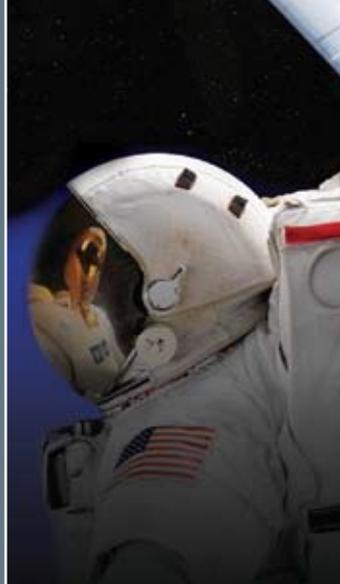
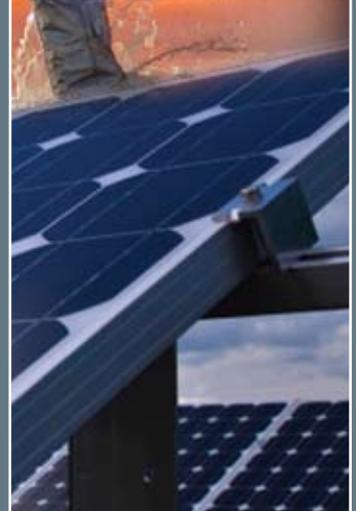
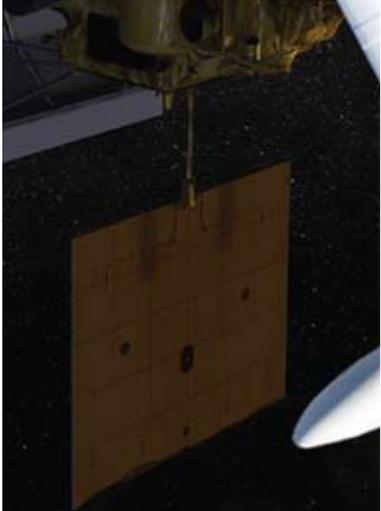
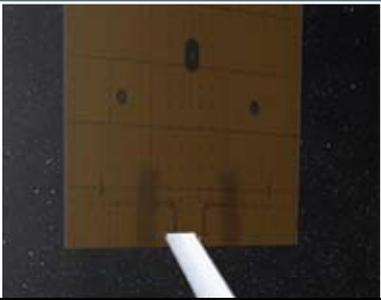




# spinoff

*NASA Technologies Benefit Society*



2011



### Health and Medicine

- 1 Bioreactors Drive Advances in Tissue Engineering (TX)
- 2 Tooling Techniques Enhance Medical Imaging (VA)
- 3 Ventilator Technologies Sustain Critically Injured Patients (NJ)
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### Public Safety

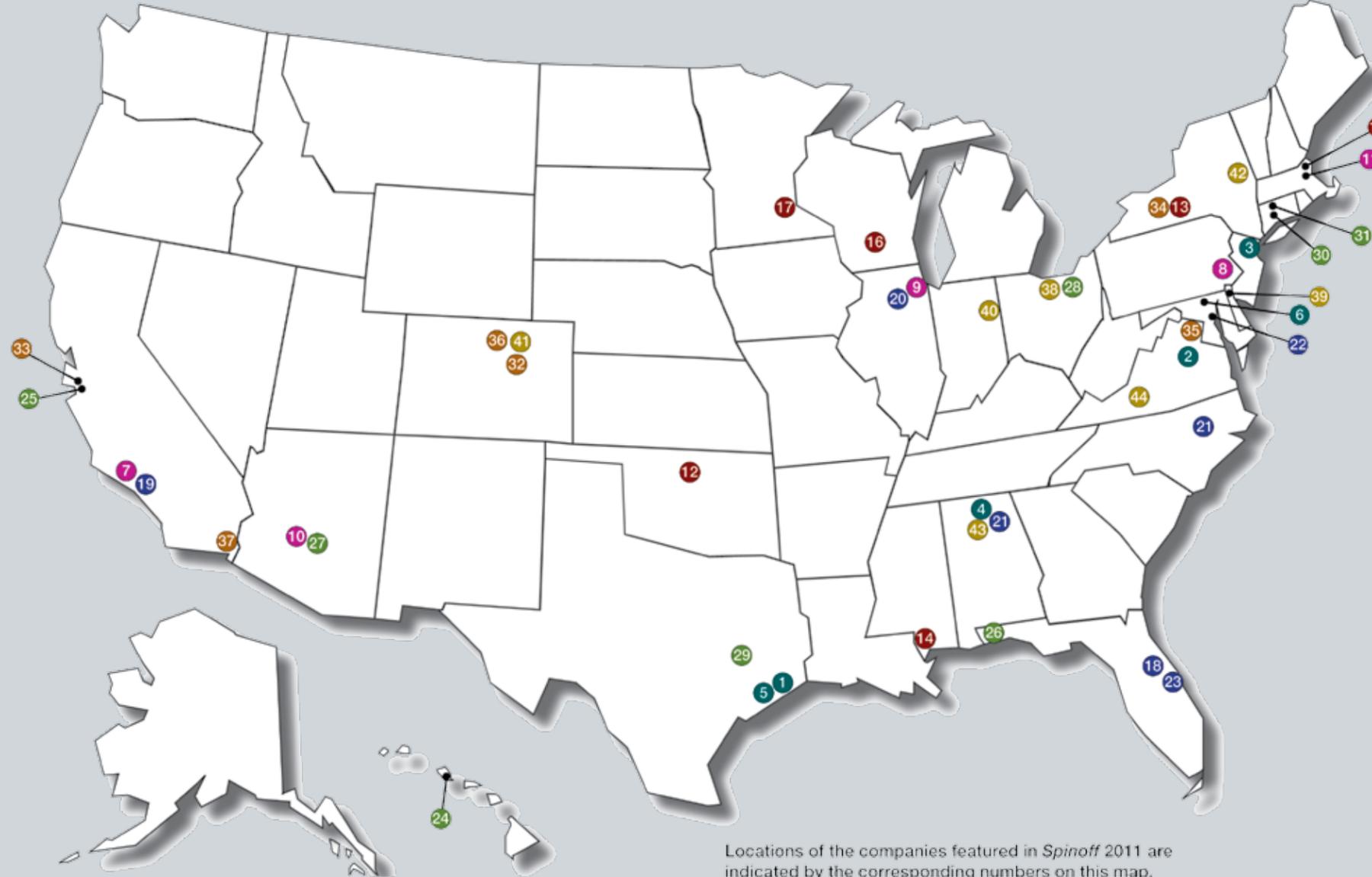
- 12 Modified Fittings Enhance Industrial Safety (OK)
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# NASA Technologies Benefiting Society



Locations of the companies featured in *Spinoff* 2011 are indicated by the corresponding numbers on this map.



