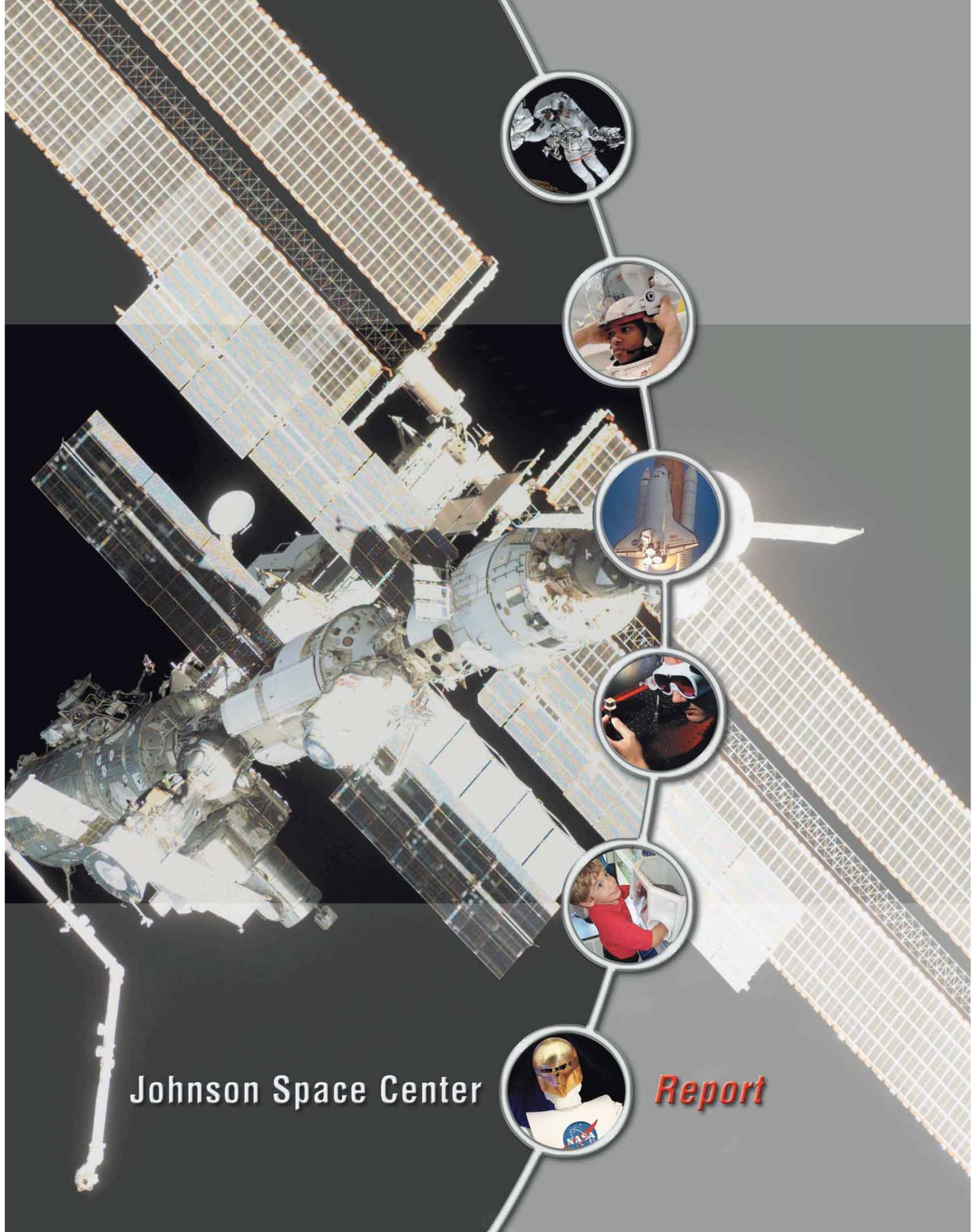
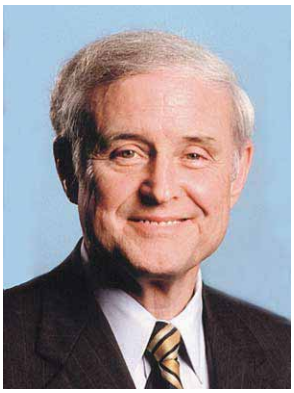

Johnson Space Center
Report

Space Shuttle *Atlantis* spent nearly 12 days in orbit during September 2000, seven of which were spent docked with the International Space Station. While in orbit, the STS-106 crew successfully prepared the International Space Station for the arrival of the first permanent crew.

Contents

A Message from the Director



It is my pleasure to present this review of achievements by the Johnson Space Center (JSC) for 2001. We hope it goes far towards representing the Center's progress, operations and community impact throughout the year. Our workforce derives immeasurable satisfaction and motivation from the many successes of our programs. We hope to share some of that positive energy with you in the coming pages.

I am honored to report that we have successfully completed our first full year of "crewed" operations on board the International Space Station in 2001, bringing the space station to life with a record-setting assembly schedule – a schedule that we met. Last year's missions resulted in the station gaining self-sufficiency and becoming fully operational, and for the first time in decades, JSC supported two programs simultaneously. We have safely supported flying an International Space Station crew 24-hours-a-day, 7-days-a-week, 365-days-a-year, while continuing to work space shuttle missions. One of the tangible results has been a tremendous sense of accomplishment for the teams at JSC; making such difficulties look routine is a testament to the Center's workforce and the amount of teamwork built around the Agency for those involved in our two flight programs.

A special highlight this past year was the establishment of JSC's Space Launch Initiative Office. Through its auspices, we will manage research and development of technologies unique to flying humans in space as part of NASA's almost $5 billion Space Launch Initiative, helping us to stay at the forefront of human spaceflight. This new office at JSC will assist in developing technologies for the next reusable human spacecraft, work that could mean hundreds of millions of dollars of research efforts managed from Houston over the next few years.

Although we at JSC were not as directly affected as some by the events that occurred on September 11th, we participated through the crewmembers aboard Space Shuttle *Endeavour* and the International Space Station as they helped to mark the three-month anniversary of the attacks in a nationwide remembrance. Additionally, *Endeavour* orbited the Earth with 6,000 small American flags that were part of the Agency's "Flags for Heroes and Families" program. Also aboard the shuttle were three large U.S. and Marine Corps flags, which had been flying at the World Trade Center, the Pentagon and the Pennsylvania State Capitol during the attacks.

As I depart JSC and return to Stennis Space Center, I am simultaneously saddened over my own departure from friendships begun and friendships strengthened this past year, and yet heartened by the incoming leadership of Jefferson D. Howell, Jr. I know Jeff Howell will do well by NASA and, in particular, the wonderful people at JSC.

And while I am looking forward to returning to my home state and my family, I will cherish my status as a JSC alumni and my good fortune at being Center Director for a wonderful group of dedicated spaceflight professionals. Thanks for the memories, JSC; it has been a wonderful year.

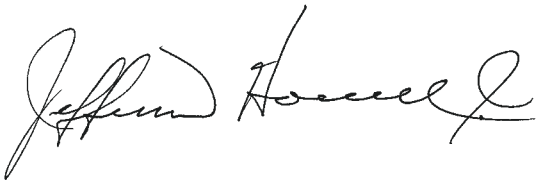
A Message from the Incoming Director

As I come on board, Johnson Space Center (JSC) continues to transition during an extended period of change. This past year has witnessed several leadership changes at JSC. Roy Estess came over from Stennis Space Center as the Acting Center Director and quickly established his presence and set the tone with his personal leadership and great dedication to the task at hand. Later in the year, Randy Stone, a 34-year veteran of Mission Control and JSC, was first named Acting Associate Director and then Deputy Director of JSC by Roy Estess. Randy brings a rich tradition to the position, having contributed to the Apollo and Skylab Programs, the Apollo-Soyuz Test Project, the Space Shuttle Program and, most recently, with the International Space Station Program.

As I check in, my first order of business is to recognize the great achievements this past year of the JSC workforce, both civil servants and contractors. While new to the civil servant ranks at NASA, I have been a member of the JSC workforce for three years and I bring a great appreciation for what this group is capable of accomplishing.

As you read through the past year's chronicle, you will no doubt be impressed with the technical and engineering challenges that were met. You may even be surprised to learn a few things about our involvement in education and the community in general. However, you would not be surprised about these accomplishments if you had ever visited JSC. With that in mind, I hope that if this document sparks your interest in an area you contact us for more information, or even request a visit to find out first hand what it is we do.

In closing, I am very honored to succeed Roy Estess, a man who the JSC community is forever indebted to for his stewardship and personal sacrifice during the past year. Roy held the JSC ship on a steady course during a time of great achievement tempered with extensive attention from many venues. The JSC family will long remember his leadership and friendship. From us to Roy and his family, a hearty Texas THANK YOU!



Johnson Space Center Report

*The **Vision** of NASA is to improve life here, to extend life there, and to find life beyond. NASA's **Mission** is to understand and protect our home planet, to explore the Universe and search for life, and to inspire the next generation of explorers…as only NASA can.*

At JSC, our mission is to expand the frontiers of space and knowledge by exploring, using and enabling the development of space for human enterprise. We have seen unprecedented accomplishments and delivered numerous benefits to America and the world through Human Exploration and Development of Space initiatives. JSC hosts two of these initiatives: the Space Shuttle Program and the International Space Station.

Human spaceflight is JSC's chief responsibility, including the recruiting and training of U.S. astronauts and the planning and operation of the International Space Station and space shuttle flights. We also coordinate shuttle and station program activities throughout NASA Centers nationwide. Our Center is the training base and home for our nation's astronauts and the site of Mission Control, where a talented team of flight controllers monitors the work of our men and women in space.

We have successfully completed our first full year of crewed operations on board the International Space Station in 2001 with a record-setting assembly sequence – bringing the station to life. Our missions during the year resulted in the station gaining self-sufficiency – it is fully operational without the presence of a shuttle.

And for the first time in decades, JSC began supporting two on-orbit programs simultaneously. We have worked carefully to support flying two spacecraft by training and supporting two separate crews – successfully running the most difficult series of missions since the Apollo era. This achievement brings a tremendous sense of accomplishment for the teams at JSC – making such difficulties look easy is a testament to the Center workforce.

During 2001, a total of 18 spacewalks were conducted – 12 from the shuttle and six from the station. We've recently completed some of the most challenging spaceflights in history, setting records for the number of spacewalks and the amount of hardware assembled in orbit. And four crews of astronauts changed places to live and work on the station during 2001, all during continued station assembly.

As we continue to explore and work in space, we at JSC are engaged in an intense and sustained effort to better understand the physiological changes in astronauts and the causes underlying these changes, and to develop ways to prevent or to mitigate them. The increased information about body functions derived from this effort is paving the way for prolonged missions in space.

Many specific experiments were delivered to the International Space Station via the space shuttle, even during the continued assembly of the International Space Station. Experiments were conducted not only on the physiological changes in astronauts, but with cancer research, protein crystal growth, radiation exposure and changes to the surface of the Earth. These are just some examples of experiments that help to provide valuable data to improve our life on Earth.

Space engineers at JSC continued work on the X-38 prototype space station "lifeboat" or crew return

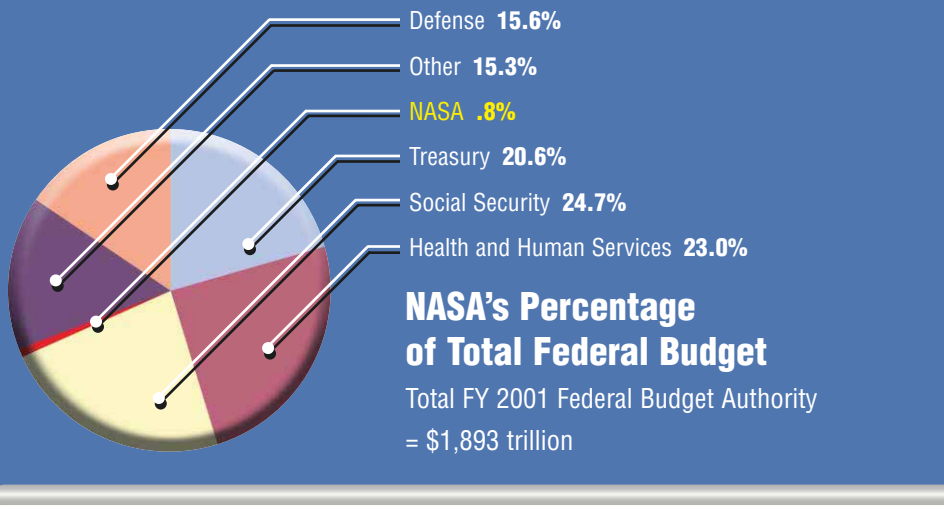
vehicle. Lessons learned from its innovative technology development will prove useful in future spacecraft design.

