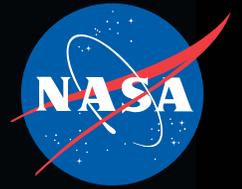


National Aeronautics and Space Administration

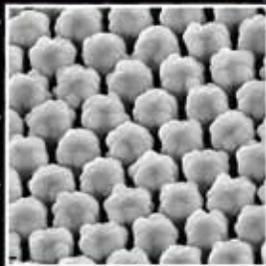


2009 Accomplishments

Ames Innovative Partnerships Program Office



ames ipop





NASA photo

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Lisa L. Lockyer

It is my pleasure to present this Report, highlighting just a few of the many fiscal year 2009 (FY09) accomplishments of the Innovative Partnerships Program (IPP) Office at NASA's Ames Research Center.

The IPP Office is located in the Entrepreneurial Initiatives Division within the New Ventures and Communications Directorate (Code V). We are part of a large team that is focused on developing collaborations with industry, academia, and other government agencies; managing and executing the NASA SBIR/STTR* programs; licensing Ames' intellectual property; coordinating educational

outreach and internship programs; and communicating with external stakeholders and our internal community. In short, we serve as a bridge to the external community and support the entrepreneurial community here at Ames.

Our commitment to innovation and entrepreneurship is reflected in our goals as well as by what we achieved in FY09.

Goal	Achievements in FY09
Partnerships To find technology that can be infused into and used by NASA mission directorates	<ul style="list-style-type: none"> ■ 200 Space Act Agreements processed ■ 49 significant Space Act Agreements executed ■ \$21 million earned in revenue plus cost avoidance
Spinoffs To make Ames' technology available to and used by industry, academia, and other government agencies to benefit the general public	<ul style="list-style-type: none"> ■ 223 new technologies reported ■ 9 patent applications submitted ■ 14 patents issued ■ 4 licensing agreements signed ■ \$280,000 earned in royalty revenues and licensing fees
Innovation Investments To support Ames researchers in their cutting-edge science and engineering work	<ul style="list-style-type: none"> ■ \$600,000 invested and \$800,000 leveraged for Ames technology development projects ■ \$45,050 in awards received from NASA's Inventions and Contributions Board, recognizing 38 Ames inventors
Small Business Support To help develop small businesses as an economic engine for the nation	<ul style="list-style-type: none"> ■ More than \$21 million invested in more than 90 small U.S. businesses via SBIR/STTR*

* Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs

I am proud of our record of success and look forward to continuing to expand our portfolio of innovative partnerships, spinoffs, innovation investments, and small business investments. Finally, I am pleased to introduce David Morse as the new chief of the Entrepreneurial Initiatives Division, who will lead Ames' IPP efforts.

Lisa L. Lockyer
 Deputy Director
 New Ventures and Communications Directorate



NASA photo

Ames plays a critical role in virtually all NASA space and aeronautics missions. Partnerships that leverage external capabilities are key to how Ames achieves its space-focused missions. From creating intelligent, high-performance, and reliable exploration technologies to designing the next generation of small spacecraft, partnerships are contributing to Ames' achievements.

Prognostics

Ames offers extensive capabilities to address prognostics technology needs for space exploration. In addition to developing technology, Ames' Prognostics Center of Excellence (PCoE) makes data available to the external research community to extend the knowledge we have gained to others for the benefit of the entire industry. Also aiding organizations beyond Ames, the Advanced Diagnostics and Prognostics Test Bed (ADAPT) encompasses several test beds in one laboratory—enabling development, maturation, and benchmarking for system health management applications.

A Boost for Next-Generation Actuation Systems

A 2009 Space Act Agreement (SAA) with Moog Inc. promises advancement in prognostics research for an electro-mechanical actuation system (EMAS). Ames innovators are helping their counterparts at Moog understand NASA's research in vehicle health management and prognostics for flight control actuation systems. The collaborative research is focusing on failure-model physics, prognostics algorithms, and advanced sensor technologies. Researchers hope to use the agreement as a springboard to boost Moog's next-generation actuation systems. In return, Ames will be able to apply the company's domain expertise to NASA's Integrated Vehicle Health Management (IVHM) project, an important part of the Aviation Safety Program.

Structural Advancements with Composite Materials

Investigation of composite material failure models, damage propagation models, diagnostics algorithms, prognostics algorithms, and advanced sensor technologies—that is the goal of a 2009 SAA with Stanford University. The agreement matches Ames' unique prognostics technology expertise with Stanford's structures and composites laboratory. This mix of skills stands to benefit NASA's use of composite materials for aircraft structures, improving maintenance and reliability. Also, the partnership gives Stanford access to NASA's existing prognostics algorithms and will help university researchers gain expertise in data integration and interpretation.



Partnership Success: IPP Funds Electronic Prognostics for Critical Avionics Systems

A 2006 IPP Partnership Seed Fund—awarded project brought together innovators at Ames and Impact Technologies LLC to develop predictive health management techniques—with the ultimate goal of improving avionics systems. The partners worked together to develop aging models and prognostics algorithms to predict the remaining life of electronic components—new technology that will help improve aircraft safety, reduce maintenance costs, and minimize flight delays and cancellations for NASA and the larger aeronautics community.

For more information about the Seed Fund, see pages 14–15.

Prognostics Industry Day

Representatives from academia, government, and commercial organizations came together in early FY09 for Ames' Prognostics Industry Day, which highlighted the work of the PCoE and provided information about the potential for health management and prognostics for future engineered systems. The event served as a forum for industry feedback as well as demonstrations, poster sessions, and question-and-answer periods, which helped identify areas for mutual collaboration and discussion between Ames and several potential partners. These successful outcomes will be pursued well into the coming years.



Spacecraft

Developing space missions to be both sustainable and cost effective, the Small Spacecraft Division at Ames focuses on common, reusable architectures and secondary payloads to reduce mission costs. Several FY09 agreements benefit from—and are providing benefits to—this division.



Image courtesy of Odyssey Moon Ventures LLC

Commercial Lunar Lander

A reimbursable SAA with Odyssey Moon Ventures LLC (OMV) combines Ames' common spacecraft bus (CSB) with the company's commercial space systems. The CSB's modular design provides capabilities that can be adapted to meet specific mission parameters, so OMV plans to use it to develop a commercial robotic lunar lander—"MoonOne." This agreement promises to boost the company's enhanced technical capabilities while furthering NASA's lunar exploration goals. OMV plans a series of robotic missions to the moon over the next decade, benefiting NASA's Commercial Orbital Transportation Services Program, which is developing small spacecraft for lunar surface and space exploration.