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### Industrial Productivity

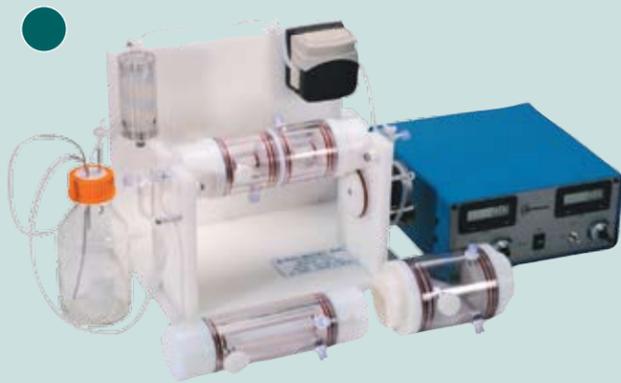
- 38 Nanotube Production Devices Expand Research Capabilities (OH)
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The Nation's investment in NASA's aerospace research has brought practical benefits back to Earth in the form of commercial products and services in the fields of health and medicine, transportation, public safety, consumer goods, environmental resources, computer technology, and industrial productivity. *Spinoff*, NASA's premier annual publication, features these commercialized technologies. Since its inception in 1976, *Spinoff* has profiled 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 at [www.sti.nasa.gov/spinoff/database](http://www.sti.nasa.gov/spinoff/database).

Visit the Office of the Chief Technologist at <http://www.nasa.gov/oct>.

**N**ASA *Spinoff* highlights the Agency's most significant research and development activities and the successful transfer of NASA technology, showcasing the cutting-edge research being done by the Nation's top technologists and the practical benefits that come back down to Earth in the form of tangible products that make our lives better. Since 1976, *Spinoff* has profiled over 1,750 of the most compelling of these technologies, annually featuring the best and brightest of partnerships and innovations in the fields of health and medicine, transportation, public safety, consumer goods, energy and environment, information technology, and industrial productivity.

## Health and Medicine



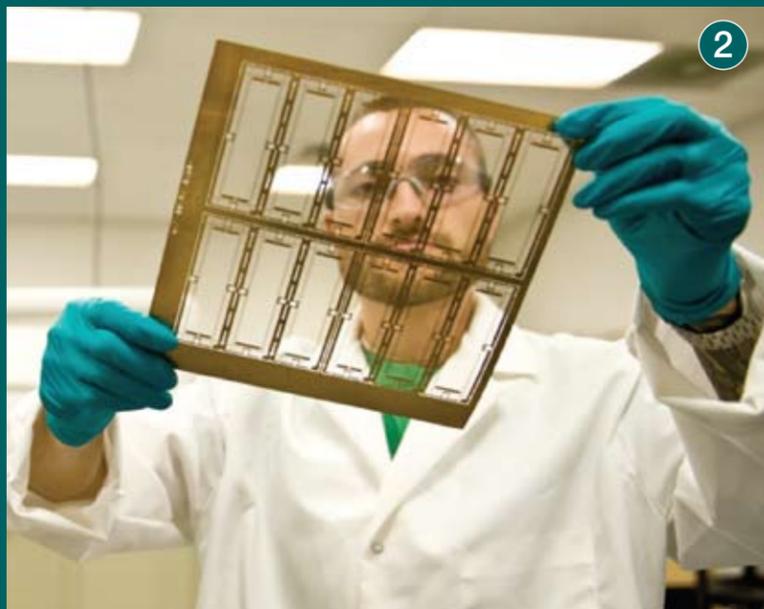
### Bioreactors Drive Advances in Tissue Engineering

Johnson Space Center innovators created a rotating wall bioreactor that mimics microgravity conditions, allowing for healthier, more natural-forming cell cultures. Licensed to Synthecon Inc. of Houston, the technology now enables drug development and medical research into treatment for conditions such as diabetes and cancer.



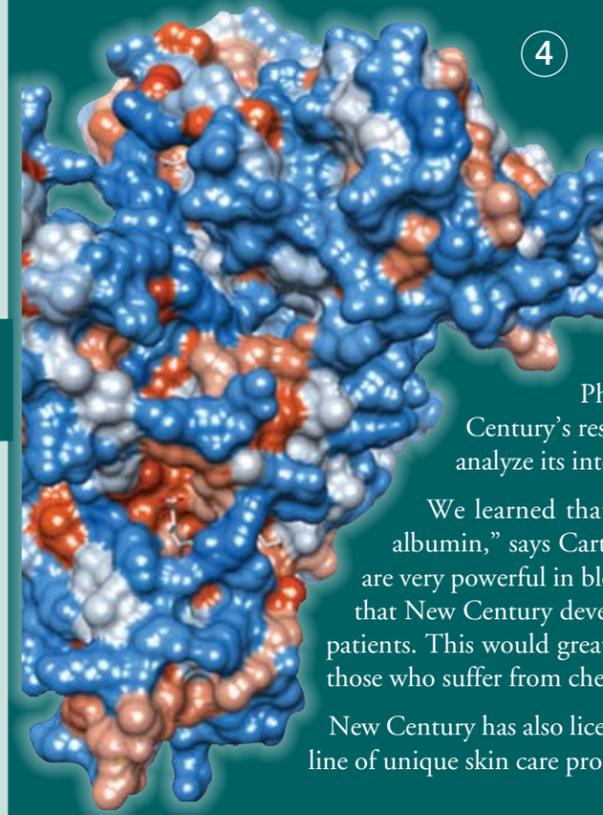
### Ventilator Technologies Sustain Critically Injured Patients

Drawing on the expertise of Johnson Space Center space medicine experts under the auspices of a Space Act Agreement, Impact Instrumentation Inc. of West Caldwell, New Jersey, made advances in medical ventilator technology now incorporated into emergency medical solutions for soldiers and civilians around the world.