To support all that we do here at JSC, we employ approximately 16,000 people in federal and contractor positions. Our workforce represents small towns and big cities, suburban neighborhoods and rural areas. At the close of the workday, employees go home to communities throughout Houston that have been enriched by JSC's presence.

A Look Ahead

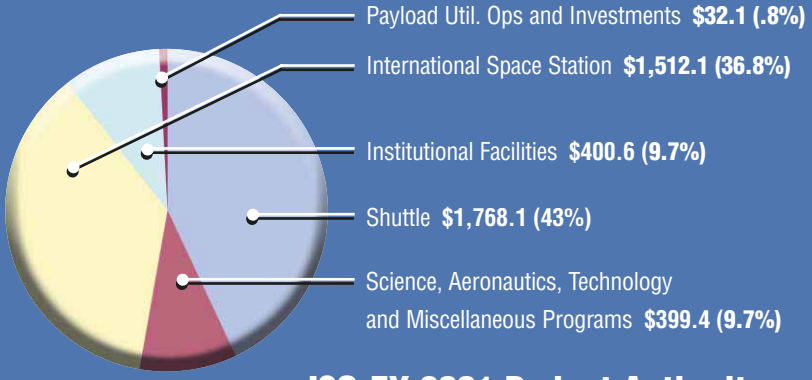
2002 began with the shuttle fleet matriarch *Columbia*'s return to space on the first non-International Space Station shuttle flight in more than two years. In addition, flights by *Atlantis* and *Endeavour* will begin to haul more than 50 tons of additional components to the International Space Station and more than three dozen new experiments and two new laboratory racks. *Discovery* will remain on the ground in 2002 for standard maintenance and inspections.

Columbia began the new year with a flight to the Hubble Space Telescope on mission STS-109, the fourth mission to service the space telescope since its launch in 1990. Five spacewalks were successfully conducted during the flight to install an advanced new camera system, reactivate an existing infrared instrument system, and install new solar arrays and a new power controller.



NASA's Percentage of Total Federal Budget

Total FY 2001 Federal Budget Authority = $1,893 trillion



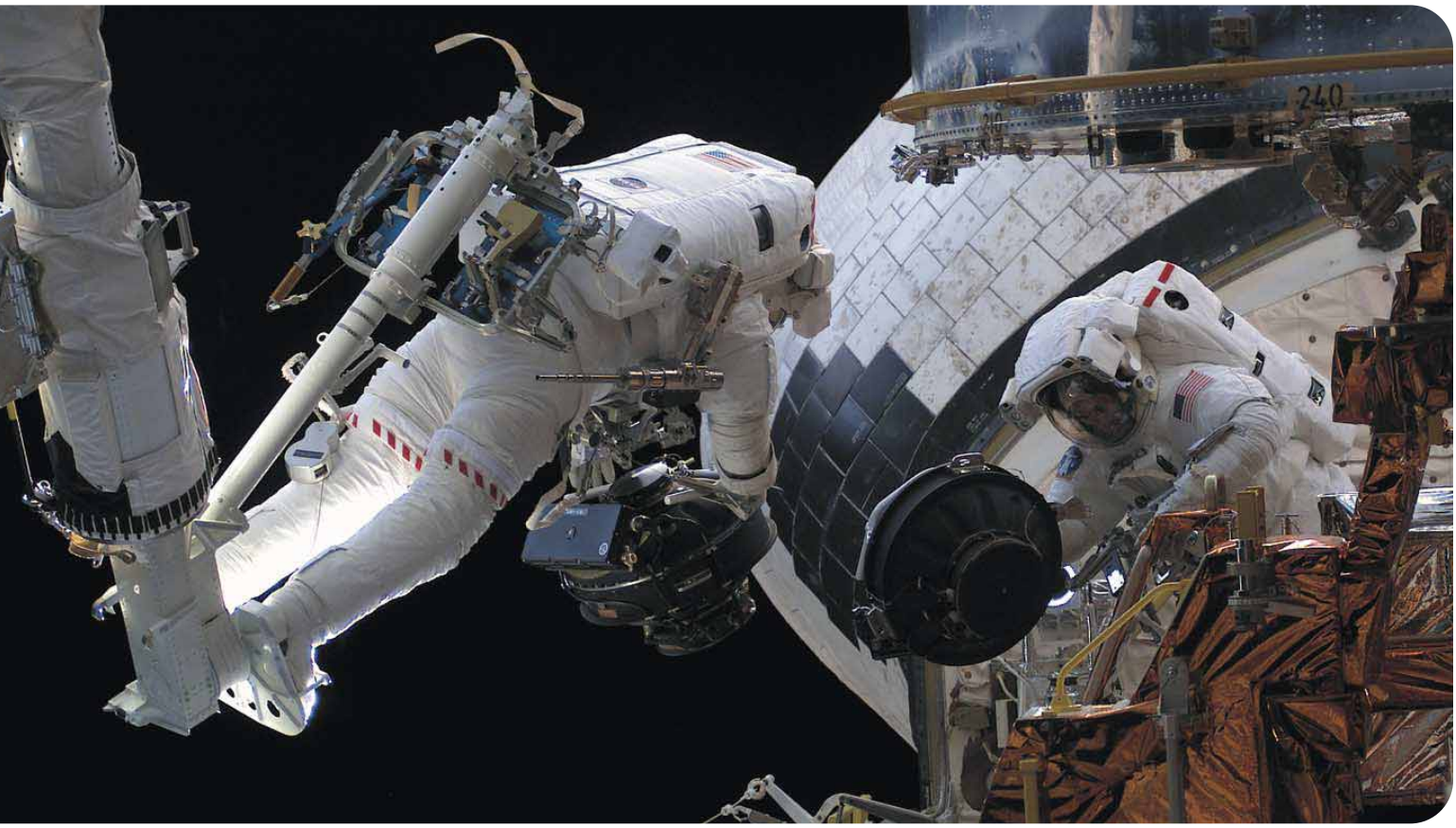
JSC FY 2001 Budget Authority by Major Program Activities at JSC

Total Budget Authority = $4,112

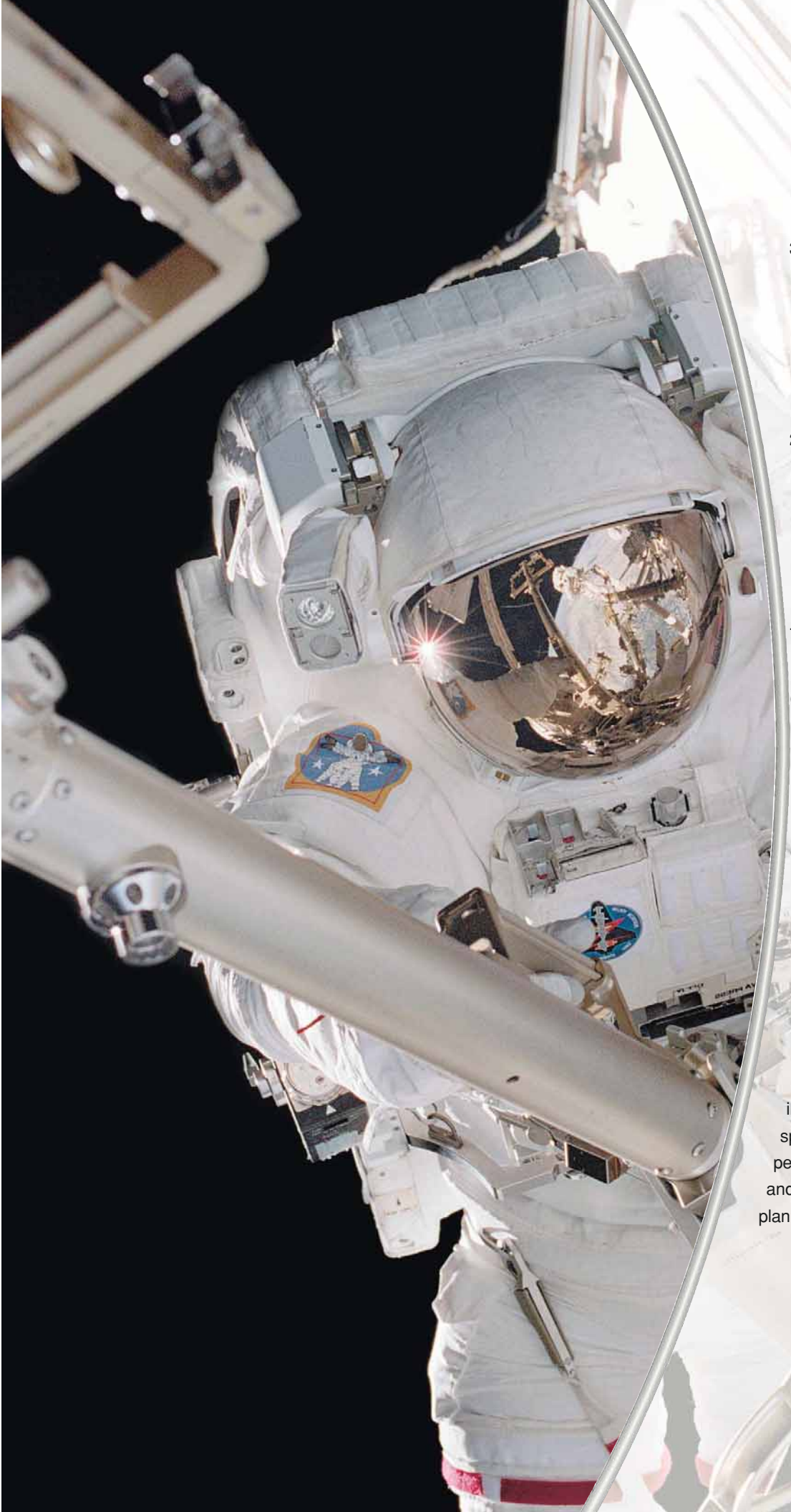
All dollars are expressed in millions

The mission extended the lifetime and capabilities of the now-famous orbiting telescope. Also in 2002, NASA plans to break our record set last year for the most spacewalks ever conducted in a single year.

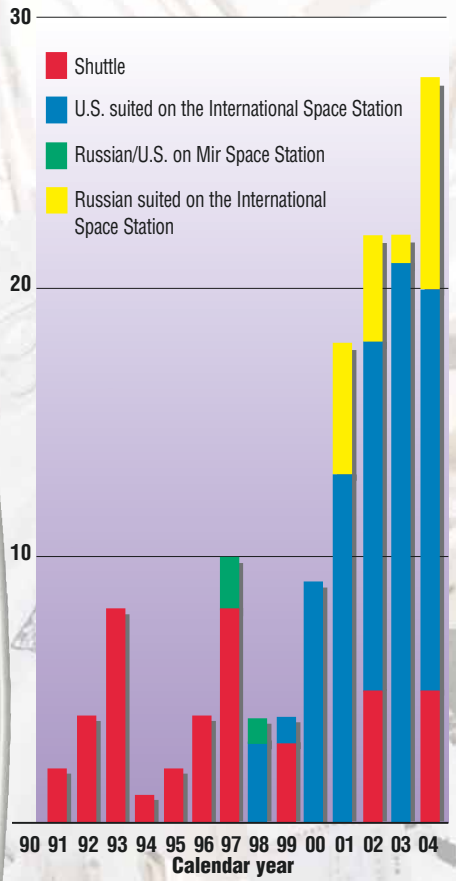
From the space shuttles alone, 15 spacewalks are planned, coupled with seven spacewalks planned for crews from the International Space Station.



STS109-E-5401 (March 5, 2002) – With his feet secured on a platform connected to the Remote Manipulator System (RMS) robotic arm of the Space Shuttle *Columbia*, astronaut Michael Massimino, mission specialist, hovers over the shuttle's cargo bay while working in tandem with astronaut James Newman, mission specialist, during the STS-109 mission's second day of Extravehicular Activity (EVA).



Spacewalks performed per year



As we embark on building and maintaining the International Space Station, the demand on the U.S. spacewalk team, both astronauts and ground personnel, has seen growth. In 2002, we expect to exceed the record number of spacewalks set in 2001. JSC is NASA's hub for spacewalk activity, coordinating and performing everything from tool design and fabrication to space suit processing, planning, choreography and crew training.

