National Aeronautics and Space Administration

Goddard Space Flight Center's

Innovative Partnerships Program Office

Accomplishments 2009

Building on the past. Innovating in the present.

Preparing for the future.

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Nona Minnifield Cheeks

Chief
Innovative Partnerships Program Office
NASA's Goddard Space Flight Center

As we welcome a new year of promise and innovation, we once again look back at our past achievements and strengths with this 2009 Accomplishments Report.

As chief of Goddard's Innovative Partnerships Program (IPP) Office, I am thankful to lead a team that helps usher in collaboration, innovation, and ingenuity by nurturing relationships within NASA and beyond. Technology infusion and technology transfer relationships offer considerable growth for both NASA and our partners. And like all relationships, they grow and develop over time. So this year, we celebrate not just the accomplishments of 2009 but also the growth that our ongoing contributions have achieved—and the important ways in which they are helping us secure a prosperous future.

In 2009, the IPP Office helped Goddard Space Flight Center celebrate its 50th anniversary by hosting a 50 Years of Technology Spinoffs event commemorating the five decades of Goddard research and the many spinoff products that have their roots in Goddard technologies.

Goddard is involved in ongoing relationships with other government agencies. Agreements with these agencies have been nurtured over many years—and such ongoing relationships are helping to ensure that cross-government collaborations make the best use of innovation and stakeholder interest.

Goddard's state-of-the-art facilities also have given birth to many collaborative agreements that were sustained and supported in 2009. As outside organizations make use of the data and technical services supplied by these facilities, their success helps position Goddard for future partnerships.

NASA innovations of years past as well as those being developed now will help move NASA missions and IPP efforts forward. In this report you will read about some of Goddard's contributions to the Hubble Space Telescope, Lunar Reconnaissance Orbiter, and the Solar Dynamics Observatory and how the IPP Office has helped those technologies find new ways to contribute internally for NASA as well as externally to benefit the nation's economy and society.

Throughout 2009, IPP Office staff and Goddard innovators worked to identify new partnerships, network with scientific and aeronautic professionals in universities and industries, share technology transfer best practices, and extend the reach and reputation of Goddard technologies and capabilities. All of these accomplishments position Goddard to pioneer even more of the great discoveries that will define our times.

I trust that you will enjoy learning about these collaborative relationships that we continue to nurture and sustain—as well as our other ongoing achievements—through reading this report. ■

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The IPP Office has a long history at Goddard of nurturing relationships with innovators, managers, and contacts beyond NASA that we will continue to strengthen well into the future. We are here to help ensure that the quality innovations Goddard contributes to NASA missions can be used by other industries and to form strong networks with outside organizations to help serve NASA's needs. We invite you to contact us to learn more.

Find us online: http://ipp.gsfc.nasa.gov

Or call us: 301.286.5810

Building a Culture of Collaboration
Advancing Scientific Discoveries

"It's so important to bring everyone—science, engineering, IPP—together early to develop trust and build mutual understanding."

—Orlando Figueroa, Director, AETD, NASA's Goddard Space Flight Center

Goddard's IPP Office is a part of the Applied Engineering and Technology Directorate (AETD) at Goddard. The AETD is well positioned to develop the critical technologies that will enable key scientific discoveries and advancements for the future. As Goddard takes further steps to integrate the efforts of AETD and the Sciences and Exploration Directorate (SED), the future of technology development is beginning to take shape—along with a vision for the larger scientific questions those technologies will help to answer.

An Organizational Approach to Collaboration

When Orlando Figueroa became Director of AETD, he identified key areas he wanted the organization to focus on. "The first was creating a symbiotic relationship with the science community. The two sides—science and engineering—must recognize the critical role they each play in our future success," said Figueroa.

AETD's Chief Technologist, Michael Johnson, echoes that sentiment. "We have some of the best engineers and scientists in the world here at Goddard, but to be the best at what we do, we really need to talk to each other. We need both science and engineering to come together to meet our goals."

Figueroa noted that a commitment to this symbiotic relationship with SED can be seen through both formal programs and an overall culture of collaboration. "The idea is to start developing a trusting relationship so the contributions of both sides are acknowledged and appreciated," said Figueroa. A new effort to help facilitate this goal is the Science and Engineering Collaboration Program (SECP)—the only program of its kind at NASA—in which engineers are placed alongside scientists and vice versa, enabling them to trade operational roles. "By having an engineer wear the scientists' shoes, they learn how to think like a scientist and vice versa—and this expands their views of the others' discipline," said Figueroa. "This helps tremendously in building trust between science and engineering."

In addition to the SECP, Johnson noted that there also are more informal collaborative constructs in place between the two directorates. For example, inter-management council meetings are composed of scientists, engineers, and program managers. And at the grassroots level, engineers developing systems for missions often interact directly with their science colleagues to maintain open lines of communication and to make sure the systems will meet the scientists' needs for the mission. "We try not to just rely upon a formal process," said Johnson. "SECP is very important, but it's also critical that a desire to communicate and collaborate be infused throughout our organization from top to bottom."

Nick White, PhD, Director of SED, agrees. "It's not helpful to view artificial barriers between science and engineering," Dr. White said. "We have different organizations, but in terms of developing technologies, I see it as a seamless team that works towards development. Scientists write proposals, but to be successful they do it in collaboration with the engineering directorate."

"It's not helpful to view artificial barriers between science and engineering. We have different organizations, but in terms of developing technologies, I see it as a seamless team that works towards development."

—Nick White, PhD, Director, SED,
NASA's Goddard Space Flight Center

"The future will be about how our scientists and engineers work together to infuse numerous technology advancements into systems in ways that will enable new mission concepts and measurement capabilities."

—Michael Johnson, Chief Technologist, AETD,
NASA's Goddard Space Flight Center

Looking into the Heart of the Scientific Issues of Our Time

Success in developing the next crop of technologies for science missions is a priority, as Goddard's leaders look toward the most ambitious areas of scientific study handed down by the Decadal surveys and the National Academy of Sciences. "AETD needs to be at the forefront and in sync with what the science community needs to answer the scientific questions of the future," noted Figueroa.

White said that over the next 10 years, comprehensive programs will examine four areas of scientific study:

Earth Science: Major areas of focus will be research into how and why the planet is changing and the impact of climate changes on the planet.

Astrophysics: NASA continues to research questions surrounding dark energy and dark matter as new focus areas are being investigated and will be announced in summer 2010.

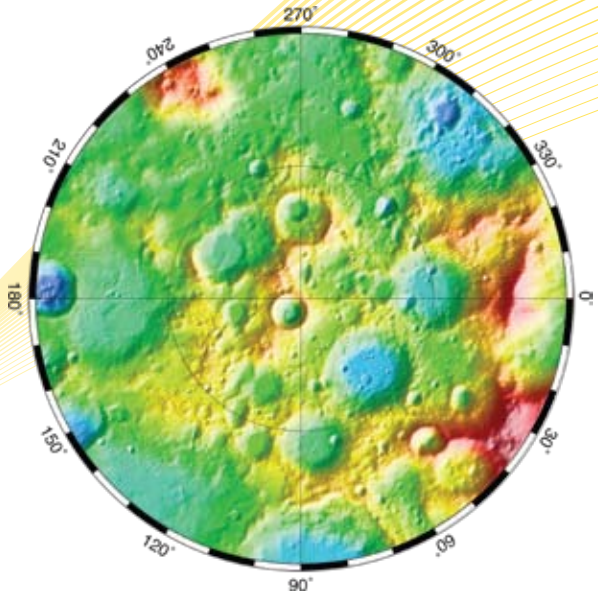
Heliophysics: Research will surround solar events that affect Earth's energetic field, predicting such events, and understanding how they may impact science missions.

Planetary Science: Primary focus continues to be the search for fundamental building blocks of life within our solar system and evidence of life beyond it.

Building the Right Mix of Technologies for Science

As Goddard scientists delve deeper into the heart of scientific questions, they will rely on Goddard engineers to develop more advanced technologies than ever before. "It would be challenging to answer tomorrow's questions with today's technologies," said Johnson. "To address the questions our science colleagues will pose, we will have to develop more sensitive, accurate, intelligent, and robust systems that use resources more efficiently. Tomorrow's technologies will lead to novel mission concepts and system architectures and enable measurements in ways that we've never done before."

