

play kit in Bamboo based on Optics

PRODUCT DESIGN
PROJECT II

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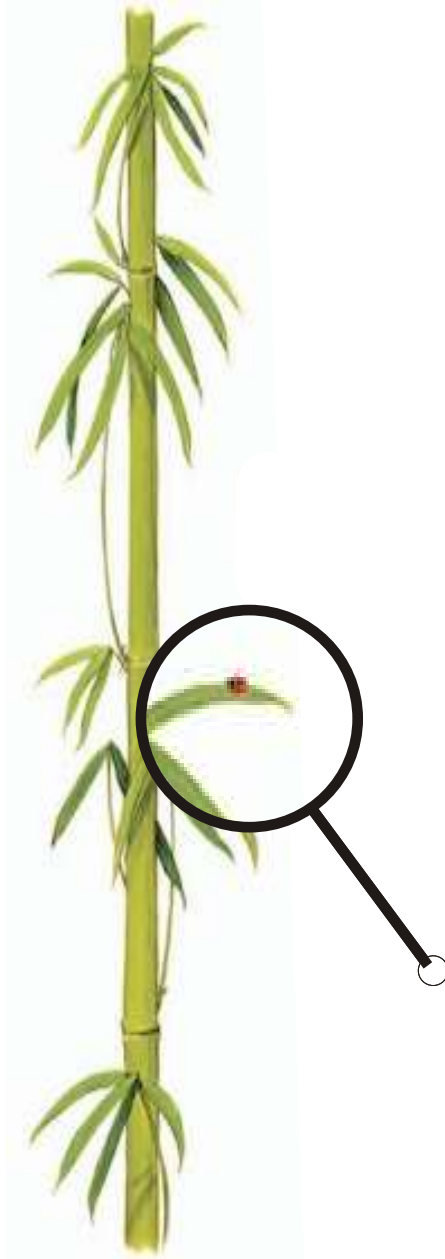
Guide: *Prof. A.G. Rao*

Submitted in the partial fulfillment of the requirements for the degree of

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in
Industrial Design

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The Product Design Project II titled “ **Play Kit in Bamboo based on Optics** “ by **Rupesh Nath. U, 0 5 6 1 3 0 1 0** “ is approved as a partial fulfillment of the requirements for Post Graduate Degree in Industrial Design.

Project Guide

Chair Person

Internal Examiner

External Examiner

Date

ACKNOWLEDGEMENT

With a sense of achievement and satisfaction, as I reflect upon my project activity, I filled with a deep sense of gratitude towards the important few whose help and support was instrumental in the completion of my project.

I wish to express my gratefulness to my guide **Prof. A.G. Rao** who encouraged and inspired me in undertaking this project. I thank him for his guidance, co-operation and valuable advice throughout the course of my project.

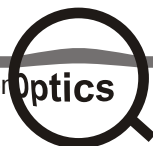
With deep sense of indebtedness, personal achievement and pride myself be able to state with conviction that I have immensely benefitted from auspicious and prestigious association with him. His patient involvement, his interest and care in my difficulties and his enlightening presence have been responsible for the project to take its present shape. Gratitude from the core of our hearts is all due to him.

I thank my department **Industrial Design Center** for providing me with wonderful facilities during the course of my project development.

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I also would like to thank my senior **Sunil** and my batch mate **Sachin** for backing up when i am depressed.

Last but not the least I extend my heartfelt thanks to one and all who encouraged, helped and supported me from time to time.



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Study of School Curriculum of 6th to 12th standards
Interaction with user

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Final Concept

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Reference and Bibliography



Reflecting the philosophy, "*Children do not play to learn - but they learn from playing* "

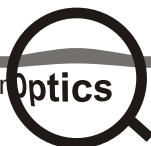
Initiate a learning process where standard optical devices are manipulated to obtain known results with defined learning objectives. The process or activity will be a play, which will lead to trigger creative and open-ended results bringing in new learning objectives to comprehend the principles of light in a tacit way.

The fallout of the play will become a tool to compare and understand the principles of light, which are taught as theories in higher studies. In short providing practical knowledge as an experiential learning before getting theoretical knowledge.

There are lot of things, which nobody taught us, but we know them and most of these we learnt while playing with the things around us. A child can find joy and excitement in discovering things. Play is very much an essential activity in the child's daily activities contributing in a manner similar to health and development. For a child a plaything can be anything from a simple stick or a stone to complex play objects. Playthings are indirect teachers for kids, which implant knowledge in playful mode. Hence, right kind of toys has direct implication on the overall development of the child.



Playing is an excellent and unique means of improving the child's perceptual, manipulative and conceptualising abilities while he is having fun. Although the importance of concrete experience in learning process has long been recognized by educational psychologists children are rarely given an opportunity to learn through play and manipulation. Our educational system is too bookish, promoting routine learning of facts and methods rather than encouraging learning of facts from experience.



Nowadays children have many varieties of play kits. With new technologies and materials many possibilities and challenges are introduced in these kits. In this project, bamboo has been taken as a primary material for designing the kit. It is a natural material and its cohesiveness with ecological balance should set new standards of awareness for parents and teachers. The unique properties of bamboo one explored and the understanding of constraints kept in mind in the design approach. Its properties like hollowness, shape, and availability in various diameters and wall thickness were studied. In addition, bamboo as a material is used in a very limited ways. This is an approach to introduce bamboo as an eco-friendly material in this highly competitive market and showing a new dimension to the bamboo crafts persons.



Hence, this project aims to develop a play kit or science kit in bamboo using the optical devices, which could become a tool to help children learn principles of optics in an enjoyable and interesting way through play as an activity.

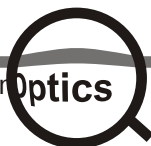
Aim

- To design an aid to explore important concepts of optics through their expressive activities i.e., through play and comprehend the principles of optics in a tacit way, most broadly to help them become better learners.
- The design challenge is to develop features that are specific enough so that kids can quickly understand how to use them but general enough so that kids can continue to find new ways to use them.
- Exploring the bamboo as material and developing product to utilize the advantageous properties of the material.



Scope

- To design a play kit with mirrors, convex, concave lenses, convex and concave mirrors which can be handled by 10 years and above age group.
- Using user friendly, warm to touch properties of bamboo.
- Use of innovative joints to make the kit easy and convenient to play without having the fear of handling precise elements like mirror and lenses.



- An aid to understand the abstract theories and relate them with every day experiences.

Why Optics ?

Imagine the world without light, or imagine yourself without eyes, yes it is dark and dark and dark everywhere. Light is an essential source for our life and eyes are also very essential part our perception. Our day starts with rise of the light source and in one day, we experience with different kinds of light starting from sunlight to moonlight, in-house lighting to out door lighting, candle light to flood light.

Knowledge gained during the childhood will play a very important role in the development of the individual since it is the period during which the maximum development of the intellectual abilities occurs. The intellectual abilities develop from the process of learning. Hence children must have concrete experiences from which they are able to compare with reality instead of abstract form and find meaning quickly in what ever they read and hear.



Light is a source by seeing or playing gives a feeling of other world. People really enjoy when they themselves manipulate or see others manipulate the light. The optical devices, which are given in higher studies, are not easily available for play. They are given once or twice for a serious activity in their whole educational system (primary and secondary). Play is spontaneous and voluntary activity that is inherently pleasurable and enjoyable. Play has the potential to provide the concrete experience so necessary for learning. The value of play both in educational terms and in terms of promoting social interaction and developing the children's perceptual, manipulative and conceptualizing abilities has long been recognized by the child psychologists. However, children are rarely given an opportunity to learn through play and manipulate.

Hence, this project aims to provide children eco-friendly, playful optical devices to manipulate, explore and gain some learning experience which could be useful in their learning of fundamental principles of optics.

Optics is one of the major areas where people does not have much play kits, and the existing one are also not playful. It is still an area with high opportunities for exploration.

Why in Bamboo ?

- Natural Material, Eco-friendly, fast growing biomass, one of the grass family and it can be cut in the Forest, it also has high value in the market, much elegance can be brought in the product .
- Naturally curved cylindrical body gives an advantage of form and shape.
- Coiled plate can be used for cap and bottom. This will help reducing use of wood and will act as a good substitute
- Bamboo is solid and easily blocks light. This helps in directing light in one particular direction.
- It does not get heated up by bulb light.
- Assembly is very simple and can be easily done by children.
- Provides flexibility in sizes to accommodate different sizes of material
- Electrical insulator
- Lack of any toxic constituents

From market aspect:

- ? No such toy in market
- ? Gives freedom to creativity
- ? Can cover a wide range age groups



Stage 1

Study

- Understanding cognitive developments of the user
- Learning processes of child
- Syllabus of NCERT and optical instruments used in laboratory
- Interaction with kids, parents and few others

Stage 2

Understanding the Material

A study was done to understand inherent properties of bamboo, its availability, form, sizes, usages and processes. People have just started exploring bamboo as a material for play kits but they are up to very basic levels. Combining with other materials it can be explored more and the elegance can be achieved. Good use of bamboo itself can add to the elegance of product.

Stage 3

Market Study

Market Study of the existing play kits in bamboo as well as in other materials was done to understand the market trend and to develop a deeper understanding of the categorisation.

The games or kits were classified according needs of different age groups. This study has also given a clear idea of target group and its position in the market.



Stage 4

Ideation

Initially mirrors were taken to generate ideas, slowly other optical devices were brought in the kit.

Stage 5

Exploratory Models and Arriving at Final Concept.

To get hands on experience as a new material like bamboo, the ideas generated are directly tried out in bamboo. As the process continued some elements were decided and keeping them as constraint final concept is derived.

Stage 6

Testing and Optimising

Since the age group is new to optical devices, the kit is tested and optimized to provide what they need.

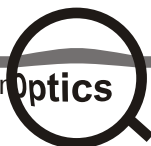


STAGE

Child psychology and Learning Process

Study of School Curriculum of 6th to 12th standards

Interaction with the user



Stages of cognitive development

Cognitive development refers to **"...how a person perceives, thinks, and gains an understanding of his or her world through the interaction and influence of genetic and learned factors"** (Plotnik, 1999)

Piagetian Model

1. Sensorimotor stage (0 to 2 years)
2. Pre-operational stage (2 to 7 years)
3. Concrete operational stage (7 to 12 years)
4. Formal operational stage (12 years and above)

Charecterstics of the age group

Charecterstics of the age group of 10 years and above have been selected as the target user group for the project. The following are the charecterstics of the age

Child can perform true mental operations, represent transformations as well as static states and solve conservation, class inclusion, time, and many other problems. Child becomes increasingly critical of their own products, they start working in groups, and they like to explore more in detail. Child still has difficulty in thinking of all possible combinations, as in the chemical problem and of transformations, but they improvise on their own account combinations of materials that need not necessarily serve a useful purpose.

Theories of Learning

Piaget's theory of learning

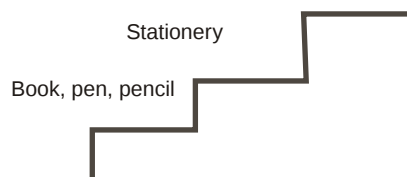
The child performs an action which has an effect on or organises objects, and the child is able to note the characteristics of the action and its effects. Therefore an **action is better than observation**. (described in detail in Piaget 2001)

Vygotsky's theory of the zone of proximal development (ZPD)

The distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers (Vygotsky, 1978)

Independent problem solving ←—————▶ Problem solving under guidance

Skemp's theory of learning



He introduced the idea that concepts constructed by humans from a hierarchy viz. primary, secondary, tertiary and so on. For example book, pen, pencil are primary concepts. Stationery is a secondary concept. **Learning by hierarchy, towards goal**

Jerome Burner's 'Theory of Instruction' and 'Constructive theory'

With the proper structured knowledge within a proper sequence if the children discover for themselves what is beyond it and how to do it, nothing more is rewardable and motivating than this

The idea of motivation and reward is very important because when the teenager sees the positive results of his/her actions, he/she is motivated to go to next level. The use of current / past knowledge means that the teenager recalls and applies to an activity, the previous skills and knowledge he/she has learnt or come across.

Children learn more when assigned a task which motivates them to use the acquired knowledge

Dienes 'Theory of Learning'

Zolta Dienes theory of learning is a process of an increasingly intricate play. He says that these plays are of two types primary play and secondary play.

Primary play Activity with materials without any task i.e., **open ended**.

Secondary play Activity performed with awareness, **aimed at an end**, which is beyond the immediate gratification of desires.

