EEP Binder - Table of Contents

***NOTE: this electronic copy may not match with the original EEP binder in terms of layout and content; some of which may have been edited, or added. In Addition, most pages within the EEP binder that are not typed up, (i.e hand-written pages, or photocopies from textbooks) have not been reproduced electronically, nor has anything that appears in the binder after "**Constellations, Stars, Suns, etc. by Marlene Keeley & Mark Karpinski"**.**
Be warned that the number one rule of computers still applies here, i.e. "computers are stupid". Thus this electronic document, which is scanned and recompiled into a word document by a computer, is bound to have several faults in page layout and spelling.

-Electronically reproduced by Brian Foo

Stuff

Stuff not in the electronic version, but in the real binder

Constellations, Stars, Suns, etc. by Marlene Keeley & Mark Karpinski
Possible alternative stations - Comets
Asteroids
Distances
Static Pictures
Shuttles
GravityComputer Sensors
Colouring Exercise
Lexington Space Booklet for Kids
How to Build a Hover Craft
Space Camp Newsletters (old)
Satellites information forms (old)
Rockets Spiel (old)
Evaluation Forms/Request Forms (old)
Phone Trees
Lexington Contact Info
Launch Procedures
Hot Lab Proposal, by Marlene Keeley
Science Project: Gerbils, by Andria Green and Marion Tang

* with thanks to the following:
Hilary Myron & Miriam Padolsky (95-96)
Andria Green & Sarah Mark (96-97)
Marlene Keeley & Tern Oda (97-98)
Margot Cragg & Daniel Kekez (98-99)
James Clark & Elizabeth Smith (99-00)
Nic Zuchowicz & Adrian Archer, Kevin Williams & Shain Davidson (00-01)

Elementary Education Programme

For the past eleven years, the Ottawa Carleton District School Board has operated a Space Simulation programme designed
to interest students at all grade levels in science and technology by engaging them in activities related to space exploration.

Now located at the Ottawa Carleton Educational Media Centre, it consists of (1) a mock lunar or planetary habitat, with the
facilities necessary to accommodate a team of "astronauts" for up to 72 hours; (2) a mission control linked to the habitat by
headsets, computers, and closed circuit television.

These facilities are used in two ways:
- Elementary Education Programme
- Simulated Space Missions (For Elementary or High School Students)

The Elementary Education Programme

The Elementary Education Programme is designed and conducted by high school students from Lisgar Collegiate Institute. Classes visit the site and take part in activity sets under the guidance of the older students. The activities are designed for different grade levels and usually last about
90 minutes, meaning the class field-trip lasts a half day. Groups usually arrive around 9:30 or 1:00 and depart around 11:00 or 2:30. Longer programmes, including a full day programme, are available for older students. These programmes are held over three-day periods, several times during the school year — usually in February, March and May. They are stand-alone programmes, requiring no preparation or follow-up. They benefit, however, from related in-class study whereby the visit serves as an introduction or follow-up to a class investigation of space, technology, communications, or some similar topic. The programmes have been running for seven years and usually accommodate more than 600 pupils from Kindergarten to Grade 8 each year.

Galactic Tours
Age Group: Kindergarten/Grade 1
Duration: 90 minutes (minimum)
Description: The Galactic Tours programme consists of ten stations, representing the sun and the planets, which are staffed by student instructors. Pupils receive a passport and are led by their student guide to each of the stations/planets. At each stop, they participate in an activity
appropriate to the site and get their passports stamped. Activities might relate to topics such as the greenhouse effect, meteorite impacts, orbits of the planets and moons and demonstrations of the effects of very low temperatures. Other possible stations may cover the space shuttle and the
possible existence of alien life. The presentations and

activities all involve the children directly and take into account their age, energy, and attention span.

Cosmic Science

Age Group: Grades 2 to 6

Duration: 90 minutes (minimum)

Description; In the Cosmic Science programme, the younger pupils (grades 2/3) divide their time between an advanced version of the Galactic Tours (see previous) and a set of hands-on activity stations. The older pupils (grades 4/5/6) move between a selection of five or six activity stations. The content of these stations varies with age level and may include topics such as rocketry, radio and computer communications, electrostatics, and Newton's Laws of Motion.

Satellites

Age Group: Grades 7/8

Duration: Full day

Description: In teams and with an older student counsellor, the pupils research and design a satellite to perform a function of their choice. Students research appropriate materials, cost, weight, and orbit, with provided resources. Once designed, they order components from a satellite parts shop, run by the older students. At the end of the design phase, pupils prepare and deliver their proposal to a panel of aerospace officials and executives (played by the older students) who judge their entries. After the presentations of all groups, the panel retires, weighs the merits of each satellite, and returns to deliver a verdict. The strengths and weaknesses of the proposals are discussed with the pupils and the panel awards the "contract" to the winning bid. All pupils receive individual certificates of participation.

Simulated Space Missions

Age Group: Grade 5 to High School

Duration: Full day (multiple day is optional)

Description: The Simulated Space Mission programme consists of a scaled-down version of the annual mission of the Ottawa Carleton Educational Space Simulation. For elementary pupils, the mission is normally a single-day program, although some groups have extended it to an overnight mission. The format, which is flexible and can be adapted to the aims of the teacher, is usually as follows:

A period of preparation and in-class activities, during which the pupils plan their mission. The co-ordinator is available to visit the teacher or class and provides

them with resource materials and suggestions. The pre-visit activities vary greatly from class to class, and there is much potential for interdisciplinary activities. Pupils might study the planet they plan to visit, create science
experiments for their astronauts to perform, research food and nutrition, design a mission logo, write short stories with a space theme, create a class newspaper, etc. Some teachers concentrate on direct preparation for their mission, while others use the mission and space theme to create activities in other subject areas. The coordinator also visits the class to introduce them to radio- communications skills and leaves headsets, walkie-talkies, and video-conferencing equipment for the pupils to practice on.

The mission. The class is divided ahead of time by the Schoolteacher into two groups, each containing half of the class, and further subdivided into two-person astronaut teams. Typically a class may have groups A and B, each containing 6 or 7 two-person teams. In the morning, team A launches in the simulated space shuttle, under radio control from team B, which is acting as mission control. On arrival at the chosen planet, A enters the simulated habitat and carries out a series of pre-planned activities, each of about 20 minutes duration, Meanwhile, team B completes their own set of different activities back on mission control. Radio, computer, and video communication is maintained between the habitat and mission control by rotating teams of astronauts and control personnel

The mission lasts for 2 to 2.5 hours, after which the astronauts return to Earth. After a short break for lunch, the teams reverse roles and team B then launches to the chosen destination. Students in each location (habitat and mission control) will conduct several activities. The co-ordinator can provide you with a list of activities which you can use as is, modify, or substitute to suit your class. The activities include the following: manipulation of a joystick-controlled robot, bio-medical experiments (pulse and blood-pressure), computer and radio communications, Space-walk on planetary surface to collect samples, analysis of samples, computer sensor investigations of sound and light and various interactive computer Programs.

If desired, the habitat can also be treated as a simulated biosphere. A teacher interested in stressing environmental concerns can use the closed habitat as a model to demonstrate some of the problems facing the larger bio- sphere in which we all live.

