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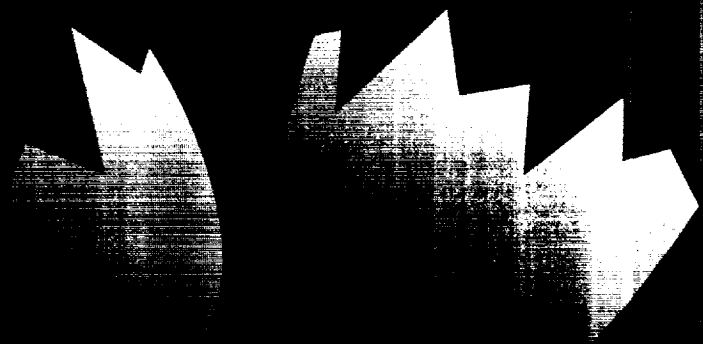
Aerospace Technology

INNOVATION

NASA Incubators Allow Business to Grow



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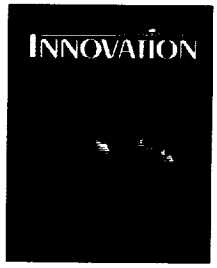

About the Cover:
NASA incubators help early stage businesses successfully launch new products that incorporate NASA technology.

Online Edition: Go to **http://nctn.hq.nasa.gov** on the World Wide Web for current and past issues.

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COMMERCIAL DEVELOPMENT MISSION UPDATE

Date*	Flight	Payload	Sponsor/Coordinator
4/01	STS-100 ISS Flight "6A"	Protein Crystal Growth (PCG) Generic Bioprocessing Apparatus (GBA) Advanced Astroculture	Center for Biophysical Sciences and Engineering BioServe Space Technologies Wisconsin Center for Space Automation and Robotics
11/01	STS-108 ISS Flight "UF-1"	Advanced ASTROCULTURE™ Zeolite Crystal Growth (ZCG) Microencapsulation Electrostatic Processing System (MEPS) Commercial Biomedical Testing Module (CBTM) Consortium Complex Autonomous Payload (CONCAP IV-4)	Wisconsin Center for Space Automation and Robotics Center for Advanced Microgravity Materials Processing Center for Space Power BioServe Space Technologies Consortium for Materials Development in Space

* As of January 2001.

WELCOME TO INNOVATION

Commercializing Technology: NASA's Incubator Program

By Julie A. Holland
Director, NASA Commercialization Center
California State Polytechnic University, Pomona

COMMERCIALIZING TECHNOLOGY IS A DAUNTing task. Of every 11 new product ideas, only one will successfully make it to the marketplace. Fully 46 percent of new product investment becomes sunk costs. Yet, a few good companies consistently attain an 80 percent technology commercialization success rate and have led the way in establishing best practices.

The NASA Incubator program consists of nine incubators, each residing near a NASA research center. The purpose of the incubators is to use the best practices of technology commercialization to help early stage businesses successfully launch new products that incorporate NASA technology.

THE INCUBATORS ARE A NOVEL NEW PROGRAM THAT EXTENDS THE COMMITMENT NASA HAS MADE TO COMMERCIALIZING ITS TECHNOLOGY FROM LICENSING AND SPONSORED RESEARCH TO A FULL COMPLEMENT OF PHYSICAL RESOURCES AND TECHNICAL ASSISTANCE.

The incubators are a novel new program that extends the commitment NASA has made to commercializing its technology from licensing and sponsored research to a full complement of physical resources and technical assistance. Most importantly, the nature of the technical assistance is matched to the complexities of navigating a successful new product design and launch.

The promise has always been there. NASA invests millions of dollars annually in basic and applied research in order to meet the objectives of its missions. The result is a rich source of technology either developed internally and available through licensing, or developed externally by a company through some form of NASA-sponsored research. This investment creates a significant source of emerging technology that can typically be demonstrated in at least one space-related application.

This is a very real opportunity for the small technology business. The high-risk period, including the discovery and early applied phases of an emerging technology's development, has been funded by NASA. Intellectual property rights can be secured. As significant as this contribution is, the complex process of commercializing is only beginning. It is at this interface that NASA's network of nine business incubators assumes responsibility.

The type of company that benefits most is the early stage technology company that wishes to license technology developed at one of the NASA Centers or already owns the intellectual property rights through a NASA-sponsored research agreement. Regardless of the genesis, the company intends to develop the technology and has the technical capacity to convert the research and early development phase to a fully applied environment. Typically, minimal effort has been put into confirming a viable market and establishing the business case.

The first overarching objective is to instill the best practice culture of market pull as opposed to technology push. It means moving from a mentality of "the technology works" to the reality of "who will benefit from using the technology."

The NASA Alliance for Small Business Opportunity (NASBO) launched late in 2000. The 12-month pilot is testing a commercialization support program in preparation for a national roll-out using NASA's network of incubators. This is yet another example of innovative initiatives available through NASA.

Whether a company is developing its own technology or seeking to license technology, the process is rigorous and requires both strategic and tactical expertise.

NASA's network of incubators provides a very real opportunity to convert technology commercialization risk into a reward by ensuring that there is continuity in the process and an extended application-oriented infrastructure. ✪

COVER STORY

NASA Incubators Allow Business to Grow

SINCE NASA'S FOUNDING IN 1958, THE agency's programs have sponsored and produced advanced research and technology involving a broad range of technical disciplines and industries.

Commercial and secondary use of this knowledge and innovation continues to generate great dividends and growth for U.S. enterprises and quality of life. The harvesting of NASA's technological resources originated with the Space Act of 1958 creating NASA, which mandated wide dissemination of the agency's research and development results. Today, NASA's commitment to sharing the results of NASA-funded research and technology is served by a network of technology transfer and commercialization organizations sponsored by and affiliated with NASA. This network, the NASA Commercial Technology Network, includes nine NASA-sponsored incubators, charged with accelerating the formulation, growth and success of small, technology-based companies, via the use of NASA research and development.

THE MAIN GOAL OF AN INCUBATION PROGRAM IS TO PRODUCE SUCCESSFUL GRADUATES, WHOSE BUSINESSES ARE FINANCIALLY VIABLE AND FREESTANDING WHEN THEY LEAVE THE INCUBATOR, GENERALLY IN TWO TO THREE YEARS.

NASA has made a major effort to provide technology commercialization opportunities to the private sector, but there are constraints on the amount of ongoing assistance NASA can provide to entrepreneurs once they obtain the rights to a NASA technology. The result is that a large percentage of entrepreneurs fail because they are not able to get the long-term technical and business-related advice and mentoring they need to be successful. Business incubation has become an important means for addressing this problem. According to the Impact of Incubator Investments Study in 1997, 87 percent of incubator graduates are still in business five years after completing the program.

NASA's incubators work with young businesses, helping them to survive and grow during the initial start-up period. Incubators provide hands-on management assistance, access to financing and exposure to critical business and technical services. The main goal of an incubation program is to produce successful graduates, whose businesses are financially viable and freestanding when they leave the incubator, generally in two to three years.

"The idea is to more directly impact commercialization by adding not just the licensing feature but also some instruction for small companies in product development. It was really marrying the field of business incubation with the technology commercialization objectives that NASA had," said Julie Holland, director of California State University, Pomona, NASA Commercialization Center.

The first NASA incubators—the Ames Technology Commercialization Center, affiliated with NASA Ames Research Center, and the University of Houston/NASA Technology Commercialization Incubator, affiliated with NASA Johnson Space Center—were founded in the early 1990s. According to Kevin Barquinero, a former NASA employee who served as the grant manager for the incubators' cooperative agreements, "The basis for choosing Ames and Johnson is they were the centers that were the most diametrically opposite. Ames is the most university-like, while Johnson is mission-oriented."

NASA partnered with the IC² Institute, operator of the Austin (Texas) Technology Incubator, one of the country's most successful incubators. Experiences gained by IC² from operating the Austin Technology Incubator were considered vital to the NASA Incubators.

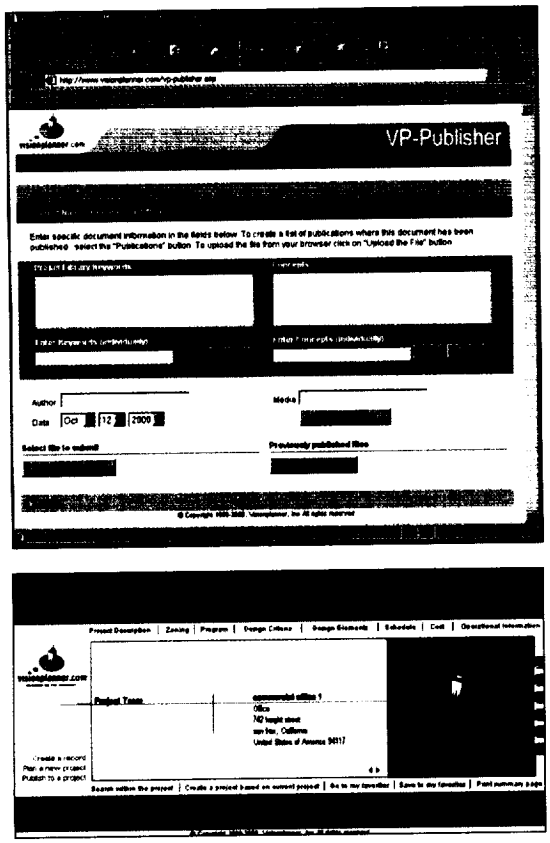
Barquinero also stated that IC²'s expertise involved partnering with the local community, including doctors, lawyers, bankers, marketing experts and accountants, to make NASA's incubators successful.