Light or Optics syllabus as prescribed by NCERT, ICSE and other boards for 6th to 12th

Standards:

- ? Materials in terms of transparent, translucent, opaque, and shadow formations.
- ? Reflections from glass, metal, real and virtual images using convex and concave mirrors
- ? Laws of reflections, multiple reflections
- ? Images formed by concave mirror, convex and concave lens; related concepts centre of curvature, principal axis. Optical centre, focus, dispersion of light through prism
- ? Focal lengths of concave, convex mirrors and lenses, either using single lens or combination of lenses

Practical experiments on light or optics are conducted only for the classes 10th and 12th standards only.



Class	Age (in years)	Topics on Optics
VI	10-11	No topics
VII	11-12	Convex and Concave mirrors (Theory only)
VIII	12-13	Laws of Reflection, Spectrum (Theory only)
IX	13-14	No Topics
X	14-15	Study of images formed by Convex and concave lenses, Convergence and divergence using lenses, reflection of light through prism
XII	15-16	Focal lengths of convex and concave mirrors and lenses respectively, Nature and size of images formed using all the lenses and mirrors

- Emphasis on basic conceptual understanding of content
- Promoting process skills, problem solving abilities and applications
- Concepts and contents should be useful in real life situations



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Children:

Age Group : 10 to 15 yrs
No. Of childrens : 10
Schools Visited : K.V. IITBombay, K.V. Gandhinagar

Questionnaire : * Topics taught in Optics
* Topics difficult to understand
* Which topics are enjoyable
* Comparison of the experiments with any other things around
* Any play items using optics



Reply for the above questions:

- The kit can be used either by single or a group
- Change in the device can be allowed
- Child should relate knowledge in the device with academics
- Device should need minimum guidance
- It should look like a product designed for children

Teacher:

No. Of Teachers: 2

Questionnaire: * Which topics are difficult to teach in optics
* How many experiments students have to do in optics
* Are theory and practical taught on the same day/week?
* About apparatus
* What kind of other experiments in optics are done

Reply for the above questions:

- Activity should be initiative and interactive
- Teachers and academics will play a major role
- Peer groups influence the type of game they choose to play

Parents:

No. Of parents : 3

Questionnaire : * Does yourchild play with any optical instruments
* What are the playing timings?
* What influences to buy any play kit?

Reply for the above questions:

- Cost may not be a factor if the product is worthwhile
- Proud of their child's achievements
- First learn and teach
- Knows what are likes and dislikes of the child



Why do they lack interest?

- Our educational system is too bookish, promoting routine learning of facts and methods rather than encouraging learning of facts and methods or from learning experience.
- Understanding of the subject will depend on how **teacher teaches**
- Rigid curriculum (32 hours / week for all subjects) is one of the reasons where teachers are not able to provide children a little extra time to explore with the laboratory equipments.
- Teachers are scared about the accidents if children are given a chance to explore without any restrictions
- Learning process is more **restricted to classroom** only, after the school children will watch TV or doing home work.
- Not much **exploratory models or kits** are available in optics

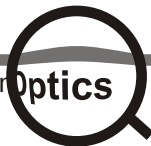
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STAGE

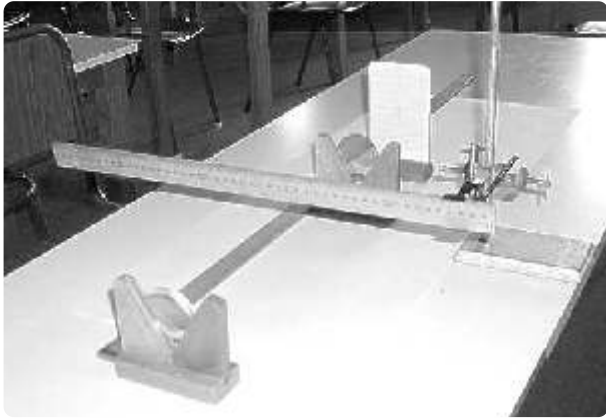
Physics Laboratory Equipment

Playful and Educational Kits

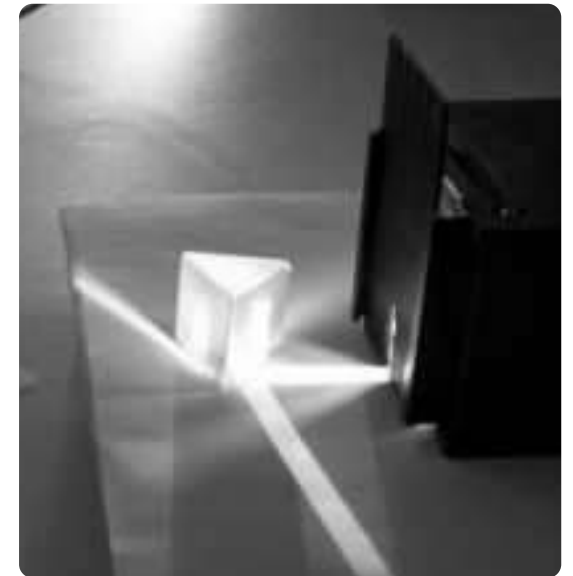
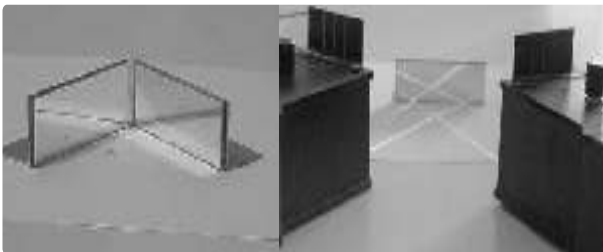
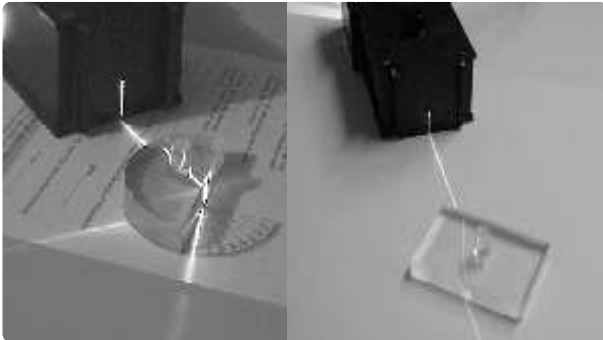
Similar Products

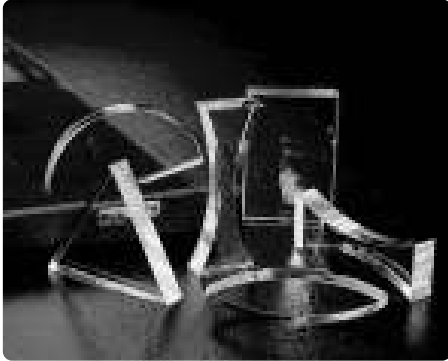


PHYSICS LABORATORY EQUIPMENT



- Laboratory equipment looks very serious and meant for only certain applications.
- No protection is provided to the equipment
- Children are scared of damaging of the equipment
- Mostly the equipments are made of natural material or metal.





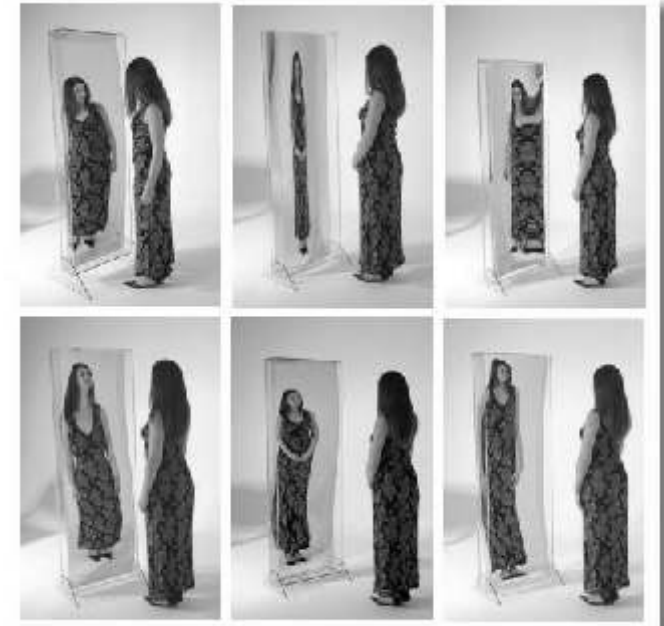
- Kits made with optical devices are hardly playful
- All products are made with plastics but not explored with bamboo or any other natural material
- Only one or two devices is provided with the kit.
- Items with mirrors are not given to handle. They are used as display boards and are bigger in size
- Not much exploratory optical kits are available in Indian market
- The area in optics is still wide open

SIMILAR PRODUCTS

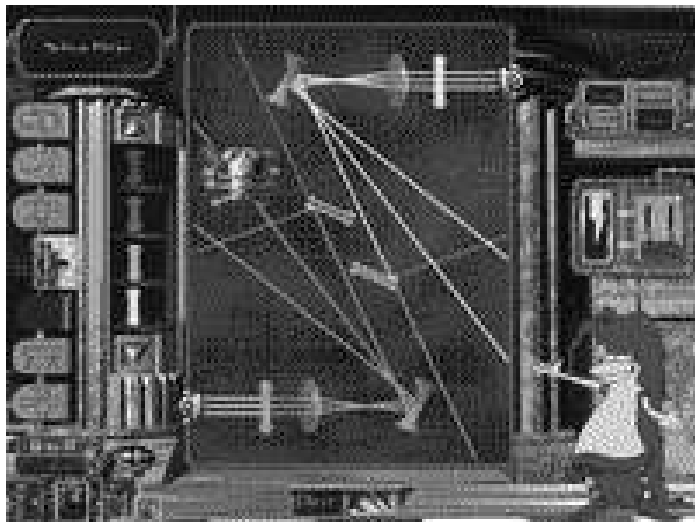
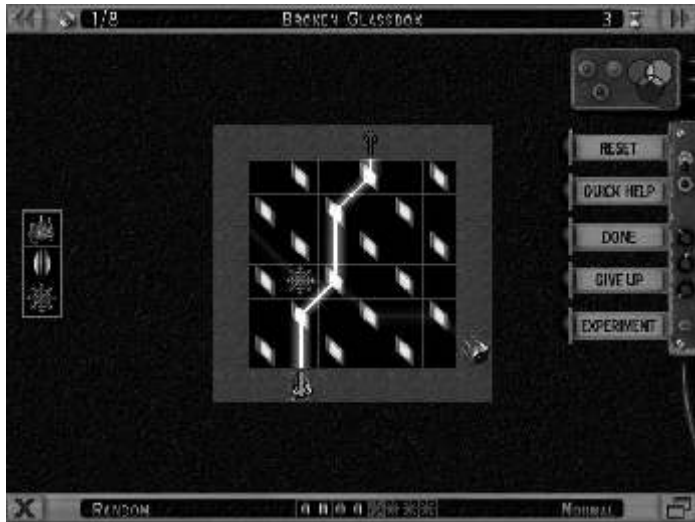
Products: Zoom In - Zoom Out



Products : Fun with Mirrors



Products: Play with LASERS (Virtual or Real)



Similar Products (Kaleidoscope)





