National Aeronautics and Space Administration

spinoff

2015

NASA Spinoff Technology Across the Nation

Health and Medicine

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2. Audio App Brings a Better Night's Sleep (UT)
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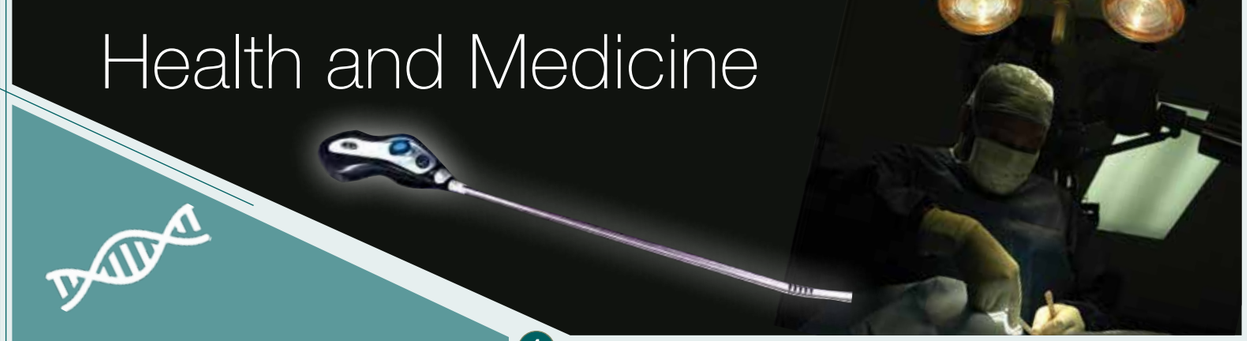
This map details the geographic location of each company that appears in *Spinoff* 2015. For a deeper look at how spinoffs have benefited your state and local economy, scan this code.

Health and Medicine



NASA is continually developing new ways to keep its astronauts comfortable and in peak condition, always with an eye on sustainable systems that will enable deep-space missions in the future. The resulting technologies have found numerous applications for the general population, including devices that help patients to exercise more efficiently, rehabilitate more quickly, eat healthier, or get a better night's sleep.

1 3D Endoscope to Boost Safety, Cut Costs of Surgery

Dr. Hrayr Shahinian, director of the Skull Base Institute in Los Angeles, enlisted the help of the Nano and Micro Systems Group at the Jet Propulsion Laboratory to develop the world's first endoscope suitable for brain surgery and capable of producing a 3D video image. The Multi-Angle Rear-Viewing Endoscopic Tool is also the first endoscope of its kind capable of steering its lens back and forth.

To create a 3D image with a single, tiny lens, the scientists squeezed two apertures behind the lens and set each to filter for different bandwidths of the red, green, and blue light that makes up the visible spectrum. A lamp cycles rapidly through all six of these bandwidths, with only three passing through each aperture, producing two images that can be processed into a 3D image, the way animals perceive depth using the two different viewpoints of their eyes.

The technology hasn't yet been approved by the Food and Drug Administration, but Shahinian says the enhanced visibility will improve safety for many types of operations, speeding patient recovery and, ultimately, reducing medical costs.

2 Audio App Brings a Better Night's Sleep

Neuroscientist Seth Horowitz was part of a NASA-funded team at State University of New York Stony Brook demonstrating that low-amplitude vestibular stimulation could induce sleep. After recognizing the same stimulation could be applied through sound, Horowitz founded Sleep Genius, located in Park City, Utah, and released a mobile app of the same name that helps people to get a more restful sleep.

3 Liquid Cooling Technology Increases Exercise Efficiency

To keep astronauts' airtight spacesuits from becoming hot and humid, Ames Research Center developed liquid cooling garments that were integrated into each suit's long underwear. Vasper Systems, in San Jose, California, is using the technology in its liquid-cooled compression cuffs, which help people exercise more efficiently by concentrating lactic acid in their muscles.

4 Algae-Derived Dietary Ingredients Nourish Animals

In the 1980s, Columbia, Maryland-based Martek Biosciences Corporation worked with Ames Research Center to pioneer the use of microalgae as a source of essential omega-3 fatty acids, work that led the company to develop its highly successful Formulaid product. Now the Nutritional Products Division of Royal DSM, the company also manufactures DHAgold, a nutritional supplement for pets, livestock and farm-raised fish that uses algae to deliver docosahexaenoic acid (DHA).

