

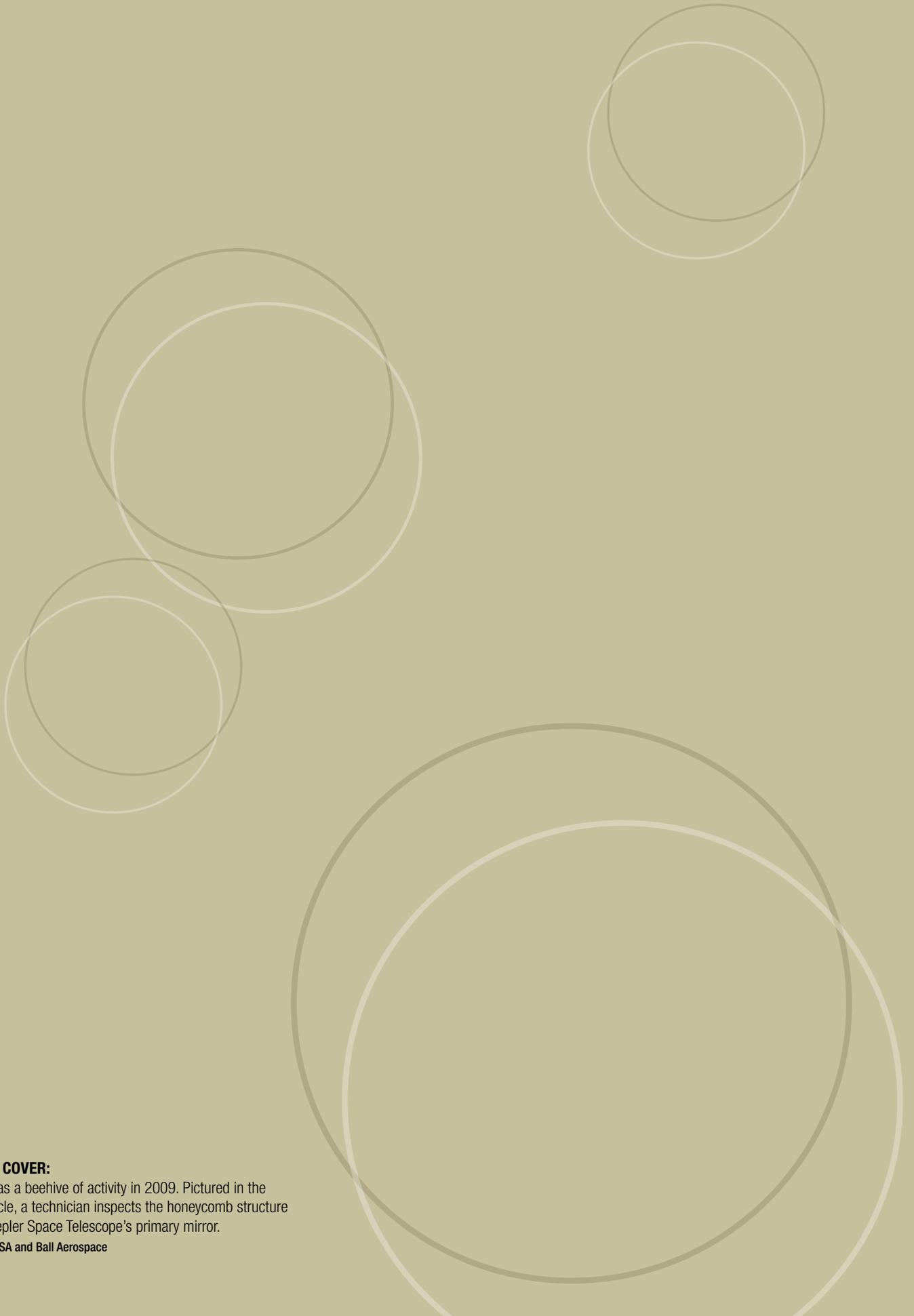
2009 ANNUAL REPORT TO THE ADMINISTRATOR



NASA
INVENTIONS AND
CONTRIBUTIONS BOARD

**Crafting
Innovation**





ON THE COVER:

NASA was a beehive of activity in 2009. Pictured in the large circle, a technician inspects the honeycomb structure of the Kepler Space Telescope's primary mirror.