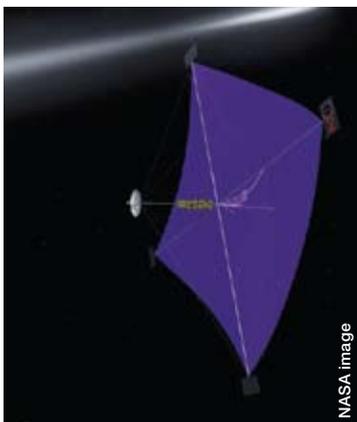
Ground Propulsion Systems and Personal Rapid Transit

An SAA with Unimodal Systems LLC leverages the company's design for the SkyTran™ personal rapid transit system to demonstrate NASA's Plan Execution Interchange Language–Universal Executive (PLEXIL-UE) techniques. The agreement will enable investigation of acceleration, jerk, vibration, and control software based on PLEXIL-UE, which offers intelligent control for ground-based propulsion systems. The SkyTran system, used as a model, will offer valuable feedback on the applicability of PLEXIL-UE for space and aeronautics activities. At the same time, this partnership will help Unimodal further develop SkyTran—a revolutionary form of transport that promises to eliminate traffic congestion, mitigate greenhouse gases, and reduce petroleum dependence.

SkyTran is a trademark of Unimodal Systems LLC.



Image courtesy of Unimodal Systems LLC



NASA image

Solar Sail Propulsion Concepts

Innovators at Ames and the Planetary Society are collaborating on a feasibility study to determine how solar sail propulsion technologies can be integrated into small spacecraft platforms—and even provide potential applications for such systems. By demonstrating the limits and capabilities of solar sail techniques, researchers hope to glean insight into viable uses for small spacecraft. Ames innovators from the Small Spacecraft Division also will serve as judges and evaluators at educational competitions—a valuable outreach effort that will provide input for the study, making it a win-win information exchange.



Technology Innovation

In 2009, IPP's *Technology Innovation* magazine focused on NASA and the growing private space sector, describing how the agency and private industry are working together for mutual benefits. Several Ames technologies and partnerships were featured.

For more information, see page 10.

As the environmental and strategic importance of Earth observations grows, Ames is playing a key role in making those observations possible and interpreting the data obtained. By partnering with companies, universities, and other government laboratories, Ames maximizes the value of its capabilities while tapping into complementary external expertise to increase scientists' understanding of our home planet. For more about how we are "Keeping an Eye on Earth," see pages 12–13.

Google: A Key Partnership

Ames' partnership with Google Inc. has spawned dynamic and interactive projects that connect and benefit humankind. Under an umbrella Space Act Agreement (SAA) signed in November 2006, Google and Ames have been working together on multiple projects that put NASA's work into the hands of more scientists and engineers—professionals and amateurs alike. This report highlights just a few of those projects.



Global Connection



The Global Connection Project is a collaborative effort of scientists from Ames, Google, Carnegie Mellon University, and the National Geographic Society, who are dedicated to connecting, informing, and inspiring global communities through the power of

spatial images. Thanks to this project, users of the Google Earth™ mapping service (<http://earth.google.com>) can zoom in on high-resolution aerial imagery of Africa as well as almost any other point on our planet. The project also supported the development of the GigaPan™ robotic camera mount, which allows anyone with a digital camera to create and share ultra high-resolution panoramas across the globe via the Web (<http://gigapan.org>).

Google Earth is a trademark of Google Inc.

GigaPan is a trademark of GigaPan Systems. The GigaPanSM system was developed by Carnegie Mellon University in collaboration with Ames' Intelligent Robotics Group, with support from Google Inc.

Disaster Response

The researchers collaborating on the Global Connection Project also aided in disaster response efforts following Hurricane Katrina by processing approximately 8,000 high-resolution images of flood-damaged New Orleans. The team created new software tools to present the images, taken over 10 days, in a searchable, stitched-together format. The GigaPan system made the preparation of image overlays faster than was previously possible and provided real-time information and updates for rescue and aid workers.

Planetary Content

Through the Planetary Content Project, data and images collected by NASA and the science community at large can be easily published, shared, and explored via various Google mapping services. In 2009, "armchair" exploration of the moon and Mars was enhanced via the Google Earth 5.0 mapping service. The newly launched Moon in Google Earth feature (<http://earth.google.com/moon>) and Mars in Google Earth feature (<http://earth.google.com/mars>) provide access to interactive, 3D images and much more from NASA's many missions to these heavenly bodies. These services are proving to be an excellent way for NASA to reach students, educators, engineers, and scientists—all at the same time.

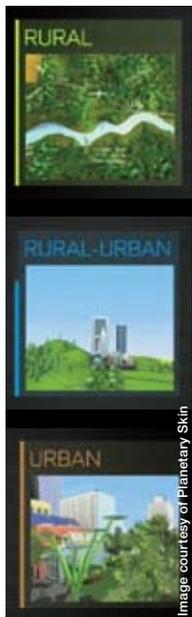
The GREEN Initiative

Another project, known as the GREEN (for Global Research into Energy and the Environment at NASA) Initiative, is exploring how Ames—with its extraordinary combination of information scientists, computer engineers, Earth and atmospheric scientists, astrobiologists, ecologists, nanotechnologists, modelers, robotics and sensor engineers, fluid dynamicists, and life support systems engineers—can contribute to the transition from petroleum-based energy to sustainable, carbon-neutral energy sources. Since the project was initiated in 2007, the team has hosted five technical seminars; conducted three pilot projects in the areas of biofuels, other clean energy options, and remote sensing data/analysis focused on climate change; and, in 2009, launched NASA's first Web site dedicated to green collaborations and initiatives: Greenspace (<http://green.arc.nasa.gov>).

Other Partnerships

Studying the Layers of the Earth

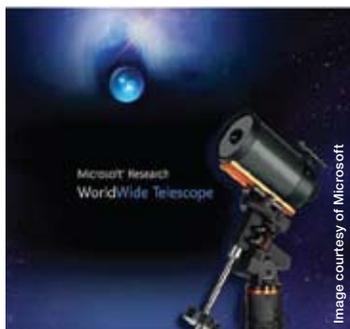
In March 2009, Ames partnered with Cisco Systems Inc. to develop Planetary Skin (<http://www.planetaryskin.org>)—an online collaborative



global monitoring platform. Just as the skin of our bodies has many layers, Earth has many layers of information that need to be captured, collected, analyzed, and reported around the world. The platform will enable environmental data to be measured, reported, and verified in near real-time to help mitigate global climate change. The “skins” will focus on biosphere systems such as water, food, biofuels, biodiversity, energy, and climate change risks. A video is available that explains the project’s unifying approach to managing global resources and risks while enabling environmental markets (<http://www.planetaryskin.org/resources/videos>).

