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TECHNOLOGY INNOVATION

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PATHWAYS BEYOND INNOVATION

The NASA Alliance for Small Business Opportunity

PLUS

NASA and EPA Team to Provide New Look at Corn

Cleveland Health Center Collaborates on Heart Monitor for Astronauts

www.nasa.gov

Upcoming Events

Jan. 10-13, 2006: 43rd Aerospace Sciences Meeting & Exhibit, Reno, Nev.

The 43rd AIAA Aerospace Sciences Meeting and Exhibit, with its traditionally multidisciplinary character, provides an ideal forum for scientists and engineers from industry, government, and academia to share and disseminate scientific knowledge and research results with a view toward setting new milestones for human flight.

http://www.aiaa.org/content.cfm?pageid=230&lumeetingid=666

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http://www.nationalspacesymposium.org/index2.cfm

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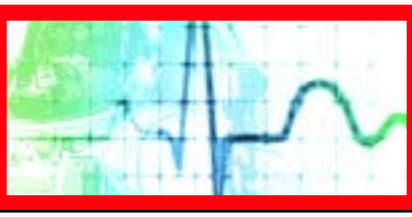

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UPFRONT with...

Carl G. Ray

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NURTURING INSPIRED INNOVATION

We are continually reminded of our vulnerabilities. For example, devastation caused by Hurricane Katrina presented the nation with a reality yet to be conquered. However, Katrina also served as a catalyst to fire our thirst for innovative contributions and to intensify the search for better solutions.

There will always be new challenges that feed the need for innovation and an ever-present human spark to explore and satisfy our own innate curiosity of the unknown unbounded by age or any other social or economic factor. Often, all that's needed is the excitement generated by an opportunity to contribute or by coming face to face with a challenge that needs to be met.

In 2004 President George W. Bush declared a new vision for space exploration. The announcement committed our nation to the exploration of the solar system, set forth a clear mission for NASA, and renewed the sense of excitement in the continuation of a journey this country started 45 years ago and the innovation demonstrated by the human spirit.

The Vision for Space Exploration, because of its goals of sustaining human presence and meeting far-off challenges, provides a prime opportunity for the now-emerging space industry. Undoubtedly, the vision's impact is widespread. One significant effect, on a scale as vast as space itself, will be in the form of innovations resulting from technological accomplishments and sought as solutions for long-term needs.

One challenge is to create environments and pathways in which these innovations can flourish into contributing technologies, feeding further development into applications and value-added products.

Take for instance the reaction by the very young to President Bush's announcement. A small group of these future engineers, scientists and astronauts gather in the backyard of a home located in a small Midwestern town. They've heard the news about going to the moon and are experimenting with a shoe box lined with aluminum. "We need to put the shiny side up, so that the light will continue to reflect around the box," one child says. With their box now fully lined, the children put it into the sunlight, quickly closing the lid to capture the light inside. They rush inside the house and down to the dark basement. There, with hearts pounding in anticipation, they slowly open the box.

Even armed with the foundational knowledge of the only possible result in my example, were you still curious? Two, a small business recently presented to me an innovation it thought NASA might be interested in. It is a light-storage device housed inside a high-tech box, with minimum energy convergence loss. Instead of foil though, the device uses fiber-optic cables and prisms.

The Vision for Space Exploration will continue to inspire new generations of explorers and contribute to the already increasing acceleration of innovation and new technologies for use in space and on Earth.

NASA News Briefs

CRADA Paves Way for Advancing Medical Imaging and Disease Management

NASA and Bartron Medical Imaging LLC have partnered through a cooperative research and development agreement (CRADA) for further development of software that will benefit medical imaging and disease management. This is the first time NASA has relied solely on CRADA authority to enter into a cooperative agreement.

Officials from NASA have announced the signing of the CRADA with the New Haven, Conn.-based business. The agreement will enable the joint development of a three-dimensional version of NASA Goddard Space Flight Center's recursive hierarchical segmentation (RHSEG) software. This software can be used to analyze image, and potentially nonimage, data and benefit medical imaging and disease management.

In the past, space act agreements have been primarily used for partnerships, under which NASA has no authority to agree in advance to issue a partner an exclusive license to the resulting technology patents. The collaborator may be granted an exclusive license only after NASA publishes notice in the Federal Register that the collaborator has applied for such a license. If no other applications or objections are received within a certain time frame, then the license can be granted.

PHOTO CREDIT: NASA/GSFC

Fitz Walker of Bartron Medical Imaging LLC (left), Dr. Jennifer Diederich and Dr. Alan Lurie of the University of Connecticut School of Medicine view dental X-ray images with the Med-Seg™ viewer.

Because other government agencies routinely use CRADAs, industry is more familiar with those partnership agreements. "It is our hope that this CRADA with Bartron will stimulate more partnerships between NASA and industry," says Keith Dixon, patent attorney in Goddard's Office of Patent Counsel. "These partnerships can benefit not only American industries but also the American people."

According to Dixon, this CRADA grants in advance a partially exclusive license for the resulting technology patents within Bartron's fields of use, including the diagnosis and treatment of breast cancer, cervical cancer, brain cancer, heart disease, osteoporosis and periodontal diseases.

The CRADA is particularly beneficial for Bartron because investors require a guarantee of exclusivity before they provide the necessary investment capital to proceed with a development effort. This investment would not have been possible with a space act agreement.

Major Breakthrough Technology for Early Diagnosis and Treatment

Currently, Bartron sells the Med-Seg™ imaging device, which uses the two-dimensional version of the RHSEG software. The device is designed to analyze digital X-rays, soft tissue scans, mammograms, ultrasounds, MRI images and CT scans for the diagnosis and management of

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diseases. Because the RHSEG software produces segmentations of an image, the Med-Seg device can reveal image details that the naked eye could not previously see. As a result, physicians can more quickly and accurately diagnose diseases and prescribe appropriate treatment — a benefit that can not only relieve pain and suffering, but also save lives.

By enhancing the software's capabilities to three dimensions, Bartron's device might be able to produce a much finer detailed view — down to the pixel level — of all sides of a tumor or lesion. Bartron President and CEO Fitz Walker says, "We believe this will drastically improve very early diagnosis and treatment of disease."

Although current technology produces 3-D imagery, the RHSEG software will be able to segment that image data in ways that very clearly define problem areas. For example, Bartron anticipates that the 3-D version of Med-Seg might be able to identify very early buildup of soft plaque within the arteries of the heart, enabling early treatment and potentially reducing the need for bypass surgeries.

In mammography, Med-Seg has the potential to identify density levels of microcalcifications, thereby discovering a malignant breast tumor well before it would have been seen in a traditional mammogram.

In addition to diagnostics applications, Walker anticipates that the new version of Med-Seg will be capable of real-time 3-D analysis in interventional medical procedures.

Another important aspect of Med-Seg is its ability to provide physicians with truer images than are available with other image-analysis devices. Med-Seg does not manipulate an image, so what the physician sees is truly what is there. To assist in the further development of Med-Seg, Bartron is seeking physicians' input on ease of use, what they need to see, how they want to see it, and how they want to save and retrieve data.

It is anticipated that future NASA projects will be able to take advantage of the 3-D extension of the software. Patent attorney Dixon says, "While we don't have a crystal ball to see what lies in the future, there is always a benefit to further developing a technology. It is very likely this 3-D implementation will benefit NASA as well as our quality of life."

"Since a primary application of this technology is for medical imaging, it is reasonable to expect that NASA may also be able to use this technology aboard the international space station or in support of the NASA Exploration Initiative for Moon/Mars exploration and/or colonies," says Nona Cheeks, chief of Goddard's Office of Technology Transfer.

Partner Roles

Under the agreement, each party will work independently. Dr. James Tilton, lead researcher in the RHSEG project who spent more than 20 years developing the suite of RHSEG technologies for use in remote sensing, will develop the 3-D implementation for the basic hierarchical segmentation software as well as the recursive formulation, including artifact elimination and parallel extensions. He will perform all testing, produce documentation, and assist with installation and integration with Bartron's hardware at the company's facility at Prince George's County Technology Assistance Center in Maryland.

Bartron is responsible for developing the clinical and regulatory protocol, the interface for the software and hardware, a data compression and encryption tool, and a region labeling tool.

Bartron Medical Imaging and NASA have an established relationship that dates to 2002, when NASA issued a nonexclusive license to Bartron for its RHSEG software. ■

For more information, contact NASA Goddard's Office of Technology Transfer, (301) 286-5810, techtransfer@gsfc.nasa.gov.

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NASA News Briefs

NASA and Lehigh University Announce Joint Research Agreement

A new joint research agreement will give NASA officials access to Lehigh University's nanotechnology and electron microscopy facilities. The collaboration will help NASA develop technologies for the James Webb Space Telescope (JWST), which is scheduled to replace the renowned Hubble Space Telescope in 2011, as well as for Mars rovers and other spacecraft.

The unique facilities at Lehigh's Center for Advanced Materials and Nanotechnology in Pennsylvania provide an excellent opportunity for NASA to expand its capabilities without incurring the expense of building or acquiring the facilities.

