

The 2000 BMDO Technology Applications Report



Technology, Working for You Now.



Did you know?

The Ballistic Missile Defense Organization (BMDO) is funding the development of advanced technology to strengthen our Nation's defense against ballistic missile attacks. While much of this technology investment will eventually be inserted into defense systems, it is already working for you now—through commercial applications. Commercialization of BMDO technology creates jobs, leads to new capabilities and products, and helps small businesses grow. Commercialization helps BMDO, too, when its technology developers make further cost reductions or performance improvements to win new customers in commercial markets. The 2000 BMDO Technology Applications Report highlights 18 examples of BMDO-funded technology with commercial activities. It also features three examples of BMDO-funded technology with commercial activities that have already benefited BMDO systems.

For more information visit BMDO's Technology Transfer Web site at
<http://www.acq.osd.mil/bmdo/bmdolink/html/transfer.html>



*The 2000 BMDO
Technology Applications Report*



Technology, Working for You Now.

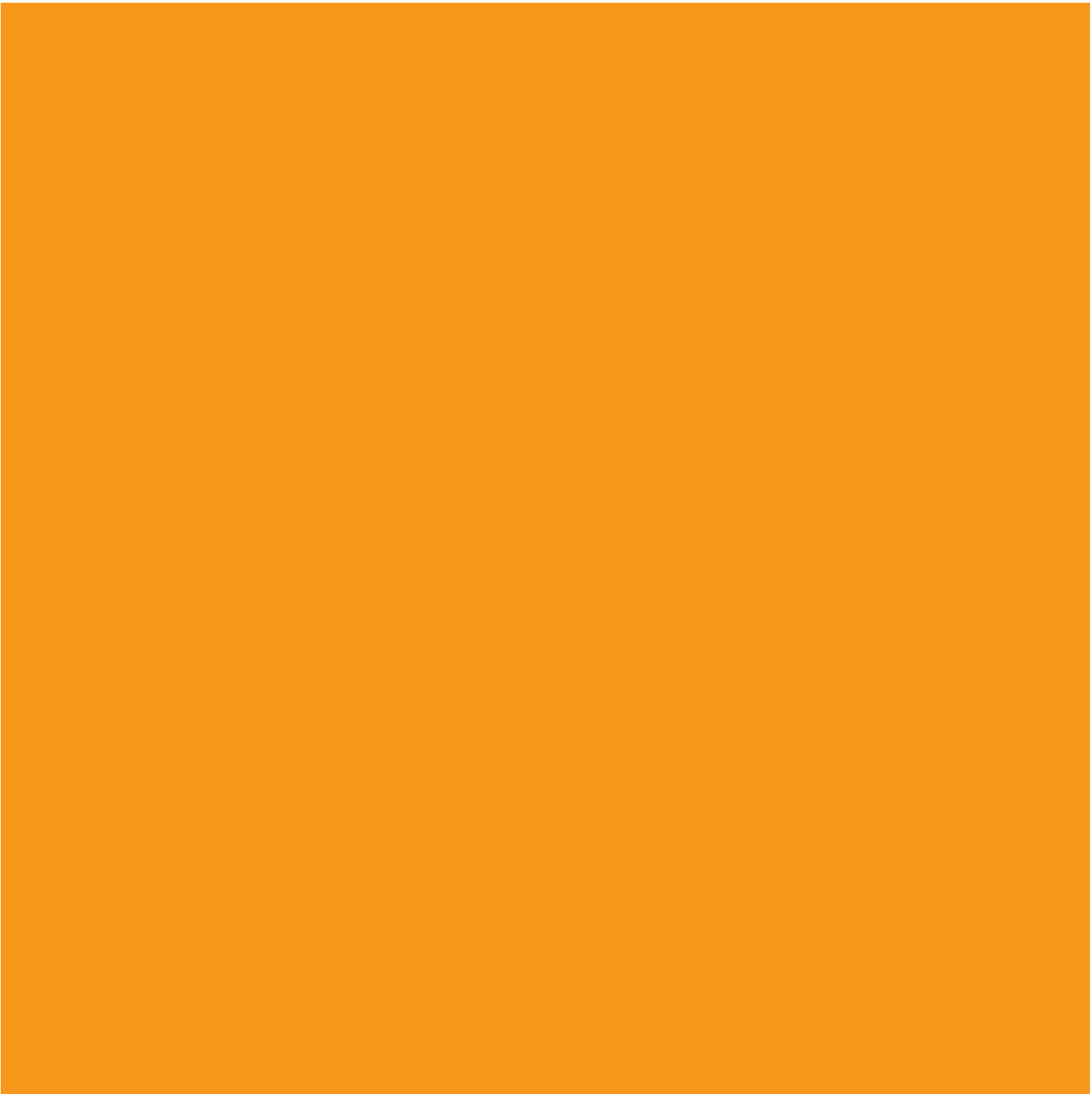




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The 2000 BMDO Technology Applications Report

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

*Advanced Technology—
Key to a Secure Future*



PATRIOT FOR DEFENSE

As we enter the 21st century, America is faced with a growing threat to national security and to global stability: ballistic missiles. Today, only China and Russia have long-range missiles that can strike the United States, and neither country is considered a threat. However, many other nations are taking advantage of an ever-widening access to technology, information, and expertise to speed both the development and deployment of these weapons. As a recent demonstration by North Korea attests, it will be only a few short years until some of these nations have the same long-range capabilities as China and Russia and can place the United States, as well as its troops and allies abroad, at significant risk.