### Tooling Techniques Enhance Medical Imaging

Collaborating with Goddard Space Flight Center, Mike Appleby developed a manufacturing process to create specialized components for a NASA Sun imaging satellite. Through SBIR funding, Appleby's company, Mikro Systems of Charlottesville, Virginia, perfected the process now used to fabricate advanced parts for medical and security imaging devices. The company added 37 jobs as a result of its NASA work.



### Protein Innovations Advance Drug Treatments, Skin Care

While at Marshall Space Flight Center, Dan Carter and colleagues mapped the atomic structure of albumin, an important blood protein, for the first time. Albumin tends to bind with other substances within the bloodstream, greatly affecting how they are dispersed throughout the body.

Having mapped albumin's atomic structure, Carter formed New Century Pharmaceuticals of Huntsville, Alabama, to build on this achievement. New Century's researchers were able to use their exhaustive knowledge of albumin's structure to analyze its interaction with specific medications.

"We learned that the bulk of large complex anticancer drugs bind to the same location in albumin," says Carter. "We also learned of molecules that have no anticancer activity and which are very powerful in blocking that particular binding site." The resulting drug combination approach that New Century developed opens new possibilities for fine-tuning cancer treatments for individual patients. This would greatly reduce the amount of drugs required for an effective dose—good news for those who suffer from chemotherapy's toxic side effects.

New Century has also licensed its breakthroughs to a company that has used the technology to develop a line of unique skin care products, designed to improve skin health by replenishing its albumin levels.

# TREATING DISEASE



### Mass Analyzers Facilitate Research on Addiction

To enhance the technology that monitored hydrogen and oxygen levels in the orbiter while on the launch pad, Kennedy Space Center awarded an SBIR contract to Houston-based Ionwerks Inc. After the SBIR, Ionwerks incorporated many of the innovations into its commercial laser imaging spectrometer. Today, Ionwerks sells the spectrometer for biological mass spectrometry and basic biological research.



### Frameworks Coordinate Scientific Data Management

Jet Propulsion Laboratory computer scientists developed a unique software framework to help NASA manage its massive amounts of science data. Through a partnership with the Apache Software Foundation of Forest Hill, Maryland, the technology is now available as an open-source solution and is in use by cancer researchers and pediatric hospitals.



# Transportation

7



## Cameras Improve Navigation for Pilots, Drivers

Advanced Scientific Concepts Inc. (ASC), of Santa Barbara, California, received SBIR awards and other funding from the Jet Propulsion Laboratory, Johnson Space Center, and Langley Research Center to develop and refine its 3D flash LIDAR technologies for space applications. Today, ASC's NASA-derived technology is sold to assist with collision avoidance, navigation, and object tracking.



9

## Advisory Systems Save Time, Fuel for Airlines

Heinz Erzberger never thought the sky was falling, but he knew it could benefit from enhanced traffic control. Throughout the 1990s, Erzberger led a team at Ames Research Center to develop a suite of automated tools to improve the efficiency of air traffic control operations. Called CTAS, one of the tools in the suite—the traffic management advisor—was adopted by the Federal Aviation Administration and implemented at traffic control centers across the United States. Another one of the tools, Direct-To, followed a different path.

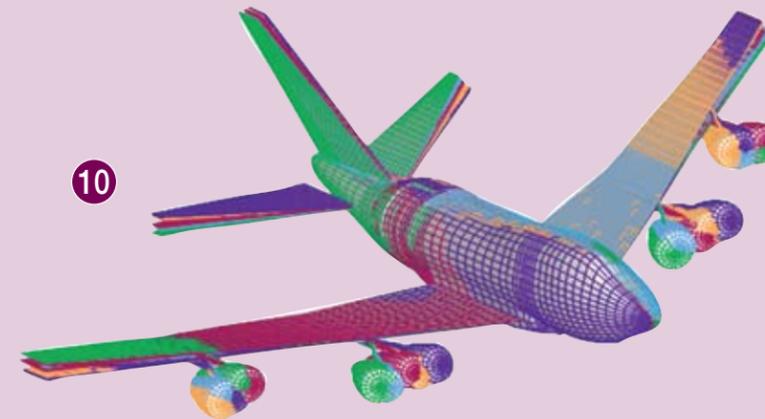
Chicago-based Boeing licensed Direct-To and by 2010, incorporated it into a product called Direct Routes. Now the NASA spinoff technology is commercially available as part of Boeing's InFlight Optimization Services. It provides real time advisories to aircraft for suggested shortcuts that are prechecked for traffic conflicts, wind conditions, established airspace constraints, and other factors. When there are small course adjustments along an airplane's intended route that can reduce at least 1 minute of flight time, the pilot is notified.

According to Boeing, Direct Routes can save tens of thousands of minutes per year for a medium-sized U.S. operator and an estimated 20 million gallons of fuel per year for commercial airlines—the equivalent of approximately \$50 million per year. This means a direct reduction of thousands of tons of carbon emissions each year as well.

Currently available in a subscription service, potential customers include commercial airlines, business aviation, military, general aviation, and international flights.

# SAVING FUEL

10



## Modeling Programs Increase Aircraft Design Safety

Partnering with Dryden Flight Research Center through the SBIR program, ZONA Technology Inc. of Scottsdale, Arizona developed innovative tools for addressing a key safety concern during aircraft design. The company is also working on a cost-effective alternative to wind tunnel testing through another Dryden SBIR project.



11

## Fly-by-Wire Systems Enable Safer, More Efficient Flight

Using the ultra-reliable Apollo Guidance Computer that enabled the Apollo Moon missions, Dryden Flight Research Center engineers, in partnership with industry leaders such as Cambridge, Massachusetts-based Draper Laboratory, demonstrated that digital computers could be used to fly aircraft. Digital fly-by-wire systems have since been incorporated into large airliners, military jets, revolutionary new aircraft, and even cars and submarines.

8

## Integrated Design Tools Reduce Risk, Cost

Thanks in part to a SBIR award with Langley Research Center, Phoenix Integration Inc., based in Wayne, Pennsylvania, modified and advanced software for process integration and design automation. For NASA, the tool has resulted in lower project costs and reductions in design time; clients of Phoenix Integration are experiencing the same rewards.





