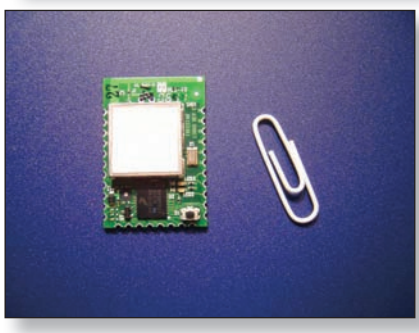
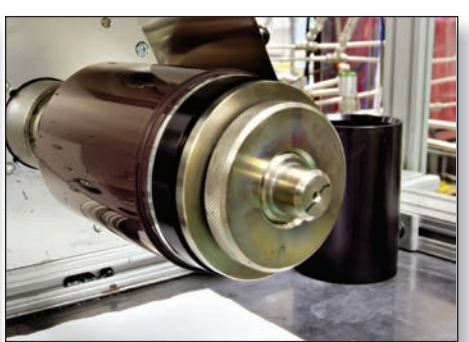
DARPA SBIR/STTR Success Reports

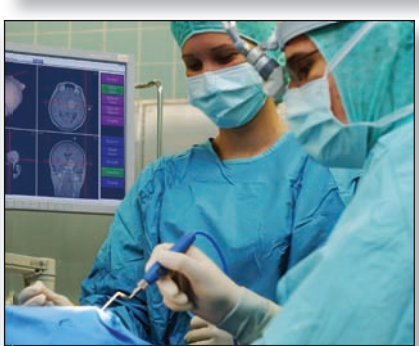
Volume 2

Advancing
state-of-the-art
defense technology

www.darpa.mil/sbir







Contents

Acknowledgement

Each year, small businesses participating in the DARPA Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs tackle "DARPA hard" problems. Through commitment, dedication, innovative thinking and entrepreneurship, these small businesses continue to have a vital role in supporting DARPA's mission to maintain the technological superiority of the U.S. military and prevent technological surprise from harming our national security.

The technologies and solutions described in this SBIR/STTR Success Report booklet illustrate the range of important problems being addressed by DARPA and the benefits of applying the innovative technologies and solutions developed by these small businesses into operational environments. Some of these companies have also successfully developed technologies for dual-use applications—both for the military and for civilians—which include a decision support tool for emergency first responders, a patient monitoring device for healthcare providers, and energy-efficient lighting.

Transitioning technology beyond Phase II and into operational environments is extremely challenging. We thank the small businesses whose success stories are published in this booklet for sharing their transition pathways, challenges and valuable lessons learned so others may benefit from their experiences.

This DARPA SBIR/STTR Success Reports booklet was produced by the Foundation for Enterprise Development, La Jolla, CA (*www.fed.org*).

Introduction

DARPA's mission is to maintain the technological superiority of the U.S. military and prevent technological surprise from harming our national security. DARPA funds researchers in industry, universities, government laboratories and elsewhere to conduct high-risk, high-reward research and development projects that will benefit U.S. national security. This funding supports research in a wide variety of scientific disciplines. When a DARPA research program is completed, the technology is available to the military services and to defense contractors for use in military systems.[1]

Small businesses are active participants in DARPA research programs. In addition to responding to DARPA's Broad Agency Announcements (BAAs), one of the main programs through which small businesses can participate is the Small Business Innovation Research (SBIR) program, which was established by Congress in 1982 to provide high-tech small businesses with less than 500 employees access to Federal research and development (R&D) funding. Small businesses also participate through the Small Business Technology Transfer (STTR) Program, which was established by Congress in 1992. The STTR Program funds cooperative R&D projects between small businesses and not-for-profit research institutions such as universities to move research to the marketplace.

Under Phase I, the first phase of the SBIR and STTR Programs, DARPA provides up to $99,000 for a 6 to 12-month effort to test the merit and feasibility of a particular concept. If Phase I proves successful, DARPA may invite the company to submit a Phase II proposal for a 24-month effort of up to $750,000 to further develop the concept and achieve specific technical milestones. The ultimate goal of both programs is to reach Phase III, in which companies must obtain funding outside of DARPA to further develop the concept into a product, process or service to sell in commercial and military markets. Phase III is essential to maturing the technology and understanding the issues involved in fielding it within relevant markets. While the responsibility for securing Phase III funding lies with the company, DARPA works with the SBIR and STTR companies in support of transition activities and assists companies in meeting the needs of the military.

There are still many challenging scientific and technological problems yet to be solved. We hope each company's success story serves as motivation for SBIR and STTR companies to remain focused on their transition path and for new small businesses to consider participating in future SBIR or STTR solicitations.

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[1] DARPA. [Web site]. Available from http://www.darpa.mil/. Accessed 23 January 2009.

MobileCare™ Monitor—Non-Intrusive Health Monitoring for Post-Combat Wellness Management System

Technology-Infused Wristwatch Remotely Monitors Recovering Veterans and the Elderly

Technology and Innovation

Under this DARPA SBIR project, AFrame Digital developed a non-invasive, small, low power, and low cost ambulatory monitoring system. The MobileCare™ Monitor system consists of a wearable watch-like device containing various physiological and environmental sensors, a secured wireless data network, and a data storage and analysis system. Sensors monitor the patient's heart rate, temperature, activity, stability, and location, operating 24/7 to provide an active "safety net" for the patient.

The system is primarily to be used for monitoring and alert services for returning soldiers with traumatic brain injuries (TBI), burns, amputations, risk of infection, and posttraumatic stress disorder (PTSD), as well as services for the elderly. Using Bayesian and trend analysis, this integrated system can continuously monitor multiple physiological and environmental data collected by the sensors and analyze the relationships among multiple data streams. It provides immediate patient status, identifies anomalies, and generates and sends real-time alerts to caregivers about important changes in the medical status of a patient.

AFrame has received Phase II funding from DARPA to conduct field trials as part of the Innovative Model of Living (IML) project at Vinson Hall Retirement Community (VHRC), a veteran-focused senior healthcare facility. Rear Admiral Kathleen Martin (Ret.), CEO of VHRC, said, "The IML comes as a direct response to a clear message from VHRC residents that they want a living environment that allows them to age in place, prolonging their independence and quality of life." The system is also being tested at Brooke Army Medical Center (BAMC) and Walter Reed Army Medical Center (WRAMC) to fully understand the recovery patterns of trauma patients.

The MobileCare™ system is housed in a watch-like device which monitors a patient's status and transmits real-time alerts.

Joint Collaborations

The DARPA SBIR project supported building collaborations with BAMC, WRAMC, The US Army Institute for Surgical Research and the US Army Medical Research and Material Command for the research studies and validation of the system. In addition, research collaborations were established with a number of universities, including Virginia Tech, University of Virginia, and Virginia Commonwealth University/ Medical College of Virginia.

Lessons Learned

- Obtaining IRB approvals to collaborate with military research organizations under an SBIR is often a lengthy process, especially if the collaboration includes working with human subjects. Start the approval process as early as possible, and

AFrame Digital's MobileCare™ battery charger.

also include the approval process as a critical path in the project plan, budget and schedule.

- Conduct field trials as early as possible to obtain feedback from both military and civilian end-user communities (dual-use) so that system refinements can be incorporated into the final design. This is a key step to ensuring that the final product will best meet functional and operational requirements in both of these markets.
- Know your regulatory requirements (local, state and federal) and plan for these key compliance efforts as early as possible in the development schedule.

Economic Impact

The DARPA SBIR project provided funding to design and develop an initial prototype of the MobileCare Monitor system and to conduct field tests. This project directly helped the company receive private investments to support additional development activities.

The DARPA SBIR project was also instrumental in securing SBIR funding from the National Institutes of Health/National Institute on Aging (NIH/NIA) to apply the technology to the Non-intrusive Locomotion and Gait Stability Analysis Monitoring System for the Elderly, a research program focused on developing a system that can accurately detect a fall and, in fact, prevent falls by sending gait instability alerts to care providers.

AFrame Digital currently has a patent pending for the entire MobileCare Monitor System and has developed additional intellectual property associated with the monitoring and service components of the system. AFrame Digital's business model consists of a multi-year lease for the monitoring device and a monthly subscription fee for monitoring and alert services. AFrame is currently filing for pre-market notification with the FDA (510K clearance) to market the system in the U.S. The FDA 510K application will be submitted in December 2008.

About the Company

AFrame Digital was founded in 2005 to apply wireless technology and advanced analytics to long-term health monitoring and alerting systems. The company's executives and board bring a combination of experience from Fortune 50 companies and startups in the wireless business—including DHL/NetExpress, Freddie Mac, MCI, NYNEX, CyberCash (acquired by VeriSign), and Caspian Networks—and from a range of healthcare and military telemedicine research organizations. ■

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Founded: 2005
Number of employees: 6

Micro-Sensor System for 3-D Visualization of Robotic Medical Procedures

Micro Sensors Are Expanding Surgical Capabilities for Military

Ascension Technology Corporation
Making Minimally Invasive Possible

Technology and Innovation

To expand the use of robotics in surgical procedures, physicians need to know where surgical instruments are located within the human body. Ascension's micro sensors meet this requirement by tracking the tip of flexible endoscopes, catheters, probes, and other instruments. 3-D tracking enables instrument guidance, collision avoidance, system calibration, and improved procedural reliability.

