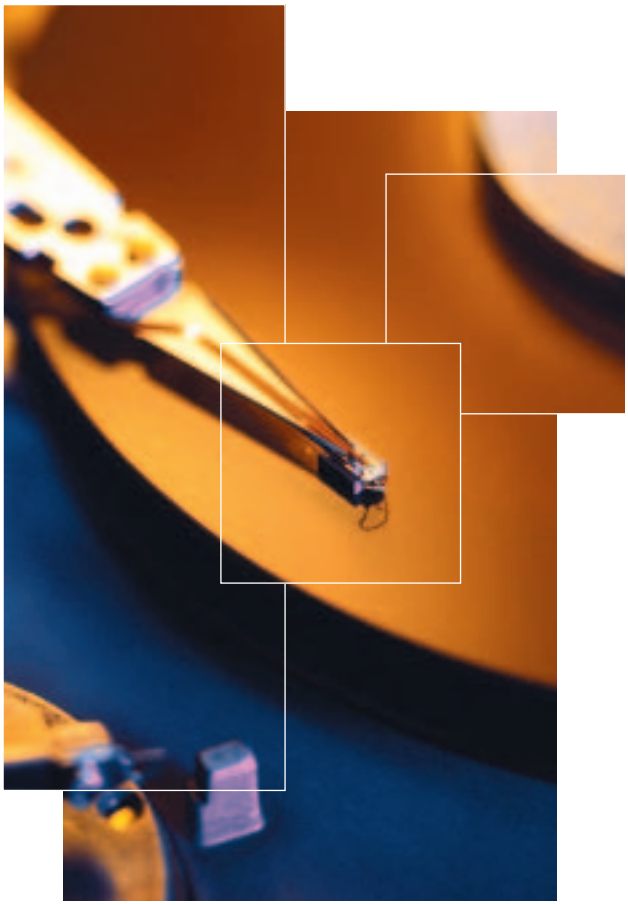
2004 MDA Technology Applications Report

MISSILE DEFENSE AGENCY
DEPARTMENT OF DEFENSE

2004 MDA
Technology Applications Report



Foreword

The Missile Defense Agency (MDA) funds the creation of cutting-edge technologies to develop a ballistic missile defense system. This system will provide a defense against ballistic missiles targeted at the United States, its territories, its deployed military, and its allies. The complexities of the system, which is described as hitting a bullet with a bullet, require advanced technology from almost every field—materials, energy, nanotechnology, photonics, and the list continues. Much of this advanced technology, while being developed for its capabilities in missile defense, can be used elsewhere.

By Congressional mandate, all Federal research and development organizations must strive to transfer government-funded technology to areas beyond the Federal government. MDA, and its predecessors BMDO and SDIO, has benefited from this advanced technology; so too, have public and private companies as well as other government organizations. Technology can serve more than one purpose and can accomplish more than one task. When MDA-funded technologies result in commercial products, industry grows, jobs are created, and sometimes new businesses are born. Transferring technology also helps MDA by strengthening the technology base of the companies funded.

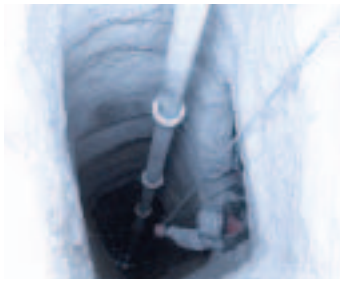
Since 1986, the MDA Technology Applications program has assisted small and large companies, universities, and Federal laboratories in commercializing their MDA-funded technologies. The program leverages the expertise of technology professionals, business experts, and communicators to accelerate the maturation and commercialization of technologies funded for MDA. The *2004 MDA Technology Applications Report*, an annual publication produced by the program, highlights 20 examples of MDA-funded technologies that are successfully being used in areas beyond missile defense. And the MDA Technology Applications program will continue to assist MDA-funded companies, in turn, promoting more industry growth, job creation, and national competitiveness.

Paul Koskey,
Director, Technology Applications Program

Table of Contents

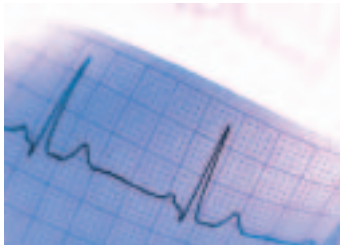
Cape Cod Research, Inc.
page 20

Dynamic Structures and Materials, LLC
page 26



Genex Technologies, Inc.
page 32

NanoSonic, Inc.
page 40



NVE Corporation
page 44

OmniCorder Technologies, Inc.
page 44

The Value of Technology Transfer

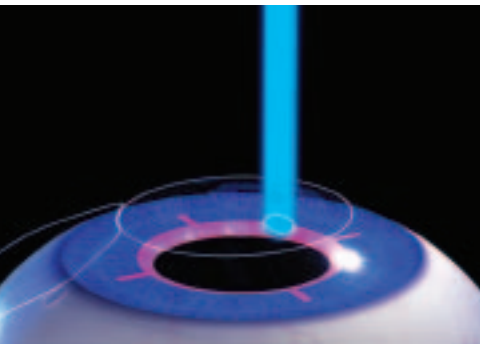
Beam-shaping optics, high-fidelity actuators, and a secure peer-to-peer network are just a few of the cutting-edge Missile Defense Agency (MDA)-funded technologies featured in this report. The technologies are advanced, and their technical names are confusing to a non-technical reader; their names do not make clear the technologies' uses in the day-to-day lives of the general public. But, what if the technologies were called "a precisely focused laser that can kill cancer cells and leave healthy ones intact," or "a mobile generator that can run off the engine of a car continuously for days and nights without any maintenance," or "an e-mail program controlled by the user that prevents all spam from entering an inbox?" When described this way, the usefulness of MDA-funded technologies to the general public is apparent . . .

Introduction

The Value of Technology Transfer

Why Transfer Technology?

MDA assists with the transfer of technology to commercial markets ultimately to meet its mission of ballistic missile defense. The benefits of commercialization help keep MDA-funded technologies alive and available for use in ballistic missile defense. Commercialization can improve the performance of technologies and establish their reliability. And quantity production as a result of commercialization can reduce technology costs.



. . . So why is MDA funding technologies for cancer treatments, generators, and spam prevention? The answer is simple: It's not.

Missile Defense Agency Technology

MDA's mission is to develop and field an integrated ballistic missile defense system capable of providing a layered defense for the United States and its deployed forces, friends, and allies against ballistic missiles of all ranges in all phases of flight. Imagine trying to hit a bullet with a bullet. This is MDA's task. The technological needs of this complicated system have led to the research and development of many advanced technologies—for example, flexure-based piezoelectric actuators to control divert attitude and control thrusters for missile platforms, and an omnidirectional surveillance system to offer a wide field of view for missile seekers. These are just a few of the technologies that are described in this report and funded by MDA to support the ballistic missile defense system. And all of them—although having their uses in missile defense—have also been successfully transferred to other areas of government or into the commercial sector. For instance, carbon-aerogel electrodes were funded by MDA for use in batteries, supercapacitors, and waste cleanup for the ballistic missile defense system. However, these same carbon aerogels are also being used to make brackish water in Texas safe to drink. This is technology transfer.

Technology Transfer

The U.S. Federal government research and development (R&D) budget for FY 2003 was $117.3 billion. DOD's portion of that budget was $58.6 billion. There is a lot of cutting-edge technology being developed to defend the Nation. However, it can have additional uses, in the commercial market or other government agencies, beyond the area of defense. Seeing this, the United States Congress has passed numerous laws requiring Federal agencies to spend a portion of their research and development budgets on technology transfer endeavors.

The *2004 MDA Technology Applications Report* features 20 MDA-funded technologies that are being successfully utilized in applications beyond missile defense. The users of these technologies include medical professionals, the military, first responders, commercial companies, universities, and NASA.

For many years, the medical industry has benefited from the advancement of technologies funded by MDA, or its predecessors BMDO and SDIO. For example, as a direct result of BMDO-funded SBIR projects to create laser radar (LADAR) systems for missile tracking and space docking, Autonomous Technologies Corporation—now a division of Alcon Laboratories—created a new device for corrective eye surgery, which has been performed on millions of people in the United States. In 1998, Autonomous' technology was FDA-approved for use on people. It is now called the LADARVision® System and sold by Alcon. The system customizes the laser treatment to the problems of each individual eye. And the insertion of MDA-funded technologies into the medical arena continues. The following report features three technologies that are being used by medical professionals.

The September 11 terrorist attacks have caused a large increase in technologies developed for first responders and the military. MDA, and its predecessors BMDO and SDIO, has funded many technologies having dual use in missile defense and homeland security. One of the many homeland security needs highlighted by September 11 was more technological equipment for first responders, specifically firefighters, when responding to emergencies. Well before September 11, BMDO-funded technology was answering this need. The Jet Propulsion Laboratory (JPL) was funded by BMDO to develop imaging cameras based on quantum well infrared photodetectors (QWIPs) for ground-based and space-based surveillance at long wavelengths. However, it was found that the QWIP camera could also detect hot spots, hidden pockets of smoldering wood that can flare up even after the fire appears to be extinguished, after large wild fires. These hot spots are not easily visible to the human eye. In 1996, the QWIP camera was used to extinguish hot spots from the fires in Malibu, CA. QWIP Technologies, Inc., currently holds a license to make and sell the QWIP camera for surveillance and monitoring purposes. This year's report has six articles on technologies funded for ballistic missile defense that are also being used to meet the needs of first responders or the military.

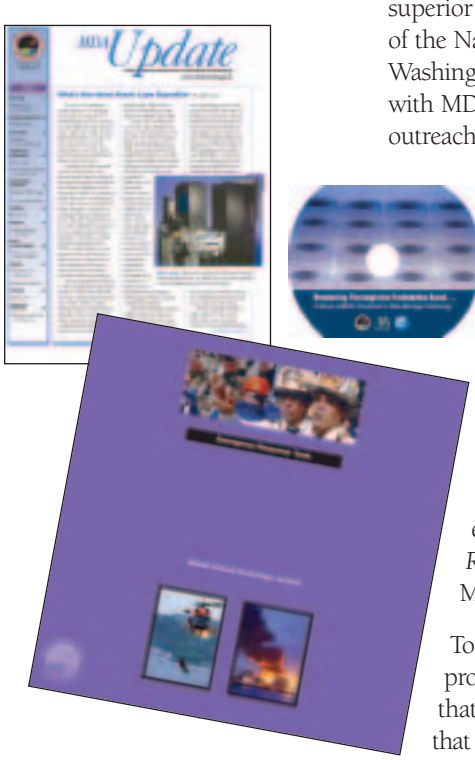
Since SDIO's creation in the 1980s, companies have been using ballistic missile defense technologies to advance products for the commercial market. Energy, environment, information, manufacturing, materials—these industries and many more have made advancements due to MDA-funded technologies. For example, Hayes and Associates was funded by BMDO to develop a material for fast aerospace vehicles that can absorb large quantities of heat with limited overall temperature rise. Hayes also turned this material into a warming tray and sold it to Pizza Hut. The warming tray keeps the pizza warm and crispy while in route to being delivered. This is just one of the many ways ballistic missile defense technologies are being used in commercial industry. Universities and even NASA use technologies that originated in missile defense for their research and spinoffs onto the commercial market. This 2004 report features 11 MDA-funded technologies that are being used by commercial companies, universities, or NASA.

MDA Technology Applications Program

Many of the companies funded by MDA are small businesses, which often do not have resources for marketing, expertise in business planning, or the know-how required to make business connections. So MDA's technology transfer program helps these companies mature and commercialize their MDA-funded technologies through better business planning and raised visibility for their work. This helps MDA improve its return on investment.

It can take years for MDA to be ready to use a tiny accelerometer that it funded a small technology company to develop. Businesses need revenue. Small businesses often do not have the resources to wait years for MDA to incorporate its technology into a missile guidance system. So without any sales, the company may go bankrupt. But if the business transfers the MDA-funded technology to an automobile manufacturer that needs a smaller, cheaper, more accurate accelerometer, it creates a new revenue source for itself. Now the business is thriving and the technology is available when MDA is ready to insert it.

The MDA Technology Applications (TA) program leverages the expertise of technology professionals, business experts, and communicators to accelerate the maturation and commercialization of technologies funded for ballistic missile defense. This is vital for developing superior technology to defend the United States and its allies, promote the economic growth of the Nation, and enhance our quality of life. The National Technology Transfer Center-Washington Operations (NTTC-WO) supports the program through a cooperative agreement with MDA. Its unique approach to MDA technology transfer includes business assistance and outreach support services.



Publicity

The TA program offers free publicity to all MDA-funded companies. One form of publicity is the *MDA Update* newsletter, a 16-page, quarterly publication that highlights MDA-funded technologies being commercialized or having strong potential for commercialization. This publication helps MDA-funded researchers by raising the visibility of their technologies outside the ballistic missile defense community.

Special reports that focus on specific types of technology, such as fiber optics, or timely application areas such as counter-terrorism are also published. For example, the program recently released a report on MDA-funded technologies with applications in emergency response. It also produces this publication, the *MDA Technology Applications Report*, annually to acknowledge those companies that have successfully transferred MDA-funded technologies to other aspects of life.

To facilitate dialogue between technology developers and outside organizations, the TA program also provides a Web site with a searchable database of MDA-funded technologies that provides one- to three-page abstracts on these technologies, links to the companies that developed them, and current news about MDA-funded companies and technologies. The TA program also attends and exhibits at industry meetings and conferences across the Nation to network with those interested in MDA technology developments and keep informed about industry needs.

Business-Planning Assistance

The TA program offers business-planning services in the form of Business Focus Workshops (BFWs) and Technology Application Reviews. The BFW provides a unique opportunity for researchers with early-stage MDA-funded technology development projects to receive personalized business assistance in a one-day format. Working one-on-one with a panel of business experts assembled by the TA program, the researchers create a presentation outlining their business goals. The panel listens to the presentation and gives advice and potential business contacts. The advice can help researchers create a more formal business plan for their MDA-funded technologies.

The TA Review is designed for researchers with MDA-funded technologies past the prototype stage. In many cases, these researchers have previously attended BFWs. In a two-day format, each company attending the TA Review gives a structured presentation—including an overview of their technology and detailed information about their business strategy—to a panel of 15 to 20 reviewers who have experience in areas such as venture capital, intellectual property, and strategic partnerships. The panel provides commercialization advice and business contacts. Often, members of the review panel are able to provide specific additional recommendations and limited assistance, even after the TA Review.


Technology Applications

Cancer Treatment

Apollo Instruments, Inc.
Irvine, California

Have you ever tried to get a fever? Probably not. When most people get a fever, they take medicine to cure it. However, some doctors are beginning to use fevers as the cure. They have found it to be a natural defense the body employs to fight sickness, and they are purposefully inducing them in people that have diseases such as cancer.