## Public Safety

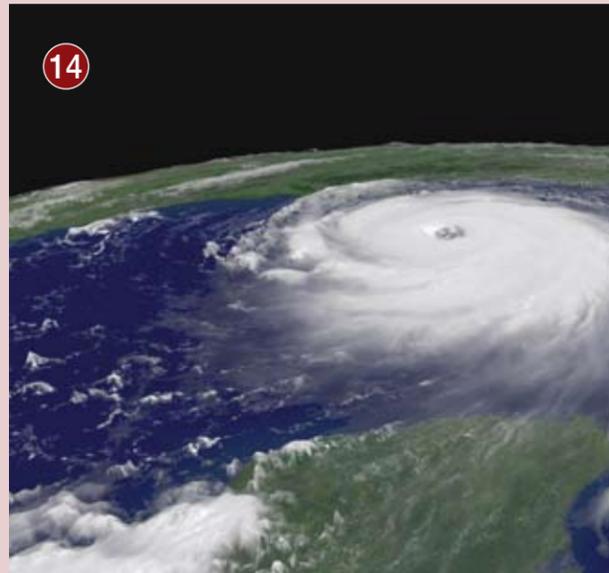
13



### Modified Fittings Enhance Industrial Safety

Concerned with the safety of the connections on pressurized air hoses, engineers at Kennedy Space Center modified a fitting to control the air supply hose in the event of an accidental release. An Enid, Oklahoma-based business, PT Coupling Company, licensed the technology and incorporated it into a new line of products to automatically prevent rapid separation of the fittings, enhancing worker safety.

14



### Information Systems Coordinate Emergency Management

NVision Solutions Inc., based in Bay St. Louis, Mississippi, partnered with Stennis Space Center through multiple channels, including SBIR contracts. Among the results is a comprehensive emergency management system in use by municipal governments, national security organizations, and every NASA center—earning the company more than \$2 million in revenue.

13



### Simulation Tools Model Icing for Aircraft Design

Glenn Research Center developed the LEWICE software for simulating how ice builds up on aircraft surfaces, a potential detriment to safety and performance. American Kestrel Company LLC of Ithaca, New York, partnered with Glenn through a Space Act Agreement and now distributes LEWICE with an improved interface to aircraft manufacturers worldwide, saving clients hundreds of thousands of dollars in testing and design costs.

15



### Imaging Systems Provide Maps for U.S. Soldiers

Goddard Space Flight Center worked with Flight Landata Inc., based in North Andover, Massachusetts, to develop a spectral imaging instrument for airborne applications. Through SBIR funding, Flight Landata demonstrated the operational capability of the instruments. Today, the company provides unclassified high-resolution geospatial data for tactical military missions.

17



### Alloy-Enhanced Fans Maintain Fresh Air in Tunnels

Marshall Space Flight Center developed a high-strength aluminum alloy three to four times stronger than conventional aluminum alloys at high temperatures. Twin City Fan Companies Ltd. in Minneapolis, Minnesota, licensed the alloy and is currently employing the technology to make impellers for safety ventilation fans in rail and road tunnels.

16



### High-Pressure Systems Suppress Fires in Seconds

By applying principles from a new kind of rocket engine developed by Orbital Technologies Corporation of Madison, Wisconsin, under SBIR contracts with Marshall Space Flight Center to fire hose nozzles, company subsidiary HMA Fire improved the performance of its ultra high pressure fire suppression systems, which extinguish many fires in significantly less time and using less water than traditional systems.

# FIGHTING FIRES



## Consumer Goods



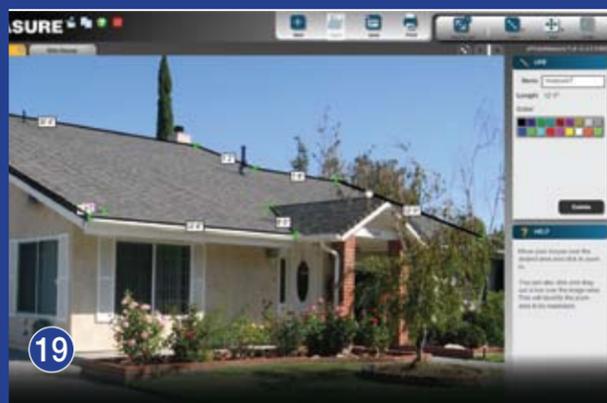
### Control Algorithms Charge Batteries Faster

Advanced Power Electronics Corporation of Orlando, Florida, partnered with Glenn Research Center through the SBIR program to develop an advanced power converter for space systems. The company incorporated control algorithms created through the partnership into a solar charger that charges batteries 30 percent faster than comparative devices.



### Retrofits Convert Gas Vehicles Into Hybrids

Working with Glenn Research Center through the NASA Illinois Commercialization Center, NetGain Technologies LLC of Lockport, Illinois, developed a retrofit system for converting gas-powered vehicles to gas-electric hybrids. The partnership also resulted in a line of electric motors for vehicles marketed by NetGain Motors Inc., the production of which supports over 100 jobs at the company's manufacturing facility.



