



# NASA Technologies Enhance Our Lives

*Spinoff* 2008 highlights recent significant research and development activities across the Agency and the successful transfer of NASA technologies to the marketplace. This brochure summarizes the commercial technologies profiled in *Spinoff* 2008; the full text is available for download at [www.sti.nasa.gov/tto](http://www.sti.nasa.gov/tto), and print copies can be requested by calling (301) 286 0561 or through [spinoff@sti.nasa.gov](mailto:spinoff@sti.nasa.gov).

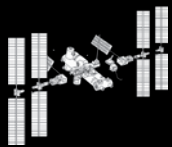
## SPINOFF



### 50 YEARS OF NASA-DERIVED TECHNOLOGIES (1958-2008)



International  
Space Station



Telescopes and  
Deep Space Exploration



Satellites and Imaging  
Technology



Space  
Transportation



Astronaut Life  
Support



Aeronautics  
Research



Innovative technologies from NASA's space and aeronautics missions (above) transfer as benefits to many sectors of society. Each benefit featured in *Spinoff 2008* is listed with an icon that corresponds to the mission from which the technology originated. The numbered bullets correspond to points on the centerfold map, illustrating the geographic distribution of the featured companies.



## Health and Medicine

### ① Robotics Offer Newfound Surgical Capabilities

Barrett Technology Inc., of Cambridge, Massachusetts, completed three Phase II Small Business Innovation Research (SBIR) contracts with Johnson Space Center, during which the company developed and commercialized three core technologies: a robotic arm, a hand that functions atop the arm, and a motor driver to operate the robotics. Among many industry uses, a recent adaptation of the arm has been cleared by the U.S. Food and Drug Administration (FDA) for use in a minimally invasive knee surgery procedure, where its precision control makes it ideal for inserting a very small implant.



### ② In-Line Filtration Improves Hygiene and Reduces Expense

MRLB International Inc., of Fergus Falls, Minnesota, designed the DentaPure waterline purification cartridge using water purification research conducted by Umpqua Research Company, of Myrtle Creek, Oregon, as part of SBIR contracts from Johnson Space Center. Various models now address a variety of needs, and are used in dental offices and dental schools across the country. Currently the only waterline system recognized by the FDA as a medical device which meets all known standards and by the U.S. Environmental Protection Agency (EPA) as an antimicrobial device, DentaPure has also been utilized by the U.S. Air Force.



### ③ LED Device Illuminates New Path to Healing

Quantum Devices Inc., of Barneveld, Wisconsin, was granted a NASA SBIR contract to develop an LED light source for use in a surgical environment. Several SBIR contracts from Marshall Space Flight Center helped develop the High Emissivity Aluminum Light-emitting Substrate (HEALS), then successfully applied it in cases of pediatric brain tumors and the prevention of oral mucositis in pediatric bone marrow transplant patients. The HEALS and subsequent WARP 10 technologies have won many awards, including a "Tibbets Award." Recently, the next-generation device, the WARP 75, was released.



### ④ Advanced Polymer Coats Leads on Implantable Medical Device

Langley Research Center's Soluble Imide was licensed by Medtronic Inc., of Minneapolis, Minnesota, for use as insulation on thin metal wires connected to its implantable cardiac resynchronization therapy devices, for patients experiencing heart failure. The devices resynchronize the contractions of the heart's ventricles by sending tiny electrical impulses to the heart muscle, helping the heart pump blood throughout the body more efficiently.







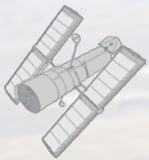
### **5 Lockable Knee Brace Speeds Rehabilitation**

Gary Horton, owner and operator of Horton's Orthotic Lab Inc., in Little Rock, Arkansas, was visiting Marshall Space Flight Center when he unexpectedly received assistance with a knee brace he was designing. Marshall engineers shared with him designs they had developed for a lockable joint with a hinge brake. Horton licensed the technology from Marshall and then set about applying the design concept to a new type of orthotic, a knee brace that automatically unlocks during the swinging phase of walking, but then is able to reengage for stability upon heel strike.



### **6 Robotic Joints Support Horses and Humans**

Cable-compliant joints developed at Goddard Space Flight Center provided the key elements in the NASA Equine Support Technology (N.E.S.T.). The device supports a horse's weight with a special harness and controls the pelvis without restricting hip movement. Enduro Medical Technologies, of South Windsor, Connecticut, expects the N.E.S.T. to revolutionize treatment for horses with leg injuries. The human version of the technology, released in 2003, is currently assisting U.S. service personnel rehabilitating from spinal cord or brain injuries at Walter Reed Army Medical Center, in Washington, DC.



### **7 Photorefraction Screens Millions for Vision Disorders**

Marshall Space Flight Center scientists adapted optics technology for eye screening methods using a process called photorefraction, using a camera system with a specifically angled telephoto lens and flash to photograph a subject's eye. In 1991, NASA transferred the exclusive license for the system to Vision Research Corporation, of Birmingham, Alabama, and over 3 million children have been screened for vision disorders since.



