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Pegasus/TOMS Launch Successful from Vandenberg AFB

The Goddard-managed Total Ozone Mapping Spectrometer Earth Probe (TOMS-EP) satellite was successfully launched July 2 aboard an Orbital Science Pegasus XL vehicle.

The launch occurred just after midnight at 12:48 PDT, putting TOMS-EP into an orbit of 517 statute miles. The satellite is expected to be fully operational by the end of July.

The successful launch means that high-resolution measurements of the total column amount of ozone from space will once again be available to scientists.

The data flow, which began in 1978 with the launch of the Nimbus-7 satellite and continued with the start of the TOMS Meteor-3 mission, ended when Meteor-3 was deactivated in December 1994.

Initial checkout of the satellite and the spectrometer found only minor issues to work. Project Manager Phil Sabelhaus termed the launch and beginning stages of the flight as near perfect.

"We're in great shape and hope to have a fully operational instrument within a short time."

Goddard Team Develops Commercial Off-the-Shelf Ground System Prototype

In just 90 days, NASA's Goddard Space Flight Center integrated a prototype space flight ground support system using commercial off-the-shelf (COTS) software products. This accomplishment sets the stage for lower costs and shorter development time for future spacecraft ground systems.

Developed by a NASA-industry team, the "proof-of-concept" project called Integrated Monitoring, Analysis, and Control COTS System (IMACCS) is based 85 percent on commercially available computer products and 15 percent on government products, and has performed all functions successfully under stress of live mission data.

Development of the IMACCS was accomplished at about one-seventh the cost of a typical ground system using non-COTS products. This cost of the IMACCS implementation with no redundancy was \$525,000, said Gary Meyers of Goddard's Mission Operations and Data Systems Directorate (MO&DSD).

"The success of this prototype opens the door for refining NASA's approach to ground system services. With IMACCS, we not only processed real data but actually commanded the Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX) spacecraft. It clearly shows the potential to support Goddard's goals to deliver high-quality, highly-productive missions for our customers but more quickly and with less cost to the taxpayer," he said.

IMACCS demonstrates that developing a ground system in one year for mission customers is an achievable goal in the evolution from large missions to smaller single-purpose ones. IMACCS is one of several innovative, lower-cost initiatives Goddard is pursuing as alternatives to larger customized ground support systems.

"With a combination of COTS and Government-Off-The-Shelf (GOTS) products, IMACCS and products like it are key to substantial savings over development and operations items in future missions. Their high use of mature off-the-shelf products costs less in time, material, and labor," he said.

The IMACCS prototype is a collaboration between Goddard and industry. Goddard's MO&DSD implemented the COTS-based system with an industry team led by the Computer Sciences Corporation (CSC). CSC supported the integration of software and hardware products from Loral Test and Information Systems; Altair Aerospace Corporation; Analytical Graphics, Inc.; BBN Software Products Corporation; Storm Integration, Inc.; The MathWorks; and Talarian, Inc.

IMACCS Functional Capabilities

IMACCS meets the majority of ground system needs of a typical scientific spacecraft. Elements included in the IMACCS system cover health and safety

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Goddard Center Director Joe Rothenberg, left, and Associate Director for Mission to Planet Earth, Bob Price, second from left, meet with employees during a recent get together. Rothenberg and other senior managers are holding "get acquainted" sessions with employees throughout the center.

NASA Satellite Station Aids Fire Fighting

By Ernie J. Shannon

During a season in which fires have scorched more than 23 million acres of Mongolian forest and range lands, a NASA meteorological satellite receiving station is helping to save lives and livestock.

An exceptionally dry winter which saw little snowfall has given way to a hot and dry summer providing tinder for large forest fires across northern Mongolia. The conflagration has consumed 8.6 million acres of forests and 14.3 million acres of grasslands and has claimed 800 lives and 7,800 livestock. It could, however, have been much worse for man and beast.

In the midst of this record-setting fire season, Goddard researcher Dr. Compton J. Tucker, of the Earth Sciences Directorate, traveled to Ulaanbaatar, Mongolia in May, site of the satellite station, to monitor its operations. Because of the rapidly changing course and intensity of the fires, keeping the station in operation has become extremely important to the Mongolian fire-fighting effort. Tucker said the NASA-installed equipment has played a key role in fighting the fires.

"The meteorological satellite receiving station is invaluable for locating wild fires and tracking their movements," Tucker said. "Using several channels on the advanced very high resolution radiometer instrument aboard a National Oceanic and Atmospheric Administration (NOAA) satellite, wild fires can be identified and monitored."