Enhancing Microsoft’s WorldWide Telescope with NASA Data

Ames and Microsoft have joined forces to increase literacy and workforce population in science, technology, engineering, and mathematics. Under an SAA signed in 2009, Ames is contributing NASA’s vast quantities of planetary data to Microsoft’s



WorldWide Telescope tool, combining the power of a geobrowser with story-boarding, presentation, and audio-recording capabilities. The resulting platform will be able to

tell stories about planetary science and exploration. Ames also is designing new infrastructure and processes that will make additional images and planetary data available for use in the WorldWide Telescope product.

Protecting Petroleum Pipelines

The Ames–BP Pipelines collaboration to advance monitoring technologies for liquid/gas pipelines and pipeline rights-of-way (ROWs) is mitigating security threats to the nation’s energy infrastructure, improving public and environmental safety, and enhancing NASA’s Earth science research. The



partners are developing and implementing an advanced imaging system for small, unmanned aircraft systems. Such a system can remotely detect intrusions into liquid pipeline ROWs and trace gases from liquid/gas pipeline releases. The migration from manned to unmanned aerial systems and satellites will

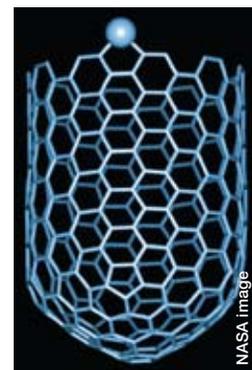
provide more frequent, consistent, and accurate surveillance, effectively address security threats, and help meet Department of Transportation (DOT) regulations requiring safe and reliable operations. The technology improvements also will benefit NASA’s Science Mission Directorate.

In addition, Ames is working to coordinate and combine the assets, expertise, and capabilities of federal agencies such as the DOT’s Pipeline and Hazardous Materials Safety Agency, research organizations such as the Petroleum Research Council International, and petroleum companies to improve public safety as well as environmental and situational awareness.

Working on a Small Scale

In 2009, Ames signed two SAAs with MSGI Security Solutions Inc. to advance NASA-developed solar cell technology and an air-monitoring sensor used on the space shuttle. MSGI will co-develop and commercialize these technologies, both of which make use of nanotechnology—the super-small structures that are a core capability of Ames. For one project, MSGI will focus on scalable, renewable energy solutions that cost less per watt than conventional energy sources. In the other project, MSGI will launch its first prototype of a handheld diabetes sensor.

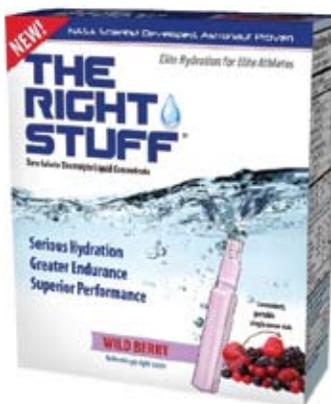
Derived from NASA technology, this device can detect diabetes from a patient’s breath, eliminating the need for expensive laboratory tests and inconvenient trips to a laboratory facility.



The partnerships discussed in this report are only a few of the more than 75 agreements signed at Ames in 2009.



Innovative technologies from NASA's space and aeronautics missions can be used in many ways that benefit society. Therefore, Ames is committed to "spinning off" its innovations into new products that improve human health, enhance transportation, ensure public safety, protect our environment, and generally make our lives easier. These spinoffs—as well as others from across the agency—are profiled each year in NASA's *Spinoff* magazine. Since 1976, *Spinoff* magazine has published 165 stories of technologies emerging from work at Ames Research Center.



Rehydration Beverage

A NASA-developed rehydration beverage served as the inspiration for a start-up company, Wellness Brands Inc., which was launched upon exclusively licensing the novel technology from Ames in 2009. The patented beverage formula was developed as a better way to avoid dehydration in astronauts during and after spaceflight, which was historically treated by having the astronauts take salt tablets with water. But this method could be detrimental to their health because the high levels of sodium ingested could actually worsen dehydration and require substantial additional amounts of water. The NASA Rehydration Beverage was developed as a response to this problem, offering an effective way to restore and maintain optimal water levels quickly.

NASA offered the formula for license, recognizing the potential benefits for high-endurance athletes or people experiencing the dehydrating effects of illness or air travel. Now marketed by Wellness Brands as The Right Stuff™ liquid concentrate, the beverage formula has become the company's premier product and is available in single-serving, 16.5-milliliter recyclable plastic vials in citrus blend, wild berry, or unflavored varieties. This concentrate can be added to water or any training beverage. The company initially is marketing the product to elite and endurance athletes and is in discussions with college and professional sports teams.

The Right Stuff is a trademark of Wellness Brands Inc.

Algae-Based Biofuels

Algae Systems LLC was created in 2009 when the company licensed Ames' two-patent Offshore Membrane Enclosure for Growing Algae (OMEGA) system. The OMEGA system, which consists of large plastic bags with inserts of forward-osmosis membranes, uses photosynthesis to grow freshwater algae in processed wastewater. The algae absorb carbon dioxide from the atmosphere and nutrients from the wastewater using solar energy, producing biomass and oxygen. Nutrients are contained in the bags as the algae grow, while the cleansed freshwater is released into the surrounding ocean through the forward-osmosis membranes. The system can help reduce contamination in coastal areas, and the forward-osmosis membranes use relatively small amounts of external energy compared to conventional methods of harvesting algae. Once the process is complete, the algal remains can be used to produce oil as well as fertilizer, animal feed, and other products. Algae Systems plans to conduct field experiments in its pilot project in Tampa Bay, Florida and, given favorable results, integrate the technology into a biorefinery to produce renewable energy products.



Aircraft Advisory Service

In 2009, The Boeing Company licensed Ames' Direct-To software, an advanced tool for measuring and monitoring air traffic, weather, and airport availability. The company plans to integrate the software into its Strategic Pre-Alignment of Aircraft En Route (SPACER) system—a real-time, fuel-saving advisory service for aircraft in flight. When combined with the Direct-To software, the SPACER system promises to automatically find all aircraft flying on inefficient routes, determine whether it is possible to save time by bypassing some route segments, and indicate whether the improved route is free of conflicts with other aircraft. Continuously searching for simple, wind-optimal re-route opportunities with at least 1 minute of time savings within the next 30 minutes of flight, the SPACER system offers potential for reduced emissions and accelerated implementation of four-dimensional, trajectory-based air traffic management (ATM) operations and automation algorithms. Commercial potential for the Direct-To-enhanced SPACER system is very broad, which would provide significant royalty revenue to Ames that could be used to fund additional innovative research at no cost to the taxpayer.