Audio/Video connection with students at your home school.

For five years, the older students have successfully connected with their home school during
their. missions, via video conferencing. As well, about twenty elementary schools have been connected by video conferencing to their home school while conducting missions. Pupils at the school were able to see and talk to the "astronauts," receive reports, debate issues, jointly create documents etc. If there are no technical difficulties we will gladly be able to provide this activity for your school.

The Planetarium

Age Group: Kindergarten to High
Duration: 1 afternoon per school, 20 mm. per class
Description: The newest addition to the Elementary Education Programme is an inflatable planetarium. Two senior students will bring the planetarium to the school, and as many interested classes as possible may visit for a 20 minute presentation for each class. The class enters the dome, upon which full-sky pictures are projected. The senior students use photographs and diagrams to discuss stargazing, the history of the constellations, and meteorology. The presentation is tailored for different grade levels, taking age and attention span into account.

Scheduling

The following are tentative dates for holding sessions of the Elementary Education Programme:

November - Satellites
February - Galactic Tours and Cosmic Science

March - Galactic Tours and Cosmic Science
April - Satellite, Simulated[Space Missions
May -Galactic Tours and Cosmic Science

The planetarium will be available to schools from October until May.

Cost of Participation

The Elementary Education Programmes held at the Ottawa Carleton Educational Media Centre — Galactic Tours, Cosmic Science, Satellites, and Simulated Space Missions are free. The only cost to a visiting class is busing. The Space Simulation covers all other costs and the high school students give their time and assistance voluntarily. We will be charging a fee of $50.00 for the use of the planetarium. The fee covers the entire school, regardless of how many classes are taking advantage of this opportunity. The money will be used to help cover the costs of transporting the planetarium, and to help the Space Simulation buy supplies to make the Elementary Education Programme more enjoyable for all those involved.

History of the OCESS

For the past eleven years, the Ottawa-Carleton Educational Space Simulation (OCESS) has played a significant role for students at all grade levels

At the high school level, students have had the opportunity to learn and develop skills of problem solving, group dynamic leadership creativity, organization and management. They have also been exposed to a high level of educational programmes, adapting them to three different science and technology in the forms of computer use and programming communications, and the development and conducting of science experiments for the missions. The integrated nature of the programme draws science-oriented students as well as some who have an interest in space but who are not necessarily strongly interested in science or technology. The latter group has produced artwork and murals, theme music for the missions, and press kits and articles for newsletters which are instrumental in the extensive media coverage of the missions. At the same time, they have worked with the technology of the missions and developed an understanding of and appreciation for it. Some students gained experience and credit towards course work by building the actual habitat, preparing food for the missions, and doing other specialty jobs.

More than 80 students from Lisgar Collegiate, Highland Park High School, and McArthur High School were involved in the preparation and execution of the first two missions. As well, students travelled to Lexington, South Carolina to participate in missions there, while similar groups came to Ottawa to work with us. A number of lasting friendships and a useful understanding of our southern neighbours have resulted from this exchange.

In 1992, on elementary level, Dunlop Public School, a K-6 school of 350 students, also experienced the science and technology programme. The habitat was transported and assembled in their gymnasium, remaining there for two weeks. During this time, every pupil took part in a mission.
The missions varied in length from half an hour for the kindergarten children to 20 hours for a team of grade 5/6 pupils. A group of high school students from the OCESS was highly instrumental in the success of the elementary school programme. They worked with teachers in the classroom, preparing for the missions, they assembled the habitat and set up the mission control, they acted as guides and mission leaders for the younger children, and their infectious enthusiasm was much appreciated by the dedicated and innovative staff of the school.

In 1993, the high school students developed space-related, educational programmes for different elementary grades. That year, over 500 students visited the habitat, located in the former Ottawa Tech Building, to take part in these programmes. The activities lasted about one and a half hoursand involved the younger pupils in hands-onactivities designed to teach them about space, the shuttle, communications rockets etc.

Over the past 7 years, the students have expanded their educational programmes, adapting them to three age levels- essentially primary, junior, and intermediate. During this time, they have accommodated at their the site over 1,300 pupils for the 90-minute and other programmes. During the same time span, more than 30 classes, ranging from grades 5-8, have planned and conducted simulated space missions to places such as the moon, venues, Mars, and Pluto. Responses from teachers and pupils to the programmes offered by the OCESS have been most encouraging and we hope to continue operations at a higher level than last year.

During the last 5 years, the OCESS has begun to take advantage of Internet and computer communication technologies. By exposing students to computer technologies such as videoconferencing at an early age, they are becoming familiar with new skills which will soon become common in the workplace. Our members have also spent a considerable amount of time developing and managing our website, which combines talent in writing, art, and programming.

The OCESS is a unique blend of contributions from school board, staff, parents, sponsors, and students.

both high school and elementary levels, parents make; major contribu-tions of time and skills by preparing food, facilitating trans-portation and opening their homes to billet visiting students. Private sponsors, recognizing the value of such a programme to students who will soon be in the workplace, have generously helped the Ottawa Carleton District School Board in the funding of the programme. Students have contributed to the programme from their own personal strengths. As well they have gained knowledge and understanding of science and technology while developing transferable skills that they w ill need later in any workplace. This is an excellent combination of parents, private companies and universities, teachers, and students themselves working together to provide a rich learning environment for the youngsters involved and to prepare themselves for the challenges that lie ahead.

Sponsorship

The Ottawa Carleton Educational Space Simulation is generously supported by local, national, and international
corporations and organizations who share our goals. They enable us to acquire necessary equipment and materials through their funding. Among these organizations are:

Spar Aerospace
Nortel Networks
Digital Equipment of Canada
Object Technology International Inc.
Carleton University, Faculty of Engineering
S.H.L. Systemhouse
Cognos inc.
Intel Canada
B.O.C Gases(canox)
Capital cars online
©Computers Plus
City Com
Canmet Casting Laboratory
OCDSB
OCEMC

As well, we are grateful to many other organizations which have assisted us over the years by providing financing, materials and other support: The Federal Government of Canada, Science Culture Canada Program, Lockheed-Martin Canada, Rockwell International of Canada, CAL Corporation, Telesat Canada, University of Ottawa, Ken-wood Canada, Westboro Carpet, Builders' Warehouse, C.F.R.A. Radio, and the Pineview Golf &Country Club.

*WHAT THE WEBSITE SAYS ABOUT EEPS

GET WHEN NET IS BACK UP

Contacting Teachers

Initial Contact

At the beginning of the year, a package is sent out the the principals of all the elementary schools of the OCDSB. This package contains the information needed by the teachers. The teachers who wish to attend can contact the OCESS by mailing, faxing, emailing, or phoning in their requests.

Deciding Dates

Extremely important!!! Once you know what grade levels are interested in coming, you need to decide when to hold EEPs. There are no specific times of the year for different programs (there used to be, but we decided those were irrelevant!). Make sure to schedule some EEPs during the Mission - these should probably be Cosmic Sciences or Galactic Tours, but Satellites would technically be possible as well. Remember that Cosmic Sciences and Galactic Tours last 1/2 day each, while Satellites are full-day programmes. It is highly recommended that the EEP commanders, planetarium commanders, and Mr Hussey set dates at THE BEGINNING of the year. If you don't, all hell WILL break loose later on in the year. Just have dates available, and slot people in when the forms begin to arrive. If want they want isn't available, too bad for them.

