Breakthroughs

Science. Technology. Innovation.

FALL 2003

Science and technology on the front lines

Pages 8-15

A dialogue with the Director

-Page 4

Pursuing the hydrogen economy

-Page 7

PACIFIC NORTHWEST NATIONAL LABORATORY

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

Breakthroughs

Published by: Pacific Northwest National Laboratory, a multiprogram research facility operated by Battelle for the U.S. Department of Energy's Office of Science.

Staff:
Editor, Tim Ledbetter
Associate editor, Ginny Sliman
Writers for this edition: Bill Cannon, Geoff Harvey, Tim Ledbetter, Staci Maloof and Ginny Sliman

Frequency: Three times a year

Subscription price: Free.
Current edition, archives and subscription information available at http://www.pnl.gov/breakthroughs

Direct general inquiries and distribution questions to:
Tim Ledbetter
Phone: 509-375-5953
Fax: 509-375-6550
E-mail: tim.ledbetter@pnl.gov

Direct business inquiries to:
Marketing Communications
Toll-free phone: 1-888-375-PNNL (7665)
E-mail: inquiry@pnl.gov
Web site: http://www.pnl.gov

Direct media inquiries to:
Media Relations
Phone: 509-375-3776
E-mail: greg.koller@pnl.gov

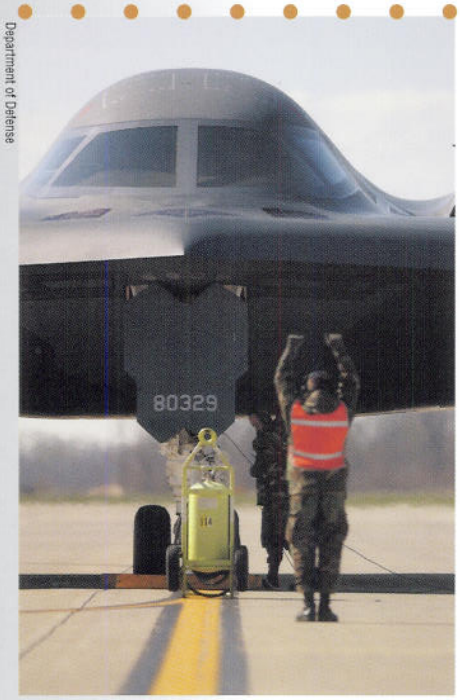
editor's screen

Pacific Northwest National Laboratory is known for its strengths in fundamental science and for being the location of the William R. Wiley Environmental Molecular Sciences Laboratory, a state-of-the-art research facility offering advanced research laboratories and instrumentation. While these capabilities evoke images of researchers in lab coats working with test tubes and beakers, PNNL also is recognized for its ability to integrate its basic science with technology to produce applications for national needs in energy, the environment and national security. In fact, a significant portion of PNNL's work is conducted for the U.S. Department of Defense.

In this edition of Breakthroughs, we highlight science and technology solutions that PNNL is delivering to the American military, as well as the role PNNL is playing in helping to transform and modernize various elements of the armed forces. Most agree that America must respond to an evolving world landscape and unconventional threats with innovative approaches to national defense.

Also in this edition, we interview PNNL's director, who discusses his plans for taking the Laboratory to new levels of achievement. In addition, we update readers on recent awards and honors received by staff at PNNL and examine a project that is helping King County, Wash., with the ponderous task of attaining a healthy balance between growth and protection of treasured water resources. ●

Contents



Department of Defense

A special thanks to the U.S. Department of Defense for images that appear on our cover and in the Special Report section.

DOE, Battelle agree to new contract

Scientific stretch goals are among the hallmarks of the new operating contract at Pacific Northwest National Laboratory.

U.S. Department of Energy and Battelle representatives gathered Aug. 26 at PNNL to sign the document, which allows Battelle to continue managing PNNL through Sept. 30, 2007.

The new contract builds on performance-based contracting used by DOE for the past several years. The pact includes three stretch goals—or major projects—in biological and environmental research, basic energy sciences and advanced scientific computing research.

"I believe the new contract is a truly wonderful opportunity for us to continue setting the benchmark for managing and operating a successful national laboratory," said Battelle Senior Vice President and PNNL Director Len Peters. Peters praised both DOE and Battelle representatives for their diligence in negotiating and finalizing the agreement.

Battelle has operated PNNL for DOE since 1965.

In the photo, Paul Kruger (left), manager of DOE's Pacific Northwest Site Office, and Len Peters sign the new contract. ●

PNNL supercomputer achieves full operations

Pacific Northwest National Laboratory is home to the United States' fastest operational unclassified supercomputer. PNNL's 11.8 teraflops industry-standard HP Integrity system came to full operating power in late August.

Based on peak performance, the PNNL machine is the fifth fastest system in the world.

"The U.S. Department of Energy continues to demonstrate its competitiveness in high-performance computing capabilities by investing in new systems and new approaches to scientific inquiry," said Secretary of Energy Spencer Abraham.

The supercomputer will enable scientists to solve scientific problems that are more complex, and do so more quickly, than other architectures.

"With this machine, PNNL is providing a balanced architecture that is designed specifically for environmental, chemical and biological sciences and the priorities of DOE's Office of Science," said PNNL Director Len Peters.

The supercomputer is housed in the Molecular Science Computing Facility of the William R. Wiley Environmental Molecular Sciences Laboratory, a DOE scientific user facility located at PNNL. Scientists from around the country can access the supercomputer for research through a competitive proposal process. ●

More power to the energy champ

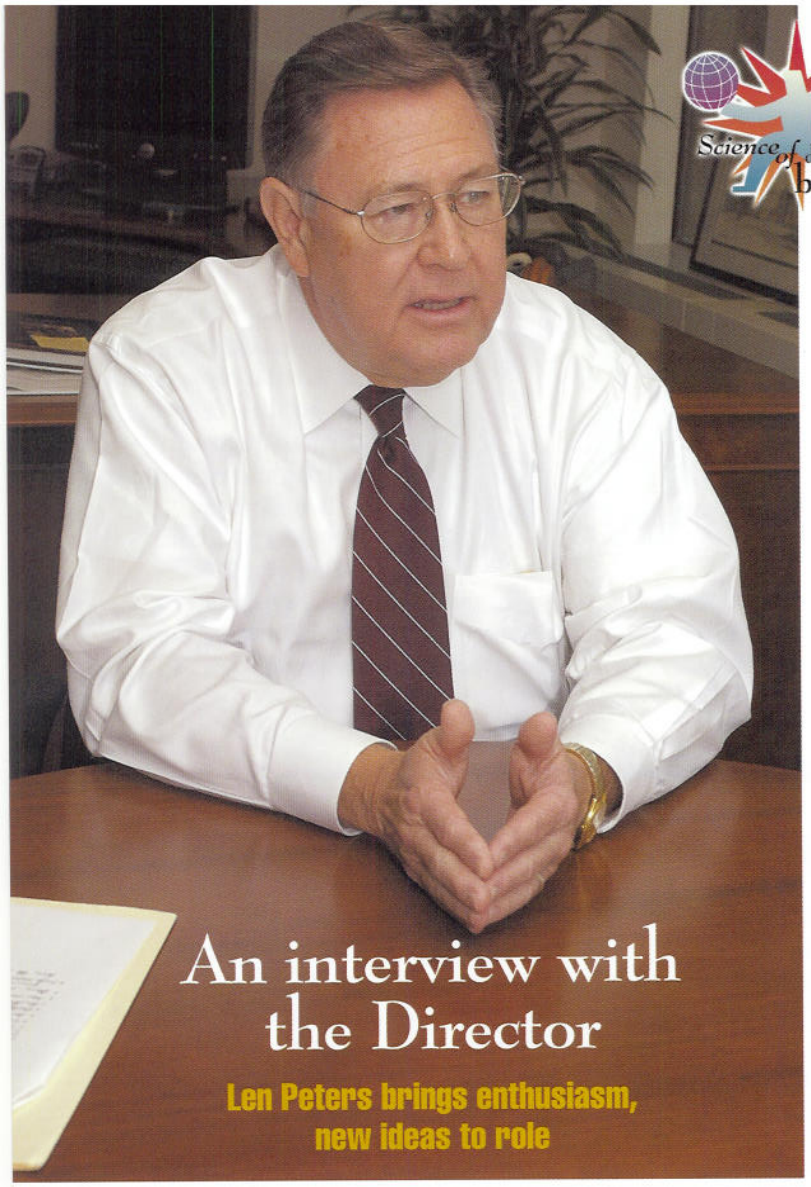
Pacific Northwest National Laboratory's Mike Moran has earned national recognition for his leadership in implementing innovations that promote energy conservation, reduce energy consumption and save taxpayer money.

