

FEDERAL TECHNOLOGY TRANSFER



*Transferring Federally Developed
Research and Technology
to the Marketplace*



LETTER FROM THE CHAIR

Welcome to the exciting world of federal technology transfer. Every day, hundreds of federally funded laboratories apply their research and development expertise for the advancement of science. More than 700 laboratories and research centers—representing almost all federal departments and agencies—conduct approximately \$70 billion in research and development annually and employ more than 100,000 scientists and engineers. Their science has the capacity to enrich our lives by making them safer, more convenient, and more fulfilling. From medicine to transportation to communications, these research facilities investigate everything that is known and extract knowledge from the previously unknown. The effort, desire, and creativity of these scientists is unparalleled.



But all this work is for nothing if the genius is not let out of the bottle. It is essential that the fantastic developments happening behind laboratory doors be transferred from the theoretical to the practical. To capitalize on the nation's investment in federal research, the expertise and technology must be brought to the marketplace. This commercialization enhances not only the nation's socioeconomic well-being in the global marketplace, but also ensures its security and prominence. This transfer is accomplished through the outstanding work of scientists, agency representatives, and technology transfer professionals.

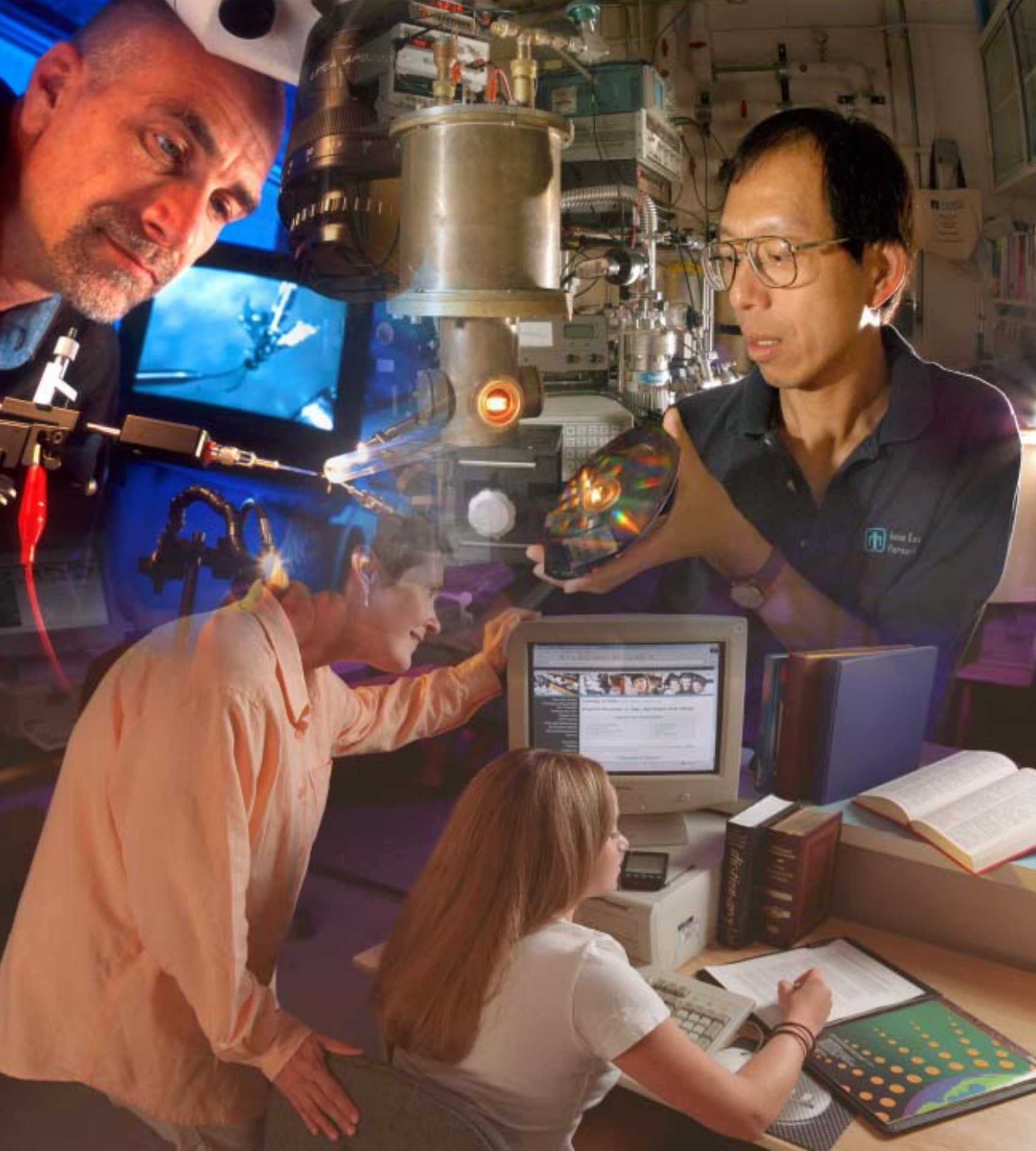
This achievement requires a vision, a plan, and a methodology. It is with great honor that the members of the Federal Laboratory Consortium for Technology Transfer (FLC) assist with generating this vision, plan, and methodology. Since its organization in 1974 and its formal charter through the Federal Technology Transfer Act of 1986, the FLC has developed tools and services to ensure that the efforts of federal engineers and scientists are not left on a shelf. The publication you are about to read is only a small representation of how cutting-edge federal laboratory expertise becomes prevalent in our everyday lives through the execution of technology transfer.

Sincerely,

E. L. Linsenmeyer

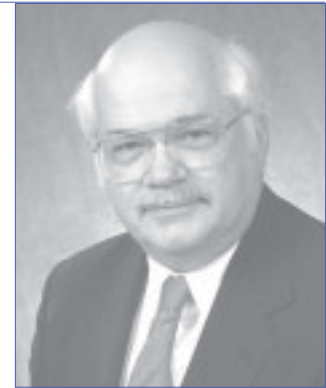
Ed Linsenmeyer

FLC Chair



TECHNOLOGY TRANSFER EXCELLENCE


In 2003, the FLC asked its member laboratories and representatives from various federal agencies to submit their favorite examples of emerging federal technology transfer projects. Predictably, the candidates submitted were from a myriad of projects, representing all stages of project maturity. Some of these technologies have already made it to the marketplace, while others are just beginning their journey.



For most, it will take decades for their whole story to be told, as one inventor after another creates new avenues to use these technologies to make American products even better. From exotic medical equipment to items filling supermarket shelves, we eagerly await what American inventiveness will create next. We look forward to seeing our lives, and our children's lives, improve because of the dedicated research being conducted by these government inventors.

It is no small task to compile these stories, and we are grateful to the FLC representatives, their respective agency representatives, and the laboratory employees for their assistance in guiding us toward the projects represented in this publication. Beyond including those on their way to the marketplace, we also endeavored to highlight technologies that were of high potential impact and human interest. I think you will note this as you turn the pages; but, recognize that this is only a selection of a far greater and growing list of outstanding innovations having their genesis within the federal laboratory system. There were many we could not include, but we look forward to doing so in future publications as we gaze through the looking glass of technology.

We look forward to seeing the development of the remaining candidates as they mature and their potential becomes apparent. For those projects, much of the hard work has now been done by the scientists and engineers of the federal laboratories. Their inventiveness has been captured by the men and women who transfer technology from those laboratories to American industry. Now it's time for American imagination to take over.

Sincerely

Al Jordan

FLC Marketing and Public Relations Chair



Technology Transfer Excellence



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*Gaze through
the looking glass
of technology*



NASA SURGERY-SAVING PROBE BETTERS WOMEN'S HEALTH CARE

Every week in the United States, approximately 18,000 surgical breast biopsies are performed on women with suspicious breast lesions that later are determined to be benign. A revolutionary early breast cancer detection tool based on NASA technology hopes to put an end to that.