5 Space Grant Research Launches Rehabilitation Chair

Working with funding from the National Space Grant College and Fellowship Program—which was implemented by NASA headquarters to fund research, education, and public service projects—a biomedical engineering student created a vibration-based system that could combat bone loss from prolonged trips to space. A rehabilitation chair incorporating the technology is now sold by Sheboygan, Wisconsin-based VibeTech Inc. and is helping people recover more quickly from injuries and surgery.

6 Vision Trainer Teaches Focusing Techniques at Home

Based on work Stanford Research Institute did for Ames Research Center, Joseph Trachtman developed a vision trainer to treat visual focusing problems in the 1980s. In 2014, Trachtman, operating out of Seattle, released a home version of the device called the Zone-Trac. The inventor has found the biofeedback process used by the technology induces an alpha-wave brain state, causing increased hand-eye coordination and reaction times, among other effects.

Transportation

NASA is best known for its audacious forays into the void beyond Earth's atmosphere, but "aeronautics" comes before "space" in the agency's name, and from its inception NASA has worked continuously to advance air travel for all Americans. Its endeavors have contributed directly to aircraft fuel efficiency, noise reduction, and safety and have also improved air traffic control and eased human flight through the sound barrier.

7 Aircraft Geared Architecture Reduces Fuel Cost and Noise

NASA teamed up with East Hartford, Connecticut-based engine manufacturer Pratt & Whitney to overcome a long-known inefficiency in turbofan engines, which power virtually all commercial aircraft today.

Turbofans have traditionally been designed with a central shaft driving two engine parts: the turbine and the fan. But fans are more efficient the slower they spin, whereas turbines work better the faster they spin.

Through a Space Act Agreement, the company gained access to NASA's aeronautical experts and various engine-testing facilities at Glenn Research Center. With additional funding from other agency programs, Pratt & Whitney developed and tested a geared box wherein the turbine and fan spin at their optimal speeds. The result is a more than 15 percent increase in fuel efficiency and a nearly 75 percent reduction in noise.

Since debuting its PurePower Geared Turbofan engines in February 2013, the company has reported more than 5,500 PurePower engine orders and commitments. By using the engines, airlines could save $1.5 million in fuel costs per aircraft annually and release 3,000 fewer tons of carbon dioxide into the atmosphere.

8 Ubiquitous Supercritical Wing Design Cuts Billions in Fuel Costs

A Langley Research Center engineer's work in the 1960s and '70s to develop a wing that could more easily pass the speed of sound resulted in the supercritical wing, which turned out to also significantly increase subsonic efficiency. The design was shared with industry. Today, Renton, Washington-based Boeing Commercial Airplanes, as well as most other plane manufacturers, apply it to all their aircraft, saving the airline industry billions of dollars in fuel every year.

9 Flight Controller Software Protects Lightweight Flexible Aircraft

Lightweight flexible aircraft may be the future of aviation, but a major problem is their susceptibility to flutter—uncontrollable vibrations that can destroy wings. Armstrong Flight Research Center awarded SBIR funding to Minneapolis, Minnesota-based MUSYN Inc. to develop software that helps program flight controllers to suppress flutter. The technology is now available for aircraft manufacturers and other industries that use equipment with automated controls.

10 Cabin Pressure Monitors Notify Pilots to Save Lives

In 2013, San Diego-based Aviation Technology Inc. obtained an exclusive license for the technology behind the cabin pressure monitor invented at Kennedy Space Center and built its own version of the product. The Alt Alert is designed to save lives by alerting aircraft pilots and crews when cabin pressure becomes dangerously low.

11 Ionospheric Mapping Software Ensures Accuracy of Pilots' GPS

IonoSTAGE and SuperTruth software are part of a suite created at the Jet Propulsion Laboratory to enable the Federal Aviation Administration's Wide Area Augmentation System, which provides pinpoint accuracy in aircraft GPS units. The system, used by more than 73,000 planes, facilitates landings under adverse conditions at small airports. In 2013, IonoSTAGE and SuperTruth found their first commercial license when NEC, based in Japan, with US headquarters in Irving, Texas, licensed the entire suite.