The U.S. Department of Energy has named Moran, manager of PNNL's Facility Infrastructure Services, an Energy Champion. The prestigious award is part of DOE's You Have the Power program that recognizes individual leaders within the DOE complex.

Over the past three years Moran has instituted a variety of innovative energy conservation programs, including competitions between PNNL buildings to reduce energy consumption and acquisition of reasonably priced "green power" from a nearby wind farm.

Along with the recognition of Moran's efforts comes a poster with his picture, which has been distributed to other agencies to promote energy conservation. While it's Moran's face on the poster, he is quick to point to the contributions of his staff members, who constantly are looking for innovative ways to reduce costs and improve service. The team's efforts have saved PNNL over $500,000 in the past four years.

"We are pleased that our activities help PNNL conduct research in a cost-effective manner," Moran said. ●



Science of doing business

An interview with the Director

Len Peters brings enthusiasm, new ideas to role

Dr. Leonard Peters joined Pacific Northwest National Laboratory as director on April 1, 2003. Outgoing and affable, Peters insists that new acquaintances refer to him simply as "Len." His leadership style is similarly direct and free of pretense.

We recently visited with Len to see how he is settling into his new role and to gain a better understanding of his vision for PNNL.

After some time on the job, what are your impressions of PNNL?

By the middle of August, I had attended about 35 briefings across the Laboratory, visiting with staff in research directorates, business support services, operations and many other areas. After attending these briefings, I'm even more amazed and impressed with the breadth and depth of capability here at PNNL. The people are great. Staff and management know their jobs and are very dedicated to the Laboratory and Battelle (the operator of PNNL for the U.S. Department of Energy). They want this place to succeed.

National research and development needs are evolving. Is PNNL positioned to respond to these needs?

My sense is we are quite well positioned. Let me cite a few examples. There's the issue of the hydrogen-based economy, or using hydrogen to eventually replace fossil fuels as our primary source of energy. Related to that, we are recognized as one of the leaders in solid oxide fuel cells. We also will be working on safety issues surrounding hydrogen use, so I think we are positioned very well in that initiative, which President Bush has said is important to the nation. We're very strong in surface science, and I believe surface science, catalysis and interfacial science are keys to how the nation goes about making the hydrogen economy a reality.

Our work focused on developing a robust power grid system for the nation is important in terms of energy efficiency, homeland security and national security.

In the area of biology, we are focused on systems biology and are applying our unique capabilities in chemistry and physical chemistry. That builds on the strengths we have at the William R. Wiley Environmental Molecular Sciences Laboratory (EMSL).

We are an important contributor to national security, and are recognized as a leading contributor to the Department of Homeland Security as it gets up and operating. We have a number of people back in Washington, D.C., working with DHS, especially in their research and development activities, and PNNL is viewed as an asset.

Where does PNNL face challenges?

We have considerable strengths in the environmental area, whether it's in groundwater, water quality, ecology, atmospheric chemistry or climate change. As national needs continue to evolve, we will pursue new opportunities in environment-related work. We have to look at how we can in fact change or realign some of our strengths with the environmental priorities at this time. I'm confident we will do it, because we have very good capabilities and people in that particular area.

With DOE's Office of Science (SC) having oversight for PNNL, how well are we aligned with DOE-SC priorities?

When you really look at the DOE national laboratories, for the most part they are fundamentally physics-based laboratories. That's natural, as the system grew out of the Manhattan Project, a physical sciences-based activity. I think we are a unique part of the national laboratory system in that our fundamental strengths are in chemistry. Scientist per scientist, we have more chemists than any of the other laboratories. Certainly we have quality people in physics, biology, computing, mathematics and other areas, but fundamentally we are a chemistry laboratory. We have to use that as our unique strength and signature for the Department of Energy. I think we are doing that with EMSL, with our

Genomes to Life (GTL) work, and with the GTL facility we will be bidding on.

Our biologists bring the problems to the table, and we use that union of strong physical chemistry and insight from biologists to attack problems. Whether you are talking about catalysis, bio-based products or emissions reductions, those all have significant surface science, chemical catalysis and interfacial phenomena associated with them. We have considerable strengths in those areas that are aligned with where DOE wants to go.

In the whole area of national security and homeland security, we have strong capabilities in radiation and chemical detection, and we are developing strong capabilities in bio-detection, which aligns with Office of Science needs.

Another aspect involves partnerships. The Office of Science wants its laboratories to develop strong partnerships with universities in the region and across the country. We certainly are building on what already has been done, and are seeking to cultivate stronger relationships with research universities.

PNNL is proud of its success in achieving simultaneous excellence in science and technology, operations and community/regional leadership. PNNL also is proud of its customer service approach. I assume you are pleased with the Laboratory's progress in these areas.

Yes. It's clear that we know how to deliver things on time and on budget. We have a culture—that preceded me by a long time—that listens to the client carefully. I think we do a very good job of delivering what clients want in a timely fashion and a fiscally responsive manner. And we do that because we have good people—we bring the right people to the table. If in fact a program is going through our Energy Science and Technology Directorate and they need scientists from the Environmental Technology Directorate, those people move to that project very readily. That's one of the ways we can exploit the capabilities that we have—by bringing the right people to bear on the problem at that point in time. We will continue to maintain and grow that culture.

We are recognized as, if not *the* leader, then certainly one of the leaders in the national labs in terms of how we operate. We operate efficiently, effectively and responsibly. We want to make sure that safe operations are so second nature to us that we can concentrate on doing outstanding research and development and contributing to the nation, the region and to the community overall.

