2007 Technology Applications Report

Technologies:
Here Today, Here Tomorrow

MISSILE DEFENSE AGENCY
DEPARTMENT OF DEFENSE

The line between the present and the future often is blurred. What sounds futuristic to some is commonplace to others. Swarms of tiny wireless computers for monitoring environments, 3-D face-recognition software, solar-powered homes, cars that help drive themselves, cancer treatment that does not rely on surgery or drugs, information displays that respond to voice commands—these are all technologies that straddle the divide that separates Today from Tomorrow.

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Introduction

The line between the present and the future often is blurred. What sounds futuristic to some is commonplace to others. Swarms of tiny wireless computers for monitoring environments, 3-D face-recognition software, solar-powered homes, cars that help drive themselves, cancer treatment that does not rely on surgery or drugs, information displays that respond to voice commands—these are all technologies that straddle the divide that separates Today from Tomorrow.

Such innovations are ripe or nearing maturity, but they have not yet become pervasive. For example, 3-D face-recognition is being used today by corporations and law enforcement organizations, although the average American may still think of facial recognition as something that appears only in science-fiction films.

A Surprising Path

As technologies trek toward the future, they tend to sneak up on us. Sometimes, it's difficult to see them coming—in part because many of them take a unique path to the future. And often, that unique path involves the Missile Defense Agency (MDA).

Over the past two and a half decades, the agency and its predecessors—the Ballistic Missile Defense Organization (BMDO) and the Strategic Defense Initiative Organization (SDIO)—have funded thousands of promising technology research projects for missile defense, and hundreds of them have led to innovations beyond missile defense. For exam-

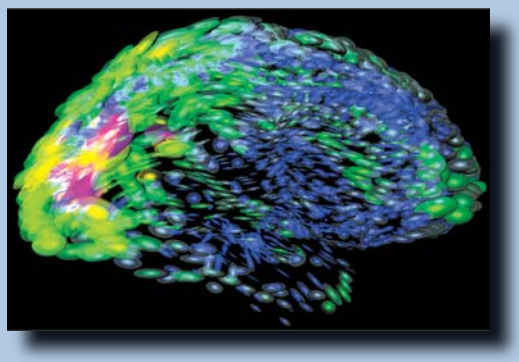
ple, a research project on battlespace simulation contributed to the development of a 3-D camera that is being used for commercial applications such as facial recognition. And research projects on semiconductors for use in missile defense applications have led to new materials that are being included in next-generation lighting technologies.

Looking for Potential

This special report features a sampling of technologies that stand on the line between Today and Tomorrow. All of these innovations have a legacy of support from U.S. ballistic missile defense programs. And although MDA and its predecessors funded the innovations for their potential in missile defense, the technologies are not limited to missile defense. Their potential extends far into the commercial world. Some of them are very real today, though they might sound futuristic. Others are more forward-looking.

As MDA continues to support research and development of new technologies that show promise for missile defense—and as the commercial world steps up to support those technologies for other applications—such innovations will continue to move toward the future and toward reality.

You can follow the path of MDA-funded technologies by reading about additional innovations at the agency's technology transfer Web site, **www.mdatechnology.net**.



As promising technologies trek toward the future, their path to development often involve MDA.

Missile Defense: A mission built on technology

The mission of the Missile Defense Agency is to develop and field an integrated ballistic missile defense system for defending the United States, its military forces, and its allies.

As envisioned, the system will be able to engage all classes and ranges of ballistic missile threats—in all phases of flight—by using assets such as complementary interceptors; land-, sea-, air- and space-based sensors; and battle-management command and control systems. By fielding a layered defense system and targeting missiles in all phases of flight, MDA exploits opportunities that increase the advantage of missile defense systems and complicate an aggressor's plans.

MDA continues to develop, rigorously test, and evaluate production, deployment, and operational alternatives for the ballistic missile defense system. The system being developed and tested by MDA today is primarily based on hit-to-kill technology. The challenge has been described as hitting a bullet with a bullet—a capability that has been successfully demonstrated in tests.

MDA Supports New Technology

Building the tools required to accomplish the mission has presented a host of complex technical challenges to planners of ballistic missile defense. To help address those challenges, MDA has funded businesses as well as universities and national laboratories to develop technologies that can play a role in missile defense. The innovations emerging from these funding partnerships range from sensors to computer systems to advanced materials.

MDA continues to fund scores of research-and-development projects annually to help promising missile defense technologies thrive. But MDA alone cannot fund the entire development life cycle for each technology. So MDA-funded researchers also must seek commercial opportunities that will allow their innovations to mature. By finding commercial partners and new market opportunities, researchers can pull in additional capital and resources to improve their technologies.

Research Pays Off

Ultimately, MDA can benefit from these commercial enhancements to the technologies. For example, commercial customers of MDA-funded innovations such as software or imaging technology might require product improvements or features that MDA also could find useful as it deploys and enhances the ballistic missile defense system.

MDA's investment in advanced technology already is paying off. Previous special reports produced by the MDA Technology Applications program—and available online at www.mdatechnology.net—have chronicled commercial successes that have emerged from MDA-funded projects.

This Technology Applications Report turns an eye toward the future, looking at how technologies originally funded for missile defense are also moving toward tomorrow—toward other, more commercial applications that can improve areas such as health care, home life, business, and transportation, as well as areas related to domestic safety and security.

Technologies originally funded for missile defense are finding applications in other areas such as health care, business, and domestic safety.

Technology Applications: Beyond missile defense

The MDA Technology Applications program helps MDA-funded researchers commercialize and scale up their technologies. Commercialization and technology transfer efforts by the program ensure that MDA-funded technologies survive and mature, allowing them eventually to be rolled into the missile defense system.

Helping Researchers

The program helps MDA researchers by guiding business strategies and increasing public and industry awareness of MDA-funded technology. Specifically, the MDA Technology Applications program, in seeking to fulfill this mission, offers free workshops and commercialization reviews that help MDA-funded researchers and companies focus on their business strengths and problems. The program also disseminates information about MDA-funded technologies through printed and electronic special reports, a searchable repository of articles at www.mdatechnology.net, and a quarterly publication called the *MDA TechUpdate*, distributed to a broad range of readers in business, government and media.

Benefits For All

MDA promotes commercialization because it reduces costs and improves the reliability of the ballistic missile defense system. Commercialization also benefits the economy of the United States and helps improve the lives of its citizens. The success of the MDA Technology Applications program and its focus on commercialization, therefore, is vital for developing superior technology for defending the United States and it allies; promoting the economic growth of the nation; and enhancing the quality of life in the United States.

The MDA Technology Applications program is supported through a cooperative agreement between MDA and the National Technology Transfer Center's Washington Operations.

This report has been written and produced for the Missile Defense Agency (MDA) Technology Applications program by the National Technology Transfer Center-Washington Operations.

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At Home

A home is a sanctuary—a place where you can feel safe and secure. And if the home is one that runs efficiently, the abode can become an even more comfortable place. Innovations with a legacy of missile defense research funding are emerging as tools for creating better homes. Technologies funded originally for missile defense can be used to make more energy-independent homes; tough, lightweight building blocks for houses; noise-resistant windows; and more efficient lighting solutions. These new technologies will help make homes the solid and welcoming sanctuaries that we all wish them to be.

