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# SPACE CENTER Roundup

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## New era of worldwide space exploration begins

By James Hartsfield

When *Endeavour* lifts off next month, it will lift more than just a new space station; more than the promise of unprecedented space research; more even than the cornerstone of the largest spacecraft ever built – it will have aboard the start of a new era of worldwide space exploration.

As the first of about three dozen shuttle missions to assemble the International Space Station, the STS-88 crew will initiate a construction site in Earth orbit, where a state-of-the-art laboratory complex will take shape during the coming years as components from across the globe are joined together.

“The International Space Station... is a stepping-stone to the future, and the future of space exploration is all of us working together,” *Endeavour* Commander Bob Cabana said.

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## Assistant to the President for Science and Technology pledges support for NASA

President Clinton's assistant for science and technology visited JSC recently, and returned to Washington pledging to support the International Space Station program and its objectives.

Dr. Neal F. Lane visited JSC on September 22, toured facilities and received briefings on activities here related to the Human Exploration and Development of Space.

Tommy Holloway, manager of the Space Shuttle Program, and United Space Alliance's President and CEO Russ Turner briefed Lane on shuttle operations, while Randy Brinkley, manager of the

International Space Station program, provided an overview of station progress and plans. Dr. Nigel Packham, crew commander, Lunar/Mars Life Support Test Project, discussed closed loop life support system development efforts, and Dr. Doug Blanchard provided a tour of the Lunar Lab in Bldg. 31. John Muratore, X-38 project manager, provided an overview of the X-38, the crew return vehicle for the ISS.

According to Lori Garver, head of NASA Headquarters' policy and plans office, Lane pledged to support the ISS program and its objectives. ■



JSC Photo S98-13551 by Mark Sowa

Dr. Bonnie Dunbar (left), JSC's assistant director for University Research and Affairs, and JSC Director George Abbey (right) brief Dr. Neal F. Lane, assistant to the President for science and technology, on the current status of the International Space Station.



Skylab celebrates 25th anniversary.  
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Employees stay healthy and safe.  
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Polyglot engineer reviews station parts.  
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# Skylab paved way for International Space Station

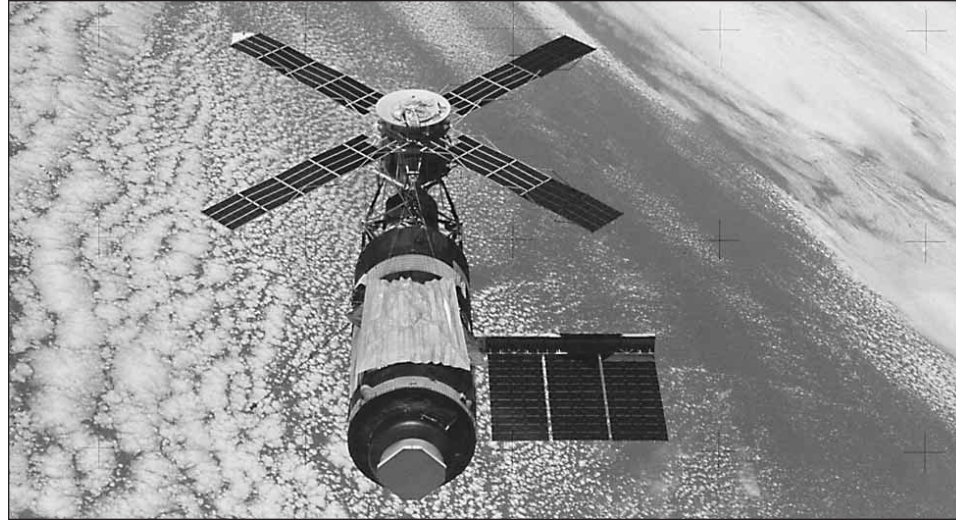
This month marks the 25th anniversary of the launch of the third and final crew to live aboard America's first space station, Skylab.

The Skylab Orbital Workshop was launched with no crew on May 14, 1973. Subsequent crewed missions were launched later that year on May 25, July 28 and November 16. Mission objectives were to show that space station operations were medically feasible, define design requirements, and demonstrate science performance during long-duration flight.

The launch of the workshop was marred by the loss of its thermal/micrometeoroid shield during ascent. One of the main solar panels was also lost and the other pinned down. It reached orbit with inadequate electrical power and dangerously high temperatures inside. These problems, which threatened total loss of the mission, were overcome by the work of the engineering teams at JSC, Marshall Space Flight Center and their contractors.

The first crew was launched 10 days later than planned, but with a full set of equipment with which to erect a substitute for the heat shield and to free up the unextended solar panel. Their success showed the value of extravehicular activities for repair of orbiting spacecraft.

Skylab 2 crew members were Charles Conrad Jr., Paul Weitz and Joseph Kerwin. During their 28-day mission, the crew conducted solar astronomy and Earth resources experiments, medical studies and



NASA Photo SL4-143-4706

**The Skylab space station cluster in Earth-orbit is shown as photographed from the Skylab 4 Command and Service Module during the final fly-around before returning home.**

five student experiments. The crew returned to Earth on June 22.

"The in-flight medical experiments gave a very complete picture of the long-term effects of weightlessness on physiology," said Kerwin. "The benefits of exercise as a countermeasure were dramatically demonstrated. Life support, diet and waste management design questions were answered, and the *Skylab Experience Bulletins* provided International Space Station designers a complete book of human factors guidelines."

Alan Bean, Jack Lousma and Owen Garriott flew aboard Skylab 3. The crew

conducted extensive scientific and medical experiments during the 59-day mission, returning to Earth on September 25.

The last of the Skylab missions, Skylab 4, was also the longest – 84 days. Gerald Carr, William Pogue and Edward Gibson conducted numerous experiments, including an observation of the comet Kohoutek, before returning to Earth on February 8, 1974.

By successfully completing increasingly longer missions, Skylab's crews demonstrated the capability to conduct long-duration, human-tended space operations. Also, resupply of space

vehicles, performed most recently during the shuttle-Mir missions and critical to the future operation of the International Space Station, was attempted for the first time with Skylab and proven to be effective.

Following the final human-tended phase of the Skylab mission, ground controllers performed some engineering tests of certain Skylab systems – tests that ground personnel were reluctant to do while crew were aboard. Results from these tests provided data on long-term degradation of space systems.

Upon completion of these tests, Skylab was positioned in a stable attitude and systems were shut down. It was expected that Skylab would remain in orbit eight to 10 years. However, in the fall of 1977, it was determined that Skylab was no longer in a stable attitude as a result of the effects of greater than predicted solar activity.

On July 11, 1979, the empty Skylab spacecraft reentered the Earth atmosphere, scattering debris over the Indian Ocean and Western Australia.

The Skylab program demonstrated that humans could live and work in space for extended periods of time, and it expanded humanity's knowledge of solar astronomy well beyond Earth-based observations.

"Skylab was a prototype," said Kerwin. "It was intended to pave the way for a permanent space station. Its designers and operators will take special pride in the future success of the International Space Station." ■

## WSTF ISO certification extended into next century

By Ray Melton

The White Sands Test Facility passed a significant milestone in September with the completion of a successful audit to extend its ISO 9001 quality system certification into the 21st century.

White Sands originally achieved its certification in October 1995. It was the first NASA installation to accomplish certification under the rigorous international standard confirming that management policies and practices meet

the highest standards for production and service.

A representative of Det Norske Veritas, White Sands' third-party registrar, performed the extension audit September 22-24, reviewing management, quality system, document control, internal audit, and corrective and preventive action systems to ensure documented practices met ISO 9001 requirements. In addition, for a more comprehensive sample, other aspects of the White Sands Quality System were

reviewed, including processes supporting Procurement, Customer Agreement, Process Control, and Control of Measurement Equipment. Only four minor nonconformances were identified during the audit, and those already are well into the corrective action process.