What are the keys to future success at PNNL?

At the end of the day, the people and the facilities we have are the keys to success. One without the other does not get it done. We have to make sure that we hire the very best people, nurture them and develop them. We must keep our facilities at the cutting edge. If you have bright people, provide them with the facilities and wherewithal to conduct work, they are going to deliver good science and technology for our clients, be it DOE, DHS, the National Institutes of Health, other federal agencies or private sector clients. ●

Where does Len Peters want to take PNNL? There are seven objectives on his road map for the future.

1 Emphasize chemistry

"We will exploit our strengths and uniqueness in chemistry. We want to make sure that DOE recognizes us as their chemistry laboratory. This ties in specifically with EMSL, and the way we're going to aggressively pursue systems biology and proteomics and make contributions to the nation's research and development needs."

2 Build the energy portfolio

"We have to remember that we are a Department of *Energy* laboratory. We're building our energy portfolio right now through work focused on hydrogen, fuel cells and GridWise™ (a program seeking to improve the nation's energy delivery system). We're going to be focusing on expanding work in those areas. We also can apply our considerable strengths in the chemical sciences area to our energy portfolio."

3 Realign environmental work

"We must realign our environmental work to address evolving national needs. We have strengths that are second to none in the world, be they related to subsurface science, ecology or atmospheric research. Our capabilities are an asset to the nation and we have an obligation to make sure we do not allow these assets to dissipate in any way."

4 Contribute to homeland security

"We are currently beginning to build a solid relationship with the Department of Homeland Security. We're going to continue to build that relationship, and we are going to do it in a way that the Department of Energy and the Office of Science see as beneficial. I believe it is critical to get DHS up and operating with a good, strong science and technology base, and PNNL is a part of that formula."

5 Build new facilities

"Within the next seven years, we will move out of a significant number of the facilities in the 300 Area (part of DOE's Hanford Site, north of the main PNNL campus) where we conduct work. It is critical to PNNL that we make this transition in a way that builds future science and technology strengths. We have to look where the science is going and pursue new facilities."

6 Strengthen the area's science and technology base

"We are going to be a much greater catalyst for building the private sector science and technology base in the region. I believe very strongly that PNNL can't exist in a healthy way in this community without that broader base. In the next few months, we will be announcing ways we think we can be a catalyst for building the private sector science and technology base."

7 Assume stronger regional role

"Regional advocacy involves expanding our relationships with the research universities in the region, and using those relationships to create stronger ties over and through the "Cascade Curtain" of Western Washington and Oregon. Increasingly, we are being seen as a major science and technology resource in the region. We will continue to build that image through expansion of our university relationships, as well as relationships with state governments, industry and other Northwest entities." ●

Researchers help county balance water and growth equation

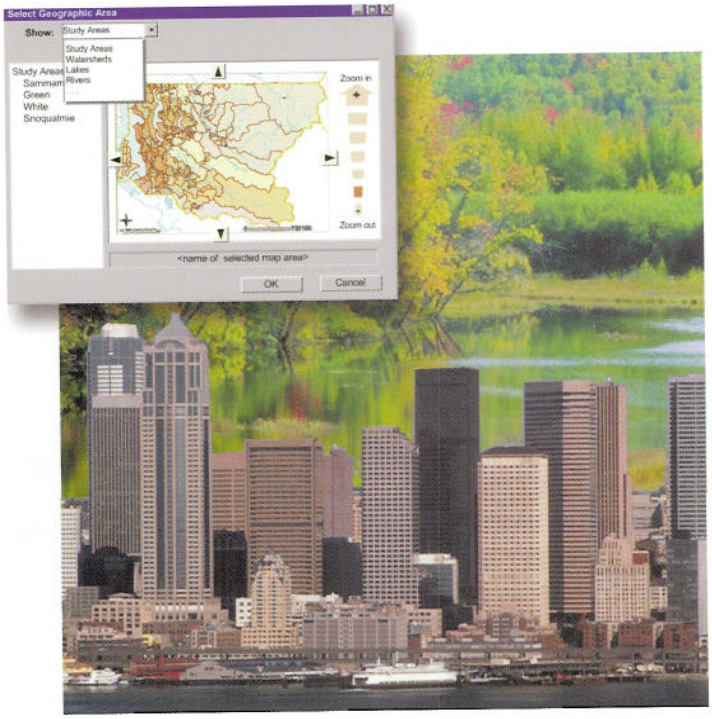
Population growth in a city or county often is a sign of health—a positive reflection of a region's economic, social, environmental and other "quality of life" features. But for many municipalities, maintaining a healthy balance between regional growth and natural resource management is increasingly difficult.

In King County, Wash., which includes the expansive Seattle metropolitan area, the county's Department of Natural Resources and Parks is looking to Pacific Northwest National Laboratory for assistance with a new approach to planning and resource management. PNNL is working with the county to develop a computational modeling system that predicts the potential impacts of urban activities, including growth, on the area's watersheds, lakes, estuaries and rivers.

"Ecologically, King County is a very diverse area. From the Cascades to the Puget Sound, there are multiple watersheds, rivers and large lakes, all of which are important to the region. And in the middle of this, we have the Seattle metro area," said David Thurman, a PNNL senior research scientist leading the modeling system project. "Managing growth and planning for the future are significant challenges in King County and many other areas of the United States."

PNNL began working with the county in 2000 to lay the groundwork for the Integrated Water Resource Modeling System (IWRMS), which should be completed within the next two years. The system will offer a modular, distributed software architecture that supports the incorporation of legacy and newly developed computational water resource models and data sets into an integrated whole that can be accessed via individual computer workstations. Initially, IWRMS will include the Hydrological Simulation Program-FORTRAN watershed model, lake and river models developed by the U.S. Army Corps of Engineers and human and ecological health risk models yet to be developed. Once the IWRMS is operational, the county will be able to integrate additional data and models—everything from simulations of urban growth and land-use effects on watersheds to water flow and quality in rivers, lakes and estuaries—into the system, which will provide automatic data transformation between models. The resulting system will enable the county to better understand how potential development actions might affect water resources and other elements of the environment.

"It could be used to evaluate diverse scenarios such as drinking water withdrawal from urban lakes or discharge of treated water on agricultural fields. The goal of the system is to provide a flexible modeling environment the county



can adapt to a variety of scenarios, enabling production of scientifically valid modeling results in a timely fashion," Thurman said. "Our goal isn't so much to develop a system, but to help the county build a problem-solving capability."

Approximately a dozen researchers located at PNNL's Seattle and Richland, Wash., campuses are developing the system in partnership with county staff. To date, much of the project has focused on defining the system requirements and establishing interactions with "stakeholders"—or the various county staff who will be using the system and its outputs. Several prototype systems will be delivered to the county over the next couple of years and fine-tuned based on feedback from the users. The final system not only will provide valuable new capabilities to the county, but will significantly reduce the amount of time needed to produce useful data and, possibly, lead to quicker, more effective decision making.

"We believe this type of system would be valuable to many municipal governments who are wrestling with complex growth and natural resource management issues and who have a desire to use computational models to help inform their decision making," Thurman noted. ●

PNNL focuses on the hydrogen economy

It appears the hydrogen economy is coming, and Pacific Northwest National Laboratory will be helping to fuel it.