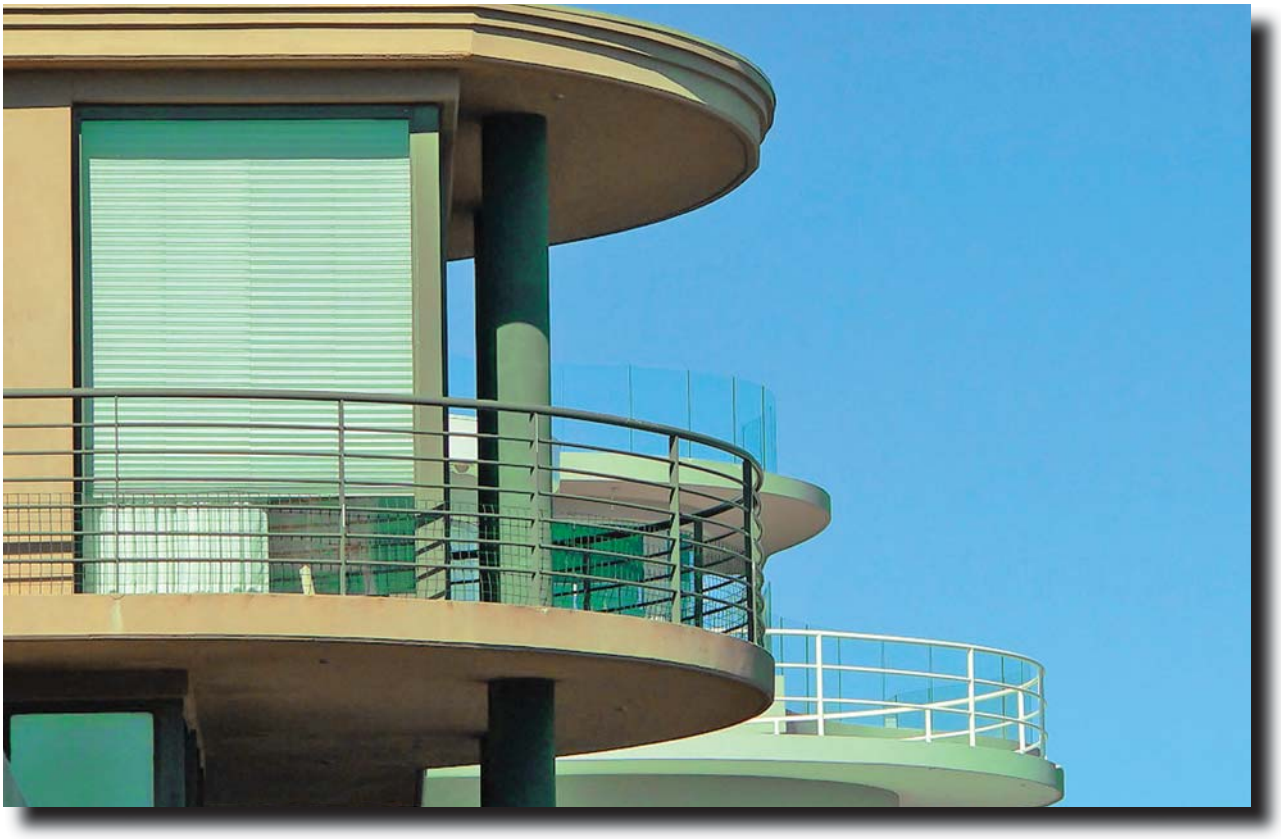
QRDC, Inc.

Daystar Technologies, Inc.

Cree, Inc., and EMCORE

Touchstone Research Laboratory

New construction approach controls noise and vibration in the home



QRDC's Energy-Based Smart Skin Structure can actively control vibration and acoustic energy to make homes more peaceful.

QRDC, Inc.

The Technology

Energy-based vibration-control system

The Commercial Application

Whether it is a high-rise condominium or a residential neighborhood in a bustling area, noise and vibration can be a nuisance—be it the sound of a barking dog, a low-flying aircraft, or the building vibration from strong wind. A solution to the problem is a technology developed by QRDC, Inc. (Huntsville, AL). The technology, a method of controlling vibration and acoustic energy by actively channeling energy flow to strategically spaced "energy sinks," can be applied to windows and other parts of a structure. QRDC calls its innovation "Energy-Based Smart Skin Structure" (EBS3). The technology is effectively a smart design for windows and other materials that allows noise and vibration to be dissipated easily. The company now offers EBS3 as both a design solution and as a retrofit solution.

The Missile Defense Connection

QRDC received BMDO SBIR Phase I and Phase II funding to develop an energy-based vibration and control system for load-bearing skin surfaces, and to develop a fully functioning prototype of EBS3 for more efficient flight, as well as for protection against aerodynamic loads and reduction of airframe vibrations.

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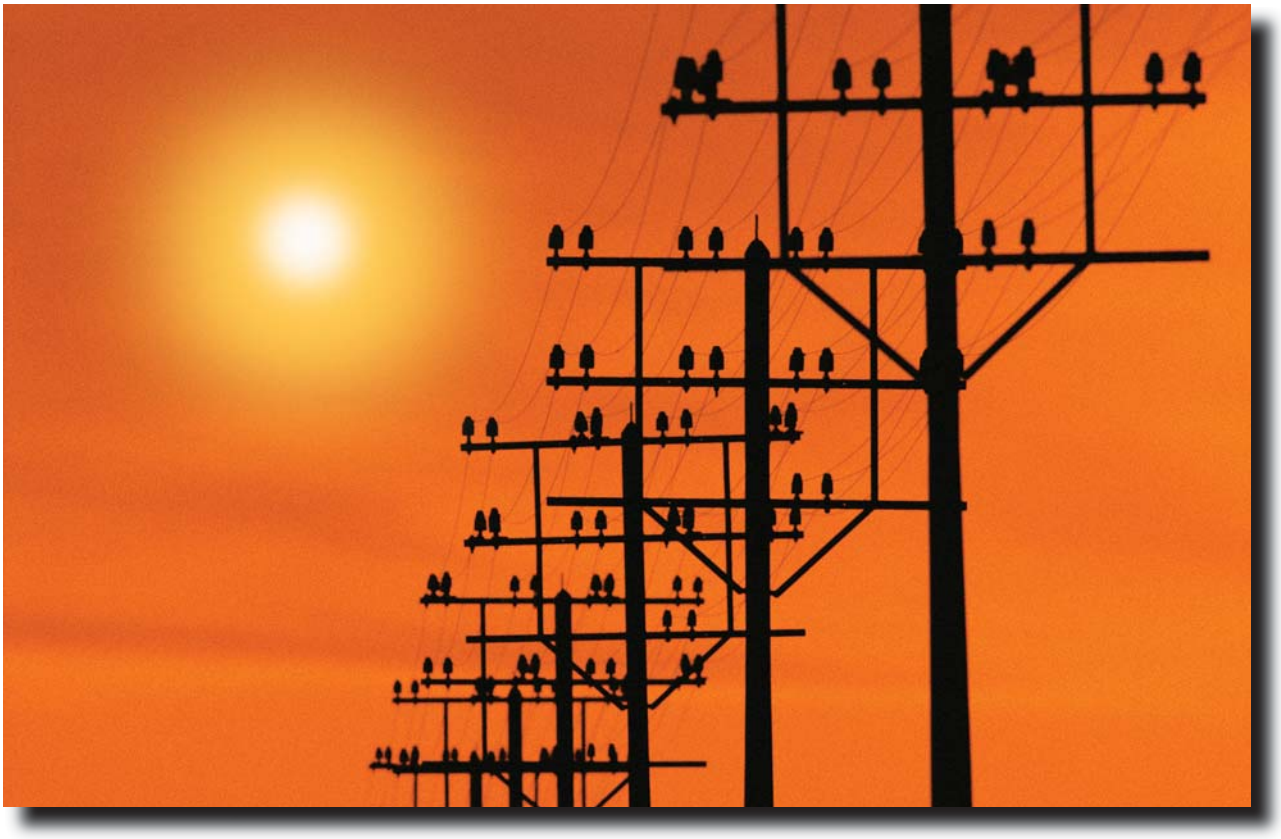
Super-thin solar cells help end dependence on the electrical grid



DayStar's sputtering technique may lead to decentralized home and office power generation and use in appliances.

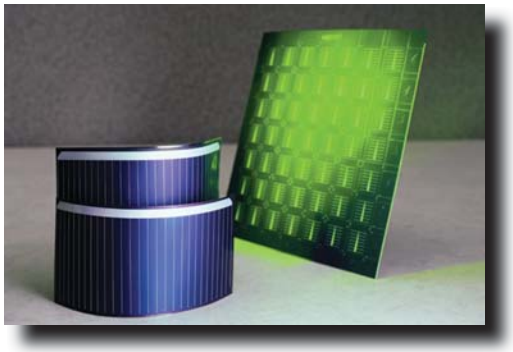
DayStar Technologies, Inc.

The Technology

Thin-film photovoltaic cells

The Commercial Application

Power companies and others seeking alternatives to fossil fuels have a limited demand for solar power—mainly because it is relatively expensive. But if a company called DayStar Technologies, Inc. (Halfmoon, NY), has its way, solar cells could be as lightweight, easy to make, and inexpensive as camera film. DayStar has set its sights on proving that high processing speed can reduce the cost of solar power by 50 percent or more. The company has developed a sputtering technique to deposit copper-indium-gallium-diselenide onto wafer-thin stainless steel foil, using an in-line manufacturing technique that minimizes waste and produces large flexible sheets that can be fitted onto complex geometric forms. Once production reaches a low-cost level, a host of potential commercial applications opens up for solar cells, including decentralized (home and office) power generation and use in appliances.



The Missile Defense Connection

BMDO, predecessor to MDA, originally awarded a Phase I SBIR contract to DayStar in 1999 to determine if copper-indium-gallium-diselenide (CIGS) thin-film photovoltaic cells on stainless-steel foil could be manufactured instead on an even lighter foil substrate for use in space assets. The results were very successful: a power-to-weight ratio of over 1400 Watts per kilogram. In 2000, BMDO awarded a follow-on Phase II contract to see if DayStar could reduce manufacturing costs and achieve high-volume production.