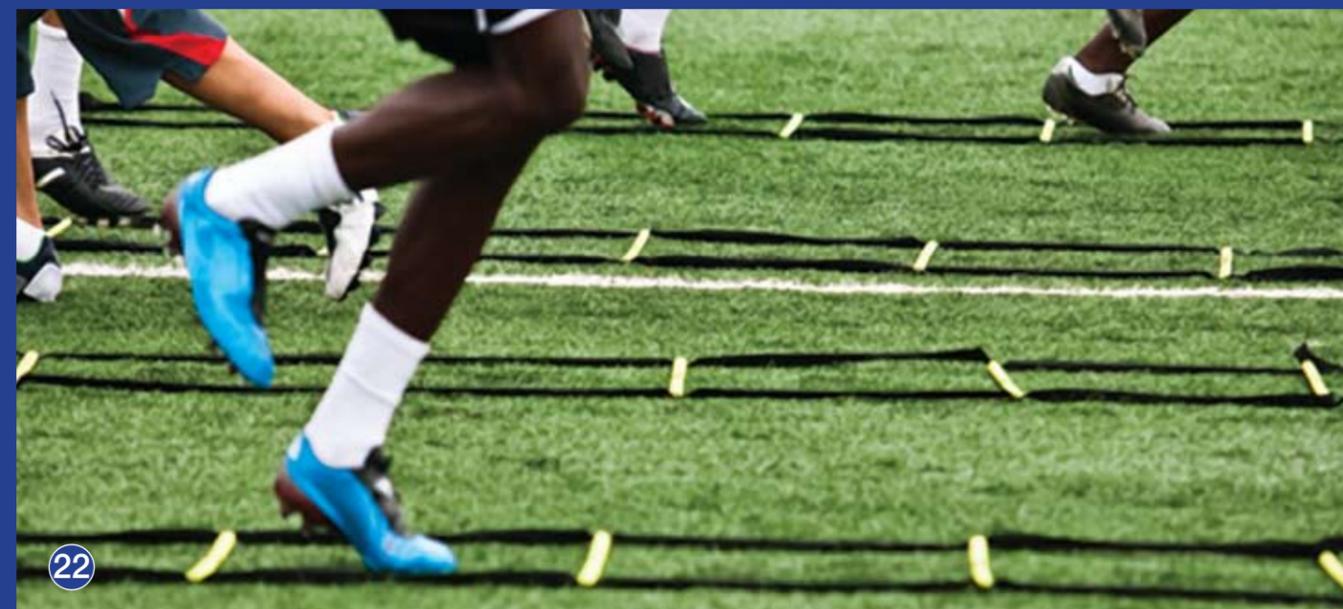
### Software Programs Derive Measurements from Photographs

A scientist at Kennedy Space Center devised a software program to calculate the unknown dimension of objects in photographs to assist in the investigation following the Columbia disaster. In 2008, DigiContractor Corporation of Tarzana, California, licensed the technology for a product line that can calculate measurements from photos for applications from landscaping and flooring projects to crime scenes and auto accidents.



### NASA Missions Inspire Online Video Games

Goddard Space Flight Center and other NASA groups provided funding for Army Game Studio, of Redstone Arsenal, Alabama, and Virtual Heroes of Applied Research Associates, in Raleigh, North Carolina, to develop an online video game to help inspire the next generation of scientists, engineers, and explorers. The game has been downloaded nearly 300,000 times, and an expanded version is in the works.



### Monitors Track Vital Signs for Fitness and Safety

In microgravity, disorientation affects most astronauts in some cases causing severe vomiting. To combat this disorientation, NASA trained astronauts to self-regulate their own physiological responses and to suppress unpleasant symptoms. Crucial to the program's success were sensors used to track physiological symptoms in real-time.

Zephyr Technology, located in Annapolis, Maryland, proved to have the device NASA needed. Working through a Space Act Agreement with Ames Research Center, Zephyr's monitors enabled NASA to conduct its studies, and allowed the company to improve its own technology as well. Zephyr's BioHarness, a vital-signs monitor, is now used to track the health and fitness of soldiers, first responders, pro athletes, and consumers looking to get in shape.

# BOOSTING FITNESS



### Thermal Components Boost Performance of HVAC Systems

A Rockledge, Florida-based company, Mainstream Engineering Corporation, works with NASA to develop advanced thermal control technology for spacecraft. Most recently, Mainstream developed new products, based on SBIR work with Johnson Space Center, that improve air conditioner performance and filtration—a boon for allergy and asthma sufferers.



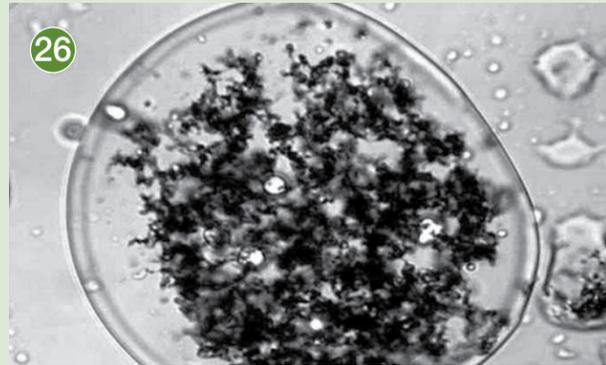
# Energy and Environment



## World Wind Tools Reveal Environmental Change

Originally developed under NASA's Learning Technologies program as a tool to engage and inspire students, World Wind software was released under the NASA Open Source Agreement license. Honolulu, Hawaii-based Intelesense Technologies is one of the companies currently making use of the technology for environmental, public health, and other monitoring applications for nonprofit organizations and government agencies. The company saved about \$1 million in development costs by using the NASA software.

24



26

## Remediation Technologies Eliminate Contaminants

Kennedy Space Center scientists developed a technology called the Activated Metal Treatment System (AMTS) that safely absorbs and breaks down an environmentally hazardous chemical commonly found in older paints. Bio Blend Technologies, based in Cantonment, Florida, licensed AMTS as well as Kennedy's Emulsified Zero Valent Iron technology, acquiring the capability to remediate the toughest cases of environmental contamination.



27

## Receivers Gather Data for Climate Research, Weather Prediction

A technology developed at NASA's Jet Propulsion Laboratory (JPL) uses a technique to help scientists improve weather forecasts, monitor climate change, and enhance space weather research. JPL turned to Tempe, Arizona-based Broad Reach Engineering Company to produce the receivers. The company licensed the technology and then commercialized it for Earth science use by NASA and international organizations.



25

## Analzers Measure Greenhouse Gasses, Airborne Pollutants

Los Gatos Research Inc. of Mountain View, California, partnered with Ames Research Center to develop instrumentation for detecting signs of life in deep sea and deep space environments. This led the company to commercialize a range of highly accurate and sensitive analyzers for detecting pollutants and greenhouse gasses. Los Gatos plans to grow from 30 to nearly 50 full time employees by the end of 2011.



28

## Coating Processes Boost Performance of Solar Cells

While working on Glenn Research Center funded projects, scientist Maria Faur invented a process for coating solar cells that both significantly reduces production costs and increases cell efficiency. Faur's company, North Olmstead, Ohio based SPECMAT Inc., has licensed the process to a company that believes it could revolutionize the solar energy industry.



29

## Analzers Provide Water Security in Space and on Earth

Working with Johnson Space Center, OI Analytical, based in College Station, Texas, developed a total organic analyzer to monitor the quality of the water supply onboard the International Space Station. The company commercialized the technology, which provides significant cost savings and improved efficiency for water quality monitoring on Earth.