### **8 Periodontal Probe Improves Exams, Alleviates Pain**

Visual Programs Inc., of Richmond, Virginia, licensed the Periodontal Structures Mapping System from Langley Research Center. The resulting Ultrasonographic Probe (USProbe) is a noninvasive tool to make and record differential measurements of a patient's periodontal ligaments. The USProbe automatically detects, maps, and diagnoses problem areas by integrating diagnostic medical ultrasound techniques with advanced artificial intelligence. In addition to solving the problems associated with conventional probing, the USProbe may also provide information on the condition of the gum tissue and the quality and extent of the bond to the tooth surface.



### **9 Magnetic Separator Enhances Treatment Possibilities**

Since 1988, NASA has issued over 25 SBIR contracts with 4 NASA centers to the company now known as Techshot Inc., of Greenville, Indiana. Currently, Techshot and a spinoff company, IKOTech, are marketing the Magsort, a Quadruple Magnetic Sorter, which collects specific biological cells from a liquid suspension by running it through a magnet assembly. Its applications include the detection of rare cancer cells in circulating blood and the removal of undesired cells from bone marrow transplants.







## Transportation

### 10 Lithium Battery Power Delivers Electric Vehicles to Market

Hybrid Technologies Inc., a manufacturer and marketer of lithium-ion battery electric vehicles, based in Las Vegas, Nevada, and with research and manufacturing facilities in Mooresville, North Carolina, entered into a Space Act Agreement with Kennedy Space Center to determine the utility of lithium-powered fleet vehicles. NASA contributed engineering expertise for the car's advanced battery management system and tested a fleet of zero-emission vehicles on the Kennedy campus. Hybrid Technologies now offers a series of purpose-built lithium electric vehicles dubbed the LiV series, aimed at the urban and commuter markets.



### 11 Advanced Control System Increases Helicopter Safety

With support and funding from a Phase II NASA SBIR project from Ames Research Center, Hoh Aeronautics Inc. (HAI), of Lomita, California, produced HeliSAS, a low-cost, lightweight, attitude-command-attitude-hold stability augmentation system (SAS) for civil helicopters and unmanned aerial vehicles. HeliSAS proved itself in over 160 hours of flight testing and demonstrations in a Robinson R44 Raven helicopter, a commercial helicopter popular with news broadcasting and police operations. Chelton Flight Systems, of Boise, Idaho, negotiated with HAI to develop, market, and manufacture HeliSAS, now available as the Chelton HeliSAS Digital Helicopter Autopilot.



### 12 Aerodynamics Research Revolutionizes Truck Design

During the 1970s and 1980s, researchers at Dryden Flight Research Center conducted numerous tests to refine the shape of trucks to reduce aerodynamic drag and improve efficiency. During the 1980s and 1990s, a team based at Langley Research Center explored controlling drag and the flow of air around a moving body. Aeroserve Technologies Ltd., of Ottawa, Canada, with its subsidiary, Airtab LLC, in Loveland, Colorado, applied the research from Dryden and Langley to the development of the Airtab vortex generator. Airtabs create two counter-rotating vortices to reduce wind resistance and aerodynamic drag from trucks, trailers, recreational vehicles, and many other vehicles.



### 13 Engineering Models Ease and Speed Prototyping

System-response models developed by LMS International NV, a Belgium-based company with over 30 offices worldwide including Troy, Michigan, were used to calculate side-wall loads on J-2X nozzles at Marshall Space Flight Center. The J-2X will power the Ares launch vehicle—NASA's next-generation spacecraft. LMS engineers gained knowledge to be used for engineering applications in a wide range of other industries. By providing onsite support for tests, the LMS technical support and development staff seize opportunities like the work with NASA to expand their knowledge of tests and dynamics in real-world applications.

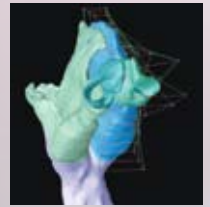






#### **14 Software Performs Complex Design Analysis**

Optimal Solutions Software LLC, of Provo, Utah, and Idaho Falls, Idaho, creates highly innovative engineering design improvement products to enable engineers to more reliably, creatively, and economically design new products in high-value markets. The company entered into an SBIR contract with Stennis Space Center, under which it extensively used its arbitrary shape deformation software to improve pressure loss, velocity, and flow quality in the pipes utilized by NASA. The product is available under the trade name Sculptor.



## **Public Safety**

#### **15 Space Suit Technologies Protect Deep-Sea Divers**

Paragon Space Development Corporation is a Tucson, Arizona-based firm specializing in aerospace engineering and technology development, and is a major supplier of environmental control and life support system and subsystem design for the aerospace industry. Through its work with NASA, the company has developed a suit for protecting divers who are called on to work in extreme and dangerous conditions, such as high pressure, toxic chemical spills, the hot waters of the Persian Gulf, and around chemical warfare agents.



