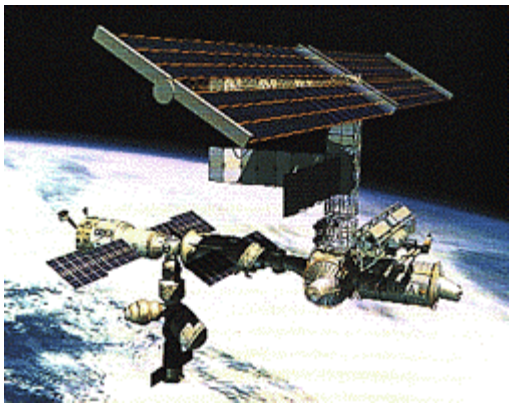
International Space Station

Galaxy Explorers will understand the following: The major components of the International Space Station (ISS). The history and current status of the ISS. The engineering considerations in designing the ISS. The amount of support and cost associated with the ISS. The value of the ISS for science and space exploration.

Standard:
Science Content
Abilities of technological design
Technology Education Content
Galaxy Explorers will develop an understanding of the attributes of design
Galaxy Explorers will develop an understanding of engineering design
Galaxy Explorers will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
Galaxy Explorers will develop abilities to apply the design process

DISCUSSION:

HISTORY OF THE INTERNATIONAL SPACE STATION



The International Space Station will be a permanent laboratory for human-monitored long term research in the unique environment of Earth-orbital space, an environment that cannot be replicated on Earth for long duration experiments. Research at the station will focus on two key areas: life sciences and materials sciences.

Life sciences research is expected to lead to a clearer understanding of basic processes and that will provide a foundation for development of advanced medications for improved human health. Materials research offers promise of improved metals, composites and plastics for significant advances in technologies for communications, transportation and a broad range of industrial processing operations.

The International Space Station draws upon the resources and scientific/technological expertise of 16 cooperating nations, including the U.S., Canada, Japan, Russia and nine nations of the European Space Agency (Belgium, Denmark, France, Germany, Italy, Norway, Spain, the Netherlands and the United Kingdom). The prime contractor is The Boeing Company and the principal subcontractors are McDonnell Douglas Corporation and the Rocketdyne Division of Rockwell International.

While the Phase I flight program advanced to orbital docking operations in 1995, manufacturers were turning out the first hardware components of the space station. By January 1995, 25,000 pounds of station hardware had been built; it was estimated that the total would reach 100,000 pounds by the end of 1995.

A major piece of flight hardware was rolled out in April 1995: a large Boeing-built module known as a node that serves as a storage area, a housing for electrical power conversion equipment and as a connecting passageway between the living and laboratory quarters of the space station. The Node 2 is used for pressure and leak tests and join the space station complement in 1999. In the meantime, Boeing put the finishing touches to Node 1, whose exterior structure was completed in July 1995; Node 1 was the first U.S. hardware delivered to orbit. Boeing is building a third node.

Phase II of the space station construction program began in November 1997 with the launch on a Russian Proton vehicle of the "FGB." The FGB is a 42,600-pound element, built in Russia but purchased by the U.S., that includes the energy block, contingency fuel storage, propulsion and multiple docking points.

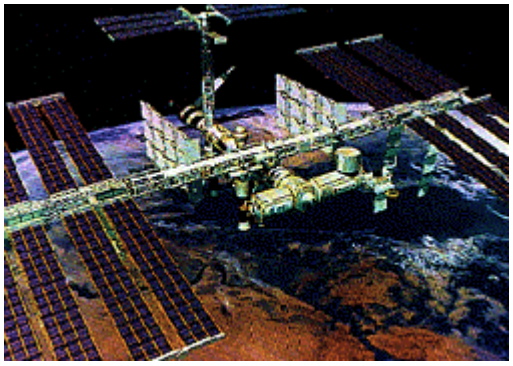
A month later the Boeing node was delivered by the Space Shuttle and attached to the FGB. In May 1998, the embryo space station grew with the addition of the Proton-boosted Russian Service Module, which provides life support and habitation facilities, utilities and thrusters. Shortly thereafter, the crew transfer vehicle - a Russian Soyuz TM capsule - was joined to the station. At this point, the station was able to accommodate long duration stays of three - person crews.

Further additions to the expanding station in the latter part of 1998 and early 1999 included one of the four U.S. solar array modules, which provides about 23 kilowatts of power; the U.S. laboratory module; the Canadian-built mobile servicing system; and a utilization flight bringing up equipment for outfitting the laboratory module.

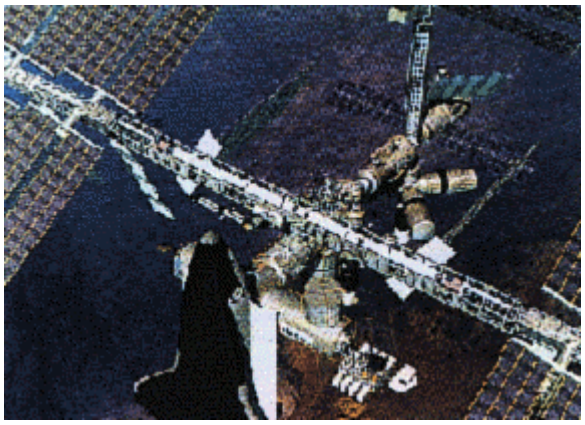
In April 1999, Phase II ended with the completion of assembly and outfitting of the interim human-tended configuration of the International Space Station. The large segment at the top is the 112-foot-long U.S. solar array module. The FGB is in the center of the photo; docked with it at far left is the Russian Service Module and below it the Soyuz TM crew transfer vehicle. At the right end of the station is the U.S. laboratory module and Node 1, a storage module. Atop the laboratory is the Canadian mobile servicing system.