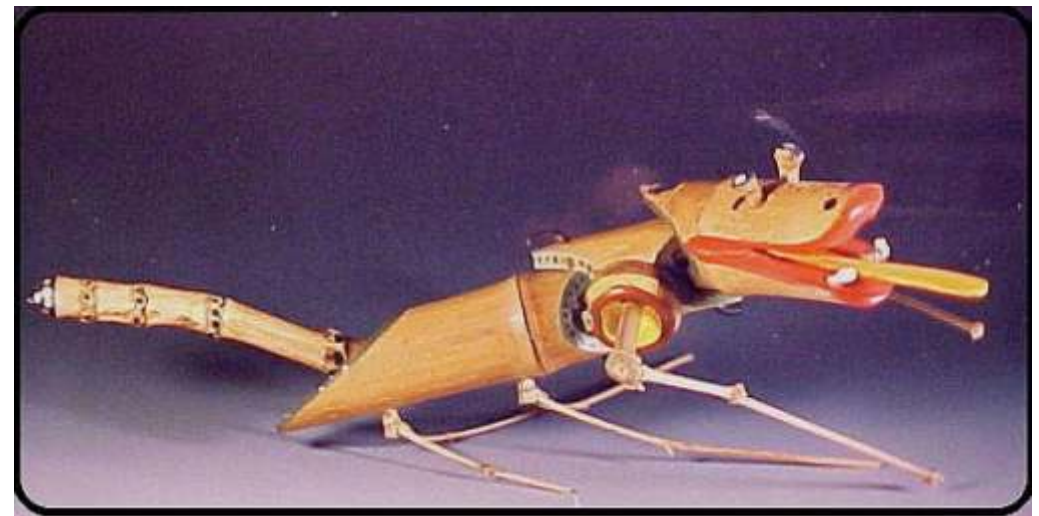


Products made with bamboo are not explored much, especially in optics area

Detailing of the bamboo products is very crude

It is good to see application of colors on bamboo material

Play kits made with bamboo are mostly puzzles



III

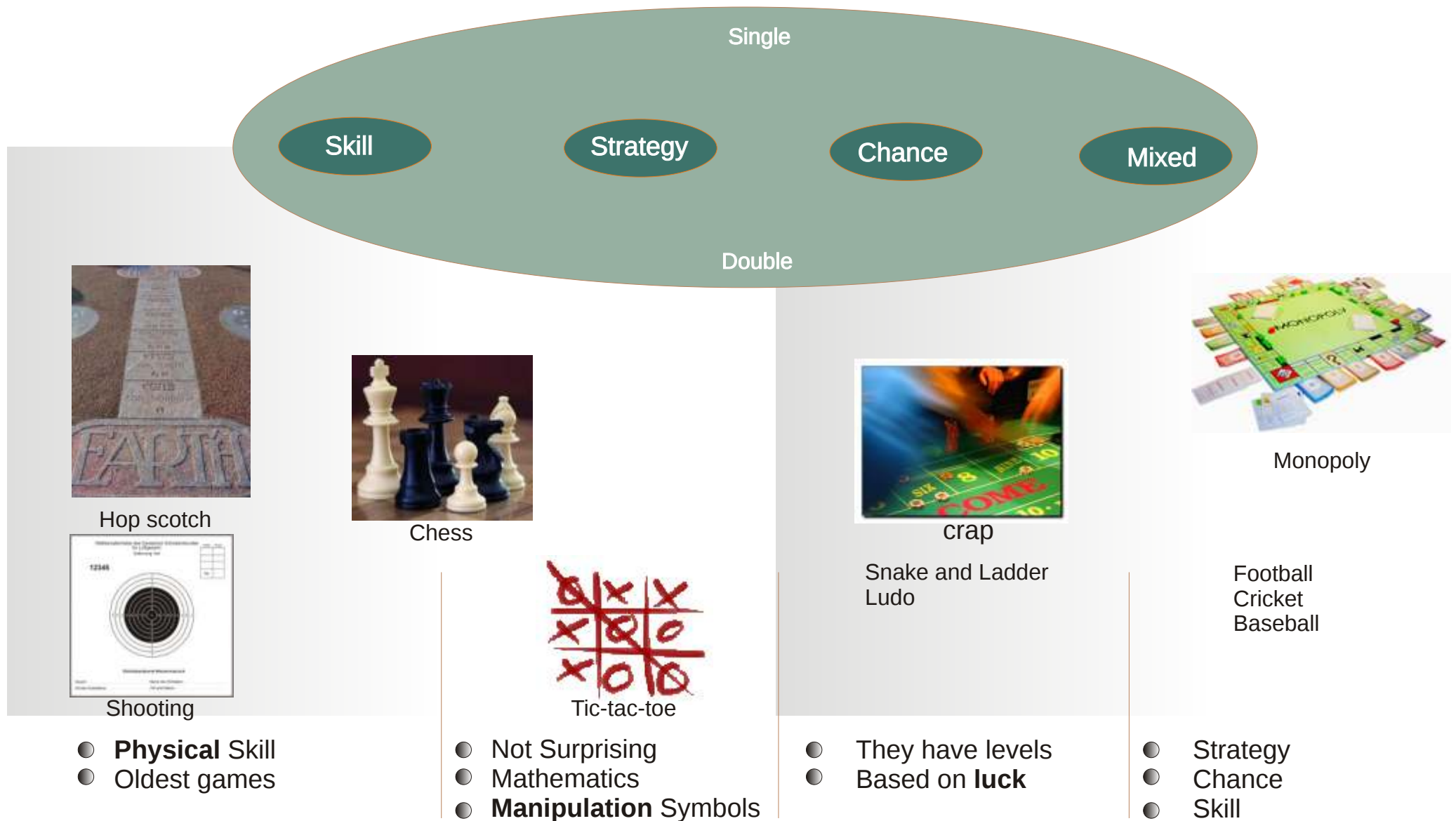
STAGE

Analysis of Play Kits and Games

Play Kit and age groups

Inferences and Product Brief

ANALYSIS OF PLAY KITS AND GAMES





Children of **age group 3-5** years enjoy ‘pretend play’ a lot. Dolls play an important role in pretend play. During pretend play, children explore the activities or reactions of the people surrounding them. In addition, fantasy provides a safe haven, which leads believe, where they can work out the most troubling concerns. . Many parents now recognize that little boys get as much out of doll play as little girls do.

No one ever said play should be a quiet process. 3-5 is the age when children are in the stage of language development. So it can be said noisier the play, the better. The right toys can enhance emerging verbal and listening skills by providing play opportunities that make children sensitive to the sounds and language they hear even as they produce words on their own. Playing with puppets helps in the development of verbal skills because, when performing little dramas, kids talk in different voices and experiment with different speech patterns. A set of building blocks provides opportunities for the child to discover spatial relationships and the relation of parts to the whole. Playing with blocks also introduces the child to numerous mathematical and comparison concepts.

6-8 years is the age group when children undergo social development and cooperative play becomes an important part. Play is an important vehicle for social growth, and to help teach kids social skills and strategies, toys and games that foster friendships and promote sharing, cooperation and teamwork are particularly important. Around this age, the collecting different kits or toys will become a hobby.



The improved manual dexterity of 6- to 8-year-olds allows for their play to include more challenging and complex building toys that strengthen cognitive abilities and perceptual skills. Eye-hand coordination is strengthened as they snap pieces together. Along with construction toys, jigsaw puzzles that require fitting multiple parts to form a whole offer children excellent opportunities to refine and coordinate perceptual, motor and cognitive skills.

No matter how artistically able, all children should be provided with a wide range of materials and experiences that get their creative juices flowing. From stamp pads, visual and performing arts experiences can be vehicles for self-expression and the communication of feelings and emotions.

Children of age 9 and up are ready for more sophisticated problem-solving experiences that challenge them to use information in a fairly strategic and efficient manner. By now children are able to handle complex puzzles with small pieces that improve finger dexterity and small-muscle manipulation skills. In addition to puzzles--and for real manual challenge--kids of this age enjoy realistic three-dimensional model-building projects.

Adolescents are beginning to grapple with more abstract concepts in their school studies and can benefit from activities at home that engage them in the world of ideas rather than just the world of objects.

With "walkmen" in their ears and calculators on their wrists, teens integrate technology into almost every aspect of their daily existence. And although the primary focus of many of these high-tech items is entertainment, the educational value should not be overlooked.



- ? Laboratory apparatus are not designed to play with
- ? Less safety precautions have been taken
- ? Each apparatus is designed for specific purpose no combinations are available
- ? Interaction with devices is very less
- ? No variation in the level of fun
- ? No product or game has used different principles or apparatus for a given task
- ? LASER should not be used
- ? No games with kaleidoscopes are explored
- ? Bamboo has certain constraints like bending, storing conditions, nailing, joining, Shrinkage etc.
- ? New technology is also being involved with bamboo
- ? Children of this age group enjoy creative kits more.
- ? They need change and things to explore
- ? Surprise element attract a lot
- ? Develop hobby and like to spend time for it.
- ? Start collecting things and collections are very precious to them

Target Users : School Children of the age group of 10+ years or VI th standard onwards
(Concrete operational stage)

Objectives :

With the kit children may not learn the principles of optics immediately but it can become an aid to compare and understand for in their higher education, i.e., help children to learn in a tacit way.

Aimed to enhance creativity and provide possibility to create new things

It should have entertainment as well as educational value

Scope for exploring more in optics in a tacit way

Kit should make children more sensitive towards manipulating the light and images with different optical devices

Product is to be put forward to the higher class or schools or science museums, etc.

Should be more interactive with involving one or more persons



Features :

Properties of bamboo are to be used properly

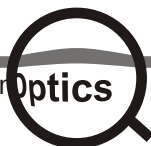
Product should have features, which permit children to play, modify and learn.

Care to be taken to design components to avoid accidental injury with proper surface finishes to Avoid bamboo fibers to hurt fingers

Safe joints and rounded edges

Should satisfy children's developmental needs

Playfulness as important element and some semantic clues of the scientific optical equipments should remain which will help them in future to recognize and recall the activities played



IV

STAGE

Bamboo and its Properties

Exploration with Bamboo

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Selection

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After studying all the bamboo types and their properties I selected few of them which I will be considering during the project for exploration. These are:

1. *Bambusa* bamboos: This is a thick walled and one of the most common bamboos. Its diameter varies from 1.5 to 18 cm and inter-nodal distance from 20 to 40cm. It is available almost through out India and abundantly available in Maharashtra, Karnataka and Bastar. Local names are Katoba, Baroowa, Daba, Katang, Kalak.
2. *Dendrocalamus Strictus*: This is one of the important bamboos of India. It is a thick walled bamboo having diameter from 2.5 to 8 cm. Its inter-nodal distance varies greatly from 30 to 62 cm. It is usually found in UP, MP, and semi dry zones.
3. *Gigantochloa Albociliata* (Reed Bamboo): It is a small diameter bamboo having diameter from 1.5 to 2.5 cm. Its Inter-nodal distance varies from 15-38 cm. It is easily available at various parts of India like W. Bengal, Arunachal, Assam, Meghalaya, Kerala, etc.
4. Mes (local Name): This bamboo is a solid bamboo and it is found usually in dry places and Maharashtra and MP. Its diameter varies from 3 to 6 cm.
5. *Dendrocalamus Giganteus*: It is a gaint bamboo with diameter varying from 20 to 30 cm. It has a wall thickness of 2 to 2.5 cm. It is available in Calcutta, Arunachal, Assam, Manipur, Nagaland and W. Bengal and Kerala regions.

The above bamboos were selected based on their properties like wall thickness and diameter. A complete range of diameters from 1.5 cm to 30 cm can be covered in these 5 types of bamboos. Also the varying wall thickness from thin wall to solid bamboo is incorporated in this list.



(Ref: Sonalika Ritu; -Toys in Bamboo Industrial Design project III report, IDC IIT Bombay)

In *Primary Preparation* the culms are cross-cut with a special fine-toothed saw made of hard Molybdenum-steel for requiring the desired lengths.

The *Secondary Preparation*

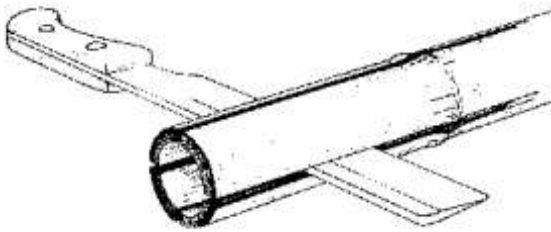
In *Dry Processing* the bamboo is heated evenly up to 120°C. By doing that, the gummy substances and water appear at bamboo surface and can be wiped off with a dry cloth.

In *Wet Processing*, the culms are kept immersed in boiling water for 1-2 hours or in Caustic Soda solution (0.2-0.8%) or in Sodium Carbonate Solution (0.2-1.2%) for 10-15 minutes. Afterwards the culms are dried with a cloth.

For *Leaching out starch*, different methods are used, mostly the *Immersion Method*, where bundles of bamboo culms are kept immersed in water for a period of up to 90 days either in stagnant or slushy sweet water. Flowing water gives better results. The other method is used mainly in India. The culms are felled and left upright in the bamboo forest without removing the branches and leaves for two weeks. Continuing its natural assembly of starch and sugars to cellulose, the still living bamboo culms reduce starch by itself.

By *Smoking over fire*, the bamboo-wood can be made more resistant against insects and rots. Chemical treatment like Borax-Solution, DDT, Lindane implement some danger to health and should be avoided therefore.





Splitting of bamboo to make strips

Bamboo strips can be made by *radial* or *tangential splitting*. Analogous to rough splitting, the radial splitting is made but the knives are far smaller.

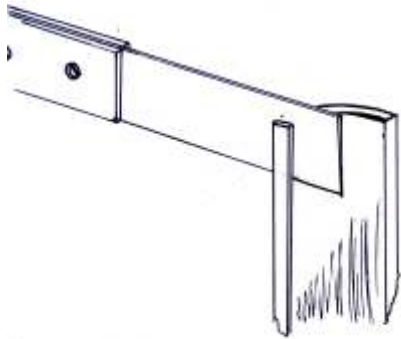
When making *tangential split*, the split is done parallel to the outer surface. The inner portion usually is discarded. For both, Tangential and Radial splitting, a *simple, sharp knife with a blade of 8cm length and 2cm width* is used. The handle of knife should be 10cm long.

The *finish* can be done with a sharp plane, for example a balsa plane for modeling. So rectangular cross-division of a split can be achieved.

