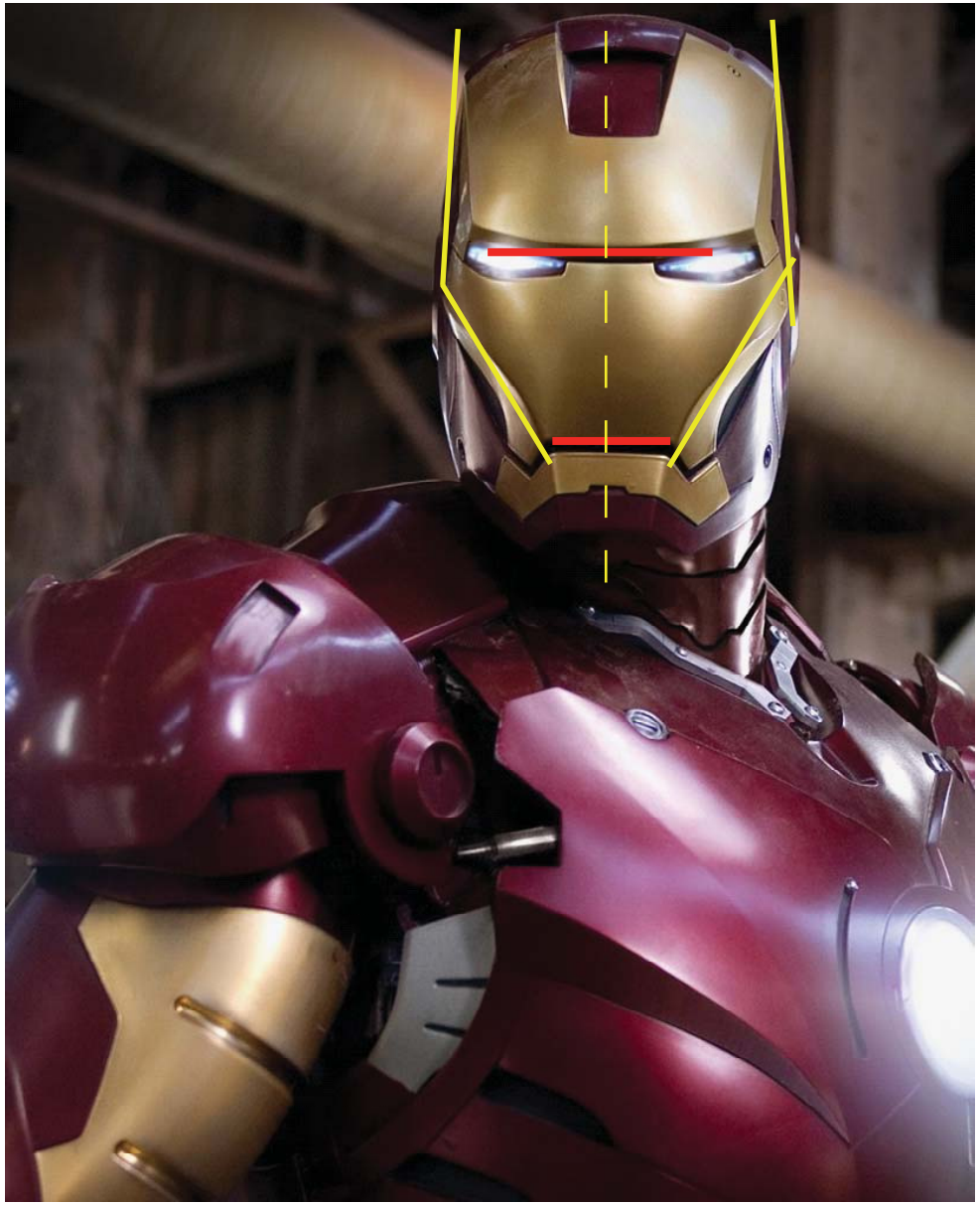


Image 16:
Iron man *[19]*

7.4 The brave and fearless, powerful heros - Iron man

Iron man, a science fiction movie character shown in *image-14,* made as a wearable power suite also evokes a fearless character.

Direction of lines: Dominated by vertical lines with the horizontal lines coming on face which are made by eyes and mouth.

Other attributes which share the beside image with fearlessness are powerful because of muscular body, strong because of vertical lines of face pointing upwards. Pointed sharp corner treatment adds aggression. The over lapping glossy body elements makes it hard at the same time rugged.

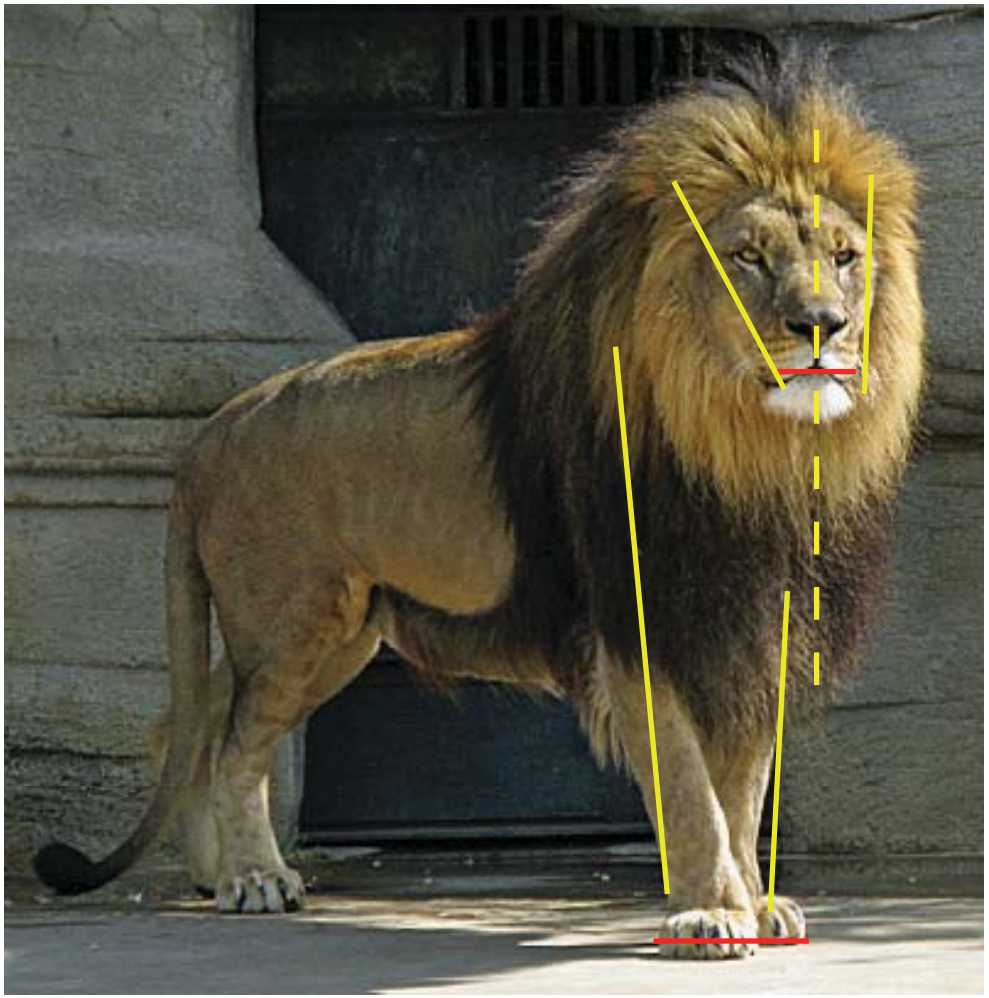


Image 17: A fearless lion *[20]*

7.5 Fearless in nature: Lion

Seating on top of a food chain, a lion with all its authority and power seems fearless in *image 15.*

Direction of lines: when seen from front, the form is dominated by vertical lines with the horizontal lines coming on face which are made by mouth. The horizontal line created by the feet also adds to the stability of whole form.

Other attributes which share the beside image with fearlessness are majestic, authoritative, heedful, powerful because of layers of hairs and strong legs. Pointed sharp corner treatment of eyes leaves a possibility for aggression.

From side view, the forward pointing nose and face geometry is nicely balanced with backward curved hairs and eyes. Though the mass is concentrated more towards front with tapering lines of body towards rear; the vertical line created with tail and the almost horizontal top line of body neutralizes the movement of tapered lines. The vertical, upright stance created with the vertical lines of front legs also gives it attentive looks.

Image 18:
GMC Denali XT, 2008 *[12]*

7.6 Fearless Man-made

GMC Denali XT

According to the American car company GMC, the Denali XT features a muscular form and wide, firmly planted stance giving the vehicle a confidently capable road presence. Minimal overhangs, huge 23-inch wheels, sleek head lamps and a low roof profile deliver an aggressive, performance-oriented appearance. The sports utility truck (SUT) has a wide appearance created by flared wheel arches. *[12]*

The interpretation for fearless:
In side view, the vertical lines of front grill and rear end with almost vertical door opening lines gives the vehicle a upright stance. The inclined line of bonnet and windows do add some dynamism to the form but it is dampened with stable horizontal lines at rear and roof line. The narrowed front section with rear visual mass gives the vehicle a poised look. It looks 'ready' to move ahead. The pointed, sharp headlights and tail lights do give it a bit of aggression. The wheel arch fairing gives muscles to the vehicle by creating sharp value change.

7.7 Decoding fearless

Table 3 was prepared as a summary of the above analysis.

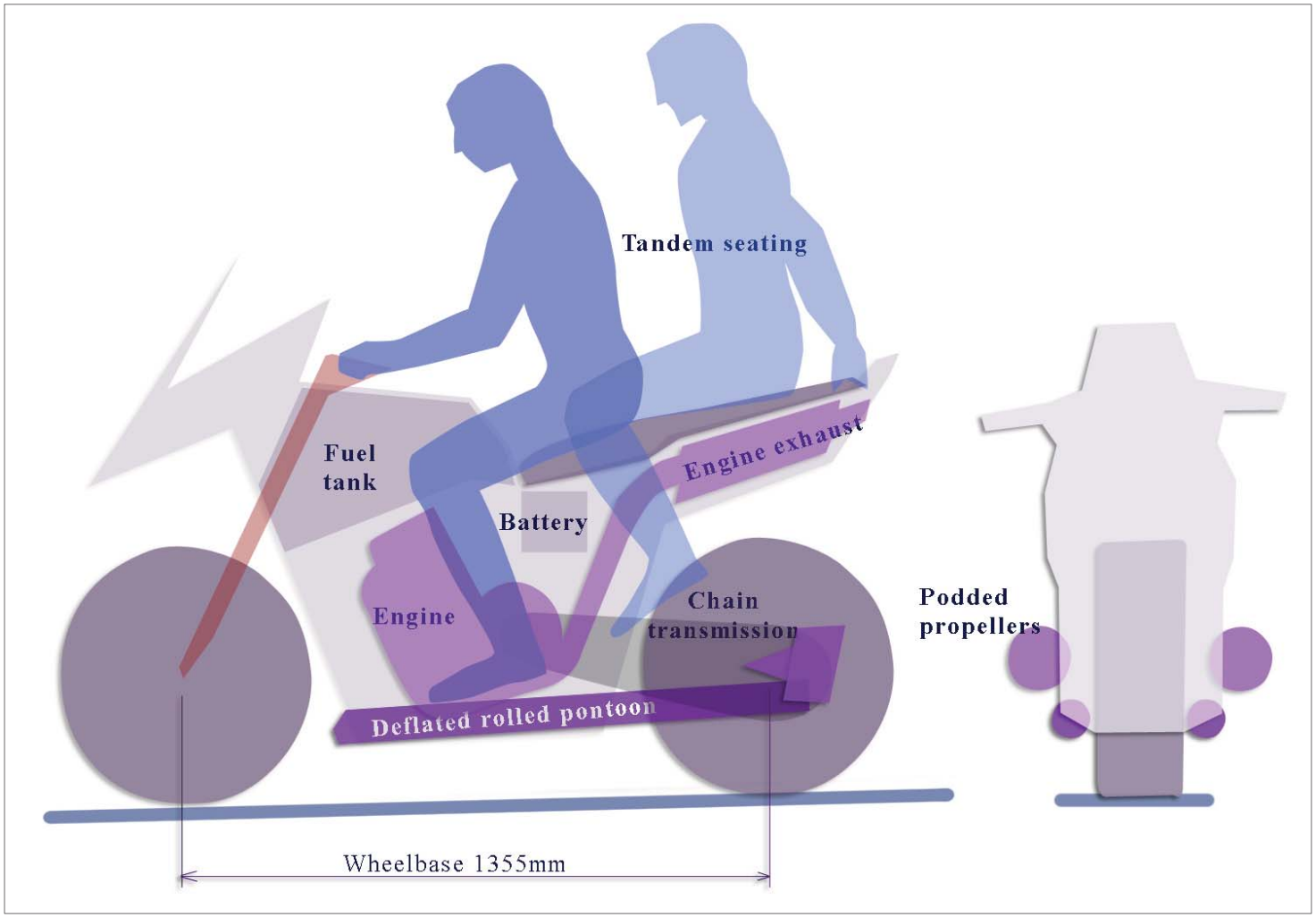
	Attributes	**Features**
'Fearless'	Controlled Aggression	Moderated use of sharp elements
	Strong form	Dominant vertical lines with stable horizontal lines
	Poised	Motion created with inclined line but dampened by horizontal lines
	Powerful	Muscularity because of sharp value change
	Heedful, alert	Pointed element indicating direction and concentration

Table 3: Decoding fearless

THE LAYOUT

8. The layout

Taking the guidelines from design brief and considering the selected idea of inflatable pontoons connected with pivoted flaps on either side of two wheeler, a final layout was prepared as shown in *fig. 5.* Conventional engine was chosen as power source and podded electric propulsion was chosen for water mode. Please refer *chart 4* in appendix for more details.

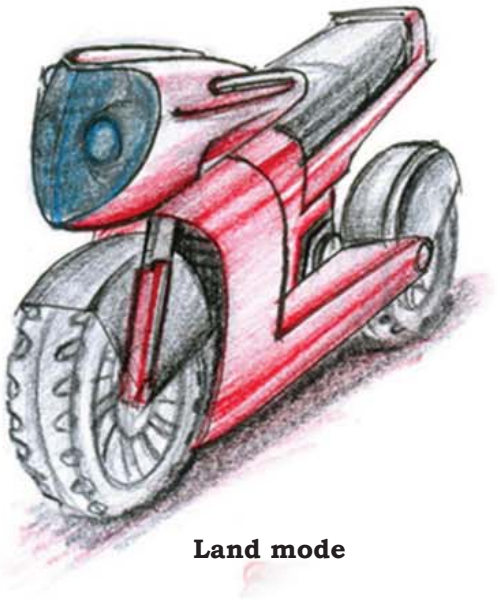


- Powertrain - conventional IC engine and chain drive power transmission
- Wheel size and wheelbase is fixed with reference to the present day two wheelers.
- Front suspension - fork with telescopic dampers
- Rear suspension - Uni suspension system
- Two podded propellers - one at each side, mounted below rear wheel axis
- Ground clearance - 150 mm

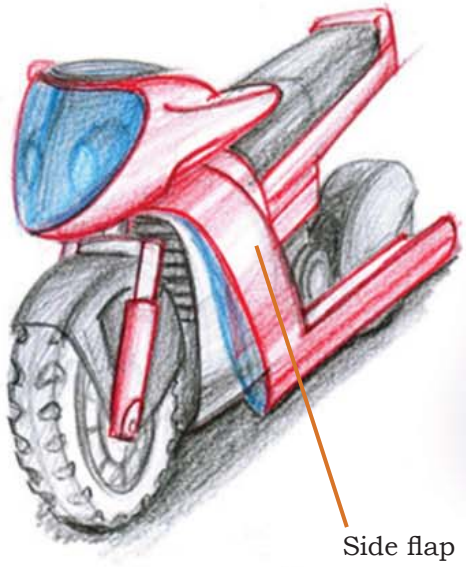
Fig 5:
Layout

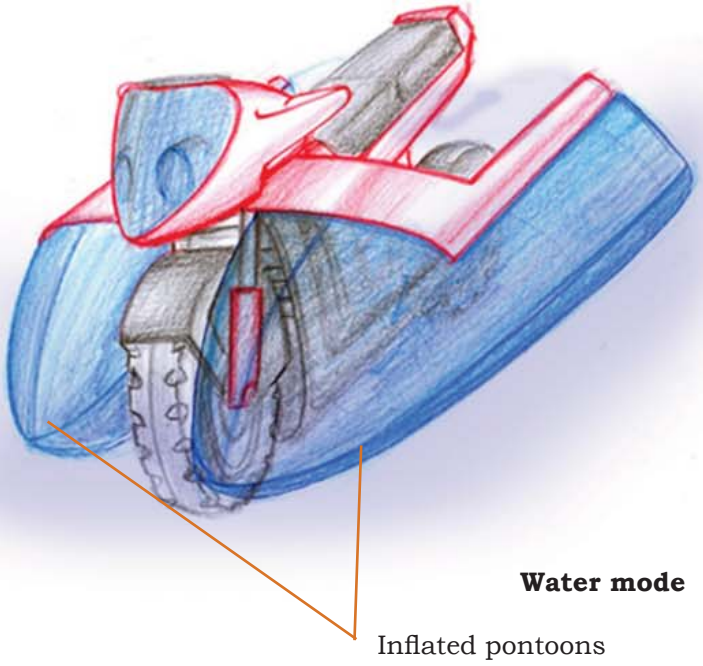
TRANSITION FROM LAND MODE TO WATER MODE

9. Transition from land mode to water mode



Land mode



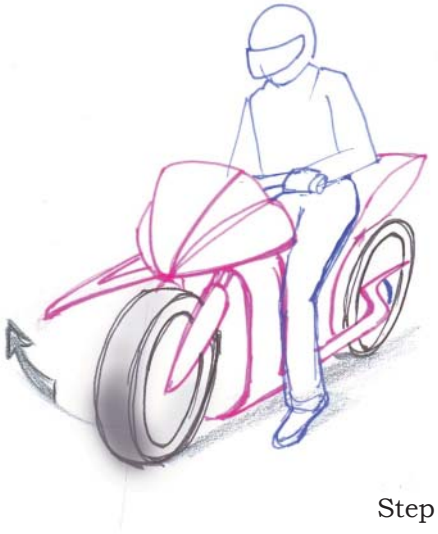


Water mode

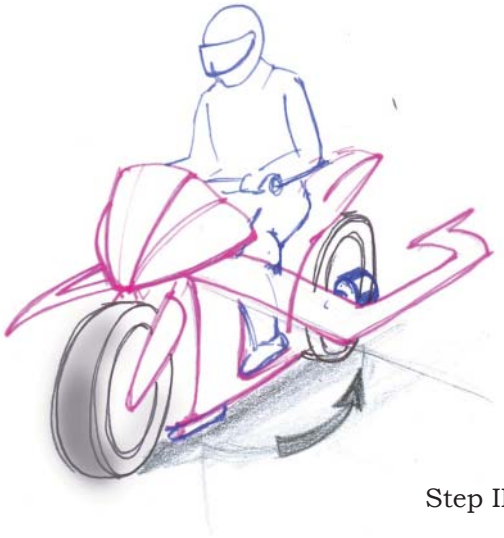
Initial visualization of the transformation from land to water mode. The side flaps opens and the pontoons are inflated for water mode.

9.1 Steps for changing into water mode from land mode

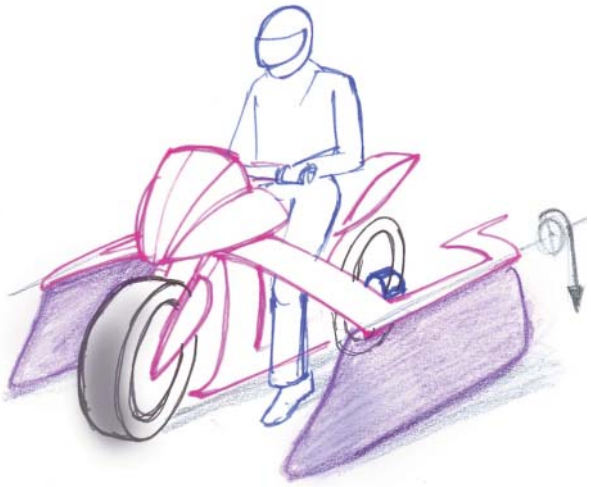
Step I



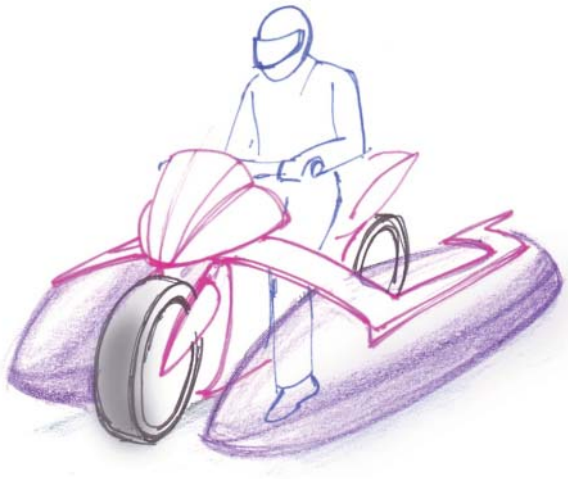
Step II



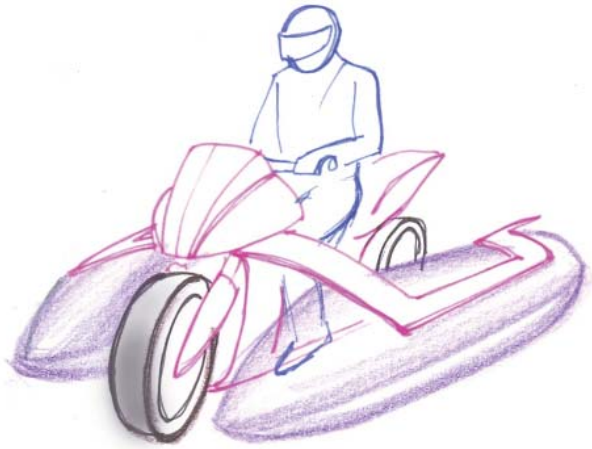
Step III



Step IV



Step V



Step VI

Description of steps:

Step I: Vehicle stopped

Step II: Vehicle balanced with left leg while the right side flap opens

Step III: Vehicle balanced with right leg while the left side flap opens up

Step IV: Vehicle is balanced by either of the legs while the inflatable pontoons are rolled out from the side flap housings from both sides. This step is further explained in further discussion.