Our Programs

At JSC, our chief responsibility is human spaceflight. This includes the planning and operation of the International Space Station and space shuttle flights. NASA's space shuttles have launched more than 2 million pounds of cargo and more than 500 crewmembers into space. And in the International Space Station era, we have already completed more than 16 flights – which include 12 space shuttle missions.

The International Space Station Program

The International Space Station is a bright star orbiting around Earth every 90 minutes, making its rounds over 95% of the Earth's population. Human spaceflight has been transformed through the International Space Station, and has evolved into cooperative endeavors of world nations, businesses and academic institutions. There is great hope ahead, and many countries are planning to reap many benefits from operating and using this incredible new station in Earth's orbit.

The International Space Station represents a global partnership of 16 nations, including the five partner countries: the United States, Russia, the European Union, Canada and Japan. It is an engineering, scientific and technological marvel ushering in a new era of human space exploration. The International Space Station has grown from a 70-ton, efficiency apartment-sized foothold in orbit to a space laboratory of unprecedented capability. The station is now a 150-ton orbiting complex with volume about that of a three-bedroom house.

As assembled, the International Space Station provides an environment where gravity, a fundamental force on Earth, can be controlled for extended periods. This ability to operate in microgravity opens up unimaginable research possibilities. Establishing a unique, state-of-the-art orbiting laboratory complex, the International Space Station will expand the parameters for space research. The unique capabilities of its laboratories will enable discoveries that may benefit people all over the world.

The Cellular Biotechnology Program at JSC uses NASA cell culture technology and the microgravity of space to advance ground-breaking research in biomedical science. Currently, NASA's biotechnology cell science research aboard the International Space Station is working to provide controlled cultivation of cells into healthy, three-dimensional tissues that retain the form and function of natural, living tissue. Studying normal growth and replication of human cell tissue outside

A Quick Look at the International Space Station

Total residents and visitors since start of assembly: 79
Men: 68 Women: 11

Spacewalks since start of assembly: 38
Shuttle-based: 25 Station-based: 13

Crewmember nationality since start of assembly:

U.S.:	58	Italy:	1
Russia:	15	France:	1
Canada:	3	Japan:	1

Station Expedition crew mission duration from time of official handover:

Expedition One:	136 days on station, 141 days in space
Expedition Two:	163 days on station, 167 days in space
Expedition Three:	125 days on station, 129 days in space

living organisms is difficult. However, cells grown in microgravity – the low-gravity environment inside spacecraft orbiting the Earth – much more closely resemble those found in our bodies here on Earth. Bioreactor-based cell growth in microgravity permits cultivation of in vitro tissue (outside an organism) cultures of sizes and quality not possible on Earth. Such a capability provides unique opportunities for breakthrough research in the study of human diseases, including various types of cancer and heart disease.

The Cellular Biotechnology Office is currently engineering station-based hardware components that will provide a controlled environment for cultivating cells in vivo (inside an organism). These components will act as an interim platform for cellular research until the permanent Biotechnology Facility is delivered.

The space station Biotechnology Facility will be a complete research laboratory facility with static- and rotating-wall bioreactors, analytical equipment for on-orbit analysis, systems for supplying gas mixtures to bioreactors and for low-temperature stowage, and computer systems and software to control and monitor facility and experiment hardware and to transmit experiment data back to Earth.

Protein Crystal Growth With science being performed on the station, scientists are no longer restricted to relatively short-duration flights to conduct structural biology experiments. In 2001, the Protein Crystal Growth-Single Thermal Enclosure System (PCG-STES) experiment flew within the U.S. Lab EXPRESS (Expedite the Processing of Experiments to the Space Station) Rack 4 during the Expedition Four mission. The PCG-STES experiments should accomplish three goals:

- First, establish a protein crystal growth facility that would greatly increase experiment and coinvestigator capacity, increasing the odds of obtaining suitable crystals and, consequently, increasing the overall science return from each mission.

International Space Station Quest Airlock: A Doorway to Space

In July 2001, NASA successfully delivered and checked out a new airlock, the "Joint Airlock" for the International Space Station. This was a critical flight for the space agency as it completed Phase II of the International Space Station, making the orbital outpost a crewed, self-sustaining platform for science and low Earth orbit observations.

The International Space Station Joint Airlock is currently operational for Extravehicular Mobility Unit (EMU) spacewalking use, and, when fully outfitted, it will support either U.S. EMU or Russian Orlan suit use for EVAs from a common portal on the International Space Station.

International Space Station Milestones

- In July 2000, Service Module launch set in motion an unprecedented succession of spaceflights.
- A total of 24 flights gave us the 300,000 pounds of microgravity facility we have today, with nearly 15,000 cubic feet of living and working space and our fourth Expedition crew in residence.
- The addition of 19kW of power with the P6 solar array on STS-97, quintupled onboard computing and activated a fully functioning laboratory delivered on STS-98 in February 2001.
- In April 2001, a state-of-the-art robotics system was added by deploying the Canadarm2 station robotic arm.
- More than 50,000 hours of U.S. payload run-time have been logged since STS-106 in September 2000.

The installation of the Joint Airlock opened the door to station-based EVA capabilities for the U.S. Now, U.S. EVAs can occur without the shuttle docked for both maintenance tasks and to finish the International Space Station assembly work. Additionally, the Joint Airlock allows NASA to keep EVA hardware on orbit and thus fly less EVA equipment on the shuttle. The Joint Airlock also increases equipment transfer time by allowing hatches to remain open longer between the shuttle and the station.

The Joint Airlock gives the Space Shuttle and the International Space Station Programs many new EVA options for the International Space Station assembly, maintenance and docked shuttle mission use. The delivery of the Joint Airlock was a milestone in the International Space Station Program to facilitate future EVA endeavors.

- Second, produce protein crystals of improved size and order in support of numerous structural biology and structure-based drug design research programs.
- Finally, use the facility to delineate factors contributing to the effect of microgravity on the growth and quality of protein crystals.

Astronaut Janice Voss, mission specialist, looks over a checklist on *Endeavour*'s aft flight deck. Just above Voss' shoulder is an electronic still camera aimed at Earth targets for the EarthKAM project.

EarthKAM The Earth Knowledge Acquired by Middle School Students (EarthKAM) is a NASA education program that enables thousands of students to photograph and examine Earth from a space crew's perspective. EarthKAM brings education out of textbooks and into real life. By integrating Earth images with inquiry-based learning, EarthKAM offers students and educators the opportunity to participate in a space mission and to develop teamwork, communication and problem-solving skills.

This program benefits the public as well as the students. First, it introduces Earth science research to thousands of middle-school students around the globe. Using the Internet, students control a special digital camera mounted in the window of the International Space Station U.S. laboratory. Then the EarthKam team collects these photographs and posts them on the Internet for public viewing. Long after the photographs are taken, students and educators continue to reap the benefits of EarthKAM. Educators later use the images alongside suggested curriculum plans for studies in physics, computers, geography, math, Earth science, biology, art, history, cultural studies and more.

Teaching from Space Program Our Teaching from Space Program's (TFSPs) goal is to facilitate educational opportunities that use the unique environment of human spaceflight. These opportunities are accomplished through partnerships with formal and informal educational communities aligned with national education standards and state curriculum frameworks.

TFSP develops comprehensive packages consisting of on-orbit opportunities, interactive Web sites, distance learning education programs and hands-on activities that support science, mathematics,

technology, engineering and geography curricula. In FY 2001, TFSP flew the first International Space Station education payload with the Expedition One crew and launched a second education payload with the Expedition Four crew. In addition, TFSP coordinated 13 live education programs for the International Space Station with potential impact to more than one million students around the world.

International Space Station 2002 and Beyond In 2002, Phase III assembly and operations of the International Space Station will continue to focus on expanding and powering up the station. Fulfilling the commitments NASA has made to the International Space Station partner countries will require support and leadership beyond program boundaries. As we move into the future, we will be challenged to keep the financial aspects of the program in balance with our technical performance. And budgeting is always at the forefront. In the future, we may need to consider a broader set of issues to meet the challenges brought on by a leaner budget. This will mean research prioritization and careful expenditure of resources.

The Space Shuttle Program

Our space shuttle remains the most sophisticated human spacecraft in the world. The shuttles are the driving force that enables us to build and maintain the International Space Station. The unprecedented and unequaled accomplishments of NASA's Space Shuttle Program were recently celebrated with the program's 20th anniversary. The shuttle, which was on the drawing boards even before humans first landed on the Moon in 1969, was envisioned as a way to deliver humans and cargo to and from a space station.

Mr. Estess' tenure as acting center director resulted in a stellar 14 months for the shuttle program. We flew seven flawless missions, starting with STS-98 in February 2001, and finishing with STS-109 in March 2002. All flights but one were dedicated to space station assembly and maintenance. The other mission was the servicing of the Hubble Space Telescope. We flew five flights in six months, a great tribute both to the expertise and diligence of the entire shuttle team, and to NASA as an agency dedicated to safety first and continuing the exploration of space.

Houston, Go for Launch

Since 1965, JSC's Mission Control has been the nerve center for America's human spaceflights. Since the International Space Station assembly began in 1998, the Center has become the focal point for human spaceflight worldwide. The teams that work in Mission Control, Houston, as it is most widely known, have been vital to every U.S. human spaceflight since the Gemini IV mission in 1965, including the Apollo missions that took humans to the Moon and the more than 100 space shuttle flights since 1981.

Now with a permanent human presence aboard the International Space Station, flight control teams of experienced engineers and technicians are on duty 24-hours a day, 365-days a year, monitoring spacecraft systems and activities. Flight controllers keep an unblinking watch on the crew's activities, monitoring the spacecraft's performance, checking and rechecking every number to ensure operations proceed as planned. These highly trained flight controllers have the skills needed to closely monitor and maintain increasingly more complex missions and then respond to the inevitable unexpected event.

Mission Control Center also coordinates with the Russian Control Center to support the International Space Station. This is a partnership that completed a successful year in 2001.

Who are the people behind the scenes? They are the astronaut trainers, mission planners, engineers and astronauts – Mission Operations. They design, direct, manage and implement overall mission operations for the Space Shuttle and the International Space Station Programs as well as plan future expansion and activities on the International Space Station.

Maintaining the long-term safety and viability of the Space Shuttle Program is a challenge that the management team has been examining. Since 1993, the program's workforce has been reduced by nearly 50%, and with that reduction came budget decreases as well. Yet we have not reduced the number of our flights. In fact, in FY 2001, we successfully flew that record number of seven demanding shuttle missions, all while staying within our budget.

The success of the Space Shuttle Program is due to the complementary skills and experience of the NASA and contractor workforce. Individually, neither the contractor nor the NASA workforce has the necessary and required skills to successfully operate the program. However, collectively the requisite skills and experience exist to maintain the safety and viability of the program. We must protect the future of the Space Shuttle Program by nurturing a new generation.

At JSC, we set high standards for successful and safe programs with a measurable return on investment. Safety and risk management continue to be major considerations in all of our programs, but especially in the Space Shuttle Program.

We have taken the leadership role in the development of a more useful assessment tool to aid in program decision-making. This effort is well under way, with complete systems assessment tools scheduled for release in March 2003. Initial phases of this software have already been used to evaluate upgrade candidates, and are proving to be a valuable tool.