So what are the technologies of the future that Goddard engineers will be developing in the coming years?



NASA image courtesy of Erwan Mazarico

The Lunar Orbiter Laser Altimeter (LOLA) is delivering valuable data and stunning images of the lunar surface, like this relief map of the south polar region of the moon.

White said scientists can define categories of technologies now that will likely be needed far into the future. "For Earth science, laser and lidar technologies are critical," he said. On the heliophysics front, new sensor technologies will provide more precise observations of solar events. Specifically, Figueroa noted that Goddard is developing a fast-plasma analyzer that will help answer questions about the particles given off by the sun and their impact on Earth's environment. "We will also soon have instruments observing the sun constantly to see if we can predict its activity and what that activity may mean for us," he said.

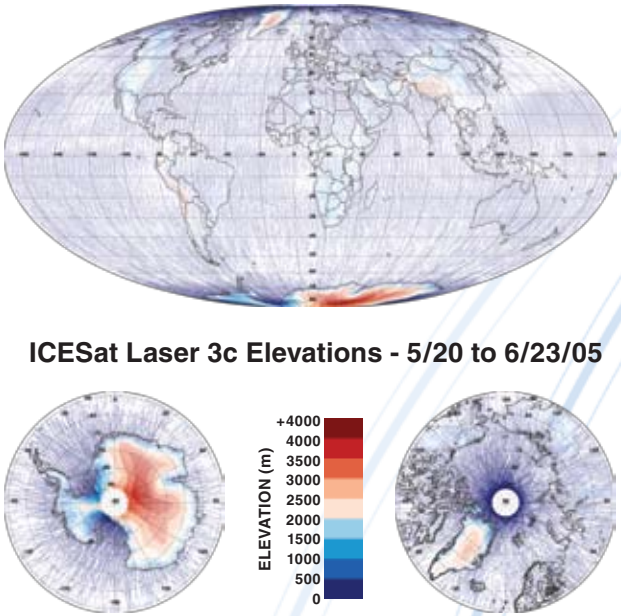
Johnson added that new technologies developed for astrophysics and planetary science missions will need to be more flexible for deep space conditions. "Being able to operate systems over much wider temperature ranges opens up many possibilities," Johnson said. "And being able to process data while in orbit will facilitate novel architectures." But Johnson also noted that Goddard is not just working on a magic bullet. "There is no one breakthrough technology," he said. "The future will be about how our scientists and engineers work together to infuse numerous technology advancements into systems in ways that will enable new mission concepts and measurement capabilities."

Collaborating beyond NASA

While tight coupling of science and engineering within Goddard is critical to future technology development, finding opportunities beyond the center and beyond NASA will also be crucial to future mission successes. "Even though we have some of the greatest talent in the world at Goddard, it does not all reside here," said Johnson. "It's incumbent upon us to leverage talent, resources, and technologies that reside outside Goddard to the fullest extent possible."

Figueroa noted that the IPP is key to facilitating relationships that will bring the best technologies to Goddard to meet future mission needs. "If we are tackling a technology problem, knowledge of who out there is working on those technologies is critical. IPP can help with that," said Figueroa. "They can also help identify other technologies that are cutting edge outside of Goddard."

Figueroa said that building these relationships early is ideal. "A lot of our technologies were born in the SBIR program, something the IPP handles very well." He noted that the Small Business Innovation Research (SBIR) program can help strengthen collaboration at an early stage and provide the building blocks for future infusion. (See pages 9, 14, and 19 of this report for more SBIR program successes.) "The future is sometimes made or broken with those initial steps," Figueroa said. "That's why it's so important to bring everyone—science, engineering, IPP—together early to develop trust and build mutual understanding." ■



C.A. Shuman and V.P. Suchdeo
Code 614.1 Cryospheric Sciences Branch NASA/GSFC

An ICESat world elevation map, showing all elevation data gathered through the Laser 3C period.

NASA photo by Bill Ingalls

The Lunar Reconnaissance Orbiter and Lunar Crater Observation and Sensing Satellite left for the moon on June 18, 2009.

Mission: Lower Risk

A critical reason for tight collaboration between science and engineering is to help lower the risk of Goddard missions. Figueroa said several recent missions provide examples of this risk reduction. ICESat (Ice, Cloud, and Land Elevation Satellite) provides one such example. Figueroa noted that ICESat-1 provided many lessons learned about how to go about finding the best laser technologies available. Now, as ICESat-2 ramps up, AETD is taking that learning forward. "Through our successes and through our mistakes we have become very good at scanning for the best instruments available to increase the science return," said Figueroa. "We're bringing in experts to help validate our approaches, and we need to make sure everyone working on the technologies for missions is in sync. It is better risk management through collaboration."

A second example is the Lunar Reconnaissance Orbiter (LRO) and its centerpiece instrument, the Lunar Orbiter Laser Altimeter (LOLA), which was conceived and developed in collaboration between AETD and SED. "LOLA's design, testing, and verification was a joined-at-the-hip collaboration between science and engineering," said Figueroa. "And as a result, we have terrific data coming back to Earth."

Collaborating on these high-profile missions is critical, but Johnson also noted that intermingling of scientists and engineers on small missions can be just as important in lowering overall risk. "Even small missions that don't have all the visibility lay the groundwork for high-profile missions like LRO," Johnson said. The Fast, Affordable, Science and Technology Satellite (FASTSAT) experiment between NASA and the U.S. Navy is a good example. He noted that the four instruments quickly developed through collaboration between AETD and SED for FASTSAT will lead to larger heliophysics mission opportunities. "Small-budget missions lay the groundwork for relationships and can establish a level of trust and understanding between team members that can be invaluable when they work on larger missions," said Johnson. "And that helps to lower our overall risk."

Goddard Celebrates *50 Years of Technology Spinoffs*

Greg Cole of Mainstream Engineering Corporation holds a sample of the company's QwikBoost™ product line, which employs a NASA technology based on a chemical/mechanical heat pump and helps customers save money while protecting the environment.

As much as innovation provides the key to NASA's ability to research, invent, and explore, it also unlocks the possibilities for technological advances beyond the space program. For 50 years, innovators have been creating new capabilities and making new discoveries that have resulted in unique technologies with surprising uses beyond NASA. With the assistance of the IPP Office, these technologies have yielded amazing new products that enrich our standard of living, benefitting:

- Health and medicine
- Public safety
- Defense and homeland security
- Transportation
- Environment
- Communication
- Industry and manufacturing
- Consumer goods

Looking back, we recognize some of the standout spinoffs from the last half-century.

QwikBoost is a trademark of Mainstream Engineering Corporation.

Marking Goddard's 50th anniversary, the IPP Office commemorated five decades of Goddard research that produced spinoff technologies.

Black & Decker

In the mid-1960s, NASA was preparing for the Apollo missions to the moon and needed a tool that astronauts could use to obtain samples of rocks and soil. They sought a lightweight, compact, powerful drill capable of digging deep into the surface of the moon. Innovators worked with Black & Decker to invent a battery-powered magnet-motor drill. The tool was used to extract rock samples from the surface of the moon while operating in extreme temperatures and zero-atmosphere conditions. This research led Black & Decker to subsequently develop lightweight, cordless medical instruments, hand-held vacuum cleaners, and other tools for everyday consumers.

MPI Outdoors

In the space program's early days, NASA needed to make its balloon satellites highly reflective in order to bounce radio signals from one station on the east coast up to the reflecting satellite and back to a second station on the west coast. The satellites also had to inflate in orbit and be very thin and lightweight for launch. To answer this need, innovators developed a new plastic film coated with a superfine mist of vacuum-vaporized aluminum. In the early 1960s, MPI Outdoors licensed the technology, leading to the development of the Original SPACE® Brand Blankets, which fold into a 3-ounce package the size of a deck of playing cards. MPI also has used the technology to develop protective fabrics that retain up to 80 percent of the user's body heat, helping to keep someone warm for hours in cold weather or preventing post-accident shock.

SPACE is a registered trademark of MPI Outdoors.

Black & Decker's Greg Moores talks about the company's cordless tool technology used in NASA's Apollo missions that is now commonplace in homes around the world.

