

Educational Toy Design With Robotic Elements

FINAL THESIS PROJECT

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Approval Sheet

The industrial design project 3 titled “Educational Toy Design With Robotic Elements ” by Abneet Chauhan, is approved for partial fulfilment of the requirement for the degree of ‘Master of Design’ in Product Design.

Guide.....

Chairperson.....

Internal
Examiner.....

External
Examiner.....

Date.....

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Introduction

There is a saying “Nobody can teach but can learn.” Designers also believe that learning is more important than teaching. Children should learn on their own rather than being taught, but not everything (in practical behavior). When a child grows, he starts learning from everything in his surroundings. In this way somethings are taught and some he grasps from his own experiences. Both ways of learning, have an equal and important role. Sometimes classroom learning is made more effective by using the way of experiential learning.

The target users in classroom teaching are introduced to abstract concepts of science, which results in difficulty. For better teaching of science kids are given experiments and activity for better understanding of actual phenomena. It also removes classroom boredom. But these experiments and activities have to be taught.

This project is an attempt to introduce an active and attractive medium to make learning & teaching playful and interesting. These playful science activity can encourage kids to learn on their own, where cognitive learning, teaching of science and play happen together at same platform.

Why robotics ?

Robotics is increasingly being considered as the Fourth essential R (after the 3 R's, Reading, wRiting and aRithmetic).

It is truly a multi-disciplinary field which combines mechanical, electrical, electronics and computer programming domains of science.

How robotics is good for children:

One of main benefits of robotics is that it excites students about science, technology & maths. Robotics is ideal for young students because it exposes their potential of developing, building & creativity with the hand-on application of maths, science & eng. concepts.

Robotics motivates children to understand how things work. It encourages them to use their creativity and imagination skills during designing robots.

In compare to other electronic toy like video game etc. these can interact with and within their environment.

What is being given by robotic toys:

Apart being very beneficial for kids from education point of view, robot is a highly liked toy by children. They are crazy about these sensor enabled gizmo toys because:

In compare to other toys, robot toys look 'Live Characters'. They have humanoid interface which interact with the children, some time just like their pets. These toys have sensors, enable it to see, hear, and feel, making it the ideal companion.

Robot toys keep a child totally occupied with its ability to shake a leg, turn, shoot in combat, speak and pronounce very empowering statements like, 'I am at your command'!

Machine man is always very adventurous robotic fantasy character for kids. Generally that comes from future or other planet in their science fiction stories. In robotics they like its mechatronics look full of fantasy. They live in their imagination with these command following robots

What is the current scenario of playing & teaching through robotic toys:

“The robot toys are marketed within a special segment of manufacturers who cater to the need of the child to have a companion who can walk and talk in the typical restricted family unit of our times. It is to enhance the whole ‘educational toy’ concept”.

From a journal on ‘artificial life and robotics’ by Jeffrey Johnson
key words ‘Children, robotics, and education’

Market is full of these revolutionary toys, which are offering not only wide spectrum of educational knowledge with different way of learning & playing but social skills also, and team work also tacitly.

To understand the current scenario lets take some examples,

like ‘Lego Mindstorm’ which is a line of interlocking building block sets, combining programmable bricks with electric motors, sensors, gears, stepper motors, axial etc. by using which child can make his own creative design & can program that for corresponding function. This kit provides play, challenges, problem solving, building of own thought, education in science, math & technology, robotic education like knowledge of sensors, actuators, electronics & programming; and a lot of tacit learning.



One more example is ‘WOWWEE’ products which have futuristic superhero kind of form with humanoid interactive interface. Recently they introduced some pets which look and behave like a real pet. They obey their commands.

Some robots are serving for physical disabled kids.

My vision:

The interest in robotics has surprisingly increased in few last years. This new way of offering education is playful and full of energy. But this associated science education is being served tacitly. Beyond the experiential learning, will we be able to design a robotic aid which will teach some concepts of science fundamentals, math, and other subjects of their course.

The passion and energetic behavior of kids towards such toys can be useful in learning complex science terms. This will be extended version of their classroom activity/ experiments with robots. This will encourage children to sharpen the concepts and will push development of their minds.

Need of the project

Every child loves to play and it is necessary for him because playing provides him an enriching experience, which develops skills and knowledge. In this way children explore & learn effectively. But as a child grows up, distance between playing and learning starts increasing. The two major causes are:

1. Due to lack of experiential learning, the relation between play and learning become weak and students are forced to study compared to playing.
2. Other cause can be the abstract manner of course concepts, it becomes hard for them to digest.

Thus children turn towards taking interest in game rather than in study. Severity of this problem grows after the primary school level. So there is a need to fill this gap of learning & play in this age segment.

Objective

Design and development of robotic enabled play & learning aid , which will encourage children to learn science fundamentals by involving them into some activities. This will establish & strengthen the connection between the abstract concept of science fundamentals and practical experience.

With robotic as an attractive playful media, children will learn some robotic fundamentals also simultaneously.

Learning Objective

My objective in this project is to learn design process that involves the understanding of psychology & behavior of kids as users, their process of learning & how to provide much incentive to spark their creativity. The project is an opportunity for me to learn how to create a playful platform in between teaching science concepts & cognitive learning, with the application of robotics.

Apart from a lot of prototyping work, this project will also help me in understanding the current scenario of market of robotics for kids and accordingly design the development needed for a product to be successful.

PROJECT BRIEF

OBJECTIVE :

Design and development of **robotic** enabled play & learning aid , which will encourage the child to establish & strengthen the connection between the abstract concept of **science fundamentals** and practical experience.

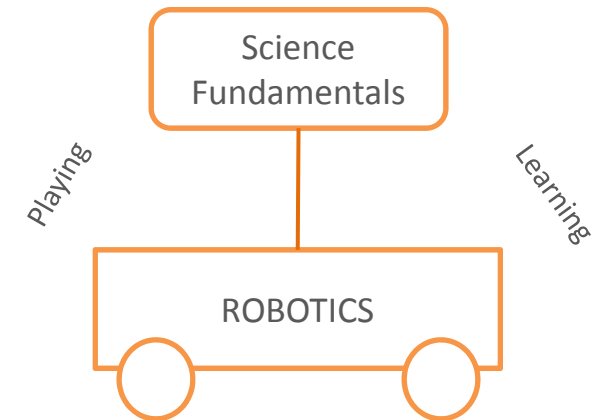
TARGETED USER:

School going children

Age group 11 – 15 years (7th -9th grade)

Both male & female

Upper middle class



DESIGN METHODOLOGY

Understanding Current Scenario

Toykit.....game.....
Existing toy analysis



Understanding the children psychology & behavior

According to Piaget's theory
Michael L. Commons's Model of hierarchical complexity
According to Seymour Papert



Robotics

What is robotics?
Robotics components
Play & learning with robotics



Design Brief



Ideation & Exploration



Concept Development



Refinement



Final Design Proposal

User study

- Work shops
- Observation

Teaching Robotics
itself

Exploration of areas
where robotics can
enhance the play &
learning values

Understanding Current Scenario

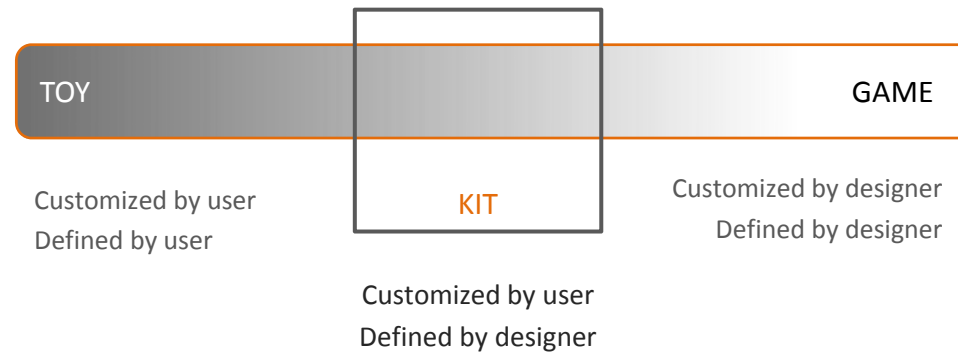
Toykit.....game.....

GAME:

Play
Rules
Competition

TOY :

Play
fantasy



Understanding Current Scenario

Existing toy analysis

Puzzle

Construction toys

Games & activity

Dolls / animals or miniature

Vehicles

Arvind Gupta's toys

Robotic toys

UNDERSTANDING THE CHILDREN'S PSYCHOLOGY & BEHAVIOR

According to Piaget's theory

There are four levels of development
(1) infancy, (2) preschool, (3) childhood, and (4)
adolescence

Each stage is characterized by a general cognitive structure that affects all of the child's thinking. Each stage represents the child's understanding of reality during that period. Development from one stage to the next is thus caused by the accumulation of errors in the child's understanding of the environment; this accumulation eventually causes such a degree of cognitive disequilibrium that thought structures require reorganizing.

The four development stages are described in Piaget's theory as

1. Sensorimotor period (years 0–2)

- During this stage, the child learns about himself and his environment (world) through movement and senses (use five senses to explore)
- During this stage children are extremely egocentric, meaning they cannot perceive the world from others viewpoints and explore using senses

2. Preoperational period (years 2–7)

- During this stage the child learns to use and to represent objects by images and words, in other words they learn to use symbolic

thinking. Thinking is still egocentric: The child has difficulty taking the viewpoint of others

- **The Preconceptual stage (2-4 years)**

is marked by egocentric thinking and animistic thought (thinking is influenced by fantasy). A child who displays animistic thought tends to assign living attributes to inanimate objects, for example that a glass would feel pain if it were broken.

- **The Intuitive stage (4-6 years)**

is when children start employing mental activities to solve problems and obtain goals but they are unaware of how they came to their conclusions. For example a child is shown 7 dogs and 3 cats and asked if there are more dogs than cats.

3. Concrete operational period (years 7–11)

Important processes during this stage are:

Seriation—the ability to sort objects in an order according to size, shape, or any other characteristic. For example, if given different-shaded objects they may make a colour gradient.

- **Transitivity**- The ability to recognize logical relationships among elements in a serial order (for example, If A is taller than B, and B is taller than C, then A must be taller than C).

UNDERSTANDING THE CHILDREN'S PSYCHOLOGY & BEHAVIOR

- **Classification**—the ability to name and identify sets of objects according to appearance, size or other characteristic, including the idea that one set of objects can include another.
- **Decentering**—where the child takes into account multiple aspects of a problem to solve it. For example, the child will no longer perceive an exceptionally wide but short cup to contain less than a normally-wide, taller cup.
- **Reversibility**—the child understands that numbers or objects can be changed, then returned to their original state. For this reason, a child will be able to rapidly determine that if $4+4$ equals 8, $8-4$ will equal 4, the original quantity.
- **Conservation**—understanding that quantity, length or number of items is unrelated to the arrangement or appearance of the object or items.
- **Elimination of Egocentrism**—the ability to view things from another's perspective (even if they think incorrectly). For instance, show a child a comic in which Jane puts a doll under a box, leaves the room, and then Melissa moves the doll to a drawer, and Jane comes back. A child in the concrete operations stage will say that Jane will still think it's under the box even though the child knows it is in the drawer.

[Children can now conserve and think logically but only with practical aids. They are no longer egocentric.]

4. Formal operational period (years 11–15)

- Children develop abstract thought and can easily conserve and think logically in their mind. The ability to generate abstract propositions, multiple hypotheses and their possible outcomes is evident.
- They can handle proportions, algebraic manipulation, other purely abstract processes. If $a + b = x$ then $a = x - b$. If $ma/ca = IQ = 1.00$ then $Ma = CA$.
- They are capable of hypothetical and deductive reasoning. Teaching for the adolescent may be wide-ranging because he'll be able to consider many possibilities from several perspectives.
- Thinking becomes less tied to concrete reality. Formal logical systems can be acquired.
- During this stage the young adult is able to understand such things as love, "shades of gray", logical proofs, and values.

UNDERSTANDING THE CHILDREN'S PSYCHOLOGY & BEHAVIOR

Michael L. Commons's Model of hierarchical complexity

The MHC is a non-mentalistic model of developmental stages. It specifies 14 orders of hierarchical complexity and their corresponding stages. It is different from previous proposals about developmental stage applied to humans. Instead of attributing behavioural changes across a person's age to the development of mental structures or schema, this model posits that task sequences form hierarchies that become increasingly complex. Because less complex tasks must be completed and practiced before more complex tasks can be acquired, this accounts for the developmental changes seen, for example, in individual persons' performance of tasks. (For example, a person cannot perform arithmetic until the numeral representations of numbers are learned. A person cannot multiply numbers until addition is learned).

Furthermore, previous theories of stage have confounded the stimulus and response in assessing stage by simply scoring responses and ignoring the task or stimulus. The Model of Hierarchical Complexity separates the task or stimulus from the performance. The participant's performance on a task of a given complexity represents the stage of 'developmental complexity.

Instead of giving full model structure, a selected useful area is presented as following :

UNDERSTANDING THE CHILDREN'S PSYCHOLOGY & BEHAVIOR

Stage	What they do	How they do it	End result
Primary (years 4-7)	Simple logical deduction and empirical rules involving time sequence Simple arithmetic	Adds, subtracts, multiplies, divides, counts, proves, does series of tasks on own	Times, places, counts acts, actors, arithmetic outcome, sequence from calculation
Concrete (years 7-10)	Carry out full arithmetic, form cliques, plan deals	Does long division, short division, follows complex social rules, ignores simple social rules, takes and coordinates perspective of other and self	Interrelations, social events, what happened among others, reasonable deals, history, geography
Abstract (years 10-13)	Discriminate variables such as stereotypes; logical quantification; (none, some, all)	Form variables out of finite classes Make and quantify propositions	Variable time, place, act, actor, state, type; quantifiers (all, none, some); categorical assertions (e.g., "We all die")
Formal (years 13-15)	Argue using empirical or logical evidence Logic is linear, 1 dimensional	Solve problems with one unknown using algebra, logic and empiricism	Relationships (for example: causality) are formed out of variables; words: linear, logical, one dimensional, if then, thus, therefore, because; correct scientific solutions

UNDERSTANDING THE CHILDREN'S PSYCHOLOGY & BEHAVIOR

According to Seymour Papert

Papert believed that it wasn't the fact that children were unable to think and understand difficult things, they simply needed an 'intelligent machine' or something to get them over the learning curve.

Constructionism learning is an active process in which people actively construct knowledge from their experiences in the world. He says that there is joy in the act of learning and if this joy could be transferred into all the classrooms, than they would be exiting places of learning.

ROBOTICS

What Is Robotics ?

Robotics is a branch of engineering that involves the conception, design, manufacture, and operation of robots. This field overlaps with electronics, computer science, artificial intelligence , mechatronics, nanotechnology , and bioengineering.

Definition of robot in ISO 8373:

“An automatically controlled, reprogrammable, multipurpose, manipulator programmable in three or more axes, which may be either fixed in place or mobile for use in industrial automation applications”

The Robotics Institute of America (RIA) uses a broader definition:

A robot is a "re-programmable multi-functional manipulator designed to move materials, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks"

ROBOTICS

Components Of Robot

Power source

At present; mostly (lead-acid) batteries are used, but for the purpose of toy, potential power sources could be:



Duracell 4.5V
Alkaline Battery
(rechargeable)



9V Battery 6LR61 6LF22



8.4V Rechargeable NiMh
(Nickel Metal Hydride)
AA Size, 1300 mAH
Standard DC Jack connector

*Structure*

The structure of a robot is usually and mostly mechanical and can be called a kinematic chain (its functionality being similar to the skeleton of the human body). The chain is formed of links (its bones), actuators (its muscles), and joints which can allow one or more degrees of freedom.

ROBOTICS

Actuation

Actuators are the "muscles" of a robot, the parts which convert stored energy into movement. By far the most popular actuators are electric motors, but there are many others, powered by electricity, chemicals, and compressed air.

MOTORS:

The vast majority of robots use electric motors, including brushed and brushless DC motors.

Stepper Motors:

They rotate in discrete steps, under the command of a controller. This makes them easier to control, as the controller knows exactly how far they have rotated.



12V, 160mA
5 wires, unipolar stepper* motor
1.8 degree step angle

Piezo Motors:

A recent alternative to DC motors are piezo motors or ultrasonic motors. These work on a fundamentally different principle, whereby tiny piezoceramic elements, vibrating many thousands of times per second, cause linear or rotary motion. The advantages of these motors are nanometre resolution, speed, and available force for their size.



12 Volts geared DC motors of various rpm
Shaft diameter = 6 mm; Weight = 130 gms
Available in wide range of torque and rpm combination

Other kinds of actuators which are generally used for higher application:

Air Muscles

Electro-active Polymers

Elastic Nanotubes



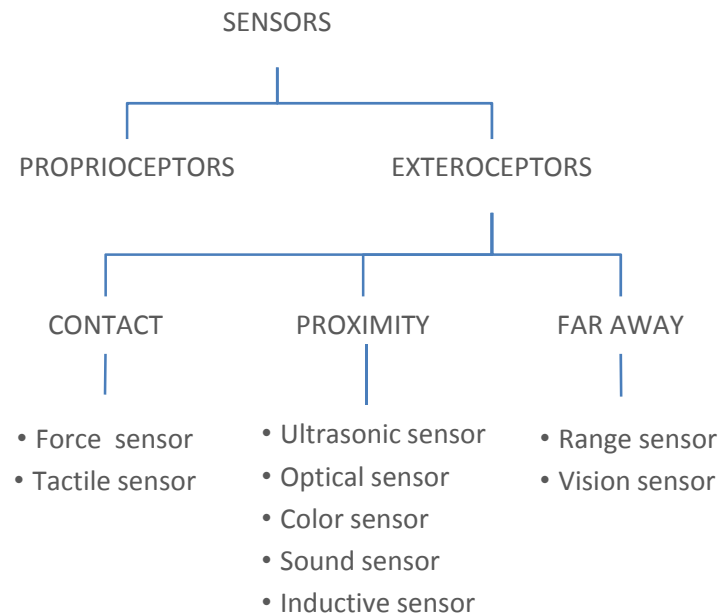
ROBOTICS

Sensors

Since the “action” capability is physically interacting with the environment, two types of sensors have to be used in any robotic system:

“**proprioceptors**” for the measurement of the robot’s (internal) parameters

“**exteroceptors**” for the measurement of its environmental (external, from the robot point of view) parameters



Ultrasonic Sensor:

The Ultrasonic Sensor is able to detect an object and measure its proximity in inches or centimetres.



Ultrasonic sensor pair
(transmitter and receiver)
tuned for 40Khz. 16mm
Diameter

Touch Sensor:

The Touch Sensor reacts to touch and release, enabling the robotic creation to "feel" like never before! It can detect single or multiple button presses.

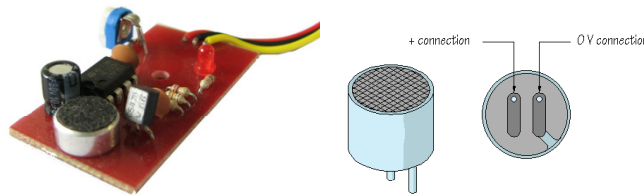


SFE Capacitive Touch Sensor

ROBOTICS

Sound Sensor :

The Sound Sensor allows the robot to hear! The Sound Sensor is able to measure noise levels in both dB (decibels) and dBA (frequencies around 3–6 kHz where the human ear is most sensitive), as well as recognize sound patterns and identify tone differences.



Compact module
Preset for adjusting output pulse time
3 pin easy interface connectors
Bus powered module
Indicator LED

Another name for a sound sensor is a **microphone**. The diagram shows a **cermet microphone**: 'Cermet' stands for 'ceramic' and 'metal'

Light Sensor:

The Light Sensor assists in helping the robot to "see". It enables your robot to distinguish between light and dark, as well as determine the light intensity in a room or the light intensity of different colours.

Compass Sensor:

The Compass Sensor is able to measure the earth's magnetic field and calculates a magnetic heading to tell which direction your robot is facing. The compass has a built-in calibration to help reduce magnetic interference from other sources.

Accelerometer Sensor:

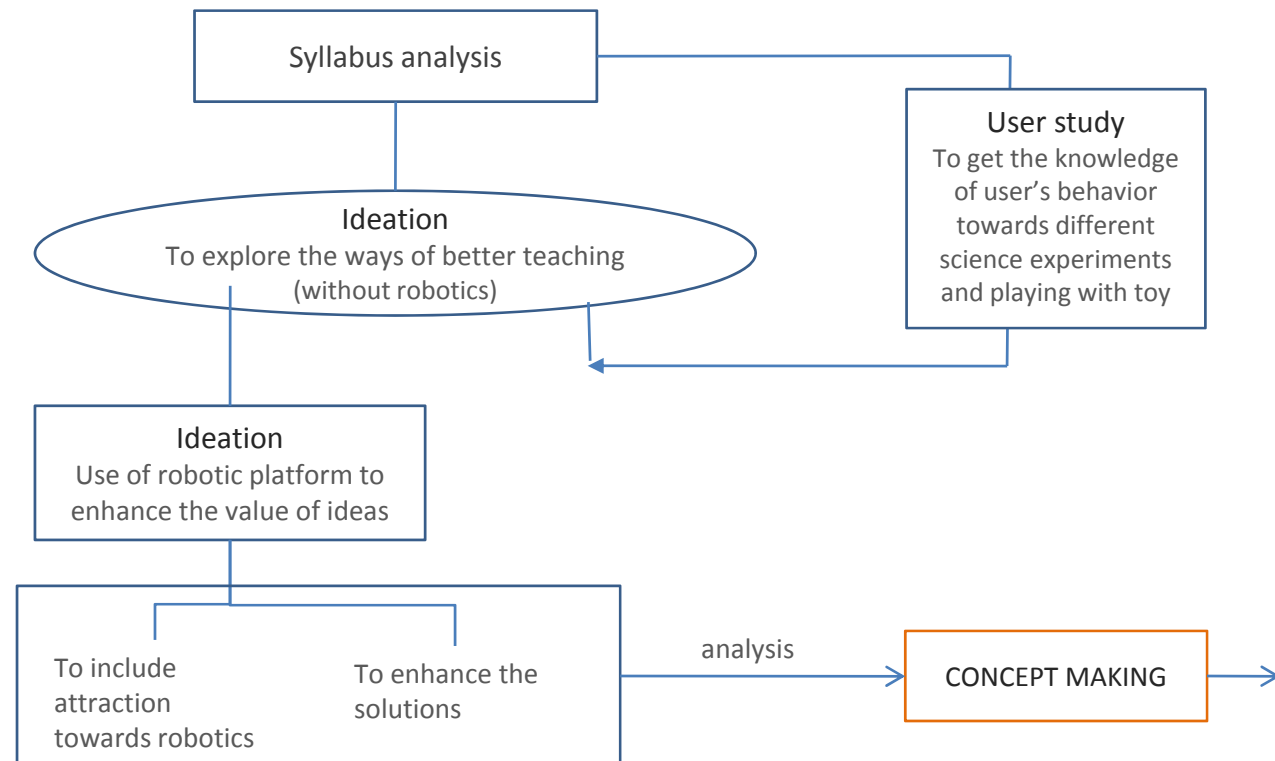
The Accelerometer Sensor lets robotic creation know which way is up and when your robot tilts left or right, up or down, or side to side. This three-axis accelerometer sensor also measures acceleration so you can measure g forces just like jet fighter pilots and astronauts.

Colour Sensor:

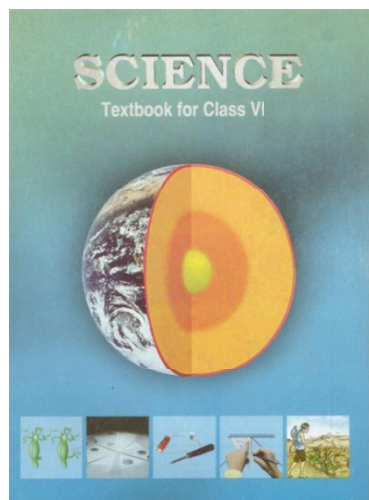
The Colour Sensor enables your robot to distinguish not only between black and white, and also a range of bright and pastel colours.

FUNDAMENTALS FOR IDEATION

Ultimately project is about better teaching over conventional ways. For the better teaching with robotic technology, generation of an activity was simplified by dividing the process in to some progressive stages . To make it happened syllabus of science (NCERT) was analyzed first to decide the suitable topics to teach. Since robotics is more about some dynamic output, every topic of their science book does not go with the particular behavior of robotics.



SYLLABUS ANALYSIS



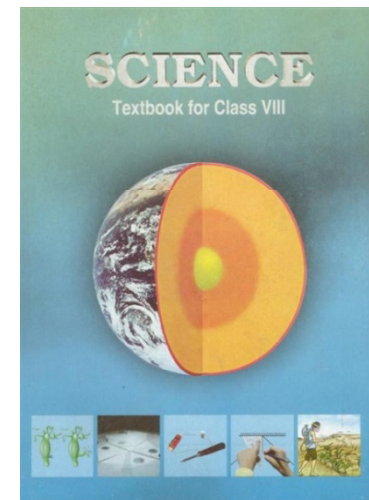
Class VI

Motion and Measurement
 Light, Shadow and Reflection
 Electricity and Circuits
 Fun with magnets
 Body movements



Class VII

Measurement
 Light
 Heat & temperature
 Sound
 Electric charge



Class VIII

Force & Pressure
 Friction
 Sound
 Chemical

SYLLABUS ANALYSIS

In this way some topics are selected to teach which are related to robotics. So, motion related topics like Speed, Acceleration, Velocity, Distance over time, etc. seemed to be near to the nature of robotics and can create dynamic output. Besides this, some scope is found in other topics also.

For the deep analysis ,
Reading of the related chapters;
Analysis of class room teaching;
Analysis of laboratory teaching;
were done. Content of chapters in different standards are as follows:

Motion and Measurement

6th standard

Different type of measurements around us

Standard units of measurement

Correct measurement of length (how to measure things around us correctly; wrong & right ways in measurement)

Type of motion

Units of measurement

7th standard

Indirect methods of measurement of length

Measurement of such object for which direct measurement is not possible

Area of regular surface / volume of regular object

Area of irregular surface / volume of irregular object

8th standard

Different type of motion

Speed

Co-relation b/w Speed, Distance & Time

Unit of speed

Light

6th standard

Difference in transparent, opaque and translucent

Shadows

Reflection

7th standard

Source of light

Travels in straight line

Concave and convex mirror properties

Shadow and eclipse

Lunar eclipse

Reflection

SYLLABUS ANALYSIS

Sound

7th standard

Sound is produced by vibrations

Amplitude, Time period and Frequency

Loudness and pitch

Audible and inaudible sounds

Sound needs a medium for propagation

Reflection of sound and Echo

Noise and Music

USER STUDY

User study has been done to find the truth from the field & from the given environment with robotic & non robotic toys.

It included the workshop (conducted by TRI, SINE IIT Bombay), interviews of children and observation during their playing with the toys.

Apart from this it was about getting an experience to make my view accurate which helped me in further processes.

Workshop

Conducted by TRI Technology Pvt Ltd

Name of workshop: iTrix

TRI Technology Pvt Ltd deals in robotic toys. For different related purpose they often conduct some workshops . Even many companies of same field conduct workshop to give basic robotic education for selling their robotic toys.



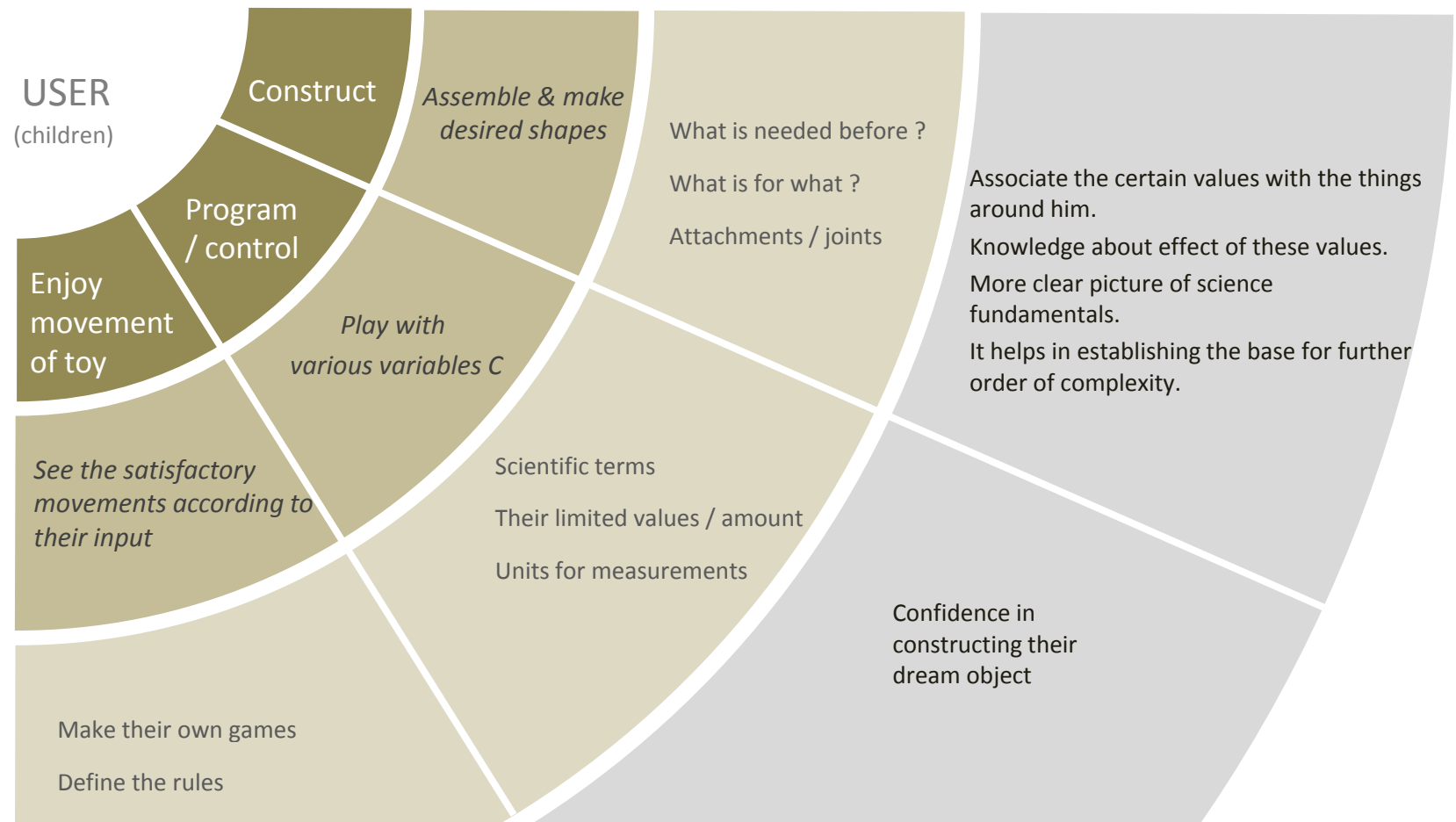
This workshop was mainly for testing one of their upcoming products which was about learning 'robotics' just like Lego Mindstorm, but it was different in some ways. It had different kind of constructional unit.

(The full description of product & photos of the workshop has not been added here, because of some security reason which are meant for under developing products.)

How children interacted with robotics and what they learned, were observed at the workshop where around 10 students of age group 10 – 15 years were participating.

USER STUDY

How do they interact with the robotic toy ...



USER STUDY



A session with children

Four students were observed and interviewed in this session. Their attributes are as follows:

Harish	Age 10 years	Class 6 th	Male
Ashwarya	Age 12 years	Class 7 th	Female
Athira	Age 13 years	Class 7 th	Female
Anusha	Age 10 years	Class 5 ^h	Female

First they were asked some questions like:

Which is your Most favorite subject ? / Do you like science ?

Tell me some practical /experiments which have been done in your class?

Do you remember what did you learn from this practical? / For which topic it was done?

Etc.

Apart from this they were given some science activities from their science book (NCERT syllabus) to see:

Are these activities communicative enough to teach the related topic without giving extra info., “what, where & how is it happening “?

How much are these good to catch their interest?

After this they were given some toys and game kits which included:

Some NIRMITI Toys

Electronic vehicle toy

Transformer toys

Robotic toy (WOW WEE made ROBOSEPIEN)

and they were asked to play with these without giving any information about, how to play, what to do , etc.



USER STUDY



CONCLUSION:

Children were not able to associate the experiment (done in their class room) with the corresponding science theory. They remembered just the process (fun of doing) and forgot the purpose of doing.

During given experiments, they all did the activity with interest but most of them always looked for instructions, and they were not looking that much interested in knowing the what and how it was happening.

With the given toys, following were the observations:

In the starting, everybody was fascinated with robotic toy 'WowWee', but later when they tried to play with that on their own, they drastically lost their interest.

Girls don't want to operate masculine shaped robot. They like soft toys.

Ashwarya was looking more interested in small one, motor driven toy.

Nirmity blocks and Jodo were successful in creating interaction with some meaningful shapes without giving any instruction.

Construction type kit was more able to involve them in activity.

Size of toy matters for kids.

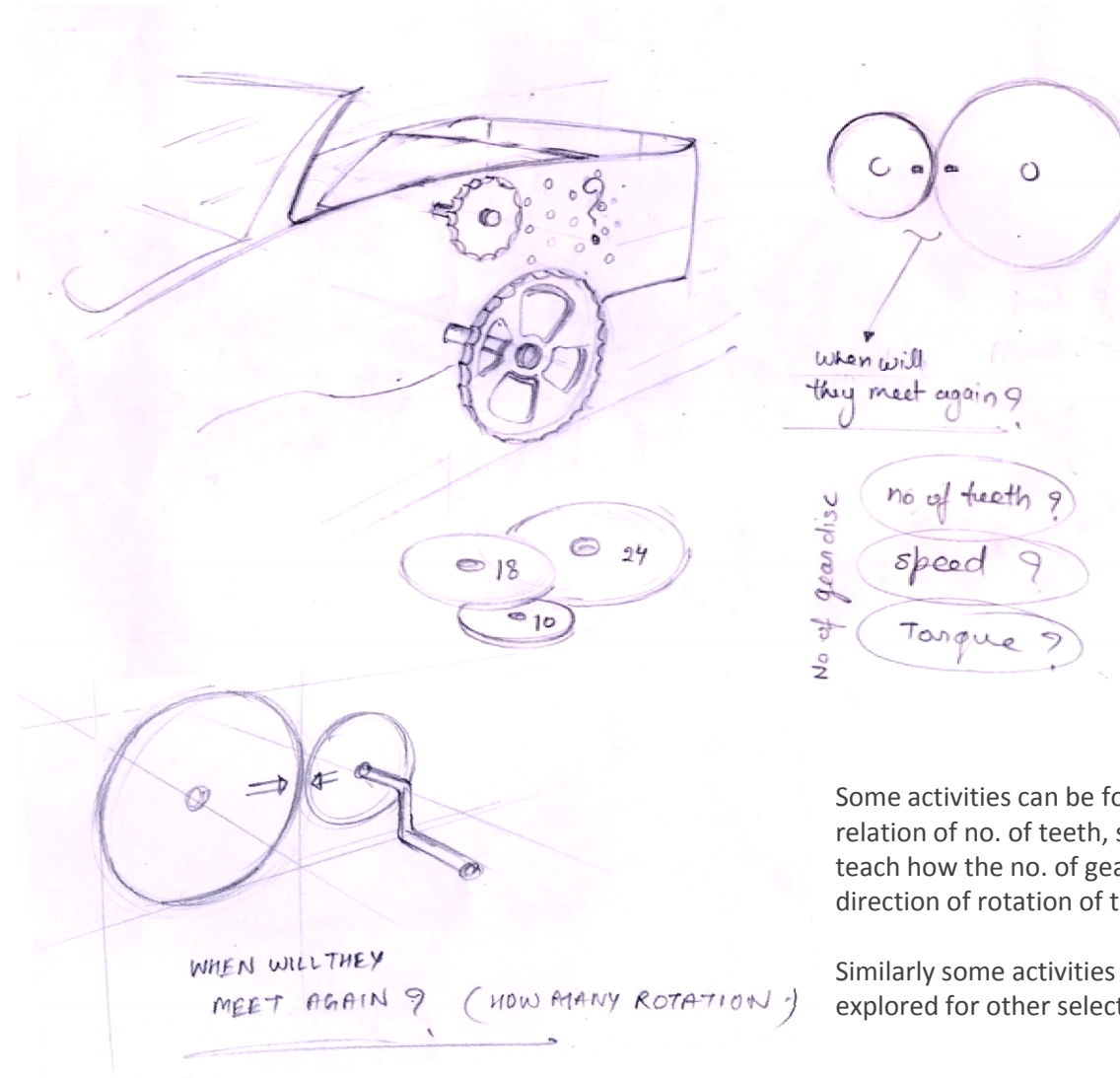
IDEATION

Without Robotics

In the first stage of ideation, 'to make teaching of science better (without robotics)' was tried as an objective. Ideation was not restricted with selected topics only, it went beyond also. Topics like Gears, Measurement, etc. (co related with motion and robotic precision) were also in consideration. 'Basic fundamental of Gears' is not in their syllabus but according to M. Common's Model of hierarchical complexity, it comes in that order in which it is to be taught to targeted age group.

IDEATION

Gears

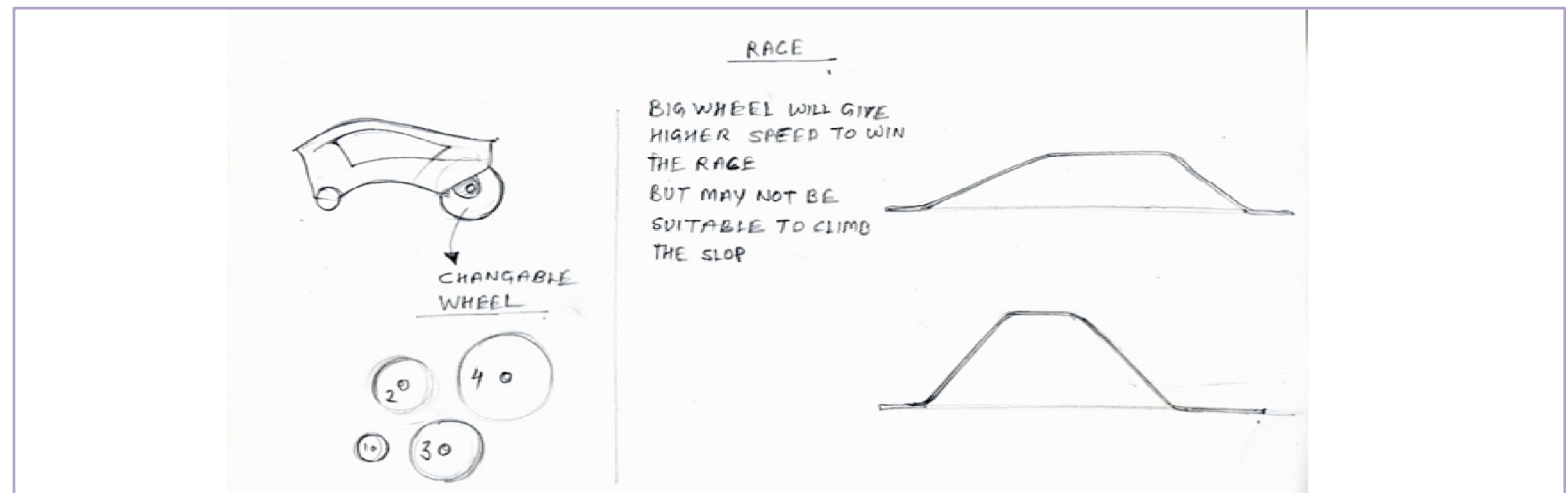
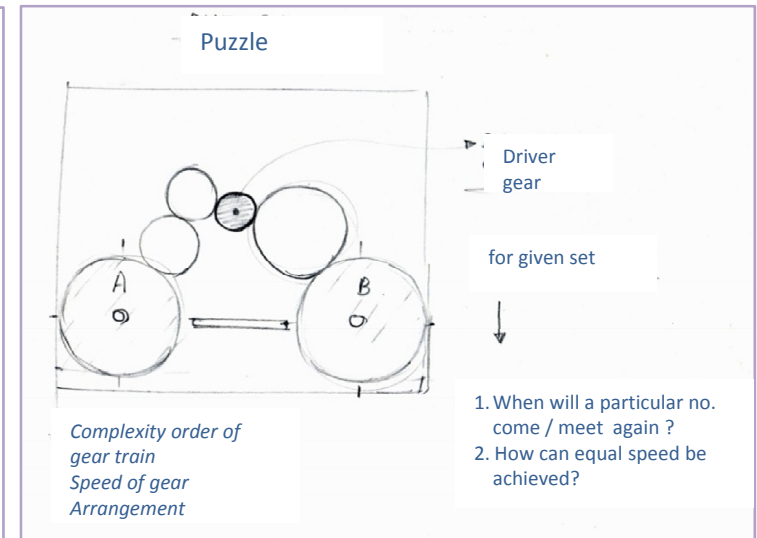
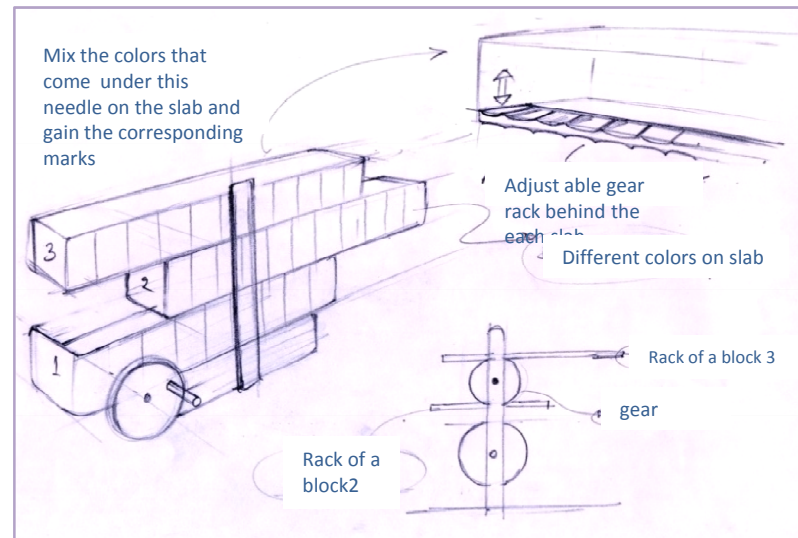


Some activities can be formed to teach simple correlation of no. of teeth, speed and torque or to teach how the no. of gears are set to change the direction of rotation of the gear.

Similarly some activities / experiments are explored for other selected topics.

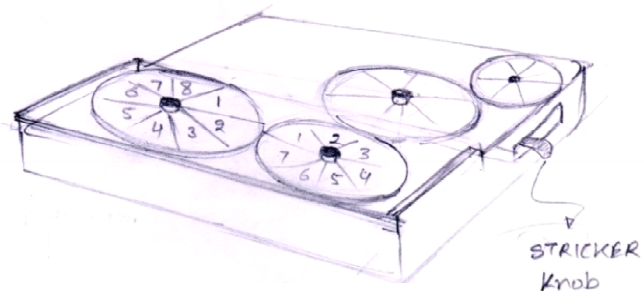
IDEATION

Gears



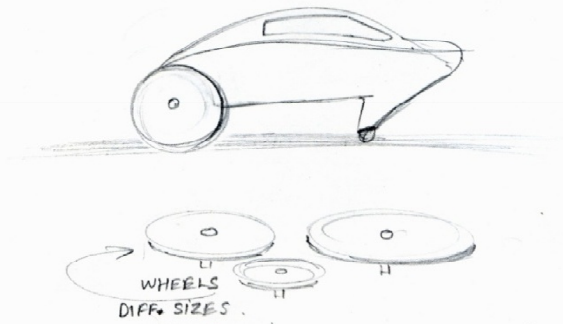
IDEATION

Gears

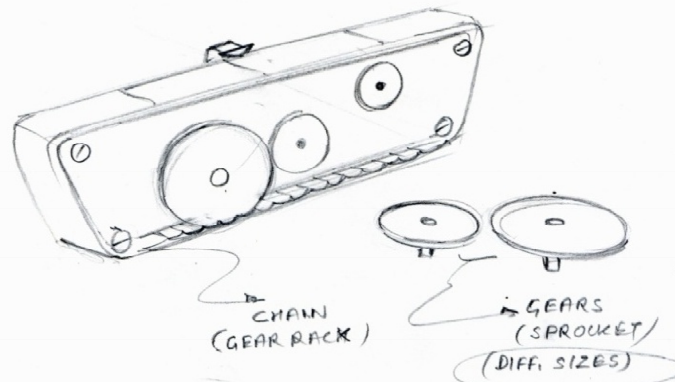


To match the no. of both wheels.
What should be selected from given set,
and for which position?