Credit: NASA and Ball Aerospace

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MESSAGE FROM
THE CHAIR

Foreword





Message from the Chair

How do we create what never was, and why do we do it? How we do it is dictated by physics; the requirements bind every design. The common language is math and science, which is the intellectual toolset scientists and engineers use to solve the design problem.

Why do we do it? We do it because these challenges unlock the potential to revolutionize the world. The transcontinental railroad connected the Atlantic and Pacific oceans through a single, continuous mode of transportation. The Moon

landing showed that it was possible for humans to leave Earth, explore a different celestial body, and return home. These achievements permanently changed human perceptions of time and space. The ability to travel distances that once seemed insurmountable made our world smaller and more interconnected.

New, daunting challenges are waiting for us as we expand the human presence in space, search for life in the universe, and improve life here on Earth. They will demand the absolute best we have to offer and just as the vision for the transcontinental railroad was laid out during the dark days of the Civil War, we cannot let our current troubles make us pull back. If history teaches us anything, it teaches us that there will be failures and losses along the way. History also teaches us that if we persevere and learn, success will bring benefits that extend beyond what we can imagine today. That's why we do it: because through creative and dedicated efforts to address our most pressing problems, we are able to transform society. Much as Lewis and Clark and Mackenzie could not have imagined transcontinental railroads and interstate highways, much less airplanes and rocket ships, our successors will see and do things on Earth and beyond Earth we have not yet imagined. We must continue up that path, but in every journey there is a time to pause and look at what has taken us to where we are. Join me in recognizing a few of those who paved the way for our progress with their inventiveness.

**Dr. Michael G. Ryschkewitsch, Chair
NASA CHIEF ENGINEER**

THE ICB MISSION

Introduction



The ICB Mission

The NASA Inventions and Contributions Board (ICB) reviews and values contributions to the Government and the Nation with the assistance of five staff members and a legal counsel. Many of these are inventions and contributions that have the potential to enable future space exploration and improve life here on Earth. The 21-member Board is comprised of technical specialists individually nominated by their home Center and appointed by the Administrator to provide the diverse expertise needed to evaluate new and unique technologies from the various Centers and is authorized to approve awards up to \$100,000 without congressional notification. This year, the ICB approved over 3,100 individual cash awards totaling over \$1.95 million to those who contributed to the technical development of significant NASA-sponsored technologies.