#### **16 Fiber Optic Sensing Monitors Strain and Reduces Costs**

Luna Technologies, a division of Luna Innovations Incorporated, based in Blacksburg, Virginia, licensed technologies developed at Langley Research Center as part of the ultrasonic dynamic vector stress sensor. Luna released the Optical Vector Analyzer (OVA), Distributed Sensing System (DSS), and the Optical Backscatter Reflectometer (OBR) platforms. The OVA platform fiber optic sensing instruments include a set for linear characterization of single-mode optical components. The DSS and OBR platforms are two different techniques for distributed sensing: the DSS uses Fiber Bragg Gratings, and the OBR uses standard telecom-grade optical fiber.

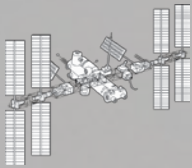


#### **17 Polymer Fabric Protects Firefighters, Military, and Civilians**

In 1967, NASA contracted with Celanese Corporation, of New York, to develop a line of PBI textiles for use in space suits and vehicles. In 2005, the PBI fiber and polymer business was sold to PBI Performance Products Inc., of Charlotte, North Carolina, under the ownership of the InterTech Group, of North Charleston, South Carolina. PBI Performance Products now offers two distinct lines: PBI, the original heat and flame resistant fiber; and Celazole, a family of high-temperature PBI polymers available in true polymer form. PBI is now used in numerous firefighting, military, motor sports, and other applications.







### **18 Advanced X-Ray Sources Ensure Safe Environments**

Ames Research Center awarded inXitu Inc. (formerly Microwave Power Technology), of Mountain View, California, an SBIR contract to develop a new design of electron optics for forming and focusing electron beams that is applicable to a broad class of vacuum electron devices. This technology offers an inherently rugged and more efficient X-ray source for material analysis; a compact and rugged X-ray source for smaller rovers on future Mars missions; and electron beam sources to reduce undesirable emissions from small, widely distributed pollution sources, and remediation of polluted sites.



## **Consumer, Home, and Recreation**

### **19 Wireless Fluid-Level Measurement System Equips Boat Owners**

While developing a measurement acquisition system to be used to retrofit aging aircraft with vehicle health monitoring capabilities, Langley Research Center developed an innovative wireless fluid-level measurement system. The NASA technology was of interest to Tidewater Sensors LLC, of Newport News, Virginia, because of its many advantages over conventional fuel management systems, including its ability to provide an accurate measurement of volume while a boat is experiencing any rocking motion due to waves or people moving about on the boat. These advantages led the company to license this novel fluid-level measurement system from NASA for marine applications.



### **20 Mars Cameras Make Panoramic Photography a Snap**

The Mars rover Panoramic Mast Assemblies inspired scientists at Ames Research Center and Carnegie Mellon University to find more “down-to-Earth” photographic and virtual exploration applications for consumers. With the Austin, Texas-based Charmed Labs LLC, scientists created a prototype for the Gigapan robotic platform for consumer cameras, which automates the creation of highly detailed digital panoramas. The scientists also created a Web site and photographic stitching software to accompany the Gigapan platform.



### **21 Experiments Advance Gardening at Home and in Space**

NASA research with BioServe Space Technologies and AgriHouse Inc., developing aeroponic gardening for space flight, inspired an innovative home gardening appliance. AeroGrow International Inc., of Boulder, Colorado, designed and released the AeroGarden line of countertop gardens based on NASA studies. One element, the Seed Pod, has since been used by BioServe as part of an experiment on the International Space Station, as its design would protect tomato seeds and prevent premature germination.







## **22 Space Age Swimsuit Reduces Drag, Breaks Records**

Because of Langley Research Center's experience in studying the forces of friction and drag, Los Angeles-based SpeedoUSA asked the Agency to help design a swimsuit shortly after the 2004 Olympics. The LZR Racer reduces skin friction drag 24 percent more than the previous Speedo racing suit. The research seems to have paid off; of the 25 world records in swimming broken at the Beijing 2008 Olympic Games, 23 were by athletes wearing the LZR Racer.



## **23 Immersive Photography Renders 360° Views**

An SBIR contract through Langley Research Center helped Interactive Pictures Corporation, of Knoxville, Tennessee, create an innovative imaging technology. This technology is a video imaging process that allows real-time control of live video data and can provide users with interactive, panoramic 360° views. The camera system can see in multiple directions, provide up to four simultaneous views, each with its own tilt, rotation, and magnification, yet it has no moving parts, is noiseless, and can respond faster than the human eye. In addition, it eliminates the distortion caused by a fisheye lens, and provides a clear, flat view of each perspective.