Advanced technology is key to countering these emerging threats. The technological superiority of America's missile defense systems depends on BMDO's strategic research commitments in areas such as sensing, materials, electronics, propulsion, and communications. Such advances are essential for building and fielding surveillance systems to detect, identify, and track ballistic missiles; interceptor and directed energy weapons to destroy ballistic missiles in flight; and battle management systems to coordinate the collection, communication, and analysis of data.

Technology advances are helping BMDO to develop missile defense systems both for use in confined "theaters" of conflict and for protection of the U.S. homeland. These systems include the following:

- National Missile Defense, a nationwide system for long-range, high-altitude defense
- PATRIOT Advanced Capability-3 (PAC-3), a mobile, ground-based system for low-altitude defense
- Theater High Altitude Area Defense (THAAD), a rapidly relocatable, high-altitude defense
- Navy Area, a ship-based low-altitude defense
- Navy Theater Wide, a ship-based high-altitude defense
- ARROW, a defense system for Israel
- Medium Extended Air Defense Systems, a short-range defense system for the United States, Germany, and Italy.

*Commercialization Is Good
for BMDO and Its Sponsors*



COMPUTERS FOR DIAGNOSTICS

BMDO technology development is obviously intended for defense needs. In some cases, however, this technology must wait for an opportune time to be inserted into BMDO systems. BMDO has found that a route through commercial applications for this “technology-in-waiting” can be very beneficial for both BMDO and its sponsors—the Nation and its taxpayers.

Small businesses play a major role in developing and commercializing BMDO technology innovations. When these businesses find new opportunities for their innovations outside of BMDO, they grow significantly, creating new jobs and new industries across the country. They also create new products that provide substantial economic and social benefits. Here are just a few examples:

- New drugs and medical therapies are providing hope for the sick and a healthier life for all.
- New computer and networking products are boosting worker efficiencies and productivity levels.
- And new manufacturing systems are increasing our Nation’s economic competitiveness worldwide.

Pages 6 through 17 of this publication highlight 18 examples in which BMDO technology has spun off into commercial markets and is working for you now.

Commercialization helps BMDO when its technology is further improved by the developers. By reducing the cost or improving the performance of a BMDO technology, a developer hopes to win new customers in the private sector. For example, it may come up with a new technique to significantly lower the manufacturing cost of an infrared sensor. Now, the sensor is more affordable for industrial customers to use in emissions monitoring systems and for BMDO to use in missile seeker heads. See pages 18 and 19 of this publication for three examples in which BMDO technology has already spun off into commercial markets and then back into BMDO systems.

Working for you now.

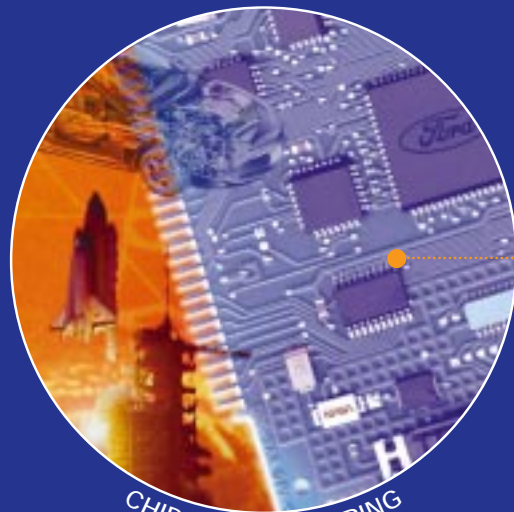
EMDO-funded technologies
make driving safer and more
enjoyable.



AIR BAG FOR SAFETY



ADDITIVE FOR COOLING



CHIP FOR MONITORING

Automotive Applications

- **Miniature Accelerometer Triggers Safety Air Bags**

With BMDO funding, Silicon Designs, Inc. (SDI; Issaquah, WA), developed a miniature accelerometer that can navigate “smart” missile interceptors to their targets. What BMDO liked best about SDI’s device was that it consumed little power and operated over a wide temperature range and after long exposure to space radiation. But others appreciated its ability to measure changes in velocity—as in the sudden stop of an automobile in a collision—as well as its low manufacturing cost. TRW and Ford Motor Company licensed SDI’s accelerometer technology for use in air bag deployment systems. Produced at a cost of \$5 each, the accelerometers made obsolete “ball-and-tube” devices, which lacked the ability to discriminate between crashes that needed the air bag to deploy and those that did not. Air bag systems using SDI’s miniature accelerometer can be found in about 25 million automobiles worldwide.



- **Liquid Additive Gives a Cooling Boost to Air Conditioners**

Mainstream Engineering Corporation (Rockledge, FL) developed a liquid additive that can enhance the performance of advanced heat pumps used in heat rejection systems aboard BMDO spacecraft. This additive, called QwikBoost™, is now being marketed as a performance booster for automobile air conditioners. QwikBoost circulates through the air-conditioning system and increases the system’s cooling capacity. An increased cooling capacity means faster cool-downs and greater cooling capability—all the better when your car feels more like an oven on hot summer days. Once the additive is introduced into the system, it remains active for the life of the system and does not need to be replaced. It also offers environmental and energy efficiency benefits, which earned Mainstream Engineering a prestigious award from the U.S. Small Business Administration. QwikBoost is packaged in a 3-ounce can and is now available at automobile supply outlets.

- **Neural Network Technology Monitors Engine Performance**

Addressing guidance and control challenges for BMDO missile interceptors, NASA’s Jet Propulsion Laboratory (JPL; Pasadena, CA) has developed neural network technology that electronically emulates the learning functions of the human brain. This technology is now being applied by the Ford Motor Company to meet the stringent automotive emissions standards of the next millennium. Starting in 2001, neural network chips developed by JPL will continuously monitor Ford car engines for misfires that contribute to pollutant emissions. As these engines log more and more mileage, the chips learn how to detect and identify malfunctioning components, virtually eliminating distracting false alarms about engine misfires that vehicle dashboards sometimes signal with current diagnostic technology. Millions of Ford cars and trucks may ultimately be fitted with these chips.