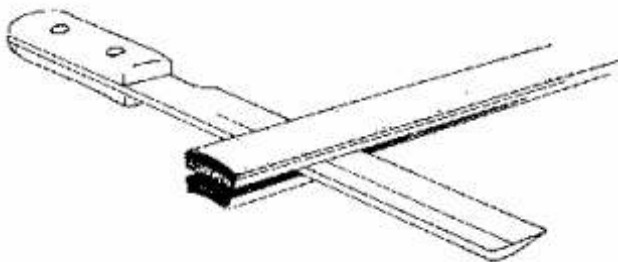
Whole culms or splits can be bent / straightened by applying heat evenly to the point where it is to be bent. The bamboo-fiber bundles (Cellulose, with a tearing strength like reinforcing steel for concrete) are embedded in a matrix which becomes pliable when heated. The heat should be just sufficient for bending in order not to damage the fibers by burning them. After cooling with water or air, the splits / culms keep its new form.

The source of heat in India is mostly the charcoal fire. For small works Spirit burners are also used. It is easier to bend green culms / splits. The heat should be applied evenly and should be just sufficient for bending. It must not change its colour to dark brown or black, because it is weakened considerably by burning.

In case of whole culms to be bent, the culm is filled with sand before bending to avoid undesired cracks and fissures. In case of very thick splits to be bent, they have to be thinned at the desired bending point to avoid undesired tangential splitting.



Radial splitting



Tangential splitting

Drilling in bamboo:

Like other wood, bamboo can also be drilled; but more than other wood, bamboo can split while drilling. Therefore, drilling is made with *High numbers of revolutions (rpm)* from the hard outer to soft inner bamboo part. As drill bits sharp *Brad-point drill bits* are used. In case of desired precision holes with sharp edges, a red hot metal pin or tack is used. The hole can be worked carefully with a metal needle-file or sanding paper.

Dyeing of bamboo:

For colouring of bamboo besides natural colours, many synthetic colours are also used. But there are some rules which need to be followed for dying process:

It is important to remove the outer waxy skin of bamboo, otherwise the colour won't adhere and wear off fast (also glue won't stick).

It is recommended to bleach the bamboo strips before colouring, because it will take the colour more evenly. To increase colour fastness, the coloured pieces should be washed in a warm Acetic acid solution.

Applying of copper sulfate solution will give a shining green colour.

Smoking gives a brown colour and also will keep away insects.

(ref: <http://members.aol.com/woinem1/index/bamboo.htm>)





Bamboo and its Applications

Bamboo is a versatile material used in various applications. It is often used in construction, furniture, and handicrafts. The image shows a hand holding a piece of bamboo that has been cut into a series of horizontal slats, demonstrating a traditional craft technique.



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Bamboo Strips

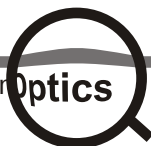
Bamboo can be split into fine strips of various thickness and width sizes. This provides flexibility in nature and long lengths. Different woven and other forms which require flexibility can be made using this property.

Its flexibility allows it to be used as rope or joining material. Few woven elements can also be integrated in toys. The coiling technique opens up new dimension in designing.

Flat Thick strips

Bamboo splitting of thickness more than 4-5 mm gives a planer surface on both sides or just one side. But bamboo flattening process is slowly becoming popular. When a larger flat area is required then, more than one piece can be added.

Nature of wood can be explored by this method. Requirement of straight forward boxlike or planer forms can be possible by this method.



V

STAGE

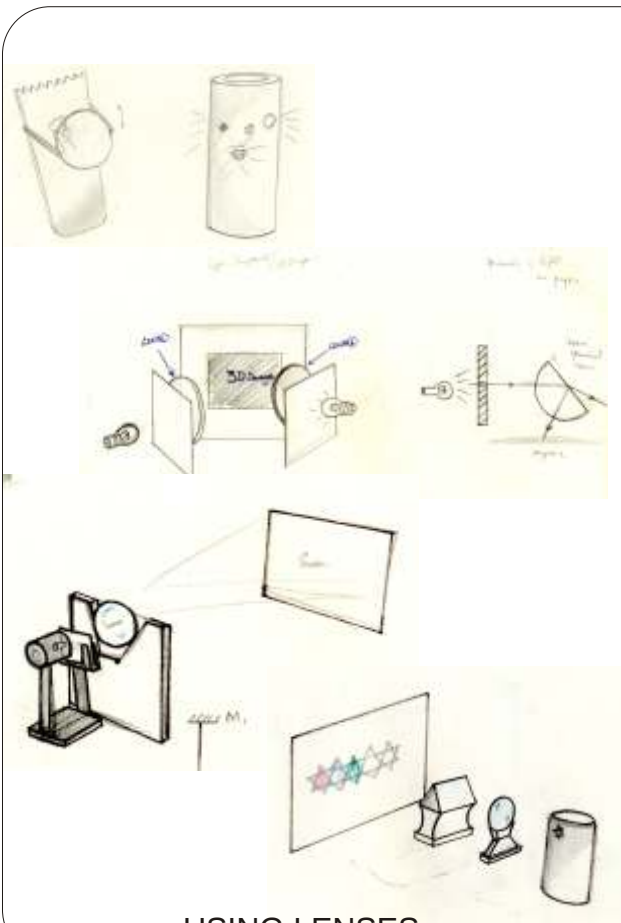
Initial Ideations

Conceptual Ideations

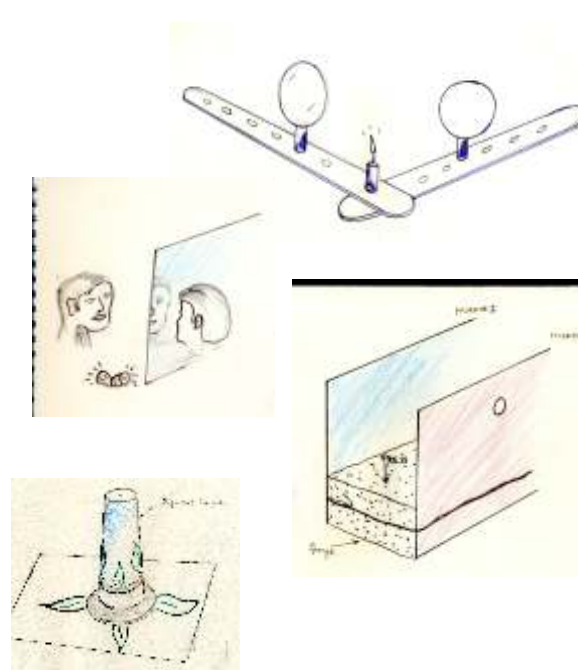
Exploratory Stage

Final Concept

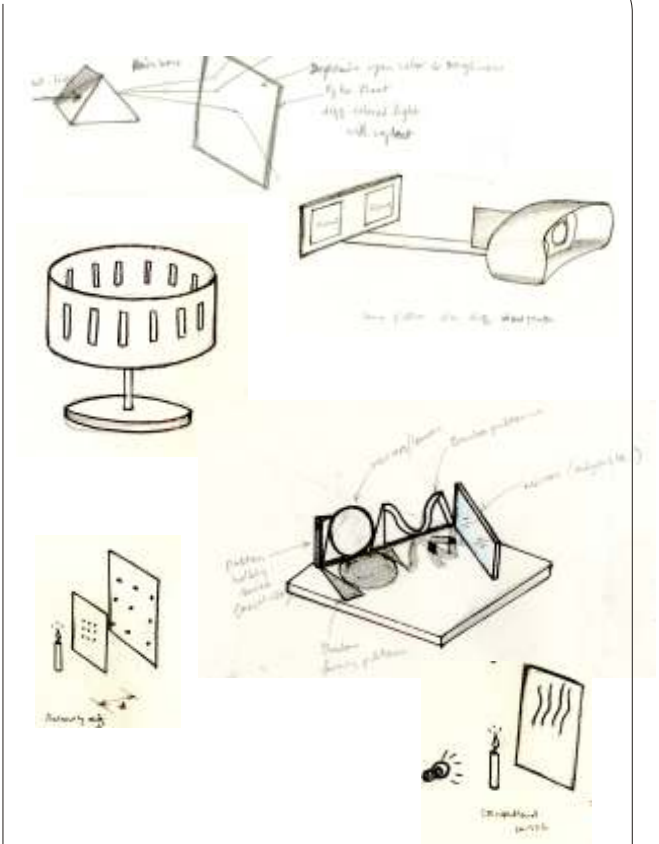
Different ideas were generated and analyzed at every step. Few starting ideas were influenced by existing kits and were tried out to see how they can be replicated using bamboo as material. Different qualities of bamboo were explored in different ideas and at many stages this helped understanding limitations of material. Simultaneously the ideas are explored with the material to get some inputs about detailing, complexity with material, manufacturability, etc.



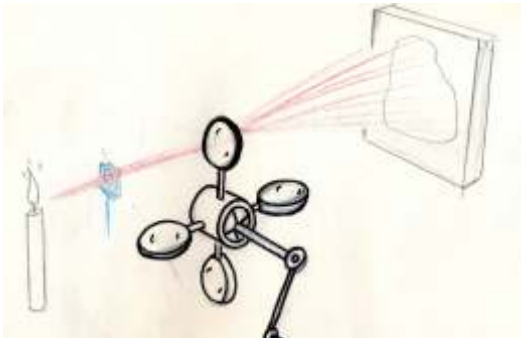
USING LENSES



USING MIRRORS

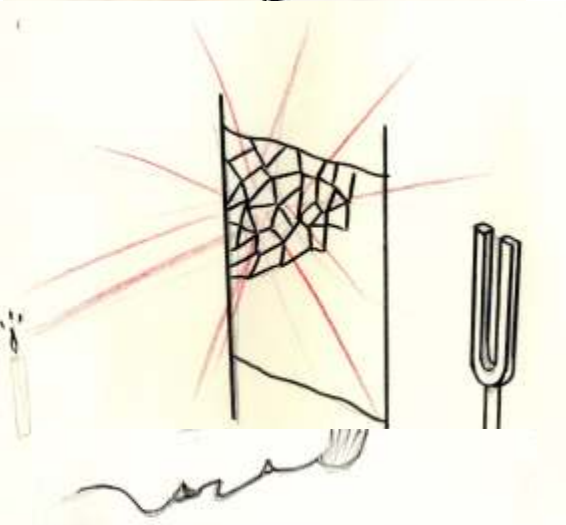


USING LIGHT AND SHADOWS

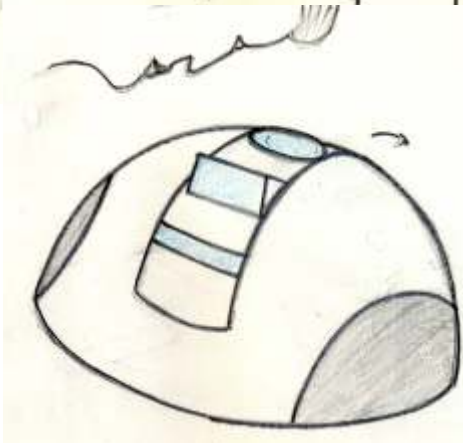


General Ideations

This is to arrange different lenses in one unit and project the light on the screen to know immediate effect on the image formed on the screen. Has a limitation of using only lenses and single use only.

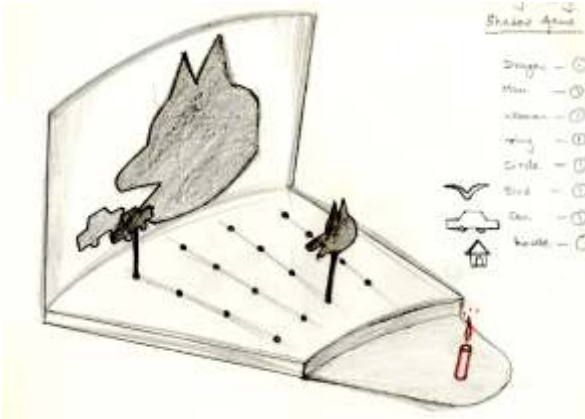


Dancing mirrors, which are fixed on the flexible layer (cloth, plastic cover), then with the help of tuning for the layer can be vibrated and some moving reflections from the mirrors can be seen.