Contacting Teachers

Once dates are decided, you must talk to the interested teachers. Lunch-time and after school phone calls are the best way to tell teachers the dates of the EEPs. Remember that some schools run from 8 to 2:30, some 8:30 to 3, some 9 to 3:30, and then others are just plain weird. Call near the beginning of the year to schedule.

When calling the school in question, ask to speak to the teacher who wished to attend. If he/she is busy, leave a message saying your name, the OCE Space Simulation, and either to call you back at Lisgar (239-2696) or that you'll call back later. Be prepared to play games of telephone tag.

When you get ahold of the teacher, tell them your name and that you're from the OCE Space Simulation. Explain why you are calling: the dates of the EEP, and ask if they are interested.

Sessions are a half-day (except Satellites), or 1.5 to 2 hours long. Having two classes attend one session is NOT recommended, as class sizes have ballooned in recent years and 35-40 kids is too much. Make sure to write down when they are coming (Date & time), and their estimated times of arrival and departure. Ensure that they know the location (Media Centre, 605 Bronson, next to the Queensway, parking off of Chamberlain) and that bussing and lunches for the students are their responsibility. Leave your name and Lisgar's phone number so that they can contact you if they need to.

About 1-2 weeks before the EEP, call the teacher again to confirm the class' attendance and determine how many students will be arriving and when. Write this down! Ask about any allergies you should be made aware of. Calling to confirm is VERY IMPORTANT - if you don't confirm, they might forget, and then they won't come (this has happened before).

For Satellites, recommend to teachers that students bring a lunch, unless the teacher wants to take them across Bronson (heavy traffic, especially cars coming off the Queensway offramp) to the fast food places.

Staffing

Getting the students

Once you know when the EEP will occur you should begin recruiting staff from Sim members.

Recruiting should begin about 2-3 weeks before the EEP. It's much easier to tell people that they're needed than it is to beg for staff at the last minute.

EEP attendance is not an excuse for missing tests or assignment due dates. Any students attending should inform their teachers of their absence BEFORE the EEP. Homework, rescheduling tests, etc. is the students' responsibility.

Pass out permission forms at a meeting 2-3 weeks in advance of the EEP, or let people know the forms are available from the EEP commanders or in Rm.

303.

Staffing stations

Different programmes require different numbers of students to staff them. When you decide which students will be responsible for which stations make sure to take into account their obvious strengths, weaknesses, interests, and so on. Any student may do any station, with the exception of Neptune - anyone working with liquid nitrogen must have taken or be taking OAC Chemistry, or else have Mr. Hussey's permission. Do NOT include yourself in any number estimates.

Ideal numbers of staff

Galactic Tours: 5 Group leaders + 5-6 Station people + 2 EEP commanders
Cosmic Sciences: 5 Group leaders + 5 Station people + 2 EEP commanders
Satellites: 5-8 Group leaders + 2-3 Sams +1-2 Brenton/Browns + 1 roving reporter/mad scientist + 3-6 Board of Director members + 2 EEP commanders

(As you can see, Satellites is the most staff-intensive programme - it is adaptable, but it definitely needs more than the others. If you have fewer than necessary for Galactic Tours or Cosmic Sciences, just eliminate a station or do MC/HAB all at the end for the entire group, it's up to you. Be flexible!)

List to Saul

Once you know who is coming, they must return permission forms to you or Mr Hussey. You must make a list for Mr Hussey, who will email the names to Saul so that your absence shows up as a field trip. If Mr Hussey is not at school for whatever reason, give Saul a list yourself. Mr Hussey gets all the permission forms once the list is made. The list *should'it be given to Saul 48 hours before the EEP (official school policy); however, if you get the list to Mr Hussey by the beginning of lunch the day before the EEP, it should be fine.

Sample list:

Jan 20, 2000
James Clark 13C 8:00 - 3:30
GabrieUe Wilson 13A 8:00 - 3:30

Galactic Tours

-Intended for students in K-grade 1/2

- works best with only one class at a time
- half-day programme
- remember to go shopping for flowers, lettuce, gummie worms, marshmallows, flour, cocoa, corn starch, etc. (if needed) the day before, and remind Mr Hussey to pick up some liquid nitrogen

Students are given a tour of the solar system, visiting each of the planets and the sun. Before they begin this tour, they are given a passport which they can stamp at each station and stickers describing their group. Try to have them write their names on their passports. Each station contains an activity to teach the students a bit about the solar system. As well during the session the students are given a tour of the habitat and mission control, and can also go to Create-An-Alien or Shuttles if time/staff permit.

Staffing:
- students are broken up into groups of 5-8, depending on how many group leaders and students you have (group leaders can do MC/HAB if necessary)
- need 1 simmie for each group + 1 for Neptune + 1 each for MC/HAB, Create-An-Alien, Shuttles + 2 for the tours
- if possible have 2 simmies stationed on Tours; when a group arrives, the group leader takes half and one summer can take the other half. This way 2 groups can do Galactic Tours at the same time, with 4 groups - the kids get to do more stations, faster.
- simmie at Neptune must have taken or be taking OAC Chemistry or have Mr Hussey's permission

Time:
- length depends entirely on how long the class is staying
- budget 10 minutes to get started, 10 minutes to say goodbye at the end
- divide the rest of the time up evenly

Remember to hand out evaluation forms to any teachers and parents who wish to fill them out, and try to collect them at the end.

Set up the computers in Mission Control to our website, CMES, Navicomp, etc., make sure the emergency light is plugged in and ready to go, and make sure the Habitat is CLEANED UP before the EEP begins.

Supplies: lists of necessary materials should be in the boxes for Galactic Tours, Create-An-Alien, and Shuttles/Rockets; any large materials not in the boxes should be in Keplemicus; stickers are in the stickers box; evaluation forms are in the Satellites box; mats on the planetary surface

NB - for the Pluto station (with hazelnuts) MAKE SURE none of the kids has severe nut allergies

NB2 - when making Magic Mud, put in corn starch FIRST and SLOWLY add water - you don't need a whole bowl-full, just a bit in the bottom

Cosmic Sciences

- intended for students in grades 2/3 to 6
- works best with one class at a time
- half-day programme
- remember to go shopping for flowers, lettuce, gummie worms, marshmallows, flour, cocoa, corn starch, etc. (if needed) the day before, and remind Mr Hussey to pick up some liquid nitrogen

Students are divided into groups which visit various stations, designed to teach them about some of the various aspects of science or nature relating to space. There are a wide range of potential stations, but usually only 5 are needed.

Staffing:

- students are divided into groups of 5-8, depending on how many group leaders you have
- need 1 simmie per group + 1 for each station; extra people are divided among stations where they can be most useful; group leaders can do MC/HAB if necessary
- simmie on Pit Demo (liquid nitrogen) must be taking or have taken OAC Chemistry or have Mr Hussey's permission

Time:

- same as Galactic Tours: 10 minutes each for beginning and end, split up time at stations based on remaining time
- stations generally need about 15 minutes, but 20 minutes is often too long for certain stations (ie Rockets)

Stations:

MC/HAB; Rockets; Pit Demo (the solar system); Newton's Laws; Electrostatics; Create-An-Alien (if necessary)

Remember to hand out evaluation forms to any teachers and parents who wish to fill them out, and try to collect them at the end.