Public Safety

From technologies meant to safeguard astronauts to crucial Earth-observation data, much of what NASA does has applications in keeping the general public safe and in helping people find or monitor resources such as drinking water, agricultural products, and forest cover. The agency also partners with industry to pioneer safety solutions, from preventing oil spills to assessing potential structural damages or increasing visibility under hazy conditions.

13 Shock Absorbers Save Structures and Lives during Earthquakes

With NASA funding, North Tonawanda, New York-based Taylor Devices Inc. developed fluidic shock absorbers to safely remove the fuel and electrical connectors from the space shuttles during launch. The company is now employing the technology as seismic dampers to protect structures from earthquakes. To date, 550 buildings and bridges have the dampers, and not a single one has suffered damage during an earthquake.

12 Water Mapping Technology Rebuilds Lives in Arid Regions

Turkana County in northwest Kenya was reeling from years of drought when, in September 2013, an incredible find was announced: at least 66 trillion gallons of water beneath its surface. The previously untapped catchment system has the potential to improve Kenyans' lives for generations.

The find was made possible in part by NASA archive data. French geologist and geophysicist Alain Gachet started his own oil, mineral, and gas exploration company in the mid-1990s called Radar Technologies International (RTI), which has an office in New Braunfels, Texas. Utilizing images taken by NASA's Spaceborne Imaging Radar (SIR), which uses radio waves to map Earth's topography, he was probing for oil when an inadvertent discovery of leaks in a subsurface pipeline made him realize he could also look for subterranean water.

Gachet used the SIR data together with Landsat satellite datasets and information from NASA's Shuttle Radar Topography Mission to develop his proprietary WATEX system, which is able to reveal and map underground water reserves. He has located water for refugees in Darfur, Western Sudan, and other war-torn countries.

14 Software Facilitates Sharing of Water Quality Data Worldwide

John Freighery was an environmental engineer at Johnson Space Center when a new, simplified version of the coliform bacteria test was developed for astronaut use on the International Space Station. Through his New York City-based mWater Foundation, Freighery is using the test to help rural communities monitor their water supplies for contamination. The organization has also developed a mobile phone app to make the information publicly available.

15 Underwater Adhesives Retrofit Pipelines with Advanced Sensors

Houston-based Astro Technology Inc. used a partnership with Johnson Space Center to pioneer an advanced fiber-optic monitoring system for offshore oil pipelines. The company's underwater adhesives allow it to retrofit older deepwater systems in order to measure pressure, temperature, strain, and flow properties, giving energy companies crucial data in real time and significantly decreasing the risk of a catastrophe.

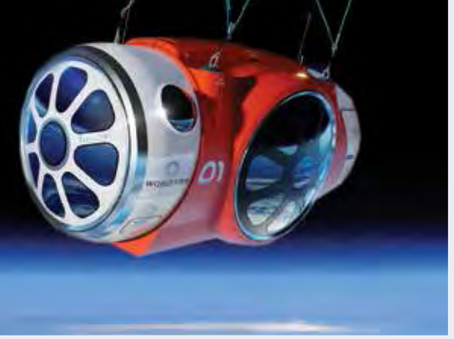
16 Laser Imaging Video Camera Sees through Fire, Fog, Smoke

Under a series of SBIR contracts with Langley Research Center, inventor Richard Billmers refined a prototype for a laser imaging camera capable of seeing through fire, fog, smoke, and other obscurants. Now, Canton, Ohio-based Laser Imaging through Obscurants (LITO) Technologies Inc. is demonstrating the technology as a perimeter security system at Glenn Research Center and planning its future use in aviation, shipping, emergency response, and other fields.

17 3D Lasers Increase Efficiency, Safety of Moving Machines

Canadian company Neptec Design Group Ltd. developed its Laser Camera System, used by shuttles to render 3D maps of their hulls for assessing potential damage. Using NASA funding, the firm incorporated LiDAR technology and created the TriDAR 3D sensor. Its commercial arm, Pearland, Texas-based Neptec Technologies Corp., has sold the technology to Orbital Sciences, which uses it to guide its Cygnus spacecraft during rendezvous and dock operations at the International Space Station.