ON THE JOB
SINCE 1958

Background



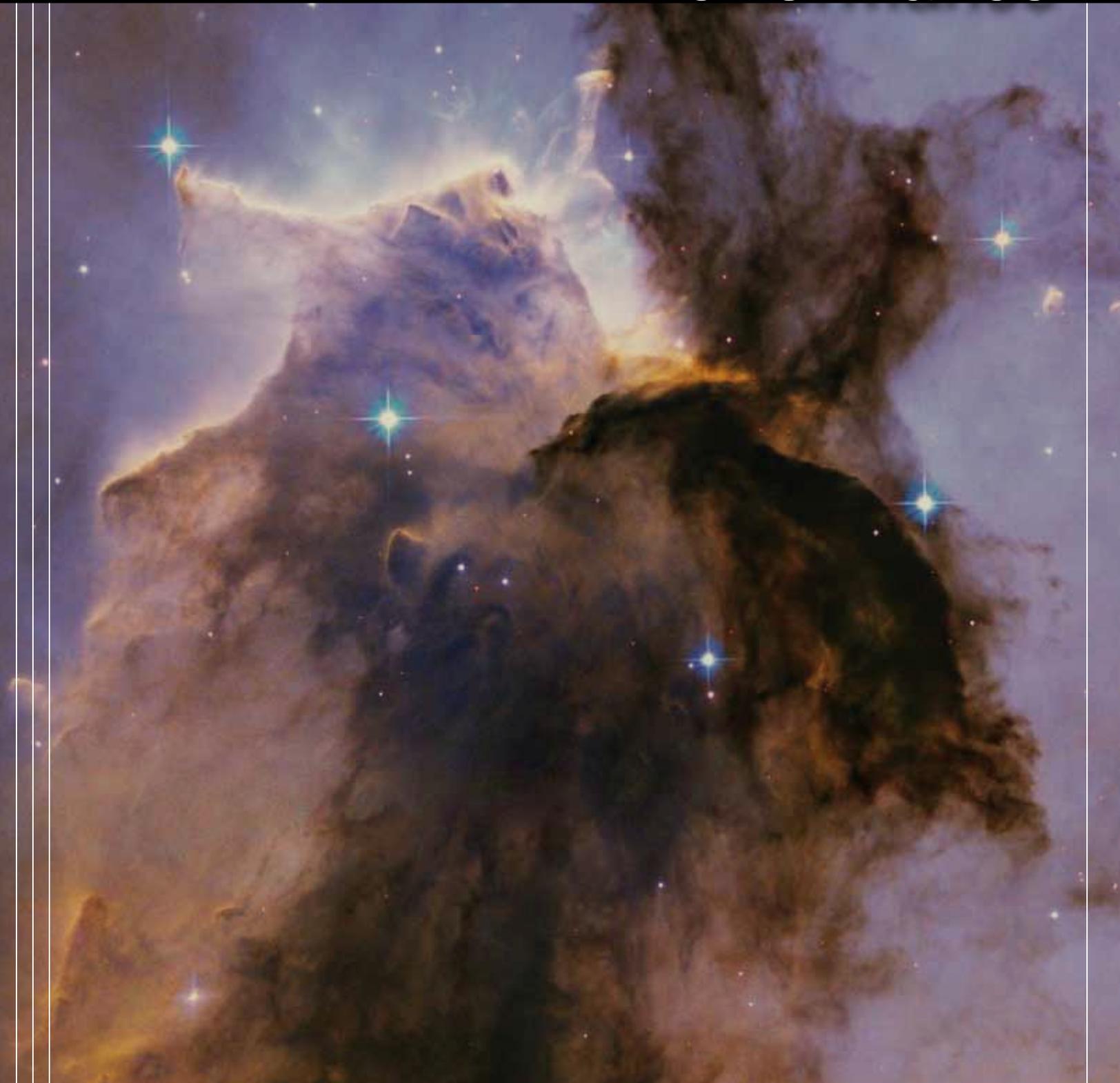
On the Job Since 1958

Since the creation of NASA and its ICB in the Space Act of 1958, the ICB has presented over 100,000 awards to inventors for the relentless and tireless innovations they have made to accelerate the progress of science and aerospace. Information on the highlights of the last seven years of awarded technologies is available in the previous annual reports from the ICB, archived online at http://www.nasa.gov/offices/oce/icb/Annual_Report.html. To identify the best of the best, the ICB also conducts annual competitions to select and recognize NASA's Invention of the Year (see: <http://www.nasa.gov/offices/oce/icb/Yearly-Comps.html>) and Software of the Year (see: http://www.nasa.gov/offices/oce/icb/2009_SOY_Winners.html).

While it is difficult to estimate the impact of these inventions on the U.S. economy and world commerce, it is assuredly in the billions of dollars. You will see from the descriptions of past and current NASA-sponsored inventions that, although they accomplish their intended purposes well, we have yet to see all the ways that these technologies may directly benefit us in other areas.