In Phase II, the International Space Station progressed gradually from human-tended capability to its ultimate status as a fully operational permanent orbital research facility. Among key additions to the human-tended core configuration are the remaining modules of the U.S. solar array; the Japanese Experiment Module (JEM), delivered in 2000; the European Space Agency (ESA) laboratory, 2001; and the eventually a U.S. habitation module. Delivery of the habitation module has been delayed due to cost overruns. The U.S. is studying new designs to make maximum of the station.

Depending on design changes, the completed station will measure 361 feet from tip to tip of the solar arrays. That corresponds to the length of a football field, including both end zones; however, the area covered by the station complex is equal to that of two football fields. The pressurized living and working space is roughly equivalent to the passenger cabin volume of two 747 jetliners.



It is expected there will be seven laboratories. The U.S. is providing two of them, the basic laboratory module and a Centrifuge Accommodation Module. There will be three Russian research modules, the Japanese JEM and the ESA's Columbus Orbital Facility. The U.S., ESA and Japanese laboratories together provide 33 International Standard Payload Racks; additional payload space will be available in the Russian modules. In addition, the JEM has an exposed "back porch," with 10 mounting spaces for experiments that require long duration contact with the space environment; the JEM has a small robotic arm for mounting and moving back porch payloads.



The ESA module is visible to the left of the Orbiter, the JEM (marked NASDA) to the right. The central structure connecting the modules and the main solar power array is the U.S.-built integrated truss; generating a combined 92 kilowatts, the four modules of the power array rotate on the truss, maximizing their exposure to the Sun.

At the "rear" of the station assembly is the Russian service module. The vertical structure next to the service module is the Russian-built Science Power Platform (SPP) with its own solar array; the SPP provides additional power and heat rejection for science and operations. Just above the Orbiter's node, on the integrated truss, is the Canadian module servicing system with its 55-foot robot arm and a mobile transporter that enables it to move along the truss for robotic assembly and maintenance operations.

The International Space Station will operate at an altitude of 240 miles. At that altitude, minute drag forces will cause the station to lose height very gradually, so it will be necessary to reboost it every 90 days. The reboosting will be accomplished by the FGB.

Beginning with the 1997 launches of the Russian Proton and the Space Shuttle, there will be near five-dozen flights until fully operational status is attained. The Space Shuttle will make over two-dozen flights for assembly operations and utilization/outfitting. The Russian Proton and Progress, and Ukrainian Zenit launch vehicles will make over 40 flights; 19 of them will be made by the Progress vehicle, bringing up propellant for the

FGB's reboosting work. There will also be one flight of the Ariane 5 launch vehicle for delivery of ESA's Columbus module.

SPACE STATION IDENTIFICATION

The space station is a large human tended spaceship that orbits 335 460 kilometers (208-285 statute miles) above the Earth. This station is used as a permanent laboratory where astronauts live and work. In the near future, a crew of six will work 90 days and then another group will come to the station. The first crew will retum to Earth. NASA plans four trips each year. The whole station should be in place and operating in 2008.

Some of the most important parts of the space station are the truss, photovoltaic arrays, laboratory modules, nodes, habitat module and radiators. A description of these six parts follows:

A. A truss (trus) is a backbone like metal structure located on the outside of the station. The truss is used to suwort and connect other parts of the space station.
B. The photovoltaic arrays (pho~to~vol~ta~ic a~ray) are sets of solar panels grouped togeffler in big sheets. These arrays collect light rays from the Sun and use it to make electricity to power the '~'equipment and machines on the space station.
C. The laboratory modules (lab~ra~to~ry mod ules) are filled with most of the equipment used for studying processes, manufacturing materials, and doing experiments. Every day the astronauts will work in these modules. ~_
D. Nodes (nodes) attach one module to another, and they are used as passageways so that the astronauts can go from one module to another. The nodes are also used for some experiments and for storage ~
E. The astronauts will live in the habitat module (hab~tat mod~ule). They will **coolc, eat, clean, sleep,** bathe, exercise, and relax in this module. ~
F. A radiator (ra di~a tor) removes heat from the space station. Energy in the form of electricity from the photovoltaic arrays is used to perform work in space station.

~his s~ne ene~yy iis converted to heat during this work and must be removed or

the space station will become too hot to live in. (Energy in = energy out is an important and fundamental science concept).

Show NASA ISS Intro Video (11:33 min)

Mission Team Activity

ENGINEER YOUR OWN SPACE STATION
Materials and Tools:

An assortment of hard cardboard tubes (from towels)
PVC pipe connectors
2-liter soft drink bottles
one or two sheets of cardboard,
one or two sheets of aluminum foil,
sharp scissors,
glue
other materials (potted plant seeds, miniture model furnitures, etc.)

Procedures:

The Mission Team members should use creativity to design and build their own space station. Equip the Space Station with a laboratory, an equipment and supply storage unit, living quarters, and a solar array to power the Station. Try adding a robot arm to service all parts of the Station.

Connect plastic soda bottles with PVC joints, then cut the bottles and design the compartments. Add in boxes as lab modules and habitats, foil over cardboard for solar arrays, etc.

Mission Team Leader Notes:

Make sure the Galaxy Explorers are attaching the pieces of the habitat to form a space station. The ideal way to conduct this activity is to have teams build one component to be integrated with the rest of the other teams. **TEAM WORK IS AN ESSENTIAL PART OF THIS ACTIVITY**.