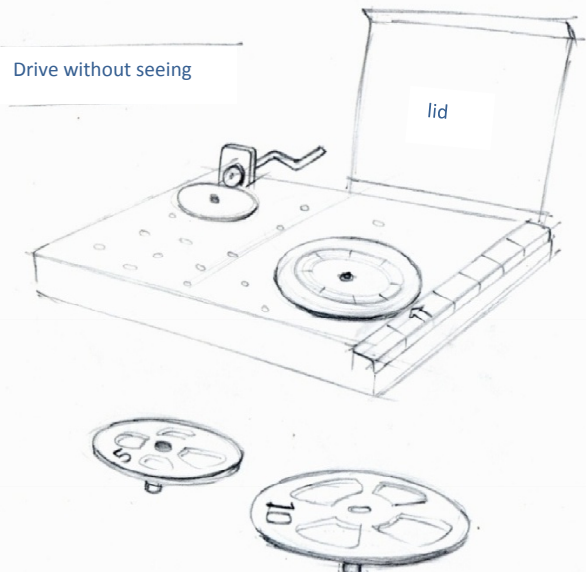
Different size of wheels will show fast & slow speed



How can it move its max distance through given set of gears?

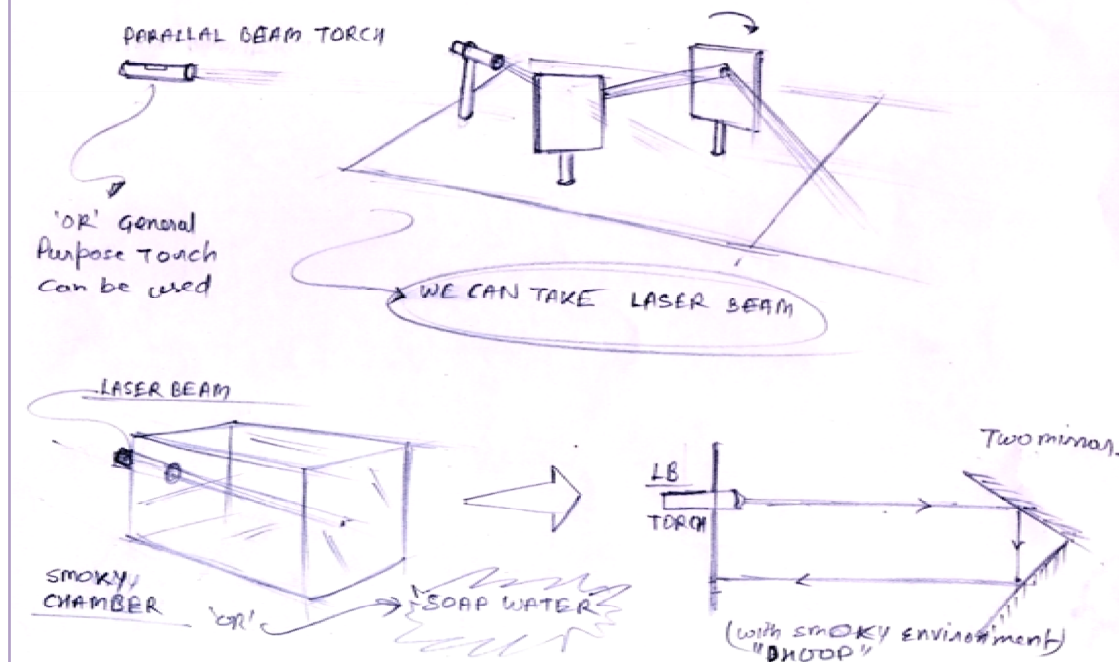
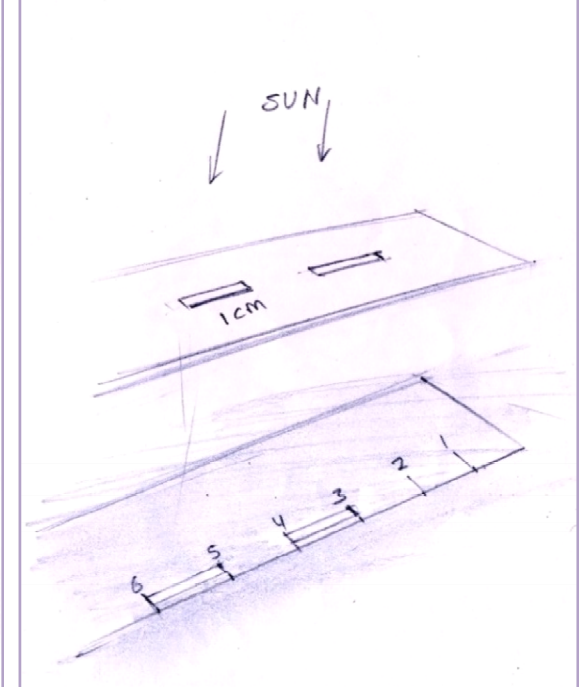


Drive without seeing



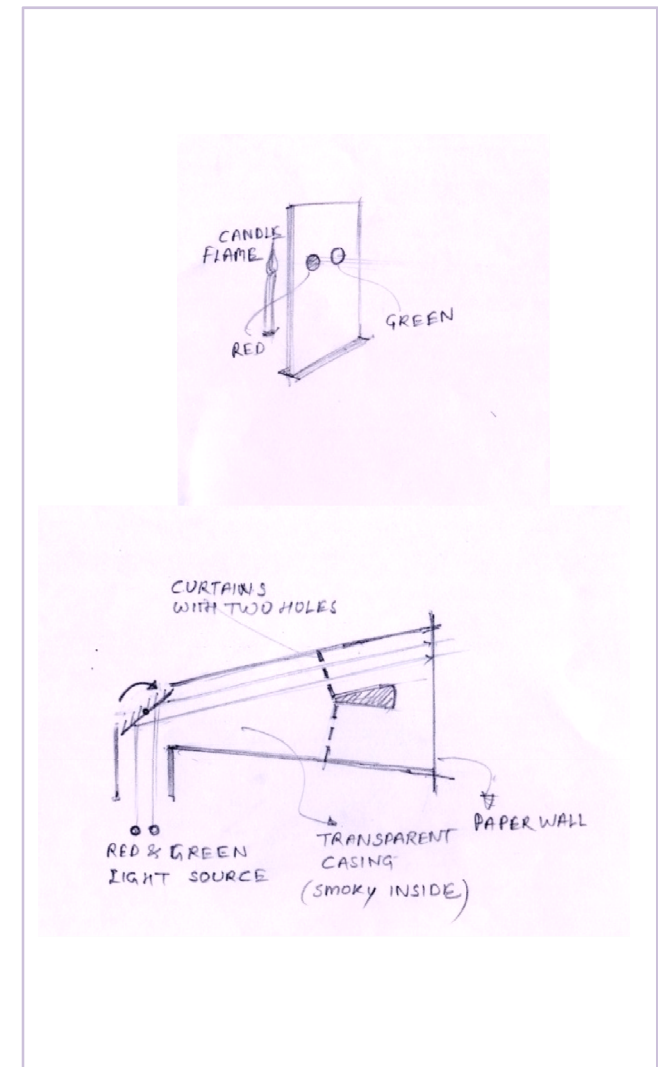
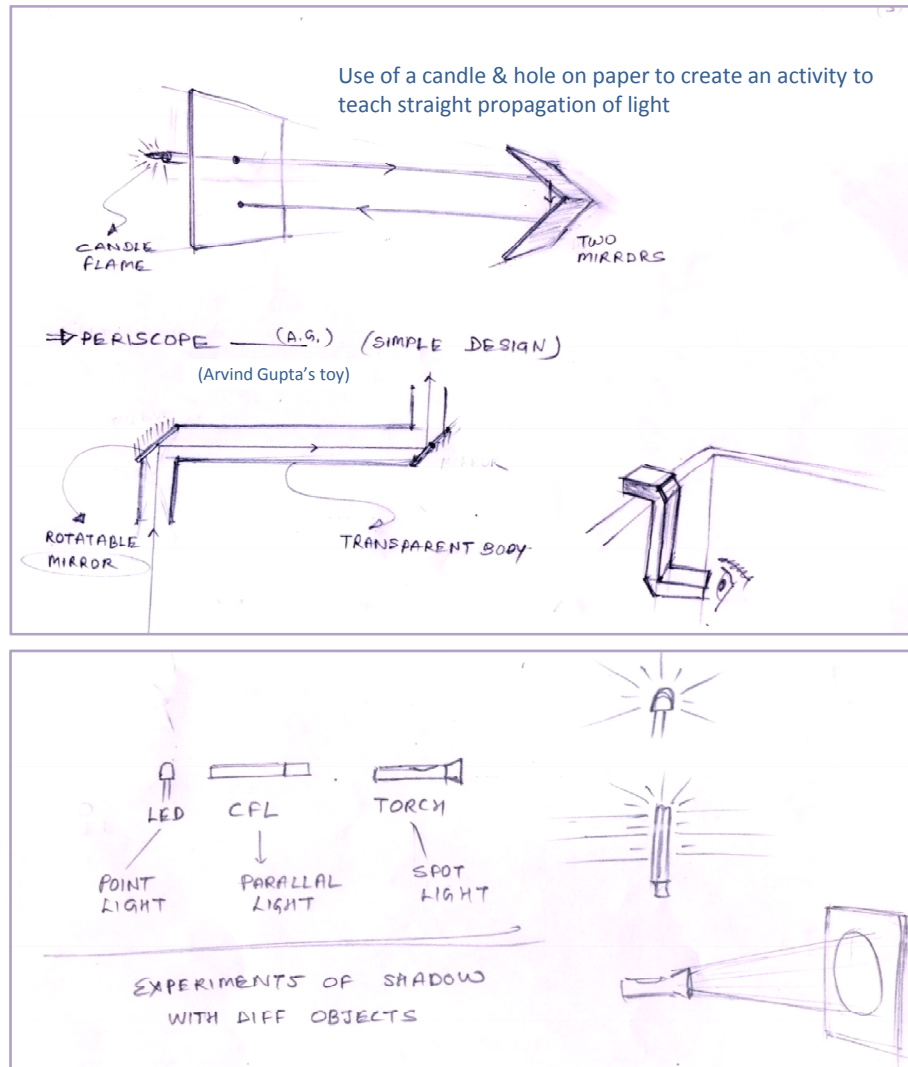
IDEATION

Light

Straight propagation & Reflection of lightParallel light beam comes from sun

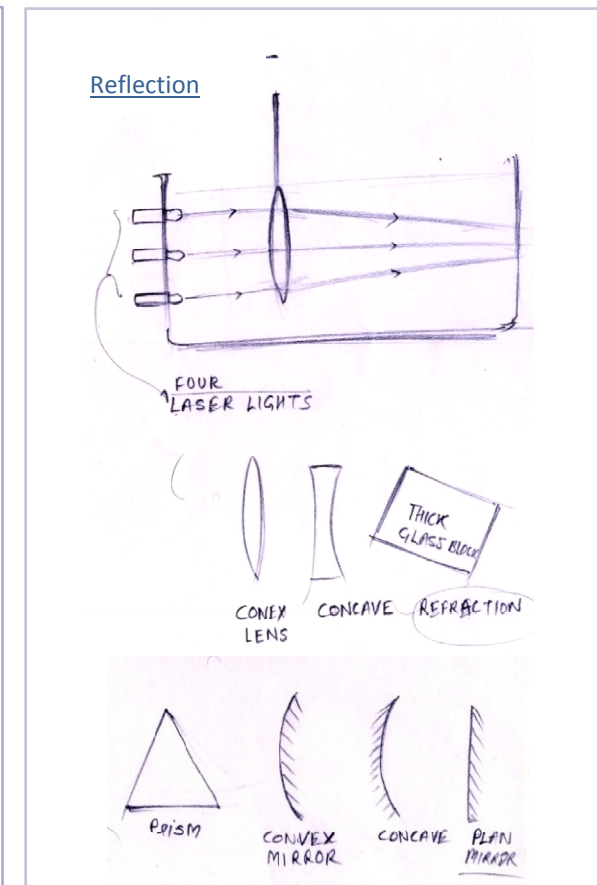
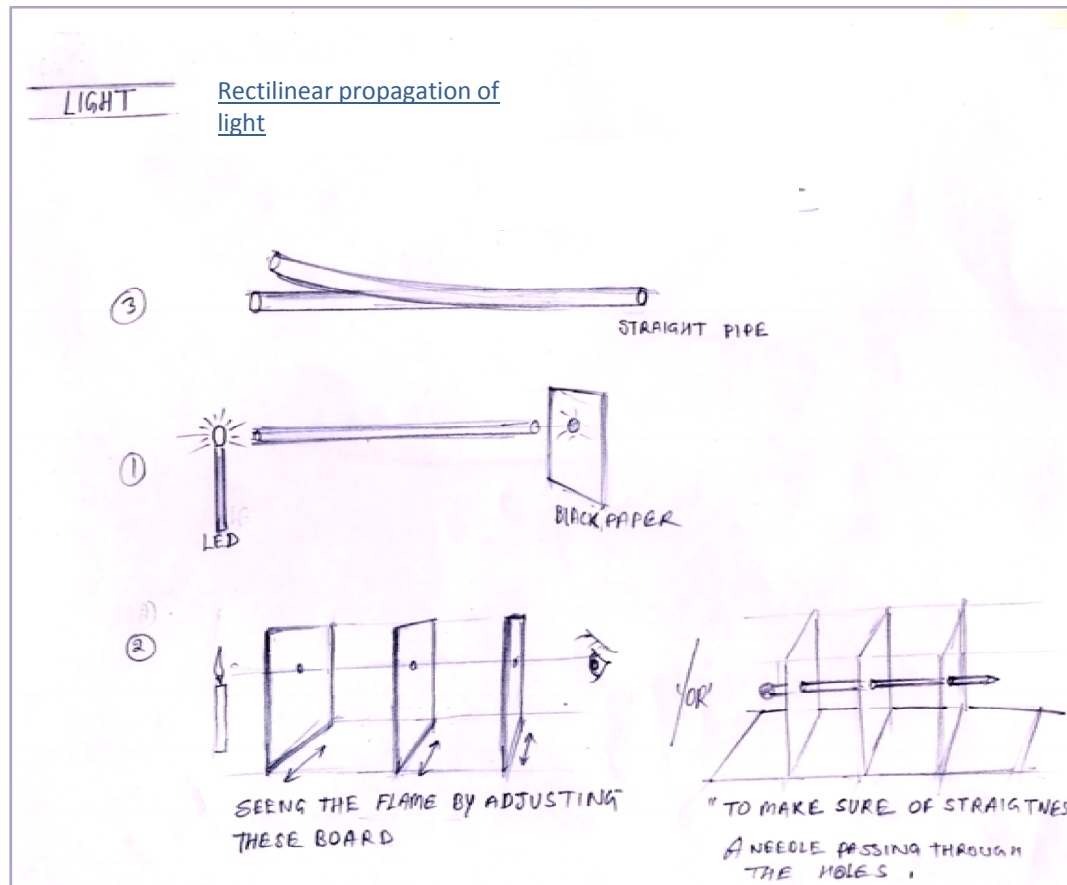
IDEATION

Light



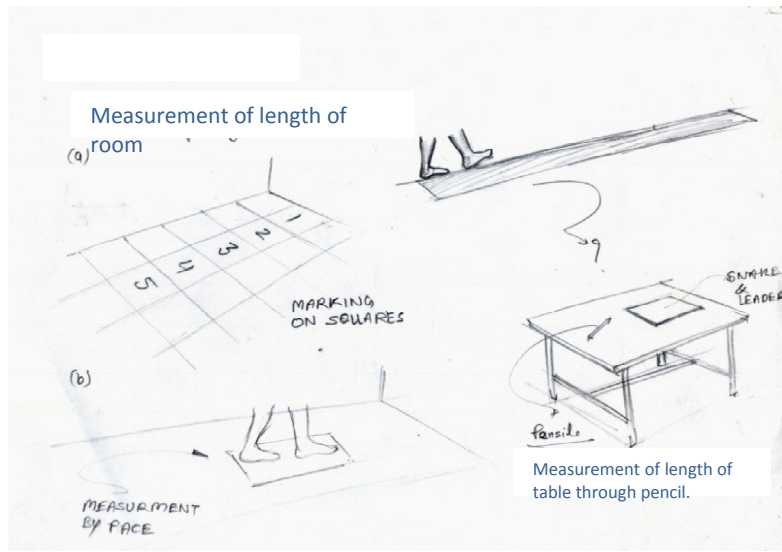
IDEATION

Light



IDEATION

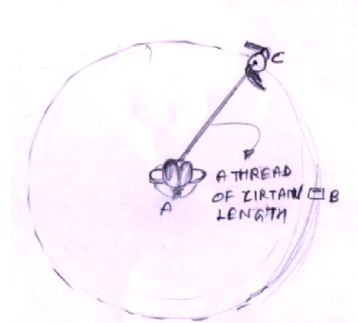
Measurement



Path

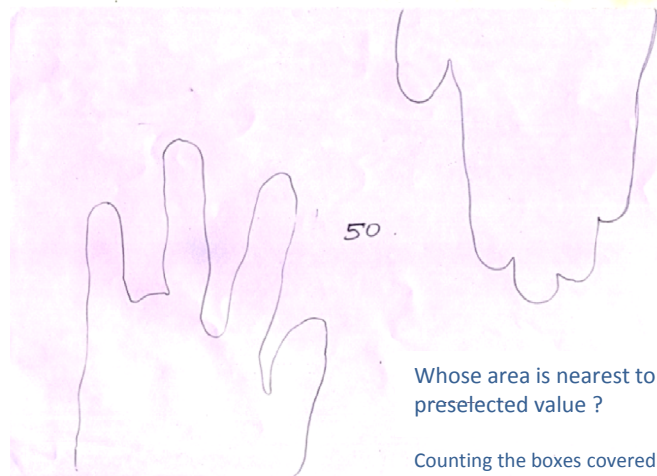


1. Speed ?
2. Who will reach first ?



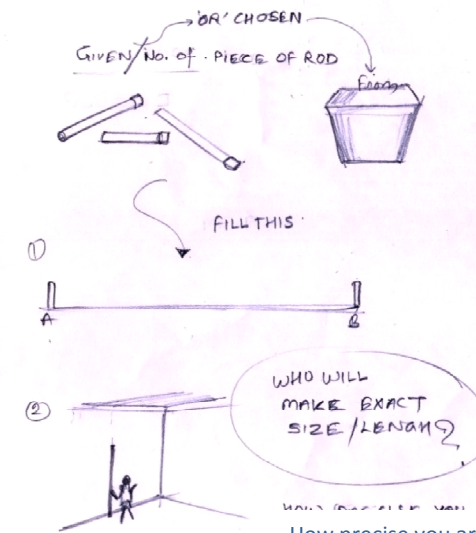
Counting by pace

Perimeter
& diameter



Whose area is nearest to
preselcted value ?

Counting the boxes covered by your
hand



How precise you are ?

IDEATION

Measurement

In FIRST SIGHT
AREA OF EACH OF ALL
CARD BOARD
AMOEBA,
LOOKS ALL MOST
EQUAL

WHICH AREA IS BIG?

THEY WILL HAVE A GRAPH PAPER/GRID

AREA MEASUREMENT
BY COUNTING THE
SQUARES UNDER
CURVE

WHICH AMOEBA IS OF
LARGEST PERIMETER?

A THREAD
CAN BE
USED TO
MEASURE

SAME MATERIAL

IRREGULAR
SHAPED BLOCKS

① IF ALL BLOCKS
HAVE SAME
WEIGHT.

② IF ALL BLOCKS
HAVE DIFF.
WEIGHT

WHICH HAS BIG VOLUME?

TO MEASURE
THE VOLUME

DIFFERENT MATERIAL

BUT →

HARD WOOD ALUMINIUM IRON

* SIZE & SHAPE SHOULD
BE SAME

THEY WILL NOT HAVE
EQUAL WEIGHT
BUT
EQUAL VOLUME

AFTER DOING 1st Activity

IDEATION

Brainstorming Session

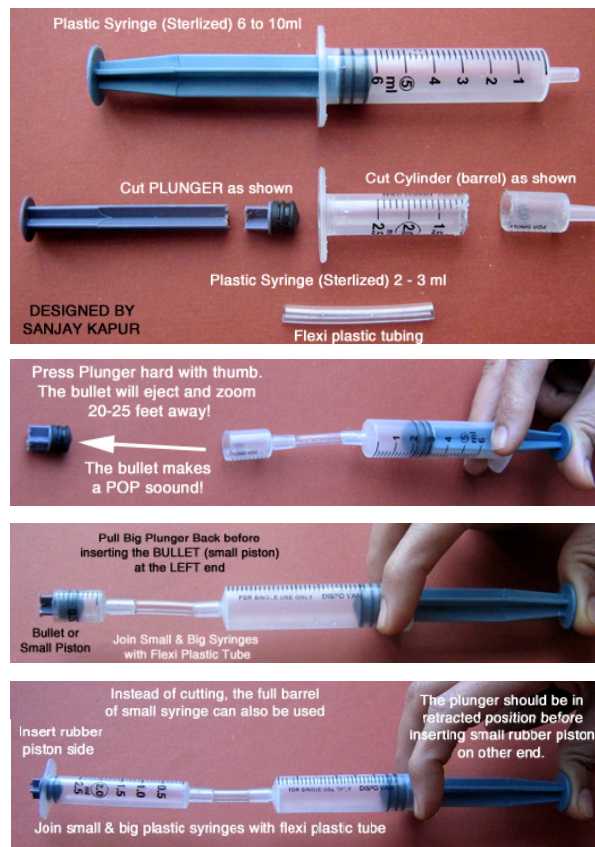


From whole research work, user study & even during ideation stage, 'giving them to do some related activities' is found as a better way to understand the abstract concept of science for children. By doing, they understand the phenomenon easily, deeply & impact fully.

In order to develop activities, a brainstorming session was done with some of my batchmates to enhance the effectiveness in the ideation process .

IDEATION

Analysis Arvind Gupta's Toys



In the search of 'activities' to teach required topics Arvind Gupta's toys were also analyzed, which have the methodology of "Do It Yourself ". Their principle is that a child will better understand a scientific concept if it is incorporated into a toy.

Analysis:

Low cost (use of recycled and easy to procure material).

High level of interest and curiosity.

The range of these toys is unlimited.

Toy / apparatus may not be well & good functional product.

There can be conflicts in purposes of instruments, being used fully or partially as a part of the educational toy. Children identify things on the basis of their purpose also, for example syringe is identified as an instrument of medical treatment.

IDEATION

Using Robotics

Till here, some areas in their syllabus have been explored to teach, and related experiments have been tried in form of games. Now robotics is being used on these ideas, some to include playfulness and some are on the basis of functionality.

Instead of sticking with a topic of science and doing many ideations only for that, in this stage, ideation was done for different topics to find some thing valuable.

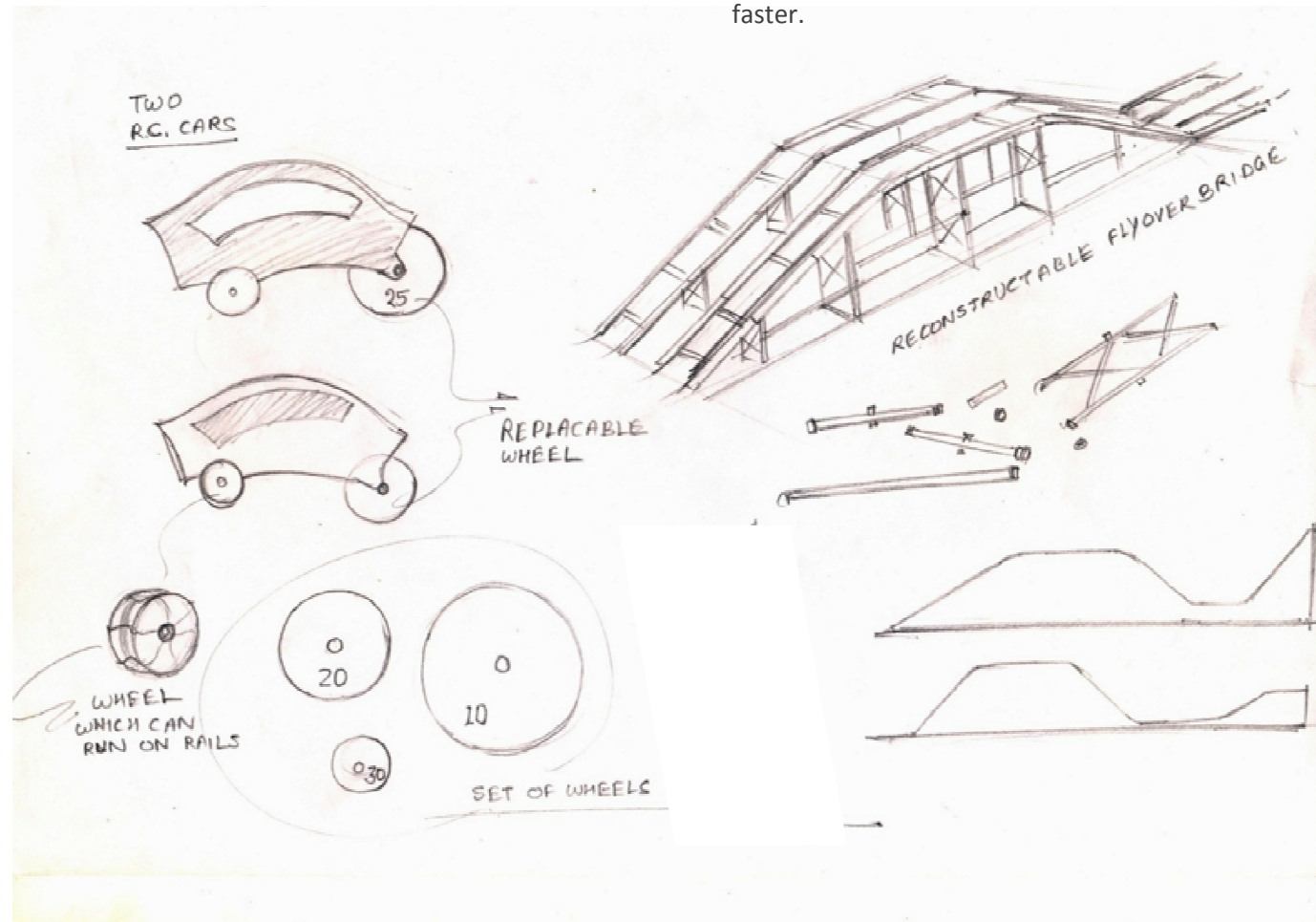
These ideas are like a stage from where some educational game can be developed. These ideas are Robotic Educational Activities which have some play value.

IDEATION

1

Torque v/s Size Of Wheel v/s Speed

There will be a path detective sensor in three wheel car. Driver wheel will be removable which will come in multiple sizes. This kit will include constructional parts to make track and move on it. Big wheel may not climb on high slope but it will be faster.



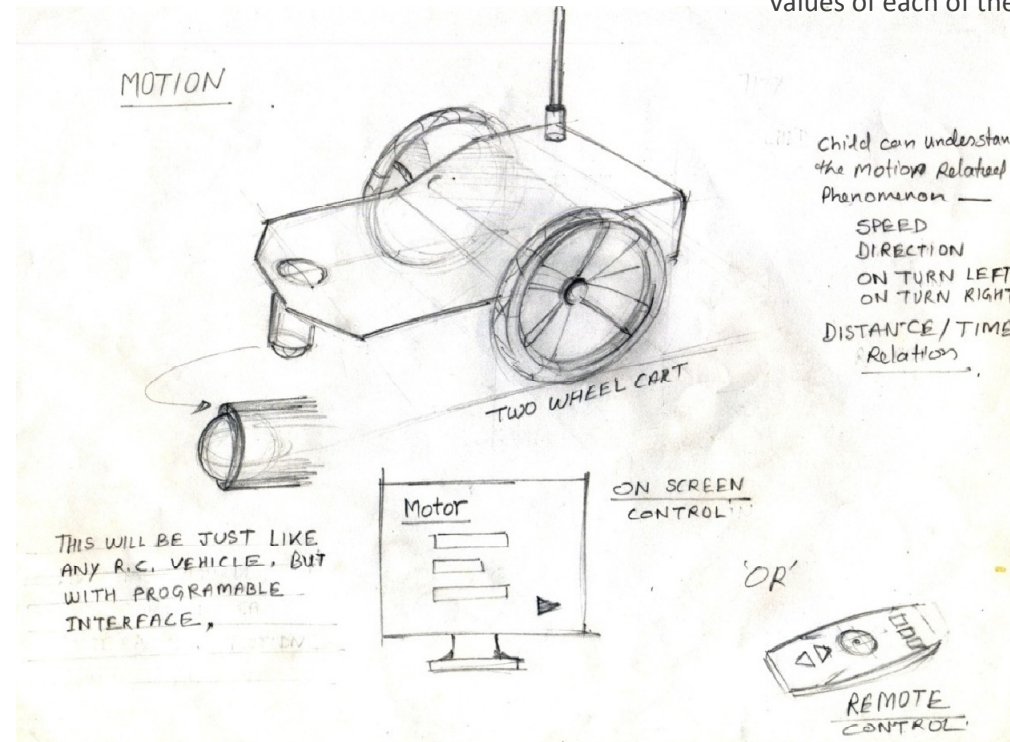
IDEATION

2

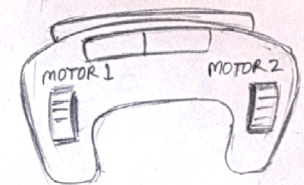
Speed and turning of a car

Children have to make robotic vehicle which has two wheels, attached with two separate motor and one castor wheel in front of it.

The toy car can be RC or programmable which will have screen prompt to put the speed and similar values. Children will see the effect by changing values of each of the motors.



MOTOR 1	
SPEED	
Time	
MOTOR 2	
SPEED	
Time	

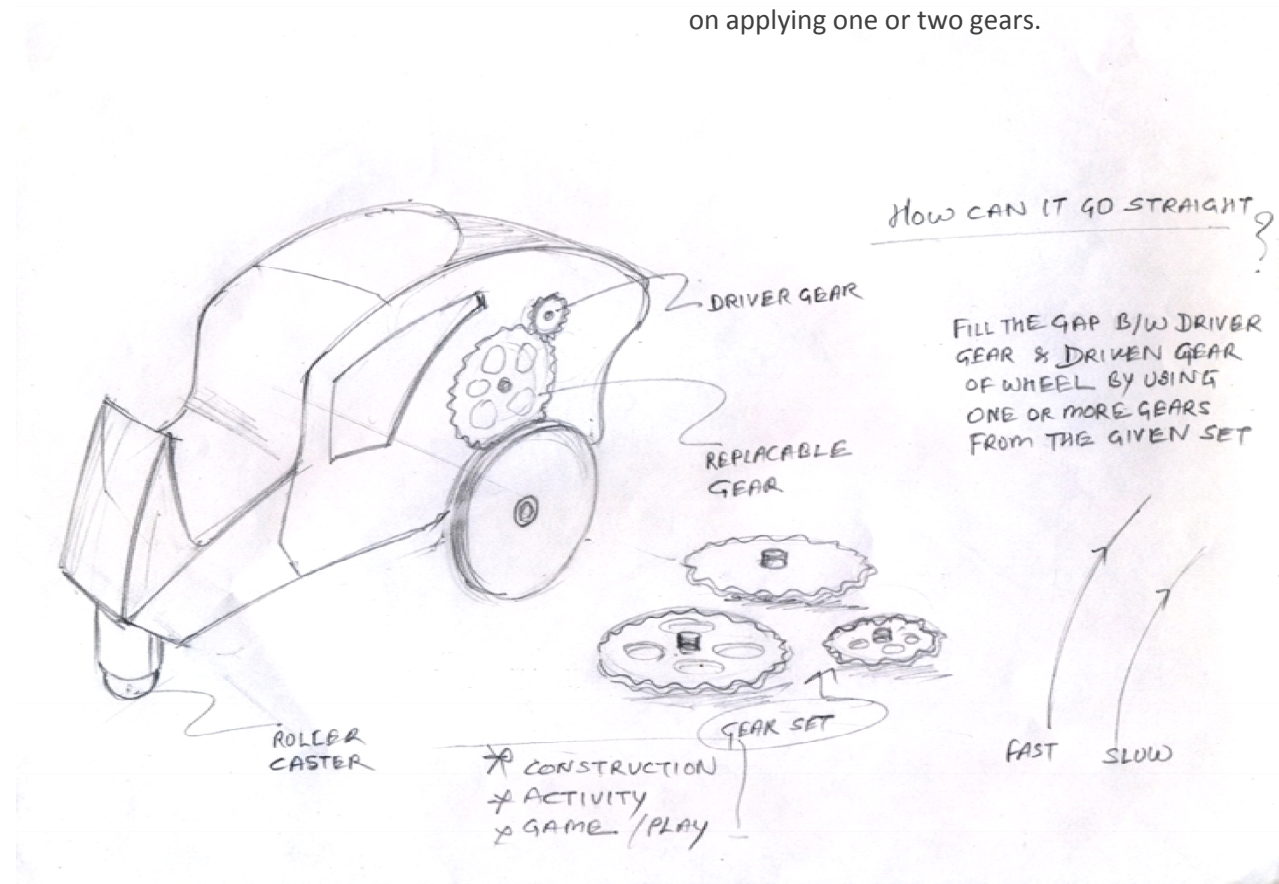


IDEATION

3

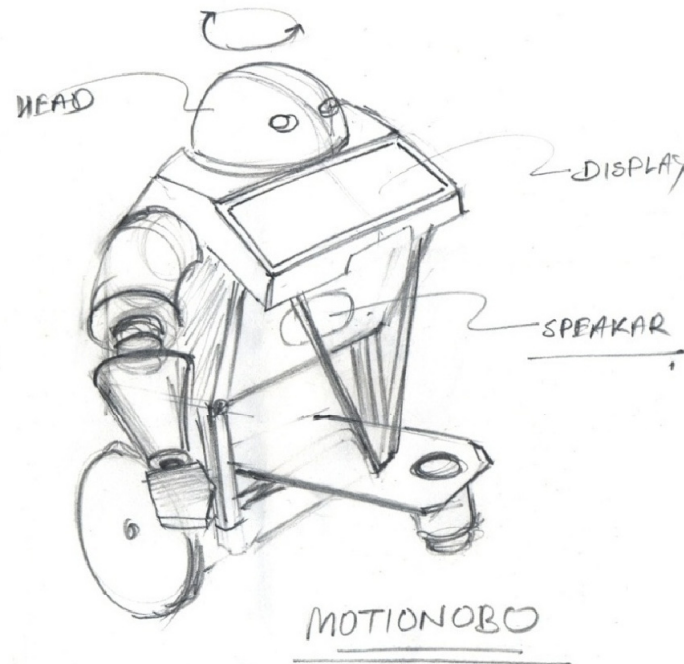
Gear train and turning of a car

There is a toy car having two independent wheel and one castor wheel. One gear set will be to fill the gap between driver gear and driven wheel. Children can see the effect of number of teeth of applied gear and see the direction of movement on applying one or two gears.



IDEATION

4

Motion

This demonstrating robot called Motionobo will teach fundamentals of motion in his own voice as well as perform to explain a topic such as:

Linear/ non-linear motion

Speed

How to turn left/right

Acceleration

Velocity

Co relation between speed distance and time

2D co-ordinates

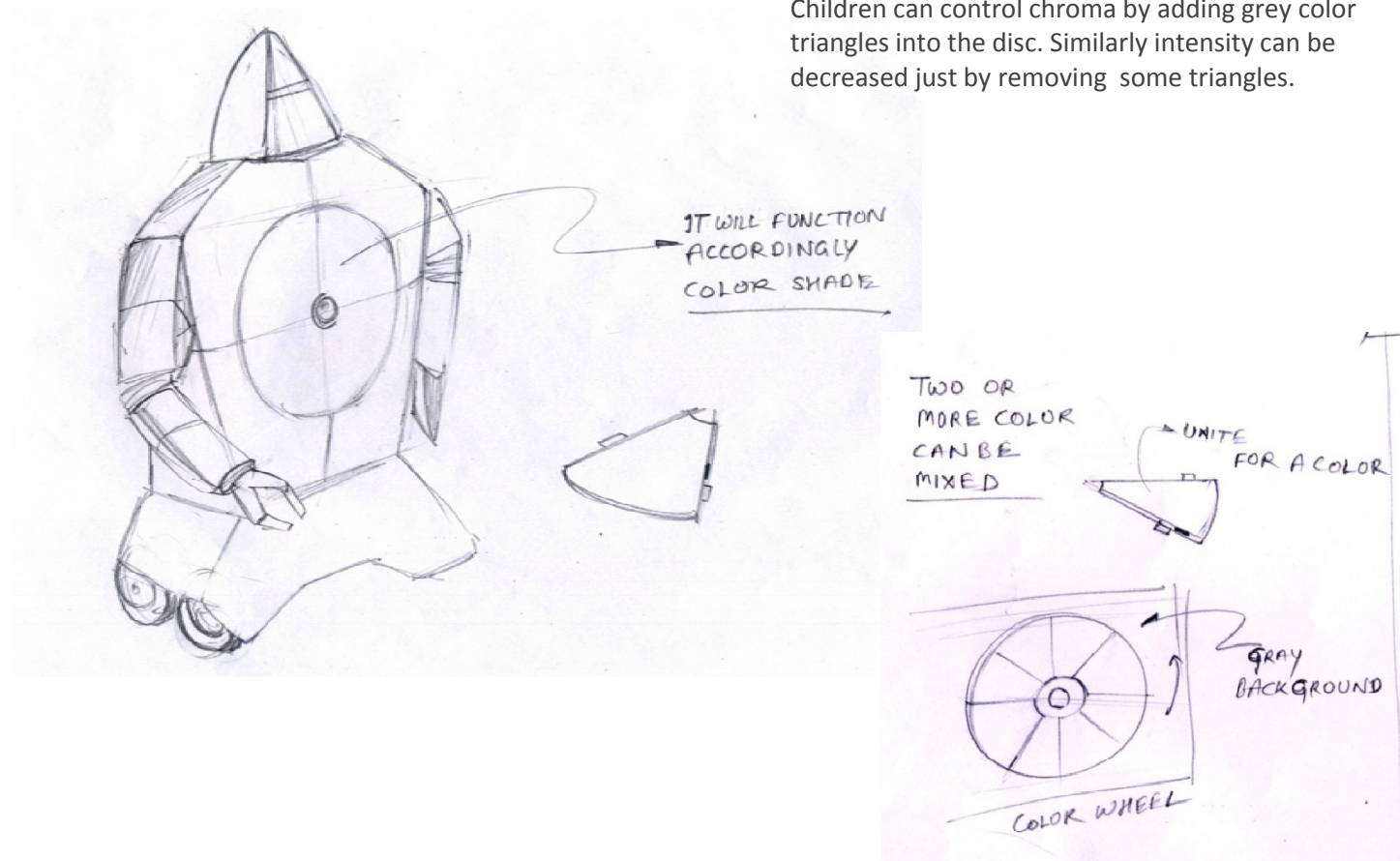
This enables children to construct it themselves. After the whole demo /lecture it can be operated by remote.

IDEATION

5

Colour combination

This robot will be commanded to do certain function for corresponding color shade by putting a color disc. It will be prepared by choosing one or more color combinations. Children can control chroma by adding grey color triangles into the disc. Similarly intensity can be decreased just by removing some triangles.

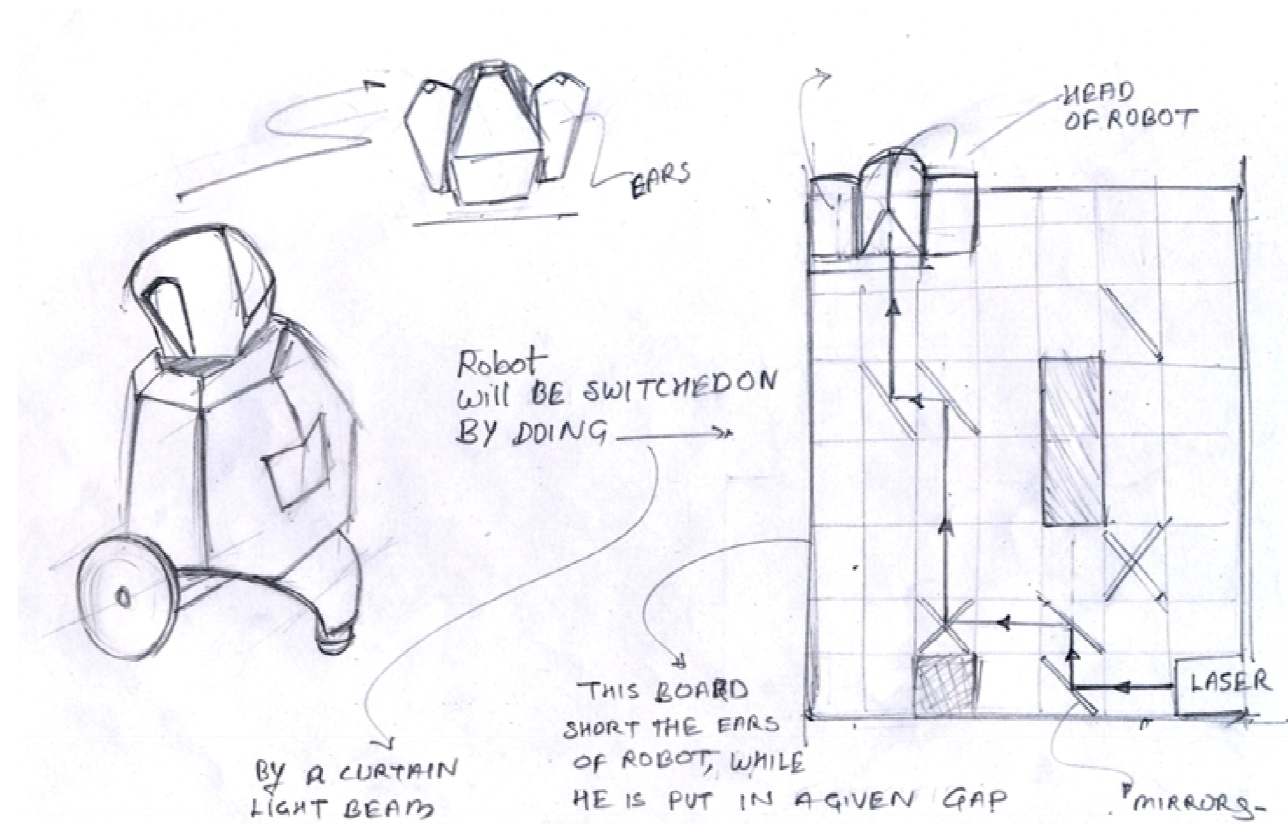


IDEATION

6

Reflection & Straight propagation of light

Some educational games, when children will play and win, they will start the robot. Like, this game is about learning reflection phenomenon. Board of this game will have two slots where the head of the robot can fit.