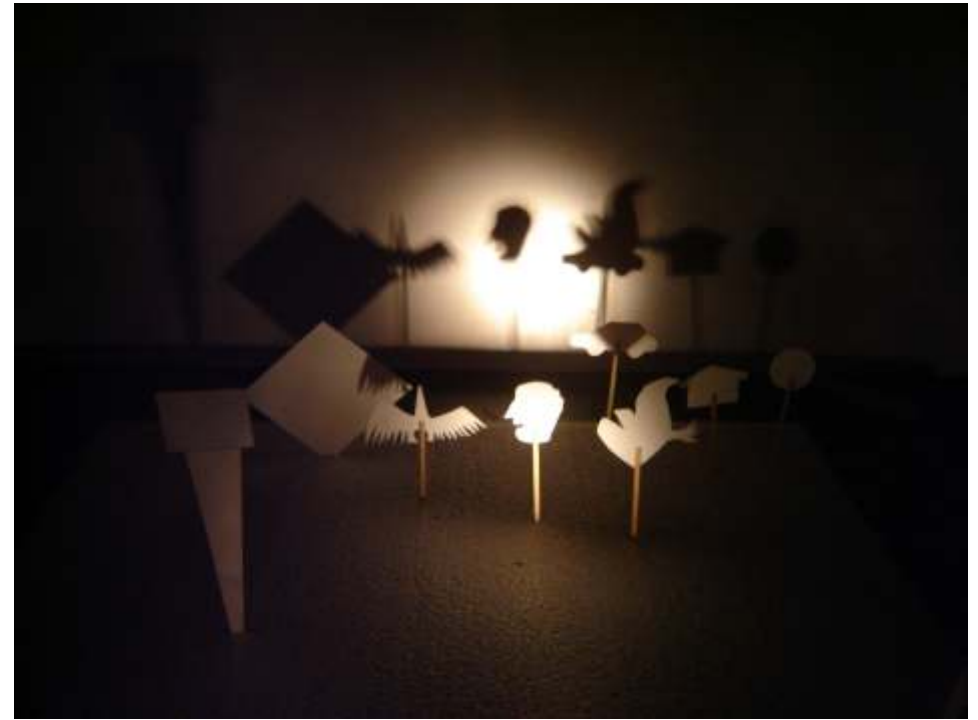
This idea has rotating unit in which all the mirrors, lenses and prism can be fitted and effect of light can be seen through our naked eye.

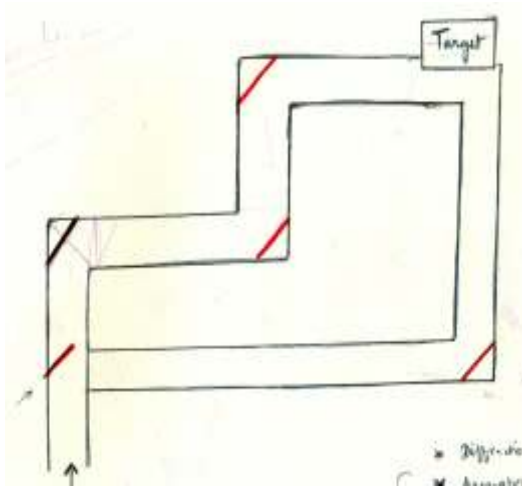
IDEATION AND EXPLORATORY MODELS



Initial ideations came as how many ways the lens, mirrors and shadows are manipulated in a playful manner and also some principles are also tried out there

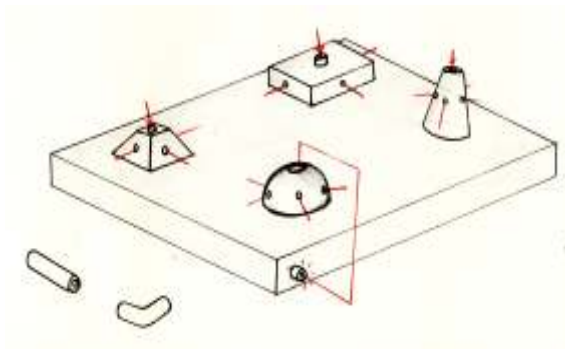
Shadow game, a negative of light which can be used as a story telling game with some animated shadows by moving light source. This idea is explore with the exploratory model. The main disadvantage of this ideas is, it has to be played in dark areas and also required large area.





Periscopic game

This idea has the use of periscopic view, it's a modular unit which can be assembled and some hidden objects can be seen



From the above idea this game idea has evolved, in this the modular parts which consists of mirrors are assembled and all the required points can be connected and gain some points. It is a dual player game. Skill and logic to attain the task quickly are required to play.

IDEATION AND EXPLORATORY MODELS

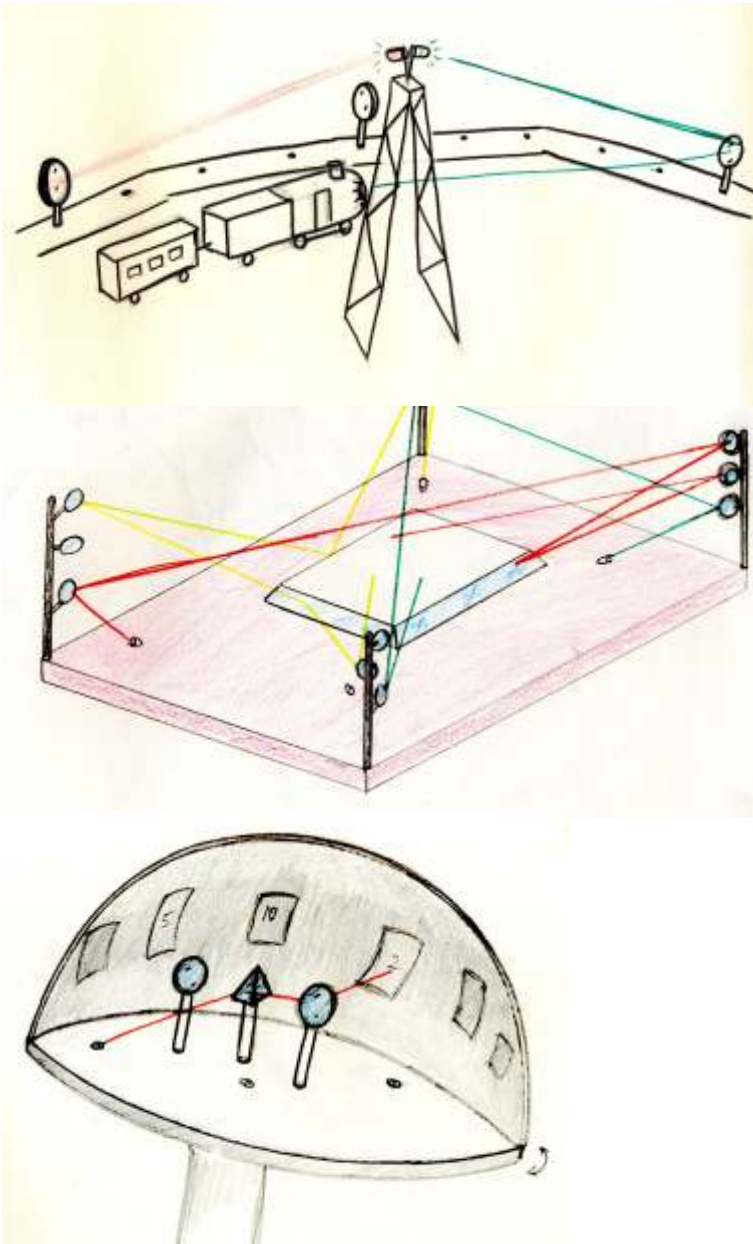
Ideations using Mirrors

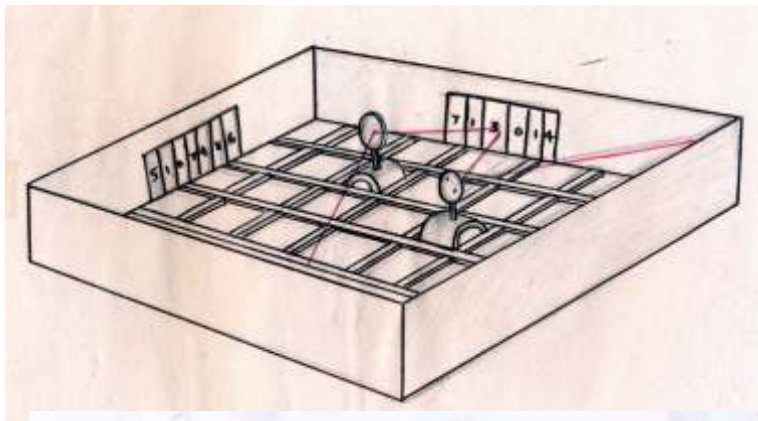
Train signaling idea emerged with the reflection of different colored lightings, Only few lenses are used in this may be lasers may have to be used.

Stage lighting is one game in which children can produce different patterns with limited source provided to them

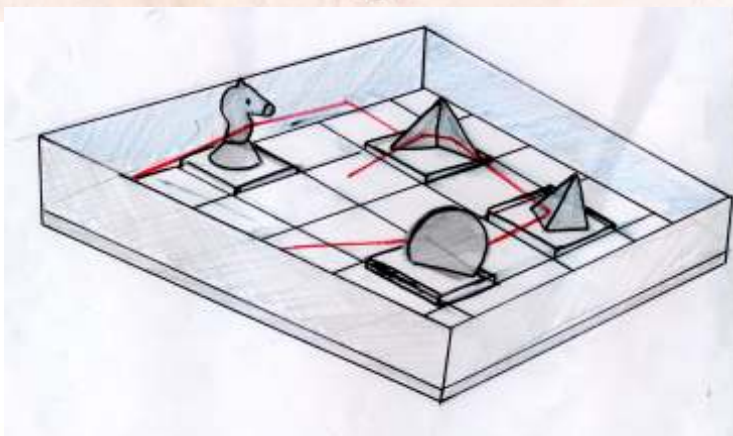
From the above idea the game of hitting the target is evolved, in this idea s a dome with some targets points are given, with the help of lenses and mirrors and a light source he has to hit the target. Dome is rotated and it stops randomly and chance goes to other user.

Some skills, logic to hit the target.

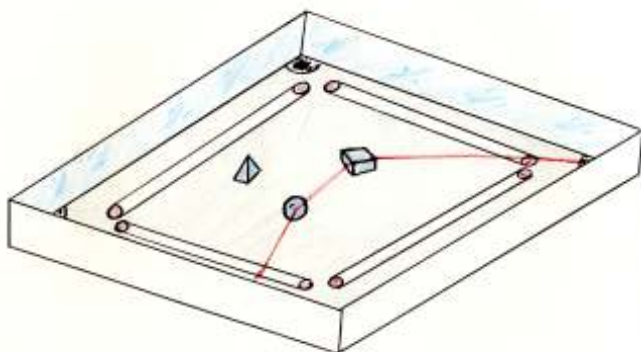




The previous dome game idea is further simplified into a rectangular feasible box with some elements with mirrors or lenses



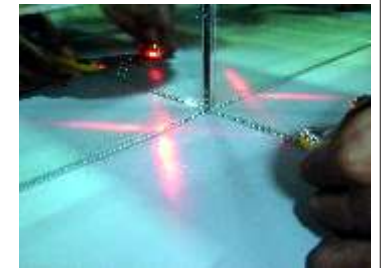
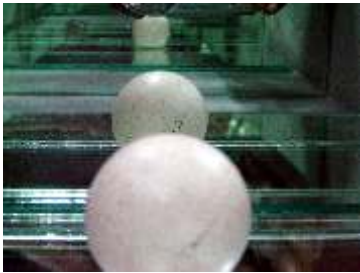
This idea came with the inspiration of a chess game, same lenses and mirrors are used to play.

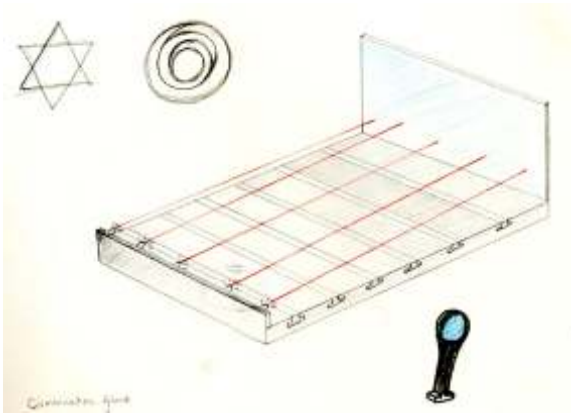


This idea came with the inspiration of carrom board, instead of coins lenses and a light source is used to hit the target.

IDEATION AND EXPLORATORY MODELS

Mirrors are big and giving fun when it is looked at, but the enclosure of the box is not giving much to play. Simultaneous detailing of the elemental prop is done.