Dublin, California-based BioLuminate Inc., the startup company licensed by NASA to develop, produce and market the "Smart Surgical Probe," is set to begin human testing on volunteer patients at the University of California Medical Center in Davis and at the University of California, San Francisco. The Smart Surgical Probe originally was developed by Dr. Robert Mah at NASA's Ames Research Center, Moffett Field, Calif.

"This device is being developed to make real-time, detailed interpretations of breast tissue at the tip of the needle," said Mah. "The instrument may allow health care providers to make expert, accurate diagnoses as well as to suggest proper, individualized treatment, even for patients in remote areas."

This technology and its resulting product may enable physicians to diagnose tumors without surgery, dramatically reducing the number of unnecessary breast biopsies women undergo annually.

Smart Surgical Probe's sensors gather information the

moment the needle is inserted into tissue. Computer software compares the real-time measurements to a set of known, archived parameters that indicate the presence or absence of cancer.

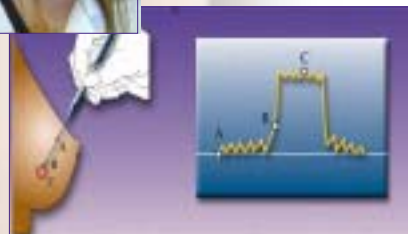
By taking the Ames Smart Surgical Probe and developing it further in collaboration with the **Lawrence Livermore National Laboratory**, Livermore, Calif., BioLuminate hopes to be able to produce a real-time-measurement instrument that will reduce the need for unnecessary surgery. "If we are

successful, the probe will significantly improve women's health care, and could potentially reduce annual health care costs," said BioLuminate president and CEO Richard Hular.

"The commercialization of this NASA technology is an outstanding example of applying space research technology to bring health care benefits down to Earth," noted Phil Herlth of the Ames Commercial Technology Office.



The technology aims to reduce the 18,000 unnecessary biopsies women undergo annually by enabling physicians to diagnose tumors without surgery.



NASA Ames Research Center
www.arc.nasa.gov

PNNL TECHNOLOGY CLEANS EMISSIONS

Working with industry partners, **Pacific Northwest National Laboratory** (PNNL) developed an exhaust after-treatment system for lean-burn diesel and gasoline engines based on non-thermal plasma (NTP) assisted catalysis. This system converts harmful oxides of nitrogen (NO_x) and particulate matter (PM) emitted from vehicle engines into clean air components.

In lab tests with a simulated gas mixture, this technology reduced NO_x by nearly 100%. Tests with actual diesel engines have achieved greater than 75% NO_x reduction over a range of operating conditions and up to 50% PM reduction.

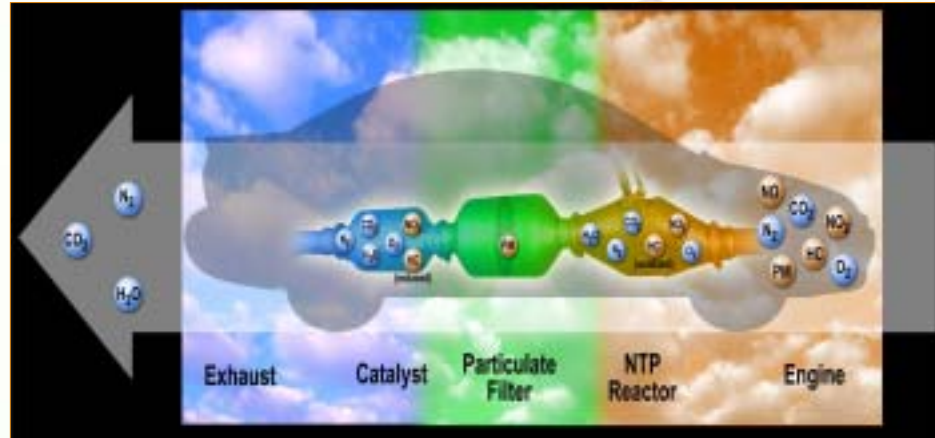
By adding an optional particulate filter, this system can reduce PM emissions by up to 90%.

The exhaust after-treatment system performs well in the lean-burn conditions of energy-efficient diesel engines, where conventional three-way catalytic converters are

inadequate. It also could easily be incorporated into existing tailpipe designs with little modification as a retrofit option for older vehicles.

The system combines an electrically energized gas, or plasma, with specialized catalyst materials that selectively bring about chemical reactions to reduce NO_x. A technology that effectively reduces NO_x and PM emissions from vehicles is needed because these emissions pose environmental and health risks. NO_x emissions

react with water vapor in the atmosphere to form acid rain and are a precursor to ozone, a major component of smog. PM emissions cause respiratory irritation and possibly contribute to chronic health problems. Moreover, a September 2002 Environmental Protection Agency report links diesel emissions to cancer in animals.



Adding a particulate filter to the PNNL system can reduce PM emissions by 90%. PM emissions cause respiratory irritation and possibly contribute to chronic health problems.

Pacific Northwest National Laboratory
www.pnl.gov



SAN DIEGO LAB DESIGNS EARLY WARNING FOR OIL SPILLS

In eliminating environmental hazards, an immediate and effective response to oil spills is second only to preventing them.

To control the damage caused by such spills, the **Space and Naval Warfare Systems Center San Diego's** (SSC San Diego) Environmental Sciences Division develops new technology to sample, monitor and provide remediation for environmental hazards, particularly in the marine environment.

As part of this effort, five SSC San Diego environmental scientists developed an "Underwater Spectroscopic Detector."

The device was developed to address an essential but often overlooked aspect of oil spill prevention and response strategies—rapid, reliable spill detection. Such detection allows rapid response and thus minimization of environmental damage and resulting cleanup costs.

The invention includes fluorescence-based sensors deployed just below the water surface to detect increased hydrocarbon concentration. When such a detection occurs, a radio signal is transmitted

immediately to a base station computer, and designated responders are alerted via automated phone call.

SSC San Diego entered into a licensing agreement with Applied

Microsystems, a Canadian company that designs and manufactures water quality monitoring instrumentation.

Applied Microsystems developed the technology into an integrated oil spill early warning system called Spill-Sentry™. The system includes spill detection buoys for deployment in the field and a PC-based reporting/coordinating station. The buoys communicate with the base station via cable, radio or satellite communication protocols and transmit data to the base regularly, at intervals determined by the user. Upon arrival, the data are analyzed to determine if a spill has occurred.

If one is detected, automatic alarms notify appropriate personnel to respond, providing the spill location to speed the process.

The capability offered via this technology transfer allows government monitoring agencies and commercial customers to deploy sensors in marine environments subject to potential spills—offshore drilling platforms, underwater pipelines, and ship and boat fueling piers. This capability provides a substantial improvement in environmental protection and significantly reduces the costs of any required reaction, remediation and cleanup should a spill occur.



SSC San Diego and Applied Microsystems' technology assures a spill will be reported immediately and a response initiated almost as soon as the spill occurs.



SSC San Diego Environmental Sciences Division
www.spawar.navy.mil

BERKELEY TECH SAVES POWER AND MONEY

EnergyPlus software, an energy simulation program for buildings designed by **Lawrence Berkeley National Laboratory**, allows architects to calculate the impacts of different heating, cooling, and ventilating systems, as well as the effects of various types of lighting systems and windows.

Since Berkeley Lab first released the software in April 2001, it has been licensed by over 10,000 end users, 55 collaborative developers, and seven commercial distributors.

Energy use in buildings accounts for one-third of the nation's total energy use and two-thirds of its electricity use. Thus, even small gains in efficiency translate into enormous savings.