2009 AWARDS
STATISTICS AND METRICS

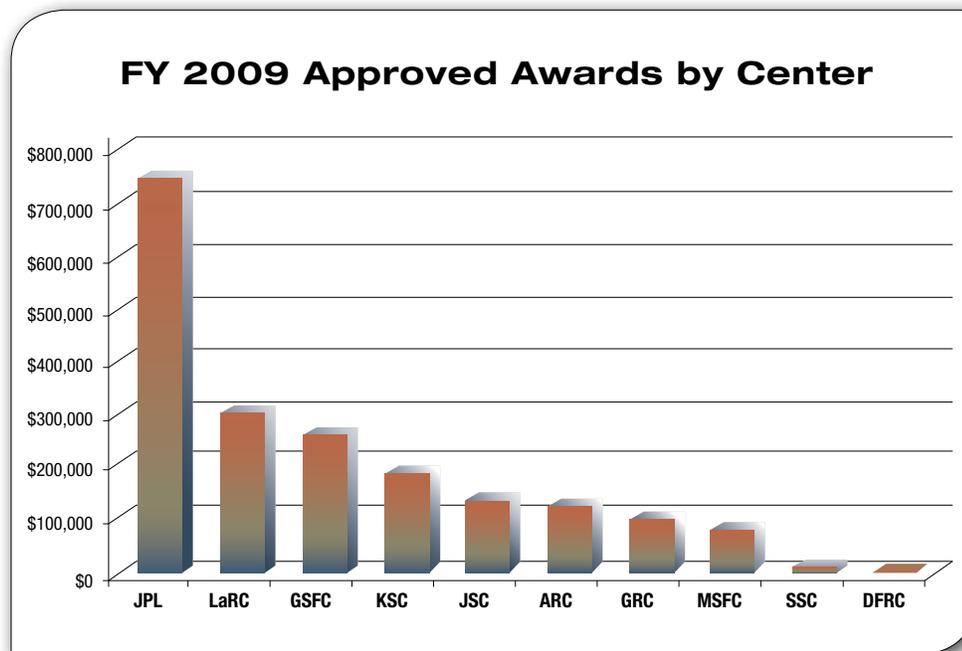
Performance



The Invention Awards Program continues to enjoy strong participation across NASA. The number of inventors approved for the various award types illustrate the level of activity:

1. 604 individual Board Action Awards were reviewed and approved in 6 meetings.
2. 755 patent holders were recognized.
3. 640 software authors were approved.
4. 1,114 NASA Tech Briefs authors were approved.
5. There were 8 Exceptional Cases—inventions with at least one inventor who was approved for an award of \$5,000 or more.

The awards program participation levels at each Center vary as the chart below shows.



Exceptional Cases



Each year, several award applications result in at least one awardee that is approved for an award of \$5,000 or more. This occurs frequently in the Yearly Competitions, but can happen on any case that has a large value to NASA and the Nation but not too many inventors dividing up the award. When this occurs, the entire case is classified as Exceptional and the inventors' awards must go to the NASA Administrator for approval. Descriptions of the Exceptional Board cases for 2009 follow. Each technology is identified by a unique tracking code which consists of a three-letter code designating the lead NASA Center for its development and a five-digit number assigned to it at the time it was reported to NASA.

The Center Code Definitions are:

- Ames Research Center: ARC
- Dryden Flight Research Center: DFRC or DRC
- Glenn Research Center: GRC or LEW (formerly Lewis Research Center)
- Goddard Space Flight Center: GSC or GSFC
- Kennedy Space Center: KSC
- Langley Research Center: LaRC or LAR
- Jet Propulsion Laboratory: JPL or NPO (formerly NASA Pasadena Office)
- Johnson Space Center: JSC or MSC (formerly Manned Spaceflight Center)
- Marshall Space Flight Center: MSFC or MFS
- Stennis Space Center: SSC
- Headquarters: HQ

Yearly Competitions

2008 Invention of the Year Competition

The Office of the General Counsel supports the NASA inventors through the Invention of the Year (IOY) Awards Program. The IOY is actually two competitions: (1) the NASA Commercial Invention of the Year and (2) the NASA Government Invention of the Year.

The Invention of the Year Awards are an important part of the NASA patent program. The eligibility requirements for the NASA Commercial Invention of the Year Award are linked to the National Inventor of the Year event promoted by the Intellectual Property Owners Educational Foundation (IPOEF). Only inventions that were commercialized to non-Government customers during the last four years (2005-2008) were considered. The NASA Commercial Invention of the Year may be nominated by NASA for the National Award. The National Inventor of the Year is announced by the IPOEF and recognized at a reception in Washington, DC.

The eligibility requirements for the NASA Government Invention of the Year are based on the impact the nominated inventions have had on NASA's mission and in other Government programs. While commercial sales may exist, the deciding factor for the Government Invention of the Year Award is the value of the Government uses of the nominations. Each Center may submit a maximum of two nominations, both of which are considered for each award.

This year, the 2008 NASA Commercial Invention of the Year Award was conferred upon the Langley Research Center nominee, LAR-15834-1: "Composition of and Method for Making High Performance Resins for Infusion and Transfer Molding Processes." This invention has found application in a high-temperature resin known as PETI-330 specifically designed for use in the fabrication of composites using low-cost processes such as resin transfer molding, resin infusion, and vacuum assisted resin transfer molding (VARTM).



PETI-330's flowability allows it to be used to fabricate complex structures for high temperature applications.