▲ *Dr. John Takacs, an engineer at The Boeing Company, is using Apollo's fiber-coupled laser diode for high-power experiments. Apollo's beam-shaping optics have enabled high-brightness and high-power laser diodes for fiber-coupled, collimated, or other solid-state laser devices.*

The University Health Network (formerly Princess Margaret Hospital, Toronto, Canada) is experimenting with a more targeted approach than elevating the temperature of the whole body. Using a fiber-coupled laser diode developed by Apollo Instruments, Inc., the hospital is studying the hyperthermia treatment of cancer by raising the temperature on the location of the cancer cells. Under the high-power beam of the laser, the temperature of the cells quickly increases. Cancer cells are less tolerable to high temperature than normal cells. Therefore, unlike conventional treatments such as chemotherapy, only the cancer cells are killed under the laser beam. The normal cells survive. Apollo's superior beam-shaping technique and thin fiber-beam delivery system enables doctors to focus the beam more precisely on cancer-inflicted areas of the body.

Lasers

Description: Laser devices that incorporate beam-shaping technology and have output ranging from 10 to 500 watts (W)

Price Range: $2,000-$70,000

Customer Base: United Health Network, Lightwave Electronics, The Boeing Company, Northrop Grumman Corporation, Lawrence Livermore National Laboratory, and Sandia National Laboratory

Benefits: 1. High brightness (106 W/cm^2), 2. High power (500 W), 3. Very compact (dimensions depend on laser model)

Additional Applications

Medical: Can be used for dermatology treatment, hair removal, and some surgery applications to stop bleeding and heal blood vessels

Materials: Can provide metal treatment in the form of cutting, welding, and soldering, and is capable of welding plastic

Printing: Can create printing plates using computer-to-plate processing, which can make newspaper print plates with a direct-write laser, avoiding wastewater and other toxic materials

Advanced Beam-Shaping Optics

Achieving high brightness in high-power laser-diode beam delivery is a crucial step in the successful and efficient use of high-power laser diodes in many applications. Apollo Instruments has developed advanced beam-shaping optics in laser diode arrays (LDAs) that can substantially maintain brightness while increasing power output by beam combination. Apollo uses various configurations of specialized optical elements that shape and rearrange the beams to achieve high-efficiency and high-power coupling into an optical fiber. In one configuration, two groups of prisms are used to divide and rearrange the beams from the

Company Vision

"Apollo Instruments' goal is to become a major player in the high-brightness, high-power laser market to provide advanced technology and products worldwide for both original equipment manufacturers and system applications. The company will continue its research and development activities to maintain the leading position in beam-shaping technology and provide cost-effective solutions for users in research and industrial fields."

Dr. Peter Wang,
Vice-President

LDA. In another configuration, mirrors are used. Conventional LDAs are limited in power output and brightness due to optical design and focusing issues. To increase the power output of a standard LDA, more emitters are commonly added to a laser diode bar. Between the emitters are spaces of about 500 microns. This area is often referred to as "dead space" because it does not generate any light. The presence of the dead space decreases the brightness of the LDA devices. In addition, the raw output beam from an LDA is highly divergent and suffers from two asymmetries—astigmatism and an elliptical beam profile. When the noncircular, astigmatic, incoherent beam from the LDA is focused, the beam spot is greatly elongated. This is undesirable for most applications because the beam can not be focused. Apollo's beam-shaping optics have enabled high-brightness and high-power laser diodes for fiber-coupled, collimated, or other solid-state laser devices.

MDA Application

Years Funded: 2000-2003

Apollo was originally given funding to determine the feasibility of high-brightness, fiber-coupled diode lasers using its beam-shaping technology. Once Apollo proved the capabilities of its beam-shaping optics, MDA awarded the company a contract to develop a series of fiber-coupled laser diode devices of various power levels. The company has recently received more MDA funding to develop a kilowatt-class fiber laser that could significantly improve laser-based communication systems for ballistic missile defense applications. Communications systems require a high-quality laser beam able to reach its target over a great distance without diffusing. The fiber laser also doesn't have heat management problems like solid-state lasers.

Company Profile

Business Overview: Apollo Instruments manufactures and supplies high-brightness collimated and fiber-coupled laser diode modules and lasers, high-speed and high-resolution imaging systems, and provides contract research and custom optical design services.

Founded: 1996

Employees: 14

2003 Revenues: Proprietary

Facility: Apollo Instruments is housed in a 5,000-square-foot building with independent manufacturing capabilities, state-of-the-art developmental laboratories, and production areas capable of making hundreds of laser devices annually.

Partners: None

Contact Information
Peter Wang, VP
Apollo Instruments, Inc.
Telephone: 949·756·3111
Web: www.apolloinstruments.com

Power Generators

Aura Systems, Inc.
El Segundo, California

What is the worst that happens to you when the electricity goes out? Power is not only lost to your home but also to your community—the hospital, the communications systems, and the town infrastructure. In the United States, our utility companies restore power and return our lives to normal, but our soldiers in overseas combat operations must rely on themselves and the equipment at hand for their electricity.

▲ *Aura's mobile generator, AuraGen®, can be mounted under the hood of an automobile. It works whether or not the vehicle is moving. The most popular way for an engine to drive the AuraGen is with belts, however a power take-off or hydraulic drive system would work as well.*

Soldiers in the DOD Joint Communications Group operating in Iraq and Afghanistan are using the AuraGen® VIPER, a mobile underhood induction power generator, developed by Aura Systems, Inc., for their electricity needs. The soldiers had planned on using conventional generator systems, or gensets, as their primary source of power, however they soon came to rely on the VIPER. Most conventional gensets require 30 minutes of preparation time to be started and must be shut down every 100 hours for scheduled routine maintenance. The VIPER, a ruggedized version of the original AuraGen technology, provides the soldiers with 60 Hertz (Hz) of alternating current (AC) and/or direct current at all times; and the VIPER can provide engine-off silent operation. The VIPER does not need scheduled routine maintenance to keep it operational. The soldiers needed something that could operate continuously, whether they were moving or not, during down time or in combat. They ran the VIPER for 60 days non-stop in one operation, and in another they ran it continuously for 40 days.

AuraGen®/AuraGen Viper®

Description: Mobile generators that can be mounted under the hood of a vehicle or vessel for commercial or military applications

Price Range: $4,750-$12,000

Customer Base: Con Edison, Inc., DOD, U.S. Army, Cox Communications, Time Warner, Schlumberger, GM, Federal Bureau of Investigation, National Oceanic and Atmospheric Administration, BAE Systems, Kvichak Marine Industries, and first responders

Benefits: 1. High-quality power (thousands of watts, pure sine wave) at any speed, 2. Low weight (150 lbs) and small size (<1 cubic foot), 3. High reliability with no scheduled maintenance required-power on demand

Additional Applications

Emergency Response: Provides electricity for law enforcement, fire, rescue, and communication capabilities and equipment needed to respond to crises

Military: Provides power operations in Iraq, Afghanistan, and elsewhere

High-Fidelity Actuators

Aura leveraged its high-fidelity actuator (HFA) technology, which is completely electromagnetic and does not require petroleum-based or hydraulic fluids, to develop the AuraGen mobile generator. HFAs provide the high forces and long strokes produced by hydraulic or pneumatic actuators but with the speed and precision of voice coil actuators. Aura's research in HFA's contributed to the development of AuraGen, an electromagnetic rotary actuator (motor) used as a generator that can be mounted under the hood of an automobile. The most popular way for an engine to drive the AuraGen is with belts. However a power take-off or

Company Vision

"Aura Systems intends to be a dominant force in the mobile vehicle and vessel industries. The company will have a broad customer base across national, state, and local governments in defense, homeland security, emergency response, and mobile services, and commercial applications encompassing the full scope of mobile power systems for work and recreation. This will be extended internationally. Advanced AuraGen power systems that will be more powerful, flexible, and compact will extend Aura's market reach and penetration."

Neal Meehan,
President and CEO

hydraulic drive system would work as well. The AuraGen operates whether the vehicle is moving or stopped. It is capable of continuously converting a small portion of engine energy into 60 Hz alternating current power (120/240 volts), which is the standard for home electricity power specifications in the western hemisphere. The AuraGen VIPER is the ruggedized version of the AuraGen. VIPER is approved for airdrops into dangerous areas and is capable of withstanding rough environments such as the ocean or desert. The continuous operation and reliability of both systems make them suitable for emergency or dangerous situations where providing routine maintenance every 100 hours, needed by conventional generators, is not practical.

MDA Application

Years Funded: 1988-1991

Aura was funded to develop a test stand for the lightweight exoatmospheric projectile's (LEAP's) high-response thrusters. The company created its HFAs for use in the test stand, which was developed to replicate the high-fidelity conditions needed in spacecraft control. It was able to control and measure with great sensitivity the kinetic energy weapon and its thrusters. The test stand is called the kinetic hit-to-kill integrated laboratory (KHIL). It utilizes Aura's technology to counteract the thrust force of an active projectile providing a highly accurate 6-degree-of-freedom measurement of the thrust at above-kilohertz resolution.

Company Profile

Business Overview: Aura Systems is a publicly traded company that manufactures and markets the AuraGen and AuraGen Viper underhood generator.

Founded: 1987

Employees: 52

2003 Revenues: $5 million

Facility: Aura Systems is housed in 73,000 square feet of space that includes office, laboratory, engineering, and production capabilities.

Partners: None

Contact Information
Ron Goldstein, VP, Government/Military
Aura Systems, Inc.
Telephone: 310·643·5300 ext. 213,
Web: www.aurasystems.com

Secure Electronic Communications

Avanza Technologies, Inc.
Los Alamos, New Mexico

How many unsolicited e-mails, better known as spam, do you receive daily? How many times have you changed your e-mail address trying to rid yourself of spam? Imagine the amount of time and money you would save if you used spam-free e-mail.

▲ *Avanza's It'sM*iMail™ puts control into the hands of the user by employing unique e-mail addresses that act like standard addresses except they control user identification, usage permissions, and communication requirements.*

Avanza Technologies, Inc., partnered with Certicom Corporation, a cryptography developer for software vendors and device manufacturers, to develop a cryptosystem small enough to fit into an e-mail address that works efficiently over various platforms. Workers spend an average of 15 minutes every day going through unsolicited e-mail, according to a survey of workers at Fortune 500 companies conducted by Nucleus Research, Inc., and companies will lose an average of $1,934 per employee in 2004 because of time spent going through spam. Avanza's It'sM*iMail™ puts control into the hands of the user by employing unique e-mail addresses that act like standard addresses except they control user identification, usage permissions, and communication requirements. The owner of the It'sM*iMail address decides who can e-mail them and who can not by creating unique addresses, automatically stored in the contact list, for each sender, and it only allows receipt of e-mails from senders the user has authenticated. If the sender's address is not recognized, the e-mail will not be accepted. Further, the owner controls who can read the message, who can respond to it, and how long the address remains valid.

It'sM*iMail™

Description: Secure e-mail solution for individuals, families, and businesses of all sizes

Price Range: Application-dependent (number of users and features)

Customer Base: Certicom, Rassmussen Iron Works, large corporations and small businesses, and individual users

Benefits: 1. Eliminates undesirable e-mail, 2. Ensures identity of sender (public-key distribution; public keys embedded in e-mail addresses), and 3. Is entirely private to the individual user or company (no control repository, central authority, or cross-referencing, and it's non-transferable)

Additional Applications

Cyber Security: Can detect illegal activities from Web sites, as well as track messages and contents across networks

Bank: Can provide international banks with a secure virtual network of encrypted documents for file sharing

Government/Defense: Can be configured to allow only users at a specified computer to read and encrypt designated e-mail

Secure Node-To-Node Network

Avanza's Managed*i™ software architecture helps securely manage information, identity, and the way both are exchanged across a physical network. Every machine or appliance in a Managed*i network becomes a potential node and a mechanism for routing a transmitted packet on to its intended destination. In Managed*i, a transmission is secured with binary logic code and encrypted before it is further clarified by an extensible markup language standard. In fact, Managed*i is security intrinsic—all data, commands, and applications are

Company Vision

"Avanza Technologies is a software company that specializes in the design of innovative context-based identity and privacy solutions. Avanza's It'sM*iMail product line uses patent-pending technology and Elliptic Curve Cryptography (ECC) to deliver unprecedented owner-controlled e-mail addresses embedded with non-transferable public keys that can only be used by the intended recipient. The resulting Managed* Identity™ easily enables users to securely communicate via e-mail by providing unique identity-based transactions."

Philippe Richard,
Vice President for Technology

double-key encrypted at all times. Only when verification of both the acceptable sender and receiver takes place does a set of data packets then proceed to a readable standard.

It'sM*iMail is actually Managed*i applied to an e-mail transport and is Avanza's first commercial product based on Managed*i. Most e-mail is based on the "pretty good privacy" standard of public-key infrastructure developed in the late 1980s. It allows people to securely send e-mails, but it does not provide receivers any assurances of the sender's true identity. Now, 25 years later, e-mail has raised major security concerns, which include the transfer of computer viruses, the abundance of spam, and the release of personal identification information. Avanza's public-key dissemination technique enables It'sM*iMail users to provide keys to whomever they chose to receive their e-mail, and each key is non-transferrable. As a result, users are assured of the sender's identity when they receive an e-mail. It'sM*iMail automatically saves all keys in the address book, and it works with all existing technology.

MDA Application

Years Funded: 2002-2003

Avanza was funded to develop a robust and secure peer-to-peer network environment that can integrate diverse data sources. The project was called Secure Communication Object Repository Environment (SCORE). The company developed an advanced prototype of the network while being funded through the contract. Avanza has an additional MDA contract to develop more organic computing paradigms, which are part of the message routers that support It'sM*iMail. It'sM*iMail represents an implementation of SCORE for existing mail transports that requires no changes to the existing infrastructure. Future implementations are planned that will support a wide range of other network infrastructures.

Company Profile

Business Overview: Avanza is a designer of innovative solutions for developing, managing, and securing distributed information environments.

Founded: 2000

Employees: 7

2003 Revenues: Proprietary

Facility: In Los Alamos, NM, Avanza is housed in a 2,000-square-foot facility that contains a training center, research and development facility, and a 40-server test infrastructure. In Whittier, CA, Avanza has marketing and corporate office space.

Partners: Certicom

Contact Information
Philippe Richard, VP for Technology
Avanza Technologies, Inc.
Telephone: 505·663·5600
Web: www.avanzatech.com

Oil Drilling

Cape Cod Research, Inc.
East Falmouth, Massachusetts

How much are you spending on gasoline? The future of oil and gasoline does not look promising because of the depletion of oil supplies and the instability of many oil-producing countries. So the oil industry is continually searching for oil and using technological advancements to more accurately drill.

▲ *A Tracer Technologies technician is spiral winding high power density batteries. Cape Cod Research designed the supercapacitors used in these batteries, which are developed to meet the needs of the oil and gas service industry.*

Cape Cod Research, Inc., teamed with Tracer Technologies, Inc., has developed a family of lithium-ion (Li-ion) batteries. Cape Cod Research designed the supercapacitors used in these batteries, which are developed to meet the needs of the oil and gas service industry, for companies such as Schlumberger, Haliburton, Baker Hughes, and Pathfinder, in their oil well measuring tools. An oil well measuring tool is designed to withstand 500-G (force of gravity) shocks, continuous low-frequency vibration, hydrogen sulfide, pressures of 18,000 pounds per square inch (psi), and temperatures up to 150°C. Real-time oil measurements require high-power, robust batteries that can provide the surges of energy necessary to operate the many devices found in the measuring tool. The new Li-ion batteries are designed to operate safely and reliably at conditions normally unreachable by any other conventional room-temperature rechargeable battery. Cape Cod Research's supercapacitor design provides the high power—about 10 times more than conventional cells—needed by tools used in oil and gas exploration operational under some of the harshest conditions on Earth.