Consumer Goods



NASA's innovations and partnerships have steadily found their way into the commercial market in countless consumer products, ranging from the obvious—such as technology and training that will one day enable civilian trips to space—to the unexpected, such as inventions that turn up in speakers, skin cream, lighting systems, and air purifiers. They even include devices to monitor personal ultraviolet exposure or to improve your golf swing.

18 Air Revitalization System Enables Excursions to the Stratosphere

After signing a Space Act Agreement under NASA's Commercial Crew Development program, designed to develop technologies for transporting astronauts to and from the International Space Station, Tucson, Arizona-based Paragon Space Development Corporation created the Commercial Crew Transport-Air Revitalization System (CCT-ARS): a modular air revitalization system for keeping spacecraft free of impurities and excess metabolic substances.

The CCT-ARS has been transferred to other industries, for instance, in refuge chambers for miners in the event of a disaster (*Spinoff* 2013). The leadership at Paragon, through the creation of another company, Tucson-based World View Enterprises Inc., is also using the technology to send customers to the stratosphere.

At a launch site, likely in Page, Arizona, customers will board a pressurized capsule fitted with the CCT-ARS and attached to a large polyethylene helium balloon. Crewmembers will guide the craft to heights of about 100,000 feet, high enough to see the roundness of Earth and vastness of the universe.

The craft could also be used for research, carrying payloads, and maybe doing dedicated, instrumented science flights.

The maiden launch is targeted for late 2016.

19 Magnetic Fluids Deliver Better Speaker Sound Quality

In the 1960s, Glenn Research Center developed a magnetized fluid to draw rocket fuel into spacecraft engines while in space. Sony has incorporated the technology into its line of slim speakers by using the fluid as a liquid stand-in for the speaker's dampers, which prevent the speaker from blowing out while adding stability. The fluid helps to deliver more volume and hi-fidelity sound while reducing distortion.

20 Bioreactor Yields Extracts for Skin Cream

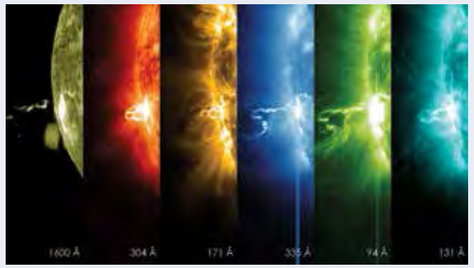
Johnson Space Flight Center researchers created a unique rotating-wall bioreactor that simulates microgravity conditions, spurring innovations in drug development and medical research. Renuèll Int'l Inc., based in Aventure, Florida, licensed the technology and used it to produce a healing skin care product, RE`JUVEL. In a Food and Drug Administration test, RE`JUVEL substantially increased skin moisture and elasticity while reducing dark blotches and wrinkles.

21 Private Astronaut Training Prepares Commercial Crews of Tomorrow

A new company that includes a handful of former NASA personnel is already taking applications for the first comprehensive commercial astronaut training approved by the Federal Aviation Administration. Waypoint 2 Space, located at Johnson Space Center, hopes to draw space tourists and enthusiasts and future commercial crewmembers with first-hand NASA know-how, as well as agency training technology.

22 Activity Monitors Help Users Get Optimum Sun Exposure

Goddard scientist Shahid Aslam was investigating alternative methods for measuring extreme ultraviolet radiation on the Solar Dynamics Observatory when he hit upon semiconductors that measured wavelengths pertinent to human health. As a result, he and a partner established College Park, Maryland-based Sensor Sensor LLC and developed UVA+B SunFriend, a wrist monitor that lets people know when they've received their optimal amounts of sunlight for the day.



23 LEDs Illuminate Bulbs for Better Sleep, Wake Cycles

Life on the International Space Station (ISS) wreaks havoc on an astronaut's biological rhythms, and one way NASA mitigates the problem is through the use of LED lighting to alternately stimulate energy and focus and induce relaxation. Satellite Beach, Florida-based Lighting Science partnered with Kennedy Space Center to commercialize an LED system designed for the ISS, resulting in its DefinityDigital product line of light bulbs now used in numerous homes, hotel chains, and resorts.

