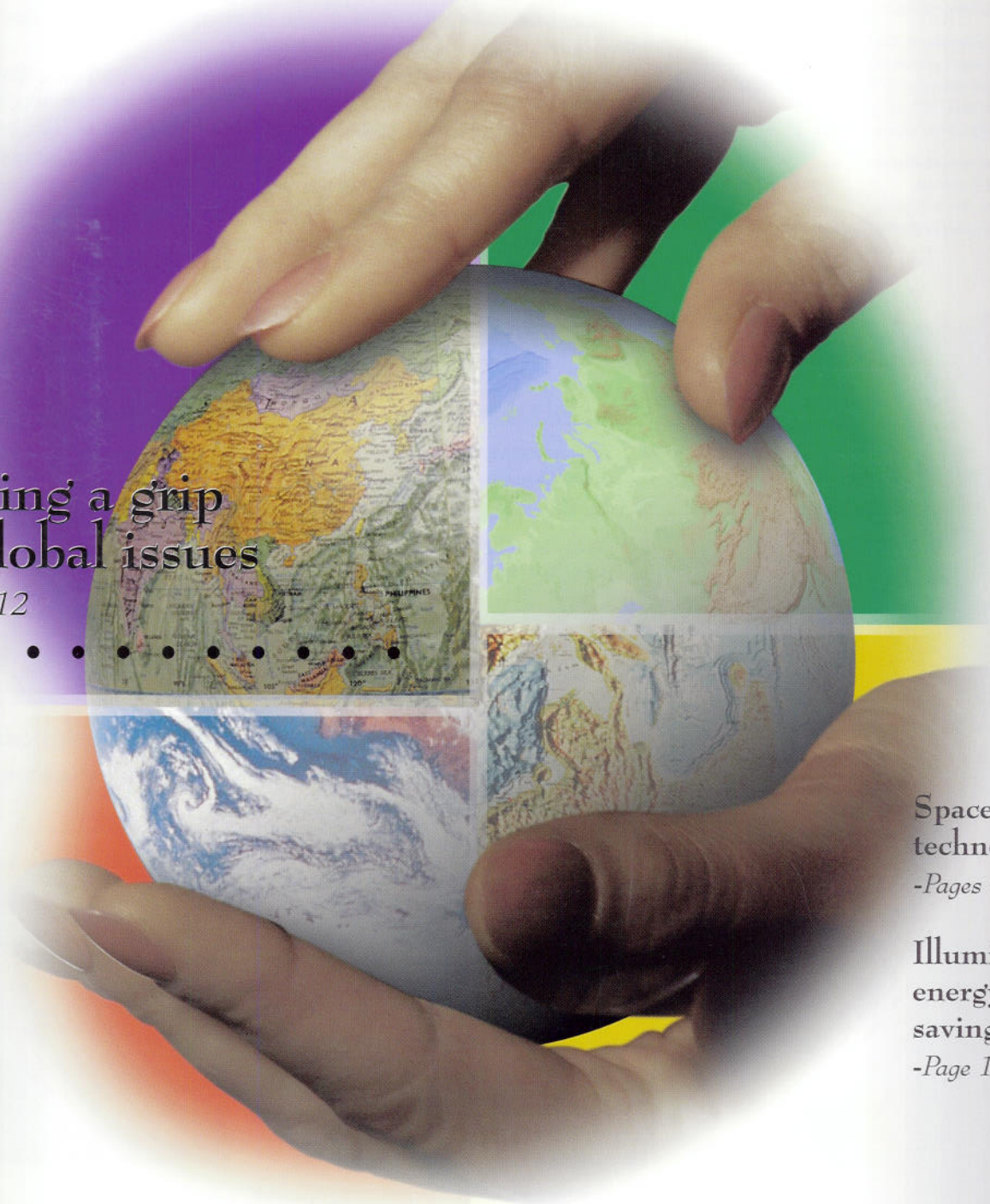
Breakthroughs

Science. Technology. Innovation.

SPRING/SUMMER 2001



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PACIFIC NORTHWEST NATIONAL LABORATORY

OPERATED BY BATTELLE FOR THE U.S. DEPARTMENT OF ENERGY

Breakthroughs

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editor's screen

Science in the service of humanity.

While this is a common phrase around Pacific Northwest National Laboratory, its meaning became especially clear as I worked on the special section of this issue devoted to the Laboratory's global impact.

Pacific Northwest's scientists and engineers are addressing critical issues that make a difference on a global scale. For example, contributing to the fundamental understanding of global change can help decision-makers shape national and international policies based on scientific knowledge. The Laboratory supports all aspects of global security, from ensuring that nuclear materials are safe and accounted for to helping diversify the economies of Russian cities that once relied solely upon weapons production.

Every day, Pacific Northwest's scientists and engineers are developing new solutions for government and industry clients. Some of these technologies are ready to move out of the laboratory and into real-world applications. Others will be developed further before their promising future can be realized. Please contact us for more information about how Pacific Northwest is helping solve global problems, or how our breakthrough science and technology might solve a problem for you. —*Pamela Harrington, editor*

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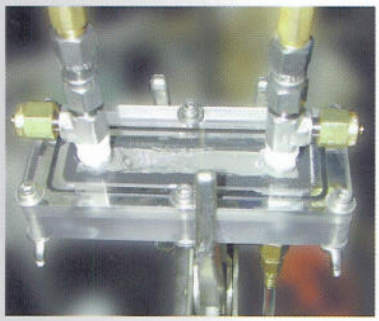


Technologies featured in cyberspace marketplace

These days you can find anything on the web—even technology solutions ready for commercialization. Technologies developed at Pacific Northwest National Laboratory are now among those listed on yet2.com, the first global forum for commercialization and technology transfer via the Internet.

Battelle, which manages the laboratory for the U.S. Department of Energy, is one of more than 60 founding sponsors of yet2.com—joining the likes of Mitsubishi, Proctor and Gamble, DuPont and Ford. Together, yet2.com's members represent approximately 15 percent of the world's annual research and development spending, making the site the single largest source of intellectual property.

Battelle already has submitted more than 40 patented technologies from Pacific Northwest and other laboratories it helps manage. These ready-to-license technologies appear at **www.yet2.com**. ●

Oh boy, what a buoy!

Although most buoys are permanent fixtures serving a single purpose, researchers at Pacific Northwest National Laboratory's Marine Sciences Laboratory have developed a lightweight portable buoy complete with cell-phone technology and interchangeable sensors.

The bio-optical monitoring buoy is designed to validate satellite signals recorded and relayed from space while simultaneously monitoring water quality parameters in coastal, estuarine and inland waters. It provides remote measurements of biological, chemical and physical processes that can be used for natural resource assessment of these waters. For example, it may one day help detect and predict harmful algal blooms.