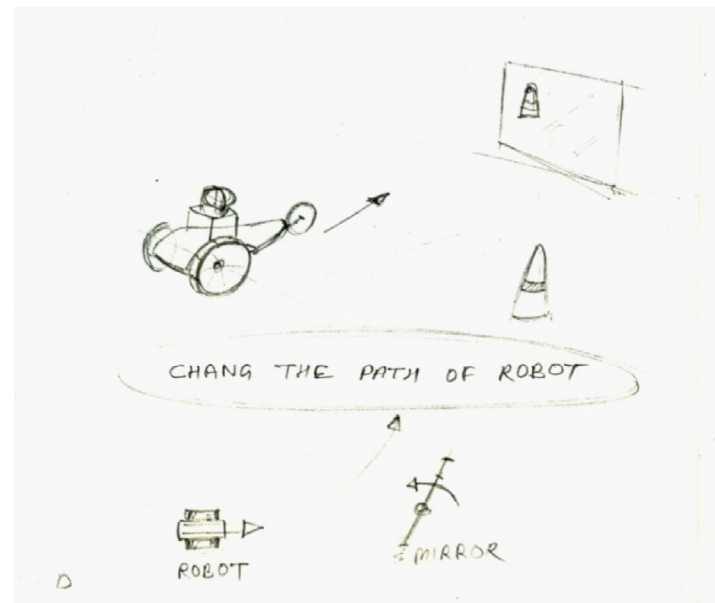


IDEATION

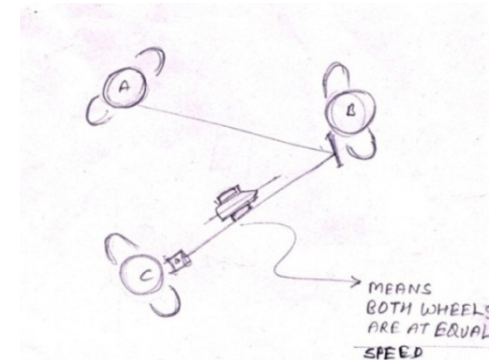
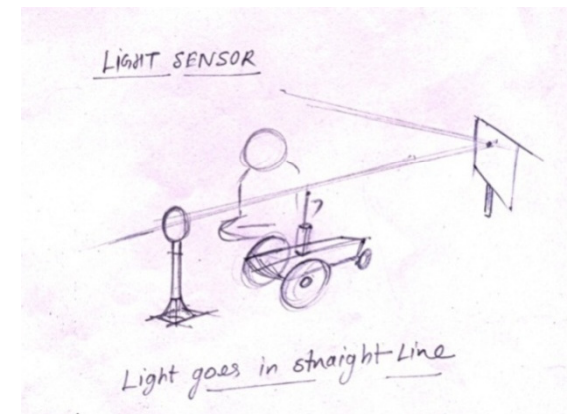
7

Reflection & Straight propagation of light*Some more ideas for reflection:*

1. By putting a mirror, the child can create confusion for the robot which is already programmed to follow particular object. Result may be very interesting, if the path will be traced.



2. Robot will have such sensors which can allow it to follow the straight laser beam. It can be deflected by putting mirror in the path and by doing this many interesting games can be possible.

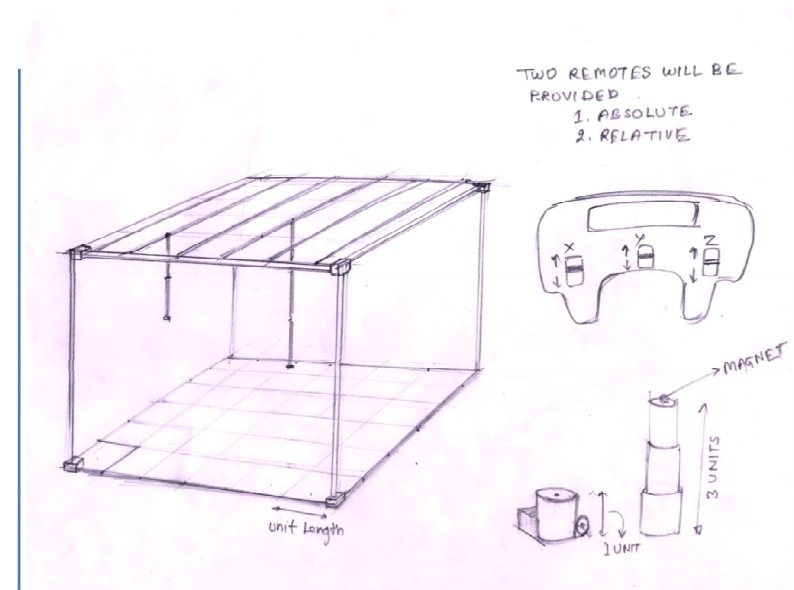
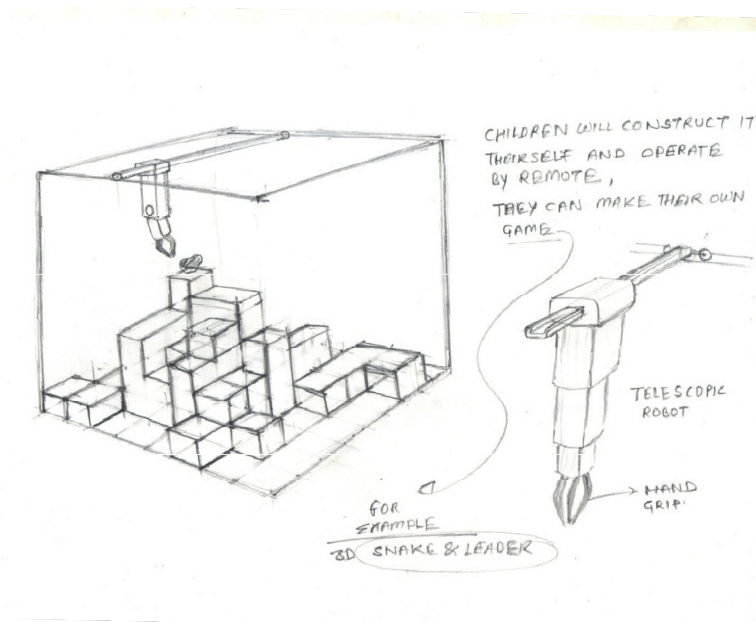


IDEATION

8

3D coordinates

A telescopic robot's location can be shifted by a remote by using three buttons for X, Y & Z directions. For this activity cubical frame will be made by joining elemental sticks, and similar 3D maze will be created by the user.



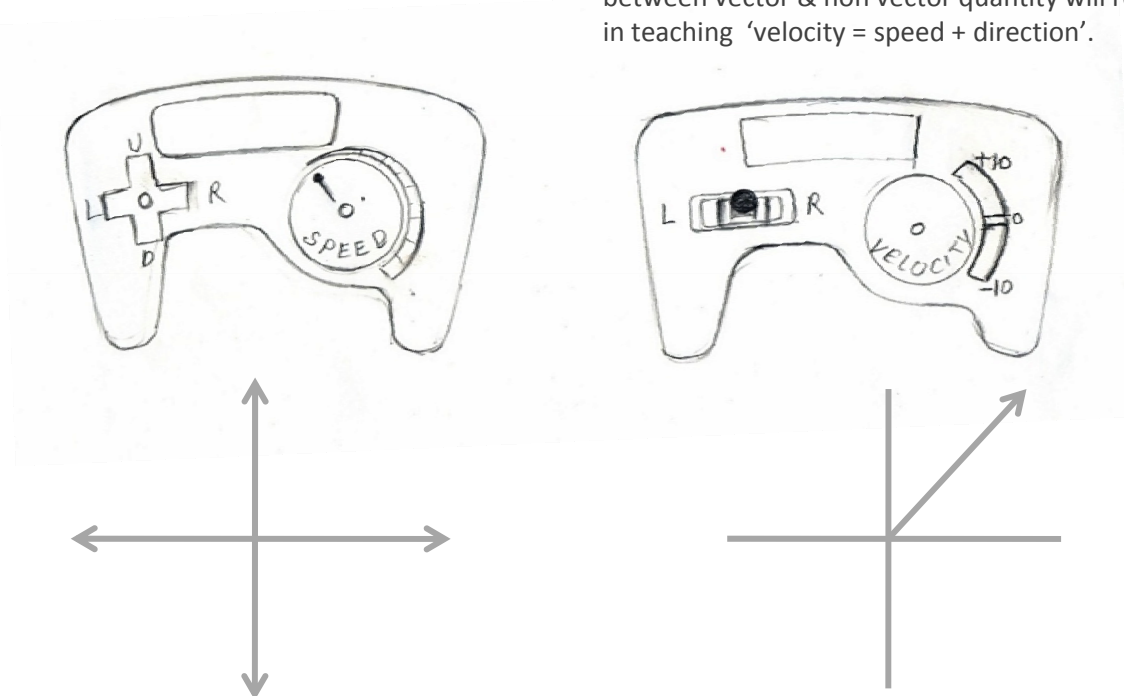
IDEATION

9

Velocity v/s Speed

There will be two separate robot for velocity and speed. From Speed one, robotic cart will move only in orthogonal directions. From velocity one, robotic cart will move diagonally also. Because velocity knob which reflects the vector behavior of velocity, provides forward and backward movement.

Speed remote has four navigation buttons for forward, backward, left and right and one knob for speed. Remote interacts in such a way that user feels that direction from navigation buttons is nothing itself and speed value is nothing itself. Both are being used simultaneously to move the car. On the other hand, velocity remote will have the rotating knob with positive and negative value for forward and backward direction with the value of speed. By using both remote one by one, difference between vector & non vector quantity will be reflected in teaching 'velocity = speed + direction'.



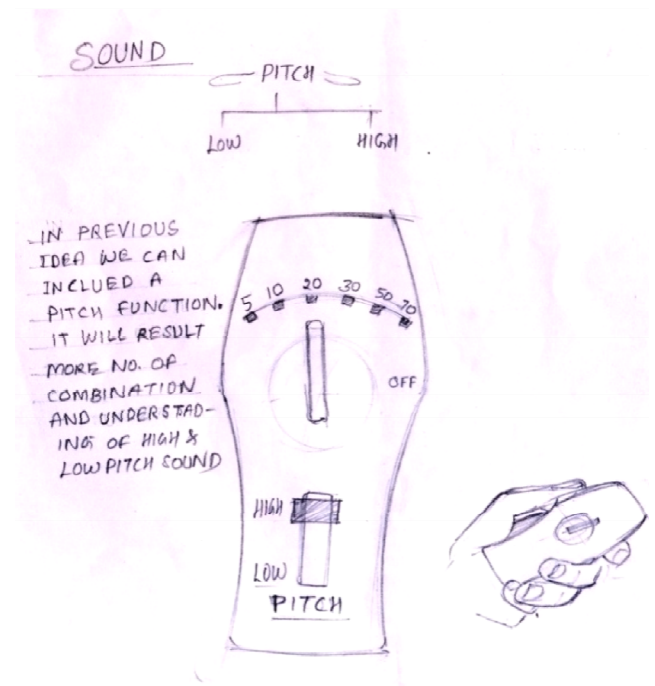
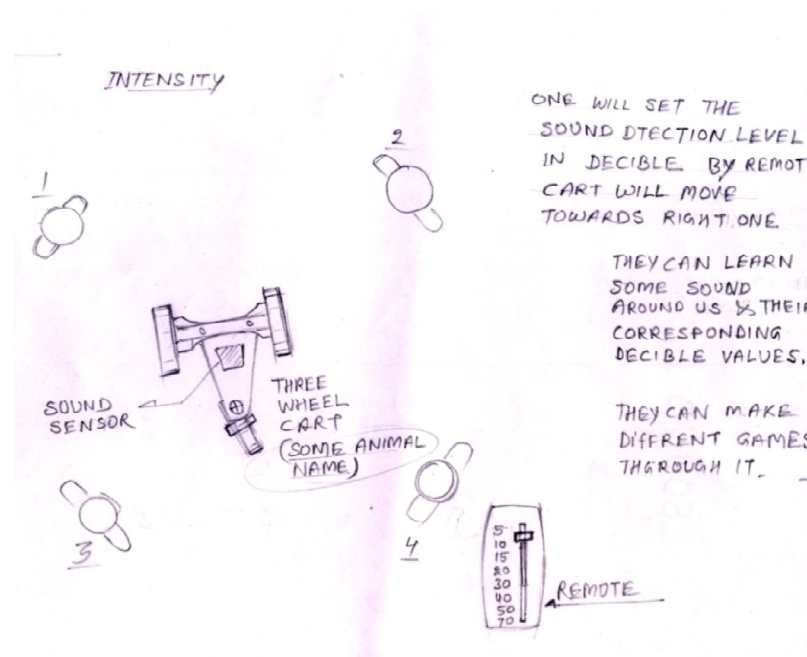
IDEATION

10

Pitch and Intensity of sound

One child will set the sound detection level in db by remote. And he will ask other players to produce sound after hiding the remote. Sonix, three wheel cart will move towards nearly matched sound and he will get points.

Children can learn decibel value for corresponding sounds from our surroundings, with a lot of fun. Children of this age will be able to make their own games.

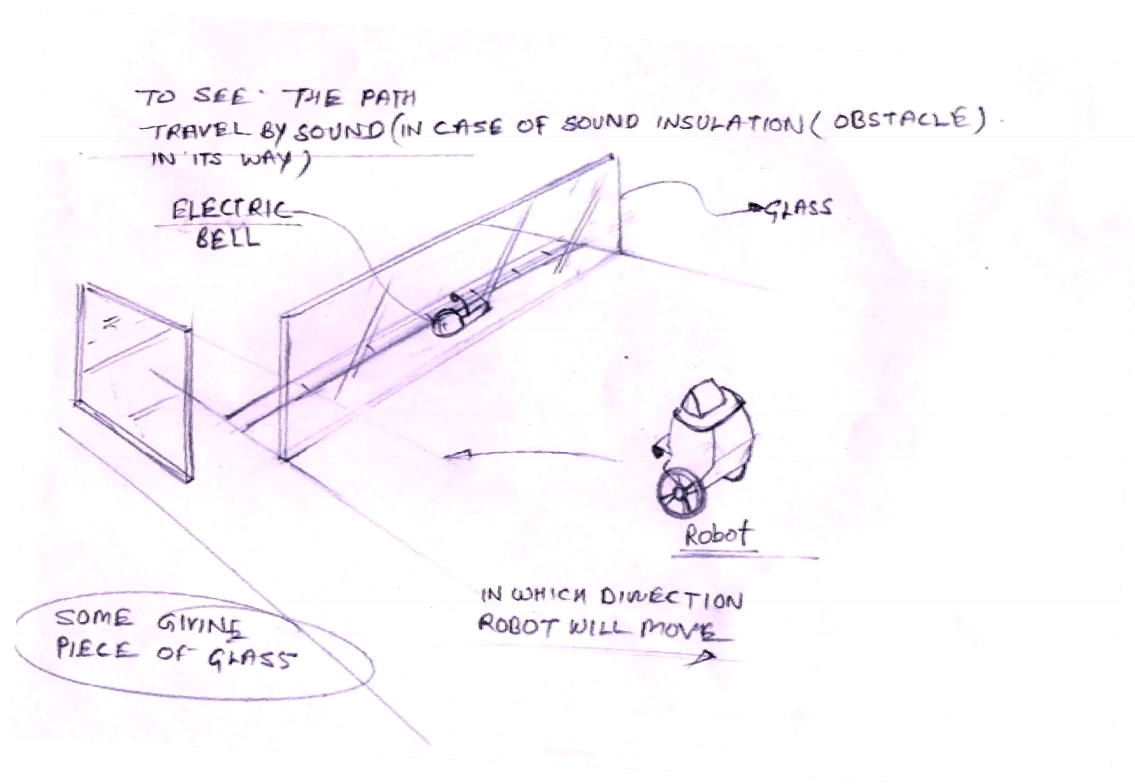


IDEATION

11

Experience of Reflection & Propagation of sound

For this experiment, in the kit there will be some pieces of glass to deflect the path of sound produced by an electric bell. A robot will move in that direction and will show the path of propagation of sound which cannot be seen otherwise.

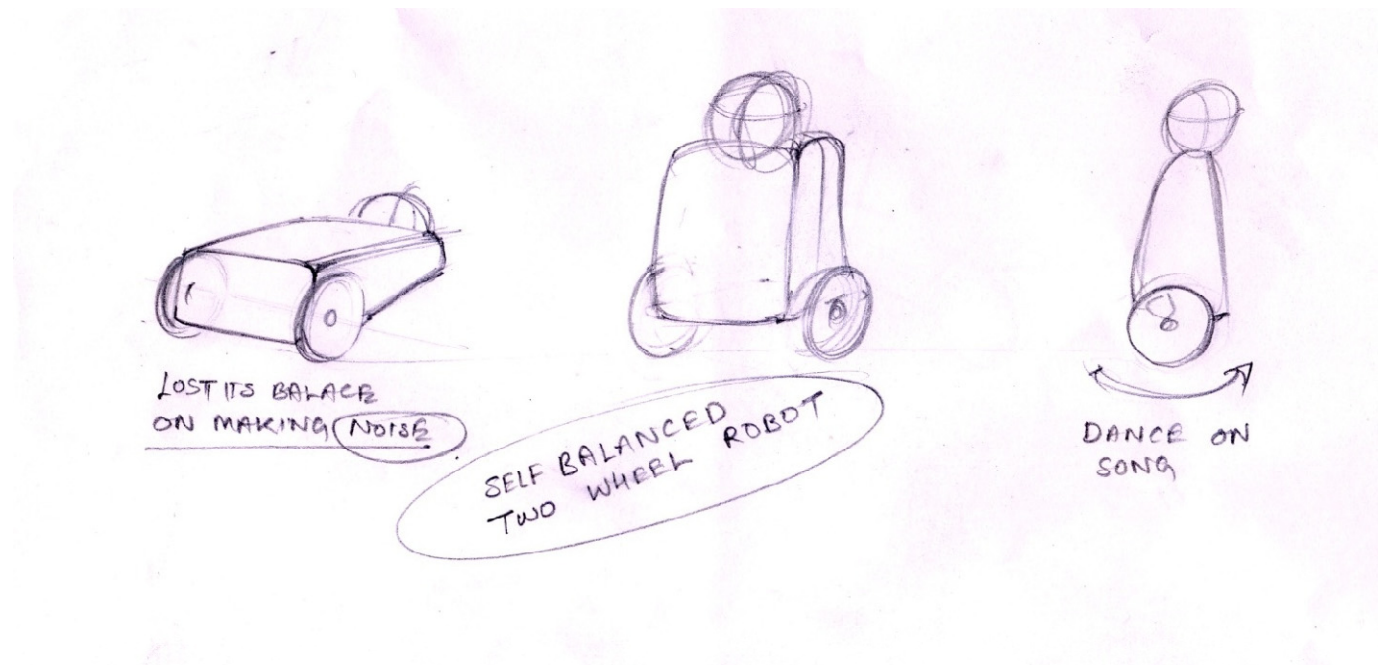


IDEATION

12

Interactive way to tell the difference
b/w noise & music

Two-wheel balancing robot will be inactive, when children will make a noise. In normal condition robot will be active & balanced on its wheels. In case of music it will dance. Children will learn the difference b/w noise & music from such fun loving interactive toy.



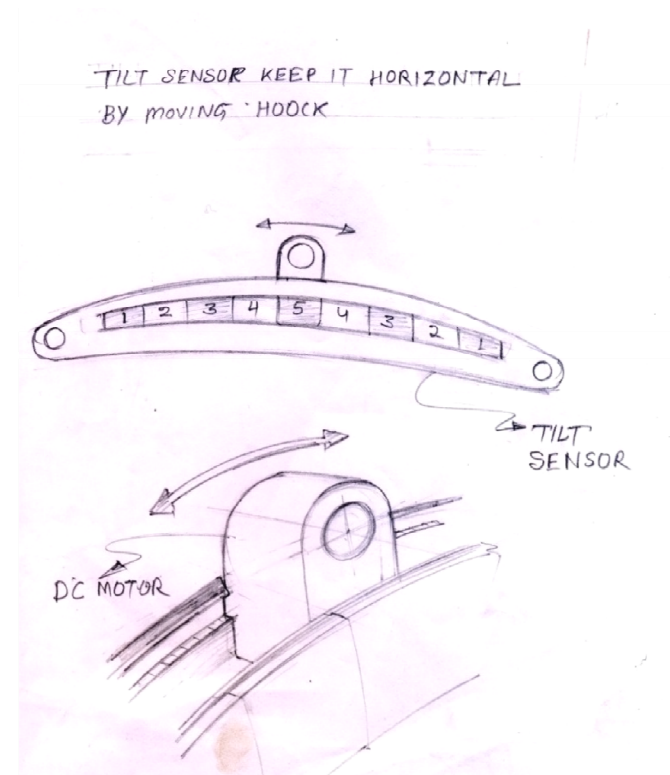
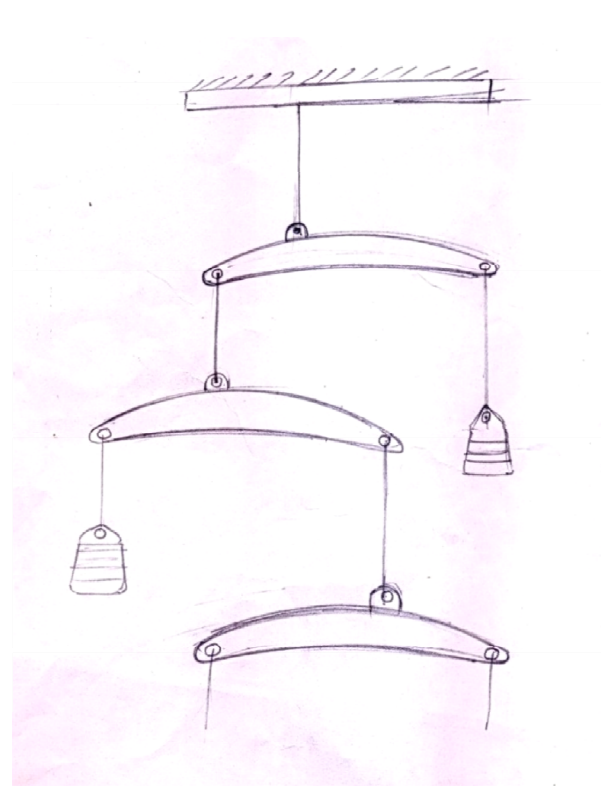
IDEATION

13

Funda. of balance & fulcrum

Every leaf will have a tilt sensor & a stepper motor to move the hook on its top periphery. Children will make the arrangement as shown in the fig. Hanging of one more leaf will reposition the hooks of all leaves..

If they will try to get 5 which is in middle, another leaf may shift towards lower value. So it will be challenge to them to get highest score which will be addition of numbers on all leaves in the arrangement.



IDEATION

Evaluation on the basis of :

“Why are robotic toys more fascinating than simple mechanism toys ? “

Humanoid kind interaction (intelligence)

Mechatronics form with fantasy

Power of controlling / programming

Ideation		7	Humanoid kind interaction (intelligence) Power of controlling / programming
1	Power of controlling / programming	8	Power of controlling / programming
2	Mechatronics form with fantasy Power of controlling / programming	9	Power of controlling / programming Humanoid kind interaction (intelligence)
3	<i>No use of robotics</i>	10	Humanoid kind interaction (intelligence)
4	Humanoid kind interaction (intelligence) Mechatronics form with fantasy	11	Humanoid kind interaction (intelligence)
5	Humanoid kind interaction (intelligence) Mechatronics form with fantasy	12	Humanoid kind interaction (intelligence)
6	Humanoid kind interaction (intelligence)	13	Humanoid kind interaction (intelligence)

IDEATION

Analysis

As from evaluation chart none of the ideas is having all robotic characteristics to grab the children's interest. But out of these, two characteristics:

Power of controlling / programming
Humanoid kind interaction (intelligence)

which are unique and essential to take the advantage of robotics also to create the required interest.

So, 7th & 9th ideas are selected which are to teach -
'Reflection & Straight Propagation of Light' &
'Difference between Velocity and Speed'.

In this journey, as we move ahead things become clear and vagueness is gone. In most of the ideas of the last stage, there is a kit for a robotic educational activity and this kit (whole assembly) can be categorized as:

Main robotic character (robot)

Complementary path to move on (downplay track)

Wireless remote control to drive

Programming interface

Other supplementary components

It is also important that which part (any of above) is playing main roll in conduction of focused education. In selected ideas education is being conducted as in following manner:

7th through *Main robotic character (robot)*

9th through *Wireless remote control*

IDEATION

An activity with 'Wireless Remote Control' has some advantages over other ideas:

- It gives more Degree of Interaction.
- Zoom Factor - offers more opportunity to involve the children in activities .
- It's Real Time Feedback offers new type of User Experience to the Child.
- It reduces boredom through active participation.

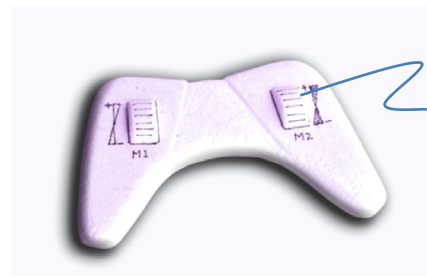
So, the potential within the 9th idea was taken to go ahead in the project and some of the best aspects of the other ideas were assimilated in it for value addition

IDEATION

Education Through Interaction of Remote Control Interface

Education will be conducted through interaction of remote control of robotic cart. So, there will be various remotes which will have certain kind of interaction to control a robotic toy cart. Each remote interface has particular way of controlling the cart, through which children will learn associated science phenomenon. Like :

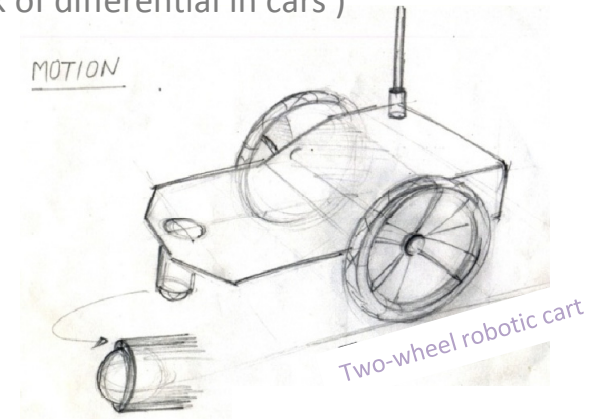
- What happens, if a cart turn left / right (Work of differential in cars)



Two scroll wheel-type speed controllers

This remote has two separate scroll wheel-type speed controllers which can be moved forward and backward in direction to move two wheels of robot separately.

By using such kit children can have some fun loving & educational activities, for example: To move the cart straight to reach point to point in minimum time. And these can become game by defining set of rules their own and on.



From such kind of interaction of remote, children will have experiential learning of how speed of both wheel has to be maintained for diff. motion as linear motion, circular motion of diff. radius.

IDEATION

- Difference b/w Velocity & Speed

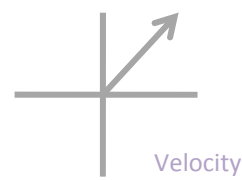
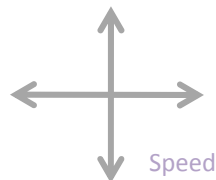


Velocity

Speed

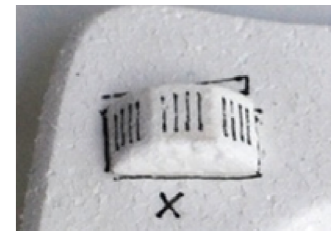
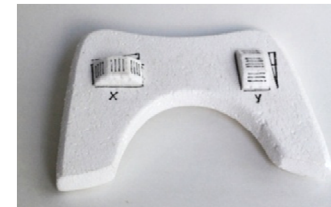
There will be two separate remotes for velocity and speed. Speed remote has four navigation buttons for forward, backward, left & right direction and one knob for speed value. Remote interacts in such a way that user feels that direction from navigation buttons and speed value is nothing itself. Both are being used simultaneously to move the car.

On the other hand, velocity remote will have the rotating knob with positive and negative value for forward and backward direction with the value of speed. Velocity knob reflects the vector behavior of velocity. Resulting movements of robotic cart in both cases are also different. From Speed remote cart can be driven only in orthogonal directions.



- 2D Co-ordinate system

This remote has two octagonal regulating type cyclic keys which are to be used in moving the robotic cart in orthogonal directions. For indicating it, the keys are also in orthogonal direction on the remote.



It works on relative coordinate system. What ever is your orientation to view the cart, if you wants to move the cart, 3 units in +ve direction of X and 4 units in -ve direction of Y, both keys will have to be rotated in steps accordingly.

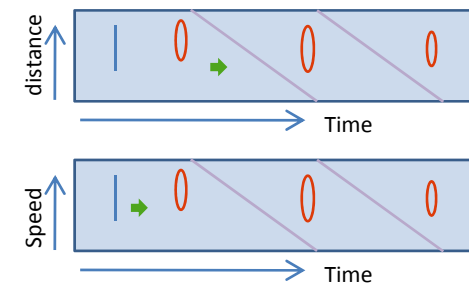
By using this kind of interface children will get experiential learning of 2D co-ordinate system

IDEATION

- Distance -Time relation & Speed -Time relation



This is a general 4 channel RC remote of a robotic toy car. Apart from having turning control & speed up buttons, there is a LCD screen on the top of the remote. It can be used to display Distance -Time relation or Speed -Time relation with the instant feed back from robotic cart, moving on the ground. Children can learn co relation of distance, speed, time and acceleration.



Height of pointer will represent the instant value of Distance or Speed from cart.

IDEATION

Analysis / Evaluation

This concept, '*Education Through Interaction Of Remote Control Interface*' is good enough in terms of 'play value & learning values of experiencing science' but not able to convey phenomenon of robotics itself.

Targeted user is in the age where robotics is just introduced as an application of electronic science. The basic definition is needed here which can be helpful to identify the robotics among the vast realm of electronics, that is "ability to be programmable and ability of taking self decision accordingly".

RC system is also the part of robotics and still these two characteristics occurs but at the level of internal mechanism only. which is difficult for targeted user to understand due to instant controlling nature of RC system, unlike Programming inter face Control.

So, for such enumerable reasons, here we will have to go with the '*Education Through Interaction With Programming Interface*'.

For the further ideation, area of teaching is narrow down into some certain topics so that complexity order in teaching and right discrimination of topics could take place. It will help children in understanding the concept deeply and precisely (right amount in right order) and by considering *Complexity Order* we can hold the interest of wide range of user who are not very specific in terms of grade and age.

So, in this way "**Motion**" is the subject in focus.

IDEATION

Education Through Interaction with Programming Interface

Topics in Focus

Definition of speed

Co-relation between speed, distance and time

Straight line motion & curved line motion

Basic work of “differential” in motorcar

Difference between Speed and Velocity

Acceleration

IDEATION

Speed — Distance travelled per unit time.
It is the scalar quantity that is the magnitude of velocity.

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

Velocity — Rate of change of position.
— Rate and Direction of the change in the position of an object.
— Speed + Direction

1. What is speed in a moving object
2. co-relation between speed, distance & time
3. speed is the distance travelled in one sec.
4. Difference between speed & velocity.
(speed is a scalar of velocity)
5. How to measure the velocity if it is vector —

Straight line Motion —

- * measurement of distance (by speed & velocity)
- * Distance vs Displacement

↓

Total path covered by an object = change of position = magnitude of displacement + Direction

— change in the numerical value of position w.r.t. initial value
— shortest distance between initial & final positions

Total Distance = 50m and time = 100s
Total Displacement = 30m in 100s and magnitude of displacement

Circular Motion —

- * measurement of distance (by speed & velocity)

On a complete circle, displacement is zero and distance covered = $2\pi r$

Use $\frac{2\pi r}{t}$
 $v = \frac{2\pi r}{t}$

1. New method of measurement of length
(some time they can measure time also —)
→ Through $u = \frac{s}{t}$?
(common part of confusion)
2. Understanding of units
3. Difference between Total distance covered & magnitude of displacement
4. measurement of displacement
5. Resultant direction
6. angular speed ? (r.p.m.) which is independent of r
7. Measurement of distance and displacement on circular track.

$$\text{Average speed} = \frac{\text{Total distance covered}}{\text{Total time}}$$

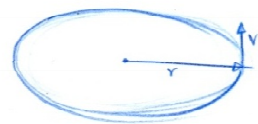
$$\text{Average velocity} = \frac{\text{Displacement}}{\text{total time}}$$

1. Why do we need to know average speed or average velocity?

2. average speed ? (understanding of word "Average")

3. How average velocity is different from average speed

4.



When a body moves in a circle
Its speed is constant (Linear)

but its velocity is changing continuously because of change of direction
then average velocity will be zero

⑤ Difference of angular speed & Linear speed

What is to be taught ?

What is speed in a moving object.

Its co-relation with distance & time

Difference between Speed and Velocity

How to measure the velocity, if it is a vector term..

New method of measurement of length (by using speed and time/speed, time etc.)

Difference between 'total distance covered' and 'magnitude of displacement'

Measurement of displacement

What happens when a car turns

Why do we need to know Average Speed or Average Velocity

Average speed (understanding the word 'average')

IDEATION

What else needs to be considered?

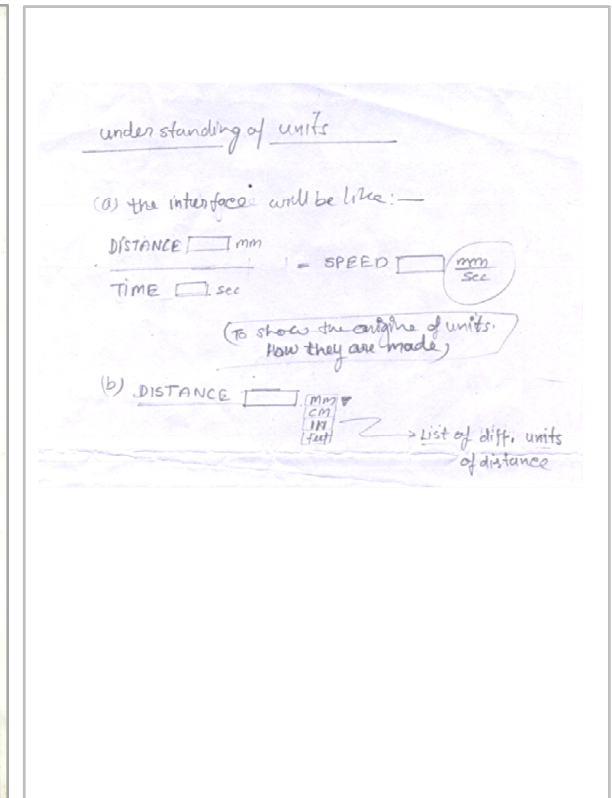
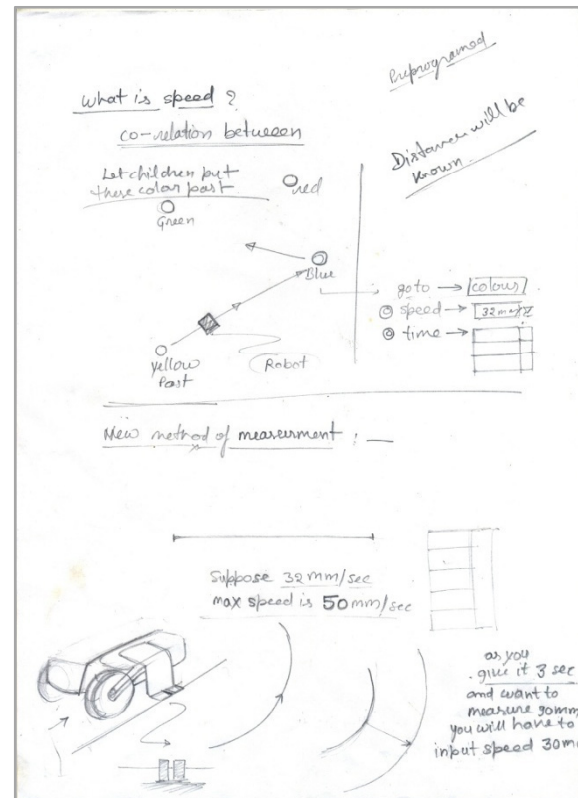
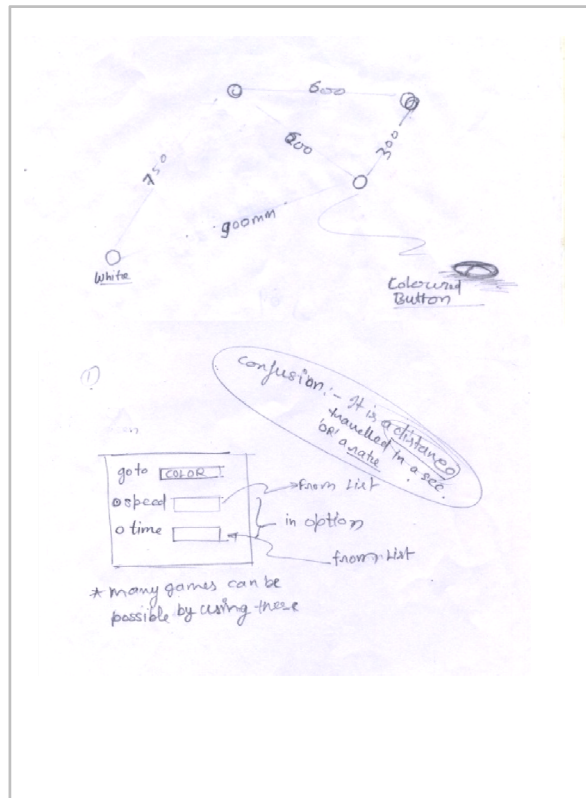
There are no specific age and grade of user. He / she can be of any age between 11 to 15 years old, and from any grade between 6th to 9th . So structure of the concept should be in such a way that any one of targeted user group could start the activity with his level of intellectuality .

There will be a robotic game kit which contains a robot and some supplementary components. The robot will be re-configurable and it could be programmed through a GUI on computer to perform some educational games. Topic covered by these games are in series of order of teaching .

Now, education conduction will be happened through *Interaction With Programming Interface* , but rest of the kit must also be taking participation in conduction of other tacit education. In this perspective we can take benefits from running robot on the ground, which associates the practical experience of science fundamentals.

IDEATION

What is speed in a moving object? And Its correlation with distance & time.



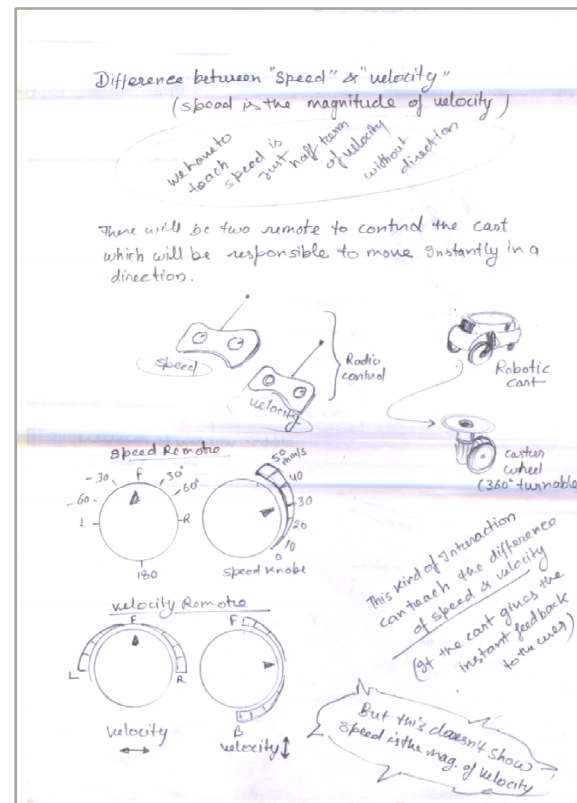
$$\text{Speed} = \text{Distance} / \text{Time}$$

Unit of Speed

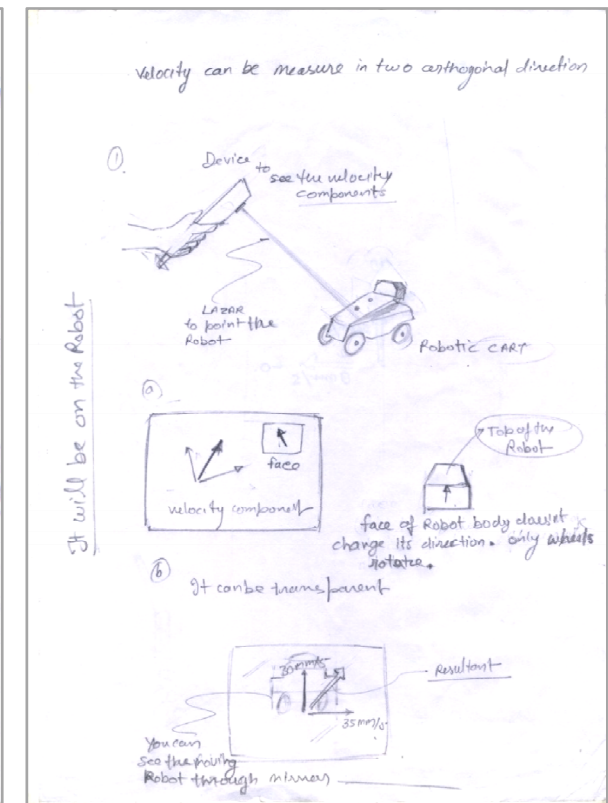
IDEATION

Difference between Speed and Velocity

How to measure the velocity, if it is a vector term..



