Design of Educational Products for ISRO

Project 3
Product Design

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Guide
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Approval Sheet

Project 3 entitled **" Design of Educational Product for ISRO "** by Kiran . P . Kulkarni is approved in the fulfillment of the requirement for the **Masters degree in Industrial Design.**

Guide

Chairman

Internal examiner

External examiner

Acknowledgement

The project started with a dream of bringing the beauty of space exploration to common man. This gave me an opportunity to meet some of the wittiest space scientists, enthusiastic students, seasoned teachers and working with my guide.

I would like to express my gratitude to my guide, Prof. Athavankar, for constantly posing me “crucial” questions, challenging me to seek for the answers. He is responsible for exposing me to the excitement of the project all the time. Every time we would discuss I would make sure that I have answered him his previous questions.
The initial part of the project revolved around my wish to discuss my project with ISRO. I was aspiring to find support for my ideas. Mr. Krishna Murthy, Director of Public Relations helped me by constantly responding to me and also giving me an opportunity to present my initial concepts at the Head Office, Department of Space, Bangalore giving me confidence to pursue the project.
I would wish to thank ISRO Team, for taking their time off to give me some of the perceptive ideas about my project. Talking with Maestros was an eye opening for me for their deep interests and dedication to the space exploration.

I would like to thank students and teachers of Shree Sharada Vidyaneketan School, Bangalore for giving me full support for interacting with their students. Mrs. Satya Purna for lending me her video camera.

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ISRO

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Part 2 Understanding the context

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Introduction

We shall not cease from exploration, And the end of all our exploring, Will be to arrive where we started, And know the place for the first time…

When the tongues of the flame are in-folded, Into the crowded knot of fire, And the fire and the rose are one.

-T S Eliot, Four Quartets

When I was ten years old, I would look at the clear dark sky of my village with sparkling stars. One day unusually I discovered a star moving. It moved at a great speed and disappeared. I showed it to my cousins. After a while he discovered another moving star. It became a game for the next one hour. We played daily after dinner for the next few days.

After a couple of years I came to know that they were man made satellites sent to space to monitor earth!
I wondered how could we send it up; make a star and make it move so fast along a straight line high up in the dark sky. These wonders made me want to know more about satellites.

The Space exploration is ancient but recently in the last two centuries, the new way of thinking called science and its applications has made this dream fueled with large possibilities of ideas. It leads us to a huge body of research, discoveries and findings creating a great wealth of human knowledge. It is a task to comprehend.

My experiences made me to discover more about satellites. I feel an incident can kindle your curiosity, and imbibe a way of thinking to know about the phenomena by discovering it.

I wished to work with ISRO for its new spirit of encouragement and commitment to bring scientific knowledge to common people. ISRO is one of the leading research centers of the world that have mastered the technology of building Satellites and facilities for National use. We launched our first satellite “Aryabhatta” in 1975 after that there was no look back on the developments in Space Technology.

The Satellite program involves design and building of satellites for various applications involving National Tasks. Two families one of communication and the other earth observing satellites dominate our satellite program.The launcher program involves the design; fabrication and launching of launch vehicles.

Interactions with the scientists and engineers inspired me to take a challenge to make complex concepts of science easier, imaginative, playful, and pleasurable and experience educational value to the understanding of the general audience.

We encounter science as prescribed by the syllabi in our schools and colleges. We relate ourselves to words of the book to understand, not giving a chance to relate to the experience of the phenomena by using our imagination. **I have tried to explore the design of an educational product with these concerns.**

1.1 Aims of the Project

- The project aims to kindle and promote a natural liking to search and discover the elements of sky and experience space exploration.
- To aid the user with information experience, a space interesting enough to dwell into the subject.
- To design a self-motivating three-dimensional experience based learning unit to be used in public environments.
- To open up new avenues in the possibilities of game like group interaction in public places.

1.2 Methodology

- **Part 1 . Search for the idea**

  To see the possibilities of design intervention.

- **Part 2 . Understanding the context**

  To investigate into the problems of communication of scientific concepts.

  Learning about the user.

  To understand interactions in public environments.

- **Part 3 . Product Conceptualizing**

Part 1 . Search for the Idea

2.0 - Institute and education.

My initial search was to understand the role of ISRO as a Research institute and its attitude toward education.

2.1- ISRO- Background and Communication Efforts.

Government of India set up Space Commission and Department of Space (DOS) in June 1972. Indian Space Research Organization (ISRO) under DOS executes Space programme through its establishments located in different places in India.

Main objective of space programme includes development of satellites, launch vehicles, Sounding Rockets and associated ground systems. The prime objective of ISRO has been to develop space technology and its application to various national tasks.

2.2 - Attempts made by ISRO to reach out to general public.

- **In-house publication** is responsible for bringing most of the promotional work of the organization to the general Public. It includes quarterly magazine- “Space India” published for limited circulation. The magazine contains the latest News of the organization covering popular subjects like new initiatives of Space Programs, mission description & objectives, technological breakthroughs, project accomplishments, contributions of individuals, reviews, News of seminars and future visions of the organization.

- **Promotional materials** like project specific publications describe the project objectives and applications. Posters and stickers as carry materials to delegates and visitors contain images of satellites and launch vehicles showing its specifications and project visions. Scaled down Models of launch vehicles and satellites are included as mementoes for delegates.

- **Permanent in-house exhibitions** in different Centers[1] showcase a run-through of organizational achievements and accomplishments over the years. It exhibits scaled models of satellites and launch vehicles with posters containing information on various space initiatives by the organization. It is not opened for general public.

- ISRO participates in trade shows and College Technical festivals all over the world interacting with student and Business community. **Stalls** containing a showcase of organization are put up in the occasions.

- The **website**[2] gives an insight into the organization with constant updates of events, programs, services, decade plans, research initiatives and so forth.(www.isro.org)

- ISRO contributes information of interests to **Public Museums**[3] providing them with required images and texts.
  The Vishveswariah Museum, Bangalore, India has opened an exclusive wing showcasing Indian Space Program.

Conclusions

- ISRO's communication efforts have been **largely promotional** in nature, describing the performance of the organization.

- **Education** has **not been a key interest** for the organization, as its primary focus is to develop space technology and applications for national tasks

- ISRO has the responsibility of bringing the organizational developments like mission data and project reports to other professionals and general public of the country which it is following by various mediums as mentioned above.

2.3 - **Attempts made by ESA(**European Space Agency**)**
NASA (National Aeronautics and Space Administration)

To the contrary, other Space agencies like European Space Agency of European Union, National Aeronautics and Space Administration of USA having the similar responsibilities of developing space technology to their nation show a keen interest in building exhaustive educational resources and programs planned encouraging the sprit of science and space exploration.

- An insight into websites[4] of the agencies shows a deep inclination to channel the vast knowledge of science and technology to common people through elaborate educational programs.

- Apart from latest updates and organizational information, Student specific projects, distant education, Student experiments, Educational events, competitions and Training for teachers dominate the program of these research Institutes.

- The responsibility of education seems to be of one of the primary interests of the institutes abroad.

Observations

- A research institute could be an influential resource center for educational purposes.

- Its invaluable resources could aid the existing educational systems by constant interactions with the general audience.

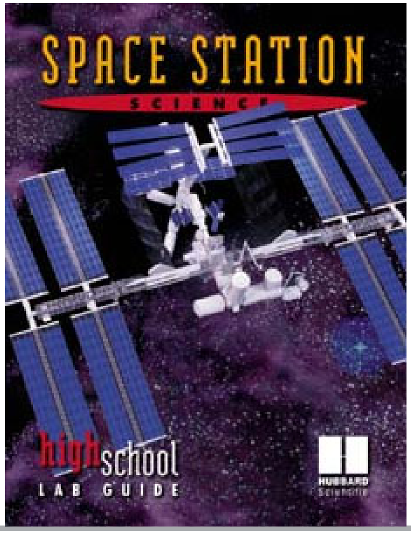
- A research center could involve actively assisting local schools with materials and expert opinions on subject. By this social responsibility it could inspire next generation students.

This gives an opportunity for the designer to involve himself in the design of communication which would be easily understood by the common people.

3.0 - Space as a resource for Communication aids - an overview

Three dimensional objects which facilitate an experience of Space exploration available in market were seen to find out the variety and range of products today. It was done by attending Science museums and searching from the internet. Existing product families were analyzed for their learning objectives.

3.1 - Individually owned



Space Station- Educational Aid – ESA

Lab guide includes twelve exciting lab activities, giving students the opportunity to conduct experiments similar to those that the astronauts will be performing while on the space station.
Hands on activities cover different subjects in physical, chemical, biological, life, earth and space sciences.
Reproducible student worksheets and internet sites are also included.

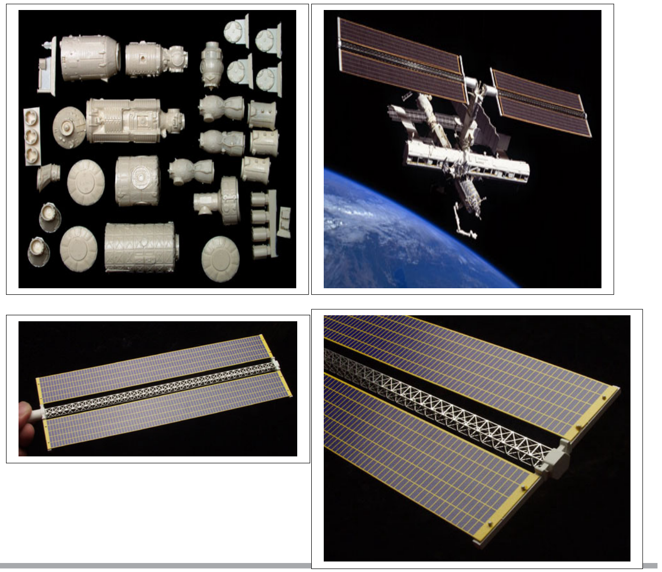
This would aid he students and teachers with relevant material and creating activities to know more about the international Space station.

Space Explorer - Toy

A Toy in the form of a planet rover.

This type of Toys encourage for individual owning and playing.

ISS Module Detail Set - Kit



This detail set includes all the pressurized modules presently on orbit with the ISS. Each one is accurately textured and replaces the corresponding modules from the InterMountain ISS kit. Two Soyuz and one Progress are also included. The kit comes with new Russian solar arrays for the modules and the spacecraft.

Assembly and building would be the primary activity a kit can create and hence a sense of accomplishment after the finish.

3.2 Public Spaces

Space Race - Theme exhibition.

Space Race is the theme of the permanent exhibition at the Smithsonian Museum. Large number of exhibits showcasing the events followed during the Space race is displayed.
An exhibition is best suited to expose to large amount of information to the audience by appropriate theme and display.
An exhibition explains concepts of science by rich visual experience of posters, pictures and models and also giving a point of view of the creator by its theme.

Information Kiosk - Space explorers kiosk.

A kiosk is an information system or an electronic self service unit specifically designed for popularly information and transaction purposes.
It gives an opportunity to play games, learn about aspects of space exploration by involving attractive design of screens and usage. Topics like Space exploration contains large amount of information which could made available in a easy and efficient way to the audience.

Simulators

Simulator is a creation of environment for performing an action. It is like a stage set which gives a near real experience of action.

A space shuttle simulator gives you a real environment of ht cockpit of the shuttle enabling you to control the flight virtually.An amalgamation of electronics and creation of environment gives opportunities for near real gaming experience. Large number of games is designed with varying contexts and complexities to create interest in the audience. Simulators are popular gaming stations designed for racing games, flight experience etc.

3.3 - Virtual **Application softwares**

Many simulators in the form of software are developed to be played from any Personal Computer. A software program generates the graphics and game which could be experience on a regular computer screen.

The picture is a simulation of a Eagle Lander Simulator showing the controls and display of the Virtual Vehicle capable of recreating the environment of moon to navigate and explore.

3.4 - Observations - Scope for design

- Educational Aids need the **assistance of teachers** and a proper introduction into the **syllabi** of the education system for effective use of product. They might contain well thought rich information about the topic and create activities for children to involve while learning the concept. They become the **priced possessions** of schools.

- Educational Toys encourage **individual owning** and **playful**, simple usage for fun. They may constitute **lesser educational** value and hence realization of scientific concepts.

- Educational kits are characterized by **building** as primary activity which might become like any building activity of a house or a truck.

- Kiosks are conceived as information and **service providers** limiting the possibility of extending the design for transactions or information viewing. The design could become very general.

- Exhibition design on themes of space exploration is widely explored. It tends to become **space design** than a product conceptualization.

- Simulators are exiting products but most often designed for **gaming purposes**. They are widely accepted as gaming tools. They usually replicate the context to give near real experience.

4.0 Solution Space

4.1 - Initial exploration of Solution Space

Scope

- To identify topics of interests and search for an opportunity to develop educational products.

- To understand how industrial design can potentially play its role by creating communication aids from the vast field of Space exploration.

Sl. No	INFORMATION TYPE- TOPIC	CONSTITUENTS	SOURCE	USER	DESIGNERS ROLE	FORM OF PRESENTATION	DESIGN
1	SPACE TECHNOLOGY "The scientific method and material used to achieve a commercial or industrial objective."	Technical Data/info Analysis of data Technical development plans Research findings Raw material specifications	Institute Scientists, Research ***Facilities,*** Raw material dealers	Scientists Raw material dealers	**Information Structuring Publications**	Printing Movie **Live information**	Report Style sheets **Kiosk**
2	SPACE EXPLORATION "Ranging over for purposes of discovery"	Studies of Space Sciences Studies of celestial bodies Lunar missions	Astronomers Scientists	Students Children Astronomers Scientists Artists Writers	**Visualization**	Movie clips Space news Print Simulation **Games**	Book Magazine CD **Game** Movie **Stall** Planetarium **Exhibition**
3	SPACE TRAVEL	Travel Space probes Humans in space Space tourism	Futurists Doctors Scientists Biotechnologist Writers Poets, Astronomer Sociologists	Space travel Enthusiast, Students Children Artists Business Enthusiasts	**Visualization** **Experience** **Clarity info**	Painting Rendering Movie **3D-games** Reports Story **Play** **Teaching**	Book **Simulator** **Exhibition** **Game** **Kiosk** Movie **Kiosk** **Toy** **Educational Kit**

4	SPACE TECHNOLOGY APPLICATION	Technology for the use of mankind Benefits and advantages Weather monitoring Earth soil monitoring Communication	Scientists Farmers Sociologist Military Geologist Business Enthusiast	Common People Farmers Fishermen Military Public planners Students Businessman	**Visualization Interpretation Device Concepts**	Print Statistics Technical paper **Game** **Educational kit** Graphs Photographs **Models**	Poster Sticker Magazine Report **Game** **Kiosk** **Simulator** **Exhibition** **Stall**
5	**SATELLITES/ ROCKETS** "Space Vehicles"	Working, making, Building, controlling, Conceptualizing	Engineers Scientists Physicists	Government Students Scientists #Relative Educational institutes	**Visualization Interpretation Simulation**	**Illustrations** **Models** **Educational Aids** Movie **3d modeling** Photography	**Educational Aids** **Game/kit** **Model** **Gift/toy** **CD** Movie **Animation** **Exhibition** **Kiosk**
6	**HISTORY OF INDIAN SPACE PROGRAM**	Narrating, documenting	Historians Critics Teachers Scientists	Educational institutes	**Interpretation Visualization Illustration**	Time chart Print Movie Interactive Media	**Exhibition** Text book Film CD

4.2 - Observations

- Space exploration is a **vast field** of Science covering several popular topics as mentioned above.

- The topics cover some of the most important **phenomena of modern science** and the latest advancement in technology and research

- It is possible to pick almost any topic to further develop into a communication aid, but some topics like **Satellites and Launch** Vehicles are popularly known to people and would interest them.

- Some of the Topics give an opportunity for an **industrial designer** to intervene. Some of the design explorations could be in the form of teaching aids, information kiosks, toys, exhibitions etc.

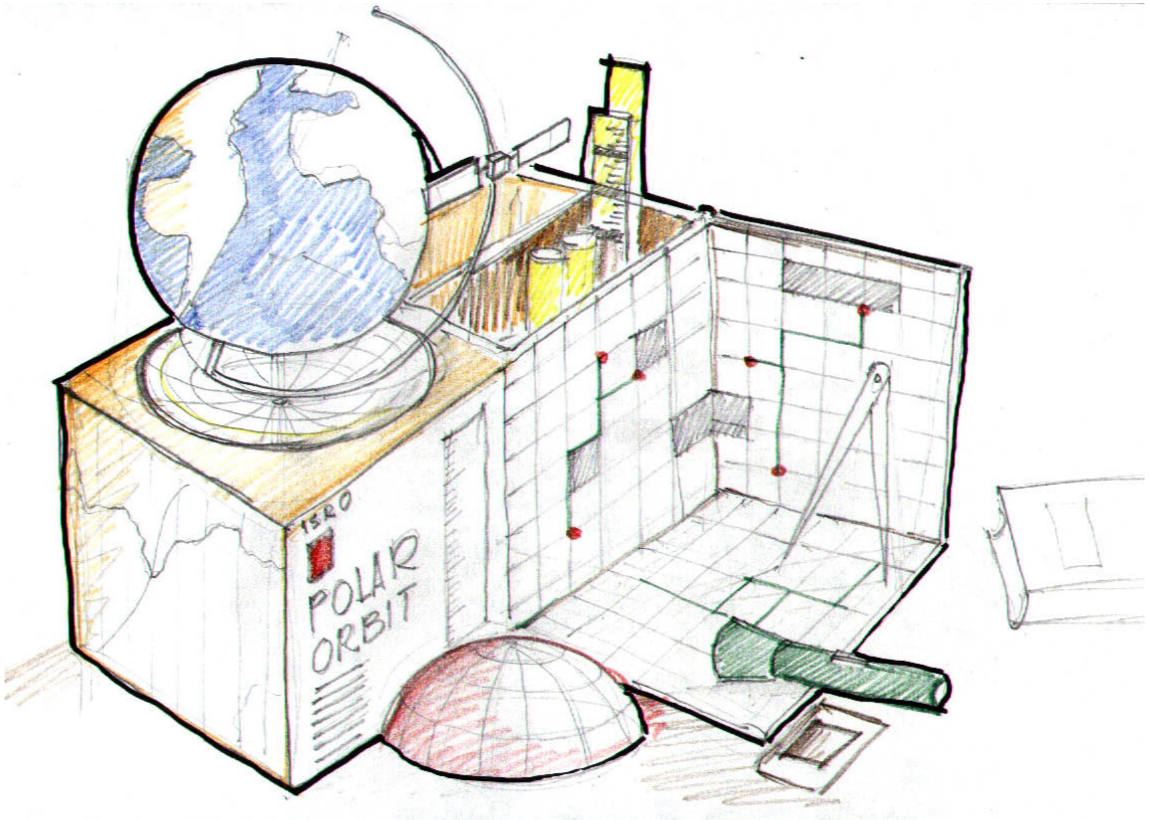
- Making scientific concepts easy to understand, extending an experience, structuring of information, envisioning new ways of teaching, motivating them to explore further, promoting, giving identity could be some areas where a designer is likely to involve.

4.3 - **Initial exploration for Solution Space**

Initial ideation was a brainstorming into various design interventions possible

- Educational Aids
- Educational kits
- Educational toys
- Theme Exhibition
- Permanent Interactive Display
- Information Kiosks
- Stall
- Simulators
- Others - Space souvenirs, Game / Gifts

- **Educational aids -** To design 3d educational aids to school-children to explain a scientific concept with the assistance of a teacher like aid to explain polar orbit.



Advantages

A powerful **visualization** tool.

Learning becomes an experience.

Encourages **group learning**

Simplification of a complex concept.

Story building ability.

Disadvantages

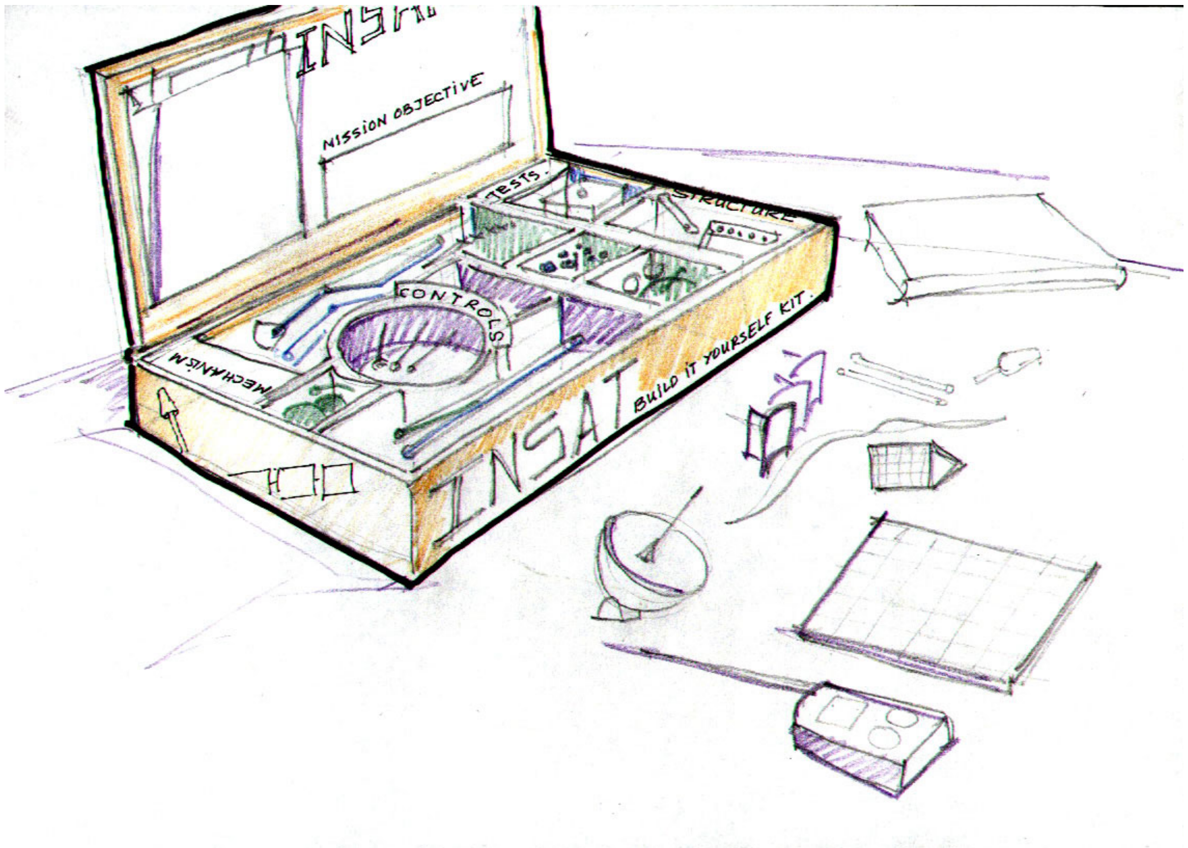
It can explain only **one concept.**

Needs assistance and hence not self motivating.