Since the 1980s, medical researchers have explored using magnetic tracking devices to track the navigation of instruments, but the results have been disappointing. Sensor sizes were too large to attach to medical instruments, and nearby ferrous metal structures distorted the accuracy of the magnetic trackers. With DARPA funding, Ascension Technology Corporation focused on addressing those issues by:

- Miniaturizing magnetic field sensors from 5mm to 1.8 mm
- Developing a flat transmitter that can be placed beneath the patient to screen out metals—such as steel structures in operating room tables or rescue vehicles—and deliver a clear signal above its surface.

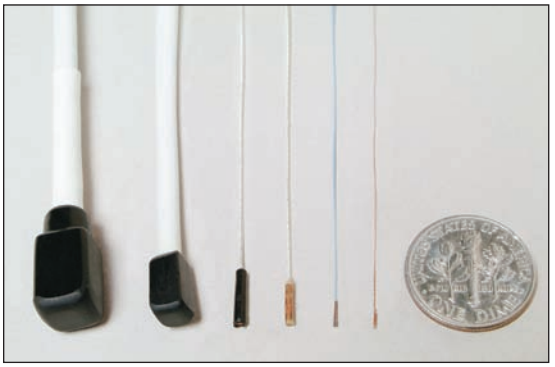
By combining these advances with Ascension's pulsed DC (direct current) magnetic technology, the company has produced a commercial medical system called *3-D Guidance*. It simultaneously tracks up to eight low-cost, disposable sensors, measures the position and orientation of each sensor in the patient, and generates data for 3-D visualization.

Ascension's micro sensors precisely localize and navigate medical instruments within a patient's body for image-guided procedures and visualization

3-D Guidance is currently undergoing evaluation by numerous medical device manufacturers for incorporation into minimally invasive and image-guided products. Based on feedback from potential users, Ascension is also modifying the design to include smaller sensors and developing transmitter configurations for different medical procedural arrangements. The first medical system using the new technology will be released in the near future.

For military applications, DARPA supported the incorporation of 3-D tracking technology into a larger robotics-based medical system that is being developed to triage and treat injured soldiers on the battlefield.

Ascension Technology Corporation



With DARPA support, Ascension has miniaturized magnetic field sensors from 5mm to 1.8 mm to facilitate the tracking of instruments within the body. Even smaller systems are now available.

Joint Collaborations

Since the company was founded, Ascension has collaborated with leading researchers to develop and advance 3-D tracking. The company's pulsed DC technology was initially developed in the late 1980s with funding from the U.S. Air Force. In the 1990s, the National Institutes of Health (NIH) funded the first level of sensor miniaturization. More recently, NIH funding has helped to improve the technology's accuracy and range of operation.

DARPA has also introduced Ascension to robotics companies developing innovative computer-assisted procedures.

Lessons Learned

- Identify and research DARPA program areas and requirements for new technology. This information will support targeted white paper and proposal development.
- Meet with DARPA program managers to discuss proposed concepts and gain valuable feedback on meeting DARPA's program requirements.
- Identify potential end-user applications that can drive development plans and lead to additional collaborations.

Economic Impact

DARPA SBIR has provided approximately 20% of the funding for development of Ascension's magnetic tracking technology. Along with other SBIR programs, it enabled Ascension to expand its technology into many military and medical configurations and enter the market for image-guidance of medical instruments.

Several medical companies have invested funds to configure 3-D Guidance tracking devices to meet their unique procedural requirements.

About the Company

Ascension Technology Corporation, located in Milton, Vermont, makes 3-D tracking devices for medical guidance, minimally invasive surgery, real-time visualization, and target acquisition. ■

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Ernest B. Blood, President and CEO
Founded: 1986
Number of employees: 37

Swarm Autonomous Routing Algorithms

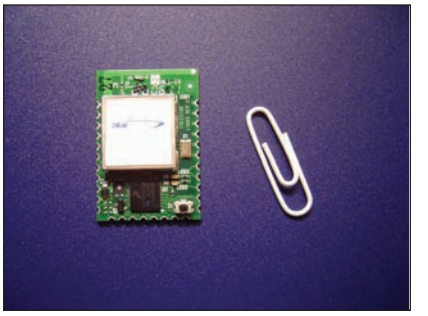
Swarm Routing Algorithm Opens Scalable Ways to Connect Battlefield or Emergency Communication Networks

Technology and Innovation

With the advent of portable computing and wireless communication, there has been increased attention to military and civilian applications for mobile ad hoc networks (MANETs) — infrastructureless, dynamic networks, formed spontaneously by wireless mobile nodes that communicate directly through each other. Most existing MANETs have performance shortcomings because their standards and routing protocols are based on those of wired and small, non-moving wireless networks. Therefore, they do not deal well with mobility, change, or the absence of a fixed network structure.

With DARPA SBIR support, along with matching funds from the U.S. Army Communications-Electronics Research, Development and Engineering Center (CERDEC), Bluetronix has developed a simple, reliable solution to a nagging challenge, Swarm Autonomous Routing Algorithm (SARA), to address shortcomings in MANETs. SARA's unique approach uses local data with neither a center point of control nor routing tables. By executing in a purely autonomous, distributed manner, SARA enables scalability to tens of thousands of nodes in a network, rapid initialization, and greater network efficiency. Bluetronix swarm differs from other approaches in that it needs no prior knowledge, learns as it communicates, is distributed in nature, and uses no access points, control points or routing tables.

With the swarm autonomous routing, MANETs offer many potential advantages over infrastructure-based networks. For example:



The ant-inspired Swarm Autonomous Routing Algorithm is built into Bluetronix's 802.15.4 swarm module.

- They self-organize, so they require no setup or configuration.
- They are efficient, using minimal battery power to handle large volumes of data quickly without routing tables.
- They are flexible (able to handle a dynamic topography), adaptable (able to handle nodes joining and leaving the network), scalable (able to handle increasing and decreasing numbers of nodes without modification), mobility capable (able to handle mobility and high speeds) and robust (able to withstand losses and continue functioning effectively).
- They heal quickly through self-reorganization.

Current and future uses of MANETs include battlefield communications, on-site disaster relief management (particularly in areas where the existing communications infrastructure has been destroyed), low-cost relay points for Cellular and WiFi, and sensor networks to enhance homeland security. An 8-bit stamp-sized module for sensor networks

has been developed and FCC approved and a 3-D graphic visualizer has been developed for sensor networks.

Joint Collaborations

Bluetronix collaborated with the Army SBIR office for matching funds in the development of this technology.

Lessons Learned

- Continuing proof of technology performance is needed to open new doors
- Getting others to support a new approach to an old problem sometimes takes great effort, tenacity and strong collaborators.
- Focus on one or two specific applications for validation and commercialization
- Don't rely on any one sponsor but rather establish a network of believers in your technology through collaborators.

Economic Impact

As a result of SBIR funding, Bluetronix has developed both simulations and prototype systems to demonstrate performance and proof of concept. The swarm routing algorithms and prototypes developed in this program have advanced Bluetronix from concept to several pending tangible products. With the direct feedback from DARPA and other agencies, Bluetronix plans to further their product development in both DoD and commercial organizations in 2007 and 2008. Bluetronix is currently pursuing contract work beyond the SBIR program for Phase 3 and commercial developments that can be paralleled back to DoD for leveraged design and product with only necessary modifications.

As a result of this DARPA SBIR, Bluetronix has filed several patents and intends to submit a third early in 2007.

About the Company

Bluetronix, Inc., headquartered in Chagrin Falls, Ohio conducts research, development, product development and commercialization for advanced algorithms for use by government agencies (e.g., DoD), and high-growth commercial industries. The company's areas of focus include: mobile communications, intelligent computing, network optimization, micro-electromechanical systems, sensor networks, energy optimization and internetworking. ■

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Mark J. Heiferling,
President
Founded: 2002
Number of employees: 4

HyperX™ Technology

Next Generation Processor Chip for the Battlefield

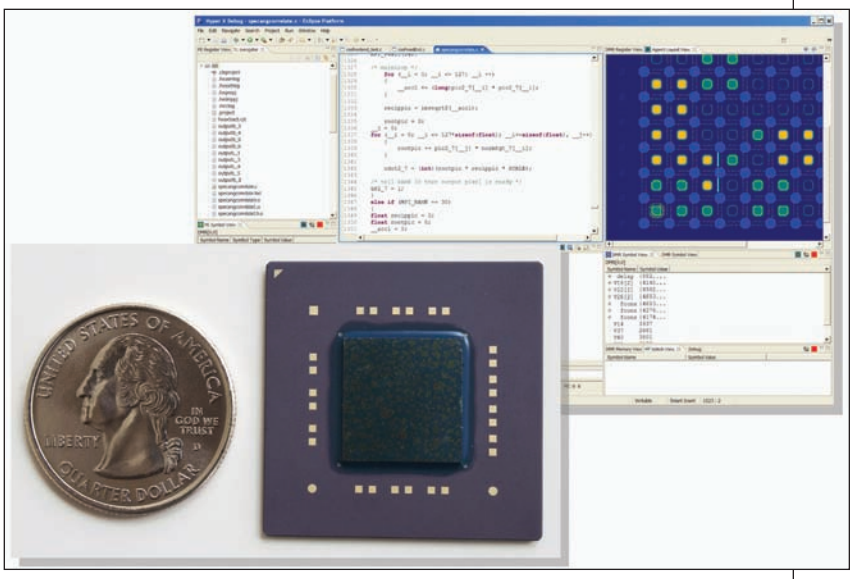
Technology and Innovation

Next generation embedded signal processing solutions must be able to transform dynamically to meet emergent threats and respond in real time to the demands of a network-centric battlefield. This requires immense computational speed in a reconfigurable, compact, low-power device.