## **24 Historic Partnership Captures Our Imagination**

Victor Hasselblad AB, of Gothenburg, Sweden, has enjoyed a long-lived collaboration with NASA, especially Johnson Space Center. For over four decades, Hasselblad has supplied camera equipment to the NASA Space Program, and Hasselblad cameras still take on average between 1,500 and 2,000 photographs on each space shuttle mission. Collaboration with NASA has allowed a very small company to achieve worldwide recognition—Hasselblad's operations now include centers in Parsippany, New Jersey; and Redmond, Washington; as well as France and Denmark—and consumer camera models have featured improvements resulting from refinements for the space models.

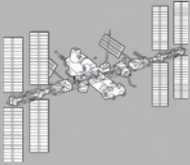


## **25 Outboard Motor Maximizes Power and Dependability**

Developed by Jonathan Lee, a structural materials engineer at Marshall Space Flight Center, and PoShou Chen, a scientist with Huntsville, Alabama-based Morgan Research Corporation, MSFC-398 is a high-strength aluminum alloy able to operate at high temperatures. MSFC-398 was licensed for marine applications by Bombardier Recreational Products Inc., and is now found in the complete line of Evinrude E-TEC outboard motors, a line of two-stroke motors that maintain the power and dependability of a two-stroke with the refinement of a four-stroke.







## **26 Space Research Fortifies Nutrition Worldwide**

NASA's Controlled Ecological Life Support Systems program attempted to address basic needs of crews, meet stringent payload and power usage restrictions, and minimize space occupancy, by developing living, regenerative ecosystems that would take care of themselves and their inhabitants. An experiment from this program evolved into one of the most widespread NASA spinoffs of all time—a method for manufacturing an algae-based food supplement that provides the nutrients previously only available in breast milk. Martek Biosciences Corporation, in Columbia, Maryland, now manufactures this supplement, and it can be found in over 90 percent of the infant formulas sold in the United States, as well as those sold in over 65 other countries. With such widespread use, the company estimates that over 24 million babies worldwide have consumed its nutritional additives.



## **27 Aerogels Insulate Missions and Consumer Products**

Aspen Aerogels, of Northborough, Massachusetts, worked with NASA through an SBIR contract with Kennedy Space Center to develop a robust, flexible form of aerogel for cryogenic insulation for space shuttle launch applications. The company has since used the same manufacturing process developed under the SBIR award to expand its product offerings into the more commercial realms, making the naturally fragile aerogel available for the first time as a material that can be handled and installed just like standard insulation.



# **Environmental and Agricultural Resources**

## **28 Computer Model Locates Environmental Hazards**

Catherine Huybrechts Burton founded San Francisco-based Endpoint Environmental (2E) LLC in 2005 while she was a student intern and project manager at Ames Research Center with NASA's DEVELOP program. The 2E team created the Tire Identification from Reflectance Model, which algorithmically processes satellite images using turnkey technology to retain only the darkest parts of an image. This model allows 2E to locate piles of rubber tires, which often are stockpiled illegally and cause hazardous environmental conditions and fires.



## **29 Battery Technology Stores Clean Energy**

Headquartered in Fremont, California, Deeya Energy Inc. is now bringing its flow batteries to commercial customers around the world after working with former Marshall Space Flight Center scientist, Lawrence Thaller. Deeya's liquid-cell batteries have higher power capability than Thaller's original design, are less expensive than lead-acid batteries, are a clean energy alternative, and are 10 to 20 times less expensive than nickel-metal hydride batteries, lithium-ion batteries, and fuel cell options.







### 30 Robots Explore the Farthest Reaches of Earth and Space

Deep Ocean Engineering (DOE) Inc., of San Leandro, California, received several SBIR awards from NASA to develop remotely operated vehicle (ROV) technologies with Ames Research Center. DOE engineers developed a concept for a versatile and robust locomotion methodology based on snake and worm morphologies. This “super snake” has the ability to transition seamlessly from one environment to another, such as land to water to burrowing into soft sediment. DOE ROVs are in use by U.S. armed forces, Hydro Quebec, and more than 40 universities and scientific organizations.



### 31 Portable Nanomesh Creates Safer Drinking Water

In 2003, Seldon Technologies Inc., of Windsor, Vermont, began designing a carbon Nanomesh for filtering impurities from drinking water. Testing in EPA-certified facilities showed that Seldon’s filters removed more than 99 percent of bacteria and viruses, numerous chemical contaminants, and endotoxins, such as *Escherichia coli* (*E.coli*) and *Salmonella*. Using a carbon Nanomesh, the WaterStick filters about 5 gallons (200 milliliters) of water a minute simply using water pressure and gravity—without electricity, heat, chemical additives, or environmental impact.



### 32 Innovative Stemless Valve Eliminates Emissions

Big Horn Valve Inc. (BHVI), of Sheridan, Wyoming, won a series of SBIR and Small Business Technology Transfer (STTR) contracts with Kennedy Space Center and Marshall Space Flight Center to explore and develop a revolutionary valve technology. BHVI developed a low-mass, high-efficiency, leak-proof cryogenic valve using composites and exotic metals, and had no stem-actuator, few moving parts, with an overall cylindrical shape. The valve has been installed at a methane coal gas field, and future applications are expected to include in-flight refueling of military aircraft, high-volume gas delivery systems, petroleum refining, and in the nuclear industry.