Lithium-Ion Batteries

Description: Batteries that can be used in extreme temperature and pressure environments

Price Range: $100+/battery cell

Customer Base: Proprietary

Benefits: 1. More power (10 times more than a conventional dry cell), 2. Increased safety, 3. Higher reliability

Additional Applications

Electronics/Electric Vehicles/Power Supplies: Can provide memory protection and load-leveling applications

Multilayer Capacitors

Capacitors accumulate electric charge and energy on the surfaces of conducting plates. These electrodes are normally insulated from each other, but by shorting them together, pulsed power is created. Changing the structure and materials used to develop capacitors has been effective in meeting the power needs of down-hole exploration. Tracer Technologies' Li-ion cells are coupled with Cape Cod Research's design for multilayer capacitors, or supercapacitors. Cape Cod Research's supercapacitors use organic polymers, which offer processing, materials handling, and stabilizing advantages over the inorganic materials typically used.

Company Vision

"Cape Cod Research's mission is to develop proprietary breakthrough technology that can alter or change the competitive dynamics of an industry, can have multiple applications, and can address major markets. The company's primary focus is the development, testing, and marketing of environmentally compliant coatings, resins, composites, adhesives, photonics materials, and fuel cell membranes that are state-of-the-art and innovative compared with present day technologies. Cape Cod Research hopes to continue to develop cutting-edge technologies for addressing the nation's needs while developing new marketing areas for supercapacitor technology."

Myles Walsh,
President

Tracer's batteries are made for harsh conditions such as those encountered by the oil industry. Additional sources of oil and gas may provide everyone with lower-priced energy and more political flexibility in dealing with developing nations.

According to the Energy Information Agency in the Department of Energy, the United States import of total gross oil (crude and products) in 2002 was an estimated 11.4 million barrels per day, which represents more than half of U.S. oil demand. Around two-fifths of this oil came from nations in the Organization of Petroleum Exporting Countries (OPEC), which consists of eleven developing countries including Saudia Arabia—one of the top U.S. suppliers of oil in 2002.

MDA Application

Years Funded: 1991-2002

MDA funded Cape Cod Research to develop multilayer capacitors for high-energy batteries. The company expanded on its development of electrochemical capacitors, which were based on conducting polymers with performance characteristics exceeding those of competing carbon and mixed metal-oxide-based capacitors. Missile defense systems in MDA have the basic need of high power that will last a long time. Cape Cod Research developed the supercapacitor design, and its SBIR partner, Tracer Technologies, incorporated it into its Li-ion batteries. Some of Tracer's lithium batteries have a long shelf life of 10 years, can operate in hot and cold temperatures, and are radiation-hardened for space applications such as missile defense.

Company Profile

Business Overview: Cape Cod Research develops, tests, and markets environmentally compliant state-of-the-art coatings, resins, composites, adhesives, photonics materials, and fuel-cell membranes.

Founded: 1982

Employees: 20

2003 Revenues: $2 million

Facility: Cape Cod is housed in more than 6,000 square feet of space, of which 4,000 square feet is for research, development and engineering activities.

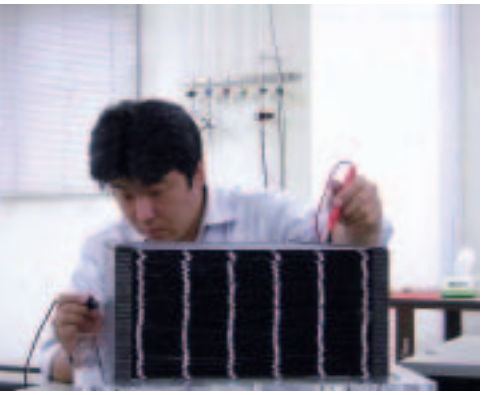
Partners: Tracer Technologies, Inc.

Contact Information
Myles Walsh, President
Cape Cod Research, Inc.
Telephone: 508·540·4400
Web: www.capecodresearch.com

Water Purification

CDT Systems, Inc.
Dallas, Texas

Have you ever swallowed seawater at the beach? If so, you know it's not drinkable. Seawater is 38,000 parts per million (ppm) salt. By comparison, some of the water in Texas is three times as salty. The state has problems with water shortages, droughts, brackish water, and hyper-saline water.



▲ *Mr. Yaunori Ohtsuka, assistant manager of the environmental business division at Air Water, Inc., in Japan, is assembling a 52-sheet carbon aerogel AquaCell. The capacitive deionization process uses sheets of carbon-aerogel electrodes packaged as AquaCells to absorb ions such as sodium and chloride.*

The Texas Water Resources Institute, a part of Texas A&M University, is testing the CDT Systems, Inc., AquaCell™ water-purification system for use in desalination of brackish water in the state. Currently available technologies such as reverse osmosis are effective; they are also expensive and high maintenance. AquaCells were developed using carbon-aerogel-based electrode technology licensed from Lawrence Livermore National Laboratory (LLNL). While they are not yet being tested on Texas' hyper-saline water, AquaCells can provide a low-maintenance, low-cost method for desalination of brackish water with salinity in the 3,000-8,000 ppm range for drinking or irrigation purposes. The institute has found that AquaCells can reduce the salinity of this water to 300 ppm, which is considered excellent drinking water. The institute also found, in combination with a pre-treatment like filtration, AquaCells could be used to clean "produced" water, which is a possible new source of water. Produced water refers to water that is created during oil and gas production. For every barrel of oil, 7 to 10 barrels of water are created, which is then re-injected into the well. The institute is testing the ability of AquaCells to clean this water for human use as well.

AquaCells™

Description: Brick-like carbon-aerogel-based electrodes that can remove impurities from water

Price Range: $1,200-$1,500/ module

Customer Base: Texas A&M University, Air Water, Inc.

Benefits: 1. Energy efficient (1.2 volts), 2. Low operating and maintenance costs (no chemical-balancing requirement), 3. Very durable (minimum life cycle of 10 years)

Additional Applications

Manufacturing: Can purify water used in manufacturing processing and can be used as a light and sturdy insulating material for advanced technologies

Mining: Can remove heavy metals and hazardous materials from wastewater streams

Power Plants: Can treat heat exchanger and boiler feed water used in fossil-fuel and nuclear power plants

Military: Can be used to remove contaminants from water generated by military operations and can clean water for military personnel use

Capacitive Deionization with Carbon-Aerogel Electrodes

CDT Systems licensed the capacitive deionization (CDI) process with carbon-aerogel electrodes from LLNL for water treatment applications. The CDI process, now referred to as CDT, uses sheets of carbon-aerogel electrodes packaged as AquaCells to absorb ions such as sodium and chloride. Water containing salts, heavy metals, or even radioactive isotopes is pumped through

Company Vision

"CDT Systems' goal is to be the 'Intel' of the water industry. The company will provide its CDT AquaCell to systems integrators, engineering, and construction organizations, municipalities, and governments world wide, while continuing its development program to enhance its AquaCell performance and reducing its costs to customers."

Dallas Talley,
CEO

the AquaCells. An electric potential is then applied across the electrodes, attracting the negatively and positively charged ions to purify the water with each pass over an AquaCell, removing 1,000 parts of contaminant per million. One AquaCell (15" x 27" x 30") can process up to 1,000 gallons of water per day. The system has no moving parts and uses simple electrostatic regeneration, compared with ion-exchange systems that require acids, bases, or salt solutions for regeneration. It does not require the use of membranes or high-pressure pumps, which reduces the maintenance requirements. When an AquaCell has become sufficiently saturated with removed contaminants, it is bypassed, and water is routed to other AquaCells with remaining capacity. The loaded AquaCell is then shorted out or reverse-polarized, expelling the contaminants into the waste stream for disposal, recycling, or concentrating. According to the United Nations, as of 2002 an estimated 1.1 billion people lacked access to clean drinking water in the world. CDT Systems' AquaCell system is mobile (grid- or solar-powered) and operates on less than half the power needed to operate reverse osmosis.

MDA Application

Years Funded: 1992-93

Lawrence Livermore National Laboratory (LLNL) was funded by MDA to develop low-weight, low-cost carbon aerogel technologies to be used in batteries, supercapacitors, and waste cleanup. The large surface area of aerogel technology is ideal for holding electrical charge (batteries and capacitors), while its large percentage of entrained air makes it ideal as an insulator.

Company Profile

Business Overview: CDT Systems, formerly Far West Group, can provide immediate and long-term solutions to desalinization issues worldwide.

Founded: 1996

Employees: 7

2003 Revenues: None reported

Facility: Currently, CDT Systems rents office space and uses other laboratories

Partners: Air Water, Inc., and Carbon-Carbon Advanced Technologies, Inc.

Contact Information
Dallas Talley, CEO
CDT Systems, Inc.
Telephone: 972·934·1586
Web: www.cdtwater.com

Data Analysis

Datamat Systems Research, Inc./InferX
McLean, Virginia

Have you ever tried to report a co-worker error to your boss without getting anyone in trouble? It usually requires telling select details while still maintaining a level of secrecy to protect your friend or co-worker. Keeping secrets while getting relevant information to the right people is the balancing act the U.S. government is trying to accomplish.

▲ *InferX, a spinoff of Datamat, produces InferAgent software, which is designed to maintain the secrets of database owners while still communicating relevant information. It analyzes distributed information without moving or sharing it.*

The Combat Vision Laboratory, which is part of Lockheed Martin's Missile Fire Control group, tested data analysis software called InferAgent™ on an internal research and development project. The software, which is distributed by InferX, a spinoff of Datamat, can analyze distributed information without moving or sharing it. It is designed to maintain the secrets of the database owners while still communicating relevant information. The Combat Vision Laboratory tested the software while investigating different sensor phenomenology—everything a sensor can see—and how it affects sensors that control target identification and destruction on missiles and other types of munitions. In this particular project, the laboratory found it was able to identify missile targets by running a limited amount of laser radar, or LADAR, data through the InferAgent software.

InferAgent™

Description: Software suite that analyzes data distributed among different databases without moving or aggregating it

Price Range: $250,000-$1,000,000 (lease-per-month option available)

Customer Base: Lockheed Martin, Northrop Grumman Corporation, Air Force Research Laboratory, U.S. Army Space and Missile Defense Command, Missile Defense Agency, and George Mason University

Benefits: 1. Works on multiple dispersed data sets without aggregation, thus preserving privacy, 2. Reduces cost with rapid return on investment, 3. Provides time-critical predictive analysis

Additional Applications

Insurance and Healthcare: Can provide efficiency in disease management, claim handling and processing, fraud prevention, medical bill review, and marketing

Finance: Can detect fraud and money laundering, and provide marketing analysis

Telecommunications: Can provide risk management and fraud detection capabilities, and do marketing analysis

Homeland and Transportation Security: Can discriminate targets and profile cargo

Defense: Can provide new intelligence information buried within dispersed data and predict future outcomes and events

Networked Predictive Analytics Software

Many organizations collect volumes of data and store it in databases at different locations. Traditionally, to extract useful information from this data, the databases must be combined together at one location. This can be difficult because database owners often have privacy

Company Vision

"Datamat Systems Research's distributed data mining and knowledge discovery tools and solutions can be integrated with mission-critical solutions in support of a variety of industries. We are currently focused on providing our technology and consulting services to the Department of Defense, Department of Homeland Security, and to the Intelligence Community."

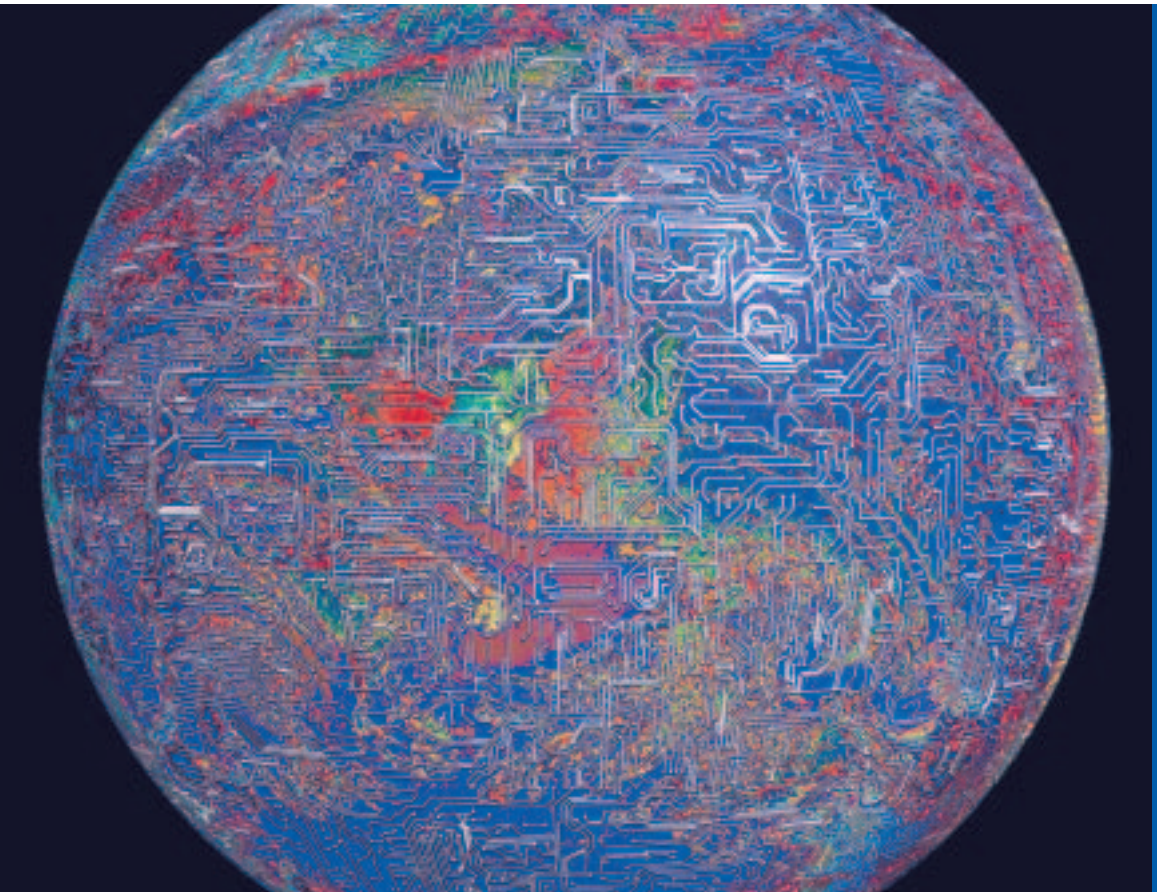
B.K. Gogia,
Chairman, CEO, and President

restrictions placed on their data and do not want to move or share it. However, InferAgent software is designed to deal with the world as it is—disjointed, different, distributed—and extract knowledge from it. InferAgent™ controls the integrity of local data sources yet passes their correlated knowledge through to decision makers without the need for the data itself. The technology relies on independent software knowledge agents installed at every distributed database location. Each knowledge agent has access to only its own local database and is responsible for obtaining information from that local data source. A Java-based tool called Mediator synchronizes the collection of information from each location and generates global models. A 3-D visualization capability helps decision makers recognize and understand the discovered relationships and patterns presented by these models. Using InferAgent, industry and government agencies (for instance, the FBI and CIA) could access, mine, and provide predictive analysis on data stored in their own respective databases without moving the data or compromising their privacy concerns.