24 Charged Particles Kill Pathogens and Round Up Dust

To keep plants fresh longer in space, Marshall Space Flight Center awarded funding to the University of Wisconsin-Madison to develop a titanium oxide-based device that reduced the amount of decay-inducing ethylene gas in the air. Electrolux (now Dallas-based Aerus Holdings) furthered the technology by developing an air purification product that kills pathogens both in the atmosphere and on surfaces.

25 Balance Devices Train Golfers for a Consistent Swing

As part of the effort to understand the effects of spaceflight on astronauts, NASA funded research that resulted in a commercial product to treat balance disorders. West Palm Beach, Florida-based Sports Therapy Inc. worked with the inventor to modify the technology, creating the Dynamic Balance System (DBS) for sports applications. DBS is now used by Professional Golfers' Association-owned facilities and golf academies to help players achieve an effective, balanced swing.

Energy and Environment

NASA has an obvious interest in energy efficiency, and its work in this area has been repeatedly commercialized, such as technology that reclaims oil and gas at drilling sites. But tools the agency builds to observe Earth, Mars, and the far reaches of the universe also help organizations monitor the environment and find a multitude of secondary environmental applications on our planet.

26 Landsat Imagery Enables Global Studies of Surface Trends

In 2008, the US Geological Survey, which has managed the data gathered by NASA-built Landsat satellites since 1972, made its entire archive of Landsat imagery publicly available for free. The data crunchers at Mountain View, California's Internet giant Google wasted no time. In late 2010, the company unveiled Google Earth Engine, a cloud computing platform for accessing and processing Landsat images going back to the 1970s, and scientific study of worldwide trends in surface cover over time suddenly became possible.

In 2013, in collaboration with *Time* magazine, Google Earth Engine released the Timelapse feature, which allows users to watch a time-lapse animation of almost any land area on Earth running from 1984 to 2012. The following year, Google also completely regenerated its Google Maps and Google Earth imagery, using 2012 data from the Landsat 7 satellite.

The company also partnered with a University of Maryland professor to build a fine-grained model of global changes in forest cover between 2000 and 2012. This study appears to be only the beginning of what can be learned from decades of Earth imagery.

27 Ruggedized Spectrometers Are Built for Tough Jobs

The Mars Curiosity Chemistry and Camera instrument, or ChemCam, analyzes the elemental composition of materials on the Red Planet by using a spectrometer to measure the wavelengths of light they emit. Principal investigator Roger Wiens worked with Ocean Optics, out of Dunedin, Florida, to rework the company's spectrometer to operate in cold and rowdy conditions and also during the stresses of liftoff. Those improvements have been incorporated into the firm's commercial product line.

28 Gas Conversion System Reclaims Fuel for Industry

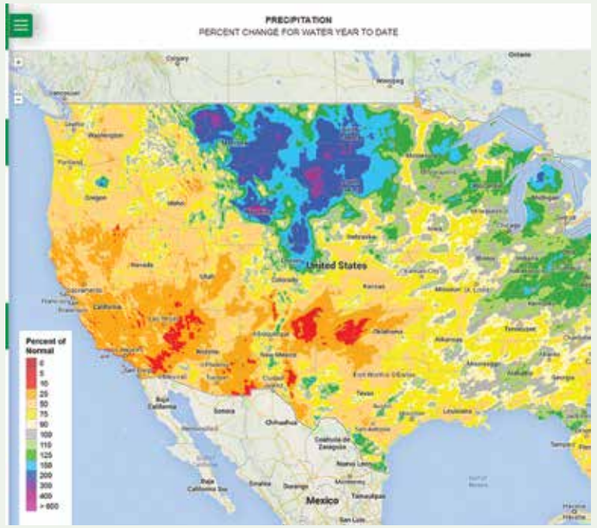
A human trip to Mars will require astronauts to utilize resources on the Red Planet to generate oxygen and fuel for the ride home, among other things. Lakewood, Colorado-based Pioneer Energy has worked under SBIR agreements with Johnson Space Center to develop technology for those purposes, and now uses a commercialized version of the technology to recover oil and gas that would otherwise be wasted at drilling sites.

29 Remote Sensing Technologies Mitigate Drought

Ames Research Center has partnered with the California Department of Water Resources to develop satellite-based technologies to mitigate drought conditions. One project aims to help water managers adjust their irrigation to match the biological needs of each crop, and another involves monitoring areas where land is fallow so emergency relief can more quickly aid affected communities.

