The International Space Station: ALPHA !!

Construction of the International Space Station, nicknamed Alpha, continues. The mission of the ISS is to "enable long-term exploration of space and provide benefits to people on earth."[1] NASA says the new station will also help to maintain U.S. leadership in space and in global competitiveness…to create jobs and economic opportunities today and in the decades to come…and to sustain and strengthen the United States strongest export sector—Aerospace technology. The ISS will act as an orbiting science institute performing long-duration research materials and life sciences and medical research.[2] It will also accelerate "breakthroughs in technology and engineering that will have immediate and practical application on Earth."[3] Just as important, the ISS will develop new partnerships with the nations of the world. This is important because the technological and medical breakthroughs that will occur will not just benefit the US, but the world community as a whole. It is in the international community's best interest to partner in this effort.

The station is in a 51.6 degree inclined orbit with an altitude of 250 statute miles. It provides excellent Earth observations with coverage of 85 percent of the globe and overflight of 95 percent of the population.[4] The ISS, call sign: Alpha, will be four times the size of MIR when completed, and will have a mass of over 1 million pounds. It will measure 360 feet across and 290 feet long, and will have almost an acre of solar panels to provide power to six state of the art laboratories.[5] A soyuz rocket launched the first full time crew, Expedition 1, from the Baikonur Cosmodrome on 31 Oct 2000. It is scheduled to be permanently occupied with up to a crew of seven, for at least the next ten years!

The most significant contributions to the ISS will come from those that have the most experience to offer: the US and the Russians. The Russians have the heavy lift capability to boost the largest portions of the ISS to orbit. But they also have "vast experience in long-duration space flight" and contribute a tremendous amount of expertise to the effort.[6] The Americans, on the other hand, have a vehicle that can not only lift considerable payloads to orbit, but will be used on a routine basis and will be the workhorse of the effort (yes, the shuttle). But the Americans also bring the pocketbook. The ISS is tremendously expensive, with the ultimate price tag of @ $37 billion when it is completed. So it is in our best interest to try to "share the cost" as much as possible. The following table outlines the cost of the ISS:

Development Cost	1998 & Prior	Cost to Go	Total Cost
Development	8.9	3.1	12.0
Operations	0.8	4.0	4.8
Research	1.1	2.2	3.3
Russian Program Assurance	0.3	0.9	1.2
Crew Return Vehicle	0.0	0.8	0.8
Subtotal - Development Complete	11.1	11 to 13	22 to 24
	(cost commitment is a range)		

Mature Operational Costs
Anticipated 10-year life (estimated to be $1.3 per year x 10 years) = $13 total.
Total End of Program Cost estimate: Range of $35 to $37 billion

All numbers are in billions of RY$s

Our partners will be contributing over $10 billion to this effort. In fact, Russia, the European Space Agency, Canada and Japan have already expended more than $6 billion on their development programs.[7] The ISS truly is the "largest scientific cooperative program in history" and will be supported by the resources and expertise of 16 nations.[8] In additional to the countries listed above, the following countries will also participate: Belgium, Brazil, Denmark, France, Germany, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom. Having laid the groundwork for international participation, we will now turn to some of the more significant contributions the partner nations will make.

To fully assemble the ISS, three Proton, 37 space shuttle, and more than 50 Soyuz launches will occur over the five and one-half year assembly phase.[9] Additionally, the European Space Agency and Japan are planning to launch scientific payload modules as part of the assembly process. American and Russian astronauts are planning on over 1700 hours of space walks conducting assembly and maintenance activities. On-orbit crew time has been allocated as follows: US: 48.9%, Russia: 30%, Japan: 12.8% and Europe: 8.3%.[10]

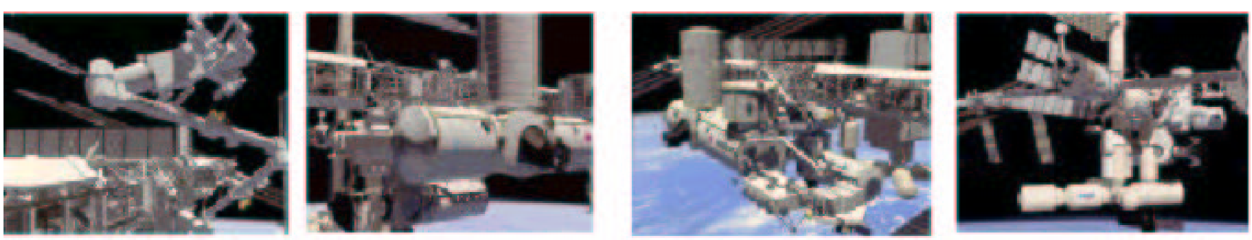
Russian launched the first station component, Zarya, on 20 Nov 1998. The $235 million module was used initially for attitude and control, and contains 16 external propellant tanks and will hold over 6.1 metric tons of propellant.[11] The Russians also launched the $300 million Zvezda service module on 12 July 2000. Its launch was delayed over a year due to software problems as well as launch delays.[12] Russia also plans on providing Docking Compartment 1 in 2001, a Universal Docking Module in 2002, the Science Power Platform in June, 2002, and two Research Modules in the 2004-2005 timeframe. Russian budget limitations could hamper the deployment of these component. The draft Russian budget for space for 2001 was 3.49 billion rubles, but 8.35 billion are required to properly fund space-related activities.[13]