According to the American Ambassador to Mongolia, Donald C. Johnson, the meteorological station is providing the Mongolian National Emergency Commission with day-to-day reports on the fires' progress throughout the country. The near real-time information has allowed the commission to warn inhabitants, especially those with large herds, to move out of the paths of flames to safety.

Ambassador Johnson said that the Mongolian station employees rise each day at 2 or 3 a.m. to catch the first pass of the NOAA satellite. They then prepare a comprehensive report for the emergency commission pinpointing the location of fires, tracking the movement and giving early warning to government officials.

NASA provided the satellite receiving station to Mongolia through a Memorandum of Understanding agreement. In June 1995, Goddard hardware engineer Patrick Coronado and software engineers Gene Shaffer and Allan Lunsford, all of the Space Data and Computing Division in the Earth Sciences Directorate, installed a new antenna, image processing system and other equipment at the receiving station. In December, NASA and Mongolia extended the Memorandum of Understanding for an additional five years.

Ambassador Johnson, in a letter to NASA Administrator Dan Goldin, praised the work of Tucker and his associates and said, "I have made improved science cooperation with Mongolia one of the top priorities during my service here as ambassador. Contributions such as the NASA-provided station have enabled us to strengthen this bilateral cooperation in ways that are tangible and clearly understood by the 'average citizen.'"

Earth Alert Technology Demonstrated at Goddard

By Donna Drelick

Imagine that you are camping in a remote, desolate area. No electricity, no phones, no contact with civilization—just what the doctor ordered. But as luck would have it, fires have erupted in the forest surrounding your camp site. Because you are cut-off from communication, you have no way of knowing of this impending disaster. If only you had a portable device that could give you such information.

Such a system, called "Earth Alert" has been developed through a joint project by Goddard and the Scientific and Commercial Systems Corporation (SCSC), Beltsville, Md. The portable system designed to provide warning of disasters via a hand-held, pager like device was demonstrated at Goddard on July 2.

"We have shown that existing NASA

technology can be used for humanitarian service while creating a niche for American industry," said Patrick Gary, of the Computer Networks & Communications Branch, one of the designers of the system.

Goddard engineers initially conceived and co-developed the warning system to broadcast survival information to isolated populations using old weather and communications satellites. The Office of Commercial Programs provided support for the project while SCSC provided labor and the manufacturing of the prototype.

Earth Alert manually enters and transmits information from weather satellite uplink stations to geostationary altitude where the satellite system rebroadcasts it back to Earth. A solar powered, pole-mounted communications repeater ground station then

receives and broadcasts the message to personal receivers. The personal receivers produce an audio tone and a visual symbol message. The symbols communicate across language and literary barriers by illustrating hurricanes, floods, fire, and other disasters. The total time needed to broadcast the warning is 15 seconds.

"We envision numerous uses for Earth Alert," stated Janice Lee of SCSC. "We'd like to see this product get in the hands of everyone who can benefit from such a warning system. Fishermen, tourists on island resorts, campers, people who live near chemical plants. Wherever we could minimize a disaster before it happens."

Earth Alert will be tested with the Hawaii State Civil Defense Office later this summer, using the former GOES-2 weather

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Center Enters Refocusing Era

By Ernie J. Shannon

Goddard is changing. With a mandate formulated at the White House, reinforced on Capitol Hill and stamped with approval by NASA Administrator Dan Goldin, the agency and Goddard are refocusing the Center's mission and workforce.

No longer are faster, better and cheaper words used to orchestrate the latest total quality management program, they are happening at Goddard and promise to be the foundation upon which Goddard enters the next century.

In the middle of this maelstrom Center Director Joe Rothenberg moves easily, convinced of the rightness and necessity to "retool" Goddard and reset the course the organization and its more than 3,000 civil servants will tread during the next decade.

"We are restructuring ourselves at Goddard and it's about what we do and how we do it," Rothenberg says. "We must change the way we perform our responsibilities to allow us to meet the timeliness and costs envisioned by our administrator as well as the administration and Congress. I know that many people refer to the changes here as a 'reengineering' effort. However, that connotes radical change and that's not what we are about." Rather, Goddard is about refocusing the work in a

common sensical manner that draws upon the best skills and capacities of the center's workforce. It's called "Project Goddard."