Working for you now.

BMDO-funded technologies
are enhancing the
performance of computers,
networks, and software.



HEAT PIPE FOR COOLING



SOFTWARE FOR DEBUGGING



ISOLATOR FOR COMMUNICATIONS

Computer and Networking Applications

- Heat Pipes Cool Hot Processors in Portable Computers

With funding from several Government agencies, including BMDO, Thermacore, Inc. (Lancaster, PA), has developed miniature heat pipe technology that can direct heat away from electronic systems—even when these systems are moving or turned upside down. This unique capability makes Thermacore's heat pipes ideal for cooling the microprocessors found in today's portable computers. Alternative cooling methods, such as electrically powered fans, are much larger and have higher power consumption levels. Thermacore has sold over 5 million heat pipe units for cooling notebook and subnotebook computers equipped with Intel Pentium® chips. Although specifically designed for space-limited applications, the company's technology has also been adapted for cooling much larger—and much hotter—devices, including computer workstations and telecommunications base stations.



- Processing Tool Leads to New Debugging Software

With BMDO funding, ParaSoft Corporation (Pasadena, CA) developed a processing tool that allows existing software to run on parallel systems. This tool has evolved into five major products that provide developers with a fast and easy way to improve software reliability and expedite the debugging and testing processes. ParaSoft's flagship product, Insure++®, automatically detects bugs in C/C++ software code and programs. Its functionality is enhanced by two add-ons: Inuse®, a graphical memory monitor, and TCA®, which displays test coverage analysis. Other products include Codewizard®, which analyzes source code to verify C++ coding standards, and jtest!®, which helps catch bugs in Java™ software. ParaSoft's customers include most commercial software developers (e.g., IBM, Lotus, Microsoft), many Government agencies (e.g., the Internal Revenue Service, the Naval Research Laboratory, the United States Postal Service), and many U.S. Department of Defense contractors (e.g., Boeing, Hughes Aircraft, Lockheed Martin).

- Fiber Isolator Increases the Quality of Fiber-Optic Communications

To improve the quality of fiber-optic communications, BMDO funded E-TEK Dynamics, Inc. (San Jose, CA), to develop a polarization-insensitive fiber isolator (PIFI) that can reduce unwanted light reflections inside optical fibers. Now, the isolator has become a key component in erbium-doped fiber amplifiers (EDFAs), which amplify light signals along optical fibers. Without the isolator, amplifying a signal would be like sending a fax of a fax; the quality of the signal decreases each time it is amplified. To date, E-TEK has captured over 50 percent of the entire EDFA isolator market, selling its devices to Alcatel, Corning, Lucent, Nortel Networks, and other EDFA equipment manufacturers that supply telecommunications companies, including AT&T, MCI WorldCom, and Sprint. The fiber-optic equipment maker JDS Uniphase Corporation recently acquired E-TEK Dynamics in an all-stock deal worth about \$15 billion.

Working for you now.

BMDO-funded technologies have spurred the development of many consumer products that improve the standard of living for Americans.



GENERATOR FOR POWER



MOISSANITE FOR JEWELRY



BATTERY FOR ELECTRONICS

Consumer Applications

- **Materials Research Uncovers a New Diamond Substitute**

With BMDO funding, Cree, Inc. (Durham, NC), developed a process for producing large single crystals of silicon carbide, a semiconductor material with attractive properties for electronic devices. While improving this process, Cree's scientists synthesized clear moissanite, a carbon-based mineral that has physical characteristics closer to diamond than any other known gemstone material. Recognizing that this material could be easily mistaken for diamond, Cree formed a business alliance with C3, Inc., to explore the jewelry market. Cree currently supplies bulk SiC crystals exclusively to C3, now Charles & Colvard, which is marketing moissanite gemstones through jewelry retailers in more than 50 U.S. cities. Charles & Colvard also produces a retail device to differentiate moissanite from real diamond.



- **Electromagnetic Research Contributes to Under-Hood Power Generator**

Researchers at Aura Systems, Inc. (El Segundo, CA), developed electromagnetic technology that can measure the thrust of propulsion systems for BMDO missile interceptors. Some of this electromagnetic technology is now part of the company's patented rotary device called AuraGen™. Mounted inside a vehicle's engine compartment, AuraGen turns an idling engine into a mobile power generator that produces up to 5,000 watts of electricity to run power tools, lights, emergency equipment, or electronic devices, including computers and TVs. With an Aura Systems' Emergency Power kit, the engine can provide enough electricity during an outage to power a home's major appliances. AuraGen is now available for over 70 vehicle models and has been installed in thousands of service vehicles operated by utility, media, and food service companies, as well as local, state, and Federal governments. This year, the General Motors Corporation is featuring AuraGen in its 2000 GMC Professional Sierra Show Truck designed for contractors and construction personnel.

- **Lithium-Ion Battery Packs More Power for Portable Electronics**

At PolyStor Corporation (Dublin, CA), BMDO funded the development of a lithium-ion (Li-ion) battery whose smaller size, lighter weight, and powerful design make it ideal for use on satellites. Now, the battery is finding new consumer applications here on Earth. Because the battery offers an energy storage capacity 15 to 30 percent greater than competing Li-ion batteries, it allows developers to extend the operating times of portable electronic devices such as digital cameras, cellular phones, and notebook computers. To scale up for mass production, PolyStor has purchased a fully automated assembly line that can produce 500,000 Li-ion batteries every month. By 2005, the company hopes to produce 100 million cells per year.