"It takes time and money to build labs like Lehigh's," says researcher Dr. Brian Jamieson of NASA Goddard Space Flight Center in Greenbelt, Md. "We often work with universities, and agreements like this one let NASA benefit from their investment while giving something back to the school."

The partnership also gives Lehigh students and faculty the chance to conduct real-world research with NASA.

Professor Richard Vinci, director of Lehigh's Nano- and Micro-Mechanical Behavior Laboratory (NMBL), says the collaboration will help advance understanding of the behavior of aluminum thin films, measuring only nanometers in thickness, when they are exposed to harsh temperatures in space (30 K or minus 406 F). A nanometer (nm) is one billionth of a meter.

"The benefits of this collaboration to the Lehigh NMBL are threefold," says Vinci. "We will have the opportunity to work on devices that are technologically important, we will gain the ability to test thin films in torsion through collaborative use of NASA's facilities, and we will have a strong justification for further developing cryogenic thin-film testing capability in our own laboratory. Torsional, temperature-dependent fatigue behavior in metal thin films is currently an unstudied area, and little is known about any thin film mechanical behavior at the extremely low temperatures relevant to NASA, so there should be many opportunities to make fundamental discoveries."

Professor Chris Kiely, director of Lehigh's Nanocharacterization Laboratory, says the collaboration with NASA will help Lehigh learn how to make its world-class electron microscopes more easily available to users at remote sites. Of specific interest to NASA is Lehigh's new JEOL 2200FS aberration-corrected transmission electron microscope (TEM), which enables scientists to simultaneously image and chemically analyze individual columns of atoms in crystalline materials.

About NASA's Research

One of the many instruments that will fly aboard the JWST is the near infrared spectrograph (NIRSpec), which is used to study galaxy and star formation, chemical abundances, active galactic nuclei, and more. NIRSpec's aperture contains tiny shutters that can be programmed to open and close individually as required for space observations. The microshutters are made up of thin films, whose performance at cryogenic temperatures and under torsional (or twisting) stress is not fully understood.

Under the agreement, NASA will have access to Lehigh's NMBL, which has unique tools for studying the properties and mechanics of thin films. These include a tool for sputter deposition of metal alloy films of arbitrary composition, and several instruments that can characterize the mechanical behavior of nanometer-thick metal films over a wide range of temperatures with unparalleled resolution.

"The behavior of thin films under these conditions is a virtually untapped area of research," according to Goddard's Michael Beamesderfer.

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"This research collaboration will not only provide us with a very useful understanding of the thin film materials used in the microshutters, but also begin to build a foundation for materials selection for future missions."

NASA researchers also will use Lehigh's NMBL to test miniaturized low-leakage valves for use in mass spectrometers and other science instruments. "Mass spectrometers could be used on a rover to understand the chemistry of Mars, such as whether the methane that's been observed is biogenic," says Jamieson.

The problem is that current spaceflight mass spectrometers are too large to be used in all the ways that space scientists prefer. Miniaturizing an instrument's valves is one way to reduce the size of the overall system, thereby improving its effectiveness in searching for signs of life on the Red Planet. However, those valves also must provide high-quality, long-term performance without leaking. "Working with Lehigh will help us to improve the valve interface to ensure the seals are effective after repeatedly opening and closing," says Jamieson.

Remote Use of Lehigh's Electron Microscopes

Lehigh has the most extensive collection of electron microscopes of any U.S. university. The aberration-corrected JEOL 2200FS TEM has an image resolution of 0.1 nm, which is equivalent to about half the width of an atom. Internet 2 and special software developed by JEOL enable scientists at remote sites to operate the microscope— and view specimens — at their computers.

"Up until recently, remote microscopy has been cumbersome and not really practical," says Kiely. "But Internet 2 and better software are making it more viable for someone at NASA to do experiments in our labs. The only thing you cannot do remotely is to load a specimen. Everything else — setting the apertures, controlling the alignment and acquiring data — can be done remotely.

"If you're working at a remote lab, after a few minutes, you don't realize that you're not sitting right in front of the microscope."

Goddard's lead nanotechnology researcher, Dan Powell, plans to establish an operation interface to enable access to Lehigh's instrument from Goddard's facilities. The ability for offsite study of micro- and nano-scale structures should demonstrate the potential for space-based remote microscopy. Under the agreement, Lehigh can provide a Goddard researcher with up to 100 hours of JEOL TEM instrument time and equipment for remote demonstrations.

"This kind of real-time remote access to cutting-edge equipment is great for NASA," says Powell. "Not only does it minimize our infrastructure costs, which is a benefit to the taxpayer, but it also allows us to establish an ongoing relationship that will continue to benefit NASA well into the future." ■

For more information, contact Ted Mecum, Goddard Space Flight Center, (301) 286-2198, Ted.Mecum@nasa.gov.

Please mention that you read about it in Technology Innovation.

SBIR Partnership Leads to Industrial Opportunities

Cincinnati-based A&P Technology, with the support of NASA's Small Business Innovation Research (SBIR) program at NASA Glenn Research Center in Cleveland, has developed an approach to manufacturing affordable composite fan cases with damage-tolerant braided fiber architecture to address the issue of containing failed fan blades in aircraft engines. A&P Technology has developed this technology for future product lines through partnerships with Williams International and Honeywell International and sponsorship with General Electric Aircraft Engines.

The braided fan case has a toughness

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superior to aluminum and enables significant reductions in weight and fuel consumption. This new, low-cost manufacturing process has helped to reduce the weight of the largest structure in a high-bypass aircraft engine by more than 30 percent. This approach is recognized as one of the most promising emerging technologies in the nation. It also contributed to the Jet Engine Containment Concepts and Blade-Out Simulation Team's receiving the Turning Goals into Reality (TGIR) award.

Unique collaborations and in-kind contributions between large and small businesses, the Federal Aviation Administration, NASA, Ohio State University and the University of Akron enabled rapid development and fabrication of prototype composite fan cases for direct comparison to the metal fan cases currently used in aircraft engines. This technology is supported by a $260,000 SBIR Phase III award from the Aviation Safety and Security Program and will explore improvement in the design of composite sandwich structures. ■

For more information, contact Dr. Gary D. Roberts, NASA Glenn Research Center, (216) 433-3244, Gary.D.Roberts@nasa.gov or Pam M. Schneider, A&P Technology, (513) 688-3286.

Please mention that you read about it in Technology Innovation.

GeoSyntec Consultants Receives STTR Contract and License Agreement for KSC's Environmental Cleanup Technology

NASA's Kennedy Space Center (KSC) has signed a nonexclusive license agreement with GeoSyntec Consultants for the use and sale of Emulsified Zero-Valent Iron (EZVI). The innovation, developed by environmental researchers working under the directions of KSC's Dr. Jacqueline Quinn, and professors from the University of Central Florida, employs the use of zero-valent iron in an emulsion formula to reductively dechlorinate DNAPL sources in polluted groundwater.

GeoSyntec intends to market this technology to clients across North America, Europe and Australia. Additionally, GeoSyntec has been awarded funding from the DOD Environmental Security Technology Certification Program (ESTCP) to enhance the application of this technology through further laboratory and field demonstrations.

During the early history of the space program, the ground around Launch Complex 34 (LC-34) at Kennedy Space Center was polluted with chlorinated solvents used to clean Apollo rocket parts. Dense non-aqueous phase liquids (DNAPLs) were left untreated in the ground and contaminated the fresh water sources in the area. DNAPLs are a common cause of environmental contamination at thousands of DOE, DOD, NASA and private industry facilities. Industrial operations including dye and paint manufacturers, dry cleaners, chemical manufacturers, metal cleaning and degreasing facilities, leather tanning facilities, pharmaceutical manufacturers and adhesive and aerosol manufacturers can have problems with DNAPLs.

GeoSyntec Consultants Inc., a small, environmental consulting and groundwater remediation services company with commercialized specialty products for groundwater remediation, played a key role in supporting Kennedy Space Center's efforts in testing this cost-effective method of treating the contaminated sites. GeoSyntec completed demonstration testing of the EZVI technology under the NASA STTR program for the Cape Canaveral Air Station Launch Complex 34 (LC-34) in 2002 and 2003. ■

For more information, contact Max Green, Kennedy Space Center, (312) 867-4322, gary.green-1@ ksc.nasa.gov.

Please mention that you read about it in Technology Innovation.

Looking Back

A FOLLOW-UP ON A NASA SUCCESS

LADARVision 4000

A technology developed originally for docking satellites and spacecraft is now being used to enhance life on Earth through LASIK, the most widely performed laser vision-correction surgery.

LADARVision® tracking technology was originally developed in a joint effort between NASA and the Department of Defense's Ballistic Missile Defense Office for docking satellites and spacecraft. The U.S. military, in developing target tracking and weapons firing control, also used this specialized technology.

Alcon Inc., a Fort Worth, Texas, company, then developed the invention commercially through NASA's Small Business Innovation Research program at Johnson Space Center. This work in the area of pointing and scanning laser beams led to the LADARVision eye surgery system.

When a surgeon uses the LADARVision system, the doctor sees an image just like one that a fighter pilot would see as he tracks a target. The doctor uses the image to track involuntary eye movements during LASIK surgery at a rate of 4,000 per second, 15 times faster than any other LASIK system used today.