During its maiden voyage in the fall of 2000, a field test demonstrated that the buoy could communicate with researchers and provide customized data in near real-time. The buoy promises to be more cost-effective than conventional data collection methods that require labor-intensive and expensive shipboard platforms. It also can be easily modified for different applications and to meet clients' research needs. ●

Biomolecular Networks Initiative launches Web site

Pacific Northwest National Laboratory introduced a new Web site in April to share information about its Biomolecular Networks Initiative.

The Web site, found at **www.biomolecular.org**, describes the Laboratory's multidisciplinary research program that integrates molecular biology, biochemistry, physics, mathematics and computer science to build an understanding of complex biological systems.

The goal of the initiative is to gain new knowledge about the function of proteins and how they work as part of the molecular networks that control the inner workings of living cells. Key to the initiative are collaboration opportunities with industry, academia and other national laboratories. More information about this program will appear in a future issue of *Breakthroughs*. ●

Bio Molecular Networks

Counting cosmic rays

When the National Aeronautics and Space Administration's Mars Odyssey spacecraft headed off to the red planet in April, it was equipped with an instrument developed in part by Pacific Northwest National Laboratory.

"This instrument will be useful to measure radiation in possible future manned missions to Mars," said Steve Thompson, in Pacific Northwest's engineering physics group. Without the protection of the Earth's atmosphere in space, radioactive particles thrown off by the sun and stars could pass through people's bodies and potentially cause harm.

In a cooperative effort, Pacific Northwest built the hardware and NASA supplied the software for the device nicknamed MARIE, for Mars Radiation Environment Experiment.

One goes up, another comes down

A related radiation measurement device invented by Pacific Northwest in the mid 1990s went down with the Russian Mir space station in March.

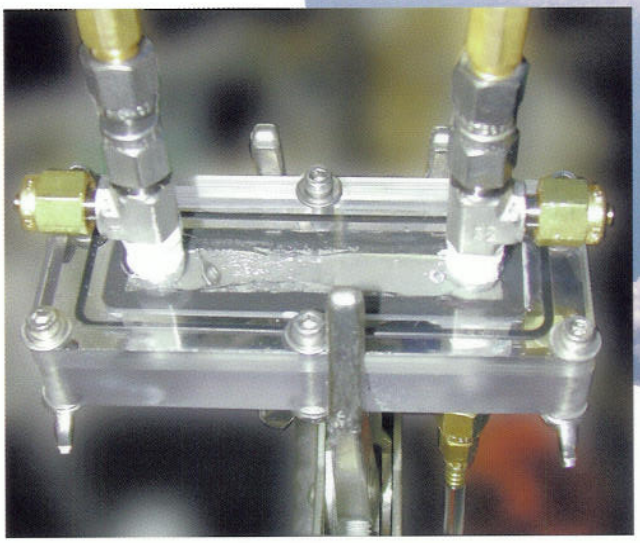
With nearly 30 years' experience in developing radiation measurement technologies, the Laboratory produced a device that can measure the types and varying levels of cosmic rays encountered during the course of a flight.

The "tissue equivalent proportional counter" simulates the nucleus of a human cell and records the energy deposited and resulting tissue damage as cosmic radiation passes through the body's cells. In addition to Mir, these detectors have been standard equipment on space shuttle missions since 1996 and are used on the international space station.

Battelle, which manages Pacific Northwest for the U.S. Department of Energy, transferred the technology to Far West Technologies. Far West is customizing a device for commercial airlines in Europe that are interested in tracking and limiting crews' exposure to cosmic rays. ●

Photo courtesy of NASA

MicroCATS *in space*



While some people are planning summer vacations to theme parks with wild amusement rides, researchers at Pacific Northwest National Laboratory are planning a trip on a reduced gravity aircraft—affectionately known as the Vomit Comet.

Through a contract with the National Aeronautics and Space Administration, the Laboratory is furthering the development of micro chemical and thermal systems, or MicroCATS, for chemical processing in space applications. The contract calls for both ground testing and testing in reduced-gravity situations. For Ward TeGrotenhuis and Susie Stenkamp of the Laboratory's chemical and biological processes development group, this means that one or both of them may be experiencing weightlessness and performing mid-air laboratory tests.

"Most conventional chemical process equipment requires gravity to operate," TeGrotenhuis said. "However, the vapor-liquid separator that we're testing has extremely small channels that cause other forces, such as surface tension, to dominate."

When a two-phase fluid—fluid that contains a mixture of liquid and gas—flows through the device, it separates the liquid into one stream and the gas into another. As simple as it may sound, this process can be so problematic without gravity that it can affect which technologies are selected for space systems.

NASA is interested in new technologies for advanced systems for life support, extra-vehicular activity and even for missions to Mars. One concept involves converting carbon dioxide from the Martian atmosphere into propellant for the return trip to Earth after a robotic mission to retrieve rock samples.

The vapor-liquid separator that will be tested as soon as this summer was originally developed for the U.S. Department of Energy's Office of Transportation Technologies as part of its Fuel Cells for Transportation program. "There is very little room for a vehicle's fuel processing system, so separation technologies have to be small," TeGrotenhuis said. "It was a natural fit to adapt this technology for space applications where size and weight are driving factors."

The single-channel test unit is about the size of a pocket tape recorder. It holds a thimbleful of liquid in a channel about as wide as a toothpick. An actual unit would incorporate a stack of these channels with thin walls between them, intensifying the process and increasing the system's throughput.

TeGrotenhuis and Stenkamp will be trained and qualified for the trip on NASA's Reduced Gravity Aircraft, which can climb at a 45 degree angle from 24,000 feet to 32,000 feet and drop back to 24,000 feet about every 65 seconds. They have been told, however, that the ride is not as bad as a roller coaster because it is much smoother. After getting their feet wet, they might even look forward to a second trip to test a condenser gas-liquid separator and a microchannel distillation device that will be developed if the project for NASA continues.

This project is funded by the NASA Office of Biological and Physical Research and is managed by the Microgravity Research Division of the NASA Glenn Research Center. The results will be useful in Pacific Northwest's continued development of MicroCATS for multiple applications. See **www.pnl.gov/microcats**. ●

A national lab with global impact

Albert Einstein once said, "Imagination encircles the world." At Pacific Northwest National Laboratory, we take this message to heart. The innovations of our scientists and engineers not only address some of the most critical challenges facing our nation—they are making a mark on the world.

Pacific Northwest is a U.S. Department of Energy national laboratory; however, our efforts extend far beyond the geographic boundaries of this country. Our work for government agencies and industry clients, both in the United States and abroad, has global impact.