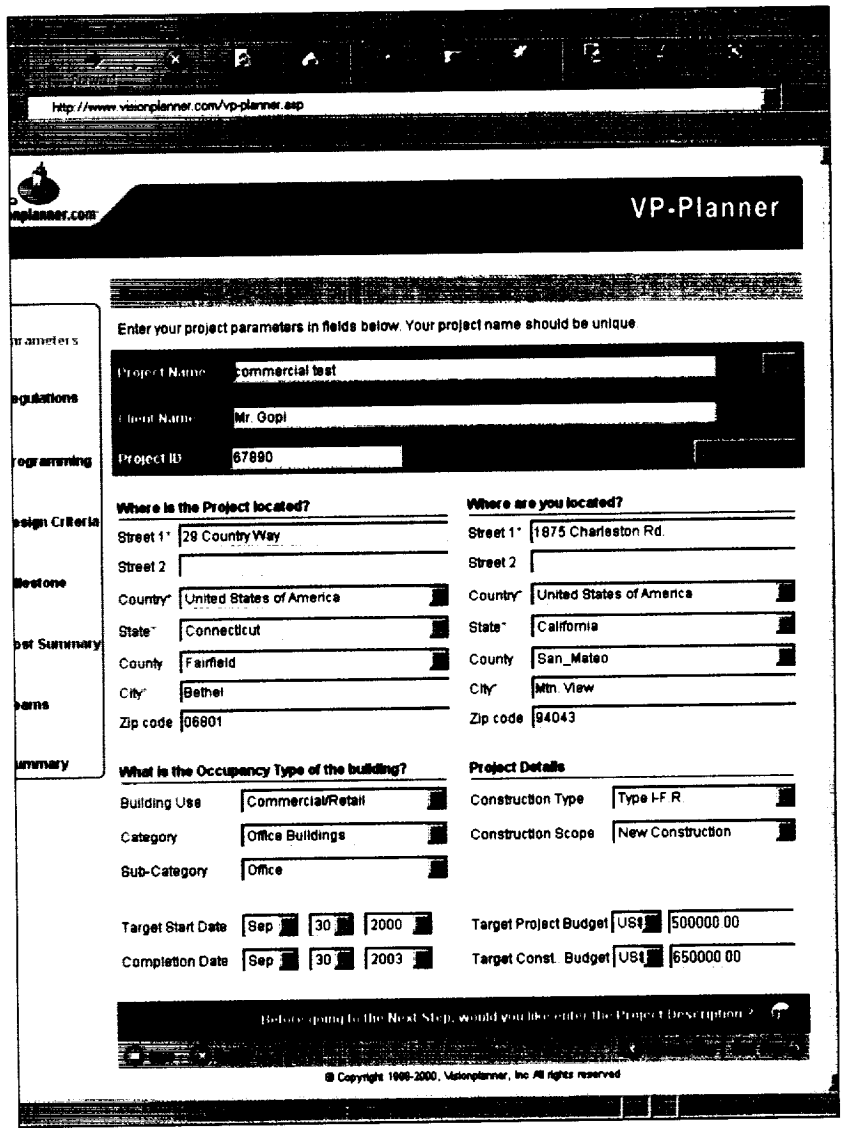
The nine NASA incubators, each affiliated with a NASA field center, function as separate entities, sharing ideas and best practices via conference calls, but with no formal network. In September 2000, eight of the nine incubators met at NASA Goddard Space Flight Center to craft a strategic plan. Calling them-

selves NASA Inc., the group worked to establish metrics to define their overall performance in terms of new companies, new licenses, new products and new investments. "We want to support each other in how we do things when they're effective," Holland said. "But we're also looking for ways that the group as a whole make a larger impact in terms of technology commercialization. We want to provide a national network for NASA."

The nine NASA incubators are located across the country. Eight incubators are affiliated with a single field center. The ninth is affiliated with two centers. The incubators are:

- Ames Technology Commercialization Center (ATCC), San Jose, California. A physical and virtual incubator, ATCC uses a lab-to-market approach which takes the technological output of NASA Ames Research Center's laboratories and pairs that technology with appropriate markets to create and foster new industry and jobs. *http://ctoserver.arc.nasa.gov/incubator.html*
- Business Technology Development Center (BizTech), Huntsville, Alabama. BizTech serves the Huntsville-Madison County community by creating new jobs, achieving technology transfer from the government labs to the commercial marketplace, and enhancing economic development in the area. BizTech's founding sponsors are NASA Marshall Space Flight Center, the Tennessee Valley Authority (TVA), the Alabama Department of Economic and Community Affairs (ADECA), the city of Huntsville, and Calhoun Community College. The facility is located





VisionPlanner streamlines the pre-planning stage of projects and upfront analysis. It was developed under the umbrella incubator program of The Enterprise Network, which operates the Ames Technology Commercialization Center, one of the first NASA incubators. Artwork provided by VisionPlanner, Inc.

on 40,000 square feet donated by Calhoun.
http://europa.uah.edu/biztech/index.html

- NASA Baltimore Incubator at the Emerging Technology Center (ETC), Baltimore, Maryland. NASA Baltimore Incubator provides commercialization and technology transfer assistance to Maryland universities, NASA Goddard Space Flight Center and federal laboratories seeking to create high technology ventures in the state of Maryland.
http://www.etcbaltimore.com
- Florida/NASA Business Incubation Center (FNBIC), Titusville, Florida. The FNBIC is housed on the Titusville, Florida, campus of Brevard Community College. It is managed through a joint partnership between the Technological Research and Development Authority, Brevard Community College and NASA Kennedy Space Center.
http://technology.ksc.nasa.gov/FNBIC
- Hampton Roads Technology Incubator (HRTI), Hampton, Virginia. HRTI was chartered to promote economic development of the city of Hampton Roads through the commercialization of new technologies developed at NASA Langley Research Center, local universities and other regional government and industrial research and development laboratories.
http://www.hr-incubator.org
- Lewis Incubator for Technology (LIFT), Cleveland, Ohio. LIFT is a business incubator program designed to nurture new and emerging technology-based businesses. LIFT, managed by Enterprise Development, Inc., is a cooperative effort of NASA Glenn Research Center, the Ohio Department of Development, the Great Lakes Industrial Technology Center and Enterprise Development, Inc.
http://www.liftinc.org
- Mississippi Enterprise for Technology, Inc (MsET), Stennis Space Center, Mississippi. MsET, located at NASA Stennis Space Center, is a private, non-profit organization dedicated to creating high-skill, high-wage jobs in Mississippi. MsET helps industry utilize the scientific and technical expertise, facilities and other resources of NASA and the U.S. Navy and their prime contractors, as well as federal laboratories, the Mississippi Department of Economic and Community Development and Mississippi colleges and universities. MsET operates a full-service, NASA-sponsored incubator program and partners with the Mississippi Space Commerce Initiative to develop remote sensing companies in an industry cluster at NASA Stennis Space Center.
http://www.mset.org
- NASA Commercialization Center (NCC), Pomona, California. Located at California State Polytechnic University, Pomona, NCC is jointly funded by the University and NASA. It is dedicated to helping small businesses access and commercialize technologies developed by NASA Jet Propulsion Laboratory and NASA Dryden Flight Research Center.
http://www.nasaincubator.csupomona.edu/home.html
- University of Houston/NASA Technology Commercialization Incubator, Houston, Texas. Located at the University of Houston, UH-NASA is jointly funded by the University and NASA. Its mission is to bring together technologies developed by NASA with the resources needed for additional development with the entrepreneurial interests to make technology transfer a commercial reality.
http://www.research.uh.edu/otm/techmanage.html

THE NASA BUSINESS INCUBATORS SUPPORT NASA'S COMMERCIAL MISSION BY PROVIDING SMALL BUSINESSES WITH ACCESS TO NEW TECHNOLOGY AND THE KNOWLEDGE TO USE THE TECHNOLOGY TO MAKE THEIR BUSINESS GOALS A REALITY.

Business incubation is a dynamic process of business enterprise development. The NASA business incubators support NASA's commercial mission by providing small businesses with access to new technology and the knowledge to use the technology to make their business goals a reality. ✱

For more information, contact The Enterprise Network (TEN) and Ames Technology Commercialization Center (ATCC), Dr. A. William Musgrave, Jr., President & Chief Operating Officer ✆ 408/557-6820 ✉ *bill@ten-net.org*, Jeanette Hazelwood, Corporate Communications ✆ 408/557-6879 ✉ *jeanette@ten-net.org*, Gopal Patwardhan, Director of Venture Development, ✆ *408/557-6716* ✉ *gopal@ten-net.org*. Please mention you read about it in *Innovation*.

CCT Continues Successful Commercial Growth

COMMAND AND CONTROL TECHNOLOGIES Corporation (CCT) is automating commercial, multi-vehicle spaceport launch control systems in four states, while it continues to support NASA. The company licensed the Control Monitor Unit (CMU) software technology from NASA in 1997 and is now developing three products. One is its signature product, the Command and Control Toolkit™ (CCTK). The T-Zero™ launch control software and the Spaceport RangeNet™ software augment the capabilities of the CCTK.

CCT Vice President Kevin Brown said his company now counts spaceport agencies in Florida, Alaska, Virginia and Washington among its customers. The Titusville, Florida company, a graduate of the Florida/NASA Business Incubator, has responded to proposal requests from 4 other state spaceport agencies, and is in discussions with 10 other states.

A major milestone occurred in December 2000 when the Spaceport Florida Authority used CCT's technology to successfully launch a suborbital Lite-Star rocket. The launch was designed to validate new hardware and procedures at Cape Canaveral Air Force Station's Launch Complex 20, a newly reactivated launch facility that is now available through the Spaceport Florida Authority to support a variety of small orbital and suborbital launch vehicles and "spaceport technology" programs.

Another major milestone occurred when CCT announced successful completion of acceptance testing and final delivery of spaceport operations software and computer systems at the Kodiak Launch Complex (KLC) in Alaska. KLC is the nation's first commercial spaceport not colocated with a federal facility. Acceptance testing was completed December 17, 1999 by the CCT field team on-site at KLC.

CCT was started in 1997 as a self-initiated spinoff of a three-person McDonnell Douglas Space Systems (now The Boeing Company) management team. The team and their staff had spent more than 10 years developing a high performance software technology on contract to NASA; one of their first acts upon starting CCT was to execute a Space Act agreement granting them rights to improve and sell the software to programs outside of NASA.

Today, CCT employs 20 personnel and has realized revenue growth of 350 percent from 1997 to 1999. The company spent its first three years as a tenant in the Florida/NASA Business Incubation Center, where it had access to a variety of business and technology resources. In April 2000, CCT moved its headquarters from the 900-square-feet of space in the incubator to a 4,400-square-foot office in Titusville, Florida, just outside the main gate of Kennedy Space Center (KSC).

CCT WAS RECOGNIZED AS THE NASA-KSC SMALL BUSINESS SUBCONTRACTOR OF THE YEAR FOR 1998 AND RECEIVED AN ECONOMIC DEVELOPMENT AWARD FROM A LOCAL ECONOMIC DEVELOPMENT AGENCY.

Brown said that CCT was recognized as the NASA-KSC Small Business Subcontractor of the Year for 1998 and received an economic development award from a local economic development agency. Most recently, CCT was named one of the 100 fastest growing companies in Florida by the fifth annual *Florida 100*.

The Spaceport Florida Authority recently entered into an agreement with CCT to provide a turnkey, state-of-the-art launch control system for Launch Complex 20 on the Cape Canaveral Spaceport. The new system will provide the spaceport with four launch controller stations, a state-of-the-art launch event sequencer, simulation software for testing and operator training, data archival and retrieval, vehicle commanding and live on-screen video. The system will be based on CCT's Command and Control Toolkit™ package augmented with the newly released T-Zero™ launch control software. The Spaceport Authority is considering an expansion of the system to include CCT's commercial range operations software. The Spaceport RangeNet™ software adds the capability to generate range maps, projected trajectories and range safety displays. During flight, the software obtains vehicle position information and

plots present position and instantaneous impact points for the entire mission.