For several months, a group of employees have been working as a Strategic Planning Group. The group, chaired by Earth Science Directorate Deputy Director Dot Zukor and composed of representatives from all major center organizations, recently developed a mission statement or blueprint for Goddard. The statement, though not yet finalized, promises to outline the center's core business in the coming years as well as make a case for the change necessary to accomplish the work.

"As we restructure and emphasize certain areas while de-emphasizing others, it is my hope that the Strategic Plan will illuminate the future and provide motivation to bring projects to fruition quicker at a lot less cost while working with greater unity than ever before with the contracting world, academia and others," Rothenberg said.

Rothenberg says he is already seeing "buy in" to the changes from employees throughout the center, especially from younger employees excited by the challenges.

"Our challenge, believe it or not, is developing the same enthusiasm among management. We need the same enthusiasm and

fire to bring about such programs as the Small Explorer effort. Small Explorer is just the beginning and it's about more science for lower costs...in other words, more science for the dollar."

Rothenberg is not flying by the seat of his pants in this era of change. Already, he foresees the day when Goddard can seal a spacecraft contract in a month. Such ideas as pre-qualifying subcontractors, putting spacecraft on a GSA list of sorts and holding mini-competitions for contracts are just a few of the ideas in their infancy here. There are many more.

"I can easily see Goddard employees working on innovative missions that occur in short periods of time that will be fun and scientifically challenging for our workforce. We'll bring our significant skills and experience to bear on projects that return large quantities of data to our science communities and to the nation at large," Rothenberg says.

The mandate for change is set in stone and the budgetary realities of today will force changes whether the center wants them or not. Goddard's challenge, and it's one Rothenberg readily accepts, is to proactively restructure the workforce and its skills to meet the changes before they arrive.

Integrated Product Development Teams— A New Way of Doing Business

by Donna Drelick

What do you get when a half-dozen engineering experts from competing industries and government lock themselves in a room for three hours in the desert southwest? In the case of the New Millennium program, designs for a lightweight Advanced Land Imaging Instrument and an exciting new way of doing business for Goddard.

Plans for the technologically advanced hyperspectral Land Imager Instrument, which will be the primary payload of the EO-1 mission of the New Millennium Program, were born on an October evening in a Sante Fe, N.M., condominium. The concept for the advanced scientific instrument materialized after a late night session of brainstorming by a small group of government and industry experts. The initial plans made on that autumn evening have since survived many levels of intense scrutiny.

"We learned that if you get the right industry experts together in a room, they collectively will produce a superior product," said Goddard's Bernard Seery, the co-lead on the Instrument Technologies and Architecture New Millennium Integrated Product Development Team. "We knew right

from the start that we could put individual interests aside and contribute as a team to get the job done. The development of the Advanced Land Imager Instrument is an excellent example of ingenuity and teamwork working for a common cause."

Under Goddard project management, the Advanced Land Imager will be developed from instrument technologies proposed by members of the Integrated Product Development Team, which designed a road map that brings industry and government together to deliver breakthrough technologies.

The team of industry partners will be led by Don Lencioni of the Massachusetts Institute of Technology's Lincoln Laboratory, Lexington, Mass., a federally funded research and development center. In order to expedite the transfer of technology into the commercial sector, Lincoln Lab and its partners, SSG and Hughes, will provide open access to U.S. industry regarding the design and performance of the Advanced Land Imager.

The new multispectral/hyperspectral Land Imager instrument will demonstrate remote-sensing measurements of the Earth consistent with data collected since 1972 through Landsat. However, the new instru-

ment will acquire data with finer resolution and will lay the groundwork for future land imaging instruments to be more compact and less costly.

The all silicon carbide Advanced Land Imager represents an approximate sevenfold decrease in mass and electrical power usage demands compared to the Landsat 7 multispectral instrument. The instrument also will extend the existing measurement capabilities by using an advanced high resolution "spectrometer-on-a-chip", which requires no scan mirror and is built around a novel wedge filter structure and high temperature infrared detector array.

The spacecraft support structure, including advanced electrical power and data-handling subsystems, will be provided by Swales & Associates, Inc., of Beltsville, and Litton Industries of College Park.

The goal of the New Millennium program is to identify, develop, and flight-validate key instrument and spacecraft technologies that will enable new and more cost effective approaches to conducting science missions in the 21st century. The launch of the first New Millennium Earth orbiting mission is planned for late 1998.

Using Editors When and Where it Counts

by Judith Goode, *The Editorial Eye*

Being asked to do too little too late is the common fate of technical editors. They often join the project team when document plans have long since been approved and writers are finishing their drafts.