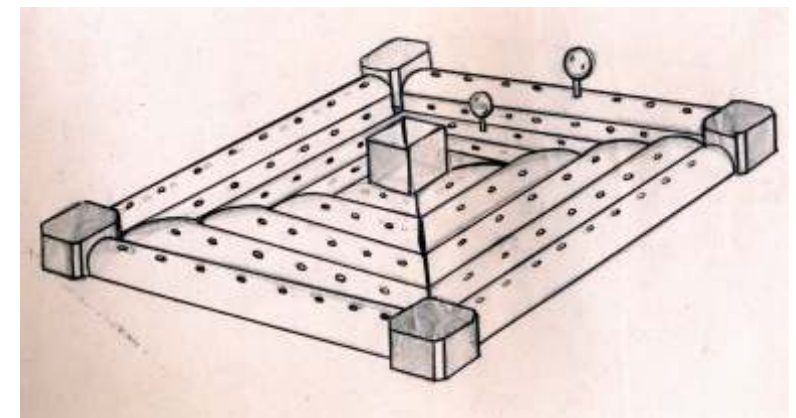
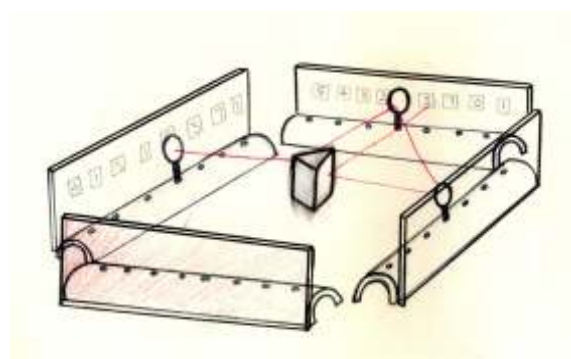
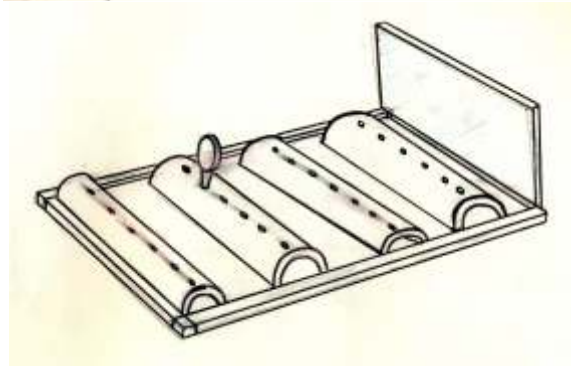


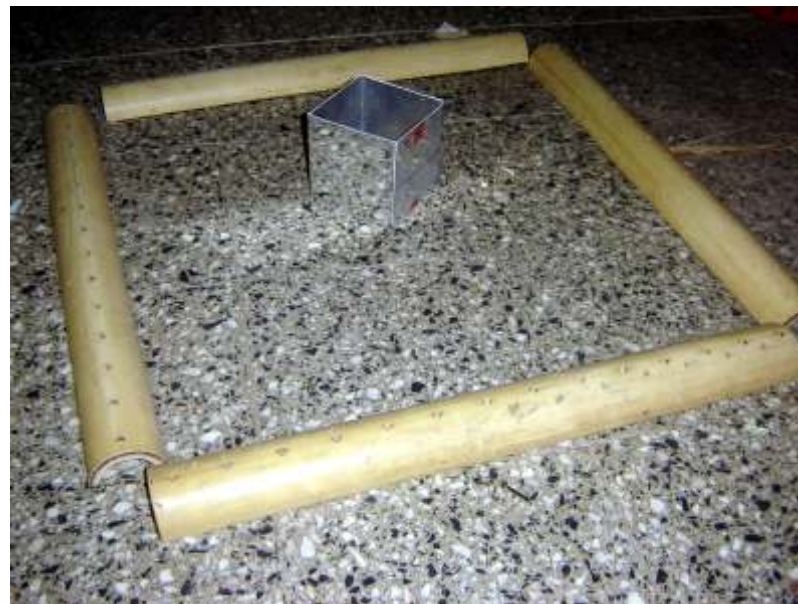
Lenses and Mirrors

The same idea which is still simplified to replicate with bamboo

This is a knockdown model for arranging all the lenses and see the combination of what kind of images are formed.

Full of bamboo is brought in this idea and tried to give a grid for play, certain strategies were developed to make a game, which is having a central mirror, light source and directional mirrors





IDEATION, EXPLORATORY MODELS AND DETAILING

Lens, handle and stand

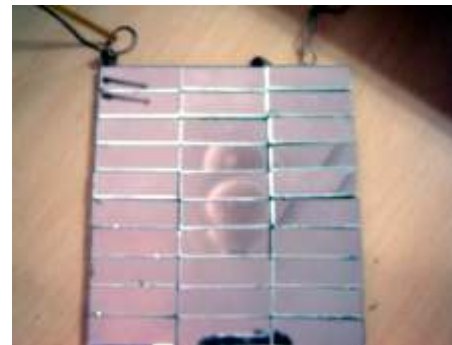
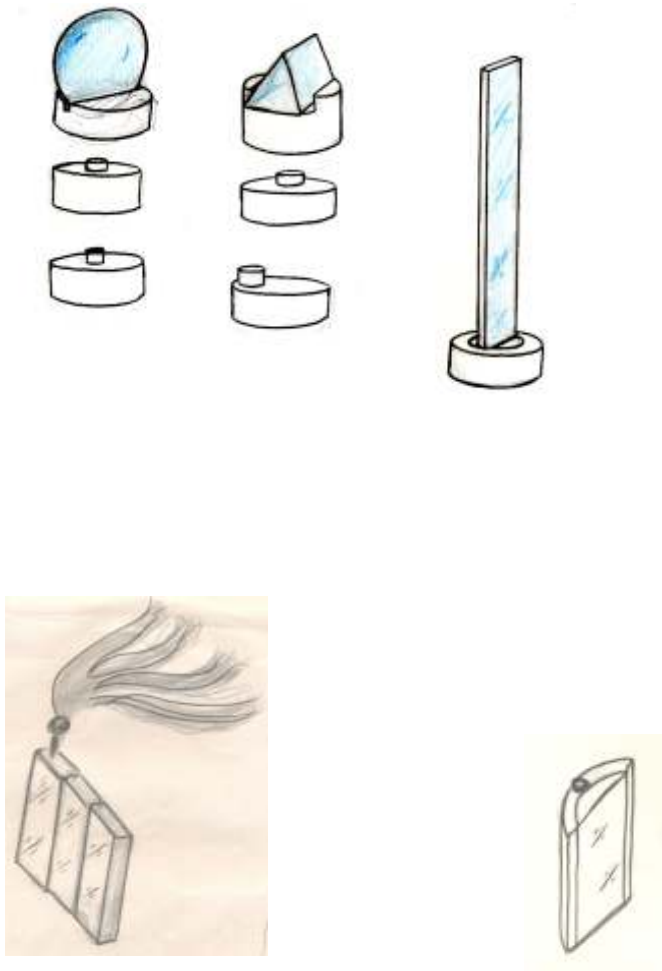


IDEATION, EXPLORATORY MODELS AND DETAILING



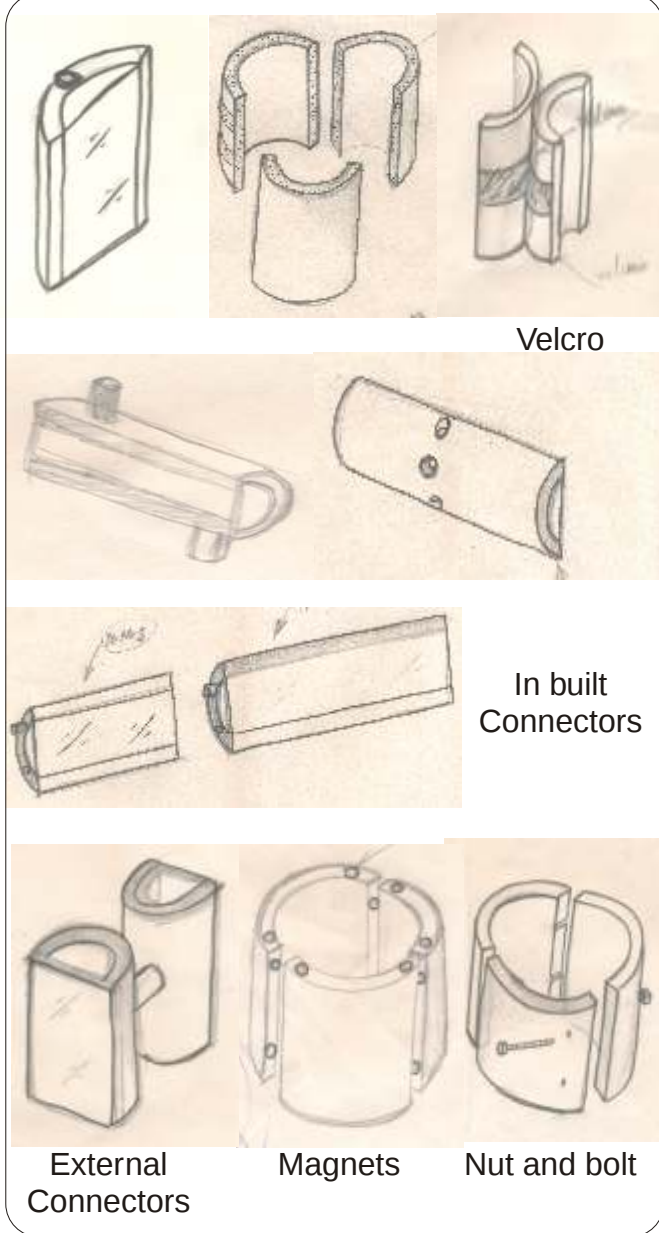
Playing with Mirror Elements

To better understand the properties of the material, started doing explorator models with the ideations. In this process working with material is given much importance and implemented immediately after the thought process.