EnergyPlus was developed as a collaborative effort between Berkeley Lab's Simulation Research Group, the University of Illinois at Urbana-Champaign, and the **U.S. Army Construction Engineering Research Laboratory**.

The simulation has been integrated into the design of a new federal office building in San Francisco. It is projected that over 20 years, the software will save nearly \$9 million in energy costs associated with the building, according to Tim Christ, project manager for the lead design firm, Morphosis. The

modeling tool also saved \$1.5 million in construction by simplifying the building's facade.

"We are the first people to use Energy Plus to model natural ventilation flows for a major building," noted researcher Philip

Have of the Commercial Buildings Systems Group at Berkeley. "Basically, other energy simulation programs can't deal with the natural ventilation issues," said Erin McConahey of Arup, the project's engineering consulting firm, "The combination of airflow and energy modeling in a single package not only allowed us to predict energy performance, but also to calculate surface temperatures, track air change rates, and predict comfort."

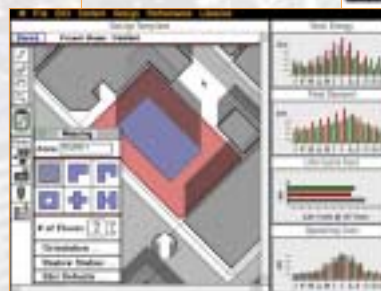
A predecessor of EnergyPlus, named DOE-2, has already saved an estimated \$20 billion in energy costs since 1980. Over the next decade, EnergyPlus is expected to exceed those savings.



Computer rendering of the new federal building to be built in San Francisco. The building was designed with the aid of the EnergyPlus software distributed and partly developed by Berkeley Laboratory.

Lawrence Berkeley National Laboratory
www.lbl.gov

U.S. Army Construction
Engineering Research Laboratory
www.cecr.army.mil



NREL'S CATALYTIC CONVERTER WARMS COLD STARTS

While today's passenger cars emit 95% less pollution than similar cars did 25 years ago (before the catalytic converter was introduced), this is not so for typical sport utility vehicles (SUVs), minivans, or light trucks. Because they are not subject to the same emissions regulations, these vehicles can legally produce up to five times more pollutants than passenger cars can. Beginning in 2004, however, SUVs, minivans, and light trucks will have to meet the same standards that cars must meet — and they are tougher than those for today's automobiles.

This is good news for our environment. But not as good as it could be, because EPA standards primarily address pollutants that are emitted while a car is warmed up and running. They do not address the warmup, or "cold-start," period, during which today's cars and small trucks produce more than 50% of their emissions. The reason for so many emissions during the cold-start period is that current technology catalytic converters do not start to work until they reach a temperature of about 300°C (572°F).

To reach this temperature, it typically takes about two

minutes of operation. During those two minutes, the vehicle produces 60%-80% of its pollutants. Of all vehicle trips taken, 98% are within 24 hours of a previous trip. Conventional catalytic converters cool down within half an hour after the vehicle is turned off, which means for the great majority of trips, cold-start pollution raises its ugly specter.

This specter soon may dissipate, thanks to **National Renewable Energy Laboratory (NREL)** scientists.

They helped develop a prototype catalytic converter utilizing compact vacuum insulation, phase-change materials, and variable conductance that can maintain its operating temperature 24 hours or longer, thus greatly reducing "cold-start" pollution.

NREL then collaborated with Benteler Industries, which

has licensed the catalytic converter technology, to engineer a production-ready version. Compared to other concepts on the market, the new converter is cheaper, more versatile, lighter, and longer lasting. And, it is the only one that deals with cold-start emissions.

The NREL/Bentler catalytic converter reduces emissions of carbon monoxide, hydrocarbons, and nitrogen oxides below the levels called for in the new standards.



Compact vacuum insulation (CVI) is one of the important technologies incorporated into the catalytic converter. CVI is not only essential to minimizing cold-start emissions, it also has many other applications that range from refrigeration to cooking utensils.



National Renewable Energy Laboratory
www.nrel.gov

FOREST PRODUCTS LAB BUILDS TECHNOLOGY TO BUILD

Homeowners want durable, healthy, low maintenance, and energy-efficient homes. Builders want low cost, labor-saving building products.

For almost 4 years, the **Forest Products Research Laboratory's** (FPL) Advanced Housing Research Center team has been working hard to bridge the gap between homeowners and builders by transferring the latest research on wood-framed housing and demonstrating new building products and technologies.

About 90% of America's housing is built from wood and in, 2002, more than 1.5 million single-family housing starts were recorded in the United States.

Advanced technologies and alternative building methods can radically improve the energy efficiency, affordability, durability, environmental performance, disaster resistance, and safety of our nation's housing. However, although many of these technologies



The advanced wood-frame design of FPL's demo house includes energy-saving technology, recycled materials, water-conserving plumbing fixtures, and improved durability.

and building methods exist, their adoption by homeowners and builders is not so easy to accomplish.

Under the umbrella organization of the Partnership for Advancing Technology in Housing (PATH), which integrates 13 federal agencies and more than 300 industry partners, the FPL team formed a partnership with two leading wood products associations to build a 2,300-ft², four-bedroom, two-story research demonstration house on the grounds of FPL in Madison, Wisc.

The goal was to illustrate design and construction recommendations to help ensure the durability of wood-framed house construction; provide a field laboratory; feature innovative housing technologies; and transfer technologies and information to builders, homeowners, wood associations, electricians, plumbers, building trade schools, federal agencies, and the consuming public.

Engineered wood products used in the demo house, such as I-joists, glue-laminated beams, and finger-jointed studs, provide a resource-efficient, high performance building system.

The finger-jointed studs used to build the demo house are manufactured by New South, Inc., and the Georgia Pacific Company of Diboll, Tex. The shingle technology of the demo house was developed in cooperation with Teel-Global Resource Technologies of Baraboo, Wisc.

Forest Products Research Laboratory
www.fpl.fs.fed.us



AIR FORCE VEIN VIEWER SAVES TIME AND LIVES

In an effort to enhance emergency medical response capabilities, scientists from the **Air Force Research Laboratory's (AFRL) Materials and Manufacturing Directorate (ML)** have invented, developed, patented and licensed a breakthrough medical technology.

ML's Vein Viewing Device can be used to see beneath the skin and through body sections to show the vasculature in a broad range of lighting conditions. The device dramatically shortens the time between occurrence of a wound and the intravenous (IV) administration of life-sustaining fluids, a factor that could save the lives of severely wounded soldiers, auto accident victims, and trauma victims at the scene of a major catastrophe. Due to the technology's potential for a broad range of civilian medical uses, ML established a Cooperative Research and Development Agreement (CRADA) with InfraRed Imaging Systems (IRIS) Inc., of Columbus, Ohio, to manufacture and market the technology to the medical industry.

Manufacturing of the vein viewer device will provide both the Air Force and the medical community with the solution to a long-felt need for a reliable, accurate and inexpensive point-of-care device for viewing a patient's veins rapidly and

accurately in conditions where the lighting is less than optimal, perhaps even abysmal. On the battlefield, in hospitals, and at the scene of accidents, prompt IV administration has the potential of saving countless lives.



Using night vision goggles and AFRL's vein viewing device, a researcher sees beneath the skin to inspect the vasculature of a hand.

A prototype device was demonstrated at Wright-Patterson Medical Center, Cincinnati Children's Hospital Medical Center, and Columbus Children's Hospital. Physicians involved in the demonstrations suggested that the technology could be effectively used to alleviate a great deal of suffering by patients, including infants, the elderly, and patients who must undergo painful medical procedures requiring repeated access to veins, such as chemotherapy or dialysis.