MiniMed, Inc.

NASA's development of the Programmable Implantable Medication System (PIMS) began in 1980 through a Goddard-sponsored technology utilization project at Johns Hopkins University's Advanced Physics Lab. PIMS employs a tiny, microminiaturized fluid control system that was licensed to Pacesetter Systems and yielded a spinoff company: MiniMed Technologies Limited. The company continued development of the PIMS technology into an implantable insulin pump, which was inducted into the Space Technology Hall of Fame in 1988. The next 26 years of research and development resulted in other implantable devices based on PIMS, including a cochlear implant to aid the deaf and new products to aid people with diabetes and other chronic illnesses.

(L-R) Greg Moores, Black & Decker; Fred Gregory, former NASA Deputy Administrator and veteran shuttle astronaut; Nona Cheeks, Chief of Goddard's IPP Office; Doug Comstock, Director of NASA's IPP; Greg Cole, Mainstream Engineering Corporation; and Fitz Walker, Bartron Medical Imaging.

Mainstream Engineering Corporation

In 1988, NASA was trying to develop a way to extract heat from a spacecraft using less power. Goddard partnered with Mainstream Engineering Corporation through an IPP Small Business Innovation Research (SBIR) grant to develop new spacecraft heat rejection systems. This collaboration led to development of a unique, low-cost additive that increases the performance of air conditioners, heat pumps, refrigerators, and freezers. Introduced in 1998 by Mainstream as the QwikBoost additive, this product works by increasing the cooling capacity of a refrigerant, reducing energy use and expenses. Today, the QwikBoost additive is commercially available everywhere and is also in use by NASA. Mainstream now produces an extensive line of Qwik refrigeration and air conditioning products.

Bartron Medical Imaging

In the 1990s, Goddard's Recursive Hierarchical Segmentation (RHSEG) software system was developed for use in Earth remote sensing applications. RHSEG provides an improved approach to image analysis by offering selectable levels of detail that increase accuracy for two- and three-dimensional images. In 2002, Bartron Medical Imaging (BMI) licensed the RHSEG software and used it as the basis for its Med-Seg™ medical imaging product. Today, the Med-Seg product is being applied to clinical problems and is expected to improve diagnostic, treatment, and follow-up therapeutic applications. BMI credits the technology spinoff for helping to jumpstart its product development efforts and for leading to improved medical imaging that benefits patients and care providers.

Med-Seg is a trademark of Bartron Medical Imaging LLC.

Partnering Mechanisms

These spinoffs, and many others like them, have occurred through technology transfer, partnerships, SBIR funding, the IPP Partnership Seed Fund, and other mechanisms. The IPP looks for ways in which NASA's technology needs and capabilities align with those of industry, universities, or other government laboratories. We then bring the organizations together into a partnership. By finding compatible needs and research goals among diverse organizations, the IPP:

- Adds value to NASA's mission directorates by facilitating technology development and then infusing it into NASA programs and projects
- Addresses NASA's technology barriers via cost-shared, joint-development partnerships
- Facilitates technology transfer for commercial applications that benefit the economy and improve life on Earth

The IPP's goals and these spinoff successes are expected to increase in the coming years, as Goddard innovators continue to develop technologies for NASA missions that will be applicable beyond the space program. ■

(L-R) Doug Comstock, Janelle Turner, Sharon Moore, Darryl Mitchell, Krystal Kennedy, Dwight Norwood, Carmela Goodall, Ted Mecum, Dale Clarke, Nona Cheeks (holding a model of the Black & Decker moon drill), Enidia Santiago-Arce, Irene Tzinis, Melissa Jackson, Laura Walker, Laura Schoppe, Rebecca Gillespie, and Fred Gregory.

Collaboration with Other Government Agencies
Moving Broad Innovation Forward

The IPP Office focuses on building long-term relationships with other government agencies to collaborate and innovate. These ongoing relationships will take us into the future and help to ensure that we are consistently putting our combined resources and innovations to work for tomorrow's scientific advancements and burgeoning technologies. Many new relationships were established in 2009, and other partnerships have been growing for some time.

NASA photo by Kim Shiflett

With smoke and steam rolling across the launch pad, a Delta IV rocket begins its ascent into the sky with the GOES-O satellite aboard.

Ongoing Relationship with NOAA Feeds Collaborative Efforts for GOES Program

A memorandum of understanding (MOU) between NASA and the National Oceanic and Atmospheric Administration (NOAA) enabled the two organizations to collaborate on the Geostationary Operational Environmental Satellite (GOES) program and its recently launched satellite GOES-NOP (launched June 27, 2009). Following that successful launch, Goddard and NOAA are now preparing for the next generation of the GOES program, which will include improved spacecraft and instruments for more timely and accurate weather forecasts and detection and observation of meteorological phenomena. The upcoming GOES satellites will also be equipped with improved spectral, spatial, and temporal resolution; real-time lightning detection maps; increased dynamic range; and improved data capacity.

This ongoing collaboration also paved the way for additional technology transfer activities led by the IPP Office. For example, a reimbursable Space Act Agreement (SAA) between Goddard and Lockheed Martin enabled collaborative testing of Goddard's "Navigator" GPS receiver (see page 14) to determine its suitability for the GOES-R program. Administered by the IPP Office, this agreement—and others like it—helped contribute the technologies and testing necessary for the GOES program.

Technical Exchange Group with DIA Offers Opportunity to Share New Innovations

Promoting cross-agency technology infusion for mutual benefit is the goal behind a 2007 MOU between Goddard and the U.S. Defense Intelligence Agency (DIA). Administered by the IPP Office, the agreement created a Technical Exchange Group (TEG) between the two organizations. The TEG now meets biannually with the goal of sharing new technology developments, plans, and future aerospace and defense mission needs and requirements in order to identify potential areas of technical exchange, infusion, and partnerships. The collaboration provides a basis through which the DIA advocates for appropriate infusion of Goddard-developed technologies throughout the defense intelligence community.

Agreement with ONR to Enable Shared Test Results for Mutually Beneficial Missions

An MOU signed in 2009 between Goddard and the Office of Naval Research (ONR) provides yet another example of the importance of collaboration with other government organizations. Goddard and ONR tested the Hawaii-4RG™ (H4RG) large-format focal plane technology for use within their respective missions. The H4RG technology is a next-generation readout integrated circuit for visible and infrared instrumentation in ground-based and space telescopes. As part of the agreement, Goddard provided ONR with 12 H4RG readout integrated circuits, which ONR processed into fully functional detectors and arranged for performance and radiation effects testing. Test results were shared between the organizations, enabling broader use of this third-party technology by two government organizations while making efficient use of taxpayer dollars and testing resources.

Hawaii-4RG is a trademark of Teledyne Imaging Sensors, a Teledyne Technologies Company.

Multi-Year Collaboration with DoD Hopes to Redefine Mission Design and Implementation

A 2009 reimbursable SAA with the Department of Defense's (DoD's) Operationally Responsive Space (ORS) Office involves the transfer of multiple Goddard technologies to DoD, helping to significantly extend the reach of Goddard innovations to other government agencies. Transferred innovations and capabilities include enterprise ground system core components and interfaces, range safety and operations, platforms for launch vehicle and spacecraft applications, and management and system engineering support to ORS. Administered by the IPP Office, the agreement represents a multi-year collaborative effort that will redefine the way space missions are designed and implemented. Officials at Goddard and ORS anticipate that the agreement will help to streamline the process by which technological components are developed for programs. The agreement is expected to abate the stifling effects of economic downturns on research through strategic transfer and widespread reuse of government technologies and capabilities.

IPP Innovation Fund and Partnership Seed Fund Awards Keep Collaboration with AFRL Moving Forward

Goddard has had a long-standing collaborative relationship with the Air Force Research Laboratory (AFRL), through which both organizations are advancing composite and navigation technologies for the benefit of missions and future scientific achievements. A research and development effort among Goddard, AFRL, and The Aerospace Corporation in 2007 was a recipient in the first-ever round of Goddard Innovation Fund awards. The funding enabled development of carbon nanotube–enhanced polymers and advanced flat-plate technologies for rapid, low-cost composite structures. The initial use for these polymers and flat-plate technology innovations was to infuse lightweight composite materials having very high performance properties into future spacecraft structures. Another collaborative initiative between Goddard and AFRL received a Partnership Seed Fund award to develop a plug-and-play capable GPS receiver to benefit NASA's future science missions.