*Read about many more amazing spinoffs—which directly benefit the private sector, supporting global competition and the economy—in **Spinoff** magazine at <http://spinoff.nasa.gov> or by calling 443.757.5802.*



Portable Rock and Mineral Analysis Tool

A Phase 2 Small Business Innovation Research (SBIR) contract allowed InXitu Inc. to develop an automated sample handing (ASH) system for planetary X-ray diffraction (XRD) and X-ray fluorescence spectrometry (XRF) instruments that enable analysis of materials. The company's efforts led to its Terra product—the first truly portable XRD/XRF system designed specifically for rock and mineral analysis. The innovation uses a low power X-ray source and an energy-dispersive, two-dimensional charge-coupled device (CCD) to obtain XRD and XRF data with no moving parts. The system offers fast identification of materials, an easy-to-use interface, simplified sample preparation, rugged operation, and autonomous operation within a watertight, dust proof, lockable housing. The tool can be used on a rover or lander for NASA planetary missions, and in 2009 some features of the system were incorporated into the CheMin instrument, developed at Ames for the Mars Science Laboratory mission. *For more information about SBIR, see pages 18–21.*

Publication herein does not constitute NASA endorsement of the product or process, nor confirmation of manufacturers' performance claims related to any particular spinoff development.

Ames makes its cutting-edge technologies—more than 140 reported and 9 patented in 2009—available to non-NASA organizations so that the American taxpayer continues to reap the benefits of these innovations. To make sure potential users/licensees know what Ames has to offer, we promote these technologies—as well as Ames’ facilities and expertise—in many print, digital, and event-based venues. These performance metrics have a direct impact on the formation of partnerships and licenses.

NASA Tech Briefs

As the most pervasive design engineering magazine, *NASA Tech Briefs* provides a unique and powerful way for engineers, managers, and scientists to learn about NASA technologies. Published jointly by NASA and the private sector company, Tech Briefs Media Group, *NASA Tech Briefs* has more than 400,000 readers.



The monthly magazine features exclusive reports about innovations developed by NASA and its industry partners and contractors that can be applied to further develop new or improved products and to solve engineering or manufacturing problems.

NASA Tech Briefs spans a wide array of fields, including electronics, physical sciences, materials, computer software, mechanics, machinery, automation, manufacturing, fabrication, mathematics, information sciences, and life sciences. Most of the briefs offer a

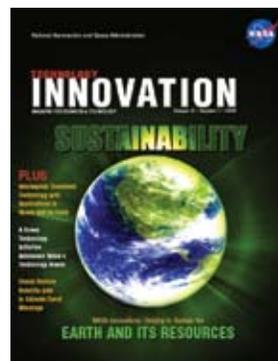
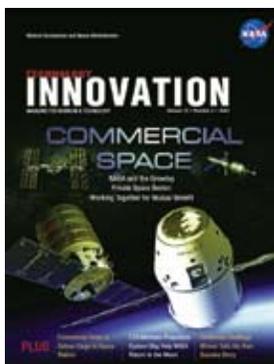
In 2009, NASA Tech Briefs published 19 Ames technologies submitted by the IPP Office.

technical support package that explains the technologies in greater detail and provide contact points for questions and licensing discussions.

Technology Innovation

Because NASA seeks to create partnerships and cooperative activities with U.S. enterprises, IPP publishes *Technology Innovation* magazine. Subtitled “Magazine for Business and Technology,” *Technology Innovation* provides information about NASA’s technology needs and opportunities as well as interesting facts and feature articles about the agency’s successes. As a result, the magazine opens doors to establish new partnerships to develop technology that is applicable to NASA’s mission technology needs and contributes to commercial competitiveness in global markets. The 2009 issues focused on sustainability and commercial space. For more information, see http://www.nasa.gov/offices/ipp/products/product_innovation.html

In 2009, Ames published eight stories in Technology Innovation.



Ames’ Science and Technology Showcase

As part of the center’s Platinum Jubilee events that celebrated 70 years of innovation, Ames hosted an outdoor Science and Technology Showcase on June 29, 2009. Designed to inform the public about NASA missions and cutting-edge research and technology, the showcase featured more than 40 exhibits, highlighting life science, robotics, information technology, unmanned aerial vehicles, and more.

More than 1,000 people attended the 2009 Science and Technology Showcase.



Software Offerings from Ames

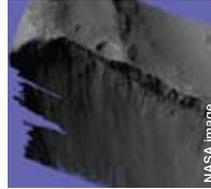
Software developments are a key capability at Ames, and we make many of our programs available via open source. The following are some of Ames' top software innovations released in 2009.



Robot Application Programming Interface Delegate (RAPID) is open source software developed for remote operations. It promotes interoperability among software modules to speed robot prototyping, development, and experimentation.



Cart3D Adjoint Adaptation Module extends mesh generation capability to permit cell-by-cell mesh enrichment. For example, it can provide a method of estimating numerical errors in user-specified output functions for fluid flow simulations.



NASA Neo-Geography Toolkit (NGT) transforms geospatial data into cartographic products, such as visible image base maps and topographic models. It also can perform parallel data processing and transform raw data into standard formats.

In 2009, Ames innovators reported more than 80 new software developments, representing about one-third of all new technologies reported for the year. For more about software innovations at Ames, see <http://technology.arc.nasa.gov/factsheets/index.cfm>

NASA Signs Agreement with SourceForge.net

Ames researchers now have access to the world's largest open source software development site, thanks to a Terms and Conditions Agreement signed in 2009. In addition, NASA personnel agency-wide are able to upload projects, making them available as open source.

For more information, see <http://sourceforge.net>

sourceforge



Man-Machine Integration Design and Analysis System (MIDAS) employs simulation and visualization to study human-machine interfaces. It can be used to evaluate operator performance in cockpits, mission control centers, and individual workstations.



Quick Image Processing Software Environment (QuIP) can be used by non-experts for human-gaze tracking, feature tracking, and image filtering. It also can display images on screen and provides graphical and user interface tools.



Problem Reporting Analysis and Corrective Action (PRACA) provides International Space Station personnel access to a single database package for tracking problems with the station and its associated infrastructure, and it can be used for similar tasks in other industries.

Open Source Success: Improving PRACA for NASA Missions

Originally developed by the Human-Computer Interaction Group at Ames, the PRACA system was written as an extension of the open-source Bugzilla tool. Using Bugzilla as the starting point dramatically reduced PRACA's development cost—dropping the price tag from about \$1 million to about \$100,000.

IPP re-released PRACA as open-source software in April 2008, enabling further enhancements to be made by the open-source community, at no cost to NASA. PRACA's enhanced version has since been implemented at a number of NASA centers and in various missions. The software also has been used by Lockheed Martin and ATK Space Launch Systems.

keeping an eye on earth

Many of IPP's activities in 2009 focused on caring for our home planet.

Partnerships

Our partnerships with Google, Cisco Systems, Microsoft, BP Pipelines, MSGI Security Solutions, and others were established to benefit NASA space exploration activities. Yet many of these partnerships have generated down-to-Earth benefits.

See pages 6–7.

