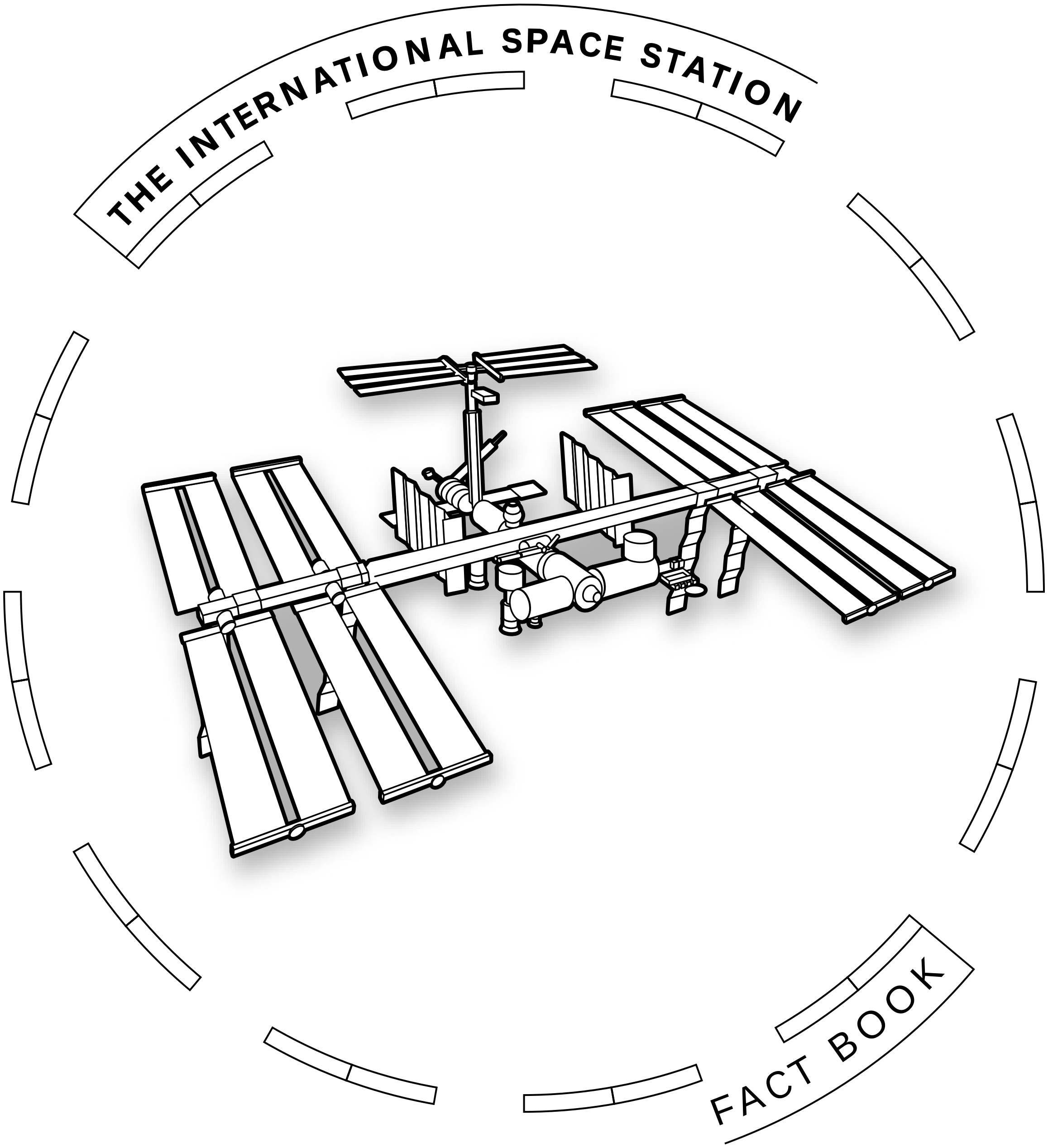
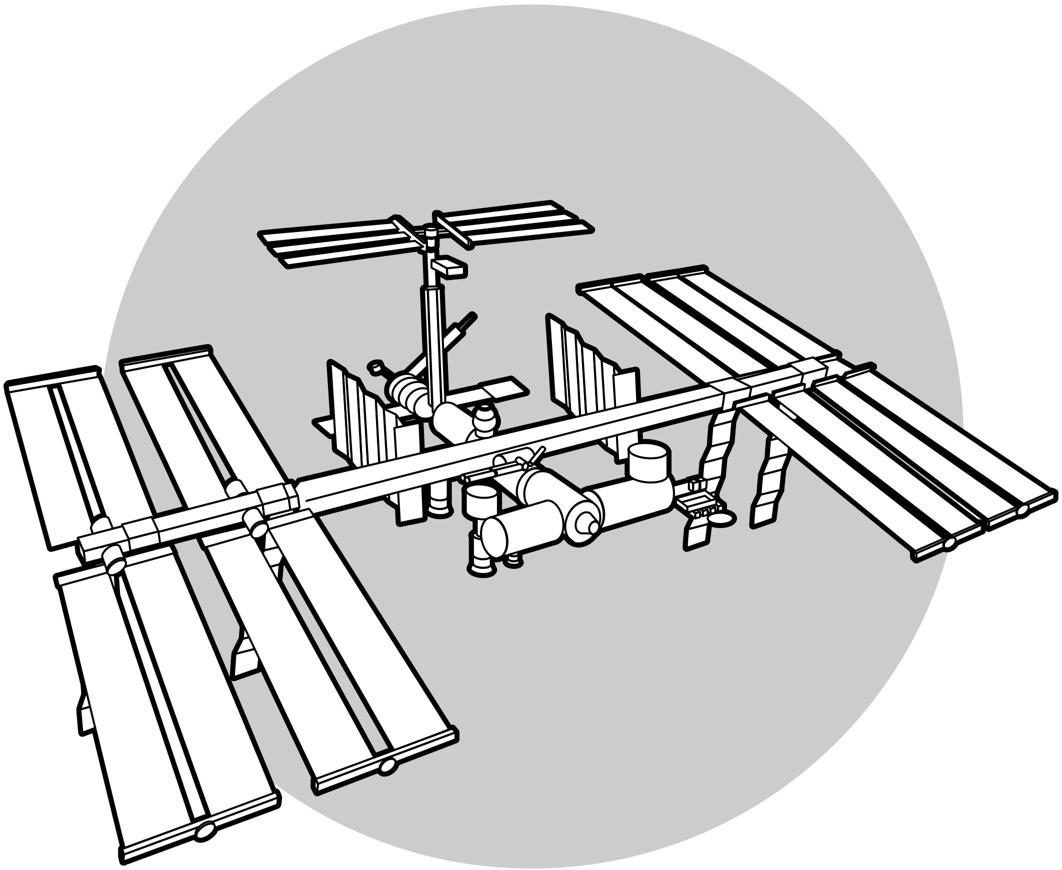