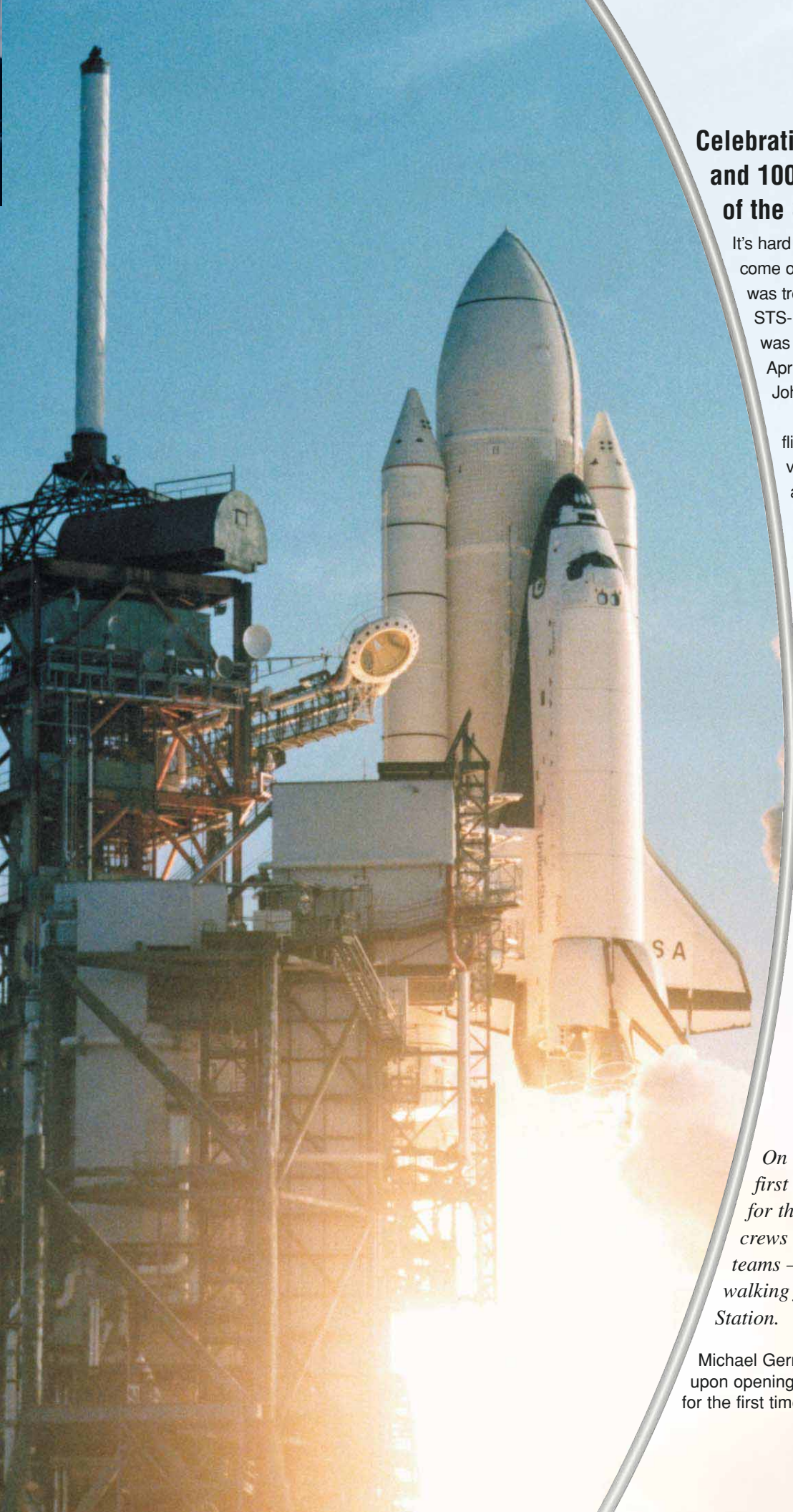
The Industrial Engineering for Safety (IES) initiative is making dramatic improvements in risk reduction. This initiative, designed to evaluate and implement modifications to reduce workforce and collateral damage risk, currently has 25 funded projects and several more projects in study.

We have recently installed a "glass cockpit," or the Multifunction Electronic Display Subsystem (MEDS), on Space Shuttle *Atlantis.* The MEDS has increased capabilities, decreased weight and power consumption, and replaced obsolete equipment on the flight deck of the shuttle.

The 11 new full-color, flat-panel display screens in the shuttle cockpit replace 32 gauges and electro-mechanical displays and four cathode-ray tube displays. The cockpit display is 34 kilograms (75 pounds) lighter and uses less power than before, and its color displays provide easier pilot recognition of key functions. Similar technology, commonly called "glass cockpit" instrumentation, is already in use in commercial aircraft. The MEDS will be among the first U.S.-manufactured liquid crystal flat panel displays to be used in aerospace.

The new cockpit will be installed in all shuttles by the end of 2002. It sets the stage for the next cockpit improvement planned to fly by 2005: a "smart cockpit" that reduces the pilots' workload during critical periods.

Our flight schedule for 2002 will be just as demanding and exciting as this past year, with seven launches scheduled. The success of the last months has demonstrated the tremendous capability of the space shuttle and the team that "makes it happen." We have an aggressive schedule planned, including the recent successful completion of our first mission of 2002, a re-service mission to the Hubble Space Telescope with five EVAs.



Celebrating 20 Years and 100 Flights of the Space Shuttle

It's hard to believe that a whole generation has come of age since the shuttle first flew. There was tremendous excitement when *Columbia,* STS-1, the first reusable orbiter to fly in space, was launched from Cape Canaveral on April 12, 1981, piloted by NASA astronauts John Young and Robert Crippen.

Now more than 20 years and 100 flights later, the space shuttle fleet's four vehicles – *Columbia*, *Discovery*, *Atlantis* and *Endeavour* – comprise the world's primary reusable system for reliable human space travel. Since that first launch, space shuttles have supported the Mir and International Space Stations; maintained the Hubble Space Telescope and other satellites; launched several planetary spacecraft; and staged hundreds of experiments in orbit.

Even with its record of accomplishments, the shuttle fleet is in the early stages of operational life. Each orbiter has a structural design life of at least 100 missions, and the most flown of the four has only expended about 30% of its life. With thousands of upgrades already in place and more improvements planned, the shuttle fleet will likely be flying well into the next decade.

On this historic anniversary of the first Moon walk, it's a real honor for the integrated shuttle and station crews – along with the flight control teams – to usher in a new era of spacewalking from the International Space Station.

Michael Gernhardt, STS-104,
upon opening the Quest airlock
for the first time

Technology Transfer and Commercialization

Part of NASA's charter is to build partnerships and transfer the technology it develops to the private sector for applications that will benefit people throughout the nation and the world. Space-based technology has already enriched a wide range of human activities – how we communicate with one another, how we process information, how we travel, and how we study our planet's biosphere, to name a few. It has improved our quality of life by showing us new ways to treat our sick and injured, to grow our food, and even to correct our vision.

Throughout 2001, the Technology Transfer and Commercialization Office at JSC actively sought to increase its number of partnerships with the commercial sector. And we were successful: in 2001, 87 technologies were marketed to potential commercial partners. Also during the year, 23 agreements were developed and 18 technologies were licensed for beneficial commercial applications.

Our Technology Transfer and Commercialization Office vigorously markets the Center's technology to companies throughout the nation, including technologies available for licensing, research and development capabilities as well as the usage of JSC's specialized facilities. We implement NASA's directive by sharing advanced technologies and unique capabilities with U.S. business and industry.

The Technology Transfer and Commercialization Office at JSC supports a wide range of responsibilities, including technology evaluation, intellectual property, commercialization, patent licensing, joint development partnerships, Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, grants and Space Act Agreements. These functions enable the Center to more closely align its way of doing business with that of the private sector, and to help identify the Agency's technology needs and leverage its resources.

Commercial Agreements

NASA strives to continue to develop technology with a meaningful real-life application here on Earth as well as in space. We strive to make beneficial space technologies available to the world through developmental partnerships and licensing agreements with business and industry. Below are a few examples of how we achieve our goal:

- Our technology will aid coffee growers in their search for "heavenly coffee." In cooperation with other NASA Centers, JSC will develop an unpiloted aircraft, known as an "Uninhabited Aerial Vehicle" (UAV), to aid Hawaiian coffee growers by providing the growers with color images of their crops. From this information, the growers will know, down to the day, the best time for harvesting the beans, thus bringing the best flavor to consumers. As part of NASA's UAV-based science demonstration program, these flights will show the ability of this type of aircraft to carry Earth-viewing scientific payloads in long-duration missions at altitudes exceeding the endurance of a pilot in a

traditional aircraft. These capabilities will benefit both U.S. scientific and commercial objectives well into the new millennium.

- An eight-year-old boy from Magnolia, Texas, suffers from four skin diseases that kept him out of the Sun and its potentially harmful ultraviolet (UV) radiation. However, that has all changed thanks to NASA and the Hypohidrotic Ectodermal Dysplasia (HED) Foundation. In April 2001, the boy received a special UV-blocking suit that was developed from NASA space-based technology. The suit, which covers him from head to toe, allows him to go outside, protected from harmful light.
- The MicroMed DeBakey Ventricular Assist Device (VAD®) was developed in collaboration with Dr. Michael DeBakey, Dr. George Noon and a team of NASA engineers. The VAD® was created to assist patients with congestive heart failure. The tiny blood pump bridges the gap between a heart patient's need for immediate support and the availability of a donor heart. It has been approved for commercial sales in Europe and is currently being used in clinical trials in the U.S. NASA patented the invention, and the patent was licensed exclusively to a Houston company, MicroMed Technology, Inc.

As part of JSC's continuing medical device initiative, in 2002 medical technology transfers and joint development opportunities will be the focus of an event between NASA and the Houston Medical Center technology transfer community. We will have a joint targeted licensing event for medical technologies in early March 2002. This type of small, focused event, done in partnership with a local medical school, may be replicated in other parts of the country in the future.

Small Business Innovation Research and Small Business Technology Transfer

Congress established the Small Business Innovation Research (SBIR) Program in 1982 to provide increased opportunities for small businesses to participate in research and development in order to increase employment and improve U.S. competitiveness. The program's specific objectives are to stimulate U.S. technological innovation, use small businesses to meet federal research and development needs, increase private-sector commercialization of innovation derived from federal research and development, and to foster and encourage participation by socially disadvantaged businesses.

The Small Business Technology Transfer Program (STTR) awards contracts to small business concerns for cooperative research and development with a nonprofit Research Institution (RI), such as a university. The goal of the program is to facilitate the transfer of technology developed by an RI through the entrepreneurship of a small business. The groups must agree on how the intellectual property will be shared between them.

Beneficial Uses for NASA Space Technology

From UV-blocking fabrics to agricultural data gathering, technologies developed for exploring space find many uses on Earth.

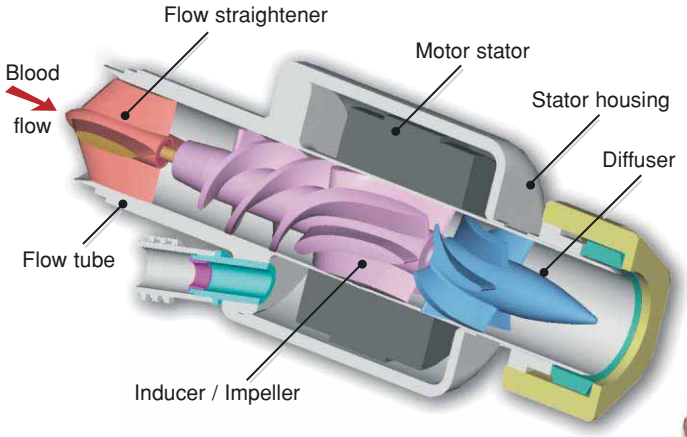
Partnering for Success

Key to JSC's technology transfer success is the partnership between the Center and its technology transfer marketing partner, the Mid-Continent Technology Transfer Center (MCTTC). The MCTTC partnership helps market NASA/JSC technologies and also aids in identifying commercial opportunities. Technology transfer includes high-effort projects, such as license agreements and Space Act Agreements, as well as direct technical assistance offered to companies with specific technical problems.

MCTTC also directly supports the JSC Commercial Technology Office in its effort to create and assess new technology submissions from inventors, to develop marketing materials for the inventions and to work to keep the technology portfolio complete and up to date.