White Sands engineering functions were the major focus of the audit, as well as a review of institutional support activities provided for the White Sands Complex, the facility responsible for Tracking and Data Relay Satellite System ground control

activities. Base support functions were recently transitioned to the Test, Evaluation, and Maintenance contractor, AlliedSignal Technical Services. The ISO 9001 audit confirmed that the transition continues to progress smoothly.

White Sands will receive a new certificate to extend its ISO 9001 registration through September 2001, issued under a NASA-wide contract with DNV. As with the previous certification, DNV will perform periodic audits every six months. ■

Continued from Page 1

## STS-88 to begin construction of the space station

"We are bringing hardware from all over the world and assembling it in space with people from all over the world, working together despite different languages, different backgrounds, different customs and different ways of doing things. We are making that all work."

With Cabana aboard *Endeavour* will be Pilot Rick Sturckow and Mission Specialists Nancy Currie, Jerry Ross, Jim Newman and Cosmonaut Sergei Krikalev. *Endeavour*'s crew will launch Dec. 3. Two weeks earlier, on Nov. 20, the first station component, the U.S.-owned, Russian-built Zarya module, will be boosted to orbit from the Baikonur Cosmodrome, Kazakstan, by a Russian Proton rocket. *Endeavour*'s mission will be to rendezvous with and capture Zarya using the shuttle's robotic arm, controlled by Currie, and attach Zarya to Unity in the shuttle's cargo bay. Ross and Newman will then perform three space walks in later days of the flight to hook up data, electrical and fluid lines between the two components and install additional exterior equipment.

After *Endeavour* departs, Zarya will act as a sort of space tugboat, providing Unity with early power, propulsion,

communications and the capability to dock via remote control with the third station component, the Russian-provided Service Module, an early living quarters scheduled to launch from Baikonur in July 1999. *Endeavour*'s flight begins a series of about 45 U.S. and Russian flights that will assemble the station during the next five years.

"STS-88 will be among the most complicated space shuttle missions we have ever flown, but at the same time it is probably among the simpler International Space Station assembly missions," said STS-88 Lead Flight Director Bob Castle. "You will see a lot of things on this flight that will be common activities in assembly missions to come – manipulators moving large pieces around and then the crew performing several space walks to finish the connections."

*'On STS-88, we're learning to work with a new set of people in Russia. We benefitted a lot from the Shuttle-Mir missions, but on those we worked mostly with RSC-Energia.'*

— Robert Castle

to have elements that aren't even built in the same country... mated together for the first time over 200 miles up," Currie said. "It has been a very detailed and complex task to manufacture parts ... to that strict of a tolerance and to devise ways to test them on the ground to ensure their compatibility."

STS-88 will include a long string of firsts. For the first time, the shuttle crew will not have a direct line of sight toward a module they capture with the arm. Currie's view of the Zarya during the robotic arm operations will be obstructed

by the Unity module and she will rely on TV views and a new, Canadian-developed "space vision system" for cues. The Zarya module, at 43,000 pounds, will be the most massive structure ever moved using the shuttle's mechanical arm.

"We're going to have elements that aren't even built in the same country... mated together for the first time over 200 miles up," Currie said. "It has been a very detailed and complex task to manufacture parts ... to that strict of a tolerance and to devise ways to test them on the ground to ensure their compatibility."

The station's five years of assembly in orbit will encompass hundreds of hours of space walks, and its success will depend on the practice and planning performed on the ground, explained Jerry Ross, who already has accumulated 23 hours of space-walking experience on previous shuttle missions.

"One way to describe what it's like, flight after flight, is if you can imagine waking up on Christmas morning and Santa Claus has delivered a whole bunch of 'to be assembled' things to your kids, and you get out the instructions, sit there and just try to figure out 'tab A in slot B' and all that stuff," Ross said.

Another first for STS-88 will be that Mission Control must coordinate with a Russian company, the Khrunichev Space and Rocket Center which built Zarya, that was not involved during shuttle-Mir missions.

"The team is ready. The crew is ready. The launch delays have been disappointing, but we have put them to good use and we are better prepared than we would have been. Now we are ready to go," Castle said. ■

## C O M M U N I T Y N E W S

**Safety & Total Health Day: Measuring success**

By Mary Peterson

**S**eptember 23. The day was hot, maybe a bit uncomfortably so, but it was little noticed as one JSC employee made his way to a booth he had not seen on any previous Safety & Total Health Day.

The booth he sought did not have trinkets or giveaways and, for that matter, only a couple of people milled around, mostly looking at a dog of questionable pedigree but with the unmistakable quality of being somebody's "important" friend.

It was here, at the Texas Hearing & Service Dogs booth, that Rudy Lira of Information Dynamics, Inc. learned for the first time there could be special help for his hearing-impaired daughter, help in the form of a canine companion who could alert her to danger, to a possible break-in, or any number of life's threats less imposed on those who can hear.

Lira was just one of hundreds who participated in the third annual Safety & Total Health Day observance who took away far more than simple reminders to stay safe and be healthy.

"This was the greatest S&TH Day since we began," said Space Shuttle Management Integration Office employee Baley Davis. "I think people learned more this time and were truly interested in getting the most out of the information that was available." Citing the key elements set forth by JSC Director George Abbey — close call reporting, a review of reported incidents, and the introduction of the Voluntary Protection Program — Davis said, "I think the structure was good, and it gave us a more mature program than we have had in the past."

"People seemed to feel more comfortable participating in S&TH Day, and they have accepted it as an annual event that has a distinct purpose." Davis said further that many in his group had expressed an interest in serving on committees and having an even deeper involvement in the future.

The 1998 S&TH Day offered many employees their first look at the center's most ambitious safety and health incentive ever, the OSHA Voluntary Protection Program. Managers and group leaders led the overture in their individual groups, and this effort was supplemented by a VPP



JSC Photo S98-14255 by Steve Candler

Assisting the Crash Dummies on Safety and Total Health Day are (left to right) Elvis, Nurse Vera, JSC Director George Abbey, Seymore Safety, and JSC Deputy Director Jim Wetherbee.

booth sponsored by the JSC Safety Action Team where questions were answered and information distributed.

"Comments were positive and encouraging," according to Deborah Mika, a senior safety engineer and VPP coordinator for Hernandez Engineering. "Many said they had just had a presentation about VPP and wanted to know more. They know it's coming," she said. Mika added that even though VPP is still in its infancy here, a surprising number of people see it as a good thing for them personally as well as for the center as a whole and want to know how to join a committee and take an active part.

And what is VPP? Mika responded, "VPP is a tool JSC is using to take our safety and health program to the next

level of excellence."

While many were searching out information on a troubling health problem or how to manage a safety issue, still others used at least part of the day for some self-improvement. Larry Weir, director of Health-Related Fitness at the Gilruth Center, said, "We had an equally enthusiastic, if not as large, crowd of fun run participants as last year. And, although it was hot, we warned everyone to take it easy, so, thankfully, we had no injuries, just fun." The aerobics dance class, new this year, also was a highlight for several people. It will be back.

Finally, there was no better example of Safety & Total Health Day answering a personal need than that demonstrated by the selfless blood donors to help friends

and family of JSC. One, a tiny 3-year-old girl undergoing cancer treatment and, another, a United Space Alliance employee who had undergone cardiovascular surgery, were among the beneficiaries of the record 595 pints of blood donated at the S&TH Day blood drive. Of that total, 107 replacement units went to the child and 32 went to the USA employee.

By any measure, S&TH Day was a success. It is tangible evidence that JSC does care about its employees and their welfare. Abbey, in his statement at Teague Auditorium, reaffirmed this when he said, "You are important to us, and your wellness means a lot to us. You represent our most important resource." ■

**GILRUTH CENTER NEWS**

**Hours:** The Gilruth Center is open from 6:30 a.m.-10 p.m. Monday-Thursday, 6:30 a.m.-9 p.m. Friday, and 9 a.m.-2 p.m. Saturday.