It may tend to become playful and Learning can be limited to concepts.

It's not a **hand on** experience.

- **Educational Kits -** To design creative educational kits for children so that learning becomes a hand –on, enjoyable and self taught experience like build your own satellite.



Advantages

Kindles the natural ability of child to **search and discover.**

Learning with **hands on** experience.

To clarify and apply theoretical knowledge gained at school.

To develop **manual skills** with **purposeful observation.**

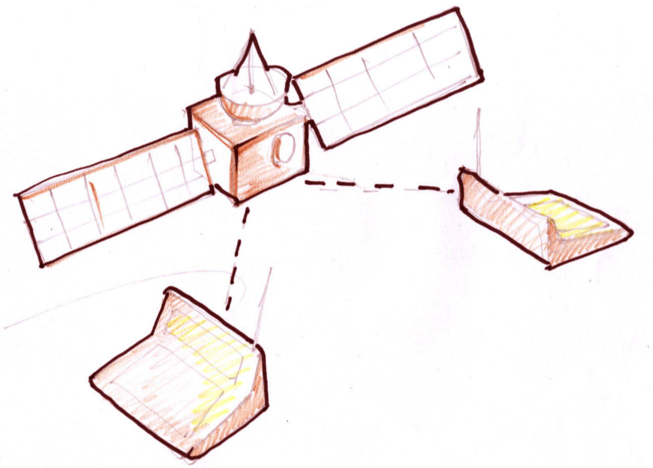
Disadvantages

It can explain only **one concept.**

Needs assistance.

It may tend to become playful and Learning can be limited to a concept.

It depends on the **Individuals interest** and likings over the subject.



○ Educational Toys - **To design an educational toy explaining concept of satellite communication.**

Advantages

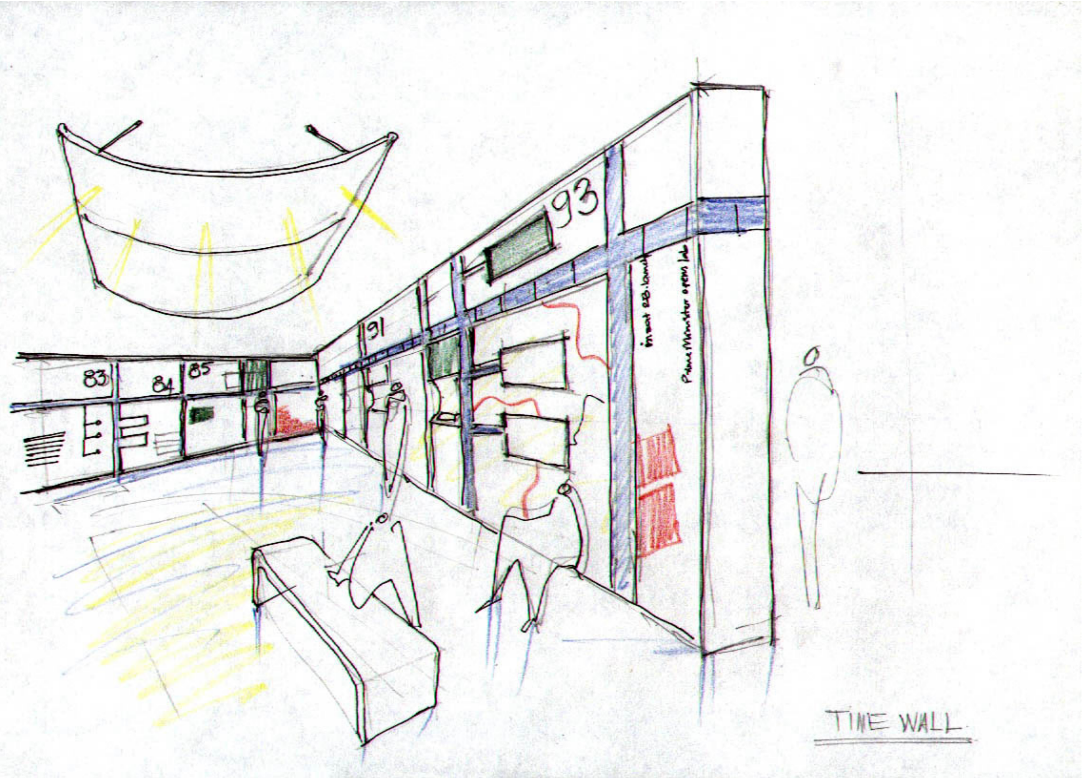
- Individual oriented.
- Fun dominated.
- **Learning** happens by engaging play with the object, meddling and relating to the shape and working of the toy.
- Hands on experience.

Disadvantages

- It may tend to become only playful.

- Learning of scientific concepts might not happen.

- **Theme Exhibitions - To design a thematic temporary exhibition for ISRO like the history of Indian Space Program.**



Advantages

Addresses to a **larger public.**

Ability to communicate **larger degree** of information compared to above mediums.

Rich graphics and information structuring makes it an experiential learning.

Disadvantages

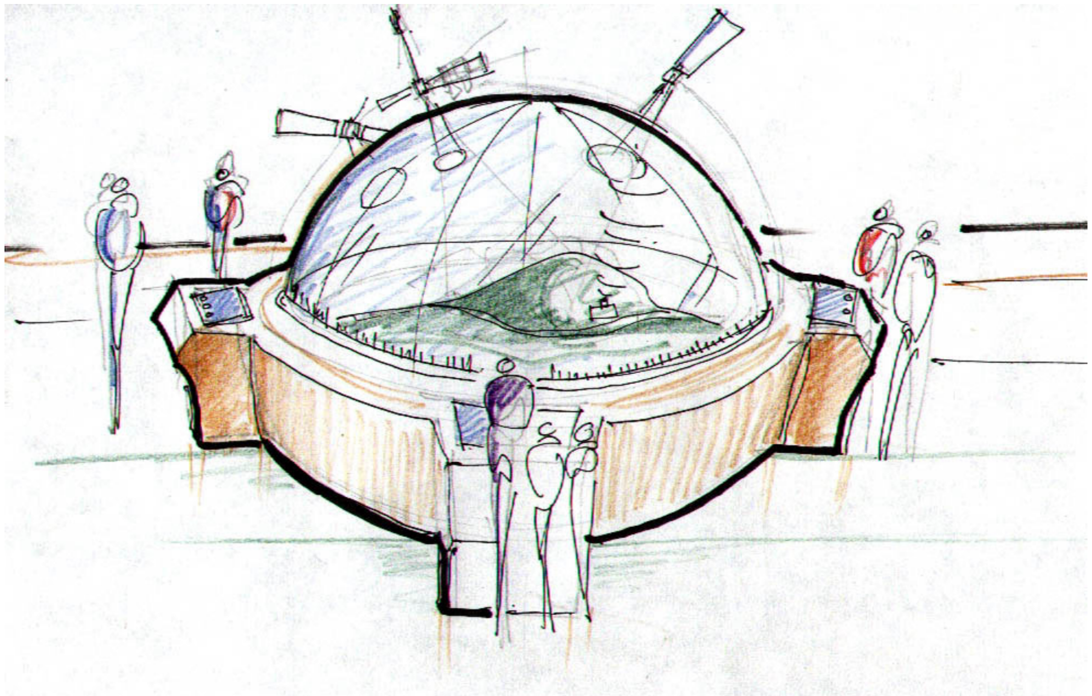
Contains primarily **static information.**

Information is limited to display or theme.

It's more of a see and experience concept.

Permanent Interactive Display - To design an interactive display explaining a scientific phenomena or concept as a part of museum or exhibition.

It is theme based. It demonstrates a working of a device by allowing you to control a certain part of it either mechanically or electronically like satellite working.



Advantages

Hands **on experience** to control and experience.

Clarifies and explains a single theme.

Powerful **visualization** material.

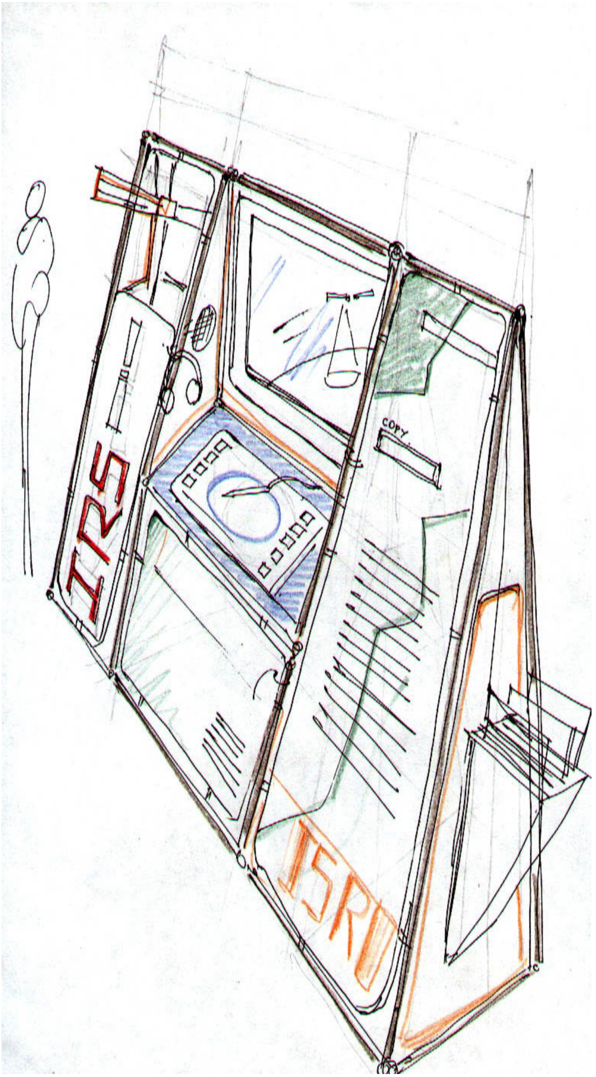
Disadvantages

Becomes an object to play with.

Becomes an extension of a theme in a museum.

Explains a single concept.

Permanent in nature.



○ **Information Kiosks -** To design an interactive information Kiosks for ISRO to provide dynamic, experiential information to the users.

Advantages

Provides interactivity.

Dynamic information.

Self serviced technical application.

Improved access to information using the internet.

Virtual visualizations.

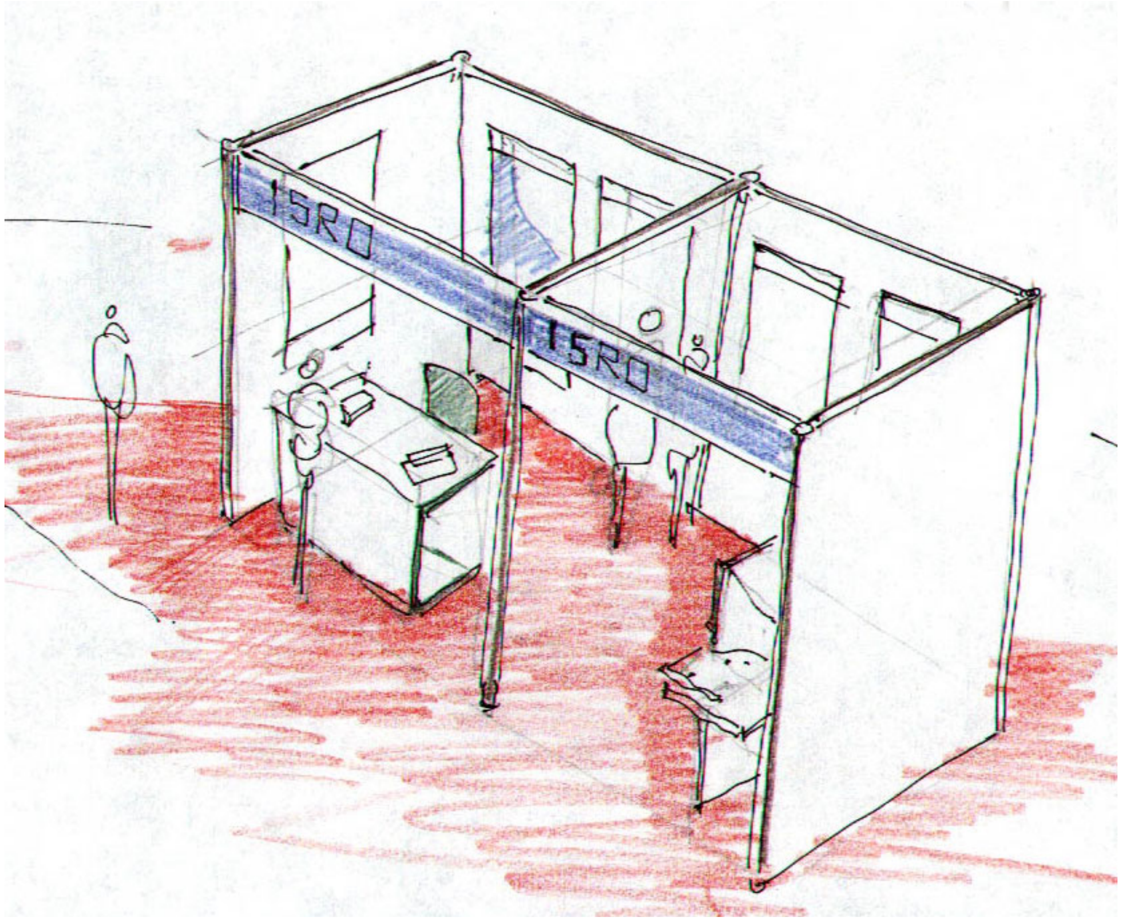
Right of ownership.

Disadvantages

One person at a time.

Technology dependant.

○ **Exhibition Stalls -** To design a stall for ISRO as a solution to temporary display easy to install to advertise the working of the company.



Advantages

- Gives a **range of required information in a one place** to varied users.

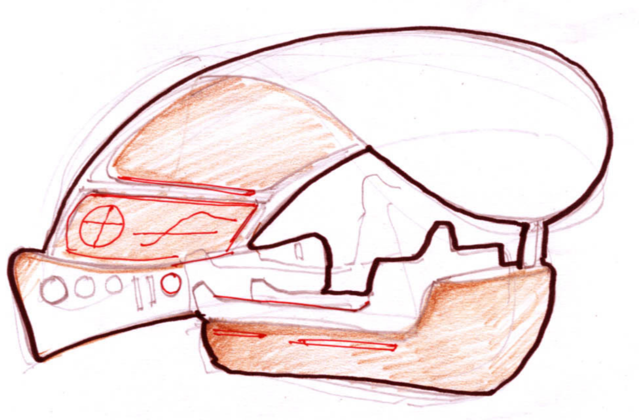
- Projects an Image of the company, since it part of other stalls at a festival or conference.

Disadvantages

Provides General information.

Non experiential.

Focused to business interests.



○ Simulators

Advantages

- Designed for a **near real experience.**

- Designed keeping a particular **task** in mind like racing, skiing, flying etc.

- Learning happens by the interaction with the object by a control.

- The audience becomes a part of the object and the activity.

Disadvantages

- Tends to become only a gaming device.

- Might Lack educational content.

4.4 - Conclusion - **Search for idea**

- Space exploration could be an exciting topic to explore the possibility of educational products.

- A research institute can be encouraging by acting as a backbone of resource and expert advisors taking initiatives of spreading the concepts of Space exploration to the understanding of common people.

- Though Space exploration is a vast field of knowledge some topics like satellites and launching vehicles are popularly known among the people.

- A variety of Industrial design possibilities could be explored explaining certain phenomena of Space Exploration in a creative, pleasurable way so that it encourages the curious minds of students and people to pursue their passion.

Part 2 . Understanding the context

5.1 - Criteria

- Product would be envisioned keeping ISRO as the knowledge base.

- It would be designed for Public Museums, Science Centers or Planetariums and to be installed by ISRO.

- Children are a part of major visitors to Science Centers. Hence a study of the children to know their actions and manners would give an insight into the problems of communication of Scientific Concepts and its experience.

5.2 - Interaction with children

Interactions with the children as end users aimed at understanding the problems of communication faced while we attempt to create products explaining scientific concepts. The initial interaction with children was from class nine. It primarily focused on :

- Knowing the existing knowledge of the students, its source, medium and depth of understand of phenomena.
- Experiencing the problems faced while communicating scientific ideas.
- Seeing the users reaction to different methods of information assimilation.
- Observing the medium of communication and the way of use.

The children whom I interacted were a mix from urban and semi urban areas showing a clear indication of level of exposure to subject. It was implemented in a normal class room environment.

The interaction was arranged in the form of special lecture to students where on the first day I gave a lecture using materials like posters, scaled models and relevant charts. The lecture was an introduction to space exploration to students.

Second day, I tried to explain specific concept of launching of satellites. This activity helped me to understand users (students) and problems of explaining a phenomena to students.

Teams were made to have active group discussions while a question was posed to the group. The group used the materials to narrate back the understanding of the concept.

5.3 - Insights during the Interaction

Problems while explaining

A concept explanation requires an **appropriate usage** of information type like Text, Diagram, Picture, Video, Poster, Illustration, Model, Voice, and Animation.

Mediums

Each medium has its own **limitation** while a concept is narrated, making the student understand only a part of the concept.

- **Text** is hardly noticed by the student during active involvement of an event like a lecture or video show and any amount of text would not encourage him to read and understand the concept.

- A **Picture** is a helpful visual only when **aided by theory**. Though it gives a view of real environment it restricts the student to feel the concepts since they are abstract.

- **Poster** is seen as a **collectable** and priced possession among students.

- An i**llustration** is a useful aid to interest the student to give an imaginative narration of concept. Appropriate illustration makes the conceptual understanding quicker and effectively **easier to understand.** But it lacks the experiential quality.

- **Model** is a good medium to explain the working of a device, it encourages the students to visually experience the physical form and hence remember its discreet parts. But model has to be aided with explanation.

- **Voice** or narration is a very effective medium to involve the student into the subject. A good explanation can create inspiring interest in the student and a lecture has been a faithful tool for teaching over the years. **Constant conversation** keeps students engaging and involved.

Terms

Terms and **physical relations** catch the interest of students. Since the system of education persuades the students to remember the concepts rather than realize it, terms like apogee, gravity, geostationary, thrust, lift etc seem to evoke constant competence among the students.

Terms act like barriers for lesser exposed students. They find it difficult to get involved in the discussion as they do not understand the terms relating to the concept. Knowing the terms keeps up the confidence of the students to a high degree.

Source

- **Academic books** play an important role in relating to the subject.
- Awareness of objects like satellites and rockets seemed to be aided by an **influence of television** more than a book or a picture.
- There is an extensive access to games played on **computers** with a similar subject.
- Many students largely **depend on the teacher** for clarification in school environments.

Activity

- A **group activity** initiates larger involvement than individual activity in a classroom situation since children know each other.
- Relating directly either by use of examples of real life situations help the students to understand effectively.

5.4 - Interactions in Public Environments - A Museum Case-Study

Observation aimed at getting an insight of users in Public environments. Vishweswariah Industrial and Technological Museum, Bangalore, has dedicated a special exhibition on Indian Space Program. It included exhibits explaining the basic principles of Launch Vehicles, Satellites, control centers, models of objects in space, an audio-visual presentation, mock-up of mission control center, time chart and a technology description through posters. Some of the insights during the observation were -

- Most of them have a **pre set time-a plan** to see all the displays of the museum. Except for students visit which are planned for educational benefits others especially tourists spend very less time on exhibits to experience its content.

- Audience try to be a **part of the exhibit**, some of them expressed through standing next to the exhibit posing for a picture. It is an event for them. Very few also find themselves in-between display of latest technology for the first time having a mysterious feel of the display.

- The Strict posters loaded with information and plain display of models fail to attract the attention of the audience if the concept for which it was intended is not met.

- The **computer screen** is a popular **attraction** and the size becomes important to be noticed in an information filled environment. **A need of assistance** is seen by the audience for exhibits containing a medium of computer.The Screen creates an image of a sophisticated machine to the audience. Very few other than students are comfortable with it.

5.5 – Insights

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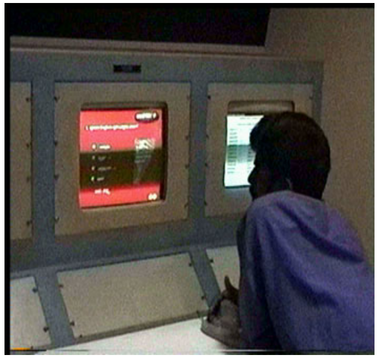
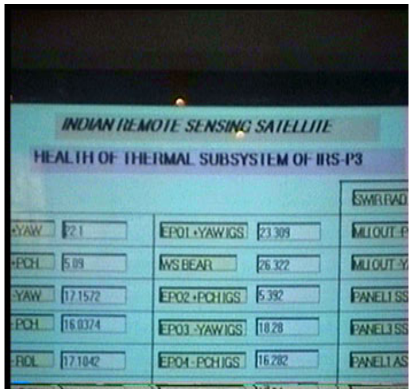
5.6 - Mock Up Of Mission Control Center



A mock Up Environment of a mission control center of a satellite was created as a part of display of the museum to give a feel of environment of mission control and tracking of satellite just like in real situation.



5.7 Observations

The software installed to show the realism of tracking failed to communicate what it was meant to be to the audience as it contained the real coding visuals used in original software which are difficult to understand.
An Easy to understand Visual would have helped to realize the intent

The **concept** was left unnoticed due to little attention given to its **realization.** It could not capture the essence of the mission control as it did not answer the questions faced by the audience. Just installing three terminals of computers attracted the audience but left them confused over its intent. Attention to details, clarity of joints and appropriate form govern the realization of concept

One of the terminals provided multimedia information on satellites. This terminal acting like a kiosk attracted audience to experience the show on the screen. It provided information in the form of diagrams, animation and voice explanation.**Dynamic information design attract audience to indulge into the subject.**

The unit allowed for collective group interaction due to its size and the creation of enclosure.Collective group interaction in the form of looking at the screen together, discussing to understand the display allows participation and exchange of ideas by free discussion.
It is ideal for problem solving situations.