MDA Application

Year Funded: 1996-1999

Datamat developed the technology for use in an advanced warfare management system. Mobile command posts must have accurate, real-time knowledge of friendly, enemy, neutral, and noncombatant activities and locations. Datamat's technology is capable of integrating data from different air, land, and sea components. The company is designing, developing, and testing the software functionality within evolutionary Command, Control, and Battle Management Communications (C^2BMC) systems.



Company Profile

Business Overview: Datamat is a technology research and development company and provider of distributed data-mining and knowledge-discovery tools and solutions. InferX develops and markets predictive analysis software for dispersed remote databases using patented distributed mining technology.

Founded: Datamat 1992; InferX 1999

Employees: Datamat 15, InferX 6

2003 Revenues: Datamat $1.7 million, InferX $220,000

Facility: Datamat and InferX share the same building. Both companies have office and lab space totaling 6,000 square feet.

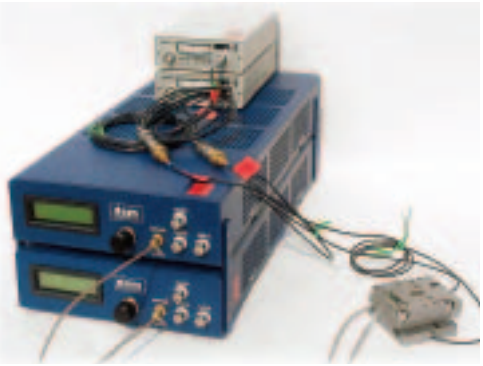
Partners: None

Contact Information
B.K. Gogia, President
Datamat Systems Research, Inc./InferX
Telephone: 703·917·0880
Web: www.dsri.com

Nanopositioning

Dynamic Structures and Materials, LLC
Franklin, Tennessee

Have you ever built a house of cards? You need to delicately place each card on a new layer. Similarly, in semiconductor processing, manufacturers must precisely position the silicon wafers that serve as substrates for tiny circuits. However, in this process "just right" is on the order of nanometers, which is thousands of times smaller than the width of a human hair.



▲ *DSM's standard nanopositioning stages can be custom-configured into a multi-axis system for original equipment manufacturer applications. The positioning system has a displacement range of up to 1 mm, which surpasses industry standards by several hundred microns, and a positioning resolution that will fit the application requirements and constraints.*

To precisely position and manipulate objects measured at the micrometer or nanometer (nm) scale, manufacturers and researchers typically use nanopositioning systems. A custom-designed, piezoelectric, long-stroke nanopositioning stage developed by Dynamic Structures and Materials, LLC (DSM), is a key component of a new integrated film-thickness metrology tool designed by Nanometrics, Inc., for use in semiconductor processing. The metrology tool is used in a vacuum environment to measure the thickness of films deposited onto silicon wafers. DSM's positioning system is capable of positioning a wafer in the vertical direction over a 1 millimeter (mm) travel range with sufficient design stiffness and dynamic response so that the stage is less susceptible to vibration disturbances from the environment. And DSM's stage can be integrated inside a vacuum without contamination concerns.

Long-Stroke Nanopositioning Stage

Description: Flexure-based nanopositioning stages with long travel range

Price Range: $5,000-$20,000 (depending on design)

Customer Base: Nanometrics, Inc.

Benefits: 1. Long-stroke nanopositioning capability (up to 1000 microns; 15-nm resolution), 2. High stage stiffness (5 times stiffer than comparable 1000-micron displacement stages), 3. Custom configuration ability with a compact form factor (can produce the same range of stroke in a smaller package than most competitors)

Additional Applications

Materials: Can provide positioning systems for materials characterization research

Semiconductor Equipment: Can provide original equipment manufacturers with custom nanopositioners for custom applications

Defense: Can be used as a micro-positioner for space-based interferometry (light/sensor interaction) applications, for high-specific-power actuators, and for high-precision pointing platforms

Flexure-Based Piezoelectric Actuators

DSM has found the most commercial success for this technology in micro- and nanopositioning applications where the capabilities of the flexure-based piezoelectric actuators are leveraged for manufacturing and/or inspection/measurement processes associated with the semiconductor industry. The need for larger wafers and more complex processes are putting increased demands on the capabilities of the nanopositioning stage in semiconductor processing.

Company Vision

"MDA funding continues to be a key enabler for Dynamic Structures and Materials' success. The multiple commercial opportunities that DSM has already experienced as a direct result of technologies funded through MDA SBIR will provide a foundation for the company's future efforts in MDA programs. We anticipate that the next 10 years will include several Phase III contracts for MDA platforms, and we expect DSM's technical strength and revenues to compete with even the largest names in the piezo actuator industry."

Jeff Paine,
President and CEO

DSM's standard nanopositioning stages can be custom configured into a multi-axis system for original equipment manufacturer applications. It has a displacement range of up to 1 mm, which surpasses industry standards by several hundred microns, and a positioning resolution that will fit the application requirements and constraints. The servo-controlled, closed-loop systems have a ultra-low velocity ripple on the order of 20 nm over a 1 mm scan. This means that even while moving at a speed of 500 microns/second, the stage never deviates more than 20 nm from its planned trajectory from one point to another. Another key feature of DSM's nanopositioning stage is that it restricts undesirable tilt of the stage's output platform to less than 20 micro-radians over a full 1 mm displacement range.

MDA Application

Years Funded: 1997-2003

DSM was funded to develop miniature, compliant, spatial, parallel manipulator technologies for mobile control surfaces, which are used in manipulating, pointing, and tracking applications such as fast steering mirrors or missile seeker heads. The nanopositioning stage technologies developed by DSM may also contribute to the development of lower-cost, higher-quality sensors for missile defense. DSM was recently awarded two SBIR Phase II contracts, which will leverage the core positioning and control technologies developed for the nanopositioning stage products. The company will develop piezo actuation and compact drive electronics for use in the miniature kill vehicle program and also to control the divert and attitude control thrusters for missile platforms.

Company Profile

Business Overview: DSM produces micro-positioning and nanopositioning devices and systems for custom precision motion solutions.

Founded: 1998

Employees: 10

2003 Revenues: Proprietary

Facility: DSM is housed in a building that contains laboratory and office space.

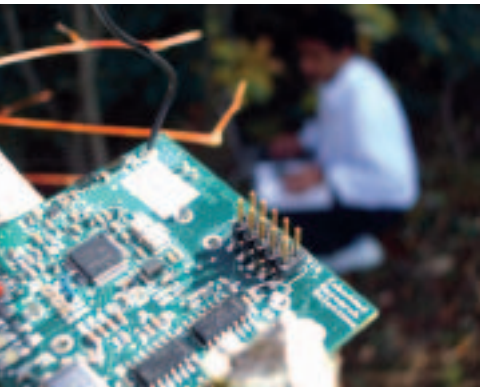
Partners: None

Contact Information
Murray Johns, COO
Dynamic Structures and Materials, LLC
Telephone: 615·595·6665
Web: www.dynamic-structures.com

Machine Health and Diagnostics

Embedded Research Solutions, Inc.
Annapolis, Maryland

Have you heard that one day you will be able to walk into a store, pick up an item, and walk back out without ever standing in a line at a register? You will be charged and your account debited as you walk out the door. This will be accomplished with pervasive computing, which is currently being used in other formats such as real-time monitoring of military equipment.



▲ *An engineer is using ERS nodes to do environmental monitoring of a forest. Multiple nodes make a remote network that can simultaneously gather data and securely transmit it back to a central database in real time.*

Lockheed Martin is developing a new airplane to house command and control centers for the military. The airplane contains expensive, highly critical military equipment, which needs to be continuously monitored to ensure it doesn't overheat. Lockheed is using remote monitoring technology developed by Embedded Research Solutions, Inc. (ERS), to gather data on the health of its military equipment. ERS's technology collects information in real time, and it will be gathering data on approximately 70 different points of interest such as temperature and humidity levels. It also automatically corrects the situation if levels are not normal. For example, if the equipment is getting too hot, the remote monitoring technology, or nodes, transmits a signal to the cooling system, telling it to turn on.

Remote Monitoring Technology

Description: Remote monitoring and control system consisting of wired or wireless nodes that form a network, gather data, control, and transmit information back to a computer in real time

Price Range: $200/node

Customer Base: Lockheed Martin, Empirical Technologies Corporation, Johns Hopkins University, and Hewlett Packard

Benefits: 1. Is scalable and reconfigurable, 2. Offers guaranteed real-time performance, 3. Provides secure transmissions

Additional Applications

Environmental: Can monitor the environment using wireless sensor arrays spread over land and in water

Health: Can simultaneously monitor the physiological health and performance of a group of people such as military troops, medical patients, or athletes

Security: Can track people and objects within buildings, malls, parks, and other locations

Defense: Can monitor what is or is not present, such as people, equipment, and biohazards among other things, in a given area

Miniature Software

ERS developed matchbook-size, reconfigurable computers that can be used with or without wires, depending on the application. The computers can be attached to sensors and distributed widely, allowing users to create real-time networks that can automatically gather data at many locations. The company combined its miniature software with commercial off-the-shelf hardware to create radio-frequency-based nodes, which are embodied in a port-based framework. This means each software piece on the node has a particular function, which is mapped

Company Vision

"Embedded Research Solutions envisions that pervasive computing, the mass integration of embedded processors in objects, will be the next technology frontier. The impact on our lives could well surpass that of the personal computer. It is ERS's mission to create the enabling infrastructure, tools, and products to increase our security, health, and standard of living."

Drew Sweetak, President/CEO

into the interfaces of other objects within the software. Multiple nodes make a remote network that can simultaneously gather data and securely transmit it back to a central database in real time. Each node is robust enough to be given instructions in real time, and it can reconfigure itself to gather different information. The reconfigurability of the nodes enables them to work with many types of instruments, perform multiple functions, and share data with similar devices. The company's miniature software can run on relatively inexpensive 8-bit processors, as well as processors as powerful as 64 bits. ERS's miniature software consumes less than 1,000 bytes of random access memory (RAM). In comparison, collecting data at network nodes using conventional software and hardware might require processors having hundreds of thousands of bytes of RAM.

MDA Application

Years Funded: 2002-2003

MDA funded ERS to develop pervasive computing technology that can provide intelligent sensing and control to missile defense systems. ERS's miniature computers can be applied to the continuous real-time monitoring of equipment and weapon health, distributed real-time command, control, and communication systems, environmental and battlefield remote monitoring of parameters, and supply logistics, and it can enable the collection of data in a missile during impact, enabling the re-creation of the activity for analysis.

Company Profile

Business Overview: ERS develops software and electronics for pervasive computing applications.

Founded: 2000

Employees: 10

2003 Revenues: $840,000

Facility: The company is housed in a 5,000-square-foot building, which includes a hardware and software laboratory, a testing laboratory, radio-frequency equipment, light manufacturing, and office space.

Partners: Technology Development Corporation (TEDCO)

Contact Information
Drew Sweetak, President/CEO
Embedded Research Solutions, Inc.
Telephone: 410·571·7950
Web: www.embedded-zone.com

Landmine Neutralization

General Sciences, Inc.
Norristown, Pennsylvania

Have you ever seen the effects that anti-personnel land mines can have on a country? Most people have seen the commercials, news reports, and advertisements that show pictures of civilian landmine casualties. Who you don't always see or hear about are the people trying to neutralize the landmines.

▲ *GSI has demonstrated its Oximet-Filled Mine Killer Projectiles systems for antipersonnel landmine neutralization. GSI projectiles are made of highly exothermic metal composite, which releases energy when a sufficient shock, such as from an impact velocity of approximately 1,000 feet per second, is applied.*

According to an article in the *Landmine Monitor*, excavation-digging the mine out of the ground is the most common activity performed by demining incident victims. The U.S. Army Humanitarian Demining Division is testing Oximet-Filled Mine Killer Projectiles™ developed by General Sciences, Inc. (GSI), for use in anti-personnel demining situations. GSI's mine neutralization technology is capable of penetrating the ground so excavation of the land mine is not required. The company expects its projectiles can neutralize land mines without detonating them. Even if they did detonate, GSI's projectiles would allow people to be at a greater distance from the land mines when they are destroyed. Therefore, they are safer than today's conventional method.

Oximet-Filled Mine Killer Projectiles™

Description: Aluminum-titanium reactive composite that can be shaped into projectiles and fired at unexploded land mines to destroy them

Price Range: $3-$10/projectile

Customer Base: U.S. Army

Benefits: 1. Penetrates the ground up to 6 inches, so there is no need to excavate the land mine, 2. Cannot be reused as a weapon, 3. Is cheaper and safer than the current method of detonation to destroy land mines

Additional Applications

Oil Drilling: Can withstand the high temperatures and other pressures associated with an underground environment for extracting oil

Defense: Can be used as a composite material for missiles and other hardware

Exothermic Metal Composite

Current landmine neutralization techniques use explosives to detonate and destroy the land mines. These explosives can be used as weapons if they fall into the wrong hands. Therefore, transporting and storing the devices require strict security. GSI developed projectiles and delivery systems for anti-personnel landmine neutralization that cannot be used as a weapon at any time. GSI projectiles are made of highly exothermic (gives off heat) metal composite, which releases energy when a sufficient shock, such as from an impact velocity of approximately 1,000 feet per second, is applied. When the reaction is initiated, the material deflagrates, or burns rapidly without an explosion. The rate and intensity of the burn is controlled by manipulating the sizes of the composite's constituent particles, the ratios of its binders, and the composition of its exothermic material. The company is currently testing the projectile and delivery system to ensure it can neutralize a land mine without detonating it.

Company Vision

"General Sciences is working toward the transition of its reactive materials development into hardware programs involving lethality enhancement for MDA and other DOD applications such as reactive structures and reactive fragments, and is proceeding with the manufacture of mine-neutralization devices for humanitarian and military purposes. Scale-up and commercialization of products for DOD and oil exploration applications are also a major goal."

Peter Zavitsanos,
President

The *2003 Landmine Monitor Report*, a report produced for the past five years by the International Campaign to Ban Landmines, identifies 82 countries that were affected by land mines or unexploded ordnance in 2002. There are 15,000 to 20,000 new landmine casualties reported each year. In 2002, 15 percent of the reported casualties were military and the rest were civilian.

MDA Application

Years Funded: 1997-2001

GSI was funded to develop an exothermic metal composite to enhance the lethality of hit-to-kill vehicles. The composite can be drilled, machined, or molded, and can be used to form components of an interceptor missile. The impact would cause the composite to release its energy and thereby enhance damage, enlarge the area/volume of target destruction, and provide a high-temperature fireball rich in UV, which could help destroy biological agents. GSI is working with a defense contractor to transfer the composite into missile defense.

Company Profile

Business Overview: GSI uses energetic materials to develop exoatmospheric components for satellites, warheads, payloads, and reactive darts.

Founded: 1985

Employees: 13

2003 Revenues: Proprietary

Facility: GSI is housed in a 12,000-square-foot building on 33 acres of land. The company has a ballistic facility with vacuum equipment, but GSI uses other facilities for its high-velocity tests for such projects as missile defense.