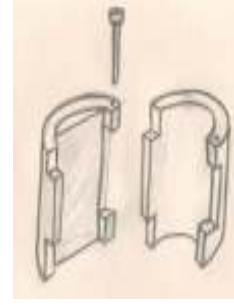


IDEATION, EXPLORATORY MODELS AND DETAILING

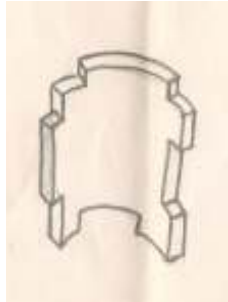
Joint Detailing



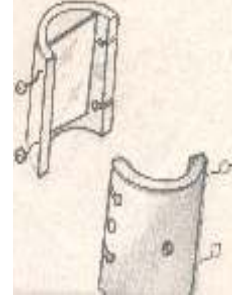
Hinges



In Vertical Position



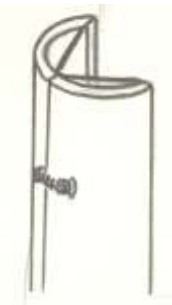
Snap joints



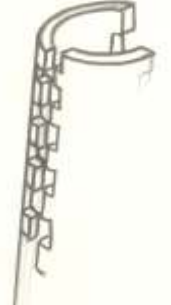
Thread and Bead



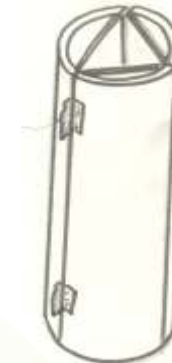
Chain and magnets



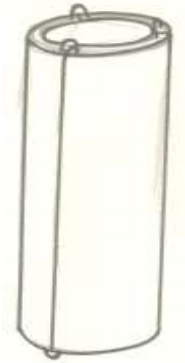
Connectors



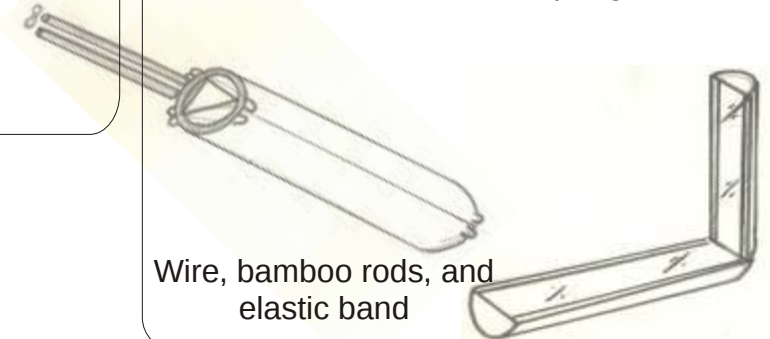
Snap joints



Velcro



Spring steel wire



Wire, bamboo rods, and elastic band

IDEATION, EXPLORATORY MODELS AND DETAILING



Velcro



Magnets



Bamboo Stick



Connector

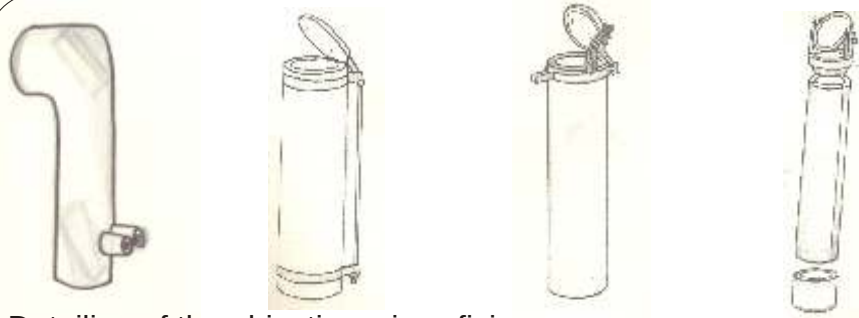


Hexagonal Kaleidoscope
with an attached sheet

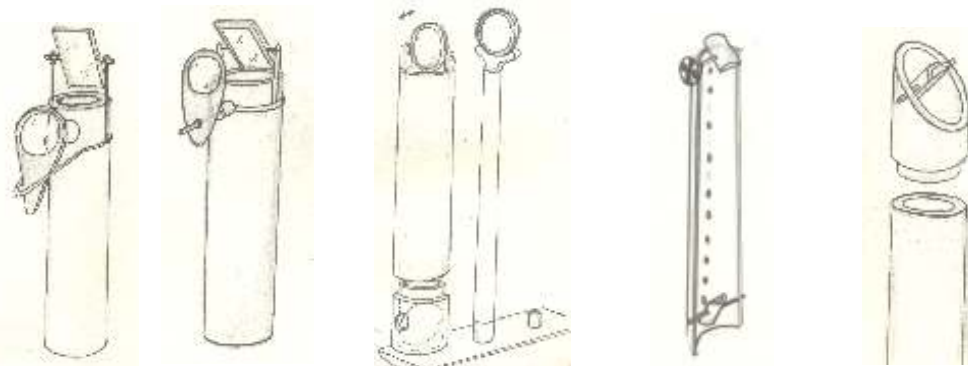


Straight and Tapered
Kaleidoscope

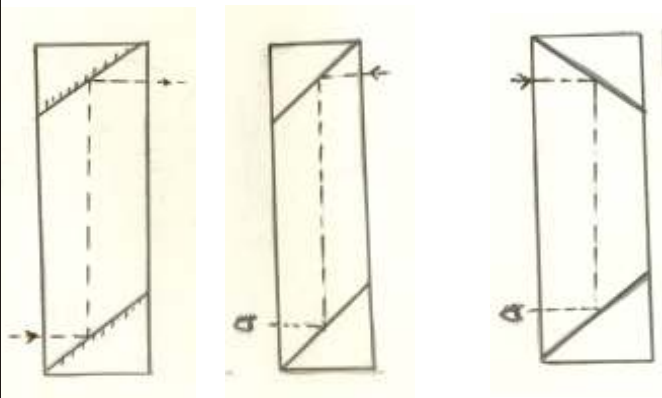




Detailing of the objective mirror fixing



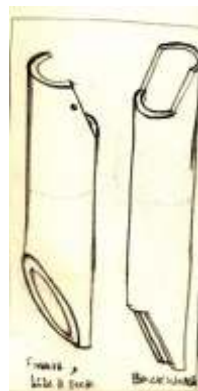
Accommodating lens in periscope



Hide and See

Looking forward

Looking Backward

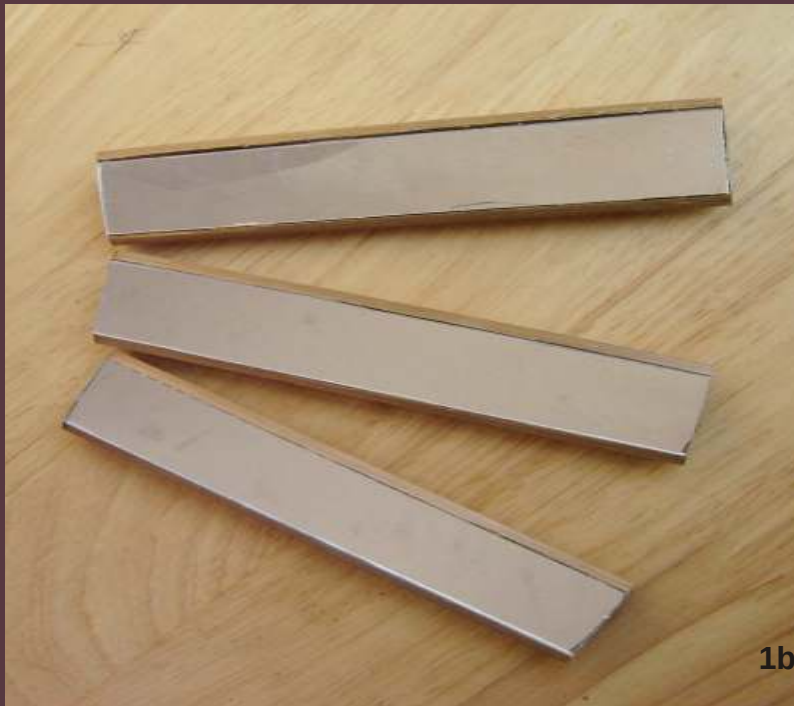


Kits Consists of



1a

Mirror Elements



1b



2

Periscope



3

Prism



4

Concave Mirror



6

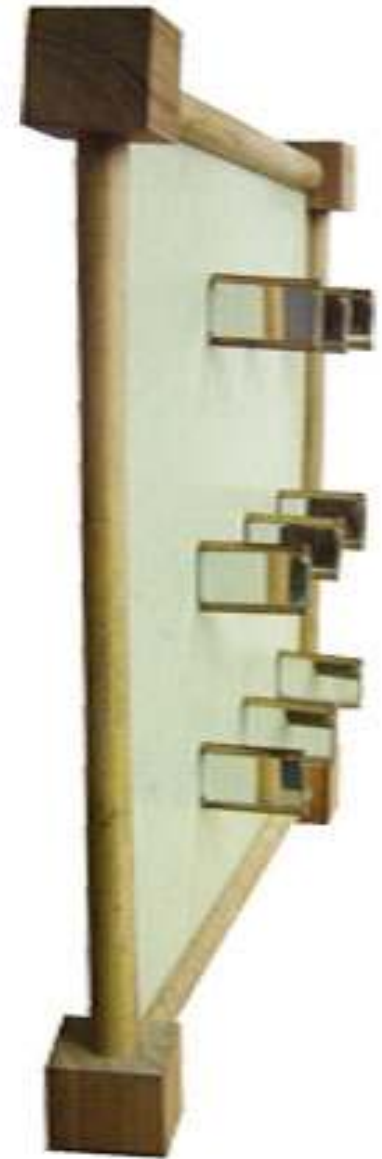
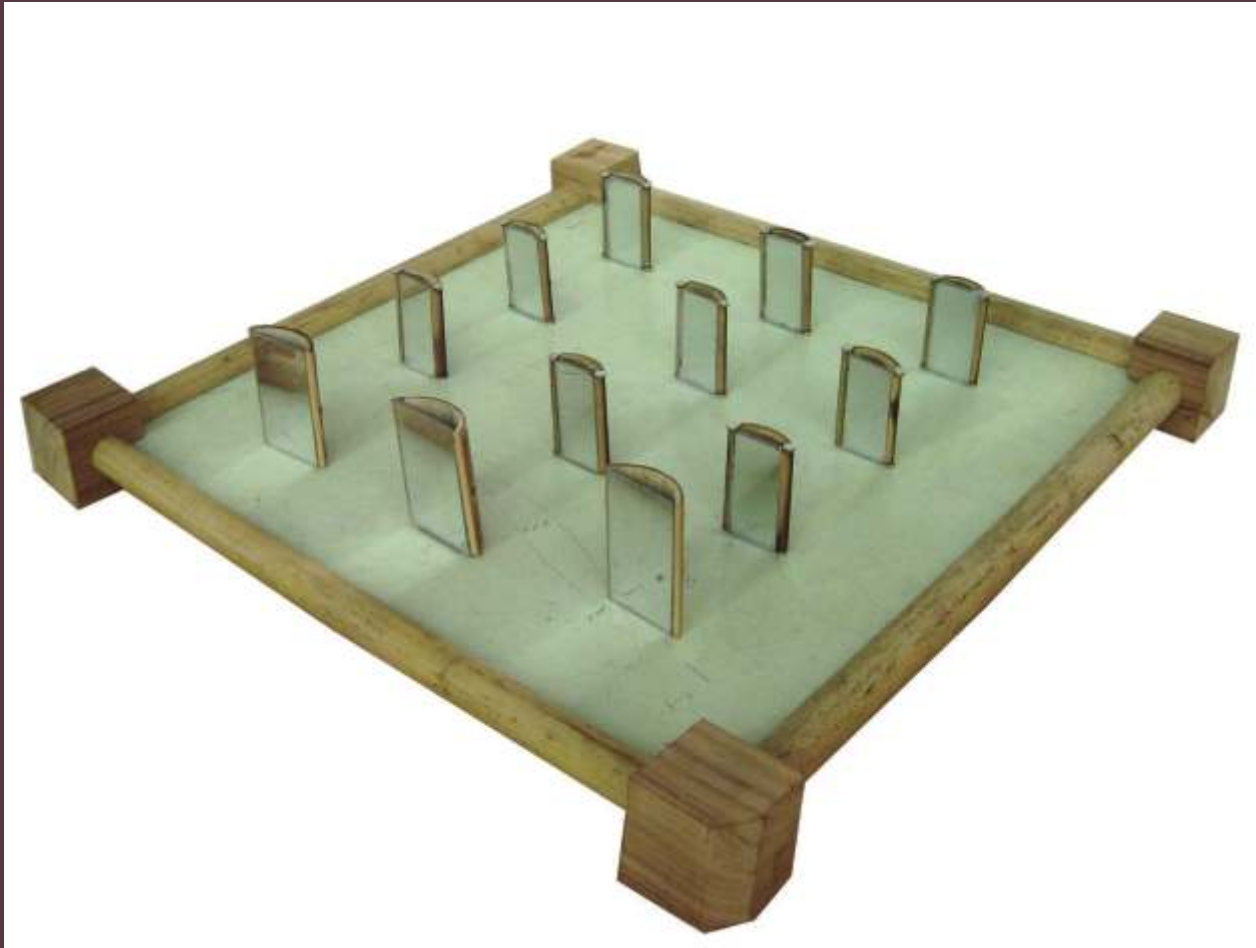
Concave Lens



5

Convex Lens

7 A Board to Play



8 Connectors



Kit consists of

- 1a) Mirror Elements - Shorter
- 1b) Mirror Elements - Longer
- 2) Periscope
- 3) Prism
- 4) Concave Mirror
- 5) Convex Lens
- 6) Concave Lens
- 7) A Board to Play
- 8) Connectors - bamboo sticks, full bamboo
- 9) Instructions booklet

The designed kit is an optical based educational play kit for 10 years and above. The play kit becomes a tool to help children learn principles of optics in an enjoyable and interesting way with play as a medium. With the use of natural material that is bamboo, the product imparts a feel of warmth, playfulness, user friendliness, and harmlessness.

It is an introductory kit to light and optics using lenses, prisms and mirrors. Fun projects include making your own kaleidoscope, periscope and using curved mirrors (concave and convex) to create funny images or exploring the size of the image. A great way to start exploration through play.

Light bounces and bends through convex and concave lens and mirrors. Set includes one convex lens, one concave lens, one convex mirror, one concave mirror, nine small elements of mirrors, three tapered and three straight long mirrors, one prism, one board, connecting sticks and an instructions booklet.

The previous two pages shows prototypes with different variations out of which the final concept has been derived.



Kit 1 : Concave and Convex Lens and Mirror

This kit consists of convex lens, concave lens, convex lens and concave lens. In this kit the confusion between the concept of convexity and concavity is reduced with the help of information through graphics and the form.

The graphics on the product are the representation of ray diagrams of the science text books. The outer form also goes with the type of lens. Which will be felt by the children while they are playing and when they refer to the ray diagrams they can recollect easily about the form and remember easily.

Construction is mainly based on coiling technique. There are mainly four parts Lens/Mirror, Wooden block with a laser cut graphics, Two bamboo locking rings and one outer Outer ring. The dimensions and drawings are given in the drawing sheet.



Concave Lens

Convex Lens

Kit 2 : Kaleidoscope

This kit consists of mirror elements, end cap to join the mirror elements.