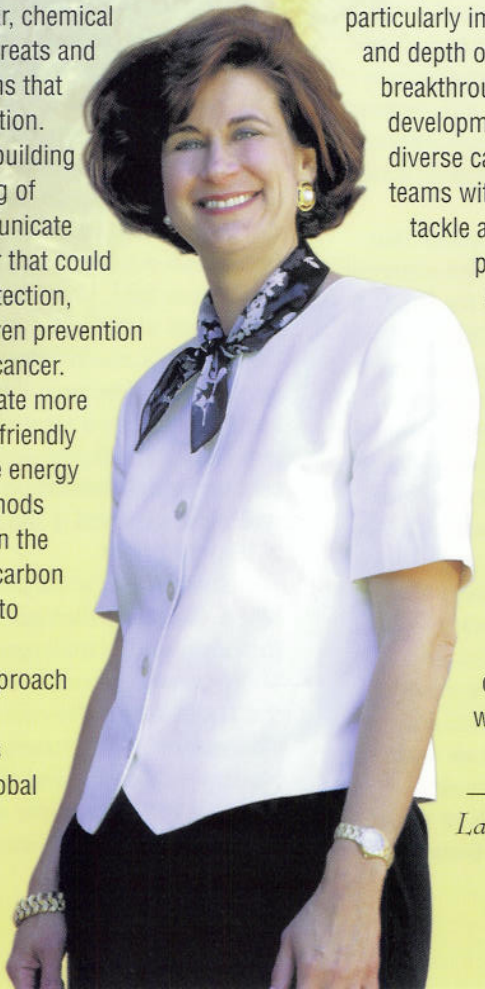
As we strive to expand scientific knowledge and deliver new technologies, we are tackling tough global issues such as climate change, energy efficiency and environmental concerns. We develop technologies to help keep the world safe from nuclear, chemical and biological threats and support programs that prevent proliferation. Our research is building an understanding of how cells communicate with one another that could lead to better detection, treatment and even prevention of diseases like cancer. We also investigate more environmentally friendly ways to generate energy and explore methods to store carbon in the earth to control carbon dioxide releases to the atmosphere.

Even our approach to research and development has become more global in recent years. We recognize that science is no longer based on single disciplines. Single researchers or isolated teams are not as likely to make the significant discoveries and breakthrough advancements needed to solve today's complex problems.

Instead, we take an interdisciplinary approach. Along with our unique competency in molecular science, we bring together biological, physical and information sciences. We look for opportunities to form partnerships with others, working with clients and collaborating with researchers from around the globe. The William R. Wiley Environmental Molecular Sciences Laboratory, a national user facility here on our campus, also serves as a world-class international scientific resource.

As I complete my first year as Laboratory Director, I have been particularly impressed by the breadth and depth of Pacific Northwest's breakthrough research and development. With our staff's diverse capabilities, we can form teams with unique expertise to tackle a myriad of issues. I am proud of our dedicated staff members who travel all over the globe and take time away from their families to do such important work. In the years ahead, I look forward to seeing our researchers continue to explore the frontiers of science and technology—and in doing so—make our world a better place.

—Lura Powell
Laboratory Director



Global change—

Researchers at Pacific Northwest National Laboratory are contributing to the scientific understanding of global climate change—pursuing a broad understanding that will serve as the foundation for future policy and technology solutions.

"The issues surrounding global climate change span environmental, energy, economic and political arenas," said Bill Pennell, director of the Laboratory's global environmental change research program. "We are learning to recognize and appreciate these complex connections and interrelationships, which is critical to solving this challenging problem."

The program covers research activities ranging from the role of clouds in maintaining the heat balance of the atmosphere, to how climate change might affect human activities, to the roles of economic policy and technological change in finding solutions to the climate change problem.

Grounding greenhouse gases

Moving carbon out of the atmosphere and storing it in the ground offers a promising approach to reducing greenhouse gases, principally carbon dioxide, in the atmosphere. Researchers at Pacific Northwest National Laboratory are exploring how different soil management practices affect the fungal activity in soils and how that relates to the soils' ability to store carbon.

The Laboratory's research shows that unmanaged land and native land have relatively more fungal activity—and therefore more stored carbon—than land that is intensively managed.

"This research improves our understanding of carbon storage and can help develop soil management plans to increase storage and reduce greenhouse gases in the atmosphere,"

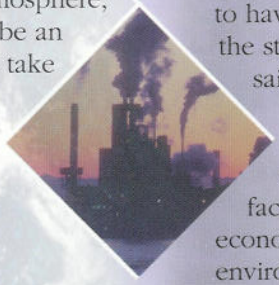
addressing a global concern

To help understand the impacts of global change, Pacific Northwest's scientists are investigating how future climate change might affect wheat production in eastern Washington. Using a laboratory-developed regional climate model, they also are examining how climate change over the next 30 to 50 years might affect precipitation patterns, water resources and stream conditions for salmon in the western United States. They have conducted similar "impact assessment" studies for other countries, such as China.

In 1998, Laboratory researchers developed and led the Global Technology Strategy Program. This first serious effort to find a workable solution to the climate problem brings together an international coalition of industry, government, and non-governmental organizations.

In addition to conducting original research, Laboratory scientists contributed to international assessments of the scientific understanding of climate change coordinated by the United Nations' Intergovernmental Panel on Climate Change in 2001.

"All of this work points to the need to ultimately cap the concentrations of greenhouse gases in the atmosphere," Pennell said. "This will not be an easy thing to do, and it will take time. There are no silver bullets—no simple, single actions either in terms of technology or policy—that will solve the problem."



said Vanessa Bailey in the Laboratory's biogeochemistry resources group.

Researchers examined soil from locations that were managed differently, studying samples from two areas of eastern Washington; from the Cascade Mountains, also in Washington; from Mobile, Ala.; and restored native prairie land in Illinois.

"Farmland managed with no tillage had more fungi and more stored carbon than neighboring farmland that was managed with conventional plowing," Bailey said. "Similarly, land that had returned to native prairie had more fungi and more stored carbon than neighboring land that was farmed."

The project revealed that soil collected from a cooler, moister climate at high elevations had more stored carbon than similar soil from hotter, drier climate conditions at lower elevations. Another observation, Douglas fir trees treated with nitrogen fertilizer had greater fungal activities and stored more carbon than those nearby that had not been fertilized.

The U.S. Department of Energy's Carbon Sequestration in Terrestrial Ecosystems Project, which is led by Pacific Northwest, Oak Ridge National Laboratory and Argonne National Laboratory, supported this research. Along with Bailey, the Laboratory's Harvey Bolton, Jr. and Jeffrey Smith from the U.S. Department of Agriculture's Agricultural Research Service were involved in the project. ●

Research partnership formed

Pacific Northwest National Laboratory and the University of Maryland have joined forces to advance the understanding of global climate change. The Joint Global Change Research Institute, announced in March 2001, will investigate the scientific, social and economic implications of climate change, both nationally and globally.