The US launched the $300 million Unity module, a multi-hatch node, on the shuttle on 4 Dec 1998, and connected it to Zarya. The Unity module was a critical piece of the puzzle because it contains 4 additional ports that other ISS components will attach to. Other significant components recently launched by the shuttle were the Z-1 truss assembly in October, 2000 and the P6 integrated truss and the first main solar array (one of eight costing $450 million) in

November 2000. Many other components will be launched by the shuttle, to include the $1.4 billion Destiny laboratory, which successfully launched on the orbiter Discovery on 7 Feb 01.

Canada will be responsible for providing the Space Station Remote Manipulator System (SSRMS), which will be a 17 meter robotic arm capable of being located anywhere on the station. It will be able to move objects up to 100 tons in zero g. They will also be providing a Special Purpose Dexterous Manipulator (SPDM) and a Remote Service Base. The SPDM will be a two-arm robot that will carry out some space-walk tasks, and the service base will transport hardware along the truss structure. The SSRMS passed integration testing in September 2000 and is scheduled to be launched in April 2001.[14]

The Japanese are currently working on an Experiment Module (JEM) and Centrifuge Assembly Module (CAM) for the ISS. The JEM will hold 23 equipment racks for experiments, an experiment logistics module and an exposed storage platform. The JAM will contain a centrifuge facility and a Gravitational Biology Facility. The JEM is planned to be launched in late 2002, and the CAM in 2006.[15] The following figure depicts various partner segments:



Canadian Robotics *ESA Columbus Lab* *Japanese Lab* *Russian Segment*

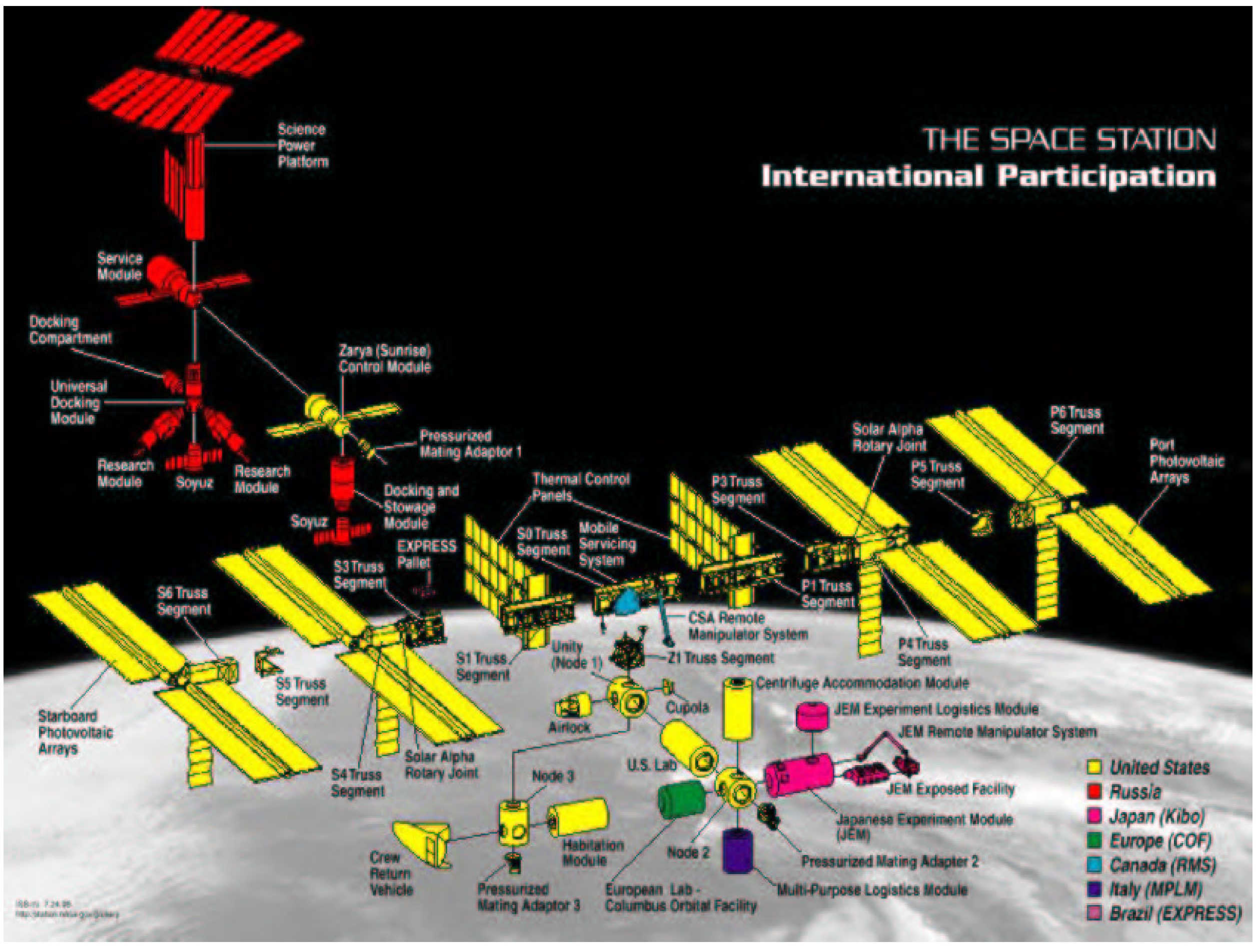
Germany will be providing the Columbus Orbital Laboratory, due to be launched in October, 2003. The structure is based on the Multi-Purpose Logistics Module (MPLM) and will contain the European Physiology Module. It is estimated to cost $672 million.[16]