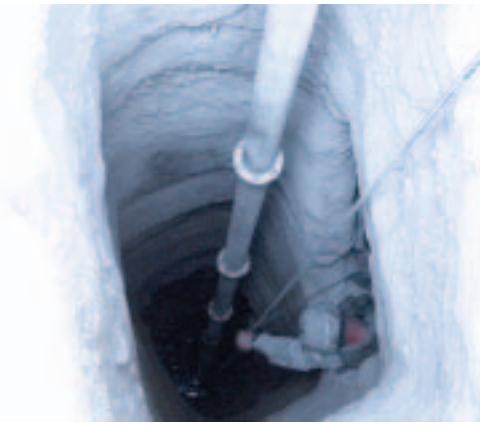
Partners: None

Contact Information
Peter Zavitsanos, President
General Sciences, Inc.
Telephone: 215·723·8588
Web: www.general-sciences.com

First Response

Genex Technologies, Inc.
Kensington, Maryland

Were you ever scared to go into a dark basement or cellar when you were a kid? Logically, you knew there were no monsters down there, but fear still crept up your spine when you stared into the dark. As an adult those fears are behind you ... unless you are a soldier in Afghanistan or Iraq, where the monsters hiding in holes in the ground are all too real.



▲ *The 82nd Airborne uses the OmniEye WellCam™ camera to search wells in Afghanistan for enemy combatants and caches of weapons. Genex Technologies used its OmniEye 360° camera in conjunction with Alion Science and Technology to develop the camera.*

Soldiers must search wells and caves for enemy combatants hiding themselves and their weapons. To make this job a little less dangerous, Genex Technologies, Inc., in partnership with Alion Science and Technology, developed two new products from its OmniEye™ 360° series of technologies: WellCam™ and Eyebot™. The OmniEye WellCam was developed at the request of the U.S. Army Night Vision and Electronic Sensors Directorate in response to a critical requirement from the Rapid Equipment Force (REF). WellCam provides soldiers with a 360° image of wells without actually having to enter one; the image shows up on a laptop or personal digital assistant (PDA). EyeBot, or robot eyes, is incorporated into Alion's CaveDog—a robot that searches caves. EyeBot provides the CaveDog with a 360° field of view and the ability to zoom in on an object or person in both night and day vision. The EyeBot uses passive thermal and visible sensors for all day/night/weather operations, and it can also fuse the two images for improved driving and detection of targets. Walls of caves are thermally neutral, so if a person is standing in a cave his heat signature is going to stand out like a 1,000-watt bulb.

OmniEye™/WellCam™

Description: Surveillance system with a 360° panoramic viewing capability

Price Range: <$1,000 in quantities
Customer Base: U.S. Army, U.S. Marines, Lockheed Martin, Northrop Grumman Corporation

Benefits: 1. Captures images in a 360° field of view, day or night, and in all weather, 2. Fits in small areas and weighs less than 8 ounces, 3. Rugged and waterproof with no moving parts

Additional Applications

Security: Can be used as surveillance cameras in and around protected areas

Emergency Response: Can enter dangerous or hard-to-reach areas to locate lost or injured persons

Omnidirectional Surveillance System

A large part of a first responder's task involves searching, whether it be for weapons of mass destruction and enemy combatants in the Middle East or survivors from events such as the September 11 attacks. To make this task less dangerous, Genex developed an omnidirectional surveillance system that offers 360° panoramic viewing capability in real time. The OmniEye camera line is capable of capturing a hemispherical view of an area without traditional pan and tilt turrets. The system is based on a patented design of a convex mirror and accompanying image processing software. Typically, a soldier enters a dark cave or well looking for enemy combatants and weapons, or emergency personnel responding to an earthquake or tornado search dangerous shifting debris for survivors. The mirror in the OmniEye reflects a

Company Vision

"Genex Technologies is a world leader in 3-D imaging, 3-D facial recognition, and intelligent surveillance. Our vision is to help customers capture and understand more information than ever before. Genex accomplishes this vision by creating simple, practical solutions that solve some of today's most challenging imaging needs."

David Tunnell,
VP of Government Solutions

complete view of its surroundings into a camera, which transmits the images to a computer. Using Genex software, the computer removes the distortion in the picture and then presents the image on a computer screen. The system provides the eyes needed to search dangerous areas, which in turn saves human lives. And unlike other wide-viewing-angle cameras, such as those with fish-eye lenses or other convex mirrors, Genex's approach has no distortion in the panoramic view.

MDA Application

Years Funded: 1996-2002

Genex was funded to develop an omnidirectional 3-D imaging camera. The camera can provide 3-D imaging capability and omnidirectional viewing in real time for simulation training and battlefield modeling at an affordable cost. Once fully developed, Genex's camera can also offer wide field-of-view detection for missile seekers. Once an object is detected, the camera focuses into a narrow field of view for precision tracking and recognition purposes.

Company Profile

Business Overview: The company specializes in developing novel imaging and display products.

Founded: 1995

Employees: 40

2003 Revenues: $5.5 million

Facility: Genex has more than 10,000 square feet of laboratory space and is capable of designing, building, and testing prototypes for various electro-mechanical systems, robotics devices, imaging systems, and software.

Partners: Camera and Optics Manufacturers, Embedded Image Processing Manufacturers, Security Industry, and Biometric Industry

Contact Information
David Tunnell, VP of Government Solutions
Genex Technologies, Inc.
Telephone: 301·962·6565
Web: www.genextech.com

Integrated Circuits

Genus, Inc.
Sunnyvale, California

Do you have a favorite television show? Most people have at least one they hate to miss. And soon you may not have to rush home to watch it. Smaller memory chips with higher capacitance density are making an activity like watching your favorite television shows on your cell phone possible.

▲ *Genus developed atomic layer deposition (ALD) equipment, a variant of chemical vapor deposition, as an answer to a growing demand for more sophisticated coating techniques as feature sizes keep shrinking. ALD is an advanced process with improved precision and conformity for depositing layers of metallic oxides and other compounds on target substrates.*

Samsung Electronics Co., Infineon Technologies AG, and other manufacturers are developing next-generation dynamic random access memory (DRAM) using atomic layer deposition (ALD) equipment developed and manufactured by Genus, Inc. DRAM is a computer's short-term memory; it is the electronic holding place for instructions and data that your computer can access quickly. In an effort to fit more memory in a smaller space, DRAM companies are using ALD to demonstrate high-capacitance density DRAM chips that are sub-100 nanometers (nm) in size. Higher capacitance density in a smaller space enables more information storage per chip, in turn making computer electronics function faster. For example, Infineon has demonstrated fully functional 256-megabit (MB) DRAM chips fabricated with the ALD process.

StrataGem™

Description: Atomic layer deposition equipment for applying atomic-scale physical buffers

Price Range: $3 million

Customer Base: Infineon Technologies AG, Samsung Electronics Co., Ltd., Seagate Technology LLC, and Western Digital Corporation

Benefits: 1. Excellent conformality, 2. Very uniform high-quality films (deposited film suitable for use in a device), 3. Excellent electrical characteristics—breakdown field larger than 8 megavolts per centimeter

Additional Applications

Data Storage: Provides dielectric isolation films above and below ferromagnetic sensor films in CD reader heads

Computer Electronics: Can provide surface passivation for MEMS and films for advanced photo masks (pattern transfer plate of transparent glass) for the development of integrated circuits

Atomic Layer Deposition

Semiconductor chips are getting increasingly more crowded as device feature sizes keep shrinking. Smaller feature size demands more sophisticated coating techniques. Physical deposition, dipping or submerging an object in a chemical bath, and even chemical vapor deposition (CVD)—releasing a precise amount of gas into a temperature-controlled vacuum chamber—are no longer adequate. So, Genus developed special atomic layer deposition equipment as part of its extensive deposition product line.

ALD, a variant of CVD, is an advanced process with improved precision and conformity for depositing layers of metallic oxides and other compounds on target substrates. Using state-of-the-art precision pneumatic valves and a unique design for transporting chemical precursors from tank to valve, Genus invented ALD equipment that could layer metal oxides and

Company Vision

"Genus is destined to be a leading supplier of ALD and CVD systems enabling equipment in semiconductor, data storage, and other emerging segments."

Tom Seidel,
EVP and CTO

nitrides on targets with high-aspect-ratio features. Genus' ALD equipment differs from the traditional CVD processes by bringing chemical precursors to the surface one at a time instead of running a deposition process continuously. The chemistry of the precursors creates a self-limiting, saturating surface layer. By quickly changing the precursor, a second layer or coat can be placed on the first with exactly the same kind of self-limiting, saturating results. Standard cycle times are about three seconds but a more advanced process of a half-second is in customer demonstration.

MDA Application

Years Funded: 1998-2002

Genus was originally funded to develop ultra-thin (less than 80 angstroms) barrier metals to advance copper interconnect technology used in integrated circuitry. From this funding, the company demonstrated the development of a process and tool capable of controlling atomic-level reactions. With further funding from MDA, Genus tested similar processes for integrating new high dielectric constant (high-K) materials in devices such as advanced complimentary metal-oxide semiconductor (CMOS) gate insulators and DRAM capacitors. Since the initial SBIR funding, Genus has sold approximately $80 million worth of ALD tooling to customers in the United States, Japan, Korea, Germany, Ireland, Taiwan, and Singapore.

Company Profile

Business Overview: Genus designs, manufactures, and markets capital equipment and deposition processes for advanced semiconductor manufacturing as well as for emerging non-semiconductor applications.

Founded: 1981

Employees: 160

2003 Revenues: $56 million

Facility: Genus is an independent, self-contained manufacturer with 100,000 square feet of space that includes a manufacturing facility, Class 10 demonstration laboratories, development laboratories, and a training facility.

Partners: Proprietary

Contact Information
Thomas Seidel, EVP and CTO
Genus, Inc.
Telephone: 408·747·7140
Web: www.genus.com

Coatings

Inovati
Santa Barbara, California

Have you ever had a deep scratch down the side of your car that you waited too long to fix? The exposed metal reacts with rain and oxygen in the air to form a corrosion product—commonly called rust. If rain can cause something to rust and deteriorate, imagine the capabilities of salt water. That is what the U.S. Navy deals with on a daily basis.

▲ *Inovati's KM coating development system, which is smaller than an office desk and does not require hearing protection, is used for development of coatings by aeronautics, space, defense, and industrial customers.*

The Naval Surface Warfare Center (NSWC) Carderock Division is responsible for all technical aspects of improving performance of ships, submarines, military watercraft, and unmanned vehicles for the Navy. The NSWC recently installed a Kinetic Metallization (KM) coating development system developed by Inovati. KM is a solid-state deposition process that creates and applies corrosion-resistant coatings. Conventional thermal spray coatings tend to be ineffective in seawater because they are excessively porous, which allows seawater to seep through. KM allows the deposition of fully dense coatings, minimizing porosity and in turn reducing corrosion. Thermal spray also contains scattered concentrations of oxides, which create pathways for the corrosion process. KM coatings have oxides evenly distributed throughout, which creates a more uniform microstructure that blocks the corrosive properties of sea water.

Kinetic Metallization

Description: Solid-state deposition process that applies superior wear- and corrosion-resistant coatings

Price Range: $160,000

Customer Base: U.S. Navy, U.S. Air Force, The Boeing Company, Lockheed Martin, Hendry Telephone Products, NASA, Royal Australian Navy, Pratt & Whitney, Honeywell Inc., Goodrich Corporation

Benefits: 1. Creates stronger, more effective coatings than thermal spraying while remaining cost-effective, 2. Is more environmentally friendly than electroplating, 3. Preserves the original microstructure of the material using a low-temperature process

Additional Applications

Automotive: Provides light-weight structures, wear-resistant surfaces, bearings, fuel cells, and electrical sensor components

Medical: Provides porous coatings on joint replacement implants to promote long-term biological fixation and bio-compatible coatings on other implanted medical devices

Materials: Provides new materials for smart structures (embedded sensors, shape altering, nano-particle consolidation) and amorphous metal consolidation

Aerospace: Provides gas turbine engine airfoil repair and coating, hard chrome replacement, cadmium replacement, rocket nozzle coatings, and free-form fabrication of attitude thrusters

Kinetic Metallization

KM is a solid-state process that can blend metals and alloys, which are normally unmixable using conventional processes. Inovati developed the KM process to produce metal coatings for wear resistance, corrosion protection, and metal joining. The process uses an inert gas as a carrier to spray metallic powders such as aluminum, titanium, niobium, molybdenum, or

Company Vision

"KM will be the leading surface engineering process for premium quality coatings and spray-formed goods within five years. Specific market-penetration goals include replacement of 25 percent of the preeminent thermal spray (HVOF, LPPS, D-Gun) coatings market, 15 percent of the functional electroplating market, and will enable the production of new materials not currently available."

Howard Gable, President

copper onto a metal substrate. Similar to thermal spray coating, but achieved at temperatures far below the melting point of the powders, the velocity of a carrier gas provides the energy needed to make the metal powder bond to the substrate. Inovati's KM process makes stronger, more durable coatings by balancing the pressure and velocity of the carrier gas, which keeps the particles soft without heating them to the point where they melt, oxidize, or otherwise interact. If they did interact, the particles would waste their reactivity before hitting the substrate, and could only stick to it via a weak mechanical bond. The precisely controlled KM process delays the chemical reaction until impact with the surface, at which time the particles deform and increase their surface area about four-fold. By doing so, they expose fresh metal surfaces that reacts (adhesively) with the substrate and (cohesively) with each other, which produces a strong metallurgical bond. KM allows nanoparticles to be consolidated while maintaining their characteristics—ductility, strength, magnetic permeability—for which they were engineered. The process is also environmentally friendly while maintaining the same or better properties as those applied with conventional coating techniques.

MDA Application

Years Funded: 1997-1999

Originally, MDA funded Inovati to develop an improved, low-cost, solid-state coating process to provide wear resistance, corrosion protection, and metal joining for lightweight missile structures. Recently, MDA has become interested in using the company's KM process for energetic structural materials and production of thruster nozzles. Besides coatings, the system can be used for spray-forming applications in structural elements of interceptor missiles, which will immediately start burning at very high temperatures upon impact with the target.

Company Profile

Business Overview: Inovati uses its Kinetic Metallization technology to provide coating services. The company also manufactures and sells the system plus related equipment and consumables.

Founded: 1989

Employees: 6

2003 Revenues: $2 million

Facility: Inovati is housed in a 5,000-square-foot facility with full manufacturing capabilities.

Partners: None

Contact Information
Howard Gabel, President
Inovati
Telephone: 805·571·8384
Web: www.inovati.com

Thermal Management

Metal Matrix Cast Composites, Inc.
Waltham, Massachusetts

Do you enjoy sitting at a desk all day? Where would you go if a high-speed Internet connection for all applications were as mobile as your cell phone? In 2004, Hughes Network Systems and Boeing Satellite Systems hope to launch a new satellite system, Spaceway, that will enable customers to wirelessly connect to the Internet from anywhere at any time.

▲ *Michael Mata, a Boeing satellite systems technician, is building part of the Spaceway phased-array downlink antenna. MMCC's MetGraf™ material (gold parts underneath the radar horns) is being used to improve the phased-array radar.*

Boeing purchased MetGraf™ aluminum graphite composite material from Metal Matrix Cast Composites, Inc. (MMCC), to improve the phased-array radar used on Spaceway. MetGraf is providing the thermal management function, enabling the system to operate at or below its maximum temperature range. Due to the material's unusually low density, the antenna mass is reduced, which in turn reduces launch expenses. The satellite system will operate in the Ka-band spectrum and offer high-bandwidth and high-speed communications capabilities for broadband and multimedia applications. It also will integrate with existing communication technologies.