"By combining the capabilities of our two institutions, we expect to have a powerful impact on the study of global climate change," said Lura Powell, director of the Laboratory. "We are looking forward to partnering with the university's first-class faculty and graduate students in economics, public policy, earth and environmental sciences, engineering and the social sciences."

The joint institute brings together about 25 Pacific Northwest climate change researchers now based in Washington, D.C., with top Maryland faculty and research scientists. The collaboration includes well-known scientists who bring leadership in areas of research ranging from atmospheric chemistry to remote sensing and resource economics.

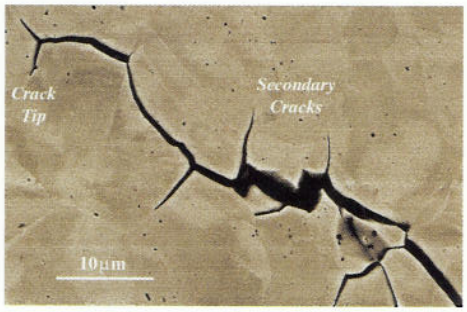
Gerald Stokes, previously associate laboratory director for the Laboratory's fundamental science effort, is director of the joint institute. "We are entering a whole new era in the way society deals with the climate, energy and the environment," Stokes said. "This unique partnership recognizes and brings together the combined forces of research and scholarship that are required to find solutions for this new era." ●

Clearing up core corrosion cracking

Operators of commercial nuclear power plants throughout the world share a common concern—ensuring the continued performance of the reactor's core components.

In a project with the Electric Power Research Institute (now officially known as EPRI), Pacific Northwest National Laboratory is taking a closer look at what causes corrosion or cracking in reactor core components. With collaborative funding from more than seven countries and a dozen agencies, researchers are studying core component materials to build an understanding of the radiation-induced material changes that promote environmental cracking.

"For the first time, we are examining material characteristics and stress corrosion cracks at near-atomic resolution on actual components removed from commercial power reactors," said Steve Bruemmer, who manages several projects at the Laboratory that are part of the larger international program.



Bruemmer explained that a joint project with the Department of Energy's Office of Basic Energy Sciences is instrumental in the international research. "We're applying knowledge and unique characterization techniques developed through DOE programs to work with international partners on a problem that plagues the industry worldwide."

Nearly 100 existing light-water reactors produce a significant portion of the electricity in the United States, so this research is increasingly important as the nation's demand for electrical power continues to rise. ●

Preserving liquid assets

Researchers at Pacific Northwest National Laboratory have partnered with Mexican experts to develop a sustainable water management strategy for Mexico City and its aquifer, which serves 20 million people.

The team members completed an assessment of injecting treated wastewater back into the aquifer and developed a set of integrated simulations of the water system for evaluating potential actions. Social and health implications, costs and stakeholder involvement also were evaluated. In an anticipated second phase, the team will help develop a pilot program for the aquifer-injection concept. ●

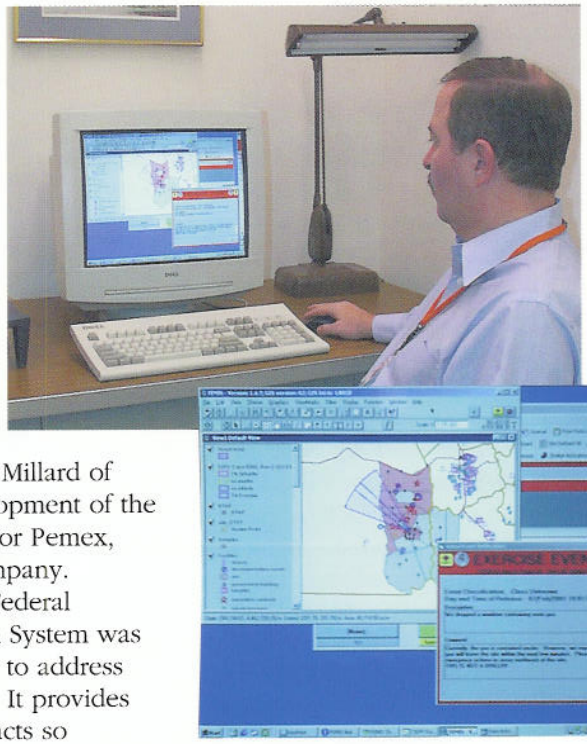
Moving Indonesia toward technology-based business

Slick software aids Mexican oil industry

Through adaptation and translation, software originally developed by Pacific Northwest National Laboratory for the U.S. Army will soon be installed at an oil refinery in Mexico.

EMA*DVANTAGE*, short for Emergency Management Advantage, is based on a system created to prepare for emergencies at chemical weapons storage depots. "Both the depot and the refinery have known that centralized hazards can potentially affect the general public," said Dave Millard of Pacific Northwest who led the development of the original system and helped adapt it for Pemex, Mexico's state-owned petroleum company.

To create **EMA***DVANTAGE*, the Federal Emergency Management Information System was translated into Spanish and modified to address situations specific to the oil industry. It provides scenarios, task lists and federal contacts so officials can plan for and respond to events ranging from fires and explosions to toxic gas dispersion.



Battelle, which manages the Laboratory for the U.S. Department of Energy, is marketing the technology for use with other emergency scenarios such as threats of earthquakes, forest fires or volcanoes. Battelle's connection to Pemex stems from an alliance that was created in 1998 with the National Autonomous University of Mexico, the Mexican Petroleum Institute and the Metropolitan University of Mexico. For more information on the Laboratory's emergency management software, see **www.showcase.pnl.gov/show?it/FEMIS.** ●

When an agency of the Indonesian government wanted to develop a more business-like approach to providing technology services to the private sector, it found a "twin" in the United States to help with the transition.

According to a World Bank report, for years Indonesia relied on its natural resources—oil, natural gas and forestry. In the 1980s, however, Indonesia began focusing on developing its technology capabilities as the most promising source of sustainable growth for the future.

As part of this effort, Battelle entered into a contract with Indonesia's Agency for the Assessment and Application of Technology in 1997 to work on a multi-year project funded by World Bank. Battelle manages Pacific Northwest for the U.S. Department of Energy. In addition to a small core project team of Battelle and Laboratory staff, many others from Pacific Northwest brought specific expertise to the project.

The project compared and contrasted Battelle's practices and processes with those of the Indonesian agency. "The project staff adapted Battelle's business processes and approaches to business development, public relations, contract management and intellectual property to fit the agency's and Indonesia's needs," said Mary Zalesny, project manager for the Twinning Arrangement of the Management and Business Integration System Project. "We updated hardware and created automated information systems to effectively manage human resources, budgets and projects."

One of the project's main objectives was to guide and support the Indonesian agency through organizational changes as it began the transition toward a private-sector-oriented technology service organization. This piece involved developing a project management plan, a communications plan and plans for leadership development. The assistance with transition also helped the agency through major organizational restructuring and three changes in its senior leadership.