30

## Catalyst Substrates Remove Contaminants, Produce Fuel

A North Haven, Connecticut-based company, Precision Combustion Inc. (PCI) worked with Glenn Research Center to prove the viability of its technology for catalytic reduction of emissions from combustion. Also enhanced through Marshall Space Flight Center SBIR program funding, PCI's NASA-improved air filtration devices can be coated with a variety of materials to promote chemical reactions and remove environmental contaminants.



31

## Rocket Engine Innovations Advance Clean Energy

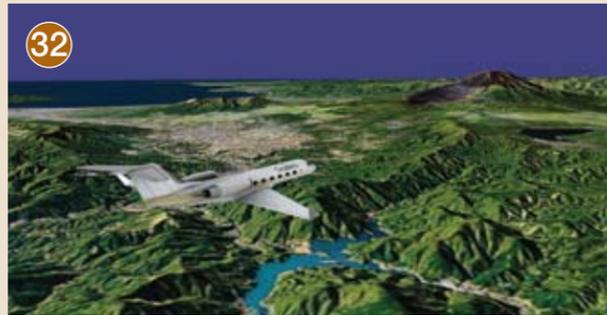
After 30 years and 135 missions, the feat of engineering known as the Space Shuttle Main Engine (SSME) boasted a 100 percent flight success rate. The SSME was designed under contract to NASA by Rocketdyne, now part of Pratt & Whitney Rocketdyne (PWR), based in East Hartford, Connecticut. After working with Marshall Space Flight Center, PWR used its rocket engine experience to make clean energy gasification technology.

Compared to standard gasification systems, the capital cost to build a commercial plant using PWR's technology is estimated to be 10-20 percent less, and is expected to reduce carbon dioxide emissions by up to 10 percent more.

# LOWERING EMISSIONS



# Information Technology



## Technologies Render Views of Earth for Virtual Navigation

SBIR contracts with Langley Research Center and satellite data from Stennis Space Center allowed Littleton, Colorado-based TerraMetrics Inc. to develop a satellite imagery and terrain data product line that features in Google Earth, as well as a 3D terrain-rendering engine that enables synthetic vision solutions for aircraft, enhancing pilot's situational awareness during flight.



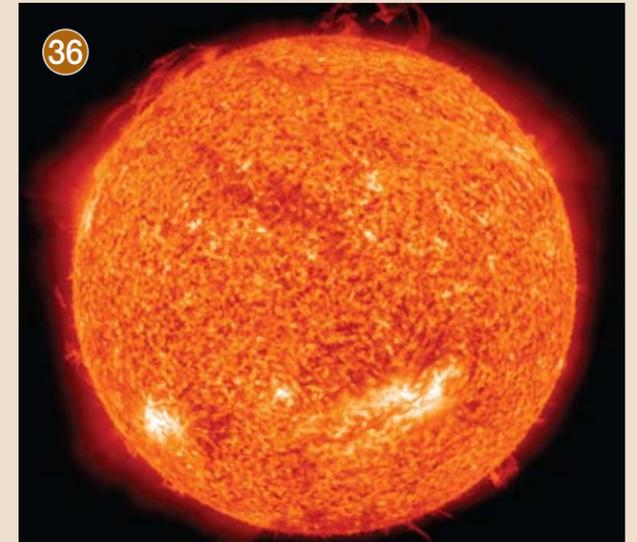
## Tools Ensure Reliability of Critical Software

To demonstrate the feasibility of using a tool to automatically check software for compliance, the Jet Propulsion Laboratory awarded SBIR funding to GrammaTech Inc. of Ithaca, New York. Today, the software tool has hundreds of users worldwide, including Fortune 500 companies, educational institutions, and government agencies working on satellites, avionics, medical devices, and consumer electronics.



## Electronic Handbooks Simplify Process Management

REI Systems, a Herndon, Virginia-based small business, received a Goddard Space Flight Center SBIR award to build a framework for storage, retrieval, and update of heterogeneous data objects. Today, the company applies the approach to managing information in every one of their custom software applications for various Federal agencies and has more than 60,000 users for its NASA derived model, with over \$6 billion in financial transactions per year.