6.0 - **Product Brief** – Level 1

The project involved design of Educational Products with the support of ISRO. Initial essential **objectives** of the project were:

- To design a self motivating, three dimensional, experienced based learning unit in public environments.
- To inspire an enquiry into the subject of space exploration.
- To instigate an interaction with the product to realize the scientific concept.
- To provide opportunity to control the variables achieving specific goals.
- To involve direct relationship with the content.
- To envision orchestrated handling of the concept becoming an experience.

Target Users

1 - The primary target audience is students of the age group 12 years or class of VII STD and above.

2 - Anyone visiting the museum

The product will be in the **form** of

- an experience unit.
- will allow user to control specific variables.
- express the concept boldly.

The product was envisioned to be installed in public places like Museums, planetariums, Science centers.

7.0 - Concept Generation

7.1 - Theme

Since “Space Exploration” is a vast area to comprehend, I decided to focus on specific themes based on the above studies. Criteria for choosing the theme are :

- It should be popular topic Known to the children and other people.
- It should be known to wide range of audience.
- It should add on to the audience’s existing knowledge.
- It should be integral to objectives of ISRO.

Theme Chosen

“Artificial Satellites”

7.2 - Concepts

Initial ideations were largely done explore the various possibilities in the design of products. It was essential to narrow down on a specific theme and develop the idea.

The concepts are envisioned to be placed in museum environments. The concepts are analyzed to see its pros and cons to suit the requirement of product by mentioning its :

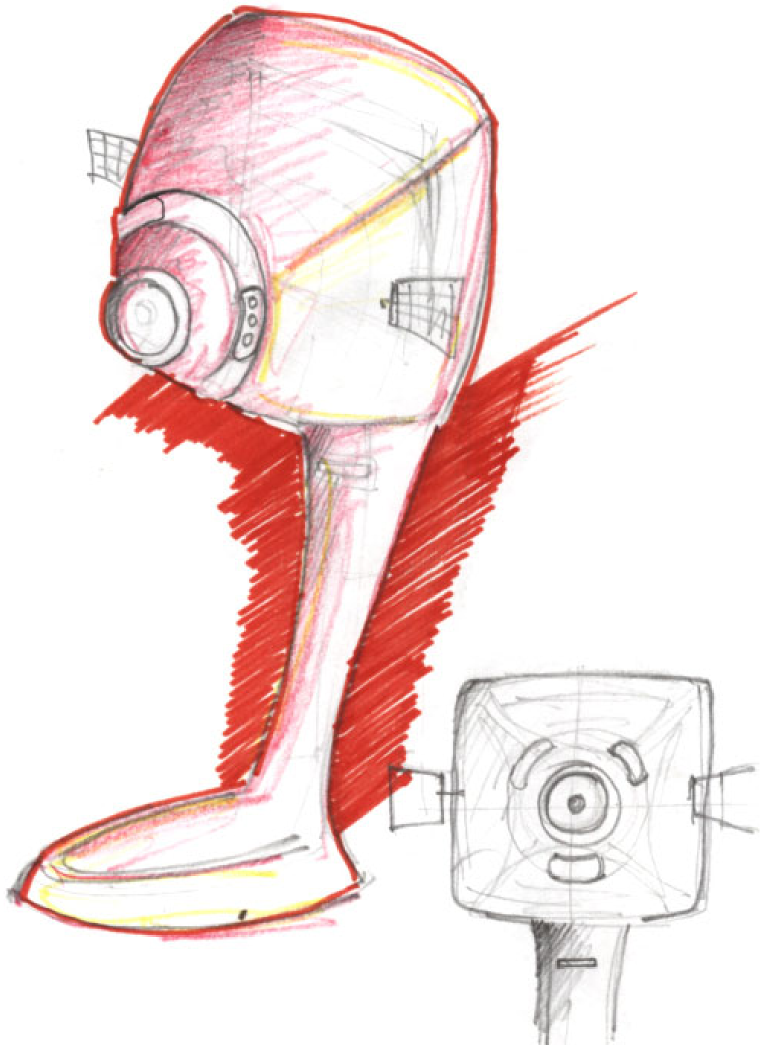
Background – the visualization of the concept.

Experience – the actions come upon during the search.

Learning - the knowledge gained during the experience.

Tasks - the effort involved by the user.

And What does the concept lack?

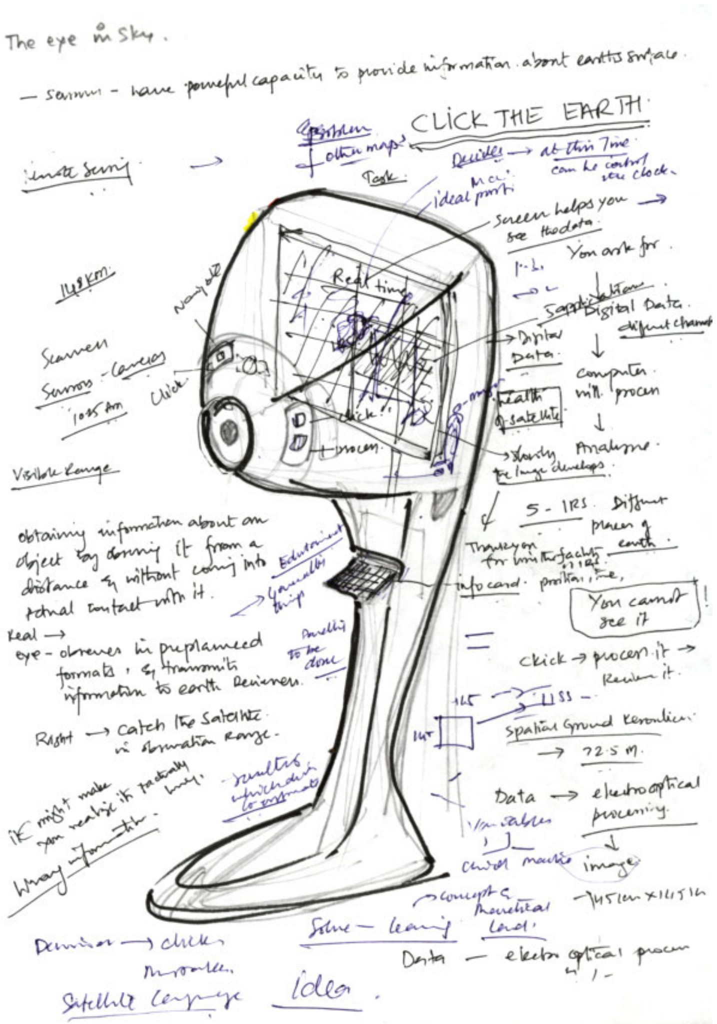


7.3 - Concepts 1- **“Watch the earth”**

Background

If one compares the earth to a hen’s egg. Its atmosphere is very thin - like the shell. In fact, if the earth were shrunk to the size of an egg, the atmosphere would be thinner than the shell of the egg. We human beings live our lives in this atmosphere clinging to the earth. The atmosphere and water, which covers 70% of the earth’s surface, generate dynamic cloud formations. It is these clouds which give it such an expressive appearance.

In 1877 the Italian astronomer Giovanni Schiaparelli thought he saw canals on the surface of the planet Mars - if he had been able to see earth from space the beauty of its always-varying aspect compared to Mars would have had a much greater fascination for him. A desire to see these wonderful effects for myself led to this concept.



Experience that is created

- To look through the eyes of camera of a satellite towards earth and experience the view of the earth as seen from satellites.
- Role playing by using the imagery for various applications.
- To watch the earth melting, flooding, burning, and raining.
- To create a game like situation.
- To Zoom near to the surface of the earth.

Learning

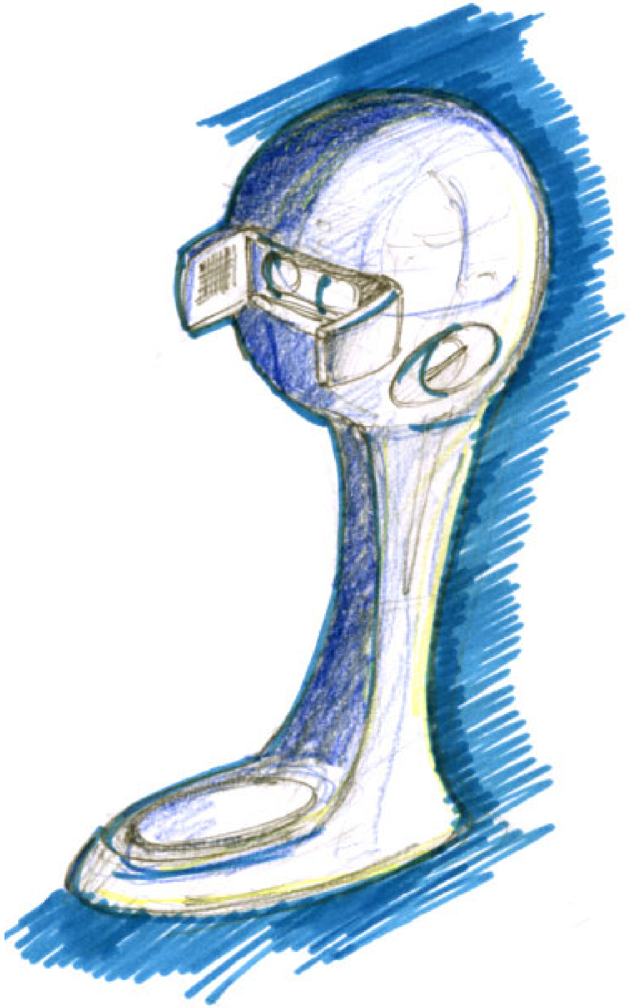
- Developing aesthetic sensibilities by exposing to extraordinary imagery of earth taken by satellites to the audience.
- To introduce to remote sensing applications of satellites.Visualization through photographs.

Task

- Use imagination to navigate the surface of earth.
- Solve the game like situation imposed.
- Selecting different applications of the satellite.

What the concept lacked ?

- Device does not relate to school syllabi.
- Might be bit complex to understand initially as it has more to do with earth knowledge than space knowledge.
- Does not allow you with direct relationship with the subject.



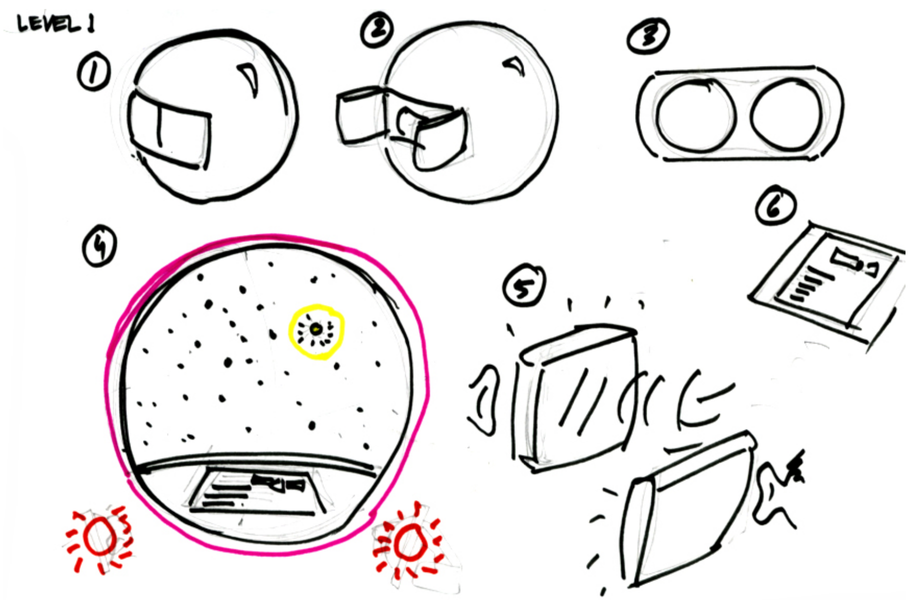
7.4 - Concept 2 – **Finding Satellites in the dark sky**

Background

Satellites when launched in space mix with the stars shine in the dark sky alone with the millions of other stars. They are sometime visible to our naked eye in the night sky. Satellites in orbit look like stars, but they move across the sky, and there are a lot of them visible on any given night. You can see the satellites because sunlight reflects off of their solar panels or communications antennas, and sometimes they will appear to "flare" briefly as sunlight glints off of something on the spacecraft. The global set of Iridium satellites produces especially bright flares that can be the brightest thing in the sky!
Students tools in school as well as at home has been the faithful globe used to visualize the positions in space. He bases his observation with the reference to the globe which is a non experiential model to relate directly. The satellite finder reverses the situation by creating an environment of dark sky.

Experience

- To watch the dark sky very similar to planetariums.
- To search for satellites in simulated time.
- To encounter other events of the night sky.
- To create a game like situation.



Learning

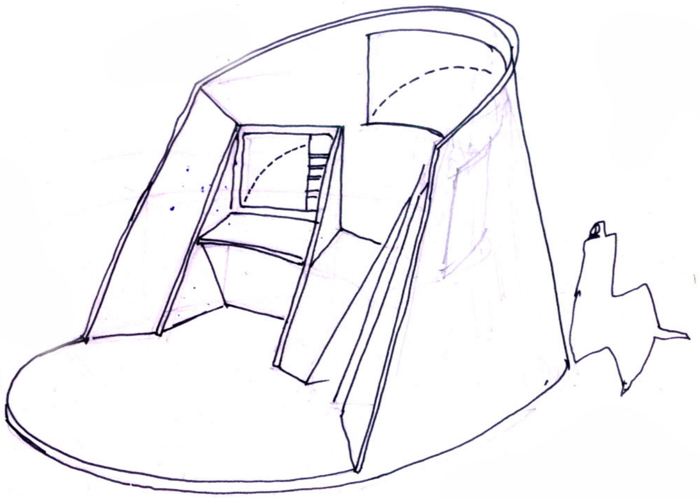
- To track artificial satellites in the dark sky.
- To know more about the satellites and its use.
- To add to the audience existing understanding of Artificial Satellites.

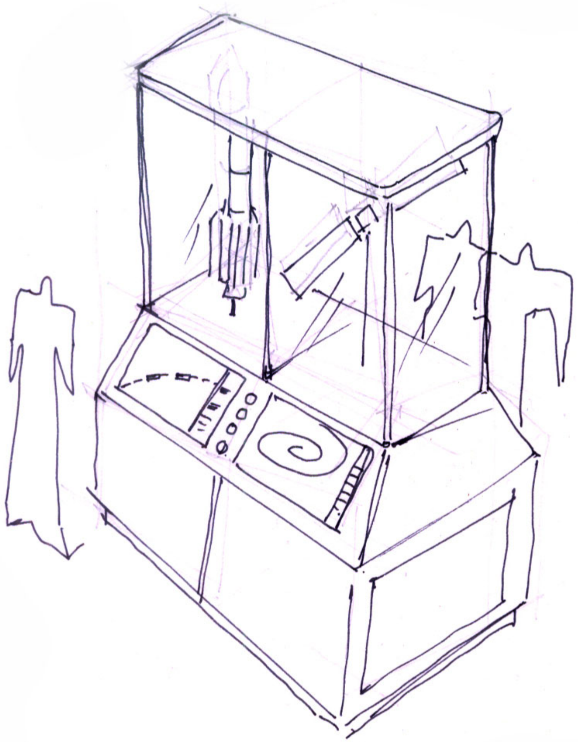
Task

Search and discover Artificial Satellites in the dark sky.

What the concept lacked ?

It lacked levels of complexity to attract different levels of users.





7.5 - Concept 3 – **Launch and orbit raising events.**

Background

The launching of a rocket is a historical event. It requires participation of all the engineers and workers of an institution. Launching is done with extensive and careful planning. The sequence of events carries on for more than 15 days from the day of launch. The lift off is witnessed by the general audience through direct telecasting. The series of events from the building of rocket, injecting the fuel, placing the satellite, preparing for launch, liftoff, separation of stages, ejection of satellite into space, maneuvering it to its planned orbit constitutes a launch event. It is an experience of complex calculations of many parameters. Launch pad is a simulated situation of the event.

Experience

To experience a rocket launch.
To place the satellite in its final orbit.

Learning

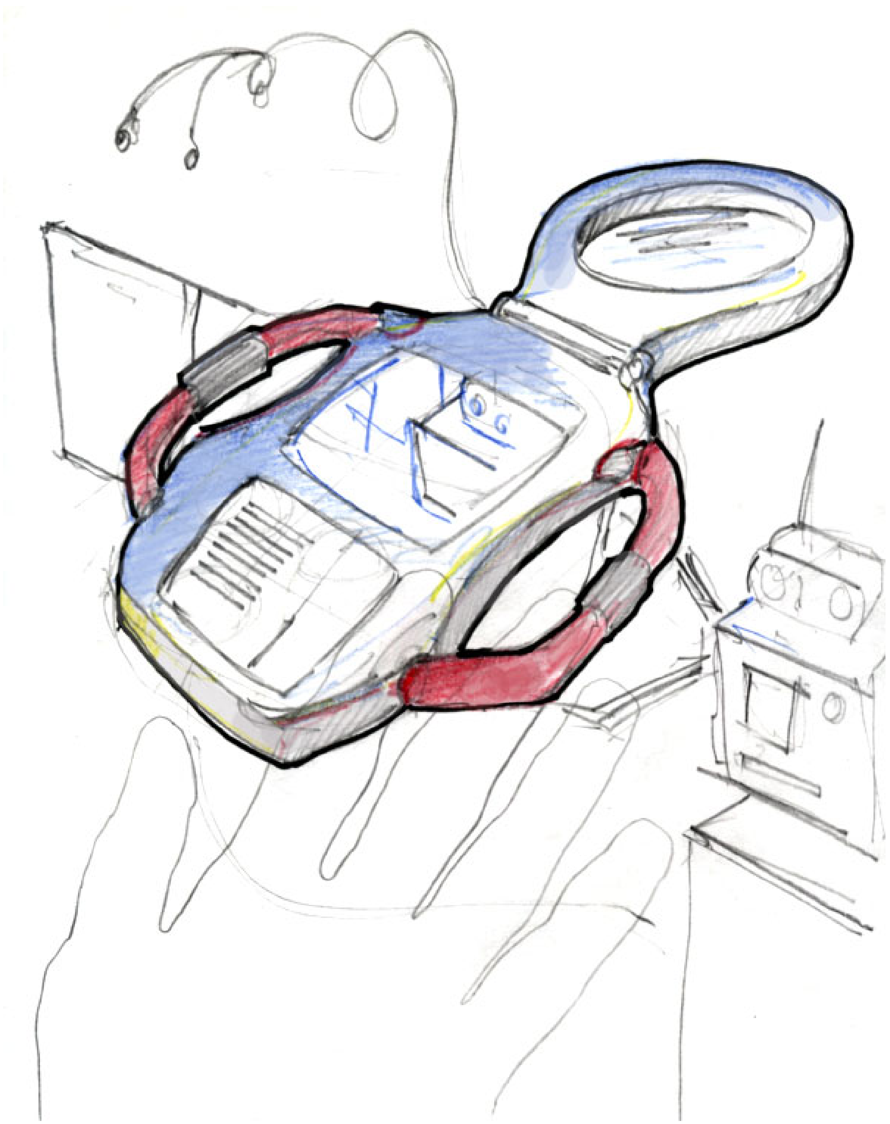
To learn about the basic concepts of gravity, thrust, motion through the engaging of events.

Task

Prepare for the launch.
Place the satellite in its orbit.

What the concept lacked ?

Concepts required pre-knowledge about the event.
It was huge to comprehend as it involved many scientific concepts.



7.6 - Concept 4 - **“Info lens”**

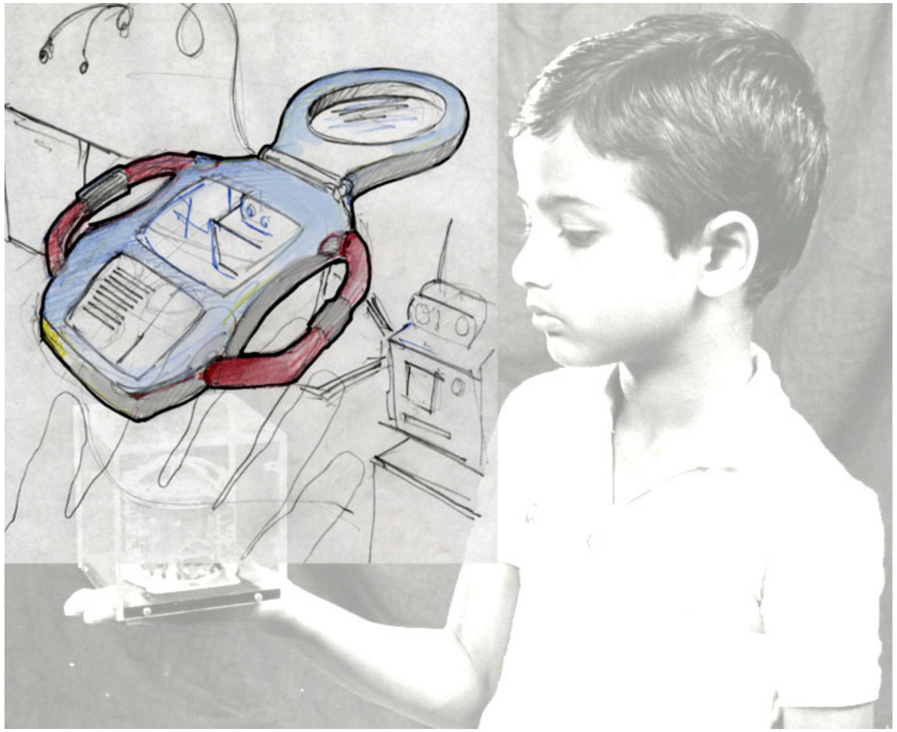
Recovering information from Physical Models

Background

Physical models dominate the visual experience of objects. They are a primary resource of a museum. People try to relate and gain understanding by experiencing scaled models of objects of space exploration. Models give information of its physical shape. Some models try to communicate the working of the display. Otherwise they become a static piece of shapes arranged in a museum environment. “Info Lens” tries to make the static piece of display into an active by a device which can constantly provide information by looking at the display.

Experience

Active inflow of information getting the user to know the essential information just while looking at it



Learning

- Info lens was conceived as more of information provider of the object of display.
- Learning would happen by getting to know more facts about the object.

Task

- Hold the lens and scan over the model.
- Read the screen to know more about the object of display.

What does the concept lack?

- Realization of single concept.
- More seen as an add-on to the display.
- Might be too sophisticated in public environments.