Air Force Research Laboratory
Materials and Manufacturing Directorate
www.ml.afrl.af.mil

PNNL TRANSFERS NONINVASIVE INSPECTION TECHNOLOGY

Security at the border requires technologies to ensure security at the source. Ensuring such capability is at the heart of Pacific Northwest National Laboratory's (PNNL) research and development.

The Acoustic Inspection Device (AID) developed at PNNL, which is manufactured and marketed by Mehls, Griffin & Bartek Ltd. (MGB), allows the noninvasive examination of contents in sealed containers and can help screen bulk solids. This technology aids in the detection of hidden contraband and weapons of mass destruction.

Preventing such items from entering the country illegally helps ensure the safety and security of our nation, deters smuggling, and aids in the verification of treaty compliance.

The AID, a hand-held device, consists of onboard, real-time data acquisition, and signal conditioning electronics; operations software and an interactive database; and a front-end, ultrasonic detection/measurement system. It rapidly discriminates and identifies liquid contents in sealed containers, determines if there are concealed compartments within sealed containers of liquid, and detects hidden compartments in solid forms such as metal ingots and tar kegs that may contain contraband or weapons of mass destruction.

The AID can identify a variety of liquids over a prescribed temperature range, such as water, fruit juices, gasoline, diesel

fuel, oils, milk, and chemical warfare agents, as well as the precursor chemicals for fabricating these agents.

The device allows these determinations to be made without opening the container, significantly reducing health and safety risks associated with intrusive inspections.

Additionally, the AID will save the enduser time and money by providing a safe, rapid method for examining shipments without having to use costly and time-consuming invasive methods (i.e., sampling and laboratory analysis methods).

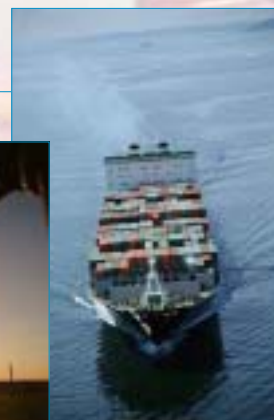
The AID's ability to identify contents in sealed containers will have an enormous, positive impact on the economy. For example, it takes 20 minutes to sample one 55-gallon drum on a truck that potentially carries many drums. Using AID, that time is reduced to just a few seconds per drum.

MGB is currently customizing AID for the U.S. Customs Service, which will be a prime user of the technology along with many new and emerging customers and applications as a result of ongoing marketing efforts by MGB. Potential end users include the Air Force, hazardous material personnel, and the power, pipeline and pharmaceutical industries.



The Acoustic Inspection Device allows inspectors to quickly and easily determine the contents of a container. This noninvasive method of examining sealed containers and verifying contents is significantly safer and faster than conventional inspection methods.

Pacific Northwest National Laboratory
www.pnl.com



ARMY TEST CENTER TRANSFERS “ROAD” SCHOLAR

The U.S. Army Aberdeen Test Center (ATC) is acquiring, transferring, and databasing data for a nationwide U.S. Department of Transportation (DOT) safety study known as the Intelligent Vehicle Initiative (IVI) in order to evaluate the actual benefit of the latest collision avoidance safety systems integrated into 100 tractor-trailers during 20 million miles of commercial operation.

Through previous research, the National Highway Transportation Safety Administration developed initial estimates that show crash avoidance systems—such as warning drivers, recommending control actions, and introducing temporary or partial automated control of the vehicle in hazardous situations— have the collective potential to reduce motor vehicle crashes by one-sixth, or about 1.1 million crashes annually. DOT IVI research focuses on eight safety related areas: rear-end collisions, roadway departure collisions, lane change and merge collisions, intersection collisions, driver impairment monitoring, vision

enhancement, vehicle stability, and safety impacting systems.

The Volvo Trucks North America (VTNA) portion of the research emphasizes the adaptive cruise control, rear-end collision warning, and implementation of electronic disc braking systems.

Electronic disc braking systems are being fielded for the first time in the United States. The 2-year, 100-vehicle, nationwide operational test will allow DOT, VTNA, the independent evaluator, Battelle, and a commercial fleet, U.S. Xpress, to understand the required technical performance, user acceptance, and benefits of the collision countermeasures.



The commercial vehicle platform of the IVI research, which includes heavy trucks and buses, focuses on collision avoidance associated with drowsy drivers, rollover and stability, and intelligent diagnostics and electronic braking.



U.S. Army Aberdeen Test Center
www.atc.army.mil

BERKELEY DISCOVERS DISCOVERY

Until Lawrence Berkeley National Laboratory scientist Peter Schultz thought of a better way, materials discovery was a costly, slow, and laborious process.

In the early 1990s, Dr. Schultz and colleagues invented a super-efficient materials research process that combined miniaturizing with parallel processing. In 1994, the startup company Symyx Technologies, Inc., licensed the invention and began developing research tools that can create and screen new materials hundreds to thousands of times faster than traditional methods at a fraction of the cost.

Combinatorial techniques had been successfully applied in the pharmaceutical industry to discover new drugs when Schultz and coworkers in the Molecular Design Institute of Berkeley Lab proposed that the same approach could be extended to materials science.

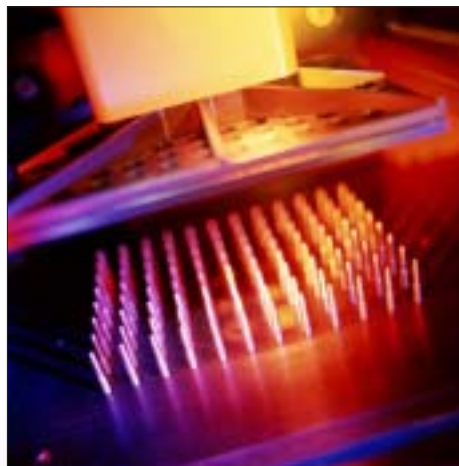
When searching for a new material, scientists define its desired properties and then decide which combinations of elements are most likely to yield those properties. Using automated devices to maximize speed, a library of 10,000 distinct materials can be placed onto a one-square-inch surface area. This library is subjected to varying environmental conditions, and tests are employed to screen for specific chemical and physical properties.

The Berkeley Lab concept is a radical improvement on traditional materials development, where compounds are created one at a time and painstakingly tested to search for desired qualities. Chemical catalysts, genomic probes, fuel cell components, and battery electrodes are just some of the materials that can be developed with this methodology.

Since 1994, when Symyx licensed the Berkeley Lab technology, the now profitable company has commercialized a polymer used for coating proteomics arrays and identified 12 new materials that are in development.

In a collaborative effort with Dow Chemical, Symyx identified several new classes of catalysts to enable the production of novel high-value plastics and reduce the cost of polymer manufacturing.

The company also entered into collaborative agreements with Merck & Co., Eli Lilly and Company, Exxonmobil Chemical Company, Rhodia S.A, Celanese, ICI, Unilever and others. Symyx has 210 employees and is still growing.



Symyx' Parallel DMTA™ measures various mechanical properties of an array of 96 thin solid films as a function of temperature and other environmental conditions.

Lawrence Berkeley National Laboratory
www.lbl.gov



NAVAL SEA SYSTEMS COMMAND FLOWS TECHNOLOGY TO INDUSTRY

Cynthia M. Leahy and J. Howard Kucher are not technologists. Nor are they scientists, mathematicians or inventors. They are business people betting on their ability to spot a good idea and turn it into sales.

Leahy and Kucher founded Wickford Technologies, Inc. after professors at the University of Baltimore, where Kucher was studying for his master's degree in business administration, introduced them to the world of federal research.

Kucher, chief operating officer, and business partner Cynthia Leahy, president, incorporated Wickford Technologies and signed an exclusive contract with the U.S. Navy to produce the Differential Pressure Flow Sensor.