PETI-330 is the only commercially available off the shelf (COTS) high-temperature resin that has both the low and stable melt viscosity required for VARTM processes, and provides high temperature structural mechanical properties in composites. In addition, under license, pre-impregnated carbon fiber tape products are being manufactured intended specifically for airframe and jet engine applications.



The MILT unit is mounted on a robot for automated scanning of damage to a thermal protection system component.

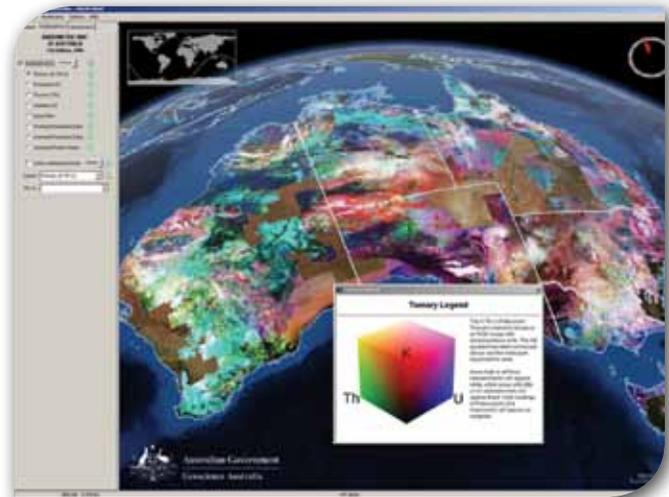
The 2008 NASA Government Invention of the Year Award was conferred upon the Ames Research Center's ARC-14652-1: "High Speed Three-Dimensional Laser Scanner with Real Time Processing." This invention has found application in a Mold Impression Laser Tool (MILT), a hand-held instrument used to scan Space Shuttle tiles to detect and measure the amount of any damage. The MILT unit wirelessly transmits flaw dimensions and location information to a laptop computer enabling the operator to easily take measurements up to several meters away without cumbersome cables. Several MILT instruments are currently in use

at the Kennedy Space Center where they provide accurate and reliable tile flaw information for the Shuttle maintenance crews. MILT technology been adapted for other NASA programs, including the Crew Exploration Vehicle (CEV), the Stardust Sample Return Capsule Program, and the Mars and Lunar Rover Programs. Below, it has been adapted to a robot arm for automated scanning of a thermal protection system component.

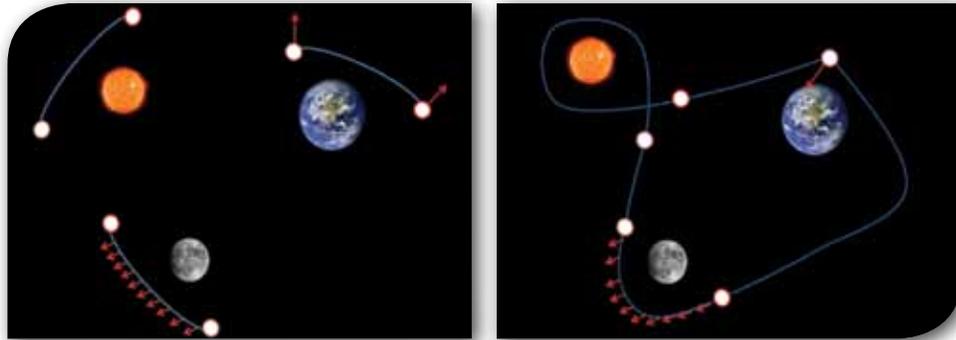
2009 Software of the Year (SOY) Competition

The 2009 SOY Winner is NASA Ames ARC-15166-1: "World Wind Java (WWJ) Software Development Kit (SDK)." It consists of modular components that can be combined to operate as a single system. The architecture of the heritage "World Wind.net" version restricted its use because it was an application instead of SDK plug-in technology. For these reasons, World Wind was refactored into cross-platform Java and re-architected into a highly portable API-centric SDK. Because World Wind, the client, is "not" an application but a software development kit (SDK), it allows applications to focus on information intelligence, "their" value-added. The modular architecture also improves the ability to advance the overall technology due to the increased ability to optimize individual components.