Set up the computers in Mission Control to our website, CMES, Navicomp, etc., make sure the emergency light is plugged in and ready to go, and make sure the Habitat is CLEANED UP before the EEP begins.

Supplies: lists of necessary materials should be in the boxes for the stations; any large materials not in the boxes should be in Keplemicus; stickers are in the stickers box; evaluation forms are in the Satellites box; mats are on the planetary surface; chairs for rockets in the Meeting Room; chairs for Newton's Laws in the Green Room

NB - for the Pluto station (with hazelnuts) MAKE SURE none of the kids has severe nut allergies

NB2 - when making Magic Mud, put in corn starch FIRST and SLOWLY add water - you don't need a whole bowl-full, just a bit in the bottom

NB3 - when putting up string for Rockets, DO NOT tape it to the walls; tie it to the grate or windows, but try to avoid risking pulling paint off the walls

Satellites

- intended for students in grades 7 & 8
- works best with one class at a time
- full-day programme

Students are divided into groups of 5-8, which design a satellite. Group leaders provide advice to the students. Brenton & Brown Market Analysts are available in MC for ideas, or for assisting with the Library Galactica (books in MC + internet access for web searches). Sam's Satellites provides cost analysis for the groups. Roving reporters or scientists can also help generate ideas among the groups. After preparing the parts of the satellite, a design, obtaining a cost analysis, filling out the cost analysis sheet, preparing a speech (and press release, if time), the group will present their satellite to a Board of Directors, who will choose one to "sponsor."

Staffing:
- students are divided into groups of 5-8, depending on how many group leaders you have
- need 1 simmie per group + 2-3 Sams +1-2 Brenton & Browns (+ 1 roving reporter/scientist) + 3-6 Board of Director members

Time:

- students spend the whole morning designing their satellites, working through lunch if necessary
- work backwards:
- 5-10 minutes for goodbyes at the end
- 20 minutes for presentations by Board of Directors and certificates
- 30 minutes for Board of Directors to deliberate and prepare certificates
- 30-45 minutes for presentations to Board of Directors (depends on number of groups)
- 50-60 minutes for lunch, cleaning up for presentations
- remainder of time is spent on creating the satellite

Supplies:

- paper (lined + poster), cost analysis sheet, cost sheet (group leader's eyes only), satellite info
booklet, ruler, pencils, markers, etc. for each group
-junk, posters, cost sheets for Sam's
- books + set-up computers in MC for Brenton and Brown
- costumes (provided by simmies) for Sams, Brenton & Brown, reporter/scientis, and B.ofD.'s
- posters in poster folder; evaluation forms in Satellites box
- all cost sheets + certificates + satellite info booklets are in the Satellites box

Remember to hand out evaluation forms to any teachers and parents who wish to fill them out, and try to collect them at the end.

NB - do not tape posters directly to the walls, as this might tear off the nice new paint
NB2 - try to encourage simmies to bring their own lunches; teachers can take their kids to
MacDonald's, etc., if they want, but it's not recommended, and the students get jealous if we have
fast food and they don't.
NB3 - remember that Board of Directors people are only signed out for the afternoon

A Guide to Pit DemoBy Nik Zuchowicz and Stephen Smith

If you are running out of time, and haven't yet done Neptune, do it!

The sun - This station is about eclipse.

Materials: lamp, ping-pong ball, orange or suitable round object to represent Earth.
-Talk about shadows, and how when the moon passes behind the Earth, it comes into Earth's shadow. Make this clear by "orbiting" the orange with the ping pong ball; make it obvious that its in shadow by bringing the balls fairly close to the lamp and each other and moving the ping pong ball in and out of the shadow.
-Then use the ping-pong ball to put part of the orange in shadow.
-Make the difference between the lunar and solar eclipse clear. Also make it clear that the moon only covers part of the planet so only certain parts of the planet can see the eclipse at any one time.
-Mention that this also applies to other planets, with their own moons, and very
occasionally one planet passes in the shadow of another.

Mercury

Mean solar distance: 58 million kilometres

Satellites: none

Materials: Tape

-This station is about orbits. There should be masking tape in a circle on the ground with an X in the middle.
-Explain gravity a bit in relation to how powerful the sun is.
-Talk about how the sun pulls in the planets at the same time as the planets are trying to go straight in a direction and thus orbit in a circle, never getting much closer or further
-Demonstrate with a kid on the X and another "orbiting." If there is time, try with more kids on more orbits, or even using kids as natural satellites orbiting moving planets

Venus

MSD: 108 million kilometres,

Satellites: none

Materials: Lamp, jug

-Talk about the suns rays and how they can become trapped by thick atmosphere. Talk about the greenhouse effect
-Demonstrate by shining the lamp on the plastic jug with black paper on it
-Put kids hands in there to show how well the greenhouse holds heat

Earth

MSD: 149 million kilometres

Satellites: 1, the Moon

-Don't use this planet

- If they ask for Earth, say we are already there, why find out about what we already know? Get them to pick another.

Mars

MSD: 228 million kilometres, two

Satellites: 2,Phobos and Deimos

Materials: plastic bin, flour or something similar, small pink crystals or an appropriate alternative that can be separated from the sand, preferable as well a marble to represent the meteorite

-This station is to research how meteorites affect the surface of the planet

Jupiter

MDS:

Satellites:

Materials: Trampoline, little collapsible puppet

-Talk about how gravity varies from place to place in space

- Get kid to jump on trampoline, say this is gravity on earth. Hold kid on shoulders (not to hard) and ask to jump, say this is gravity on a larger planet.

- hold up puppet, push bottom to crush (say this is gravity on Jupiter)

Saturn

MDS:

Satellites:

Materials: salad spinner, paper stars

- Say this is like orbiting, show stars all spread out in salad mixer, spin salad spinner and show kids all the stars around the edges

Uranus

MDS:

Satellites:

Materials:

Neptune

MDS:

Satellites:

Materials: Materials: liquid nitrogen, flowers that crush well, marshmallows, balloons, hammer and accessories

-Mention right away that this is the coldest planet in the solar system

-This is very fun for the person using the nitrogen. Don't get carried away, we need to save flowers and marshmallows for later

-Talk about molecules, how they are always moving, and how they move slower when cool and faster when hot. Mention how molecules on Neptune are so far from the Sun's heat that they hardly move at all.
-Talk about how when you freeze something like flowers, they are easy to break as the water in them is frozen and can be easily smashed.
-Fun part: Take stuff and put in liquid nitrogen. Smash it!
-Also the marshmallows are edible straight out of the N2

Pluto

MDS: 5930 million km

Satellites: 1, Charon

Materials: Bowl, Styrofoam S things, 1 coloured

- Pluto was discovered relatively recently, and was very hard to find since it's so small and dark. It's like finding a tiny white dot in a sea of stars, like a needle in a haystack, or a marble in a box
- Place marble or two tin bowl of Styrofoam; make kids compete to see how fast
they can find the marble without looking

Create an alien speech

Welcome to the Create An Alien Centre. Today we are going to talk about the kind of life that we may find out in space. Do any of you have ideas of what an alien life form might look like? Well, today we're going to create one of our own. We want to create a new species that has different qualities than humans. For example, your species might have an extra arm or it might be able to breathe underwater as well as breathing air. You can pick a new planet for your alien to live on, or they can live on Earth. You can read about \ We will tell you about (depending on age) a planet and you can design your alien with the qualities it will need to live in this environment. For example, if you pick Pluto your creature would likely need some kind of warm outer layer because of the extreme cold. Have fun and don’t forget, be as creative as you like.