30 Satellite Data Inform Forecasts of Crop Growth

During a Stennis Space Center-led program called Ag 20/20, an engineering contractor developed models for using NASA satellite data to predict crop yield. The model was eventually sold to Genscape Inc., based in Louisville, Kentucky, which has commercialized it as LandViewer. Sold under a subscription model, LandViewer software provides predictions of corn production to ethanol plants and grain traders.



31 Probes Measure Gases for Environmental Research

NASA's Orbiting Carbon Observatory-2 satellite will make the first space-based measurements of carbon dioxide in Earth's atmosphere. In support of the mission, Goddard Space Flight Center will fly air missions from Wallops Flight Facility to gather finer-grained data in areas of interest. Goddard started working with Blacksburg, Virginia-based Aeroprobe Corporation through the SBIR program in 2008 to develop sensors for such flights, and the company has since commercialized the resulting product.

Information Technology

The tremendous complexity of NASA missions has led the agency to develop information technology tools for countless functions, and many of these have since been licensed for commercial use, such as software that assists in home building, project planning, and vehicle-noise management. Commercial entities are also increasingly finding unique ways to employ NASA data in a variety of solutions, such as in cloud computing platforms that enable environmental research.

32 Cloud Computing Technologies Facilitate Earth Research

NASA's Earth-observing satellite data can be used to investigate an array of environmental issues, from deforestation to aerosol accumulation. To help NASA-funded researchers quickly access and analyze satellite data, in 2010 the Advanced Supercomputing Division at Ames Research Center led the development of NASA Earth Exchange (NEX). Through NEX, researchers not only have access to datasets; they can also tap into Ames' Pleiades supercomputer, and the platform facilitates collaboration and information sharing.

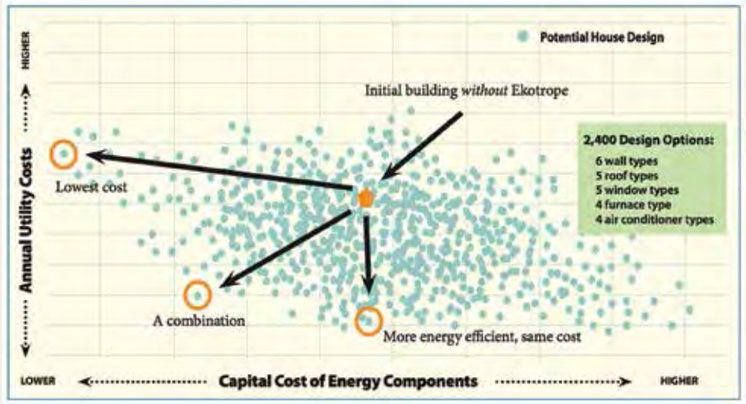
To open access even further, in November 2013 NASA and Amazon Web Services (AWS) announced that, through a nonreimbursable Space Act Agreement, for a year Amazon would host OpenNEX, which contains the agency's Landsat satellite data from the 1970s to 2005, Moderate Resolution Imaging Spectroradiometer vegetation indices, and the NEX Downscaled Climate Projections.

With OpenNEX, NASA-funded researchers no longer need to get cleared for security, and the greater scientific community also has the same access to NASA datasets and AWS's supercomputing services. And, like NEX, OpenNEX has a platform for sharing and collaboration.

If well-received, OpenNEX will continue beyond the first year and more datasets will be added.

33 Software Cuts Building Costs, Increases Energy Efficiency

To sort out the best combinations of technologies for a crewed mission to Mars, NASA Headquarters awarded grants to MIT's Department of Aeronautics and Astronautics to develop an algorithm-based software tool that highlights the most reliable and cost-effective options. Utilizing the software, Professor Edward Crawley founded Cambridge, Massachussetts-based Ekotrope, which helps homebuilders choose cost- and energy-efficient floor plans and materials.