7.7 Concept realization

Criteria for selection

Any one of the above concepts would have been developed further. I choose to develop the idea of finding satellites (Concept 2) in the dark sky for following reasons :

- Satellite finding included exploring searching and thus mystery in the product.
- Satellites were a popular subject of interests to students.
- The product could be made for Museum environments could be used by user above 12 years.
- I could relate it to my personal experience and hence it would be comforting to narrate to others.
- The tasks in the product would grow with complexity thus creating different levels for different users.
- It would encourage further probe into the subject by involving the audience into an experience.
- It would give a sense of accomplishment.

Other concepts could be added to existing setup.

8.0 - Finding satellites – a Study of existing Methods

8.1- Back ground

Night sky

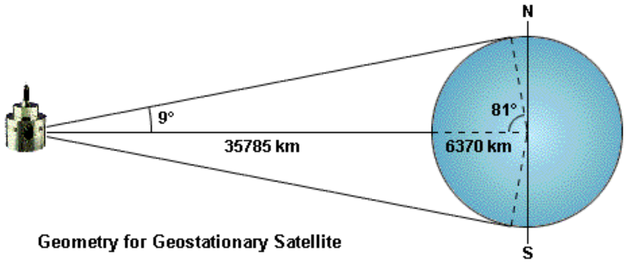
For much of recorded history, humans have been watching the night-sky for aesthetic appreciation, to gain insight, and predict the future. To search for satellites you need look into the night sky. Night sky becomes the backdrop on which you are provided to search for satellites. Night sky contains other visible elements like the stars, moon and the planets. You could locate some of the satellites in a clear dark sky moving at a great speed. It looks like a moving star.

Satellites

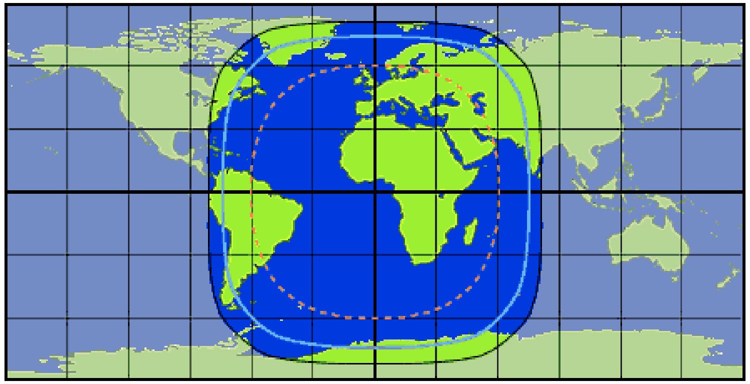
There are many satellites floating in space. It is estimated that about 8000 **satellites** have been launched into space so far. Of those satellites, 2974 were still in orbit at the end of November 2003, and 2669 had fallen back into the atmosphere of the Earth where almost all of them burned up.

Watching

Some Satellites which are in low altitude are visible to the naked eye due to a highly reflective surface reflecting Suns light. Satellite watching could an interesting activity to know more about sky and satellites.



Geometry for Geostationary Satellite



Maximum theoretical coverage
Imaging and telecommunications coverage
Meteosat images within this area used quantitatively

8.2 – **Terms Used while Finding Satellites.**

8.2.**1 - Satellite Orbit** - Satellites orbit is path traced out by a moving satellite in space. It is a perfect balance between the gravitational force due to the Earth, and the centripetal force necessary to maintain the orbit of the satellite. There are different types of orbit.

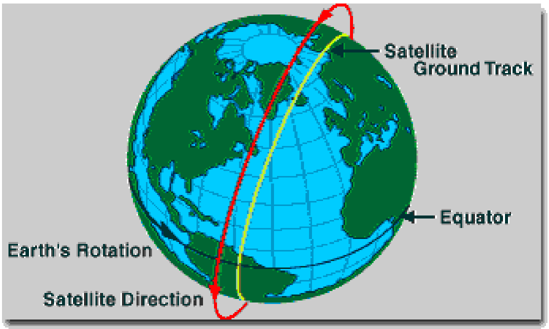
Geosynchronus Orbit

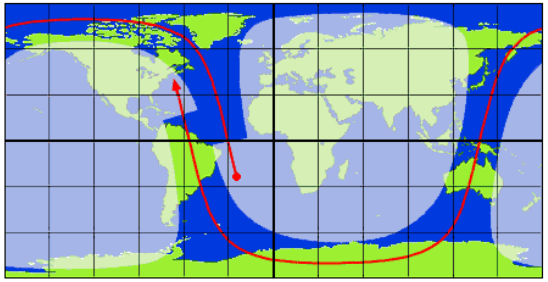
It is a type of orbit where the **satellite is over the same point of Earth always.** It moves around the Earth at the **same angular speed** that the Earth rotates on its axis.

So the orbital radius required for a geostationary, or geosynchronous orbit is 42,300km. Since the radius of the Earth is 6378 km the height of the geostationary orbit above the Earth's surface is ~36000 km.

The rotational period is equal to that of the Earth. The orbit has zero inclination so is an equatorial orbit (located directly above the equator). The **satellite and the Earth move together** so a GEO satellite **appears as a fixed point** in the sky from the Earth.

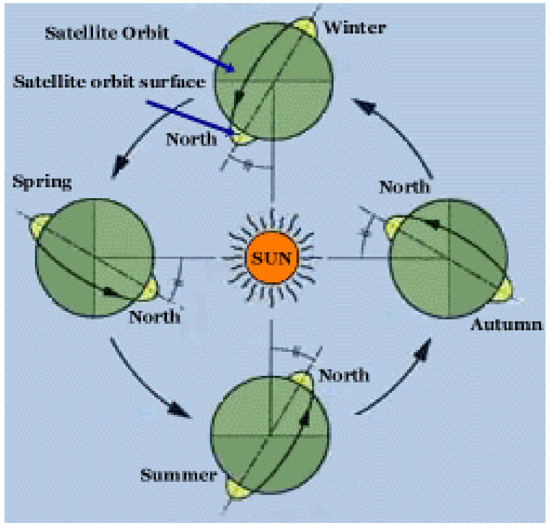
The advantages of such an orbit are that **no tracking is required from the ground station** since the satellite appears at a fixed position in the sky. The satellite can also provide **continuous operation** in the area of visibility of the satellite. Many communications satellites travel in geostationary orbits, including those that relay TV signals into our homes.





A Low earth orbit

A low earth orbit (LEO), or medium earth orbit (MEO) describes a satellite which circles close to the Earth. Generally, LEOs have altitudes of around 300 – 1000 km with low inclination angles, and MEOs has altitudes of around 10,000 km.
A special type of LEO is the Polar Orbit. This is a LEO with a high inclination angle (close to 90degrees).
This means the **satellite travels over the poles.**



Sun synchronus orbit

These orbits allow a satellite to **pass over** a section of the Earth at the same time of day. Since there are 365 days in a year and 360 degrees in a circle, it means that the satellite has to shift its orbit by approximately one degree per day.
These satellites orbit at an altitude between 700 to 800 km. These satellites use the fact since the Earth is not perfectly round (the Earth bulges in the center, the bulge near the equator will cause additional gravitational forces to act on the satellite.
This causes the satellite's orbit to either proceed or recede. These orbits are used for satellites that need a constant amount of sunlight. Satellites that take pictures of the Earth would work best with bright sunlight, while satellites that measure long wave radiation would work best in complete darkness.

– Azimuth & Altitude – finding a point in sky 11

Altitude - The **altitude** is the distance an object appears to be above the horizon. The angle is measured up from the closest point on the horizon.

Azimuth - The **azimuth** of an object is the angular distance along the horizon to the location of the object. By convention, azimuth is measured from north towards the east along the horizon

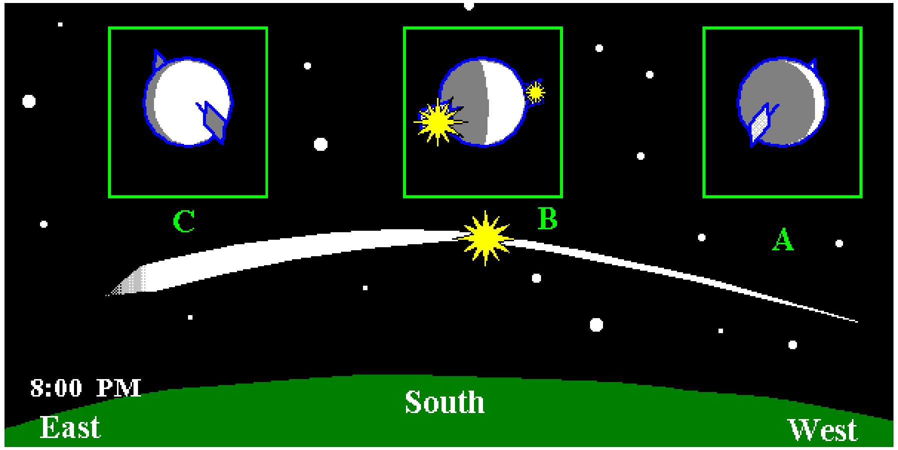
Visibility

Man-made satellites are visible when two conditions are met: the observer must be on the night side of the planet, and the satellite must be in sunlight. (Very few satellites have any lights, so they can only be seen if they are in sunlight.)

These two conditions occur for a period after sunset and similarly before sunrise. The duration of time for which these conditions are met depend on the time of year. During the summer, the northern hemisphere has the maximum amount of sunlight overhead, so satellites are visible later into the night. **Summer is the best time of the year to look for satellites.**

Looking down on the Earth from above the North Pole. At position A, the satellite is in sunlight but cannot be seen because the observer (the red dot) is also in sunlight; the sky is too bright. Shortly after sunset, the observer is in a dark sky (position B) while the satellite, passing hundreds of miles overhead, is still in direct sunlight. Thus, the satellite is visible from position B. (The satellite is about to go into the Earth’s shadow, so it may vanish as it crosses the observer’s sky.) Later at night (position C), the observer is in a dark sky, but the satellite is no longer illuminated with sunlight, so the satellite is not visible. (If drawn to scale, the satellite would be about five times closer to the Earth.)

Phase Effects

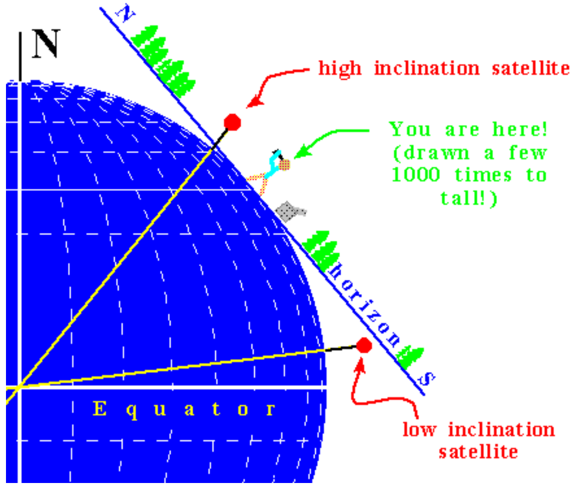


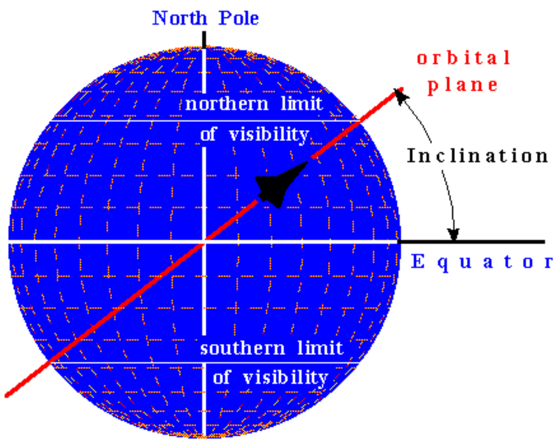
If you could view a satellite at very high magnification, you would see it go through phases as it crosses the sky, much like the Moon has phases. Although the analogy between the satellite's phase and the Moon's phases not perfect due to the shape and reflectivity, a satellite is generally brightest when it is in the opposite part of the sky from the Sun, and faintest when in the same part of the sky as the Sun. Therefore, satellites are brightest in the east after sunset, and brightest in the west before sunrise.

The time after sunset (or before sunrise) affects the height of the Earth's shadow in your sky, and therefore, how low in the sky satellites may be seen.

As a satellite crosses the sky from west to east, its appearance changes based on the amount of sunlight reflected. At point A in the west, the satellite is faint because only a sliver of sunlight is reflected towards the observer (shown in the inset). At point B, a chance reflection off of the solar panels causes a bright "flare". As the satellite passes to the east, it gets brighter as the amount of sunlight reflected towards the observer increases. Near the "full phase" at point C, the satellite reaches the maximum brightness. Moments later, the satellite disappears as it enters the Earth's shadow. (Evening pass is shown; morning passes are brighter in the west than in the east.)

Inclination





A second factor that affects the visibility of a satellite is its inclination. Satellites orbit the Earth in a plane; seen from the edge of the orbit, the plane looks like a line. The inclination is the angle of the orbit with the Earth's equator. Essentially, the inclination indicates how far north and south the satellite travels during each orbit. For us observers at 40° latitude, some satellites never travel far enough north to rise above our horizon (low inclination orbit). Other satellites in higher inclination orbits can pass directly overhead. Still higher inclination orbits can cause the satellite to pass north of the observer. Thus, satellites are visible in any part of the sky.

The inclination of a satellite's orbit determines how far north or south it travels. The northern most latitude (and southern) that it passes directly over is equal to the inclination angle.

A satellite in a low inclination orbit may never get above your horizon. A satellite whose inclination matches your latitude can pass straight overhead. A high inclination satellite (inclination greater than your latitude) can pass to your south, straight overhead, or to your north. (Diagram highly exaggerated.)

Altitude

Although satellites are far away (normally a few hundred or several hundred miles away), they need to travel relatively fast to remain in orbit.

The net effect is that a typical satellite appears to travel about as fast as a high flying jet. Really low satellites (100 miles) about to reenter the Earth's atmosphere appear to travel really fast! High altitude satellites (1000 miles) appear to travel slower.

If you go really high (22,300 miles), the satellite does not appear to move at all! (This is the well-known geosynchronous orbit, where weather and transoceanic satellites are located.)

Prediction Chart

The prediction tables give the circumstances, i.e. the timing, geometry and visibility conditions, for every pass in the format shown in the following example:

Date (PST)	Time (PST) of AOS	MEL	LOS	Duration of Pass	Azimuth at AOS	MEL	LOS	Max Elev	Visib Code	Orbit	MET at AOS
Thu 15-Nov-2001	03:01:36	03:06:40	03:11:44	00:10:08	233	146	67	55.8	NNNNN	17070	1091/04:21:36
Thu 15-Nov-2001	04:37:26	04:42:31	04:47:34	00:10:08	268	351	70	42.8	NNNNV	17071	1091/05:57:26
Thu 15-Nov-2001	06:13:34	06:18:39	06:23:42	00:10:08	288	10	90	40.8	NVVVV	17072	1091/07:33:34
Thu 15-Nov-2001	07:49:24	07:54:29	07:59:38	00:10:14	293	214	123	65.4	DDDDD	17073	1091/09:09:24
Thu 15-Nov-2001	09:25:33	09:29:48	09:33:59	00:08:26	281	225	170	11.3	DDDDD	17074	1091/10:45:33

Time of pass

The three columns labeled **Time of AOS (Acquisition of Signal), MEL (Maximum Elevation) and LOS (Loss of Signal)** are those times at which the spacecraft rises above the minimum elevation angle, reaches maximum elevation and finally passes below the minimum elevation angle on the other side of the pass. The minimum elevation angle that is used as a constraint for the pass predictions is shown in the header of each prediction table. The Duration of Pass is the time span between AOS and LOS part of the pass, but the observer in darkness and therefore can observe the station. The best passes to watch are those with a visibility code of VVVVV, NVVVV, or VVVVN, and a maximum elevation higher than 30 degrees. These passes typically occur within 1-2 hours before local sunrise or after local sunset.

The last two columns in the prediction tables indicate the number of the orbit, or revolution, of the ISS around the Earth, and the Mission Elapsed Time (MET), i.e. the time since launch of the first module.

Geometry of Pass

The next four columns describe the geometry of the pass. The **azimuth angles**, or compass directions, are given for the point of AOS, MEL and LOS. The units are degrees, where 0 deg is north, 90 deg east, 180 deg south, and 270 deg west. The **maximum elevation** is also given in degrees. The first example shows that the spacecraft will rise at 233 deg in the southwest, then rises to the maximum elevation of 55.8 deg at 146 deg in southeastern direction, and then sets at 67 deg in the northeast. It should be noted that a pass with a maximum elevation of more than 60 deg appears to observers as an overhead pass. For satelites in circular orbits the point of maximum elevation also corresponds to the closest distance, or range.

Visibility

The Visibility Code column shows the **lighting conditions of the space station** at the moment of AOS, one third of time into the pass, at MEL, two thirds of time into the pass, and at LOS, respectively. A visibility code 'DDDDD' would indicate that the space station is in the daytime part of its orbit all the time during the pass, and the Sun is above the local civil twilight limit (-6 deg elevation), so that the sky is generally too bright to view the station. A 'NNNNN' would indicate that the station is in the Earth's shadow (orbital night) for the entire duration of the pass, so it would not be visible either. The interesting passes to observe are those where there are at least three V's in the visibility column, meaning that the space station is in sunlight for parts of the pass, but the observer in darkness and therefore can observe the station. The **best passes to watch** are those with a visibility code of **VVVVV**, **NVVVV**, or **VVVVN**, and a maximum elevation **higher than 30 degrees**. These passes typically occur within 1-2 hours before local sunrise or after local sunset.

The last two columns in the prediction tables indicate the **number of the orbit**, or revolution, of the ISS around the Earth, and the **Mission Elapsed Time (MET)**, i.e. the time since launch of the first module.

8.3 – Inference

-The definitions give the picture of all the variables required to find to spot a satellite in real situation.

Orbits

Satellite orbits help in identifying the Satellite showing its path n sky. They help to know the Visibility of the satellite- Polar orbit satellites is visible to Naked eye. This gives an opportunity for searching for satellites.

Knowing the satellites orbit would help the student to identify with the location of the satellite – like how far is it from him, what is its shape?, how does it move in sky etc.

Visibility

The parameters for visibility can be challenging variables testing the student’s skill of recognizing the type of satellite just by its visibility. It gives an opportunity to design the characteristics of the moving satellite in sky.

Prediction Charts

Prediction charts can become a key in finding satellites. Using the method in different scenarios envisioned can facilitate easy learning of pass predictions and hence help the student to use it in real situations.

8.4 CLUES FROM SUBJECT

1 Satellite Types and its use in Design of the product

Satellites are launched into space for a wide range of applications. **Solar System Observation Satellites** are used for observing the sun and the planets in the solar system. **Communications Satellites** are used for long-range direct communication.

- **Broadcast Satellites** are used to allow any home equipped with an antenna to receive signals.
- **Weather Satellites** are used to help meteorologists predict the weather.
- **Earth-Observation Satellites** are used to monitor the Earth's environment from space.
- **Geodetic survey satellites** are used to accurately measure distance and direction between two points on the Earth's surface
- **Navigation Satellites** are used to support navigation systems.
- **Military Satellites** are used for reconnaissance, communications, and missile and rocket-launch detection.
- **Technology Satellites** are used to check functions.
- **Astronomical Observation Satellites** are used for scientific surveys that target space.

Inference

- Knowing the satellites type would help the student to **identify** with the name of the satellite.
- It would help him in **build interest on finding** other satellites using the clues given to him earlier.
- Knowledge about application may inspire him to discuss it with his friends.
- Because of their nature of applications Satellites are placed in different altitudes and hence it **gives scope to compare** for recognizing the satellite.
- It could aid in **creating strategies** for searching like – search a communication satellite etc.

8.5 Searching for satellites

Some Standard methods are used to search for satellites in the night sky. These methods would help to device a way to find for satellites in the product. Methods contain the phenomenon explained earlier.

8.6 - **Inference**

- Standard methods could be a base to design the interaction possibilities in the product.
- A method of search would be the essence of the product.
- Visibility strategy could be the initial way of navigating as a starter.
- Prediction method could be a challenging clue to engage the audience in later levels.
- The design of interaction would lie in creating interesting sequence of events using these methods.

8.7 Taking Pictures of Satellites as a Task – An Overview

Background

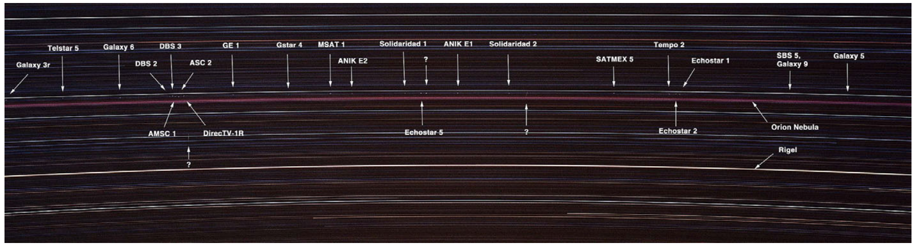
Special Equipments are used to locate satellites

Binoculars are helpful to distinguish satellites from airplanes, and they also enable you to see (or track) fainter satellites. Due to the smaller field of view, you may need to do more searching before "stumbling" across a satellite. Likewise, a telescope is no ideal for general satellite observing because of the very small amount of sky they show. Although you will occasionally have a satellite pass through the telescope's field of view, you will see more satellites just by looking up with your eyes.

A telescope is required for very high altitude satellites like the Lageos, GPS, and geosynchronous satellites.

Camera - Photographing satellites is easy, if you have a camera with which the shutter can be held opened (called the "B" or bulb setting). Put the camera on a tripod and aim it at a point in the sky where the satellite will be seen (or ahead of where the satellite is heading). Hold the shutter open with a cable release, and wait for the satellite to pass through the picture. If the exposure is short (30 to 60 seconds) and using a normal length lens (35 to 75 mm), the stars will be pinpoints or short streaks. The satellite will be a long streak passing through the photograph! Longer exposures will cause the stars to make longer streaks (due to the Earth's rotation), which may or may not create the effect you are looking for.

Examples of Photographs attempted by people to search for satellites in dark sky.