NASA originally developed the CMU to provide a comprehensive array of capabilities for use in controlling and monitoring complex systems of equipment under development for the International Space Station (ISS). CCT has continued to support NASA in this effort and is currently involved with several new projects, including a Small Business Innovation Research (SBIR) project with NASA Ames Research Center. This project will concentrate on developing methods for managing the flight paths of reusable launch vehicles through commercial airspace. The flight management methods will encompass all phases of mission planning for reusable launch vehicle operations, including air traffic control, near-Earth and orbital airspace management, and abort site selection.

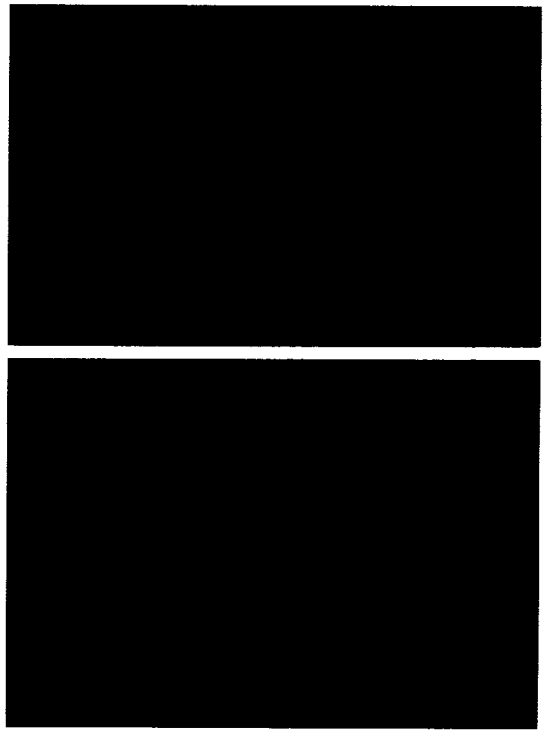
In September 2000, the NASA launch facility in Wallops Island, Virginia, ordered several CCT software products to determine if the maturity of the software is suitable for the high launch rates supported at their site. In addition, NASA awarded a $600,000 research contract to CCT to determine how to integrate flights of future reusable rockets (those that launch and then land similar to the Space Shuttle) into the nation's air traffic control system. In November, CCT joined as a subcontractor to The Boeing Company to help NASA with research at KSC. This study will address the feasibility of producing a portable payload test and verification system (PTVS) for the Space Shuttle and ISS. CCT is also involved in two other projects at KSC. One is providing consulting services, product maintenance and technical support for advanced life sciences technology and software. The other involves software tool development for testing ISS simulators. ✪

For more information, contact Tom Gould at NASA Kennedy Space Center ✆ 321/867-6238 ✉ *thomas.gould-1@ksc.nasa.gov* Please mention you read about it in *Innovation*.

How to Work in Your PJs

THINK YOU MUST DRESS FOR SUCCESS EVEN in the bold new world of telecommuting? Maybe not, even if your employer has a videophone to display your image.

A digital human-image animation computer system under development at NASA Jet Propulsion Laboratory (JPL) in Pasadena, California, can use the smallest units of speech, called phonemes, to manipulate a person's facial movements in an image. The system is driven by language rather than by manual animation controls. While development is in the early stages at this point, the eventual result will be photo-realistic animation of a person speaking.



Digital Personnel, a digital, voice-driven, human-image animation computer system under development at NASA Jet Propulsion Laboratory, will make it possible to use an image of any human face and make it appear to be speaking naturally. Photo provided by NASA Jet Propulsion Laboratory

"This is voice-driven, so the image morphs in response to a voice or equivalent input," said principal investigator John Wright of JPL. "Real-time animation is a key step in our development process. Unlike cartoon morphs, this technology uses video and facial movements of real people as its building blocks."

The system, called Digital Personnel, will make it possible to use an image of any human face and make it appear to be speaking naturally. With a videophone, it would be possible to have the option of always portraying the image you wish—no more "bad hair days." A celebrity figure appearing to speak might be another option for an image.

Communication capabilities are being designed for this technology to allow Digital Personnel to work efficiently over telephone as well as data lines. Lower bandwidth—the rate of data transmission, or bits per second—will be used by this system, compared to the bandwidth required to transmit real video images. This will allow broader use of the technology while also preserving the appearance of reality in the speaking facial image.

"Digital Personnel is next-generation technology using voice-driven animation of real human images," said Jerry Ruddle, vice president of sales and marketing at Graphco Technologies, Inc. in Newtown, Pennsylvania. "It will enable us to provide virtual personnel for commercial applications in numerous markets. Web-based customer support, with user-friendly speaking interfaces, is an important application for this technology. Along with other uses for human-like Web applications, we project video telephones, broadcasting, distance learning, video games and motion pictures will also create significant demand for this human-machine interface technology."

One application of the system might be an online help desk—a live voice projecting through a digital person would assist the user. The real support representative, while speaking, could leaf through documents with his or her head down. The Web image would be the digital person looking at and "speaking" directly to the user.

Digital Personnel could also enhance e-commerce by providing a user-friendly presence. Product demonstration, promotion and celebrity representation interaction would be possible with online customers.

"We are excited about the acquisition of this technology and about our collaboration with JPL on future development," said Cristian Ivanescu, chairperson and CEO of Graphco Technologies, Inc. "The Digital Personnel technology complements our market offerings for secure database and information-sharing systems for law enforcement, government and industry."

Graphco Technologies, Inc. has acquired the exclusive worldwide rights to Digital Personnel, a patent-pending technology that makes it possible to synthesize photo-realistic talking individuals for e-commerce and e-support. ✱

For more information, contact John Wright at NASA Jet Propulsion Laboratory, Principal Investigator on Digital Personnel ✆ 818/393-2706 ✉ *John.R.Wright@jpl.nasa.gov* Please mention you read about it in *Innovation*.

Active Particle Fallout Monitor Commercialized

THE AEROSPACE ENGINEERING GROUP (AEG) of IDEA, LLC is commercializing the Active Particle Fallout Monitor (APFM), an automated monitoring system that will benefit both NASA and private industry.

The Beltsville, Maryland-based company joined with NASA in January 1999 at Kennedy Space Center (KSC) in a Cooperative Agreement to commercialize the KSC-developed prototype. The private and government sectors targeted for marketing of the commercial APFM include the aerospace, aeronautical, semiconductor processing, electronics fabrication and medical industries, or anywhere that spaceflight hardware is processed or fabricated. AEG believes there is no limit to the types of industries that would benefit from the APFM. Any industry or business that requires or has an interest in monitoring the level of fallout contamination will be targeted. This also could potentially include hotels, apartment complexes, corporate buildings or any environment where the air quality concerns occupants to the point that facility managers want to provide an air quality level of assurance. AEG's marketing plan calls for the production and sales of 300 units in early 2001.

AEG enhanced the innovation after setting up office and laboratory operations at the Palm Bay, Florida, Open Access Cleanroom through negotiations with the Florida/NASA Business Incubation Center. The company has experience in developing contamination-sensitive spaceflight hardware and is aware of the potential problems that can result from fallout. The one-year agreement called for AEG to evaluate the system capability and performance, its market potential, quantify system reliability and improve system performance. This work culminated in production of a manufacturing prototype and accumulation of data contained in a final project report that was furnished to NASA.

NASA is using AEG's new APFM in the KSC Space Station Processing Facility (SSPF) to monitor components for the International Space Station (ISS). The components are being prepared for flight on the ISS in cleanrooms. Validation testing

of the system in the SSPF demonstrates that the technology performs as well and better than existing methods of particle detection.

Particle fallout is a source of contamination that is a concern by NASA and aerospace-related industries. Depending on the type and size of the particles, fallout can be a source of contamination that can affect the performance of sensitive spaceborne instruments and support equipment. NASA, at KSC and other centers, has been aware of this issue for several years and has sought to develop different types of monitoring systems that are designed to quickly alert spacecraft and spaceflight hardware developers and customers of possible fallout problems.

NASA developed and patented an instrument that directly images, sizes and counts contamination particles. AEG obtained license rights to the instrument and another patented KSC-developed technology to help with the project. One is an exclusive license to commercialize the "Detector for Particulate Surface Contamination" (now called the APFM), developed by the NASA Contamination Monitoring Laboratory (CML) and the former KSC Engineering Support Contractor, I-NET, Inc. The second license is non-exclusive for the "Particle Fallout/Activity Sensor," also developed by CML and I-NET.

Traditionally, measurement of the particle fallout contamination level in a facility is accomplished by placing a witness plate in the area where particle fallout is to be measured for several weeks. The plate is then transported to a laboratory where particles are manually counted under a microscope. This process is tedious, time-consuming and prone to human error, including errors caused by handling and transportation of the witness plates.

The APFM is a quantitative particle fallout monitor that measures the size and number of particles that are collected on a surface representing contamination collecting on surfaces at the point of use. The APFM can measure particles from 5 to 750 microns in diameter and calculate their contribution to percent area coverage. The instrument correctly processes irregularly shaped particles as well as fibers, and provides a quantitative measure of the cleanliness of a room according to MIL Standard 1246.

The APFM allows manufacturing personnel to take actions to eliminate contamination before it becomes a major problem. The APFM consists of two units—a processor and associated sensor heads. It works by using two CMOS imaging sensors (cameras) to examine a surface and determine the number and size of particles that are being deposited on that surface. ✱

For more information, contact Tom Gould at NASA Kennedy Space Center ✆ 321/867-6238 ✉ Thomas.Gould-1@ksc.nasa.gov Please mention you read about it in *Innovation*.

KSC TEAM WINS TECHNOLOGY AWARD

The Federal Laboratory Consortium (FLC), Southeast Region, recently presented an award for "Excellence in Technology Transfer" to three NASA Kennedy Space Center (KSC) employees for developing and commercializing the "Gas-Liquid Supersonic Cleaning and Cleaning Verification Spray System" technology.

"We are very proud of our people who won this award. It is a first for KSC but it won't be the last," said Ken Payne, director of the Spaceport Engineering and Technology Directorate. "As we progress toward being a true spaceport technology development center, we will have many additional opportunities to share our technology with industry to make life better for humankind."

Eric Thaxton and Raoul Caimi received the FLC award, and along with the late Gary Lin, developed the Gas-Liquid Supersonic Cleaning System to perform precision cleaning and cleanliness verification of complex Space Shuttle mechanical and electronic parts. The system uses a supersonic gas-liquid jet instead of CFC-113 solvents.