Licenses

Technologies developed by Ames are being used by private companies to make Earth a safer and cleaner place to live.

See pages 8–9.

Events

In 2009, Ames hosted and attended the following events that addressed environmental topics.

Sustainable Urban Development Workshop January 9–10	This conference explored and documented how NASA technologies can contribute to a sustainable urban environment.
Sustainability and Exploration Expo April 21	Approximately 40 exhibits and renowned speakers highlighted research in the areas of exploration and sustainability.
Armory Lovins Lecture May 1	Physicist, author, and world-renowned energy innovator Armory Lovins lectured on “Profitable Solutions to Climate, Oil, and Proliferation.”
Sustainable Brands 2009 Conference May 31–June 4	Deborah Bazar of Ames’ IPP Office delivered a presentation on “Sustainable Technologies and Partnering with NASA.”
Western Energy Summit July 30	Focused on “Accelerating Energy Innovation,” this summit examined the key lessons from California’s success in developing and deploying sustainable energy solutions.
International Energy Conversion Engineering Conference August 2–5	Jeff Smith of Ames’ Entrepreneurial Initiatives Division presented a paper entitled, “Leveraging NASA Capabilities for a Cleaner, Greener Earth,” at this American Institute of Aeronautics and Astronautics (AIAA) event.
Sustainability Base Groundbreaking Ceremony August 25	This new environmentally friendly building will be a highly efficient facility supporting a wide range of NASA’s aeronautics and space exploration missions.





Publications

In February 2009, IPP published the “Sustainability” edition of *Technology Innovation* magazine.

See page 10.

Web Sites

In January 2009, Ames launched NASA’s first Web site dedicated to green collaborations and initiatives. Located at <http://green.arc.nasa.gov>, Greenspace features “Green NASA Ames”—describing the center’s work to promote alternative energy and environmental projects, such as sustainable institutional practices and environmentally responsible work and lifestyle habits. It also includes information about Sustainability Base, a new high-performance green building at Ames—the greenest ever built by the federal government and a symbol of NASA’s leadership in seeing, understanding, and benefiting life on Earth. This Web site was an outgrowth of Ames’ GREEN Initiative with Google.

See page 6.



In addition to fostering strategic collaborations between NASA and small and large businesses, universities, or other government agencies, IPP also provides funding through mechanisms such as the Innovation Fund and the Partnership Seed Fund, which play a key role in advancing critical technologies both for NASA and the commercial marketplace.

NASA photo

Innovation Fund Supports Novel Technologies

Initiated in 2009, the NASA Innovation Fund is a new funding mechanism that supports NASA innovators in the early stages of formulating concepts for novel technologies that have the potential to revolutionize the way the agency performs its missions. Of particular interest are innovations with the potential to address national and global challenges. Two technology development projects at Ames received this funding in 2009.

Small Payload Quick Return

Once the Space Shuttle Program is completed, NASA will need a new way to routinely return small samples from the International Space Station in order to ensure that use of the station's microgravity/biology laboratory facility is maximized. This project furthered the development of a non-propulsive, three-stage, de-orbit capability for sample sizes weighing no more than 3 kg and measuring 10 cm by 10 cm by 30 cm. Novel features include a Stage 1 re-entry lightweight drag sail and a Stage 2 tubular deployed vehicle that performs the aero-assist portion of re-entry. This technology eventually might provide a means of retrieving small satellites or upper rocket stages. It also could offer commercial and government entities a simple way to retrieve small payloads.



NASA image

Graded Ablating TPS Materials Development, Characterization, and Modeling

This project allowed researchers to gain a better understanding of the influence of gradation on the performance of thermal protection system (TPS) materials, standardize the approach for processing graded TPS materials, and develop an initial thermal response model. Graded materials offer several advantages for ablator systems. In addition to enabling gradual change in material properties, they eliminate the need for joints or bonding agents in dual- and multi-layer materials. A graded ablator also has less mass than current ablator systems. In fact, it is expected that the weight savings would be substantial enough to significantly enhance or enable crewed and robotic missions.



NASA photo

Seed Fund Bridges Technical Gaps

NASA's IPP Seed Fund supports highly leveraged partnerships, where all participants share the costs, risks, benefits, and outcomes. Funding awards to center-based projects range from \$100,000 to \$250,000, and the program requires matching funds from a developer or partner as well as support from one or more existing NASA programs or projects.

Selection criteria include project relevance and value to NASA, scientific merit and feasibility, resource funding structure, capability and strength of the partnership team, and realistic planning and budget. Clear and measureable performance indicators are required, with special consideration given to proposals that indicate the anticipated technology readiness level (TRL) advancement at the end of the 1-year project. Proposals that address cross-cutting technology that supports the needs of more than one mission directorate are encouraged as well as proposals that include elements of collaboration between centers. *continued on page 15*

Another Mechanism for Funding Innovation

The Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs are another way that IPP invests in innovation to benefit NASA missions. *For more information, see pages 18–21.*

New IPP Seed Fund Projects in 2009

Rapid Sample Management and Handling Microfluidics System Development

Partner: Raydiance Corporation

The partners on this project are working to drive down payload costs and development times for the fluidics components of nanosatellite spaceflight missions. A relatively new form of spaceflight, nanosatellites are about the size of a loaf of bread and have a mass of between 1 and 10 kg, including fuel. The Small Spacecraft Division at Ames (*see page 5*) is combining its fluidic design expertise with a unique, ultrafast laser-based fabrication tool, created by Raydiance to develop, validate, and apply specific in-situ bioanalytical technologies, instruments, and systems. Products emerging from this effort will support exploration and other missions, experiments, and research objectives on free-flying small satellites. This project is expected to advance this technology from TRL 3 to 6, ideally culminating in a low-cost demonstration flight mission.

Miniaturized Fluorescence Imager for Autonomous In-Situ Biological Space Flight Payloads

Partners: Heinz Optical Engineering LLC and United Science LLC

Under this project, the partners are demonstrating a miniaturized, multi-color fluorescence imager, capable of 5 micrometers or better resolution. Such a small instrument will dramatically increase the number and type of biological assays possible on small, autonomous space missions. The project is expected to advance this multi-color fluorescence imaging technology from TRL 3 to 6. The instruments may be integrated as payloads on other satellite platforms or in facilities aboard the International Space Station. Eventually, the technology could become part of autonomous, in-situ lunar and planetary research laboratories.