**Gilruth badges:** Required for use of the Gilruth Center. Employees, spouses, eligible dependents, NASA retirees and spouses may apply for photo identification badges from 7:30 a.m.-9 p.m. Monday-Friday and from 9 a.m.-2 p.m. Saturdays. Cost is \$10. Dependents must be between 16 and 23 years old.

**Nutrition intervention program:** Six-week program includes lectures, a private consultation with the dietitian and blood analysis to chart your progress. For details call Tammie Shaw at x32980.

**Defensive driving:** One-day course is offered once a month at the Gilruth Center. Pre-registration required. Cost is \$25. Call for next available class.

**Stamp club:** Meets every second and fourth Monday at 7 p.m. in Rm. 216.

**Weight safety:** Required course for employees wishing to use the Gilruth weight room. The next classes are scheduled for 8 p.m. Nov. 12. Pre-registration is required. Cost is \$5. Annual weight room use fee is \$90. The cost for additional family members is \$50.

**Exercise:** Low-impact class meets from 5:15-6:15 p.m. Mondays and Wednesdays. Cost is \$24 for eight weeks.

**Step/bench aerobics:** Low-impact cardiovascular workout. Classes meet from 5:15-6:15 p.m. Tuesdays and Thursdays. Cost is \$32 for eight weeks. Call Kristen Taragzewski, instructor, at x36891.

**Yoga:** Stretching class of low-impact exercises designed for people of all ages and abilities in a Westernized format. Meets Thursdays 5-6 p.m. Cost is \$32 for eight weeks. Call Darrell Matula, instructor, at x38520 for more information.

**Ballroom dancing:** Classes meet from 7-8:15 p.m. Thursdays for beginner advanced classes and from 8:15-9:30 p.m. for beginner-intermediate and intermediate students. Cost is \$60 per couple.

**Country and western dancing:** Beginner class meets 7-8:30 p.m. Monday. Advanced class (must know basic steps to all dances) meets 8:30-10 p.m. Monday. Cost is \$20 per couple.

**Fitness program:** Health-related fitness program includes a medical screening examination and a 12-week individually prescribed exercise program. For more information call Larry Wier at x30301.

**Gilruth Home Page:** Check out all activities at the Gilruth online at: <http://www4.jsc.nasa.gov/ah/exceaa/Gilruth/Gilruth.htm>.

**TICKET WINDOW**

Bldg. 3 Exchange Store hours are 7 a.m.-4 p.m. Monday-Friday.

Bldg. 11 Exchange Store hours are 9 a.m.-3 p.m. Monday-Friday.

For more information, please call x35350.

Aeronautics Day at Astroworld Nov. 15 (closed to the public).

Tickets are available for \$17.50 for all ages.

The following discount tickets are available at the Exchange Stores:

General Cinema Theaters . . . . . \$5.50

Sony Loew's Theaters . . . . . \$5.00

AMC Theaters . . . . . \$4.75

Moody Gardens (2 of 6 events) . . . . . \$9.75

Space Center Houston . . . .adult \$10.25 . . . .child (4-11) \$7.00  
(JSC civil service employees free.)

Metro Tokens and value cards available.

UPS early bird special: save 10 percent on all packages mailed in November.

Photo processing: 3-inch single prints, \$2.99; 3-inch double or 4-inch single prints, \$3.99; 4-inch double prints, \$5.99.

EAA events:

Anastasia on Ice, Nov. 28, \$10.

Coming soon:

EAA Christmas Party

# Launching a new star

## Unity node ready to launch

By James Hartsfield

Launching aboard *Endeavour* in December, the six-sided Unity connecting module, the first U.S.-built space station component, will lay a foundation for all future U.S. International Space Station modules in orbit, just as it has already done on the ground.

"The biggest challenge we've had is in being the first," explained Bill Bastedo, who has overseen much of Unity's construction as the launch package manager for the last two and half years at JSC. "We've had to handle all the processes first. In many cases, we've had to invent the processes needed to build it and the processes to deal with those who'll launch and operate it. We also made all the mistakes you would expect when you're doing things for the first time."

Construction of Unity began in the fall of 1994 at a manufacturing facility at the Marshall Space Flight Center. In June 1997, it was shipped from Marshall to Kennedy Space Center for final assembly and launch preparations. Simultaneously, two conical mating adapters that are attached to Unity for launch were built in Huntington Beach, Calif. Unity has six berthing ports, one on each side, to which future modules will attach. With the two mating adapters attached, it weighs about 25,350 pounds and measures 36 feet in length and 15 feet in diameter.

"In 1996, it was tough just to coordinate our team meetings - we had people spread out in four time zones: at Kennedy, Marshall, Houston and Huntington Beach," Bastedo said. "And we had four different cultures and sets of work control systems

to integrate." Bastedo and about 10 other engineers in the station program's mission integration and vehicle office work on the launch package team for Unity.

Although it is a passive passageway, Unity is a complex hub of the station through which resources such as fluids, environmental control and life support systems, electrical and data systems are routed. More than 50,000 mechanical items, 216 lines to carry fluids and gases and 121 internal and external electrical cables using six miles of wire had to be installed in the module. The detailed and complex hardware installation required more than 1,800 drawings. Bastedo said the work on Unity has often gone far above and beyond the call of duty, and everyone at JSC, Boeing and elsewhere has exceeded each challenge.

"We have had to track literally hundreds of interfaces that Unity must make," Bastedo said. "It makes hundreds of connections on orbit and that translates into many test requirements and specifications. It is no accident that every time we leak check it, it is better than the specifications by more than a factor of 20 - an outstanding

achievement when you have 172 sealing areas. The engineering planning, the workmanship and the overall quality of the hardware have been outstanding."



KSC Photo 97EC-0944

Astronauts (from left) C. J. Sturckow, pilot; Nancy Currie, mission specialist; Bob Cabana, mission commander; and Jim Newman, mission specialist, pose with the Node 1 of the International Space Station.

Among those instrumental in the team's success have been Randy Galloway, former element manager for Unity, and Brian Mitchell, the current element manager, both JSC employees in residence at MSFC, Bastedo said. Also, Beth Cerrato's efforts to integrate efforts of the design team and the launch processing team have been vital. Other

key contributors have included Karen

Engelauf, a primary liaison between the team and mission operations personnel; Kim Ulrich, who was a key to successfully integrating Unity into the shuttle; Paul Marshall, the developer of the basic concepts used to certify the Unity and other equipment as ready for flight; and Elizabeth Smith, who performed several key integration functions, Bastedo said. Key members of the team who will complete the

development and support of mission operations include Dave Herbek, Ronnie Johnson, Eric Smistad and Linda Kurz.

At KSC, Unity was moved to the launch pad at the end of October to be installed in *Endeavour*. The milestone is a little bittersweet, Bastedo said.

"When you go see it there at KSC... it is clear how much work has gone on. In less than two years, it has gone from an empty pressure shell to a fully outfitted spacecraft. Every member of the team has a tremendous sense of pride. We're doing what we set out to do," he explained. "But we all get a funny feeling, too. After awhile, you have to say goodbye. I guess it feels kind of like watching your kids go off to school." ■

## Zarya node: A testament of U.S. and Russian teamwork

By James Hartsfield

The Zarya control module, the first component of the International Space Station to launch, has reflected the nature of the International Space Station program as a whole throughout its development, said JSC Russian Elements Manager Mark Geyer.

"This is the first really major piece of hardware built jointly by Russia and the U.S., and in that

aspect it is a microcosm of the station itself,"

Geyer said. "It started our processes of how we work with Russia... how we perform tests together, how we build hardware together, even how we write software together."