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Long-lasting, energy-efficient white LEDs brighten homes

White LED technology from companies such as Cree and EMCORE has the potential to revolutionize the way lighting is used in the home and to minimize the amount of electricity that is used.

CREE, Inc., and EMCORE

The Technology

Silicon-carbide and gallium-nitride semiconductor materials for developing white light-emitting diodes

The Commercial Application

Companies such as Cree, Inc. (Cree Lighting), and EMCORE (GELcore) are top players in the lighting industry's race to boost the performance of white light-emitting diodes (LEDs), making them attractive and affordable for use in home lighting. Up until now, incandescent bulbs have been used for lighting our homes. But they produce low light quality while being energy-inefficient, and they have a short lifespan. LED solid-state lighting can significantly increase energy performance. By increasing the number of lumens per watt of electricity while reducing the amount of heat produced and the space needed, white LED technology has the potential to revolutionize lighting.

The Missile Defense Connection

Through Phase I and II SBIR awards, MDA and its predecessors have funded companies including Cree, EMCORE, Advanced Technology Materials, Inc. (ATMI), WideGap Technologies, and Sterling Semiconductor to develop various semiconductor materials. For missile defense applications, such materials have shown promise for long-range and short-wave amplifiers for radar, optical data storage, and high-temperature/high-power electronics.*

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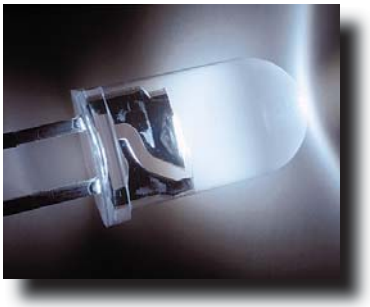

* Note: WideGap changed its name to Nitres, Inc., and was later acquired by Cree, which also acquired ATMI's gallium-nitride substrate and epitaxy business. GELcore is an EMCORE joint venture with GE Lighting. And Sterling was acquired by Dow Corning.

Transforming coal into light, tough building blocks for homes

Touchstone's carbon foam could make an ideal core material for next-generation structural insulated panels because of its high structural strength, low thermal conductance, and fire-resistant properties.

Touchstone Research Laboratory

The Technology

Carbon-foam processing technique

The Commercial Application

Touchstone Research Laboratory (Triadelphia, WV) has developed a breakthrough technology that cheaply and quickly processes coal into a multitasking substance called CFOAM®. The lightweight carbon foam has a remarkable array of properties that make it perfect for use as a versatile construction material that could be used in home construction. CFOAM is extremely durable, machinable, lightweight, and fire-resistant, and can function as both an electrical conductor and a thermal insulator. The U.S. Department of Housing and Urban Development has even investigated its use for safeguarding Federal office buildings against heat and blast.

The Missile Defense Connection

Touchstone Research Laboratory received a number of Phase I SBIRs and one STTR from MDA to develop the carbon-foam process for thermal protection of space components, and lightweight parts for spacecraft construction.

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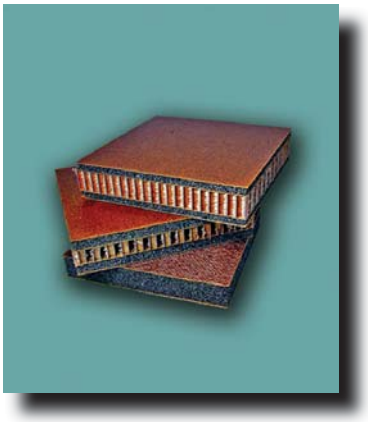


At Work

A quest for efficiency and for well-managed information are hallmarks of the modern work environment. The concept of value—getting the most out of resources—remains a key focus of any organization that seeks to generate a profit or operate within budget. And as MDA and its predecessors have sought tools to improve efficiency, those innovations have proven useful in organizations beyond defense. Many tools that can be used today and tomorrow to improve work efficiency have roots in MDA projects.

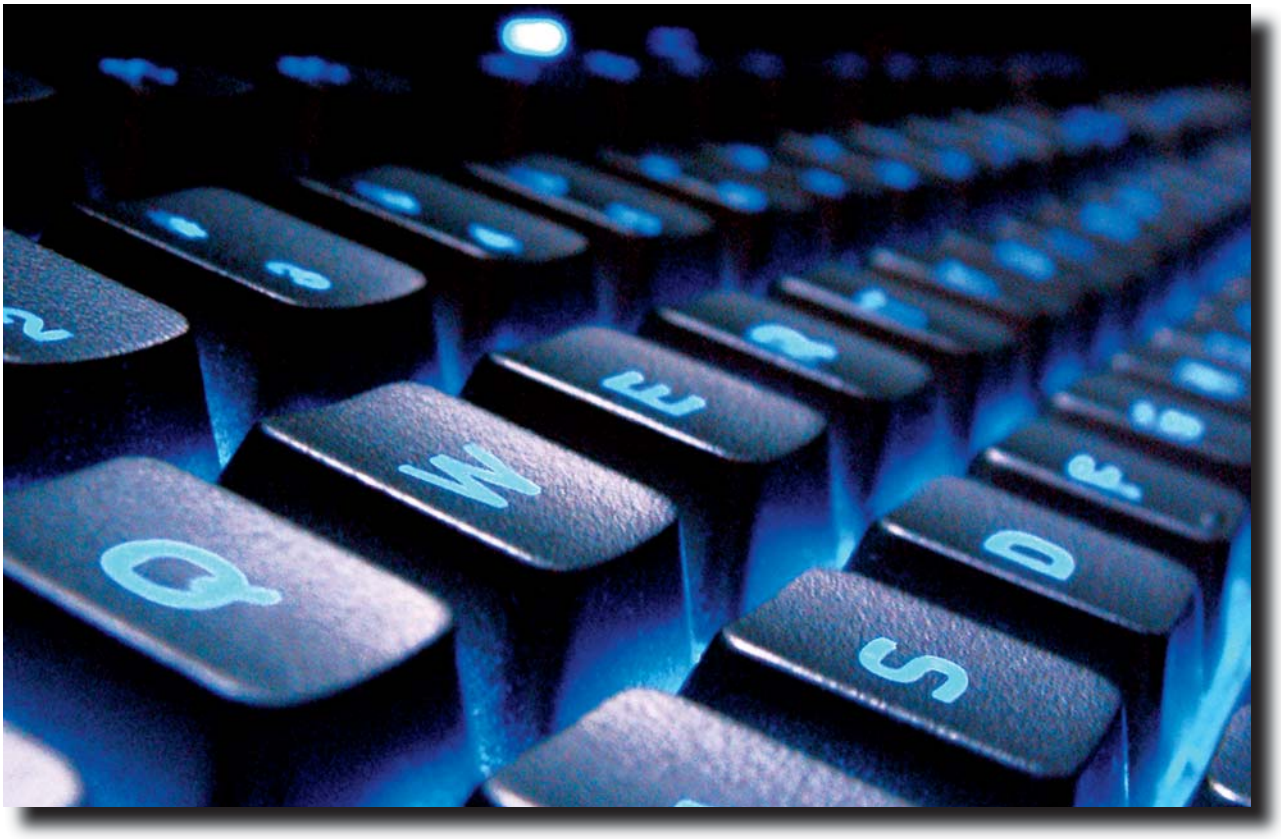
Datamat Systems Research, Inc.

Process Instruments, Inc.

Knowledge Based Systems, Inc.

PointServe, Inc.

Sharing data while maintaining privacy



Datamat's technology can analyze intelligence across various organizations without actually moving any of the data.

Datamat Systems Research, Inc.

The Technology

The InferAgent™ data-analysis software tool

The Commercial Application

Extraction of useful information from data often requires tapping into many distributed databases. But database owners often have privacy restrictions placed on their data and, thus, do not want to (or cannot) move or share it with other sites or organizations. The software tool InferAgent™ addresses that challenge. The product, developed by Datamat Systems Research, Inc. (McLean, VA), analyzes data stored in large, distributed databases and transforms it into useful information—without actually moving the data. The tool can be used to analyze intelligence across various organizations for making observations and decisions not possible using a single organization's database. For example, health care institutions could work together to detect fraudulent claims, or two financial companies could team up to uncover transactions that match patterns indicating potential criminal activities.

The Missile Defense Connection

MDA predecessor BMDO funded Datamat to develop data-mining and knowledge-discovery technology for use in an advanced warfare management system. The company is expanding upon the original technology to address the problems of real-time target discrimination, information overload, and limited decision support.