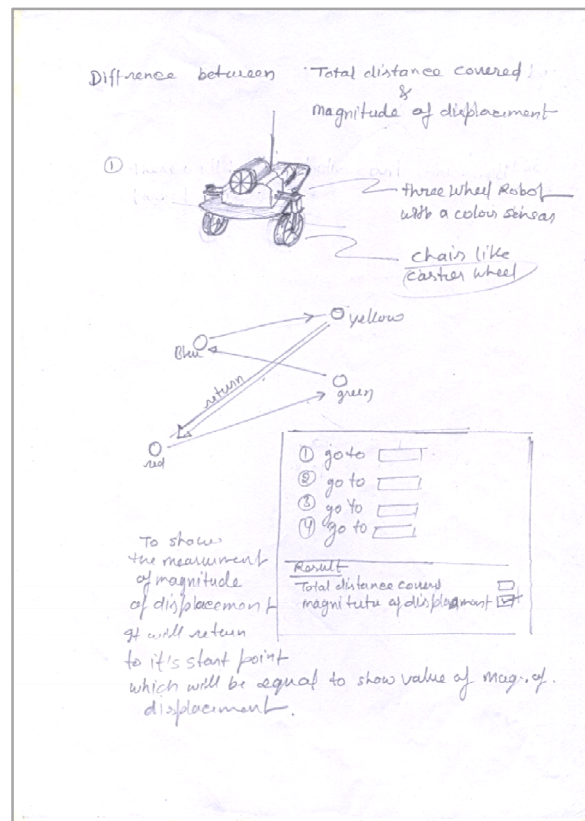
Velocity = Speed + Direction



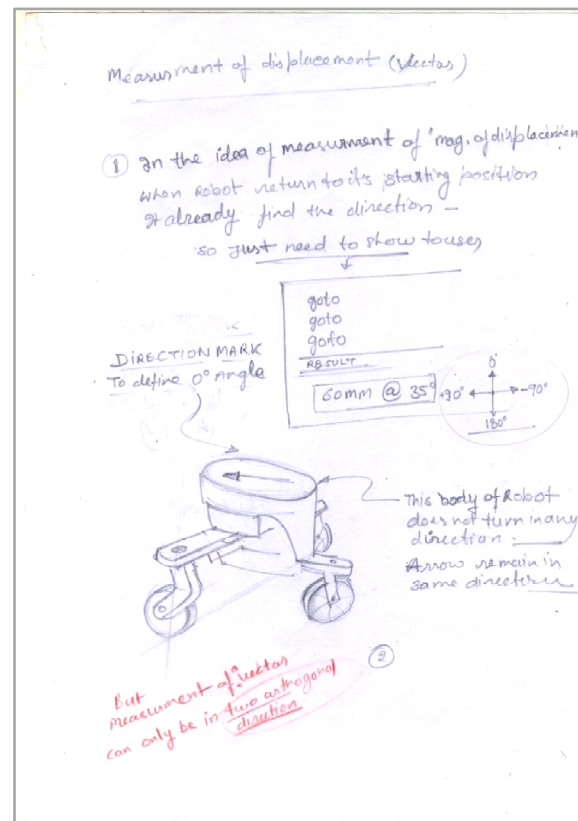
Measurement of velocity in two orthogonal direction

IDEATION

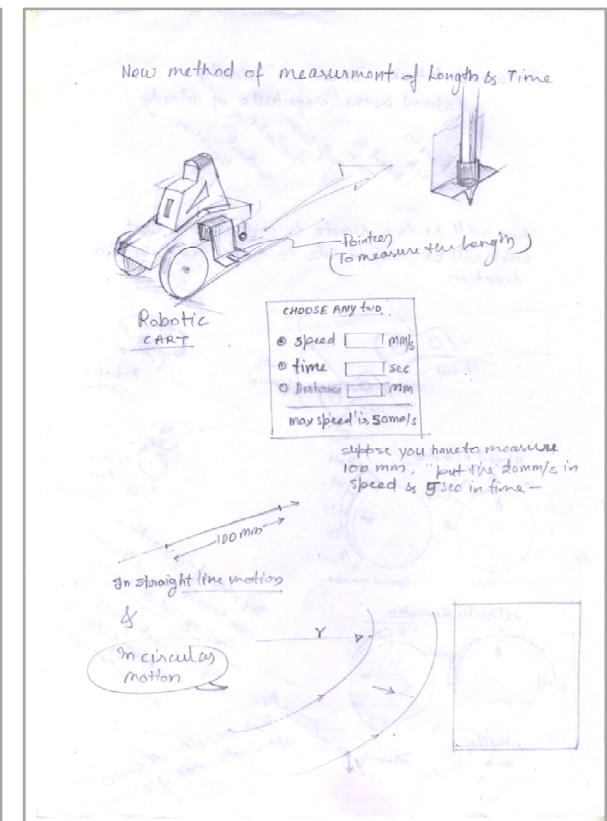
Difference between 'total distance covered' and 'magnitude of displacement'



Difference between 'total distance covered' and 'magnitude of displacement'



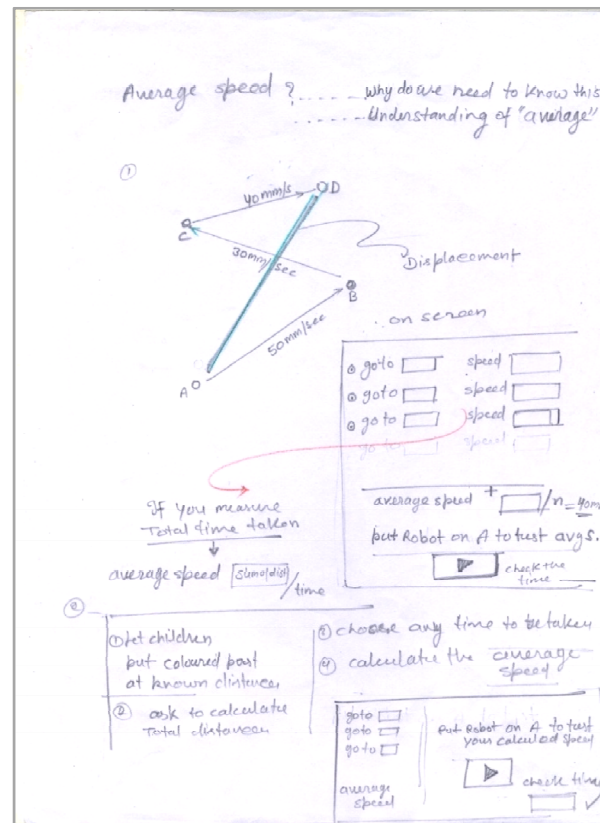
Measurement of displacement



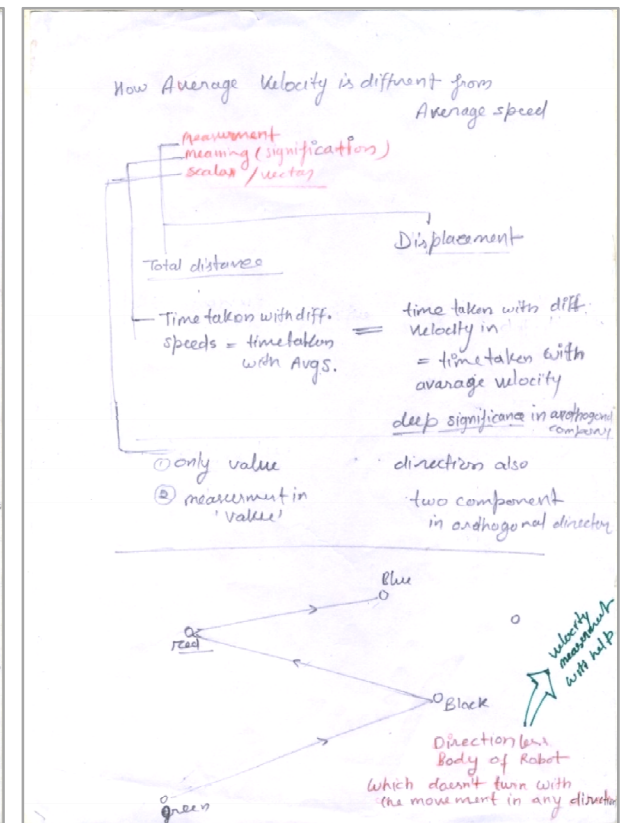
New method of measurement of length (by using speed and time/speed, time etc.)

IDEATION

Average speed (understanding the word 'average')



Why do we need to know Average Speed or Average Velocity?



Difference between Average Speed and Average Velocity

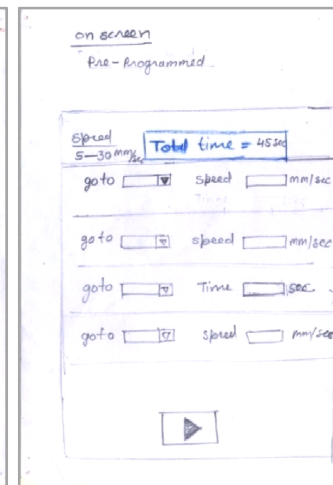
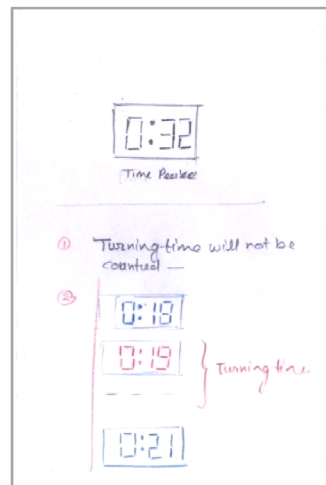
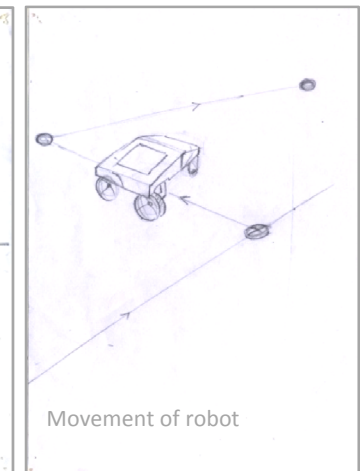
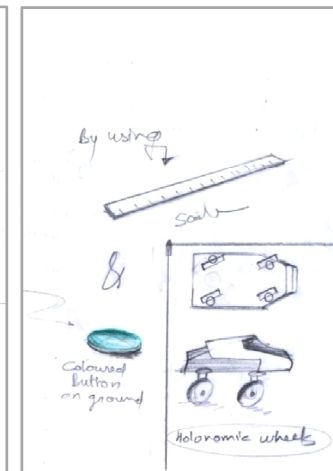
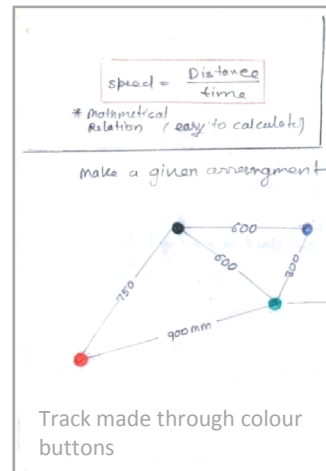
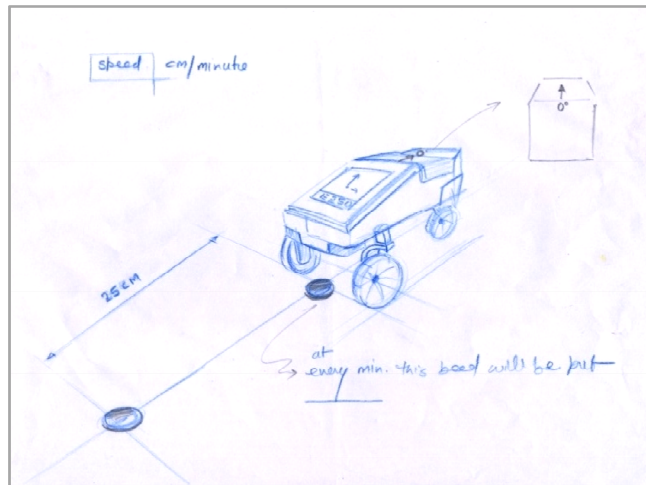
IDEATION

Evolution of Ideas

On the basis of degree of play factor, Some potential ideas were refined till next stage

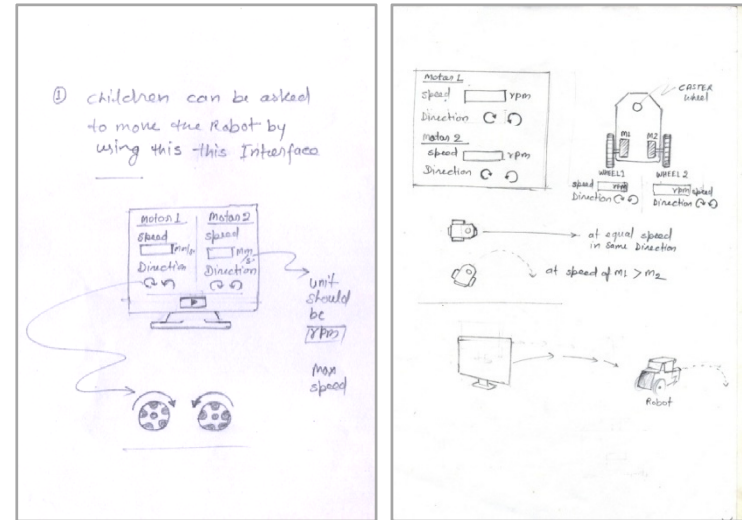
To learn co-relation b/w speed, distance and time, there will be a game on computer, result of which will lead to generate instructions to be performed by robot on the ground. (more detailing of the game)

Some more details of New Method of Length Measurement

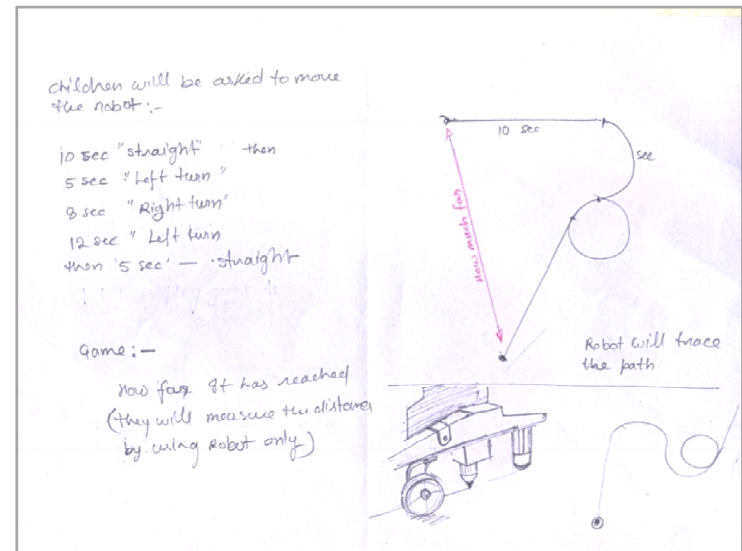
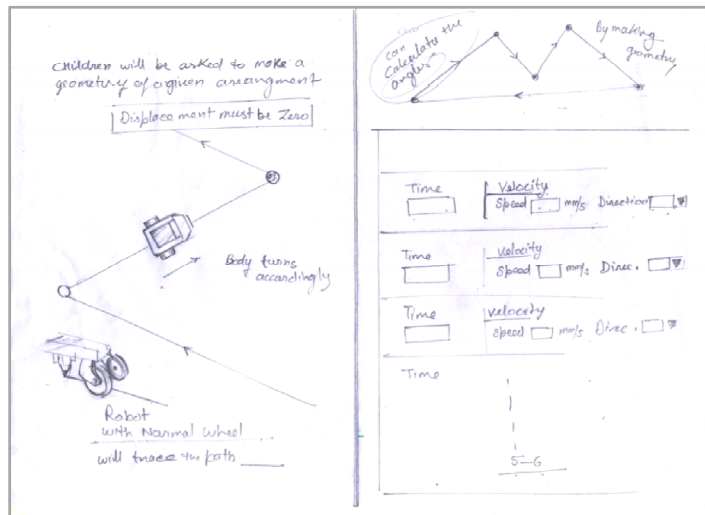


IDEATION

Evolution stages for the idea of teaching 'what happens with the speed of two wheels when a car turns'

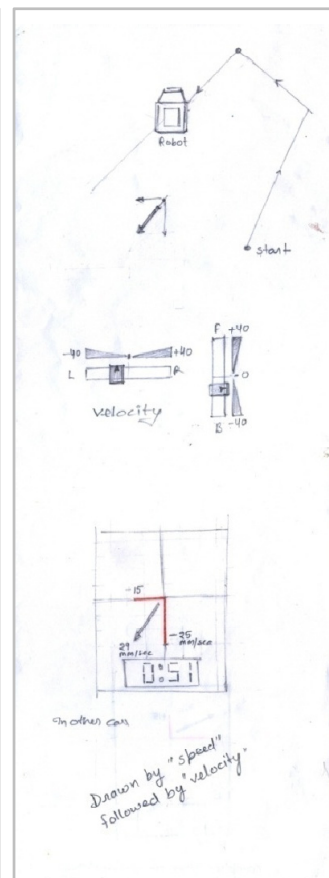
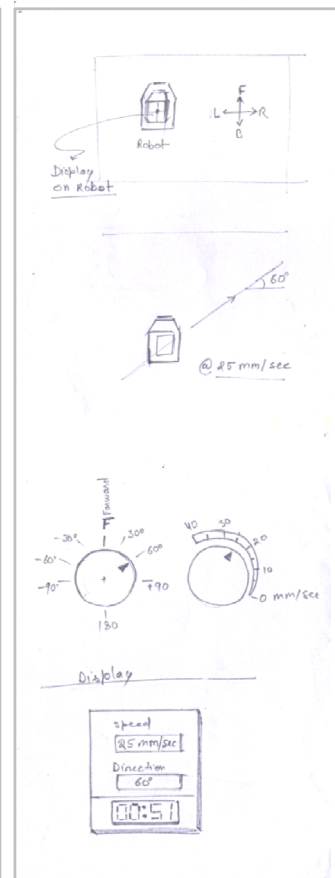
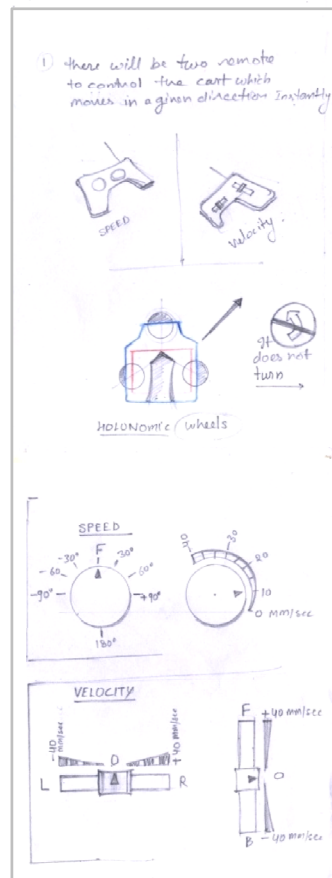


Solution of issue of inputting direction (absolute and relative) is evolved for the game to teach velocity.

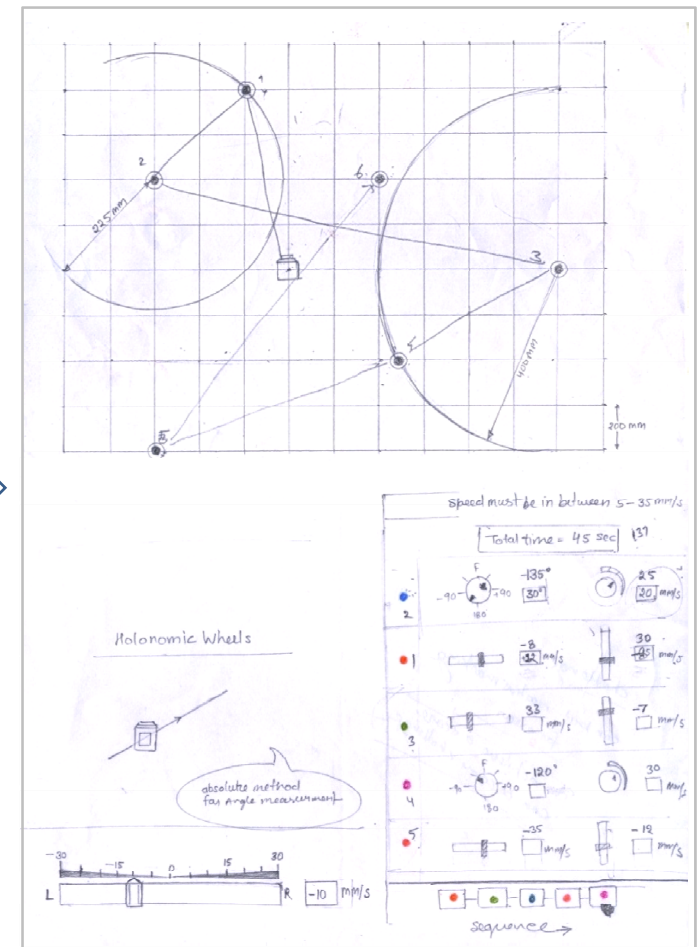


IDEATION

In earlier idea, which was having two separate remotes for speed and velocity, knob and slider kind of buttons are used for speed and velocity respectively as an improved interaction. And this is implemented in screen interface



Game to teach the same



IDEATION

Selected Ideas

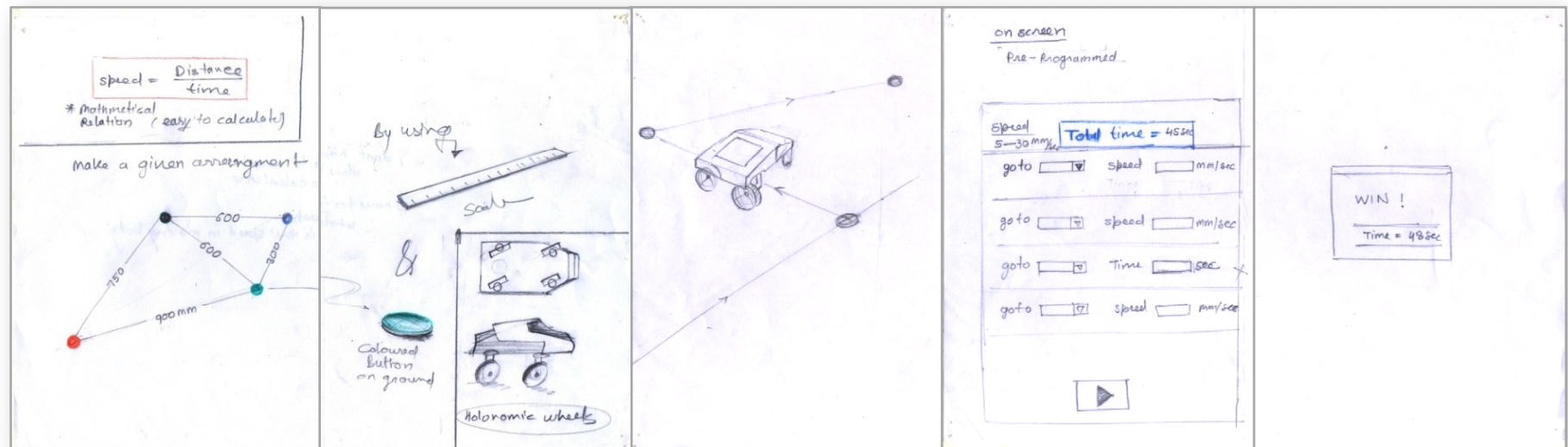
Three ideas are selected to teach three topics like:

Speed

Velocity

Difference between Speed & Velocity

These are co-related topics in sequence of complicity order in understanding. So, these all are taken together to make a concept of three individual games. Now if a child has finished knowing about Velocity, he can move on to 'Difference between Speed & Velocity'.

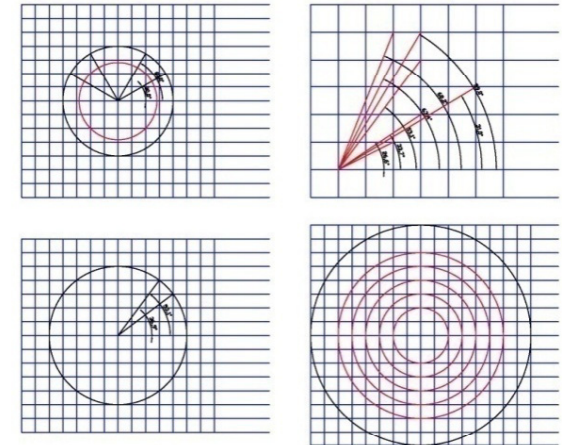


1. What is speed in a moving object and Its co-relation with distance & time

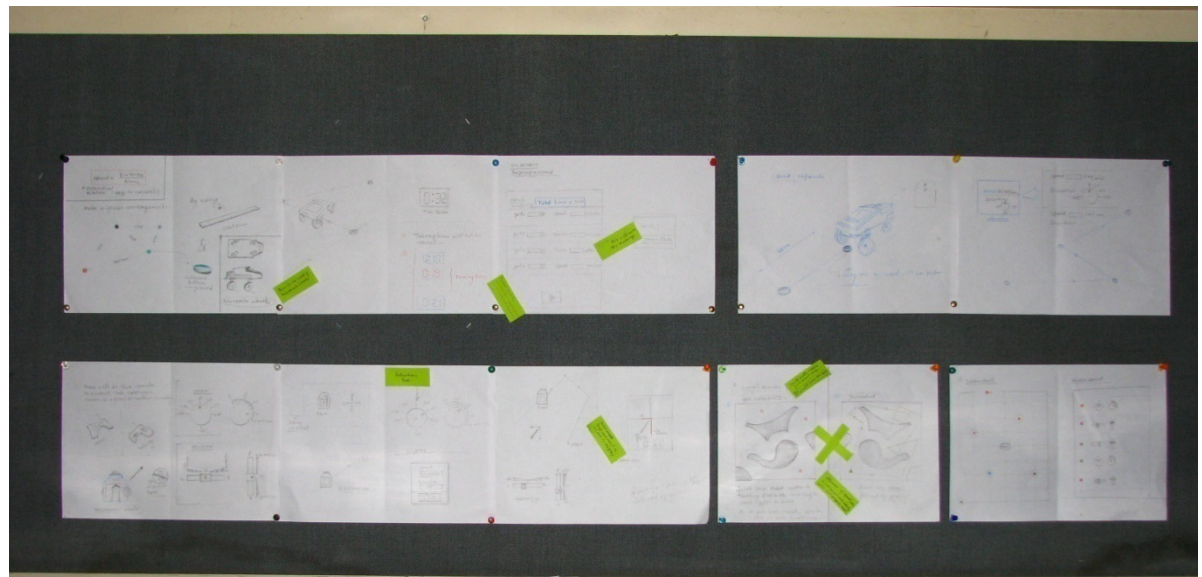
IDEATION

Debugging

To find out certain
point on a circle within
a particular grid



Refinements
Against chances of failure
to enhance the play values



GAME CONCEPT

There is a robotic game kit which contains a robot and some supplementary components. The robot is re-configurable and it can be programmed through a GUI on computer to perform some educational games. Topic covered by these games are in series of order of teaching .

GAME CONCEPT

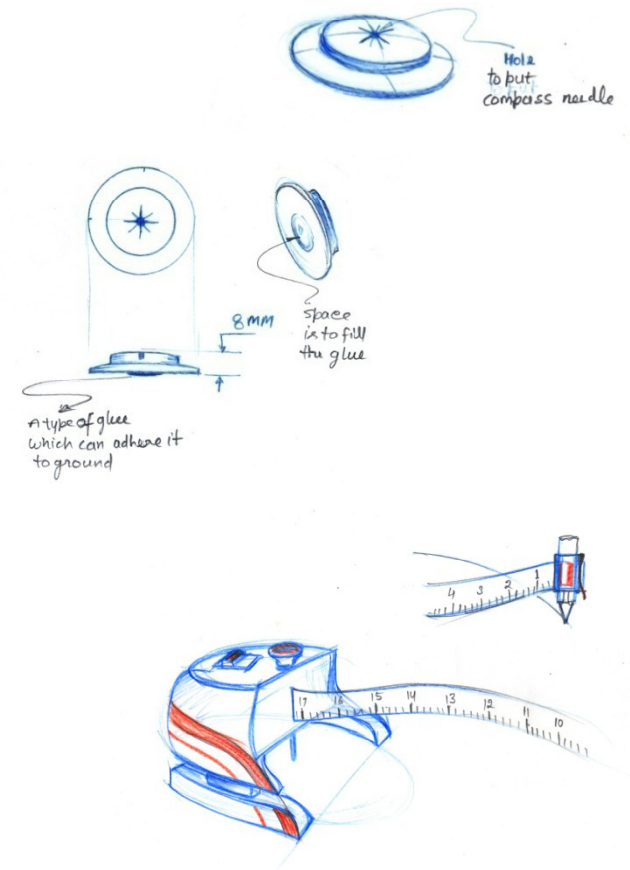
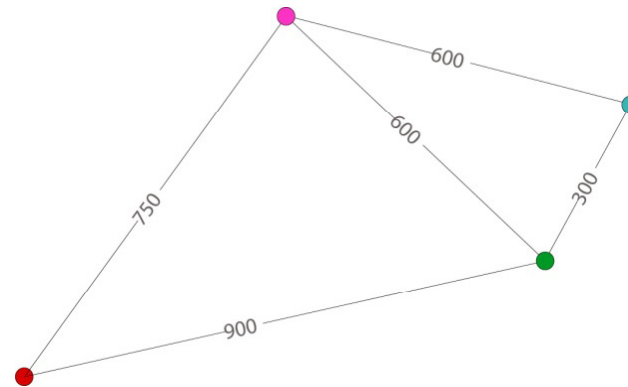
Game 1

No. of players : one

Name of game : speed

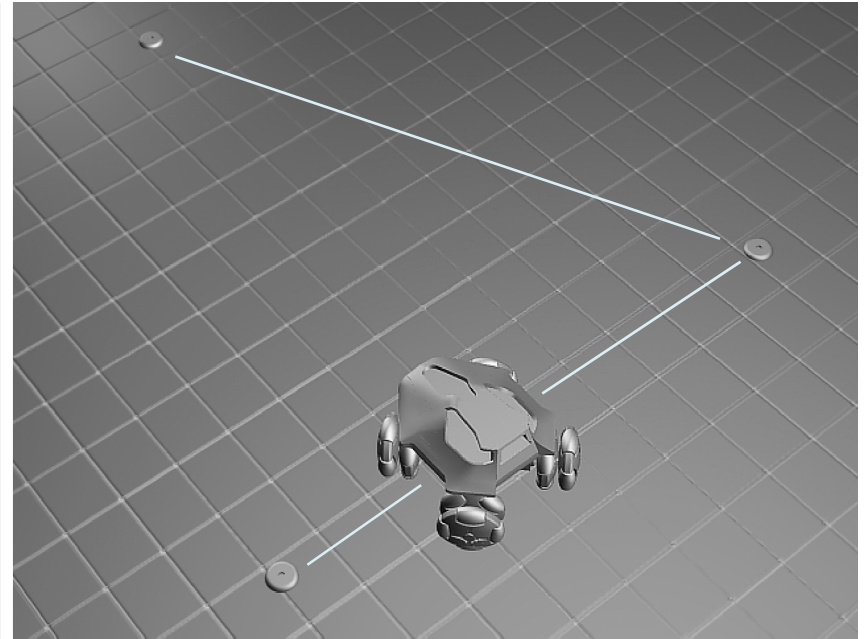
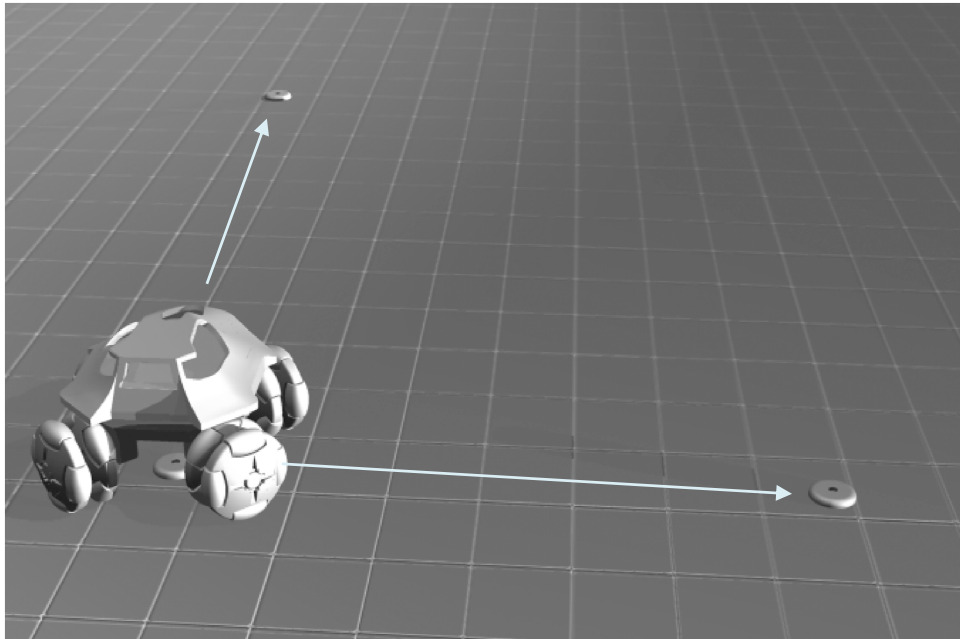
How to play

A set of some colored buttons, measuring tape & a compass will be given to the player to make a proposed path geometry on the floor by putting the buttons on the desired nodes. They can try more geometrical paths, available with certain target time for each.



GAME CONCEPT

Now, player has to put the robot over any of the buttons. Robot will automatically adjust to correct its position w.r.t. the colored button.



GAME CONCEPT

On the screen, there is corresponding time target displayed on the top. And this time has to be distributed among the given no. of segments of the path. Child has to choose the colors in a sequence where robot has to reach with a desired speed. Which means, how much time will be spent in each segment within the limitation of speed so that total time can meet the target .

The screenshot shows a game interface with a grey background. At the top, a box labeled "TOTAL TIME" displays "45 sec". Below this, a text instruction states "Speed must be in between 5 – 35 mm/sec". There are four identical rows for segment control. Each row starts with "Go to" followed by a dropdown menu currently showing "color". To the right of each dropdown is a "Speed" label and a text input field, followed by "mm/sec". At the bottom center is a large blue button with a white right-pointing triangle and the word "RUN" inside.

During run time, a time piece on the top of the robot will display time taken in individual segment journey .

Score of the game:

Score will be collected from individual segments. If player reaches exact on time at selected color, will get 10 points . On delay or fast of 1-2 sec, he will get 8 points. On delay or fast of 3-5 sec, he will get 5 points. On delay or fast of >5 sec, he will get 0 point.

GAME CONCEPT

Play values (Game analysis) :

Game strategy must encourage them to learn.	YY	Strategy to adjust the time in different segment to meet the target, encourages to find suitable speed for each segment.
Ability to attract the repeat play	YY	Sequence of adjustment of time followed by individuals are different. If player could not achieve the targeted Total Time.
Maintaining uncertainty	YYY	Multiple tracks are given and one track can have N no. of solutions. It creates enough degree of uncertainty in the game. Children of this age group will be able to make their own track after spending sometime with it .
Balance of luck & strategy	YY	Here, strategy is more than luck. If certain time will be given to complete the game, luck factor will be there. From which color does the player starts moving the robot, will affect the winning.
Quick and easy learning	YY	GUI for game is clear to be informative. Sequence of asking for data inputting, guides to player to do desired task, will encourage learning through out the process smoothly and automatically.
Ability to hold interest for long time.	YY	Uncertainty factor works for it. Game has lot of interesting things like marking on the ground, measuring, putting colour buttons, setting of robot, movement with intelligent behave of robot. Playing the game, calculations, performance etc.
Possibility of player becoming an expert with practice, intellect or both.	YYY	After playing multiple times they will become skilled in finding the suitable speed by calculating faster.

Learning

Science Education :

What is speed in a moving object And Its co-relation with distance & time

Tacit learning :

Fast calculation

Measurements

To trace the geometry

Knowledge of handling robot

Perceiving of effect of sensors

GAME CONCEPT

Game 2

No. of players : one

Name of game : velocity

How to play

This game also has real physical activity with the robot by using 'computer preprogramming control' on the screen. – Which means user will interact with combined model of physical and digital, whatever input he will be giving on digital interface, output result will be the movement of a robot on the floor. This will resemble the characteristic of a robot.

The kit of this game includes a set of grid papers which are given to the player. He will be asked to draw a close circuit (closed path) on it by using his geometric tools. The path should have

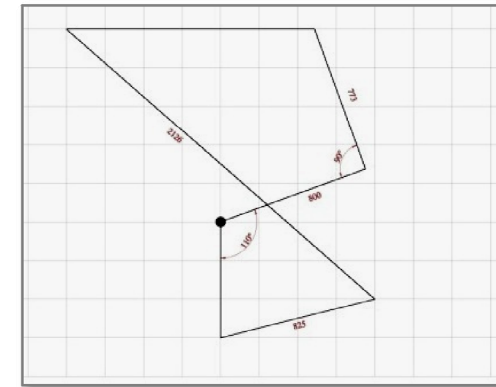
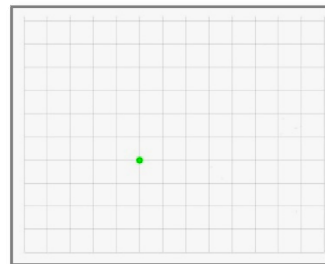
5 no. of straight segments

zero displacement

max. length of each segment = 100 cm

min. length of each segment = 15 cm

Blank
Grid paper



In the starting of game children will be taught basic theory regarding speed, velocity, displacement etc.

If they face any difficulty to make the circuit, they can see some ready made circuits in help menu.

To play this game child has to measure the relative angle also. Means with the reference of previous angle

GAME CONCEPT

Now he has to make a mark on the ground to put the robot on it. For each segment time is always constant, that is 30 sec. and now on screen, he has to input the velocity for each segment in sequence (in terms of Speed and direction)

Speed must be in between 5 – 35 mm/sec

TIME FOR EVERY SEGMENTS
30 sec

Measurement of angle
+ve -ve

Velocity 1
Speed mm/sec Direction

Velocity 2
Speed mm/sec Direction

Velocity 3
Speed mm/sec Direction

Velocity 4
Speed mm/sec Direction

Velocity 5
Speed mm/sec Direction

RUN

Score of the game

The player has to complete his self made circuit . And if the display of robot shows displacement is zero – he will get 100 marks
if displacement is 1-5 cm , he will get 70 marks.
if displacement is 5-10 cm , he will get 40 marks.
if displacement is >10 cm , he will loose the game.

During run time, path travelled by robot will be tracked on the screen display. Robot LCD display will shows the distance covered in each segment, so that the player can fix the error, if any.

No. of errors direct affect the rewarded score.

Order of complexity

After playing previous game, player is introduced with a little bit more complex game where the direction (in relative angle) has to be inputted with the knowledge of speed.

GAME CONCEPT

Play values (Game analysis) :

Game strategy must encourage them to learn.	YY	In every segment of closed track, player has to input speed and direction to define velocity as a complete term. it clarifies that $velocity = speed + direction$
Ability to attract the repeat play	YY	What ever player draws on the grid paper, robot perform by moving accordingly.
Maintaining uncertainty	YYY	Player has to draw his own track on the Grid paper
Balance of luck & strategy	YY	Here , contribution of luck factor is very less to win the game. Only intellectuality and practice are main factors which is essentially good for such games.
Quick and easy learning	YY	GUI for game is clear to be informative which conduct the education. Sequence of asking for data inputting, guides to player to do desired task, which encourage learning through out the process smoothly and automatically.
Ability to hold interest for long time.	YY	Uncertainty factor works for it. Game has lot of interesting things like to get performed by the robot on the track made by the player, measuring angle on a grid, setting of robot, movement with intelligent behave of robot. Playing the game, calculations, performance etc.
Possibility of player becoming an expert with practice, intellect or both.	YYY	After playing multiple times children will become skilled in taking +ve and -ve angles which will be lead by their level of intellect and practice of the game

Learning

Science Education :

Rate and direction of the change in the position of an object, is velocity.

Velocity = Speed + Direction

Tacit learning :

To draw the geometry on grid paper.

Fast calculation.

Measurements of angle in absolute and relative system

Knowledge of handling robot

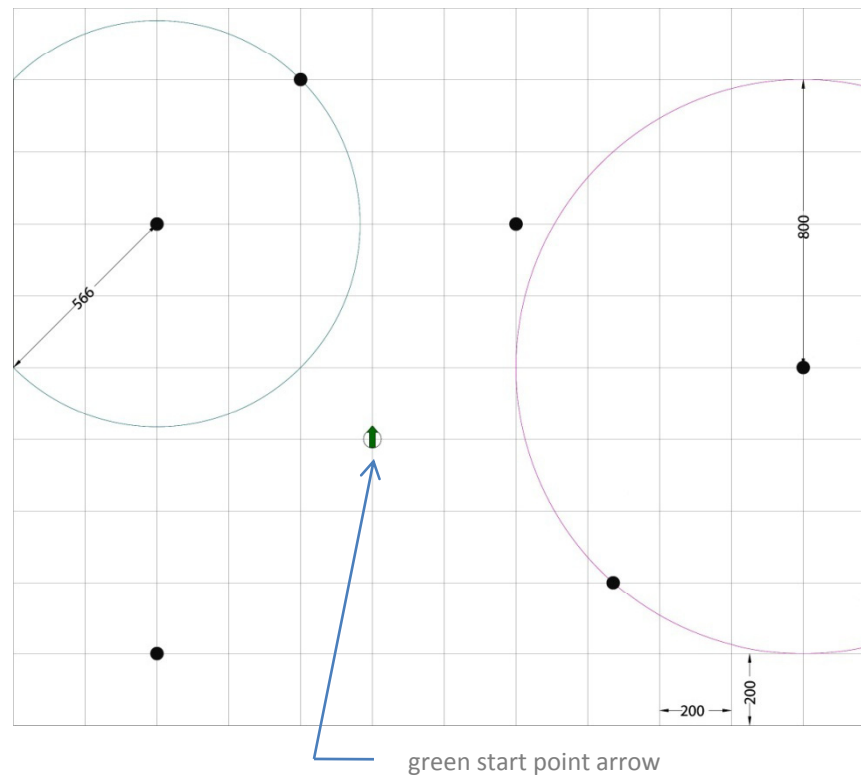
Perceiving of effect of sensors

GAME CONCEPT

Game 3

No. of players : one

Name of game : Difference between velocity and speed



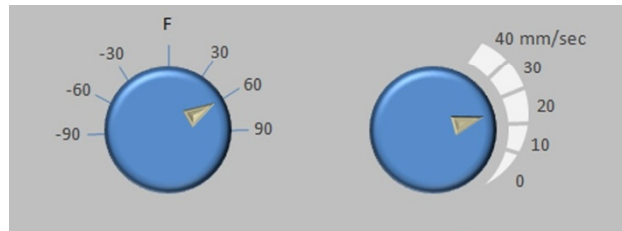
How to play

This game is also played with physical and digital interface. The player will be instructed to open the mat on the floor. It has a grid in the background & some destination dots. Robot is put on the green start point arrow. It is capable to correct its direction along the arrow direction.

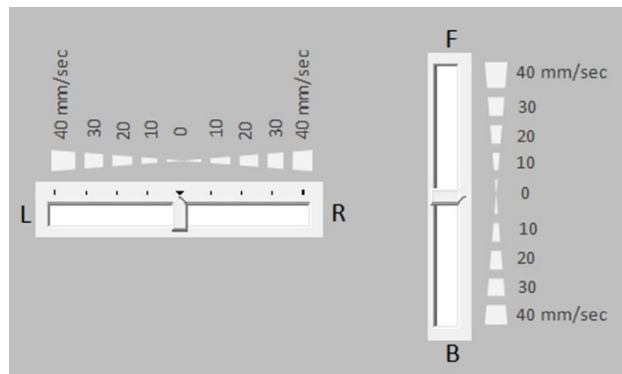
Now, child (the player) will be asked to imagine a path for the movement of robot in 5 steps by joining these black dots.

Input interface has targeted Total Time at its top & has very unique way of inputting the velocity for several segments of the path. For some of the segments, knob type buttons are on the screen to input the velocity in terms of speed and direction. But for some, velocity values has to be inputted in two orthogonal direction by using slider type control buttons.