Zarya will be boosted to orbit by a Russian Proton Rocket from the Baikonur Cosmodrome, Kazakstan, on Nov. 20. Built by Russia but owned by the U.S., construction of the 42,600-pound module

began in late 1994 at the Khrunichev State Research and Production Space Center in Moscow under a subcontract to The Boeing Co.

Instrumental in overseeing the construction of the module from JSC since its inception has been Doug Drewry, the station program's launch package manager for Zarya.

Along with

Drewry, Jack Bacon at JSC also has been a key person in the module's development, providing engineering

support to resolve technical issues throughout the process. With them, a Boeing team of about 10 people, led early on by Ginger Barnes and now by Mike Wood, has provided oversight of the module's construction, including a resident Boeing office at Khrunichev.

Working on the Zarya development has meant spending many nights away from home and family, said Geyer, with

the average number of trips to and from Russia during the last four years standing at between 15-20 for almost everyone.

"The biggest challenge in development of Zarya has been building the level of trust and mutual understanding between U.S. and Russian counterparts that is

necessary to allow the kind of technical

interchange and joint decision-making required," Geyer said. The team at times has had to break down barriers of not just language, but also culture and engineering philosophies.

"You have to do more than just hear an interpreter to speak the language well," Geyer explained. "We started off with really no processes agreed to among us and now we have hundreds, hundreds that we use for not just the Zarya but also other components. We have made a lot of progress."

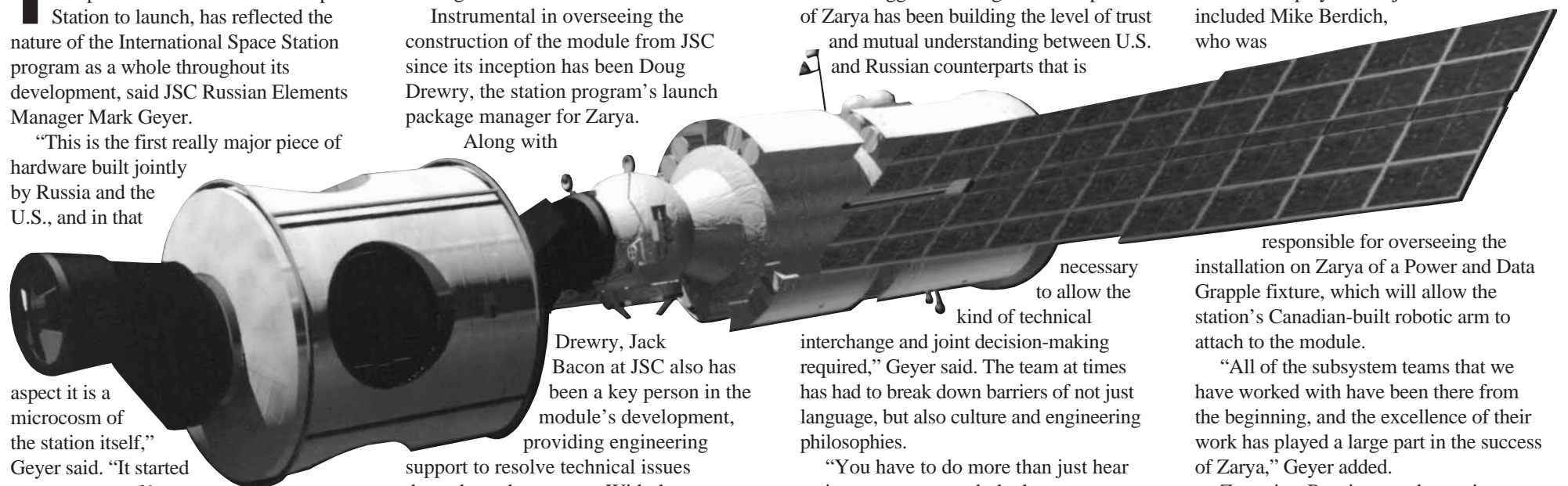
Geyer said the Boeing team that has been on-site at Khrunichev in Moscow has

been instrumental in maintaining the lines of communication concerning day-to-day activities in development of the module. Others who played a major role at JSC included Mike Berdich, who was

responsible for overseeing the installation on Zarya of a Power and Data Grapple fixture, which will allow the station's Canadian-built robotic arm to attach to the module.

"All of the subsystem teams that we have worked with have been there from the beginning, and the excellence of their work has played a large part in the success of Zarya," Geyer added.

Zarya is a Russian word meaning "Sunrise" and is symbolic of the dawn of new international cooperation in space. Zarya will provide orientation control, communications and electrical power to Unity, as well as the ability to rendezvous and dock with the third component, the Russian-provided Service Module, an early living quarters, in July 1999. ■



# Station flight controllers finish generic training

Four teams of International Space Station flight controllers completed their generic training in September and began conducting the first STS-88 flight-specific simulations. This milestone capped a year of intensive preparation that began with basic voice protocol simulations in the fall of 1997 and advanced to complex exercises using new Space Station Training Facility-provided simulators.

During their generic training, the teams simulated the most critical elements from the launch package 2A and 3A timelines, including extravehicular activities and system activation. Each flight control team worked through a series of 12 mission scenarios, which included various aspects of standalone ISS operations and integrated shuttle/ISS assembly missions.

"Progress to date has been astounding," said ISS Flight Director Sally Davis. "Most of the people on these teams were not flight controllers on the Space Shuttle Program before, so this assignment is their first experience working in the space program. They have come so far and have made so much progress that they really do function like a flight control team."

Each team has its own assigned station flight director. In addition to Davis, Mark Kirasich, Mark Ferring and Jeff Hanley were named to fill these positions in June 1996. Kirasich is the lead station flight director for 2A, while Ferring heads 2A.1, Davis leads 3A and Hanley directs 4A.

For the early assembly missions, an experienced shuttle flight director will be the lead for shuttle operations and for the overall increment. Each flight will also have the lead for the station who will work issues associated with the space station.

The station teams will begin operations in the Mission Control Center-Houston (MCC-H) with the launch of the FGB. Continuous around the clock staffing will be provided during the docked phase of 2A. After the shuttle undocks, the teams in Houston will rotate, providing full Flight

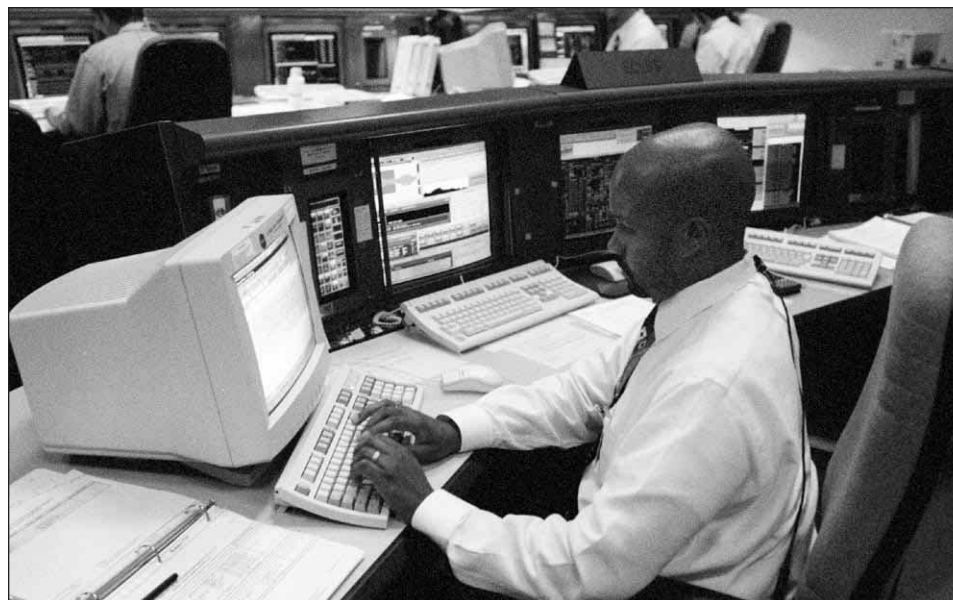
SDO will respond to questions from Moscow and monitor high-level telemetry of the spacecraft. If any anomalous events occur, the SDO will call the flight director who will call in other team members as necessary. Twenty-four-hour support will be provided if required.