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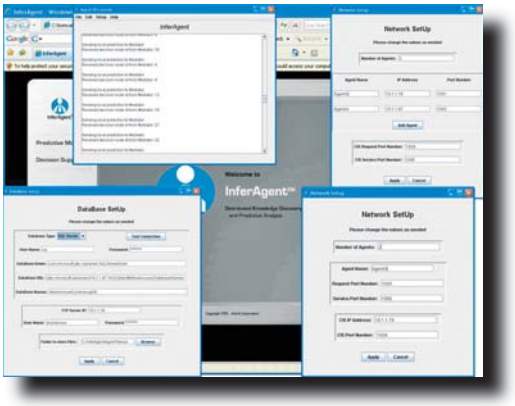

Monitoring processes and improving quality-control in factories

Process Instruments' spectroscopy system can improve monitoring and quality-control processes in many of today's factories.

Process Instruments, Inc.

The Technology

Compact, highly sensitive Raman spectroscopy system

The Commercial Application

In factories that work with petrochemicals, pharmaceuticals, polymers, and other products, analyzing chemical concentrations of sample streams is key to monitoring processes and controlling quality. Raman spectrometers have emerged as an analysis tool to fit that need, but at times the devices can prove too bulky, too costly to maintain, and not as sensitive as desired. Process Instruments, Inc. (Salt Lake City, UT), has developed a smaller, cheaper, and more sensitive Raman spectroscopy system for industrial process monitoring. The key to this system is a special frequency-stabilized, near-infrared diode laser that offers high power (more than 1 watt) and long life (more than 9,000 hours). System advantages include a simple, rugged, and compact design suitable for field use; low-maintenance requirements due to the elimination of moving parts; no sample preparation (which other spectroscopic techniques have required); and good spectrographic stability.

The Missile Defense Connection

MDA and its predecessor, BMDO, funded several Phase I and Phase II SBIR awards for Process Instruments. The SBIR projects have focused on Raman spectroscopy and analysis. Raman spectroscopy instruments could prove valuable for quality control and process monitoring during the manufacture of key components for terrestrial and space-based ballistic missile defense.

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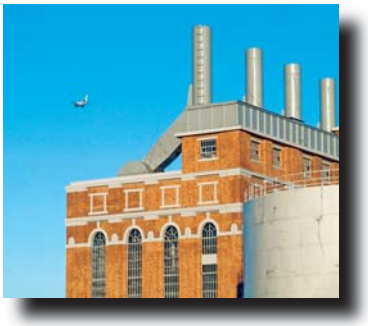

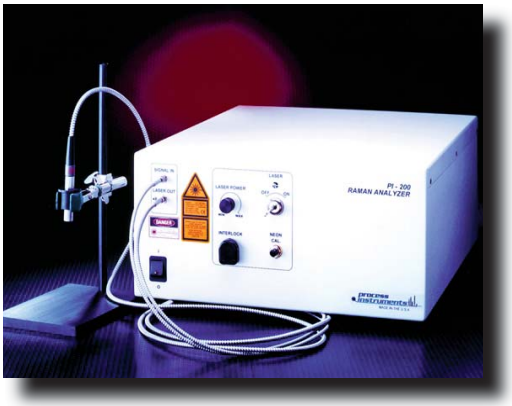

Fusion software helps monitor flow of money and inventory

KBSI's fusion software can help businesses save money by predicting cash-flow trends and tracking parts needed for machinery repairs.

Knowledge Based Systems, Inc.

The Technology

Integrated data experimentation and fusion system

The Commercial Application

Knowledge Based Systems, Inc. (KBSI; College Station, TX), has developed an integrated data experimentation and fusion system (IDEFS), that integrates different data sources into a cohesive software system, ultimately supporting a variety of automated decision-making applications.

IDEFS uses data collection, data manipulation, and knowledge-extraction techniques to create a seamless monitoring and forecasting tool with many applications. KBSI's solutions include Cash InfoMart™, which helps businesses save money by predicting cash-flow trends and by ensuring that an ATM, for instance, has enough $20 bills in place for the day's transactions. Also, using IDEFS technology, KBSI has developed online software that tracks parts used in machinery repair. This approach can streamline busy maintenance facilities by allowing mechanics to locate and order specific parts in real time. The software can help minimize delays in repairs caused by difficulty in locating a missing part.

The Missile Defense Connection

KBSI developed its fusion software and data-mining techniques with help from a Phase II SBIR contract. The work focused on improving processes for making decisions across a wide range of defense issues.

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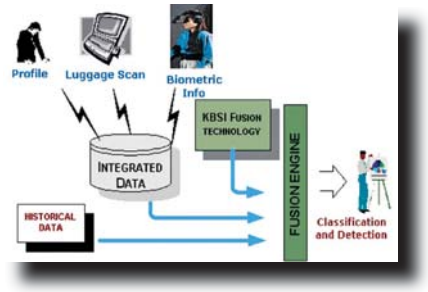
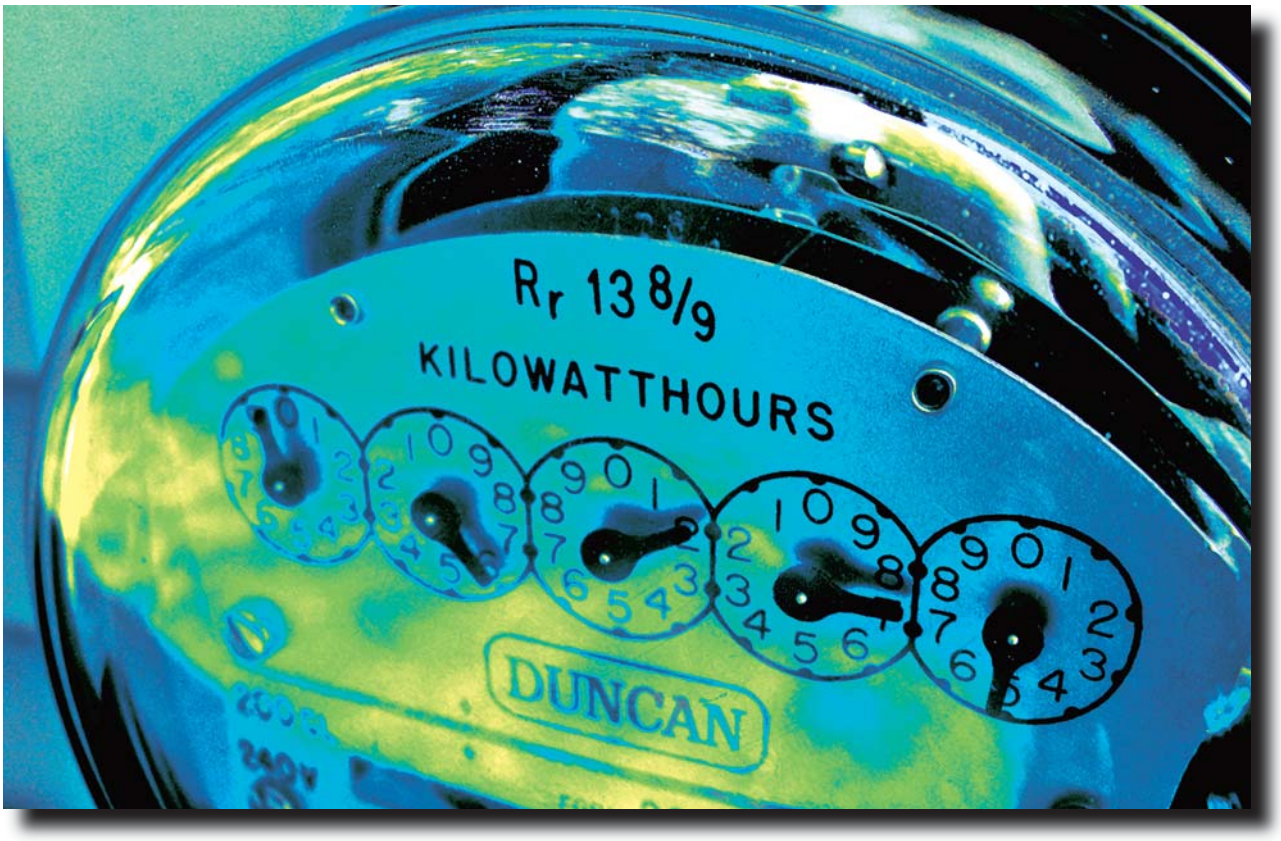


Using software to route field workers efficiently



PointServe's software can help organizations better manage mobile workers, improving response time, customer service, and customer satisfaction.

PointServe, Inc.

The Technology

Algorithms for autonomous command and control

The Commercial Application

Many of today's service-based companies rely on mobile work forces to meet their customer needs. From in-home healthcare to the delivery of services such as gas, cable, and utilities, the work forces that provide these services are routed from one location to the next, stay in contact with home offices and customers, and require real-time responses from management as their day unfolds. Energy Service Optimization (ESO) software from PointServe, Inc. (Austin, TX), can reduce costs and resources, improve response time, customer service, and customer satisfaction. The algorithms themselves originally were econometric (involving economic measurement) and are, therefore, well-suited to the needs of the business world. At Southern Union Gas, PointServe software is used to manage in-house and outsourced staff. And the ServiceMaster Company relies on PointServe for several of its home-care services, including pest control and lawn care.