Eye surgeons across the country are utilizing the LADARVision 4000 for LASIK surgery. In October 2002, Alcon's LADARVision system, consisting of LADARVision 4000 and the LADARWave wavefront measurement device, became the first to gain FDA approval for wavefront-guided LASIK. The resulting procedure, called CustomCornea, allows surgeons to measure and address visual distortions that previously went undetected. The precision of the tracking device and the small spot beam make the LADARVision system the premier equipment to deliver these precise treatments.

The technology was awarded a Certified Space Technology™ seal and inducted in 2004 into the Space Foundation's Technology Hall of Fame. ■

PHOTO CREDIT: NASA/JSC

A DOCTOR USES THE LADARVISION 4000 TO PERFORM LASIK EYE SURGERY.

Pathways Beyond Innovation

By Carl G. Ray

Innovation is defined as the process of taking new ideas to a point of inventing something new; or a new way of doing things. Through the application of research results and discoveries, innovation provides a pathway for creating new, value-added products and increasing efficiencies of scale for organizational operations. Innovation is the catalyst that keeps technology moving forward and businesses continuing to contribute to economic growth.

However, that contribution is accomplished only when the innovation is complete. For the average small business participating in the NASA Small Business Innovation Research (SBIR) program, the development of research into applied technologies, the application of these technologies to NASA mission systems and the transfer of these technologies to the marketplace as a product for commercialization are not easy efforts. Even with early-stage funding

from the federal government, these firms struggle to move their technologies to the end of the innovation pathway.

NASA is pursuing new approaches to facilitate the successful transition of its SBIR award-winning companies into investment-ready, reliable, high-tech business competitors. The NASA Alliance for Small Business Opportunity (NASBO) is a critical destination on NASA's SBIR innovation pathway that may help more small businesses close the technology-to-product gap.

For a long time, the small-business community has been — and continues to be — one of the most significant sources of innovation. Another growing set of resources are the many research institutions throughout the United States. Congress recognized the potential of these communities back in 1982 when it established the SBIR program, and again in

1992 when it created the similar, but smaller, Small Business Technology Transfer (STTR) program.

These programs are legislated as federal research-and-development (R&D) set-asides for small high-technology firms.

SBIR is a set-aside program for small business concerns (SBC) to engage in federal R&D with the end goal being commercialization of their resulting technologies as products in the marketplace. STTR is a set-aside program to facilitate cooperative R&D between SBCs and U.S. research institutions (universities) to transfer technologies and develop them into commercial products.

The objectives of these programs are to increase opportunities for SBCs to participate in government R&D, improve overall U.S. competitiveness and contribute to national economic growth. STTR has the additional goal to encourage formal relationships between SBCs and nonprofit research institutions for the purpose of providing a pathway to move institutional discoveries to the commercial marketplace.

Currently, five federal agencies with R&D budgets exceeding $1 billion are required to participate in the implementation of the STTR program. The following 11 federal departments or agencies, all with R&D budgets exceeding $100 million, are required to participate in the implementation of the SBIR program:

- Department of Agriculture
- Department of Commerce
- Department of Defense
- Department of Education
- Department of Energy
- Department of Health and Human Services
- Department of Transportation
- Environmental Protection Agency
- National Aeronautics and Space Administration
- National Science Foundation
- Department of Homeland Security (new in 2005)

In total, the annual budget for these programs across all agencies represents an R&D investment of over $2.2 billion. The NASA contribution is approximately $124 million.

The law established SBIR funding at 2.5 percent and STTR funding at .3 percent of each participating agency's extramural (externally contracted) R&D budget. Each agency may develop its own program implementation in accordance with the Small Business Administration, which sets the policies and guidelines for the program. In total, the annual budget for these programs across all agencies represents an R&D investment of over $2.2 billion. The NASA contribution is approximately $124 million, including the SBIR and STTR programs.

Both programs are implemented in three highly competitive phases. At NASA, Phase I of an SBIR award is funded at $70,000 for six months and targeted toward establishing feasibility of the pursued research. Then, where laudable results are found, firms may continue to pursue Phase II funding for up to two years and $600,000.

Phase III, however, is the point at which the company must find alternate funding to develop the technology further and/or pursue product development. Not unlike the challenge in the traditional "start-up" pathways of the marketplace, this highly competitive stage continues to be the most challenging.

NASA has participated in these programs since their inception. In 1994 NASA made a major shift in their implementation, resulting in agency-specific goals that included organizational restructuring to administer the programs together, strategic alignment with mission objectives and a more holistic approach to the congressional intent.

For more than 10 years the SBIR and STTR programs had significant value-added innovations such as paperless, Web-based electronic management and subtopic alignment with Mission Directorate programs.

Still, participating businesses found themselves facing the same challenge as small businesses in the traditional path marketplace: Investment funding for advanced technology development and/or commercialization is very difficult to obtain.

Lessons learned from discussions and workshops with investment representatives, business service firms and the SBIR firms revealed two significant realities that the new holistic approach needed to address:

- Innovation can successfully move into the marketplace only by attracting additional financial support.

- Many Phase II SBIR/STTR firms, like their counterparts in the small-business community, are typically not prepared to competitively enter the marketplace because of a lack of business maturity.

Another lesson learned was that although NASA SBIR and STTR technologies are aligned with mission program needs, additional funding to mature those technologies is needed to reduce the risk of program infusion and to bring better "fit, form and functional" solutions to the table.

The challenge was to find a way to improve the attractiveness of the NASA SBIR Phase II firms to the investment community and increase the potential for NASA to leverage the benefits of the SBIR- and STTR-developed technologies.

Thus was the catalyst for NASBO, which was piloted in 2002 in collaboration with the NASA Commercialization Center (NCC) at CalTech in Pomona, Calif. The pilot was designed to explore frameworks for mechanisms and incentives for creating strategic partnerships between the various small-business service providers, including incubators, universities and their affiliates, large contractor firms with potential interest as partners, and most importantly, early-seed capital investors and venture-capital entities.

The pilot was designed to explore frameworks for mechanisms and incentives for creating strategic partnerships between the various small-business service providers.

The concept was to use the large volume and high quality of the NASA SBIR Phase II portfolio to attract the resources for technology investment. That investment attraction is based on two unique aspects of the SBIR and STTR programs:

- When Phase II companies enter relationships with a NASBO chapter, they have already proven feasibility and successfully developed technology using the federal dollars from these programs.

- Firms typically own the intellectual property culminating from their developed technologies. This is perhaps most attractive to early-stage investors.

Each relationship would provide a scalable, market-driven partnership with end-to-end commercialization capabilities, including business-development services and self-sustaining funding sources. The entity would then submit a proposal for a nonfunded partnership with NASA to become a NASBO chapter. Proposals must demonstrate a capability and commitment to provide business services to the SBIR firms, and to be a source of investment funds that can support a required implementation plan.

The NCC pilot has run for two years, during which time eight SBIR companies received NASBO-funded business services, and three ventures successfully moved to the marketplace. To show the potential extent of NASBO benefits, the NCC provided the guidance, interface and funding support for one of the companies to acquire the flight test required to approach NASA Jet Propulsion Laboratory about utilizing (SBIR Phase III) the technology in one of the mission programs. This capability may prove to be the most significant benefit of NASBO, increasing NASA utilization and infusion of SBIR/STTR technologies.

Currently, NASA has one NASBO chapter under a nonfunded Space Act Agreement with Technology Tree in Houston. Two other entities are working with NASA on making the transition to NASBO chapters: the NCC at CalTech, and Georgia Tech's

PHOTO CREDIT: ANGELA GILLESPIE

THE CENTER FOR TRAINING, TECHNOLOGY & INCUBATION AT CAL POLY POMONA IS THE HOME OF THE NASA COMMERCIALIZATION CENTER. THIS BUSINESS INCUBATOR IS AN IMPORTANT RESOURCE THAT OFFERS SMALL BUSINESSES AND ENTREPRENEURS CRITICAL GUIDANCE THROUGH THE TURBULENT WATERS OF PROJECT START-UP.

Southeast Regional Technology Transfer Center in Atlanta. The National Technology Transfer Center in Wheeling, W.Va., also is participating as a developmental NASBO member.

While focused on providing business services to NASA SBIR Phase II firms, each NASBO chapter may be uniquely structured, such as:

- The chapter can specialize in different technology or industry areas.
- The partnerships may be geographically regional or national.
- The funding sources may be from the investment community or local sponsorship.

NASBO extends the innovation pathway beyond the technology challenges and through the program infusion and/or business barriers. This is how research and technology, via the NASA SBIR-STTR pathway, are transformed into viable products, services and systems for space exploration and commercial markets.

Many NASA SBIR Phase II companies have state-of-the-art technologies, but have found pursuit of investment and ventures daunting. NASBO can provide a conduit for these Phase II firms that have a confirmed technical novelty and validated technical team but need help developing their competitive business potential.

The dramatic increase in our highly competitive and globalized markets demands a renewed emphasis on successful innovation. Rapid changes in the markets have created a new world of competition. Because the current arena is set in a truly global context with high-quality competitors and risk assessment, the rules of engagement are vastly different from those of just a few years ago.