Step V: Both pontoons are inflated

Step VI: The vehicle is ready to be driven into the water for amphibious experience.

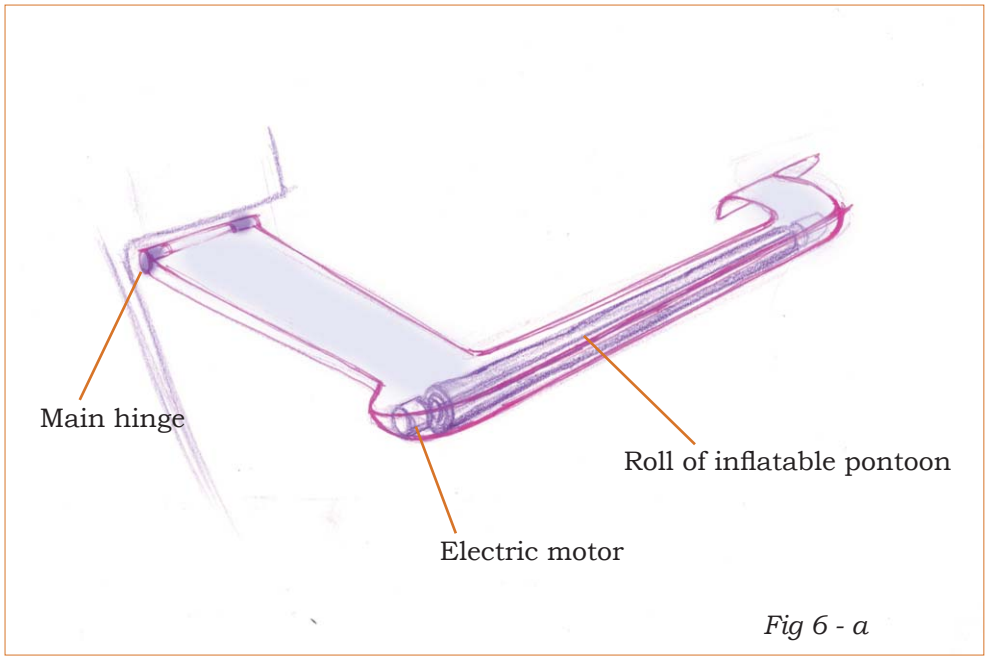


Fig 6 - a

9.2 Details of step IV

The step IV of the transition is elaborated with *fig 6 a-d*. The housing holds the roller of the inflatable pontoon. An electric motor attached to the roller shaft unrolls the inflatable pontoon while changing to water mode.

While changing from water mode to land mode air is sucked out from inflated pontoon with the help of air pump. The deflated pontoon is now rolled back into the housing. As the length of the pontoon is more than the length of the housing, the shape of the housing corner coming in contact with the pontoon is made rounded to achieve overlapping of the pontoon.

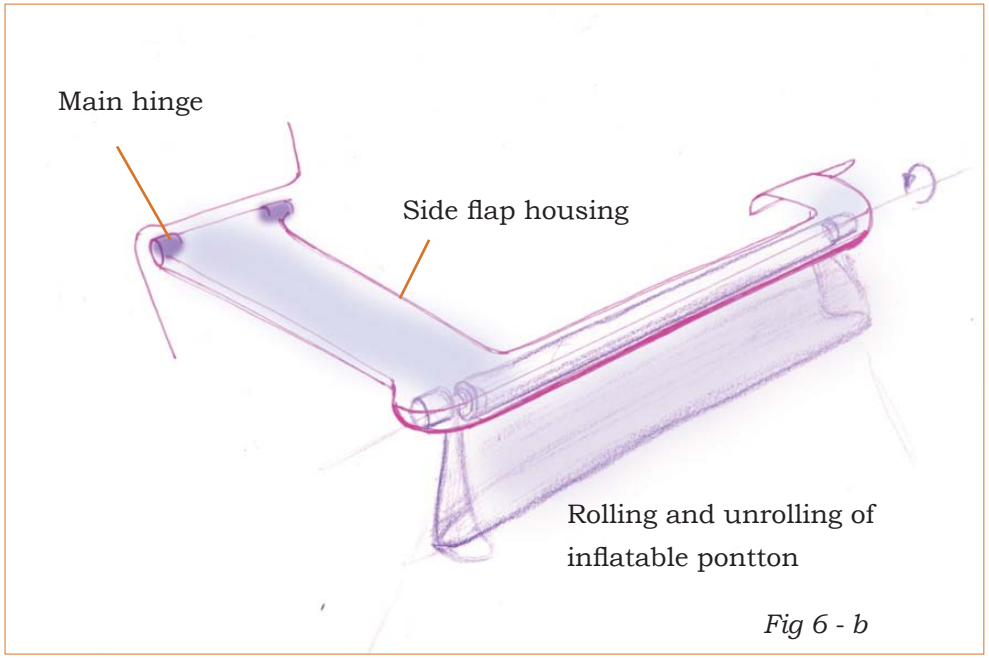


Fig 6 - b

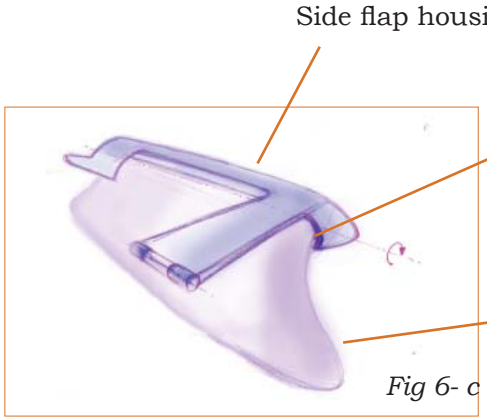


Fig 6- c

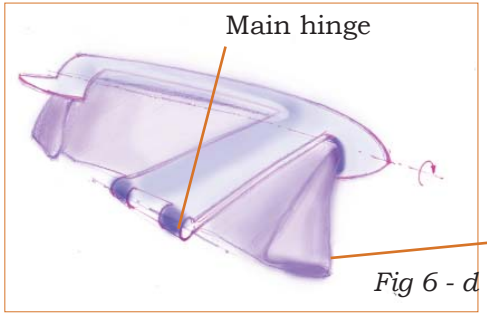


Fig 6 - d

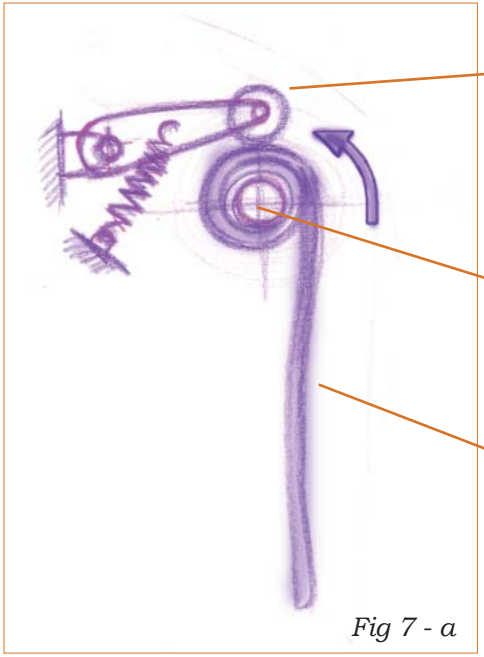


Fig 7 - a

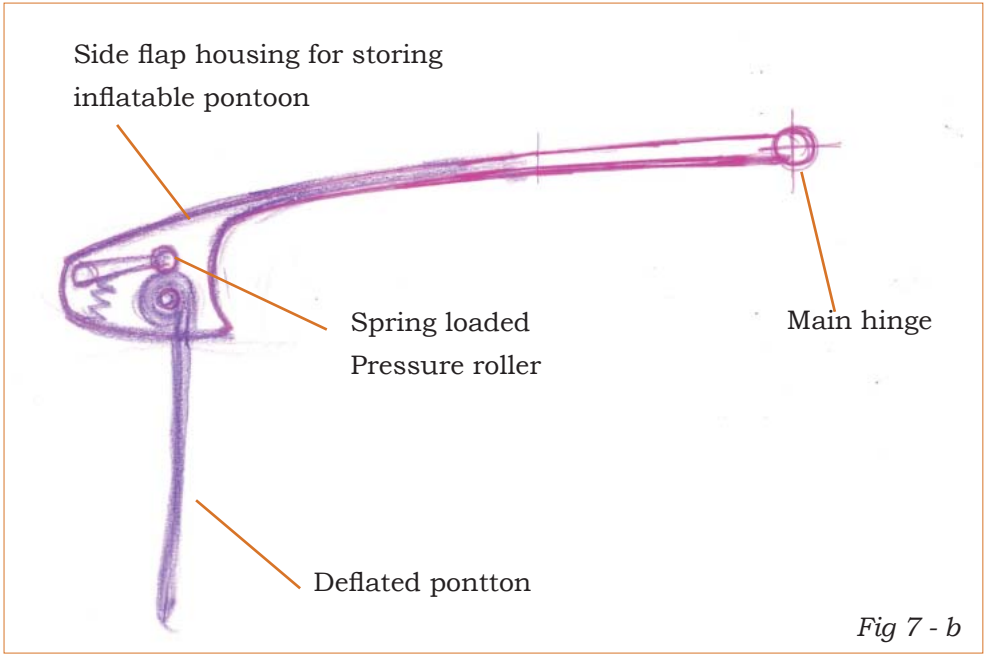


Fig 7 - b

9.3 Making a roll of deflated pontoon

As the deflated pontoon will be overlapped and there is a space constraint, the rolling of deflated pontoon needs to be packed tightly and neatly. To achieve this a spring loaded pressure roller is proposed which will keep a constant pressure on the rolled in or rolled out deflated pontoon. Fig 13 a-b explains the concept of pressure roller and its position in the side flap.

9.4 Inflating and deflating of pontoon

The pontoon needs to be rolled and inflated, deflated at same time. The inflated pontoon is fixed with a hollow shaft with holes. The air pressure is supplied by a air pump mounted in the main body. The supply line is connected with the hollow tube through a sealing which allows rotation of roller shaft but avoids any leakage as shown in *fig. 8*.

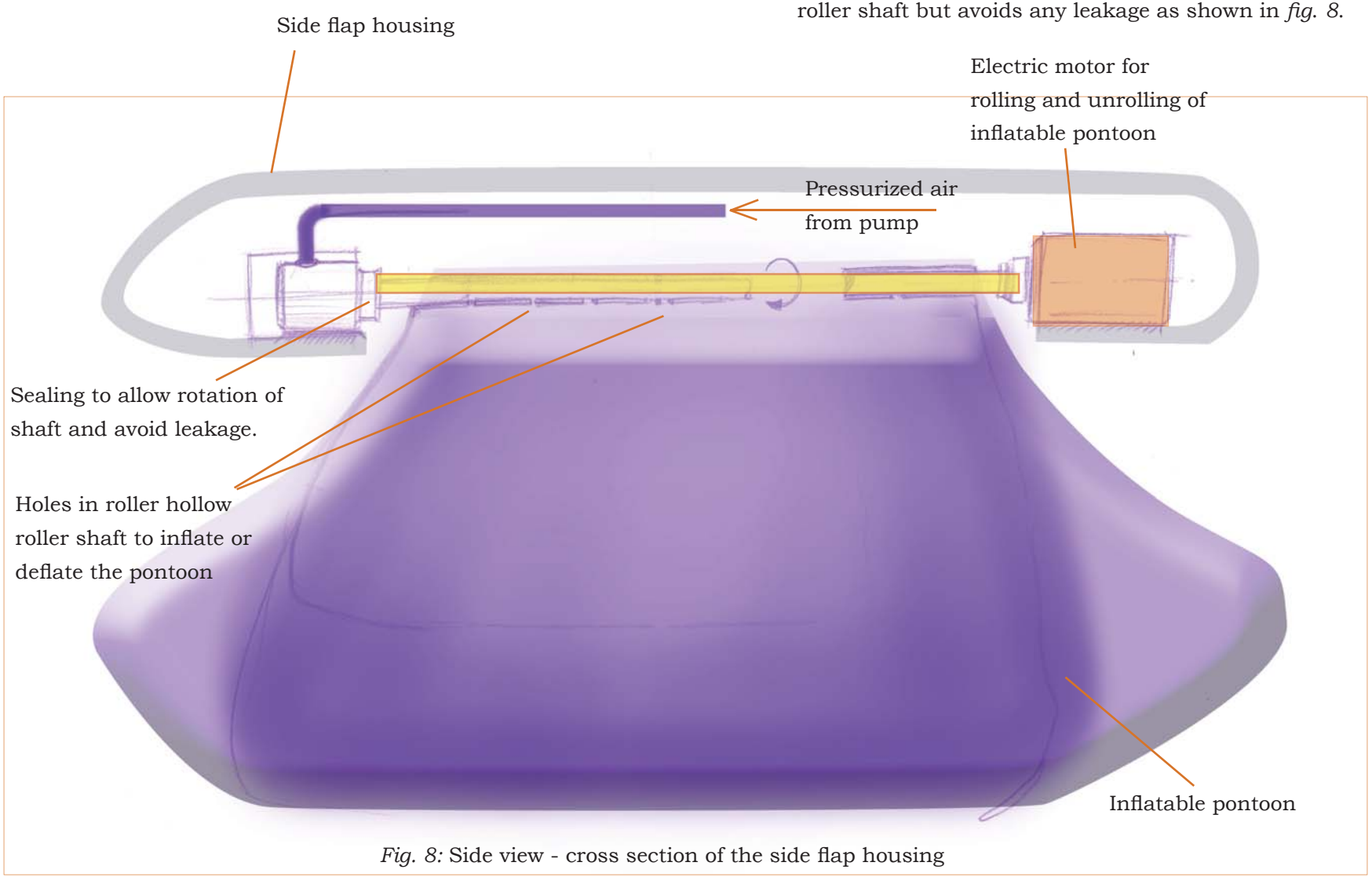


Fig. 8: Side view - cross section of the side flap housing

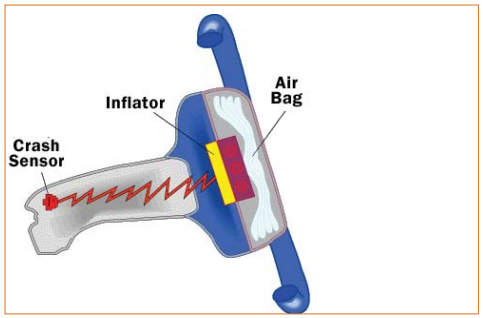


Fig. 9 a:
Air bag in packed condition [13]

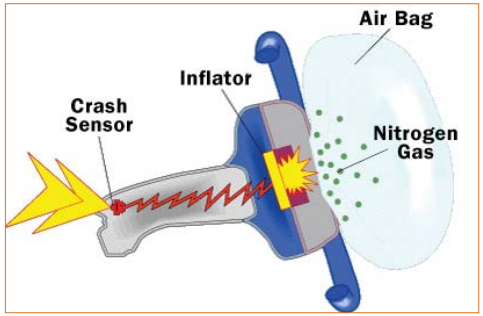


Fig. 9 b:
Working of the air bag in automobile steering wheel *[13]*

Image. 19:
DC air pump *[14]*

9.5 Inflating and deflating of pontoon: source of air

The possible technologies for inflating and deflating the pontoons were considered for the proposed amphibious vehicle. The technology of chemical reaction used to inflate air bags in the automobiles shown in *fig 9,* will take less time to inflate the pontoons but it will involve the replaceable chemical cartridge system. The air bag technology also does not help in deflating the pontoons.

A DC air pump is already in-use technology for inflating and deflating boats and other inflatable with car battery as power source. A DC air pump shown in *image. 19* was chosen for inflating and deflating the pontoons of amphibious two wheeler. Please refer *appendix 6* for more details of the air pump.

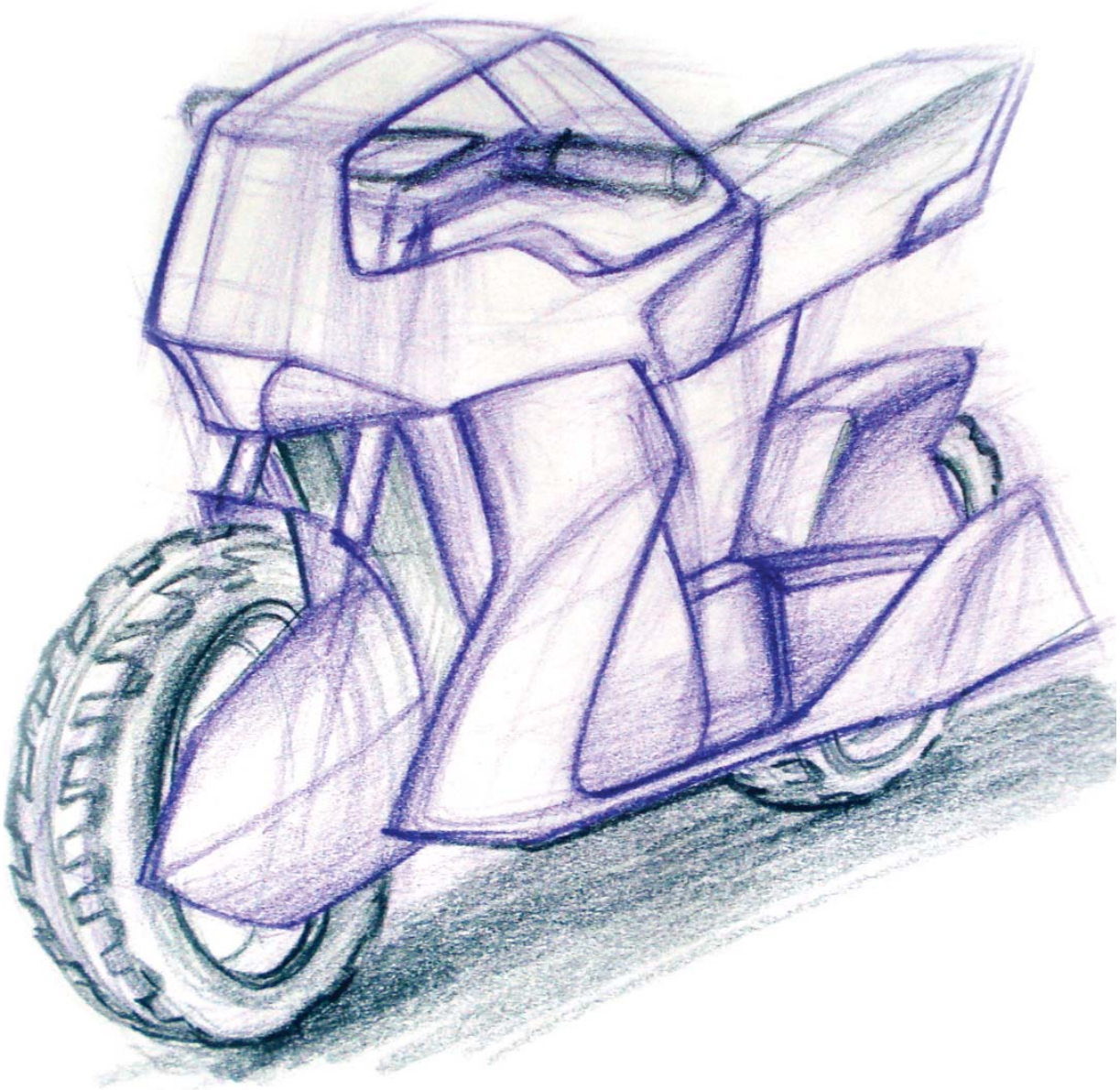
IDEATION FOR FORM

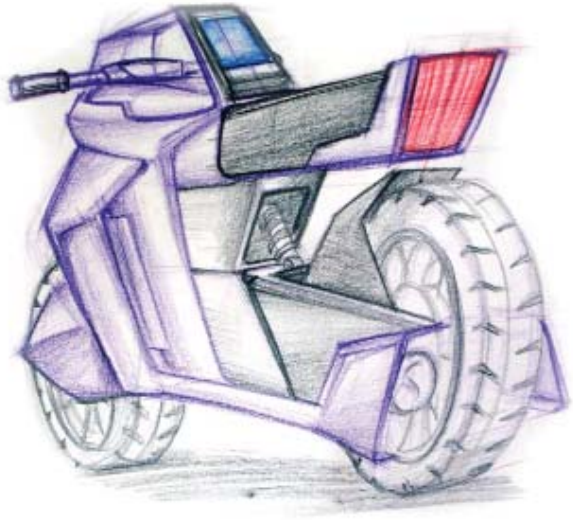
10. Ideation for form

Once all the elements for the amphibious two wheeler were in place and the fearless character defined, the second stage of ideation and sketching started for giving it a form.

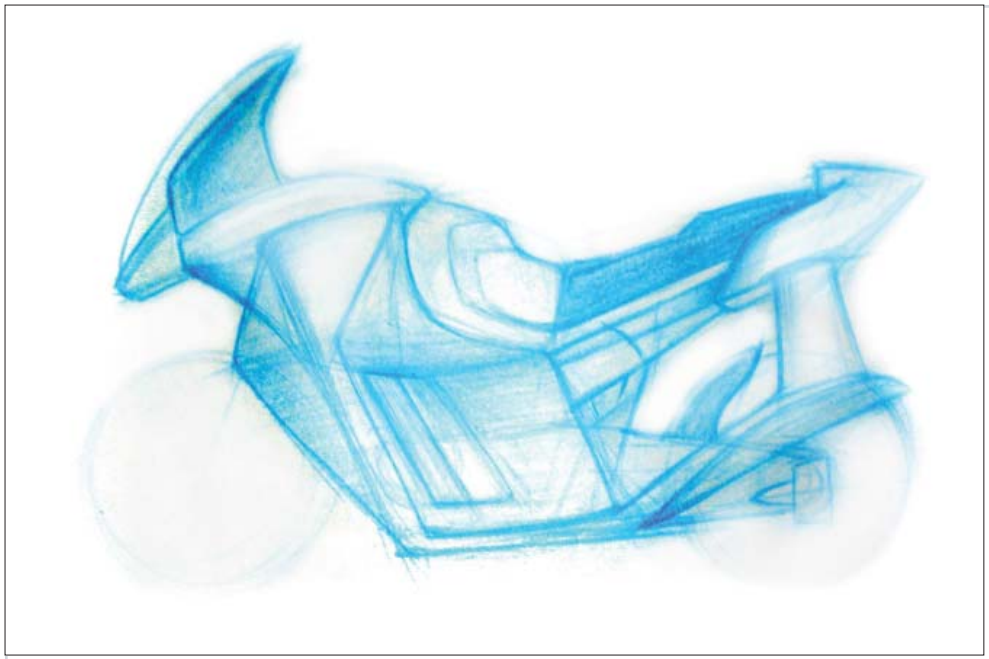
Some of the sketches and the thinking process while sketching them is documented in the following pages.