1- Geostationary Satellites

This long-exposure photograph taken on January 3, 2001, shows nearly two dozen space satellites hovering over Kitt Peak, AZ, southwest of Tucson. Nineteen commercial communications satellites in the image have been clearly identified using location data on the Internet. The reddish Orion Nebula and the bright star Rigel, among others, are visible as bright streaks due to the rotation of Earth during the exposure. Amateur photographer Bill Livingston, a staff scientist with the National Science Foundation's National Solar Observatory near Tucson, took the image using basic camera equipment.

1

2

2 - Low Orbit – Space objects

1. Photo of the Hubble Space Telescope crossing the summer Milky Way. Taken from Mount Pinos, California.

2. One of the first Iridium flare photos. Taken Sept. 20, 1997.

3. International Space Station

The 1m telescope in the Toyayama astronomical observatory can track artificial satellites.

Inferences

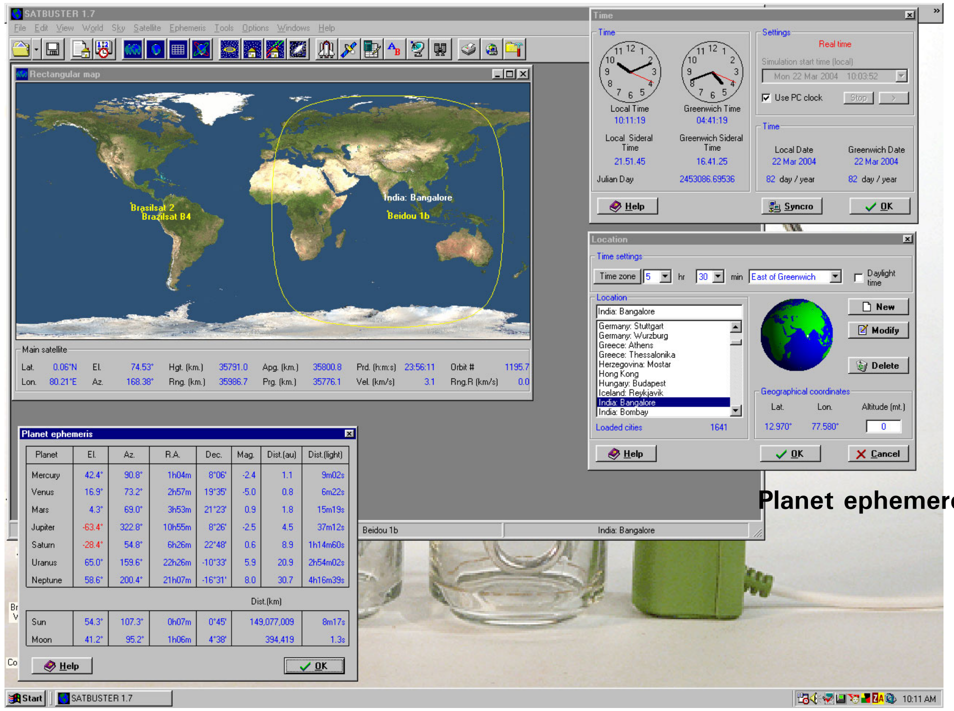
- The possibility of taking pictures of satellites offers following insights into the design of product.
- The experience of spotting satellites can be extended into recording the event making satellite finding fun and pleasurable.
- The users could collect pictures of satellites found and make it into a priced possession.
- Use of special equipment would attract the users to engage with the night sky with an enhanced experience.
- Special Equipment which acts like a camera or a binocular would give the opportunity to experience the physical features of satellites more closely.
- Providing a similar facility of taking photograph would encourage the students to do the same in real situation.

8.8 - **Clues from Software packages**

Many Software Packages are available (freely downloadable from the internet) which helps you to find satellites in space.

Location

Time



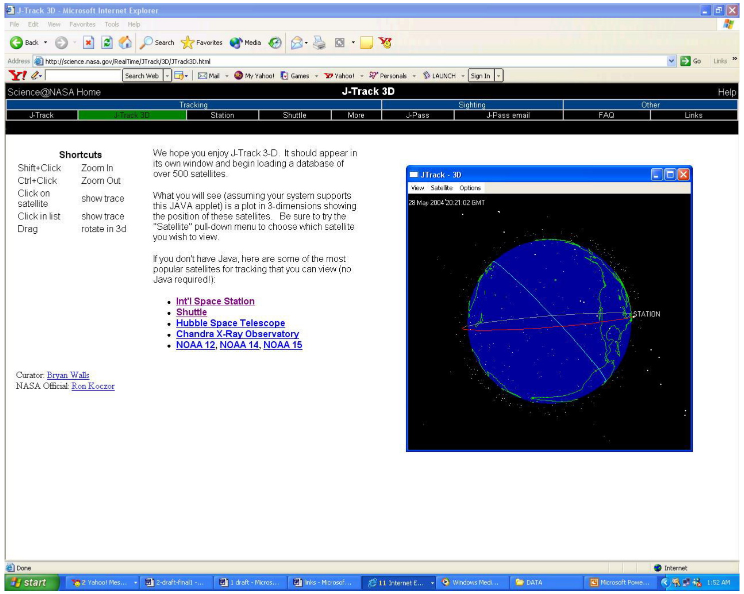
Planet ephemeres

Satellite path

8.8 .1- **SatBuster 7.0**

Some of the applications Satbuster 7.0 offers are :

1- path prediction charts.
2- orbital elements of satellite.
3- Computing relative motion of 2 satellites.
4- Computing ephemeris.
5- Generating local sky map.
6- Graphically showing the rise and set of satellite on the world map.
7- List of all satellite, and current locations.

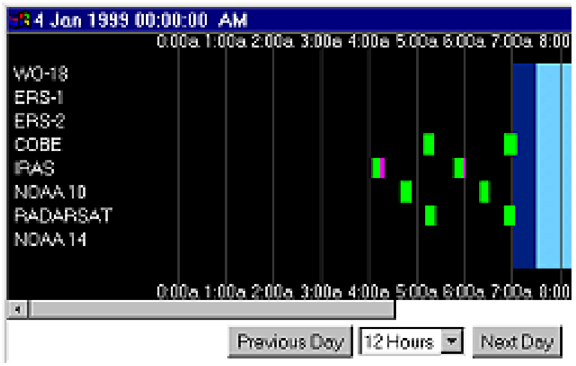


J - Track 3d

Real Time Three dimensional View of earth showing all the satellite positions.

Features

Current satellite passes.
3D navigable model of earth and position of all the satellites with respect to earth in real time.
A quick tour of important satellites.
E-mail service of satellite passes.



Time Bar Chart

Working

The time bar chart shows all passes during a single day (from midnight to midnight), based on the search criteria you entered. The start date and time are displayed in the upper left hand corner. Time increases from left to right and the satellites are listed on the left side. The satellites can be scrolled, if necessary, using the right hand scroll bar, and time can be scrolled using the scroll bar below the display.
The colored bars represent satellite passes. Green indicates that the satellite is in sunlight, and pink that the satellite is in shadow. The background color on the chart indicates day and night on the ground, with black for night and light blue for day. Navy blue indicates twilight at dusk and dawn. You can resize the time bar chart window to fit your screen. **Note:** if a satellite you selected does not have any valid passes during the day displayed, the satellite's name will not appear on the chart.

Inferences – Software Packages

- Software packages could provide easy and reliable source to create a dynamic environment for finding satellites.
- They inform you with accurate results.
- They could aid you with relevant information and help you to make the subject easy to understand.
- Software packages support real time information giving an opportunity to connect the user with near real experience of real time.
- Software packages support graphics of sky and locations to give a near real experience of night sky.

8.9 - **Observations** – Finding Satellites

- Looking into various methods of finding satellites gave me insights into the working of the concept.
- Satellites could be found if you know your location and time on earth.
- The parameters of location of satellites is explained by certain geometric terms like the altitude and azimuth.
- Predicting satellites involves the ability to understand prediction charts.
- The modern computing has allowed developing various software packages powerful enough to provide the information about the location and pass of satellites accurately.
- The spirit of satellite finding encourages experiencing scientific concepts like elevation, azimuth, orbit, path prediction, ephemeris, inclination, phase effects etc.
- Satellite finding is a popular hobby which gets connected with different communities interested in searching of satellites all over the globe.

9.0 - Product Brief - Level 2

- **Product should give an experience of searching for satellites and getting education through this direct experience to the audience.**
- This is done by conceiving an **“experience unit”** containing the simulation of dark sky for near real experience and control unit enabling the users to interact with it.
- It would be a device to **search for Artificial Satellites** and know more about them.
- **It would motivate the user to involve him in searching for satellites by providing different levels of complexities.**
- Attract different users with respective knowledge levels.
- Aid the user with theory as required by making it familiar and easy to understand and educationally active.
- **Installed in public places as satellite finding could be a collective experience.**
- **Use software capabilities in computing relevant accurate information.**
- Allow the audience to collect and store their performance over the product.
- To give a real time experience of satellite finding.
- **To encourage the audience to perform the same in real locations and situations.**

10.0 Ideation

The design of product involved creating an experience unit of night sky and the design of various controls which would enable the audience to interact with night sky for finding satellites.

The design of product boiled down to

a- Design of form
b- Design of interaction

Design of Form

- The overall form would contain an experience unit creating an environment of night sky.
- To look into the ease of working of the product

Design of interaction

Interaction with the product would allow the user to have a self motivating experience of finding satellites. It would allow him to freely move through the screen in search for satellites.

It would give opportunities to create appropriate challenges by careful building of complexity in the task of spotting the satellite in sky.

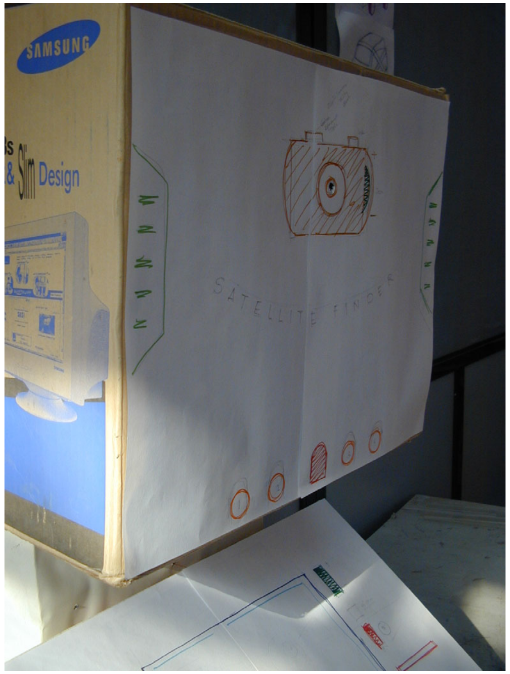
Some of the **elements of Screen** while interacting are :

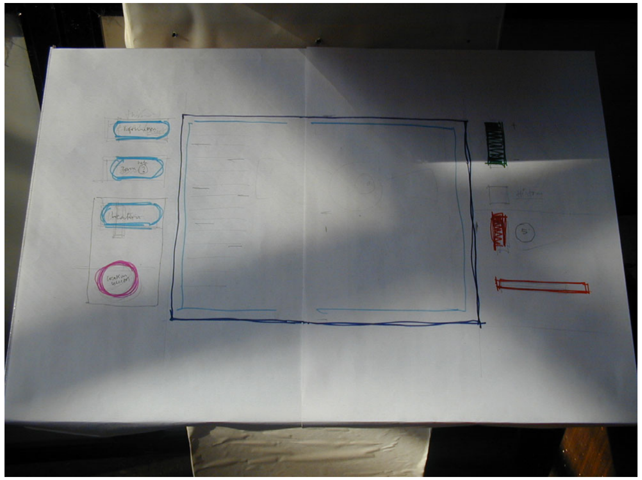
Stars shown in a sky map.
Other celestial bodies like the planets and moon.
Real time movement of elements.
Satellites moving in the sky.
The panoramic view of the ground showing the location.
Display of required set of information as envisioned like azimuth, elevation, current direction, names of constellations.

Design of interaction involved

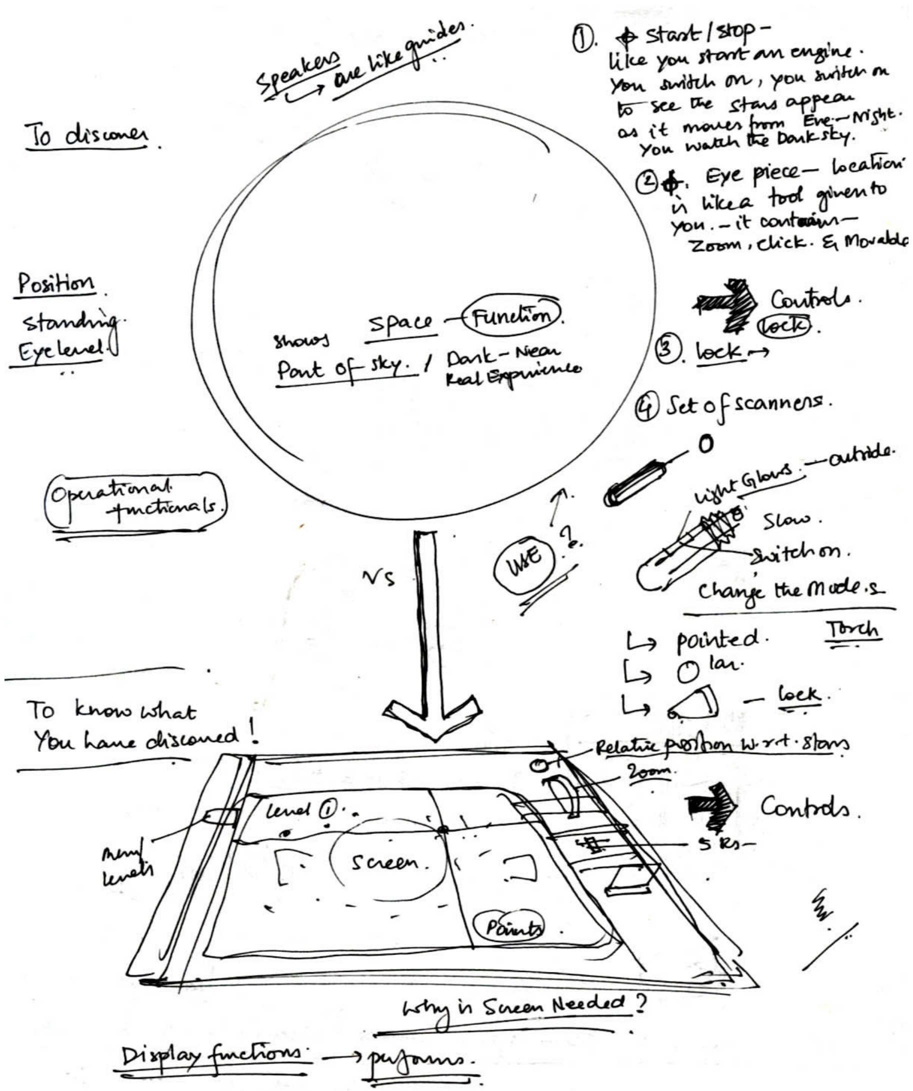
1- a facility to catch satellite.
2- a provision to look at satellite from a close distance to enjoy its physical features.
3- to build complexity in use by different strategies for different level of use.
4- to aid constant theory as required to help the audience with knowledge base.
5 - to facilitate easy navigation in screen space.

10.1 - **Initial Ideation**

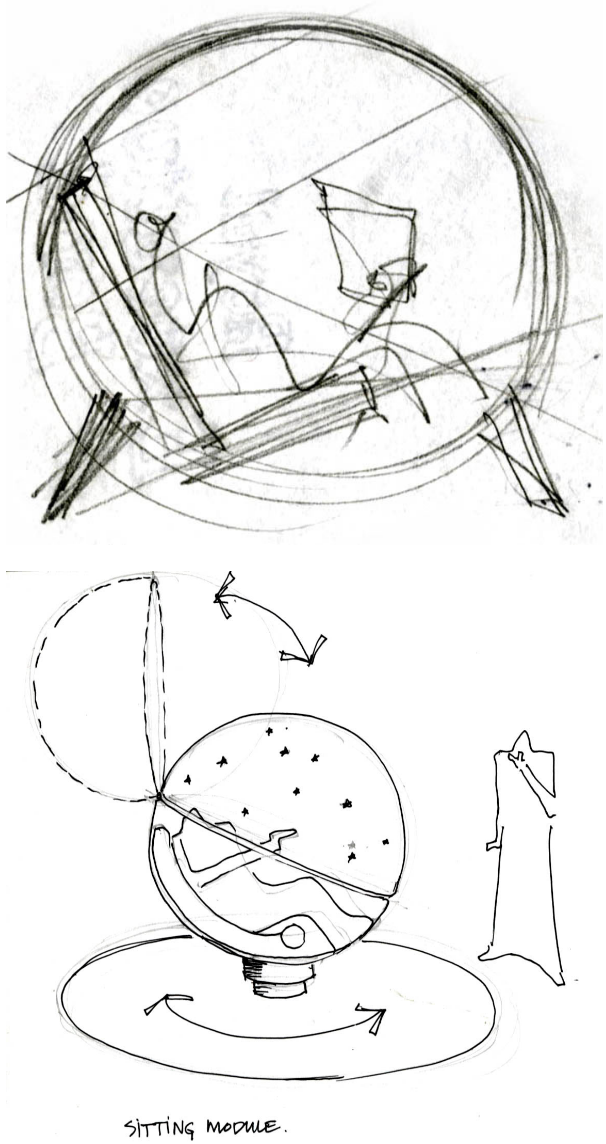




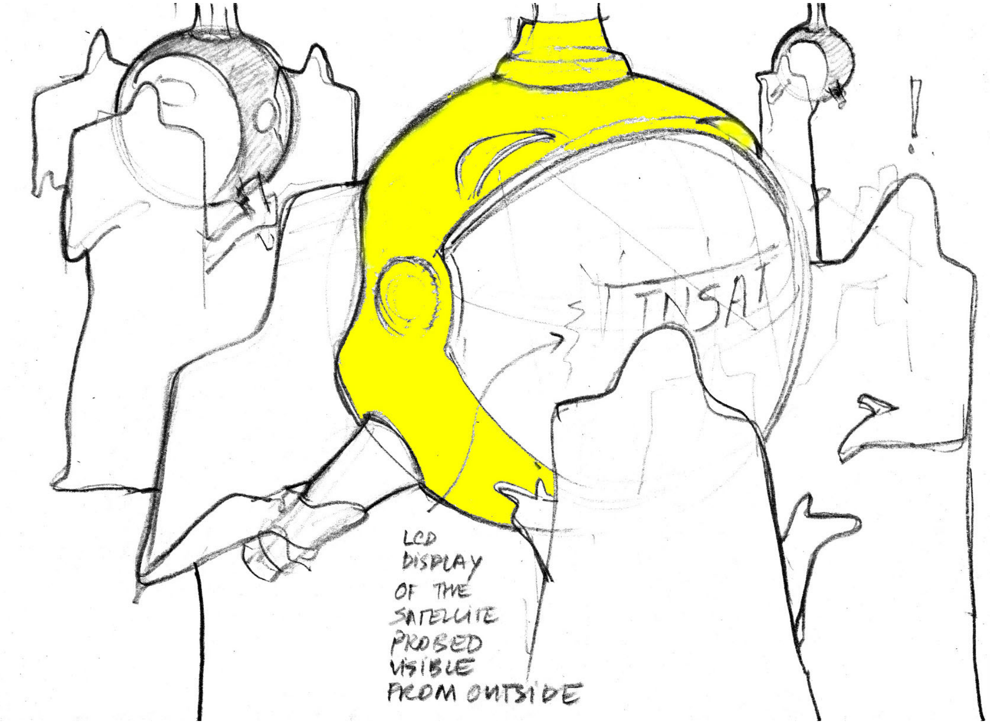
A mock Up Model to visualize it contents.