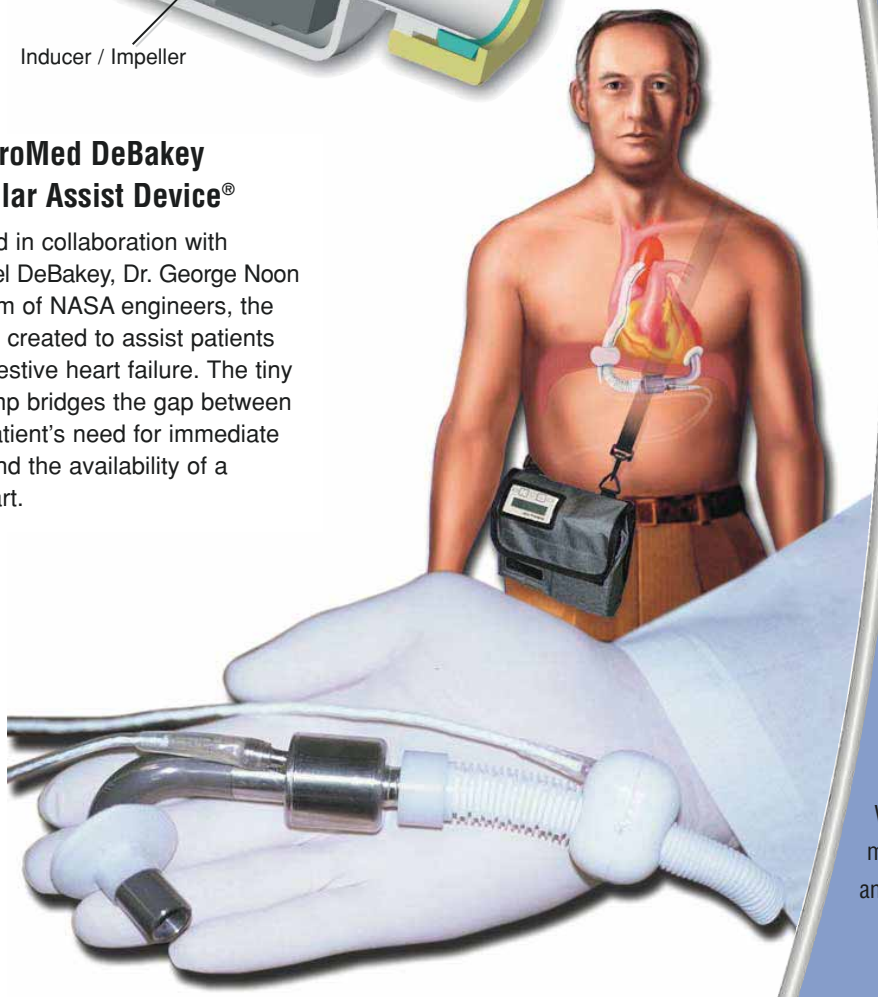
JSC participates with Clear Lake Area Economic Development Foundation (CLAEDF) to attract space-related business and industry to hold functions or open operations in the local area. Our Technology Outreach Program in the Office of Technology Transfer and Commercialization helps small business access and use NASA technologies in beneficial commercial applications.

The Technology Outreach Program (TOP) helps apply technology developed for space exploration to small businesses. The goal is to accelerate the transfer of these technologies to the marketplace by matching businesses with space industry technical teams made up of TOP's partners. These teams analyze the technical challenges posed, and then tap into the universe of technology that has been created for space exploration. The program provides up to 40 hours of engineering assistance at no cost to the business seeking the technical assistance.



The MicroMed DeBakey Ventricular Assist Device®

Developed in collaboration with Dr. Michael DeBakey, Dr. George Noon and a team of NASA engineers, the VAD® was created to assist patients with congestive heart failure. The tiny blood pump bridges the gap between a heart patient's need for immediate support and the availability of a donor heart.



Engineering Excellence at NASA's White Sands Test Facility

White Sands Test Facility (WSTF) is JSC's state-of-the-art research and testing site in Las Cruces, New Mexico. The WSTF capabilities for space-simulated vacuum firings of solid and liquid rocket propulsion systems are among the best in the nation, and the sophisticated laboratories for evaluating potentially hazardous materials and components for both Earthly and aerospace applications are similarly outstanding.

WSTF team members test rocket engines, resolve space mission anomalies and investigate new materials and components. They also refurbish space shuttle propulsion and life support system components for reflight, design and fabricate spaceflight hardware, and perform tests to validate new components that will enhance mission safety and extend the operational life of existing spacecraft systems.

In addition to the work done there for NASA, including all the other NASA field Centers, many other fascinating and challenging test projects are conducted by WSTF for its customers such as the U.S. military, other U.S. government agencies and private industry.

Crewmembers

Space Shuttle and International Space Station

1. STS-92 *Discovery*
2. STS-97 *Endeavour* with Expedition One crew
3. STS-98 *Atlantis*
4. STS-102 *Discovery* with Expeditions One and Two crew exchange
5. STS-100 *Endeavour*
6. STS-104 *Atlantis*

7 STS-105 *Discovery* with Expeditions Two and Three crew exchange

8 STS-108 *Endeavour* with Expeditions Three and Four crew exchange

9 STS-109 *Columbia*

STS-92 *Discovery*

- Installed Z1 truss and the Pressurized Mating Adapter 3 onto Unity
- Tested the Simplified Aid for EVA Rescue (SAFER)

STS-97 *Endeavour*

- Delivered the P6 Integrated Truss System
- Installed the giant solar arrays

STS-98 *Atlantis*

- Delivered and installed the Destiny Laboratory Module
- Moved the Pressurized Mating Adapter 2 to the forward end of Destiny
- Performed tests to help a disabled spacewalker

STS-102 *Discovery*

- Completed the longest spacewalk in space shuttle history
- Delivered the Expedition Two crew
  - returned the Expedition One crew

STS-100 *Endeavour*

- Delivered and installed Canadarm2
- Delivered first parts of the Remote Manipulator System

STS-104 *Atlantis*

- Delivered and installed the Quest Airlock
- First spacewalk from the new airlock

STS-105 *Discovery*

- Delivered the Expedition Three crew
  - returned the Expedition Two crew
- Installed the first external experiment, "Materials International Space Station Experiment"

STS-108 *Endeavour*

- Delivered the Expedition Four crew
  - returned the Expedition Three crew
- Attached the Raffaello Multi-Purpose Logistics Module
- Flew 6,000 small U.S. flags, part of the "Flags for Heroes and Families" campaign

STS-109 *Columbia*

- Fourth shuttle mission dedicated to servicing Hubble
- Tied record for the number of EVAs in a single mission, performing five EVAs

For the names of crewmembers and additional mission information see www.spaceflight.nasa.gov

Research and Development at JSC

Research and Development (R&D) at JSC covers a wide spectrum of disciplines in support of NASA's Human Exploration and Development of Space initiatives. Our Center's dedicated team of scientists, engineers and craftspeople have managed the design, development and testing of all U.S. human spacecraft and related systems – from the tight working space of the Apollo capsule to the expansive, and still expanding, research and living space aboard the International Space Station.

JSC leads NASA's research and development in several key areas. In bioastronautics research – the study of human physiology in space – we strive to understand the space frontier and the opportunities, capabilities and limitations of humans living and working on that frontier. As NASA's center of excellence for astromaterials, JSC coordinates the study of materials from space, including samples from the Moon, meteorites from Antarctica and cosmic dust from the Earth's stratosphere. And JSC leads NASA's engineering efforts for human spaceflight, turning the vision of design into the reality of a functional, orbiting spacecraft capable of supporting human life.

Bioastronautics

Bioastronautics research at JSC explores human health and performance in space. The research studies the effects of microgravity on humans for improved life support, health and longer mission duration.

JSC's Bioastronautics Program Office defines the medical standards NASA uses for astronaut selection, and provides physiological and psychological support to astronauts while they train. The Office provides medical care both in space and during postflight recovery and training, and monitors any test or training activities conducted in hazardous environments, such as the Neutral Buoyancy Laboratory, a large indoor pool used to train astronauts for spacewalks; the thermal vacuum chambers; the hypobaric training chambers; and the KC-135 aircraft used to simulate reduced gravity.

Through various partnerships between medical and research institutions, the Center also conducts spaceflight health studies to help understand and develop health solutions on Earth. For instance, we study areas such as: cardiovascular, neurovestibular, immunological, nutrition, musculoskeletal and barothermal physiology – all contributing to longer life here on Earth.

At JSC we develop onboard experiments in fascinating new biomedical frontiers. One way we accomplish this research is with the station-based Human Research Facility (HRF). The HRF provides an on-orbit laboratory that enables life science researchers to study and evaluate the physiological, behavioral and chemical changes induced in human beings by spaceflight. Since scientific research, including human research, is a primary goal of the International Space Station, areas of concern to humans' well-being and performance – such as renal stone risk, bone density deterioration and the effects of ionizing radiation – are studied using the HRF system.

Engineering and Design

JSC serves as the home of design and planning for human spacecraft. The Center controls both shuttle and

Robonaut

Our engineers created the Robonaut to aid astronauts in space and reduce the need for human EVAs. This project seeks to develop and demonstrate a robotic system that can function as a spacewalking astronaut equivalent, as well as a helping hand here on the ground. The futuristic humanoid Robonaut jumps generations ahead by replacing the special robotic grapples, targets and tools of traditional on-orbit robotics with two dexterous five-fingered hands, while still keeping the human operator in the control loop through its telepresence control system.

Engineers implemented Robonaut's new autonomous abilities this year, enabling it to understand voice commands from its human operator and to recognize and retrieve spacewalking tools. Working side-by-side with humans, or going where the risks are too great for people, machines such as Robonaut will expand the ability for construction and discovery.

Since our first payload reached the space station in September 2000, we have launched more than 4.6 tons of research hardware and experiments, and returned more than 1 thousand pounds of hardware, samples and other data to Earth.

John Uri, Expedition Four
science mission manager

the International Space Station operations and works in concert with partner countries in the development, launch, assembly and operation of the International Space Station hardware. The task of turning the vision of design engineers into the reality of a functional, orbiting spacecraft capable of supporting human life is a monumental one. With Mercury, Gemini, Apollo, Skylab, the Space Transportation System (shuttle) and now the International Space Station, NASA has accomplished the task time and again. And the success of these programs is due to the Center's broad depth of engineering expertise. This expertise encompasses all functions related to human spacecraft: life support systems; power systems; crew equipment; guidance, navigation and control; electrical power generation and distribution; cooling systems; structures; flight software; robotics; and space suits and spacewalking equipment. Our engineers work hard to ensure safe and efficient designs to support our goal at JSC to expand the human presence in space through exploration.

JSC scientists and researchers are also exploring advanced technologies and innovative integration of existing technology to help achieve success at lower costs. For example, JSC partnered with Cisco Systems and updated the telephone system for communications operations for the crew of the International Space Station – the Softphone. The Softphone makes calling someone from orbit as easy as placing a call from any desk at JSC – and it's free! This is a major revolution in the way people in space communicate with people on Earth. For decades the only way to communicate with astronauts was via radio, which has limitations and relatively low signal quality. By donning a headset plugged into their laptops, the astronauts can now speak directly with their families.

Astromaterials and Earth Observations

The people at JSC help make NASA an innovator in space exploration. Yet, space exploration is only one component of our jobs – research plays an enormous role in our discoveries. One particular area of study that helps us understand the makeup of our solar system is the study of astrobiology, or extraterrestrial materials.

JSC is the curator of all extraterrestrial materials for NASA, from the first Moon rocks to meteorites from Antarctica. The newly developed Astromaterials Acquisition and Curation Office was established at JSC in July 2001. The mission of the Office is to support the international planetary science community. This is accomplished through the curation of current extra-terrestrial sample collections, curation of samples from future spacecraft missions, advanced planning efforts for all sample return missions, and focused research and development in support of current and future sample curation.

From Earth to Mars, the newly formed Astro-materials Research and Exploration Science (ARES) Office provides fascinating insight into a complex subject matter. ARES conducts astromaterials curation and basic research in planetary and Earth sciences as well as space debris. Additionally, ARES supports human spaceflight missions through image analysis, monitoring orbital debris and training astronauts in Earth observation.

NASA gave the ARES curation team the leadership role in planning for sample handling, which includes quarantine and curation, for the eventual Mars Sample Return mission. We have more than 300 kilograms (66 pounds) of Moon rocks, which have been studied for more than 30 years by scientist worldwide, and they continue to be a source of important scientific information about the makeup of the Moon.

The National Science Foundation – in cooperation with the Smithsonian and NASA – collaborates to further this research by sending a team of scientists and explorers to Antarctica for meteorite collection. Each year JSC acquires approximately 1,000 meteorites, in a frozen state, from Antarctica. JSC has many notable meteorites in its collection, including meteorites that are from the planet Mars.

Martian meteorite and experimental studies provided insight into the earliest history of Mars' formation and differentiation, the evolution of Mars' atmosphere, magmatic history, and the existence of a magma ocean on Mars. ARES scientists also provided new evidence on both sides of the debate over fossil life in meteorite ALH84001 – a 4.5-billion-year-old rock. It is believed to have once been a part of Mars, and to contain fossil evidence that primitive life may have existed on Mars more than 3.6 billion years ago.

Expanding our knowledge of Earth and environmental science and processes of change over time helps us to explore our natural world. And Earth observations studies help us to analyze global changes, climactic conditions and the impact of humans on our environment. When our astronauts photograph the Earth from the International Space Station's optical-quality window, ARES is responsible for cataloging all the images that are taken as well as making them available to the public.