Nanotechnology Research Benefits from Collaboration with NIST

An MOU collaboration between NASA and the National Institute of Standards and Technology (NIST) enables Goddard and NIST researchers to work together using joint expertise and NIST's new Advanced Measurement Laboratory in support of individual and joint research goals.

The MOU calls for Goddard and NIST to jointly define and manage research projects in nanoscience and microelectromechanical systems device design, technologies, operational protocols, fabrication technologies, and device metrology. The results of this collaboration are expected to support advancements in chemical and biological detectors, power generation, thermal management systems, radio frequency electronics, electro-optic devices, and distributed sensor networks. ■

The IPP Office is pleased to announce the following new agreements with other government agencies:

	PARTNER	TECHNOLOGY/FOCUS
SPACE ACT AGREEMENT	Air Force Research Laboratory Space Vehicles Directorate	Wavefront sensing algorithms
	Bureau of Indian Education	Science and technology education
	National Institute of Standards and Technology	Microwave noise source measurements
MEMORANDUM OF UNDERSTANDING	Defense Intelligence Agency	Technical Exchange Group
	NASA's Ames Research Center	Nanotechnology research
	National Institute of Standards and Technology	Cryogenic propellant slosh tank
	Office of Naval Research	Development and test of a hybrid visible silicon readout integrated circuit

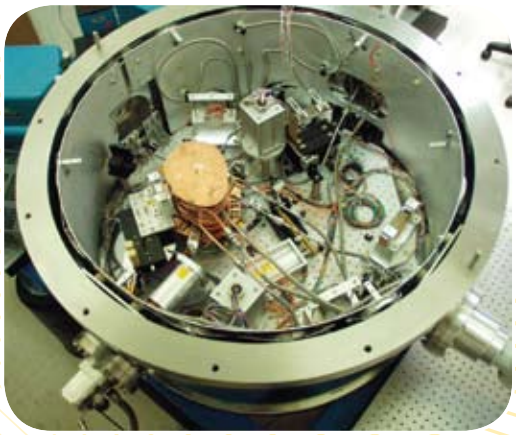
Goddard Facilities
Ushering in Partnerships and Innovation

Goddard's specialized facilities offer technical expertise and state-of-the-art equipment for technology development, testing, and characterization.

Cryogenic High Accuracy Refraction Measuring System Facility

Goddard's Cryogenic High Accuracy Refraction Measuring System (CHARMS) is a one-of-a-kind facility used to measure the refractive index of optical materials. This highly versatile facility can provide measurements at cryogenic temperatures and a wide range of wavelengths with unsurpassed accuracy.

The success of NASA infrared missions depends on the availability of accurate refractive index data for optics operating at cryogenic temperatures. Several NASA missions, including the James Webb Space Telescope (JWST) and the Kepler Photometer, have directly benefited from the facility. The IPP Office has executed Space Act Agreements to enable use of the CHARMS facility by organizations outside NASA as well. Recent partners have included the University of California Observatories/Lick Observatory (UCO/Lick) and the Harvard–Smithsonian Center for Astrophysics. CHARMS can also provide custom measurements to outside organizations and publish the measurement data, making it available to the larger scientific community.



Goddard's CHARMS facility characterizes the material properties of prismatic samples.

"We're benefiting not only from our own agreement but also from others. We've used data from several other measurements the CHARMS facility has taken in the past, and I anticipate we will benefit from more of the facility's published data in the future. It's a great benefit for everyone in aerospace to have that information made public."

—Dr. Harland Epps, Astronomer, Professor, and Optics Design Consultant, UCO/Lick

Radiation Effects Facility

Because space missions often expose materials and electronics to substantial degrees of radiation, precise measurement of their radiation tolerance is critical to help ensure the safety and longevity of NASA's long-term space operations. Goddard's Radiation Effects Facility (REF) examines ionization and displacement damage of electronics and materials as well as instrument calibration requirements for devices in space. Functional and parametric performance changes occur at different ionization levels in space, making the REF's radiation-damage testing vital for a variety of aerospace equipment, including electronics, microcircuits, sensors, couplings, lenses, and filters as well as paints, coatings, and aircraft structural materials. The facility also produces and calibrates sensors, X-ray machines, and other radiation measurement instruments.

Organizations beyond Goddard can also make use of the REF, typically through partnership mechanisms administered by the IPP Office. Recently, Texas Instruments began testing at REF with Goddard innovators, investigating the requirements for engineering and marketing radiation-tolerant electronics to serve potential NASA contracts and aerospace companies that manufacture spaceflight equipment.

Inside the Damage Van de Graaff Test Chamber in Goddard's REF.

"Understanding the result of scaling on radiation effects is critical for the future of spacecraft electronics. We can't investigate these effects without the support of other commercial and university partners. Technology transfer makes this possible through collaborative, cost-saving agreements with research partners."

—Ken LaBel, Engineer, Goddard's REF

Detector Development and Characterization Laboratories

The Detector Development Laboratory (DDL) and Detector Characterization Laboratory (DCL) at Goddard offer facilities for specialized development and testing of detector technologies. The DDL is a 24,000-square-foot, highly advanced semiconductor fabrication facility used frequently for testing microelectromechanical systems (MEMS) and nanotechnology devices. The DDL has been used to develop transition edge sensor detector arrays for the Atacama Cosmology Telescope and for the International X-ray Observatory. The DDL facility also assisted with development of a silicon thermistor calorimeter array for Suzaku, Japan's fifth X-ray astronomy mission, and a microshutter array system for the JWST.

The DCL consists of several laboratories, including class 100 and 10,000 clean rooms for testing contamination-sensitive detectors and subsystems. It is used to perform complete optical and electrical characterizations of large-format detector arrays operating in the ultraviolet, visible, and infrared spectrums.

The DCL offers optical and electrical characterization capabilities for large-format detector arrays. The facility can provide testing at temperatures below 1 Kelvin, enabling characterization of superconducting and other cryogenic detectors. The facility has been used for testing and characterization of the Wide Field Camera 3 instrument for the Hubble Space Telescope, the Linear Etalon Imaging Spectral Array instrument for the New Horizons mission to Pluto, and the Near Infrared Spectrograph Detector Subsystem for the JWST.

The DDL provides access to a toolset that can produce innovative detectors or bulk micro-machined MEMS devices. Shown here is the wet sector bench for solvents and corrosives.

Both the DDL and DCL are available for use by U.S. companies, universities, and other government agencies for research and development projects, alongside NASA engineers working on technologies for NASA missions. Arrangements for use are negotiated through Space Act Agreements administered by the IPP Office. These partnerships help extend Goddard's investment in these world-class facilities for broader scientific advancement.

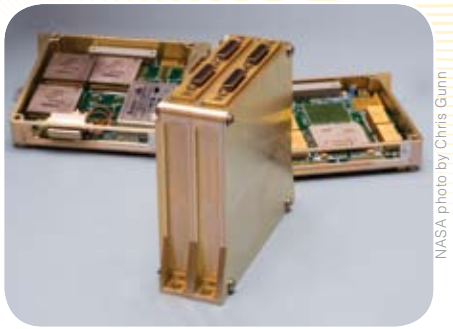
Goddard Mission Services Evolution Center Development Lab

The Goddard Mission Services Evolution Center (GMSEC) laboratory is a cross-organizational effort providing mission-enabling data systems that help reduce the costs of mission development, operations, and maintenance by enabling connectivity among other labs for coordinated development and testing. The lab provides multiple operating systems, languages, and communications protocols and facilitates technology development, benchmarking, demonstrations, evaluations, system integration, functional testing, and what-if scenarios. Innovators involved with Goddard missions can try out GMSEC-compliant government-off-the-shelf and commercial-off-the-shelf technologies to evaluate them for potential use in flight and ground systems. Goddard's IPP Office facilitates the sharing of GMSEC software via the agency's software release process. (For more about Goddard's 2009 Software Usage Agreements, see page 17.) ■

Goddard Technologies Fill Mission Needs and Find Commercial Success

Hubble Space Telescope

Celebrating its 20th anniversary in orbit in 2010, the Hubble Space Telescope (HST) was the first major optical telescope to be placed in space, and it continues to send NASA fabulously detailed images. Launched on May 11, 2009, Hubble's fourth servicing mission (SM4) took more than 20 new technologies into orbit for the first time. Several of these new technologies, which the IPP Office will be working to commercialize as well as infuse within NASA, are described below.