Working for you now.

BMDO-funded technologies are being used to produce nearly every advanced integrated circuit on the market today.



CONTAINERS FOR GASES



POWER COMPONENT FOR LITHOGRAPHY



TOOL FOR WAFER MANUFACTURING

Manufacturing Applications

- **Delivery System Protects Chip Makers From Hazardous Gases**

BMDO-funded research at ATMI, Inc. (Danbury, CT), resulted in a safe gas handling system called the Safe Delivery Source (SDS®), which is now an industry standard for the semiconductor manufacturing market. The SDS is a safer and more efficient way to deliver arsine, phosphine, and boron trifluoride in the manufacturing process for doping logic and memory chips. It increases the yield, improves the safety, increases the purity, and minimizes the cost of producing and storing process gases for semiconductor production. Before ATMI's product, the semiconductor industry delivered gases using pressurized cylinders, which posed safety and storage hazards. The tanks were also inefficient and were the major cause of implanter downtime during changing and replacement. Distributed through a licensing agreement with Matheson Gas products, the SDS is now being used for ion implantation at 80 to 90 percent of related semiconductor manufacturing facilities in the world.



- **Power Source Contributes to Worldwide Chip Production**

With BMDO funding, Science Research Laboratory (SRL; Somerville, MA) developed a power source called the Solid-State Pulsed Power Module (SSPPM). The SSPPM was originally designed to replace thyratron circuits in BMDO pulsed power applications. However, SRL has licensed Cymer, Inc., to use the device in its excimer lasers deployed in lithography steppers worldwide. Using the SSPPM, Cymer is now the world's leading supplier of krypton fluoride lasers, used in more than 90 percent of steppers sold in the deep ultraviolet lithography market worldwide and accounting for a total of more than \$400 million in sales. Cymer sells its lasers to suppliers such as Nikon and Canon in Japan, ASML in Holland, and Silicon Valley Group-Lithography in the United States, who, in turn, market their steppers to major semiconductor producers such as Intel and Motorola.

- **Material Deposition System Allows High-Volume Wafer Manufacturing**

BMDO funded EMCORE Corporation (Somerset, NJ) to fine-tune its TurboDisc™ system, which is key to the low-cost, high-volume production of compound semiconductors. Today, TurboDisc systems are being used by some of the world's leading semiconductor manufacturers, including Hewlett-Packard, Samsung, and Siemens. Adding multi-wafer capabilities to its TurboDisc technology, EMCORE has created a new tool called SpectraBlue™, which deposits commercial-quality indium gallium nitride (InGaN)-based materials on epitaxial wafers. Finished InGaN wafers are essential to high-volume production of blue and green light-emitting diodes (LEDs). Popular commercial applications for these LEDs include traffic signs, outdoor displays, and automotive lighting.

Working for you now.

BVDO-funded technologies not only improve the quality of life, they save lives, too.



CAPACITORS FOR HEART DEFIBRILLATORS



TRACKER FOR EYE SURGERY



DRIVE FOR BIOPSIES

Medical Applications

- **Thin-Film Capacitors Power Up Lifesaving Devices**

Maxwell Technologies, Inc. (San Diego, CA), formerly Maxwell Laboratories, developed thin-film capacitors that could supply intense bursts of power very quickly to orbiting BMDO electromagnetic weapons. Now, the company is applying its capacitor technology to portable defibrillators—lifesaving devices that shock a heart back into its normal rhythm after a cardiac seizure. These devices need capacitors that can charge up and deliver power in a snap because the sooner the heart begins beating again normally, the greater the patient's chance of survival. Available to paramedics for several years, portable defibrillators are now finding their way into public places, including airports, health clubs, and shopping malls. And many contain Maxwell capacitors. Maxwell has supplied hundreds of thousands of capacitors for use in portable defibrillators developed by leading device makers, including Hewlett-Packard and Zoll Medical.



- **Laser Radar Allows More Accurate Eye Tracking During Surgery**

Autonomous Technologies Corporation (ATC; Orlando, FL) originally developed a laser radar (LADAR) system for BMDO missile tracking and space docking. Today, the company has extended that technology to photorefractive keratectomy, a procedure that can improve mild to moderate nearsightedness by modifying the shape of the cornea. It has created an eye tracking system called LADARVision™, which is a key element in a new medical laser product known as T-PRK®. By tracking the continual, involuntary movements of the eye, LADARVision can maintain accurate placement of the T-PRK laser beam. Until now, doctors kept the eye steady by asking patients to stare at a blinking red dot. ATC recently merged with Summit Technology, a leading manufacturer of ophthalmic laser systems. Together, the two companies are marketing this technology to physicians on a per-procedure service fee basis. ATC's LADARVision system is now in use at more than 20 offices and eye care centers throughout the United States.

- **Rotary Drive Positions Needle Biopsy Device With High Precision**

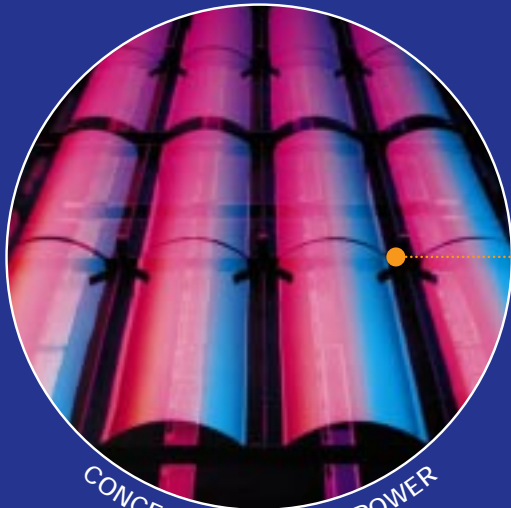
BMDO funded research at Sagebrush Technology, Inc. (Albuquerque, NM), on a rotary drive that could significantly improve the positioning accuracy of laser communications equipment. Since then, the Roto-Lok® drive has found its way into dozens of commercial applications requiring high precision and reliability. For example, Roto-Lok is now part of Fisher Imaging's needle breast biopsy system called MAMMOTEST®, which offers a minimally invasive alternative to surgery after a suspicious lesion is found through a mammogram. Roto-Lok enables the physician to aim and deliver the needle with great accuracy and smooth motion, which are of utmost importance in any biopsy. By 2001, Sagebrush Technology will have sold over 390 Roto-Loks to Fisher Imaging for this medical application.