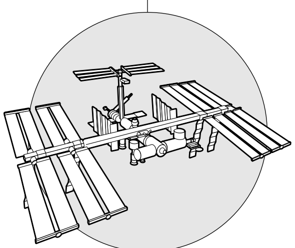
National Aeronautics and Space Administration

http://spaceflight.nasa.gov

March 2000



The International Space Station



On-Orbit

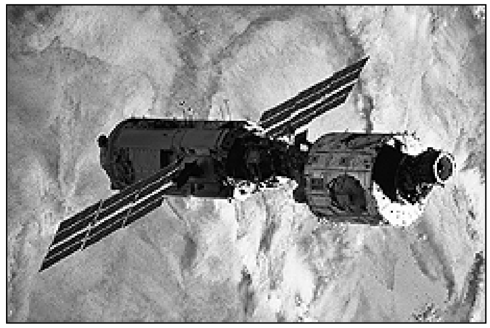
Assembly

Began in

1 9 9 8

Hardware

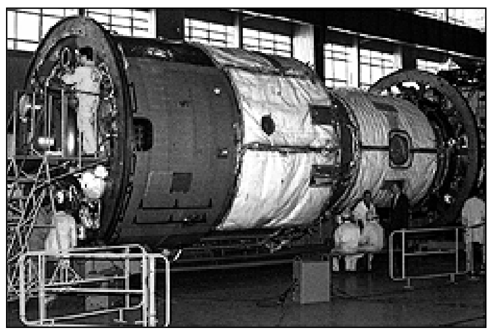
- Assembly on orbit of the International Space Station (ISS) began with the launch of the U.S.-owned, Russian-built Zarya control module on November 20, 1998, from the Baikonur Cosmodrome in Kazakstan.



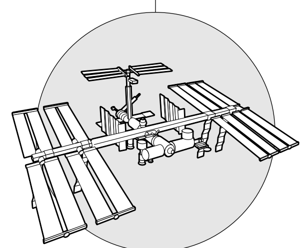
The attached Unity and Zarya modules.

- The launch of the Space Shuttle Endeavour from the Kennedy Space Center, Florida, followed on December 4, 1998, carrying the U.S.-built Unity connecting module. Endeavour's crew attached Unity and Zarya during a 12-day mission to begin the station's orbital construction.

- With the landing of STS-96, Flight 2A.1, NASA has successfully completed the first-ever visit to the ISS—transferring almost 2 tons of equipment and supplies



The Russian-provided crew living quarters, Zvezda.



- The third component, a Russian-provided crew living quarters and early station core known as Zvezda, is scheduled for launch Summer 2000. Zvezda, which means “Star” in English, arrived at the Baikonur launch site on May 20, 1999.

- The Prime Contractor is approximately 90 percent complete, and U.S. elements for the next 15 flights are now at the launch site.