World Wind, by providing access to sophisticated technology based on open standards, increases the opportunity for competition and entrepreneurial enterprise while simultaneously helping to standardize the infrastructure for information exchange. The WWJ SDK accomplishes this by being engineered in compliance with internationally embraced Open Geospatial Consortium (OGC) Web Mapping Service (WMS), to which NASA is a signatory (along with DHS, NOAA, NGA, EPA, and the USGS). These OGC WMS are protocols for requesting and delivering geospatial data. The WWJ WMS server supports these protocols while allowing for any degree of additional innovation or customized application. Users include European Space Agency, Japan Aerospace Exploration Agency, PEMEX (Mexico Petroleum Company), General Dynamics, World Bank, Sun Microsystems, IBM, Northrop Grumman, and the Government of Australia. Geoscience Australia (USGS equivalent) is using World Wind for public access to geologic data such as that shown in the image above.



Scientists all over the world use World Wind to display their data such as the environmental data shown here.

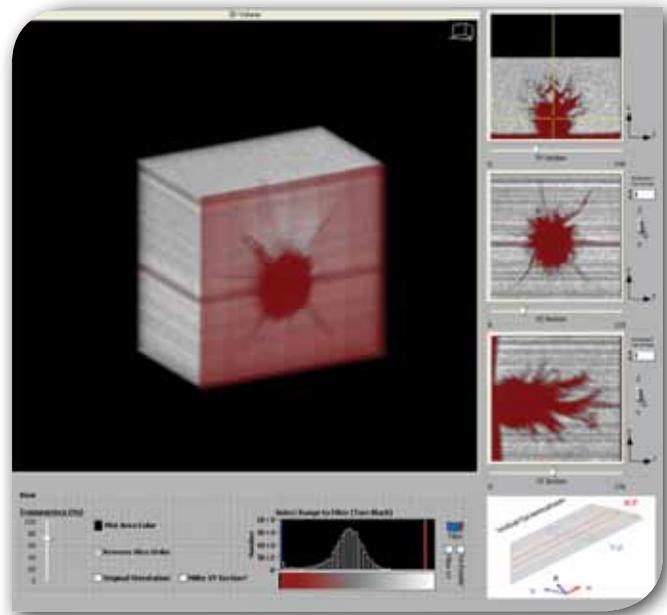


Missions can be created through user arrangement of trajectory segments (building blocks) in an initial guess (left) followed by Copernicus optimization and meeting of constraints.

Johnson Space Center received an Exceptional award for its 2009 SOY Runner Up MSC-24209-1: “Copernicus Trajectory Design and Optimization System.” This software system implements a comprehensive approach to mission design, trajectory analysis, and optimization. It integrates state-of-the-art algorithms in spacecraft state propagation, optimization, and interactive visualization, allowing the user to design spacecraft missions for nearly all possible solar system destinations.

The system accommodates the use of many types of propulsion systems, any number of spacecraft, and any user-definable force field models. All of these features are accomplished within a single architecture via a comprehensive interface, or passively via external interfaces that execute batch processes. The Constellation Program and the Orion Project have identified Copernicus as a primary performance analysis tool. It has allowed engineers at JSC to quickly gain a deep understanding of how lunar mission design affects vehicle performance requirements. This knowledge has been instrumental in allowing JSC and other NASA Centers to meet a very demanding Orion development schedule. In addition, this tool has enabled a very small team of engineers to produce comprehensive analyses supporting selection of Orion propellant loading and tank sizing requirements, as well as selection of candidate Ares-V launch vehicles. Copernicus is being used to provide analysis and performance information in support of the Review of U.S. Human Space Flight Plans Committee (a.k.a. the Augustine Panel). Non-aerospace applications and uses involve the exploration and verification of algorithms to solve dynamical systems and algorithms to solve small to large-scale optimization problems.