Documentation managers in industry settings tend to assume that editing is value added at the end of the writing cycle. But early in the process is actually when a technical editor can be most helpful. Skillful editing can cut about 25 percent of excess from almost any technical document and improve what's left.

A technical document is any information developed by technical writers and editors for a specific audience: a user guide, a technical proposal, product specifications, online help, or the like.

A technical editor brought in at the 11th hour has to rely on the project manager for

an evaluation of what needs to be done - and that evaluation may not be right. Even if the editor reviews the document and makes recommendations, the schedule and the budget probably no longer permit major changes. An editor confined to a quick pass for mechanical style and consistency can't save a flawed document even if it is sure to let users down.

In the technical divisions of major publishers like McGraw-Hill, a "developmental editor" is involved before writing begins. This editor works with the writer on shaping the document, acts as a sounding board, and influences decisions on structure and language. Here are ways editors can help technical documents:

Fewer words equal shorter documents: This formula may seem obvious, but in practice it's ignored. Technical documents

typically have just too many words that add up to too many pages that add up to costly production time. One reason is that writers are asked to incorporate text from documents written by others: proposal boilerplate, companion-product descriptions, or instructions for using a new application.

Before the writer even sees this additional text, the documentation manager should give it to a technical editor for rigorous editing. The editor can note potential style problems, pare down the sheer number of words a writer will have to incorporate, and make it likelier that the final document will work as a coherent whole. Another reason to look closely at technical copy being cobbled together from several writers is inconsistent terminology. I was

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Home Page Sparks Comments Worldwide

Goddard Space Flight Center's home-page is getting reviews from around the country and even overseas as it continues to evolve. Following are some examples of the weekly comments collected in the Public Affairs Office:

"Thank you! Thank you! You cannot possibly imagine what it means to the 'little guys' to have access to such beautiful and awesome images as those generated by the HST. It makes me appreciate how small I am and also how we, the people of the Earth, are truly one together."

"I am student, study information and communication...I have many interest in Satellites...I will work for satellite communication...Actually, I don't know much about the Internet...and its system...and here the site is free of charge...Anyway, I am very glad to come here."

"What a great homepage! I like the layout too."

"I never got a chance to tell all of you at the National Aeronautics and Space Administration what a great job you are doing!!! Keep up the good work!! You are our future."

"Congratulations on a very well done page. I thought the Astro news page maintained by Sky and Telescope was great, but yours is something else. I happened upon it by chance. I think it should be advertised everywhere space buffs can hear about it."

"When I was younger, I was always interested in space. I never had the opportunity to study it the way I dreamed of. But thanks to the pictures and articles that are available to me through the Internet I feel like I am there. I just wanted to say 'thank you.'"

Technical Information Services Temporarily Relocated

The Technical Information Services Branch (Code 253) has temporarily relocated several of its services due to the HVAC renovation work being done in Bldg. 8. These service areas include the Service Center, Photography, Cost-per-Copy and Copy Management. Employees can still reach these staff members at their current phone numbers except Jane Semeraro and Jim Power, who can be reached at 220-1701.

The Service Center has been moved to room N-15 in Bldg. 8. Passport photos will be taken in the Bldg. 8 auditorium (2nd floor) when the facility is available. Call the Service Center at 6-3000 to schedule an appointment. Most staff members will be back in place by the end of August and the entire renovation should be completed by November.

Daedalus Enterprises Awarded NASA Phase II SBIR Contract

NASA has awarded Daedalus Enterprises, Inc., of Ann Arbor, Mich., a Phase II Small Business Innovation Research (SBIR) contract. The contract is entitled "Laser Search and Rescue" and has a value of \$599,958.

Daedalus will design and build a new system with a day/night search capability. Using this instrument, a search mission will be able to quickly and accurately locate any specially marked components (hull or airframe fragments, life rafts, life jackets, etc.) of a downed aircraft or watercraft in distress.

This instrument has the potential to significantly reduce the search time between the occurrence of the accident and the de-

termination of the accident location. This reduction in time will greatly increase the probability of survival for the occupants of the aircraft or watercraft. Daedalus has received support commitments from the Civil Air Patrol, the U.S. Coast Guard and two manufacturers of relative materials, Reflexite Corporation and 3M.

Since 1983, federal agencies with large research and development budgets have conducted SBIR programs to strengthen the role of small innovative firms in federally supported research and development. Daedalus has been active in the program since its inception and has received 18 Phase I and 11 Phase II awards.