### 33 Web-Based Mapping Puts the World at Your Fingertips

NASA’s award-winning Earth Resources Laboratory Applications Software (ELAS) package was developed at Stennis Space Center. Since 1978, ELAS has been used worldwide for processing satellite and airborne sensor imagery data of the Earth’s surface into readable and usable information. DATASTAR Inc., of Picayune, Mississippi, has used ELAS software in the DATASTAR Image Processing Exploitation (DIPEX) desktop and Internet image processing, analysis, and manipulation software. The new DIPEX Version III includes significant upgrades and improvements compared to its esteemed predecessor. A true World Wide Web application, this product evolved with worldwide geospatial dimensionality and numerous other improvements that seamlessly support the Web version.







## Computer Technology

### 34 Program Assists Satellite Designers

Annapolis, Maryland-based designAmerica Inc., a small aerospace company specializing in the development and delivery of ground control systems for satellites and instrumentation, assisted Goddard Space Flight Center in the development of the ASIST software, a real-time command and control system for spacecraft development, integration, and operations. It was designed to be fully functional across a broad spectrum of satellites and instrumentation, while also being user friendly. The company now has rights to commercial use of the program and is offering it to government and industry satellite designers.



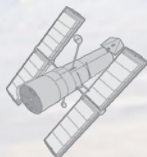
### 35 Water-Based Coating Simplifies Circuit Board Manufacturing

The Polymers Branch at Glenn Research Center's extensive knowledge of polyimide chemistry and its expertise in the synthesis of ultraviolet light curable polyimides were the critical components that allowed Advanced Coatings International, of Akron, Ohio, to prototype the platform chemistry for a polyimide-based, waterborne, liquid photoimable coating ideal for the manufacture of printed circuit boards.



### 36 Software Schedules Missions, Aids Project Management

Through several long-term SBIR contracts, Knowledge-Based Systems Inc. (KBSI), of College Station, Texas, developed three advanced system management softwares: WorkSim, Model Mosaic, and AIOXFinder. Used independently or as a suite, these programs help manage complex projects and have been applied to several NASA missions.



### 37 Software Analyzes Complex Systems in Real Time

VIASPACE Inc., of Pasadena, California, licensed the Spacecraft Health Inference Engine (SHINE) software from NASA. It was designed to monitor, analyze, and diagnose real-time and non-real-time systems and, in addition to having been used on at least eight major NASA missions, has found application in the military and industrial realms.



### 38 Wireless Sensor Network Handles Image Data

Vexcel Corporation, of Boulder, Colorado, received STTR funding through Goddard Space Flight Center to develop wireless sensor network technology that now aids in the high-speed handling of image data. This technology has uses in both the commercial sector, where it is used to relay satellite imagery to the desktop, and in the government sector, where NASA is finding continued use in terrestrial and interplanetary studies.

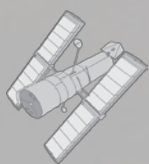






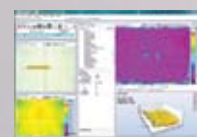
#### **39 Virtual Reality System Offers a Wide Perspective**

As part of an SBIR agreement to improve the telepresence of Johnson Space Center's Robonaut, Baltimore-based Sensics Inc. created a head-mounted display with a high-resolution, three-dimensional panorama. The Sensics piSight is now being sold commercially for high-end virtual reality applications. Virtual surroundings appear in the viewfinder and respond to head movements.



#### **40 Software Simulates Sight: Flat Panel Mura Detection**

Radiant Imaging Inc., of Duvall, Washington, licensed the Spatial Standard Observer (SSO) software from Ames Research Center. The SSO simulates a simplified model of human spatial vision, operating on a pair of images that are viewed at a specific viewing distance with pixels having a known relation to luminance. The SSO software was used to develop the TrueMURA Analysis Module, incorporated into Radiant Imaging's ProMetric 9.1 system. When used in conjunction with the ProMetric Series Imaging Colorimeters, the new software module provides a complete characterization and testing system for flat panel displays, especially LCD panels and displays.



#### **41 Inductive System Monitors Tasks**

The Inductive Monitoring System is software developed at Ames Research Center that uses artificial intelligence and data mining techniques to build system-monitoring knowledge bases from archived or simulated sensor data. This information is then used to detect unusual or anomalous behavior that may indicate an impending system failure. iSagacity Inc., based out of Portland, Maine, executed a nonexclusive license and is now offering it for use for water treatment plants, water heating and cooling in the process industry, oil refineries, public water distribution, and power generation plants.