The company's product was originally developed by Michael Deeds, an engineer at the **Naval Sea Systems Command** at Indian Head, Md., to measure the speed of torpedoes launched by submarines. Because of its original marine application, the device was most easily adapted for use by sailboats, but numerous industrial applications may prove promising for Wickford.

Wickford's first market for the sensor is racing sailboats that need to measure the flow of the water to determine their speed. The company is also working on an application that would allow companies to determine the speed and volume of substances flowing through pipes and another that would track the speed of aircraft.

The technology easily transfers from water applications to air applications.

"With the current technology used by airlines," Leahy said, "sensors hang from the bottom of the plane and can become easily clogged and frozen. Wickford's devices would lie flat against the plane, helping companies avoid hefty fines that the Federal Aviation Administration can levy for improperly functioning sensors."

Thanks to federal research and the ability to transfer it to the commercial marketplace, Leahy believes her company has tapped into a \$1.8 billion flow sensor market.



J. Howard Kucher of Wickford Technologies examines an early prototype of the Differential Pressure Flow Sensor developed by the Naval Sea Systems Command.



Naval Sea Systems Command
www.navsea.navy.mil

AIR FORCE ADVANCES ON INDUSTRY

From timepieces to checkout counters, Air Force technology has taken flight.

Engineers at the **Air Force Research Laboratory Materials and Manufacturing Directorate**, working with Raytheon Electronic Systems, completed an advanced development effort to evaluate forming techniques and optimize fabrication processes for a tough, lightweight, transparent ceramic material that offers outstanding potential for both military systems and commercial products.

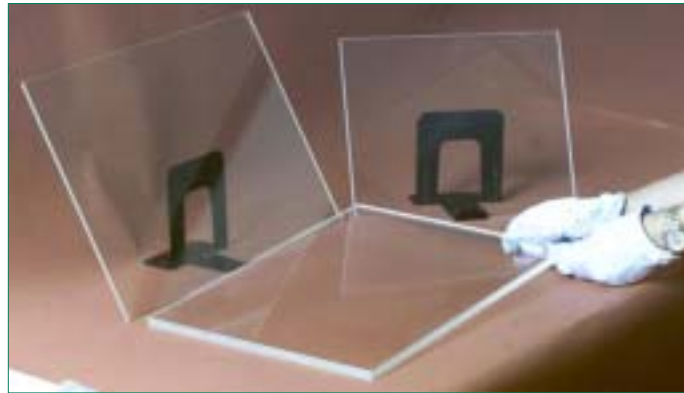
Polycrystalline aluminum oxynitride, known commercially as ALON™, offers performance and scaling not otherwise possible for large, lightweight, infrared transparencies. This new technology could play a significant role in the development of affordable, transparent armor, including windows for military reconnaissance aircraft where trimming life-cycle costs could save up to \$25 million while providing greater protection for flight crews.

ALON™ has excellent mechanical and optical properties, and provides a number of advantages when compared to conventional transparent armor, including dramatic life-cycle cost savings.

As part of an advanced development effort, engineers have fabricated an ALON™ plate for flight testing on reconnaissance aircraft, as well as plates for ballistics testing and transparent armor applications.

Other primary military applications include forward-looking infrared windows and domes, such as missile domes and towed underwater sensors; riot shields; and protective headgear for bomb disposal operations.

Promising commercial applications include supermarket scanner windows (currently being field tested), watch crystals, and scratchproof lenses.



The AFRL-Raytheon collaboration has led to a fabrication process hitting the market that has advanced everything from head gear to wristwatch technology.



Air Force Research Laboratory
Materials and Manufacturing Directorate
www.ml.af.mil

NASA MAINTAINS INDUSTRY BEARING

Extremely high temperatures are not always conducive to durability and smooth operating conditions. To overcome this challenge, the NASA Glenn Research Center (GRC) was awarded a patent for a new high-temperature solid lubricant coating material, PS300.

A combination of wear-resistant metals and ceramics with solid lubricant additives, PS300 reduces friction and wear in sliding contacts from below ambient to over 650 °C (1200°F). This lubricant is an outgrowth of over three decades of high-temperature tribological research and was specifically developed as a shaft lubricant to protect foil air bearings used in oil-free turbomachinery such as gas turbines.

During startup and shutdown, prior to developing a gas film, sliding occurs between the shaft and top (inner) foil surfaces. Solid lubrication must be provided to reduce friction and wear.

Traditional solid lubricants (e.g., graphite, Teflon®) readily solve this problem at low temperatures. High temperature operation, however, had been a key obstacle. PS300 has shown to provide good friction and wear properties in foil bearings at

least to 650°C . The coating has successfully lubricated foil bearings for over 100,000 cycles without wearing out.

PS300's low material cost, ease of manufacturing, and thermal stability make it ideal for transfer from aerospace to industry.

In one spinoff, a steam turbine manufacturer experienced severe wear and sticking of its steam turbine control valves due to the high steam pressures and temperatures associated with steam-turbine-based power plants. To solve this problem, the NASA coating was plasma spray-deposited onto the large valve stems and ground to the desired thickness

and surface finish. These valves were put into service and, upon inspection at one- and two-year intervals, have shown no signs of wear or degradation.

In a second spinoff, a major manufacturer of welding rods and equipment experienced wear and seizure of conveyor bushings in their welding rod drying furnaces, which had been in service for 50 years. To respond to this technical need, Advanced Materials of Twinsburg, Ohio, a NASA patent licensee working in conjunction with GRC staff, fabricated free-standing bushings of PS300 material using powder metallurgy techniques. The first of 12 furnaces was retrofitted with over 2000 bushings using GRC material. These bushings have experienced no measurable wear after a successful year of service.



NASA's high temperature foil coating can withstand temperatures of at least 650°C due to its high-temperature friction and wear characteristics.



NASA Glenn Research Center
www.grc.nasa.gov

ARMY LAB CURIOSITY ADVANCES CELL PHONES, CD-ROMS, AND MORE

A technology for improving the manufacturing yield of infrared detectors was developed at the **U.S. Army Communications-Electronics Command, Research, Development, and Engineering Center's** Night Vision and Electronic Sensors Directorate (NVESD).

In 1990, the NVESD laboratory established a semiconductor "microfactory." Its purpose was to provide a facility for government, university, and industrial scientists to develop radical new processes for the fabrication of infrared sensors.

In 1992, **Dr. John H. Dinan** of NVESD, the recipient of the 2002 Federal Laboratory Consortium Innovative Partnership Award, studied manufacturing yield data for the current generation of infrared detectors and the military requirement for the next generation. He concluded that a single semiconductor material—mercury cadmium telluride (MBE)—could be used for all generations and that MBE was the most attractive deposition technique.

After Dinan developed the microfactory, he chose the Small Business Innovative Research (SBIR) program as a vehicle for developing a real-time control technique. A J.A. Woollam Co., Inc., proposal of was chosen.

Woollam proposed to develop the technique and guide it from a laboratory curiosity to a robust semiconductor processing technology.

In anticipation of the high yields that the use of SE will provide, NVESD transferred this technology to Rockwell Scientific Company (RSC) in Camarillo, Calif. and to Raytheon Vision Systems (RVS) in Goleta, Calif. where it is now being used to fabricate all next-generation mercury cadmium telluride devices for military systems. It is interesting to note that RSC and RVS purchased their SE equipment from J. A. Woollam Co., the original SBIR innovator! The Woollam Co. has now sold dozens of these instruments to customers for a variety of applications, including lasers, cell phone circuitry, and CD players.



The microfactory semiconductor processing facility

U.S. Army Communications-Electronics Command
www.monmouth.army.mil



FOR SPACE AND NAVAL TECH, SEEING IS BELIEVING

One of the areas of substantial interest and significance to **Space and Naval Warfare Systems Center San Diego** (SSC San Diego), as the Navy's lead command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) center, is integrated circuit design and fabrication technology.