Rocket Experiment

One of the activity centers during the Ottawa Board of Education Space Simulation Education Programs was the rocket center. Here the students performed an experiment which simulated the actions of a real rocket. What follows is the discussion which we had with the students before doing the experiment, as well as the experiment itself

"Have any of you ever seen a space ship launch on T.V.? Every spacecraft is carried out into space by a powerful rocket. A rocket is the only kind of engine that can work in space, where there is no air, because it carries its own oxygen to bum as fuel. Other engines, such as aircraft jet engines, rely on oxygen in the air to bum their fuel. At a space shuttle launch the main engines and rocket boosters fire and me shuttle lifts off. At two minutes into the flight, the solid rocket boosters are empty of fuel; they separate from me shuttle and parachute back to Earth and into the ocean. These rockets can be rescued from me ocean and used again. After eight minutes, the fuel tank that contains the fuel is burned in the shuttle's engines, then it too detaches from the shuttle and falls back to Earth. On its way back to Earth it bums up and so it is not used again. Can anyone guess why this happens? (*Because it goes through the atmosphere, traveling at high speeds and friction makes it bum up. Tell the students to rub their hands together and say that their hands getting warm is the same phenomenon mat makes the fuel tank bum up, i.e. friction.)* Then the shuttle's engines take it the rest of the way, until it is orbiting Earth. But taking shuttles into space is only one use for rockets. What are some other things that rockets are used for? (*Rockets are also used in guns, missiles, fire crackers etc.*) Rockets can also be used to carry experiments into space. Some rockets are what we call stage rockets. A stage is kind of like a section of a rocket.

(Choose one student as demonstration model.)

These rockets blast off the ground. When the fuel in the first stage has burned up, it drops off and falls back to Earth. (*Student should drop to knees.)* Now the rocket is smaller and lighter so it is easier for the next stage to take it higher into space. Eventually the second stage runs out of fuel and falls back to Earth. (Student should sit on floor.) Now the rocket is even lighter. Soon there is only one stage left and this one takes the payload into space. Today we are going to a science experiment that simulates a rocket taking a shuttle into space. Whose space shuttle will get there first?"

Experiment

<u>Purpose:</u> To simulate the actions of a real rocket.

<u>Materials:</u> one balloon (preferably sausage shaped, but round will do) per student string, straws cut in half,

masking tape

Procedure:

1. Thread one half straw onto a piece of string approximately 2.5 metres long.

2. Tie the string (with the straw still on it) between two table legs.

3. Blow up a balloon, but do not tie it.

4. While one person holds the balloon shut, tape the balloon to the bottom of the straw.

5. Slide the straw, with the balloon still attached, until it is touching one of the table legs.

6. Release the balloon and let it slide along the string to the other table leg.

(Note: If there is enough room, several strings can be set up so that many balloons can be released at the same time, perhaps in a race.)

Other Suggestions: Experiment with ways to make the rocket better. Some suggestions that we were given include: using more than one balloon, using round balloons instead of sausage shaped balloons, using less tape to make it lighter...

Another idea is to set up one very long string, approximately fifteen to twenty metres, and see how far the balloon rocket can go.

After the experiment was finished, we discussed the results.

"Why did the straw move?

(Because the action of the air rushing out of the balloon caused the reaction of the balloon moving forward. Use an example such as: the action of me smiling at you causes the reaction of you saying hello. Explain that our little rocket works the same way as a real rocket except that real rockets use a different kind of fuel for propulsion.)

Would this still have worked if we had the straw going from the floor to the ceiling?"

(Not as well, because the force of gravity pulling the rocket to the ground would be acting against the force of the air pushing up. Real rockets have to be very powerful to overcome the force of gravity; our rockets aren't strong enough.)

Space Shuttle Experiments

Two ideas to improve shuttle performance

1. Add two paper clips to the nose section so your shuttle will fly more smoothly It the paper clips are not there, the glider has too much lift and will not go forward. Not to mention that they stop the nose from crinkling up it you crash!

2. When you fly the shuttle, make sure you throw it straight and evenly. Try different amounts of force until you get a smooth glide.

Experiments:

Try these and try to guess what will happen.

1. Turn the glider on its side and throw.
2. Turn the glider upside down and throw.
3. Bend the flaps down, then throw the glider upside down and throw.
4. Move the flaps strait up. aim the glider downwards about 45 degrees and throw.
5. Put one flap up and one flap down and throw.

6. Add another paper clip to the nose and throw.
7. Add more paper clips to the tail, and throw.
8. Turn the corners of the wings up or down and throw.

Satellites

Satellites Presentation

Part 1: Introduction
Part 2: Where you find satellites in everyday life
Part 3: Types of satellites '
Part 4: General Parts of satellites
Part 5: Specific Parts of satellites
Part 6: Satellites and Engineering

Part 2: Where you find satellites in everyday life

Ask kids: Where do you come across satellites in your everyday life?

Possible answers: live news broadcasts and other television, overseas phone calls, "satellite picture" on weather forecast, faster internet access through DirecPC satellite technology, etc.

Other examples of satellite use:

- Fishermen use the satellite Global Positing System to determine their location anywhere on the planet to within 15 metres. Once he finds out where the fish are, he can come back to precisely the same place.
- Farmers can use satellite data to tell the difference between moist and dry soils.
- "Using television via the satellite, medical specialists in London, Ontario monitored physicians in an operating room in Moose Factory, 900 kilometers to the north . . . Natives in Fort Chipewyan and other Alberta locations participated in a trial in which informative television programs were produced by a native communications society in Ontario." taken from: Canada: 25 Years in Space by: Doris H. Jelly

Part 3: Types of Satellites

Different satellites have different functions; here are some examples of popular types of satellites and some of their functions:

Reconnaissance

- used to spy on other regions of planet
- take pictures of foreign military bases (Using a Charge Coupled Device, which registers images digitally, they can photograph an object as small as a grapefruit.)
- detect enemy missile launches and nuclear explosions in space
- pickup and record foreign radio and radar transmissions

Weather

- provides information on weather conditions
- broadcasts information to receiving satellites around the world
- provides early warning of dangerous tropical storms (ex. hurricanes, typhoons, cyclones)

Navigation

- designed to aid navigation at sea and in the air
- it can track anything that has a transmitter or gives off some sort of readable signal or radiation (ex. a ship on the ocean, a mountain climber, a forest fire) Ex. Sarsat

Astronomy

- study stars, planets, moons, black holes, neutron stars, etc.
- collect their data from earth orbit (no atmosphere to get in the way of telescope, unlike scientists observing from the Earth)
- can be used to make star maps or study mysterious stellar phenomena Ex. Hubble

Space Exploration

- don't orbit Earth like astronomy satellites
- are sent off into the solar system and beyond
- find out planetary information, more detail about distant stars, galaxies
- must be very durable because it takes the satellite many years to reach outer planets Ex. Voyageur

Atmosphere Studies

- study different aspects of the Earth's atmosphere
- Canada's first satellite ever was an atmospheric studies satellite: Alouette

Communications

- provide worldwide linkups of radio and television transmissions, telephone service
- Canada is a leading producer of communications satellites

History of Communications Satellites:

- first tried bouncing signals off moon
- didn't work because rough surface of moon didn't reflect signals predictably
- bounced signals off 30-metre mylar balloon (Echo 1) and it worked
- communications satellites avoid the limitations placed by the curvature of the Earth so the communication can easily be worldwide

Possibility of showing movie clip here. In English, "The Conquest of Space" 0000-0974.