HyperX™ technology from Coherent Logix, Inc. is a new integrated hardware and software platform to enable embedded system solutions from algorithm to hardware. The HyperX processor is real-time reconfigurable and adaptable, and completely under software control—an approach that supports field upgrades and thus lowers system lifecycle costs. At the core of the HyperX processor is resource-balanced unit-cell-based hardware fabric that is designed to produce families of single chip processors.

Coherent Logix's companion software development tools provide a complete system-to-algorithm-to-hardware development flow for the HyperX processor families based on the American National Standards Institute's (ANSI) standard for C programming language.

The chip's ten-fold increase in both power and throughput performance over current state-of-the-art reconfigurable and general programmable processors will lead to small, lightweight, low-power, high-performance, real-time signal processing solutions that are not feasible or deployable today. And HyperX's unique automated optimization capabilities will facilitate production of high-quality, fast and efficient designs, resulting in a rapid time-to-market development process.



HyperX Technology-based development methodology to enable real-time software-defined systems

Military applications for HyperX technology include hyperspectral and multispectral image/data fusion, software-defined radio (SDR), Synthetic Aperture Radar (SAR), portable sensor systems, remote sensor platforms, surveillance receivers, anti-jam Global Positioning System (GPS), automatic target recognition and threat cueing, ad-hoc networking, and secure data transmission.

Potential commercial applications include software-defined radio, video and image processing, data compression, encryption, and industrial and medical imaging.

Coherent Logix, Inc.

Joint Collaborations

The HyperX technology has been developed in collaboration with military and civilian application sponsors as well as a prime contractor to ensure the technology meets the requirements of next generation commercial and military platforms. In addition to funds from DARPA, Coherent Logix received matching funds and sponsorship from the U.S. Air Force, U.S. Army, and the Joint Program Offices (JPEO/PEO/PM) to help implement HyperX technology for deployment in a variety of military systems.

Lessons Learned

- Consistently monitor both DoD research and operational programs to identify where the company's ideas for new technologies can be best aligned to meet current or emerging requirements.
- Be prepared to seize opportunities — such as DARPA SBIR solicitations — that allow you to prove the efficacy of your ideas.
- Create a user feedback mechanism for the technology development phase of a program by gaining end-user sponsorship.
- Build support with more than one DoD sponsor for a broadly enabling technology that cuts across multiple platforms and fulfills multiple program requirements.

Economic Impact

Coherent Logix has had substantial growth as a direct result of DARPA and other DoD SBIR funding. DARPA was instrumental in helping Coherent Logix secure funds from other DoD agencies and the venture capital community.

About the Company

Coherent Logix, Inc. is enabling real-time software-defined systems through its HyperX technology-based development methodologies. Coherent Logix has two research and development facilities in Austin, Texas and Silicon Valley (Milpitas, California). Enjoying access to a wide variety of laboratories, resources, and intellectual capital in both markets, Coherent Logix possesses all the elements for successful growth. ■

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Michael B. Doerr, Chief Technology Officer

Software Tool Suite for Complex System Development

Innovative Tools Provide Cost and Schedule Efficiencies in Managing Complex System-of-Systems (SoS) Development, Upgrade, and Maintenance Projects

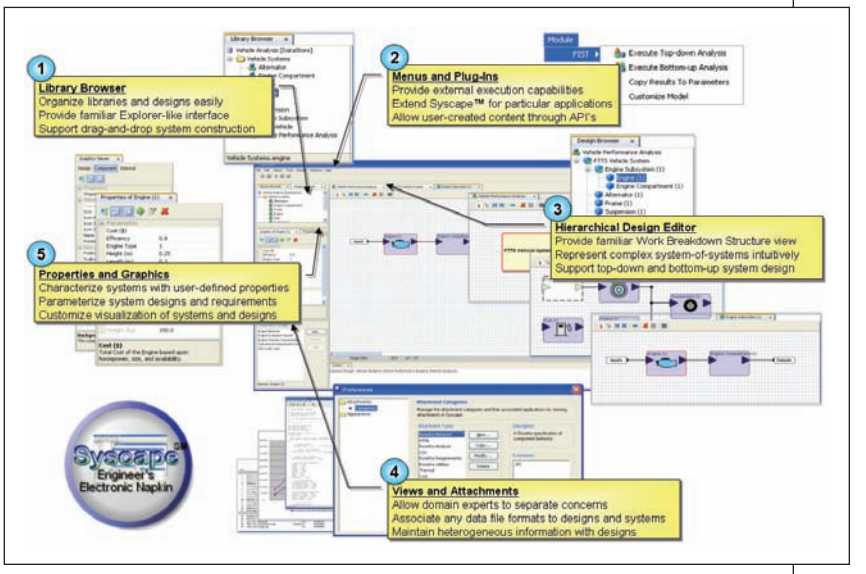
Technology and Innovation

EDAptive Computing, Inc. (ECI) has leveraged more than $8M in DoD SBIR funding from DARPA, U.S. Air Force, U.S. Army, U.S. Navy, Missile Defense Agency, and Office of the Secretary of Defense to develop a diversified set of innovative tools, mature processes, and solutions that can be used to reduce the development, modification, and verification cycles of complex, reliable and secure DoD systems throughout the system's entire lifecycle. An independent study funded by the U.S. Air Force concluded that the company's methods and tools can result in as much as 75 percent savings in a new system development or upgrade.

EDA*STAR*™ is ECI's state-of-the-art tool-suite solution for capturing and validating system requirements. The tool-suite follows the system development life cycle, and greatly aids the system designer at every step of the system development process.

Syscape™ allows designers to analyze a conceptual system-of-systems — a system made up of component subsystems — and see the effects of trading off various subsystem components.

ModSpec™ provides a graphical user interface environment for developing, executing, and model-checking formal specifications of high-integrity systems, where reliability is essential. Such systems might include ballistic missile defense, avionics, distributed networks, space probes, nuclear plants, and medical and automotive systems.



EDAptive® Syscape™: Enabling rapid analysis of system-of-systems

EDA*SHIELD*™ is used to assure trustworthiness as well as generate anti-tamper logic for protecting hardware/software against reverse engineering. **EDA*SHIELD***™ can be used to diagnose, predict, and correct errors after a system has been deployed using **EDA*STAR***™ created models.

SystemCritics™ provides a model-based, on-board, diagnostic and self-healing solution for autonomous error detection and correction within a system. SystemCritics™ can be applied wherever environmental/external errors cause misdiagnosis and erroneous requests for maintenance actions.

EDAptive Computing, Inc.

Joint Collaborations

ECI is currently applying **EDA***STAR*™ and SystemCritics™ in the development of a two-way, machine based language translator for use by JFCOM under an ongoing NAVAIR SBIR Phase III project. Under the Air Force Mentor-Protégé program, ECI has worked with Lockheed Martin to accelerate commercial adoption of **EDA***STAR*™ tools within their diversified set of programs.

Lessons Learned

- Maintain an on-going dialogue with existing and potential customers to understand emerging requirements and discuss potential ideas that can form the basis of new or improved solutions.
- Develop peer-to-peer relationships with other SBIR companies. These companies can be important sources of information on DoD acquisition programs, specific market opportunities, and U.S. government contracting practices as well as sources of lessons learned in research and commercialization.
- Once development is well underway, shift senior executives' focus from project execution to marketing and business development activities. Developing a detailed understanding of the marketplace and customer requirements and fostering relationships with key potential customers and funding sources are critical to transitioning technology and realizing growth objectives.
- Participate in standards development associations and industry user and working groups to drive the adoption of new technology. ECI is currently participating in the IEEE Rosetta Working Group formed under the Design Automation Standards Committee (DASC).

Economic Impact

The funds provided by DARPA and other DoD SBIR programs enabled ECI to grow from a start-up to a small company ready for the next phase. ECI staff grew from 5 in 2000 to 15 in 2007, and planned revenue for 2007 is over $3 million. ECI has successfully transitioned its SBIR-developed technologies to two Phase III contracts (ATLAS and CURE), and received additional investments from prime contractors and several DoD organizations including the award of a sole-source IDIQ five-year/$45M ceiling Navy (NAVAIR) contract vehicle that can be used by any agency to apply ECI tools and methods to complex systems upgrades and recertification.

About the Company

ECI *www.edaptive.com* is an SBA certified 8(a) small business headquartered in Dayton, OH, with satellite offices in Springfield, OH and Washington, D.C. ECI provides services and products to the military and aerospace markets. Current contract vehicles include IDIQ sole source Phase III SBIR with NAVAIR, GSA PES Schedule, and Navy Seaport-e. ■

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Praveen Chawla, Ph.D.,
President
Founded: 1997
Number of Employees: 15

Energy-Efficient Lighting

Coated High-Efficiency Distributed Lighting Systems Reduce Energy Costs

Technology and Innovation

Under this DARPA SBIR, Energy Focus successfully upgraded their High Efficiency Distributed Lighting (HEDLight) system by implementing an innovative process to effectively apply an organometallic external barrier coating (thin film) to arc tubes. The coatings extended lamp life by preventing or delaying lamp failure by devitrification, a condition where the surface of the fused quartz develops deposits, cracks or wrinkles. The program succeeded in extending DC arc source lamp life by a factor of five, more than twice the program goal. The arc source coating technology not only reduces operational costs by extending the lifetime of lighting components, but also improves the quality of light in existing High Intensity Discharge (HID) lighting systems.