Beyond the innovation and new technology, a highly volatile business arena exists in today's market. For SBIR, the federal government is fulfilling its role with initial R&D investment. NASBO may be a way to ensure that this investment achieves its maximum potential.

Today the challenges for much of the new technology coming from R&D investments are about not only the technology gap but also the business barriers in the marketplace. It's not enough to transfer federally funded technology. The government must be innovative in developing appropriate links and partnerships with state, regional and local supporting infrastructures to facilitate the transition of these small businesses to highly qualified commercial marketplace competitors.

Developing these kinds of pathways will not only help businesses flourish but also increase the value of the SBIR federal R&D investment. NASBO provides a critical element to the SBIR-STTR innovation pathway by helping small businesses make a big difference and continue investing in America's future with NASA. ■

Opportunity for Partnership

Simple, Low-Cost Method for Producing Submicron-Sized Tips for Field Emitters and Atomic Microscope Styli

NASA Goddard Space Flight Center seeks companies to license this method for producing arrays of pointed structures or cones used in a variety of electronic and mechanical equipment applications. This low-cost, simple method yields a template containing large numbers of cones that are uniform in size and equally spaced. This template then can be easily coated with metals or semiconductors to tailor the mechanical and electrical properties of the tip.

Micron- and submicron-sized pointed structures are used in electrical and mechanical equipment applications where sharp tips are needed. However, existing methods to produce these structures—materials synthesis and etching—are plagued with difficulties. The equipment (e.g., deep reactive ion etching) can be very expensive, and the resulting arrays are small with tips/cones of varying heights and aspect ratios. However, a researcher at NASA Goddard Space Flight Center has developed a new, cost-effective process for producing large numbers of uniform point structures.

This innovative process involves dropping or spinning a ferrofluid (i.e., a liquid containing Fe2O3 particles) onto a glass, quartz, or other substrate. A magnetic field is then applied using simple permanent or electro-magnets, causing the ferrofluid to form pointed structures that are uniformly aligned with a maximized aspect ratio. The ferrofluid then is dried at room temperature. The result is a template that can serve as a substrate for subsequent film growth through any standard thin-film deposition technique, including evaporation, sputtering or chemical vapor deposition. Templates have survived vacuum testing at 10–6 Torr. The conformal films applied to the template will reflect its pointed structure.

NASA's ferrofluid technique may be particularly useful for creating

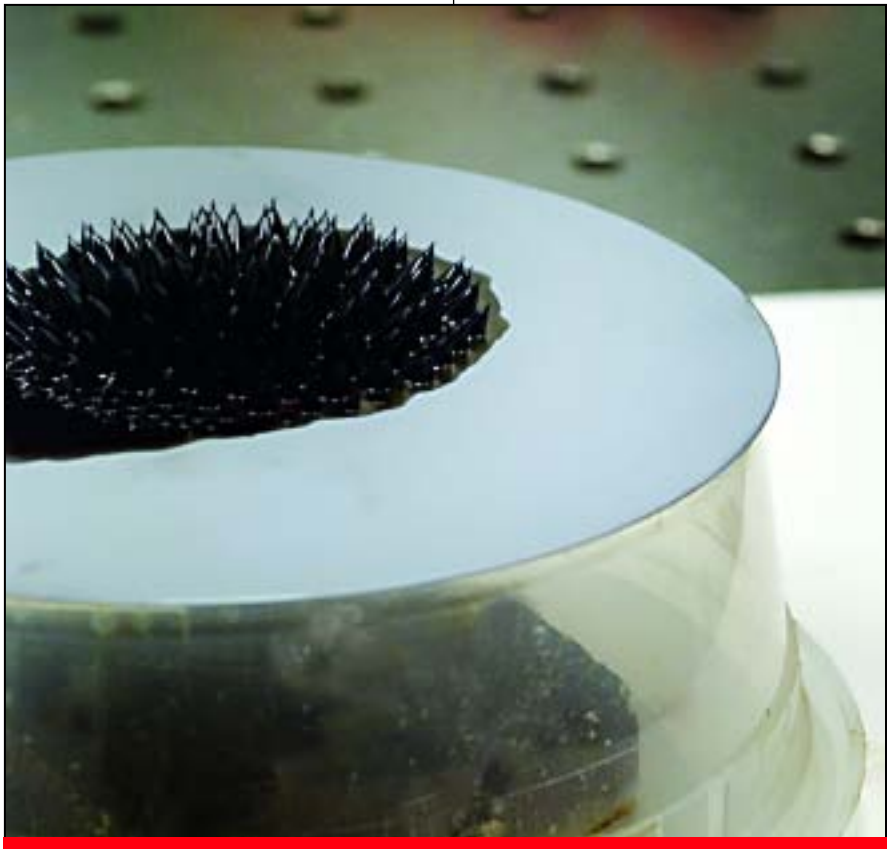


PHOTO CREDIT: NASA/GSFC

ARRAYS OF POINTED STRUCTURES OR CONES THAT CAN BE USED IN A VARIETY OF ELECTRONIC AND MECHANICAL EQUIPMENT WERE PRODUCED BY UTILIZING THE LOW-COST METHOD FOR PRODUCING SUBMICRON-SIZED TIPS FOR FIELD EMITTERS AND ATOMIC MICROSCOPE STYLI.

Opportunity for Partnership

emitters to be coated by wide bandgap semiconductors, which can absorb and emit electrons in the ultraviolet light bands. These materials, such as readily available ZnO, are an excellent alternative for the traditional large, high-voltage photocathode systems. Coating the templates created with Goddard's technology with ZnO or other oxides avoids the oxidizing properties associated with metals typically used in photocathodes (e.g., tungsten, chromium). Therefore, the photocathodes are less susceptible to contamination, decay and radiation damage, and may be more chemically and structurally stable.

This technology is expected to provide a low-cost electron source useful in a wide range of electronics and mechanical equipment applications such as field emission displays, field emission devices, photocathodes, scanning tunneling microscopes, atomic force microscopes, far ultraviolet (UV) photolithography and low-power propulsion systems.

The benefits of this innovation include the following:

Low cost: This method uses basic equipment and an inexpensive, commercially available material to produce the pointed-tip arrays.

Versatile: The template can be formed on a variety of substrates (e.g., glass, quartz, sapphire) and can be coated with various materials (e.g., zinc oxide [ZnO] and other semi-conductors, metal).

Scalable: Unlike other methods that yield arrays of limited size, this process has the potential for large-scale (>4") fabrication of pointed-tip arrays.

Simple: This three-step process is an easy alternative to materials synthesis and etching techniques, which are the current standards for making pointed-tip arrays.

Consistent: The method yields a template of needle-like tips uniformly aligned and with a high aspect ratio.

NASA Goddard is pursuing patent protection for this technology. ■

For more information, contact NASA Goddard's Office of Technology Transfer, (301) 286-2642, techtransfer@gsfc.nasa.gov.

Please mention that you read about it in Technology Innovation.

The Revolutionary TETwalker

NASA Goddard Space Flight Center offers the opportunity to partner in the further development of this innovative technology for use in robotics and other applications requiring extreme mobility and adaptability in varied environments.

The TETwalker represents a revolutionary idea in robotics and structural architecture. It is a creative application of Addressable Reconfigurable Technology (ART), developed by NASA researchers at Goddard Space Flight Center working jointly with Langley Research Center. This highly integrated three-dimensional mesh of actuators and structural elements has the potential to autonomously change form to optimize its function, reconfigure into specific tools, and perform tasks in a wide range of terrain and environment. This is the first element in the development of a synthetic skeletal muscular and skin system to be controlled by a synthetic neural system.

The tetrahedron module is configured using readily available, addressable, electromechanical components. Lightweight telescoping struts are attached at each end to pivoting nodes to allow movement over a wide range of angles. Motors within the nodes control the telescoping struts, allowing specific sections of the tetrahedron to lengthen or shorten, changing its center of mass. This enables the tetrahedron to maneuver in a controlled flip-

flop motion by toppling over in alternating directions.

By grouping multiple tetrahedra, many degrees of freedom/function and much smoother locomotion are possible, including the formation of flattened and conformable surfaces (e.g., draping over obstacles) as well as slithering, rolling and amoeboid/caterpillar-like motions. Independent shaping of the top and bottom interconnected nodes is also possible, to allow reconfiguration for multiple complex functions, such as forming tools and for communications.

Benefits of the innovation include:

- Radically reconfigurable and scalable: Because the shape, size and volume of its elements can be controlled, the ART structure can take on multiple configurations and perform multiple tasks.
- Robust: The tetrahedral shape is the most stable geometric structure.
- Enhances control: As the size of each element gets smaller and the number of elements increases, the degree of freedom and level of control are greatly enhanced.
- Reduces mass: Having no hard body, the tetrahedron is lightweight and can be very compact but with the ability to expand as needed.
- Reduces power requirements: Its low mass has minimal power requirements. Future plans to incorporate nanotechnology will further decrease the required operational power density.
- Undifferentiated architecture eliminates need for dedicated components: The technology has the potential to reconfigure itself in response to its changing needs and environments, reducing the need for dedicated tools and components.
- Reduces failures: ART intrinsically is massively redundant; if one section is damaged, it has the potential—in an advanced form—for self-repair.