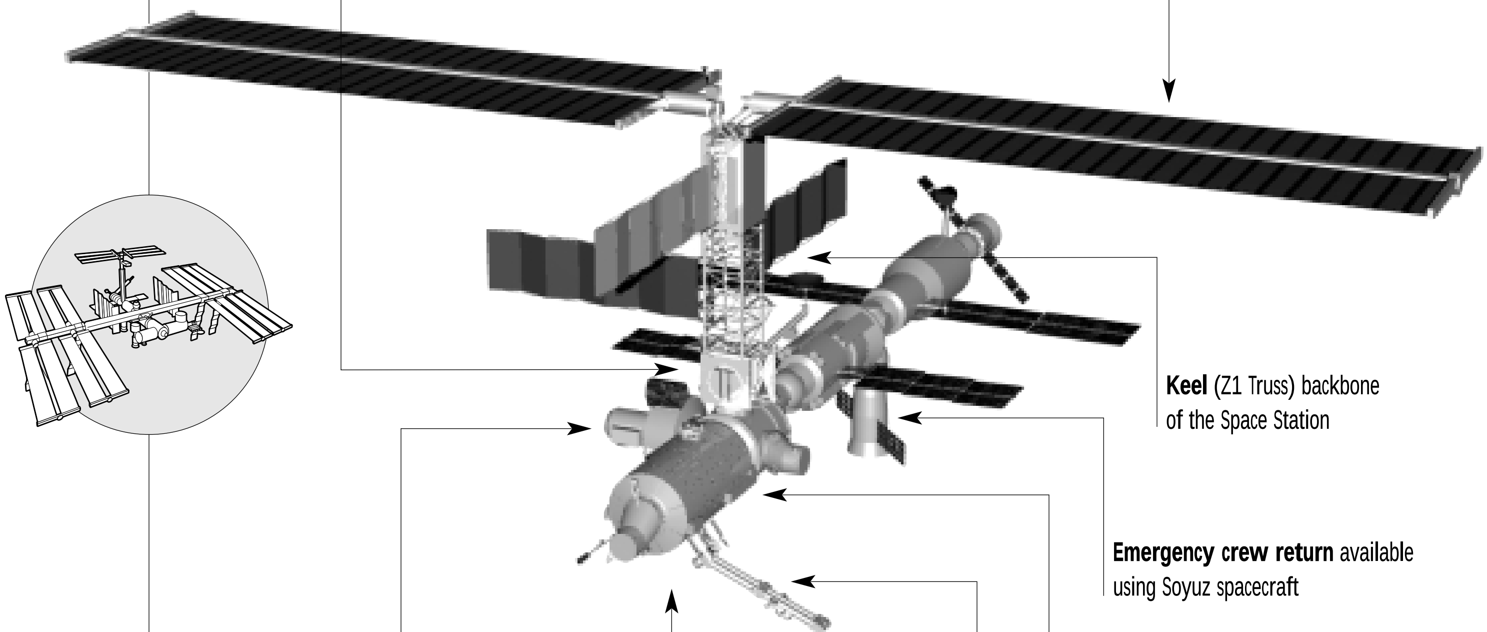
Crew

- The first five crews to live and work aboard the ISS have been selected and are actively training.

Early next year, an international crew of three will begin living and working aboard the International Space Station, starting permanent human presence aboard the outpost. The crew has been in training for the mission since late 1996 and includes International Space Station Commander Bill Shepherd, a U.S. astronaut; Soyuz Commander Yuri Gidzenko, a Russian cosmonaut; and Flight Engineer Sergei Krikalev, also a Russian cosmonaut.

The First Crew

On-Orbit Vehicle—One Year After Service Module Launch



Three-person crews rotate about every 90 days. Permanent human presence achieved.

Why a Space Station?

The mission of the International Space Station is to enable long-term exploration of space and provide benefits to people on Earth.

- *To create a permanent orbiting science institute in space capable of performing long-duration research in the materials and life sciences areas in a nearly gravity-free environment.*

- *To conduct medical research in space.*

- *To develop new materials and processes in collaboration with industry.*

- *To accelerate breakthroughs in technology and engineering that will have immediate, practical applications for life on Earth—and will create jobs and economic opportunities today and in the decades to come.*

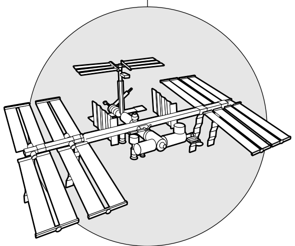
- *To maintain U.S. leadership in space and in global competitiveness, and to serve as a driving force for emerging technologies.*

- *To forge new partnerships with the nations of the world.*

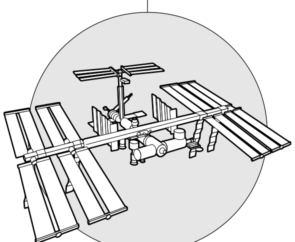
- *To inspire our children, foster the next generation of scientists, engineers, and entrepreneurs, and satisfy humanity's ancient need to explore and achieve.*

- *To invest for today and tomorrow. Every dollar spent on space programs returns at least $2 in direct and indirect benefits.*

- *To sustain and strengthen the United States' strongest export sector—aerospace technology—which in 1995 exceeded $33 billion.*



It's All About Life on Earth . . . and Beyond

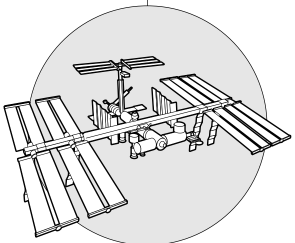


Leadership	Space Station is one of the most exciting and challenging international programs leading the world into a new millennium and providing inspiration for future generations.
Research	Space Station will be a unique world-class laboratory providing an international platform for advances in science and technology.
Business	Space Station will enable the creation of new commercial enterprises that can use the environment, technologies, and research applications of space to build profit-based private business.
Education	Space Station serves as a virtual classroom in space to the benefit of educators and students alike.
Exploration	Space Station is the gateway to human space exploration and meets the deep-seated need of people throughout history to explore the unknown, to understand their world and the universe, and to apply that experience for the benefit of all here on Earth.

- U.S.-led, single largest international aerospace project ever undertaken by humankind.
- Assembly involves complex on-orbit operations and unprecedented hardware/software integration.
- Fosters peaceful relations among the 16 participating countries by building trust and sharing mutual goals for the benefit of all peoples.
- An international human experiment—an exciting "city in space"—a place where we will learn to live and work "off planet" alongside our international partners.

- Provides the only laboratory minimizing the effects of gravity where long-term scientific research can be carried out.
- Research will help fight diseases such as influenza, diabetes, cancer, osteoporosis, and AIDS.
- Low-gravity environment unmasks fundamental processes that will lead to new manufacturing processes and products to benefit life on Earth.
- Provides a unique space platform to better observe and understand our Earth's environment and the universe in which we live.