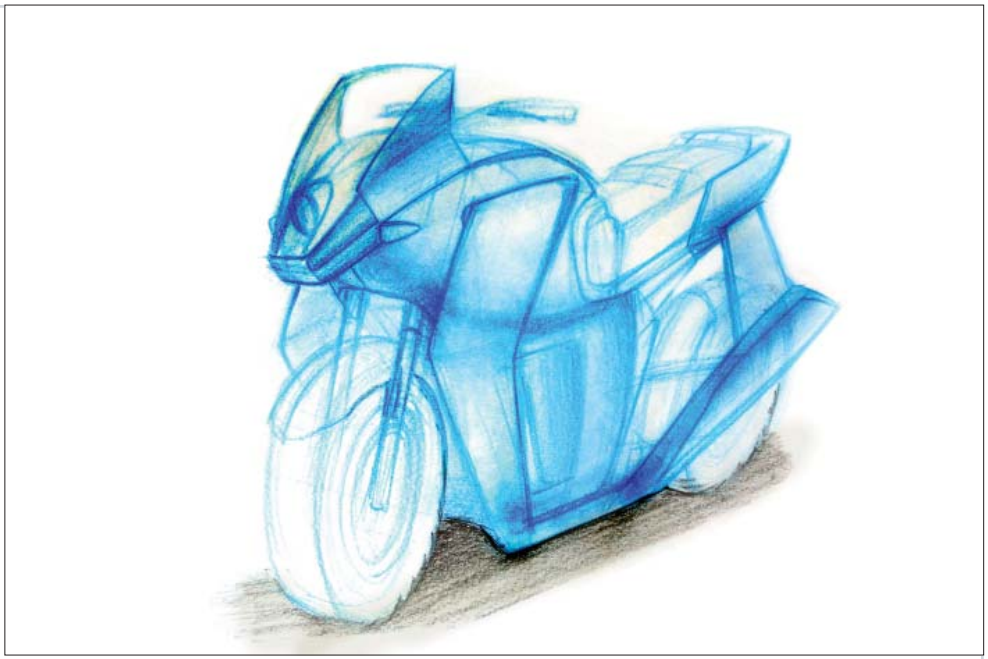
Chasis of Yamaha FZ with wheelbase of 1355mm was used as areference for considering factors like handling, braking, saddle height, ground clearance and riding comfort.

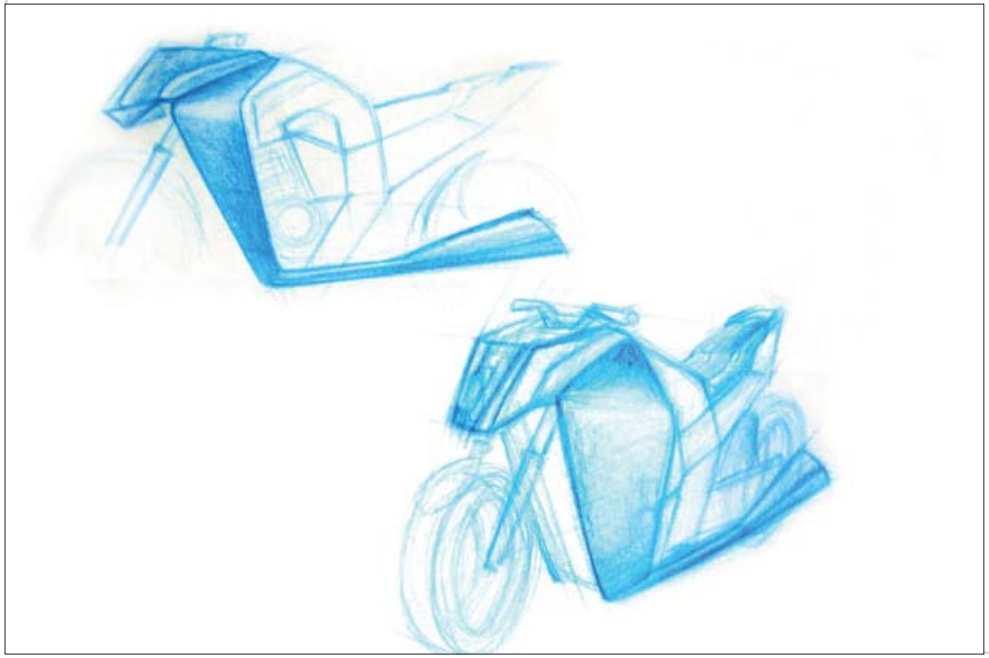


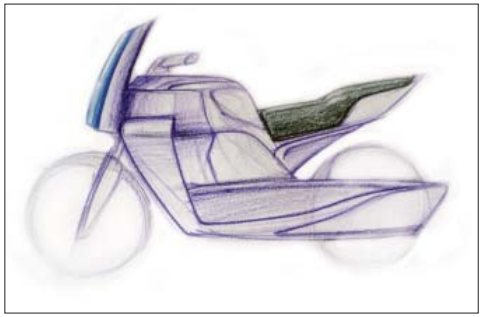


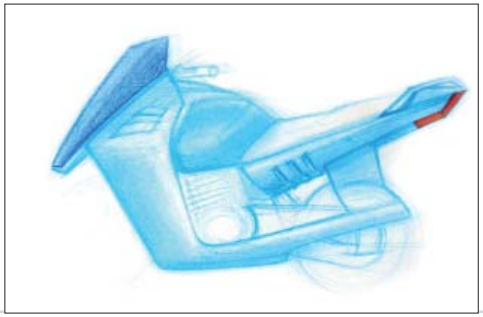
Beside sketches show an amphibious two wheeler in land mode. Fuel tank is covered with the front fairing, only a opening eft to access the handle. Front and rear wheel covers which also acts as mudguard are made curved and pointed to give it a streamlined bottom appearance. The forward pointing side flap though emphasized motion and added muscle to the overall appearance; it was found unpractical after considering steering envelop of front wheel. The LCD display was mounted on the envelop of front fairing over tank.



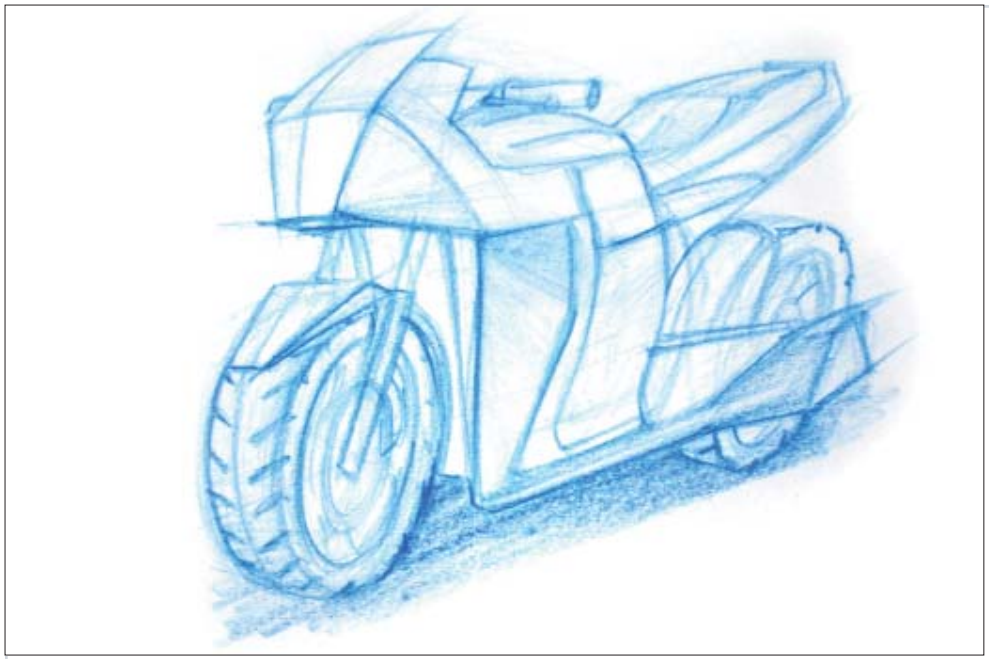


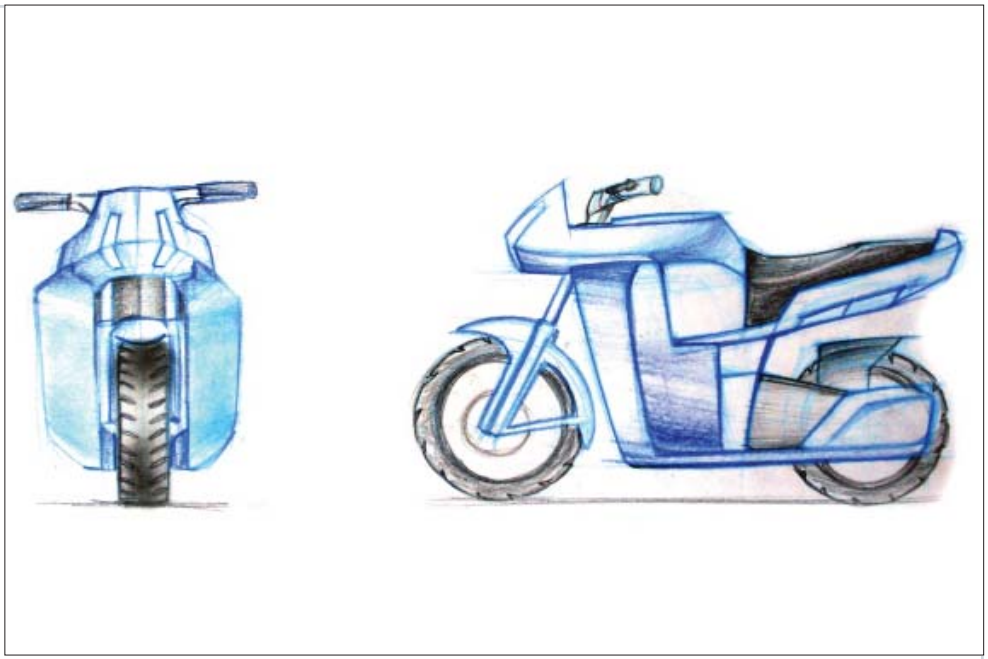


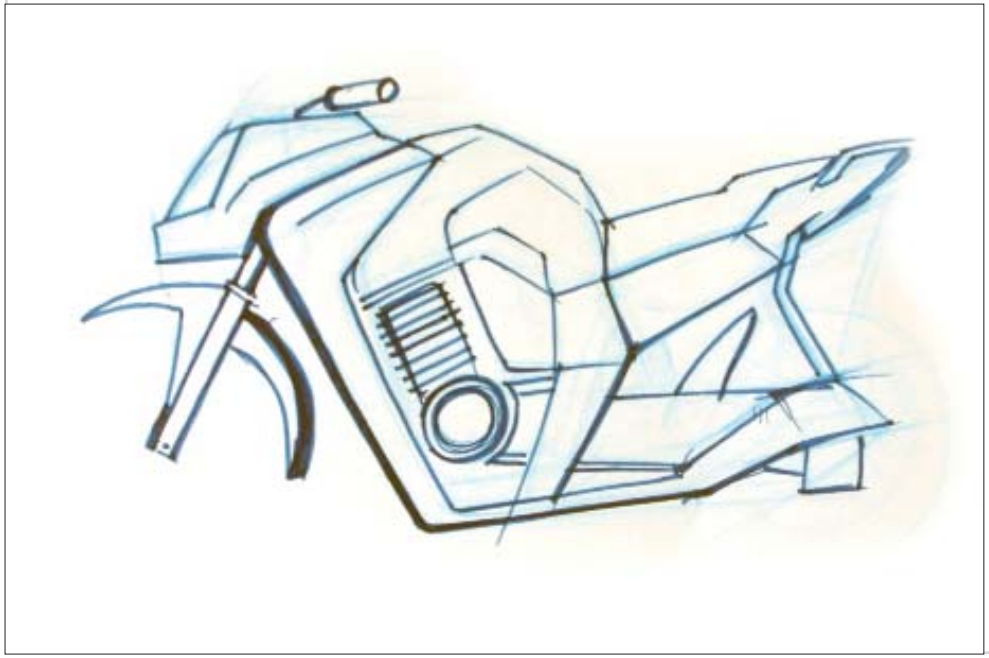


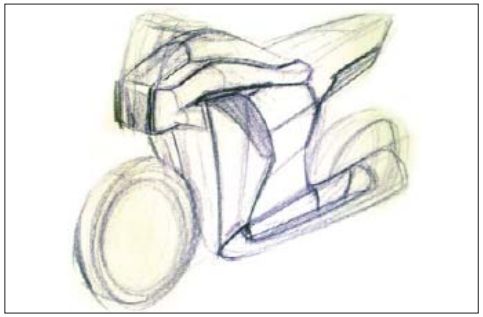


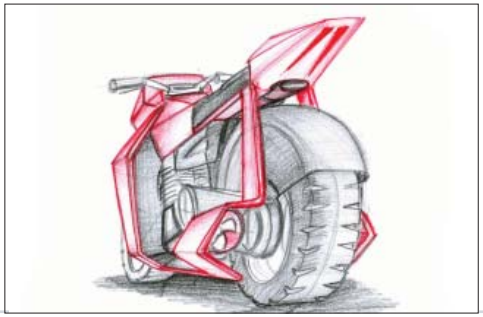
The side flap was emphasized. A conscious attempt was done to give it a raised chest appearance by pulling the side flaps in forward direction. The side flaps also acts as a wind shield and a leg guard in land mode. The propeller was covered from top side with the side flap which was more free flowing towards rear. The propellers were left visible from side view to make it look more than a regular two wheeler.



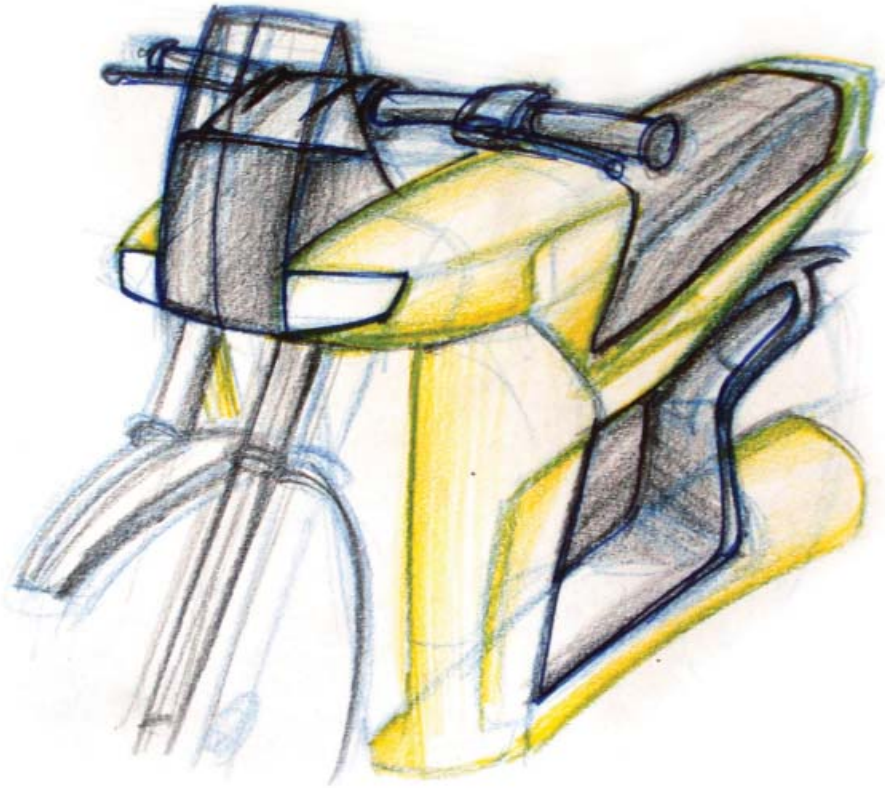


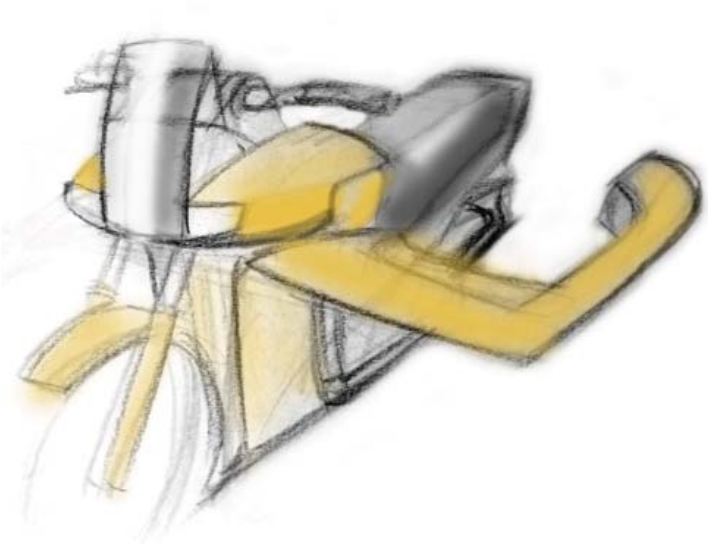




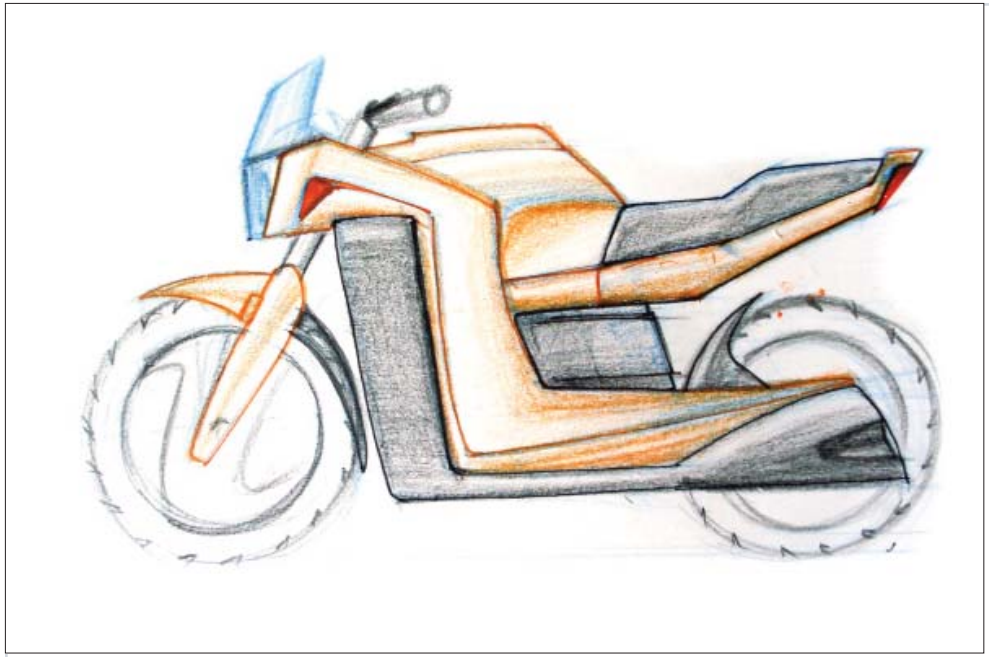


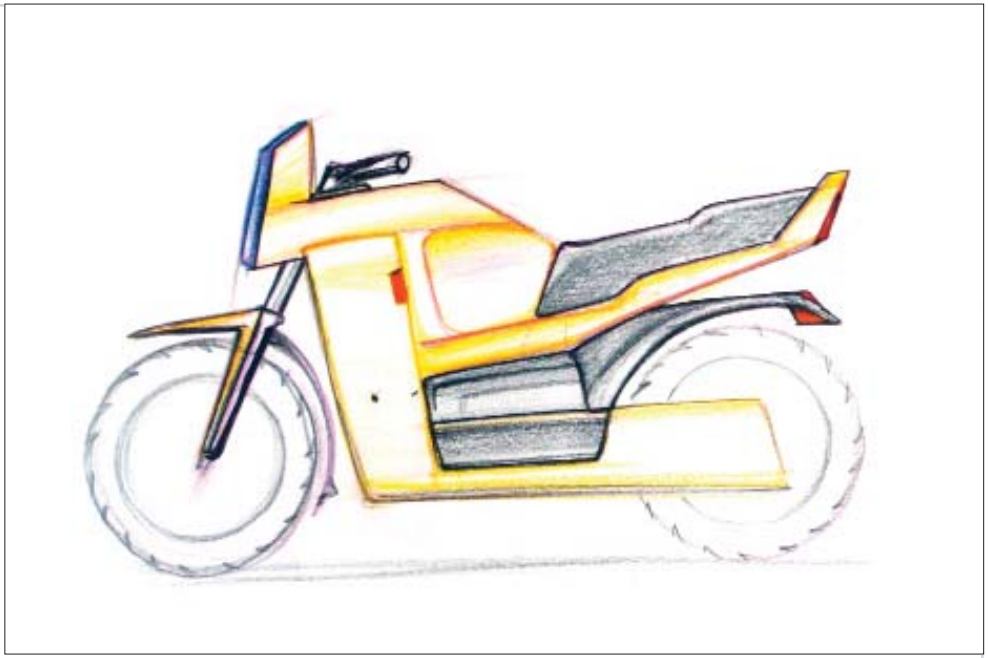
Rugged and muscular looks were on mind while sketching faceted side panels. At the same time there was an attempt to make it look streamlined. Muscle lines on the fuel tank were emphasized. A necked bike look of the two wheeler was also a part of exploration but was not considered as a possible direction for further exploration because of possible problems with water exposure.