This technology was needed to replace freon and chlorofluorocarbons (CFCs), because of new laws targeting their use. The technology was also needed to reduce other cleaning solvent use.

Dr. Ron Barile, a scientist with Dynacs, Inc., the KSC Engineering Development Contractor, continues to perform the majority of needed testing, verification and modifications.

Three private companies are licensed to commercialize the Gas-Liquid Supersonic Cleaning technology, thanks to Melanie Chan, licensing manager with the KSC Technology Programs and Commercialization Office, who received the third FLC award. She worked with the innovators to transfer the technology.

CryCle Cryogenic Development, Inc. of the Netherlands became the first foreign firm to license a NASA invention patented in the United States.

Preferred Engineering of Danbury, Connecticut, licensed the system for use in nuclear power plant maintenance.

Va Tran Systems of Chula Vista, California, a leader in carbon dioxide precision cleaning, was interested in the system's ability to remove hydrocarbon contamination.

The FLC cited the benefits and significance of the technology transfer when announcing the award. ✱

For more information about the Gas-Liquid Supersonic Cleaning System, please see "Kennedy Space Center Technology Cleaning Up" in the May/June 2000 issue of *Innovation*. For more information, contact Tom Gould at NASA Kennedy Space Center ✆ 321/867-6238 ✉ *Thomas.Gould-1@ksc.nasa.gov* Please mention you read about it in *Innovation*.

NASA and FEMA Partner to Prevent Disasters

NASA AND THE FEDERAL EMERGENCY MANagement Agency (FEMA) recently signed a Memorandum of Understanding (MOU) and joined in partnership on a major natural disaster initiative.

The initiative is affiliated with Project Impact: Building a Disaster-Resistant Community. The cooperative agreement will result in updated and more accurate maps of floodplains, a better understanding of wildfires, and maps to improve disaster recovery and mitigation by state and local communities throughout the United States.

Under the new partnership arrangement signed by NASA Administrator Daniel S. Goldin and former FEMA Director James Lee Witt, NASA and FEMA will apply science, technology and remote sensing research images of Earth taken by satellites to emergency management issues on the ground, such as mapping of floodplains and earthquake fault lines, and observation of wildfires and other natural hazards.

"This new partnership between NASA and FEMA demonstrates the diverse and wide-ranging applications of NASA's Earth science research and technology and its benefit to the American people," said Dr. Ghassem Asrar, Associate Administrator for Earth Sciences, NASA Headquarters, Washington, DC. "The Office of Earth Sciences is eager to form new partnerships with other government agencies such as FEMA, as well as with industry and public groups to expand America's use of our Earth science data."

"I am extremely happy to have NASA as a Project Impact partner," said Witt. "Using the technologies by NASA for disaster prevention will help in saving lives and make communities all across America disaster-resistant."

The agreement outlines a first cooperative effort to map floodplains in California's Los Angeles basin; around Sacramento, California; Virginia Beach, Virginia; the Red River along the North Dakota and Minnesota borders; and San Francisco, California. Using laser-imaging and radar-mapping data, NASA and FEMA are evaluating technology for creating more accurate maps of these areas that will help state and local officials model and understand drainage and run-off, which are vital to their disaster preparedness. Local communities will benefit from these precise maps by better understanding the physical characteristics of their communities.

Former FEMA Director James Lee Witt (left foreground) and NASA Administrator Daniel S. Goldin (right foreground) signed an agreement to use space technology to aid disaster prevention. NASA photo.

At the same time, NASA Earth scientists will gain valuable data for technology development, validation and calibration of satellites and the understanding of land use, land cover and flood hazards. America's flood insurance industry also will benefit from the accuracy of these new maps, which will provide more precise views of flood-threatened areas.

As the agreement is implemented, NASA researchers and their FEMA colleagues will use a variety of public and private satellites and aircraft-mounted Earth-observing instruments. These efforts will help in understanding issues such as soil permeability and saturation, which affect how much water during a flood would likely be absorbed, as opposed to remaining above the ground and possibly causing damage to crops, houses and communities.

"THIS NEW PARTNERSHIP BETWEEN NASA AND FEMA DEMONSTRATES THE DIVERSE AND WIDE-RANGING APPLICATIONS OF NASA'S EARTH SCIENCE RESEARCH AND TECHNOLOGY AND ITS BENEFIT TO THE AMERICAN PEOPLE."

Satellite imagery also can provide state and local officials with maps of vegetation in areas prone to wildfires. This information can be used by firefighters to determine which types of plants are more likely to fuel wildfires and better predict what paths such fires may take.

Using airplanes and spacecraft that observe characteristics of Earth invisible to the naked eye, researchers can better see characteristics of Earth's surface that are changing and can indicate where earthquake fault lines or volcanoes may be expanding, which is vital data for understanding and preparing for these dangerous phenomena.

The partnership between the space program and FEMA is part of NASA's Earth Science Enterprise, a coordinated research program that studies Earth's land, oceans, ice, atmosphere and life as a total sys-

NATIVE AMERICANS LEARNING FROM GLOBAL INFORMATION SYSTEM

"Fundamentals of Remote Sensing," a course taught by a geology professor at the University of Cincinnati in Ohio is now available at Minnesota's Leech Lake Tribal College (LLTC), thanks to a partnership between NASA Glenn Research Center (GRC) and the OhioView Consortium.

Dr. Richard Beck will use a televideo conferencing facility to link up with the Geographical Information System (GIS) Laboratory at LLTC in Cass Lake, Minnesota. The remote sensing course started at the beginning of January.

As part of the collaboration, Native American Remote Sensing, Inc. (NARSINC) and the Water Resources Office at the Leech Lake Reservation will develop a custom GIS with five applications: wild rice harvesting, maple syrup tapping, fish and wildlife management, water resource management and map digitizing for reservation boundaries.

GRC's electrical engineering technician, David R. Plumer, is the Native American Liaison for the project selected by the NASA Native American Advisory Council, an advisory group managed by GRC's Office of Equal Opportunity. Plumer will organize communication between the various partners in the project: GRC, NARSINC, LLTC and the University of Cincinnati.

The OhioView Consortium is an educational outreach program in remote sensing that is designed to increase awareness, develop applications and decrease costs. Partners include GRC, the U.S. Geological Survey EROS (Earth Resources Observation Systems) Data Center, OhioLINK, the Ohio Supercomputer Center, OARnet (Ohio Academic Resources Network), NREN (NASA Research and Education Network) and a consortium of eight Ohio universities. The eight universities are: Bowling Green State University, Ohio University, the University of Cincinnati, Kent State University, The Ohio State University, Miami University of Ohio, the University of Akron and the University of Toledo.

The OhioView Consortium has recently become a nationwide organization and is called AmericaView. There are presently 20 states in the consortium.

For more information on the new LLTC course, please visit *http://www.lltc.org, http://gateway2earth.org* or *http://www.narsinc.com*

tem. This initiative is part of an aggressive new strategy devoted to significantly increasing the application of NASA remote sensing data, information, science and technologies to societal needs, ensuring maximum return on taxpayer investments.

For more information, contact David Steitz at NASA Headquarters 202/358-1730 *dsteitz@hq.nasa.gov* Please mention you read about it in *Innovation*.

Emergency Vehicle Warning System Tested

A SYSTEM DEVELOPED FOR E-VIEWS, INC., with the help of the Technology Affiliates Program at NASA's Jet Propulsion Laboratory (JPL) in Pasadena has been approved for testing in Monrovia, California. The city council has approved an agreement with E-Views to develop and implement an Emergency Vehicle Intersection Early Warning System that will alert drivers to approaching emergency vehicles to reduce the potential for traffic collisions.

The E-Views system involves the installation of transponders in several police and fire emergency vehicles and the installation of visual display boards on traffic signal mastarms above the centers of the intersections in Monrovia, California.

The transponders will communicate via microwave with receivers on the display boards. As the emergency vehicle approaches the intersections, the police officer or firefighter activates the transponder, which automatically turns the traffic light to yellow, then red, for cross traffic.

The intersections' visual warning display signs will also be activated and approaching drivers will see bright flashing vehicle warning symbols on the displays informing them of the direction from which emergency traffic is approaching, from as far as 3,500 feet. The lighted icons will appear to move across the displays synchronized with the actual emergency vehicle's movement.

Monrovia Chief of Police Joe Santoro, reporting to the City Council on the project, said, "When responding to emergencies with red lights and sirens, emergency vehicles present a serious traffic hazard to themselves and other vehicles and pedestrians while passing against traffic through an intersection. Confusion, inattention, mobile phones, car radios, hearing impairment, distracting children and failure to hear sirens and see flashing lights are just a few of the many causes of serious accidents that result in multi-million-dollar lawsuits against cities and states."

Santoro said that in the United States alone, more than 156,000 accidents involving emergency vehicles occurred at intersections from the early 1980s to 1995, resulting in 6,550 deaths. National Safety Board statistics show that 40 percent of firefighters killed in the line of duty died in accidents on the way to an incident. The majority of these accidents are at intersections.

In 1997, Santoro reported, more than 15,000 accidents with emergency vehicles responding to emergency calls occurred in the United States, resulting in 8,000 injuries, 500 fatalities and millions of dollars in liability claims and vehicle repairs.

Through JPL's Technology Affiliates Program, large and small businesses can work with JPL engineers to solve specific tasks. Upon joining this innovative program, E-Views, formerly E-Lite Limited, partnered with JPL engineers with specialized expertise to solve engineering design issues. These included not only E-Views' customized transponders, but also comprehensive designs that blend with existing city communications infrastructures.

The Technology Affiliates Program is just one of several JPL technology transfer programs designed to bring the benefits of the space program to American industry.

For more information, visit the Commercial Technology Program's Web site at *http://techtransfer.jpl.nasa.gov* or contact Conrad Foster, technical group supervisor at NASA Jet Propulsion Laboratory 818/354-5070 *Conrad.Foster@jpl.nasa.gov* Please mention you read about it in *Innovation*.

NASA Robotics Could Help Spinal Cord Patients

NASA ENGINEERS AND NEUROPHYSIOLOGISTS from the University of California, Los Angeles (UCLA), are creating a robot-like device that could help rehabilitate thousands of Americans each year with spinal cord injuries.

"We are developing a prototype robotic stepper device that, when testing is complete, will become

the basis of a rehabilitation approach that can potentially help some people now wheelchair-bound take their first steps," said Jim Weiss, program manager for collaborative neural repair at NASA Jet Propulsion Laboratory (JPL), Pasadena, California. "This system can do the work of three therapists and help monitor patient progress in a controlled manner."