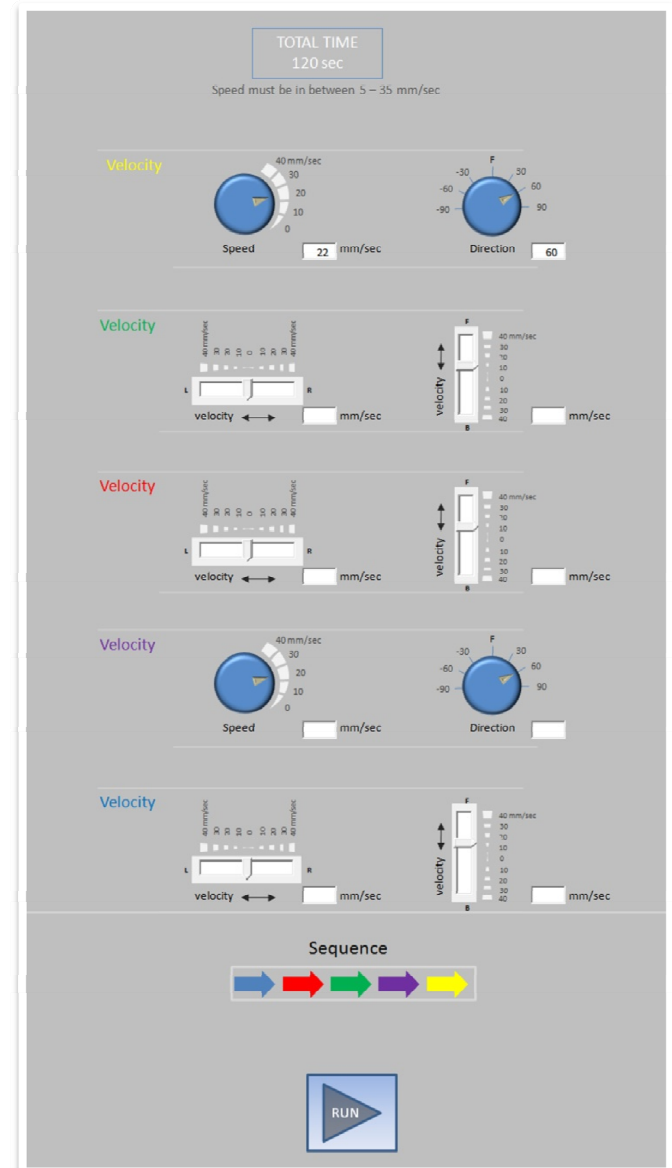
GAME CONCEPT



For where speed and direction are known



For where angle of direction are not known

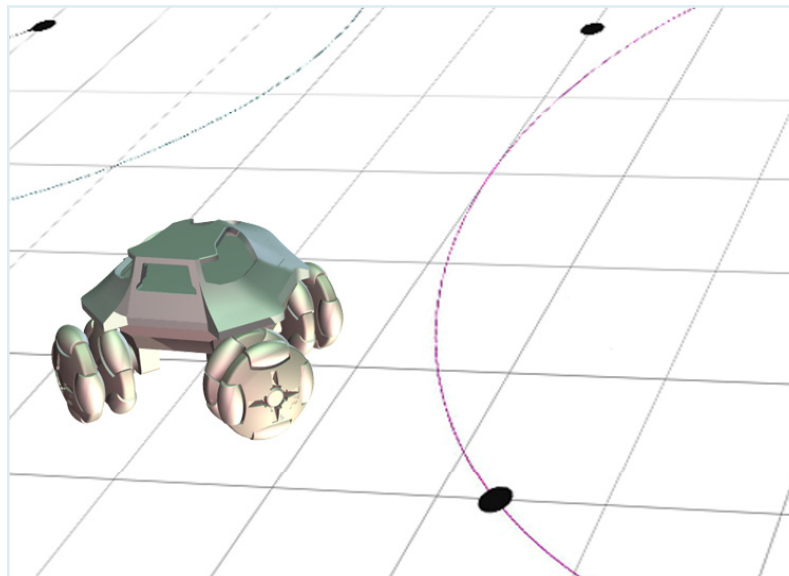


GAME CONCEPT

Already taught formula will help to find these values. Distance can be calculated because of grid in the background. Time taken for each segment is on your choice but to win the game total time should meet the target time which excludes the time taken in turning at the black dot.

LCD of robot will display real time graphical info. of velocity, so that measurement velocity may be easily understandable.

Robot body does not turn while it change the angle of direction. This behavior shows that angle of direction must be measured always from the direction of green arrow of starting point.



Score of the game

Score will be collected from individual segments of the path. If player reaches exact at destination dot, will get 10 points . Otherwise 0 point. (every dot will have a tolerance zone of 2 cm radius)

Order of complexity

If anybody wants to learn 'Difference Between Velocity And Speed' he must be knowing about velocity and speed first. So, this game is suggested to play after playing first two games. If a child is from 9th standard and he has been exposed with terms like speed and velocity for past 2 years, he can play directly game 3 to understand the complexity of Difference between Speed as a non-vector and Velocity as a vector term.

Similarly complexity level in interaction or difficulty level of the game goes up with the series of these.

GAME CONCEPT

Play values (Game analysis) :

Game strategy must encourage them to learn.	YY	When the player feels that he is not able to find the accurate direction without measuring from the mat. He has to use orthogonal velocities method.
Ability to attract the repeat play	YY	What ever player feeds the sequence on screen, robot performs by moving accordingly. It is different every time.
Maintaining uncertainty	YYY	Hundreds of track can be possible on the mat which gives some degree of uncertainty in no. of times it can be played .
Balance of luck & strategy	YY	Here , contribution of luck factor is very less to win the game. Only intellectuality and practice are main factors which is essentially good for such games.
Quick and easy learning	YY	GUI for game is clear to be informative. Sequence of asking for data inputting, guides to player to do desired task, encourage learning through out the process smoothly and automatically.
Ability to hold interest for long time.	YY	Uncertainty factor works for it. Game has lot of interesting things like to get performed by the robot on self made track, measuring angle on a grid, setting of robot, movement with intelligent behave of robot. Playing the game, calculations, performance etc.
Possibility of player becoming an expert with practice, intellect or both.	YYY	After playing multiple times children will become skilled in visualizing , which method can be used for particular segments and they will become expert in resolving velocity vector in two orthogonal directions

Learning

Science Education :

Difference between Speed as a non-vector and Velocity as a vector term

Velocity is always relative (because of direction)

Velocity can be measured in two orthogonal directions

Tacit learning :

Fast calculation

Measurements

Some geometrical fundamentals

Knowledge of handling robot

Perceiving the effect of sensors

ROBOTIC KIT

Objective

Designing of a generic robotic kit which can be used to play not only these three games (which are to teach : Speed, Velocity, Difference b/w Speed & velocity respectively) but also more educational games in future.

ROBOTIC KIT

Components required to be a robotic toy

Requirement according to Games

Game 1	Qty.	Game 2	Qty.	Game 3	Qt
Microprocessor	1	Microprocessor	1	Microprocessor	1
Power sources	1	Power sources	1	Power sources	1
LCD display	1	LCD display	1	LCD display	1
Omni directional transmission	1	Omni directional transmission	1	Omni directional transmission	1
Colour detector	1	Obstacle detector	1	Colour detector	1
Obstacle detector	1	Base frame	1	Obstacle detector	1
Base frame	1			Base frame	1

In the phase of designing of a generic robot (product in focus), Some components are being considered to be detachable to enhance the value of the product. Because of some reasons:

This makes it flexible to be used for another games which will be developed for the next version to teach some other topics.

This will be the right judgment with robotic kit considering it for upper middle class.

Students of this age group can learn assembly of the components in desired manner and programming of that accordingly.

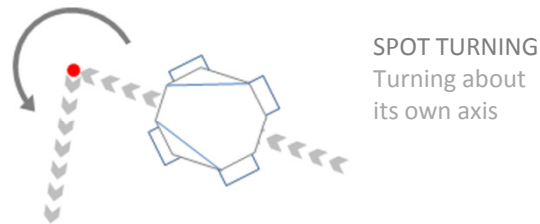
Here, the meaning of 'detachable' is that the part can be replaced from another substitute by such a user of age group of 11-15 years.

Required detachable components

TRANSMISSION SYSTEM

For current need only **Omni Directional Transmission** is required because of several purposes:

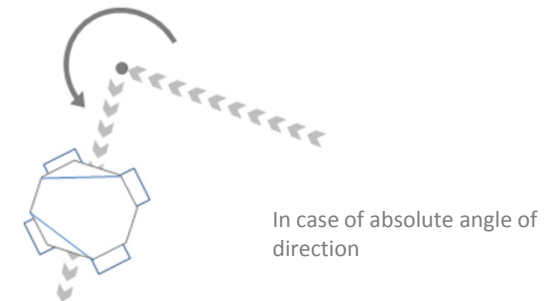
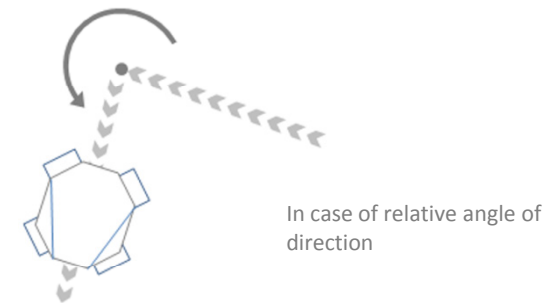
Spot turning (to turn at a position about its axis of center of mass without moving in an arc)



Where the inputted angle of direction is relative, the whole body must turn in the direction to show its meaning to user.

Where the angle of direction is absolute (every time measured from direction of starting), only direction of movement will change without turning body of robot. So that at every turning user can see how much angle is being changed.

But for some other games (to teach other science terms) it can be normal transmission with differential or without differential where each of its wheel have separate driver motor.



ROBOTIC KIT

SENSORS

For such flexible design of the system, it is needed that different sensors must be replaceable.

One sensor like obstacle detector needs to change its position as per different requirements.

POWER SOURCE

Different battery type can be needed to change for different purposes.

PRODUCT BRIEF

Functional requirements

Generic

Reconfigurable

Modular

Easy installable

Spot turning

PRODUCT BRIEF

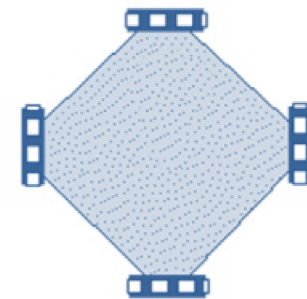
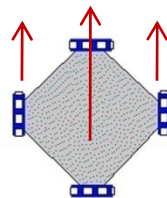
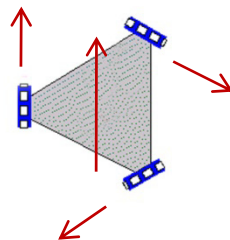
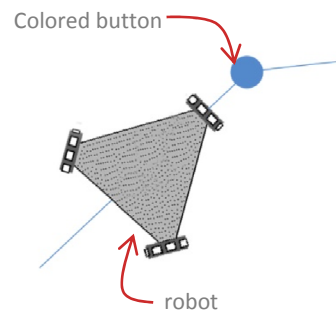
Technology

Required components & features

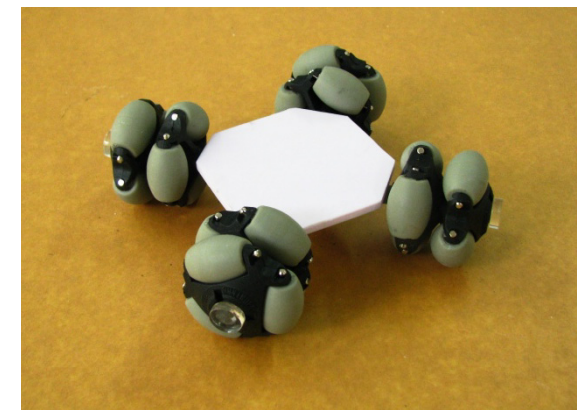
Robotic assembly must be in such a way that whole **transmission system** can be changed as per requirement of any other type transmission and be easy to connect to power source and microprocessor output.

3 transwheels transmission can serve the purpose but in case of 'Game 1' colored button of 8 mm height will create obstruction for one of the transwheels. As shown in fig (left).

With a three wheel design, it is impossible to get 100% efficiency from its wheels. No more than one wheel will ever be aligned with the direction of motion. But with four, two wheels can move at 100% efficiency, while the other two remain idle, for full speed and more efficient motion. All other angles will also be more efficient than with a three-wheeled Omni-wheel robot.



4 Omni-directional transwheels transmission system



PRODUCT BRIEF

Compatibility of base frame of the body with sensors must be in such a way that it allows us to attach and detach different sensors on its peripheral structure without the hurdle of data and power connections.

As there is need to observe 360-degrees around it. Omni directional sensor can solve the purpose. The omni directional sensor is the image sensor that can observe 360-degrees at a time. Surrounding scenery is reflected to the convex mirror, and it takes a picture of the image with the camera upward installed.

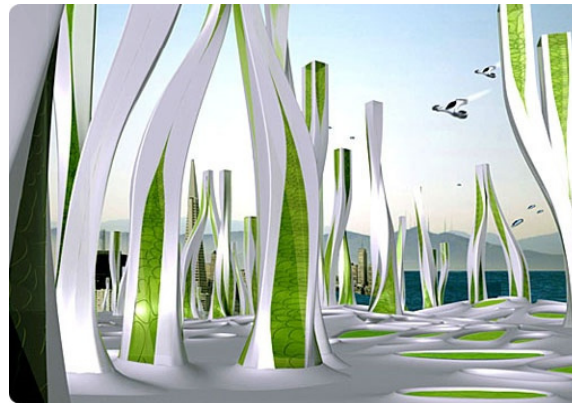
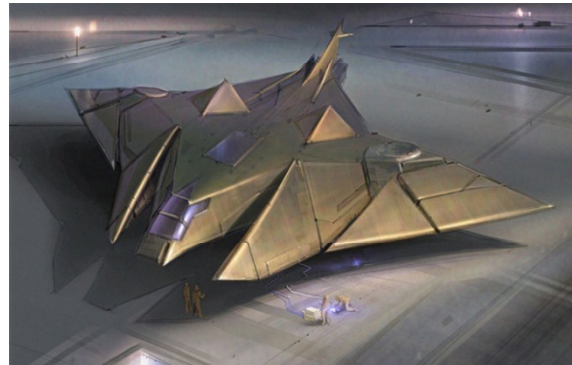
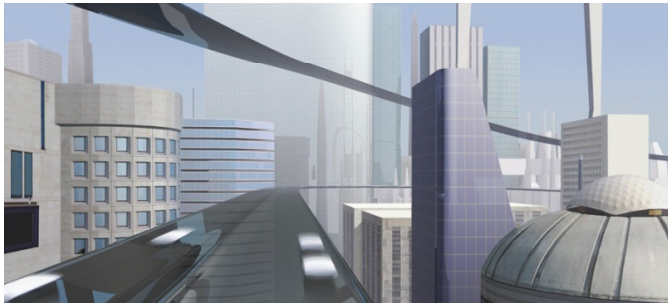
Vertical view is upper side 10-15 degree and lower side about 55 degree.



One LCD display is needed on the top of robot body so that player can see the required parameters to know from any direction. Orientation of LCD could be rotation-able.

PRODUCT BRIEF

Form



Key words to design

Sophisticated

Flashy colour / jazzy

Big / giant size

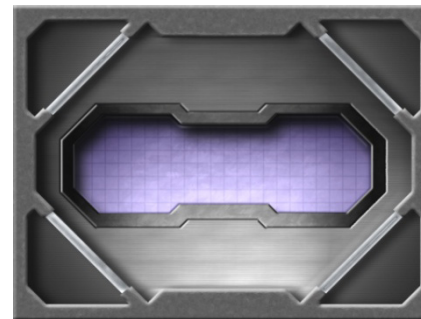
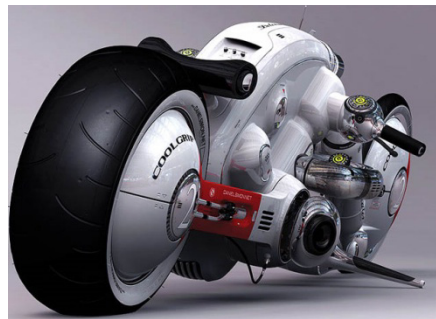
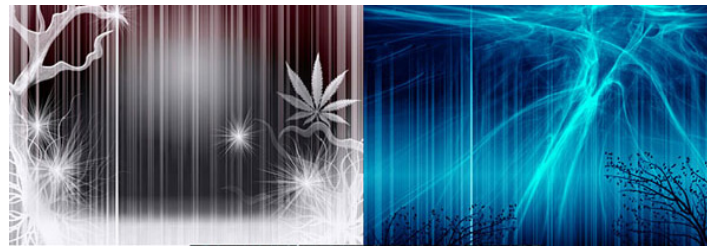
Precision

So much details

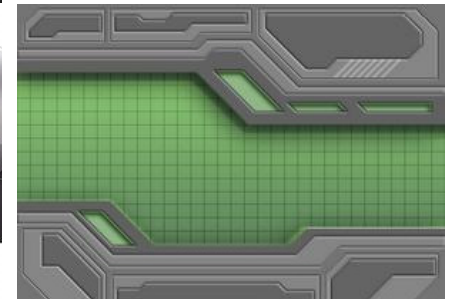
Geometric + organic forms

Fantasy (exaggeration, dreamy)

PRODUCT BRIEF



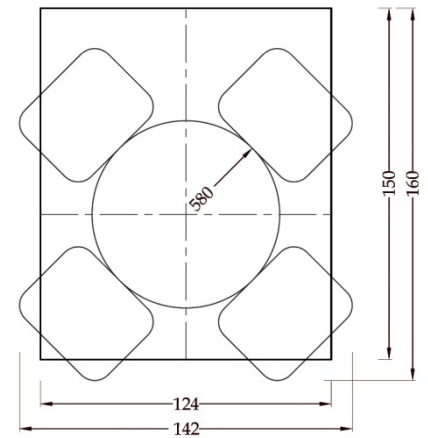
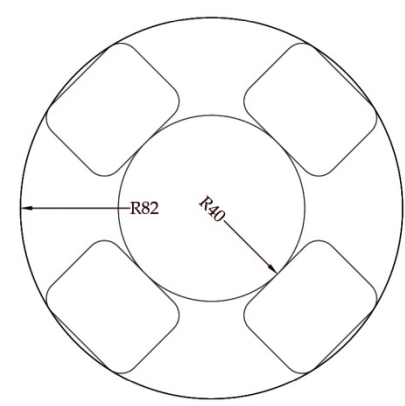
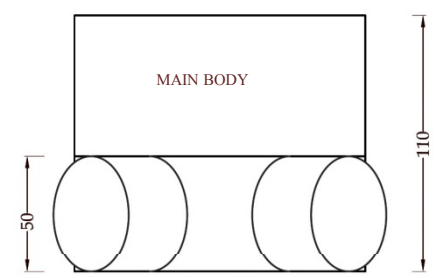
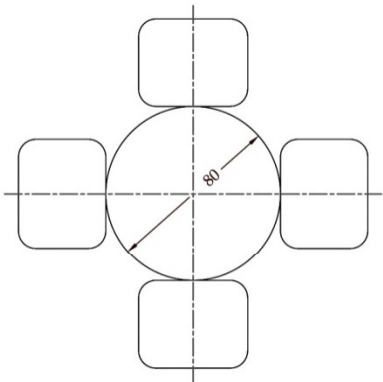
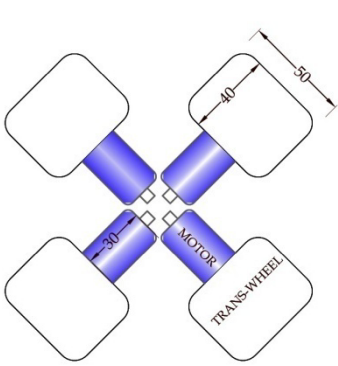
Sophisticated
Flashy colour / jazzy
Big / giant size
Precision
So much details
Geometric forms
Fantasy (exaggeration, dreamy)



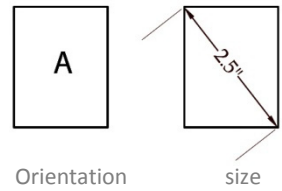
PRODUCT BRIEF

Basic Dimensions

Dimensions are selected on the basis of min requirement and the available standard min size of trans wheels.



LCD Display



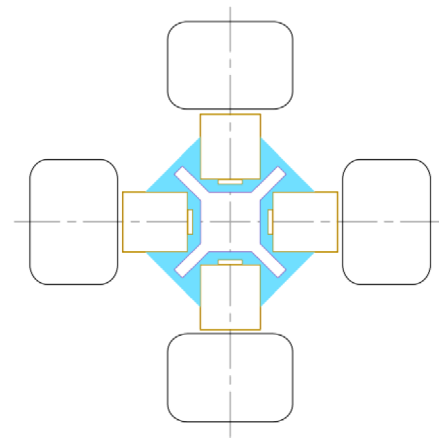
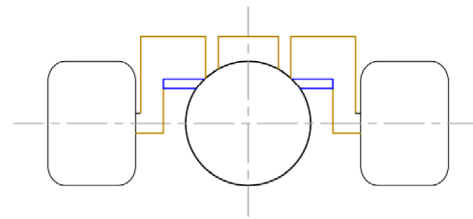
Orientation

size

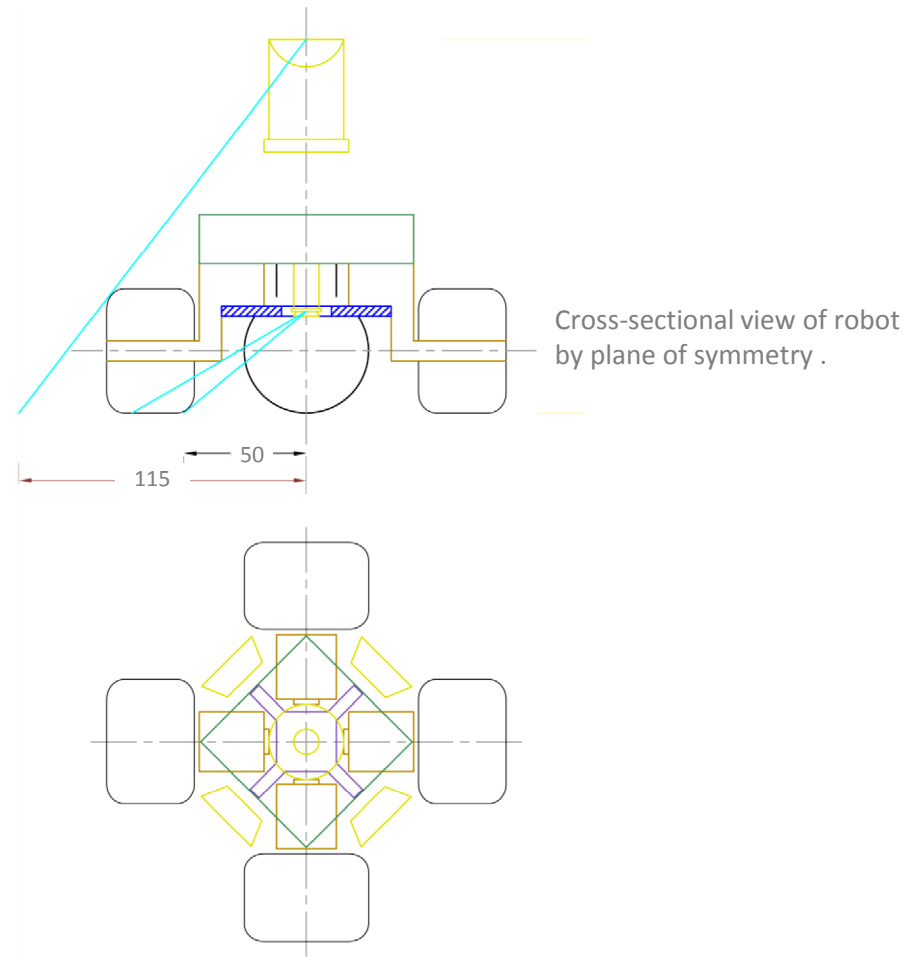
All dimensions are in mm

PRODUCT BRIEF

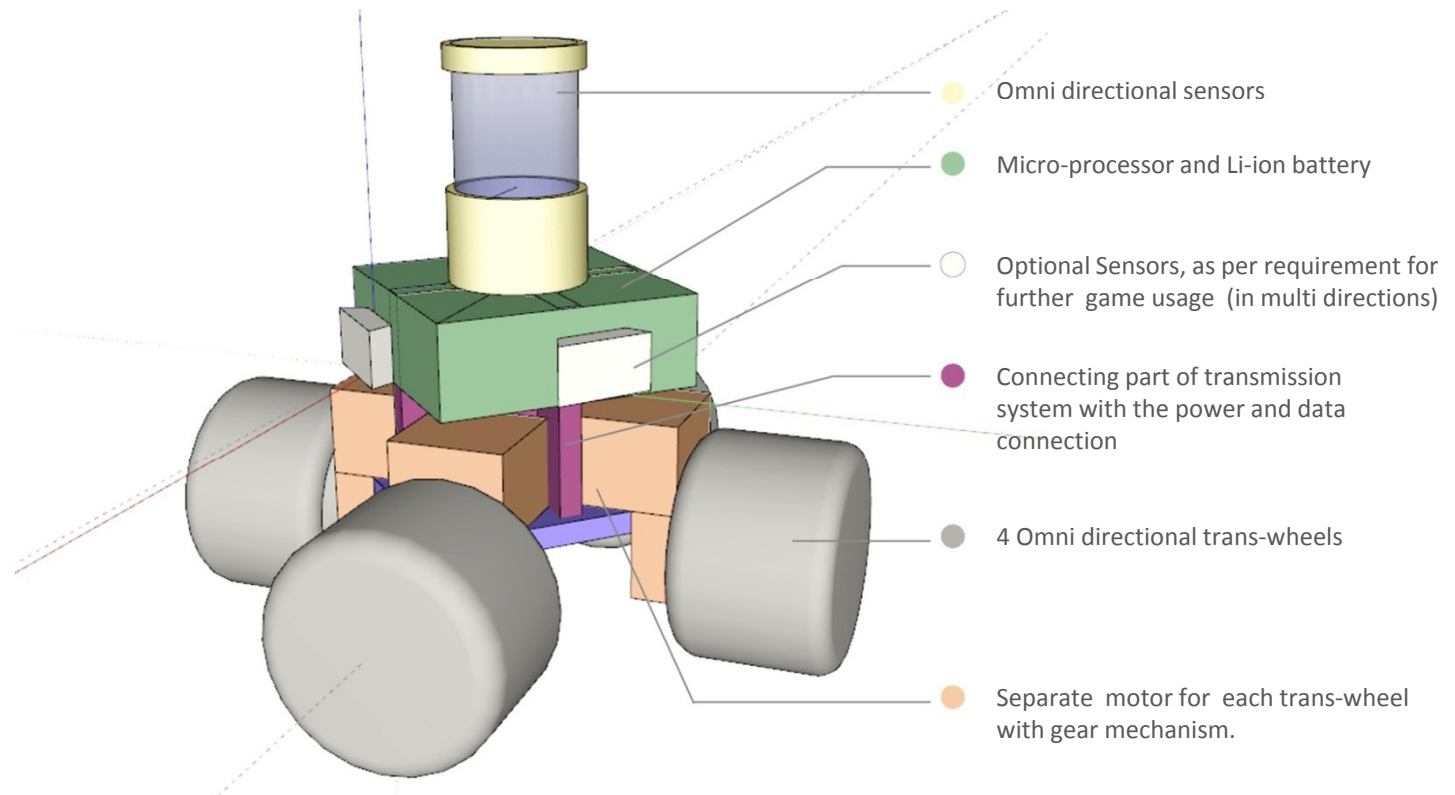
Basic Structure



Side-front view and Top view of
Four trans-wheels
Omni Directional Transmission system



PRODUCT BRIEF



Basic model in 3d view for the reference of form exploration

PRODUCT BRIEF

Game Application

A Game application must have following features:

On screen **GUI application** for front hand uses.

A **robotic language** is required to program the robot. it is to work in back hand of GUI.

Wireless setup between robot and computer.

There will be a need to **setup some protocols**, through which data transmission will take place.

Some guidelines for 'on screen interaction' with **GUI Application**:

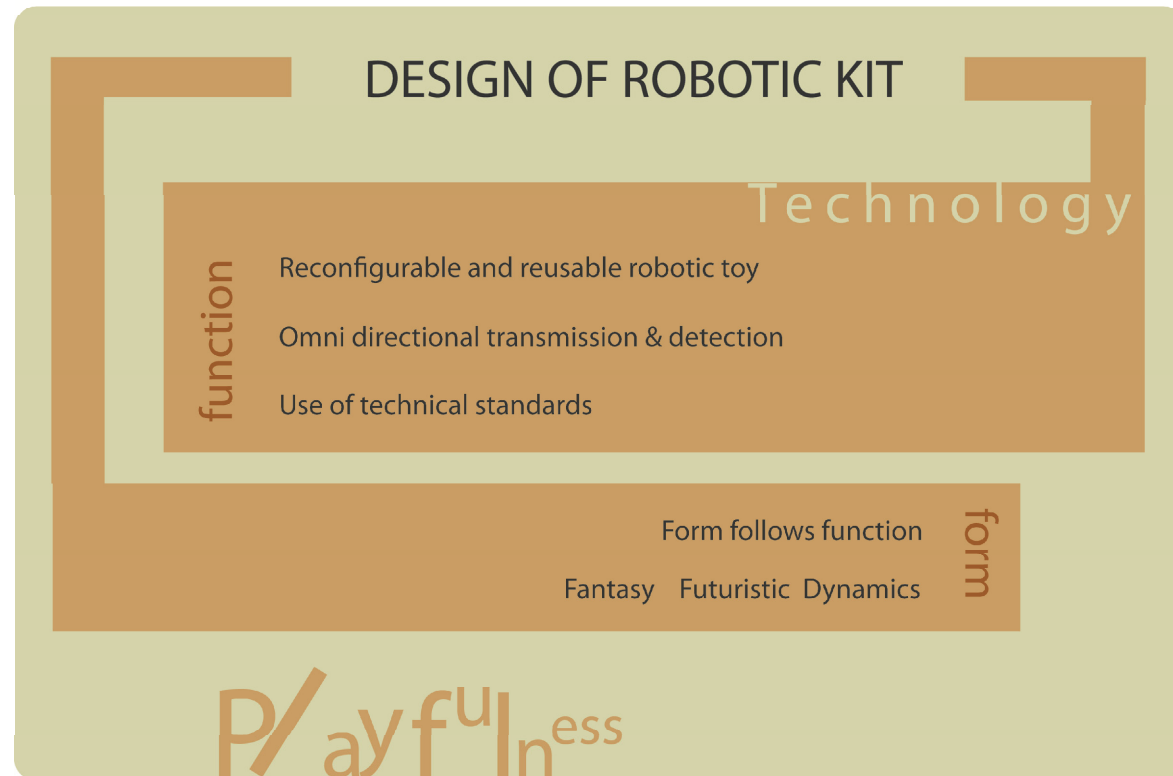
Interface will bind children to follow instructions of the game.

Interface will generate interest through its characteristic and features.

There should not be any chance of faking the system to win or to fail the system.

Graphics on the Interface should satisfy their emotional need and match the level of thought of their age group which generally fantasizes powerful alien characters or robotic heroes (theme and colour scheme)

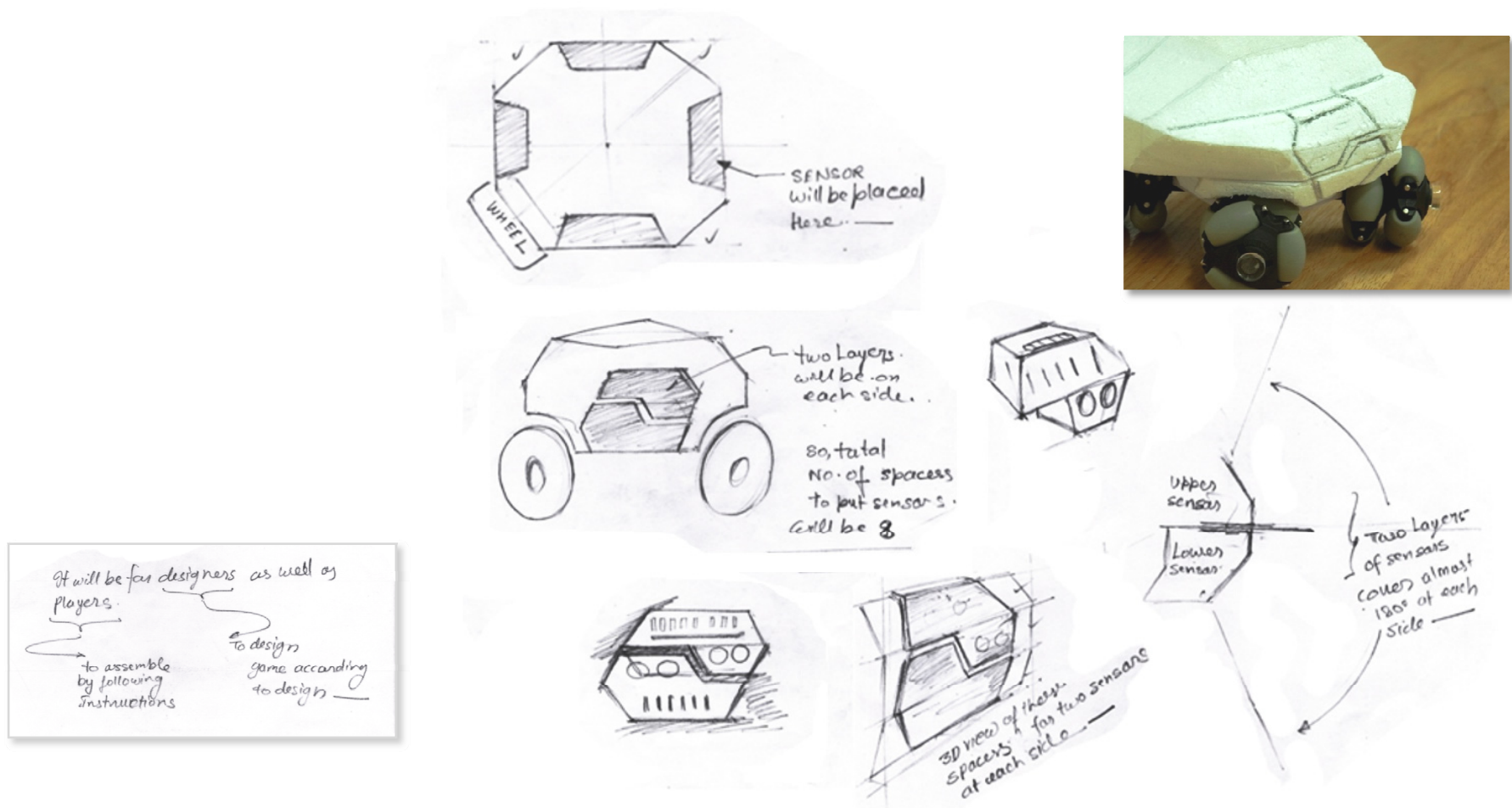
PRODUCT BRIEF



IDEATION FOR DESIGNING A RECONFIGURABLE ROBOT

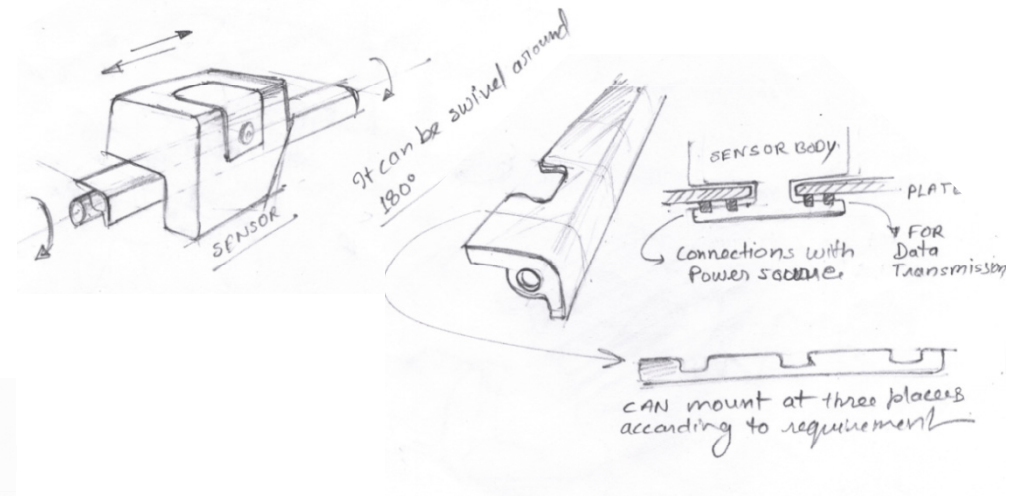
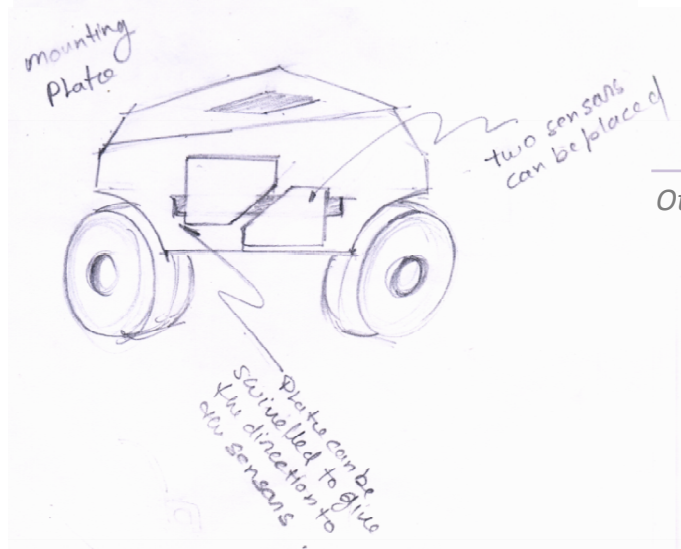
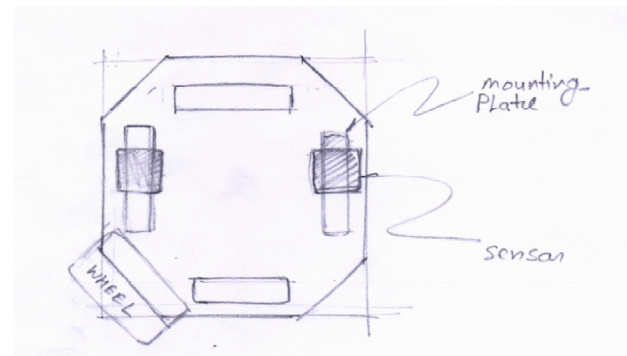
for accommodation of sensors on the body of robot in order to cover maximum envelop to the sense.

Idea 1

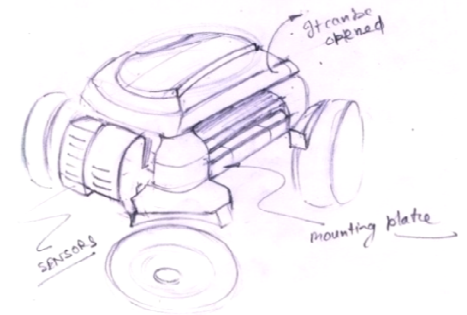
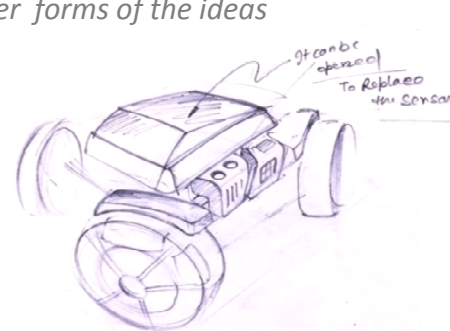


IDEATION FOR DESIGNING A RECONFIGURABLE ROBOT

Idea 2



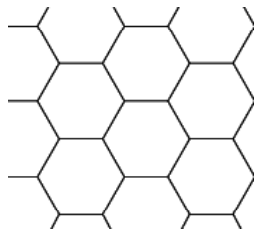
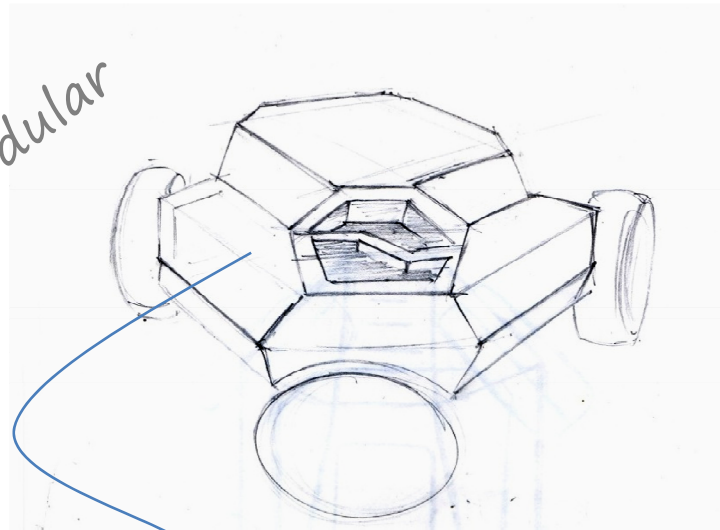
Other forms of the ideas



IDEATION FOR DESIGNING A RECONFIGURABLE ROBOT

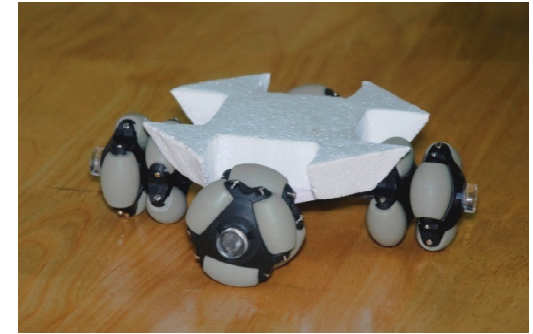
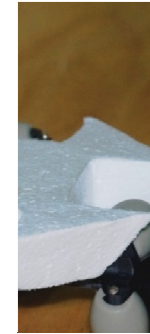
Idea 3

modular



This modular form may be a solution to cover max envelop around the robot

It has different faces in different directions. Two faces make a hexagon . So each face is equal in shape n size which allows any type of sensor in any cavity.



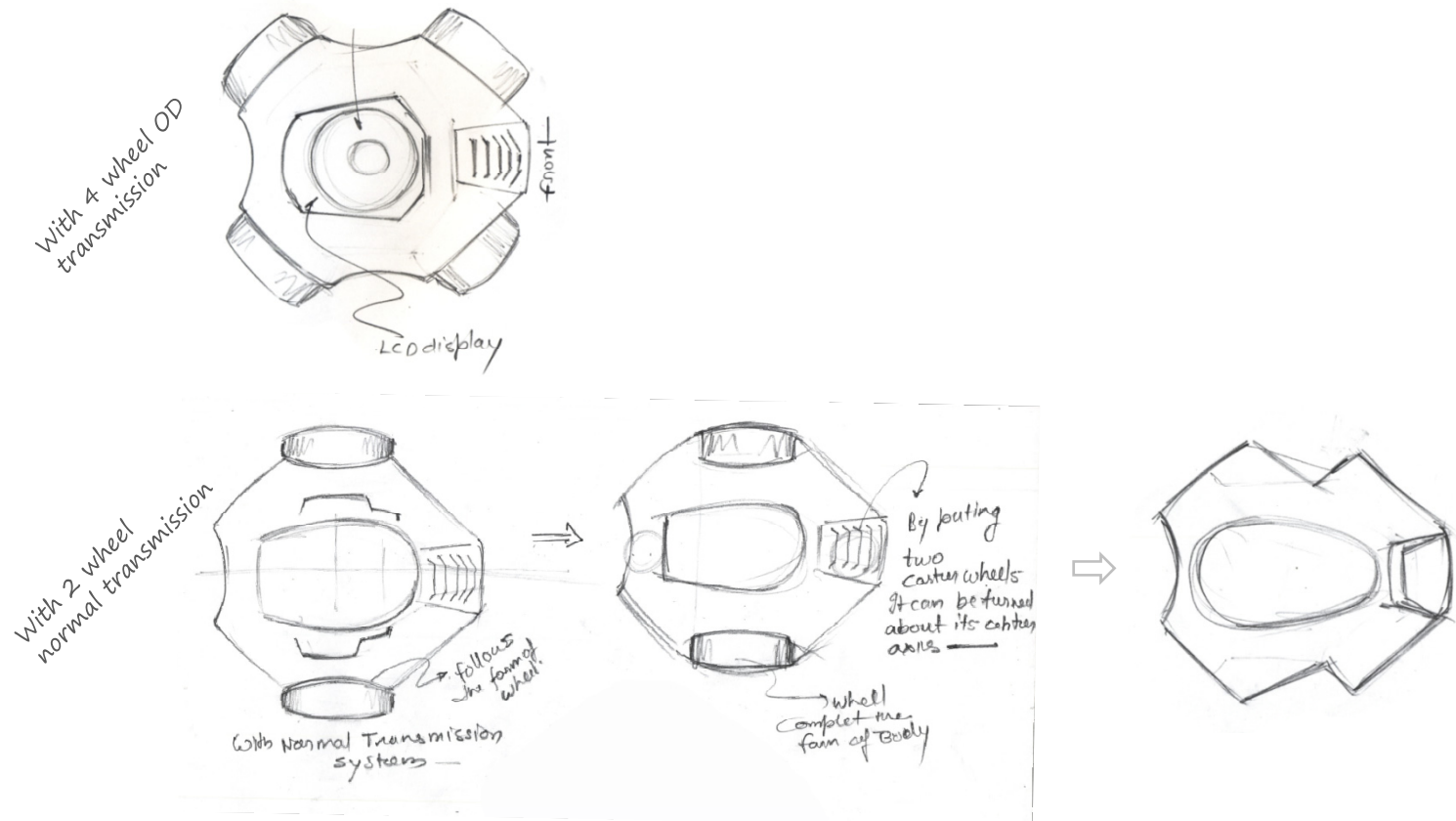
IDEATION FOR DESIGNING A RECONFIGURABLE ROBOT

Replaceable transmission System

Body must be compatible for all kind of transmission system (function wise and form wise both)

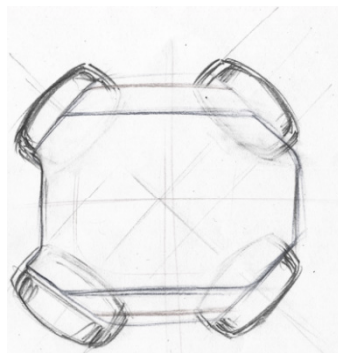
After combining they should look integrated.