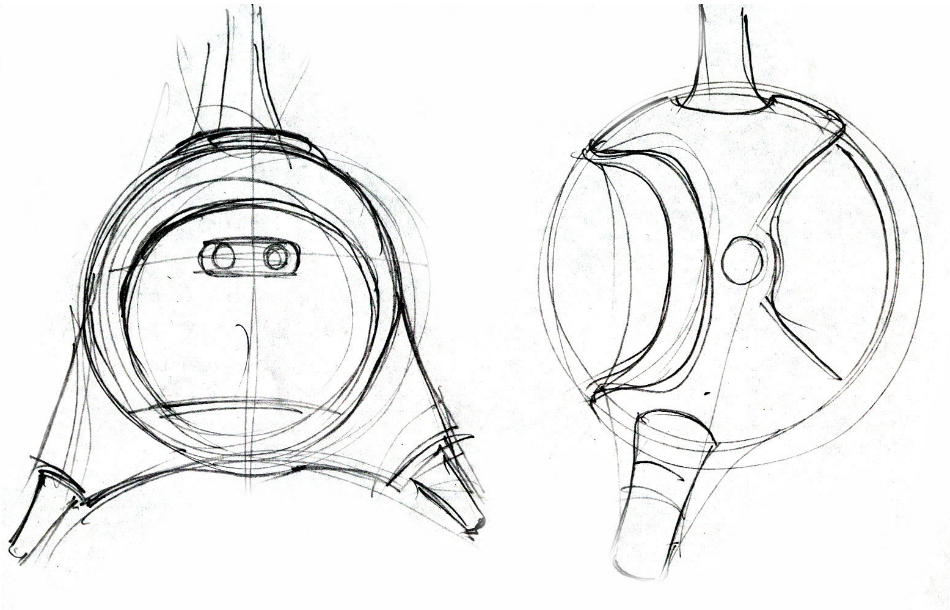


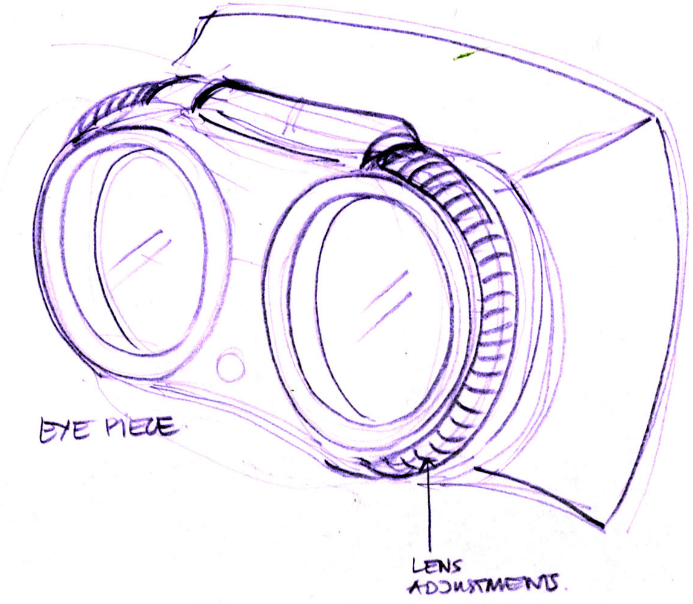
Visualizing the screen and the control

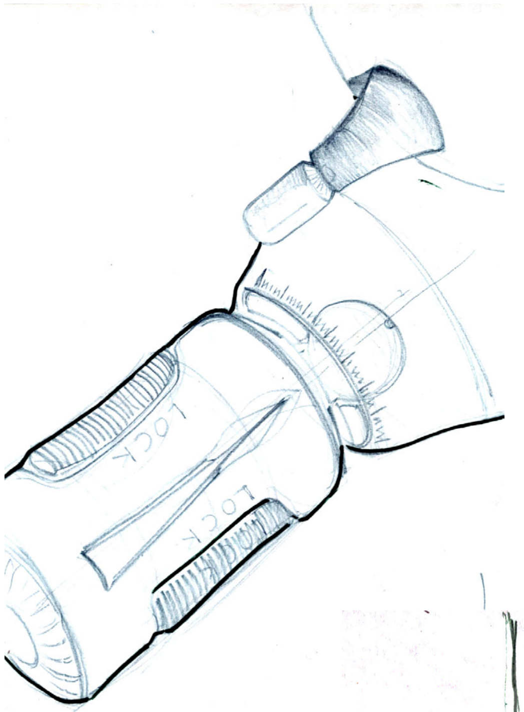


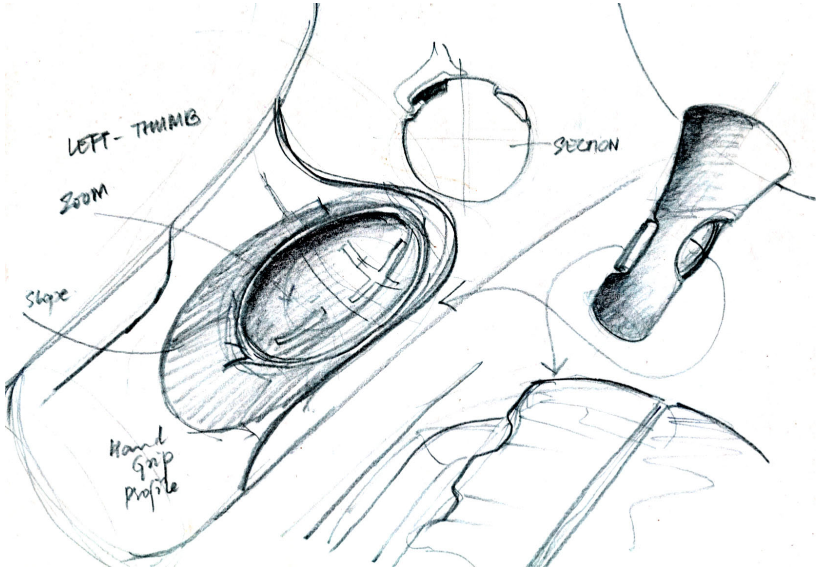
Ways of watching

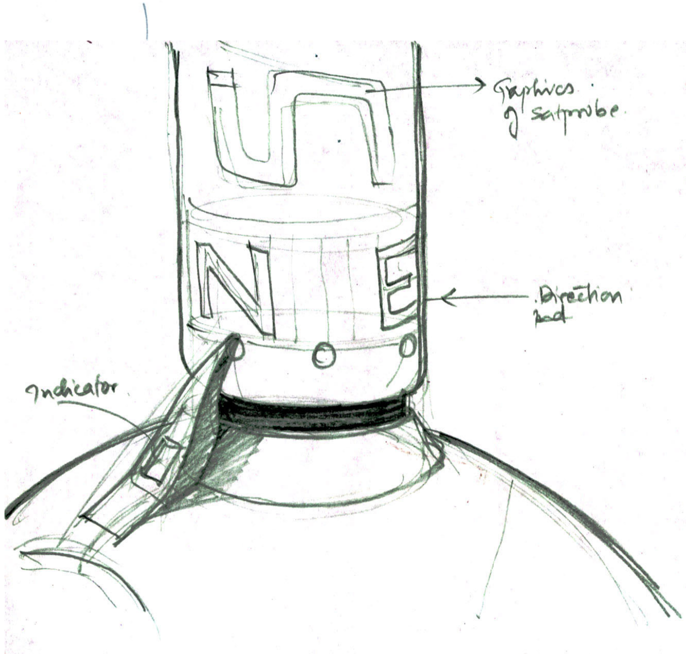

TNSAT
LCD
DISPLAY
OF THE
SATELLITE
PROBED
VISIBLE
FROM OUTSIDE

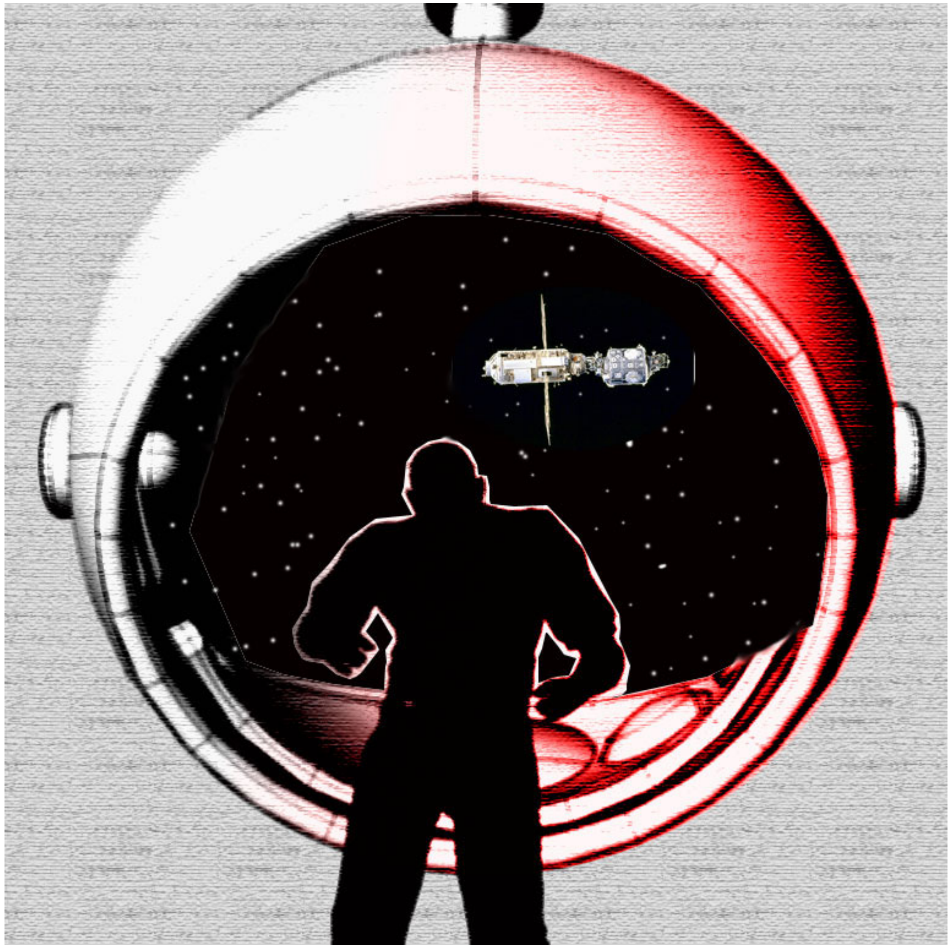


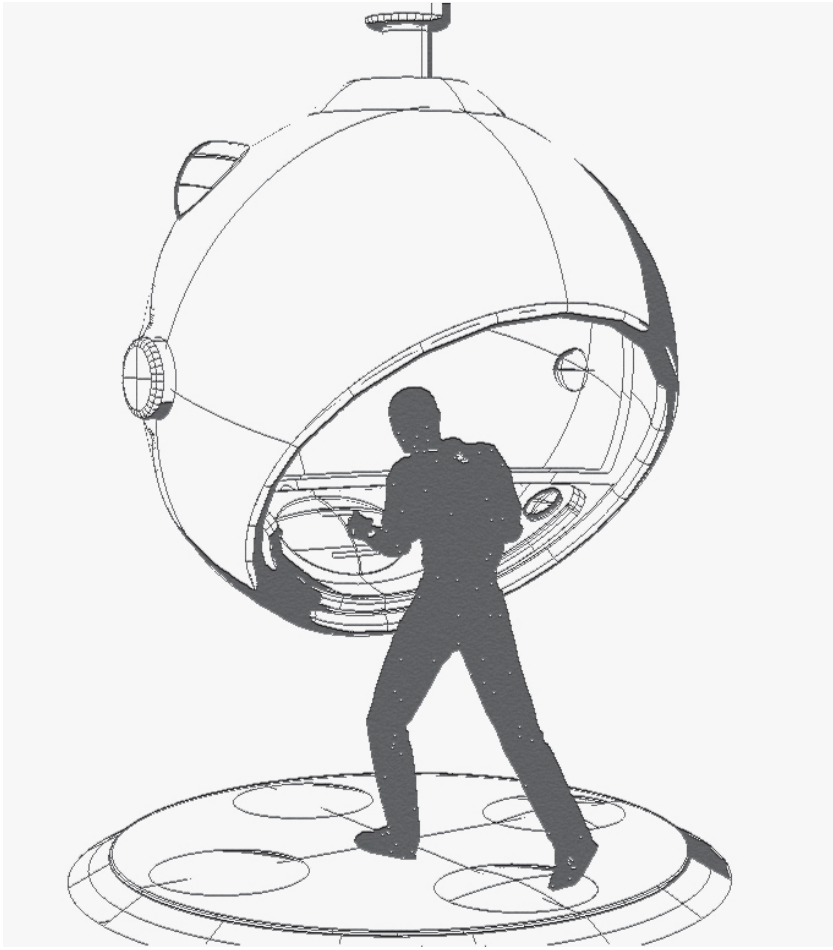

EYE PIECE
LENS ADJUSTMENTS


LOCK
LOCK


LEFT- THUMB
ZOOM
SECTION
Slope
Hand Grip Profile


Graphics
Direction pad
Indicator





Screen as Enclosure

Screen as Enclosure

11.0 – Search For Technologies

At this stage of the project I looked into possible technologies which are available. The product involved a hardware component consisting of screen capable of showing the night sky, and the software part involving the creation of sky, its controls and possibilities of interacting with it.

Hard ware:

Twin projector
Display

-A version of this display was shown at the Microsoft Research Show "TechFest" in 2001. -Various tests have been conducted using
this display to measure utility etc.
-A somewhat concave screen was better aesthetically than a flat screen.

11.1 Curved Screens

Curved Screens are elongated curved versions of existing flat screen of Televisions and Computers. The extended horizontality would hive the user a panoramic experience of night sky. They are back lit and can have high resolution of images making the experience enhanced. Some attempts to develop the technology of curved screen are briefed

11.2. – Twin Projector Display with Curved screen

DSHARP

Cutaway showing the behind the screen modules on the office table.

1 Special aspheric mirror for correcting the projected image to the curved screen
2 Projector Module
3 DLP Projectors

Though version achieves the curved screen for panoramic view, it lacks the surface a night sky to be envisioned.

11.3- Projection Systems on domes

Smaller Versions of planetariums (which give the very real experience of night sky) work on the principle of projecting on a domical surface giving an illusion of night sky. The light source provides extremely bright illumination that casts the image on the film through a **lens** onto a **screen**.

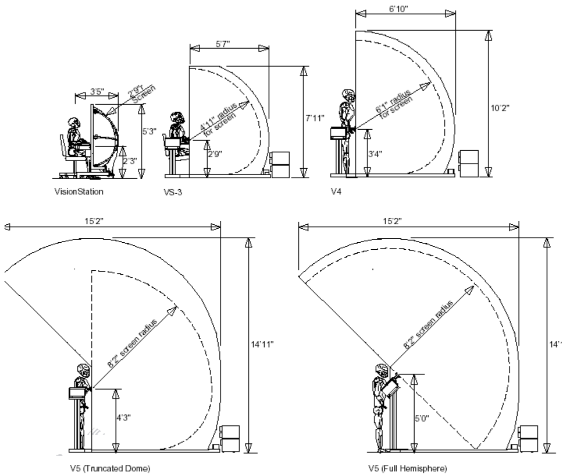
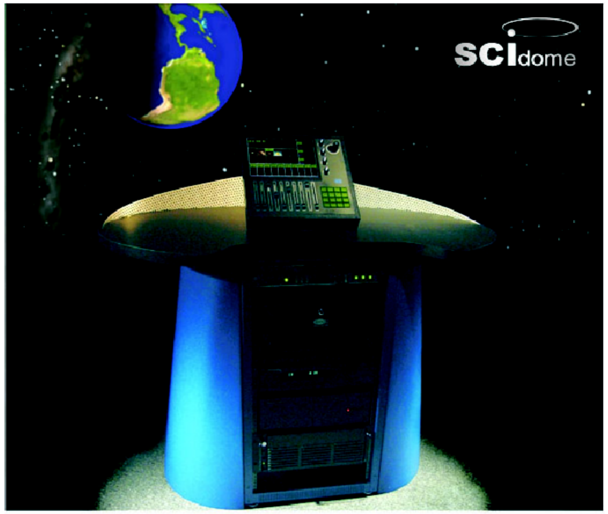


Figure 1. Side Views of the Vision Series Models

VisionStation® - it is a multi-user, single projector hemispherical display system.

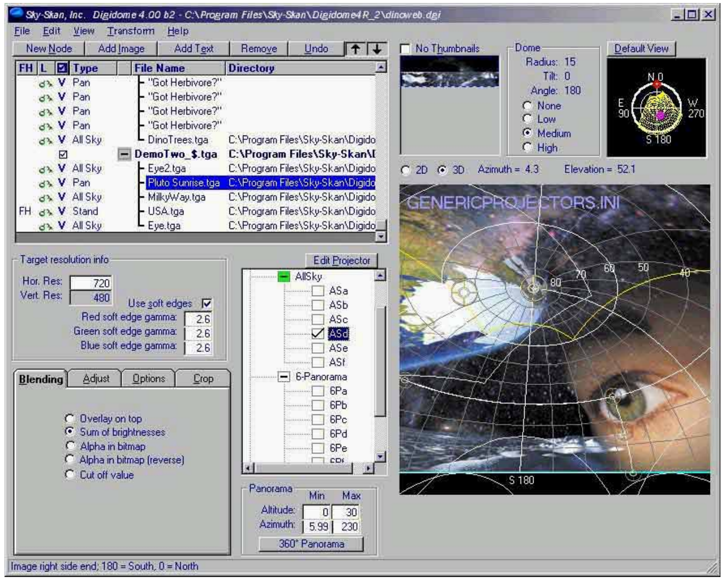
11.4 -Digital Planetariums



SciDome™ Digital Planetarium

SciDome is a single projector, full dome display system designed specifically for smaller size dome theaters. The system displays real-time computer graphics, pre-recorded educational presentations and live-action video. Astronomy simulation is provided by Starry Night™ Dome, versatile, easy to use software. It can be used in combination with traditional planetarium special effects or as a stand-alone dome display system.

SciDome displays a bright, seamless full dome image onto dome projection screens up to 10 meters. The image source is a digital (D-ILA) projector displaying SXGA resolution graphics. The projection uses a wide angle lens to create total coverage on the dome.



11.5 - Software

DigiDome^{TM} Image Processing Software

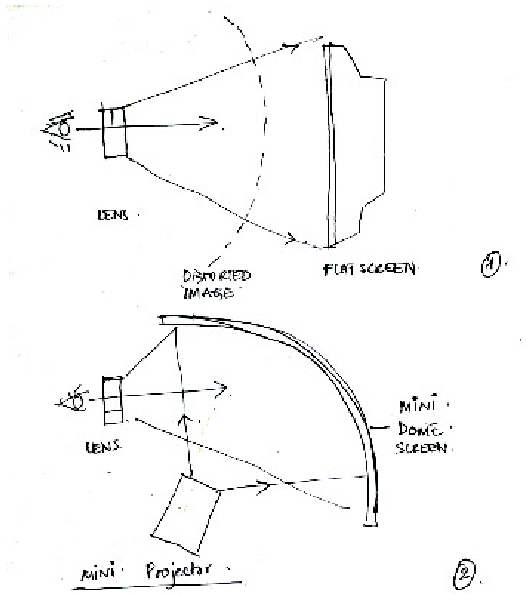
Allows to process multiple dome configurations simultaneously for slide distribution, provides alpha channel and luminance keying for multi-layered composition, and features a real-time fully interactive interface designed to allow you to quickly and create stunning all-sky and panorama slides for your dome. It provides you with pixel-perfect images for any dome projection system utilizing overlapping slides of any size.

Starry Night Pro

It is real time night sky simulation, “fly to” views of deep sky objects, up-to-date close-up imagery of planets. It automatically connects to the internet each time the program is started and updates the entire database to provide accurate, up to the minute visualization of space.

It allows seeing the sky from anywhere on Earth or lifting off and visiting any solar system body or any location up to 20,000 light years away. View 2,500,000 stars along with 170+ deep-space objects like galaxies, star clusters and nebulae. Travel 15,000 years in time. OpenGL® support renders stunning 3D graphics for realistic views of the sky. Print handy star charts to explore outside.

11.6 - Inference



Projection technology on to domes is best suited to create simulation of night sky

Existing Projection technology on to domes can be modified to suit the requirements of the product

Software assists the workings of night sky by providing facilities for graphic rich environments and easy navigation

The Visionstation and Digital Planetarium technologies are to the scale of individual audience, **affordable, controllable** and **can be installed in public places.**

12.0 -Design of Interaction

Finding satellites needed an involvement of audience to contribute their basic presence like location and time.

Some of the **objectives** for allowing the audience to interact for a product experience were -

- To involve with the search by directly interacting and being responsible to the actions
- To give an opportunity for design of different kinds of **challenges** posed for different users with different level of background of the subject
- To make the **learning pleasurable by motivating** the users to handle controls for self exploration of the concept
- To aid to the direct experience by providing specific controls designed to accomplish the task which was imposed
- To design imaginative tasks in real time situations

12.1- Creating an interactive experience

Interactive experience could be fashioned by creating complexity of use to attract prolonged involvement

By visualizing levels of difficulty

Assigning different tasks for each levels

Visualizing strategies to find satellites using the existing methods by creating different situations

Experience could be concieved in two ways

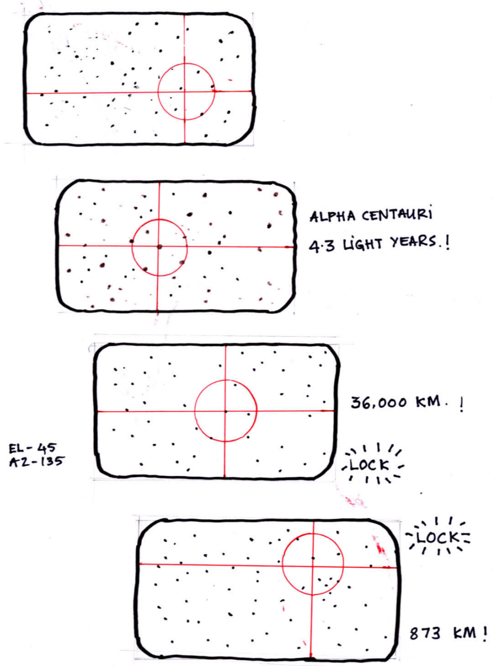
a- **Experience while Searching**

b- **Experience by facing a challenge**

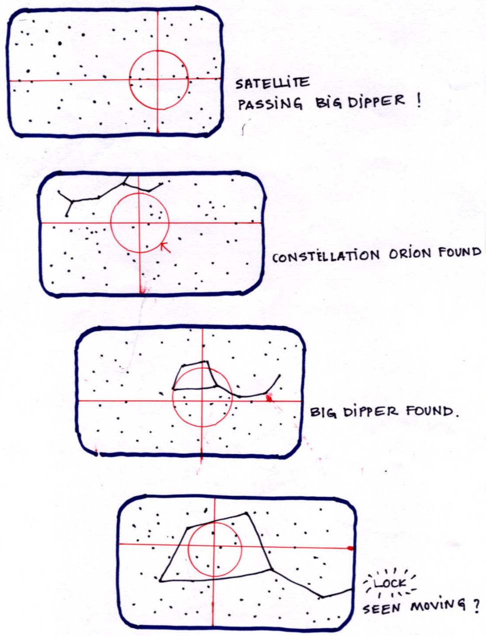
12.2 - Experience while Searching

The concept encourages for involving with night sky allowing you to navigate the dark space providing an oppertunity to spot tiny dots. This challenges only your perception initially. Many ways of searching involving the knowledge of the audience could cerate prolonged interest in the search. Here are some ways of achieving interesting search strategies.

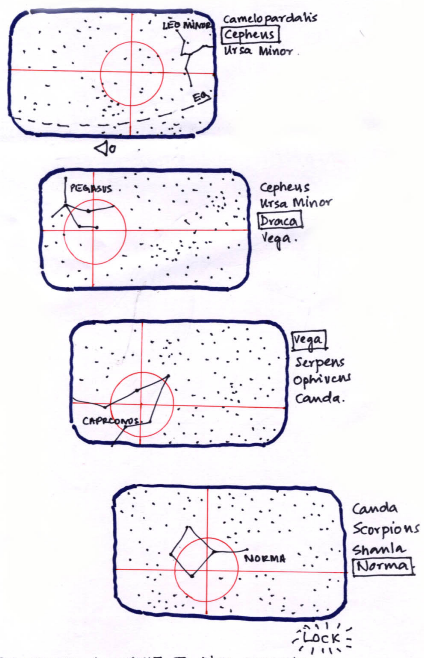
12.2 - Experience while Searching



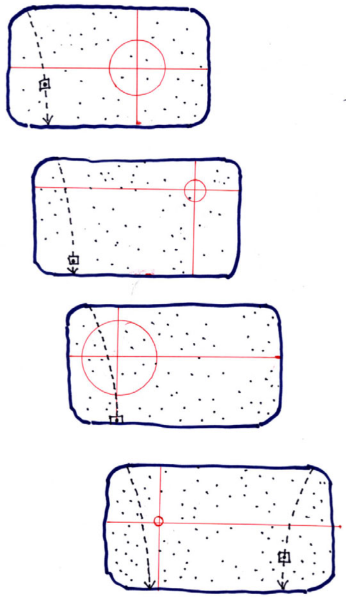
DISTANCE REVEALED AS EYE POINTER SCANS ON IT.