#### **42 Mars Mapping Technology Brings Main Street to Life**

Berkeley, California-based earthmine inc. licensed 3-D data-generation software and algorithms from NASA's Jet Propulsion Laboratory originally used to create a 3-D representation of the local terrain to allow autonomous routing of the Mars Exploration Rovers. earthmine combined the software and algorithms with its unique capture hardware and Web delivery technology in a system that integrates the information to deliver accurate street-level geospatial data through a Web-based interface. Complete municipalities are collected through high-quality, 3-D panoramic images—including every road, alley, and freeway—to create a complete, consistent, and publicly accessible geospatial view of cities for official and commercial applications.







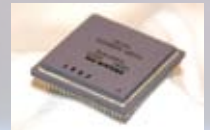
#### **43 Intelligent Memory Module Overcomes Harsh Environments**

3D Plus USA Inc., of McKinney, Texas, licensed Radiation Tolerant Intelligent Memory Stack technology from Langley Research Center for systems and methods to detect a failure event in field programmable gate arrays. In partnership with Langley, 3D Plus developed the first high-density and fast access time memory module tolerant of space radiation effects. This module decreases design complexity for space-based electronics requiring memory with its simple interface and internal radiation tolerance management. Expected applications include commercial or scientific geostationary missions and deep space scientific exploration, and high-reliability computing in other radiation-intensive environments like nuclear facilities.



#### **44 Integrated Circuit Chip Improves Network Efficiency**

Under a 2002 Space Act Agreement, Rockville, Maryland-based BAE Systems Inc. worked with Goddard Space Flight Center to create a SpaceWire-based application-specific integrated circuit (ASIC) chip for bridging existing space electronics and Goddard's new link-and-switch routers. BAE Systems' ASIC integrates easily into an onboard system and also decreases the part count, overall system complexity, ongoing costs, and power requirements for the system's board while also improving speed and reliability.



## **Industrial Productivity**

#### **45 Novel Process Revolutionizes Welding Industry**

Glenn Research Center, Delphi Corporation, and the Michigan Research Institute entered into a project to study the use of Deformation Resistance Welding (DRW) in the construction and repair of stationary structures with multiple geometries and dissimilar materials, such as those NASA might use on the Moon or Mars. Traditional welding technologies are burdened by significant business and engineering challenges, including high costs of equipment and labor, heat-affected zones, limited automation, and inconsistent quality. DRW addresses each of those issues, while drastically reducing welding, manufacturing, and maintenance costs.



#### **46 Sensors Increase Productivity in Harsh Environments**

California's San Juan Capistrano-based Endevco Corporation licensed three patents for high-temperature, harsh-environment silicon carbide (Si-C) pressure sensors from Glenn Research Center. The company is exploring their use in government markets, as well as in commercial markets, including commercial jet testing, deep well-drilling applications where pressure and temperature increase with depth, and in automobile combustion chambers.





#### **47 Portable Device Analyzes Rocks and Minerals**

inXitu Inc., of Mountain View, California, entered into a Phase II SBIR contract with Ames Research Center to develop technologies for the next generation of scientific instruments for materials analysis. The work resulted in a sample handling system that could find a wide range of applications in research and industrial laboratories as a means to load powdered samples for analysis or process control. Potential industries include chemical, cement, inks, pharmaceutical, ceramics, and forensics. Additional applications include characterizing materials that cannot be ground to a fine size, such as explosives and research pharmaceuticals.



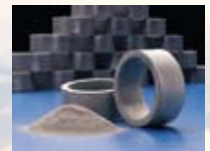
#### **48 NASA Design Strengthens Welds**

Friction Stir Welding (FSW) is a solid-state joining process—a combination of extruding and forging—ideal for use when the original metal characteristics must remain as unchanged as possible. While exploring ways to improve the use of FSW in manufacturing, engineers at Marshall Space Flight Center created technologies to address the method's shortcomings. MTS Systems Corporation, of Eden Prairie, Minnesota, discovered the NASA-developed technology and then signed a co-exclusive license agreement to commercialize Marshall's design for use in high-strength structural alloys. The resulting process offers the added bonuses of being cost-competitive, efficient, and most importantly, versatile.



#### **49 Polyimide Boosts High-Temperature Performance**

Maverick Corporation, of Blue Ash, Ohio, licensed DMBZ-15 polyimide technology from Glenn Research Center. This ultrahigh-temperature material provides substantial weight savings and reduced machining costs compared to the same component made with more traditional metallic materials. DMBZ-15 has a wide range of applications from aerospace (aircraft engine and airframe components, space transportation systems, and missiles) to non-aerospace (oil drilling, rolling mill), and is particularly well-suited to use as face sheets with honeycombs or thermal protection systems for reusable launch vehicles, which encounter elevated temperatures during launch and reentry.



#### **50 NASA Innovation Builds Better Nanotubes**

Nanotailor Inc., based in Austin, Texas, licensed Goddard Space Flight Center's unique single-walled carbon nanotube (SWCNT) fabrication process with plans to make high-quality, low-cost SWCNTs available commercially. Carbon nanotubes are being used in a wide variety of applications, and NASA's improved production method will increase their applicability in medicine, microelectronics, advanced materials, and molecular containment. Nanotailor built and tested a prototype based on Goddard's process, and is using this technique to lower the cost and improve the integrity of nanotubes, offering a better product for use in biomaterials, advanced materials, space exploration, highway and building construction, and many other applications.