2009 Accomplishments for Previously Funded Seed Fund Projects

Projects	Partners	Accomplishments
Aeronautics Research		
Advanced Thermal Protection Systems for Hypersonic Flight in Air and Planetary Atmospheres	Touchstone Research Laboratory	Developed and produced robust ablative TPS systems with greatly improved thermomechanical properties and reduced mass
Electronic Prognostics for Critical Avionics Systems	Fiber Materials Inc.	Created aging models and prognostics algorithms that aid in predicting the remaining life of select faulted electronic components
Exploration Systems		
Integrating Sensor Suites and Rover Systems for Surface Prospecting: Enabling In-Situ Resource Utilization by Human-Robot Teams	Ball Aerospace and Technologies Corporation University of Tennessee	Field tested a robotic site survey system where two planetary rovers performed systematic surveys of several simulated lunar sites, proving the system suitable for planetary surface missions and terrestrial use
Science		
Advances in Photometric Precision for All Sky Exoplanet Surveys	MIT's Kavli Institute	Assisted in the design, development, testing, and performance verification of a new imaging system to be used with the Transiting Exoplanet Survey Satellite (TESS)
Concept Study for the Application of Phase Diversity-Only Adaptive Optics and Lightweight Optics to NASA Science and Exploration Missions	Google Inc.	Created conceptual design, developed preliminary observatory architecture, and completed implementation project schedule and cost estimate
Demonstration of Precise Wavefront Control for Space Optics with a MEMS Deformable Mirror	General Dynamics Advanced Information Systems	Developed a mirror that improves diffraction-limited performance for nearly all space optical systems, detects Earth-like planets near bright stars, and reduces cost and mass for space observatories
Demonstration of a Phase-Induced Amplitude Apodization Coronagraph in a Very High Contrast Imaging Test Bed	Lockheed Martin	Manufactured a pair of high-quality aspheric mirrors to create a highly efficient coronagraph that can be used to deliver very high contrast images
ICE-AX: ISRU Characterization Experiment – Astrobiology Explorer	Subaru Telescope	Accelerated development of a low-mass robotic drill for subsurface water searches, lowering the cost of payload/lander and accommodations approach
SmallSat Technologies for Cost-Effective Hyperspectral Remote Sensing of the Environment	Northrop Grumman Space Technology Utah State University Research Foundation	Completed new sensor design and proven prototype, with cost/performance comparisons
Space Operations		
A Lunar Communication and Navigation Satellite Network Architecture Using Internet Protocol, Laser Communication Technologies, and Small Satellites	Ball Aerospace and Technologies Corporation Cisco Systems Inc.	Characterized the technical parameters of a lunar communications architecture, based on networking and laser technologies on a small satellite platform
Evolved Antenna Technology Applied to Two Fundamental NASA Applications	Carnegie Mellon University JEM Engineering LLC X5 Systems Inc.	Generated optimized designs and engineering models for two spacecraft communications antennas



NASA photos

Awards were presented to the Ames development teams for World Wind Java, the Wildfire Research Applications Project, the 3D Laser Scanner,

The significant technological advancements achieved by Ames' world-class innovators every year—and reported in invention disclosures as described on page 10—deserve to be recognized. The IPP Office strives for Space Act Awards from NASA's Inventions and Contributions Board (ICB) as well as prestigious awards from external organizations.

NASA ICB Awards

NASA's ICB issues awards with a maximum monetary value of \$100,000 to technologies with high marks for significance; stage of development; actual/potential use by NASA, the government, or industry; and creativity. The following Ames technologies received exceptional recognition in 2009.

Software of the Year Award

The Software of the Year (SOY) Award is an honor chosen annually among software titles at all NASA centers by the NASA Software Advisory Panel. Ames boasts the 2009 SOY Award winner, adding to a legacy of previous winners, including seven other titles since 1994. The winner for 2009 is the World Wind Java Software Development Kit (SDK) and Web Mapping Services (WMS) Server—a combination of server and client technology that delivers geospatial data in Earth context.

Government Invention of the Year Award

NASA established the Government Invention of the Year Award to recognize the agency's most innovative inventions. The board announced in FY09 that Ames' Three-Dimensional (3D) Laser Scanner was the recipient of this prestigious award for 2008. The technology is used in a hand-held instrument that scans space shuttle tiles to detect and measure the amount of any damage. The scanner has been adapted for use on the Crew Exploration Vehicle (CEV), in the Stardust Sample Return Capsule Program, and in the Mars and Lunar Rover Programs.

Exceptional Space Act Award

The Space Act Awards Program provides recognition and monetary awards for inventions and contributions that have helped to achieve NASA's goals. In 2009, an Exceptional Space Act Award was given to Ames' Inductive Monitoring System (IMS). IMS provides health monitoring for complex NASA systems, enabling early detection of anomalies to improve effectiveness and lower risk.

R&D 100 Award



NASA photo

The R&D 100 Awards, given by *R&D Magazine*, honor innovations designed to meet societal, scientific, or business challenges now and in the future. In 2009, this prestigious award was given to Ames' 3D Laser Scanner, which also won NASA's Government Invention of the Year Award (see story at left).



Mold Impression Laser Tool, Chimera Grid Tools, and the Inductive Monitoring System.

Federal Laboratory Consortium for Technology Transfer (FLC)

The FLC seeks to promote technology transfer at federal labs. Its annual awards program is one way the FLC achieves this goal. Ames was granted several regional and national awards from the FLC in 2009.



NASA photo

Laboratory Director of the Year

S. Pete Worden, PhD was named FLC's Laboratory Director of the Year for 2009. Dr. Worden has been instrumental in his support of competitive mission proposal development, pursuit of licensing opportunities,

and educational outreach. His vision emphasizes partnerships, and he also has led Ames' development as a leader for green/clean technologies.

Outstanding Commercialization Success

The FLC bestows recognition on federal technologies that have been successfully commercialized. Ames' Chimera Grid Tools (CGT) software package received this FLC award in 2009. The tool, which performs computational fluid dynamics (CFD) analysis, has been distributed via Software Usage Agreements to more than 480 organizations. World Wind Java SDK (see page 16) also received this FLC award.



Outstanding Partnership

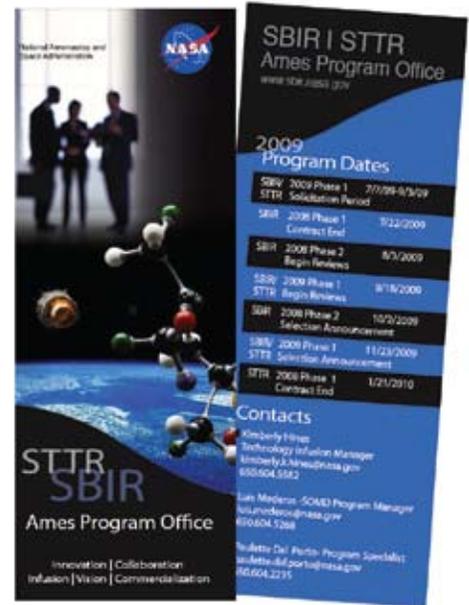
The Wildfire Research Applications Project (WRAP) was selected for two FLC awards in 2009. This joint effort—teaming Ames with NASA's Dryden Research Center, the National Interagency Fire Center, the Federal Aviation Administration, and the U.S. Department of Agriculture's Forest Service—explores innovative technologies that have the potential to improve remote sensing of events involving fire. The technical and scientific team assembled for the project offers fire management expertise with science and engineering acumen from NASA, industry, and academia. The project's 2009 activities included a sensor test flight from Edwards Air Force Base and wildfire imaging support.