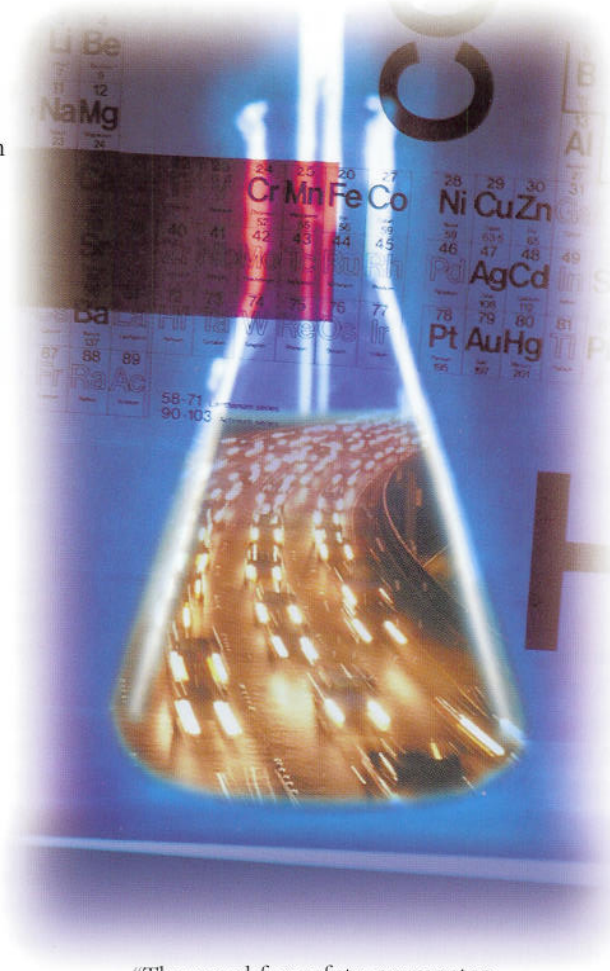
Earlier this year, President Bush called on America's scientists and engineers to overcome the obstacles in producing hydrogen-powered vehicles "so that the first car driven by a child born today could be powered by hydrogen." He also announced plans for more than $1 billion in research funding to help get the job done.

But moving toward hydrogen-powered cars and a broader "hydrogen economy" is easier said than done, as there are many challenging issues to resolve, including hydrogen production, safety and storage.

"Our research capabilities at PNNL have positioned us to become a key provider of science and technology to help address these issues and others," said Moe Khaleel, a Laboratory Fellow in PNNL's Energy Science and Technology Directorate.

"One area we will be exploring," he continued, "is hydrogen production from renewable resources, including biomass gasification and high temperature steam electrolysis. We also will be looking at ways to apply fuel cells to the more efficient operation of large trucks."

In the hydrogen safety arena, the U.S. Department of Energy already has tapped PNNL to lead national safety efforts through the Hydrogen Codes, Standards, Safety and Utilization Program. PNNL has been involved in codes and standards development for years, but this new role will have a broader emphasis.



"The need for safety permeates every element of the hydrogen economy," said PNNL Program Manager Bruce Kinzey. "Our efforts will be focused on wide-ranging safety issues, including education and training for the public, examination of the risks and failures associated with hydrogen systems and, to a lesser degree, we will still contribute to codes and standards.

"Hydrogen has been used for years, but it has been carefully controlled and the people who use it have been very well trained," Kinzey added. "The hydrogen economy is essentially a new application and safety will be important in gaining consumer acceptance."

The Laboratory also is pursuing solutions for hydrogen storage. Researchers at PNNL have, for many years, studied hydrogen in structural materials and, more recently, have been pondering advanced storage concepts. According to Russell Jones, a Laboratory Fellow, PNNL will respond to DOE's call for hydrogen storage proposals with as many as five projects focused on new materials. PNNL also proposes to partner with Los Alamos National Laboratory and other organizations to create a center for hydrogen storage research, where the focus would be on chemical hydrides as a storage medium.

In addition to supporting the national hydrogen economy effort, PNNL is shedding more light on the subject in the Pacific Northwest region. In June, PNNL and the Northwest Energy Technology Collaborative sponsored the Hydrogen Production and Northwest Transportation Conference in Seattle, Wash. The event brought together 150 industry, government and business leaders to discuss ways the region's technological capabilities, entrepreneurial spirit and energy resources can advance the hydrogen economy concept.

Presentations from the conference and additional information are available at **http://www.pnl.gov/energy/hydrogen/**. ●

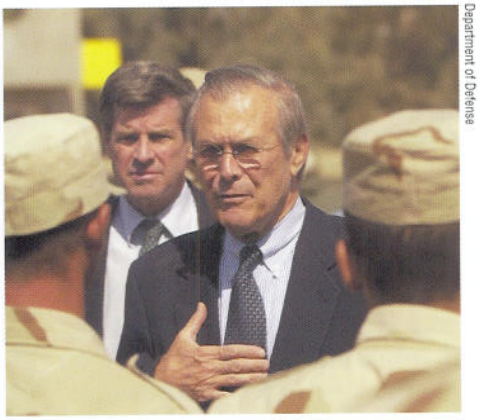
Science, technology and America's military in the 21st century

PNNL capabilities are supporting the armed forces in a time of change

The U.S. Department of Defense contends that it is America's oldest, largest, busiest and most successful company. With roots that reach back to the nation's founding days, a workforce of more than two million people (civilian and active duty), responsibilities that span the globe and an impressive legacy of protecting the country, DoD is indeed one of the nation's premier institutions.

And while some might add "resistant to change" to the department's list of attributes, actually change—or "transformation" as the defense community terms it, is front and center these days at DoD.

In a speech last year at the National Defense University in Washington, D.C., Defense Secretary Donald Rumsfeld, keying on the transformation theme, recounted some of the details of the 2001 battle of Mazar-e-Sharif in Afghanistan. Rumsfeld told the story of how U.S. Special Forces personnel, on horseback, signaled enemy targets to the coalition aircraft flying above. Then, joined by Afghan fighters, the Americans rode their horses into battle just as precision-guided bombs rained down on Taliban and al-Qaida positions.



Department of Defense

Donald Rumsfeld

The point of his remarks, Rumsfeld emphasized, was not that America should start stockpiling saddles, nor that the battle was a model for future warfare. "Coalition forces took existing military capabilities—from the most advanced (laser-guided weapons), to the antique (40-year-old B-52 planes updated with modern electronics) to the most rudimentary (a man on a horse with a weapon)—and used them in unprecedented ways, with devastating effect on enemy positions."

Rumsfeld added that preparing for the future will require the military to adopt very innovative approaches, to think differently and creatively.

Department of Defense

U.S. Special Forces troops ride horseback as they work with members of the Northern Alliance in Afghanistan in 2001.

TECHNOLOGY on TARGET

Cooling systems

Some days in Iraq the temperature soars to well over 100 degrees Fahrenheit. But even on relatively cooler days, U.S. military personnel wearing heavy protective clothing and performing labor-intensive tasks not only are uncomfortable, but may be vulnerable to heat stress.