The device, still in the developmental phase, will look like a standard treadmill with robotic arms attached to the front. The treadmill will be used in conjunction with a suspension harness used to variably support the patient's weight while walking on the moving treadmill. The arms attach to the patient's legs and ankles using mechanisms resembling knee braces that guide the legs properly on the moving treadmill.

"WE ARE DEVELOPING A PROTOTYPE ROBOTIC STEPPER DEVICE THAT, WHEN TESTING IS COMPLETE, WILL BECOME THE BASIS OF A REHABILITATION APPROACH THAT CAN POTENTIALLY HELP SOME PEOPLE NOW WHEELCHAIR-BOUND TAKE THEIR FIRST STEPS."

The robotic stepper device is one of several projects in the Neural Repair Program supported by the UCLA Brain Research Institute and JPL. UCLA neurologists now believe that by using the robotic stepper device as a rehabilitation approach, many patients functionally confined to wheelchairs currently may be able to learn to walk again, and those with limited movement could improve their level of functional walking. Researchers emphasize the robotic stepper is still under development and is not yet ready for use in rehabilitation. However, the device could be part of clinical trials at UCLA by 2004.

"We see tremendous potential for rehabilitation that uses this form of therapy," said Dr. Reggie Edgerton, Professor in the Departments of Physiological Science and Neurobiology at UCLA. "Some rehabilitation centers around the world are starting programs that will allow therapists to train individuals afflicted with spinal injuries, stroke and perhaps other neuromotor disorders to improve their mobility and stepping capacity," Edgerton said. "This robotic device could help therapists in those rehabilitation efforts."

Current rehabilitation therapies are labor-intensive, requiring up to four therapists per patient. Unlike therapists, who can only estimate and observe a patient's progress, the robotic device takes precise force, torque, acceleration and resistance measurements of the patient's movement, assessing each step the patient takes on the moving treadmill. These precise measurements would help therapists monitor the day-to-day progress of their patients and provide valuable information on the effectiveness of the therapy. These measurements will be analyzed every millisecond by a model-based control system to assist the therapist in controlling the therapy.

JPL robotic engineers have worked alongside UCLA neurophysiologists and therapists to develop the device, which has highly sensitive sensors that collect up to 20 different data readings per leg while the patient is walking on the moving treadmill. The device, connected to a computer, displays the information on a screen for therapist monitoring and assessment of the patient's progress.

According to Weiss, the same device could also be useful in helping to maintain normal astronaut movements in differing microgravity situations, and then help retrain them to walk normally prior to their return to Earth after prolonged periods in space, such as extended missions on the International Space Station.

JPL and UCLA are actively pursuing efforts to commercialize the robotic system. JPL technically supported UCLA in filing a patent application in August.

"Many technologies developed at NASA for space exploration have tremendous medical applications. We can provide practical solutions based on our engineering experience," said Dr. Antal Bejczy, senior research scientist and lead engineer on the robotic stepper device at JPL. ✱

For more information, contact Jim Weiss at ✆ 626/354-5420 ✉ *James.R.Weiss@jpl.nasa.gov* Please mention you read about it in *Innovation*.

"Lifeboat" Lands Safely

THE WORLD'S LARGEST PARAFOIL CARRIED AN advanced X-38 test craft to a touchdown on November 2, 2000 at NASA Dryden Flight Research Center at Edwards, California.

This was the first flight test of the final configuration of the X-38 atmospheric test vehicle that included a rounded aft end, identical to the shape of the X-38 spaceflight vehicle now under construction at NASA Johnson Space Center, Houston, Texas. A space test of an uncrewed X-38 is planned for August 2002 when it will be released from a Space Shuttle to fly back to Earth.

Released from under the wing of NASA's B-52 aircraft at an altitude of 36,500 feet, the X-38 had a flight control problem that resulted in a 360-degree roll following the drop from the B-52. As scheduled, at 24 seconds into the flight the X-38's 80-foot diameter drogue parachute was deployed and the vehicle recovered from the roll.

The flight test also featured a 7,500-square-foot parafoil with a surface area more than one-and-a-half times that of the wings of a 747 jumbo jet. A second problem occurred at 19,000 feet when the parafoil began its deployment while the X-38 was in a nose up attitude. However, the parafoil deployed without damage and flew to a safe touchdown less than half a mile from the original target. Touchdown speed was less than 40 miles an hour. "Today our design faced a test. Most systems worked well, some didn't," said X-38 program manager John Muratore. "We're going to take the results of this test, improve the design, and we will be back to test it again. That's the nature of flight testing," he added.

The X-38 is a prototype "lifeboat" for the International Space Station, designed to carry up to seven passengers home from orbit in an emergency. The project combines proven technolo-

The X-38 vehicle 131R demonstrates a huge 7,500 square-foot parafoil that will enable the Crew Return Vehicle (CRV) to land on the length of a football field after returning from space. The CRV is intended to serve as an emergency transport to carry a crew to safety in the event of problems with the International Space Station. Photo provided by NASA Dryden Flight Research Center.

gies—a shape borrowed from a 1970s Air Force lifting body project—with some of the most cutting-edge aerospace technology available today, such as the most powerful electric motors ever used to control a spacecraft.

An innovative approach is enabling the X-38 to be developed at a tenth of the cost of past estimates for such a project. Although the United States leads the development of the X-38, international space agencies also are participating. Contributing nations include Germany, Belgium, Italy, the Netherlands, France, Spain, Sweden and Switzerland. ✱

For more information, contact Leslie Williams at NASA Dryden Flight Research Center ✆ 661/276-3893 ✉ *leslie.williams@dfrc.nasa.gov* Please mention you read about it in *Innovation*.

NASA Center Opens New Office

NASA HAS CREATED A NEW PROGRAM office to lead efforts to enable development of a new reusable launch vehicle for flight in 2010 that will be dramatically safer and less expensive than today's rockets.

The new Second Generation Reusable Launch Vehicle (RLV) Program Office at NASA Marshall Space Flight Center in Huntsville, Alabama, is part of NASA's Space Launch Initiative and an integral part of the agency's Integrated Space Transportation Plan.

Other elements of the plan include upgrades for safety of NASA's first generation RLV—the Space Shuttle—and developing technologies for third and fourth generation transportation systems.

The office, charged with identifying requirements and developing technologies for the second generation RLV, is seeking proposals from industry and academia to reduce the business and technical risk associated with developing the next-generation reusable launch system. The proposals are a step toward enabling development of a launch system beginning in 2005, leading to an operational system that will dramatically increase safety and reduce the cost of spaceflight.

The second generation RLV program will build on NASA's former X-33, X-34 and current X-37 program testing new materials, structures, propulsion, computers and other technologies needed to meet the program's goal of significantly increasing safety to a 1 in 10,000 chance of loss of life and reducing payload launch costs from $10,000 per pound today to $1,000 per pound.

"We hope that this program will give a boost to America's efforts to build a safer and more economical 'highway to space,' make the multi-billion-dollar commercial space industry a clear world leader and stimulate competition—all for the good of the economy, as well as our nation's future space exploration plans," said Dan Dumbacher, manager of the Second Generation RLV Program Office.

Earlier this year, NASA solicited industry proposals and awarded contracts to define national mission needs and top-level system requirements to meet safety and cost goals for a second generation RLV. They were the springboard for the five-year, $4.5 billion effort to reduce the risk associated with building and operating next-generation launch systems. The effort also is aimed at enabling more than one commercial option for private ownership and operation of reusable launch vehicles, as well as opening additional market opportunities for getting cargo to the International Space Station.

NASA field center roles in the new program include: Marshall for program management, propulsion, cryogenic tanks; Langley Research Center, Hampton, Virginia, for airframe development; Ames Research Center, Moffett Field, California, for thermal protection systems and automated vehicle health monitoring; Kennedy Space Center, Florida, for ground operations; Dryden Flight Research Center, Edwards, California, for flight testing; Johnson Space Center, Houston, for crew systems and flight operations support; Glenn Research Center, Cleveland, for subsystems and propulsion support; and Stennis Space Center, Mississippi, for engine systems testing. The U.S. Department of Defense also will be involved in defining requirements and coordinating technical activities for the Second Generation RLV Program. ✱

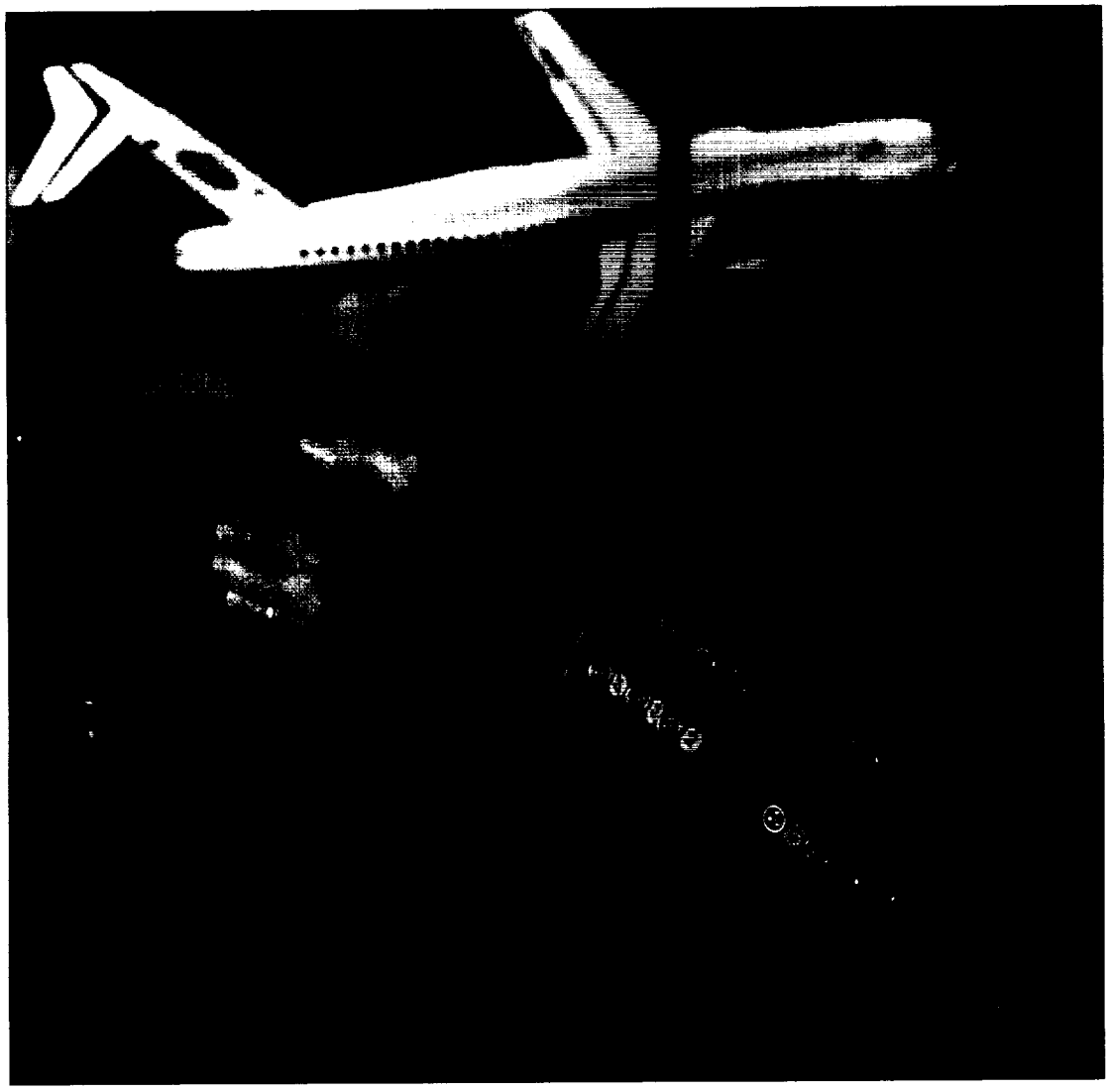
For more information, contact Rosalie Allen, Manager, Program Planning and Development, Space Transportation Directorate, NASA Marshall Space Flight Center ✆ 256/544-0117 ✉ *Rosalie.W.Allen@msfc.nasa.gov* Please mention you read about it in *Innovation*.