34 Portable Planetariums Teach Science

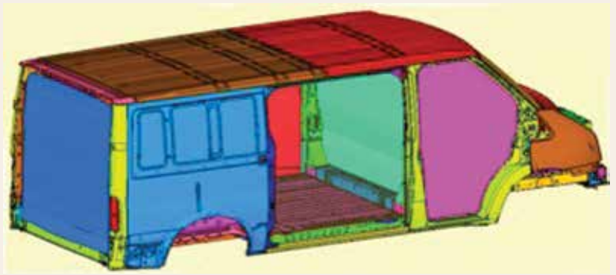
With the Internet proving to be the wave of the future, in the 1990s Johnson Space Center awarded grants to Rice University in Houston for developing the world's first Internet-accessible museum kiosk. Further grants were awarded to the school for creating educational software for use in homes and schools, leading to the creation of Museums Teaching Planet Earth Inc. The company has gone on to develop and sell portable planetariums and accompanying educational shows.

35 Schedule Analysis Software Saves Time for Project Planners

Since the early 2000s, a resource management team at Marshall Space Flight Center has developed and improved the Schedule Test and Assessment Tool, a software add-on capable of analyzing, summarizing, and finding logic gaps in project schedules. Companies like Lanham, Maryland-based Vantage Systems Inc. use the tool to manage NASA projects, but it has also been released for free to more than 200 US companies, agencies, and other entities.

36 Sound Modeling Simplifies Vehicle Noise Management

Under two SBIR contracts with Langley Research Center, Ann Arbor, Michigan-based Comet Technology Corporation developed Comet EnFlow, a software program capable of predicting both high- and low-frequency noise and vibration behavior in plane fuselages and other structures. The company now markets the software to airplane, automobile, and ship manufacturers, and Langley has found an unexpected use for it in leak detection on the International Space Station.



Industrial Productivity

Because NASA often pushes the limits of technology in attempting to do what no one has done before, the agency has pioneered a wide variety of industrial innovations, many of which are just as useful to commercial manufacturers as they are in building rockets or developing space-rated electronics. These can be new alloys and lubricants, technology for mass-producing unbelievably tiny parts, large-scale camera calibrators, and more.

37

Custom 3D Printers Revolutionize Space Supply Chain

Like a desert caravan, a space flight crew must bring with it everything it will need over the course of its journey into an utterly barren environment. This has always meant allotting room for every gyroscope or astrolabe, every LED housing or oil lamp.

All that is about to change.

Under a series of SBIR contracts with Marshall Space Flight Center, Made In Space Inc., based in Moffett Field, California, built a prototype of a high-precision 3D printer capable of operating in microgravity and is creating a final printer to be installed on the International Space Station (ISS).

Once the printer is installed, NASA will become a paying customer, using the machine to create parts, tools, and other supplies that currently have to be brought via infrequent resupply missions. However, NASA will be far from the only customer. The device will be available to companies, universities, government agencies, and artists who are interested in the ability to create objects in space and even launch them into low-Earth orbit from the ISS.

38

Improved Calibration Shows Images' True Colors

Innovative Imaging and Research, located at Stennis Space Center, used a single SBIR contract with the center to build a large-scale integrating sphere, capable of calibrating a whole array of cameras simultaneously, at a fraction of the usual cost for such a device. Through the use of LEDs, the company also made the sphere far more efficient than existing products and able to mimic sunlight.

39

Micromachined Parts Advance Medicine, Astrophysics, and More

In the mid-1990s, Marshall Space Flight Center awarded two SBIR contracts to Potomac Photonics, now based in Baltimore, for the development of computerized workstations capable of mass-producing tiny, intricate, diffractive optical elements. While the company has since discontinued the workstations, those contracts set the stage for Potomac Photonics to be a leader in the micromachining industry, where NASA remains one of its clients.

40

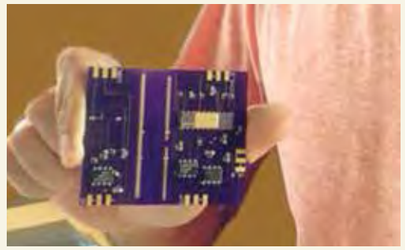
Metalworking Techniques Unlock a Unique Alloy

Approached by West Hartford, Connecticut-based Abbot Ball Company, Glenn Research Center agreed to test an intriguing alloy called Nitinol 60 that had been largely unused for a half century. Using powdered metallurgy, the partners developed a method for manufacturing and working with the material, which Abbott Ball has now commercialized. Nitinol 60 provides a unique combination of qualities that make it an excellent material for ball bearings, among other applications.