Outstanding Technology Development

The FLC also recognizes technologies that have the potential for wide impact within their original government lab and beyond. Outstanding technology development recognition was given to Ames' Mold Impression Laser Tool (MILT), 3D Scanner (see page 16), and Java PathFinder (JPF). Closely related to the 3D Scanner, MILT is a handheld instrument used by shuttle maintenance crews to automatically detect, quantify, and record flaws on the space shuttle's thermal tiles. JPF offers a verification system for high-reliability Java programs, making model checking feasible.

sbir/sttr small business support

Technological innovation is the overall focus of NASA's Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs. These programs are vital to the achievement of NASA missions and to the nation's prosperity and security.



About the Programs

NASA's SBIR/STTR programs provide opportunities for small, high-technology companies and research institutions to participate in government-sponsored research and development (R&D) efforts in key technology areas. In SBIR contracts, the small business operates independently; STTR contracts involve a research institution partnering with a small business to develop a technology. The SBIR/STTR programs fund R&D and demonstrations of innovative technologies to fulfill NASA needs. These needs are described in the annual SBIR/STTR solicitations. Innovations receiving SBIR/STTR funding also have significant potential for successful commercialization.

SBIR/STTR Offices at Ames

The IPP Office at Ames Research Center serves as the home for two lead SBIR/STTR offices. The first, known as the Level II Program Office, executes requests from Headquarters (i.e., the Level I Program Office) and manages the SBIR/STTR activities at all 10 NASA field centers to ensure program goals are being met. The Level II office also organizes NASA's overall program plans, providing technical and programmatic cohesion among the 10 centers.

The second SBIR/STTR office at Ames—the Level III Program Office—has a center-focused view, enhancing the value of the SBIR/STTR programs at Ames by thoroughly pursuing infusion and commercialization. This office also focuses on efforts related to NASA's Space Operations Mission Directorate.

Connecting with Small Business

The SBIR Office at Ames is continually reaching out to small businesses to educate them about the SBIR/STTR programs and inspire them to submit proposals. For example, an SBIR representative was a speaker at the March 2009 "Alternative Financing" panel, co-sponsored by the San Jose BioCenter and the center's legal sponsor, Orrick. More than 200 attendees learned about various financing opportunities, including NASA's SBIR/STTR programs. Of particular interest was the additional \$35 million in SBIR/STTR funding made available this year as part of the federal government's stimulus package. *More information about 2009 funding appears on page 20.*

Another example is the May 2009 meeting between NASA and Lockheed Martin, where participants sought to identify opportunities to infuse SBIR/STTR technologies into the company's programs. This meeting was followed by a brainstorming session with NASA's technology infusion managers (TIMs) to identify additional opportunities to match up SBIR/STTR technologies with the agency's prime contractors.

Promoting SBIR/STTR

To ensure that NASA reaps the benefits of SBIR/STTR investments, the Ames IPP Office undertakes several outreach efforts each year.

SBIR/STTR Space Operations Mission Directorate Technology Investments Catalogue

The 2009 catalogue highlights the previous year's Phase 2 projects and the current year's Phase 1 awards, creating opportunities for partnerships between NASA researchers and SBIR/STTR companies.



SBIR/STTR National Conference

Held in Connecticut, the 2009 conference was particularly successful as it included the opportunity for one-on-one meetings. During these meetings, small companies could ask technology infusion managers questions regarding their technology and where it might be applicable to NASA programs and projects. As a result, more SBIR/STTR proposals were submitted during the 2009 solicitation period than in prior years.

Other Promotional Materials

In 2009, NASA's SBIR/STTR programs issued a brochure containing program information, the 2009 schedule of deadlines, and examples of successful



infusions. In addition, NASA published an SBIR/STTR Participation Guide, to be handed out to interested companies. This printed guide became a key marketing tool for the SBIR/STTR programs, which offer the annual solicitation solely in an electronic format.

SBIR/STTR Newsletter: The Concept

This newsletter is a key way for NASA to communicate with SBIR/STTR awardees, other small business organizations, and university and high-tech industrial communities. Launched in spring 2009, *The Concept* provides information about upcoming events, such as proposal writing workshops, as well as new opportunities for funding and partnering. Articles give readers tips for greater success in their SBIR/STTR endeavors as well as stories of successful infusion of SBIR/STTR technologies into NASA missions.



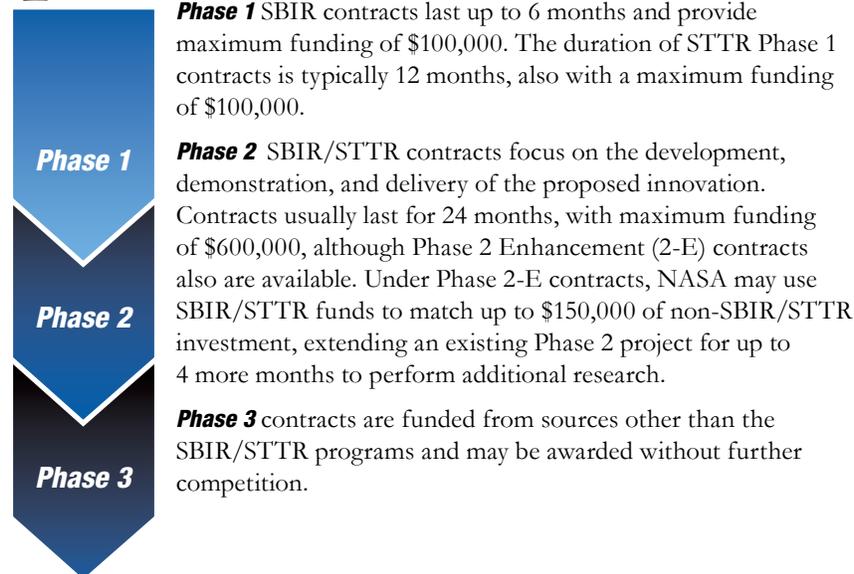
sbir/sttr 2009 contracts

NASA's SBIR/STTR programs, along with similar programs offered by other federal agencies, contribute to the economic engine that drives hiring and other growth for small businesses—the backbone of the U.S. economy and the future for U.S. technology development.

In total, the SBIR/STTR programs at Ames Research Center issued \$21.6 million in contracts to small businesses in 2009.