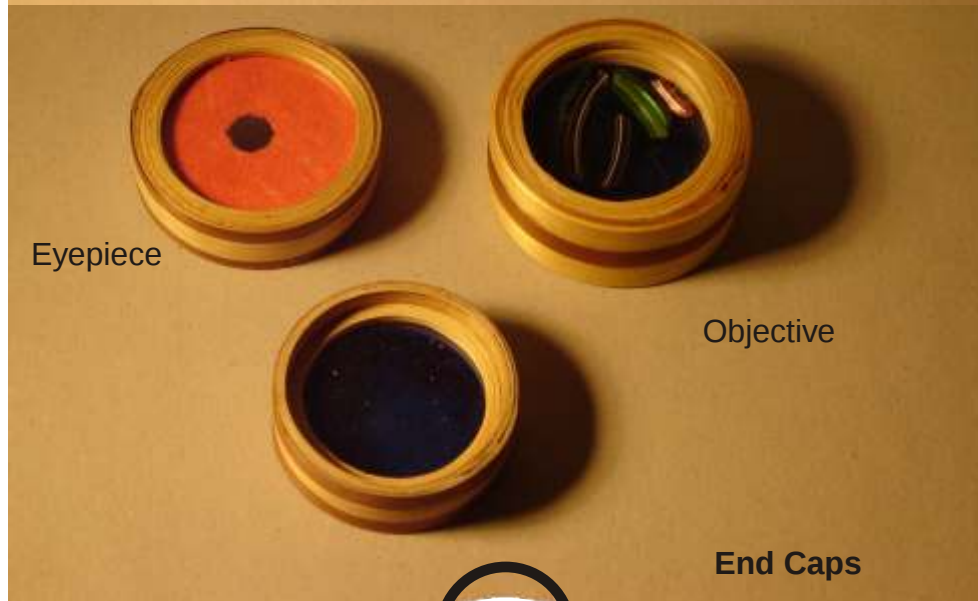
The kit is designed to demystify. Kaleidoscope and to enable to learn the principles of mirror reflection. Three mirror elements are knocked down to three separate 'easy to handle' parts which can be played with. This feature is unique to this design. Separable top and bottom parts facilitate play by inserting different elements like glass, end covers, inserts, etc.

The innovation came with the splitting of the kaleidoscope barrel into three parts. Optimal use of form and properties of the natural material that is bamboo with scientific devices like mirror which is more fascinating for the children. Each part of the kaleidoscope will give an opportunity for the children to explore more than a kaleidoscope. With the single element or combination of elements the children can tacitly learn the principles of reflections and internal reflections.





Straight Mirror Elements



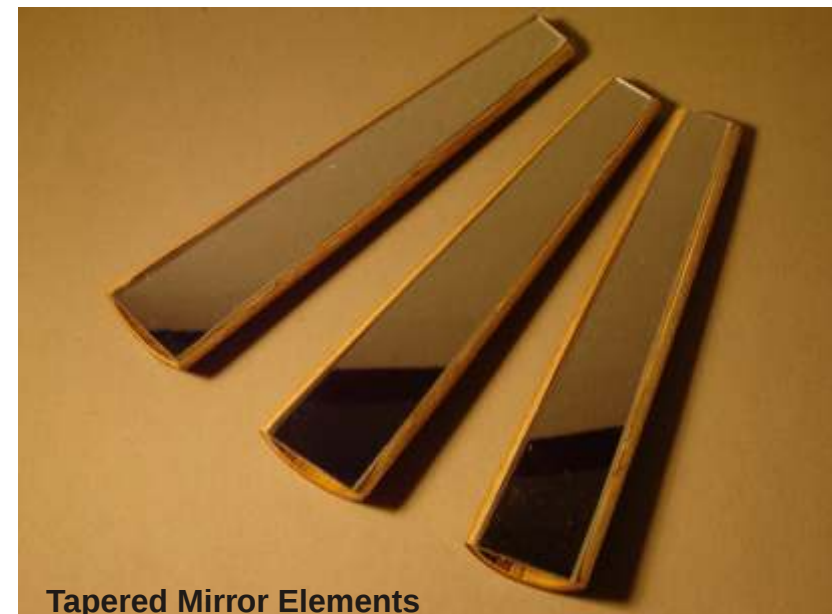
Eyepiece

Objective

End Caps

End covers which also have uniqueness in giving an opportunity to insert different objects other than glass pieces like transparent papers, sand, ants, etc. The whole modularity of the kit gives the kid to assemble from end cover to whole body. Some of the graphics were utilized to give some direction to children for assembling.

Tapered mirrors have given one more dimension for the children to know about the principles of horizon by comparing the images or patterns Formed in side the kaleidoscope.



Tapered Mirror Elements



The difference between straight and tapered kaleidoscope is the formation of horizon. Which is more in tapered kaleidoscope. So the images formed will be at the center of the screen where as in straight it will be at the edges of the mirrors. In tapered the number of images formed will be more.



FINAL PRODUCT

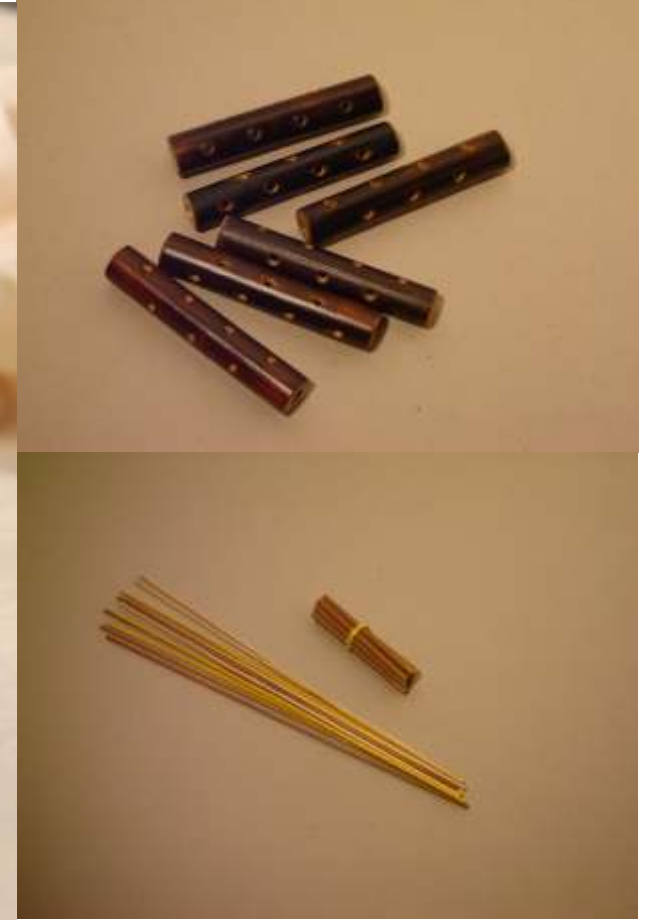


This kit mainly consists of plane mirror elements short in size with magnets on the top edges. An 1'x1' iron board and bamboo connectors.

Some more props are provided with the kit like some graphic instruction sheets for playing with mirrors and some physical props like letter F, connectors, etc.

Since it is an exploratory kit on optics, whatever the ever activities done with the mirror are have to be seen in the mirror. To restrict the bending activity of the user iron board and magnets are used, so that the mirror elements will get stuck on the board and the user can lift the board up and see images forming.





The edge of the mirror element has to be matched with the lines on the chart given with the kit and an object or prop has to be kept at the center which forms multiple images. The number of images formed will depend on the angle between two mirrors. As the angle between two mirrors gets reduced the number of images gets increased and as they are kept parallel the images formed will be infinity. Which is the same principle applied in saloon shops and jewellery shops.

As the angle between two mirrors gets increased the number of images will get reduced and becomes one or can be said zero. So this becomes a straight mirror.

Some more explorations can be done like breaking a circular line and making to a continuous straight by connecting or arranging the mirrors. Some more explorations can come from by connecting the mirror elements with the help of bamboo connectors and learn the principles of periscope by projecting some object at down or up to some targeted mirror or a source.

Some more can be like projecting the sunlight to all the edges of the board. And winning some point. After one is done the next user has to change the direction and project it in a reverse direction.

With this kit children can learn the basics of optics. They will learn these principles in a tacit way and compare or relate them with the existing scenarios or theories.

Mainly symmetric is one topic on which children are used to be confused. So this kit can become a tool to explore and learn about symmetry and its principles. A grid sheet is provided on which they can draw the some pattern either known or unknown one and try to make asymmetry of it with the help of mirrors . Like this they can make some patterns of their choice. For example drawing a flower, user has to draw only one petal and replicate it. They can color them and it can become a beautiful patterns or rangoli. Some of the explorations are shown in the next page which are done by me.

It has a tremendous scope to become a full kit with unique ness in giving children to explore the principles of optics in a different way than they expect. Knocking down is one the unique property which has come up as an innovation in kaleidoscope kit. Interpreting the exist for of the lens with the form and graphics was one more uniqueness. Protection around the lens gives the children a direction for play or explore without any fear. The third kit can be developed with inclusion some more games and strategies to explore more principles.



Lenses and Circular Mirrors

Coiling Technique

For glasses which is in circular in shape coiling technique is used to protect it. The process in coiling technique is as showing in figure.

Prepare the required size strips

Scrape the strip with flat sand paper

Mould of required dia is prepared

Applying good adhesives (fevicol and fevi quick) on the inside of the strip it is coiled till the required dia is obtained.

Before fixing the end it has to be made thin and adhesive is applied and kept for drying upto minimum 2hrs.

After drying all the surfaces are sanded and if any gaps found then sawdust is filled and again sanded.

For all kinds of rims for the circular or oval shapes this is method can be adopted.

Handles and Mirror handle element

Smoking or Firing Method

For almost all the handle are given brown handles made of bamboo, the color is achieved by smoking or by firing

If bamboo is smoked upto 12 hours, golden yellow can be achieved and if smoked upto 48 hours, rich brown color can be obtained.

I have used firing method for my handles which requires a little skill to achieve uniform color other wise the bamboo will burn and gives black coal.



Others

Manufacturing processes such as cutting, smoothing, drilling, boring, shaving, etc can be done with the help of proper tools.

Tools developed by IDC department gives enormous number of techniques for any of the above processes.

PRECAUTIONS



Since the fibres are oriented along the longitudinal axis of the cylindrical culm, it should not be cut linearly from the edge otherwise it will crack and break up.

Hardened strips can be made softer by soaking them for some time.

Apply proper pressure while doing coiling technique

Proper dia should be chosen for drilling a hole. Upto half the dia of the culm can be drilled.

Edges and peeled out small fibres must be treated properly by sanding to avoid hurting fingers or eyes.

Proper tools and proper positions should be acquired to avoid accidents.





Convex Lens (Magnifying Lens)

Lens which makes small objects appear larger. Both sides of the lens are usually curved outside to form double convex lens

Activities

Zooming in and out

Enlarging the images or objects

Thread counting in the cloth

Reading the text

Exploring the parts of the tiny insects

Looking into your own hands how neat they are?

Palmistry

Burning a paper

Seeing the light rays in the water

Pencil needle

Observer your own hair

Books and Desertations

- NCERT, ICSE Science Text books
2005 release
- Creative Aid for School Children
Muralidhar K - 2003 - *IDC, IITB*
- Aid for Children Learn Sound
Srihari Tulasi - 1999 - *IDC, IITB*
- Bamboos of India a compendium
K.K.Seethalakshmi and M.S. Muktesh Kumar -1998 -
INBAR
- Bamboo Craft Design
A.G. Rao and Madhavi Koli - 1994 - *IDC, IITB*

Physics Stuff

- <http://www.exploratorium.edu/snacks/iconlight.html>
(Small explorations on light)
- http://www.bbc.co.uk/schools/scienceclips/ages/10_11/see_things.shtml
(Small online game task is to divert the light to the required point)
- http://en.wikipedia.org/wiki/Main_Page
(Child psychology and learning theories)
- <http://physics.kenyon.edu/EarlyApparatus/Titlepage/Optics.html>
(Pictures of olden days optical devices)
- <http://www.scitoys.com/scitoys/scitoys/light/polariscope.html>
(Some exploratory models in physics and optics)
- http://www.rpi.edu/dept/phys/ScIT/InformationTransfer/reflrefr/rr_index.html
(Topics on reflection, refraction and optical fibers)
- <http://laser.narr.as/laser.swf>
(Online laser game)
- <http://education.nic.in/htmlweb/reflection.swf>
(Online tutorials in hindi on light)

Bamboo Related

- <http://www.bamboocraft.net>
(Bamboo Art & Craft Gallery)
- <http://www.easttroybasketry.com/sherman.htm>
(Bamboo basketry)
- <http://www.peepandthebigwideworld.com/activities/playreflections.html>
- <http://www.civilization.ca/aborig/stones/toys/tymenu.htm>
(Olden days toys in bamboo)

Market Study

- <http://www.einsteins-emporium.com/science/l-optics/sl110.htm>
(Science kits)
- <http://www.opticsplanet.net/spottingscopes.html>
(Microscope, Telescopes, etc.)