Editors

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once asked to edit the final draft of a maintenance manual — all 600 pages of it. Right away, I found alarming inconsistencies. The writer mentioned that more than half of the draft had been written by someone in another group and he's simply downloaded those files into his document. When I pointed out that terminology for a procedure central to the book varied from chapter to chapter, he said, "I didn't have time to read the imported files."

The writer acknowledged the exhausting redundancies and inconsistencies I found and responded enthusiastically to my edits — until he realized that there wasn't time in the schedule to make all the changes online. He managed some primitive fixes, but the book went to press still weighing in at 600 pages.

Earth Alert

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satellite as a communication relay for the islands. Tsunami (seismic sea waves) warnings are severely needed by the State of Hawaii, and this device may prove to provide that warning system. Once the system has been tested, it will be ready for manufacturing. "Earth Alert is an excellent example of how NASA technology can be used for humanitarian efforts at a very low cost. I think this shows that NASA is a good world neighbor," said George Alcorn, Chief of the Commercial Programs Office.

Goddard Engineer Receives Premiere AIAA Award

by Donna Drelick

Glenn Lightsey claims that working on the Global Positioning System (GPS) is a once in a lifetime opportunity which makes him feel like a 'kid in a candy shop'. Well, that kid has received a sweet reward.

The American Institute of Aeronautics and Astronautics (AIAA) National Capital Section has presented Goddard's Glenn Lightsey with the Young Engineer/Scientist Award. The premier award is presented to an AIAA member under the

is completing his Doctorate from Stanford University. These educational opportunities were a result of the Goddard Research and Study Fellowship Program.

"Goddard provided me with wonderful opportunities. Because of this, almost by providence, I found myself in the right place at the right time," said Lightsey.

While at Stanford, Lightsey was able to work with Brad Parkinson, a world expert in GPS. Although GPS was conceived in

Until recently, the system was used primarily by the military. Lightsey, however, took a basic ground receiver and changed the software to allow the receiver to work in space, thereby creating the capability of a spacecraft to track itself. The new capability means that a spacecraft is one step closer to autonomy.

As Lightsey is able to reach his potential, he feels that it is his responsibility to see GPS reach its potential.



Glenn Lightsey shown with his GPS hardware.

age of 36, for significant accomplishment and career leadership in aerospace and aeronautics.

"This is a tremendous honor," stated Lightsey. "Goddard has been great to me, and I am proud to represent the Center with this award." Lightsey has worked at Goddard since 1986, when he was hired "fresh-out" of Princeton. Since then, he has received a Master's Degree in Electrical Engineering from Johns Hopkins and

the 1970's, it took almost 20 years to make it operational. "All of a sudden, it was operational and I was working for someone who conceived it. I began designing and planning GPS on spacecraft and was able to bring this expertise back home to Goddard," said Lightsey.

The Global Positioning System is a constellation of 24 satellites in orbit that generate signals from which positions can be computed either on or above the Earth.

"This technology is far reaching and exciting. In the future, it could literally be on all spacecraft in low Earth orbit. Goddard is at the forefront of this technology and we feel that it is our job to lead the world in its development."

Lightsey is originally from Columbia, S.C., and makes his home now in Ellicott City with his wife, Jeannie, and their four month old son, Connor. Thus far, the young engineer says "life has been a wild ride."

Greenbelt Hams Gear Up to Set Long Distance Contract Records

Hundreds of local amateur radio operators, including a number of Goddard employees, worked around the clock for a weekend in late June setting up two-way radio communication stations, getting on the air and contacting thousands of other operators in the U.S. and Canada as part of the American Radio Relay League's (ARRL) Field Day.

According to Robert DiRosario, president of the Goddard Amateur Radio Club, Field Day is the annual "shakedown run" for the ARRL's national field organization.

"Field Day is a way for hams to get outdoors and have fun under some difficult conditions," DiRosario says. "But it's also a chance to fine-tune emergency communication skills. We use generator and battery power, and we set up antennas in the field. The idea is to put together a self-sufficient, working station quickly and begin making contacts."