Part 4: General Parts

No matter what its purpose is, all satellites have 5 general parts that they MUST HAVE in order to function.

Power Source

- every satellite needs a source of power ex. solar panels, batteries
- different satellites need different power sources depending on their orbit and purpose ex. space exploration satellites may get too far away from sun to use solar power if satellite is only "viewing" it's target at night, it may be unable to use solar power

Bus

- bus is the technical term for a satellite's body, which encases all the scientific equipment and other components
- bus should be lightweight, sturdy, and able to withstand extreme temperatures
- the smaller and lighter a satellite, the better
- each material has distinct advantages and disadvantages ex. aluminium, mylar, steel, kevlar, etc.

Communications

- All satellites need to have some means of communication with the earth
- In order to receive signals, the satellite must have some kind of receptor (ex. antenna, parabolic dish)
- must also have some kind of transmitter to send information back to Earth ex. parabolic dish, hyperbolic dish, antenna

Internal

- All satellites must have a method of storing and analyzing the data collected by the satellite, and a way of controlling its various systems
- This is usually in the form of some type of computer
- you need to decide what functions your computer will need to fulfill ex. storing data, controlling communications, telling camera when to take picture

Orbit

show orbit diagram

- Depending on the orbit, the satellite sees differently and can be used by different people

Polar

- travels over both the North and South Poles while the Earth revolves slowly under the satellite
- permits the entire Earth to be mapped

Elliptical

- distance from Earth varies
- allows satellites to make scientific measurements at varying altitudes

Sun-Synchronous

- passes over each region of the Earth at the same time of day
- allows a satellite to take pictures with the sunlight always hitting the Earth from the same angle

Equatorial

- always in orbit above the equator
- allows a satellite to study this area of the Earth closely

Geostationary

- always in the same position relative to the Earth
- stationed over a target or a region day and night
- satellite dishes can be permanently mounted to point at the satellite for transmitting and receiving
- travels at the same speed the planet rotates; therefore, at very great height above the Earth

Part 5: Specific Parts

- the specific parts of a satellite are those parts which your type of satellite needs to fulfill its purpose

Ask: Can you think of any specific parts that, say, a weather satellite would need?
- radar, infrared cameras (measures heat), radiometers (measures radiation, temperature), sounders (measure temperature), camera to take moving pictures (video)
- internal computer (stores large amounts of data, regulates transmission of data, etc.)
- some sort of transmitter to relay data to Earth, must be fast
- other...

Part 6: Satellites and Engineering

- when you are divided into groups, you will have to decide how you want to approach designing your satellite
- you can either be an inventor or an engineer
- as an inventor, you can choose the purpose of your satellite according to your own interests
- engineers, instead, use research to design things that the public needs or wants ie. they don't design something and then see if anybody wants it, they find out what people want and then design it
- you can be an engineer using market research that will tell you some problems in society that can be solved using satellites
- your group leader will give you more information about how to go about this.

Now we are going to design one satellite as a big group, so somebody, give me an idea for a type of satellite...

Select: General Parts: power source, bus, internal, communications, orbit

Specific Parts
etc.

Schedule: Satellites

9:00

-Students arrive
-Ice breakers
-Satellites speech
-Scenarios
-Split up into groups

10:30

-Juice break

10:45

- Begin satellites
- Design
- Cost analysis

12:00

-Lunch / Cost analysis

12:30

-Complete redesign of satellites
- Draw diagram
-Plan presentation

1:05

-Presentations

1:50

-Mini-missions
-Mission control
-Habitat
- Experiments (Judges evaluate satellites)

2:50

-Judging

3:30

-End of day and posters

Steps to Satellites

1. Choose goals (type of satellite)
2. General parts (power source, bus (body), internal, communications, orbit)
3. Specific parts
4. Cost analysis
5. Redesign

6. Diagram
7. Plan presentation
8. Present satellite to the panel of judges

The Design Process

1. Identify the problem
- market research
- what does the customer need / want

2. Criteria and Constraints
- what's (not) good enough?
- what's better than ... ?

3. Generate ideas (possible solutions)
- creative, no judgment
- consider production, materials, manufacturing, disposal

4. Evaluate alternatives
- use criteria and constraints
- weight and prioritize criteria
- simulations, prototypes, and models

5. Select the best solution

6. Optimization

7. Implementation
- make it
- documentation
- service, support, life cycle evaluation

8. Disposal

Vocabulary

Criteria - guidelines
- specifications
- evaluators
- measuring sticks
- "the ....the better"

Constraints – boundaries - establishes feasibility / viability

Optimization - improvement with respect to constraints

Suboptimization - improving 1 factor, thus reducing the quality of the whole solution

What is engineering?

- application of science
- problem solving
- creative design
- answering needs / wants
- designing
- product oriented

Types of Engineering:

aerospace, electrical, chemical, civil, mechanical, systems, nuclear, environmental, computer, biomedical, metallurgical, mechanical, military, mining, resources, ceramics, aeronautical, wood, sanitary, geological, petroleum, industrial, automotive, science

What makes a good engineer?

- thinks fast (finish projects)
- good analytical skills
- innovative / creative
- leader/team-worker
- knowledgeable
- thoroughness
- education
- perceptive
- enjoys problem solving
- compromise
- responsible
- open to criticism
- confidence
- good communications skills
- willing to learn
- risk-taker (advancement)
- hard work
- adaptable

How are engineers important to society? /

- help improve quality of life
- apply technologies
- help advance science
- help bring structure to me world

Market Research

1. Of the 8300 objects larger than 10 cm which are currently orbiting the Earth, only 500 (6) are active satellites (Science et Vie 65). Because there is so much space junk in orbit, it is becoming increasingly likely that a collision will occur. For example, the space shuttle's window was recently cracked by a fleck of paint in orbit.

2. Because of the increasing levels of pollution in the Earth's ocean, many species of marine wildlife are facing extinction. The oceans are so vast, however, that it is very difficult to measure exactly the severity of this problem. Furthermore, violations of existing ocean dumping laws are difficult to detect and punish.