The coated HEDLight systems have a lamp life of over 15,000 hours with 400 lumens of light per spot. This performance is achieved at 13 watts per spot and compares favorably to legacy incandescent lights of the same lumen output, which use 50 watts and have a life expectancy of only 4,000 hours. The lights provide 75% energy savings.

The arc lamp coatings investigation was built on the success of lighting systems developed under DARPA's HEDLight program, designed to deliver ultra-efficient low-maintenance lighting systems to the Navy. That program installed 17 HID and 175 LED lighting fixtures on three ships over 26 months for a 36% savings in energy with no failures (zero maintenance).

Energy Focus' energy-efficient LED lighting systems (right) replace legacy lighting (left) on ships such as the Arleigh Burke Class guided missile destroyer.

The commanding officer of the USS Pearl Harbor reported that the Energy Focus lighting system brought "a significant improvement in overall lighting quality and brightness. … It represents advances not only in improved workspace lighting, … but likewise is a viable solution toward labor and cost savings efficiency."

Of the more than 34 thin film material systems under investigation, at least five showed significant improvements in lamp life, lamp output or both. Breakthroughs were also made for reducing the cost of the lamp coating methods. The improvements in output are the result of UV light directed back into the lamp for photonic absorption and re-emission at longer (red) wavelengths, further enhancing energy efficiency and color. Coated lamps using this technology are in service at the Ft. Meade commissary and are generating a continuous savings

The bay door of this DDG-class Navy destroyer's helicopter hangar had to be opened to allow for adequate light (left), until the installation of Energy Focus' lighting systems provided ample lighting in addition to reducing power cost by 36 percent.

of more than $23,000 per year in combined energy and maintenance expenses.

Full-scale implementation of the modified arc sources in parking lots, warehouses, retail areas and commissaries would yield significant energy and cost savings for the Navy. Incorporation of this technology into the company's commercial and military illuminator systems is already planned for 2009. Energy Focus was awarded the DARPATech 2007 Small Business Innovation Research Award for Excellence for its work on this program.

Joint Collaborations

Energy Focus, Inc. collaborated and served as primary contractor on the initial DARPA HEDLight project. The company was also a member of a consortium for DuPont on the DARPA-funded Very High Efficiency Solar Cell (VHESC) project.

Lessons Learned

- Emphasize the alignment of development objectives with military specifications from day one. It is critical to understand the ownership and history of each requirement in addition to the requirement itself.
- Identify and involve the program executive office (PEO) that is responsible for fielding new systems in the area of interest in order to benefit from their experience.
- Identify opportunities to get feedback directly from end users, as this can be instrumental in perfecting product design.
- If the product has a known commercial application, investigate requirements within the DoD to understand certification processes required to sell to military markets.
- In the SBIR Phase II contract, include a testing and evaluation task that allows organizations participating in these activities to procure prototype units.
- Costs and conditions for installing, testing and evaluating prototypes can vary by location. Obtain projected costs and detailed information for specific locations (for example, ensure that requisite components to interface with legacy systems are available).
- Engage the DARPA project manager from project inception. A manager who provides leadership and vision and is focused on identifying and supporting technology transition activities is critical.

Economic Impact

SBIR funding has supported the growth of efficient lighting technology from about $3 million in 2005 to about $14 million in 2008. Approximately 50% of Energy Focus' technology development was supported by DARPA.

About the Company

Energy Focus, Inc. designs, develops, manufactures and markets lighting systems for wide-ranging uses in both the general commercial and the pool and spa lighting markets. The company's headquarters are in Solon, Ohio, with additional offices in California, the United Kingdom and Germany. ■

Company Information

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Email: kleak@efoi.com
Founded: 1985
Number of employees: 88

Physically Small VHF/UHF SAR Antenna

Compact, Lightweight Antenna Technology Enables VHF/UHF SAR Operation on Small UAV Platforms

FIRST RF Corporation

Technology and Innovation

Unmanned aerial vehicles (UAVs) are a critical asset to support the warfighter in the 21st century battlefield, carrying a variety of sensor systems specifically designed to collect and disseminate data to support tactically focused intelligence, surveillance, and reconnaissance (ISR) missions.

The requirement for a new ultrahigh frequency (UHF) synthetic aperture radar (SAR) antenna design for UAV platforms resulted from findings that the UHF SAR antenna systems designed for traditional airborne platforms increased mission costs when applied to the smaller UAV platforms. Prior to the development of FIRST RF's antenna technology, quad-ridged horns at 200 megahertz had been used to achieve the bandwidth product necessary. These types of horns were quite large, with typical dimensions of 36" by 36" by 72". The size of these antenna systems limited the types of airborne platforms that could accommodate the UHF SAR system, driving up the mission cost. Also, the aircraft modifications necessary to integrate a radome and aerodynamic faring for the quad-ridged horns were quite expensive and time consuming to implement.

The challenge of transitioning very high frequency (VHF) SAR technology to small, tactical platforms like UAVs lies in achieving adequate antenna characteristics (transmit and receive specifications) within the allowable size, weight, and mechanical constraints.

FIRST RF's design approach was to optimize the radiation efficiency of an electrically small (less than 8" depth at UHF frequencies) antenna by bringing it in close proximity to a ground plane (less than a 1/10 of a wavelength) at the lowest frequency of operation, yet allowing it to radiate efficiently and maintain the desired pattern performance without using depth as the means to achieve broadband performance.

Design and manufacture of narrow-band antennas in close proximity to a ground plane can be quite challenging and unrepeatable, given the high Q (energy stored in a small electrical volume). The creative leap was in finding a way to radiate this energy at the lowest frequency yet maintain the pattern and performance over several octaves of bandwidth.

Under this DARPA SBIR project, FIRST RF Corporation leveraged the knowledge acquired during previous DoD SBIR-funded projects to develop ultra broadband (greater than 300:1 bandwidths) antenna projects for electronic warfare (EW) and communications systems. This allowed FIRST RF to design and develop a small, lightweight, compact, broadband, and high power/efficiency UHF and VHF airborne antenna technology that enables VHF/UHF airborne SAR systems to operate on small UAV platforms.

FIRST RF's UHF SAR antenna reduces volume relative to horn in this DC-3 aircraft.

Joint Collaborations

FIRST RF, in collaboration with primes, has developed advanced antenna and radio frequency (RF) technologies for future airborne and ground-based sensors. FIRST RF has successfully transitioned the technology developed under the DARPA SBIR project to VHF/UHF airborne SAR systems companies and airborne ISR systems integrators, including Northrop Grumman, Lockheed Martin, Sky Research, SRI International, and General Dynamics. Government customers include the U.S. Army, Air Force, and Navy; DARPA; NASA; and the Jet Propulsion Laboratory. Platforms slated for integration include the Predator UAV and well as DC-3 aircraft.

Lessons Learned

- Development of any new technology or product is a risky venture with the possibility of failure. Constant review of critical tests, measurements, and design simulations need to be shared with the customer quickly in order to provide the knowledge needed to modify development activities to increase the probability of the project's success.
- The DARPA program manager is key to supporting transition success by identifying potential integration partners and end users.
- Acceptance of a new technology component into existing platforms is a lengthy process. To move technology from the lab into the field, it is essential to develop relationships with the government and system primes early in the development cycle to confirm requirements and address opportunities for partnering and collaboration.

Economic Impact

The antenna developed under this SBIR has transitioned to the Army's Tactical Reconnaissance and Counter-Concealment Enabled Radar (TRACER) program that intends to fly both the UHF and VHF SAR systems on the General Atomics Predator UAV platform. In addition, this SBIR program has spawned a line of airborne VHF and UHF antenna systems that will initially be used for SAR, but will also begin to be used for communications and other ISR missions.

FIRST RF has several patents and patent-pending technologies related to ultra broadband antenna technology, and they have received contracts for the qualification and production of multiple UHF and VHF airborne antenna systems. Sales growth is expected to continue to rise 10 to 20 percent per year over the next 5 to 10 years to meet anticipated requirements for FIRST RF-developed systems.

Since 2003, FIRST RF Corporation has been awarded over 30 Phase I SBIR contracts from the U.S. Army, Navy, and Air Force, as well as DARPA. Over half of these have transitioned to Phase II. Phase III funding awarded has exceeded $1M.

About the Company

FIRST RF Corporation develops and manufactures advanced antennas and RF systems for aerospace, defense, civil, and commercial markets. Since 2003, FIRST RF has fielded over 75,000 antennas for EW and communications systems in Iraq and Afghanistan. In 2005, FIRST RF received the Army's *Top 10 Inventions of the Year* award, which started as an SBIR contract for a broadband EW antenna system for CREW systems. FIRST RF antenna systems are designed for affordability, reliability, optimum RF and mechanical performance. The company has over 40 different antenna systems in production. ■

Company Information

FIRST RF Corporation
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Farzin Lalezari, President & CEO
Theresa Boone, Chief Operating Officer
Founded: 2003
Number of employees: 100

DICAST® Continuous-Cable Fiber Optic Chemical Sensors

Chemical Agent Detection System Covers More Ground and Sounds the Alarm Sooner

Technology and Innovation

Until recently, complete-coverage chemical detection systems for large facilities were expensive and not very effective. Point sensors detect chemicals in the immediate vicinity, so many sensors are required to cover a large area, and gaps in coverage may delay alarms until the chemical plume reaches a sensor. Standoff detectors can cover a wide area, but they require a clear line of sight to recognize dangers.