NASA photo by Chris Gunn

The SpaceCube processor was the most powerful yet the lightest piece of equipment on the SM4 servicing mission.

SpaceCube

Goddard's SpaceCube is a small hybrid computer that provides up to 25 times the processing power of a typical flight processor. This innovation was the brain of SM4's Relative Navigation Sensors (RNS) system. The SpaceCube processor recorded imagery of HST as it came near the shuttle for docking and as it was later released. Controlling three cameras, a global positioning system receiver, a command and telemetry module, and 500 gigabytes of memory, SpaceCube also managed the real-time image processing and tracking algorithms used to determine the exact position and attitude of HST.

There is an ongoing effort to develop a SpaceCube 2.0, which offers 100 times more data than the initial processor, include applications where there is a high quantity of incoming data and a need for real-time on-board processing or data reduction. Goddard's IPP Office is currently seeking patent protection for this processing technology and is negotiating agreements with university and industry partners for further development.

Navigator Global Positioning System (GPS)

The Navigator GPS technology also had its first flight validation on HST's SM4, as part of the RNS system. Now fully flight-qualified, Navigators are currently being developed for the Magnetospheric MultiScale mission,

The Navigator GPS technology, part of the RNS system, flew for the first time on SM4.

the Global Precipitation Measurement (GPM) mission, and the Geostationary Operational Environmental Satellite R-Series (GOES-R) program. Goddard's IPP Office is currently negotiating a commercial license for the Navigator GPS as well.

Titanium Matrix Composite (TMC)

The shuttle transported SM4's instrument package using a new carrier whose composite and two of its six struts were made of TMC. This new material was originally developed through a collaborative effort between the Robert C. Byrd Institute and FMW Composite Systems. The TMC technology was flown in space for the first time on SM4. Commercially, it will soon fly as part of the new Boeing 787 aircraft.

Microchannel Plate

An IPP-administered SBIR award to Pegasus Glassworks yielded a high-gain, sheared microchannel plate technology that was used in the MultiAnode Microchannel Array detectors in HST's Space Telescope Imaging Spectrograph instrument. The plates were also used in the Advanced Camera for Surveys and the Cosmic Origins Spectrograph which were new HST instruments on SM4.

NASA photo by Chris Gunn

The shuttle's new lightweight carrier, composed in part with TMC, transported the new instruments for SM4.

Space Portable SpectroReflectometer (SPSR)

Another IPP-administered SBIR award to AZ Technology, Inc., resulted in the development of the SPSR. This hand-held instrument measures key thermal properties of material surfaces and was used during the extra-vehicular activities during SM4. The SPSR instrument has since been flight-qualified and is being used for extra-vehicular activities aboard the International Space Station. ■

Goddard Technologies Fill Mission Needs and Find Commercial Success

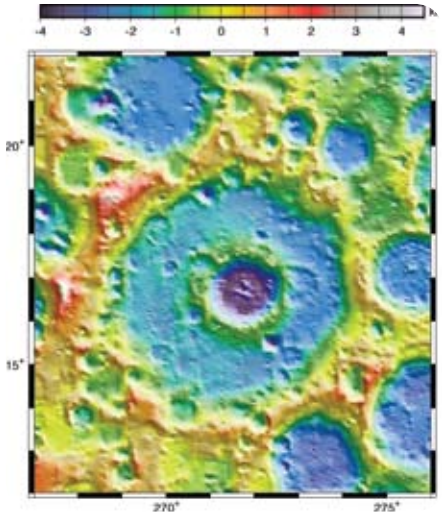
Lunar Reconnaissance Orbiter

Led by Goddard Space Flight Center, the Lunar Reconnaissance Orbiter (LRO) is an unmanned mission designed to create a comprehensive atlas of the moon's features and resources. Launched in June 2009, LRO is already returning images to Earth, including three-dimensional images of the moon. The LRO mission is an excellent example of how reusing existing technology and sharing innovations across missions contributes to NASA's success. Goddard's IPP Office encourages and fosters technology development, reuse, and sharing both within NASA and externally.

The LRO mission had an aggressive schedule that did not allow for the development state-of the-art technologies. Instead, the team often adapted existing technologies to meet LRO's mission needs. From the spacecraft to its instruments to the components and software that compose them, the LRO team leveraged from technologies that were already in production at Goddard. The following are just two examples.

Core Flight Executive (cFE) Software

The highly successful flight software used on LRO was one of the highlights of mission development. Developed by Goddard's Flight Software Branch, cFE helps streamline the software development process, managing previously flown software to handle routine spacecraft tasks, such as telemetry, health and safety, stored commanding, and more. The cFE software is part of the larger Core Flight Software system, which isolates platform-dependent interfaces, provides a reusable plug-and-play software component library, includes an integrated development environment, and features a graphical interface that allows missions planners to peruse a catalog and select the components they want for their mission.



This image of the Einstein craters on the moon's western limb is just one of many being sent to Earth by LRO.

LRO's use of cFE represents the first step in a much larger effort to provide an automated, platform-independent system that offers reusable software to all types of missions. The IPP Office is contributing to that larger effort by facilitating the sharing of cFE with NASA mission managers via the Software Release Process and Software Usage Agreements.

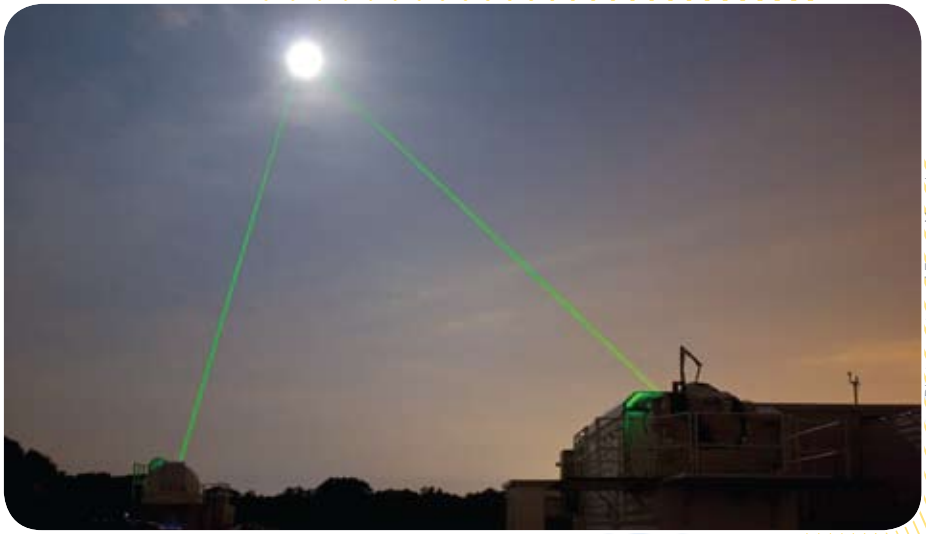


Photo courtesy of Erwin Mazarico

LOLA's range imaging system can optically detect laser pulses from Earth, determining LRO's precise orbit position.

Lunar Orbiter Laser Altimeter (LOLA)

Goddard's LOLA technology is a descendant of both the Mars Orbiter Laser Altimeter (MOLA) flown on the Mars Global Surveyor spacecraft and the Mercury Laser Altimeter (MLA) currently deployed on the Mercury Surface Space Environment Geochemistry and Ranging (MESSENGER) satellite. For LRO, LOLA will perform similar tasks to MOLA and MLA, but it will do so with three to five times greater accuracy than MOLA. Its timing resolution is significantly better than MLA as well. With LRO now launched, the LOLA design team is now working on the Geoscience Laser Altimeter System (GLAS) designed for the Ice, Cloud, and Land Elevation Satellite-2 (see page 7). They are also working closely with Goddard's IPP Office on potential commercialization for the technology. ■

Goddard Technologies Fill Mission Needs and Find Commercial Success

Solar Dynamics Observatory

The Solar Dynamics Observatory (SDO) mission is designed to help scientists understand the origin of the sun's energy and how it is stored and released into the sun's atmosphere. Through this mission, scientists will gain a better understanding of how the sun's magnetic fields are formed and how this translates into solar events—flares, coronal mass ejections (CMEs), sunspots—enabling better prediction of space weather. Several advanced innovations developed at Goddard have made the SDO mission possible, and they have already been leveraged for other NASA missions. Below are three examples of how Goddard's IPP Office is contributing to the distribution of technologies to benefit other NASA missions.