Current cooling systems can be integrated with protective suits to provide some degree of relief. Unfortunately, these systems are heavy—weighing 25 pounds or more.

Researchers at Pacific Northwest National Laboratory are working on some cool solutions for hot situations. Supported by funding from the U.S. Army's Natick Laboratory, the researchers are developing a self-contained personal unit that would provide approximately 150 watts of cooling and weigh about six pounds. Additionally, funding from Ft. Belvoir, Va., is providing opportunities to explore development of other lightweight, portable cooling devices.

Chief Engineer Bob Wegeng said PNNL's efforts are centered on the creation of a miniature version of a heat-actuated heat pump, including microchannel heat exchangers and other microchannel components. "This approach is substantially more process intensive than if the same unit operations were performed using conventional technologies," he explained, "resulting in a system that is much smaller and lighter."

The key to the device is the development of an extremely compact "thermochemical compressor," which would replace the bulky, mechanical compressor that is present in conventional cooling systems and which requires an electrical supply in order to operate.

PNNL staff members are joined in the project by Oregon State University researchers via the Microproducts Breakthrough Institute, a PNNL-OSU collaborative research effort focused on developing advanced microproducts.

In addition to cooling for soldiers, Wegeng said other military-related applications that may emanate from the research activities include thermal control for electronics equipment as well as air conditioning for military vehicles and cooling systems for transportable containers. ●

The challenges ahead

Many experts agree that transformation of the U.S. military from a heavy, "grind it out" fighting corps to a more rapid and tactical force is necessary. They also agree that the "symmetrical" warfare that most people think of—two enemies squaring off on a battlefield—is not the scenario of the future.

"America's military is more or less configured for Cold War threats. The threats we face today are very diverse, from terrorists to rogue nations. We have to be able to rapidly move a major force to a distant place and respond," said Terry Doherty, director of Pacific Northwest National Laboratory's Department of Defense Programs. U.S. war efforts in Afghanistan and Iraq, he noted, have provided glimpses of how a transformed military would operate—quickly and lethally.


Doherty

Mario Bagaglio, deputy director of DoD Programs at PNNL, contends that the U.S. military force "is the best in the world, and that has been proven over and over." But changes around the globe, he continued, "dictate that we be able to go anywhere at anytime and be able to fight when we get there, without an extensive buildup of forces over months."


Bagaglio

Doherty, Bagaglio and their PNNL colleagues are well acquainted with the military's transformation initiatives, which were launched in the late 1990s and continue to gather momentum. In fact, PNNL researchers are working in many different areas to supply breakthrough technologies that will help march the military from its Cold War configuration—and costly infrastructure—to a leaner, more affordable and effective defense system.

The desired capabilities will require innovation, which good research and development can deliver. "When you look at the next three to five years, I believe there are some fruitful opportunities across the spectrum of basic and applied research and development," Doherty said. "We're seeing changes in military philosophy, prompted partly by the 9/11 tragedy and Iraq. Ideas that were being talked about several years ago are beginning to become reality. Science and technology have a role to play."

PNNL: long-standing support and a focus on the future

PNNL has played an integral role in national defense for many decades. The Laboratory's involvement stretches back to its genesis in the 1940s as the research arm of the Hanford Site. Over time, PNNL's capabilities and contributions have evolved and diversified. Now, with science and technology as key ingredients in the recipe for military transformation, Bagaglio believes PNNL's legacy of defense-related research will serve as a vital resource for a new generation of military needs and challenges. The Laboratory's capabilities span the scientific and technical disciplines, ranging from fundamental science inquiries to development of energy efficiency strategies that will help military bases spend less money for electricity and other power sources.

"At PNNL, we don't build planes and ships, but we support the military in many ways. Our capabilities are focused in areas such as advanced sensors and electronics for diagnostic and prognostic devices, lightweight power systems and new materials, which contribute to current and future armed forces needs," Bagaglio said.

And according to Russel Rhoads, a senior logistics program manager at PNNL, "The largest single area we are impacting is U.S. Army logistics, where we are providing


Rhoads

Online training

Quick and effective training of personnel is a challenge faced by many organizations, including the armed forces.

At Pacific Northwest National Laboratory, a multidisciplinary team of research staff is developing an innovative computer-based training method that could offer a viable alternative to classroom instruction while enhancing overall learning.

In the past year, the research team, led by Chief Scientist Frank Greitzer, delivered to the U.S. Army an online, interactive course designed to help soldiers learn to assemble, use and troubleshoot a wireless communication system on the battlefield. Greitzer said the Army's Program Executive Office/Enterprise Information Systems was pleased with the product, but the war in Iraq and other issues intervened, placing the online course in a holding pattern.

But recently, the Army completed a review of the PNNL-developed course and contacted Greitzer, explaining there is growing interest in developing training methods that are more efficient and effective. That's good news for the research team at PNNL, which has been asked to proceed with development, including adapting the training system to comply with some new Army requirements.

Although computer-based training might seem the wave of the future, Greitzer said it has not made as much progress as one might expect. "It can be very dry and passive for students, and to be effective, multimedia elements should be tied closely to learning objectives," he noted. "What our team did was utilize multimedia technology to create integrated, visually dynamic and interactive instruction that is structured very methodically to address specific learning objectives, from simpler concepts up to the complex."

This training technique offers quizzes, interactive elements that provide important morsels of information, an emphasis on troubleshooting and a final, scenario-based exercise. "In the exercise, the soldiers go into the field virtually, develop a deployment plan, set up the wireless equipment and troubleshoot problems, such as frayed cables or improper equipment settings. We address all the major learning objectives of the course," Greitzer explained.

The development project is drawing upon PNNL expertise in multiple areas, including national security, information technology, cognitive science, instructional design, multimedia/graphics design and network communications. PNNL is using a tool that was built in-house, Pachelbel™, to develop and deliver this innovative distributed learning course.

new approaches to policy, processes and technology that improve the coordination of Army activities. We played a major role in development of the Army's new logistics system." PNNL currently has staff co-located with the Army's Logistics Transformation Agency at Fort Belvoir, Va. The group of PNNL experts advises the Army on a wide range of logistics issues.

PNNL also is working with the Army at Fort Lewis, Wash., to create "Stryker Brigade" combat teams. Each team is designed for rapid deployment and is built around the "network-centric" approach, which depends on acquisition of intelligence and related information to rapidly pinpoint enemy positions and take action before the enemy has time to think. The project also is deploying a new set of interim fighting vehicles that are lighter than tanks, and thus easier to transport from one location to another.

"PNNL has a team of staff helping Fort Lewis to plan and execute how they put the brigades together and how to deal with supportability issues (supply lines, etc.), which is key to deployment. Our staff members also are watching how this brigade is coming together and are identifying issues and impacts," Rhoads noted. "We are in a unique position. We are gaining insights to the technology issues that are going to occur between assembling this highly deployable force and the end-state future combat system."

Department of Defense

PNNL is making contributions to the military in a number of other areas, including:

Fundamental science—The state-of-the-art William R. Wiley Environmental Molecular Sciences Laboratory, located at PNNL, and PNNL's strengths in areas such as chemistry and biology will continue to produce key scientific knowledge that can be applied to the development of new chemical and biological detection technologies.