The Missile Defense Connection

The autonomous command-and-control algorithms were developed at MIT Lincoln Laboratory for the MSX (Midcourse Space Experiment) of BMDO, MDA's predecessor. The algorithms were designed to allow the MSX satellite to control its own resources while optimizing observing time.

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On the Go

Getting from Point A to Point B often sounds simpler than it is. But travel brings with it the challenges of safety and efficiency. Can you get where you are going without breaking down, getting hurt, or injuring someone? And can you travel without breaking your budget—be it in an automobile, a jet, or a train? Those questions become even more critical as we head into the future—facing the challenges of urban growth, long commutes, packed highways, a travel-hungry populace, and the potential for pollution from fuel emissions. Tools that were funded with help from MDA are helping to make travel safe, clean, and efficient. With these innovations, we're not just driving toward Point B; we're driving toward a better future for transportation.

Acellent Technologies, Inc.

Boundless Corporation

SatCon Applied Technology, Inc.

WaveBand Corporation

Monitoring the health of structural components

Acellent's SMART Layer® chassis-mounted sensor network could enhance transportation safety by acting as a vehicular structural integrity inspection system able to forewarn drivers or pilots of potential problems.

Acellent Technologies, Inc.

The Technology

"Intelligent" composites with integrated sensor network

The Commercial Application

Acellent Technologies, Inc. (Sunnyvale, CA), has developed sensor technology, called "SMART Layer®," that could be used in composite-based structural components such as car chassis and airplane wings as a network of sensors to help owners and operators monitor structural wear and tear. Acellent's technology, which consists of a thin dielectric film embedded with a network of sensors, monitors structures for misuse, damage, impact, or fatigue. SMART Layer serves essentially as a built-in inspection system that includes an array of sensors. The commercially available technology could enhance safety by alerting users of structural damage before it becomes apparent.

The Missile Defense Connection

BMDO, MDA's predecessor, funded Acellent to integrate the company's existing SMART Layer technology with composites to create "intelligent composites," which could help monitor structural health of missiles and space assets. The project was funded through Phase I and II SBIR awards in 2000 and 2001.

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Battery saves weight by merging with vehicle structure

Boundless's structural lithium batteries could make possible vehicles in which power sources also can serve as structural components, resulting in cars, aircraft, and space vehicles with efficient "energized" structures.

Boundless Corporation

The Technology

Structural lithium batteries

The Commercial Application

Boundless Corporation (Boulder, CO) has the ability to incorporate special lithium batteries into the physical design of a vehicle or device, creating an "energized" structure that not only saves weight and space but also boosts battery performance. The company sees potential for the technology in spacecraft, unmanned aerial vehicles, automobiles, and other relatively large portable devices that require batteries. By distributing batteries throughout a structure, and closer to the devices that use them, the Boundless approach seeks to avoid heat build-up that can occur with large centralized batteries. Less thermal fatigue means structural batteries should last longer. The distributed approach also avoids energy loss that can occur when long wires are used to deliver battery power. Boundless continues to focus on product development and already has shipped functional batteries for a NASA project to use small satellites to measure radiation in Earth's magnetosphere.

The Missile Defense Connection

Through a Phase II SBIR award, MDA funded Boundless' structural batteries for their potential in onboard power systems in an effort to provide high power at reduced mass and volume. MDA's High Altitude Airship has such a requirement for reduced mass and volume.

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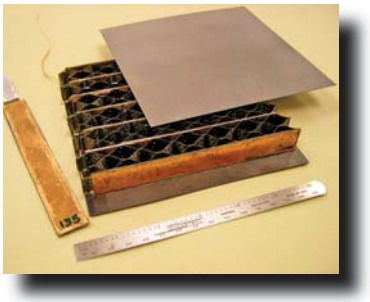

New cooling technique boosts power in next-generation vehicles

SatCon's passive phase-change engine-cooling system could double horsepower in electric-powered and hybrid next-generation vehicles.

SatCon Applied Technology, Inc.

The Technology

Cooling scheme for electric motors

The Commercial Application

Hybrid cars, electric vehicles, and other next-generation vehicles will require electric motors—the part of the engine that converts electrical input into mechanical work output. And improvements in the mechanism to cool those motors could allow automobile designers to double their horsepower in the same space under the hood. SatCon Applied Technology, Inc. (Cambridge, MA), a subsidiary of SatCon Technology Corporation, is working on such improvements with its passive phase-change cooling techniques. By using the company's patented "pumpless" method of moving liquid coolant, an induction traction motor, which normally has a maximum power output of 50 kilowatts, can be modified to operate at a maximum power output of 100 kilowatts (about 130 horsepower). The modification adds very little extra weight or expense. The SatCon method relies on capillary action to draw coolant through windings, and to wick condensed vapor on an outer shell back into the loop.

The Missile Defense Connection

In 1997, MDA predecessor BMDO awarded SatCon an SBIR Phase I contract to study four different concepts for advanced cooling of electric motors, which are used widely in many industries beyond that of automotive. BMDO also awarded an SBIR Phase II contract to SatCon in 1999.

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Cruise control that adapts to road conditions

WaveBand's scanning radar antennas could enable adaptive cruise control, using an automobile's computer system for terrain- and weather-based calculations.

WaveBand Corporation

The Technology

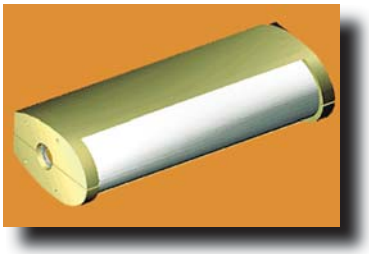
Solid-state, electronically controlled millimeter-wave radar scanning antenna

The Commercial Application

A scanning antenna developed by WaveBand Corporation (Torrance, CA) will be ideal for adaptive cruise control (ACC) systems in automobiles. In these systems, radar provides a vehicle's computer with the location, speed, and direction of any potential obstacles. Because WaveBand's antenna scans, it covers more area than the fixed-beam radar antennas in current ACC systems and provides the car's computer with more data on which to base its calculations. The computer then accelerates or decelerates the car as needed. The WaveBand antenna will be a more attractive option than competing devices because of its low production cost and its ability to penetrate rain, snow, and fog. These features will also make the antenna attractive for all-weather landing systems in commercial aircraft.

The Missile Defense Connection

WaveBand, now a unit of Sierra Nevada Corporation, originally developed the scanning antenna with the help of SBIR contracts from MDA predecessor BMDO in the late 1990s. The company demonstrated the antenna as a lightweight, low-cost component of a radio-frequency missile seeker that would offer all-weather target acquisition capability. The antenna design provides flexibility to accommodate different frequency-band requirements and room-limitation characteristics of the missile environment.



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In the Hospital

Few things indicate a society's level of scientific advancement better than the health of its people and the tools it uses in medicine. In the United States each year we see lengthening life expectancies and the introduction of scores of new medical technologies—everything from surgical instruments to imaging and diagnostic tools to new methods of treatment. And many of the medical innovations emerging trace part of their lineage back to MDA and its predecessor agencies. A tool used for imaging in a missile-related project, for example, might also be used to image human organs, aiding in the diagnosis and treatment of diseases and disorders. MDA-funded innovations that can be applied in the medical world are very much a reality; they are guaranteeing a future in which Americans live healthier lives. And the future will hold even more medical applications with ties to MDA-funded technologies.