Government Computer News Honors 2 at Goddard

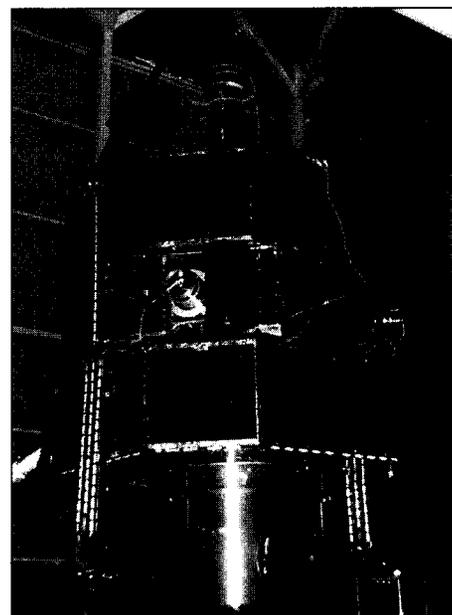
Government Computer News recently honored two Goddard employees with awards for their hardware and software contributions to education.

Fritz Hasler of the Laboratory for Atmospheres and Ed Masuoka of the Laboratory for Terrestrial Physics received awards during a luncheon at the National Press Club in Washington, D.C.

Continued next column

The computer organization honored Hasler for his efforts to make remote sensing data available to students K through 12 and beyond. According to the award nomination committee, "Hasler has been instrumental in making NASA remote sensing data appealing to students and the general public and getting visualizations out to them via network television, the print media and the Internet. He has accomplished this through innovative cooperative efforts with universities, private companies, the American Meteorological Society, the Smithsonian Institute, other NASA centers, NOAA and the White House."

Masuoka, who heads the Computing Systems Office, was honored for his management of the Moderate Resolution Imaging Spectroradiometer (MODIS), a key Earth Observation System instrument. The nominating committee said, "Developing software and integrating a computing system to support the MODIS instrument have been a major challenge that Masuoka has successfully undertaken. The result of his effort will improve the future of information technology in the area of remote sensing."



Shown here is the Goddard-managed Fast Auroral Snapshot (FAST) Explorer as it sits in a cleanroom in Building 7 at Goddard Center just prior to shipment. FAST departed Goddard for its Vandenberg AFB launch site in California June 21. Launch for the space science department is currently set for Aug. 16 from a Pegasus XL rocket.



About 250 people attended the recent Asian/Pacific American Heritage Day celebration at Goddard. Among those welcoming the audience were Angelita Kelly, Code 505; Dr. Cynthia Cheung, Code 631; Dillard Menchan, chief, Equal Employment Opportunity Office, Maria So, Code 441; Dr. Bhakta Rath, associate director of Research for the Naval Research Laboratory; Center Director Joe Rothenberg; Center Deputy Director Al Diaz; Center Associate Director Mary Kicz; Dr. Hong-Yee Chiu, Code 915; Asuntha Chiang, Assistant to Senator Barbara Mikulski, and Kaleem Kawaja, Code 224, chairperson for ACAPAE.

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IMACCS

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monitoring, real-time commanding, attitude and orbit determination, attitude sensor calibration, station acquisition, data generation, planning and scheduling, and data trending. The only function not included within IMACCS, but exists on the operational SAMPEX ground system, is the task of science data preparation.

"In a subsequent, rapid integration project, the IMACCS element were combined with a combination of COTS and GOTS communication systems (a 4.3 meter antenna at modular radio frequency, interface equipment) in just a few weeks," said Meyers. Directorate management witnessed a real SAMPEX pass monitored from an end-to-end COTS system that occupied two conference tables (plus an antenna).

Since the initial implementation, the spacecraft operations automation capabilities available within the COTS tools have been exploited to create a highly-automated IMACCS configuration. New capabilities include the preplanning of pass activities, orbit navigation, the detection of anomalous behavior, and the notification of appropriate personnel. Further, the system is capable of initiating corrective action and preparing materials for spacecraft engineers to use in their evaluation of the problem.

All of these enhancements are bringing IMACCS closer to space flight control in a "lights out" environment, meaning without human intervention, said Bob Rankin of Computer Science Corporation. The preparation of evaluation materials helps turn the "lights on" when the engineer begins to evaluate the anomaly. In addition, work is underway to add the capability to prepare and distribute science data.

IMACCS Life-Cycle Activities

The implementation of the IMACCS system was completed in three months compared to the two years required to develop the original SAMPEX system. Tasks completed during the implementation effort covered a sizable portion of the normal development cycle for a typical ground system. The most significant areas not covered were the requirements development and early design phases of the typical ground system, mission requirements generation, science planning, and the operational activities. A typical ground system life-cycle development phase includes requirements development, system design, system implementation, system test, and operational support.



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The GODDARD NEWS Staff is:

Executive Editor: Jim Sahli

Managing Editor: Ernie J. Shannon

Contributing Editors: Donna Drelick,

Tammy Jones, W. Allen Kenitzer