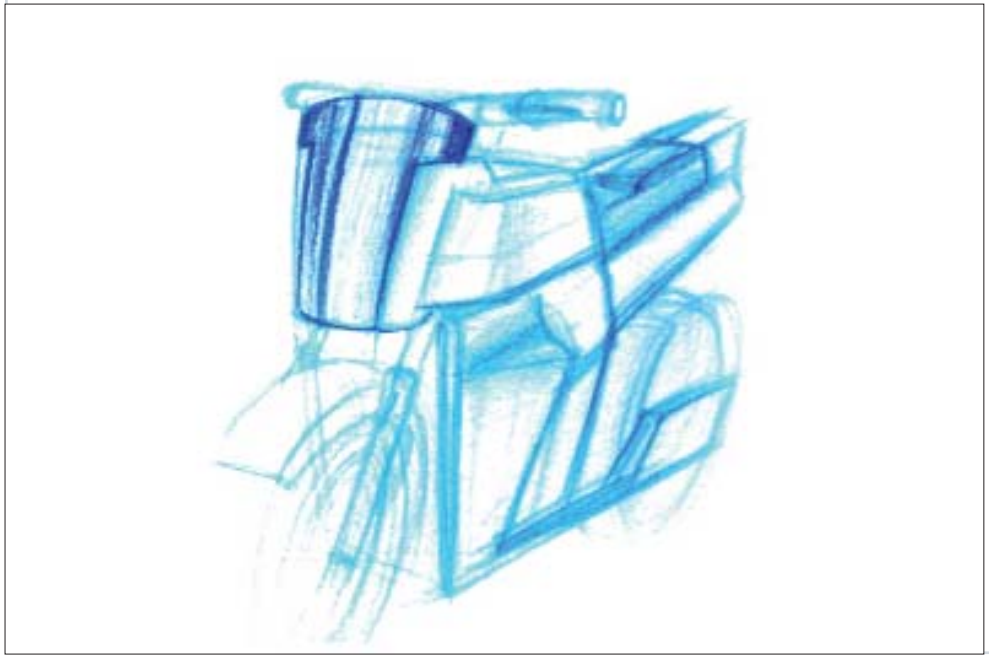


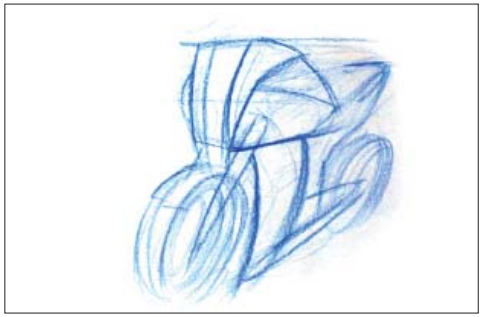


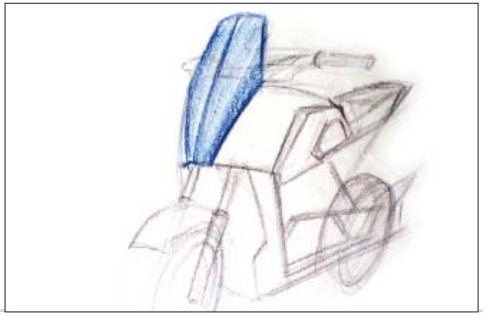
The front part of head lights and wind shield glass was widened to break away from the pointed nose appearance of conventional two wheelers. The two head lights were placed on either side of the wind shield glass which was slightly curved to suggest motion. The fairing around head lights which was narrowing at front bulging in middle and again narrowing in rear was thought to be sign of power.











The inclination of lines created by side flap was kept in check to give it an upright stance rather than emphasizing direction. The stability was added with the horizontal bottom line and the possible movement was suggested by pointed front and rear. Options for front fairing were explored.

CONCEPTS

11. Concepts

The sketched ideas were short listed on the basis of personal opinion. The selected ideas were rendered in digital media for better visualization. Soft-modeling tool was also used in this stage for understanding space constraints and proportions. 1:5 scaled mock-ups were also used to understand the form details.

The concepts and the thinking process behind each of it is as shown in further pages.

One of the concept was soft modelled for better visualization of proportions and understanding the space availability.

Concept 1

Opening of the side flap

The side propellers from rear view.

Concept 1

Concept 2

Most of the rear part borrowed from the conventional two wheelers, this concept tries to integrate the side flaps with the front fairing. Though the head light is made pointed, its verticality adds to the vertical stance which is created with the side flaps lines and side fairing lines pulled back from side indicators. The dynamism created by sharp tapering rear is dampened by the horizontal bottom lines.

image 20
A thermocol mock-up of concept 2

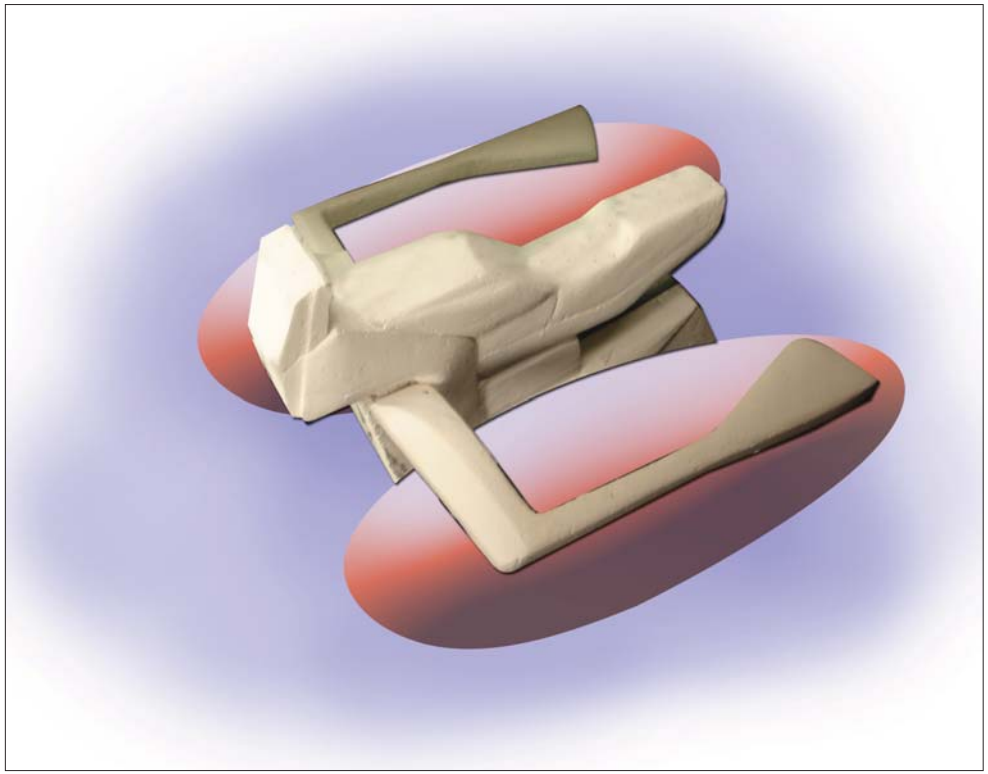


image 21
Thermocol mock-up of concept 2, edited to visualize water mode.

Concept 3

The dominating front fuel tank with the muscle line which follows the leg profile and integrated front fairing gives the overall powerful appearance to this concept. The integrated side flaps makes the wings. The fairing below seat tries to match the tail feathers and the body made with bulky fuel tank. The side flaps, the tail treatment and fuel tank pushes the looks of this concept towards a bird.

image 22
A thermocol mock-up of concept 3

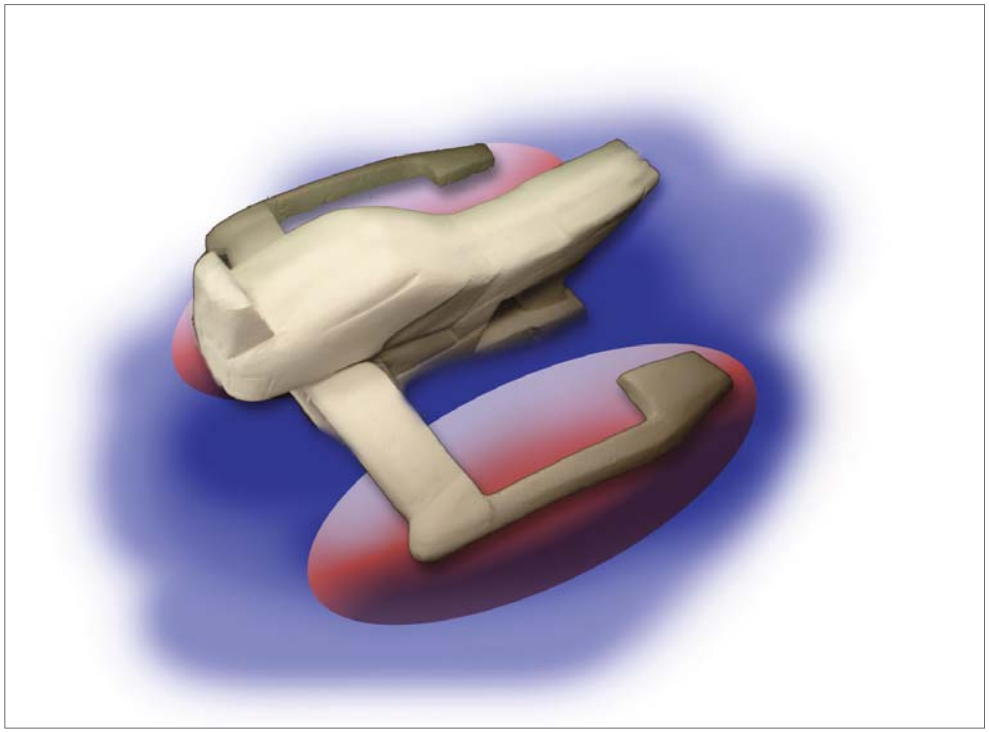


image 23
Thermocol mock-up of concept 3, edited to visualize water mode.

Concept 4

The fuel tank and front fairing lines taken from a fish, this concept tries to bring out the ability of swimming of the amphibious two wheeler. The side flaps are given more inclination than previous concepts. But at the same time the movement created by the inclined lines of side flaps and pointed rear end is arrested by the horizontal bottom lines. The protuberant shape of the rear end of the side flaps adds to the floater looks of amphibious two wheeler.

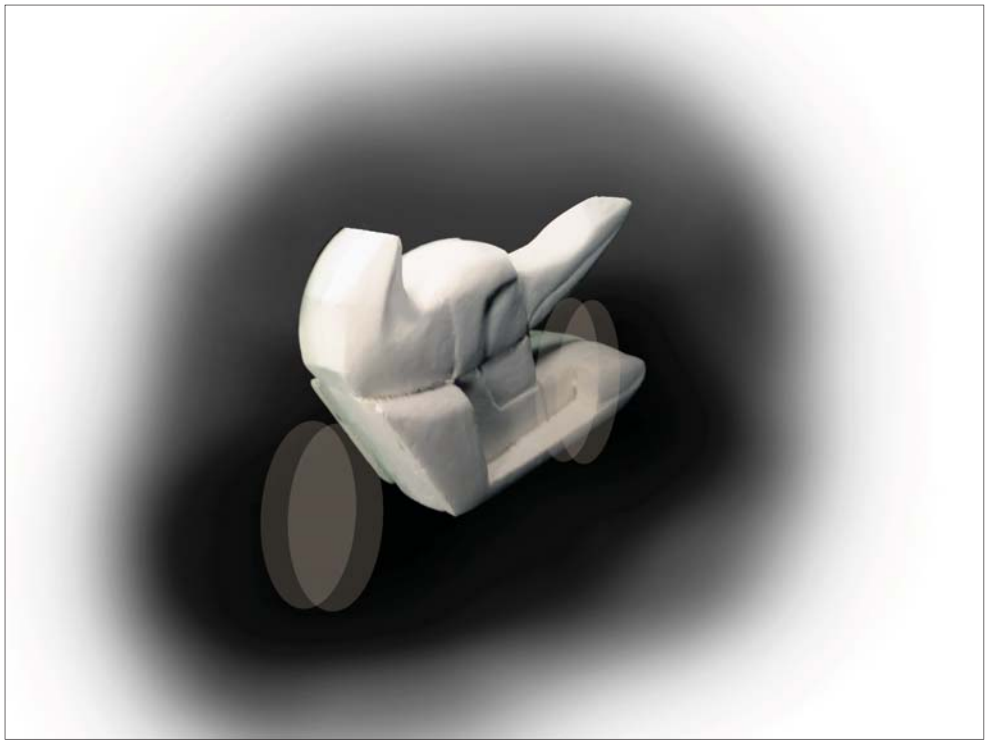


image 24
A thermocol mock-up of concept 4

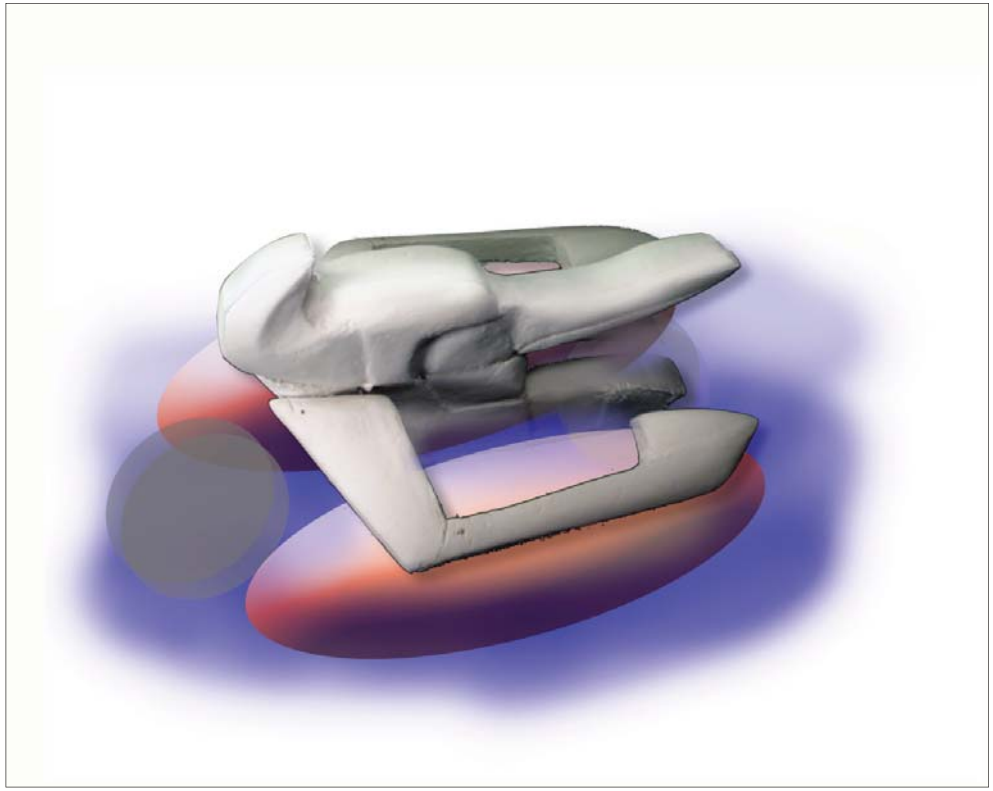


image 25
Thermocol mock-up of concept 4, edited to visualize water mode.

Concept 5

This concept tries to integrate the side flaps with the contemporary forms of the two wheelers. An attempt to make the vertical stance is done with the side flaps line. The forward motion indicated with narrowing and pointed front and rear is restrained with the bottom horizontal lines of side flaps. The power is proposed with the muscle line of fuel tank and overlapping front fairing on fuel tank.

image 26
A thermocol mock-up of concept 5

image 27
Thermocol mock-up of concept 5, edited to visualize water mode.

Concept 6

This concept makes the power statement with ruggedness created with faceted panels. A rear wheel covering coming from the main body tries to integrate the rear wheel the rugged body. Most of the rear elements adopted from the conventional bike and the uni color scheme for body and side flaps forces the appearance of this concept to a conventional two wheeler.

image 28
A thermocol mock-up of concept 6

image 29
Thermocol mock-up of concept 6, edited to visualize water mode.

Concept 7

The muscular front fairing and fuel tank gives the power to this concept. The faceted and pointed rear end gives the hint of ruggedness and dynamism. The overlapping elements of main body and a lightening shape created with them also suggest power and motion. The pointed head lights also suggest some aggression. But all the motion evoked with the inclined lines is subdued with the horizontal lines of side flaps.

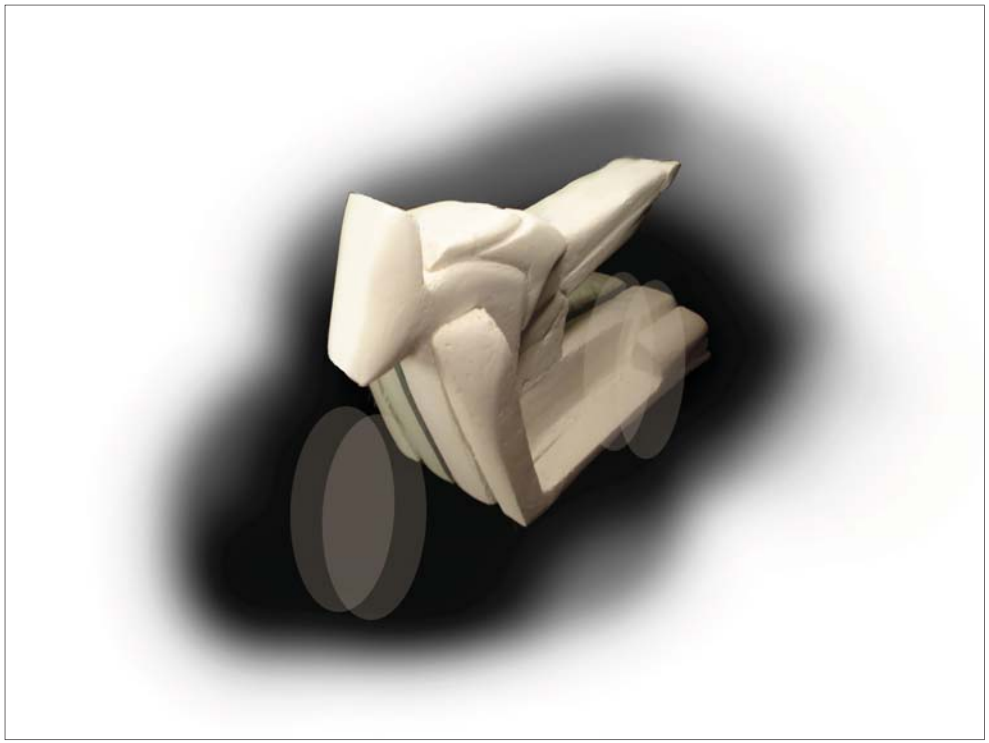


image 30
A thermocol mock-up of concept 7

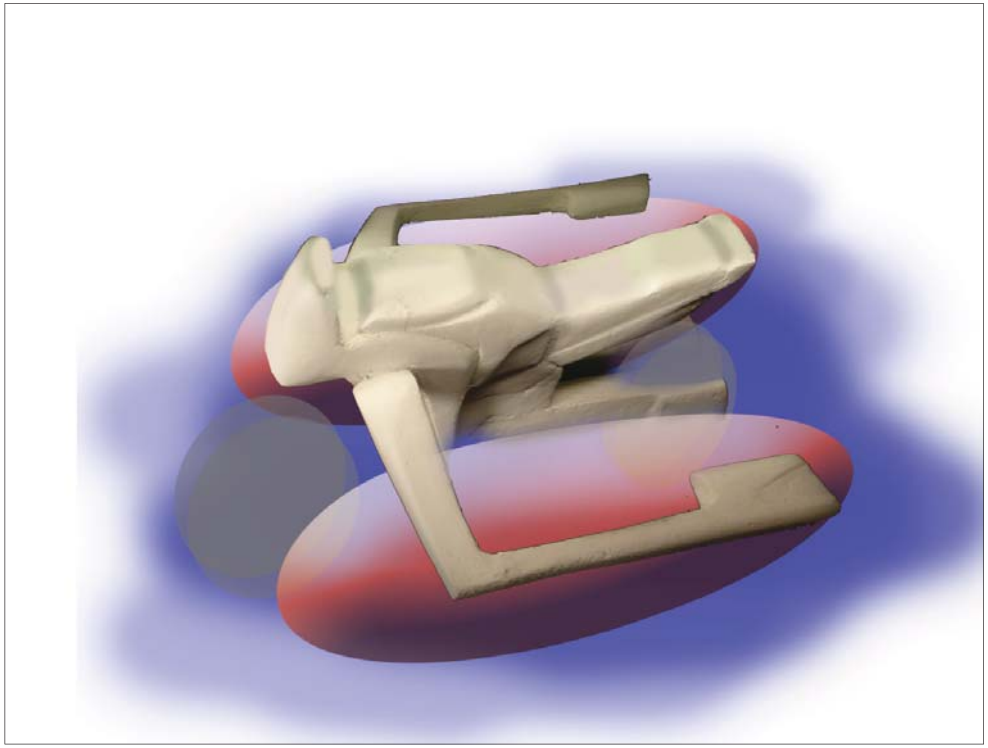


image 31
Thermocol mock-up of concept 7, edited to visualize water mode.

Concept 8

Front was modified in concept 3 to give it more vertical stance. The fuel tank was stretched in forward direction with a long muscle line to indicate strength.

Concept 9

A fuel tank integrated with the front fairing tries to give a raised head appearance to the two wheeler. The verticality of the side flaps and the horizontal lines at bottom makes it too stable. The front fairing with an opening left for handle and the rounded bottom side of side panels were some of the interesting features to take ahead for next concepts.

image 32
A thermocol mock-up of concept 9

image 33
Thermocol mock-up of concept 9, edited to visualize water mode.