If international collaboration on such a major transition wasn't challenging enough, the project spanned a time of political upheaval in Indonesia.

"The multiple changes in leadership and an economic crisis that devaluated the local currency forced the team to adjust the project to ensure its continued value and relevance to the agency. Nonetheless, we still accomplished the project's primary objectives," Zalesny said. "Being successful in international work requires flexibility and making adjustments to deal with the unexpected, while maintaining high project standards." ●

Helping keep the world at peace

At Pacific Northwest National Laboratory, the concept of "security" extends far beyond the traditional meaning of the word to include addressing environmental, economic, energy and health concerns.

"Activities with no obvious direct connection to security are often quite relevant. Health, energy and the environment are very important to attaining global stability and improving the well being of mankind," said Jim Fuller, who leads the Laboratory's Defense Nuclear Nonproliferation Sector.

With that in mind, Pacific Northwest is focusing on applying the science and technology associated with these other U.S. Department of Energy and Laboratory missions to help resolve the long-term root causes of global instability, in turn, helping minimize the need for mass destruction weapons.

"We are different from the nuclear weapons labs in that we are able to take a very multidisciplinary approach to our global security mission," said Mike Kluse, associate laboratory director for the National Security Division. "We bring the Laboratory's diverse expertise to bear on issues like nonproliferation while being very creative and impactful in the process."

Fuller explained that the Laboratory's efforts have begun to extend beyond Russia and the Former soviet Union into China, south Asia and northeast Asia. "We're trying to leverage and adapt other international activities as they relate to helping stabilize economies and democratize governments," he said. "In this way, we maximize our impact, as well as that of our clients at DOE's National Nuclear Security Administration.

The traditional approach

As one might imagine, activities that fall within the more traditional scope of security deal directly with monitoring and reducing inventories of mass destruction weapons and material. Some examples of how Pacific Northwest supports these U.S. government efforts include:

Protecting and controlling nuclear materials: Pacific Northwest supports the DOE's Materials Protection, Control and Accounting Program by sharing knowledge, new technologies and inventory tracking practices with Russia to help reduce the threat of unsecured nuclear material that could be used to make weapons.

Improving safety at nuclear power plants: The Laboratory's International Nuclear Safety Program provides technical leadership to an international effort to reduce risks at 67 operating reactors at 21 Soviet-era plant sites in nine countries. With expertise in nuclear engineering, operational safety, regulatory standards and nonproliferation, staff members work with other national laboratories and businesses in the United States as well as the nuclear power plants and scientific organizations of the host countries.

Reducing smuggling risks: Pacific Northwest supports the U.S. Departments of Defense and Treasury in conducting their International Border Security Training Program. The program has provided 14 countries in Central and Eastern Europe and the former Soviet Union with assistance in preventing illicit transfers of materials, commodities

and components that could be used for weapons of mass destruction. International border enforcement officials in this comprehensive hands-on training also learn about the most current detection technologies. Laboratory staff developed the training with the U.S. Customs Service and teach the technical portions of the course.

Nuclear warhead dismantlement transparency: Working for both the U.S. Department of Defense and DOE's National Nuclear Security Administration, Pacific Northwest has been asked to undertake key roles in developing and implementing warhead dismantlement transparency and confidence-building methods. For example, the Laboratory leads the effort to "authenticate" or validate the radiation measurement systems used for monitoring weapons-origin fissile material at a storage facility built by the United States in the southern Urals.

Less traditional approaches

Minimizing national security threats extends beyond dealing directly with weapons of mass destruction, nuclear materials and smuggling. Nontraditional

approaches to global security are focused on increasing trust and encouraging nations to cooperate and collaborate. A few highlights include:

Moving technologies to the marketplace: Through the Initiatives for Proliferation Prevention program, Laboratory scientists and engineers work with chemical, biological and nuclear institutes in Russia, Ukraine and Kazakhstan to help commercialize nonweapon technologies. This program is aimed at providing gainful, non-defense employment for former weapons scientists. Pacific Northwest develops industrial partnerships with Western businesses to help bring technologies to market.

Increasing energy efficiency in North Korea: Through intermediary contacts, Laboratory staff have come to believe that the government of North Korea would welcome interactions that could lead to improved energy supplies and use. Pacific Northwest can apply its energy efficiency expertise to help North Korea build on systems already in place. In addition to helping North Korea serve critical energy needs, these projects would serve security objectives by engaging and building better relations with a country that has traditionally kept itself isolated from other nations.

Collaborating with India: DOE established a U.S.-India Science and Technology Initiative in response to two agreements aimed at scientific and technical cooperation between India and the United States signed in 2000. Through this initiative, Pacific Northwest and another national laboratory are working with U.S. agencies and the Indian government and scientific communities to identify appropriate, nonsensitive areas for technical collaboration. These collaborations are meant to address national and international problems, build trust and contribute to regional stability in south Asia.

Restructuring Russian debt: The Laboratory has led the adaptation of the highly regarded debt-for-nature debt swap approach (typically implemented to enhance bio-diversity) to one of debt-for-security, or debt-for-nonproliferation. This concept promotes the exchange of Russia's inherited Soviet-era debts for increased Russian underwriting of projects that are of interest to U.S. and European debt holders. One version of this approach would establish a Russian EcoFund to underwrite defense conversion and economic stabilization programs by cleaning up Russian cold war radioactive wastes.

Lessons-learned in economic diversity: The Laboratory has hosted four official visits by city administrators and entrepreneurs from Russian closed cities who came at their own expense to learn how the Laboratory, the surrounding community and other stakeholders have converted from their dependence on DOE's defense mission at nearby Hanford and remained viable.

A focus for the Northwest

The Laboratory has the ability to be the hub of activity in the region for broader involvement among nongovernment organizations and academic, commercial and state and local government stakeholders.

Creating a center: The Pacific Northwest Center for Global Security, established in 1998, is a Laboratory effort to involve Northwest academics, private foundations, state governments and nongovernmental organizations in government efforts to reduce the threat of nuclear, chemical and biological weapons. "The Pacific Northwest Center for Global Security partners with organizations throughout the region and helps position the Laboratory and its research sponsors to respond to changing conditions of the post-Cold War environment," said Fuller, the center's director. "The center also serves as a means to inform the Laboratory about the current state of global security and nonproliferation and to reach out to scholars and policy makers." See **http://pnwcgs.pnl.gov/**.

Sharing knowledge for the future: Pacific Northwest and the University of Washington established The Joint Institute for Global and Regional Security Studies to enhance international security education at the University. The joint institute is focused on expanding the University's teaching, research and public outreach programs on nonproliferation and related international security issues. This partnership also supports interaction between Laboratory science and engineering staff and international studies students.