- Creates unique opportunity for the private sector to conduct research on tomorrow's products today.
- Allows for international cooperation while also promoting technological leadership and international economic competitiveness.
- Provides an engineering testbed for commercial and exploration systems and technologies.
- Opens new frontiers for business development and entrepreneurial spirit.
- Provides needed, quality jobs around the globe and creates a wide range of science and technology career opportunities for today's youth, preparing them for a knowledge-based economy.



- Inspires in a new generation a sense of wonder and inquisitiveness about the world and the universe in which they live.
- Supports educators in stimulating students in the study of science, mathematics, technology, engineering, and geography.
- Students and educators will not only benefit from the knowledge gained by researchers aboard the International Space Station, but will be able to actively participate in that research.

- Provides the foundation for the future exploration and development of space.
- Allows the study of long-term effects of weightlessness on the human body and testing of new technologies for application to future human space exploration.
- A testbed to understand and adjust our home methods before sending humans to Mars and beyond.
- Allows critical technology research in fluids, combustion, life support systems, and the radiation environment, which is needed for future human space exploration away from Earth.

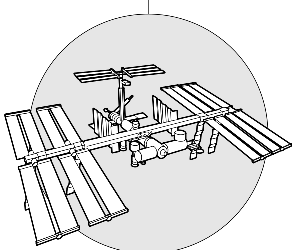
Medical Research and the Life Sciences

The early space program and experiments conducted on the Space Shuttle have made remarkable contributions to medical research and the study of life on Earth. The Space Station is the next step: a permanent orbiting laboratory.

- The Space Station will provide a unique environment for research on the growth of protein crystals, which aid in determining the structure and function of proteins. Such information may greatly enhance drug design and research in the treatment of diseases.

- Biomedical experiments on the Space Station may contribute new insights into human health and disease prevention and treatment, including heart, lung, and kidney function, cardiovascular disease, osteoporosis (bone calcium loss), hormonal disorders, and immune system function.

- Space Station research will build on the proven medical research already conducted on the Space Shuttle. The Space Station will enable long-term research with multiple subjects among the crew.



- Research equipment developed for the Space Station is already paying dividends on the ground. Scientists are growing cancerous tumor samples in NASA's new cell-culturing device so that tumors can be studied outside the body, without harm to the patient.

- Medical equipment technology and miniaturization techniques developed for the early astronauts are still paying off today, 30 years later. For example:
  - NASA developed a "cool suit" for the Apollo missions, which is now helping to improve the quality of life of multiple sclerosis patients.
  - NASA technology has produced a pacemaker that can be programmed from outside the body.
  - NASA developed instruments to measure bone loss and bone density without penetrating the skin, which are now being used by hospitals.
  - NASA research has led to an implant for delivering insulin to diabetics that is only 3 inches across, which provides more precise control of blood sugar levels and frees diabetics from the burden of daily insulin injections.

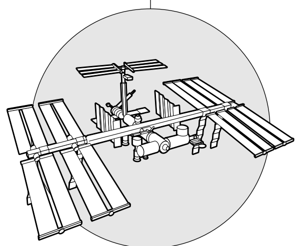
- Space Station will provide a laboratory for long-term studies of the effects of the space environment on terrestrial organisms that will provide unique information about biological processes and systems. This knowledge can be applied to support future space flight activities and to scientific and medical questions on Earth.

Technology and Engineering for the Future

The race to the Moon required great advances in engineering and technology that still fuel our economy today. The Space Station will be a testbed for the technologies of the future, as well as a laboratory for fundamental and applied research.

- Experimental research in combustion science, fluid physics, and materials science in the near absence of gravity produces new insights into industrial processes that cannot be replicated on Earth. Space Shuttle experiments to study metal alloy solidification in space could lead to making lighter, stronger superalloys. A better understanding of the combustion process can lead to energy conservation on Earth. A 2-percent increase in burner efficiency for heaters would save the United States $8 billion per year.

- The Space Station will be an industrial research and development laboratory to test lower cost heating and cooling systems, long-life power converters, safer chemical storage and transfer processes, air and water purification systems, waste management systems, and recycling systems. Advances in environmental controls on the ISS will have a direct application to environmental improvements on Earth.