Intelligent Optical Systems, Inc. (IOS) has developed a chemical detection system that can provide highly effective coverage of very large areas and perimeters at a much lower cost than other systems.

DICAST® (Distributed Intrinsic Chemical Agent Sensing and Transmission) is a linear chemical detector. The product is based on fiber optic cables that sense specific chemical agents along their entire length through stable, highly-sensitive reagents integrated into the fiber's plastic coating. DICAST detects both toxic industrial compounds and military chemical warfare agents, such as chlorine, hydrogen cyanide and sarin. When detection is needed for new chemicals, IOS engineers individual fibers that are highly sensitive to the new agent(s). The cables, which are passive, can be laid out for hundreds of feet, curving around corners to provide seamless sensor coverage. DICAST's cables can do the work of dozens of point detectors.

DICAST senses the presence of chemical or toxic agents anywhere along the cable's length.

DICAST's sensing components respond to the presence of a toxic chemical in seconds, and the alarm moves along the fiber at the speed of light. The system can be set up as one long path or numerous individual sites and monitored from a secure facility far from the actual sensing location.

Since DICAST units can be placed in a central location, fewer of them are needed to completely cover an area.

DICAST is the product of multiple SBIRs. Early development was funded by the National Aeronautics and Space Administration (NASA) to detect moisture and pH. Under DARPA, IOS demonstrated that the optical fibers could be made sensitive to chemical substances of interest to the military and can be used in both alarm-style and position-resolved systems, which can chart the concentration of the target chemical every 10 centimeters. IOS is currently involved in a post-Phase III,

large-scale, multi-year project—sponsored by the Pentagon's Technical Support Working Group (TSWG)—to develop deployable DICAST systems for toxic industrial compounds and military chemicals.

Military and homeland security applications include perimeter protection against chemical warfare agents. Other applications include monitoring of industrial fencelines; security for heating, ventilation, and air conditioning systems; decontamination verification in areas previously contaminated; and pipeline leak detection.

Joint Collaborations

Intelligent Optical Systems worked with many private companies and three federal agencies (NASA, DARPA, and TSWG) to develop DICAST. To meet Phase III goals, IOS subcontracted work to 10 companies, two universities, and one government laboratory, located in 11 U.S. states and one Canadian province.

Lessons Learned

- Use the SBIR projects as a springboard to larger research funds and programs.
- Terminate contracts to underperforming contractors quickly, and don't assign critical path tasks to organizations not designed to meet tight schedules.
- Get to know the people within DARPA. They can provide key insight into the technology that the DoD needs.

Economic Impact

DARPA funding allowed IOS to demonstrate that DICAST—originally conceived as a corrosion detection system—could be used to detect chemical of military concern. The successful demonstration has opened up new markets and helped attract additional funding (including the $15 million TSWG contract) that has led to the deployment of two beta-test systems and products.

DARPA and other SBIR funding has been crucial in driving IOS's growth. Almost all of the company's technology has sprung from SBIR projects.

IOS has secured DICAST-related subcontracts from two very large American companies, and discussions of possible applications and alliances continue with commercial and government organizations. The company holds 22 patents (two for DICAST) with 16 more pending (four for DICAST). OpTech Ventures, LLC (Optech) was recently formed to market and commercialize IOS's technologies through subsidiaries, joint ventures and the formation of new companies.

About the Company

Located in Torrance, CA, a suburb of Los Angeles, IOS was created in 1998 as a spinoff of Physical Optics, Inc. IOS's mission is to become a leading research and development organization in optical sensing and analytical instrumentation. ■

Company Information

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Robert Lieberman, Ph.D., President and CTO
Founded: 1998
Number of employees: 40

Autonomous Satellite Docking System and 3-D Docking Sensor Algorithms

Technologies Extend the Life and Function of Our Satellites

Technology and Innovation

Satellite technology is fulfilling an ever-increasing number of critical military and civilian uses, but their expense makes it imperative that their usable life be extended as long as possible. Thus, efficient satellite operation, routine servicing and repair is increasingly important. Recognizing this need, DARPA set up the Orbital Express Advanced Technology Demonstration to develop and test an autonomous satellite servicing system. Although the Michigan Aerospace Corporation (MAC) docking mechanism is not on board the Orbital Express mission, the company is developing sensors and algorithms to enable autonomous docking and repair of satellites on orbit along with a compliant, lightweight capture mechanism for future missions.

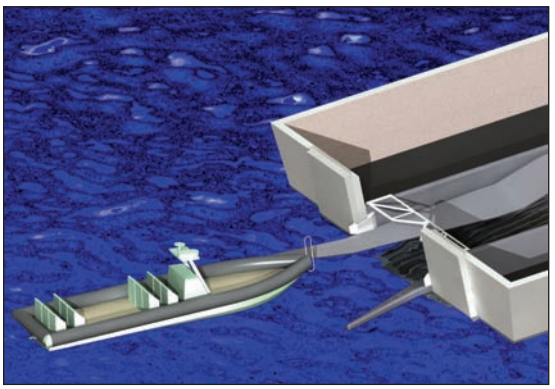
3-D Docking Sensor Algorithms are being developed, under an SBIR contract, to extract information about a target spacecraft's position, orientation, and spin rates from 3-D long-range data. MAC's software is robust, even with low signal-to-noise data, and is capable of running in real time for on-orbit rendezvous and docking operations. Software previously available for this purpose was developed by sensor manufacturers specifically for their own sensors. MAC's software is completely sensor independent.

The Autonomous Satellite Docking System (ASDS) is a compliant, lightweight docking mechanism that enables soft docking of two space assets, such as satellites, and subsequent establishment of a rigid connection for resupply or repair operations. ASDS employs an integral cable-cone latching mechanism, which is scalable from nano- or micro-satellites to large space assets, making the system versatile. ASDS's latching technology can be used in a wide range of vehicle capture applications. For example, the technology has been tested in a Phase II Navy SBIR to replace more labor-intensive and hazardous methods of launching and recovering unmanned vehicles.

The flight crew from the Autonomous Satellite Docking System testing aboard the KC-135 microgravity aircraft in 2002

Joint Collaborations

As a result of DARPA SBIRs, MAC has collaborated directly with two NASA centers—the Johnson Space Center and Marshall Space Flight Center—and has formed numerous other partnerships with companies. MAC has teamed with several



This latch mechanism is based on technology developed during the ASDS program, and is used to capture surface vehicles for a Navy launch and retrieval system

companies to optimize the ASDS design and used dynamic simulation to address docking requirements for various types of military, civil, and commercial space assets. MAC frequently teams with large aerospace companies for platform development, integration, and testing in a relevant ground, marine, airborne, or spaceborne implementation environment. The company has teaming agreements with three prime aerospace companies and alliances with several more.

Lessons Learned

- Establish formal teaming agreements with the primes in the early stages of development to accomplish final product integration and testing.
- Communicate with the sponsoring agency's program manager. This person is the best source of information on transitioning to the military and finding appropriate partners.
- Make technology easily compatible with existing or planned systems by understanding the technical needs of both the program office and corporate partners. Finding the ideal niche for your technology is critical to commercialization success.

Economic Impact

MAC has received DARPA SBIR contracts from Phase I and II development of the algorithm and latching enabling technologies for support of satellite programs. SBIR programs have provided needed funds for product development and have opened doors for teaming relationships with several prime defense contractors that has led to additional funding opportunities.

Since 1997, MAC's revenue has grown from $497,000 to over $5.5 million (estimated for 2007). This growth is based largely on commercialization success fueled by the SBIR program and mutually beneficial corporate partnerships to transition this technology to the market. To support growth, MAC recently expanded its Ann Arbor facilities by adding high-bay assembly and manufacturing space and opened three new offices. MAC has obtained one patent (and another is pending) related to mechanisms for spacecraft and other vehicles.

About the Company

Michigan Aerospace Corporation has its headquarters and a manufacturing facility in Ann Arbor, MI. They also have offices in Berkeley and Los Angeles, CA and Phoenix, AZ. The company is an advanced engineering and products company that provides a broad spectrum of services, from initial concept design and research and development through production and support. ■

Company Information

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Peter Tchoryk, Jr., CEO
Founded: 1997
Number of employees: 30

Nanostructured Thin-Film Solar Cell Production

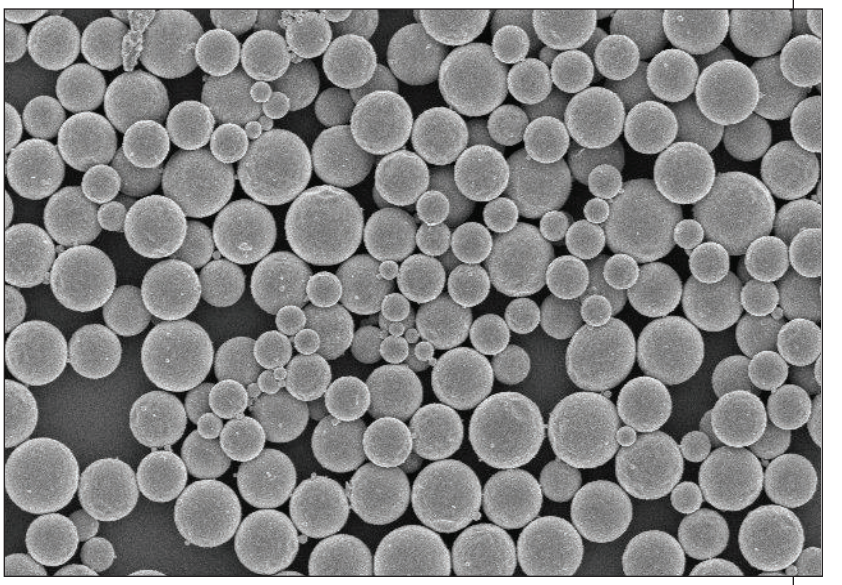
Cell Production Leads the Way Toward Longer-Lasting Portable Power

Technology and Innovation

Maintaining enough power to keep communications flowing and equipment functioning is a vital issue for the warfighter, especially in remote or hazardous situations. There is a critical need for low-cost, durable solar modules that provide portable power sources without the need for energy re-supply.