The future is extremely exciting for ARES. We have a number of sample return missions planned over the next 10 to 15 years. One of the sample return missions we are anticipating is the Mars Sample Return. We plan to go to Mars by way of a robotic mission that will collect soil from the surface and subsurface, looking for Martian life.

The NASA *Stardust* mission will be the first mission to return samples from a comet. This mission was launched in 1999 and is expected to return in February 2006. The spacecraft will fly through the tail of Comet Wild 2 with a collector plate exposed, collecting comet

Biotechnology Research on the International Space Station

In August 2001, the Cellular Biotechnology Operations Support System (CBOSS) experiment was installed in an EXPRESS Rack, a facility designed for quick and easy installation of hardware and experiments, in the space station's Destiny laboratory.

CBOSS consists of a cryodewer, an incubator and a refrigeration device for cells, a gas containment and delivery system, and a stowage system for necessary supplies. The overall mission of CBOSS is to support a series of flight experiments using bioreactors to provide the environment and metabolic support necessary for three-dimensional tissue development in the microgravity environment of space. The cells under study, include ovarian and colon cancer cells, as well as human kidney cells.

Prior to experiment initiation, the cells are maintained in a cryogenic state. Over a period of days the crew thaws, feeds and incubates the cells. Upon experiment completion, the cell cultures are preserved and refrigerated until return to Earth for further investigation. Scientists then study the samples for analyses of cell alterations and for molecular expression of genes, proteins and other molecular markers. The first cells grown in CBOSS were returned to Earth for analysis in December 2001, and more cell cultures will be grown aboard the space station in 2002.

NASA and The National Space Biomedical Research Institute

JSC's bioastronautics research leads and complements the NASA-funded efforts of other scientists and organizations such as the National Space Biomedical Research Institute (NSBRI). NSBRI is a JSC cooperative partnership managed by Baylor College of Medicine, and includes 12 other prominent research institutions. NSBRI studies the effects of microgravity on astronauts in orbit, including aging, osteoporosis and sleep disorders. Exploring the way humans react and adapt to space may help lead to a better understanding of these conditions and to develop advances that will lead to treatments on Earth.

dust for study and curation. Scientists thus expect to learn more about the birth and evolution of life in the solar system by studying these comet and dust particles.

Another mission we are looking forward to returning is the NASA *Genesis* mission, which will collect solar wind ions and atoms. The Genesis mission began its 1.5 million-km (932,057-mile) journey Sunward in July 2001. Solar wind samples will be collected for approximately two years, before the mission returns to Earth. The mission's return date is August 2004; this will be the first sample return since Apollo 17. JSC is responsible for sample curation and overall mission contamination control. The latter included the clean storage and subsequent installation of the collector materials into the payload hardware, as well as the precision cleaning of the disassembled flight payload hardware.

University Research Activities Through JSC

JSC benefits from numerous University Research partnerships. NASA dollars spent through University Research Grants and Cooperative Agreements support joint research projects that fulfill many early developmental needs of the agency, while helping guide the future R&D strategies of space exploration. These relationships help to build a pipeline of talent that advances knowledge for the country.

Since the beginning of the Apollo Program in the 1960s, JSC has supported university faculty and students who are conducting basic and applied research. We support scientific research, engineering research and technology development. Much of this research is at the early Technology Research Levels (TRL 0-3). Some of this research is directly used by JSC and its contractors for implementation into flight, hardware/software, and some research data form the basis by which NASA scientists and engineers make better judgments for guiding the future R&D strategies of space exploration. The students who participated in this work, undergraduate and graduate, have become a part of the pipeline of talent that has advanced microgravity science and engineering, human physiology in space, spacecraft design and spaceflight operations. Doctoral students supported by NASA have, in turn, become university faculty educating the next generation of space-exploring scientists and engineers.

During FY 2001, NASA appropriated $1,118,241,050 into university research programs. Approximately $97,505,001 of that was coordinated through JSC. An example of how this type of investment can be used, to further research that may be beneficial to humankind, is the study currently under way at Baylor College of Medicine. The National Space Biomedical Research Institute (NSBRI), at Baylor College of Medicine, has been tasked to collectively study the effects of space on the human body, and to develop medical countermeasures so that humans may continue to explore longer and farther into space. The NSBRI forms the center of focus for the developing discipline – BioAstronautics, involving universities throughout the U.S. The NSBRI is a consortium of 12 universities and laboratories led by the Baylor College of Medicine. Other participants include Brookhaven National Laboratory, Harvard Medical School, the Massachusetts Institute of Technology, Morehouse School of Medicine, and the University of Washington.

Another way JSC supports university research is through a cooperative agreement between the Center and Rice University. This research examines the field of nanotechnology materials. It has resulted in an improved

NASA's Reduced Gravity Student Flight Opportunities Program

NASA's Reduced Gravity Student Flight Opportunities Program (RGSFOP) is designed to provide students practical and theoretical knowledge of science. Approximately 1500 students representing more than 200 schools in 46 states have participated in NASA's RGSFOP since it began in 1995.

NASA's university research programs serve not only to unlock new discoveries about our world, but also to train and inspire the next generation of scientific explorers who will be vital to maintaining the United States' technical and economic leadership in years to come.

Bonnie Dunbar, Ph.D., Astronaut
Assistant Director for University Research

process for making single-wall carbon nanotubes. These nanometer-diameter hollow tubes have the extraordinary properties of being 10 to 100 times stronger than steel at one-sixth the weight, while also being as electrically conductive as copper and as thermally conductive as a diamond. The collaboration with Nobel Prize winner Richard Smalley's group has resulted in a spin-off company in Houston to commercialize and develop this new technology.

JSC also supports "no exchange of funds" programs. In this unique program, JSC partners with the University of Houston (UH) to expose both faculty and students to "real life" engineering problems while providing support to the Engineering and Space and Life Sciences Directorates. This program has proven itself mutually beneficial to JSC, the faculty and the students. The partnership allows JSC engineers and UH faculty to work together during the summer, with the students participating in actual design problems. This program attracts the top students and faculty, which has greatly benefited engineering research at JSC.

UH Dean of Engineering, Dr. Ray Flummerfelt, stated early in the program that NASA was his first choice because of the powerful motivation that human spaceflight provides for both his students and his faculty. Industrial and Mechanical Engineering students have supported projects in manufacturing, thermal analysis, development of the International Space Station Human Research Facility, and advanced exploration with the Gateway-Moon Project as well as research into noise suppression.

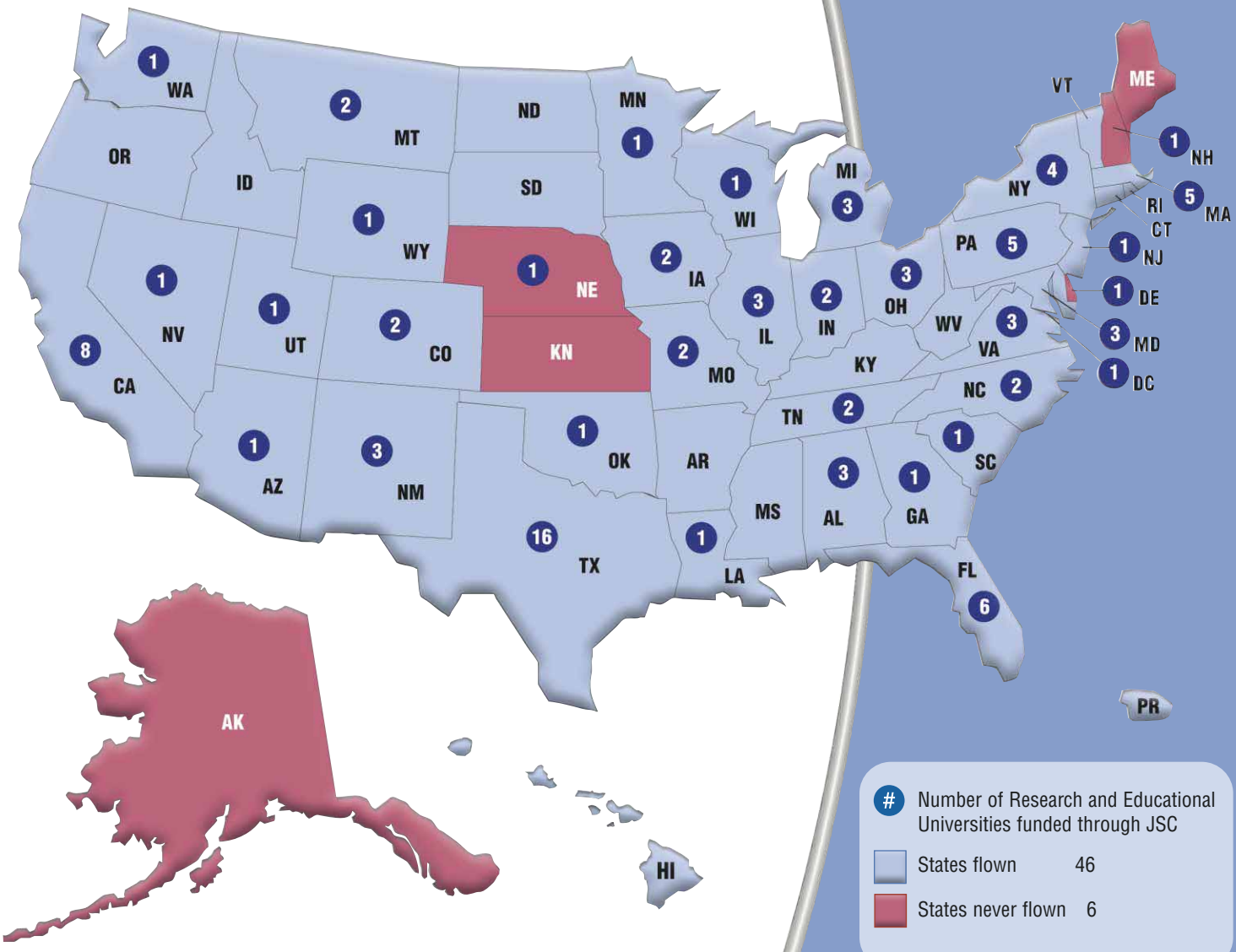
JSC also supports university research through cooperative agreements. Currently JSC has a Cooperative Agreement with Texas Tech University (TTU). In this program, Advanced Life Support research is being conducted in the areas of plant growth in closed environments; this research is applicable to long-duration space missions. TTU is examining plant performance and engineering challenges associated with maintaining atmospherically sealed plant growth environments. Research is also under way to examine biological bioreactors for recycling wastewaters, and the fate of pharmaceuticals in water recycling systems. Additionally, a special project with TTU faculty and students is dedicated to the application of NASA water recycling technology for processing waste waters in "colonias" along the Texas-Mexico border, which does not have water treatment infrastructures. Finally, a computer science research task is addressing the development of a new computer language, Sequence L, that will simplify the representation of algorithms that have parallel computational properties, thus allowing for faster processing.

JSC and the University of Texas Medical Branch (UTMB) have entered into two new programs. The first provides for specialized training in Space Life Sciences for selected doctoral students at both UTMB and at the University of Texas Health Sciences Center in Houston. The program was started in 2000, curriculum has been developed, and 15 students are now enrolled. Additionally, UTMB and JSC have developed a combined internal medicine-aerospace medicine residency program. Both the American Board of Internal Medicine and the American Board of Preventive Medicine have approved the program.

NASA Reduced Gravity Student Flight Opportunities Program

Participating States: 1997–2001

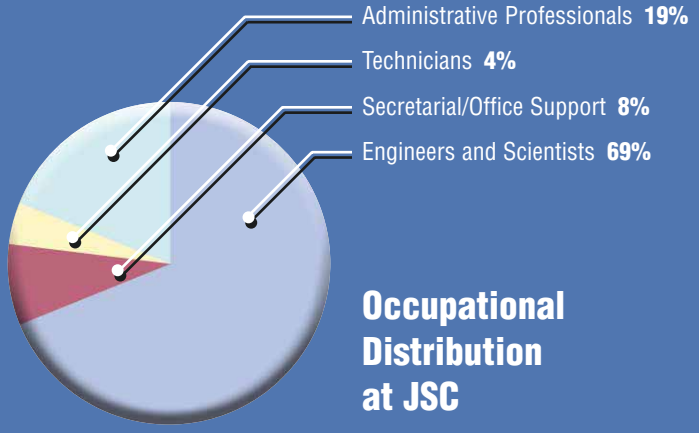
University Research Grants



The People of JSC

JSC is a positive force in the community it calls home. With a measurable workforce of federal and contractor employees, we impact the local economy and beyond. Our workforce is a varied, talented and highly educated team that enhances the quality of our mission.