Concept 10

A curve made by front fairing, fuel tank and the rear end tries to give it some dynamism. A venturi shaped negative space between the curved bottom end of side panel and the top curve of rear end and front fairing evokes a controlled motion character.

image 34
A thermocol mock-up of concept 10

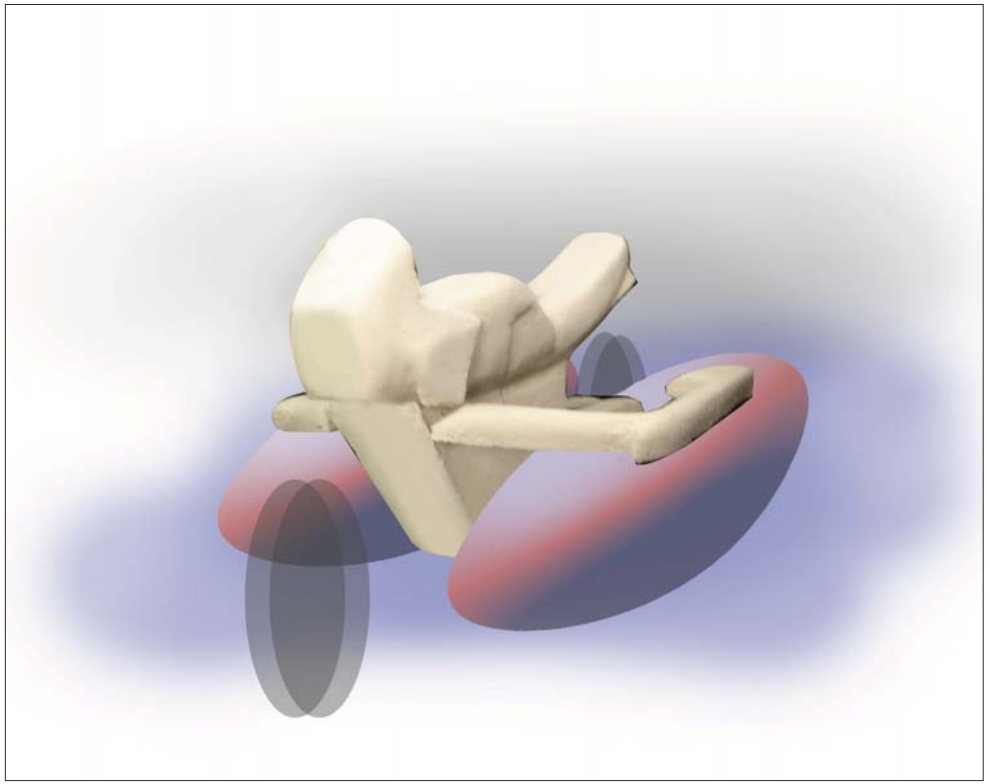


image 35
Thermocol mock-up of concept 10, edited to visualize water mode.

Concept 11

This concept was a result of an attempt to break away from the regular two wheeler look. The rear wheel cover was exaggerated by integrating it with the main body. The podded propeller was shown off as a visual element in side view. Fuel tank muscle was stretched backward to add powerful looks. An element was added at bottom of body, towards front wheel to give it a ready to move stance. The wheel rims were given away for wheel disks.

Concept 12

A skirt was added on rear wheel to eliminate the floating appearance of seat. The skirt blocked the empty space between rear wheel and seat, thus adding visual mass to the whole vehicle. The line starting from fuel tank and ending on rear end after passing on the skirt; is making a visual depression around seat. This visual depression is giving inviting feeling to the vehicle's appearance.

Concept 13

This concept moves more toward organic form. The backward pulled front fairing overlaps the muscular fuel tank accentuating feeling of power. The side propellers are intentionally left exposed from side view to make it ‘more than a bike’. The rear wheel cover which also acts as a mud-guard is connected with the main body. This was done to add more visual volume at bottom section and also after taking inspiration from water jet ski boats.

Concept 14

Concept 6 was refined to achieve this concept. The muscular rugged looks of the previous concept are kept same. Seat is given more visual mass and ruggedness with the additional inclined lines. The rear wheel cover is made a noticeably big and is connected with the main body. The rear bottom was tried to be matched with the water jet ski.

CONCEPT EVALUATION

Image 36
User survey

12. Concept evaluation

The final concept was chosen after evaluating concepts by 12 potential users. Cards were prepared for each concept. The evaluators were asked to rank the concepts by arranging the cards according to their personal preference. A question like 'Is this a regular bike or more than that?', was also asked to understand the 'more than bike' quality of each concept.

The results of evaluation were tabulated as shown in table 4.

Concept no.	Concept	Preference no.* 1 to 10 scale (10 prefered most of the times - 1 less preferred)	Feeling of 'more than bike' 1 to 10 scale (10 towards more than bike - 1 towards bike)	Novelty 1 to 10 scale (10 More novel - 1 novel)	Total	Mentionable comments
1		3	7	6	16	Techie, unusual boxy
2		4	3	4	11	everyday bike
3		6	4	4	14	everyday bike, but something different
4		6	5	5	16	Directional, shrper front would have suited more
5		8	3	4	15	Everyday bike, slick, zippy
6		6	4	4	14	Feeling of power Weak front connection with wheels

Table 4: Evaluation of concepts

* - Please refer appendix 7 for sample calculation of preference no.

Concept no.	Concept	Preference no. 1 to 10 scale (10 prefered most of the times - 1 less preferred)	Feeling of 'more than bike' 1 to 10 scale (10 towards more than bike - 1 towards bike)	Novelty 1 to 10 scale (10 More novel - 1 novel)	Total	Mentionable comments
7		5	4	3	12	dislike of color
8		6	4	4	14	Feeling of power and motion
9		3	6	6	15	Too stable
10		5	3	4	12	Dislike of front treatment
11		6	5	5	16	Dislike of front
12		4	6	6	16	Powerful, bulky visually weak front wheel connection

Table 4: Evaluation of concepts

* - Please refer appendix 7 for sample calculation of preference no.

Concept no.	Concept	Preference no. 1 to 10 scale (10 prefered most of the times - 1 less preferred)	Feeling of ‘more than bike’ 1 to 10 scale (10 towards more than bike - 1 towards bike)	Novelty 1 to 10 scale (10 More novel - 1 novel)	Total	Mentionable comments
13		6	6	5	17	Appealing front fairing
14		7	5	5	17	Tank or hummer in bike,

Table 4: Evaluation of concepts

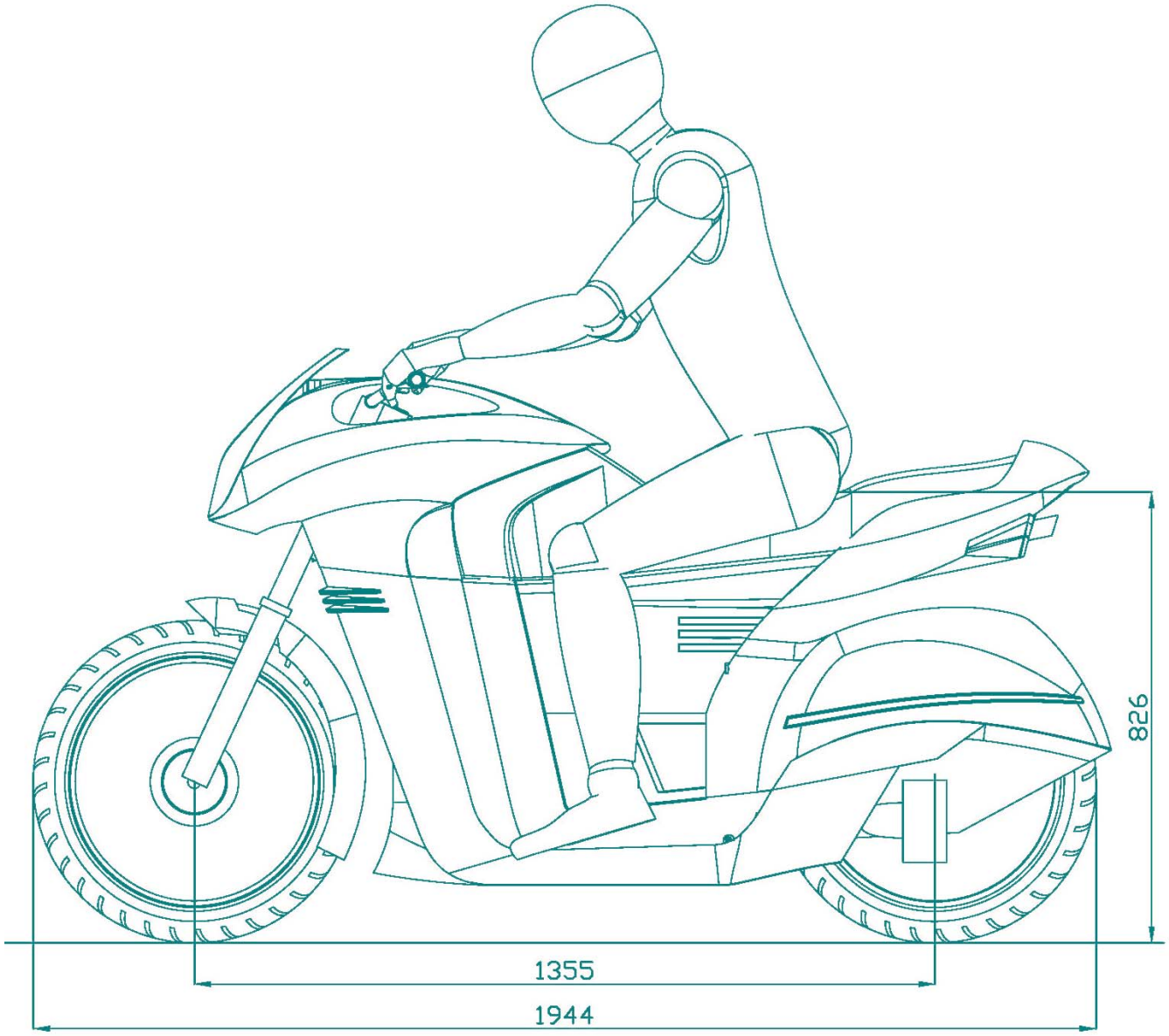
* - Please refer appendix 7 for sample calculation of preference no.

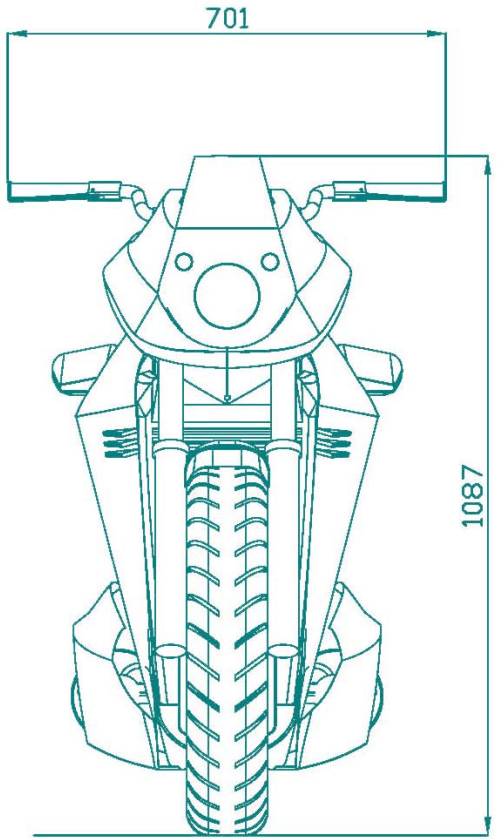
SELCTED CONCEPT

13. Selected concept

Based on the quantitative evaluation and qualitative understanding of users opinions, concept 13 was chosen for further refinements.

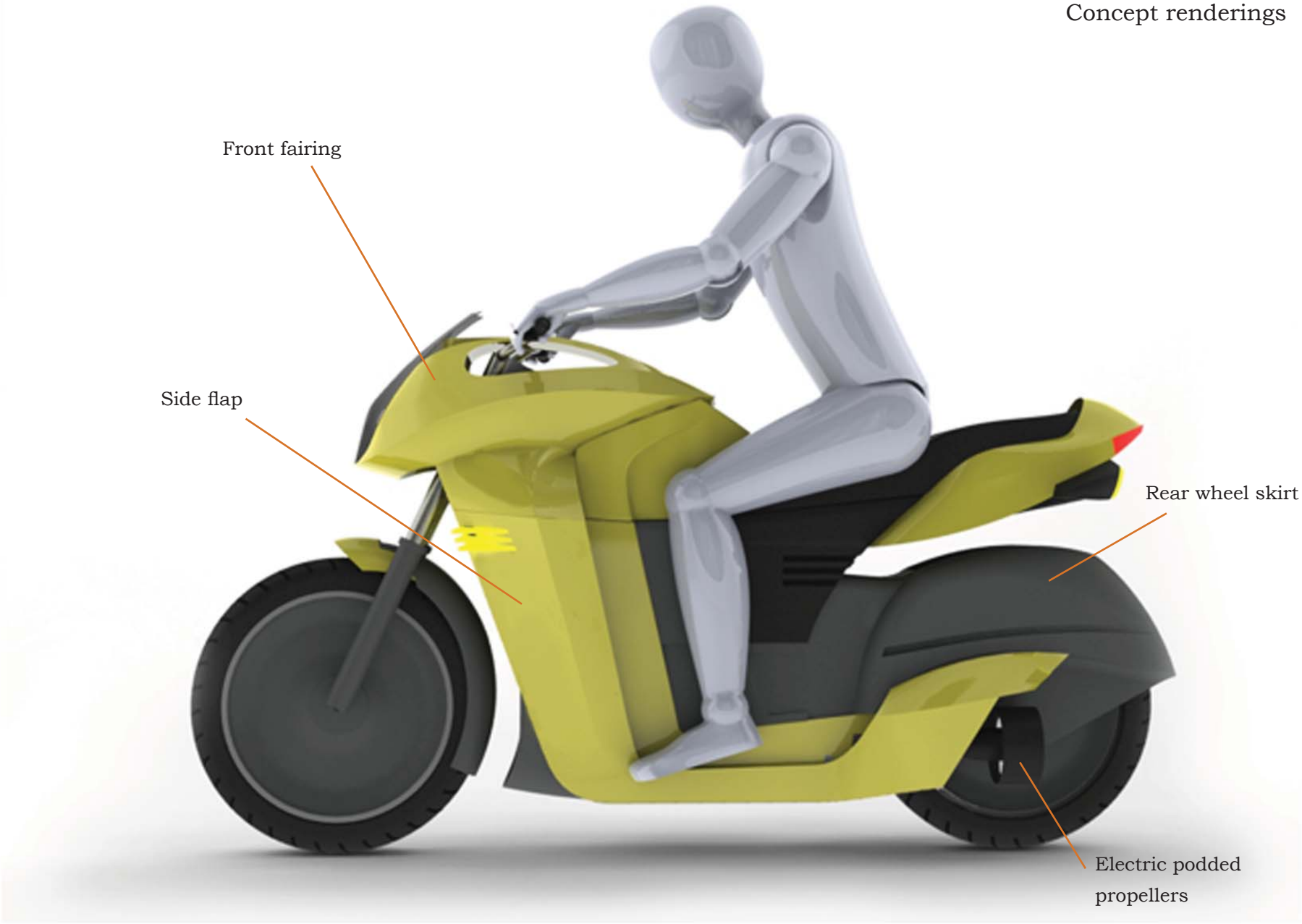
13.1 Concept drawing





13.2 Concept renderings

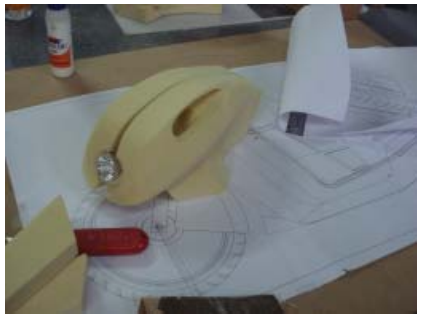
Concept renderings



Concept renderings

MODEL MAKING








14. Model making

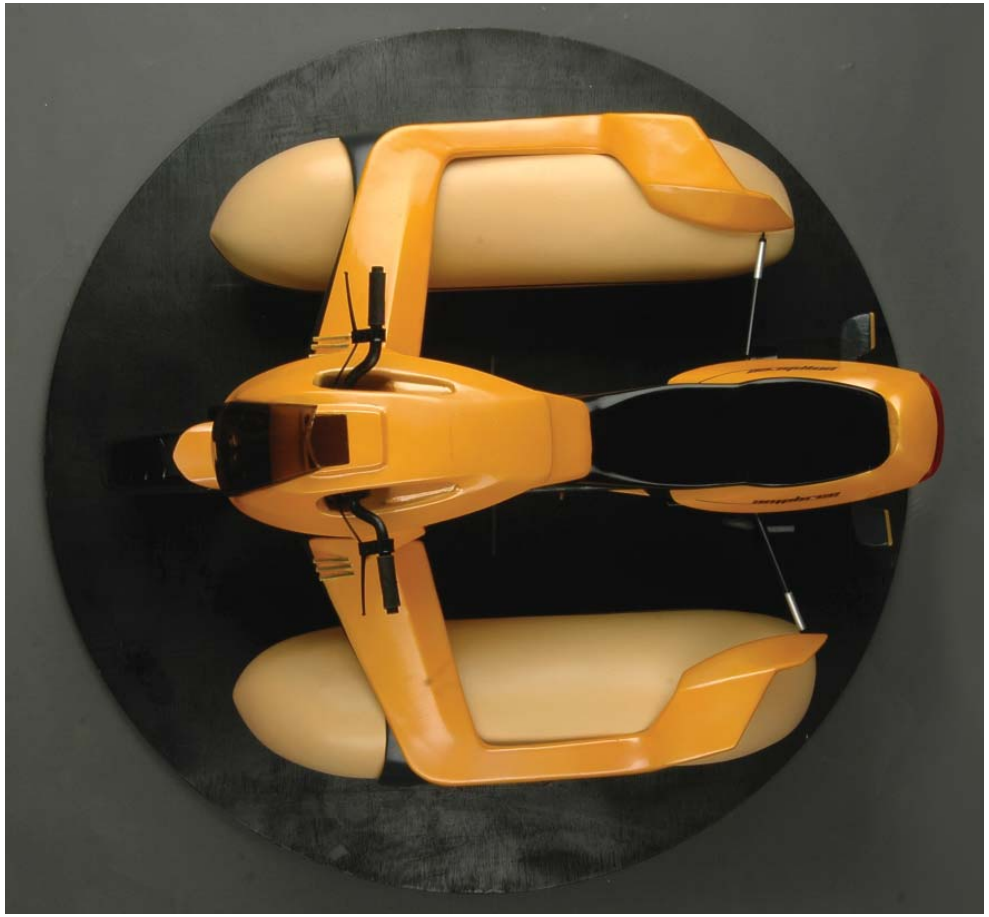
The software model was used for CNC milling. The parts like main body, fuel tank with front fairing, seat, wheels were CNC milled in halfs in PU foam and joined together. The model was mounted on two pins going through the wheels. Images beside shows the process in a glimpse.

AMPHREE

BREAK THE GROUND BARRIER

15. AMPHREE - Break the land barrier

An aspiration to work simultaneously with Marine and Automotive sciences led to an amphibious two wheeler called AmPhree which can run on land and on water surface. Build with proven technologies AmPhree is proposed for year 2020 as a first generation of the futuristic amphibious two-wheelers. The front fairing over the fuel tank is inspired by a boat hull which cuts through the water while the bike-ness is retained by using diamond type frame for fixing layout. AmPhree becomes more than a bike with the additional elements like side flaps mounted below front fairing and the podded electric propellers mounted on rear wheel axis. The rolled PVC inflatable bags stored inside the side flaps allow AmPhree to look sleek on road and the same when inflated gives it required buoyancy and stability in water mode. With a poised, ready to attack, fearless stance AmPhree is designed to break the borders of land.