Under a DARPA funded SBIR program, Nanosolar developed improved production techniques to create high-efficiency solar cells that are lightweight, flexible, durable, cheap, and easy to produce. Nanosolar is applying a new technique in the emerging field of nanotechnology to address critical power shortcomings: efficiency, durability and availability. This technology can extend mission durations, increase the range of mission distance, and minimize supply chain logistics and the personnel risk typically associated with re-suppling power sources.

Nanosolar has developed a way to produce rolls of thin-film solar cells that are printed directly on the substrate material with an ink made up of tiny nanoparticles containing the proper ratio of elements required to make the cells absorb solar energy. This technique has required innovations in seven different areas to dramatically improve the cost-efficiency, yield, and throughput of thin-film solar cell production: nanostructured components, printable semiconductors, printable electrodes, rapid thermal processing, low-cost substrates, roll-to-roll processing, and fast assembly.



Ink made up of nanoparticles allows semiconductors to be printed on the thin film

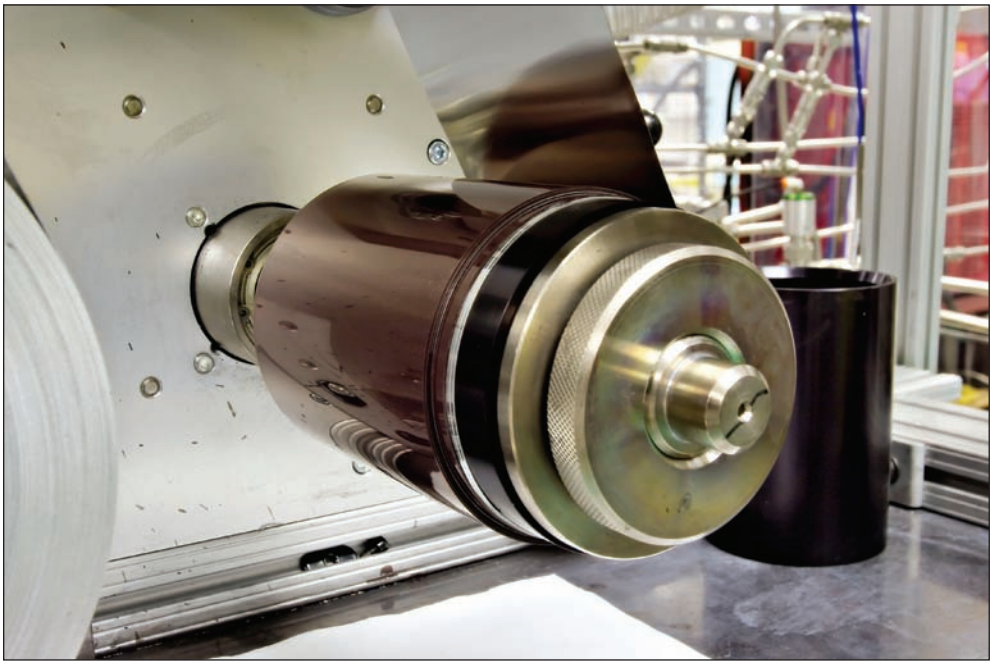
These contributions would not have been possible with earlier solar power technologies—first generation silicon-wafer solar cells, or the second generation commercial thin-film solar cells.

Joint Collaborations

Nanosolar is working with the U.S. Army as well as the U.S. Marines to define requirements for military applications. In addition, Nanosolar worked with the U.S. Air Force through an Air Force Research Lab sponsorship of an earlier DARPA program on flexible photovoltaics.

Nanosolar is working with Lockheed Martin to provide portable power for high-altitude airship technology. In the

Nanosolar, Inc.



Thin-film roll-to-roll processing

fall of 2006, Nanosolar signed a long-term agreement with Conergy—the largest solar company in Europe—to develop large-scale photovoltaic systems that will provide custom-tailored, cost-efficient solar solutions to the U.S. commercial rooftop market.

Lessons Learned

- Have a liaison help early on in areas of new applications so that the company understands those needs.
- Develop technology from a framework of manufacturability, rather than designing the product and then determining how to manufacture it.
- Beta test a prototype with appropriate military personnel to acquire performance data in the field.

Economic Impact

Funding from DARPA has also aided Nanosolar in raising additional private equity capital. In 2006, Nanosolar completed a Series C stock financing, which brought in over $75 million.

About the Company

Nanosolar, founded in 2001, is establishing itself as a leader in solar power thin-film development. The company is working on both military and civilian applications. Nanosolar is headquartered in Palo Alto, California, with operations in Germany and China. At the end of 2006, the company began to build manufacturing facilities in San Jose, California and near Berlin, Germany. ■

Company Information

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Martin Roscheisen,
Co-Founder/CEO
Brian Sager, Co-Founder/VP
Founded: 2001
Number of employees: 88

Tactical Group Decision Analysis System (TGDAS)

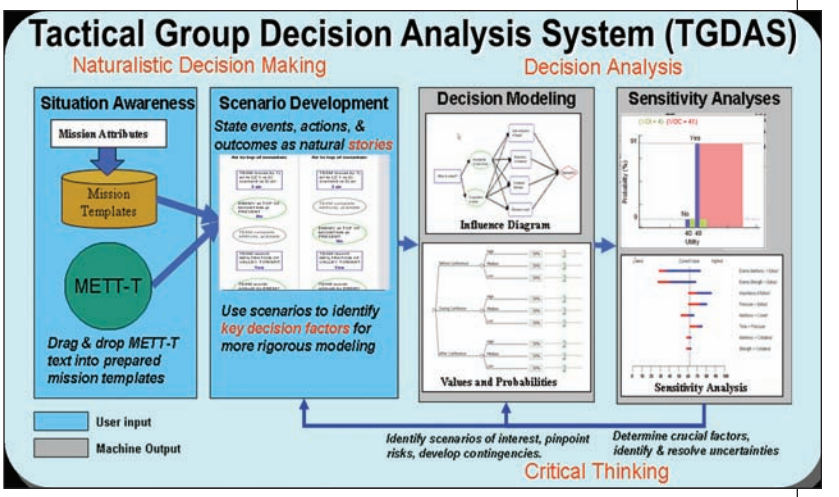
Enhanced Support Tools for Improved Collaborative Planning and Decision Making

perceptronics solutions

Technology and Innovation

At the center of today's military command and control operations is the need for distributed real-time collaborative tactical planning and decision making associated with rapidly changing events, including response to asymmetric warfare and counter-terrorist operations. Of particular concern is collaboration across services, agencies, and organizations, or in operations involving coalition partners dispersed in different geographical locations.

Building upon an earlier DARPA-sponsored project on computer-based group decision aids, under this SBIR project Perceptronics developed the Tactical Group Decision Analysis System (TGDAS). TGDAS is a suite of model-based support tools that incorporates the latest research in cognitive decision aiding—including influence diagrams, mental models, and critical thinking concepts. It integrates the principles by which individuals make decisions in real time and under adverse conditions (referred to as "naturalistic decision making" (NDM)) with those for effective collaboration. It then applies methods of rigorous decision modeling and computational analysis to derive the "best" course of action. It does this by weighing the risks as represented by the conditional probabilities of success and failure of the alternative courses of action in estimating the value and likelihood of various potential outcomes.



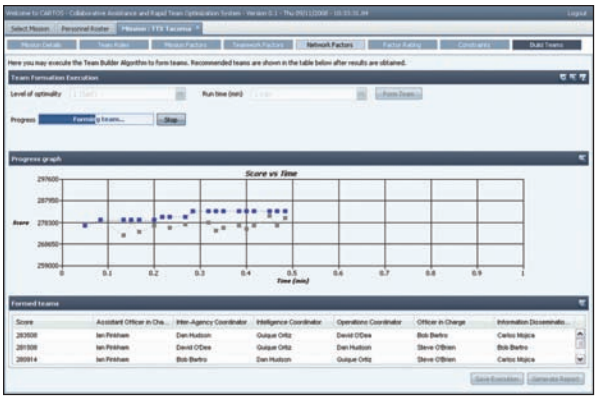
TGDAS combines influence diagrams, mental models, and critical thinking concepts to help users make better decisions quickly across organizations.

A contract was awarded by USSOCOM and DARPA to facilitate the transition of the TGDAS products into the SOMPE suite of planning and decision support tools and other USSOCOM programs. The TGDAS products include core tools for developing and evaluating alternative courses of action (COAs) as well as NAIMS (Netcentric Adaptive Information Management System), a related tool for organizing and prioritizing information items by their relevance to the decision situation.

Joint Collaborations

In addition to being awarded a contract by USSOCOM, Perceptronics Solutions, Inc. has collaborated with a number of organizations, including the USC Computer Science Department and the UCLA Sociology Department.