This is the first element in the development of a synthetic skeletal muscular and skin system, to be controlled by a synthetic neural system.

While the TETwalker is currently controlled remotely, also under development is a synthetic neural system to enable the TETwalker to function autonomously. This neural system will allow the TETwalker to adapt and actively reconfigure itself according to its environment and recognized needs. Like the physical architecture, the neural system has a three-dimensional, node-driven architecture.

Future developments will reduce size using Micro-Electro-Mechanical Systems (MEMS) and then further using Nano-Electro-Mechanical Systems (NEMS). With this refinement, even greater control and agility will be possible.

Potential applications for the technology include the following:

- Wheelchairs and other assistive devices: The effective ART skeletal/muscular frame system enables fluid motion over any terrain and supports performance of varied functions.
- Human performance enhancement and enablement: ART can function as an adaptive exoskeleton to enhance strength, reach and other functions.
- Robots: ART's maneuverability and ability to reconfigure itself make it particularly useful in (but not limited to) situations where tasks must be performed in inhospitable environments (e.g., gathering environmental samples, finding and defusing bombs, search and recovery).
- Mining: ART can be configured for thin-vein mining applications.
- Toys and novelties: The unique abilities of the technology also open the door to a new era of toys and novelty items. ■

For more information, contact NASA Goddard's Office of Technology Transfer, (301) 286-2642, techtransfer@gsfc.nasa.gov.

Please mention that you read about it in Technology Innovation.

When a team of NASA scientists designed a one-of-a-kind catalyst to help space lasers perform at peak capacity, they never imagined that their invention would come down to Earth and improve the quality of the air for race car drivers.

But landed it has, in the form of an air-purifying system that cleanses contaminants and toxins from race car cockpits, helping some of the nation's top NASCAR drivers breathe easier at 200 mph.

The extremes of space operation have something in common with the rigors of high-performance competitive driving. Both require tough, durable, efficient systems that

Partnership Helps Virginia Company Grow, Racers Breathe Better

operate reliably under extreme conditions with little or no maintenance. The catalyst was developed as part of a NASA atmospheric-monitoring project that never flew in space. For that mission, the catalyst would have recycled and recaptured carbon dioxide, a source of laser power. The system of which it was a part had to be foolproof and fail-safe, criteria that must be met on the ground as well.

In a race car, at very high speeds and temperatures, the catalyst must constantly remove carbon monoxide and other harmful gases before they affect the driver's health. Cleaner air virtually eliminates flu-like symptoms such as headaches, fatigue and dizziness that traditionally linger for days after races.

"It's performance technology meeting satellite technology," says Matt Davis, a consulting engineer for Penske Engineering. "When they close that helmet and that visor and hook up the cooling system, they breathe good, clean air. They're going around the

track at more than 190 miles an hour and the air is less toxic. That really helps the drivers."

The catalyst is made by STC Catalysts Inc. (SCi), a subsidiary of Science and Technology Corp., of Hampton, Va. As an adopter of the original NASA research, SCi has an exclusive licensing deal with NASA Langley Research Center. Under the terms of this deal, the company sells carbon dioxide-recovering catalysts for laser-power systems, primarily overseas, to laser makers in Italy and South Africa.

About the size of an oversize coffee mug without a handle, the catalyst features a unique surface chemistry and airflow over and through a formulation of platinum and tin oxide incorporated within a honeycombed ceramic form.

Since the beginning of its partnership with the racing industry, SCi has seen its fortunes grow. Demand for their product is forcing the company to move to larger quarters near its corporate parent, upgrade its laboratory, add staff and triple production capability.

"The caliber of NASA technology is so high, I can't help but feel there's a lot more out there just waiting for someone to come along and use it," says Davis.

Taking innovation from benchtop to marketplace is often a laborious process. For SCi, this process has taken nearly a decade.

"It's not simply pulling technology off a shelf somewhere and putting it in a car," says George Wood, the catalyst's co-inventor and SCi vice president for business development.

New products need to find the right markets and buyers. Sellers must validate, test, retest, certify and then repeat the process as new generations of product debut.

Additional markets for the catalyst could be opening. SCi is exploring a variety of opportunities for the catalyst to filter air, particularly in extreme conditions. An emergency filtration system for first responders

PHOTO CREDIT: NASA/LaRC

The InCar System, using the NASA-developed catalyst, is now helping race car drivers breathe better by filtering contaminated air before it enters the driver's helmet.

is one such option. Others might include purifying systems for laboratories and hospitals using chemical preservatives and as pollution controls on automobiles.

"We're expanding. We're looking for additional markets. Getting an application from the laboratory to the marketplace is a long process. You can't do it overnight," says Wood. ■

For more information, contact Dr. George M. Wood, STC Catalysts Inc., (757) 766-5822, gwood@stcnet.com.

Please mention that you read about it in Technology Innovation.

NASA

Did you know?

An interesting fact to stimulate the mind

Q

NASA research aimed at improving crash protection for airline passengers led to the development of what cushioning material that was used in space shuttle seats, as well as in many commercial applications?

A

Temper Foam

With the idea of developing a new airline seat to provide better impact protection and comfort during long flights, NASA's Ames Research Center developed an open-cell polyurethane-silicon plastic foam that takes the shape of impressed objects but returns to its original shape even after 90 percent compression. The material offers better impact protection in an accident and enhances passenger comfort on long flights. Numerous spinoffs of the original technology include orthopedic support cushions used in wheelchairs and other medically related support applications; use in sports equipment, such as helmets; and even use in the furniture industry as mattresses and cushions.

NASA and EPA Team to Provide A New Look at Corn

Can you tell the difference between traditional and bioengineered corn into which genes have been inserted to make the plant resistant to insects? A NASA technology is starting to make the differences clearer because of a snapshot.

The Environmental Protection Agency (EPA) has teamed with NASA to use hyperspectral imaging technology to ensure that appropriate crop-management practices are used to prevent the development of resistance in corn pest populations. Pest resistance could severely limit the continued use of these new varieties of corn. With more than 25 million acres of corn planted in 2005, it is physically and economically impractical to sample each acre. Early use of hyperspectral imaging provides the ability to efficiently distinguish the characteristics of traditional and bioengineered corn and identify pest-infestation conditions.

Hyperspectral imaging uses a special camera to cut one snapshot into 120 color-specific images. Hyperspectral means that you are getting many more images within the spectrum of just one picture. Each image shows a unique characteristic, not distinguishable by the human eye.

The patented, portable hyperspectral sensor was a 2005 inductee into the Space Foundation's Space Technology Hall of Fame, which honors innovators who transform technology developed for space use into commercial products.

The hyperspectral camera and its applications were developed by the Institute for Technology Development (ITD) at NASA Stennis Space Center in Mississippi. The institute is one of several NASA Research Partnership Centers managed for NASA Headquarters by NASA Marshall Space Flight Center in Huntsville, Ala.

"This effort will enhance NASA's understanding of image-processing

techniques to extract knowledge from hyperspectral data sets," says Brian Mitchell of NASA's Space Partnership Development Program at Marshall. "The research being conducted with genetically modified plants and plant growth has the potential to contribute significantly to our ability to grow sustainable and nutritional crops in space for our astronaut crews. This could prove vital for long-duration exploration missions."

The hyperspectral technology supports NASA's Vision for Space Exploration and long-term spaceflight goals. The Vision calls for space shuttles to return to safe flight to complete the international space station, and human and robotic exploration of the solar system.

"This knowledge is vital to future Mars missions," says George May, director of the ITD. "When we go to Mars, we will have to grow our own food source. This technology enables early detection of stresses in plants, such as nutrient problems, so that corrective action can be taken to maintain the food supply."

Hyperspectral imaging also can be used in treating astronaut wounds in space. The ITD is developing a portable, handheld camera for astronauts to capture images of wound sites. These images will allow doctors to identify the severity of a wound or how a wound is healing, and decide the best treatment. This could save precious time in diagnosing and treating a problem and speed up healing time.

Hyperspectral imaging also will be able to detect mold and toxins in spacecraft — a necessity during long-duration missions to ensure that astronauts have a clean, healthy environment.

PHOTO CREDIT: NASA/MSFC

A HYPERSPECTRAL CAMERA IS HELPING THE ENVIRONMENTAL PROTECTION AGENCY AND NASA ENSURE APPROPRIATE CROP MANAGEMENT PRACTICES.

A healthy environment also is what the EPA is looking for when monitoring corn crops. The agency is working with a hyperspectral camera — about the size of a loaf of bread — mounted onboard a small aircraft. The aircraft typically flies about 8,000 feet above the terrain, imaging the same sites every 10 days during growing season. All of the images are then put into a computer system, where data-mining techniques are used to extract knowledge about the corn plants.