NASA photo by Barbara Lambert

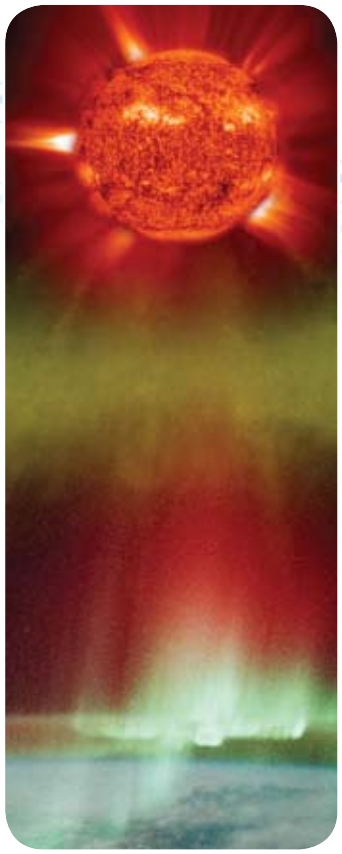
Goddard contributed many innovations to SDO, including the SpaceWire data link technology, the MTASS Attitude Determination and Sensor Calibration System, and the Coldfire SDN Hardware Diagnostics technology.

SpaceWire Data Link

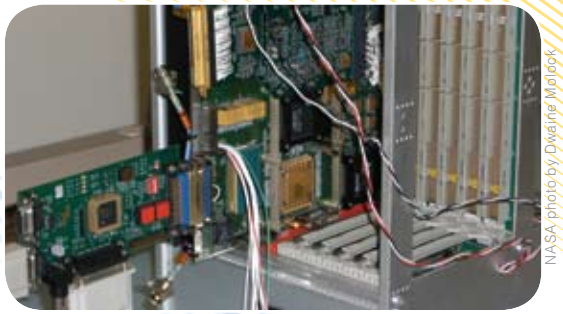
The SDO data team created a high-speed data bus to direct and process images using Goddard's SpaceWire data link technology. The SpaceWire technology has flown before but not at this level of performance. In addition to being used for the recent SDO and LRO projects, the SpaceWire technology is also slated for use on the upcoming Geostationary Operational Environmental Satellite (GOES) and the James Webb Space Telescope (JWST) missions. The IPP Office has worked extensively over the years to ensure maximum usage of Goddard's SpaceWire-based technologies. During 2009 alone, the IPP Office secured seven Software Usage Agreements for Goddard's SpaceWire "Link and Switch" technology.

MTASS Attitude Determination and Sensor Calibration System

The Multi-Mission Three-Axis Stabilized Spacecraft (MTASS) Attitude Determination and Sensor Calibration System serves as a more efficient and cost-effective multi-mission software system. Originally developed in the mid-1990s, MTASS has been incorporated into 21 planned or on-orbit missions. As the standard software package that Goddard uses for attitude determination and sensor calibration, MTASS helps maintain the stringent attitude required for SDO to provide reliable data and images. Through the Software Release Process, the IPP Office has facilitated access to the MTASS through the Software Release Process and Software Usage Agreements (see page 17).



A coronal mass ejection (CME) particle cloud blasted from the sun as it impacts Earth and creates an aurora.



NASA photo by Dwaine Maldock

The Coldfire SDN Hardware Diagnostics technology will test and debug computer hardware and can be customized for use with a variety of different processors.

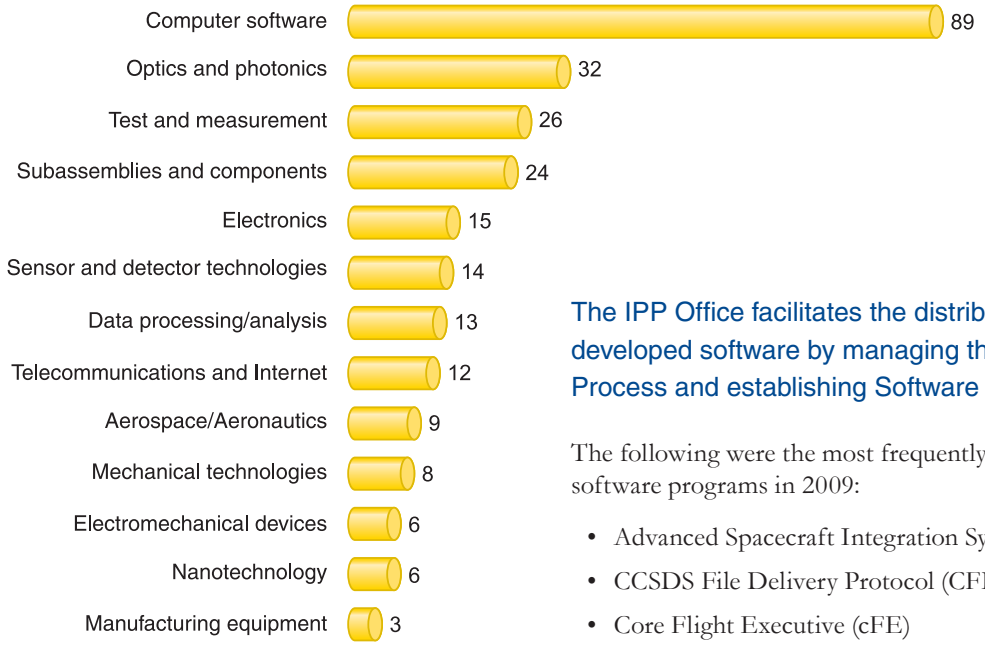
Coldfire SDN Hardware Diagnostics Technology

Coldfire Subsystem Data Node (SDN) Hardware Diagnostics software is a flexible means of testing and debugging custom computer hardware. SDO mission personnel used the software to run diagnostics during the early check-up phases to debug the hardware interfaces and ensure that the hardware was performing as designed. The software identified some problems with the SDO hardware that subsequently were corrected. In 2007, NASA's Headquarters funded a project to develop an enhanced version of the ColdFire processor. The IPP Office supported the technology's inventor through the process of getting this technology registered so that it could be released to the university selected to complete that design. ■

Technology Transfer Metrics for 2009
Making Our Innovations Available

New technology reporting is one key way to ensure that the innovations developed at Goddard find their way into missions and can be used beyond NASA in industry, academia, and other government organizations. These documented innovations often lead to further scientific discovery and advancements as well. The IPP Office uses training and outreach activities, publicity materials, and Web content to encourage Goddard innovators to report their technologies. Some of these technologies receive patents, while most of our software innovations are made available through Software Usage Agreements.

Goddard innovators filed more than 250 New Technology Reports (NTRs) in 2009, reflecting the diligent work of the IPP Office to increase technology reporting.



Goddard secured 10 new patents in 2009, the most received in any year of the past decade.

U.S. PATENT NO.	TITLE
7,504,921	Stepping flextures
7,601,091	Modular gear bearings
7,513,546	Conformal gripping device
7,544,146	Anti-backlash gear bearings
7,512,568	Evolvable synthetic neural system
7,609,978	Interferometric polarization control
7,543,274	System and method for deriving a process-based specification
7,548,199	Radiation-hardened fast acquisition/weak signal tracking system and method
7,513,459 7,513,460	Method and associated apparatus for capturing, servicing, and de-orbiting earth satellites using robotics

The IPP Office facilitates the distribution of Goddard-developed software by managing the Software Release Process and establishing Software Usage Agreements.