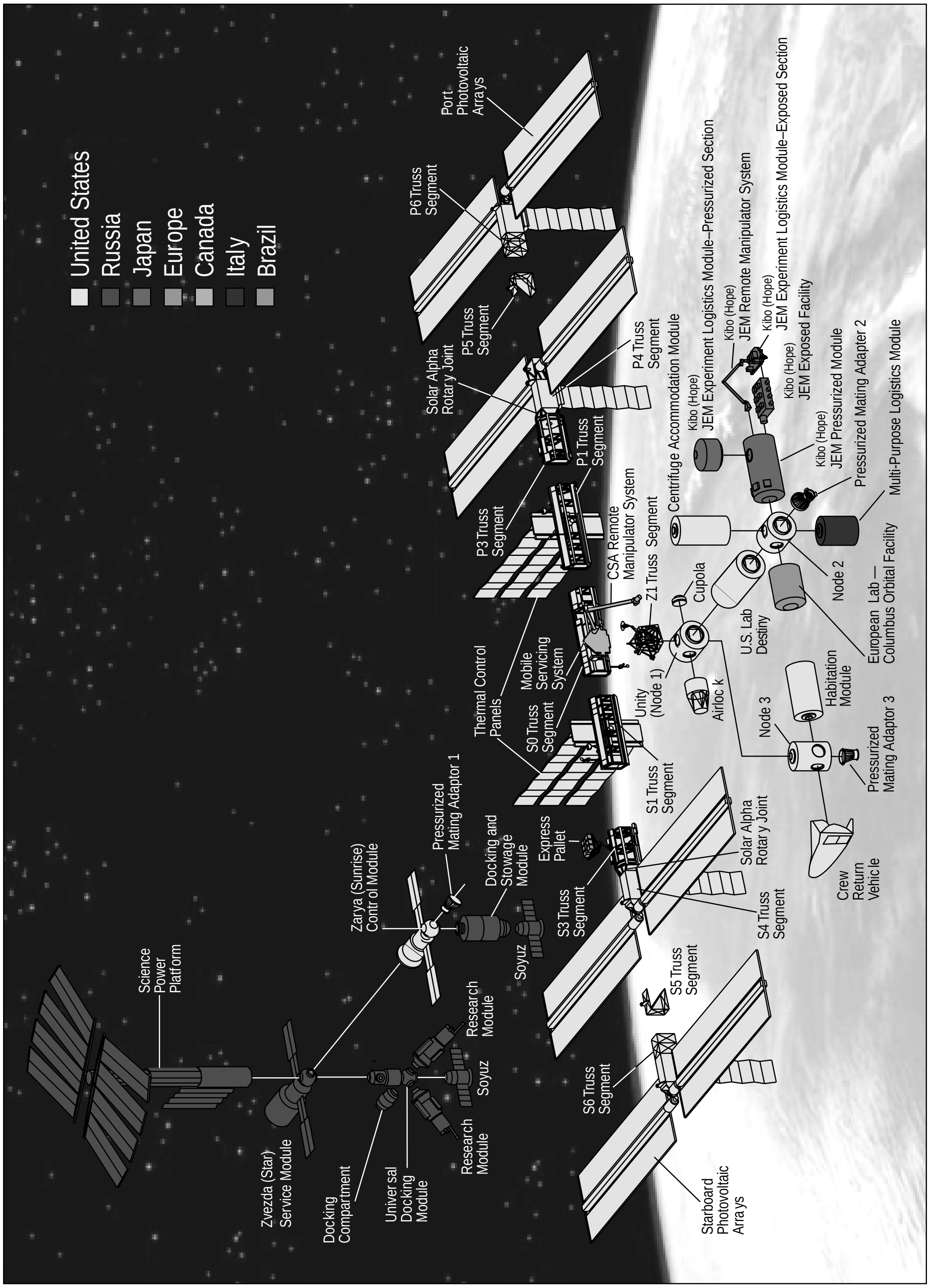
- Telerobotic and robotic systems validated on the Space Station will increase human efficiency in space and result in reliable, low-maintenance robots for industry and commercial purposes on Earth.

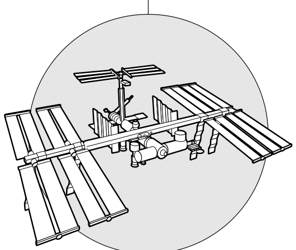
- Research on large space vehicles will lead to improved computer software for developing new, lightweight structures, such as antennae and solar collectors, with precision pointing accuracy. Such developments stand to benefit the communications, utility, and transportation industries.

- Similar to the Apollo program before it, the Space Station will be a proving ground for advances in communications, computers, and systems integration. The International Space Station program will use telepresence, telescience, expert systems, and communications and data integration on an unparalleled scale.

- Space Station facilities with the near absence of gravity will permit researchers to study materials that could not exist and processes that could not take place in full Earth gravity. These materials include polymers for everything from paint to contact lenses, semiconductors for high-speed computers and electronics, high-temperature superconductors for efficiency in electrical devices, and crystals for medical research use.

International Participation





A New Era of Peaceful Cooperation

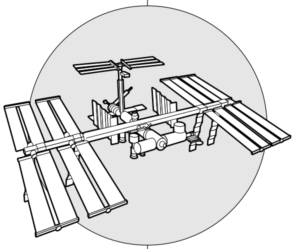
As the world redefines itself in the wake of the Cold War and moves into the new millennium, the Space Station is a catalyst for international cooperation and a powerful symbol of U.S. leadership in a changing world. The Space Station:

- Continues the largest scientific cooperative program in history, drawing on the resources and scientific expertise of 16 nations: the United States, Belgium, Brazil, Canada, Denmark, France, Germany, Italy, Japan, Netherlands, Norway, Russia, Spain, Sweden, Switzerland, and the United Kingdom.

- Helps to focus the aerospace industry of Russia and other countries on nonmilitary pursuits to reduce the risk of nuclear proliferation and slow the traffic in high-technology weaponry to developing nations.

- Will provide international commercial opportunities for U.S. companies.

- Taps into the Russians' vast experience in long-duration space flight to benefit the international partnership.



- Serves as a symbol of the power of nations to work together on peaceful initiatives and offers a test case for building mutual trust and shared goals.

- Demonstrates that former adversaries can join forces in a peaceful pursuit at a fraction of the cost of the arms buildup in the Cold War era.

- Draws significant financial support from the partner nations, which will collectively add more than $10 billion to the U.S. contribution. The partners from Russia, the European Space Agency, Canada, and Japan have already expended more than $6 billion on their development programs.

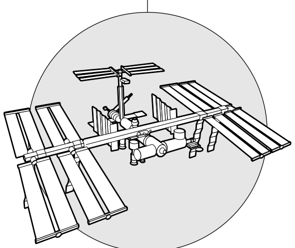
Inspiration and Investment in the Future

The Space Station will inspire a new generation of Americans to explore and achieve, while pioneering new methods of education to teach and motivate the next generation of scientists, engineers, entrepreneurs, and explorers.

- Space science is a catalyst for academic achievement. Enrollment trends of U.S. college students majoring in science and engineering track closely with the funding trends of the U.S. space program.