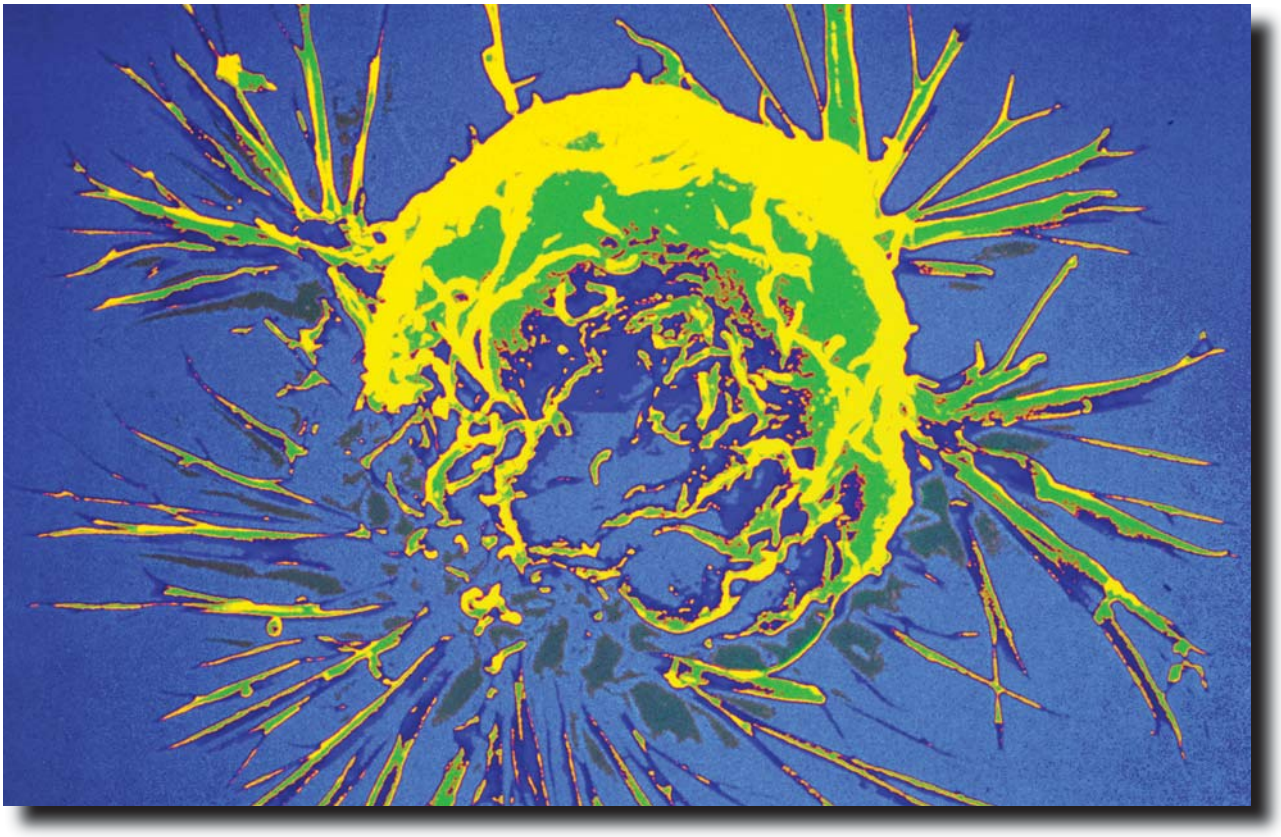
Celsion Canada

Spire Corporation

Advanced BioPhotonics, Inc.

Kestrel Corporation

Microwave-focusing techniques target deep tumors within the body

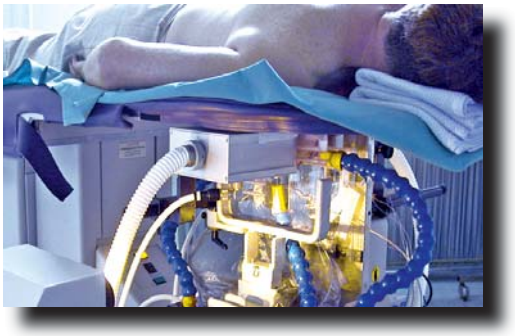


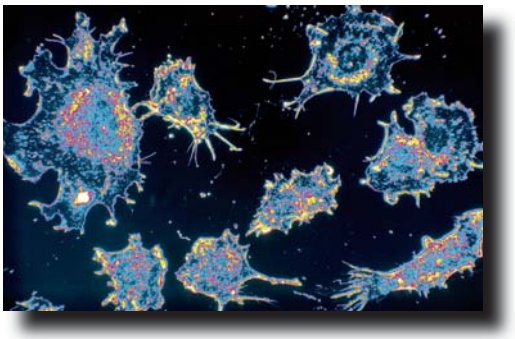
Selectively heating malignancies with Celsion's technology may offer new ways to battle cancer, especially breast and liver tumors.

Celsion Canada

The Technology
Adaptive phased-array antenna

The Commercial Application
An adaptive phased-array (APA) antenna can "null" or cancel out electromagnetic waves in the microwave part of the spectrum. Just as microwave ovens preferentially heat the water in food, high-intensity microwaves, when properly focused by the APA technology, can be trained onto tumors relatively deep in the body while sparing normal tissue. Celsion Canada (Columbia, MD) is undertaking an ambitious program combining the APA heating technology with conventional chemotherapy drugs. The approach may someday result in more effective treatment of breast and liver tumors. Eventually it is hoped that APA can be applied remotely, without the need to insert any needle into the tumor.





The Missile Defense Connection
In the 1980s, while working on general missile defense technology for the Strategic Defense Initiative Organization at MIT's Lincoln Laboratory, Dr. Alan Fenn developed an adaptive phased-array antenna for radar anti-jamming. Dr. Augustine Cheung, founder of the medical device company Celsion Corporation, acquired an exclusive license to Fenn's technology and incorporated it into an early device, the MicroFocus 1000™.

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Fibre laser lights the path to portable microsurgery

Spire's compact laser-surgery technology can access small anatomical spaces while also illuminating the target.

Spire Corporation

The Technology

Compact, continuous-wave laser that operates at room temperature, without the need for water cooling

The Commercial Application

Medical lasers such as the various types of yttrium-aluminum garnet (YAG) lasers, as well as carbon-dioxide lasers, can be bulky and costly, limiting their use to easily accessible surgical fields. In addition, when accessing small spaces such as the inner ear, a second source of illumination is needed. Spire Corporation (Bedford, MA) has developed a 1.2-watt, 2,712-nanometer, diode-pumped, continuous-wave fiber laser that answers the mail on both counts. (For comparison, the width of a human hair is approximately 80,000 nanometers.) The laser, based on an erbium-ZBLAN glass fibre, makes possible a smooth incision in a microsurgical space, while illuminating the surgical target. The portable laser could someday be used in field hospitals or in emergency situations. It also will enable specialists to take their lasers to sites that lack equipment, bringing advanced medical care to rural regions and other underserved areas.

The Missile Defense Connection

Over the years, MDA and it predecessor, BMDO, have awarded several SBIR Phase I and II contracts to Spire to investigate new laser-diode materials for projects such as aligning MDA's High Energy Chemical Laser (HEL) weapon.

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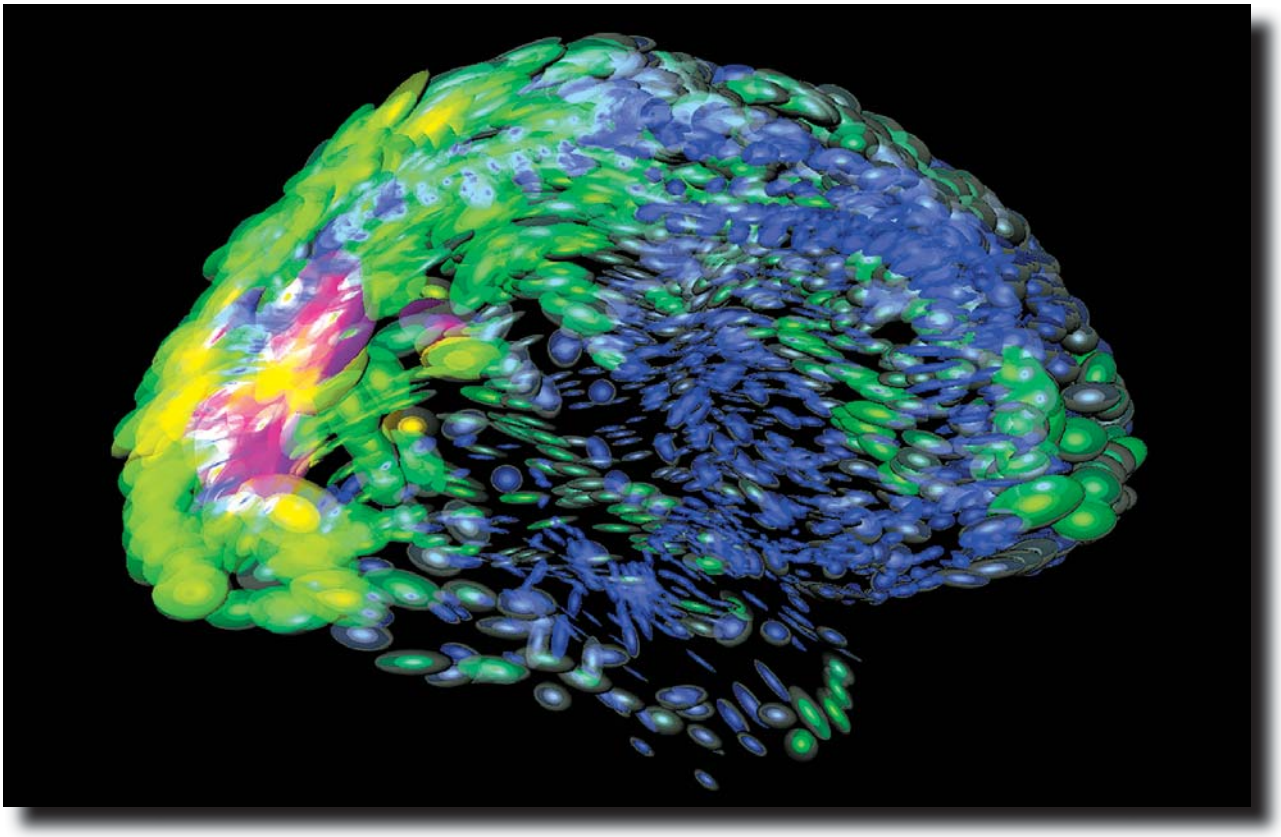
Monitoring tissue with “new eyes” in the surgical suite



A QWIP-based camera from Advanced BioPhotonics offers a noninvasive imaging technique to help supplement MRI and CAT scans in surgical and patient-monitoring applications.