Serving closed cities: The Laboratory works with the Foundation for Russian American Economic Cooperation (FRAEC) to bring about peaceful enterprises and create economic opportunities in Russia's "closed" nuclear cities that once were home to secret nuclear weapons facilities. As part of the Nuclear Cities Initiative, the Laboratory and the Seattle-based foundation have jointly established International Development Centers in two of 10 nuclear cities. These centers assist with the transition to an open-market economy and help create jobs for former nuclear weapons scientists and engineers. FRAEC is the nation's oldest nongovernment organization specializing in business and trade work in Russia.

Building bridges: As a result of the activities of the Pacific Northwest Center for Global Security, the Laboratory has memberships in the Washington State China Relations Council and the Washington Council on International Trade.

"I believe that we can best serve DOE and the country by engaging with and involving the widest possible number of organizations and people from the region in this critical work," Fuller said. "We have the ability to effectively and efficiently bring regional resources to bear on a wide range of mutually beneficial and rewarding activities that are consistent with the foreign policy objectives of the United States." ●

Centers support energy efficiency in six nations

Over the last 10 years, the Czech Republic has been improving energy efficiency in its hospitals and health facilities, schools, industrial plants and city-owned buildings. One of six energy-efficiency centers that Pacific Northwest National Laboratory helped establish—The Czech Republic Center for Energy Efficiency—leads these efforts.

Between 1990 and 1994, the Laboratory's Advanced International Studies Unit provided planning and logistical support for energy efficiency centers launched in Poland, Russia, Bulgaria, China, Ukraine and the Czech Republic. The centers are nongovernmental, not-for-profit organizations founded by local experts. Their purpose is to make energy efficiency business possible in countries transitioning to market-based economies.

"Transition economies rank least efficient in the world," said Gerald Stokes, director of the Joint Global Change Research Institute, a collaboration between the Laboratory and the University of Maryland. "Increasing energy efficiency is unique in that it generates economic growth and reduces environmental emissions."

Creating a framework for energy efficiency

The centers help increase the focus on energy efficiency through collaborative research and involvement in new domestic laws and international agreements. "The energy efficiency centers have played a key role in creating their nations' energy efficiency laws and policy reform," said Bill Chandler, director of the Laboratory's Advanced International Studies Unit.

In one example, the Beijing Energy Efficiency Center provided expertise in integrated resource planning to the Shenzhen Utility Corporation and persuaded the city to invest in demand side management rather than additional power plant capacity. The Chinese Electric Power Law now requires that integrated resource planning and demand-side management be considered in plans for new electric power development.

"Transition economies rank least efficient in the world. Increasing energy efficiency is unique in that it generates economic growth and reduces environmental emissions."
—Gerald Stokes, director of the Joint Global Change Research Institute

Stimulating private-sector business

In another success story, the Russian Center for Energy Efficiency located a Russian partner for a United States firm that distributes a technology used with coal-burning electricity plants and district heating, hot water and steam facilities. The two companies formed a joint venture around the technology, which helps mitigate sulfur dioxide emissions. Through assistance like this, the centers have helped stimulate millions of dollars of private-sector business and technology transfer.

Informing and educating

The energy efficiency centers are developing a new culture of energy efficiency with professional training and public education. For instance, EnEffect, the Bulgarian Center for Energy Efficiency, trained experts who then trained local energy managers on energy-efficient management practices such as municipal energy planning and management, business plan preparation and auditing.

The same center also adapted a Bulgarian version of a manual for architects about improving energy efficiency in multistory residential buildings and developed a reference guide for residential consumers entitled *How to Save Energy at Home.*

Initial funding for the centers came from a combination of public and private resources including the U.S. Department of Energy, the U.S. Environmental Protection Agency and the U.S. Agency for International Development, as well as the World Wildlife Fund, Charles Stewart Mott Foundation, and the John D. and Catherine T. MacArthur Foundation. The centers achieved financial independence after about three years of operation and have solidified into institutions that can continue increasing energy efficiency in these transition economies after initial funding from the United States government ends. ●

Progress recognized with international awards

The leaders of two energy efficiency centers received the Climate Technology Initiative's World Climate Technology and Leadership Awards in 2000 for accelerating the spread of environmentally sound technologies and practices.

The awards were presented to Zhou Dad, the founder and first executive director of the Beijing Energy Efficiency Center in the People's Republic of China, and Igor Bashmakov, the director of the Center for Energy Efficiency in Russia. Dad received the award for transforming the delivery of energy services in China. Bashmakov was recognized for establishing institutions throughout the Russian Federation that specialize in energy efficiency and in enhancing public education on energy and climate change.

In another awards program, the Association of Energy Engineers named Pacific Northwest National Laboratory as the winner of its International Energy Project of the Year. The Laboratory and its partners, the Ukrainian Energy Efficiency Center and Industrial Real Estate, worked with Gostomel Glass Plant in Ukraine to develop a comprehensive energy-efficiency program and attract financing for implementation. Already more than $750,000 has been invested in energy-efficient improvements at the plant. ●

A bright idea in efficient lighting

After shedding light on what could make compact fluorescent light bulbs more attractive to businesses and consumers, a program that introduced shorter, brighter and less expensive bulbs has seen shining success.

About three years ago, the U.S. Department of Energy, with help from Pacific Northwest National Laboratory, decided to combat the reasons that businesses and consumers were not buying energy-efficient, long-lasting alternatives to conventional incandescent bulbs.

"We knew that one of the main barriers was size, because many of the compact fluorescents on the market were too long to fit in existing fixtures," said Terry Shoemaker, who is involved in program communications and outreach activities.

On behalf of DOE's Office of Building Technology, State and Community Programs, Laboratory staff members met with manufacturers and potential large-quantity buyers such as owners and operators of multifamily housing to gain an understanding of their interests and needs.

"As a result, we developed a technology procurement program for improved, smaller compact fluorescent light bulbs, called subcompact fluorescents or sub-CFLs," Shoemaker said. "We wrote the specifications for bulbs that would meet customer requirements and issued a competitive solicitation to suppliers to produce the bulbs for the program."

Pacific Northwest signed agreements with four suppliers and negotiated prices and terms for their products. Once the agreements were in place, volume buyers could purchase any of 17 new models introduced through the program directly from the participating manufacturers. By early 2001, sales reached more than 2.5 million bulbs—more than twice the program's goal.

"We are very pleased to have helped introduce these innovative, energy-efficient light bulbs, and we're especially pleased to see how their sales have grown," said Jim Brodrick, DOE's program manager for the Sub-CFL Technology Procurement Program. The sales figures translate into more than $100 million in energy savings and an avoided release of nearly a million tons of carbon dioxide into the environment over the lives of the bulbs.