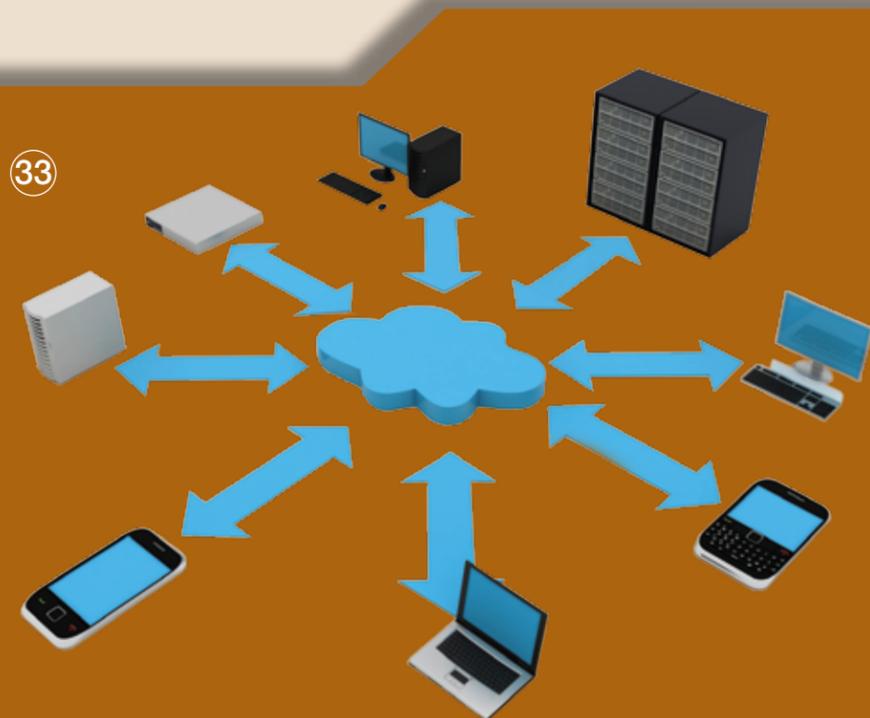


## Software Innovations Speed Scientific Computing

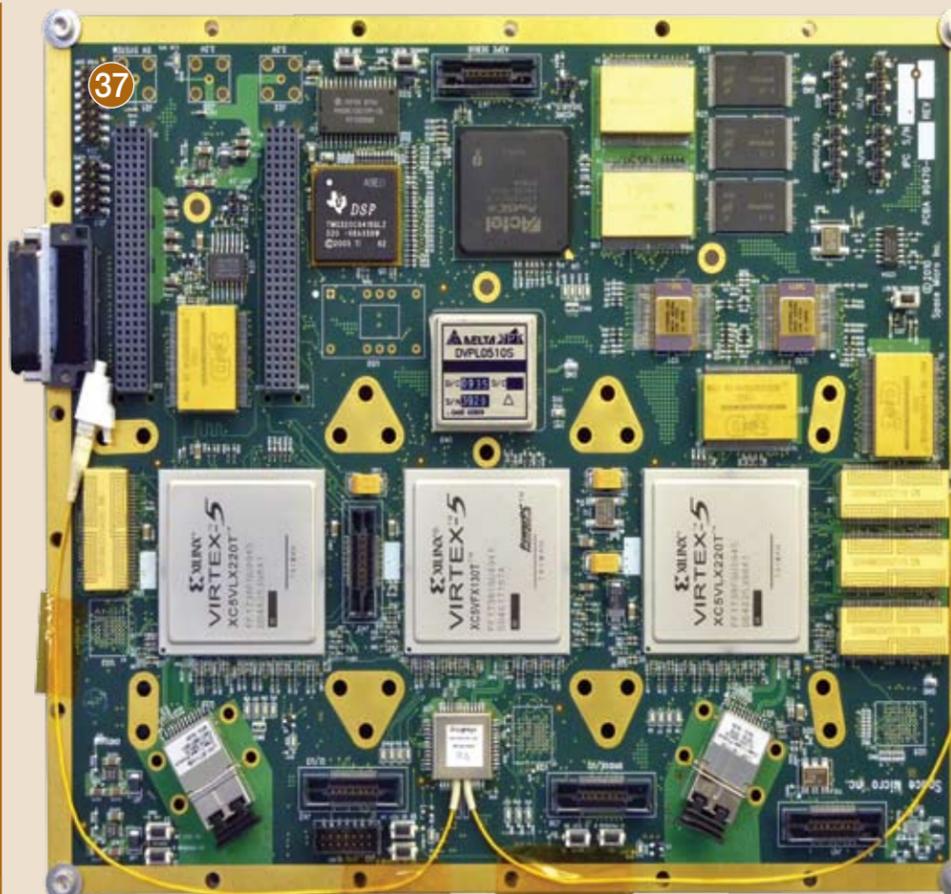
To help reduce the time needed to analyze data from missions like those studying the Sun, Goddard Space Flight Center awarded SBIR funding to Tech-X Corporation of Boulder, Colorado. That work led to commercial technologies that help scientists accelerate their data analysis tasks. Thanks to its NASA work, the company doubled its number of headquarters employees to 70 and generated about \$190,000 in revenue from its NASA-derived products.

## Content Platforms Meet Data Storage, Retrieval Needs

Archivas Inc. partnered with Goddard Space Flight Center through the SBIR program to advance technology for archiving and accessing immense amounts of data. Hitachi Data Systems Corporation of Santa Clara, California, acquired the company and now offers the NASA derived technology to provide powerful content management and cloud computing tools for multiple businesses and healthcare providers.



# ARCHIVING DATA



## Controller Chips Preserve Microprocessor Function

To develop controller technology for a variety of missions, Marshall Space Flight Center partnered with a San Diego-based company, Space Micro Inc., through the SBIR program. Today, the technology is embedded in the company's entire series of high-performance, radiation-hardened computers for space. The company has expanded from 4 employees at the beginning of its NASA partnership to 43 today, growing from a \$1 million to a \$8 million company.



## Industrial Productivity



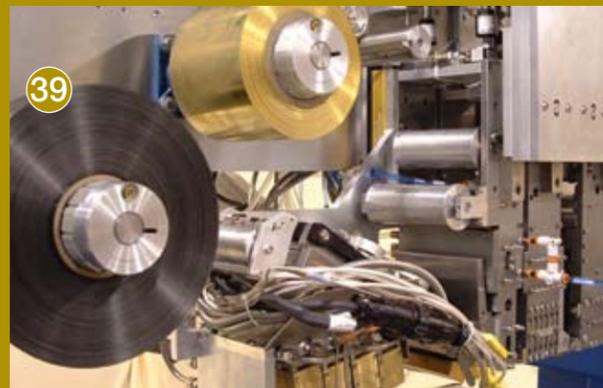
### Nanotube Production Devices Expand Research Capabilities

To assist in research on how to improve solar cells, scientists at Glenn Research Center devised a new way to grow high-quality carbon nanotubes. Glenn released the technology to the inventors, one of whom founded Nanotech Innovations in Oberlin, Ohio. Today, the technology is supporting the incorporation of carbon nanotubes into education curricula, research, and product development endeavors.



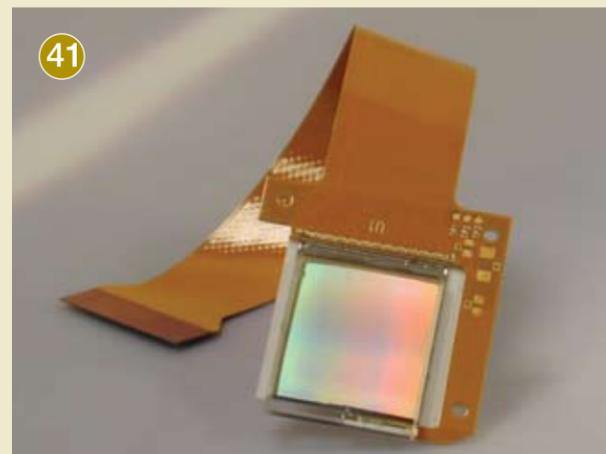
### Polyimide Foams Offer Superior Insulation

Pennville, Indiana-based GFT LLC licensed the TEEK polyimide foams from Langley Research Center. The company now offers the foams in a variety of forms to provide safe, high-performance, environmentally friendly insulation for pipes on marine vessels and other applications. The company recently completed a deal that will keep it manufacturing its NASA-developed foams for the next 10–15 years.