Idea 1

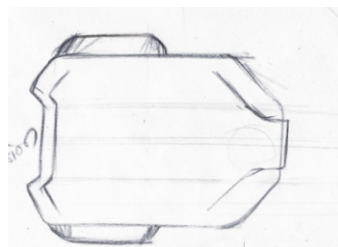


IDEATION FOR DESIGNING A RECONFIGURABLE ROBOT

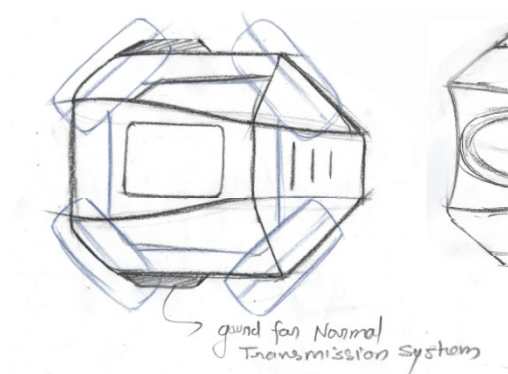
Idea 2



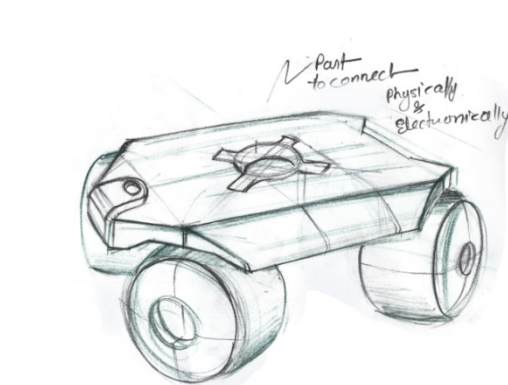
With 4 wheel
OD transmission



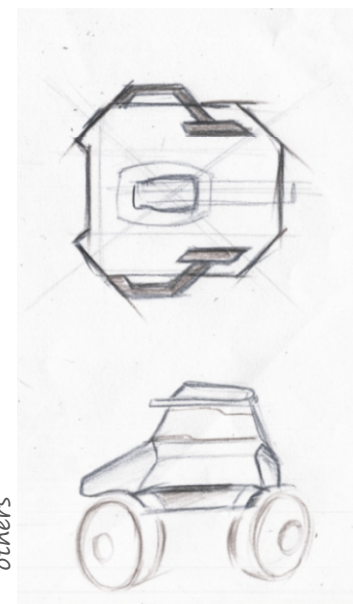
With 2 wheel
normal transmission



ground for Normal
Transmission Systems



Part
to connect
physically
&
electronically



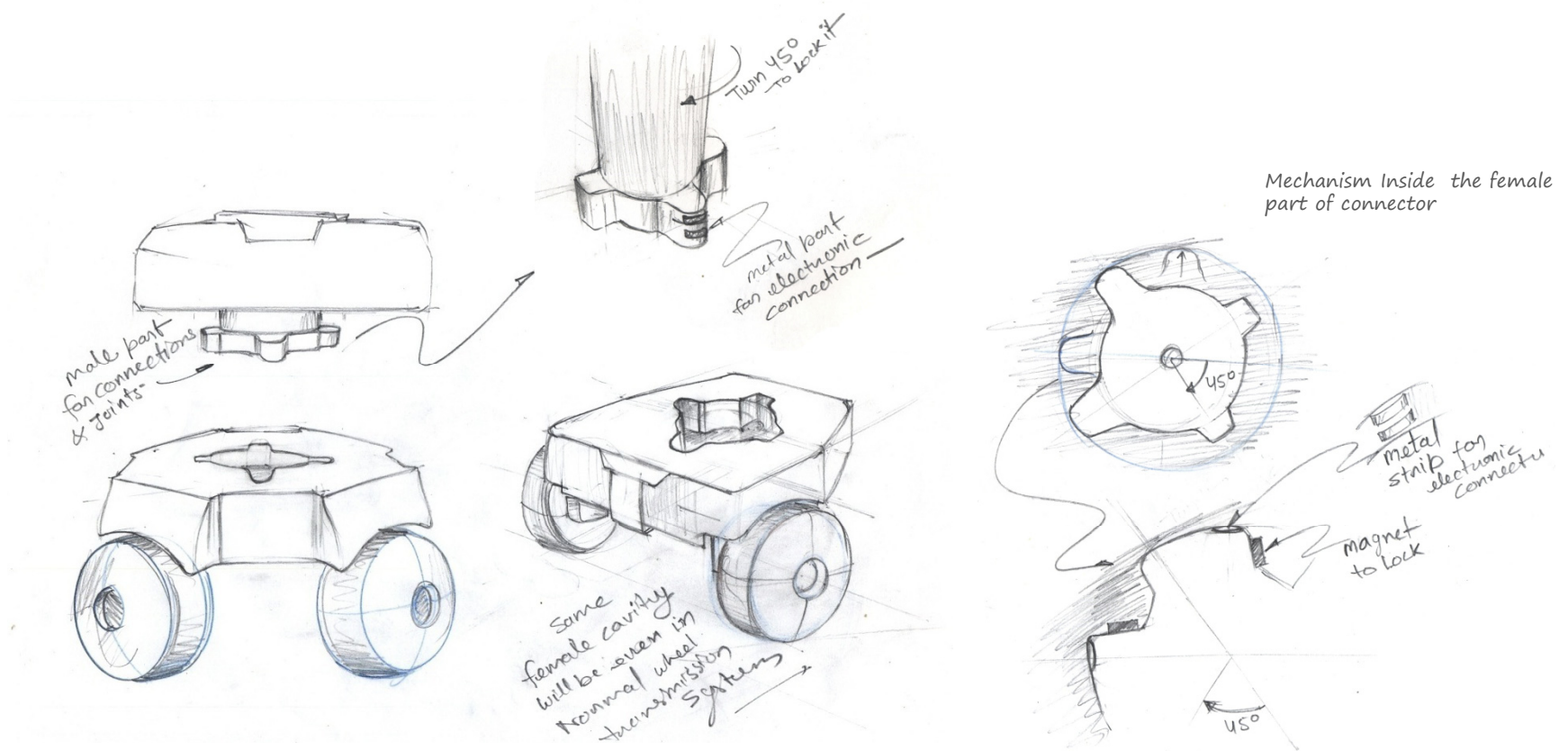
others

IDEATION FOR DESIGNING A RECONFIGURABLE ROBOT

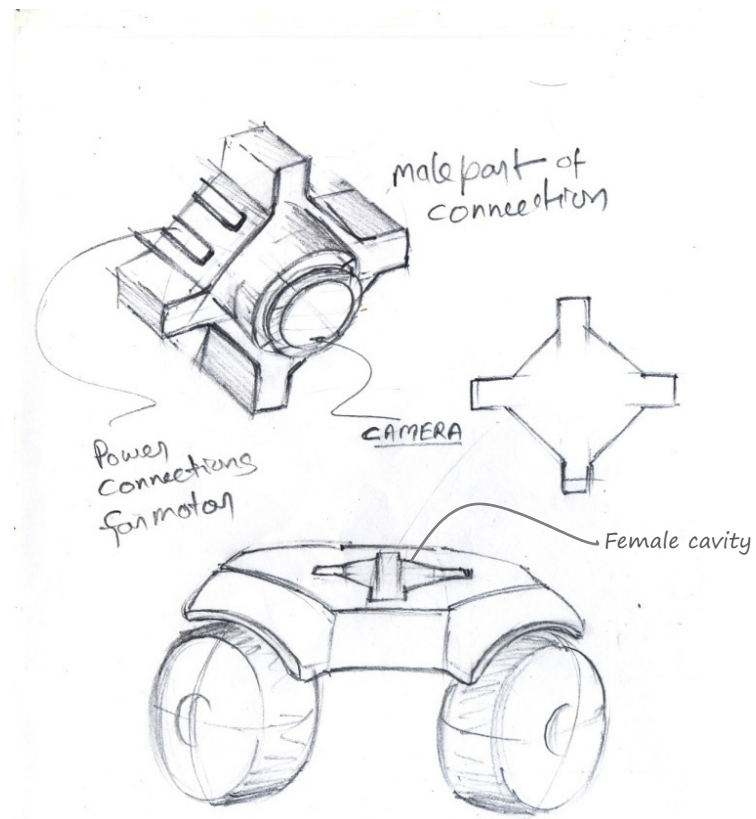
Replaceable transmission System

Connection of basic frame and replaceable parts must be hassle free, proper, easily replicable.

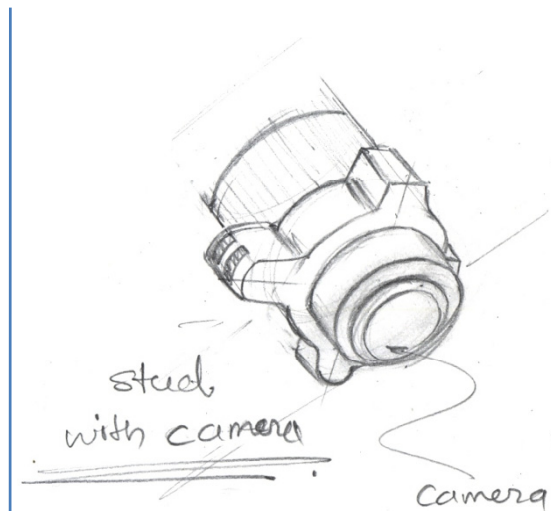
Idea 1



IDEATION FOR DESIGNING A RECONFIGURABLE ROBOT



Idea 2



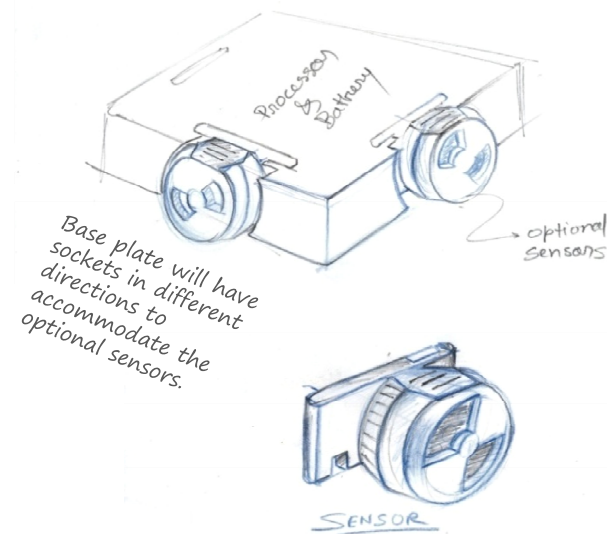
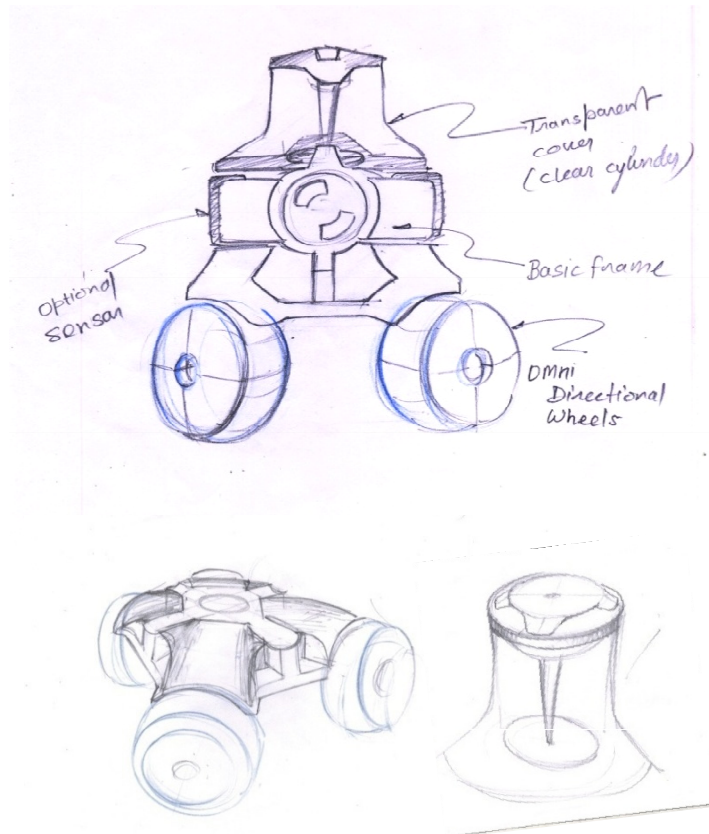
Camera installation with the connector of IDEA 1

IDEATION FOR DESIGNING A RECONFIGURABLE ROBOT

Accommodation Of Optional Sensors

Ideation to accommodate one or more optional sensors which may be needed for other games in future. These must cover all possible direction.

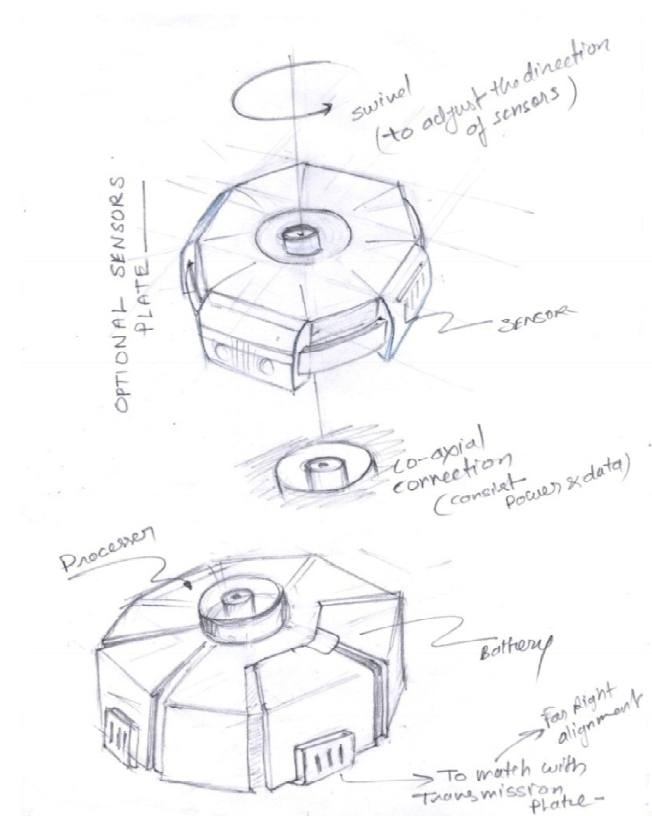
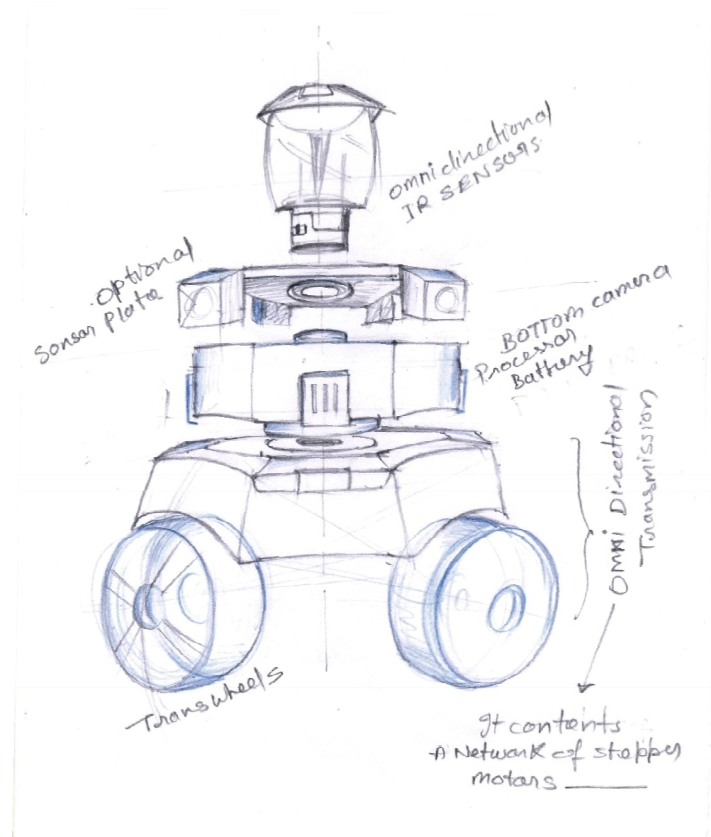
Idea 1



Idea is beneficial, If only one sensor is needed. There is no need to put any sophisticated assembly for installing that.

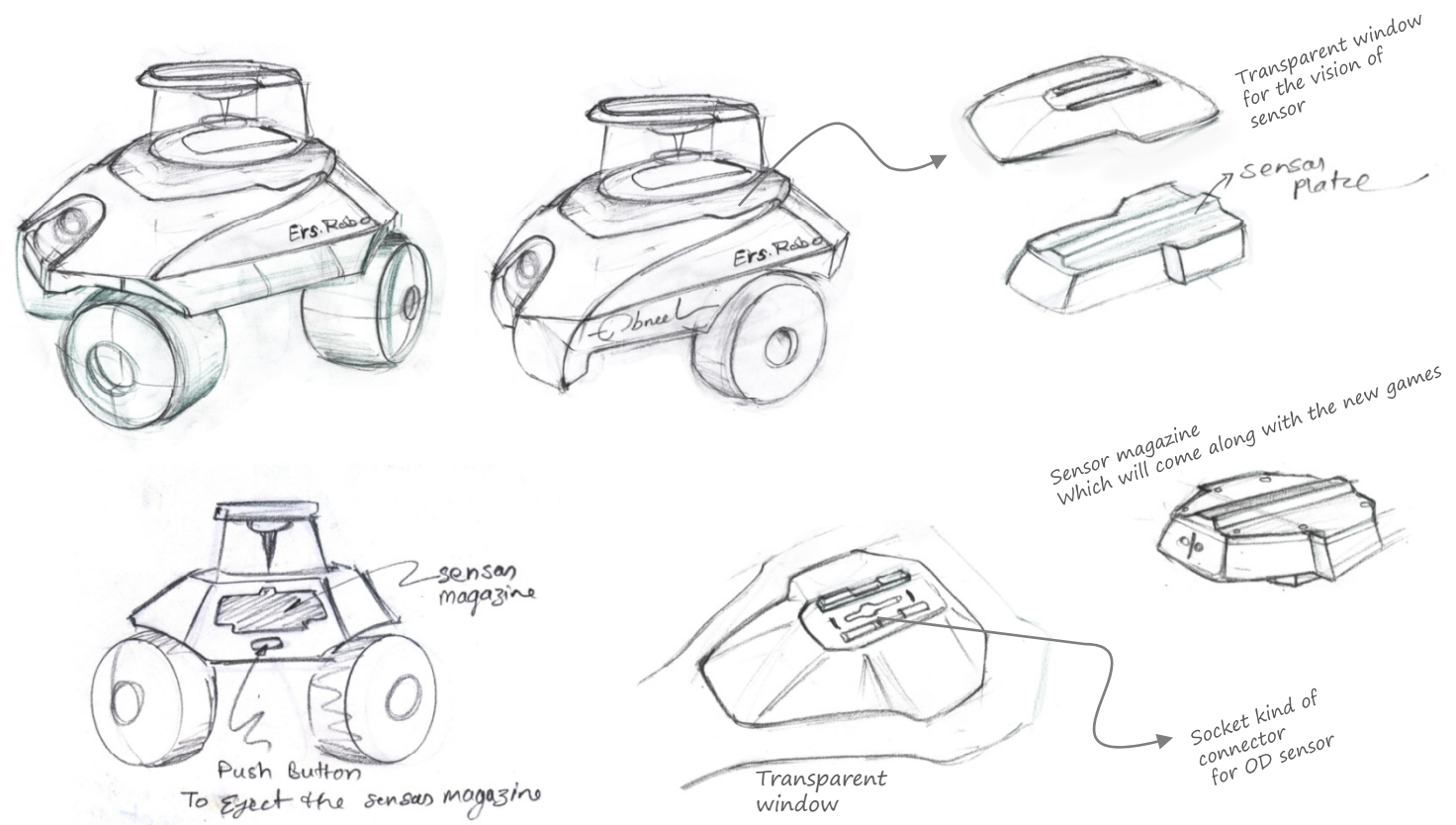
IDEATION FOR DESIGNING A RECONFIGURABLE ROBOT

Idea 2



IDEATION FOR DESIGNING A RECONFIGURABLE ROBOT

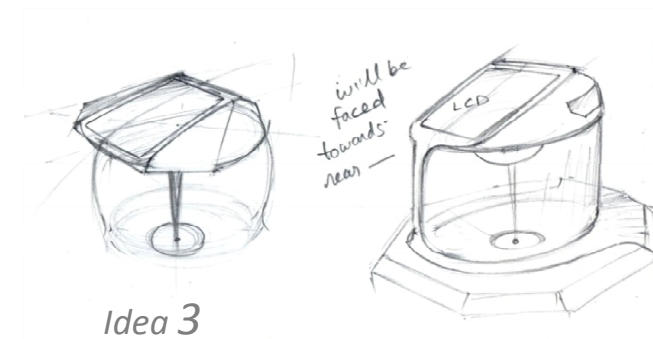
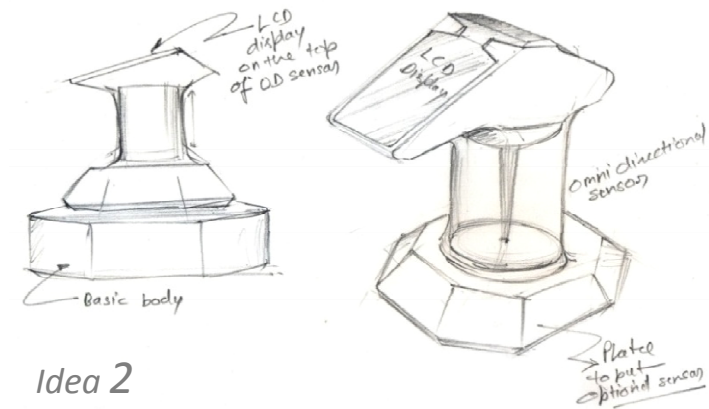
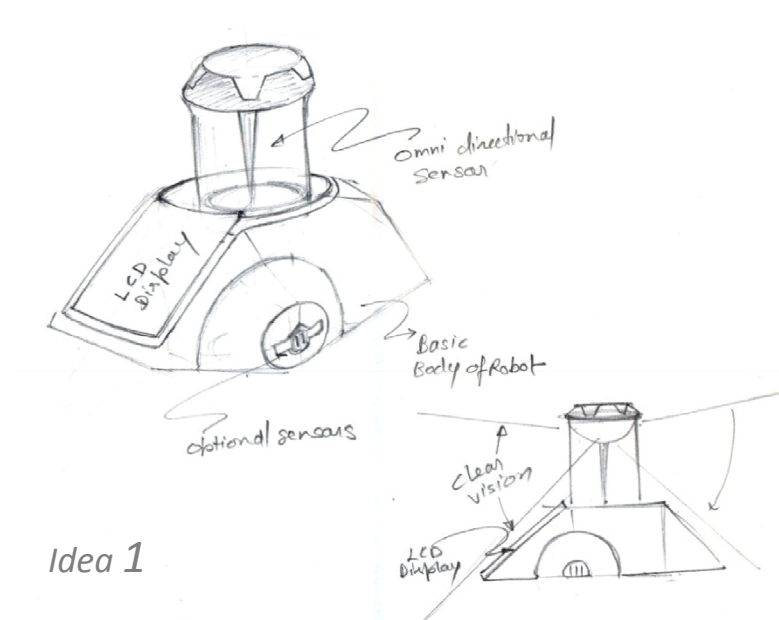
Idea 3



IDEATION FOR DESIGNING A RECONFIGURABLE ROBOT

Placement of LCD display

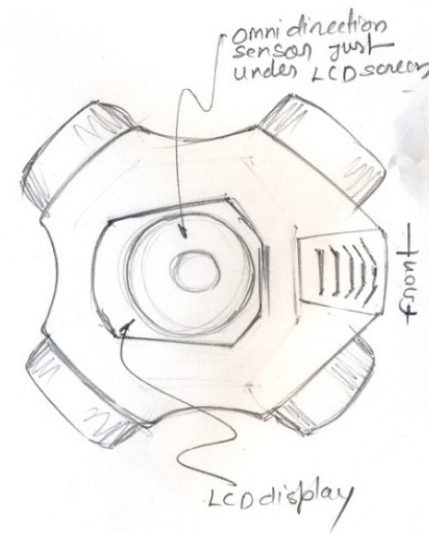
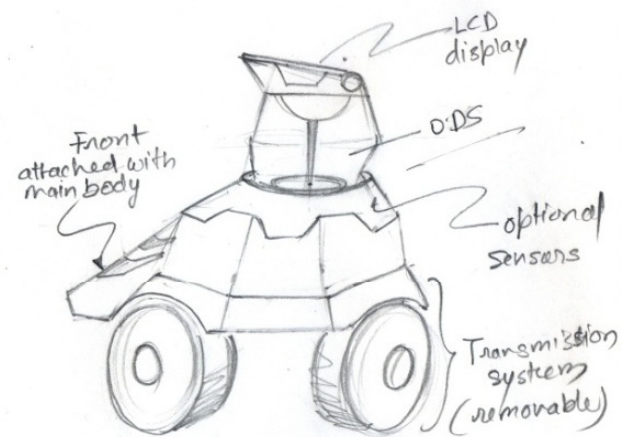
Placement of LCD display on the body of robot should not disturb the vision of sensors



IDEATION FOR
DESIGNING A
RECONFIGURABLE
ROBOT

Front of the vehicle to create language of direction of movement

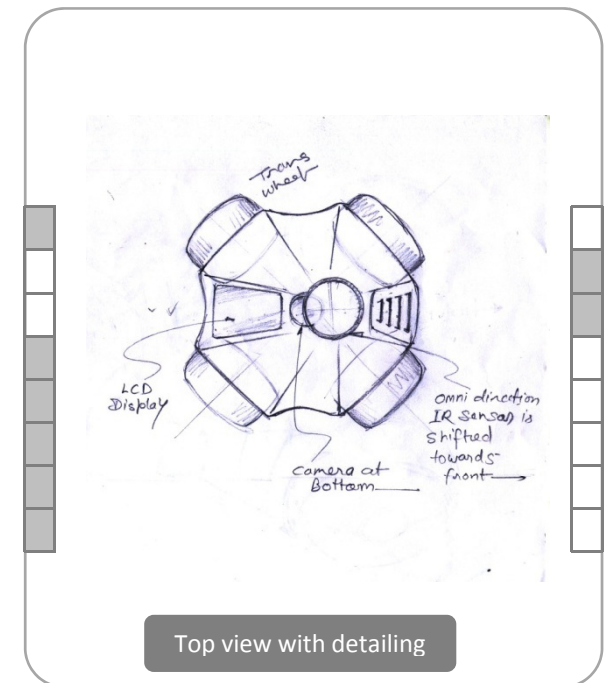
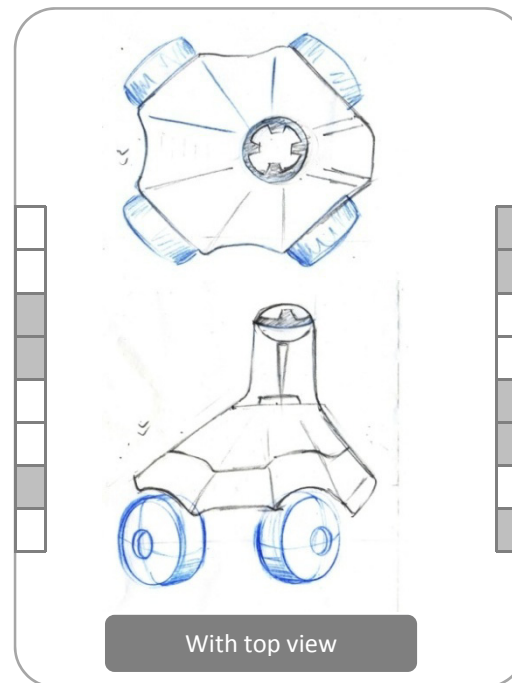
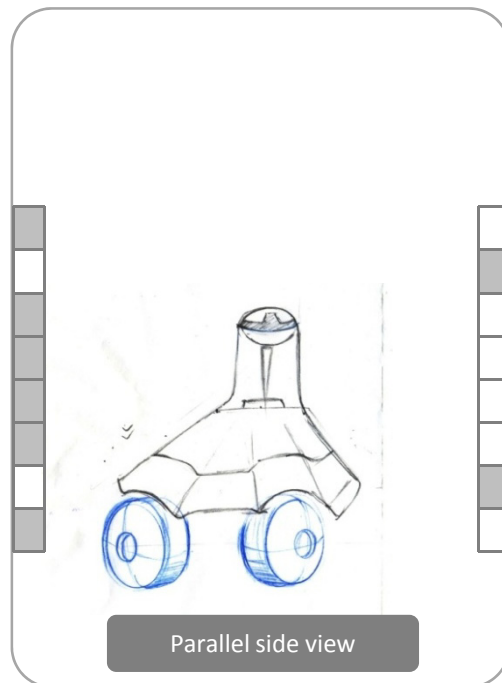
Idea 1



IDEATION FOR DESIGNING A RECONFIGURABLE ROBOT

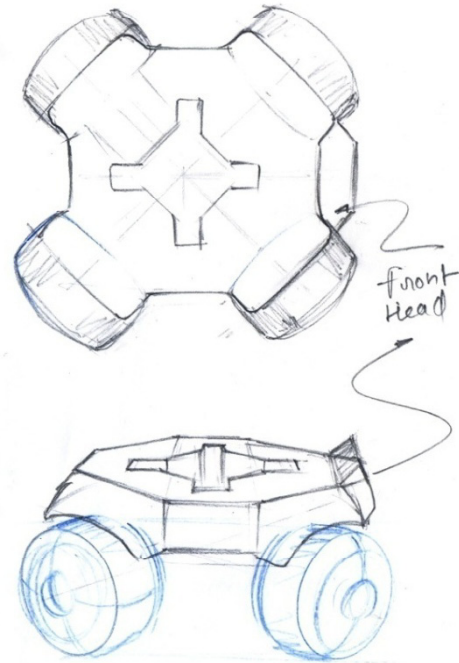
Study to find the characteristics which are responsible to make a side of the vehicle as its front

People were asked to perceive, which side is appealing to be the front of this new vehicle? These were shown to them one by one



One gray block means that one mentioned the front in that side.

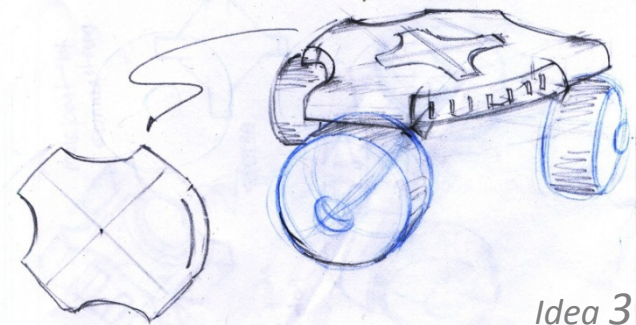
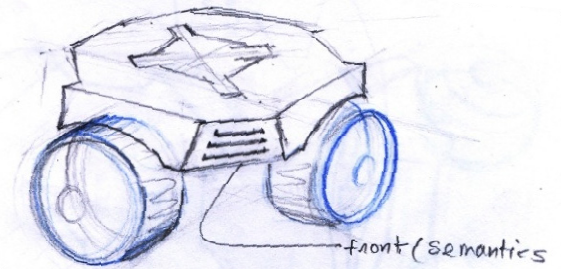
IDEATION FOR DESIGNING A RECONFIGURABLE ROBOT



Idea 1

language of direction of
movement in
transmission part only

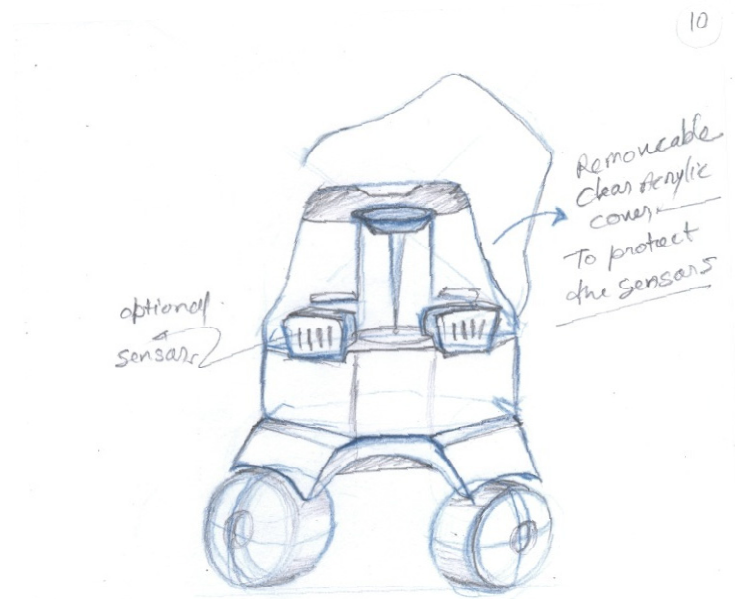
Idea 2



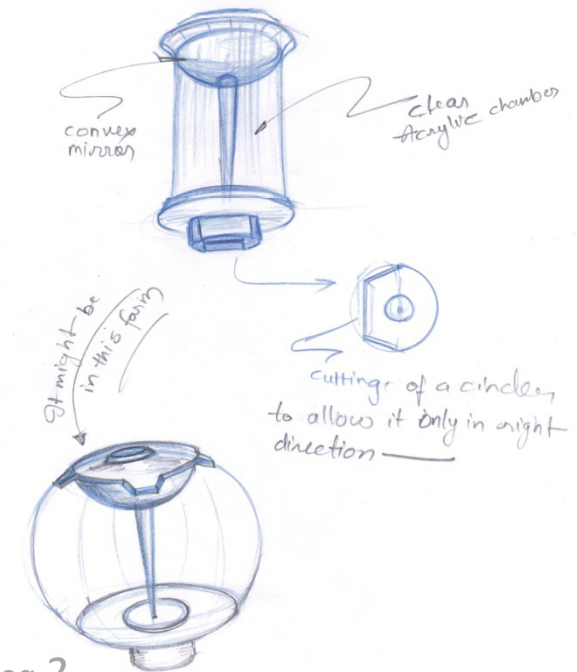
Idea 3

IDEATION FOR DESIGNING A RECONFIGURABLE ROBOT

Protection Of Omni Direction Sensors



Idea 1



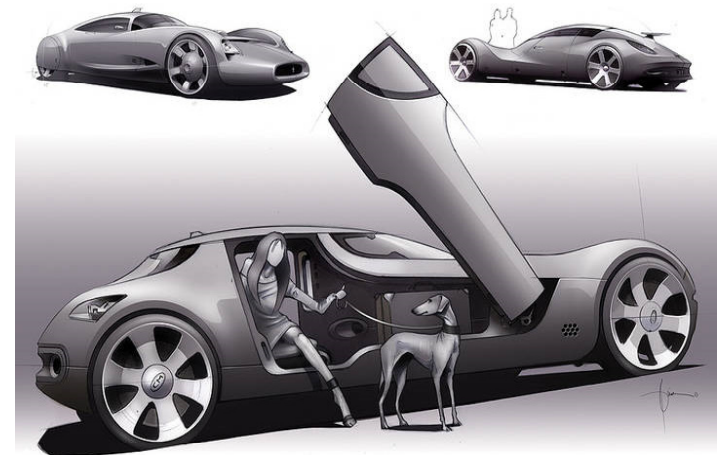
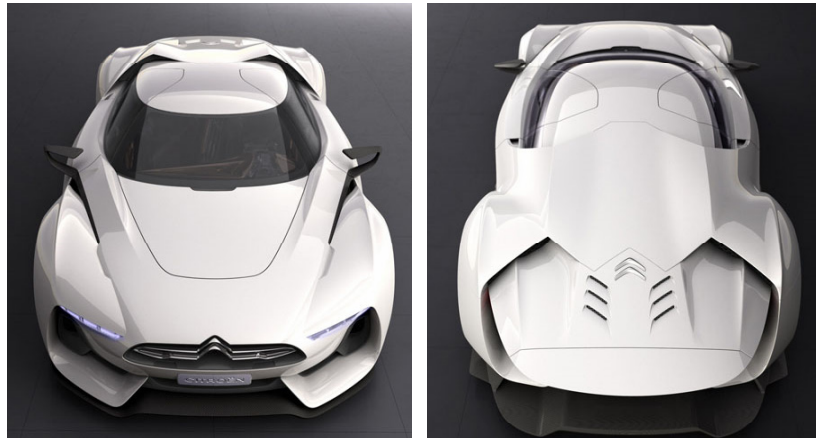
Idea 2

FORM EXPLORATION

Ideation for solving several functional issues have been done. Now, ideation for the form is to be through, which must be base on some good functional solutions. Means, form of the product should follow the functions of the product.