Environmental technology—PNNL will continue to help solve emerging environmental issues, such as working with the Army to ensure minimal impacts to the environment from the operations and training activities carried out at various installations and demilitarization of other sites.

Energy—PNNL is applying its capabilities in fuel cells, materials and other disciplines to provide small power sources for soldiers and deliver energy efficiency applications that reduce energy consumption at military installations. PNNL's Decision Support for Operations and Maintenance™, an intelligent diagnostic software program that increases productivity and helps ensure that equipment is running efficiently, is being used at Marine Corps installations where it is significantly reducing energy usage and saving taxpayer dollars.

Information technology—PNNL's visualization technologies, which sort through large amounts of data (text, images, video, sound) to find common themes and relationships, currently are being used by the military, particularly for intelligence purposes. Similar to homeland security, making good use of a diverse array of information is critical for identifying potential threats, now and in the future.

"PNNL's strengths in DOE mission areas connect well to the nation's defense challenges. Many of the researchers at PNNL who are looking at these challenges are scientists and engineers who themselves were in the military in the past," Doherty said. "For them, and all of us, it's a personal priority to develop the next generation science that will protect our homeland and win our battles around the globe." ●

Infrared sensing

On the battlefield and elsewhere, there are growing concerns about the possible use of chemical agents. Such materials are relatively easy to make, hide and release, and pose a potentially lethal threat to troops and civilian populations. Infrared sensing is showing significant promise as a technique for quickly detecting chemical effluents in the environment.

Scientists in the Infrared Technologies Program at Pacific Northwest National Laboratory are developing a new generation of remote and point sampling chemical sensors for the U.S. Department of Energy, the Defense Advanced Research Projects Agency (DARPA) and others. Envisioned applications include a wide variety of defense and homeland security operations, environmental and industrial applications and medical diagnostic equipment.

The chemical sensors are based on spectroscopic sensing techniques enabled by miniature, selectively tunable lasers operating in the mid-wave and long-wave infrared regions of the spectrum. These particular regions are known as atmospheric transmission windows because water and carbon dioxide, two gases present in large concentrations in the atmosphere, do not absorb here. It thus becomes possible to detect minute concentrations of other gases present in the local environment because interference effects are minimal.

The particular lasers that the Infrared Technologies Program is using are quantum cascade and interband cascade lasers, which currently are being developed at Lucent and Maxion Technologies.

PNNL's Infrared Sensing Initiative, which was completed in 2003, served to help PNNL establish a broad technical capability in designing and building components critical to infrared sensing, an attribute now considered unique among DOE laboratories. ●

For soldiers, tiny may be big in solving battlefield power needs

The enemy is not the only challenge that a soldier faces in the combat zone.

As troops move across an unforgiving battlefield, individual soldiers carry an array of advanced electronic devices, powered by heavy, cumbersome batteries, which often need to be replaced on a daily basis. It has been reported that during Operation Iraqi Freedom, battery supplies barely met the demand.

Certainly the electronic devices—which include computers, radios, laser sights, night vision displays, global positioning systems and environmental sensors—provide a competitive edge, but the U.S. armed forces are looking for ways to lighten the load.

For several years, Battelle researchers at Pacific Northwest National Laboratory have worked with the U.S. Army to develop small, lightweight power sources. About a year ago, the effort became a joint Army-Navy program for the Army's Communications-Electronic Command and the U.S. Marine Corp's Expeditionary Program. The principal researchers are Matt Donnelly, Jamie Holladay and Daniel Palo.

Through this work, scientists are developing a fuel cell power system designed to produce about 100 watts of energy for recharging batteries and powering small electronic devices. The system, which should be complete in about two years, will use methanol fuel, a Battelle-developed fuel processor and a proton exchange membrane fuel cell to produce electricity. When developed, the unit will be about the size of a half-gallon container of ice cream. Eventually these small power systems will be transitioned to run on other hydrocarbons such as butane, propane and kerosene-based JP-8 fuel for the military.

Before delivering the final technology, Program Manager Chip Larson said there will be several intermediate steps or objectives.

In March 2004, for example, researchers will provide a small suitcase-sized version of the system that will still be portable, but will not offer optimized capabilities. Continuing optimization and miniaturization efforts will follow, bringing the device down to the size of a shoe box. In the third and final year, the system will be further fine-tuned, reduced in size and made more rugged for military use.

According to Larson, "The system will require minimal operator intervention. All the soldier will have to do is keep it fueled."

One of the prime advantages of such a power source is that there will be no need for the soldiers to carry hydrogen, nor will the military have to store and transport the gas. "Our plan is to produce a system where methanol goes in one end and electrons come out the other," Larson said. "Methanol is flammable, but it is certainly much easier to manage than hydrogen."

Development of the system will rely on multiple capabilities, including microtechnology, advanced catalysts, new sensor technologies and smart systems. In addition, a key focus of the effort is to ensure that the finished system uses as many "off-the-shelf" components (pumps, fans and other parts) as possible. "These power systems will have to be built in large quantities at some point in the future, so we are making sure that the parts we use, where possible, are commercially available or can be adapted from commercial parts. We don't want a situation where parts have to be made by a researcher in a laboratory," Larson explained.

Although initially the power system will be used to recharge batteries, it's envisioned that the technology will evolve into a power supply that is integrated with equipment used by soldiers.

"Most everyone agrees that the soldier of tomorrow is going to be carrying more electronics. Today, troops carry about five electronic devices and some experts believe that number will grow to eight or nine over the next decade," Larson said. ●

Moving Army logistics forward

As the U.S. Army modernizes its fighting units, it also needs to modernize the way it supports these troops. Pacific Northwest National Laboratory staff are working with the U.S. Army's Logistics Transformation Agency (LTA) to help transform the way the Army supports our troops.

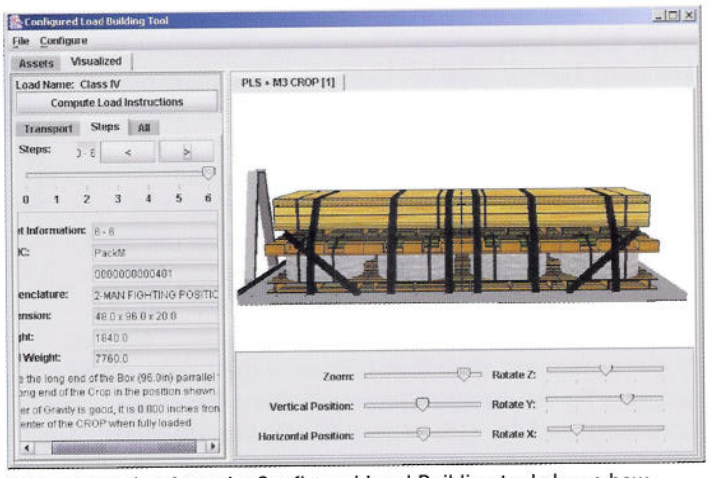
"The backbone of a successful war is logistical support—from providing the right types of material to getting that material to combatants in a timely and reliable manner," said Dave Scharett who manages PNNL's work with LTA.