- NASA is a leader in the development of virtual reality and telepresence technologies, giving students many of the benefits of actually being on the Space Station and interacting with real astronauts.

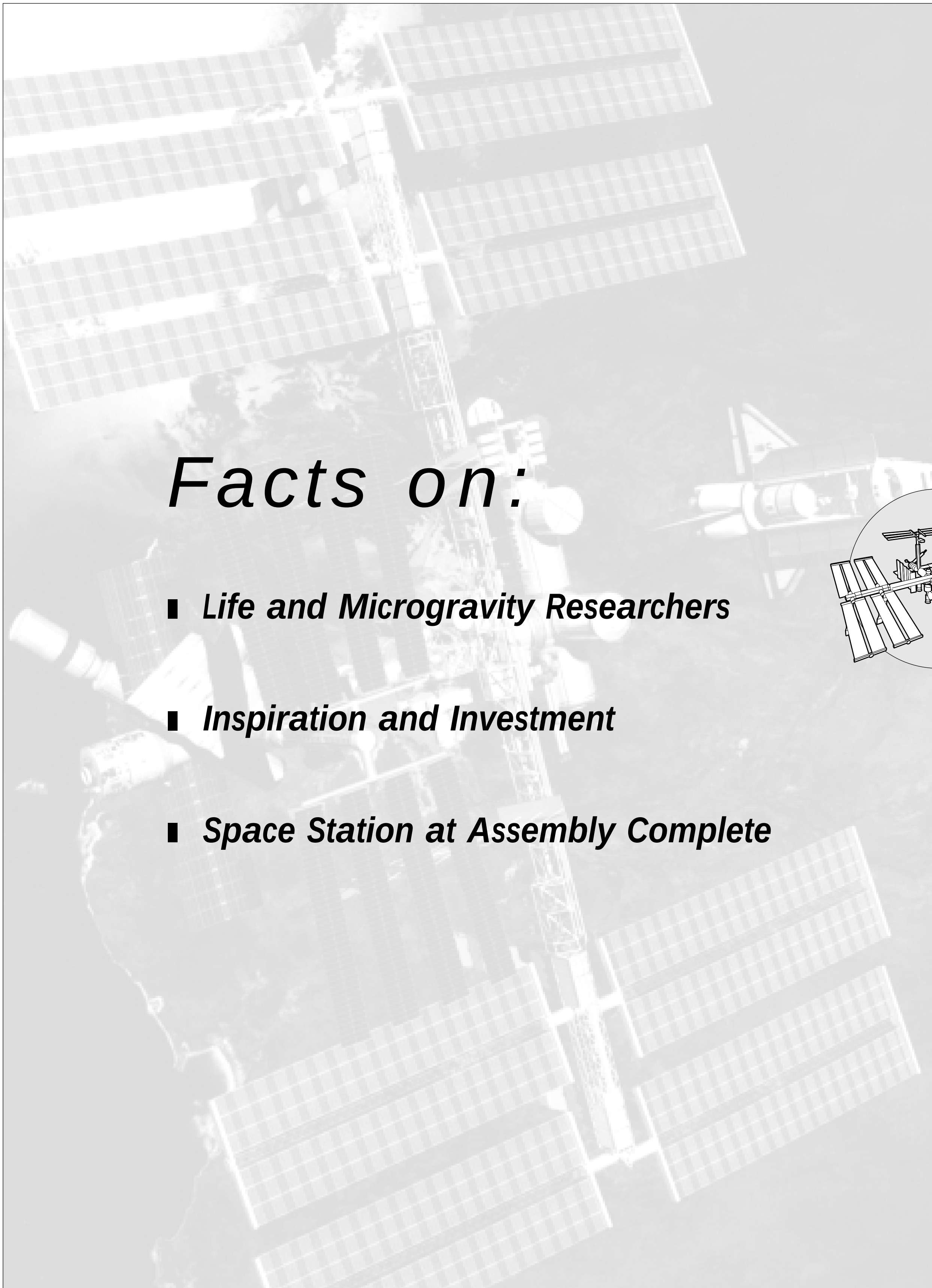
- Astronauts and cosmonauts serve as role models, capturing the imagination of future leaders and encouraging more students to study science and engineering.



- In addition to lessons from space, students of the future will have experiments on the Space Station and will conduct them from their classrooms on the ground. Students will transmit and receive data, manipulate equipment remotely, and evaluate the experiments through data interpretation.

- With the new international focus, students will absorb broad lessons in the value of cooperation as we work with partners in Russia, Europe, Japan, and Canada.

- Teachers and communities across the nation are already using Space Station concepts in the classroom. NASA receives unsolicited drawings and models of the Space Station by students of all ages. Communities and states conduct “Space Week,” during which students live in a bus outfitted as a Space Station.



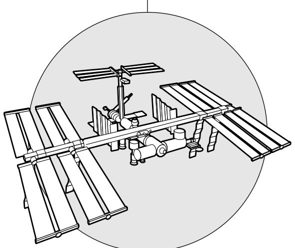
Facts on:

- ***Life and Microgravity Researchers***
- ***Inspiration and Investment***
- ***Space Station at Assembly Complete***

Facts on Life and Microgravity Researchers

Statistics (1999 estimates)

- There were about **872 funded investigations** in 1999.
- Investigators represent more than **100 institutions of higher learning** and more than **40 laboratories** and other institutions in **41 states and the District of Columbia.**
- More than **2,000 students** were supported through NASA research in 1999.
- Life and microgravity researchers published about **1,500 journal articles** in 1999.
- There were more than **1,200 new research proposals** received in 1999.
- NASA's collaboration with industry made progress through the Commercial Space Centers (CSC) during Fiscal Year 1999. Industry investment in CSC's was estimated at over $50M, and 159 industry affiliates participated in the CSC program.