Working for you now.

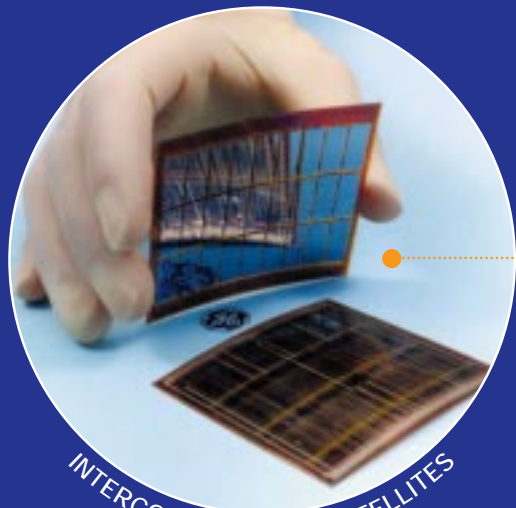
BMDO-funded technologies are helping NASA and commercial companies to explore space and establish communications satellites.



CHIP FOR PATHFINDER



CONCENTRATORS FOR POWER



INTERCONNECTS FOR SATELLITES

Space Applications

- **Computer Chip Runs Mars Pathfinder, Commercial Satellites**

Funding from BMDO allowed the Air Force Research Laboratory (AFRL; Albuquerque, NM), formerly Phillips Laboratory, to modify a commercially available computer processor chip for use in BMDO surveillance satellites. Since then, NASA's Jet Propulsion Laboratory (JPL; Pasadena, CA) has used the new chip to build a flight computer powerful enough to run the Mars Pathfinder spacecraft. Among its many features, the chip can perform as many as 35 million instructions per second and requires only 100 milliwatts of power per million instructions. Using the chip, the Mars Pathfinder flight computer runs 20 times faster—at one-tenth the weight—than its predecessor used for the Cassini spacecraft. In addition, the new chip is on board several orbiting commercial satellites, including those in Loral's Globalstar constellation. A panel of space experts considers AFRL's chip the most significant technical contribution to space technology during the past decade.

- **Solar Concentrator Provides More Power for Deep Exploration Spacecraft**

With funding from NASA and BMDO, ENTECH, Inc. (Keller, TX), developed a solar concentrator that could lower the cost and increase the efficiency of photovoltaic systems. Like a magnifying glass, the device concentrates light onto a small area of solar cells, greatly enhancing their power efficiencies. Because considerably less cell area is required compared with conventional arrays, tremendous cost savings in space power applications can be realized. An array of 720 ENTECH solar concentrators is currently providing 2,500 watts of power for NASA's New Millennium Deep Space 1 probe, launched in October 1998. Most of this power is being used by an electric propulsion system that enabled the probe to visit the asteroid Braille in July 1998. With the solar concentrators performing flawlessly, the probe is currently moving toward a planned encounter with a comet.

- **Interconnect Technology Allows Dense Electronics Aboard Spacecraft**

High-density interconnect technology initially developed by General Electric's Corporate Research and Development Center (Schenectady, NY) could make radiation-hardened electronics smaller, lighter, and cheaper for BMDO satellite constellations. This technology, now owned by Lockheed Martin (LM; Moorestown, NJ), can benefit onboard space computing, power devices, sensing computers, and computer chips. It has already been incorporated into LM's most advanced satellite model, the A2100, which has been used for five telecommunications satellites. For NASA, it has been designed into the Tropical Rainfall Measuring Mission and Deep Space 1 satellites.

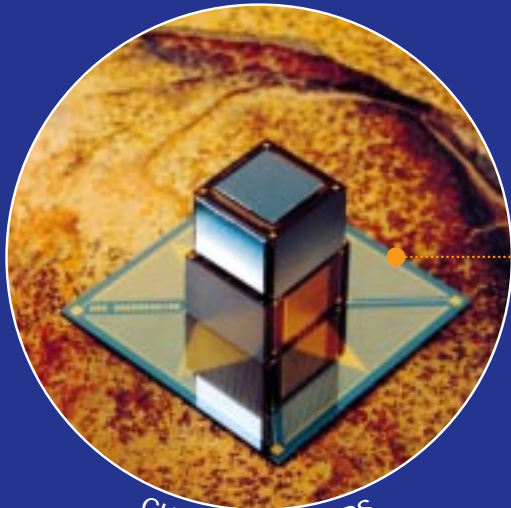


Working for you now.

BMDO-funded technologies that take a detour through commercial markets are often significantly improved before being inserted into BMDO systems.