Continuous flight control team support will begin in Houston with the 4A mission currently scheduled for August 1999. With 4A, key components of the U.S. power system – solar arrays, batteries, power distribution elements – will be delivered.

The training facilities and control center have followed parallel courses of development. Last fall, the first pieces of the station control center were delivered to Bldg. 30 and the first versions of the ISS simulator were delivered to the SSTF. In the spring, the second iterations of these facilities were delivered, and the station flight control teams and flight crews began conducting generic simulations in earnest. Recently, the final flight releases became available and have been used for STS-88 flight-specific training.

The blue Flight Control Room in Bldg. 30 is used primarily for station operations. Although shuttle operations will be based in the white FCR and station operations in the blue FCR, they are interchangeable. Since station training will continue after the assembly missions start, plans are under way to develop a third FCR.

Many new systems had to be developed and installed in the control center to conduct station operations, principally those used to process telemetry and station commands. These systems passed a major hurdle with the successful completion of an end test between the control center and the flight hardware at KSC in August. Currently, the interface between the MCC-H and the MCC-Moscow (MCC-M) is being tested. This interface allows U.S. communications assets to be used by the MCC-M and Russian communications assets to be used by the MCC-H. ■



JSC Photo S98-14110 Benny Benavides

**NASA Flight Controller Kwatsi Alibaruho, responsible for environmental control and life support systems, participates in a recent simulation.**

Control Team support for several hours each day. During this time, the teams will verify that the on-orbit elements are healthy, conduct required maintenance activities and test objectives, and review and approve the Moscow-generated flight plan.

Once these activities are completed, one individual – a shift duty officer – will staff the control center for the rest of the day. The

"The operation of the International Space Station is a U.S.-led effort," said Kirasich. "The ISS flight director in Houston will review and approve every daily plan. The control center in Moscow will play a major role in station operations as well. The MCC-Moscow will generate the daily plans early in the program and will operate the Russian segment."

## Getting down to the nuts and bolts: Putting the station together

In December, members of the STS-88 crew will attach Unity to Russia's Zarya control module. Prior to the shuttle's rendezvous with Zarya, astronauts will use the shuttle's Remote Manipulator System to lift Unity out of the payload bay. The shuttle will then dock with Zarya, using the RMS to latch Unity to Zarya. Once the components are attached, astronauts will conduct three space walks to connect power and data transmission cables among Zarya, Unity and two Pressurized Mating Adapters.

And so begins construction of the International Space Station, a project that will turn Earth orbit into a daily construction site for the next five years. Astronauts will perform more space walks in those years than have been conducted since space flight began. Approximately 160 EVAs, totaling about 1,700 crew hours, or about 850 EVA hours, are planned for station assembly—about as many EVA hours as have been conducted in the history of human space flight to date.

During the first seven shuttle assembly missions, there is no U.S. capability for space walks to be conducted from the station without the space shuttle present. The Russian Service Module provides a capability for station-based Russian space walks using only Russian spacesuits, but the U.S. capability will not be available until the Joint Airlock Module is attached to the station during the seventh space shuttle assembly mission, STS-101.

After the Joint Airlock Module is operational, the philosophy of space walk training for maintenance tasks for increment crewmembers will shift due to the increasing complexity of the station and the ability of the station crew to

perform space walks. Because the station's growing size and complexity will make it next to impossible to train station crew members for every EVA task they may be called upon to perform during a mission, training will increasingly aim toward providing crew members with a general suite of EVA skills.

To assemble and maintain the ISS, space-walking astronauts will work in partnership with a new generation of space robotics. The space shuttle's mechanical arm and a new space station arm will operate both as "space cranes" to maneuver large modules and components and as space "cherry pickers" to

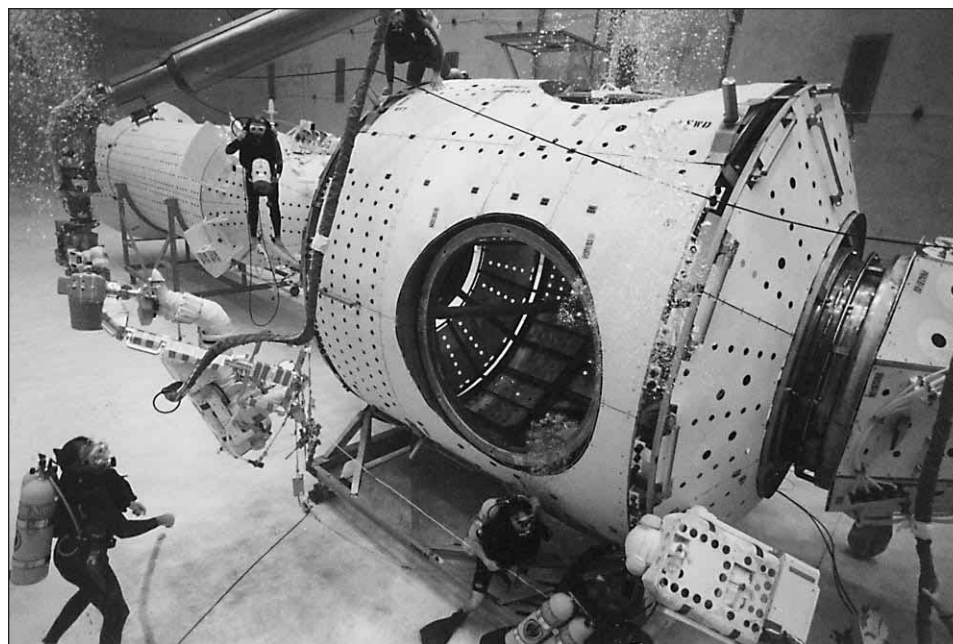
SSRMS, is a larger and more advanced version of the shuttle's RMS. The SSRMS will have the new capability to move around the station's exterior like an inchworm, locking its free end on one of many special fixtures placed strategically around the station and then detaching its other end and pivoting it forward. In addition, the station arm eventually will be able to ride on a Mobile Remote Servicer Base System platform that will move on tracks along the length of the station's truss, putting much of the station within grasp of the arm.

The SSRMS is scheduled to launch in December 1999. The Mobile Remote Servicer Base System will launch in August 2000.

Canada is also providing the Special Purpose Dexterous Manipulator, or Canada Hand, a smaller two-armed robot that can handle some of the delicate tasks that astronauts typically perform, such as tightening and loosening bolts. The Canada Hand is scheduled to be launched and attached to the robotic arm in May 2002.

What will be the major challenges in assembling the station? Probably not putting the larger pieces together, according to Harbaugh. He said that since the overall mating of large structures will be validated on the ground, the major problems that may arise will concern other issues such as bringing the smaller items together and seeing that they are properly secured. But the time has come to begin that assembly process.

"We have reviewed the three space walks planned for STS-88, and that training process is very mature and the crew is ready to go," said Harbaugh. "It's time to get to work." ■



JSC Photo S97-11949

**Astronauts perform a training session in the Neutral Buoyancy Laboratory of the Sonny Carter Training Facility.**

"We have demonstrated through shuttle-Mir that we can train people and walk them through tasks so that they have an appreciation for what will have to be performed on orbit without ever having practiced that specific task beforehand on the ground," said Gregory Harbaugh, head of the EVA Office. "This philosophy differs significantly from our previous approach to EVA training."

maneuver astronauts to work areas.