MetGraf™

Description: Carbon-fiber aluminum-graphite composite material used to make heatsinks (gallium-arsenide amplifiers for phased-array radar)

Price Range: Application-specific

Customer Base: Defense contractors

Benefits: 1. High thermal conductivity (200 W/mK) and controlled thermal expansion, 2. Low density (2.4 grams/cc), 3 Easy to machine

Additional Applications

Power Semiconductors: Can provide low thermal expansion, high thermal conductivity, lightweight heatsinks for insulated gate bipolar transistors and other high-reliability power devices

Aerospace and Shipboard Electronics: Can replace heavy materials such as copper molybdenum heatsinks and provide thermal conductivity improvements in addition to lower costs

Advanced Pressure Infiltration Casting Process

MMCC uses its Advanced Pressure Infiltration Casting (APIC™) process to manufacture composites reinforced with finely grained graphite fibers for thermal management applications. APIC enables manufacturers to affordably cast plate stock of aluminum-graphite composite that is subsequently machined into complex electronic packaging components. MMCC's composite is attractive for thermal management because it possesses high thermal conductivity approaching that of pure copper or aluminum, but without the associated thermal expansion mismatch problems. If the chip and the heatsink expand at different rates as they are attached by braze or solder or even during cyclical operation, disbonding can result. Attaching the chip package to the copper or aluminum substrate with a compliant adhesive prevents disbonding. However, adhesives have low thermal conductivity and the bonds have low heat-transfer coefficients, ultimately limiting chip performance. Because MMCC's com-

Company Vision

"Within a few years Metal Matrix Cast Composites expects to have demonstrated its breakthrough performance materials in broad electronic and aerospace applications and should be enjoying very rapid growth, probably as part of a much larger corporate enterprise."

Robin Brumwell, CEO

posite has a closely matched coefficient of thermal expansion to the semiconductor package, the chips can be brazed or soldered to produce both high conductivity and a high heat transfer interface. In the APIC™ process, a mold is preheated in an inert atmosphere at or above the temperature of liquid metal. Molten metal is poured into the mold, and the mold is evacuated in a vacuum and insulated to prevent heat transfer. It is then placed in an autoclave and pressurized. In the final step, it is lowered onto a chilled surface for directional solidification. MMCC also developed a surface treatment, which hermetically seals the components to block the penetration of gases and liquids for high-reliability applications.

MDA Application

Years Funded: 1994-2003

MMCC was funded to develop electronic thermal management composites with high thermal conductivity and precisely controlled thermal expansion. The company is currently using its materials to develop a sunshade for the Exoatmospheric Kill Vehicle (EKV). Most EKV parts are made of highly toxic beryllium. But, MMCC can provide materials that are not toxic, cost half as much as beryllium parts, and have high stiffness and low density.

Company Profile

Business Overview: MMCC produces advanced metal alloy composites using ceramic and graphite fibers, whiskers, and particulate reinforcements.

Founded: 1993

Employees: 14

2003 Revenues: $2.5 million

Facility: The company has a 15,000-square-foot composite foundry that contains the largest pressure-casting autoclave in the metal-matrix cast composites industry.

Partners: None

Contact Information
James Cornie, Director of Technology
Metal Matrix Cast Composites, Inc.
Telephone: 781·893·4449
Web: www.mmccinc.com

Miniaturizing Electronics

NanoSonic, Inc.
Blacksburg, Virginia

Have you ever had to travel with a laptop? It feels light and looks small, until you have to stand on a crowded subway with one hanging off your shoulder. But laptops, along with other electronics such as cell phones and personal digital assistants, are getting smaller and lighter.

▲ *NanoSonic is using an electrostatic self-assembly process to develop flip-chip interconnects for the semiconductor industry. Flip-chips provide more reliable and longer-lasting electrical connections between the chip and the substrate.*

A Fortune 500 semiconductor manufacturer is using flip-chip technology, which is the mounting of a chip with its active side facing the substrate, to develop next-generation miniaturized, longer-lasting electronics. Flip-chip technology, although it was introduced in 1964 and contained superior electrical performance, was rarely used because of cost issues such as expensive interconnects. Flip-chip interconnects, or underbumps, are the electrical connection between the chip and the substrate. NanoSonic, Inc., is helping to make flip-chip technology more cost effective for semiconductor manufacturers. NanoSonic revived an inexpensive coating process called electrostatic self-assembly; using nanocomposites, the company fabricates thin-films that possess the same degree of electrical conductivity as bulk metals. The process also alleviates thermal management problems existing with solder, because the process operates at room temperature. Therefore, using NanoSonic's technology, the semiconductor industry can further miniaturize its technology and improve the lifetime and reliability of its products.

Flip-Chip Interconnects

Description: Curable polymer interconnects with properties equivalent to metal solder

Price Range: $1-$29 per gram

Customer Base: Major government contractors and microelectronics manufacturers

Benefits: 1. Inexpensive coating process, 2. Environmentally friendly materials, and 3. Higher reliability

Additional Applications

Biomedical/Microelectronics/Energy: Can be used to create smaller, more portable devices with superior performance

Modified Electrosatic Self-Assembly Process

According to the Interconnect Focus Center, which researches new solutions that will enable the semiconductor industry to transcend interconnect limitations, there is an interest in using nanotechnology to develop novel, high-conductance electrical interconnects. NanoSonic's polymer interconnects do not contain lead and have a low processing temperature; they are being used to replace common solder electrical interconnects. High thermal and electrical conductivity require using a very thin layer of material between the substrate and the components, however this is hard to achieve with solder. Unlike NanoSonic's interconnects, solder requires a high-temperature process, which creates thermal management problems. By replacing metal solder with a curable polymer having similar properties, better-performing interconnects can be made using a low-temperature manufacturing process called electrostatic self-assembly (ESA). ESA can produce thin-film materials with nanoscale-level molecular

Company Vision

"NanoSonic's goal is to use its nanotechnology portfolio to make the transition from nano to macro. Part of the reason nanotechnology has not resulted in a lot of direct applications yet is that the technologies have not moved from the very small scale to the people-sized scale."

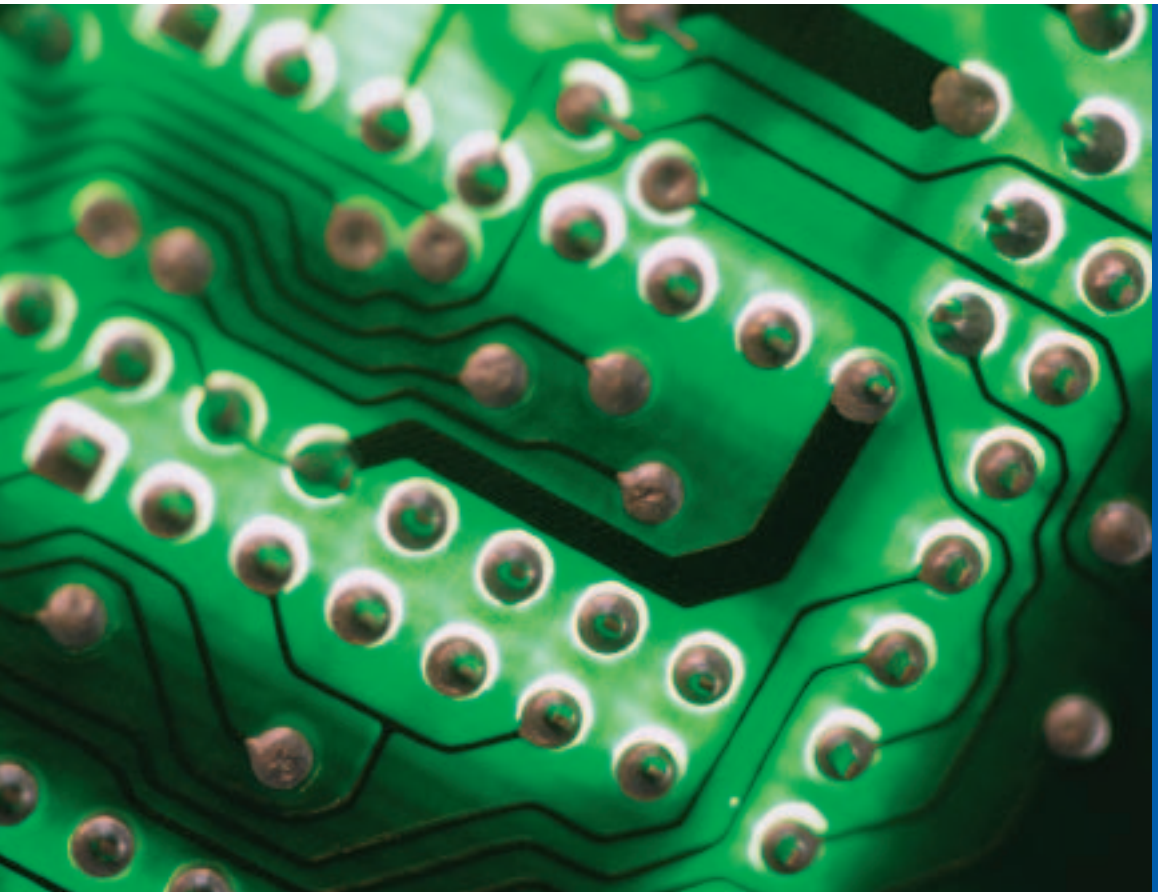
Rick Claus,
President

uniformity. It involves dipping a substrate into aqueous solutions containing anionic and cationic materials such as polymer complexes; metal and oxide nanoclusters; cage-structured molecules such as fullerenes; and proteins and other biomolecules. Nearly perfect molecular order is achieved by individual molecules seeking least-energy configurations—the tendency of any substance to change to the state of least energy. Absorbed from water solutions, these molecules bond with others already attached at the substrate surface. Material properties can then be precisely controlled through the successive stacking of ultra-uniform, nanometer-thick layers of the film.

MDA Application

Years Funded: 1998-2001

MDA funded NanoSonic to develop nonlinear optical (NLO) thin films, which can replace telecommunications mechanical components and improve speed and reliability, using ESA. Funding was also provided to demonstrate the feasibility of using ESA processes to integrate such multiple functions as electro-mechanical actuation, semiconductor junction-based signal processing, thermal transport, and optical switching and modulation into nanostructured organic/inorganic thin-film actuator materials, which could be useful in spacecraft control.



Company Profile

Business Overview: Using its electrostatic self-assembly process, NanoSonic has fabricated ultra-uniform, nanometer-thick layers of material into functional ultra-thin films, thick films, and bulk materials for commercial and government applications.

Founded: 1998

Employees: 40

2003 Revenues: $4 million

Facility: NanoSonic has a 10,000-square-foot building that houses offices, research and development, and manufacturing capabilities.

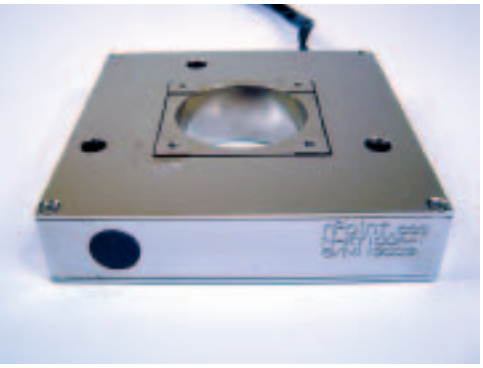
Partners: None

Contact Information
Richard Claus, President
NanoSonic, Inc.
Telephone: 540·953·1785
Web: www.nanosonic.com

Atomic Force Microscopy

nPOINT, Inc.
Madison, Wisconsin

Have you ever tried to read a text message on your cell phone or type on your laptop with the bright sun glaring down on you? The sun glare can make it almost impossible to see the screen at times.



▲ *nPoint closed-loop nanopositioners feature high resonant frequencies, enabling high-speed movement, and the mounting holes feature unique flexures that decouple the strain and stress in the stage body, maintaining the accuracy and stability of the stage position.*

3M has developed Vikuiti™ Brightness Enhancement Films, which will increase the brightness of your LCD screen, enabling brighter viewing with less drain on the battery. The films are created with micro-optics, which are tiny—less than 2 millimeters in diameter—optical components. nPoint, Inc., developed for 3M a nanopositioner that enables researchers to accurately measure micro-optics, traditionally a challenge. Traditional atomic force microscopes are capable of measuring high magnifications of small areas. nPoint's custom nanopositioners enable researchers to scan larger areas on taller micro-structures, producing precise, high-resolution measurements. For example, conventionally researchers could use atomic force microscopy (AFM) to measure a structure that is 100 x 100 x 5 microns. Using nPoint's nanopositioners, 3M researchers are capable of scanning 500 x 500 x 100 microns—approximately 20-times larger—while still providing nanometer precision in all three dimensions.

Nanopositioners

Description: Facilitates imaging, measuring, and manipulating at the sub-molecular level

Price Range: $10,000/axis of motion

Customer Base: Proprietary

Benefits: 1. Closed-loop operation, 2. Accuracy values within 5 nanometers and resolution values within 1 nanometer, 3. Out-of-plane motion less than 5 nanometers for 100 x 100-micron scanning stage

Additional Applications

Defense: Can enhance imaging resolution in images in airborne (manned and UAV) and satellite target identification

Semiconductors: Can position/scan probe or sample for inspection with high resolution/accuracy

Optical Microscopy: Can enhance image resolution in standard microscopy and make confocal microscopy possible

Telecommunications: Can be used in fiber alignment

Nanopositioners

Used to image samples with nanometer resolution, AFM is applied to research in a variety of fields. An atomic force microscope uses a micro-fabricated tip attached to a cantilever beam to scan a surface and create a high-resolution topographical image. Most atomic force microscopes use open-loop scanners. Therein lies the problem with accuracy, because open-loop scanners lack feedback loops and are not self-correcting. Highly reliable measurements

Company Vision

"In a 10-year time frame, nPoint would expect to be a $30-$50 million company and would have most likely been acquired by a larger instrumentation company."

Katerina Moloni,
Vice President of Marketing

cannot be collected. However, nPoint's nanopositioners are closed-loop scanners, which contain active feedback loops and offer accuracy and resolution values of 5 nanometers (nm) and 1 nm, respectively.

Using funding from DARPA, nPoint designed a capacitance micrometer for use with its nanopositioners. This capacitance micrometer has a displacement resolution that is less than the diameter of an atom and is integrated into the design of the positioning stage, eliminating the need for externally mounted feedback devices. The company uses high-end piezoelectric elements that enable increased travel for a given positioner size. The nanopositioners feature high resonant frequencies, enabling high-speed movement, and the mounting holes feature unique flexures that decouple the strain and stress in the stage body, maintaining the accuracy and stability of the stage position.

MDA Application

Year Funded: 2000

nPoint was funded to develop advanced nanopositioners with enhanced speed and range of motion made from novel materials to improve measurement, positioning, and machining. The company's goal is to enable the speedy fabrication and inspection of microelectronics, which in turn will facilitate the quicker completion of components needed for the missile defense system.