3. Unexpected volcanic activity can wipe out entire communities in very short |periods of time. Furthermore, active volcanoes, usually situated in remote areas, are rarely found in the same region, so it is difficult for one governing body to monitor this serious problem. Therefore, the communities in problem areas are not being forewarned of imminent danger.

4. The commercial airline industry has grown drastically in the past half-century, and it has reached a point where the skies are literally cluttered with air traffic. There is a need for greater safety and more globalization of radar monitoring systems.

5. If a large meteor travelling through space collides with the Earth, much of the life on the planet could be destroyed.

6. Canadian peacekeepers in remote areas are having difficulty keeping in contact with Canada. Many soldiers are not only having difficulty receiving their orders, they are also feeling isolated and out of touch with their homeland.

7. Currently, the world population is heavily dependent on fossil fuels such as oil, gasoline, coal, and natural gas as sources of power. These resources, however, are non-renewable and may soon become dangerously depleted, plunging the world into a fuel crisis.

8. Crime in large urban centres is threatening the lives of city dwellers. The size of the problem is becoming unmanageable for even the largest police departments, like those in New York City and in Los Angeles, California.

Judging Criteria

You are a Board of Directors made up of the President of the Canadian Space Agency, the President of Spar Aerospace, and the Minister for Science Culture Canada. It will be your job to evaluate the satellites presented to you and select the one that Canada will send into space. Your evaluation will be based on the following criteria: practicality, necessity, total cost, average cost per part, efficiency, durability, and creativity. You will receive a chart from each group showing the average efficiency, durability, and cost, as well as the total cost. You will have to evaluate the other aspects as a group. Use good judgement and impartiality but remember to keep the children's feelings in mind. While they are making their presentations, stay in character and try to draw out longer explanations from them. Do not spend too long with each group because we have several groups to get through. After the presentations, each member of the board will have the opportunity to ask 3 questions to the group(s) of their choice.

Part	Efficiency	Durability	Cost
Communications			
Parabolic Dish	2	2	2
Hyperbolic Dish	1	3	3
Antennae	4	1	1
Power Source			
Solar Panels	1	2	2
Battery	3	4	1
Nuclear	1	2	4
Solar Panels with Battery	1	1	2
Bus Material			
Aluminium	1	1	2
Plastics			
Thermoplastic	1	2	3
Mylar	1	3	3
Duct Tape	1	1	1
Norway	2	1	5
Penguins	5	5	3
Steel	4	1	2
Special			
Radar	1	2	2
Infrared Camera	1	3	3
Radiometer	2	4	2
Encryption device	1	1	3
Camera	2	1	1
Charged Coupled Device	1	3	4
High Res telescopes	2	3	4
Large Reflector Dishes	1	2	1
Sounders	1	4	1
Wave Guides	1	1	1
Wave Filters	1	2	2
Ionosonde	2	3	3
Compressed Gas Thrusters	1	4	2

Checklist: Redesigning phase

- Does your satellite have a purpose?

- Can you explain it to the Board of Directors?

- Does it have the ability to fulfil this purpose?

- Does your satellite design include the parts necessary for all satellites?

- Does your satellite have parts to perform all of its functions?

- Does your satellite have any unnecessary parts?

- Have you thought of all possible functions of your satellite? Innovative functions?

- Can you increase your satellite's efficiency or improve upon its parts?

- How will your parts be mounted on your satellite?

Parts of a Satellite

NOTE: These parts of the satellites are only suggestions. These are not all of the parts necessary for your satellite; you must think of some on your own. This list is just a guideline to get you started. Once you have a good idea of what your satellite needs to operate, create your own parts and accessories. Be creative and imaginative!

Weather

- Radar is very efficient, moderately durable, and moderately expensive

- Infrared cameras which measure heat so it can be used to detect cold fronts and volcanoes erupting: very efficient, moderately durable, and moderately expensive.

- Radiometers that measure the changing levels of radiation reaching a small detector as the instruments scan the scene below. They also measure infrared as well as visible so they can produce cloud images even at night in addition to providing data about the temperature of land, ocean, and clouds. They are moderately efficient, with poor durability, and moderately expensive.

- Sounders use measurements of radiation to compute temperatures in the atmosphere at various altitudes up to about 25 miles. They are very efficient, with low durability, and very inexpensive.

Reconnaissance

- An encryption device that encodes digital images before they are sent to the Earth is very efficient, very durable, and moderately expensive.

- From the beginning, satellites have had ordinary cameras which take snap photos. The film is parachuted into the ocean to be retrieved by a plane swooping under it and picking it up, or by a ship if it falls into the ocean. Cameras are very efficient, very durable, and very inexpensive.

- More recently, they use a Charge Coupled Device (CDD) which registers images digitally which are then beamed to ground stations and recreated as images. A Charge Coupled Device is very efficient, moderately durable, and very expensive.

- High resolution telescopes are moderately efficient, moderately durable, and very expensive.

Fun Fact: outfitted with powerful optics of classified design, these CCDs can photograph an object as small as a grapefruit

Astronomy

- Radio telescopes which pick up radio waves for analysis by astronomers (i.e. it's the way we "see" things that are too far away to see in normal light). They are very efficient, very durable, and very expensive.

Communications

- Large reflector dishes are very efficient, moderately durable, and very inexpensive.

- Wave guides which allow satellites to manipulate radio waves and redirect them within the satellite for processing, are very efficient, very durable, and very inexpensive.

- Wave filters clarify a signal by filtering out all other noise. They are very efficient, moderately durable, and moderately expensive.

Atmospheric Studies

- An ionosonde measures the ionization of the atmosphere (actually the gases that form it). It is moderately efficient, very durable, and moderately expensive.

- radiometers (see WEATHER for explanation)

Space Exploration

- Compressed gas thrusters are used to manoeuvre the satellite. They are very efficient, with low durability, and very inexpensive.

- power source other than solar because the satellite will travel too far away from the sun to use its power

- It will require a more sophisticated computer because when it is traveling in space it will take too long for any message transmitted by the satellite to get to Earth and back. Therefore, the computer must have decision making skills. Such a computer is very efficient, very durable, and very inexpensive.

For all Remote Sensing Satellites

(Remote Sensing - i.e. observing something far away)

- Remote Sensing Satellites are navigation, weather, reconnaissance, land and sea observation, atmospheric studies, etc.

- They require equipment to observe Earth such as telescopes, infrared sensing equipment, radar, etc... Use your imagination!! :)

Parts Overview

Communications: Overview

- All satellites need to have some means of communication with the earth.
- This is done by way of radio waves; moving at the speed of light, this method allows for very fast communications (only a very small time lag).
- In order to receive these radio waves, the satellite must have some kind of receptor (antennae, parabolic dishes...)
- If the satellite has to send information back to earth as well as receive it, it will need some kind of transmitter.

Think! Will the function of the satellite (The kind of information it has to relay) require a certain kind of transmitter?