Glenn Research Center's SOY Honorable Mention was also in the Exceptional category. LEW-18460-1: "Nondestructive Evaluation (NDE) Wave & Image Processor Software (A Software Platform for Post-Processing Waveform-Based NDE)." This package was created to provide a comprehensive, interactive, menu-driven, state-of-the-art, integrated software tool for advanced visualization, processing, and analysis of all types of NDE and Structural Health Monitoring (SHM) waveform- and image-based data. Once the data set is imported into the software, advanced visualization, processing, and analysis can be accomplished all in one facility, in one run, and independent of vendor software resident on particular equipment. Although intended for the NDE professional, there is nothing to prevent it from being used for any other RF signal or image processing and analysis application. The capabilities are provided in a user-friendly, interactive, commercial-grade graphical user interface. It has been used in the NASA Engineering and Safety Center (NESC) sponsored-program for External Tank (ET) Thermal Protection System (TPS) NDE for research into signal processing methods for terahertz data. The NESC program sponsored its development and it was used to analyze data from the terahertz NDE method that was under development for NDE of the shuttle external tank thermal protections system foam. It being used NDE data processing in the Aircraft Aging and Durability (AAD) project (NDE for Composites task), Advanced Composites Technology (ACT) project (NDE for Composites), Seal development for CEV Low Impact Docking System (LIDS) (NDE for seals), and Code Q (X-ray Computed Tomography for Exploration). The product is available as a public download for the NDE community from NASA and has been downloaded over 200 times.



While specifically designed to provide an integrated processing and display environment for data from non-destructive material tests, this software can be used for other kinds of data as well.

Langley Research Center's SOY Honorable Mention was in the Exceptional category as well. LAR-16100-1: "System IDentification Programs for AirCRAFT (SIDPAC) SIDPAC, version 2.0" is a collection of over 300 programs written in MATLAB®, which perform a wide variety of tasks related to aircraft system identification—a branch of system theory that involves building high-fidelity mathematical models based on measured data from experiments. SIDPAC includes tools for experiment design, data analysis, kinematic consistency checking, static and dynamic modeling, simulation, numerical integration and differentiation, smoothing, filtering, finite Fourier transformation, statistical modeling and evaluation, optimization, parameter estimation, model accuracy quantification, model validation, and more. SIDPAC can be used for new aircraft development, flight envelope expansion, flight data analysis and modeling, flight experiment design, control system design, flying qualities assessments, flight research, trajectory reconstruction, wind-tunnel testing, aircraft simulation development, and accident investigation, among others. It is fully documented and its contents are explained in the AIAA textbook entitled Aircraft System Identification, Theory and Practice. It is used by LaRC, DFRC, MSFC, and GRC. In addition, SIDPAC is used at Boeing, Lockheed-Martin, Northrup-Grumman, Raytheon, Goodrich, Bell Helicopter, Cessna, Eclipse Aviation, Arnold Engineering and Development Center, the National Research Council of Canada, the U.S. Navy test center at Patuxent River, MD, the U.S. Air Force Flight Test Center at Edwards, CA, and the Air Force Research Lab at Wright-Patterson, OH. SIDPAC is also used by over 40 universities and small businesses and several universities offer courses in its use.



SIDPAC has been broadly accepted for its ability to identify the flight responses a flight system generates from pilot inputs.

More ICB Exceptional Cases



The ICB regularly recognizes Exceptional contributions beyond those entered in the yearly competitions. Glenn Research Center's LEW-17826-1: "Method And System For Fiber Optic Determination Of Nitrogen And Oxygen Concentrations In Ullage Of Liquid Fuel Tanks" is one example. This fiber optic sensor is used for the laser Raman spectroscopic determination of nitrogen, oxygen, and hydrocarbons in explosive environments such as aircraft fuel tanks. These concentrations are used to determine the efficacy of Onboard Inert Gas Generation Systems (OBIGGS) which are now being mandated for use on commercial aircraft to prevent explosive fuel/air mixtures from forming in aircraft fuel tanks. Its intrinsic safety is due to the lack of heated components or fuel-wetted electrical connections. The sensor was used as the Raman signal collection fiber which enabled the acquisition of multi-scalar data in high pressure swirl-stabilized flames for code validation in the Fundamental Aeronautics Program (FAP). It was a critically enabling technology that permitted the collection of the world's first quantitative data set of correlated multi-scalar combustion data in high pressure swirl-stabilized flames which will yield labor costs reductions in the further development of the National Combustion Code (NCC). Non-aerospace uses include industrial gas monitoring and medical uses such as anesthesia gas and respiration monitoring.



This fiber optic gas analyzer can be used to determine the explosion risk of aircraft fuel tanks or monitor other critical gas mixtures.