Amphree top view in water mode

Amphree view in water mode

1. Amphree in water mode

2. The right pontoon deflates

3. The right pontoon is rolled in the side flap

4. The right flap starts closes

5. The right flap closes completely

6. The left pontton deflates

7. The left pontton is rolled in the left side flap

8. The left flap starts closing

9. The left flap closes and the AMPHREE completelytransorms in land mode

Water mode to land mode and Land mode to water mode transformation takes four minutes. The time depends on the the discharge rate of selcted compressor. Land mode to water mode transformation will happen in the reverse sequence as that of shown in beside images.


break the ground barrier
amphree
IDC 2010

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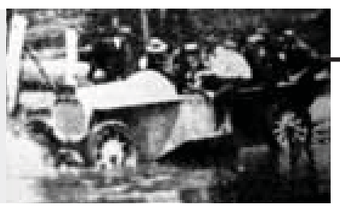
APPENDIX - 1

AMPHIBIOUS VEHICLE

Model	Description	Image	Year	Image	Model	Description
Magrelen Amphibium Invention	Denamrk, combustion engine		1899 1905		Richmond	USA, three wheeler, paddles on backwheels Boat + 3 wheels
Amphi II Boat + 4 wheels	USA, made by Admiral Howell and his son		1909 1913		Lambert Cyclecar	Scotland Box + 3 wheels
Hydromotor (Delia) 1st amphibious in production	USA, **small production,** maybe a handful cars		1914 1915		Zeiner, Hydro-Automobil	Austria, Prop removable Removable propeller
Monnot, Hydrocar Removable appendages	USA, wheels + axles removable, runs backwards in water		1917 1922		Mathieson, Seacar	England, rescue boats on Ford T chassis Boat with wheels
Hydromobile Retractable wheels	France, first plans in 1924 with removable wheels, actually built with retractable wheels! Good water performance		1926 1926		McLaughlin Maine Mobile	USA, air-propelled Air propelled
La Comet Peddle power	France, **paddle wheels**		1933 1934		Baulig, Land-Wasser-Auto	Germany, **crossed the English Channel successful.** Achievement
Trippel, Versuchswagen 5 curved shape bodywork	Germany, mid engine		1936 1941		Trippel, SG 6/41	Germany, new designed SG 6 Sleek and streamlined
Baier, Familien-Freizeit-Auto Floating car	Germany		1953 1954		Porsche, Typ 597	Germany, **no extra water propulsion** wheels as water propulsion
Dauphin, Ann Phibi Amphibious bus	USA, amphibious motorhome, goes backwards in the water		1960 1961		IWK u. DWM, Amphicar	Germany, **production car** car which can swim
UAZ-3907 Box with propellers	Russia, **twin props**		1975 1977		Mayer, prototyp No.2	Germany Sleek and streamlined
The wave Boat on wheels	USA, homebuilt amphibious motorhome		1984 1985		Triton	Russia, high speed performance in water Hard chine hull bottom & wheels
GMC prototype Waterjet	England, **Jetdrive** unit in the front, goes backwards in the water		1990 1992		Sealander MKII	New Zealand, Jetdrive unit, high water performance Waterjet with retractable wheels
Isuzu, Nagisa Boat mounted on car frame	Japan, high speed performance in water		1955 2000		Dutton 4 x 4	England, 4WD, Jetdrive unit, **based on Suzuki Samurai.** Slick and streamlined
Aquada	England, high speed amphibian, **retractable wheels.**		2001 2002		Al´tkam Stalker	Russia, 4WD, 7 seater, **main floatation by huge tires, water propulsion by spinning wheels.**
Watercar	USA, high speed amphibian, **retractable wheels.**		2003 2004		Rinspeed splash	Switzerland, foldable **hydrofoils!!!**

MODERN-DAY AMPHIBIOUS VEHICLES

MAX amphibious
- Floatable boxy frame
- Tires gives additional buoyancy and also provide propulsion in water by spinning

Hydra Spyder
- Retractable front and rear suspension system
- All aluminum lower hull with fiberglass upper structure also flotation foam
- Sports car looks

Amphibious motor coach
- Ferry in Dubai
- Construction of a coach with inflatable bags for additional floatation from sides

Al´tkam Stalker
- 4WD, main floatation by huge tires, water propulsion by spinning wheels.
- Rugged, ATV looks

Quad Ski
- Personal water sports amphibian
- Retractable wheels
- Hard chine bottom with power boat appearance

DUKW
- Though its a vintage world war II design it still serves as a ferry in Boston

Watercar
- Retractable wheels
- Boxy looks

Dobbertin Hydrocar
- looks of a Space ship
- Enclosed volume

Aquada
- looks of a sports car with aerodynamic curved body and hydrodynamically shaped bottom

Rinspeed splash
- Foldable hydrofoils
- Pivoted water propulsion mounted at rear
- Closed canister construction of body for achieving floatation in water in low speed

Fast track amphibious vehicle
- Retractable tracks on either side for land
- A shape of floating capsule with radius at ends and flat sides

C & T Amphibious
- Electric amphibious vehicle
- Closed body for floatation and propeller at rear for water propulsion

Gibbs Humdinga
- 4WD, retractable wheels
- Hard chine hull bottom
- Rugged looks

Sealegs
- High speed boat with retractable wheels
- Electric hub motor drives the wheels on land

AMPHIBIOUS VEHICLES

Observations
- Fixed volume for buoyancy i.e. no attempt to add volume while making a transition from land to water or vis-a-vis
- Transverse stability in water achieved by regular proportions of road vehicle with respect to beam/width
- though approach of achieving buoyancy with tires is also taken in some amphibious vehicles, but increased drag reduces performance in water
- Propulsion in water is achieved in different manner depending upon the speed requirement and the overall structural and layout constraints i.e. Rotating wheels in water for slow speed application, waterjet or propeller in combination with retractable wheels for high to medium speeds.
- Most of the attempts are to give a hydrodynamic bottom for water mode to reduce water resistance and hence retractable wheels seems appropriate choice for high speed.
- While attempting an amphibious vehicle the basic structure (from outside) is kept as it is i.e. like a car/sports boat/high speed boat/ATV.
- Apart from the elements like propeller or waterjet outlet which pops out from rear side of the vehicle, its difficult for a novice to identify the vehicle as amphibious

inferences
- Different configurations like floating box with wheels, boat with retractable wheels, car with bottom of a boat and retractable wheels; give different performance as they are specifically designed for purposes like recreation, adventure sports, rescue operations, patrolling, etc.
- For an amphibious vehicle most of the attempts are majorly to make a floating platform with wheels otherwise the contemporary vehicle forms are dressed upon the floating boat.

AMPHIBIOUS TWO-WHEELER

Cyclomer
- Hollow, bulbous float wheels with the small globes on outriggers to sustain it in water
- All the floats revolve freely, resulting in a minimum drag

Amphibious bike
- A pair foldable airbags on each wheel and
- seven paddles on the back

AMPHIBIOUS TWO-WHEELERS

Observations
- Struggle to make up a sufficient volume for buoyancy
- Struggle to keep the transverse stability in water which requires increase in beam/width
- Problems faced in carrying the pontoons/floaters on land therefore alternate approach of inflatable bags or floats seems appropriate.
- For cycles propulsion with peddle power seems appropriate but with motorized two wheeler rotating wheel in longitudinal plane is very inefficient way of moving
- Most of the attempts are to give a hydrodynamic base for water mode to reduce water resistance
- while attempting an amphibious two wheeler the basic structure of cycle or motorized bike is kept as it is and the ‘add-ons’ are crudely attached to it.
- transition time from land mode to water mode and vis-a-vis is different for different configurations
- As two wheeler needs to be balanced by rider, launching of amphibious two wheeler in water must be a tricky activity

inferences
- A seamless integration of floaters and two wheeler form is required
- As floaters/pontoons are non functional elements while traveling on road, they should be collapsible/foldable
- An alternate propulsion method should be adopted for waterborn motorized bike
- The transition from land mode to water mode should be quick
- While launching an amphibious two wheeler in water, a balancing aid is also desired

Amphibian bicycle - China
- 8 water gallons that are closed on top
- Peddle power

Finalists in the 12th International Bicycle Design Competition
- Floats on water with the inflatable wheels which fit inside the existing wheels

Mohd. Saidullah
- Retractable pontoons added on sides of cycle
- Peddle power

Attachment on bike:
- Floaters attached around the racing bike
- Water propulsion by rotating rear tire

Shuttle-Bike in a backpack
- The floats can be blown up by means of a small pump driven by pedal-power to inflate the floats on the spot
- Flexible drive shaft to drive propeller
- Rudder assembly on front wheel

Alteration in bike:
- Engine and transmission removed and a pair of swimmers added along with the massive tires
- Peddle power

APPENDIX - 2

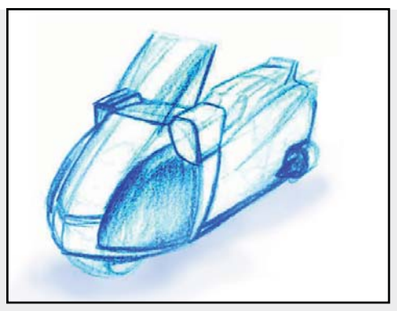
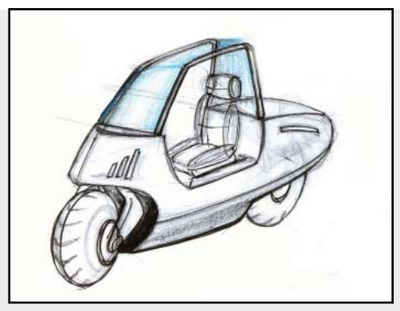
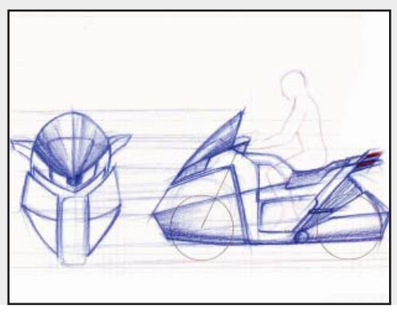
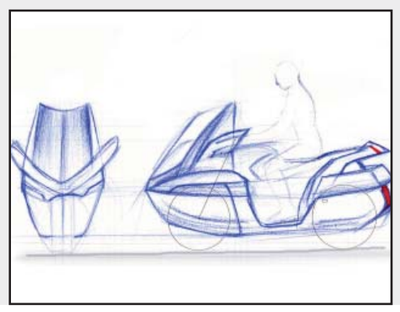
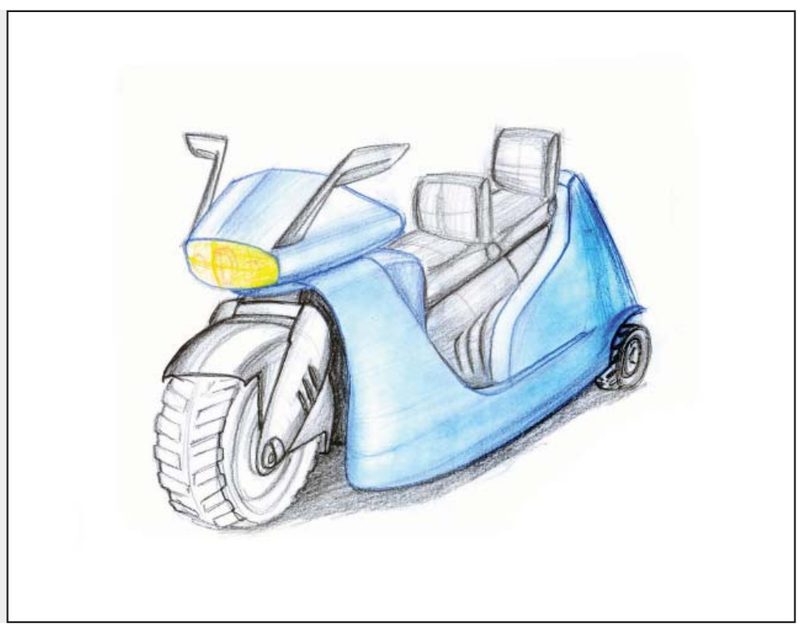
IDEAS
TO MAKE IT AFLOAT

GROUP I
Self floating

Floating with in-built volume
- Boxy construction
- Boxy construction with angled surfaces and tires also adding to total buoyancy
- Pivoted pontoons at the front wheel with the bulky rear
- Retraction mechanism for wheels

Main advantage
- Simple construction

Mentionable drawback
- will have less transverse stability in water
- the volume required to make it afloat, will make it look bulky and hard to manoeuvre on road

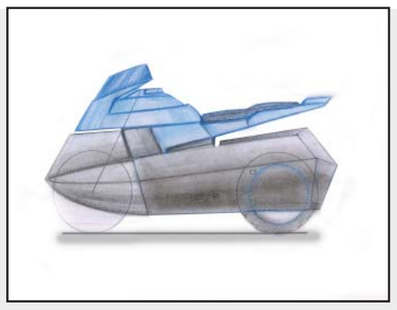
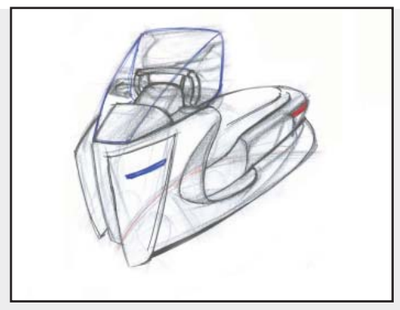
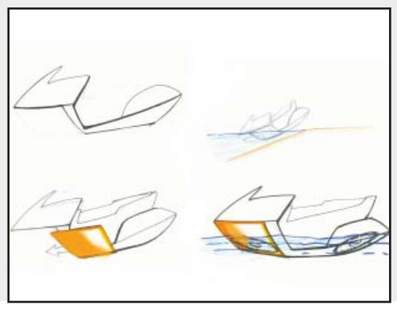
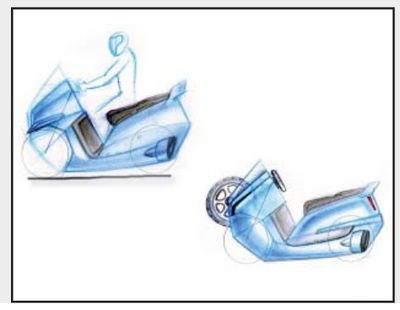
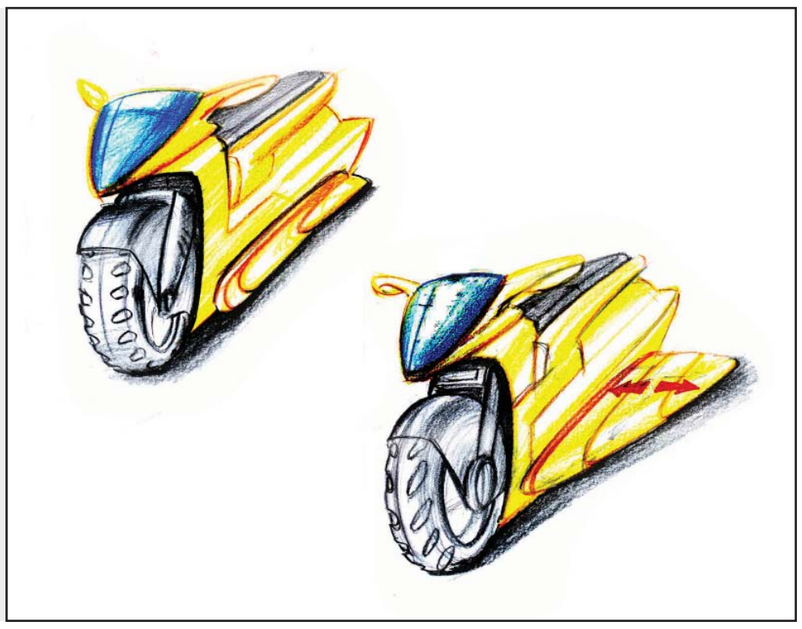






GROUP II
Self floating + Mechanical flaps

Mechanical flaps
- Flaps to envelope the front wheel
- Once in water front and rear wheel retractable upwards

Main advantage
- Transformation capability

Mentionable drawback
- moving parts, less reliability, more complications in linkages and actuators
- the volume required to make it afloat, will make it look bulky and hard to manoeuvre on road

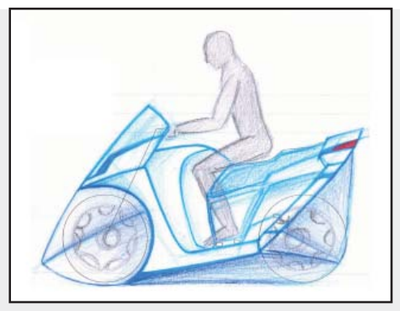
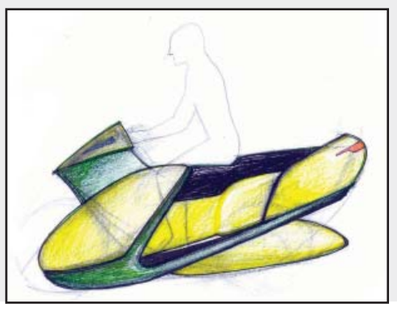






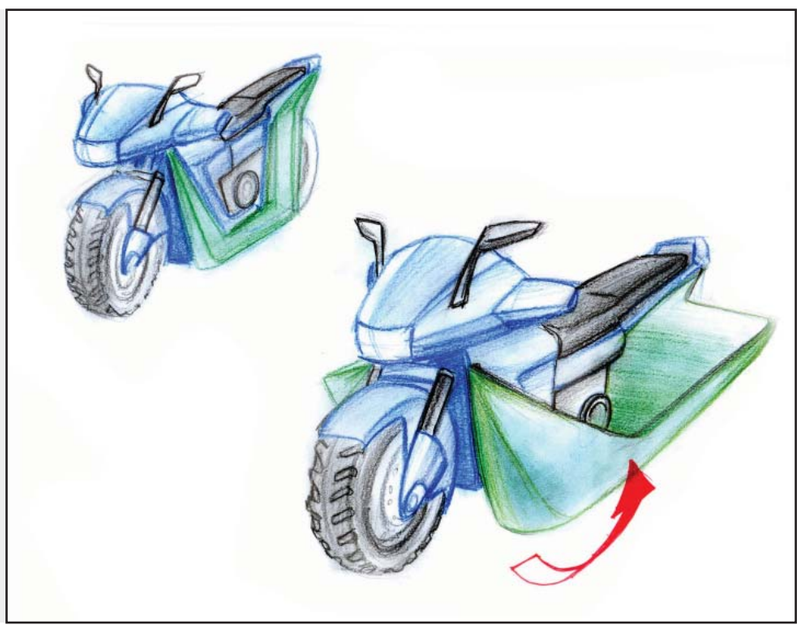
GROUP III
Stretchable fabric with collapsible frame

Stretchable fabric with frame work
- Collapsible framework with stretchable fabric to build up the necessary volume for floatation whenever necessary

Main advantage
- Transformation capability

Mentionable drawback
- moving parts, less reliability, more complications in linkages and actuators
- The framework required to stretch the fabric to give required volume should be strong enough to withstand forces in dynamic condition.
- Vulnerable to sharp objects

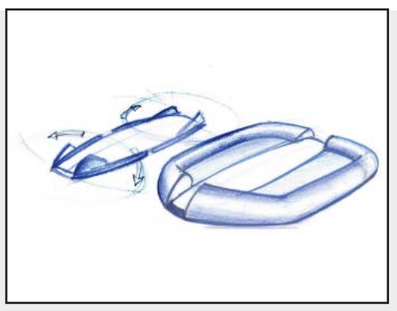
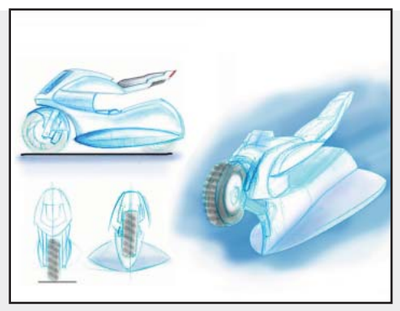
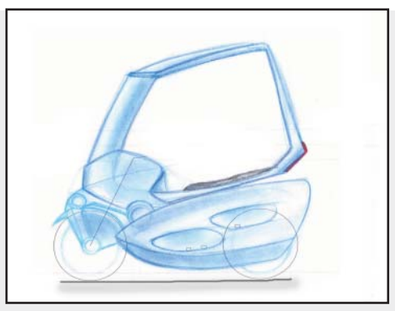
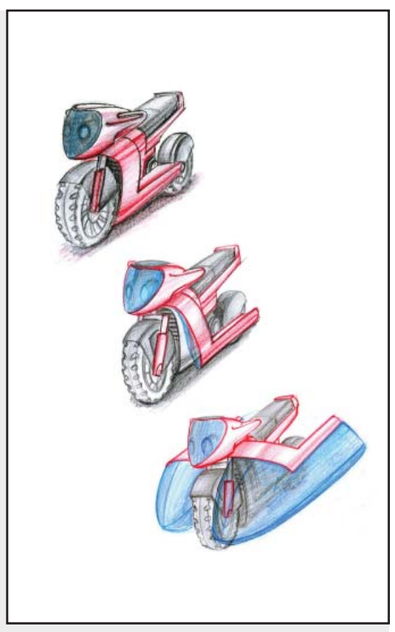


GROUP IV
Inflatable floaters/pontoons

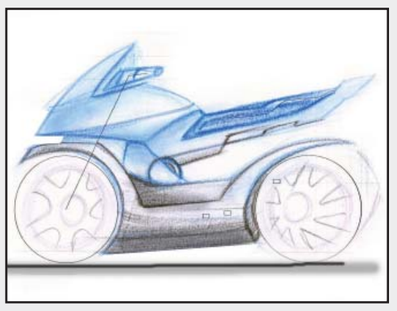
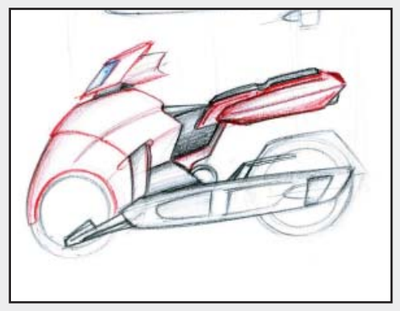
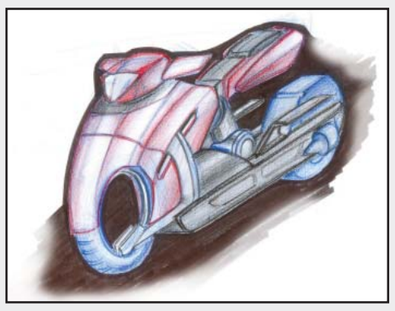
Inflatables
- Collapsible and inflatable bottom plate, on which any two-wheeler body can be mounted
- An inflatable pontoons inclosed in a hardcasing which also serves for a permanent buoyancy

Main advantage
- Proven technology
- Occupies almost negligible volume when not in use
- Possibilities for quick transformation
- Transformation capability

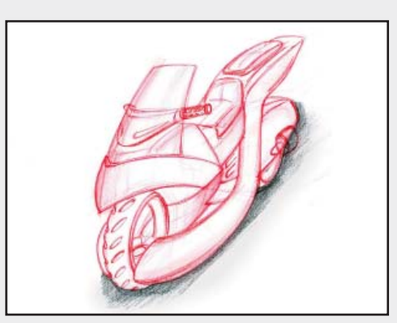
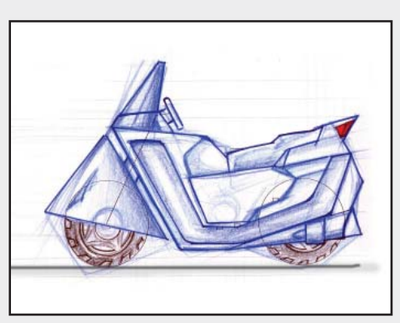
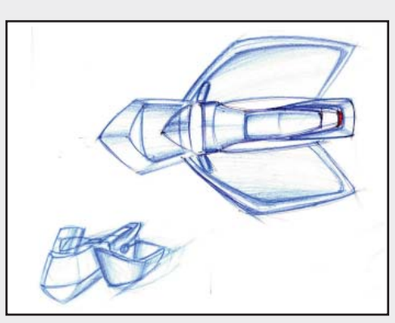
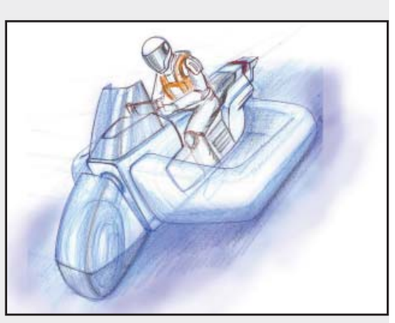
Mentionable drawback
- If no consideration is given to the deflated shape or packaging of the floaters, when deflated the floaters looses volume and becomes a sheet, which may not be desired.
- When deflated the floaters needs to be properly secured.
- It is vulnerable to sharp objects