- CONSTELLATIONS APPEAR SENSING THE EYE POINTER



STAR NAMES AS CLUE TO FIND SATELLITE PASS.



EYE POINTER SENSES MOVEMENTS OF SATELLITES.

Search Strategies

12.3- Experience by creating Situations

Satellite type	Search strategy	Challenge	Visualization	Previous knowledge required	Expected to learn
PO	Visibility	Testing your visibility skill	Moving star, blinking, reflecting	Looking	Turning the product, locking the satellite
PO GO	Searching before somebody does	To compete with someone	Some agencies are already ready to track down a certain satellite	To read azimuth and altitude and search for point in space	Searching from a location
PO GO	Searching more than 1 satellite in given time	To meet the task in given time	Pass predictions are used and real situations are given	Using prediction hint to catch	There could many satellites over your head at a given location and time
PO	Catching in anticipated location	Selecting the right location	Choosing different locations	The geography of earth or names of important cities	Locating different places and remembering satellite passes over that location
PO GO	Giving an incentive	Search for a "family" of satellites to get a free model of satellite	Different locations are visualized	Earlier level	Learn about satellite families
PO GO	Creating a celestial event	Find a satellite before a comet destroys other satellite	Comet is seen in some part of sky	Which satellites to save	Dangers of outer space
PO	Forecasting in different times	find satellites which will pass in next week	Prediction interpretation	Reading prediction charts	Anticipating passes in real life

Appropriate challenges can be devised to keep the interest of the audience by creating various situations.
Situations create conditions for the user testing him to meet the task.
Diverse imaginative situations could be envisioned making the probe pleasurable.
Some of the ways are explained here.

PO -Polar orbit

GO - Geostationary Orbit

12.4 - Brain storming into other possibilities of system

With the facility of a sky space and computable controls it is possible to make the activity of satellite finding interesting in many ways

Album
To make it less complex use the sky space showing locations and pictures of satellites for pleasurable viewing and acting like game of memory

Event
An event is visualized which becomes a special occasion to find satellites like
Find the satellite while the comet is passing
Find satellites in a location near an airport
Find a satellite in morning sky

Orthodox method
Finding satellites by the existing methods, simulation the sequence in the sky space
Setting your location, using the prediction chart and finding the satellite

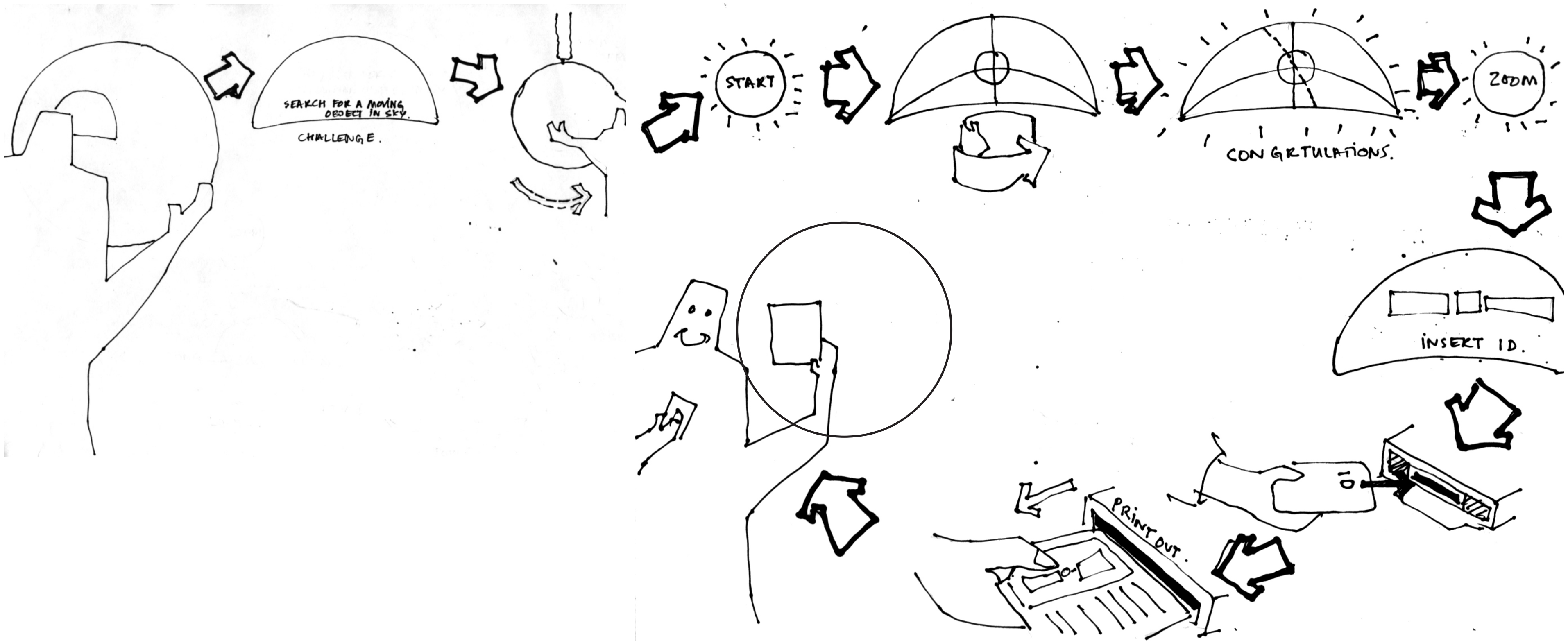
Brain storming

Real Time
Experience finding satellites just passing over your head
Wait for the next satellite to pass

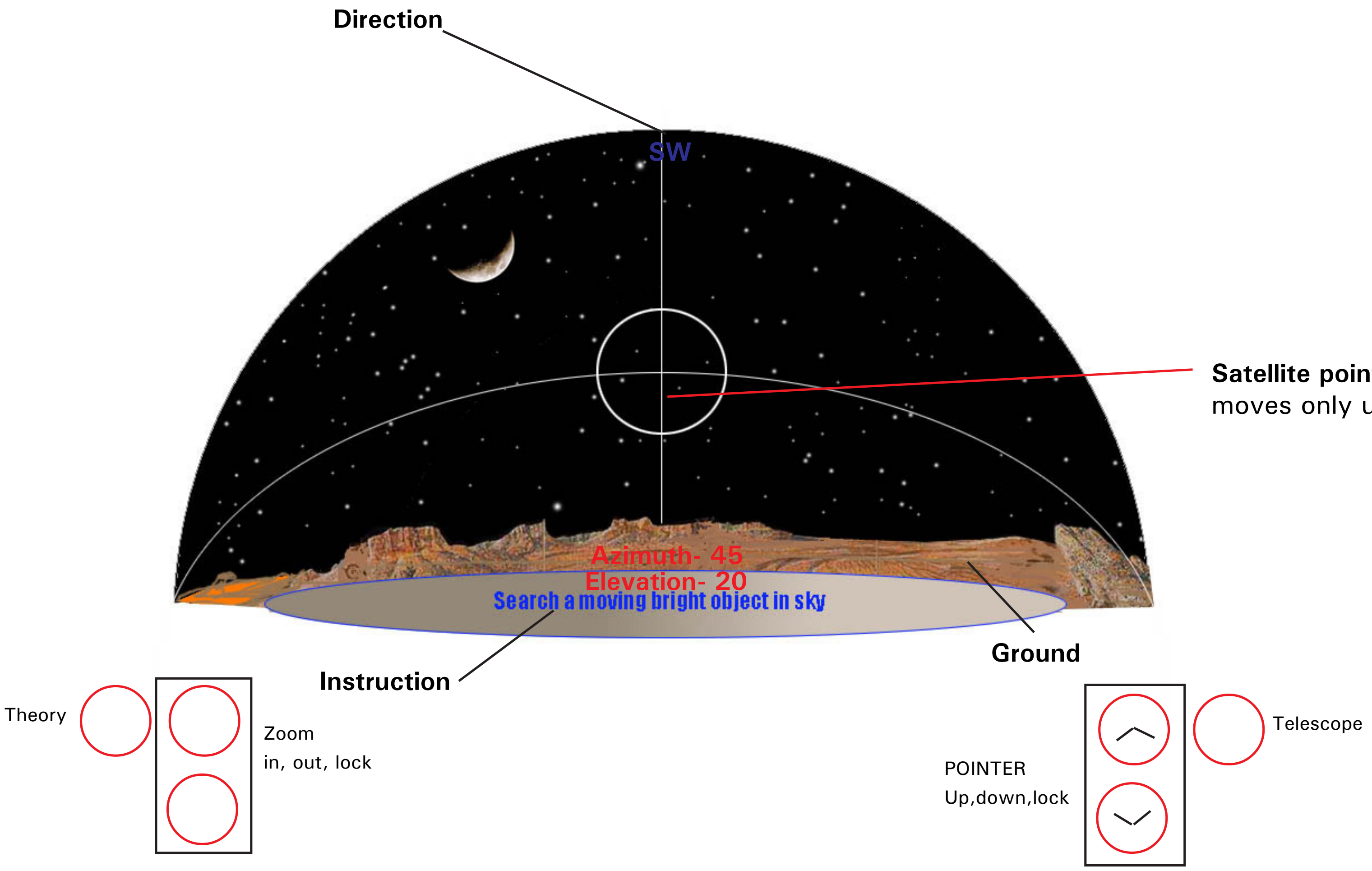
Mathematically involving
Find a satellite by calculation of local elevation and azimuth
Solve the problem to look out for its location

Assigning roles
To Make audience a part of the mission by assigning him a responsible role in the play, an astronomer, a space scientist or an engineer, a kid etc. hence creating a situation according to his personality.

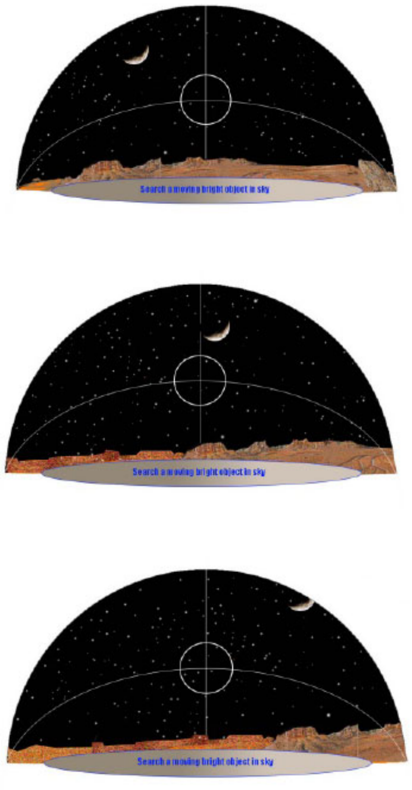
12.5 Scenario

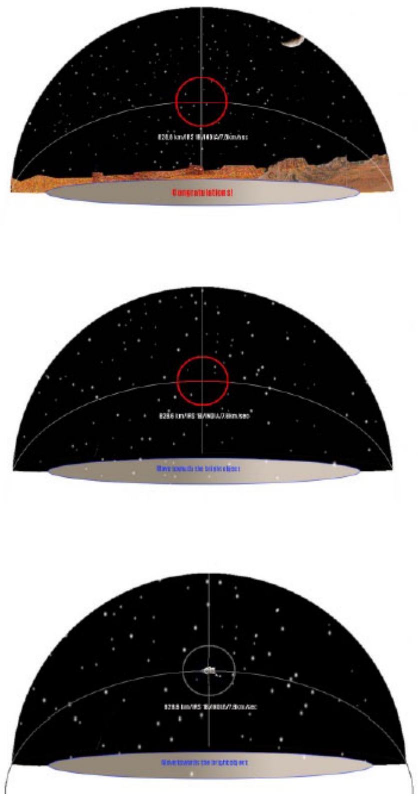


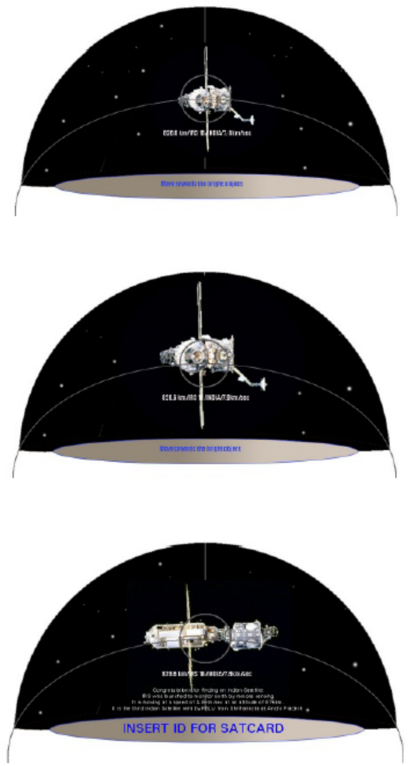
12.6 Screen Layout and Navigation

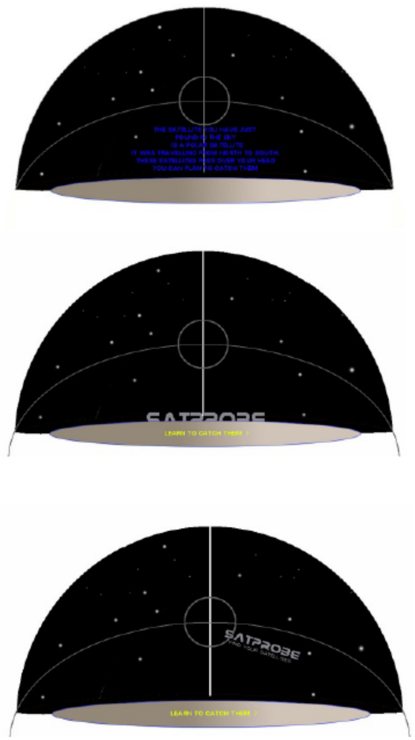


12.7 Screen Navigation - A Scenario









12.8 - An example of creating complexity by orthodox methods

Level 1 – Beginner
Task- Search for a moving star in the night sky
Challenge –Searching a moving object amidst star filled sky, pointing, selecting, locking
Accomplishment- Catching a polar Satellite

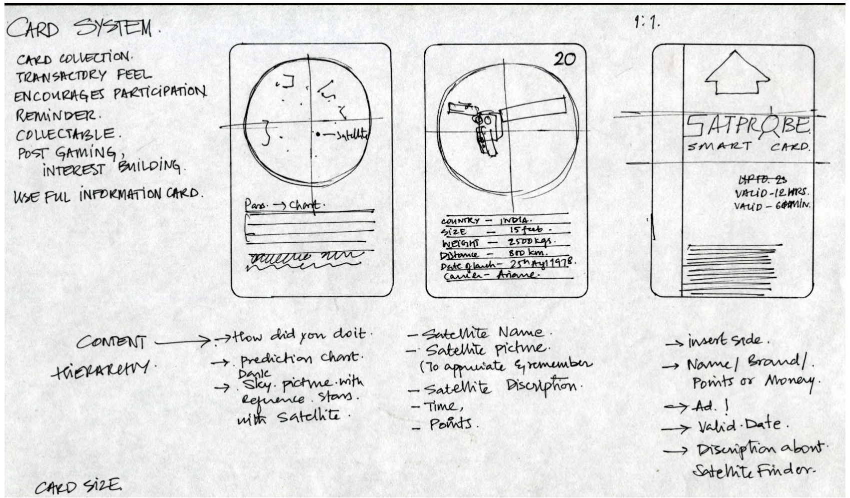
Level 2-Amateur
Task-Search for polar satellite
Challenge-Choosing the Location, Read the Path Prediction, search for the Polar Satellite
Accomplishment-Understanding Path Prediction

Level 3- Pro
Task -Search for a Geo-Stationary Satellite
Challenge-Read the sky map, finding the equator, selecting the Satellite from the geostationary belt
Accomplishment-Catching the Geostationary Satellite

Level 4 – Master
Task- Search for a Geo-Stationary Satellite
Challenge-Choosing the Location, Read the Path Prediction, search for the Geo-Stationary Satellite
Accomplishment-Catching the Geostationary Satellite

Level 5 – Master
Task- Search for only known satellites – anticipate using your previous experience
Challenge- choose the appropriate location to catch the anticipated satellite
Accomplishment-understanding satellite movements

Level 6 – Master
Task- search for only know satellite- knowledge of sky map
Challenge-remember the shy map to anticipate satellite path
Accomplishment-remembering satellites paths with respect to star positions



12.9 - Creating Sense of Accomplishment

Finding satellites could be memorable activity. Students like to collect memories from the experience. Audience feel encouraged when their effort is recognized and credited. There could be many ways of creating opportunities to the audience to credit their efforts and hence learn from the experience

- Providing points system credited to encourage students to use it and personalise more.

-Giving a provision for collecting information which becomes a priced possession and encourage group activity

-Priced possession could be in the form of education cards which becomes a collectable, which could induce a game in it etc.

-Since the Screen offers Video possibilities on a domical surface, small videos could act as perks given to audience after accomplishing a certain task or completing levels. Videos may contain a historical events related to the satellite found, how was it made, and so forth.

Educational Cards

Videos

12.10 Arriving at Controls

The controls were designed for the scenarios explained earlier in the chapter. The basic functions:

On-Screen controls

Key 1 – Move up, Move Down, Lock – Pointer at satellites – for Right Hand

Key 2- Zoom in, zoom out – to travel towards the satellite – For left hand

Key 3- Help/theory –providing theory whenever required for right hand

Key 4- Provision Key for selection, activating special equipment for left hand

Other Controls

Knob 1- Height Adjustment

One or two player action and easy access to change games

12.11 Popular controls - Observations

Consoles for Video Games, Joysticks and the computer keyboard are the popular controls available

A Video Game Console in the example shows twelve variable Swithches in which two track ball would contain the active control. Thumbs are Extensively used.

Joysticks are used in Racing Games involving a vehilcle. They are best suited for navigating virtual vehicles.

Key boards are inevitable control devices for computer games.

Children seemed to be used to handle two simultaneous variables and operate a 12 switch consoles for various gaming application

13.0 Design of Form

The design of the form was happening parallely

The form of the product would contain the screen and the controls.
The form should big enough for an individual to experience the interaction
The form should hold a spirit of Space exploration
The form should create interest for other audience not using the product by engaging them.

The product would contain

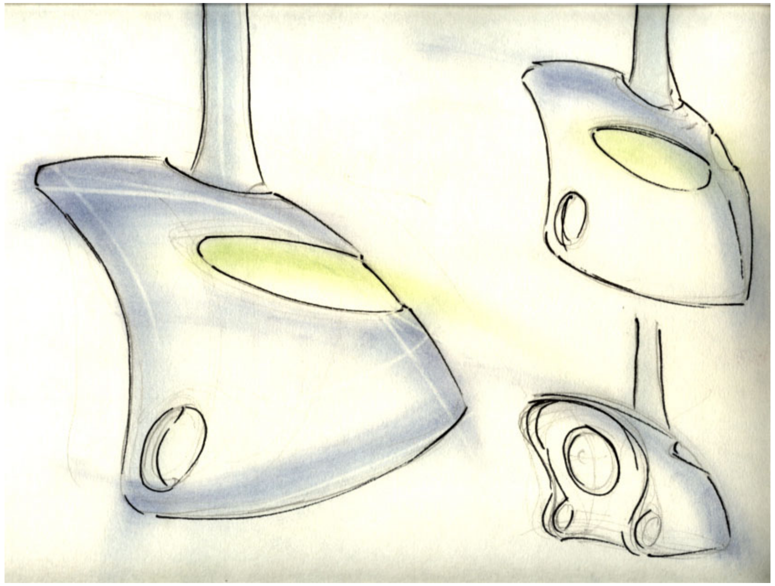
A Mini Digital Projector displaying high resolution graphics of night sky
Rotatable Domical surface for projection
Controls
Card Reader – a facility to identify the user
Card Printer – for printing instant educational cards
Main Computer – for computing Sky and satellite Parameters

The form was envisioned to reflect other related games of Space exploration.