Hands-Off Approach Lands Passenger Jet

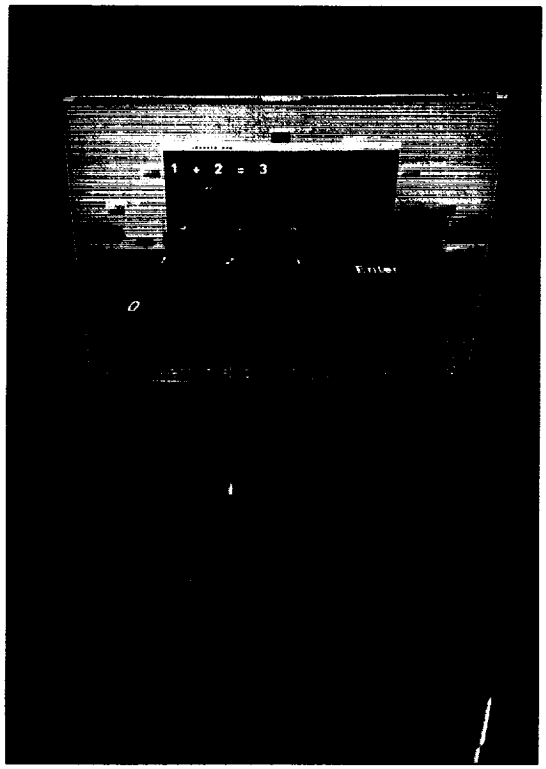
IMAGINE BEING ABLE TO LAND A JUMBO JET without ever taking control of the stick. NASA scientists recently demonstrated the ability to control a 757 passenger jet simulation, using only human muscle-nerve signals linked to a computer.

Scientists outfitted a pilot with an armband implanted with eight electrodes. The sensors read muscle nerve signals as the pilot made the gestures needed to land a computer-generated aircraft at San Francisco International Airport in California. The pilot also demonstrated the ability to land a damaged aircraft during emergency landing drills. The work was reported in the October 2000 proceedings of the World Automation Congress.

"This is a fundamentally new way to communicate with machines—another way to talk with our mechanical world," said the paper's principal author, Dr. Charles Jorgensen, head of the Neuroengineering Laboratory at NASA Ames Research Center, Moffett Field, California. The other authors are fellow Ames researchers Dr. Kevin Wheeler and Dr. Slawomir Stepniewski. "This new technology is significant in that bioelectric control of computers can replace computer keyboards, mice and joysticks for some uses," Jorgensen added.



A pilot outfitted with an armband implanted with eight electrodes was able to land a computer-generated aircraft. Photo provided by NASA Ames Research Center.



Scientists at NASA Ames Research Center's Neuroengineering Laboratory recently demonstrated the ability to control a 757 passenger jet simulation, using only human muscle-nerve signals linked to a computer. Photo provided by NASA Ames Research Center.

"In the experiment, a pilot closes his fist in empty air, makes movements and creates nerve signals that are captured by a dry electrode array on his arm," said Jorgensen. "The nerve signals are analyzed and then routed through a computer, allowing the pilot to control the simulated airplane."

The pilot sees the aircraft and control panel projected on a large, dome-shaped screen while flying the aircraft.

Engineers made the first prototype armband from exercise tights, and used metallic dress-buttons as dry electrodes. "An advantage of using bioelectric machine control is that human nerve signals can be linked directly with devices without the aid of joysticks or mice, thereby providing rapid, intuitive control," Jorgensen added. "This technology also is useful for astronauts in spacesuits who need to control tools in space."

Bioelectric control uses "neural net" software that "learns" patterns that can slowly change and evolve with time, as well as combining many patterns together to generate a response.

Nerve signal patterns, each of which is potentially as unique as a fingerprint, are a perfect application for neural net software. A particular nerve-signal pattern tells muscles to move in a certain way. A computer can match each unique nerve-signal pattern with a particular gesture, such as making a fist or pointing. Scientists designed software that can adjust for each pilot's nerve patterns, which can be affected by caffeine use, biorhythms, performance stress and the amount of fat under the skin.

To demonstrate bioelectric muscle control of the simulated 757 airplane during emergencies, researchers combined this technology with two other NASA developments, the ability of the neural net software to learn to fly damaged airplanes and propulsion-only landing of aircraft.

In about one-sixth of a second, a computer onboard a damaged aircraft can "relearn" to fly a plane, giving the pilot better control. Severe damage, such as partially destroyed wings, fuselage holes or sensor failures greatly alters how an airplane handles, and a pilot's controls may respond oddly or might not work at all, according to Jorgensen.

"When we combined the three technologies, the bioelectrically wired pilot took the simulated aircraft into landing scenarios with a cascading series of accidents, first locking rudder controls and then progressing to full hydraulic failure," said Jorgensen. "For each case, successful landings were demonstrated for autopilot, damaged and propulsion-only control."

The Neuroengineering Laboratory is also studying the use of direct measurements of brain electrical activity or EEG to control computers and other devices. Dr. Leonard Trejo is training test subjects to change their own brain activity for use as a command signal to select items from a computer menu or to navigate through complex data displays. Sensors in a lightweight headset, much like the headphones of a portable CD player, amplify tiny electrical signals generated by the brain and transmit them to a computer, where they are converted into signals that can be used for control. In the future, it may be possible to combine direct brain control and nerve-muscle control in a completely hands-free interface such as a wearable cockpit. ✸

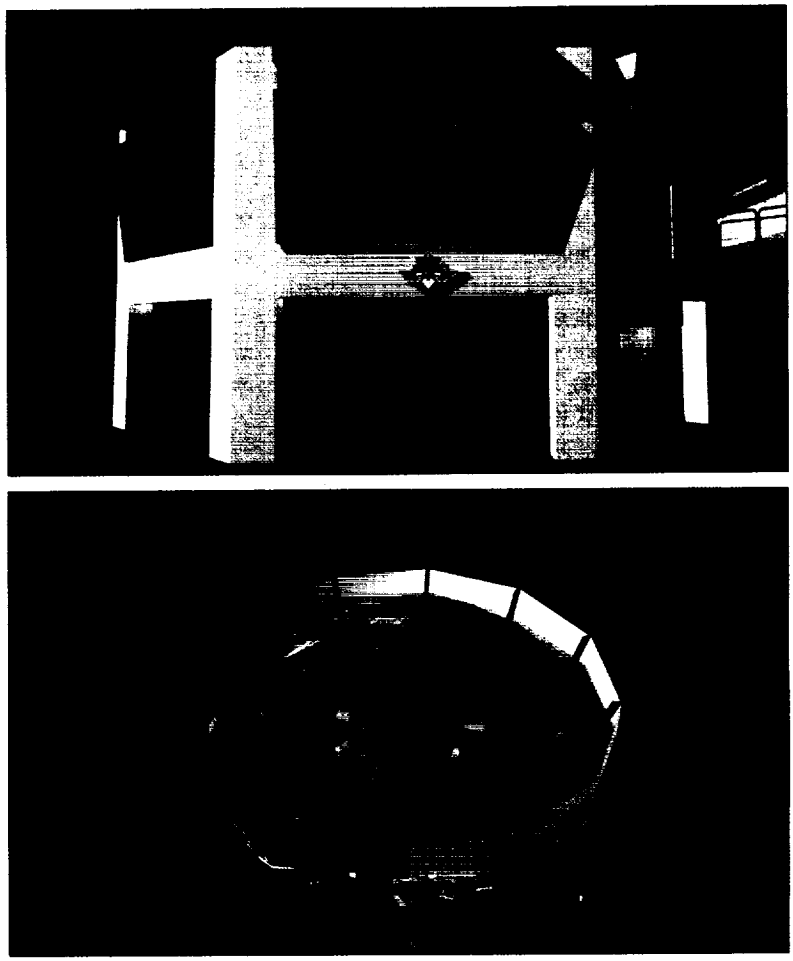
For more information, contact Phil Herlth, Technology Commercialization Manager at NASA Ames Research Center ✆ 650/604-0625 ✉ *pherlth@mail.arc.nasa.gov* Please mention you read about it in *innovation*.

AIRPORT TOWER SIMULATOR WINS AWARD

Popular Science magazine editors recently recognized FutureFlight Central, NASA's airport tower simulator, in the aviation and space category of the magazine's "Best of What's New" contest.

FutureFlight Central, a virtual reality simulator, can replicate the complete operation of an airport from the point of view of the air traffic control tower. The simulator is helping planners test ways to reduce airport delays, increase capacity and maintain safety.

"Airport planners who use our simulator can test solutions to critical problems in the safety of a virtual world," said Nancy Dorighi, manager of the FutureFlight Central simulator at NASA Ames Research Center, Moffett Field, California. "FutureFlight Central not only uses modern computer technology, but also permits controllers, pilots and ground personnel to perform their jobs during the simulations. That allows those people to influence decisions that later will affect them on the job," Dorighi said.