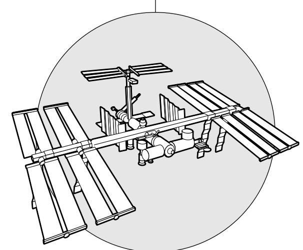
Background

- Life and microgravity science research is solicited through an open, highly competitive, peer-review process to ensure that the most meritorious science gains access to orbit.
- Historically, NASA's resources have allowed the agency to accept only about the top fifth of the proposals it receives for life and microgravity research. This level of selectivity is comparable to that of other major U.S. science funding sources, such as the **National Institutes of Health** and the **National Science Foundation.** Only 10–20 percent of these accepted proposals lead to flight experiments, so selection for flight is even more competitive.
- Because of the great demand for limited orbital research opportunities, NASA selects research for flight opportunities only if it cannot be conducted on Earth. Flight research is selected from and supported by a larger research effort on the ground.
- NASA is fully committed to its close working relationship with the scientific community and to full access to NASA facilities for the most meritorious scientific research. NASA works with the scientific community through its advisory committees and subcommittees, the **National Research Council,** and working groups of distinguished scientists.

Facts on Inspiration and Investment—Today

Astronauts

- Astronauts make thousands of appearances each year all over the world.
- Eighteen percent of the active members of the astronaut corps are women.
- Col. Guion S. Bluford, USAF, was the first African-American in space (1983).
- Dr. Sally K. Ride was the first American woman in space (1983).
- Lt. Col. Ellison S. Onizuka, USAF, was the first Asian-American in space (1985).
- Dr. Franklin R. Chang-Díaz was the first Hispanic-American in space (1986).
- Col. Eileen Collins, USAF, was the first female Space Shuttle pilot (1995).
- Shannon Lucid broke the endurance record for an American in space (188 days) and the world record for a woman in space, which included her stay aboard the Mir Space Station from March to September (1996).
- More than 36 years after he made history as the first American to orbit Earth, John Glenn returned to space to continue science investigations into the effects of space on the human body.

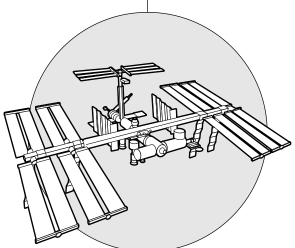


Education (http://education.nasa.gov)

- Aerospace Education Services Program
  - A nationwide program designed to enhance educator awareness and understanding of scientific research and technological development.
  - Uses NASA's unique assets to support local, state, and regional curriculum frameworks, as well as existing and emerging national education standards.

- NASA Student Involvement Program
  - A national program of investigations and design challenges.
  - Provides opportunities for students from kindergarten through secondary school.
  - Links students directly with NASA's diverse and exciting mission of research, exploration and discovery.

- Urban Community Enrichment Program
  - Provides urban youths with greater exposure to aerospace topics in an interdisciplinary manner.
  - Raises awareness of multi-cultural contributions to aerospace.
  - Fosters greater student awareness of careers in mathematics, science, and engineering.
  - Increases teacher and community awareness of NASA resources and technical assistance programs which can be used as a supplement to the existing curriculum.



- NASA Educational Workshops for Teachers
  - Model the integration of the national standards in mathematics, science, technology and geography.
  - Provides educators with an opportunity to observe NASA's state-of-the-art research and development through direct interaction with NASA scientists, engineers, technicians, and educational specialists at a NASA Field Center.
  - Incorporates activities into the workshop to help educators adapt their new content knowledge, experience, and materials into their specific educational situations.

Americans and the Space Program

- The National Air and Space Museum averages more than 9 million visitors per year.

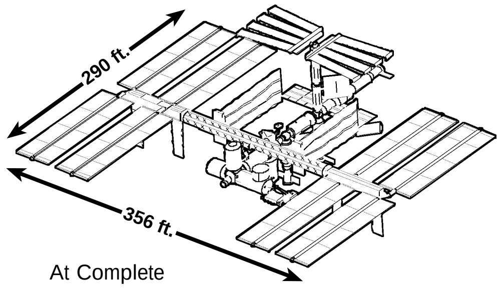
- NASA operates hundreds of traveling exhibits each year, which are attended by millions of people.

- Millions of people visit NASA Visitor Centers every year.

Facts and Figures at Assembly Complete

Statistics

	Current Stats		
	Today	Percent	At Complete
Weight (lbs)	74,000	7.4%	~1 Million
Volume (cf)	5,045	12.0%	43,000
Power (kw)	2	1.4%	110
Atmosphere (psi)	14.7	yes	14.7
Inclination (degrees)	51.6	yes	51.6
Altitude (miles)	220	yes	220
Crew (persons)	0	0.0%	7
Assembly Flights	3	4.3%	46



At Complete

Hardware

- **"Zarya" ("Dawn")—Control Module**—launched on a Proton vehicle on November 20, 1998. Provides early propulsion and power.

- **Russian Zvezda Service Module**—launch on a Proton vehicle scheduled for Summer 2000. Provides early living quarters, life support, attitude control, and reboost capability.

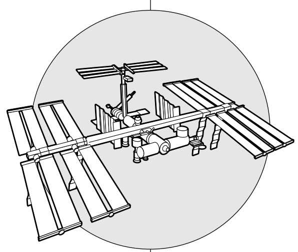
- **Canadian Mobile Servicing System**—includes a 55-foot robot arm with 125-ton payload capability, as well as a mobile transporter, which can be positioned along the truss for robotic assembly and maintenance operations.