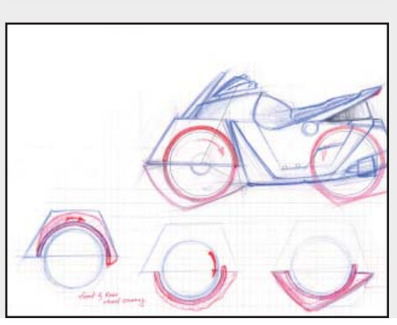
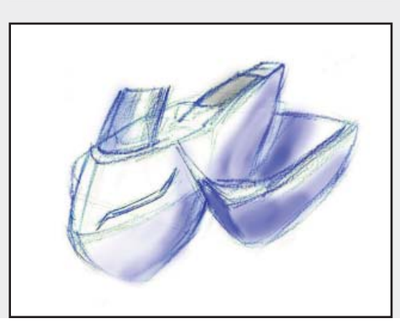
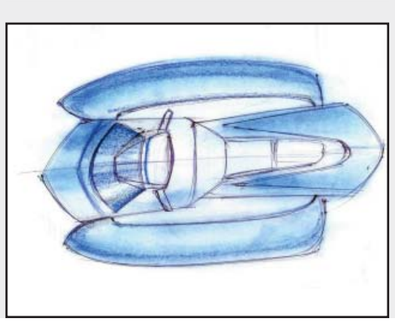
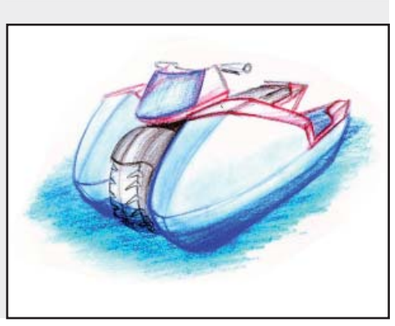
- Inflatable floaters housed in the plastic casing at bottom side of the two wheeler. The plastic casing slides open in transverse direction while deploying inflate floaters

- Inflatable side pack - with a protective pivoted plastic casing

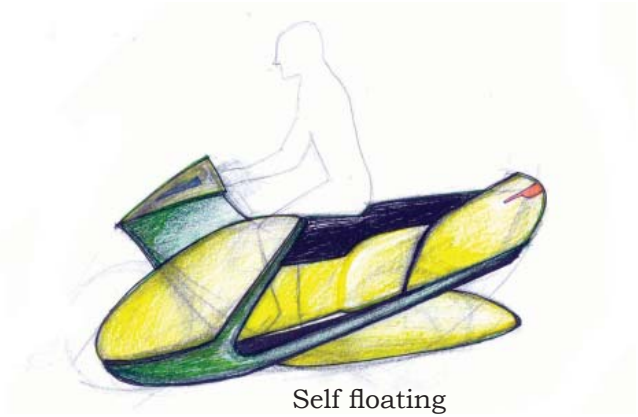





- Inflatable covers for wheel
- Combination of inflatable wheel covering and side pack

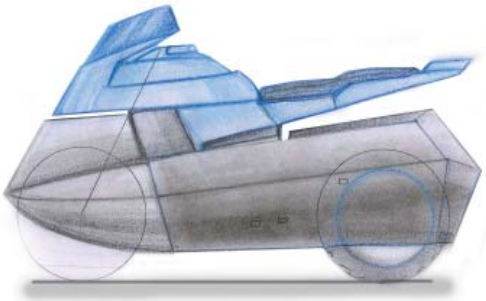





APPENDIX - 3

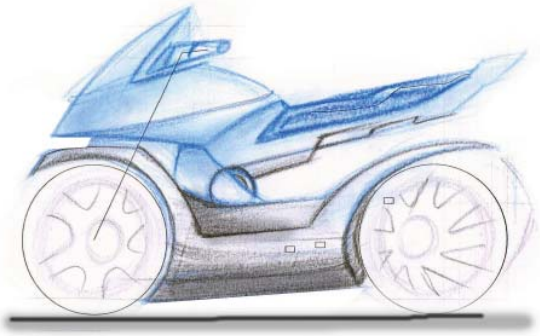
Appendix 3: Ideation for making two wheeler afloat



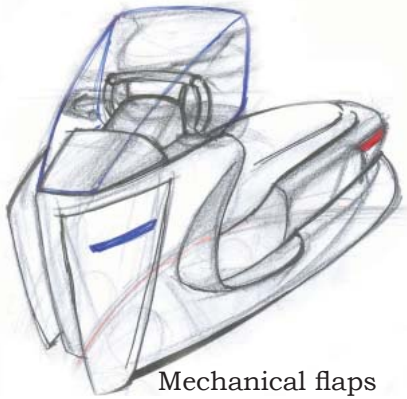
Self floating



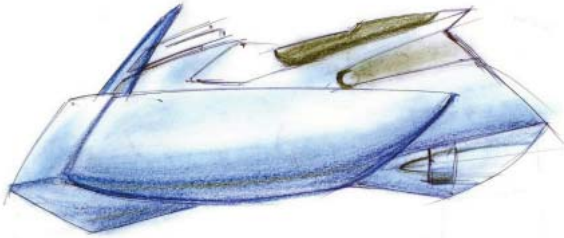
Mechanical flaps
+ inflatables

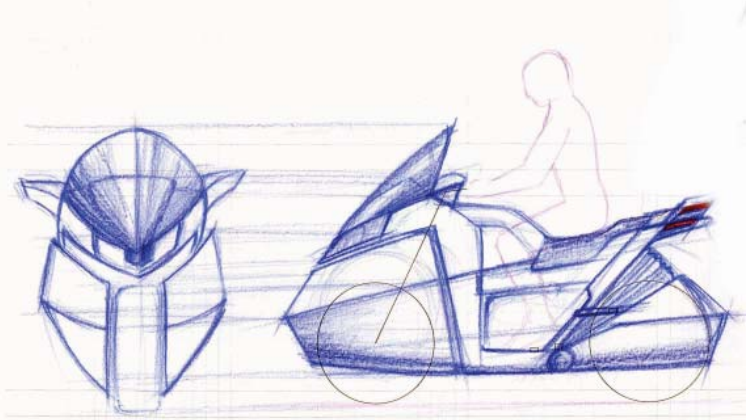


Mechanical flaps



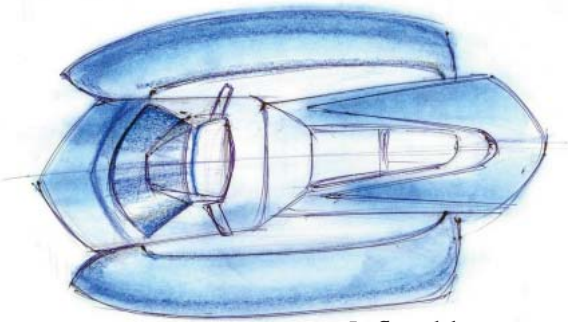
Mechanical flaps





Mechanical flaps

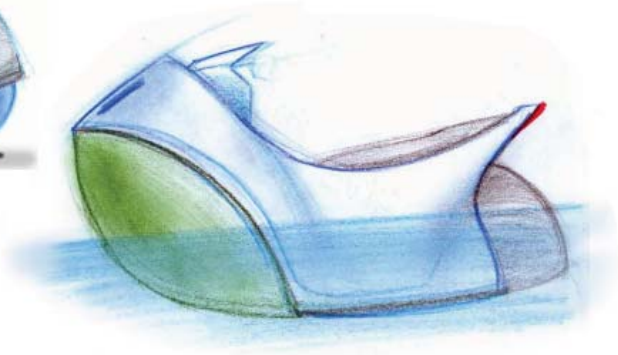
Streatchable fabric with
structure



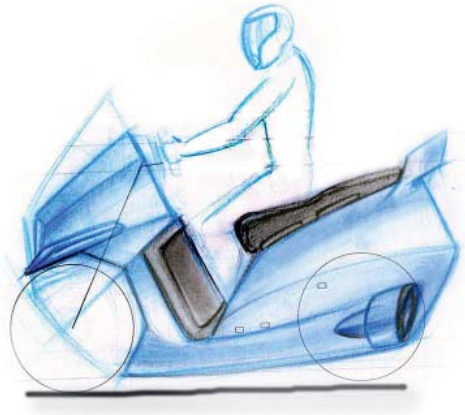
Inflatables

Appendix 3: Ideation for making two wheeler afloat

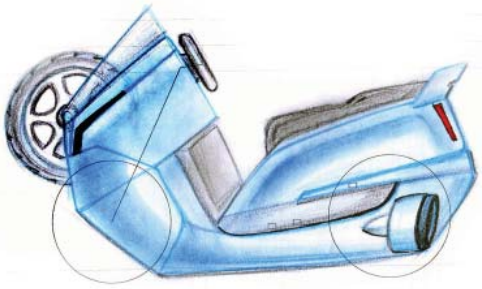
Streatchable fabric with structure

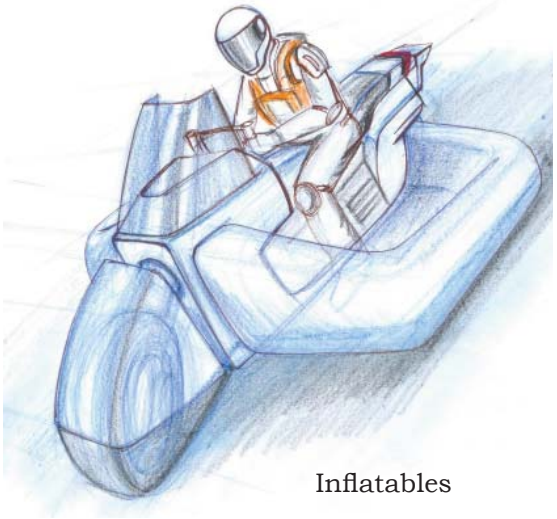


Mechanical flaps + inflatables



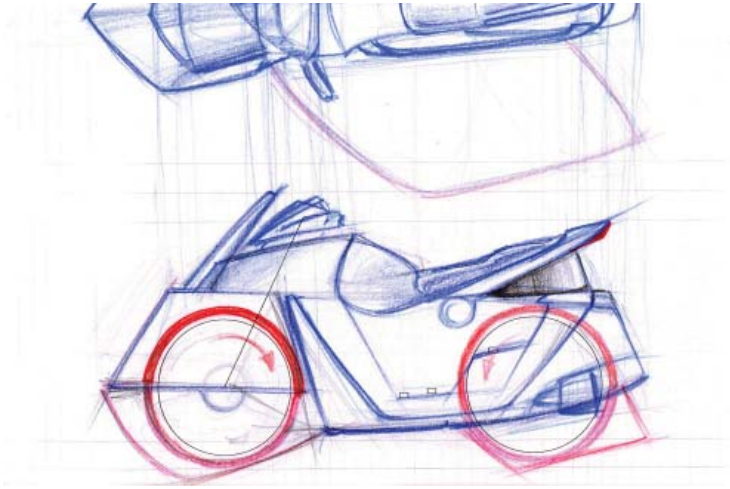
Self floaing + Mechanical flaps + retractable wheels



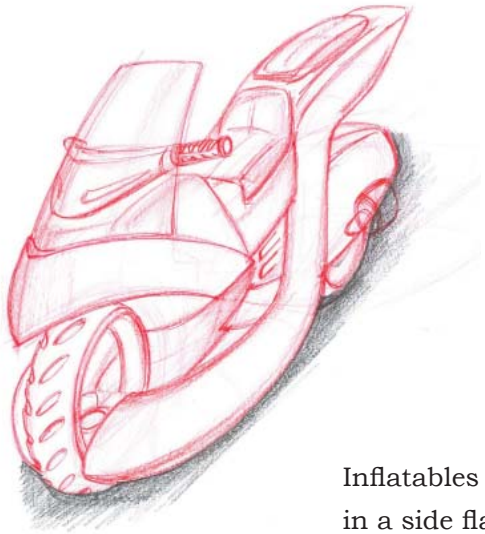


Inflatables

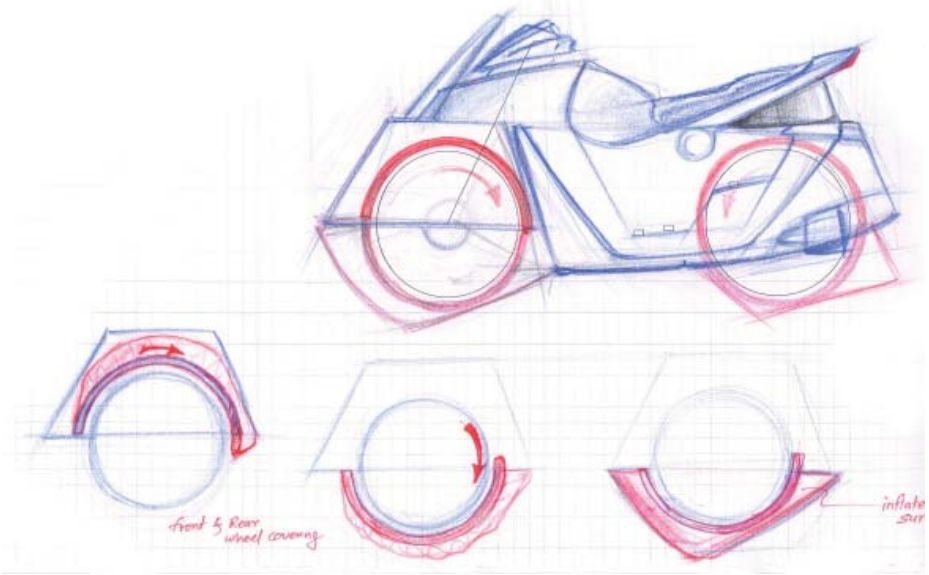
Appendix 3: Ideation for making two wheeler afloat

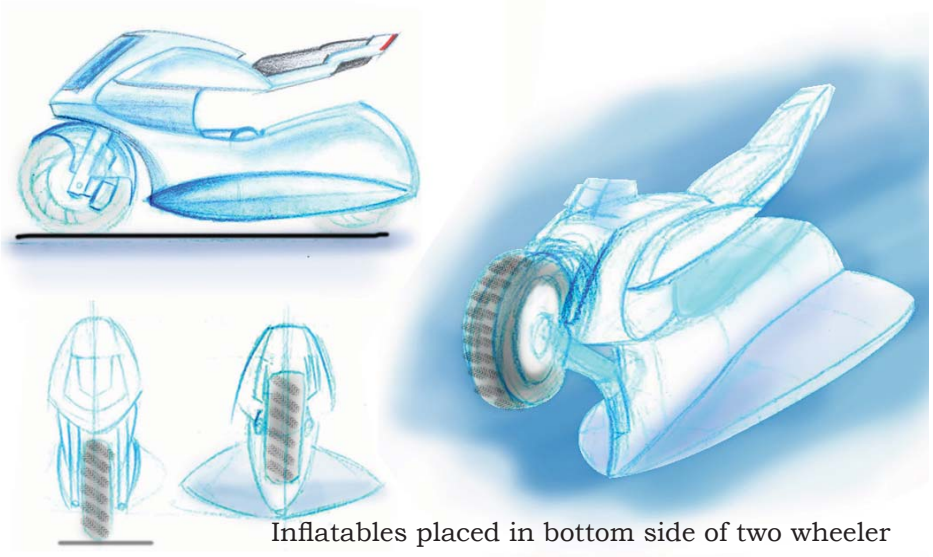


Inflatables + provision of hydrodynamic covering on wheels



Inflatables housed in a side flap





Inflatables placed in bottom side of two wheeler

APPENDIX - 4

SELECTING TECHNOLOGY
FOR MOVING ON ROAD

Conventional IC engine
- Proven technology
- High power to weight ratio can be achieved

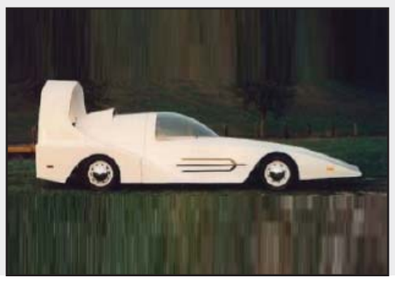
Challenges:
- Air intake and exhaust points should be kept above water line

Electric drive
- No requirement of power transmission shafting

Challenges:
- Low power to weight ratio
- Larger and heavier batteries required for long range and high speed

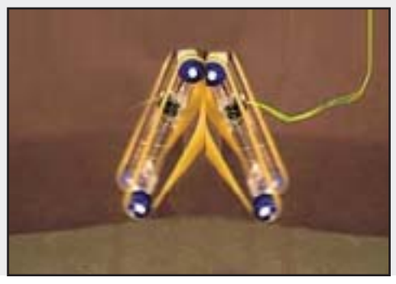
Air propulsion
- An air propeller propelling the wheeled body on road

Challenges:
- In-efficient way of traveling on land
- The thrust of air disturbs the surrounding environment



Biomimicry
- Inspired by movement in nature

Challenges:
- The technology is its in research stage and still to be adopted for practical applications



Selected propulsion medium for land mode
- Conventional IC engine with following modifications
- Modifications - Larger alternator coupled with it for generating electricity for water mode propulsion
- Engine exhaust and intake should be maintained above water line all the time.

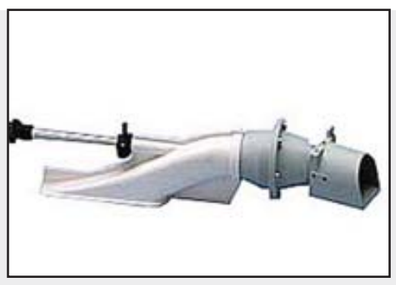
FOR PROPELLING IN WATER

Propeller
- Proven technology

Challenges:
- Shafting
- It will need a protective covering when not in use, on land

Waterjet
- Proven technology
- High speed

Challenges:
- Poor performance for slow speed

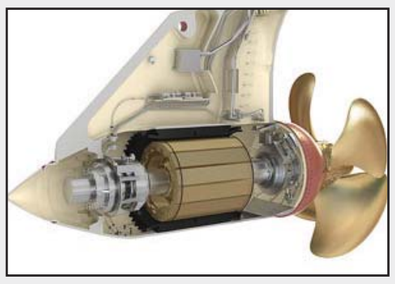


Rotating wheels as propulsion
- No additional propulsion needed as wheels can move on land as well

Challenges:
- slow speed
- Low efficiency

Podded propulsion
- Proven technology, Motor housed in a protective casing and propeller directly coupled with motor shaft

Challenges:
- The onboard regular electric supply needs to be altered



Hydrofoil with propeller/waterjet
- Once in motion, it lifts the whole body, hence reducing drag.