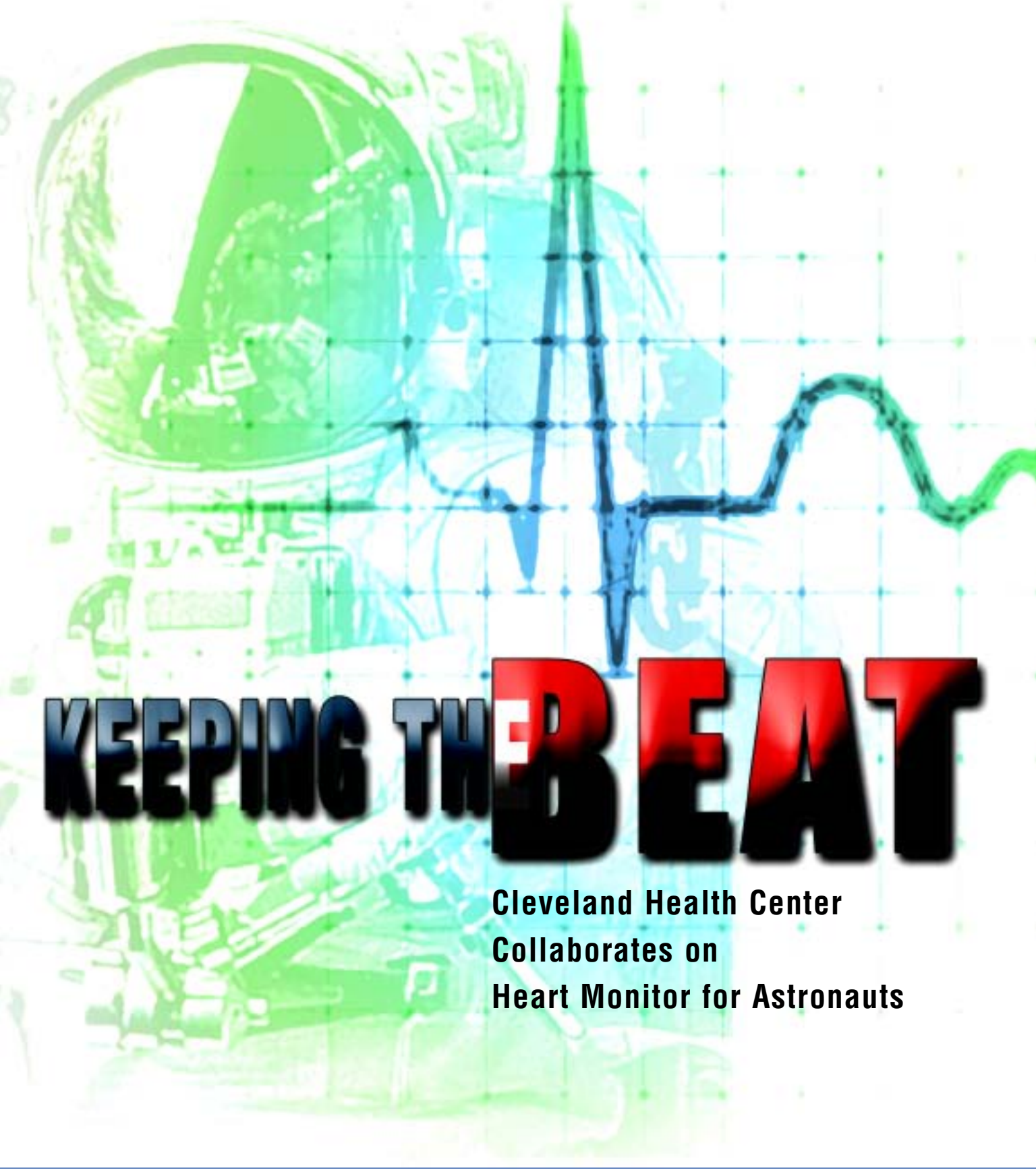
"A major concern is to ensure the optimal productive life for the biotech crop due to the expected environmental benefits," says John A. Glaser of the EPA Office of Research and Development's National Risk Management Research Laboratory in Cincinnati.

"The spectral imagery of corn hybrids collected during the 2004 growing season begins to show that imagery can be developed into a component of biotech crop monitoring," adds Glaser. "We are pleased to see that the ability to accurately distinguish transgenic from nontransgenic hybrids begins to answer the needs of our decision support system. The clarity of infestation effects in the imagery strongly underscores the potential utility of imagery for crop monitoring."

The hyperspectral imaging system is trademarked and patented under U.S. Patent No. 6,166,373, issued Dec. 26, 2000, and is available only from the Institute for Technology Development, or under license. ■

For more information, contact Brian Mitchell, Marshall Space Flight Center, (256) 544-7161, Brian.K.Mitchell-1@nasa.gov.

Please mention that you read about it in Technology Innovation.



KEEPING THE BEAT

Cleveland Health Center Collaborates on Heart Monitor for Astronauts

On the space shuttle, astronauts can see splashes of Earth's ocean blue, desert red and forest green all in a single glance out the window — a sight that can make anyone's heart skip a beat.

PHOTO CREDIT: NASA/GRC

RESEARCHERS WILL TEST THIS PROTOTYPE OF THE HEART MONITORING SYSTEM FOR AMBULATORY PATIENTS WITH ARRHYTHMIA SYMPTOMS.

In fact, there is evidence that astronauts in space experience slight variations in heart rhythms. But the breathtaking views might not be causing this problem; rather, the likely culprit is weightlessness.

As NASA prepares to send humans farther into space, researchers want to know how changes in heart rhythms affect an astronaut's health. To find out, a team from NASA Glenn Research Center in Cleveland and the MetroHealth Medical Center has developed a method for doctors on Earth to monitor astronauts' hearts in space.

Variations in the heart's rhythm are called cardiac arrhythmias. If untreated, they can lead to chest pains, fainting or even sudden cardiac death. This type of heart attack is the most common cause of death in the United States.

"There is clearly evidence that astronauts have experienced arrhythmias as part of space flight," says Dr. David Rosenbaum, director of MetroHealth's Heart and Vascular Center. "So we wanted to use this technology to determine how microgravity and weightlessness affect the heart over long periods of time."

The heart-monitoring system will use an advanced electrocardiogram (EKG) pioneered at MetroHealth to amplify astronauts' heart patterns and detect slight changes in rhythm during exercise stress tests. These subtle variations appear in 70 percent to 80 percent of patients at risk for cardiac arrhythmias.

Flight surgeons will be able to monitor astronauts' heart rates from the ground using NASA's award-winning Embedded Web Technology. This miniature server records the EKG and sends the information over the Internet, allowing the surgeons to see the heart data in real time on a standard Web browser.

Last summer, researchers tested the system on 15 people to make sure that it will work in the space environment.

"In low gravity, your heart actually floats inside your chest cavity," says Michael Mackin, NASA's chief engineer for the project. "We wanted to make sure that the EKG readings in space would be consistent with those on the ground."

A team of Glenn and MetroHealth researchers conducted tests on the ground and on NASA's K-135 low-gravity flight research aircraft. The plane flew up and down in about 45 hill-shaped maneuvers called parabolas. At the peak of each parabola, the test subjects experienced approximately 20 seconds of very low gravity similar to the weightlessness experienced on an orbiting spacecraft.

"We're still evaluating the test results, but it appears that the system works in low gravity and the readings from the flight are consistent with the ones we took on the ground," says Mackin.

Mackin hopes to use the new system on the international space station to determine whether long-term spaceflight affects the heart. This information is vital before NASA sends astronauts to Mars and beyond, trips that will last months, if not years.

This technology also may improve care for thousands of patients on Earth. The team will conduct clinical tests on the ground version of the system. This version includes a Global Positioning System to track a patient's location. It will allow medical professionals to monitor outpatients with symptoms of arrhythmia in real time — something they have never been able to do. In an emergency, the hospital will know where to find the patient.

"Doctors will be able to check on their patients using any cell phone, handheld digital device, laptop or desktop computer with a Web browser," says Mackin. "And patients with arrhythmia symptoms will be able to leave the hospital and go on with their days safely."

According to Mackin, NASA's Embedded Web Technology could help medical professionals monitor patients with diabetes, wounds, pulmonary problems and other conditions. It also has practical applications in everyday appliances.

"This technology can be used to control or monitor any device that contains a computer, software, input sensors and output actuators," says Mackin. "In other words, you could use it with a car, DVD player, fax machine or kitchen appliances."

Clearly, the heart-monitoring system is a marriage of two technologies with immeasurable potential. NASA's Embedded Web Technology and MetroHealth's advanced EKG could save countless lives on Earth and answer fundamental questions about human survival in space. ■

"Doctors will be able to check on their patients using any cell phone, handheld digital device, laptop or desktop computer with a Web browser. And patients with arrhythmia symptoms will be able to leave the hospital and go on with their days safely."

For more information, contact Laurel Stauber, Glenn Research Center, (216) 433-2820, Laurel.J.Stauber@nasa.gov.

Please mention that you read about it in Technology Innovation.

Did you know?

An interesting fact to stimulate the mind

What innovations stem from a battery-operated magnetometer system used to obtain samples from the lunar surface and subsurface for the study of Moon soil?

Cordless Tools

The Black & Decker Corporation, working with NASA's Goddard Space Flight Center, created a lightweight, compact power drill with its own independent power source to dig into the hard lunar surface. In the years following the Apollo Program, Black & Decker refined this spin-off technology and created entire lines of handy cordless tools for widely different industries. These cordless products now account for hundreds of millions of dollars in sales in America alone.