FutureFlight Central, which can replicate the complete operation of an airport from the point of view of the air traffic control tower, recently received an award from Popular Science *magazine The simulator is helping planners test ways to reduce airport delays, increase capacity and maintain safety. Photo provided by NASA Ames Research Center.*

FutureFlight Central can house as many as a dozen air traffic controllers, and it can represent the busiest U.S. airport towers in size and capability. The facility is a walk-in, full-scale, 360-degree simulator that can realistically test new patterns of ground traffic, new tower locations and many other airport factors in a realistic, computerized world.

"We can represent any airfield in existence, or as planned for the future," Dorighi said. "We can measure the impact of a change on the airport's capacity, and let the controllers try it first-hand, all before anything is built."

In FutureFlight Central, scenes evolve in the same manner that real-world changes occur. Airplanes come and go, and weather changes. Controllers use a simulated radio system, radar displays and other familiar tools. ✱

More FutureFlight Central information is on the Internet at *http://ffc.arc.nasa.gov*

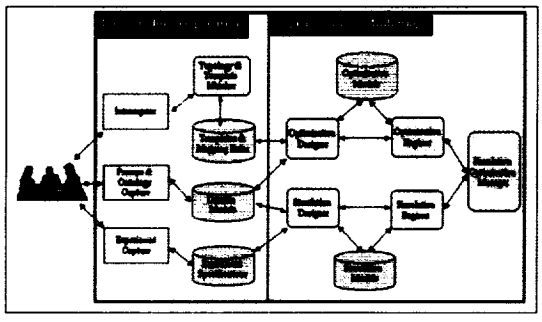
Expert Software Product Commercialized

A TEXAS COMPANY SPECIALIZING IN ARTIFICial intelligence applications is marketing an expert software system developed under a Small Business Innovation Research (SBIR) contract with NASA Kennedy Space Center (KSC).

Knowledge Based Systems, Inc. (KBSI), of College Station, Texas, is commercializing the Optimization Modeling Assistant (OMA) within its ProSim™ simulation tool. KBSI is a dynamic analysis, modeling and systems software development company specializing in business redesign and corporate integration software and services. KBSI provides tools, training and consulting for a wide range of enterprise needs, including business process analysis, project and cost management, activity-based costing, process and data modeling, discrete event simulation, workflow optimization and functional analysis.

The OMA is a knowledge-based software tool that facilitates optimization model development. It provides intelligent assistance for developing optimization models from structured domain descriptions. The intended users of the tool include domain experts who are unfamiliar with or novices at using optimization techniques to solve their problems. The tool provides knowledge-based assistance to users in the various steps of the model development process, like knowledge acquisition, simplification, model design, interpretation of results and sensitivity analysis.

KBSI innovator Dr. Perakath Benjamin believes that the OMA will result in an increase in the use of optimization models in solving various manufacturing, operations planning, logistics, scheduling and business engineering problems. ProSim™ is marketed as a state-of-the-art process modeling tool that can visually capture corporate knowledge of key processes and allows the user to create animated simulations and visualizations of workflow, index the distributed corporate information sources with a process knowledge map, publish the knowledge base on the World Wide Web, package and distribute standardized process knowledge with the ProSim™ viewer and show cross organization processes with swimlane.



Knowledge Based Systems, Inc. is commercializing an expert software system developed under an SBIR contract with NASA Kennedy Space Center. Photo provided by NASA Kennedy Space Center.

The OMA was developed under an SBIR contract with KSC. The project's approach applies knowledge-based systems techniques to the automation of the optimization design process. ProSim™ has been used at KSC for modeling shuttle flow process. OMA optimization tools are currently targeted for integration with the KSC Spaceport Systems Processing Model. The University of Central Florida is working with KSC on this simulation model. Other federal efforts are using and extending OMA at Tinker Air Force Base and at the Corpus Christi Army Depot.

The OMA supports the automatic design of an optimization model from management's description of a problem and statement of a set question that needs to be answered. The project attempts to improve the capability of domain experts to provide accurate descriptions of their systems, situations or problems; improve the productivity of experienced optimization analysts in technique selection, model design and execution; facilitate effective communication between domain experts and optimization analysts; and automate the design of executable optimization models. ✱

For more information, contact Tom Gould at NASA Kennedy Space Center ✆ 321/867-6238 ✉ *Thomas.Gould-1@ksc.nasa.gov* Please mention you read about it in *Innovation*.

SBIR Program Reauthorized

SOMETIMES EVEN THE BEST-LAID PLANS GO awry. That is exactly what happened to NASA's (SBIR) Program during the fall of 2000. The program had planned to award its program year 1999 Phase II contracts (which had been selected in late August) in early November. It had planned to announce its selections for program year 2000's Phase I contracts on October 13, with contract negotiation and award to be completed by mid-December. However, the Congressionally mandated SBIR Program's authorization expired on September 30, 2000, and the reauthorization got caught up in the end of the Congressional year, which was further exacerbated this year by the uncertainty of the Presidential elections.

Because NASA could not be certain that the SBIR Program reauthorization language would end up in a bill that was actually passed by Congress and signed by the President, it was determined that the program could not move forward with awards unless and until the program was fully reauthorized. That reauthorization was accomplished on December 21, 2000, as part of the Consolidated Appropriations Act of 2000.

NASA quickly moved forward to make both the selections and awards that had been held up. The Program Year 2000 Phase I selections were announced on December 22, 2000, with negotiations and awards scheduled to be completed by February 16, 2001. The vast majority of Program Year 1999 Phase II contracts were quickly finalized, with most signed and underway by early January.

The reauthorization extends the program for an additional eight years, through September 30, 2008. In addition, the major elements of the program remain unchanged. The amount of funding for the program is held constant at 2.5 percent of each participating agency's extramural R&D budget and the three-phase structure of the program is also unchanged.

There were several improvements made to the program in the new legislation. The most important of these may be the improved protection of the small business's intellectual property rights through the Phase III process. In addition, there is a new program entitled the Federal and State Technology Partnership, or FAST Program. This program will provide local mentoring and support programs for companies interested in pursuing SBIR contracts or grants. The funding for the FAST Program will be initiated at the state level with matching funds provided by the federal government.

Other improvements to the program include further development of electronic data management that will assist firms with commercialization efforts as well as identifying business mentors. The National Research Council was directed to conduct comprehensive studies of the SBIR Programs at agencies, including NASA, with SBIR budgets of more than $50 million. The studies will attempt to determine how the SBIR Program has stimulated technological innovation and used small businesses to meet federal research and development needs.

Although there was a fairly significant delay in getting the program reauthorized, the NASA SBIR Program has tried hard to catch up and get back on track. There are two final adjustments that will occur in the near future. The first will be the selection of approximately 28 additional Program Year 1999 Phase II awards. Due to the delay in reauthorization, there was a level of uncertainty about the NASA SBIR budget for the current fiscal year. After the program's status became clear, the final budget determination, which increased the budget by several million dollars, was made.

The second significant adjustment to the future schedule is being made to complete the catch-up effort. That adjustment is a modification of the Program Year 2001 schedule. Originally, the SBIR Solicitation was scheduled to come out in May of 2001. That date has been moved up and the 2001 Solicitation will open on March 28; the full Solicitation will be available on the SBIR Program's Web site at *http://sbir.nasa.gov* The Solicitation will close on June 6, 2001. ✱

For more information, visit the SBIR Web site at *http://sbir.nasa.gov*

SMALL BUSINESS PROJECTS SELECTED

Developing a new class of deep-sea vehicles for sample collection is just one of the 280 research proposals NASA has selected for Phase I contract awards as part of its Small Business Innovation Research (SBIR) Program. The combined total of the awards is expected to be more than $19 million.

The goals of the SBIR Program are to stimulate technological innovation; increase the use of small business, including women-owned and disadvantaged firms, in meeting federal research and development needs; and increase private sector commercialization of federally funded research results.

NASA received 1,847 proposals, submitted by small, high-technology businesses from across the country. The proposals were reviewed for technical merit and feasibility, as well as relevance to NASA research and technology requirements. The selected firms will be awarded fixed-price contracts valued up to $70,000 each to perform a six-month Phase I feasibility study.

Companies that successfully complete the Phase I activities are eligible to compete for Phase II selection the following year. The Phase II award allows for a two-year, fixed-price contract in an amount up to $600,000.

Research into the development of the new class of deep-sea vehicles project is being undertaken by Deep Sea DNA of Point Richmond, California. The object of the research is to reduce the costs of deep-sea exploration and retrieval of biological and geological samples via the development of a new generation of deep-sea craft. The vehicles will be simple to operate, easily controlled and tracked and have efficient communications systems. NASA's interest in deep-sea exploration is based in the astrobiology program, which includes the study of the origin, evolution and distribution of life in the universe. Astrobiology provides a biological perspective to many areas of NASA research, linking such endeavors as the search for habitable planets, exploration missions to Mars and Europa, efforts to understand the origin of life and planning for the future of life beyond Earth.

The NASA SBIR Program Management Office is located at NASA Goddard Space Flight Center, Greenbelt, Maryland, with executive oversight by NASA's Office of Aerospace Technology, NASA Headquarters, Washington, DC. Individual SBIR projects are managed by NASA's ten field centers. ✱

For more information, contact Michael Braukus at NASA Headquarters ✆ 202/358-1979 ✉ *mbraukus@hq.nasa.gov* Please mention you read about it in *Innovation*.

TECHNOLOGY OPPORTUNITY SHOWCASE

Moving Forward

Technology Opportunity Showcase *highlights some unique technologies that NASA has developed and that we believe have strong potential for commercial application. While the descriptions provided here are brief, they should provide enough information to communicate the potential applications of the technology. For more detailed information, contact the person listed. Please mention that you read about it in* Innovation.

Thin Film Heat Flux Sensor

NASA Glenn Research Center is seeking partnerships with industry for aerospace and non-aerospace applications for the purpose of transferring the process for fabricating thin film heat flux sensors. Benefits of the sensors include the fact that they can measure heat flux at temperatures up to 1,700 degrees F; can be fabricated directly on parts without cutting into the part; are minimally intrusive in engines; are of small mass, so high frequency measurements can be made; provide accurate knowledge of heat loading on critical propulsion system components; and can measure heat fluxes up to 88 BTU/ft^2 sec. The heat flux sensor has now been incorporated into a multi-function sensor that measures strain magnitude and direction, surface temperature, and heat flux. Potential commercial uses include measuring heat flux incidents on ceramic engine parts and rocket engine parts, measuring heat flux in automotive engines and aircraft engines, measuring furnace output, detecting fires, and for calorimetry.