Italy will be providing three MPLMs, dubbed Leonardo, Raffaello and Donatello. Each 4,080kg module will hold up to 9,070kg of cargo, and will cost approximately $135 million.

Italy is also working on a cupola, to be used as an observation tower. It will be 2 meters in diameter and 1.5 meters high and has six lateral windows and a skylight! Leonardo is due to be launched in February 2001, and the cupola is supposed to launch in May 2004.[17]

Brazil has pledged $20 million to support the funding for an Express Pallet and a Technology Experiment Facility. The Express Pallet is planned for launch in 2003.

The following figure visualizes the contributions of out international partners.



In additional to this on-orbit hardware, France is also building an Automated Transfer Vehicle (ATV) to be launched on an Ariane 5. This vehicle will be capable of carrying 9 metric tons of supplies to the ISS. The vehicle will dock with the Russian service module and can be used to boost the station's orbit. At the end of its life, it will be filled with trash and burned up when it deorbits. There are proposed contract for 7-11 ATVs at $70 million each, and 8-12 Ariane 5s, at $115 million each.[18]

Some of our international partners will also support operations through the use of their ground stations. In addition to the stations at the Johnson Space Center and the Russian mission Control Station, operations will be conducted from Oberfafenhoffen, Germany, at the Columbus Orbital Facility Control Center, St. Hubert, Quebec, at the Mobile Servicing Systems Operations Complex, Toulouse, France, at the Automated Transfer Vehicle Control Center, and Tsukuba, Japan, at the Tsukuba Space Center.[19]

There is no question, however, that the United States is taking a leading role with continued ISS development. As the ISS continues to take shape, the U.S. will be launching even more advanced and complex modules for research. Plans include the U.S. Laboratory Module, which will contain a $75 million Fluids and Combustion Facility (FCF), and is due to launch in 2003. It will accommodate up to 30 microgravity experiments per year and will be operated remotely from the Glenn research Center. This module will also contain three Material Science Research Racks (MSRRs), to be used for microgravity experiments.[20] NASA also continues to develop the Habitation Module. It will be based on a Transhab inflatable module, built from layers of polyurethane foam. Recent funding cuts has slowed the development of this project.

NASA continues work on the Crew Return Vehicle (CRV). It will be a ‘lifeboat’ attached to the station in the event an emergency evacuation becomes necessary. Four CRVs will be built, designed to carry seven astronauts. They are based on the X-38 experimental vehicle and will cost @ $500 million for the four. Recently, nine ESA governments have pledged $116 million to the development of the new version of the CRV.[21]

By the time of its completion, the International Space Station will be considered the eighth wonder of the world. By far the most complex international scientific project in history, it is being built with the help of 16 nations—a truly world-wide effort to promote the future of scientific exploration. Following in the footsteps of Mir, this next step in space exploration will significantly increase our knowledge of operating in the space environment, and facilitate the next ‘giant leap’, the colonization of the moon and manned exploration of Mars. The incredible amount of experimentation that will take place on the station will lead to new breakthroughs in science, breakthroughs that we can scarcely comprehend at the moment. These advancements in science will not just benefit U.S. citizens, but the world community as a whole. This INTERNATIONAL effort will pay for itself many times over, through the advancement of human kind, and will help to quench our knowledge of not only space, but what is beyond.

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