Integrated circuits are the hearts and brains of computer hardware systems that provide the nation's warfighters with C4ISR capabilities.

One such capability provided by SSC San Diego is micro-displays. The technology is based on a number of patents by SSC San Diego inventors **Dr. Randy Shimabukuro, Dr. Stephen Russell and Bruce Offord**.

An extremely bright, high resolution display eliminates requirements for millions of interconnections between the display and its control circuitry, reducing the required number to only three (power, signal and ground). The technology offers

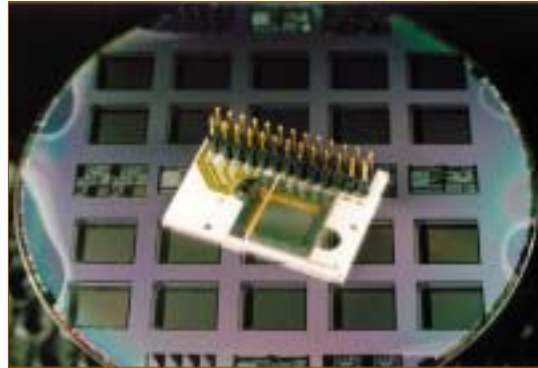
improved imaging and video in virtual presence applications for the warfighter.

The technology also demonstrates dual-use applications for emergency service personnel such as law officers, firefighters and paramedics, who can utilize imaging systems in the field to provide situation assessment updates as they work to contain emergencies.

In February 1999, Optron Systems, Inc., licensed the technology. Under a Cooperative Research and Development Agreement (CRADA), SSC San Diego and Optron Systems collaborated on the fabrication of a first-generation, monochrome micro-display.

In March 1999, Radiant Images, Inc., a spinoff from Optron Systems, was formed to commercialize the invention. The company has obtained investment capital and has produced a second generation, full color micro-display for initial sales to original equipment manufacturers.

When fully implemented, this technology can provide warfighters and emergency response personnel with such capabilities as head-mounted displays that convey information required in the completion of their duties, leaving their hands free to perform essential operations like firing weapons or tending to injured.



SSC San Diego's first-generation monochrome prototype on a silicon-on-sapphire wafer with microcircuits and the second generation full-color display.



Space and Naval Warfare Systems Center Command
www.spawar.navy.mil

SANDIA'S ANSWER TO ANTHRAX

Immediate decontamination is at the heart of survival when it comes to chemical and biological attack.

A technology developed by **Sandia National Laboratories** (SNL) has been transferred to two commercial entities to raise the odds of survival under such an attack.

MODEC, Inc., and EnviroFoam Technologies, Inc. (EFT) are two SNL partners that hold non-exclusive rights to commercialize SNL's decontamination formulation technology.

This decontamination technology neutralizes chemical and biological agents and can begin decontaminating a site even before a specific contaminant is identified.

The formula is nontoxic, noncorrosive, and environmentally benign, yet highly effective when used as a first response against chemical-biological agents such as VX, mustard, soman, and anthrax. The decontamination formulation can be deployed as a foam, mist fog, spray, or liquid.

MODEC specializes in mass casualty response systems for weapons of mass destruction, while EnviroFoam Technologies designs and manufactures foam deployment systems for fire suppression and other applications for local, state, and federal agencies.

The foam could be sprayed from a handheld canister, from trucks, or it could be incorporated into fire sprinkler systems. In FY02, the licensees supplied decontamination solutions to help remediate the anthrax contamination in Washington, D.C. and New York.

Federal authorities used the technology to remediate the mailrooms and freight elevators in the Hart Senate Office Complex, as well as in the Dirksen and Ford Congressional offices in Washington, D.C. The formulation, dispersed as a fog, was also used to decontaminate portions of New York post offices.

EnviroFoam Technologies has also received an order from the U.S. Army Central Command for several thousand gallons of its EasyDECON™ solution.



Sandia National Laboratories researcher Mark Tucker examines two petri dishes: one with a simulant of anthrax growing in it, the other treated with a new decontaminating foam developed at SNL. SNL licensed commercialization rights to the foam last year to two companies: Modec, Inc. and EnviroFoam Technologies.

Sandia National Laboratories
www.sandia.gov



NASA BRINGS VIDEO INTO FOCUS

Two NASA Marshall Space Flight Center researchers, using their expertise and equipment for analyzing satellite video, have created technology that can dramatically improve video images. The scientists' invention, called Video Image Stabilization and Registration (VISAR), stabilizes camera motion in the horizontal and vertical, produces clearer images of moving objects, smoothes jagged edges, enhances still images, and reduces "snow."

The development of VISAR began when the FBI approached NASA scientists for help. The FBI had acquired blurry, unclear home video footage of the bombing at the 1996 Olympic Summer Games in Atlanta. Currently available technology was inadequate to sufficiently improve the video. The scientists put their expertise and equipment to work. The footage that the scientists produced was impressive and revealed telling detail.

The VISAR technology has matured dramatically since this initial case. VISAR has far-reaching applications in the post-processing of video or digital sequences. Some of the many applications for post-processing include law enforcement and security

videos, automobile cameras, home videotapes, instant replays of sporting events, and medical and scientific imaging.

As a result of a license agreement signed in 2000, VISAR has

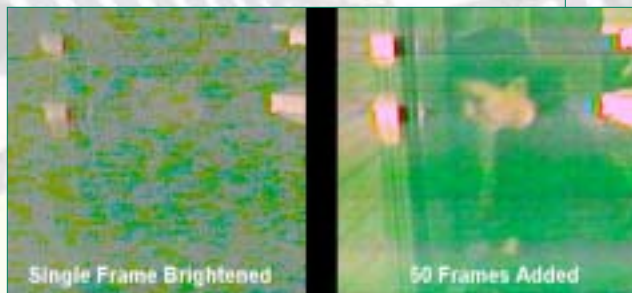
been incorporated into a video tracking and enhancement system, VideoAnalyst™, developed by Intergraph Government Solutions.

The technology is a comprehensive, effective, and affordable solution for advanced video analysis and enhancement. It combines capabilities previously found only in high-end broadcast-quality systems with the tools necessary to capture, analyze, enhance, and edit almost any type of video. Intergraph now has more than 60 sites of VideoAnalyst systems.

Skylark, LLC, a small Montana startup company, has requested two nonexclusive licenses in the areas of 3D video-editing special effects software and amateur personal home computer use for video-editing.



NASA inventors Dr. Paul Meyer (left) and Dr. David Hathaway view a license plate number revealed by using the Video Image Stabilization and Registration — VISAR — software to improve poor quality footage. Meyer and Hathaway invented the software at NASA's Marshall Space Flight Center in Huntsville, Ala.



NASA
www.nasa.gov

NAVY MEDICAL DNA MAP SAVES LIVES

U.S. Navy scientists lead by **Captain Daniel J. Carucci**, at the **Naval Medical Research Center (NMRC)** provided expert scientific guidance and technology, and critical leadership in collaboration with an international group of genome centers and funding agencies in publishing the complete genomic sequence of the human malaria parasite, *Plasmodium falciparum*.

Navy scientists provided critical protocols, reagents and expertise for the sequencing effort, including highly purified chromosomal DNA and, with its partner, The Institute for Genomic Research (TIGR), completed the sequencing of 4 of the 14 total *Plasmodium falciparum* chromosomes.

These same scientists accomplished the first-ever completed chromosome for malaria, which was published in *Science* in 1998, providing the foundation for the completion of the remaining 14 chromosomes.

This completion was heralded by the National Institutes for Allergy and Infectious Diseases (NIAID) as one of the top five scientific accomplishments of 1998.