After such success, DOE began transferring the program to the Northwest Energy Efficiency Alliance in spring 2001. NEEA, a nonprofit group of electric utilities, state governments, public interest groups and industry representatives, will manage the program with continued support from the Laboratory.

"DOE achieved its goal. Today the market is responding to the growing popularity of sub-CFLs," said Linda Sandahl, program manager at the Laboratory. "As NEEA takes over, they will focus on outreach to retailers, especially small and medium retailers who would like to offer these products."

As part of its ENERGY STAR® Residential Lighting Program, NEEA is channeling sub-CFL sales through a distributor that makes bulk purchases and passes the savings on to the individual retailers. The bulbs, which meet the same strict performance criteria, are available from NEEA's website, **www.betterbulbsdirect.com**. ●

What's in a bulb?

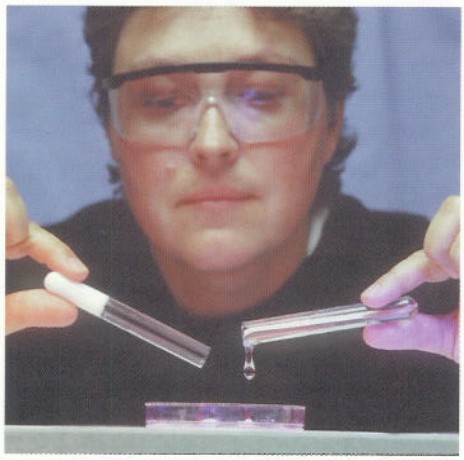
In addition to fitting in standard fixtures—perhaps the most significant improvement in the 17 new subcompact fluorescent light bulbs introduced through the Department of Energy program—sub-CFLs offer other advantages over conventional incandescent bulbs. For example, they

- **Produce enough light to replace standard 60- to 100-watt incandescent bulbs while using only a third of the energy or less.**
- **Save an average of more than $15 a year in energy costs when used 12 hours a day**
- **Last eight to ten times longer, which saves time and cost associated with replacing burned-out bulbs.**

Drug delivery right on target

One of the challenges in treating cancerous tumors with chemotherapy and medical isotopes is maximizing the treatment of cancer cells while minimizing the potential for harming healthy tissue. With materials being developed at Pacific Northwest National Laboratory, however, a more targeted approach might be on the way.

Researchers Anna Gutowska and Byeongmoon Jeong are working with stimuli-sensitive polymers that can change immediately from a liquid into a gel in response to an increase in temperature or other stimuli. This unique feature would enable physicians to inject a mixture of the polymer and a therapeutic agent directly into a specific target, where it would warm, harden and deliver localized treatment.



The gels show promise in treating inoperable and difficult-to-treat solid tumors in the liver, pancreas, brain, breast and prostrate. "While much more research remains to be done before this becomes an accepted medical procedure, we are very excited about its potential," said Gutowska, a senior research scientist.

After initial research funded by the U.S. Department of Energy, the Laboratory is applying National Institutes of Health funds to optimize the materials and investigate the long-term effects of leaving them in the body.

Jeong is exploring the use of biodegradable gels that would serve as a delivery system for protein drugs such as insulin. Protein and peptide drugs are typically injected daily because they break down in the stomach if given in a pill form. As an alternative, the gels would form a reservoir under the skin and slowly release the drugs directly into the bloodstream over a week or even several months.

In related research, the Laboratory is collaborating with the Medical University of South Carolina on an approach to repair articular cartilage—the durable cartilage that cushions joints.

First, researchers are developing a three-dimensional cell culture system that would support in-laboratory growth of the cells that generate articular cartilage. They also are developing a biodegradable polymer gel that could be injected at the site of the injury. The gel would serve as a temporary synthetic "scaffold," supporting the growth of injected cartilage-forming cells.

Researchers are conducting preliminary studies on the gels' biocompatibility and efficacy as a drug delivery system.

As development continues, Pacific Northwest is seeking research and clinical partners to move the technology into real-world applications. ●

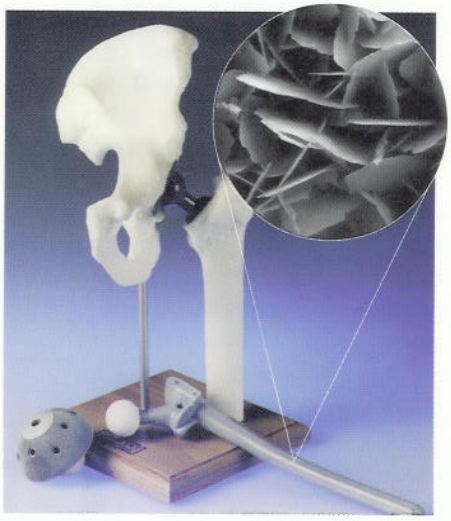
More than the bare bones for implant patients

Children may sing about how "the hip bone is connected to the leg bone," but for patients with hip replacements, this connection could cause implants to fail in less than 10 years.

At Pacific Northwest National Laboratory, researchers developed a unique bone-like coating process that addresses the problem of poor bonds between artificial joints and real bone. It could potentially increase the useful life of hip, knee and other joint replacements as well as dental implants.

In recent tests, a promising antimicrobial compound was added to the coating to help fight infection. This addition would be especially beneficial for patients with external fixator pins that go through the skin to temporarily hold a mending bone in place.

"To put it simply, our Biomimetic Coating Process makes the body believe that the implant is actually bone," said Allison Campbell who developed the process. As a result, the body creates a strong bond between the implant and the bone during the natural process of breaking down old bone and building new bone.



The Laboratory's process begins with pretreating the implant with a tether molecule. Then, the implant is soaked in a solution of calcium phosphate. "The tether acts as a template for the calcium phosphate crystals that grow on the implant surface," Campbell said. "The resulting coating mimics that of natural bone."

The water-based soaking process takes place at room temperature and can fully coat the surfaces of crevices and cavities—advantages over vapor-based techniques that require high temperatures and do not cover intricate implant features as well.

The Laboratory would like to license the patented technology to a company to support further testing and Food and Drug Administration approval. ●

One technology, countless applications

From personal security to custom clothing, better-fitting prosthetics to virtual reality video games—the list of potential applications for a new three-dimensional imaging technology developed at Pacific Northwest National Laboratory goes on and on.