Parabolic Dish

- A parabolic dish (in the shape of a parabola) will reflect all radio waves that enter in to a single point, called the focus — a feed/receiving horn is built around this focus
- The parabolic dish reflects signals from earth into the receiving horn, and also reflects signals from the feed horn back to earth.
- They are usually large, but are the most efficient means of reflecting signals
- Very durable and moderately expensive

Hyperbolic Dish

- The hyperbolic dish is merely another version of the parabolic dish — two parabolas working together (a hyperbola is much like two diametrically opposed parabolas)
- Radio waves are reflected by the large parabola into the smaller one, which, in turn, reflects them straight into the receiving horn (functioning as a transmitter, tills process would simply be reversed)
- Hyperbolic dishes are more complex that parabolic dishes, but are very efficient, very durable, and very expensive

Antennae

- Antennae are much simpler than dishes, but have to be very long in order to be large enough to pick up signals
- Transmitting is very inefficient because, unlike a dish. the signal is emitted in a spherical fashion — at least half of the radio waves are sent backwards into empty space (a dish allows the wave to be sent in one direction)
- A satellite with very long antenna has to be able to store them within itself, and to deploy them once in outer space
- STEM (Storable Tubular Extendible Member) antennas can be unrolled from a small spool
- It is very inefficient, moderately durable, and very inexpensive

Bus (Body) Overview

- The body of a satellite, also known as the bus of a satellite, encases all of the scientific equipment, and other necessary components, of the satellite.
- The bus of a satellite must be lightweight, sturdy, and able to withstand extreme temperatures.
- Generally, the smaller a satellite, the better.
- When choosing the materials for your bus, take the following into consideration: cost, weight, sturdiness, and ability to withstand extreme temperatures.

Aluminium:

- High electrical conductivity, used as an electrical conductor on electrical power lines
-Malleable and (can be shaped) and ductile (can be stretched out into a wire)
-Good heat conductivity (good for pots and pans)
-Light weight and very efficient (low density)
-Moderate cost (not mined in Canada, but can be imported in large quantities)
-Very durable and extensively used as structural materials (e.g. aircraft bodies, window frames, and house siding, and trains).
-High ability to withstand extreme temperatures

Mylar

- Mylar is the DuPont trade name for a polyester film plastic used for insulation, backing for magnet tape, balloons, and as a polyester film used to cover a metallic yarn
- Mylar is used for insulation in space suits
- No electrical conductivity
- Moderately expensive, very efficient, and moderately durable
- As a thin film, its main use would not be for bus frame construction so much as for insulation (thermal blanketing)
- As a part of the preliminary testing for early communications, ECHO I was a 30 metre in diameter helium-filled mylar balloon that was coated in thin aluminum —this was allowed to float high into the atmosphere, and them communications signals were bounce off of it.

Plastic

- No electrical conductivity.
- There are two kinds of plastics: ones that can be remelted and reformed, and those that take on a permanent form (thermoplashics).

Thermoplastics — high resistance to extreme temperatures
- High cost
- Lightweight
- Very efficient
- Moderately durable

Other plastics (ex. tupperware) — low resistance to extreme temperatures
- Low cost
- Lightweight, moderate efficiency
- Low durability

Steel

- "Steel" refers to many alloys of iron and 0.1-1.5 carbon (often with other metals like chromium (for stainless steel), manganese, nickel, etc.)
- It is hard and possesses great tensile strength
- Steel can withstand extreme temperatures very well
- It is relatively inexpensive, but is very very heavy compared to other space materials
- Steel cables are often used to hold satellites in place within rockets
- Conducts electricity
- It is very inefficient, very durable, and very inexpensive Bus

Other Possibilities

- Kevlar (an extraordinarily tough fabric—used in bullet proof vests to deflect bullets)
- Graphite (lightweight form of Carbon)
- Silly Putty
- Dilithium Crystal
- Hair (Barbers across North America have been secretly selling it to NASA for years)
- Spandex
- Spam (It must be good for something)
- Penguins

Power Source

Every satellite needs a source of power.

- Factors to consider are cost, durability, and effectiveness (amount of power generated).

- Satellites use up a lot of electricity.

Think: How yill your power source be mounted in your satellite?

Solar Panels

- Solar panels consist of layers of specially-treated silicon.
- Photo voltaic cells produce electricity- when light rays knock electrons of off the atoms of a silicon layer. These electrons move from one layer to the next, generating current.
- Need large surface area, in order to produce maximum electricity
- Do not produce large amounts of electricity per cell
- Must be constantly exposed to light to produce electricity
- Can be used in tandem with a battery
- The need for large solar panels must be balanced with the need for the entire satellite to be relatively small
- Will not "run down" like a battery (completely renewable)
- They are moderately efficient, moderately durable, and moderately expensive

Battery

- In a battery, electricity' is produced by the transfer of electrons from one strip of metal to another; this is made possible by the fact that both metals are submerged in a solution that conducts electricity (an electrolyte) — electrons are carried over from one strip to the other by particles in the solution
- Some batteries are rechargeable, but recharging them would require some other source of power in orbit
- Batteries can work together with photo voltaic cells (see card "Solar Panels"); the solar cells can recharge the batteries when in sunlight
- Batteries can be compact
- Batteries will run down (eventually use up all their power); they are non-renewable
- They are low in efficiency, low in durability, and very inexpensive

Nuclear

- As fusion has not yet been perfected, all nuclear power sources would produce energy by the process of nuclear fission
- In nuclear fission, the heavy nucleus of an atom is made to split into two fragments of roughly equivalent masses; this process is accompanied by large releases of energy — it is this process that takes place in nuclear power reactors and in atomic bombs
- Nuclear power requires more volume than a normal battery, but can be compact; it doesn't necessarily require as much surface area a solar cells
- Power from a nuclear reactor is, for all intents and purposes, limitless; it won't run out before the satellite becomes useless for other reasons
- Problems with nuclear powered satellites: when a satellite's orbit decays, it falls to earth and bums up in the atmosphere, spreading radioactive particles over the earth; the rockets used to launch satellites may explode before escaping the atmosphere causing similar effects

- Very high efficiency, very high durability, very high cost

Orbit

Orbit: Overview

- Satellites can have different orbits (the path of one object around another) depending on what the satellite is going to be used for.

- For your satellite choose one of the following orbits: Sun-synchronous, polar, elliptical, equatorial, or geostationary.

Think: Each different orbit will allow the satellite to be accessed from different parts of the world, or “see” different parts of the world.

Sun Synchronous

- A satellite in sun-synchronous orbit passes over each region of the Earth at the same
time of day.

- Allows a satellite to take pictures with the sunlight always hitting the Earth from the same angle

Polar

- A satellite in Polar Orbit travels over both the North and South Poles while the Earth revolves slowly under the satellite

- Permits the entire Earth to be mapped

- Satellite will see almost the whole surface of the planet every 14 days

Elliptical

- A satellite's distance from the Earth is always different when it is in an elliptical orbit

- Allows satellites to make scientific measurements at varying altitudes

Equatorial

- A satellite in equatorial orbit will always be above the equator

- Allows a satellite to study closely this area of the planet

Geostationary

- A satellite in geostationary orbit will always be in the same position relative to the Earth

- Travels at the same speed the planet rotates• Stationed over a target or a region

day and night
- Satellite dishes can be permanently mounted to point at the satellite for transmitting and receiving

Internal

Overview

- All satellites must have a method of storing and analyzing the data collected by the satellite, and a way of controlling its various systems
- This is usually in the form of some type of computer
- For your satellite, you must decide what skills and features your computer must have