Scharett and his staff work on-site at the LTA in Ft. Belvoir, Va., to help identify advanced and emerging technologies that could support Army modernization. "A key part of that modernization is transforming the capability of logistics functions to make them more efficient, timely and less costly while not adversely affecting the force's combat effectiveness."

The team's search for technologies encompasses not only PNNL and other national laboratories, but also other federal agencies, various branches of the armed forces, universities and private industry, both nationally and internationally.

During the war in Afghanistan weight-in-motion (WIM) technology was identified to speed up loading of Apache helicopters onto C5 aircraft. Currently, all combat vehicles must be weighed and balanced before loading for deployment. To do this, a soldier must drive a vehicle onto a scale and perform calculations manually.

WIM, a combination of advanced sensors, microtechnology and artificial intelligence, performs all the calculations in an automated system. "You can drive a vehicle, including trailers, over the system at 5-15 miles per

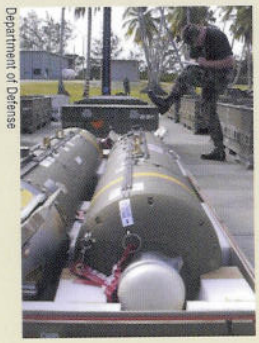


This screen shot from the Configured Load Building tool shows how equipment would be configured for two soldiers who would be setting up a traffic checkpoint.

Keeping the Army's industrial base healthy

"If the soldier shoots it, drives it, flies it, wears it or eats it, AMC provides it." Army Materiel Command's motto tells it all. AMC is one of three U.S. Army logistics operations supported by Pacific Northwest National Laboratory team members on site at AMC in Alexandria, Va.

PNNL's Susan Alten and Maude Wickline work with the Armament Retooling and Manufacturing Support (ARMS) Program and Headquarters AMC in making the Army's industrial base for ammunition as efficient and cost effective as possible. "You need to make sure the Army can get what it needs in a contingency and that during times of peace that capacity doesn't go away," Alten said.


Department of Defense

The team analyzes plant production and the best use of excess equipment. They facilitate ARMS conferences and analyze legislation that might affect the military's industrial base. PNNL's Richard Auger and Tom Shirk make recommendations and provide reports to the House and Senate Armed Services Committees.

"We want to make it in a company's best interest to help the Army maintain industrial base readiness," Alten said. "Sharing costs is one way to make the facilities more cost effective. Often we have contractor-operated facilities bring other companies in to share the facility, and in some cases idle equipment, which lowers overhead and brings down the cost of ammunition."

The PNNL group also supports the Army Ammunition Community in forecasting ammunition needs and determining the most cost-effective means of meeting these requirements, particularly under changing demands. "Right after Sept. 11, the PNNL team spearheaded the Ammunition Community's effort to determine required combat loads for munitions for the predicted force deployments. It was a huge effort in a short time, but it paid real dividends," Alten said. ●

hour without stopping. Instead of taking 30 minutes for each rig with a 20 percent error rate, it's now 30 seconds per vehicle with a zero percent error rate," Scharett said. "A Stryker Brigade has over 1,100 wheeled vehicles. Using WIM means loading in a few hours as opposed to a few days. For fast deployment, this is a great advantage."

Another new concept, configured loads packaging, is a more efficient way of distributing supplies to soldiers. "We can package supplies and configure them in a way that they can be sent from strategic level to tactical level with no need to do any reconfiguration or tailoring of load," said Dan Labin, who directs PNNL's support of the configured loads project.

Faster and more precise than current supply methods, configured loads packaging is also interactive. A commander in the field can order supplies and have them delivered in the exact configurations they want and packaged using a platform that is compatible with how they plan to unload it.

Scharett and colleague Joyce Moody also write the logistics section of the Army's science and technology master plan, which is used annually as testimony to Congress on the Army's R&D program. The plan provides the Army with information on future technologies and recommendations on which might be useful to the Army. ●

Department of Defense

PNNL performance analysis tool helps Army keep on track

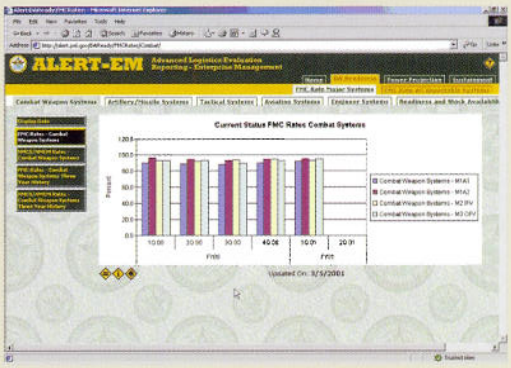
Transforming the logistics supply pipeline is an important part of U.S. Army modernization plans.

Pacific Northwest National Laboratory has developed a capability for analyzing the performance of logistics supply—quickly, using already available data and the Internet.

Advanced Logistics Evaluation and Reporting (ALERT-EM) tracks the progress of supplies in three functional areas—readiness, power projection and sustainment, using metrics such as requisition wait time, acquisition lead-time and daily dollar value. Using ALERT-EM, senior decision makers at the Pentagon can see current and historical performance of the Army's logistics system—how well it is supplying troops with everything from paper clips to ammunition.

The software has three interfaces, executive, staff and scorecard. The Metrics Scorecard compares the metrics and goals and rates the metrics as red, amber and green to show whether a metric is meeting its goal or not. Users subscribe to Scorecard and are notified by e-mail when their Scorecard metric ratings change.

Although ALERT-EM was developed for the Army, it can be adapted to other domains. ●



Technology helps maintain munitions health

For the past three years, Pacific Northwest National Laboratory has been developing a technology that monitors munitions in storage, shipment and delivery to the battlefield. Now, with the military exploring new types of ammunition, and with requirements calling for future munitions to have "health monitoring systems," PNNL's work may prove very useful.

The technology created at PNNL is known as the Remote Readiness Asset Prognostics and Diagnostic System (RRAPDS, pronounced "rapids"). The PNNL system was designed initially for anti-tank ammunition and provides key information such as munitions readiness, tracking and inventory, maintenance history and data analysis, including diagnosis of potential problems.

The system includes radio frequency sensor tags that are attached to pallets upon which ammunition is transported or stored. Each pallet may hold up to 60 munitions, with a total weight exceeding several tons.

"The sensors monitor environmental factors such as shock—which could occur if the weapons are accidentally dropped or jolted during transport—and high temperatures," said Research Scientist Jim Skorpik, who has been leading the RRAPDS project. "Shock at cold temperatures or heat at high temperatures can negatively impact the propellant within the munitions."

Information captured by the sensors can be "read" at distances exceeding 100 feet by a special interrogator device that downloads the input to a computer program that maintains a history record and other

Department of Defense

data. The complete RRAPDS process ensures that the Army knows where potential problems exist within groups of munitions and can take appropriate disposition actions. Tracking of munition conditions can be carried out from the manufacturer's location to the storage igloo and to the point of deployment.