The company is also collaborating with several major defense contractors—



TGDAS technology led to the development of tools such as the Collaborative Assistance and Rapid Team Optimization System (CARTOS), which aids in quickly forming effective teams for specific missions.

including Aptima, Lockheed Martin Advanced Technology Laboratories, and Science Applications International Corporation (SAIC)—for extension and transition of its decision support and other technologies.

Lessons Learned

- Make rapid transition and commercialization an important part of the SBIR project from the beginning, and assign responsibility for this task.
- Identify viable, potential end users early, and focus initial development efforts on meeting their specific needs before moving on to more general solutions.
- Target related DoD-funded SBIR projects that can be leveraged to further mature the technology.

Economic Impact

The initial DARPA SBIR project to develop the TGDAS led directly to additional DARPA-funded SBIR/STTR projects to enhance and extend the core technology. The successful demonstration of TGDAS also led to the award of additional SBIR contracts in the areas of decision support and human-robot interaction from DoD agencies, including the Office of Naval Research, the U.S. Army Research Development and Engineering Command Simulation and Training Technology Center, the U.S. Army Research Institute and the Office of the Secretary of Defense. Transition activities on these additional contracts are in process. As a result of these efforts, revenues have more than doubled in the past two years, one patent has issued and other patents are pending.

About the Company

Perceptronics Solutions' mission is to develop and market methods and technologies by which distributed groups of individuals can optimize the performance of real-time, collaborative decision-making tasks. Its collaborative support solutions are divided into two main areas: decision support systems and human-robot interaction. With offices in Washington, D.C. and Encino, California, its headquarters are located in Sherman Oaks, California. ■

Company Information

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Amos Freedy, Ph.D.,
President
Founded: 2002
Number of employees: 15

Global Locating System (GLS)

GLS Technology Provides Increased Security and Efficiency for Satellite Tracking of Shipments With Low-Power Devices

Technology and Innovation

Using the Global Locating System (GLS) developed under DARPA SBIR funding, SkyBitz's ground-based Service Operation Center performs positioning calculations centrally, using encrypted GPS satellite data collected and forwarded by the S-RFID tag, and is able to calculate tag position in seconds. This approach provides inherent security in satellite transmissions, unlike GPS solutions that transmit information over non-secure channels. The SkyBitz technical approach dramatically reduces power consumption by a factor of ten and decreases the logistics footprint by reducing both the cost and support service required for frequent battery replacement. Using SkyBitz's GLS, non-powered assets such as trailers, containers, and railcars can be tracked for years on internal batteries.

These characteristics closely align the SkyBitz GLS capabilities with the functionality of traditional active RFID technology. The principal difference is that SkyBitz uses a very-long-range reader, a satellite, which can read S-RFID tags (as well as output from a variety of sensors) anywhere around the globe—in real time. As requirements grow for more global and continuous monitoring of critical assets, the SkyBitz satellite-based approach to radio frequency identification is expected to become an integrated complement to traditional checkpoint-based RFID.

The primary customers for the SkyBitz GLS are transportation firms—trucking, rail, and intermodal sea containers which serve commercial transport, military customers, and public safety services. Some firms, such as Landstar, move arms, ammunition and explosives across North America for the U.S. military.

Transportation firms in the commercial, military and public safety sectors use SkyBitz' Global Locating System as a cost-effective, user-friendly way to track sensitive cargo.

The SkyBitz Satellite Radio Frequency Identification (S-RFID) tag has achieved DoD's hazards of electromagnetic radiation to ordnance (HERO) certification to monitor munitions in real time via satellite. The company is now expanding services overseas to begin serving the warfighter in the U.S. Central Command (CENTCOM) region, which includes 27 nations. In addition, SkyBitz serves a variety of public safety applications such as school bus tracking, and tracking of high value goods, food and agricultural products and HAZMAT loads.

Joint Collaborations

SkyBitz has collaborated with a number of DoD service organizations and commercial companies based upon the achievements and outputs of DARPA SBIR Phase II work, including the following:

SkyBitz, Inc.

SkyBitz's Service Operation Center performs positioning calculations in seconds and sends position reports directly to users instead of transmitting them via unsecured satellite.

- U.S. Maritime Administration, U.S. Navy, Naval Research Laboratory, and Neptune Orient Lines—in an effort to test advanced technologies to improve port security, specifically on intermodal sea containers, both aboard ship and in the yard.
- U.S. Air Force—to further the research on GLS miniaturization.
- WhereNet—to market a joint "constant visibility solution" for container tracking as demonstrated successfully under the aforementioned U.S. Maritime Administration test. Field deployments of this solution are now anticipated for DHS and DOD missions in the near future.
- Hi-G-Tek / Ports America—to combine advanced RFID security solutions from Hi-G-Tek to meet security requirements for Ports America in response to both commercial and U.S. government requirements for homeland security. These systems are not yet fielded.

Lessons Learned

- Weigh the pros and cons of outsourcing the various components of the project. It may be more effective to build an internal development team and outsource manufacturing. SkyBitz identified trailer tracking as a specific application in which it has expertise and access to the truck-load transport industry. The company focused its resources on that application to secure early key adopters of the technology.
- As a small business, the single largest challenge is convincing the first customer to buy. With this SBIR project, SkyBitz's GLS served as a solid cornerstone on which to develop their enabling technology and integrated solutions.

Economic Impact

Since the DARPA Phase II ended in 1997, SkyBitz has secured over $58 million in financing from investors used to fund product development and market expansion for its product solution into new verticals and geographies. SkyBitz has also consistently increased annual revenues and achieved over $26 million in 2007.

Based on this success, SkyBitz is currently embarking on a diversification strategy that will allow the company to serve many new vertical markets—government, rail, energy, and chemical—in many locations, including Europe, South America, and Asia.

About the Company

SkyBitz, Inc. is a mobile asset management company, providing real-time information to customers throughout North America in the fields of transportation, energy and government. In October of 2008, SkyBitz's CEO, Dr. Homaira Akbari, was named among the 2008 honorees to receive the *Washington Business Journal* "Women Who Mean Business" award. The award is presented to women who have made large contributions to their industries and communities, and have helped blaze the trail for future women business leaders. ■

Company Information

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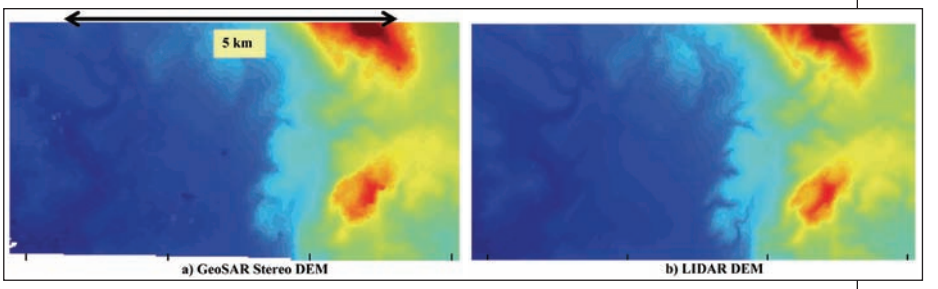
Matthew Schor, Founder and SVP Government Services
matthew@skybitz.com
Founded: 1992
Number of employees: 53

Processing Technologies for Terrain Visualization

Detailed 3-D Picture Improves Execution of Military Operations

Technology and Innovation



TSC's stereo DEMs, which compare favorably with the quality of LIDAR DEMs, can be rapidly generated over wide areas of severe, foliage-covered terrain

When operating in difficult, unfamiliar terrain, Warfighters would have a tremendous advantage if they could clearly visualize the forest density, topography (especially under foliage), width and location of trails, roads, rivers, structures and fences, and other natural and man-made features. Synthetic Aperture Radar (SAR) is the preferred sensor for providing wide-area, all-weather, day/night, high resolution views of terrain and cultural features.

Under DARPA SBIR and STTR programs, Technology Service Corporation (TSC) has developed improved methods for processing ultra-high frequency (UHF) and microwave SAR data to provide topographic and surface cover maps that show these kinds of details with great accuracy. For example, Digital Terrain Elevation Data (DTED) is being generated with better than Level 2 accuracy (accepted standard from USGS map making) in dense foliage areas using TSC-developed stereo, interferometric and tomographic SAR imaging techniques.

One of TSC's products is a system that employs stereo processing to visualize terrain in three dimensions (3-D). This unique approach uses repeat-pass single-aperture SARs, which are typical of military systems. TSC also created signal processing techniques that produce 3-D tomographic images from circular flight trajectories flown around a target area. This innovative imaging capability was demonstrated using the EarthData International (EDI) GeoSAR UHF system under DARPA SBIR funding. GeoSAR is a commercially available terrain mapping system that is owned and operated by EDI with TSC's support. With the help of TSC technologies developed under SBIR funding, GeoSAR is producing high resolution maps and radar imagery world-wide, including several regions previously considered inaccessible due to cloud cover and very rugged terrain.

DARPA has incorporated several of TSC's algorithms into its Wide-Area All-Terrain Change Indication and Tomography (WATCH-IT) workstation. WATCH-IT is being used by the US Army Communications-Electronics Research Development and Engineering Center (CERDEC). Other technologies that have been derived from TSC SBIR programs are also being used to support GeoSAR.

Joint Collaborations

Being a part of DARPA's WATCH-IT program involved collaborations with Alphatech (now BAE Systems), Essex (now Northrop Grumman), Vexcel (now Microsoft), Massachusetts Institute of Technology (MIT) Lincoln Laboratory, and the Naval Research Laboratory (NRL). These collaborations were a major

help to TSC in developing practical mapping technologies and gaining operational expertise.