Advanced BioPhotonics, Inc.

The Technology

BioScanIR®, a camera based on the quantum-well infrared photodetector (QWIP)

The Commercial Application

Advanced BioPhotonics, Inc. (Bohemia, NY), has adapted QWIP technology into its product, the BioScanIR. The QWIP-based camera can "see" the health of tissue, monitor brain activity during surgery, and help determine the effectiveness of chemotherapy. The device is highly sensitive to that portion of the infrared spectrum that makes it especially useful for detecting blood-flow-related changes in skin and tissue temperature. This translates to determining the health of surgical grafts, monitoring tumor progression or regression during chemotherapy, or even checking limb health in patients who suffer from peripheral vascular disease. The technology is noninvasive and relatively operator-independent, and it could become a very competitive player in the medical imaging market. It is being tested in major medical and academic centers in the United States.

The Missile Defense Connection

Developing the QWIP was a collective effort involving NASA, the Jet Propulsion Laboratory, and BMDO, MDA's predecessor. BMDO was interested in the QWIP's ability to detect missiles in nonboost phase, when they are not sporting their white-hot launch plumes.

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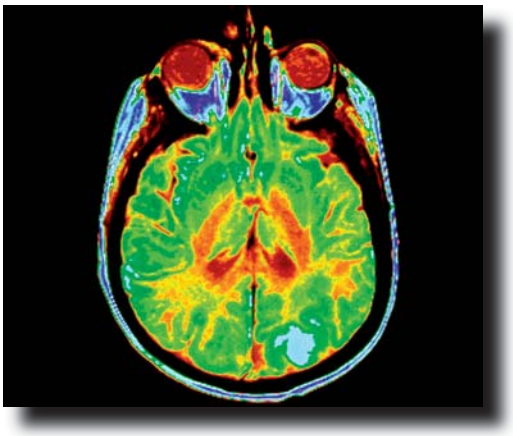
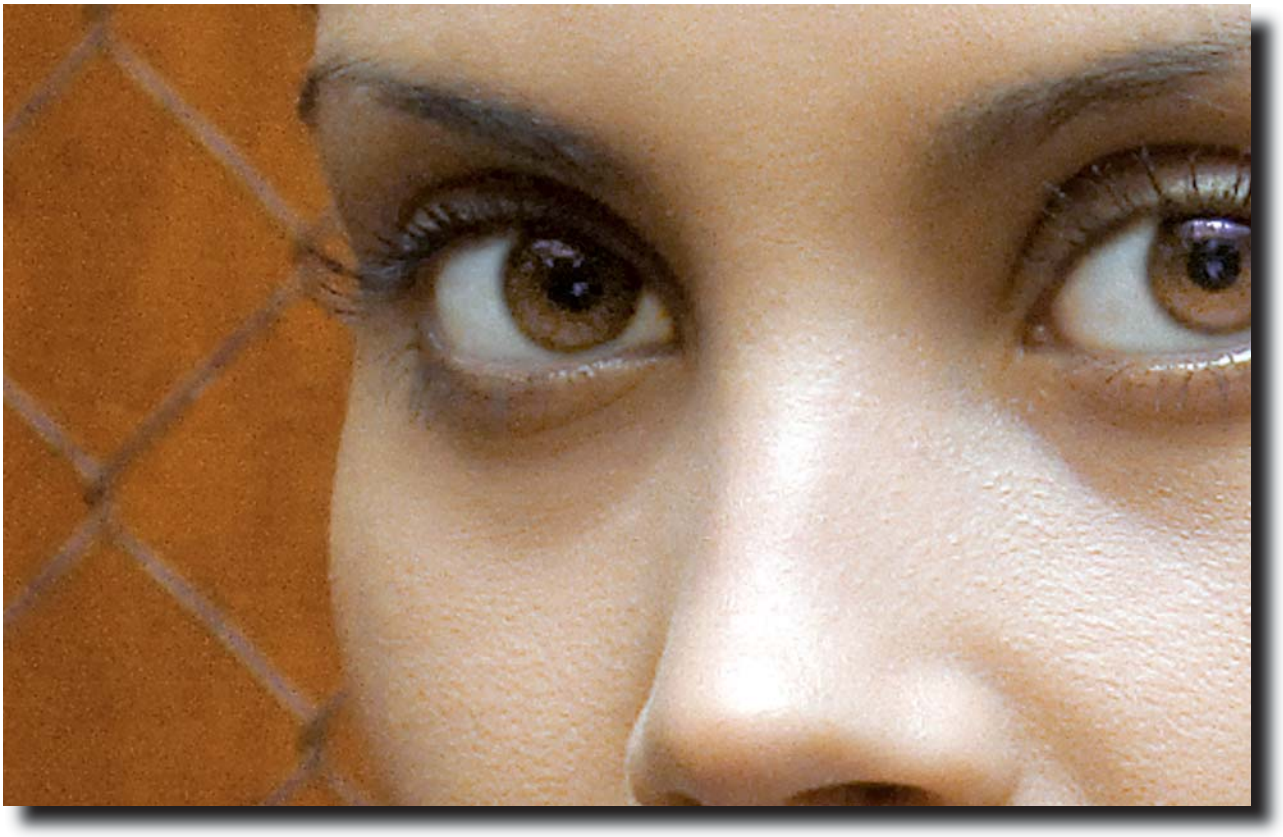


Seeing deeply into the eye's anatomy



Kestrel's technology can yield valuable diagnostic clues by examining the eye in a range of wavelengths.

Kestrel Corporation

The Technology

Hyperspectral imager

The Commercial Application

Kestrel Corporation (Albuquerque, NM) has developed a hyperspectral imager that can rapidly provide an extremely detailed picture of the eye and potentially provide much more diagnostic information than a camera can provide. Hyperspectral imaging traditionally has allowed airborne and satellite sensors to snap images of Earth's surface using hundreds of spectral bands at very narrow bandwidths. Imagery can then be analyzed to detect subtle color differences between soil composition or vegetation cover, for example. The approach can work similarly for the anatomy of the eye, measuring very subtle differences in color—clues to the onset of possible diseases and disorders. Use of the technology, therefore, could allow ophthalmologists to diagnose retinal disease years before symptoms first appear, allowing the patient a better chance at successful treatment.

The Missile Defense Connection

While researching ways to assess the targeting abilities of MDA's Airborne Laser system during a Phase II SBIR project, Kestrel Corporation developed an imager that could rapidly detect hundreds of very narrow bandwidths at a rapid rate.

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In Uniform

Law enforcement officials, emergency responders, and members of the military all rely on tools to do their jobs. But sometimes tools don't seem quite as good as they could be. A tool that allows users to see targets at a distance is great, but a tool for seeing targets at a distance and through the cover of night is even better. Sharing information instantly is wonderful, but being able to collaborate and work with shared information instantaneously is even better. Emerging technologies funded with help from MDA are leading to innovations that can be used by those in uniform as they plan for the challenges of the future. The tools of tomorrow will be better than the tools of today thanks in part to MDA support.

Embedded Research Solutions, Inc.

Irvine Sensors Corporation

Genex Technologies, Inc.

InfoValley Corporation

Tiny wireless computers expand data collection

Embedded Research Solutions' wireless technology could be used to monitor and relay vital signs of soldiers in the field.

Embedded Research Solutions, Inc.