INFRARED CAMERA FOR SURVEILLANCE



CHIP FOR SEEKERS



COMPOSITES FOR INTERCEPTORS

BMDO Applications

- **Focal Plane Arrays Fit the Bill for Data Collection**

With BMDO funding, Amber, Inc. (Goleta, CA), now part of Raytheon, developed an indium antimonide focal plane array (InSb FPA) for missile surveillance and tracking. This work led to the development of a family of RADIANCE™ infrared cameras. Hundreds of cameras were sold for security surveillance and industrial monitoring applications. Commercial sales and production scale-up significantly reduced the cost of the InSb FPA—from \$1 million to less than \$65,000—and made it much more affordable for BMDO insertion. For the THAAD interceptor seeker heads, Lockheed Martin purchased more than 60 InSb FPAs, which collect enormous amounts of data used in steering missile interceptors. Other BMDO programs, including ARROW and several recent space missions, have also taken advantage of the technology.

- **Chip-Stacking Technology Increases Memory Capacity for Infrared Seekers**

At Irvine Sensors Corporation (Costa Mesa, CA), BMDO funded development of techniques for stacking microchips to produce smaller, faster 3-D chip stacks, which could be used in everything from missile interceptors to surveillance satellites. The company later applied the same chip-stacking techniques to develop commercial memories that, with their small size and high speeds, are ideal for high-performance electronic device applications. It even formed an alliance with IBM to operate a production line to supply commercial markets. Today, Irvine Sensors supplies fast-memory chip stacks with digital signal processors for Lockheed Martin for integration into THAAD infrared seekers. Because of its prior commercialization, as well as continuing R&D efforts, these chip stacks now offer four times more memory capacity than earlier versions.

- **Composite Materials Reduce Cost for Interceptor Components**

Well over a decade ago, Fiber Materials, Inc. (Biddeford, ME), had several contracts with BMDO, then known as the Strategic Defense Initiative Organization, to develop advanced high-temperature composite materials. These materials were initially designed for use in space applications such as missile nose cones, heat shields, integral throat exit cones, and support structures. Now, the company annually sells 30 to 50 tons of high-temperature insulation materials to customers such as turbine blade manufacturers and integrated circuit producers. Its commercialization of the BMDO-funded materials has dramatically reduced the cost of several key components being inserted into THAAD by Lockheed Martin, Loral, and United Technologies. Compared with similar components in U.S. Department of Defense strategic systems, for example, carbon/carbon nozzles and quartz phenolic nose tips now cost 50 and 75 percent less, respectively.



Working for You Now



PUBLICATIONS FOR OUTREACH

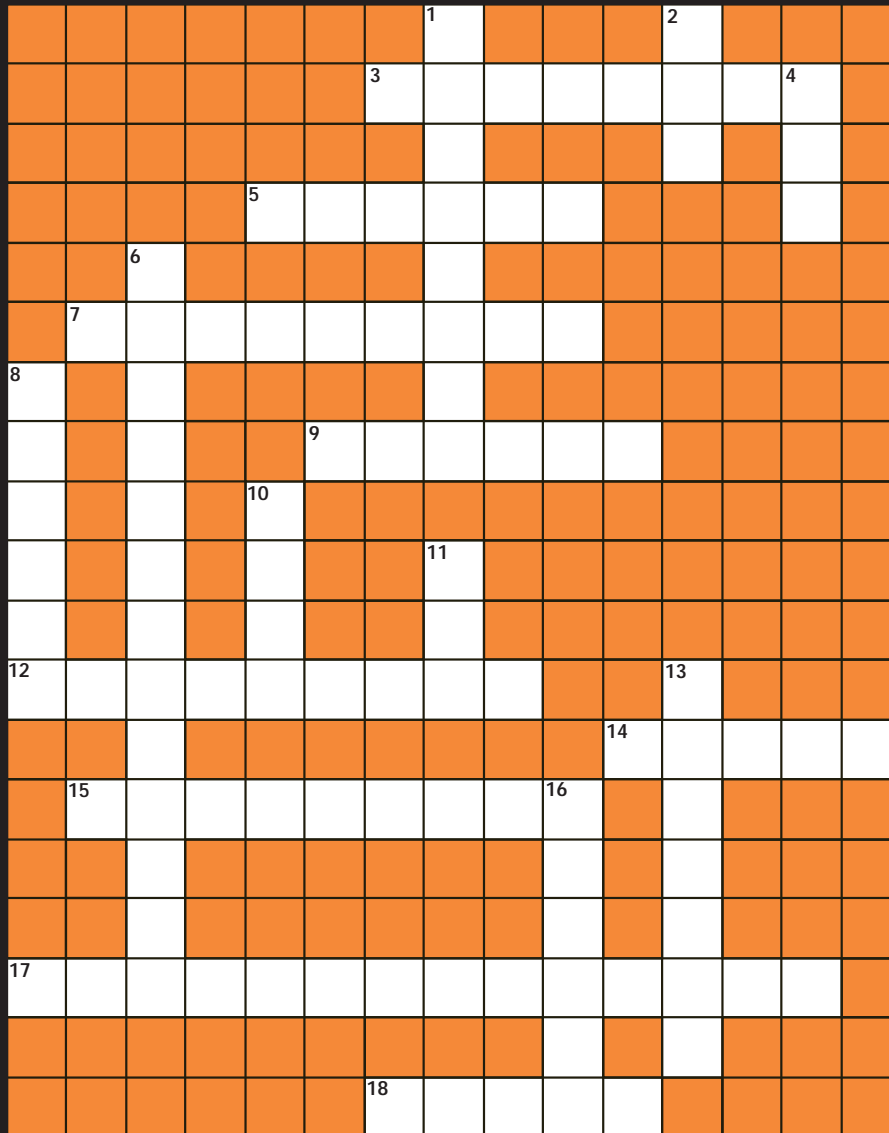
While being developed for very complex missile defense systems, some of BMDO's most sophisticated innovations can be found in products that are working for you now. You will find them in portable computers, cooling the processors; in cars, ensuring the air bags deploy correctly if needed; in industrial equipment, improving the manufacture of electronic devices; and even in ophthalmic laser systems, helping doctors more precisely perform corneal surgeries.