FORM EXPLORATION

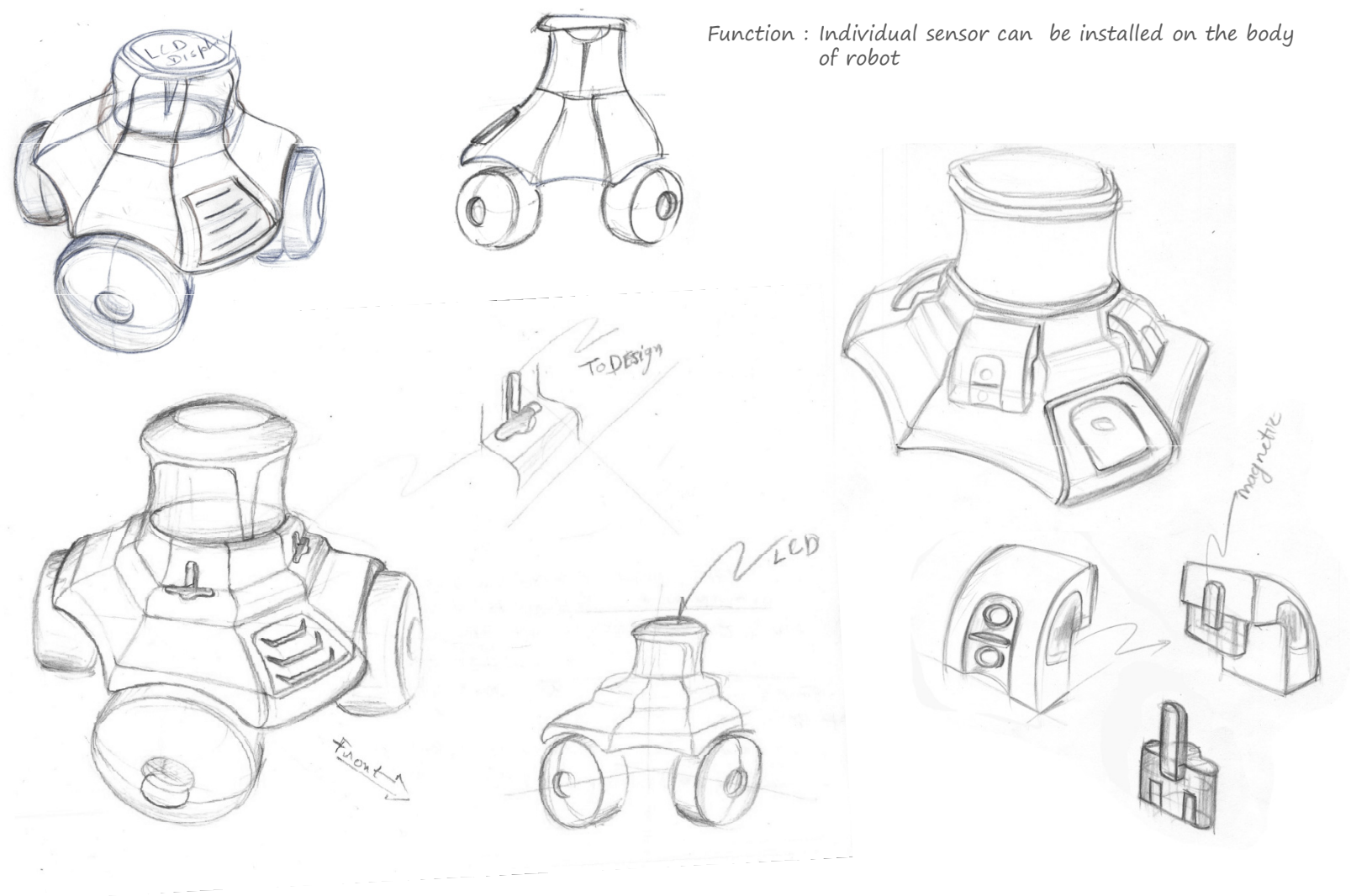
An image board of vehicles,
to take inspiration from
semantics of vehicle



FORM
EXPLORATION

Form follows functions

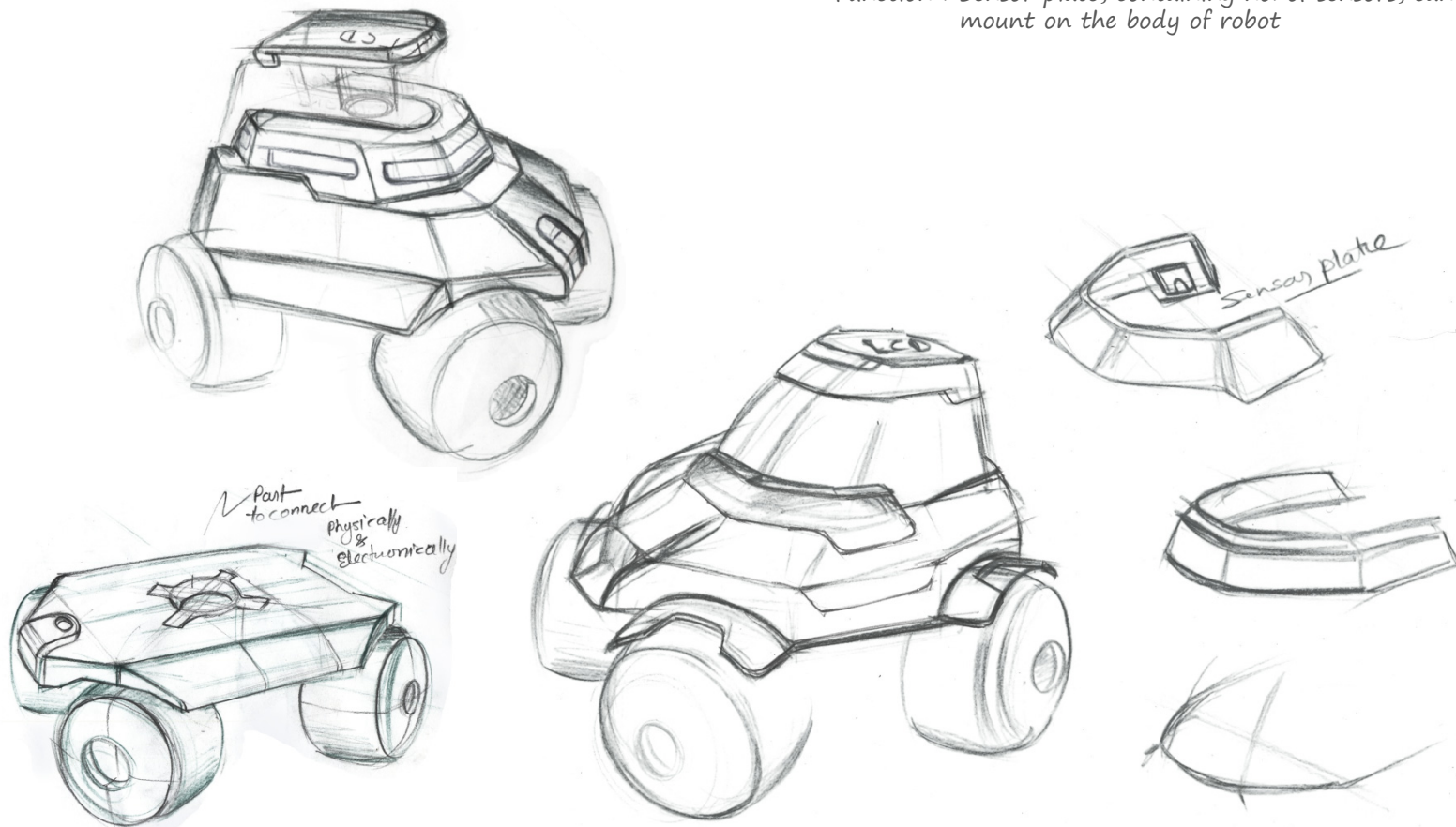
1



FORM EXPLORATION

2

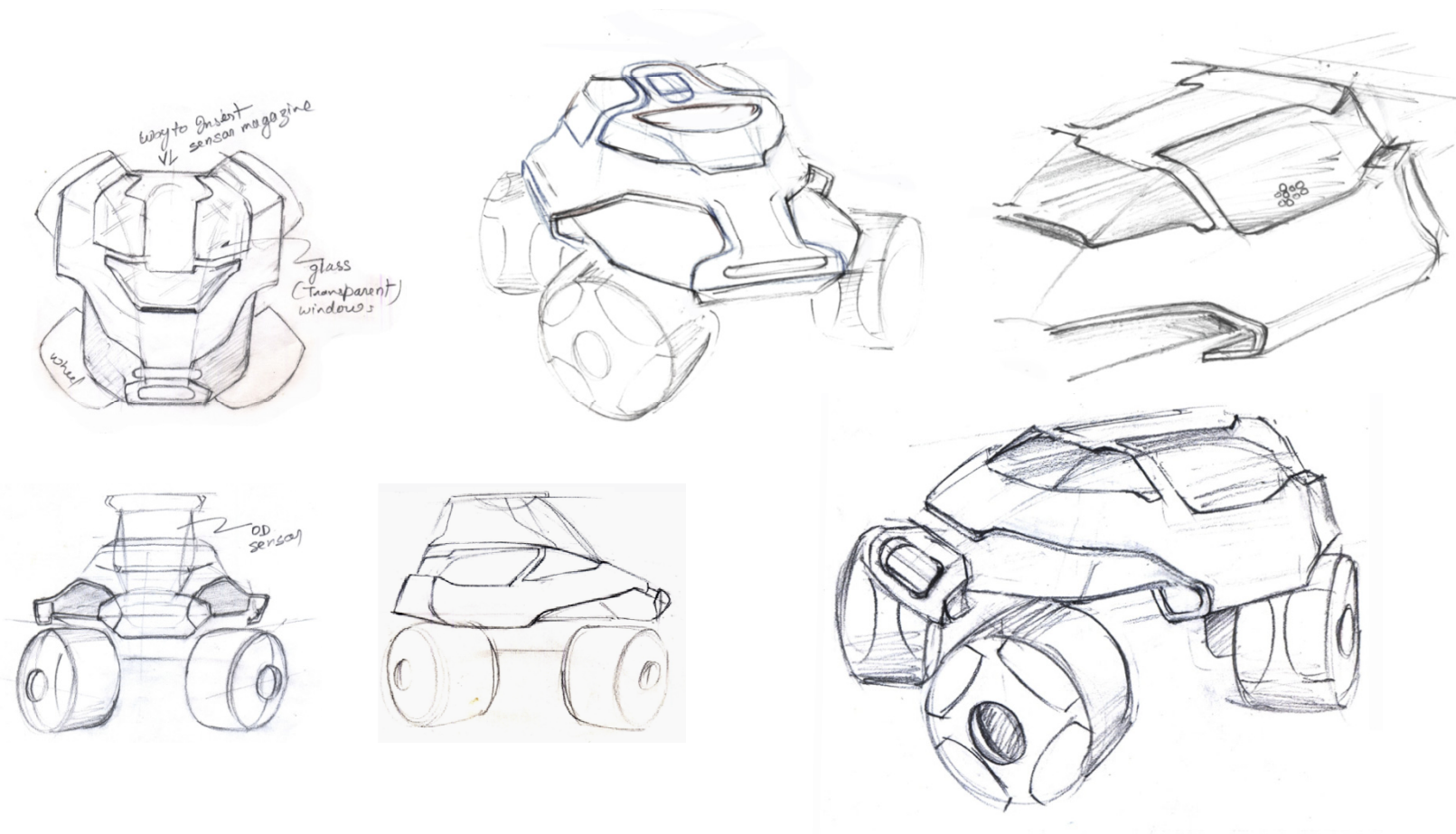
Function : Sensor plate, containing no. of sensors, can be mount on the body of robot



FORM EXPLORATION

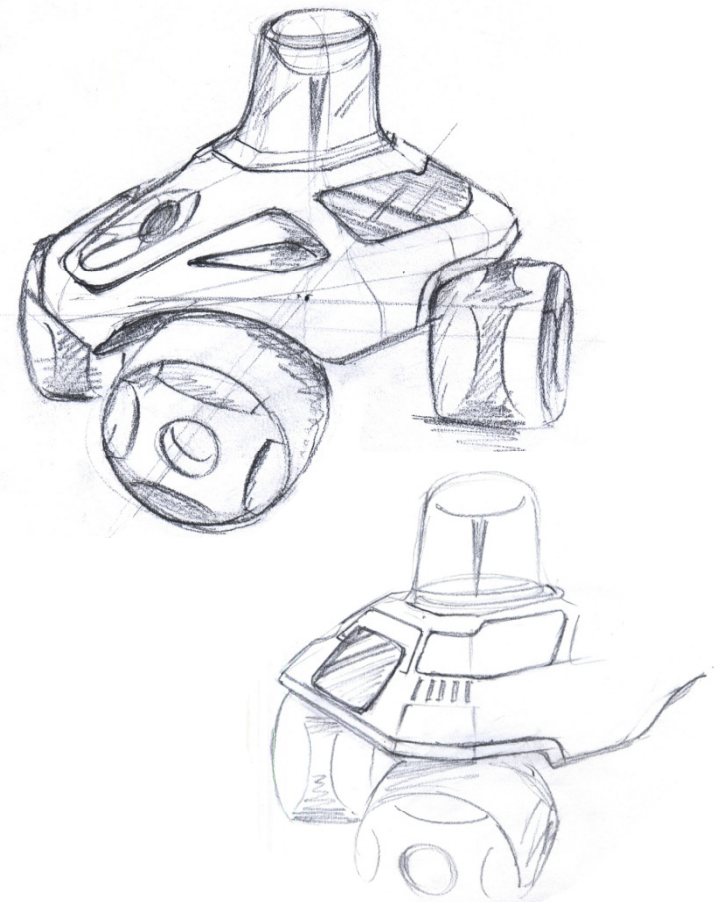
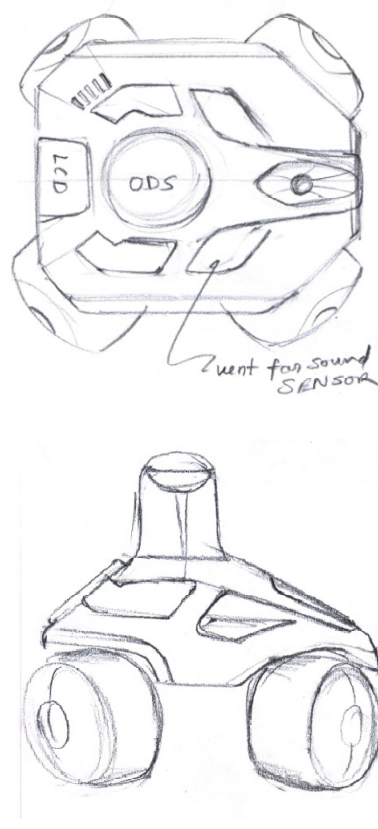
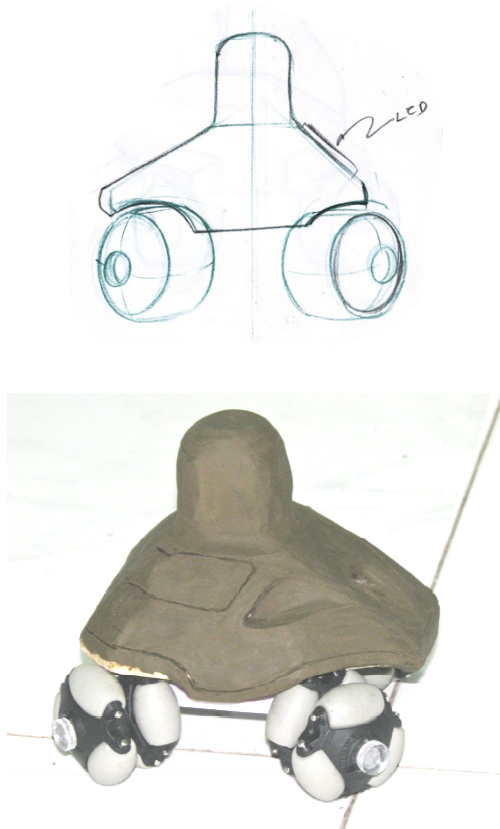
3

Function : Sensor magazine, containing no. of sensors, can be inserted into the body of robot



FORM EXPLORATION

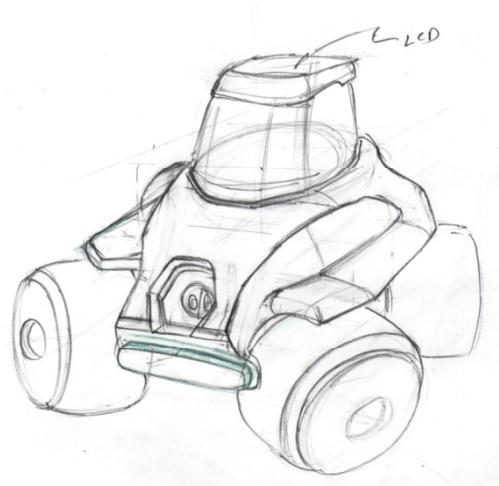
Ability of easily modality of clay is used to bring the flow of material in the form.



FORM EXPLORATION

Refinement >>>

Some exploratory mockup models

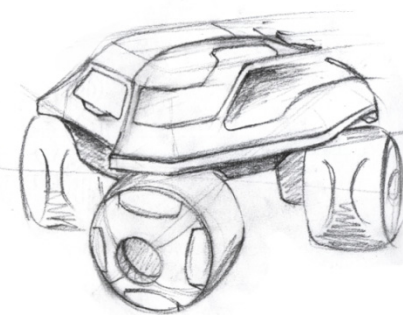
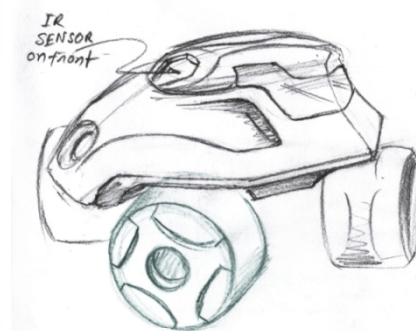
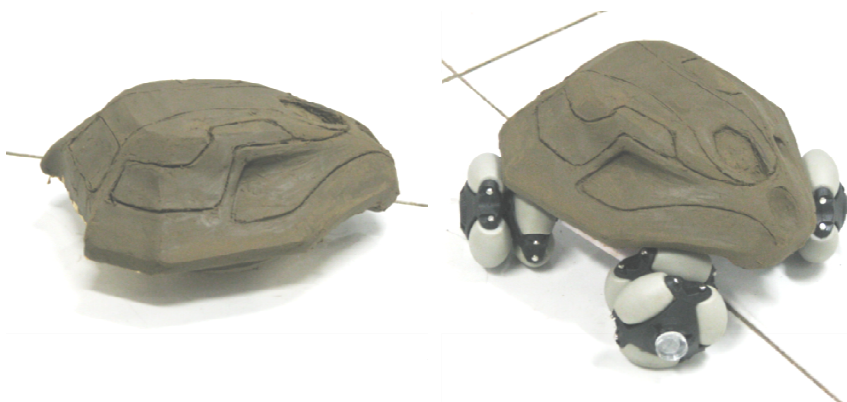
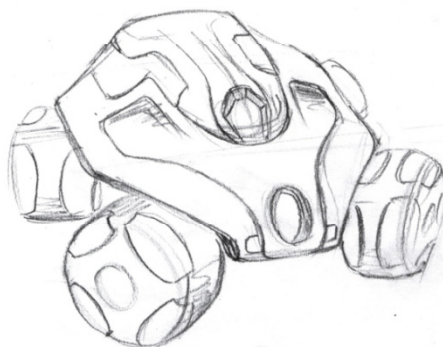
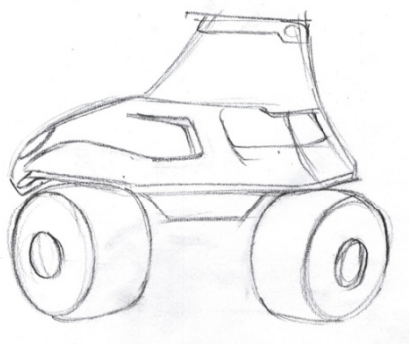


A form which I like most to consider it as a robotic product. But this form doesn't go with the function.



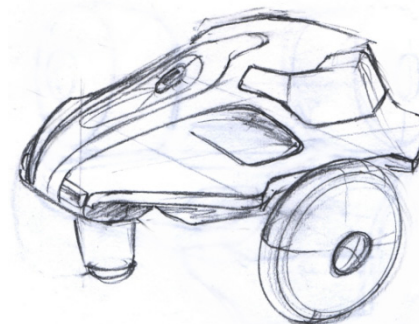
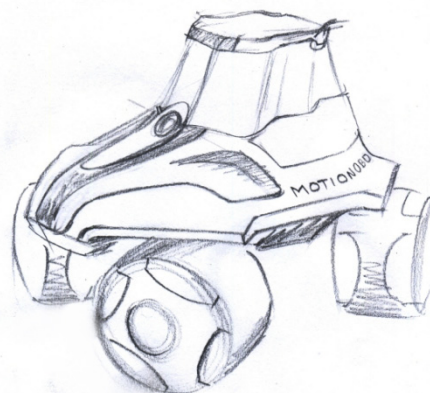
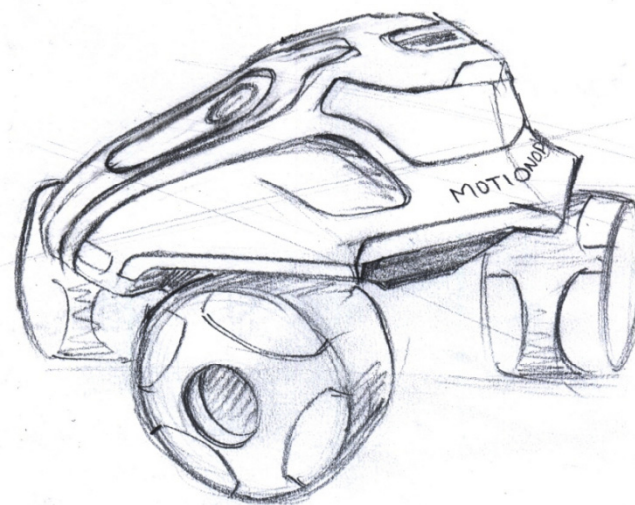
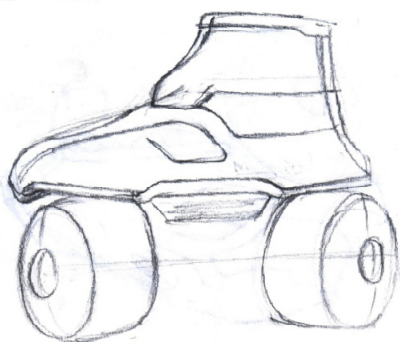
FORM
EXPLORATION

>>>>



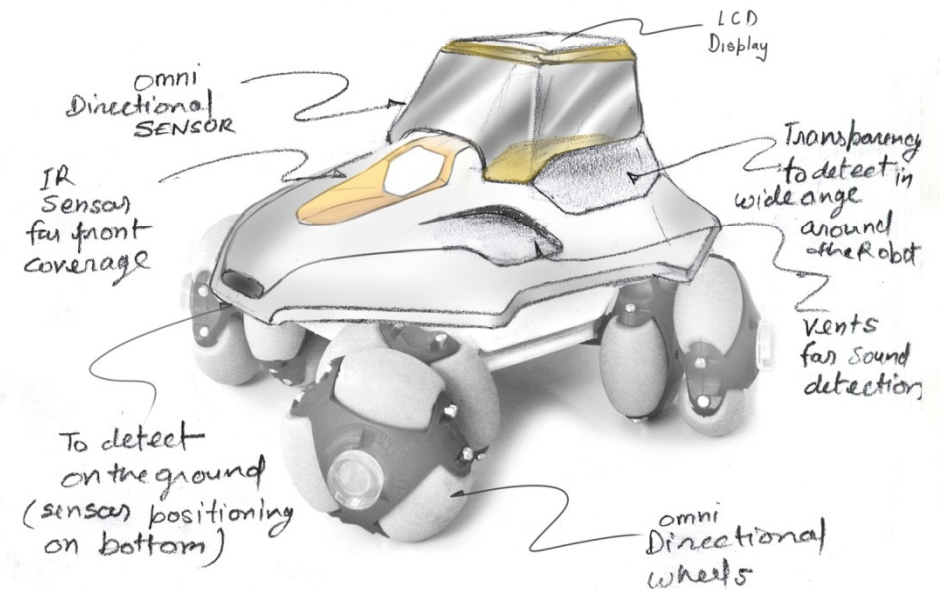
FORM
EXPLORATION

>>>>

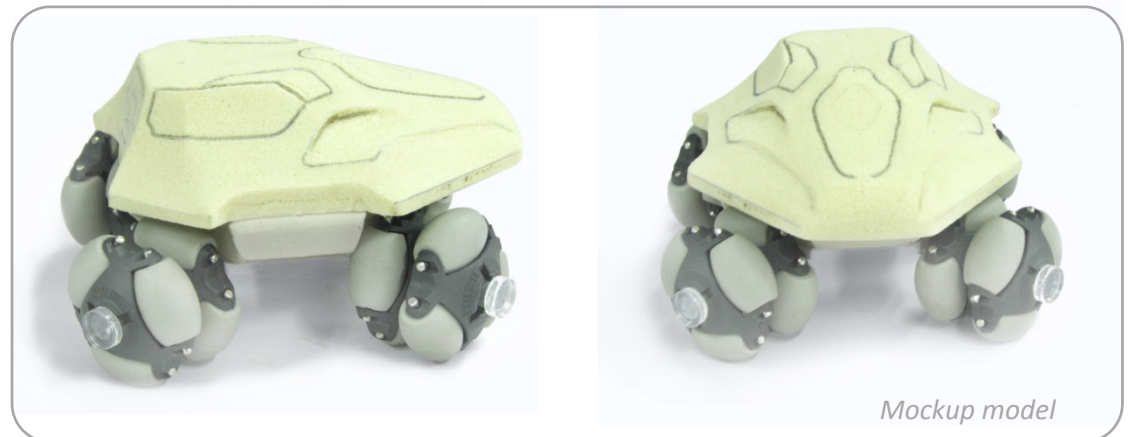
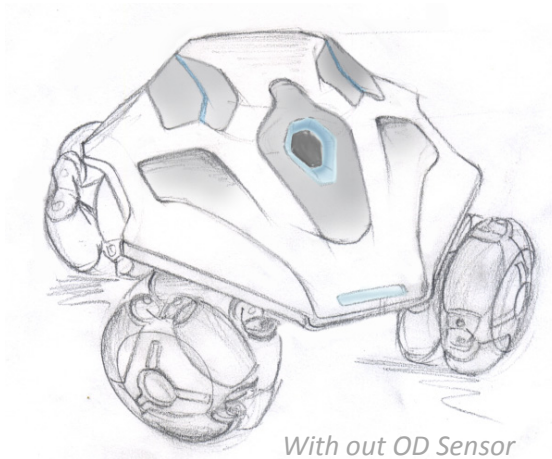


FINAL CONCEPT OF ROBOTIC KIT

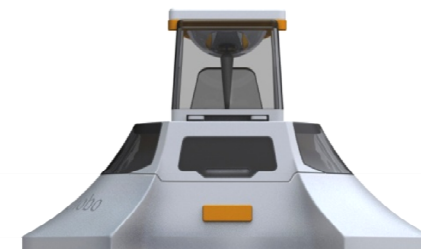
Final Form of Robot



With
OD Sensor and LCD Display



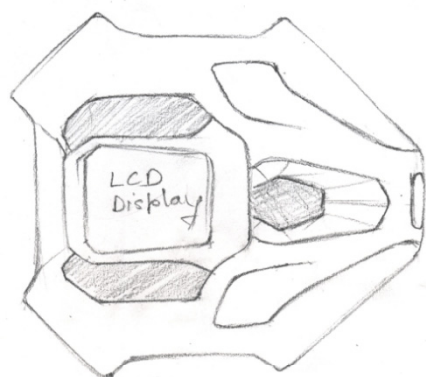
FINAL CONCEPT OF ROBOTIC KIT



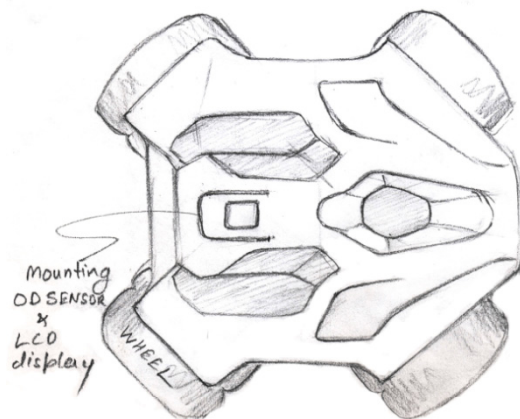
Rear view



Side view



With OD Sensor and LCD Display

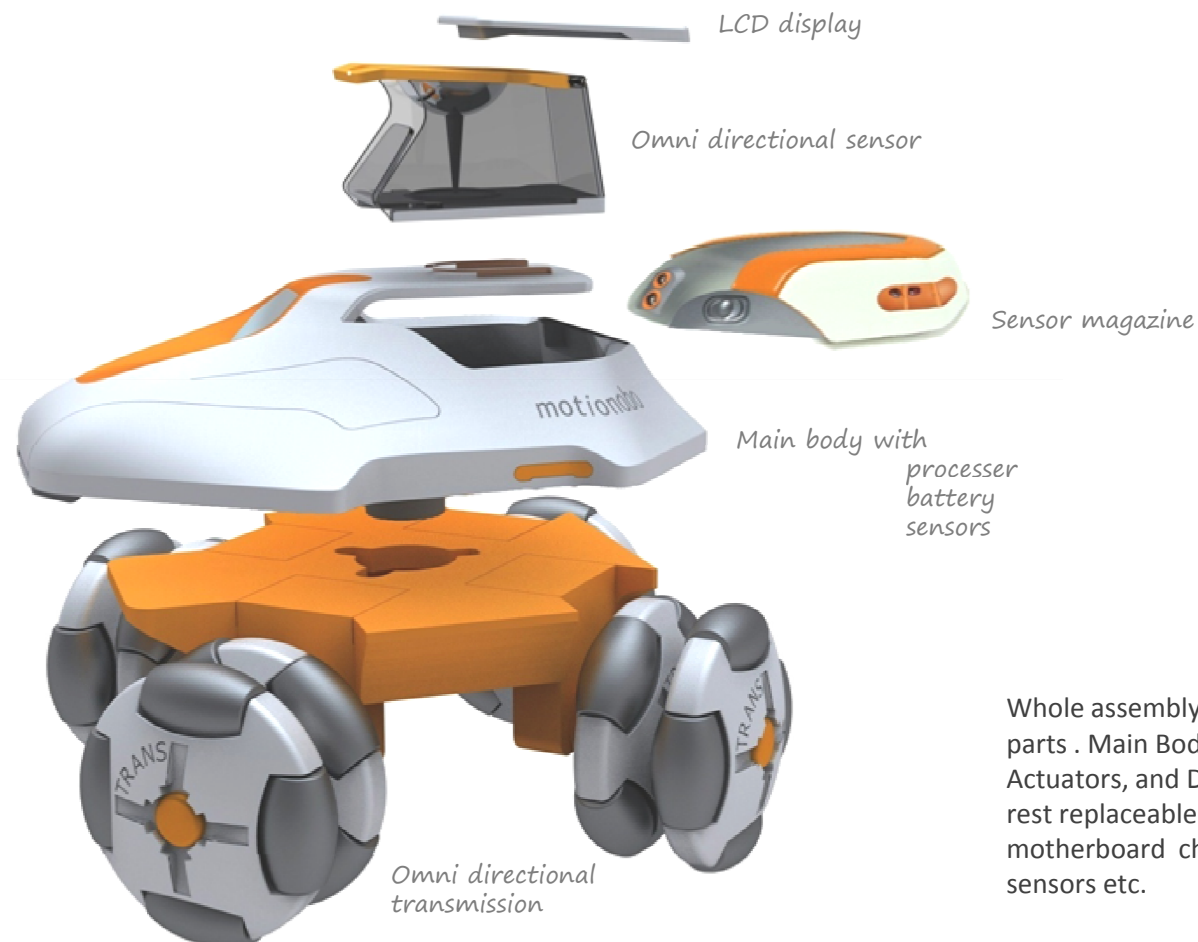


With out OD Sensor

FINAL CONCEPT OF ROBOTIC KIT

Main parts of robot

It's a generic robotic kit to be used in many of such science games (physical digital interactive games) .

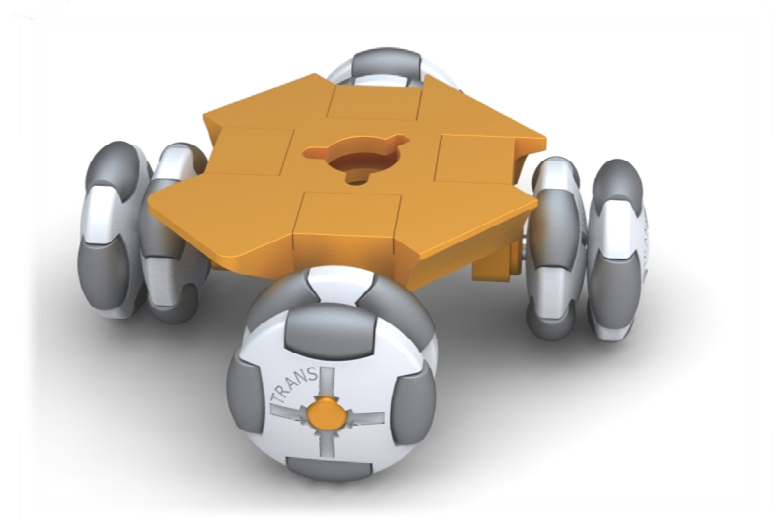
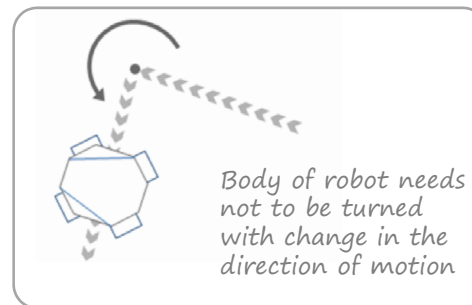
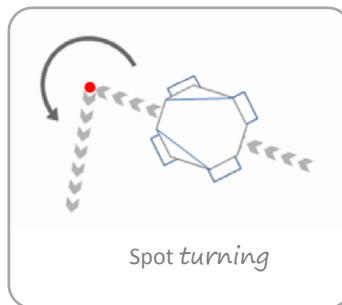
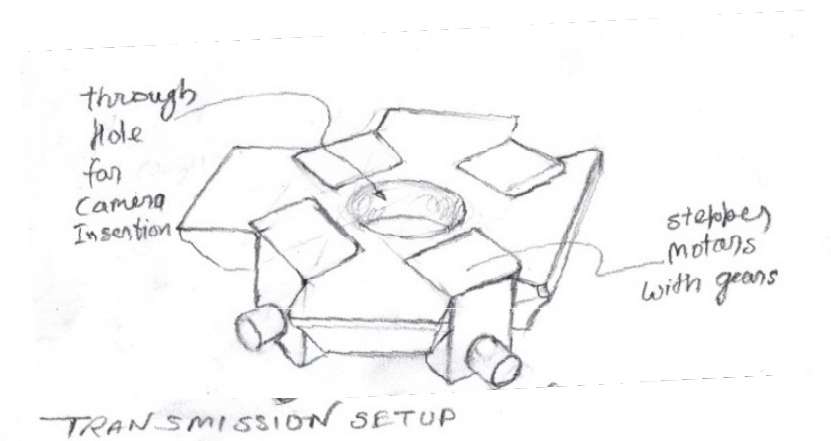
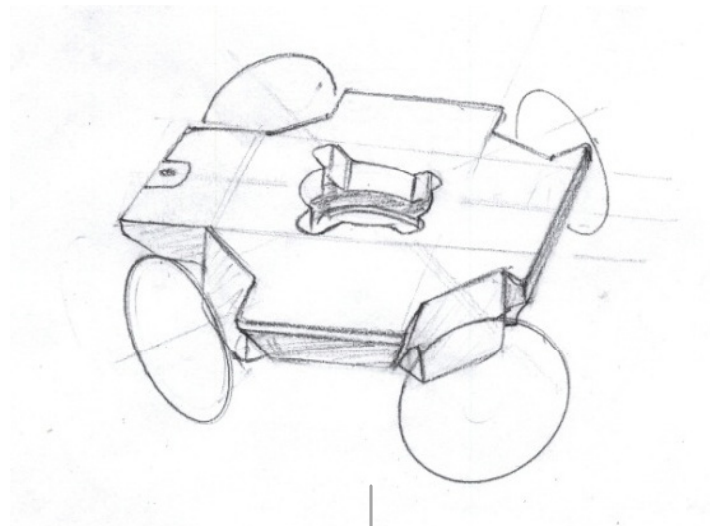


Whole assembly has been categorized into five parts . Main Body, Transmission, Sensors , Other Actuators, and Display . Main body, to which rest replaceable parts can be attached, contains motherboard chip, battery, some permanent sensors etc.

FINAL CONCEPT OF ROBOTIC KIT

features

Basically it has 4 wheels Omni Directional transmission which enable it to move in any direction with Spot Turing.

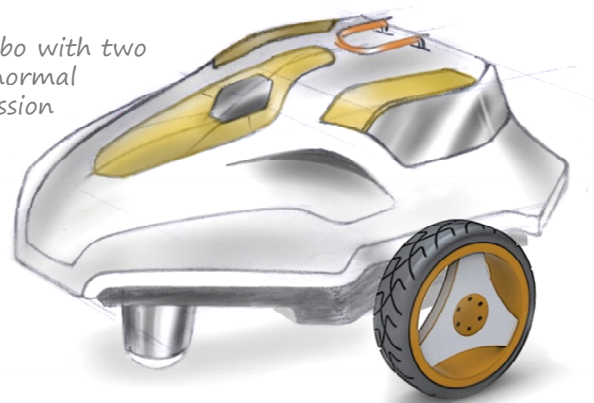


FINAL CONCEPT OF ROBOTIC KIT

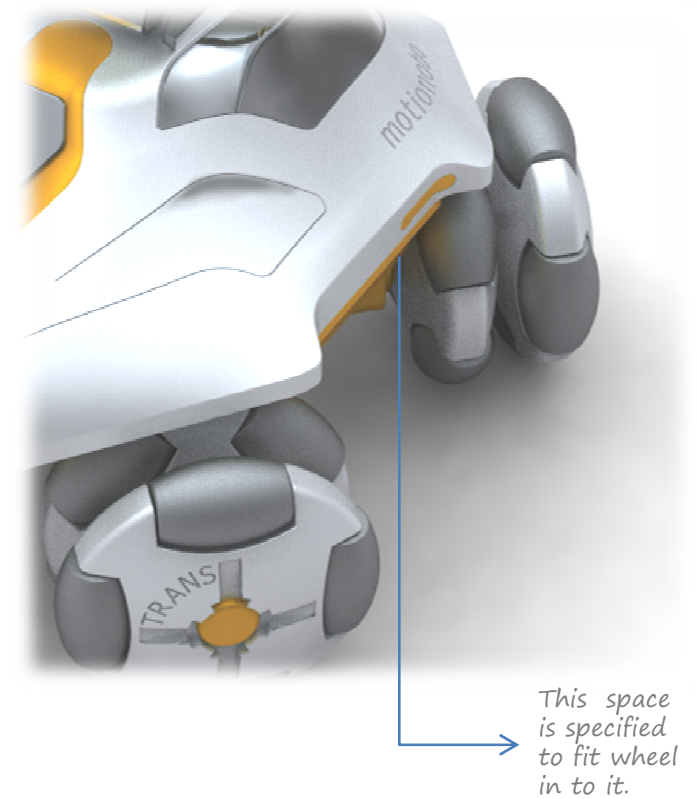
features

Other type transmission system can be fitted to main body that will be covered to meet the need of various kinds of motion.

*Motionobo with two
wheels normal
transmission*



Top view

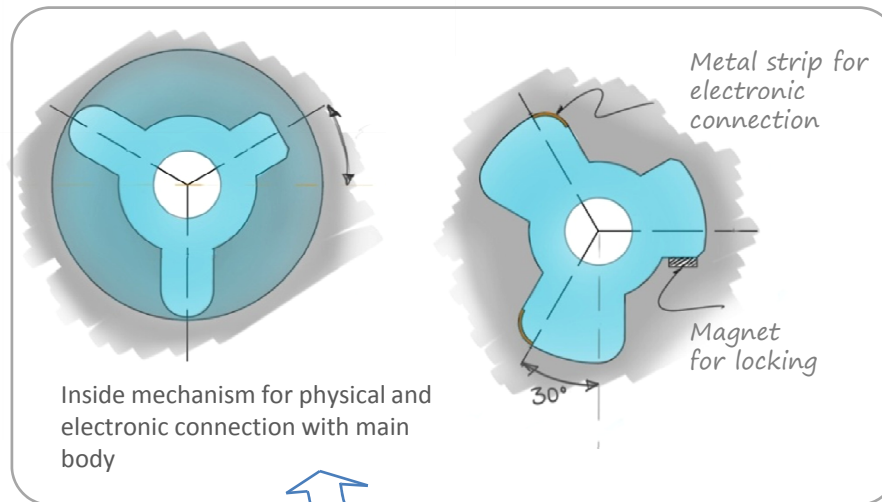


*This space
is specified
to fit wheel
in to it.*

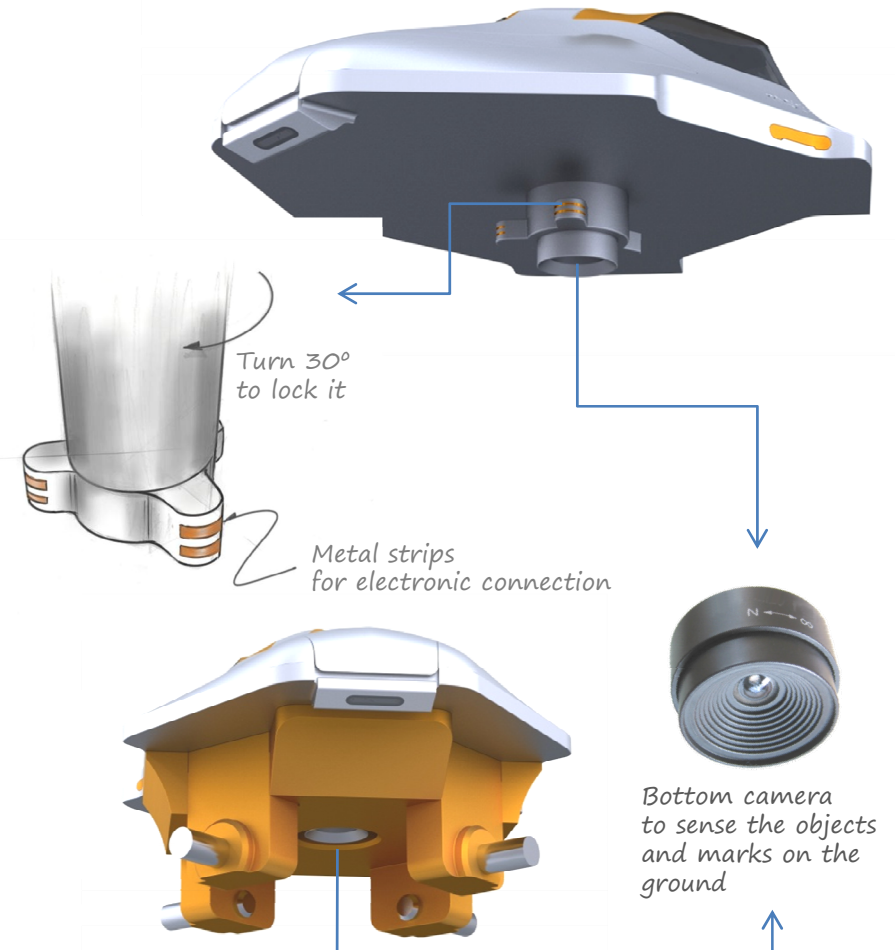
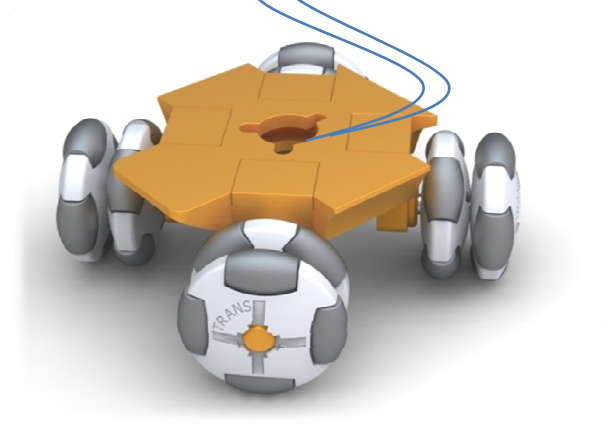
FINAL CONCEPT OF ROBOTIC KIT

features

Physically and electronically attachment / detachment of various transmission system is so easy, that children can handle it without pain.



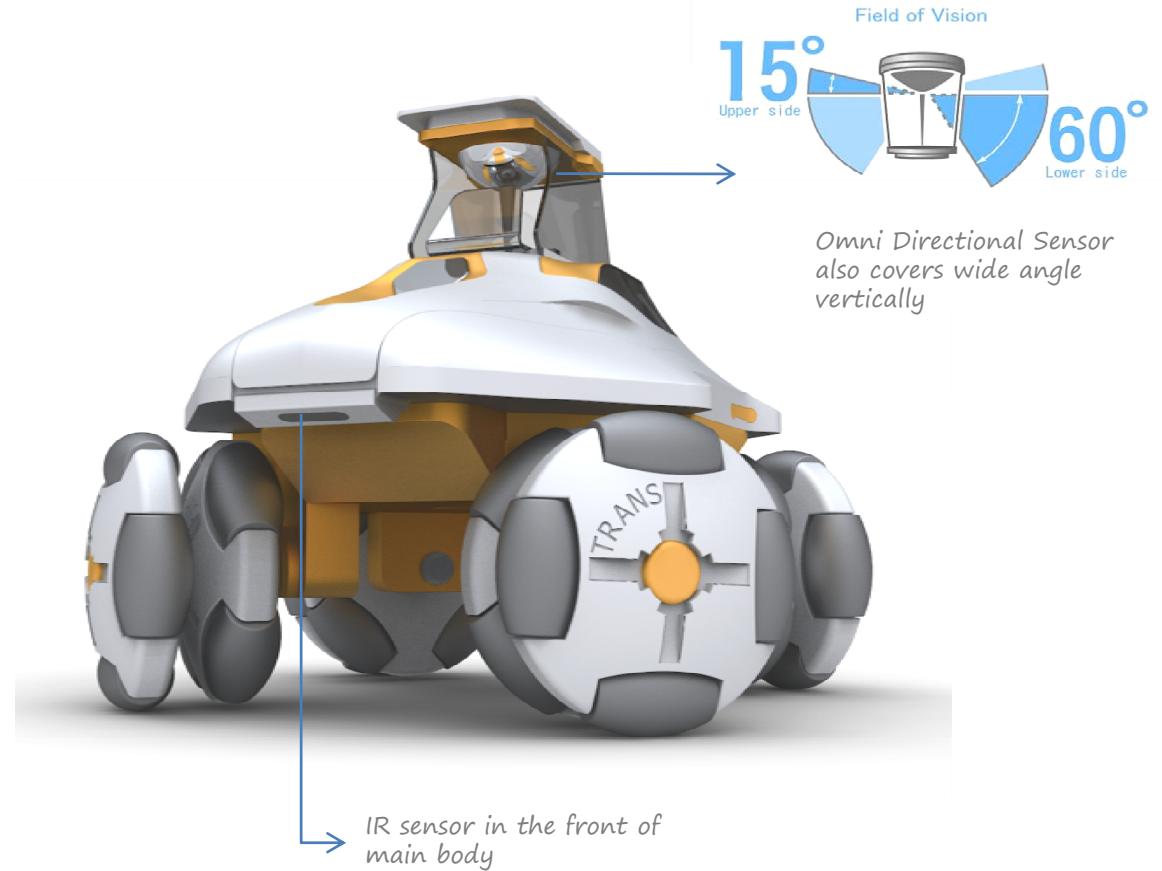
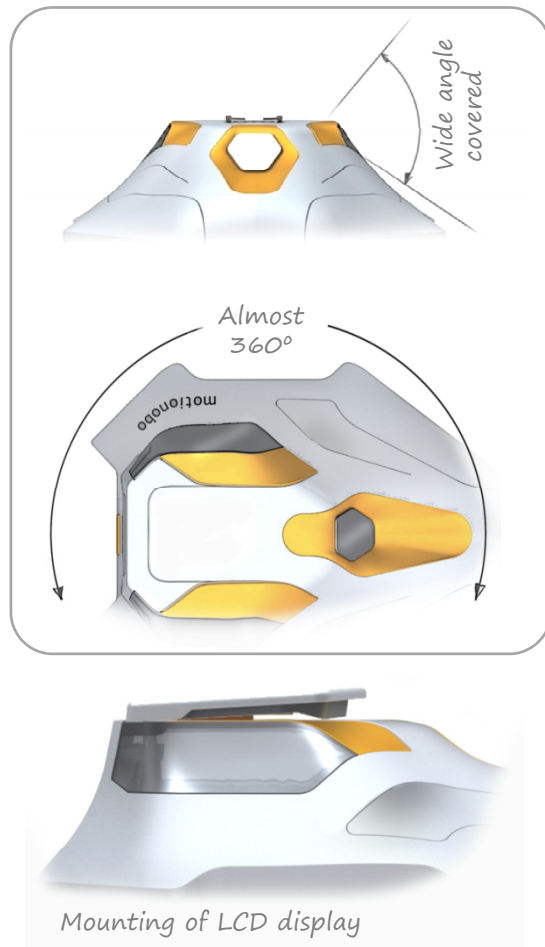
Inside views



FINAL CONCEPT OF ROBOTIC KIT

features

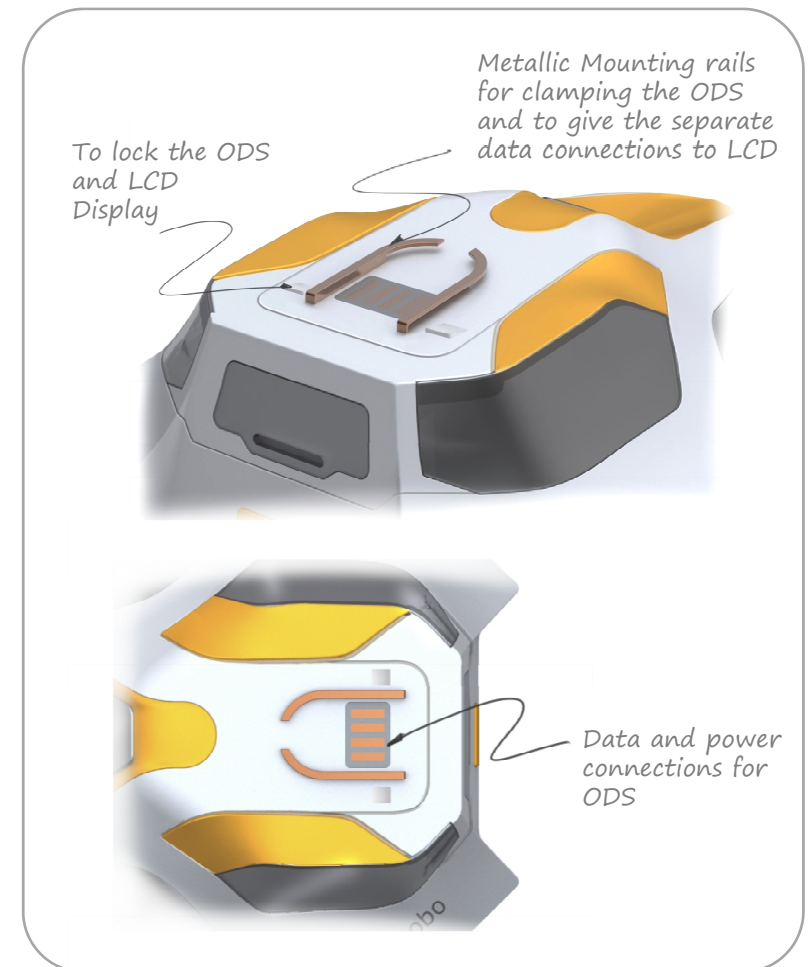
Whole body of the robot is ornamented with various no. of sensors (sound, obstacle detector, light etc.) required in different games for different purposes.