Company Profile

Business Overview: nPoint, previously known as Piezomax, a spinoff from the University of Wisconsin, sells nanopositioners and AFM microscope upgrade kits.

Founded: 1997

Employees: 12

2003 Revenues: $2 million

Facility: The company has a 6,000-square-foot building for light manufacturing, such as assembly and testing.

Partners: None

Contact Information
Katerina Moloni, VP of Marketing
nPoint, Inc.
Telephone: 608·204·8756
Web: www.npoint.com

Pacemakers

NVE Corporation
Eden Prairie, Minnesota

What happens to your heart when you are active? If you just ran a mile, your heart is going to be beating two to three times faster than when it's at rest. But sometimes there is a malfunction. When the heart cannot keep pace with the body, because it either beats too slow or too fast, doctors insert a pacemaker.

▲ *St. Jude Medical, a pacemaker manufacturer, is using NVE Corporation's giant magnetoresistive (GMR) sensors, which are highly stable and sensitive magnetic sensors, to replace the reeds of conventional pacemakers. The GMR sensors are an order of magnitude more sensitive than the reed, and they are solid-state devices, not mechanical.*

St. Jude Medical is manufacturing pacemakers using NVE Corporation's giant magnetoresistive (GMR) sensors, which are highly stable and sensitive magnetic sensors that replace the reeds of conventional pacemakers. Pacemakers must be tuned to the specific needs of each person's body. Physicians use magnetics to tune the pacemaker from outside the body. The device in the pacemaker that responds to the magnetic signals is usually a reed switch. However, NVE's GMR sensors are replacing the reeds in St. Jude's pacemaker line of products. The GMR sensors are an order of magnitude more sensitive than the reed, and they are solid-state devices, not mechanical. Mechanical devices have a known failure mechanism and may take longer to clear the U.S. Food and Drug Administration (FDA). GMR sensors have no known failure mechanism, allowing them to pass FDA quicker.

Giant Magnetoresistive Sensors

Description: Highly stable and sensitive magnetic sensors that are made of giant magnetoresistive materials

Price Range: $2-$5/sensor

Customer Base: St. Jude Medical, Inc., Agilent Technologies, Motorola, Inc., Cyprus Semiconductor Corporation, Honeywell, Inc., and Digi-Key Corporation

Benefits: 1. High sensitivity (one order of magnitude or more than a reed), 2. Small size (436 microns x 3,370 microns), 3. High impedance and low power

Additional Applications

Industrial Automation: Can be used in pneumatic cylinder positioners

Surveillance: Can be used in high-sensitivity, low-power, passive, small magnetometers, otherwise known as metal detectors

Giant Magnetoresistive Sensors

The U.S. Department of Commerce, in collaboration with other U.S. government entities, conducted a survey of more than 3,000 firms to assess the development and adoption of biotechnology in industry. While firms in several different industries are developing and applying biotechnologies, 72 percent were concentrated in human health applications. Of the human-health-focused companies surveyed, the main focus was in therapeutic and diagnostic technology. Diagnostics deals with the analysis and investigation of signs and symptoms exhibited by an organism for the purpose of diagnosing disease and injury. The GMR effect, in which an applied magnetic field changes certain materials' resistance to current flow, sets NVE's biosensor apart from other magnetic sensors for biological diagnostics. By using GMR materials, NVE produced smaller, lower-power, solid-state magnetic biosensors with extremely high sensitivity and is actively exploring other applications on biomedical devices.

Company Vision

"NVE's vision is to continue to be a leader in the practical commercialization of spintronics, which is a nanotechnology many experts believe represents the next generation of microelectronics. Product realization of spintronic products is occurring at NVE in the form of magnetic field sensing and switching, and data acquisition, transfer, and storage."

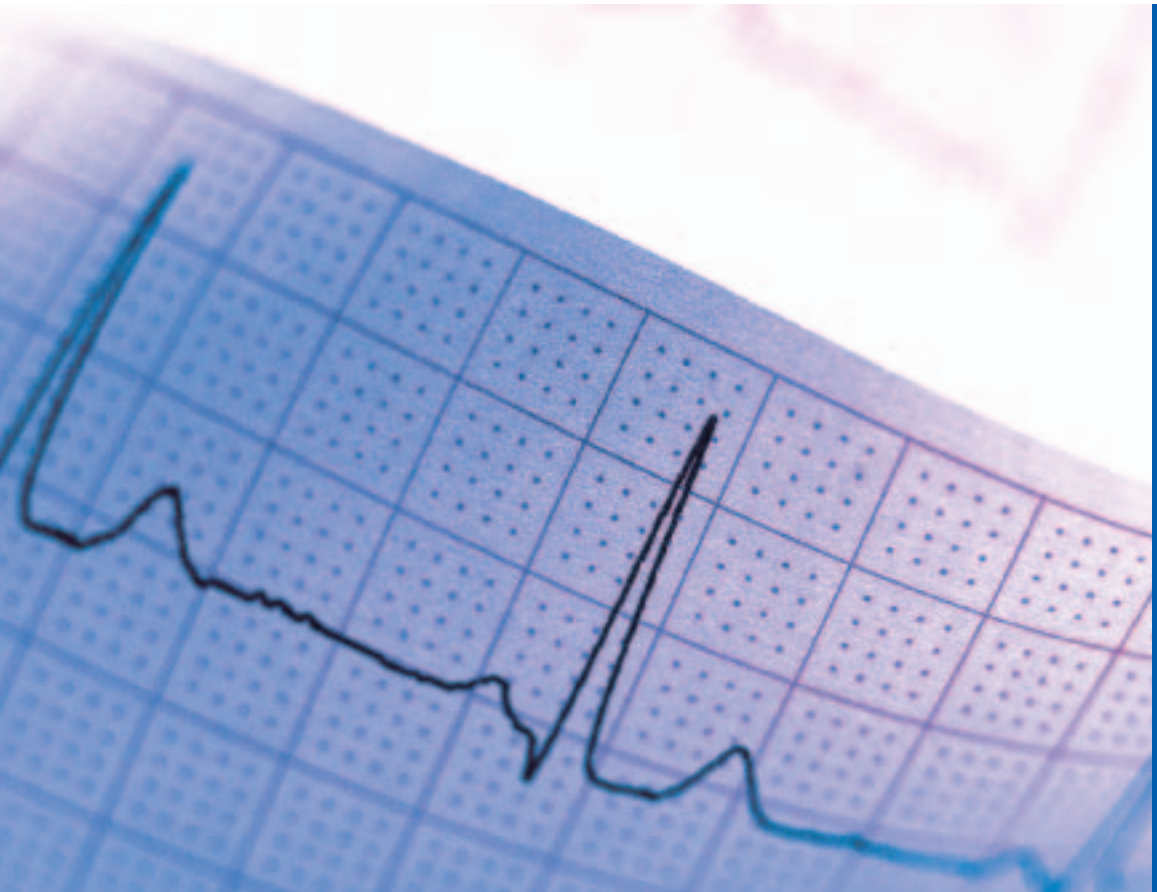
Robert Schneider,
Director of Marketing

GMR magnetic sensors are made of sandwiches of thin films consisting of alternative layers of magnetic and nonmagnetic materials. In these devices a conductive nonmagnetic interlayer separates two magnetic layers. Combined this way, the materials' resistance to current is high. An external magnetic field causes the magnetic fields in all layers to line up in the same direction, so electric resistance drops dramatically. With their high degree of stability and sensitivity, the GMR sensors can replace more conventional magnetic sensor technologies, such as anisotropic magnetoresistance, variable reluctance, or Hall-effect sensors.

MDA Application

Years Funded: 1992-2003

NVE was funded to develop GMR materials and processing technology. GMR sensors are ideal for use in space because of their radiation hardness and ability to operate over a wide temperature range. GMR sensors could replace certain optoelectronics, which are slower than magnetics and very susceptible to radiation. The GMR materials can also be applied to high-density, static magnetoresistive random access memory (MRAM), which can store information and never lose it. The sensors use less power and provide quicker access to the stored information as well.



Company Profile

Business Overview: Originally, known as Nonvolatile Electronics, Inc., NVE Corporation is now a publicly traded company specializing in spintronics—a nanotechnology that uses an electron's spin rather than its charge to sense, store, or transmit digital data.

Founded: 1989

Employees: 70

2003 Revenues: $9.46 million

Facility: The company is housed in a 20,000-square-foot facility and is capable of manufacturing 40 million devices per year.

Partners: Agilent Technologies, Honeywell, Cyprus Semiconductor, and Motorola

Contact Information
Robert Schneider, Director of Marketing
NVE Corporation
Telephone: 952·829·9217
Web: www.nve.com

Medical Imaging

OmniCorder Technologies, Inc.
Stony Brook, New York

Doesn't it feel weird when your leg falls asleep and you get that tingly feeling? Regaining communication with the nerves in your leg is just one function of the brain, which is organized into different areas, each with their own unique responsibilities. During brain surgery, neurosurgeons must map each area so the tissue is not damaged by the surgical procedure.

▲ *OmniCorder's BioScanIR® system provides the adjunctive diagnostic screening of cancer and other diseases affecting the blood flow in tissue and organs. Changes in the photon flux highlight abnormalities in the human tissue physiology. The collected data is processed and analyzed, and a report is generated through either an LCD monitor or color printer.*

The BioScanIR® System, developed by OmniCorder Technologies, Inc., has been tested by neurosurgeons at the Mayo Clinic for its ability to provide real-time imaging of the brain during surgery. Despite the availability of medical imaging methods such as magnetic resonance imaging and positron emission tomography, brain surgeons still must perform awake cortical mappings—determining which area of the brain does what during the surgery, while the patient is conscious. OmniCorder's BioScanIR system, which records infrared radiation emitting from living human tissue, is being tested as an alternative to awake cortical mappings and other medical procedures in the brain. So far, the doctors have found that BioScanIR can locate these critically important areas of the brain quickly and without contact with the brain surface, which other modalities cannot locate.

BioScanIR® System

Description: Medical imaging device that detects minute blood-flow changes (or blood-perfusion changes) associated with the presence of disease

Price Range: Variable according to application

Customer Base: (Pilot Sites) Mayo Clinic, Dana-Farber Cancer Institute, State University Hospital of New York at Stony Brook, Huntington Memorial Hospital, University of Geneva, and Ospedali Riuniti di Bergamo

Benefits: 1. Is completely non-invasive and does not use any radiation or contrast agent, 2. Produces functional images in real time, 3. Is less expensive—costing one-tenth the amount of current functioning imaging modalities such as positron emission topography

Additional Industries

Pharmaceutical: Can be used for pre-clinical drug development, clinical trials, and therapeutic monitoring

Diagnostic: Can provide medical images to help detect cancer and vascular disease

Surgical: Can provide real-time, interoperative information during surgery and is useful in pre-surgical planning and post-surgical monitoring

Quantum Well Infrared Photodetectors

NASA's Jet Propulsion Laboratory has improved infrared technology with long-wavelength quantum well infrared photodetectors (QWIPs). These infrared photodetectors are built using gallium-arsenide-based quantum wells—tiny manmade structures that are extremely sensitive to temperature changes as small as 6/1000th of a degree. The atom-sized quantum wells can be packed together in extraordinary densities, allowing them to efficiently capture infrared photons. OmniCorder acquired an exclusive worldwide license for the JPL technology for biomedical applications from the California Institute of Technology. The QWIP technology is incorporated in the OmniCorder BioScanIR system, which is a non-invasive infrared camera

Company Vision

"OmniCorder Technologies' goal is to continue to seek technologies developed by the military and aerospace industry and to re-mission them to help solve healthcare problems. The BioScanIR system is the first of what we expect to be a series of products that will improve healthcare outcomes while saving healthcare dollars."

Mark Fauci,
President and CEO

device that images, records, and analyzes very small changes in infrared photons, or infrared light, radiating from patients.

The BioScanIR cleared FDA and has received its CE Mark permitting commercial distribution for medical applications in the United States and Europe for the adjunctive diagnostic screening of cancer and other diseases affecting the blood flow in tissue and organs. Changes in the photon flux highlight abnormalities in the human tissue physiology. The collected data is then processed, analyzed, and a report is generated through either an LCD monitor or color printer. The BiosScanIR contains a cooled 256 x 256 pixel QWIP with a wavelength band of 8 to 10 micrometers, a sensitivity up to 0.0006° centigrade, and a frame rate up to 400 frames per second. All hardware and software are included in the system. The equipment also offers a user-friendly interface and a compact, mobile platform.

MDA Application

Years Funded: 1995-2004

MDA Advanced Systems funded NASA's Jet Propulsion Laboratory to develop QWIP technology for ground- and space-based infrared surveillance applications at long wavelengths to identify ballistic missiles, which have peak emissions in the 8- to 15-micron region when the hot rocket engine is not burning. QWIP technology is important for systems that require all-weather capability. The sensitivity range enables the detectors to see atmospheric conditions, which would block other wavelengths of infrared light. JPL is now using QWIP technology to develop focal plane arrays for MDA's Airborne Laser element, which is a weapons-class laser installed in a modified Boeing 747 aircraft that will seek and destroy ballistic missiles soon after launch.

Company Profile

Business Overview: The company aims to improve the quality and cost-effectiveness of healthcare services and research by identifying, acquiring, and adapting military and aerospace technology for biomedical applications.

Founded: 1997

Employees: 29

2003 Revenues: $7.8 million (funding)

Facility: OmniCorder is housed in 6,500 square feet of space, of which 2,200 square feet is dedicated to development and manufacturing.

Partners: None

Contact Information
Ann-Marie Fields, VP of Corporate Comm.
OmniCorder Technologies, Inc.
Telephone: 212·292·5710
Web: www.omnicorder.com

Mountaineering

Quoin International, Inc.
Carson City, Nevada

Do you remember how hard it was to climb a rope in gym class? Now imagine that rope is 600 feet long, and you are hauling up someone in a basket-stretcher with you. Today, mountain search-and-rescue groups must rely on ropes, pulleys, and human strength to perform rescues. However, that may soon change.

▲ *The China Lake Mountain Rescue Group is demonstrating the prototype PowerQuick™ Powered Ascender. The rescue group has provided input and testing results to Quoin throughout the development of the PowerQuick technology.*

China Lake Mountain Rescue Group (CLMRG) has been testing the PowerQuick™ Powered Ascender, a device capable of propelling a person up a rope or lifeline, from Quoin International, Inc. In April 2000, CLMRG rescued a seriously injured climber from Mount Whitney, the highest mountain in the contiguous 48 states, with a summit of 14,497 feet. The climber had taken a 40-foot fall and was stuck 600 feet below the summit. Reaching the summit at noon via helicopter, CLMRG administered medical treatment and secured the injured climber to a stretcher. The team began hauling up the climber at 6:30 p.m.; at 2:00 a.m. the stretcher crested the top of the mountain. If CLMRG had the PowerQuick device, the injured climber would have been safely at the summit about 15 minutes after the rescue team arrived.