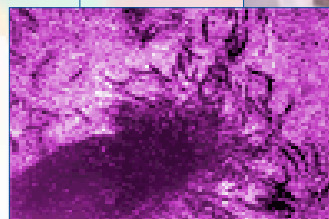
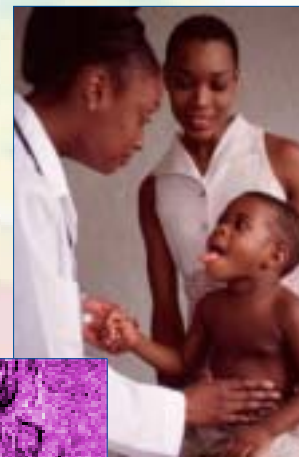
The completion of the malaria genome was recognized by *Science* as the third most important scientific breakthrough of 2002. The Malaria Genome Project provides the complete blueprint of one of the world's deadliest infectious diseases, as well as a major threat to U.S. military forces.

Research institutions across the world are now able to capitalize on the genomic and proteomic data, accelerating research and development on new antimalarial drugs, new targets for vaccines, the potential mechanisms of drug-resistant strains and have revolutionized the world research community's approach to controlling a pathogen that kills over 3 million people annually.



Aboard the USS George Washington, Hospital Corpsman 3rd Class Carlos Aguilar from Mexicali, Mexico, looks at bacterial growth on a petri dish in the ship's medical department.

Naval Medical Research Center
www.nmrc.navy.mil



AIR FORCE RESEARCHERS BETTER BRAKES, ADVANCE SAFETY

George Schmitt, of the Air Force Research Laboratory's (AFRL) Materials and Manufacturing Directorate (ML), received the Federal Laboratory Consortium For Technology Transfer's Midwest Region Technology Transfer Award for his work related to Brake-by-Wire (BbW) related technologies.

This successful transfer of Air Force technology pays dividends to the consumer, industry and the Air Force. Schmitt's leadership and contributions in the area of BbW and its related technologies could revolutionize the way that electrical systems in aircraft are constructed and that braking systems are manufactured and implemented in next-generation automobiles.

In June 2001, the AFRL and Delphi Automotive Systems signed a technical collaborative agreement to bring this new technology to the automotive industry. While conventional brake systems found on cars today are hydraulic, BbW technology will stop a vehicle by sending electrical signals to the brake system.

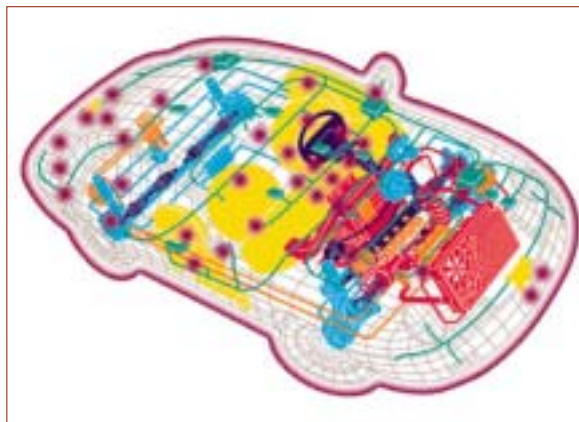
Under Schmitt's leadership experts, from the ML's Air Vehicles, and Propulsion Directorate addressed electrical motors and actuators; high-temperature insulation materials; reconfigurable control technologies; fault-tolerant architectures; and reliable wiring and connectors.

The BbW technology is expected to offer increased safety and vehicle stability to consumers, and will provide benefits to automotive vehicle manufacturers, who will be able to combine vehicle components into modular assemblies using cost-effective manufacturing processes.

Using BbW technology, the Air Force fully leverages its extensive background in landing gear and fly-by-wire

systems, while Delphi will work to integrate BbW technologies into next-generation vehicle handling and safety systems.

Introducing the technology to the commercial arena also benefits the Air Force by creating a demand for shared components, thus reducing the component cost to government and industry for their respective applications. The collaboration will also leverage investments in more electric aircraft and provide needed large-scale technology validation.



Leveraging the Air Force's extensive background in landing gear and fly-by-wire systems, Delphi will work to integrate BbW technologies into next-generation vehicle handling and safety systems.



Air Force Research Laboratory
Materials and Manufacturing Directorate
www.ml.afri.af.mil

SANDIA, ARMY ENGINEERS DAM SECURITY THREATS

Operators of U.S. dams, hydroelectric facilities, and power transmission systems can make their sites less attractive targets to terrorists using new step-by-step security assessment processes developed by the Interagency Forum on Infrastructure Protection (IFIP), a team of government dam owners, transmission system operators, and antiterrorism experts.

The IFIP includes representatives of the FBI, U.S. Army Corps of Engineers, Bonneville Power Administration, U.S. Bureau of Reclamation, Sandia National Laboratories (SNL), Lawrence Livermore National Laboratory, Southwestern Power Administration, Western Area Power Administration, and others.

The two new processes, called RAM-DSM for “Risk Assessment Methodology for Dams” and RAM-TSM for “Risk Assessment Methodology for Transmission,” takes owners, operators, and security managers of dams and transmission systems through a magnifying-glass examination of each facility’s unique situation — its potential

adversaries, vulnerabilities, consequences of attack, and existing security measures — then provides cost-benefit analyses of possible security upgrades.

The technology is crucial to protecting the integrity of the more than 75,000 dams in the U.S.

The methodologies are based on many of the formal risk-assessment tools and techniques used by SNL to protect U.S. nuclear weapons facilities. SNL is a Department of Energy (DOE) research and development lab with expertise in the physical security of national facilities and infrastructures.



The Risk Assessment Methodology provides a formal process for evaluating and improving the security of critical elements of the U.S. infrastructure.

U.S. Army Corps of Engineers
www.usace.army.mil

Sandia National Laboratories
www.sandia.gov

Lawrence Livermore National Laboratory
www.llnl.gov



LIVERMORE STRENGTHENS ENGINES, AUTOS, AND HIP JOINTS

At first glance, it would seem that bombarding a metal part with an intense stream of tiny metal or ceramic balls might not be the best approach for making that part more resistant to cracking and corrosion. And yet, shot peening is a tried-and-true technique for strengthening metals.

Now a team of **Lawrence Livermore National Laboratory (LLNL)** researchers, in tandem with colleagues at New Jersey-based Metal Improvement Co., Inc. (MIC), have replaced the tiny balls with short-lived, repetitive blasts of light from a reliable, high-powered laser.

The new technology, called the **LasershotSM Peening System**, is designed to extend the service lifetime of critical metal parts, from aircraft engine fan blades, to automotive components, to hip joints, by a factor of three to five times over conventional peening treatments. The process also holds the promise of lighter, stronger products of entirely new designs.

The new system does not have the kinetic energy limitations of metal or ceramic shot. As a result, it can induce a compressive stress layer more than 1 millimeter

(0.04 inch) thick, some four times deeper than that obtainable with shot. The increased depth effectively extends the service lifetime of parts three to five times over that provided by conventional treatments, an increase essential for preventing

cracking on blades, rotors, and gears. In fact, tests on deliberately nicked (and hence weakened) turbine fan blades show that laser peening will actually render these parts stronger than new, unflawed—but not laser-peened—blades.

In 2001, MIC finalized a contract with a major aerospace company for laser peening and broke ground for a new facility in Livermore. The technology has been used on NASA's Space Shuttle since 2001, and MIC estimates that laser peening automobile parts could save the U.S. 285 million liters of gas annually.