Three-Phase Funding

The SBIR/STTR programs provide funding in three phases:



SBIR/STTR Phase 1 and 2 Awards

The following SBIR/STTR awards were issued from Ames Research Center during 2009:

51 SBIR Phase 1 awards to 46 small businesses, totaling \$510,000

6 STTR Phase 1 awards to 5 small business–research institution collaborations, totaling \$600,000

26 SBIR Phase 2 awards to 26 small businesses, totaling \$15.6 million

2 STTR Phase 2 awards to 2 small business–research institution collaborations, totaling \$1.2 million

Beyond these yearly program awards, additional SBIR/STTR contracts were issued from Ames during 2009, thanks to funding provided by the American Recovery and Reinvestment Act (ARRA) and the federal economic stimulus package. These awards included:

7 SBIR Phase 1 awards, totaling \$700,000

5 SBIR Phase 2 awards, totaling \$3 million

The following SBIR/STTR awards were issued from the Ames Research Center's SBIR/STTR Level II Office during 2009:

366 SBIR Phase 1 awards to 265 small businesses, totaling \$36.6 million

43 STTR Phase 1 awards to 39 small business–research institution collaborations, totaling \$4.3 million

152 SBIR Phase 2 awards to 126 small businesses, totaling \$91 million

19 STTR Phase 2 awards to 19 small business–research institution collaborations, totaling \$11.4 million

Phase 3 Awards

The financial resources used for Phase 3 awards are not part of the SBIR/STTR programs. NASA or another federal agency must fund its own Phase 3 activities for follow-on development or for production of an innovation beyond Phase 2. Private-sector investment also may fund a Phase 3 effort to make the technology commercially available. The following table lists Phase 3 contracts awarded from Ames in 2009.

Small Businesses	Projects	Benefits to NASA
Michigan Engineering	Multi-Disciplinary Design Optimization with Uncertainty Software	Incorporated on NASA's Langley Research Center's lifting-body configuration HL-20 Personal Launch System (PLS) (anticipated for spaceflight in 2013)
Mosaic ATM	Surface Operations Data Analysis and Adaptation (SODAA)	Supports traffic management research in the Aviation Systems Division at Ames
Time Rover	Development and Delivery of a Tool for Analysis and Testing of Flight Critical Software	In active use at NASA's Independent Verification and Validation program for ongoing NASA projects such as Orion, James Webb Space Telescope, Juno, and more
Vulcan Wireless	Cost and Business Proposal: Asteroid Communications Architecture Study	Stems from Phase 1 and 2 work for the Air Force Research Laboratory; supports the Small Spacecraft Division at Ames



HL-20 PLS

HL-20 PLS landing simulation

Interior view of HL-20 PLS lifting body



Aviation Systems



James Webb Space Telescope (JWST)



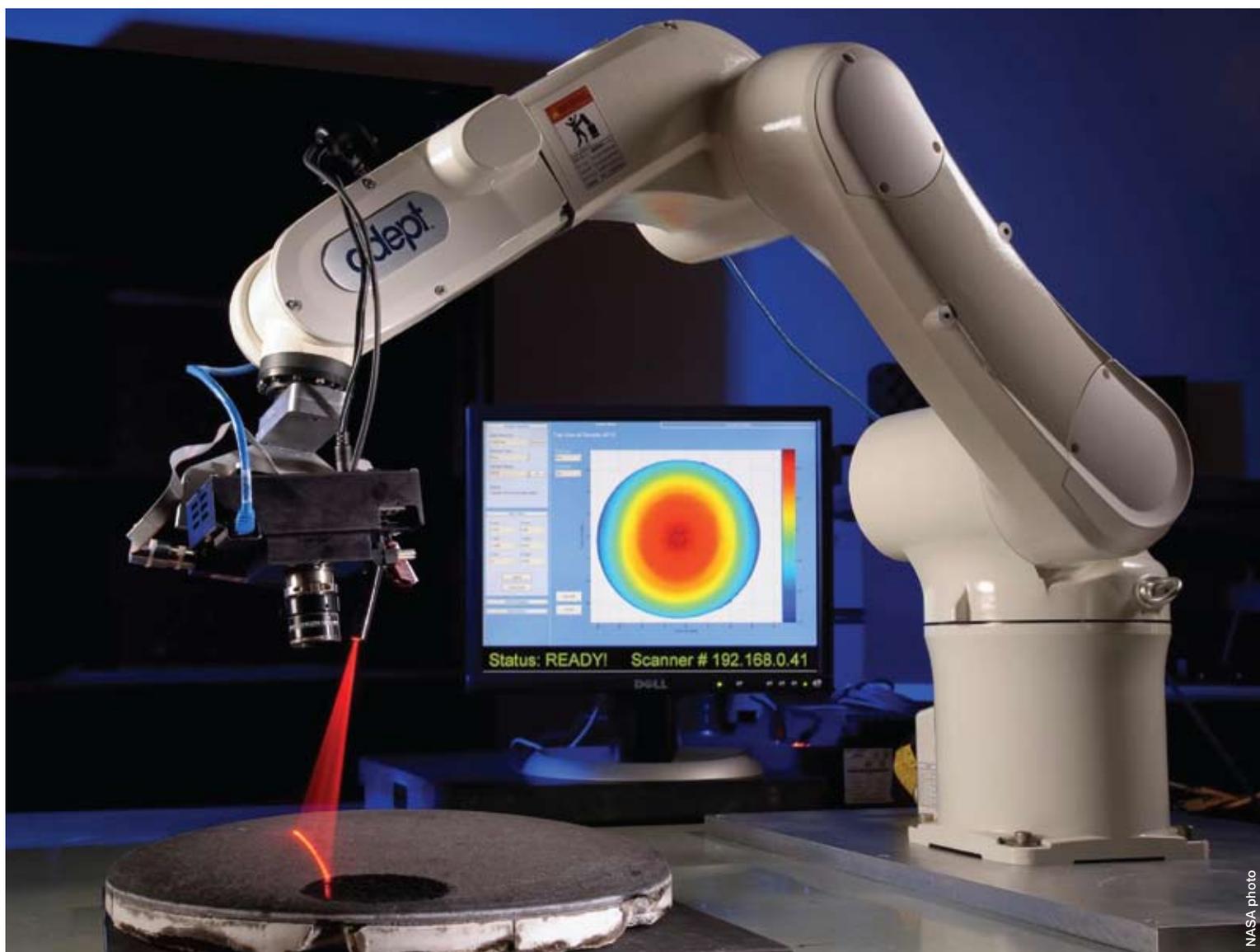
Lunar Crater Observation and Sensing Satellite (LCROSS)



Aviation Systems

where to learn more

Ames Research Center would like to hear from you—whether you are an innovator at the center or whether you are from outside of NASA and are interested in accessing Ames technology or in collaborating with our world-class researchers.



NASA photo

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