41

Low-Cost Sensors Deliver Nanometer-Accurate Measurements

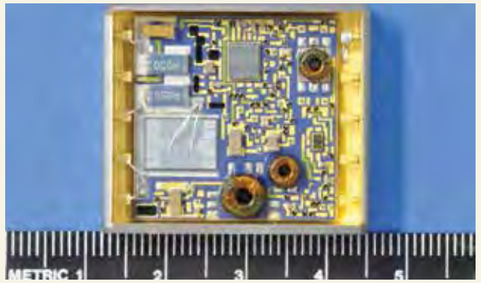
As part of a unique partnership program, Kennedy Space Center collaborated with a nearby business school to allow MBA students to examine and analyze the market potential for a selection of NASA-patented technologies. Following the semester, a group of students decided to form Winter Park, Florida-based Juntura Group Inc. to license and sell a technology they had worked with: a sensor capable of detecting position changes as small as 10 nanometers—approximately the thickness of a cell wall.



42

Electrical Monitoring Devices Save on Time and Cost

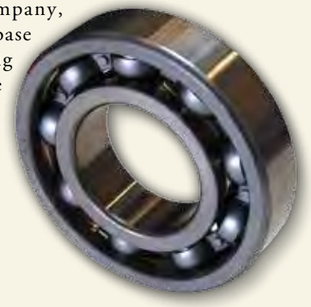
In order to protect the Solar Dynamics Observatory's instruments from blowing their fuses and being rendered unusable, Goddard Space Flight Center worked with Micropac Industries Inc., based in Garland, Texas, to develop solid-state power controllers, which can depower and then resupply power to an instrument in the event of an electric surge. The company is now selling the technology for use in industrial plants.



43

Dry Lubricant Smooths the Way for Space Travel, Industry

Reviving industry standards for coating parts in tungsten disulfide, a dry lubricant developed for the Mariner space probes managed by the Jet Propulsion Laboratory in the 1960s and '70s, Applied Tungstenite, a relatively new Temecula, California-based company, has found a client base in the mushrooming commercial space industry, as well as other manufacturers.



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Compact Vapor Chamber Cools Critical Components

Advancements in the production of proton exchange membrane fuel cells have NASA considering their use as a power source for spacecraft and robots in future space missions. With SBIR funding from Glenn Research Center, Lancaster, Pennsylvania-based Thermacore Inc. developed strong, lightweight titanium vapor chambers to keep the fuel cells operating at optimum temperatures. The company is now selling the technology for cooling electronic components.

With origins in NASA research and missions, each spinoff now benefits the public in the form of commercial products: NASA technologies are creating jobs, generating revenue, reducing costs, and even saving lives. *Spinoff* 2015 profiles more than 40 stories of successful technology transfer—but that's not all you'll find in this year's publication.

TECHNOLOGY TRANSFER PROGRAM

NASA's Technology Transfer Program is the agency's longest continuously operated mission. See how the program is making it easier than ever for businesses to find and use NASA technology—including, among other things, a software catalog released in 2014 that made over a thousand pieces of code available to the public at no cost.

SPINOFFS OF TOMORROW

In addition to its many spinoffs already benefitting society, NASA has a host of technologies that are available for licensing and partnership opportunities. In this year's publication you'll find 20 industry-ready technologies that are now on offer, as well as information on how to partner with us.

PARTNERSHIP NEWS

What do a citizen-scientist hunt for asteroids and a smartphone app for tracking crops in rural Africa have in common? Both are examples of the many beneficial partnerships NASA engages in with government, business, industry, and academia. Collaborations with the space agency are improving everything from educational toys to the cancer treatments of tomorrow.

AWARD-WINNING TECHNOLOGIES

NASA's remarkable successes in technology, innovation, and leadership are regularly honored with awards granted by government and industry alike. In this year's *Spinoff* you can read about more than a dozen awards given to individuals, mission teams, and NASA field centers for their cutting-edge achievements.

There's more space in your life than you think.

Since 1976, *Spinoff* has documented nearly 2,000 NASA technologies improving life on Earth.

See for yourself how the Technology Transfer Program is bringing NASA technology down to Earth.

To request your own free copy of *Spinoff* 2015, or to read it online, scan this code or visit **http://spinoff.nasa.gov/.**

There's more space in your life than you think.

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

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