The following were the most frequently requested Goddard software programs in 2009:

- Advanced Spacecraft Integration System Test (ASIST)
- CCSDS File Delivery Protocol (CFDP)
- Core Flight Executive (cFE)
- Core Flight Software (CFS)
- Goddard Mission Services Evolution Center (GMSEC)
- Integrated Test and Operations Systems (ITOS)
- Multi-Mission Three Axis Stabilized Spacecraft (MTASS) Attitude Determination and Sensor Calibration System
- Recursive Hierarchical Segmentation (RHSEG)
- SpaceWire Link and Switch

Networking, Recognition, and Outreach
Propelling Future Collaboration for Forward-Thinking Innovation

Throughout the year, the IPP Office supports a variety of outreach efforts to engage and educate innovators, program managers, and potential partners about the collaborative opportunities available through the IPP and to encourage the growth of new relationships and awareness of Goddard's leadership. One of the most important aspects of this outreach is participation in a wide variety of networking and recognition events.

Student Education Outreach

Goddard's IPP Office participates in student education events to encourage the next generation of scientists and inventors to learn more about NASA and Goddard as well as to encourage them to consider becoming a part of the NASA team.

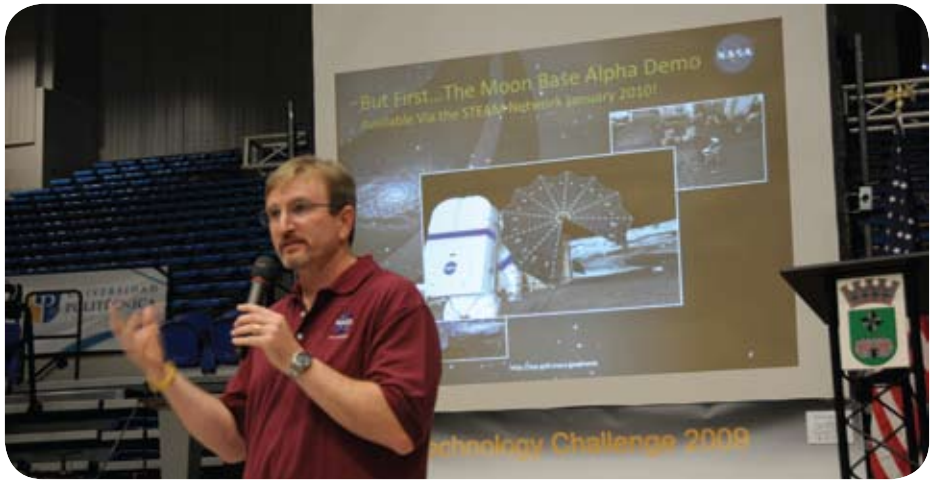
Goddard Celebrates 50 Years of Technology Spinoffs Art Contest

Goddard's IPP Office sponsored a special art contest for students in 6th through 12th grades, encouraging them to create illustrations that depicted the utilization of technology investments through technology transfer, or spinoff.

Goddard IPP presented the U.S. Department of Interior's National Park Service with the winning image from the "Goddard Celebrates 50 Years of Technology Spinoffs Art Contest" held in spring 2009. The image was created by Ja Hyun "Ashely" Lim of North County High School (Glen Burnie, Maryland). Ms. Lim painted a juxtaposition of the Statue of Liberty (maintained by the Park Service) and a Kennedy Space Center launch pad to represent how Goddard's IC531 anticorrosion coating technology was first used on the launch gantries and later on the Statue of Liberty. Approximately 200 students attended the event from two NASA Explorer Schools: Dr. Albert Einstein Academy (Elizabeth, New Jersey) and the Steinway Intermediate School (Astoria, New York).

The winning student artist, Ja Hyun "Ashely" Lim, is shown here being presented with her certificate by former NASA Deputy Administrator and veteran shuttle astronaut Fred Gregory.

Ms. Lim's winning art entry.



Technology Transfer Manager Darryl Mitchell gave a presentation about NASA's new MMO game at the Puerto Rico Institute of Robotics Second Annual Technology Challenge & VEX Robotics Puerto Rico Championship in December 2009.

PRIOR Technology Challenge

At this annual event of the Puerto Rico Institute of Robotics (PRIOR), Nona Minnifield Cheeks gave "The Spinoff Lecture," and Darryl Mitchell presented "Astronaut: Moon, Mars & Beyond" about the NASA massively multiplayer online (MMO) game initiative that is under development. Additionally, Darryl Mitchell and Enidia Santiago-Arce served as judges in two robotics competitions. Goddard IPP also hosted an exhibit featuring spinoff products from across the agency. An estimated 6,000 individuals attended the event.

Business Outreach

IPP Office staff members attend many industry and professional networking events each year, building on past contacts and adding new connections. IPP staff members attend these events with the primary goal of expanding potential partnerships for Goddard.

- **Joint-venture workshops** bring together industries with specific interest in Goddard key technologies with innovators and managers.
- **After-hours business networking events** facilitate dialogue and tours of facilities between key Goddard facility personnel and area businesses, universities, and government laboratories to identify collaboration opportunities for future follow-up.
- **Targeted industry and technology meetings** enable communication with partners and licensees in key industries that align with highly marketable Goddard technologies.
- **Technology transfer meetings** provide new information about best practices and opportunities for networking with potential partners.
- **Next Steps in Managing Innovation workshops** present information to Small Business Innovation Research (SBIR) companies about partnership opportunities with NASA and ways to move their technologies into commercial markets.

(L-R) Ted Swanson, Assistant Chief for Technology, Mechanical Systems Division; Carl Stahle, Assistant Chief for Technology, Instrument Systems and Technology Division; and Michael Johnson, Chief Technologist, Applied Engineering and Technology Directorate sit on the panel "NASA GSFC Technology Thrust and Partnerships Options" with Darryl Mitchell moderating.

Wallops Flight Facility's Geoff Bland gave a presentation about "Unmanned Aircraft System Technology for Earth Science" at the Federal Laboratory Consortium (FLC) Business Opportunities through Tech Transfer event.

Government Outreach

The IPP Office attends government events to keep an open dialogue with other government agencies in support of collaboration; to learn about programs, technologies, or policy advancements; and to educate attendees about the value of Goddard technologies and partnerships.

Innovator Outreach

Reaching out to innovators both within Goddard and across NASA is always important as the IPP strives to educate civil servants about new technologies that are available and understand what technologies are needed to fulfill mission goals. The IPP frequently sponsors mission-driven new technology forums, which encourage industries to leverage funding resources to develop or improve technologies that NASA can then infuse into missions. In addition, poster sessions and presentations within NASA present new available technologies to help mission and program managers identify technologies at Goddard that may meet their needs. ■

The IPP Office's Nona Cheeks (left) and the late Jim Chern (center) speak with Olaleye Aina, President of Epitaxial Technologies LLC (right) at the Next Steps in Managing Innovation event.

Networking, Recognition, and Outreach

Establishing Connections on the Path to Collaboration

To build relationships with Goddard innovators, expand potential industry partnerships, and learn from and work with other federal laboratories, Goddard's IPP Office participated in the following events in 2009.

Innovator Outreach

NASA's 2009 Project Management Challenge
February 24–25
Gave two presentations—"Leveraging NASA's Technology Assets" and "The Spinoff Lecture" for middle school students, both by Nona Minnifield Cheeks—and hosted an agency-wide IPP exhibit

Applied Engineering Technology Directorate (AETD) Mini Course
February 26
Presented training to Goddard personnel on "Software Intellectual Property Protection and the Software Release Process" by Ted Mecum, with several attendees requesting meetings with IPP to discuss specific cases

47th Robert H. Goddard Memorial Symposium
March 10
Joined NASA and industry experts to network on technology priorities and discuss partnership opportunities

AETD Mini Course Series
March 26
Briefed Goddard personnel on "The Software Release Process" in a presentation by Dale Clarke

Goddard Technical Managers Training Course
April 20
Presented "How to Work with GSFC's IPP Office to Benefit NASA, the U.S. Economy, and Mankind," with Nona Minnifield Cheeks explaining the activities of the Innovative Partnerships Program to technology managers

IPP Information Session
April 21
Presented "The Goddard Space Flight Center Innovative Partnerships Program Office's Ignition Fund," with Darryl Mitchell and Jim Chern discussing this technology development opportunity as well as the agency's Seed Fund