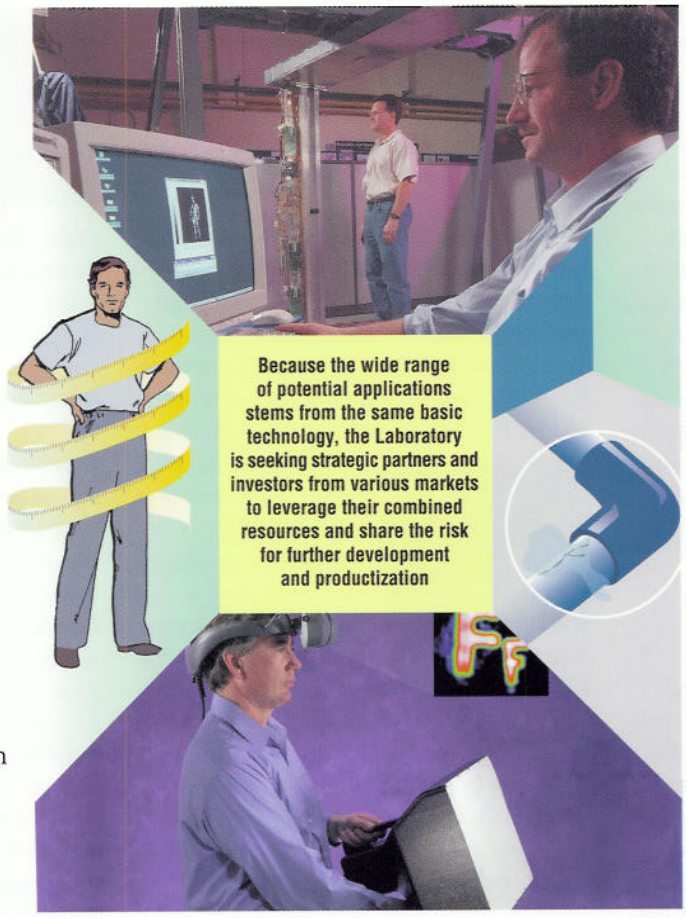
"We're talking about different variations on the same theme," said Gary Morgan, commercialization manager for the holographic imaging technology that could be customized for different markets. "This technology can generate images of items that otherwise are hidden because they are inside, behind or beneath solid objects."

The imaging system was originally developed for the Federal Aviation Administration and other federal agencies to detect plastic explosives and nonmetallic threats. It relies on nonharmful, ultrahigh-frequency radio waves with wavelengths on the order of one centimeter. These low-power waves can penetrate clothing and other nonmetallic objects.

"To put it simply, the system rapidly scans objects and sends reflected signals into a high-speed image processing computer," said Doug McMakin, an engineer who helped develop the technology. "The computer produces a high-resolution 3-D image from the data."

Researchers already have applied the technology to several other areas and are pursuing a number of new applications. They expect even more exciting applications to arise as commercialization moves forward.

Precise garment fitting: People could enter a kiosk in a shopping mall, fully clothed, and leave in a few moments with either a 3-D image of their body or a complete set of volumetric measurements on a disk. When combined with software that the Laboratory is developing for "fit-prediction" and "virtual try-on," the measurements would address the biggest drawbacks of e-commerce apparel sales—the inability to try on clothes or have confidence they will fit.



Because the wide range of potential applications stems from the same basic technology, the Laboratory is seeking strategic partners and investors from various markets to leverage their combined resources and share the risk for further development and productization

An end to one-size-fits-all: Accurate measurements of a person's size and shape could lead to custom-sized safety equipment such as helmets and harnesses where a good fit improves protection. Patients could order prosthetics without repeated trips to a doctor or manufacturer for fittings. Aircraft cockpits and seats and airbags in vehicles also could be customized.

A better look inside, behind and beneath: The ability to "look" through walls and floors—even when they're made of cement—offers significant advantages over alternative methods to locate and inspect piping or wiring. Ground-penetrating imaging also could be useful in locating buried pipes, tanks or barrels. The technology has potential for quality control in manufacturing and assembling nonmetallic components, including composite materials.

Meeting in cyberspace: Graphic images that represent real people could meet in an on-line environment for a "virtual conference." Each figure would accurately reflect a person's looks, gestures and facial expressions. Using the same approach, a realistic image could be inserted into personalized virtual reality video games and movies.

For the benefit of society: Plastic anti-personnel landmines could be located by imaging through dry sand.

A measure of stealth: A hand-held camera has been built with the imaging technology to assist ground crews in verifying an aircraft's stealth characteristics. It captures the plane's radar reflection, which determines the condition of radar-absorbing material that keeps aircrafts from being detected.

Because the wide range of potential applications stems from the same basic technology, Pacific Northwest is seeking strategic partners and investors from various markets to leverage their combined resources and share the risk for further development and productization.

"The idea is to advance the base technology and then license customized products to individual contributors for specific fields of use," Morgan said. ●

Related web sites:
www.pnl.gov/nsd/commercial/body/
www.pnl.gov/nsd/commercial/scanner/

NOTABLE Achievements

From lab to market

What do two devices to detect nuclear explosions, a sensor technology used in food processing, cancer treatment and a software program for collaboration have in common?

The researchers who developed these technologies at Pacific Northwest National Laboratory were among the 35 honored by the Federal Laboratory Consortium for technology transfer into the private sector.

Each year the FLC, composed of more than 700 federal laboratories and centers, presents Awards for Excellence in Technology Transfer. The Laboratory has received 48 of these awards since the program began in 1984—more than any other federal laboratory.

Detection technologies: Two Pacific Northwest technologies are being deployed worldwide to verify compliance with the Comprehensive Test-Ban Treaty. The Automated Radioxenon Sampler Analyzer and the Radionuclide Aerosol Sampler/Analyzer permit fast, accurate and economical detection of radionuclides emitted from nuclear explosions in the atmosphere or underground. DME Corp. in Orlando, Fla., is producing and selling these units commercially for use in a global explosion-monitoring network.

Multi-blade knife failure detector: In the food processing industry an undetected knife failure can turn high-quality goods into truckloads of low-value products hauled away for animal feed. To combat the problem, a team led by Pacific Northwest developed a system that detects knife failures within one second, triggering an alarm and signaling a blade replacement. The system is installed at Lamb Weston food processing plants around the world. The same process monitoring technology is ensuring quality and reducing costs and waste in other industrial situations where gathering real-time production and processing data is difficult.

Yttrium-90 for cancer treatment: For a decade, the Laboratory has supplied hospitals with yttrium-90, an isotope used to treat many types of cancer. Now, they are supplying their efficient method for retrieving yttrium-90 from purified strontium-90 to Perkin Elmer/NEN Life Sciences in Boston, Mass. The Laboratory transferred the production, shipping, marketing and sales of yttrium-90 to Perkin Elmer/NEN and provided training and quality control oversight to ensure Food and Drug Administration standards are met.

Environmental Molecular Sciences Laboratory Publisher software: Developed for over-the-Internet collaboration among researchers, a powerful word processing and presentation tool is now for sale on-line. EMSL Publisher allows the same software to run on any computer platform, preventing the loss of formatting or readability that can occur when users run applications on different systems. Pacific Northwest signed a license agreement with Flashline.com of Cleveland, Ohio, to sell EMSL Publisher at **www.flashline.com** (search "PNNL"). ●

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