- **Six Laboratories**
  - Two U.S.—a laboratory and a Centrifuge Accommodation Module (CAM)
  - One European Space Agency (ESA) Columbus Orbital Facility (COF)
  - One Japanese "Kibo" Facility
  - Two Russian Research Modules

- **U.S., European, and Japanese laboratories**—together provide 33 International Standard Payload Racks; additional science space is available in the two Russian Research Modules.

- **Japan's JEM**—has an exposed platform, or "back porch," attached to it, with 10 mounting spaces for experiments, which provide direct contact with the space environment. The JEM also has a small robotic arm for payload operations on the exposed platform.

- **U.S. Habitation Module**—contains the galley, toilet, shower, sleep stations, and medical facilities.



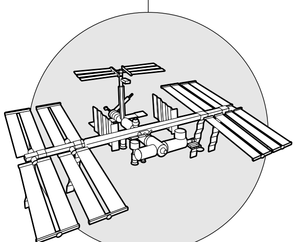
Facts and Figures at Assembly Complete (continued)

- **Three U.S. Nodes**—Node 1 ("Unity") is for storage space only; Node 2 contains racks of equipment used to convert electrical power for use by the international partners. Node 3 will house life support equipment. The nodes are also the structural building blocks that link the pressurized modules together.

- **Total Pressurized Volume**—approximately 43,000 cubic feet

- **Power**—110-kilowatt average (46-kilowatt average for research, with the Russian segment producing an additional 14 kilowatts for research). There are four large U.S. photovoltaic arrays; each array has four modules, each approximately 112 feet long by 39 feet wide. Each array generates approximately 23 kilowatts. The arrays rotate to face the Sun, providing maximum power to the Space Station.

- **External Sites**—four locations on the truss for mounting experiments intended for looking down at Earth and up into space or for direct exposure to space.



- **Three Italian Multi-Purpose Laboratory Modules (MPLMs)**—carries all the pressurized cargo and payloads launched on the Space Shuttle. Each module is capable of delivering 16 International Standard Payload Racks.

- **Emergency Crew Return**—Initial emergency crew return capability for ISS will be provided by a three-person Russian Soyuz capsule. Once the ISS achieves six-person capability, a second Soyuz will be provided until the U.S.-built Crew Return Vehicle (CRV) becomes available. The CRV is based on NASA's X-38 lifting body parafoil lander and will provide automated seven-crew return capability.

- **Progress Cargo Vehicles**—carry reboost propellant and dry cargo (up to 6,600 pounds) to the Space Station.

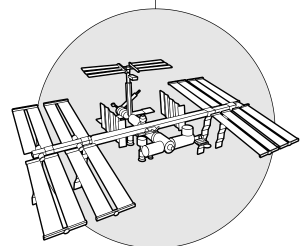
- **Transfer Vehicles**—carry reboost propellant and supplies to the Space Station. The European-developed ATV will be launched by Europe's Ariane-5; the Japanese-developed HTV will be launched by Japan's H-II.

- **Brazil**—providing the Unpressurized Logistics Carrier (ULC), EXPRESS Pallet, Z1 Attachment Site, Cargo Handling Interface Assemblies (CHIA), Window Observation Research Facility (WORF), and Technology Experiment Facility (TEF).

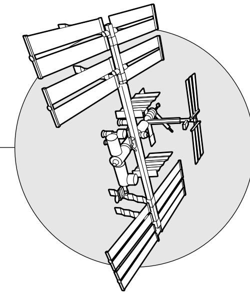
Program Funding

FY 1994–1999 (Development, Operations, Research)	$12.9
Cost to Go FY 2000–August 2004 (Development Complete)	7.4
Vehicle 1.8 Operations 3.5 Research 2.1	
Russian Program Assurance (FY 1997–August 2004)	1.3
Crew Return Vehicle (FY 2000–August 2004)	.3
NASA Estimate for Development (range)	**22.9–24.7**
Anticipated 10-year Operations*	13.0
Total Cost	**35.9–37.7**

* 10 year operations cost estimate is under review



All numbers are in billions of RY$



Assembly Sequence (as of 3/2000)

Calendar Year	1998	1999	2000	2001	2002	2003	2004	2005
Launch Summary	2	1	5	7	8	9	13	8
Shuttle Launches*	**1**	**1**	**4**	**7**	**6**	**6**	**6**	**7**
Assembly	(1)	(1)	(4)	(6)	(5)	(5)	(4)	(5)
Utilization	(0)	(0)	(0)	(1)	(1)	(1)	(2)	(2)
Russian Assmebly Launches**	**1**	**0**	**1**	**1**	**0**	**2**	**2**	**1**

Major Milestones	
"Zarya" (FGB) *1st element launch*	11/98
"Unity" (Node1) *1st U.S. element launch*	12/98
"Zvezda" Service Module	7/00
Soyuz 3-Person Permanent	10/00
U.S. "Destiny" Lab launch	1/01
Canadian Robotic Arm launch	4/01
U.S. Airlock launch	4/01
Utilization Flights	8/01, 1/02, 10/03, 1/04, 6/04, 6/05, 7/05
Japanese Kibo launch	9/03
ESA Laboratory launch	10/04
6-Person Crew Capablity	2/05
Russian Research Modules	to be scheduled
U.S. Hab Module launch	9/05

* Shuttle launches of partner elements are included in U.S. Assembly line (Japan's Kibo, ESA's COF, Canadian SSRMS, Russian SPP).

** Russian Assembly Launches excludes logistics, resupply, and crew exchange flights.

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