White Sands Test Facility

PHOTO CREDIT: NASA/JSC

Facility Focus

HIGHLIGHTING A NASA FACILITY THAT PROVIDES FUNCTION BEYOND SPACE EXPLORATION

White Sands Test Facility

White Sands Test Facility (WSTF), located in southwestern New Mexico, has been a part of the NASA Johnson Space Center since its construction in 1963. The primary mission is to provide the expertise and infrastructure to test and evaluate spacecraft materials, components and rocket propulsion systems to enable the safe human exploration and utilization of space.

WSTF is a preeminent resource for testing and evaluating potentially hazardous materials, space flight components, and rocket propulsion systems. These services are available to NASA, the Department of Defense, other federal agencies, universities, and commercial industry. Other service areas include research and development, technical consultation, technical capabilities and training.

For WSTF to do business with your organization, a reimbursable agreement must be initiated. Assistance to industry and non-NASA government customers is furnished on a cost-reimbursable basis. WSTF is able to provide a service that benefits the NASA facility and its customers. By working for clients, WSTF is able to maintain a skilled staff and increase test capability and knowledge. The customer who does business with WSTF gets the benefit of NASA's state-of-the-art technology and expertise at a fraction of the cost of what it would take to generate the data themselves.

Testing for commercial customers will be approved if the following three requirements are met: a valid reimbursable agreement is in place; the customer has provided proof of general liability insurance, as explained in the reimbursable agreement document; a check for the funding has been received by the NASA JSC Finance Office.

PHOTO CREDIT: NASA/JSC

A scientist in a state-of-the-art laboratory conducts testing of hazardous materials and propellants, air quality, aerospace hardware and ground support equipment and all materials used in space flight.

Testing for non-NASA government customers will be approved if the following two requirements are met: a valid interagency agreement or reimbursable agreement is in place; a valid purchase request, such as a Military Interdepartmental Purchase Agreement, is in hand and signed by an authorized certifying officer and containing the appropriate funding information. ■

For more information, visit http://www.wstf.nasa.gov/.

Please mention that you read about it in Technology Innovation.

Opposite Page: A night firing of the shuttle forward reaction control subsystem primary and vernier thrusters at White Sands Test Facility.

TRACeR Helps Identify Materials and Authenticate Parts

PHOTO CREDIT: NASA/MSFC

RICHARD BOOTH, LEFT, MARSHALL ENGINEERING DIRECTORATE, AND WANDA HUDSON, ATK THIOKOL, USE THE SCANNER TO ANALYZE MATERIALS IN AN F-1 ENGINE, WHICH WAS USED TO BOOST THE SATURN V ROCKET FROM EARTH'S ORBIT AND CARRY ASTRONAUTS TO THE MOON IN THE 1960S.

The recent commercialization of a NASA technology might soon put a dent in the amount of unapproved car parts in circulation.

TRACeR III-V, an enhanced, hand-held X-ray fluorescence (XRF) device, can detect chemical tag IDs, known as nanocodes or "invisible bar codes," and, thus, easily separate genuine manufacturer parts from imposters.

The value to NASA is the software's ability to tag and identify aerospace parts. During development of the technology, two patents emerged, with multiple applications benefiting NASA and the commercial market.

The history of TRACeR III-V dates to 2001, when the NASA Marshall Space Flight Center (MSFC) Technology Transfer Department and the National Technology Transfer Center (NTTC) identified KeyMaster Technologies Inc. as a potential partner to meet the Agency's need for a specialized identification device. As part of the commercialization activities of NASA's Innovative Partnerships Program (IPP), Marshall's Technology Transfer Department brought KeyMaster to the table following the November 2001 Materials Information Society conference.

Based in Kennewick, Wash., KeyMaster develops and markets hand-held XRF instruments and unique tagging technology used to identify and authenticate materials and processes. In business for more than 20 years, KeyMaster produces portable XRF instruments for a variety of markets, including environmental, mining, quality control, museum conservation, authentication and general analytical instruments.

Marshall needed such a device, but with the added ability to detect and read data matrix symbols through paint and

other coatings. At the same time, the Federal Aviation Administration (FAA) was seeking a method of detecting and eliminating the use of unapproved parts, and the hope was that a NASA-KeyMaster partnership would benefit both federal agencies, as well as the company and the general public.

Although the XRF was not suitable for reading data matrix symbols through paint, "chemical bar codes" were written into NASA Standard 6002 as an allowable variant to standard part-marking processes. The XRF's ability to detect chemical tag IDs added a dimension to an identification system available to both NASA and the FAA.

The NTTC introduction paved the way for a series of meetings between Marshall and KeyMaster. The company demonstrated the XRF solutions to Marshall's Technology Transfer Department, Engineering and Science directorates, and Reusable Solid Rocket Motor (RSRM) Project Office. Within a matter of seconds during the demonstration, the XRF detected the composition of several items that had been problematic for NASA in the past. In another impressive test, the XRF detected an identification tag through six layers of RSRM rubber blanket insulation, indicating at each step the number of layers through which it was reading.

"All indications were that the XRF could be greatly beneficial in the identification and qualification of space shuttle hardware at Marshall, but additional analysis was needed to determine the extent of the device's applicability for aerospace work," says innovator Fred Schramm of Marshall's IPP.

In addition to recognizing chemical identification tags, the XRF can identify elements in the composition of a material. Detecting other elements with low atomic numbers is important to NASA as well.

But the standard XRF device could detect no metals lighter than titanium. However, additional tests demonstrated that, when operating in a vacuum, the XRF could easily analyze aluminum alloys.

Marshall and KeyMaster signed a Space Act Agreement to collaborate on improving and adding capabilities to the company's XRF scanner. NASA agreed to provide the materials for a prototype as well as technical expertise to evaluate the new capability, and KeyMaster agreed to provide the product expertise and facilities needed to further develop the XRF.

Working with Schramm, KeyMaster developed and added a vacuum assist to the standard XRF. The result was TRACeR, the first handheld XRF to detect aluminum alloys. The enhanced device is also capable of detecting 10 additional elements. NASA's Shuttle Propulsion Office immediately purchased three units to use in Return to Flight. TRACeR is available commercially through KeyMaster.

In addition to the XRF's materials-analysis ability, NASA also was interested in the chemical tagging function, which sprays an invisible chemical tag onto fragile or otherwise unmarkable parts and products, and reads tags hidden from view by paint or other substances. The standard XRF could only determine the presence of a chemically applied tag, and its format was difficult to communicate.

To solve this issue, Schramm and KeyMaster developed software to convert the data in the chemical mixtures to ASCII and then to bar codes. Other partners are involved promoting commercial maturity. Ohio University is developing the appropriate parts-marking application for NASA, and Georgia Tech is developing a similar approach for the carpet and textiles industry.

One of the best features of TRACeR is its portability, says Schramm. Researchers can take the materials lab into the field, eliminating the need to move a piece into the lab for analysis, which often is difficult or impossible.

Value to NASA

The three TRACeR units purchased by the Shuttle Propulsion Office are being used to evaluate light-element alloys and conduct failure analysis at Marshall, analyze welding rods at the External Tank Project Office and the Space Shuttle Main Engine Project Office, and evaluate hardware at Marshall and Kennedy Space Center for contamination, corrosion and material deviations.

In addition, TRACeR likely will be used at some level in quality control during the creation of simulated "moon dust," or regolith. Regolith is needed for research to support NASA's preparations for traveling to the moon and Mars, and actually living on the lunar surface. TRACeR may be used on the lunar surface as well, to determine mineral composition for mining efficiency and to evaluate interior surfaces for contamination.

PHOTO CREDIT: NASA/MSFC

WANDA HUDSON, LEFT, AND RICHARD BOOTH, USE AN ENHANCED VACUUM X-RAY FLUORESCENT SCANNER BUILT BY KEYMASTER TECHNOLOGIES TO EVALUATE REUSABLE SOLID ROCKET MOTOR HARDWARE.

Commercial Applications

The range of commercial applications for TRACeR's tagging ability is broad. The chemical ID can be mixed with plastic packaging, sprayed on specific locations or included anywhere. It cannot be seen, smelled, removed or detected by radio frequency means.

"The tagging technology is ideal for authentication, making sure that a product is not counterfeit," says Schramm. "If injury, death or financial loss results from the failure of a product, we now have a means of proving whether the responsible product was genuine or counterfeit. This would benefit manufacturers of genuine parts who previously could not prove that a part in question was not theirs."

Already, the automotive industry, the aerospace community and the Department of Defense have expressed interest in TRACeR. Schramm says the device could prove invaluable to the pharmaceutical industry as well.

"The TRACeR can be used as an in-process evaluation tool to determine if mixtures are staying uniform in the factory, and it can also interrogate for counterfeiters that might be using a particular brand's name," he says.

Two New York museums and one in Los Angeles are using TRACeR to authenticate paintings and other artifacts by detecting certain amounts of trace elements used by original artists in their work. Also, gemologists are interested in it for assessing the presence of trace metals, which are impurities, in precious stones. This elemental "signature" helps a gemologist to determine authenticity and origin.