The RRAPDS project has been funded via the U.S. Army's Armaments Research, Development and Engineering Center in New Jersey. Most of the initial development activities at PNNL were completed within the first year, followed by work designed to enhance the system's capabilities and versatility. Special testing of the technology was conducted in South Korea in 2001 and in Kuwait in 2002. This fall, the Army is launching a series of RRAPDS demonstrations at military sites around the country where installation of the system would be beneficial.

"We also are looking down the road at new developments in Army munitions," Skorpik explained. "For example, future weapons development projects, such as one focusing on the creation of a joint common missile for all military service branches, will include health monitoring requirements.

"With RRAPDS, we have a solid understanding of health monitoring issues and have used this knowledge to develop integrated solutions," he emphasized. ●

The RRAPDS technology makes it possible to gather information about the condition of munitions.

Military extends "protect and defend" motto to the ecosystem

Experts in hydrology, soils, remote sensing and wildlife habitat analysis from Pacific Northwest National Laboratory are developing technologies that will help the U.S. Army's Yakima Training Center assess how military training exercises impact the site's arid ecosystem and make decisions about land use. The YTC is located in Washington state.

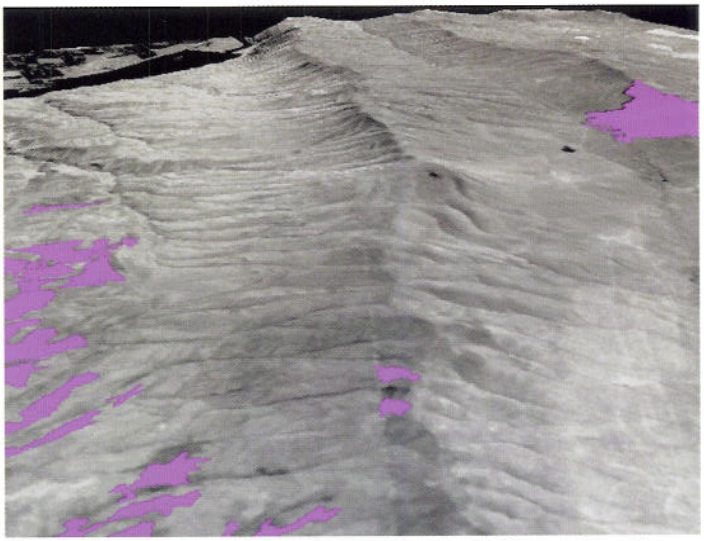
"Although YTC's overriding responsibility is training U.S. soldiers, they also have to work within a regulatory framework," said Mark Wigmosta, a PNNL hydrologist and project manager for a decision framework tool the Laboratory is creating for YTC. "They're trying to stay ahead of the curve as far as environmental regulations. Plus, they want to make the training center sustainable because if they degrade it too much, it will be more difficult to train there."

A sprawling 327,000 acres of sagebrush, volcanic formations, dry gulches and towering rock outcroppings, YTC is home to the sage grouse, a threatened species in Washington state and a candidate for endangered species status nationally. Abrams tanks, stryker vehicles, heavy artillery, tracers, bombs and grenades also inhabit YTC during training season.

Led by PNNL's Larry Cadwell and Janelle Downs, researchers provided sage grouse habitat and habitat change information that the military could use to plan training, restoration and resource management. "We went out and measured how much damage was done to the landscape after training, how many sagebrush were destroyed and how many were damaged by tracked and wheeled vehicles over the years," Downs said. "Then we combined this information with simulation models for vegetation change to produce Geographic Information System maps predicting changes to sage grouse habitat at various training intensities."

In another project, PNNL researcher Jerry Tagestad uses remote sensing data—satellite images and aerial photographs—to identify areas that burn during the training season.

The Laboratory provides YTC with a yearly map of fire locations in the form of a digital spatial data layer. "The fire product can be overlaid on a digital map of vegetation in a Geographic Information System," Tagestad said. "You click one button and can see how much vegetation—how many acres of grass, how much sagebrush—was lost during a fire. This type of fire mapping has an advantage over flying around a fire perimeter, because we can easily detect unburned areas within the burned areas. This gives us not only a more precise acreage calculation, but knowledge as to the location of unburned islands, which is extremely valuable from a restoration standpoint." YTC uses the fire map to plan restoration and sage grouse habitat management.



This three-dimensional image of the Yakima Training Center shows fires in magenta overlaid on a satellite image.

In a new project, PNNL scientists are developing a decision framework that YTC managers can use to assess and predict the impact of training activities on sediment loss and, ultimately, area watersheds. Supported by the U.S. departments of Defense and Energy and the Environmental Protection Agency, the Strategic Environmental Research & Development Program is intended to benefit all military bases.

"We're using remotely sensed images, plus more than a decade of historical data we've gathered at YTC, as inputs to hydrological models that will predict soil loss through erosion based on various training activities, intensity of training, weather conditions, topography and location on site," Wigmosta said.

PNNL technical expertise provides a solid scientific basis for decision makers in ecology, military operations and range stewardship to reach a balance between realistic training and sustainable environmental management. ●

Fisher, Stansbury honored

The Health Physics Society has named two Pacific Northwest National Laboratory senior scientists as Fellows of the Society.


Darrell Fisher


Paul Stansbury

Darrell Fisher and Paul Stansbury are recognized for their "significant administrative, educational and scientific contributions to the profession of health physics."

Fisher joined PNNL in 1978. He is a medical physicist with experience in nuclear science, environmental science, radiological protection, radiation biology and radiochemistry.

Stansbury joined PNNL in 1990 and specializes in the assessment and reduction of radiation risks in the workplace and environment. ●

Quinn assumes ETD post

Rod K. Quinn has been named Associate Laboratory Director at Pacific Northwest National Laboratory.

In the position, Quinn will head PNNL's Environmental Technology Directorate, manage more than $140 million in environmentally focused projects and oversee approximately 750 staff members.

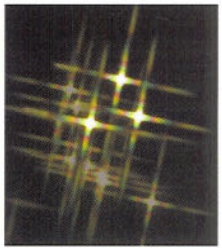
Prior to his most recent assignment as interim director of ETD, Quinn served as director for the Process Science and Engineering Division.

Quinn looks forward to working with the ETD team to design a strategy for research and business development that builds on the directorate's reputation for excellence. "ETD is a diverse and robust organization that serves a wide range of clients. To be successful, we need to capitalize on our business relationships and aggressively pursue opportunities in a variety of market sectors," he said. ●


Rod Quinn

PNNL innovations capture R&D 100 Awards

Three Pacific Northwest National Laboratory inventions have made the 2003 list of the world's 100 most important scientific and technical innovations, according to an annual competition by R&D Magazine.



PNNL was recognized for

- the Product Acoustic Signature System (PASS), a handheld tool that enlists ultrasound pulses to assay the contents of sealed containers without having to open them
- Starlight, an information visualization system that graphically depicts connections among disparate pieces of information from large, complex and dynamic collections
- FT-MS Proteome Express, an instrument that may trim years off the time required to analyze a proteome, or the entire protein set of an organism. ●

Printed on recycled paper. Printed in USA
RL-P98-007 September 2003

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy
P.O. Box 999, MSIN KI-30
Richland, Washington 99352

Address service requested