Probably the most identifiable employees that work at JSC are our astronauts and engineers. Yet we employ a wide array of professionals who support our mission. Our workforce consists of skilled clerical support, photographers, graphic artists, computer specialists, educators, biologists, business specialists and many more.



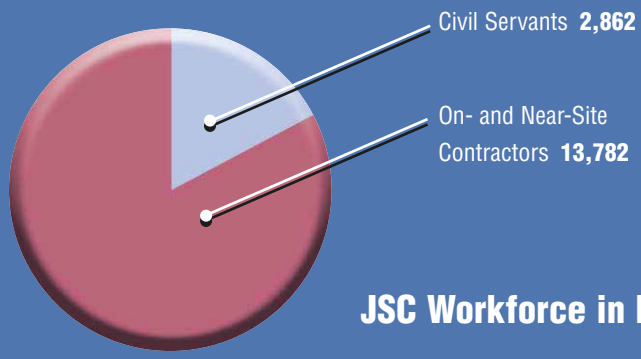
Occupational Distribution at JSC

In FY 2001, JSC contributed more than $2 billion to the local economy, largely through worker salaries, contracts, grants and local purchase of goods and services. The Center for Economic Development at the University of Houston-Clear Lake (UHCL) shows that 16% of the local workforce is directly employed in the aerospace industry. Center and contract personnel are educated and highly skilled: 1,505 have a bachelor's degree and 779 hold at least one graduate degree. The JSC workforce holds more than 209 doctorate degrees. At the end of FY 2001, 2,862 civil servants and 13,782 contractors were employed at or near the Center. A total of 633 companies and organizations worked on Center contracts, grants and agreements last year, including awards equaling $53 million to Texas colleges and universities and $5.8 million to nonprofit institutions.

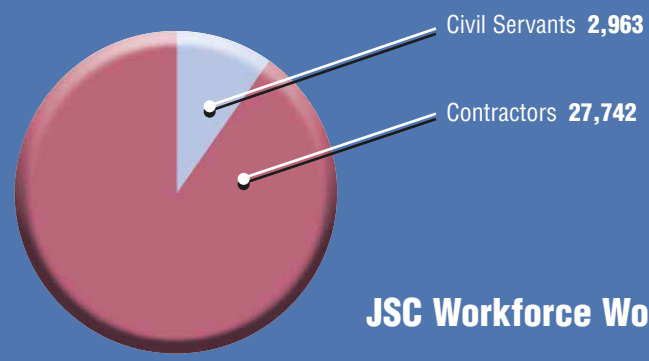
International cooperation to build and operate the International Space Station calls for strong ties on the ground. Our Russian partners not only contribute a significant amount of hardware, they also provide their control center at Korolov as well as their training facilities at the Gagarin Cosmonaut Training Center. JSC personnel live and work in Russia to train astronauts on Russian-built parts of the International Space Station, track production of hardware, develop multi-element procedures, support testing to ensure our parts work together, and serve as liaisons to maintain the strong American-Russian team relationship we have developed over the years. Additionally, the NASA infrastructure in Korolov provides the capability for NASA personnel to safely operate the U.S. Segment of the International Space Station if command and telemetry capability is temporarily lost in Houston.

Astronauts

Our astronauts are the most recognizable of the JSC workforce. JSC is home to the nation's astronaut corps and is responsible for preparing explorers from both the U.S. and our partner countries for the demands of living and working in space. About 119 men and women with primarily scientific and military backgrounds make up NASA's active astronaut corps. Once trained, astronauts are eligible for flight assignment as shuttle commanders or pilots, mission specialists, or space station Expedition commanders or flight engineers. As such, they may conduct spacewalks, operate the shuttle and station's robot arms and conduct scientific research. There are two classifications of astronauts, pilot astronauts and mission specialist astronauts.



JSC Workforce in Houston



JSC Workforce Worldwide

Pilot Astronauts Pilot astronauts play a key role in shuttle flights, serving as either commander or pilot. During flights, commanders are responsible for the vehicle, the crew, mission success and safety – duties analogous to those of the captain of a ship. During flights, commanders and pilots may manually fly the shuttle during precise rendezvous and docking operations with the International Space Station, or orbiting satellites such as the Hubble Space Telescope.

Mission Specialist Astronauts Mission specialist astronauts work with the commander and the pilot, and are responsible for coordinating shuttle operations in the following areas: shuttle systems, crew activity planning, consumables usage and experiment/payload operations. Mission specialists are trained in the details of the shuttle's onboard systems, as well as the

operational characteristics, mission requirements/objectives and supporting equipment/systems for each of the experiments conducted on their assigned missions. Mission specialists may perform EVAs, or spacewalks, operate the shuttle or station robotic arms, and are responsible for payloads and specific experiment operations.

Expedition Crews Both pilot astronauts and mission specialist astronauts are eligible for long-duration spaceflight assignments on board the International Space Station. As Expedition crewmembers, either may serve as an Expedition commander or flight engineer. They train both in the U.S. and Russia, speak English and Russian, become familiar with all aspects of space station systems, may perform spacewalks or operate the space station's robotic arm, and conduct multiple science and technology experiments during their extended stay in space.

Other Astronaut Responsibilities In addition to their roles on special flights, NASA astronauts participate actively in many other areas of JSC. Working in Safety, Engineering, and the International Space Station and Space Shuttle Programs, they provide early design input and operational spaceflight expertise. Many senior astronauts remain with the astronaut office, mentoring younger astronauts and ensuring continuity of information, while others move in to management roles at the Center. There are numerous contributions astronauts make. Just a few are mentioned below:

- Monitor the Earth from orbit and document changes in our environment
- Assist in developing new technologies and capabilities to continue humankind's advance in space, including a plasma-based interplanetary rocket
- Participate in long-term studies of the effects that spaceflight has on human health and the analogy to life on Earth, including studies in osteoporosis and neurovestibular diseases
- Track technical design, development, operations and safety issues
- Serve as spacecraft communicators ("capcoms") for space shuttle and the International Space Station missions – provide primary communication contact for crews
- Aid in the design and development activities for advanced vehicles and systems such as the X-38 and space shuttle cockpit upgrades

Factoids

1st Woman Pilot

U.S. Air Force Colonel Eileen Collins became the first female space shuttle commander when she flew *Discovery* in 1995. Even more notably, she became the first woman to command a U.S. spacecraft of any kind when she flew as commander of *Columbia* in 1999.

1st Hispanic in Space

When space shuttle *Columbia* launched in 1986, it took along the first Hispanic-American astronaut. Franklin R. Chang-Díaz, originally from Costa Rica, has flown on six shuttle missions to date.

Astronaut Candidate Selection

Astronaut candidates undergo one of the world's most selective processes – only 310 of the 38,211 applicants have been selected as astronauts. That's a less than one in a hundred chance of being selected.

Voting in Space

Astronauts can vote in space, but only those registered to vote in the state of Texas. In November 1997, Astronaut David Wolf voted via e-mail from the Mir Space Station, becoming the first American to vote from space. He received his ballot for the Houston mayoral race by way of Moscow from the Harris County elections chief.

Record Setting Spacewalks

While preparing and relocating the Pressurized Mating Adapter 3 and getting the Multi-Purpose Logistics Module ready for International Space Station delivery, Astronauts James Voss and Susan Helms completed the longest EVAs in U.S. history at 8 hours and 55 minutes. An unprecedented 18 EVAs were performed in 2001 for the International Space Station assembly.

Safety, Reliability and Quality Assurance

JSC's management system is certified for both quality and safety by recognized accreditation authorities. These certifications demonstrate JSC's commitment to deliver value to taxpayers, and to ensure the safety of its workforce.

As NASA works in the 21st century, safety and health, both on and off the job, have been designated as our highest priorities and core values.

When you come to JSC, you quickly realize that the success of every mission starts with safety. Being in the business of human exploration of space, we realize the challenges and risks associated with exploration, operating the space shuttle and building the International Space Station. We are willing to accept risks, but only in an informed manner, and we are unwilling to compromise the safety and health of our people and property or do harm to our environment.

JSC's Safety, Reliability and Quality Assurance (SR&QA) organization plays a vital and highly visible role in assuring the safety of our people and hardware, both on the ground and on orbit. SR&QA is responsible for providing engineering and analytical support to the space shuttle, the International Space Station and evolving new programs such as the X-38, robotics and Lunar Mars exploration. The SR&QA team provides expertise in the areas of safety, reliability and maintainability engineering, quality engineering and inspection, software quality and independent assurance, failure analysis, electric/electronic analysis, pressure system analysis, and ISO 9000 implementation.

Our ongoing success in all areas of spaceflight can only be achieved with the active participation of all of our people. Our goal is to achieve zero mishaps in the workplace. We are committed to reducing mishaps by strengthening our routine safety and health principles so that our daily decisions at work and at home consider safety and health first.

Voluntary Protection Program

Only 600 companies in the country have earned the VPP Star work site designation, the Occupational Safety and Health Administration's (OSHA) most prestigious award. In 1999, JSC became the first federal facility to earn both the Voluntary Protection Program (VPP) Star work site status and ISO 9001 certification. In December 2001, the White Sands Test Facility earned their "Star" demonstrating that their safety and health program is among the best in the nation.

VPP Star work site status represents the participation, dedication and sustained effort of every civil servant and contractor employee at JSC. Earning Star status was and continues to be an enormous challenge, but with it comes fewer injuries and mishaps, lower operating costs and higher productivity. In July of this year, OSHA will return to JSC to recertify the facility as a Star work site.

Since adopting VPP practices, JSC has seen an increase in employee participation in the safety program, resulting in keeping more of our people safe and working. Any injury, whether it occurs on the job or at home, represents valuable time and experience lost. Every employee is involved in day-to-day safety activities, including safety walkthroughs, close-call reporting, hazard recognition and control, and workplace inspections. VPP has fostered a renewed sense of cooperation and common concern among all of our people.

In April, JSC will host hundreds of participants at the NASA VPP Conference of Stars to share best practices and innovations with other NASA Centers and their contractors. The effort required to host such a gathering is indicative of JSC's dedication to helping others stay safe and healthy.

International Organization for Standardization

International Organization for Standardization (ISO) is a quality management certification system based on customer and employee involvement, measurement and continual improvement. It is a highly prized and sought after certification recognized by government and industry leaders.

JSC was the first federal installation to receive the Quality Management System (QMS) to the recently approved ISO 9001:2000. This registration follows intensive preparation at JSC and a three-day on-site inspection by independent auditors from National Quality Assurance, USA (NQA). This recognition places JSC among the leaders in quality management, not only within NASA, but also throughout government and across the aerospace industry.

NASA was the first federal agency to require and achieve ISO registration for all of its facilities. This gives us firm possession of the tool that, when used well, can improve even more the overall effectiveness of JSC. The QMS is an essential tool for continuous improvement to process efficiency that will enable us to lead the development of human spaceflight technologies in the future. JSC continues to use our QMS to foster the continual improvement of our processes, products and services.

We are also pleased to report that JSC is the only federal site that is both ISO 9001:2000 certified and recognized as a VPP "Star Site" by the OSHA. OSHA granted the Center VPP Star status in May 1999. JSC received its initial certification to ISO 9001 in April 1998, establishing itself as the first NASA field Center to be so registered at the time.

The JSC Receiving and Inspection Test Facility

The JSC Receiving and Inspection Test Facility (RITF) provides exceptional laboratory testing and analysis experience and capability for the JSC NASA and contractor community in electrical, mechanical and chemical testing as well as in the area of workmanship skills training. RITF expertise and state-of-the-art equipment are applied to specialties such as metallic and nonmetallic testing, electrical component evaluation including failure analysis, destructive physical analysis, and electrical component screening. This laboratory provides full capability in testing and certification of wire to NASA standards. RITF also conducts classes in NASA workmanship and inspection standards for the majority of the personnel in the JSC area requiring such training. The RITF laboratory is ISO 9002 registered and is accredited through the American Association for Laboratory Accreditation (A2LA).

SR&QA is proud to be part of the team that helps assure safe and successful spaceflight. We look forward to demonstrating our continued commitment to a safe, healthy work and home environment by conducting the first Voluntary Protection Program Conference for the Agency in April and confirming our "Star" status with the Occupational Safety and Health Administration (OSHA).