The largest robotic apparatus is Canada's primary contribution to the station, the Mobile Servicing System. This system will move equipment around the station, capture and release satellites, and service the payloads and instruments aboard the station.

The "arm," known as the Space Station Remote Manipulator System or

## Ripped from the ROUNDUP

Ripped straight from the pages of old Space News Roundups, here's what happened at JSC on this date:

1 9 7 3

**T**he crowd in the viewing sites at Cape Kennedy, Florida, waited with mounting anticipation. Meanwhile, JSC's mission controllers were just a bit tense, yet confident that all would go well. The final count began.

The Saturn 1B rocket lifted off from Cape Kennedy on Nov. 16 at 8:01 a.m. in what has been described as one of the most spectacular sights ever witnessed by man. Skylab 4 was "Go."

1 9 7 8

**O**ne of the Control Moment Gyros on Skylab was getting too cold. Shade from the space station's telescope mount was creating a lubrication problem, so controllers at Marshall and JSC wrote a maneuver to turn Skylab around, putting the shaded CMG into the sun.

1 9 8 3

**P**resident Reagan requested the Senior Interagency Group for Space to conduct a high-level study to establish the basis for an Administration decision on whether to proceed with NASA development of a permanently based, manned space station.

The interagency group will consider four scenarios for possible paths the nation's space program might take following completion of the development of the Space Shuttle. The scenarios include: the Shuttle and unmanned satellites, the Shuttle and unmanned platforms, the Shuttle and an evolutionary space station, or the Shuttle and a fully functional space station.

1 9 8 8

**J**SC plans to spend a total of \$2.22 billion in fiscal year 1989, a 26 percent increase from the previous year, including a 67 percent increase in planned space station spending.

Funding for Space Station *Freedom* comprises about 14 percent of JSC's total planned costs in 1989 as compared to the 10 percent of the center's spending it comprised in fiscal year 1988

## NASA New England Outreach Center honors JSC

JSC received the NASA New England Outreach Center's Commitment to Excellence Award at the seventh annual NASA Technology and Business Conference held in Burlington, Vt. Kenneth Martindale, JSC small and disadvantaged business specialist, accepted the award.

JSC was recognized for its continued commitment to Northeast business firms in its contracting opportunities. Firms in the Northeast receive approximately \$500 million in direct awards from NASA, with over 25 percent being awarded by JSC. Subcontract awards to the Northeast at least equal that value.

The Commitment to Excellence Award for a NASA field center commends outstanding corporate performance in efforts that further small and disadvantaged business interests. The award is presented for support of NASA's New England Outreach Center and NASA's small and disadvantaged business programs. JSC contributes to the awareness of contracting opportunities with its annual "Inspection," highlighting its technologies and facilities. ■



Kenneth Martindale, JSC small and disadvantaged business specialist, accepts NASA New England Outreach Center's Commitment to Excellence Award for a NASA field center. Attending the presentation are (left to right): Ralph Thomas, associate administrator, NASA Headquarters; Martindale; and Glenn Wright, director, NASA's New England Outreach Center.

## Prime example of community partnering wins top honors

The General Services Administration presented its Achievement Award for Real Property Innovation during a recent ceremony held at GSA Headquarters in Washington, D.C. JSC's entry, "Partnering for Land Use - Agriculture Science Center Laboratory," was selected as the winner in the Best Policy category. JSC employees Melody Nation, realty officer, and Don Holick, master planner, received the award.

An independent four-member panel comprised of real estate and management experts from industry and government selected JSC's winning entry from among

41 entrants in two categories.

By now, the sight of majestic longhorns grazing on JSC land just behind Rocket Park is very familiar. But without the determined efforts of Nation and Holick, this vision would never have become a reality.

No doubt the request from JSC Director George Abbey was a challenge - find a way to use a controlled area of JSC property for a hands-on agricultural education facility, an idea born from his desire to meet government, agency and center strategic goals and from discussions held with the superintendent

of the Clear Creek Independent School District.

Nation and Holick work in the Real Property Office, the organization responsible for developing the policy that led to the establishment of the Agriculture Science Center Laboratory. Both worked tirelessly to implement a program that is both worthwhile and meaningful to the students who use the facility.

At the October 21 ceremony and reception, GSA Administrator David Barram presented Nation and Holick with a trophy, certificates and a cash award of \$5,000 that they will share. ■

## Two secretaries earn high praise



JSC Photo S98-13231

JSC Director George Abbey (right) presents the Marilyn J. Bocking Award for Secretarial Excellence to Karen McMahon. Space Shuttle Program Manager Tommy Holloway (left) attended the presentation.

Two JSC secretaries have received the center's highest honor for clerical support, the Marilyn J. Bocking Award for Secretarial Excellence.

Karen McMahon of the Space Shuttle Program Office received her award in August. Sue Bobo of the Engineering Directorate received hers in September.

McMahon was recognized for her

outstanding support to the Space Shuttle Program flight managers and Payload Safety Review Panel chairman. She has proven to be an "invaluable asset" to the office as a result of her work in compiling the combined Space Shuttle Program integration calendar.

Bobo was recognized for her excellent support to both the Thermal Systems and



JSC Photo S98-14351

Sue Bobo accepts the Marilyn J. Bocking Award from JSC Director George Abbey (right). Chin Lin, chief of the Thermal Systems and Engineering Support Branch, attended the presentation.

Engineering Support Branch and the Crew and Thermal Systems Division. For several years, she has served in a dual secretarial role providing excellent support to both offices. She is especially conscientious of ISO 9000 compliance and has organized the quality records for the branch, as well as suggesting improvements to the processes used. ■

## Space station conference set for February

NASA will cosponsor a conference on International Space Station utilization scheduled for February 1-4, 1999, in Albuquerque, N.M.

More than 20 sessions will cover all of the major research areas to be explored on

the ISS including biotechnology, biomedicine, gravitational biology, materials science, fluids and combustion research, space science, earth science and engineering research. Sessions on commercial research and service activities

and technical presentations on ISS capabilities will also be included.

The complete list of planned papers, as well as registration and logistics information, may be found on the web at <http://www-chne.unm.edu/isnps>. ■



## P E R S O N A L I T Y P R O F I L E

**Station employee reflects program's international scope**

By John Ira Petty

When Raphael "Ralph" Anthony Grau speaks with his mother, they might use English, Spanish – or both of the above with some Italian, French and Portuguese thrown in.

Sometimes they forget to switch back to just plain English when they speak to others, which has confused some supermarket checkout people.

Grau is EEE Parts Lead in the International Space Station Program. EEE stands for electrical, electronic and electromechanical parts, "basically switches, relays, microcircuits," he said. "Every computer chip, every signal processing chip has to get my blessing for space station. The parts count has got to be in the hundreds of thousands."

Grau's multicultural, multinational background is in many ways what the Americas are about. It certainly reflects the diversity of the JSC workforce.

Grau's first name is Spanish, the middle name Italian, and last name German. "My dad was born in Cuba; his parents were from Spain. Generations before that the family was German. My mom was born in Brazil; her grandparents were Italian."

The language abilities have come in handy. For example, he regularly volunteers to do interviews with media representatives from Spanish-speaking countries. He also worked at the JSC booth at the State Fair of Texas for the Technology Transfer Office. Smiling, enthusiastic and outgoing, he handles those duties well.

At age 34, Grau has been at the NASA complex since May 1990. He worked for Ford Aerospace for three months, then got an invitation to join NASA.

He has been assigned to the International Space Station during his



JSC Photo 98E07667

**Raphael "Ralph" Anthony Grau, EEE parts lead in the International Space Station Program, displays some of the many electrical components that he has examined.**

entire NASA career. He began with reliability engineering for guidance navigation; from there he worked in maintainability, safety, quality assurance and now EEE.