PowerQuick™ Powered Ascender

Description: Lifting technology capable of propelling a person and equipment up or down a length of rope or lifeline at speeds of 1 meter per second

Price Range: $4,900

Customer Base: Search-and-Rescue groups, Defense, construction companies

Benefits: 1. Light-weight—approximately 7 pounds, 2. Capable of propelling up to 408 pounds at a rate of 1 meter per second, 3. Controllable descent and ascent, which increases safety

Additional Applications

Construction: Can be used to lift men and equipment to sites needing construction or structural repair

Defense: Can provide military personnel quicker and easier access to tall structures during defense procedures

Attitude Control System

The National Park Service and volunteer mountain rescue groups face many situations in which a rescuer must descend into remote places to save a life. Oftentimes the equipment necessary to get a person out of harm's way proves to be cumbersome or useless. Winches on ground-based rescue vehicles are worth little if the vehicles can't access victims in remote areas. A large winch on a helicopter can add significant weight, leaving less room for supplies or people. Moreover, a rope wrapped around the capstan of a winch can become tangled and cost serious life-saving time. Quoin's Tactical PowerQuick device—based on a flywheel-based attitude control system (ACS)—works by propelling a person along a length of rope or lifeline rather than winching all the rope onto a capstan at the other end. It is a man-lift technology that is powered by a turbine and high-pressure air (compressed air or air generated by a solid

Company Vision

"Quoin International's goal is to continue development and commercialization of dual-use technologies. We will manufacture and market some products in-house, such as the PowerQuick powered ascender, and others such as the flywheel attitude control system will potentially be licensed to a major defense contractor. The overall goal is to increase the company technology base and provide a healthy return to our investors."

Cathy Jacobson,
VP Business Development

propellant). Both the air source and the turbine are built into a single unit, the ACS. A miniature, compressed-gas turbine was developed as a starter mechanism for the attitude control device's flywheels. The turbine drives the flywheels at more than 100,000 revolutions per minute. Through a series of stages, the turbine converts the energy of compressed gas into rotational mechanical energy. The PowerQuick device can be incorporated into a variety of lifting chairs or other platforms.

MDA APPLICATION

Year Funded: 2000

BMDO, now MDA, funded Quoin to develop its flywheel-based attitude control device to replace conventional stabilizing thruster technology in missiles and satellites. Using the theory of gyroscopic force, the system can induce torque in a missile to control pitch, yaw, and roll. Currently, command of kinetic energy kill vehicles is achieved through the use of divert attitude and control thrusters whose exhaust gases decrease the sensitivity of the vehicle's infrared sensors. Quoin's technology reduces the number of thrusters needed for attitude control, thereby restoring some infrared sensitivity. The flywheel device is also 70 percent lighter and 80 percent cheaper than conventional thrusters.

Company Profile

Business Overview: Quoin is an engineering, technology development, manufacturing, and service company that specializes in power, control, actuation, and pyrotechnics technology.

Founded: 1990

Employees: 25

2003 Revenues: $2 million

Facility: The company has a 5,000-square-foot facility in Ridgecrest that houses the headquarters and engineering services and a manufacturing/testing facility in Inyokern, CA, for the production of Quoin's FireQuick flares.

Partners: None

Contact Information
Cathryn Jacobson, Vice President
Quoin International, Inc.
Telephone: 775·882·8100
Web: www.quointech.com

Digital Signal Processing

Sheet Dynamics Limited
Cincinnati, Ohio

Have you ever tried to hold an object perfectly still in mid-air? Similar to the way your hand is not perfectly stilled, neither is a satellite orbiting the Earth. A system has different dynamics on Earth than it does in space. Control algorithms developed and tested on the ground may not work upon reaching the stars.

▲ *A NASA astronaut demonstrates the ability of Sheet Dynamics' spatio-temporal filter to control vibration in complex systems aboard the International Space Station. DSP*developer*™, a digital signal processing software, was designed to finish the development of the STF technology, but it has since become a commercial success for the company.*

Sophisticated control algorithms are used to hold pointing devices, such as lasers or antennas, perfectly still even though the satellite platform is vibrating. Sheet Dynamics Limited (SDL) developed a system that can automatically formulate its own control algorithms upon reaching space. This project took form in the Mid-deck Active Control Experiment (MACE II), which was performed aboard the International Space Station in the summer of 2001. SDL demonstrated its MDA-funded spatio-temporal filtering (STF) technology for controlling vibration in complex systems. The company also used its DSP*developer*™, which was designed while making the STF technology, to create and implement the control algorithms that would be used on the processing system in space.

DSP*developer*™

Description: Automatically generates computer code for an embedded processor

Price Range: $5,000/installation

Customer Base: American Electric Power, Bose Corporation, DOD, PCB Piezotronics, Inc., Raytheon Company, Medrad, Inc., University of Arizona, Steward Observatory, Alliant ATK

Benefits: 1. Eliminates the need for specialized digital signal processor programming expertise, 2. Easy to use since computer code is represented in block diagram format, 3. Reduces the amount of time and effort required to develop code and complete design iterations

Additional Applications

Aerospace: Can provide active vibration, noise and motion control; damage detection

Defense: Can offer active hearing protection, engine prognostics, and health management monitoring

Medical: Can evaluate batch and real-time image processing approaches, automated feature extraction, and classification

Research & Development: Can develop high-performance "mechatronic" solutions integrating mechanical, electrical, signal processing, and control aspects

Telecommunications and Consumer Electronics: Rapid prototyping and evaluation of digital signal processing approaches

Spatio-Temporal Filtering

SDL developed spatio-temporal filtering (STF) to actively control vibration in complex systems. By integrating an array of sensors and actuators, the company demonstrated that STF technology can reduce by a factor of 10 the vibration in complex structural systems. STF achieves robust, high-performance control without the need for a complete and accurate system mode; it breaks down the complex structural vibration response of a system with many

Company Vision

"Sheet Dynamics' goal is to be the premier provider of mechatronic consulting research and development services, tools, and technology in North America, providing outstanding, creative solutions to the most difficult problems experienced in developing high-technology products and processes."

Stuart Shelley,
Principal

vibration modes into simple, single-degree-of-freedom responses. By ignoring the modes that are not problematic, the system can easily be controlled and monitored independent of the overall complexity. It can also autonomously reconfigure itself to accommodate a sensor or actuator failure. SDL created DSP*developer* to implement, test, and improve the needed algorithms to perform real-time control of real-world structural systems.

DSP*developer* is a link between the simulation software and the embedded processor. Almost all modern signal processing, control, or monitoring applications are implemented in computer code running in a specialized embedded DSP chip. Typically, an application engineer communicates the technology function to a DSP engineer who writes the program and compiles the code into assembly language. Using a block diagram simulation software program called Simulink®, created and sold by The Mathworks, an application engineer can create and validate the technology in simulation, and DSP*developer* will then automatically generate executable code from the simulation and download it to the embedded processor.

MDA Application

Year Funded: 1998

SDL developed adaptive spatio-temporal control systems to actively control vibration in structural components. MDA funded the research for large deployable space telescopes that used multiple mirrors. The relative positions of the mirrors must be maintained with an accuracy of 10 nanometers in the presence of disturbances, such as thermal gradients and on-board jitter. SDL created DSP*developer* to write the algorithms that would perform real-time control spatio-temporal control systems.

Company Profile

Business Overview: The company provides high-end R&D consulting for numerous government organizations and consults with major companies such as Emerson Corporation and Proctor & Gamble.

Founded: 1996

Employees: 12

2003 Revenues: $1 million

Facility: SDL has 3,500 square feet of office space and 1,000 square feet of high-bay lab space with a wide array of dynamic test and measurement instrumentation and capability.

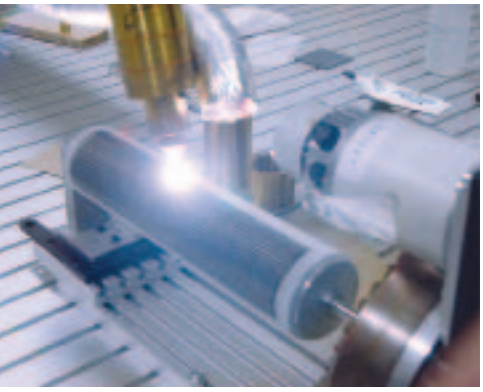
Partners: The Mathworks, BittWare, The Modal Shop, Inc., Analog Devices, Sarsen Technology, Ltd.

Contact Information
Stuart Shelley/Tom Sharp, Principals
Sheet Dynamics Limited
Telephone: 513·631·0579
Web: www.sdltd.com

Surface Treatment

Surface Treatment Technologies, Inc.
Westminster, Maryland

Do you take your car to get the oil changed, tires rotated, and engine serviced as often as you should? If you follow the owners manual, countless hours can be spent getting routine maintenance done to one car. Imagine the time-consuming and expensive routine maintenance required on an entire fleet of tractor-trailers.



▲ *ST2's Laser Induced Surface Improvement™ coating process uses laser technology to make metals more corrosion- and wear-resistant than is possible with existing surface treatment methods. A Nd:YAG or CO_2 laser beam passes over the surface, heating the substrate to a depth of up to 1 millimeter, melting the substrate and powder to form an alloy.*

The Holland Group, designers of components, systems, and services for the transportation industry, reduced the amount of routine maintenance on tractor-trailer hitches with its NoLube Fifth Wheel™ hitch. Surface Treatment Technologies, Inc. (ST2), processes the surface of the critical lock system components on the new hitch using the Laser Induced Surface Improvement™ (LISI) coating process. Conventional fifth wheels need to be lubricated on a regular basis. Holland's NoLube Fifth Wheel is coated with an environmentally friendly polymer in place of a standard lubricant. However, the polymer could not coat the lock components. So Holland selected the LISI coating process to provide wear- and corrosion-resistance for the lock. Holland was able to produce a fifth wheel that has a surface with the same wear properties of a lubricated part, but without the attendant cost, maintenance, and environmental issues.

Laser Induced Surface Improvement™

Description: Laser process that makes metals corrosion and wear resistant

Price Range: Dependent on application

Customer Base: Holland and U.S. Navy

Benefits: 1. Is a metallurgical coating (doesn't flake off), 2. Improves corrosion resistance, 3. Enhances wear resistance

Additional Applications

Transportation: Can provide wear-resistant coatings for railroad components such as train cars and power systems, and automotive applications

Laser Induced Surface Modification

The LISI process uses laser technology to make metals more corrosion- and wear-resistant than is possible with existing surface treatment methods. To create new surfaces, a metal/ceramic powder in a water-based binder is sprayed onto the metal substrate; this part of the process is optimized using a robot. A neodymium-yttrium-aluminum-garnet (Nd:YAG) or carbon dioxide (CO_2) laser beam then passes over the surface, heating the substrate to a depth of up to one millimeter (mm). In a single pass of the beam, the substrate and powder are melted to form an alloy. The patented optical package, developed by the University of Tennessee Space Institute provides a laser beam that is thermally uniform across its width to produce even melting. In addition to flat surfaces, LISI can treat complex external shapes and inner diameters as small as 0.75 inches, whereas other treatment methods are limited to diameters of no less than 4 inches.

Company Vision

"In 10 years Surface Treatment Technologies will be a premier company designing and depositing advanced coating systems for commercial and military customers. During this time, ST2 will also work to commercialize other advanced materials technologies that we are currently developing."

Timothy Langan,
President

Compared with conventional surface treatment methods, such as sprays or high-velocity oxygen fuel coatings, LISI produces more durable surfaces by creating a metallurgically bonded alloy that will not delaminate under stress. LISI will make treated metals last longer and, in some cases, even enable the replacement of expensive materials with cheaper alternatives. For example, expensive injection molds could be replaced by inexpensive molds with LISI-treated surfaces that have the same characteristics as the pricier molds.

MDA APPLICATION

Years Funded: 1998-2002

MDA funded development of LISI for the high-throughput, low-cost modification of metal surfaces to promote enhanced wear and impact resistance. The company intended to develop a corrosion barrier for large satellite tracking structures. Specifically, ST2 was focused on applying the LISI coatings to large antenna structures located at a missile tracking facility in the Pacific, which has harsh weather conditions.

Company Profile

Business Overview: ST2 focuses on developing and maturing advanced surface treatment technologies for wear, erosion, thermal, and corrosion protection of metals and ceramics.

Founded: 1997

Employees: 6

2003 Revenues: Proprietary

Facility: The company is housed in an 8000-square-foot facility with laboratory and manufacturing capabilities.

Partners: University of Tennessee

Contact Information
Tim Langan, President
Surface Treatment Technologies, Inc.
Telephone: 410·242·0530
Web: www.stt-inc.com

Up and Coming

Look for these products in 2005

Keep an eye out for the following companies that have MDA-funded technologies beginning to emerge in the commercial market:

InfoValley Corporation

Wayne, Pennsylvania

InfoValley's Interactive InfoWall™ is a large display wall that serves as a common computer screen. It allows several users to simultaneously access it from different locations as long as they are connected to the same network. MDA funded InfoValley to expand on the work it did under an Air Force Research Laboratory contract to develop a Team Computer Interface for use in Battle Management, Command, and Control.

Lithium Power Technologies, Inc. (LPT)

Manvel, Texas

LPT created a thin-film lithium-ion (Li-ion) battery that combines the elements of both battery and capacitor technology. It is lighter and cheaper to manufacture because the battery consists mostly of polymer rather than metal. MDA funded LPT to investigate the possibility of developing a hybrid power source based on metallized thin-film capacitors and polymer electrolyte batteries that can operate reliably and efficiently at room temperature.

Applied Thin Films, Inc.

Evanston, Illinois

Applied Thin Films has developed Cerablak™, an oxide that can easily be applied as a micron-thin coating on a substrate. The ultra-thin film can withstand temperatures up to 1200ºC without crystallizing or degrading, and it provides a smooth hermetic seal. MDA funded the company to prove that the coating could survive thermal stresses at the interface of the film and its substrate, and to test Cerablak's tribological properties.

Raven Technology, LLC

Brunswick, Maine

Raven has developed AC-Direct™, a generator that connects to a vehicle's engine and works without the use of inverters, instantly providing up to 5 kilowatts of household-type current. Raven incorporated AC-Direct into its Blackbird technology, which converts mechanical energy to electrical energy with up to 90 percent efficiency. MDA originally funded Dirigo R&D, Inc., which created Raven, to demonstrate a practical method of efficiently producing 60-Hertz alternating current power using resonant circuit techniques to excite the field of a specially designed high-frequency alternator for mobile applications.

2004 Technology Applications Report

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

Writer/Editor: .....Tabatha Robinson

Production Manager/Editor: .....Lisa Hylton

Contributing Writers: .....Adam Gruen, Patrick Hartary, Scott Tillett

Design and Layout: .....Renan Kiper

Technical Advisors: .....Tim Bennett, Joel Price, and Jeff Reynolds

This project is sponsored by MDA. The information presented does not necessarily reflect the position or policy of the Federal Government; no official endorsement should be inferred.

Photo Credits

Page 8 *©2003 Alcon, Inc., used with permission*
Page 18 *www.istockphoto.com*
Page 33 *Ken Zemach, Exponent*
Page 35 *Organic Tragedy, Ryan Johnson*
Page 38 *The Boeing Company*
Page 39 *The Boeing Company*
Page 43 *Apple Computer*

Missile Defense Agency
Advanced Systems (MDA/AS)
Technology Applications Program

For more information about MDA, visit:
http://www.acq.osd.mil/mda/mdalink/html/mdalink.html

For more information about MDA technology transfer, visit:
www.mdatechnology.net
http://www.acq.osd.mil/mda/mdalink/html/transfer.html

Published 2004