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### Public Safety

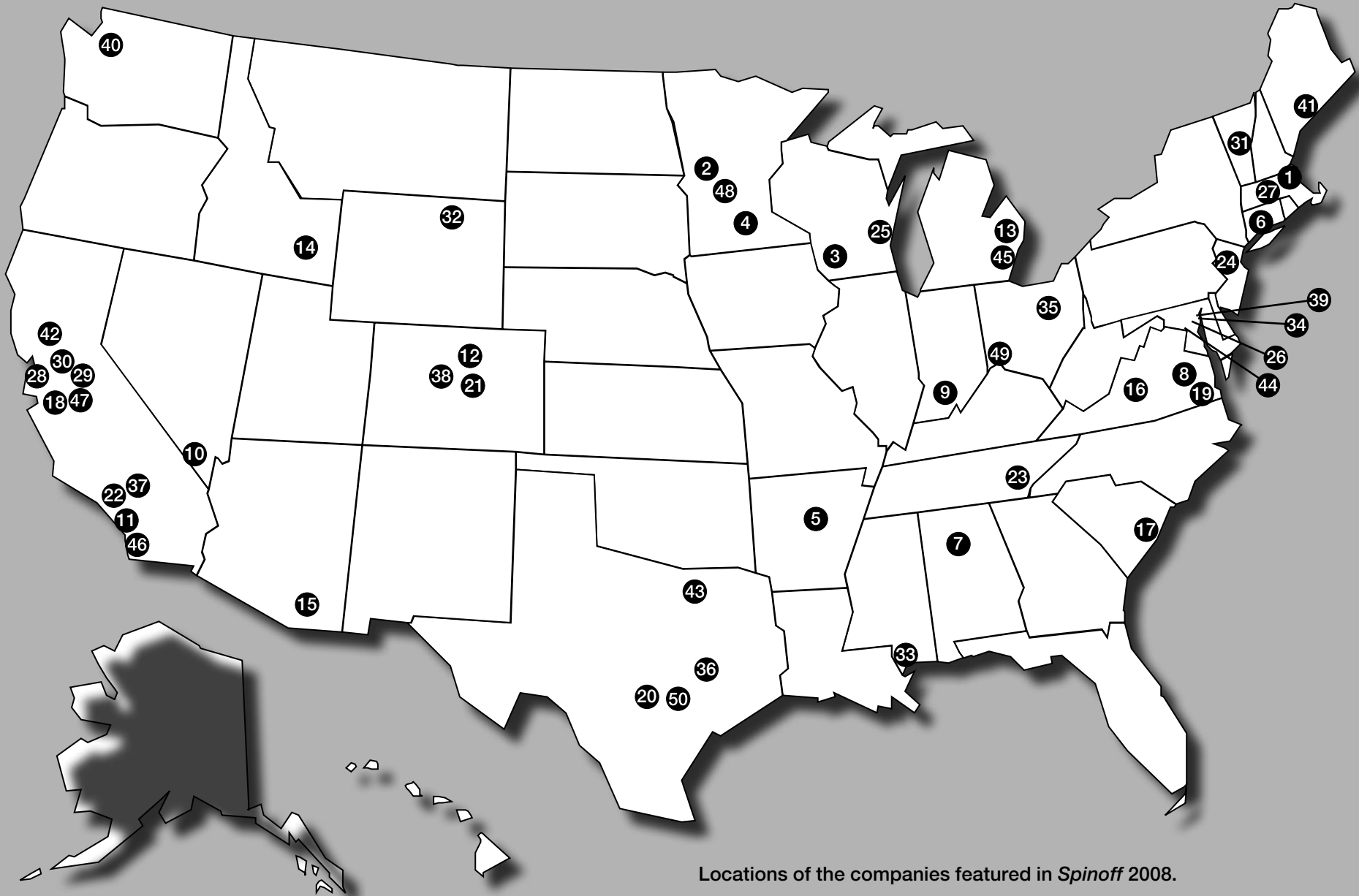
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- 20 Mars Cameras Make Panoramic Photography a Snap (TX)
- 21 Experiments Advance Gardening at Home and in Space (CO)
- 22 Space Age Swimsuit Reduces Drag, Breaks Records (CA)
- 23 Immersive Photography Renders 360° Views (TN)
- 24 Historic Partnership Captures Our Imagination (NJ)

# NASA Technologies Benefiting Society



### Environmental and Agricultural Resources

- 25 Outboard Motor Maximizes Power and Dependability (WI)
- 26 Space Research Fortifies Nutrition Worldwide (MD)
- 27 Aerogels Insulate Missions and Consumer Products (MA)
- 28 Computer Model Locates Environmental Hazards (CA)
- 29 Battery Technology Stores Clean Energy (CA)
- 30 Robots Explore the Farthest Reaches of Earth and Space (CA)
- 31 Portable Nanomesh Creates Safer Drinking Water (VT)
- 32 Innovative Stemless Valve Eliminates Emissions (WY)
- 33 Web-Based Mapping Puts the World at Your Fingertips (MS)