It has been a growing process. "When you work for safety and quality assurance you develop a good, broad-horizon system picture, because it all has to work together. Everything has to be reliable and, especially, safe. I've worked propulsion, thermal systems, micro-meteor shielding systems, data management systems— so I've had broad experience with all the core systems that make the space station tick."

Grau was born in Baltimore. His father was in petrochemical construction. "Build it and move was the family motto," he

said. The family did move, 26 times in 20 years. Grau spent 11 years in Latin America and two years in Australia.

He earned a bachelor's degree in electrical engineering from Texas A&M University, then went to work in Sugar Land for a company doing energy management systems for power companies.

Grau got tired of that after about four years. Space fascinated Grau, so he applied to Ford Aerospace.

About a year after he graduated from A&M (a year during which he took a semester-long welding class for practical and artistic applications) he started evening classes at the University of Houston-Clear Lake. In 1992 he received a master's in business administration.

"I wanted to get into the project management side," he said. "My job isn't so technical, as long as things don't break. But if they do break, I've got to understand why."

His job basically is to shake out the bugs before equipment gets on orbit.

For Grau, there is life outside the space program. Until about three years ago he was active in water skiing, snow skiing, personal watercraft, dirt bikes and more. Then he ruptured a disc in his back.

Surgery was successful, but hobbies changed. Now he builds his own computers and home theater systems.

He also enjoys inside-the-loop night life. He lives in the Greenway Plaza area, "a really vibrant part of town." Being out and about relieves the stress. "We're in a very stressful program. You need to manage stress before it eats you alive."

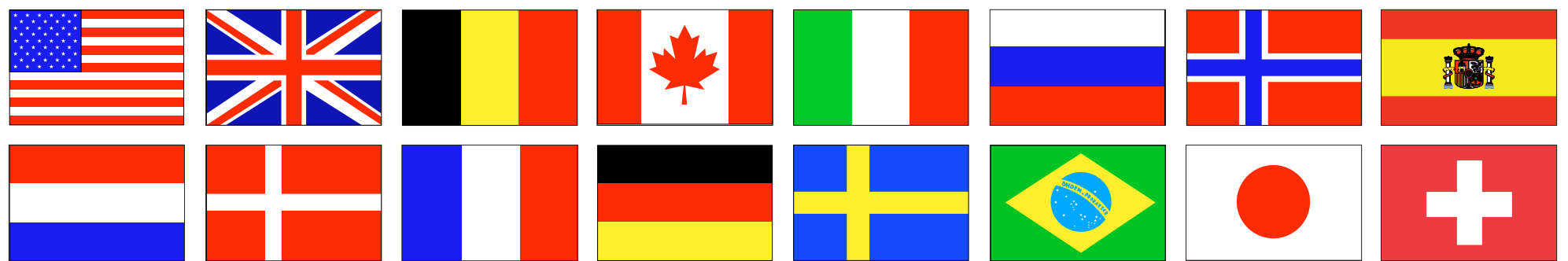
With the stress comes satisfaction. Grau says he believes there's a renewal of interest in space, "especially as we start pushing more commercialization. I think we really need to be agents of change and facilitate private industry getting into space – setting up the infrastructure and the knowhow to do it safely."

Space has become multinational. The Phase 1 shuttle-Mir program is an example of the benefits. Mir's contributions to the space station program were substantial.

"We don't normally think of gaining perspective," Grau said, "It helps so much – just taking a step sideways and looking at it with a different set of eyes and a different set of rules."

"Space isn't a single country's endeavor anymore. It has to be multinational, because of economics and technical factors. We all have our strengths we bring to the table."

Besides, Grau said, "Some of our differences are so artificial." ■

**International Partners Office provides worldwide liaison**

The International Partners Office at JSC was established five years ago to serve as a focal point in managing all of the programmatic issues associated with keeping the International Space Station program on track.

"We were not brought into existence to solve technical problems but to define and resolve programmatic issues such as resource sharing and barter agreements," said Craig Stencil, manager of the International Partners Office.

Representatives stationed at JSC and overseas serve as liaisons between the center and countries around the world. The office has a permanent representative in the Netherlands (European Space Agency), Italy (Agenzia Spaziale Italiana/Alenia Aerospazio), Japan (National Space Development Agency of Japan), Canada (Canadian Space Agency), Brazil (National Institute for Space Research) and Moscow (Russian Space Agency). Similarly, the Russian Space Agency, Canadian Space Agency, Italian Space Agency, the National Space

Development Agency of Japan and ESA have local representatives at JSC. Brazil, a recent addition to the ISS program, plans to have a full-time representative here soon.

Through this network of worldwide communication, the office is able to perform one of its primary missions: keeping JSC's ISS program manager aware of all current issues affecting the partners.

Representatives stationed overseas are responsible for ensuring that international partners build ISS elements/equipment to meet requirements. In addition, NASA has transferred production responsibility for several elements to international partners/participants. However, NASA retains responsibility for ensuring that the elements are built to meet specifications. For example, as a result of barter agreements reached with ESA, the U.S. is going to lift to orbit the ESA-built Columbus Orbital Facility. ESA, in return, is working with the Italian Space Agency to supply two elements – Nodes 2 & 3 – for

ISS. The Nodes are outfitted with U.S.-sourced components for which NASA retains responsibility and oversight.

Other projects that the office manages involve all station partners and participants. The partners recently reached an agreement on cost sharing, an effort that took years to achieve. To reach this accord, the partners had to develop a mechanism to share the expenses associated with operating on-orbit station components.

"Determining the fair share of each country's piece of the station was a complex exercise because contributions vary across nations," said Stencil. "We had to estimate what we think it will cost to operate the station, and then we had to decide what is common to everybody and, lastly, we had to reach a fair percentage for each partner and participant."

In addition to working with international partners on a daily basis, the office maintains close coordination with NASA Headquarters. Headquarters is tasked with being the final arbiter in negotiating inter-government agreements

and memorandums of understanding, but the International Partners Office sets the requirements for these agreements.

The International Partners Office works with its HQ counterpart, the Space Flight Division of the Office of External Relations, on a daily basis. Interaction among the offices includes providing support in response to Congressional inquiries concerning the International Space Station.

With all of the early partner/participant contributions on schedule for delivery, the office is now turning its attention to working issues associated with launching the station.

"Our primary challenge now is to anticipate potential threats to development activities that may become problematic," said Stencil. "These may include countries that challenge requirements or ask for more money to deal with new requirements. There are no guarantees with any development program, but I think we are starting to turn the corner to launching the station." ■

**NASA BRIEFS**

**LAUNCHES OF STATION COMPONENTS ON SCHEDULE**

The launches of the first International Space Station components – the Zarya module and the Unity module – remain on schedule following a series of technical meetings in Moscow that concluded October 2 with a meeting of representatives from all international partners. All station partners reviewed and concurred with a plan to maintain the current launch schedule for Zarya, which will launch on a Russian Proton booster November 20 from the Baikonur Cosmodrome, Kazakhstan, and for Unity, which will launch on the Space Shuttle Endeavour December 3.

**HUBBLE GOES TO THE LIMIT IN SEARCH OF FARTHEST GALAXIES**

Stretching the vision of NASA's Hubble Space Telescope farther across space and further back into time than ever before, astronomers have peered into a previously unseen realm of the universe.

A "long exposure" infrared image taken with Hubble's Near Infrared Camera and Multi-Object Spectrometer has uncovered the faintest galaxies ever seen. Astronomers believe some of these galaxies could be more than 12 billion light-years away (depending on cosmological models), making them the farthest objects ever seen. A powerful new generation of telescopes will be needed to confirm the suspected distances. "NICMOS has parted the dark curtain that previously blocked our view of very distant objects and revealed a whole new cast of characters. We now have to study them to find out who, what and where they are. We are still finding new frontiers," said Rodger Thompson of the University of Arizona in Tucson.