Elmer Johnson
Special Assistant
JSC VPP

JSC to the World

The People of the Johnson Space Center Reach Out

Contributing to our communities and sharing knowledge gained in the pursuit of exploring space is a primary goal of JSC. The R&D conducted at JSC benefits all humankind. By actively working to help those benefits become known and available to the public, the people of JSC reach out not only locally but also worldwide through community and educational outreach activities.

The commitment of JSC and our employees to share resources, ideas, technologies and their own time with our local community and throughout the nation is profound. The impact of this is seen through: educational programs, event participation, business development, and university and research partnerships.

In FY 2000-2001, Distance Learning Outpost visited 45 states and supported events such as National Engineers Week, Global Leap and Space Week. With a potential schedule for almost 800 events each year, students from across the U.S., England, Mexico, Canada and Europe are encouraged to achieve success in science, mathematics, geography, engineering and technology.

JSC builds awareness and excitement for space exploration by participating in many types of public events. JSC's many exhibits and our "Space Station Imagination" traveling space station modules help the Center reach millions of people each year. The Center plays a major role in our local community: through events such as the Houston Livestock Show and Rodeo and Houston's International Festival, we reach out to our community using exciting educational exhibits and volunteers to represent NASA and JSC to the public. At the 2001 Houston Livestock Show and Rodeo, JSC's 900-square-foot exhibit highlighted the latest information on the International Space Station, gave visitors a virtual tour of the living quarters and laboratory, and challenged children's and their parents' knowledge with a space trivia interactive display. The young were given the opportunity to "become an astronaut" by being photographed inside a mockup of an EMU suit used for spacewalks. Various JSC astronauts were on hand during weekend hours to autograph photos. JSC presented the story of America's space exploration effort to a large portion of the 1,382,183 visitors to the Houston Livestock Show and Rodeo.

As a member of the Clear Lake Area Economic Development Foundation (CLAEDF), JSC was able to share information about the International Space Station with an international audience at the 47th Paris Air Show, which took place at LeBourget Air Field outside Paris, France. In excess of 266,500 representatives of more than 149 countries attended this event. The exhibit featured space-age technology, a nine-foot-tall model of the International Space Station, and current video on the progress of station assembly flights.

The International Space Station Trailer exhibit is part of the JSC inventory of traveling exhibits. During FY 2001, it toured more than 15 cities and events throughout the U.S. where over 35,000 visitors experienced the look and feel of life on board a space station.

JSC is a well-known destination, attracting hundreds of thousands of visitors each year. In 2001, the Center welcomed many students, educators, community members and government and business leaders to sites made famous more than 25 years ago. These sites still instill a sense of wonder today.

JSC Open House invites the public to look behind the scenes and visit with the people who are an important part of

America's space exploration programs. JSC's 2001 Open House gave approximately 140,000 visitors from around the world the opportunity to see and speak with the Expedition Three crew aboard the International Space Station via satellite downlink to the stage of the Teague Auditorium.

Space Center Houston – JSC's neighboring museum, showcase and interactive center – has, for the first five years, averaged more than 800,000 visitors. It thus continues to help tell the JSC story.

In conjunction with Open House, the Clear Lake Ballunar Liftoff Festival was held on the JSC grounds. This collaboration has fostered a vibrant partnership between the Clear Lake community and JSC, NASA's home of human spaceflight. The Center for Economic Development and Research at the UH estimates the financial impact of the Ballunarfest upon the local area was approximately $8 million in 2000, and again in 2001. Estimations for the Houston region are approximately $19 million.

Employees serve, create, design and innovate at JSC. We are proud to share our news and the NASA story with the rest of the world in many ways. JSC works with national and international print as well as electronic and broadcast media on articles, television news stories, documentaries, movies and TV shows on a daily basis. JSC provides around-the-clock space shuttle mission support and commentary, broadcast coverage of shuttle preflight press conferences, status briefings and other NASA TV support.

The NASA Human Space Flight Web site is the primary mechanism for delivery of information to the public and media concerning the Human Exploration and Development of Space (HEDS). The HEDS website includes space shuttle mission coverage, International Space Station coverage, release of news concerning all aspects of the HEDS effort, and real-time and historical information at http://spaceflight.nasa.gov/.

As you can see, JSC is a positive force in the community that it calls home. A large workforce of federal and contractor employees, and the Center's economic impact, greatly influence the local economy. The Center enhances the quality of life in the area through community service, partnerships with industry and education outreach programs.

It has been an exciting year at JSC, and for the foreseeable future the Center's focus will be on safely operating the space station with America's international partner countries. Whether future space missions will travel back to the Moon, on to Mars, or beyond, the International Space Station will serve as a platform for scientific discovery and a steppingstone to future exploration in the universe.

Educational Outreach Activities

By actively working to help those benefits become known and available to the public, the people of JSC reach out not only locally but also worldwide through educational outreach activities. A few of these outreach activities include:

Mars Settlement Design Competition

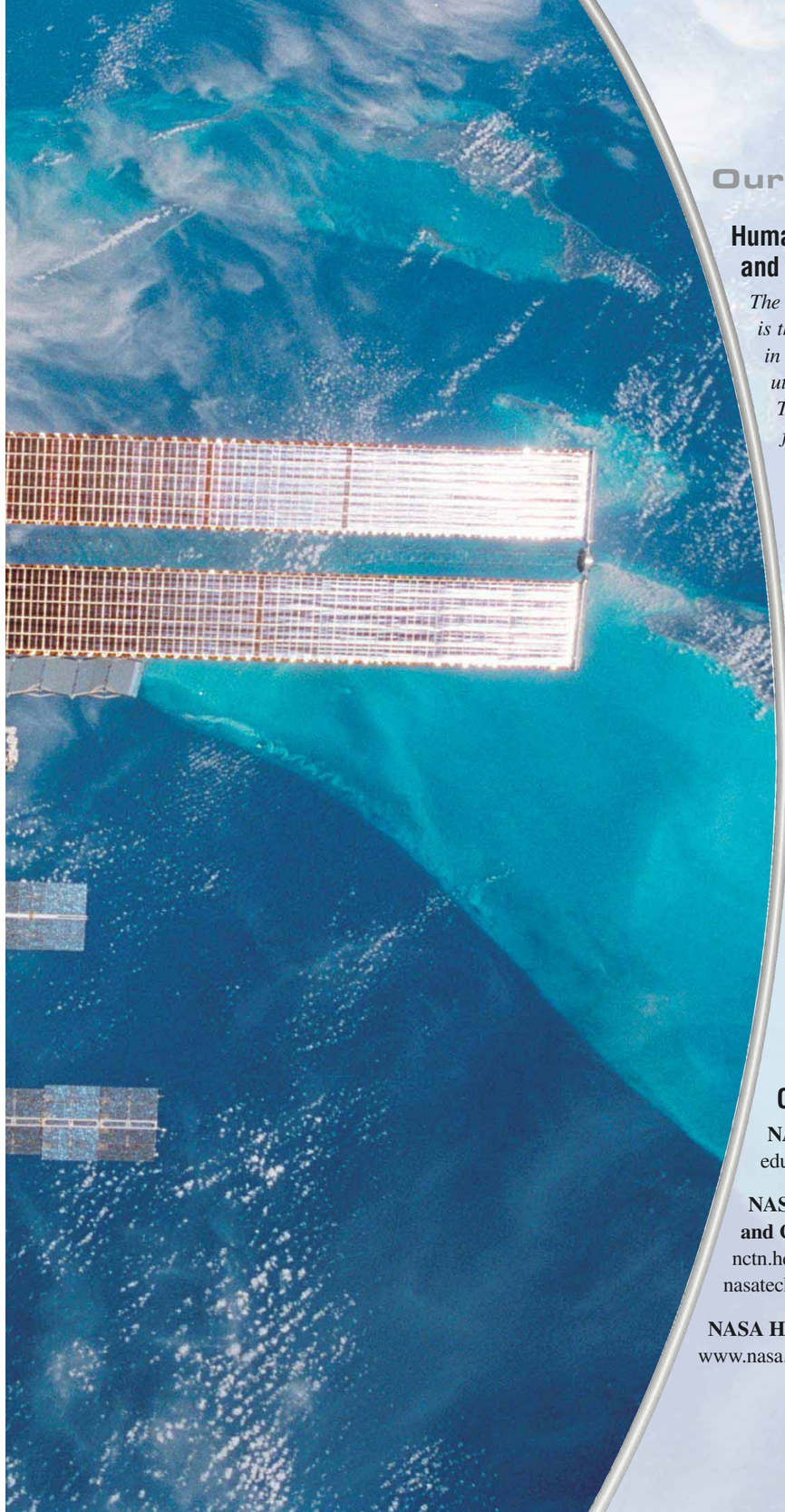
During the first weekend in February 2001, JSC hosted the third annual Mars Settlement Design Competition for Houston and Southeast Texas area high school students in grades 10, 11 and 12. Over 120 students participated, representing 38 high schools and 19 separate school districts. The three-day activity was conducted completely on site at JSC. The students formed four competitive "company" teams to live on Mars in an industry simulation game set in the middle of the 21st century.

Texas Aerospace Scholars

Education Outreach continued to serve both students and educators in FY 2000-2001. High School Aerospace Scholars (HSAS) served more than 250 high school juniors from across Texas. HSAS has become a model for successful partnerships promoting educational opportunities. The scholars completed 12 online lessons and final projects that were reviewed by NASA engineering mentors.

Distance Learning Outpost

The Distance Learning Outpost (DLO) is a unique live, real-time, interactive educational product offered by JSC's education staff. DLO offers a wide variety of educational, standards-based programs to K-12 schools, universities, museums and the public. Programs range from virtual tours of JSC's working facilities to "Expeditions" that highlight 12 space-related topics, to in-depth "Challenges" that allow students to research or construct and then present solutions to JSC experts.



Our Mission

Human Exploration and Astromaterials

The Mission of the Johnson Space Center is the expansion of a human presence in space through exploration and utilization for the benefit of all. The Center is also responsible for leadership in the field of astromaterials.

To learn more about any of the exciting programs mentioned in this publication, you may access the Web sites below:

NASA's Five Enterprises

Aerospace Technology
www.aerospace.nasa.gov

Biological and Physical Research
spaceresearch.nasa.gov

Earth Science
www.earth.nasa.gov

Human Exploration and Development of Space
spaceflight.nasa.gov

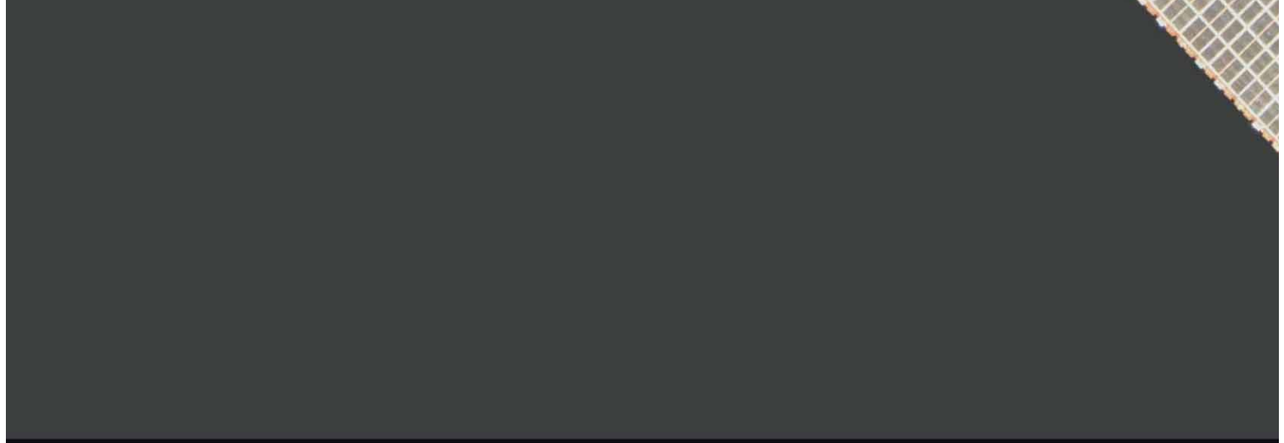
Space Science
spacescience.nasa.gov

Other Useful Sites

NASA Education Programs
education.nasa.gov

NASA Technology Transfer and Commercialization
nctn.hq.nasa.gov
nasatechnology.nasa.gov

NASA Home
www.nasa.gov



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