Challenges:
- Slow speed, chances of running aground

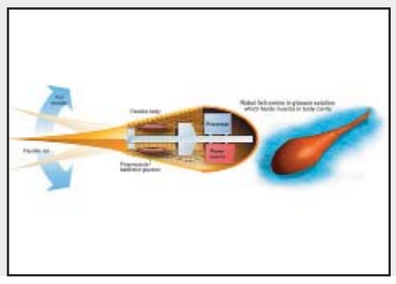
Selected propulsion medium for water mode
- Podded propeller
- Optional - Podded propeller with hydrofoil sections

Hovercraft
- Smooth transition from water to land

Challenges:
- Demands special platforms to launch
- The thrust of air disturbs the surrounding environment

Bionic- Fish propulsion
- Claimed to be more efficient than conventional propellers

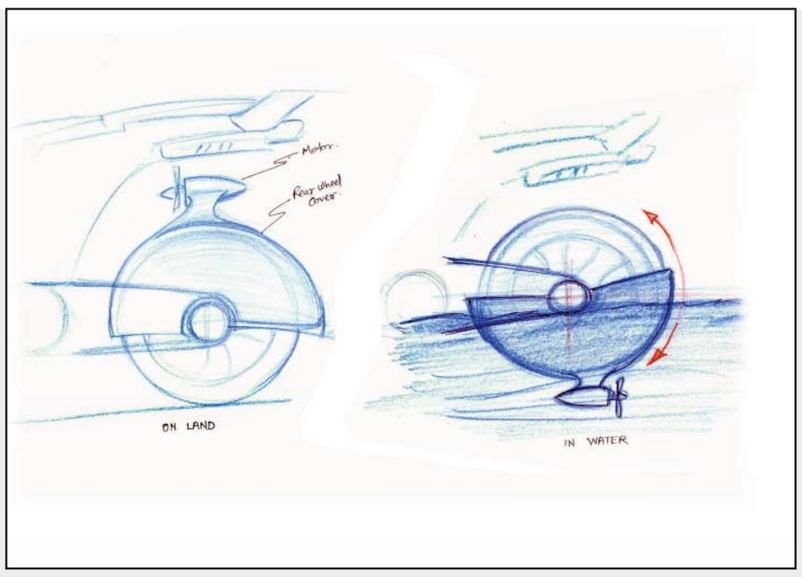
Challenges:
- The technology is its in research stage and still to be adopted for practical applications

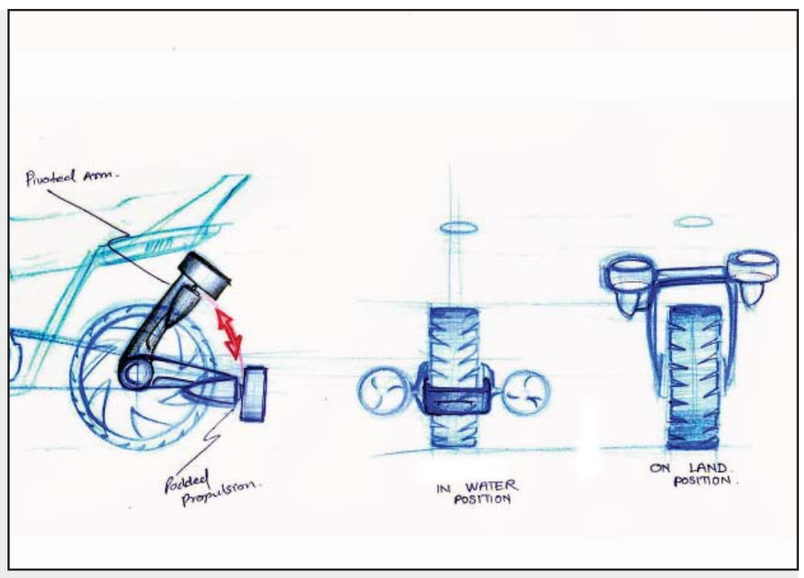


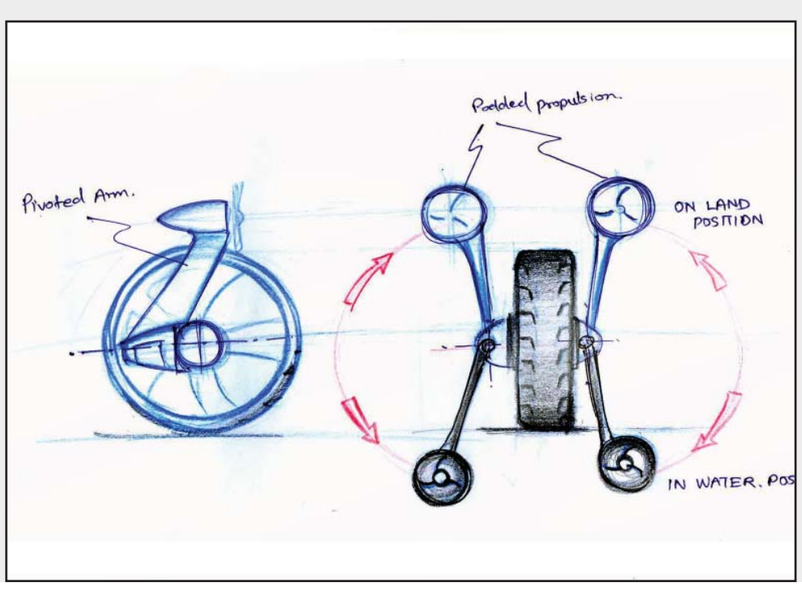
PROPELLER POSITION

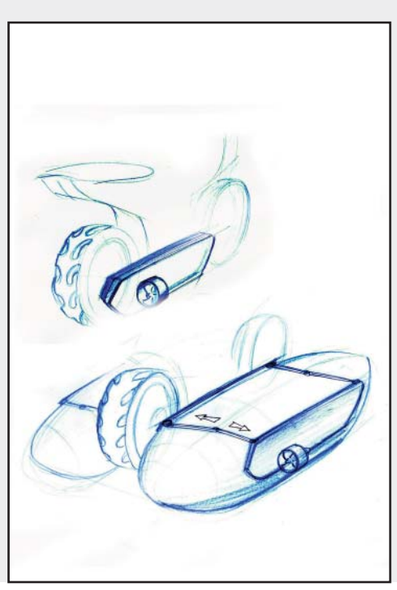
Propulsion system
- Podded propeller chosen as a propulsion for water made.
- As it is an electric drive without any mechanical drive shaft it will be simple to connect it with the on-board power source.
- When in water the rear wheel will be declutched from the main engine.
- When water mode is engaged the Front wheel steering will be locked in a straight position and thus will be ineffective.
- Main engine will now run only to generate electricity through the alternator connected to it.
- For water mode, accelerator in drivers control will be function the same way, that is to regulate the fuel supply to engine. Only this time engine will run to generate electricity.
- As there is no intention to increase the current battery size, the supply to the podded propulsion will be given directly from alternator which is coupled with engine. But to regulate the fluctuations there will be a regulator unit inbetween them.
- Once podded propellers are engaged in action, the engine will start running at a predetermined rpm, any raise of fuel with accelerator will cause further increase in rpm. This will increase the generated electricity and thus increase the speed of propellers. This configuration will save the requirement of battery with high rating..

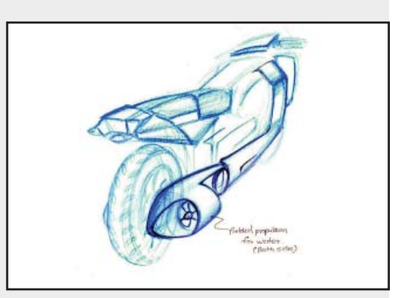
Propeller position
- The beside sketches shows some of the possible configurations for mounting podded propeller in the amphibious two wheeler.
- Two podded propeller units one on each side of two wheeler to achieve steering in water. Also it will give better maneuverability to the vehicle.
- It is clear that some of the ideas though look promising, it can not be decided as an independent entity.
- Only after deciding on the hydrodynamic shape of the two wheeler in water mode, the propeller positioning can be done for achieving better performance.

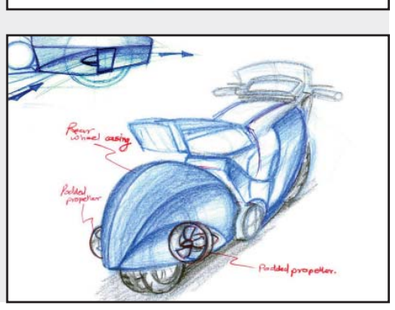




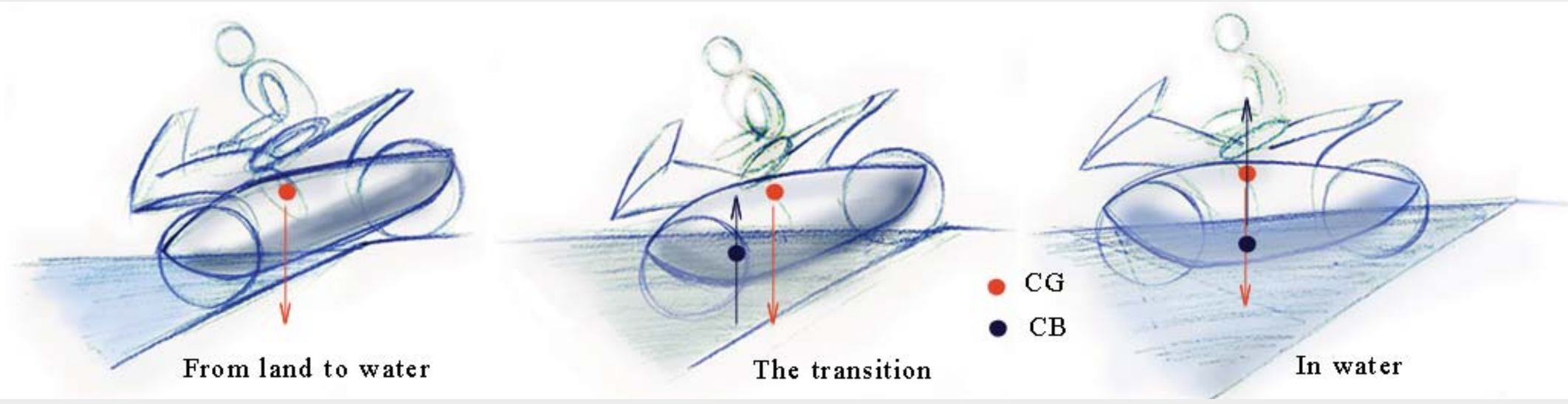






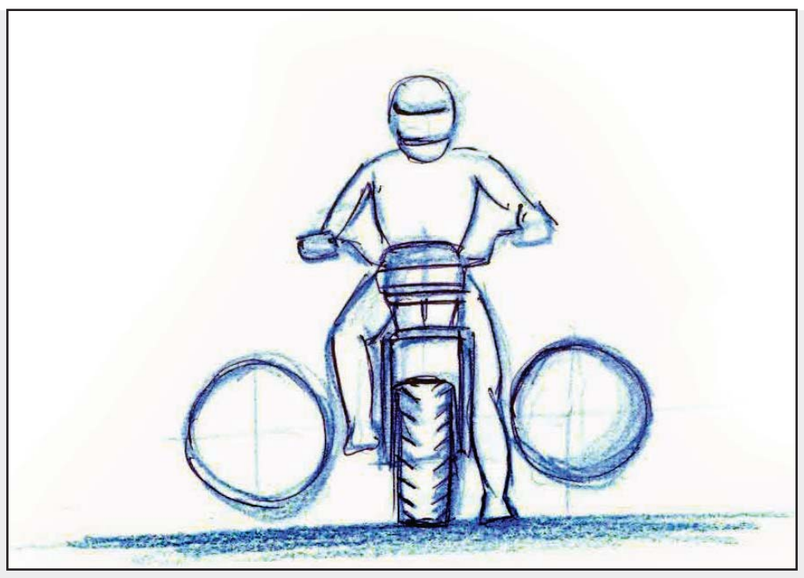


THE TRANSITION
FROM ROAD TO WATER

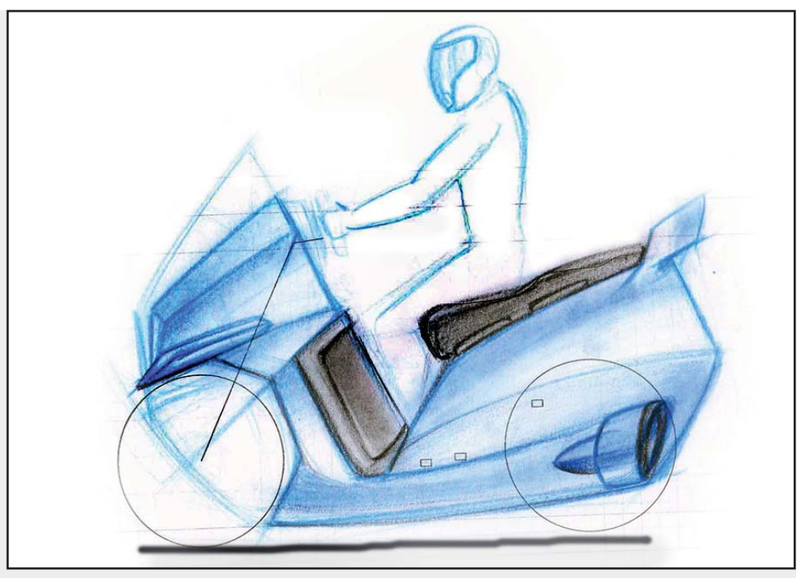


BALANCING

Balancing in water
- The couple generated by downward force acting through CG and vertical force acting through Center of buoyancy should be a corrective couple otherwise the vehicle will capsize.



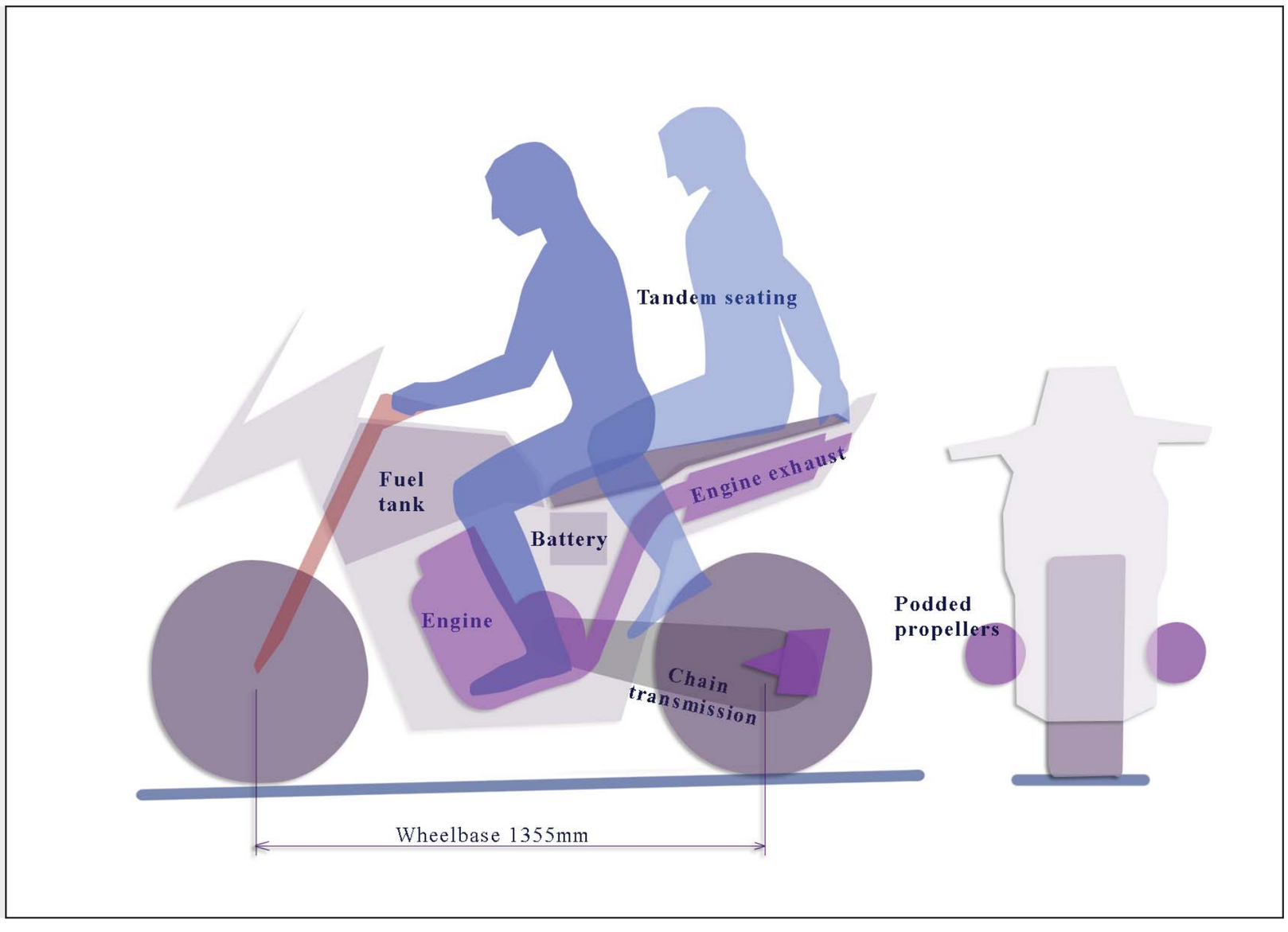
Balancing in transition phase
- Transition phase is when the vehicle gets ready to go-in or come out of the water.
- As this will be a slow speed activity there should be a space for driver to maintain balance manually.



Balancing on road
- The two wheeler should not be fat in width on raod
- It should be possible to handle the vehicle like a normal two-wheeler on road

LAYOUT
WITH SELECTED TECHNOLOGIES

Layout
- Driver and rear occupant height and posture - tandem seating arrangement for two.
- Powertrain - conventional IC engine and chain drive power transmission
- Wheel size and wheelbase is fixed with reference to the present day two wheelers.
- Front suspension - fork with telescopic dampers
- Rear suspension - Uni suspension system
- Fuel storage tank
- Two podded propellers - one at each side, mounted below rear wheel axis



APPENDIX - 5

Appendix 5: Details of inflatable pontoon

The weight to be supported in water was estimated to find out required volume of the pontoon which will immerse in water.

Two wheeler (dead weight + fuel) = 150 kg
Rider and pillion = (75 x 2) 150 kg
Luggage = 20 kg
Safety margin = 30 kg
Total = (150 + 150 + 20 + 30) = 350 kg

Volume required to be immersed in water to support 350 kg
Density of water = 1000 kg/m3
Required volume = 350/1000 = 0.35 m3
Dimensions of pontoon to make required volume of 0.35 m3

Assumption – a rectangular pontoon is assumed for simplifying calculations

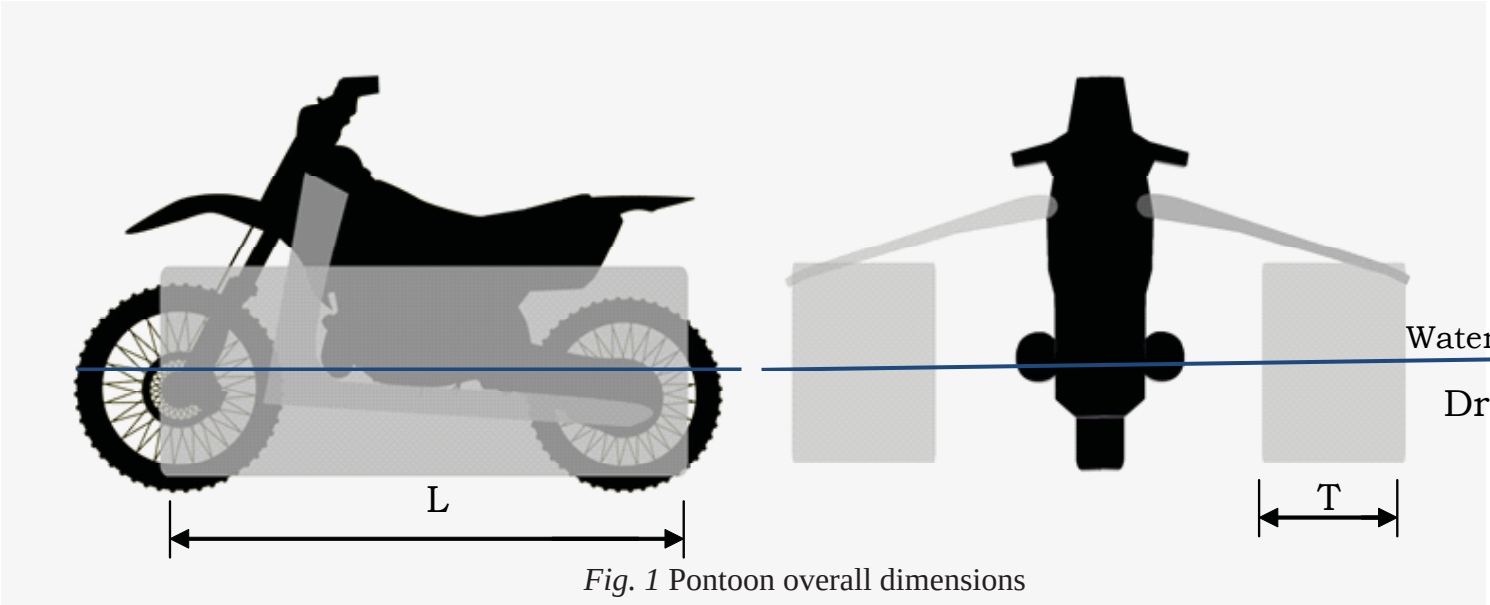


Fig. 1 Pontoon overall dimensions

Maximum Breadth of the pontoon (B)
= Saddle height of a two wheeler – 150mm (considering ground clearance when inflated on land)

Maximum length of the pontoon (L)
= wheelbase of a two wheeler +300 mm (considering longitudinal stability and also keeping check on overall length even when inflated)

Maximum thickness of the pontoon (T)
= Saddle height of two wheeler – 300 mm (clearance for leg)

Considering Yamaha Fz as a benchmark the pontoon dimensions can be calculated

Maximum Breadth of inflated pontoon (B)
= 790 – 150 = 640 mm
Maximum length of inflated pontoon (L)
= 1355 + 300 = 1655 mm
Maximum thickness of inflated pontoon (T)
= 790 – 300 = 490 mm

The immersed volume of assumed rectangular pontoon
= length x thickness x draft = 1655 x 490 x 400 = 0.3248 m3

Total immersed volume = 2 x immersed volume of one pontoon
= 0.64876 m3

Required volume for making 350 kg afloat = 0.35m3
The calculated volume is sufficiently large than what is required.
But considering hydrodynamic shape of pontoon with same overall dimensions, this gap between calculated and required volume is desired.

Material of the inflatable pontoon *[7]*

Supported Nylon or polyester fabric with Hypalon coating

Calculations for diameter of rolled pontoon

Thickness of material

Selected thickness = 1.2 mm *[8]*

While rolling the effective thickness will be four times the actual thickness of fabric as it will overlapped from sides.

Therefore thickness for calculating roll diameter

= 4 x 1.2 = 4.8mm

Effective length of the deflated pontoon

= breadth + 1/2 (thickness of inflated pontoon)

= 640 + 490/2 = 885

Assuming roller diameter = 15 mm dia.

Outer diameter of rolled pontoon = 74 mm *[9]*

APPENDIX - 6

Appendix 6: DC air pump - Product Details *[14]*

Description:

Light weight and portable Electric Air Pump is perfect for inflating small, medium and large items at the beach, camping, outdoors, on vacation or anywhere you have access to an automobile. Powerful Inflatable Air Pump with car adapter plug operates on 12 volt DC power by plugging into the cigarette lighter jack in your automobile or any other 12 volt DC accessory outlet. This Car Air Pump with barometer can be used to inflate bicycle tires, athletic balls, auto tires, and inflatables.

Non-slip rubber feet keep it securly in place.

Material: Alloy and Plastic

Max. Amperage: 12 Amp

Max. Pressure: 140 PSI

Diplacement: 27L./Min

Power Cable Length: ~272cm

Hose Length: ~99cm

Dimension: ~15.8(L) x 8(W) x 14.5(H)cm

Weight: 1652g

APPENDIX - 7

Appendix 7: Preference no.

Preference (on the basis of personal liking)	Concet no.	Preference no. (1 to 10 scale, 10 being most prefered)	Feeling of 'more than bike' 1 to 10 scale (10 towards more than bike - 1 towards bike)	Novelty 1 to 10 scale (10 More novel - 1 novel)
1	13	10	6	7
2	14	9	5	6
3	12	8	6	7
4	1	7	6	5
5	5	6	3	2
6	9	5	6	7
7	6	4	5	6
8	4	3	7	2
9	3	3	3	2
10	7	2	5	5
11	8	2	3	4
12	11	1	6	7
13	2	1	3	3
14	10	1	4	4

Table : Feedback from user 1

- Concepts coming in preference ranking 8 and 9 were always given preference no. 3
- Concepts coming in preference ranking 10 and 11 were given preference no. 2
- Concepts coming in preference ranking 12,13 and 14 were given preference no. 1

Calculating overall preference no. for a concept

- overall preference no.for a concept = (Preference no. given by user 1 + Preference no. given by user 2 +.....+ Preference no. given by user 12) / 12
- 'more than bike' rating = average of all users ratings for that concept
- Overall novelty rating = average of all users ratings for that concept