Livermore researchers who developed the LaserShotSM peening system include, from left, Lloyd Hackel, Bill Manning, Jim Wintemute, Steve Telford, Brent Dayne, and Balbir Bhachu



Lawrence Livermore National Laboratory
www.llnl.gov

NAVY TECH RELIEVES MUSCLE, JOINT PAIN

A new therapeutic medical device based on technology developed by the **Naval Aeromedical Research Laboratory** and licensed by the **Naval Medical Research Center** has recently been introduced by SeliCor, Inc. The device, marketed as the SeliTherm™ Therapeutic Warming System, is now being made available to health care providers. The system is designed to relieve pain, promote healing, and provide other therapeutic benefits by inducing deep body-tissue warming.

Pioneered by **Dr. Richard G. Olsen** of the **Naval Health Research Center**, the heart of the SeliTherm system is a helical coil design for longitudinal radio-frequency diathermy as a means of warming deep-sea divers and others at risk of hypothermia. The Department of the Navy licensed the technology to SeliCor in 2001.

Although the therapeutic value of deep-tissue or “core” warming is universally acknowledged, the traditional means of delivering core warming have been cumbersome, expensive and, in some cases, dangerous. By incorporating Dr. Olsen’s innovation into the SeliTherm™ system, SeliCor has developed

a safe, effective, convenient, and economical core warming system.

Initially, the system will be available only to clinicians, but because it is exceptionally easy and safe to use, the system will eventually be made available directly to patients by prescription for in-home use.

SeliTherm enjoys numerous advantages over conventional means of core warming. Its combination of safety, convenience, simplicity, and economy are unmatched, and its therapeutic benefits—including pain relief, easing stiffness, and improving circulation in muscles, joints, and other soft tissues—begin more quickly and last longer than those offered by conventional means.

The system addresses pain associated with carpal tunnel syndrome, osteoarthritis, diabetic neuropathy, lower back pain, Raynaud’s Disease, Reflex Sympathetic Dystrophy (RSD), fibromyalgia and sports

injuries. It has shown to be very helpful in treating muscular pain (without acute edema), strain, ligamentous sprain, and tendonous pain.



Developed through naval research, the SeliCor system provides deep body-tissue warming to promote healing and relieve pain related to a number of ailments, including osteoarthritis and fibromyalgia.



Naval Medical Research Center
www.nmrc.navy.mil

NATICK TECH AT A BAKERY NEAR YOU

An army travels on its stomach, but rarely is there time for a sitdown meal. To overcome this logistical challenge, a research team from the **Natick Research, Development, and Evaluation Center (NRDEC)** of the U.S. Army Soldier Systems Command (SSCOM) has achieved a technical breakthrough in developing military rations that look freshly prepared yet can be kept at room temperature for up to three years.

Besides meeting Army mobilization requirements, the technology reflects innovations in intermediate moisture food (IMF) technology, which carefully balances moisture, pH, and water binding to give foods soft, moist qualities without promoting microbiological growth. The team's work led to the development of several types of pocket sandwiches.

The team's transfer of IMF technology to industry resulted in the commercialization of the rations with Sara Lee Bakery. Working under two CRADAs, Sara Lee Bakery and NRDEC are actively producing extended shelf-life bakery items that do not require refrigeration. A second CRADA with GoodMark Foods, Inc., focuses on developing and commercializing meat-filled sandwich components. The team's success has also resulted in inquiries from other major industrial food organizations.

The technology simplifies shipping, distribution and handling, and increases soldier acceptance, mobility, and consumption. The team's work

also demonstrates how federal lab technology can strengthen the U.S. industrial base—providing synergistic benefits to all partners.



NRDEC's food technology ensures increased mobility and nourishment for U.S. military forces, while providing a method for increasing the shelf life of nonrefrigerated foods.



Natick Research, Development, and Evaluation Center
www.natick.army.mil

EPA MOLD DETECTION MAKES HOMES, OFFICES SAFER

It is estimated that about 50 to 100 common indoor mold types have the potential for creating health problems. Knowing they exist is half the battle.

Two Environmental Protection Agency (EPA) scientists have developed an innovative way to detect potentially dangerous molds much faster and with more accuracy. The new technology can be used to detect the mold *Stachybotrys*, commonly known as “black mold,” and more than 50 other possibly problematic molds.

Molds typically grow in buildings affected by water damage and have been found in homes, hospitals, schools, and office buildings.

Exposure to mold has been identified as a potential cause of many health problems, including asthma, sinusitis, and infections. It is also believed that molds play a major role in cases of sick building syndrome and related illnesses.

Drs. Stephen J. Vesper and **Richard Haugland** at the EPA Office of Research and Development, **National Exposure Research Laboratory** in Cincinnati, Ohio, have developed a DNA-based system that allows

for the rapid identification and quantification of molds in a matter of hours. Current methodologies require days or weeks to identify molds before remedial action can be taken. With the new technology, up to 96 analyses can be run simultaneously by laboratory technicians, reducing the labor required to analyze

samples while significantly increasing the accuracy and validity of the analysis. The new technology also enables scientists to make risk assessments by identifying which mold is present and in what numbers.

The researchers have expanded and improved the technology to cover the identification and enumeration of more than 130 problematic species of fungi and bacteria.

With the assistance of Battelle's Environmental Technology Commercialization Center, headquartered in Cleveland, Ohio, the technology has subsequently

been licensed to ten private sector testing labs across the country and the Healthy Office Company of the United Kingdom.



Mold, like that growing on a piece of ceiling tile shown above, can gradually destroy the things they grow on. The EPA's fungal detection technology can help prevent further damage to homes, save money, and avoid potential health problems.



National Exposure Research Laboratory
www.epa.gov/nerl





ABOUT THE FLC

The **Federal Laboratory Consortium for Technology Transfer (FLC)**, a nationwide network of over 700 federal laboratories, is the only government-wide forum for technology transfer (T²). Organized in 1974 and formally chartered by the Federal Technology Transfer Act of 1986, the FLC provides the framework for developing T² strategies and opportunities by promoting and facilitating technical cooperation among federal laboratories, industry, academia, and state and local governments. As the recognized leader in maximizing collaborative research for the transfer of technologies, the FLC enhances the socioeconomic well-being of the nation in the global marketplace.

The FLC is a consortium driven by the outstanding people of the federal laboratory system. These people are the scientists, agency representatives, and T² professionals who accelerate federally funded technology and expertise to the marketplace. Serving as a gateway for government, industry, and academia to access research and development, the FLC also serves as a resource for technology transfer education and training, news, programming, awards, and initiatives. These efforts facilitate the process of matching laboratory expertise with users' needs.

Government, industry, and academic personnel looking to strengthen their T² capabilities to capitalize on the nation's investment, better their position in the marketplace, or research technology can look to the FLC to foster the rapid movement of federal laboratory research results into the mainstream of the U.S. economy. The tools of the FLC enable T² professionals to develop solutions, successes, partnerships, best practices, legislation and policy, innovations, and educational opportunities.



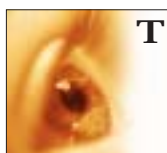
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The FLC web site makes it easy for you to find people, capabilities, and applications within the FLC's network of federal laboratories and centers. The site publicizes T² news and technology trends, and allows you to request personalized information about FLC services.



F L C N e w s L i n k

This free monthly newsletter reports on a host of technologies and training events, and highlights the technological advances of federal laboratories, industry, and academia.



T e c h n o l o g y L o c a t o r

The Technology Locator is a free service that locates federal laboratories ready to transfer their technologies to the marketplace and also brings these laboratories together for collaborative R&D. Learn more about the locator service at www.federallabs.org.



E x h i b i t s

The FLC travels to government, industry, and technology trade shows throughout the year and throughout the country, promoting the FLC's full range of services.

OTHER FLC PUBLICATIONS



Technology Transfer
Desk Reference



The Green Book
(T² Legislation and Policy)



FLC NewsLink



Tools for Innovative Partnerships:
Technology Transfer Techniques



Laboratory
Web Site Reference





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