Through BMDO's Technology Applications (TA) program, the commercialization process is fostered, developed, and promoted. It works with BMDO-funded researchers to develop sound business practices. And, over the past decade, it has shared many of its technology commercialization success stories with you through reports such as this one and other outreach materials. Some of its award-winning publications include the following:

- the *Technology Applications Report*, now in its 10th year of publication, which features innovations that have been successfully commercialized or transferred and that are working for you now;
- the *BMDO Update*, which focuses on innovations not yet commercialized but offering strong commercial potential. First published in 1991, this quarterly publication continues to draw interest from industry and trade organizations; and
- industry-focused reports, such as *BMDO Technologies Applications in Biomedicine*, *BMDO Technologies: Improving the Environment*, and *BMDO Technologies and the Electric Utility Industry*. These reports help keep industry specialists informed on technologies available for use in helping solve some of today's most public concerns.

In the years ahead, BMDO's technology investments will yield even more innovative solutions to protect the United States and its allies. In turn, BMDO's TA program will continue to encourage and guide the scientists and developers behind these innovations. And, through the commercialization process, these innovations will be brought to us—the Nation and the American taxpayer—helping us remain economically competitive and improving our daily lives.

Crossword Challenge





Across

- 3 Processing tools evolved into ____ for debugging.
- 5 Rotary drive increases the accuracy of needle placement during a ____.
- 7 Electromagnetic technology is part of a portable ____.
- 9 Miniature accelerometer triggers an automobile ____.
- 12 Lithium battery extends talk time on a portable ____.
- 14 Isolator improves signal quality in an optical ____.
- 15 Interconnect technology makes more room for electronics on a ____.
- 17 Liquid additive boosts the efficiency of an automotive ____.
- 18 Deposition process makes high-volume ____ manufacturing easier.

Down

- 1 Heat pipes remove excess heat from the processor in a portable ____.
- 2 Delivery system improves the safety of handling toxic ____ for chip makers.
- 4 Laser helps track ____ movements during surgery.
- 6 Capacitors generate the juice needed for a heart ____.
- 8 Computer chip ran the ____ computer for a mission to Mars.
- 10 Power source energizes a laser used in ____ production.
- 11 Solar concentrator harnesses the power of the ____ for spacecraft.
- 13 Silicon carbide research led to a ____ substitute.
- 16 Neural network technology monitors a car ____ for misfires.

Turn page for the answers.