Heat flux is measured by using temperature sensors (thermocouples) to determine the temperature difference across a test material. This is accomplished by fabricating a thermopile (two or more thermocouples connected in series) on the surface of a material. The thermopile is arranged so that the junctions are in concentric circles. The outer set of thermopile junctions is coated with a thin insulator and the inner one with a thick insulator. Heat passing through the insulators produces a different temperature at each set of junctions. The incident heat flux is directly proportional to this temperature difference. The thin film heat flux sensors are fabricated as a plug-type sensor on the surface of a ceramic material. They can also be fabricated directly on the surface of a part such as a turbine blade. Contact pads for the purpose of making connections to a data system are built into the heat flux sensor. Vacuum radio frequency sputtering technology and photolithography are used to fabricate the sensor. All components are thin films, so the total sensor thickness is in the 0.0004- to 0.004-in. range. ✱

For more information, contact Gus Fralick at Glenn Research Center ✆ 216/433-3645 ✉ *Gustave.C.Fralick@grc.nasa.gov* Please mention you read about it in *Innovation*.

High-Performance, Durable Actuators for Demanding Applications

NASA Langley Research Center is seeking to license a Macro-Fiber Composite (MFC) technology that is a high-performance, cost-competitive, easily manufactured piezoelectric strain actuator. This proven technology produces controlled motion when stimulated by a driving voltage or generates a potential when strained. The MFC actuator may be embedded in or attached to the surface of a flexible structure for distributed deflection, vibration control and strain sensing. Benefits of the technology include that it is made of commercial, off-the-shelf materials; is flexible, durable and damage-tolerant; conforms to surfaces; and is readily embeddable. It features increased strain actuator efficiency; directional actuation/sensing; low-cost, repeatable manufacturing processes; an environmentally-safe sealed package; and demonstrated performance.

Potential applications include use in helicopters for vibration suppression, rotor blade control and noise reduction; aircraft for buffet alleviation on rudders and air foil shaping; spacecraft for vibration suppression; actuators for shape changing, autofocusing, structural stiffening and micropositioning; sensors for dynamic structural health monitoring, direct mechanical-to-electrical conversion and accelerometers; and automobiles for speakers, interior noise abatement, braking and speed control.

The actuator is made by slicing a wafer of piezoelectric ceramic into closely spaced rectangular segments by using conventional wafer-dicing methods common to the semiconductor industry. The resulting segmented sheet is sandwiched between layers of adhesive and electroded polyimide film. This film contains interdigitated electrodes to transfer the applied voltage to the piezoelements. This assembly enables in-plane poling-alignment of randomly oriented grains found in the material to a desired electric field, actuation and sensing in a sealed, durable, ready-to-use package.

NASA Langley has filed for patent protection on the MFC manufacturing method and actuator, and offers licensing opportunities for this technology. ✱

For more information, contact Marisol Garcia at NASA Langley Research Center ✆ 757/864-5355 ✉ *m.e.garcia@larc.nasa.gov* Please mention you read about it in *Innovation*.

NCTN DIRECTORY

Moving Forward

NASA Field Centers

Ames Research Center
Selected technological strengths are Information Technologies, Aerospace Systems, Autonomous Systems for Space Flight, Computational Fluid Dynamics and Aviation Operations.

Carolina Blake
Ames Research Center
Moffett Field, California 94035-1000
650/604-1754
cblake@mail.arc.nasa.gov

Dryden Flight Research Center
Selected technological strengths are Aerodynamics, Aeronautics Flight Testing, Aeropropulsion, Flight Systems, Thermal Testing and Integrated Systems Test and Validation.

Jenny Baer-Riedhart
Dryden Flight Research Center
Edwards, California 93523-0273
661/276-3689
jenny.baer-riedhart@mail.dfrc.nasa.gov

Glenn Research Center
Selected technological strengths are Aeropropulsion, Communications, Energy Technology and High Temperature Materials Research, Microgravity Science and Technology and Instrumentation Control Systems.

Larry Viterna
Glenn Research Center
Cleveland, Ohio 44135
216/433-3484
Larry.A.Viterna@grc.nasa.gov

Goddard Space Flight Center
Selected technological strengths are Earth and Planetary Science Missions, LIDAR, Cryogenic Systems, Tracking, Telemetry, Command, Optics and Sensors/Detectors.

George Alcorn
Goddard Space Flight Center
Greenbelt, Maryland 20771
301/286-5810
george.e.alcorn.1@gsfc.nasa.gov

Jet Propulsion Laboratory
Selected technological strengths are Deep and Near Space Mission Engineering and Operations, Microspacecraft, Space Communications, Remote and In-Situ Sensing, Microdevices, Robotics, and Autonomous Systems.

Merle McKenzie
Jet Propulsion Laboratory
Pasadena, California 91109
818/354-2577
merle.mckenzie@jpl.nasa.gov

Johnson Space Center
Selected technological strengths are Life Sciences/Biomedical, Spacecraft Systems, Information Systems, Robotic and Human Space Flight Operations.

Charlene Gilbert (Act)
Johnson Space Center
Houston, Texas 77058
281/483-0474
charlene.e.gilbert@jsc.nasa.gov

Kennedy Space Center
Selected technological strengths are Emissions and Contamination Monitoring, Sensors, Corrosion Protection and Biosciences.

Jim Aliberti
Kennedy Space Center
Kennedy Space Center,
Florida 32899
321/867-6224
jim.aliberti-1@kmail.ksc.nasa.gov

Langley Research Center
Selected technological strengths are Aerodynamics, Flight Systems, Materials, Structures, Sensors, Measurements and Information Sciences.

Sam Morello
Langley Research Center
Hampton, Virginia 23681-0001
757/864-6005
s.a.morello@larc.nasa.gov

Marshall Space Flight Center
Selected technological strengths are Materials, Manufacturing, Nondestructive Evaluation, Biotechnology, Space Propulsion, Controls and Dynamics, Structures and Microgravity Processing.

Vernotto McMillan (Act)
Marshall Space Flight Center
Huntsville, Alabama 35812
256/544-2615
vernetto.mcmillan@msfc.nasa.gov

Stennis Space Center
Selected technological strengths are Propulsion Systems, Test/Monitoring, Remote Sensing and Nonintrusive Instrumentation.

Kirk Sharp
Stennis Space Center
Stennis Space Center, Mississippi
39529-6000
228/688-1914
kirk.sharp@ssc.nasa.gov

NASA's Business Facilitators

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

Joseph C. Boeddeker
Ames Technology Commercialization Center
San Jose, CA
408/557-6789

Greg Hinkebein
Mississippi Enterprise for Technology
Stennis Space Center, MS
228/688-3144

Wayne P. Zeman
Lewis Incubator for Technology
Cleveland, OH
216/586-3888, 216/229-9445

Thomas G. Rainey
Florida/NASA Business Incubation Center
Titusville, FL
407/383-5200

Celeste Moore
University of Houston/NASA Technology Center
Houston, TX
713/743-0451

Joanne Randolph
Business Technology Development Center
Huntsville, AL
256/704-6000, ext. 202

Richard C. (Michael) Lewin
Department of Business and Economic Development
Greenbelt, MD
800/541-8549

Julie A. Holland
NASA Commercialization Center/California State Polytechnic University
Pomona, CA
909/869-4477

Martin Kaszubowski
Hampton Roads Technology Incubator
Hampton, VA
757/865-2140

Ann Lansinger
Merger Technology Center NASA Business Incubator
Baltimore, MD
410/327-9150

Small Business Programs

Carl Ray
NASA Headquarters
Small Business Innovation Research Program (SBIR/STTR)
202/358-4652
cray@hq. nasa.gov

Paul Mexcur
Goddard Space Flight Center
Small Business Technology Transfer (SBIR/STTR)
301/286-8888
paul.mexcur@pop700.gsfc.nasa.gov

NASA-Sponsored Commercial Technology Organizations

These organizations were established to provide rapid access to NASA and other federal R&D agencies and 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.

Ken Dozier
Far West Technology Transfer Center
University of Southern California
213/743-2353

Dr. William Gasko
Center for Technology Commercialization
508/870-0042

David Bridges
Economic Development Institute
Georgia Institute of Technology
Atlanta, GA 30332
404/894-6786

Gary F. Sera
Mid-Continent Technology Transfer Center
Texas A&M University
409/845-8762

Charlie Blankenship
Technology Commercialization Center, Inc.
Newport News, VA 23606
757/269-0025

Pierrette Woodford
Great Lakes Industrial Technology Center
Battelle Memorial Institute
440/734-0094

Joseph P. Allen
National Technology Transfer Center
Wheeling Jesuit University
800/678-6882

Dan Winfield
Research Triangle Institute Technology Applications Team
Research Triangle Park, NC
919/541-6431

NASA ONLINE

Go to the **NASA Commercial Technology Network (NCTN)** on the World Wide Web at ***http://nctn.hq.nasa.gov*** to search NASA technology resources, find commercialization opportunities and learn about NASA's national network of programs, organizations and services dedicated to technology transfer and commercialization.

Multimedia

Classroom of the Future Offers New Program— "Astronomy Village: Investigating the Solar System" is now available as a multimedia program supplement for current middle school science curricula. The program allows students to visit a virtual community and choose from one of two core research topics: "Search for Life" and "Mission to Pluto." Each investigation encourages students to participate in scientific inquiry individually or as members of a group. The software program allows the students to learn problem-solving skills along with the science lessons. Produced and developed by NASA's Classroom of the Future (COTF), the project was developed with support from the National Science Foundation (NSF) and with additional support from NASA. The software evolved from "Astronomy Village: Investigating the Universe," a program that was released by the COTF in 1996. For more information or to obtain a copy of "Astronomy Village: Investigating the Solar System," contact the Center for Education Technologies at (304) 243-4416 or view the Web site at *http://www.cotf.edu.*

Events

The ***National Technology Transfer Center*** (NTTC) will hold the Summer Session of its annual Technology Commercialization Training Series June 4–7, 2001. The training will be held at the NTTC, located at Wheeling Jesuit University in Wheeling, West Virginia. Courses scheduled for the summer session include Commercializing Technologies and Technology Assessment. Both courses include two days of instruction and continuing education credits are available. Course objectives for Commercializing Technologies include: defining technology transfer and technology commercialization; listing key pieces of legislation that promote technology transfer and commercialization; explaining the technology adoption lifecycle and why the commercialization of technology is important; outlining the steps in forming a commercialization team; defining the major elements of the commercialization process in the private sector; analyzing a technology, outlining the next stage in the commercialization process and listing solutions to obstacles to the commercialization of a sample technology; describing the elements of a commercialization plan; and developing a commercialization plan for a sample technology. Course objectives for Technology Assessment include: an introduction to technology assessment, concepts involved in researching commercial opportunities, portfolio review and technology inventory process, opportunity assessment, commercialization strategy, and technology assessment case study. For more information about the series, visit *www.nttc.edu/train* or call 1-800-678-NTTC (6882). ✱

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