"This is just our first tentative glimpse into the very remote universe," said Alan Dressler of the Carnegie Observatories in Pasadena, Calif. "What we see may be the first stages of galaxy formation. But the objects are so faint that their true nature can only be explored with the advanced telescopes of the future."

**MARS GLOBAL SURVEYOR CAPTURES NEW VIEWS**

NASA's Mars Global Surveyor has captured some spectacular new views of Olympus Mons, the largest volcano in the solar system, and a system of giant channels on the red planet known as Kasei Vallis. The new images are available on the Internet at <http://www.jpl.nasa.gov>, <http://photojournal.jpl.nasa.gov/>, <http://mars.jpl.nasa.gov/> and at <http://www.msss.com>.

**PEOPLE on the MOVE**

**Human Resources reports the following personnel changes as of October 3, 1998:**

**Key Management Assignments**

*Earl Thompson* was named associate director, Information Systems Directorate.  
*Wayne Thomas* was named manager, Space Station Acquisitions Management Office, Business Management Directorate.  
*Ginger Darnell* was named manager, Institutional Business Management Office, Business Management Directorate.  
*Craig Dinsmore* was selected as deputy chief, EVA and Spacesuit Systems Branch, Engineering Directorate.

**Additions to the Workforce**

*Harry Axline* and *Stephen Malarchick* join the Aircraft Systems Quality Assurance Branch in the Flight Crew Operations Directorate as quality assurance specialists.  
*Terry Pappas* joins the Flight Operations Branch in the Flight Crew Operations Directorate as a research pilot.  
*Nicole Stott* joins the Shuttle Training Support Branch in the Flight Crew Operations Directorate as a senior flight simulator engineer.  
*John Yaniec* joins the Flight Operations Branch in the Flight Crew Operations Directorate as an aviation program specialist.  
*David Korth* joins the Flight Planning Branch in the Mission Operations Directorate as a flight controller.  
*Bryan Snook* joins the Cargo Integration and Operations Branch in the Mission Operations Directorate as a flight controller.  
*Frank Cho*, *John Garr*, *Holly Ridings*, and *Bridget Ziegelaar* join the Environmental Systems Branch in the Mission Operations Directorate as flight controllers.  
*Kristine Kennedy* and *Michael Wright* join the EVA and Robotics Systems Branch in the Mission Operations Directorate as flight controllers.  
*Michal Ruiz* joins the Electrical Systems Branch in the Mission Operations Directorate as a flight controller.

*Kimberly Cyr* joins the Planetary Science Branch in the Space and Life Sciences Directorate as a space scientist.

*Clarence Williams* joins the Human Resources Management Branch in the Human Resources Office as a human resources representative.

**Promotions**

*Patty Caballero* was selected as an accountant in the Cost Accounting, Reporting, and Property Branch in the Office of the Chief Financial Officer.  
*Eileen Hawley* was selected as newsroom manager in the Public Affairs Office.  
*Debra Holland* was selected as directorate secretary in the Information Systems Directorate.

**Reassignments Between Organizations**

*Lee Pagel* moves from the International Space Station Program Office to the Business Management Directorate.  
*Michael Janas* moves from the International Space Station Program Office to the Flight Crew Operations Directorate.  
*Clarence McMillan* moves from the Space Shuttle Program Office to the Engineering Directorate.  
*Robert Trevino* moves from the EVA Project Office to the Engineering Directorate.

**Reassignments to Other Centers**

*Thomas Baugh* of the Business Management Directorate moves to NASA Headquarters.  
*Diane DeTroye* of the Human Resources Office moves to NASA Headquarters.

**Resignations**

*Tracy Hancock* and *Judith Sparks* of the Business Management Directorate.  
*Michele Brown* of the Space and Life Sciences Directorate.

**DATES & DATA**

**November 10**

**Aero club meets:** The Bay Area Aero Club will meet at 7 p.m. Nov. 10 at the Houston Gulf Airport clubhouse at 2750 FM 1266 in League City. For more information, call Larry Hendrickson at x32050.

**NPMA meets:** The National Property Management Association will meet at 5 p.m. Nov. 10 at Robinette and Doyle Caterers, 216 Kirby in Seabrook. Dinner costs \$14. For details, call Sina Hawsey at x36582.

**November 11**

**IAAP meets:** The Clear Lake/NASA Chapter of the International Association of Administrative Professionals (previously Professional Secretaries International) will meet at 5:30 p.m. Nov. 11 at Bay Oaks Country Club. Cost is \$16. For details, call Elaine Kemp at x30556.

**November 12**

**MAES meets:** The Society of Mexican-American Engineers and Scientists will meet at 11:30 a.m. Nov. 12 in Bldg. 16, Rm. 111. For details, call George Salazar at x30162.

**Airplane club meets:** The MSC Radio Control Airplane Club will hold its annual auction at 7:30 p.m. Nov. 12 at the Clear Lake Park pavilion. For more information, call Bill Langdoc at x35970.

**November 13**

**Astronomers meet:** The JSC Astronomical Society will meet at 7:30 p.m. Nov. 13 at the Center for Advanced Space Studies, 3600 Bay Area Blvd. For more information, call Chuck Shaw at x35416.

**NSS meets:** The Clear Lake Area chapter of the National Space Society will meet at 6:30 p.m. Nov. 13 at the Radisson Hotel - Hobby Airport (9100 Gulf Fwy.) in the Deer Park room. The event is open free to the public.

**November 17**

**NPMA meets:** The National Property Management Association will meet at 11:30 a.m. Nov. 17 at the Gilruth Center. Cost is \$14. For details, call Mike Puryear (280-2058) or Sina Hawsey (483-6582).

**November 18**

**Astronomy seminar:** The JSC Astronomy Seminar will meet at noon Nov. 18 and 25 and Dec. 2 in Bldg. 31, Rm. 129. For more information, call Al Jackson at x35037.

**Spaceland Toastmasters meet:** The Spaceland Toastmasters will meet at 7 a.m. Nov. 18 and 25 and Dec. 2 at the House of Prayer Lutheran Church. For details, call George Salazar at x30162.

**Communicators meet:** The Clear Lake Communicators, a Toastmasters club, will meet at 11:30 a.m. Nov. 18 and 25 and Dec. 2 at Lockheed Martin, 555 Fordge River Rd. For more information, call Allen Prescott at 282-3281 or Mark Caronna at 282-4306.

**Spaceteam Toastmasters meet:** The Spaceteam Toastmasters will meet at 11:30 a.m. Nov. 18 and 25 and Dec. 2 at United Space Alliance, 600 Gemini. For details, call Patricia Blackwell at (281) 282-4302 or Brian Collins at x35190.

**Scuba club meets:** The Lunarfans will meet at 7:30 p.m. Nov. 18 at Pot Pie Pizzeria at Watergate Marina. For details, call Mike Manering at x32618.

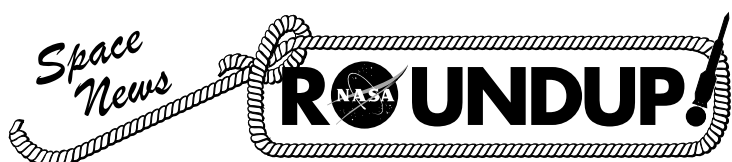
**November 19**

**Directors meet:** The Space Family Education board of directors will meet at 11:30 a.m. Nov. 19 in Bldg. 45, Rm. 712D. For more information on this open meeting, call Gretchen Thomas at x37664.

**December 3**

**Radio Club meets:** The JSC Amateur Radio Club will meet at 6:30 p.m. Dec. 3 at the Piccadilly, 2465 Bay Area Blvd. For more information, call Larry Dietrich at x39198.

**Warning System Test:** The site-wide Employee Warning System will perform its monthly audio test at noon Dec. 3. For details, call Bob Gaffney at x34249.



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