### Computer Technology

- 34 Program Assists Satellite Designers (MD)
- 35 Water-Based Coating Simplifies Circuit Board Manufacturing (OH)
- 36 Software Schedules Missions, Aids Project Management (TX)
- 37 Software Analyzes Complex Systems in Real Time (CA)
- 38 Wireless Sensor Network Handles Image Data (CO)
- 39 Virtual Reality System Offers a Wide Perspective (MD)
- 40 Software Simulates Sight: Flat Panel Mura Detection (WA)
- 41 Inductive System Monitors Tasks (ME)
- 42 Mars Mapping Technology Brings Main Street to Life (CA)
- 43 Intelligent Memory Module Overcomes Harsh Environments (TX)
- 44 Integrated Circuit Chip Improves Network Efficiency (MD)



### Industrial Productivity

- 45 Novel Process Revolutionizes Welding Industry (MI)
- 46 Sensors Increase Productivity in Harsh Environments (CA)
- 47 Portable Device Analyzes Rocks and Minerals (CA)
- 48 NASA Design Strengthens Welds (MN)
- 49 Polyimide Boosts High-Temperature Performance (OH)
- 50 NASA Innovation Builds Better Nanotubes (TX)

The Nation's investment in NASA's aerospace research has brought practical benefits back to Earth in the form of commercial products and services in the fields of health and medicine; transportation; public safety; consumer, home, and recreation goods; environmental and agricultural resources; computer technology; and industrial productivity. *Spinoff*, NASA's premier annual publication, features these commercialized technologies. Since its inception in 1976, *Spinoff* has profiled more than 1,600 NASA-derived products from companies across the Nation. An online archive of all stories from the first issue of *Spinoff* to the latest is available in the *Spinoff* database at [www.sti.nasa.gov/spinoff/database](http://www.sti.nasa.gov/spinoff/database).

Visit the Innovative Partnerships Program at <http://www.ipp.nasa.gov>.



## Innovative Partnerships Program

The Innovative Partnerships Program (IPP) facilitates the transfer of new technologies to the private sector. It is also the organization within NASA responsible for providing needed technology and capabilities to NASA's mission directorates, programs, and projects through investments and partnerships with industry, academia, government agencies, and national laboratories. IPP has offices at each of NASA's 10 field centers, and elements that include: Technology Infusion, which manages the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs and the IPP Seed Fund; the Innovation Incubator, which includes the Centennial Challenges and new efforts with the emerging commercial space sector; and Partnership Development, which includes intellectual property management and technology transfer.

In FY 2008, the Innovative Partnerships Program engaged small businesses, universities, corporations, and other government labs in advancing technology for NASA needs and transferring technology for broad public benefit:

- Selected 396 Small Business Innovation Research (SBIR) projects, with nearly \$100 million awarded to 205 firms across 31 states
- Selected 35 Small Business Technology Transfer (STTR) projects, with \$8 million awarded to 24 small businesses partnered with 22 universities and research institutions across 14 states
- Initiated 53 collaborative Seed Fund projects, leveraging IPP resources nearly 4:1 and yielding partnerships in 32 states between NASA and 51 large and small businesses, universities, Federally Funded Research and Development Centers, and other government agencies
- Documented 1,100 New Technology Reports on NASA-funded technology that could lead to patenting and transfer—110 patent applications were filed and 112 patents were awarded this year
- Executed 30 license agreements and 800 software use agreements transferring NASA technology for broad use and public benefit
- Demonstrated that commercially available parabolic flight services could be used to test needed space technologies from small businesses in zero gravity or simulated lunar gravity
- Conducted 5 Centennial Challenge prize competitions with over \$4M at stake, involving 31 teams and 14 states



## Spinoff (spin'ôf') -noun.

1. A commercialized product incorporating NASA technology or "know how" which benefits the public. Qualifying technologies include:
  - Products or processes designed for NASA use, to NASA specifications, and then commercialized
  - Components or processes involving NASA technology incorporated into a commercial product, employed in the manufacturing of a product, or used to modify the design of an existing product
  - Products or processes to which NASA laboratory personnel made significant contributions, including the use of NASA facilities for testing purposes
  - Successful entrepreneurial endeavors by ex-NASA employees whose technical expertise was developed while employed by NASA
  - Products or processes commercialized as the result of a NASA patent license or waiver
  - Commercial products or processes developed as a result of the Small Business Innovation Research or Small Business Technology Transfer programs
2. NASA's premier annual publication, featuring successfully commercialized NASA technologies.

National Aeronautics and Space Administration

### NASA Headquarters

300 E Street SW  
Washington, DC 20546

[www.nasa.gov](http://www.nasa.gov)

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