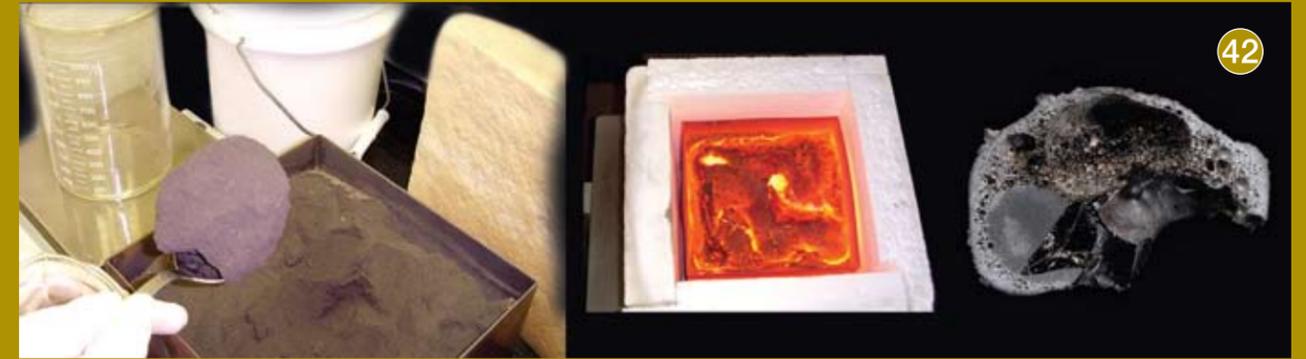
### Custom Machines Advance Composite Manufacturing

Through the SBIR program, Accudyne Systems Inc. of Newark, Delaware, developed a device for creating thermoplastic composite structures without the use of an expensive autoclave. The partnership yielded technology for the company's commercial, custom built composite manufacturing machines, helping advance composite part fabrication.



### Beam Steering Devices Reduce Payload Weight

Through SBIR contracts with both Johnson Space Center and Langley Research Center, Boulder Nonlinear Systems Inc., of Lafayette, Colorado, developed a solution to mechanical laser beam steering problems. The company's advanced optical phase array chips now have applications across fields as varied as scientific research, aeronautics, defense, telecommunications, and biomedical engineering.



### Models Support Energy-Saving Microwave Technologies

Kennedy awarded SBIR funding to Troy, New York-based Ceralink Inc., to demonstrate a microwave system that could heat lunar soil to over 2,000 °F, temperatures to solidify the surface. Ceralink also examined the feasibility of using computer modeling software to simulate microwave heating on a larger scale. As a result, the team advanced a computer modeling capability that is now incorporated into Ceralink's commercial services.

# SAVING ENERGY



### High-Temperature Coatings Offer Energy Savings

As a result of its research and development efforts for a new thermal protection material to test on the X-33 and X-34 supersonic aircraft, Ames Research Center invented the Protective Ceramic Coating Material (PCCM). Emissshield Inc. in Blacksburg, Virginia, licensed the technology and now provides more than 20 different products for hydrocarbon and chemical processing, power generation, metal production, glass making, and baking.



### Materials Advance Chemical Propulsion Technology

Glenn Research Center partnered with Marshall Space Flight Center and Aerojet through a NASA Research Announcement to work on the Advanced Materials Bipropellant Rocket. Aerojet subcontracted a company in Huntsville, Alabama, called Plasma Processes Inc. (PPI) to modify a state-of-the-art engine design so the chamber wall materials could operate at very high temperatures. The project validated PPI's process for making high-temperature materials for other applications, such as satellite and rocket propulsion for the commercial aerospace industry.

# 44

This year, NASA's annual *Spinoff* publication records the journeys of 44 of the most innovative NASA technologies—from their origins in Agency missions and programs to their transfer to the public in the form of commercial products. These spinoffs have proven benefits: They enhance quality of life, save lives, reduce costs, create jobs, and increase revenue. But that is not all you will find in *Spinoff* 2011.



## SPINOFF BENEFITS: BY THE NUMBERS

Did you know that NASA partners have created over 9,200 jobs thanks at least in part to their Agency collaboration? Or that these same partners have generated over \$1.2 billion in revenue as a result of NASA support? How about the fact that NASA spinoff technologies have saved more than 12,000 lives while extending and enhancing as many as 86 million more? *Spinoff* 2011 has the details on the quantifiable benefits of spinoff technologies.\*



## SPINOFFS OF THE SPACE SHUTTLE PROGRAM

With 2011 marking the end of NASA's Space Shuttle program, *Spinoff* celebrates the commercial technologies that have resulted from the 30-year program. Even though the shuttle fleet has retired, the program continues to enhance everyday life through new spinoff technologies that emerge from its pioneering innovations.



## BENEFICIAL PARTNERSHIPS

NASA cultivates partnerships that bring together the best of Government, industry, business, and academia to advance the Agency's many exploration and science missions. These partnerships result in outcomes that provide many benefits for the Nation and the world. Learn more in *Spinoff* 2011.

## INNOVATION ABOVE

The International Space Station (ISS) is now entering its utilization phase—reaching its full maturity as the world's most remarkable scientific facility. As scientists and engineers learn more about living and working in space, benefits are being realized on Earth in the form of spinoffs. Check out this special section exclusively available in *Spinoff* 2011.



## INSPIRING THE NEXT GENERATION

Together, NASA's Office of Education and its partners engage students, educators, families, and communities in fun and informative activities to grow future leaders and innovators for NASA and the Nation. Read about the latest programs and activities meant to prepare, inspire, excite, and encourage the young minds of today in *Spinoff* 2011.



## CUTTING-EDGE RESEARCH

Ongoing research and operations efforts, conducted by NASA's mission directorates through each of the Agency's 10 field centers, continue to broaden the horizons of human accomplishment while providing foundations that may lead to future spinoffs. Discover more in *Spinoff* 2011.



# ... AND MUCH MORE.

To learn about all of this and more, and to get your own free copy of *Spinoff* 2011, scan this code or visit <http://spinoff.nasa.gov>.

\*Data based on a NASA survey of partner companies featured in *Spinoff* since 2000, with approximately 30 percent of surveyed companies responding to date.



**NASA's investment in technology yields spinoffs that have saved thousands of lives, created thousands of jobs, reduced billions of dollars in costs, and generated over a billion dollars in revenue.**

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