FINAL CONCEPT OF ROBOTIC KIT

features

Robot has a Omni directional Sensor on the top of it. Which is able to cover all the surrounded volume as per the need.



FINAL CONCEPT OF ROBOTIC KIT

features

There is a Sensor Magazine to be inserted into back of the robot. The filling of sensors on the periphery of the sensor magazine , will be according to the games requirements.



Robot without sensor magazine



*Different sensor magazine with
different combinations for sensors*

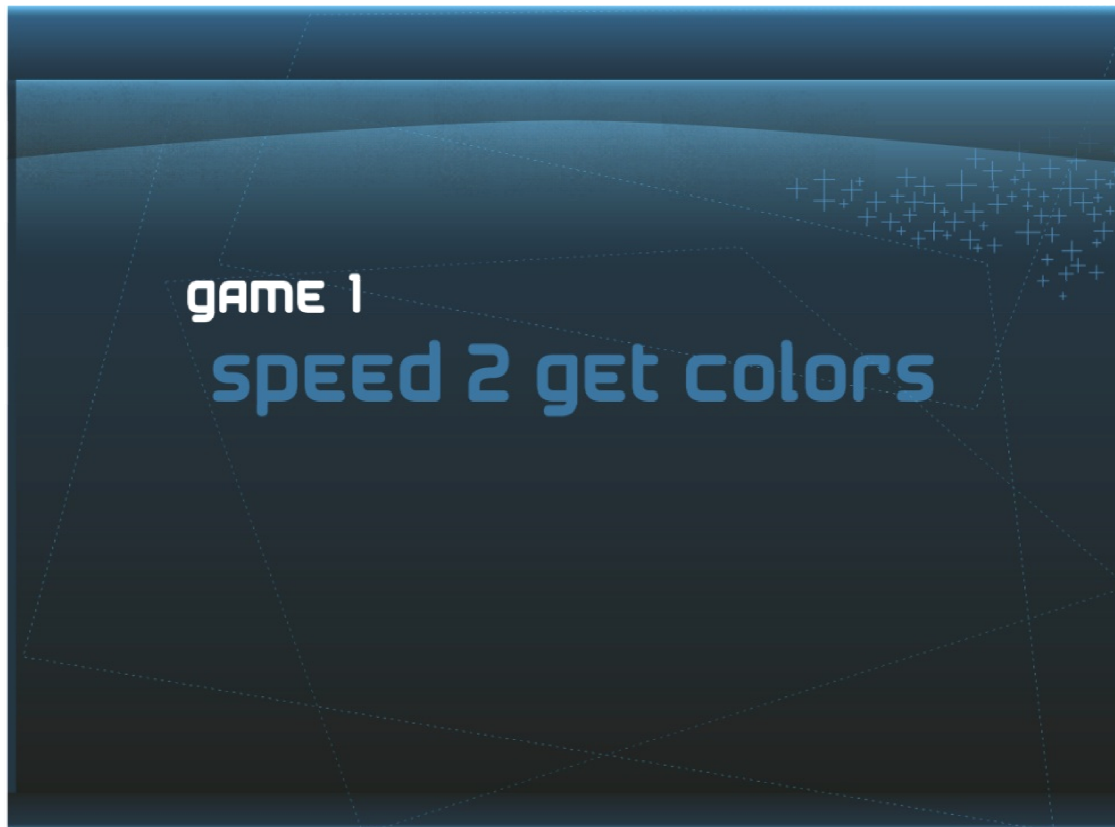
Preparation of robot for the games



Pictures of prototype



GAME 1



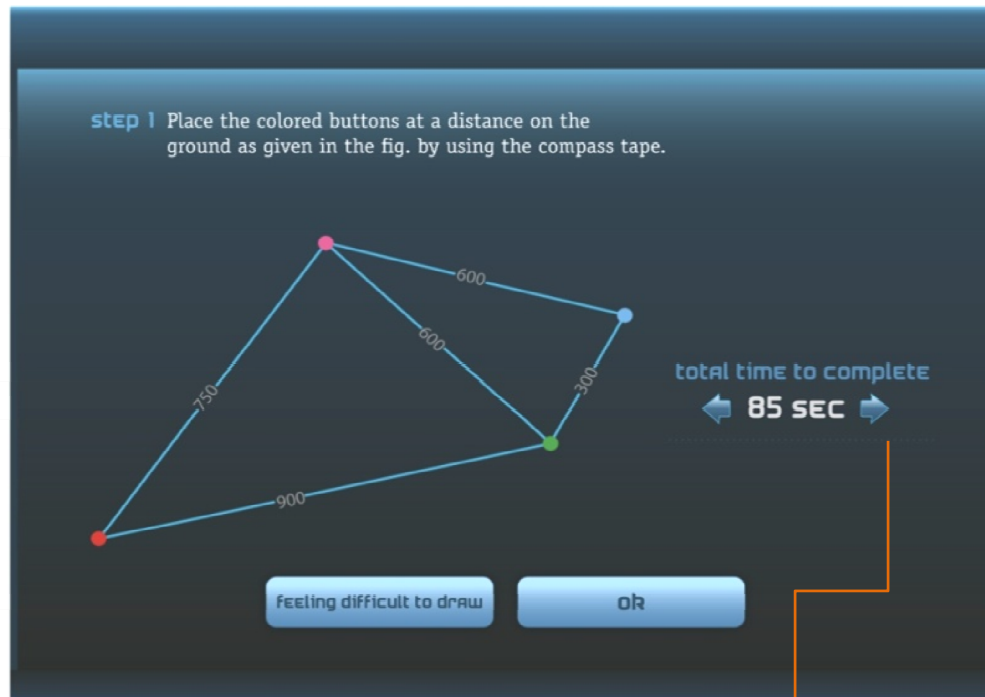
No. of players : one / two

Name of game : speed to get colors

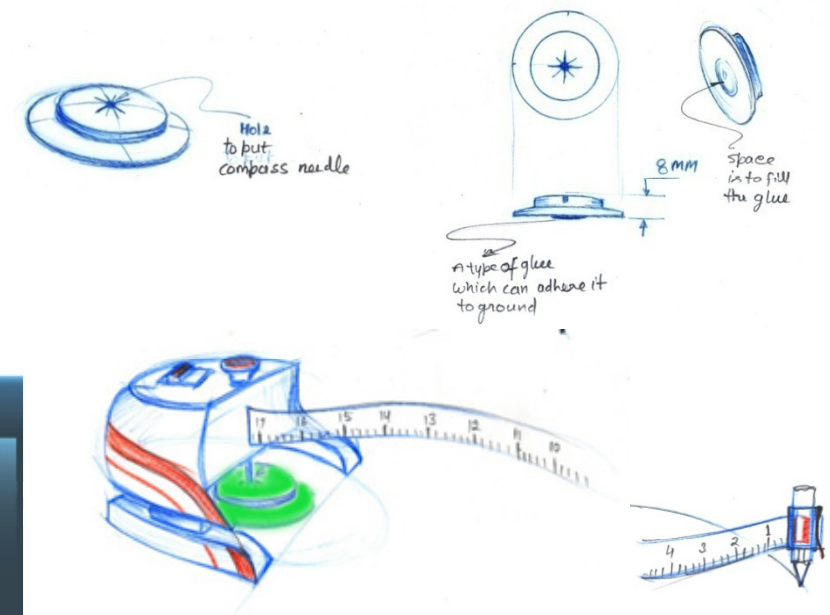
Learning topic : Speed

How to play

A set of some colored buttons, measuring tape & a compass will be given to the player to make a proposed path geometry on the floor by putting the buttons on the desired nodes. They can try more geometrical paths (tracks), available with certain target time for each.



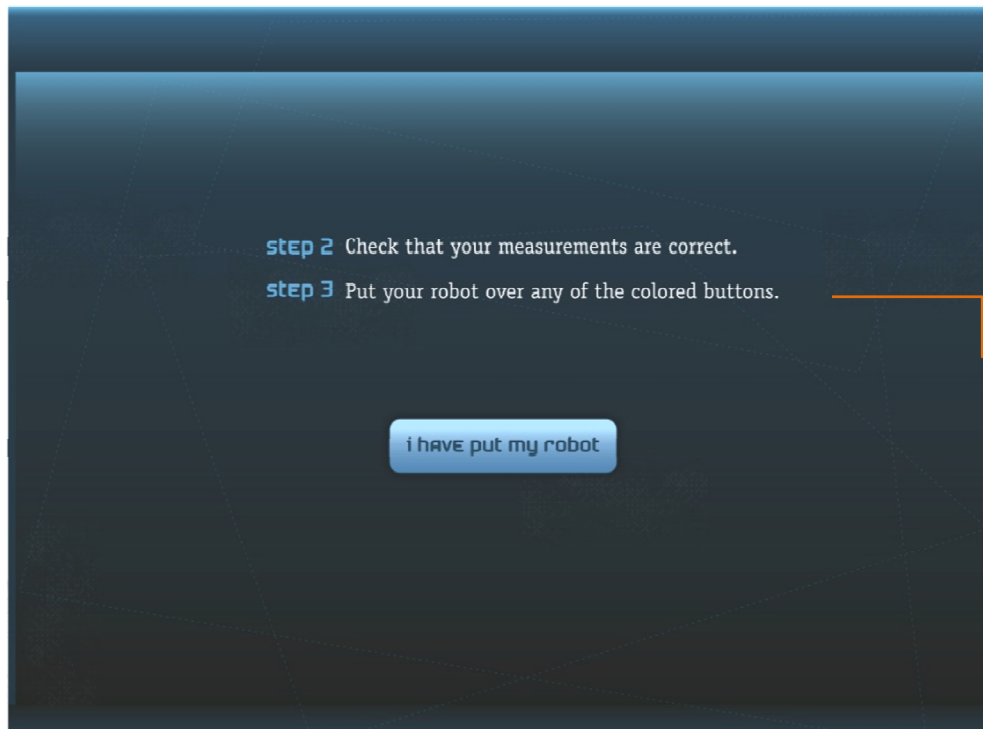
Computer Interface
Screen 1



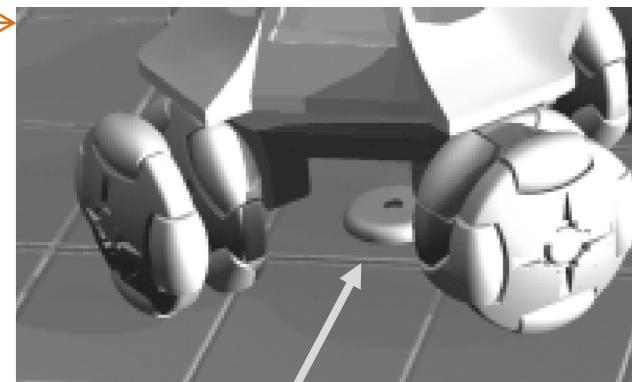
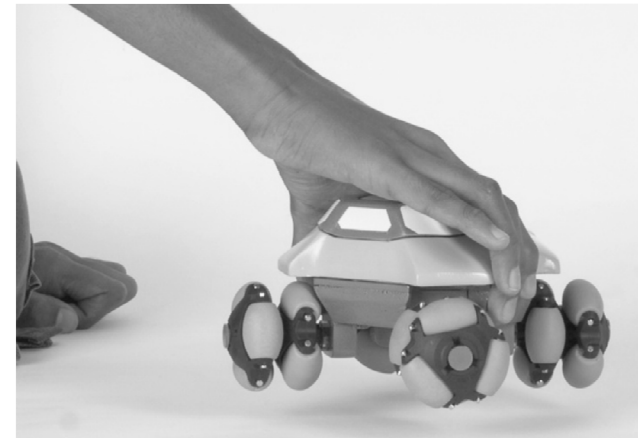
On the ground

→ To find more tracks

Now, player has to put the robot over any of the buttons. Robot will automatically adjust to correct its position w.r.t. the colored button.



Computer Interface
Screen 2

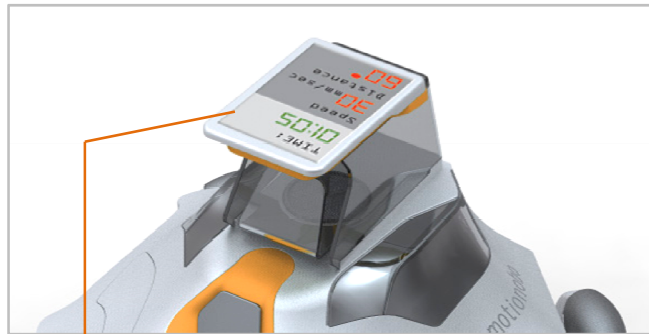


On the screen, there is corresponding time target displayed on the top. And this time has to be distributed among the given no. of segments of the path. Child has to choose the colors in a sequence where robot has to reach with a desired speed. Which means, how much time will be spent in each segment within the limitation of speed so that total time can meet the target .

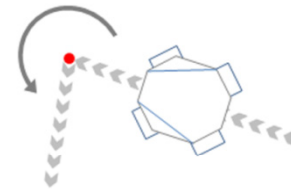


Computer Interface
Screen 3

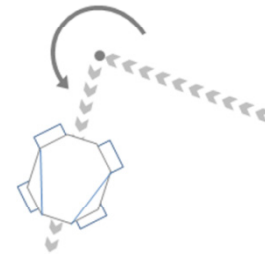
During run time, a time piece on the top of the robot will display time taken in individual segment journey .



Movement of robot



Spot turning (to turn at a position about its axis of center of mass without moving in an arc)



Body of the robot turns in the direction of motion.

Score of the game:

Score will be collected from individual segments. If player reaches exact on time at selected color, will get 10 points .
 On delay or fast of 1-2 sec, he will get 8 points.
 On delay or fast of 3-5 sec, he will get 5 points.
 On delay or fast of >5 sec, he will get 0 point.

GAME 2



No. of players : one / two

Name of game : Direction to Final destination

Learning topic : Speed

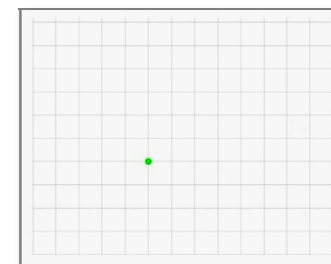
Kit



Motionobo (Robot)



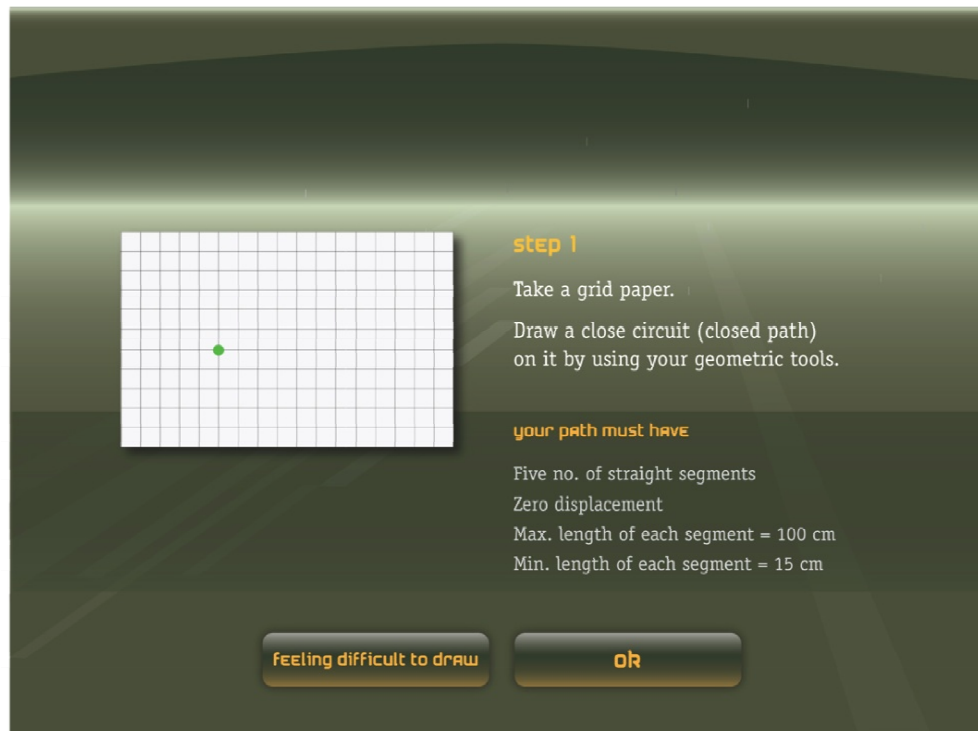
computer



Grid paper

How to play

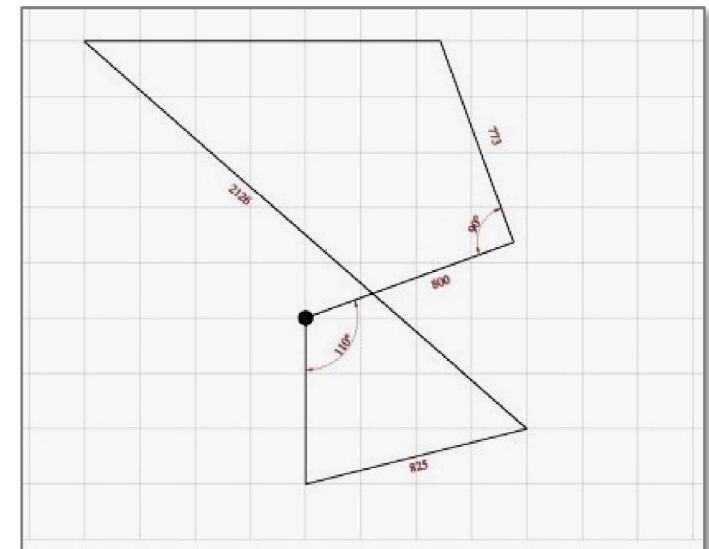
This game also has real physical activity with the robot by using 'on screen preprogramming control' – which means user will interact with combined model of physical and digital, whatever input he will be giving on digital interface, output result will be the movement of a robot on the floor. Apparently This will resemble the characteristic of a robot.



Computer Interface
Screen 1

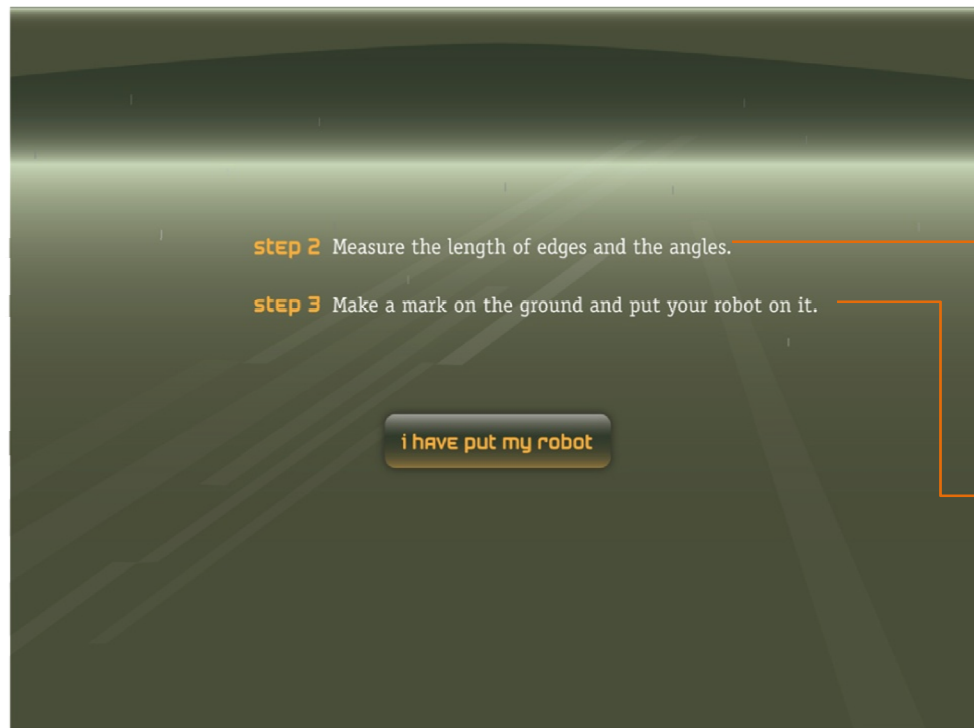
The kit of this game includes a set of grid papers which are given to the player. He will be asked to draw a close circuit (closed path) on it by using his geometric tools. The path should have

- 5 no. of straight segments
- zero displacement
- max. length of each segment = 100 cm
- min. length of each segment = 15 cm

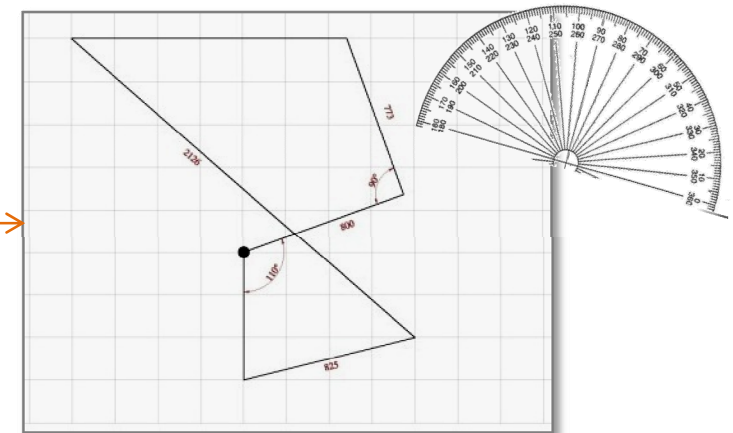


Closed circuit (track) on grid paper

To play this game child has to measure the relative angle also.
Means with the reference of previous angle. Now he has to make a
mark on the ground to put the robot on it.



Computer Interface
Screen 2



Relative measurement



For each segment time is always constant, that is 30 sec. and now on screen, he has to input the velocity for each segment in sequence (in terms of Speed and direction)

time for each segment 30 sec

Speed must be in between 5 - 35 mm/sec

how to input

Measurement of Angle
+VE -VE

velocity 1 Speed mm/sec Direction

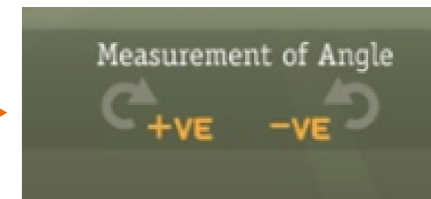
velocity 2 Speed mm/sec Direction

velocity 3 Speed mm/sec Direction

velocity 4 Speed mm/sec Direction

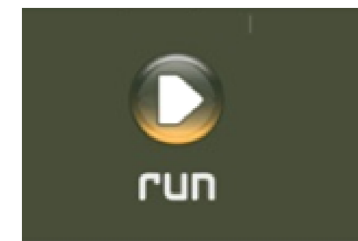
velocity 5 Speed mm/sec Direction

run



Velocity
speed direction

Examples
How to calculate the speed and angles



Computer Interface
Screen 3

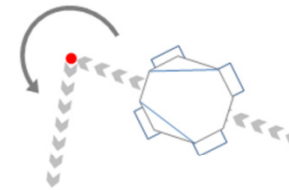
During run time, path travelled by robot will be tracked on the screen display. Robot LCD display will shows the distance covered in each segment, so that the player can fix the error, if any.



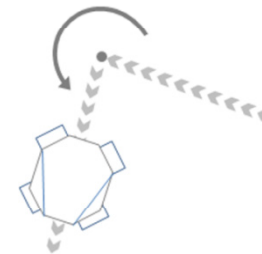
Distance covered
in last segment
400 cm
Speed
30 mm/sec
Distance
60

No. of errors direct affect the rewarded score.

Movement of robot



Spot turning (to turn at a position about its axis of center of mass without moving in an arc)



Body of the robot turns in the direction of motion.

Score of the game:

The player has to complete his self made circuit . And if the display of robot shows displacement is zero – he will get 100 marks

if displacement is 1-5 cm , he will get 70 marks.

if displacement is 5-10 cm , he will get 40 marks.

if displacement is >10 cm , he will loose the game.

GAME 3



No. of players : one / two

Name of game : All About Velocity

Learning topic : Difference between
Speed and Velocity

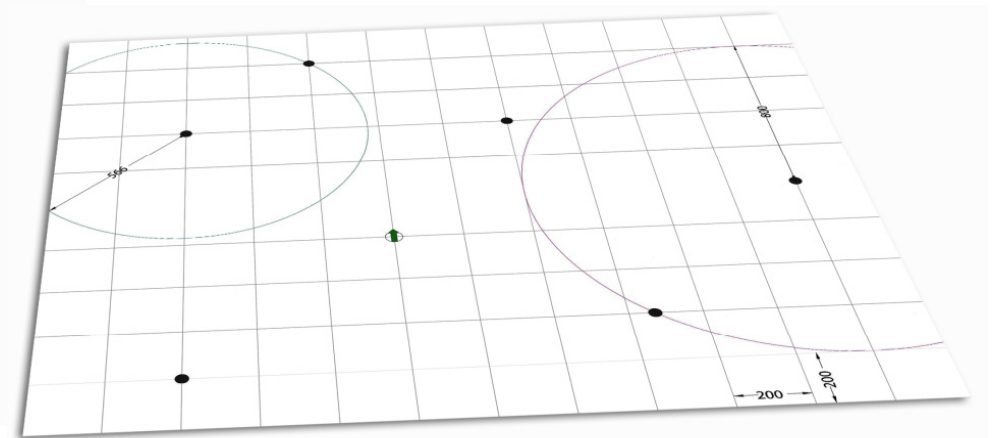
Kit



Motionobo (Robot)



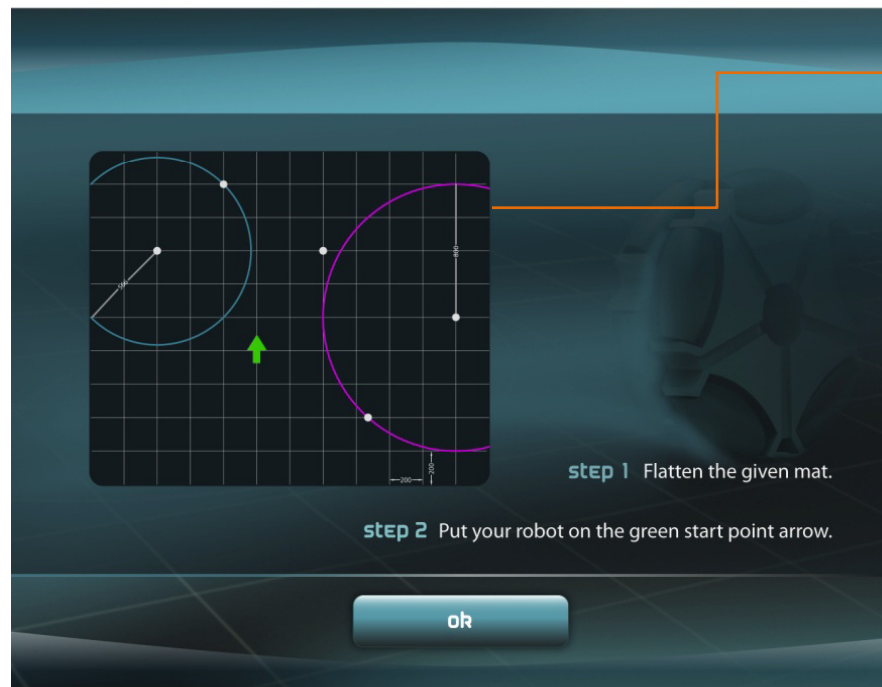
computer



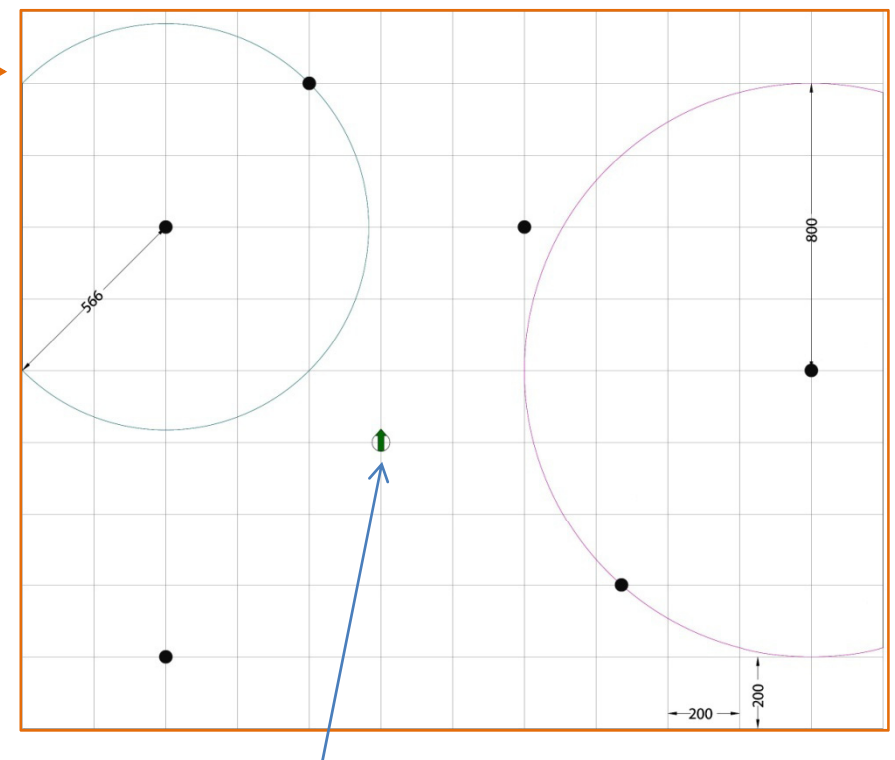
mat

How to play

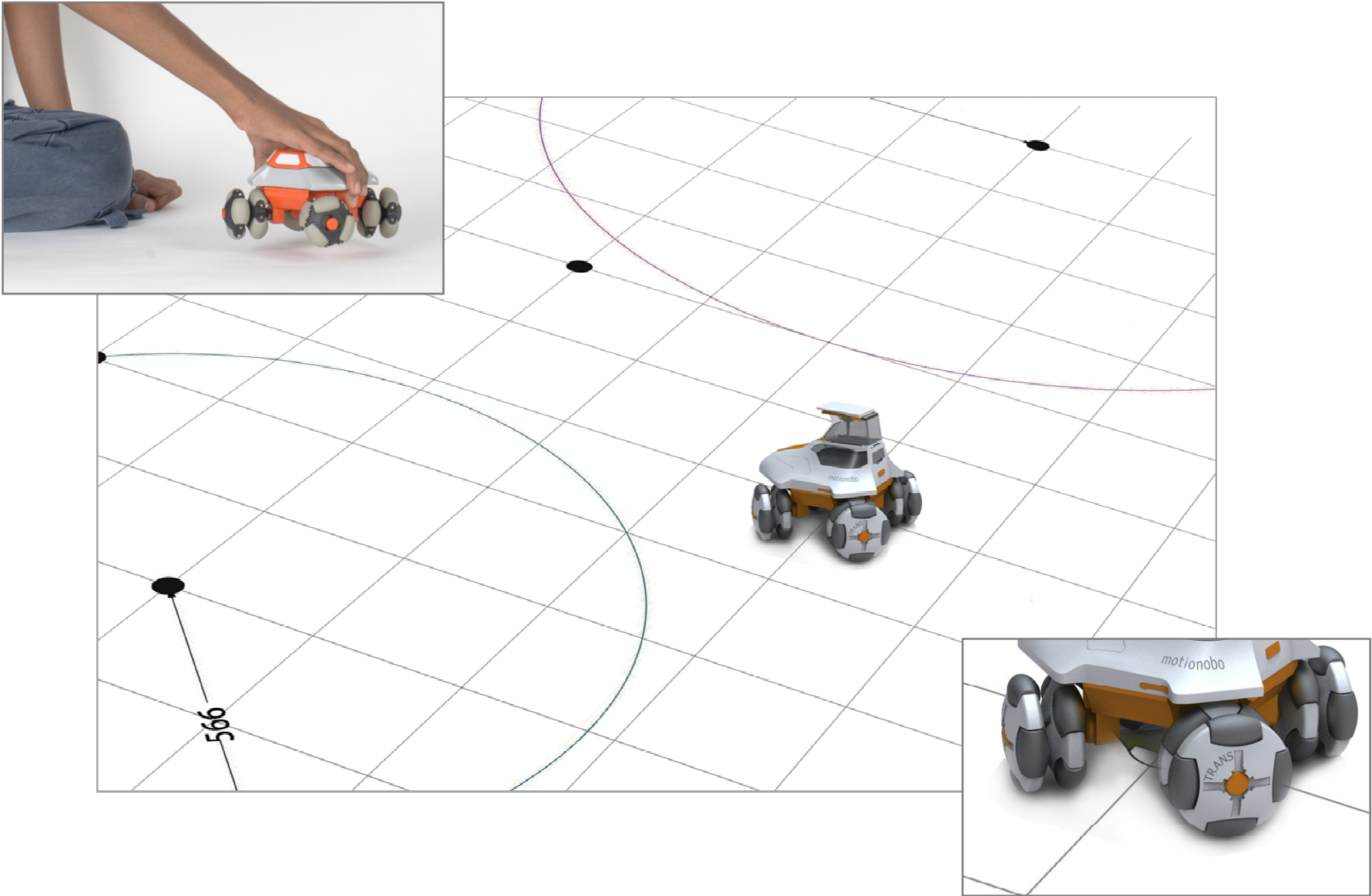
This game is also played with physical and digital interface. The player will be instructed to open the mat on the floor. It has a grid in the background & some destination dots. Robot is put on the green start point arrow. It is capable to correct its direction along the arrow direction.



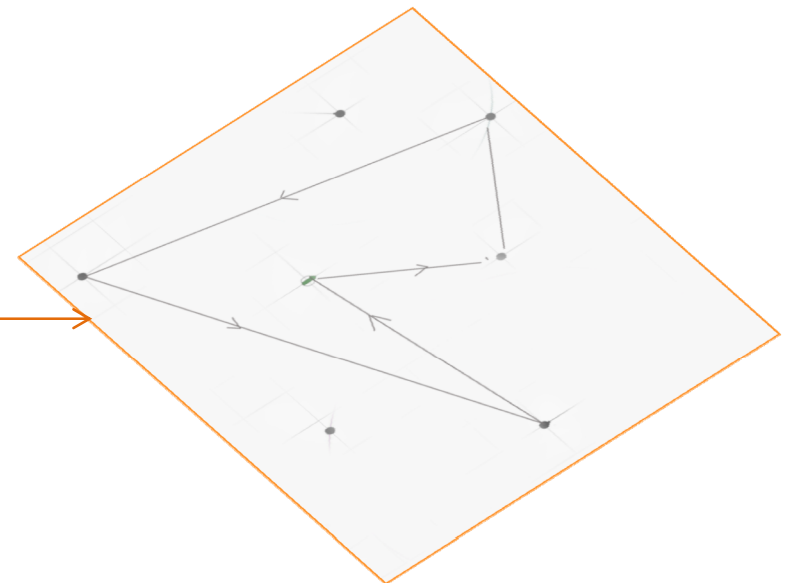
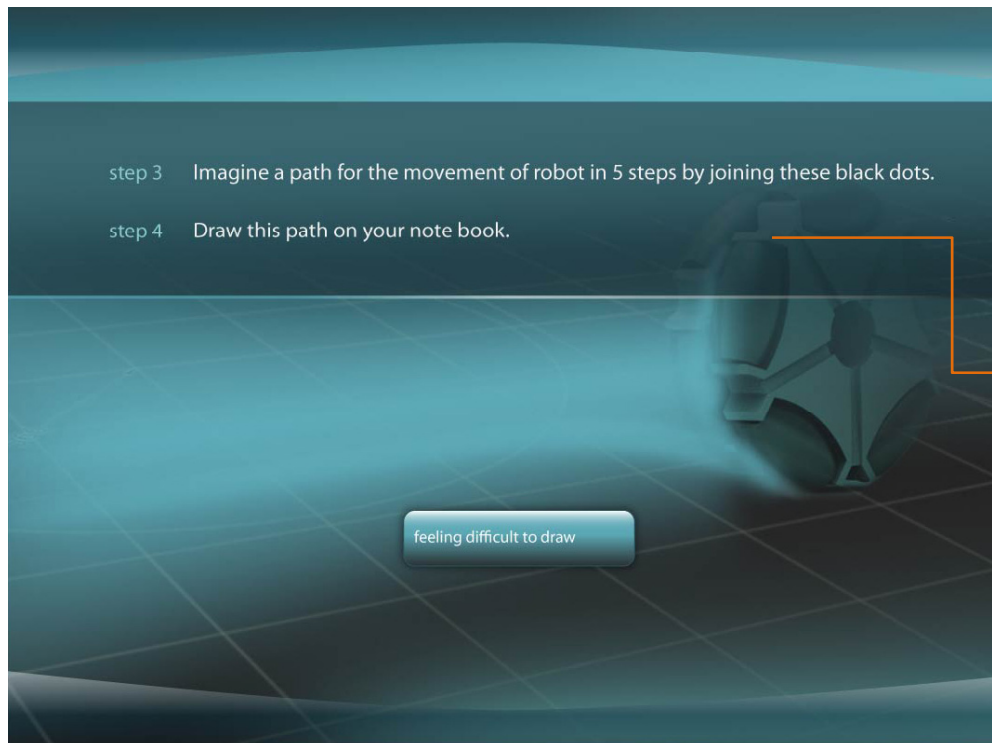
Computer Interface
Screen 1



green start point arrow



Now, child (the player) will be asked to imagine a path for the movement of robot in 5 steps by joining these black dots.



Computer Interface
Screen 2

Input interface has targeted Total Time at its top & has very unique way of inputting the velocity for several segments of the path. For some of the segments, knob type buttons are on the screen to input the velocity in terms of speed and direction. But for some, velocity values has to be inputted in two orthogonal direction by using slider type control buttons.



Computer Interface
Screen 3

Target time

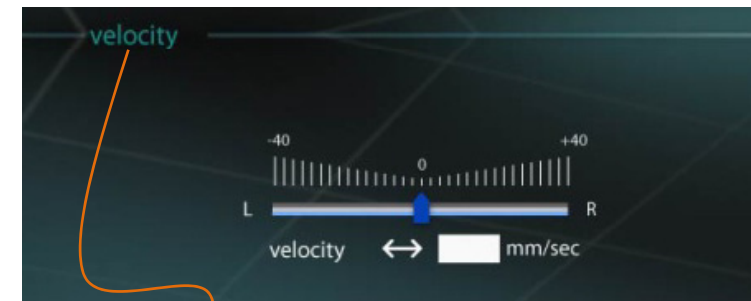
Instructions (with examples) for
"How to calculate"
"How to use the interface to input values "



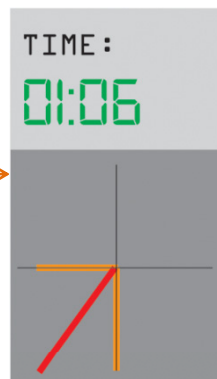
This interactive way of inputting the value makes the interface easier to convey “how to input the value even when you don’t have direction in degrees of any segment of path. Moreover it helps them to under stand that Velocity can be measured in two orthogonal directions.



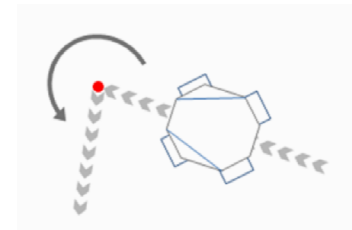
Computer Interface
Screen 3



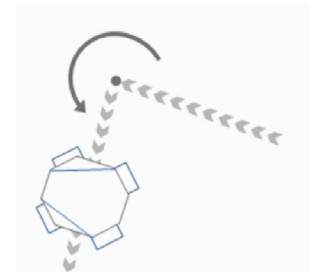
During run time, path travelled by robot will be tracked on the screen display. Robot LCD display will shows the distance covered in each segment, so that the player can fix the error, if any.



Movement of robot



Spot turning (to turn at a position about its axis of center of mass without moving in an arc)



Body of the robot does not turns in the direction of motion.

Score of the game:

Score will be collected from individual segments of the path.

If player reaches exact at destination dot, will get 10 points . Otherwise 0 point.

(every dot will have a tolerance zone of 2 cm radius)

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