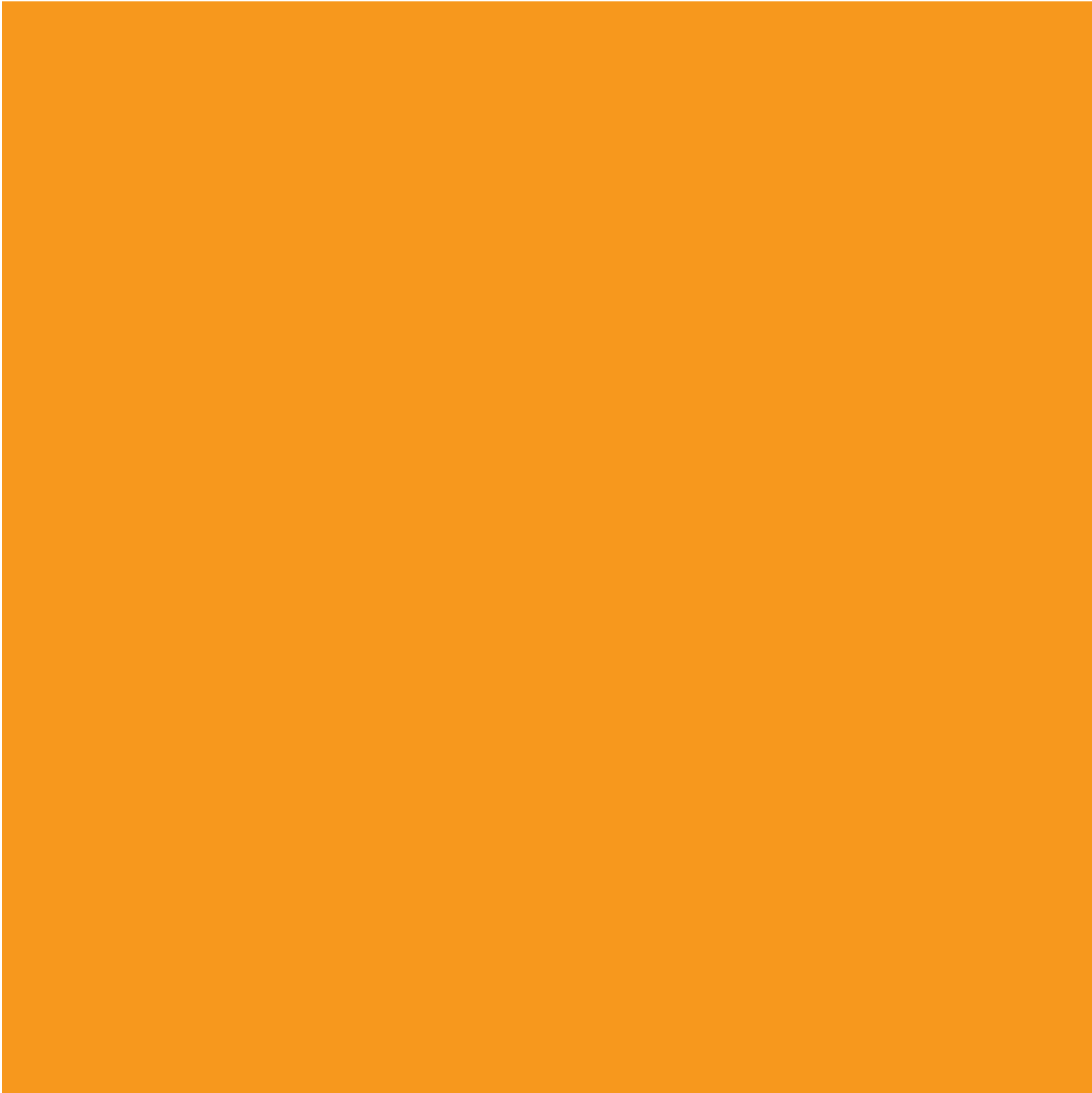
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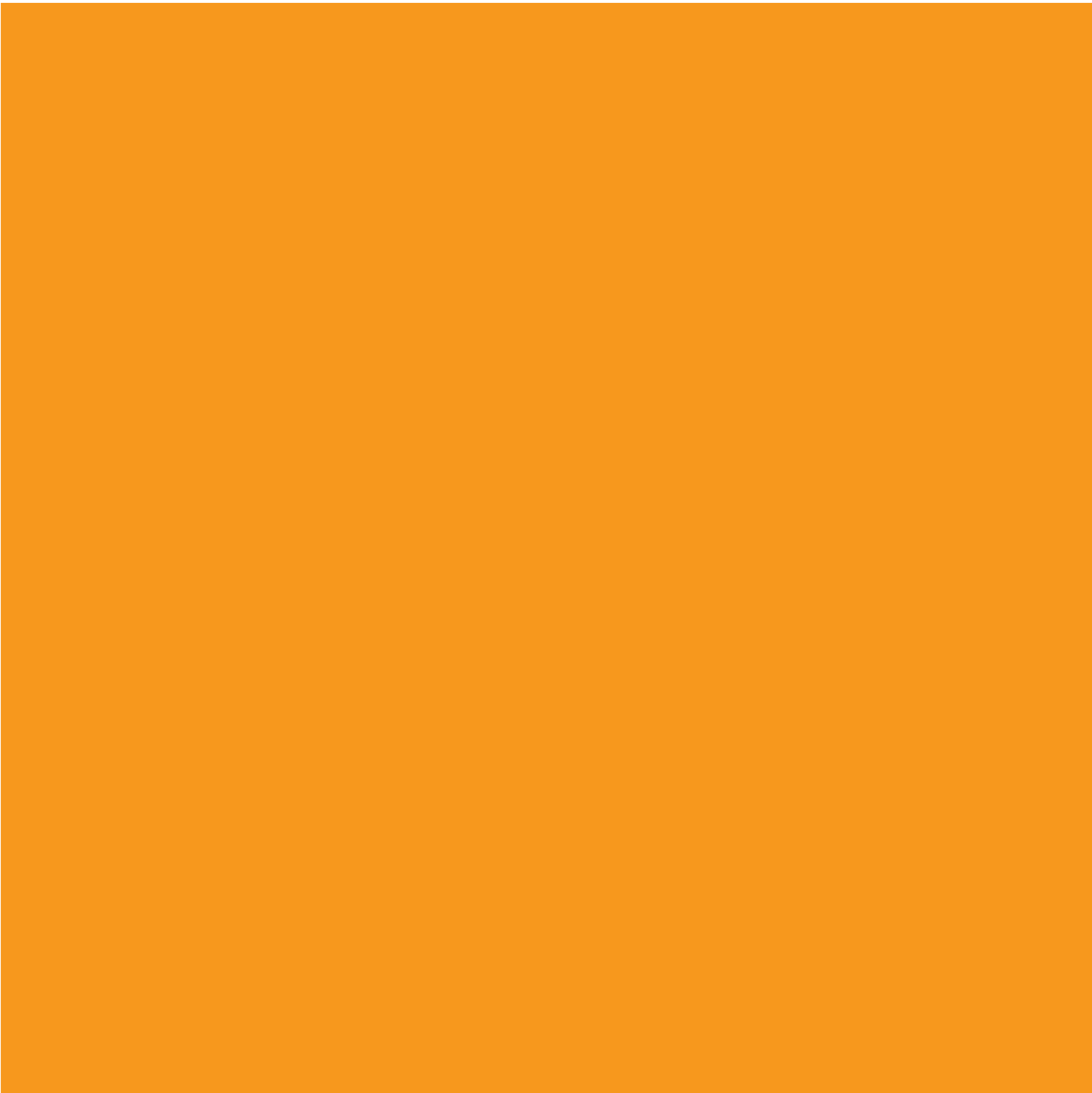
Across

- 3 Software
- 5 Biopsy
- 7 Generator
- 9 Air bag
- 12 Telephone
- 14 Fiber
- 15 Satellite
- 17 Air conditioner
- 18 Wafer

Down

- 1 Computer
- 2 Gas
- 4 Eye
- 6 Defibrillator
- 8 Flight
- 10 Chip
- 11 Sun
- 13 Diamond
- 16 Engine





Now you know.

As the 2000 BMDO Technology Applications Report shows, commercialization of BMDO technology is good for BMDO, for the Nation, and for its taxpayers. From longer-lasting batteries for portable telephones to more powerful capacitors for heart defibrillators, BMDO technology spin-offs are working for you now. BMDO is committed to the transfer of advanced technology developed for missile defense systems. By sustaining this commitment, it will continue to bring about new technology spin-offs as we move into the 21st century.

For more information visit BMDO's Technology Transfer Web site at
<http://www.acq.osd.mil/bmdo/bmdolink/html/transfer.html>



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