Technical Interchange Forum
May 18
Attended this Lockheed Martin Space Systems–hosted event to learn of programs and technical capabilities of attendees from the scientific and technological community, exploring possible partnerships that would advance missions

NASA's Business Education Program (BEP)
August 16–21
Presented "Partnership Formation" by Nona Minnifield Cheeks, an overview on IPP to mid-level managers from across NASA and the Navy

NASA's Earth Science Data System Working Group Annual Meeting
October 20
Discussed the importance of early reporting of software innovations to IPP in a presentation entitled "Software Intellectual Property Protection and the Software Release Process" by Dale Clarke

17th Annual New Technology Reporting Program
October 29
Hosted this annual event to recognize Goddard innovators and successful innovation resulting from the center's research and development, with more than 100 people in attendance and a keynote address from Greg Moores of Black & Decker Corporation (see page 8)

Goddard IPP Office hosted event

Business Outreach

Missouri Regional SBIR Conference
January 15
Presented "SBIR/STTR Program," with Jim Chern discussing how small businesses can participate in high-tech research for NASA

Ocean Tomo Live IP Auction
March 26–27
Attended and Nona Minnifield Cheeks presented "Through the Eyes of a Seller: Case Studies of the Sale of IP" as part of a panel discussion prior to the auction

Next Steps in Managing Innovation
April 2
Collaborated with prime contractors, Ocean Tomo and IXPI, Inc., to provide information about patents, licenses, and technologies to companies interested in NASA's SBIR program

American Security Challenge
May 21
Discussed Goddard technologies in a presentation entitled "Security Applications of Sensing and Detector Devices Used for Earth and Space Science Programs" by Ted Mecum

Rehabilitation Engineering and Assistive Technology Society of North America (RESNA) Annual Conference
June 23
Presented "Learning to Walk: The Secure Ambulation Module (S.A.M.)," with Darryl Mitchell discussing Goddard's compliant mechanisms technologies and the patent license to Enduro Medical Technology and several attendees expressing interest in learning more about NASA's available patent portfolio

Northrop Grumman Space Technology Forum
June 23–25
Attended discussions about progress in developing technologies that address the hardest problems and technical challenges facing government agencies today

ICAP Ocean Tomo IP Conference and Live Auction
July 22–23
Staffed a booth that featured the NASA@Home and City display and NASA spinoff products and participated in a panel discussion, with Nona Minnifield Cheeks discussing "IP Think Tank: The Future of the IP Marketplace Existing and Emerging IP Business Models"

Virginia's SBIR-Max Workshop – Advanced Phase 2 and Phase 3 Strategies
July 27
Served on a panel to advise small businesses on how to benefit most from their SBIR/STTR experience and to encourage them to commercially apply technologies developed under the SBIR/STTR program

Military and Aerospace Programmable Logic Devices (MAPLD) Conference
August 31–September 3
Discussed Goddard technologies and related partnership and licensing opportunities with companies and other government agencies in attendance, leading to the ongoing development of two Space Act Agreements

SBIR Beyond Phase 2 Conference & Technology Showcase
September 21–24
Learned about showcased technologies from SBIR Phase 2 awardees and discussed commercialization opportunities

International Astronautical Congress
October 12–16
Co-chaired a session on technology transfer trends and presented the paper "Leveraging NASA Technology" by Nona Minnifield Cheeks

National SBIR/STTR Conference
November 2–5
Met with representatives from industry, academia, other federal laboratories, venture capital firms, and angel investors, discussing how to further technology development for early- and advanced-stage ventures such as SBIR/STTR awardees

Maryland SBIR Innovation and Investment Conference
November 17
Participated in one-on-one sessions with companies with expertise in nanoparticle materials, cryogenic fiber optics, high-speed computer data system, and more

Mid-Atlantic SBIR/STTR Conference
November 30–December 2
Attended this event dedicated to enhancing the participation of small businesses in NASA's SBIR/STTR programs

Next Steps in Managing Innovation Workshop
December 8
Hosted this event to discuss potential technology applications and advancements for Goddard and commercial uses with more than 30 SBIR/STTR companies, other small high-tech firms, and universities in the northeast region

PRIOR Technology Challenge
December 9–12
Gave presentations, judged robotics competitions, and hosted an exhibit (see page 18)

Government and Technology Transfer Outreach

Inter-Agency Working Group for Technology Transfer Meeting
January 15
Presented on Goddard's ground-breaking partnership with Ocean Tomo for auctioning exclusive licenses for federally owned patents in a presentation entitled "NASA's Innovative Partnerships Program" by Nona Minnifield Cheeks

American Intellectual Property Law Association Mid-Winter Meeting
January 28
Discussed the Ocean Tomo partnership to auction exclusive licenses for federally owned patents in a presentation delivered by Nona Minnifield Cheeks entitled "Technology Transfer and Open Innovation: How NASA Uses Partnerships to Benefit the Space Program, Business, and Society"

Federal Laboratory Consortium for Technology Transfer (FLC) Mid-Atlantic Region Workshop
January 29
Supported speakers from Wallops Flight Facility presenting on their research and the potential for corresponding technology transfer and partnering opportunities for bio-based products and robotics technologies

FLC Annual Meeting
May 4–6
Participated in two panel discussions, a networking session, and an award ceremony, receiving a Regional Partnership Award for Innovative Partnerships and honorable mentions for two national awards

Intellectual Property Owners (IPO) Association Annual Meeting
September 13–15
Obtained insights into IP portfolio management, including strategies for building, protecting, and getting the most value out of the patent portfolio in today's economic climate

FLC Mid-Atlantic Region Annual Conference
September 15-17
Participated on a panel on the "Human Element of Technology Transfer," with Darryl Mitchell as moderator, and was recognized for presentations on sensors and unmanned aerial vehicle technologies at the May 2009 American Security Challenge conference

Maryland Licensing Executives Society (LES) Chapter Meeting
September 23
Attended and networked with other licensing and technology management professionals, identifying new business concepts and potential partnership opportunities

Technology Transfer Society Annual Conference
October 2
Presented on the partnership with Ocean Tomo for auctioning exclusive licenses for federally owned patents in a presentation by Darryl Mitchell entitled "To the Highest Bidder: How NASA Sold Technology Rights through a Public Auction"

LES Annual Meeting
October 19–21
Presented as a panelist on the topic of "Doing Deals with National Labs and Federal Agencies" by Darryl Mitchell

Maryland LES Chapter Meeting
November 3
Attended meeting where a representative from Merck & Co. discussed partnerships and licensing transactions in the drugs and compounds market

› Goddard IPP Office hosted event

Student and General Public Outreach

Annapolis Space Day
February 12
Coordinated technology displays and programs that highlighted partnerships between NASA and Maryland companies, helping the general public to learn more about NASA's missions, programs, technologies, and spinoffs

Maryland's Place in Space
May 30
Staffed a booth at this public educational event to celebrate Goddard's 50th anniversary

Goddard Celebrates 50 Years of Technology Spinoffs
June 4
Hosted a celebratory event to commemorate 50 years of technology transfer and decades of successful spinoffs, including guest speakers who highlighted significant technology transfer stories over the past five decades (see pages 8–9) and presenting the student art contest winner (see page 18)

NASA Day on the Hill
July 8
Attended and hosted a booth with other NASA centers to showcase NASA technology and technology transfer efforts

INTER television interview
July 15
Participated in an interview with Greg Moores of Black & Decker describing the partnership in developing the Apollo drill for the lunar surface and how that led to today's cordless tools (see page 8)

STEM Talent Post-Doc Symposium and Career Fair
July 22
Attended the event featuring Nobel prize-winner and senior astrophysicist Dr. John Mather and networked with many recent postdoctoral fellows to discuss current job and research opportunities in science, technology, engineering, and mathematics (STEM)

IPP Art Contest Winner Recognition
November 13
Presented winning image from the spinoffs art contest (see page 18) ■

National Aeronautics and Space Administration

Goddard Space Flight Center
Innovative Partnerships Program Office
Building 22, Room 290, Mailstop 504
Greenbelt, Maryland 20771

phone: 301.286.5810
fax: 301.286.0301
e-mail: techtransfer@gsfc.nasa.gov
web: http://ipp.gsfc.nasa.gov

www.nasa.gov

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