Another major development involves TRACeR in setting a new standard for carpet-cleaning equipment and chemistry. The Carpet and Rug Institute (CRI) developed a program to test the effectiveness of equipment in cleaning carpet that has been purposely soiled with XRF-detectable dirt. TRACeR quantified the carpet before and after cleanings to evaluate the cleaning equipment, and a CRI Seal of Approval, which includes certification from the Space Foundation, was given to the equipment that passed these tests. It is possible that lessons learned on Earth in the carpet industry with XRF could provide useful information for the designers of lunar living accommodations.

The applications are seemingly limitless for TRACeR, both commercially and within NASA and other government agencies. ■

For more information, contact Fred Schramm at Marshall Space Flight Center, at fred.schramm@nasa.gov, or John Landefeld at KeyMaster Technologies Inc. at jlandefeld@keymastertech.com or (509) 783-9850, Ext. 245.

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Space Act Agreements

Under a Space Act Agreement, there are a few partnering options for entities interested in doing business with NASA.

A Memorandum of Understanding/Memorandum of Agreement (MOU/MOA) is a statement of policy, practice or intention affecting a matter of concern to both NASA and another entity.

Some of the characteristics of a MOU include:

- Transfer of funds or resources is not permitted.
- Terms of the agreement are not legally enforceable.
- Signatories are at the discretion of interested parties.
- Goods and services of any kind are not permitted to NASA.

A non-reimbursable agreement is a collaborative research and development agreement in which NASA and the other party contribute personnel, use of NASA facilities, expertise, equipment, technology, etc., but no transfer of funds occurs. The transfer of funds or other financial obligation between NASA and the private entity is not permitted. Each party agrees to fund its own participation under this agreement.

A reimbursable agreement is an agreement for the reimbursable use of NASA facilities, personnel or equipment by a public or private entity wanting to advance R&D efforts. The agreement involves a transfer of funds or other financial obligations from the private entity to NASA. The terms, conditions and schedules are negotiable, but NASA must be paid in advance for each stage of the effort. No goods or services are provided to NASA. Instead, NASA provides data, facilities and services to the paying entity. ■

For more information, visit www.ipp.nasa.gov.

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Innovative Research

SBIR Program Helps New York Company Create 3-D Innovation

A small company in Rochester, N.Y., is bringing new life to 3-D images without the use of goggles or headgear, resulting in innovation in medicine, architecture, business and entertainment.

Dimension Technologies Inc. (DTI), under Phase I and II Small Business Innovation Research (SBIR) awards from NASA Ames Research Center in Moffett Field, Calif., developed a 3-D display for use in computer games, protein analysis, surgical imaging and a variety of other consumer applications.

DTI President Arnie Lagergren says, "NASA was looking for the ability, through scientific visualization, to more intuitively look at displays that could give real depth for solving fluid-flow physics problems."

In partnership with Ames, DTI developed a 3-D scientific visualization system that allows engineers to interpret large masses of data, such as those associated with the fluid flow around space shuttle launches. The technology makes images appear to jump off the screen and hang in space. It works via a patented optical system for flat-panel displays, based on parallax view, in which each eye sees the same image from a slightly different angle.

All stereoscopic imaging systems create at least two images of a scene. One image is displayed as a person's left eye sees it; the other, as the right eye sees it. The two images are called a "stereo pair." Both halves of a stereo pair are displayed simultaneously on the odd and even pixel columns of the liquid crystal display (LCD) and made visible to the corresponding eyes by a special panel that allows the light to pass through slits, creating hundreds of bright vertical lines, located behind the LCD. The lines are precisely spaced with respect to the pixel columns of the LCD. Therefore, the left eye only sees light through the odd columns and, thus, only the left-eye portion of the stereo pair, while the right eye only sees light through the even columns and, thus, only the right-eye portion of the pair.

When the halves of the stereo pair are adjusted to correspond to the scene perspective that would naturally be seen by the respective eyes, a vivid illusion of three-dimensionality is created. The objects seem to come out of the screen, giving the impression of an open window through which objects can protrude from or retreat into the background. This is DTI's Virtual Window™.

Although the displays are designed for single users, the technology allows for several people to view simultaneously, as long as their left eyes are in the left-eye zone and their right eyes are in the right-eye zone.

The unique DTI monitor allows users to instantly change from 2-D to full-color, full-motion 3-D images with the flip of a switch.

In 2003, DTI's Virtual Window was inducted into the Space Technology Hall of Fame.

On another project, DTI has worked with NASA to provide a "virtual clinic" that served as a telemedicine demonstration. NASA used it to explore how medical experts on the ground might jointly solve problems that astronauts might face during space travel.

Working with the NASA researchers has been incredibly beneficial to DTI, and Lagergren sees more partnering possibilities as NASA pursues its space exploration vision. "We get smarter as a result of understanding their applications, and we work closely with them. They're constantly keeping us in the right direction and showing us the next footprint, to be able to come up with a modified technology that could satisfy their requirements," says Lagergren.

NASA is funding DTI research on a concept for an ultra-high definition (UHD) head-mounted telepresence display for

EXAMPLES OF HOW NASA IS WORKING WITH SMALL BUSINESSES

use in its Robonaut program. The research will demonstrate a new type of lens that allows off-the-shelf microdisplays to create UHD images, instead of requiring modified, custom microdisplays to be built. It will also prove the feasibility of applying DTI's UHD technology to a head-mounted display (HMD) that NASA astronauts could use to control robots working outside the shuttle or space station. The company hopes to receive additional funding to convert its findings into a working prototype.

Other applications for UHD HMDs include simulation and training for almost any type of vehicle operation, surgical simulation, scientific data visualization, and entertainment applications such as immersive arcade games. HMDs are used in all these fields, but widespread adoption is currently hindered by lack of resolution and narrow fields of view. Eventually, displays using DTI's technology could help fulfill the promise of highly immersive virtual reality headsets for consumer-level personal computers and game consoles.

DTI displays have been adopted by the video gaming industry. With the addition of second-party software, movies and games can be displayed in "virtual 3-D," created by the software and a DTI flat panel.

DTI also is working on a special cell phone prototype, and Lagergren predicts that cell phones will follow the same path as computers.

"Eventually, the platform is going to be the cell phone. You take any of the cell phone manufacturers' visions today, it's just like the vision for personal computers 23 or 24 years ago," Lagergren says.

And DTI plans to be there.

For more information, contact
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Please mention that you read about it in
Technology Innovation.

Small Businesses Provide Technology for Mars Exploration Rovers

Innovative technologies developed under NASA's Small Business Innovation Research (SBIR) program have supported the success of the Mars exploration rovers Spirit and Opportunity during their missions on the Red Planet.

These innovations include lithium-ion batteries, which power the rovers and function at low temperatures; thermal heat switches to moderate changes in battery temperature; and a technology for producing analog-to-digital integrated circuits on a chip for the communication system that can withstand the high-radiation environment of Mars. Technical management for these three SBIR contracts was provided by NASA Jet Propulsion Laboratory (JPL) in Pasadena, Calif.

Mars Rover

Lithium-ion batteries from Yardney Technical Products of Pawcatuck, Conn., were selected for the Mars Exploration Rover (MER) mission. Their high efficiency allows the use of weight-saving smaller batteries, a critical consideration in the design of the rovers. In addition, the batteries' ability to operate at low temperatures relaxes the requirement for heating, another important consideration. To

INNOVATIVE RESEARCH

meet the needs for power during the mission and the cold Mars nights, the batteries also store electrical energy from the solar panels.

Thermal heat switches from Starsys Research Corp. in Boulder, Colo., help regulate battery temperatures on the rovers. Surface temperatures on Mars range from -128 C (-199 F) during the polar night to 27 C (80 F) at the equator at midday, when Mars is closest to the sun. At a predefined temperature, the switches move thermal radiators into contact with the batteries to provide cooling. When the temperature drops, the thermal radiators are moved away from contact. The heat switches require no external inputs for operation. Expansion or contraction of paraffin at a specific temperature provides the driving force for the switch, or actuator. Paraffin undergoes a phase change when heated to a specific temperature, resulting in a significant increase in volume.

The Mars surface, a high-radiation environment, does not have the same protective atmosphere as on Earth. Atmospheric pressure is one hundredth that of Earth's. High-energy radiation striking electronic integrated circuits can result in parts failure. To help solve the problem, San Diego-based Maxwell Technologies developed technology that provides high-energy radiation protection for commercial integrated circuit designs. The technology was used to make analog-to-digital converter integrated circuits for the Mars rovers at a significant cost savings to the mission. The alternative, a one-of-a-kind integrated circuit designed and produced specifically for the Martian environment, would require considerable time and expense.

Through the SBIR program, the small-business community is working on technology to support future NASA missions as well as developing products for the private economy. ■

For more information, contact Byron Jackson at JPL's SBIR Program Office, (818) 354-1246, Byron.L.Jackson@jpl.nasa.gov.

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NASA Innovative Partnerships Network

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Center for Commercial Applications of Combustion in Space (CCACS)

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NASA Business Facilitators
NASA has established several organizations whose objectives are to establish joint-sponsored research agreements and incubate small startup companies with significant business promise.

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These organizations were established to provide rapid access to NASA and other federal R&D agencies and to foster collaboration between public- and private-sector organizations. They also can direct you to the appropriate point of contact within the Federal Laboratory Consortium. To reach the RTTC nearest you, call 800/642-2872.

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