Another Exceptional award went to Glenn's LEW-18013, 18357, 18358: "vMetrics—Compact, Wireless, Highly Configurable, Biometric Real-Time Monitoring System," which is an ambulatory physiologic parameter-monitoring platform. It is a modular, customizable system that provides clinicians, clinical research personnel, and home health care providers the ability to monitor patients remotely for long periods of time. It has module slots which enable the user to configure the system to match specific needs by simply inserting sensor-specific data acquisition cards. The monitored data is collected and then sent in real time from the unit over any commercially implemented wireless network including Ethernet, Bluetooth, cellular phone network, and wireless medical telemetry systems. Real-time remote monitoring may enable better quality of life, and reduce dependency on hospitalization for disease management. It may reduce hospitalization costs, enabling better patient mobility, and yet enhance patient compliance to treatment, all of which work towards better medical results.



Wireless medical monitors give patients more freedom and may reduce the need for some hospitalizations.

RECOGNIZING THE
INVENTORS

The 2009 Board and Staff



Recognizing the Inventors

The Inventions and Contributions Board for this year was made up of the following membership:

Dr. Michael G. Ryschkewitsch, Chair and NASA Chief Engineer
Walter D. Hussey, Vice Chair, Office of the NASA Chief Engineer
Dr. G. Dickey Arndt, JSC
Dr. Biliyar "Bil" N. Bhat, MSFC
Dr. Donald C. Braun, GRC
Sandra A. Cauffman, GSFC
Christopher "Chris" J. Culbert, JSC
Dr. Minoru M. Freund, ARC
Dr. David H. Hathaway, MSFC
Dr. Anngienetta "Anngie" Johnson, HQ
Dr. Dochan Kwak, ARC
Carey F. Lively, GSFC
Dr. Maryann Meador, GRC
Reginald "Reg" S. Mitchell, GSFC
Dr. Ruth H. Pater, LaRC
Dr. Christa D. Peters-Lidard, GSFC
Dr. Jacqueline "Jackie" W. Quinn, KSC
Pamela R. Rinsland, LaRC
Dr. Leland "Lee" S. Stone, ARC
Caroline K. Wang, MSFC
Dr. Robert "Bob" C. Youngquist, KSC
Robert F. Rotella, Counsel to the Board, HQ

Board Staff:

Mr. Anthony "Tony" J. Maturo, Staff Director
Mr. Jesse C. Midgett, Chief Technologist
Ms. Iona Butler, Records Manager
Ms. Gail M. Sawyer, Staff Specialist
Ms. Angela F. Greene, Budget Assistant



Left to right: Robert T. Savely (JSC), Jesse C. Midgett (HQ-ICB), Melissa J. Bodeau (HQ-OSMA), Tomas J. Soderstrom (JPL), William L. Little (KSC), Scott E. Green (GSFC), Caroline K. Wang (MSFC), Roger A. Truax (DFRC), John C. Kelly (HQ-OCE), Jay G. Horowitz (GRC), Kerry M. Gough (LARC), Lori Parker (HQ-OCIO), Anthony R. Gross (ARC)

Not pictured: Anthony J. Maturo (HQ-ICB)

A special Software Advisory Panel hears presentations

for the Software of the Year Competition and advises the Board on the ranking of the nominations. This panel consists of software experts from across NASA.

In addition, the ICB is supported by Awards Liaison Officers and their staff at each Field Center, Patent Counsels and Attorneys, and technology transfer and software release authority personnel. Contact information for Awards Liaison Officers for each NASA Center is listed on the next page.

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Acronym List



2009 ICB Annual Report Acronym List

AAD	Aircraft Aging and Durability
ACT	Advanced Composites Technology
CEV	Crew Exploration Vehicle
COTS	commercially available off the shelf
ET	External Tank
FAP	Fundamental Aeronautics Program
ICB	Inventions and Contributions Board
IOY	Invention of the Year
IPOEF	Intellectual Property Owners Educational Foundation
LIDS	Low Impact Docking System
MILT	Mold Impression Laser Tool
NCC	National Combustion Code
NDE	Nondestructive Evaluation
NESC	NASA Engineering and Safety Center
OBIGGS	Onboard Inert Gas Generation Systems
OGC	Open Geospatial Consortium
SDK	Software Development Kit
SHM	Structural Health Monitoring
SIDPAC	System IDentification Programs for AirCraft
SOY	Software of the Year
TPS	Thermal Protection System
VARTM	vacuum assisted resin transfer molding
WMS	Web Mapping Service
WWj	World Wind Java

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