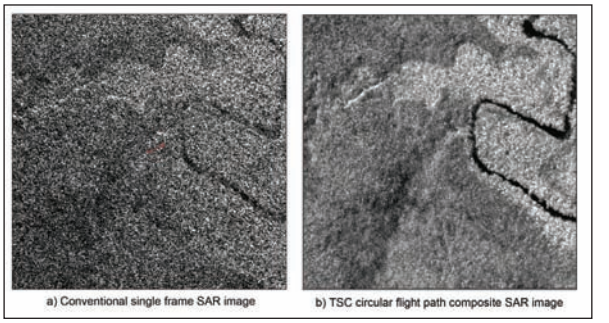
Lessons Learned

- Stay close to the end users so that prototypes and products provide benefits as soon as they are deployed. End user sponsorship is extremely important for SBIR-funded technology developments.
- Don't focus on just R&D during the SBIR program. The SBIR effort can help facilitate communications with military acquisition program managers, which is vital in the difficult process of transitioning technologies.
- Actively market the SBIR-funded technologies directly to the military, their suppliers and support contractors, all of whom have a role in the selection and advancement of system components.

Economic Impact

The WATCH-IT effort led directly to TSC obtaining funding from EDI to develop interferometric processing and digital terrain database generation techniques. They also received funds from DARPA to initiate circular flight path and tomographic imaging technologies. The image registration techniques developed under WATCH-IT led to TSC's obtaining Army contracts in the area of SAR change detection (in which accurate image registration is essential), as well as to contracts from the Air Force in the area of high-dimensional SAR signal processing.

TSC was also awarded a contract from EDI to develop a "System Engineering and Performance Plan for a Backprojection Field Deployable Computer System". This workstation, which will be used by EDI in the field for performing quality assurance and control by generating quick-look imagery products, is expected to reduce the net cost of flight operations and data acquisition. This deployable workstation will also greatly reduce the time between collection and first image output. TSC anticipates that this study could result in another contract to implement the field deployable processor.



Composite image has significantly better contrast to enhance image exploitation

TSC has won over 140 contracts and received almost $40 million in revenues from SBIRs since 1993. The SBIR program has also helped TSC expand business beyond the SBIR program, including over $30 million in non-SBIR DoD and commercial contracts. As a result, the company has grown from a $17 million business in 1993 to a $60 million enterprise in 2006, and has acquired four other companies along the way.

About the Company

Technology Service Corporation is an employee-owned, high-technology company that provides engineering services and specialized products to U.S. Government agencies and private industry. TSC develops and demonstrates sensor and subsystem prototype equipment, and designs and manufactures electronic circuit boards and test devices. TSC also develops and provides computer software for radar positioning, geographic information services, and sensor/system modeling and simulation. ■

Company Information

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Founded: 1966
Number of employees: 330

Advanced Digital Signal Processing

Mathematical Algorithm Leads to Cleaner, Improved Signal Detection

Technology and Innovation

Very high data rates and extremely high data resolution are required for advanced digital receivers to accurately capture the wide bands of data necessary to support long-range surveillance, communications, and enhanced radar detection applications. It is critical that the digital signal processing of this wideband data be performed in real time and at very high data rates (1.5 gigahertz). Such rates previously exceeded the processing rate capabilities of many digital signal processing platforms, including field-programmable gate arrays (FPGAs).

During this SBIR project, V Corp Technologies, Inc. successfully demonstrated and applied their Linearity Error Compensation (LinComp™) advanced digital signal processing algorithms and adaptive digital filtering to predict and remove noise and distortion from commercial receiver hardware, thereby significantly improving the accuracy of the signal in real time by removing 75% of the distortion.

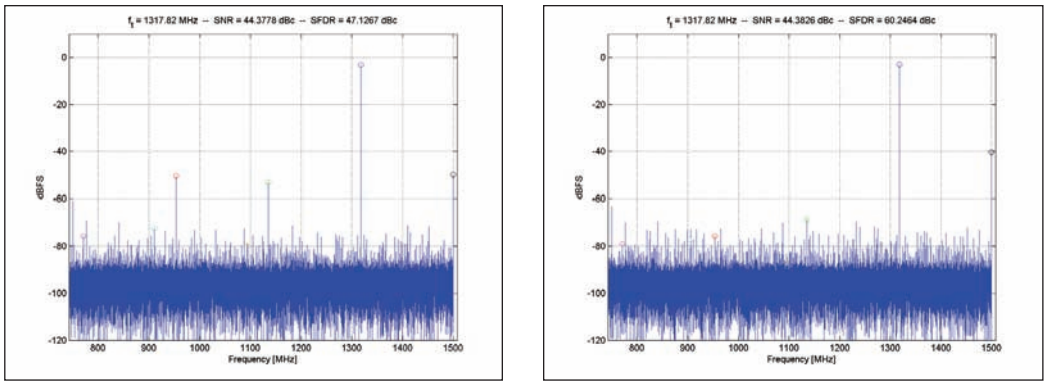
V Corp developed a mathematical model of distortion sources in digital receivers and translated the concept into a mathematical algorithm. The V Corp signal processing algorithm was then partitioned into several simultaneous parallel processes that each ran at a commensurately lower data rate, allowing the processing to run with full throughput in currently available FPGA hardware. After refining the process, the algorithm was implemented in signal processing hardware (FPGA and application-specific integrated circuit, or ASIC).

This commercial digital receiver uses V Corp's LinComp™ advanced digital signal processing technology, which significantly improves signal accuracy.

Joint Collaborations

V Corp's main avenue for success has been building long-term, mutually beneficial partnerships with commercial prime contractors while using SBIR funding to further develop and refine its engineering solutions.

Prior to the DARPA Phase II project, V Corp had established long-term, multi-year relationships with large and small commercial companies interested in their technologies. Their commercial partnerships (including subcontracting with Raytheon and General Dynamics) enhanced their ability to obtain DARPA funding, and helped accelerate this project into deployed solutions. The technology was implemented in end-user applications during the Phase II project.



Commercial receiver hardware distortion levels are reduced by 75% using LinComp™ technology, as shown in the graph at right.

Lessons Learned

- It is important to build long-term relationships with customers and potential partners and involve them during the SBIR project. These relationships provide critical insight into high-priority problems that need to be addressed, and shape the program to provide solutions that will be adopted by these (and other) customers.
- Do not rely solely on the technical point of contact (TPOC) to find applications and partners for the technology. Use the TPOC's contacts and support to help find critical applications, but also use first-hand market research to find applications (military and commercial) outside the purview of the TPOC.

Economic Impact

The DARPA SBIR program has provided critical, core funding for V Corp to develop and apply their broadly enabling algorithms to solve hard signal processing problems. In addition, DARPA funding has been combined with SBIR funding from the Navy, Air Force, and Missile Defense Agency to support V Corp's growth as a small business. This support successfully positioned the company to win numerous development contracts, which include licensing V Corp's developed technology to prime contractors for implementation in the systems being developed for fielding to support DoD shipboard, airborne, and space-based applications.

About the Company

V Corp Technologies, founded in 1997 and headquartered near San Diego, California, specializes in advanced digital signal processing techniques to compensate for non-ideal analog performance for a wide range of applications. V Corp Technologies holds 12 key patents (issued and pending) for its advanced digital signal processing techniques. ■

Company Information

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Email: scottv@v-corp.com
Founded: 1997
Number of employees: 3

Conclusion and Additional Resources

Conducting innovative research and reaching targeted technical milestones does not ensure transition success. The research must lead to a technology with practical applications for specific markets, customers and end-user communities. The business realities of delivering a technology to the market, generating revenue and sustaining a profitable business must all be addressed for successful transition to occur.

There is no doubt that transition momentum can start with an excellent technological solution to a challenging and significant national security problem. As demonstrated by SBIR- and STTR-funded companies that are transitioning their technologies, identifying an innovative solution and application to a specific problem is key. Equally important is creating and executing a transition plan that matches the solution to a need within the Federal and/or commercial marketplace as well as having a high level of technical and program management competence to advance from the laboratory to market. It is worth emphasizing that this statement has been the single most commonly shared "lesson learned" by DARPA SBIR and STTR companies that have successfully transitioned DARPA-funded technology.

While advancing from Phase II to Phase III is challenging, there are many SBIR and STTR companies that have successfully transitioned their technologies into the Federal and/or commercial marketplace. Their success stories are documented on many agency Web sites, including those below, and provide real-world examples of transitions, challenges and lessons learned.

Department of Defense (examples)

- DARPA (http://www.darpa.mil/sbir/Success_Story_Main_Page.htm)
- U.S. Army (http://www.armysbir.com/commercialization/comm.htm)
- U.S. Navy (http://www.navysbir.com/navsuccess.htm)
- U.S. Air Force (http://www.sbirsttrmall.com/Library/SBIRImpactStory.aspx)

Non-Department of Defense (examples)

- DOE (http://www.science.doe.gov/sbir/NEWWEB/success_stories.htm)
- NASA (http://sbir.gsfc.nasa.gov/SBIR/success.htm)
- NIH (http://grants1.nih.gov/grants/funding/sbir_successes/sbir_successes.htm)
- NIST (http://tsapps.nist.gov/success/sbir_successes/sbir_successes.cfm)

Additional resources on the SBIR and STTR Programs and transition process can be found on the DARPA Web site at www.darpa.mil/sbir.