The Technology

Miniature wireless computers

The Commercial Application

Tiny wireless computers attached to sensors and networked together should dramatically improve collection and sharing of data in the field and elsewhere—from battle zones to disaster sites. Such wireless sensor nodes could be deployed in an area to collect data in many spots, helping to create a more thorough information picture. They could be placed throughout the natural environment, for example, to give meteorologists a clearer understanding of weather patterns and to help them provide more accurate weather forecasts. Or Embedded's wireless technology could be used to monitor the body temperatures of soldiers in the field or the heart rates of athletes during a competition. Embedded Research Solutions, Inc. (Annapolis, MD), has developed the wireless node technology, which is commercially available from the company today. The core technology, which consists of extremely compact software programs embedded in matchbox-size hardware, is compatible with many types of sensors.

The Missile Defense Connection

The software for the Embedded technology was funded through SBIR Phase I and Phase II contracts from MDA for pervasive-computing applications, allowing multiple sensors to work together on a network.

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Camera helps users see in total darkness

Irvine Sensors' lightweight PMTV cameras will afford improved night vision for firefighters, without blurry images. The stacked memory chip used in a PMTV is smaller than a dime.

Irvine Sensors Corporation

The Technology
Thermal viewer

The Commercial Application
It is now possible to see in total darkness thanks to the personal miniature thermal viewer (PMTV), a handheld infrared camera that weighs less than half a pound. Although other thermal viewers are available on the market today, the PMTV offers a feature not found in any other model: self-calibration. Normal thermal viewers require frequent calibration in order to prevent drifting, which can cause blurry images. The PMTV, a product of Irvine Sensors Corporation (Costa Mesa, CA), stores calibration information within the device itself and adjusts automatically. In addition to being low-maintenance, it is also sturdier and more energy-efficient than standard thermal viewers. It could work well as a tool for warfighters, firefighters, or law enforcement officers trying to locate people or targets in darkness. PMTVs are currently in use in military applications and are available on the commercial market.

The Missile Defense Connection
The technology behind the stacked memory used to store calibration information was funded by MDA through several Phase I and Phase II SBIR contracts. The SBIR projects showed promise in helping to miniaturize electronics for missile seekers.

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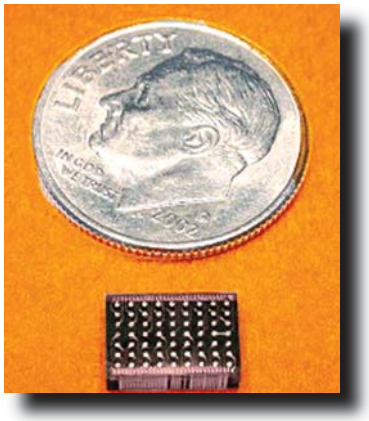

Face ID system helps law enforcement find the bad guys

The Genex 3D FaceID biometric imaging system will allow airport security officials to create real-time, digital three-dimensional sketches of suspects.

Genex Technologies, Inc.

The Technology

3-D face identification system

The Commercial Application

If a known terrorist walked through a large crowd, a camera could focus in and identify him, and law enforcement officers could nab him before anyone got hurt. That's the promise offered by 3D FaceID®, an identification system that uses biometric measurements to compare constant, distinct facial features with suspects' images in a database. Genex Technologies, Inc. (Kensington, MD), a subsidiary of Technest Holdings, Inc., created the system by developing a camera that captures full facial images in two and three dimensions simultaneously. The camera sends them to a computer running facial-recognition software, which then determines whether the person in question is a suspect. 3D FaceID boasts more accuracy than other systems because it provides full-frame 3-D images, and allows for rapid responses because it operates in real-time. Using the same platform camera technology, Genex also developed a program to help law enforcement officers easily create digital, 3-D sketches of suspects. Genex's imaging system is currently available as a commercial product.

The Missile Defense Connection

Genex developed a 3-D imaging camera with the help of SBIR Phase I and II contracts from BMDO, MDA's predecessor. The project was funded for its potential in enhancing battlefield management and simulation training. The device could be used to continuously image a missile in three dimensions.

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Collaborative display improves communication and coordination

InfoValley's interactive display could be used by decision makers at a command center to review data from the field, to share information with others in the command center, and to collaborate as they work with the information.

InfoValley Corporation

The Technology
Interactive InfoWall™

The Commercial Application
Development and deployment of an interactive information wall should allow military planners as well as law-enforcement officials to communicate and share visual data rapidly, enabling them to assess resources and deploy personnel more efficiently. The display wall, developed by InfoValley Corporation (Wayne, PA), serves as a common computer screen that can be manipulated and accessed by several users simultaneously—whether all at the same location or in different locations. An "untethered" interface means that users of InfoValley's interactive InfoWall can use laser pointers instead of computer mice and voice commands instead of key commands. The display wall is already available today as a commercial product.

The Missile Defense Connection
Software technology at the heart of the display-wall interface was funded by MDA though an SBIR Phase II award to develop a team computer interface that could be used in battle-command centers.

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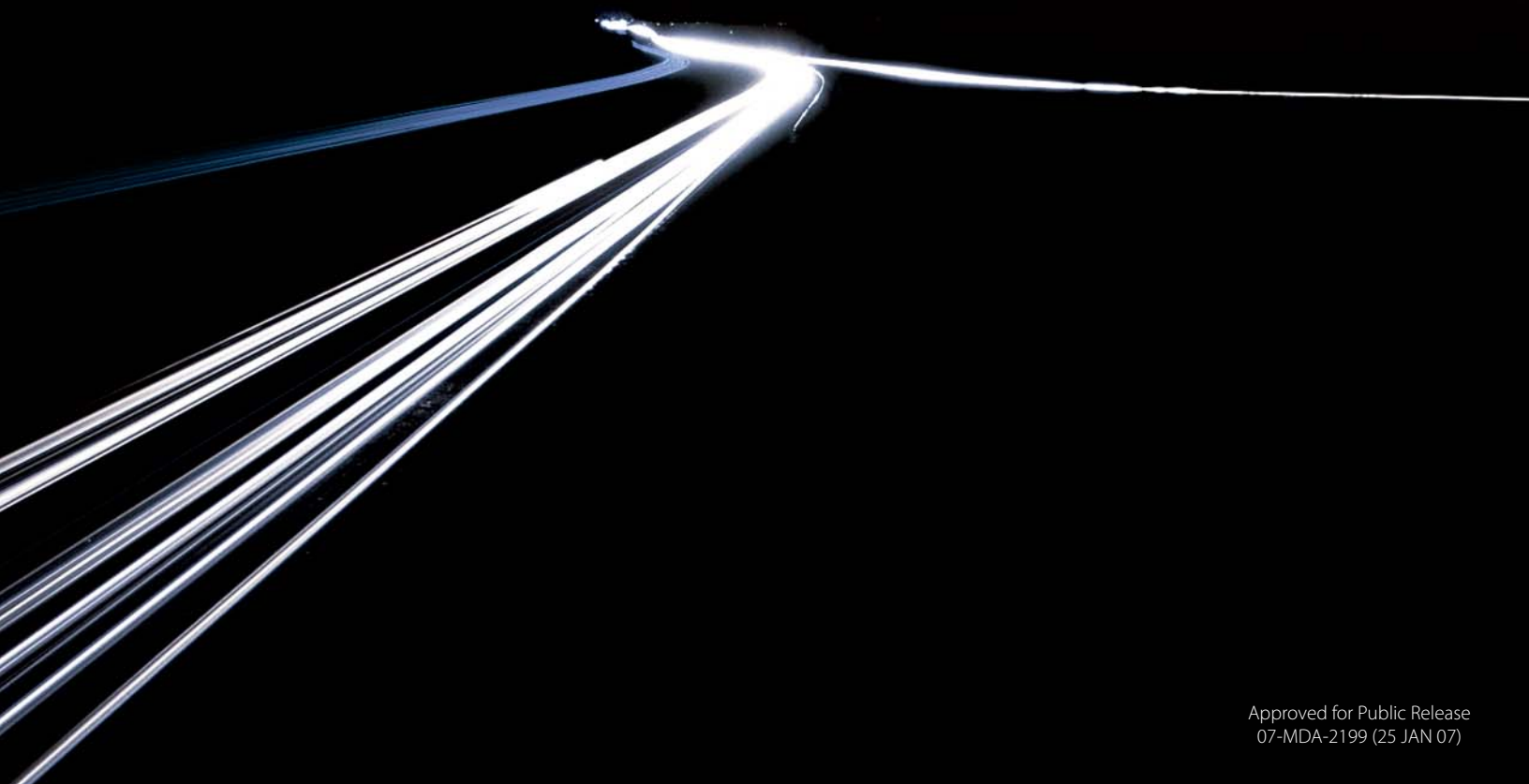
Follow the path of these technologies and other MDA-funded projects—
from their infancy to their debut in missile defense systems and in
commercial applications.

Visit the agency's technology transfer Web site,
www.mdatechnology.net, to read about innovations
that are trekking toward the future.



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07-MDA-2199 (25 JAN 07)