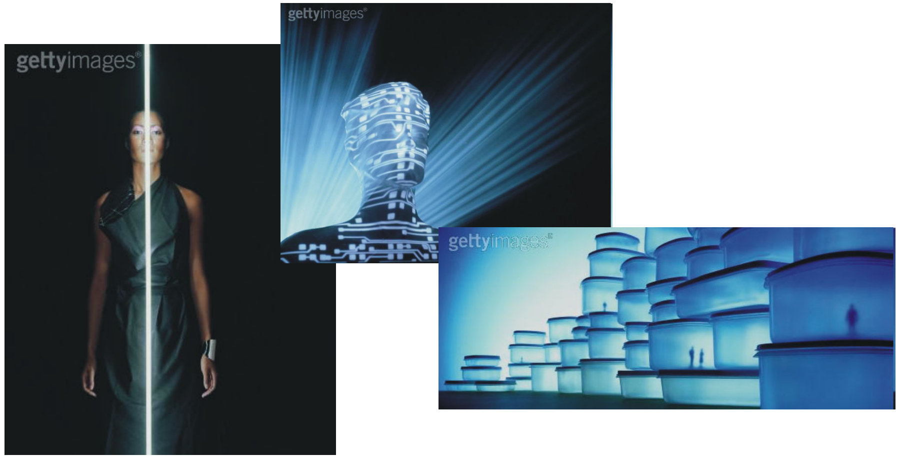
13.1 Metaphors

Metaphors were chosen relating to the spirit of space exploration. Images were collected to create an image board to see the characterisic of the

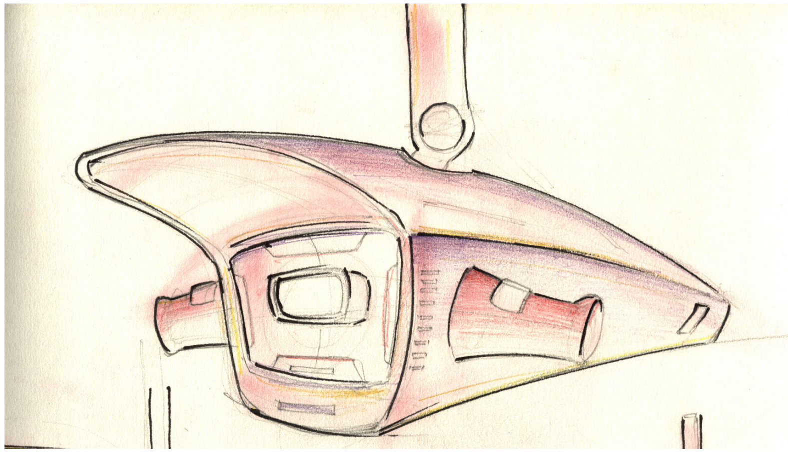
Alien like



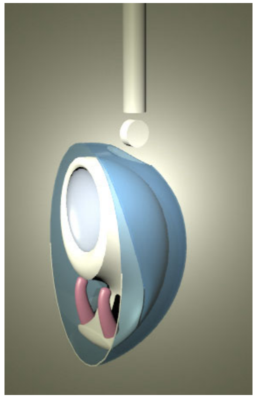
from the other world, a creature,
wide eyes, unusual biology, silent



Futuristic



Visionary, silent technology, sleek, dark, monochromatic, sophisticated, transparent, and silent,speed



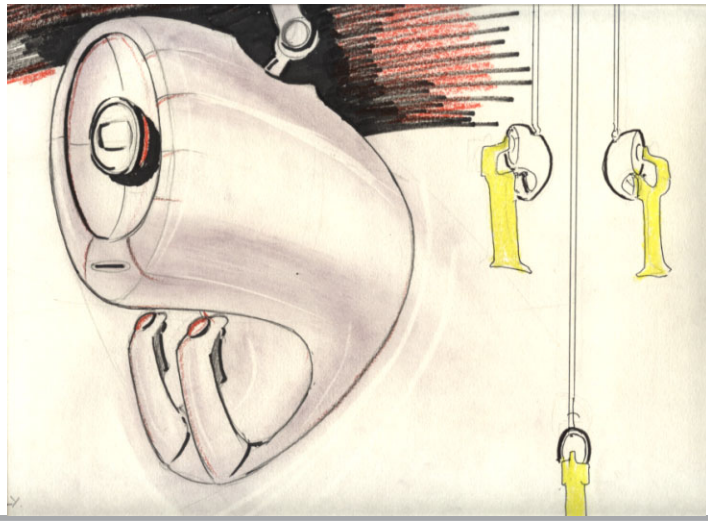
Mysterious

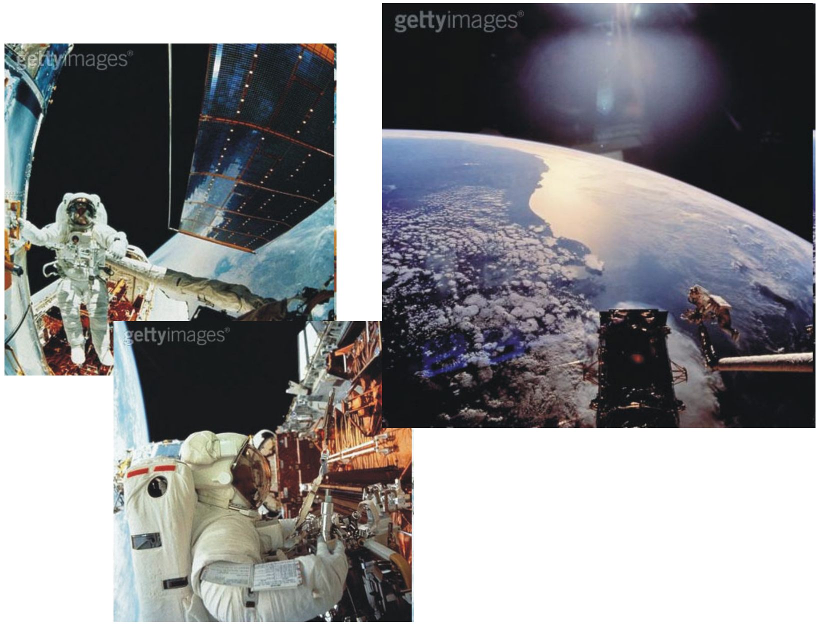
Simultaneously arousing wonder and inquisitiveness, and eluding explanation or comprehension

Mysterious, esoteric, arcane, occult, inscrutable
What is *esoteric* is mysterious because only a select group knows and understands it

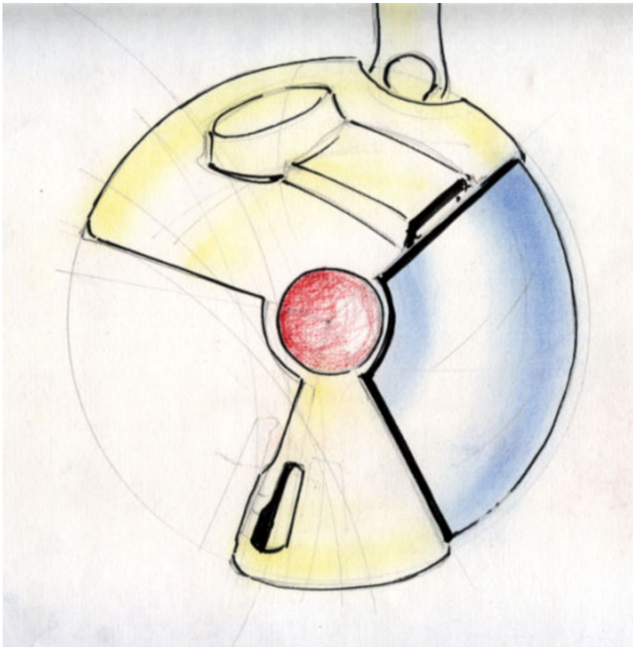
Arcane applies to what is hidden from general knowledge
Occult suggests knowledge reputedly gained only by secret, magical, or supernatural means: *an occult rite.*

Something that is *inscrutable* cannot be fathomed by means of investigation or scrutiny





Outer Space



Dark, starry, silent, dangerous
Cosmonaut, space suit, space mask or helmet, space walk, intelligent, commander, controls the space craft.

13.2 Outer Space- Space Helmet
Metaphor for Final Concept

Inspiration from **Astronauts space helmet** was the metaphor I choose to further develop on –

-The spherical form was functionally convenient to place the domical screen and projection system

-The sphere seemed to suspend in space of the museum reminded of mysterious spherical planets in space

-The helmet would act like a mask embodying the audience making him part of the product.

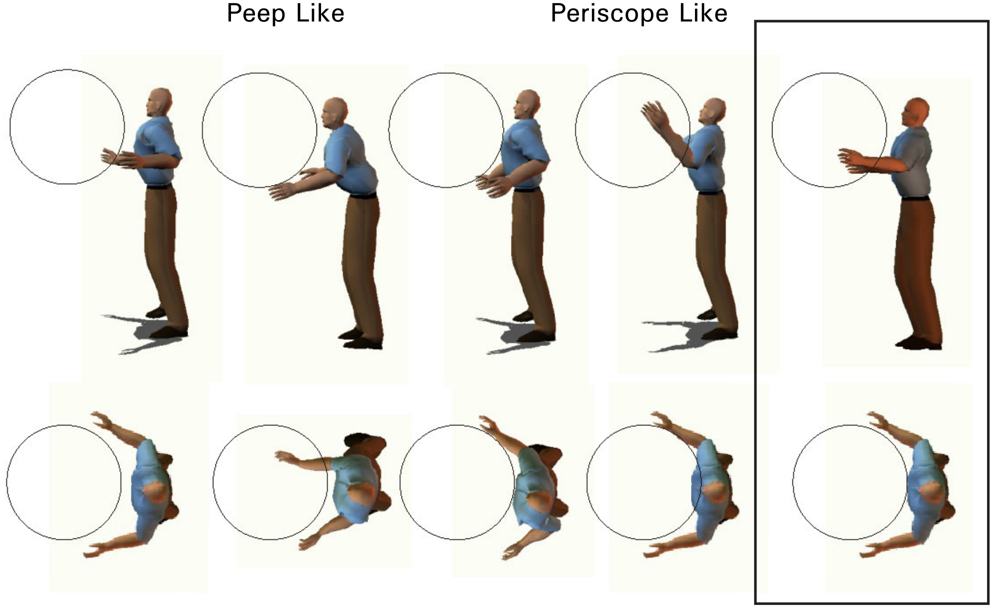
-The form suggested for rotation which helped to communicate the possibility of turning of the product

The space helmet was a popular image in the minds of audience to relate to

13.3 Deciding the postures

Peep Like

Periscope Like



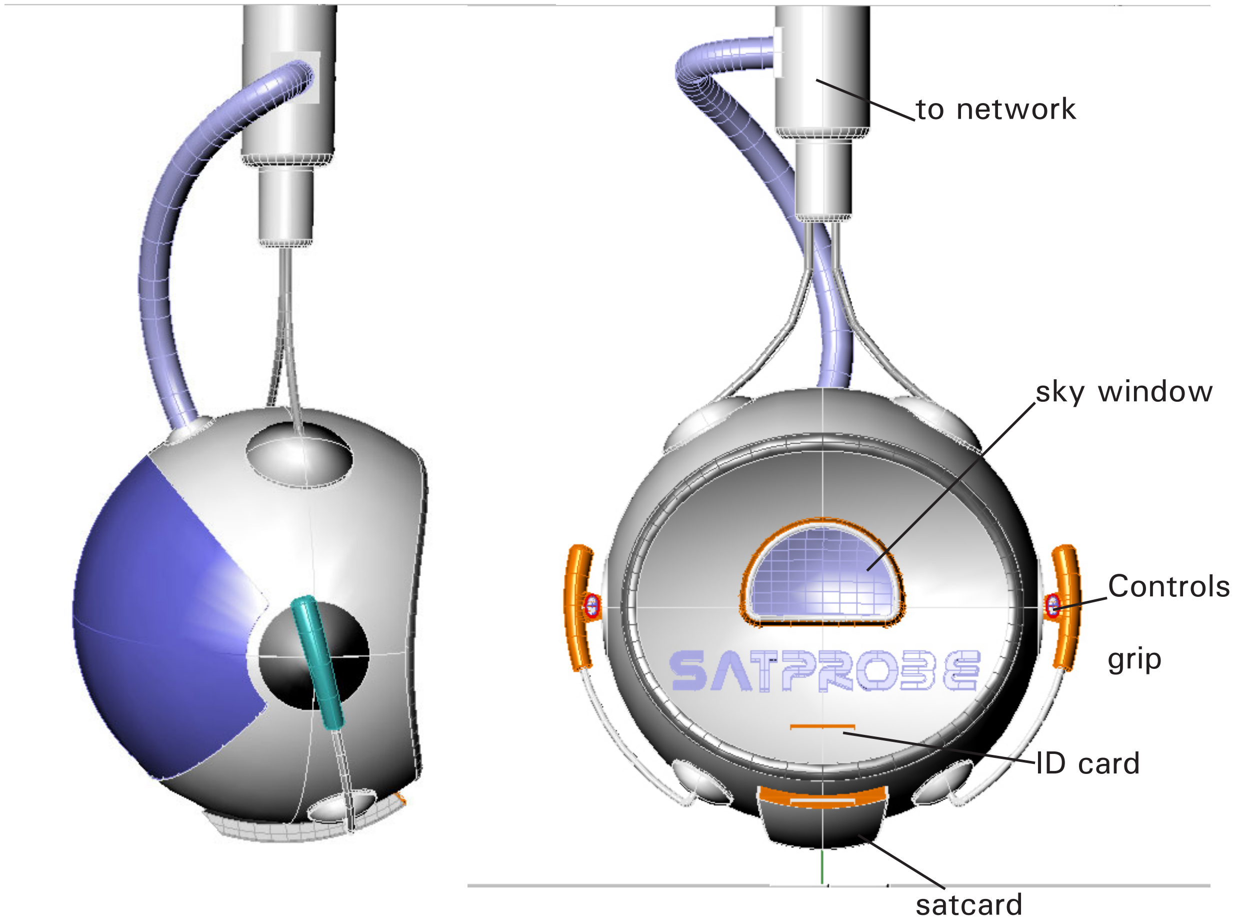
Handle Like

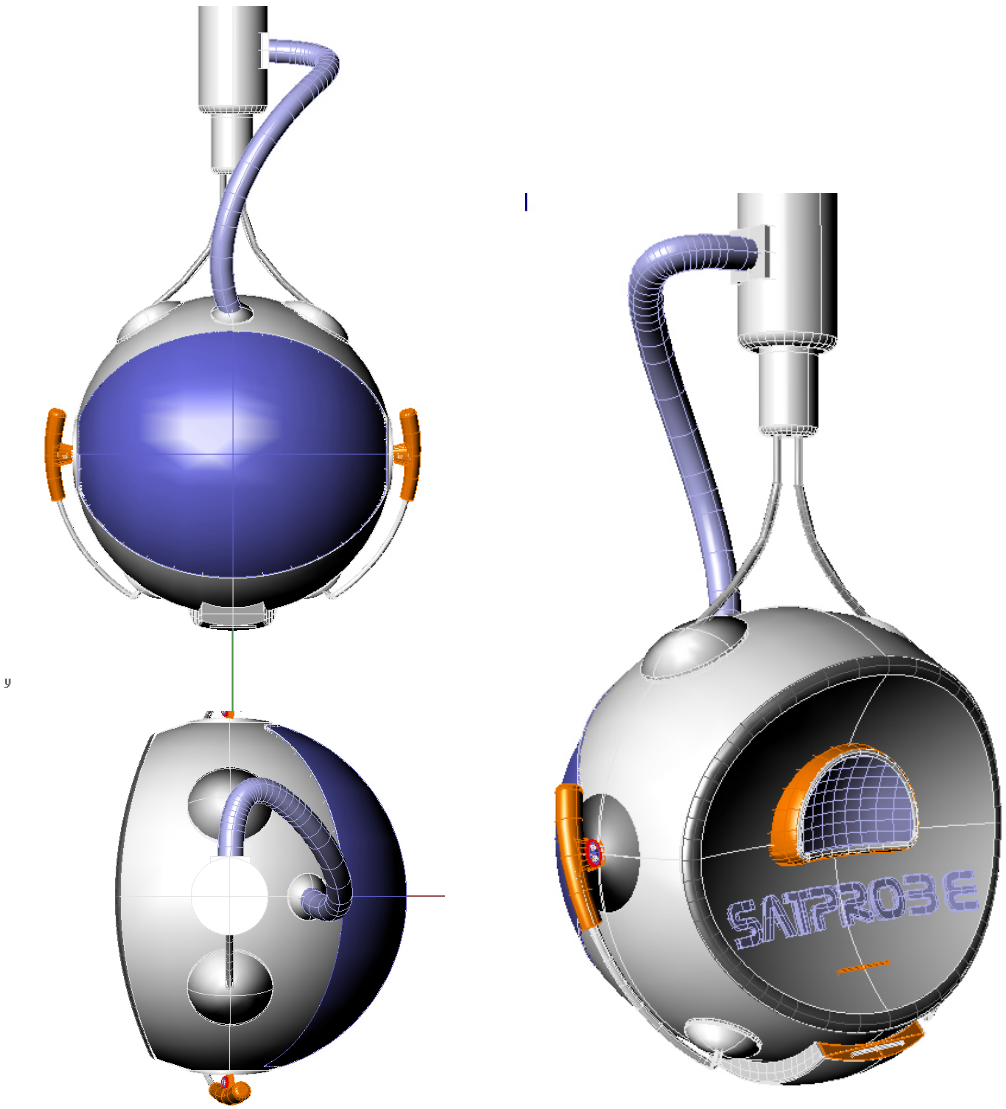
Embrace like

A variety of postures for comfortable viewing and easy control were possible. I tried to design for a posture in which the user becomes a part of the product. The product is designed for an **embrace** type of posture which gives a feeling holding a modest sphere in your arms.

13.4 Essential Measurements

13.4 Final Concept

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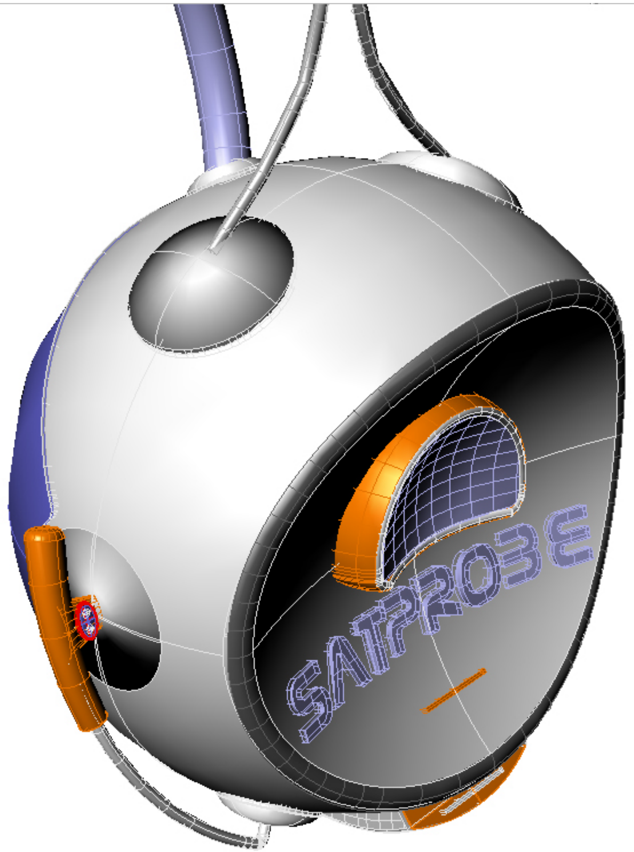
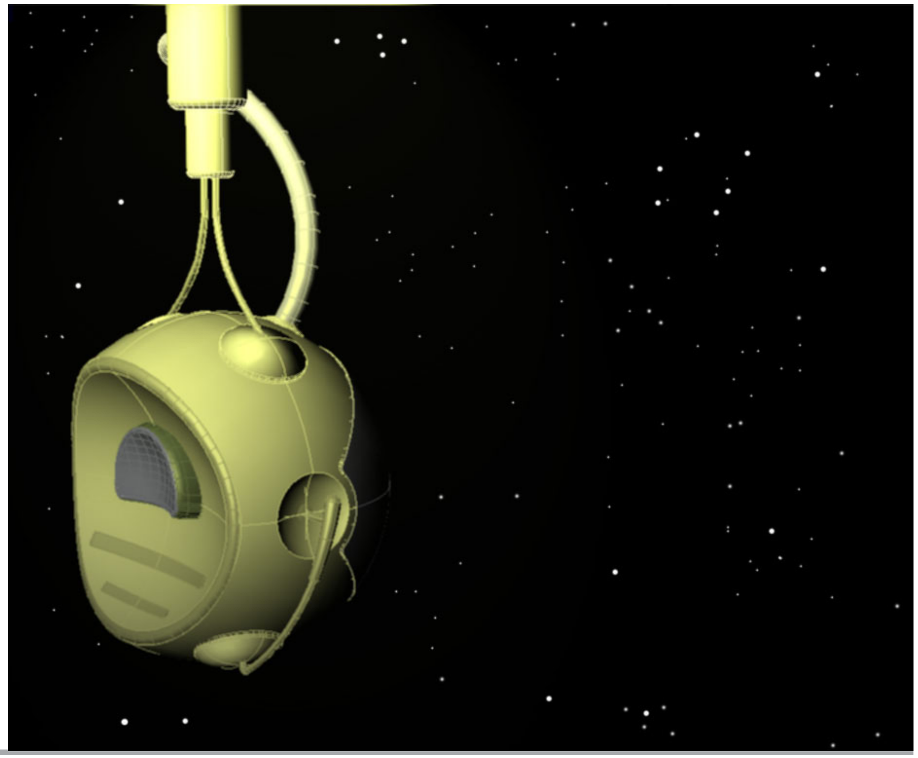
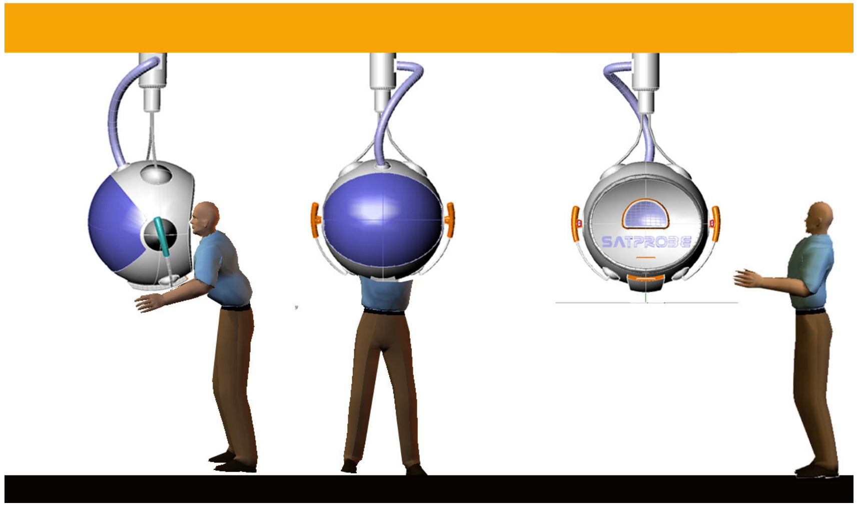

SATPROBE



14.0 Group Interaction - A Proposal

The design was thought to involve flexibility in creating different scenarios taking advantage of the system. It could cover other topics of space exploration like:

Space Walk- Repair a problem or conduct an experiment in outer space
Click the earth – Take pictures of the earth with on board cameras from satellites
Geo Belt- Fly in the geo-belt to know your Geo stationary satellites



Group Interaction

- The Unit could be connected to network using a single computer
- This allows the user to involve the search with a partner
- More number of people when connected could play in groups by teaming up
- This would act as a tool for group interaction in public environment

Annexure

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   DOS, department of Space, Bangalore
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4. http://www.nasa.gov/home/index.html
   http://www.esa.int/esaCP/index.html

5. www.esa.int

6. http://www.realspacemodels.com/

7. http://www.nasm.si.edu/

8. http://eaglelander3d.com/

9. **Shri Sharada Vidya Niketana, ISRO layout, Bangalore**

10. Orbits

11. Azimuth & Altitude

12. Visibility - members.aol.com/jwholtz/ sat/background.htm

13. Two line Elements

    Two line elements for Iridium Satellite.
    IRIDIUM 8
    1 24792U 97020A 04151.55851627 .00000002 00000-0 -62276-5 0 3975
    2 24792 86.3948 150.3013 0002450 88.0563 272.0908 14.34216854370138
    http://www.celestrak.com/NORAD/elements/

14. http://www.satobs.org/geosats.html